ELECTROMAGNETIC EMISSION COMPLIANCE REPORT FOR LOW-POWER, NON-LICENSED TRANSMITTER

Test Report No. : **OT-21O-RWD-031**

Reception No. : **2109004237**

Applicant : **NATURELINK INC.**

Address : **1206, D-dong, 30, Songdomirae-ro, Yeonsu-gu, Incheon, 21990, South Korea**

Manufacturer : **NATURELINK INC.**

Address : **1206, D-dong, 30, Songdomirae-ro, Yeonsu-gu, Incheon, 21990, South Korea**

Type of Equipment : **RF Module(BLE Module)**

FCC ID. : **2AQWI-PBLN51822**

Model Name : **PBLN51822**

Serial number : **N/A**

Total page of Report : **53 pages (including this page)**

Date of Incoming : **September 27, 2021**

Date of issue : **October 22, 2021**

SUMMARY

The equipment complies with the regulation; ***FCC PART 15 SUBPART C Section 15.247***

This test report only contains the result of a single test of the sample supplied for the examination.

It is not a generally valid assessment of the features of the respective products of the mass-production.

Tested by	Reviewed by	Approved by
Si-eon Lee / Assistant Manager	Tae-Ho, Kim / Senior Manager	Ki-Hong, Nam / General Manager
ONETECH Corp.	ONETECH Corp.	ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-21O-RWD-031	October 22, 2021	Initial Release	All

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1. VERIFICATION OF COMPLIANCE

Applicant : NATURELINK INC.

Address : 1206, D-dong, 30, Songdomirae-ro, Yeonsu-gu, Incheon, 21990, South Korea

Contact Person : Do hyun, Lee / Senior director

Telephone No. : +82-2-853-2240

FCC ID : 2AQWI-PBLN51822

Model Name : PBLN51822

Brand Name : -

Serial Number : N/A

Date : October 22, 2021

EQUIPMENT CLASS	DTS – DIGITAL TRNSMISSION SYSTEM
E.U.T. DESCRIPTION	RF Module(BLE Module)
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2020
TYPE OF EQUIPMENT TESTED	Pre-Production
KIND OF EQUIPMENT AUTHORIZATION REQUESTED	Certification
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC PART 15 SUBPART C Section 15.247 KDB 558074 D01 15.247 Meas Guidance v05r02
Modifications on the Equipment to Achieve Compliance	None
Final Test was Conducted On	3 m, Semi Anechoic Chamber

-. The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.

2. TEST SUMMARY

2.1 Test items and results

SECTION	TEST ITEMS	RESULTS
15.247 (a) (2)	Minimum 6 dB Bandwidth	Met the Limit / PASS
15.247 (b) (3)	Maximum Peak Conducted Output Power	Met the Limit / PASS
15.247 (d)	100 kHz Bandwidth Outside the Frequency Band	Met the Limit / PASS
15.247 (d)	Radiated Emission which fall in the Restricted Band	Met the Limit / PASS
15.247 (e)	Peak Power Spectral Density	Met the Limit / PASS
15.209	Radiated Emission Limits	Met the Limit / PASS
15.207	Conducted Limits	Met the Limit / PASS
15.203	Antenna Requirement	Met requirement / PASS

2.2 Additions, deviations, exclusions from standards

No additions, deviations or exclusions have been made from standard.

2.3 Related Submittal(s) / Grant(s)

Original submittal only

2.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in FCC PART 15 SUBPART C Section 15.247.

2.5 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10: 2020. Radiated testing was performed at a distance of 3 m from EUT to the antenna.

2.6 Test Facility

The Onetech Corp. has been designated to perform equipment testing in compliance with ISO/IEC 17025.

The Electromagnetic compatibility measurement facilities are located at 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea.

-. Site Filing:

VCCI (Voluntary Control Council for Interference) – Registration No. R-20122/ C-14617/ G-10666/ T-11842

ISED (Innovation, Science and Economic Development Canada) – Registration No. Site# 3736A-3

KOLAS (Korea Laboratory Accreditation Scheme) - Accreditation NO. KT085

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

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3. GENERAL INFORMATION

3.1 Product Description

The NATURELINK INC., Model PBLN51822 (referred to as the EUT in this report) is a RF Module(BLE Module). The product specification described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	RF Module(BLE Module)
OPERATING FREQUENCY	2 402 MHz ~ 2 480 MHz
MODULATION TYPE	GFSK
RF OUTPUT POWER	0.51 dBm
NUMBER OF CHANNEL	40 Channel
ANTENNA TYPE	PCB Antenna
ANTENNA GAIN	0.50 dBi
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)	16 MHz

3.2 Alternative type(s)/model(s); also covered by this test report.

-. None

4. EUT MODIFICATIONS

-. None

5. SYSTEM TEST CONFIGURATION

5.1 Justification

This device was configured for testing in a typical way as a normal customer is supposed to be used. During the test, the following components were installed inside of the EUT.

DEVICE TYPE	MANUFACTURER	MODEL/PART NUMBER	FCC ID
Main Board	NATURELINK INC.	N/A	N/A

5.2 Peripheral equipment

Defined as equipment needed for correct operation of the EUT, but not considered as tested:

Model	Manufacturer	Description	Connected to
PBLN51822	NATURELINK INC.	RF Module(BLE Module) (EUT)	-
N/A	N/A	Jig Board	EUT
ProBook 450 G7	HP	Notebook PC	Jig Board
Lenovo ideapad 320	LENOVO	Notebook PC	Jig Board

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5.3 Mode of operation during the test

For the testing, software used to control the EUT for staying in continuous transmitting is programmed.

For final testing, the EUT was set at 2 402 MHz, 2 440 MHz, and 2 480 MHz to get a maximum emission levels from the EUT. The EUT was moved throughout the XY, XZ, and YZ planes and the worst case is “XY” axis, but the worst data was recorded in this report.

-. Channel List

Channel	Frequency[MHz]	Channel	Frequency[MHz]	Channel	Frequency[MHz]
0	2 402.00	14	2 430.00	28	2 458.00
1	2 404.00	15	2 432.00	29	2 460.00
2	2 406.00	16	2 434.00	30	2 462.00
3	2 408.00	17	2 436.00	31	2 464.00
4	2 410.00	18	2 438.00	32	2 466.00
5	2 412.00	19	2 440.00	33	2 468.00
6	2 414.00	20	2 442.00	34	2 470.00
7	2 416.00	21	2 444.00	35	2 472.00
8	2 418.00	22	2 446.00	36	2 474.00
9	2 420.00	23	2 448.00	37	2 476.00
10	2 422.00	24	2 450.00	38	2 478.00
11	2 424.00	25	2 452.00	39	2 480.00
12	2 426.00	26	2 454.00		
13	2 428.00	27	2 456.00		

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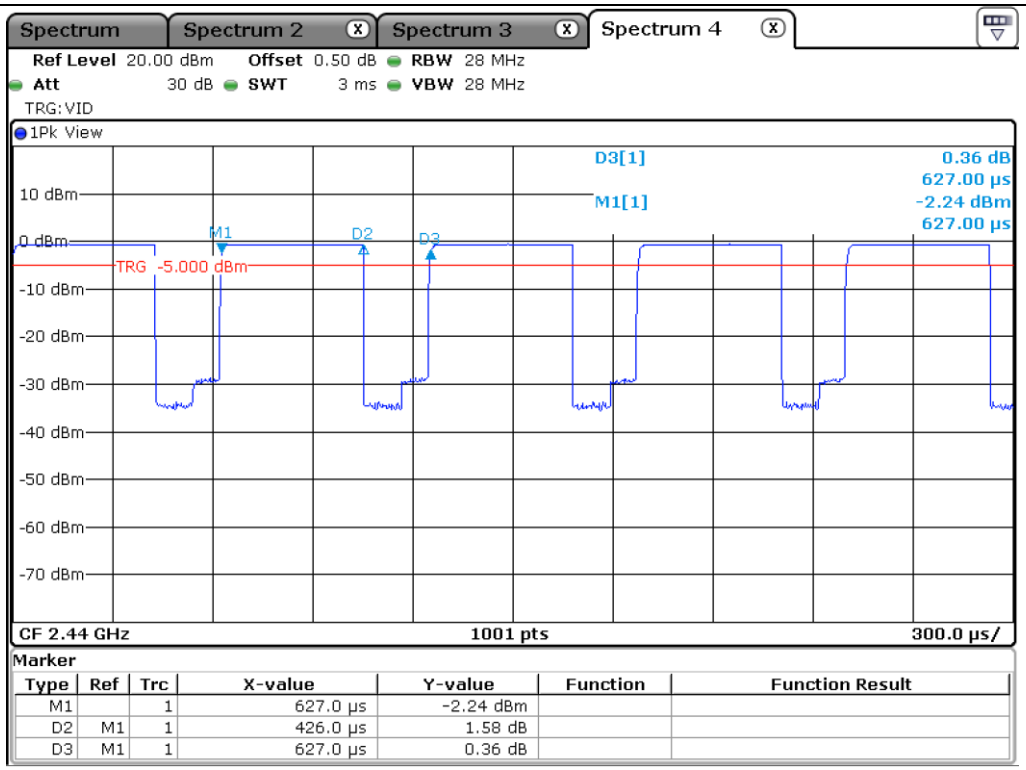
-. Duty Cycle

Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth LE	0.426	0.201	67.94	1.68
GFSK	0.426	0.201	67.94	1.68

Note – Duty Cycle : (Tx On Time / (Tx On Time + Tx Off Time)) * 100

Correction Factor : 10 * Log(1 / (Duty Cycle / 100))

-. Test Plot



Bluetooth LE

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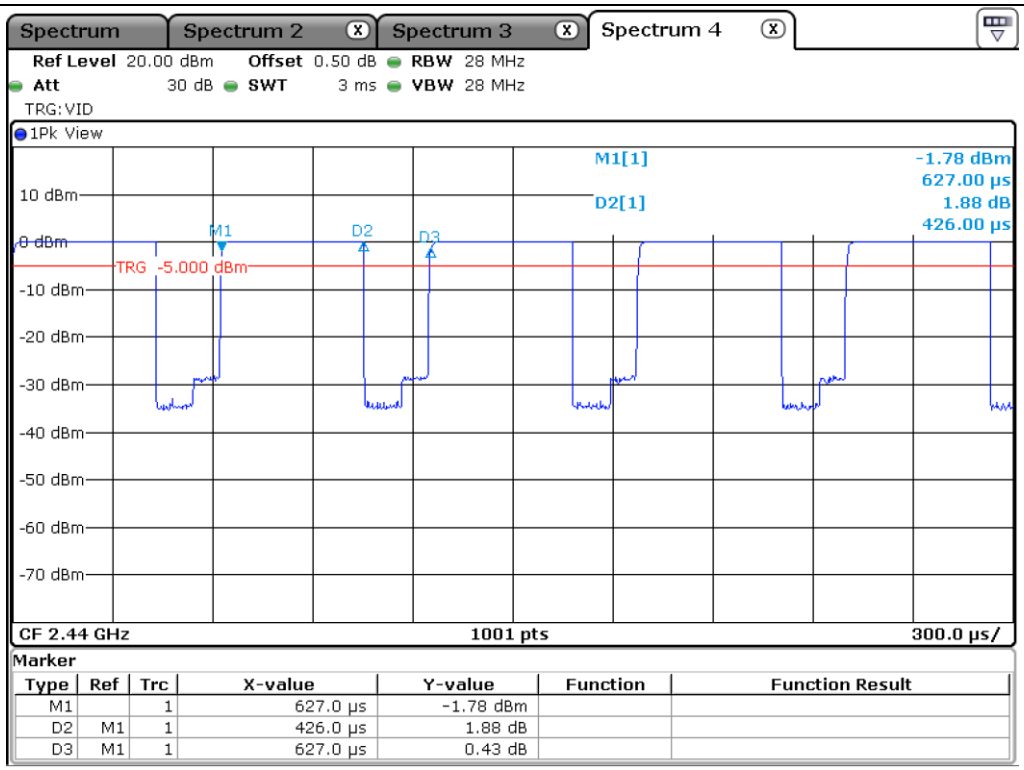

GFSK

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5.4 Configuration of Test System

Line Conducted Test: The EUT was connected to Jig Board and the power of USB was connected to Notebook PC. All supporting equipments were connected to another LISN. Preliminary Power line Conducted Emission test was performed by using the procedure in ANSI C63.10: 2020 to determine the worse operating conditions.

Radiated Emission Test: Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10: 2020 to determine the worse operating conditions. Final radiated emission tests were conducted at 3 meter Semi Anechoic Chamber.

The turntable was rotated through 360 degrees and the EUT was tested by positioned three orthogonal planes to obtain the highest reading on the field strength meter. Once maximum reading was determined, the search antenna was raised and lowered in both vertical and horizontal polarization.

5.5 Antenna Requirement

For intentional device, according to section 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.

Antenna Construction:

The antenna of the EUT is a PCB Antenna on the main Board in the EUT, so that it cannot be replaced by the user.

6. PRELIMINARY TEST

6.1 AC Power line Conducted Emissions Tests

During Preliminary Test, the following operating mode was investigated.

Operation Mode	The Worse operating condition (Please check one only)
Transmitting Mode	X

6.2 General Radiated Emissions Tests

During Preliminary Test, the following operating mode was investigated.

Operation Mode	The Worse operating condition (Please check one only)
Transmitting Mode	X

7. MINIMUM 6 dB BANDWIDTH

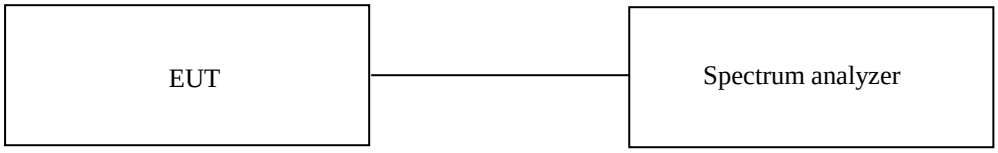
7.1 Operating environment

Temperature : 22 °C

Relative humidity : 46 % R.H.

7.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz, and peak detection was used. The 6 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 6 dB.



7.3 Test Date

September 27, 2021 ~ September 30, 2021

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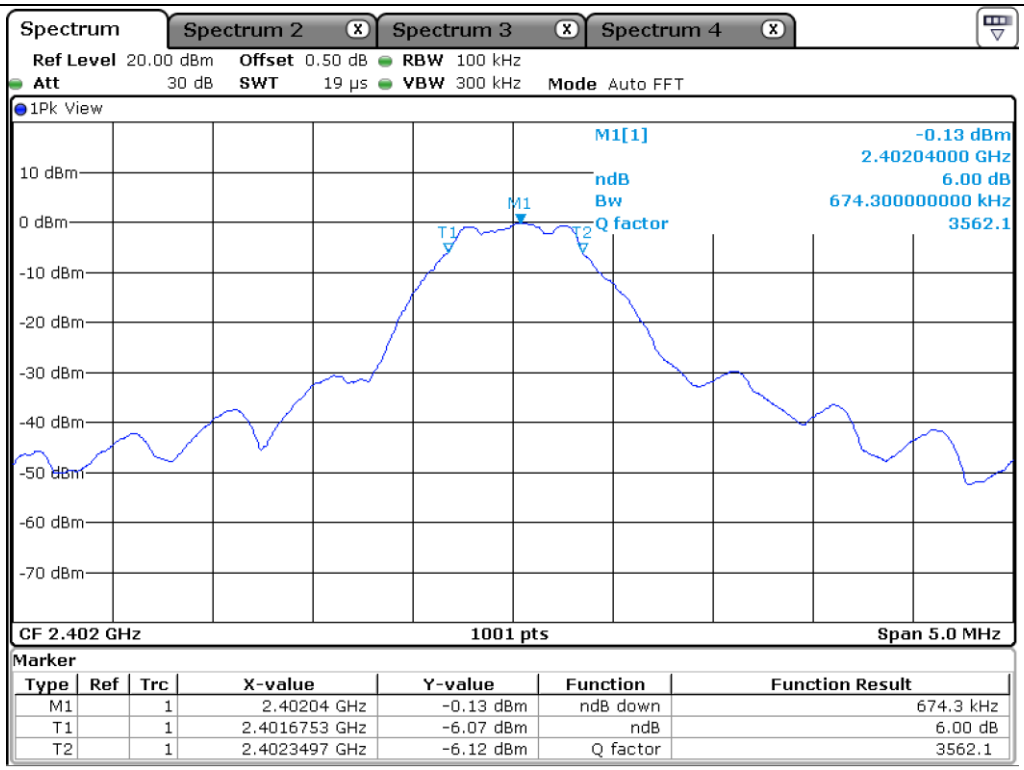
7.4 Test data for Bluetooth LE

CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (kHz)	LIMIT (kHz)	MARGIN (kHz)
Low	2 402.00	674.30	500.00	174.30
Middle	2 440.00	674.30	500.00	174.30
High	2 480.00	684.30	500.00	184.30

Remark. Margin = Measured Value - Limit



Low Channel

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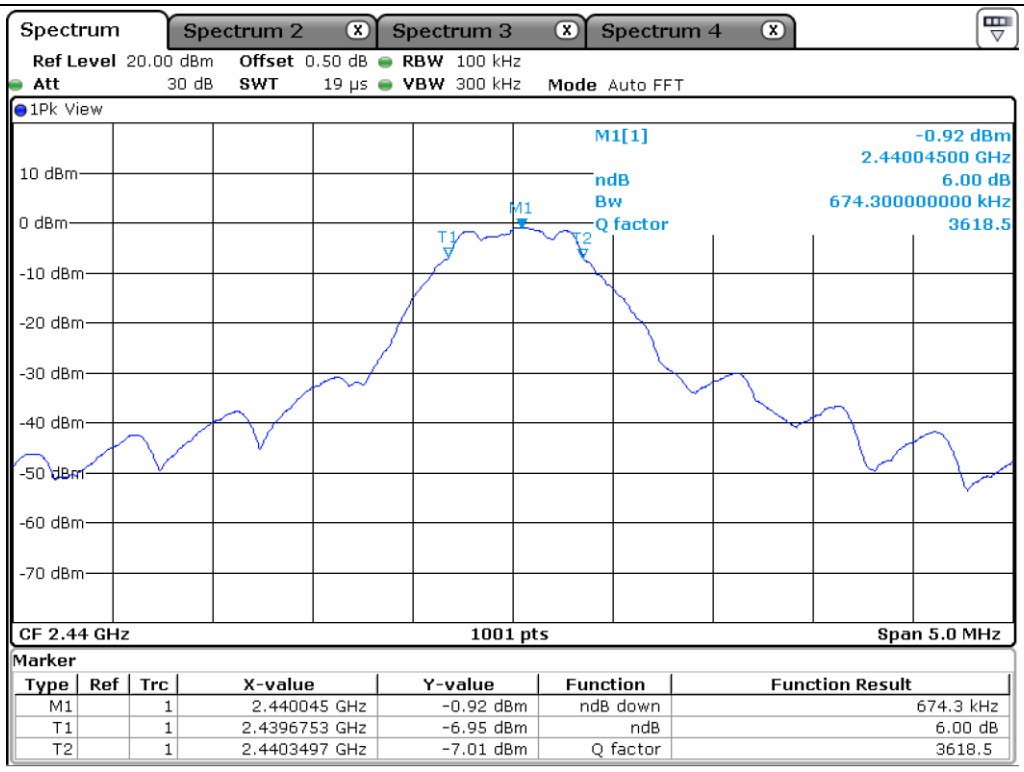
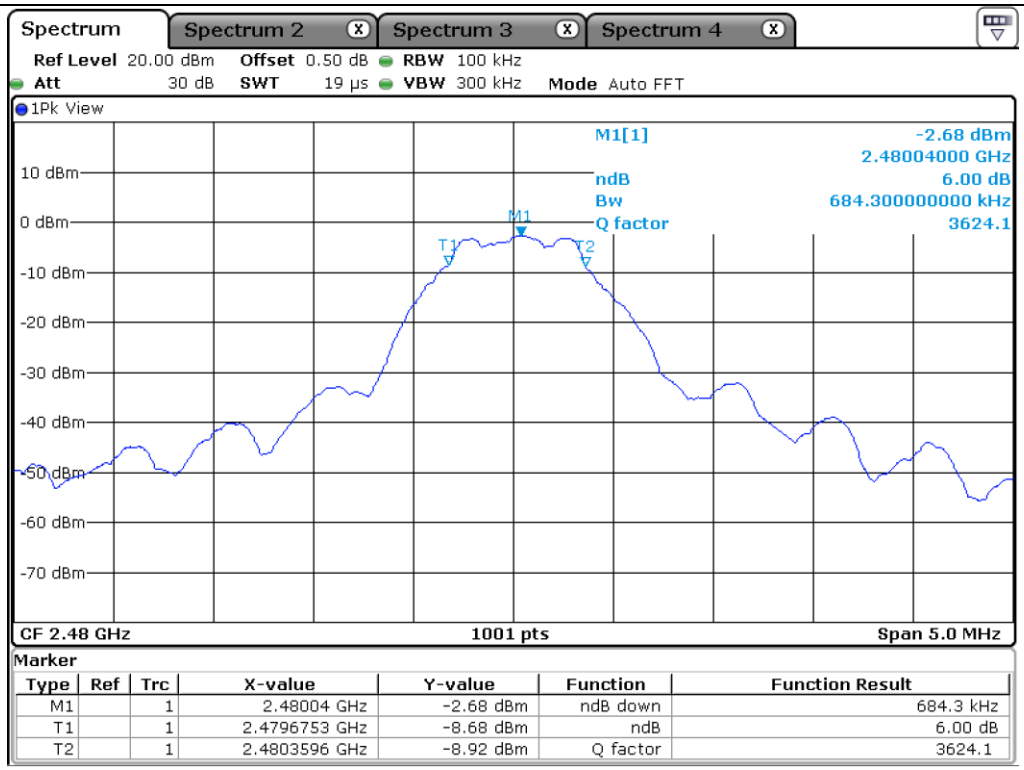


Middle Channel



High Channel

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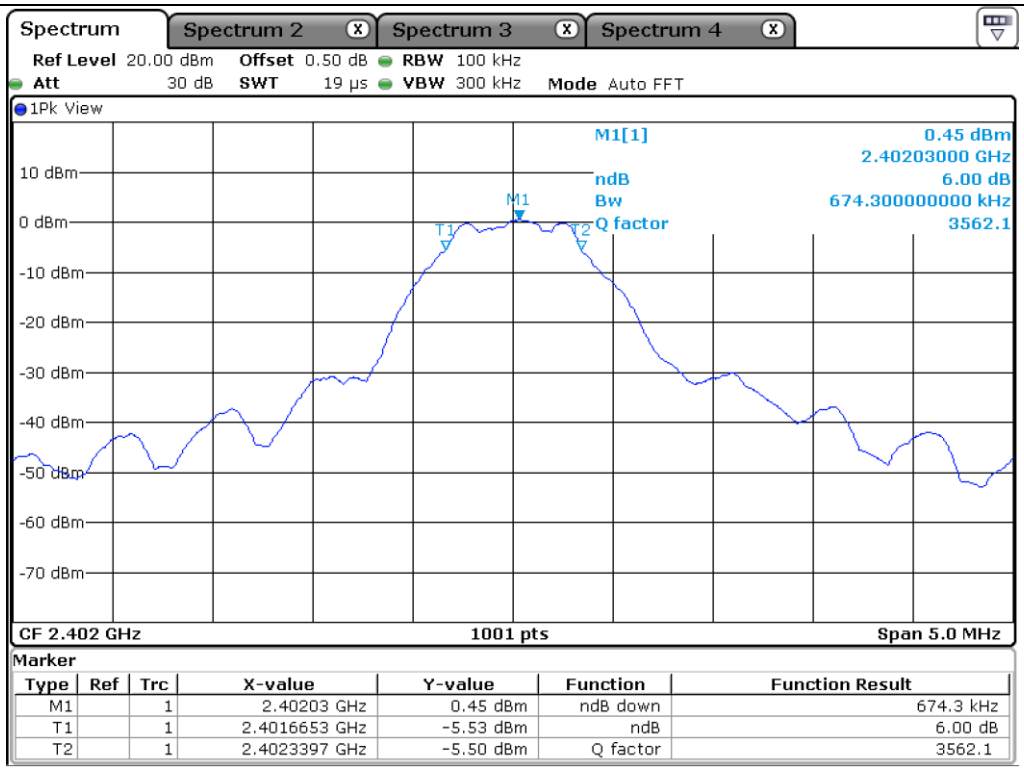
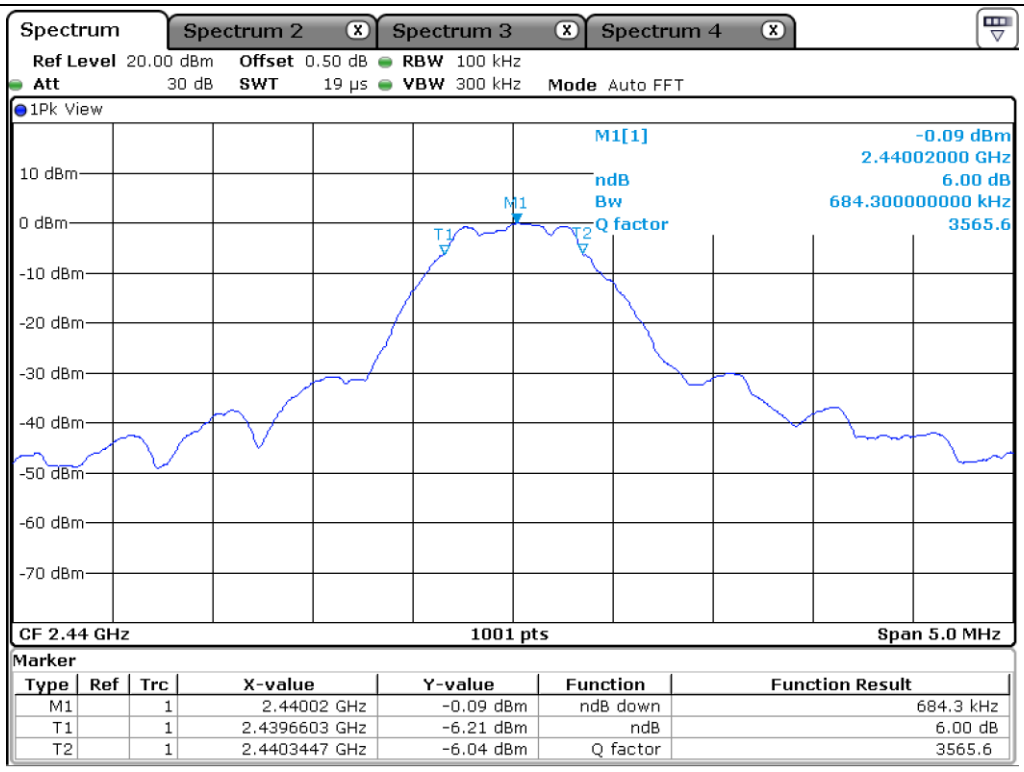
7.5 Test data for GFSK

CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (kHz)	LIMIT (kHz)	MARGIN (kHz)
Low	2 402.00	674.30	500.00	174.30
Middle	2 440.00	684.30	500.00	184.30
High	2 480.00	699.30	500.00	199.30

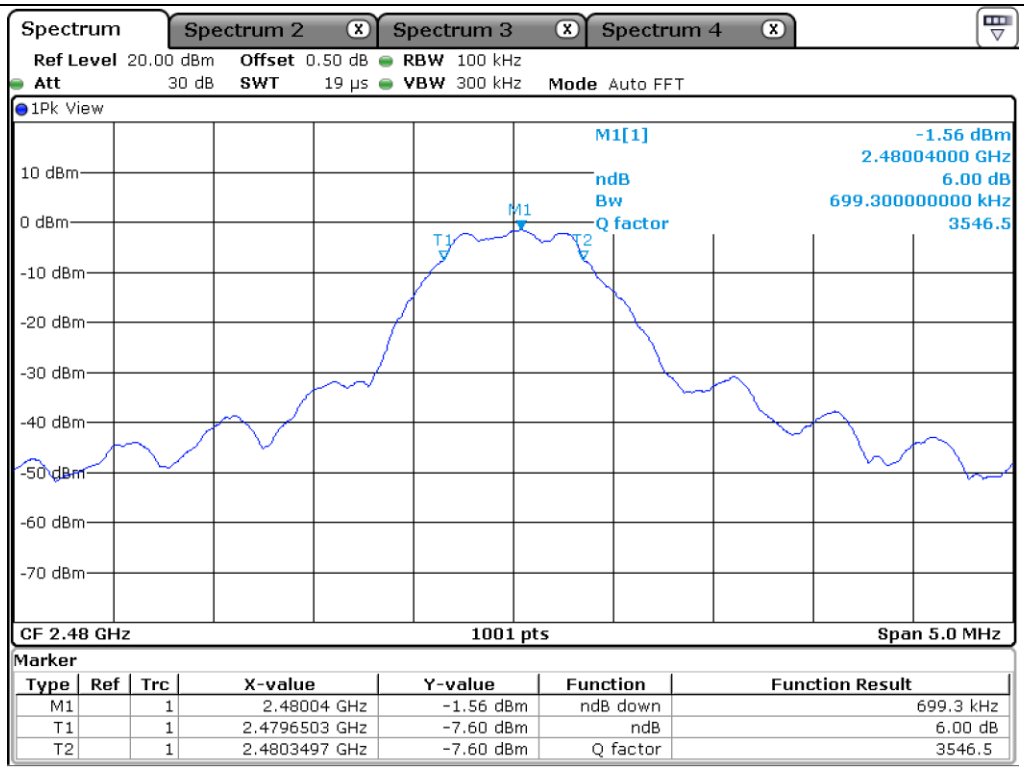
Remark. Margin = Measured Value - Limit



Low Channel



Middle Channel



High Channel

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8. MAXIMUM PEAK OUTPUT POWER

8.1 Operating environment

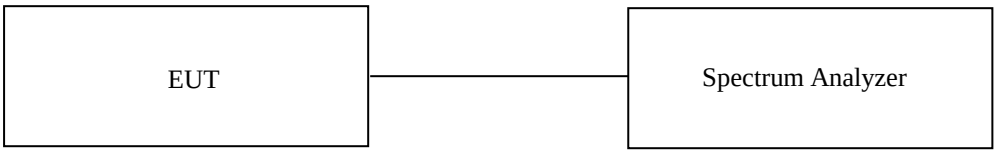
Temperature : 22 °C

Relative humidity : 46 % R.H.

8.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to ≥ DTS Bandwidth, the video bandwidth is set to 3 times the resolution bandwidth.



8.3 Test Date

September 27, 2021 ~ September 30, 2021

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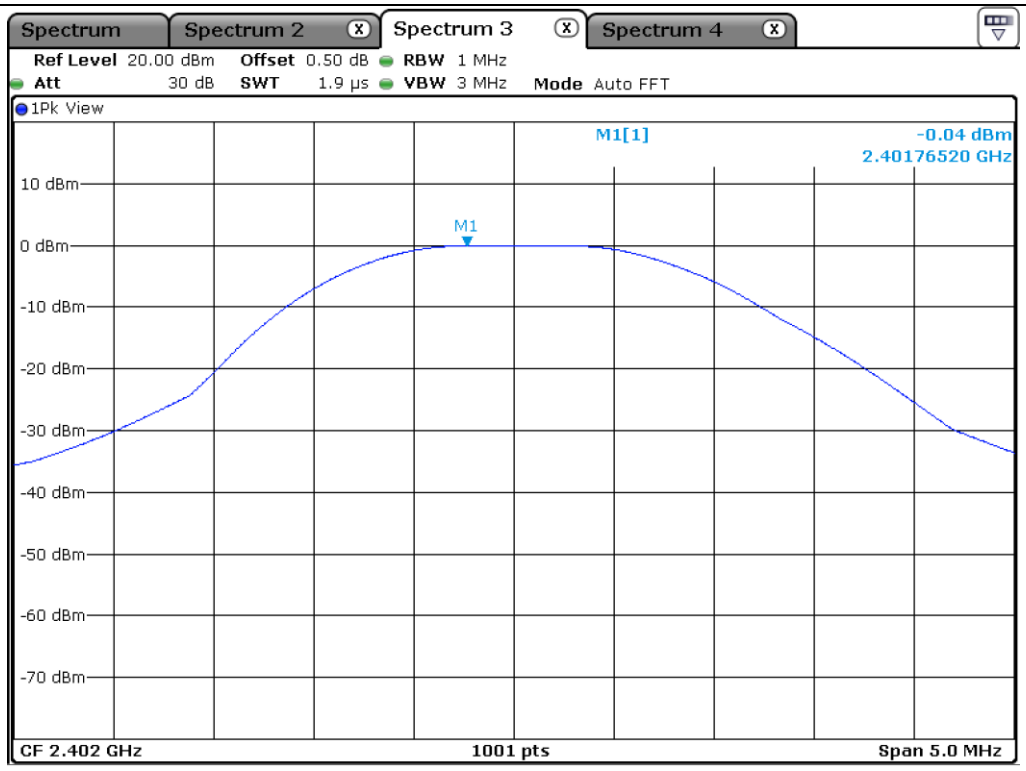
8.4 Test data for Bluetooth LE

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	-0.04	30.00	30.04
MIDDLE	2 440.00	-0.83	30.00	30.83
HIGH	2 480.00	-2.53	30.00	32.53

Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



Low Channel

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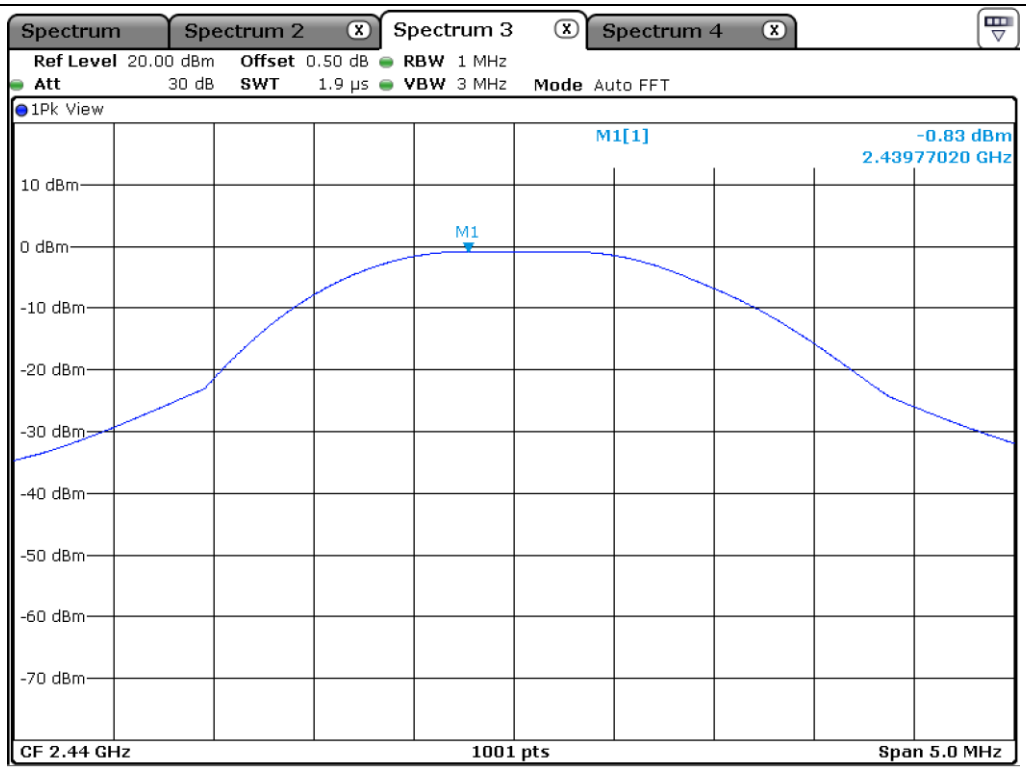
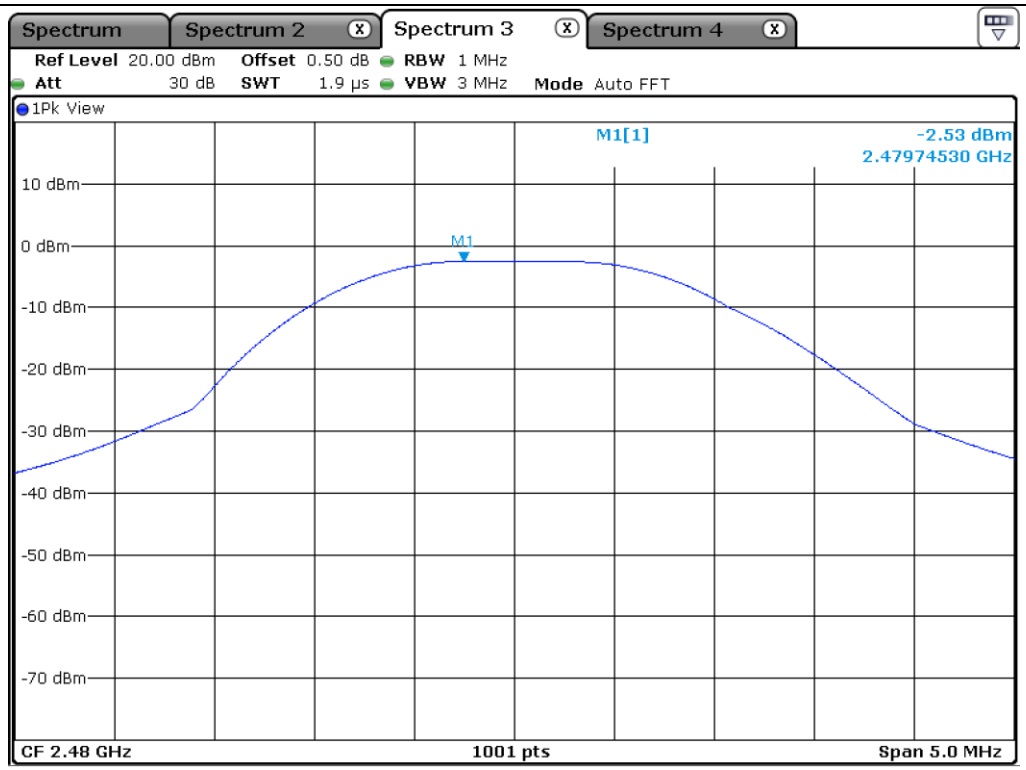


Middle Channel



High Channel

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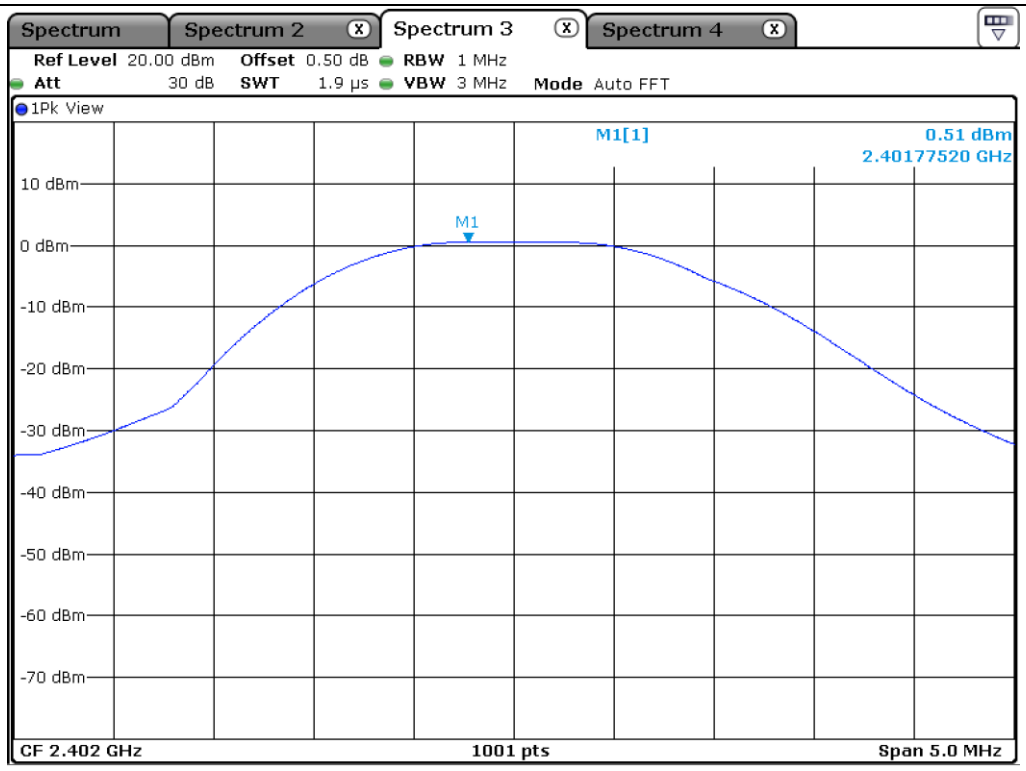
8.5 Test data for GFSK

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	0.51	30.00	29.49
MIDDLE	2 440.00	0.01	30.00	29.99
HIGH	2 480.00	-1.44	30.00	31.44

Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



Low Channel

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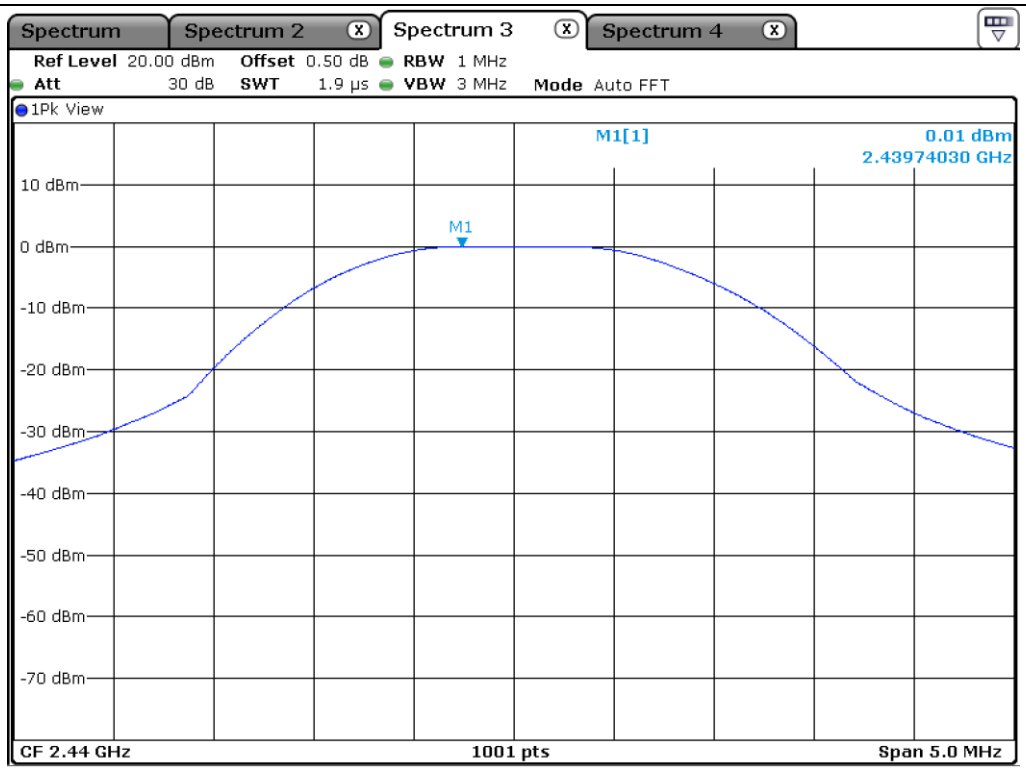
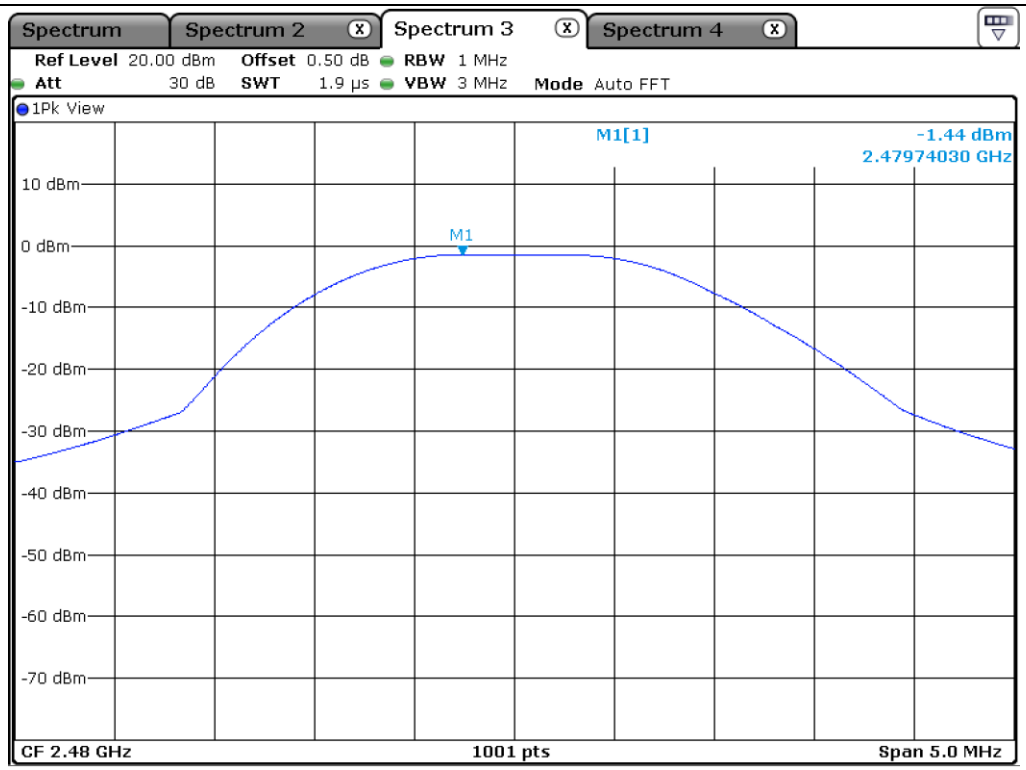


Middle Channel



High Channel

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9. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

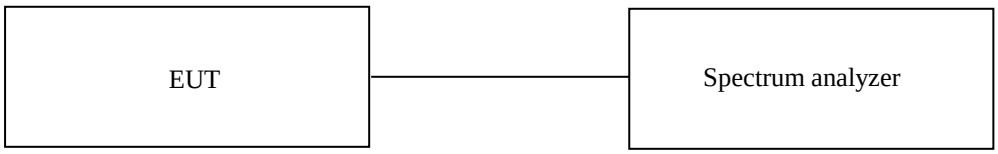
9.1 Operating environment

Temperature : 22 °C

Relative humidity : 46 % R.H.

9.2 Test set-up for conducted measurement

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz, the video bandwidth is set to 3 times the resolution bandwidth and peak detection was used.



9.3 Test set-up for radiated measurement

The radiated emissions measurements were performed on the 3 m semi anechoic chamber. The EUT was placed on turntable approximately 1.5 m above the ground plane.

The frequency spectrum from 30 MHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

9.4 Test Date

September 27, 2021 ~ September 30, 2021

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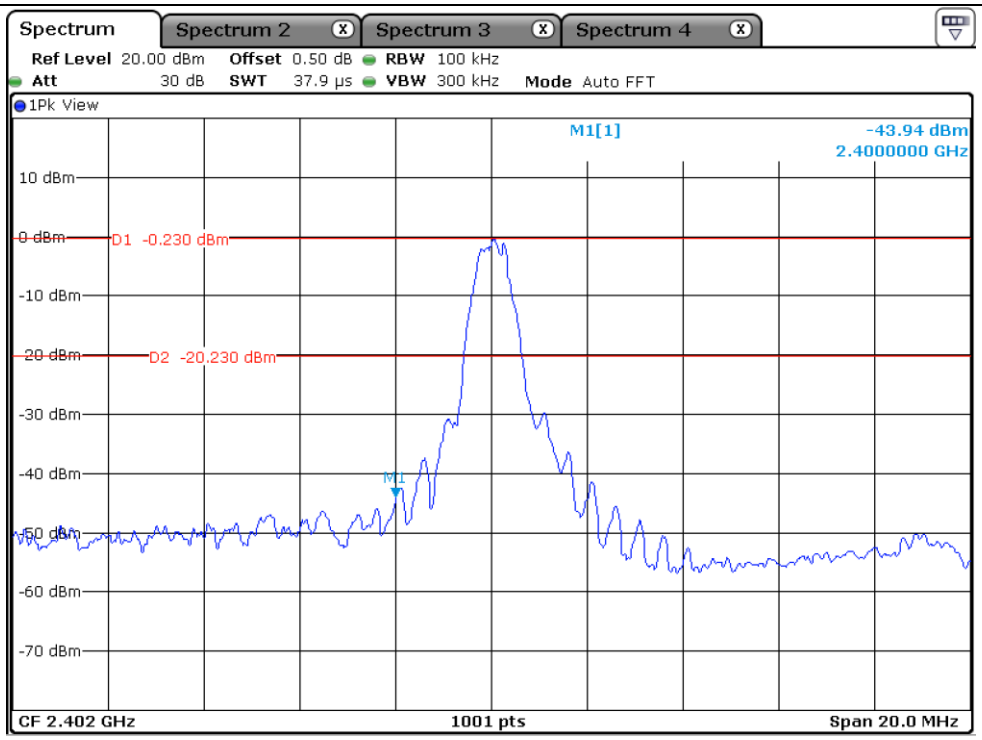
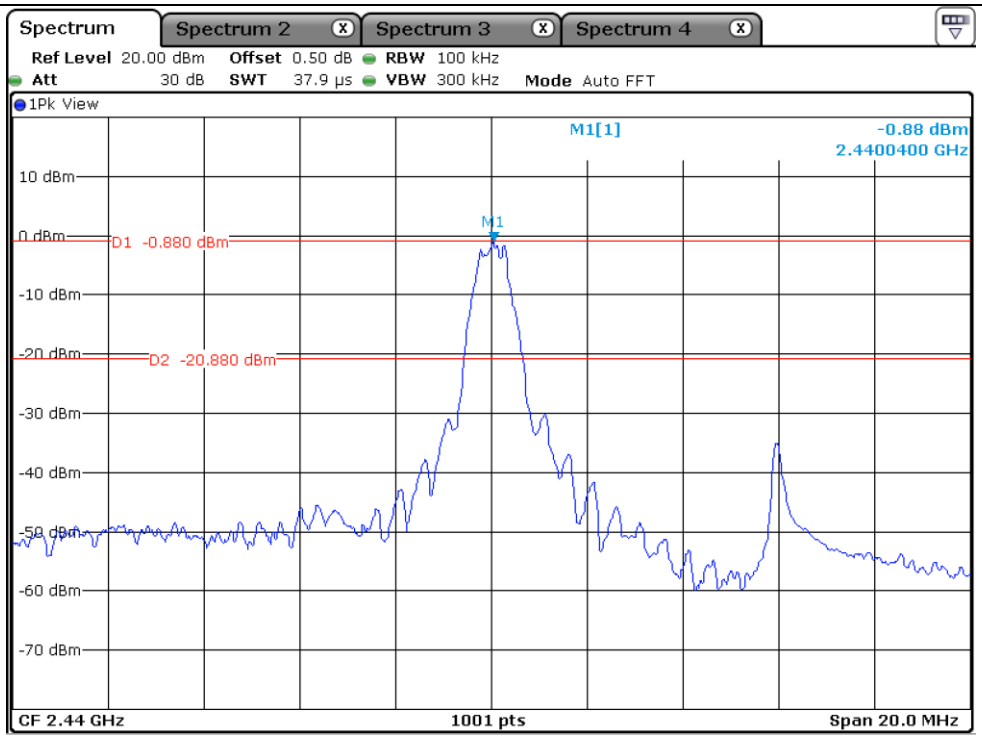
9.5 Test data for conducted emission

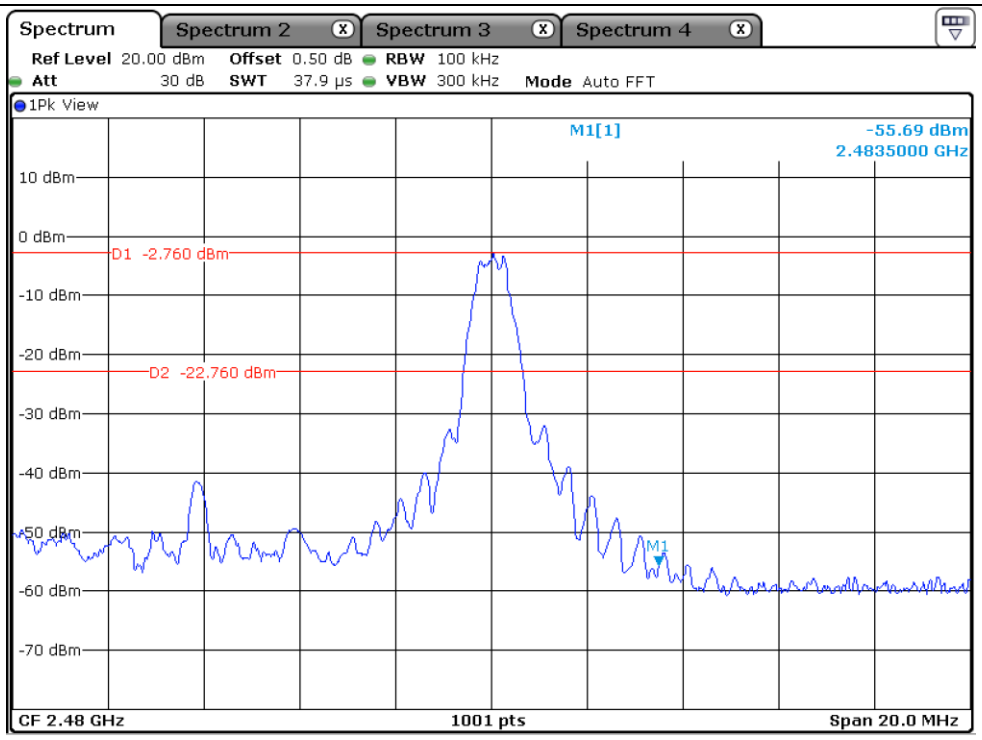
9.5.1 Test data for Bluetooth LE



Low Channel



Middle Channel



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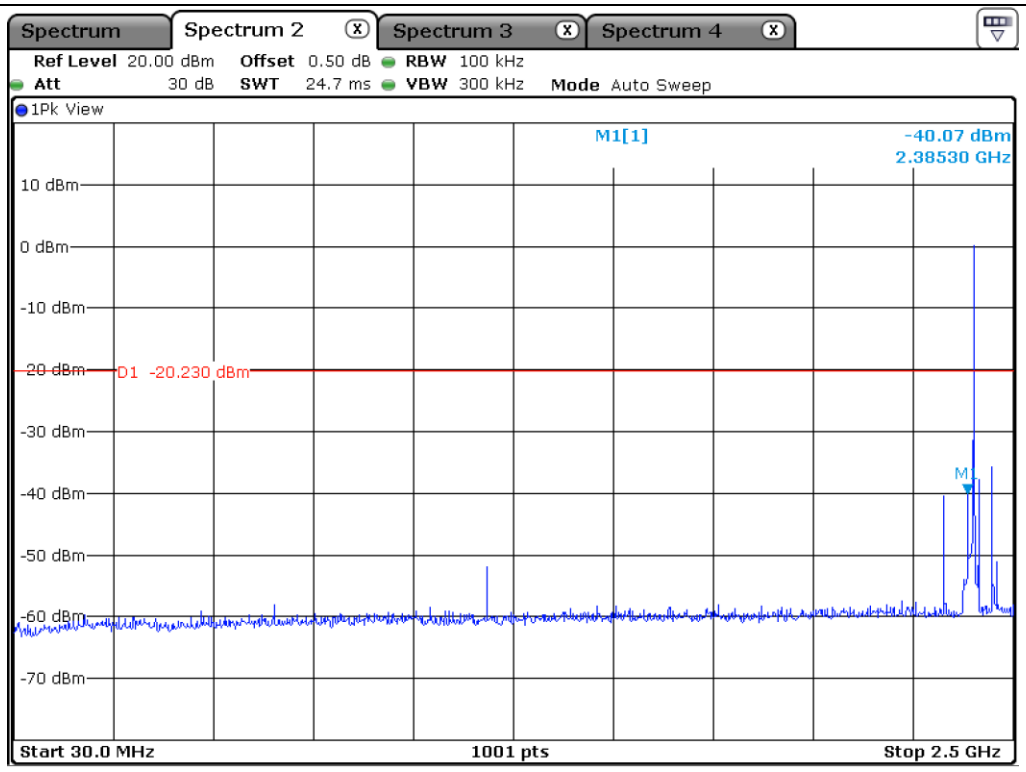
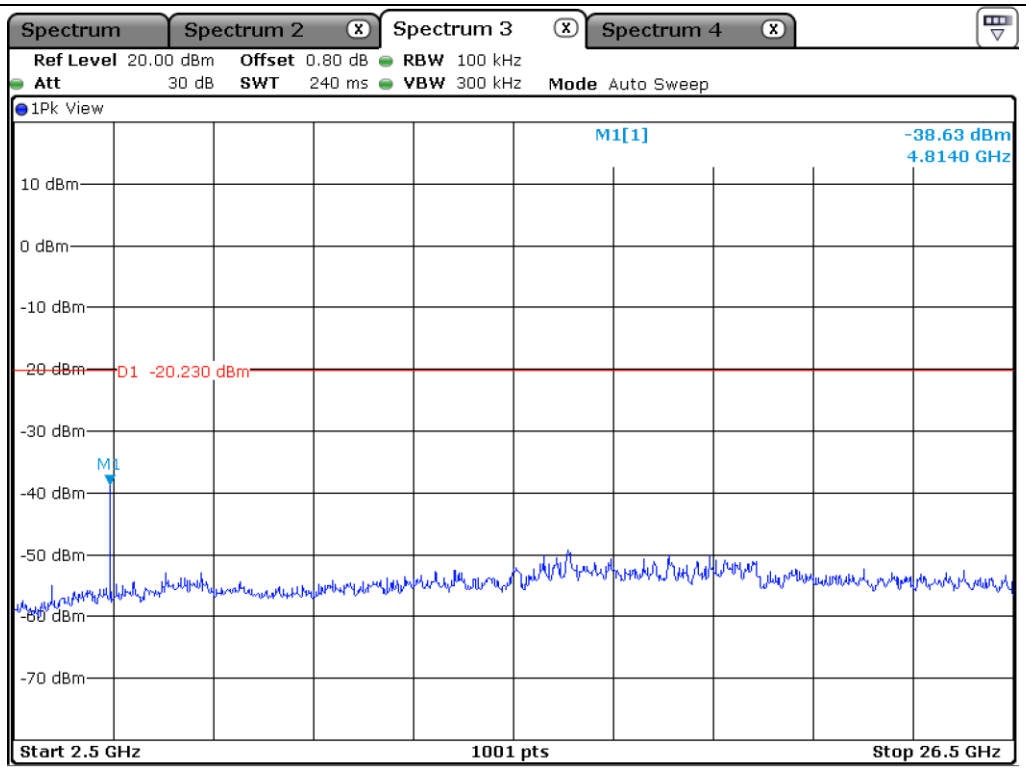


Low Channel



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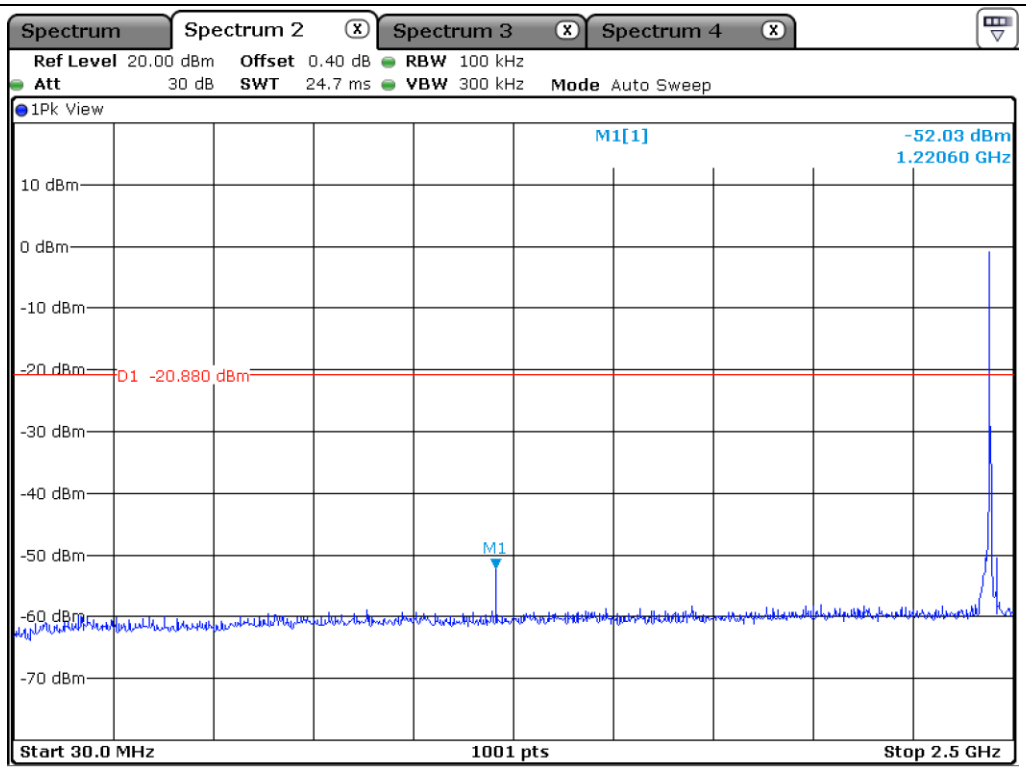
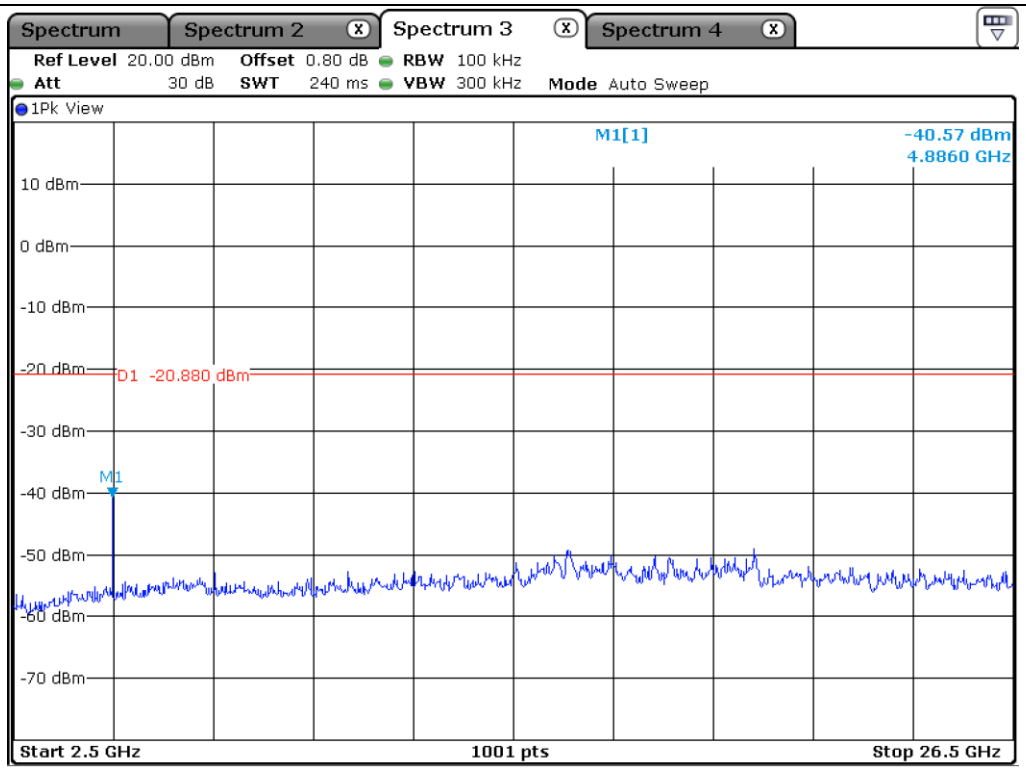
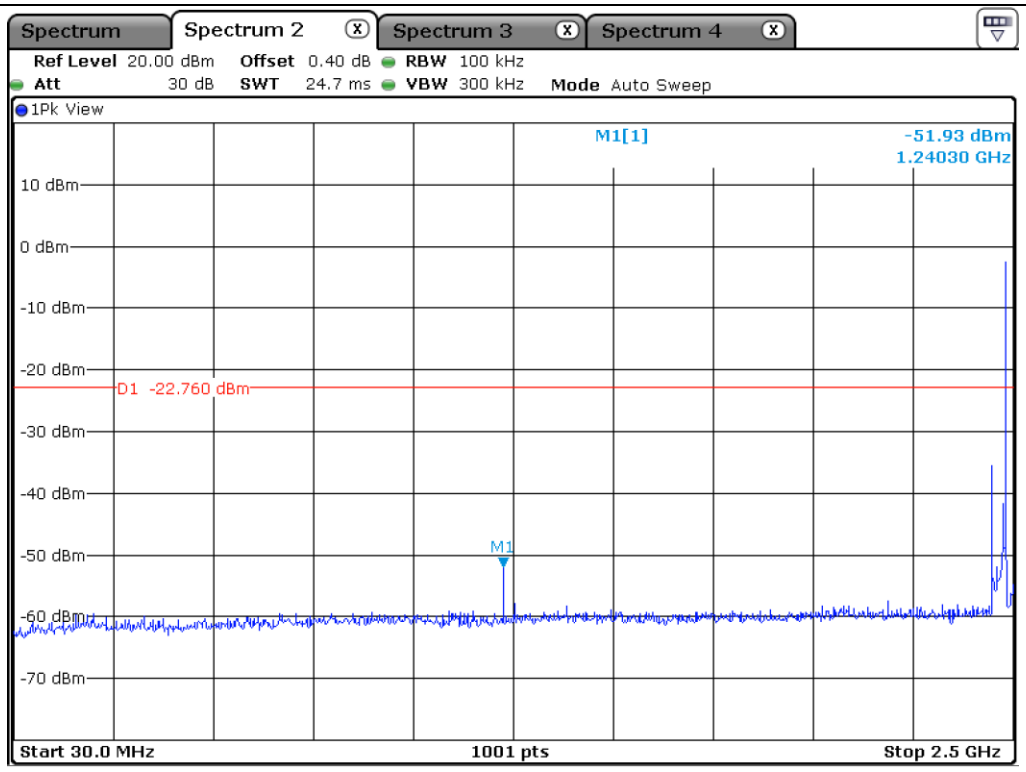


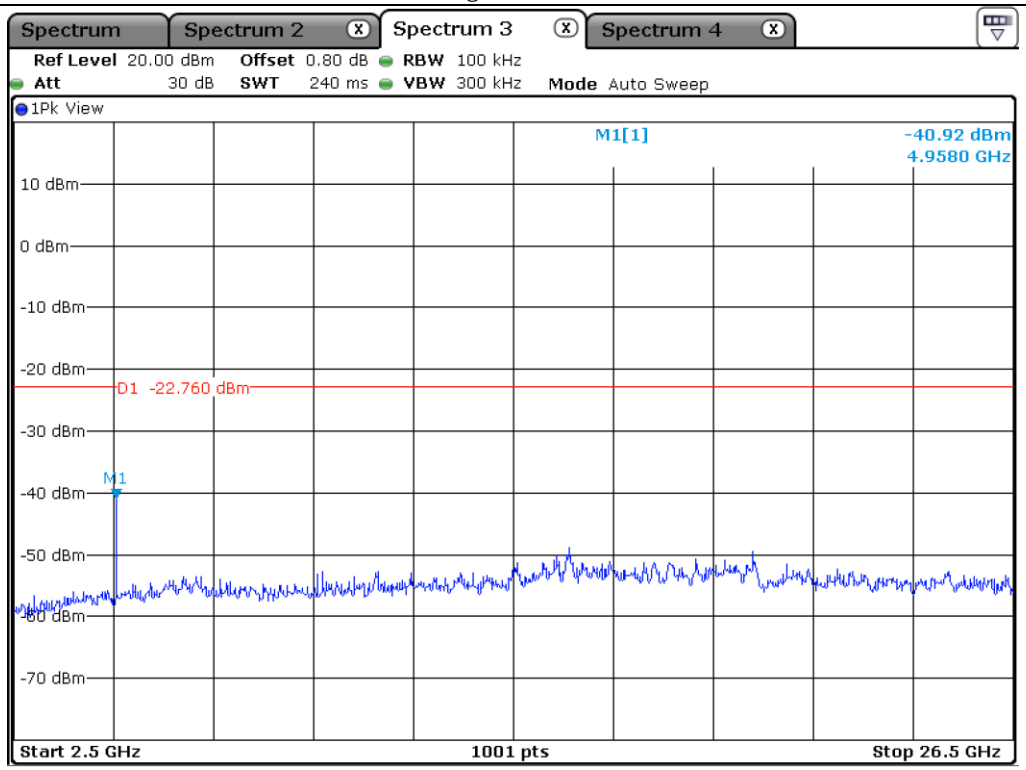
Middle Channel



Middle Channel



High Channel



High Channel

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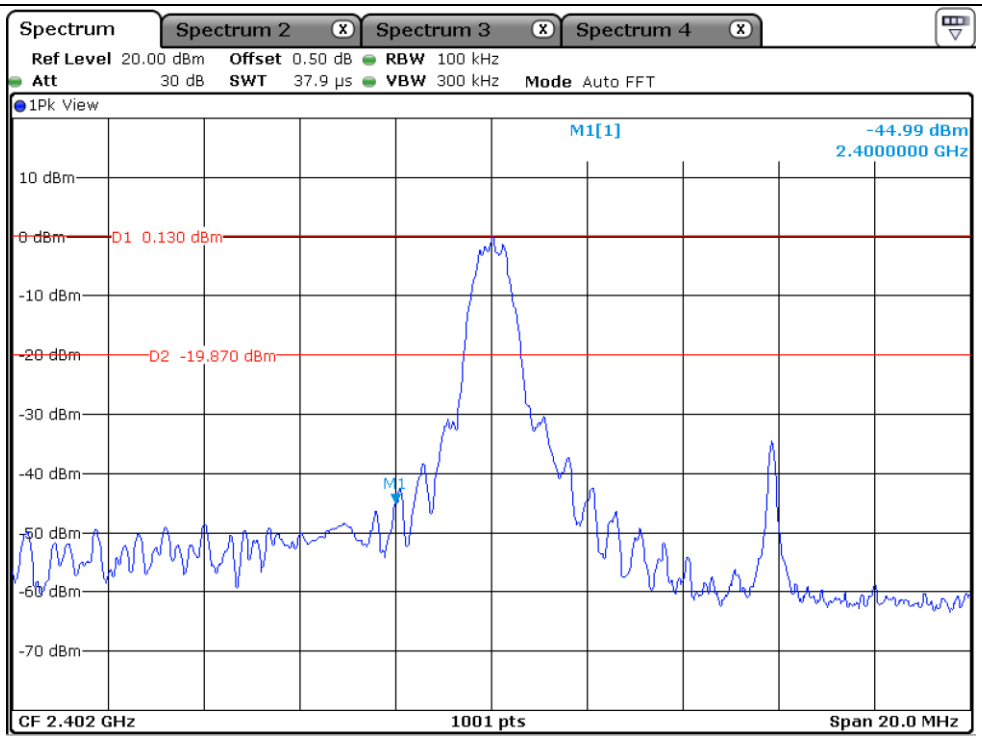
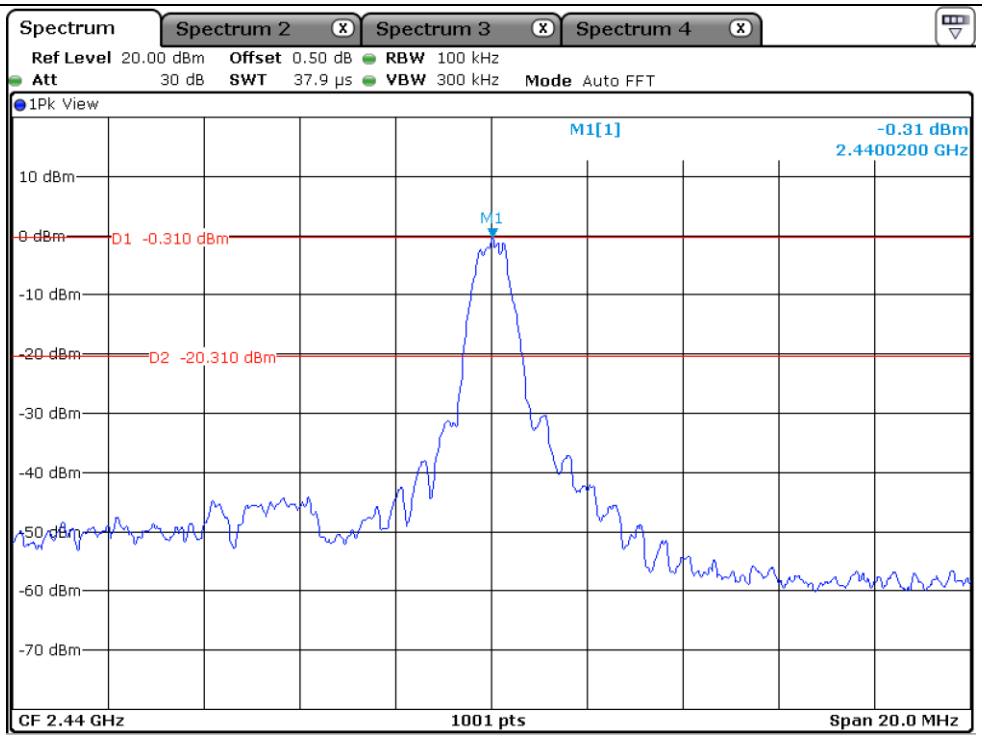
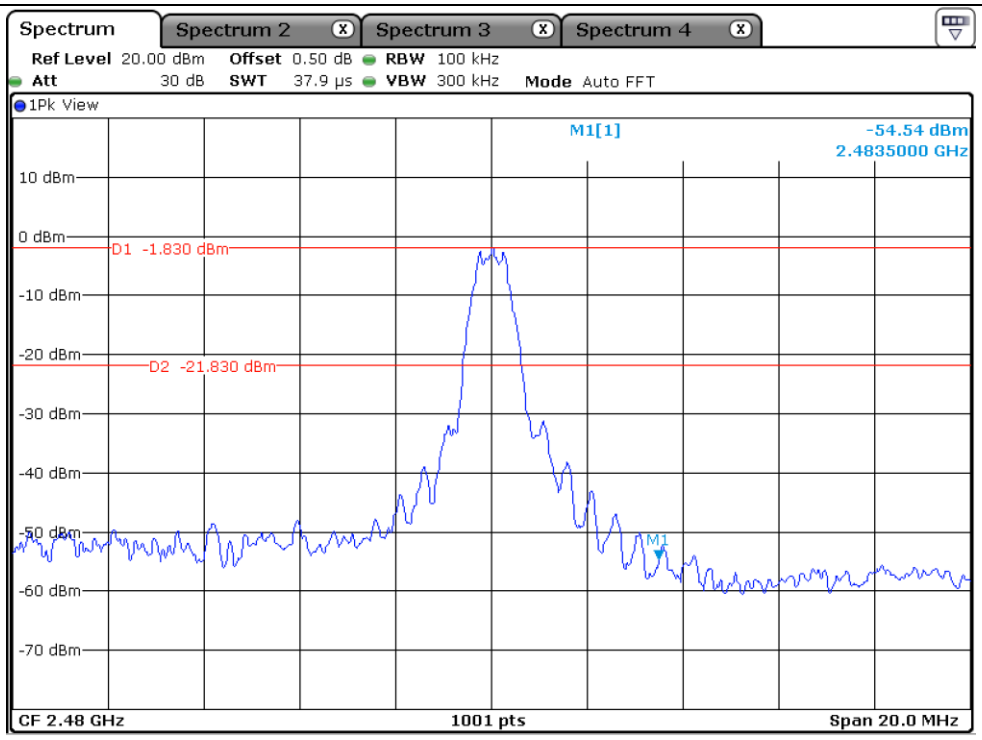
9.5.2 Test data for GFSK



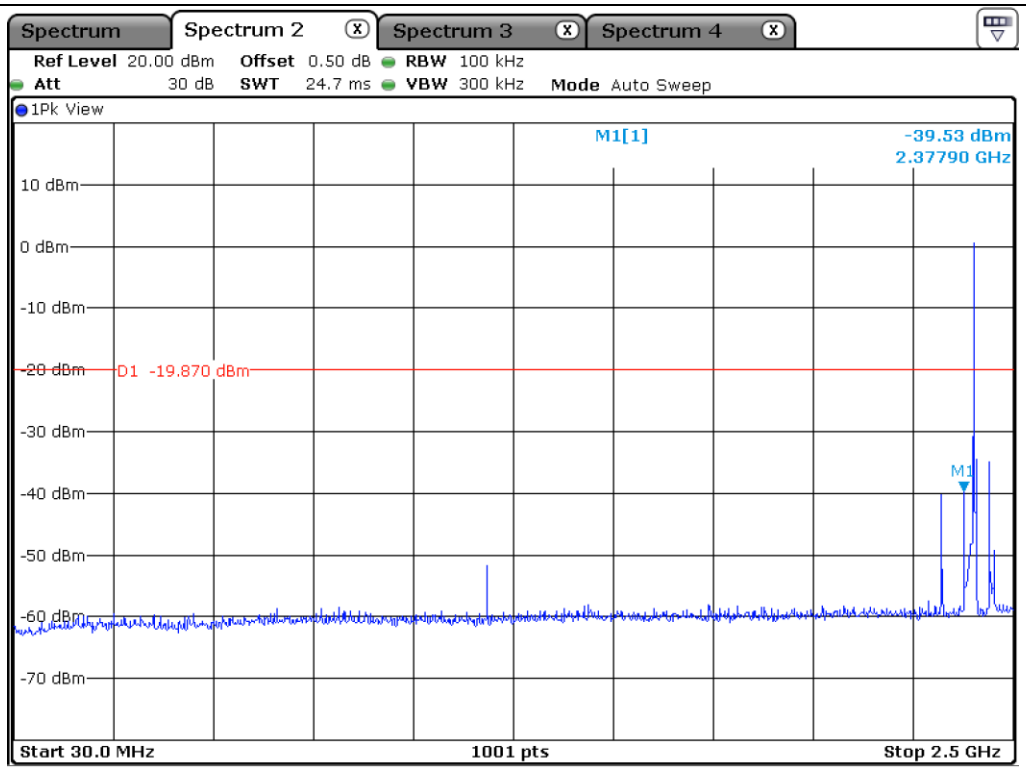
Low Channel



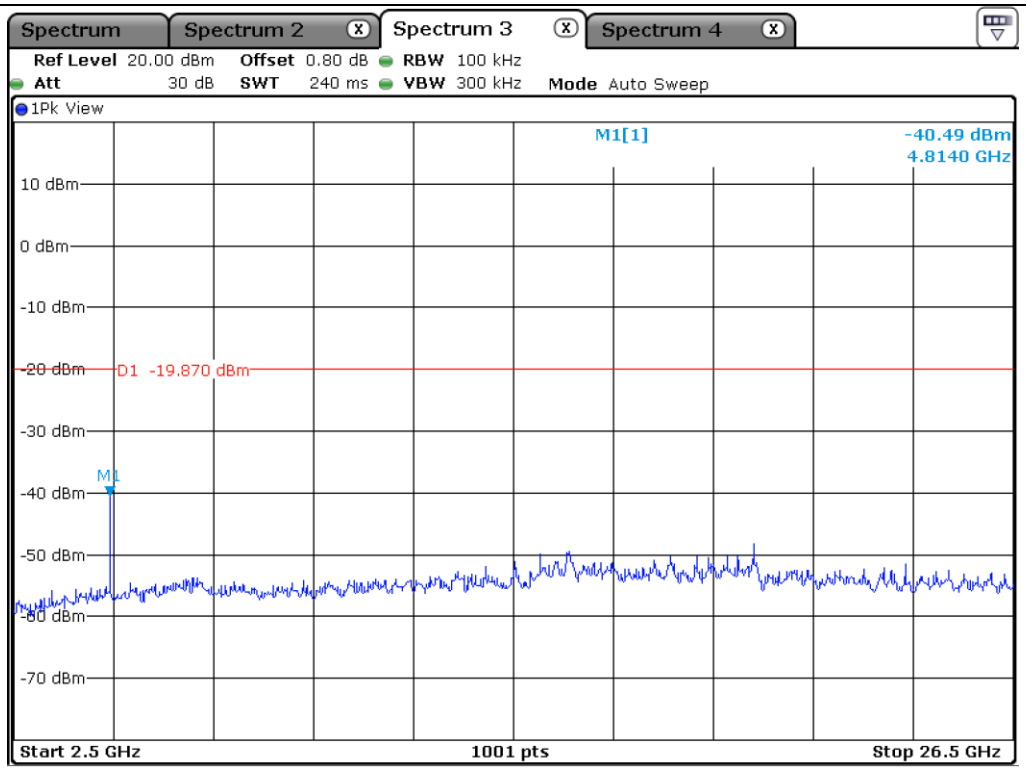
Middle Channel



High Channel



Low Channel



Low Channel

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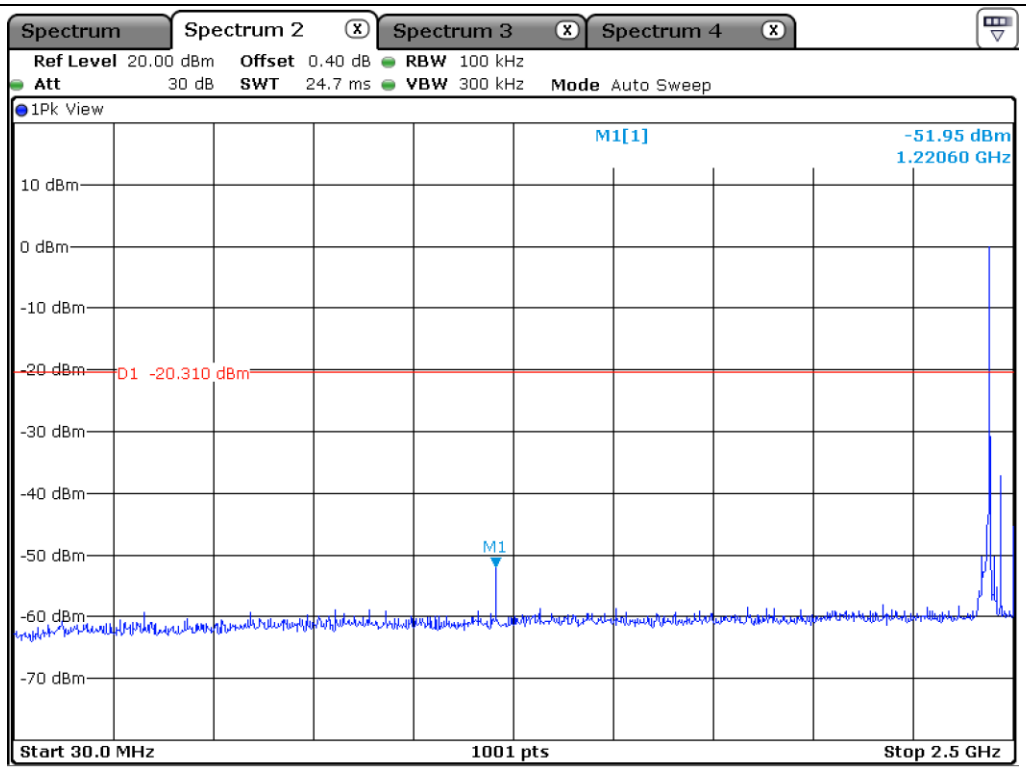
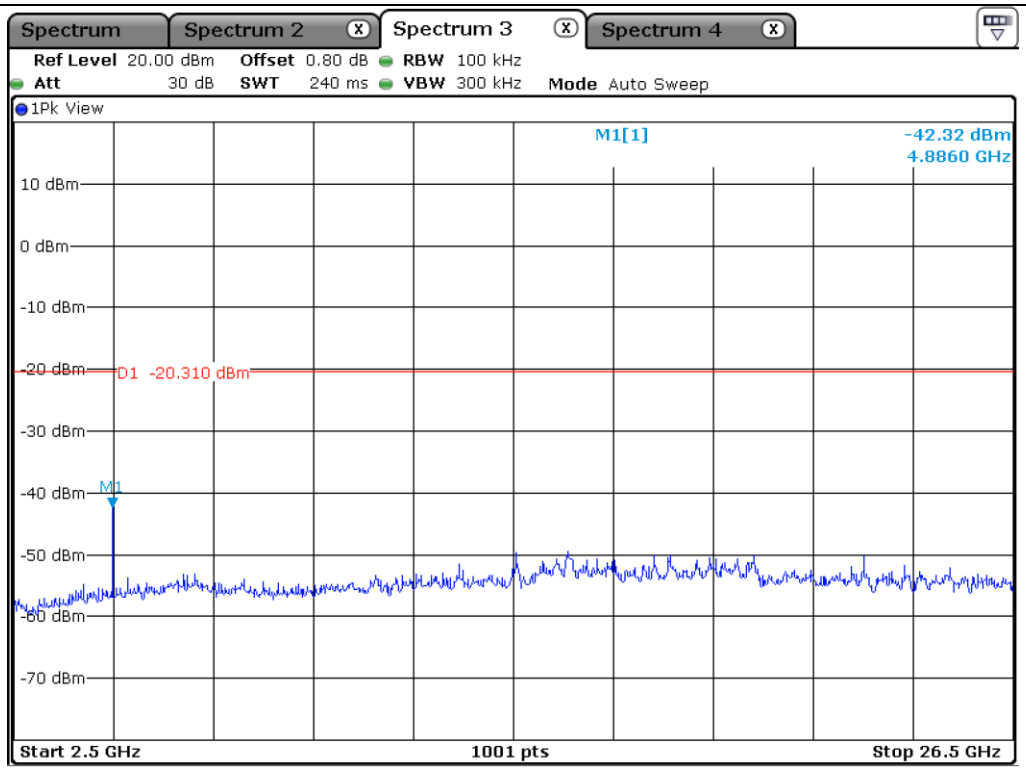


Middle Channel



Middle Channel

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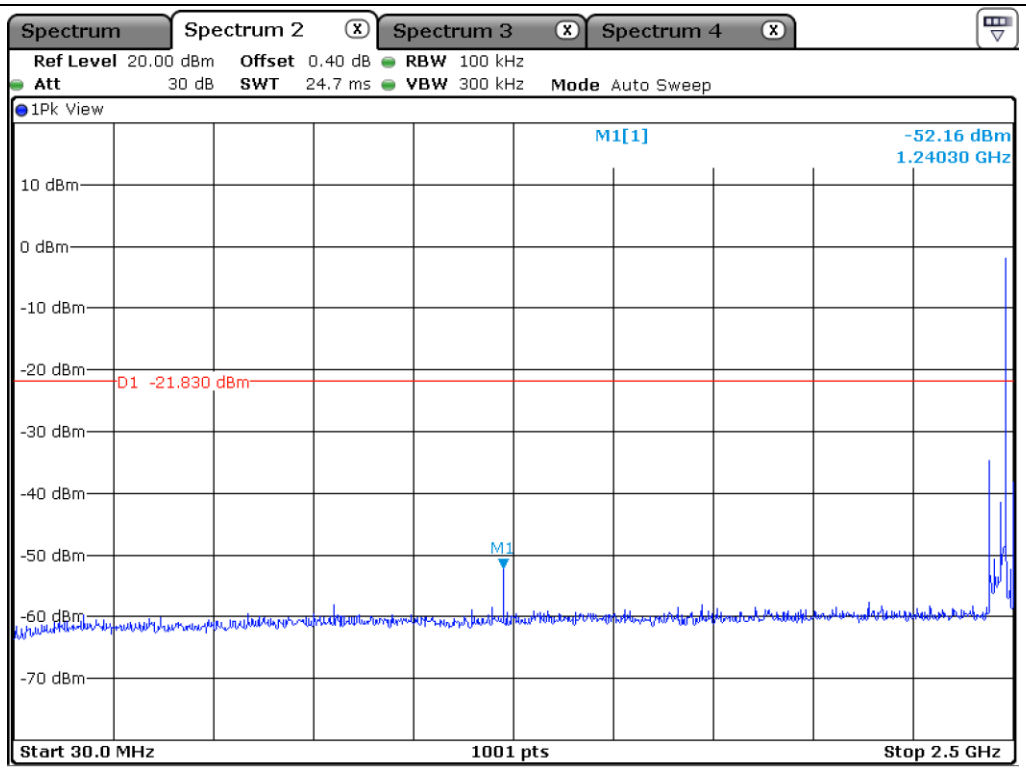
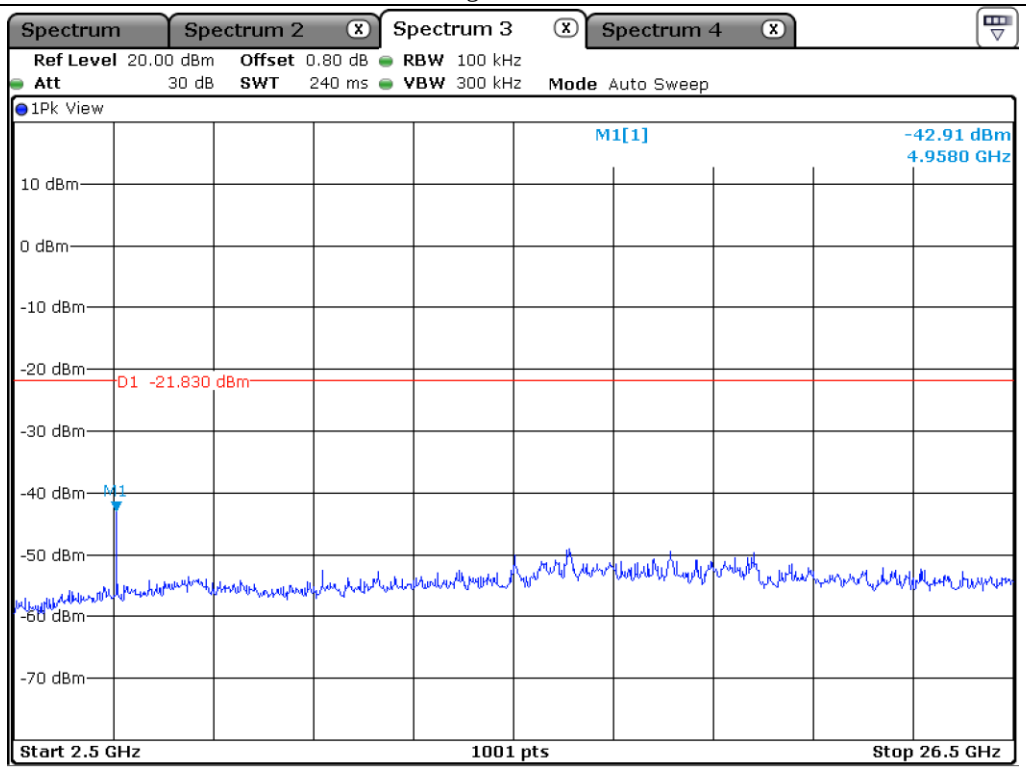


High Channel



High Channel

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9.6 Test data for radiated emission

9.6.1 Radiated Emission which fall in the Restricted Band

9.6.1.1 Test data for Bluetooth LE

-. Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode

-. Video bandwidth : 3 MHz for Peak and Average Mode

-. Measurement distance : 3 m

-. Duty Cycle : 67.94 %

-. Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
2 333.96	67.44	Peak	H	28.30	8.20	46.15	-	57.79	74.00	16.21
2 334.05	44.16	Average	H	28.30	8.20	46.15	1.68	36.19	54.00	17.81
2 333.98	66.20	Peak	V	28.30	8.20	46.15	-	56.55	74.00	17.45
2 334.05	45.18	Average	V	28.30	8.20	46.15	1.68	37.21	54.00	16.79
Test Data for High Channel										
2 483.50	58.79	Peak	H	28.70	8.33	46.06	-	49.76	74.00	24.24
2 483.50	42.68	Average	H	28.70	8.33	46.06	1.68	35.33	54.00	18.67
2 483.50	55.72	Peak	V	28.70	8.33	46.06	-	46.69	74.00	27.31
2 483.50	42.35	Average	V	28.70	8.33	46.06	1.68	35.00	54.00	19.00

Tabulated test data for Restricted Band

Remark: “H”: Horizontal, “V”: Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss – AMP Gain + Duty Factor

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9.6.1.2 Test data for GFSK

-. Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode

-. Video bandwidth : 3 MHz for Peak and Average Mode

-. Measurement distance : 3 m

-. Duty Cycle : 67.94 %

-. Result : PASSED

Frequency (MHz)	Reading (dBµV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Gain	Duty Factor (dB)	Total (dBµV/m)	Limits (dBµV/m)	Margin (dB)
Test Data for Low Channel										
2 336.29	69.79	Peak	H	28.30	8.20	46.15	-	60.14	74.00	13.86
2 336.11	48.38	Average	H	28.30	8.20	46.15	1.68	40.41	54.00	13.59
2 335.53	65.33	Peak	V	28.30	8.20	46.15	-	55.68	74.00	18.32
2 335.49	47.50	Average	V	28.30	8.20	46.15	1.68	39.53	54.00	14.47
Test Data for High Channel										
2 483.50	64.85	Peak	H	28.70	8.33	46.06	-	55.82	74.00	18.18
2 483.50	45.31	Average	H	28.70	8.33	46.06	1.68	37.96	54.00	16.04
2 483.50	61.73	Peak	V	28.70	8.33	46.06	-	52.70	74.00	21.30
2 483.50	44.09	Average	V	28.70	8.33	46.06	1.68	36.74	54.00	17.26

Tabulated test data for Restricted Band

Remark: “H”: Horizontal, “V”: Vertical

Margin (dB) = Limits (dBµV/m) - Total Level (dBµV/m)

Total Level = Reading + Antenna Factor + Cable Loss – AMP Gain + Duty Factor

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9.6.2 Spurious & Harmonic Radiated Emission

9.6.2.1 Test data for Bluetooth LE

-. Resolution bandwidth : 1 MHz for Peak and Average Mode for the emissions fall in restricted band,
1 MHz for Peak Mode for the emissions outside restricted band

-. Video bandwidth : 3 MHz for Peak and Average Mode

-. Frequency range : 1 GHz ~ 26.5 GHz

-. Measurement distance : 3 m

-. Duty Cycle : 67.94 %

-. Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 804.00	53.28	Peak	H	33.40	11.21	45.73	-	52.16	74.00	21.84
4 804.00	44.84	Average	H	33.40	11.21	45.73	1.68	45.40	54.00	8.60
4 804.00	52.13	Peak	V	33.40	11.21	45.73	-	51.01	74.00	22.99
4 804.00	43.64	Average	V	33.40	11.21	45.73	1.68	44.20	54.00	9.80
Test Data for Middle Channel										
4 880.00	53.50	Peak	H	33.40	11.23	45.80	-	52.33	74.00	21.67
4 880.00	45.70	Average	H	33.40	11.23	45.80	1.68	46.21	54.00	7.79
4 880.00	52.76	Peak	V	33.40	11.23	45.80	-	51.59	74.00	22.41
4 880.00	44.68	Average	V	33.40	11.23	45.80	1.68	45.19	54.00	8.81
Test Data for High Channel										
4 960.00	54.41	Peak	H	33.40	11.31	45.89	-	53.23	74.00	20.77
4 960.00	46.32	Average	H	33.40	11.31	45.89	1.68	46.82	54.00	7.18
4 960.00	53.35	Peak	V	33.40	11.31	45.89	-	52.17	74.00	21.83
4 960.00	44.47	Average	V	33.40	11.31	45.89	1.68	44.97	54.00	9.03

Remark: “H”: Horizontal, “V”: Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss – AMP Gain + Duty Factor

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9.6.2.2 Test data for GFSK

-. Resolution bandwidth : 1 MHz for Peak and Average Mode for the emissions fall in restricted band,
1 MHz for Peak Mode for the emissions outside restricted band

-. Video bandwidth : 3 MHz for Peak and Average Mode

-. Frequency range : 1 GHz ~ 26.5 GHz

-. Measurement distance : 3 m

-. Duty Cycle : 67.94 %

-. Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 804.00	52.52	Peak	H	33.40	11.21	45.73	-	51.40	74.00	22.60
4 804.00	43.40	Average	H	33.40	11.21	45.73	1.68	43.96	54.00	10.04
4 804.00	51.90	Peak	V	33.40	11.21	45.73	-	50.78	74.00	23.22
4 804.00	42.61	Average	V	33.40	11.21	45.73	1.68	43.17	54.00	10.83
Test Data for Middle Channel										
4 880.00	53.54	Peak	H	33.40	11.23	45.80	-	52.37	74.00	21.63
4 880.00	45.20	Average	H	33.40	11.23	45.80	1.68	45.71	54.00	8.29
4 880.00	52.79	Peak	V	33.40	11.23	45.80	-	51.62	74.00	22.38
4 880.00	43.35	Average	V	33.40	11.23	45.80	1.68	43.86	54.00	10.14
Test Data for High Channel										
4 960.00	53.15	Peak	H	33.40	11.31	45.89	-	51.97	74.00	22.03
4 960.00	44.59	Average	H	33.40	11.31	45.89	1.68	45.09	54.00	8.91
4 960.00	51.97	Peak	V	33.40	11.31	45.89	-	50.79	74.00	23.21
4 960.00	43.36	Average	V	33.40	11.31	45.89	1.68	43.86	54.00	10.14

Remark: “H”: Horizontal, “V”: Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss – AMP Gain + Duty Factor

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10. PEAK POWER SPECTRAL DENSITY

10.1 Operating environment

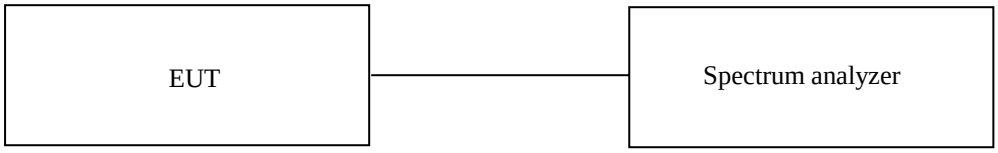
Temperature : 22 °C

Relative humidity : 46 % R.H.

10.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to 3 kHz ≤ RBW ≤100 kHz, the video bandwidth is set to 3 times the resolution bandwidth.



10.3 Test Date

September 27, 2021 ~ September 30, 2021

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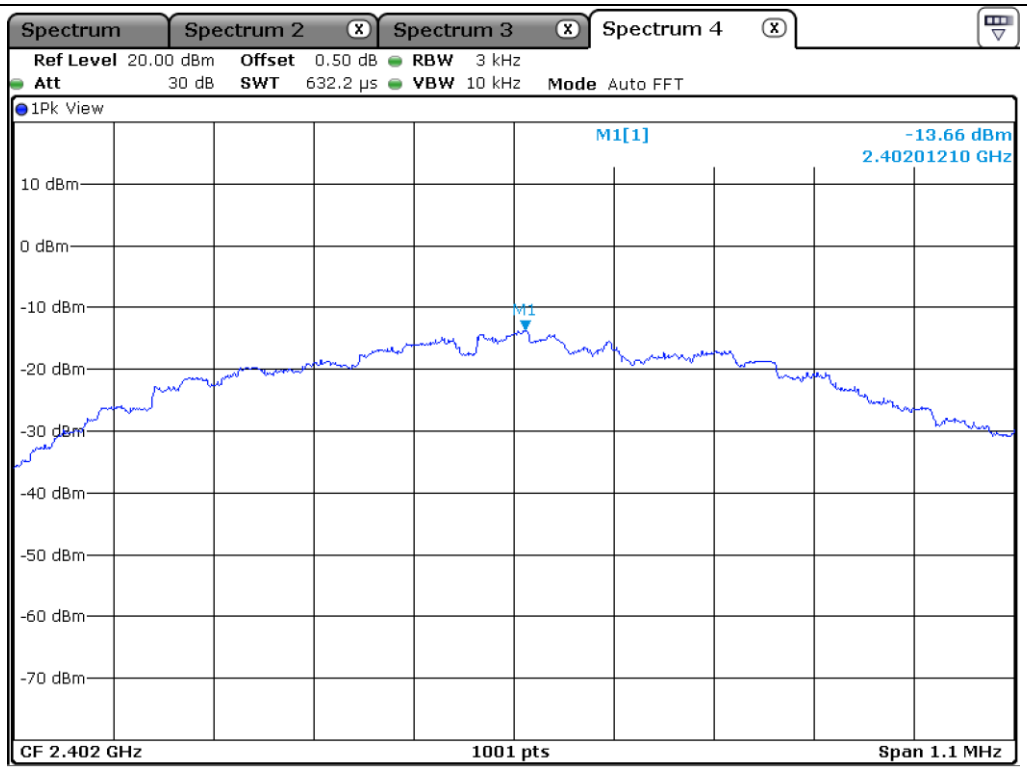
10.4 Test data for Bluetooth LE

-. Test Result : Pass

-. Operating Condition : Continuous transmitting mode

CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 402.00	-13.66	8.00	21.66
Middle	2 440.00	-14.35	8.00	22.35
High	2 480.00	-16.23	8.00	24.23

Remark. Margin = Limit – Measured value



Low Channel

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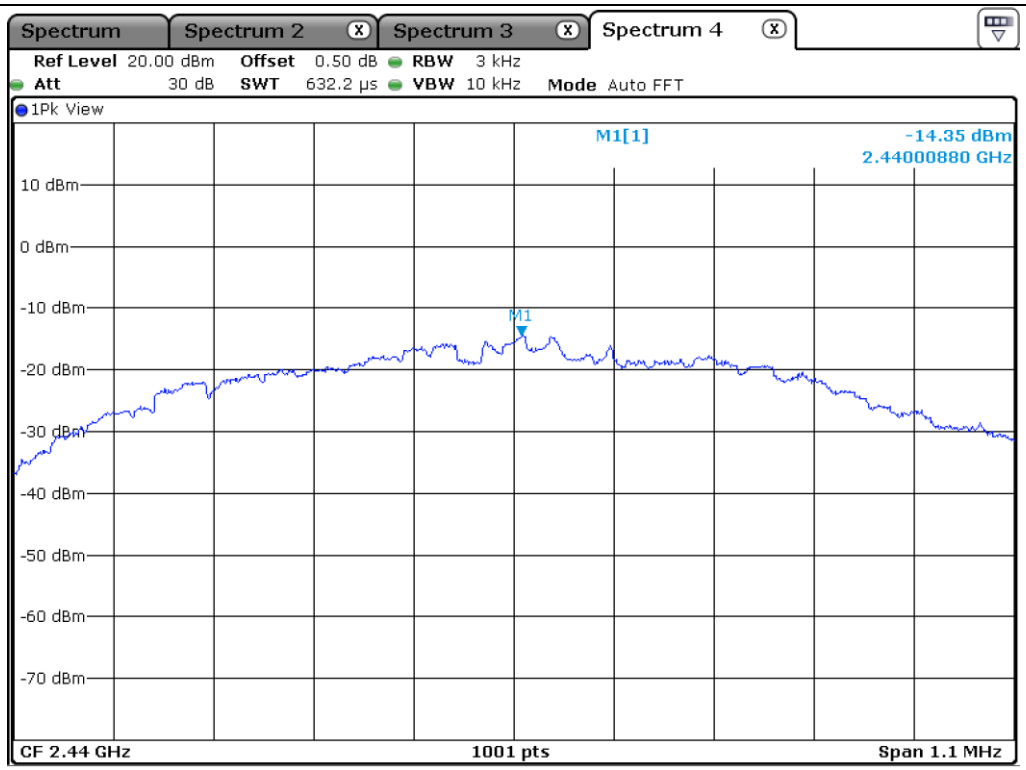
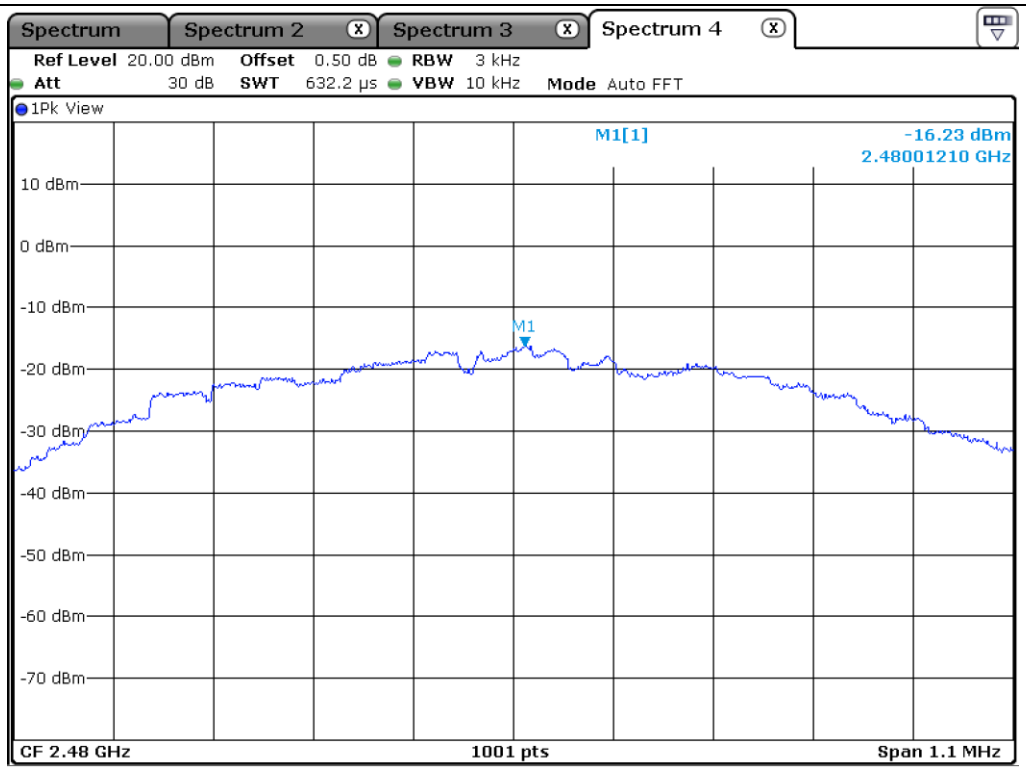


Middle Channel



High Channel

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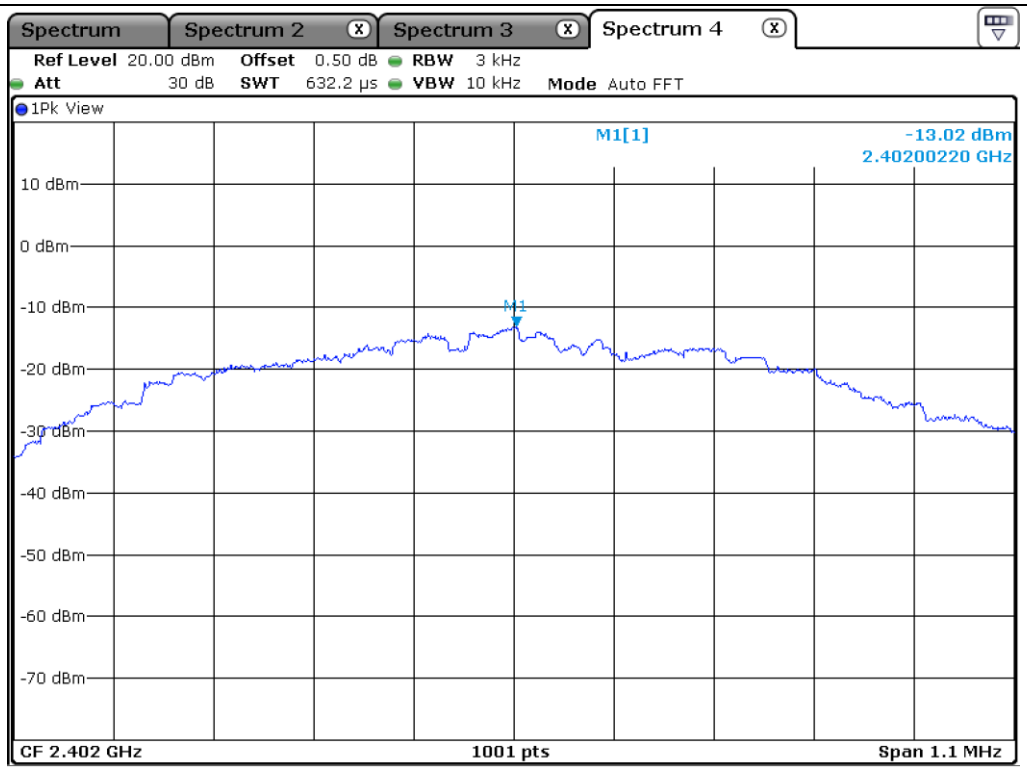
10.5 Test data for GFSK

-. Test Result : Pass

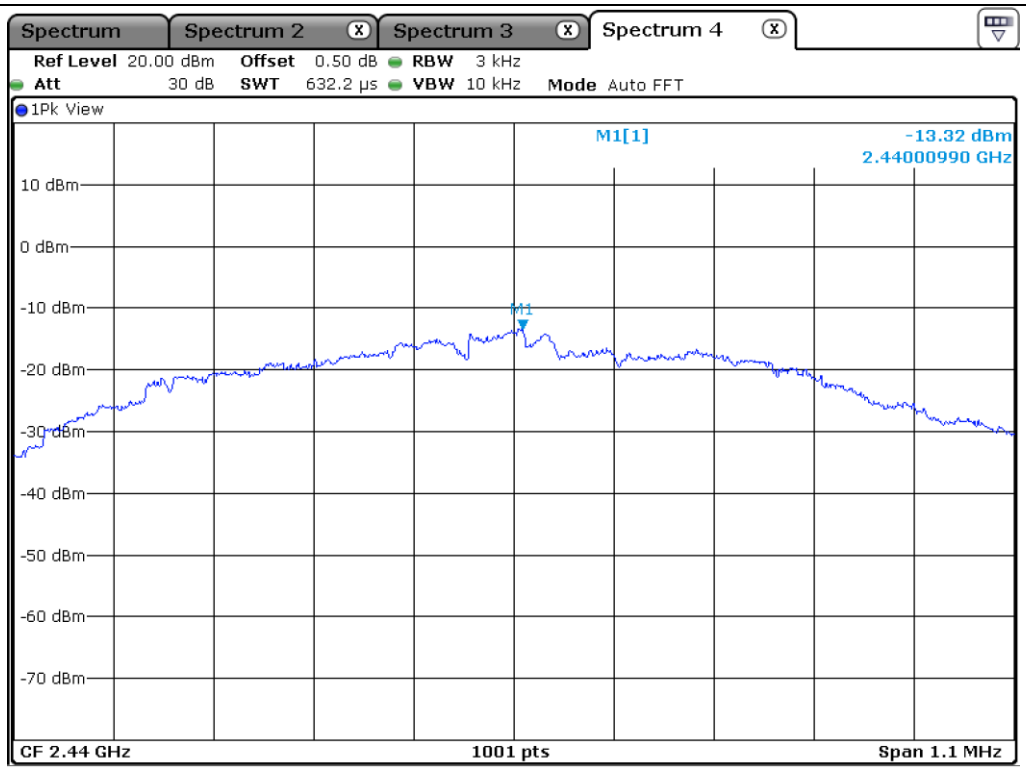
-. Operating Condition : Continuous transmitting mode

CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 402.00	-13.02	8.00	21.02
Middle	2 440.00	-13.32	8.00	21.32
High	2 480.00	-14.93	8.00	22.93

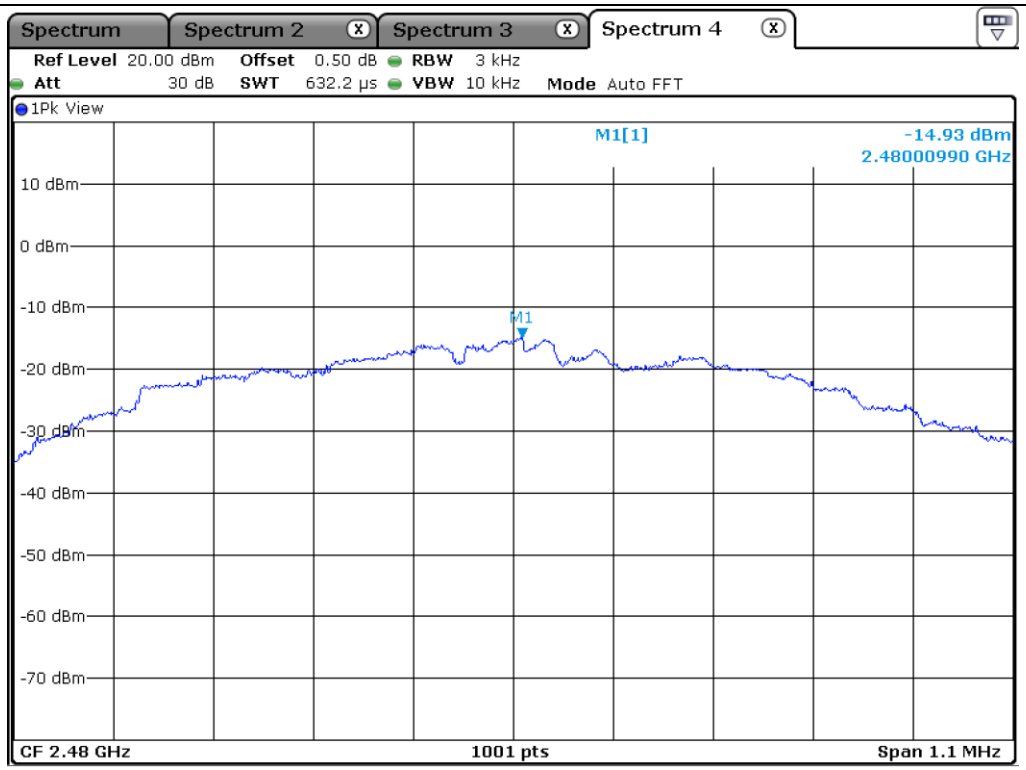
Remark. Margin = Limit – Measured value



Low Channel



Middle Channel



High Channel

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11. RADIATED EMISSION TEST

11.1 Operating environment

Temperature : 22 °C

Relative humidity : 46 % R.H.

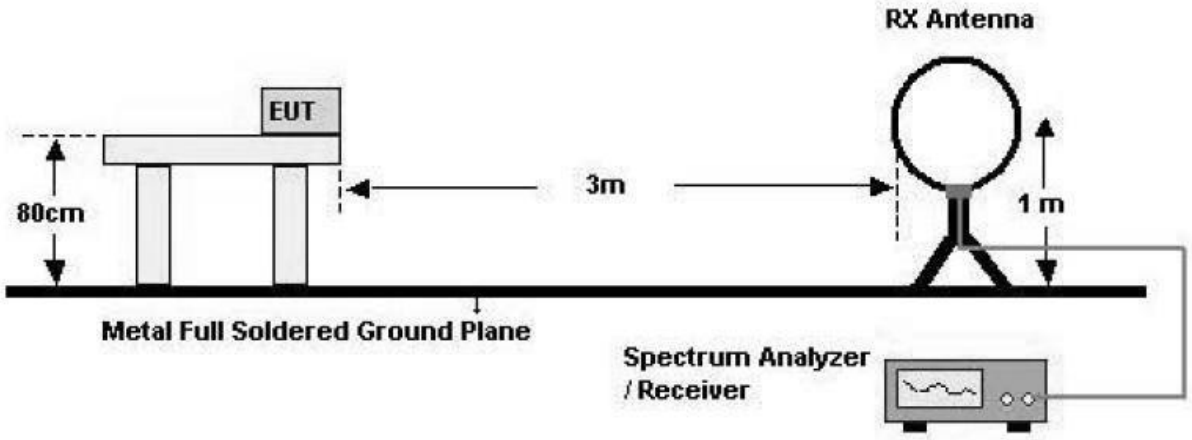
11.2 Test set-up

The radiated emissions measurements were on the 3 m semi anechoic chamber. The EUT and other support equipment were placed on a non-conductive turntable above the ground plane. The interconnecting cables from outside test site were inserted into ferrite clamps at the point where the cables reach the turntable.

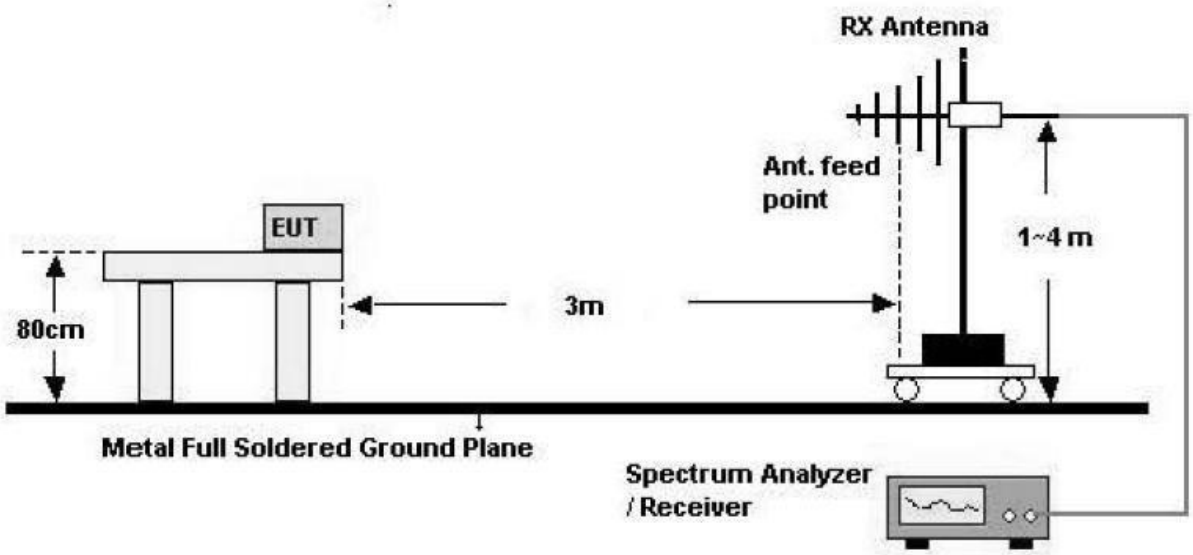
The frequency spectrum from 30 MHz to 26.5 GHz was scanned and emission levels maximized at each frequency recorded. The system was rotated 360°, and the antenna was varied in height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

- Test Configuration

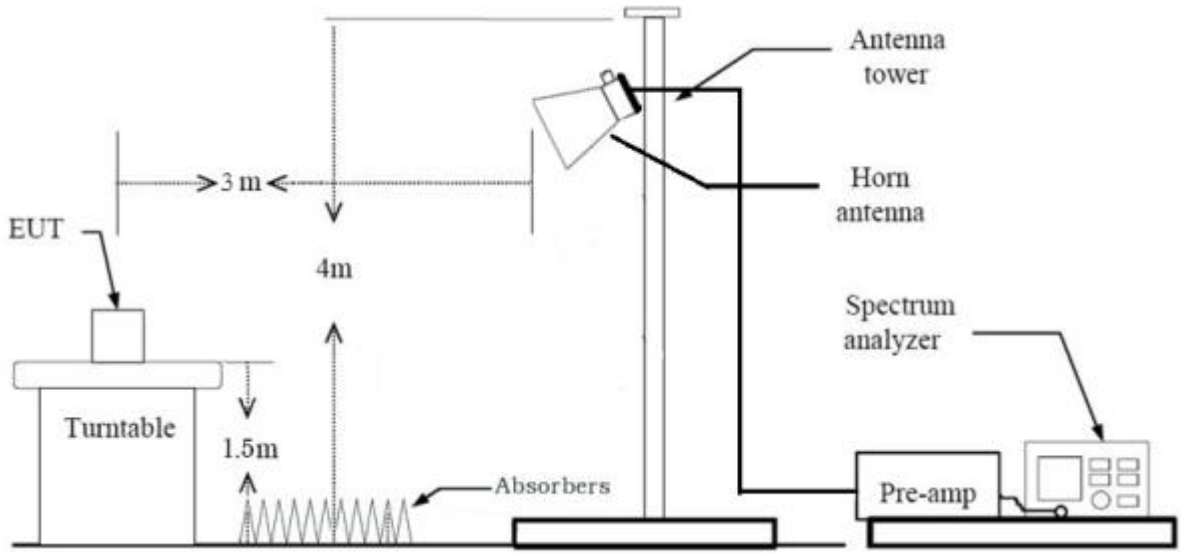
1. Below 30 MHz



2. 30 MHz - 1 GHz



3. Above 1 GHz



11.3 Test Date

September 27, 2021 ~ September 30, 2021

11.4 Test data for 30 MHz ~ 1 GHz

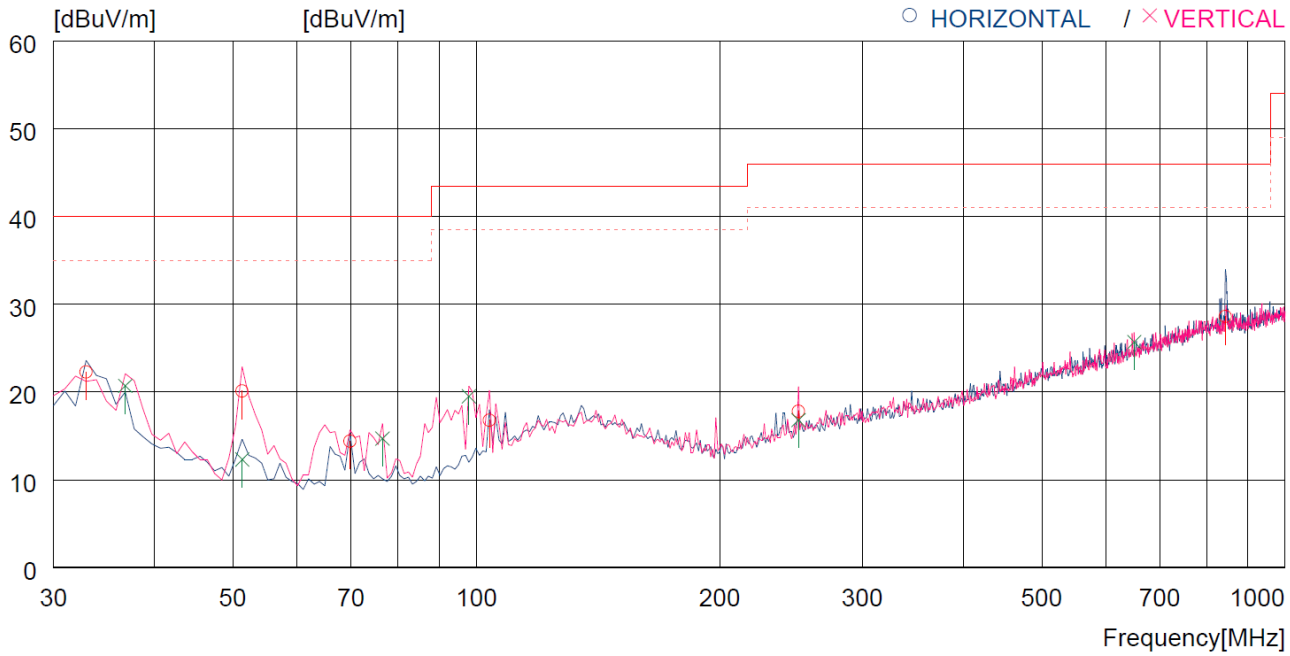
11.4.1 Test data for Bluetooth LE

Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : RF Module(BLE Module)

Detector : CISPR Quasi-Peak (6 dB Bandwidth: 120 kHz)



No.	FREQ [MHz]	READING [dBuV]	ANT [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal ------										
1	32.910	33.2	19.9	1.2	32.0	22.3	40.0	17.7	200	301
2	51.340	37.8	13.0	1.4	32.1	20.1	40.0	19.9	300	351
3	69.770	32.0	12.9	1.6	32.1	14.4	40.0	25.6	200	135
4	103.720	31.1	15.9	1.8	32.0	16.8	43.5	26.7	300	359
5	250.190	29.2	17.8	2.8	32.0	17.8	46.0	28.2	100	359
6	843.821	28.1	27.3	5.1	31.9	28.6	46.0	17.4	400	296
----- Vertical ------										
7	36.790	32.9	18.5	1.3	32.0	20.7	40.0	19.3	400	1
8	51.340	30.0	13.0	1.4	32.1	12.3	40.0	27.7	100	359
9	76.560	32.2	12.9	1.6	32.0	14.7	40.0	25.3	200	225
10	97.900	34.8	14.9	1.8	32.0	19.5	43.5	24.0	200	207
11	250.190	28.2	17.8	2.8	32.0	16.8	46.0	29.2	100	163
12	650.796	28.7	24.9	4.4	32.3	25.7	46.0	20.3	300	9

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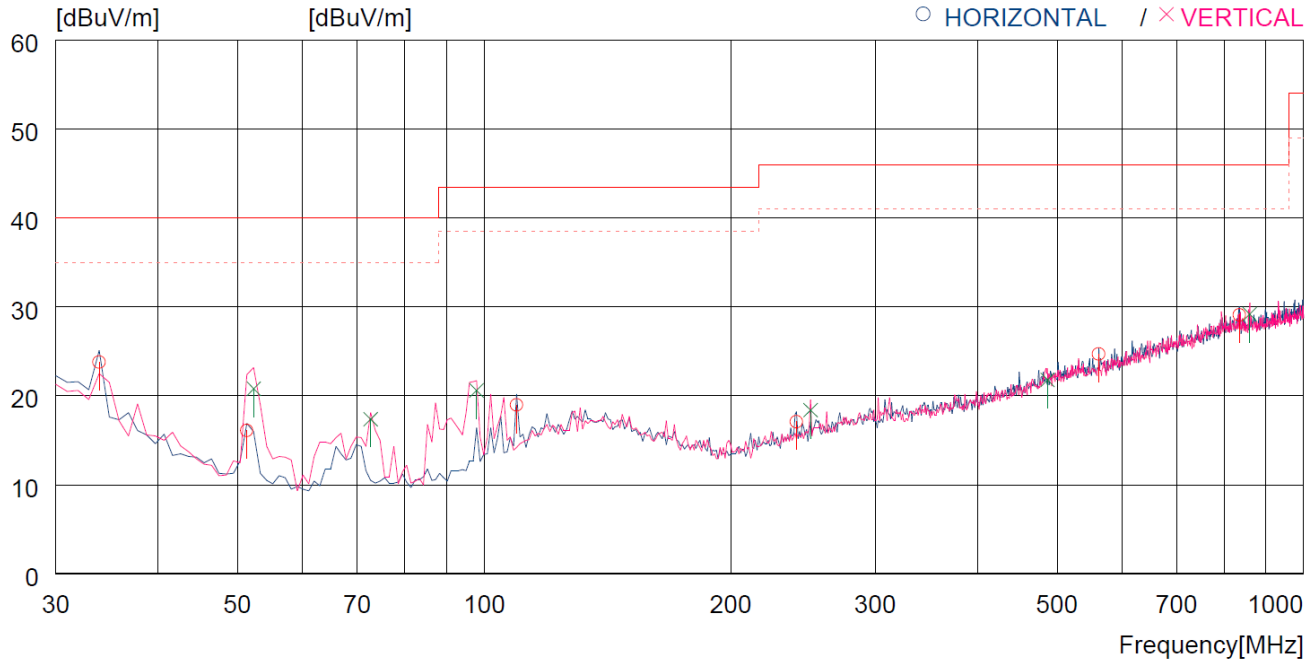
11.4.2 Test data for GFSK

Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : RF Module(BLE Module)

Detector : CISPR Quasi-Peak (6 dB Bandwidth: 120 kHz)



No.	FREQ [MHz]	READING [dBuV]	ANT [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal ------										
1	33.880	35.1	19.5	1.2	32.0	23.8	40.0	16.2	300	359
2	51.340	33.8	13.0	1.4	32.1	16.1	40.0	23.9	400	0
3	109.540	32.2	16.9	1.9	32.0	19.0	43.5	24.5	300	134
4	240.490	29.0	17.4	2.7	32.0	17.1	46.0	28.9	100	359
5	562.529	29.2	23.8	4.1	32.4	24.7	46.0	21.3	400	85
6	835.091	28.7	27.2	5.1	31.9	29.1	46.0	16.9	400	328
----- Vertical ------										
7	52.310	38.6	12.9	1.4	32.1	20.8	40.0	19.2	100	62
8	72.680	35.0	12.9	1.6	32.1	17.4	40.0	22.6	100	0
9	97.900	35.9	14.9	1.8	32.0	20.6	43.5	22.9	100	213
10	250.190	29.8	17.8	2.8	32.0	18.4	46.0	27.6	100	153
11	486.871	27.5	22.8	3.8	32.3	21.8	46.0	24.2	300	39
12	859.340	28.6	27.3	5.1	31.8	29.2	46.0	16.8	100	213

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11.5 Test data for Below 30 MHz

-. Resolution bandwidth : 200 Hz (from 9 kHz to 0.15 MHz), 9 kHz (from 0.15 MHz to 30 MHz)

-. Frequency range : 9 kHz ~ 30 MHz

-. Measurement distance : 3 m

-.Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBµV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBµV/m)	Limits (dBµV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.									

11.6 Test data for above 1 GHz

-. Resolution bandwidth : 1 MHz for Peak and Average Mode for the emissions fall in restricted band,
1 MHz for Peak Mode for the emissions outside restricted band

-. Video bandwidth : 3 MHz for Peak and Average Mode

-. Frequency range : 1 GHz ~ 26.5 GHz

-. Measurement distance : 3 m

-.Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBµV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBµV/m)	Limits (dBµV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.									

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

12. CONDUCTED EMISSION TEST

12.1 Operating environment

Temperature : 22 °C

Relative humidity : 46 % R.H.

12.2 Test set-up

The EUT was placed on a wooden table, 0.8 m height above the floor. Power was fed to the EUT through a 50 Ω / 50 μH + 5 Ω Artificial Mains Network (AMN). The ground plane was electrically bonded to the reference ground system and all power lines were filtered from ambient.

12.3 Test Date

September 27, 2021 ~ September 30, 2021

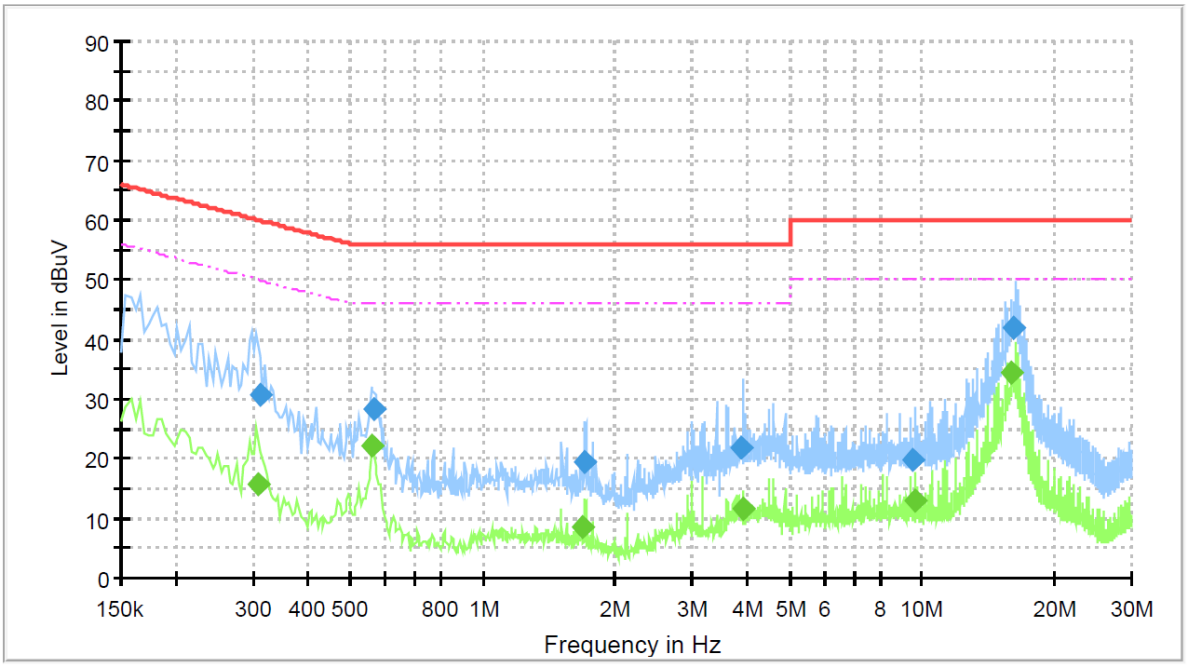
ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

12.4 Test data for Bluetooth LE

-. Resolution bandwidth : 9 kHz

-. Frequency range : 0.15 MHz ~ 30 MHz

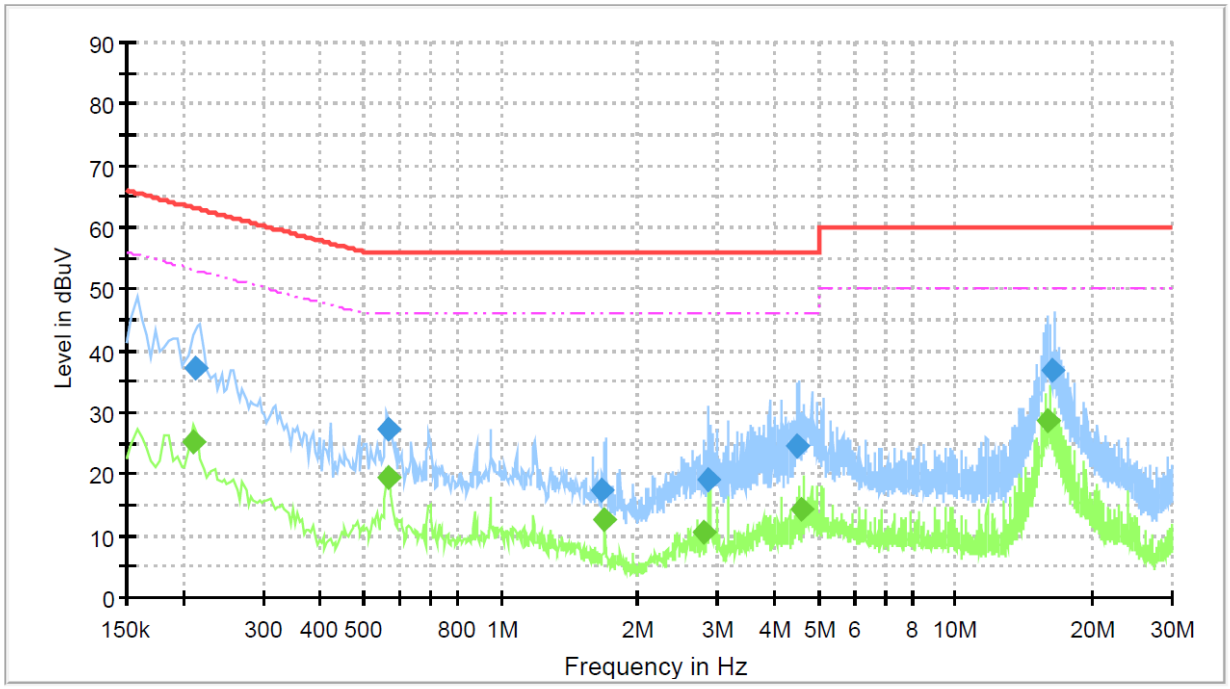
-. Tested Line : LIVE LINE



Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.308	---	15.82	50.03	34.21	9.0	L1	9.93
0.312	30.66	---	59.92	29.26	9.0	L1	9.93
0.559	---	22.28	46.00	23.72	9.0	L1	9.94
0.567	28.36	---	56.00	27.64	9.0	L1	9.94
1.680	---	8.39	46.00	37.61	9.0	L1	10.00
1.704	19.46	---	56.00	36.54	9.0	L1	10.00
3.867	21.71	---	56.00	34.29	9.0	L1	10.04
3.919	---	11.49	46.00	34.51	9.0	L1	10.05
9.509	19.88	---	60.00	40.12	9.0	L1	10.31
9.625	---	12.97	50.00	37.03	9.0	L1	10.31
16.067	---	34.39	50.00	15.61	9.0	L1	10.54
16.111	42.05	---	60.00	17.95	9.0	L1	10.54

-. Tested Line : NEUTRAL LINE



Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.209	---	25.14	53.23	28.08	9.0	N	9.94
0.214	37.19	---	63.07	25.88	9.0	N	9.94
0.563	27.31	---	56.00	28.69	9.0	N	9.95
0.567	---	19.29	46.00	26.71	9.0	N	9.95
1.672	17.51	---	56.00	38.49	9.0	N	10.01
1.692	---	12.59	46.00	33.41	9.0	N	10.01
2.797	---	10.50	46.00	35.50	9.0	N	10.05
2.853	19.16	---	56.00	36.84	9.0	N	10.05
4.476	24.56	---	56.00	31.44	9.0	N	10.08
4.592	---	14.44	46.00	31.56	9.0	N	10.08
15.895	---	28.58	50.00	21.42	9.0	N	10.65
16.282	36.83	---	60.00	23.17	9.0	N	10.67

Remark: Margin (dB) = Limit – Level (Result)

The emission level in above table is included the transducer factor that means insertion loss (LISN), cable loss and attenuator.

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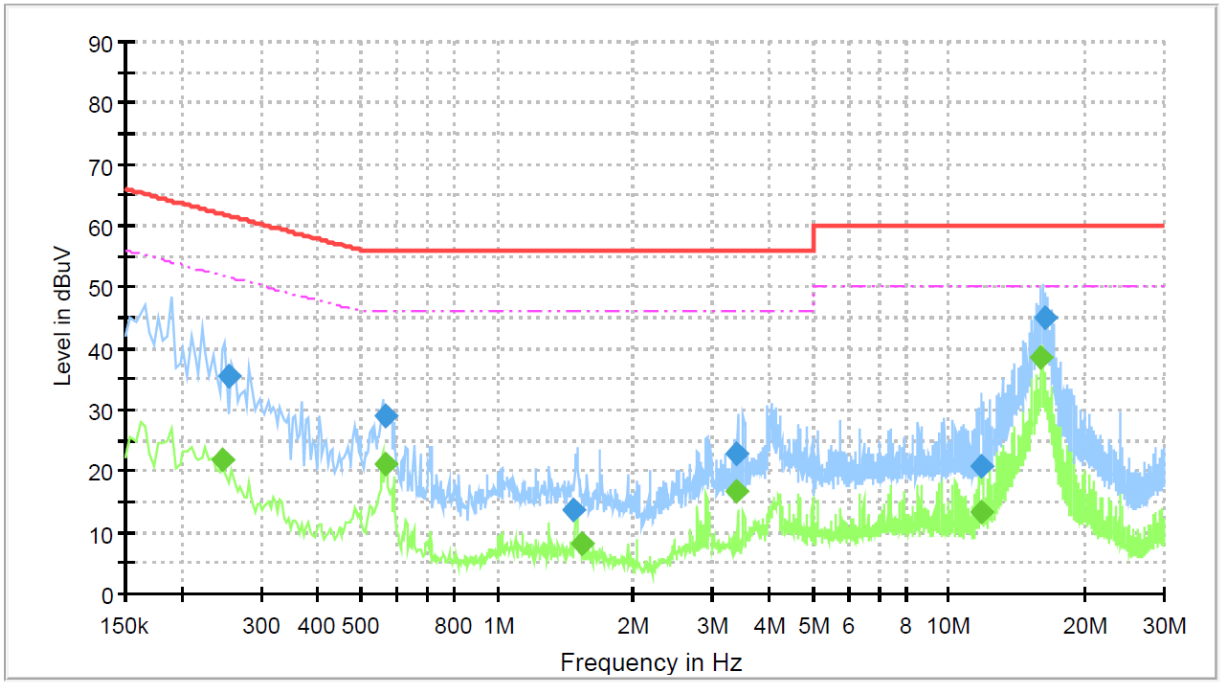
12.5 Test data for GFSK

-. Resolution bandwidth : 9 kHz

-. Frequency range : 0.15 MHz ~ 30 MHz

-. Tested Line : LIVE LINE

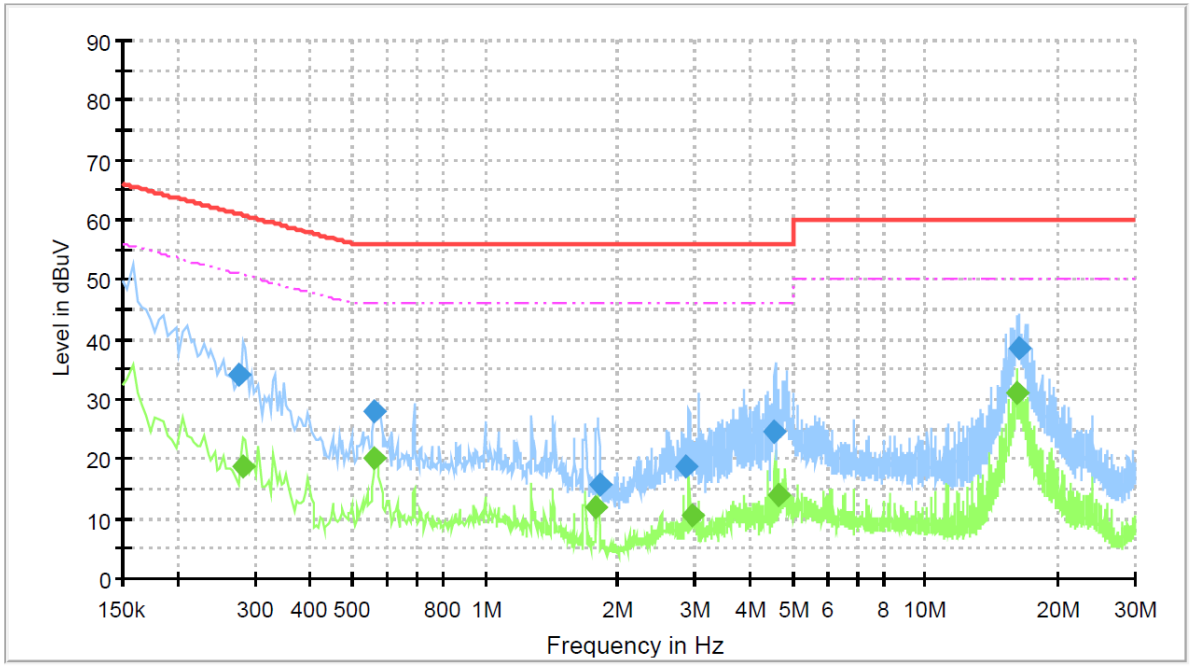


Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.245	---	21.87	51.92	30.05	9.0	L1	9.93
0.255	35.51	---	61.59	26.08	9.0	L1	9.93
0.563	29.11	---	56.00	26.89	9.0	L1	9.94
0.567	---	21.11	46.00	24.89	9.0	L1	9.94
1.480	13.54	---	56.00	42.46	9.0	L1	9.99
1.536	---	8.11	46.00	37.89	9.0	L1	9.99
3.382	22.75	---	56.00	33.25	9.0	L1	10.03
3.390	---	16.55	46.00	29.45	9.0	L1	10.03
11.739	---	13.24	50.00	36.76	9.0	L1	10.40
11.783	20.80	---	60.00	39.20	9.0	L1	10.40
15.915	---	38.57	50.00	11.43	9.0	L1	10.54
16.338	44.95	---	60.00	15.05	9.0	L1	10.55

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

-. Tested Line : NEUTRAL LINE



Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.276	34.25	---	60.93	26.68	9.0	N	9.94
0.280	---	18.90	50.81	31.90	9.0	N	9.94
0.559	---	20.04	46.00	25.96	9.0	N	9.95
0.559	28.12	---	56.00	27.88	9.0	N	9.95
1.786	---	11.98	46.00	34.02	9.0	N	10.02
1.818	15.57	---	56.00	40.43	9.0	N	10.02
2.860	18.90	---	56.00	37.10	9.0	N	10.05
2.944	---	10.73	46.00	35.27	9.0	N	10.05
4.515	24.48	---	56.00	31.52	9.0	N	10.08
4.615	---	14.13	46.00	31.87	9.0	N	10.08
16.181	---	30.86	50.00	19.14	9.0	N	10.66
16.381	38.61	---	60.00	21.39	9.0	N	10.67

Remark: Margin (dB) = Limit – Level (Result)

The emission level in above table is included the transducer factor that means insertion loss (LISN), cable loss and attenuator.

13. LIST OF TEST EQUIPMENT

Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
FSV40-N	Rohde & Schwarz	Signal Analyzer	102165	Apr. 16, 2021 (1Y)
ESU	Rohde & Schwarz	EMI Test Receiver	100261	Mar. 15, 2021 (1Y)
310N	Sonoma Instrument	Pre-Amplifier	392756	Oct. 16, 2020 (1Y)
SCU18	Rohde & Schwarz	Pre-Amplifier	102266	Jul. 14, 2021 (1Y)
PAM-840A	Com-Power	Pre-Amplifier	461339	Oct. 16, 2020 (1Y)
FMZB 1513	Schwarzbeck	Loop Antenna	1513-235	Mar. 24, 2020 (2Y)
HLP-2008	TDK	Hybrid Antenna	131316	Feb. 27, 2020 (2Y)
AH-118	Com-Power	Horn Antenna	10050061	Oct. 15, 2020 (1Y)
BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	Jan. 07, 2021 (1Y)
ESR3	Rohde & Schwarz	EMI Test Receiver	102602	Mar. 15, 2021 (1Y)
NSLK8126	Schwarzbeck	AMN	8126-404	Mar. 15, 2021 (1Y)
ESH3Z2	Rohde & Schwarz	PULSE LIMITER	357.8810.52	Mar. 15, 2021 (1Y)
DT2000-2t	Innco System	Turn Table	N/A	N/A
MA-4640-XPET	Innco System	Antenna Master	MA4640/652/43100318/P	N/A
CO3000	Innco System	Controller	1026/40960617/P	N/A