FCC CERTIFICATION TEST REPORT

Project Number	**: EA2009C-016**
Test Report Number	**: TR-W2009-010**
Type of Equipment	**: DIGITAL DOOR LOCK**
Model Name	**: T102K-TW**
FCC ID	**: 2AXLI-T102K-TW**
Multiple Model Name	**: N/A**
Applicant	**: KT&C CO., LTD.**
Address	**: KT&C BLDG, 7, Yangcheon-ro 11-gil, Gangseo-gu, Seoul, Republic of Korea**
Manufacturer	**: KT&C CO., LTD.**
Address	**: KT&C BLDG, 7, Yangcheon-ro 11-gil, Gangseo-gu, Seoul, Republic of Korea**
Regulation	**: FCC Part 15 Subpart C Section 15.247**
Total page of Report	**: 44 Pages**
Date of Receipt	**: 2020-07-02**
Date of Issue	**: 2020-09-21**
Test Result	**: PASS**

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.

Prepared by Song, In-young / Senior Engineer _____ 2020-09-21
Signature Date

Reviewed by Choi, Yeong-min / Technical Manager _____ 2020-09-21
Signature Date

ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942 Report Form_01 (Rev.2)
TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

CONTENTS

Page

1. TEST SUMMARY 4
1.1 REGULATIONS AND RESULTS 4
1.2 TEST METHODOLOGY 4
1.3 ADDITIONS, DEVIATIONS, EXCLUSIONS FROM STANDARDS 4
1.4 PURPOSE OF THE TEST 4
2. EUT (EQUIPMENT UNDER TEST) INFORMATION 6
2.1 GENERAL DESCRIPTION 6
2.2 ADDITIONAL MODEL 6
2.3 AVAILABLE CHANNEL NUMBER AND FREQUENCY 7
3. TEST CONDITION 8
3.1 EQUIPMENT USED DURING TEST 8
3.2 MODE OF OPERATION DURING THE TEST 8
3.3 PRELIMINARY TESTING FOR WORST CASE CONFIGURATION 8
3.4 TEST SETUP DRAWING 9
3.5 EUT MODIFICATIONS 9
4. ANTENNA REQUIREMENT 10
4.1 ANTENNA DESCRIPTION 10
4.2 CONCLUSION 10
5. TEST RESULT 11
5.1 6 DB BANDWIDTH 11
5.2 99 % BANDWIDTH 14
5.3 MAXIMUM PEAK OUTPUT POWER 17
5.4 PEAK POWER SPECTRAL DENSITY 20
5.5 OUT OF BAND EMISSION 23
5.6 RADIATED EMISSION 28
APPENDIX I – TEST INSTRUMENTATION 44

ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942

TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

Release Control Record

Issue Report No.	Issued Date	Details/Revisions
TR-W2009-010	2020-09-21	Initial Release
-	-	-

ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942

TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

1. TEST SUMMARY

1.1 Regulations and results

The sample submitted for evaluation (Hereafter referred to as the EUT) has been tested in accordance with the following regulations or standards.

FCC Reference Section	Description	Result			
		P	F	N.T.	Note
15.247(a)(2)	6 dB Bandwidth Occupied Bandwidth	**P**			
15.247(b)(3)	Maximum peak output power	**P**			
15.247(d)	Band Edge Conducted spurious emission	**P**			
15.247(e)	Power spectral density	**P**			
15.205(a) 15.209(a)	Radiated spurious emissions	**P**			
15.207(a)	AC power line conducted emissions			**N.T.**	Note 1

Remark:

P means Passed **F** means Failed **N.T.** means Not Tested

Note 1. The EUT shall be operated by battery, so the test was not performed.

1.2 Test Methodology

The tests mentioned in clause 1.1 in this test report were performed according to FCC CFR 47 Part 2, CFR 47 Part 15 and ANSI C63.10-2013.

KDB 558074 D01DTS Meas. Guidance v05r02: Measurement Procedure PK is used for power measurement.

1.3 Additions, deviations, exclusions from standards

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

1.4 Purpose of the test

The test was performed to determine whether the equipment under test fulfills the requirements of the regulation stated in FCC Part 15 Subpart C Section 15.247.

ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942 Report Form_01 (Rev.2)
TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

1.5 Test Facility

The measurement facilities are located at 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do 12813, Korea. Our test facilities are accredited as a Conformity Assessment Body (CAB) by the FCC and ISED Canada, designated by the RRA (National Radio Research Agency), and accredited by KOLAS (Korea Laboratory Accreditation Scheme) in Korea and approved by TUV Rheinland, TUV SÜD and Korean Register of Shipping according to the requirement of ISO/IEC 17025.

Laboratory Qualification	Registration No.	Mark
FCC	KR0160	
ISED Canada	12721A	
RRA	KR0160	National Radio Research Agency
TUV Rheinland	UA 50314109-0002	TÜVRheinland
TUV SÜD	CARAT 094465 0004 Rev.00	
Korean Agency for Technology and Standards	KT733	
KOREAN REGISTER OF SHIPPING	PCT40841-TL001	

Remark. This report is not related to KOLAS accreditation and relevant regulation.

2. EUT (Equipment Under Test) INFORMATION

2.1 General Description

The KT&C CO., LTD., Model T102K-TW (referred to as the EUT in this report) is a DIGITAL DOOR LOCK, which has function for Bluetooth low energy. The product specification described herein was obtained from product data sheet or user's manual.

Operating Frequency	2 402 MHz ~ 2 480 MHz
Kind of Class	DTS – Digital Transmission System
Max. RF Output Power	- 8.22 dBm
Modulation Types	GFSK
Number of Channels	40 CH
Channel Bandwidth	2 MHz
Generated or used Freq. in EUT	32.768 kHz, 16 MHz
Type of Antenna	■ Integrated Type ☐ Dedicated Type
Antenna Gain	-7.45 dBi
Normal Test Voltage	DC 6 V
Electrical Rating	DC 6 V
Test SW Version	nRFgo Studio Version 1.21.2.10
RF power setting in TEST SW	N/A
Software Version	20200729-009
Hardware Version	PP-200701

2.2 Additional Model

None

ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942 Report Form_01 (Rev.2)
TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

2.3 Available channel number and frequency

Operating Mode: Bluetooth LE, 2 MHz Channel Spacing					
Channel	Frequency(MHz)	Channel	Frequency(MHz)	Channel	Frequency(MHz)
0	2 402	14	2 430	28	2 458
1	2 404	15	2 432	29	2 460
2	2 406	16	2 434	30	2 462
3	2 408	17	2 436	31	2 464
4	2 410	18	2 438	32	2 466
5	2 412	19	2 440	33	2 468
6	2 414	20	2 442	34	2 470
7	2 416	21	2 444	35	2 472
8	2 418	22	2 446	36	2 474
9	2 420	23	2 448	37	2 476
10	2 422	24	2 450	38	2 478
11	2 424	25	2 452	39	2 480
12	2 426	26	2 454		
13	2 428	27	2 456		

ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942 Report Form_01 (Rev.2)
TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

3. TEST CONDITION

3.1 Equipment Used During Test

The following peripheral devices and/or interface cables were connected during the measurement:

Description	Model No.	Serial No.	Manufacturer.
DIGITAL DOOR LOCK (EUT)	T102K-TW	N/A	KT&C CO., LTD.
Notebook PC	LGR48	MEZ62599402	LG
Adapter for Notebook PC	PA-1900-08	2100630009	Dongguang Lote Power 2nd Plant
JIG Board	CP102 MODULES USB TO TTL	N/A	N/A

3.2 Mode of operation during the test

Software used to control the EUT for staying in continuous transmitting mode is programmed.

The used modulation type for the testing is GFSK.

3.3 Preliminary Testing for Worst case configuration

For finding worst case configuration and operating mode, preliminary testing was performed and radiated emission and conducted emission tests were performed with the EUT set to transmit and receive at the channel with the highest output power as worst case scenario. Since the EUT is a fixed type device, all spurious emission tests were performed in one axis direction.

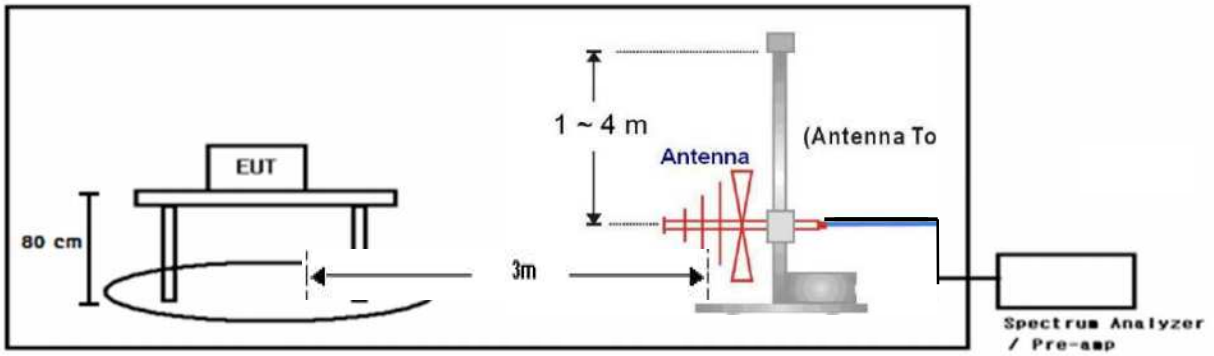
3.3.1 Test Channel and Frequency

Operating Mode	Test Channel	Frequency
Bluetooth Low Energy	Low Channel	2 402 MHz
	Middle Channel	2 440 MHz
	High Channel	2 480 MHz

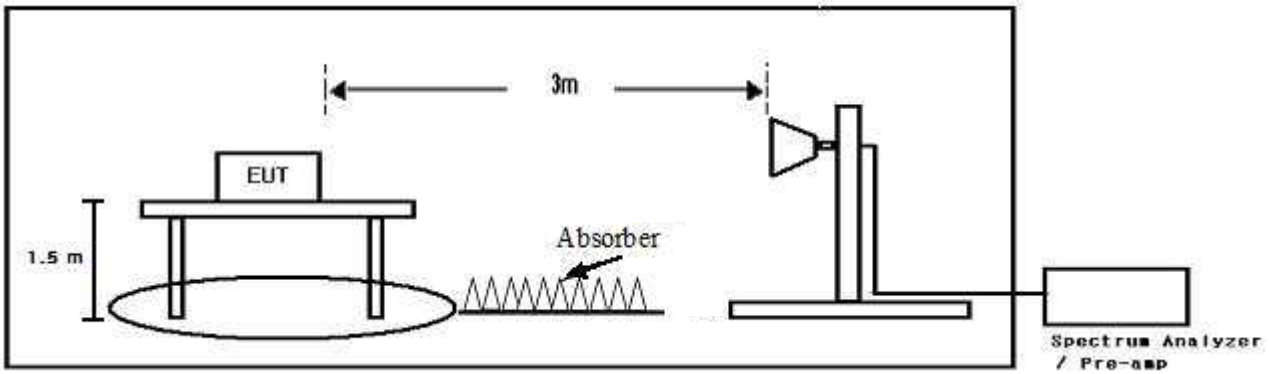
ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942 Report Form_01 (Rev.2)
TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

3.4 Test Setup Drawing

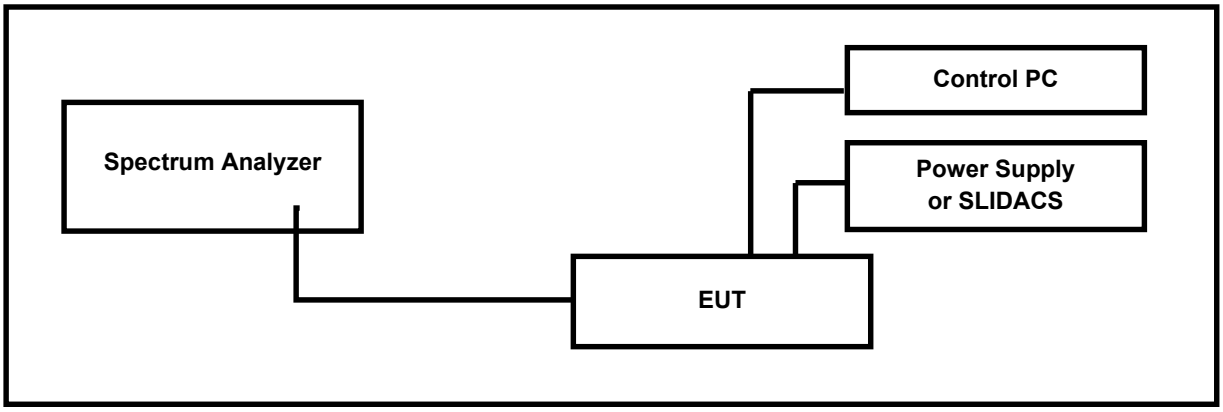
(Radiated Test below 1 GHz)



(Radiated Test above 1 GHz)



(Conducted Test)



3.5 EUT Modifications

- No EMC Relevant Modifications were performed by this test laboratory.

ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942

TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

4. ANTENNA REQUIREMENT

According to FCC CFR 47 Part 15 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. 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 provision of this section.

4.1 Antenna Description

Frequency Band (GHz)	Antenna Type	Max Peak Gain (dBi)	Connector Type
2.4	PCB Pattern Antenna	-7.45	-

4.2 Conclusion

The antenna connector type of the EUT is PCB Pattern Antenna, so the EUT met the requirement.

ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942

TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

5. TEST RESULT

5.1 6 dB Bandwidth

5.1.1 Limit

The minimum 6 dB bandwidth shall be at least 500 kHz acc to Section 15.247 (a) (2).

5.1.2 Method of Measurement

Reference to KDB 558074 D01 DTS Meas Guidance v05r02: 8.2

The transmitter output is connected to a spectrum analyzer with the RBW set to 100 kHz, VBW ≥ 3 X RBW, peak detector and max hold.

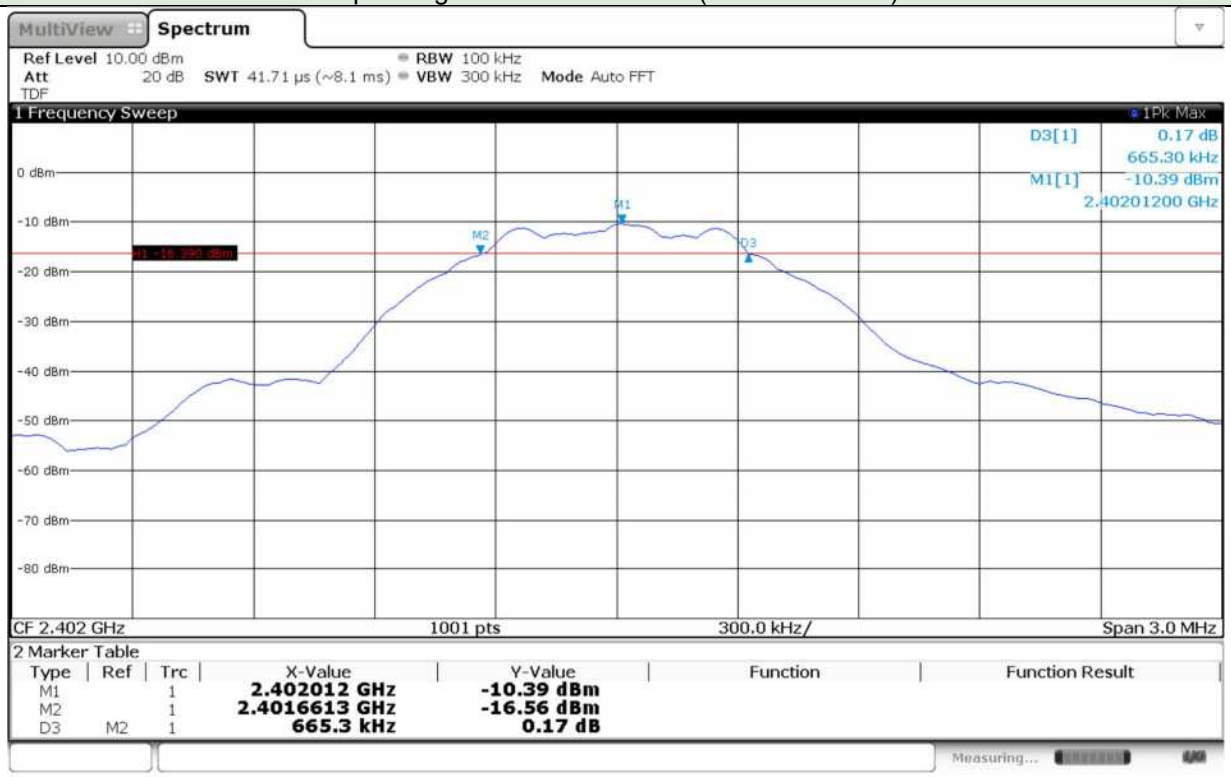
5.1.3 Test Data

Date of Test	2020-09-11	Temperature	(26.2 ± 0.5) °C
		Relative humidity	(51.1 ± 3.1) % R.H.
Test Result	***PASS***	Tested by	Do-heon Kim
Operating Mode: Bluetooth LE			
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2 402	0.67	0.5
Middle	2 440	0.67	
High	2 480	0.67	

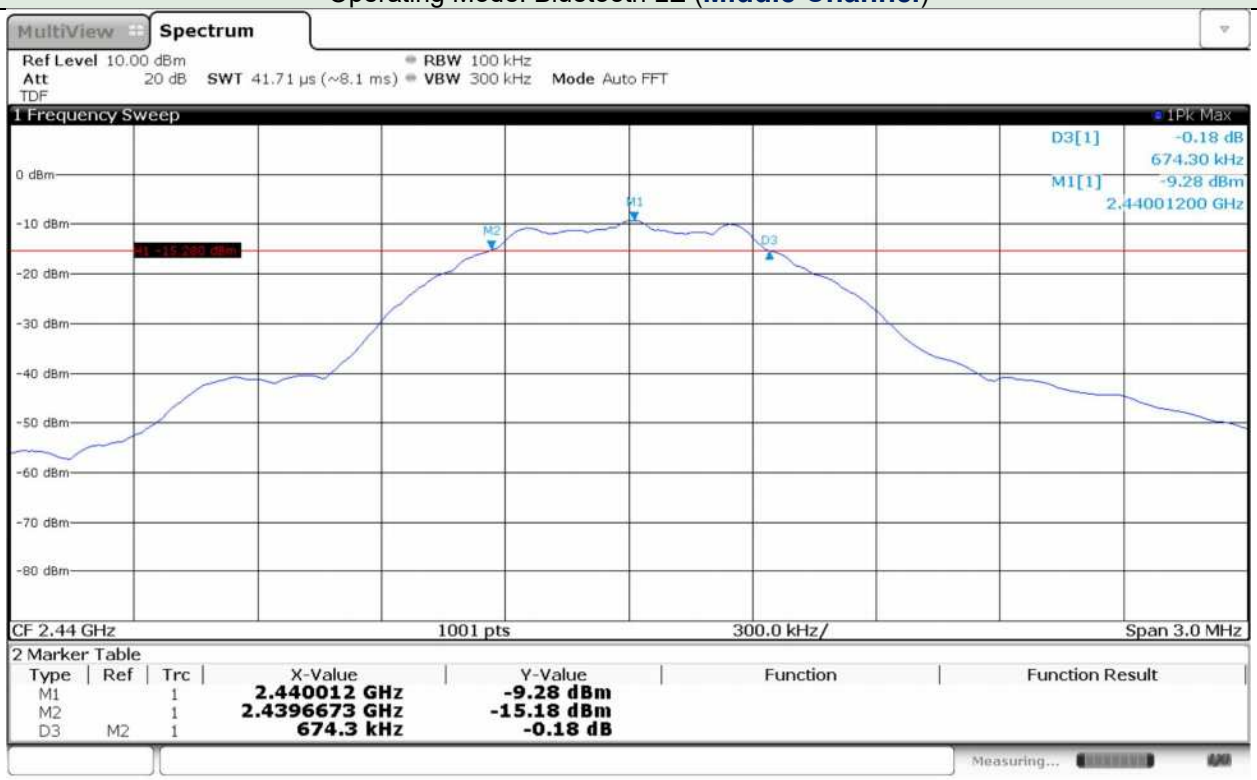
ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942 Report Form_01 (Rev.2)
TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

5.1.4 Test Plots

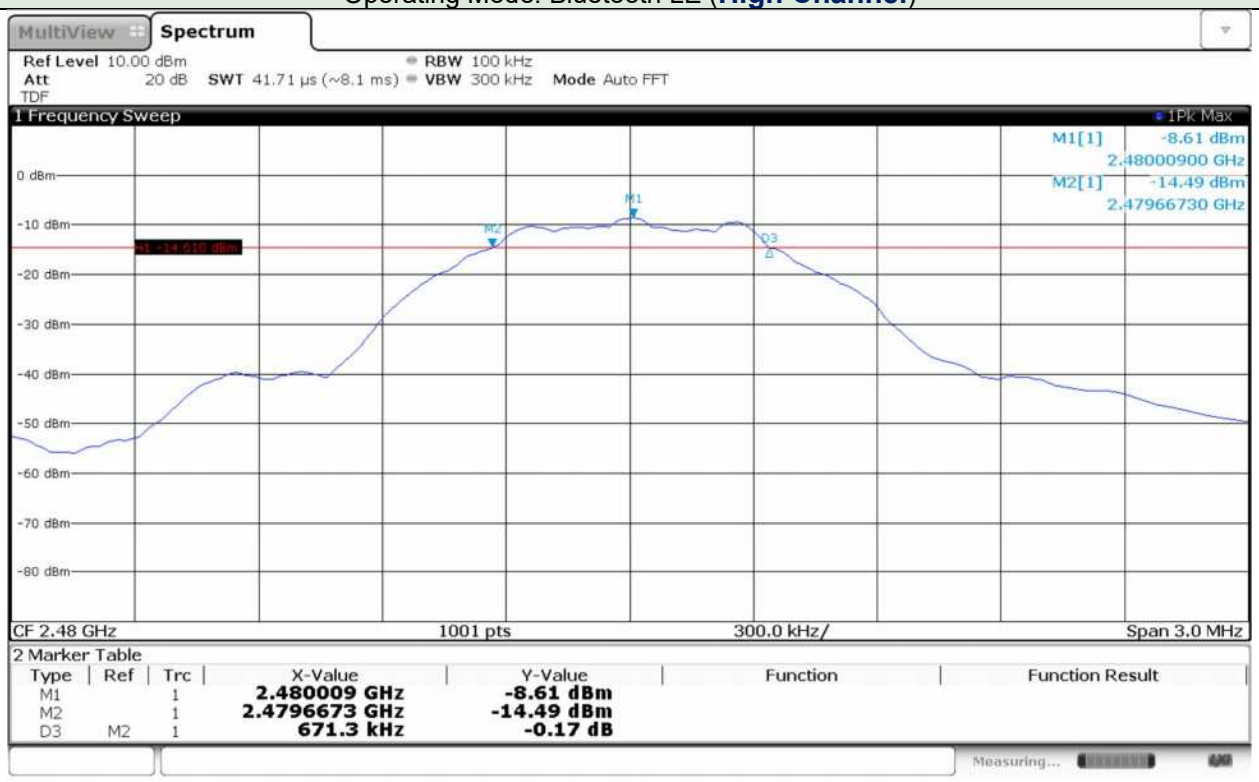
Operating Mode: Bluetooth LE (**Low Channel**)



Operating Mode: Bluetooth LE (**Middle Channel**)



Operating Mode: Bluetooth LE (**High Channel**)



ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942

TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

5.2 99 % Bandwidth

5.2.1 Limit

Not applicable.

5.2.2 Method of Measurement

The transmitter output is connected to the spectrum analyzer. The RBW is set to 1 % to 5 % of the OBW.

The span is set to capture all products of the modulation process, including the emission skirts.

The VBW is set to 3 times the RBW. The sweep time is coupled and peak detection and max hold mode is used. The spectrum analyzer internal 99% bandwidth function is utilized.

5.2.3 Test Data

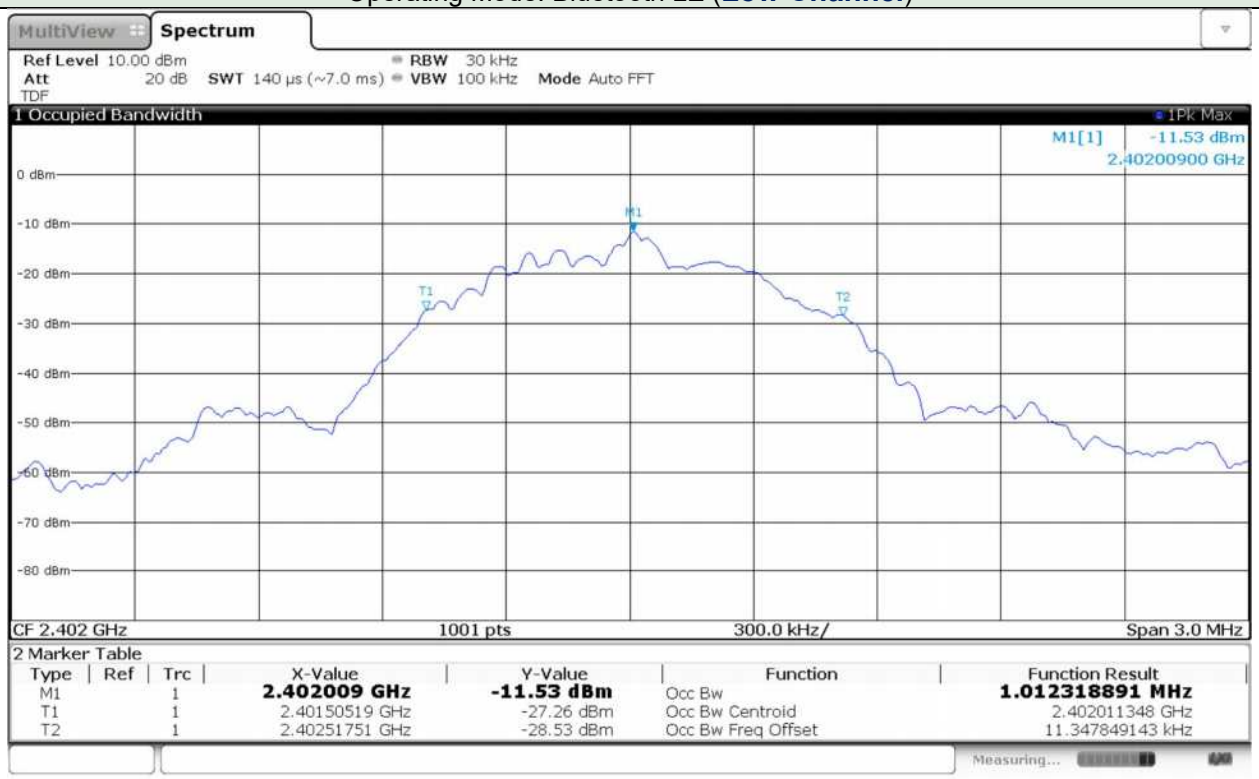
Date of Test	2020-09-11	Temperature	(26.2 ± 0.5) °C
		Relative humidity	(51.1 ± 3.1) % R.H.
Test Result	***Not Applicable***	Tested by	Do-heon Kim

Operational Mode: Bluetooth LE		
Channel	Frequency (MHz)	99 % Bandwidth (MHz)
Low	2 402	1.01
Middle	2 440	1.02
High	2 480	1.02

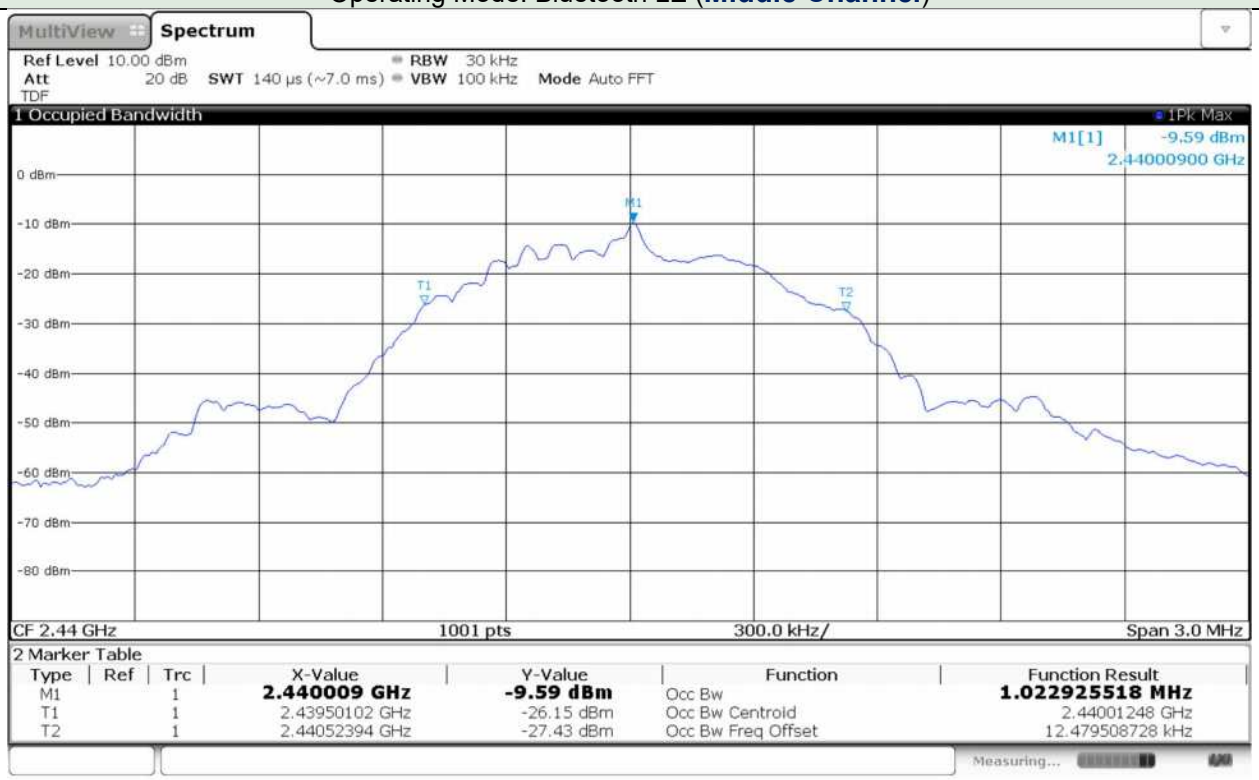
ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942 Report Form_01 (Rev.2)
TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

5.2.4 Test Plots

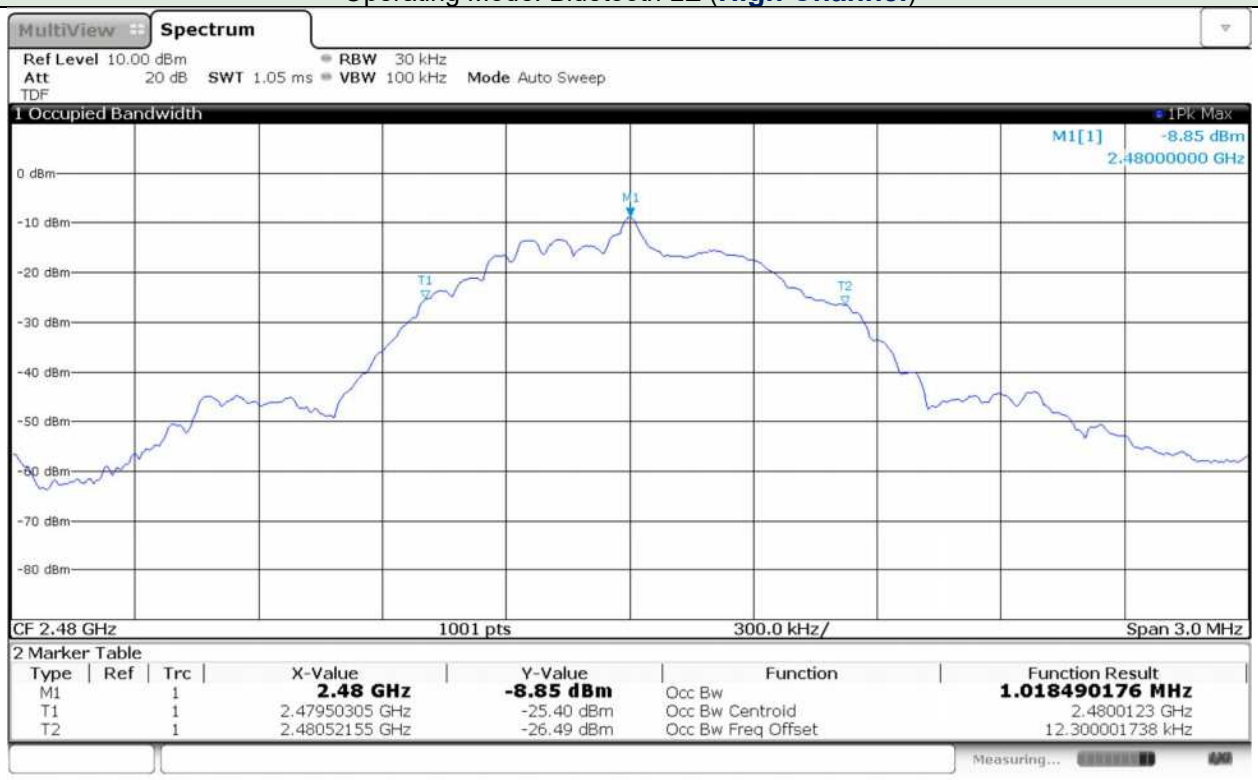
Operating Mode: Bluetooth LE (**Low Channel**)



Operating Mode: Bluetooth LE (**Middle Channel**)



Operating Mode: Bluetooth LE (**High Channel**)



5.3 Maximum Peak Output Power

5.3.1 Limit

Acc. To section 15.247, For system using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt, based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.3.2 Method of Measurement

Reference to KDB 558074 D01 DTS Meas Guidance v05r02: 8.3.1.1 RBW ≥ DTS bandwidth

The cable assembly insertion loss was entered as an offset in the spectrum analyzer to allow for direct reading of power.

5.3.3 Test Data for Output Power

Date of Test	2020-09-11	Temperature	(26.2 ± 0.5) °C
		Relative humidity	(51.1 ± 3.1) % R.H.
Test Result	***PASS***	Tested by	Do-heon Kim

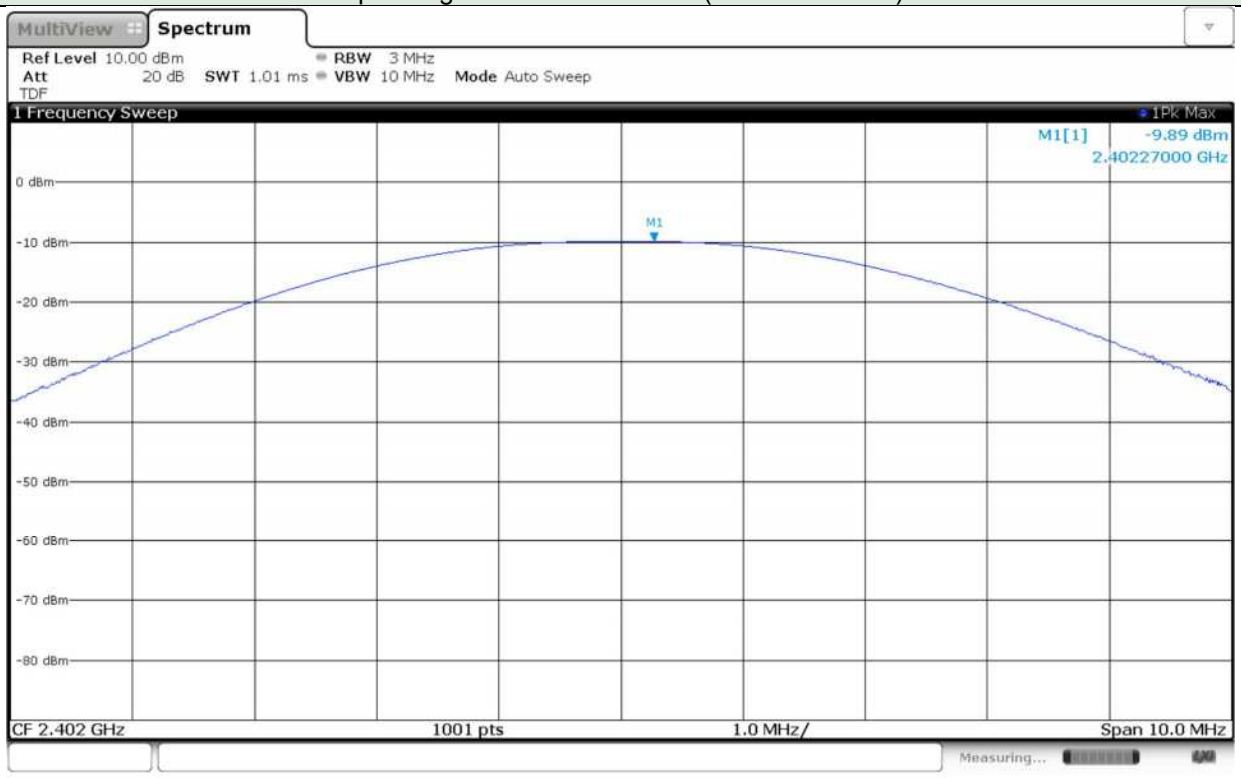
Operating Mode: Bluetooth LE				
Channel	Frequency (MHz)	Measured Value (dBm)	Limit (dBm)	Margin (dB)
Low	2 402	-9.89	30	39.89
Middle	2 440	-8.77		38.77
High	2 480	-8.22		38.22

Remark. Margin = Limit – Measured Value

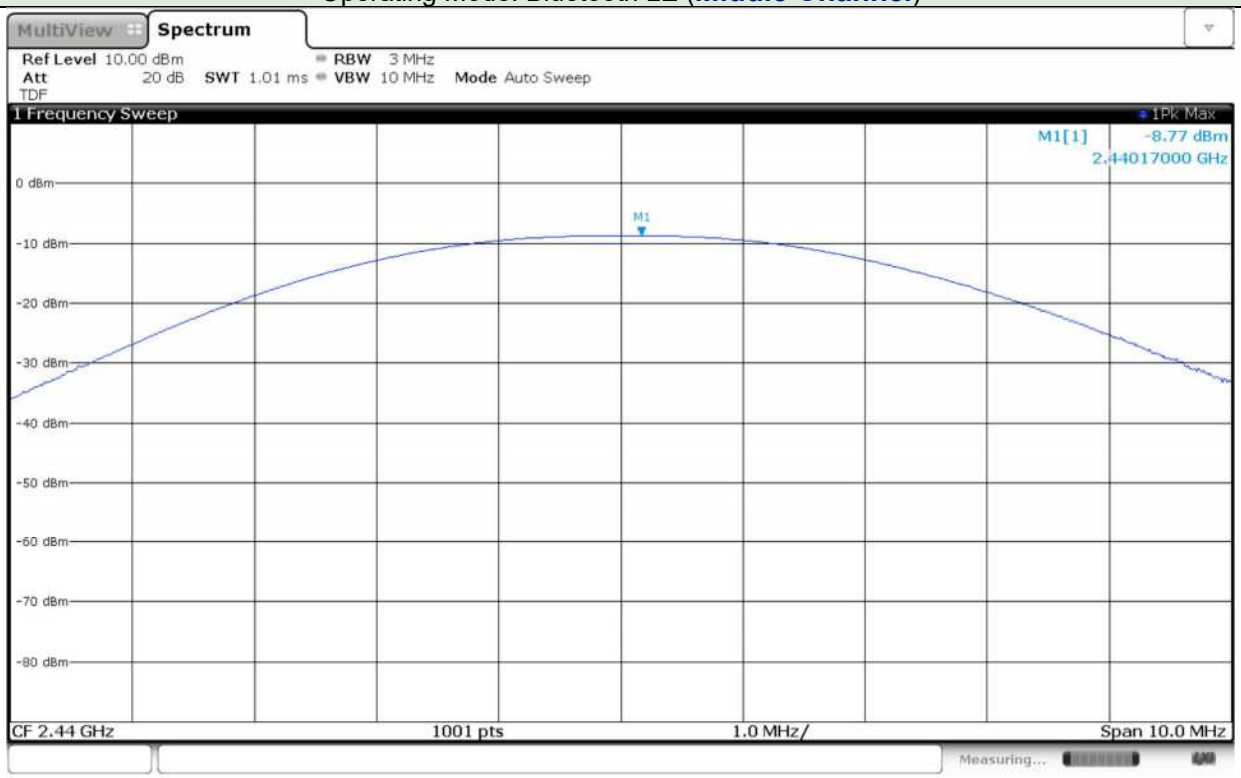
ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942 Report Form_01 (Rev.2)
TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

5.3.4 Test Plots

Operating Mode: Bluetooth LE (**Low Channel**)



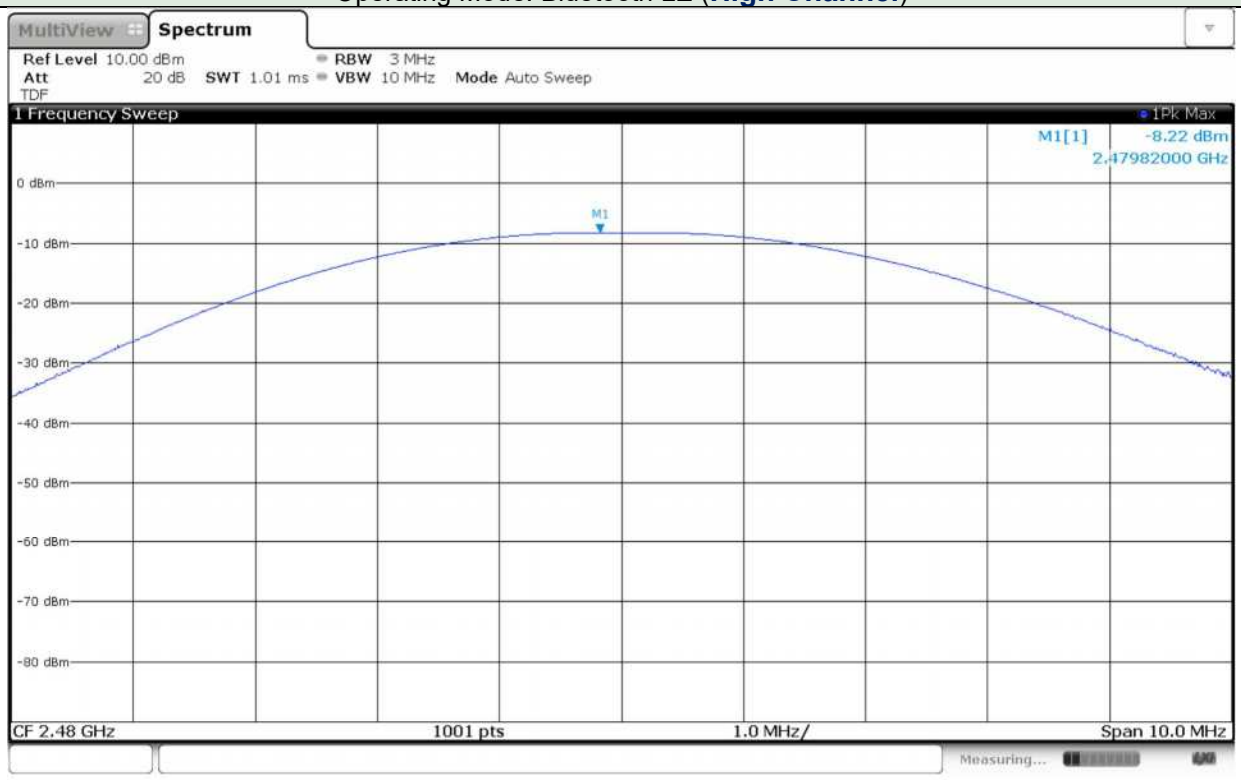
Operating Mode: Bluetooth LE (**Middle Channel**)



ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942

TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

Operating Mode: Bluetooth LE (**High Channel**)



ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942

TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

5.4 Peak Power Spectral Density

5.4.1 Limit

Acc. To section 15.247, the power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

5.4.2 Method of Measurement

Reference to KDB 558074 D01 DTS Meas Guidance v05r02: 8.4 Method PKPSD (peak PSD).

The transmitter output is connected to a spectrum analyzer with the RBW set from 3 kHz to 100 kHz, VBW ≥ 3 X RBW, peak detector and max hold.

5.4.3 Test Data

Date of Test	2020-09-11	Temperature	(26.2 ± 0.5) °C
		Relative humidity	(51.1 ± 3.1) % R.H.
Test Result	***PASS***	Tested by	Do-heon Kim

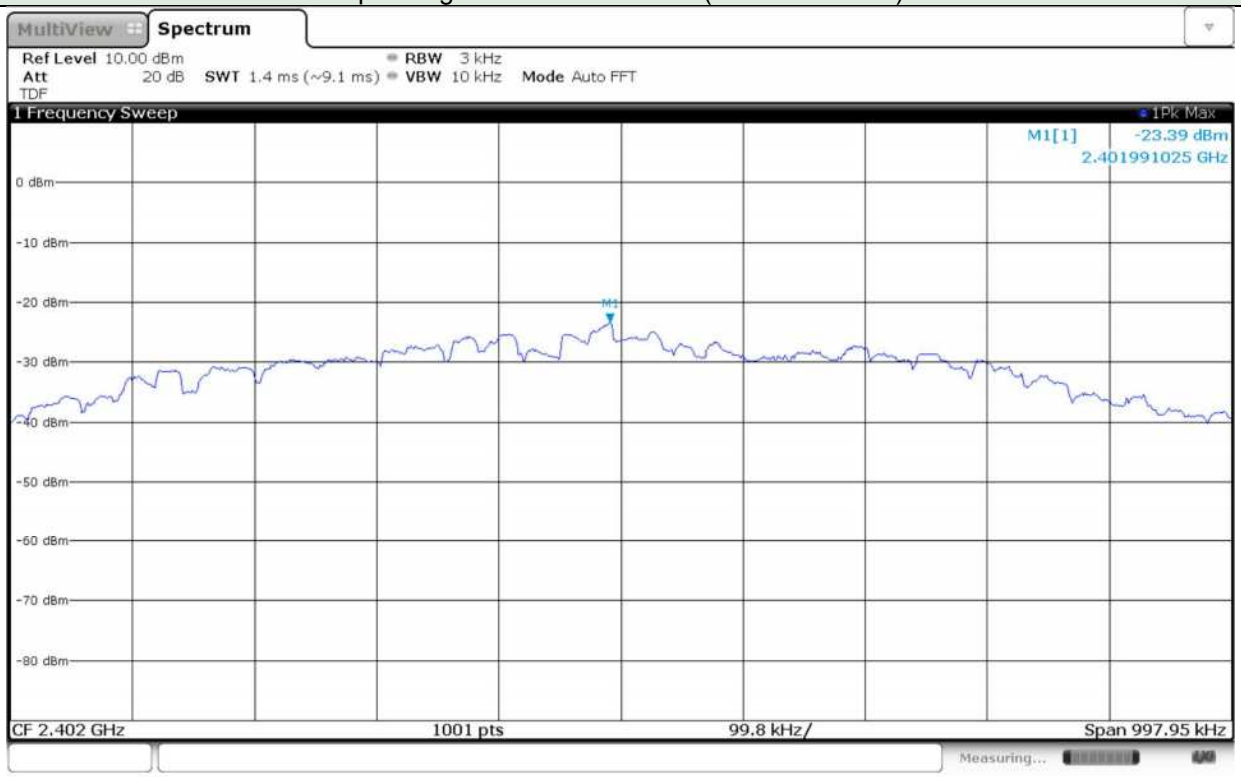
Operating Mode: Bluetooth LE				
Channel	Frequency (MHz)	Measured Value (dBm)	Limit (dBm)	Margin (dB)
Low	2 402	-23.39	8	31.39
Middle	2 440	-21.45		29.45
High	2 480	-19.32		27.32

Remark. Margin = Limit – Measured Value

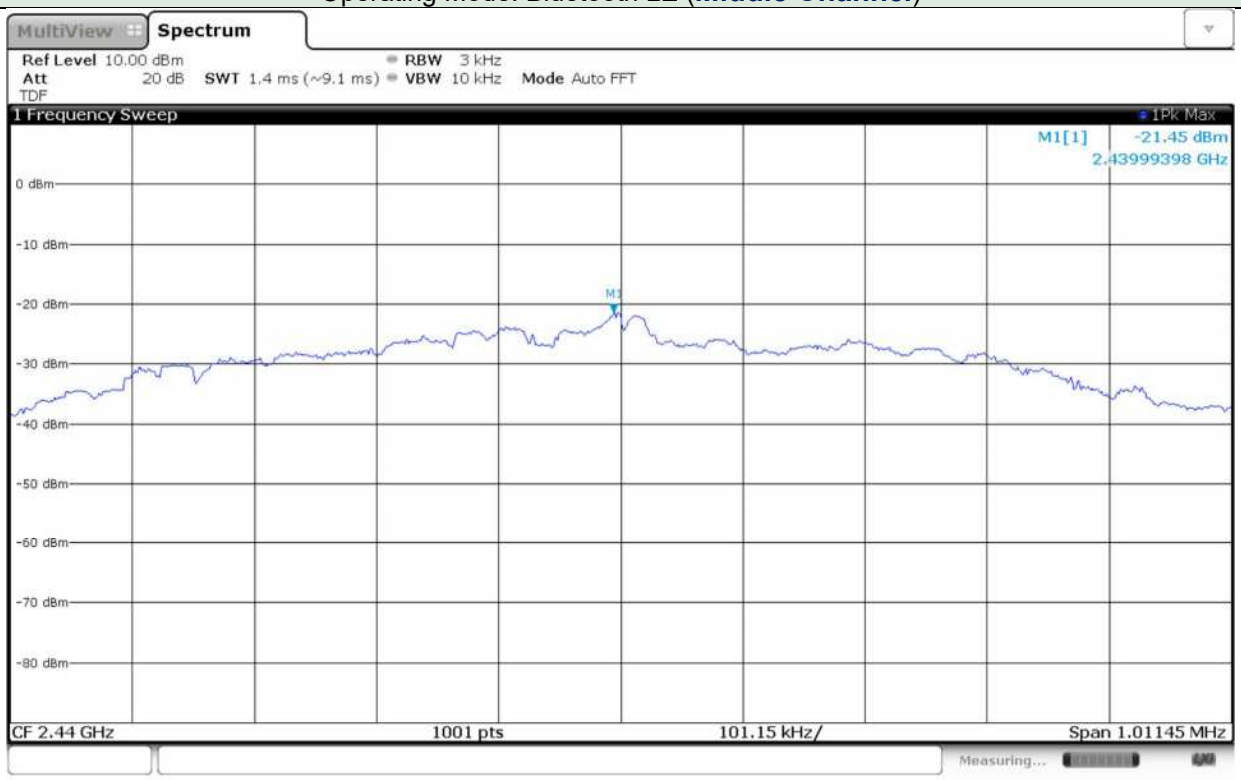
ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942 Report Form_01 (Rev.2)
TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

5.4.4 Test Plots

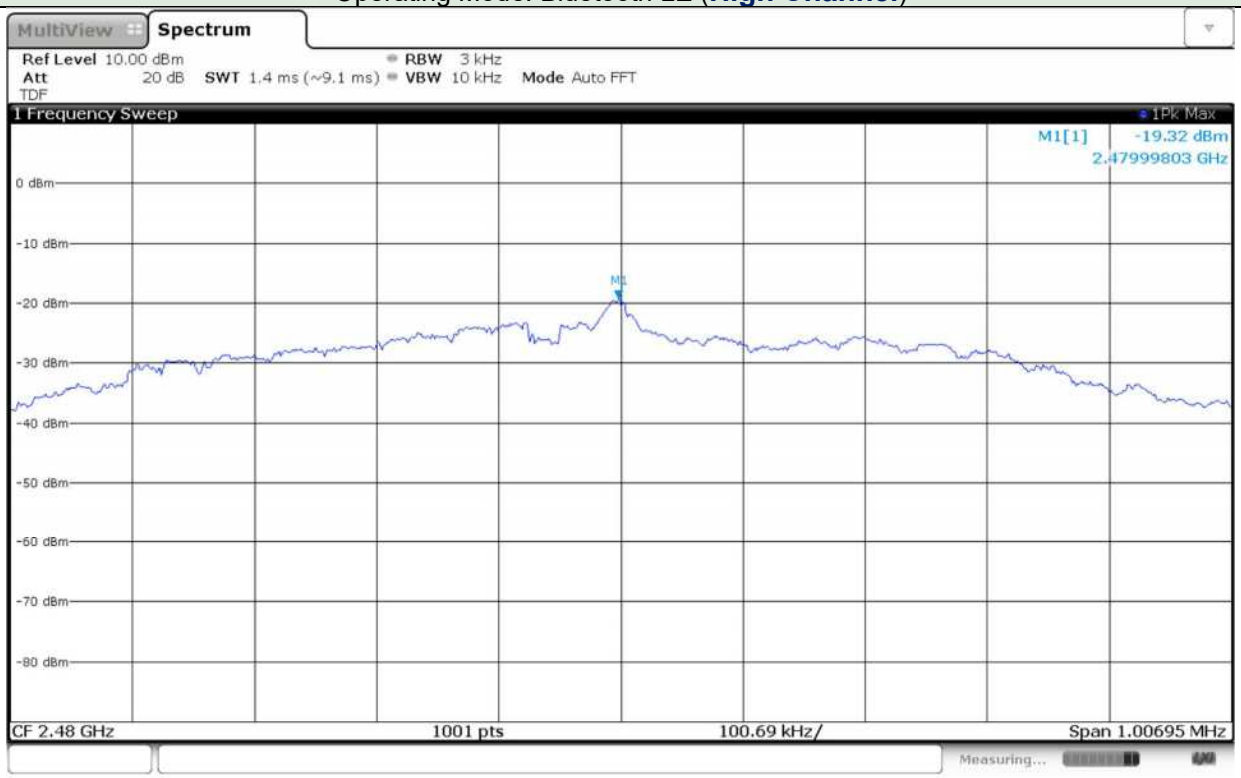
Operating Mode: Bluetooth LE (**Low Channel**)



Operating Mode: Bluetooth LE (**Middle Channel**)



Operating Mode: Bluetooth LE (**High Channel**)



ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942

TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

5.5 Out of Band Emission

5.5.1 Limit

Acc. To section 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 emission which in the restricted band, as define in section §15.205(a), must also comply the radiated emission limits specified in section §15.209(a) (see section §15.205(c))

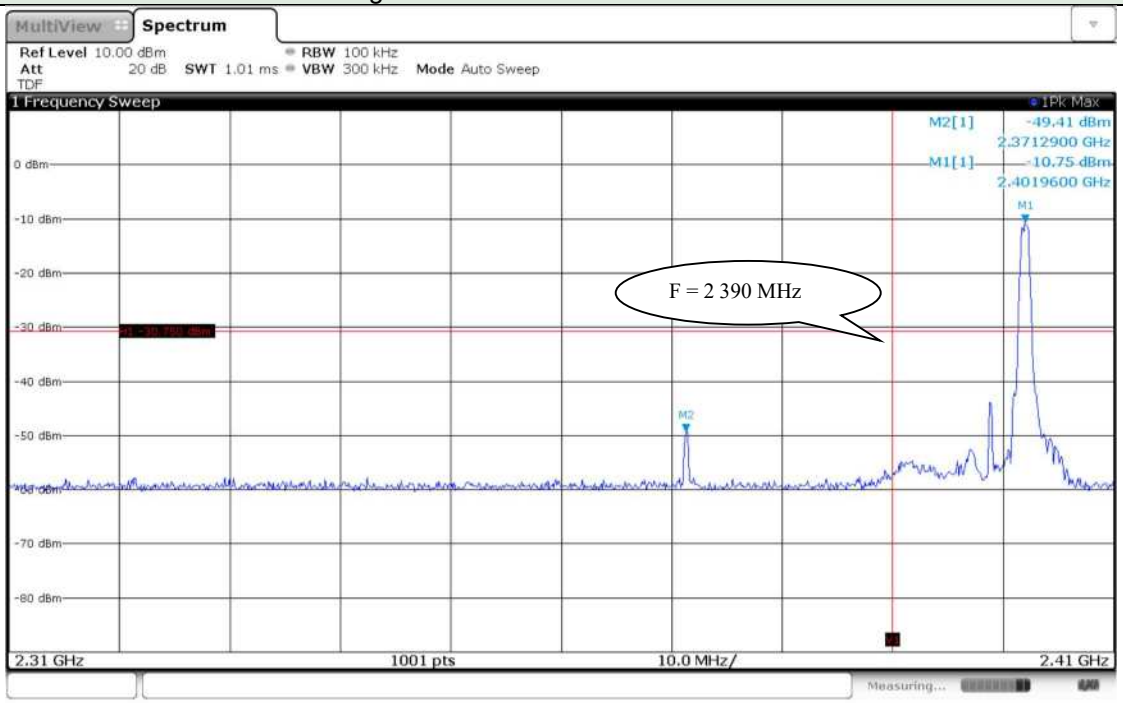
5.5.2 Method of Measurement

Reference to KDB 558074 D01 DTS Meas Guidance v05r02: 8.5 Emissions in non-restricted frequency bands. The transmitter output is connected to a spectrum analyzer with the RBW set to 100 kHz, VBW ≥ 3 X RBW, peak detector and max hold. Measurements utilizing these settings are made of the in-band reference level, band-edge (where measurements to the general radiated limits will not be made) and out-of-band emissions.

5.5.3 Test Data for Operating mode: Bluetooth LE

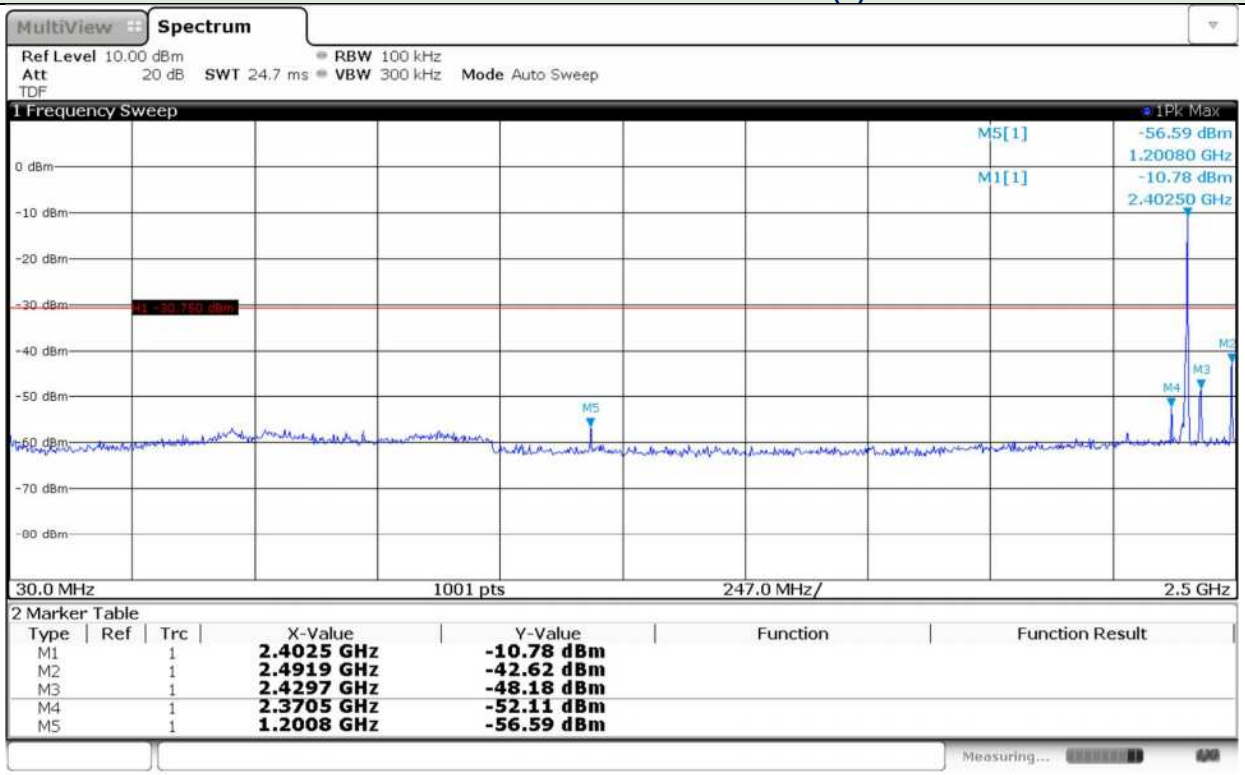
Date of Test	2020-09-11	Temperature	(26.2 ± 0.5) °C
		Relative humidity	(51.1 ± 3.1) % R.H.
Test Result	***PASS***	Tested by	Do-heon Kim

Band-edge and Restricted band – **Low channel**

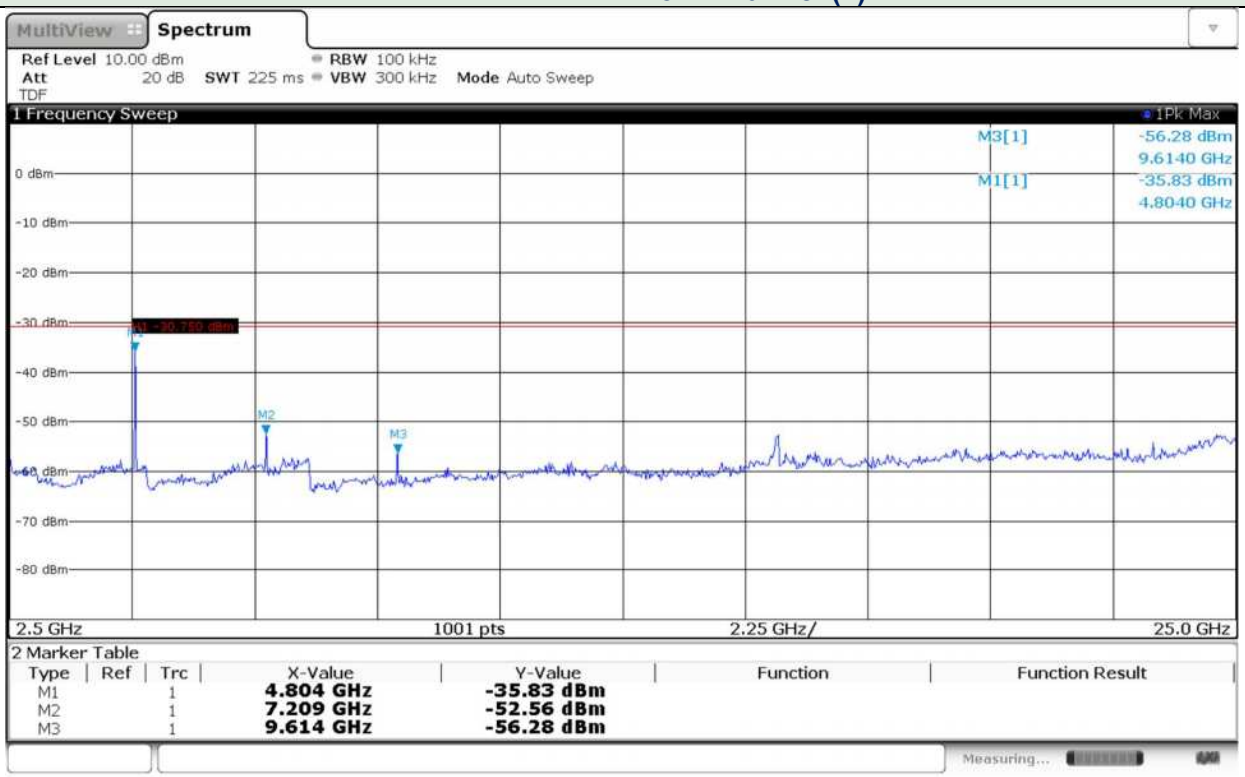


Band-edge and Restricted band – **High channel**

Non-restricted band – **Low Channel (1)**



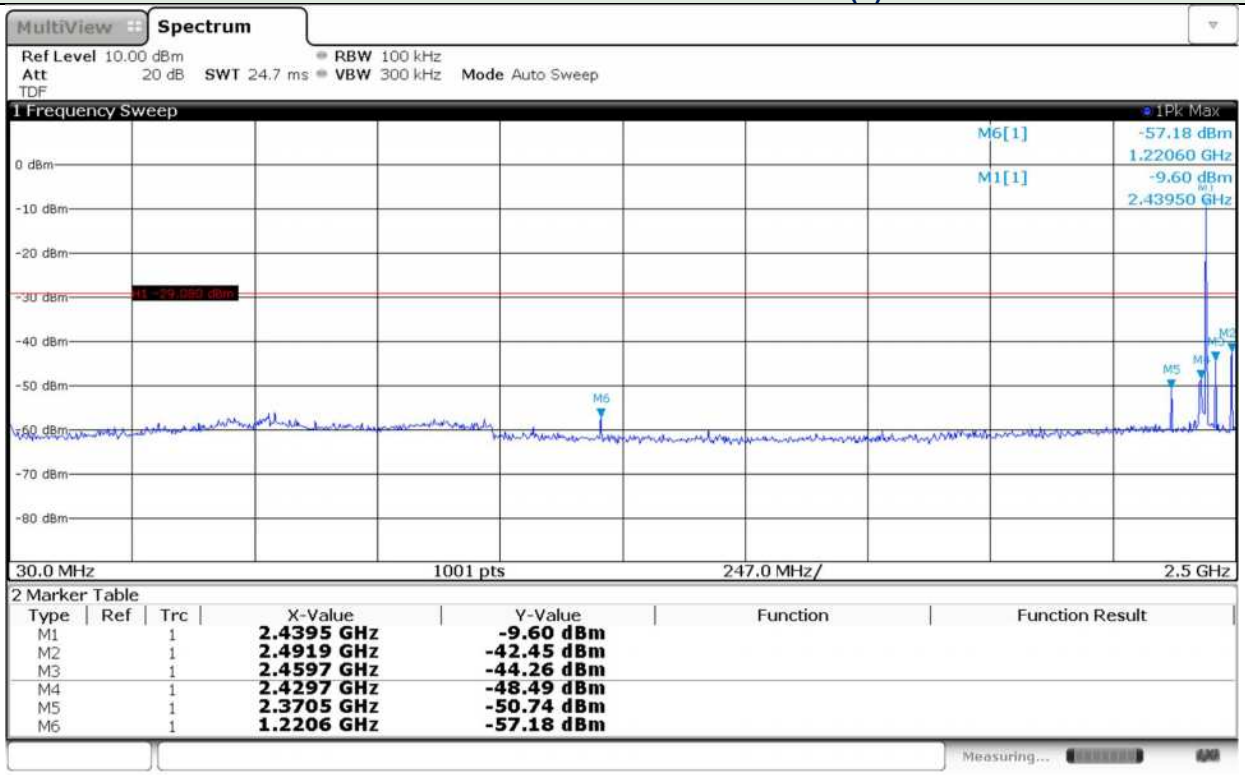
Non-restricted band – **Low Channel (2)**



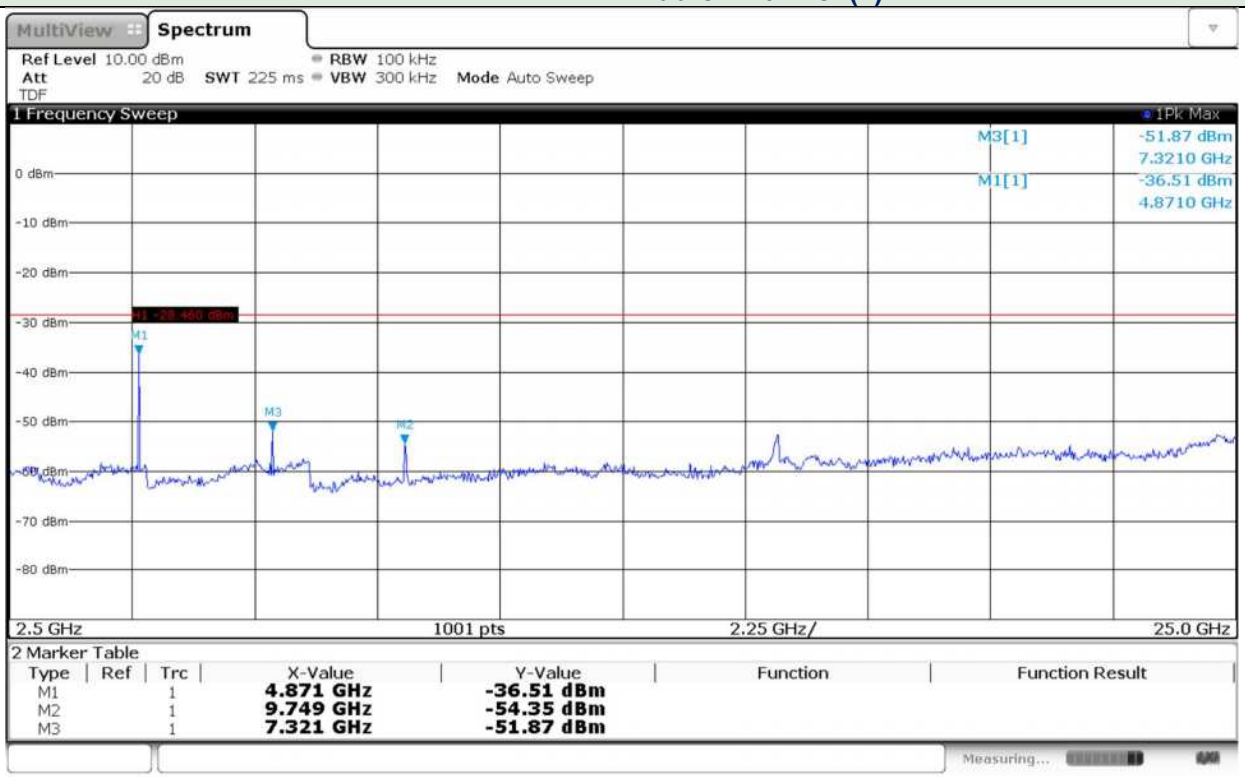
ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942

TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

Non-restricted band – **Middle Channel (1)**



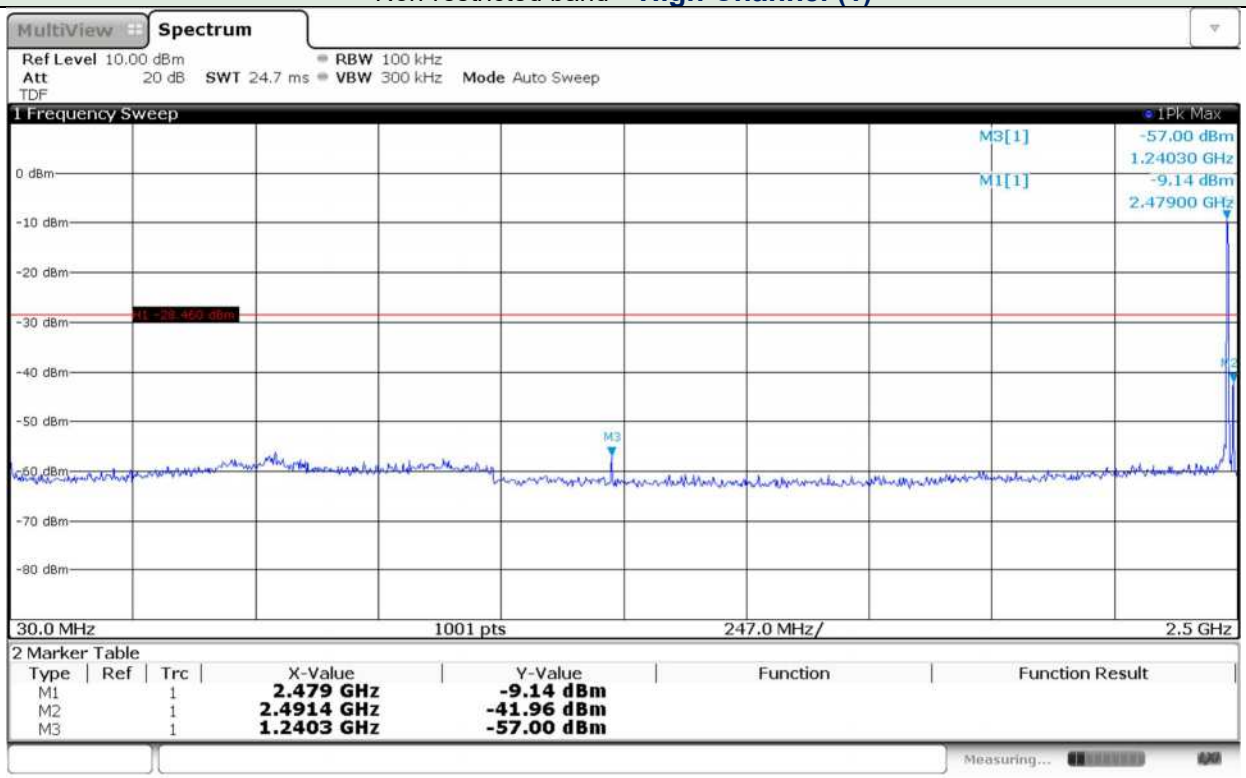
Non-restricted band – **Middle Channel (2)**



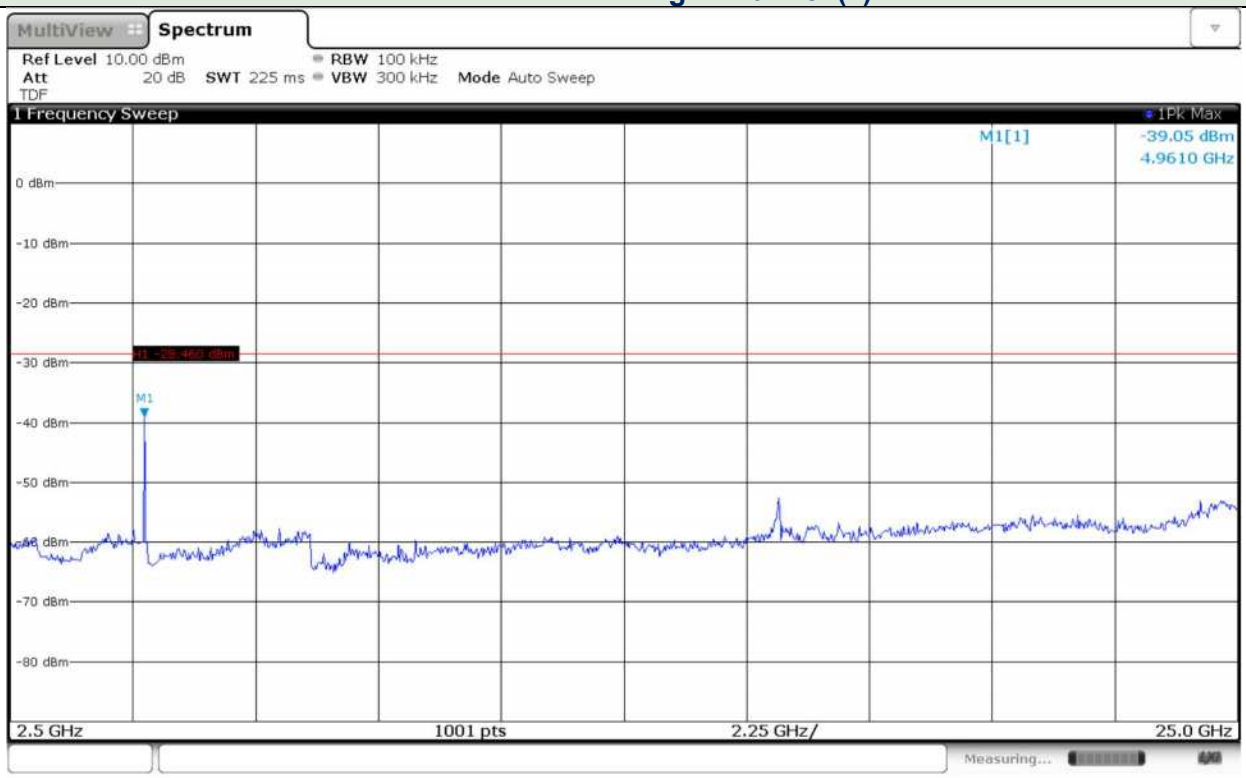
ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942

TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

Non-restricted band – **High Channel (1)**



Non-restricted band – **High Channel (2)**



ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942

TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

5.6 Radiated Emission

5.6.1 Limit

Acc. To section 15.205,15.209, following table shall be applied.

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
30 – 88	100	40
88 – 216	150	43.5
216 – 960	200	46
Above 960	500	24

5.6.2 Method of Measurement

Reference to KDB 558074 D01 DTS Meas Guidance v05r02: 8.6 Radiated emission measurements.
The radiated emissions measurements were on 3 m, semi-anechoic chamber. The EUT and other support equipment were placed on a non-conductive table 80 cm for below 1 GHz and 1.5 m for above 1 GHz 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 25 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.

For measurement below 1 GHz, the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For peak emission measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz and for average measurement, resolution bandwidth is set to 1 MHz; and the video bandwidth is set to 10 Hz, when duty cycle is more than 98 %. If duty cycle is less than 98 %, the video bandwidth is set to ≥ 1/T, where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

For measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz
The spectrum from 30 MHz to 25 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each applicable band.

ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942 Report Form_01 (Rev.2)
TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

5.6.3 Test Site Requirement for KDB 414788 D01

Acc. to KDB 414788 D01 Radiated Test Site v01, Semi Anechoic Chamber (SAC) shall be verified test results below 30 MHz with Open Area Test Site (OATS), so we compared test results between the measurements from our SAC and an OATS and found test results almost same, so we ***declare test result for below 30 MHz from our SAC is valid and met the requirement acc. to KDB 414788 D01 Radiated Test Site v01***.

5.6.4 Measurement Uncertainty

Measurement uncertainties were not taken into account and following uncertainty levels have been estimated for tests performed on the apparatus. The measurement uncertainties are given with at least 95 % confidence.

Frequency Range	Uncertainty	Frequency Range	Uncertainty
9 kHz ~ 30 MHz	±2.6 dB	30 MHz ~ 1 GHz	±4.5 dB
1 GHz ~ 18 GHz	±5.0 dB	18 GHz ~25 GHz	±5.2 dB

5.6.5 Sample Calculated Example

At 80 MHz Limit = 40.0 dBuV/m

Result (dBuV/m)

= Receiver Reading (dBuV) + Antenna Factor (dB/m) - Pre-amplifier Gain (dB) + Cable Loss (dB) = 30

Margin = Limit – Result = 40 – 30 = 10 so the EUT has 10.0 dB margin at 80 MHz

ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942 Report Form_01 (Rev.2)
TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

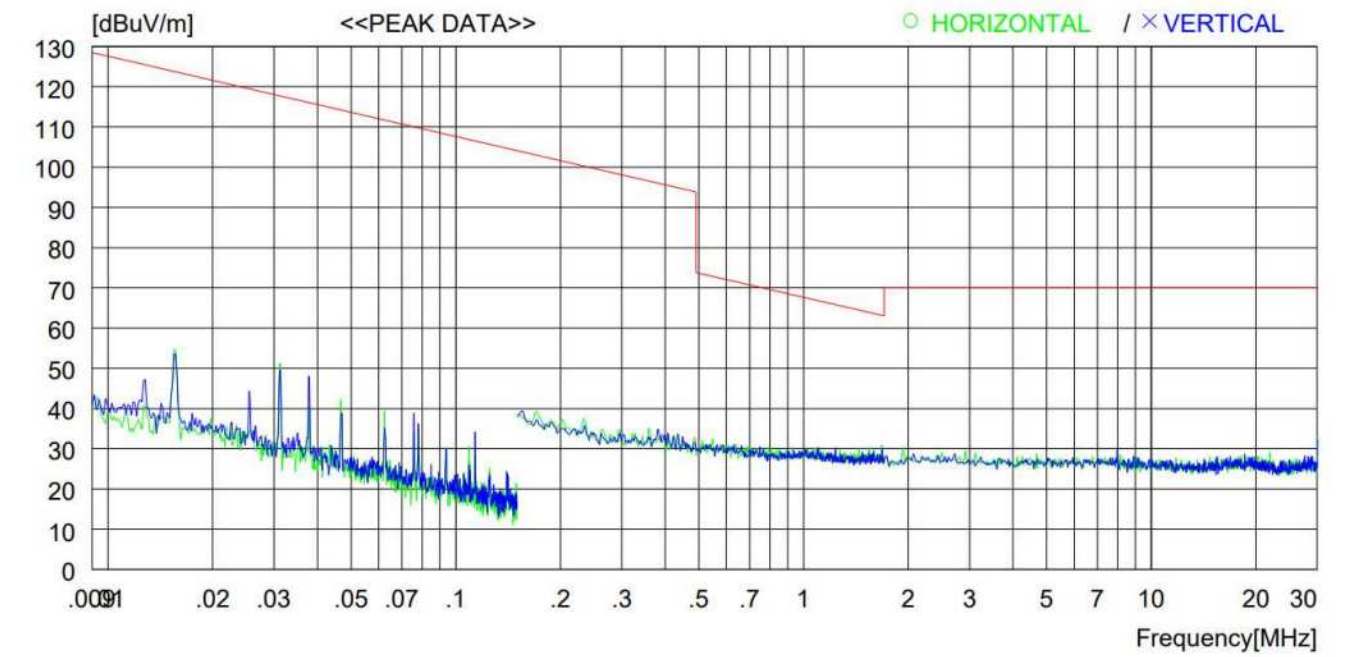
5.6.6 Test Data

Date of Test	2020-09-14	Temperature	(23.6 ± 2.7) °C
		Relative humidity	(51.8 ± 5.9) % R.H.
Measurement Frequency Range		9 kHz ~ 25 GHz	
Test Result	***PASS***	Tested By	Do-heon Kim

Frequency range	Detector Mode	Resolution BW	Video BW	Video Filtering	Measurement distance
Below 30 MHz	Peak or Q.P.	9 kHz	100 kHz	-	3 m
30 MHz ~ 1 000 MHz	Peak or Q.P.	100 kHz	300 kHz	-	3 m
Above 1 GHz	Peak	1 MHz	3 MHz		3 m
	Average	1 MHz	3 MHz		3 m

5.6.6.1 Test Data below 30 MHz

Graphical Test Data – Below 30 MHz



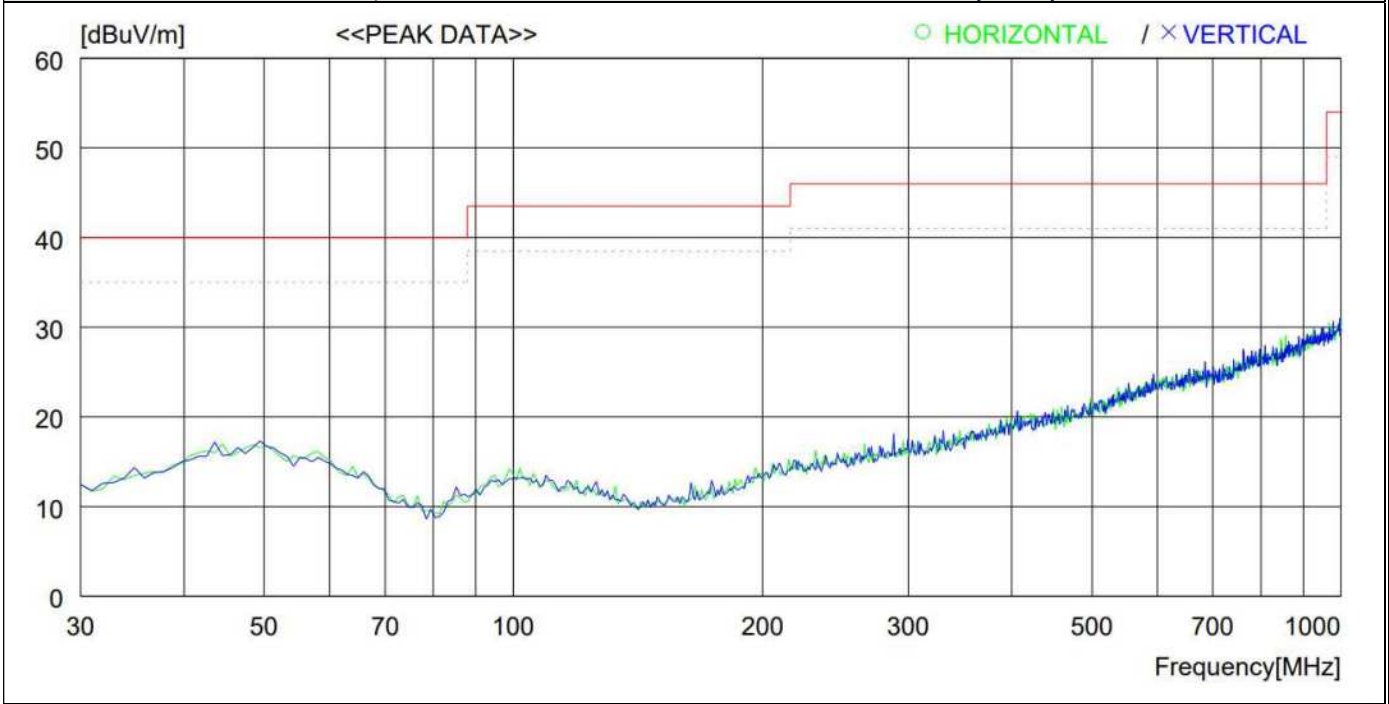
Tabulated Test Data – Low / Middle / High Channel

Frequency (MHz)	Receiver Reading (dBuV)	Detector Mode	Pol.	Ant. Factor (dB/m)	Corr. Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Degree)
* Spurious emissions that 20 dB below the limits didn't be recorded										

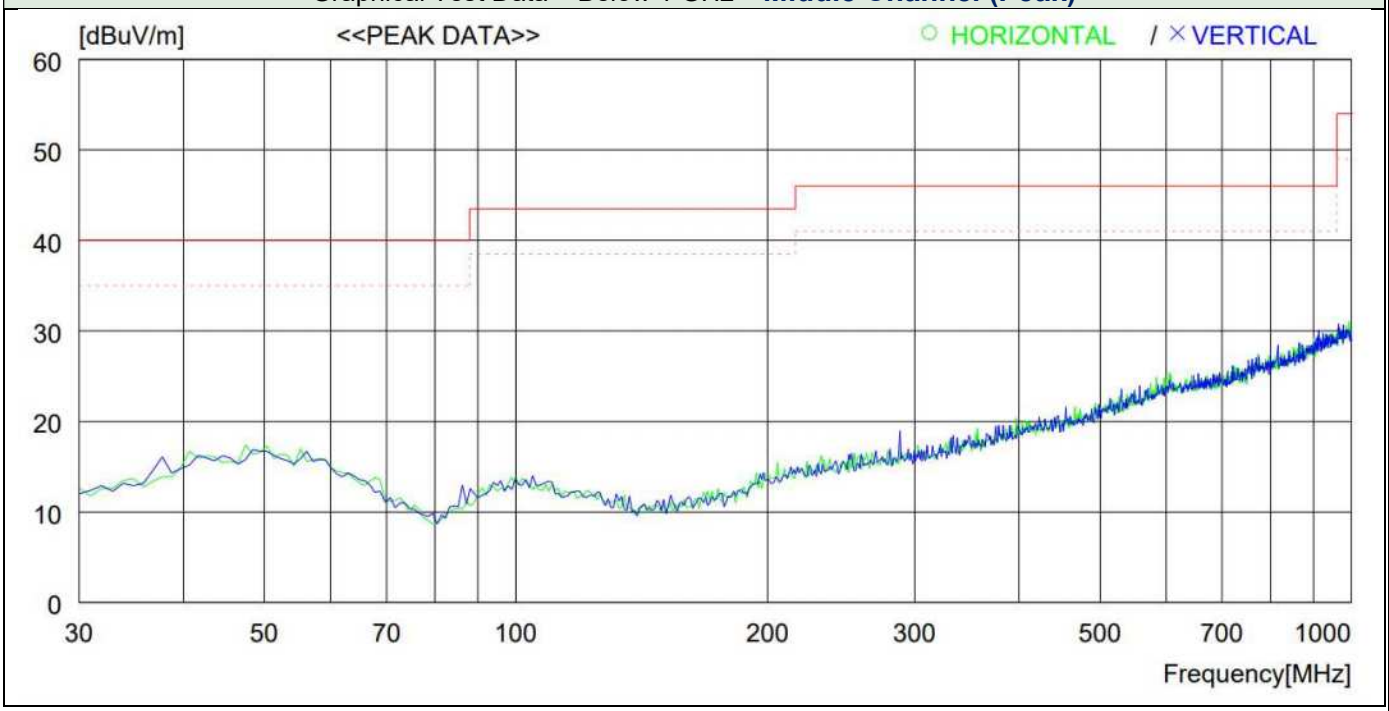
ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942 Report Form_01 (Rev.2)
TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

5.6.6.2 Test Data from 30 MHz to 1 GHz

Graphical Test Data – Below 1 GHz – **Low Channel (Peak)**

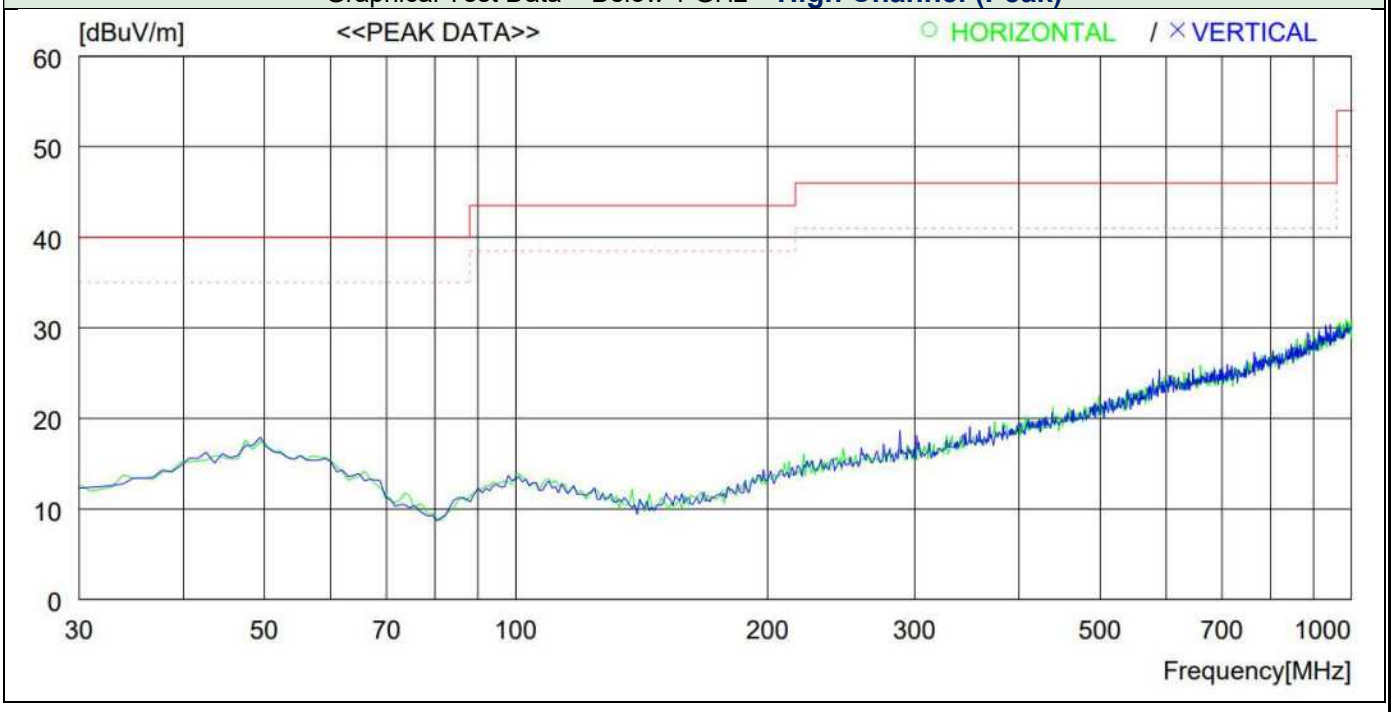


Graphical Test Data – Below 1 GHz – **Middle Channel (Peak)**



ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942 Report Form_01 (Rev.2)
TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

Graphical Test Data – Below 1 GHz – **High Channel (Peak)**



ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942 Report Form_01 (Rev.2)
TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

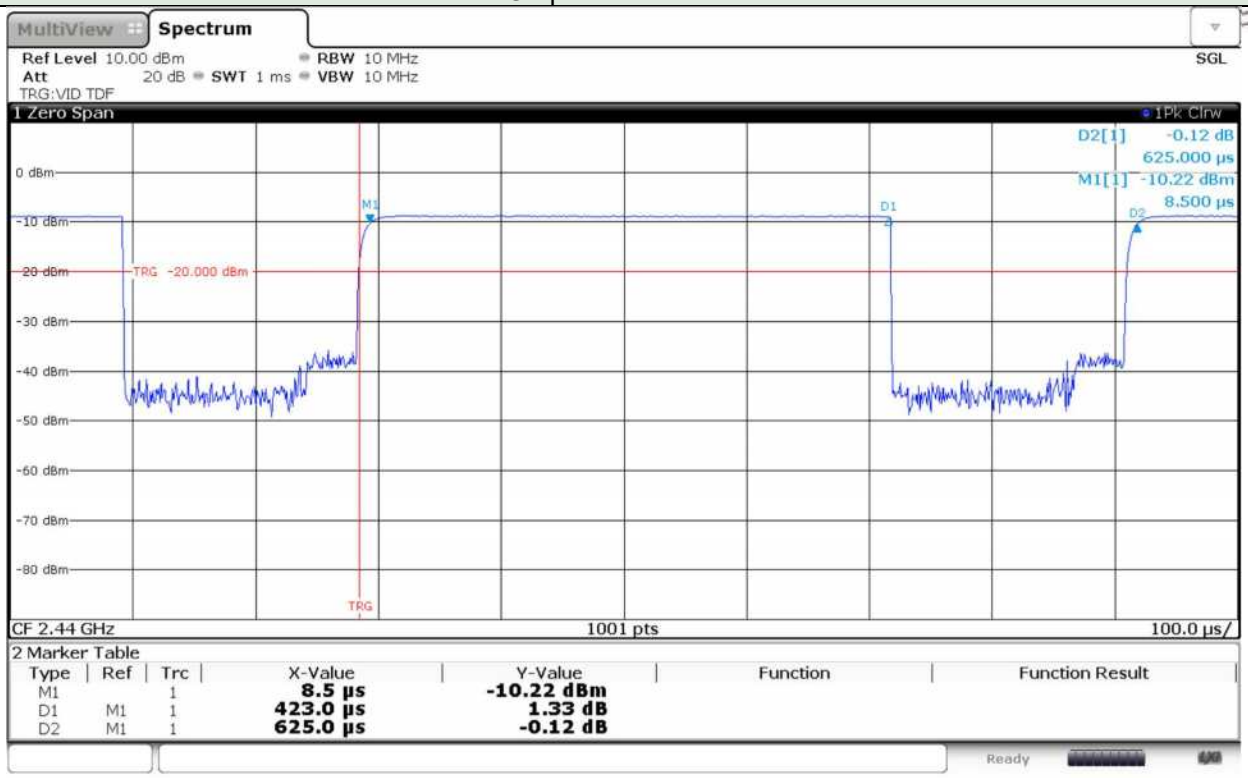
5.6.6.3 Test Data above 1 GHz

5.6.6.3.1 Duty Cycle

Date of Test	2020-09-14	Temperature	(23.6 ± 2.7) °C
		Relative humidity	(51.8 ± 5.9) % R.H.
Test Result	***PASS***	Tested By	Do-heon Kim

Detector Mode	Resolution BW	Video BW	Sweep Time
PEAK	1 MHz	3 MHz	Auto
AVERAGE	1 MHz	3 MHz	Auto
Measurement Distance	3 m		

Graphical Test Data



Tabulated Test Data

Operating Mode	On Time (ms)	On + Off Time (ms)	Duty Cycle (%)	Duty Factor (dB)
Bluetooth LE	423.0	625.0	67.68	1.70

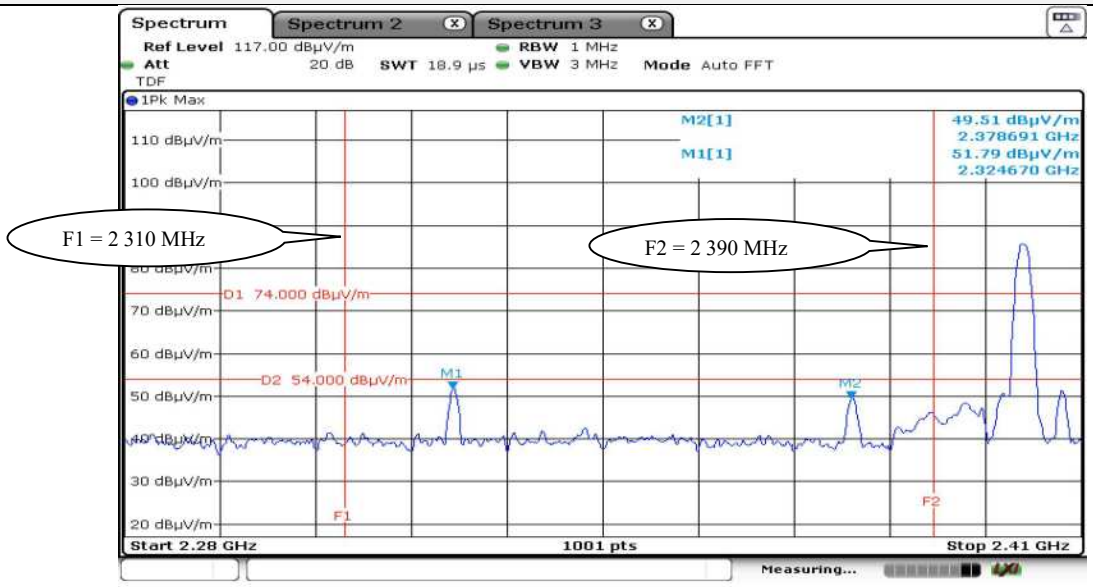
ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942

TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

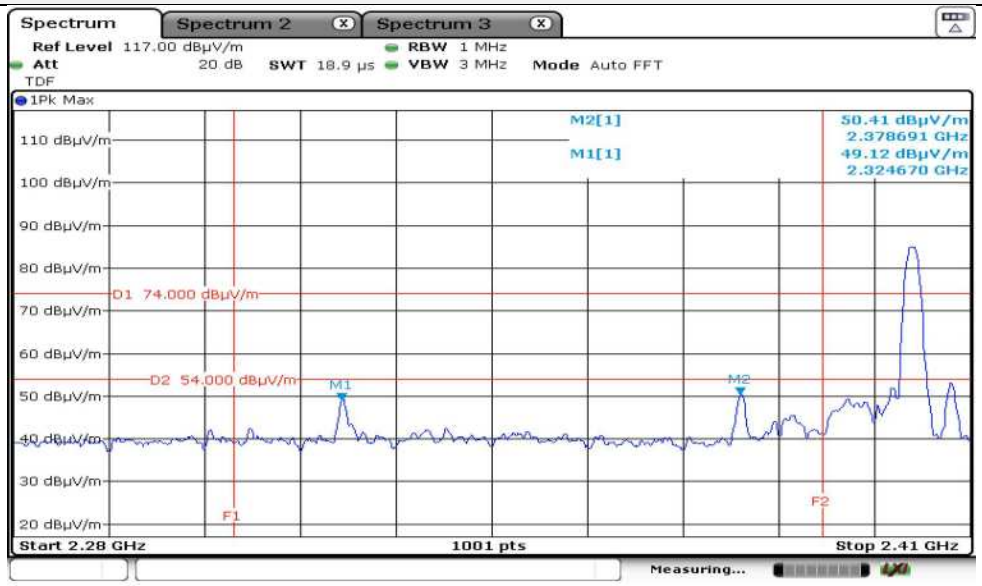
5.6.6.3.2 Test Data for Band edge (Restricted band)

Graphical Test Data – **Low Channel (Peak)**

Horizontal



Vertical



Tabulated Test Data – Low Channel

Freq. (MHz)	Detector Mode	Pol.	Measured Value (dBuV/m)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)
2 324.7	Peak	H	51.79	-	51.79	74.00	22.21	180	130
2 378.7	Peak	V	50.41	-	50.41	74.00	23.59	146	150

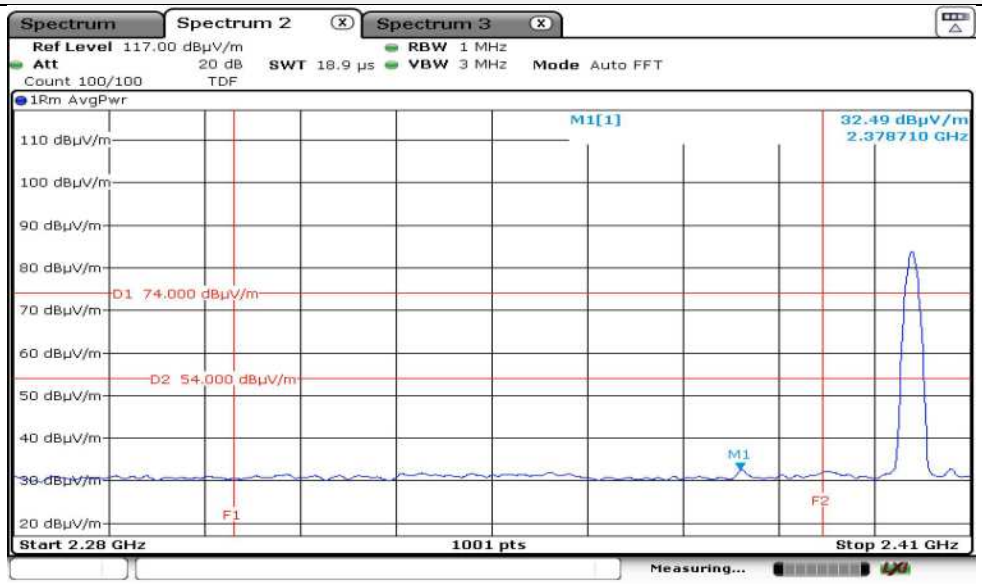
NOTE: "H" means Horizontal polarity, "V" means Vertical polarity.

Measured Value = Receiver reading + Antenna Factor + Cable Loss - Pre-amplifier Gain

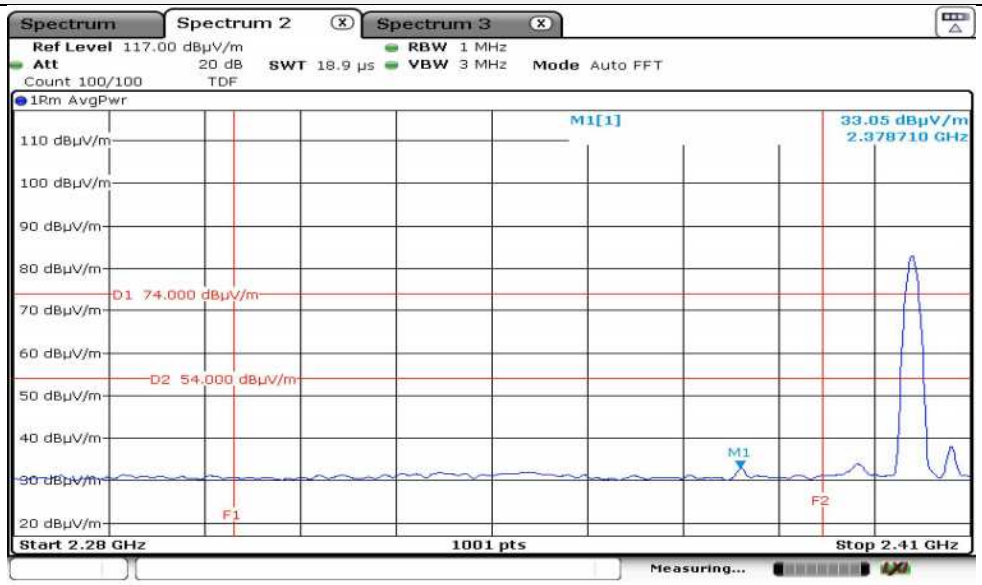
ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942 Report Form_01 (Rev.2)
TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

Graphical Test Data – **Low Channel (Average)**

Horizontal



Vertical



Tabulated Test Data – Low Channel

Freq. (MHz)	Detector Mode	Pol.	Measured Value (dBuV/m)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)
2 378.7	RMS	H	32.49	1.70	34.19	54.00	19.81	180	130
2 378.7	RMS	V	33.05	1.70	34.75	54.00	19.25	146	150

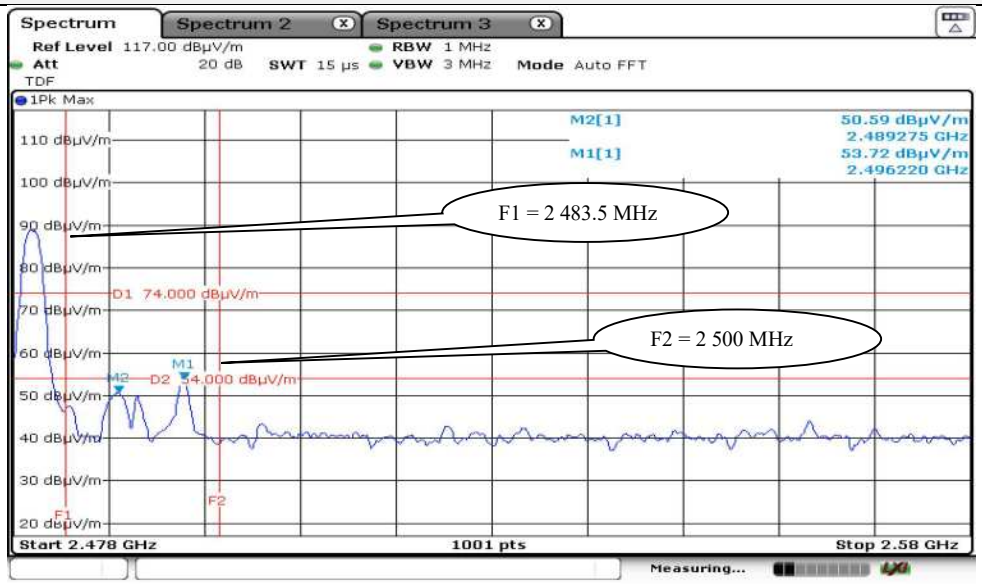
NOTE: "H" means Horizontal polarity, "V" means Vertical polarity.

Measured Value = Receiver reading + Antenna Factor + Cable Loss - Pre-amplifier Gain

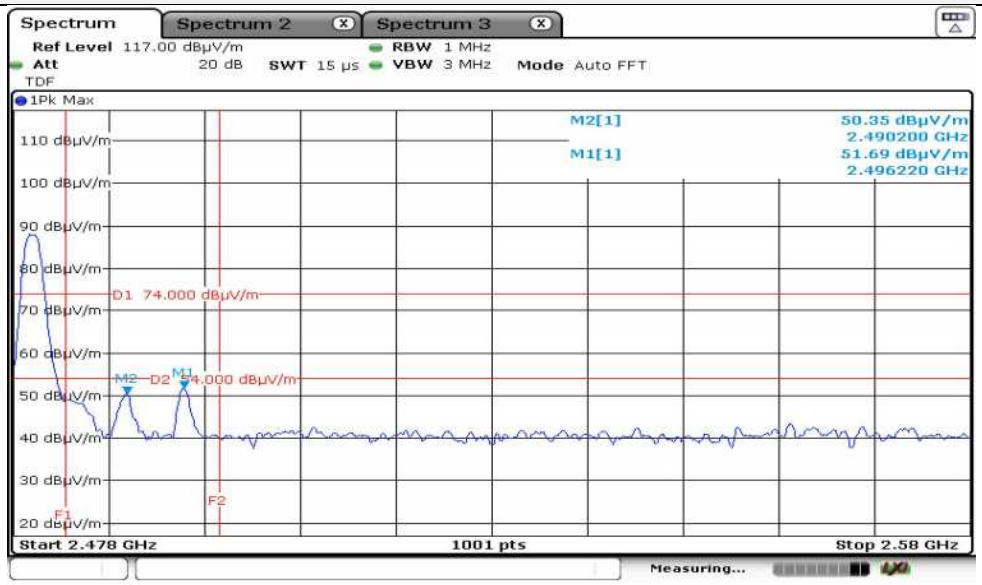
Result = Measured Value + Duty Factor

Graphical Test Data – **High Channel (Peak)**

Horizontal



Vertical



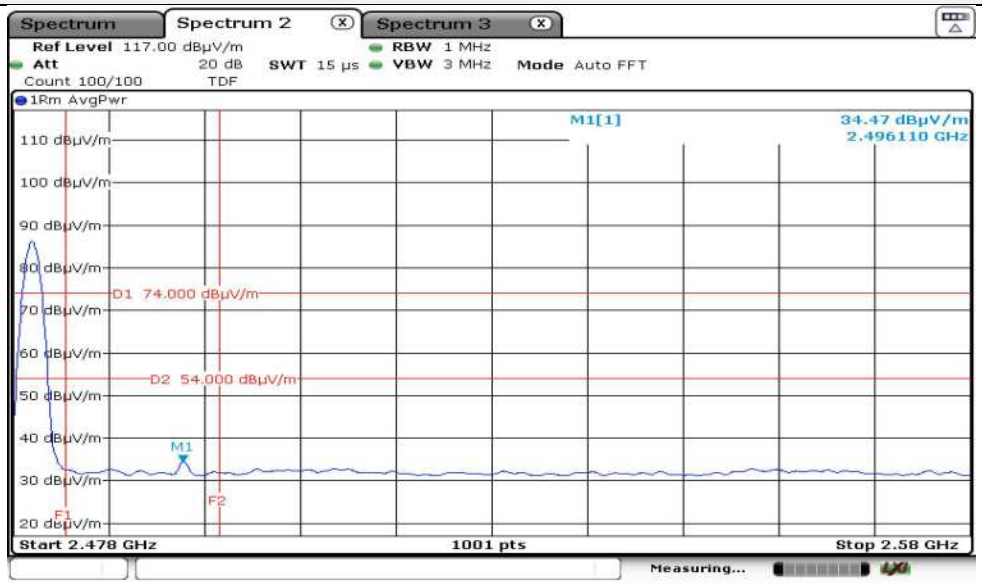
Tabulated Test Data – High Channel

Freq. (MHz)	Detector Mode	Pol.	Measured Value (dBuV/m)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)
2 496.2	Peak	H	53.72	-	53.72	74.00	20.28	200	132
2 496.2	Peak	V	51.69	-	51.69	74.00	22.31	180	172

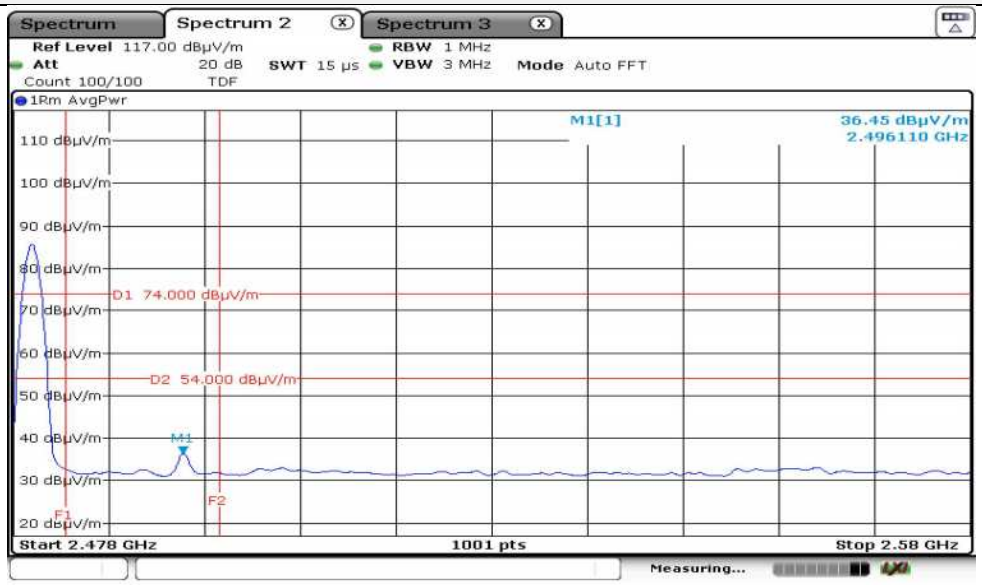
NOTE: "H" means Horizontal polarity, "V" means Vertical polarity.

Graphical Test Data – **High Channel (Average)**

Horizontal



Vertical



Tabulated Test Data – High Channel

Freq. (MHz)	Detector Mode	Pol.	Measured Value (dBuV/m)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)
2 496.1	RMS	H	34.47	1.70	36.17	54.00	17.83	200	132
2 496.1	RMS	V	36.45	1.70	38.15	54.00	15.85	180	172

NOTE: "H" means Horizontal polarity, "V" means Vertical polarity.

Result = Measured Value + Duty Factor

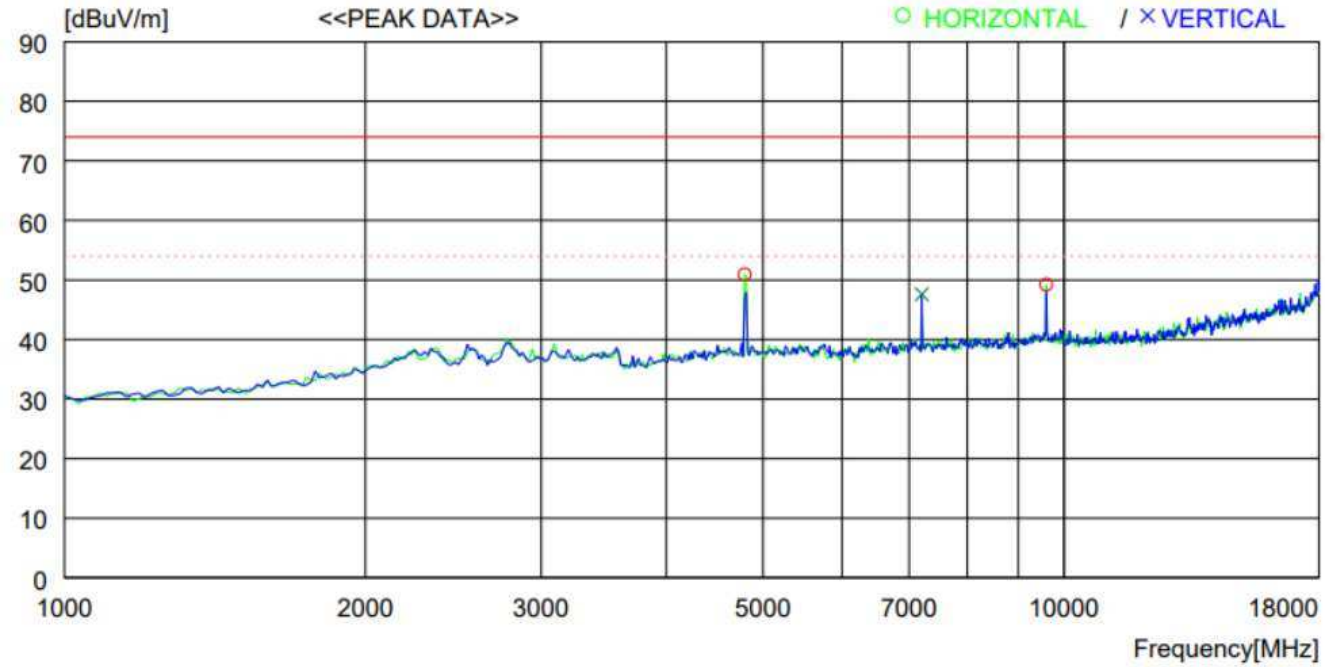
ENG Co., Ltd. 135-60 Gyeongchung-daero, Gonjiam-eup, Gwangju-si, Gyeonggi-do, Korea 464-942

TEL: +82-31-727-8300 FAX: +82-31-746-0800 http://www.the-eng.co.kr

5.6.6.4 Test Data for Harmonic & Spurious emission (1 GHz to 18 GHz)

5.6.6.4.1 Operating mode: Bluetooth LE

Graphical Test Data – **Low Channel (Peak)**



No.	FREQ [MHz]	READING PEAK [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal ------										
1	4791.000	51.3	33.6	5.8	39.8	50.9	74.0	23.1	200	0
2	9602.000	45.0	36.6	8.0	40.4	49.2	74.0	24.8	200	148
----- Vertical ------										
3	7205.000	45.5	35.1	6.8	39.8	47.6	74.0	26.4	200	0

Tabulated Test Data – Low Channel

Freq. (MHz)	Detector Mode	Pol.	Receiver Reading (dBuV)	Ant. Factor (dB/m)	Corr. Factor (dB)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)

* Spurious emissions that 20 dB below the limits didn't be recorded

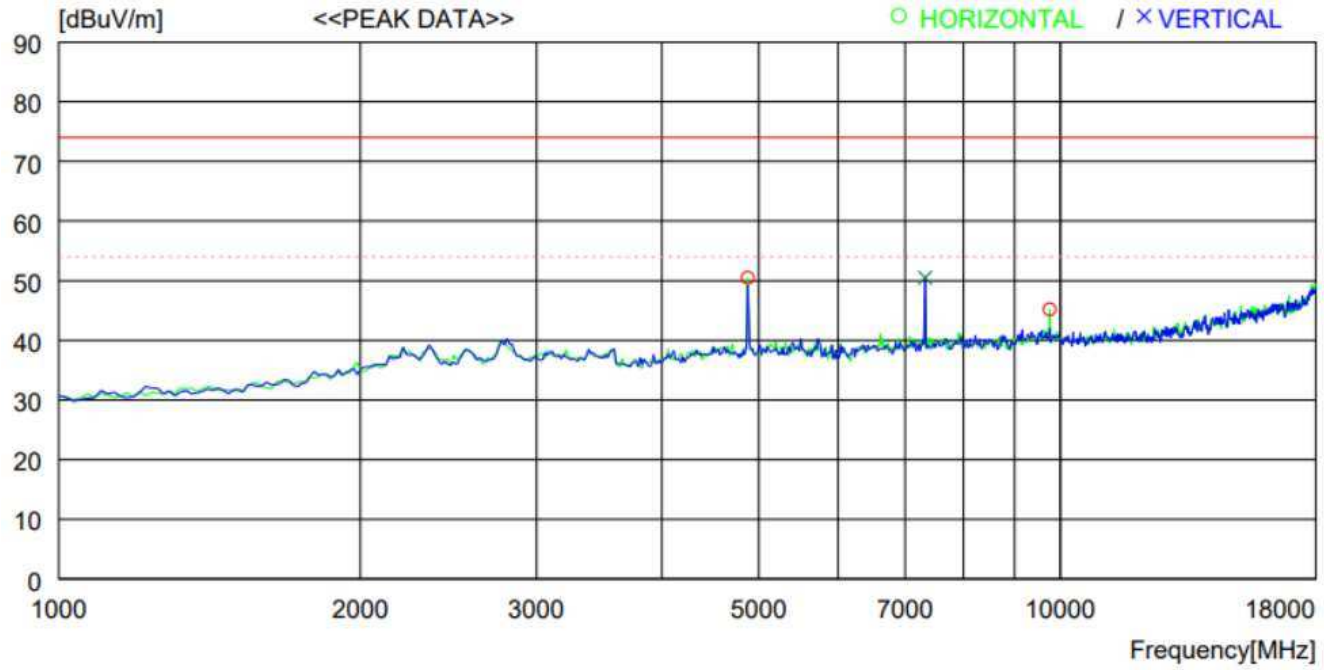
Note. "H" means Horizontal polarity, "V" means Vertical polarity.

Corr. Factor (dB) = Pre-amplifier gain - Cable Loss

Result = Receiver Reading + Antenna Factor - Corr. Factor + Duty factor

Margin = Limit – Result

Graphical Test Data – **Middle Channel (Peak)**



No.	FREQ [MHz]	READING PEAK [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA TABLE [cm]	[DEG]
----- Horizontal ------										
1	4876.000	50.7	33.7	5.9	39.8	50.5	74.0	23.5	200	201
2	9755.000	41.0	36.7	8.0	40.5	45.2	74.0	28.8	200	162
----- Vertical ------										
3	7324.000	48.1	35.2	6.9	39.7	50.5	74.0	23.5	100	173

Tabulated Test Data – Low Channel

Freq. (MHz)	Detector Mode	Pol.	Receiver Reading (dBuV)	Ant. Factor (dB/m)	Corr. Factor (dB)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)

* Spurious emissions that 20 dB below the limits didn't be recorded

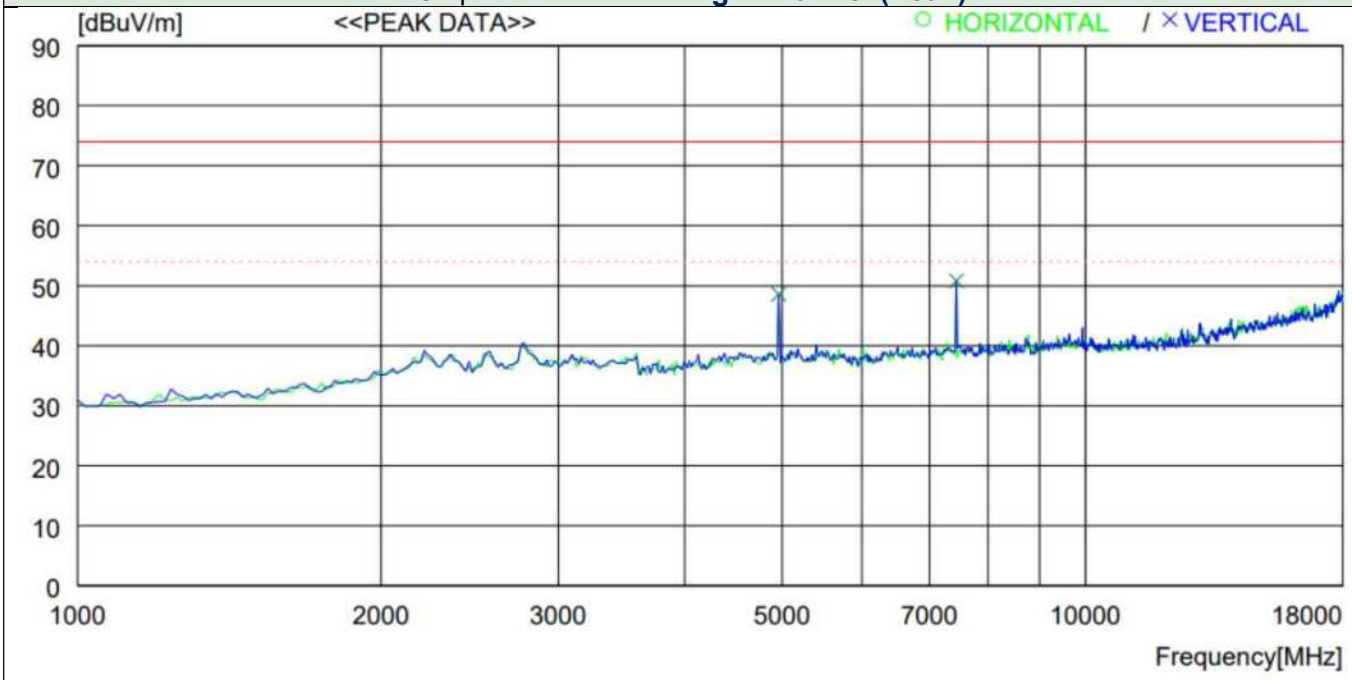
Note. "H" means Horizontal polarity, "V" means Vertical polarity.

Corr. Factor (dB) = Pre-amplifier gain - Cable Loss

Result = Receiver Reading + Antenna Factor - Corr. Factor + Duty factor

Margin = Limit – Result

Graphical Test Data – **High Channel (Peak)**



No.	FREQ [MHz]	READING PEAK [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Vertical ------										
1	4961.000	48.7	33.8	5.9	39.8	48.6	74.0	25.4	100	145
2	7443.000	48.3	35.3	6.9	39.7	50.8	74.0	23.2	200	165

Freq. (MHz)	Detector Mode	Pol.	Receiver Reading (dBuV)	Ant. Factor (dB/m)	Corr. Factor (dB)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)

Tabulated Test Data – Low Channel

* Spurious emissions that 20 dB below the limits didn't be recorded

Note. "H" means Horizontal polarity, "V" means Vertical polarity.

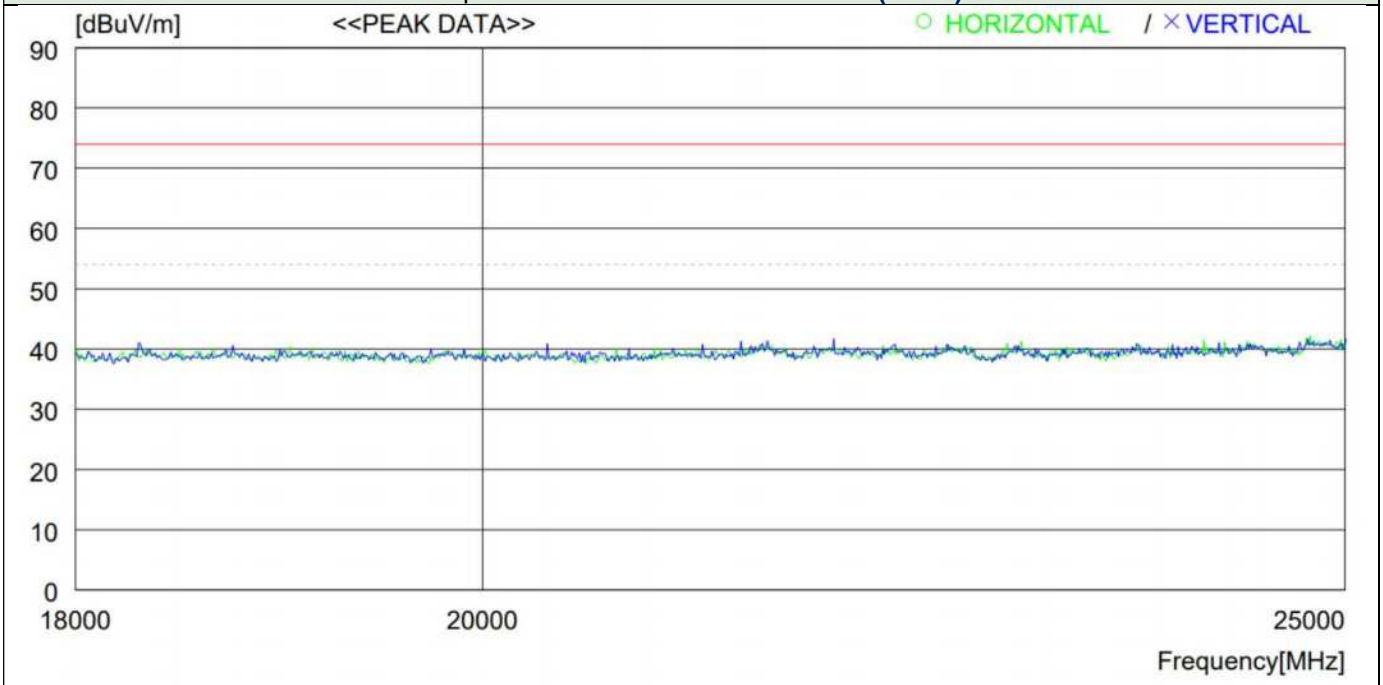
Corr. Factor (dB) = Pre-amplifier gain - Cable Loss

Result = Receiver Reading + Antenna Factor - Corr. Factor + Duty factor

Margin = Limit – Result

5.6.6.5 Test Data for Harmonic & Spurious emission (18 GHz to 25 GHz)

Graphical Test Data – **Low Channel (Peak)**



Freq. (MHz)	Detector Mode	Pol.	Receiver Reading (dBuV)	Ant. Factor (dB/m)	Corr. Factor (dB)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)
Low / Middle / High Channel											
* Spurious emissions that 20 dB below the limits didn't be recorded											

NOTE: Peak results are met average limit, so average measurement was not performed.

Emission was scanned up to 25 GHz; No emissions were detected above the noise floor which was at least 20 dB below the specification limit

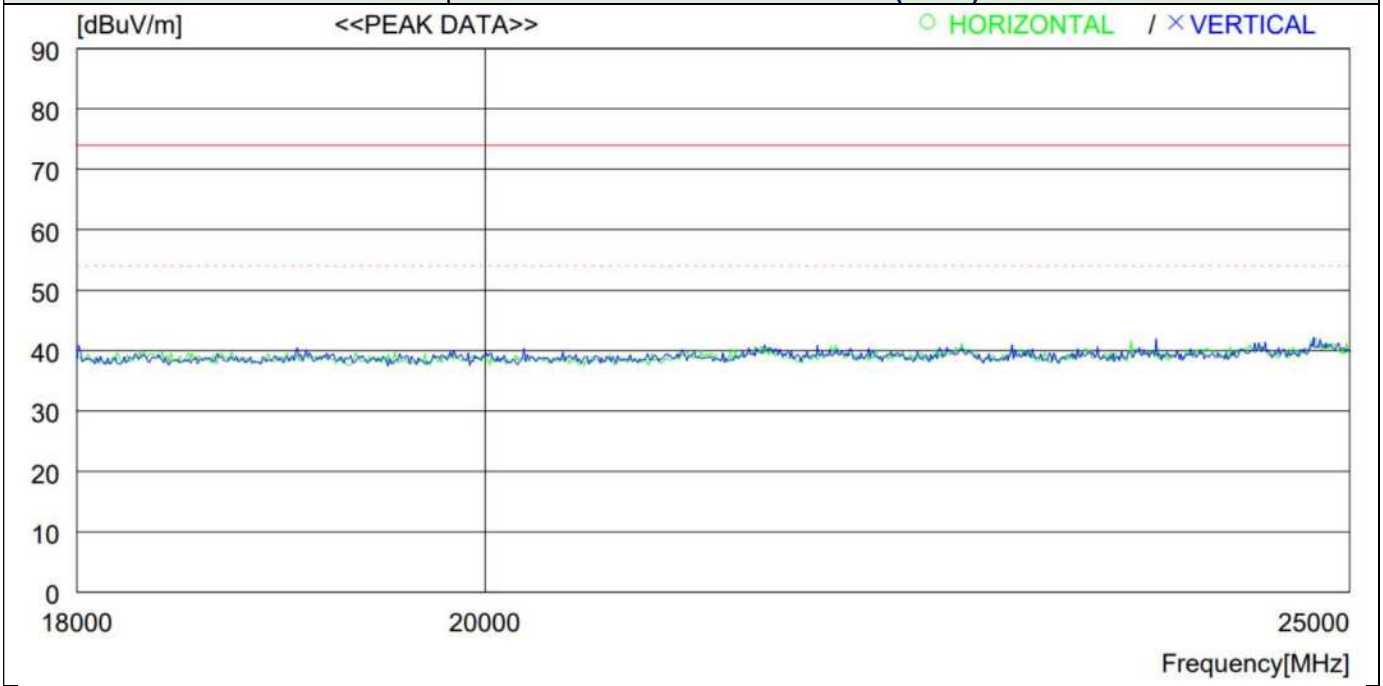
Note. "H" means Horizontal polarity, "V" means Vertical polarity.

Corr. Factor (dB) = Pre-amplifier gain - Cable Loss

Result = Receiver Reading + Antenna Factor - Corr. Factor + Duty factor

Margin = Limit – Result

Graphical Test Data – **Middle Channel (Peak)**



Freq. (MHz)	Detector Mode	Pol.	Receiver Reading (dBuV)	Ant. Factor (dB/m)	Corr. Factor (dB)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)
Low / Middle / High Channel											
* Spurious emissions that 20 dB below the limits didn't be recorded											

NOTE: Peak results are met average limit, so average measurement was not performed.

Emission was scanned up to 25 GHz; No emissions were detected above the noise floor which was at least 20 dB below the specification limit

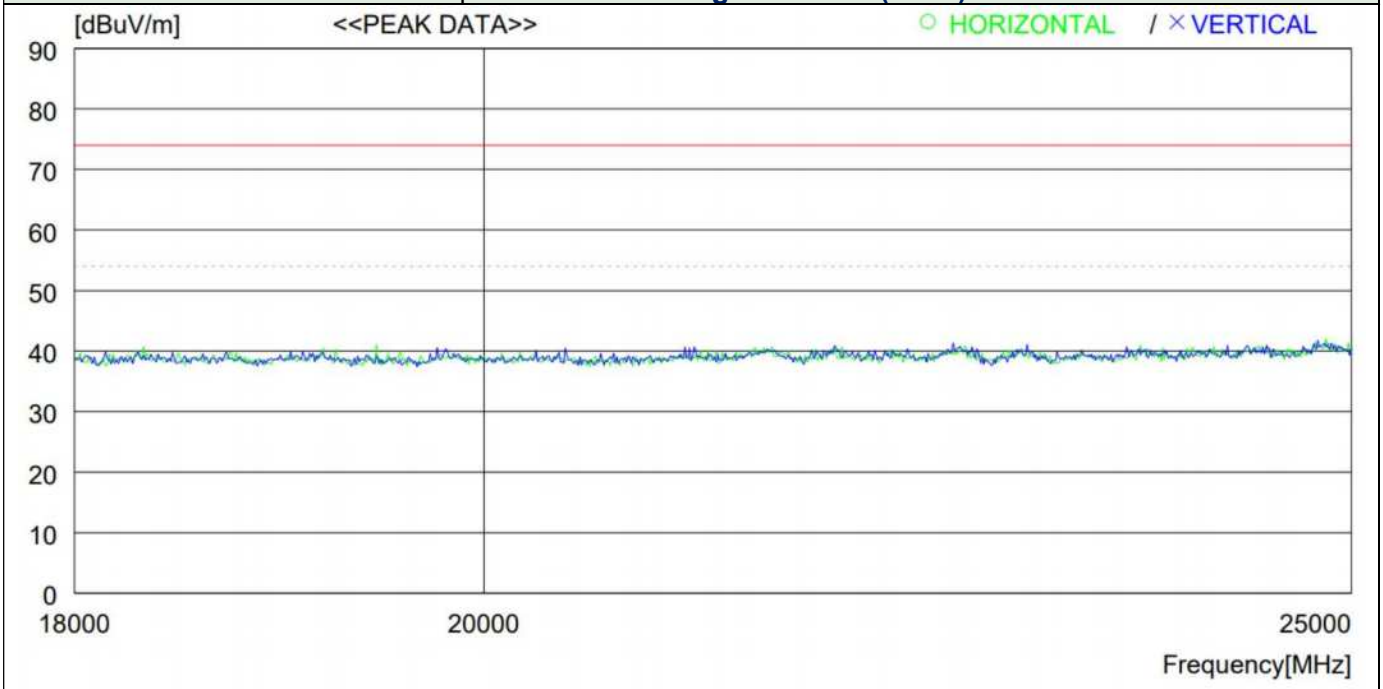
Note. "H" means Horizontal polarity, "V" means Vertical polarity.

Corr. Factor (dB) = Pre-amplifier gain - Cable Loss

Result = Receiver Reading + Antenna Factor - Corr. Factor + Duty factor

Margin = Limit – Result

Graphical Test Data – **High Channel (Peak)**



Freq. (MHz)	Detector Mode	Pol.	Receiver Reading (dBuV)	Ant. Factor (dB/m)	Corr. Factor (dB)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)
Low / Middle / High Channel											
* Spurious emissions that 20 dB below the limits didn't be recorded											

NOTE: Peak results are met average limit, so average measurement was not performed.

Emission was scanned up to 25 GHz; No emissions were detected above the noise floor which was at least 20 dB below the specification limit

Note. "H" means Horizontal polarity, "V" means Vertical polarity.

Corr. Factor (dB) = Pre-amplifier gain - Cable Loss

Result = Receiver Reading + Antenna Factor - Corr. Factor + Duty factor

Margin = Limit – Result

Appendix I – Test Instrumentation

Description	Model No.	Serial No.	Manufacturer.	Due for Cal. Date	Cal. Interval
Signal & Spectrum Analyzer	FSW 43	100578	Rohde & Schwarz	2021-04-20	1 Y
Spectrum Analyzer	FSV 13	101243	Rohde & Schwarz	2021-01-16	1 Y
Signal Generator	SMF100A	257560	Rohde & Schwarz	2021-01-26	1 Y
Attenuator	56-10	58769	WEINSCHEL	2021-01-20	1 Y
Test Receiver	ESU 26	100303	Rohde & Schwarz	2021-01-21	1 Y
Loop Antenna	HFH2-Z2	100341	Rohde & Schwarz	2021-06-21	2 Y
DC Power Supply	6032A	SG41000637	Agilent	2021-03-25	1 Y
TRILOG Broadband Antenna	VULB9163	9163.799	Schwarzbeck	2021-09-17	2 Y
Horn Antenna	HF 907	102426	Rohde & Schwarz	2020-11-20	2 Y
Notch Filter	BRM50702	G318	MICRO-TRONICS	2020-11-07	1 Y
Attenuator	6dB	272.4110.50	Rohde & Schwarz	2021-01-16	1 Y
Pre-Amplifier	310N	344015	Sonoma Instrument	2021-01-16	1 Y
Pre-Amplifier	SCU 18D	19006450	Rohde & Schwarz	2021-04-17	1 Y
Pre-Amplifier	CBL18265035	28706	CERNEX	2021-03-24	1 Y
Turn Table	DT3000-3t	1310814	INNCO SYSTEM	-	N/A
Antenna Master	MA4000-EP	4600814	INNCO SYSTEM	-	N/A
Antenna Master	MA4000-XP-ET	-	INNCO SYSTEM	-	N/A
Camera Controller	HDCon4102	6531445048	PONTIS	-	N/A
CO3000 Controller	Co3000-4Port	CO3000/806/ 34130814/L	INNCO SYSTEM	-	N/A
CO3000 Controller	Co3000-4Port	CO3000/807/ 34130814/L	INNCO SYSTEM	-	N/A

The measuring equipment utilized to perform the tests documented in this test report has been calibrated in accordance with manufacturer's recommendations, and is traceable to recognized national standards.