Electromagnetic Emission

FCC MEASUREMENT REPORT

CERTIFICATION OF COMPLIANCE

FCC Part 15 Certification Measurement

PRODUCT	:	Sgnl
MODEL/Serial No.	:	WB-S50 / Proto type
MULTIPLE MODEL	:	-
BRAND NAME	:	sgnl
FCC ID	:	2AOK2WB-S50
APPLICANT	:	Innomdle Lab Co.,Ltd. #720, 815, Daewangpangyo-ro, Sujeong-gu, Seongnam-si, Gyeonggi-do, 13449, South Korea Attn.: Jinyong Kim / Firmware Engineer
MANUFACTURER	:	Innomdle Lab Co.,Ltd. #720, 815, Daewangpangyo-ro, Sujeong-gu, Seongnam-si, Gyeonggi-do, 13449, South Korea
FACTORY	:	ELCOMTEC CO., LTD. 231, Dongbu-daero, Jinwi-myeon, Pyeongtaek-si, Gyeonggi-do, Korea
EQUIPMENT CLASSIFICATION	:	DSS (Part 15 Spread Spectrum Transmitter)
TYPE OF MODULATION	:	FHSS (GFSK (BDR), 8DPSK (EDR))
FREQUENCY CHANNEL	:	2 402 MHz to 2 480 MHz and Channel Spacing 1 MHz (79 Ch)
AIR DATE RATE	:	BDR (1 Mbps), EDR (2 Mbps, 3 Mbps)
ANTENNA TYPE	:	Chip Antenna (Integral)
ANTENNA GAIN	:	1.99 dBi max
RF POWER	:	0.67 mW
RULE PART(S)	:	FCC Part 15 Subpart C
FCC PROCEDURE	:	ANSI C63.10-2013
TEST REPORT No.	:	ETLT180607.0063
DATES OF TEST	:	June 18, 2018 to June 25, 2018
REPORT ISSUE DATE	:	July 11, 2018
TEST LABORATORY	:	ETL Inc. (FCC Designation Number : KR0022)

The Sgnl, Model WB-S50 has been tested in accordance with the measurement procedures specified in ANSI C63.10-2013 at the ETL Test Laboratory and has been shown to be complied with the electromagnetic radiated emission limits specified in FCC Rule Part15 Subpart C section 15.247.
I attest to the accuracy of data. All measurement herein was performed by me or was made under my supervision and is correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.
The results of testing in this report apply to the product/system which was tested only. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Prepared by:
Dong Jin, Seo (Test Engineer)
July 11, 2018

Reviewed by:
Kug Kyoung, Yoon (Chief Engineer)
July 11, 2018

ETL Inc.
Head office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea
Tel: 82-2-858-0786 Fax: 82-2-858-0788

Table of Contents

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

FCC MEASUREMENT REPORT

Scope – *Measurement and determination of electromagnetic emission (EME) of radio frequency devices including intentional radiators and/or unintentional radiators for compliance with the technical rules and regulations of the U.S Federal Communications Commission(FCC)*

General Information

Applicant Name	**: Innomdle Lab Co.,Ltd.**
Address	**: #720, 815, Daewangpangyo-ro, Sujeong-gu,**
	Seongnam-si, Gyeonggi-do, 13449, South Korea
Attention	**: Jingyong Kim / Firmware Engineer**

- **EUT Type** : Sgnl
- **Model Number** : WB-S50
- **S/N** : Proto type
- **Freq. Range** : 2 402 MHz - 2 480 MHz
- **Number of Channels** : 79
- **Modulation Technique** : FHSS (GFSK (BDR), 8DPSK (EDR))
- **Frequency Channel** : 2 402 MHz to 2 480 MHz and Channel Spacing 1 MHz (79 Ch)
- **Air Data Rate** : BDR (1 Mbps), EDR (2 Mbps, 3 Mbps)
- **Antenna Type** : Chip Antenna (Integral)
- **Antenna Gain** : 1.99 dBi max
- **RF Power** : 0.67 mW
- **Environmental of Tests** : Temperature: (27.8 ± 5.2) °C
  Humidity: (57 ± 17) % R.H.
  Atmospheric Pressure: (100.7 ± 0.2) kPa
- **FCC Rule Part(s)** : FCC Part 15 Subpart C
- **Test Procedure** : ANSI C63.10-2013
- **Equipment Class** : DSS (Part 15 Spread Spectrum Transmitter)
- **Place of Tests** : ETL Inc. Testing Lab. (FCC Designation Number : KR0022)

  Radiated Emission test 1;
  #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si,
  Gyeonggi-do, 445-882, Korea

  Radiated Emission test 2 and Conducted Emission test;
  #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

1. INTRODUCTION

The measurement test for radiated and conducted emission test was conducted at the ETL Inc. The site is constructed in conformance with the requirements of the ANSI C63.10-2013 and CISPR Publication 16. The ETL has site descriptions on file with the FCC for 3 m and 10 m site configurations. Detailed description of test facility was found to be in compliance with FCC Rules according to the ANSI C63.10-2013 and registered to the Federal Communications Commission (FCC Designation Number : KR0022).

The measurement procedure described in American National Standard for Method of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.10-2013) was used in determining radiated and conducted emissions from the Innomdle Lab Co.,Ltd. Model: WB-S50

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

2. PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the Sgnl (model: WB-S50).

The model WB-S50 is basic model that was tested.

2.2 General Specification

Item	Specification	
Model name	WB-S50	
Battery	3.7 V, 200 mA Chargeable Lithium-ion Battery	
Input Power	5 V, 220 mA	
Bluetooth	Version	4.2, Class 1
	Profile	HFP
	Transmission Frequency	2 402 MHz ~ 2 480 MHz
High Internal Frequency	X tal → 20 MHz	

- Frequency Channel Table

CH	MHz	CH	MHz	CH	MHz	CH	MHz	CH	MHz	CH	MHz	CH	MHz	CH	MHz
1	2402	11	2412	21	2422	31	2432	41	2442	51	2452	61	2462	71	2472
2	2403	12	2413	22	2423	32	2433	42	2443	52	2453	62	2463	72	2473
3	2404	13	2414	23	2424	33	2434	43	2444	53	2454	63	2464	73	2474
4	2405	14	2415	24	2425	34	2435	44	2445	54	2455	64	2465	74	2475
5	2406	15	2416	25	2426	35	2436	45	2446	55	2456	65	2466	75	2476
6	2407	16	2417	26	2427	36	2437	46	2447	56	2457	66	2467	76	2477
7	2408	17	2418	27	2428	37	2438	47	2448	57	2458	67	2468	77	2478
8	2409	18	2419	28	2429	38	2439	48	2449	58	2459	68	2469	78	2479
9	2410	19	2420	29	2430	39	2440	49	2450	59	2460	69	2470	79	2480
10	2411	20	2421	30	2431	40	2441	50	2451	60	2461	70	2471		

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

3. DESCRIPTION OF TESTS

The tests documented in this report were performed in accordance with ANSI C63.10-2013and FCC CFR 47 2.1046, 2.1047, 2.1049, 2.1051, 2.1053, 2.1055, 2.1057, 15.207, 15.209 and 15.247.

3.1 Radiated Emission Measurement

Radiated emission measurements were made in accordance with § 13 in ANSI C63.10-2013 "Measurement of Intentional radiators" The measurements were performed over the frequency range of 30 MHz to 40 GHz using antenna as the input transducer to a Spectrum analyzer or a Field Intensity Meter. The measurements were made with the detector set for "Peak, Quasi-peak, Average" within a bandwidth of 120 kHz and above 1 GHz is 1 MHz.

Preliminary measurements were made at 3 m using broadband antennas, and spectrum analyzer to determine the frequency producing the maximum emission in shielded room. Appropriate precaution was taken to ensure that all emission from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth and height with respect to the antenna were noted for each frequency found. The spectrum was scanned from 30 MHz to 1 000 MHz using Log-Bicon antenna. Above 1 GHz, linearly polarized double ridge horn antennas were used. Final measurements were made open site or SVSWR chamber at 3 m. The test equipment was placed on a styrofoam table. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. Each frequency found during pre-scan measurements was re-examined by manual. The EUT, support equipment and interconnecting cables were re-configured to the set-up producing the maximum emission for the frequency and were placed on top of a table height for below 1GHz is 0.8 m, and for above 1GHz is 1.5 m. nonmetallic 1.0 m x 1.5 m table. The EUT, support equipment, and interconnecting cables were re-arranged and manipulated to maximize each emission. The turntable containing the system was rotated; the antenna height was varied 1 m to 4 m and stopped at the azimuth or height producing the maximum emission.

Varying the mode of operating frequencies of the EUT maximized each emission. The system was tested in all the three orthogonal planes and changing the polarity of the antenna. The worst-case emissions are recorded in the data tables. If necessary, the radiated emission measurement could be performed at a closer distance to ensure higher accuracy and the results were extrapolated to the specified distance using an inverse linear distance extrapolation factor (20 dB/decade) as per section 15.31(f).

Photographs of the worst-case emission can be seen in Photographs of the worst-case emission test setup can be seen in Appendix B.

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

3.2 Conducted Emission Measurement

Conducted emissions measurements were made in accordance with section § 13 in ANSI C63.10-2013 "measurement of intentional radiators" The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to a Spectrum Analyzer or a Test Receiver. The measurements were made with the detector set for "Peak" amplitude within a bandwidth of 9 kHz or for "quasi-peak" within a bandwidth of 9 kHz.

The line-conducted emission test is conducted inside a shielded anechoic chamber room with 1 m x 1.5 m x 0.8 m wooden table which is placed 0.4 m away from the vertical wall and 1.5 m away from the side wall of the chamber room. Two LISN are bonded to the shielded room. The EUT is powered from the LISN and the support equipment is powered from the other LISN. Power to the LISNs are filtered by a noise cut power line filters. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and these supply lines will be connected to the LISN. Non-inductive bundling to a 1 m length shortened all interconnecting cables more than 1 m. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the EMI Test Receiver to determine the frequency producing the maximum emission from the EUT. The frequency producing the maximum level was reexamined using to set Quasi-Peak mode by manual, after scanned by automatic Peak mode from 0.15 MHz to 30 MHz. The bandwidth of the spectrum analyzer was set to 9 kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission.

Photographs of the worst-case emission can be seen in Photographs of the worst-case emission test setup can be seen in Appendix B.

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

3.3 FCC Part 15.205 Restricted Bands of Operations

(a) Except as shown 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	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.694 75 - 16.695 25	608 - 614	5.35 - 5.46
2.173 5 - 2.190 5	16.804 25 - 16.804 75	960 - 1 240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1 300 - 1 427	8.025 - 8.5
4.177 25 - 4.177 75	37.5 - 38.25	1 435 - 1 626.5	9.0 - 9.2
4.207 25 - 4.207 75	73 - 74.6	1 645.5 - 1 646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1 660 - 1 710	10.6 - 12.7
6.267 75 - 6.268 25	108 - 121.94	1 718.8 - 1 722.2	13.25 - 13.4
6.311 75 - 6.312 25	123 - 138	2 200 - 2 300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2 310 - 2 390	15.35 - 16.2
8.362 - 8.366	156.524 75 - 156.525 25	2 483.5 - 2 500	17.7 - 21.4
8.376 25 - 8.386 75	156.7 - 156.9	2 690 - 2 900	22.01 - 23.12
8.414 25 - 8.414 75	162.012 5 - 167.17	3 260 - 3 267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3 332 - 3 339	31.2 - 31.8
12.519 75 - 12.520 25	240 - 285	3 345.8 - 3 358	36.43 - 36.5
12.576 75 - 12.577 25	322 - 335.4	3 600 - 4 400	([2])
13.36 - 13.41			

[1] Until February 1, 1999, this restricted band shall be 0.490 MHz - 0.510 MHz.
[2] Above 38.6

(b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1 000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1 000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

3.4 Antenna connection requirement

(1) 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 use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

4. TEST CONDITION

4.1 Test Configuration

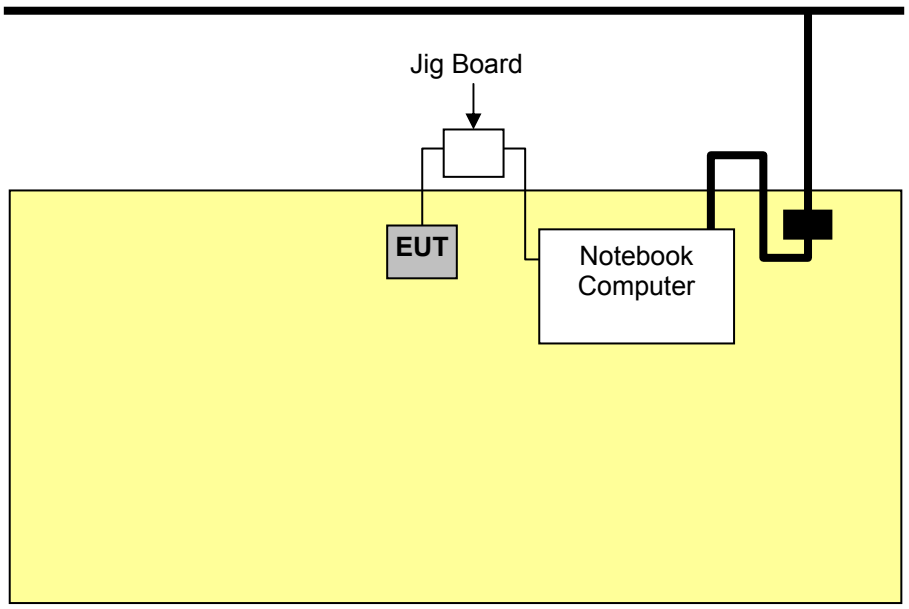
The device was configured for testing in a typical fashion (as a customer would normally use it). During the tests, the following conditions and configurations were used.

* This test was applied to X, Y, Z. and the worst result were investigated and reported.

4.2 Description of Test modes

Sgnl that has the control software.

4.3 The setup drawing(s)



: Signal Line

: Power Line

: Adapter

4.4 Support Equipment Used

Description	Model Name	Serial No.	Manufacturer
Notebook Computer	CQ35	CND9322TYH	HEWLET-PACKARD COMPANY
Adapter (for Notebook Computer)	PPP009C	F220881413024952	CHICONY POWER TECHNOLOGY (Chong Qlng) CO., LTD.

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

5. TEST RESULTS

5.1 Summary of Test Results

The measurement results were obtained with the EUT tested in the conditions described in this report. Detailed measurement data and plots showing the maximum emission of the EUT are reported.

47 CFR Part 15, Subpart C	Measurement Required	Result
15.247(a)(1)	Channel Bandwidth, Frequency Separation	**Pass**
15.247(b)(3)	Maximum Peak Output Power	**Pass**
15.247(d)	Bandwidth of Frequency Band Edges	**Pass**
15.247(a)(1)(iii)	Number of Hopping Channels	**Pass**
15.247(a)(1)(iii)	Time of Occupancy (Dwell time)	**Pass**
15.209(a)	Spurious Emissions	**Pass**
15.207	Conducted Emissions	**Pass ***
15.203	Antenna connection requirement	Integral antenna which is permanently attached and cannot be replaced.
15.247(i) 1.1307(b)(1)	RF Exposure	**Pass**

* This test was tested at main host computer (EUT was connected USB port of the host computer).

The data collected shows that the **Innomdle Lab Co.,Ltd. / Sgnl / WB-S50** complied with technical requirements of above rules part 15.207, 209 and 15.247 Limits.

The equipment is not modified anything, mechanical or circuits to improve EMI status during a measurement. No EMI suppression device(s) was added and/or modified during testing.

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

5.2 Channel Bandwidth and Frequency Separation

EUT	Sgnl / WB-S50
Limit apply to	FCC Part 15.247(a)(1)
Test Date	June 18, 2018
Environmental of Test	(31.0 ± 0.0) °C, (40 ± 0) % R.H., (100.8 ± 0.0) kPa
Operating Condition	RF transmitting continuously during the tested.
Result	Passed

5.2.1 Channel Bandwidth

Type of Modulation	Frequency [MHz]	20 dB Bandwidth [MHz]
BDR	2 402	0.821
	2 441	0.815
	2 480	0.842
EDR	2 402	1.340
	2 441	1.340
	2 480	1.330

NOTES:
1. Measure frequency separation of relevant channel using spectrum analyzer.
2. Please see the measured plot in next page.

5.2.2 Frequency Separation

Frequency hopping systems operating in the 2 400.0 MHz - 2 483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.

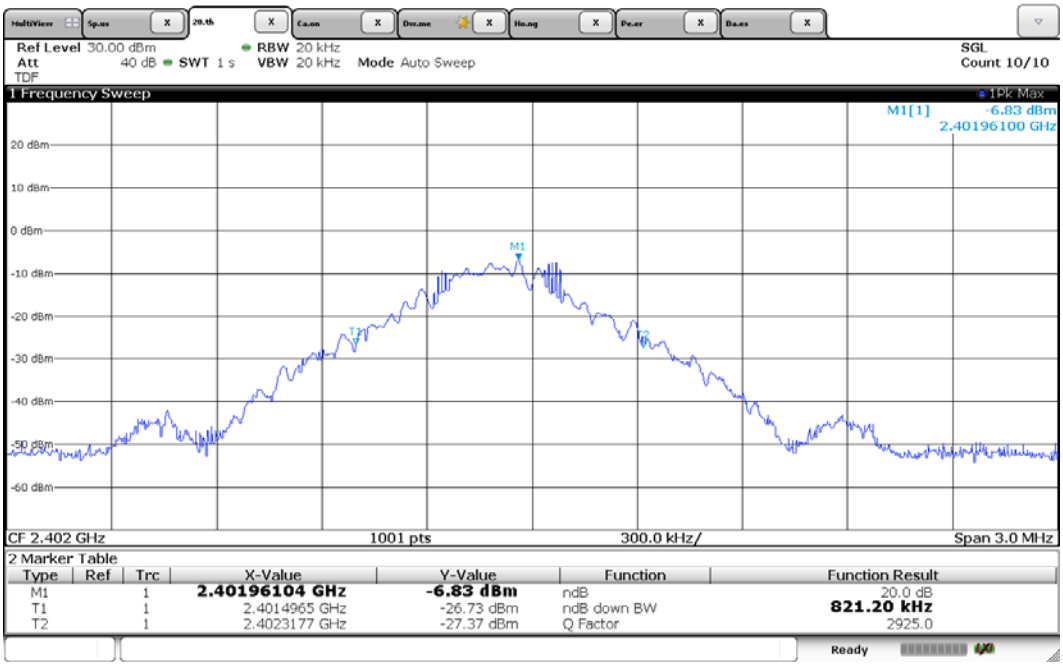
Type of Modulation	EUT Channel Separation [MHz]	20 dB bandwidth [MHz]	Limit
BDR	1.000 (Worst)	0.842 (Worst)	> 25 kHz or > 2/3 of the 20 dB Bandwidth
EDR	1.000 (Worst)	1.340 (Worst)	

NOTES:
1. Measure frequency separation of relevant channel using spectrum analyzer.
2. Please see the measured plot in next page.

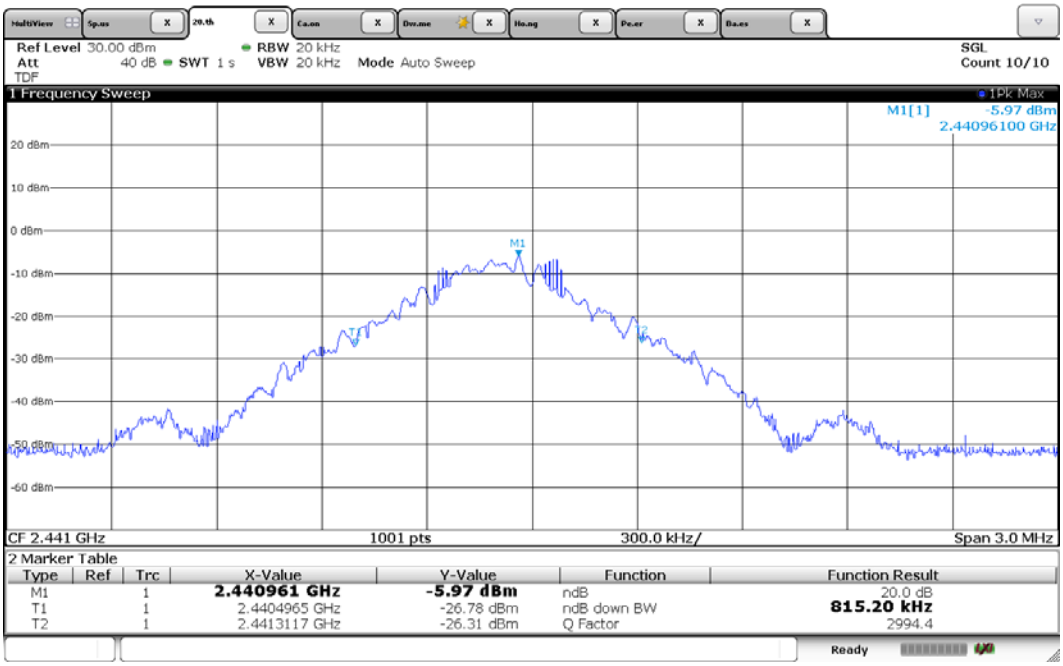
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Plots of 20 dB Bandwidth (BDR)

[2 402 MHz]

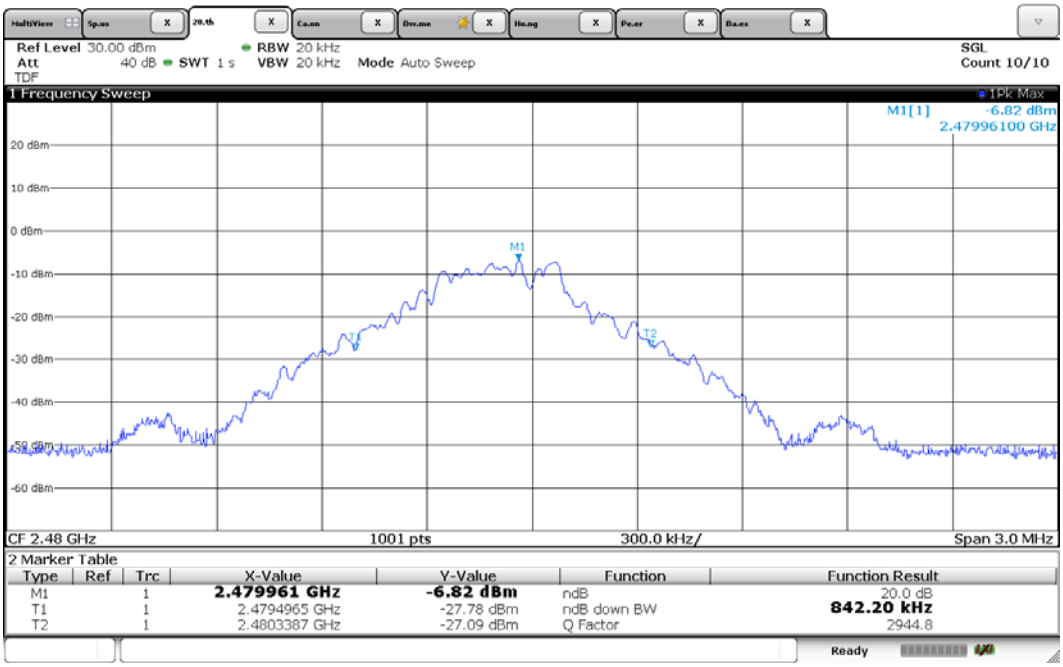


[2 441 MHz]



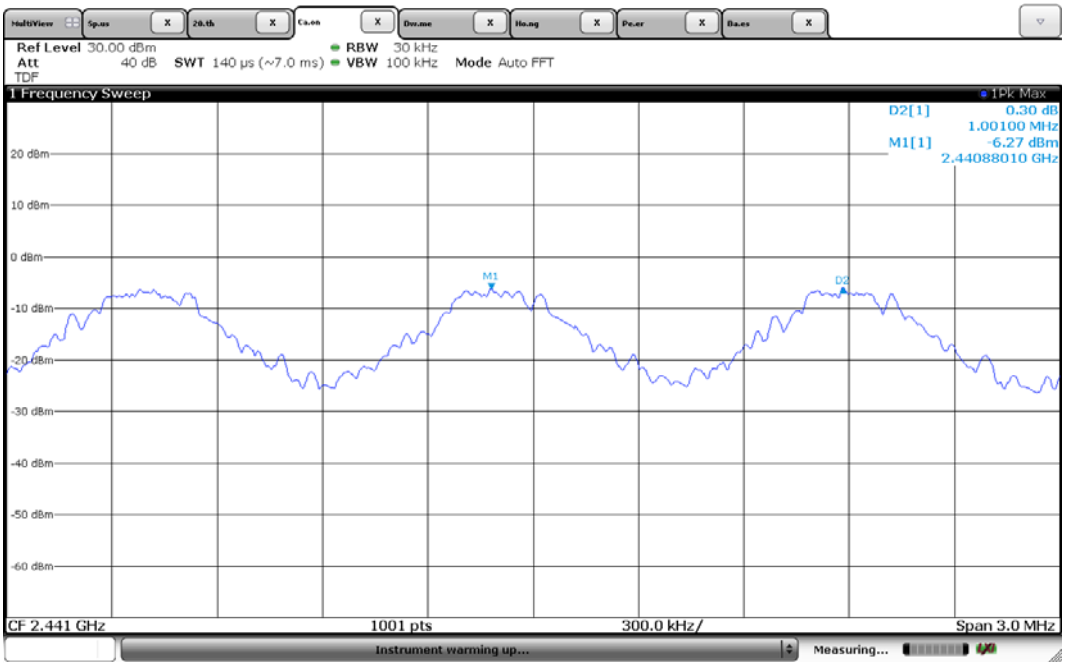
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

[2 480 MHz]



Plots of Frequency Separation (BDR)

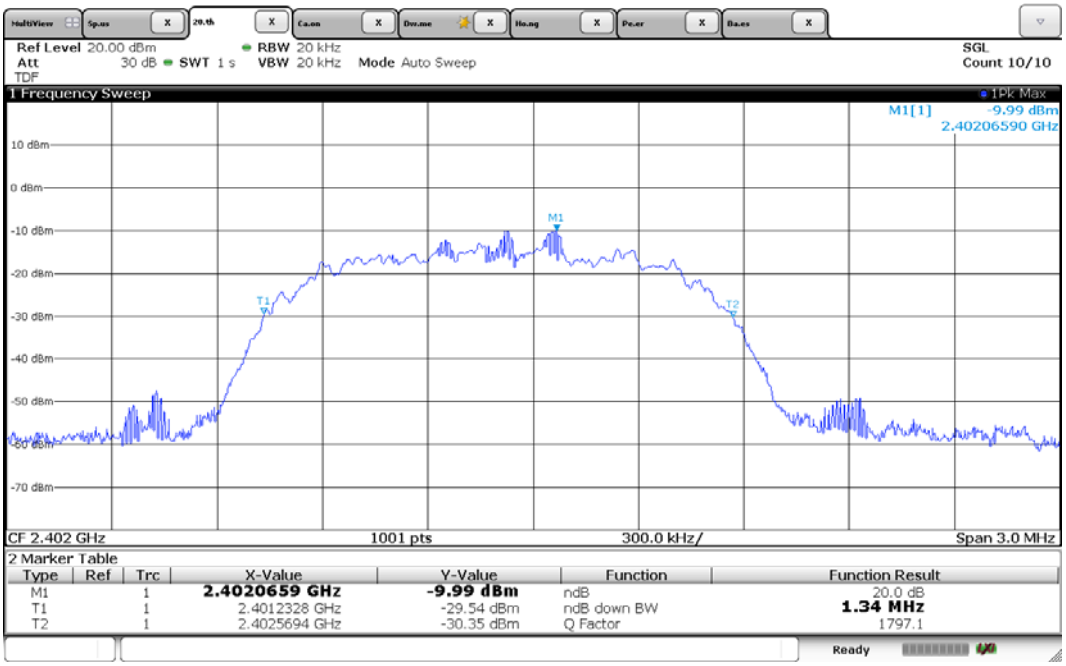
[Channel Separation]



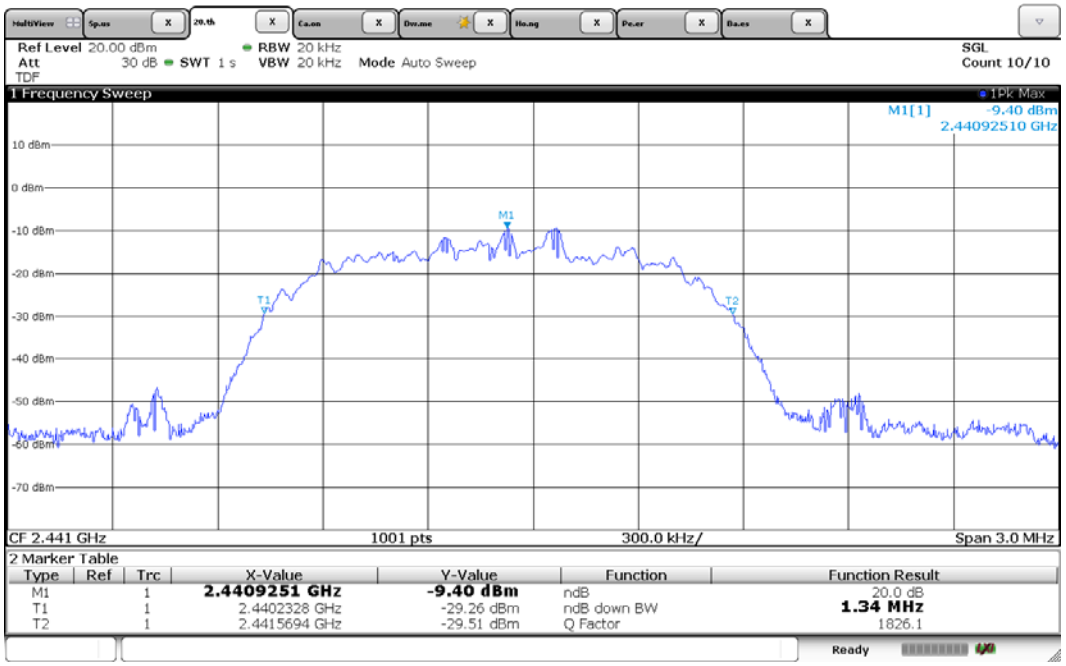
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Plots of 20 dB Bandwidth (EDR)

[2 402 MHz]

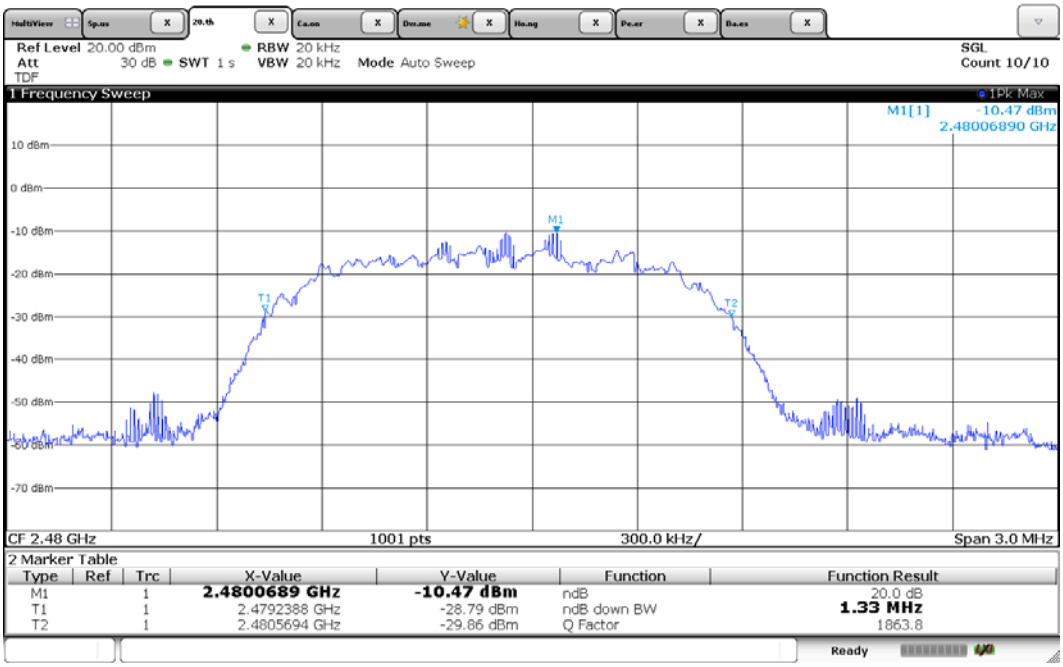


[2 441 MHz]



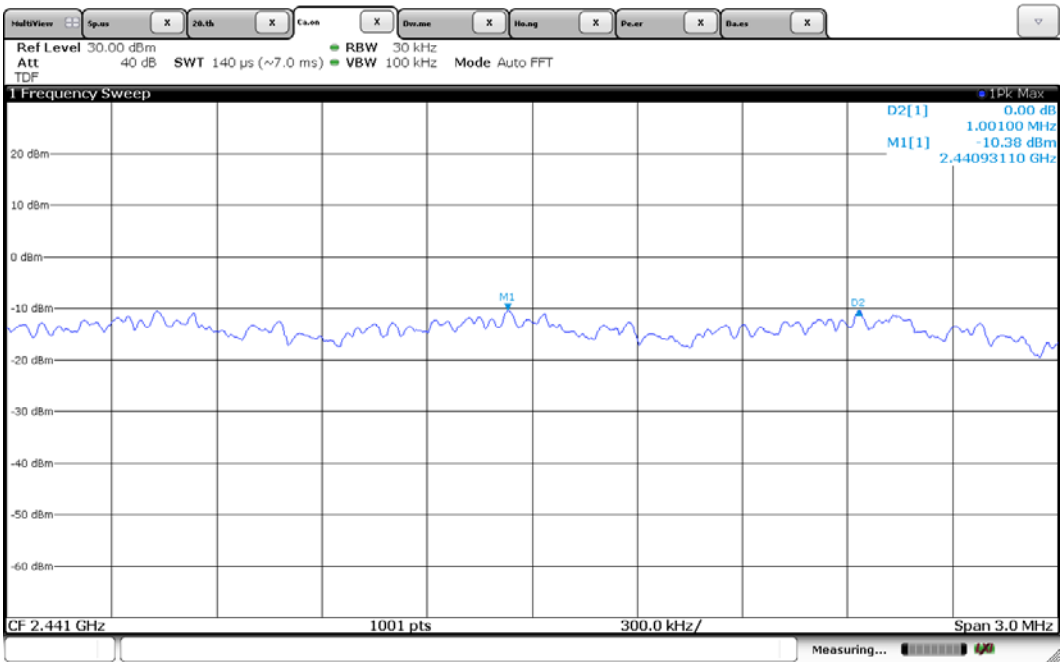
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

[2 480 MHz]



Plots of Frequency Separation (EDR)

[Channel Separation]



Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

5.3 Maximum Peak Conducted Output Power

EUT	Sgnl / WB-S50
Limit apply to	FCC Part 15.247(b)(3)
Test Date	June 18, 2018
Environmental of Test	(31.0 ± 0.0) °C, (40 ± 0) % R.H., (100.8 ± 0.0) kPa
Operating Condition	RF transmitting continuously during the tested.
Result	Passed

Limit

The maximum peak conducted output power of the intentional radiator shall not exceed the following:

For frequency hopping systems operating in the 2 400.0 MHz - 2 483.5 MHz band employing at least 75 non-overlapping hopping channels: 0.125 Watt

Test Data

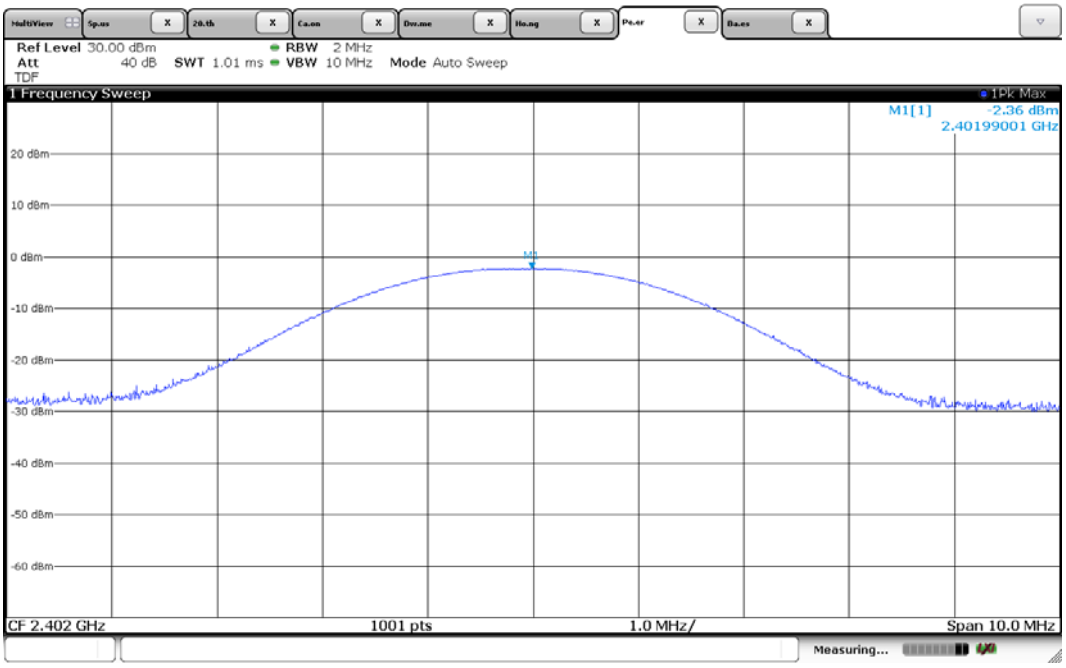
Type of Modulation	Channel	Frequency [MHz]	Output Power [dBm]	Limit
BDR	Low	2 402	-2.36	< 21 dBm (0.125 W)
	Mid	2 441	-1.77	
	High	2 480	-2.13	
EDR	Low	2 402	-2.70	
	Mid	2 441	-2.63	
	High	2 480	-3.44	

NOTES:
1. Measure conducted Channel power of relevant channel using Spectrum analyzer
2. Please see the measured plot in next page.

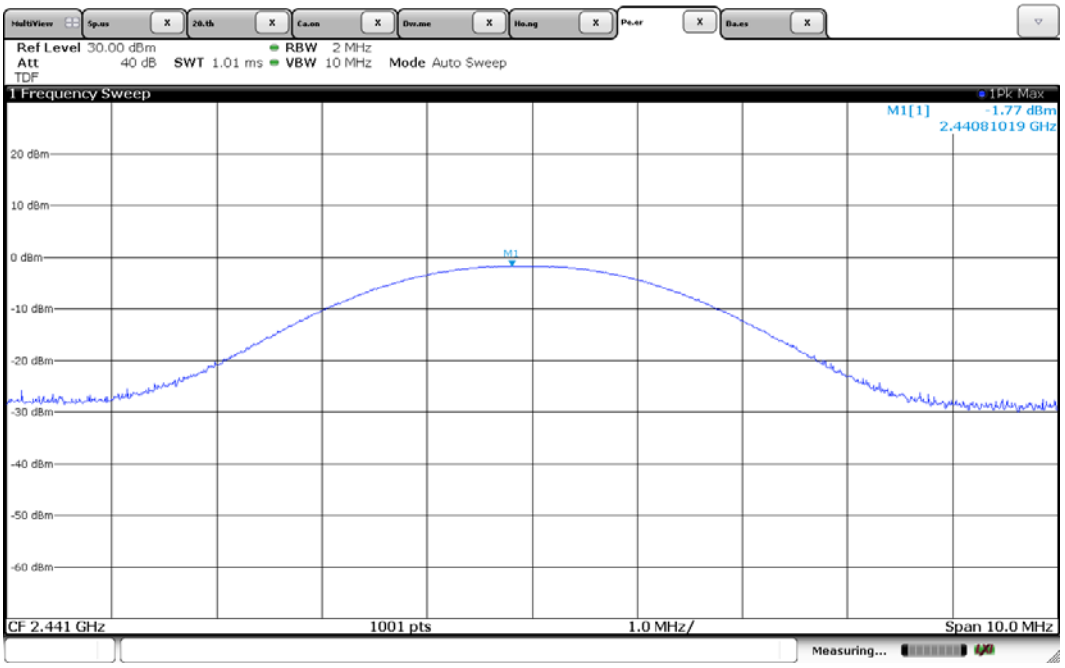
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Plots of Maximum Peak Output Power (BDR)

[2 402 MHz]

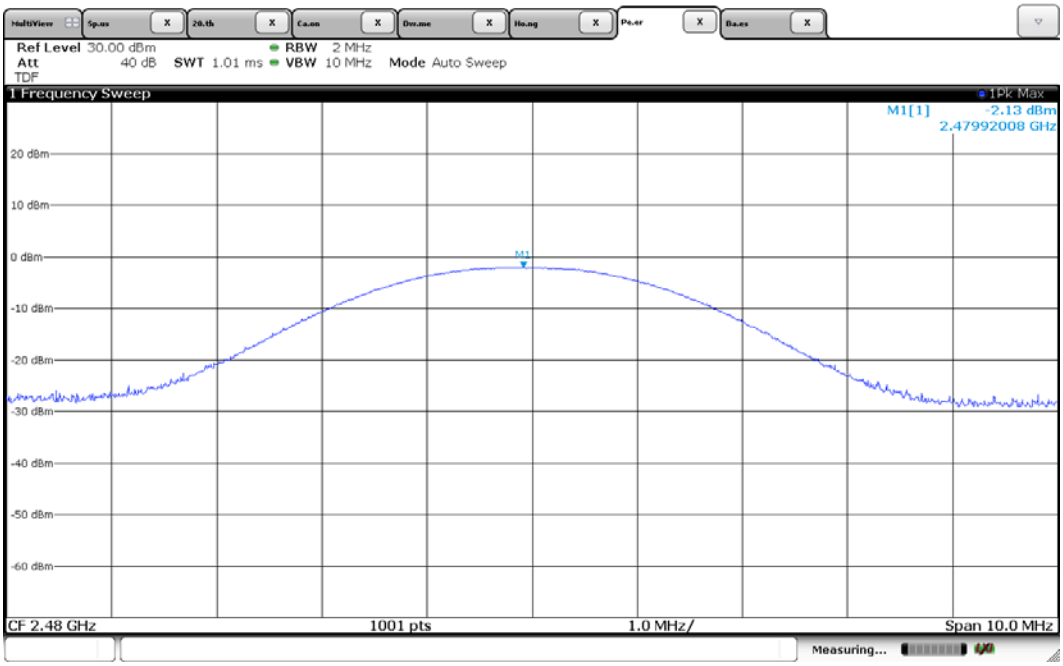


[2 441 MHz]



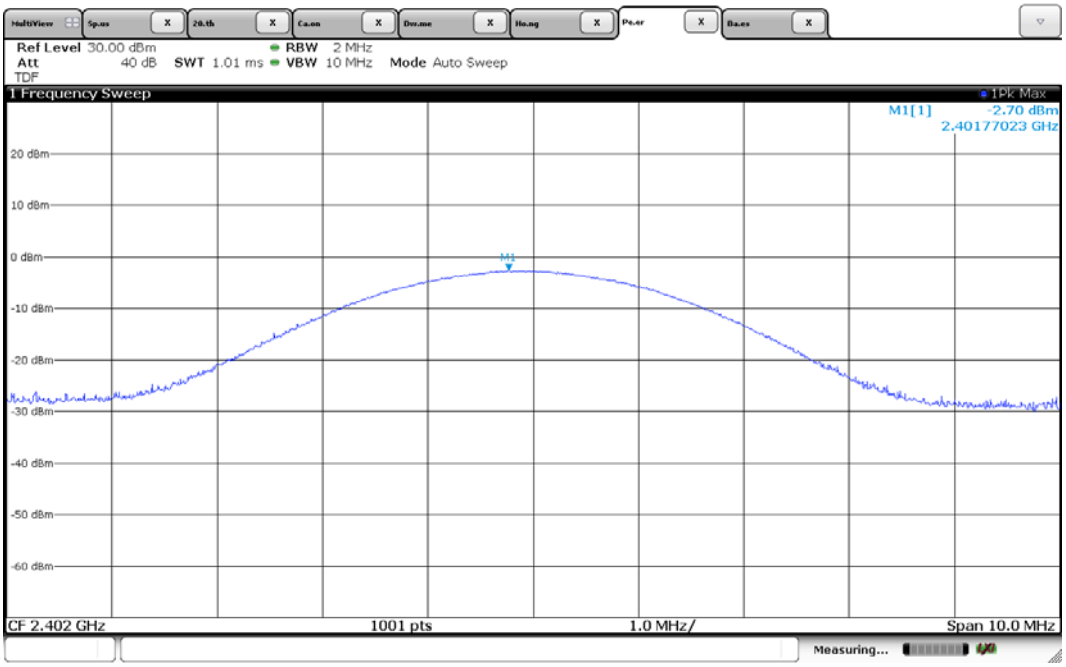
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

[2 480 MHz]



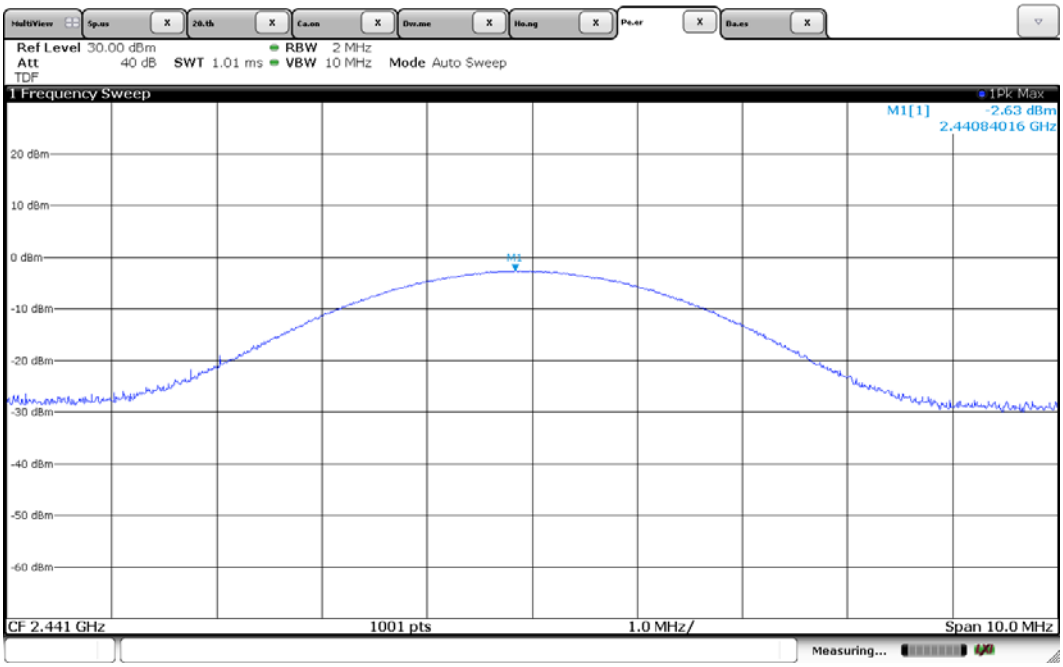
Plots of Maximum Peak Output Power (EDR)

[2 402 MHz]

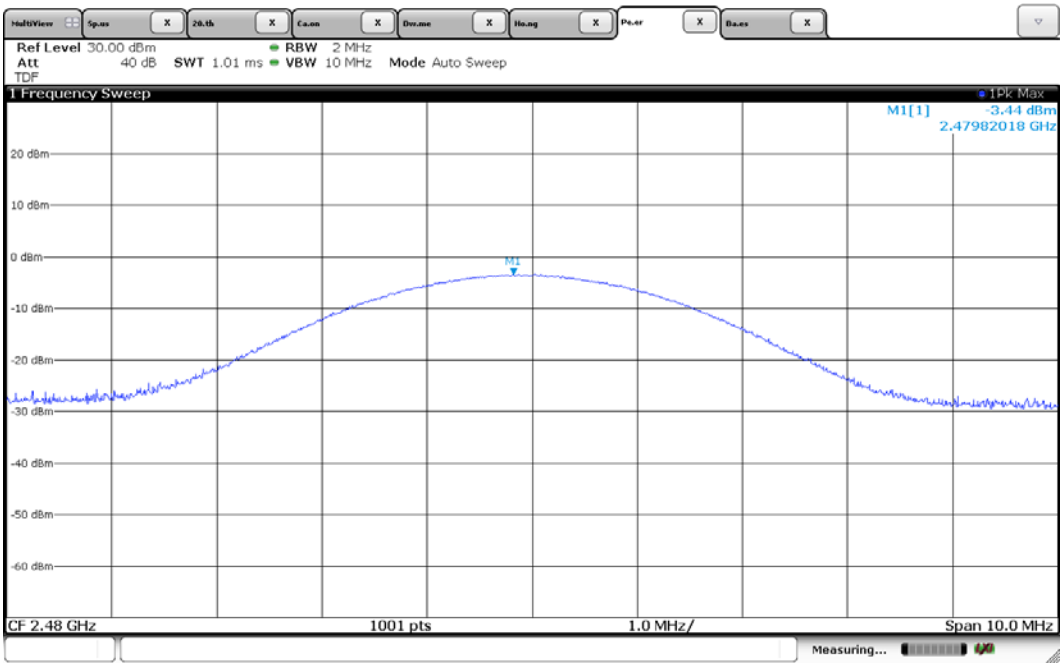


Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

[2 441 MHz]



[2 480 MHz]



Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

5.4 Bandwidth of Frequency Band Edges

EUT	Sgnl / WB-S50
Limit apply to	FCC Part 15.247(d)
Test Date	June 20, 2018
Environmental of Test	(22.8 ± 0.2) °C, (50 ± 1) % R.H., (100.5 ± 0.0) kPa
Operating Condition	RF transmitting continuously during the tested.
Result	Passed

Limit

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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

Test Results

- Refer to see the measured plot in next page.

NOTES:

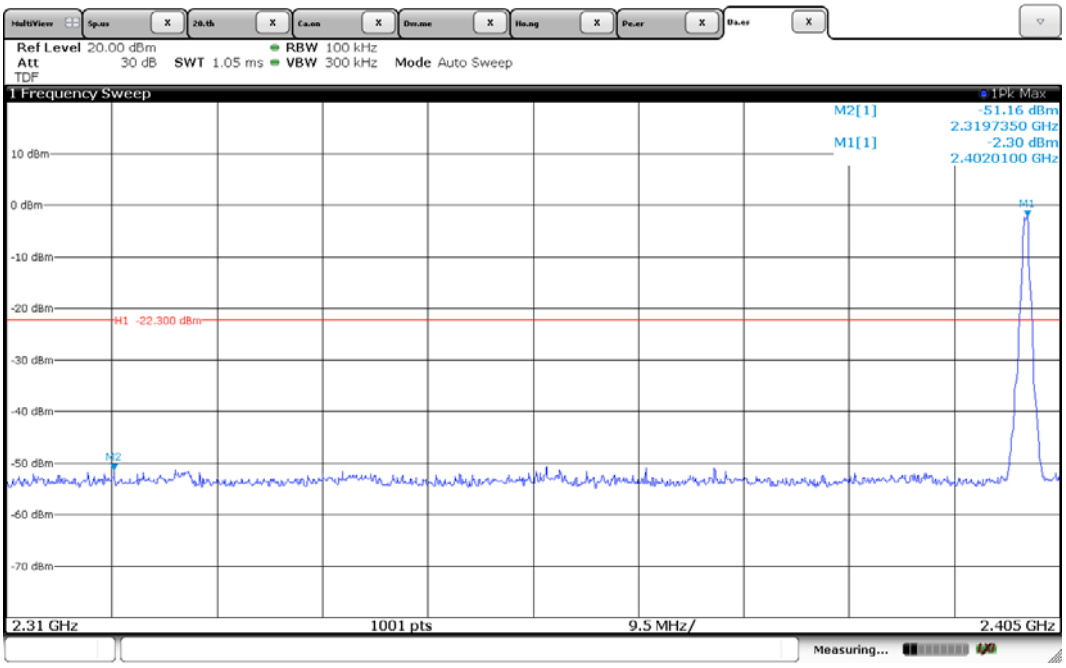
1. The test was performed to make a direct field strength measurement at the band edge frequencies.

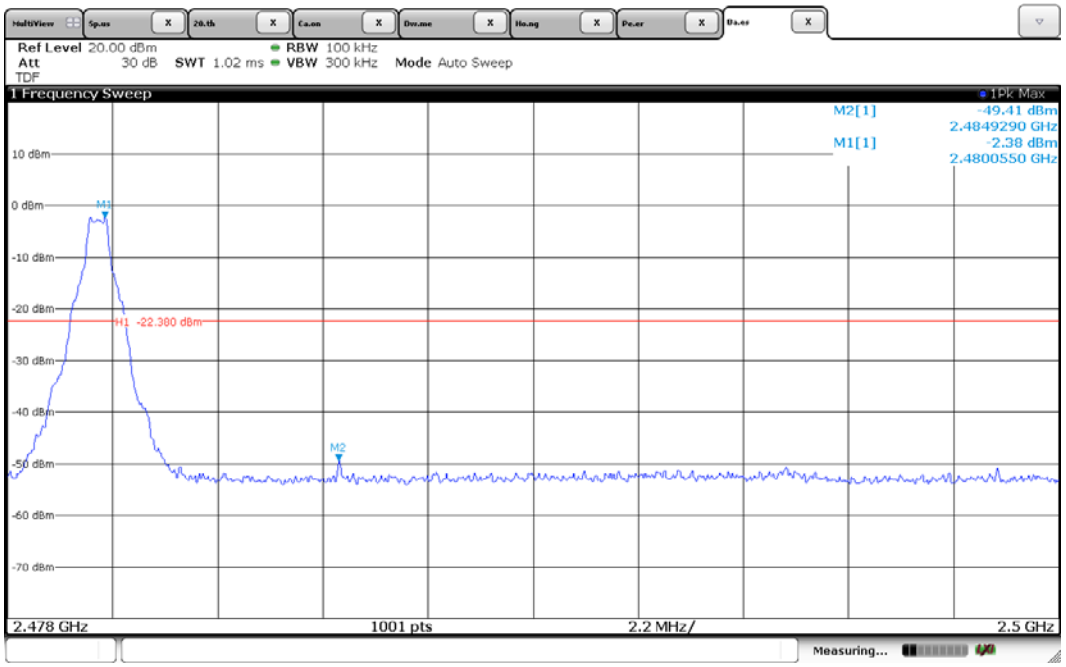
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Plots of Bandwidth of Frequency Band Edges (BDR)

[Non−hopping mode]

Conducted

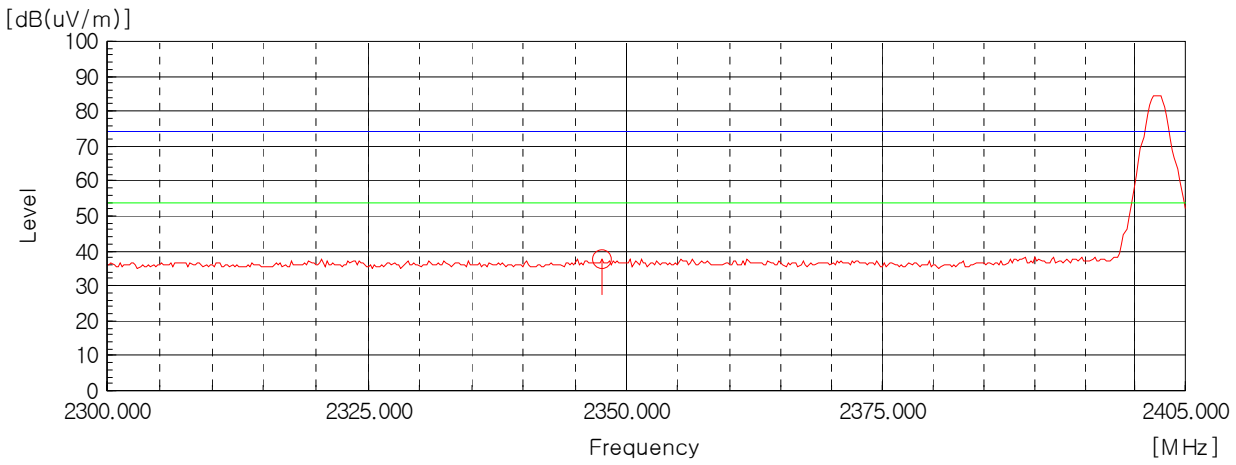




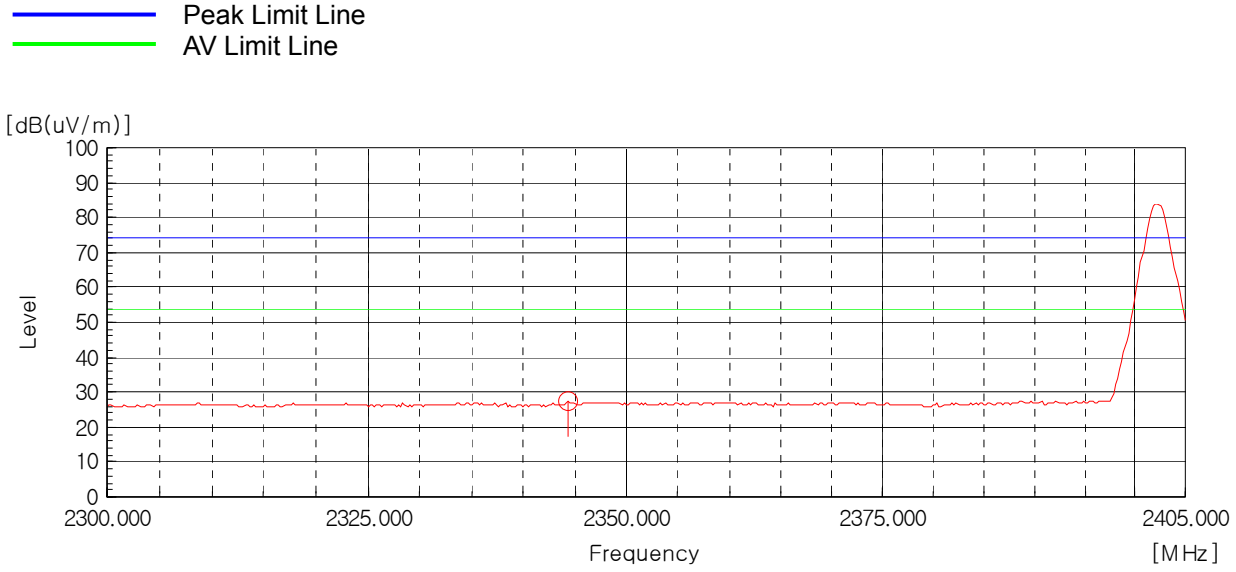
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Radiated

Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 310 MHz - 2 390 MHz), Worst case (Low, Vertical)

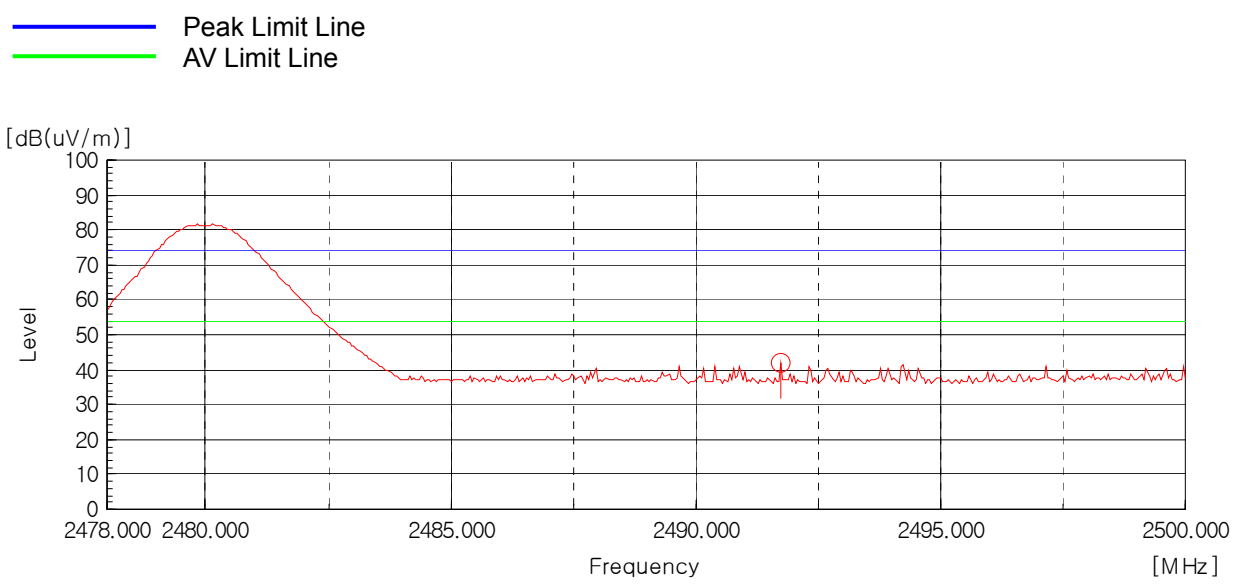


AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 310 MHz - 2 390 MHz), Worst case (Low, Vertical)

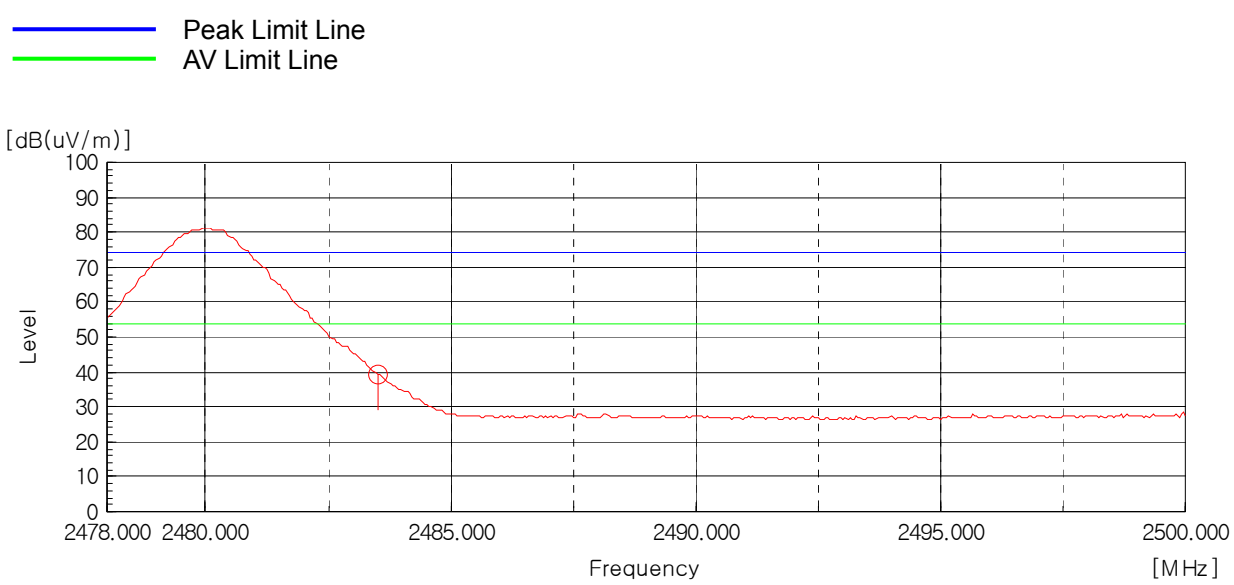


Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 483.5 MHz - 2 500.0 MHz), Worst case (High, Vertical)



AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 483.5 MHz - 2 500.0 MHz), Worst case (High, Vertical)

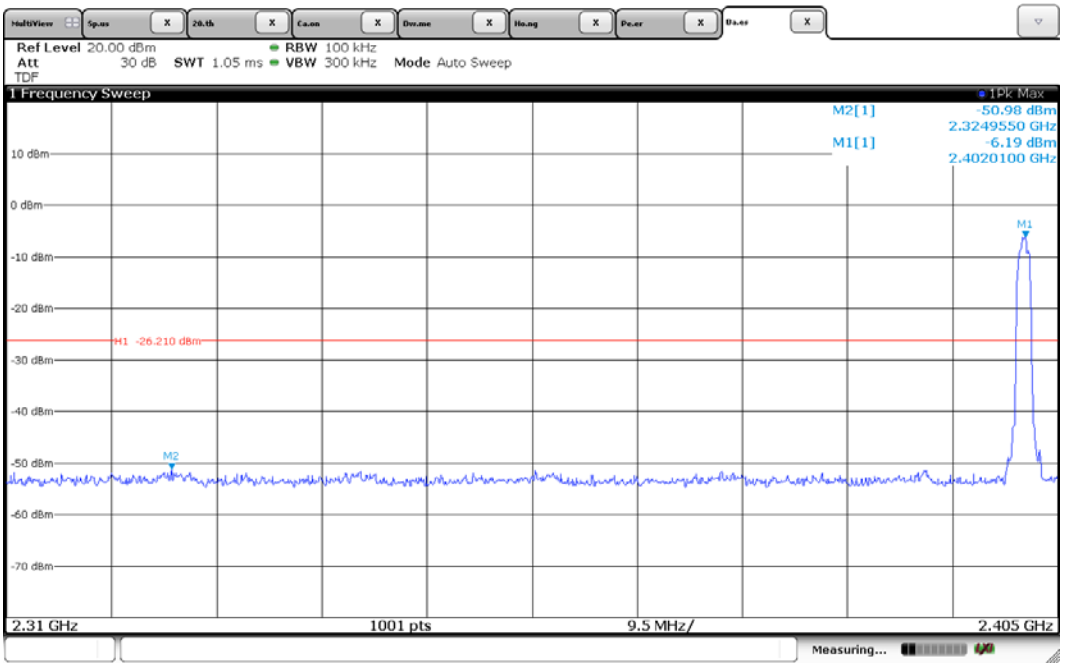


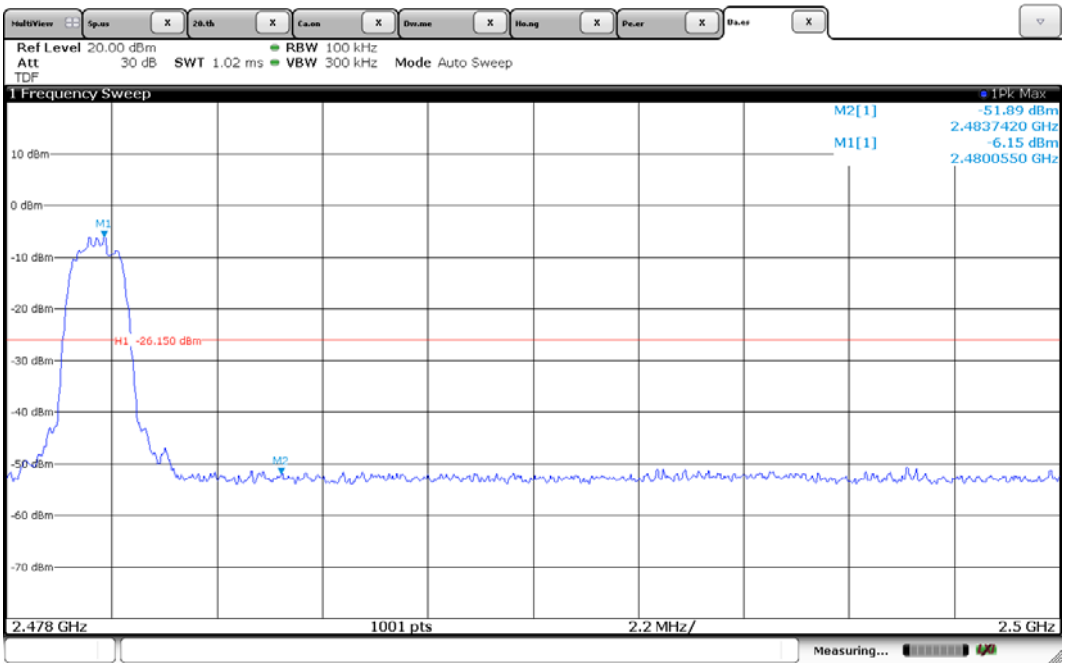
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Plots of Bandwidth of Frequency Band Edges (EDR)

[Non-hopping mode]

Conducted



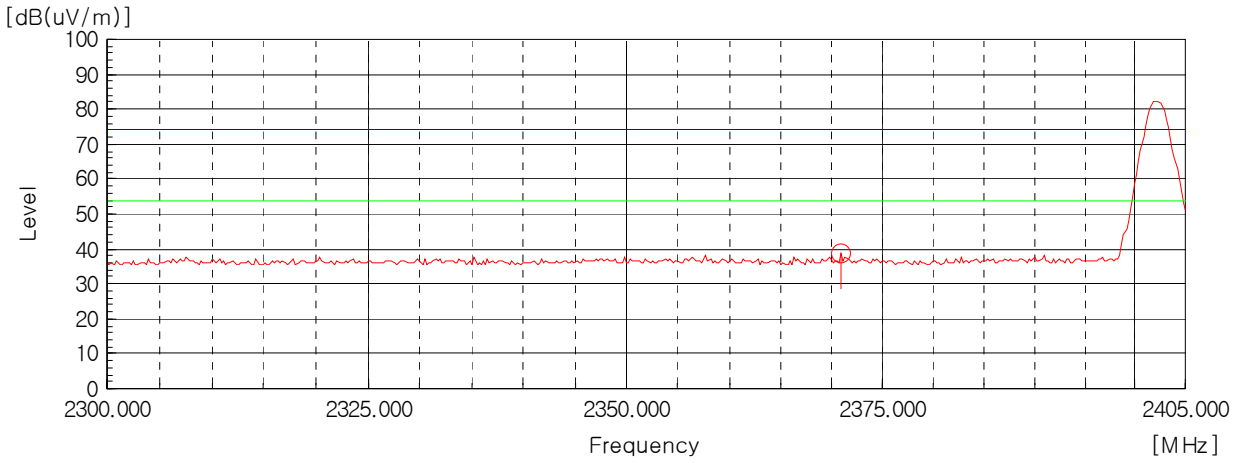


Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Radiated

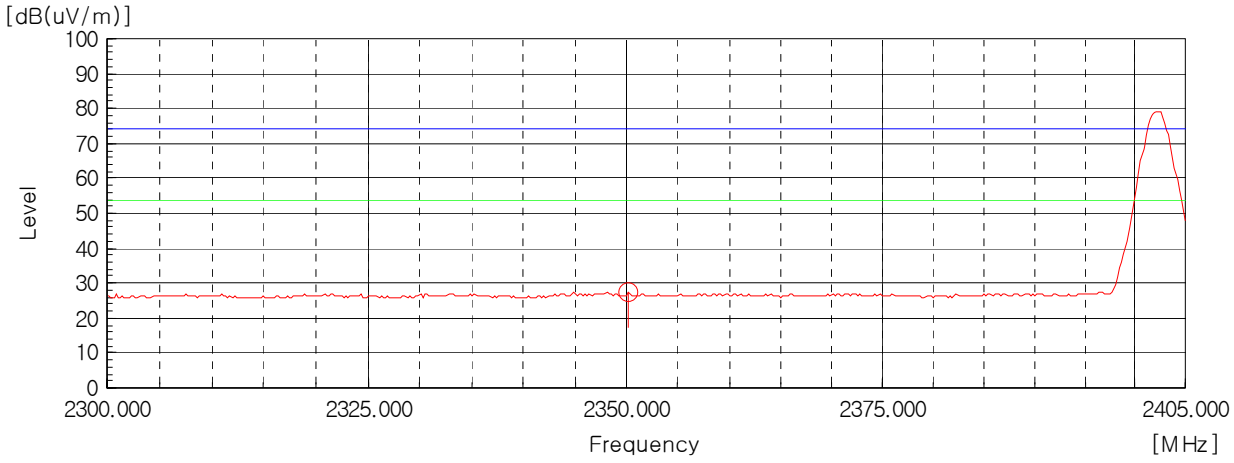
Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 310 MHz - 2 390 MHz), Worst case (Low, Vertical)

Peak Limit Line
AV Limit Line



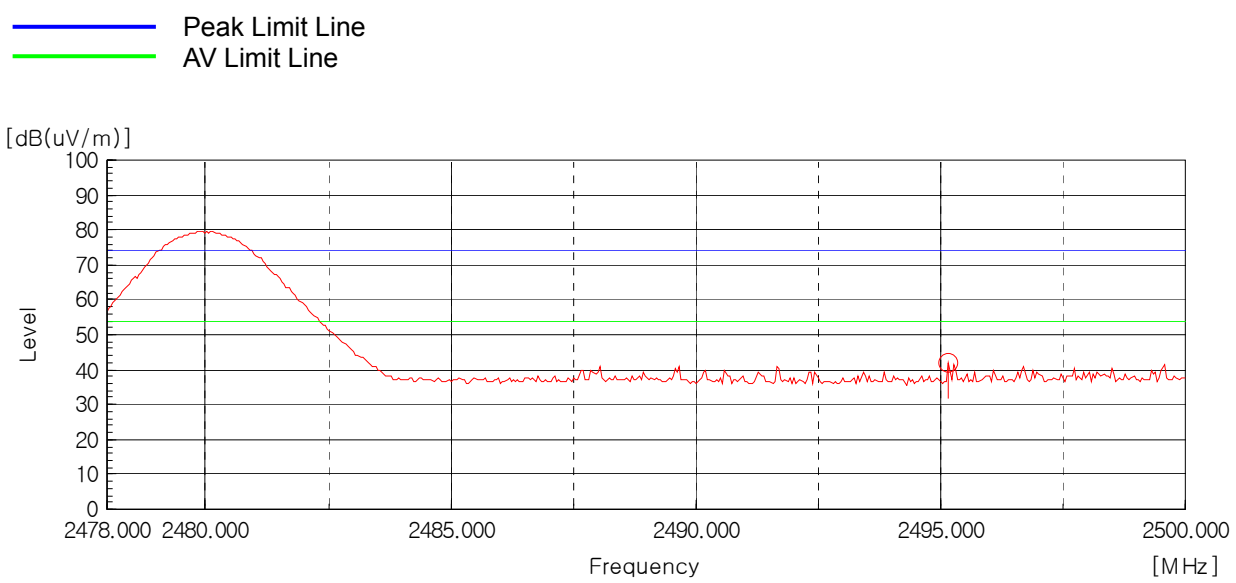
AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 310 MHz - 2 390 MHz), Worst case (Low, Vertical)

Peak Limit Line
AV Limit Line

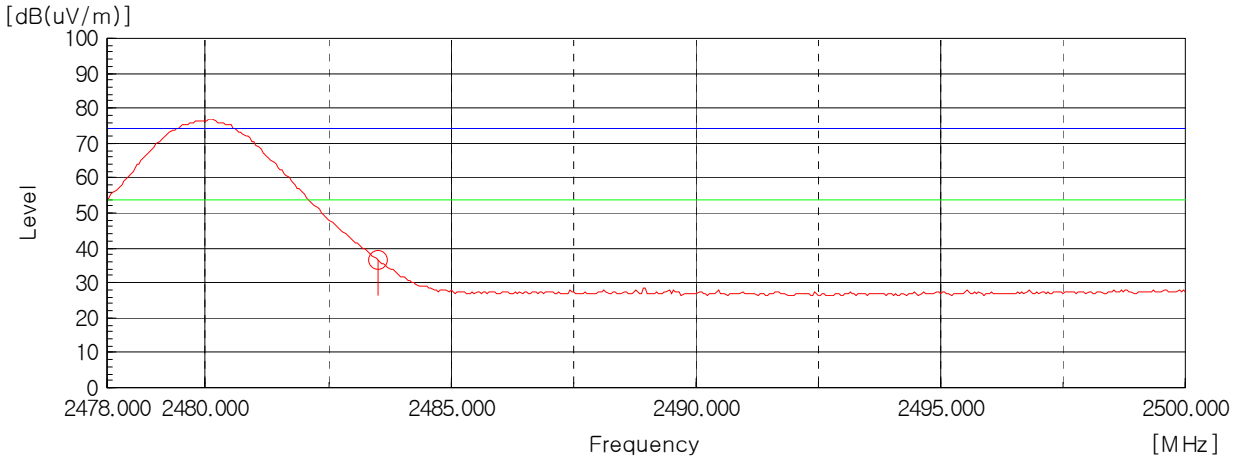


Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 483.5 MHz - 2 500.0 MHz), Worst case (High, Vertical)



AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 483.5 MHz - 2 500.0 MHz), Worst case (High, Vertical)

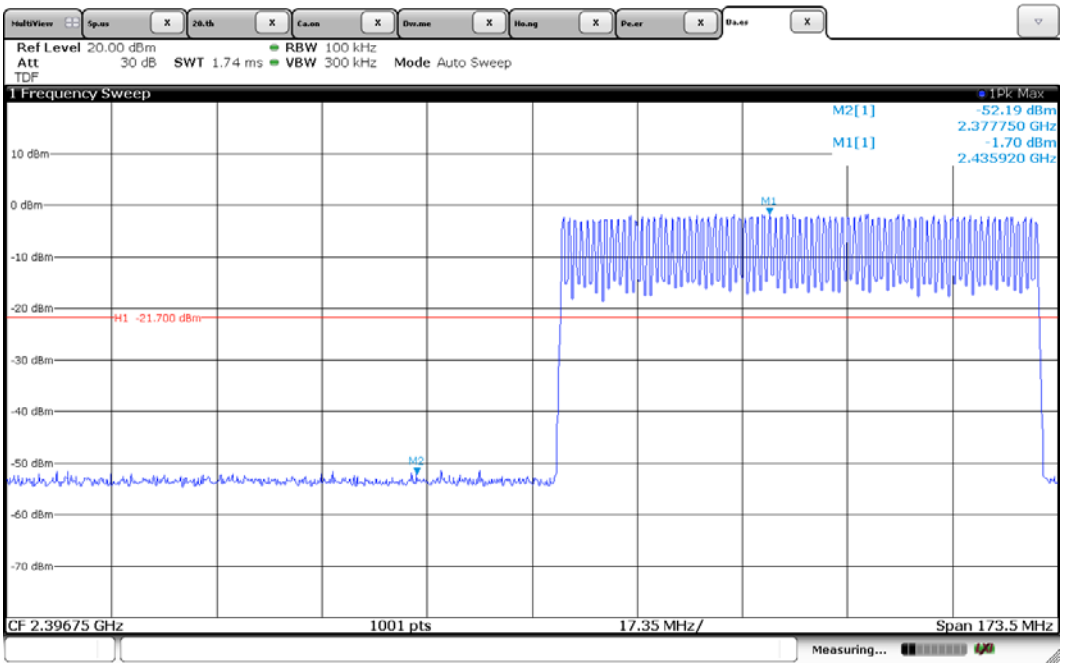


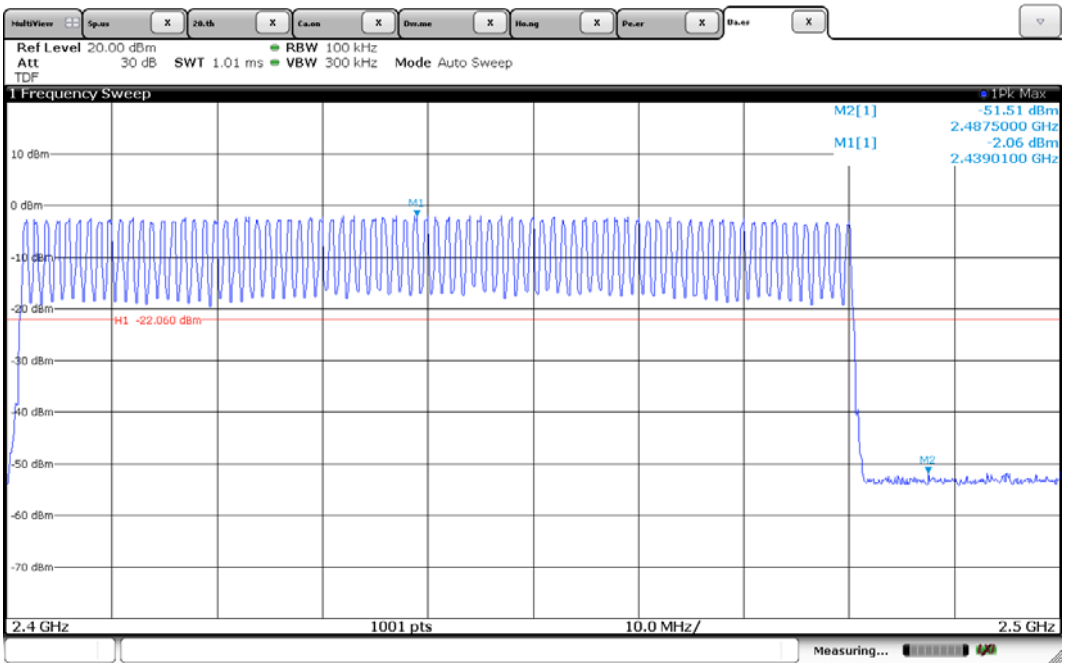
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Plots of Bandwidth of Frequency Band Edges (BDR)

[Hopping mode]

Conducted



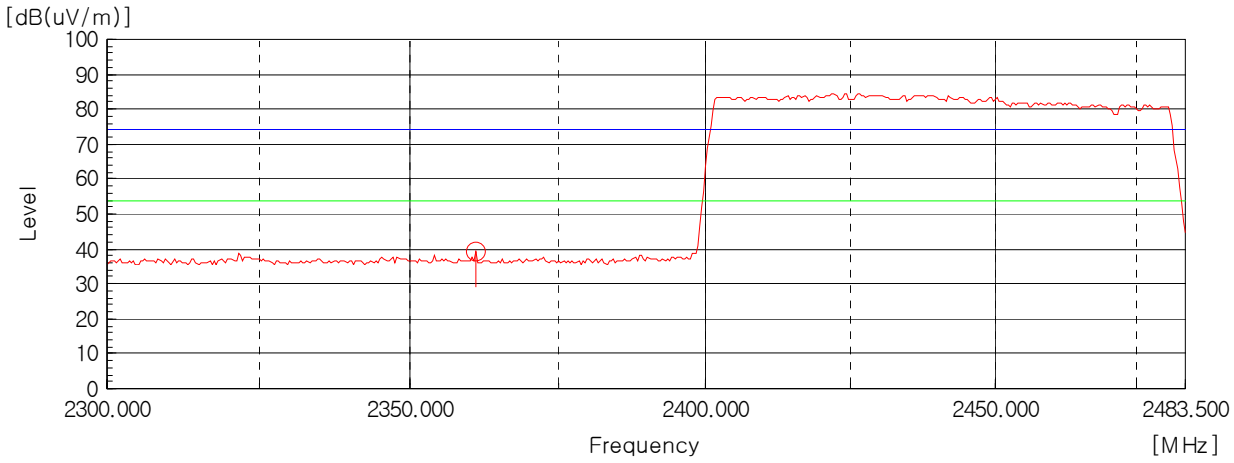


Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Radiated

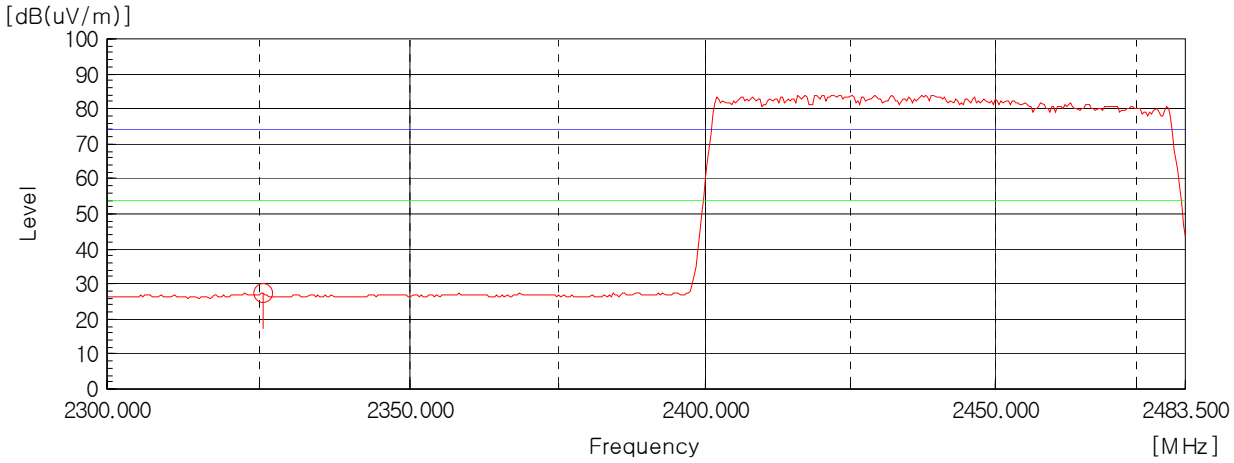
Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 310 MHz - 2 390 MHz), Worst case (Low, Vertical)

Peak Limit Line
AV Limit Line



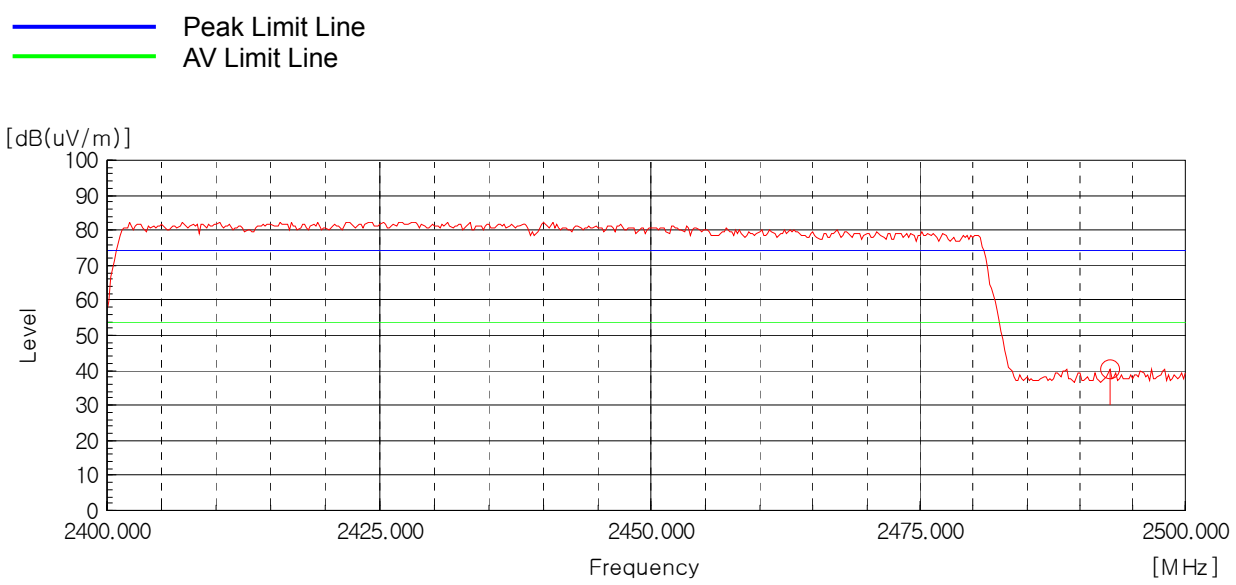
AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 310 MHz - 2 390 MHz), Worst case (Low, Vertical)

Peak Limit Line
AV Limit Line

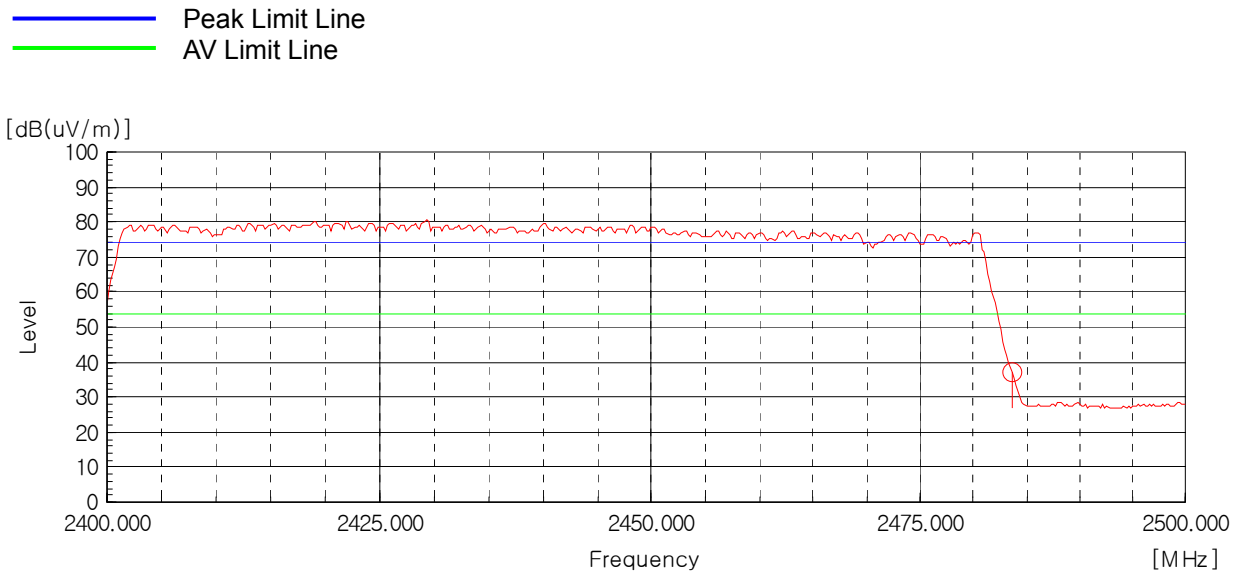


Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 483.5 MHz - 2 500.0 MHz), Worst case (High, Vertical)



AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 483.5 MHz - 2 500.0 MHz), Worst case (High, Vertical)

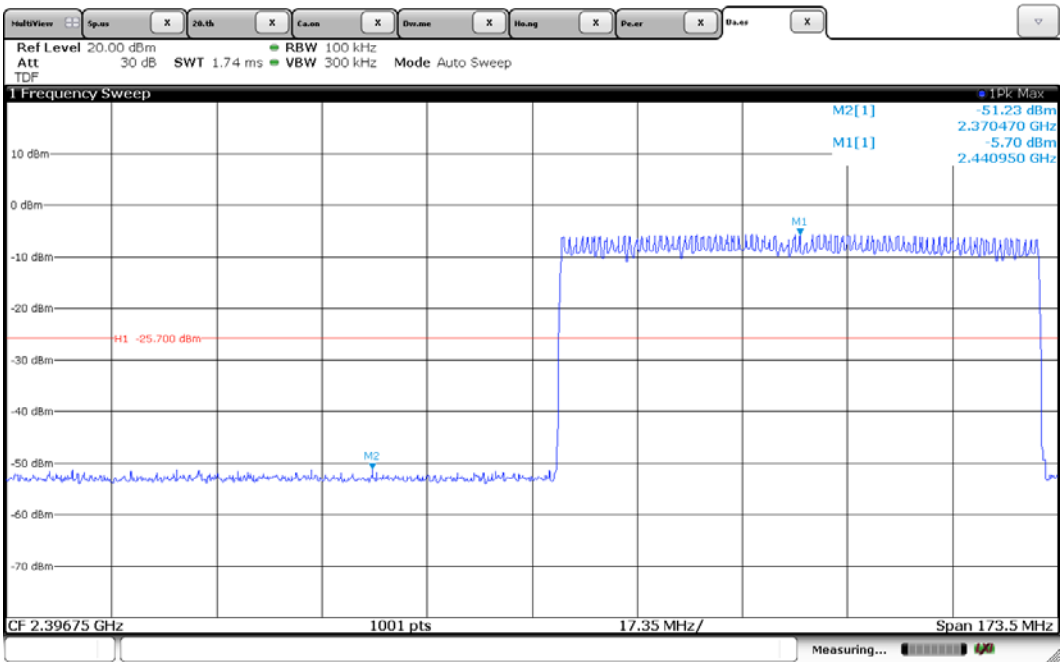


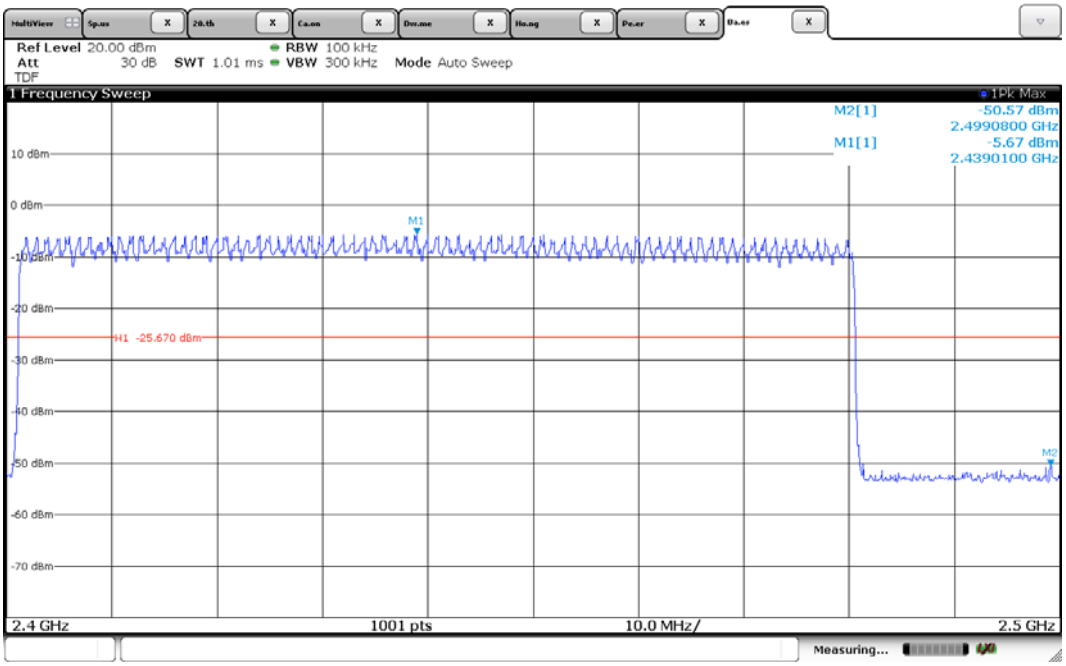
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Plots of Bandwidth of Frequency Band Edges (EDR)

[Hopping mode]

Conducted

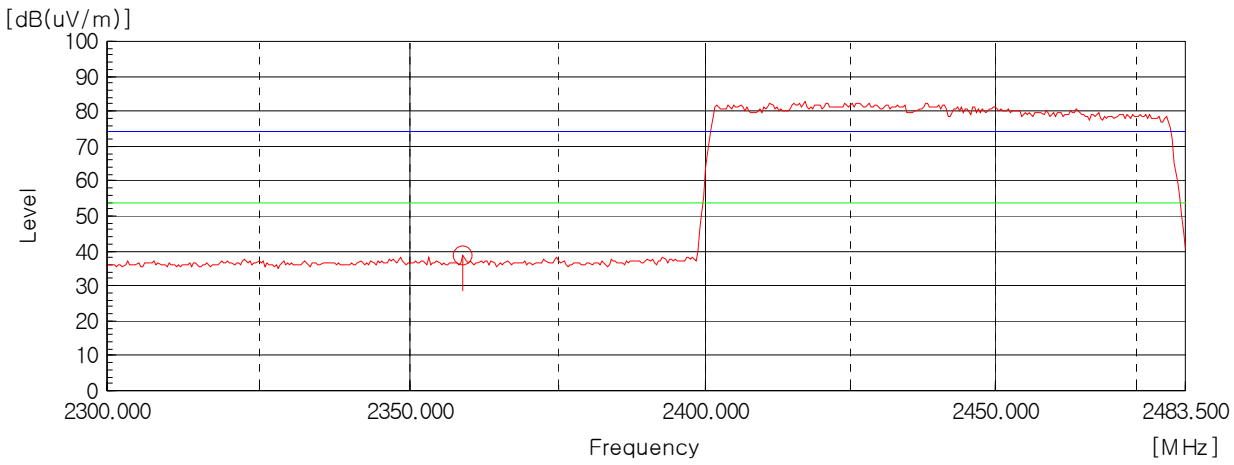




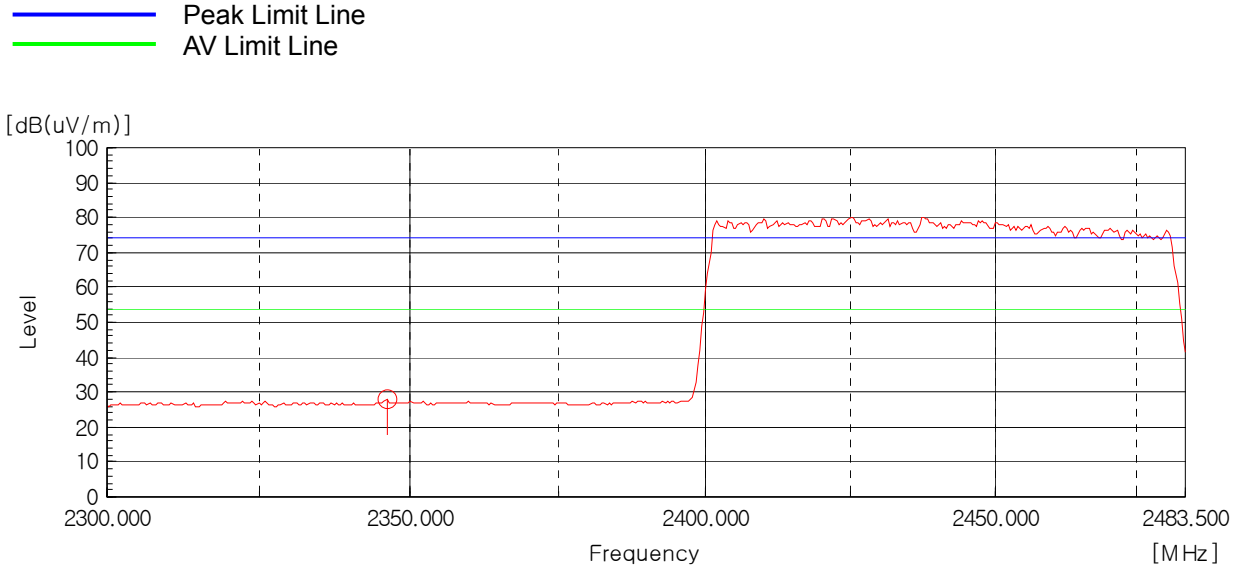
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Radiated

Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 310 MHz - 2 390 MHz), Worst case (Low, Vertical)

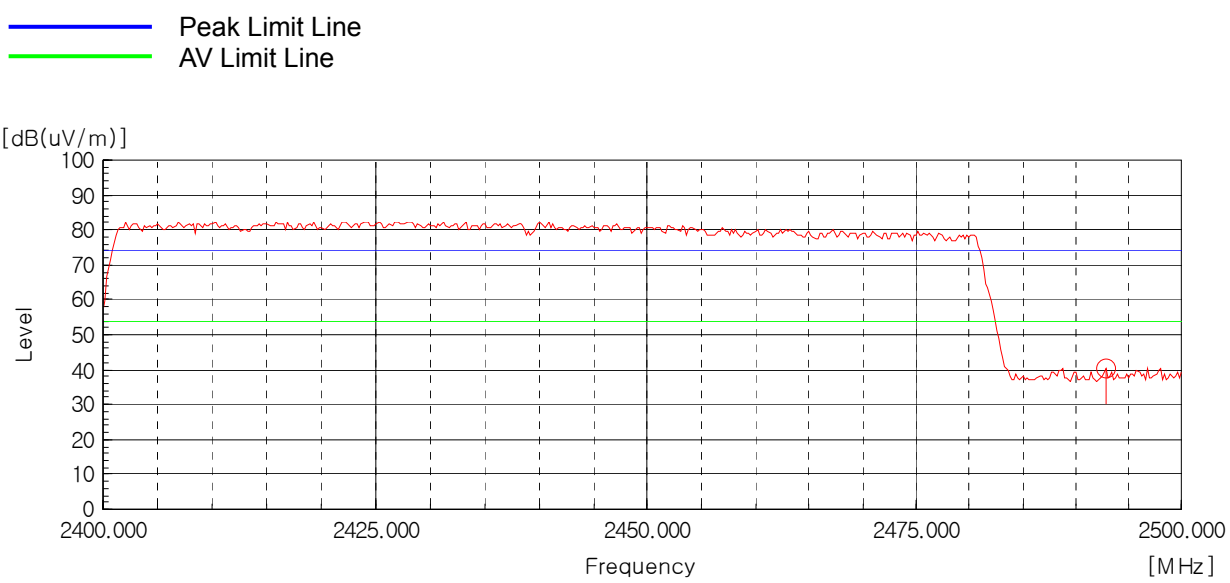


AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 310 MHz - 2 390 MHz), Worst case (Low, Vertical)

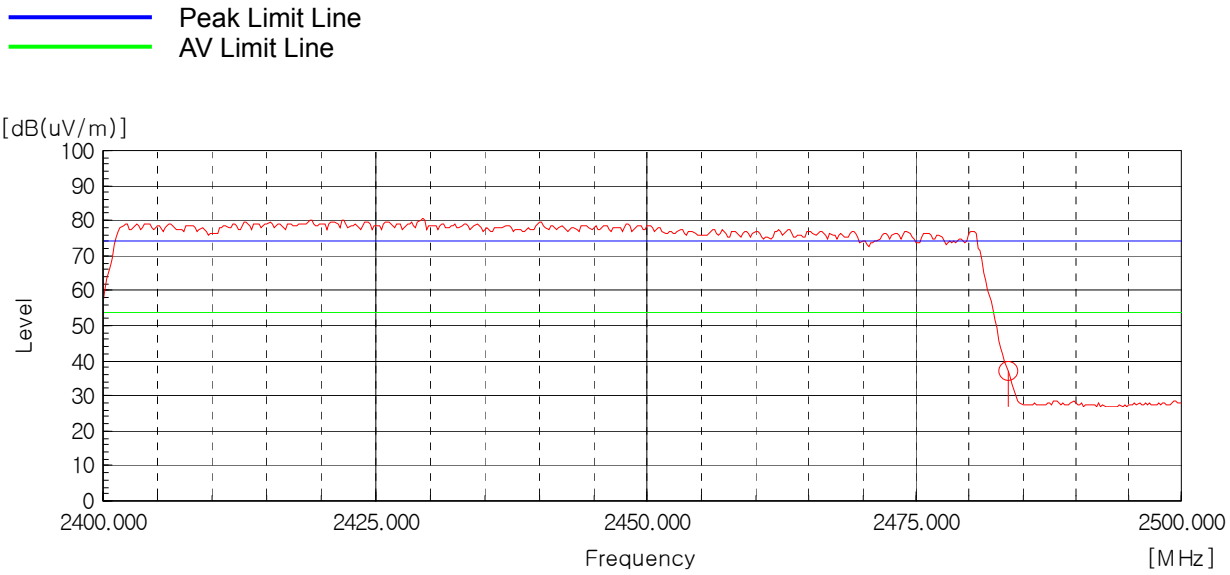


Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 483.5 MHz - 2 500.0 MHz), Worst case (High, Vertical)



AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 483.5 MHz - 2 500.0 MHz), Worst case (High, Vertical)



Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

5.5 Number of Hopping Channels

EUT	Sgnl / WB-S50
Limit apply to	FCC Part 15.247(a)(1)(iii)
Test Date	June 18, 2018
Environmental of Test	(31.0 ± 0.0) °C, (40 ± 0) % R.H., (100.8 ± 0.0) kPa
Operating Condition	RF transmitting continuously during the tested.
Result	Passed

Limit

Frequency hopping systems in the 2 400.0 MHz - 2 483.5 MHz band shall use at least 15 channels.

Test Data

Type of Modulation	Result	Limit
BDR	79	> 15 Channel
EDR	79	

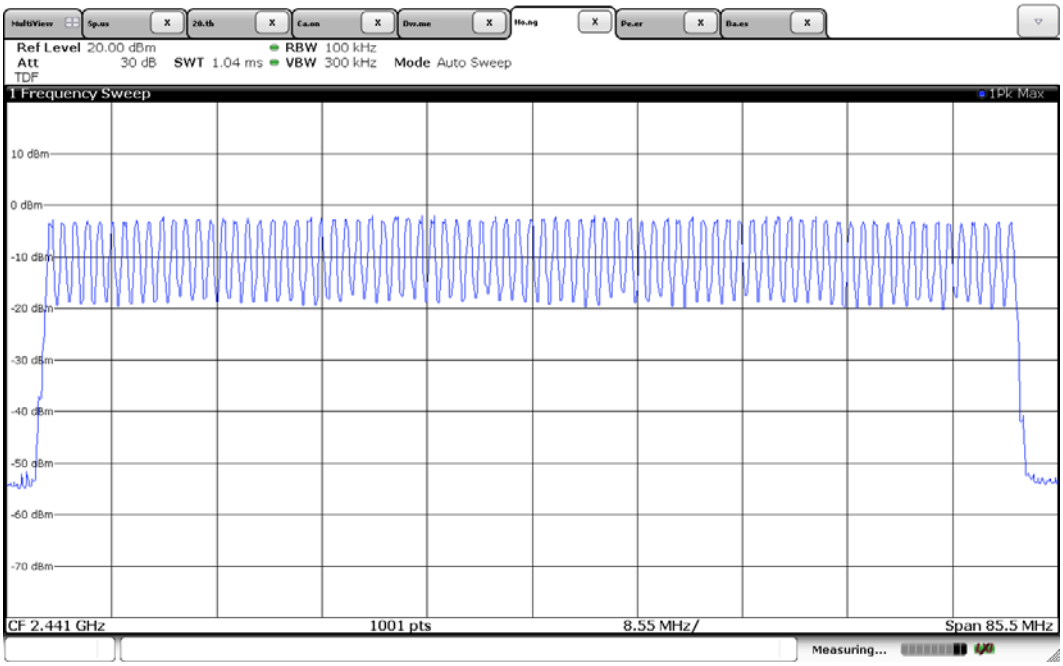
NOTES:

1. Measure number of hopping channel of relevant channel using spectrum analyzer.
2. Please see the measured plot in next page.

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

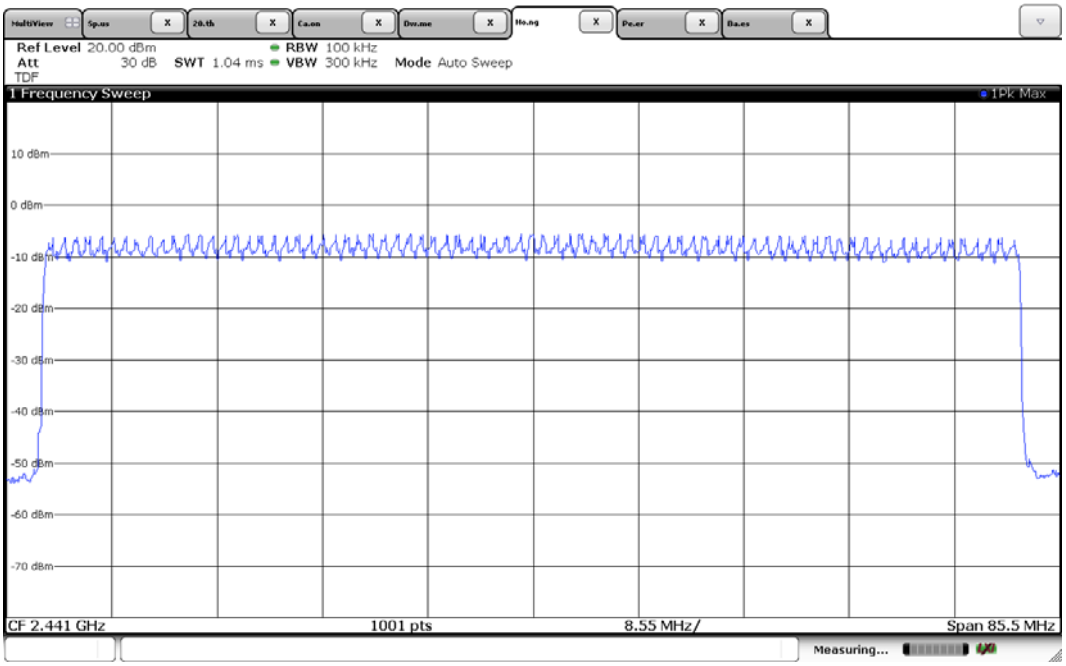
Plots of Number of Hopping Channels (BDR)

[Hopping Channels]



Plots of Number of Hopping Channels (EDR)

[Hopping Channels]



Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

5.6 Time of Occupancy

EUT	Sgnl / WB-S50
Limit apply to	FCC Part 15.247(a)(1)(iii)
Test Date	June 18, 2018
Environmental of Test	(31.1 ± 0.0) °C, (40 ± 0) % R.H., (100.8 ± 0.0) kPa
Operating Condition	RF transmitting continuously during the tested.
Result	Passed

Limit

Frequency hopping systems in the 2 400.0 MHz - 2 483.5 MHz band. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Test Data

Time of Occupancy

Test period = 0.4 [seconds/channel] x 79 [channel]
Actual = Reading x (Hopping rate/Number of channels) x Test period
- Hopping rate (DH5 Packet) = 1 600 [hopping/second] / 6 [time slot] = 266.667
- Hopping rate (3DH5 Packet) = 1 600 [hopping/second] / 6 [time slot] = 266.667

- Type of Modulation: BDR

0.4 s x 79 (CH) = 31.6 s
2.892 ms x (266.667/79) x 31.6 s = 308.480 ms

- Type of Modulation: EDR

0.4 s x 79 (CH) = 31.6 s
2.902 ms x (266.667/79) x 31.6 s = 309.547 ms

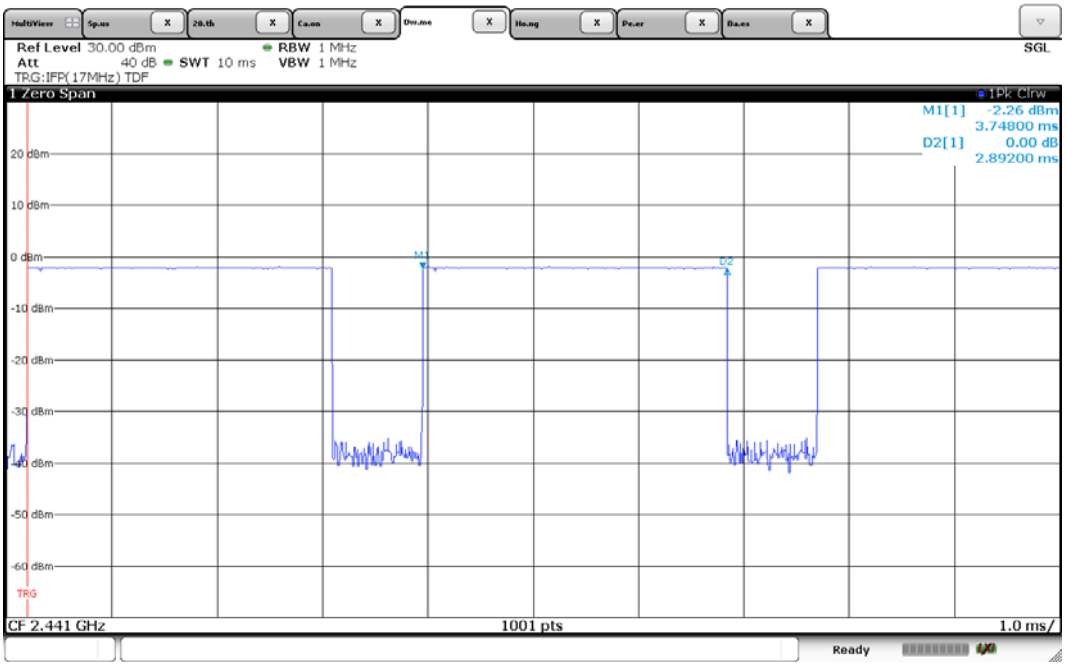
Type of Modulation	Pulse Time [ms]	Total of Dwell [ms]	Limit [ms]
BDR	2.892	308.480	400.000
EDR	2.902	309.547	400.000

NOTES:
1. BDR: This test was applied both to DH1, DH3 and DH5. (Worst case: DH5)
2. EDR: This test was applied both to 2DH1, 2DH3, 2DH5, 3DH1, 3DH3 and 3DH5. (Worst case: 3DH5)
3. Measure time of occupancy of relevant channel using spectrum analyzer.
4. Please see the measured plot in next page.

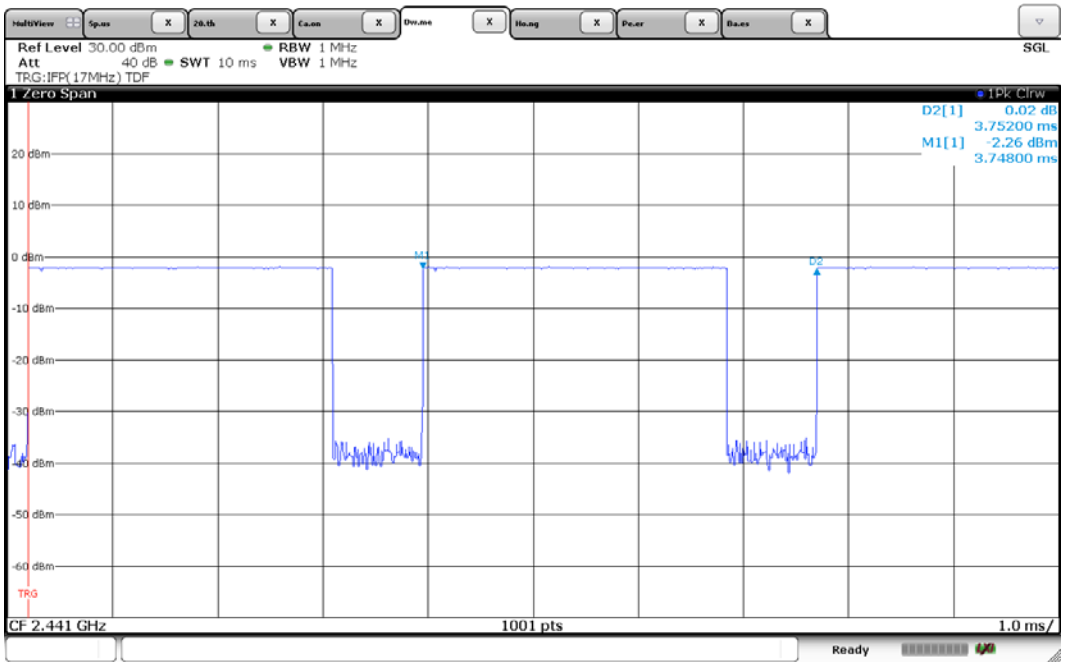
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Plots of Time of Occupancy (BDR)

[Continuous Time]



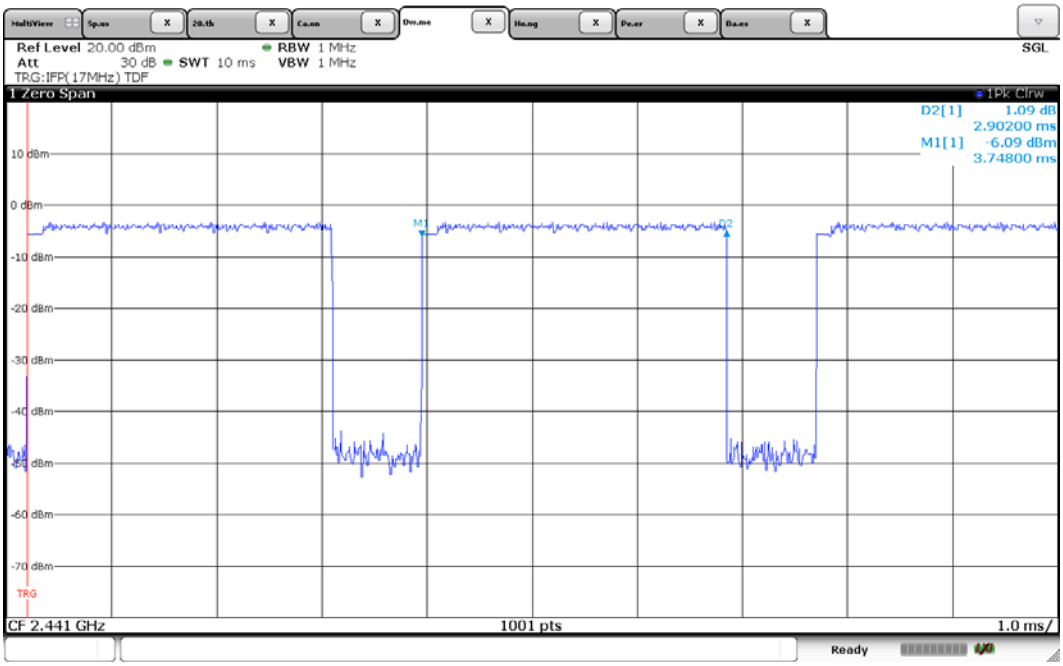
[Hopping Period]



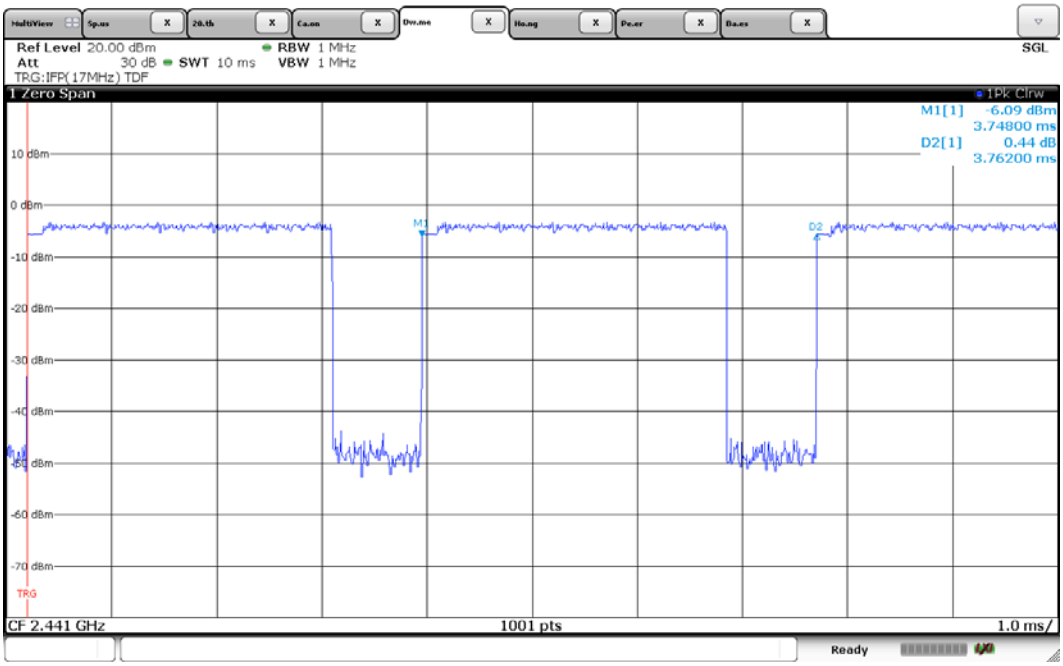
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Plots of Time of Occupancy (EDR)

[Continuous Time]



[Hopping Period]



Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

5.7 Spurious Emissions

EUT	Sgnl / WB-S50
Limit apply to	FCC Part 15.209
Operating Condition	Low CH, Middle CH, High CH Transmission
Result	Passed

Limit

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:

Frequencies [MHz]	Field Strength [μV/m]	Measurement Distance [m]
0.009 - 0.490	2 400/F(kHz)	300
0.490 - 1.705	24 000/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 MHz - 72 MHz, 76 MHz - 88 MHz, 174 MHz - 216 MHz or 470 MHz - 806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

Test Results

- Refer to see the measured plot in next page.

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Radiated Emissions Test data

- 9 kHz to 1 GHz

Test Date	June 25, 2018
Environmental of Test	(30.5 ± 2.5) °C, (60 ± 8) % R.H., (100.7 ± 0.0) kPa

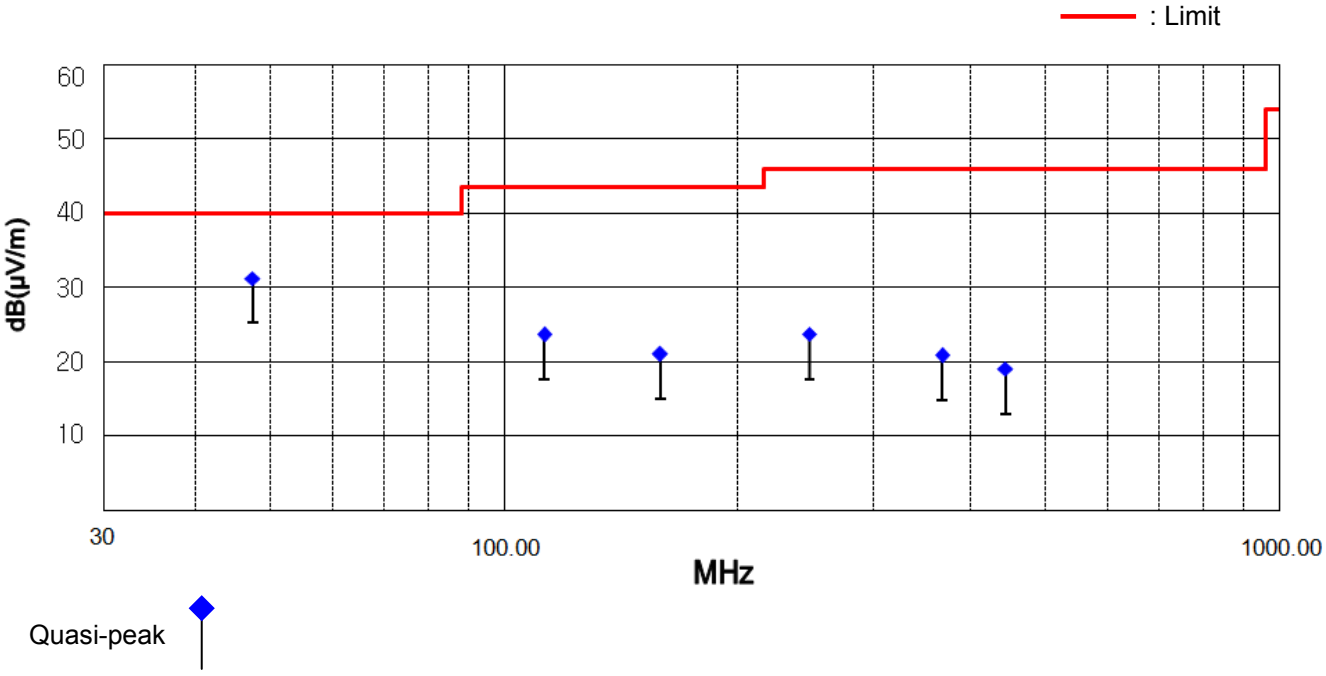
The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical.
Detector mode: CISPR Quasi-Peak mode (100 Hz, 9 kHz) (6 dB Bandwidth: 120 kHz)

- Type of Modulation: EDR (Worst case)

Frequency [MHz]	Reading [dB(μV)]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB(μV)]	Height [cm]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
47.33	50.52	V	13.27	-32.46	110	31.33	40.00	8.67
112.64	45.52	V	10.34	-32.14	122	23.72	43.50	19.78
158.92	44.55	H	8.28	-31.75	380	21.08	43.50	22.42
247.75	42.78	H	12.86	-31.83	400	23.81	46.00	22.19
367.41	37.18	V	15.25	-31.48	148	20.95	46.00	25.05
443.22	33.60	V	16.70	-31.19	172	19.11	46.00	26.89

NOTES:

1. * H : Horizontal polarization, ** V : Vertical polarization
2. The cable loss value was included the Amp. Gain.
3. Result = Reading + Antenna factor + Cable loss
4. Margin = Limit - Result
5. The measurement was performed for the frequency range 9 kHz to 30 MHz according to FCC Part 15.209.



Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

- Above 1 GHz (1 GHz to 25 GHz)

Test Date	June 25, 2018
Environmental of Test	(27.6 ± 1.4) °C, (70 ± 4) % R.H., (100.7 ± 0.0) kPa

- Type of Modulation: BDR

1. Low CH

Frequency [MHz]	Reading [dB(μV)]		Polarity (*H/**V)	Ant. Factor [dB/m]	Cable - AMP Loss [dB]	Height [cm]	Result [dB(μV/m)]		Limit [dB(μV/m)]		Margin [dB]	
	Peak	Average					Peak	Average	Peak	Average	Peak	Average
1 199.93	60.72	32.33	V	24.97	-49.55	150	36.14	7.75	73.97	53.97	37.83	46.22
2 496.08	68.19	41.52	H	27.72	-45.62	150	50.29	23.62	73.97	53.97	23.68	30.35
3 741.85	55.12	37.57	V	29.00	-45.04	150	39.08	21.53	73.97	53.97	34.89	32.44
5 241.50	51.61	35.91	V	31.63	-43.87	150	39.37	23.67	73.97	53.97	34.60	30.30
19 814.92	42.01	29.24	H	37.51	-31.83	150	47.69	34.92	73.97	53.97	26.28	19.05
21 487.96	42.94	30.06	V	37.86	-30.63	150	50.17	37.29	73.97	53.97	23.80	16.68

2. Middle CH

Frequency [MHz]	Reading [dB(μV)]		Polarity (*H/**V)	Ant. Factor [dB/m]	Cable - AMP Loss [dB]	Height [cm]	Result [dB(μV/m)]		Limit [dB(μV/m)]		Margin [dB]	
	Peak	Average					Peak	Average	Peak	Average	Peak	Average
2 494.46	60.66	37.27	H	27.71	-45.63	150	42.74	19.35	73.97	53.97	31.23	34.62
3 741.68	54.97	38.18	V	29.00	-45.03	150	38.94	22.15	73.97	53.97	35.03	31.82
5 234.10	53.45	36.68	V	31.63	-43.87	150	41.21	24.44	73.97	53.97	32.76	29.53
18 613.10	42.86	29.57	H	37.52	-32.45	150	47.93	34.64	73.97	53.97	26.04	19.33
21 464.25	42.99	29.96	H	37.85	-30.64	150	50.20	37.17	73.97	53.97	23.77	16.80
24 458.03	42.22	29.47	V	38.11	-28.50	150	51.83	39.08	73.97	53.97	22.14	14.89

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

3. High CH

Frequency [MHz]	Reading [dB(μV)]		Polarity (*H/**V)	Ant. Factor [dB/m]	Cable - AMP Loss [dB]	Height [cm]	Result [dB(μV/m)]		Limit [dB(μV/m)]		Margin [dB]	
	Peak	Average					Peak	Average	Peak	Average	Peak	Average
2 493.17	76.55	52.05	H	27.71	-45.64	150	58.62	34.12	73.97	53.97	15.35	19.85
2 994.83	64.41	49.29	H	28.40	-45.38	150	47.43	32.31	73.97	53.97	26.54	21.66
3 736.52	54.66	38.26	V	28.99	-45.02	150	38.63	22.23	73.97	53.97	35.34	31.74
5 229.77	53.49	36.35	H	31.62	-43.87	150	41.24	24.10	73.97	53.97	32.73	29.87
18 813.05	42.67	29.37	H	37.53	-32.39	150	47.81	34.51	73.97	53.97	26.16	19.46
20 486.31	42.67	29.51	V	37.56	-31.55	150	48.68	35.52	73.97	53.97	25.29	18.45

Note: Other harmonics are lower than background noise.

NOTES:

1. * H : Horizontal polarization, ** V : Vertical polarization
2. Factor = Antenna factor + Cable loss - Amp. Gain
3. Result = Reading + Factor
4. Margin value = Limit - Result
5. Measuring frequencies from 1 GHz to the 10^{th} harmonic of highest fundamental frequency.
6. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded(ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
7. Spectrum setting:
   a. Peak Setting 1 GHz to 10^{th} harmonics of fundamental, RBW = 1 MHz, VBW = 1 MHz, Sweep = Auto
   b. AV Setting 1 GHz to 10^{th} harmonics of fundamental, RBW = 1 MHz, VBW = 10 kHz, Sweep = Auto

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

- Type of Modulation: EDR

1. Low CH

Frequency [MHz]	Reading [dB(μV)]		Polarity (*H/**V)	Ant. Factor [dB/m]	Cable - AMP Loss [dB]	Height [cm]	Result [dB(μV/m)]		Limit [dB(μV/m)]		Margin [dB]	
	Peak	Average					Peak	Average	Peak	Average	Peak	Average
2 497.08	59.75	38.01	V	27.72	-45.62	150	41.85	20.11	73.97	53.97	32.12	33.86
3 736.50	54.94	38.15	V	28.99	-45.02	150	38.91	22.12	73.97	53.97	35.06	31.85
5 238.50	53.10	36.44	V	31.63	-43.87	150	40.86	24.20	73.97	53.97	33.11	29.77
20 263.04	42.35	29.42	V	37.53	-31.63	150	48.25	35.32	73.97	53.97	25.72	18.65
21 806.50	42.77	29.61	H	38.02	-30.56	150	50.23	37.07	73.97	53.97	23.74	16.90
23 503.77	42.90	30.25	H	38.00	-29.23	150	51.67	39.02	73.97	53.97	22.30	14.95

2. Middle CH

Frequency [MHz]	Reading [dB(μV)]		Polarity (*H/**V)	Ant. Factor [dB/m]	Cable - AMP Loss [dB]	Height [cm]	Result [dB(μV/m)]		Limit [dB(μV/m)]		Margin [dB]	
	Peak	Average					Peak	Average	Peak	Average	Peak	Average
2 493.73	64.13	39.24	V	27.71	-45.63	150	46.21	21.32	73.97	53.97	27.76	32.65
3 740.02	54.32	37.96	V	29.00	-45.03	150	38.29	21.93	73.97	53.97	35.68	32.04
5 244.83	52.13	36.17	H	31.64	-43.88	150	39.89	23.93	73.97	53.97	34.08	30.04
21 206.02	42.98	29.80	V	37.72	-30.77	150	49.93	36.75	73.97	53.97	24.04	17.22
23 161.74	42.74	29.92	H	38.07	-29.45	150	51.36	38.54	73.97	53.97	22.61	15.43
24 964.73	42.27	29.41	V	38.34	-28.08	150	52.53	39.67	73.97	53.97	21.44	14.30

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

3. High CH

Frequency [MHz]	Reading [dB(μV)]		Polarity (*H/**V)	Ant. Factor [dB/m]	Cable - AMP Loss [dB]	Height [cm]	Result [dB(μV/m)]		Limit [dB(μV/m)]		Margin [dB]	
	Peak	Average					Peak	Average	Peak	Average	Peak	Average
2 493.73	68.82	46.58	H	27.71	-45.63	150	50.90	28.66	73.97	53.97	23.07	25.31
2 994.33	68.44	54.53	H	28.40	-45.38	150	51.46	37.55	73.97	53.97	22.51	16.42
3 741.85	53.86	37.99	V	29.00	-45.04	150	37.82	21.95	73.97	53.97	36.15	32.02
5 236.33	52.56	36.32	V	31.63	-43.87	150	40.32	24.08	73.97	53.97	33.65	29.89
20 923.20	42.82	29.68	H	37.61	-30.97	150	49.46	36.32	73.97	53.97	24.51	17.65
23 138.49	42.79	30.02	V	38.07	-29.46	150	51.40	38.63	73.97	53.97	22.57	15.34

Note: Other harmonics are lower than background noise.

NOTES:

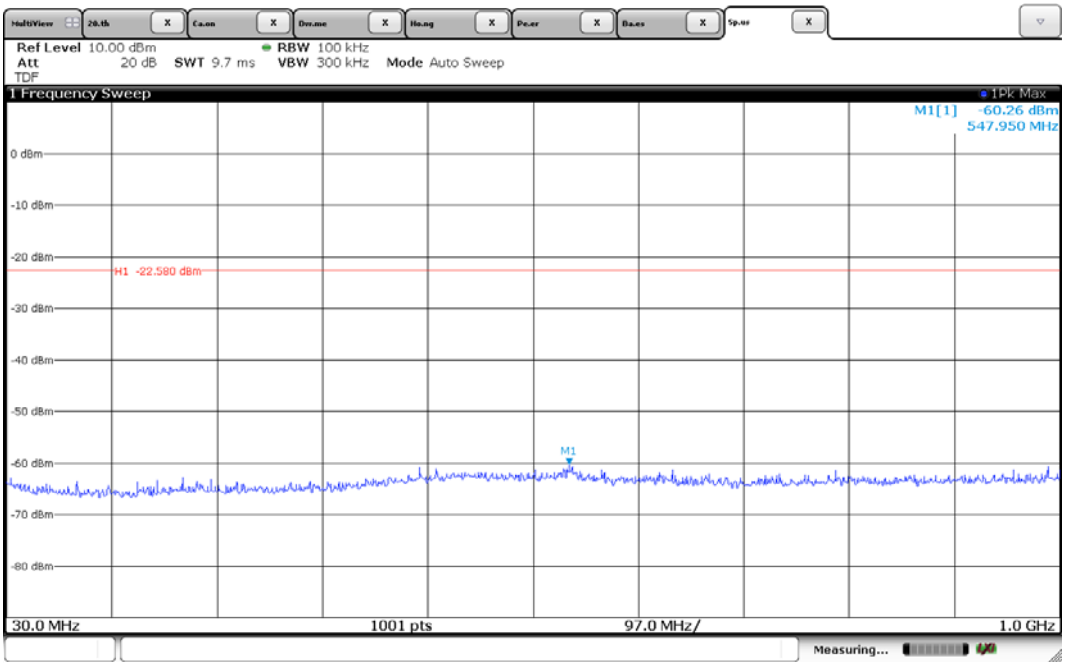
1. * H : Horizontal polarization, ** V : Vertical polarization
2. Factor = Antenna factor + Cable loss - Amp. Gain
3. Result = Reading + Factor
4. Margin value = Limit - Result
5. Measuring frequencies from 1 GHz to the 10^{th} harmonic of highest fundamental frequency.
6. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded(ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
7. Spectrum setting:
   a. Peak Setting 1 GHz to 10^{th} harmonics of fundamental, RBW = 1 MHz, VBW = 1 MHz, Sweep = Auto
   b. AV Setting 1 GHz to 10^{th} harmonics of fundamental, RBW = 1 MHz, VBW = 10 kHz, Sweep = Auto

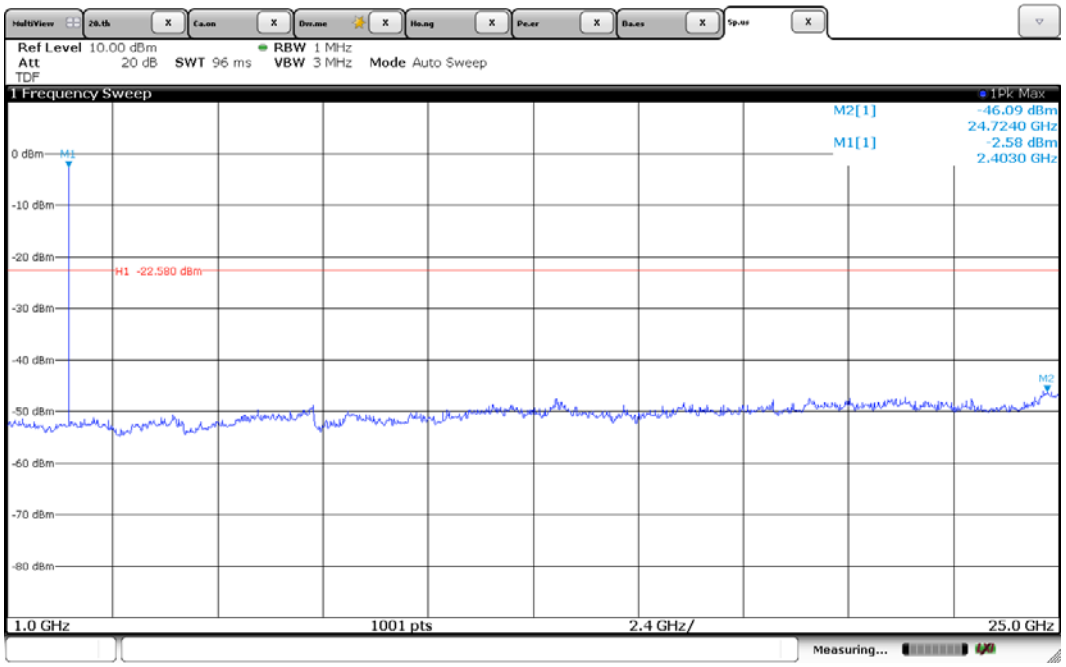
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Test Date	June 18, 2018
Environmental of Test	(31.1 ± 0.0) °C, (40 ± 0) % R.H., (100.8 ± 0.0) kPa

Plots of Spurious Emissions (Conducted Measurement) (BDR)

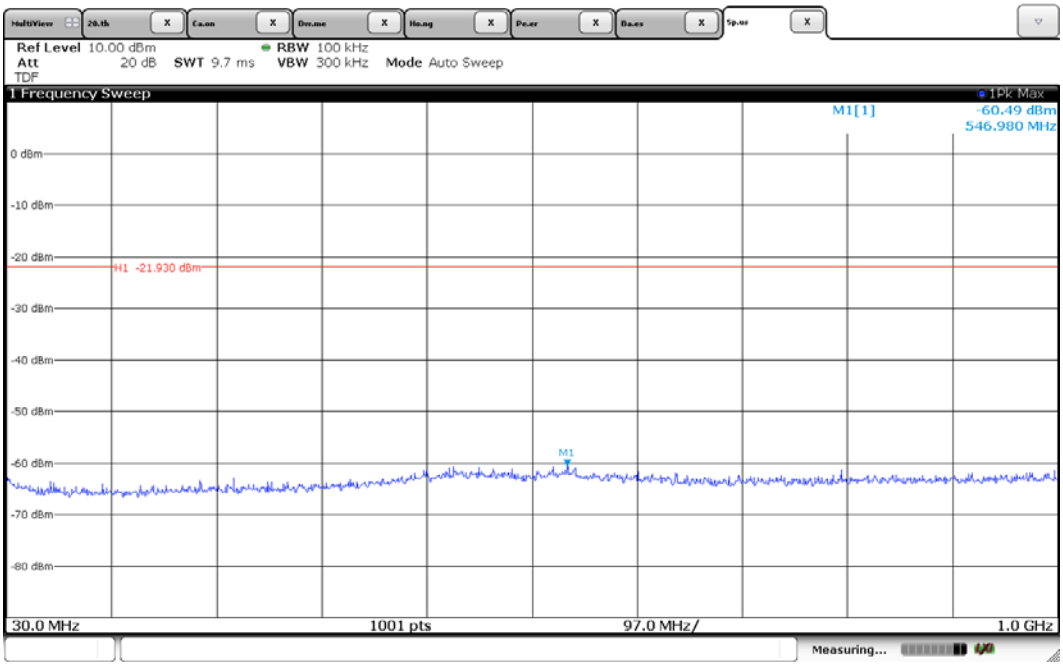
[CH Low]

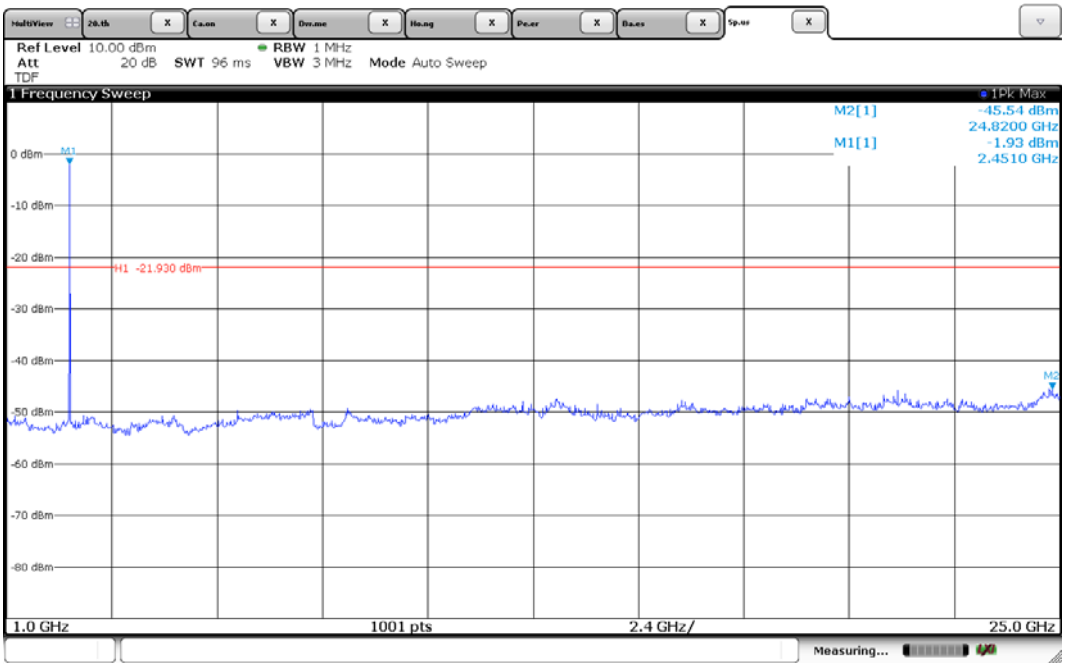




Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

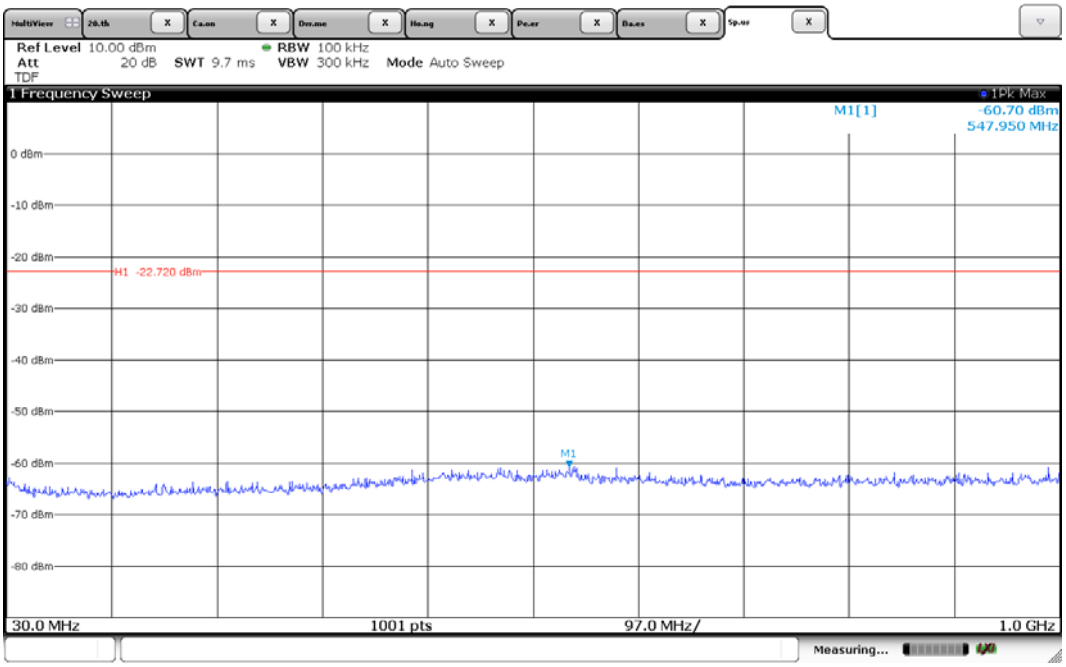
[CH Mid]

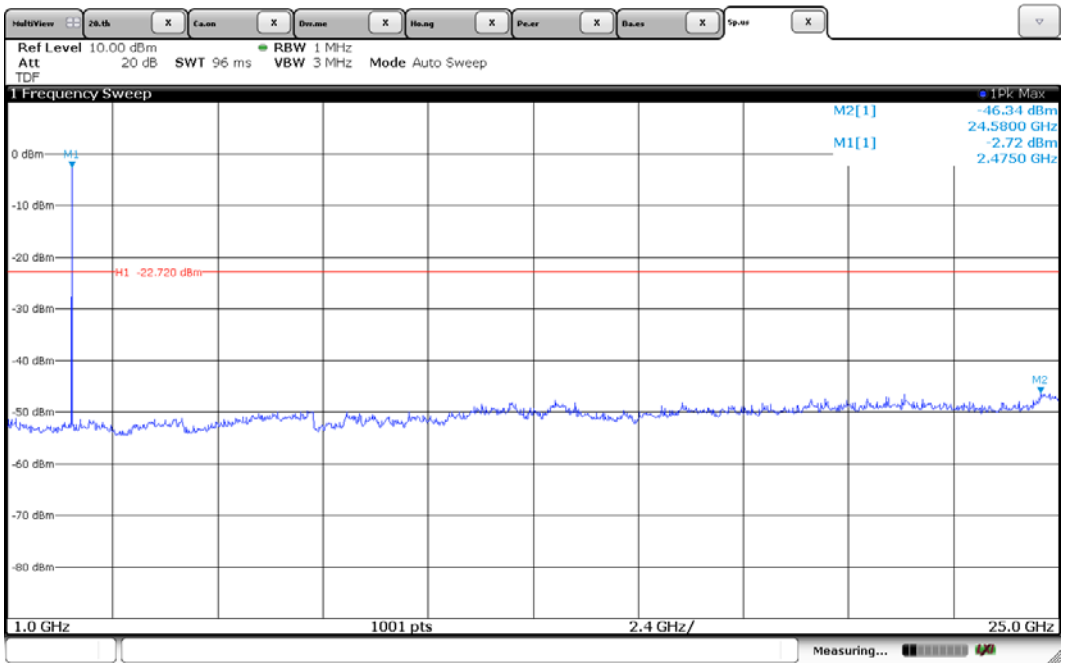




Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

[CH High]

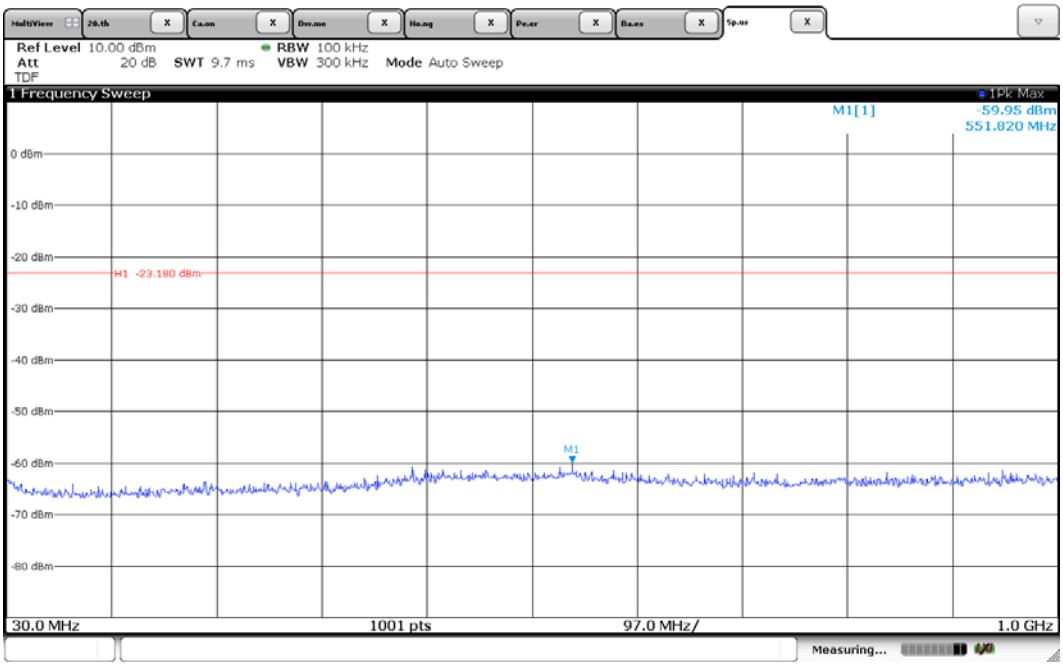


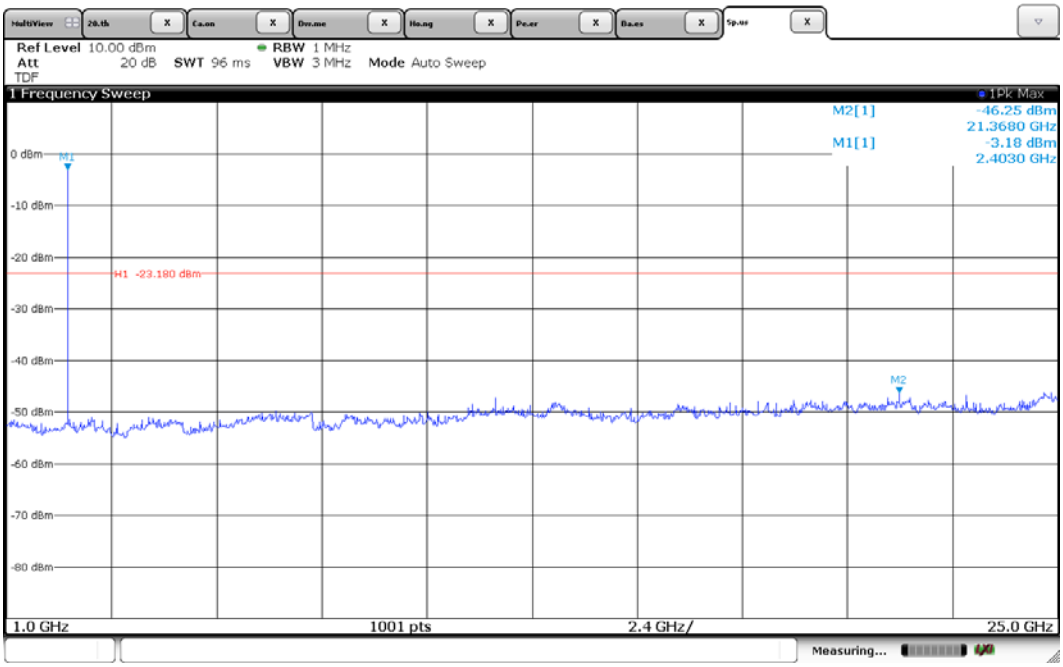


Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Plots of Spurious Emissions (Conducted Measurement) (EDR)

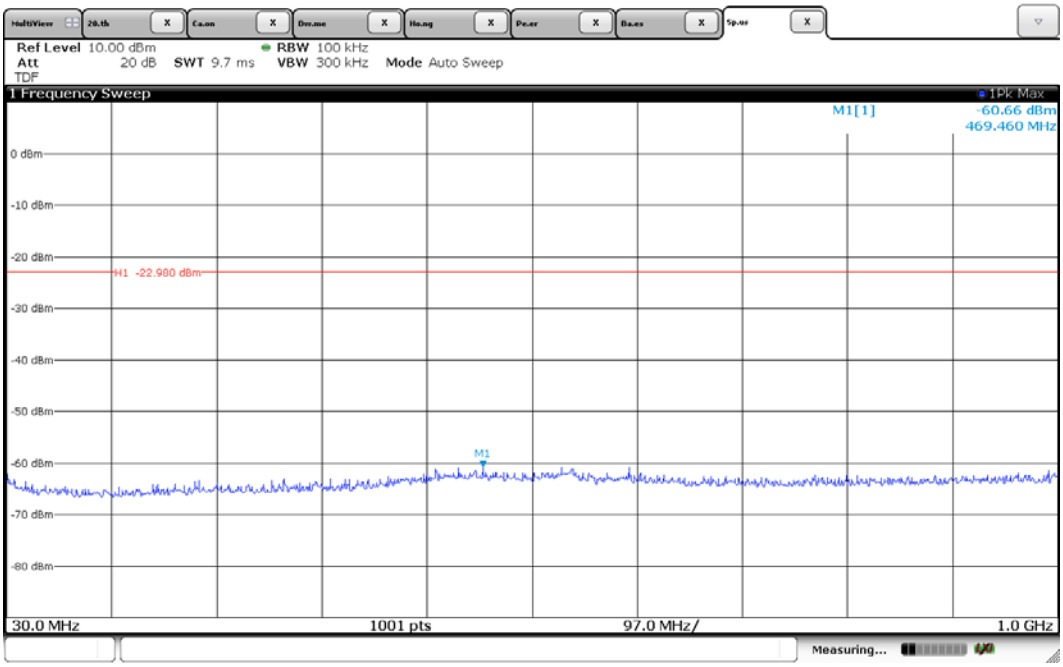
[CH Low]

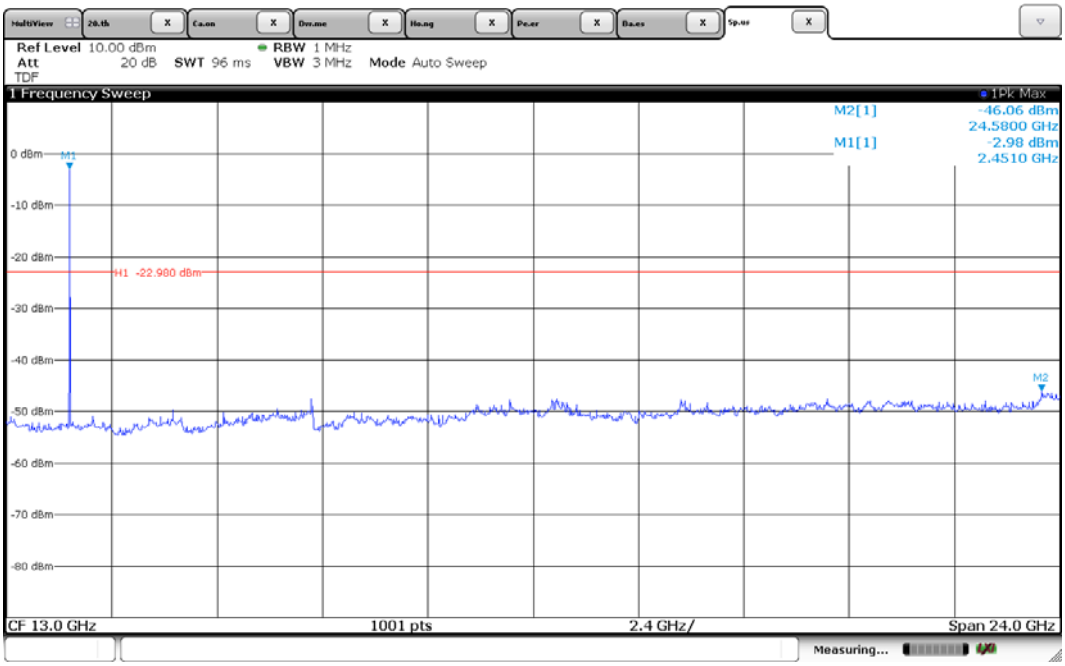




Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

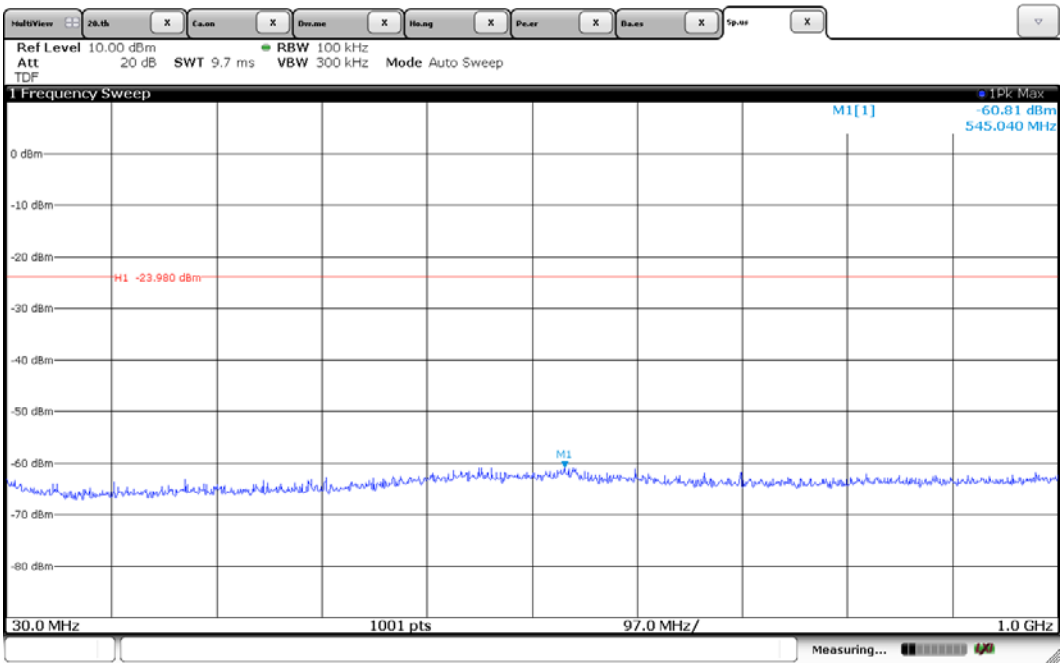
[CH Mid]

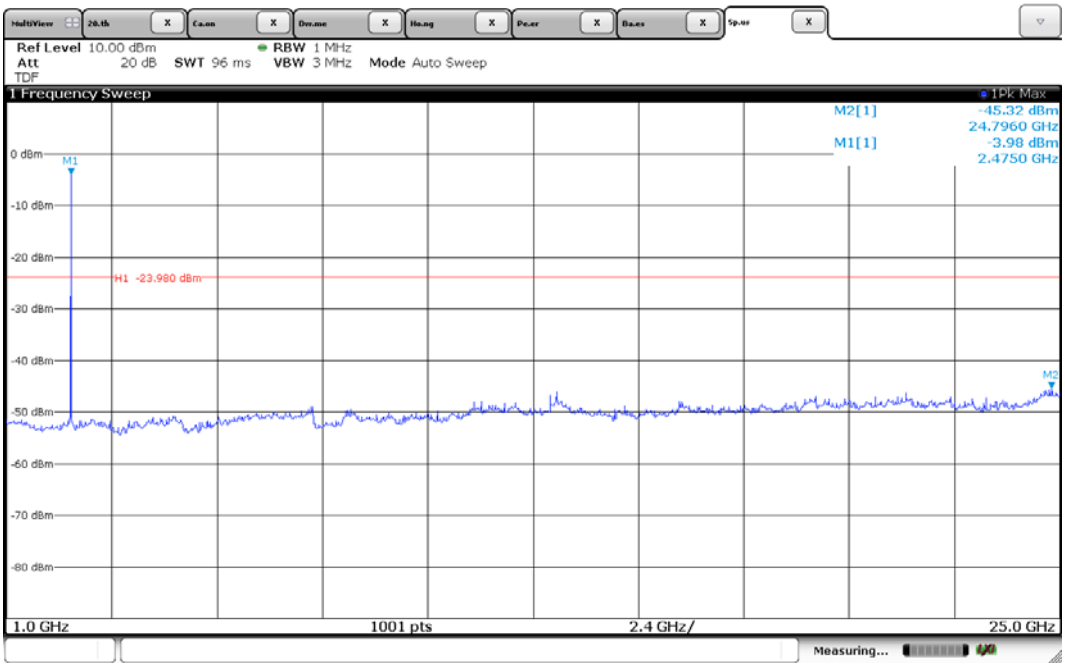




Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

[CH High]





Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

5.8 Conducted Emissions Measurement

EUT	Sgnl / WB-S50
Limit apply to	FCC Part 15.207
Test Date	June 21, 2018
Environmental of Test	(22.7 ± 0.0) °C, (47 ± 0) % R.H., (100.7 ± 0.0) kPa
Operating Condition	RF transmitting continuously during the tested.
Result	Passed by 5.11 dB

Limit

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 [dB(μV)]	
	Quasi-peak	Average
0.15 - 0.5	66 to 56 *	56 to 46 *
0.5 - 5	56	46
5 - 30	60	50

* Decreases with the logarithm of the frequency.

Test Results

- Refer to see the measured plot in next page.

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Conducted Emission Test Data

The following data and graph shows the highest levels of conducted emissions on both polarizations of hot and neutral line.
Detector mode: CISPR Quasi-Peak mode (6 dB Bandwidth: 9 kHz)

NOTES:

1. **Please see the measured data and graph in next page.**
2. **The Level (Result) value was included the reading, LISN factor and cable loss.**
3. **Delta (Margin) value = Limit - Level (Result)**
4. **Measurement were performed at the AC Power Inlet in the frequency band of 150 kHz ~ 30 MHz according to the FCC Part 15.207.**
5. **If the Quasi-Peak limit is met when using a Peak detector receiver, the EUT shall be deemed to meet both limits and measurement with the Quasi-Peak detector receiver is unnecessary.**
6. **If the average limit is met when using a Quasi-peak detector receiver, the EUT shall be deemed to meet both limits and measurement with the average detector receiver is unnecessary.**

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

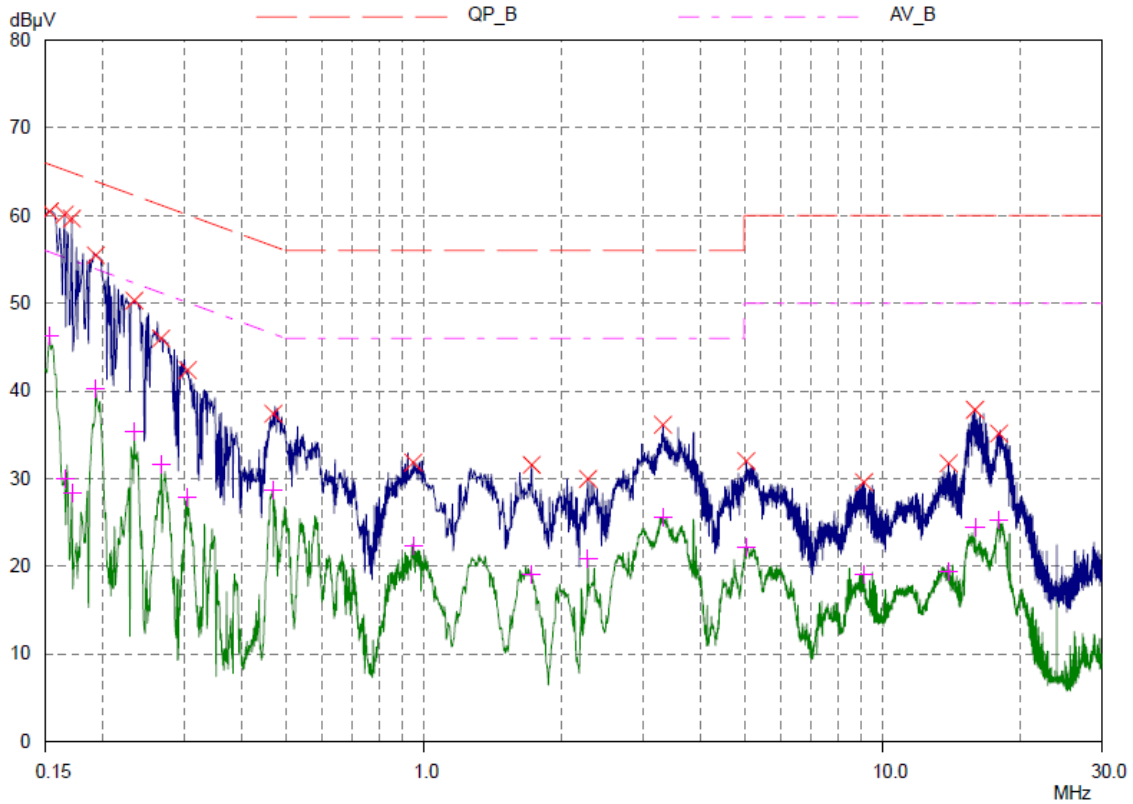
Line: HOT

ETL EMC Laboratory

Conducted Emission Test Result

EUT: ETLT180607.0063
Manuf:
Op Cond:
Operator:
Test Spec:
Comment: HOT

Prescan Measurement:
Detectors: X PK / + AV
Meas Time: see scan settings
Peaks: 16
Acc Margin: 10 dB



Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

ETL EMC Laboratory

Conducted Emission Test Result

EUT: ETLT180607.0063
Manuf:
Op Cond:
Operator:
Test Spec:
Comment: HOT

Prescan Measurement:
Detectors: X PK / + AV
Meas Time: see scan settings
Peaks: 16
Acc Margin: 10 dB

Peak Search Results

Frequency MHz	PK Level dBµV	PK Limit dBµV	PK Delta dB
0.153	60.46	65.84	5.38
0.165	60.10	65.21	5.11
0.171	59.65	64.91	5.26
0.193	55.46	63.91	8.45
0.234	50.30	62.31	12.01
0.268	45.99	61.18	15.19
0.306	42.37	60.08	17.71
0.47	37.39	56.51	19.12
0.949	31.84	56.00	24.16
1.72	31.55	56.00	24.45
2.28	29.94	56.00	26.06
3.325	36.13	56.00	19.87
5.05	32.00	60.00	28.00
9.11	29.58	60.00	30.42
13.94	31.73	60.00	28.27
15.92	37.84	60.00	22.16
17.95	35.12	60.00	24.88

Frequency MHz	AV Level dBµV	AV Limit dBµV	AV Delta dB
0.153	46.25	55.84	9.59
0.165	29.94	55.21	25.27
0.171	28.37	54.91	26.54
0.193	40.18	53.91	13.73
0.234	35.41	52.31	16.90
0.268	31.54	51.18	19.64
0.306	27.83	50.08	22.25
0.47	28.75	46.51	17.76
0.949	22.34	46.00	23.66
1.72	19.10	46.00	26.90
2.28	20.80	46.00	25.20

* limit exceeded

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Peak Search Results (continued)

Frequency MHz	AV Level dBµV	AV Limit dBµV	AV Delta dB
3.325	25.56	46.00	20.44
5.05	22.13	50.00	27.87
9.11	19.00	50.00	31.00
13.94	19.36	50.00	30.64
15.92	24.47	50.00	25.53
17.95	25.31	50.00	24.69

* limit exceeded

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

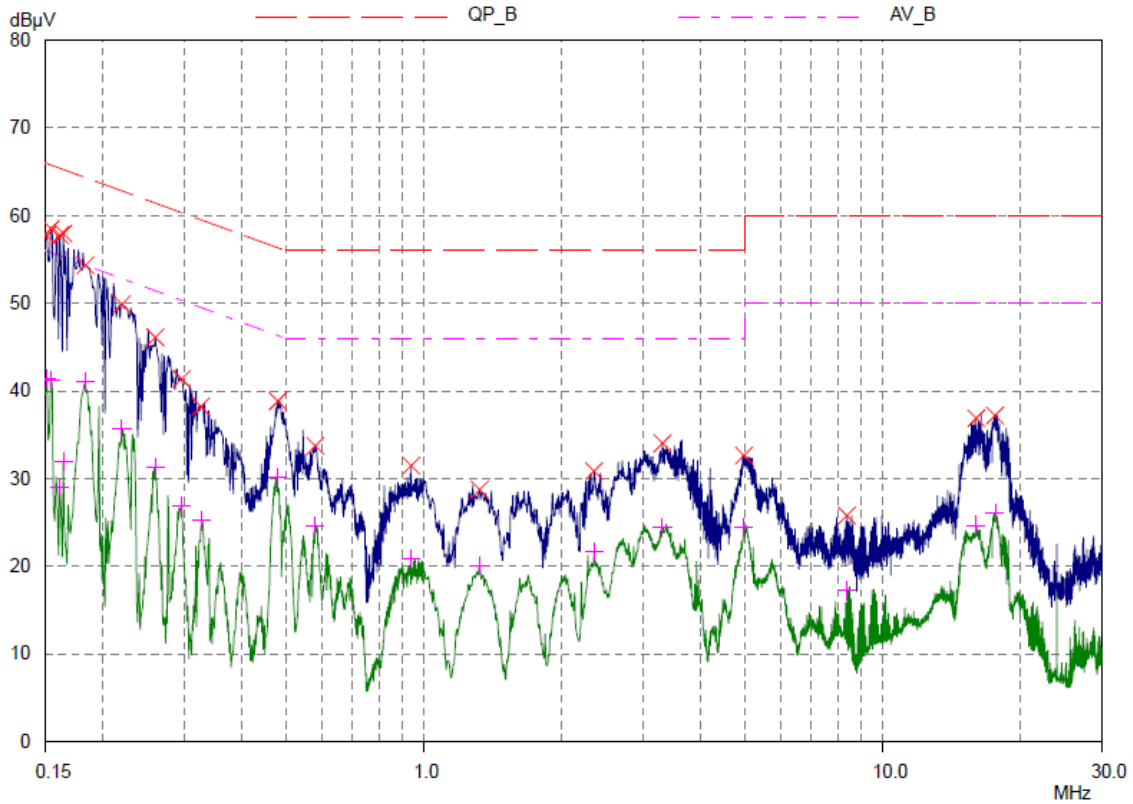
Line: Neutral

ETL EMC Laboratory

Conducted Emission Test Result

EUT: ETLT180607.0063
Manuf:
Op Cond:
Operator:
Test Spec:
Comment: N

Prescan Measurement:
Detectors: X PK / + AV
Meas Time: see scan settings
Peaks: 16
Acc Margin: 10 dB



Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

ETL EMC Laboratory

Conducted Emission Test Result

EUT: ETLT180607.0063
Manuf:
Op Cond:
Operator:
Test Spec:
Comment: N

Prescan Measurement:
Detectors: X PK / + AV
Meas Time: see scan settings
Peaks: 16
Acc Margin: 10 dB

Peak Search Results

Frequency MHz	PK Level dBµV	PK Limit dBµV	PK Delta dB
0.151	57.71	65.94	8.23
0.154	58.49	65.78	7.29
0.161	57.76	65.41	7.65
0.164	57.95	65.26	7.31
0.183	54.31	64.35	10.04
0.22	49.90	62.82	12.92
0.26	46.10	61.43	15.33
0.297	41.36	60.33	18.97
0.327	38.23	59.53	21.30
0.481	38.82	56.32	17.50
0.581	33.71	56.00	22.29
0.939	31.47	56.00	24.53
1.325	28.74	56.00	27.26
2.355	30.85	56.00	25.15
3.315	34.01	56.00	21.99
4.995	32.62	56.00	23.38
8.37	25.77	60.00	34.23
16.0	36.88	60.00	23.12
17.61	37.19	60.00	22.81

Frequency MHz	AV Level dBµV	AV Limit dBµV	AV Delta dB
0.151	41.37	55.94	14.57
0.154	41.21	55.78	14.57
0.161	28.96	55.41	26.45
0.164	31.93	55.26	23.33
0.183	41.02	54.35	13.33
0.22	35.74	52.82	17.08
0.26	31.23	51.43	20.20
0.297	26.84	50.33	23.49
0.327	25.32	49.53	24.21

* limit exceeded

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Peak Search Results (continued)

Frequency MHz	AV Level dBµV	AV Limit dBµV	AV Delta dB
0.481	30.11	46.32	16.21
0.581	24.61	46.00	21.39
0.939	20.78	46.00	25.22
1.325	20.04	46.00	25.96
2.355	21.74	46.00	24.26
3.315	24.44	46.00	21.56
4.995	24.50	46.00	21.50
8.37	17.19	50.00	32.81
16.0	24.68	50.00	25.32
17.61	26.08	50.00	23.92

* limit exceeded

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

5.9 Radio Frequency Exposure

Standard Applicable:

According to §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.

This is a Portable device with its physical nature to be used nearby, the distance between radiating structure and human is less than 20 cm.

As per KDB 447498 D01, 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

f (GHz) is the RF channel transmit frequency in GHz
Power and distance are rounded to the nearest mW and mm before calculation
The result is rounded to one decimal place for comparison

Measurement Result:

This is a portable device and the Max tune up power is (**0.71 mW**) lower than the threshold given and derived as above, where

= 0.71 (mW) / 5 (mm) * √2.441 (GHz) = 0.22 < 3.00

As the result of calculation result indicates, the RF exposure generating from given transmitter (transmitter employed digital modulation) can be excluded from SAR measurement, and is deemed compliant with RF exposure as per FCC.

Type of Modulation	Frequency [MHz]	Output Power [dBm]	Target power [dBm]	Allowed tolerance [dB]	Max tune up power [dBm]	Max tune up power [mW]	Separation distance [mm]	RF exposure	Limit
BDR	2 402	-2.36	-4.0	± 2	-2.0	0.63	5	0.20	3.00
	2 441	**-1.77**	**-3.5**	**± 2**	**-1.5**	**0.71**	**5**	**0.22**	**3.00**
	2 480	-2.13	-4.0	± 2	-2.0	0.63	5	0.20	3.00
EDR	2 402	-2.70	-4.5	± 2	-2.5	0.56	5	0.17	3.00
	2 441	-2.63	-4.5	± 2	-2.5	0.56	5	0.17	3.00
	2 480	-3.44	-5.0	± 2	-3.0	0.50	5	0.16	3.00

ex) Target power[dBm] = Max tune up power[dBm] – Allowed tolerance[dB]

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

6. SAMPLE CALCULATION

Sample Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor.
The basic equation with a sample calculation is as follows:

FS = RA + AF + CF

Where FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation Factor - Preamplifier Factor

$dB(\mu V) = 20 \log_{10} (\mu V)$: Equation
dB(μV) = dBm + 107

Example : @ 47.33 MHz

Limit = 40.00 dB(μV/m)

Reading = 50.52 dB(μV)

Antenna Factor + (Cable Loss - Amp Gain) = 13.27 + (-32.46) = -19.19 dB(μV/m)

Total = 31.33 dB(μV/m)

Margin = 40.00 – 31.33 = 8.67 dB

= 8.67 dB below Limit

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

7. List of test equipments used for measurements

Test Equipment		Model	Mfg.	Serial No.	Cal. Date	Cal. Due Date
☒	EMI TEST RECEIVER	ESCI7	ROHDE & SCHWARZ.	100851	17.08.31	18.08.31
☒	EMI TEST RECEIVER	ESCS30	ROHDE & SCHWARZ.	100087	18.03.12	19.03.12
☒	Spectrum Analyzer	FSW43	ROHDE & SCHWARZ.	103794	17.09.05	18.09.05
☒	PSA Series Spectrum Analyzer	E4440A	Agilent	US40420382	17.09.01	18.09.01
☒	EMI Test Receiver	ESPI3	R&S	100478	17.08.31	18.08.31
☒	Two-Line V-Network	ENV216	R&S	101715	18.03.12	19.03.12
☒	Two-Line V-Network	ENV216	R&S	102055	18.03.12	19.03.12
☒	Attenuator	BW-S10-2W263+	Mini-Circuits	NONE	18.03.14	19.03.14
☒	DC Power Supply	SDP 60-5D	SM Techno	605DOD 002	18.03.12	19.03.12
☒	Bi-Log Antenna	VULB9163	Schwarzbeck	01069	17.02.17	19.02.17
☒	Loop Antenna	6502	EMCO	00033743	16.09.05	18.09.05
☒	Horn Antenna	BBHA 9120D	Schwarzbeck	277	16.10.12	18.10.12
☒	Horn Antenna	BBHA 9170	Schwarzbeck	BBHA9170440	17.12.04	19.12.04
☒	AMPLIFIER	TK-PA18	TESTEK	120020	17.09.01	18.09.01
☒	AMPLIFIER	TK-PA18H	TESTEK	170010-L	18.03.12	19.03.12
☒	AMPLIFIER	BLWA 0310-1	BONN Elektronik	045672	18.01.31	19.01.31
☒	AMPLIFIER	JS44-18004000-45-8P	MITEQ Inc.	1568695	17.09.05	18.09.05
☒	Highpass Filter	WHKX3.0 /18G-6SS	Wainwright Instrument	15	18.03.13	19.03.13
☒	Highpass Filter	WHNX6-4740-6000 -26500-40CC	WAINWRIGHT INSTRUMENT GmbH	1	17.09.04	18.09.04
☒	Band Reject Filter	WRCGV 2402/2480-2382/2500-52/10SS	Wainwright Instrument	2R	17.08.31	18.08.31
☒	TURN-TABLE	TT 1.35 SI	SES	-	N/A	N/A
☒	ANTENNA MASTER	AM 4.5	SES	-	N/A	N/A
☒	TURN-TABLE	DS1200-S	Innco Systems Gmbh	2740311	N/A	N/A
☒	Controller	HD 2000	HD GmbH	C/125	N/A	N/A
☒	Antenna Master	MA4000	AUDIX	N/A	N/A	N/A

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea