

Electromagnetic Emission

FCC MEASUREMENT REPORT

CERTIFICATION OF COMPLIANCE

FCC Part 15 Certification Measurement

PRODUCT : Smart Equalizer
MODEL/Serial No. : DSBT504 / Proto type
MULTIPLE MODEL : ASBT504
BRAND NAME : DUAL, AXXERA
FCC ID : GJW-SBT504
IC : 4038A-SBT504
APPLICANT : Namsung Corporation.
ACE Techno Tower 13th Fl, 197-22, Guro-dong,
Guro-gu, Seoul, Korea 152-050
Attn.: Byungjae Ahn / Director
MANUFACTURER : Deodio Co., Ltd.
5, Bodojin-Ro, 18 Beon-Gil, Seo-Gu, Incheon, Korea
FCC 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 : PCB Pattern Antenna (Integral)
ANTENNA GAIN : -0.744 dBi max
RF POWER : 4.295 mW
RULE PART(S) : FCC Part 15 Subpart C
RSS-210 Issue 8
FCC PROCEDURE : ANSI C63.4-2009
TEST REPORT No. : ETLE140224.0282
DATES OF TEST : February 25, 2014 to March 04, 2014
REPORT ISSUE DATE : March 24, 2014
TEST LABORATORY : ETL Inc. (FCC Designation Number : KR0022)

The Smart Equalizer, Model DSBT504 has been tested in accordance with the measurement procedures specified in ANSI C63.4-2009 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 and RSS-210 Issue 8 - Category I Equipment, Annex 8.

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: 
Jeong Hwan, Pyo (Test Engineer)
March 24, 2014

Reviewed by: 
Kug Kyoung, Yoon (Chief Engineer)
March 24, 2014

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*The test report merely corresponds to the test sample(s).
This report shall not be reproduced, in whole or in part without the written approval of ETL Inc.*

Table of Contents

FCC Measurement Report

- 1. Introduction**
- 2. Product Information**
- 3. Description of Tests**
- 4. Test Condition**
- 5. Test Results**
 - 5.1 Summary of Test Results**
 - 5.2 Channel Bandwidth and Frequency Separation**
 - 5.3 Maximum Peak Output Power**
 - 5.4 Bandwidth of Frequency Band Edges**
 - 5.5 Number of Hopping Channels**
 - 5.6 Time of Occupancy (Dwell time)**
 - 5.7 Spurious Emissions**
 - 5.8 Radio Frequency Exposure**
- 6. Sample Calculation**
- 7. List of test Equipment used for Measurement**

- Appendix A. FCC ID Label and Location**
- Appendix B. Test Setup Photographs**
- Appendix C. External Photographs**
- Appendix D. Internal Photographs**
- Appendix E. Block Diagram**
- Appendix F. Circuit Diagram**
- Appendix G. User Manual**
- Appendix H. Operational Description**
- Appendix I. Antenna Requirement**
- Appendix J. Radio Frequency Exposure**

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	: Namsung Corporation.
Address	: ACE Techno Tower 13th Fl, 197-22, Guro-dong, Guro-gu, Seoul, Korea 152-050
Attention	: Byungjae Ahn / Director

- **EUT Type** : Smart Equalizer
- **Model Number** : DSBT504
- **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** : PCB Pattern Antenna (Integral)
- **Antenna Gain** : -0.744 dBi max
- **RF Power** : 4.295 mW
- **Environmental of Tests** : Temperature: (15.75 ± 6.35) °C
Humidity: (38.5 ± 7.5) % R.H.
Atmospheric Pressure: (102.2 ± 0.4) kPa
- **FCC Rule Part(s)** : FCC Part 15 Subpart C
RSS-210 Issue 8
- **Test Procedure** : ANSI C63.4-2009
- **FCC Classification** : DSS (Part 15 Spread Spectrum Transmitter)
- **IC Equipment Category** : RSS-210 Issue 8 - Category I Equipment, Annex 8
- **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

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 C63.4-2009 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 C63.4-2009 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 C63.4-2009) was used in determining radiated and conducted emissions from the Namsung Corporation. Model: DSBT504

2. PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the Smart Equalizer (model: DSBT504).

The model DSBT504 is basic model that was tested.

The multi model ASBT504 identical to basic model, except for model designation and brand name.

Model name	Brand name
DSBT504 (Basic model)	DUAL
ASBT504	AXXERA

2.2 General Specification

Item		Specification
Dimension		7" (W) x 4.1" (D) x 1.2" (H) (177.0 mm (W) x 103.4 mm (D) x 31.0 mm (H))
Power	Reference voltage	14.4 V DC (10.0 V to 16 V)
Bluetooth	Compatibility	Version 2.0 + EDR
	Support profile	A2DP, AVRCP, SPP
	Range	Up to 10 m
Audio Input	Low level	4 V RMS
	High level	10 V RMS
	Frequency response	20 Hz – 20 kHz
Audio Output	Line output voltage	4 V RMS
	Line output impedance	200 Ω
	THD	< 0.05 % @ 1 kHz, 1 V RMS
	SNR	> 85 dB @ a-weighted
	Channel separation	> 70 dB @ 1 kHz
High Internal Frequency		X-tal → 26.000 MHz (BT Module)

3. DESCRIPTION OF TESTS

The tests documented in this report were performed in accordance with ANSI C63.4-2009 and FCC CFR 47 2.1046, 2.1047, 2.1049, 2.1051, 2.1053, 2.1055, 2.1057, 15.207, 15.209 and 15.247.
IC Equipment Category: RSS-210 Issue 8 - Category I Equipment, Annex 8

3.1 Radiated Emission Measurement

Radiated emission measurements were made in accordance with § 13 in ANSI C63.4-2009 "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 0.8 m high 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.

3.2 Conducted Emission Measurement

Conducted emissions measurements were made in accordance with section § 13 in ANSI C63.4-2009 "measurement of intentional radiators". The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω /50 μ H 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. All electrical cables are shielded by braided tinned steel tubing with inner ϕ 1.2 cm. 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.

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.

4. TEST CONDITION

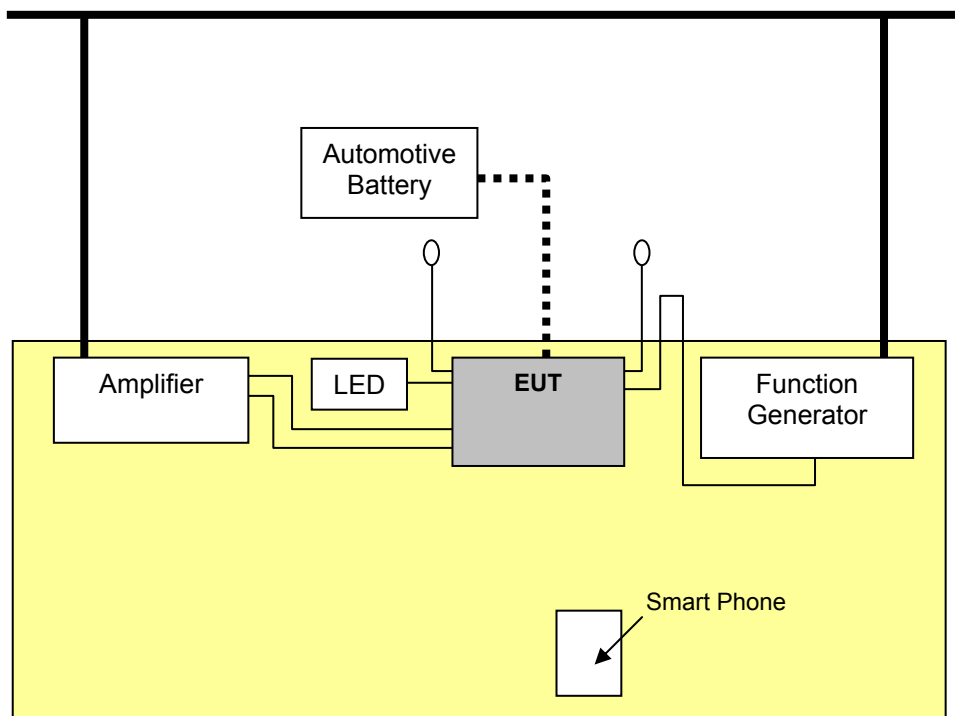
4.1 Test Configuration

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.

4.2 Description of Test modes

CSR BlueCore that has the control software.

4.3 The setup drawing(s)



- : Signal line
- ——— : Connection Cable
- : DC Power line
- : AC Power line
- : Adapter

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	RSS Standards	Measurement Required	Result
15.247(a)(1)	RSS-210 A8.2(a)	Channel Bandwidth, Frequency Separation	Pass
15.247(b)(3)	RSS-210 A8.4(2)	Maximum Peak Output Power	Pass
15.247(d)	RSS-210 A8.5	Bandwidth of Frequency Band Edges	Pass
15.247(a)(1)(iii)	RSS-210 A8.1(d)	Number of Hopping Channels	Pass
15.247(a)(1)(iii)	RSS-210 A8.1(d)	Time of Occupancy (Dwell time)	Pass
15.209 15.247(d)	RSS-Gen 7.2.5	Spurious Emissions	Pass
-	RSS-Gen 6.1	Receiver Spurious Emissions	Pass
15.207	RSS-Gen 7.2.4	Conducted Emissions	N/A *
15.247(i) 1.1307(b)(1)	RSS-102 2.5	RF Exposure	Pass

* This test was not applied. Because, EUT power supplies from automotive battery type.

The data collected shows that the **Namsung Corporation. / Smart Equalizer / DSBT504** complied with technical requirements of above rules RSS-210, part 15.209 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.

5.2 Channel Bandwidth and Frequency Separation

EUT	Smart Equalizer / DSBT504
Limit apply to	FCC Part 15.247(a)(1), RSS-210 A8.2(a)
Test Date	February 25, 2014
Environmental of Test	22.0 °C, 46 % R.H., 102.4 kPa
Operating Condition	RF transmitting continuously during the tested.
Result	Passed

5.2.1 Channel (20 dB) Bandwidth

Type of Modulation	Frequency [MHz]	20 dB Bandwidth [MHz]	Limit
BDR	2 402	0.950	2/3 of the 20 dB Bandwidth < Carrier frequency separation
	2 441	0.950	
	2 480	0.950	
EDR	2 402	1.308	
	2 441	1.292	
	2 480	1.283	

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 shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or 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)	0.950 (Worst)	> 25 kHz or > 2/3 of the 20 dB Bandwidth
EDR	1.000 (Worst)	1.308 (Worst)	

NOTES:

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

5.2.3 Channel (99 %) Bandwidth

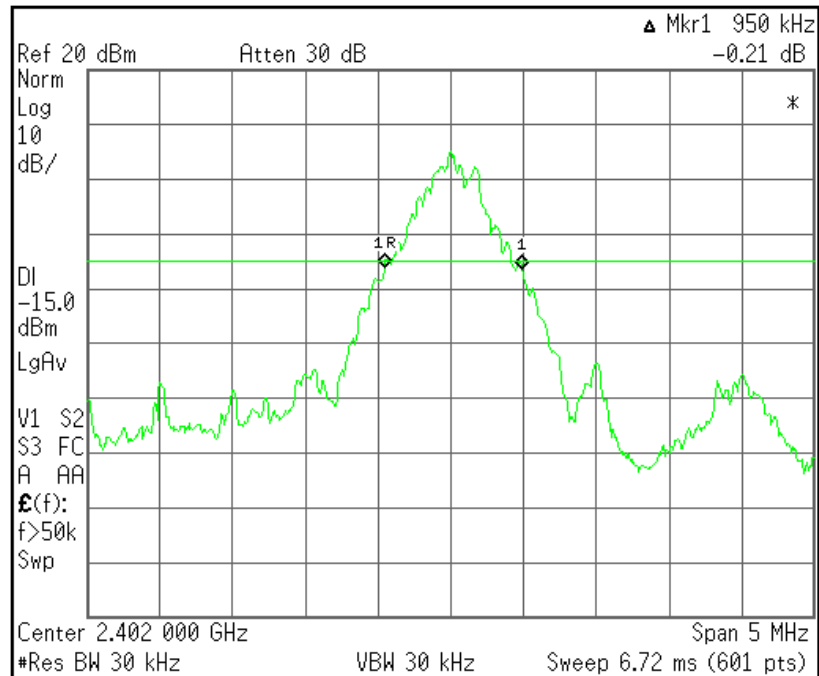
Type of Modulation	Frequency [MHz]	99 % Bandwidth [MHz]	Limit
BDR	2 402	0.968	2/3 of the 20 dB Bandwidth < Carrier frequency separation
	2 441	0.973	
	2 480	0.973	
EDR	2 402	1.225	
	2 441	1.244	
	2 480	1.263	

NOTES:

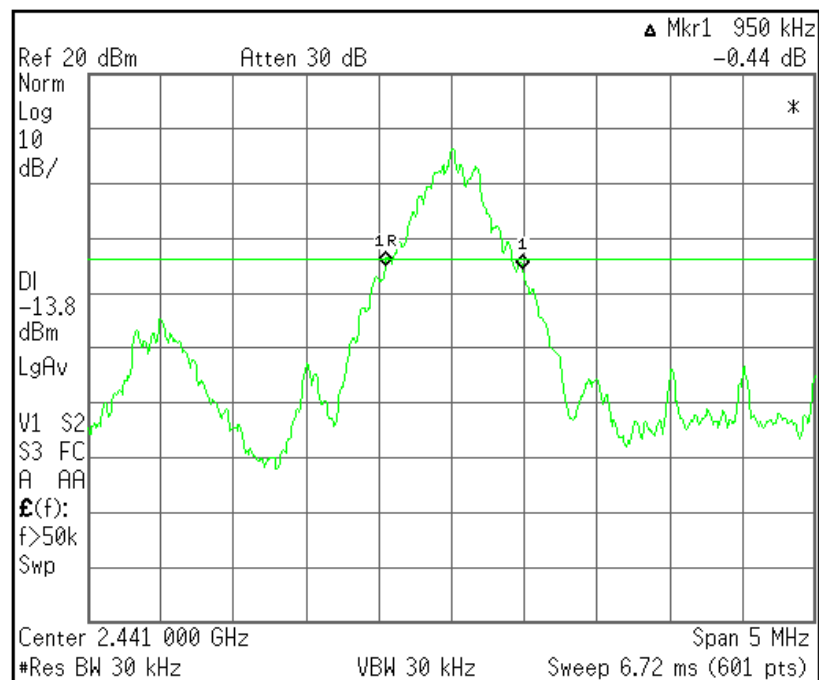
1. Measure frequency separation of relevant channel using spectrum analyzer.
2. Please see the measured plot in next page.

Plots of 20 dB Bandwidth (BDR)

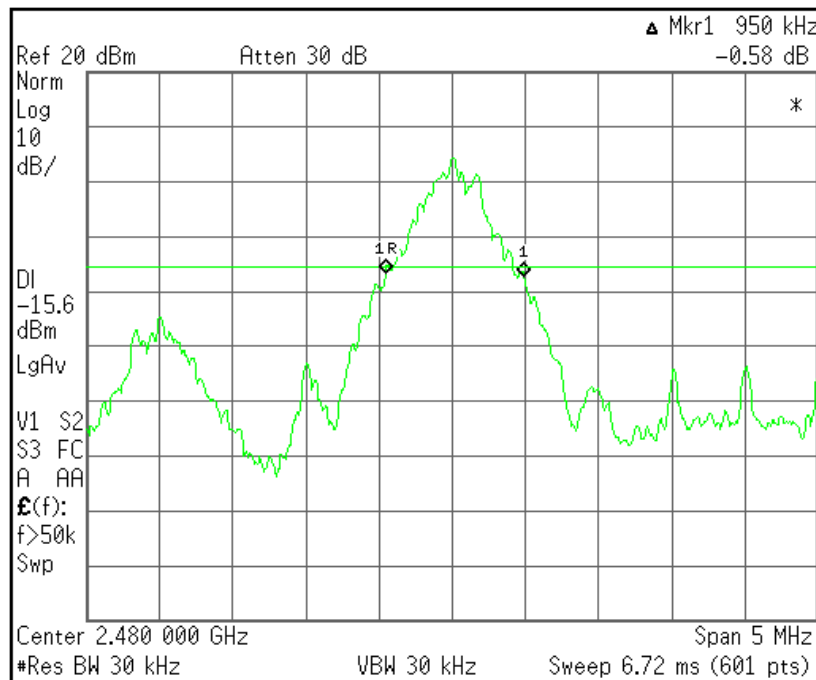
[2 402 MHz]



[2 441 MHz]

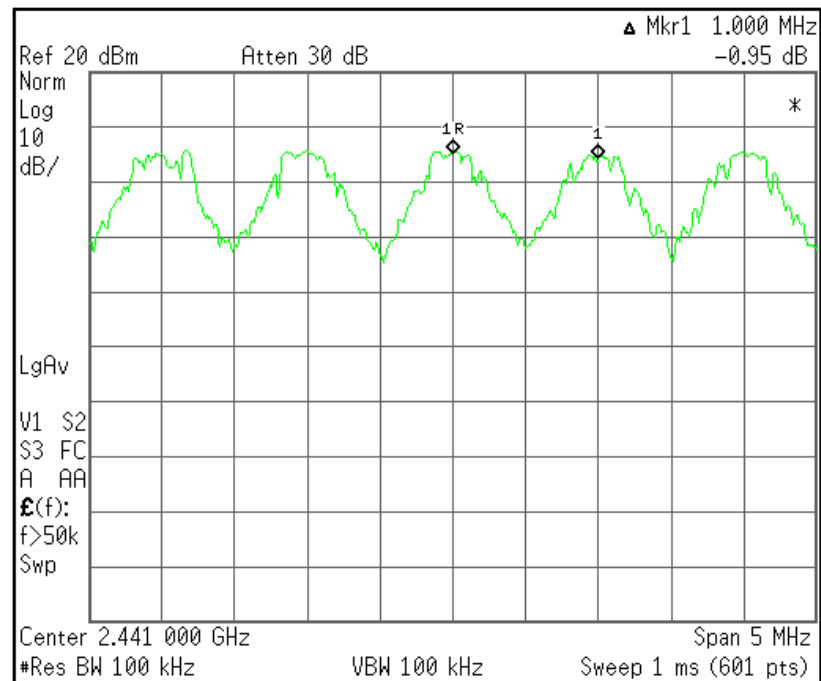


[2 480 MHz]



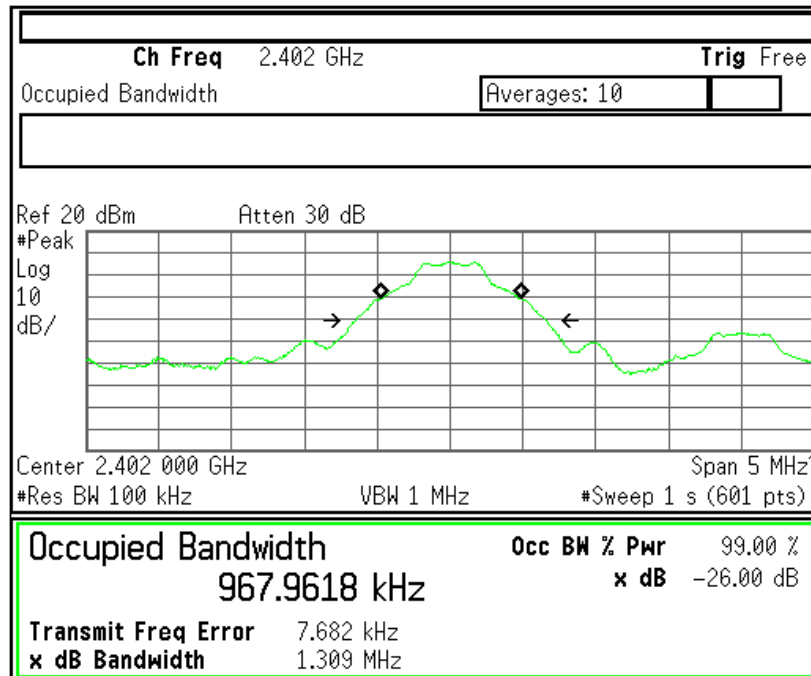
Plots of Frequency Separation (BDR)

[Channel Separation]

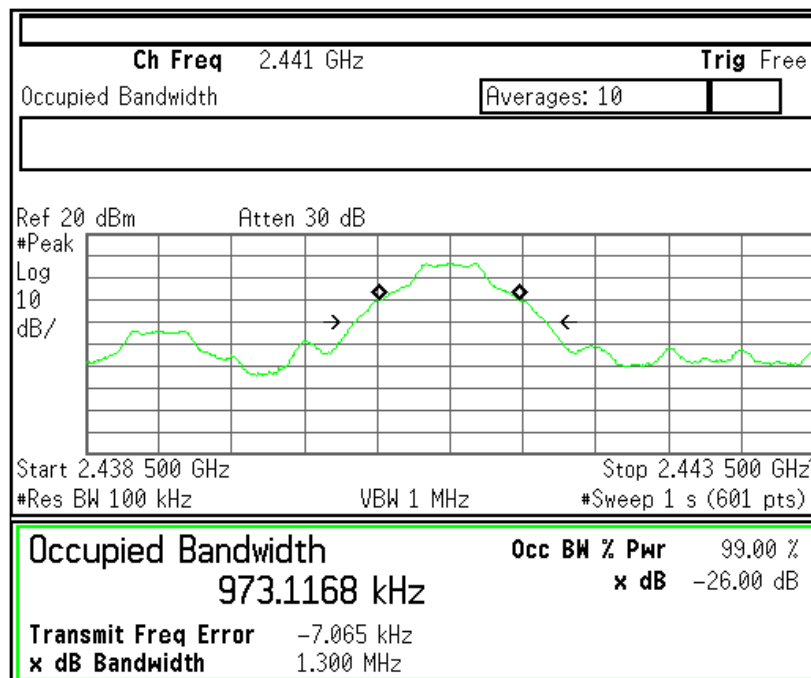


Plots of 99 % Bandwidth (BDR)

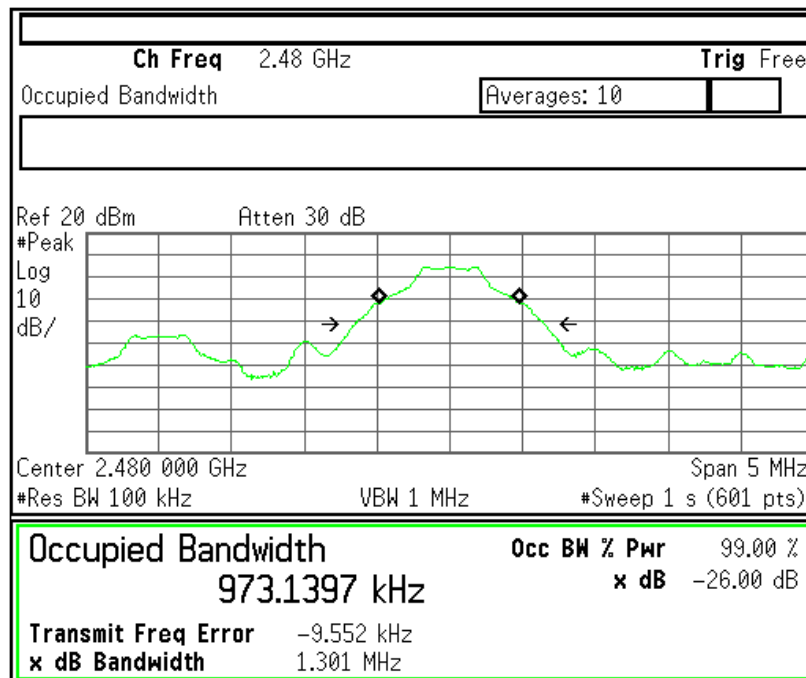
[2 402 MHz]



[2 441 MHz]

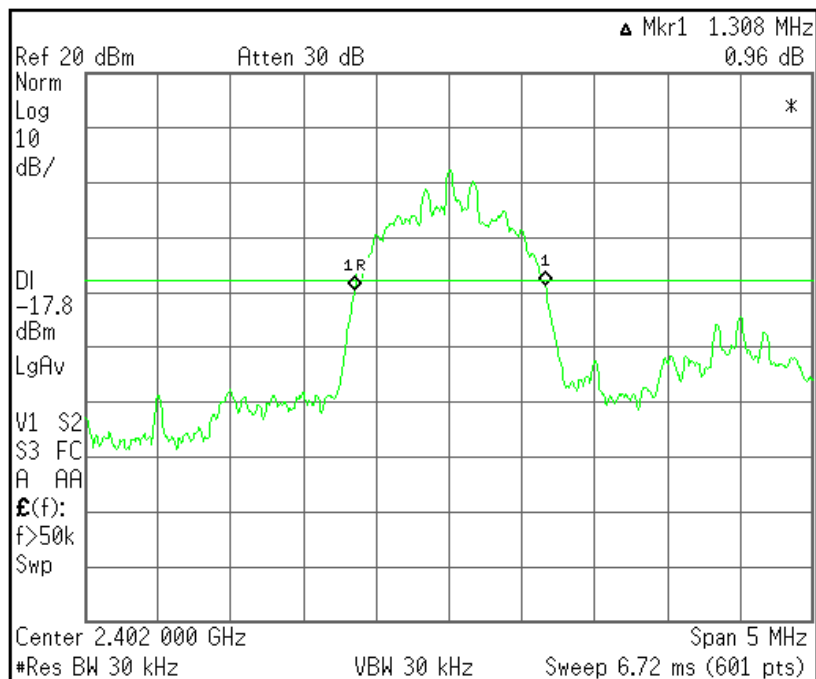


[2 480 MHz]

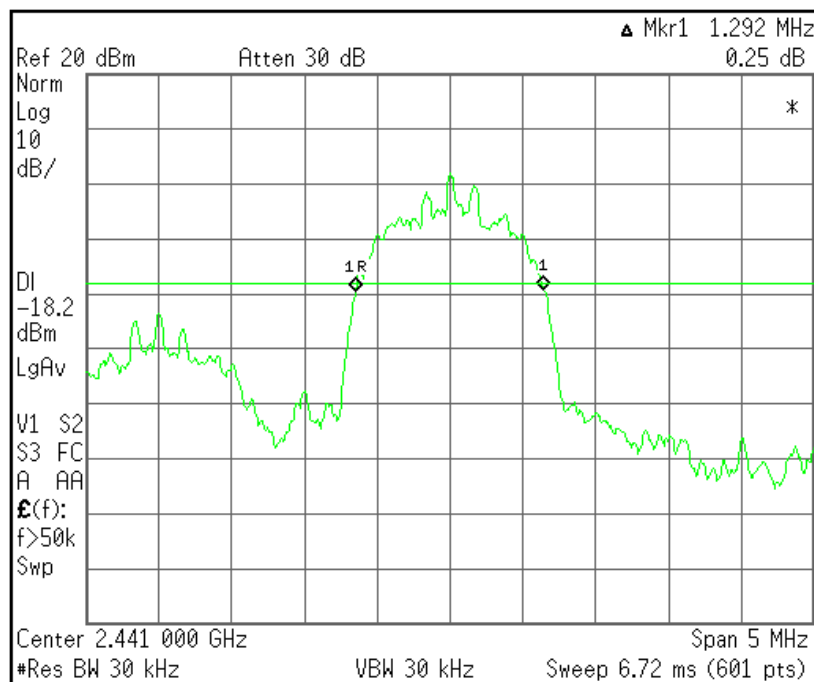


Plots of 20 dB Bandwidth (EDR)

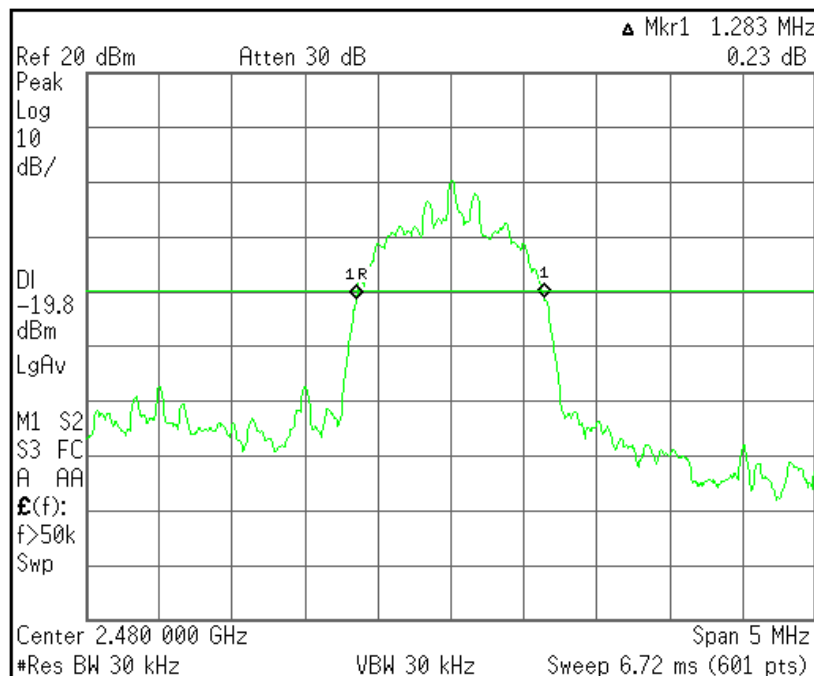
[2 402 MHz]



[2 441 MHz]

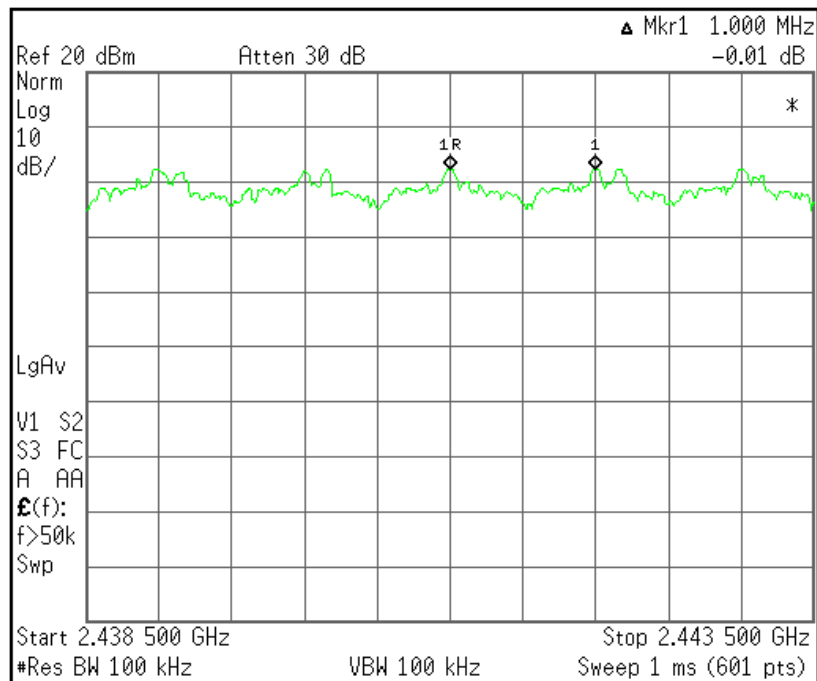


[2 480 MHz]



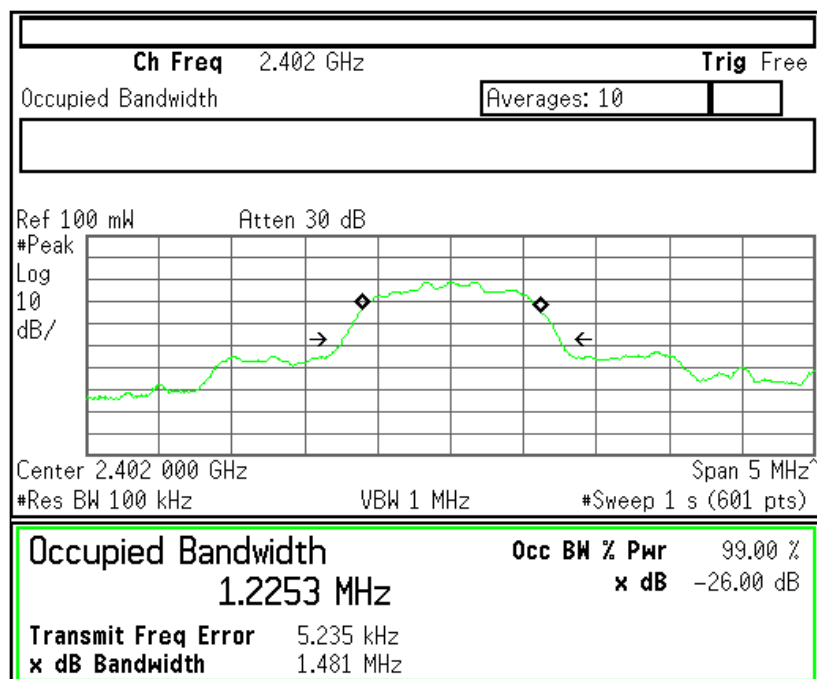
Plots of Frequency Separation (EDR)

[Channel Separation]

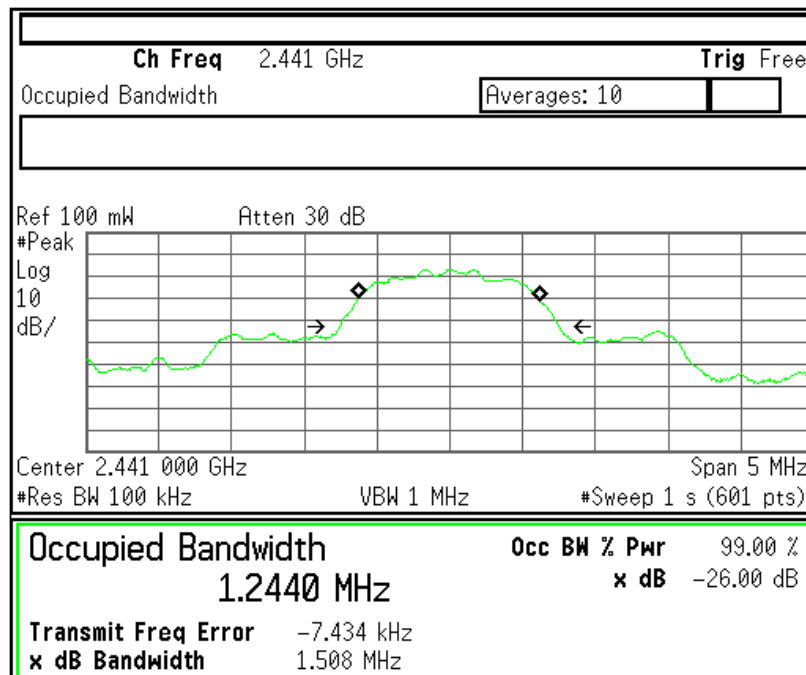


Plots of 99 % Bandwidth (EDR)

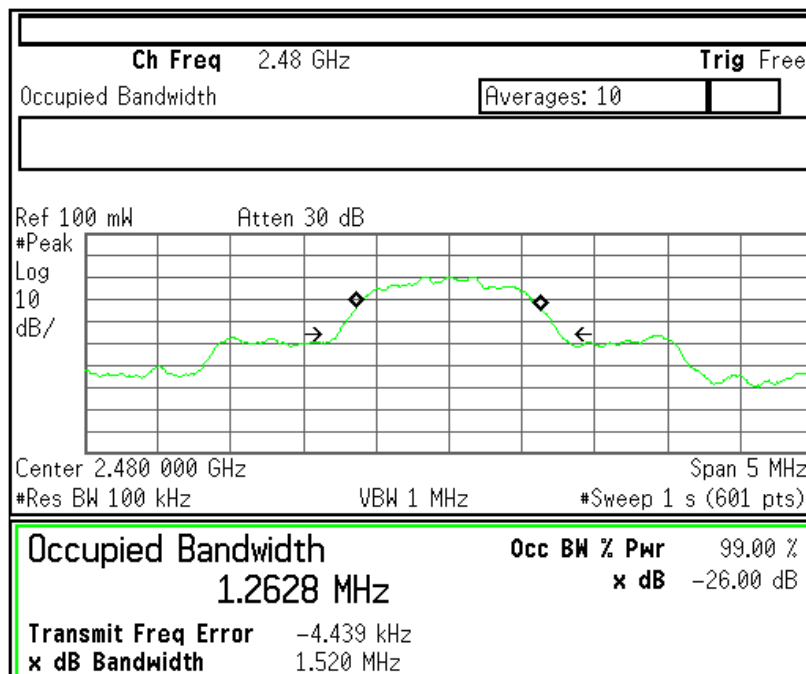
[2 402 MHz]



[2 441 MHz]



[2 480 MHz]



5.3 Maximum Peak Conducted Output Power

EUT	Smart Equalizer / DSBT504
Limit apply to	FCC Part 15.247(b)(3), RSS-210 A8.4(2)
Test Date	February 25, 2014
Environmental of Test	22.1 °C, 45 % R.H., 102.4 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: 1 Watt

Test Data

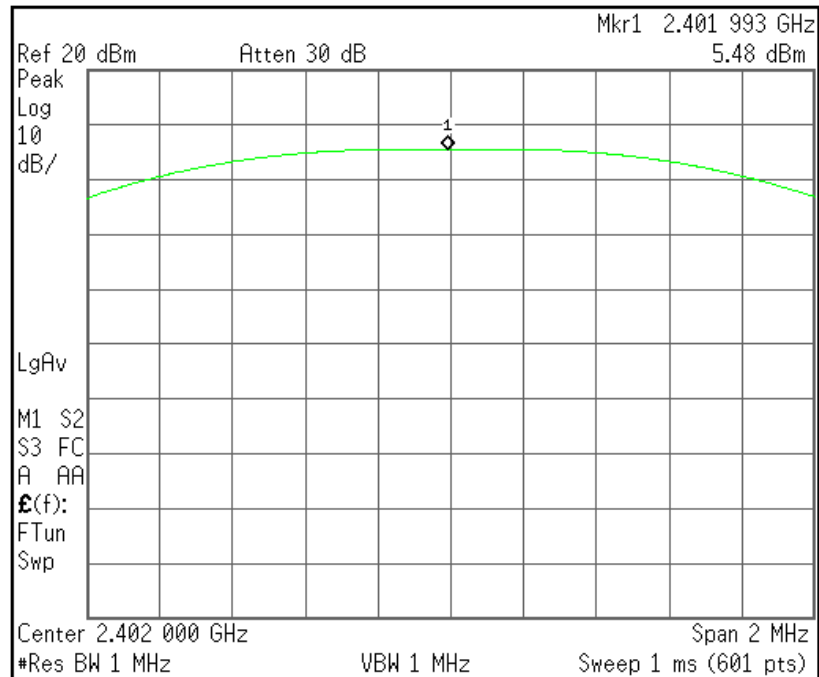
Type of Modulation	Channel	Frequency [MHz]	Output Power [dBm]	Limit
BDR	Low	2 402	5.48	< 30 dBm (1 W)
	Mid	2 441	6.33	
	High	2 480	4.61	
EDR	Low	2 402	4.19	
	Mid	2 441	4.46	
	High	2 480	2.60	

NOTES:

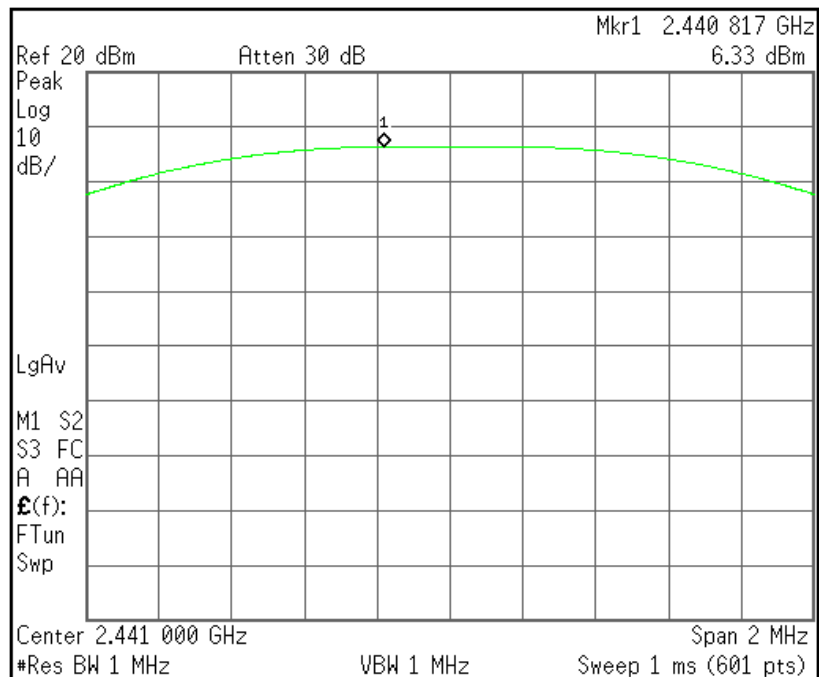
1. Measure conducted Channel power of relevant channel using Spectrum analyzer
2. RBW 1 MHz, VBW 1 MHz
3. Please see the measured plot in next page.

Plots of Maximum Peak Output Power (BDR)

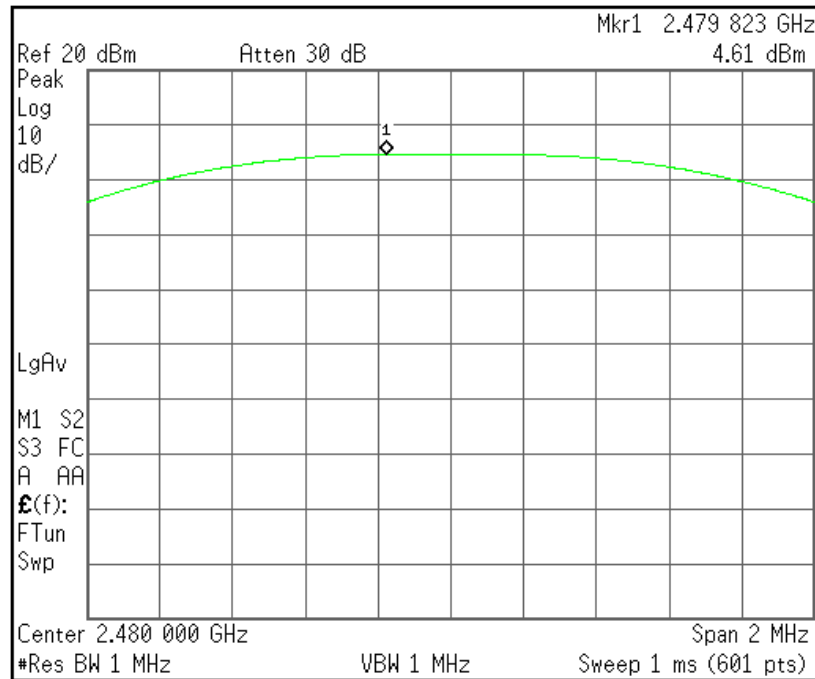
[2 402 MHz]



[2 441 MHz]

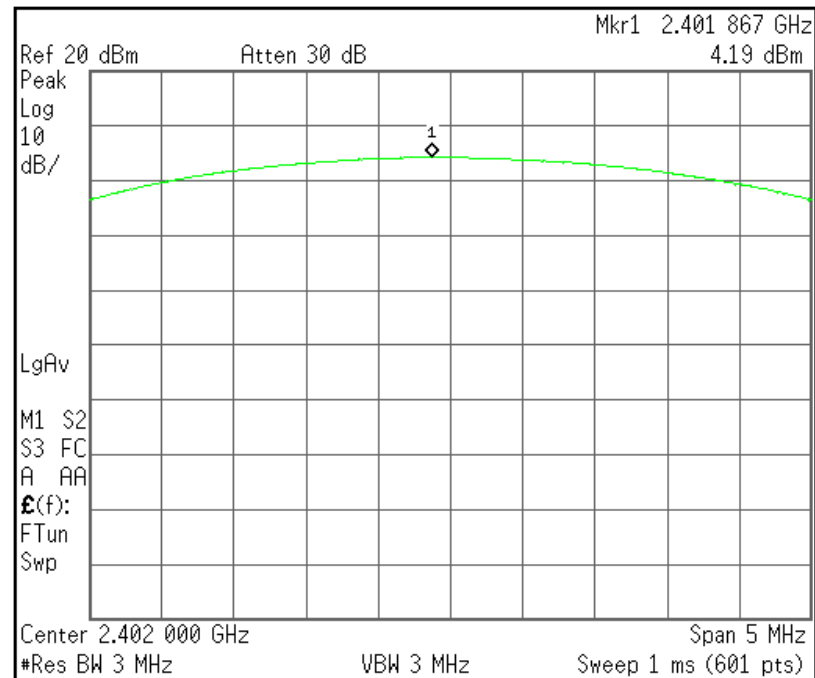


[2 480 MHz]

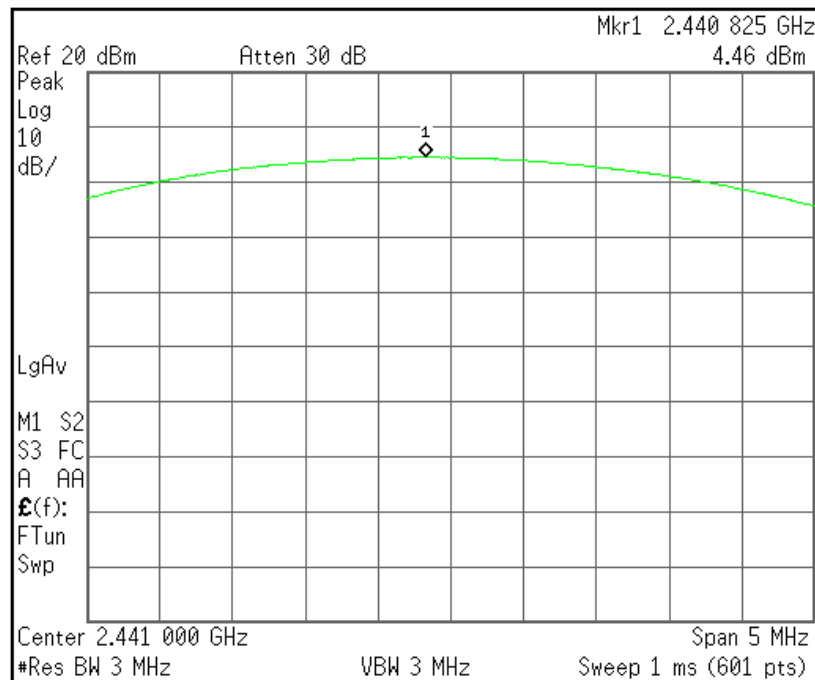


Plots of Maximum Peak Output Power (EDR)

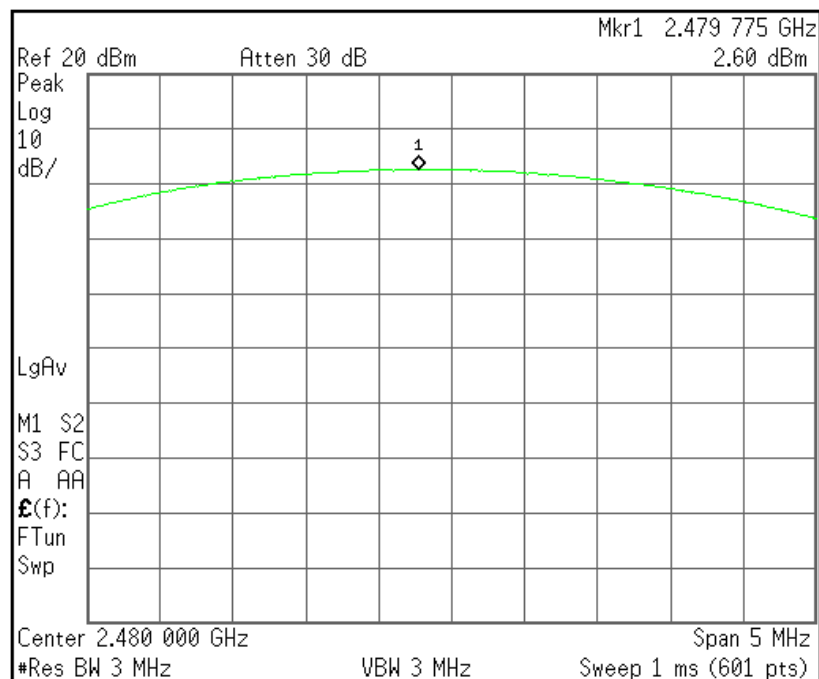
[2 402 MHz]



[2 441 MHz]



[2 480 MHz]



5.4 Bandwidth of Frequency Band Edges

EUT	Smart Equalizer / DSBT504
Limit apply to	FCC Part 15.247(d), RSS-210 A8.5
Test Date	February 26, 2014
Environmental of Test	21.9 °C, 43 % R.H., 102.6 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.

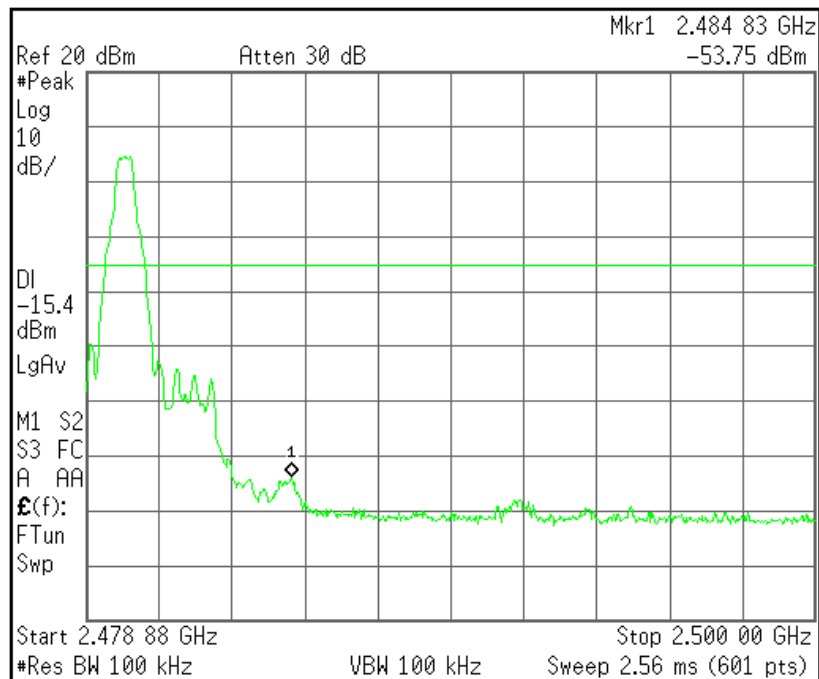
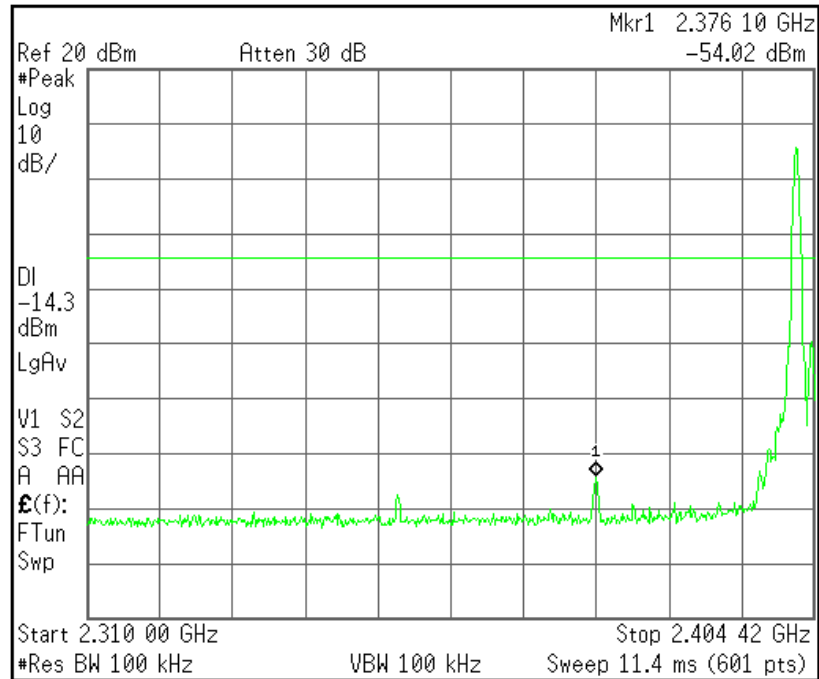
NOTES:

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

Plots of Bandwidth of Frequency Band Edges (BDR)

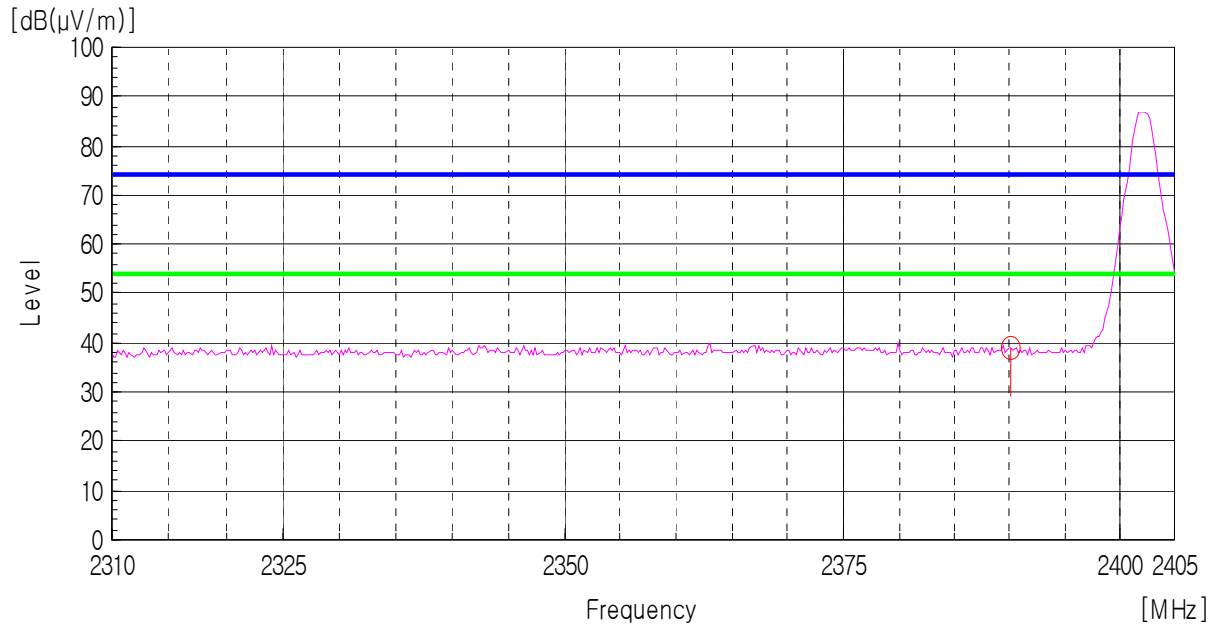
[Non-hopping mode]

Conducted

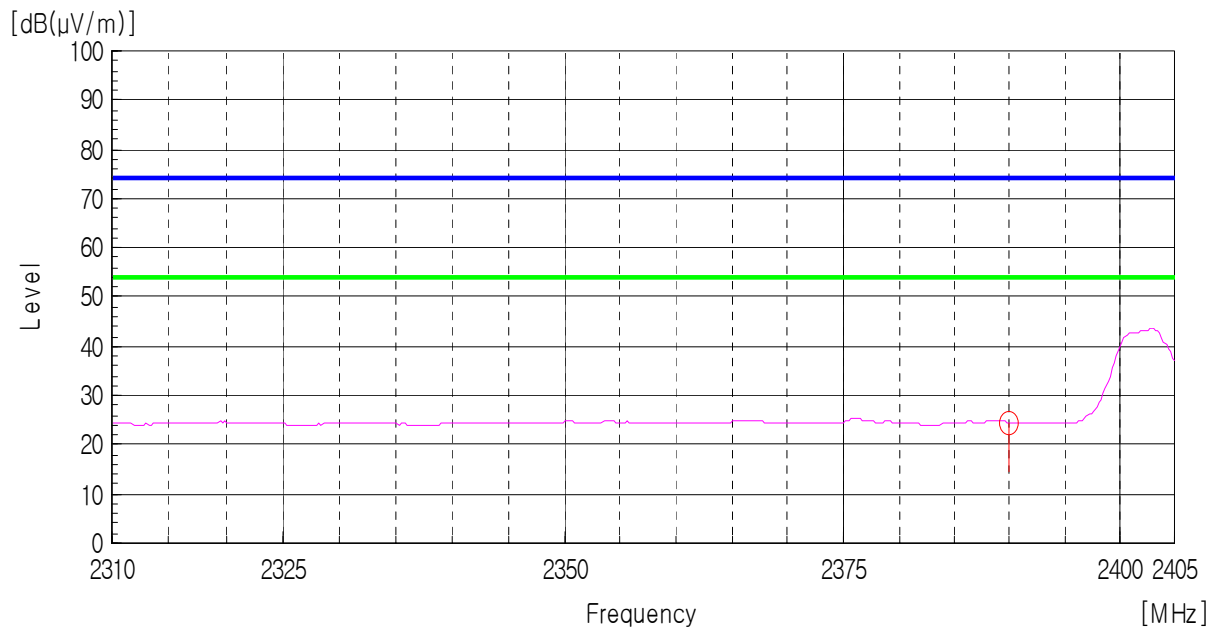


Radiated

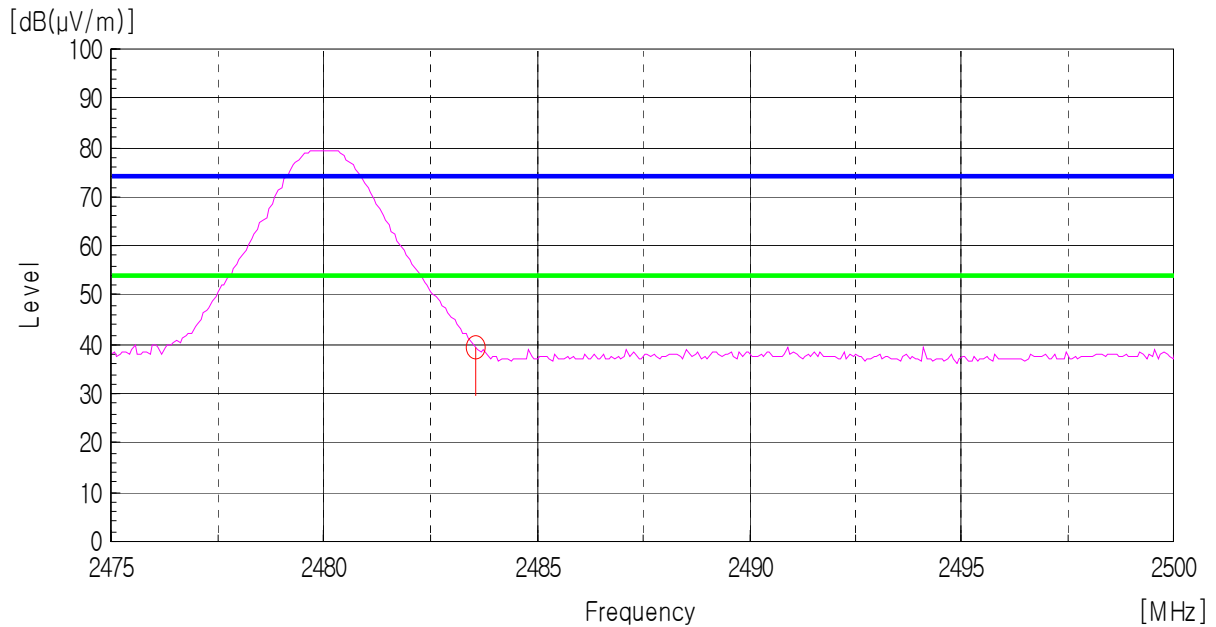
Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 310 MHz - 2 405 MHz), Worst case (Low, Horizontal)



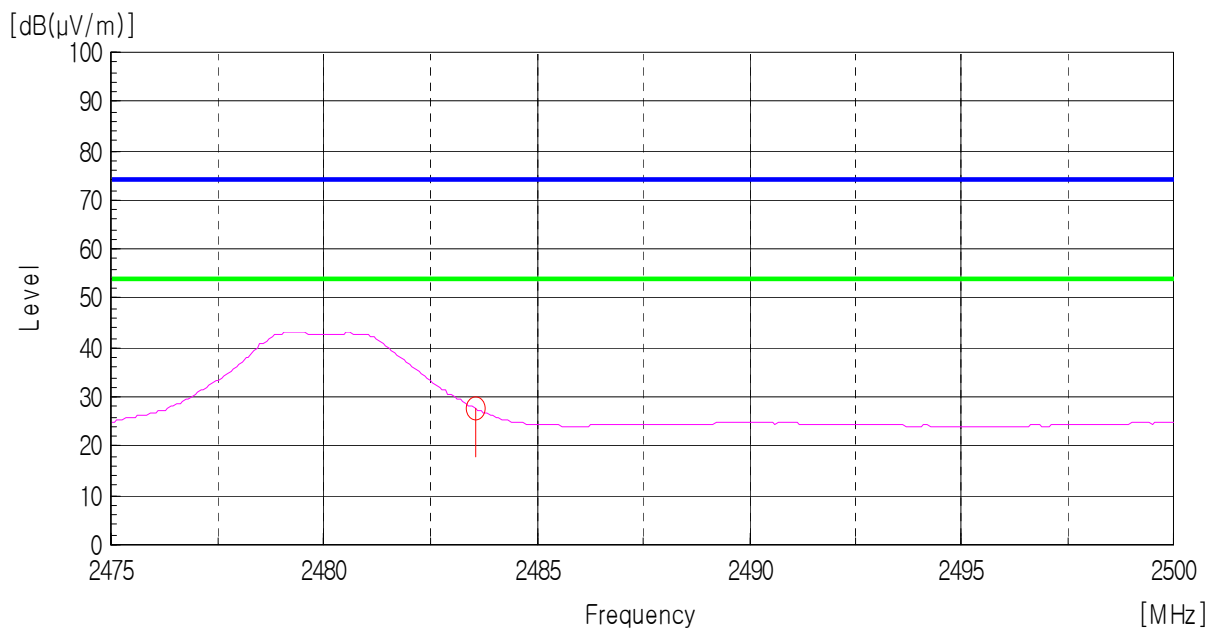
AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 310 MHz - 2 405 MHz), Worst case (Low, Horizontal)



Peak Detector: RBW: 1MHz, VBW: 1 MHz (2 475 MHz - 2 500 MHz), Worst case (High, Horizontal)



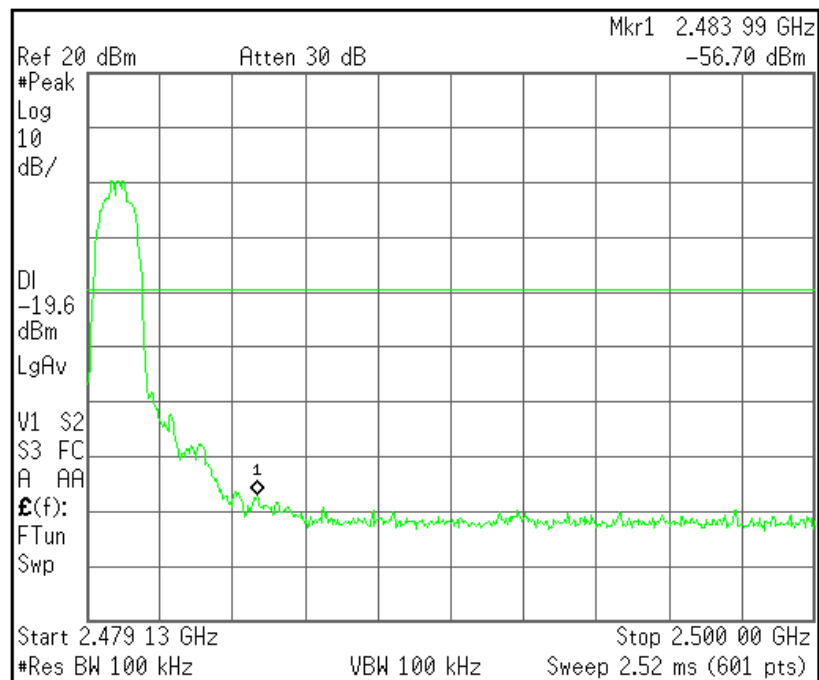
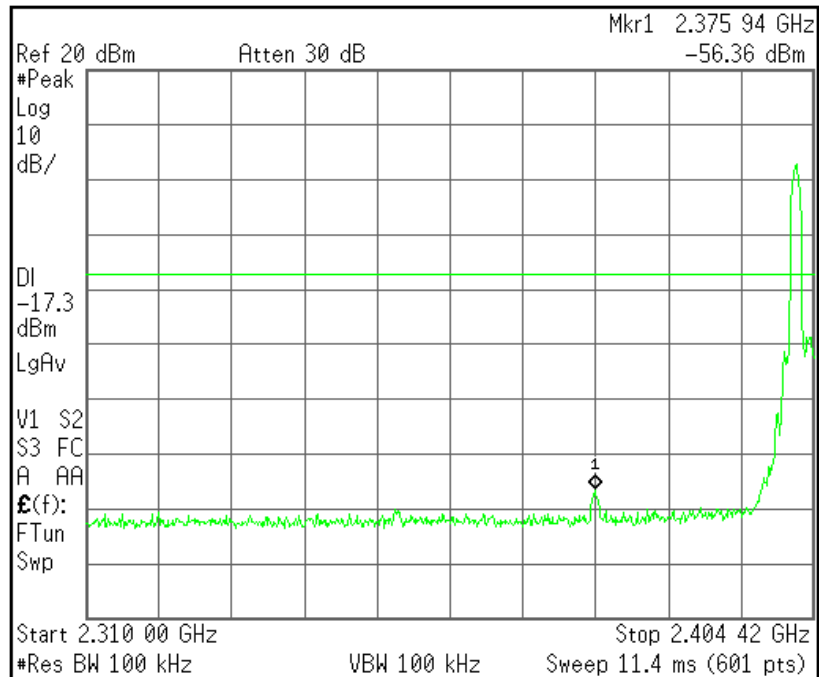
AV Detector: RBW: 1MHz, VBW: 10 Hz (2 475 MHz - 2 500 MHz), Worst case (High, Horizontal)



Plots of Bandwidth of Frequency Band Edges (EDR)

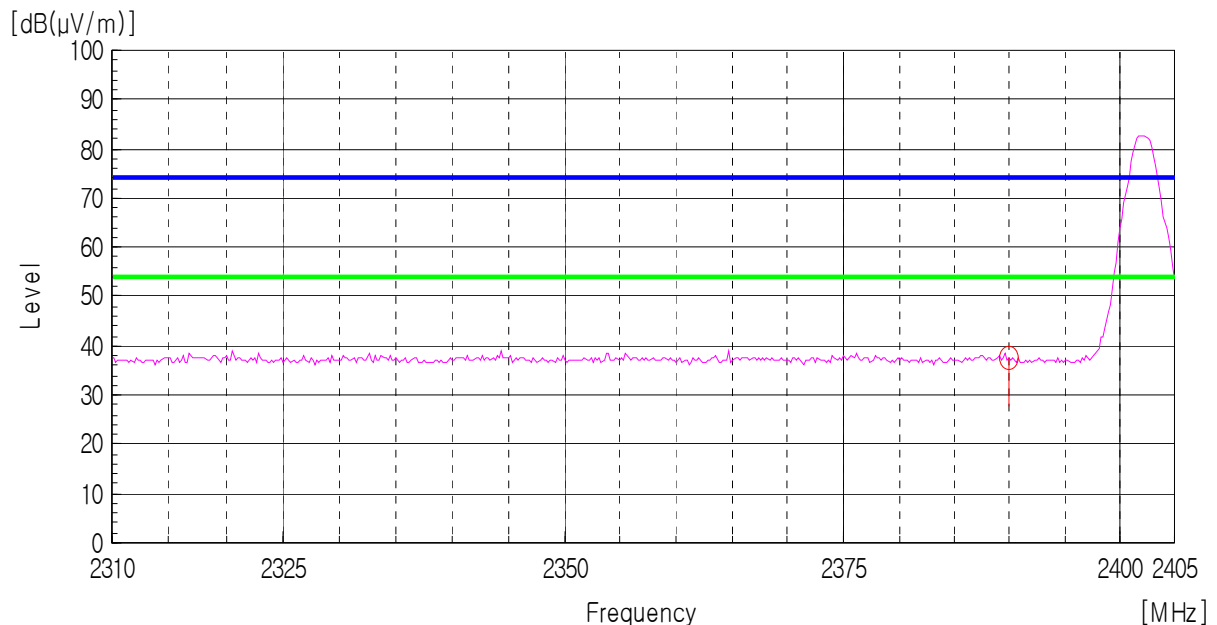
[Non-hopping mode]

Conducted

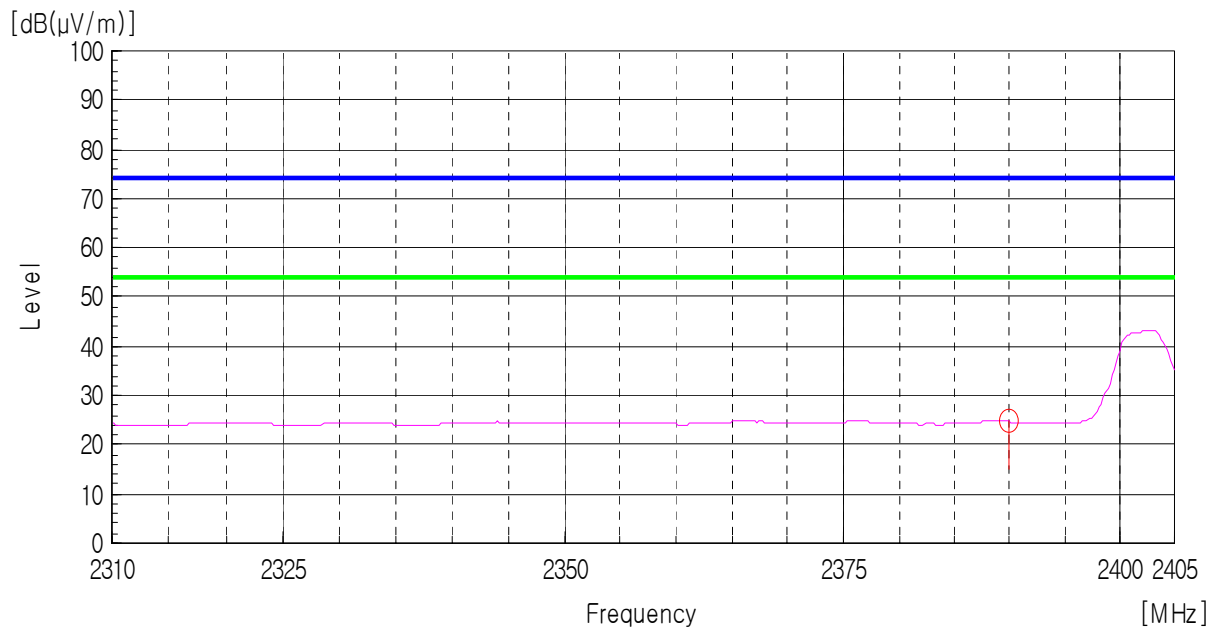


Radiated

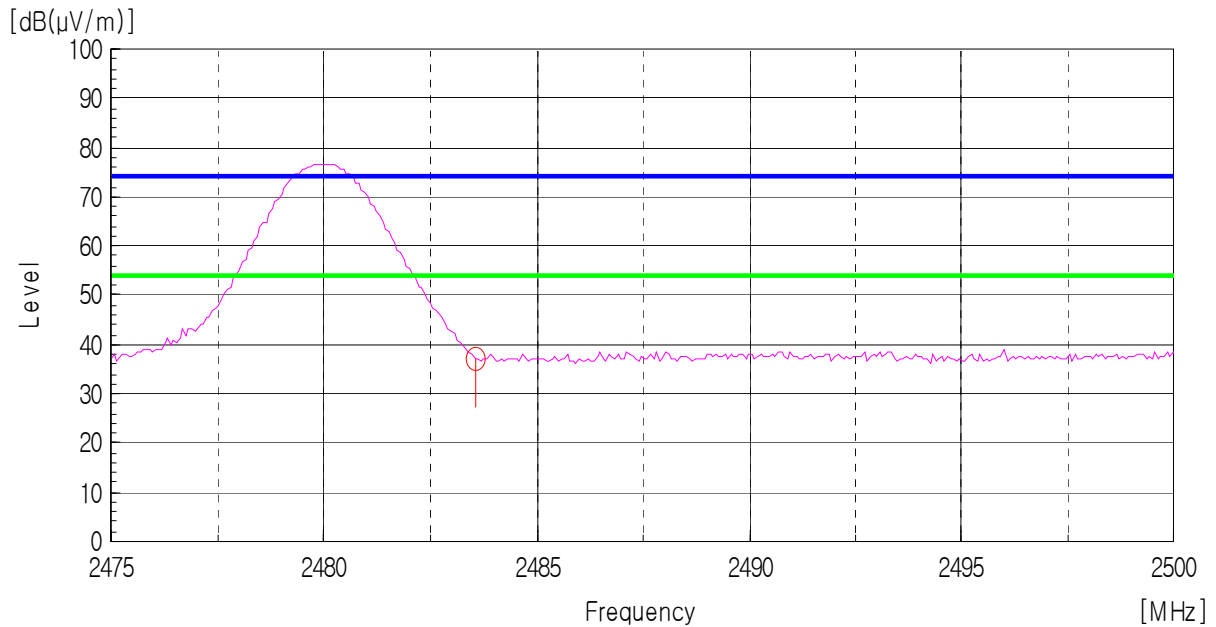
Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 310 MHz - 2 390 MHz), Worst case (Low, Horizontal)



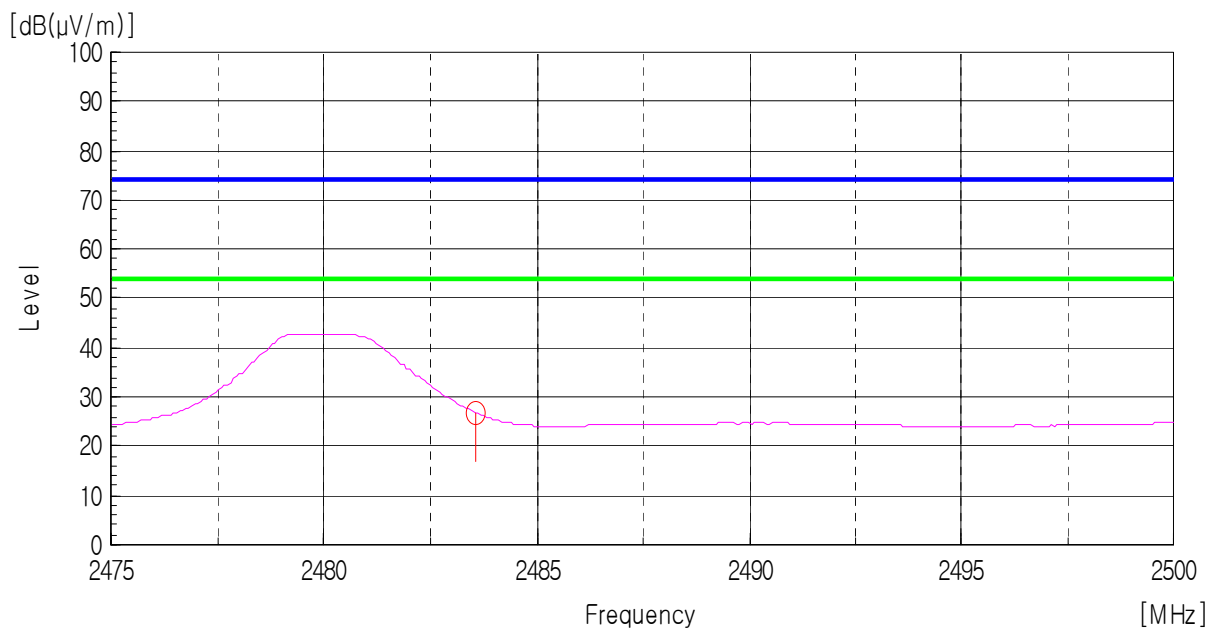
AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 310 MHz - 2 390 MHz), Worst case (Low, Horizontal)



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



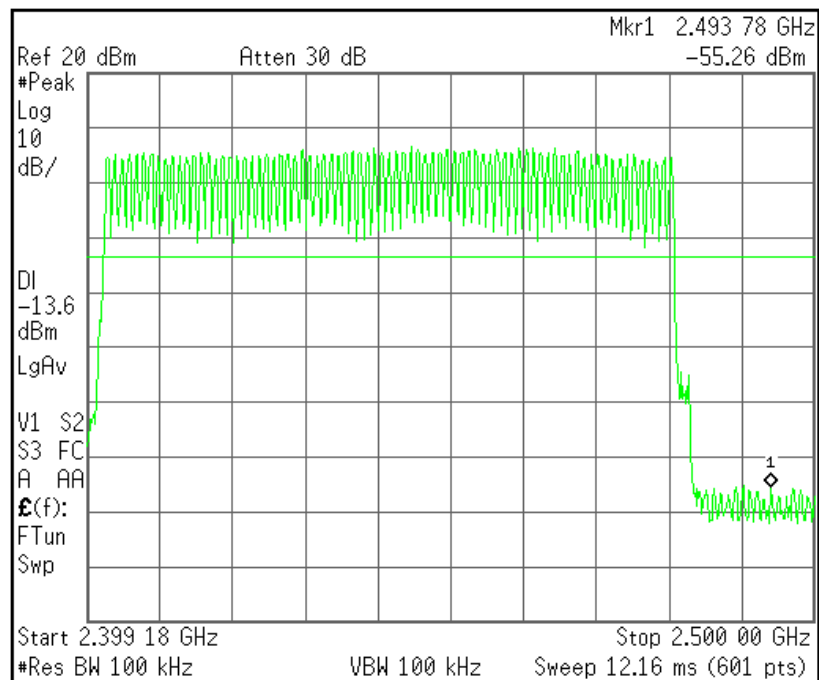
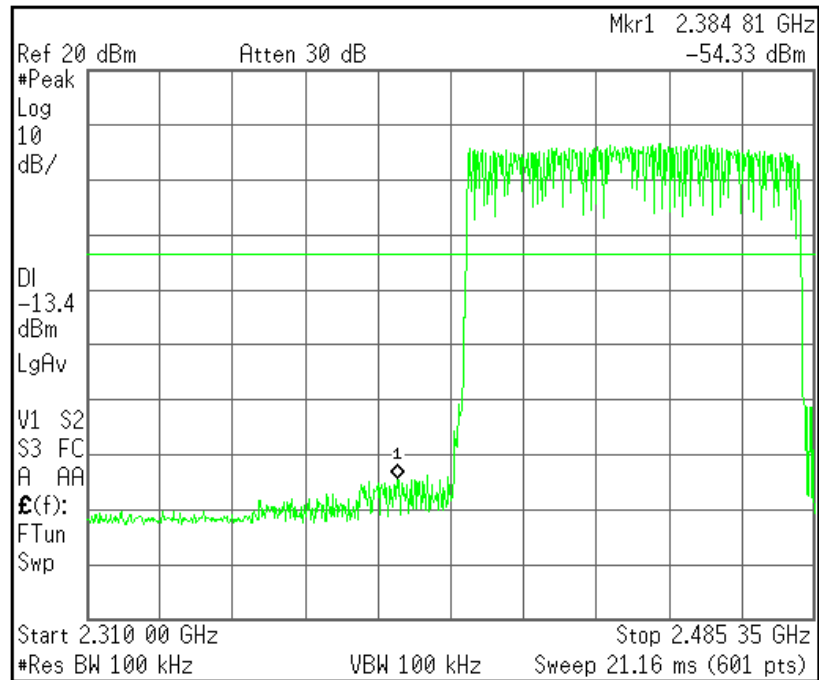
AV Detector: RBW: 1MHz, VBW: 10 Hz (2 483.5 MHz - 2 500.0 MHz), Worst case (High, Horizontal)



Plots of Bandwidth of Frequency Band Edges (BDR)

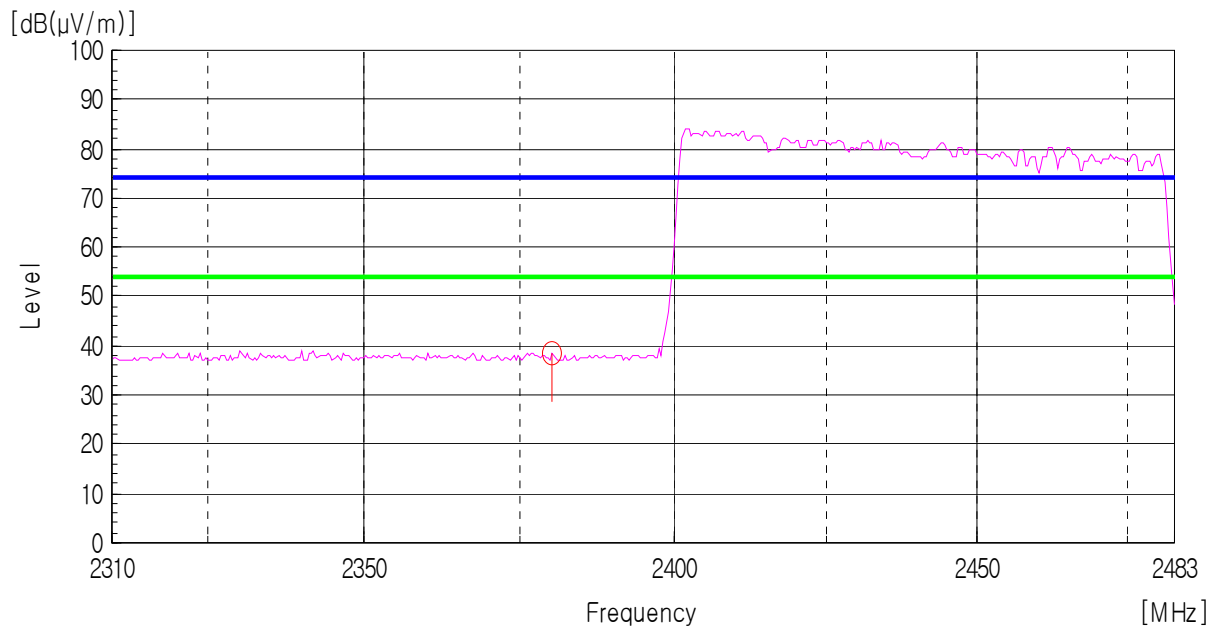
[Hopping mode]

Conducted

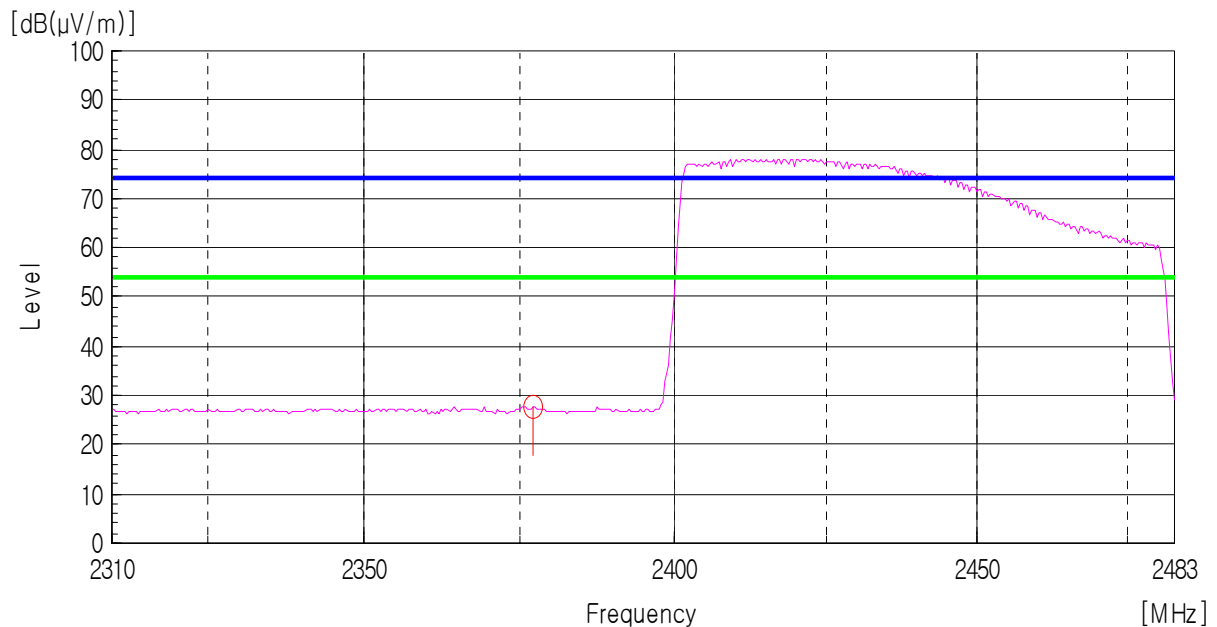


Radiated

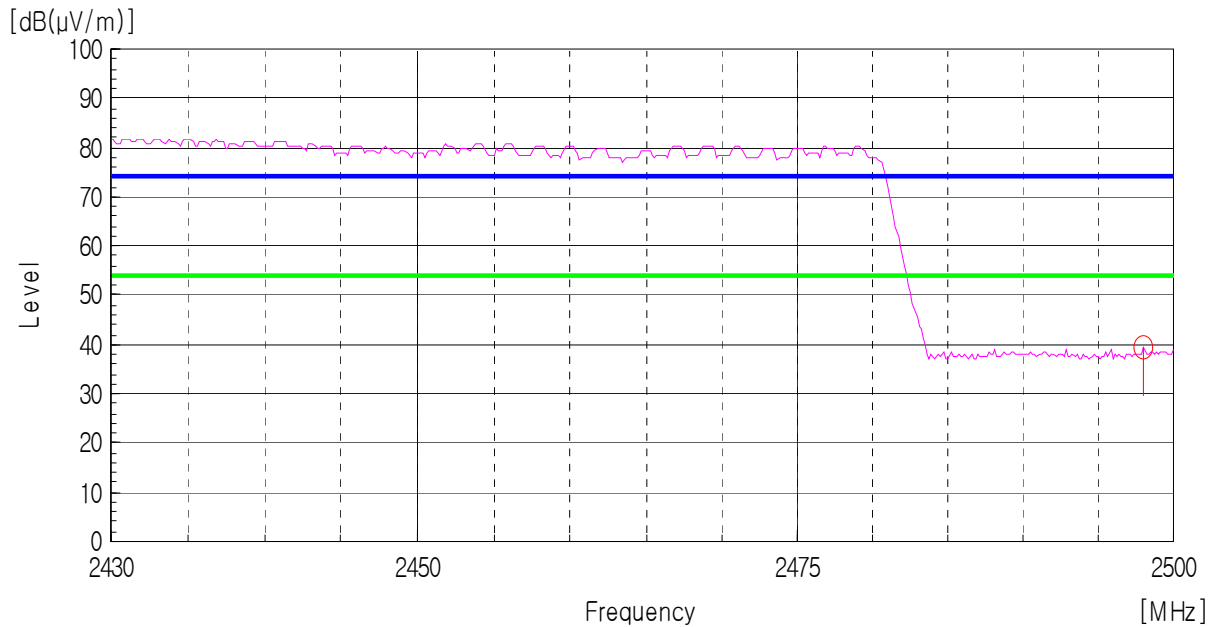
Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 310 MHz - 2 405 MHz), Worst case (Low, Horizontal)



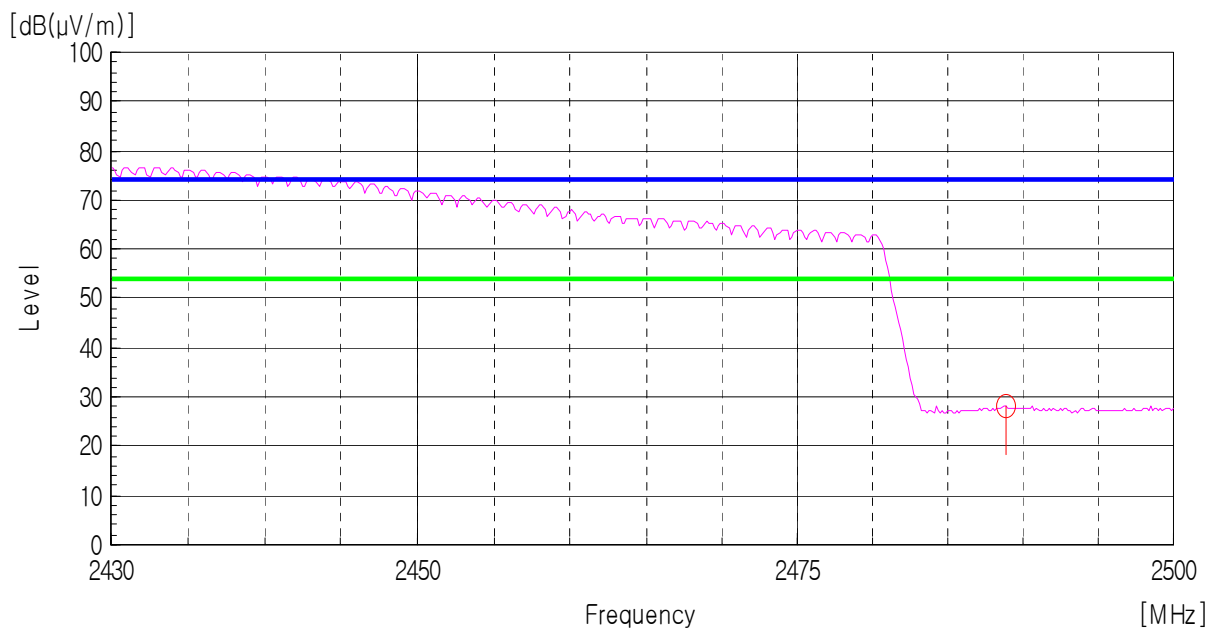
AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 310 MHz - 2 405 MHz), Worst case (Low, Horizontal)



Peak Detector: RBW: 1MHz, VBW: 1 MHz (2 475 MHz - 2 500 MHz), Worst case (High, Horizontal)



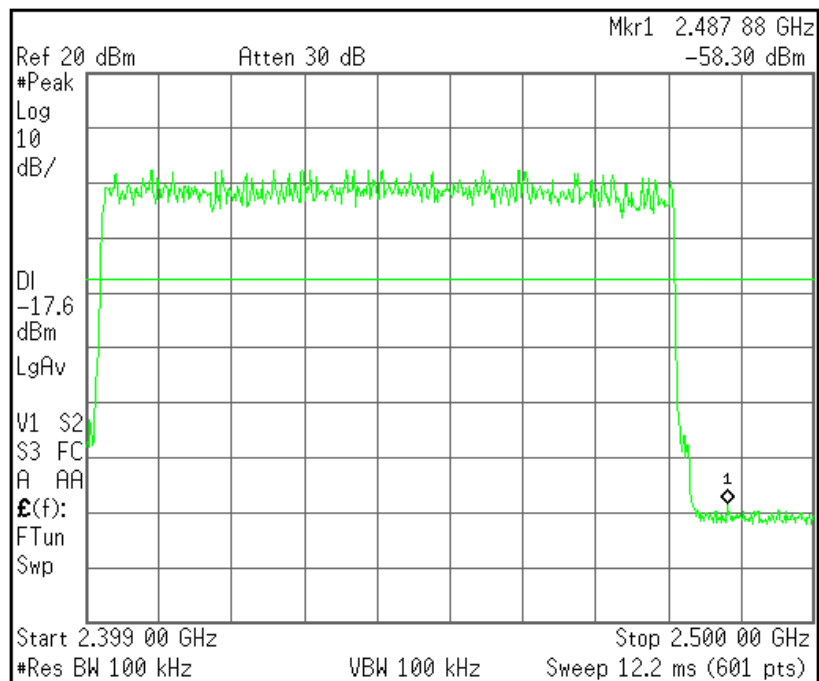
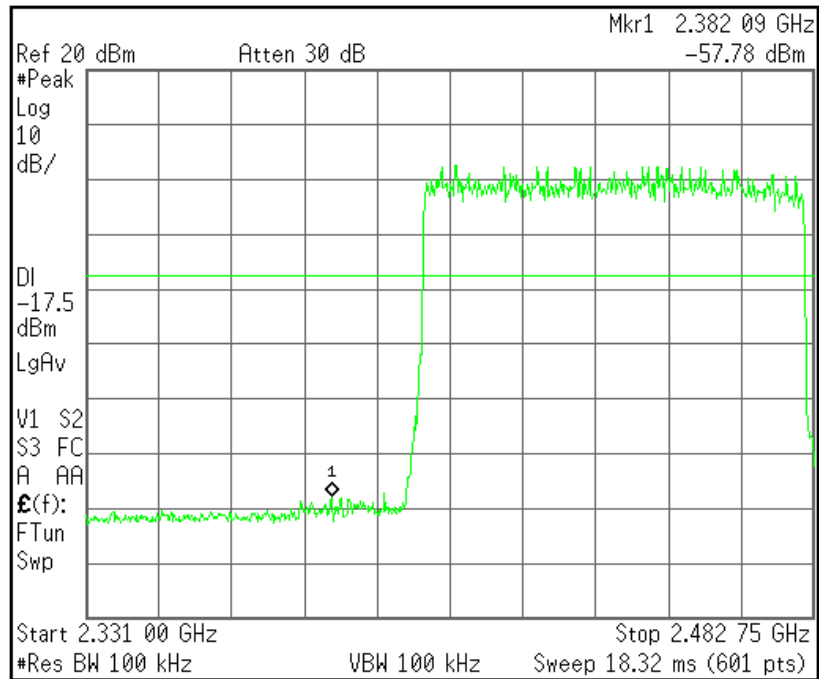
AV Detector: RBW: 1MHz, VBW: 10 Hz (2 475 MHz - 2 500 MHz), Worst case (High, Horizontal)



Plots of Bandwidth of Frequency Band Edges (EDR)

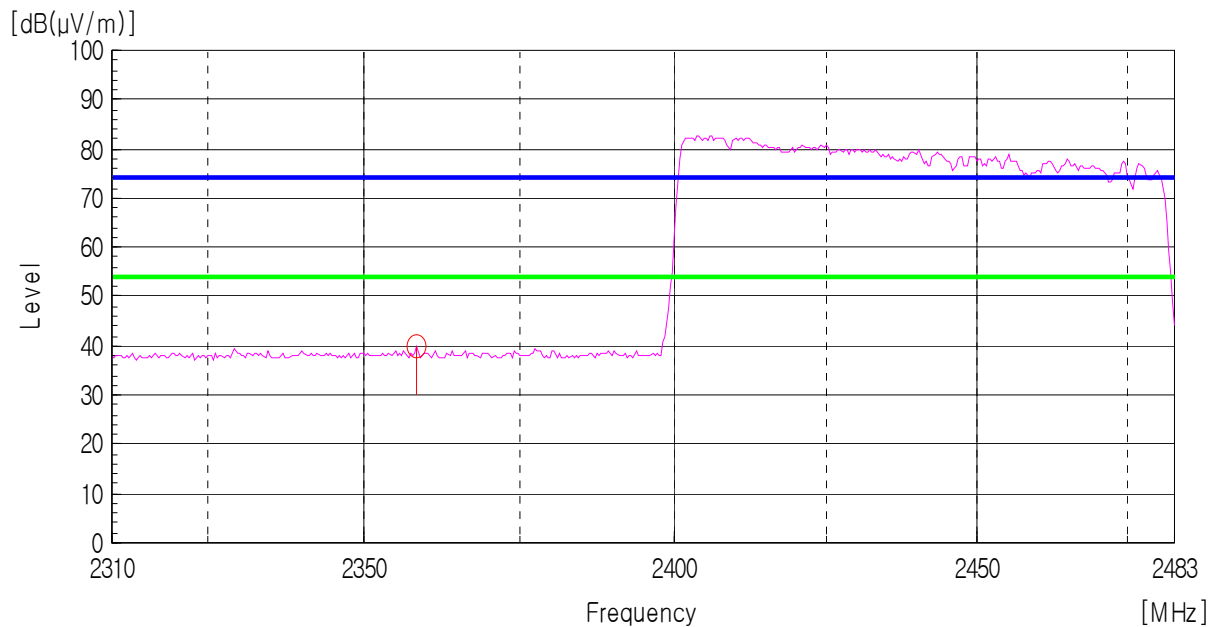
[Hopping mode]

Conducted

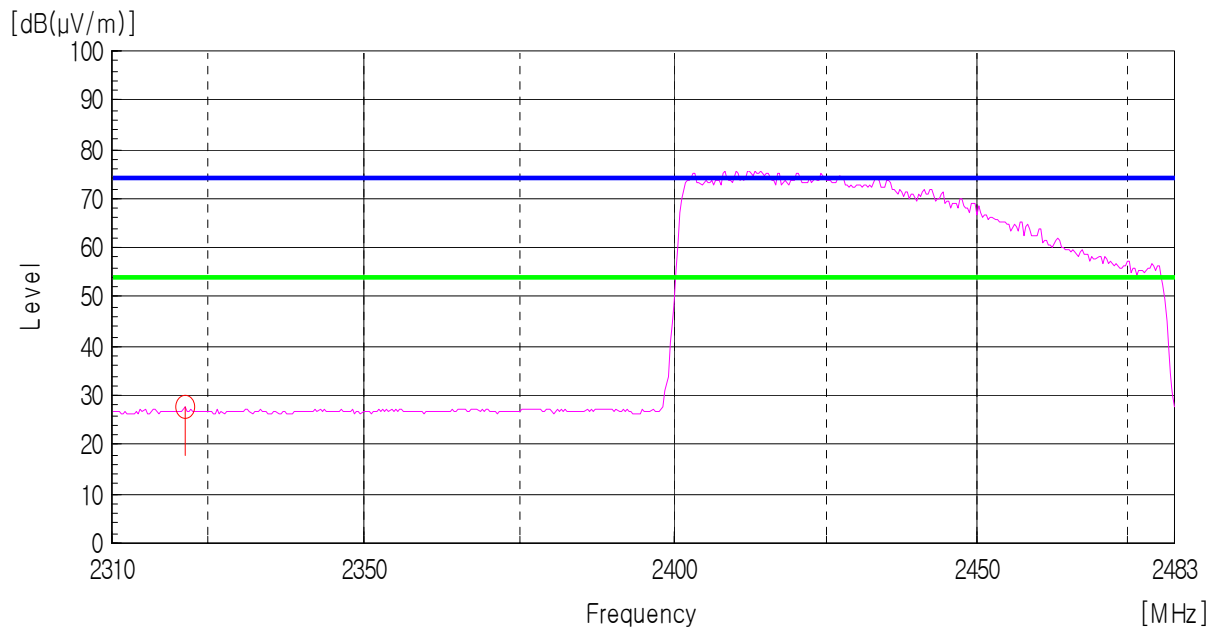


Radiated

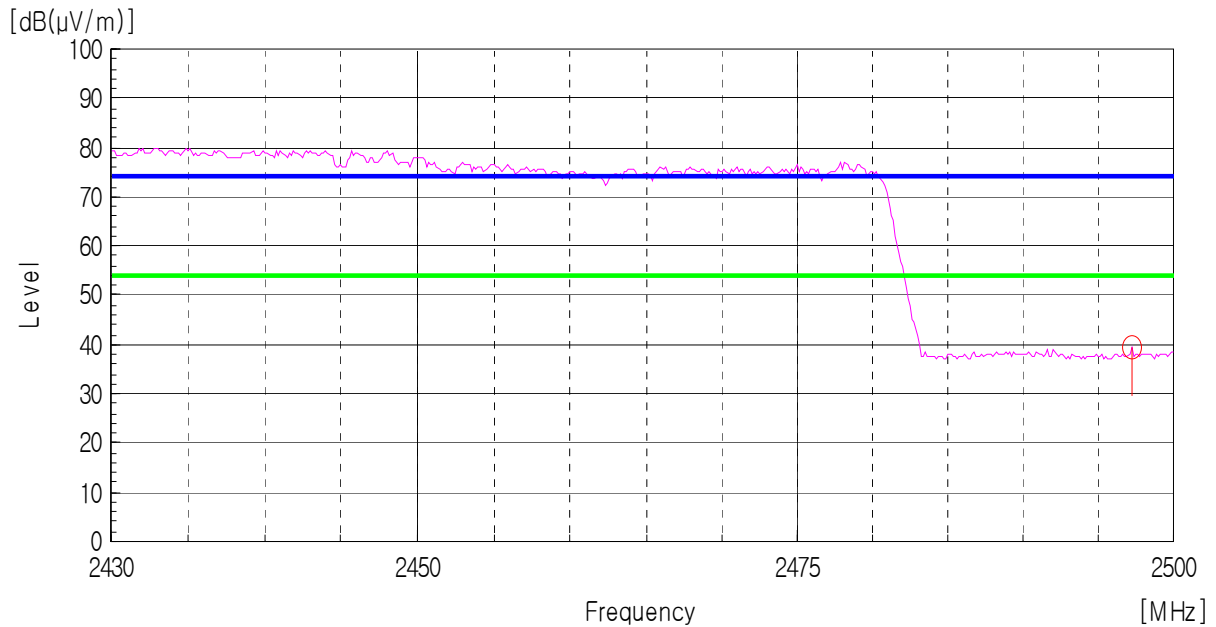
Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 310 MHz - 2 390 MHz), Worst case (Low, Horizontal)



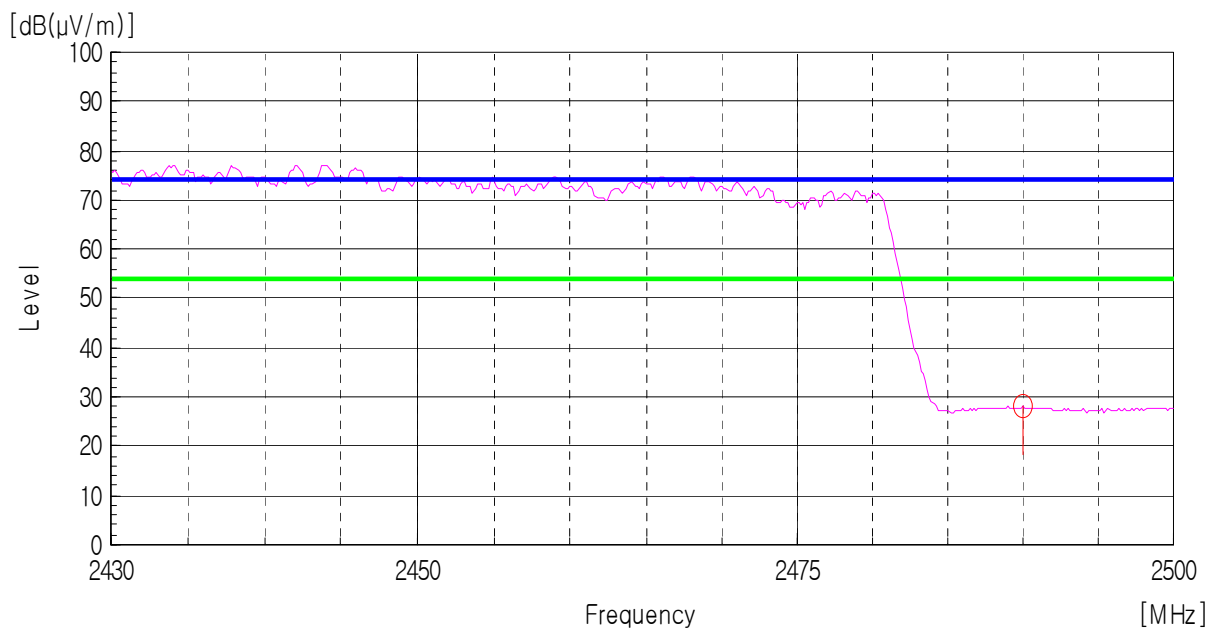
AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 310 MHz - 2 390 MHz), Worst case (Low, Horizontal)



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



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



5.5 Number of Hopping Channels

EUT	Smart Equalizer / DSBT504
Limit apply to	FCC Part 15.247(a)(1)(iii), RSS-210 A8.1(d)
Test Date	February 28, 2014
Environmental of Test	19.9 °C, 43 % R.H., 102.0 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

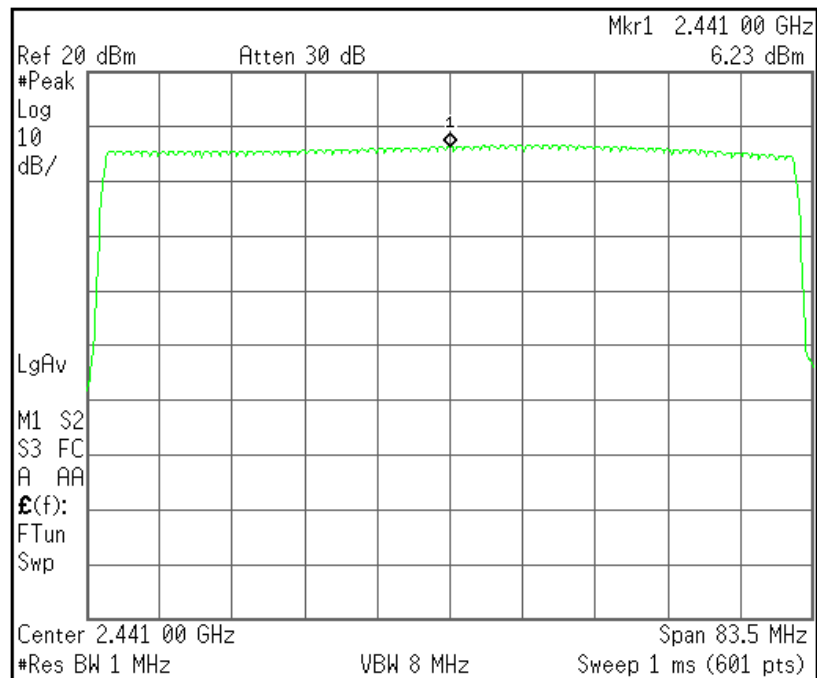
Type of Modulation	Result	Limit
BDR	79	> 15 Channel
EDR	79	

NOTES:

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

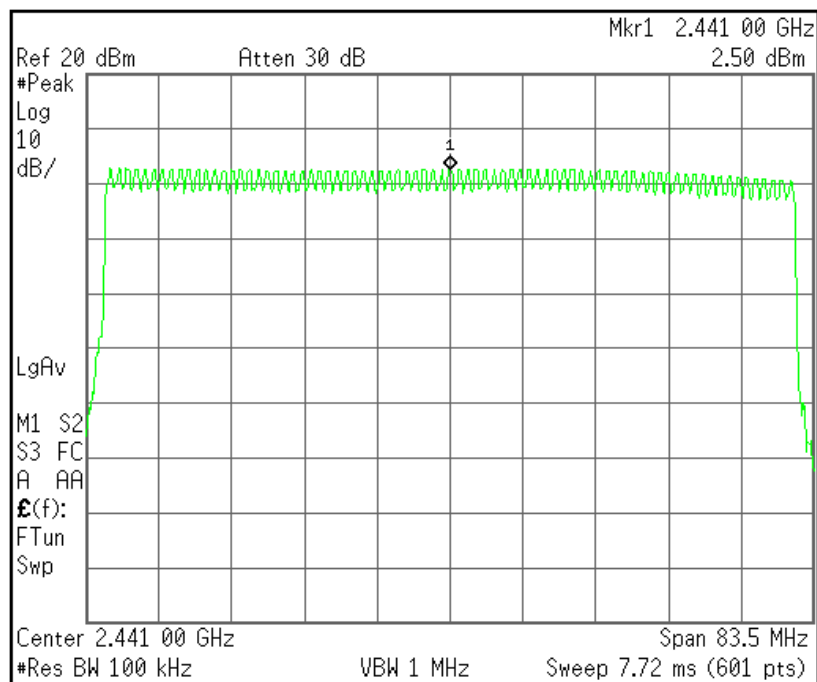
Plots of Number of Hopping Channels (BDR)

[Hopping Channels]



Plots of Number of Hopping Channels (EDR)

[Hopping Channels]



5.6 Time of Occupancy

EUT	Smart Equalizer / DSBT504
Limit apply to	FCC Part 15.247(a)(1)(iii), RSS-210 A8.1(d)
Test Date	February 28, 2014
Environmental of Test	20.3 °C, 42 % R.H., 102.0 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

- Type of Modulation: BDR

0.4 s x 79 (CH) = 31.6 s

2.915 x (266.667/79) x 31.6 s = 310.934 ms

Pulse Time [ms]	Total of Dwell [ms]	Limit [ms]
2.915	310.934	400.000

- Type of Modulation: EDR

0.4 s x 79 (CH) = 31.6 s

2.896 ms x (266.667/79) x 31.6 s = 308.907 ms

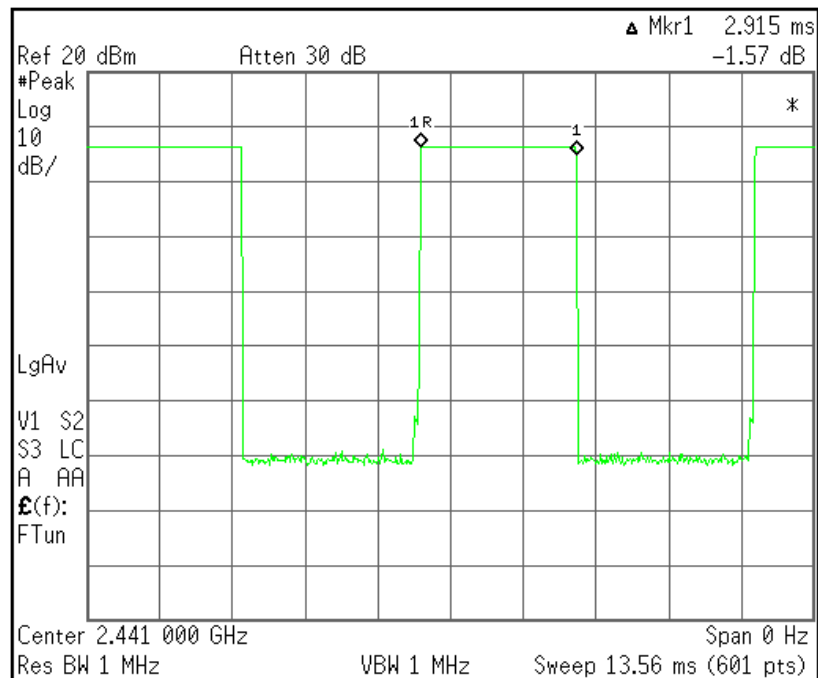
Pulse Time [ms]	Total of Dwell [ms]	Limit [ms]
2.896	308.907	400.000

NOTES:

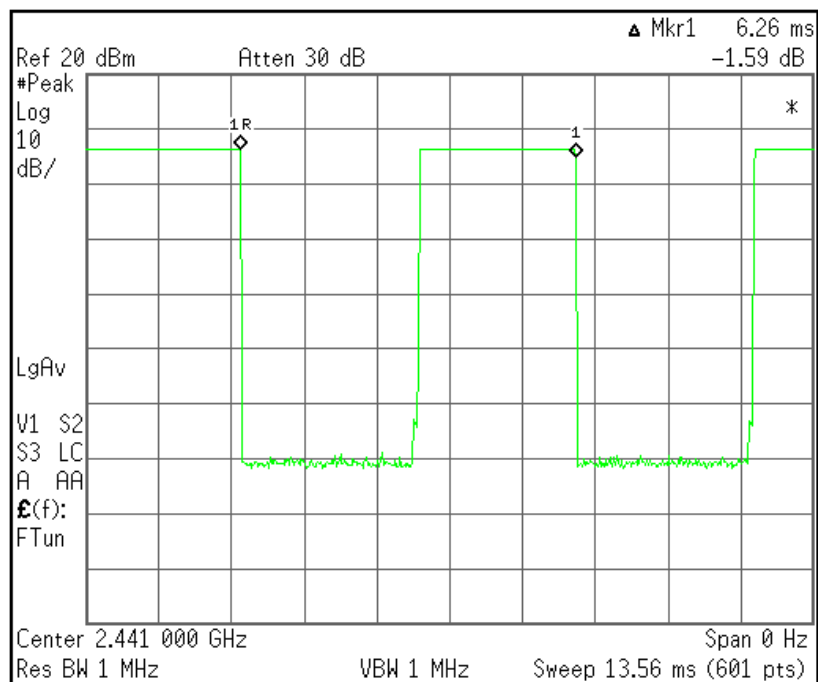
1. Measure time of occupancy of relevant channel using spectrum analyzer.
2. Please see the measured plot in next page.

Plots of Time of Occupancy (BDR)

[Continuous Time]

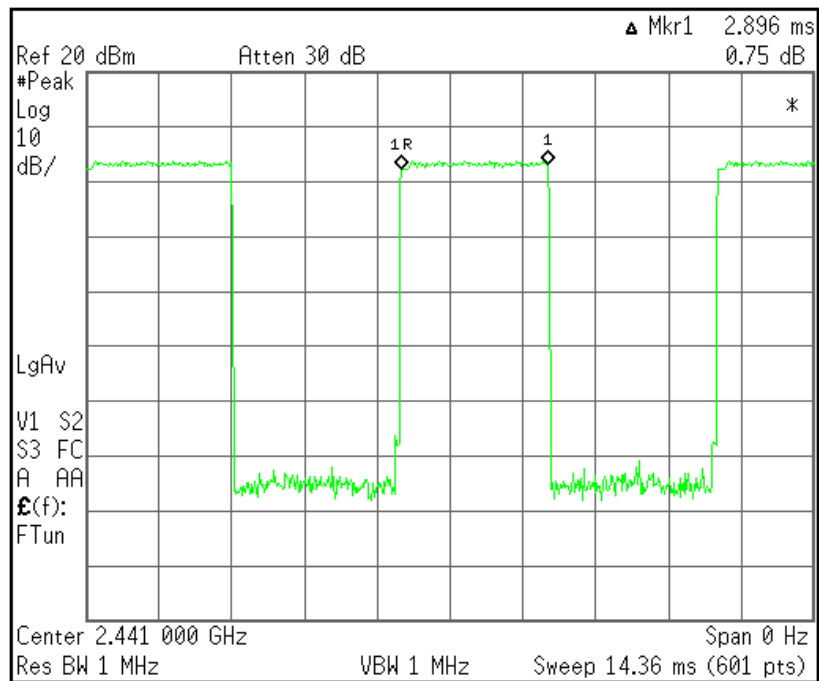


[Hopping Period]

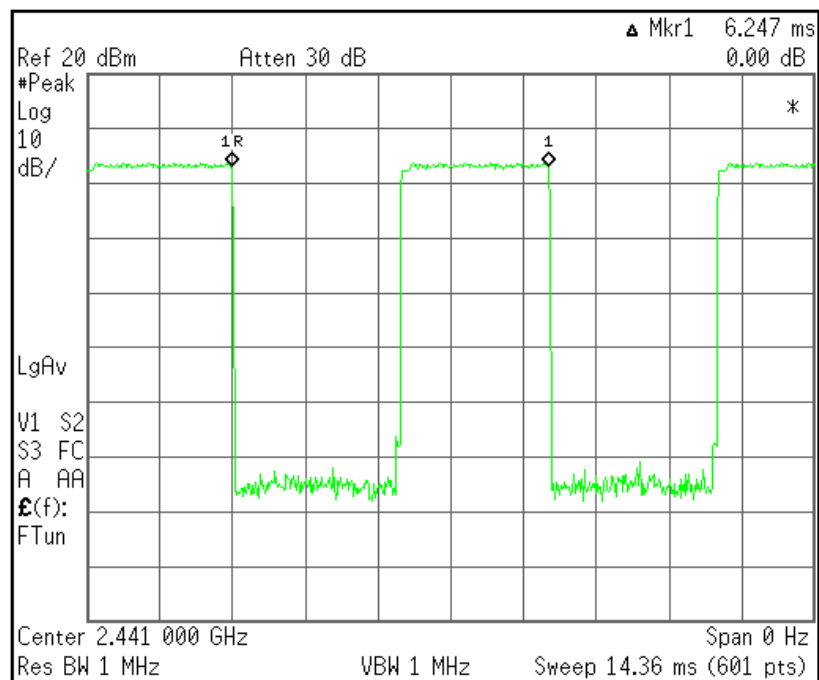


Plots of Time of Occupancy (EDR)

[Continuous Time]



[Hopping Period]



5.7 Spurious Emissions

5.7.1 Radiated Emissions (TX)

EUT	Smart Equalizer / DSBT504
Limit apply to	FCC Part 15.209, RSS-Gen 7.2.5
Test Date	March 03, 2014 to March 04, 2014
Environmental of Test	(16.25 ± 4.25) °C, (37.0 ± 3.0) % R.H., (101.95 ± 0.15) kPa
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.

Radiated Emissions Test data

- 9 kHz to 30 MHz

Test Date	March 04, 2014
Environmental of Test	12.2 °C, 34.0 % R.H., 101.9 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)

- Type of Modulation: BDR, EDR

Frequency [MHz]	Reading [dB(μV)]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
	Emission attenuated more than 20 dB below the limit are not reported.						

Result: All emissions below noise floor of 20 dB(μV/m).

NOTES:

- * H : Horizontal polarization , ** V : Vertical polarization
- Result = Reading + Antenna factor + Cable loss
- Margin = Limit - Result
- The measurement was performed for the frequency range 9 kHz to 30 MHz according to FCC Part 15.209.

- Below 1 GHz (30 MHz to 1 GHz)

Test Date	March 04, 2014
Environmental of Test	12.0 °C, 36.0 % R.H., 101.8 kPa

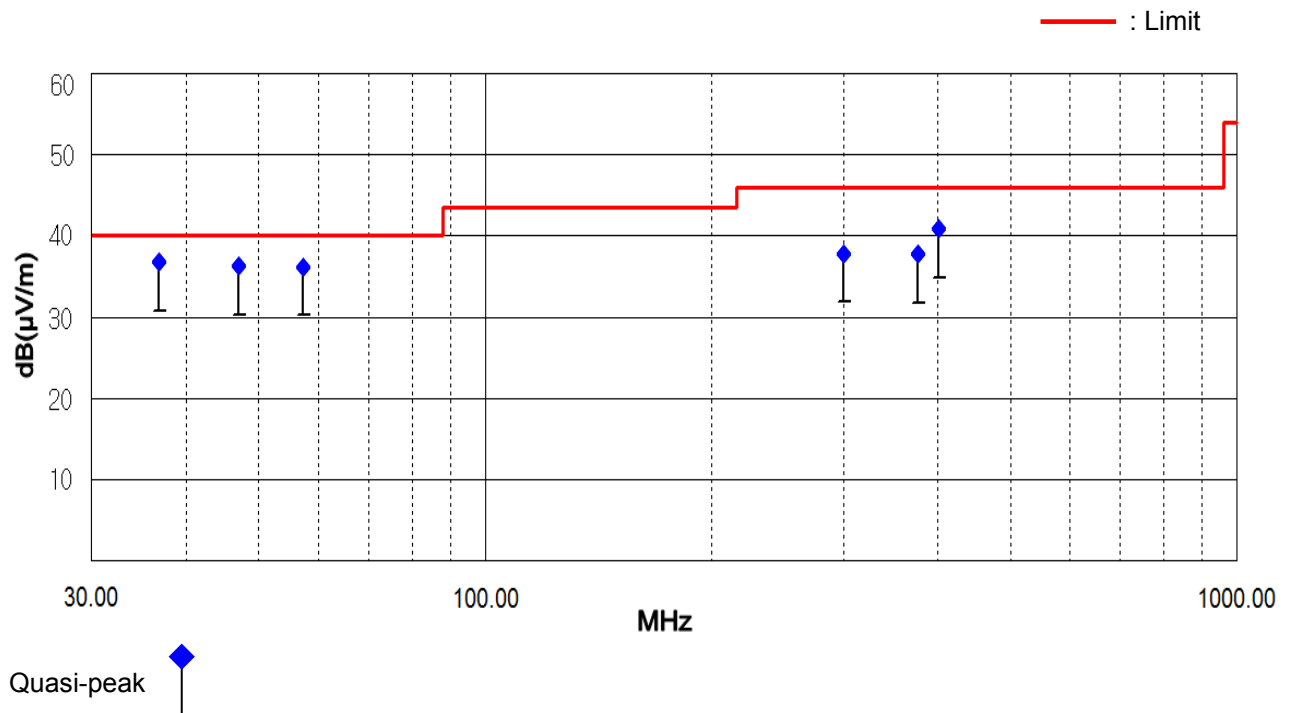
The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical.
Detector mode: CISPR Quasi-Peak mode (6 dB Bandwidth: 120 kHz)

- Type of Modulation: BDR (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]
36.81	24.78	V	11.03	0.99	100	36.80	40.00	3.20
47.04	23.53	V	11.79	1.08	101	36.40	40.00	3.60
298.89	22.26	H	13.07	2.17	388	37.50	46.00	8.50
351.25	18.45	H	14.39	2.36	370	35.20	46.00	10.80
376.20	20.43	H	15.02	2.45	361	37.90	46.00	8.10
399.97	22.65	H	15.61	2.54	167	40.80	46.00	5.20

NOTES:

- * H : Horizontal polarization , ** V : Vertical polarization
- Result = Reading + Antenna factor + Cable loss
- Margin value = Limit - Result
- The measurement was performed for the frequency range above 30 MHz according to FCC Part 15.209.



- Above 1 GHz (1 GHz to 25 GHz)

Test Date	March 03, 2014
Environmental of Test	20.5 °C, 40 % R.H., 102.1 kPa

- Type of Modulation: BDR (worst case)

1. Low CH

Frequency [MHz]	Reading [dB(μV)]		Polarity (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB]	Result [dB(μV/m)]		Limit [dB(μV/m)]		Margin [dB]	
	Peak	Average				Peak	Average	Peak	Average	Peak	Average
1 864.56	51.96	37.36	V	25.98	-37.44	40.50	25.90	73.97	53.97	33.47	28.07
2 438.24	50.56	33.76	V	27.50	-35.96	42.10	25.30	73.97	53.97	31.87	28.67

2. Middle CH

Frequency [MHz]	Reading [dB(μV)]		Polarity (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB]	Result [dB(μV/m)]		Limit [dB(μV/m)]		Margin [dB]	
	Peak	Average				Peak	Average	Peak	Average	Peak	Average
1 865.30	51.86	37.26	V	25.98	-37.44	40.40	25.80	73.97	53.97	33.57	28.17
2 438.70	50.46	33.76	V	27.50	-35.96	42.00	25.30	73.97	53.97	31.97	28.67

3. High CH

Frequency [MHz]	Reading [dB(μV)]		Polarity (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB]	Result [dB(μV/m)]		Limit [dB(μV/m)]		Margin [dB]	
	Peak	Average				Peak	Average	Peak	Average	Peak	Average
1 865.90	52.05	37.35	V	25.99	-37.44	40.60	25.90	73.97	53.97	33.37	28.07
2 438.50	50.66	33.96	V	27.50	-35.96	42.20	25.50	73.97	53.97	31.77	28.47

Result: No signal detect above second harmonic.

NOTES:

- * H : Horizontal polarization , ** V : Vertical polarization
- Cable loss = Cable loss + Amp. Gain
- Result = Reading + Antenna factor + Cable loss
- Margin value = Limit - Result
- Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
- 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.
- Spectrum setting:
 - Peak Setting 1 GHz to 10th harmonics of fundamental, RBW = 1 MHz, VBW = 1 MHz, Sweep = Auto
 - AV Setting 1 GHz to 10th harmonics of fundamental, RBW = 1 MHz, VBW = 10 Hz, Sweep = Auto

5.7.2 Conducted Emissions

EUT	Smart Equalizer / DSBT504
Limit apply to	FCC Part 15.247(d)
Test Date	March 03, 2014
Environmental of Test	20.9 °C, 40 % R.H., 102.1 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

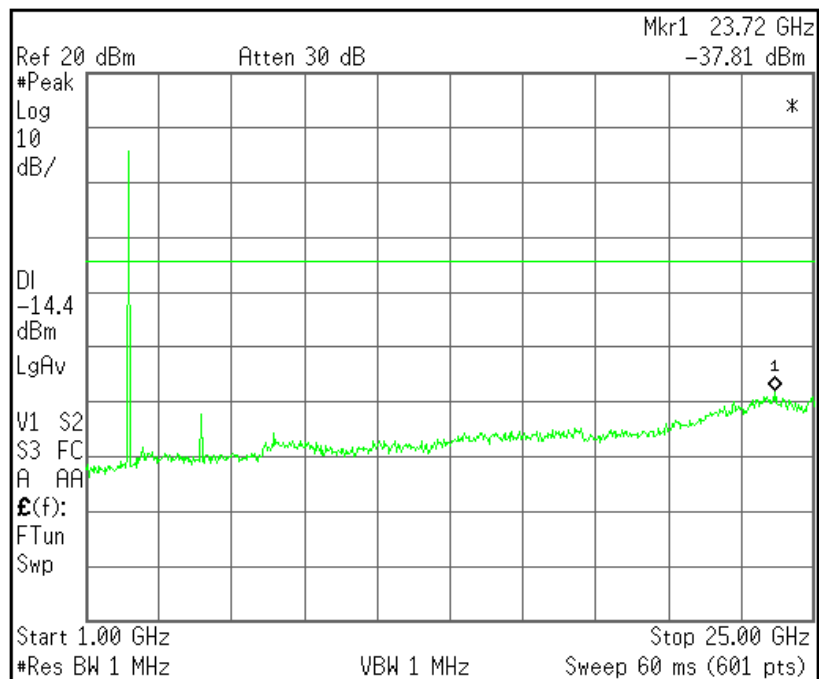
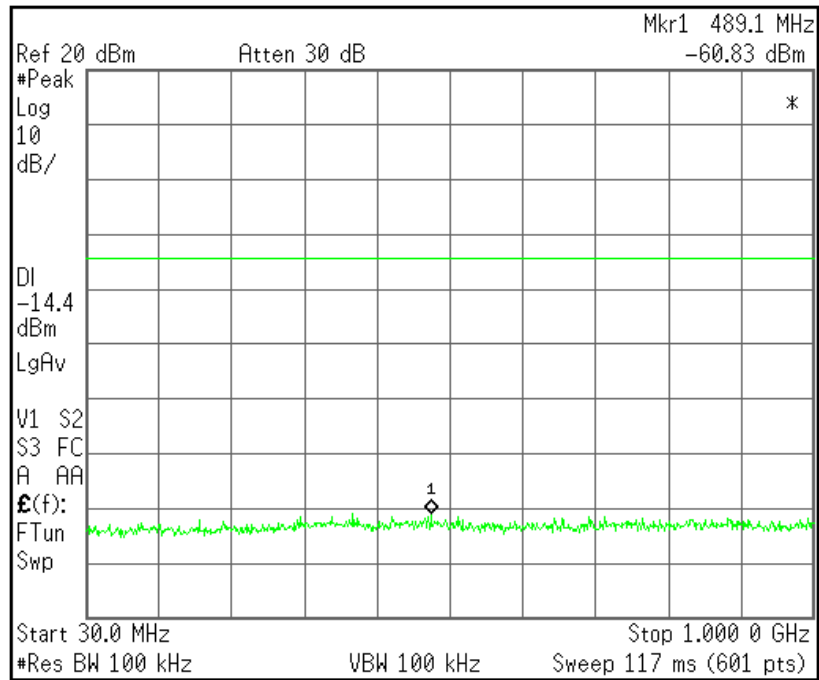
- Refer to see the measured plot in next page.

NOTES:

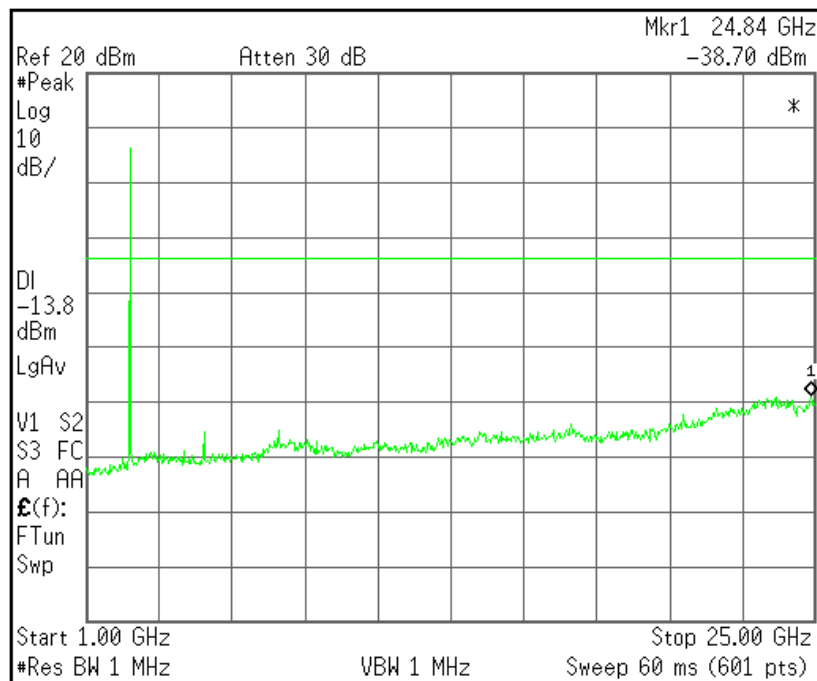
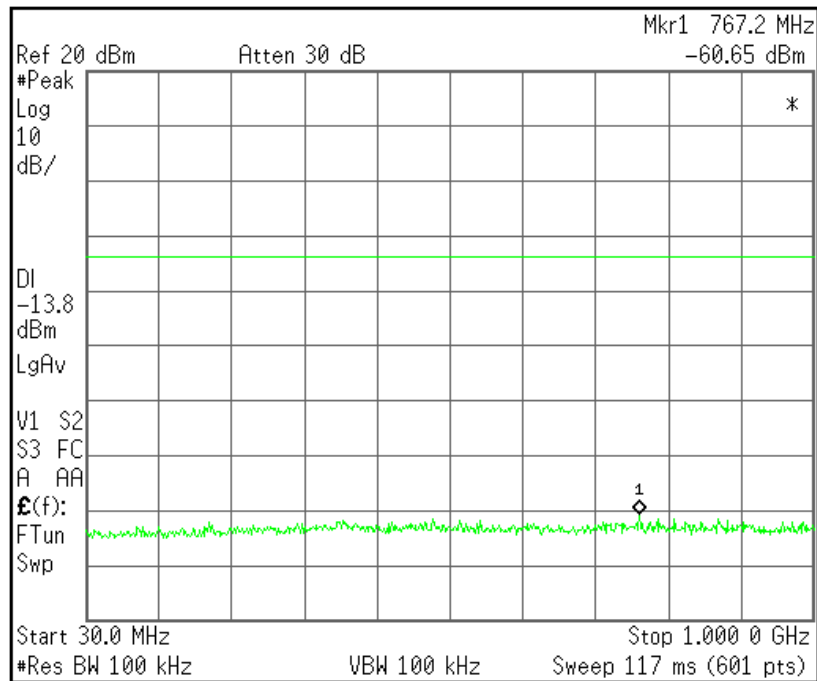
1. The test was performed to make a direct field strength measurement at the band edge frequencies.

Plots of Spurious Emissions (Conducted Measurement) (BDR)

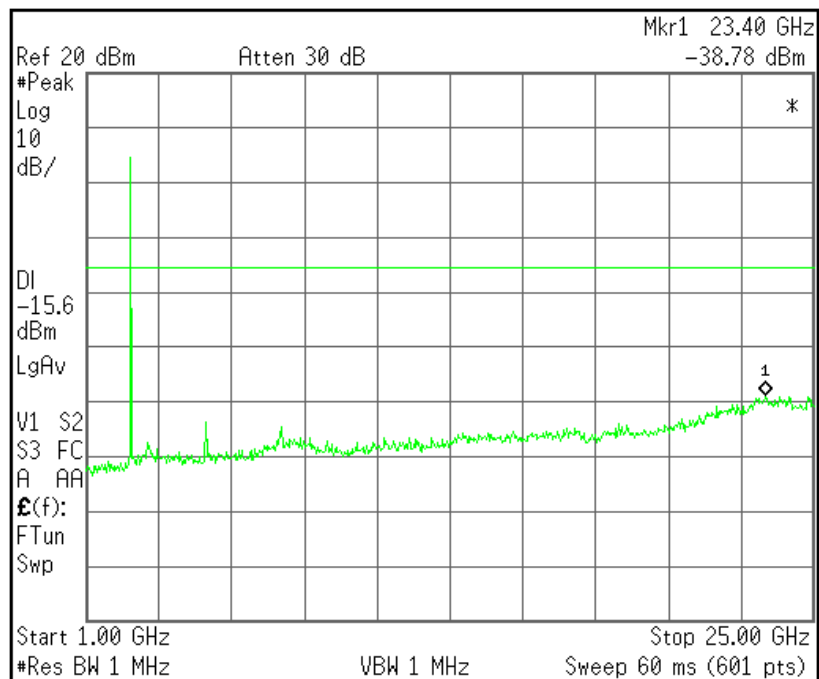
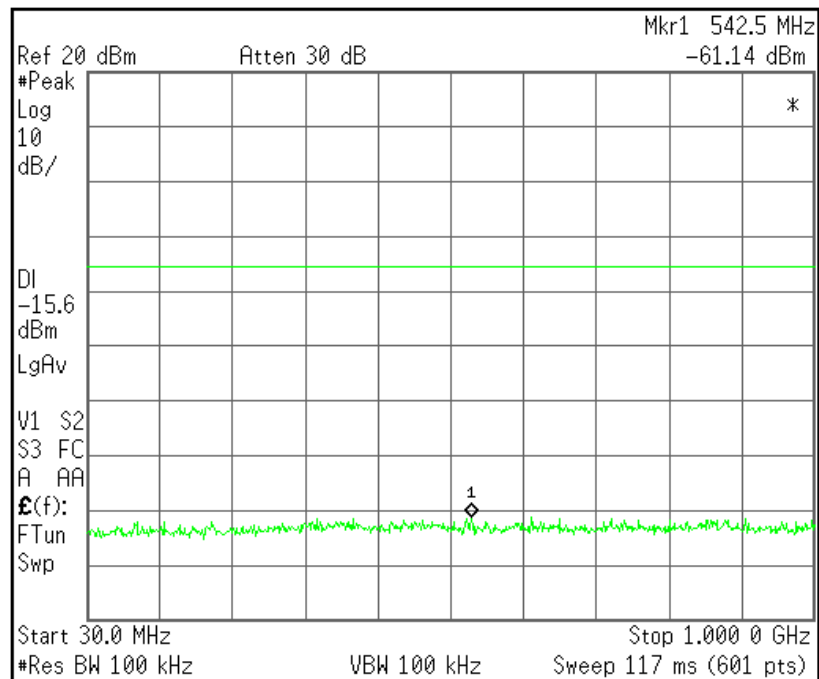
[CH Low]



[CH Mid]

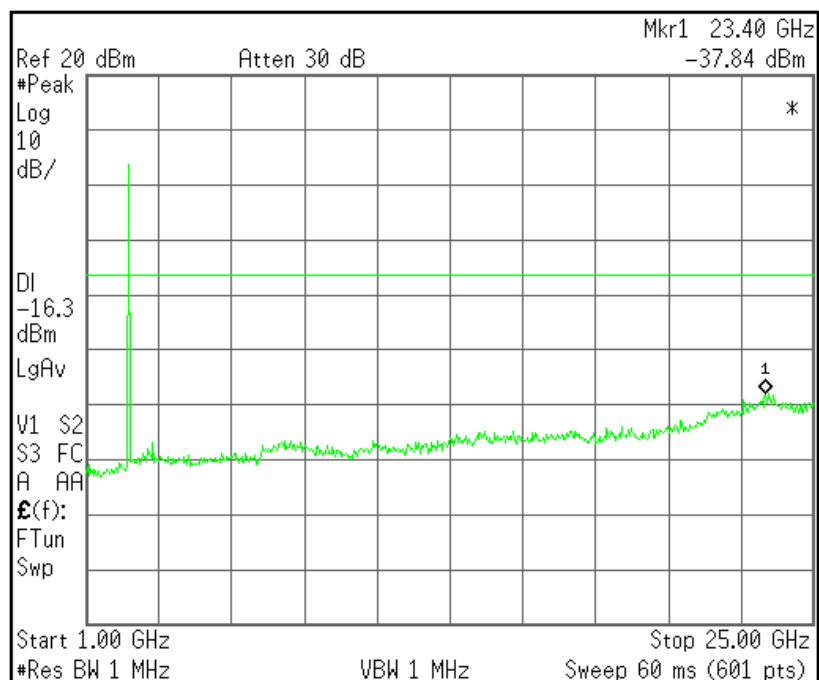
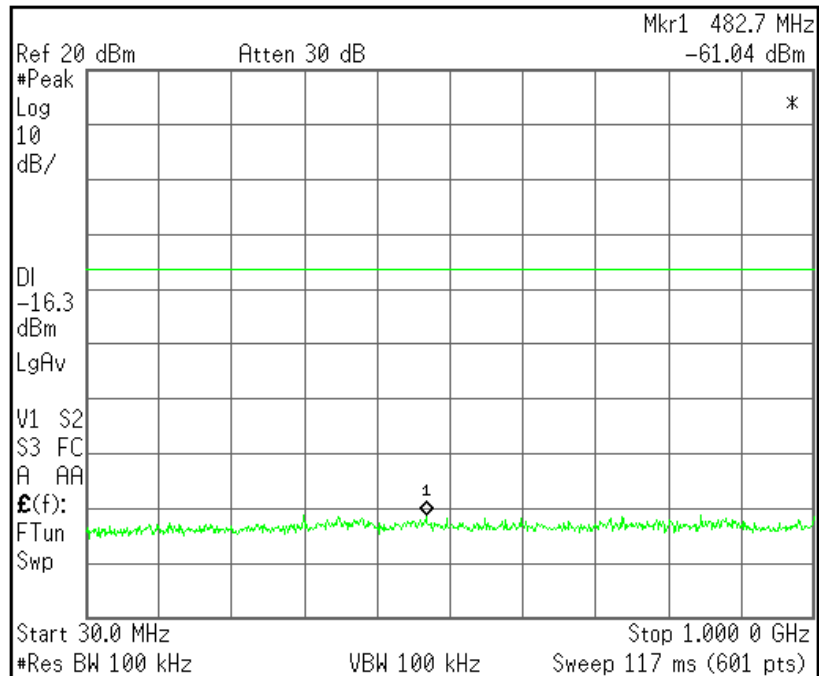


[CH High]

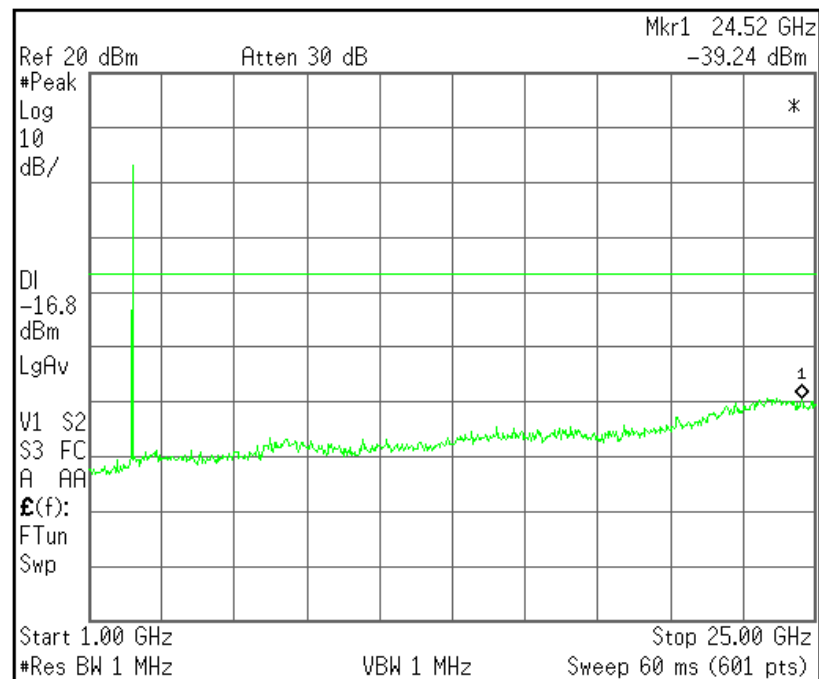
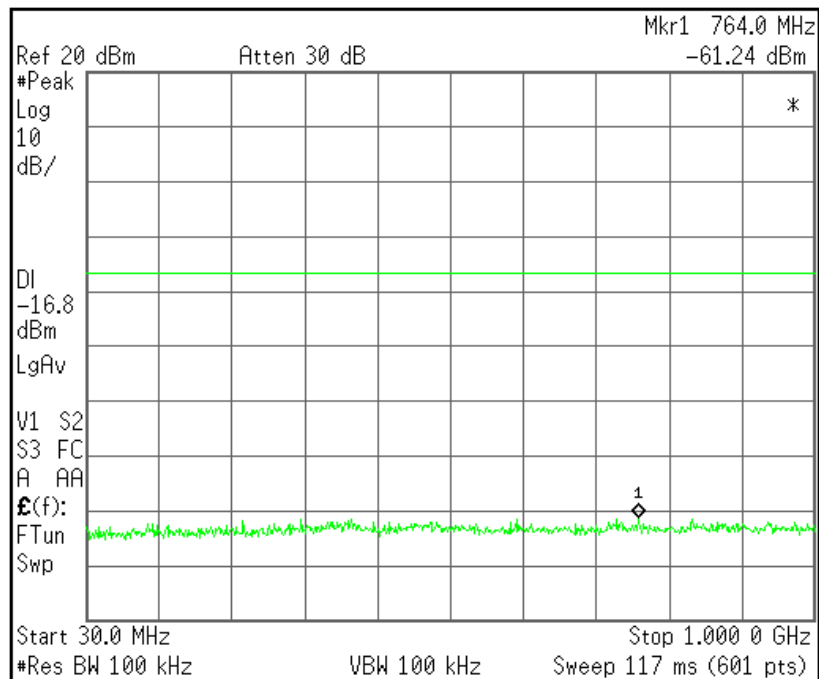


Plots of Spurious Emissions (Conducted Measurement) (EDR)

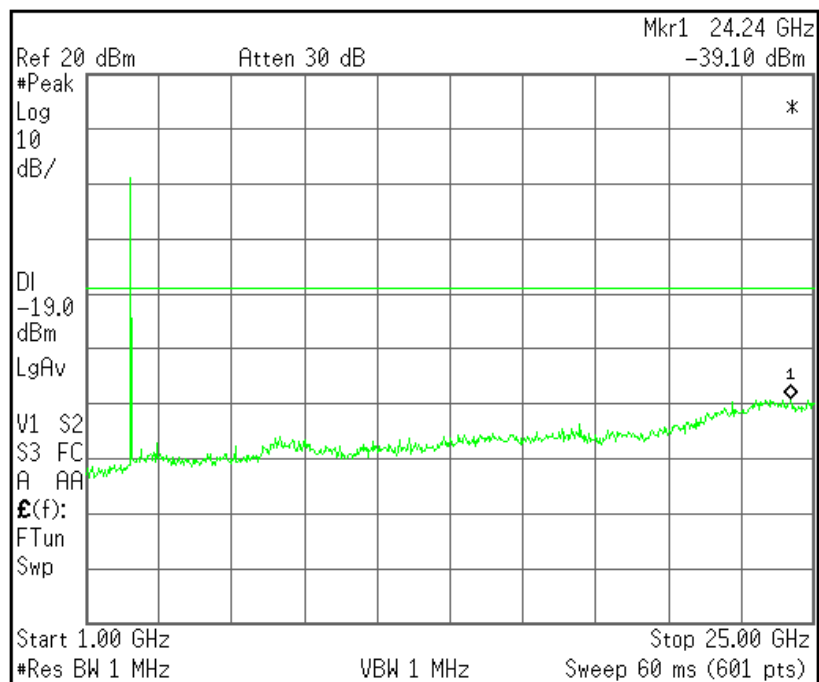
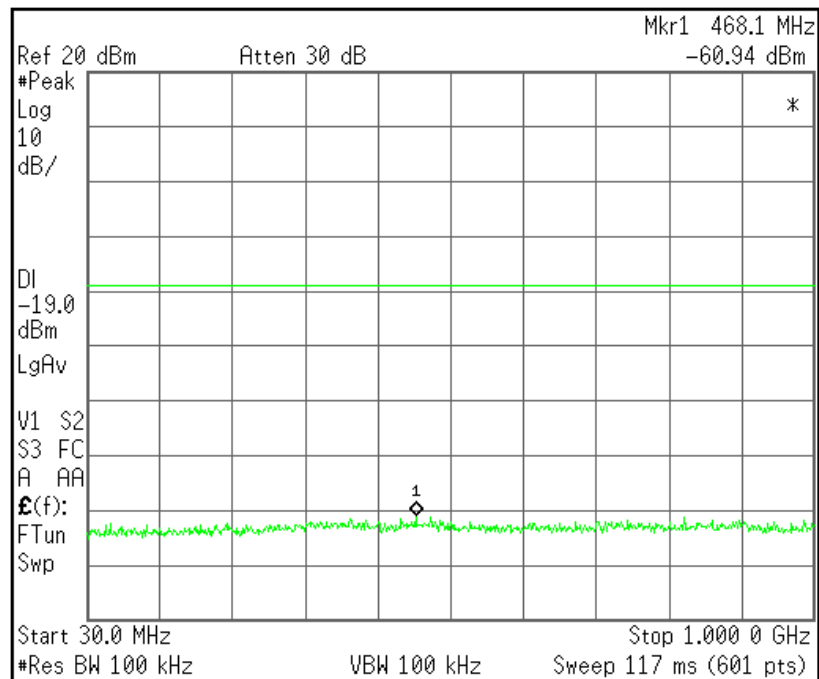
[CH Low]



[CH Mid]



[CH High]



5.7.3 Radiated Emissions (RX)

EUT	Smart Equalizer / DSBT504
Limit apply to	RSS-Gen 6.1
Test Date	March 03, 2014 to March 04, 2014
Environmental of Test	(15.1 ± 5.7) °C, (35.0 ± 4.0) % R.H., (101.95 ± 0.15) kPa
Operating Condition	Low CH, Middle CH, High CH Transmission
Result	Passed

Limit

Receiver spurious emissions at any discrete frequency shall not exceed 2 nano watts in the band 30 MHz - 1 000 MHz, or 5 nano watts above 1 GHz.

Test Results

- Refer to see the measured plot in next page.

Radiated Emissions Test data

- Below 1 GHz (30 MHz to 1 GHz)

Test Date	March 04, 2014
Environmental of Test	9.4 °C, 31.0 % R.H., 101.8 kPa

- Operating mode: RX / CH: Low, Mid, High

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

- Type of Modulation: BDR, EDR

Frequency [MHz]	Reading [dB(μV)]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
	No Spurious Radiated Emissions Found						

Result: No Spurious Radiated Emissions Found.

NOTES:

- * H : Horizontal polarization , ** V : Vertical polarization
- Result = Reading + Antenna factor + Cable loss
- Margin value = Limit - Result

- Below 1 GHz (30 MHz to 1 GHz)

Test Date	March 04, 2014
Environmental of Test	11.8 °C, 35.0 % R.H., 101.9 kPa

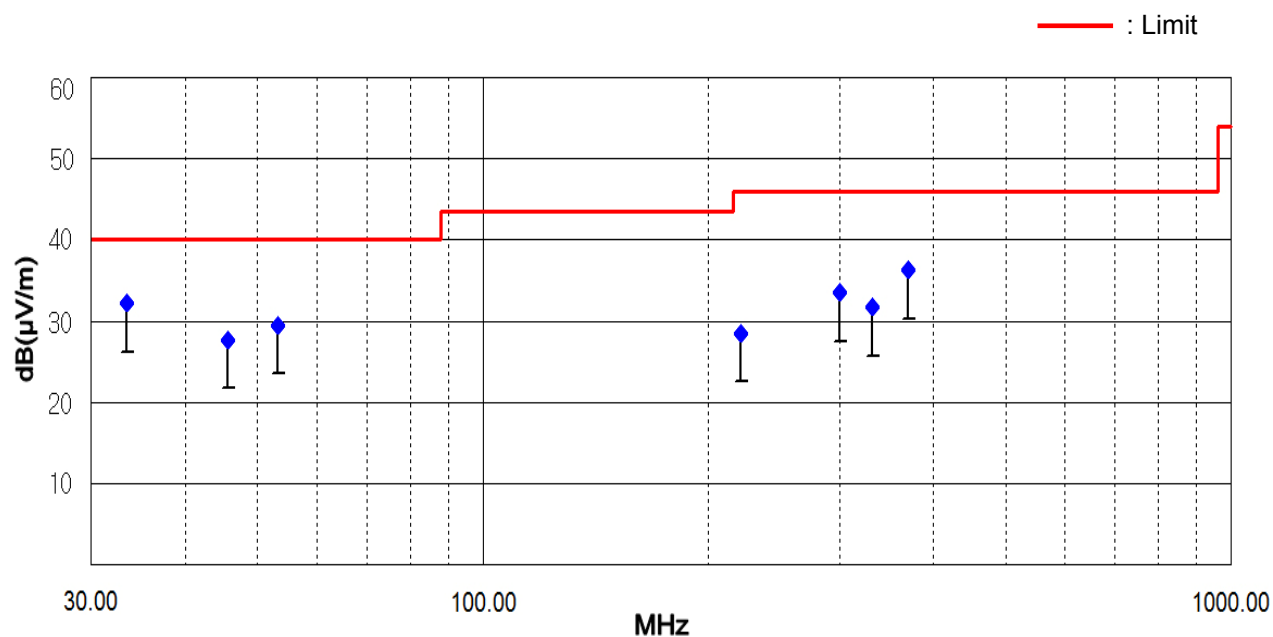
The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical.
Detector mode: CISPR Quasi-Peak mode (6 dB Bandwidth: 120 kHz)

- Type of Modulation: BDR (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]
33.40	20.55	V	10.69	0.96	100	32.20	40.00	7.80
45.68	14.89	V	11.74	1.07	101	27.70	40.00	12.30
53.18	16.80	V	11.57	1.13	102	29.50	40.00	10.50
221.57	16.57	H	10.13	1.80	382	28.50	46.00	17.50
299.97	18.21	H	13.11	2.18	391	33.50	46.00	12.50
331.81	15.50	H	13.91	2.29	373	31.70	46.00	14.30
370.70	18.99	H	14.88	2.43	351	36.30	46.00	9.70

NOTES:

- * H : Horizontal polarization , ** V : Vertical polarization
- Result = Reading + Antenna factor + Cable loss
- Margin value = Limit - Result
- The measurement was performed for the frequency range above 30 MHz according to FCC Part 15.209.



Quasi-peak

- Above 1 GHz (1 GHz to 25 GHz)

Test Date	March 03, 2014
Environmental of Test	20.8 °C, 39 % R.H., 102.1 kPa

- Type of Modulation: BDR (worst case)

1. Low CH

Frequency [MHz]	Reading [dB(μV)]		Polarity (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB]	Result [dB(μV/m)]		Limit [dB(μV/m)]		Margin [dB]	
	Peak	Average				Peak	Average	Peak	Average	Peak	Average
1 060.60	54.89	36.79	V	24.47	-38.96	40.40	22.30	73.97	53.97	33.57	31.67
1 496.92	56.47	38.37	V	25.25	-38.13	43.60	25.50	73.97	53.97	30.37	28.47
2 664.48	56.93	32.13	V	27.91	-35.64	49.20	24.40	73.97	53.97	24.77	29.57

2. Middle CH

Frequency [MHz]	Reading [dB(μV)]		Polarity (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB]	Result [dB(μV/m)]		Limit [dB(μV/m)]		Margin [dB]	
	Peak	Average				Peak	Average	Peak	Average	Peak	Average
1 060.90	55.19	36.89	V	24.47	-38.96	40.70	22.40	73.97	53.97	33.27	31.57
1 497.50	56.47	38.27	V	25.26	-38.12	43.60	25.40	73.97	53.97	30.37	28.57
2 664.68	57.03	32.23	V	27.91	-35.64	49.30	24.50	73.97	53.97	24.67	29.47

3. High CH

Frequency [MHz]	Reading [dB(μV)]		Polarity (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB]	Result [dB(μV/m)]		Limit [dB(μV/m)]		Margin [dB]	
	Peak	Average				Peak	Average	Peak	Average	Peak	Average
1 060.43	54.80	36.70	V	24.47	-38.96	40.30	22.20	73.97	53.97	33.67	31.77
1 495.91	56.48	38.48	V	25.25	-38.13	43.60	25.60	73.97	53.97	30.37	28.37
2 663.32	57.33	32.23	V	27.91	-35.64	49.60	24.50	73.97	53.97	24.37	29.47

Result: No signal detect above second harmonic.

NOTES:

- * H : Horizontal polarization , ** V : Vertical polarization
- Cable loss = Cable loss + Amp. Gain
- Result = Reading + Antenna factor + Cable loss
- Margin value = Limit - Result
- Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
- 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.
- Spectrum setting:
 - Peak Setting 1 GHz to 10th harmonics of fundamental, RBW = 1 MHz, VBW = 1 MHz, Sweep = Auto
 - AV Setting 1 GHz to 10th harmonics of fundamental, RBW = 1 MHz, VBW = 10 Hz, Sweep = Auto

5.8 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:

$$\left[\frac{\text{max. power of channel, including tune-up tolerance, mW}}{(\text{min. test separation distance, mm})^2} \right] \leq 3.0 \text{ for 1-g SAR and } \leq 7.5 \text{ for 10-g extremity SAR, where}$$

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 peak output power is (4.295 mW) lower than the threshold given and derived as above, where

$$= 4.295 \text{ (mW)} / 5 \text{ (mm)}^2 \times \sqrt{2.441 \text{ (GHz)}} = 1.342 < 3.0$$

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.

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

$$dB(\mu V) = 20 \log_{10} (\mu V) : \text{Equation}$$

$$dB(\mu V) = dBm + 107$$

Example : @ 36.81 MHz

$$\text{Class B Limit} = 40.00 \text{ dB}(\mu V/m)$$

$$\text{Reading} = 24.78 \text{ dB}(\mu V)$$

$$\text{Antenna Factor + Cable Loss} = 11.03 + 0.99 = 12.02 \text{ dB}(\mu V/m)$$

$$\text{Total} = 36.80 \text{ dB}(\mu V/m)$$

$$\text{Margin} = 40.00 - 36.80 = 3.20 \text{ dB}$$

$$= 3.20 \text{ dB below Limit}$$

7. List of test equipments used for measurements

	Test Equipment	Model	Mfg.	Serial No.	Cal. Date	Cal. Due Date
☒	EMI Test Receiver	ESVS 10	R&S	835165/001	14.03.18	15.03.18
☒	EMI Test Receiver	ESCI7	R&S	100851	13.09.05	14.09.05
☒	LogBicon Antenna	VULB9160	Schwarzbeck	3082	13.07.25	15.07.25
☒	Horn Antenna	BBHA 9120D	Schwarzbeck	277	12.05.10	14.05.10
☒	Loop Antenna	AL-130	COM-POWER	121025	12.06.14	14.06.14
☒	Spectrum Analyzer	E7405A	H.P.	US41160290	13.09.05	14.09.05
☒	PSA Series Spectrum Analyzer	E4440A	Agilent	US40420382	13.09.11	14.09.11
☒	Amplifier	TK-PA18	TESTEK	120020	13.09.05	14.09.05
☒	Band Reject Filter	WRCGV 2402/2480-2382/2500-52/10SS	Wainwright Instrument	2	13.09.05	14.09.05
☒	Power Meter	NRVS	R&S	834053/060	13.09.05	14.09.05
☒	DC Power Supply	HYP-3030	Han Young	990554	14.03.17	15.03.17
☒	DC Power Supply	DP30-05A	Toyo Tech	0300266	13.09.06	14.09.06
☒	Turn-Table	DS1200-S	Innco Systems GmbH	2740311	N/A	N/A
☒	Turn-Table	TT 1.35 SI	SES	-	N/A	N/A
☒	Antenna Master	AM 4.5	SES	-	N/A	N/A