시 험 성 적 서
TEST REPORT

성적서 번호 Report No.		ICRT-TR-E190549-0A
신청자 Client	기관명 Name	Sena Technologies,Inc.
	주 소 Address	FCC: 19, Heolleung-ro 569-gil, Gangnam-gu, Seoul, South Korea IC: 210 Yangjae-dong, Seocho-gu Seoul 137-130 South Korea
시험대상품목 Sample description		ARK
모델명 Type designation		SP66
정 격 Ratings		DC 3.7 V
시험기간 Date of test		Mar. 22, 2019 ~ Mar. 26, 2019
시험방법/항목 Test Method/Item		FCC Part 15 Subpart C §15.247 / IC RSS-247
시험결과 Test Results		Refer to 3. Test Summary
확 인 Affirmation	작성자 Tested by 성 명 (서 명) Name Hong-Kyu, Lee (Signature)	기술책임자 Technical Manager 성 명 (서 명) Name Jun-Hui, Lee (Signature)

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This is certified that the above mentioned products have been tested for the sample provided by customer and forbid the use except for original purpose.

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2019. 04. 03

주식회사 아이씨알 대표이사

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경기도 김포시 양촌읍 황금3로7번길 112
112, Hwanggeum3-ro 7beon-gil, Yangchon-eup, Gimpo-si, Gyeonggi-do, Korea

Contents

Revision History

Issued Report No.	Issued Date	Revisions	Effect Section
ICRT-TR-E190549-0A	03-Apr-2019	Initial Issue	All

1. Applicant & Manufacturer & Test Laboratory Information

1.1 Applicant information

Applicant	Sena Technologies,Inc.	
Address	FCC	19, Heolleung-ro 569-gil, Gangnam-gu, Seoul, South Korea
	IC	210 Yangjae-dong, Seocho-gu Seoul 137-130 South Korea
Contact Person	Seunghyun Kim	
Telephone No.	+82-2-571-8283	
Fax No.	+82-2-573-7710	
E-mail	shkim77@sena.com	

1.2 Manufacturer Information

Manufacturer	Sena Technologies,Inc.	
Address	FCC	19, Heolleung-ro 569-gil, Gangnam-gu, Seoul, South Korea
	IC	210 Yangjae-dong, Seocho-gu Seoul 137-130 South Korea

1.3 Test Laboratory Information

Conducted tests were performed at	
Laboratory	ICR Co., Ltd.
Address	112, Hwanggeum 3-ro 7beon-gil, Hagun-ri, Yangchon-eup, Gimpo-si, Gyeonggi-do, Korea
Telephone No.	+82-2-6351-9002
Fax No.	+82-2-6351-9007
RRA No.	KR0165
KOLAS No.	KT652

2. Equipment under Test(EUT) Information

2.1 General Information

Product Name	ARK
Brand Name	-
Model Name	SP66
Additional Model Name	-
FCC ID / ISED number	S7A-SP66 / 8154A-SP66
Hardware Version	-
Software Version	-
Power Supply	DC 3.7 V

2.2 Additional Information

Equipment Class	DSS-Part 15 Spread Spectrum Transmitter / Frequency hopping systems (FHS)
Device Type	Stand-alone
Operating Frequency	2 402 ㎒ ~ 2 480 ㎒
RF Output Power	18.33 ㏈m
Number of Channel	79
Modulation Type	GFSK / π/4-DQPSK / 8DPSK
Antenna Type	PCB Pattern Antenna
Antenna Gain	0.55 ㏈i
Antenna Operating Mode	Single Antenna Equipment with only one antenna
List of Each Oscillator or Crystal Frequency	26 ㎒

2.3 Test Frequency

Test mode	Test frequency (㎒)		
	Lowest frequency	Middle frequency	High frequency
GFSK	2 402	2 441	2 480
π/4-DQPSK	2 402	2 441	2 480
8DPSK	2 402	2 441	2 480

2.4 Worst-Case

BDR	DH5(GFSK)
EDR	3-DH5(8DPSK)

Note: The power measurement has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates.

2.5 Mode of operation during the test

- The EUT is continuous transmission mode during the test with set at Low Channel, Middle Channel, and High Channel. To get a maximum radiated emission levels from the EUT, the EUT was moved throughout the XY, YZ, XZ planes.

2.6 Modifications of EUT

- None

3. Test Summary

3.1 Test standards and results

FCC Part 15 Subpart C / IC RSS-Gen & RSS-247				
Clause		Test items	Applied	Results
§15.247 (a) (1)	RSS-247 5.1 (a) RSS-Gen 6.7	20 dB Bandwidth & 99 % Bandwidth	☒	PASS
§15.247 (a) (1)	RSS-247 5.1 (b)	Carrier Frequency Separation	☒	PASS
§15.247 (a) (1) (iii)	RSS-247 5.1 (d)	Number of Hopping Frequencies	☒	PASS
§15.247 (a) (1) (iii)	RSS-247 5.1 (d)	Average Time of Occupancy	☒	PASS
§15.247 (b) (1)	RSS-247 5.4 (b)	Maximum Conducted Output Power & e.i.r.p.	☒	PASS
§15.247 (d)	RSS-247 5.5	Conducted Spurious Emission	☒	PASS
§15.247 (d) §15.209 §15.205	RSS-247 5.5 RSS-GEN 8.9 RSS-GEN 8.10	Radiated Spurious Emission	☒	PASS
§15.207	RSS-GEN 8.8	Power Line Conducted Emission	☒	PASS
§15.203	-	Antenna Requirement	☒	PASS

3.2 Purpose of the test

- To determine whether the equipment under test fulfills the requirements of the standards stated in FCC Part 15 Subpart C Section 15.247 and IC RSS-247

3.3 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10: 2013.

Radiated testing was performed at a distance of 3 m from EUT to the antenna.

3.4 Configuration of Test System

3.4.1 Radiated emission test

Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions. Final radiated emission tests were conducted at 3 m Semi Anechoic Chamber. The turntable was rotated through 360 degrees and the EUT was tested by positioned three orthogonal planes to obtain the highest reading on the field strength meter. Once maximum reading was determined, the search antenna was raised and lowered in both vertical and horizontal polarization.

3.4.2 AC powerline conducted emission test

The EUT was connected to LISN. All supporting equipments were connected to another LISN. Preliminary Power line Conducted Emission test was performed by using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions.

3.5 Antenna requirement

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.
And according to §15.247(b)(4), the conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi.
Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

3.5.1 Result: Pass

The transmitter has a ***PCB Pattern Antenna.*** The directional gain of the antenna is ***0.55 dB***

i.

4. Used equipment on test

	Description	Model Name	Serial Number	Manufacturer	Last Cal. (cycle)
☒	Spectrum analyzer	FSW85	100864	Rohde & Schwarz	2019. 03. 04 (1Y)
☐	Spectrum analyzer	FSV40	101455	Rohde & Schwarz	2018 .07. 10 (1Y)
☒	Signal Generator	SMB100A	180607	Rohde & Schwarz	2019. 03. 04 (1Y)
☐	Wideband Power Sensor	NRP-Z81	103673	Rohde & Schwarz	2019. 03. 05 (1Y)
☐	Open Switch and Control Platform	OSP150	101000	Rohde & Schwarz	2019. 03. 05 (1Y)
☐	Environmental Test Chamber	MHK-408NKDA	1060908	TERCHY	2019. 03. 04 (1Y)
☒	DC Power Supply	XDL 35-5P	J00385373	Sorensen	2019. 03. 05 (1Y)
☐	DC Power Supply	6603D	672483	Topward	2019. 03. 05 (1Y)
☒	Loop Antenna	HFH2-Z2	100506	Rohde & Schwarz	2017. 06. 19 (2Y)
☒	TRILOG BROADBAND ANTENNA	VULB9162	120	SCHWARZBECK	2018. 11. 23 (2Y)
☒	RF Pre Amplifier	SCU08	100747	Rohde & Schwarz	2018. 04. 17 (1Y)
☒	DOUBLE-RIDGE WAVEGUIDE HORN ANTENNA	HF907	102556	Rohde & Schwarz	2017. 07. 05 (2Y)
☒	RF Pre Amplifier	SCU18	102342	Rohde & Schwarz	2018. 04. 17 (1Y)
☒	Horn Antenna	LB-42-10-C-KF	J202024625	AINFO Inc.	2018. 04. 20 (2Y)
☒	RF Pre Amplifier	AMF-4F-18265-35-8P-1	771846	MITEQ	2019. 03. 04 (1Y)
☐	Horn Antenna	LB-28-10-C-KF	J202024627	AINFO Inc.	2018. 04. 20 (2Y)
☐	RF Pre Amplifier	AMF-4D-260400-45-6P	779919	MITEQ	2019. 03. 04 (1Y)
☒	EMI Test Receiver	ESR26	101461	Rohde & Schwarz	2018. 04. 17 (1Y)
☒	EMI Test Receiver	ESR3	102119	Rohde & Schwarz	2018. 04. 17 (1Y)
☒	LISN	ENV216	102194	Rohde & Schwarz	2018. 04. 16 (1Y)
☒	RF Cable	MULTIFLEX_86	-	HUBER & SUHNER	-
☒	Chamber Cable	mwx221	-	Junkosha	-

※ All test equipment used is calibration on a regular basis.

5. 20 dB Bandwidth & 99 % Bandwidth

5.1 Operating environment

Temperature : 24 ℃

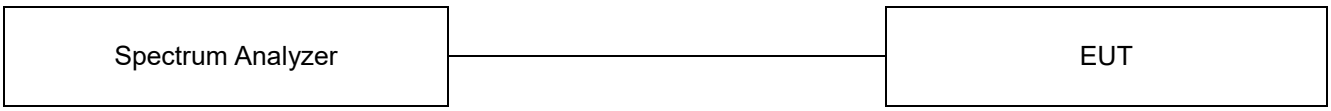
Relative humidity : 45 %

5.2 Measurement method

Standard : §15.247 (a) (2) / RSS-247 (5.1 a) & RSS-Gen(6.7)

5.3 Test setup

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 10 ㎑, and peak detection was used. The 20 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 20 dB.



5.4 Test data

Test date : 22. Mar. 2019

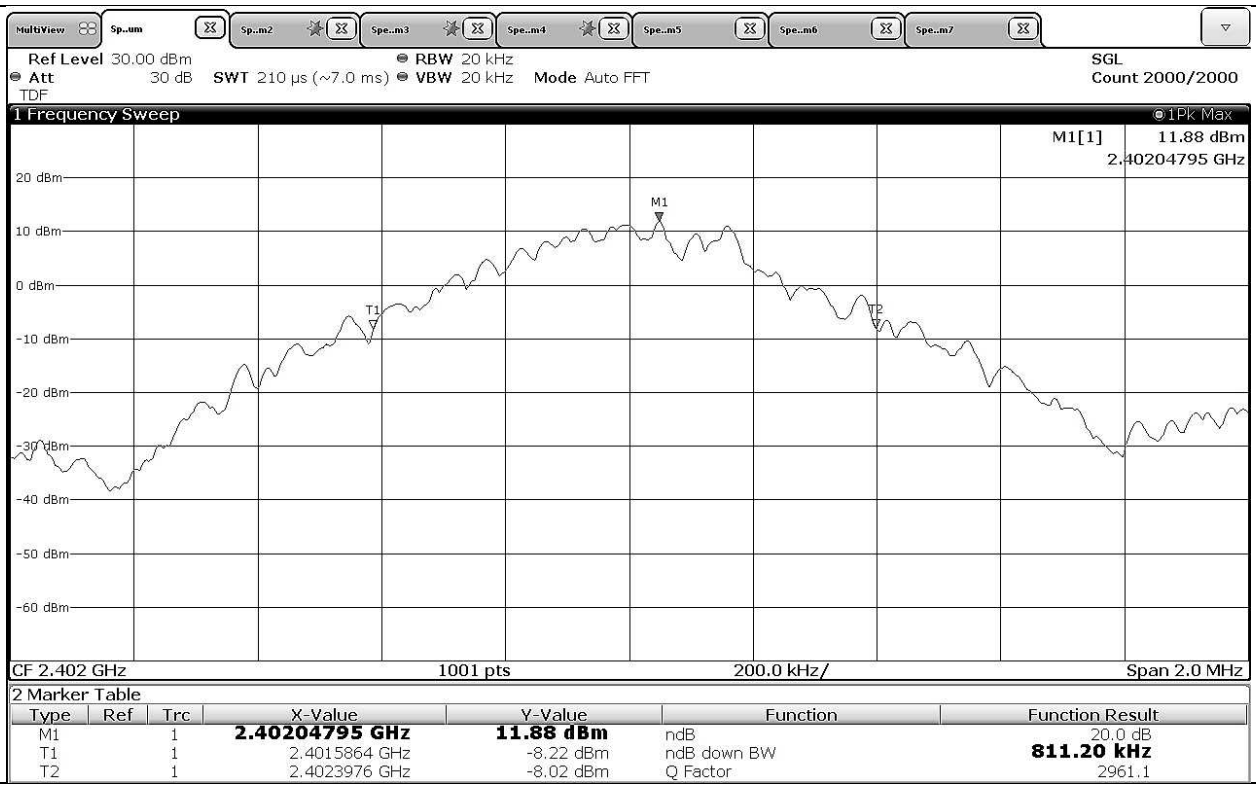
Operating mode : Transmit mode

Test Result : Pass

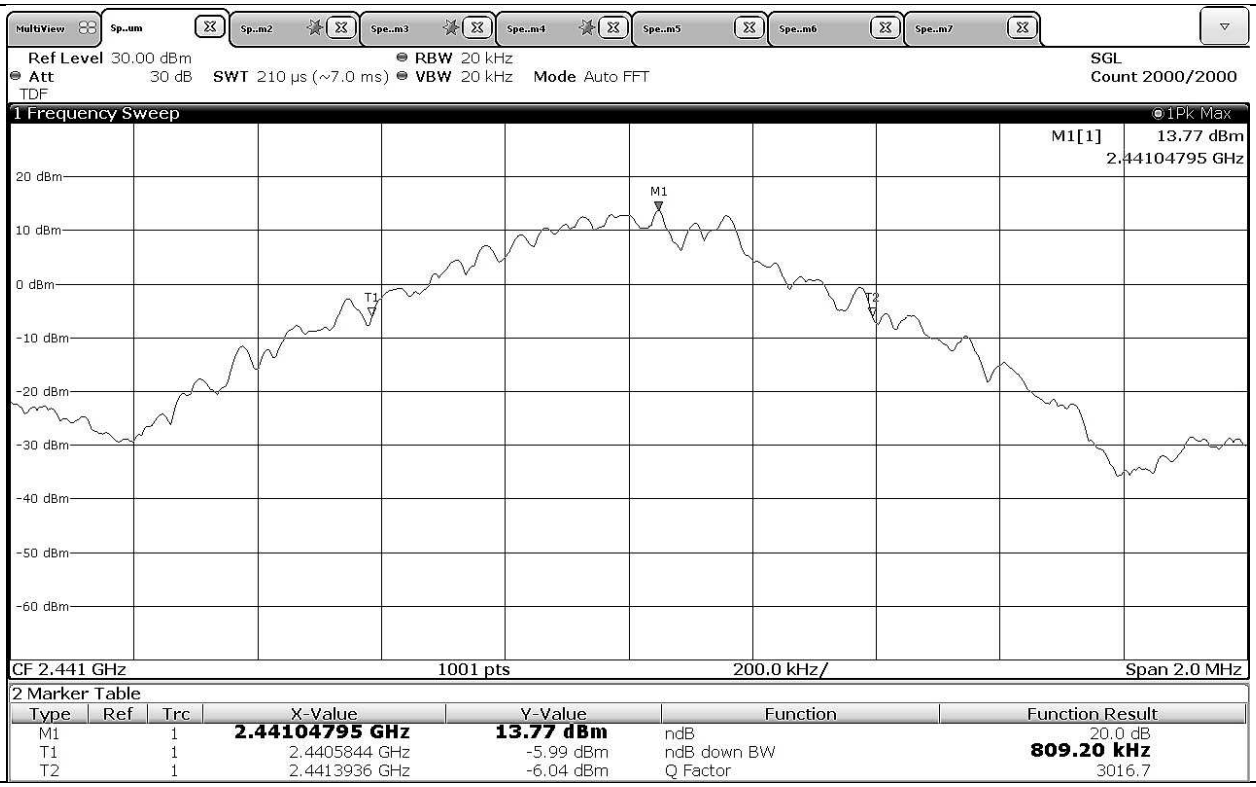
5.4.1 Measured Results

Operating Mode	Modulation Type	Channel (Frequency)	20 dB Bandwidth (kHz)	99 % Bandwidth (kHz)	Two-third 20 dB bandwidth of the hopping channel (kHz)
Transmit	BDR	0 (2 402 MHz)	811.20	860.54	540.80
		39 (2 441 MHz)	809.20	855.45	539.47
		78 (2 480 MHz)	811.20	855.92	540.80
	EDR (3 Mbps)	0 (2 402 MHz)	1 250.00	1 158.35	833.33
		39 (2 441 MHz)	1 250.00	1 159.15	833.33
		78 (2 480 MHz)	1 250.00	1 159.02	833.33

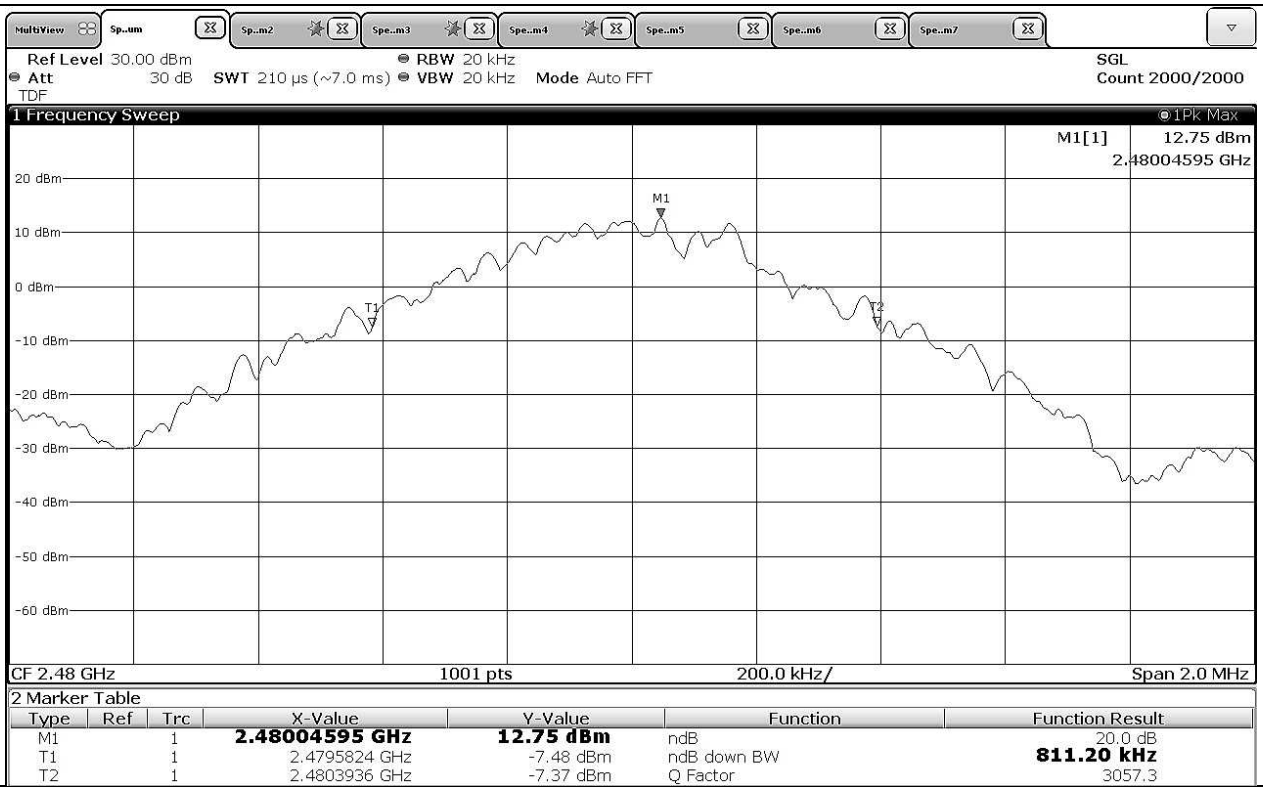
5.4.2 Measured Graph (20 dB Bandwidth)



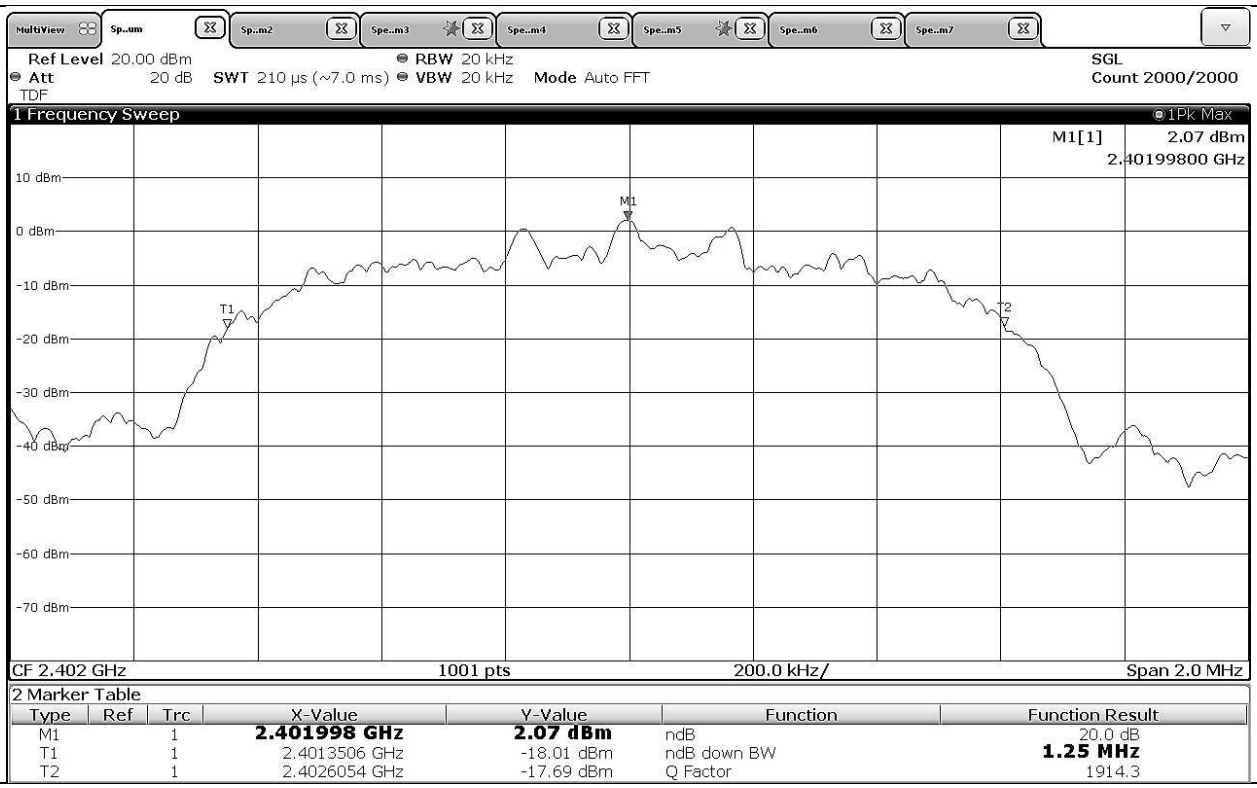
BDR_Low CH



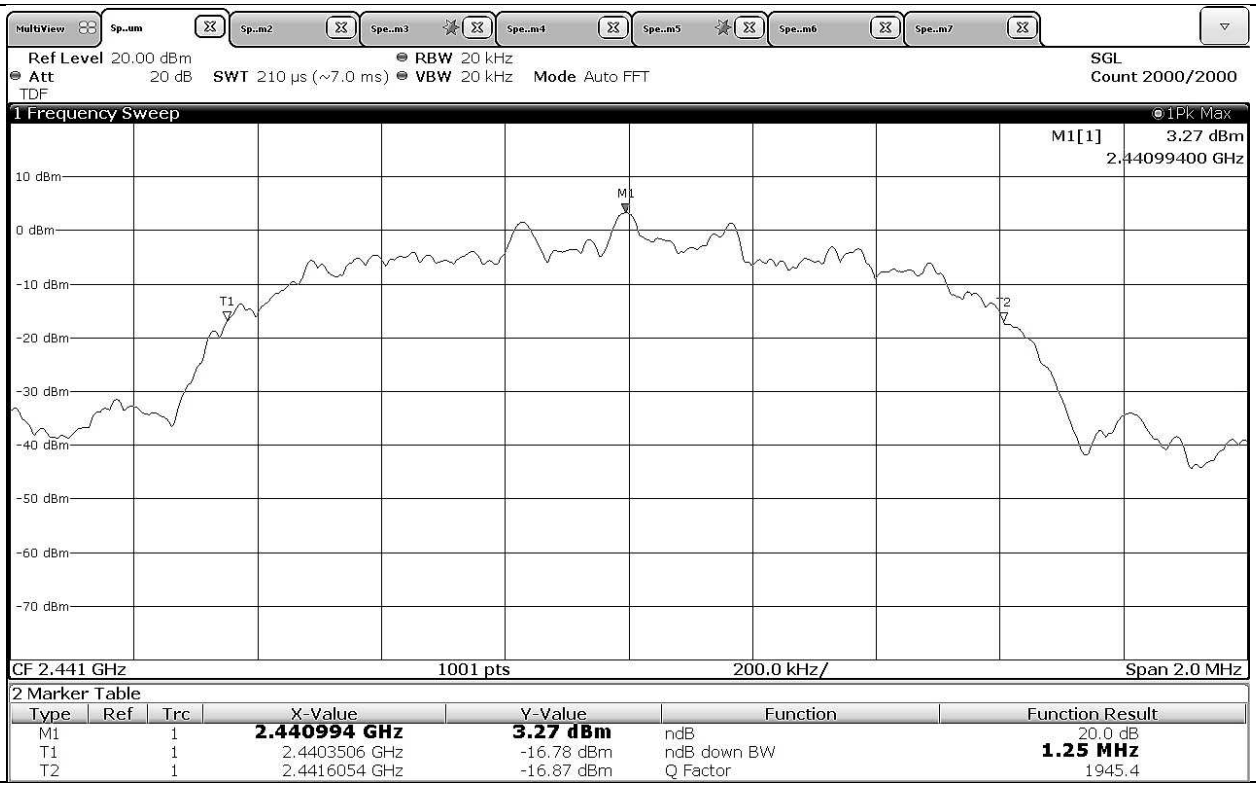
EDR_Mid CH



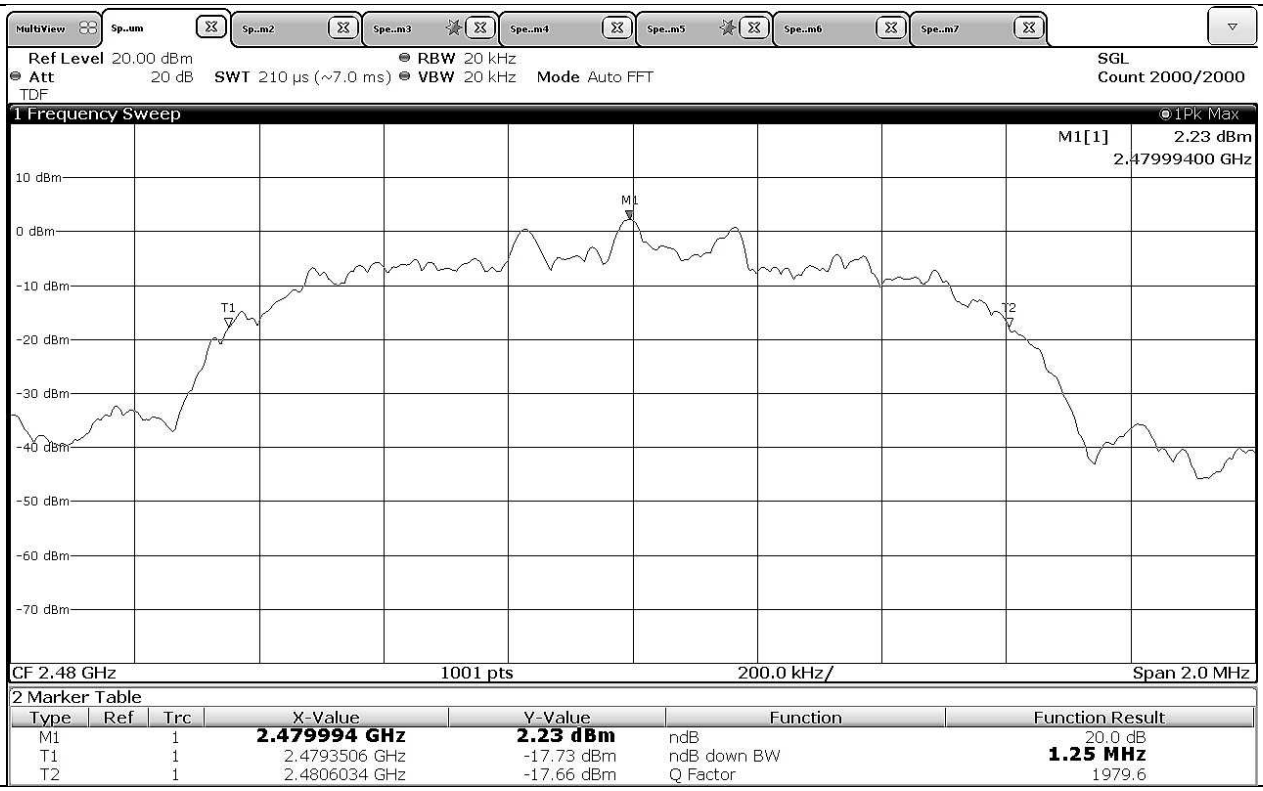
EDR_High CH


Ref Level 20.00 dBm
Att 20 dB
SWT 210 µs (~7.0 ms)
RBW 20 kHz
VBW 20 kHz
Mode Auto FFT
SGL
Count 2000/2000
1 Frequency Sweep
1Pk Max
M1[1] 2.07 dBm
2.40199800 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
T1
T2
CF 2.402 GHz
1001 pts
200.0 kHz/
Span 2.0 MHz
2 Marker Table
Type Ref Trc X-Value Y-Value Function Function Result
M1 1 2.401998 GHz 2.07 dBm ndB 20.0 dB
T1 1 2.4013506 GHz -18.01 dBm ndB down BW 1.25 MHz
T2 1 2.4026054 GHz -17.69 dBm Q Factor 1914.3

EDR_Low CH

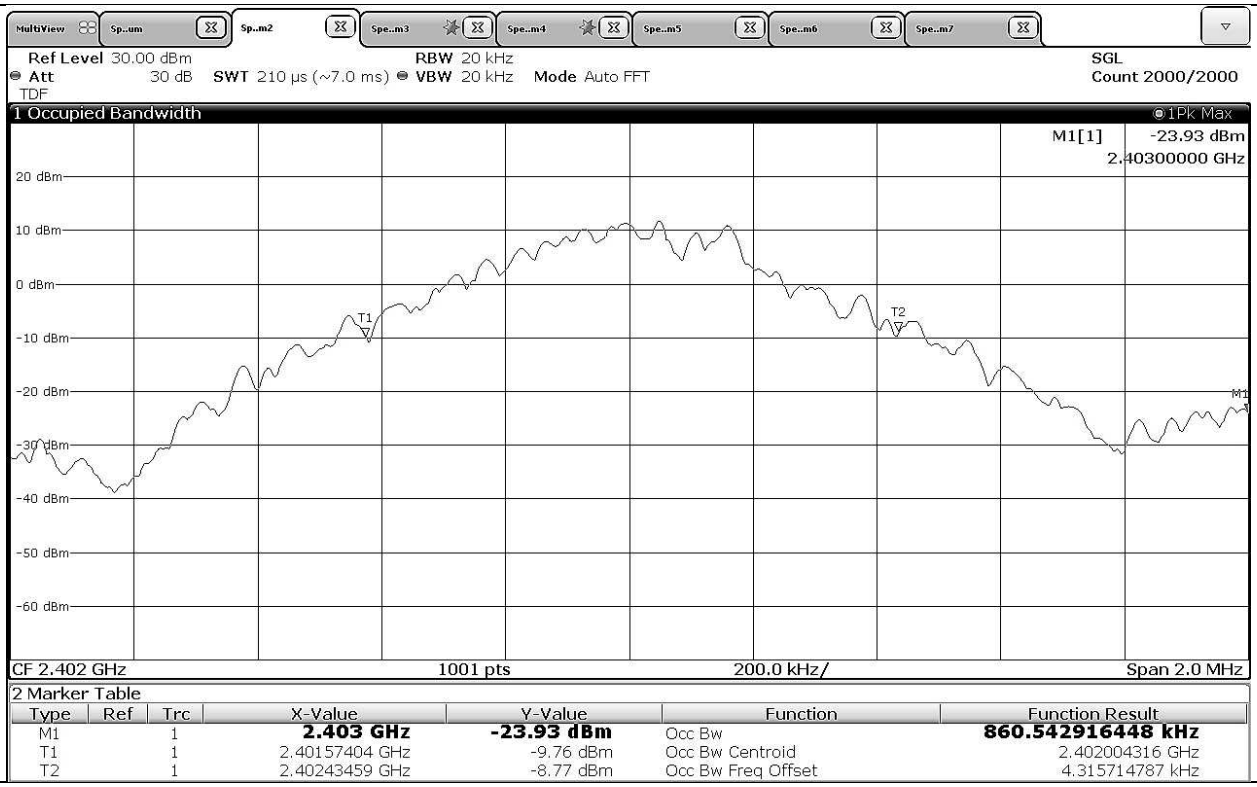


EDR_Mid CH

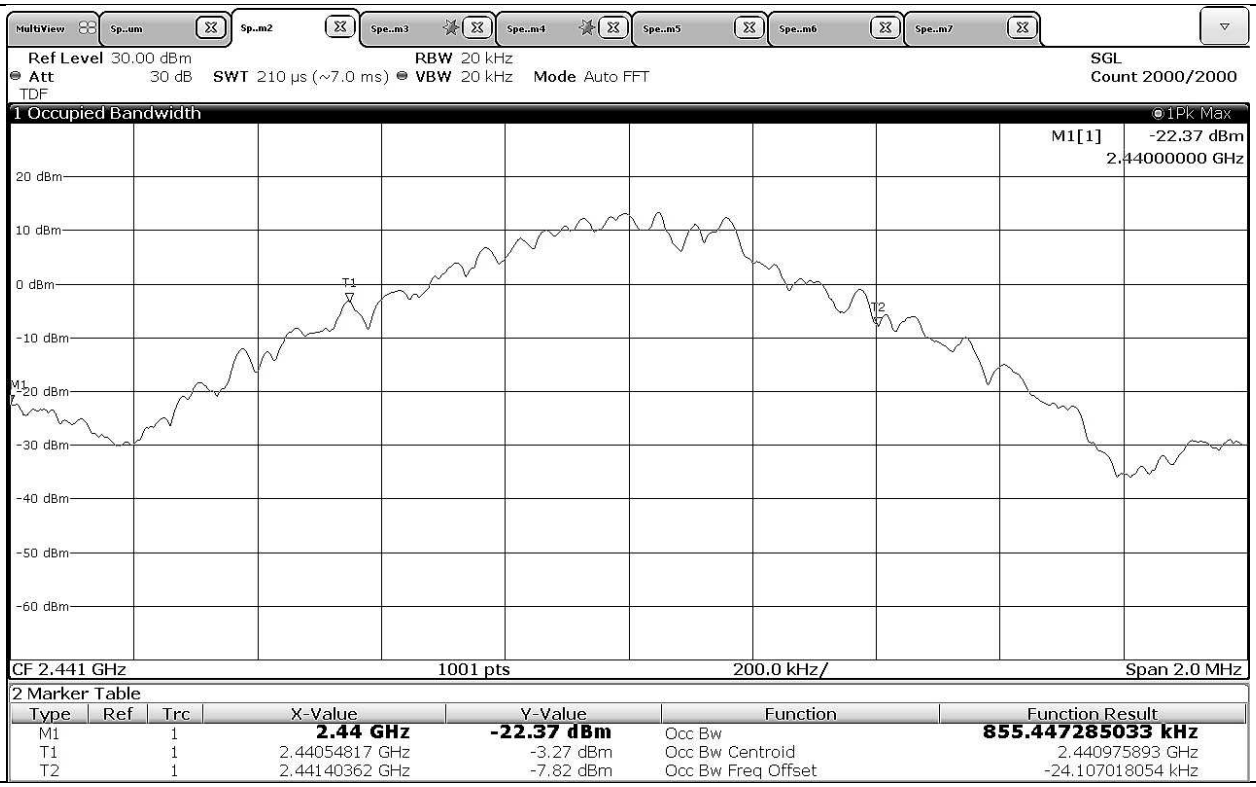


EDR_High CH

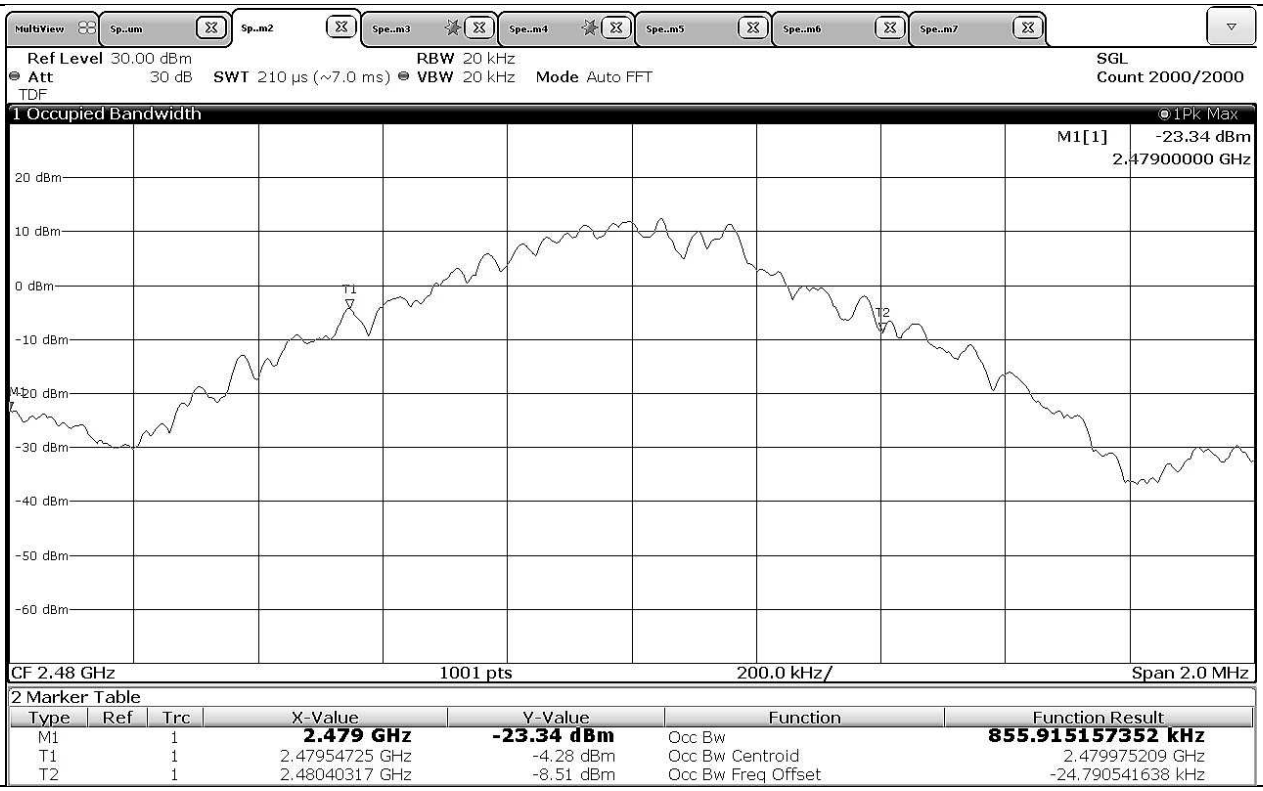
5.4.3 Measured Graph (99 % Bandwidth)



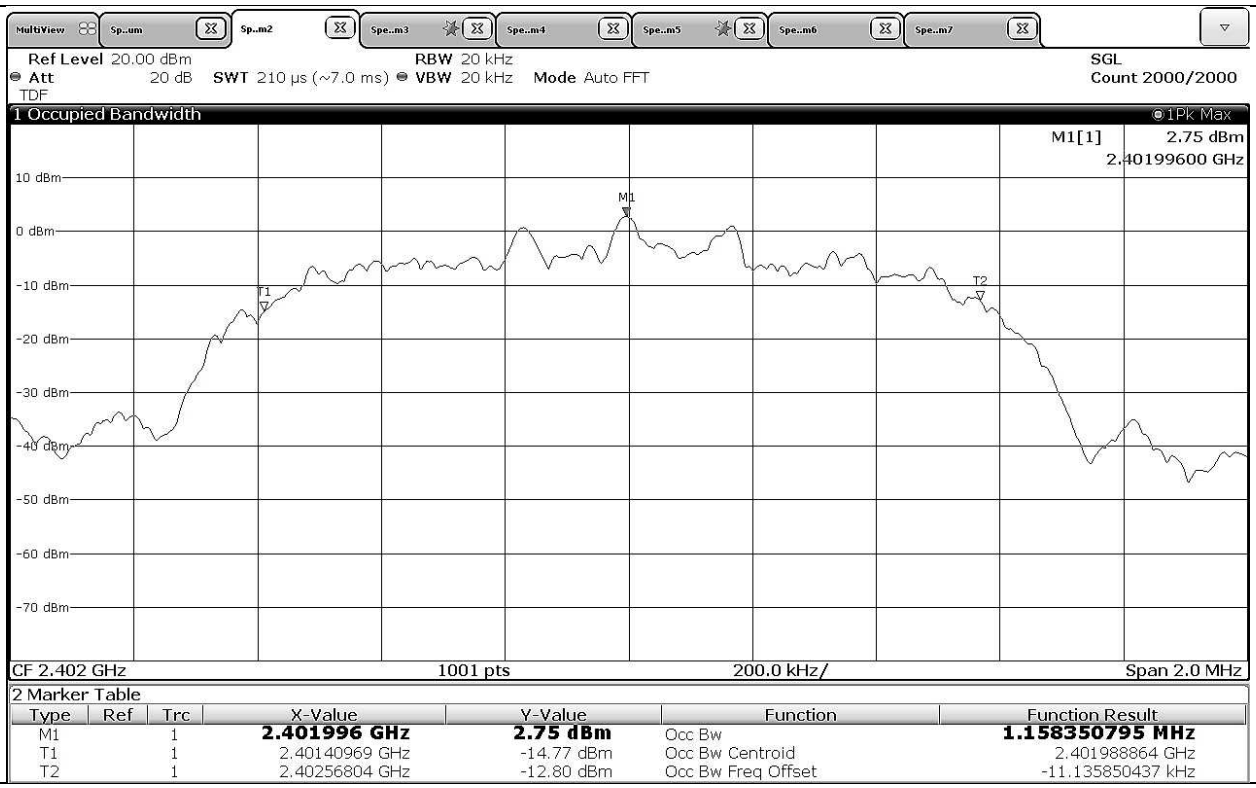
BDR_Low CH



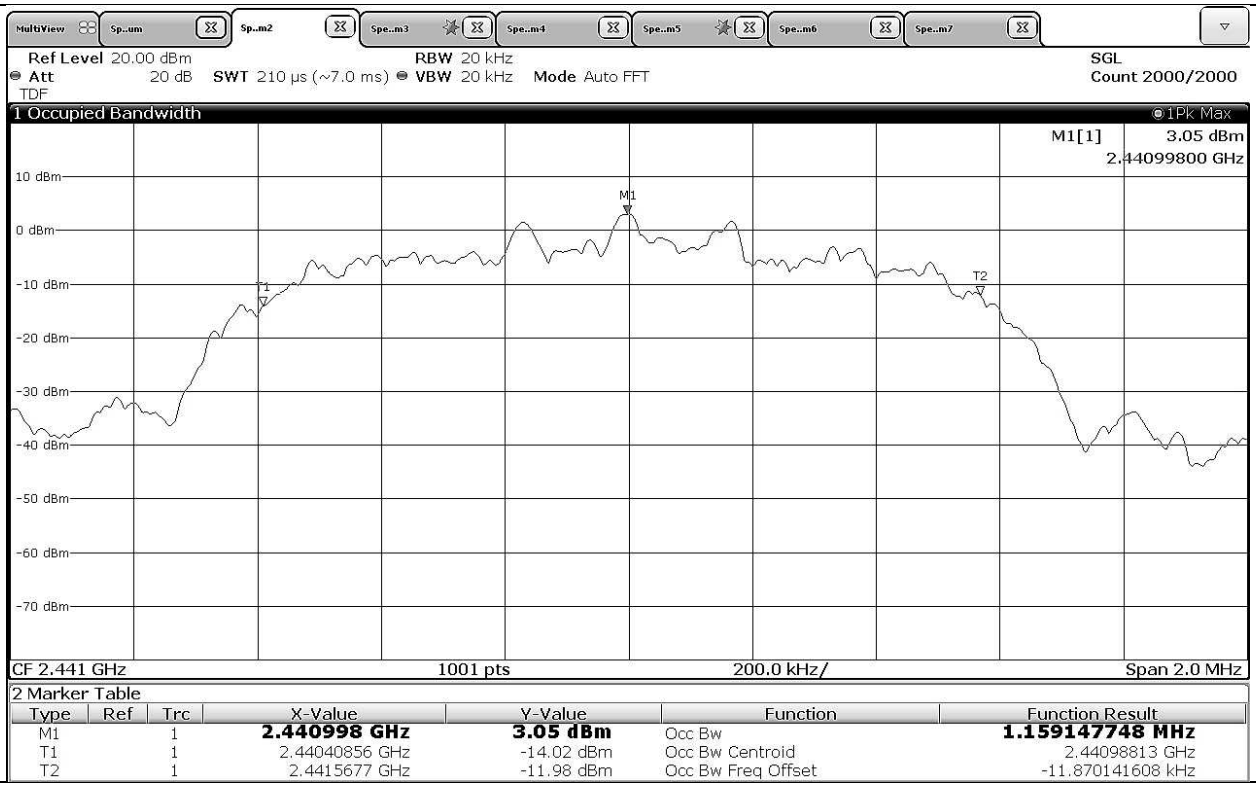
BDR_Mid CH



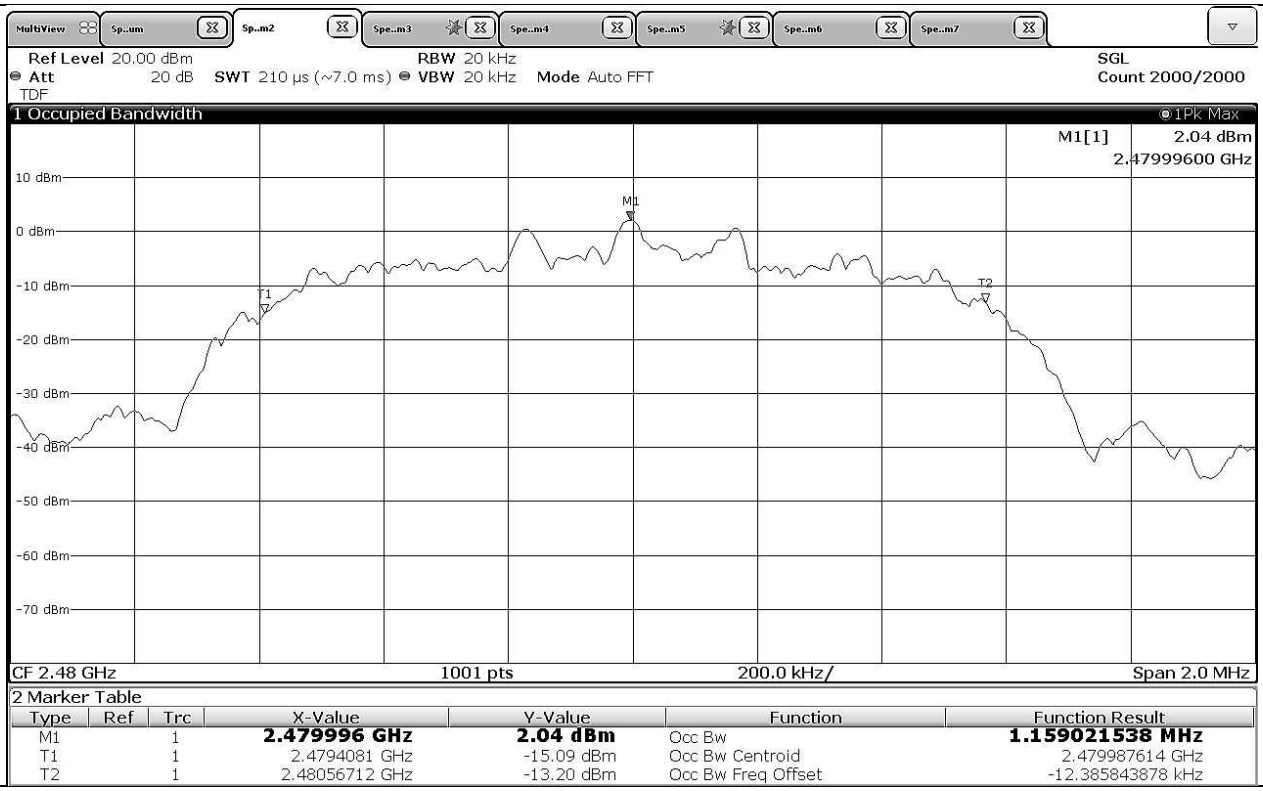
BDR_High CH


MultiView
Sp..um
Sp..m2
Spe..m3
Spe..m4
Spe..m5
Spe..m6
Spe..m7
Ref Level 20.00 dBm
RBW 20 kHz
SGL
Att 20 dB SWT 210 µs (~7.0 ms) VBW 20 kHz Mode Auto FFT
Count 2000/2000
TDF
1 Occupied Bandwidth
1Pk Max
M1[1] 2.75 dBm
2.40199600 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
T1
T2
CF 2.402 GHz
1001 pts
200.0 kHz/
Span 2.0 MHz
2 Marker Table
Type Ref Trc X-Value Y-Value Function Function Result
M1 1 2.401996 GHz 2.75 dBm Occ Bw 1.158350795 MHz
T1 1 2.40140969 GHz -14.77 dBm Occ Bw Centroid 2.401988864 GHz
T2 1 2.40256804 GHz -12.80 dBm Occ Bw Freq Offset -11.135850437 kHz

EDR_Low CH



EDR_Mid CH



EDR_High CH

6. Carrier Frequency Separation

6.1 Operating environment

Temperature : 24 ℃

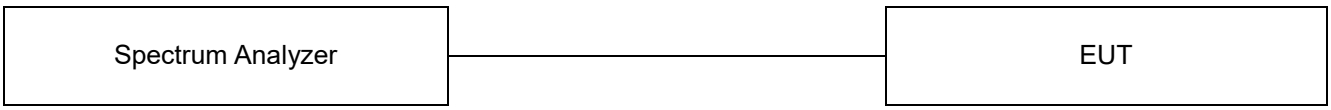
Relative humidity : 45 %

6.2 Measurement method

Standard : §15.247 (a) (1) / RSS-247 (5.1 b)

6.3 Test setup

The antenna output of the EUT was connected to the spectrum analyzer. The frequency span is set to 10 ㎒. The analyzer is set to peak hold then a pseudo-random hopping sequence of the transmitter is captured. The mark delta function was used to measure the frequency separation between two adjacent hopping channels.



6.4 Test data

Test date : 22. Mar. 2019

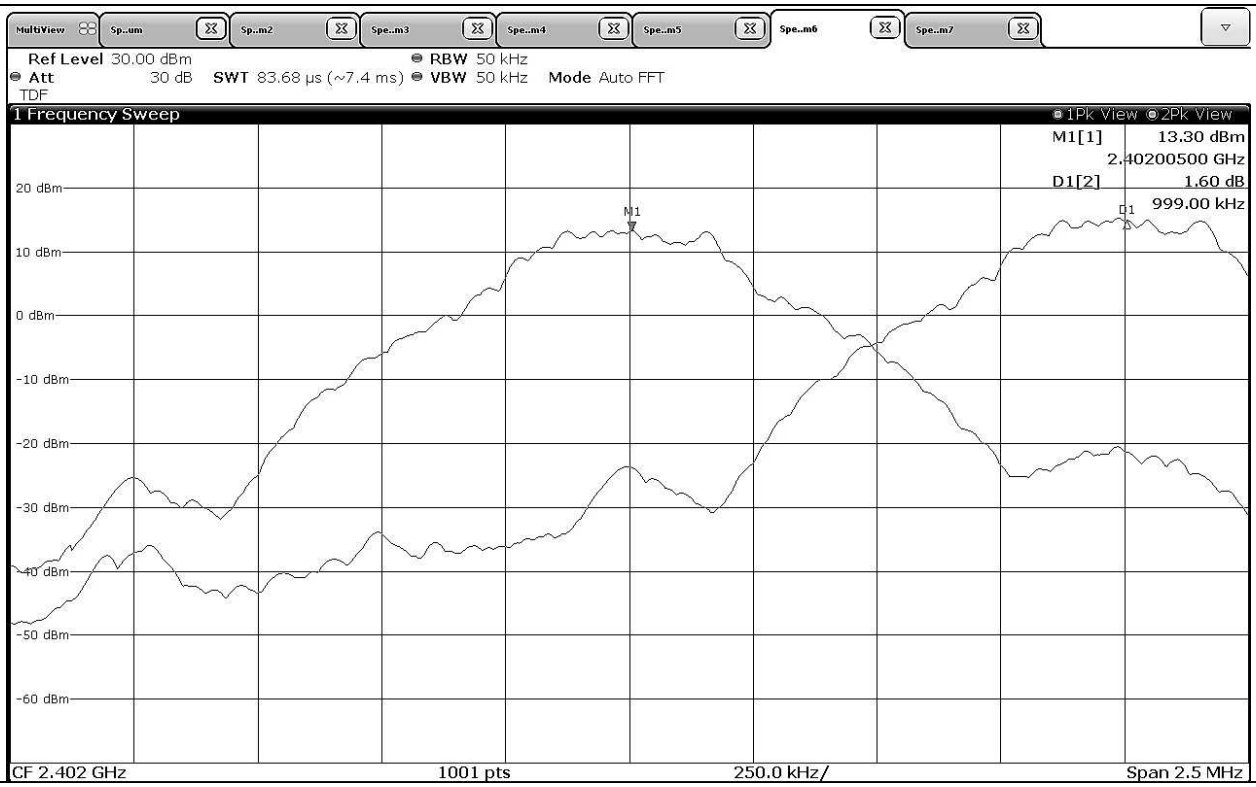
Operating mode : Transmit mode

Test Result : Pass

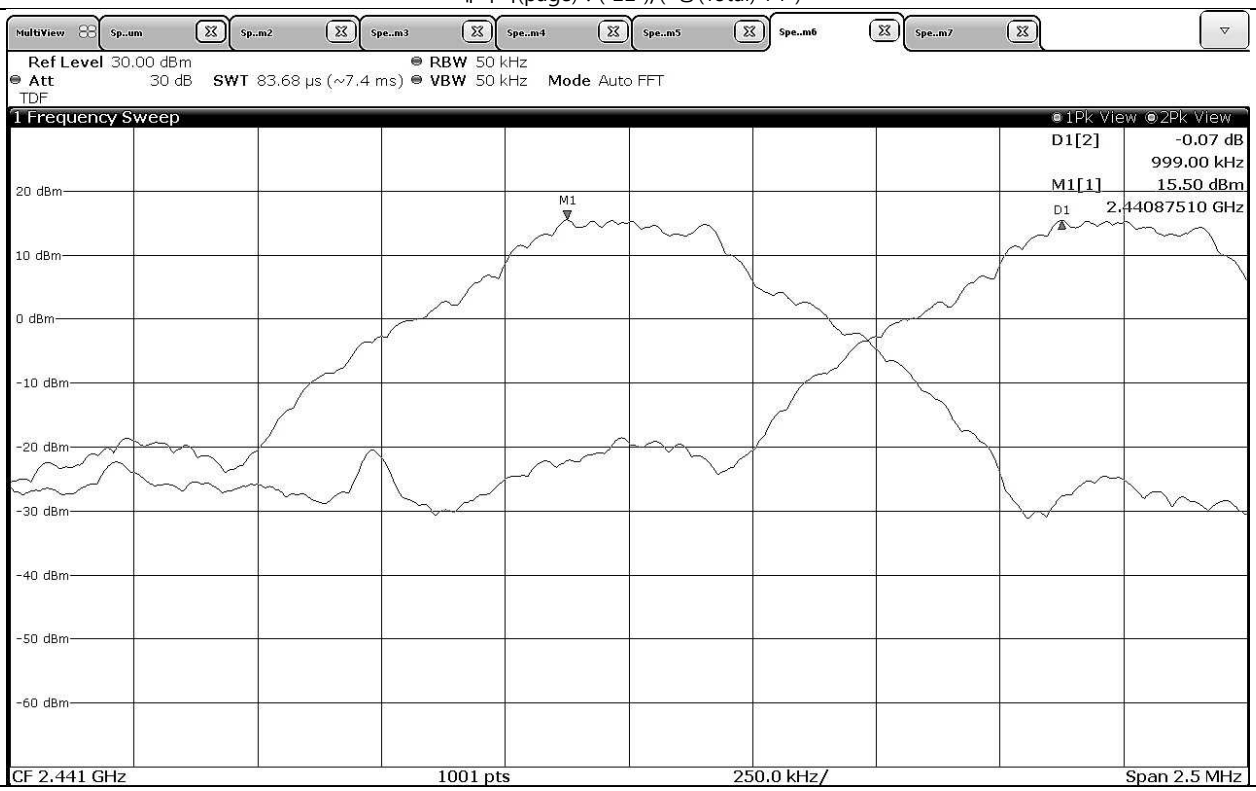
6.4.1 Measured Results

Modulation type	Channel (Frequency)	Separation (㎑)	Two-third 20 dB bandwidth of the hopping channel (㎑)	Limit
BDR (1 Mbps)	0 (2 402 ㎒)	999.00	540.80	25 ㎑ or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater
	39 (2 441 ㎒)	999.00	539.47	
	78 (2 480 ㎒)	999.00	540.80	
EDR (3 Mbps)	0 (2 402 ㎒)	999.00	833.33	
	39 (2 441 ㎒)	999.00	833.33	
	78 (2 480 ㎒)	999.00	833.33	

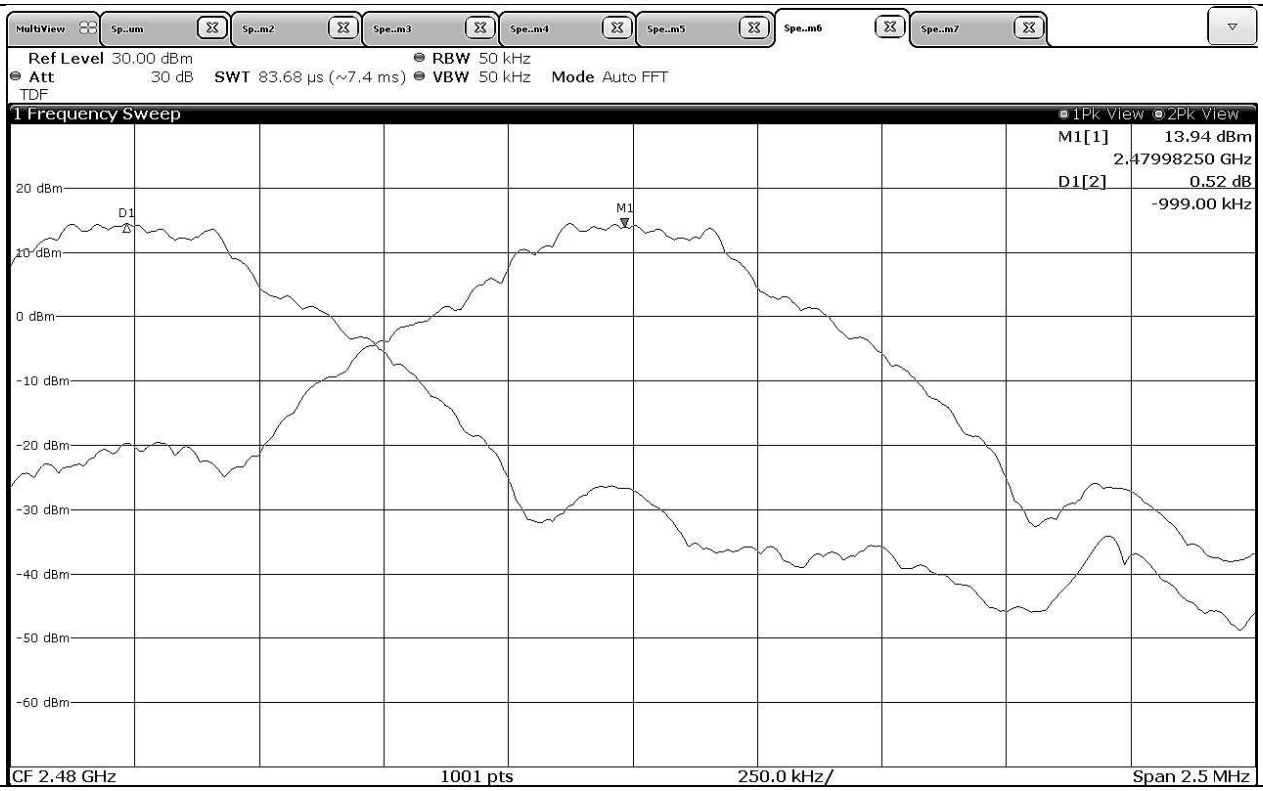
6.4.2 Measured Graph



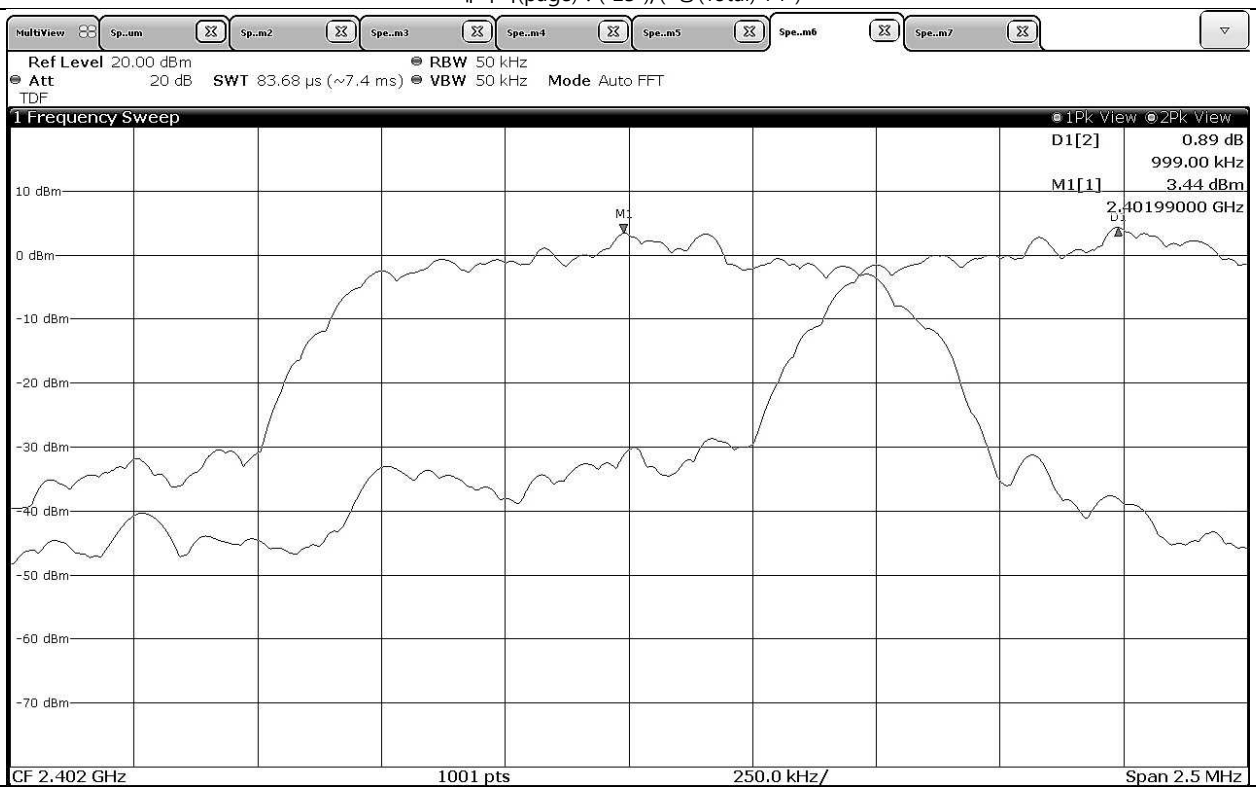
BDR_Low CH



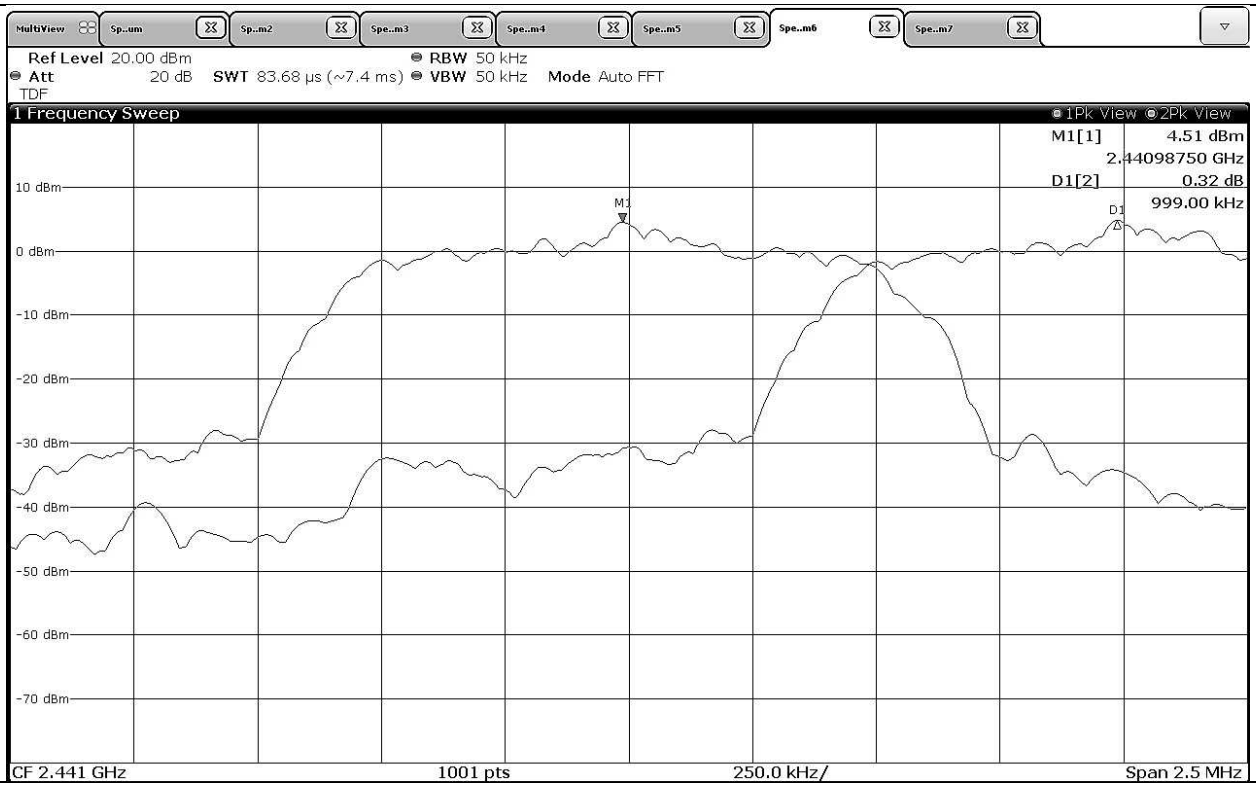
BDR_Mid CH



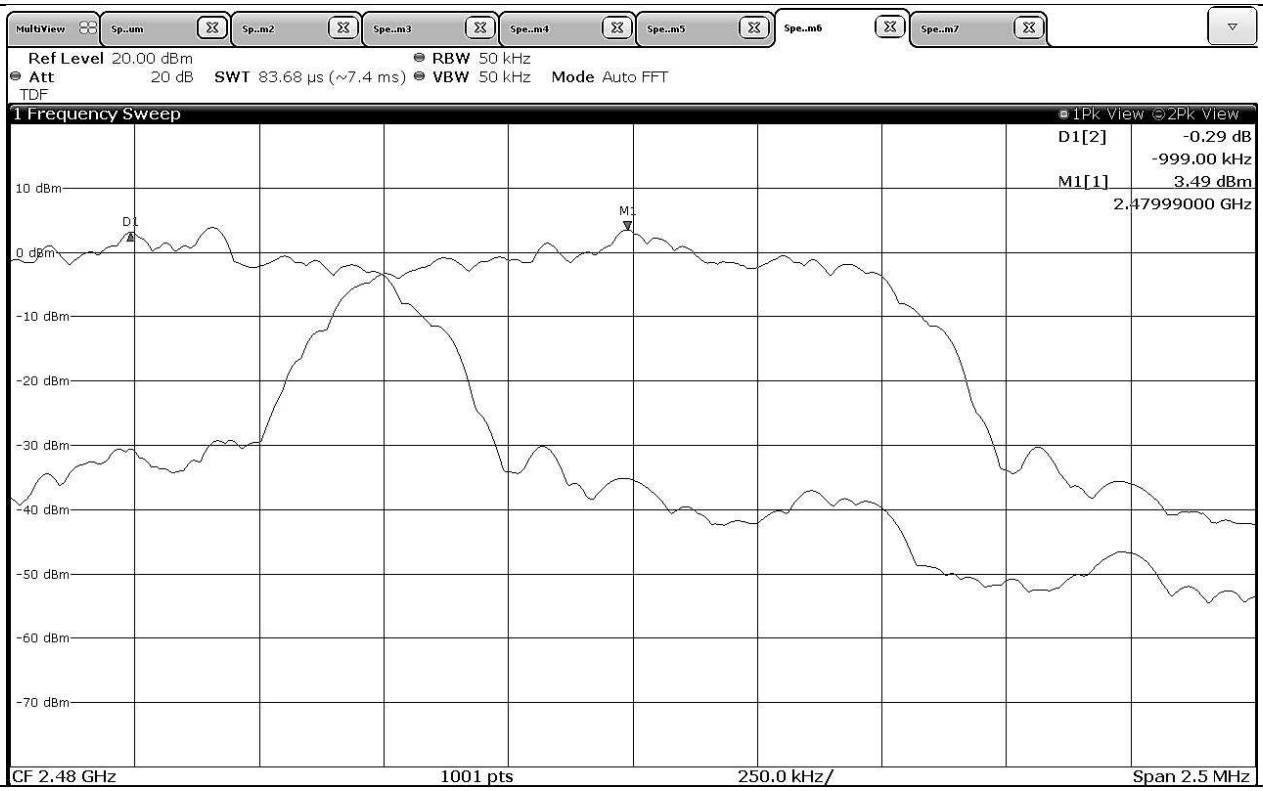
BDR_High CH


MultiView
Sp..um
Sp..m2
Spe..m3
Spe..m4
Spe..m5
Spe..m6
Spe..m7
Ref Level 20.00 dBm
RBW 50 kHz
Att 20 dB SWT 83.68 µs (~7.4 ms) VBW 50 kHz Mode Auto FFT
TDF
1 Frequency Sweep
1Pk View 2Pk View
D1[2] 0.89 dB
999.00 kHz
M1[1] 3.44 dBm
2.40199000 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
CF 2.402 GHz
1001 pts
250.0 kHz/
Span 2.5 MHz

EDR_Low CH



EDR_Mid CH



EDR_High CH

7. Number of Hopping Frequency

7.1 Operating environment

Temperature : 24 ℃

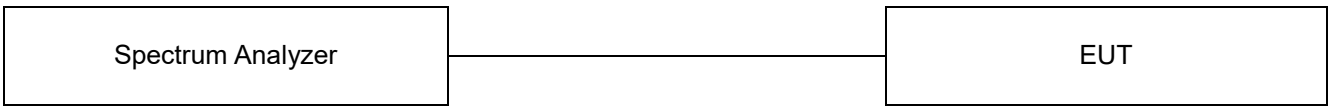
Relative humidity : 45 %

7.2 Measurement method

Standard : §15.247 (a) (1) (iii) / RSS-247 (5.1 d)

7.3 Test setup

The antenna output of the EUT was connected to the spectrum analyzer. The frequency span is set to 83.5 ㎒ and the resolution bandwidth is set to 100 ㎑. The analyzer is set to peak hold and then complete pseudo-random hopping sequence of the transmitter is captured.



7.4 Test data

Test date : 22. Mar. 2019

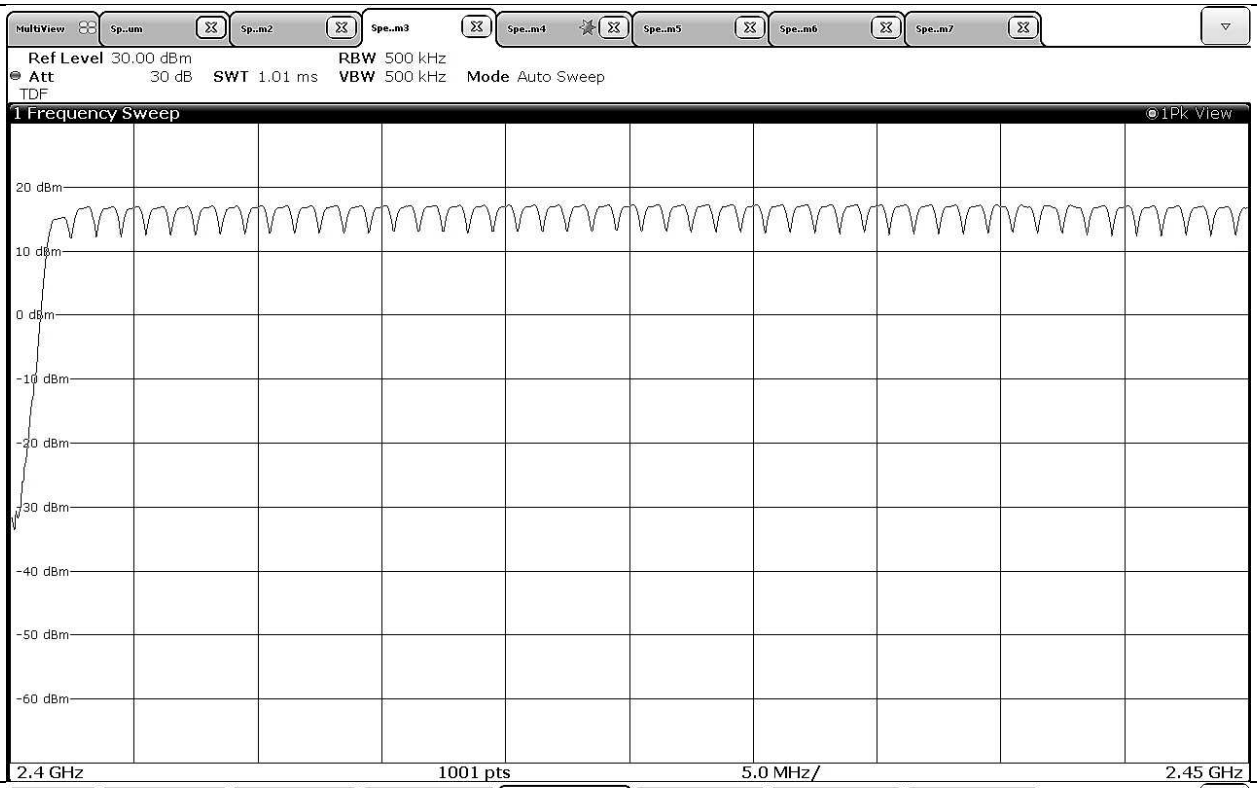
Operating mode : Hopping mode

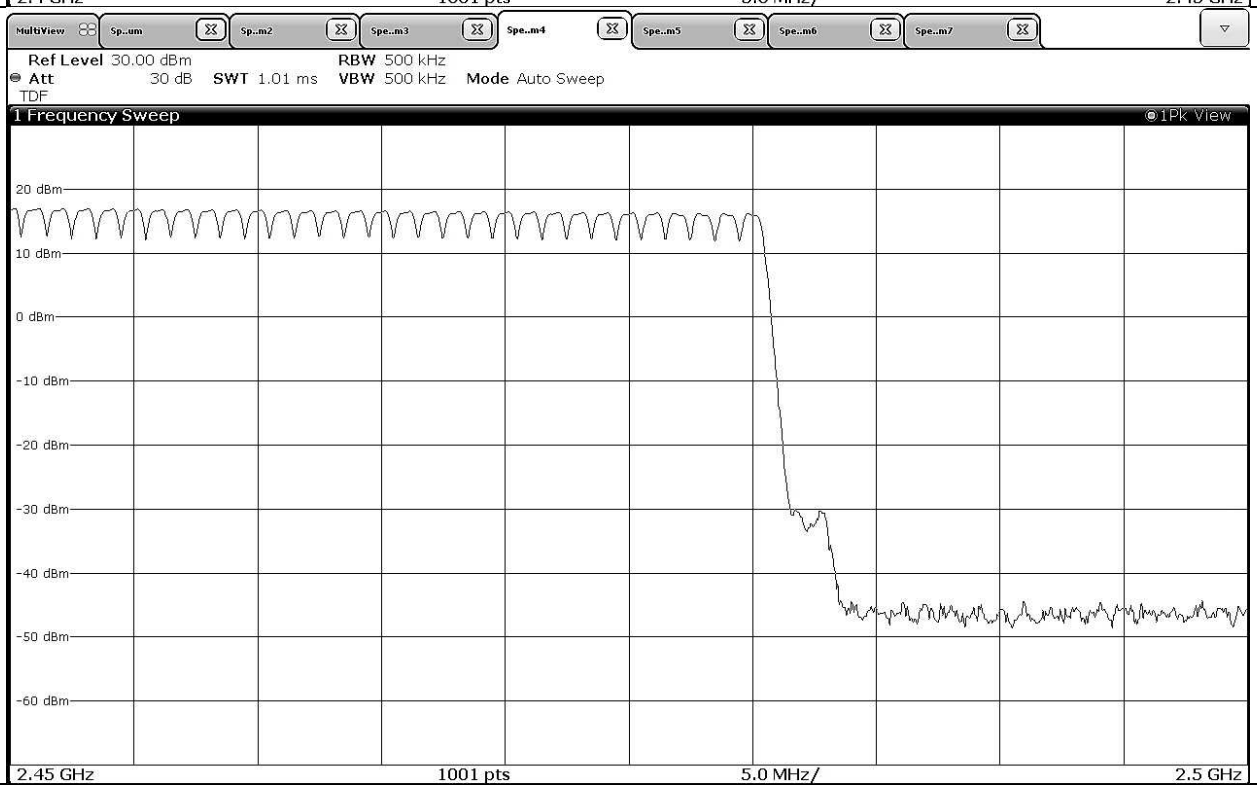
Test Result : Pass

7.4.1 Measured Results

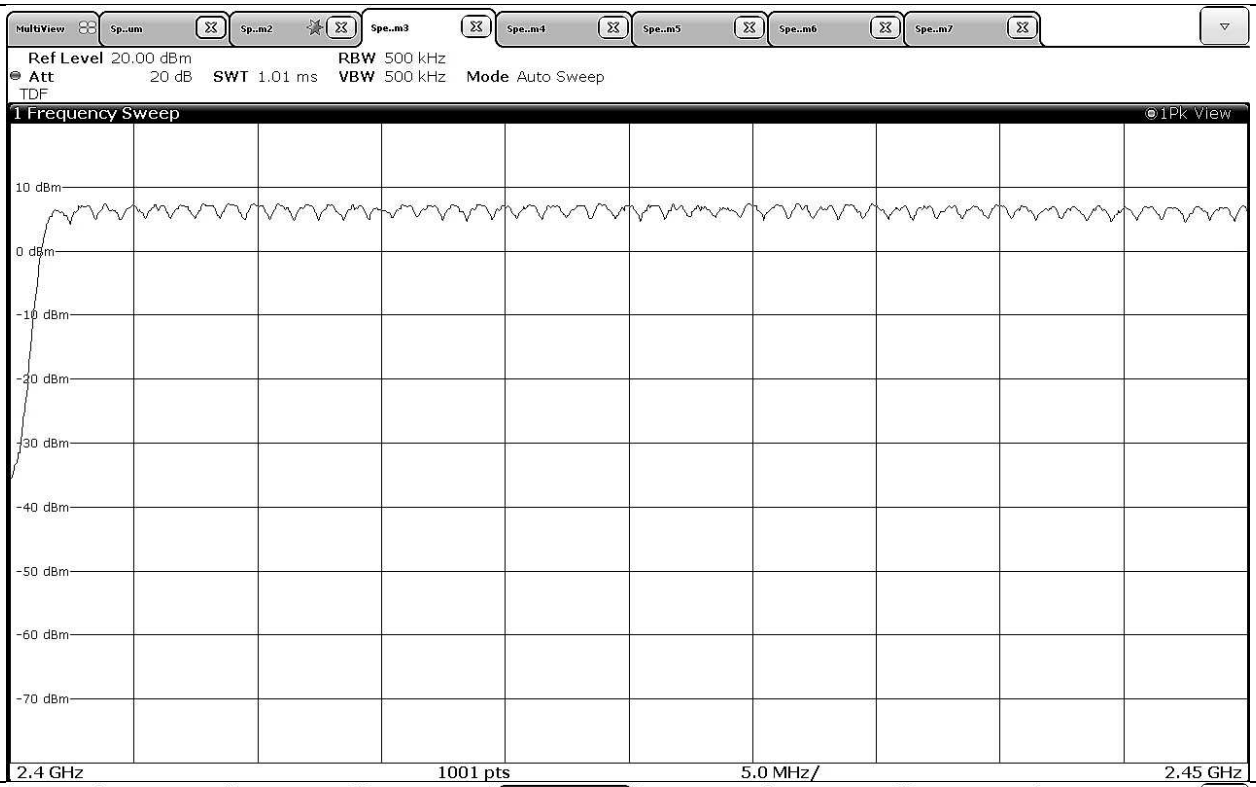
Modulation type	Hopping Channel Number	Limit
BDR	79	> 15
EDR (3 Mbps)	79	

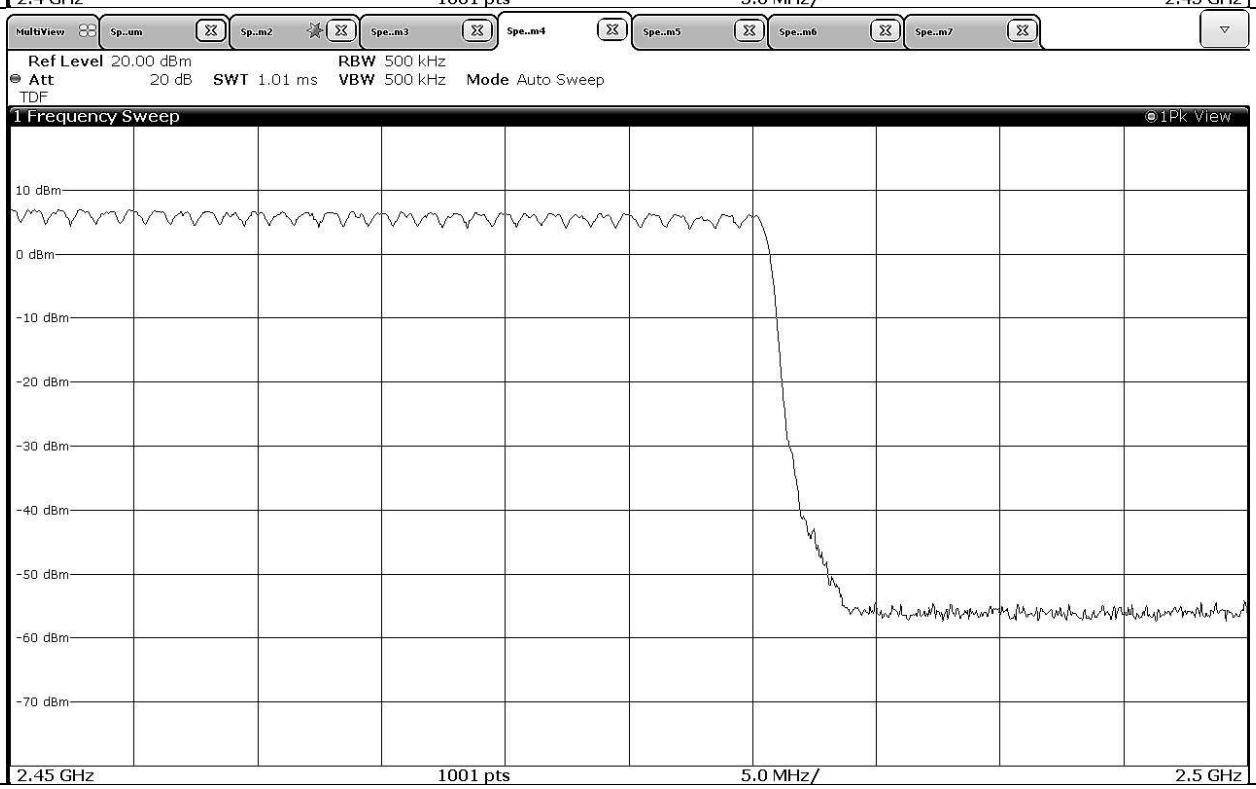
7.4.2 Measured Graph





BDR


MultiView
Sp..um
Sp..m2
Spe..m3
Spe..m4
Spe..m5
Spe..m6
Spe..m7
Ref Level 20.00 dBm
RBW 500 kHz
Att 20 dB SWT 1.01 ms VBW 500 kHz Mode Auto Sweep
TDF
1 Frequency Sweep
1Pk View
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
2.4 GHz
1001 pts
5.0 MHz/
2.45 GHz


MultiView
Sp..um
Sp..m2
Spe..m3
Spe..m4
Spe..m5
Spe..m6
Spe..m7
Ref Level 20.00 dBm
RBW 500 kHz
Att 20 dB SWT 1.01 ms VBW 500 kHz Mode Auto Sweep
TDF
1 Frequency Sweep
1Pk View
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
2.45 GHz
1001 pts
5.0 MHz/
2.5 GHz

EDR

8. Average Time of Occupancy

8.1 Operating environment

Temperature : 24 ℃

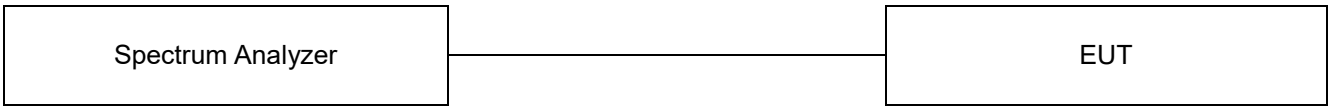
Relative humidity : 45 %

8.2 Measurement method

Standard : §15.247 (a) (1) (iii) / RSS-247 (5.1 d)

8.3 Test setup

The antenna output of the EUT was connected to the spectrum analyzer. The transmitter is set to operate in its normal frequency hopping mode. The center frequency of the spectrum analyzer is set to one of hopping channels near the center of the operating band and span is set to zero Hz. The sweep time is set to display one complete pulse. The mark delta function is used to measure the duration of the pulses.



8.4 Test data

Test date : 22. Mar. 2019

Test Result : Pass

In Theory,

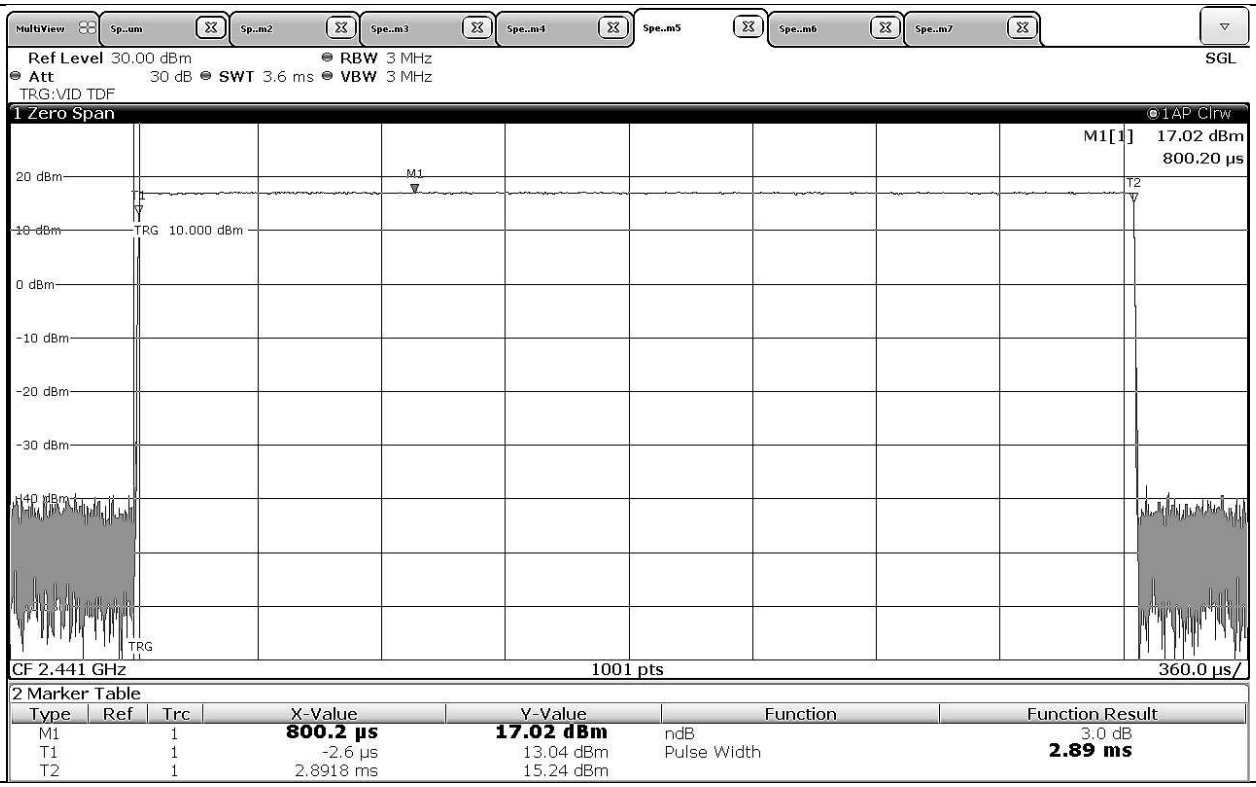
- non-AFH mode: hopping rate is 1 600 hops/s with 6 slots in 79 hopping channels. With channel hopping rate (1600 / 6 / 79) in Occupancy Time Limit (0.4 x 79) (s).
  Hops Over Occupancy Time comes to (1 600 / 6 / 79) x (0.4 x 79) = 106.67 hops.
- AFH mode: hopping rate is 800 hops/s with 6 slots in 20 hopping channels. With channel hopping rate (800 / 6 / 20) in Occupancy Time Limit (0.4 x 20) (s).
  Hops Over Occupancy Time comes to (800 / 6 / 20) x (0.4 x 20) = 53.33 hops

8.4.1 Measured Results

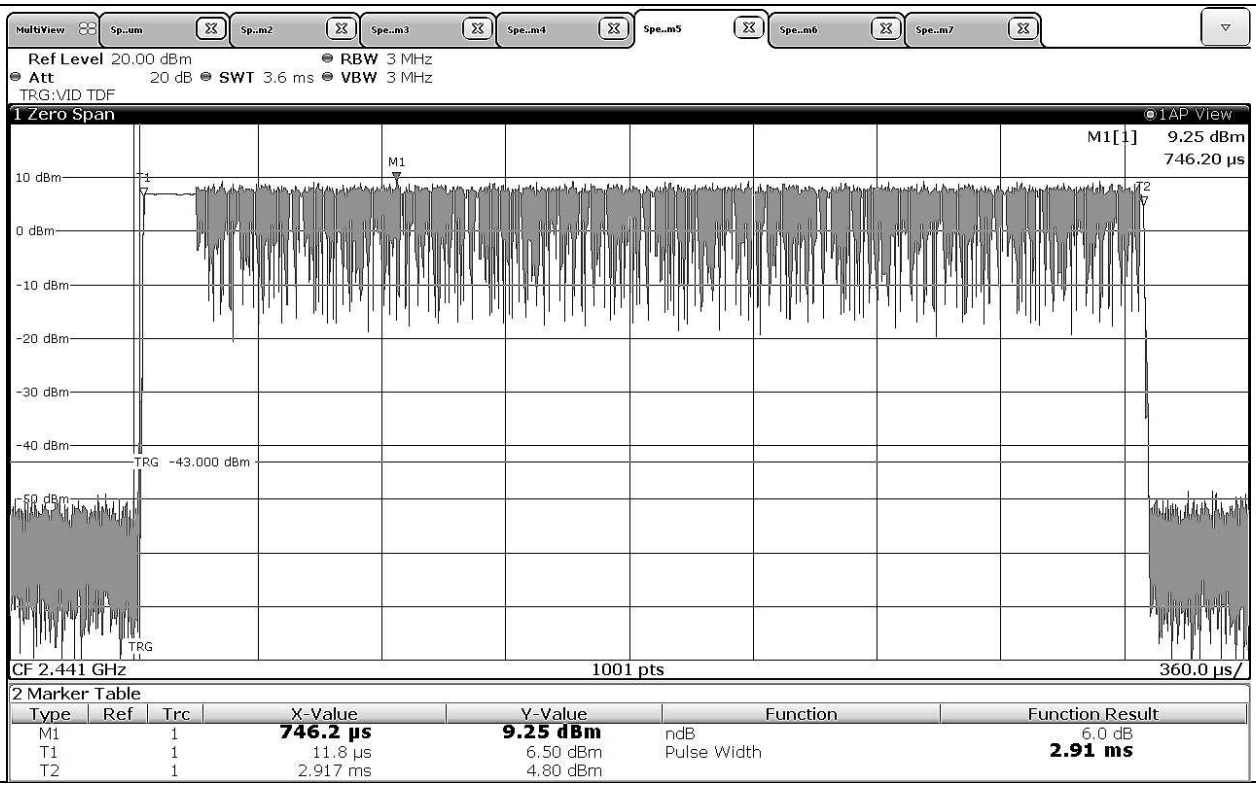
Operating Mode	Mode	Hopping Channel Number	Hops Over Occupancy Time (㎳/hops)	Package Transfer Time (㎳)	Occupancy Time (s)	Limit (s)
Hopping	DH5(non-AFH)	79	106.67	2.89	0.31	0.4
	DH5(AFH)	20	53.33	2.89	0.15	
	3-DH5(non-AFH)	79	106.67	2.91	0.31	
	3-DH5(AFH)	20	53.33	2.91	0.16	

※ Occupancy Time (s) = Hops Over Occupancy Time (hops) x Package Transfer Time (㎳)

8.4.2 Measured Graph



BDR



EDR

9. Maximum Conducted Output Power & e.i.r.p.

9.1 Operating environment

Temperature : 24 ℃

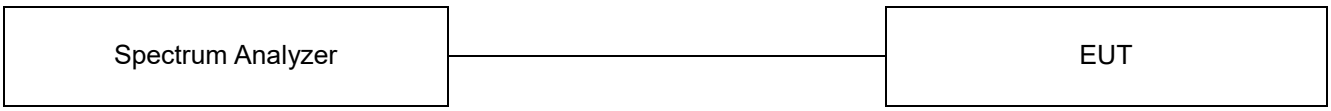
Relative humidity : 45 %

9.2 Measurement method

Standard : §15.247 (b) (1) / RSS-247 (5.4 b)

9.3 Test setup

The maximum peak output power was measured with the spectrum analyzer connected to the antenna output of the EUT. The EUT was operating in transmit mode at the appropriate center frequency.
And e.i.r.p. is added antenna maximum gain with the Maximum Conducted Output Power.



9.4 Test data

Test date : 22. Mar. 2019

Operating mode : Transmit mode

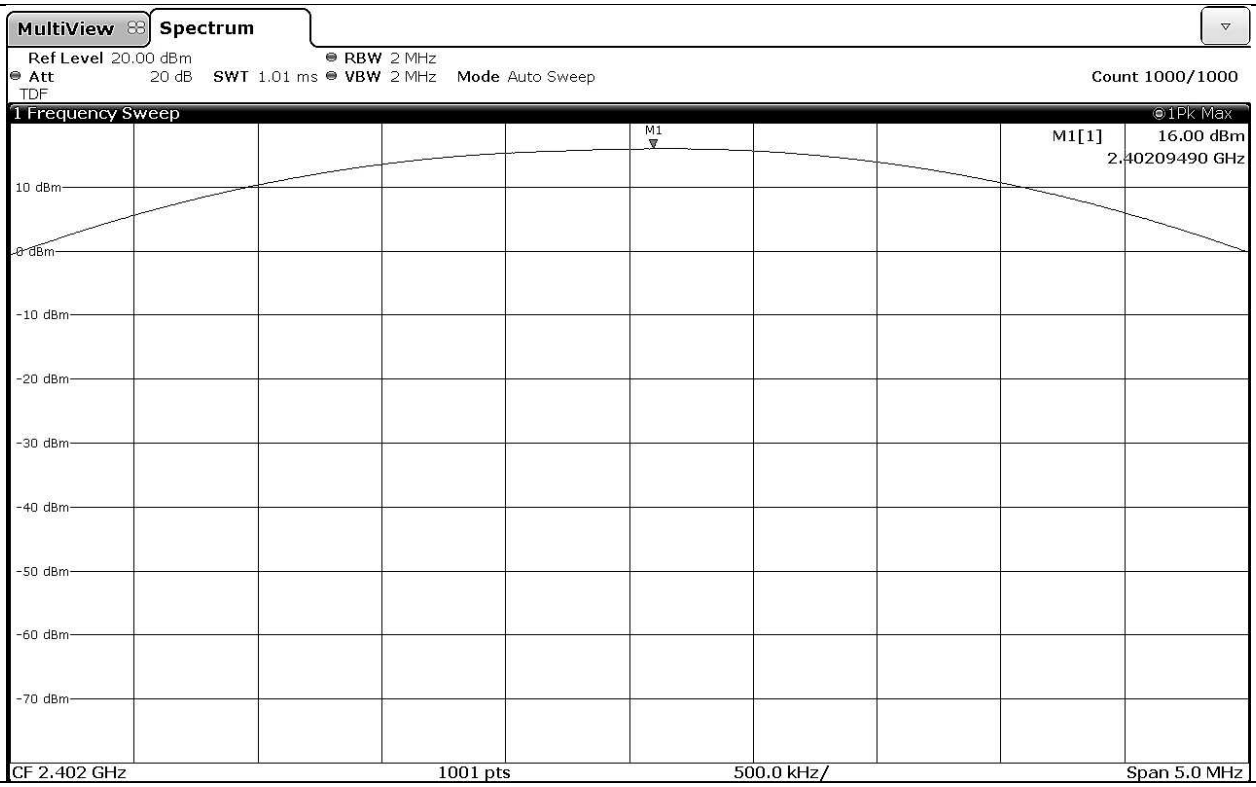
Test Result : Pass

9.4.1 Measured Results

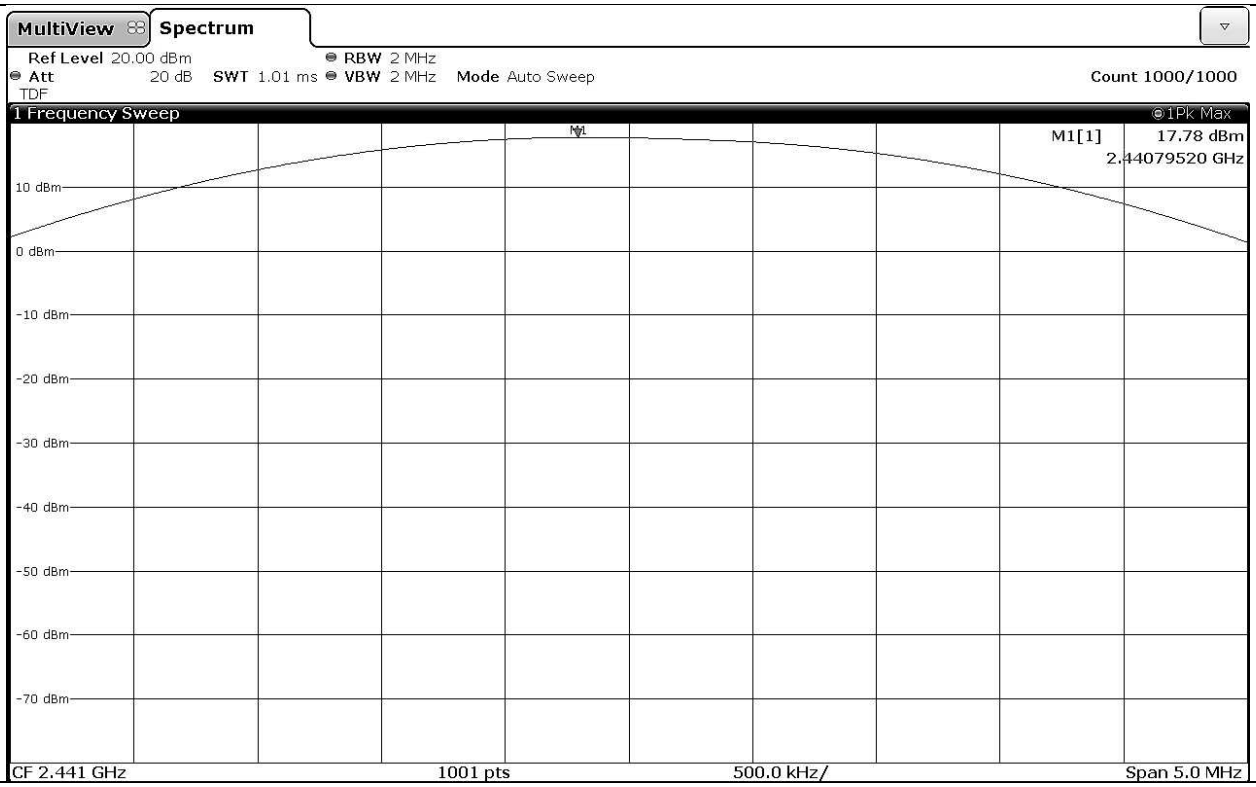
Modulation Type	Channel (Frequency)	Maximum Conducted Output Power		e.i.r.p.	
		Measured value (dBm)	Limit	Measured value (dBm)	Limit
BDR (1 Mbps)	0 (2 402 ㎒)	16.00	21 dBm (0.125 Watt)	16.55	36 (dBm) (4 Watt)
	39 (2 441 ㎒)	***17.78***		***18.33***	
	78 (2 480 ㎒)	16.87		17.42	
EDR (2 Mbps)	0 (2 402 ㎒)	8.25		8.80	
	39 (2 441 ㎒)	9.15		9.70	
	78 (2 480 ㎒)	8.24		8.79	
EDR (3 Mbps)	0 (2 402 ㎒)	8.87		9.42	
	39 (2 441 ㎒)	9.81		10.36	
	78 (2 480 ㎒)	8.85		9.40	

※ Antenna Gain : 0.55 dBi

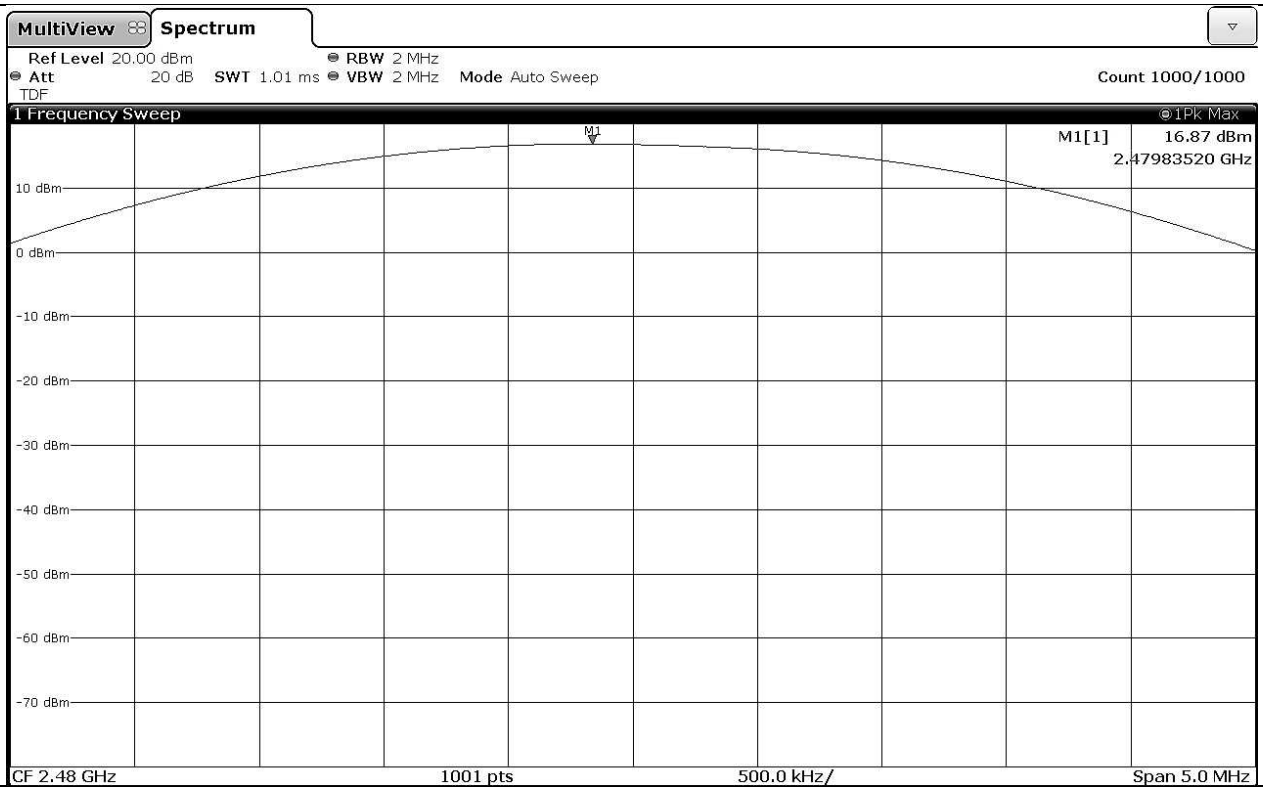
9.4.2 Measured Graph



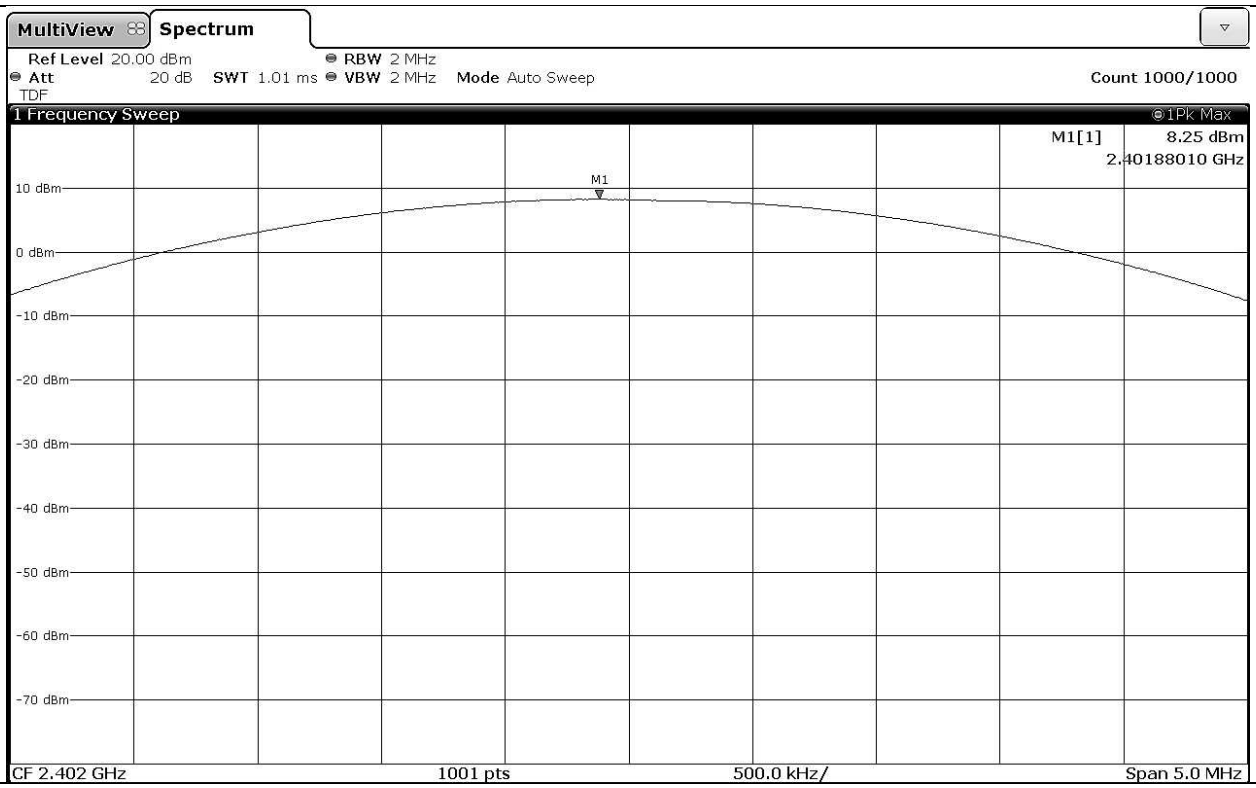
BDR_Low CH



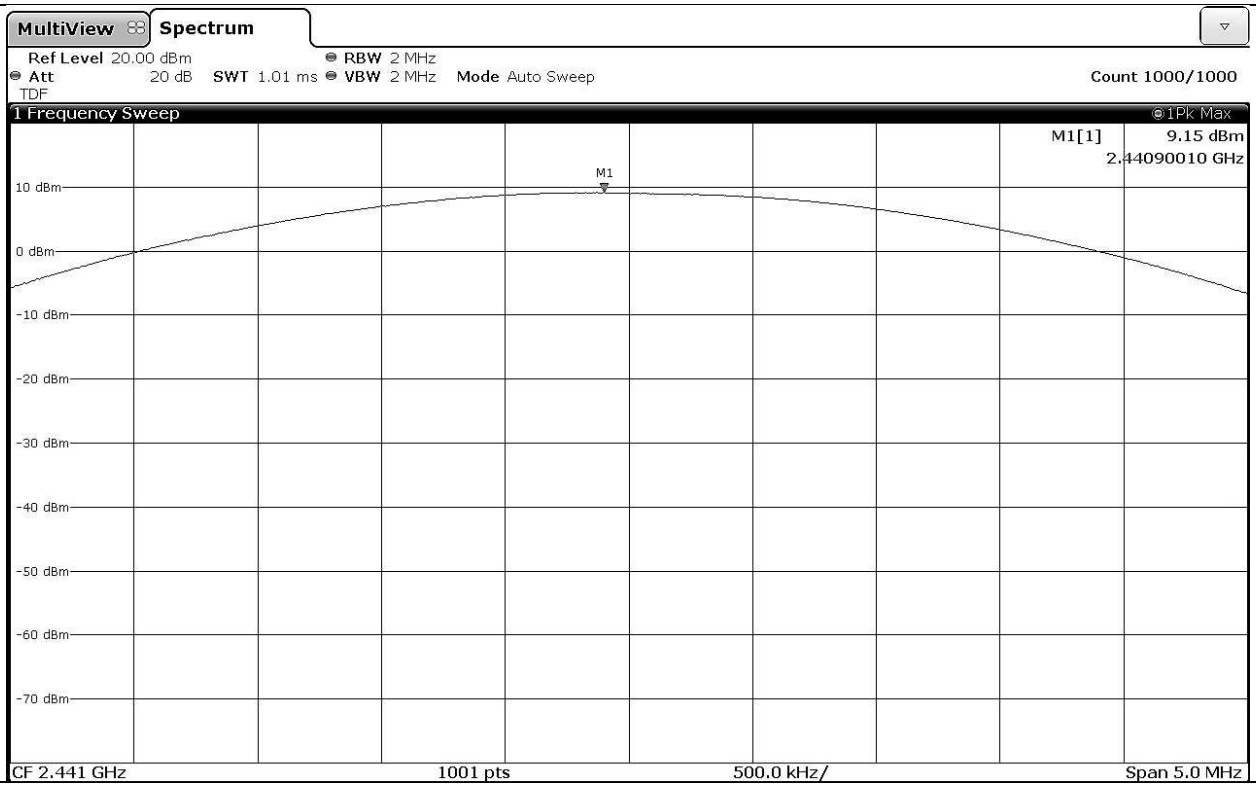
BDR_Mid CH



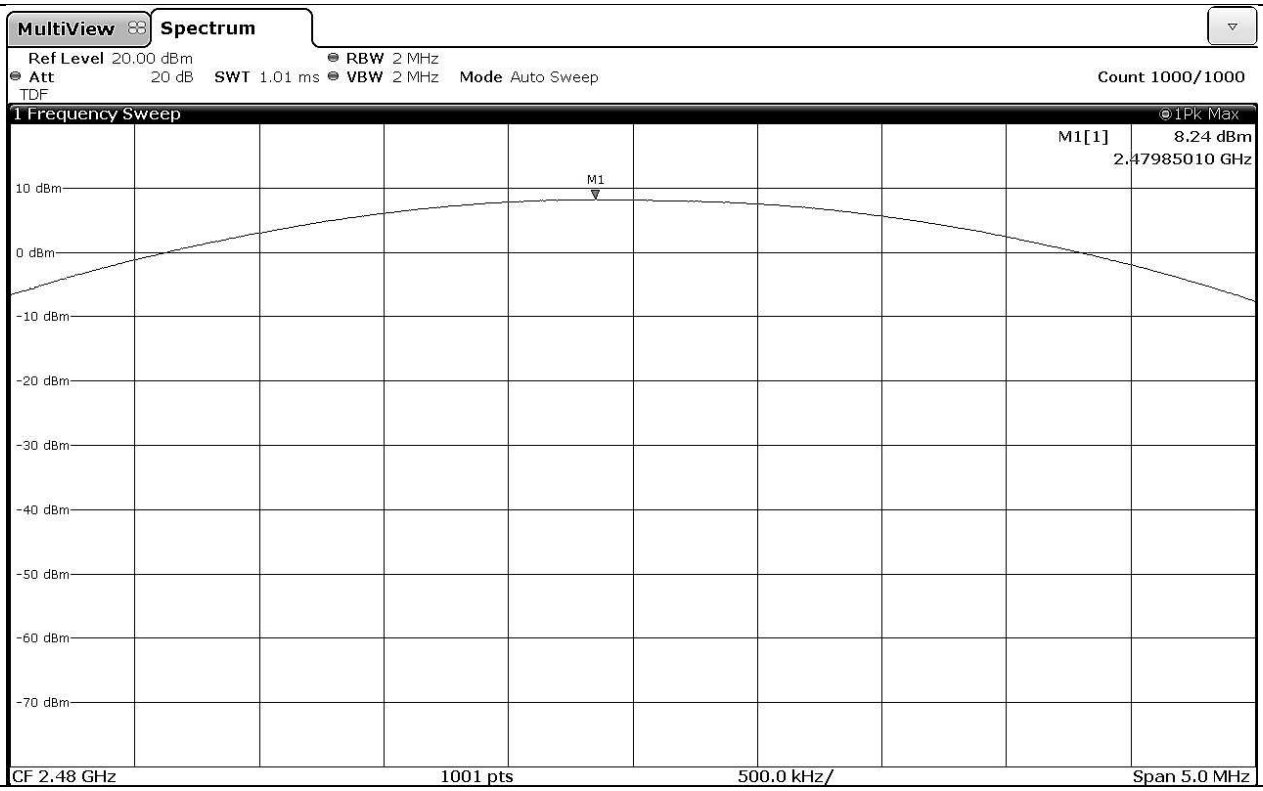
BDR_High CH



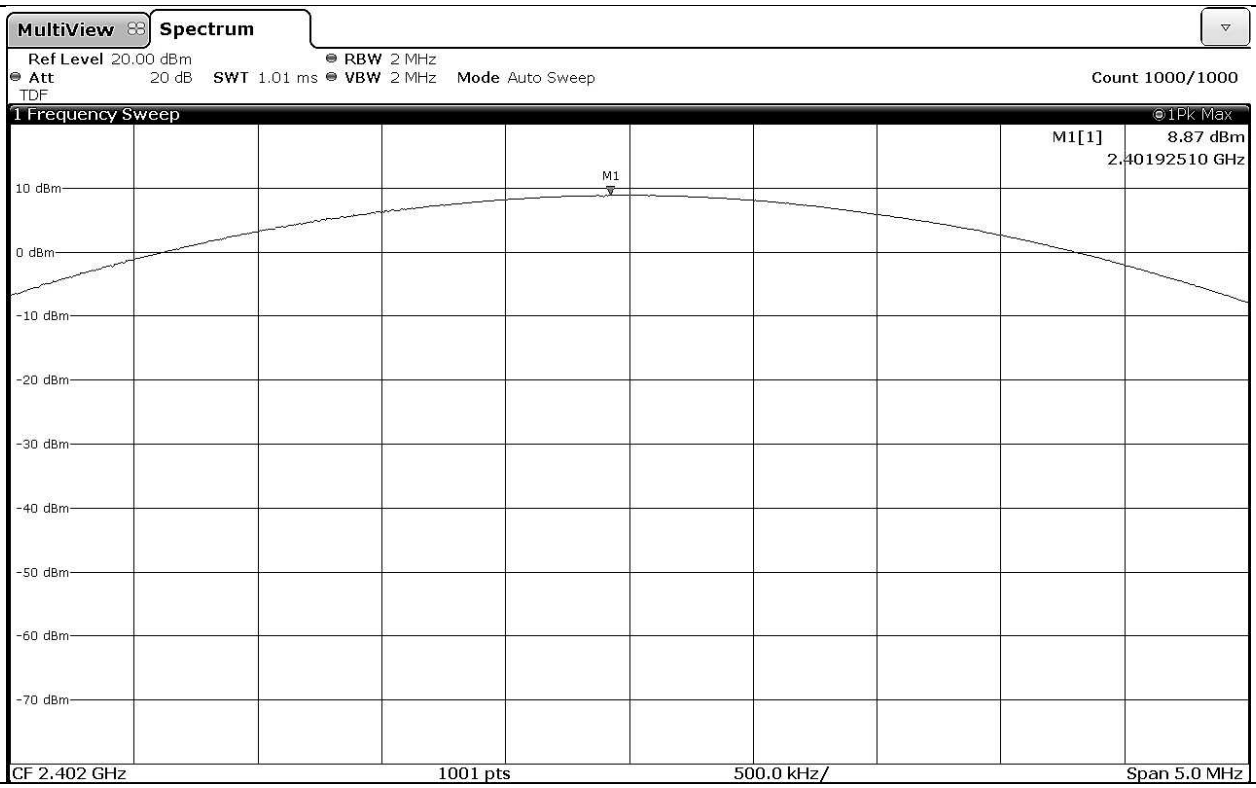
EDR (2 Mbps)_Low CH



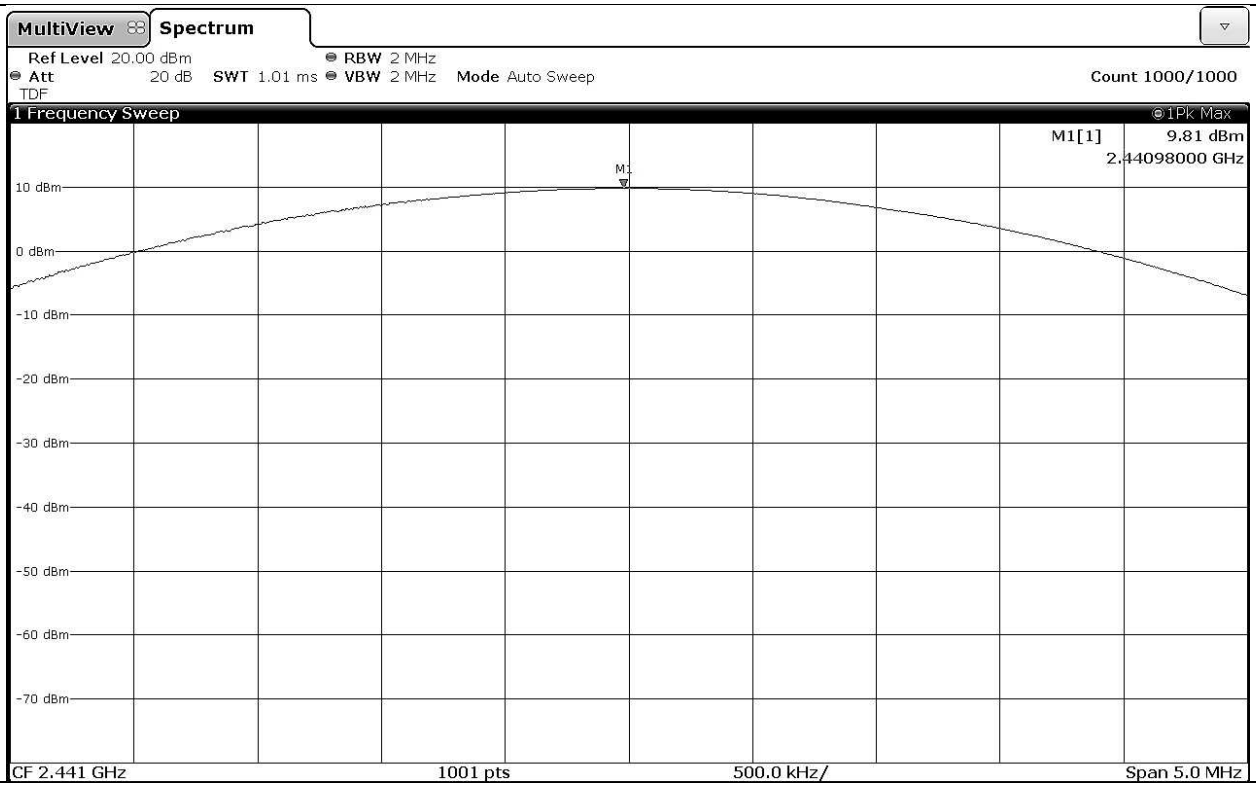
EDR (2 Mbps)_Mid CH



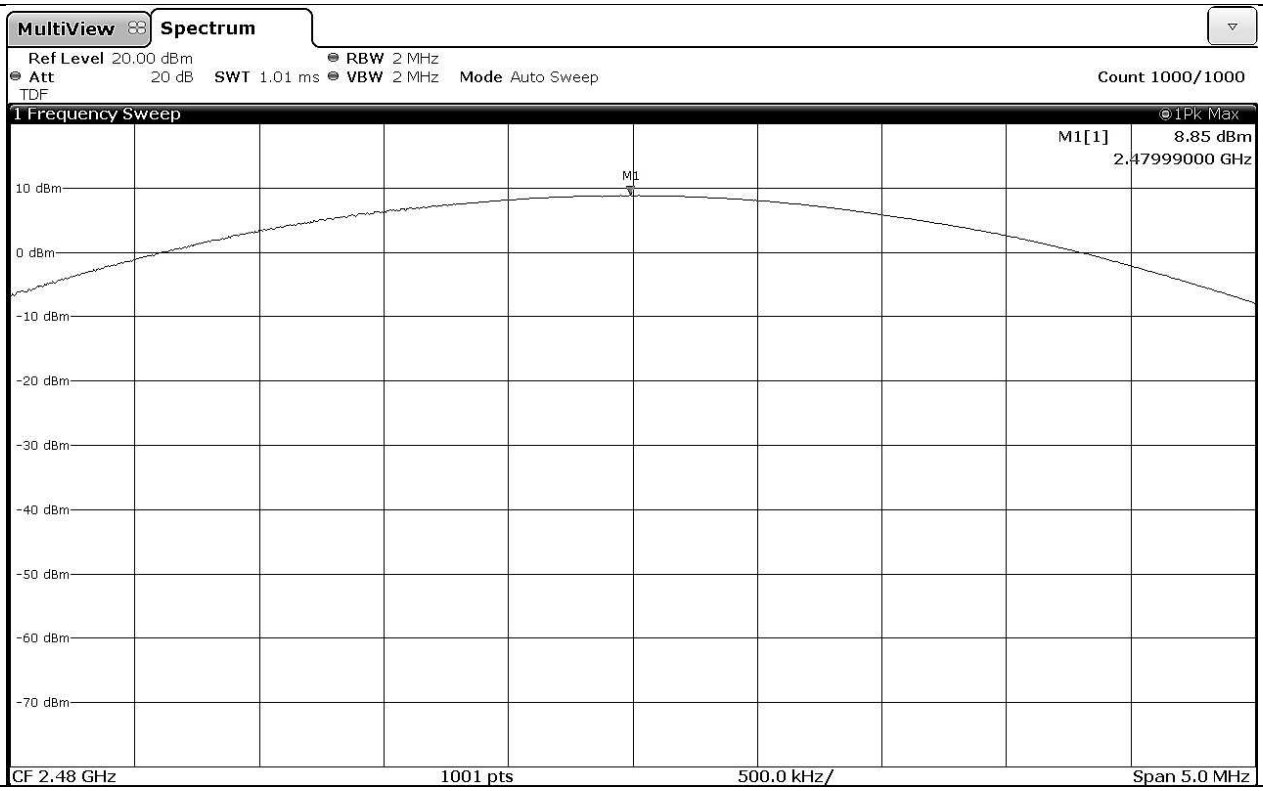
EDR (2 Mbps)_High CH



EDR (3 Mbps)_Low CH



EDR (3 Mbps)_Mid CH



EDR (3 Mbps)_High CH

10. Conducted Spurious Emission

10.1 Operating environment

Temperature : 24 ℃

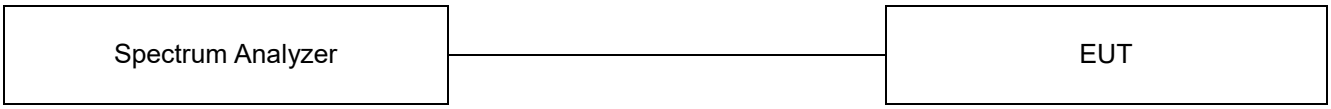
Relative humidity : 45 %

10.2 Measurement method

Standard : §15.247 (d) / RSS-247 (5.5)

10.3 Test setup

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



10.4 Test data

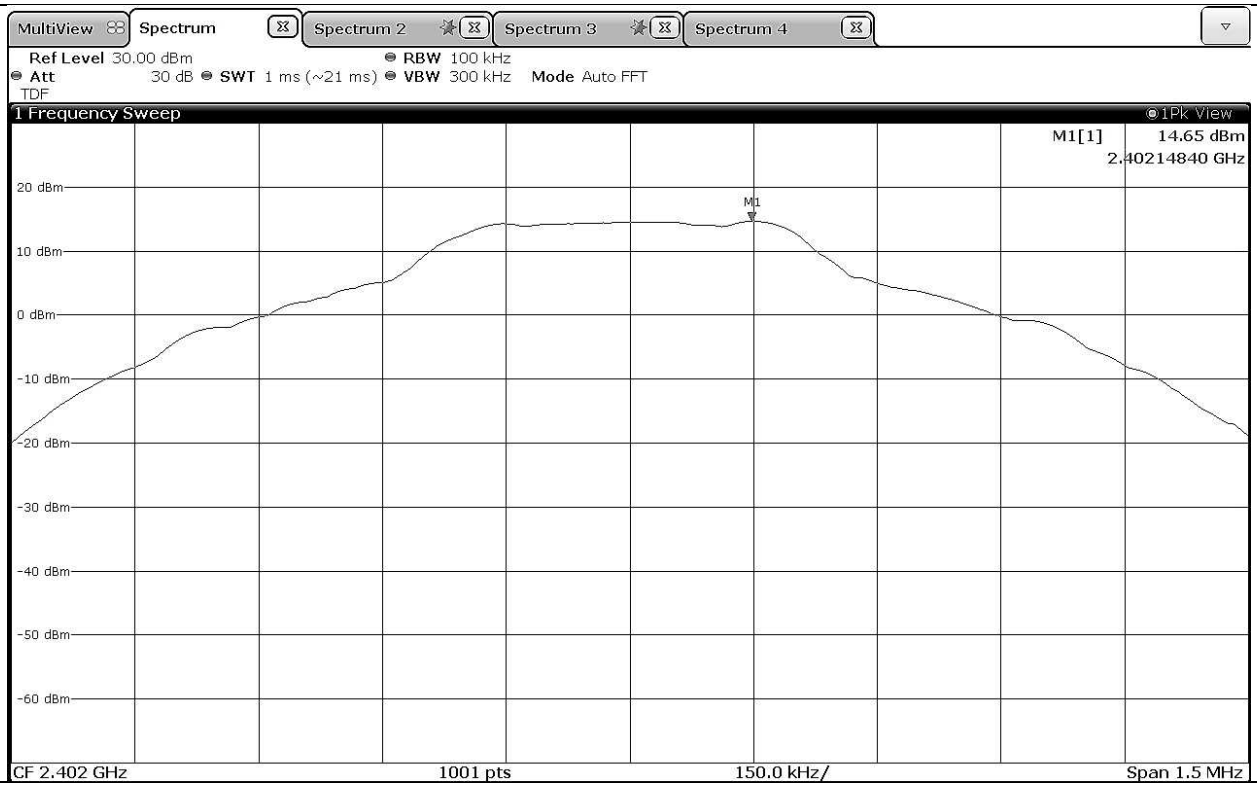
Test date : 22. Mar. 2019

Operating mode : Hopping mode

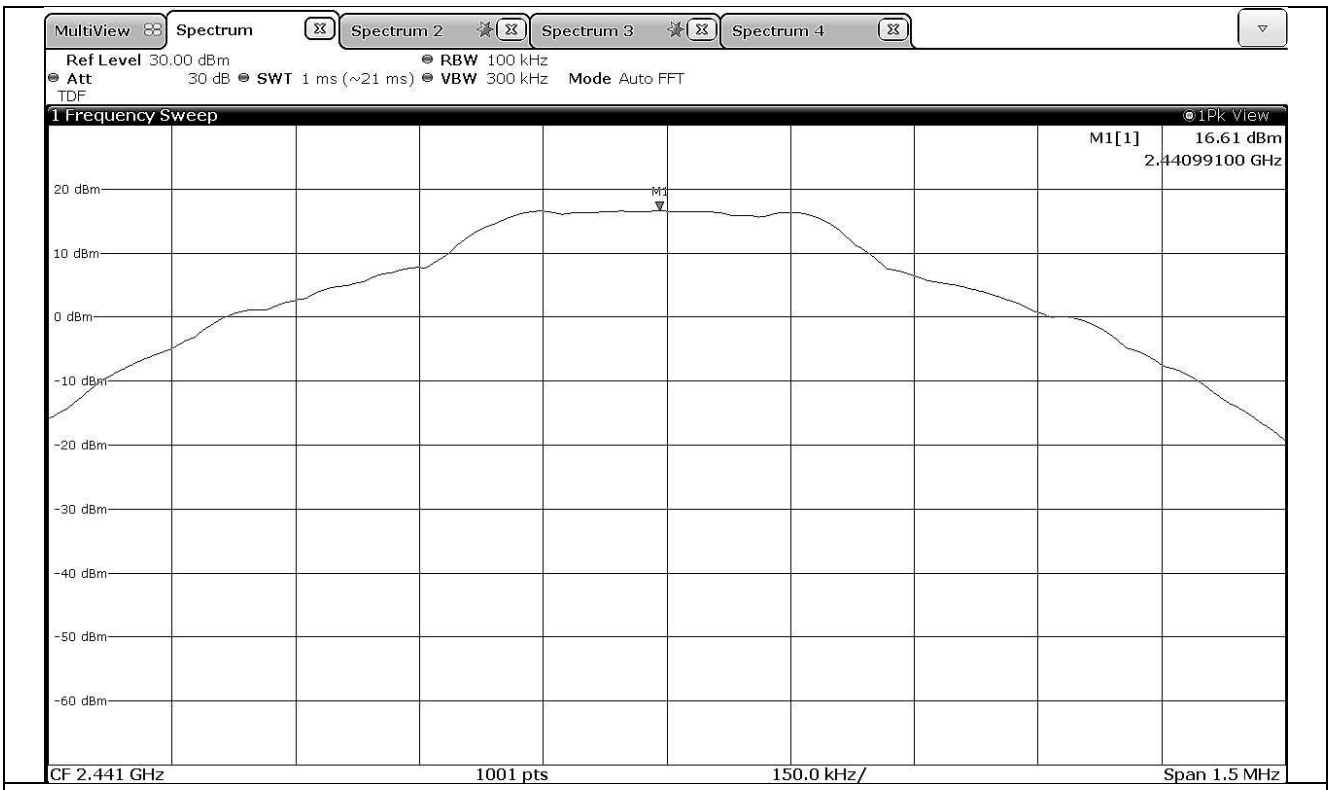
Test Result : Pass

10.4.1 Measured Results

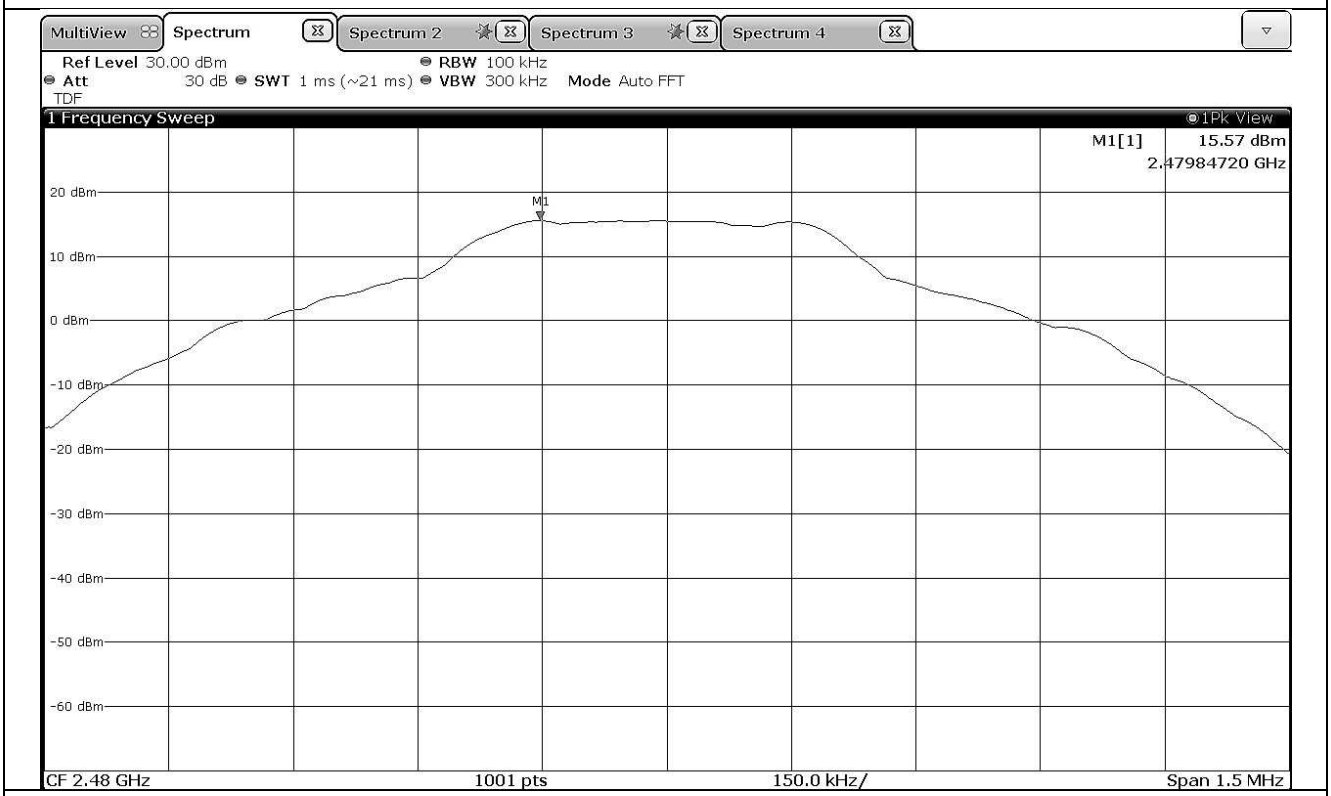
10.4.1.1 Signal level (dB m)



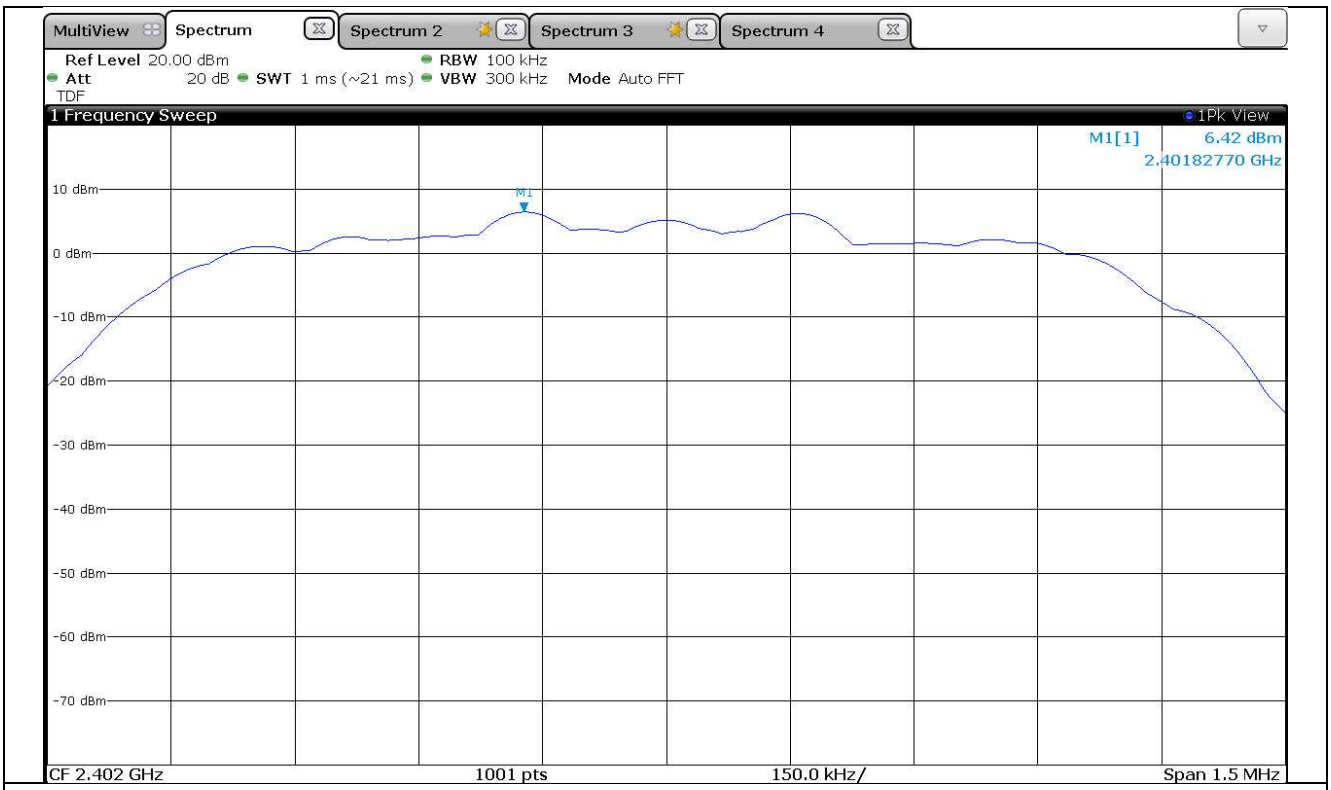
BDR_Low CH



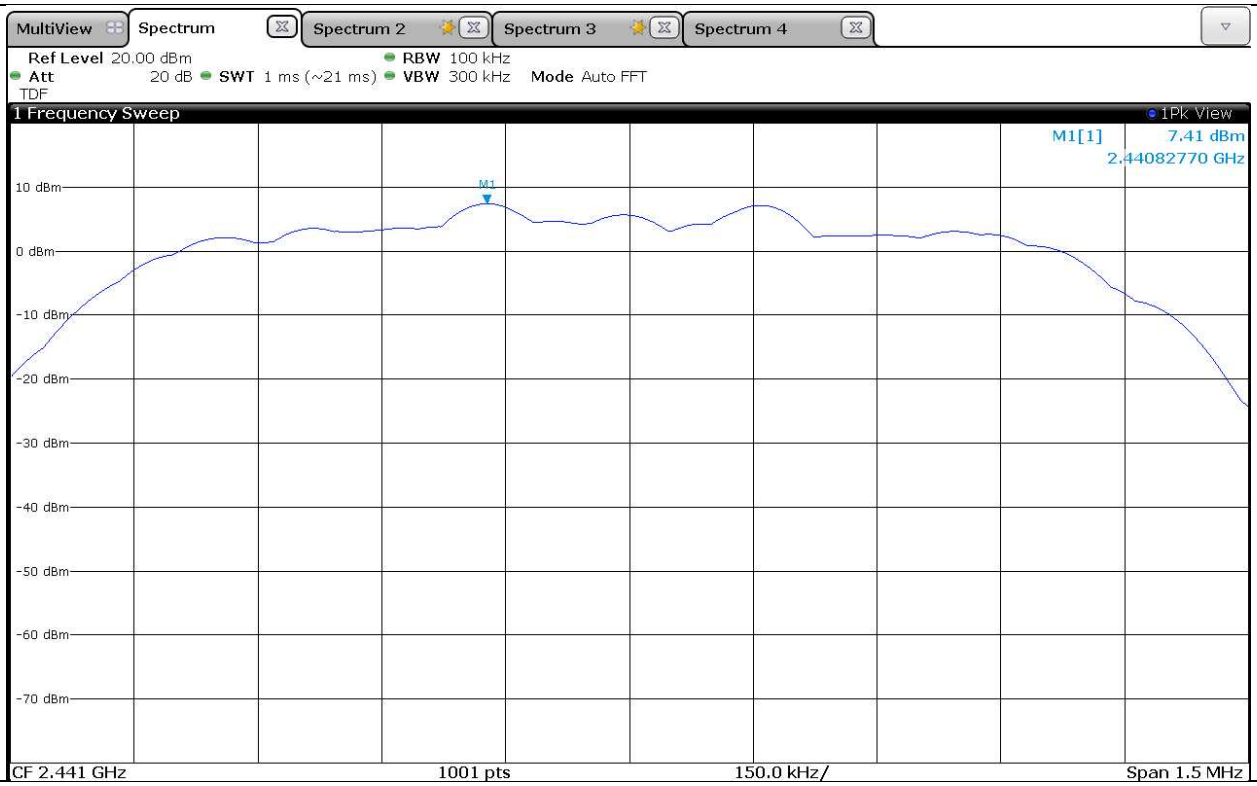
BDR_Mid CH



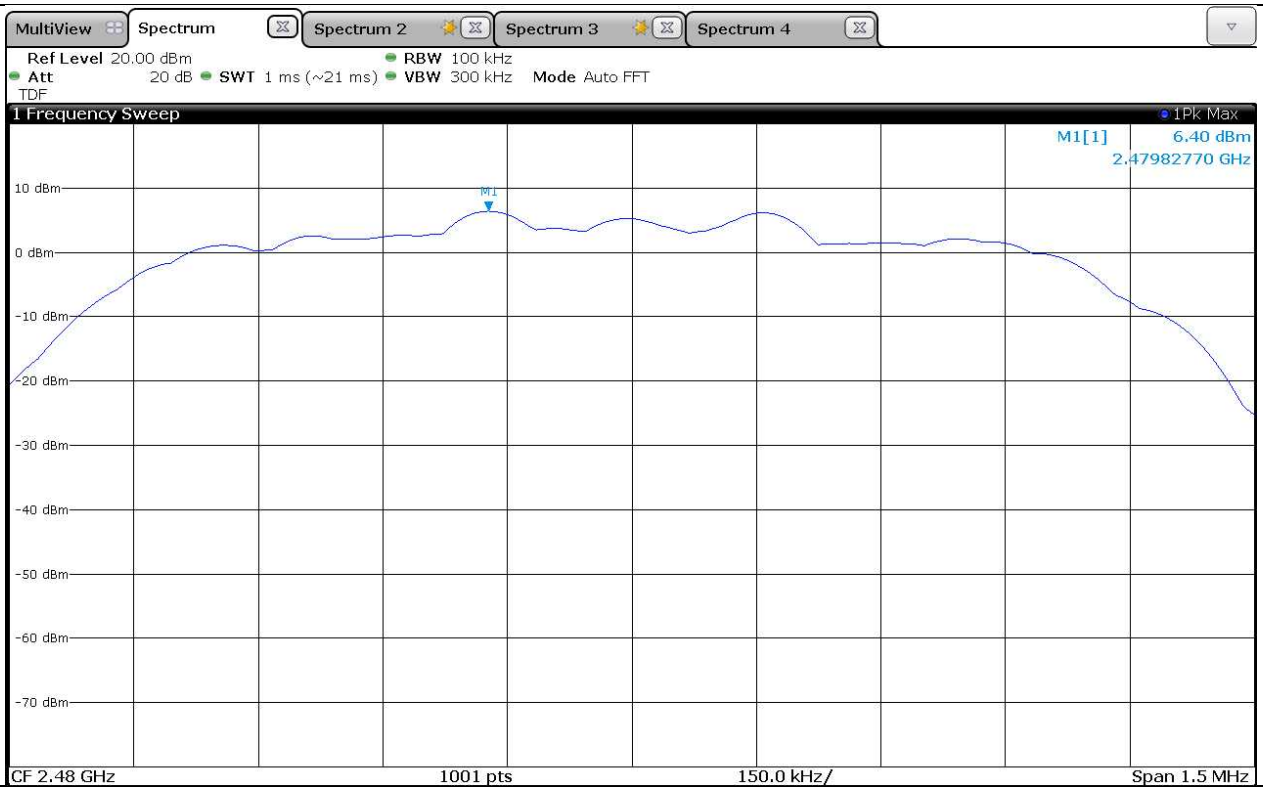
BDR_High CH


MultiView
Spectrum
Spectrum 2
Spectrum 3
Spectrum 4
Ref Level 20.00 dBm
RBW 100 kHz
Att 20 dB SWT 1 ms (~21 ms) VBW 300 kHz Mode Auto FFT
TDF
1 Frequency Sweep
1Pk View
M1[1] 6.42 dBm
2.40182770 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
CF 2.402 GHz
1001 pts
150.0 kHz/
Span 1.5 MHz

EDR_Low CH

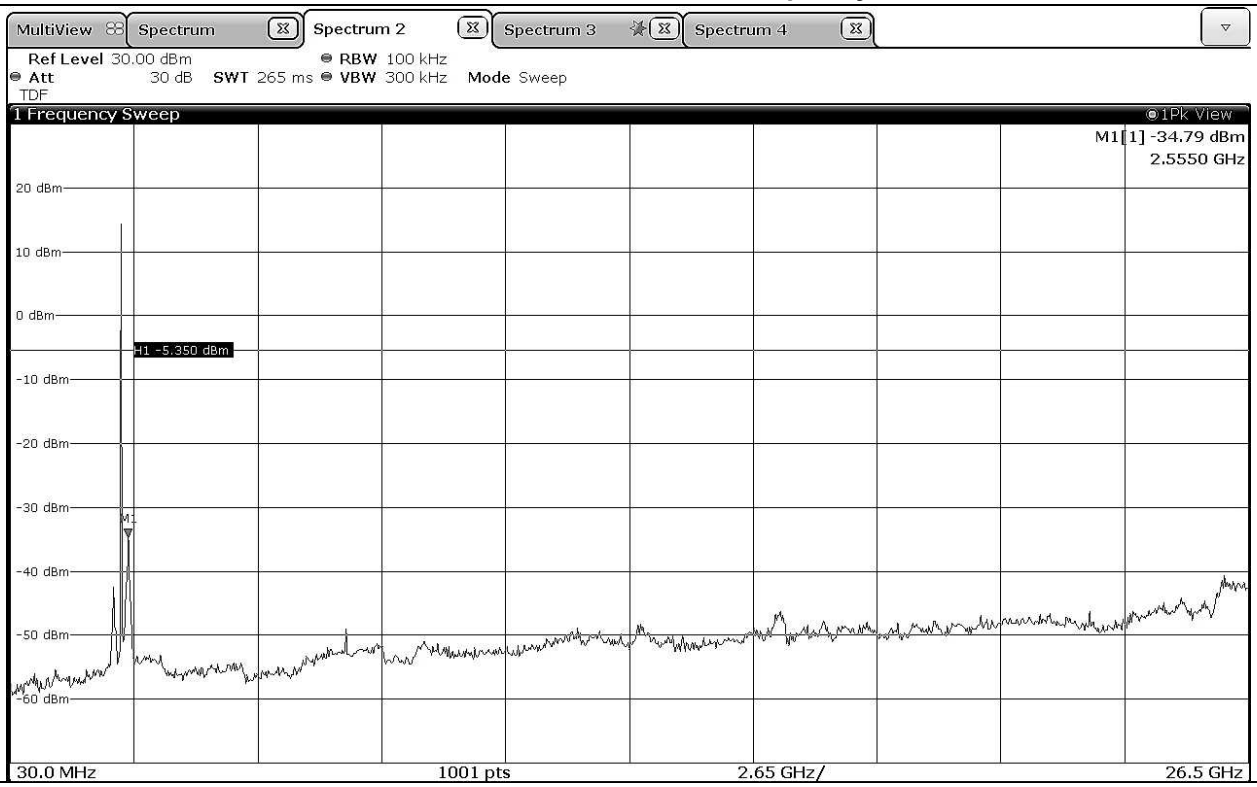


EDR_Mid CH

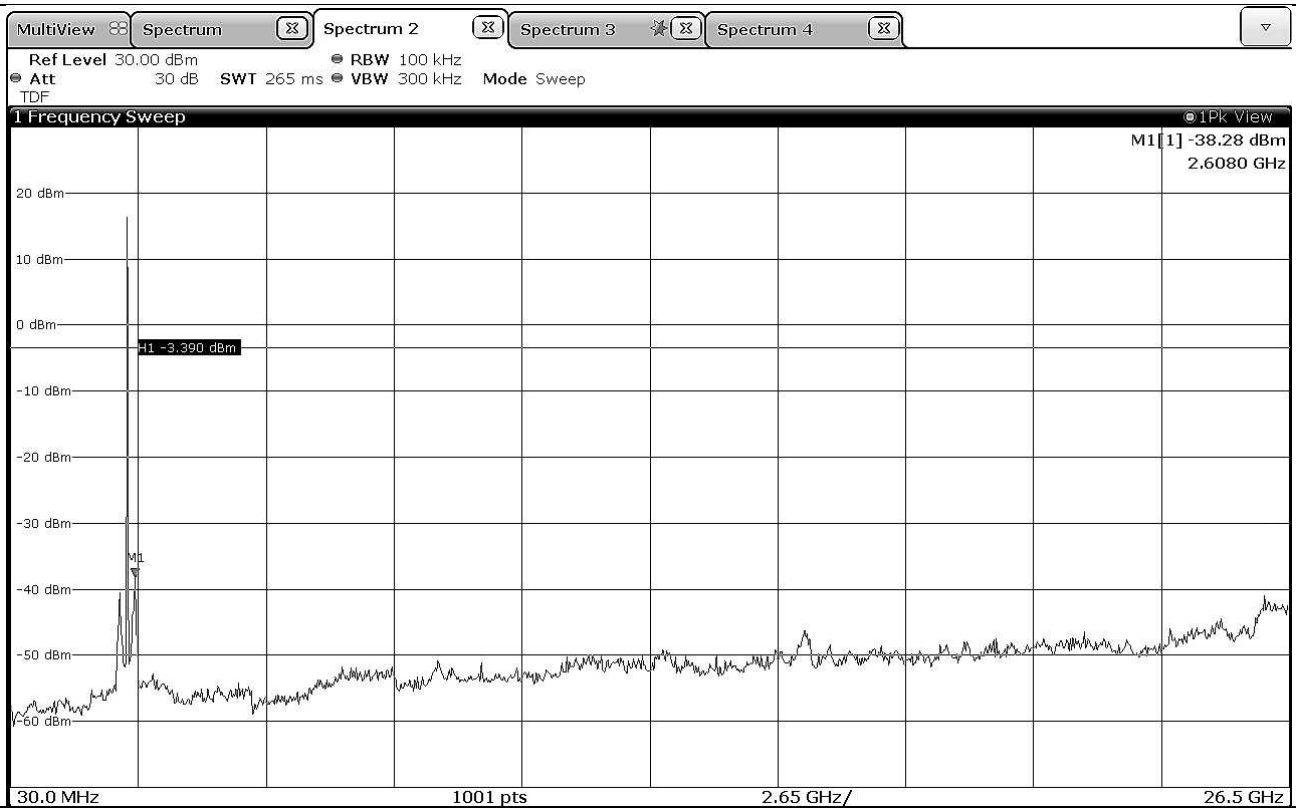


EDR_High CH

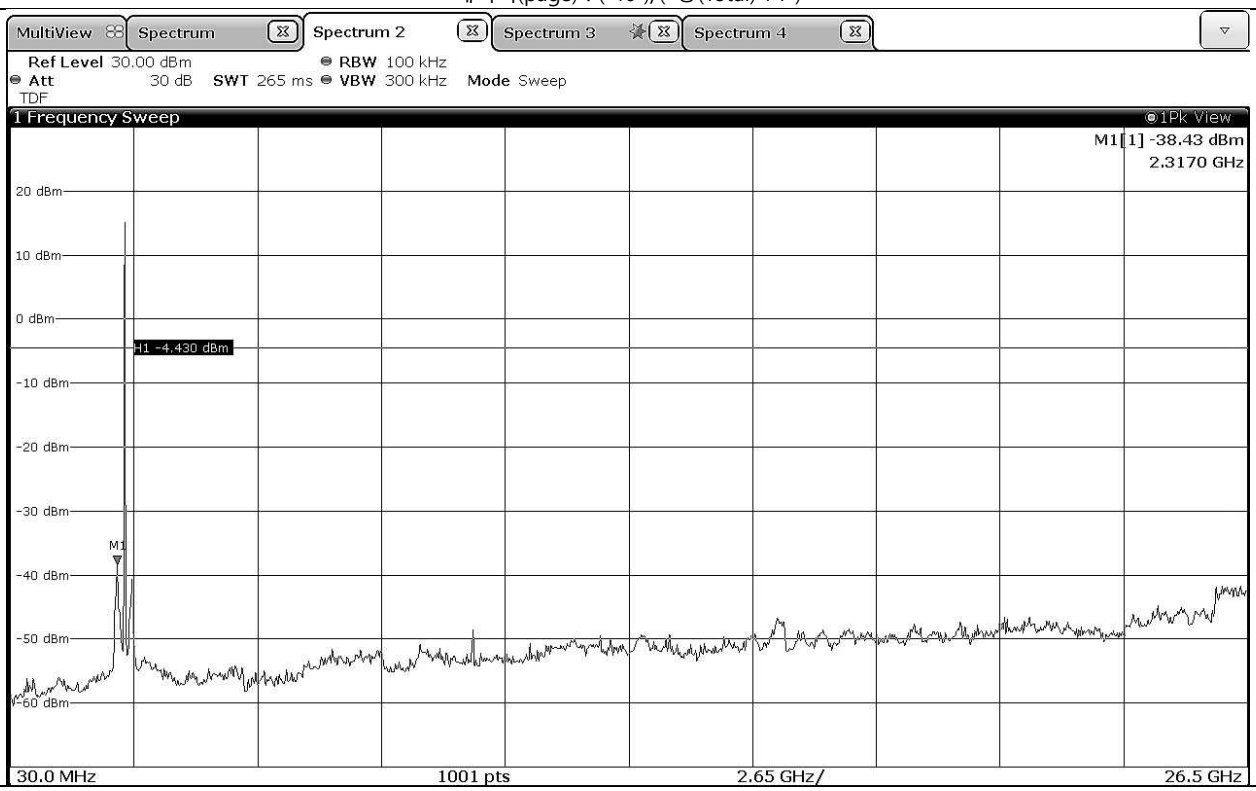
10.4.1.2 Unwanted Emissions In Non-Restricted Frequency Bands



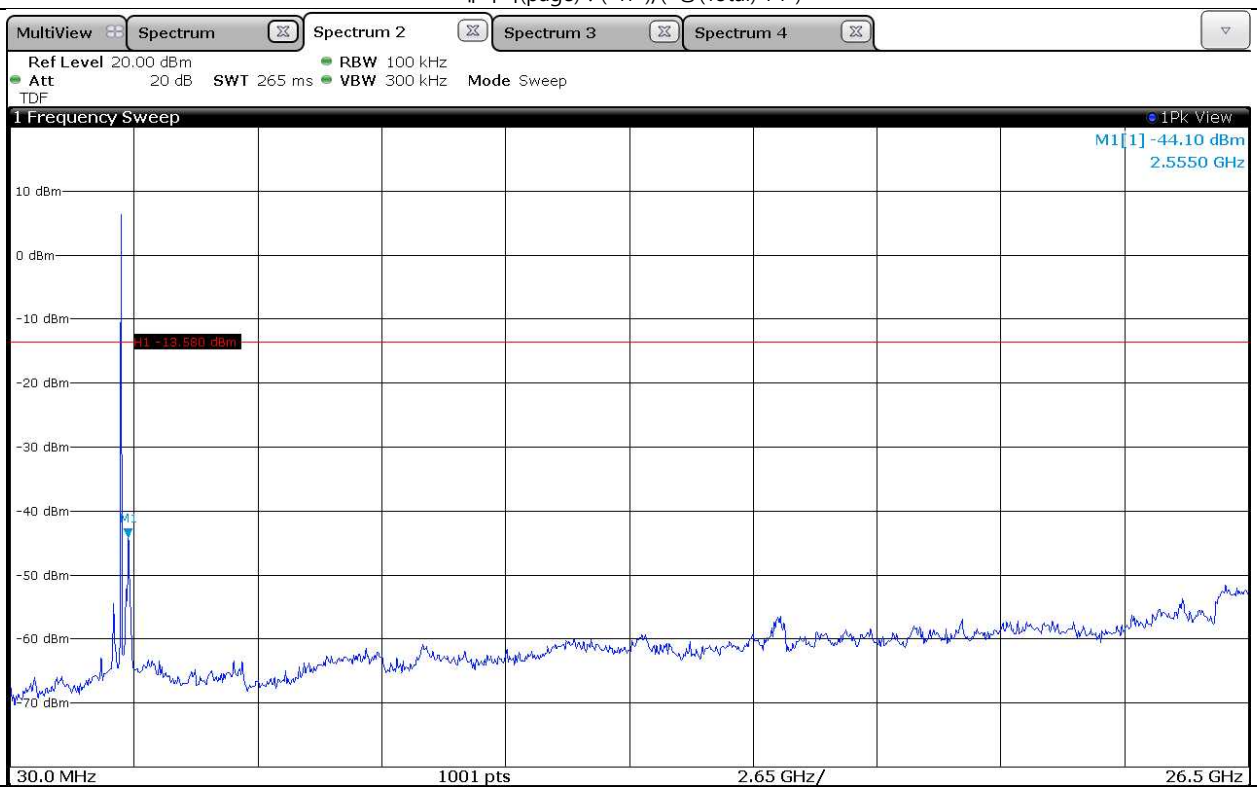
BDR_Low CH



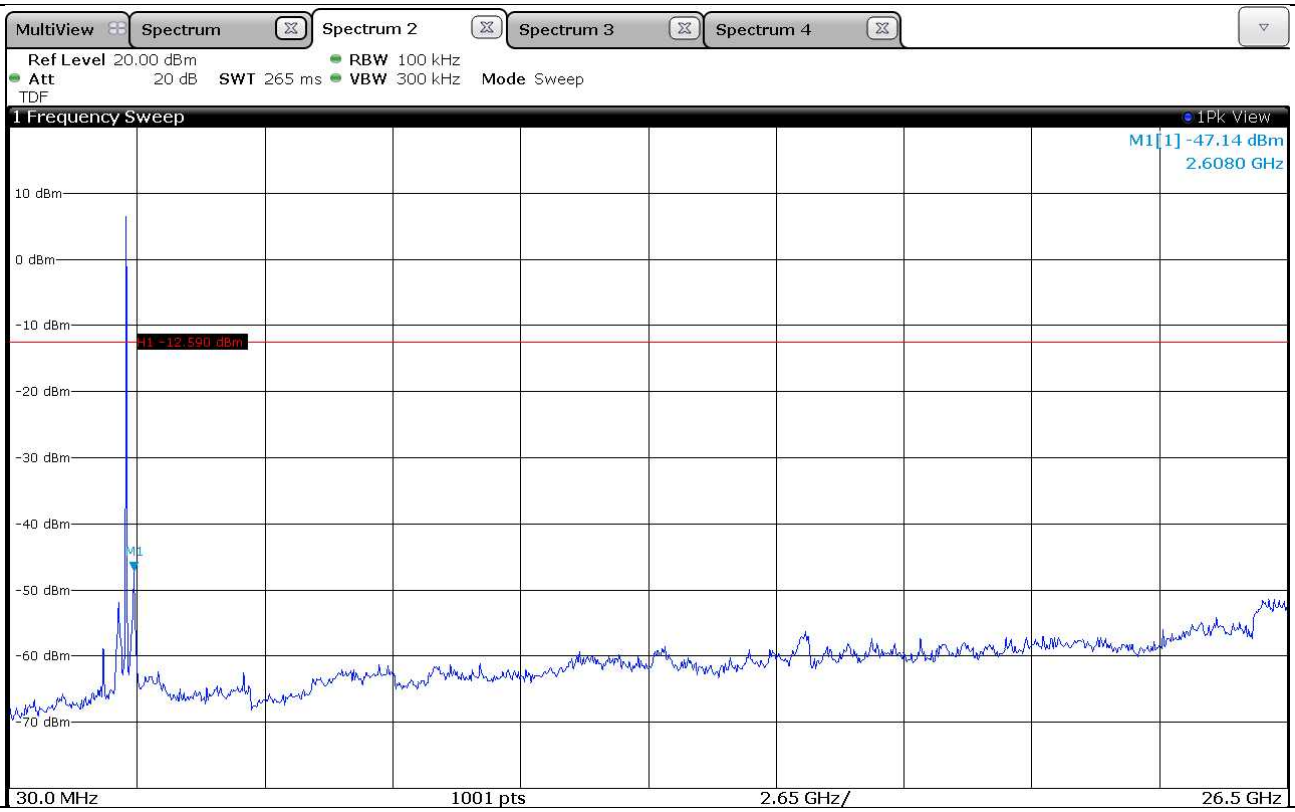
BDR_Mid CH


MultiView
Spectrum
Spectrum 2
Spectrum 3
Spectrum 4
Ref Level 30.00 dBm
RBW 100 kHz
Att 30 dB
SWT 265 ms
VBW 300 kHz
Mode Sweep
TDF
1 Frequency Sweep
1Pk View
M1[1] -38.43 dBm
2.3170 GHz
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
H1 -4.430 dBm
M1
30.0 MHz
1001 pts
2.65 GHz/
26.5 GHz

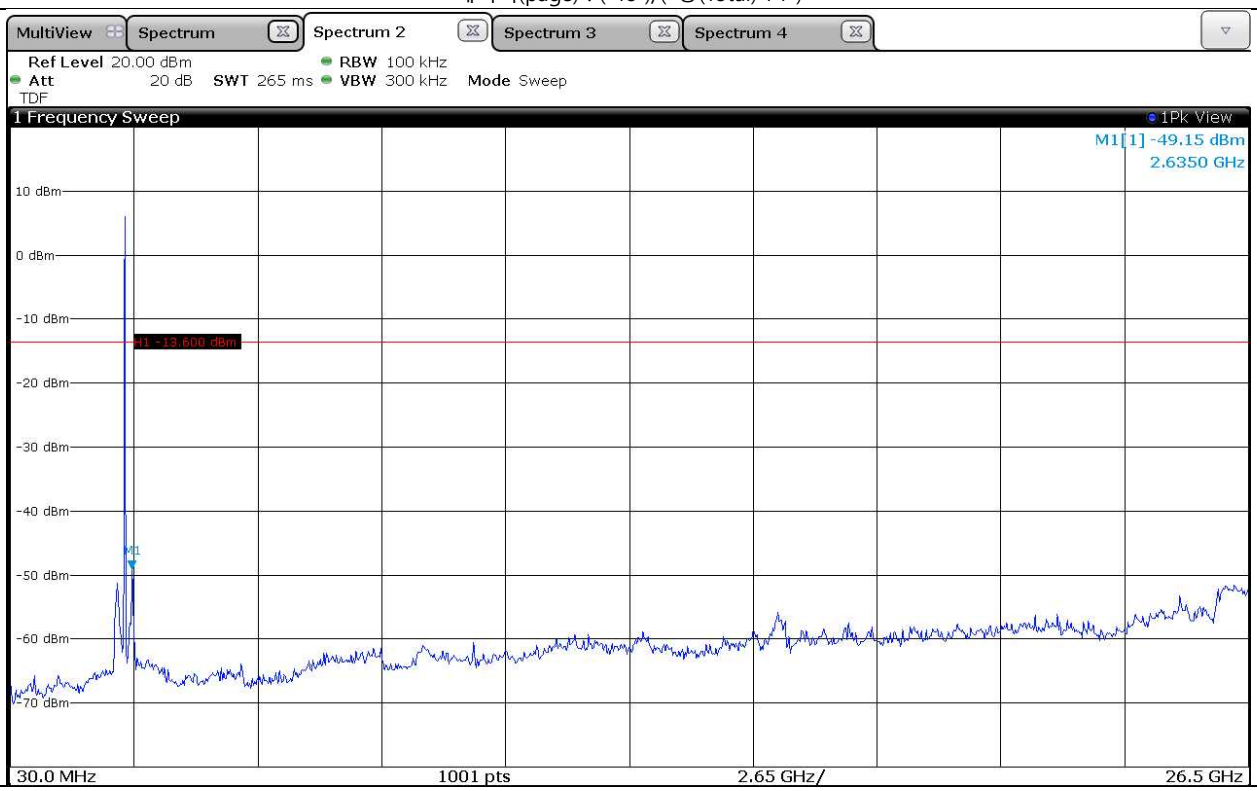
BDR_High CH



EDR_Low CH

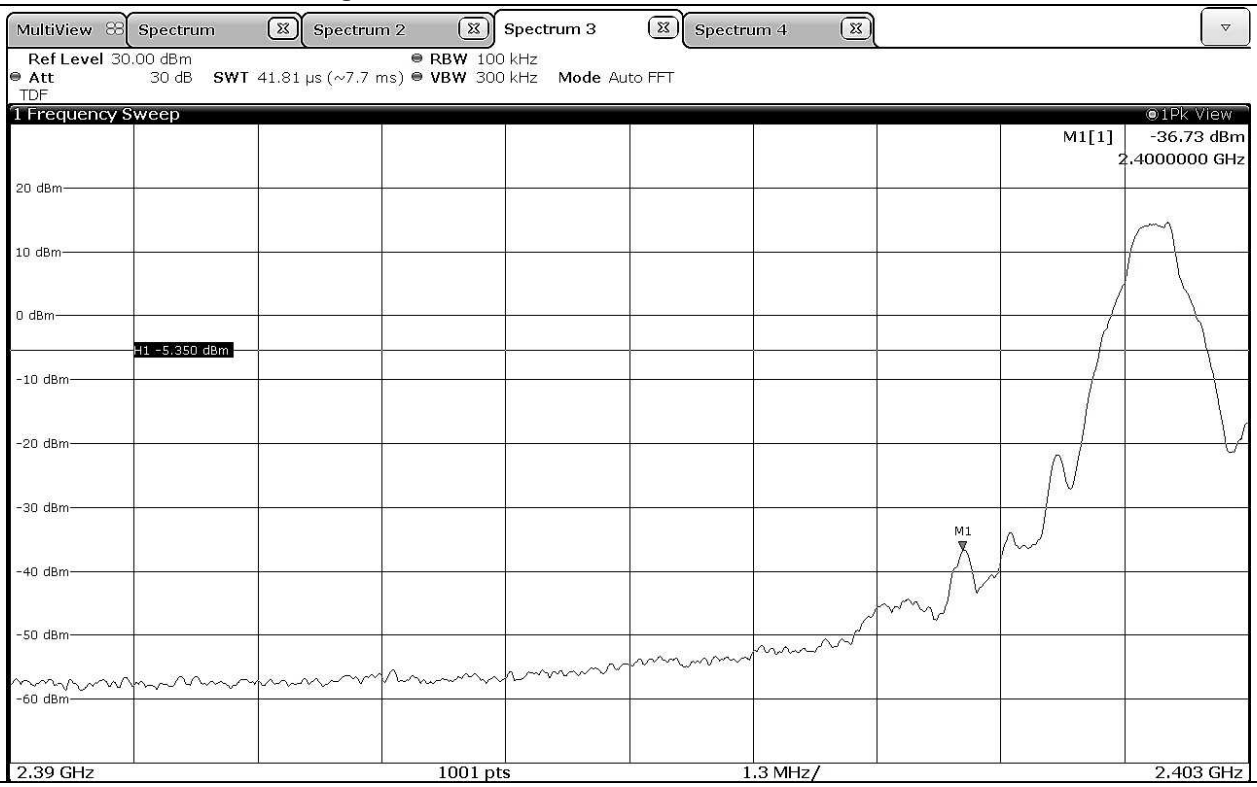


EDR_Mid CH

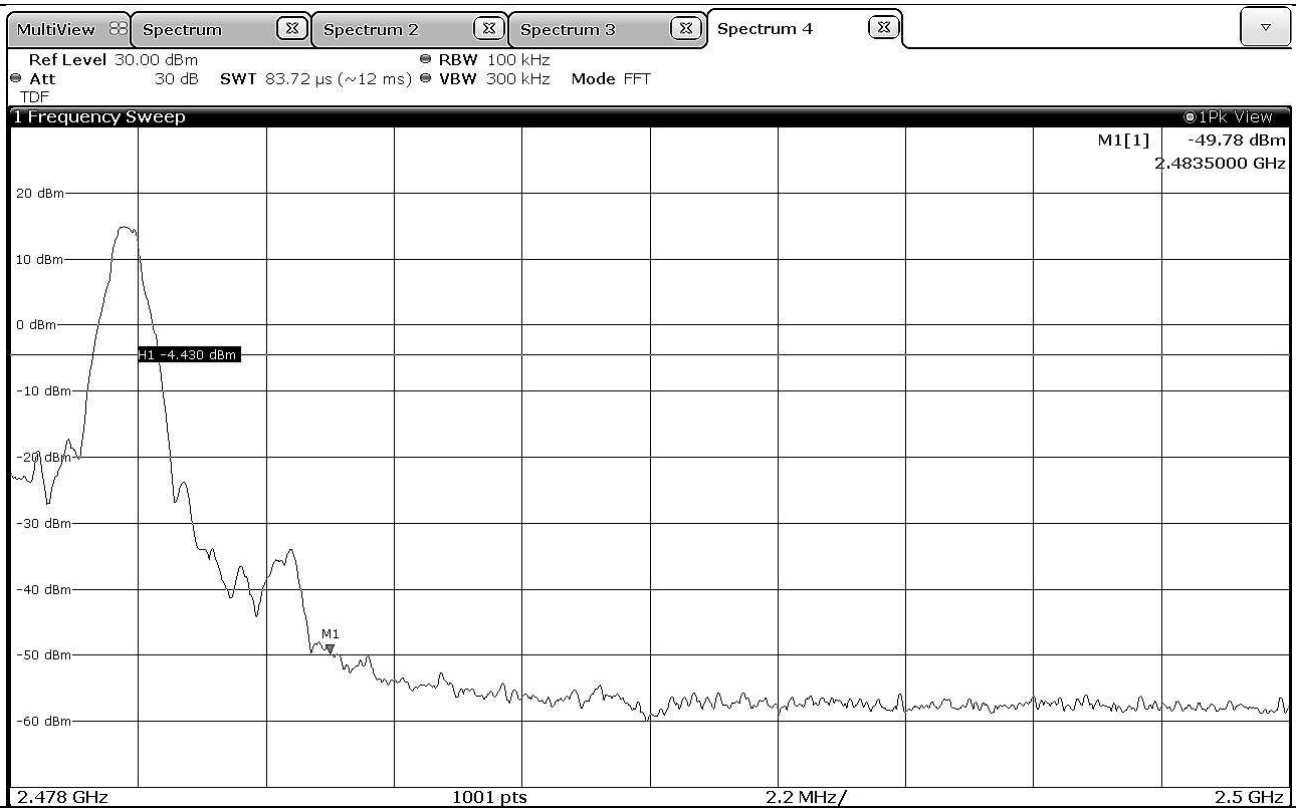

MultiView
Spectrum
Spectrum 2
Spectrum 3
Spectrum 4
Ref Level 20.00 dBm
RBW 100 kHz
Att 20 dB
SWT 265 ms
VBW 300 kHz
Mode Sweep
TDF
1 Frequency Sweep
1Pk View
M1[1] -49.15 dBm
2.6350 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
D1 -13.600 dBm
M1
30.0 MHz
1001 pts
2.65 GHz/
26.5 GHz

EDR_High CH

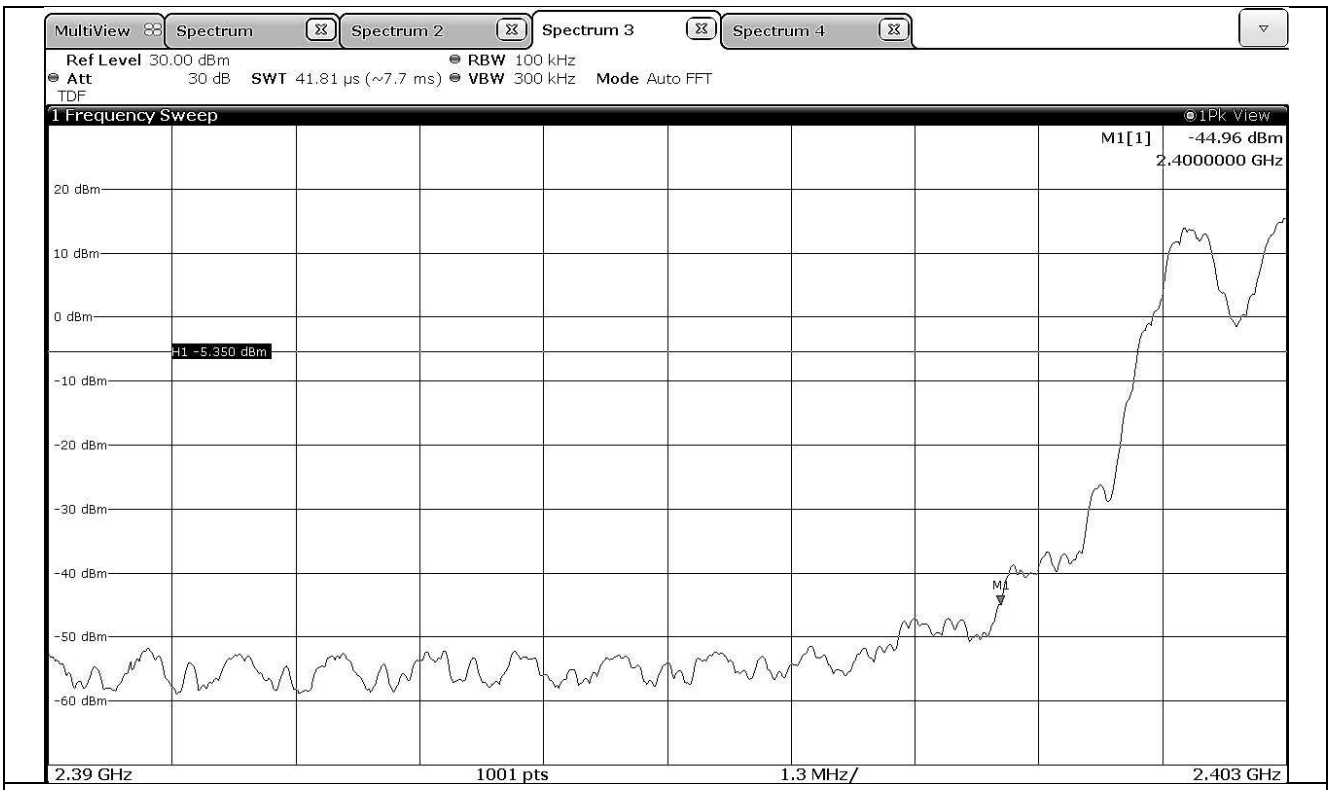
10.4.1.3 Band Edge



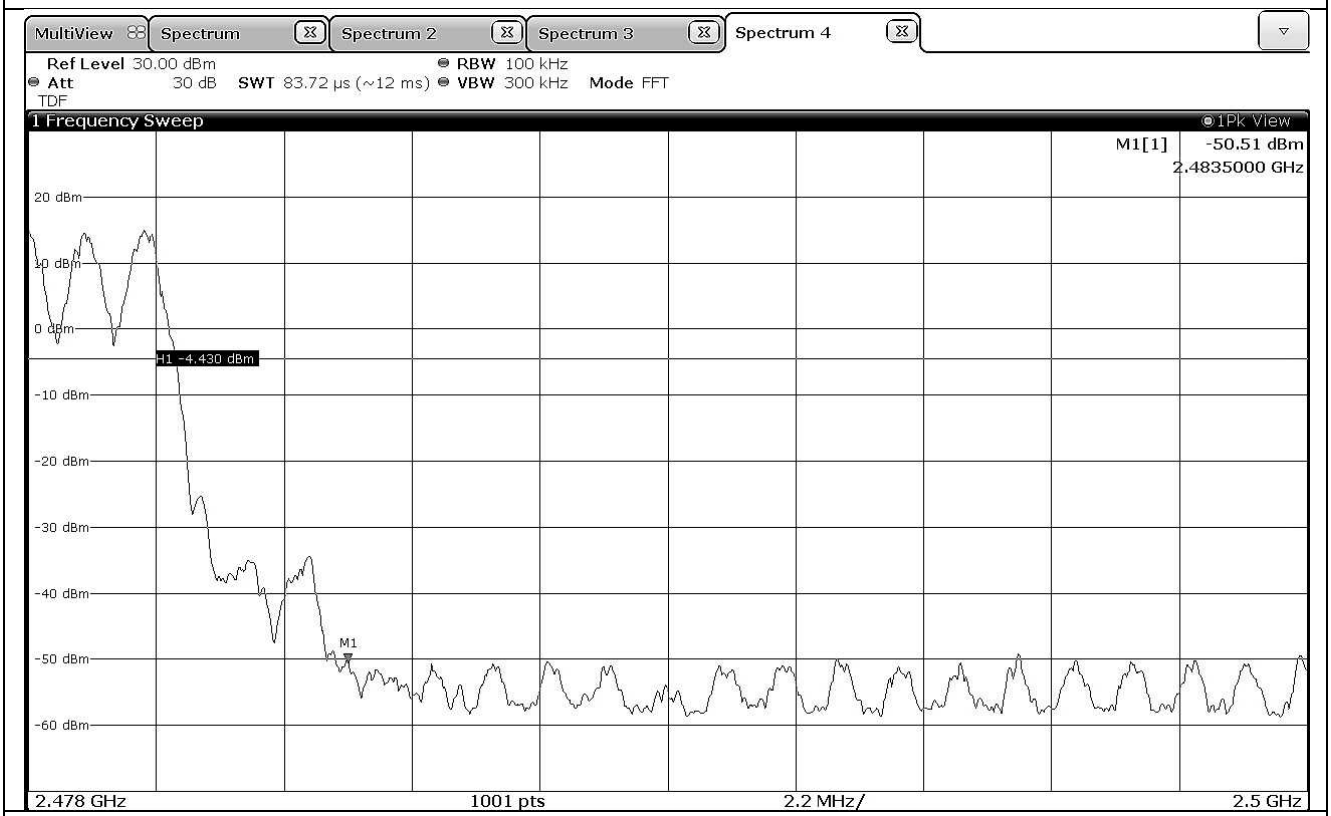
BDR_Low CH



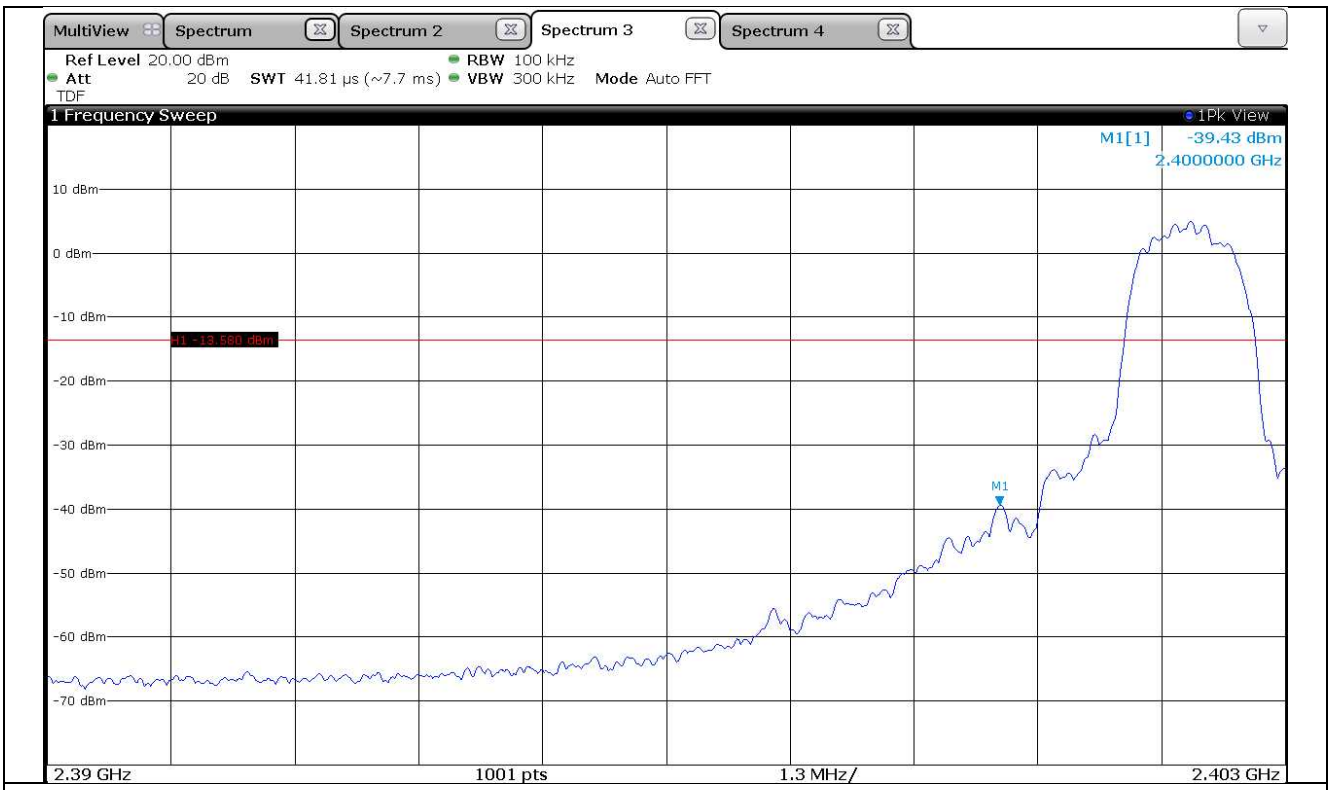
BDR_High CH



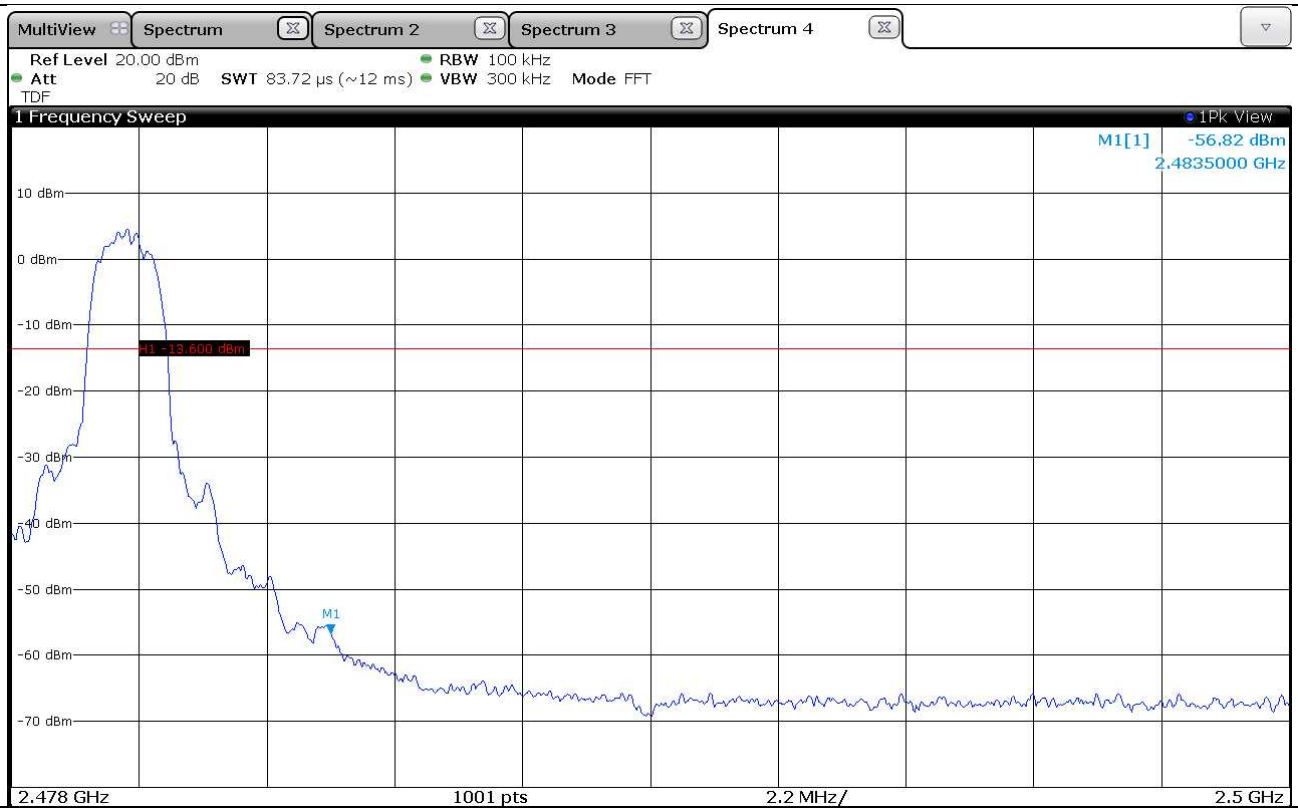
BDR_Hopping_Low CH



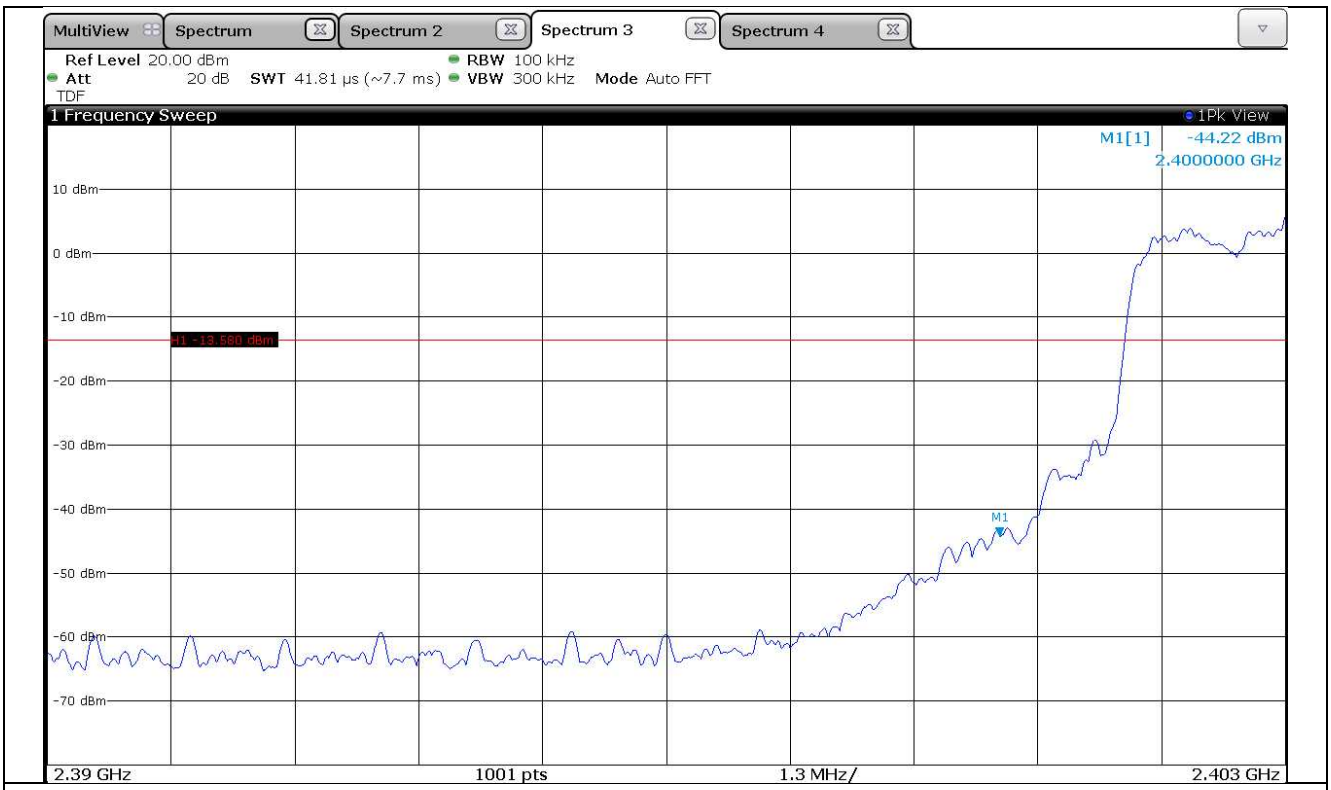
BDR_Hopping_High CH



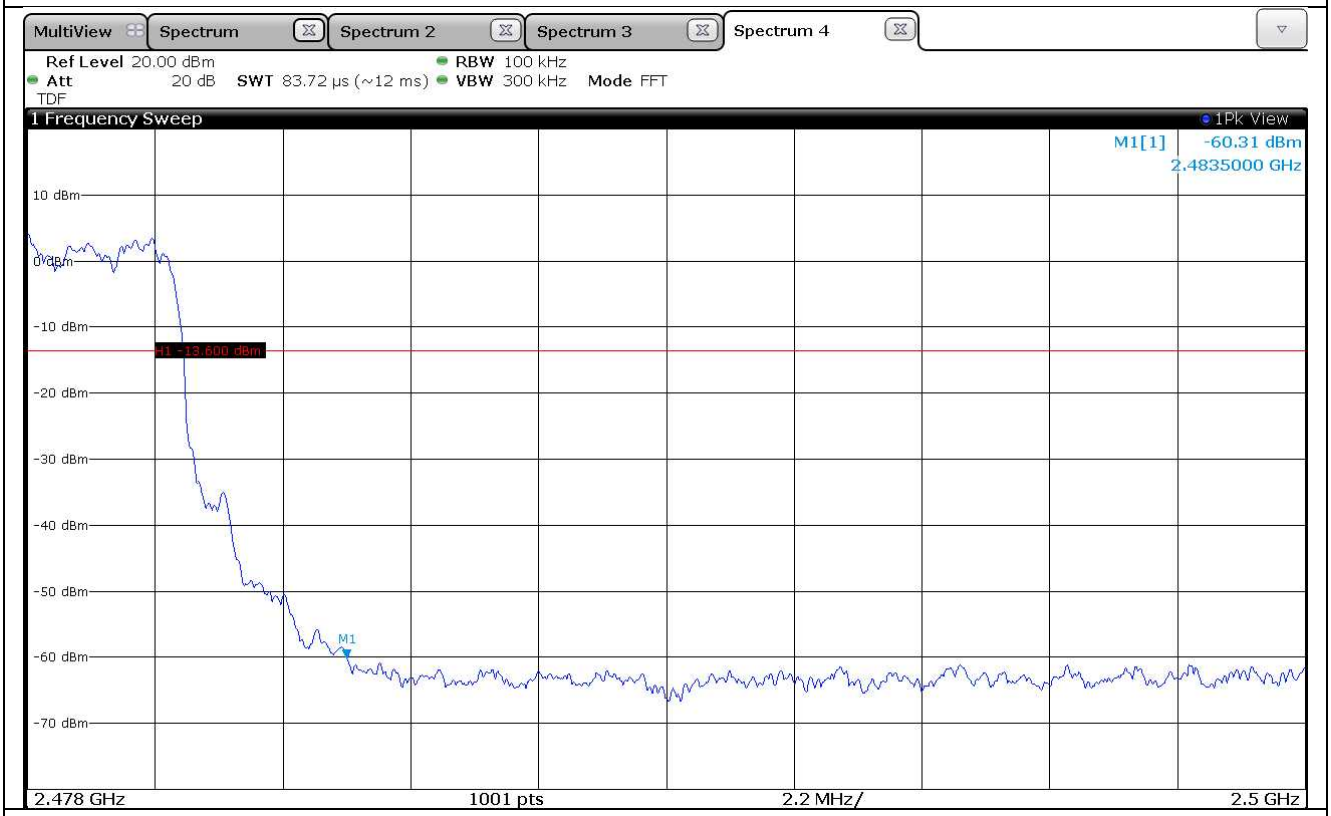
EDR_Low CH



EDR_High CH



EDR_Hopping_Low CH



EDR_Hopping_High CH

11. Radiated Spurious Emission

11.1 Operating environment

Temperature : 25 ℃

Relative humidity : 48 %

11.2 Measurement method

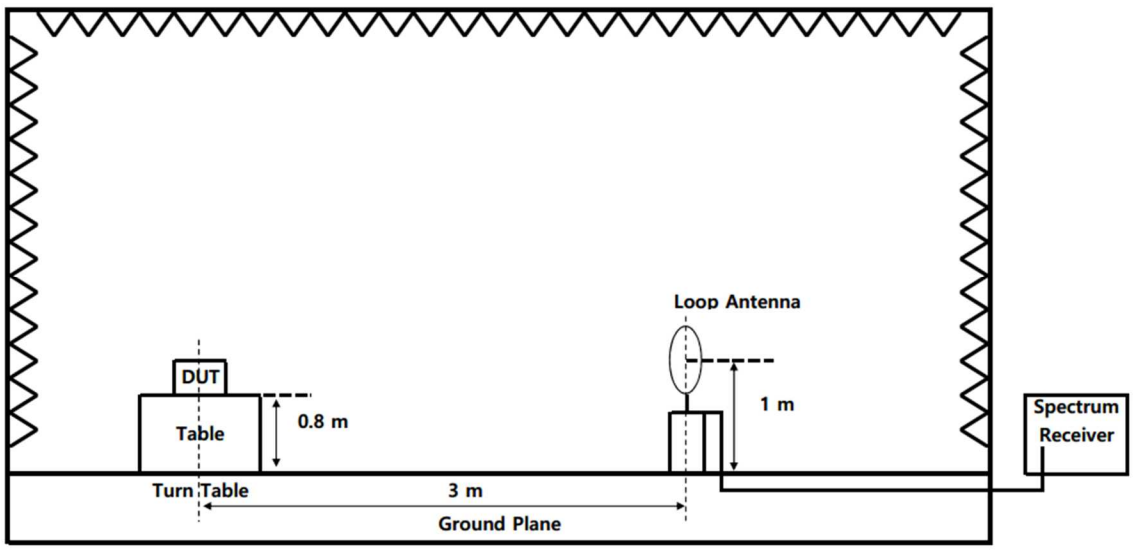
Standard : §15.247 (d), §15.209, §15.205
RSS-247 (5.5) & RSS-Gen (6.13)

11.3 Test setup

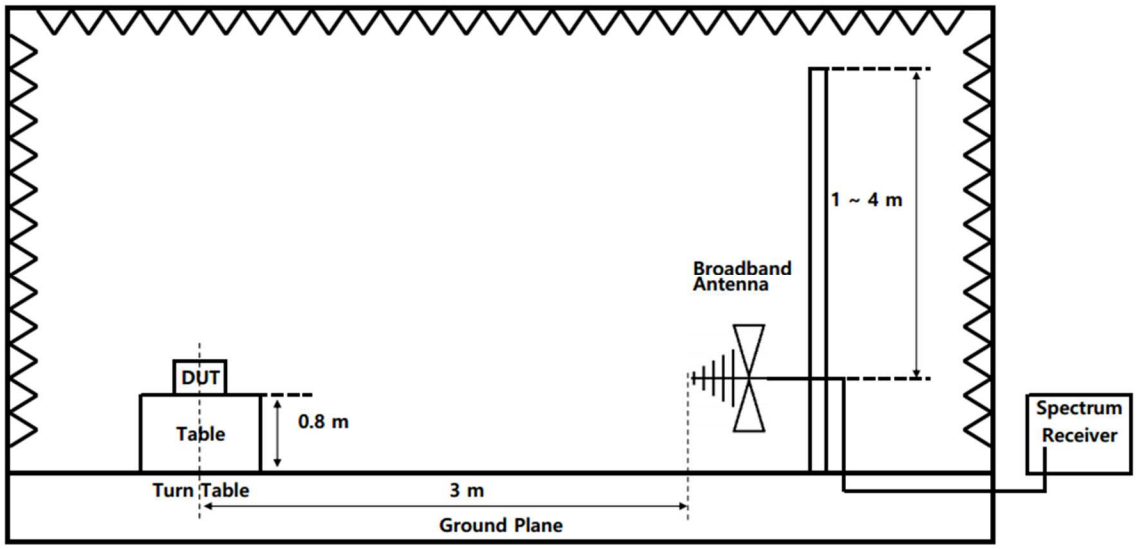
The radiated emissions measurements were performed on the 3 m, Semi-Anechoic Camber. The EUT was placed on a non-conductive turntable approximately 0.8 m above the ground plane.

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

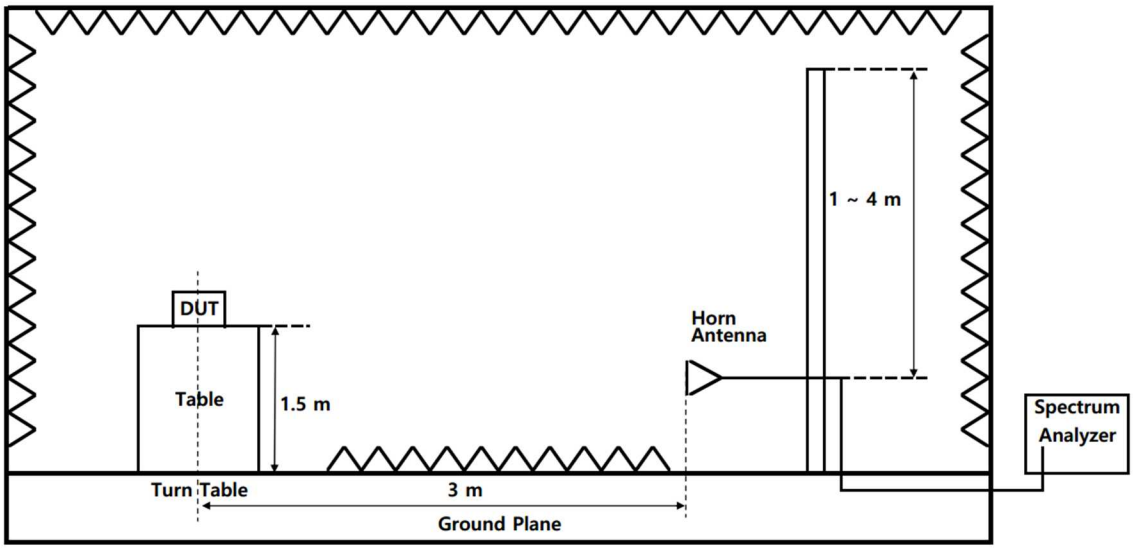
11.3.1 Below 30 ㎒



11.3.2 30 MHz to 1 GHz



11.3.3 Above 1 GHz



11.4 Test data

Test date : 25. Mar. 2019 ~ 25. Mar. 2019

Operating mode : Continuous Transmit

Test Result : Pass

11.4.1 Test data for Restricted band

11.4.1.1 BDR

Frequency (㎒)	Reading (dBμV)	Detector	Ant. Pol. (H/V)	Corr. Factor (dB)	DCCF (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Low CH								
2 376.16	52.27	Peak	H	-9.90	-	42.37	73.98	-31.61
	40.60	Average	H		-24.77	5.93	53.98	-48.05
High CH								
2 483.51	63.68	Peak	H	-9.65	-	54.03	73.98	-19.95
	47.60	Average	H		-24.77	13.18	53.98	-40.80

※ Ant. Pol. : Antenna Polarization

※ Corr Factor. : Antenna Factor + Cable Loss - Amplifier Gain

※ DCCF(Duty Cycle Correction Factor): 20 * Log(worst case dwell time / 100 ㎳) dB

※ Result = Reading + Corr Factor+ DCCF

※ Margin = Result - Limit

11.4.1.2 EDR (3 Mbps)

Frequency (㎒)	Reading (dBμV)	Detector	Ant. Pol. (H/V)	Corr. Factor (dB)	DCCF (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Low CH								
2 375.71	48.27	Peak	V	-9.90	-	38.37	73.98	-35.61
	34.58	Average	V		-24.77	-0.09	53.98	-54.07
High CH								
2 483.51	58.54	Peak	H	-9.65	-	48.89	73.98	-25.09
	41.82	Average	H		-24.77	7.40	53.98	-46.58

※ Ant. Pol. : Antenna Polarization

※ Corr Factor. : Antenna Factor + Cable Loss - Amplifier Gain

※ DCCF(Duty Cycle Correction Factor): 20 * Log(worst case dwell time / 100 ㎳) dB

※ Result = Reading + Corr Factor+ DCCF

※ Margin = Result - Limit

11.4.2 Test data for Spurious & Harmonic

11.4.2.1 Measurement Results for Below 30 ㎒

11.4.2.1.1 BDR

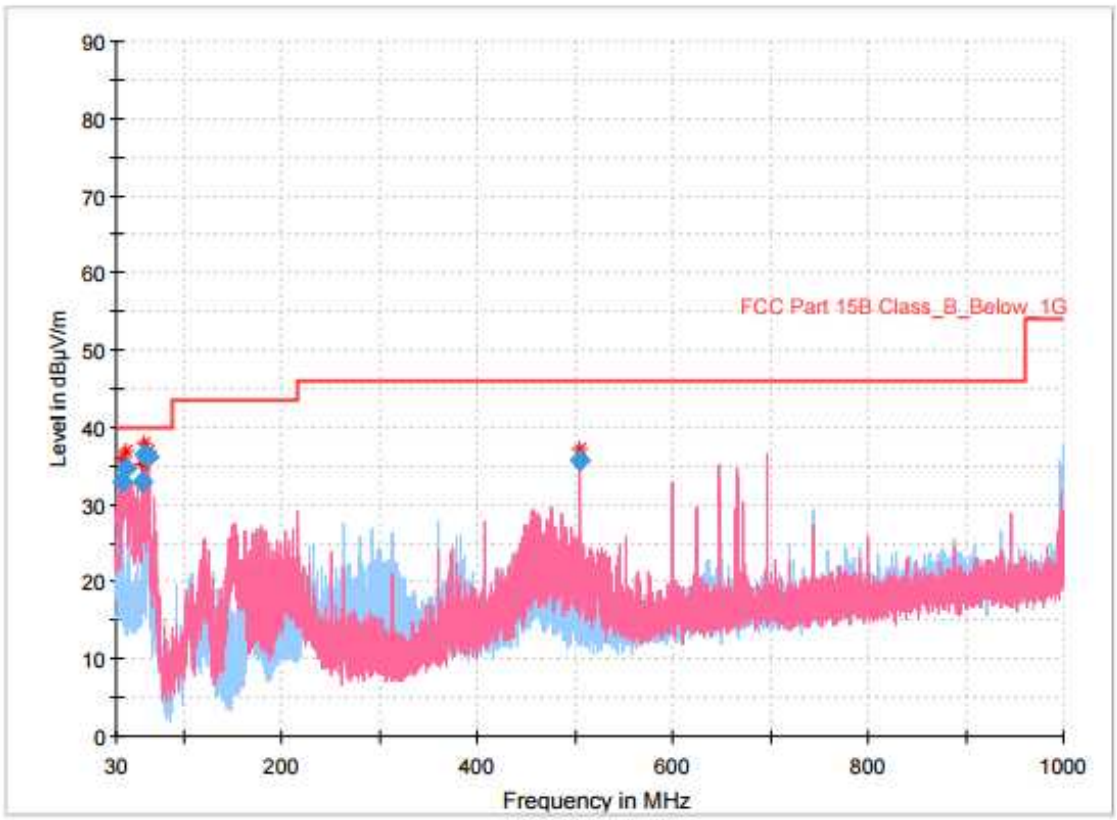
Frequency (㎒)	Reading (dBμV)	Detector	Ant. Pol. (H/V)	Corr. Factor (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Low CH							
It was not found any emissions peaks found from the EUT.							
Mid CH							
It was not found any emissions peaks found from the EUT.							
High CH							
It was not found any emissions peaks found from the EUT.							

11.4.2.1.2 EDR (3 Mbps)

Frequency (㎒)	Reading (dBμV)	Detector	Ant. Pol. (H/V)	Corr. Factor (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Low CH							
It was not found any emissions peaks found from the EUT.							
Mid CH							
It was not found any emissions peaks found from the EUT.							
High CH							
It was not found any emissions peaks found from the EUT.							

11.4.2.2 Measurement Results for 30 ㎒ to 1 ㎓

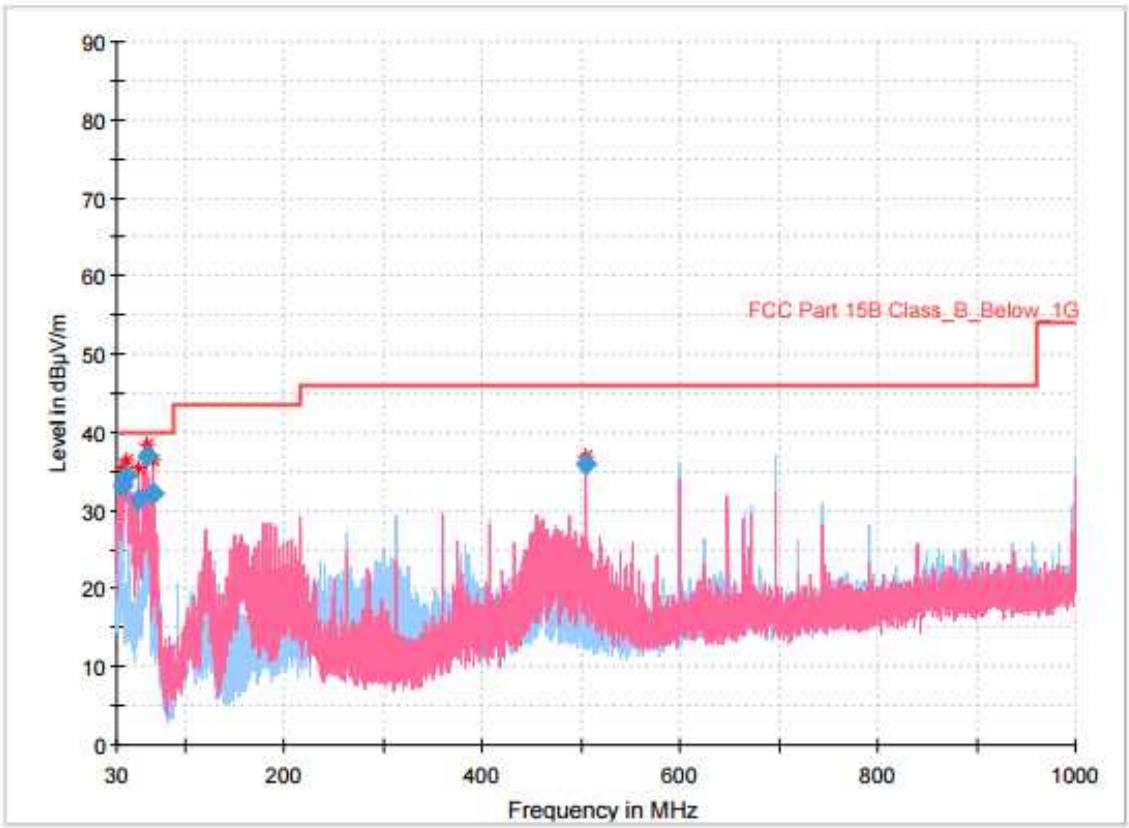
11.4.2.2.1 BDR



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
35.820000	32.95	40.00	7.05	1000.0	120.000	100.1	V	35.0	-24.5
40.185000	34.82	40.00	5.18	1000.0	120.000	100.1	V	294.0	-22.9
56.675000	32.87	40.00	7.13	1000.0	120.000	100.1	V	249.0	-22.3
59.888125	36.47	40.00	3.53	1000.0	120.000	100.1	V	273.0	-22.9
62.798125	36.15	40.00	3.85	1000.0	120.000	100.1	V	311.0	-23.6
504.026875	35.81	46.00	10.19	1000.0	120.000	100.1	V	311.0	-15.9

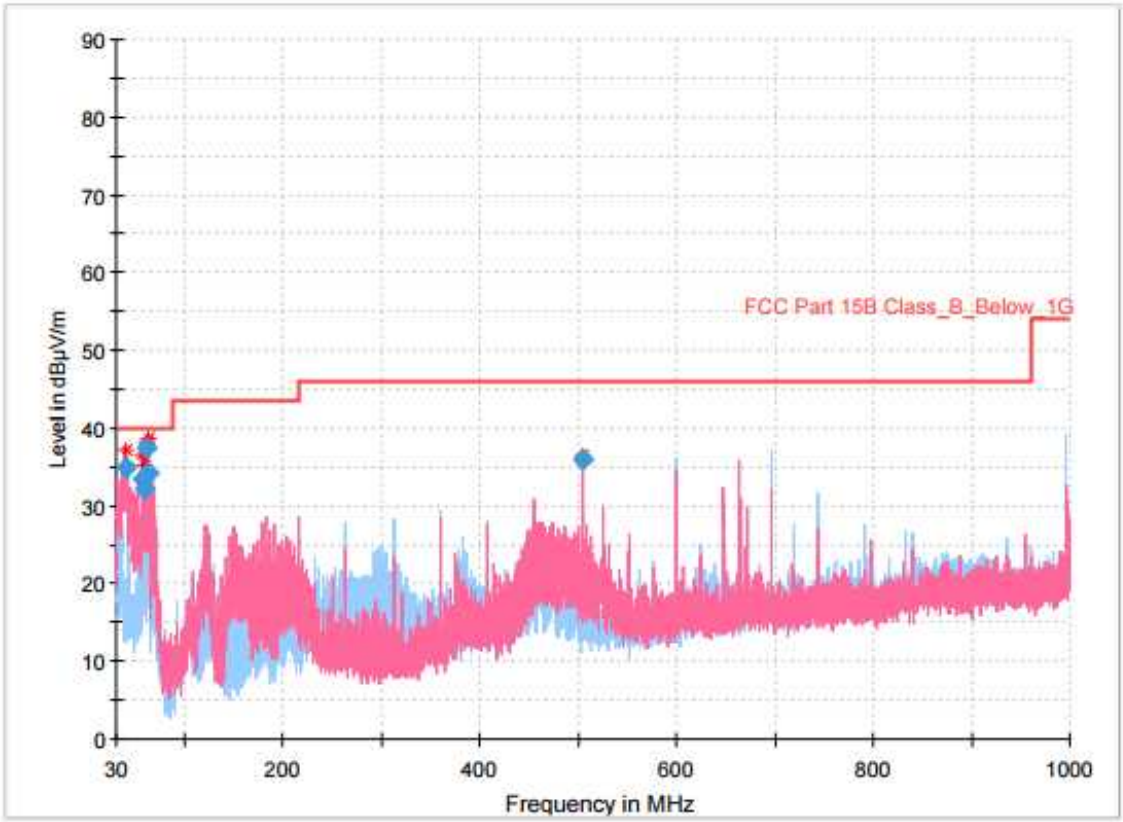
Low CH



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
35.820000	33.19	40.00	6.81	1000.0	120.000	99.9	V	187.0	-24.5
39.942500	34.38	40.00	5.62	1000.0	120.000	99.9	V	161.0	-23.0
52.370625	31.39	40.00	8.61	1000.0	120.000	99.9	V	330.0	-21.6
59.948750	36.83	40.00	3.17	1000.0	120.000	99.9	V	330.0	-22.9
68.072500	32.18	40.00	7.82	1000.0	120.000	99.9	V	103.0	-25.3
504.026875	35.84	46.00	10.16	1000.0	120.000	99.9	V	0.0	-15.9

Mid CH

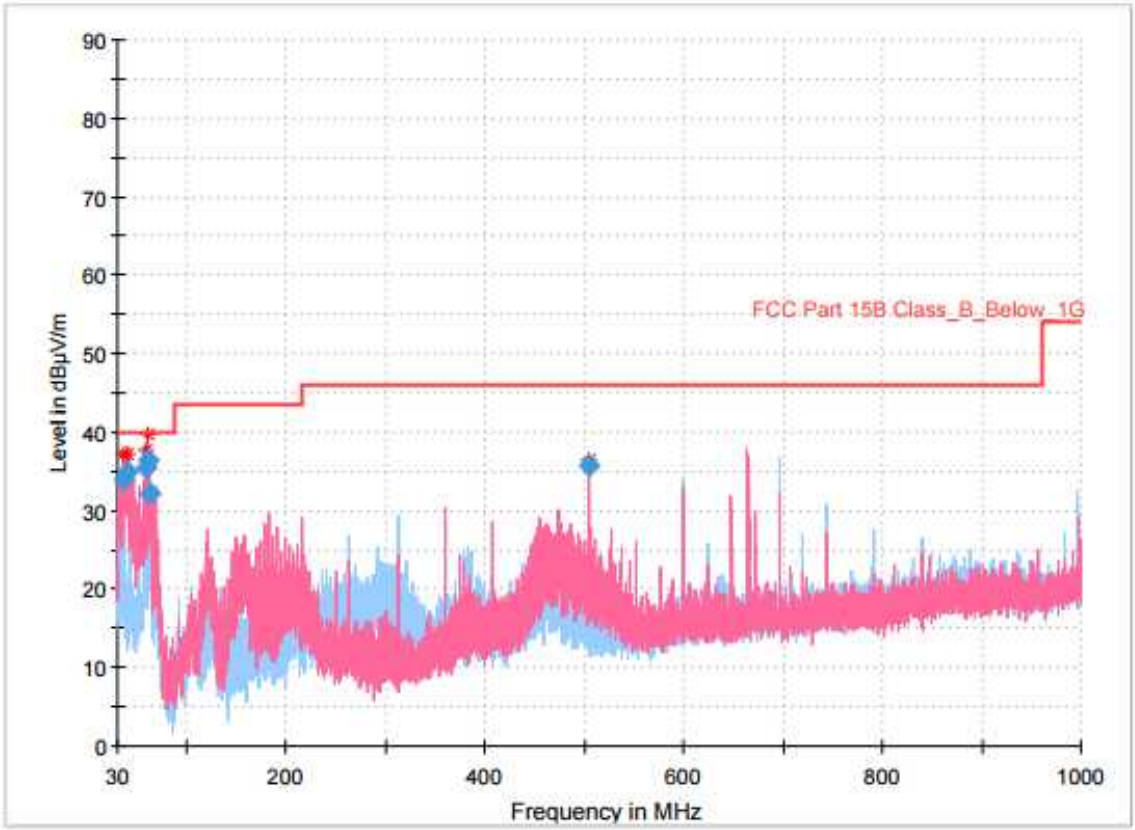


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
40.124375	34.85	40.00	5.15	1000.0	120.000	99.9	V	248.0	-23.0
57.402500	33.41	40.00	6.59	1000.0	120.000	99.9	V	262.0	-22.4
58.796875	32.22	40.00	7.78	1000.0	120.000	99.9	V	248.0	-22.7
60.070000	36.78	40.00	3.22	1000.0	120.000	99.9	V	277.0	-22.9
62.434375	34.10	40.00	5.90	1000.0	120.000	99.9	V	262.0	-23.5
504.026875	35.85	46.00	10.15	1000.0	120.000	99.9	V	0.0	-15.9

High CH

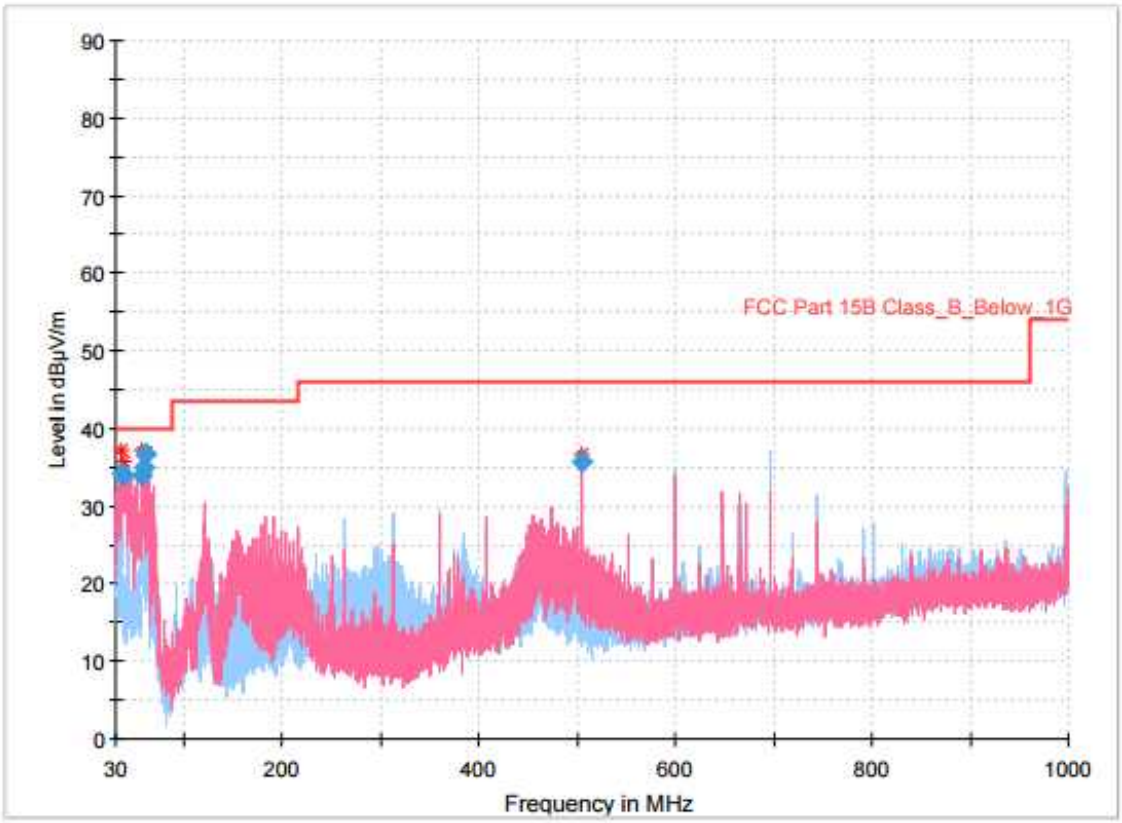
11.4.2.2.2 EDR (3 Mbps)



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
36.062500	34.04	40.00	5.96	1000.0	120.000	99.9	V	192.0	-24.4
39.881875	35.05	40.00	4.95	1000.0	120.000	99.9	V	312.0	-23.0
58.433125	35.46	40.00	4.54	1000.0	120.000	99.9	V	312.0	-22.6
59.948750	36.48	40.00	3.52	1000.0	120.000	99.9	V	312.0	-22.9
62.373750	32.21	40.00	7.79	1000.0	120.000	99.9	V	0.0	-23.5
504.026875	35.77	46.00	10.23	1000.0	120.000	99.9	V	0.0	-15.9

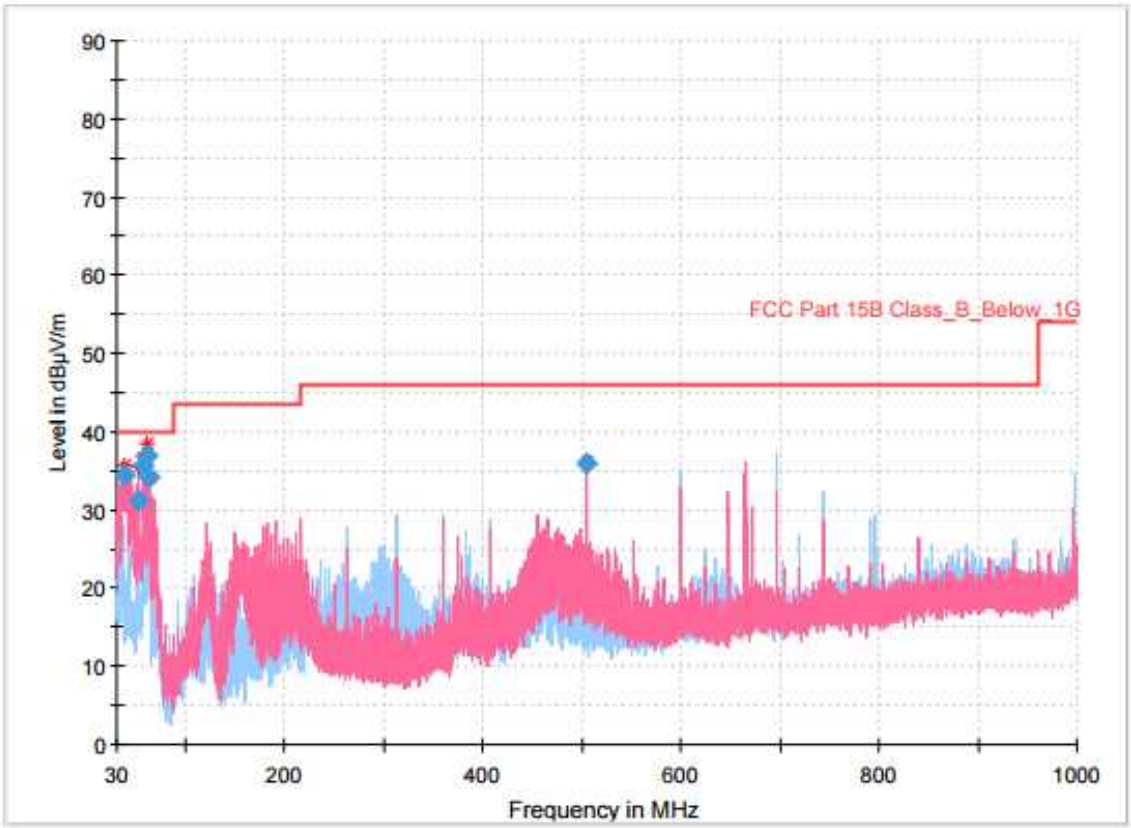
Low CH



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
36.062500	34.19	40.00	5.81	1000.0	120.000	99.9	V	143.0	-24.4
39.093750	34.05	40.00	5.95	1000.0	120.000	99.9	V	183.0	-23.2
57.038750	33.94	40.00	6.06	1000.0	120.000	99.9	V	278.0	-22.3
58.433125	35.05	40.00	4.95	1000.0	120.000	99.9	V	329.0	-22.6
59.948750	36.83	40.00	3.17	1000.0	120.000	99.9	V	329.0	-22.9
504.026875	35.65	46.00	10.35	1000.0	120.000	99.9	V	2.0	-15.9

Mid CH



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
39.154375	34.37	40.00	5.63	1000.0	120.000	99.9	V	199.0	-23.2
51.703750	31.28	40.00	8.72	1000.0	120.000	99.9	V	273.0	-21.5
57.826875	35.73	40.00	4.27	1000.0	120.000	99.9	V	311.0	-22.5
60.070000	36.84	40.00	3.16	1000.0	120.000	99.9	V	329.0	-22.9
63.343750	34.22	40.00	5.78	1000.0	120.000	99.9	V	329.0	-23.8
504.026875	35.89	46.00	10.11	1000.0	120.000	99.9	V	0.0	-15.9

High CH

11.4.2.3 Measurement Results for Above 1 ㎓

11.4.2.3.1 BDR

Frequency (㎒)	Reading (dBμV)	Detector	Ant. Pol. (H/V)	Corr. Factor (dB)	DCCF (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Low CH								
4 804.00	59.84	Peak	V	-2.22	-	57.62	73.98	-16.36
	52.41	Average	V		-24.77	25.42	53.98	-28.56
7 206.00	58.45	Peak	H	1.71	-	60.16	73.98	-13.82
	49.31	Average	H		-24.77	26.25	53.98	-27.73
Mid CH								
4 882.00	61.92	Peak	V	-1.99	-	59.93	73.98	-14.05
	53.69	Average	V		-24.77	26.93	53.98	-27.05
7 323.00	58.39	Peak	H	1.80	-	60.19	73.98	-13.79
	48.10	Average	H		-24.77	25.13	53.98	-28.85
High CH								
4 960.00	61.84	Peak	V	-1.73	-	60.11	73.98	-13.87
	53.80	Average	V		-24.77	27.30	53.98	-26.68

※ Ant. Pol. : Antenna Polarization
※ Corr Factor. : Antenna Factor + Cable Loss - Amplifier Gain
※ DCCF(Duty Cycle Correction Factor): 20 * Log(worst case dwell time / 100 ㎳) dB
※ Result = Reading + Corr Factor+ DCCF
※ Margin = Result - Limit

11.4.2.3.2 EDR (3 Mbps)

Frequency (㎒)	Reading (dBμV)	Detector	Ant. Pol. (H/V)	Corr. Factor (dB)	DCCF (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Low CH								
4 804.00	51.08	Peak	V	-2.22	-	48.86	73.98	-25.12
	39.30	Average	V		-24.77	12.31	53.98	-41.67
Mid CH								
4 882.00	52.26	Peak	V	-1.99	-	50.27	73.98	-23.71
	40.59	Average	V		-24.77	13.83	53.98	-40.15
High CH								
4 960.00	53.11	Peak	V	-1.73	-	51.38	73.98	-22.60
	41.44	Average	V		-24.77	14.94	53.98	-39.04

※ Ant. Pol. : Antenna Polarization

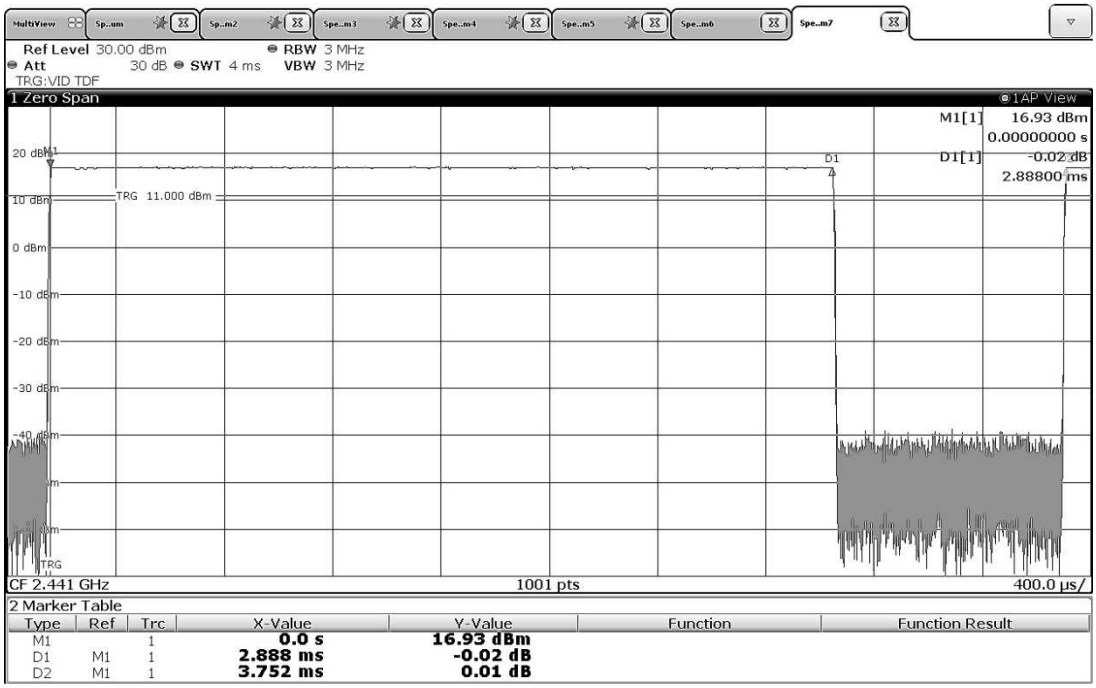
※ Corr. Factor. : Antenna Factor + Cable Loss - Amplifier Gain

※ DCCF(Duty Cycle Correction Factor): 20 * Log(worst case dwell time / 100 ㎳) dB

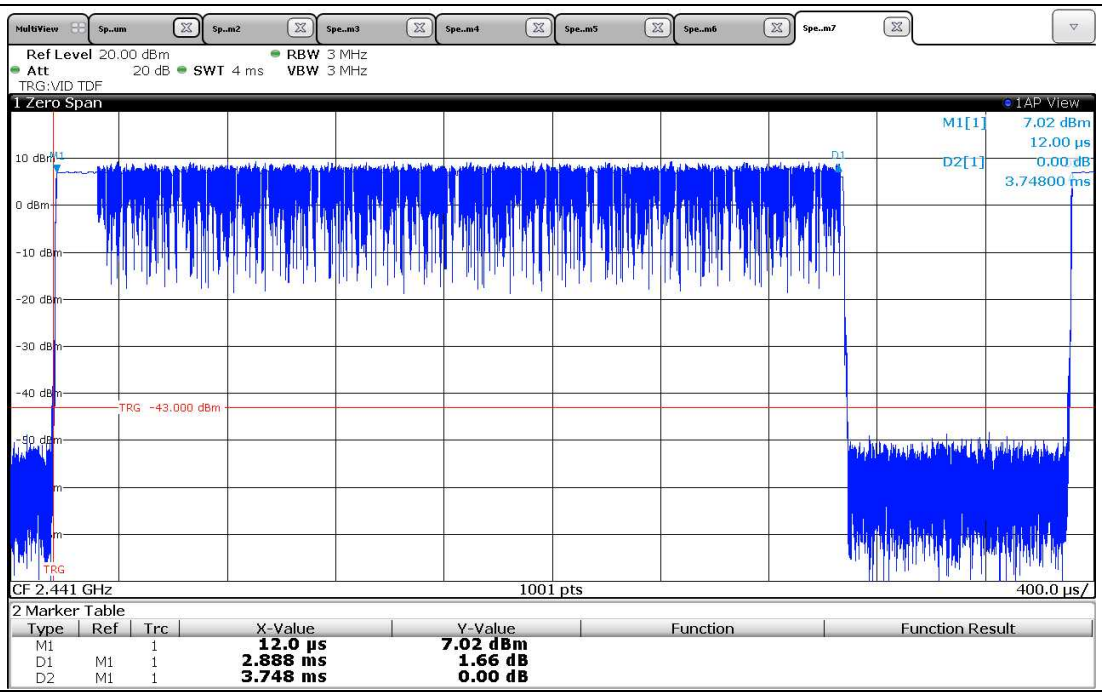
※ Result = Reading + Corr. Factor+ DCCF

※ Margin = Result – Limit

11.4.2.3.3 Measured Duty cycle



BDR



EDR

Dwell time: on time * No. of hop

DCCF(Duty cycle Correction Factor) = 20log(dwell time/100)

12. Power Line Conducted Emission

12.1 Operating environment

Temperature : 22 ℃

Relative humidity : 44 %

12.2 Measurement method

Standard : §15.207 / RSS-GEN 8.8

12.3 Test setup

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

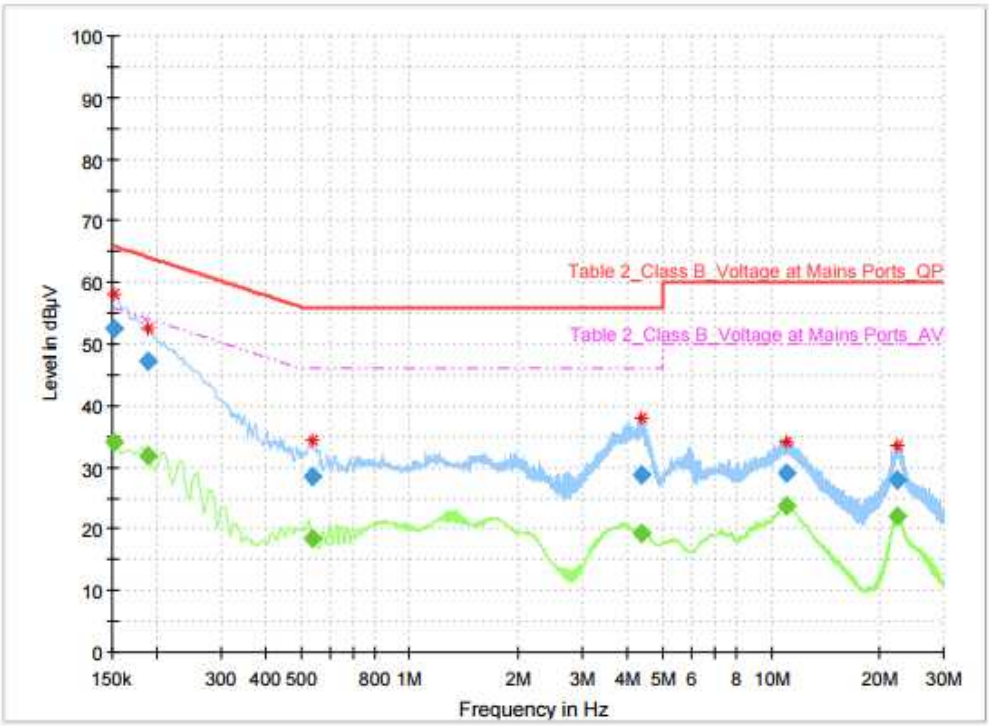
12.4 Test data

Test date : 26. Mar. 2019

Operating mode : Transmit mode

Test Result : Pass

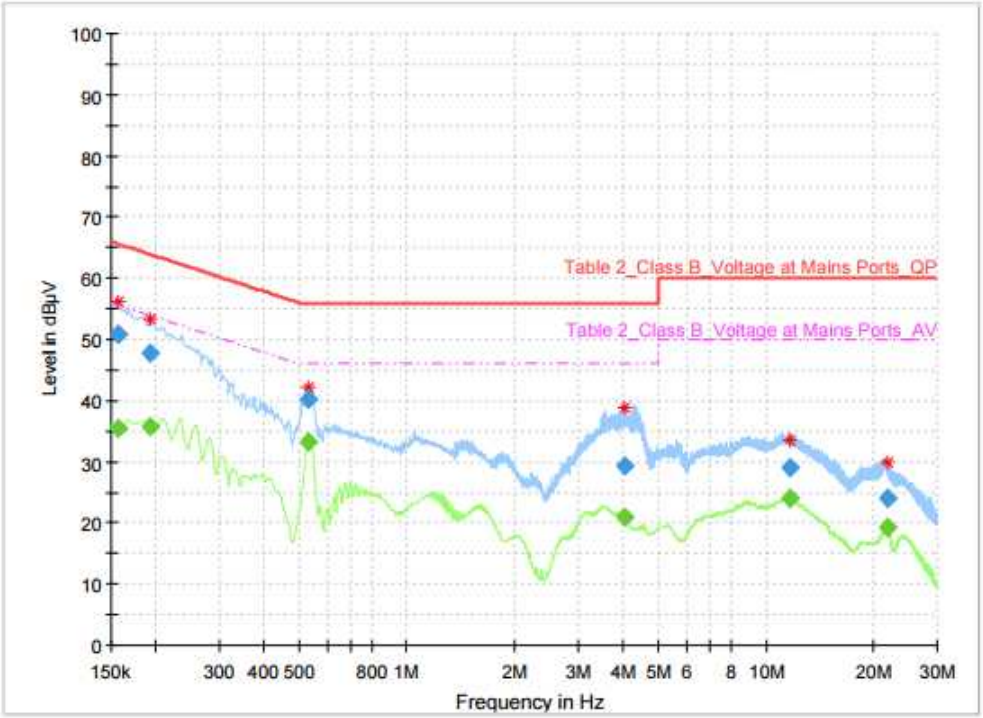
12.4.1 Measured Results & Graph



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.152250	---	34.12	55.88	21.75	1000.0	9.000	L1	ON	9.8
0.152250	52.43	---	65.88	13.44	1000.0	9.000	L1	ON	9.8
0.188250	---	31.84	54.11	22.27	1000.0	9.000	L1	ON	9.9
0.188250	47.28	---	64.11	16.83	1000.0	9.000	L1	ON	9.9
0.539250	---	18.43	46.00	27.57	1000.0	9.000	L1	ON	9.9
0.539250	28.43	---	56.00	27.57	1000.0	9.000	L1	ON	9.9
4.377750	---	19.22	46.00	26.78	1000.0	9.000	L1	ON	9.8
4.377750	28.90	---	56.00	27.10	1000.0	9.000	L1	ON	9.8
10.990500	---	23.87	50.00	26.13	1000.0	9.000	L1	ON	9.9
10.990500	28.95	---	60.00	31.05	1000.0	9.000	L1	ON	9.9
22.380000	---	21.93	50.00	28.07	1000.0	9.000	L1	ON	10.0
22.380000	27.99	---	60.00	32.01	1000.0	9.000	L1	ON	10.0

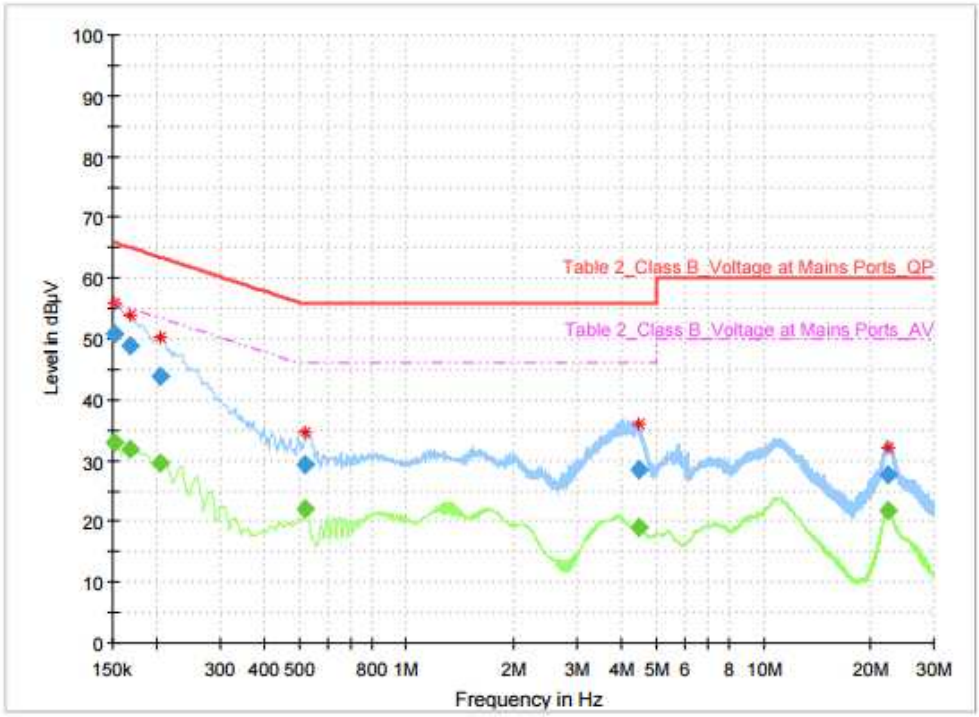
BDR_Live line



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.156750	---	35.61	55.63	20.03	1000.0	9.000	N	ON	9.8
0.156750	50.90	---	65.63	14.74	1000.0	9.000	N	ON	9.8
0.192750	---	35.62	53.92	18.30	1000.0	9.000	N	ON	9.9
0.192750	47.73	---	63.92	16.19	1000.0	9.000	N	ON	9.9
0.532500	---	33.16	46.00	12.84	1000.0	9.000	N	ON	9.9
0.532500	40.14	---	56.00	15.86	1000.0	9.000	N	ON	9.9
4.031250	---	20.97	46.00	25.03	1000.0	9.000	N	ON	9.8
4.031250	29.27	---	56.00	26.73	1000.0	9.000	N	ON	9.8
11.609250	---	23.91	50.00	26.09	1000.0	9.000	N	ON	10.0
11.609250	29.14	---	60.00	30.86	1000.0	9.000	N	ON	10.0
21.817500	---	19.18	50.00	30.82	1000.0	9.000	N	ON	10.0
21.817500	23.92	---	60.00	36.08	1000.0	9.000	N	ON	10.0

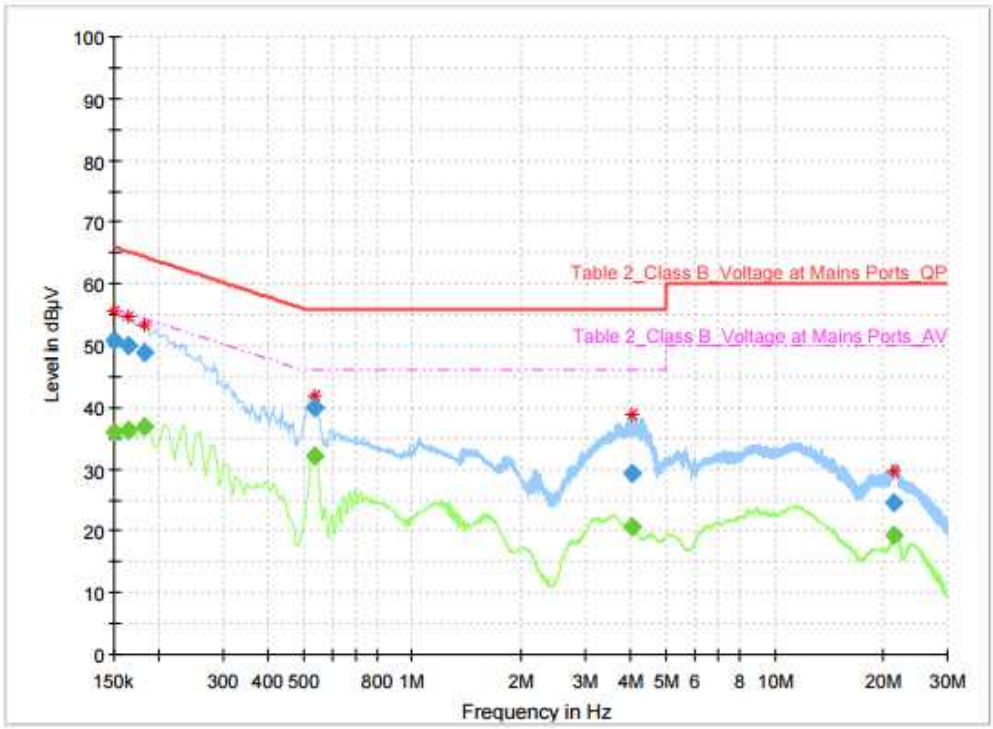
BDR_Neutral line



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.152250	---	32.92	55.88	22.96	1000.0	9.000	L1	ON	9.8
0.152250	50.91	---	65.88	14.97	1000.0	9.000	L1	ON	9.8
0.168000	---	31.93	55.06	23.13	1000.0	9.000	L1	ON	9.9
0.168000	48.84	---	65.06	16.21	1000.0	9.000	L1	ON	9.9
0.204000	---	29.54	53.45	23.91	1000.0	9.000	L1	ON	9.8
0.204000	43.80	---	63.45	19.64	1000.0	9.000	L1	ON	9.8
0.521250	---	22.11	46.00	23.89	1000.0	9.000	L1	ON	9.9
0.521250	29.22	---	56.00	26.78	1000.0	9.000	L1	ON	9.9
4.467750	---	19.05	46.00	26.95	1000.0	9.000	L1	ON	9.8
4.467750	28.48	---	56.00	27.52	1000.0	9.000	L1	ON	9.8
22.220250	---	21.81	50.00	28.19	1000.0	9.000	L1	ON	10.0
22.220250	27.67	---	60.00	32.33	1000.0	9.000	L1	ON	10.0

EDR_Live line



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.150000	---	36.09	56.00	19.91	1000.0	9.000	N	ON	9.7
0.150000	50.94	---	66.00	15.06	1000.0	9.000	N	ON	9.7
0.163500	---	36.32	55.28	18.96	1000.0	9.000	N	ON	9.9
0.163500	49.96	---	65.28	15.33	1000.0	9.000	N	ON	9.9
0.181500	---	36.95	54.42	17.47	1000.0	9.000	N	ON	9.9
0.181500	48.92	---	64.42	15.50	1000.0	9.000	N	ON	9.9
0.534750	---	32.26	46.00	13.74	1000.0	9.000	N	ON	9.9
0.534750	39.89	---	56.00	16.11	1000.0	9.000	N	ON	9.9
4.024500	---	20.53	46.00	25.47	1000.0	9.000	N	ON	9.8
4.024500	29.24	---	56.00	26.76	1000.0	9.000	N	ON	9.8
21.293250	---	19.23	50.00	30.77	1000.0	9.000	N	ON	10.0
21.293250	24.55	---	60.00	35.45	1000.0	9.000	N	ON	10.0

EDR_Neutral line