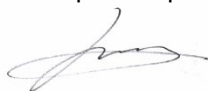


FCC & ISED CERTIFICATION TEST REPORT

Project Number : EA2002C-029
Test Report Number : TR-W2006-009
Type of Equipment : WiFi/BT Combo Module
Model Name : SBW-M3
Equipment Class : DSS - Part 15 Spread Spectrum Transmitter
FCC ID : WF5SBWM3
ISED Canada ID : 9080A-SBWM3
Applicant : Aroot Co., Ltd.
Address : 28-6, Gajangsaneopdong-ro, Osan-si, Gyeonggi-do, Republic of Korea
Manufacturer : Aroot Co., Ltd.
Address : 28-6, Gajangsaneopdong-ro, Osan-si, Gyeonggi-do, Republic of Korea
Regulation : FCC Part 15 Subpart C Section 15.247, ISED RSS-247 Issue2
Total page of Report : 81 Pages
Date of Receipt : 2020-02-10
Date of Issue : 2020-06-09
Test Result : PASS

This test report only contains the result of a single test of the sample supplied for the examination.
 It is not a generally valid assessment of the features of the respective products of the mass-production.

Prepared by	Song, In-young / Senior Engineer		2020-06-09
		Signature	Date
Reviewed by	Choi, Yeong-min / Technical Manager		2020-06-09
		Signature	Date

CONTENTS

Page

1. TEST SUMMARY	5
1.1 REGULATIONS AND RESULTS	5
1.2 TEST METHODOLOGY	5
1.3 ADDITIONS, DEVIATIONS, EXCLUSIONS FROM STANDARDS	5
1.4 PURPOSE OF THE TEST	5
2. EUT (EQUIPMENT UNDER TEST) INFORMATION	7
2.1 GENERAL DESCRIPTION	7
2.2 ADDITIONAL MODEL	7
2.3 AVAILABLE CHANNEL NUMBER AND FREQUENCY	8
3. TEST CONDITION	9
3.1 EQUIPMENT USED DURING TEST	9
3.2 MODE OF OPERATION DURING THE TEST	9
3.3 PRELIMINARY TESTING FOR WORST CASE CONFIGURATION	9
3.4 TEST SETUP DRAWING	10
3.5 EUT MODIFICATIONS	10
4. ANTENNA REQUIREMENT	11
4.1 ANTENNA DESCRIPTION	11
4.2 CONCLUSION	11
5. TEST RESULT	12
5.1 20 DB BANDWIDTH	12
5.2 99 % BANDWIDTH	16
5.3 CARRIER FREQUENCY SEPARATION	20
5.4 NUMBER OF HOPPING CHANNELS	24
5.5 TIME OF OCCUPANCY (DWELL TIME)	26
5.6 MAXIMUM PEAK CONDUCTED OUTPUT POWER	33
5.7 BAND-EDGE AND OUT OF BAND EMISSION	39

5.8 RADIATED EMISSION	50
APPENDIX I – TEST INSTRUMENTATION	80

Release Control Record

Issue Report No.	Issued Date	Details/Revisions
TR-W2006-009	2020-06-09	Initial Release
-	-	-

1. TEST SUMMARY

1.1 Regulations and results

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

FCC Reference Section	ISED Reference Section	Description	Result			
			P	F	N.T.	Note
15.247(a)(1)	RSS-247 5.1(1)	20 dB Bandwidth Occupied Bandwidth	P			
15.247(a)(1)	RSS-247 5.1(2)	Carrier Frequency Separation	P			
15.247 (a)(1)(iii)	RSS-247 5.1(4)	Number of Hopping Frequencies	P			
15.247 (a)(1)(iii)	RSS-247 5.1(4)	Time of Occupancy (Dwell Time)	P			
15.247(b)(1)	RSS-247 5.1(2)	Maximum Peak Conducted Output power	P			
15.247(d)	RSS-247 5.5	Band Edge Conducted spurious emission	P			
15.205(a) 15.209(a)	RSS 247 5.5 RSS-GEN 8.9	Radiated spurious emissions	P			
15.207(a)	RSS GEN 8.8	AC power line conducted emissions	P			
Remark: P means Passed F means Failed N.T. means Not Tested						

1.2 Test Methodology

The tests mentioned in clause 1.1 in this test report were performed according to FCC CFR 47 Part 2, CFR 47 Part 15 and ANSI C63.10-2013, and RSS-Gen Issue 4.

1.3 Additions, deviations, exclusions from standards

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

1.4 Purpose of the test

The test was performed to determine whether the equipment under test fulfills the requirements of the regulation stated in FCC Part 15 Subpart C Section 15.247, RSS-Gen and RSS-247.

1.5 Test Facility

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

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

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

2. EUT (Equipment Under Test) INFORMATION

2.1 General Description

The Aroot Co., Ltd., Model SBW-M3 (referred to as the EUT in this report) is a WiFi/BT Combo Module, which has 3 Equipment Class, DSS, DTS, and NII. This report covers only DSS portion and other functions cover other test report. The product specification described herein was obtained from product data sheet or user's manual.

Equipment Class	DSS – Part15 Spread Spectrum Transmitter
Operating Frequency	2 402 MHz ~ 2 480 MHz
Max. RF Output Power	6.21 dBm
Modulation Types	GFSK, $\pi/4$ DQPSK / 8DPSK
Number of Channels	79 channels
Channel Spacing	1 MHz
Generated or used Freq. in EUT	32.768 kHz, 37.4 MHz
Type of Antenna	☐ Integrated Type ☒ Dedicated Type (Chip antenna)
Antenna Gain	2.07dBi
Operating Temperature	- 20 °C ~ + 85 °C
Normal Test Voltage	DC 3.3 V
Electrical Rating	DC 3.3 V
Test SW Version	Broadcom BlueTool v1.9.4.5
RF power setting in TEST SW	Specify power table index 0
Software Version	Ver 1.0
Hardware Version	Ver 1.0

2.2 Additional Model

None

2.3 Available channel number and frequency

Operating Mode: Bluetooth BR/EDR, 1 MHz Channel Spacing					
Channel	Frequency(MHz)	Channel	Frequency(MHz)	Channel	Frequency(MHz)
0	2 402	27	2 429	54	2 456
1	2 403	28	2 430	55	2 457
2	2 404	29	2 431	56	2 458
3	2 405	30	2 432	57	2 459
4	2 406	31	2 433	58	2 460
5	2 407	32	2 434	59	2 461
6	2 408	33	2 435	60	2 462
7	2 409	34	2 436	61	2 463
8	2 410	35	2 437	62	2 464
9	2 411	36	2 438	63	2 465
10	2 412	37	2 439	64	2 466
11	2 413	38	2 440	65	2 467
12	2 414	39	2 441	66	2 468
13	2 415	40	2 442	67	2 469
14	2 416	41	2 443	68	2 470
15	2 417	42	2 444	69	2 471
16	2 418	43	2 445	70	2 472
17	2 419	44	2 446	71	2 473
18	2 420	45	2 447	72	2 474
19	2 421	46	2 448	73	2 475
20	2 422	47	2 449	74	2 476
21	2 423	48	2 450	75	2 477
22	2 424	49	2 451	76	2 478
23	2 425	50	2 452	77	2 479
24	2 426	51	2 453	78	2 480
25	2 427	52	2 454		
26	2 428	53	2 455		

3. TEST CONDITION

3.1 Equipment Used During Test

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

Description	Model No.	Serial No.	Manufacturer.
WiFi/BT Combo Module (EUT)	SBW-M3	N/A	Aroot Co., Ltd.
Notebook PC	15s-du0069TU	CND9503W22	HP
Adapter for Notebook PC	TPN-CA14	N/A	Chicony Power Technology (Chongqing) Co., Ltd.

3.2 Mode of operation during the test

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

The used modulation type for the testing is GFSK, $\pi/4$ DQPSK and 8DPSK.

3.3 Preliminary Testing for Worst case configuration

For finding worst case configuration and operating mode, preliminary testing was performed and radiated emission and conducted emission tests were performed with the EUT set to transmit and receive at the channel with the highest output power as worst case scenario. All spurious emission tests were performed in X, Y and Z axis direction. And the worst X-axis (9 kHz ~ 30 MHz, 30 MHz ~ 1 GHz, Above 1 GHz) test condition was recorded in this test report.

Based on preliminary testing following operating modes were selected for the final test as listed below.

3.3.1 Conducted & Radiated Test Channel and Frequency

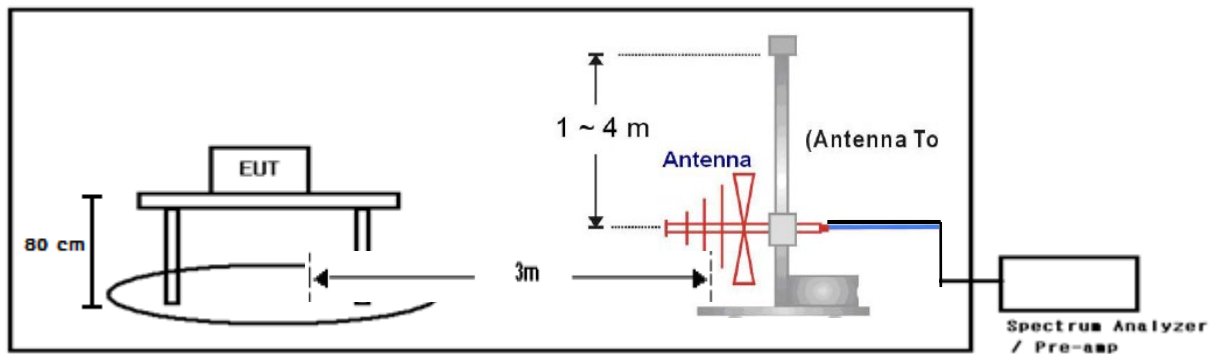
Operating Mode	Data rate (Mbps)	Measured Output Power(dBm)
BR (GFSK)	DH1	6.21
	DH3	6.21
	DH5	5.86
EDR ($\pi/4$ DQPSK)	2-DH1	5.69
	2-DH3	5.59
	2-DH5	4.94
EDR (8DPSK)	3-DH1	5.86
	3-DH3	5.82
	3-DH5	5.23

3.3.2 AC power line conducted Emission Test Mode

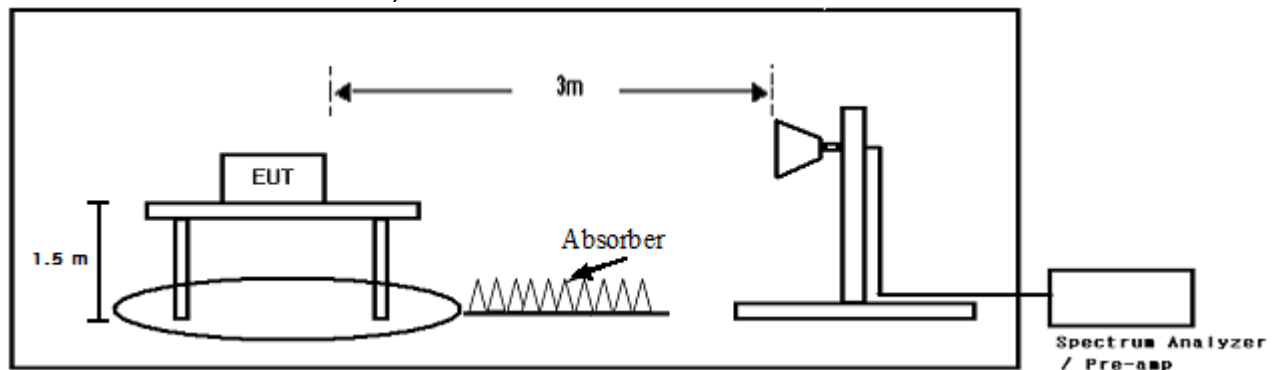
Operating Mode	Tested Channel	Data rate (Mbps)	Output Power (dBm)
BR (GFSK)	Low	1	6.21
EDR (8DPSK)	Low	3	5.86

3.4 Test Setup Drawing

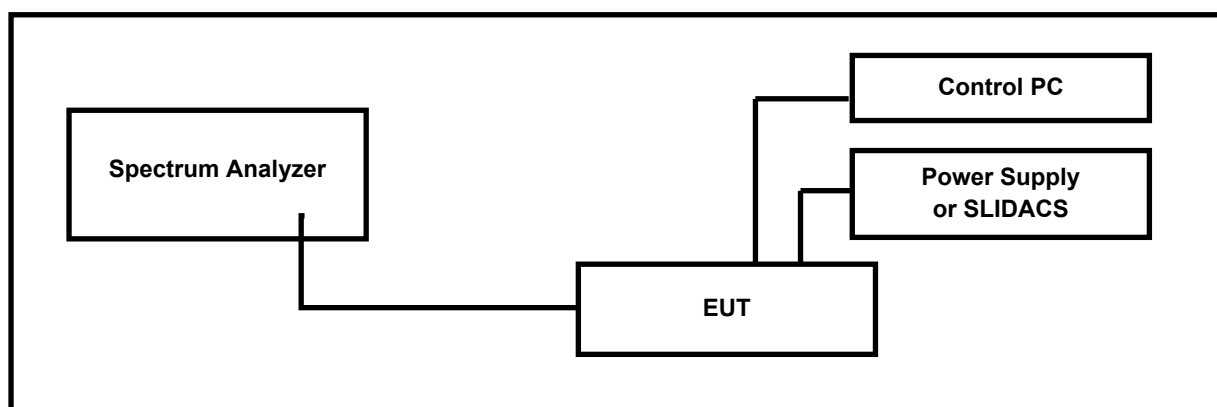
(Radiated Test below 1 GHz)



(Radiated Test above 1 GHz)



(Conducted Test)



3.5 EUT Modifications

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

4. ANTENNA REQUIREMENT

According to FCC CFR 47 Part 15 section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provision of this section.

4.1 Antenna Description

Frequency Band (GHz)	Antenna Type	Max Peak Gain (dBi)	Connector Type
2.402 – 2.480	Chip Antenna	2.07	-

4.2 Conclusion

The antenna type of the EUT is Chip Antenna, so the EUT met the requirement.

5. TEST RESULT

5.1 20 dB Bandwidth

5.1.1 Limit

Not applicable.

5.1.2 Method of Measurement

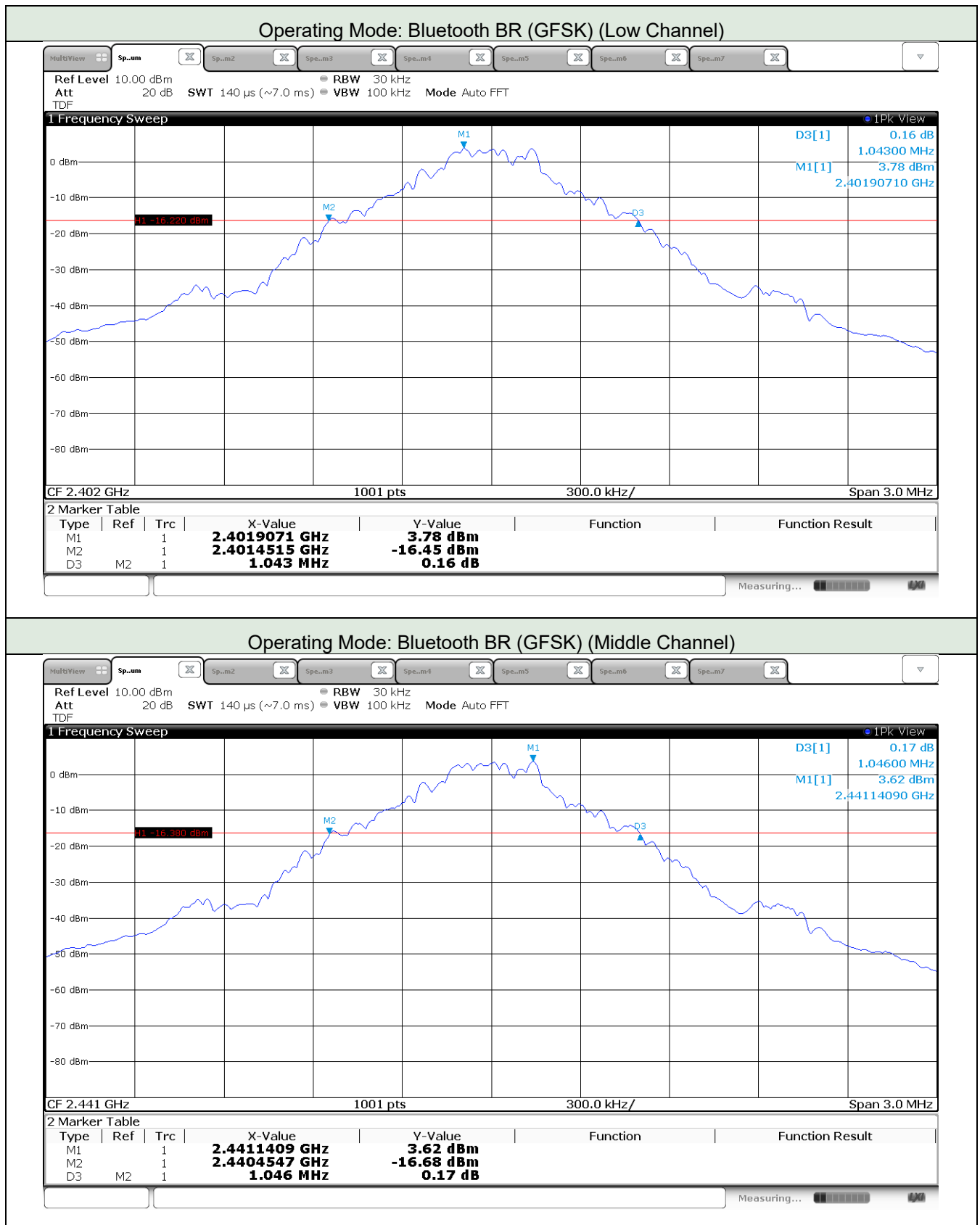
Reference to ANSI C63.10-2013 6.9.2 and 6.9.3

The transmitter output is connected to a spectrum analyzer with the RBW set to 30 kHz, VBW $\geq 3 \times$ RBW, peak detector and max hold.

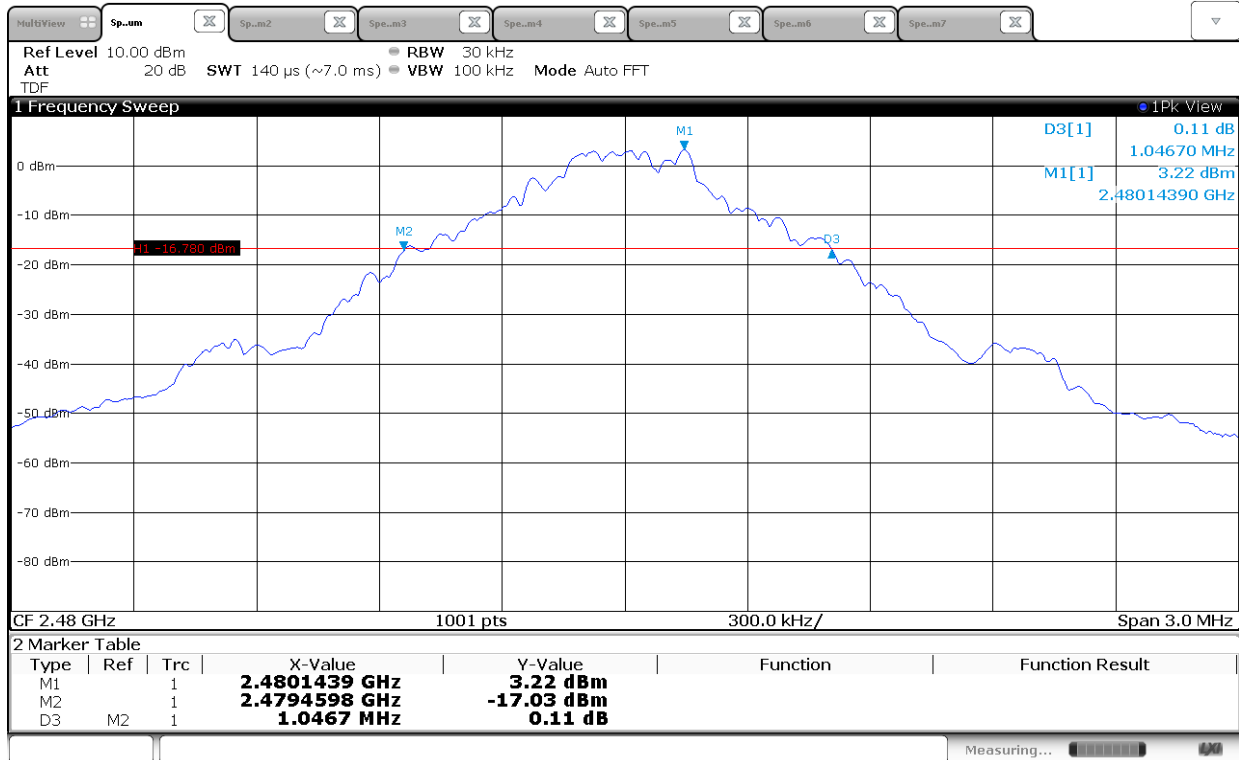
5.1.3 Test Data

Date of Test	2020-04-08	Temperature	(20.5 ± 0.8) °C
		Relative humidity	(38.6 ± 0.6) % R.H.
Test Result	PASS	Tested by	In-yong Song 
Operational Mode: Bluetooth BR (GFSK)			
Channel	Frequency (MHz)		20 dB Bandwidth (MHz)
Low	2 402		1.043
Middle	2 441		1.046
High	2 480		1.047
Operational Mode: Bluetooth EDR (8DPSK)			
Channel	Frequency (MHz)		20 dB Bandwidth (MHz)
Low	2 402		1.3337
Middle	2 441		1.3367
High	2 480		1.3374

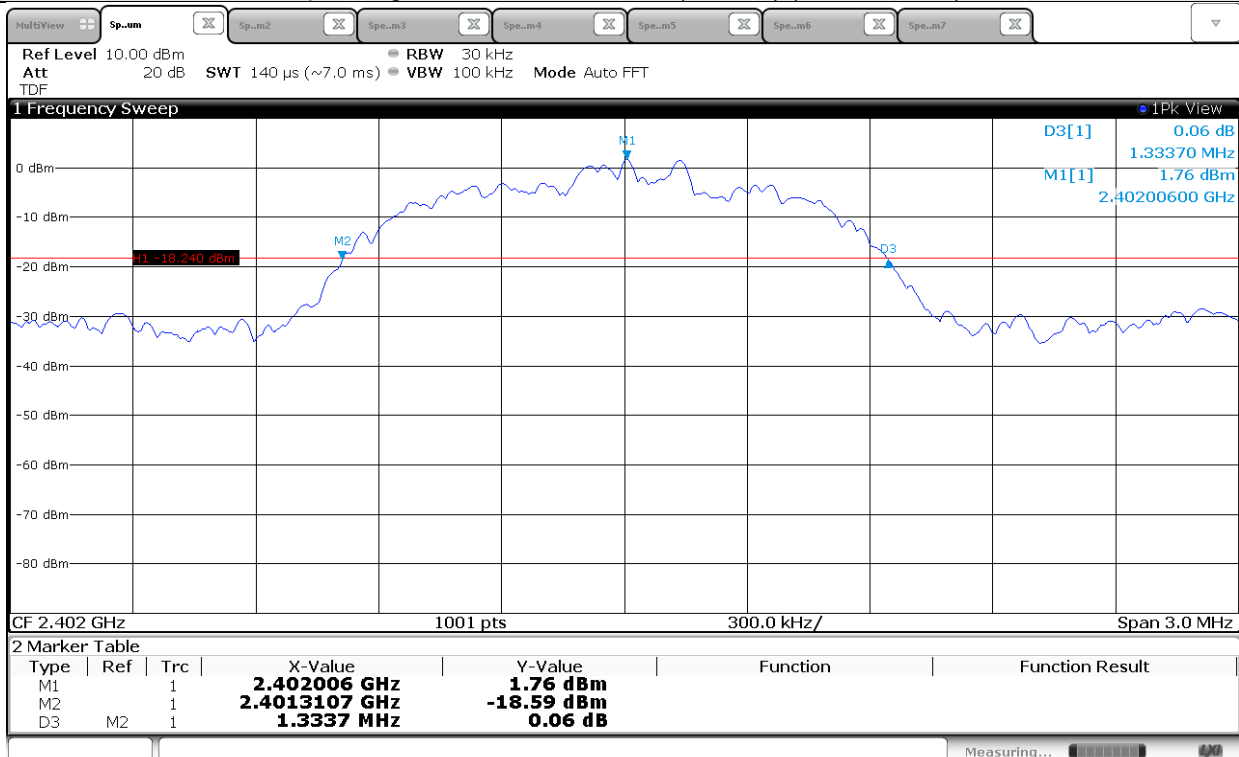
5.1.4 Test Plots



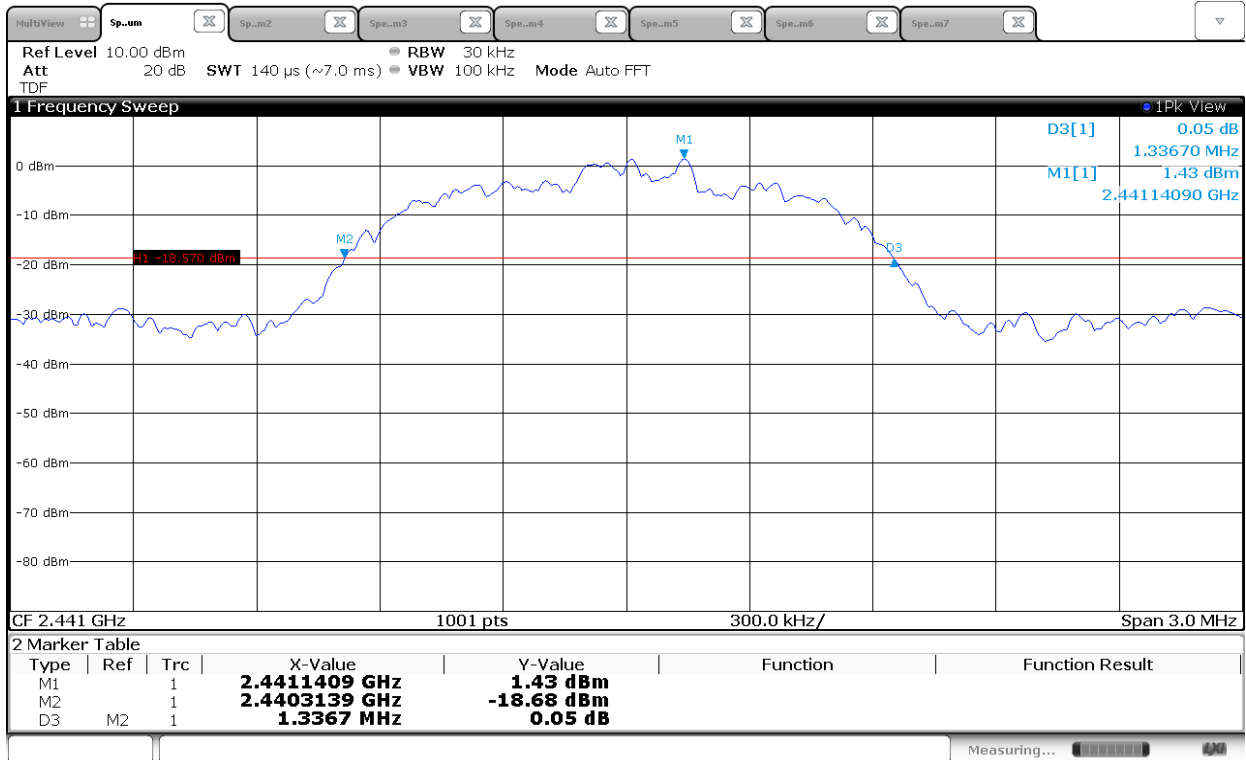
Operating Mode: Bluetooth BR (GFSK) (High Channel)



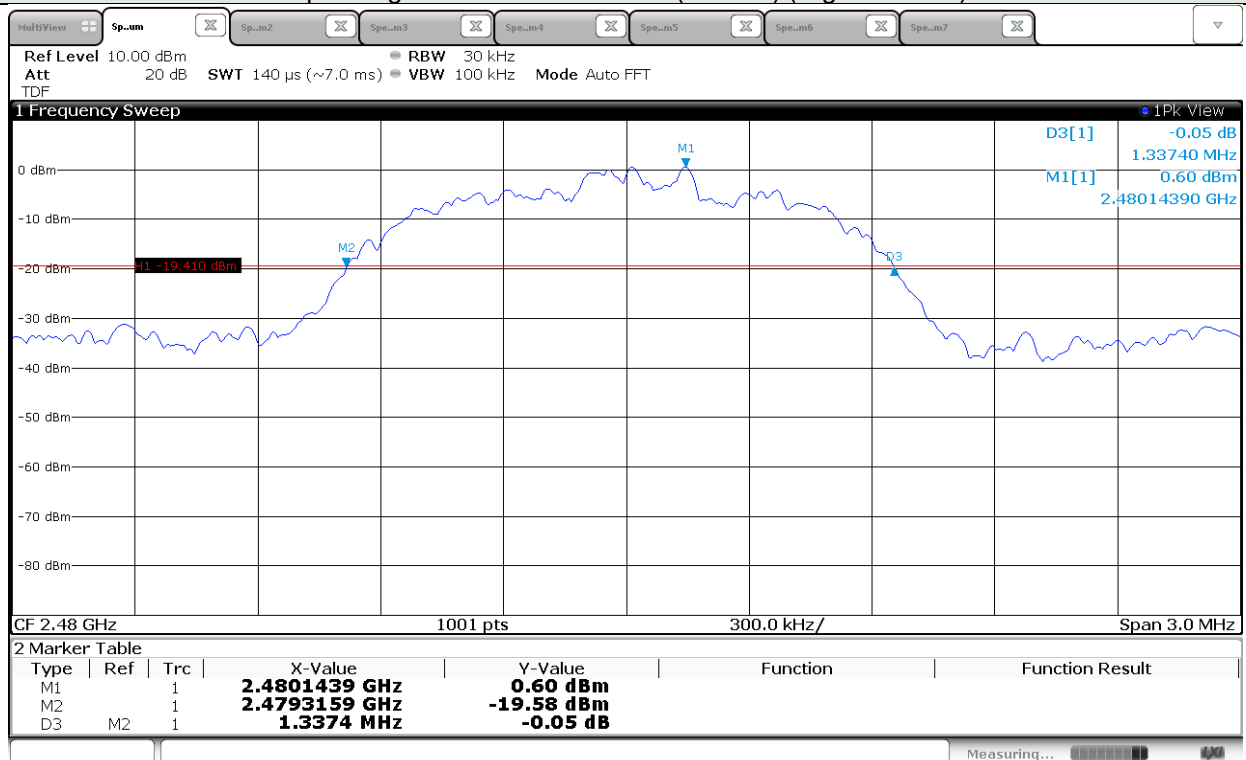
Operating Mode: Bluetooth EDR (8DPSK) (Low Channel)



Operating Mode: Bluetooth EDR (8DPSK) (Middle Channel)



Operating Mode: Bluetooth EDR (8DPSK) (High Channel)



5.2 99 % Bandwidth

5.2.1 Limit

Not applicable.

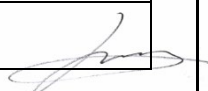
5.2.2 Method of Measurement

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

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

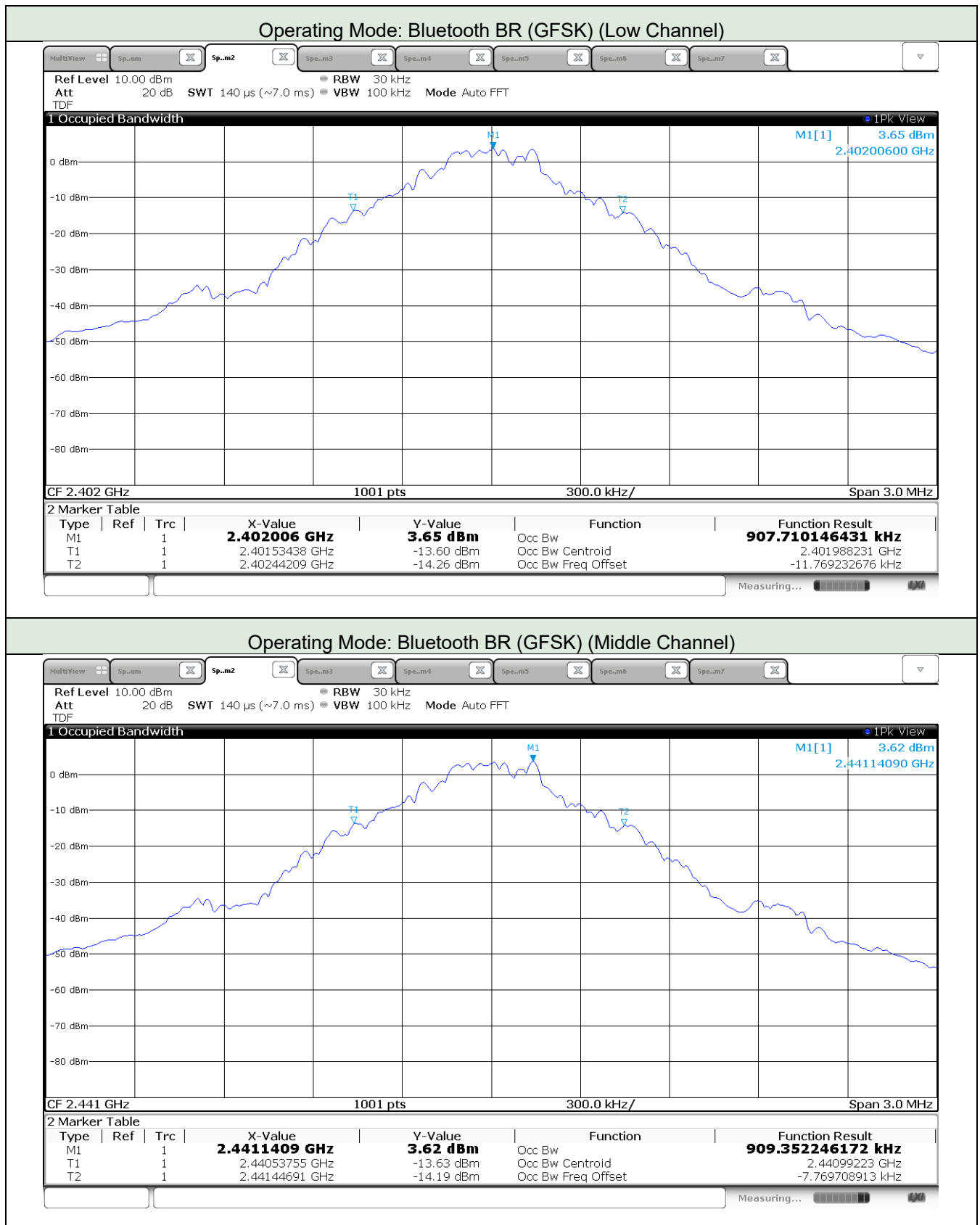
The VBW is set to 3 times the RBW. The sweep time is coupled and peak detection and max hold mode is used. The spectrum analyzer internal 99% bandwidth function is utilized.

5.2.3 Test Data

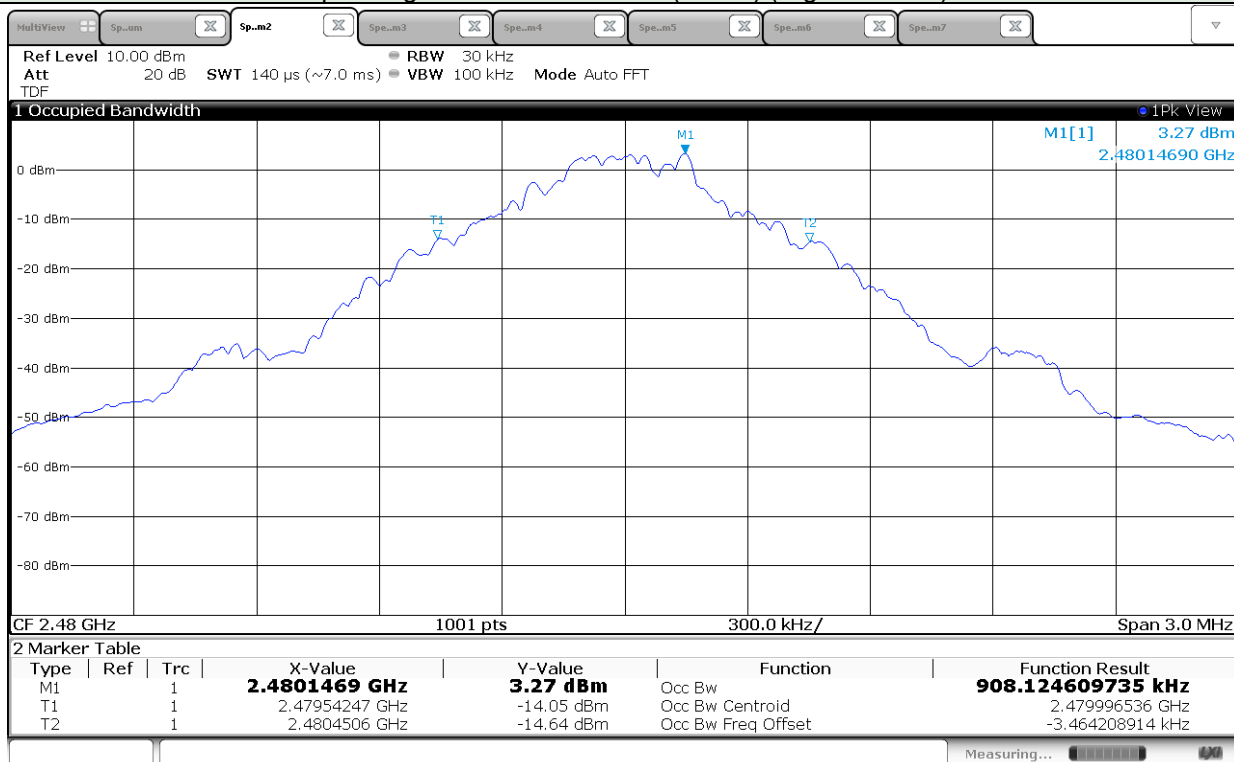
Date of Test	2020-04-08	Temperature	(20.5 ± 0.8) °C
		Relative humidity	(38.6 ± 0.6) % R.H.
Test Result	PASS	Tested by	In-yong Song 

Operational Mode: Bluetooth BR (GFSK)		
Channel	Frequency (MHz)	99 % Bandwidth (MHz)
Low	2 402	0.9077
Middle	2 441	0.9094
High	2 480	0.9081
Operational Mode: Bluetooth EDR (8DPSK)		
Channel	Frequency (MHz)	99 % Bandwidth (MHz)
Low	2 402	1.2248
Middle	2 441	1.2279
High	2 480	1.2163

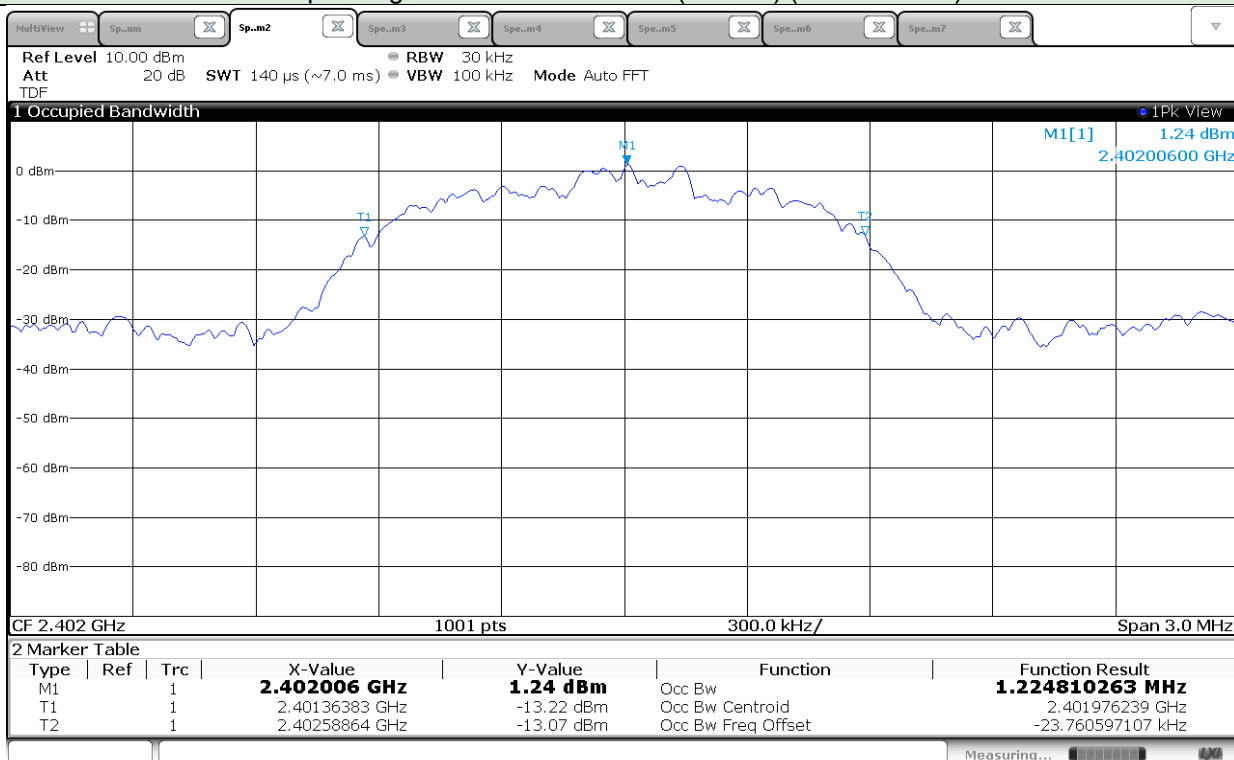
5.2.4 Test Plots



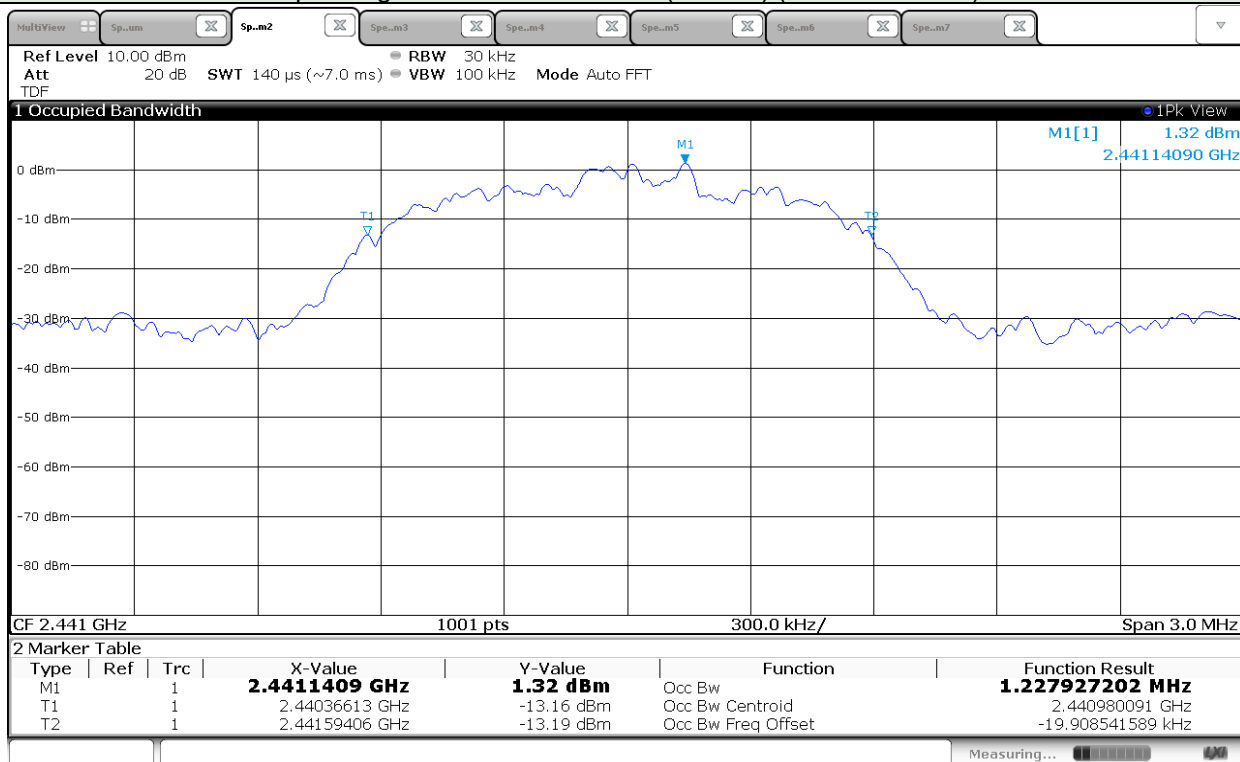
Operating Mode: Bluetooth BR (GFSK) (High Channel)



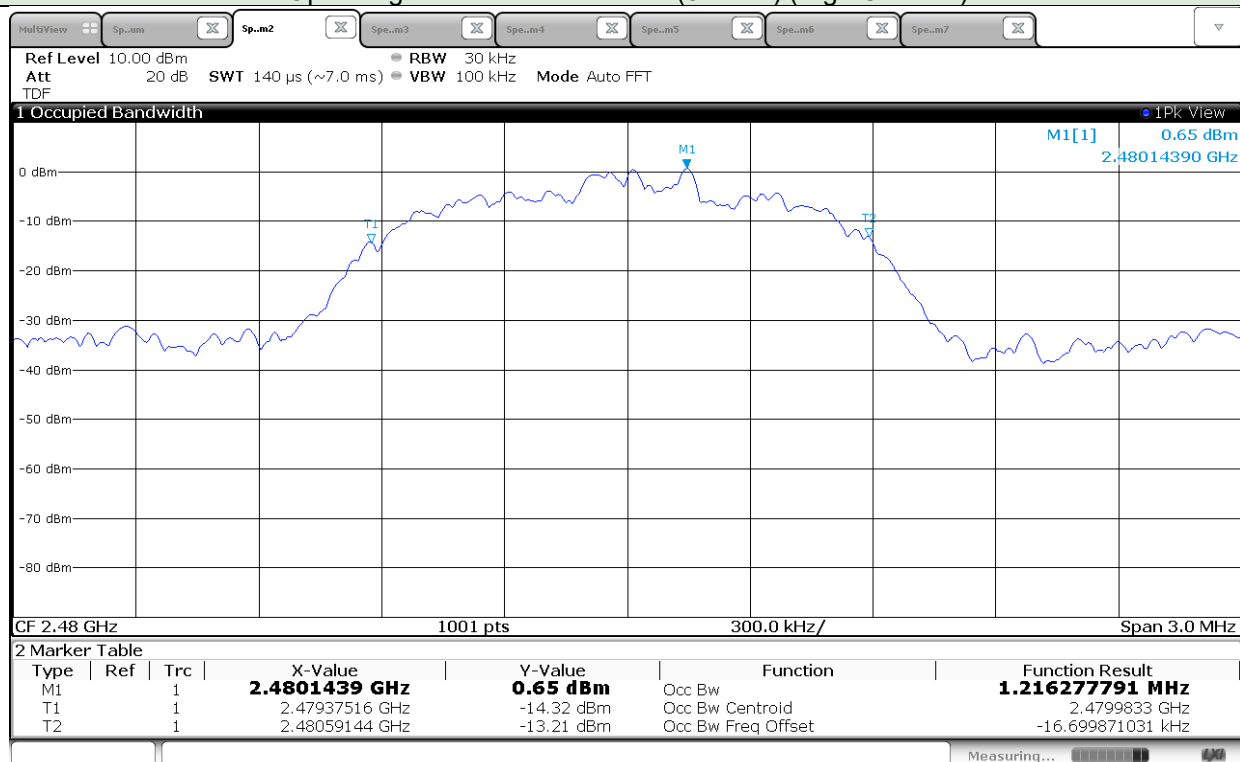
Operating Mode: Bluetooth EDR (8DPSK) (Low Channel)



Operating Mode: Bluetooth EDR (8DPSK) (Middle Channel)



Operating Mode: Bluetooth EDR (8DPSK) (High Channel)



5.3 Carrier Frequency Separation

5.3.1 Limit

Acc. To section 15.247 (a)(1) and RSS-247 5.1 (2), frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.

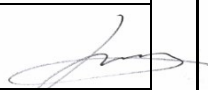
5.3.2 Method of Measurement

Reference to ANSI C63.10-2013 7.8.2

The Spectrum analyzer is set to

- a) Span: Wide enough to capture the peaks of two adjacent channels.
- b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
- c) Video (or average) bandwidth (VBW) $\geq$ RBW.
- d) Sweep: Auto.
- e) Detector function: Peak.
- f) Trace: Max hold.

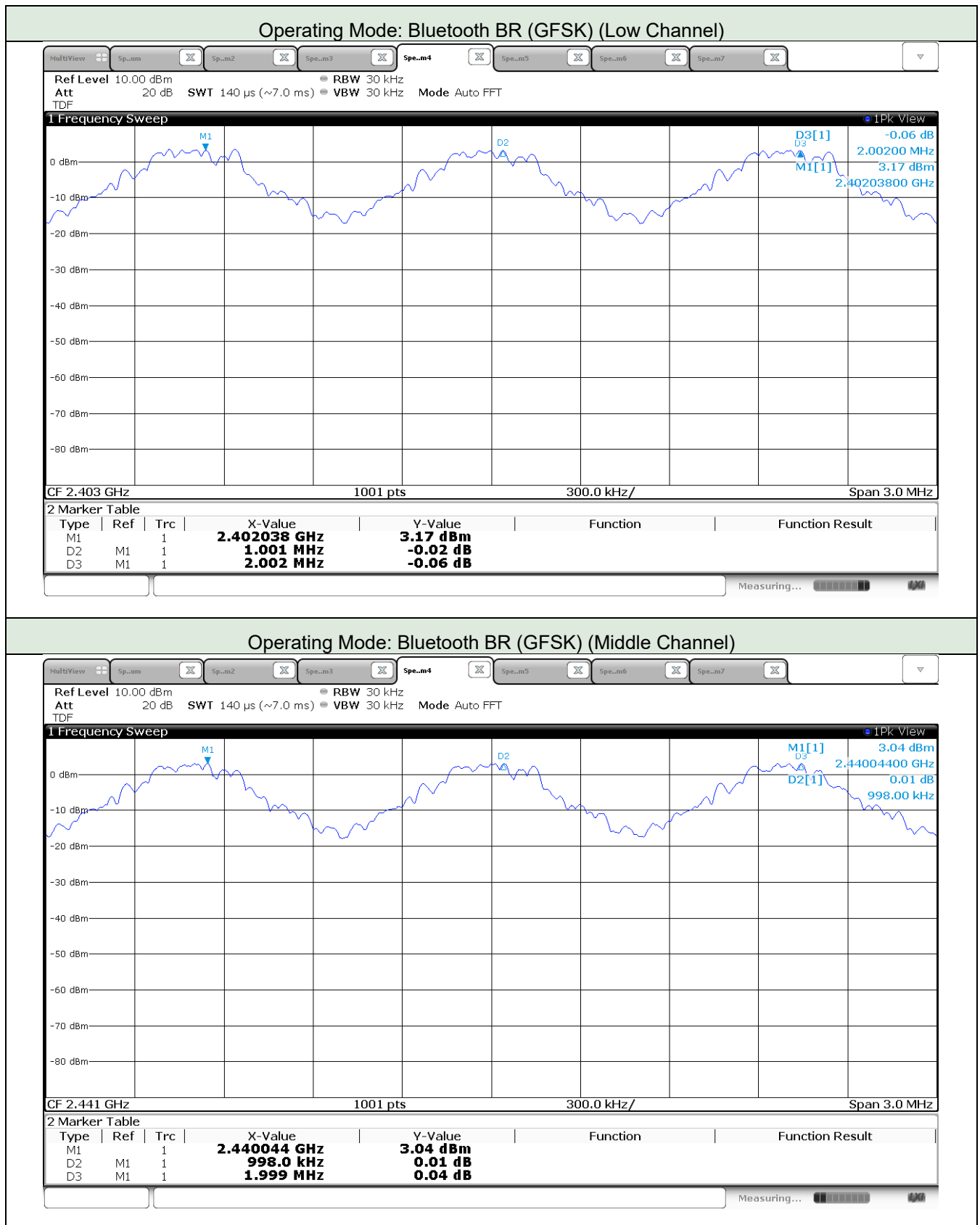
5.3.3 Test Data

Date of Test	2020-04-08	Temperature	(20.5 $\pm$ 0.8) °C
		Relative humidity	(38.6 $\pm$ 0.6) % R.H.
Test Result	PASS	Tested by	In-yong Song 

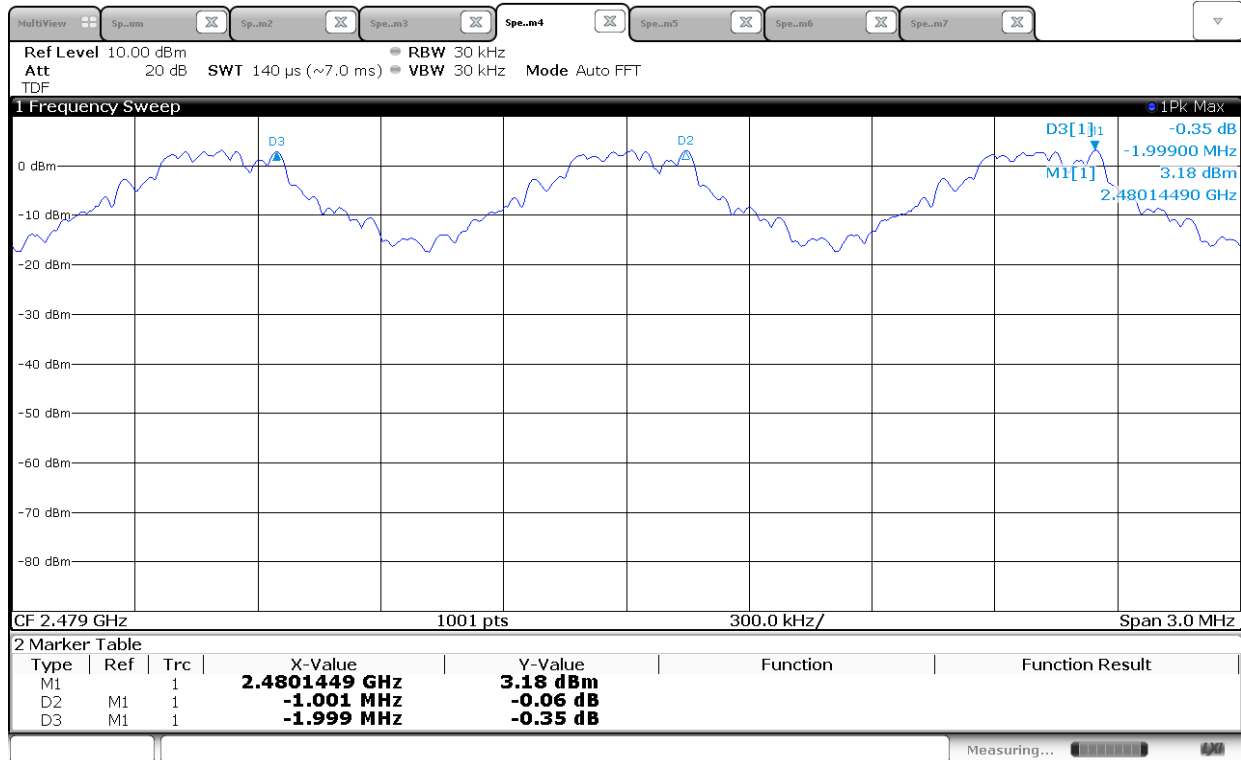
Operational Mode: Bluetooth BR (GFSK)				
Channel	Frequency (MHz)	Adjacent Hopping Channel Separation (kHz)	Two-third of 20dB bandwidth (kHz)	Minimum Bandwidth (kHz)
Low	2 402	1 001	695	25
Middle	2 441	998	697	25
High	2 480	1 001	713	25

Operational Mode: Bluetooth EDR (8DPSK)				
Channel	Frequency (MHz)	Adjacent Hopping Channel Separation (kHz)	Two-third of 20dB bandwidth (kHz)	Minimum Bandwidth (kHz)
Low	2 402	1 004	889	25
Middle	2 441	1 001	891	25
High	2 480	1 004	892	25

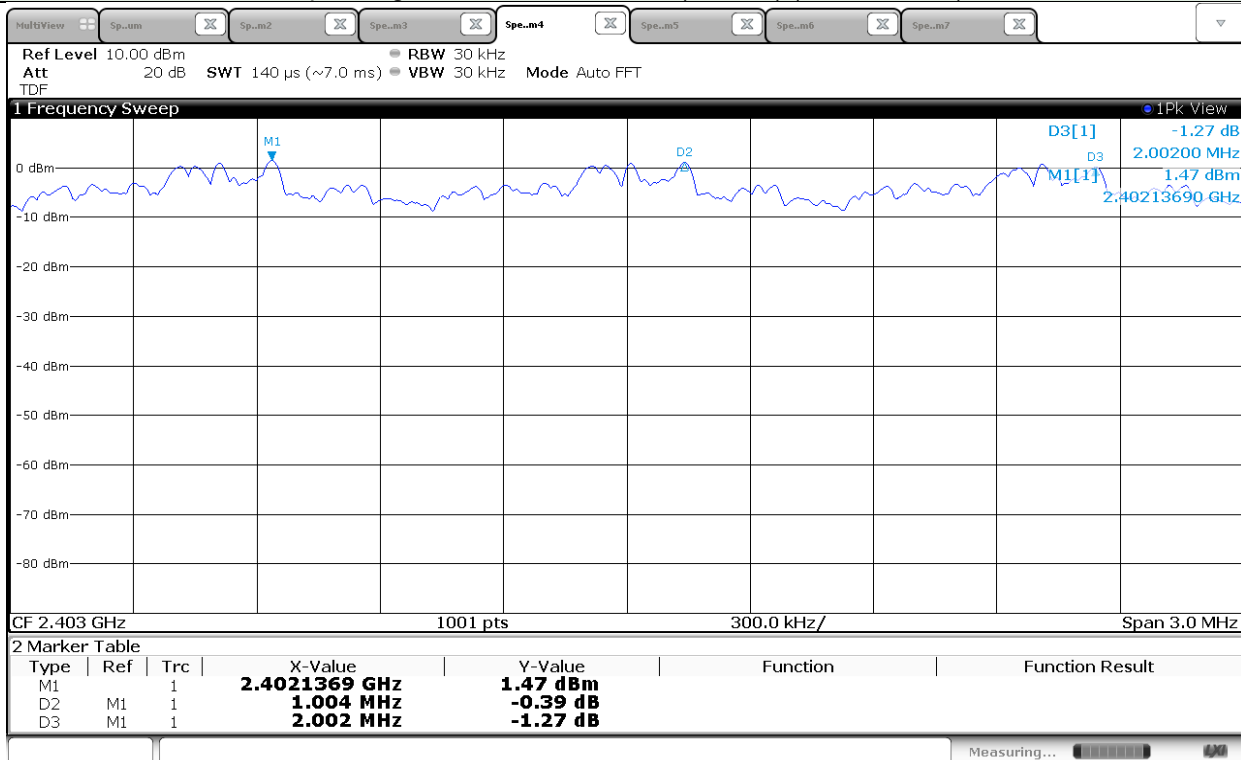
5.3.4 Test Plots



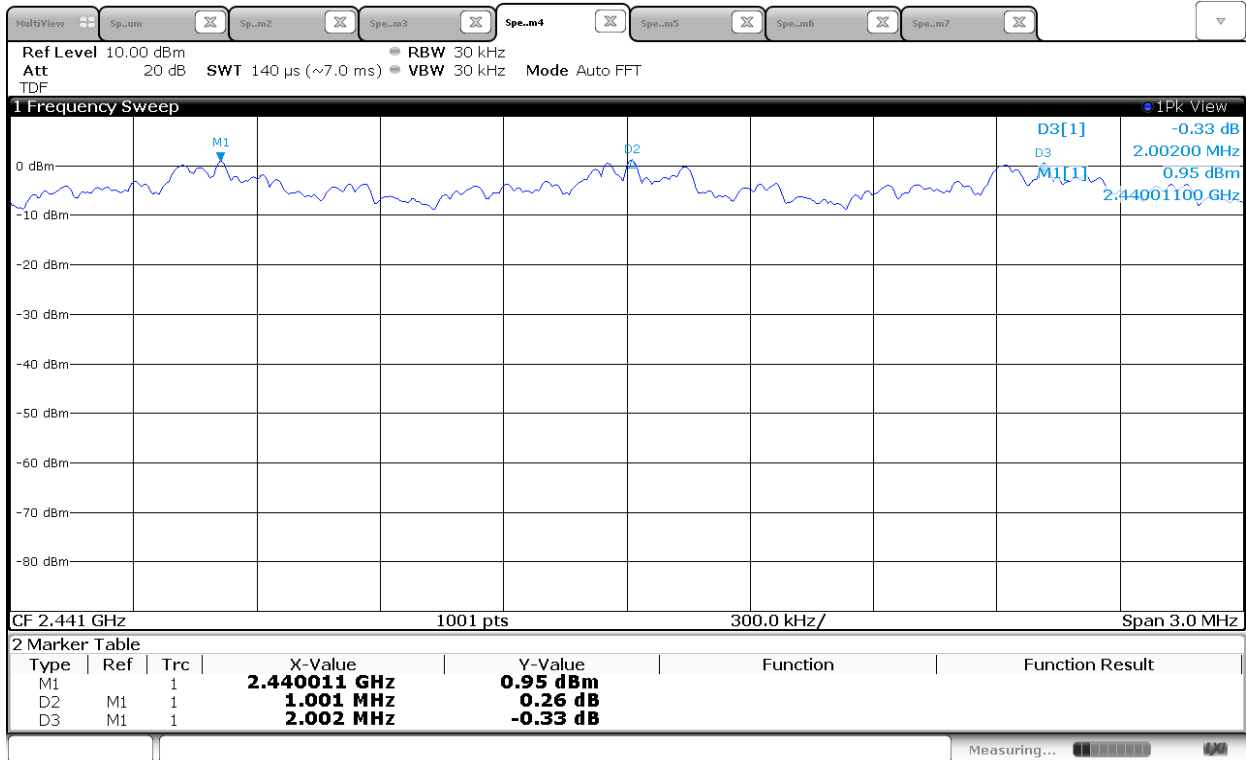
Operating Mode: Bluetooth BR (GFSK) (High Channel)



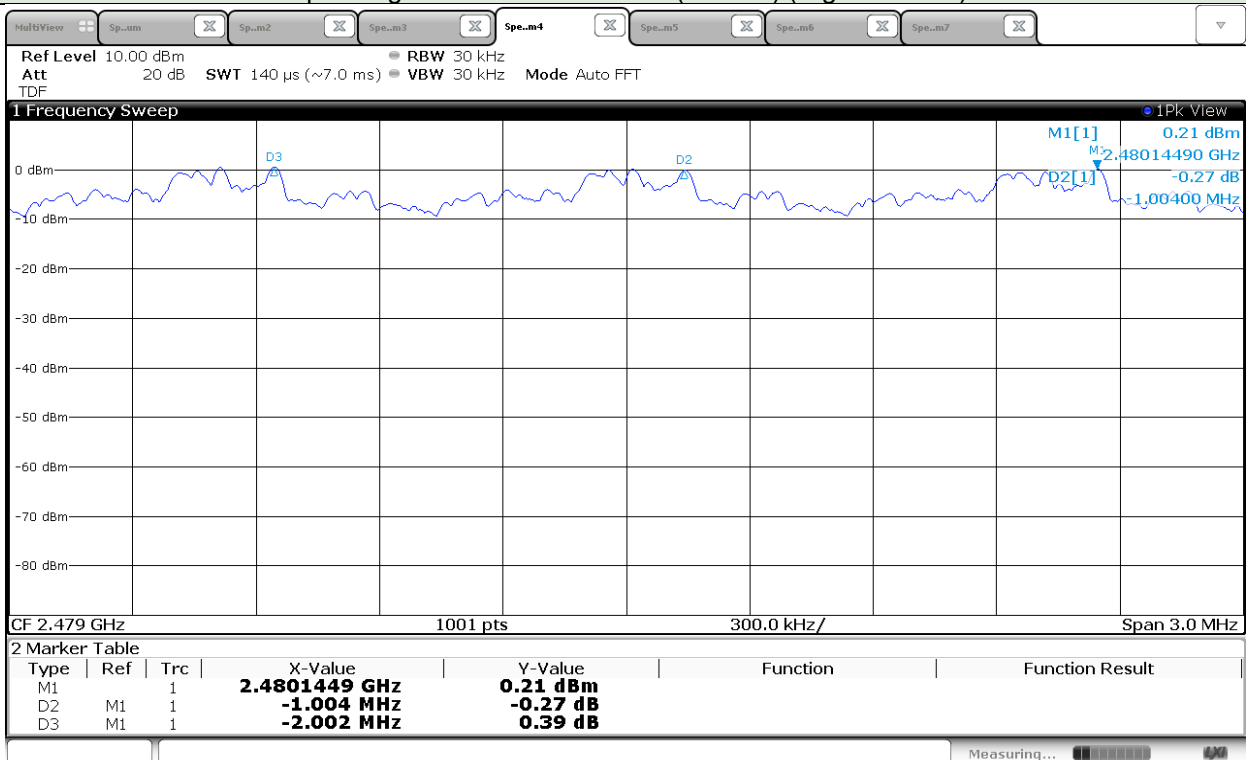
Operating Mode: Bluetooth EDR (8DPSK) (Low Channel)



Operating Mode: Bluetooth EDR (8DPSK) (Middle Channel)



Operating Mode: Bluetooth EDR (8DPSK) (High Channel)



5.4 Number of Hopping Channels

5.4.1 Limit

Acc. To section 15.247 (a)(1)(iii) and RSS-247 5.1 (4), frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

5.4.2 Method of Measurement

Reference to ANSI C63.10-2013 7.8.3

The Spectrum analyzer is set to

- a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
- b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
- c) VBW $\geq$ RBW.
- d) Sweep: Auto.
- e) Detector function: Peak.
- f) Trace: Max hold.
- g) Allow the trace to stabilize.

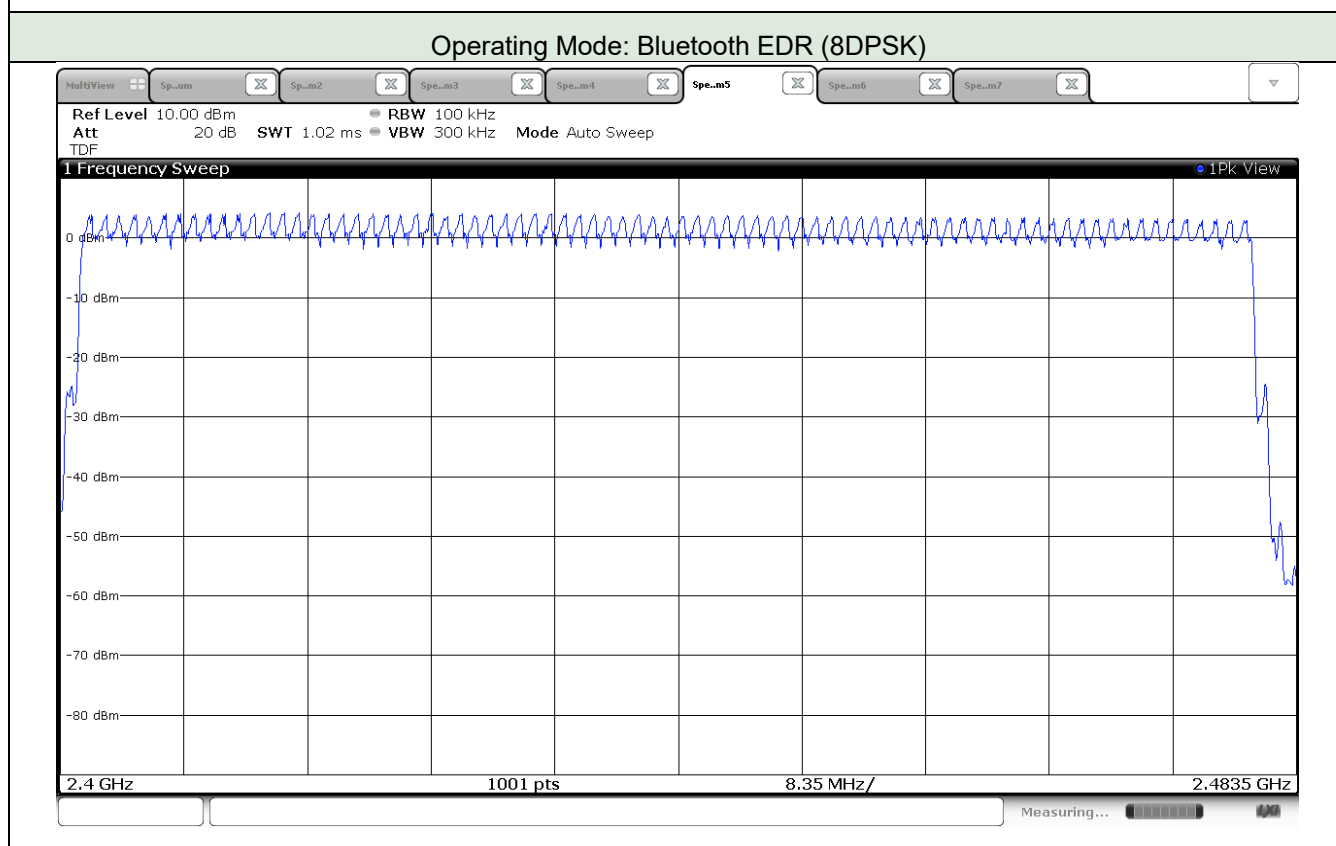
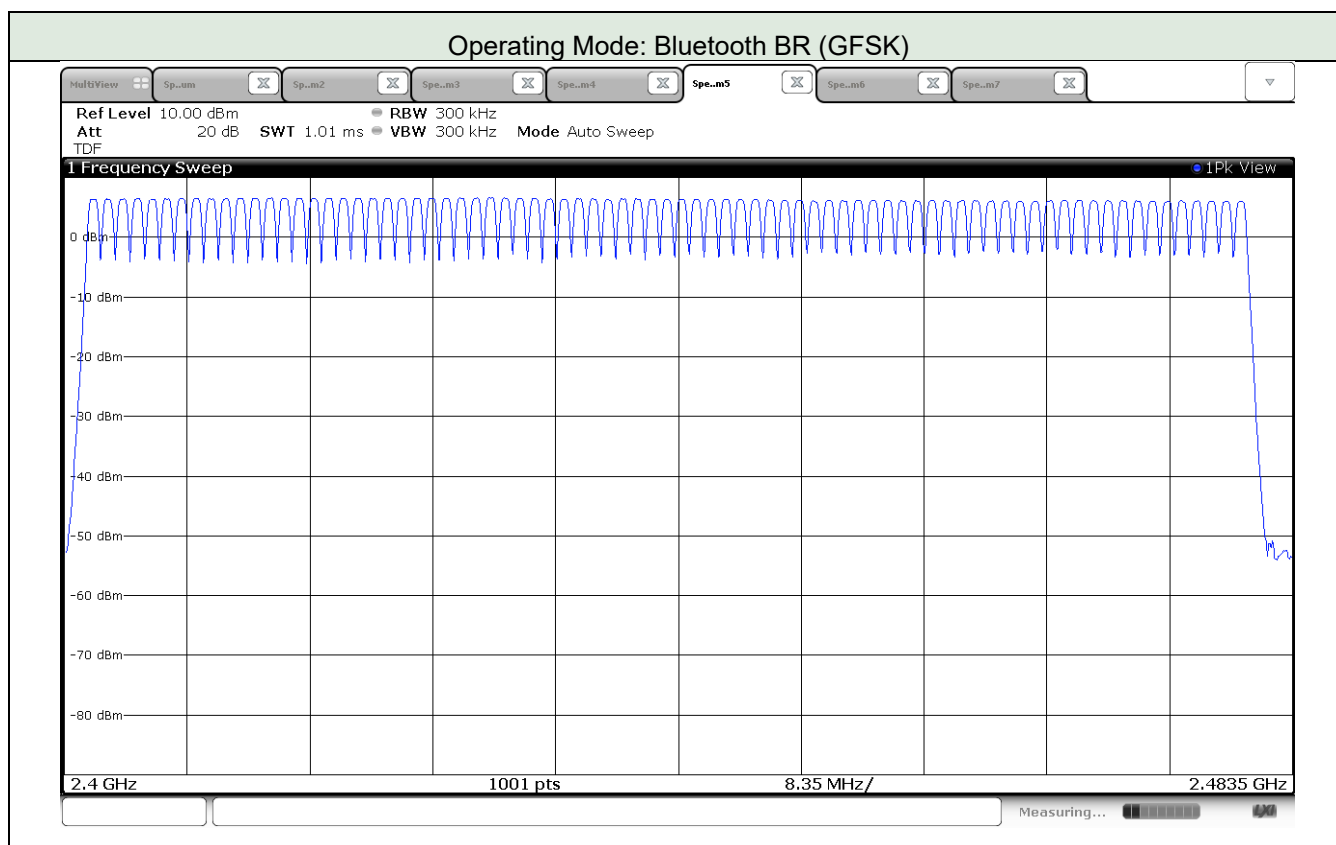
5.4.3 Test Data

Date of Test	2020-04-08	Temperature	(20.5 $\pm$ 0.8) °C
		Relative humidity	(38.6 $\pm$ 0.6) % R.H.
Test Result	PASS	Tested by	In-yong Song 

Operational Mode: Bluetooth BR (GFSK)	
Number of Hopping Channels	79

Operational Mode: Bluetooth EDR (8DPSK)	
Number of Hopping Channels	79

5.4.4 Test Plots



5.5 Time of Occupancy (Dwell Time)

5.5.1 Limit

Acc. To section 15.247 (a)(1)(iii) and RSS-247 5.1 (4), 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.

5.5.2 Method of Measurement

Reference to ANSI C63.10-2013 7.8.4

The Spectrum analyzer is set to

- a) Span: Zero span, centered on a hopping channel.
- b) RBW shall be $\leq$ channel spacing and where possible RBW should be set $\gg 1 / T$, where T is the expected dwell time per channel.
- c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
- d) Detector function: Peak.
- e) Trace: Max hold.

Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:

$$\begin{aligned} & \text{(Number of hops in the period specified in the requirements)} = \\ & \text{(number of hops on spectrum analyzer)} \times \text{(period specified in the requirements / analyzer sweep time)} \end{aligned}$$

5.5.3 Test Data

Date of Test	2020-04-08	Temperature	(20.5 ± 0.8) °C
		Relative humidity	(38.6 ± 0.6) % R.H.
Test Result	PASS	Tested by	In-yong Song 

Operational Mode: Bluetooth BR (GFSK)					
Packet size	Number of hopping Channels	Length of Transmission Time (ms)	Number of Transmission in a 31.6 (79 hopping * 0.4)	Result (s)	Limits (s)
DH1	79	0.381	320	0.122	0.4
DH3	79	1.642	160	0.263	0.4
DH5	79	2.896	106.6	0.309	0.4

Operational Mode: Bluetooth EDR (π/4DQPSK)					
Packet size	Number of hopping Channels	Length of Transmission Time (ms)	Number of Transmission in a 31.6 (79 hopping * 0.4)	Result (s)	Limits (s)
DH1	79	0.388	320	0.124	0.4
DH3	79	1.638	160	0.262	0.4
DH5	79	2.890	106.6	0.308	0.4

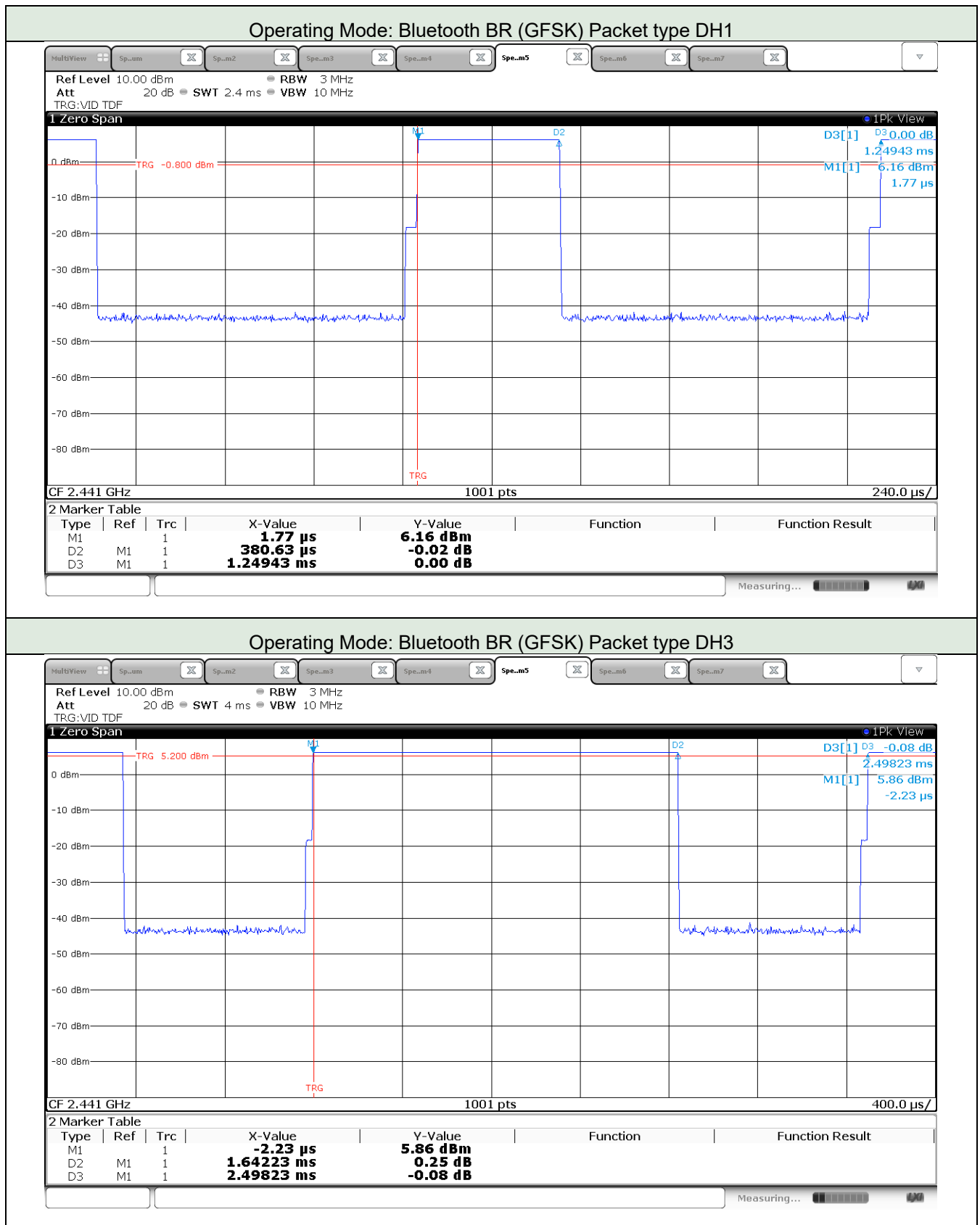
Operational Mode: Bluetooth EDR (8DPSK)					
Packet size	Number of hopping Channels	Length of Transmission Time (ms)	Number of Transmission in a 31.6 (79 hopping * 0.4)	Result (s)	Limits (s)
3-DH1	79	0.388	320	0.124	0.4
3-DH3	79	1.638	160	0.262	0.4
3-DH5	79	2.890	106.6	0.308	0.4

Note: Average time of occupancy = Transmit time per hop * Number of hopping channels in 31.6 s

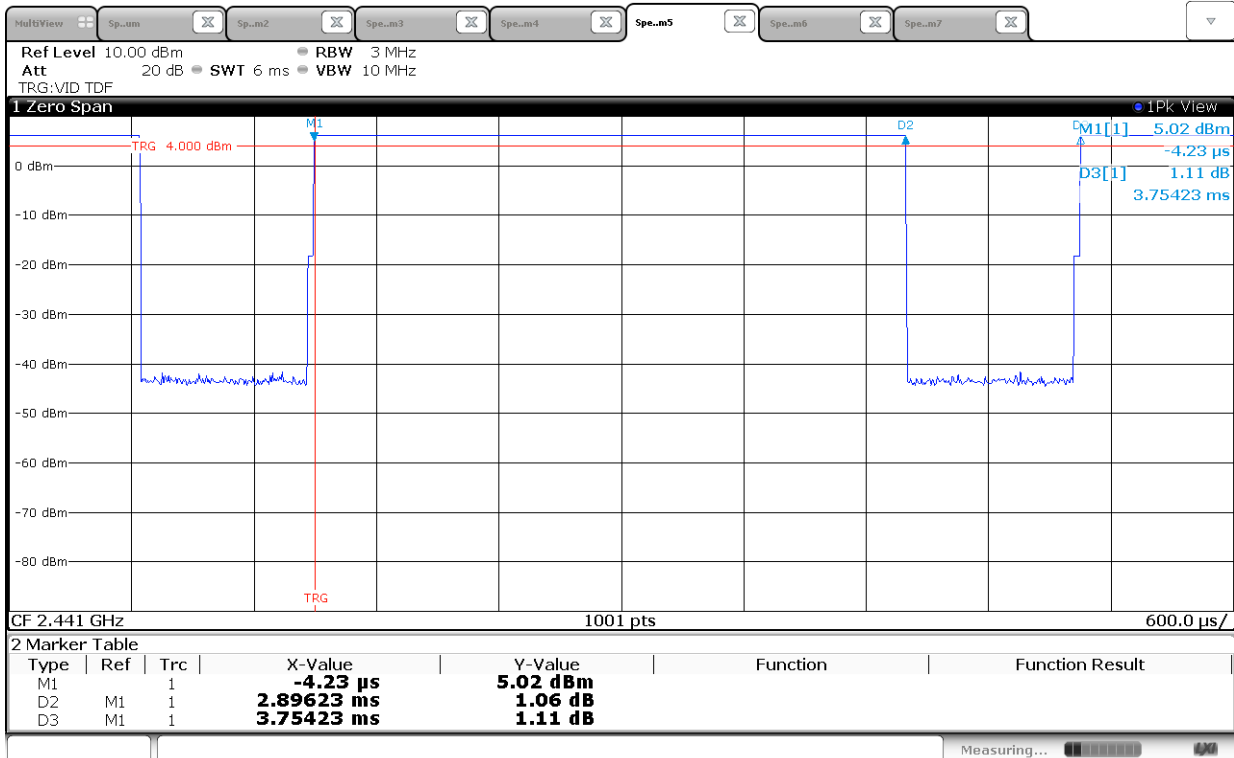
According the Bluetooth Standard Specification, the nominal hop rate is 1600 hop/s. All Bluetooth units participating in the piconet are time and hop synchronized to the channel.

- The maximum number of hopping channels in 31.6 s for DH1 = $1600 / 2 / 79 * 31.6 = 320$
- The maximum number of hopping channels in 31.6 s for DH3 = $1600 / 4 / 79 * 31.6 = 160$
- The maximum number of hopping channels in 31.6 s for DH5 = $1600 / 6 / 79 * 31.6 = 106.6$

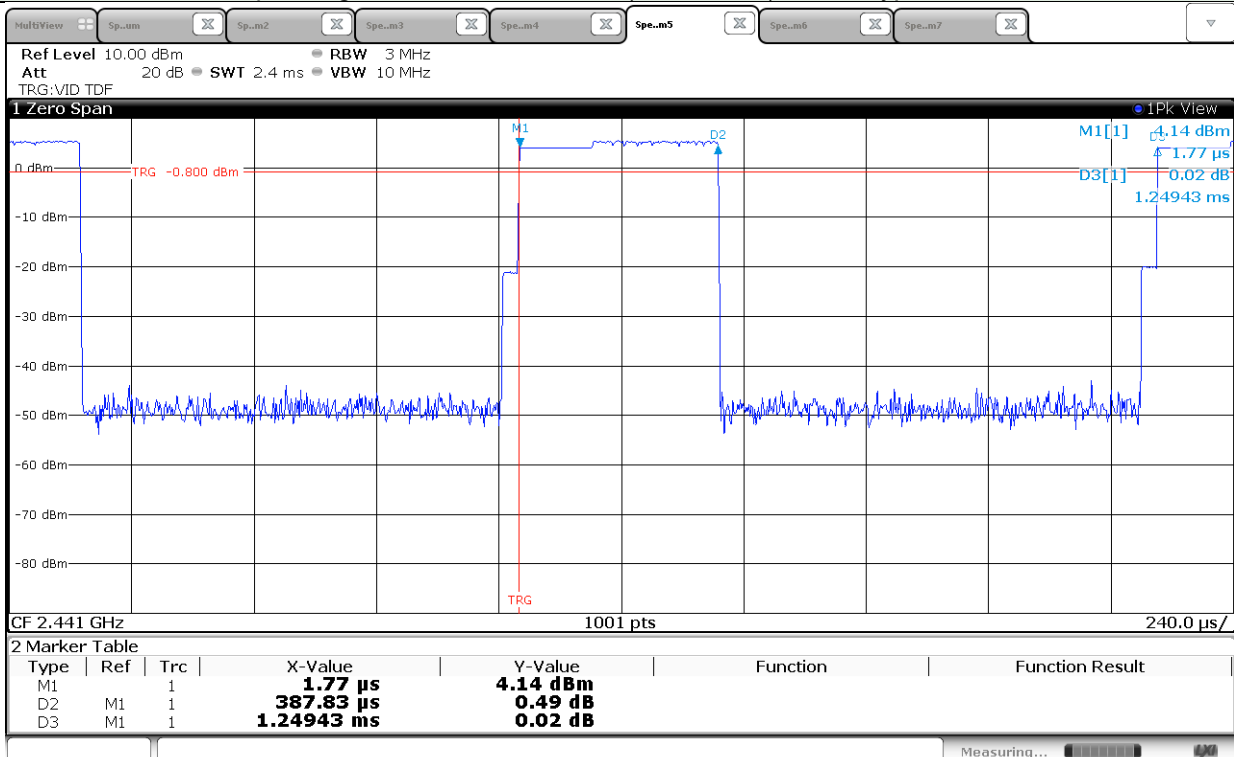
5.5.4 Test Plots



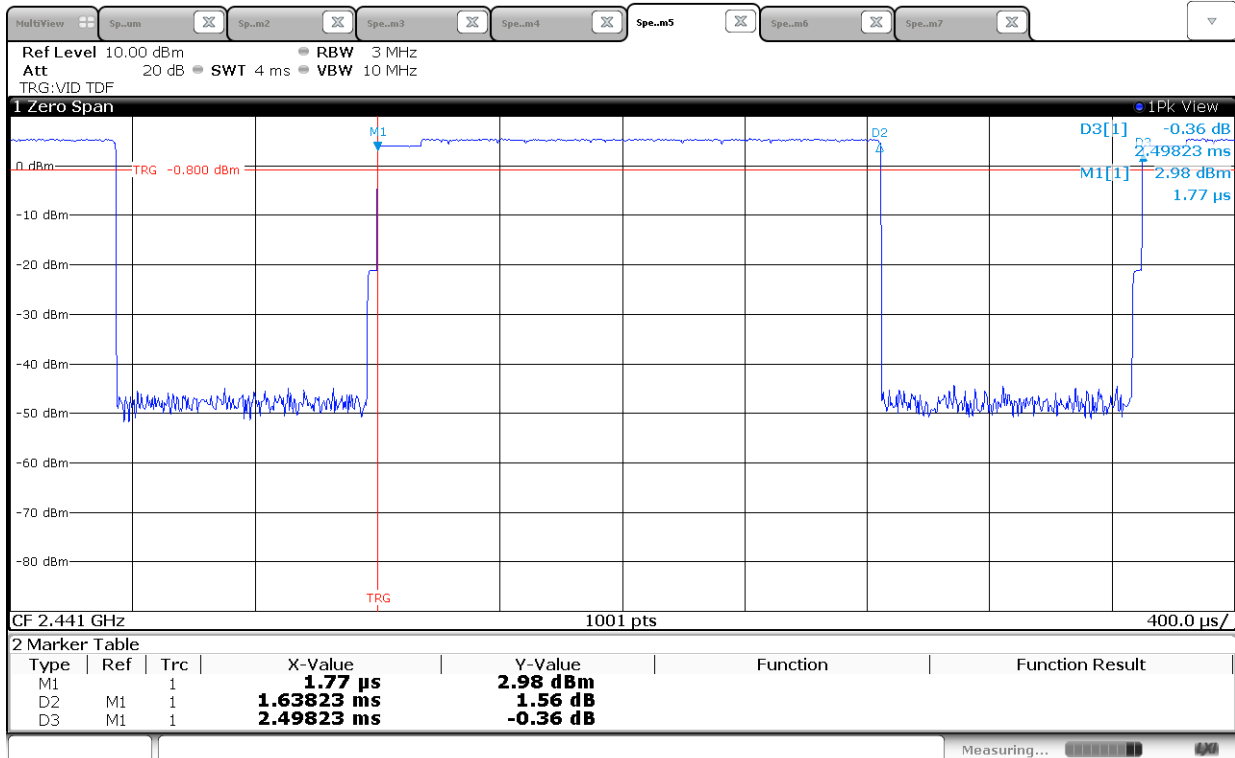
Operating Mode: Bluetooth BR (GFSK) Packet type DH5



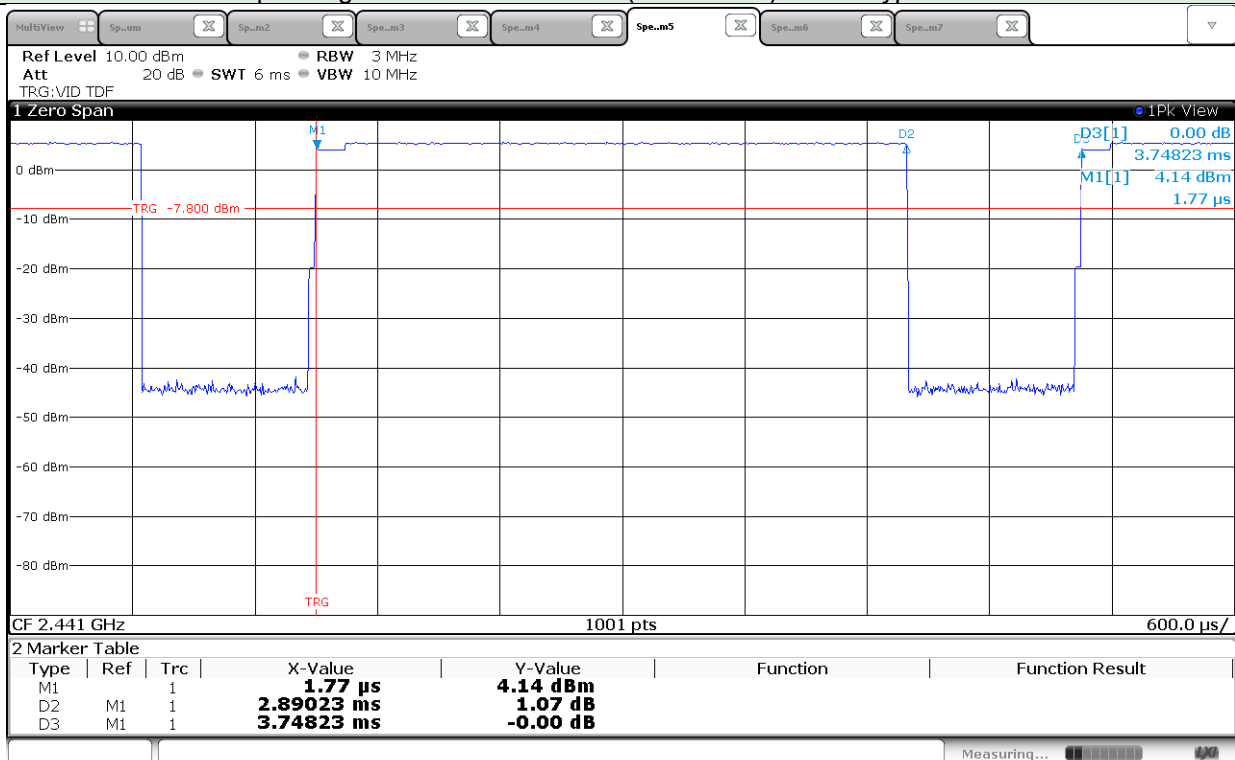
Operating Mode: Bluetooth EDR (π/4DQPSK) Packet type 2-DH1



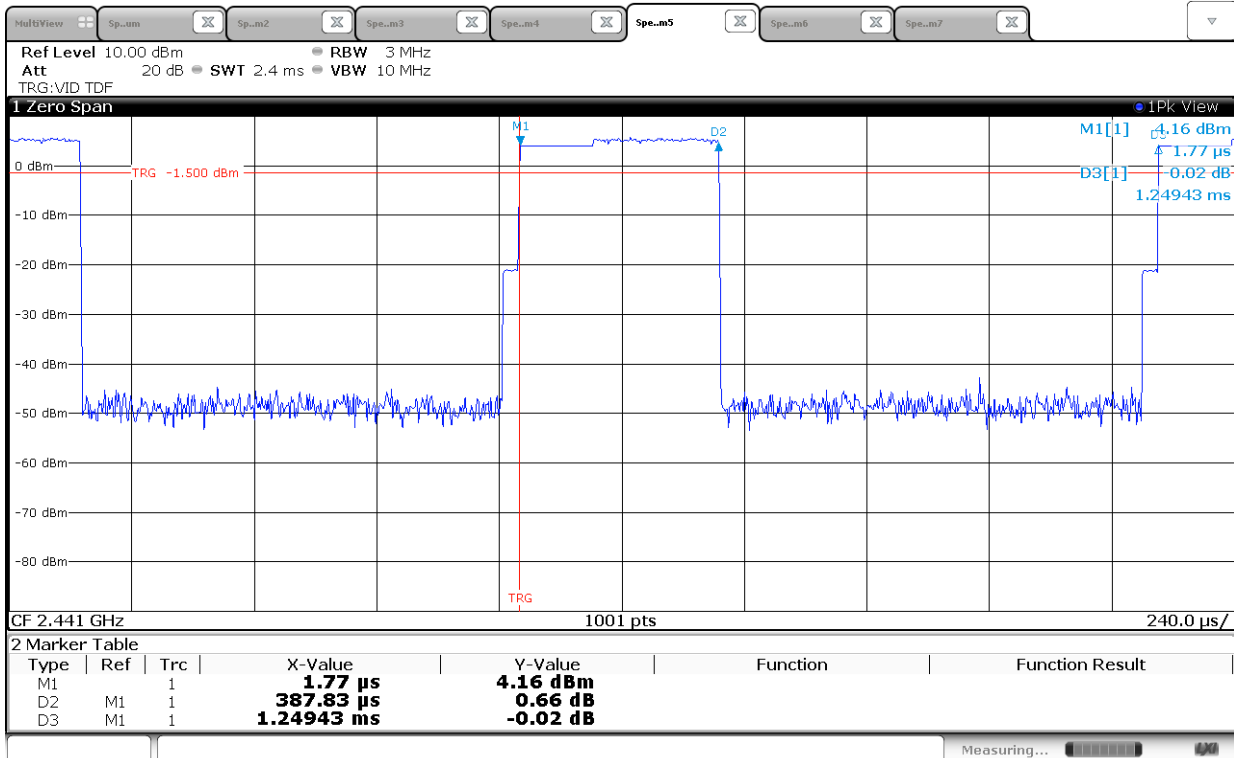
Operating Mode: Bluetooth EDR ($\pi/4$ DQPSK) Packet type 2-DH3



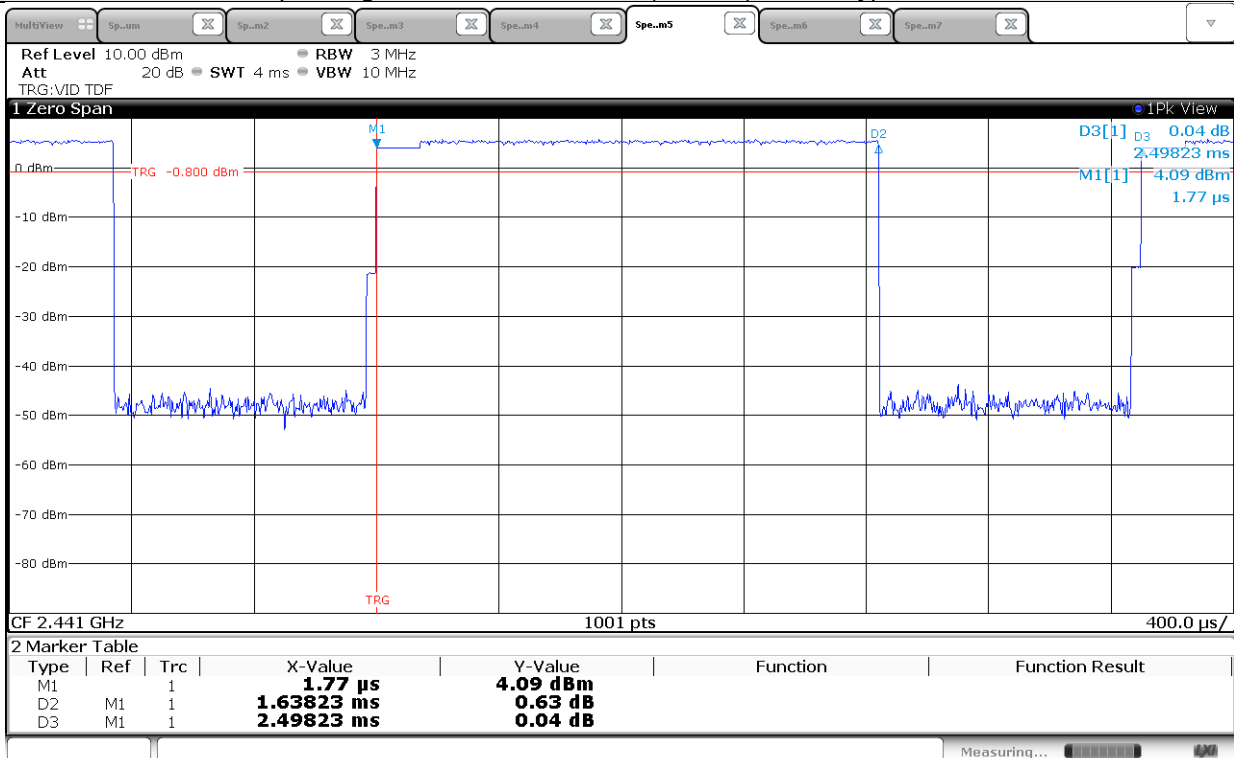
Operating Mode: Bluetooth EDR ($\pi/4$ DQPSK) Packet type 2-DH5



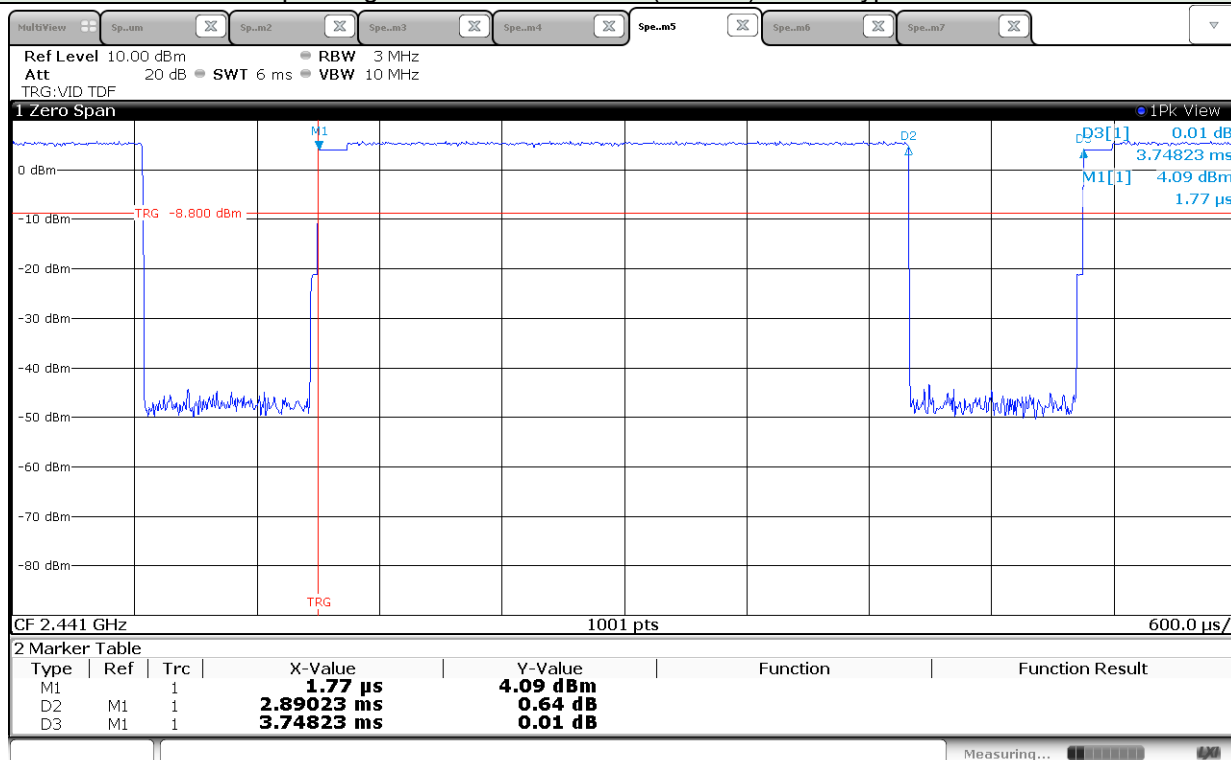
Operating Mode: Bluetooth EDR (8DPSK) Packet type 3-DH1



Operating Mode: Bluetooth EDR (8DPSK) Packet type 3-DH3



Operating Mode: Bluetooth EDR (8DPSK) Packet type 3-DH5



5.6 Maximum Peak Conducted Output Power

5.6.1 Limit

Acc. To section 15.247 (b)(1) and RSS-247 5.4 (2), For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

5.6.2 Method of Measurement

Reference to ANSI C63.10-2013 7.8.5

The Spectrum analyzer is set to

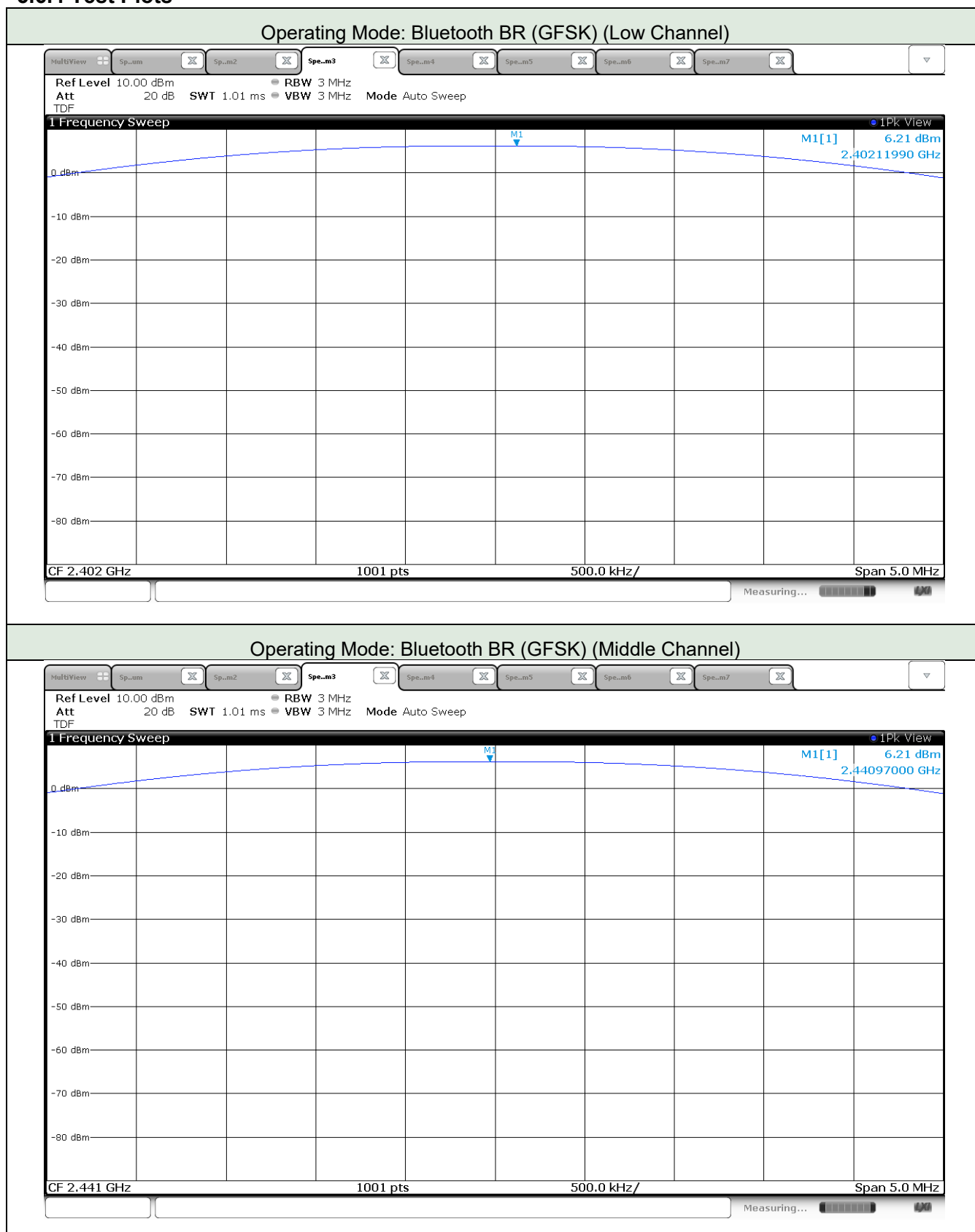
- 1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
- 2) RBW > 20 dB bandwidth of the emission being measured.
- 3) VBW $\geq$ RBW.
- 4) Sweep: Auto.
- 5) Detector function: Peak.
- 6) Trace: Max hold.

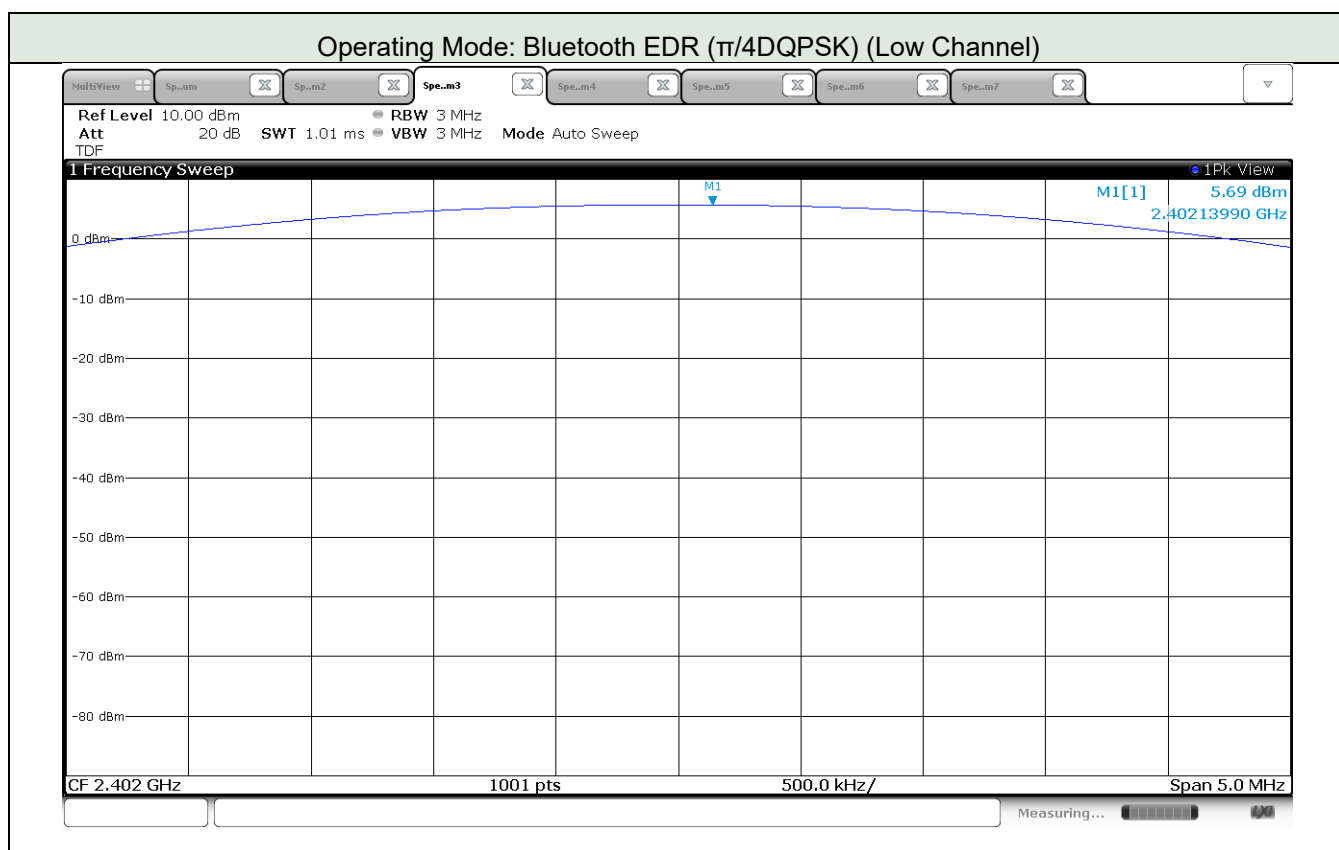
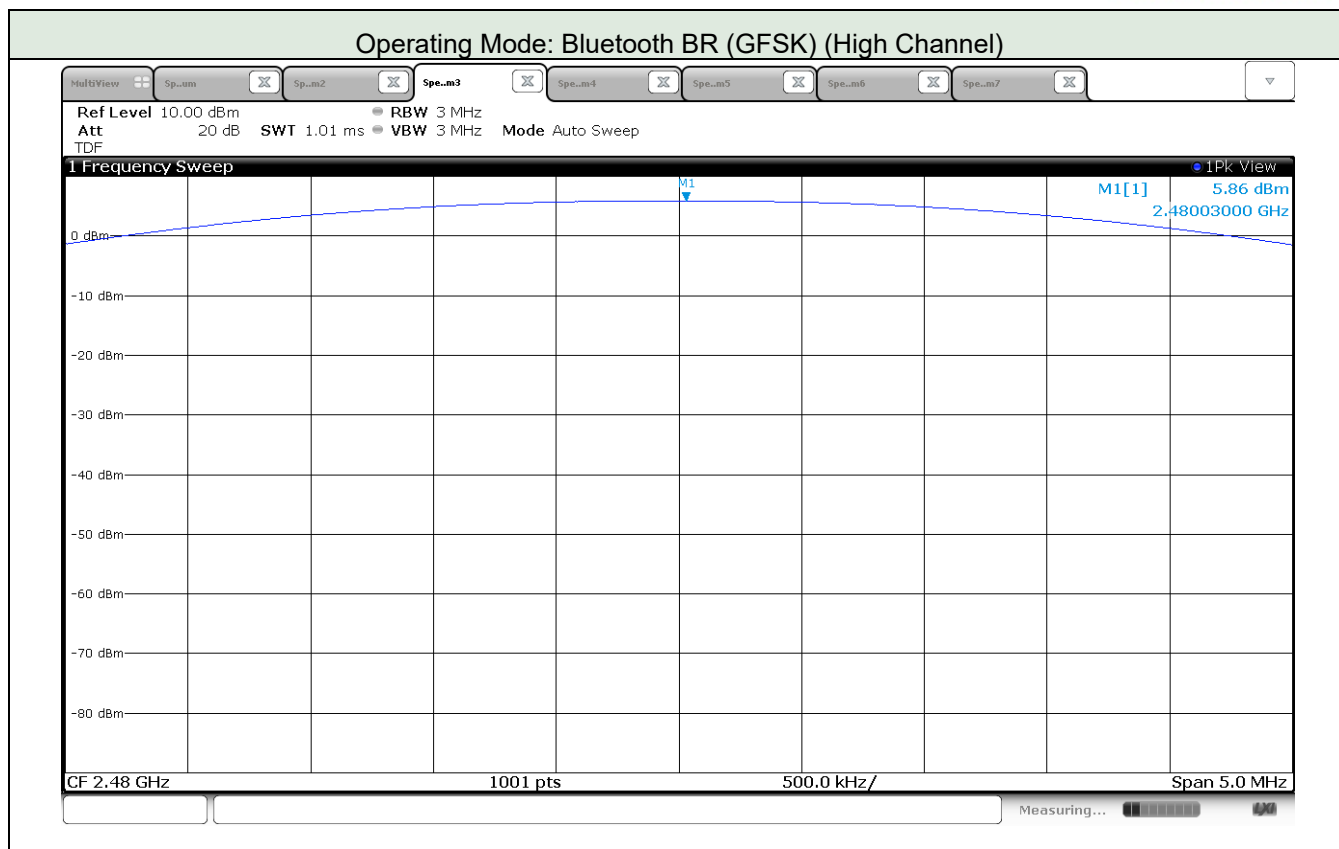
5.6.3 Test Data for Output Power

Date of Test		2020-04-08	Temperature	(20.5 ± 0.8) °C
			Relative humidity	(38.6 ± 0.6) % R.H.
Test Result		PASS	Tested by	In-yong Song 
Operating Mode: Bluetooth BR (GFSK)				
Channel	Frequency (MHz)	Measured Value (dBm)	Limit (dBm)	Margin (dB)
Low	2 402	6.21	30	23.79
Middle	2 441	6.21		23.79
High	2 480	5.86		24.14
Operating Mode: Bluetooth EDR (π/4DQPSK)				
Channel	Frequency (MHz)	Measured Value (dBm)	Limit (dBm)	Margin (dB)
Low	2 402	5.69	30	24.31
Middle	2 441	5.59		24.41
High	2 480	4.94		25.06
Operating Mode: Bluetooth EDR (8DPSK)				
Channel	Frequency (MHz)	Measured Value (dBm)	Limit (dBm)	Margin (dB)
Low	2 402	5.86	30	24.14
Middle	2 441	5.82		24.18
High	2 480	5.23		24.77

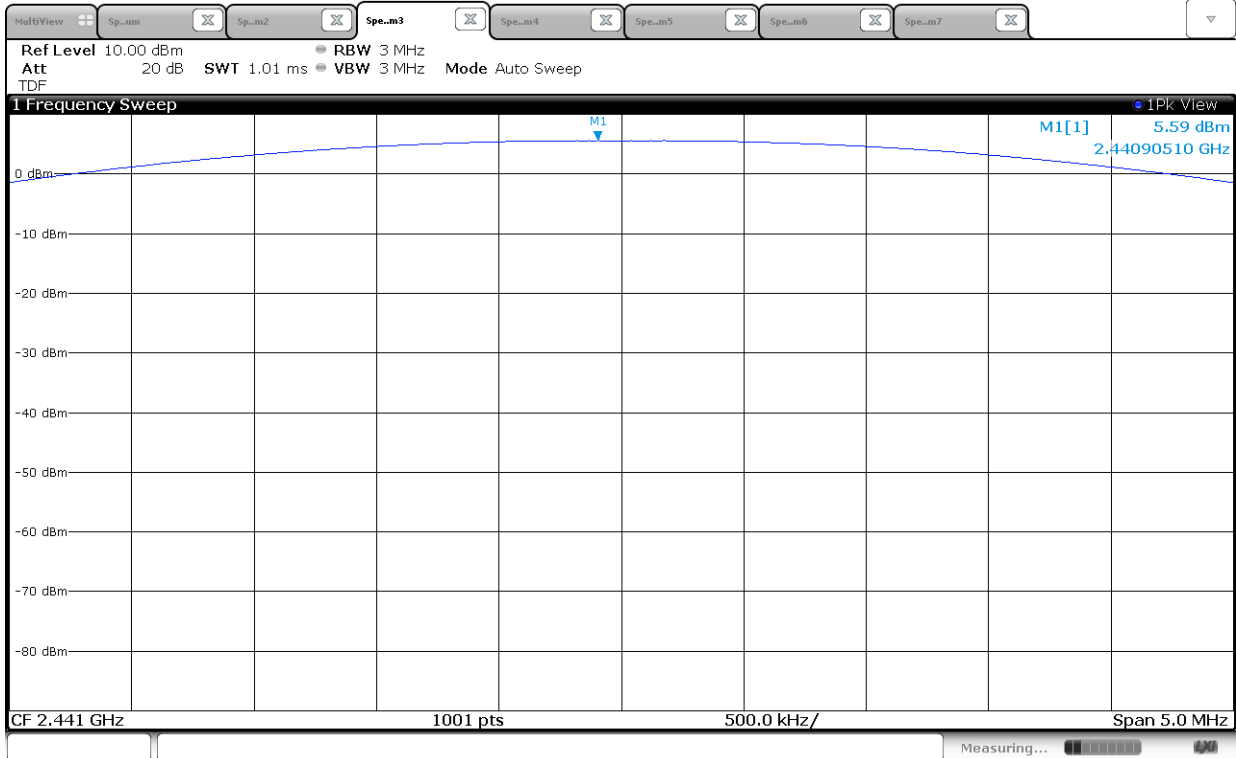
Remark. Margin = Limit – Measured Value

5.6.4 Test Plots

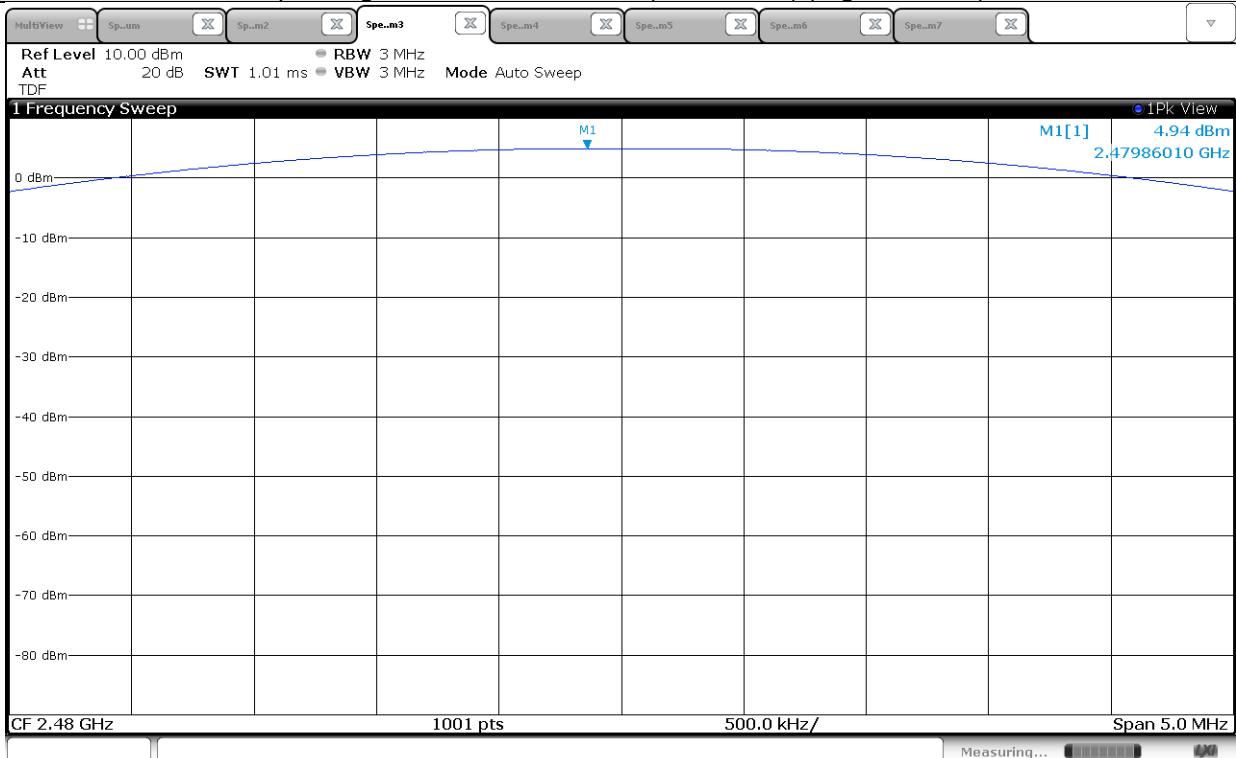




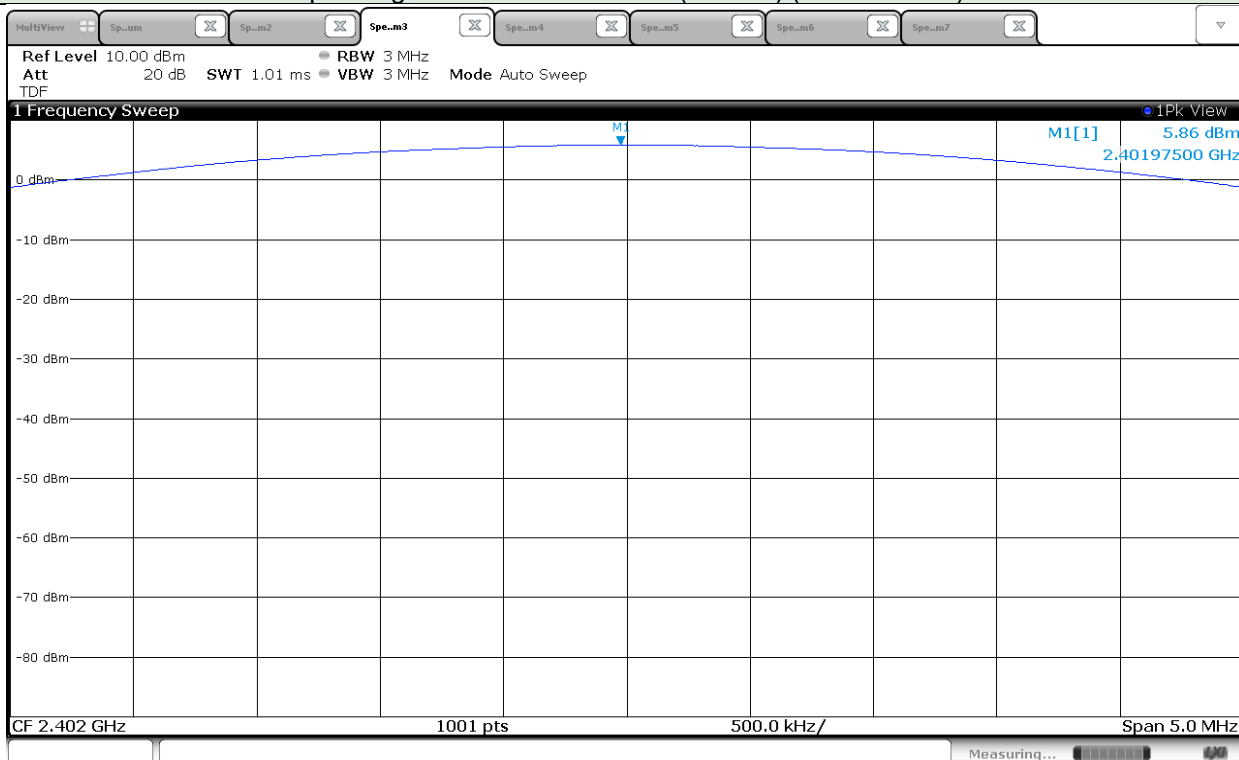
Operating Mode: Bluetooth EDR ($\pi/4$ DQPSK) (Middle Channel)



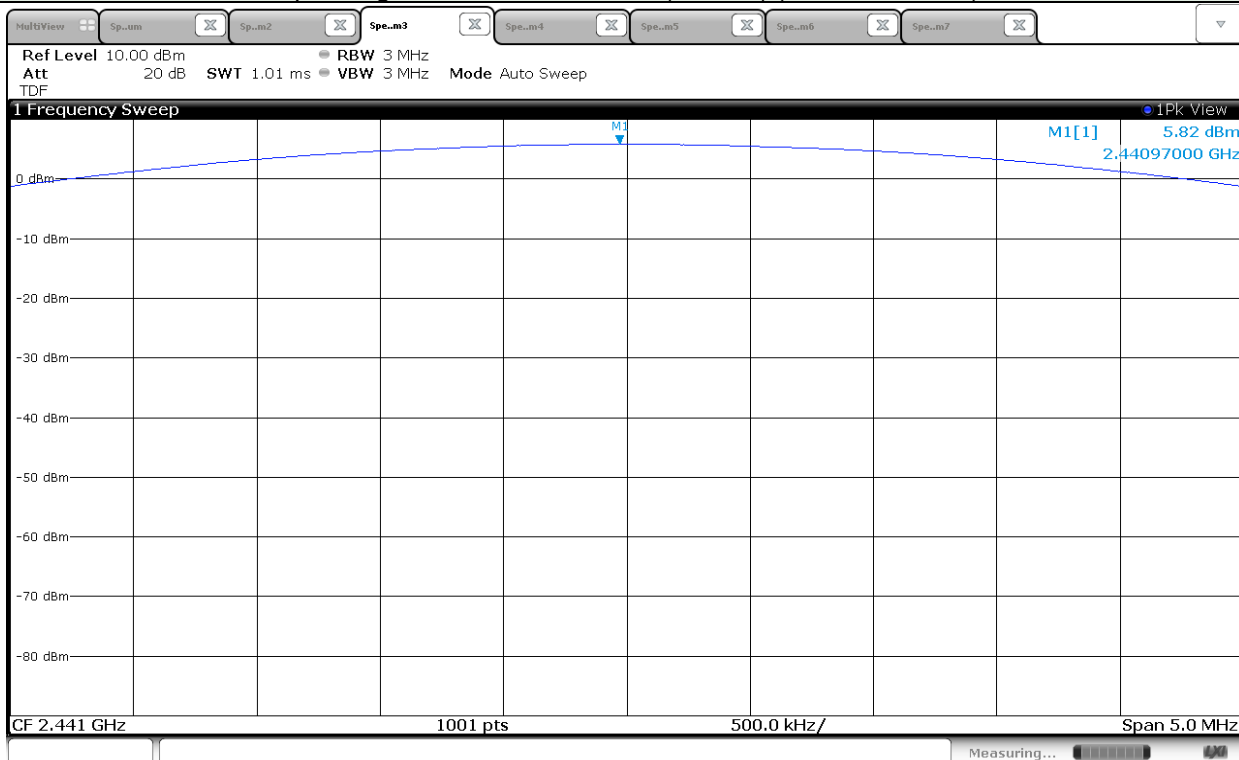
Operating Mode: Bluetooth EDR ($\pi/4$ DQPSK) (High Channel)

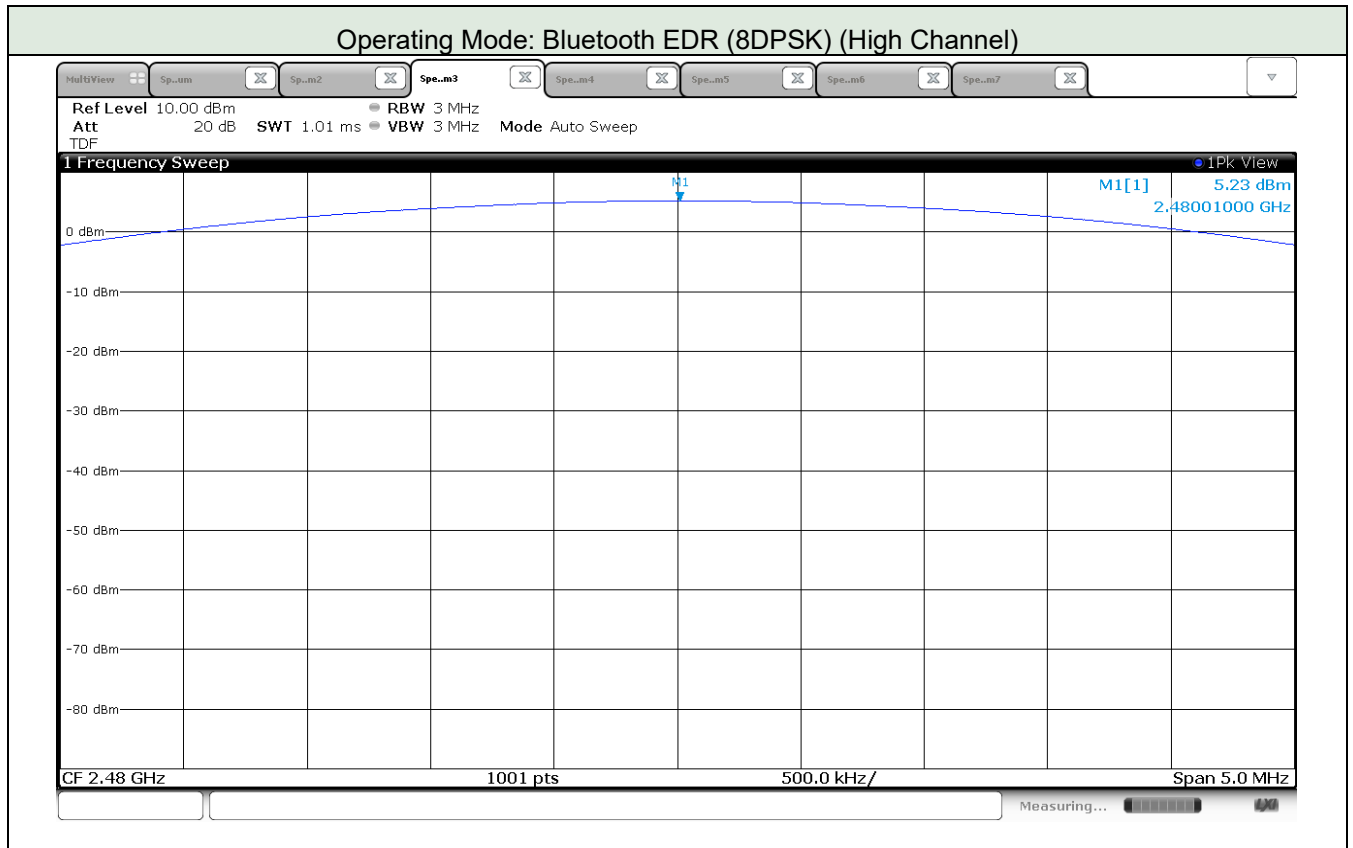


Operating Mode: Bluetooth EDR (8DPSK) (Low Channel)



Operating Mode: Bluetooth EDR (8DPSK) (Middle Channel)





5.7 Band-edge and Out of Band Emission

5.7.1 Limit

Acc. To section 15.247(d) and RSS-247 5.5, In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in 15.209(a) is not required. In addition, radiated emission which in the restricted band, as define in section §15.205(a), must also comply the radiated emission limits specified in section §15.209(a) (see section §15.205(c))

5.7.2 Method of Measurement

Reference to ANSI C63.10-2013 7.8.6 and 7.8.8

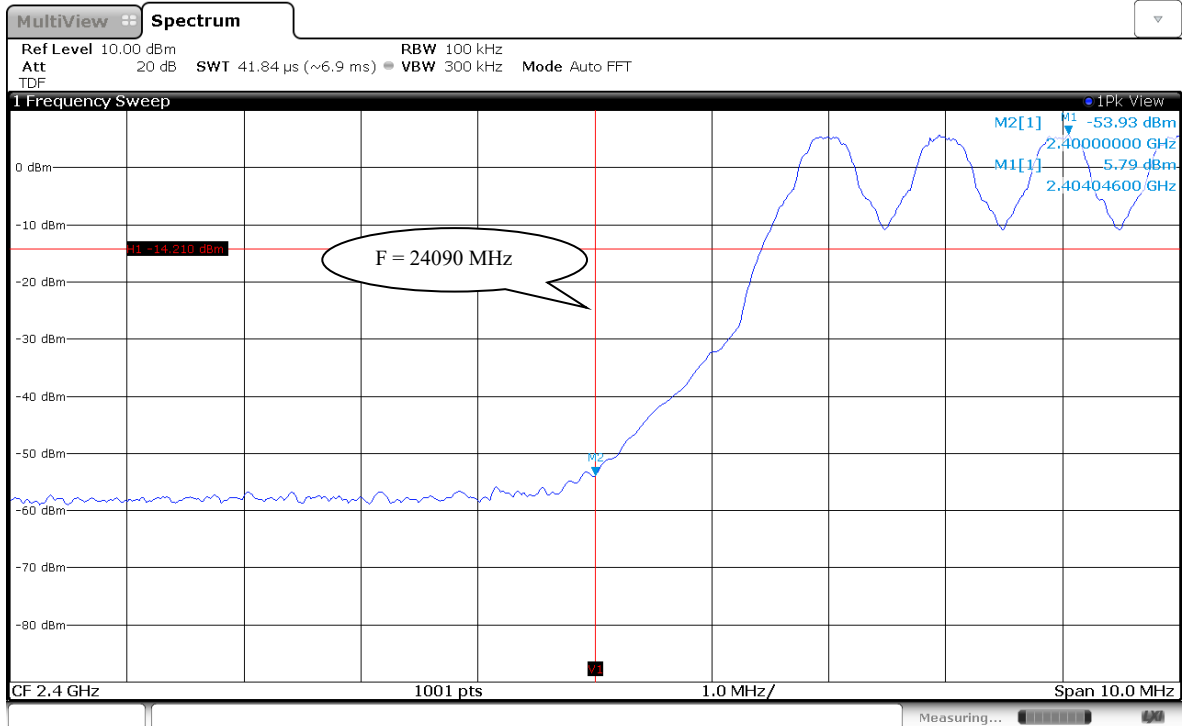
The Spectrum analyzer is set to

- 1) Span: 10 MHz.
- 2) RBW = 100 kHz
- 3) VBW $\geq$ RBW.
- 4) Sweep: Auto.
- 5) Detector function: Peak.
- 6) Trace: Max hold.

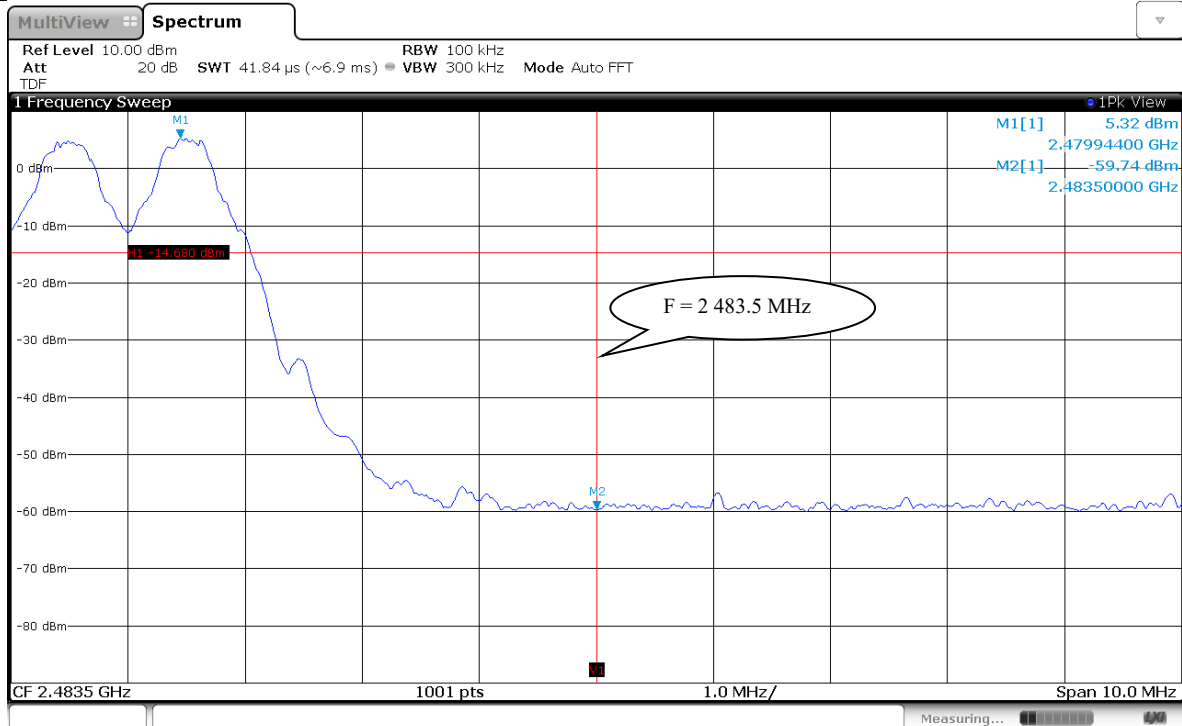
5.7.3 Test Data for Operating mode: Bluetooth BR

Date of Test	2020-04-08	Temperature	(20.5 $\pm$ 0.8) °C
		Relative humidity	(38.6 $\pm$ 0.6) % R.H.
Test Result	PASS	Tested by	In-yong Song 

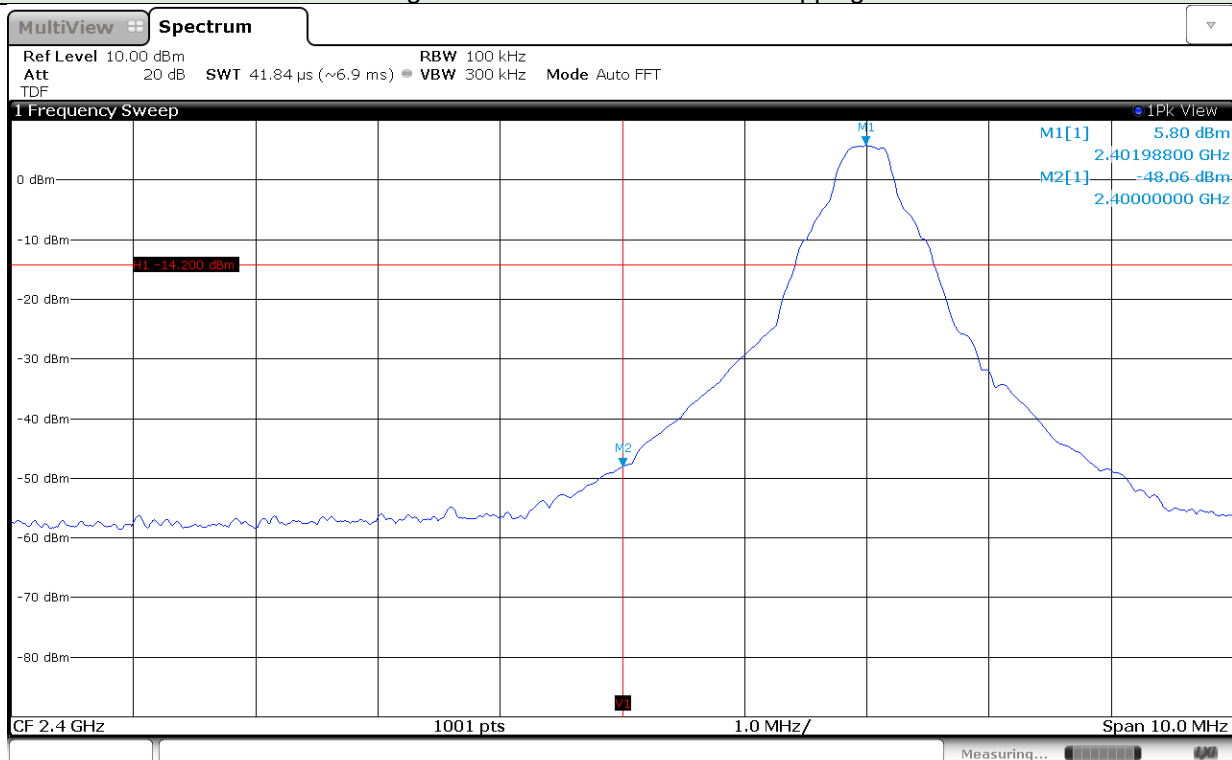
Band-edge and Restricted band – Hopping mode



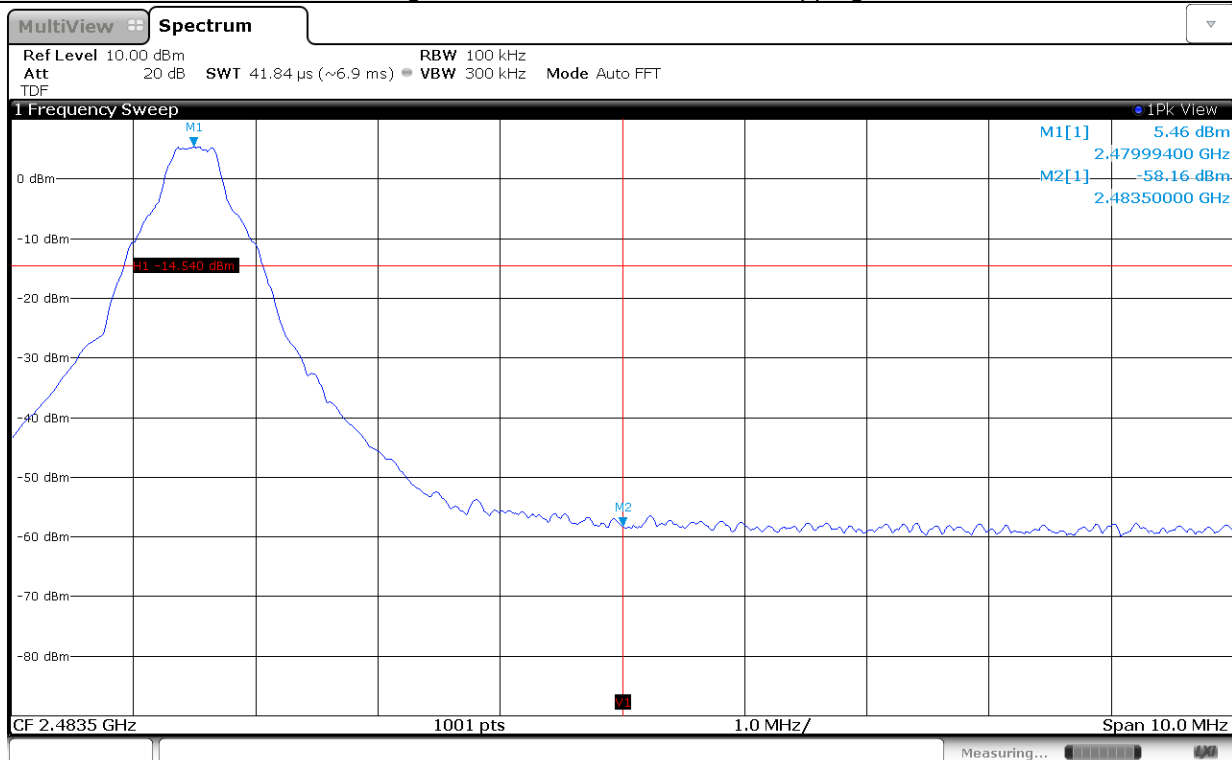
Band-edge and Restricted band – Hopping mode



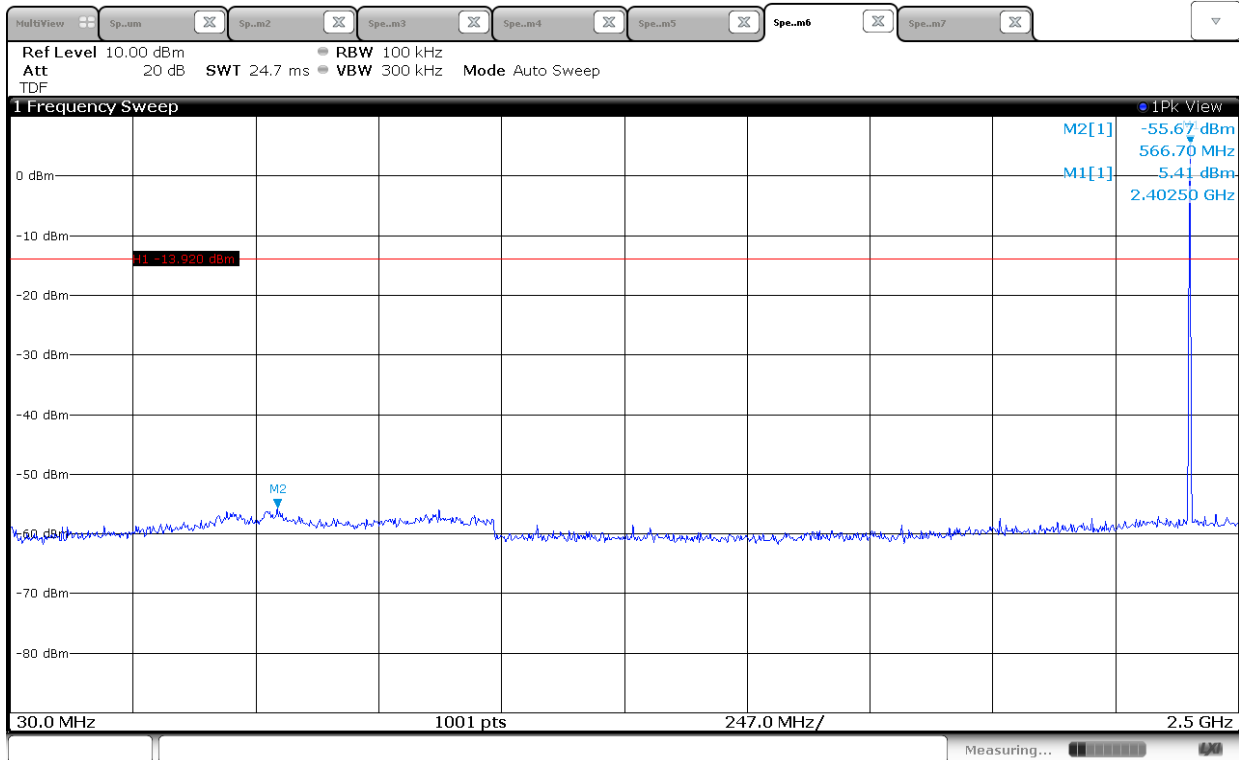
Band-edge and Restricted band – Non-hopping mode



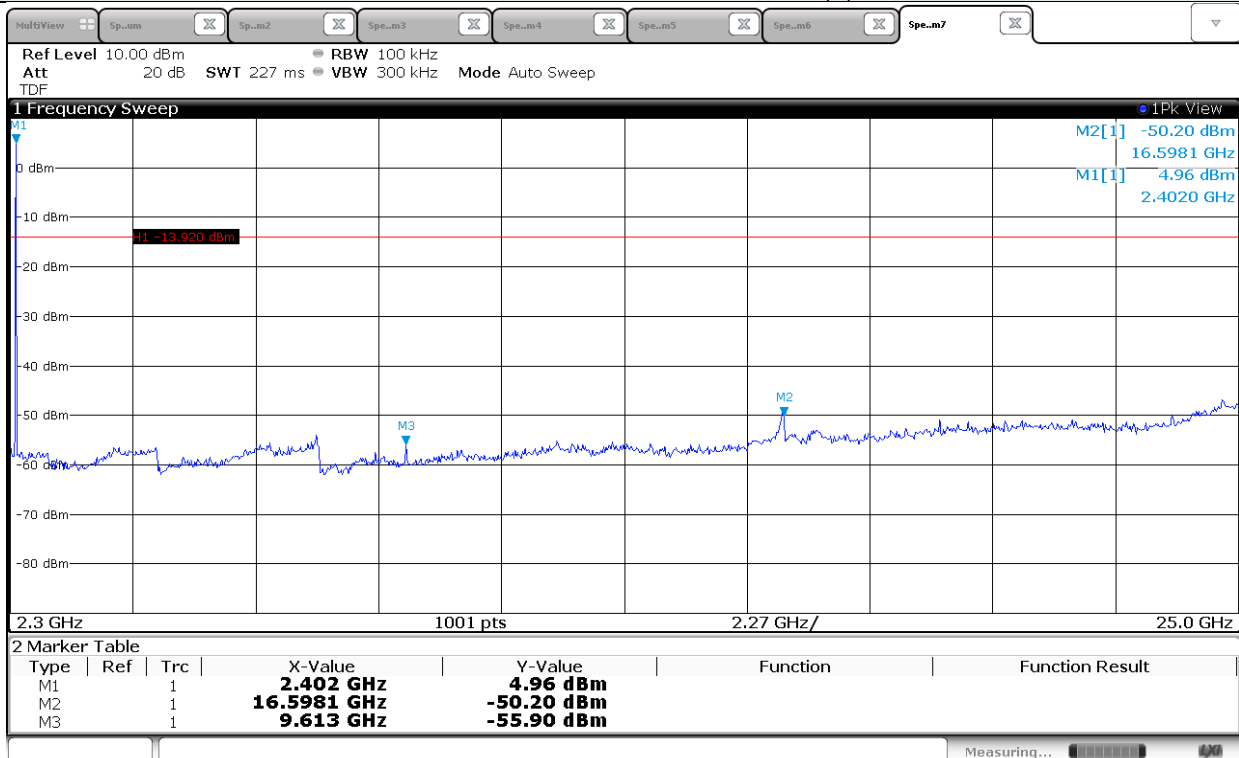
Band-edge and Restricted band – Non-hopping mode



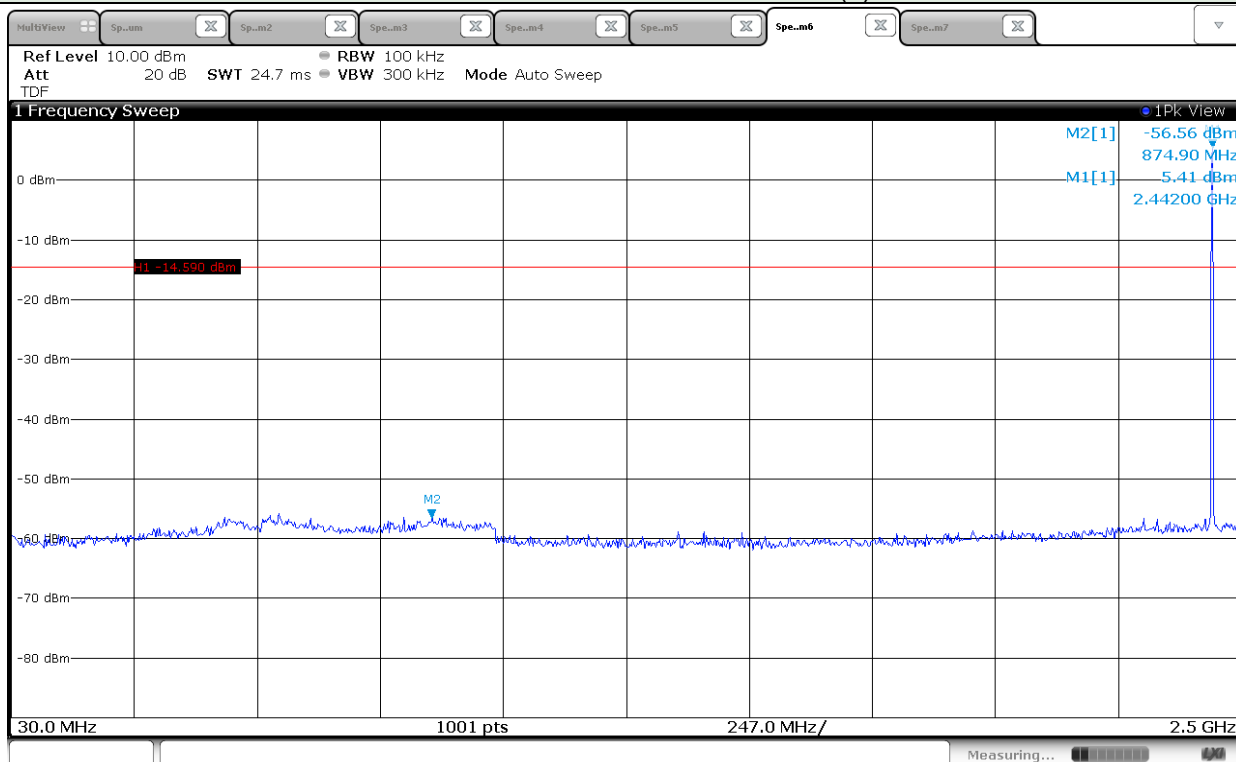
Non-restricted band – Low Channel (1)



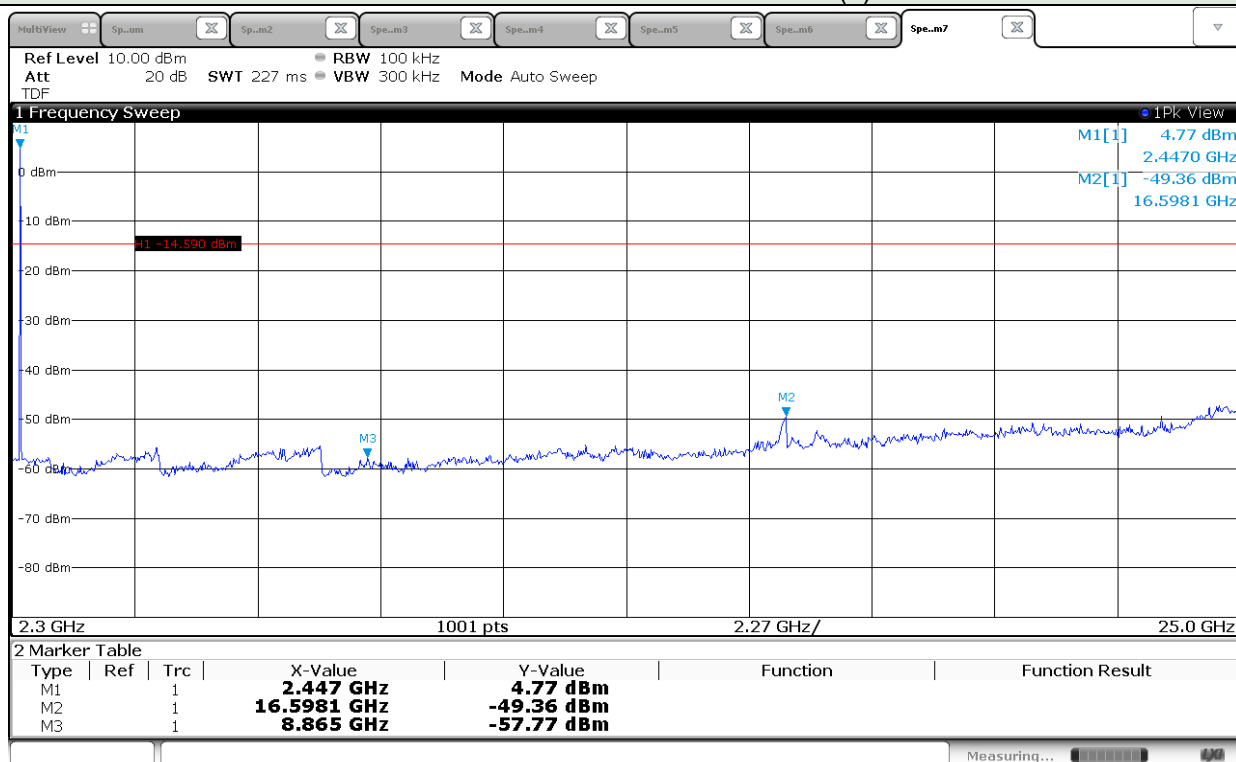
Non-restricted band – Low Channel (2)



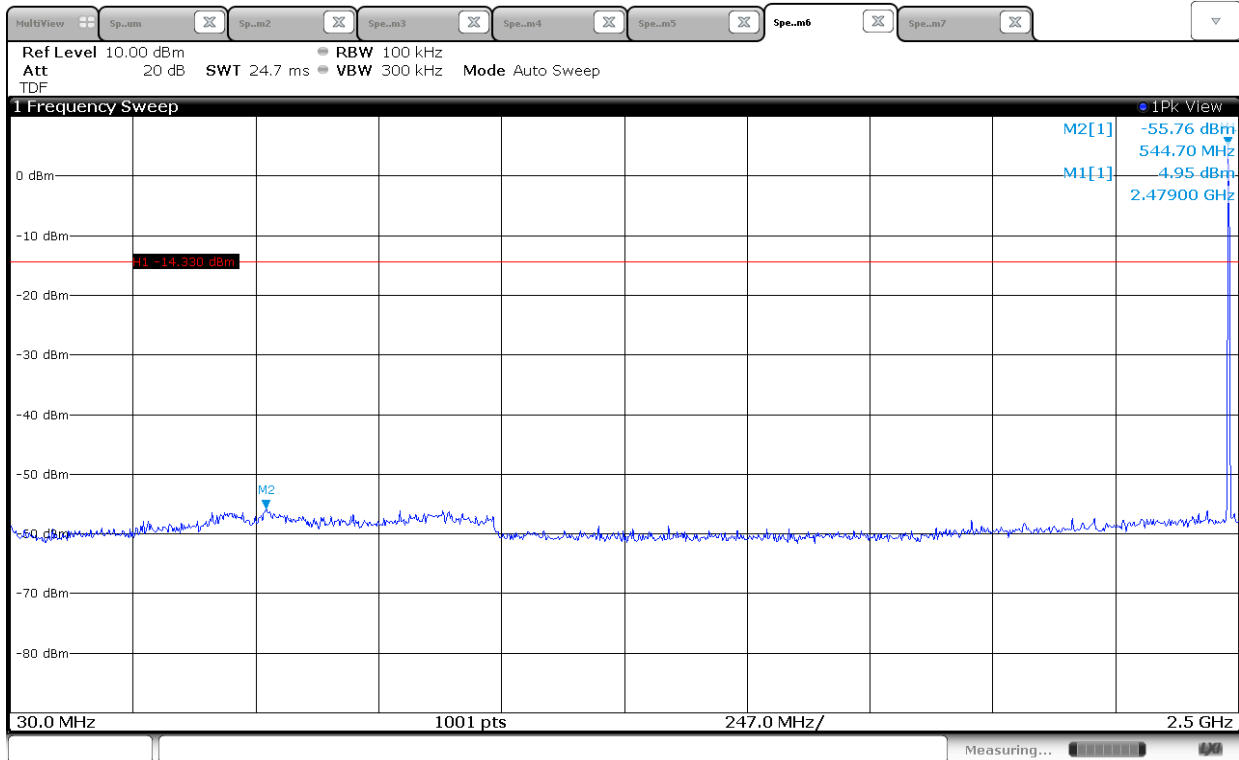
Non-restricted band – Middle Channel (1)



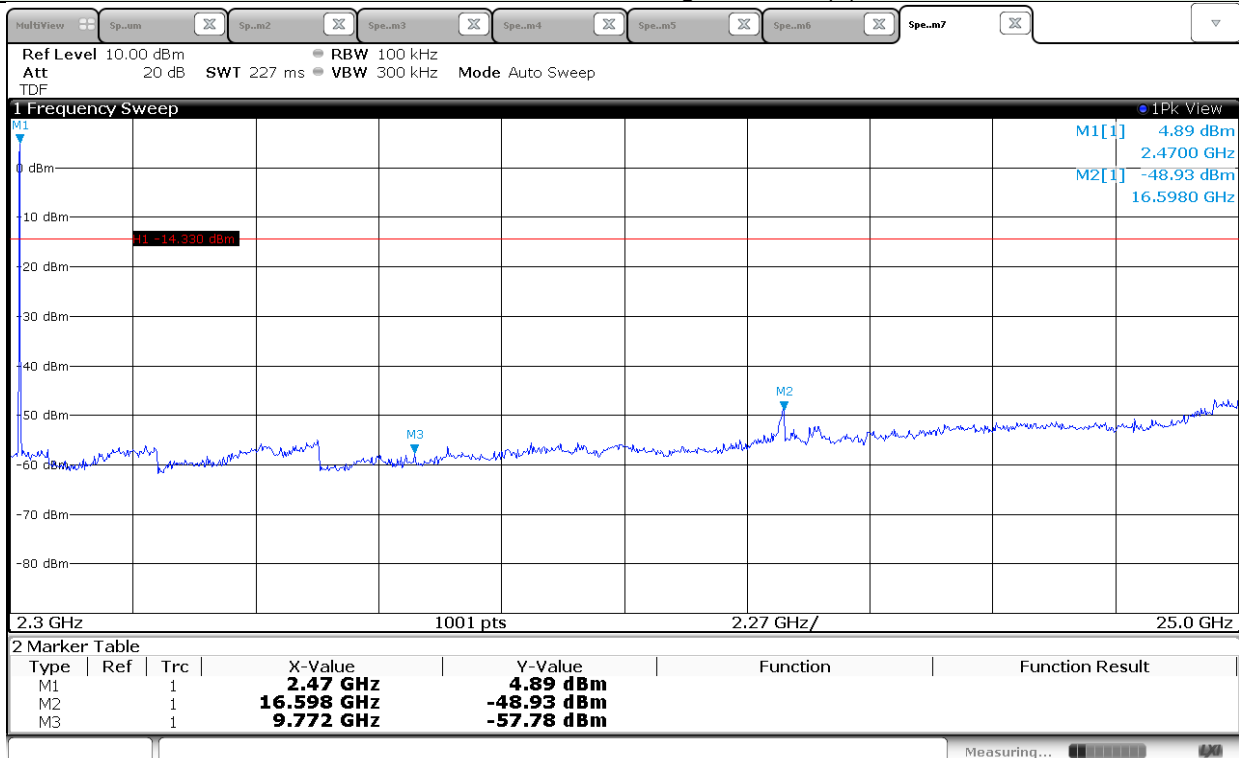
Non-restricted band – Middle Channel (2)



Non-restricted band – High Channel (1)



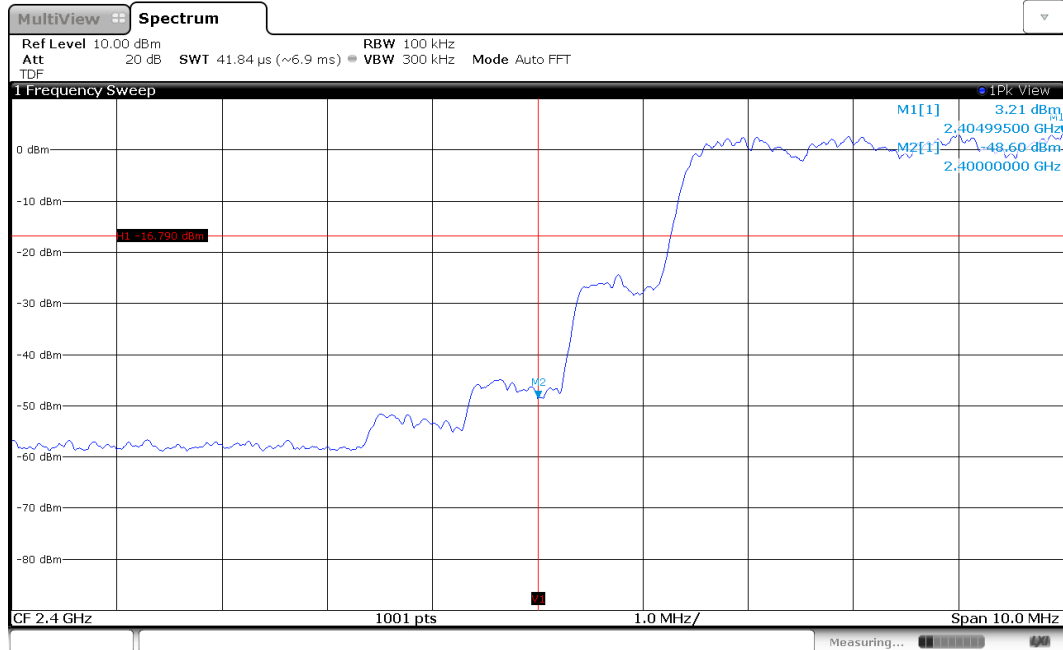
Non-restricted band – High Channel (2)



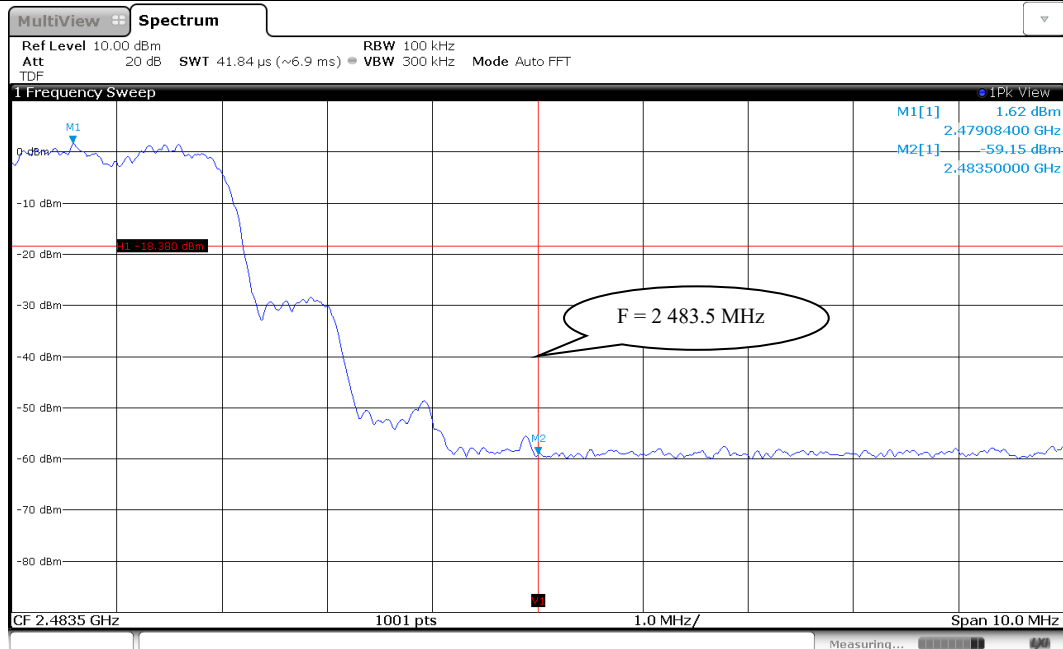
5.7.4 Test Data for Operating mode: Bluetooth EDR (8DPSK)

Date of Test	2020-04-08	Temperature	(20.5 ± 0.8) °C
		Relative humidity	(38.6 ± 0.6) % R.H.
Test Result	PASS	Tested by	In-yong Song

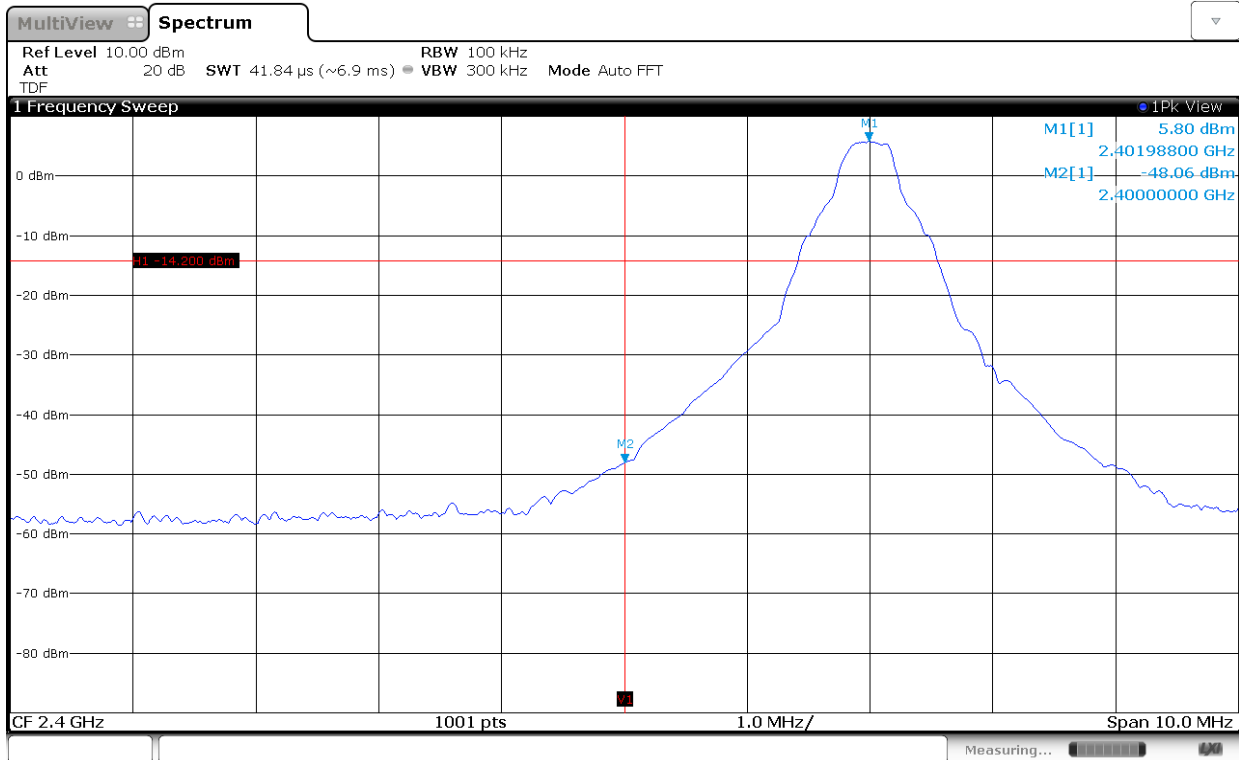
Band-edge and Restricted band – Hopping mode



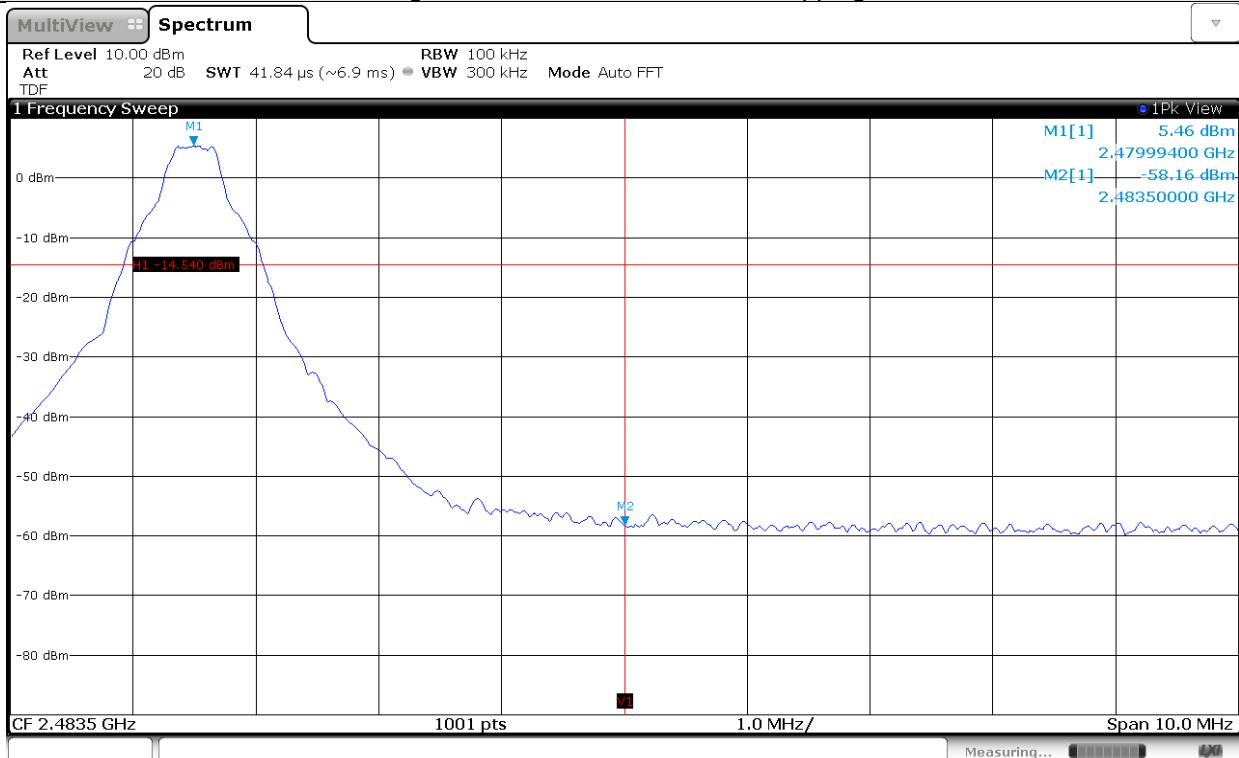
Band-edge and Restricted band – Hopping mode



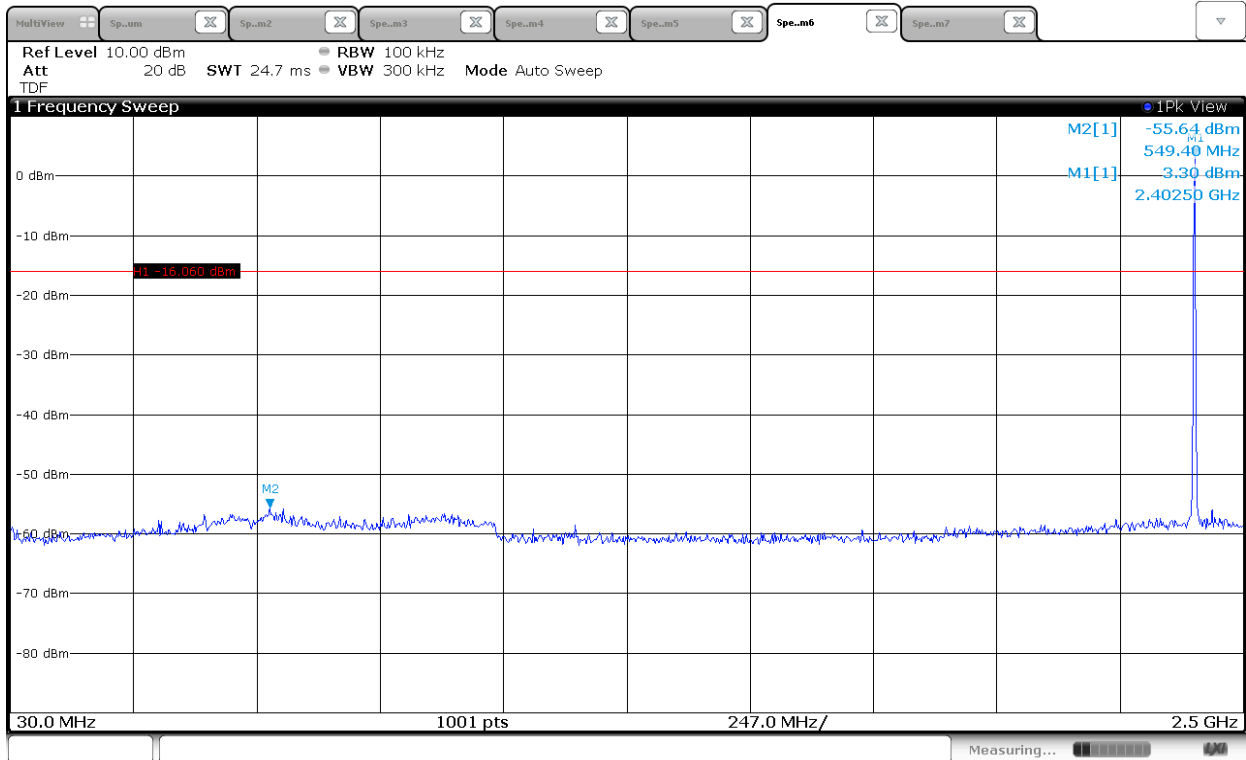
Band-edge and Restricted band – Non-hopping mode



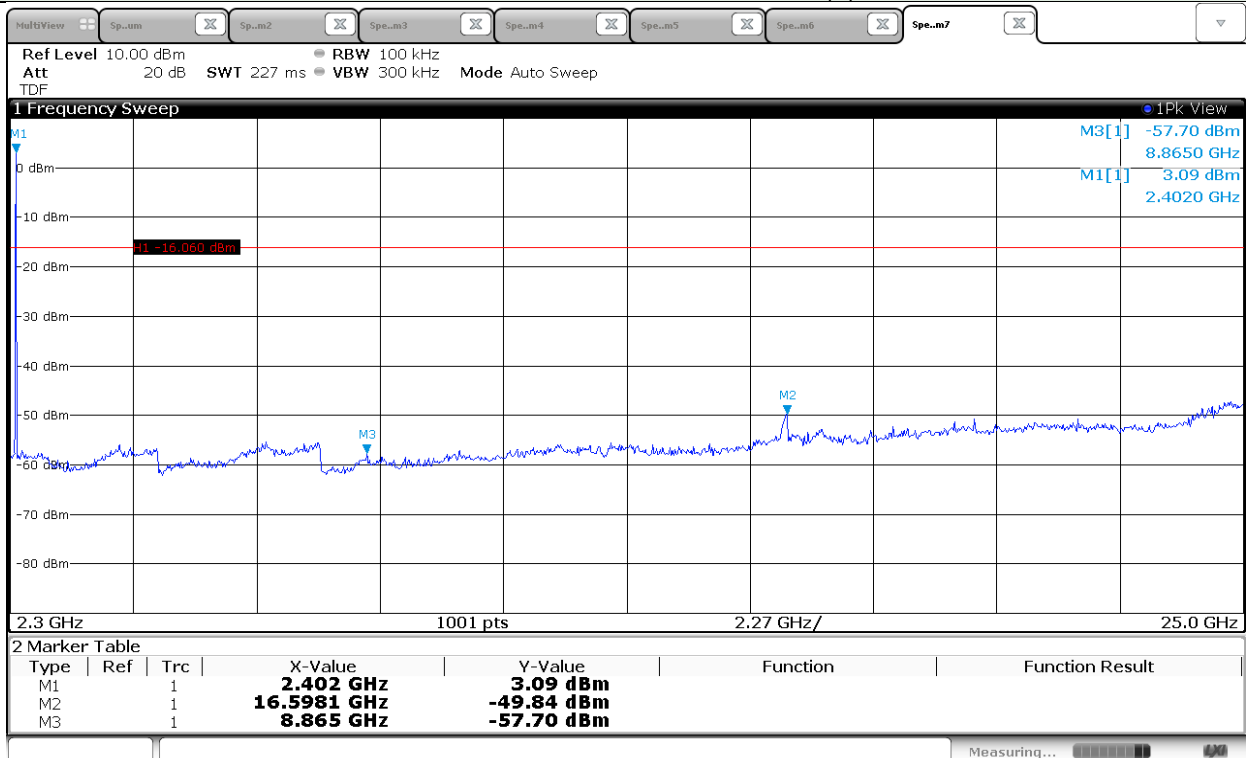
Band-edge and Restricted band – Non-hopping mode



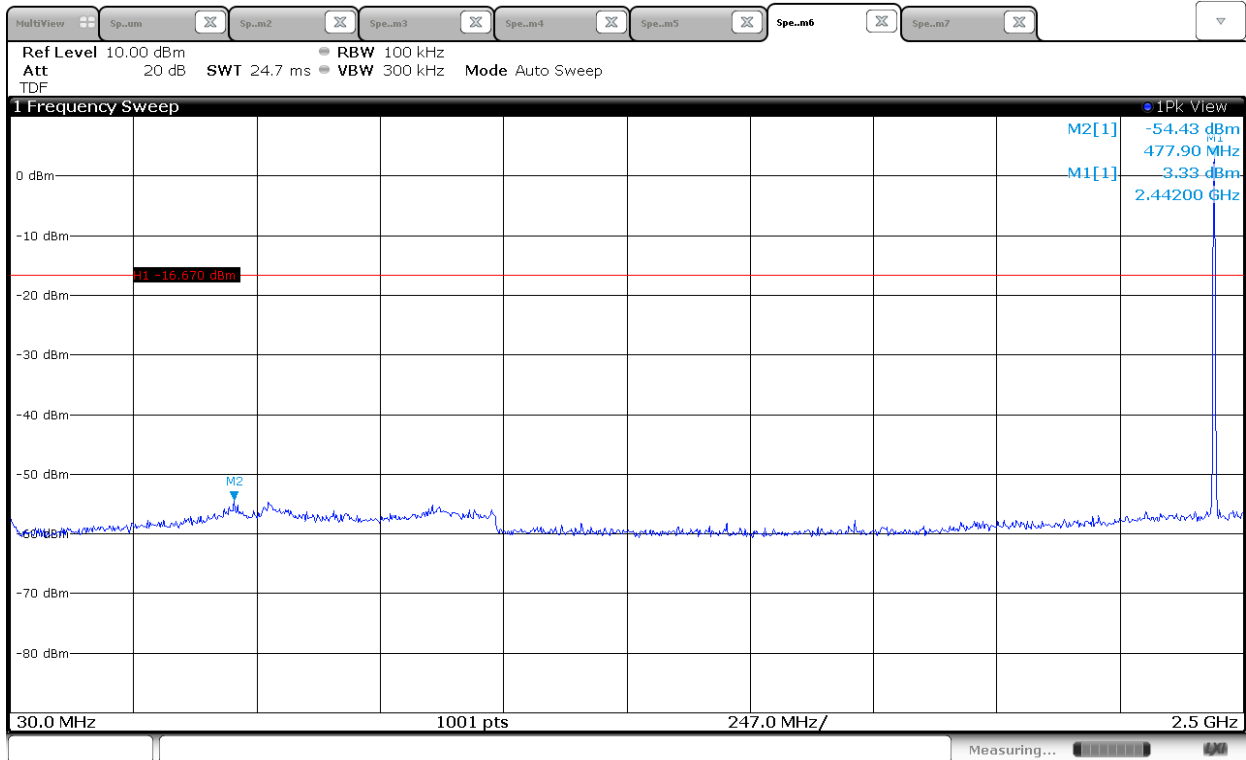
Non-restricted band – Low Channel (1)



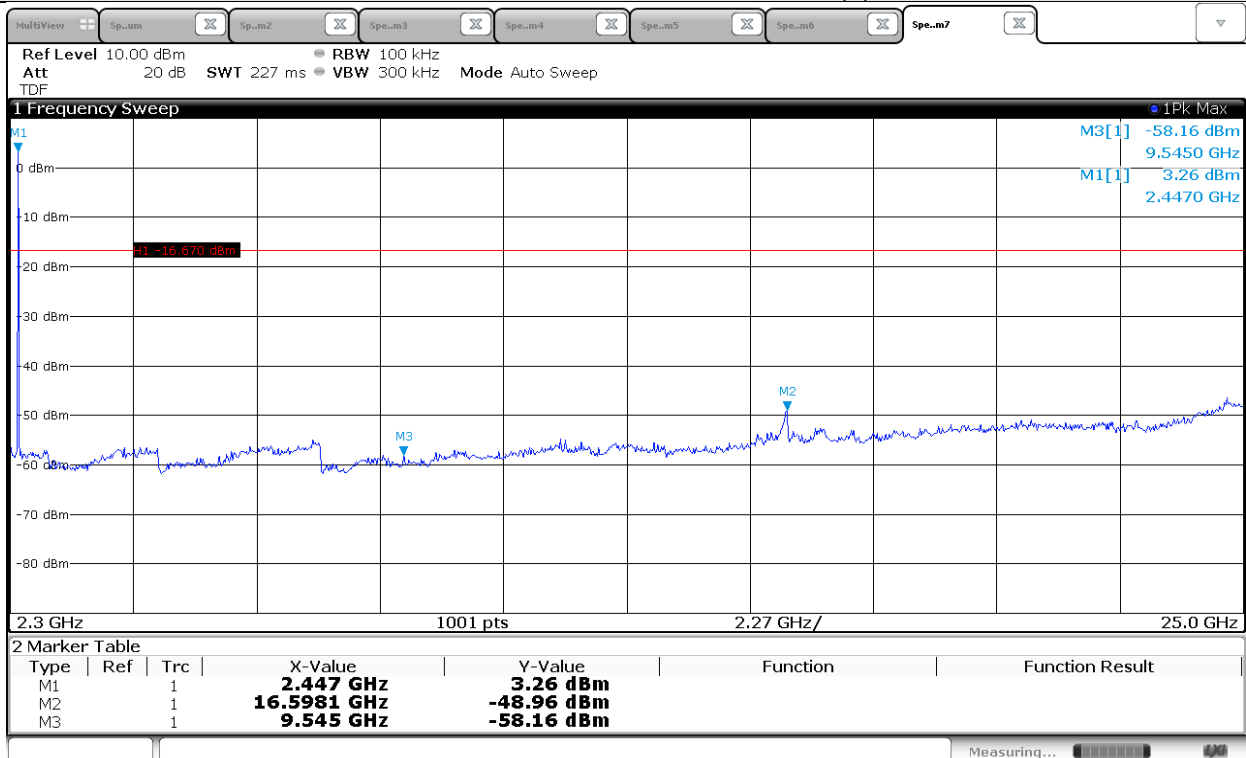
Non-restricted band – Low Channel (2)



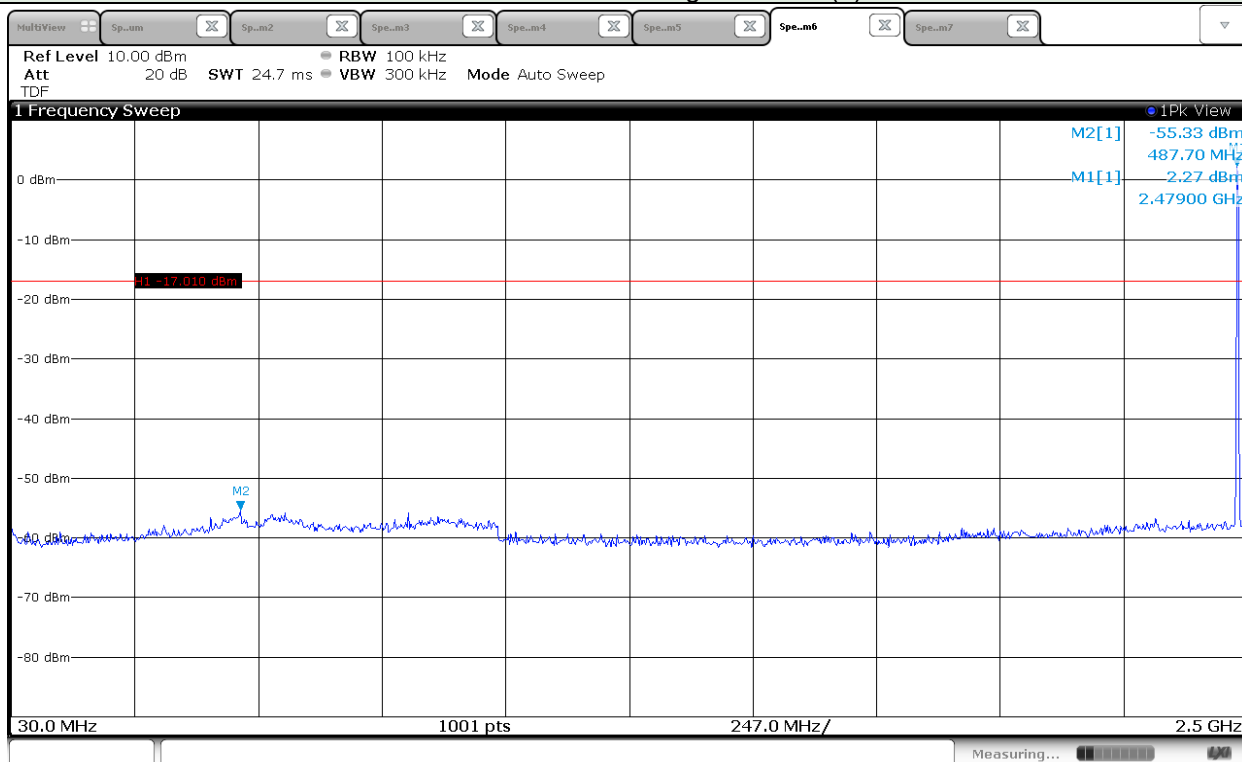
Non-restricted band – Middle Channel (1)



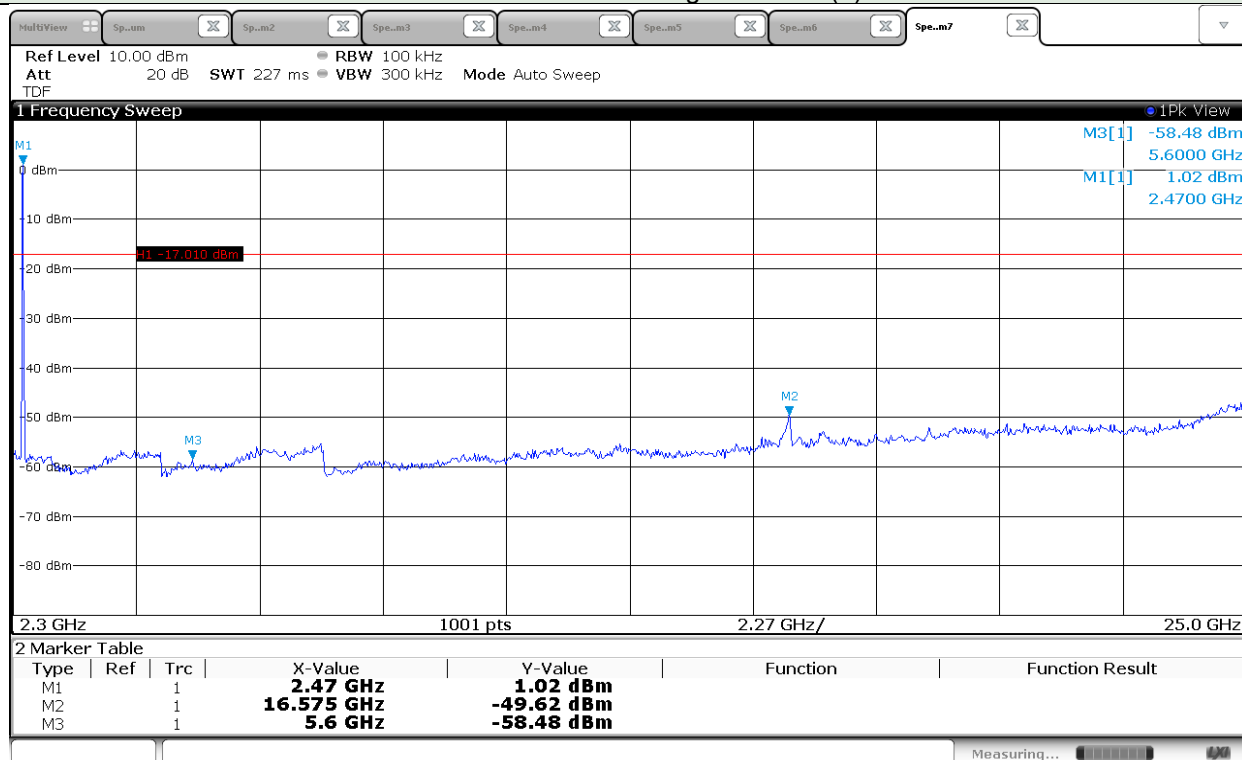
Non-restricted band – Middle Channel (2)



Non-restricted band – High Channel (1)



Non-restricted band – High Channel (2)



5.8 Radiated Emission

5.8.1 Limit

Acc. To section 15.205, 15.209, RSS-GEN 8.9, following table shall be applied.

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

5.8.2 Method of Measurement

The radiated emissions measurements were on 3 m, semi-anechoic chamber. The EUT and other support equipment were placed on a non-conductive table 80 cm for below 1 GHz and 1.5 m for above 1 GHz above the ground plane. The interconnecting cables from outside test site were inserted into ferrite clamps at the point where the cables reach the turntable.

The frequency spectrum from 30 MHz to 25 GHz was scanned and emission levels maximized at each frequency recorded. The system was rotated 360°, and the antenna was varied in height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

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

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

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

5.8.3 Test Site Requirement for KDB 414788 D01

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

5.8.4 Measurement Uncertainty

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

Frequency Range	Uncertainty	Frequency Range	Uncertainty
9 kHz ~ 30 MHz	± 2.6 dB	30 MHz ~ 1 GHz	± 4.4 dB
1 GHz ~ 18 GHz	± 5.2 dB	18 GHz ~25 GHz	± 5.2 dB

5.8.5 Sample Calculated Example

At 80 MHz

Limit = 40.0 dBuV/m

Result (dBuV/m)

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

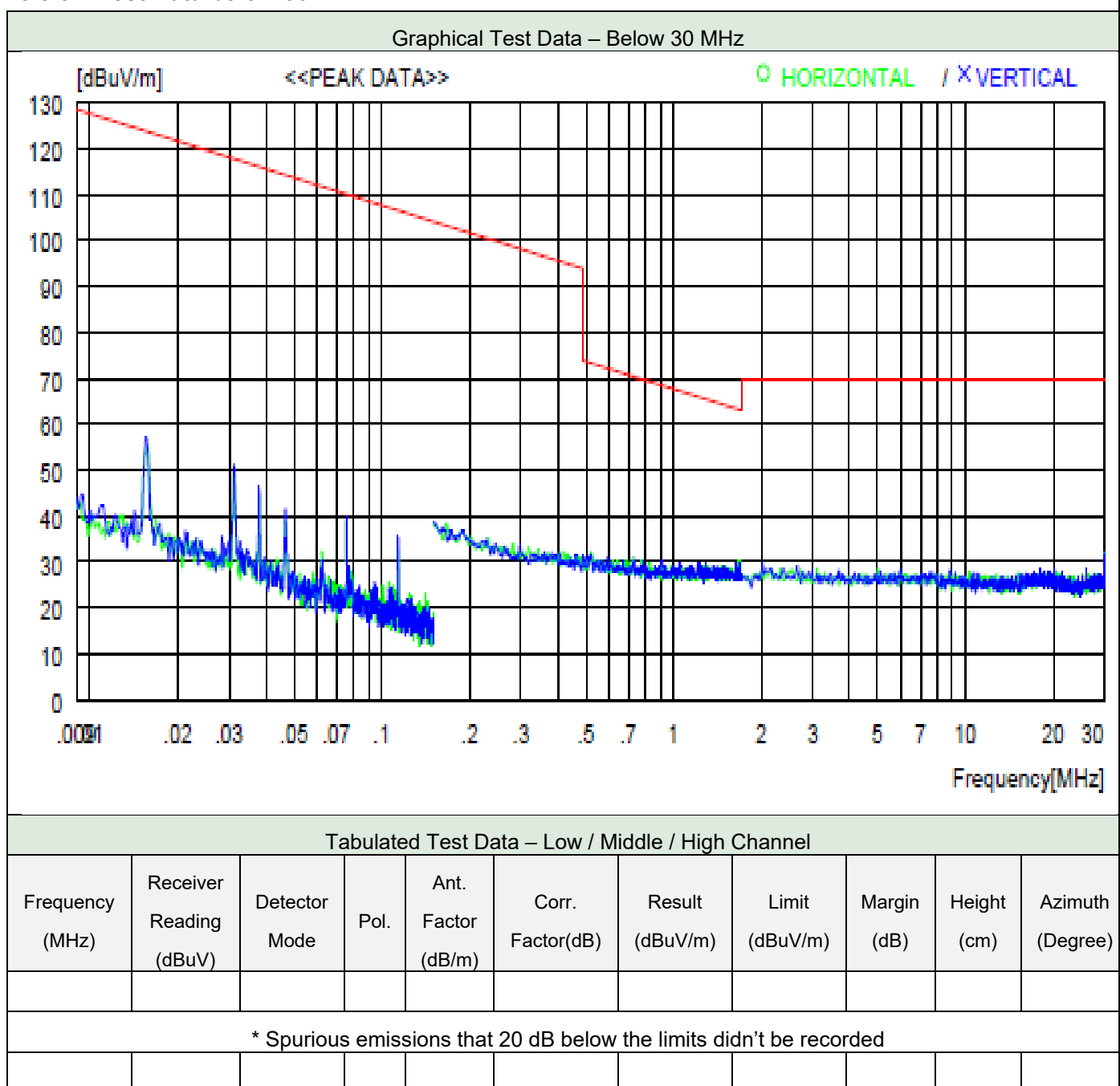
Margin = Limit – Result = 40 – 30 = 10

so the EUT has 10.0 dB margin at 80 MHz

5.8.6 Test Data

Date of Test	2020-03-16, 2020-03-31, 2020-04-09	Temperature		(20.0 ± 1.8) °C	
		Relative humidity		(39.1 ± 1.0) % R.H.	
Measurement Frequency Range		9 kHz ~ 25 GHz			
Test Result	PASS	Tested By		Do-heon, Kim 	
Frequency range	Detector Mode	Resolution BW	Video BW	Video Filtering	Measurement distance
Below 30 MHz	Peak or Q.P.	9 kHz	100 kHz	-	3 m
30 MHz ~ 1 000 MHz	Peak or Q.P.	100 kHz	300 kHz	-	3 m
Above 1 GHz	Peak	1 MHz	3 MHz		3 m
	Average	1 MHz	3 MHz		3 m

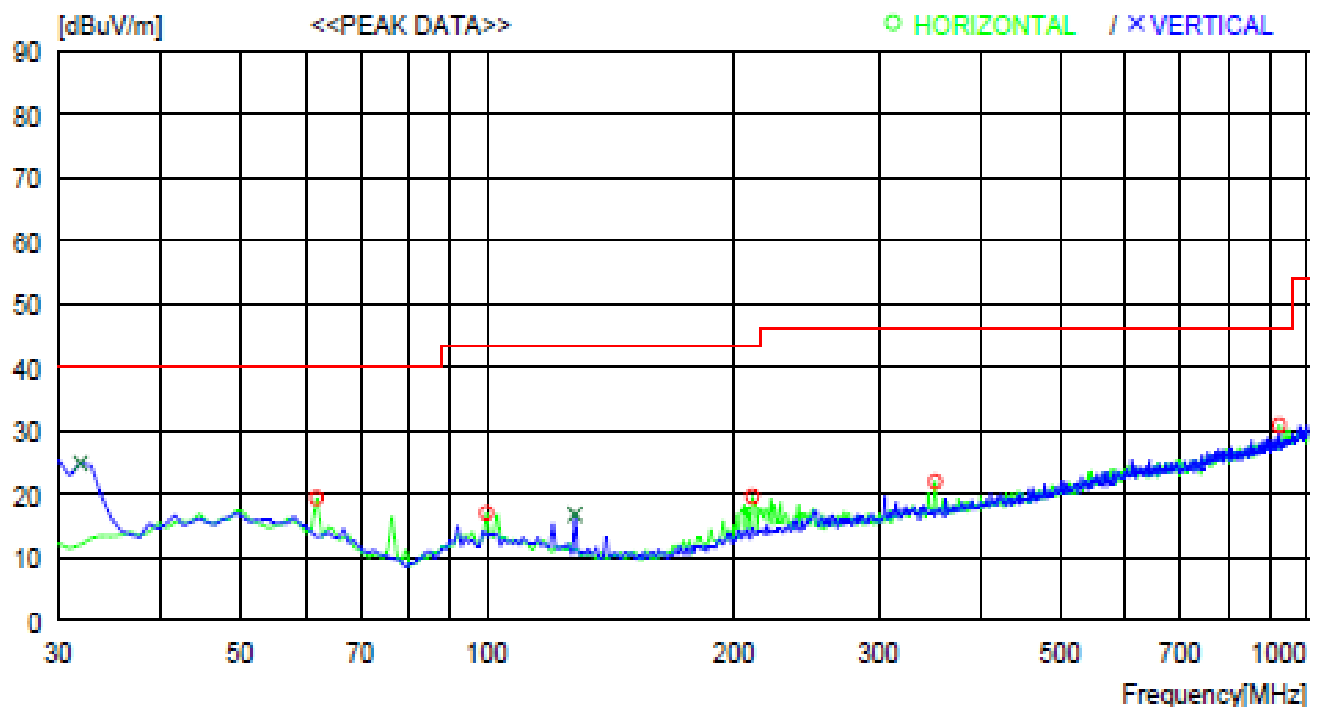
5.8.6.1 Test Data below 30 MHz



5.8.6.2 Test Data from 30 MHz to 1 GHz

5.8.6.2.1 Operating mode: Bluetooth BR (GFSK)

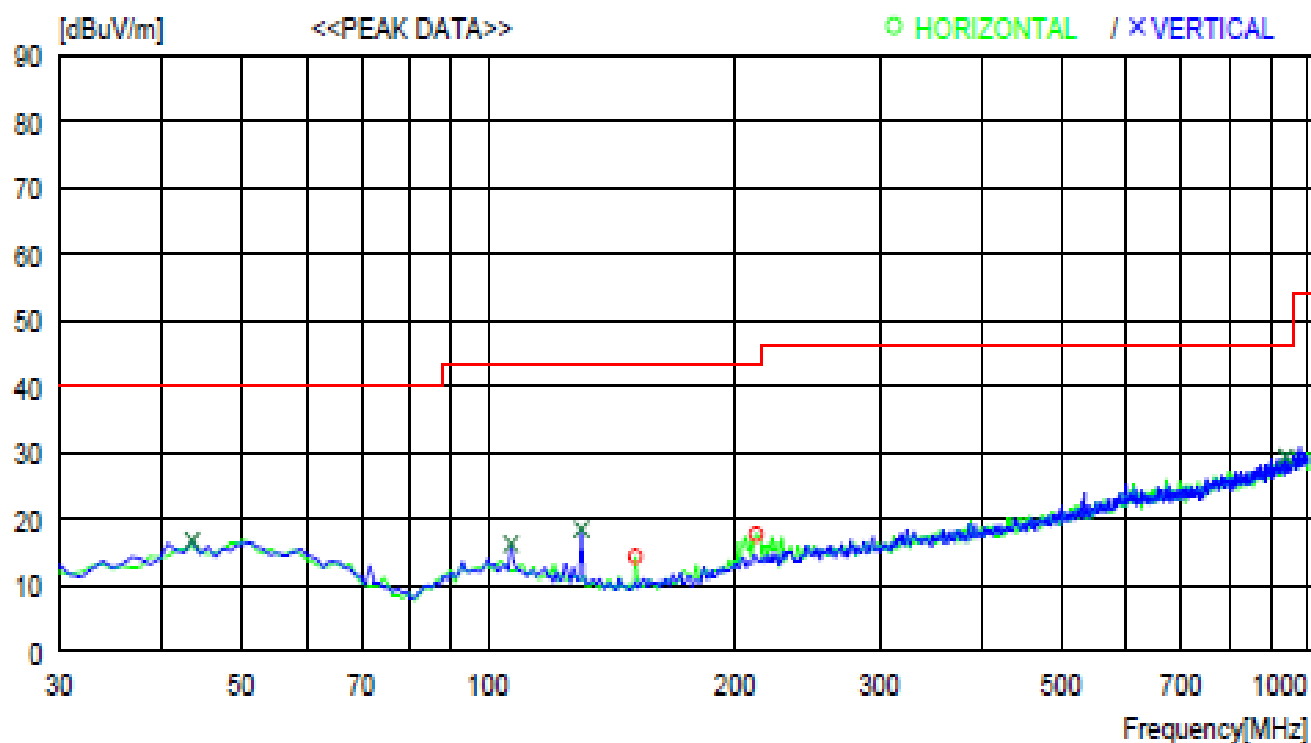
Graphical Test Data – Below 1 GHz – (Bluetooth BR (GFSK) Low channel)



No.	FREQ [MHz]	READING [dBuV]	ANT PEAK FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	62.010	32.3	12.3	7.5	32.7	19.4	40.0	20.6	400	0
2	99.840	30.4	11.2	8.0	32.7	16.9	43.5	26.6	400	78
3	210.420	31.8	11.4	9.0	32.6	19.6	43.5	23.9	100	0
4	352.040	30.1	14.5	10.0	32.7	21.9	46.0	24.1	100	358
5	924.328	28.1	22.2	12.6	32.1	30.8	46.0	15.2	400	0
----- Vertical -----										
6	31.940	39.7	10.7	7.1	32.7	24.8	40.0	15.2	400	115
7	127.970	32.1	8.9	8.3	32.6	16.7	43.5	26.8	400	142

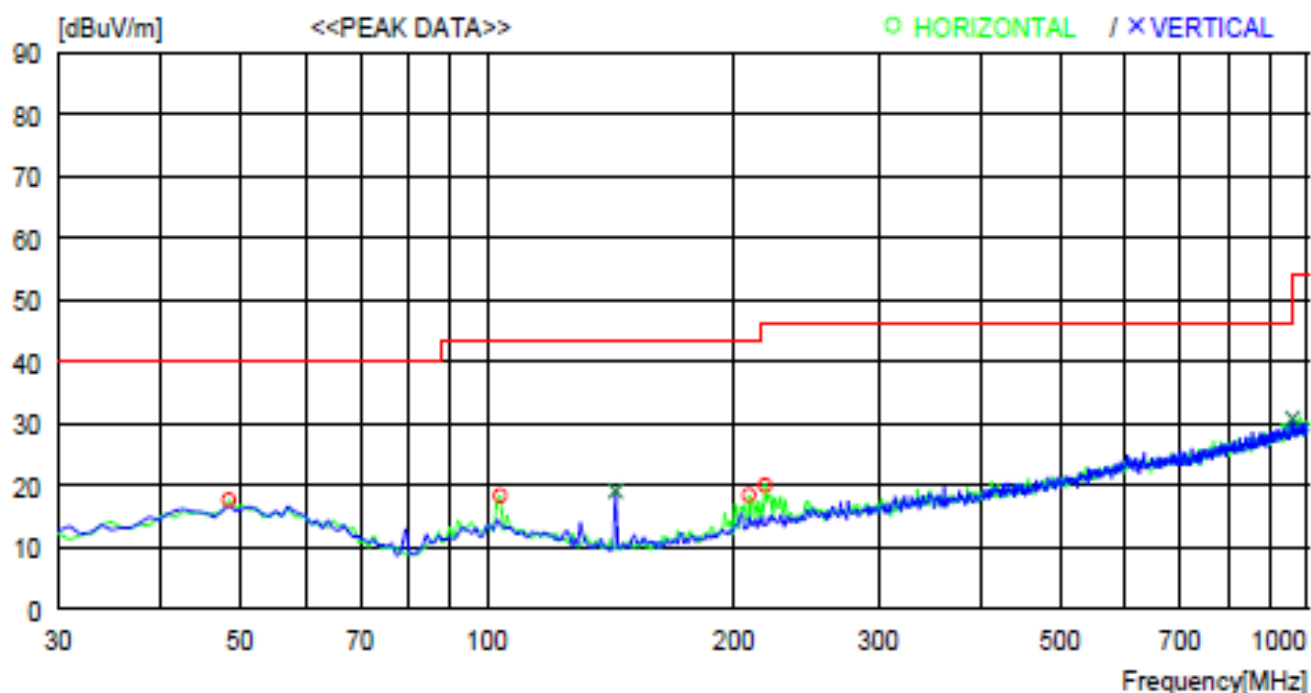
Note: "H" means Horizontal polarity, "V" means Vertical polarity.

Graphical Test Data – Below 1 GHz – (Bluetooth BR (GFSK) Middle channel)



No.	FREQ [MHz]	READING [dBuV]	ANT PEAK FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	151.250	30.2	8.2	8.5	32.6	14.3	43.5	29.2	100	359
2	212.360	29.8	11.5	9.0	32.6	17.7	43.5	25.8	100	222
----- Vertical -----										
3	43.580	28.3	13.9	7.2	32.7	16.7	40.0	23.3	300	351
4	106.630	30.1	10.7	8.1	32.7	16.2	43.5	27.3	300	167
5	129.910	33.9	8.8	8.3	32.6	18.4	43.5	25.1	300	82
6	937.908	26.5	22.3	12.6	32.0	29.4	46.0	16.6	300	0

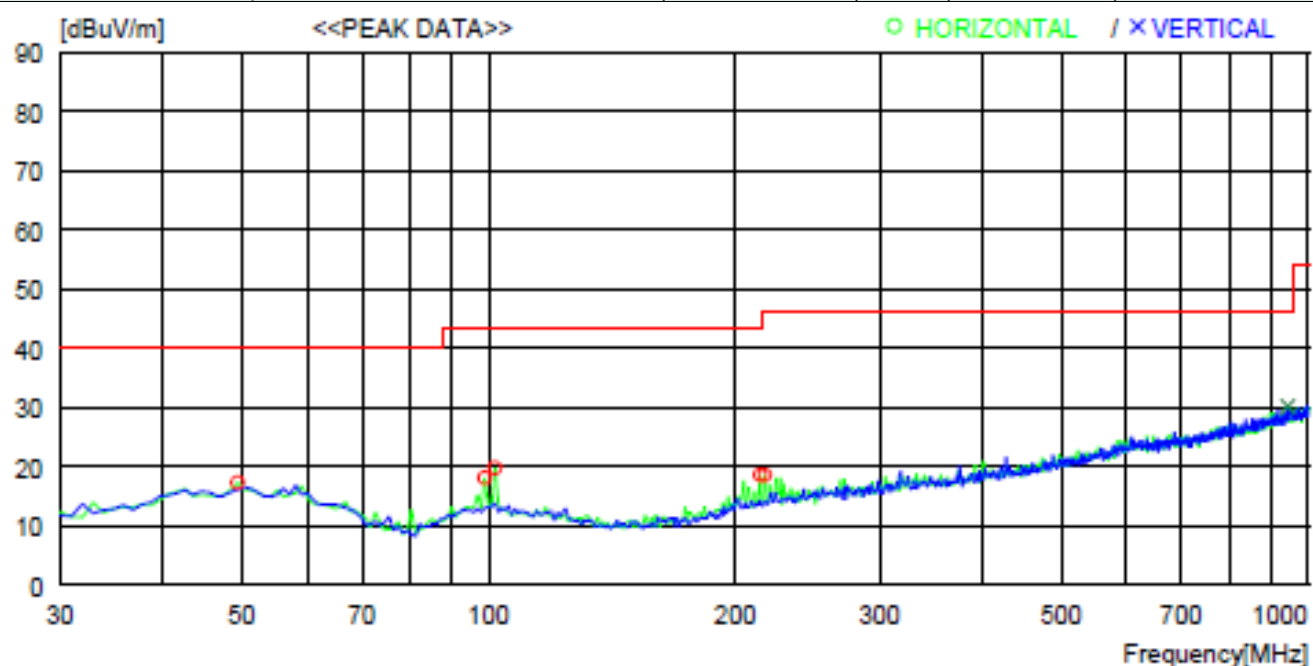
Graphical Test Data – Below 1 GHz – (Bluetooth BR (GFSK) High channel)



No.	FREQ [MHz]	READING [dBuV]	ANT PEAK FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	48.430	28.6	14.3	7.4	32.7	17.6	40.0	22.4	100	295
2	103.720	32.1	10.9	8.0	32.7	18.3	43.5	25.2	200	32
3	208.480	30.6	11.4	9.0	32.6	18.4	43.5	25.1	100	0
4	218.180	32.0	11.6	9.0	32.6	20.0	46.0	26	100	0
----- Vertical -----										
5	143.490	35.3	8.0	8.4	32.6	19.1	43.5	24.4	300	359
6	959.247	27.5	22.4	12.7	31.8	30.8	46.0	15.2	300	2

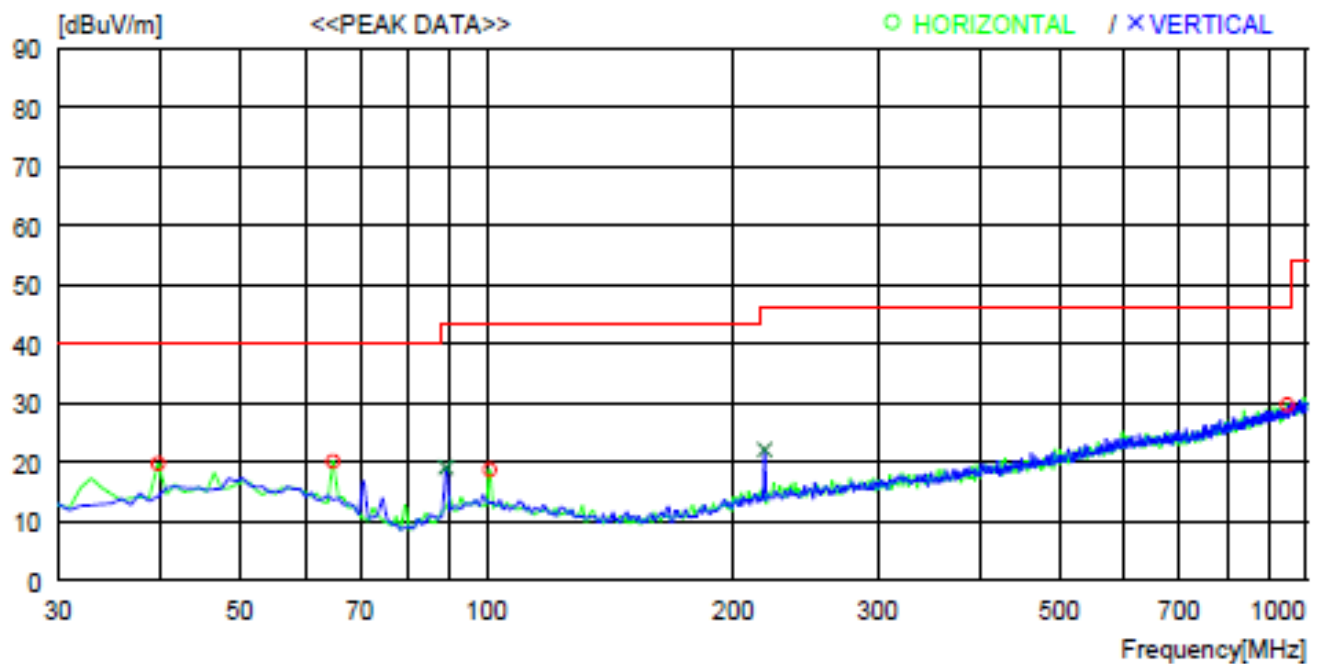
5.8.6.2.2 Operating mode: Bluetooth EDR (8DPSK)

Graphical Test Data – Below 1 GHz – (Bluetooth EDR (8DPSK) Low channel)

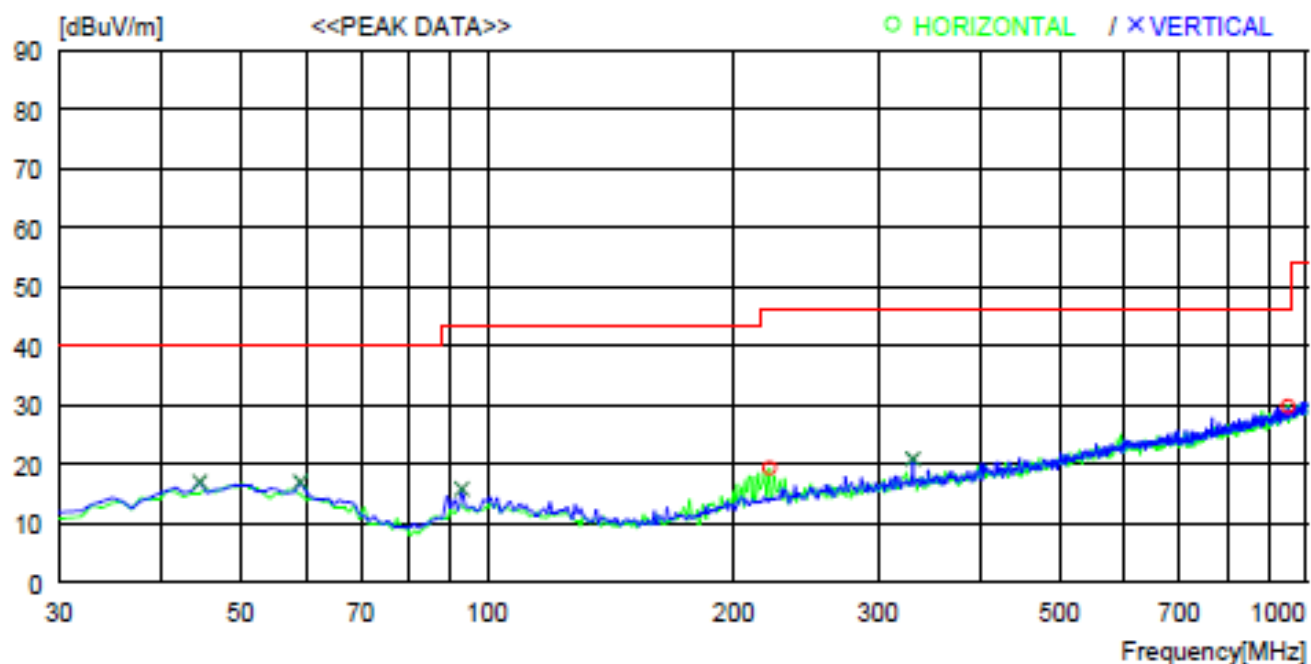


No.	FREQ [MHz]	READING [dBuV]	ANT PEAK FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	49.400	28.2	14.4	7.4	32.7	17.3	40.0	22.7	200	299
2	98.870	31.7	11.1	8.0	32.7	18.1	43.5	25.4	200	359
3	101.780	33.4	11.1	8.0	32.7	19.8	43.5	23.7	200	93
4	214.300	30.7	11.5	9.0	32.6	18.6	43.5	24.9	100	0
5	217.210	30.5	11.6	9.0	32.6	18.5	46.0	27.5	100	217
----- Vertical -----										
6	943.728	27.2	22.3	12.6	32.0	30.1	46.0	15.9	300	319

Graphical Test Data – Below 1 GHz – (Bluetooth EDR (8DPSK) Middle channel)



Graphical Test Data – Below 1 GHz – (Bluetooth EDR (8DPSK) High channel)



No.	FREQ [MHz]	READING [dBuV]	ANT PEAK FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	221.090	31.1	11.7	9.1	32.6	19.3	46.0	26.7	100	359
2	949.547	26.7	22.3	12.7	31.9	29.8	46.0	16.2	100	296
----- Vertical -----										
3	44.550	28.3	14.1	7.3	32.7	17.0	40.0	23	400	278
4	59.100	29.1	13.1	7.5	32.7	17.0	40.0	23	300	166
5	93.050	30.2	10.3	8.0	32.7	15.8	43.5	27.7	300	0
6	330.700	29.7	14.0	9.8	32.6	20.9	46.0	25.1	300	0

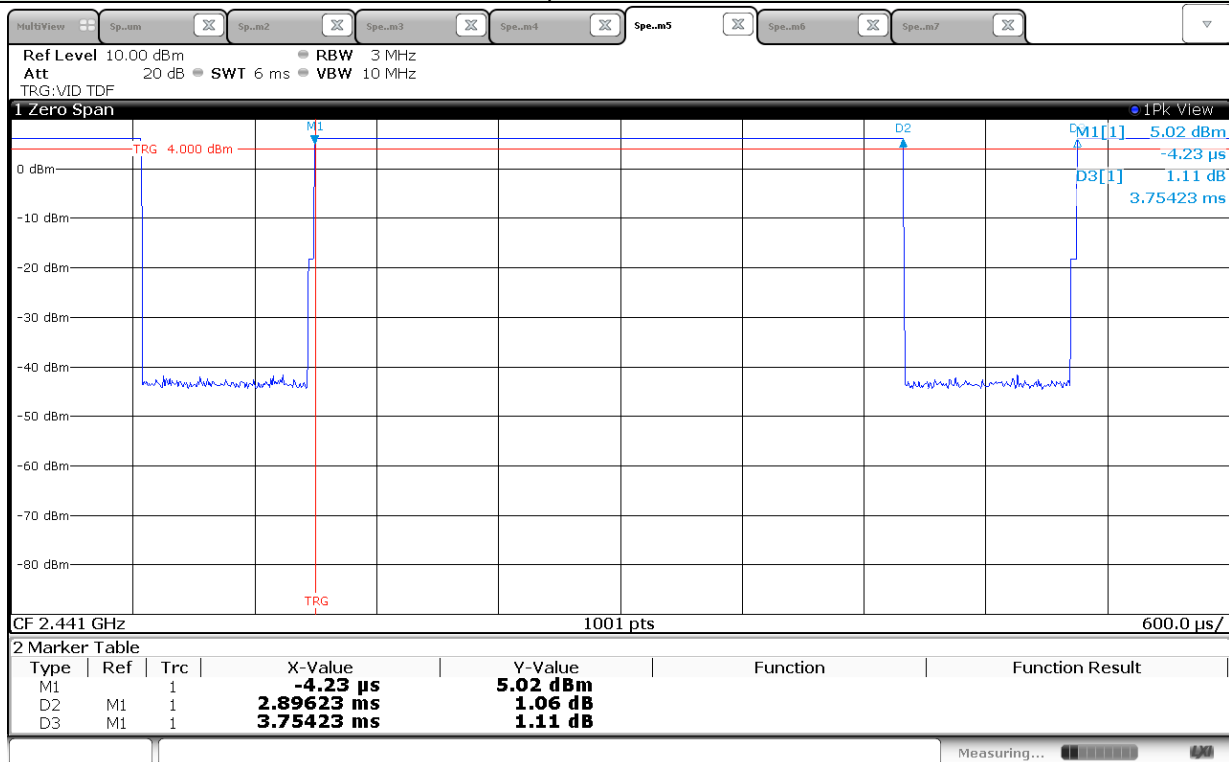
5.8.6.3 Test Data above 1 GHz

5.8.6.3.1 Operating mode: Bluetooth BR (GFSK)

Duty Cycle

Date of Test	2020-03-16	Temperature	(19.4 ± 1.2) °C
		Relative humidity	(39.3 ± 0.8) % R.H.
Measurement Distance	3 m	Tested By	Do-heon, Kim 
Detector Mode	Resolution BW	Video BW	Sweep Time
PEAK	1 MHz	3 MHz	Auto
AVERAGE	1 MHz	3 MHz	Auto

Graphical Test Data



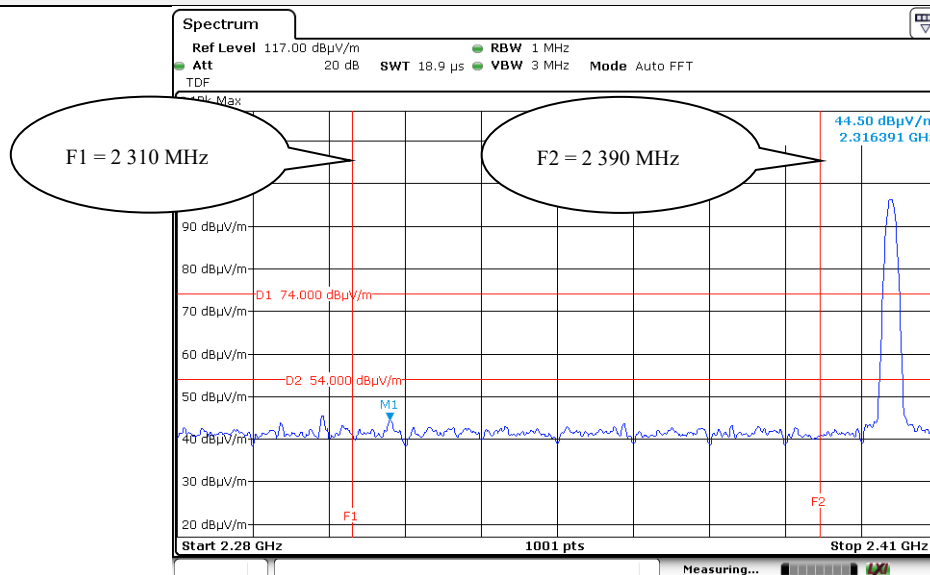
Tabulated Test Data

Operating Mode	On Time (ms)	On + Off Time (ms)	Duty Cycle (%)	Duty Factor (dB)
Bluetooth BR (DH5)	2.89623	3.75423	77.15	1.13

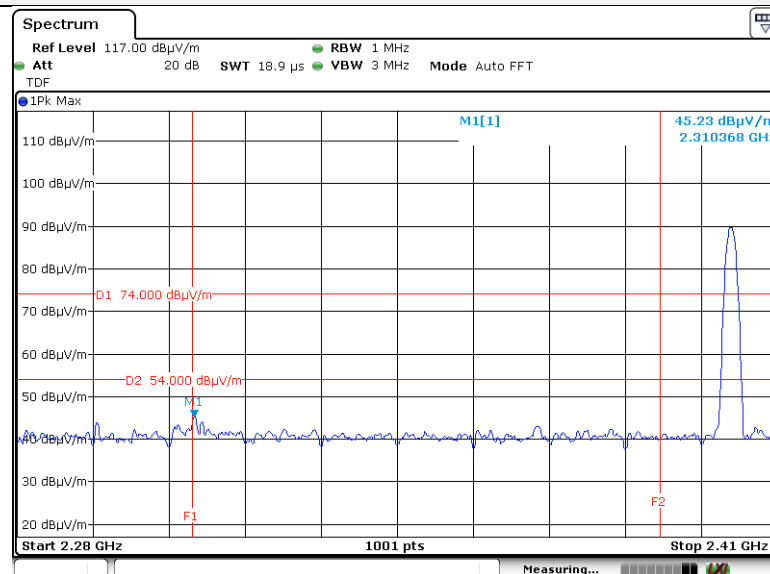
Band edge (Restricted band)

Graphical Test Data – Low Channel (Peak)

Horizontal



Vertical



Tabulated Test Data – Low Channel

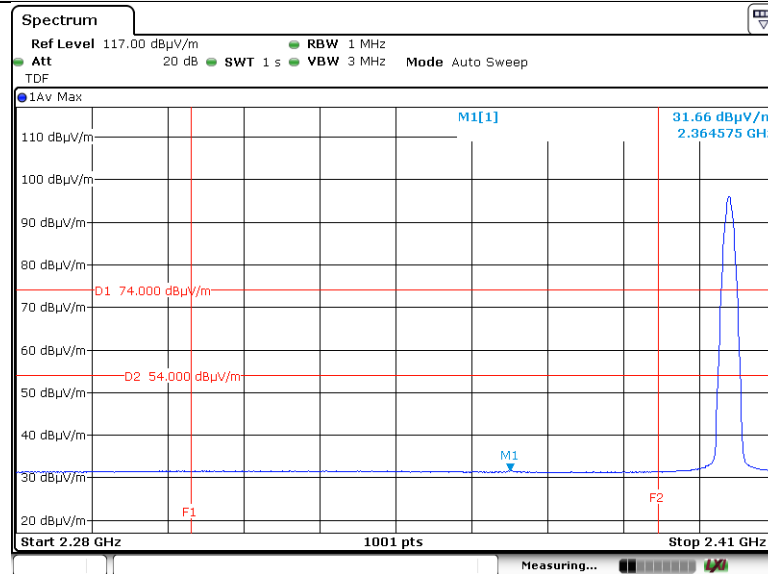
Freq. (MHz)	Detector Mode	Pol.	Measured Value (dBμV/m)	Duty Factor (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)
2 316.4	Peak	H	44.50	-	44.50	74.00	29.50	180	73
2 310.4	Peak	V	45.23	-	45.23	74.00	28.77	100	131

NOTE: “H” means Horizontal polarity, “V” means Vertical polarity.

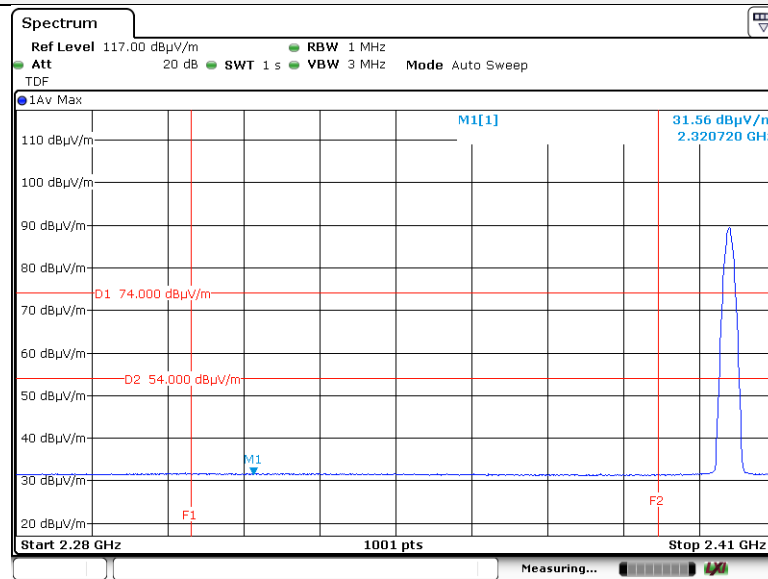
Measured Value = Receiver reading + Antenna Factor + Cable Loss - Pre-amplifier Gain

Graphical Test Data – Low Channel (Average)

Horizontal



Vertical



Tabulated Test Data – Low Channel

Freq. (MHz)	Detector Mode	Pol.	Measured Value (dBuV/m)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)
2 364.6	Average	H	31.66	1.13	32.79	54.00	21.21	180	73
2 320.7	Average	V	31.56	1.13	32.69	54.00	21.31	100	131

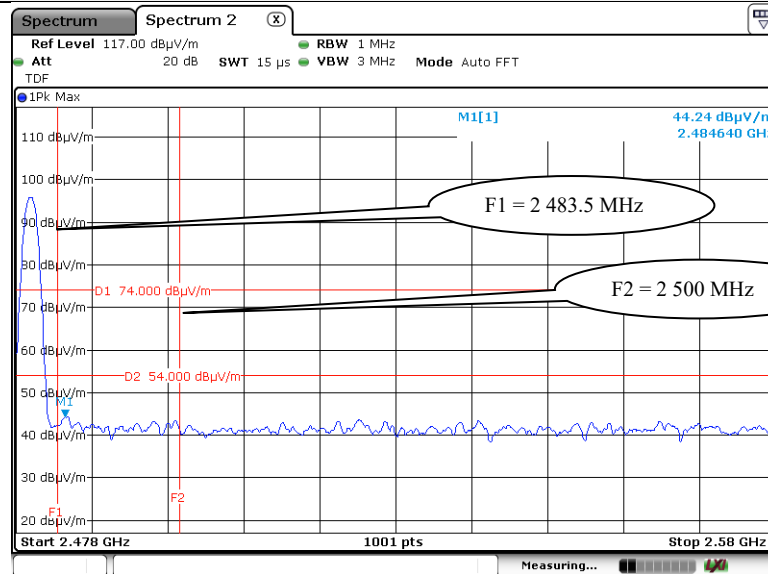
NOTE: “H” means Horizontal polarity, “V” means Vertical polarity.

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

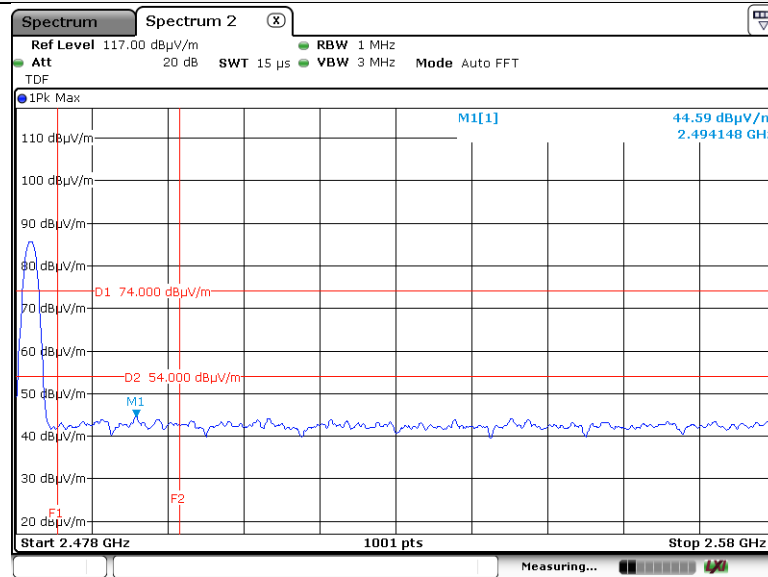
Result = Measured Value + Duty Factor

Graphical Test Data – High Channel (Peak)

Horizontal



Vertical

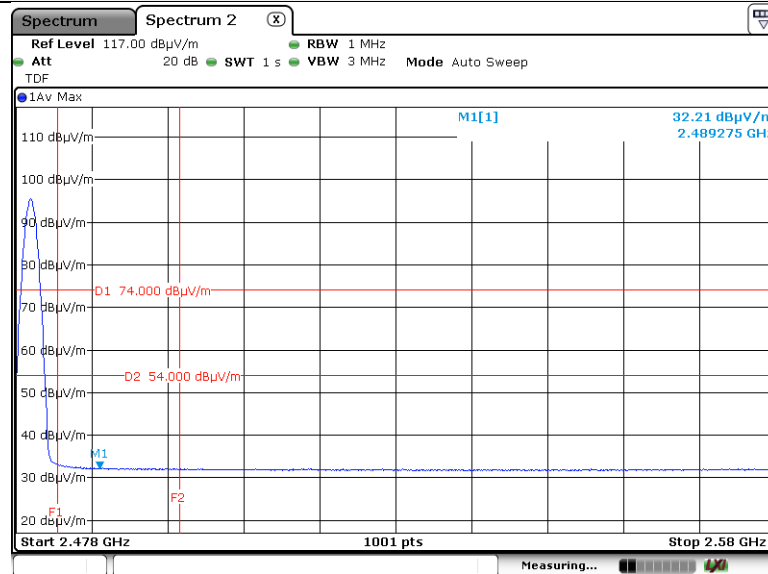


Tabulated Test Data – High Channel

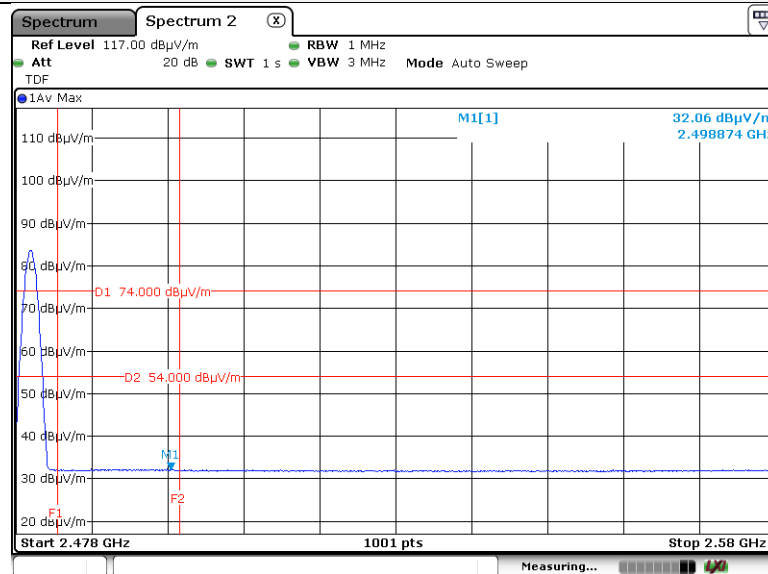
Freq. (MHz)	Detector Mode	Pol.	Measured Value (dBuV/m)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)
2 484.5	Peak	H	44.24	-	44.24	74.00	29.76	180	73
2 494.1	Peak	V	44.59	-	44.59	74.00	29.41	100	131

Graphical Test Data – High Channel (Average)

Horizontal



Vertical



Tabulated Test Data – High Channel

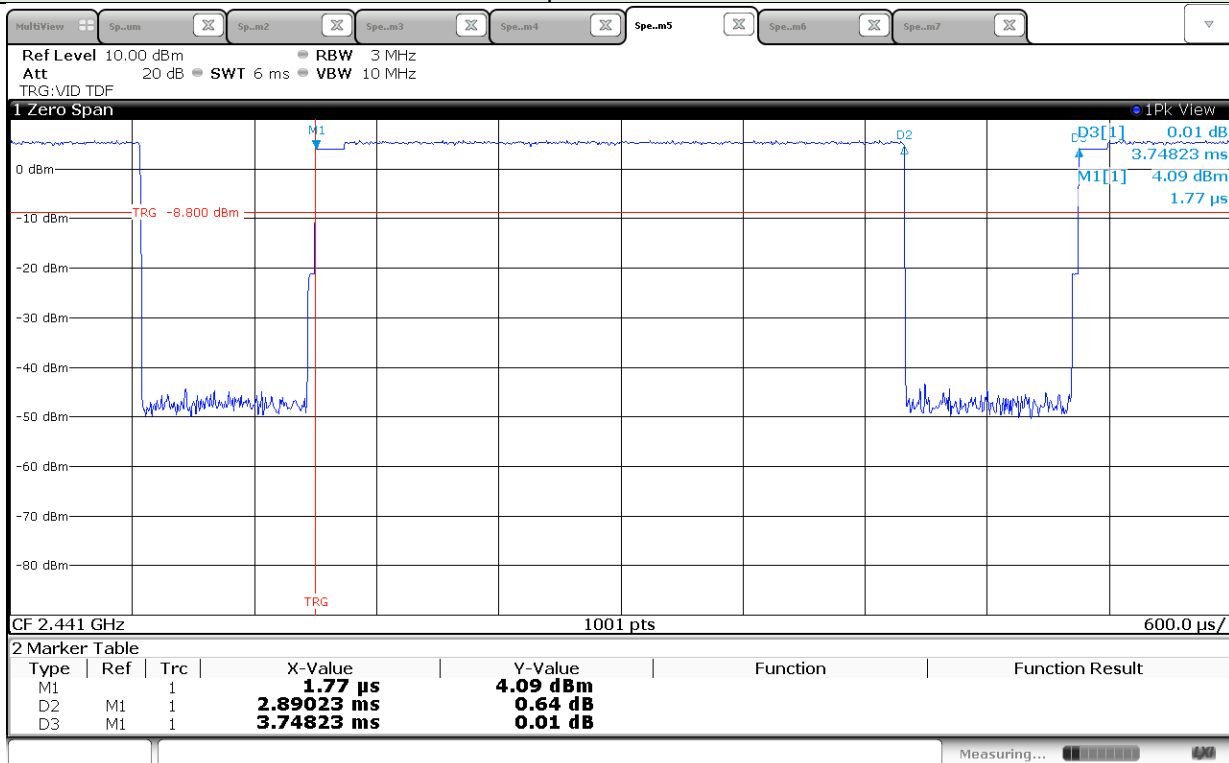
Freq. (MHz)	Detector Mode	Pol.	Measured Value (dBuV/m)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)
2 489.3	Average	H	32.21	1.13	33.34	54	20.66	180	73
2 498.9	Average	V	32.06	1.13	33.19	54	20.81	100	131

5.8.6.3.2 Operating mode: Bluetooth EDR (8DPSK)

Duty Cycle

Date of Test	2020-03-16	Temperature	(19.4 ± 1.2) °C
		Relative humidity	(39.3 ± 0.8) % R.H.
Measurement Distance	3 m	Tested By	Do-heon, Kim 
Detector Mode	Resolution BW	Video BW	Sweep Time
PEAK	1 MHz	3 MHz	Auto
AVERAGE	1 MHz	3 MHz	Auto

Graphical Test Data



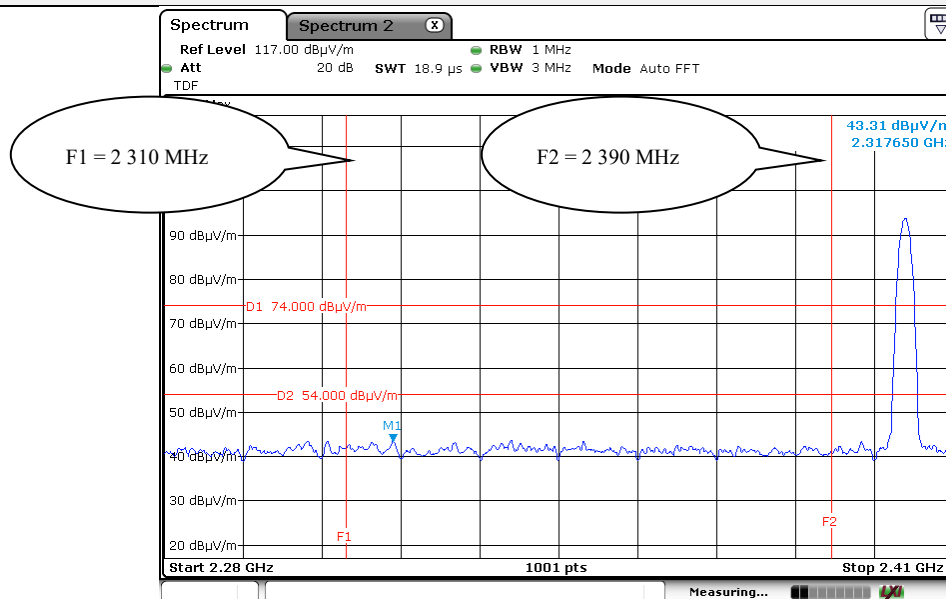
Tabulated Test Data

Operating Mode	On Time (ms)	On + Off Time (ms)	Duty Cycle (%)	Duty Factor (dB)
Bluetooth EDR (3-DH5)	2.89023	3.74823	77.11	1.13

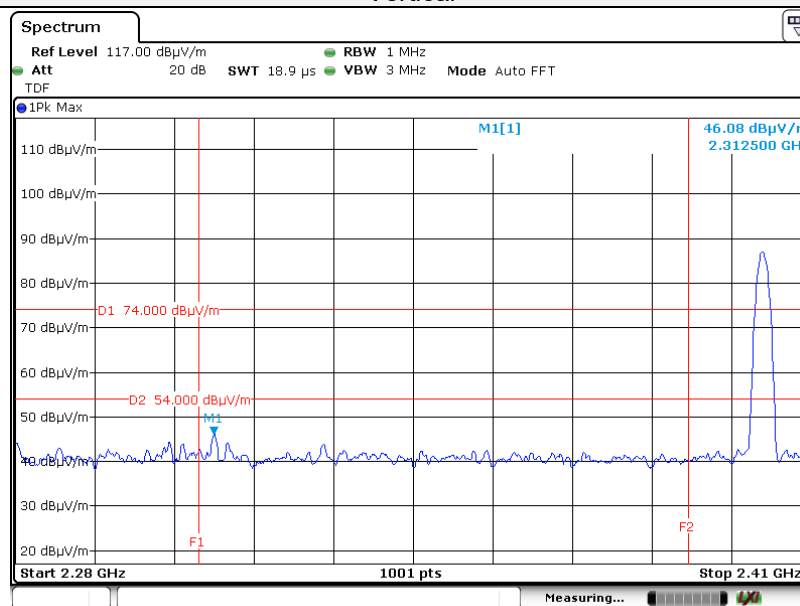
Band edge (Restricted band)

Graphical Test Data – Low Channel (Peak)

Horizontal



Vertical

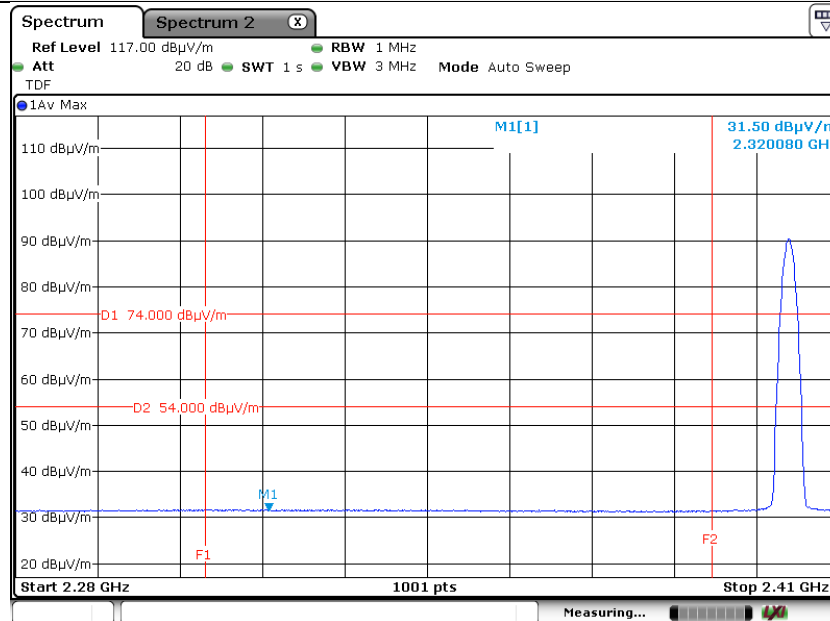


Tabulated Test Data – Low Channel

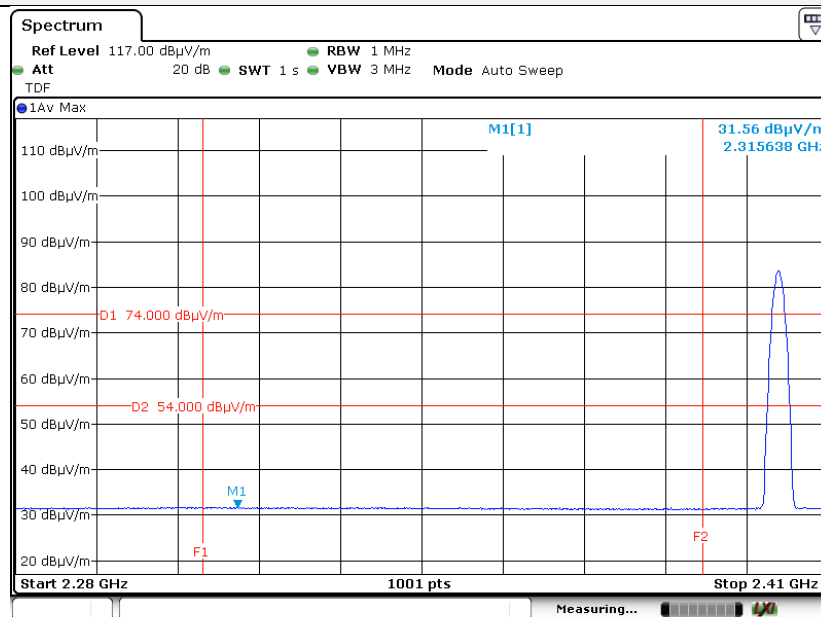
Freq. (MHz)	Detector Mode	Pol.	Measured Value (dBuV/m)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)
2 317.7	Peak	H	43.31	-	43.31	74.00	30.69	180	73
2 312.5	Peak	V	46.08	-	46.08	74.00	27.92	100	131

Graphical Test Data – Low Channel (Average)

Horizontal



Vertical

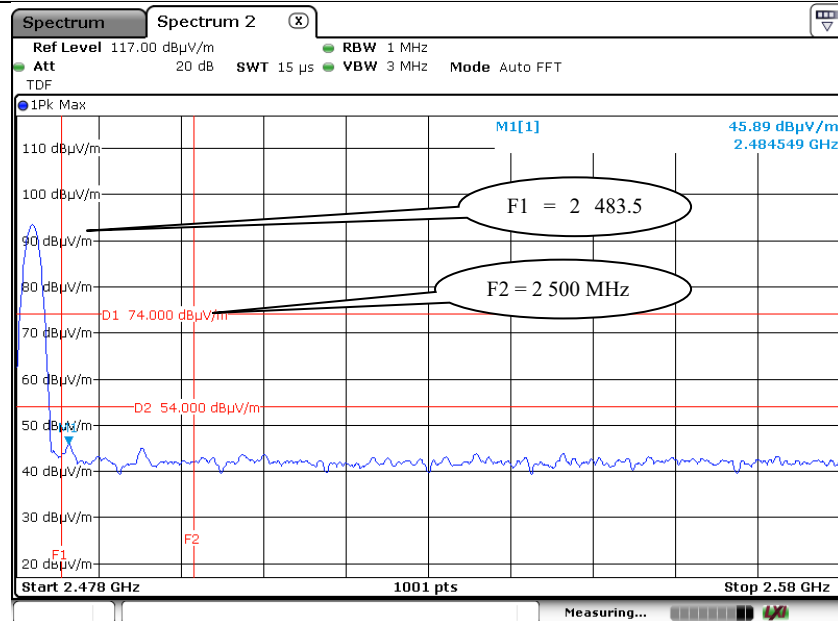


Tabulated Test Data – Low Channel

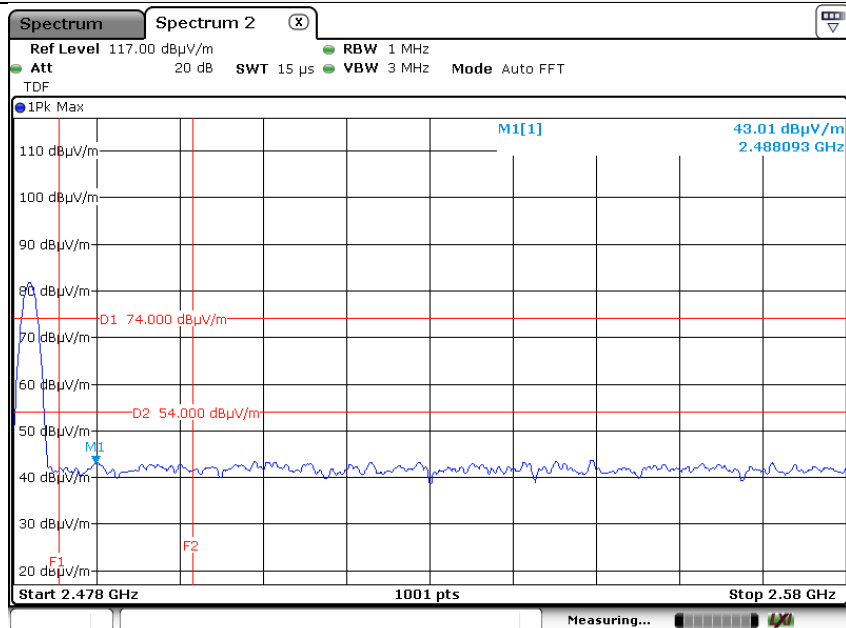
Freq. (MHz)	Detector Mode	Pol.	Measured Value (dBuV/m)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)
2 320.1	Average	H	31.50	1.13	32.63	54.00	21.37	180	73
2 315.6	Average	V	31.56	1.13	32.69	54.00	21.31	100	131

Graphical Test Data – High Channel (Peak)

Horizontal



Vertical

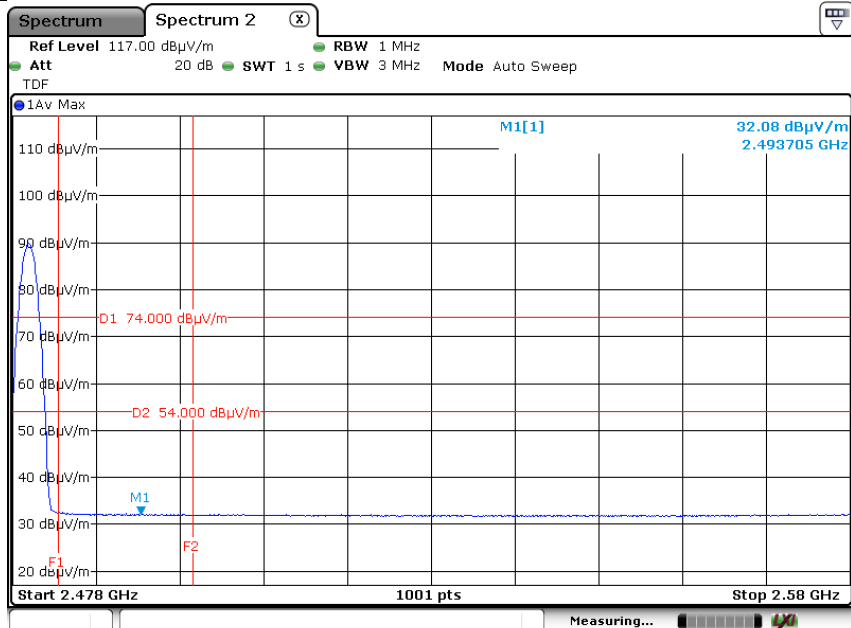


Tabulated Test Data – High Channel

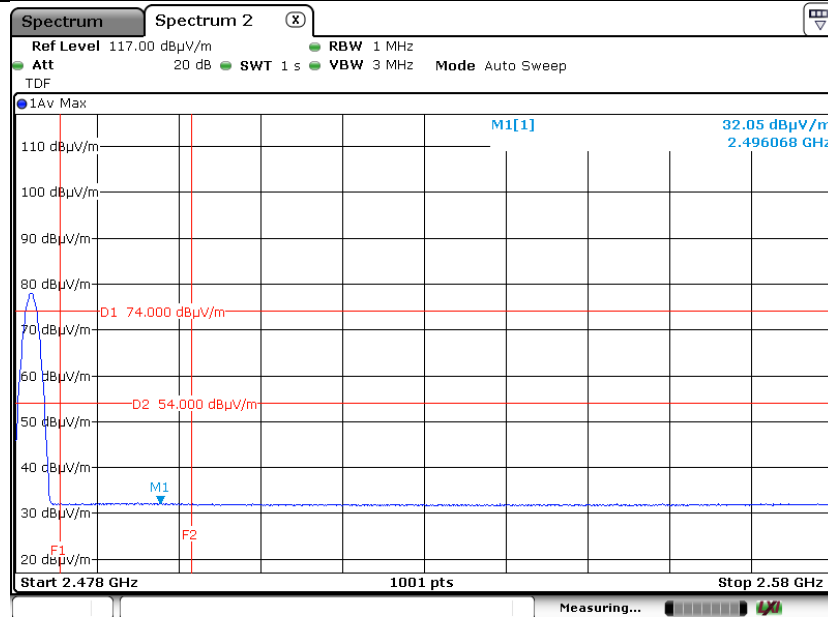
Freq. (MHz)	Detector Mode	Pol.	Measured Value (dBuV/m)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)
2 484.5	Peak	H	45.89	-	45.89	74.00	28.11	180	73
2 488.1	Peak	V	43.01	-	43.01	74.00	30.99	100	131

Graphical Test Data – High Channel (Average)

Horizontal



Vertical

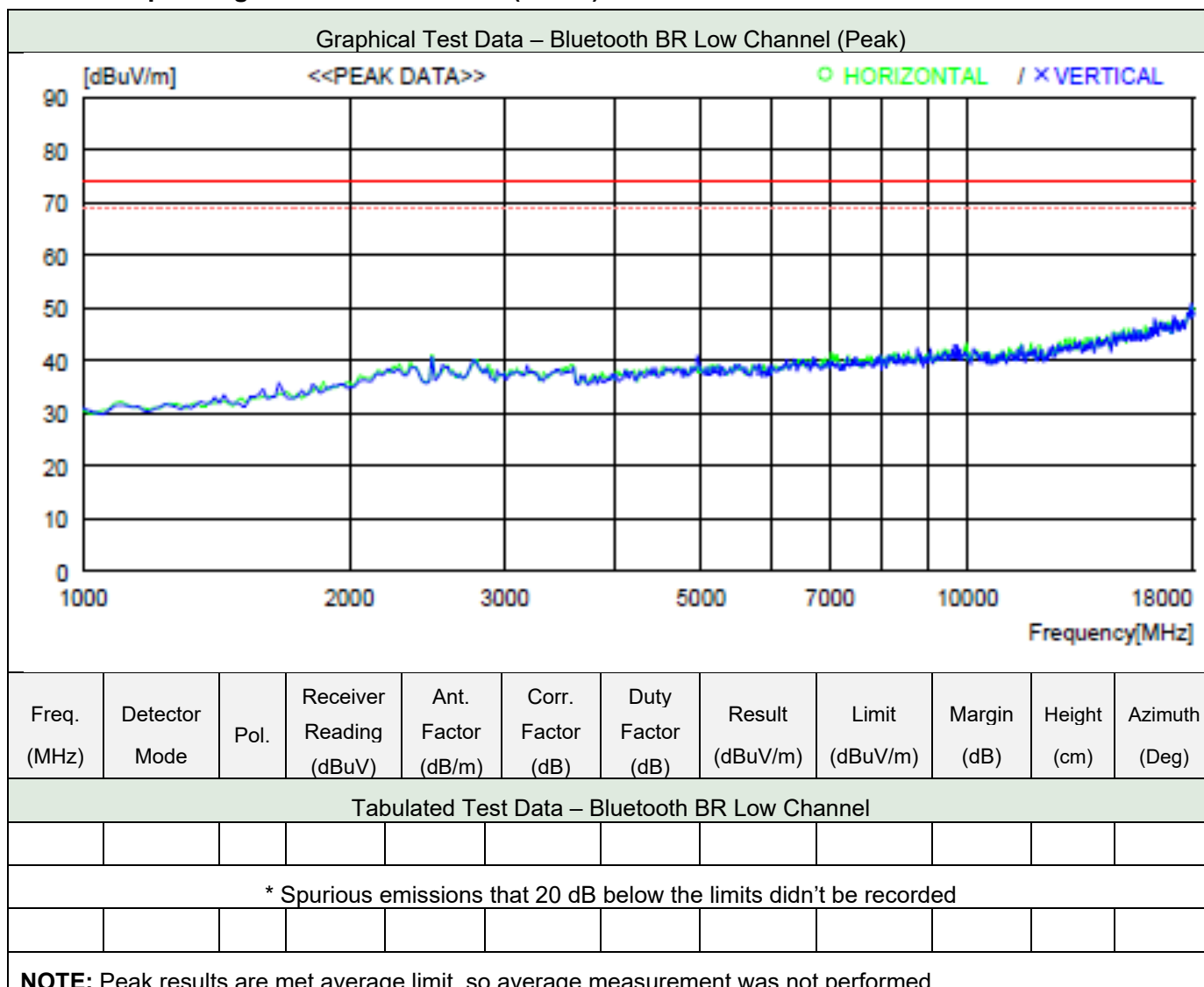


Tabulated Test Data – High Channel

Freq. (MHz)	Detector Mode	Pol.	Measured Value (dBuV/m)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)
2 493.7	Average	H	32.08	1.13	33.21	54.00	20.79	180	73
2 496.1	Average	V	32.05	1.13	33.18	54.00	20.82	100	131

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

5.8.6.4.1 Operating mode: Bluetooth BR (GFSK)



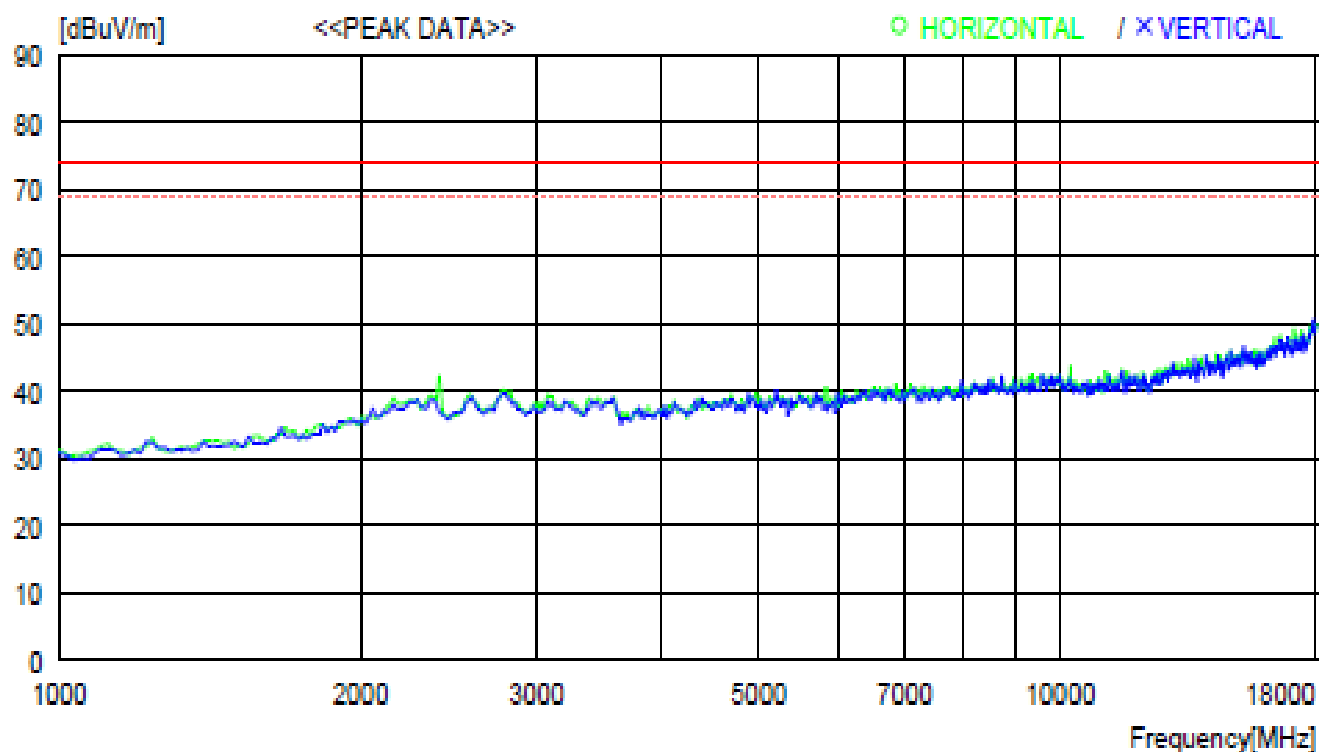
Note. "H" means Horizontal polarity, "V" means Vertical polarity.

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

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

Margin = Limit – Result

Graphical Test Data – Bluetooth BR Middle Channel (Peak)



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

Tabulated Test Data – Bluetooth BR Middle Channel

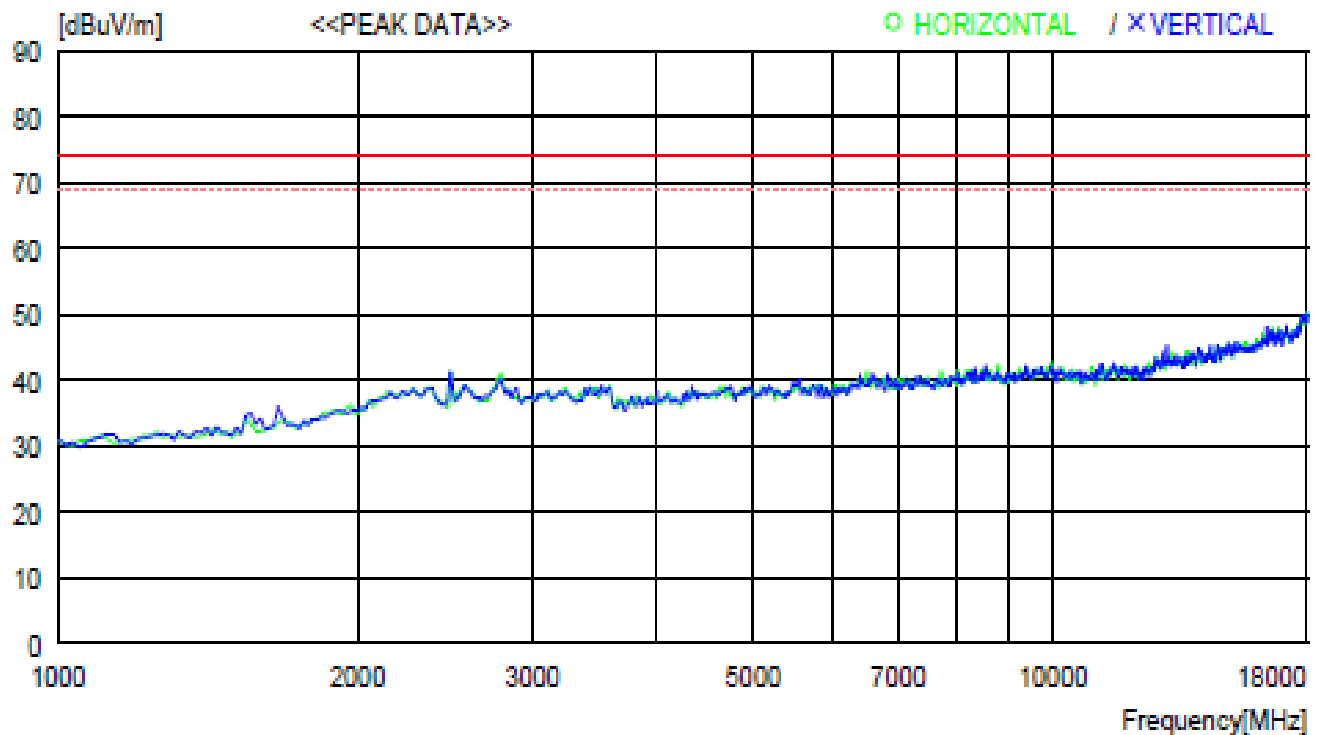
--	--	--	--	--	--	--	--	--	--	--	--

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

--	--	--	--	--	--	--	--	--	--	--	--

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

Graphical Test Data – Bluetooth BR High Channel (Peak)



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

Tabulated Test Data – Bluetooth BR High Channel

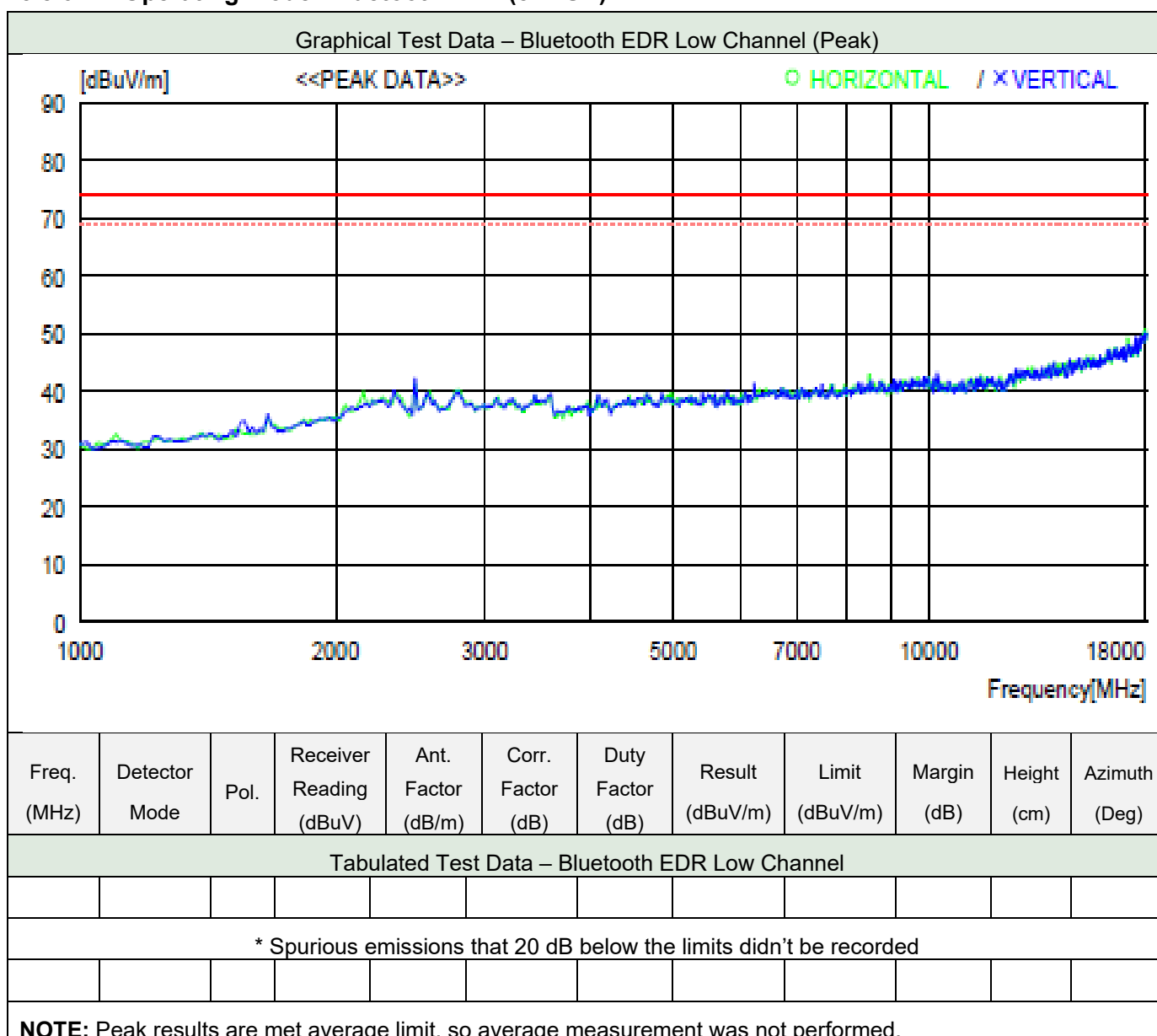
--	--	--	--	--	--	--	--	--	--	--	--

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

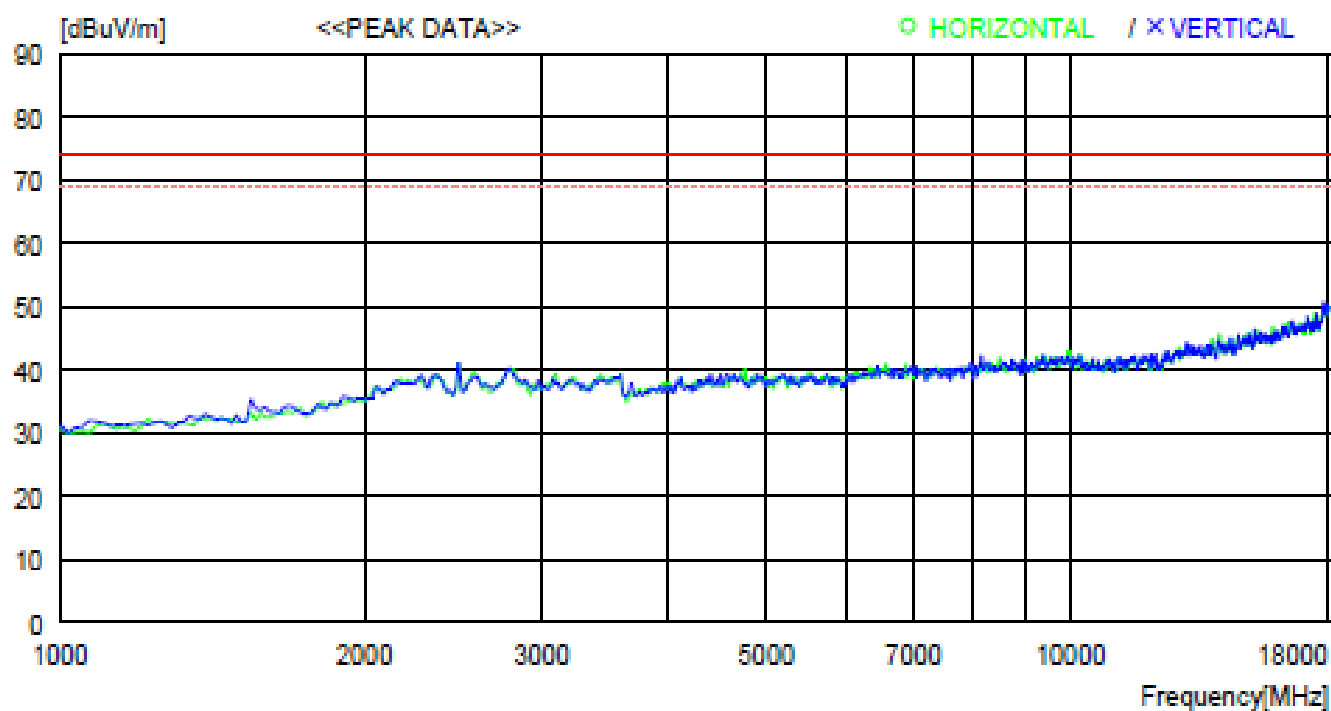
--	--	--	--	--	--	--	--	--	--	--	--

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

5.8.6.4.2 Operating mode: Bluetooth EDR (8DPSK)



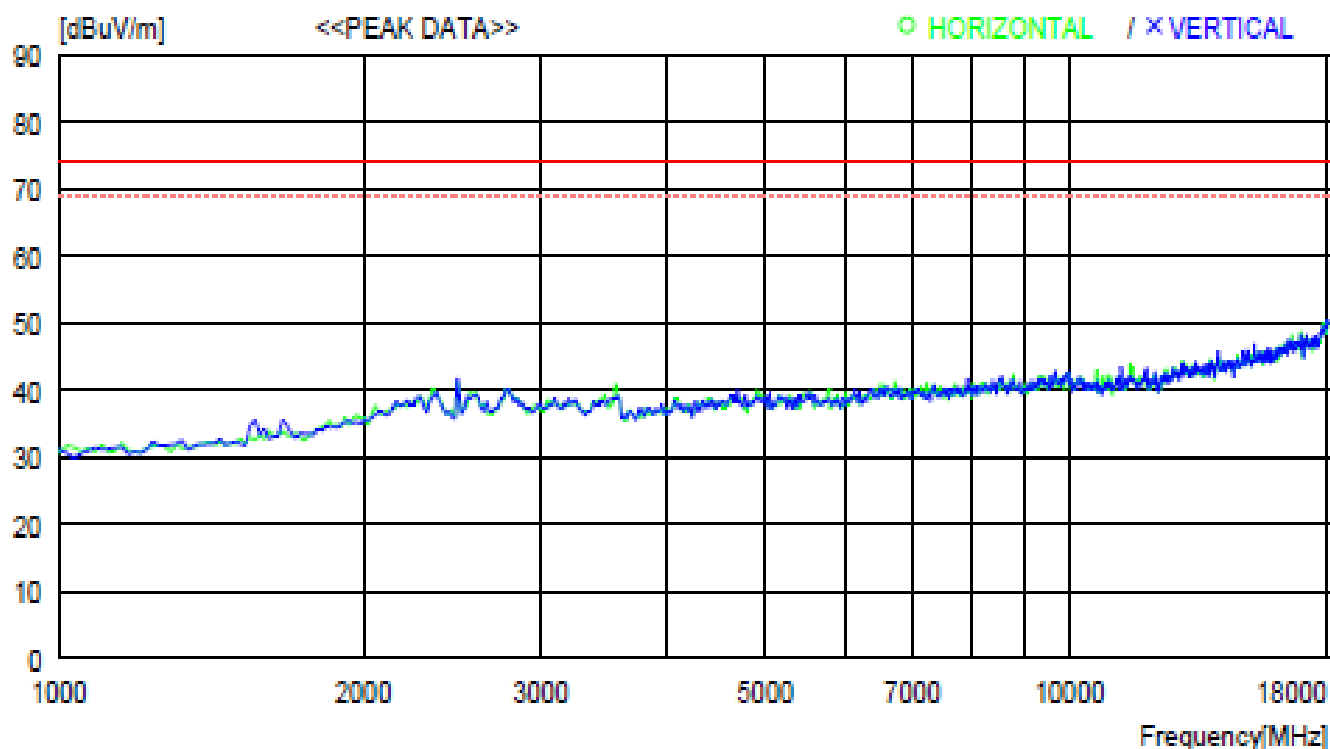
Graphical Test Data – Bluetooth EDR Middle Channel (Peak)



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

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

Graphical Test Data – Bluetooth EDR High Channel (Peak)



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

Tabulated Test Data – Bluetooth EDR High Channel

--	--	--	--	--	--	--	--	--	--	--	--

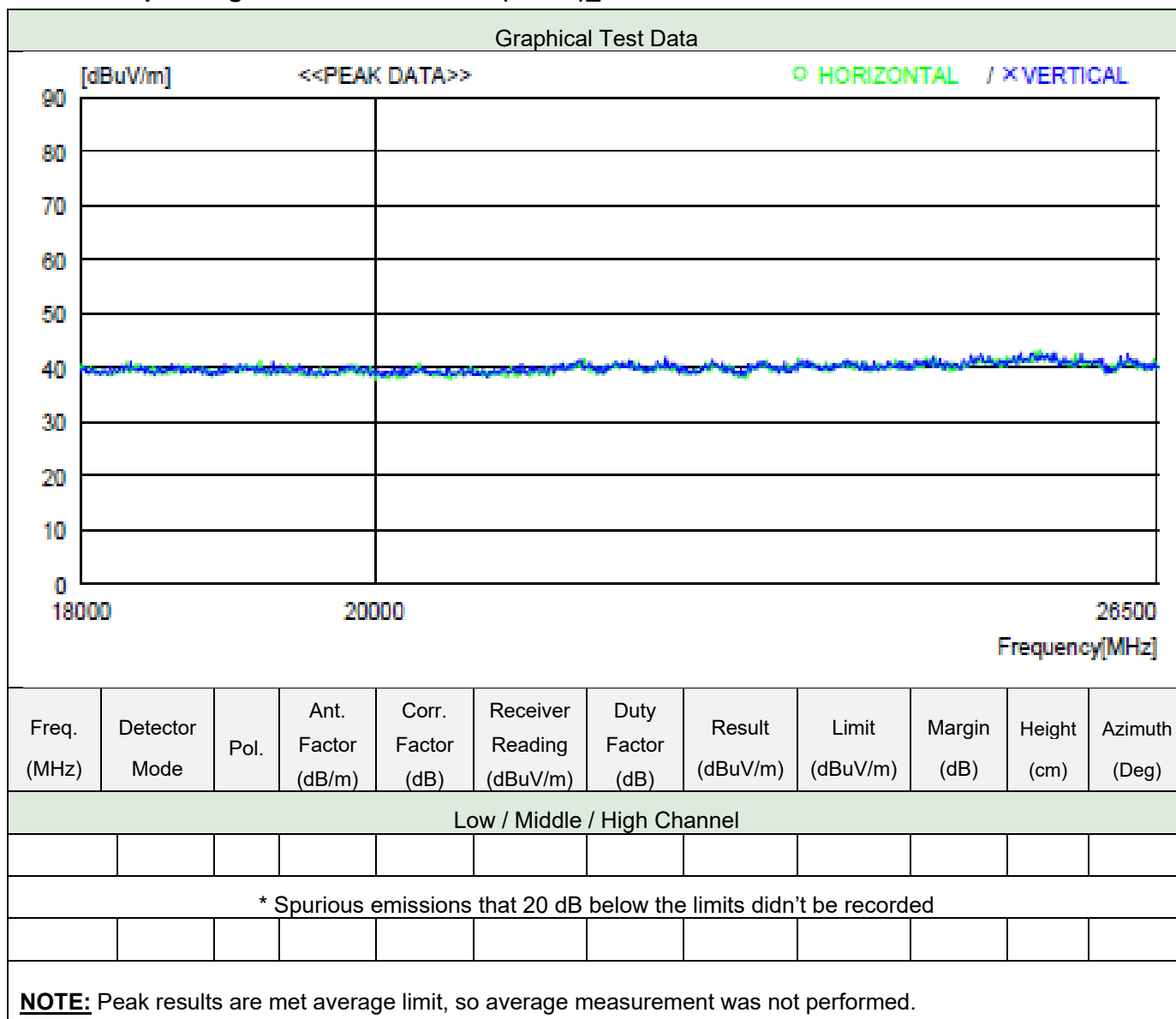
* Spurious emissions that 20 dB below the limits didn't be recorded

--	--	--	--	--	--	--	--	--	--	--	--

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

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

5.8.6.5.1 Operating mode: Bluetooth BR (GFSK)_Low Channel



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

Low channel at Bluetooth BR is worst case configuration.

5.8.6.5.2 Operating mode: Bluetooth EDR (8DPSK)_Low Channel

Graphical Test Data											
Test plot data is almost same with low channel at Bluetooth BR, so the plot is not included.											
Freq. (MHz)	Detector Mode	Pol.	Ant. Factor (dB/m)	Corr. Factor (dB)	Receiver Reading (dBuV/m)	Duty Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (Deg)
Low / Middle / High Channel											
* Spurious emissions that 20 dB below the limits didn't be recorded											
NOTE: Peak results are met average limit, so average measurement was not performed.											

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

Low channel at Bluetooth EDR is worst case configuration.

5.9 AC Power Line Conducted Emission

5.9.1 Limit

Acc. to section 15.207 (a), RSS-GEN 8.8 following table shall be applied.

Frequency Range (MHz)	Quasi-Peak (dBuV)	Average (dBuV)
0.15 - 0.5	66 to 56	56 to 46
0.5 - 5	56	46
5 -30	60	50

5.9.2 Method of Measurement

The EUT was placed on a wooden table, 0.8 m height above the horizontal ground plane and 40 cm from the vertical ground plane. Power was fed to the EUT through a 50 Ω / 50 μ H + 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.

The receiver is set to a resolution bandwidth of 9 kHz. Peak detection is used unless otherwise noted as quasi-peak or average.

The test was performed for both Neutral and Hot lines.

5.9.3 Measurement Uncertainty

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

Frequency Range	Uncertainty	Frequency Range	Uncertainty
9 kHz ~ 150 kHz	$\pm$ 2.0 dB	150 kHz ~ 30 MHz	$\pm$ 2.0 dB

5.10.4 Sample Calculated Example

At 5.31 MHz

QP Limit = 60.0 dBuV

Correction Factor (C. Factor) of LISN, Pulse Limiter and cable loss at 5.31 MHz = 9.7 dB

Q.P Reading from the Test receiver = 20.8 dBuV

(Calculated value for system losses by software EMC32 manufactured by Rohde & Schwarz)

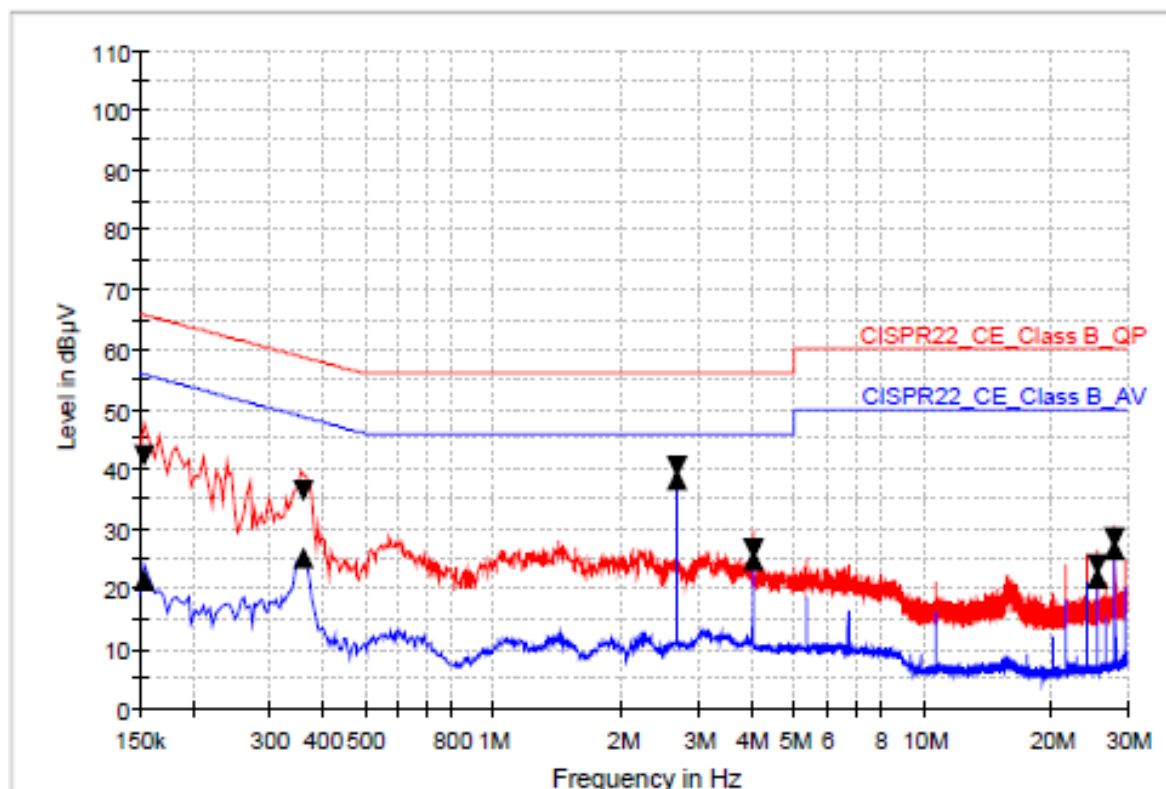
Therefore Q.P Margin = 60 - 20.8 = 39.2

so the EUT has 39.2 dB margin at 5.31 MHz

5.9.5 Worst Case Test Data

Date of Test	2020-04-21	Temperature	(21.3 ± 0.9) °C
		Relative humidity	(41.3 ± 0.8) % R.H.
Measurement Frequency Range		150 kHz ~ 30MHz	
Test Result	PASS	Tested By	Do-heon Kim 

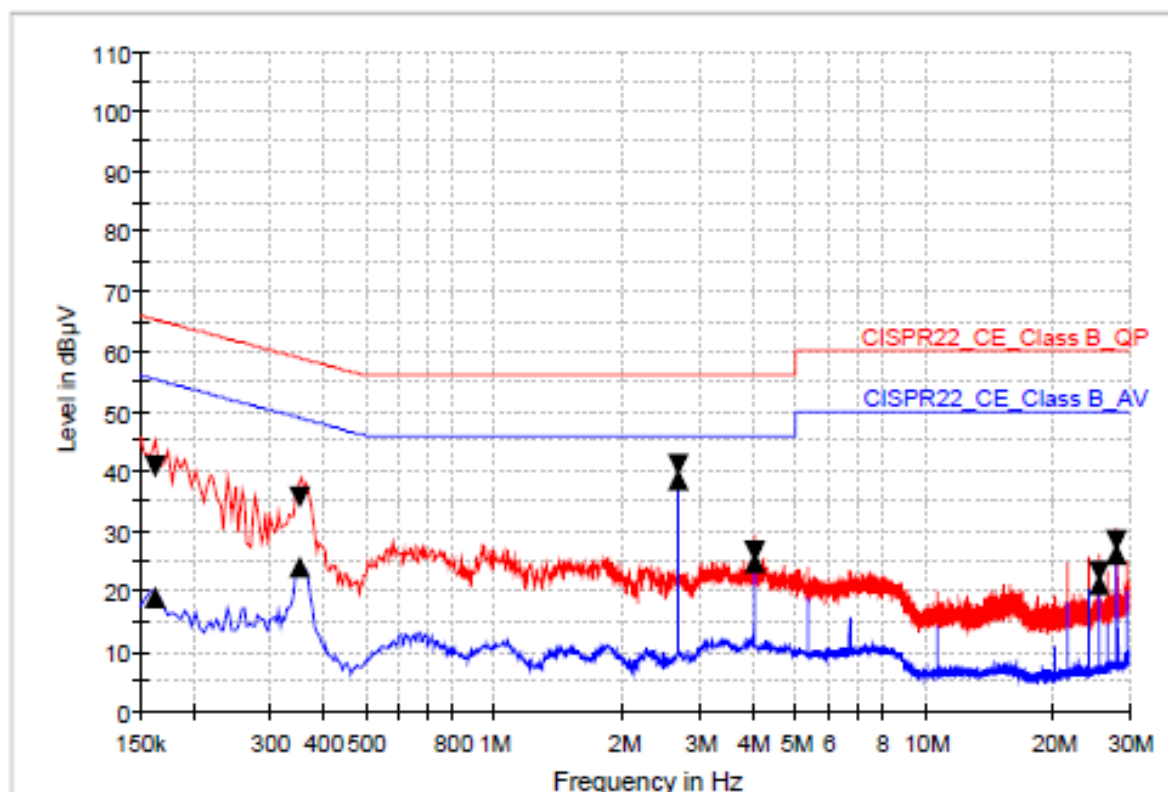
Hot Line



Limit and Margin1

Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBμV)	Margin - CAV (dB)	Limit - CAV (dBμV)
0.154000	42.4	21.5	9.000	L1	9.7	23.4	65.8	34.3	55.8
0.362000	36.5	25.0	9.000	L1	9.7	22.2	58.7	23.6	48.7
2.682000	40.5	38.4	9.000	L1	9.8	15.5	56.0	7.6	46.0
4.022000	26.5	24.7	9.000	L1	9.9	29.5	56.0	21.3	46.0
25.486000	24.0	21.9	9.000	L1	11.1	36.0	60.0	28.1	50.0
28.166000	28.4	26.4	9.000	L1	11.2	31.6	60.0	23.6	50.0

Neutral Line



Limit and Margin1

Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBμV)	Margin - CAV (dB)	Limit - CAV (dBμV)
0.162000	40.9	18.8	9.000	N	9.7	24.5	65.4	36.6	55.4
0.354000	35.7	24.0	9.000	N	9.7	23.2	58.9	24.8	48.9
2.682000	41.2	38.8	9.000	N	9.8	14.8	56.0	7.2	46.0
4.022000	26.5	24.6	9.000	N	9.9	29.5	56.0	21.4	46.0
25.486000	23.3	21.2	9.000	N	11.1	36.7	60.0	28.8	50.0
28.166000	28.2	26.3	9.000	N	11.2	31.8	60.0	23.7	50.0

Appendix I – Test Instrumentation

Description	Model No.	Serial No.	Manufacturer.	Due for Cal. Date	Cal. Interval
Signal & Spectrum Analyzer	FSW 43	100578	Rohde & Schwarz	2021-04-20	1 Y
Spectrum Analyzer	FSV 13	101243	Rohde & Schwarz	2021-01-16	1 Y
Signal Generator	SMF100A	257560	Rohde & Schwarz	2021-01-26	1 Y
Vector Signal Generator	SMBV100A	101441	Rohde & Schwarz	2021-01-26	1 Y
Power Module	OSP 120	101389	Rohde & Schwarz	2021-01-16	1 Y
Attenuator	56-10	58769	WEINSCHTEL	2021-01-20	1 Y
Attenuator	10 dB	ENG-1	Rohde & Schwarz	2021-01-16	1 Y
Test Receiver	ESU 26	100303	Rohde & Schwarz	2021-01-21	1 Y
Loop Antenna	HFH2-Z2	100341	Rohde & Schwarz	2021-06-21	2 Y
DC Power Supply	6032A	SG41000637	Agilent	2021-03-25	1 Y
TRILOG Broadband Antenna	VULB9163	9163.799	Schwarzbeck	2021-09-17	2 Y
Dipole Antenna	3121C	9001-509 9001-530	EMCO	2022-05-22	2Y
Dipole Antenna	UHA9105	N/A	Schwarzbeck	2022-05-22	2Y
Horn Antenna	HF 907	102426	Rohde & Schwarz	2020-11-20	2 Y
DOPPEL STEG Horn Antenna	HF 906	100332	Rohde & Schwarz	2021-02-14	2 Y
Horn Antenna	BBHA 9170	BBHA 9170 #783	Schwarzbeck	2020-11-26	2 Y
Notch Filter	BRM50702	G318	MICRO-TRONICS	2020-11-07	1 Y
Notch Filter	BRC50703	G139	MICRO-TRONICS	2020-11-07	1 Y
Notch Filter	BRC50704	G122	MICRO-TRONICS	2020-11-07	1 Y
Notch Filter	BRC50705	G126	MICRO-TRONICS	2020-11-07	1 Y
Attenuator	6dB	272.4110.50	Rohde & Schwarz	2021-01-16	1 Y
Pre-Amplifier	310N	344015	Sonoma Instrument	2021-01-16	1 Y
Pre-Amplifier	SCU 18D	19006450	Rohde & Schwarz	2021-04-17	1 Y
Pre-Amplifier	CBL18265035	28706	CERNEX	2021-03-24	1 Y
Pre-Amplifier	CBL26405040	28707	CERNEX	2021-03-24	1 Y

Turn Table	DT3000-3t	1310814	INNCO SYSTEM	-	N/A
Antenna Master	MA4000-EP	4600814	INNCO SYSTEM	-	N/A
Antenna Master	MA4000-XP-ET	-	INNCO SYSTEM	-	N/A
Camera Controller	HDCon4102	6531445048	PONTIS	-	N/A
CO3000 Controller	Co3000-4Port	CO3000/806/ 34130814/L	INNCO SYSTEM	-	N/A
CO3000 Controller	Co3000-4Port	CO3000/807/ 34130814/L	INNCO SYSTEM	-	N/A
EMI Test Receiver	ESCI 7	100722	Rohde & Schwarz	2021-01-16	1 Y
LISN	ENV216	100110	Rohde & Schwarz	2021-01-22	1 Y
Directional Coupler	AAMCS-UDC-0.5G-18G-SF	000757	AAMCS	2021-01-17	1 Y
Splitter	1580	SC321	WEINSCHEL	2021-01-20	1 Y
Splitter	ZFRSC-42-S+	UU90901305	Minicircuits	2021-01-17	1 Y
Attenuator	8496A	3308A3798S	HP	2021-01-16	1 Y
Attenuator	8494B	3308a38821	HP	2021-01-16	1 Y
Temperature & Humidity Chamber	SM-1.0-3800	38025	THERMOTRON	2020-08-21	1 Y
Bluetooth Tester	TC-3000C	3000C000534	TESCOM	2020-07-16	1 Y
Wireless Access Point	WAC720	4D7689EP000FB	NETGEAR		

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