TEST REPORT

Part 15 Subpart C 15.247

Equipment under test	BLUETOOTH MONO EAR-PHONE
Model name	SFα+
FCC ID	2AG88-SFAPLUS
Applicant	Soundbridge Co., Ltd.
Manufacturer	JGLOVIS Co., Ltd.
Date of test(s)	2016.02.12 ~ 2016.02.26, 03.22
Date of issue	2016.03.25

Issued to

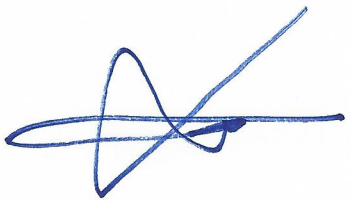
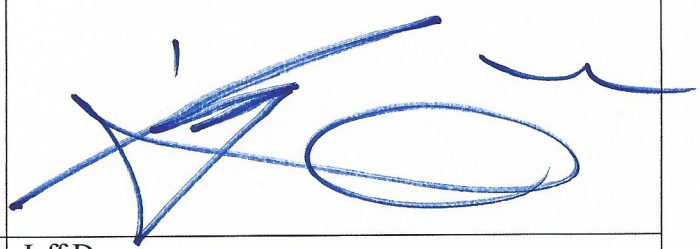
Soundbridge Co., Ltd.

41566 #810, IT Convergence Industrial Bldg. 47, Gyeongdae-ro 17-Gil
Buk-gu, Daegu, 702-832, South Korea

Issued by

KES Co., Ltd.

C-3701, Simin-daero 365-40, Dongan-gu, Anyang-si,
Gyeonggi-do,431-716, Korea
473-29, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea

Test and report completed by :	**Report approval by :**
	
Kwon-se Kim Test engineer	Jeff Do Technical manager

Revision history

Revision	Date of issue	Test report No.	Description
-	2016.03.18	KES-RF-16T0031	Initial
1	2016.03.25	KES-RF-16T0031-R1	Retest a restricted band and emission

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1. General information

Applicant:	Soundbridge Co., Ltd.
Applicant address:	41566 #810, IT Convergence Industrial Bldg. 47, Gyeongdae-ro 17-Gil Buk-gu, Daegu, 702-832, South Korea
Test site:	KES Co., Ltd.
Test site address:	C-3701, Simin-daero 365-40, Dongan-gu, Anyang-si, Gyeonggi-do,431-716, Korea 473-29, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea
FCC rule part(s):	15.247
Model:	SFα+
FCC ID:	2AG88-SFAPLUS
Test device serial No.:	☐ Production ☒ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test	BLUETOOTH MONO EAR-PHONE
Frequency range	2402 ㎒ ~ 2480 ㎒
Model	SFα+
Modulation technique	FHSS
Type of Modulation	GFSK, π/4-DQPSK, 8DPSK
Number of channels	79
Antenna specification	Antenna type: Chip , Peak gain: -0.5 ㏈i
Power source	DC 3.6V (Rechargeable Battery)

15.247(a)(1) that the rx input bandwidths shift frequencies in synchronization with the transmitted

15.247(g): In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of the regulations in Section 15.247 when the transmitter is presented with a continuous data (or information) system.

15.247(h): In accordance with the Bluetooth Industry Standard, the system does not coordinate it channels selection/ hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

Pseudorandom frequency hopping sequence
The channel is represented by a pseudo-random hopping sequence hopping through the 79 RF channels. The hopping sequence is unique for the piconet and is determined by the Bluetooth device address of the master; the phase in the hopping sequence is determined by the Bluetooth clock of the master. The channel is divided into time slots where each slot corresponds to an RF hop frequency. Consecutive hops correspond to different RF hop frequencies. The nominal hop rate is 1 600 hops/s.

Equal hopping frequency use
The channels of this system will be used equally over the long-term distribution of the hopsets.

Example of a 79 hopping sequence in data mode:

02, 05, 31, 24, 20, 10, 43, 36, 30, 23, 40, 06, 21, 50, 44, 09, 71, 78, 01, 13, 73, 07, 70, 72, 35, 62, 42, 11, 41, 08, 16, 29, 60, 15, 34, 61, 58, 04, 67, 12, 22, 53, 57, 18, 27, 76, 39, 32, 17, 77, 52, 33, 56, 46, 37, 47, 64, 49, 45, 38, 69, 14, 51, 26, 79, 19, 28, 65, 75, 54, 48, 03, 25, 66, 05, 16, 68, 74, 59, 63, 55,

System receiver input bandwidth

Each channel bandwidth is 1 ㎒.

The system receivers have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

1.2. Test configuration

The Soundbridge EAR-PHONE FCC ID: 2AG88-SFAPLUS was tested per the guidance of ANSI C63.10-2009 and DA 00-705. ANSI C63.10-2009 was used to reference the appropriate EUT setup for radiated spurious emissions testing

1.3. Frequency/channel operations

Ch.	Frequency (㎒)	Rate(Mbps)
00	2402	1,2,3
. .	. .	. .
39	2441	1,2,3
. .	. .	. .
78	2480	1,2,3

1.4. Information about accessory

Applicant	Equipment	Manufacturer	Model	Power source
Soundbridge Co., Ltd.	Portable charger	JGLOVIS Co., Ltd.	SF1PC	DC 5.0V (1A / 450mAh)

2. Summary of tests

Reference	Test description	Test results
15.247(a)(1)(iii)	20 dB bandwidth	Pass
15.247(b)(1)	Output power	Pass
15.247(a)(1)	Channel separation	Pass
15.247(a)(1)(iii)	Number of channels	Pass
15.247(a)(1)(iii)	Time of occupancy	Pass
15.205, 15.209	Radiated restricted band and emission	Pass
15.207(d)	Conducted band edge and out of band emissions	Pass

Note:

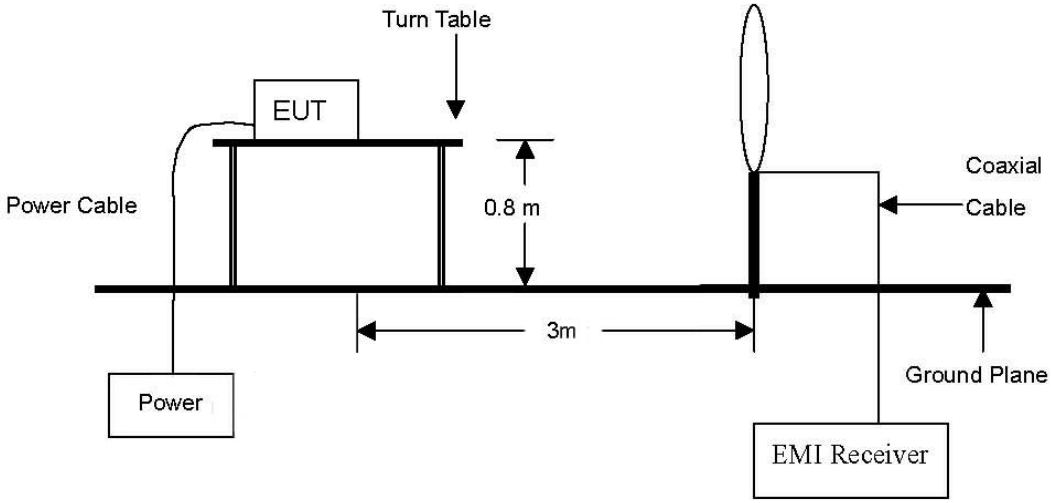
1. The EUT was tested per the guidance of DA 00-705. ANSI C63.10-2009 was used to reference the appropriate EUT setup for radiated spurious emissions testing.
2. All modes of operation and data rates were investigated. The test results shown in the following sections represent the worst case emissions.

3. Test results

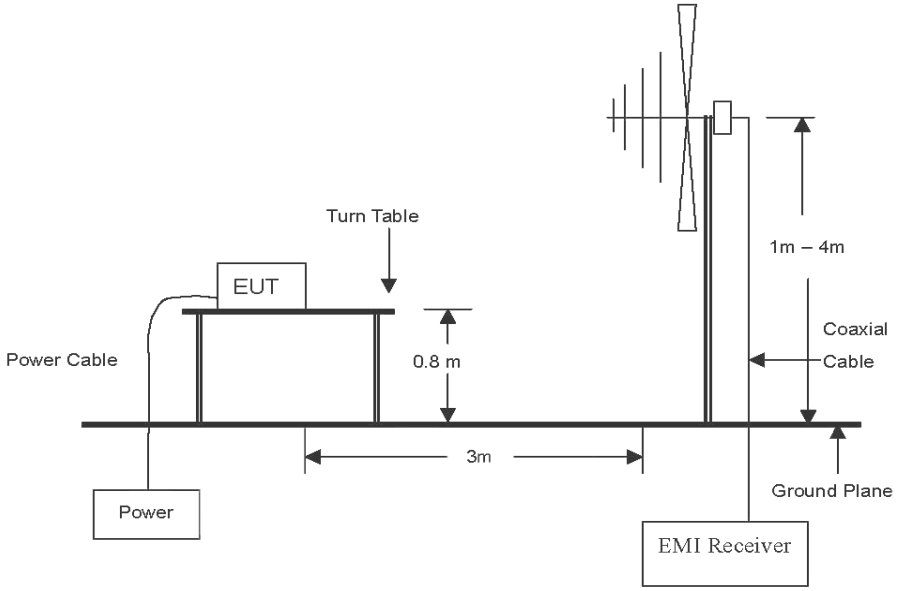
3.1. Radiated restricted band and emissions

Test setup

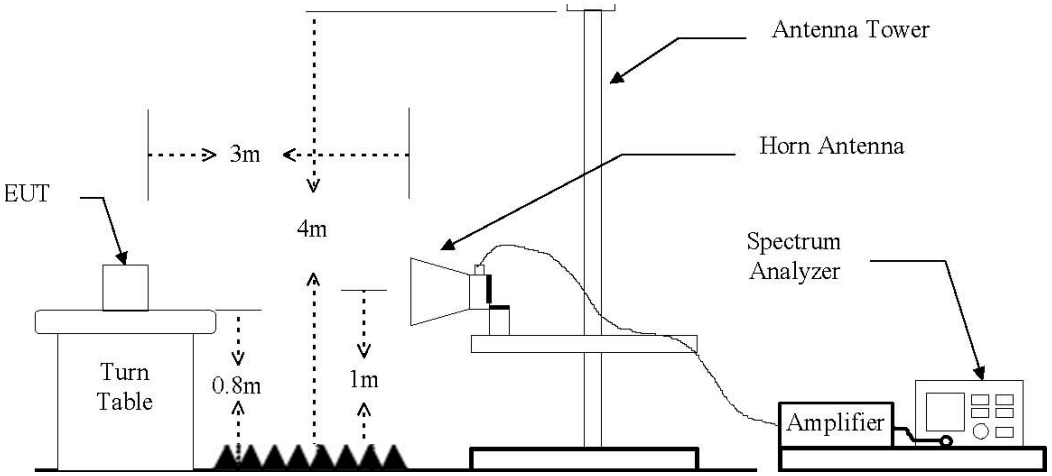
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓ emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to the tenth harmonic of the highest fundamental frequency or to 40 ㎓ emissions, whichever is lower.



Test procedure

1. The EUT is placed on a turntable, which is 0.8 m above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.
7. Spectrum analyzer settings for $f < 1$ ㎓:
   Span = wide enough to fully capture the emission being measured
   RBW = 100 ㎑
   VBW ≥ RBW
   Sweep = auto
   Detector function = quasi peak
   Trace = max hold
8. Spectrum analyzer settings for $f \geq 1$ ㎓: Peak
   Span = wide enough to fully capture the emission being measured
   RBW = 1 ㎒
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold
9. Spectrum analyzer settings for $f \geq 1$ ㎓: Average
   Span = wide enough to fully capture the emission being measured
   RBW = 1 ㎒
   VBW ≥ 1/T ㎐, where T= pulse width in seconds
   Sweep = auto
   Detector function = average
   Trace = max hold
10. Duty Cycle Correction Factor (79 channel hopping)
    a. Time to cycle through all channels = Δt=τ[㎳] × 79 channels = 229.100 ㎳, where τ = pulse width
    b. 100 ㎳/ Δt[㎳] = H → Round up to next highest integer, H '=1
    c. Worst Case Dwell Time = τ[㎳] × H' = 2.900 ㎳
    d. Duty Cycle Correction = 20log (Worst Case Dwell Time/ 100㎳) ㏈ = -30.752 ㏈
11. Duty Cycle Correction Factor(AFH mode – minimum channel number case – 20 channels)
    a. Time to cycle through all channels = Δt=τ[㎳] × 20 channels = 58.00 ㎳, where τ = pulse width
    b. 100 ㎳/ Δt[㎳] = H → Round up to next highest integer, H '=2
    c. Worst Case Dwell Time = τ[㎳] × H' = 5.800 ㎳
    d. Duty Cycle Correction(AFH) = 20log (Worst Case Dwell Time/ 100 ㎳) ㏈ = -24.7314 ㏈
    e. We applied DCF in the test result which hopping channel number is 20.

Note:

1. The spectrum is measured from 9 ㎑ to the 10th harmonic of the fundamental frequency of the transmitter using CISPR quasi peak detector below 1 ㎓. Above 1 ㎓, average and peak measurements were taken using linearly polarized horn antennas. The worst-case emissions are reported however emissions whose levels were not within 20 ㏈ of the respective limits were not reported.
2. When Average result is different from peak result over 20 ㏈ (over-averaging), according to 15.35 (c), as a "duty cycle correction factor", pulse averaging with 20 log(duty cycle) has to be used.
   Duty cycle correction factor = 20log(dwell time/100 ㎳)
3. Emissions below 18 ㎓ were measured at a 3 meter test distance while emissions above 18 ㎓ were measured at a 1 meter test distance with the application of a distance correction factor.
4. Average test would be performed if the peak result were greater than the average limit.
5. Field strength(㏈㎶/m) = Level(㏈㎶) + Correction factors(㏈/m) + Cable loss(㏈) + or F_d(㏈)
6. Correction factors(㏈/m) = Antenna factor(㏈/m) + Cable loss(㏈) + or Amp. gain(㏈)
7. Margin(㏈) = Limit(㏈㎶/m) - Field strength(㏈㎶/m)
8. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes.
9. f < 30 ㎒, extrapolation factor of 40 ㏈/decade of distance. $F_d = 40\log(D_m / Ds)$
   $f \geq$ 30 ㎒, extrapolation factor of 20 ㏈/decade of distance. $F_d = 20\log(D_m / Ds)$

Where:

F_d = Distance factor in ㏈
D_m = Measurement distance in meters
D_s = Specification distance in meters

Limit

According to 15.209(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values：

Frequency (㎒)	Distance (Meters)	Radiated (㎶/m)
0.009 ~ 0.490	300	2 400 / F(㎑)
0.490 ~ 1.705	30	24 000 / F(㎑)
1.705 ~ 30.0	30	30
30 ~ 88	3	100**
88 ~ 216	3	150**
216 ~ 960	3	200**
Above 960	3	500

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 ~ 72 ㎒, 76 ~ 88 ㎒, 174 ~ 216 ㎒ or 470 ~ 806 ㎒. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

Test results (Below 30 ㎒)

Mode:	Bluetooth
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Operating frequency:	2 402 ㎒ (Worst case)
Channel:	00

Frequency (㎒)	Level (dB㎶)	Ant. Pol. (H/V)	Correction factors (dB/m)	F_d (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No signal detected							

Test results (Below 1 000 ㎒)

Mode:	Bluetooth
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Operating frequency:	2 402 ㎒ (Worst case)
Channel:	00

Frequency (㎒)	Level (dB㎶)	Ant. Pol (H/V)	Correction factors		Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
			Ant. factor (dB/m)	Cable loss (dB)			
48.43	21.64	V	13.71	0.40	35.75	40.00	4.25
78.50	26.54	V	9.43	0.55	36.52	40.00	3.48
101.78	31.35	H	9.02	0.64	41.01	43.50	2.49
123.12	26.24	H	10.99	0.69	37.92	43.50	5.58
148.34	22.48	V	12.94	0.79	36.21	43.50	7.29
227.88	16.73	V	11.17	0.91	28.81	46.00	17.19
228.85	26.93	H	11.20	0.91	39.04	46.00	6.96
364.65	20.29	H	15.28	1.16	36.73	46.00	9.27
400.54	20.39	H	16.09	1.28	37.76	46.00	8.24
424.79	17.12	H	16.63	1.32	35.07	46.00	10.93
452.92	16.75	H	17.25	1.35	35.35	46.00	10.65

Note.

1. All spurious emission at channels are almost the same below 1 ㎓, so that low channel was chosen at representative in final test.
2. Actual = Reading + Ant. factor + Cable loss
3. Detector mode: Quasi peak
4. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes.

Test results (Above 1 000 ㎒)

Mode: Bluetooth

Transfer rate: 1 Mbps

Distance of measurement: 3 meter

Operating frequency: 2 402 ㎒

Channel: 00

Frequency (㎒)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	Correction factors		Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
				AFCL(dB)	DCF(dB)			
2389.81	42.05	Peak	H	-0.95	-	41.10	74.00	32.90
2389.67	51.73	Peak	V	-0.95	-	50.78	74.00	23.22
4804.60	49.57	Peak	H	8.07	-	57.64	74.00	16.36
4800.30	36.24	Avg	H	8.04	-24.73	19.55	54.00	40.47
4804.60	46.48	Peak	V	8.07	-	54.55	74.00	19.45
4800.30	38.85	Avg	V	8.04	-24.73	22.16	54.00	37.86

Mode: Bluetooth

Transfer rate: 1 Mbps

Distance of measurement: 3 meter

Operating frequency: 2 441 ㎒

Channel: 39

Frequency (㎒)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	Correction factors		Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
				AFCL(dB)	DCF(dB)			
4878.40	45.28	Peak	H	8.60	-	53.88	74.00	20.12
4878.40	46.40	Peak	V	8.60	-	55.00	74.00	19.00
4878.40	34.01	Avg	V	8.60	-24.73	17.88	54.00	42.14

Mode:	Bluetooth
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Operating frequency:	2 480 ㎒
Channel:	78

Frequency (㎒)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	Correction factors		Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
				AFCL(dB)	DCF(dB)			
2383.56	53.28	Peak	H	-0.45	-	52.83	74.00	21.17
2483.56	51.23	Peak	V	-0.45	-	50.78	74.00	23.22
4956.60	47.65	Peak	H	9.16	-	56.81	74.00	17.19
4956.60	33.80	Avg	H	9.16	-24.73	18.23	54.00	41.79
4956.60	47.33	Peak	V	9.16	-	54.49	74.00	17.51
4956.60	32.65	Avg	V	9.16	-24.73	17.08	54.00	42.94

Mode:	Bluetooth
Transfer rate:	2 Mbps
Distance of measurement:	3 meter
Operating frequency:	2 402 ㎒
Channel:	00

Frequency (㎒)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	Correction factors		Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
				AFCL(dB)	DCF(dB)			
2389.86	41.65	Peak	H	-0.95	-	40.70	74.00	33.30
2389.86	47.53	Peak	V	-0.95	-	46.58	74.00	27.42
4800.30	46.46	Peak	H	8.04	-	54.50	74.00	19.50
4800.30	30.54	Avg	H	8.04	-24.73	13.85	54.00	46.17
4800.30	45.16	Peak	V	8.04	-	53.20	74.00	20.80

Mode:	Bluetooth
Transfer rate:	2 Mbps
Distance of measurement:	3 meter
Operating frequency:	2 441 ㎒
Channel:	39

Frequency (㎒)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	Correction factors		Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
				AFCL(dB)	DCF(dB)			
4878.40	48.05	Peak	H	8.60	-	56.65	74.00	17.35
4878.40	28.33	Avg	H	8.60	-24.73	12.20	54.00	47.81
4878.40	46.76	Peak	V	8.60	-	55.36	74.00	18.64
4878.40	29.06	Avg	V	8.60	-24.73	12.93	54.00	47.07

Mode:	Bluetooth
Transfer rate:	2 Mbps
Distance of measurement:	3 meter
Operating frequency:	2 480 ㎒
Channel:	78

Frequency (㎒)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	Correction factors		Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
				AFCL(dB)	DCF(dB)			
2487.41	48.33	Peak	H	-0.43	-	47.90	74.00	26.10
2495.41	48.47	Peak	V	-0.38	-	48.09	74.00	25.91
4956.60	46.07	Peak	H	9.16	-	55.23	74.00	18.77
4956.60	24.60	Avg	H	9.16	-24.73	9.03	54.00	50.99
4956.60	46.25	Peak	V	9.16	-	55.41	74.00	18.59
4956.60	30.97	Avg	V	9.16	-24.73	15.40	54.00	44.62

Mode:	Bluetooth
Transfer rate:	3 Mbps
Distance of measurement:	3 meter
Operating frequency:	2 402 ㎒
Channel:	00

Frequency (㎒)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	Correction factors		Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
				AFCL(dB)	DCF(dB)			
2389.04	42.70	Peak	H	-0.95	-	41.75	74.00	32.25
2378.73	48.83	Peak	V	-1.01	-	47.82	74.00	26.18
4800.30	47.12	Peak	H	8.04	-	55.16	74.00	18.84
4800.30	26.77	Avg	H	8.04	-24.73	10.08	54.00	49.92
4800.30	43.95	Peak	V	8.04	-	51.99	74.00	22.01

Mode:	Bluetooth
Transfer rate:	3 Mbps
Distance of measurement:	3 meter
Operating frequency:	2 441 ㎒
Channel:	39

Frequency (㎒)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	Correction factors		Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
				AFCL(dB)	DCF(dB)			
4878.40	45.20	Peak	H	8.60	-	53.80	74.00	20.20
4878.40	46.76	Peak	V	8.60	-	55.36	74.00	18.64
4878.40	32.55	Avg	V	8.60	-24.73	16.42	54.00	43.60

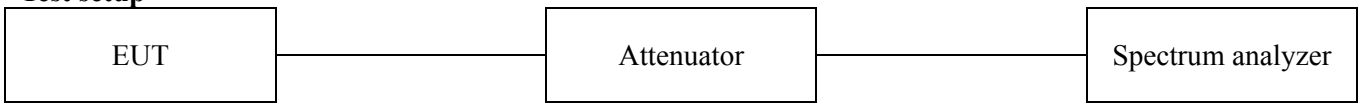
Mode:	Bluetooth
Transfer rate:	3 Mbps
Distance of measurement:	3 meter
Operating frequency:	2 480 ㎒
Channel:	78

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	Correction factors		Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
				AFCL(dB)	DCF(dB)			
2484.39	48.08	Peak	H	-0.44	-	47.64	74.00	26.36
2486.65	47.90	Peak	V	-0.43	-	47.47	74.00	26.53
4956.60	44.21	Peak	H	9.16	-	53.37	74.00	20.63
4956.60	44.51	Peak	V	9.16	-	53.67	74.00	20.33

Note.
1. Average test would be performed if the peak result were greater than the average limit.
2. Actual = Reading + AFCL(Ant. factor – Amp. gain + Cable loss) + DCF(Duty cycle correction factor)
3. Duty cycle correction factor = 20log(dwell time/100 ㎳)

3.2. Conducted band edge and out of band emissions

Test setup

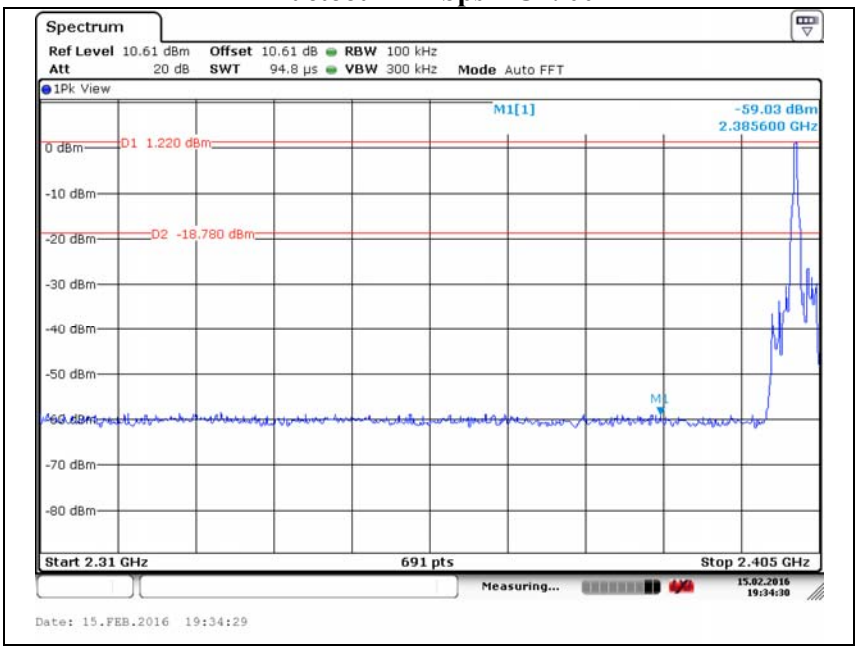


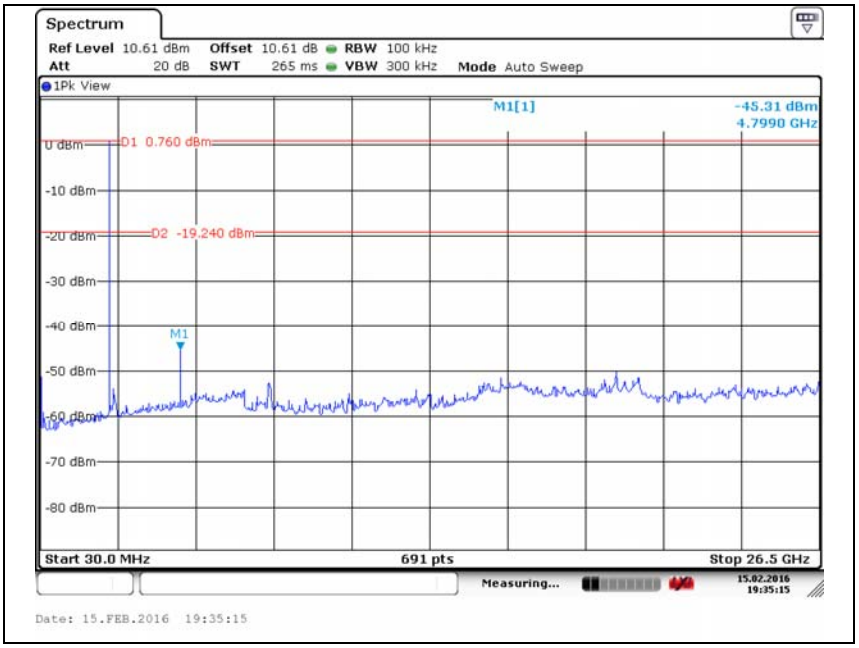
Test procedure
DA 00-705

Test setting
1. Span = wide enough to capture the peak level of the in-band emission and all spurious emissions(e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic.
2. RBW = 100 ㎑
3. VBW ≥ 300 ㎑
4. Detector = Peak
5. Number of sweep points ≥ 2 × Span/RBW
7. Trace mode = max hold
8. Sweep time = auto couple
9. The trace was allowed to stabilize

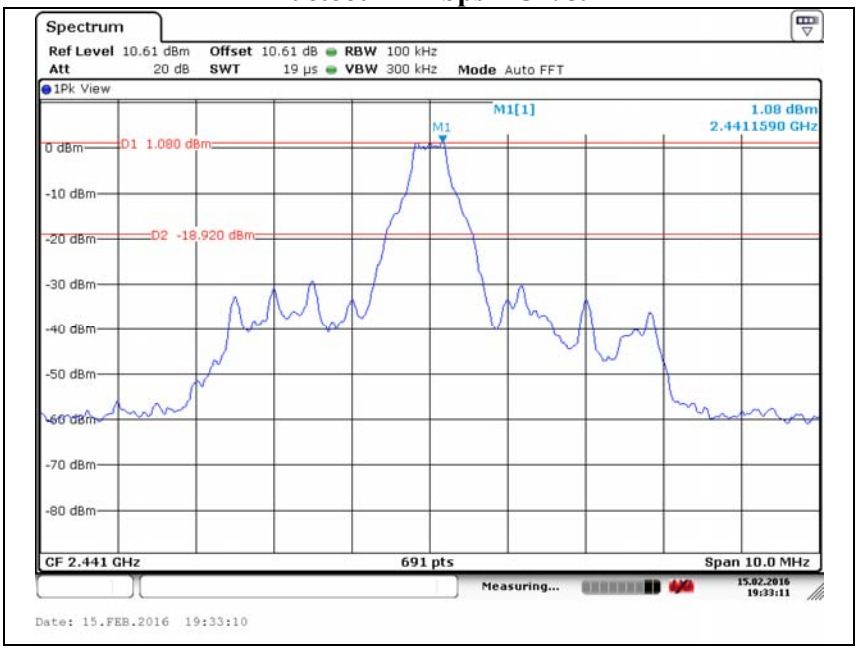
Limit
According to 15.247(d), in any 100 ㎑ bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 ㏈ below that in the 100 ㎑ bandwidth within 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 ㏈ instead of 20 ㏈. Attenuation below the general limits specified in section 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))

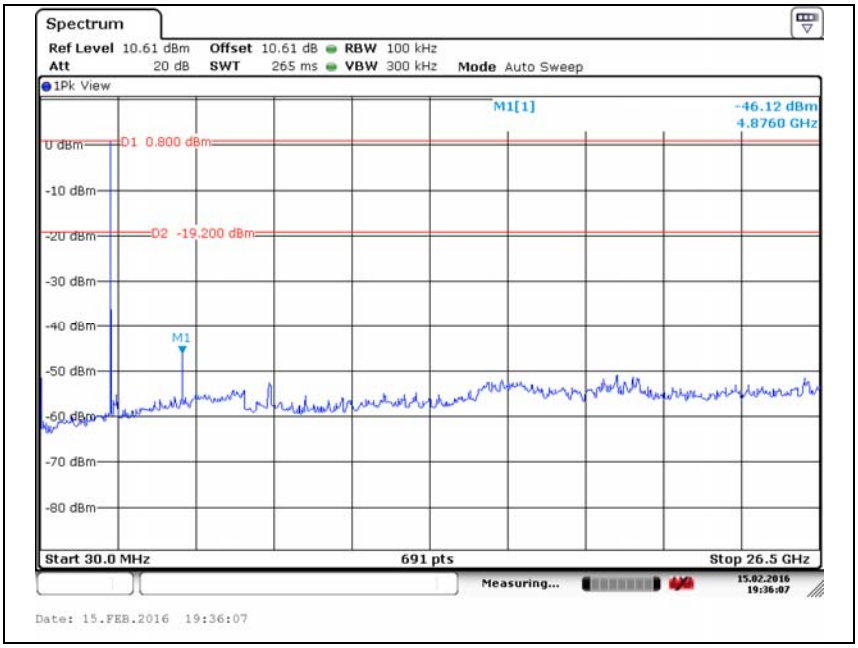
Bluetooth 1 Mbps – Ch. 00



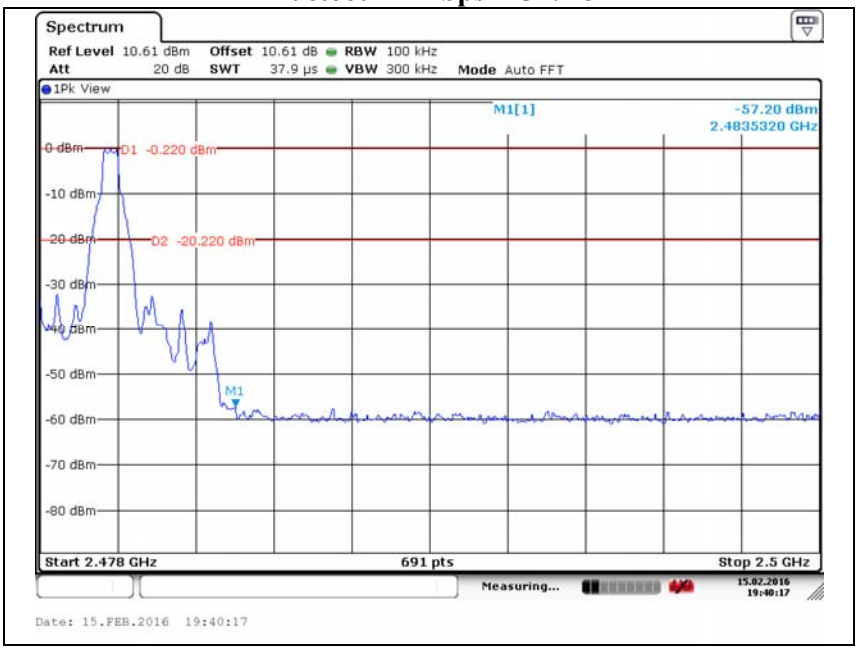


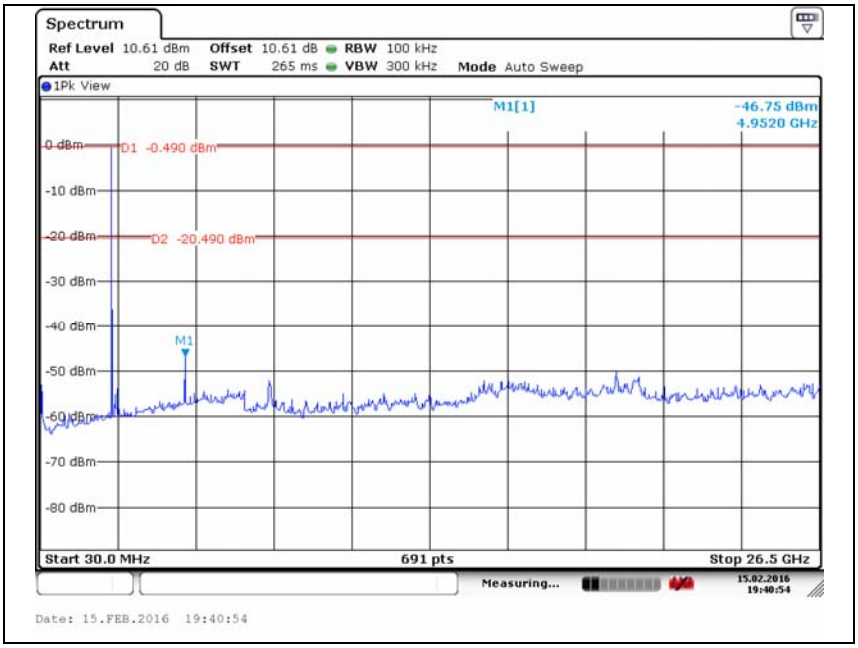
Bluetooth 1 Mbps – Ch. 39



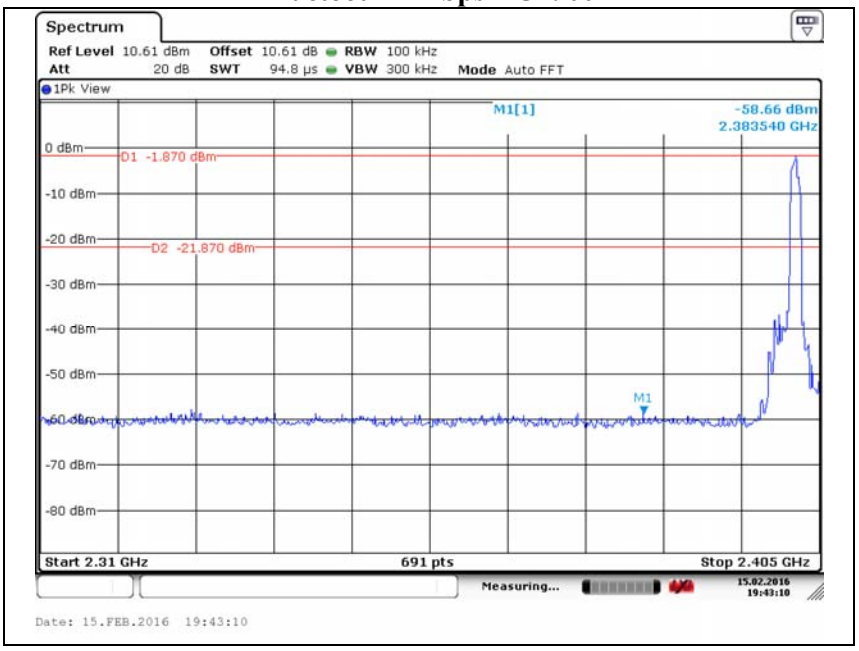


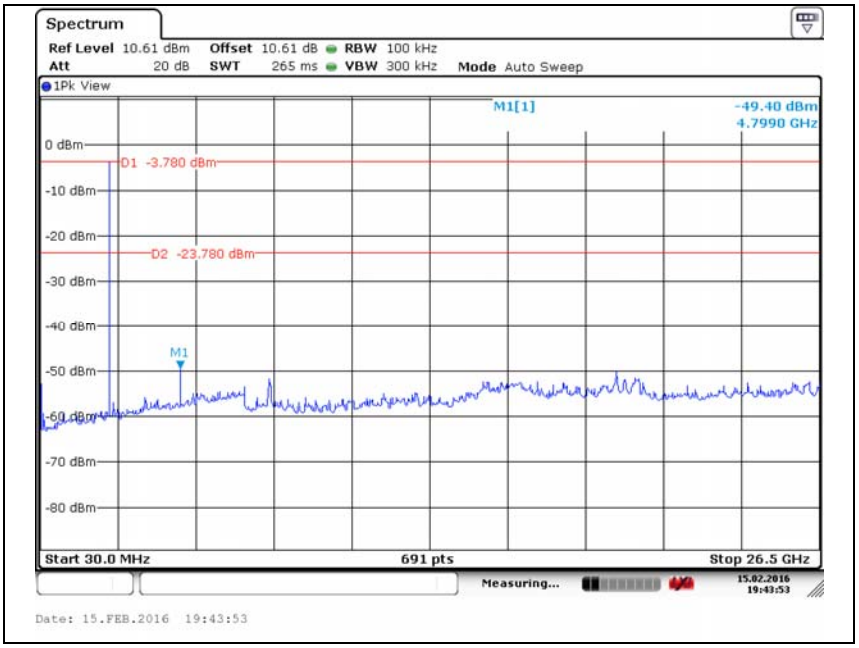
Bluetooth 1 Mbps – Ch. 78



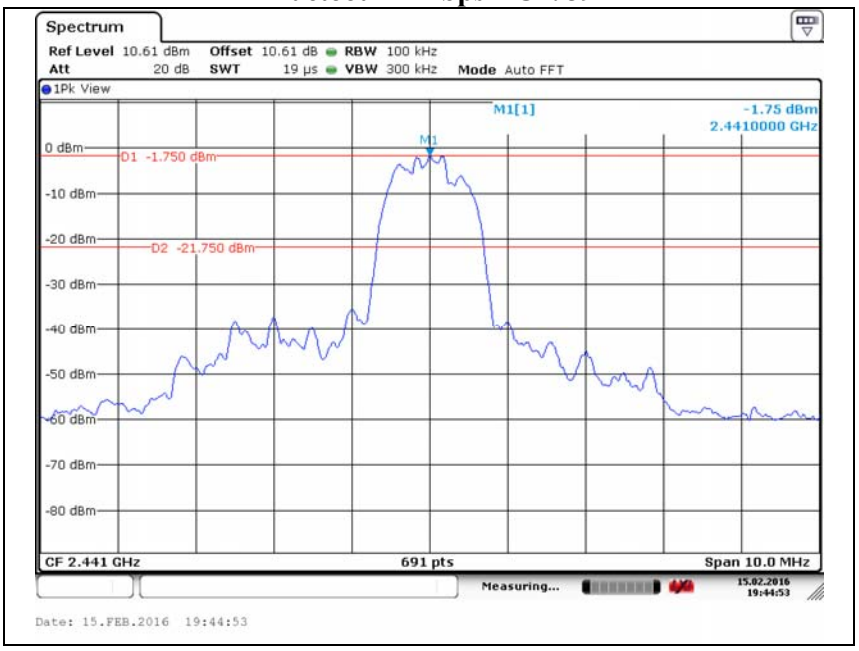


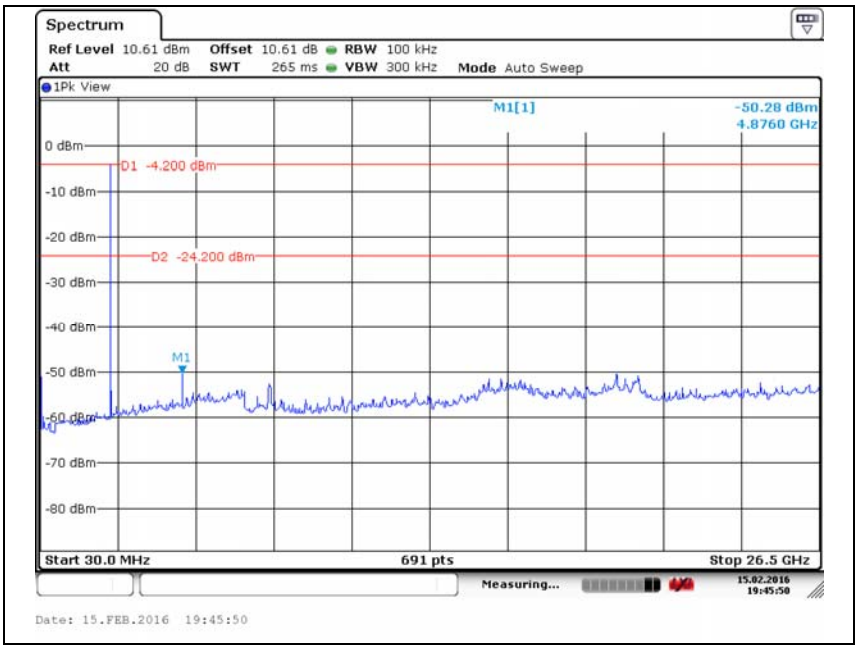
Bluetooth 2 Mbps – Ch. 00



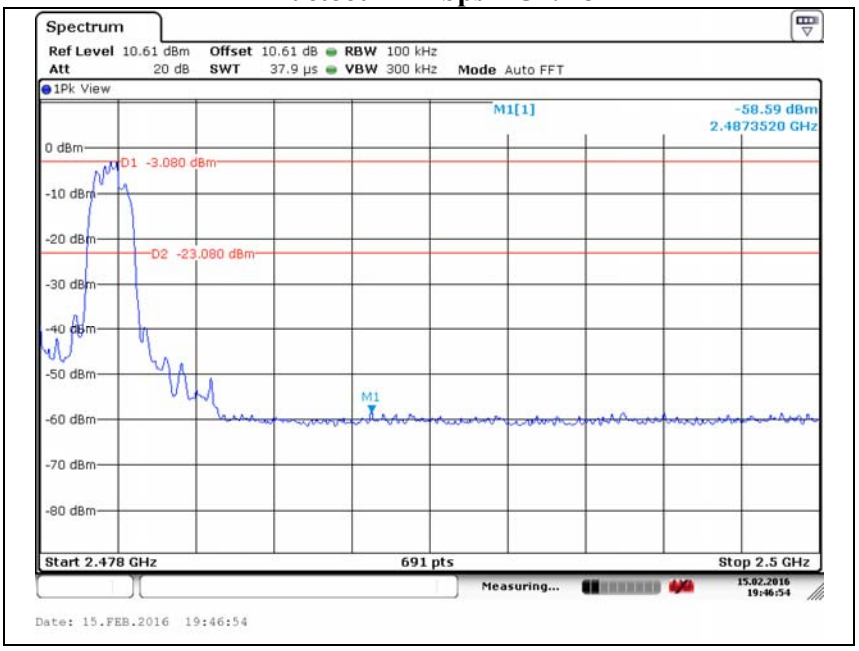


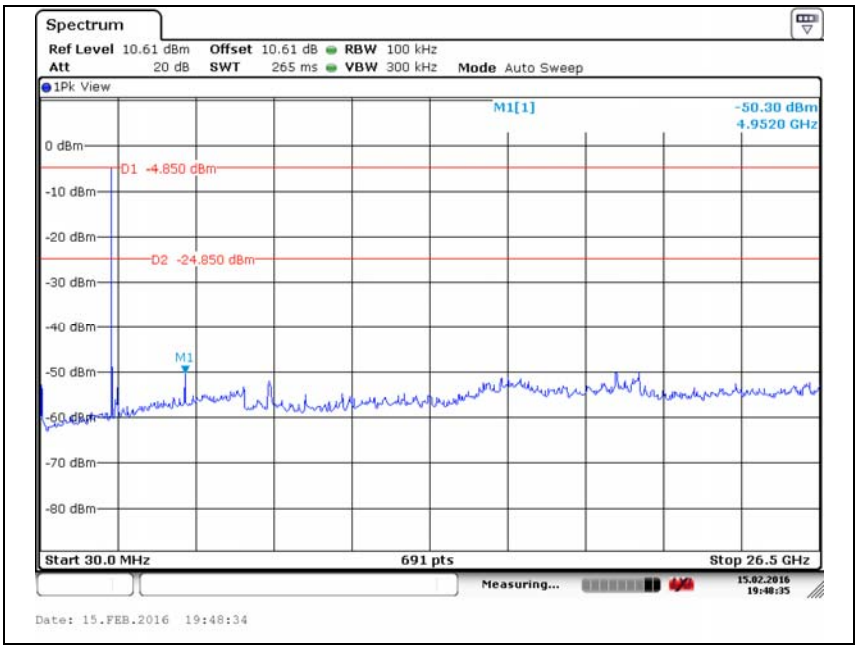
Bluetooth 2 Mbps – Ch. 39



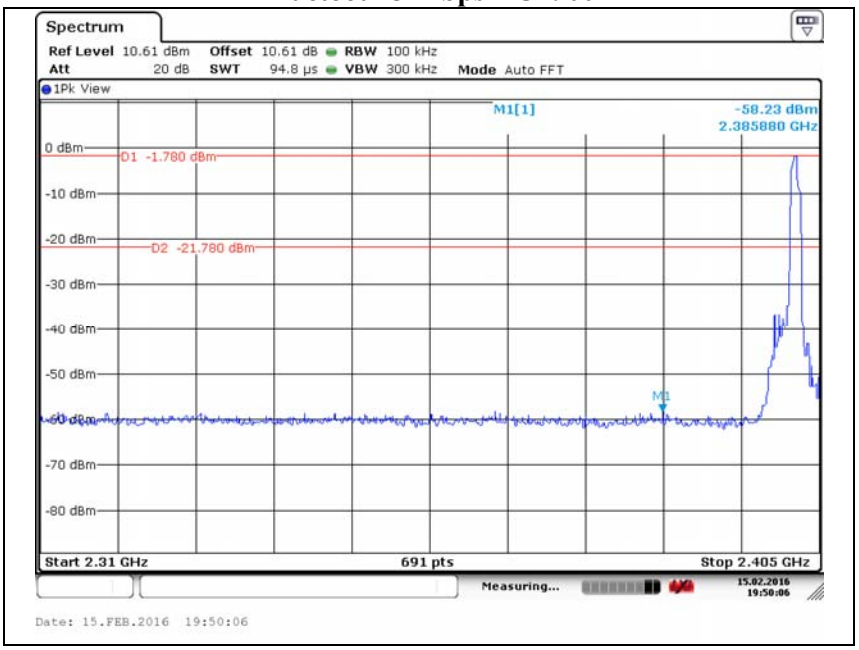


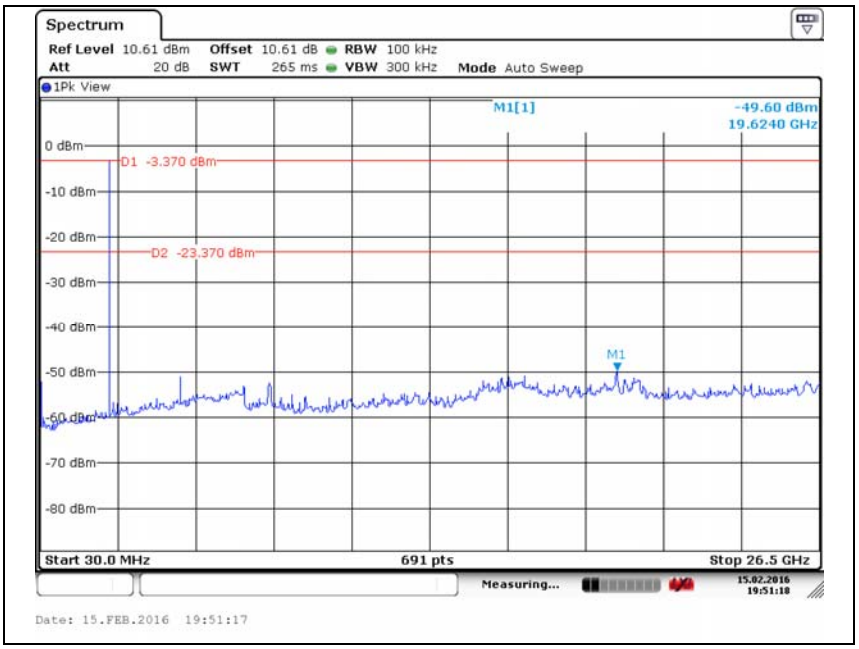
Bluetooth 2 Mbps – Ch. 78



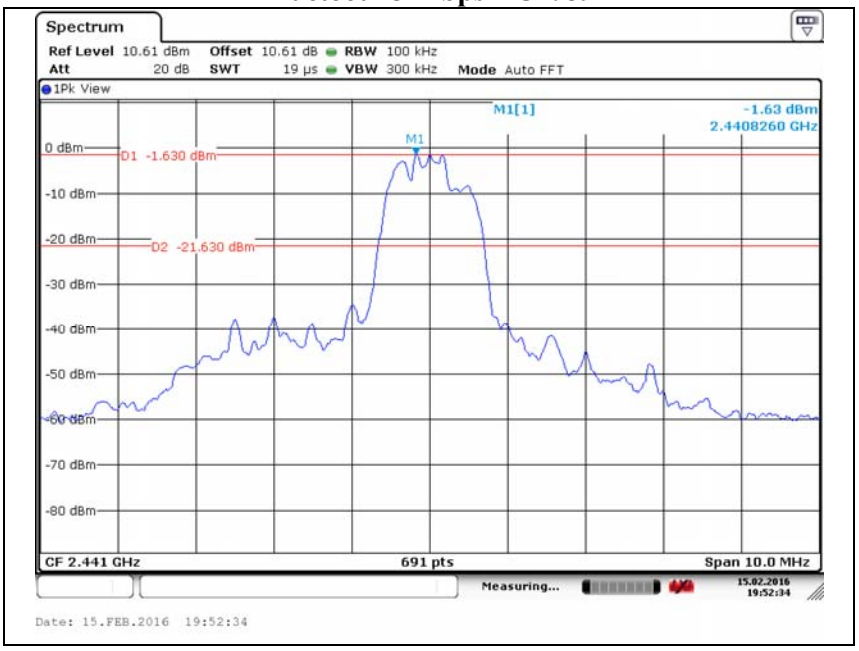


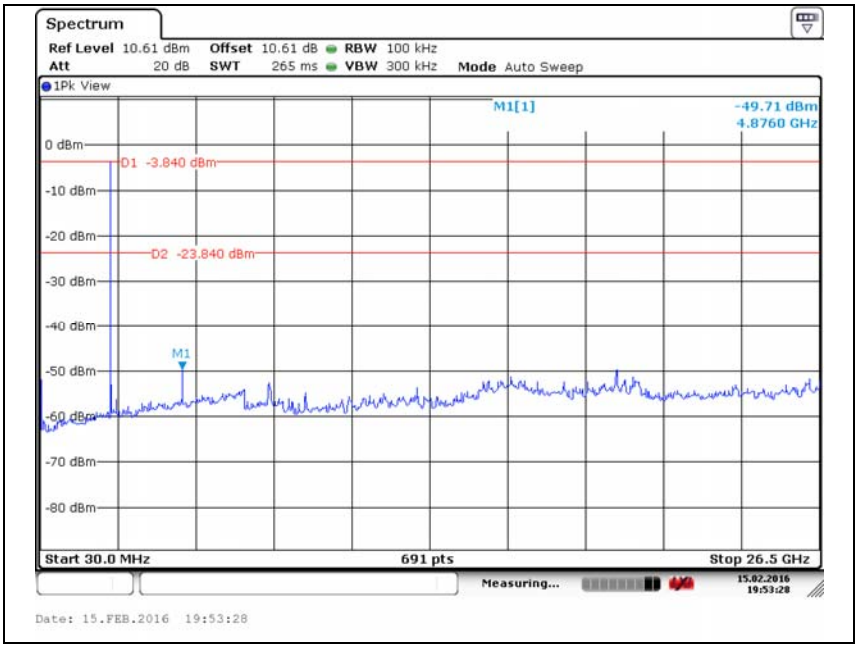
Bluetooth 3 Mbps – Ch. 00



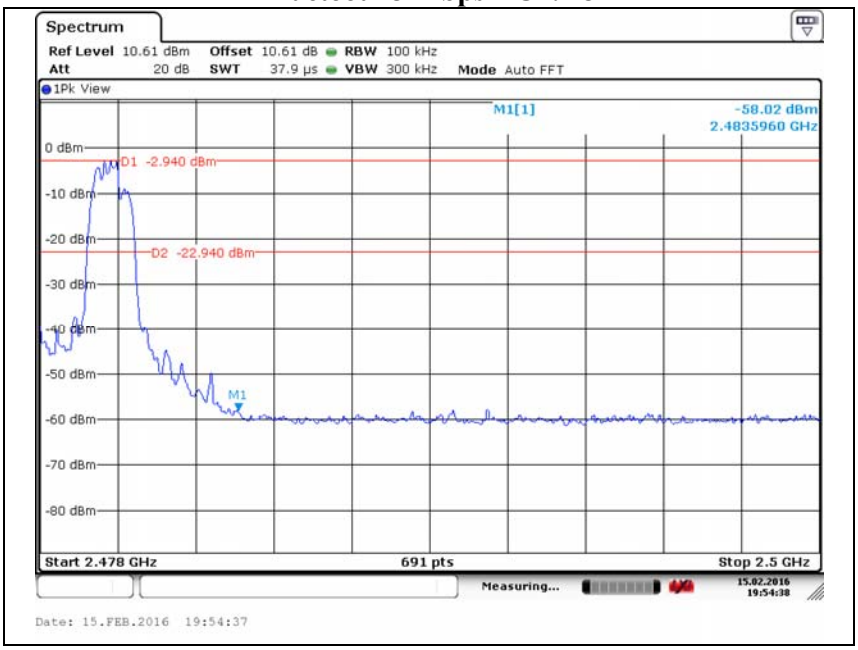


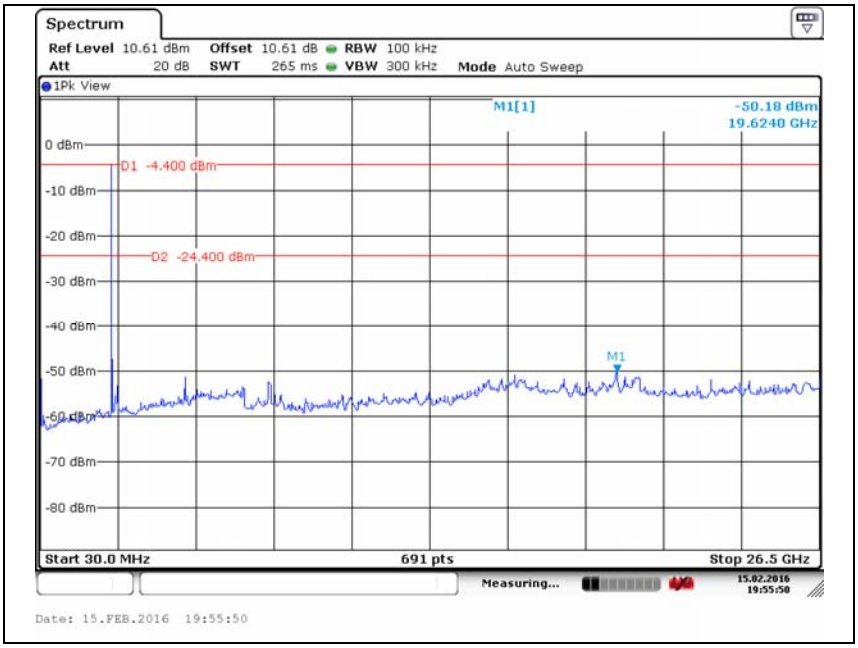
Bluetooth 3 Mbps – Ch. 39



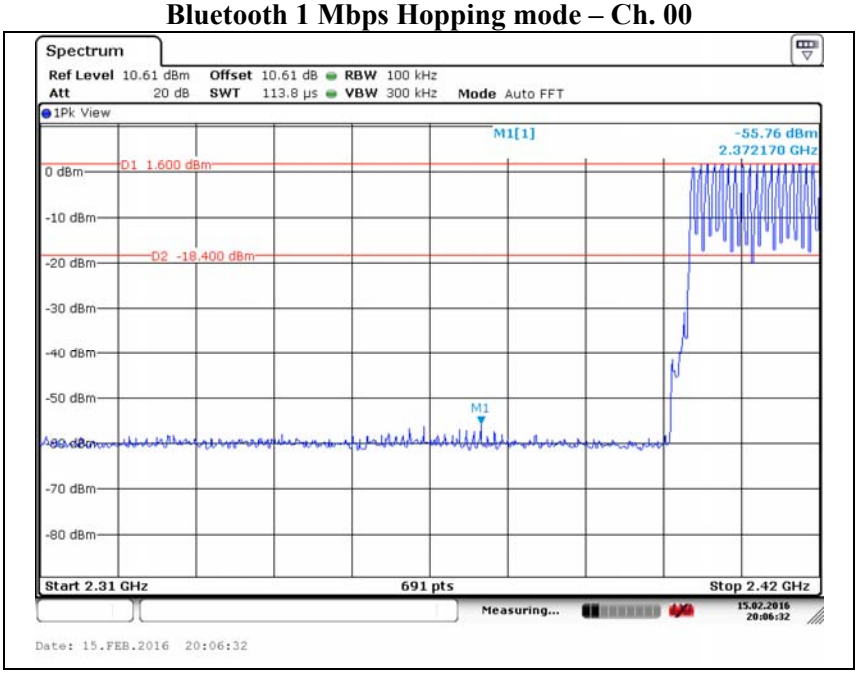


Bluetooth 3 Mbps – Ch. 78

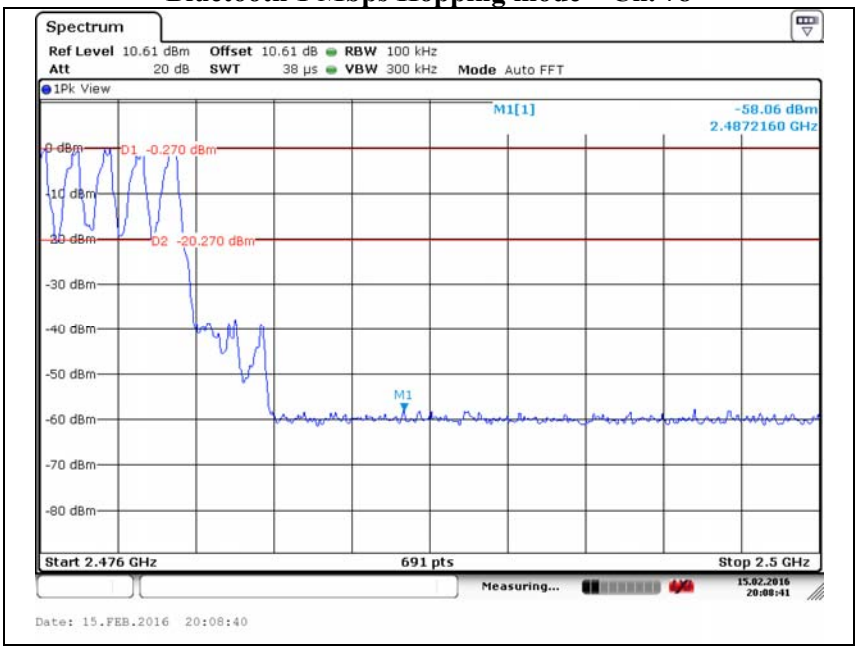




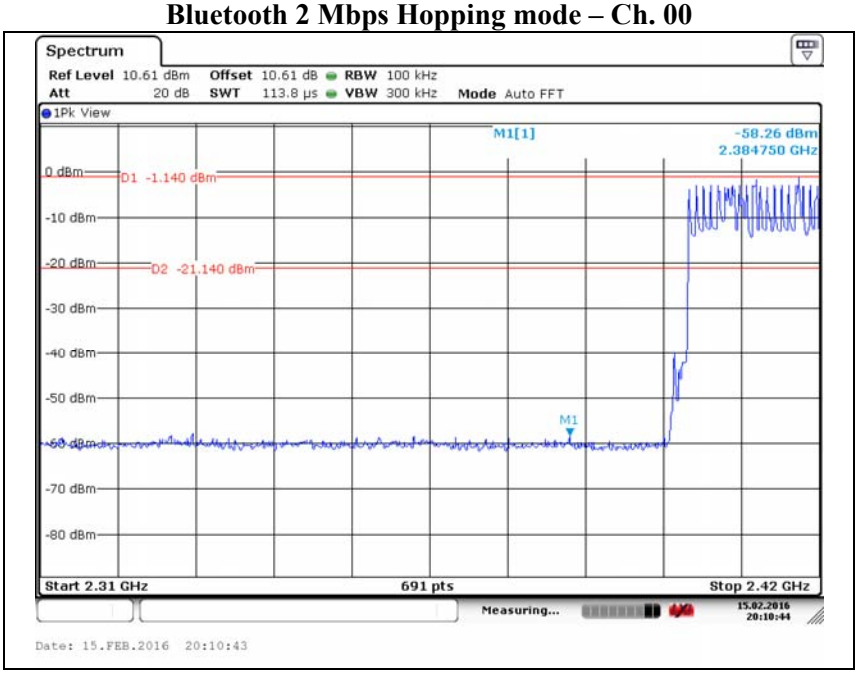
Bluetooth 1 Mbps Hopping mode – Ch. 00



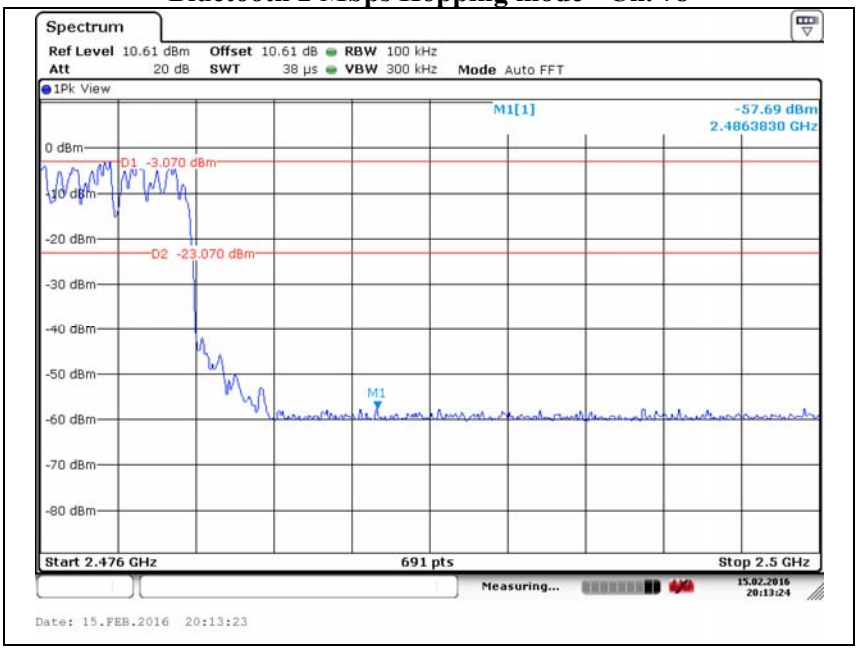
Bluetooth 1 Mbps Hopping mode – Ch. 78



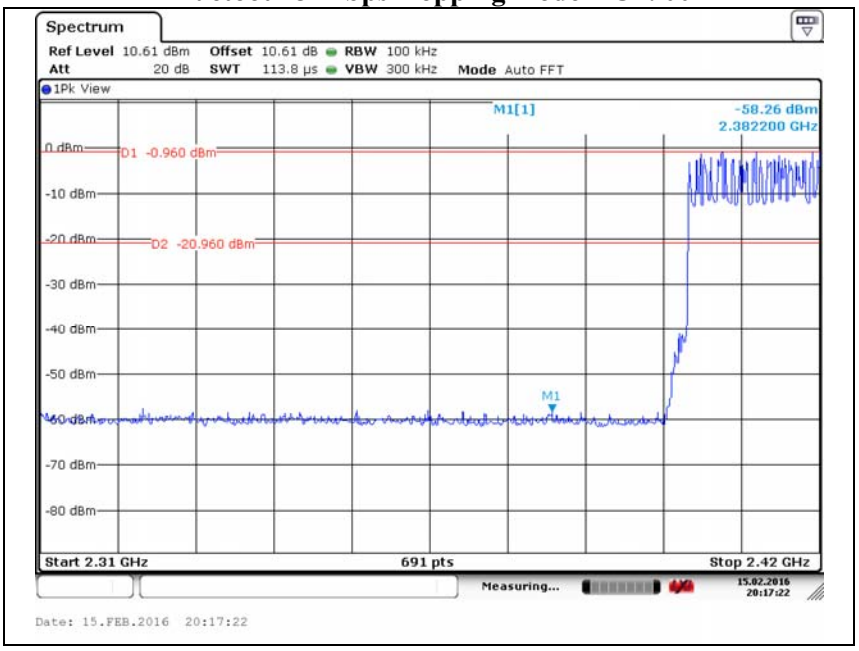
Bluetooth 2 Mbps Hopping mode – Ch. 00



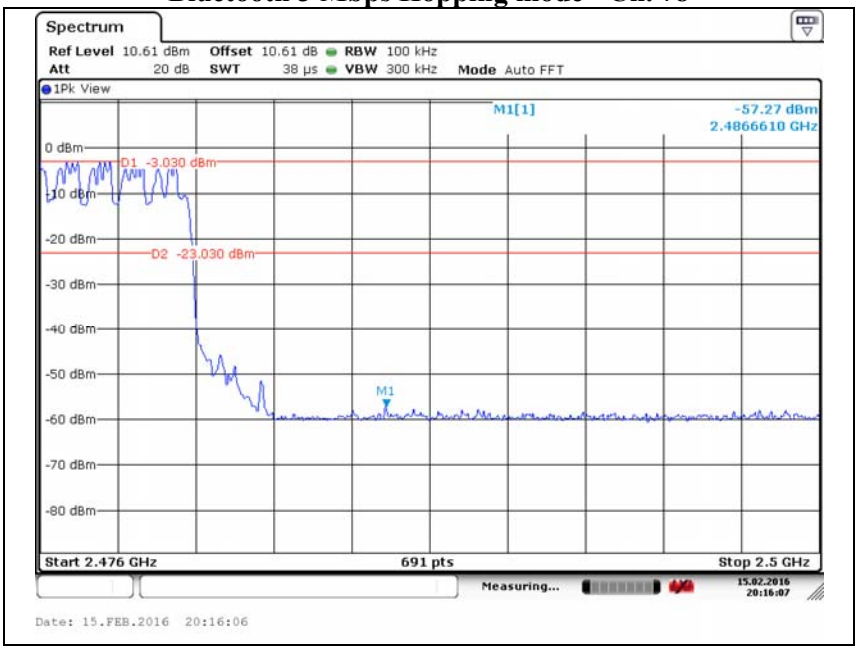
Bluetooth 2 Mbps Hopping mode - Ch. 78



Bluetooth 3 Mbps Hopping mode – Ch. 00

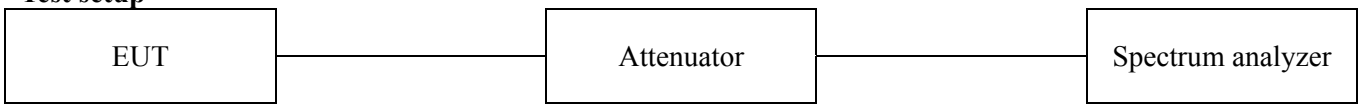


Bluetooth 3 Mbps Hopping mode - Ch. 78



3.3. 20 dB bandwidth

Test setup



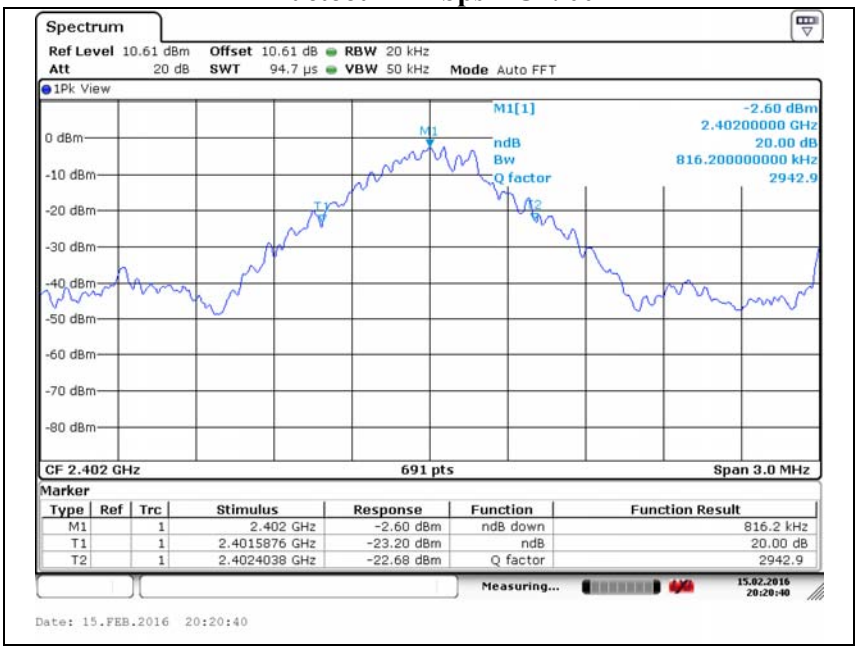
Test procedure
DA 00-705

Test setting
1. Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
2. RBW ≥ 1% of the 20 dB bandwidth
3. VBW ≥ RBW
4. Sweep = auto
5. Detector function = peak
6. Sweep = auto couple
7. Trace mode = max hold

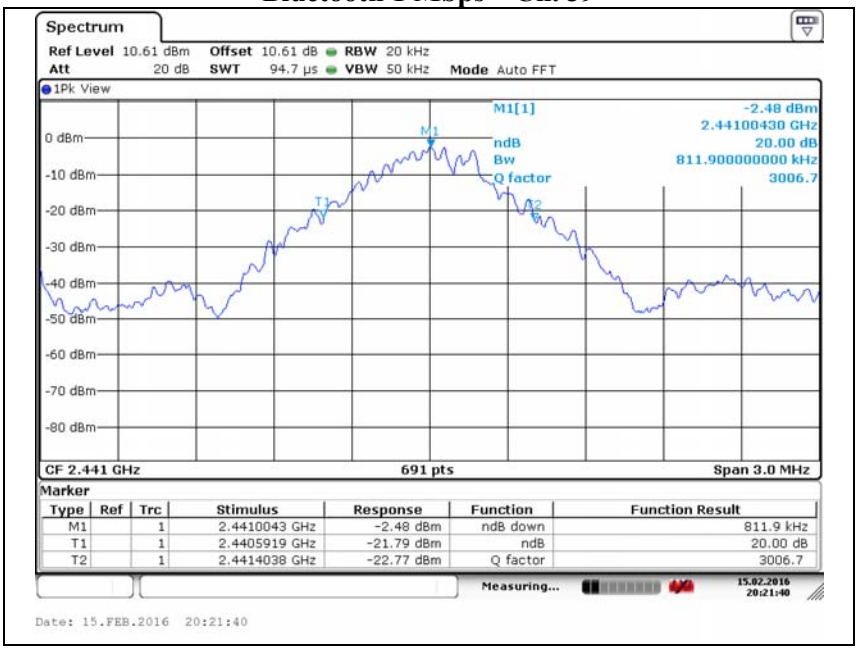
Limit
Not applicable

Frequency(㎒)	Channel no.	Data rate(Mbps)	Measured bandwidth(㎒)
2 402	00	1	0.816
2 441	39		0.812
2 480	78		0.816
2 402	00	2	1.237
2 441	39		1.237
2 480	78		1.237
2 402	00	3	1.255
2 441	39		1.250
2 480	78		1.250

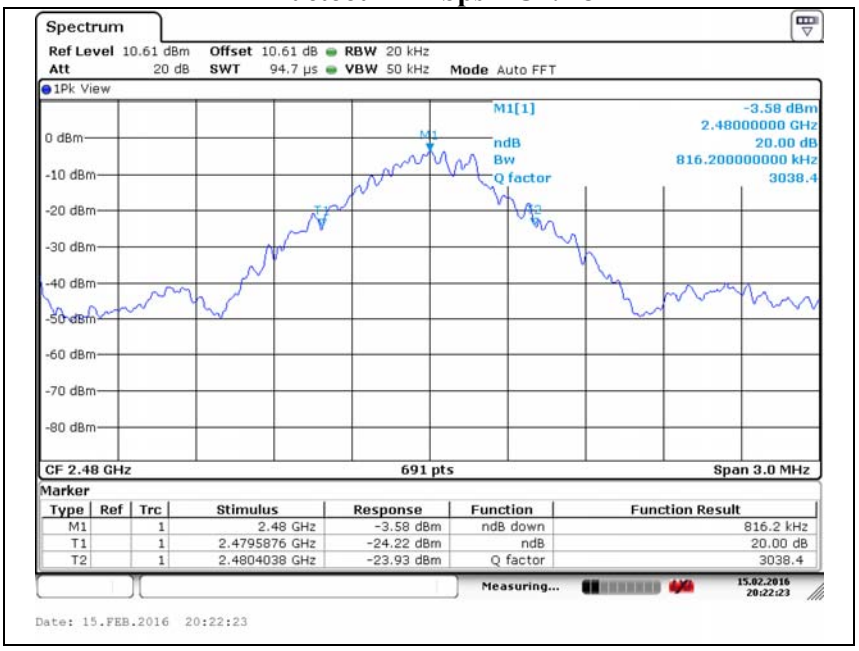
Bluetooth 1 Mbps – Ch. 00



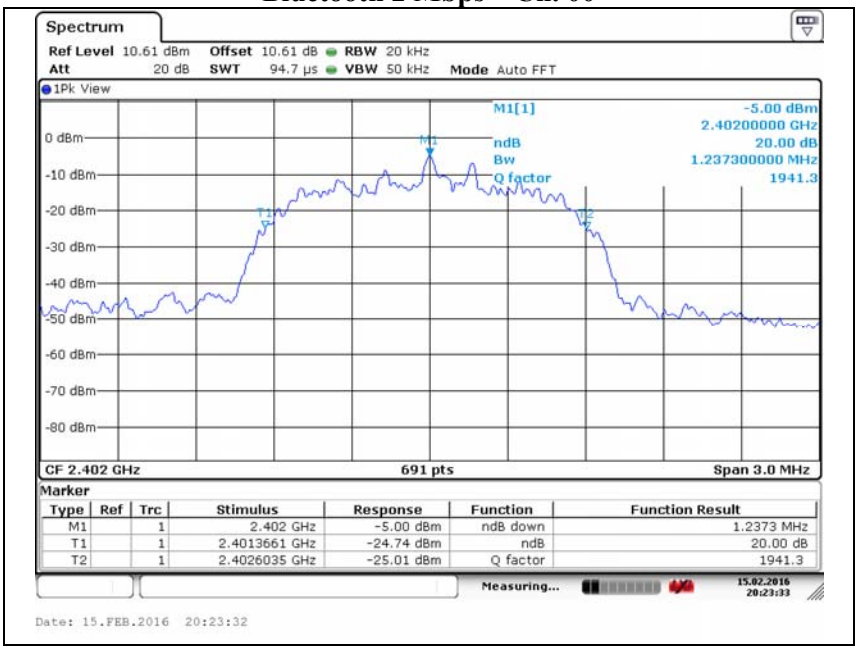
Bluetooth 1 Mbps – Ch. 39



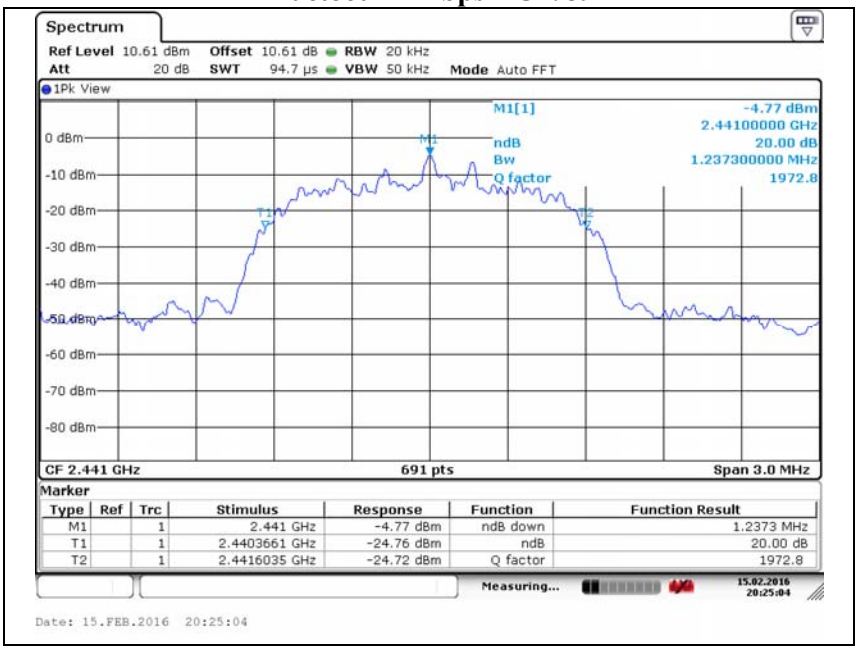
Bluetooth 1 Mbps – Ch. 78



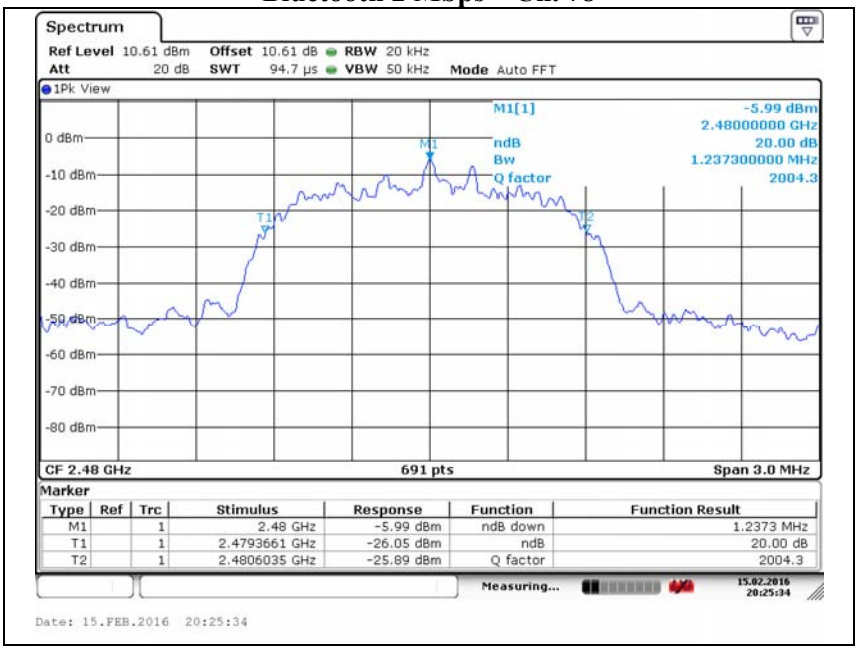
Bluetooth 2 Mbps – Ch. 00



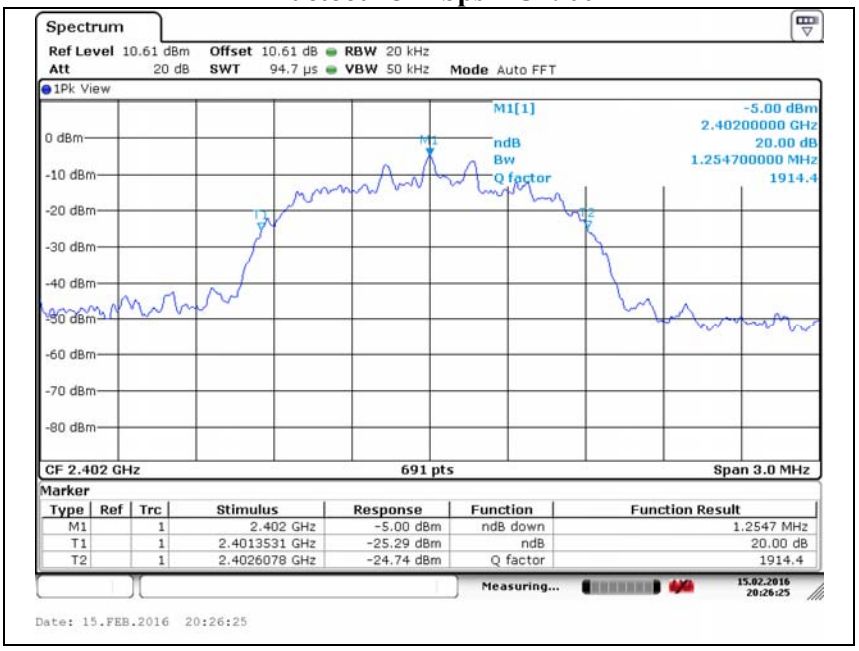
Bluetooth 2 Mbps – Ch. 39



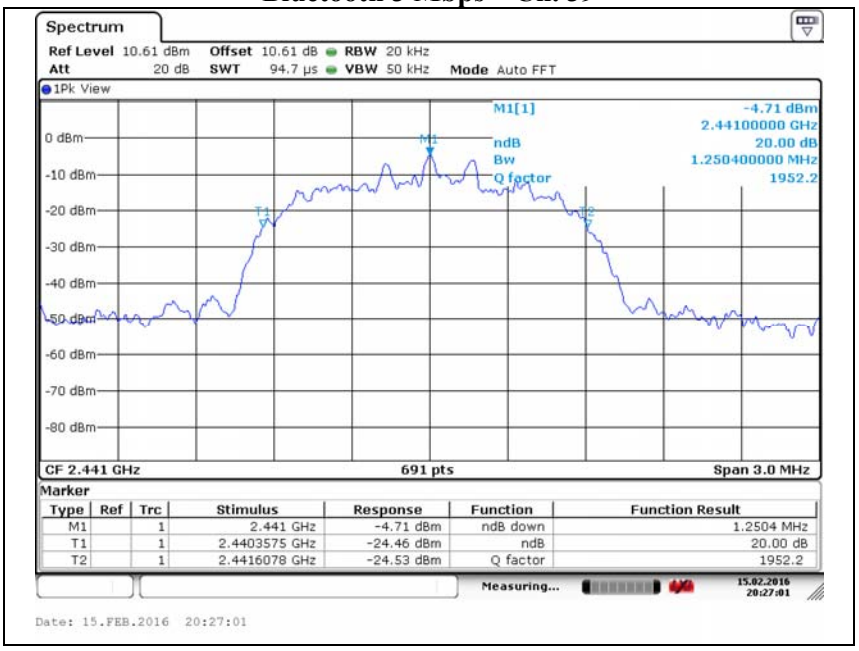
Bluetooth 2 Mbps – Ch. 78



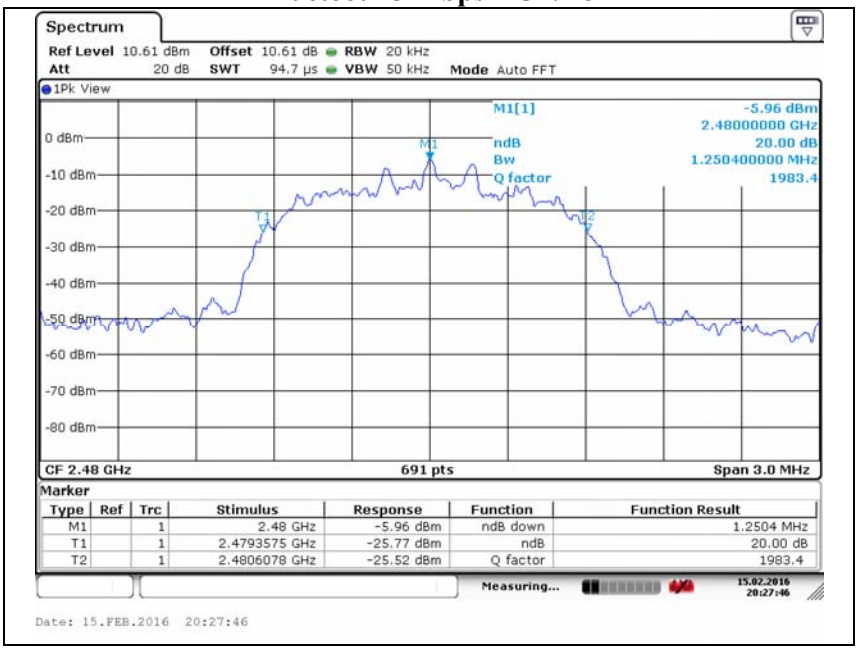
Bluetooth 3 Mbps – Ch. 00



Bluetooth 3 Mbps – Ch. 39

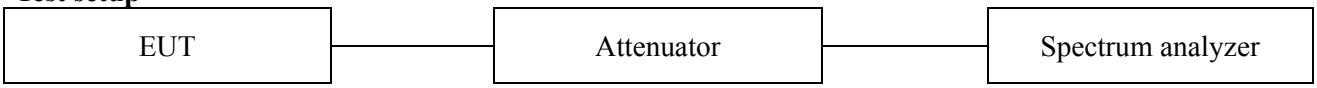


Bluetooth 3 Mbps – Ch. 78



3.4. Output power

Test setup



Test procedure
DA 00-705

Test setting
1. Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
2. RBW > the 20 dB bandwidth of the emission being measured
3. VBW ≥ RBW
4. Sweep = Auto
5. Detector function = Peak
6. Trace = Max hold

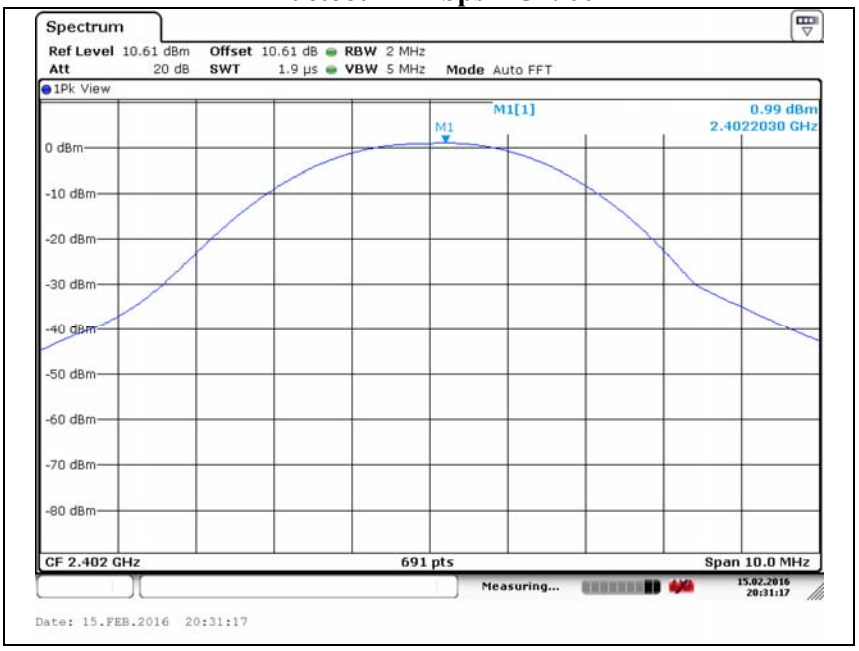
Limit
According to §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 ㎑ or the 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.

According to §15.247(b)(1), For frequency hopping systems operating in the 2 400 ~ 2 483.5 ㎒ employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 ~ 5 805 ㎒ band: 1 Watt.

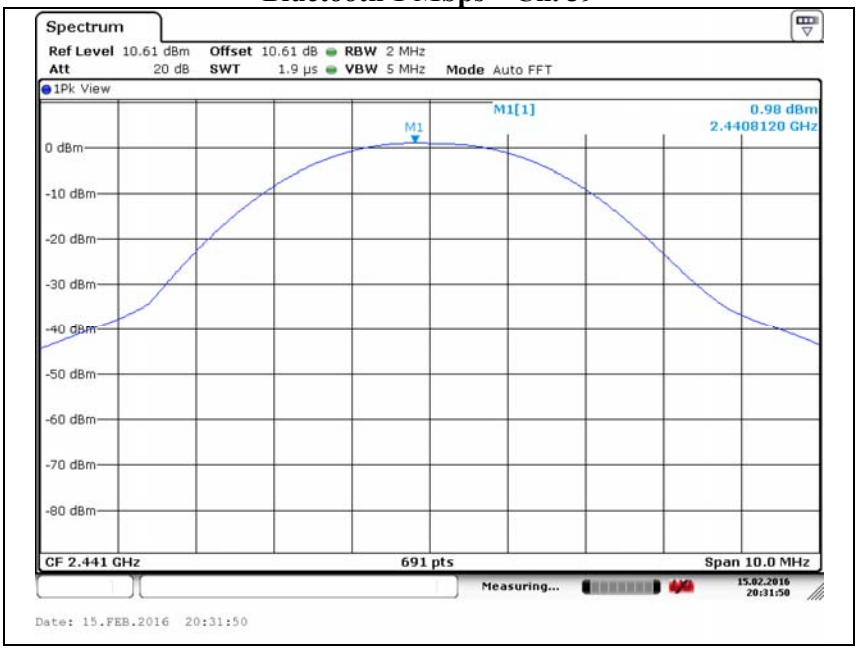
Note: In the case of AFH, the limit for peak power is 0.125 Watt.

Frequency(㎒)	Channel no.	Data rate(Mbps)	Measured power (dBm)	Peak Power Limit (dBm)
2 402	00	1	0.99	20.97
2 441	39		0.98	20.97
2 480	78		-0.10	20.97
2 402	00	2	-0.80	20.97
2 441	39		-0.57	20.97
2 480	78		-1.80	20.97
2 402	00	3	-0.49	20.97
2 441	39		-0.37	20.97
2 480	78		-1.53	20.97

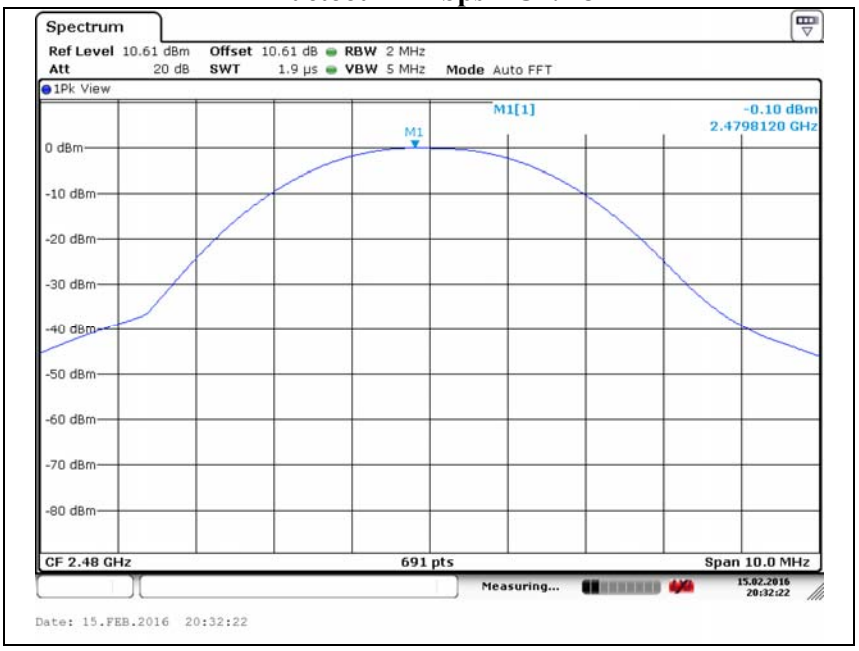
Bluetooth 1 Mbps – Ch. 00



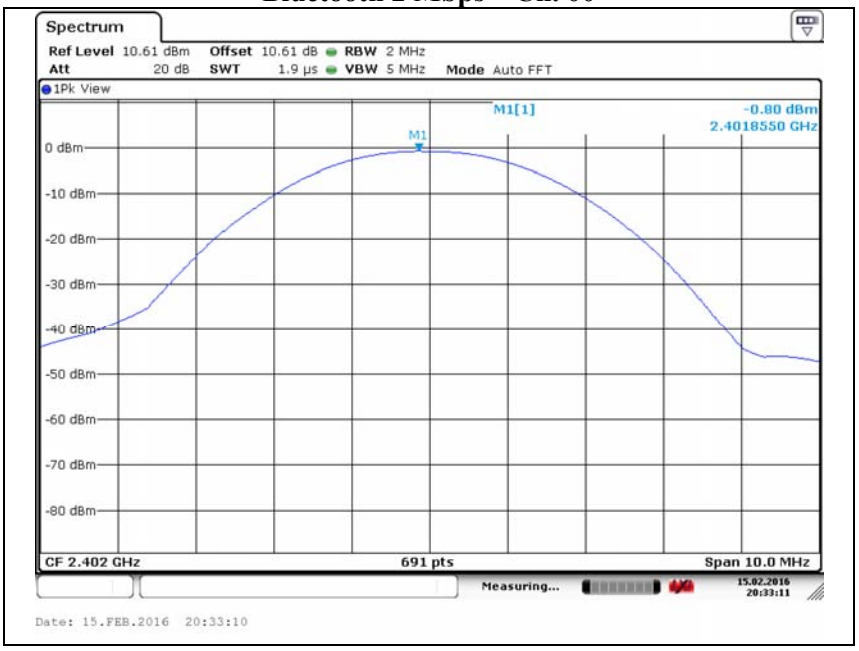
Bluetooth 1 Mbps – Ch. 39



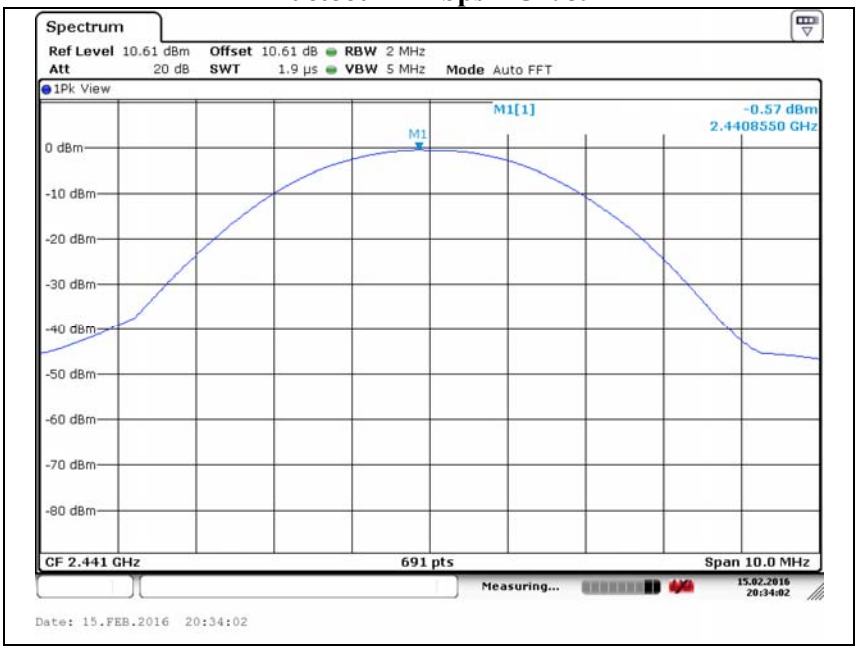
Bluetooth 1 Mbps – Ch. 78



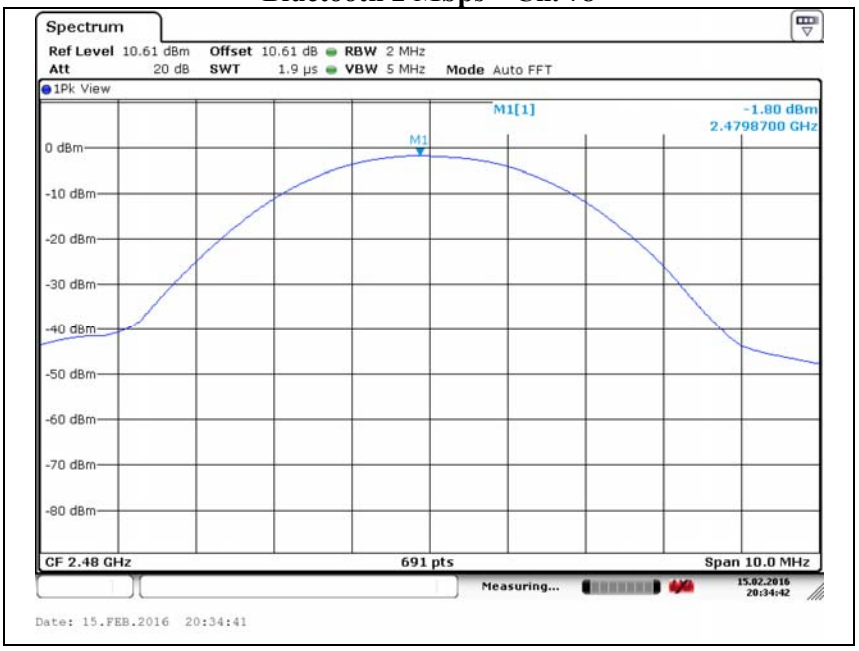
Bluetooth 2 Mbps – Ch. 00



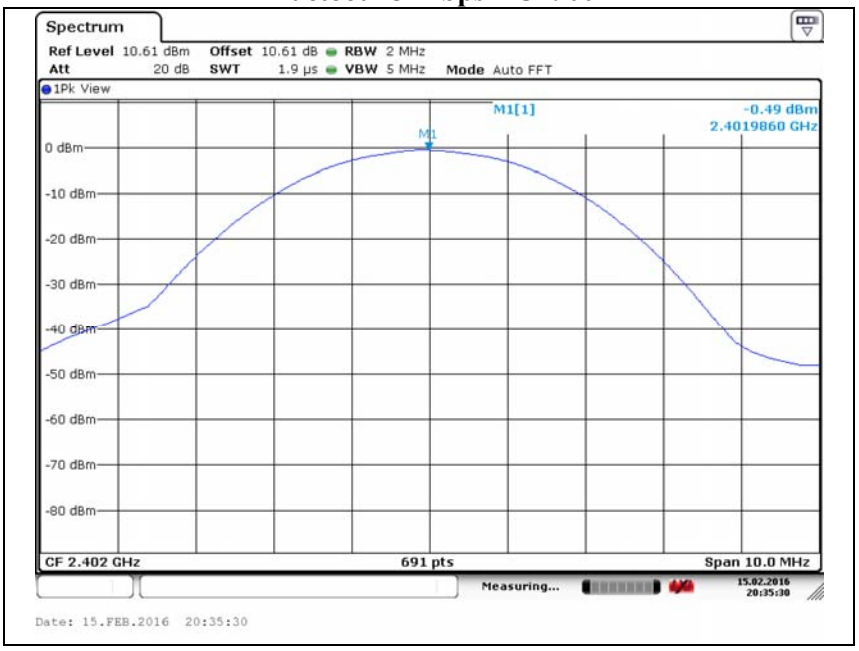
Bluetooth 2 Mbps – Ch. 39



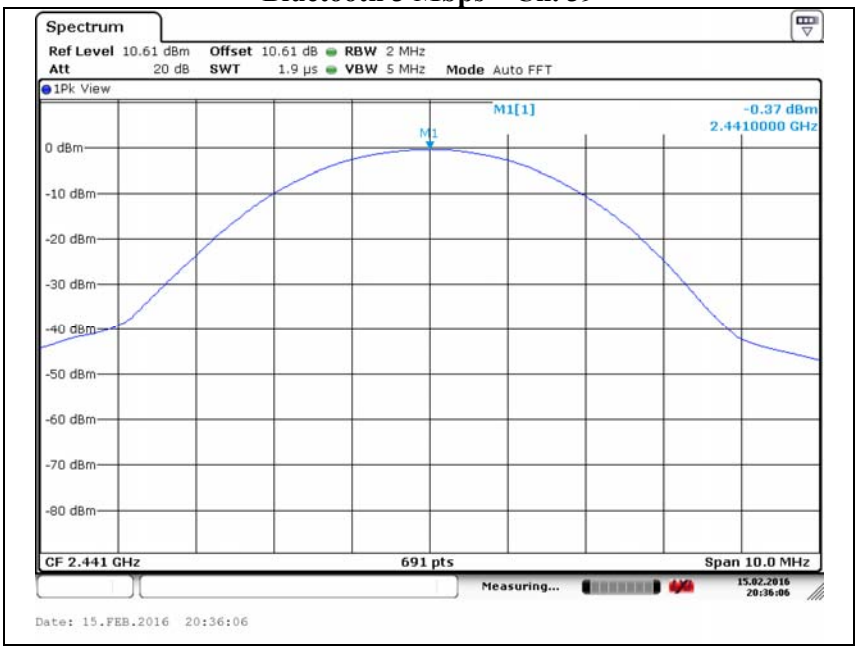
Bluetooth 2 Mbps – Ch. 78



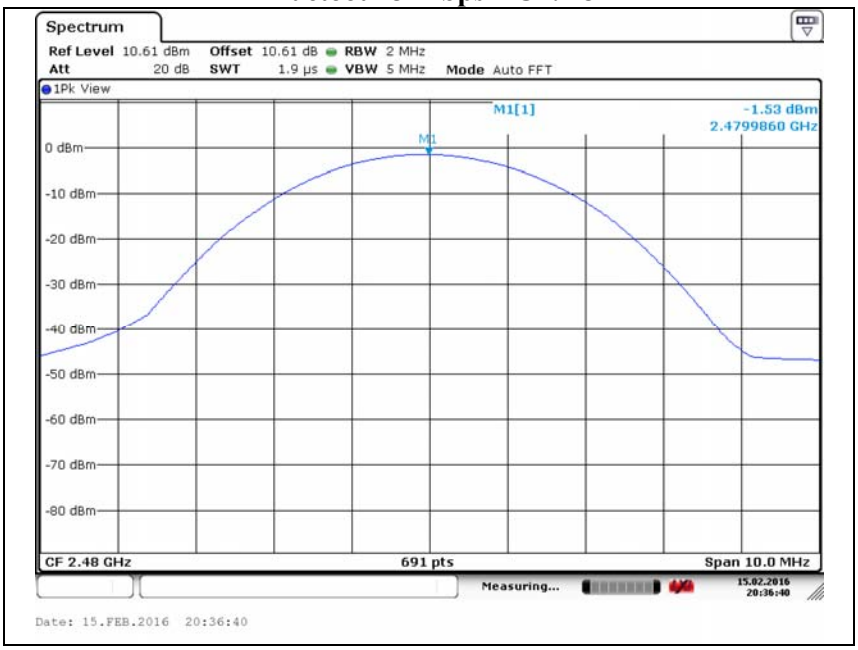
Bluetooth 3 Mbps – Ch. 00



Bluetooth 3 Mbps – Ch. 39

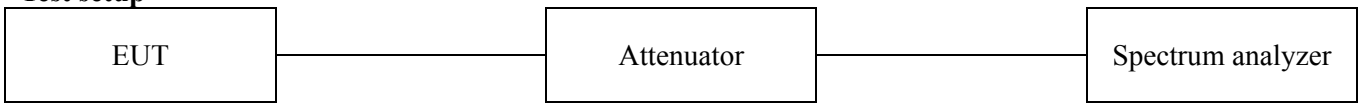


Bluetooth 3 Mbps – Ch. 78



3.5. Carrier frequency separation

Test setup



Test procedure
DA 00-705

Test Setting
1. The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:
2. Span = wide enough to capture the peaks of two adjacent channels
3. Resolution (or IF) Bandwidth (RBW) ≥ 1% of the span
4. Video (or Average) Bandwidth (VBW) ≥ RBW

5. Sweep = auto
6. Detector function = peak
7. Trace = max hold

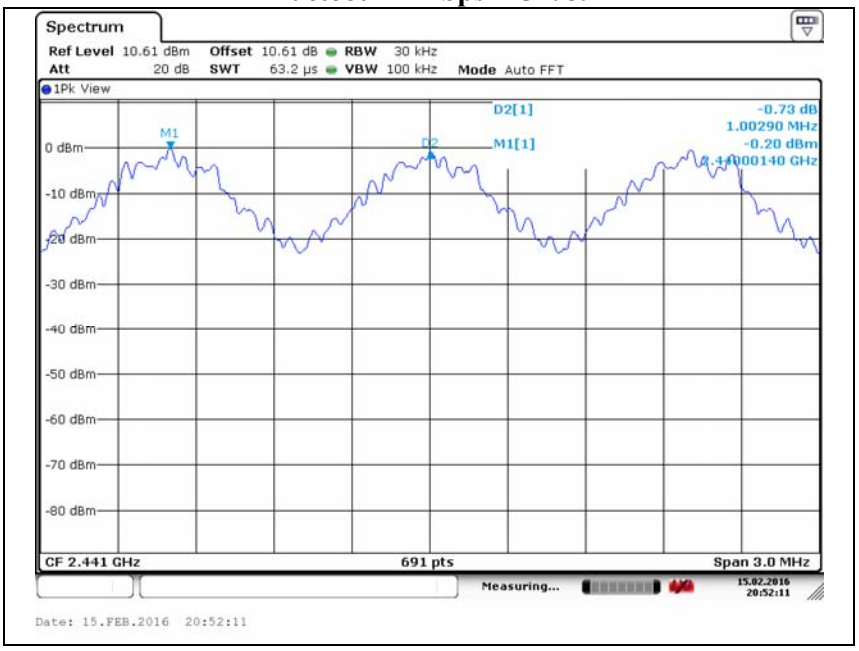
Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

Limit
According to 15.247(a)(1), frequency hopping system operating in 2 400 ~ 2 483.5 ㎒. Band may have hopping channel carrier frequencies that are separated by 25 ㎑ or two-third of 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.

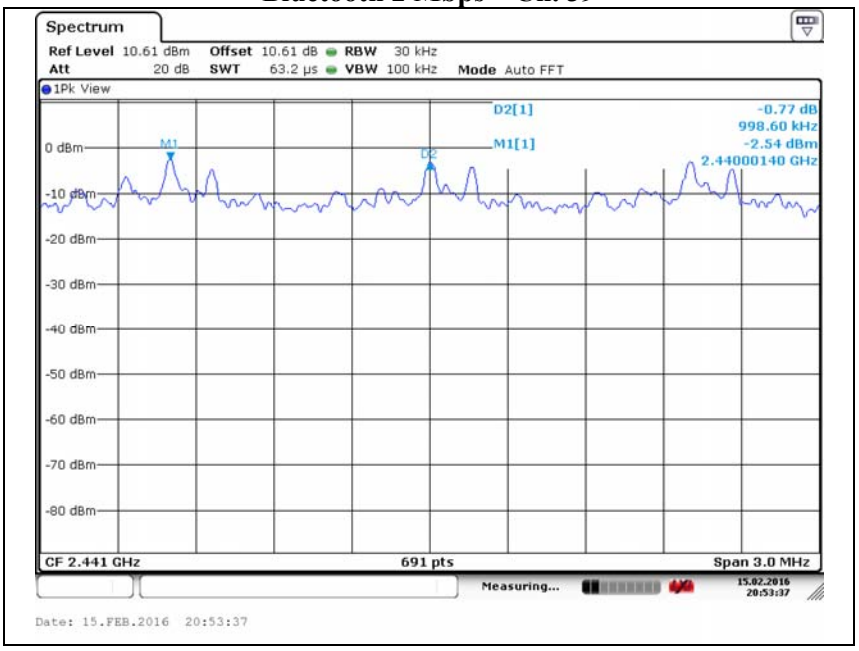
Frequency(㎒)	Channel no.	Data rate(Mbps)	Channel Separation (㎒)
2 441	39	1	1.003
2 441	39	2	0.999
2 441	39	3	0.999

Note:
Measurement is made with EUT operating in hopping mode between 79 channels providing a worse case scenario as compared to AFH mode hopping between 20 channels.

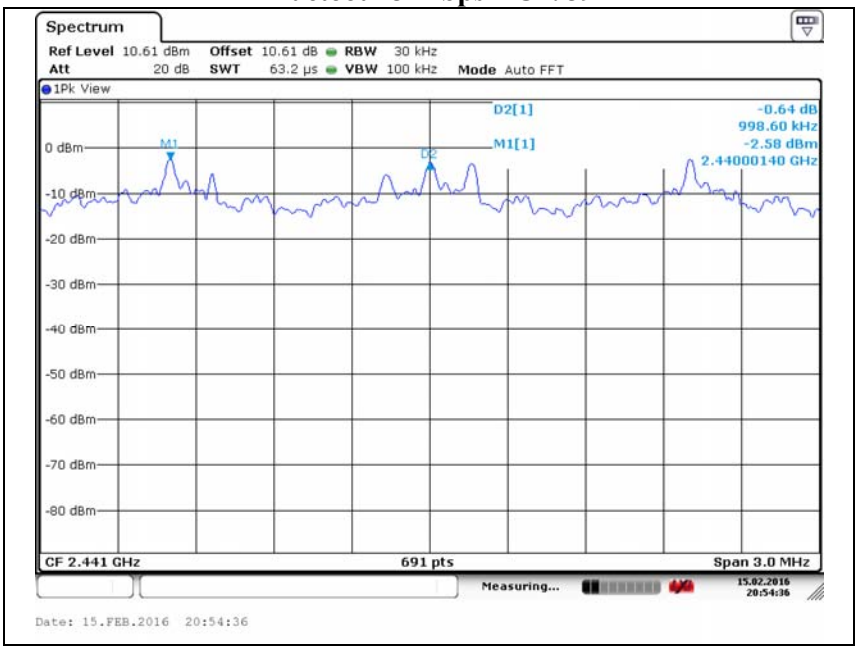
Bluetooth 1 Mbps – Ch. 39



Bluetooth 2 Mbps – Ch. 39

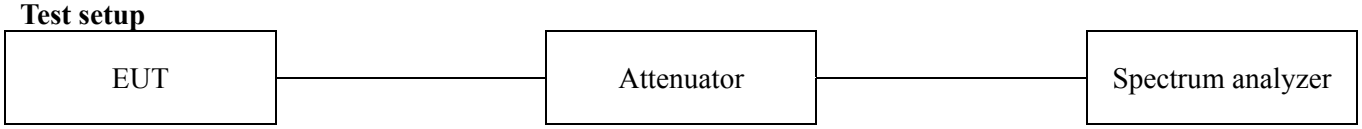


Bluetooth 3 Mbps – Ch. 39



3.6. Number of hopping frequency

Test setup



Test procedure
DA 00-705

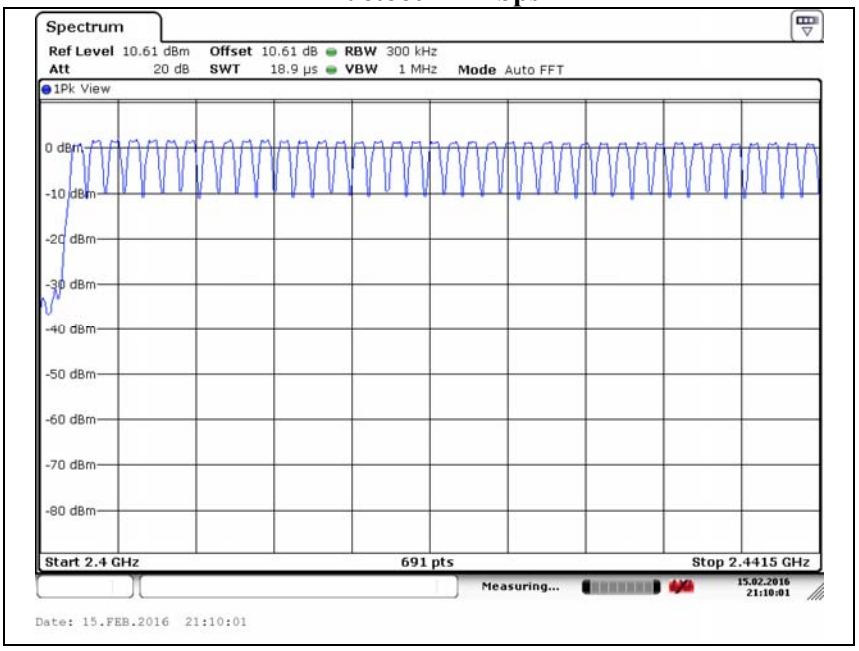
Test setting
1. The EUT must have its hopping function enabled.
2. Frequency range: 2 400 ㎒ ~ 2 441.5 ㎒, 2 441.5 ㎒ ~ 2 483.5 ㎒
3. Span = the frequency band of operation
4. RBW = 300 ㎑ (≥ 1% of the span)
5. VBW = 1 ㎒ (≥ RBW)
6. Sweep = auto
7. Detector function = peak
8. Trace = max hold

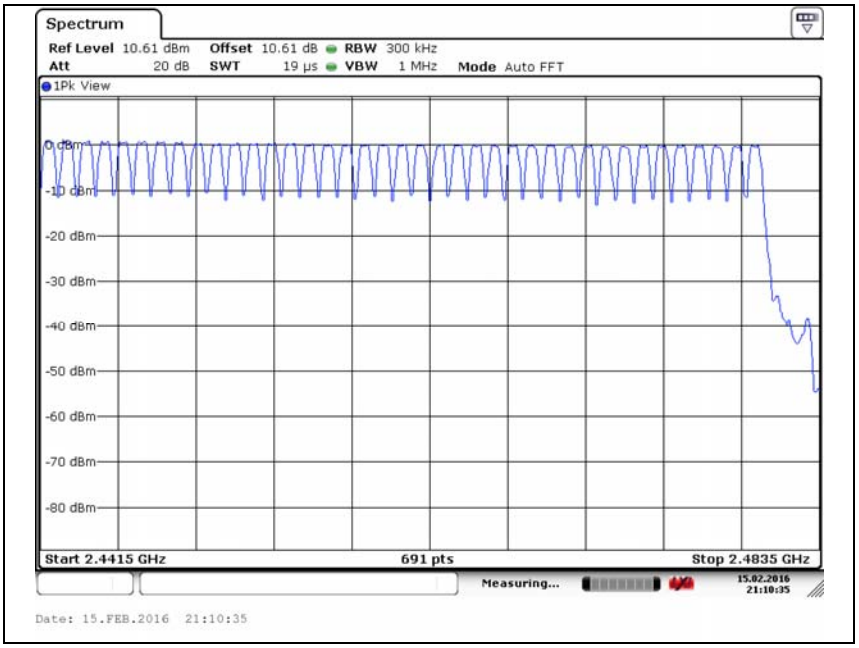
All the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

Limit
According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2 400 ~ 2 483.5 ㎒ bands shall use at least 15 hopping frequencies.

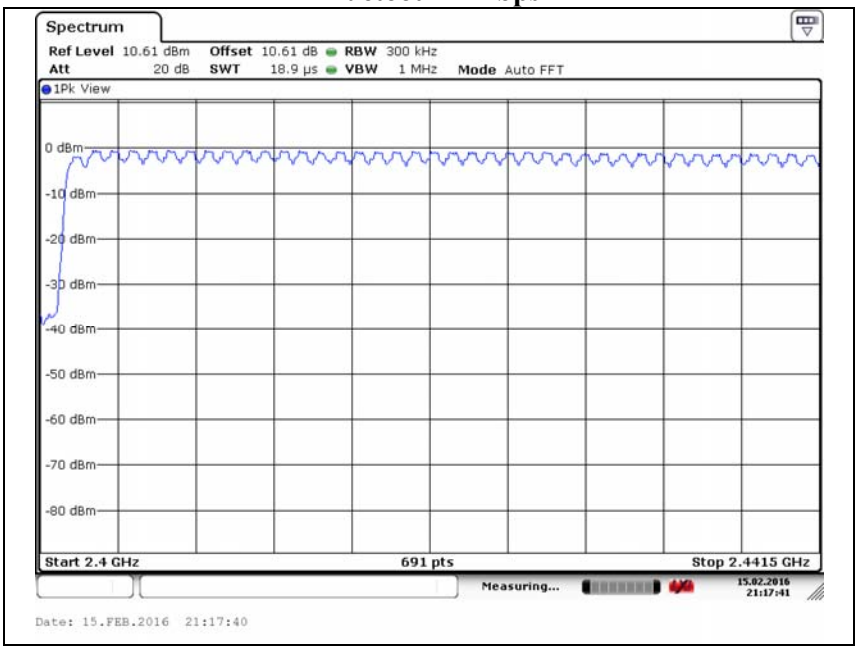
Note: In case of AFH mode, minimum number of hopping channels is 20.

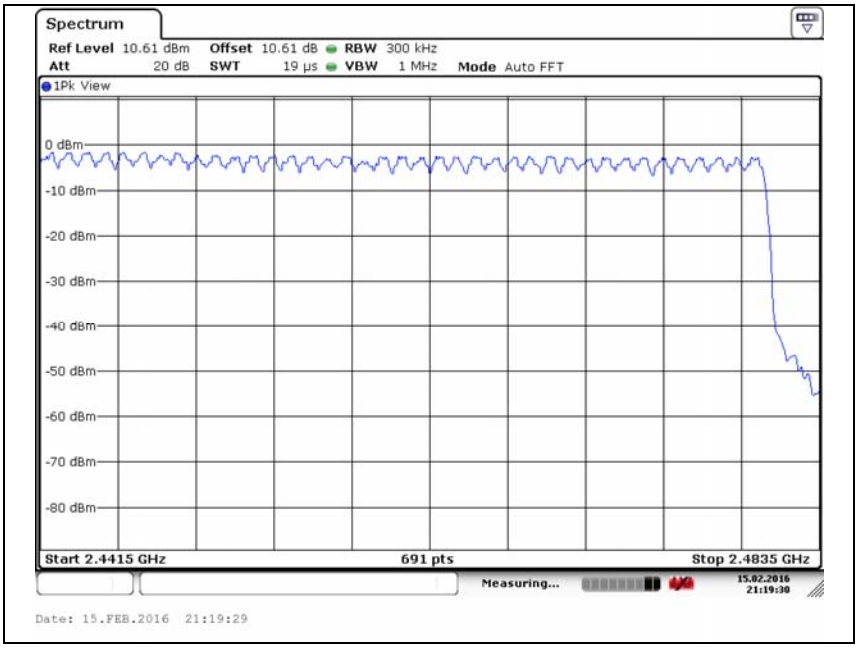
Bluetooth 1 Mbps



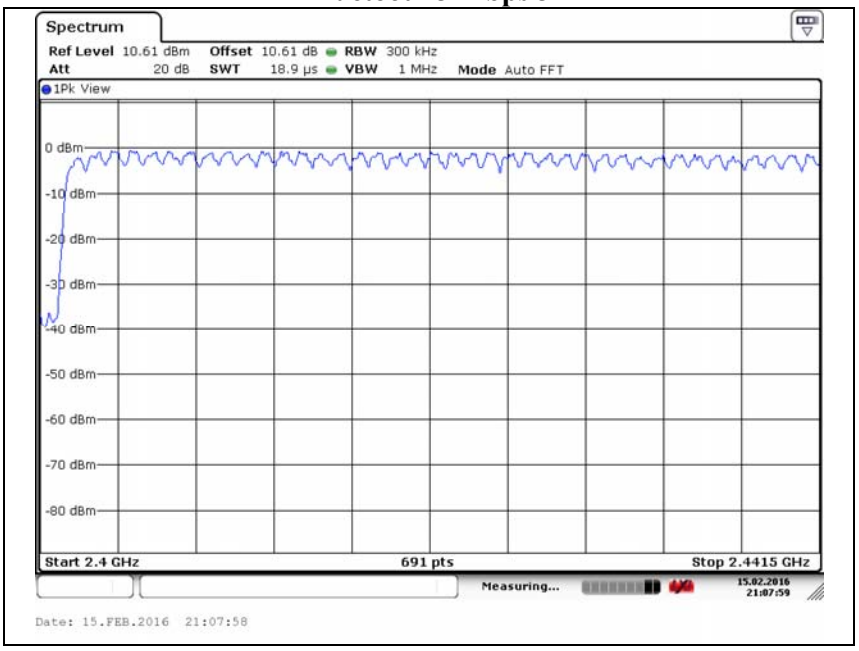


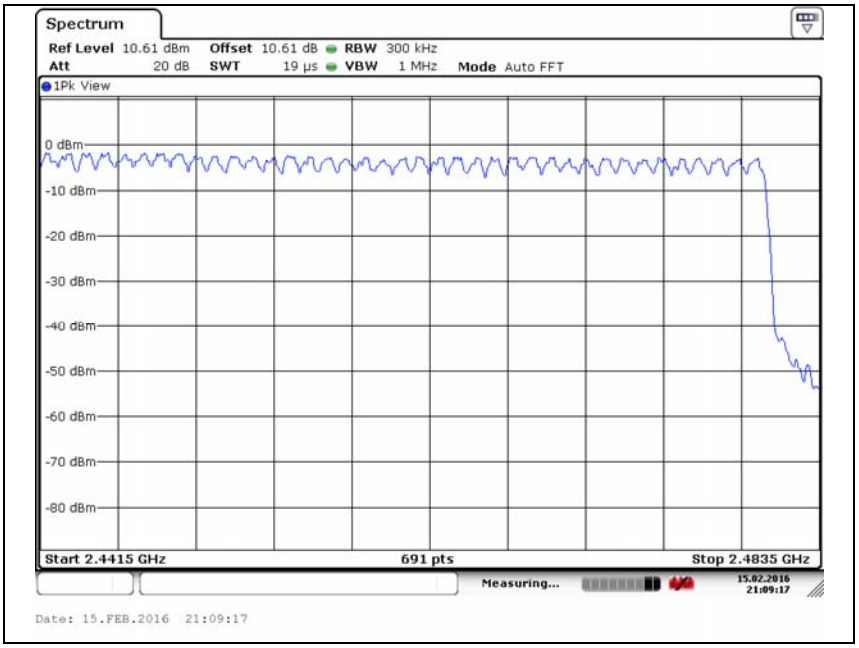
Bluetooth 2 Mbps





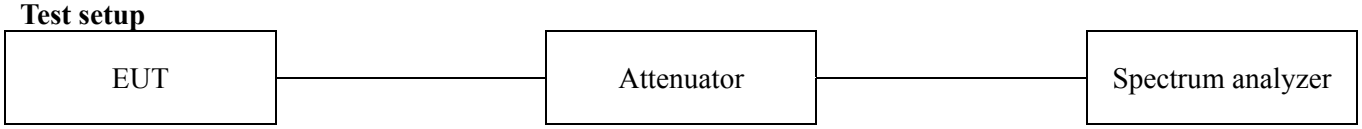
Bluetooth 3 Mbps 3





3.7. Time of occupancy

Test setup



Test procedure
DA 00-705

Test setting
1. The EUT must have its hopping function enabled.
2. Span = zero span, centered on a hopping channel
4. RBW = 1 ㎒
5. VBW = 1 ㎒ (≥ RBW)
6. Sweep = as necessary to capture the entire dwell time per hopping channel
7. Detector function = peak
8. Trace = max hold

Limit
According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2 400 ~ 2 483.5 ㎒ band, the average time of occupancy on any frequency shall not be greater than 0.4 second within a 31.6 second period.

A period time = 0.4(s) × 79 = 31.6(s)

Time of occupancy on the TX channel in 31.6 sec
= time domain slot length × (hop rate ÷ number of hop per channel) × 31.6

• Adaptive Frequency Hopping

A period time = 0.4(s) × 20 = 8.0(s)

Time of occupancy on the TX channel in 8.0 sec
= time domain slot length × (hop rate ÷ number of hop per channel) × 8.0

Operation mode: GFSK , π/4-DQPSK, 8DPSK

Packet type	Frequency (㎒)	Dwell time (ms)	Time of occupancy on the Tx channel in 31.6 sec (ms)	Limit for time of occupancy on the Tx channel in 31.6 sec (ms)
DH1	2 441	0.419	134.08	400
DH3	2 441	1.678	268.48	400
DH5	2 441	2.928	312.32	400
2-DH1	2 441	0.435	139.20	400
2-DH3	2 441	1.685	269.60	400
2-DH5	2 441	2.933	312.85	400
3-DH1	2 441	0.438	140.16	400
3-DH3	2 441	1.685	269.60	400
3-DH5	2 441	2.939	313.49	400

Note:

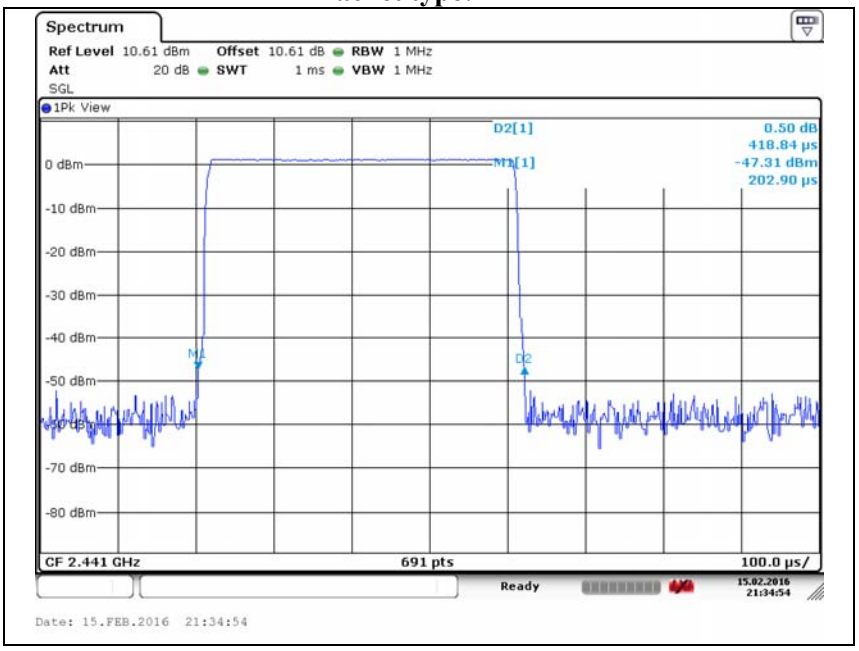
Normal Mode

DH1: Dwell time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 134.08 (ms)
DH3: Dwell time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 268.48 (ms)
DH5: Dwell time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 312.32 (ms)
2-DH1: Dwell time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 139.20 (ms)
2-DH3: Dwell time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 269.60 (ms)
2-DH5: Dwell time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 312.85 (ms)
3-DH1: Dwell time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 140.16 (ms)
3-DH3: Dwell time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 269.60 (ms)
3-DH5: Dwell time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 313.49 (ms)

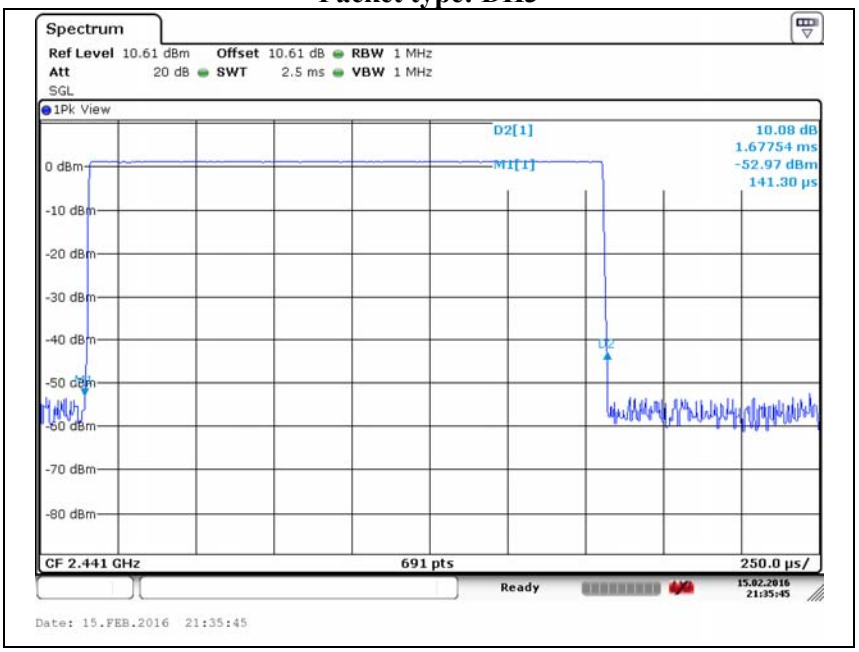
AFH Mode

DH1: Dwell time (ms) × [(800 ÷ 2) ÷ 20] × 8.0(s) = 67.040 (ms)
DH3: Dwell time (ms) × [(800 ÷ 4) ÷ 20] × 8.0(s) = 134.24 (ms)
DH5: Dwell time (ms) × [(800 ÷ 6) ÷ 20] × 8.0(s) = 156.16 (ms)
2-DH1: Dwell time (ms) × [(800 ÷ 2) ÷ 20] × 8.0(s) = 69.600 (ms)
2-DH3: Dwell time (ms) × [(800 ÷ 4) ÷ 20] × 8.0(s) = 134.80 (ms)
2-DH5: Dwell time (ms) × [(800 ÷ 6) ÷ 20] × 8.0(s) = 156.43 (ms)
3-DH3: Dwell time (ms) × [(800 ÷ 2) ÷ 20] × 8.0(s) = 70.080 (ms)
3-DH5: Dwell time (ms) × [(800 ÷ 4) ÷ 20] × 8.0(s) = 134.80 (ms)
3-DH5: Dwell time (ms) × [(800 ÷ 6) ÷ 20] × 8.0(s) = 156.75 (ms)

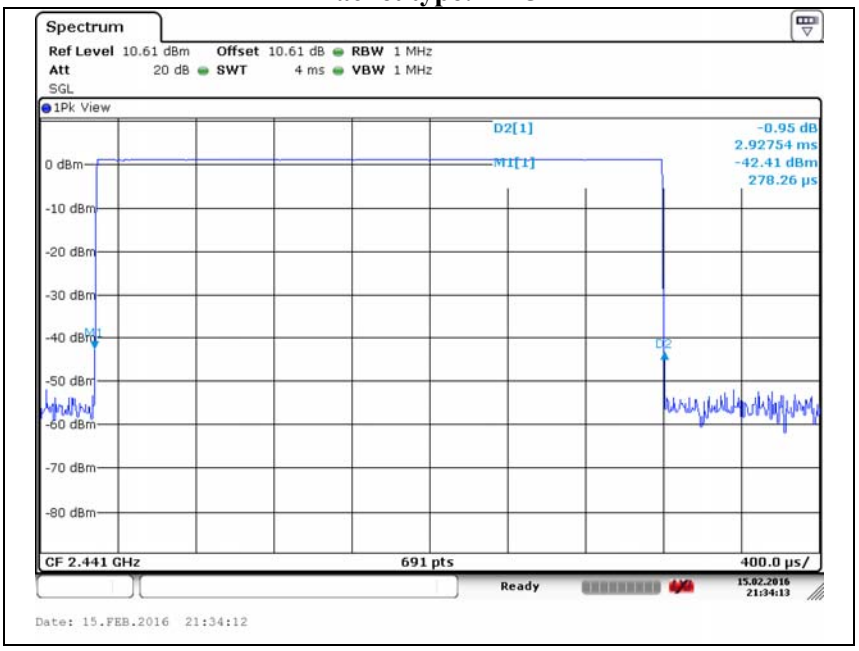
Packet type: DH1



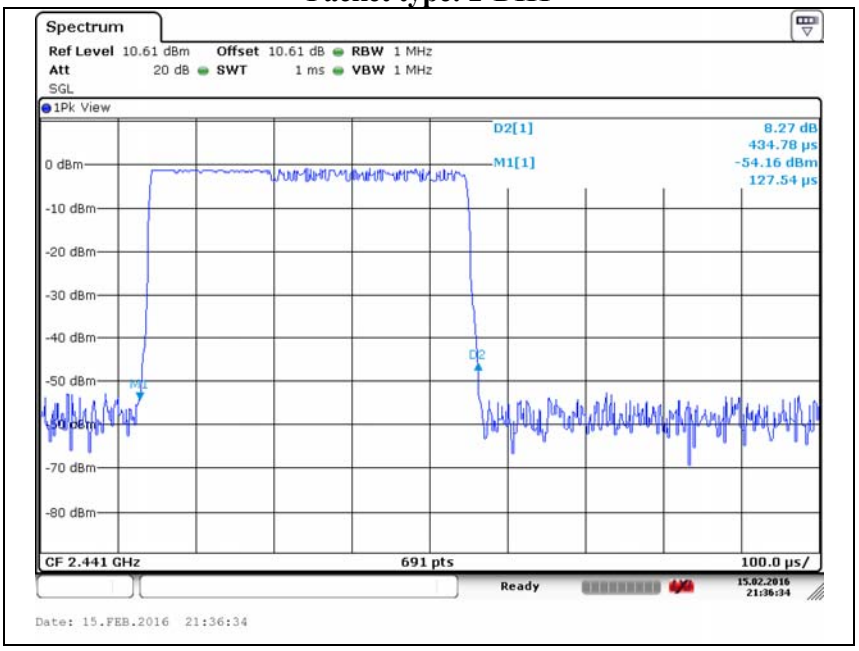
Packet type: DH3



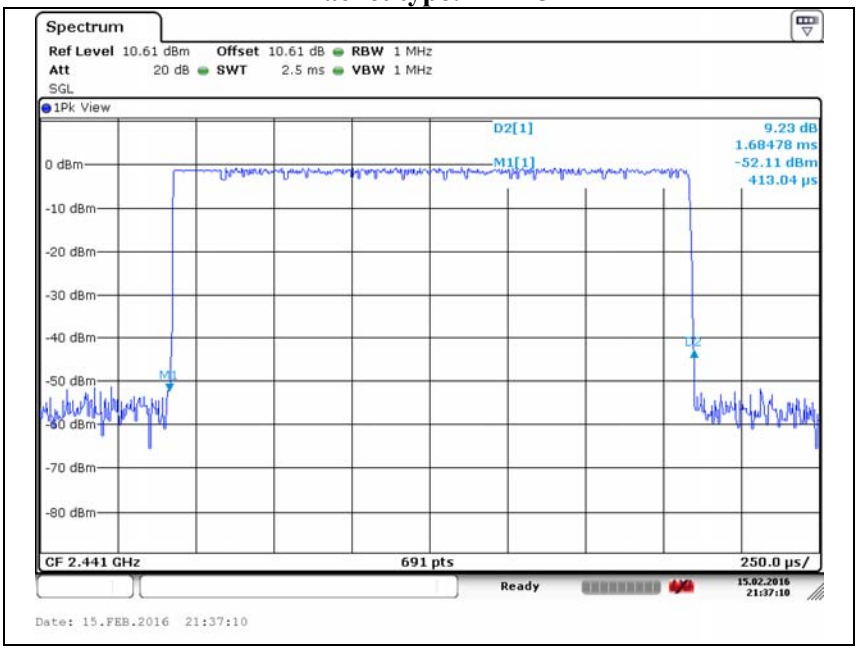
Packet type: DH5



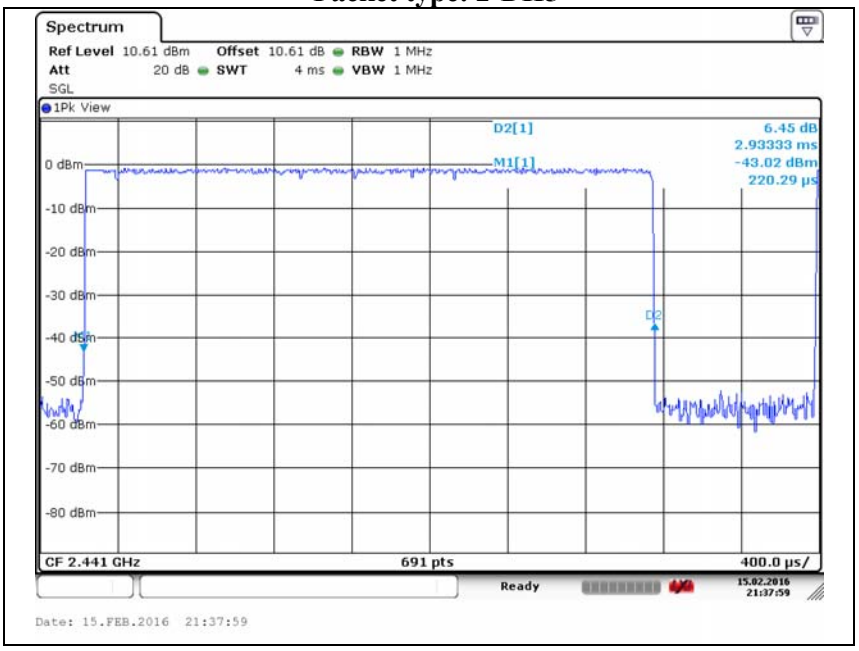
Packet type: 2-DH1



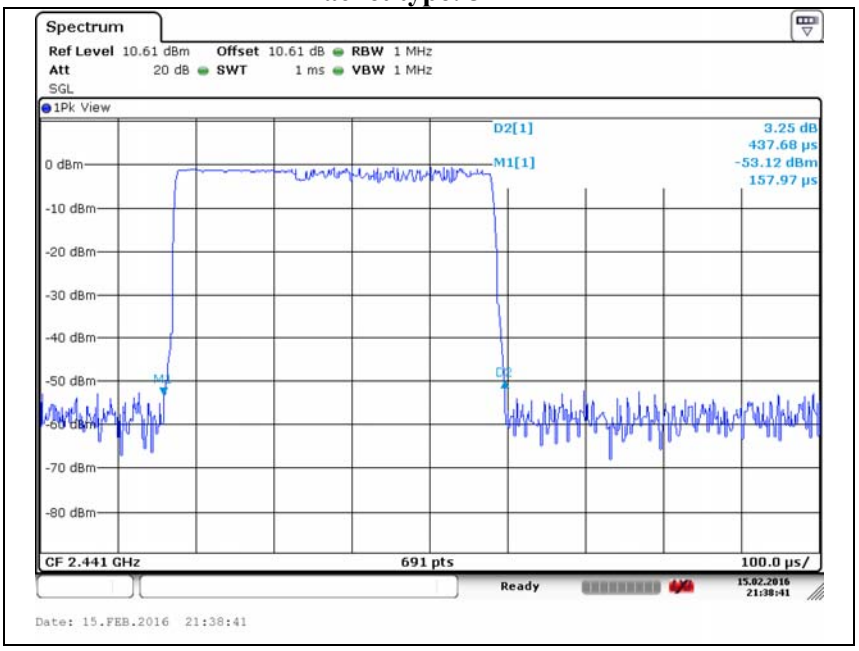
Packet type: 2-DH3



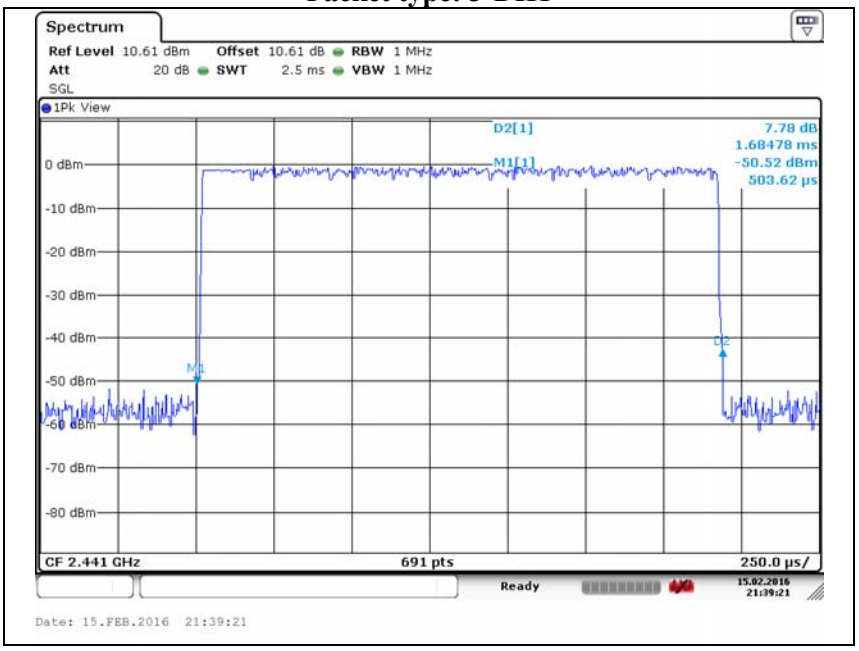
Packet type: 2-DH5



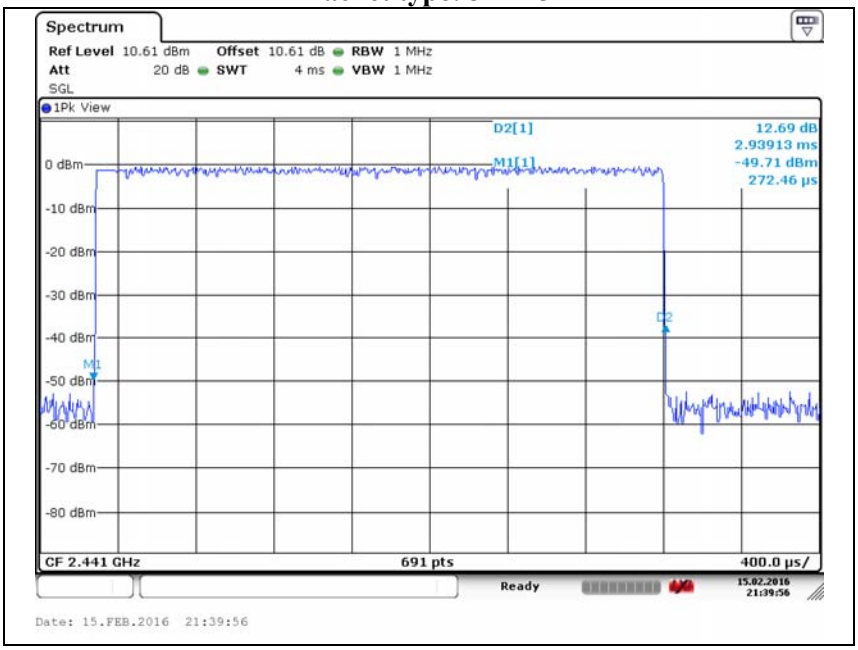
Packet type: 3-DH1



Packet type: 3-DH1



Packet type: 3-DH5



Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due date
Spectrum analyzer	R&S	FSV30	101389	1 year	2017.01.25
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2017.01.25
Loop Antenna	R&S	HFH2-Z2.335.4711.52	826532	2 years	2017.03.03
Trilog-broadband antenna	Schwarzbeck	VULB 9168	9168-461	2 years	2017.04.03
Horn antenna	A.H. System	SAS-571	414	2 years	2017.02.29
Horn antenna	Schwarzbeck	BBHA9170	BBHA9170550	2 years	2017.04.30
Low Pass Filter	Wainwright Instrument	WLK1.0/18G-10TT	1	1 year	2016.07.24
High Pass Filter	Wainwright Instrument	WHFS3000-10TT	1	1 year	2016.07.24
Preamplifier	SCHWARZBECK	BBV-9718	9718-246	1 year	2016.10.23
Broadband Amplifier	SCHWARZBECK	BBV-9721	PS9721-003	1 year	2017.01.25
EMI Test Receiver	R&S	ESR3	101781	1 year	2016.05.06
EMI Test Receiver	R&S	ESR3	101783	1 year	2016.05.06
Attenuator	KEYSIGHT	8493C	82506	1 year	2017.01.25
DC Power Supply	Aglient	6632B	US36351824	1 year	2017.01.21

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
Notebook Computer	HP	15-b008TU	5CD242B016
AC adaptor	HP	Series PPP009L-E	PA-1650-32HK