TEST REPORT

Part 15 Subpart C 15.247

Equipment under test	Thermal Mobile Printer
Model name	HP-500
Derivative model	HP-510, HP-520
FCC ID	2ALRM-HP-500
Applicant	HWASUNG SYSTEM CO., LTD
Manufacturer	HWASUNG SYSTEM CO., LTD
Date of test(s)	2017.07.17 ~ 2017.08.02
Date of issue	2017.08.08

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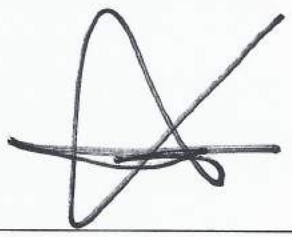
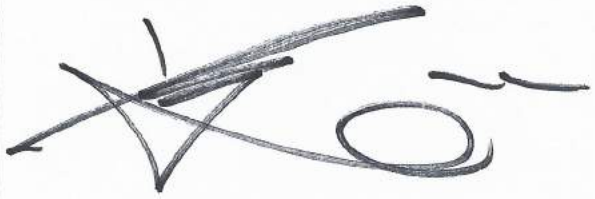
Test and report completed by :	Report approval by :
	
Kwon-se Kim Test engineer	Jeff Do Technical manager

This test report is not related to KOLAS

Revision history

Revision	Date of issue	Test report No.	Description
-	2017.08.08	KES-RF-17T0078	Initial

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1. General information

Applicant:	HWASUNG SYSTEM CO., LTD
Applicant address:	B-604, 383, Simin-daero, Dongan-gu, Anyang-si, South Korea
Test site:	KES Co., Ltd.
Test site address:	C-3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, Korea 473-21, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea
FCC rule part(s):	15.247
FCC ID:	2ALRM-HP-500
Test device serial No.:	☐ Production ☒ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test	Thermal Mobile Printer
Frequency range	BT : 2402 ㎒ ~ 2480 ㎒ (BDR/EDR) WIFI : 2412 ㎒ ~ 2462 ㎒ (11b/g/n_HT20)
Model	HP-500
Derivative model	HP-510, HP-520
Modulation technique	BT : FHSS, GFSK WIFI : DSSS, OFDM
Number of channels	BT : 79ch (BDR/EDR) WIFI : 11ch (11b/g/n_HT20)
Antenna specification	BT Antenna type : Chip antenna, Peak gain : 2.4 ㏈i WIFI Antenna type : PCB antenna, Peak gain : 4.15 ㏈i
Power source	DC 7.4 V (Rechargeable Battery)

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

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 **HWASUNG SYSTEM CO., LTD Thermal Mobile Printer FCC ID: 2ALRM-HP-500** was tested per the guidance of ANSI C63.10-2013 and DA 00-705. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing.

1.3. Device modifications
N/A

1.4. Information about derivative model
The derivative model different from the basic model in software. The circuit diagram and hardware are fundamentally same. It is for model management purpose.

1.5. Frequency/channel operations

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

1.6. Accessory information

Applicant	Equipment	Manufacturer	Model	Power source
-	-	-	-	-

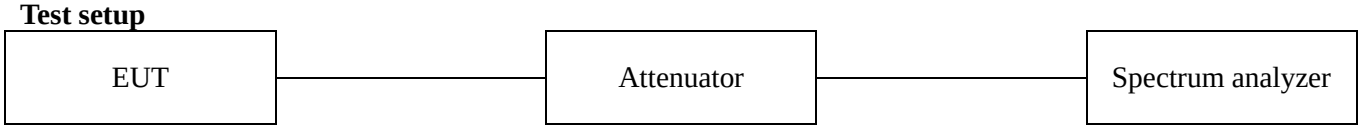
2. Summary of tests

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
15.207(a)	AC conducted emissions	Pass

3. Test results

3.1. 20 dB bandwidth

Test setup

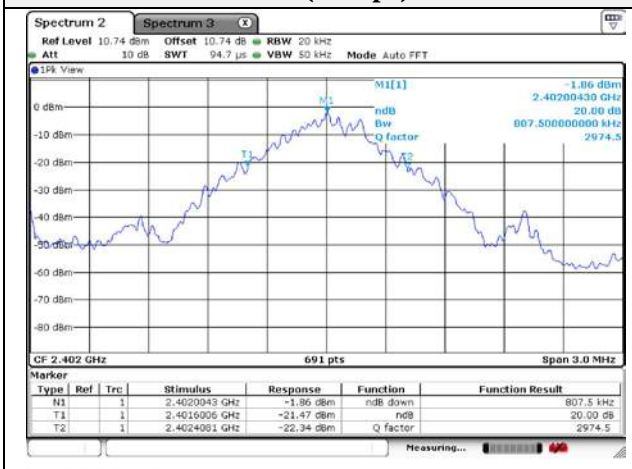
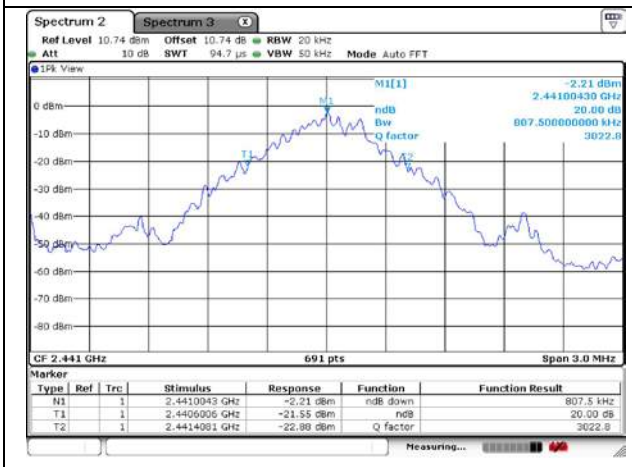
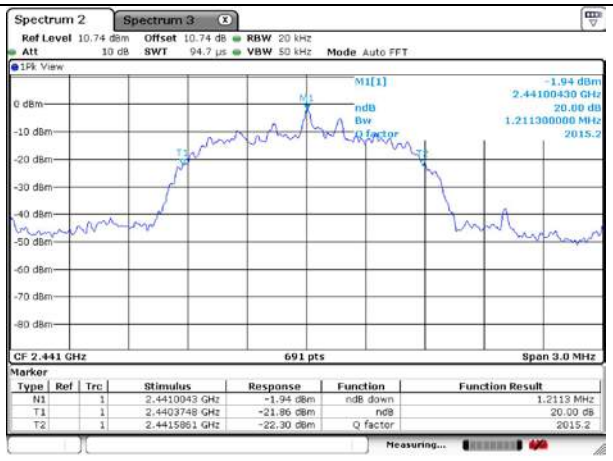
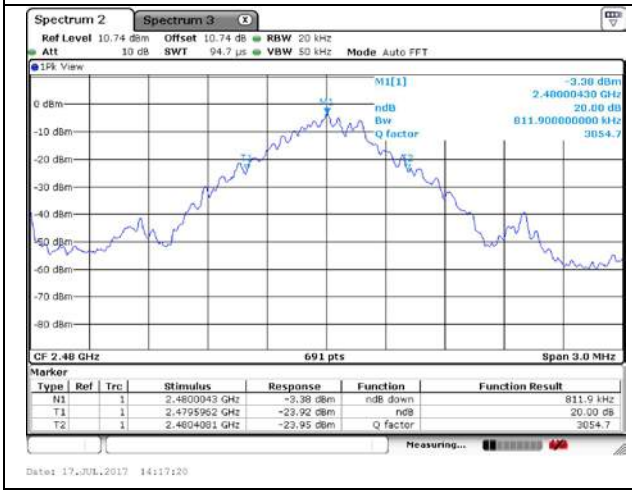
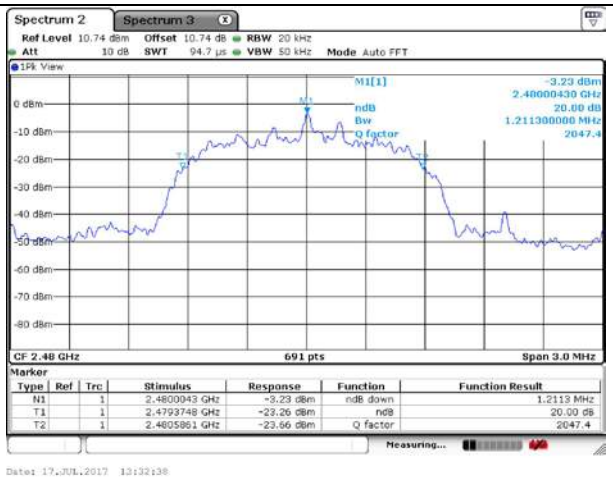


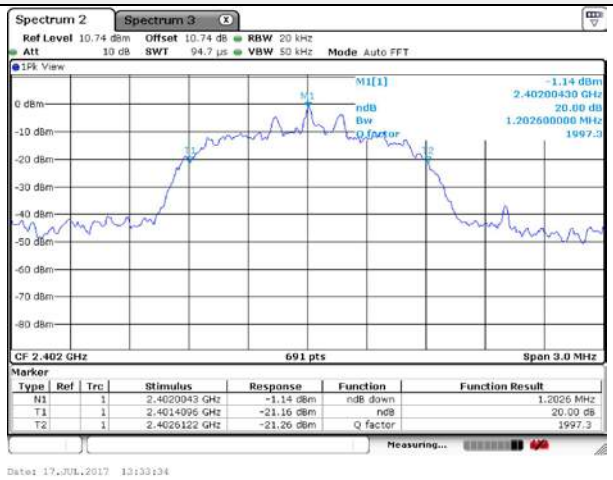
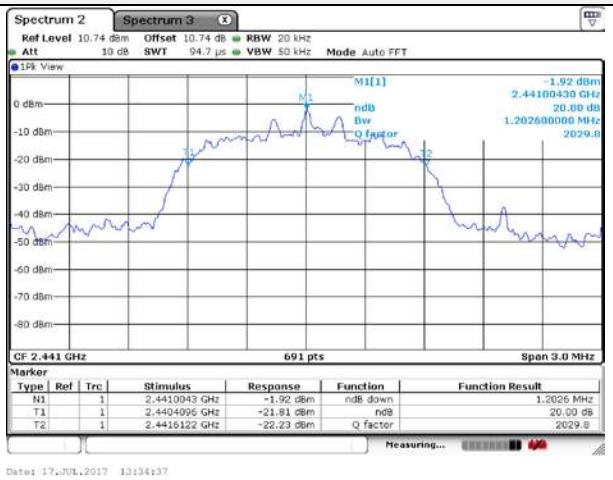
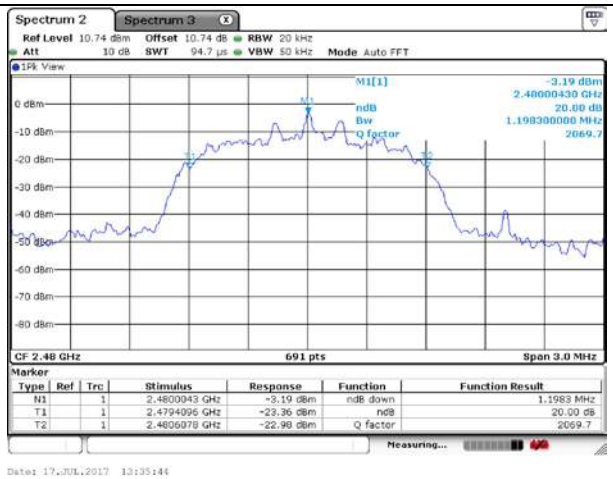
Test procedure
DA 00-705

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

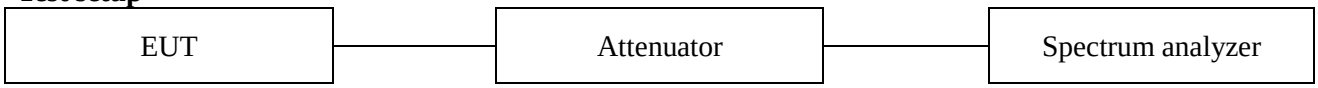
Frequency(㎒)	Channel no.	Data rate(Mbps)	Measured bandwidth(㎒)
2 402	00	1	0.808
2 441	39		0.808
2 480	78		0.812
2 402	00	2	1.207
2 441	39		1.211
2 480	78		1.211
2 402	00	3	1.203
2 441	39		1.203
2 480	78		1.198

BDR(1Mbps)	EDR(2Mbps)
	
	
	

EDR(3Mbps)	
	
	N/A

3.2. Output power

Test setup



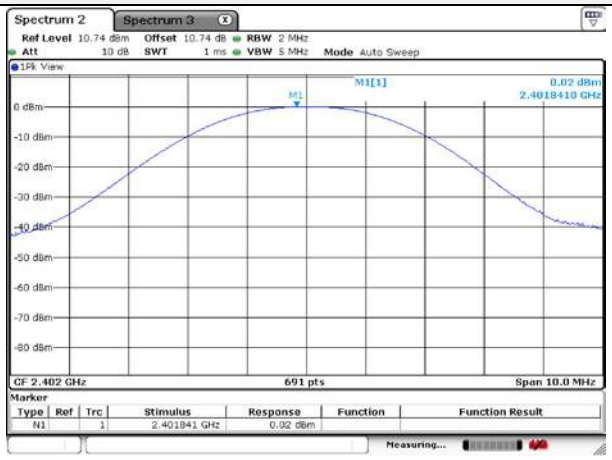
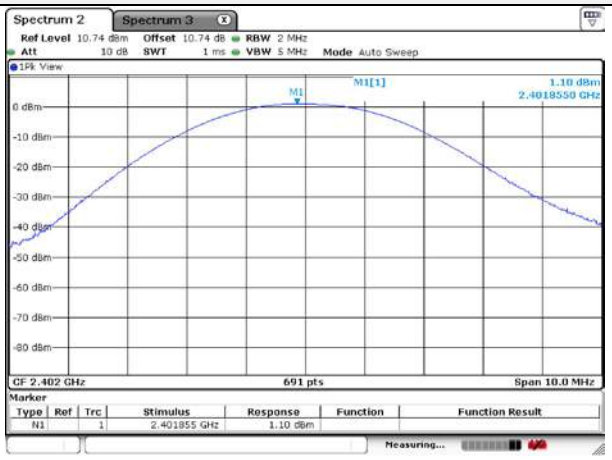
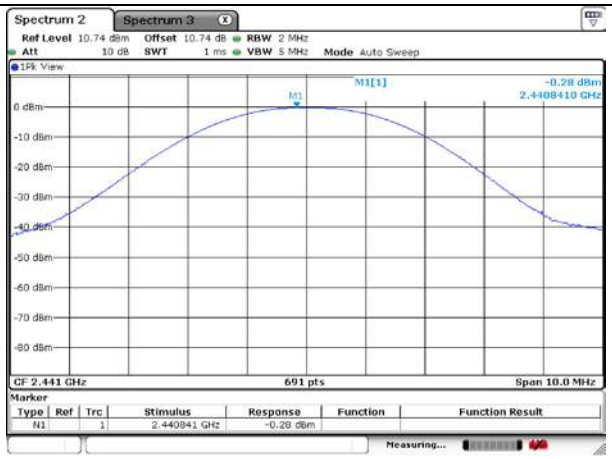
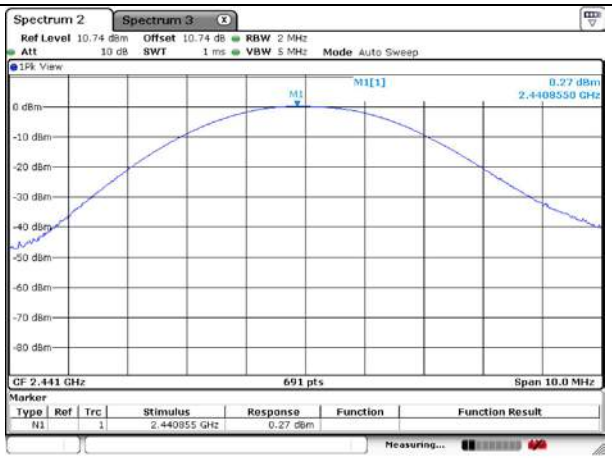
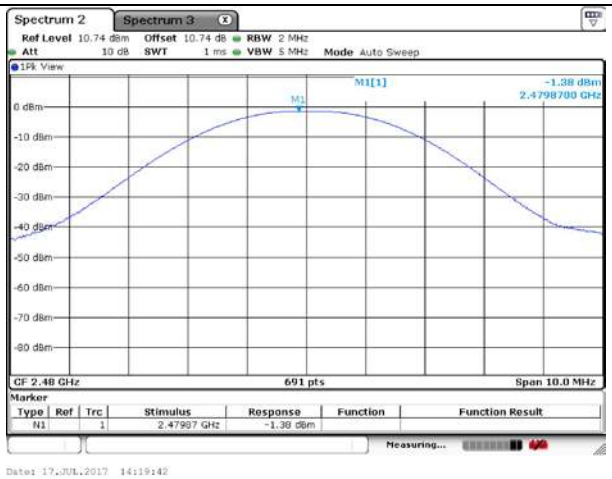
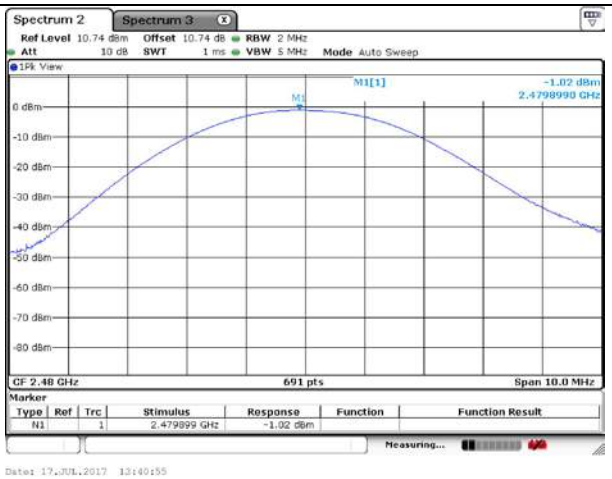
Test procedure
DA 00-705

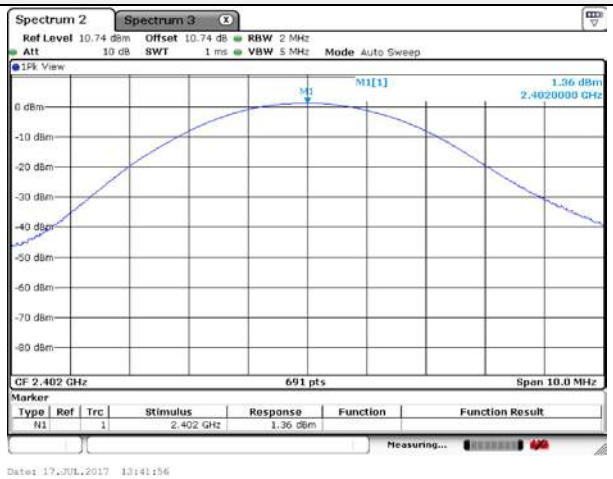
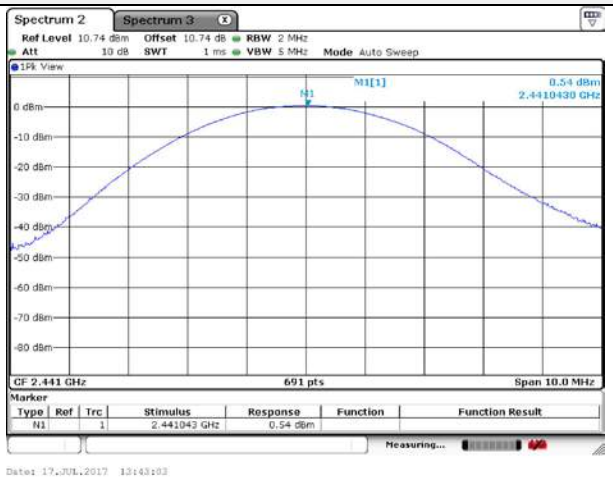
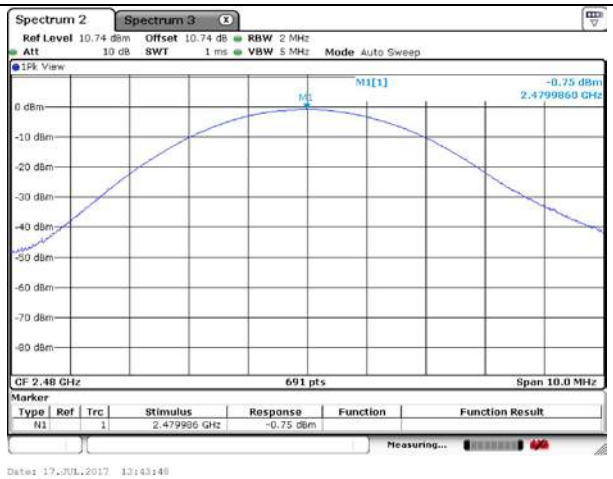
Test setting
1. Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
2. RBW > the 20 dB bandwidth of the emission being measured
3. VBW ≥ RBW
4. Sweep = Auto
5. Detector function = Peak
6. Trace = Max hold

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.

Frequency(㎒)	Channel no.	Data rate(Mbps)	Measured power (dBm)	Peak Power Limit (dBm)
2 402	00	1	0.02	20.97
2 441	39		-0.28	20.97
2 480	78		-1.38	20.97
2 402	00	2	1.10	20.97
2 441	39		0.27	20.97
2 480	78		-1.02	20.97
2 402	00	3	1.36	20.97
2 441	39		0.54	20.97
2 480	78		-0.75	20.97

BDR(1Mbps)	EDR(2Mbps)
	
	
	

EDR(3Mbps)	
	
	N/A

3.3. 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

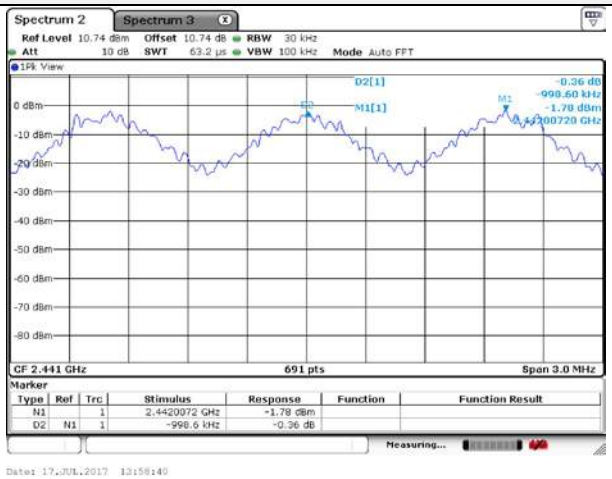
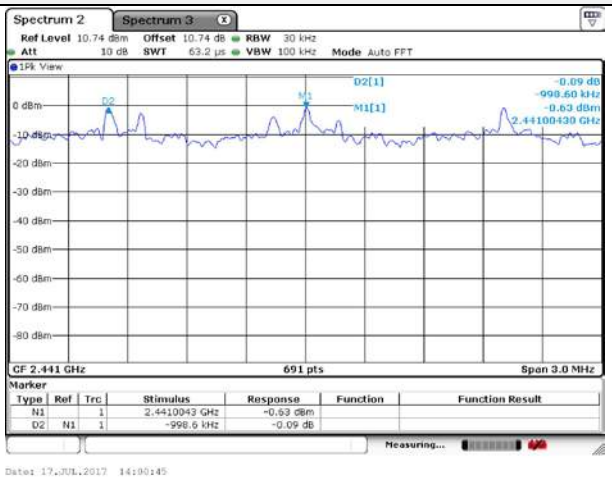
5. Sweep = auto
6. Detector function = peak
7. Trace = max hold

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 ㎽.

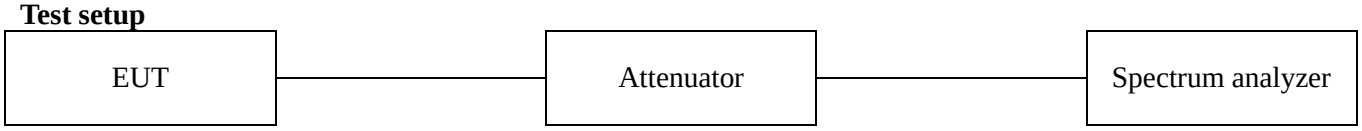
Frequency(㎒)	Channel no.	Data rate(Mbps)	Channel Separation (㎒)
2 441	39	1	0.999
2 441	39	3	0.999

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.

Hopping mode_BDR(1Mbps)	Hopping mode_EDR(3Mbps)
	

3.4. Number of hopping frequency

Test setup



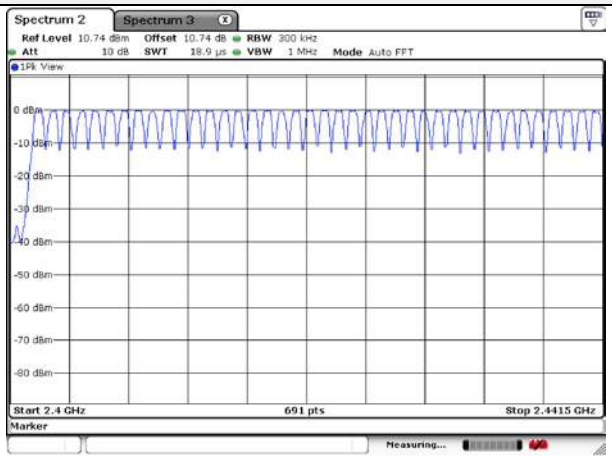
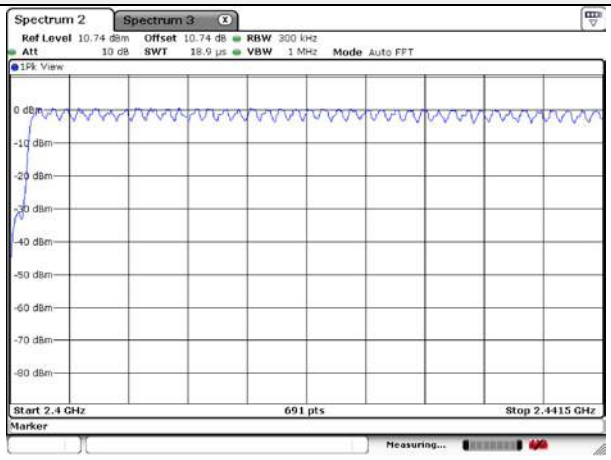
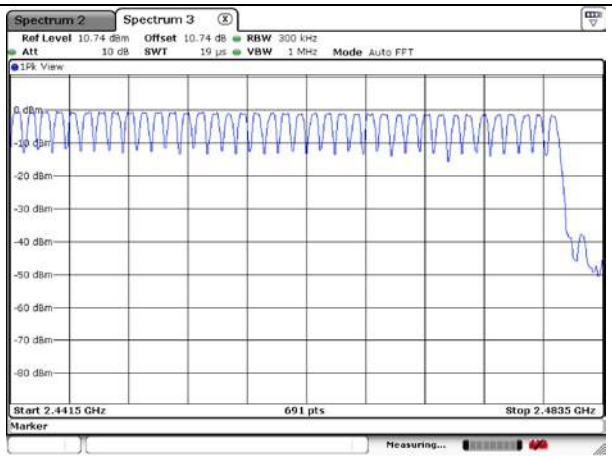
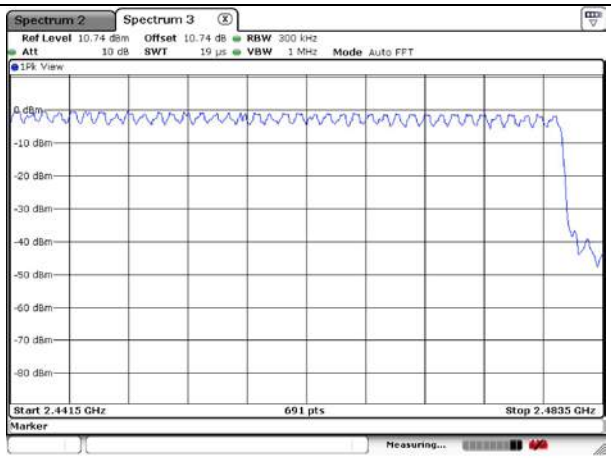
Test procedure
DA 00-705

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.

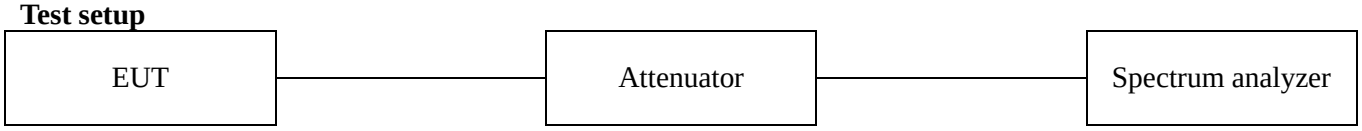
Limit
According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2 400 ~ 2 483.5 ㎒ bands shall use at least 15 hopping frequencies.

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

Hopping mode_BDR(1Mbps)	Hopping mode_EDR(3Mbps)
	
	

3.5. 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

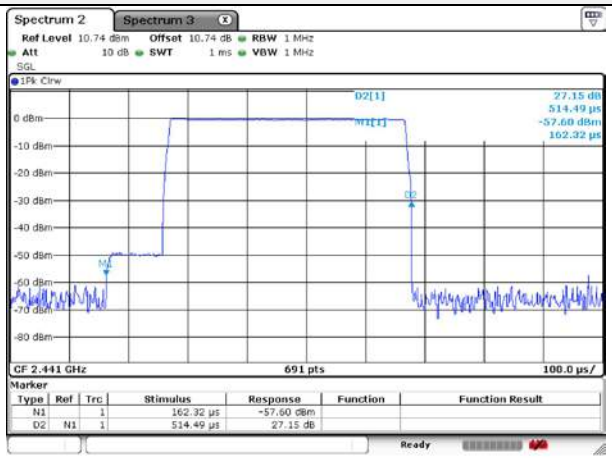
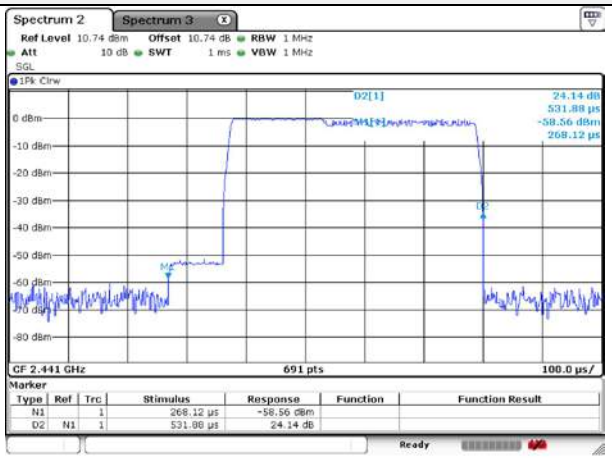
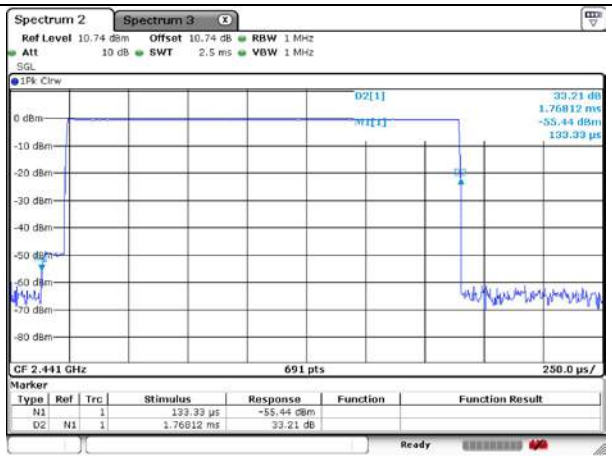
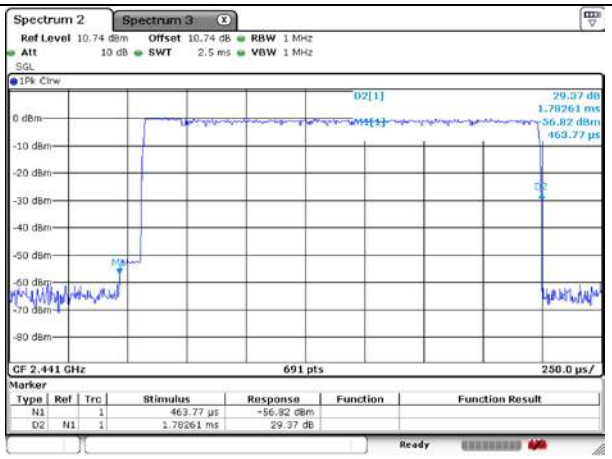
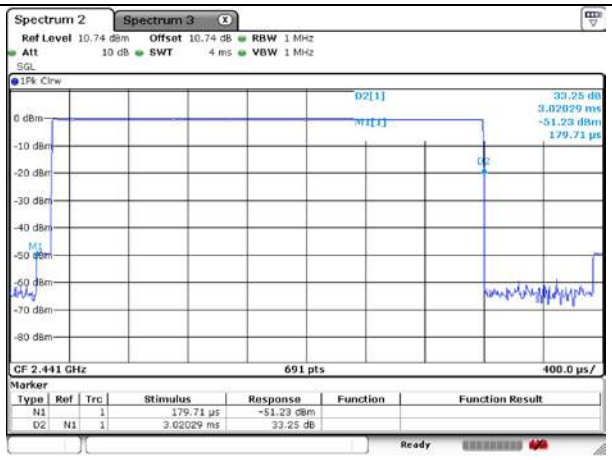
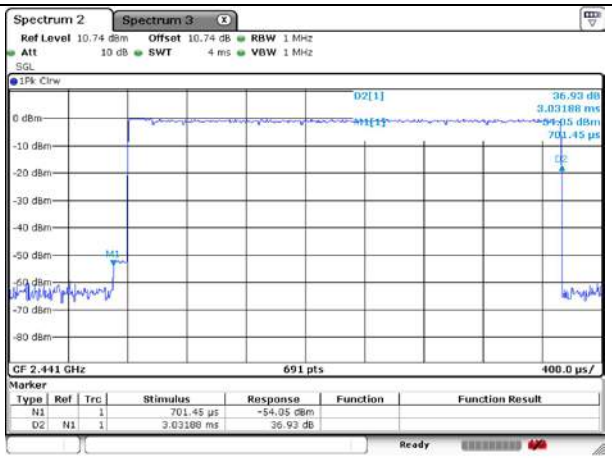
A period time = 0.4(s) × 20 = 8.0(s)

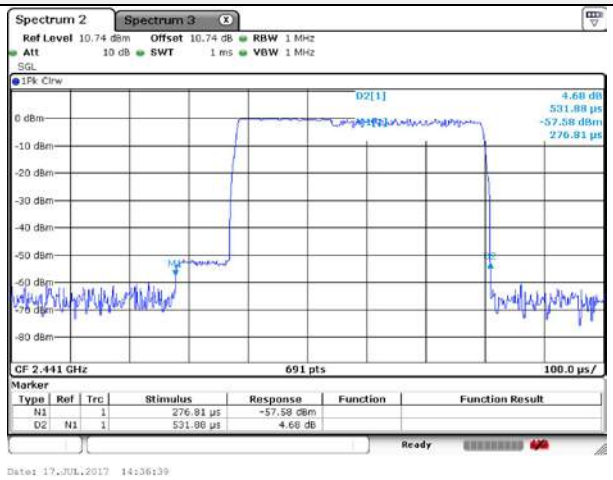
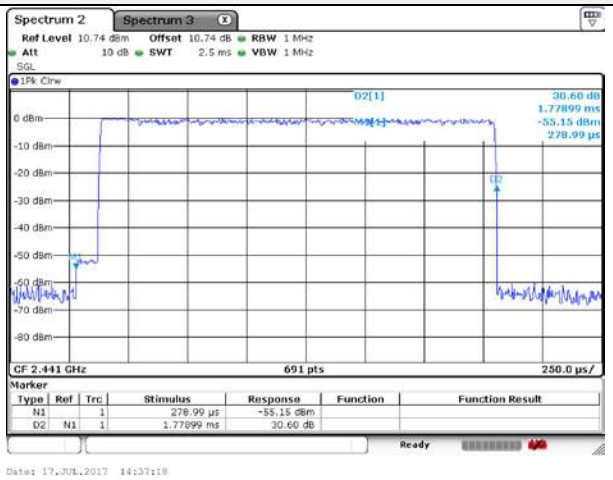
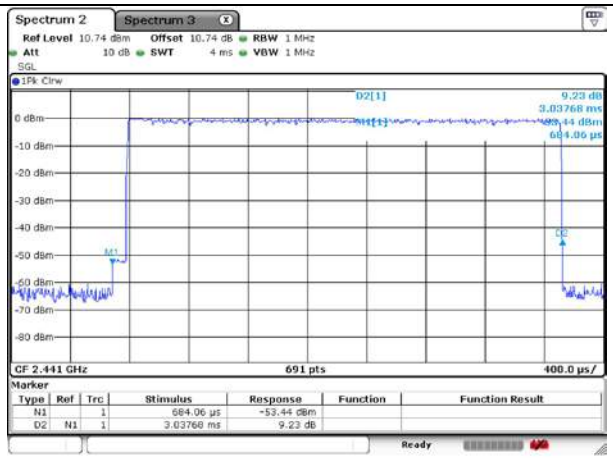
Time of occupancy on the TX channel in 8.0 sec
= time domain slot length × (hop rate ÷ number of hop per channel) × 8.0

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	0.514	164.48	400
DH3	2 441	1.768	282.88	400
DH5	2 441	3.020	322.13	400
2-DH1	2 441	0.532	170.24	400
2-DH3	2 441	1.783	285.28	400
2-DH5	2 441	3.032	323.41	400
3-DH1	2 441	0.532	170.24	400
3-DH3	2 441	1.779	284.64	400
3-DH5	2 441	3.038	324.05	400

Note:
Normal Mode
DH1: Dwell time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 164.48 (ms)
DH3: Dwell time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 282.88 (ms)
DH5: Dwell time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 322.13 (ms)
2-DH1: Dwell time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 170.24 (ms)
2-DH3: Dwell time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 285.28 (ms)
2-DH5: Dwell time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 323.41 (ms)
3-DH1: Dwell time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 170.24 (ms)
3-DH3: Dwell time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 284.64 (ms)
3-DH5: Dwell time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 324.05 (ms)

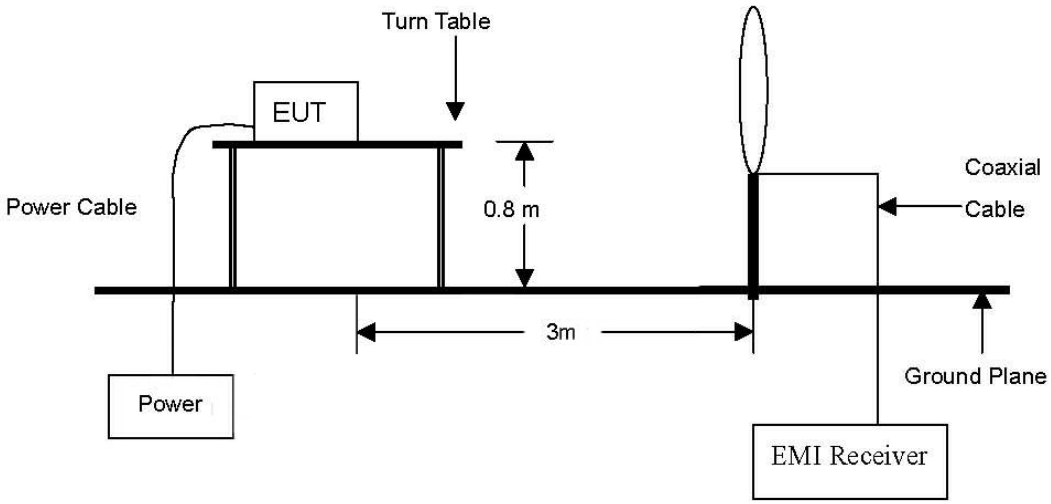
BDR(1Mbps)	EDR(2Mbps)
	
	
	

EDR(3Mbps)	
	
	N/A

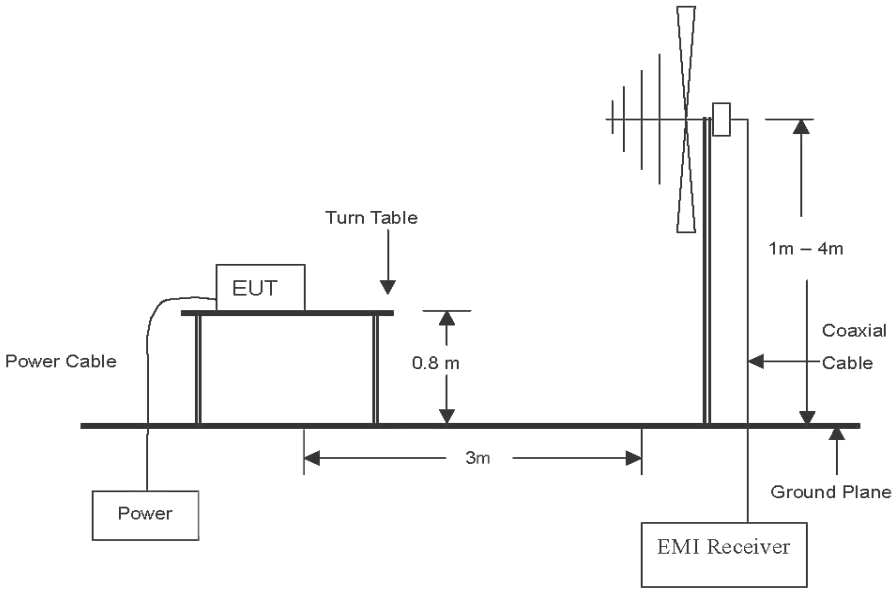
3.6. Radiated restricted band and emissions

Test setup

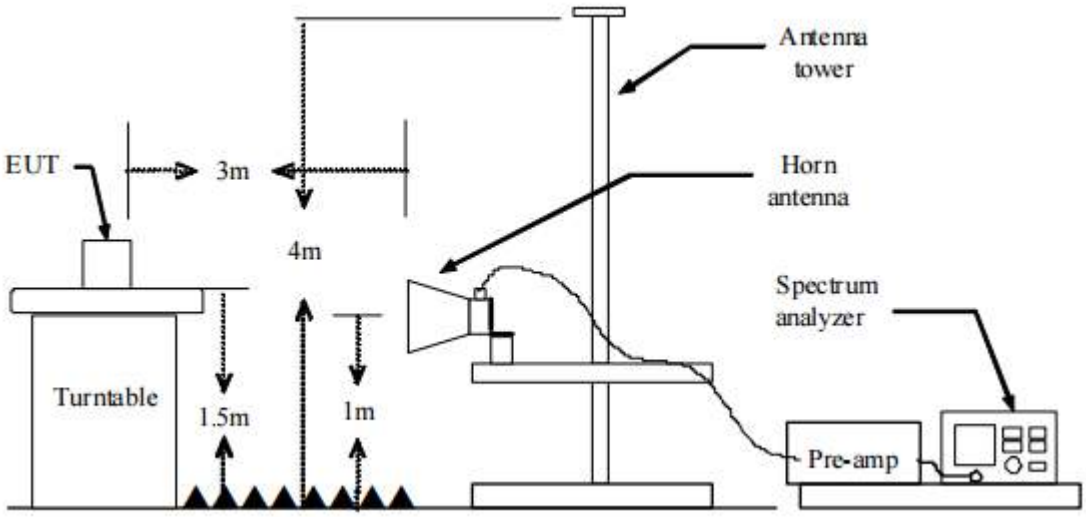
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



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 ≥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 ≥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 = 240.002 ㎳, where τ = pulse width
    b. 100 ㎳/ Δt[㎳] = H → Round up to next highest integer, H '=1
    c. Worst Case Dwell Time = τ[㎳] × H' = 3.038 ㎳
    d. Duty Cycle Correction = 20log (Worst Case Dwell Time/ 100㎳) ㏈ = -30.348 ㏈

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. All channels, modes (e.g. 802.11a, 802.11n (20 ㎒/40 ㎒ BW), 802.11ac (20 ㎒/40 ㎒ /80 ㎒)), and modulations/data rates were investigated among all UNII bands. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.
10. According to exploratory test no any obvious emission were detected from 9 ㎑ to 30 ㎒. Although these tests were performed other than open area test site, adequate comparison measurements were confirmed against 30 m open are test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.
11. 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：

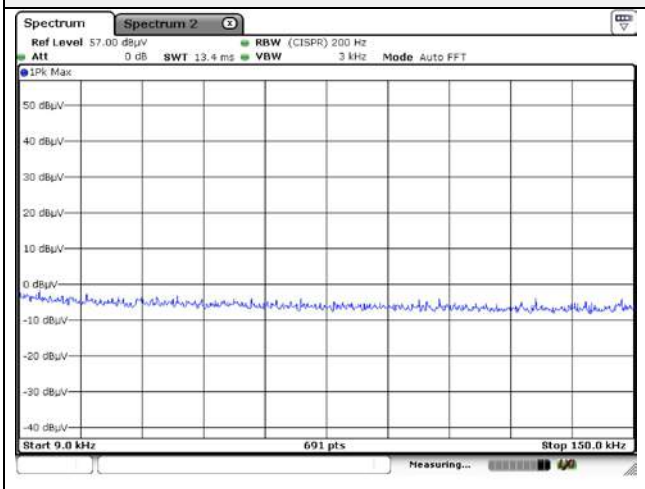
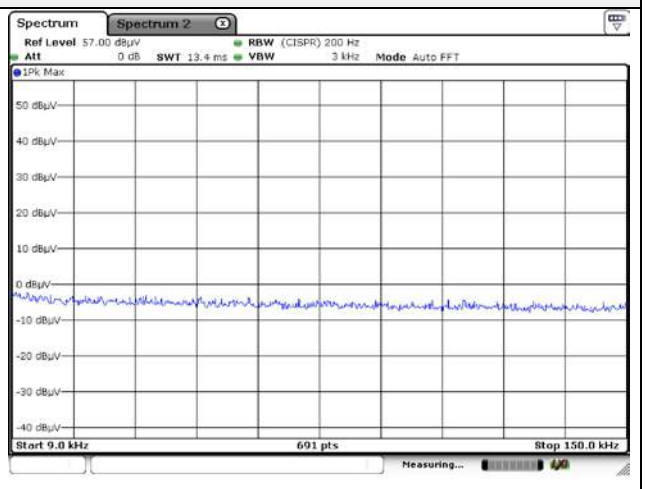
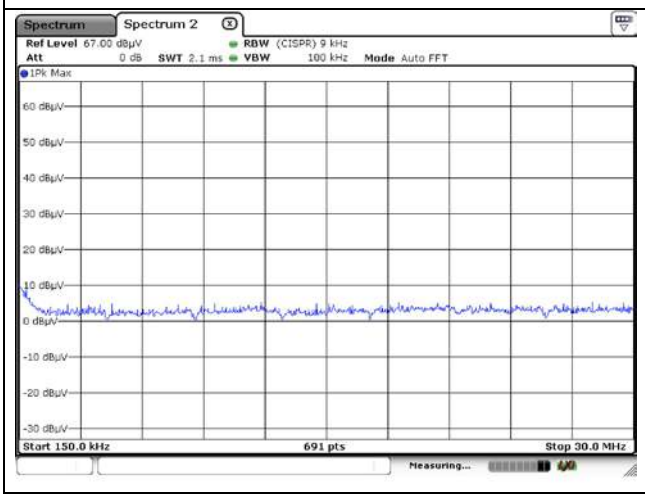
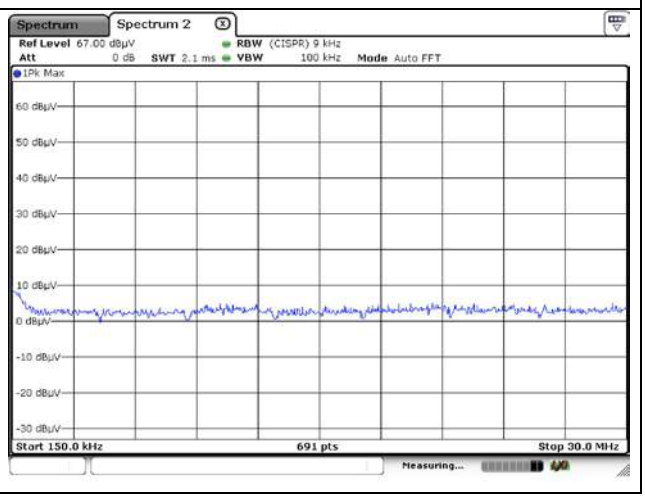
Frequency (㎒)	Distance (Meters)	Radiated (㎶/m)
0.009 ~ 0.490	300	2 400 / F(㎑)
0.490 ~ 1.705	30	24 000 / F(㎑)
1.705 ~ 30.0	30	30
30 ~ 88	3	100**
88 ~ 216	3	150**
216 ~ 960	3	200**
Above 960	3	500

**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:	EDR
Transfer rate:	3 Mbps
Distance of measurement:	3 meter
Channel:	00(Worst case)

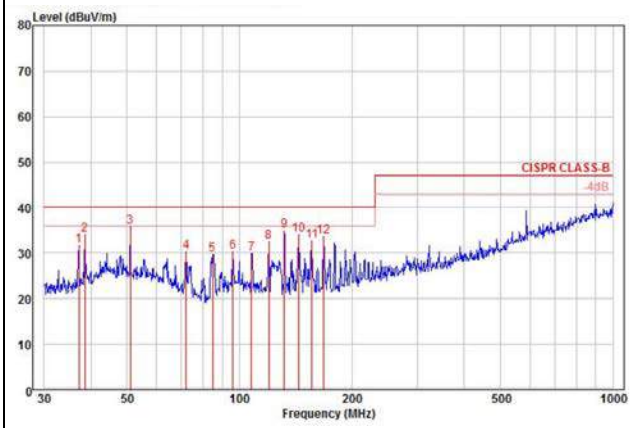
Frequency (㎒)	Level (dB㎶)	Ant. Pol. (H/V)	CF (dB)	F_d (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No spurious emissions were detected within 20㏈ of the limit							

Horizontal	Vertical
	
	

Test results (Below 1 000 ㎒) – Worst case

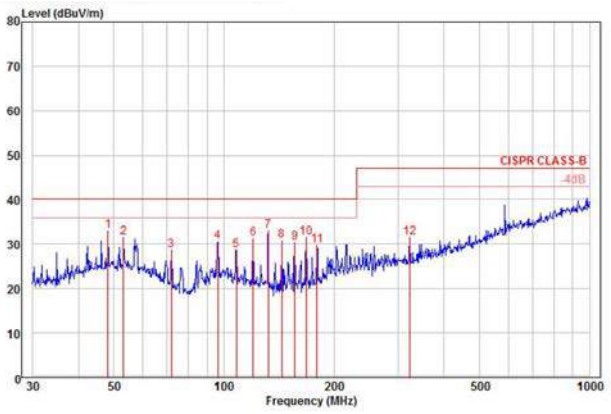
Mode:	EDR
Transfer rate:	3 Mbps
Distance of measurement:	3 meter
Channel:	00(Worst case)

Horizontal



	Freq	Level	Read Level	Ant Factor	Cable Loss	Preamp Factor	Limit Line	Over Limit	Remark	Pol/Phase
	MHz	dBuV/m	dBuV	dB/m	dB	dB	dBuV/m	dB		
1	37.15	31.61	19.45	11.57	0.59	0.00	40.00	-8.39		horizontal
2	38.62	34.05	21.33	12.11	0.61	0.00	40.00	-5.95		horizontal
3 pp	51.12	35.83	21.35	13.81	0.67	0.00	40.00	-4.17		horizontal
4	72.08	30.31	20.34	9.13	0.84	0.00	40.00	-9.69		horizontal
5	84.70	29.69	20.51	8.29	0.89	0.00	40.00	-10.31		horizontal
6	96.10	30.38	18.56	10.84	0.98	0.00	40.00	-9.62		horizontal
7	107.89	29.80	17.81	10.95	1.04	0.00	40.00	-10.20		horizontal
8	119.86	32.55	21.51	9.98	1.06	0.00	40.00	-7.45		horizontal
9	131.76	34.95	25.08	8.72	1.15	0.00	40.00	-5.05		horizontal
10	143.83	34.00	24.79	7.98	1.23	0.00	40.00	-6.00		horizontal
11	156.46	32.62	22.90	8.43	1.29	0.00	40.00	-7.38		horizontal
12	168.41	33.47	23.21	8.92	1.34	0.00	40.00	-6.53		horizontal

Vertical



	Freq	Level	Read Level	Ant Factor	Cable Loss	Preamp Factor	Limit Line	Over Limit	Remark	Pol/Phase
	MHz	dBuV/m	dBuV	dB/m	dB	dB	dBuV/m	dB		
1	48.16	32.95	18.42	13.87	0.66	0.00	40.00	-7.05		vertical
2	53.13	31.47	17.22	13.56	0.69	0.00	40.00	-8.53		vertical
3	71.83	28.63	18.59	9.20	0.84	0.00	40.00	-11.37		vertical
4	96.44	30.54	18.65	10.91	0.98	0.00	40.00	-9.46		vertical
5	108.27	28.66	16.70	10.92	1.04	0.00	40.00	-11.34		vertical
6	120.28	31.23	20.22	9.94	1.07	0.00	40.00	-8.77		vertical
7 pp	132.22	33.02	23.20	8.67	1.15	0.00	40.00	-6.98		vertical
8	143.83	30.71	21.50	7.98	1.23	0.00	40.00	-9.29		vertical
9	156.46	30.23	20.51	8.43	1.29	0.00	40.00	-9.77		vertical
10	168.41	31.29	21.03	8.92	1.34	0.00	40.00	-8.71		vertical
11	180.02	29.59	18.81	9.41	1.37	0.00	40.00	-10.41		vertical
12	322.19	31.28	15.51	13.89	1.88	0.00	47.00	-15.72		vertical

Test results (Above 1 000 ㎒)

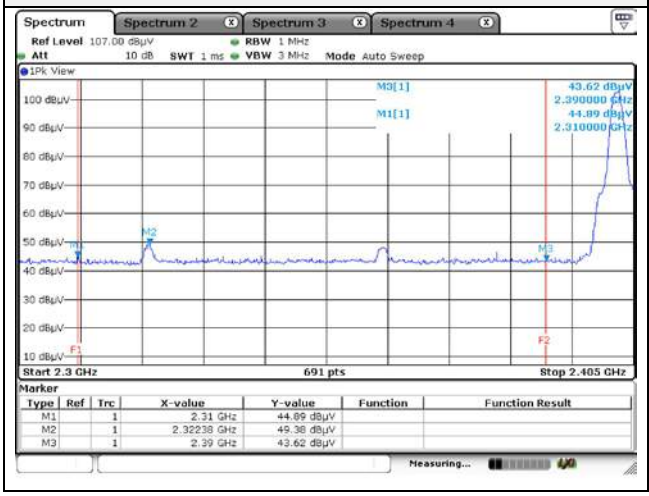
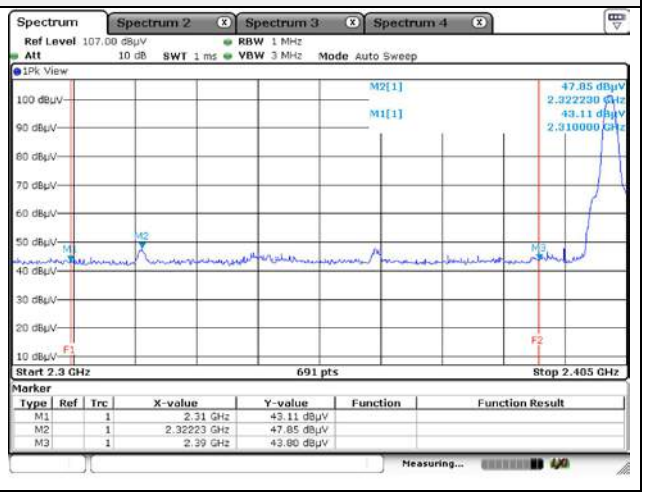
Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	00

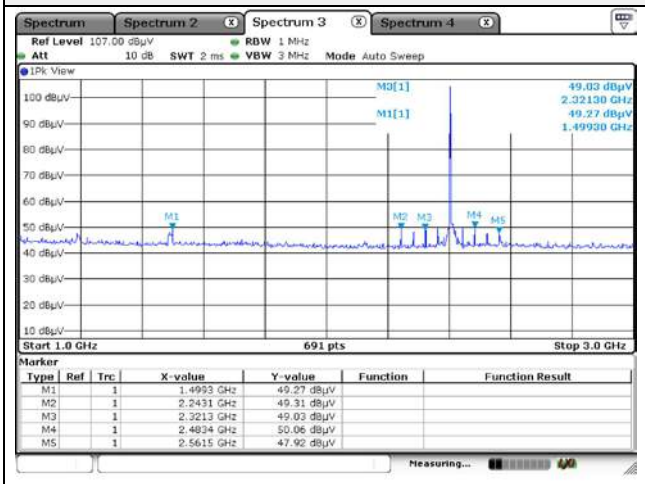
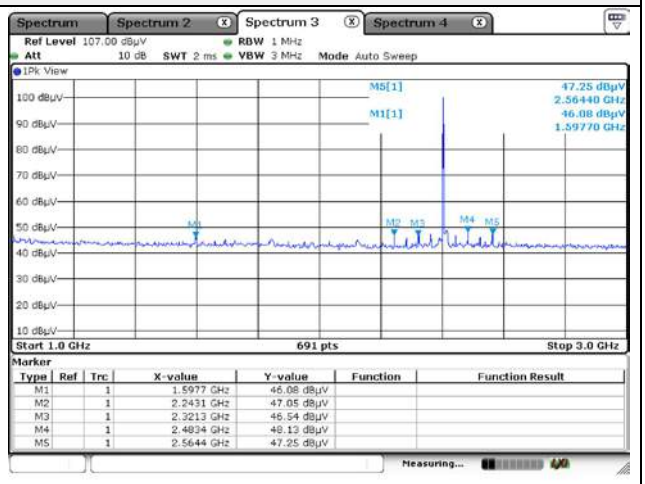
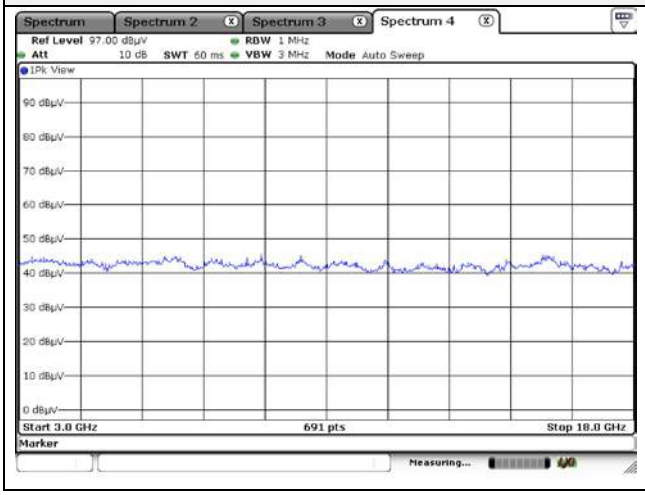
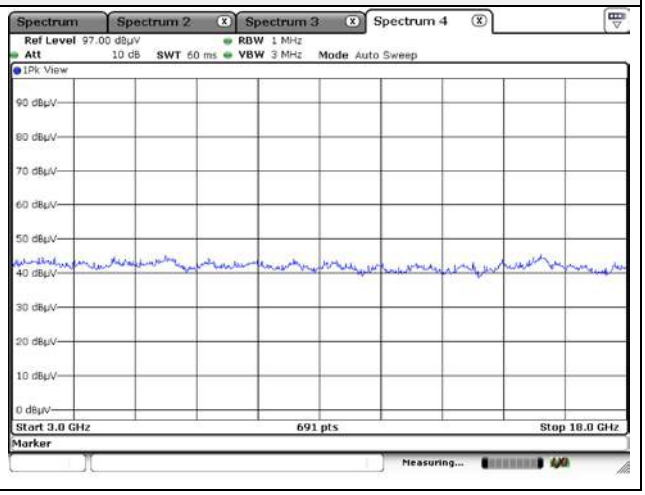
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1499.30	49.27	Peak	H	-5.98	-	43.29	74.00	30.71
2243.10	49.31	Peak	H	-0.50	-	48.81	74.00	25.19
2321.30	49.03	Peak	H	-0.35	-	48.68	74.00	25.32
2483.40	50.06	Peak	H	-0.05	-	50.01	74.00	23.99
2561.50	47.92	Peak	H	0.21	-	48.13	74.00	25.87
1597.70	46.08	Peak	V	-5.01	-	41.07	74.00	32.93
2243.10	47.05	Peak	V	-0.50	-	46.55	74.00	27.45
2321.30	46.54	Peak	V	-0.35	-	46.19	74.00	27.81
2483.40	48.13	Peak	V	-0.05	-	48.08	74.00	25.92
2564.40	47.25	Peak	V	0.22	-	47.47	74.00	26.53

- **Band edge**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2322.38	49.38	Peak	H	-0.35	-	49.03	74.00	24.97
2322.23	47.85	Peak	V	-0.35	-	47.50	74.00	26.50

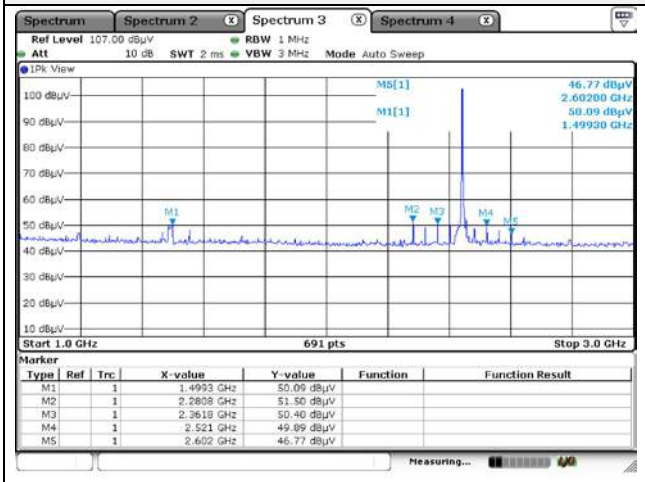
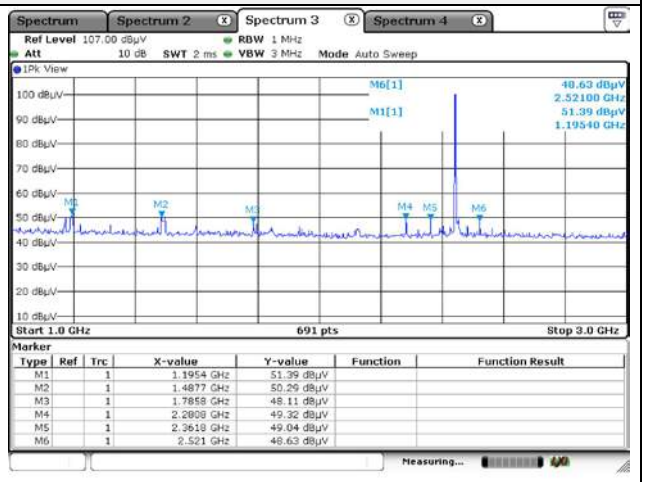
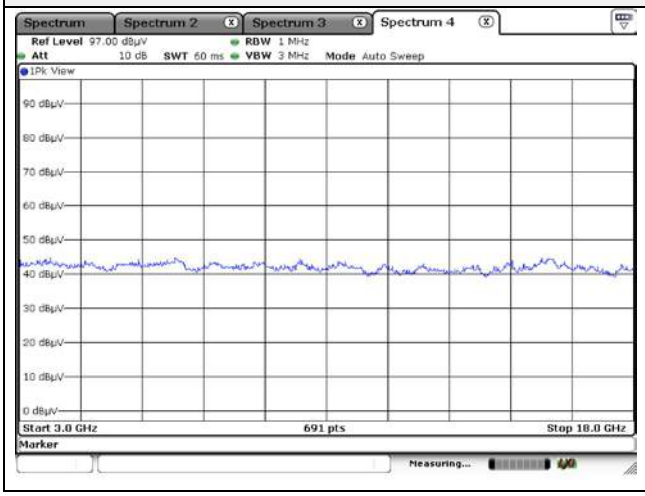
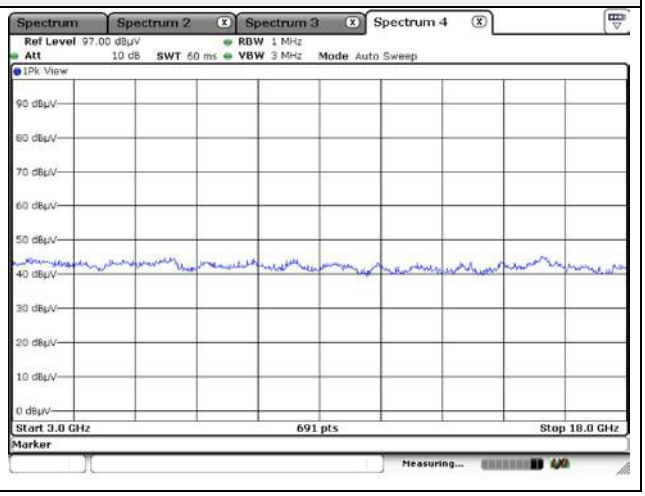
Restricted band // Horizontal // Peak	Restricted band // Vertical // Peak
	

Horizontal // Peak for 1 ㎓ to 3 ㎓	Vertical // Peak for 1 ㎓ to 3 ㎓
	
Horizontal // Peak for 3 ㎓ to 18 ㎓	**Vertical // Peak for 3 ㎓ to 18 ㎓**
	

Note.
1. No spurious emission were detected above 3 ㎓.

Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	39

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1499.30	50.09	Peak	H	-5.98	-	44.11	74.00	29.89
2280.80	51.50	Peak	H	-0.42	-	51.08	74.00	22.92
2361.80	50.40	Peak	H	-0.27	-	50.13	74.00	23.87
2521.00	49.89	Peak	H	0.06	-	49.95	74.00	24.05
2602.00	46.77	Peak	H	0.36	-	47.13	74.00	26.87
1195.40	51.39	Peak	V	-7.89	-	43.50	74.00	30.50
1487.70	50.29	Peak	V	-6.05	-	44.24	74.00	29.76
1785.80	48.11	Peak	V	-3.21	-	44.90	74.00	29.10
2280.80	49.32	Peak	V	-0.42	-	48.90	74.00	25.10
2361.80	49.04	Peak	V	-0.27	-	48.77	74.00	25.23
2521.00	48.63	Peak	V	0.06	-	48.69	74.00	25.31

Horizontal // Peak for 1 ㎓ to 3 ㎓	Vertical // Peak for 1 ㎓ to 3 ㎓
	
Horizontal // Peak for 3 ㎓ to 18 ㎓	**Vertical // Peak for 3 ㎓ to 18 ㎓**
	

Note.
1. No spurious emission were detected above 3 ㎓.

Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	78

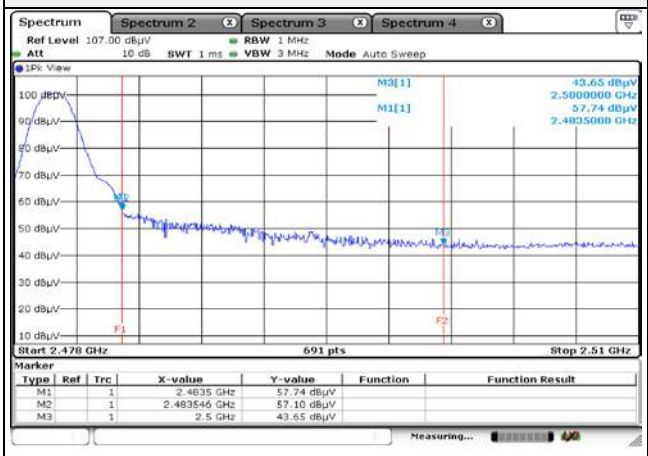
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1499.30	51.97	Peak	H	-5.98	-	45.99	74.00	28.01
2165.00	46.20	Peak	H	-0.64	-	45.56	74.00	28.44
2321.30	50.58	Peak	H	-0.35	-	50.23	74.00	23.77
2399.40	49.62	Peak	H	-0.20	-	49.42	74.00	24.58
2561.50	49.96	Peak	H	0.21	-	50.17	74.00	23.83
2639.70	49.19	Peak	H	0.49	-	49.68	74.00	24.32
1748.20	47.41	Peak	V	-3.57	-	43.84	74.00	30.16
1997.10	47.41	Peak	V	-1.00	-	46.41	74.00	27.59
2321.30	48.58	Peak	V	-0.35	-	48.23	74.00	25.77
2399.40	47.98	Peak	V	-0.20	-	47.78	74.00	26.22
2561.50	49.24	Peak	V	0.21	-	49.45	74.00	24.55
2639.70	47.56	Peak	V	0.49	-	48.05	74.00	25.95

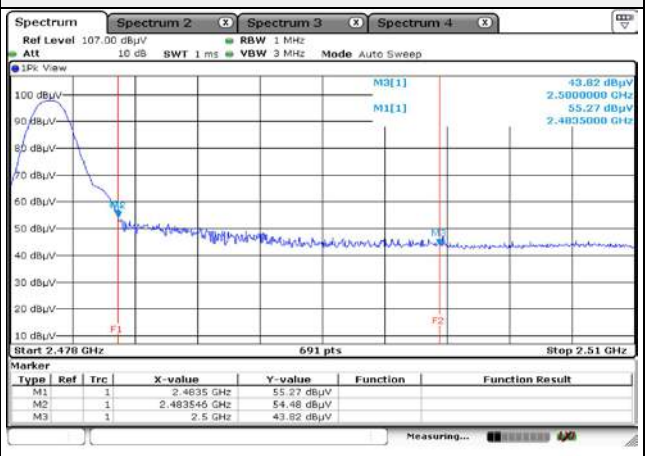
- **Band edge**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2483.55	57.10	Peak	H	-0.05	-	57.05	74.00	16.95
2483.55	46.11	Avg	H	-0.05	-30.35	15.71	54.00	38.29
2483.55	54.48	Peak	V	-0.05	-	54.43	74.00	19.57
2483.55	45.69	Avg	V	-0.05	-30.35	15.29	54.00	38.71

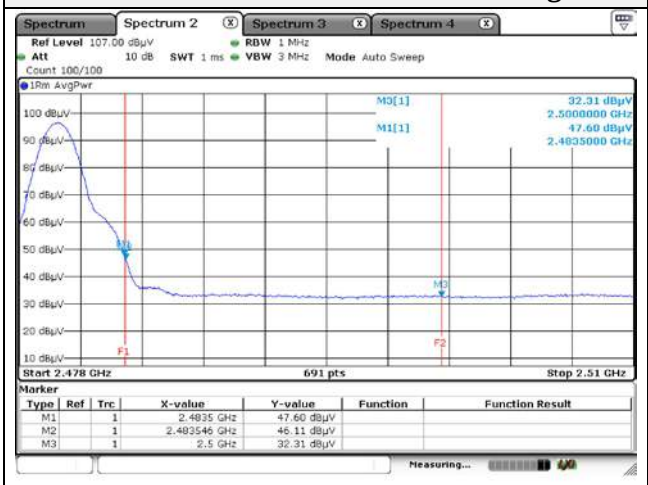
Restricted band // Horizontal // Peak



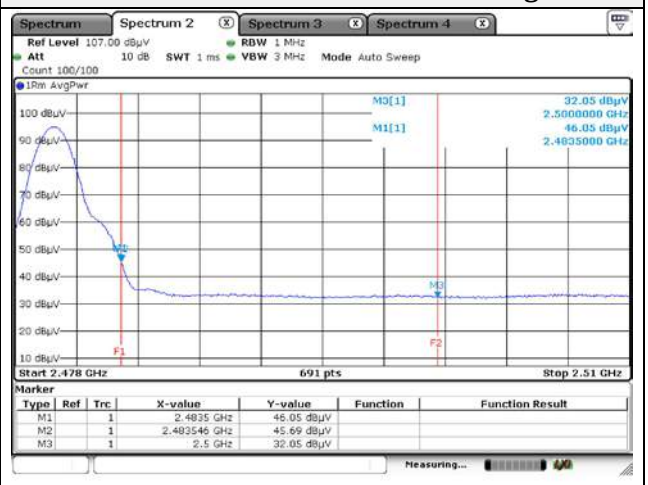
Restricted band // Vertical // Peak



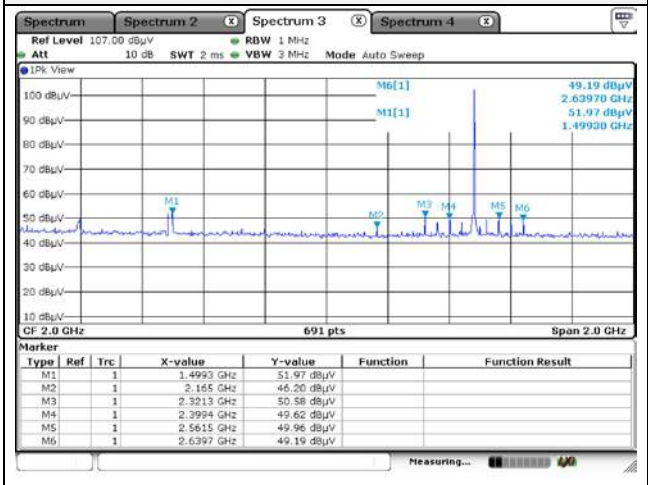
Restricted band // Horizontal // Average



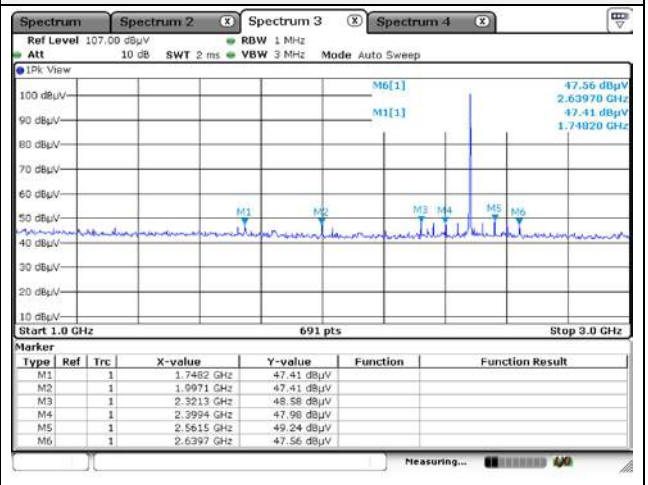
Restricted band // Vertical // Average

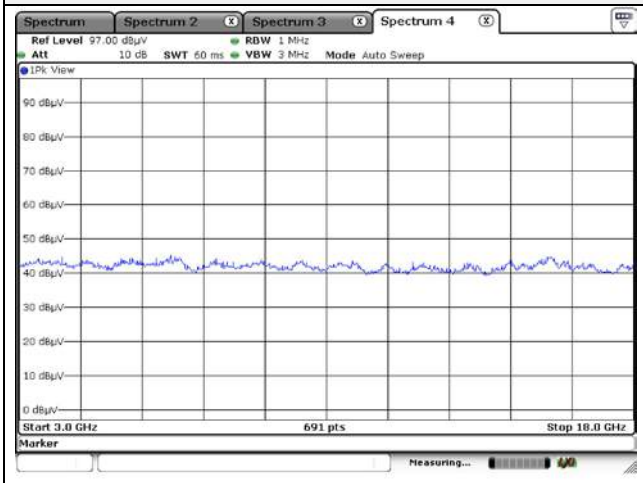
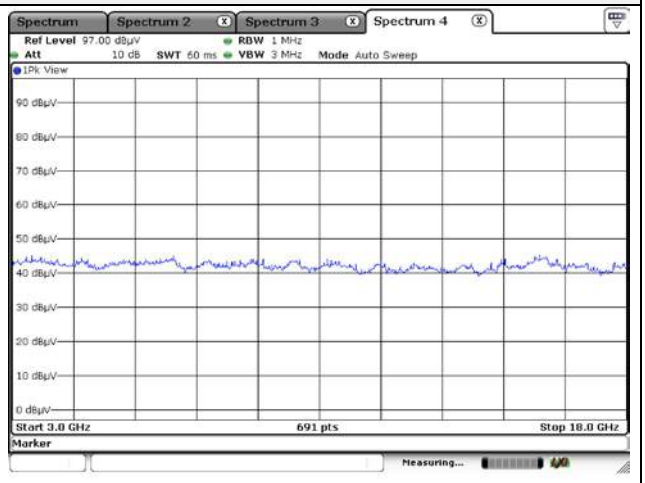


Horizontal // Peak for 1 ㎓ to 3 ㎓



Vertical // Peak for 1 ㎓ to 3 ㎓



Horizontal // Peak for 3 ㎓ to 18 ㎓	Vertical // Peak for 3 ㎓ to 18 ㎓
	

Note.
1. No spurious emission were detected above 3 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

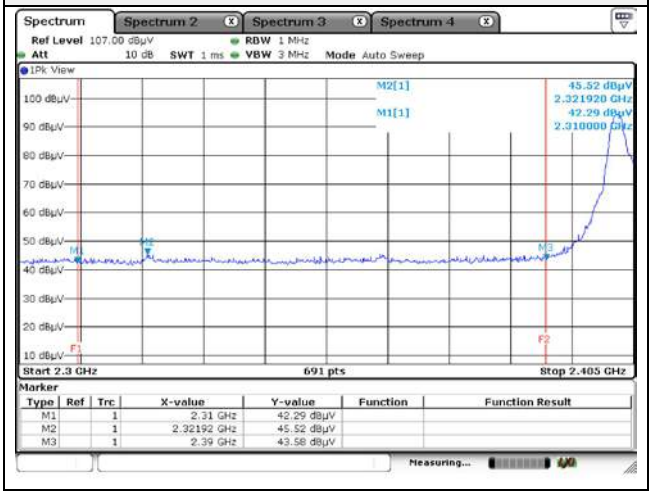
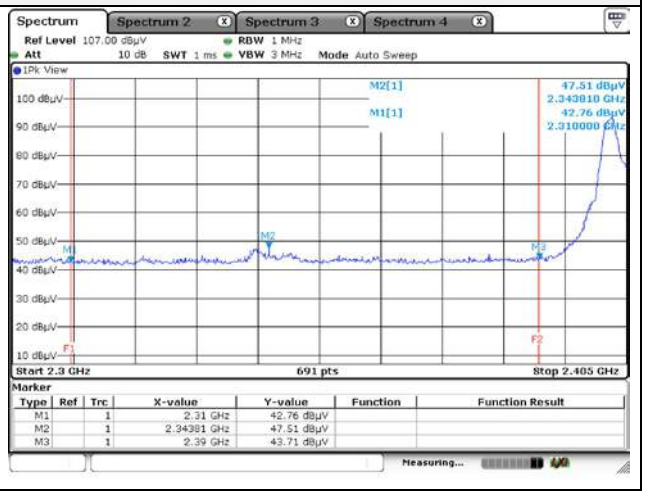
Mode:	EDR
Transfer rate:	3 Mbps(Worst case)
Distance of measurement:	3 meter
Channel:	00

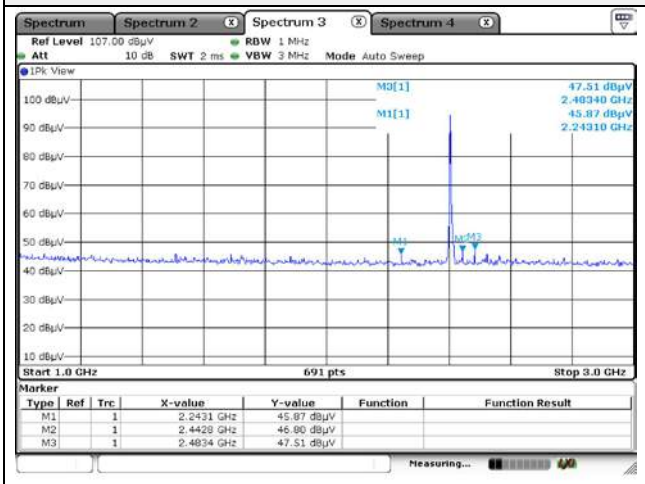
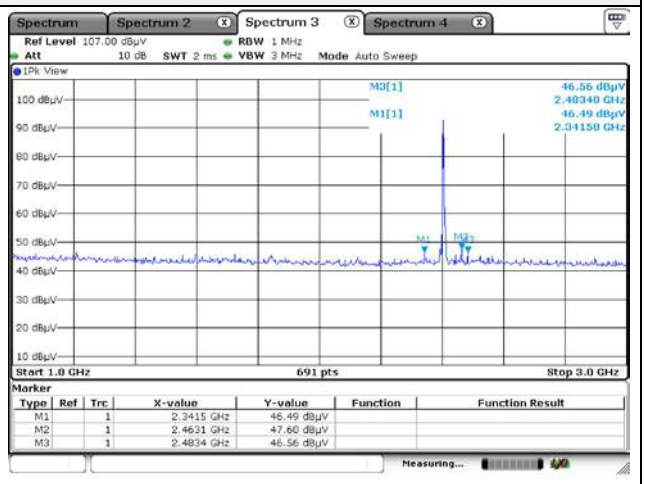
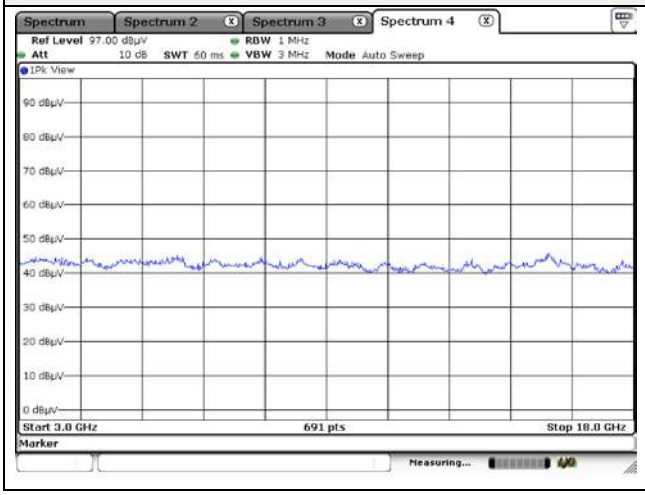
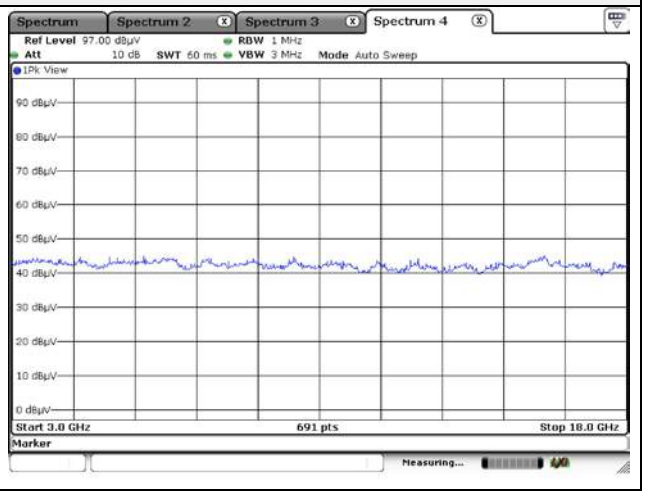
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2243.10	45.87	Peak	H	-0.50	-	45.37	74.00	28.63
2442.80	46.80	Peak	H	-0.12	-	46.68	74.00	27.32
2483.40	47.51	Peak	H	-0.05	-	47.46	74.00	26.54
2341.50	46.49	Peak	V	-0.31	-	46.18	74.00	27.82
2463.10	47.60	Peak	V	-0.08	-	47.52	74.00	26.48
2483.40	46.56	Peak	V	-0.05	-	46.51	74.00	27.49

-
Band edge

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2321.92	45.52	Peak	H	-0.35	-	45.17	74.00	28.83
2343.81	47.51	Peak	V	-0.31	-	47.20	74.00	26.80

Restricted band // Horizontal // Peak	Restricted band // Vertical // Peak
	

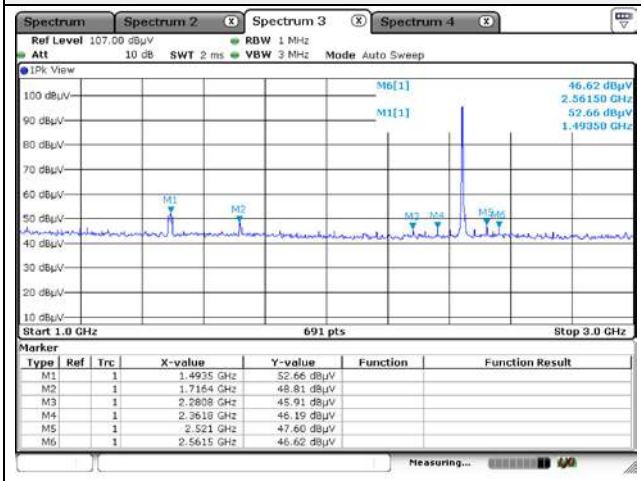
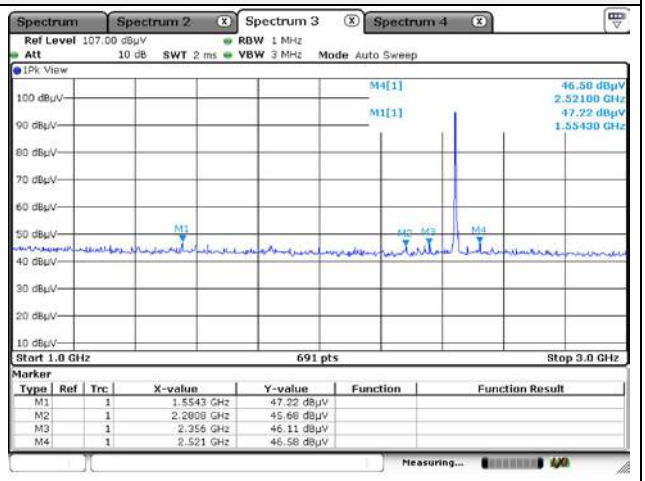
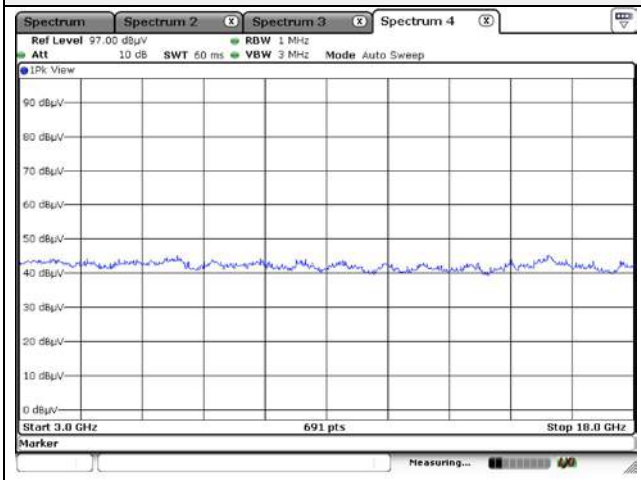
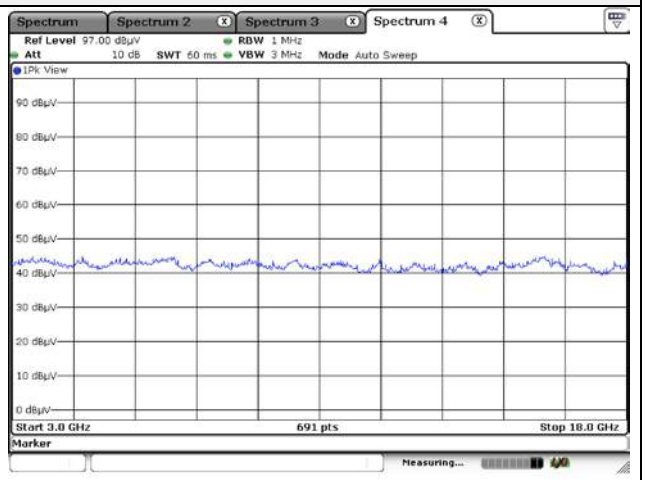
Horizontal // Peak for 1 ㎓ to 3 ㎓	Vertical // Peak for 1 ㎓ to 3 ㎓
	
Horizontal // Peak for 3 ㎓ to 18 ㎓	**Vertical // Peak for 3 ㎓ to 18 ㎓**
	

Note.
1. No spurious emission were detected above 3 ㎓.

Mode:	EDR
Transfer rate:	3 Mbps(Worst case)
Distance of measurement:	3 meter
Channel:	39

- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1493.50	52.66	Peak	H	-6.01	-	46.65	74.00	27.35
1716.40	48.81	Peak	H	-3.88	-	44.93	74.00	29.07
2280.80	45.91	Peak	H	-0.42	-	45.49	74.00	28.51
2361.80	46.19	Peak	H	-0.27	-	45.92	74.00	28.08
2521.00	47.60	Peak	H	0.06	-	47.66	74.00	26.34
2561.50	46.62	Peak	H	0.21	-	46.83	74.00	27.17
1554.30	47.22	Peak	V	-5.44	-	41.78	74.00	32.22
2280.80	45.68	Peak	V	-0.42	-	45.26	74.00	28.74
2356.00	46.11	Peak	V	-0.28	-	45.83	74.00	28.17
2521.00	46.58	Peak	V	0.06	-	46.64	74.00	27.36

Horizontal // Peak for 1 ㎓ to 3 ㎓	Vertical // Peak for 1 ㎓ to 3 ㎓
	
Horizontal // Peak for 3 ㎓ to 18 ㎓	**Vertical // Peak for 3 ㎓ to 18 ㎓**
	

Note.
1. No spurious emission were detected above 3 ㎓.

Mode:	EDR
Transfer rate:	3 Mbps(Worst case)
Distance of measurement:	3 meter
Channel:	78

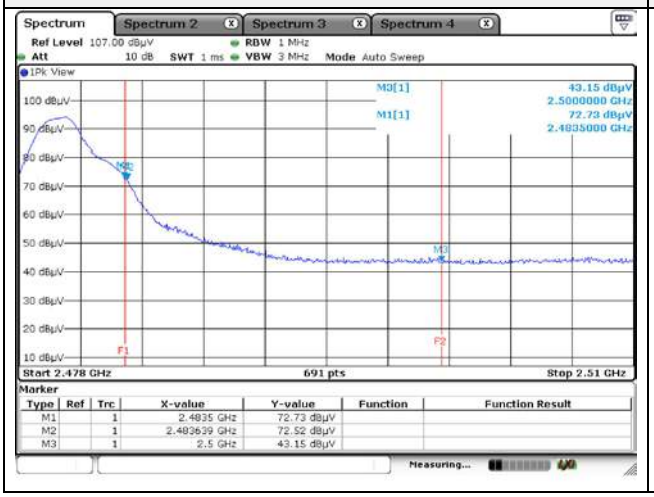
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1490.60	50.67	Peak	H	-6.03	-	44.64	74.00	29.36
2561.50	47.78	Peak	H	0.21	-	47.99	74.00	26.01
2639.70	46.99	Peak	H	0.49	-	47.48	74.00	26.52
1600.60	46.50	Peak	V	-4.98	-	41.52	74.00	32.48
1994.20	46.30	Peak	V	-1.03	-	45.27	74.00	28.73
2451.50	53.80	Peak	V	-0.11	-	53.69	74.00	20.31

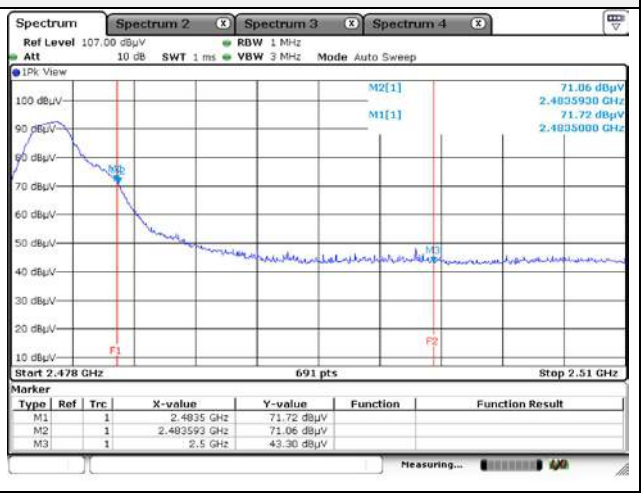
- **Band edge**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2483.64	72.52	Peak	H	-0.05	-	72.47	74.00	1.53
2483.55	52.13	Avg	H	-0.05	-30.35	21.73	54.00	32.27
2483.59	71.06	Peak	V	-0.05	-	71.01	74.00	2.99
2483.55	50.94	Avg	V	-0.05	-30.35	20.54	54.00	33.46

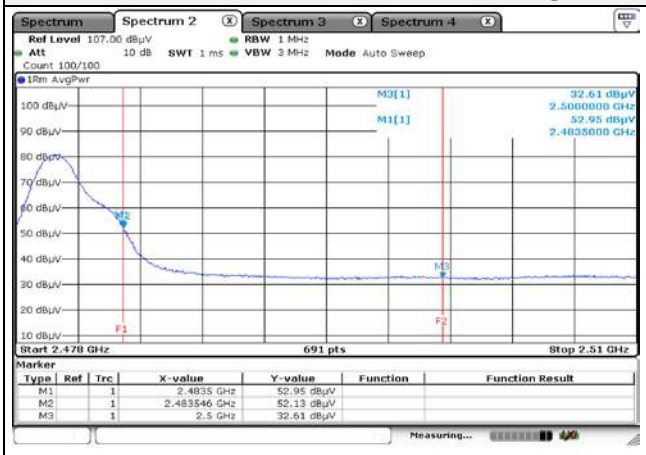
Restricted band // Horizontal // Peak



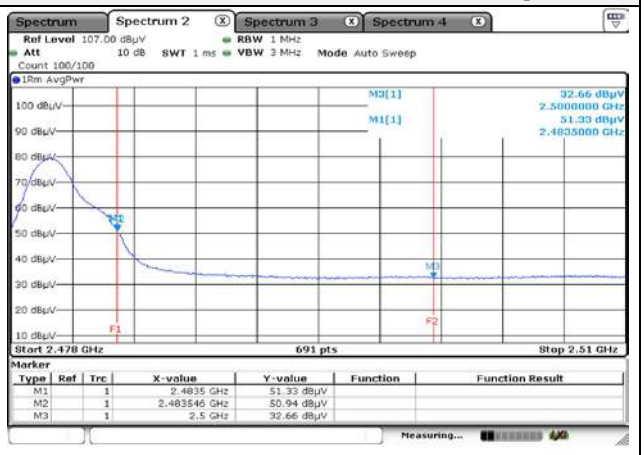
Restricted band // Vertical // Peak



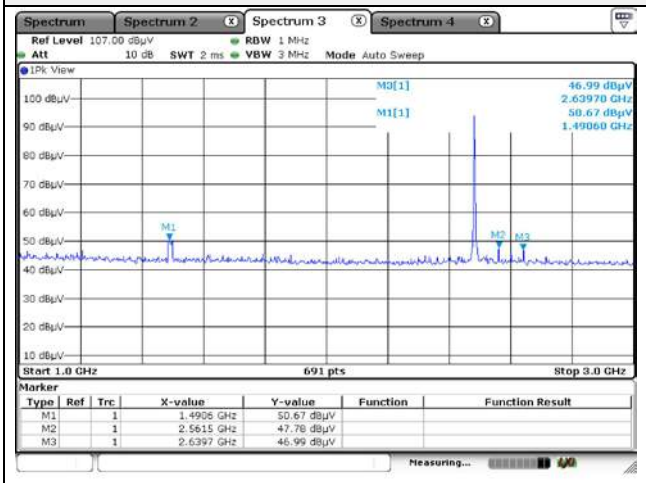
Restricted band // Horizontal // Average



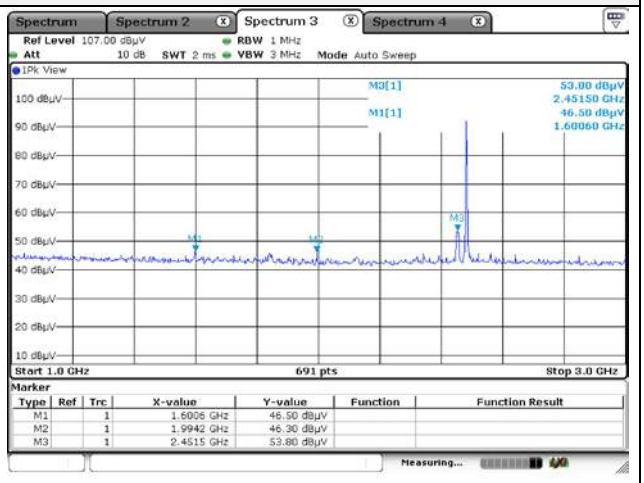
Restricted band // Vertical // Average



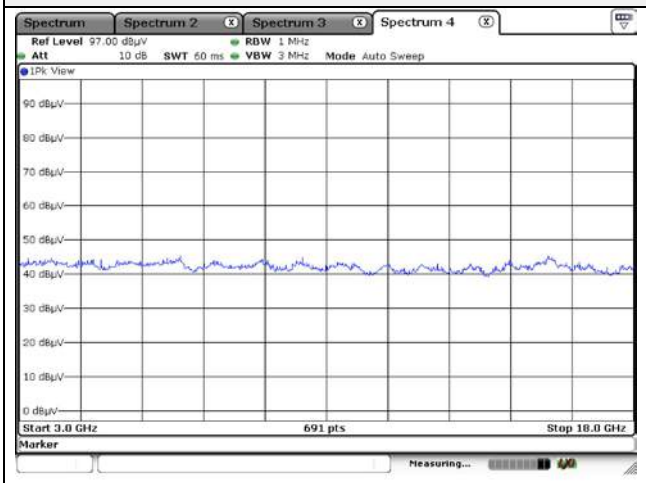
Horizontal // Peak for 1 ㎓ to 3 ㎓



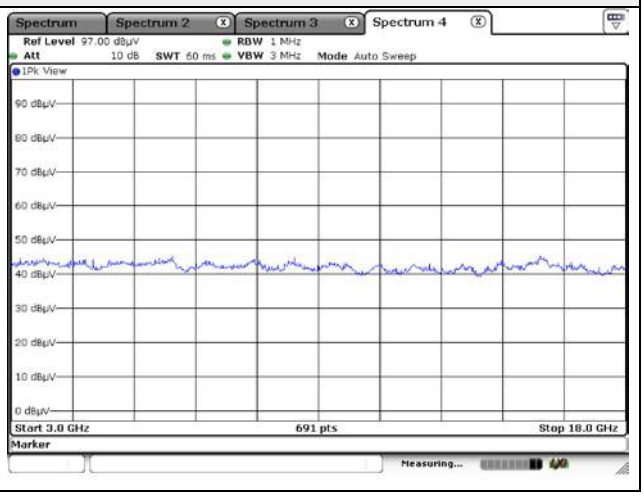
Vertical // Peak for 1 ㎓ to 3 ㎓



Horizontal // Peak for 3 ㎓ to 18 ㎓



Vertical // Peak for 3 ㎓ to 18 ㎓

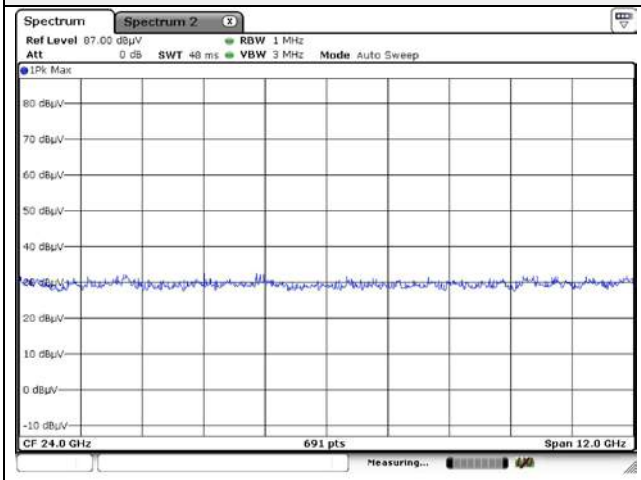
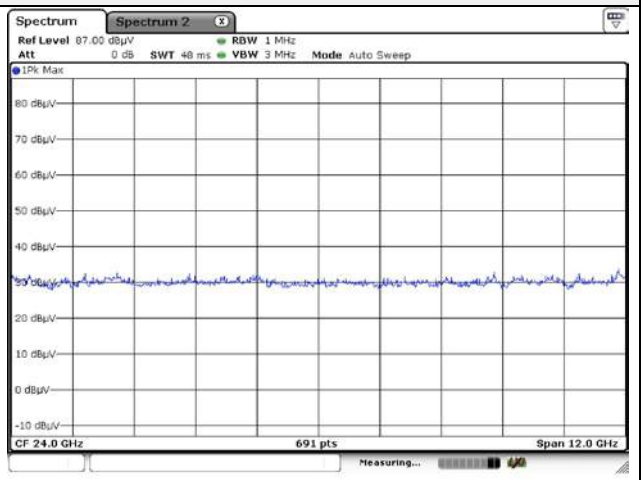


Note.

1. No spurious emission were detected above 3 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

Test results (18 ㎓ to 30 ㎓) – Worst case

Mode:	EDR
Transfer rate:	3 Mbps
Distance of measurement:	3 meter
Channel:	00(Worst case)

Horizontal	Vertical
	

Note.
1. No spurious emission were detected above 18 ㎓.

3.7. Conducted band edge and out of band emissions

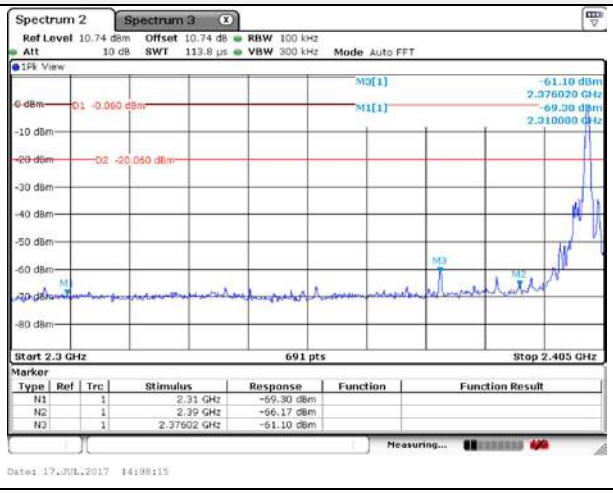
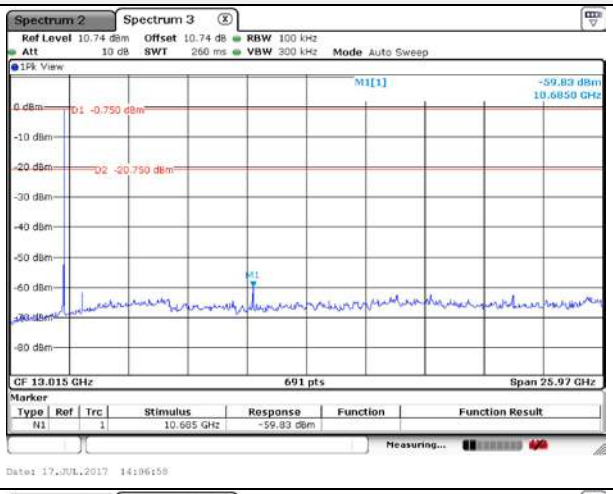
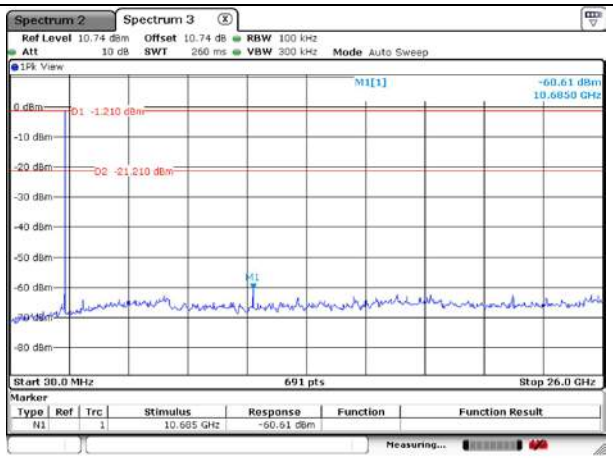
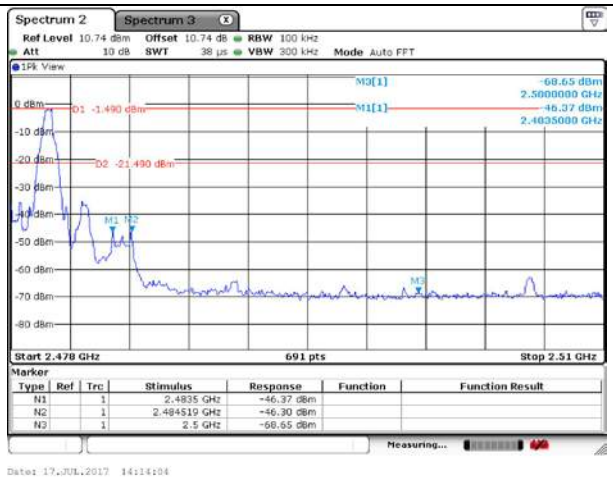
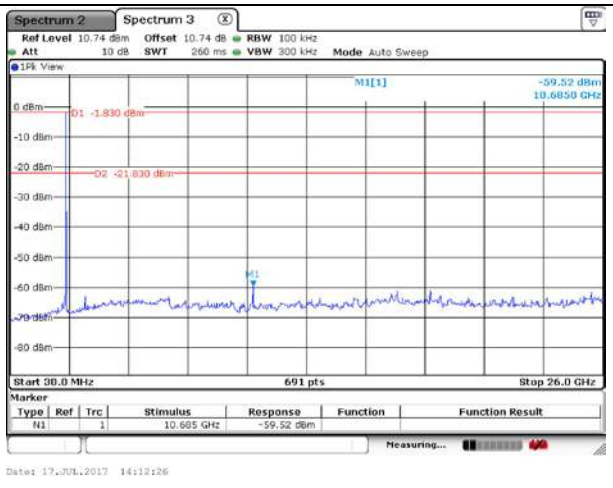
Test setup

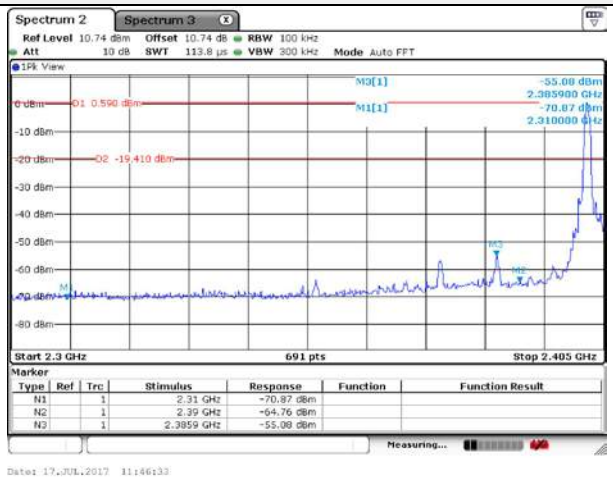
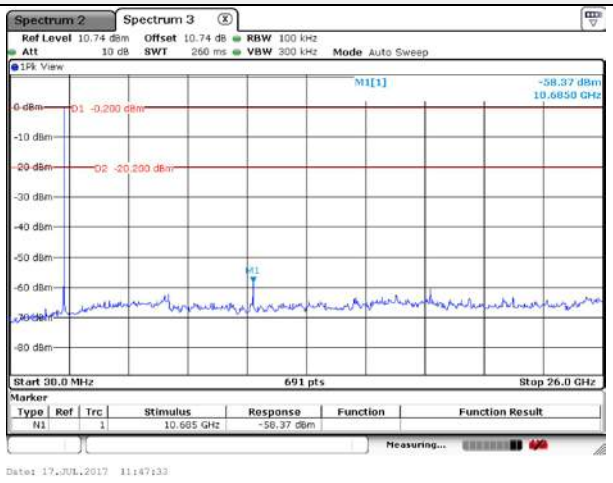
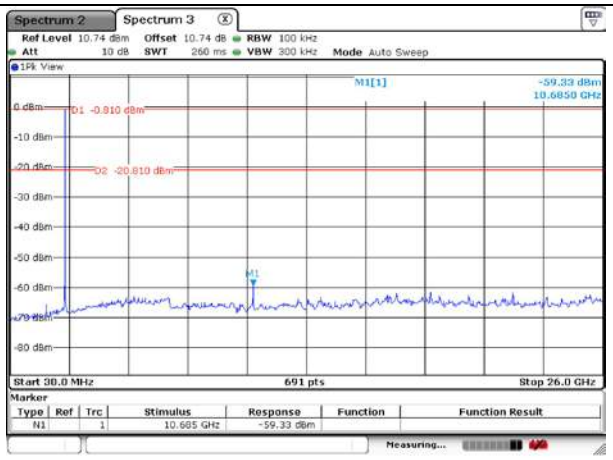
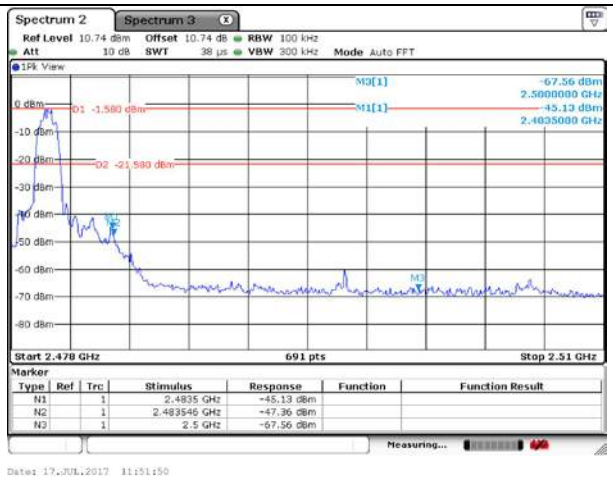
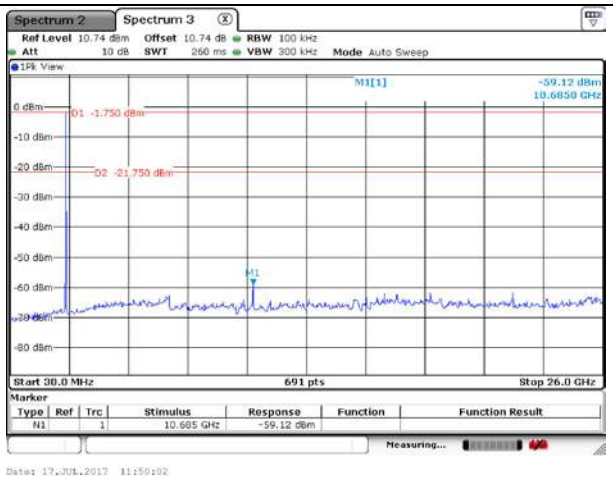
Test procedure
DA 00-705

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

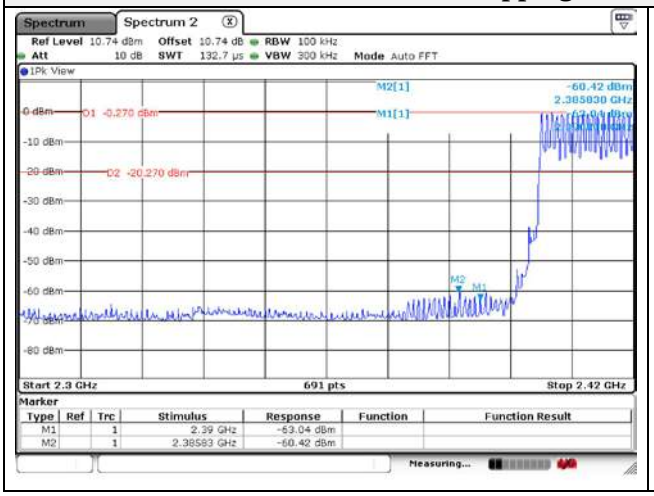
Limit
According to 15.247(d), in any 100 ㎑ bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 ㏈ below that in the 100 ㎑ bandwidth within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

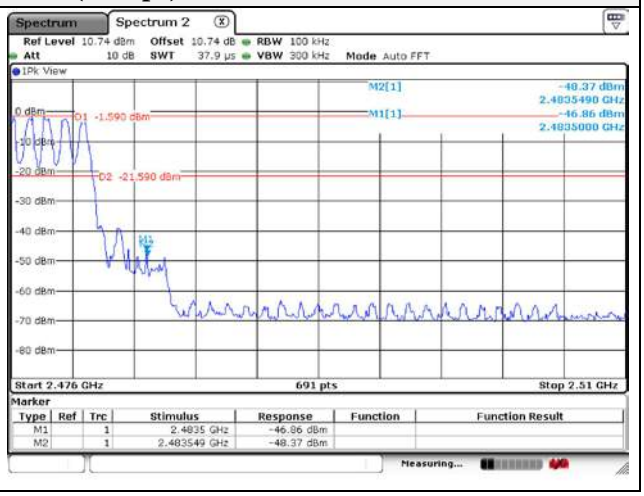
Test results

BDR(1Mbps)	
	
N/A	
	

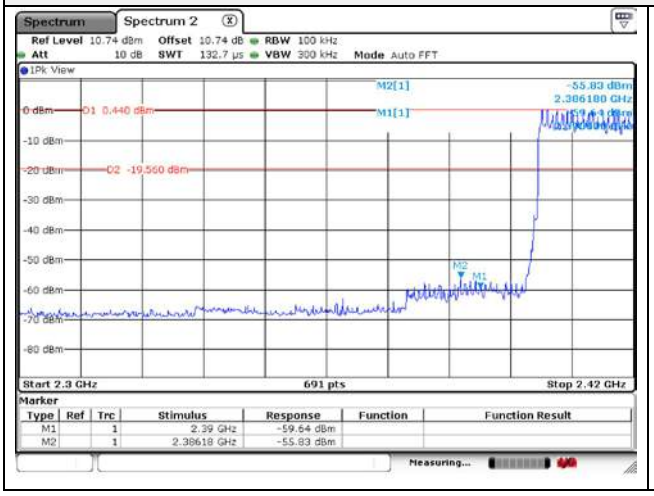
EDR(3Mbps)	
	
N/A	
	

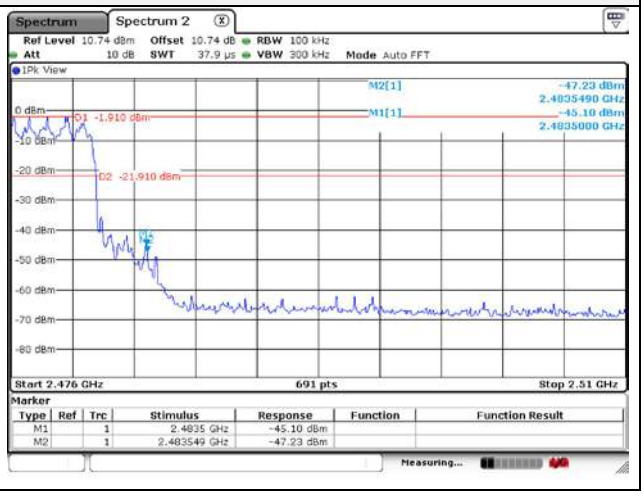
Hopping mode_BDR(1Mbps)





Hopping mode_EDR(3Mbps)





3.8. AC conducted emissions

Limit

According to 15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50uH/50 ohm line impedance stabilization network (LISN). Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequencies ranges.

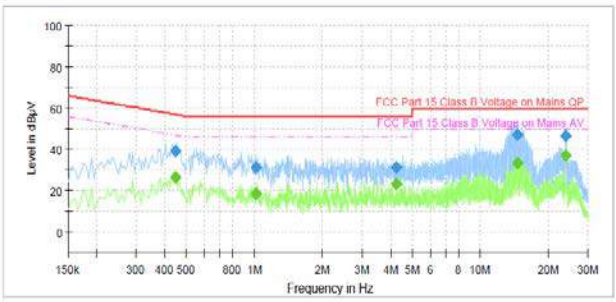
Frequency of Emission (㎒)	Conducted limit (dB㎶/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

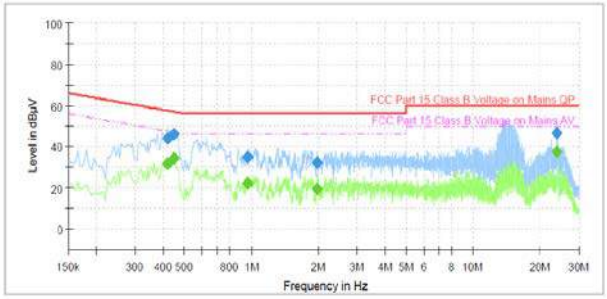
Note:

1. All AC line conducted spurious emission are measured with a receiver connected to a grounded LISN while the EUT is operating at its maximum duty cycle, at maximum power, and the appropriate frequencies. All data rates and modes were investigated for conducted spurious emission. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.
3. Both Cable loss and LISN factor are included in measurement level(QP Level or AV Level).

Test results

Hot Line





Neutral Line

Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.445000	---	26.72	46.97	20.25	1000.0	9.000	L1	19.5
0.445000	39.27	---	56.97	17.70	1000.0	9.000	L1	19.5
1.020000	---	18.71	46.00	27.29	1000.0	9.000	L1	19.8
1.020000	31.42	---	56.00	24.58	1000.0	9.000	L1	19.8
4.235000	---	23.28	46.00	22.72	1000.0	9.000	L1	19.9
4.235000	31.44	---	56.00	24.56	1000.0	9.000	L1	19.9
14.620000	---	33.18	50.00	16.82	1000.0	9.000	L1	19.9
14.620000	47.12	---	60.00	12.88	1000.0	9.000	L1	19.9
23.960000	---	37.33	50.00	12.67	1000.0	9.000	L1	20.1
23.960000	46.79	---	60.00	13.21	1000.0	9.000	L1	20.1

Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.420000	---	31.82	47.45	15.63	1000.0	9.000	N	19.5
0.420000	44.14	---	57.45	13.31	1000.0	9.000	N	19.5
0.445000	---	34.19	46.97	12.78	1000.0	9.000	N	19.5
0.445000	45.96	---	56.97	11.01	1000.0	9.000	N	19.5
0.965000	---	22.33	46.00	23.67	1000.0	9.000	N	19.8
0.965000	34.82	---	56.00	21.18	1000.0	9.000	N	19.8
1.985000	---	19.53	46.00	26.47	1000.0	9.000	N	19.9
1.985000	32.47	---	56.00	23.53	1000.0	9.000	N	19.9
23.960000	---	37.39	50.00	12.61	1000.0	9.000	N	20.0
23.960000	46.41	---	60.00	13.59	1000.0	9.000	N	20.0

Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum Analyzer	R&S	FSV30	101389	1 year	2018.01.23
Spectrum Analyzer	R&S	FSV40	101002	1 year	2018.07.04
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2018.01.23
Attenuator	KEYSIGHT	8493C	82506	1 year	2018.01.23
Loop Antenna	Schwarzbeck	FMZB1513	225	2 years	2019.05.10
Trilog-broadband antenna	SCHWARZBECK	VULB 9163	9168-714	2 years	2018.11.28
Horn Antenna	A.H	SAS-571	414	2 years	2019.02.15
Horn Antenna	SCHWARZBECK	BBHA9170	BBHA9170550	2 years	2019.02.15
High Pass Filter	Wainwright Instrument Gmbh	WHJS3000-10TT	1	1 year	2018.07.03
Low Pass Filter	Wainwright Instrument Gmbh	WLK1.0/18G-10TT	1	1 year	2018.07.03
Preamplifier	HP	8449B	3008A00538	1 year	2018.01.19
Preamplifier	SCHWARZBECK	BBV-9718	9718-246	1 year	2017.10.14
EMI Test Receiver	R&S	ESR3	101781	1 year	2018.04.27
EMI Test Receiver	R&S	ESU26	100552	1 year	2018.04.19
Pulse Limiter	R&S	ESH3-Z2 0357.8810.54	101914	1 year	2017.12.13
LISN	R&S	ENV216	101137	1 year	2018.02.03

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
Notebook Computer	LG Electronics Inc.,	LGS53	306QCZP560949
Test Board	HWASUNG SYSTEM CO., LTD	N/A	N/A