TEST REPORT

Part 15 Subpart C 15.247

Equipment under test	Wireless Module
Model name	EXT AP
FCC ID	RNH-EXTAP
Applicant	DRTECH Corporation
Manufacturer	DRTECH Corporation
Date of test(s)	2020.07.27 ~ 2020.08.22
Date of issue	2020.09.02

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Revision history

Revision	Date of issue	Test report No.	Description
-	2020.09.02	KES-RF1-20T0134	Initial

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1. General information

Applicant:	DRTECH Corporation
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Test Facility	FCC Accreditation Designation No.: KR0100, Registration No.: 444148
FCC rule part(s):	15.247
FCC ID:	RNH-EXTAP
Test device serial No.:	☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test	Wireless Module	
Frequency range	**2 402 ㎒ ~ 2 480 ㎒ (BDR)**	
	2 412 ㎒ ~ 2 462 ㎒ (11n_HT20)	
	UNII-1 5 180 ㎒ ~ 5 240 ㎒ (11n_HT20)	
	5 190 ㎒ ~ 5 230 ㎒ (11n_HT40)	
	5 210 ㎒ (11ac_VHT80)	
	UNII-3 5 745 ㎒ ~ 5 825 ㎒ (11n_HT20)	
	5 755 ㎒ ~ 5 795 ㎒ (11n_HT40)	
	5 775 ㎒ (11ac_VHT80)	
Model:	EXT AP	
Modulation technique	WIFI : OFDM	
	BT : GFSK	
Number of channels	**2 402 ㎒ ~ 2 480 ㎒ (BDR) : 79 ch**	
	2 412 ㎒ ~ 2 462 ㎒ (11n_HT20) : 11 ch	
	5 180 ㎒ ~ 5 240 ㎒ (11n_HT20) : 4ch	
	5 190 ㎒ ~ 5 230 ㎒ (11n_HT40) : 2ch	
	5 210 ㎒ (11ac_VHT80) : 1ch	
	5 745 ㎒ ~ 5 825 ㎒ (11n_HT20) : 5ch	
	5 755 ㎒ ~ 5 795 ㎒ (11n_HT40) : 2ch	
	5 775 ㎒ (11ac_VHT80) : 1ch	
Antenna specification	2.4 ㎓ Antenna type : Dipole antenna,	Peak gain : 2.28 dBi
	5 ㎓ Antenna type : : Dipole antenna,	Peak gain(UNII-1) : 2.94 dBi
		Peak gain(UNII-3) : 2.96 dBi
Power source	DC 5.0 V	
H/W version	V2.1	
S/W version	V1.0.7	

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 **DRTECH Corporation // EXT AP //FCC ID: RNH-EXTAP** was tested according to the specification of EUT, the EUT must comply with following standards and KDB documents.

FCC Part 15.247
KDB 558074 D01 v05 r02
ANSI C63.10-2013

1.3. Device modifications
N/A

1.4. Frequency/channel operations

Ch.	Frequency (㎒)	Rate(Mbps)
00	2402	BDR : 1 Mbps
. .	. .	. .
40	2442	BDR : 1 Mbps
. .	. .	. .
78	2480	BDR : 1 Mbps

1.5. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
-	-	-	-	-

1.6. Information about derivative model

N/A

1.7. Measurement results explanation example

For all conducted test items

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Offset(㏈) = RF cable loss(㏈) + attenuator factor(㏈).
= 1.01 + 10 = 11.01

1.8. Measurement Uncertainty

Test Item		Uncertainty
Uncertainty for Conduction emission test		2.46 ㏈
Uncertainty for Radiation emission test (include Fundamental emission)	Below 1㎓	4.40 ㏈
	Above 1㎓	5.94 ㏈
Note. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.		

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
15.247(d)	Conducted band edge and out of band emissions	Pass
15.207(a)	AC conducted emissions	Pass

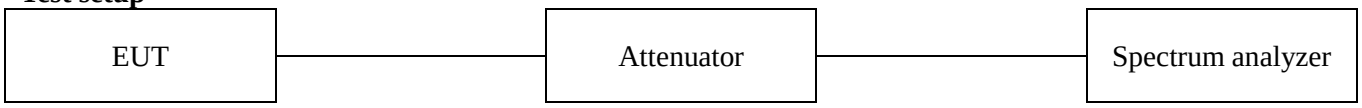
3. Test results

3.1. 20 dB bandwidth

Test procedure

ANSI C63.10-2013 clause 6.9.2 and 6.9.3

Test setup



Test setting

1. Span = The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 2.0 times and 5.0 times the OBW.
2. RBW = The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW.
3. VBW = Shall be approximately three times the RBW.
4. Sweep = auto
5. Detector function = peak
6. Trace mode = max hold

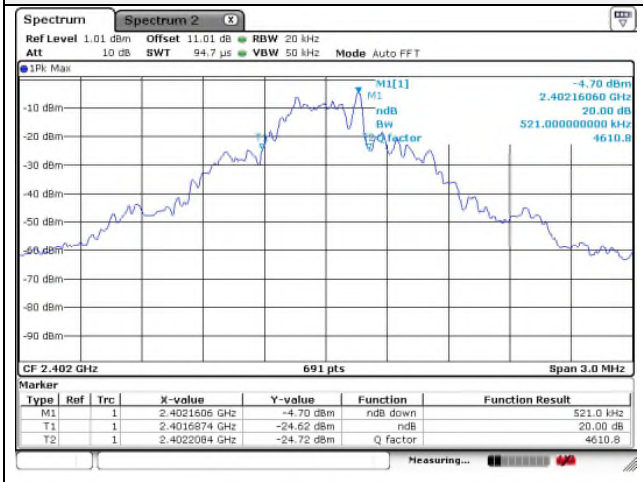
Limit

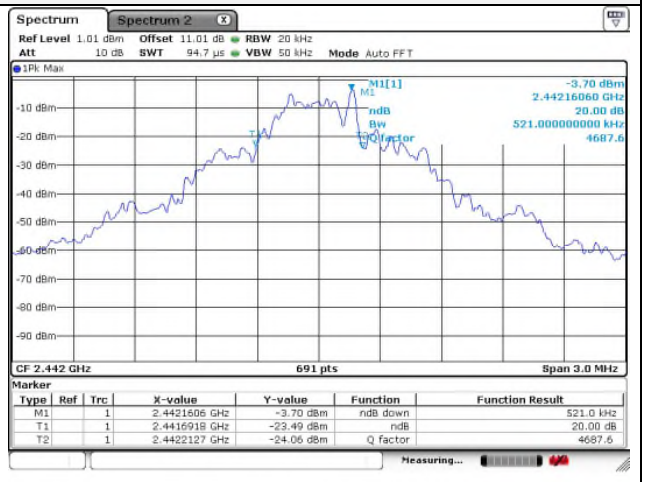
Not applicable

Test results

Frequency(㎒)	Channel no.	Data rate(Mbps)	Measured bandwidth(㎒)
2 402	00	1	0.521
2 442	40		0.521
2 480	78		0.521

BDR(1Mbps)





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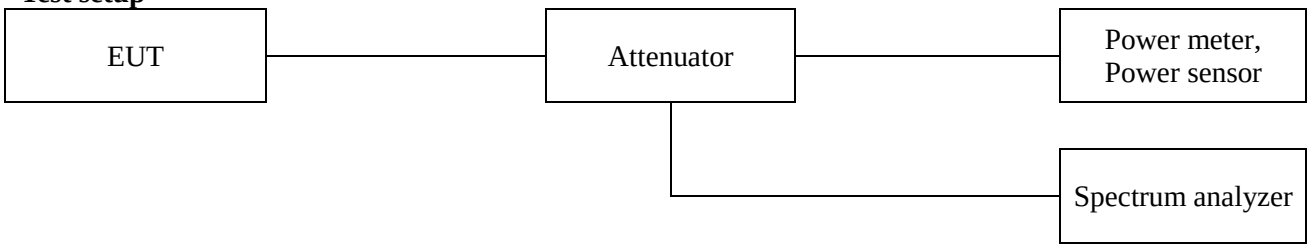
3.2. Output power

Test procedure

ANSI C63.10-2013 - Section 7.8.5

Test setup



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.

Test results

Frequency(㎒)	Channel no.	Data rate(Mbps)	Peak Power (dBm)	Average Power (dBm) Note1	Power Limit (dBm)
2 402	00	1	-1.70	-4.38	20.97
2 442	40		-0.72	-3.29	20.97
2 480	78		-0.56	-3.12	20.97

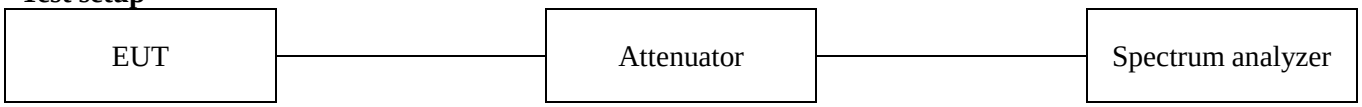
Note.
1. The average power was tested using an average power meter.

3.3. Carrier frequency separation

Test procedure

ANSI C63.10-2013 - Section 7.8.2

Test setup



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) = Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
4. Video (or Average) Bandwidth (VBW) ≥ RBW
5. Sweep = auto
6. Detector function = peak
7. Trace = max hold

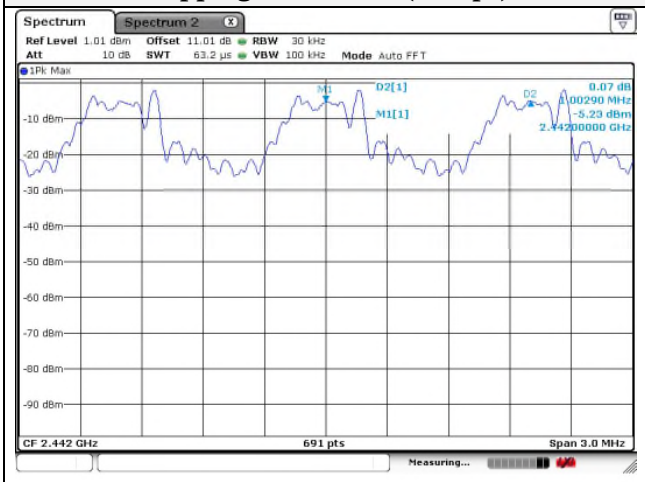
Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

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 ㎽.

Test results

Frequency(㎒)	Channel no.	Data rate(Mbps)	Channel Separation (㎒)
2 442	40	1	1.003

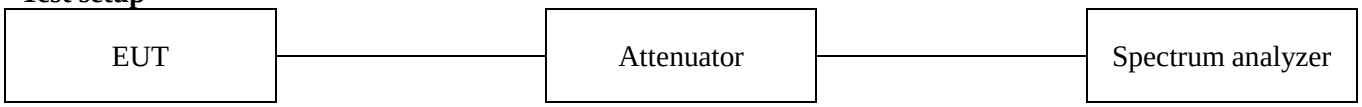
Hopping mode_BDR(1Mbps)	
	blank

3.4. Number of hopping frequency

Test procedure

ANSI C63.10-2013 - Section 7.8.3

Test setup



Test setting

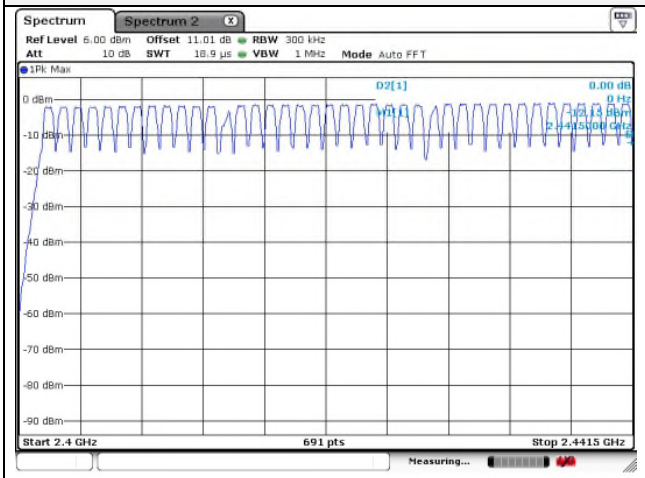
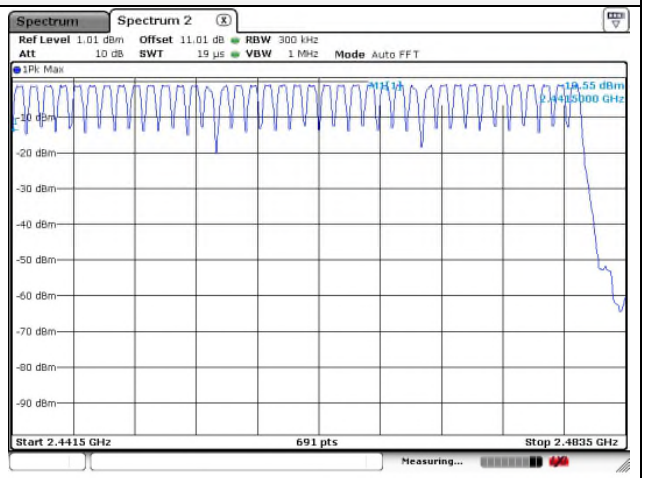
1. The EUT must have its hopping function enabled.
2. Frequency range: 2 400 ㎒ ~ 2 441.5 ㎒, 2 441.5 ㎒ ~ 2 483.5 ㎒
3. Span = the frequency band of operation
4. RBW = To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
5. VBW ≥ 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.

Test results

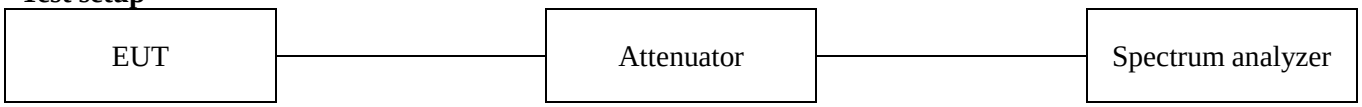
Hopping mode_BDR(1Mbps)	
	

3.5. Time of occupancy

Test procedure

ANSI C63.10-2013 - Section 7.8.4

Test setup



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

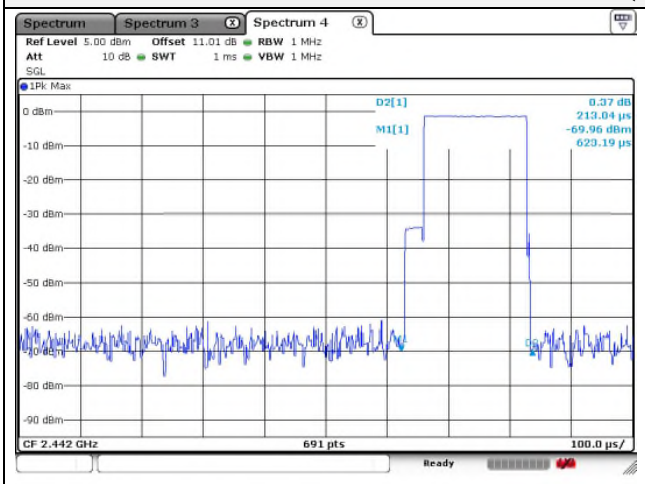
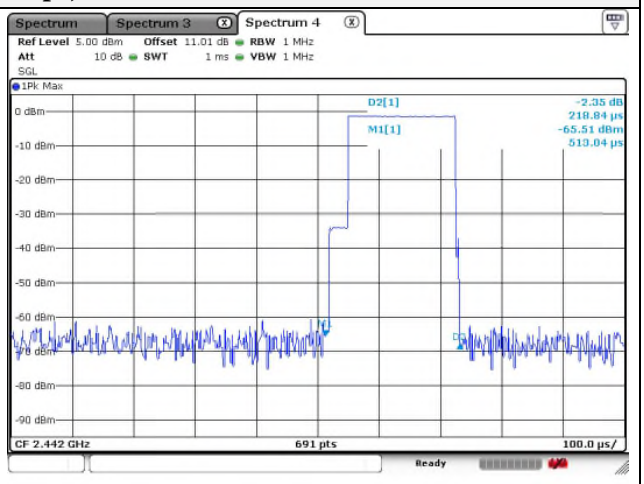
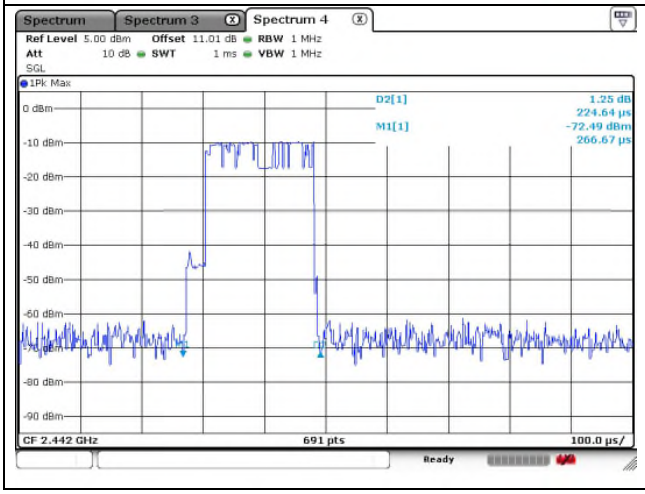
A period time = 0.4(s) × 20 = 8.0(s)

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

Test results

Packet type	Frequency (㎒)	Dwell time (ms)	Time of occupancy on the Tx channel (ms)	Limit for time of occupancy on the Tx channel (ms)
DH1	2 442	0.213	68.16	400
DH3	2 442	0.218	69.76	400
DH5	2 442	0.225	72.00	400

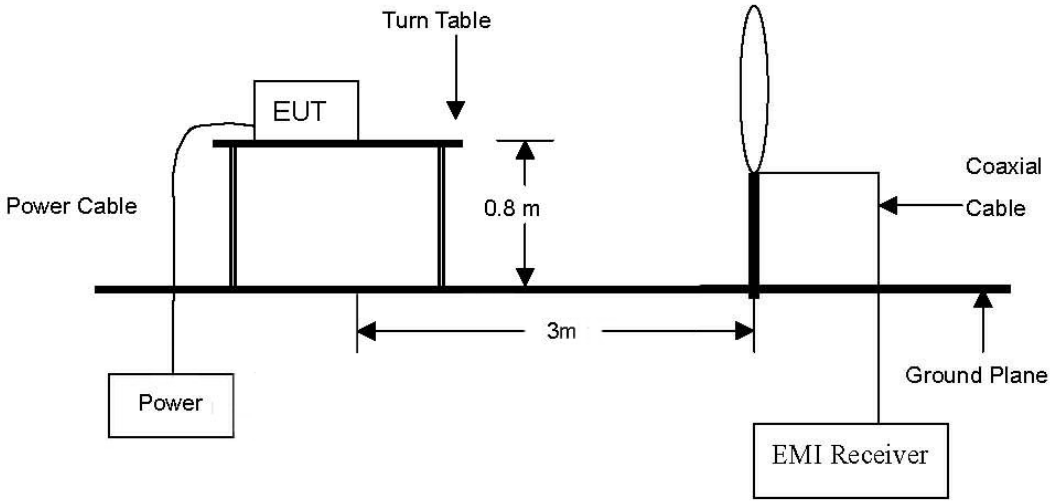
Note:
1. Normal Mode
DH1: Dwell time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 68.16 (ms)
DH3: Dwell time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 69.76 (ms)
DH5: Dwell time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 72.00 (ms)

BDR(1Mbps)	
	
	Blank

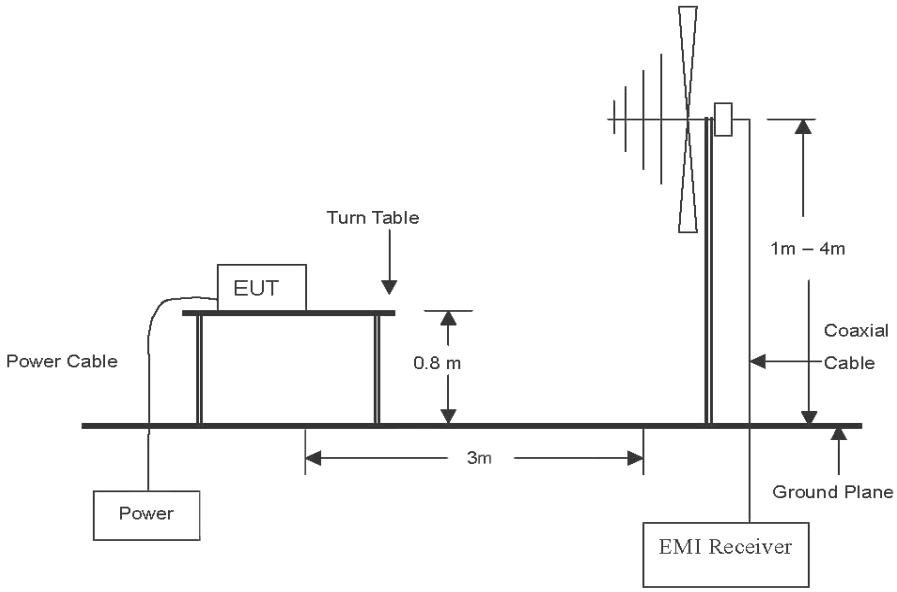
3.6. Radiated restricted band and emissions

Test setup

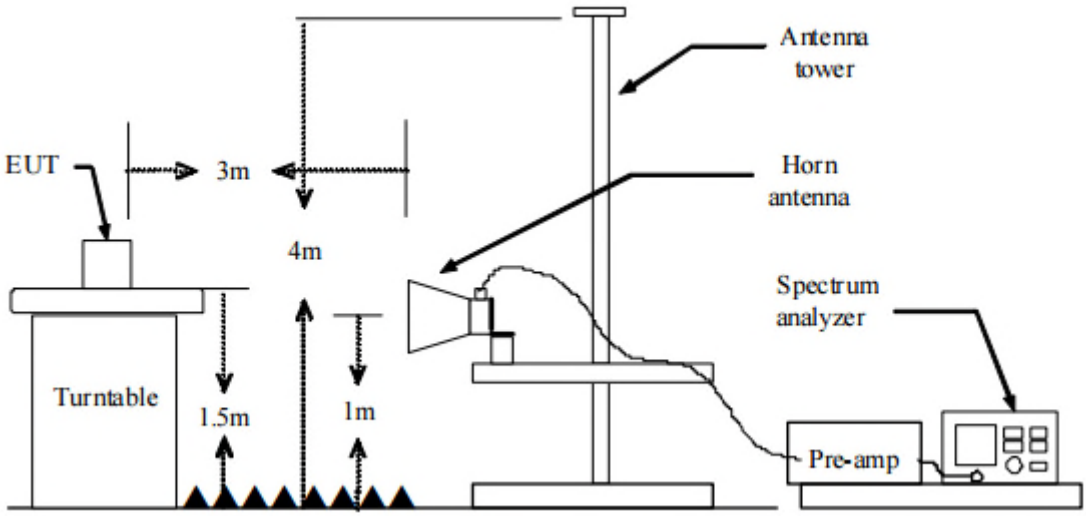
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



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

Radiated emissions from the EUT were measured according to the dictates in section 11.11 & 11.12 of ANSI C63.10-2013.

Test procedure below 30 ㎒

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel, ground parallel and perpendicular of the antenna are set to make the measurement. It was determined that **parallel** was worst-case orientation; therefore, all final radiated testing was performed with the EUT in **parallel.**
3. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test-receiver system was set to average or quasi peak detect function and Specified Bandwidth with Maximum hold mode.

Test procedure above 30 ㎒

1. The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. The antenna is a bi-log antenna, a horn antenna ,and its height are varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
3. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

5. Spectrum analyzer settings for f < 1 ㎓:
   ① Span = wide enough to fully capture the emission being measured
   ② RBW = 100 ㎑
   ③ VBW ≥ RBW
   ④ Detector = quasi peak
   ⑤ Sweep time = auto
   ⑥ Trace = max hold
6. Spectrum analyzer settings for f ≥1 ㎓: Peak
   ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
   ② RBW = 1 ㎒
   ③ VBW ≥ 3 ㎒
   ④ Detector = peak
   ⑤ Sweep time = auto
   ⑥ Trace = max hold
   ⑦ Trace was allowed to stabilize

7. Spectrum analyzer settings for f ≥1 ㎓: Average
   ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
   ② RBW = 1 ㎒

③ VBW ≥ 3 × RBW

④ Detector = RMS, if span/(# of points in sweep) ≤ (RBW/2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.

⑤ Averaging type = power(i.e., RMS)

1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
2) Some instruments require linear display mode in order to use linear voltage averaging. Log or dB averaging shall not be used.

⑥ Sweep = auto

⑦ Trace = max hold

⑧ Perform a trace average of at least 100 traces.

⑨ A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:

1) If power averaging (RMS) mode was used in step ⑤, then the applicable correction factor is 10 log(1/x), where x is the duty cycle.
2) If linear voltage averaging mode was used in step ⑤, then the applicable correction factor is 20 log(1/x), where x is the duty cycle.
3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

Note.

1. f <30 ㎒, extrapolation factor of 40 ㏈/decade of distance. $F_d = 40\log(D_m/Ds)$
   f ≥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
2. Field strength(㏈㎶/m) = Level(㏈㎶) + CF (㏈) + or DCF(㏈)
3. Margin(㏈) = Limit(㏈㎶/m) - Field strength(㏈㎶/m)
4. 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.
7. The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z, it was determined that **X orientation** was worst-case orientation; therefore, all final radiated testing was performed with the EUT in **X orientation.**
8. The worst-case emissions are reported however emissions whose levels were not within 20 ㏈ of respective limits were not reported.
9. According to exploratory test no any obvious emission were detected from 9 ㎑ to 30 ㎒. Although these tests were performed other than open field site, adequate comparison measurements were confirmed against 30 m open field 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.

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：

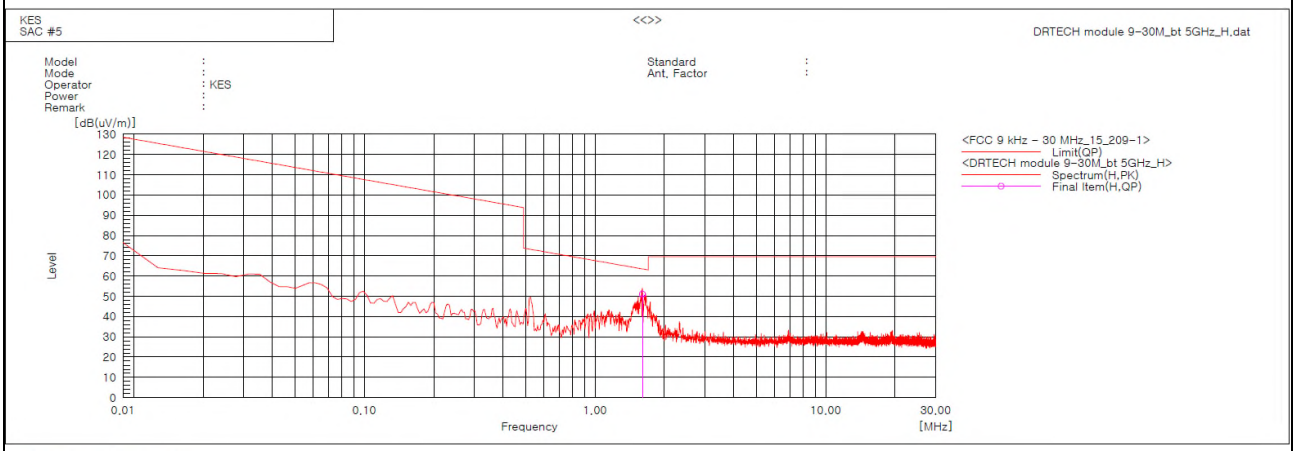
Frequency (㎒)	Distance (Meters)	Radiated (㎶/m)
0.009 ~ 0.490	300	2 400 / F(㎑)
0.490 ~ 1.705	30	24 000 / F(㎑)
1.705 ~ 30.0	30	30
30 ~ 88	3	100**
88 ~ 216	3	150**
216 ~ 960	3	200**
Above 960	3	500

**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:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	78(Worst case)
ANT #1	Dipole Antenna

Horizontal

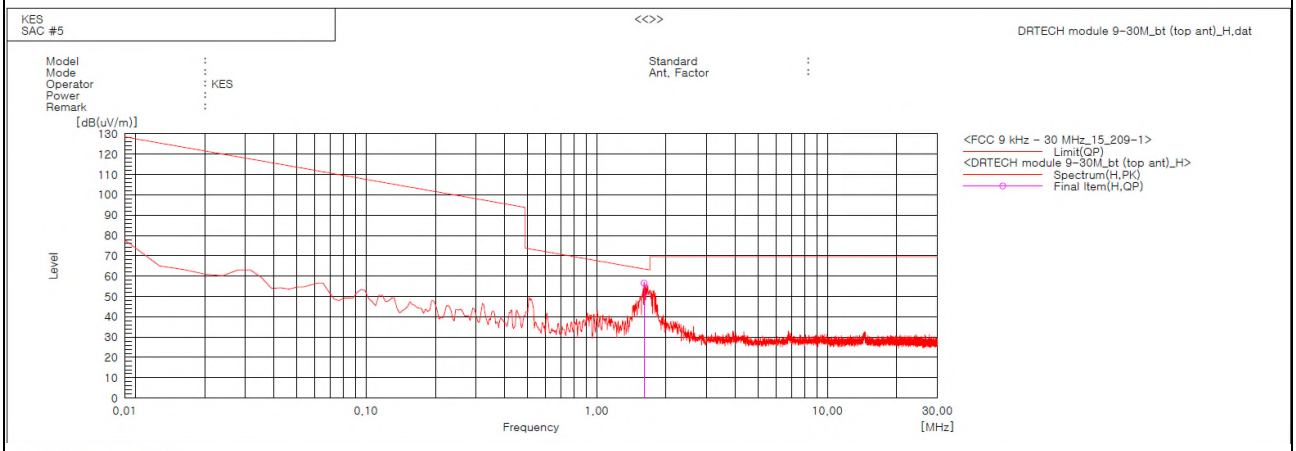


Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]	Remark
1	1.606	H	30.4	20.7	51.1	63.5	12.4	100.0	359.6	

Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	78(Worst case)
ANT #2	PCB Antenna(Top)

Horizontal

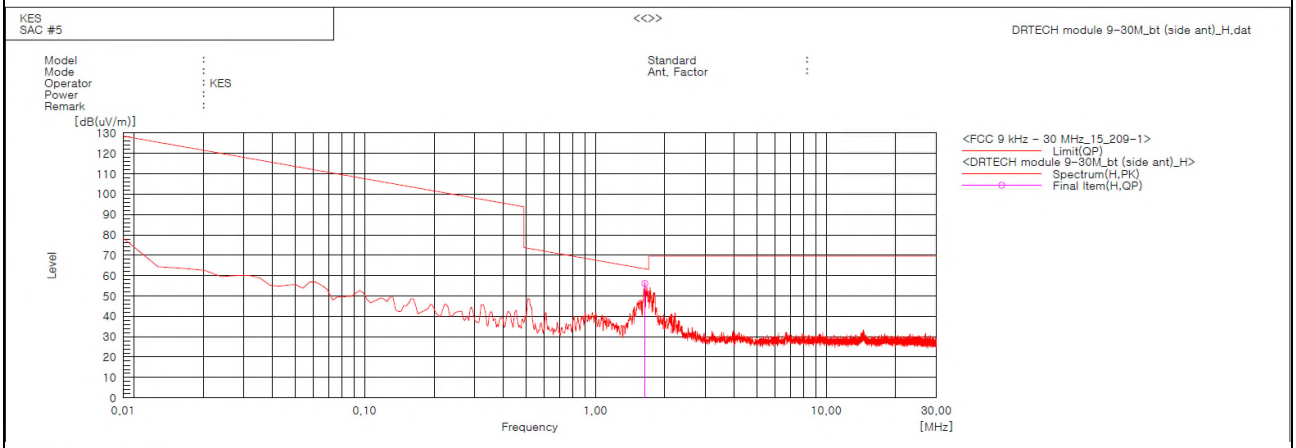


Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]	Remark
1	1.606	H	35.8	20.7	56.5	63.5	7.0	100.0	7.5	

Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	78(Worst case)
ANT #3	PCB Antenna(Side)

Horizontal



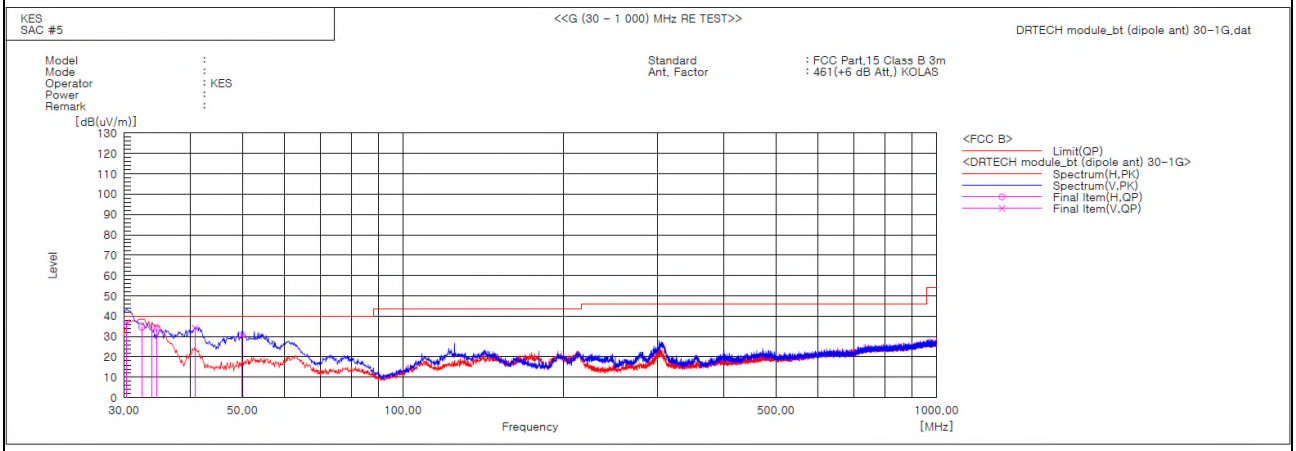
Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]	Remark
1	1.640	H	35.5	20.7	56.2	63.3	7.1	100.0	354.9	

Test results (Below 1 000 ㎒)

Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	78(Worst case)
ANT #1	Dipole Antenna

Horizontal // Vertical

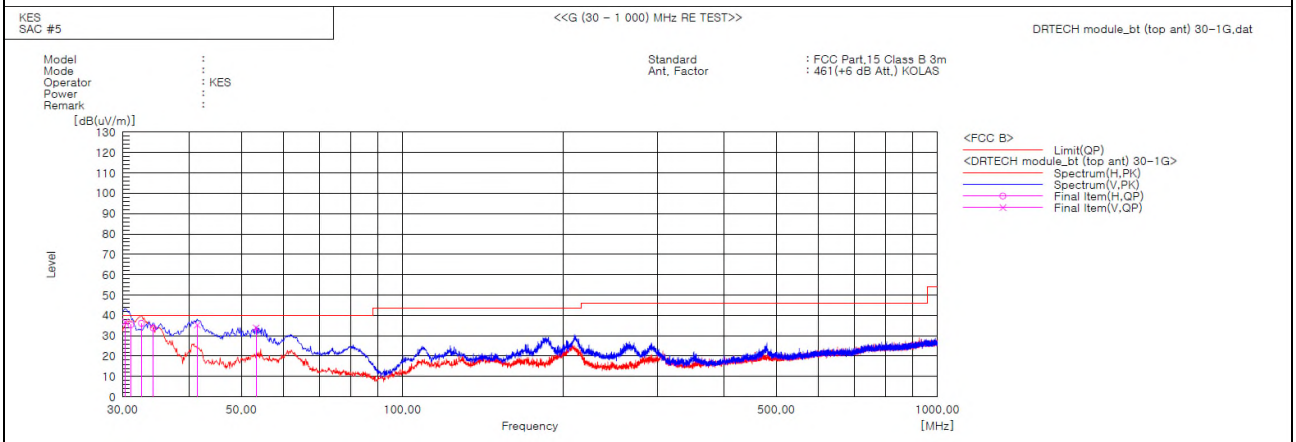


Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]	Remark
1	30.364	V	51.3	-14.3	37.0	40.0	3.0	100.0	72.8	
2	32.425	H	48.7	-14.1	34.6	40.0	5.4	355.0	169.5	
3	33.880	H	48.7	-14.0	34.7	40.0	5.3	376.0	127.9	
4	34.608	H	48.3	-14.0	34.3	40.0	5.7	252.0	76.0	
5	40.791	V	47.4	-13.2	34.2	40.0	5.8	100.0	278.1	
6	49.885	V	43.7	-12.9	30.8	40.0	9.2	102.0	237.6	

Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	78(Worst case)
ANT #2	PCB Antenna(Top)

Horizontal // Vertical

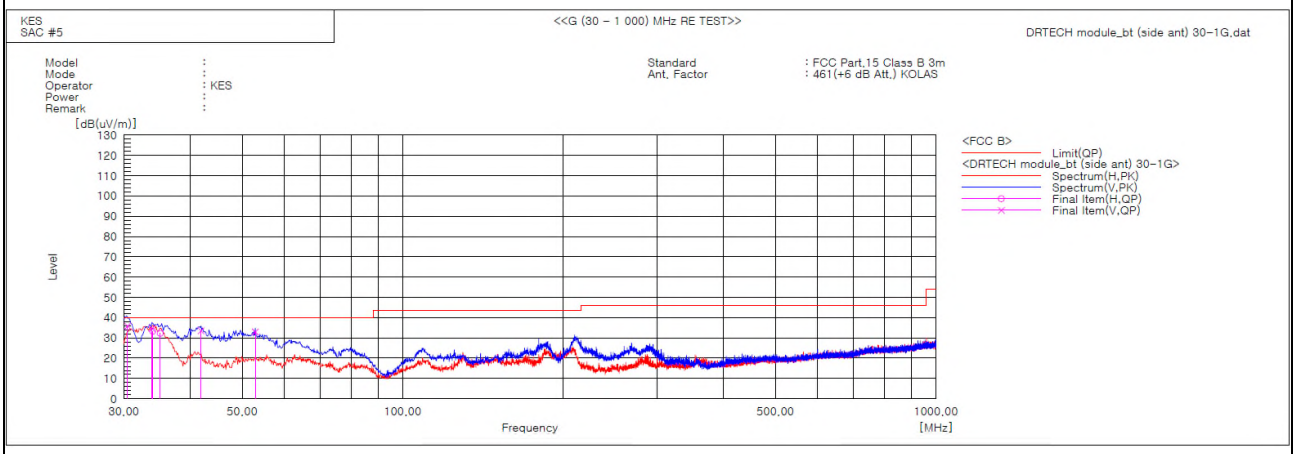


Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]	Remark
1	30.364	V	51.2	-14.3	36.9	40.0	3.1	122.0	150.1	
2	31.091	H	49.6	-14.2	35.4	40.0	4.6	356.0	142.1	
3	32.546	H	50.2	-14.1	36.1	40.0	3.9	386.0	145.0	
4	34.244	H	47.8	-14.0	33.8	40.0	6.2	242.0	201.7	
5	41.398	V	48.4	-13.1	35.3	40.0	4.7	106.0	244.9	
6	53.280	V	47.0	-13.1	33.9	40.0	6.1	100.0	333.2	

Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	78(Worst case)
ANT #3	PCB Antenna(Side)

Horizontal // Vertical



Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]	Remark
1	30.485	V	50.2	-14.3	35.9	40.0	4.1	100.0	129.7	
2	33.880	V	48.7	-14.0	34.7	40.0	5.3	100.0	34.4	
3	34.001	H	47.3	-14.0	33.3	40.0	6.7	363.0	152.4	
4	35.093	H	46.2	-13.9	32.3	40.0	7.7	400.0	33.5	
5	41.883	V	46.6	-13.0	33.6	40.0	6.4	175.0	247.0	
6	52.916	V	46.1	-13.1	33.0	40.0	7.0	135.0	152.1	

Test results (Above 1 000 ㎒)

Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	00
ANT #1	Dipole Antenna

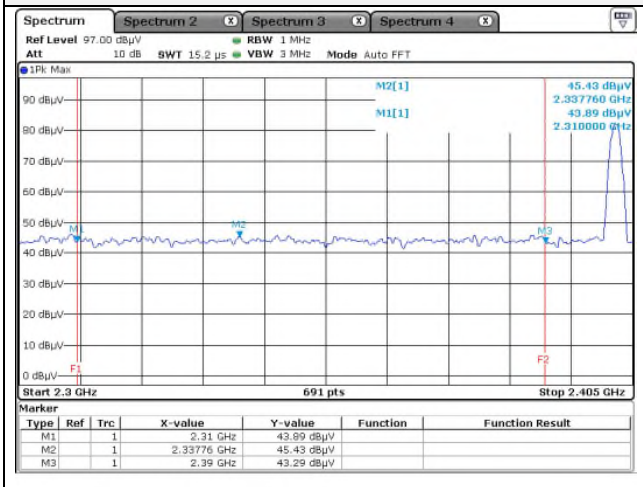
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1152.00	49.14	Peak	H	-11.27	-	37.87	74.00	36.13
2549.90	46.55	Peak	H	-3.22	-	43.33	74.00	30.67
1140.40	48.59	Peak	V	-11.27	-	37.32	74.00	36.68
2619.40	46.74	Peak	V	-3.11	-	43.63	74.00	30.37

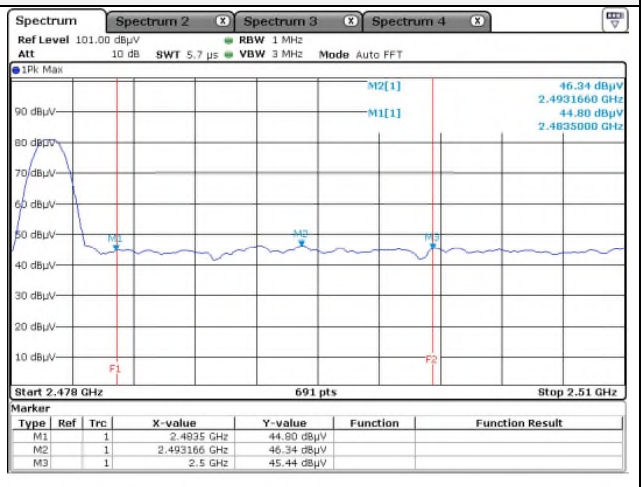
- **Band edge**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2337.76	45.43	Peak	H	-6.88	-	38.55	74.00	35.45
2322.87	45.70	Peak	V	-6.81	-	38.89	74.00	35.11

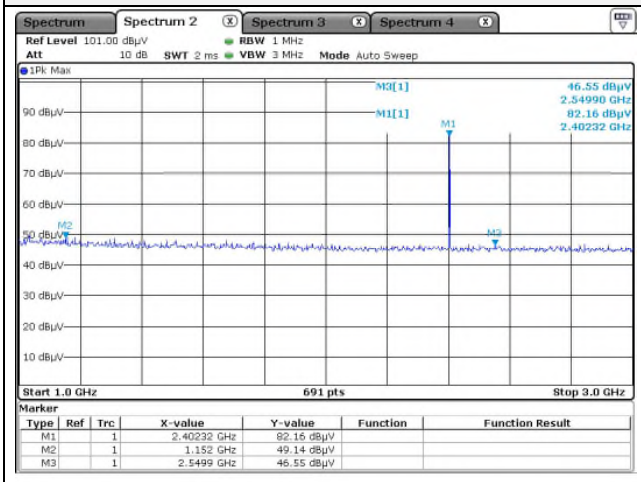
Restricted band // Horizontal // Peak



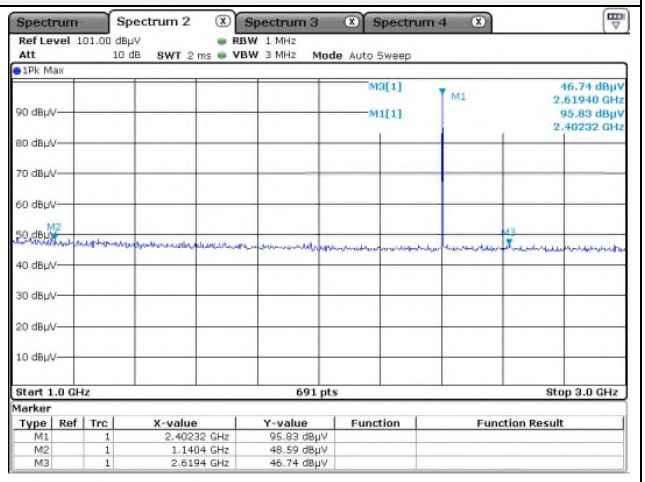
Restricted band // Vertical // Peak



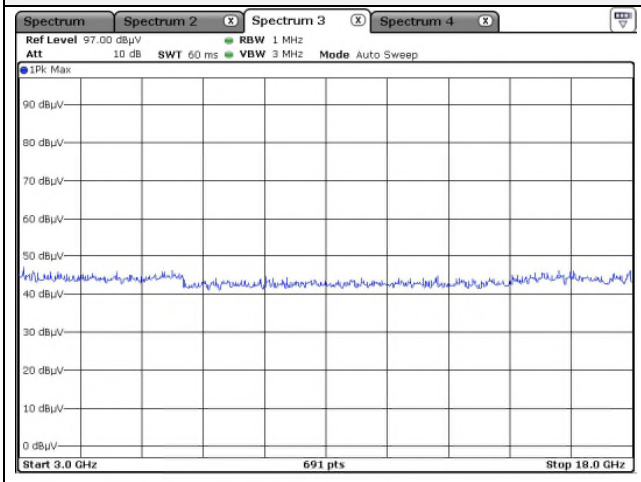
Horizontal // Peak for 1 ㎓ to 3 ㎓



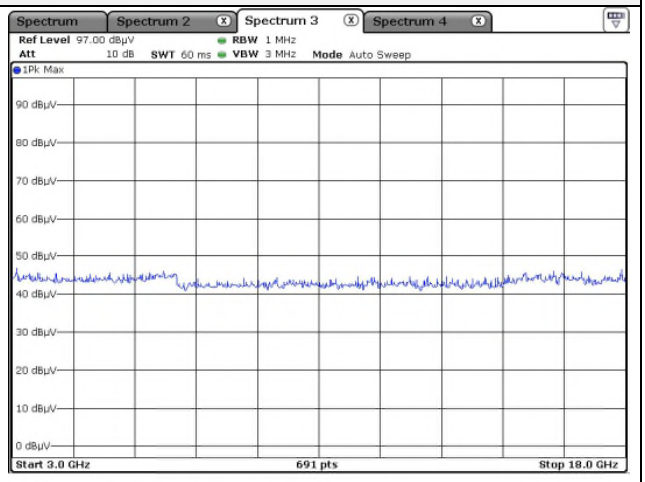
Vertical // Peak for 1 ㎓ to 3 ㎓



Horizontal // Peak for 3 ㎓ to 18 ㎓



Vertical // Peak for 3 ㎓ to 18 ㎓



Note.

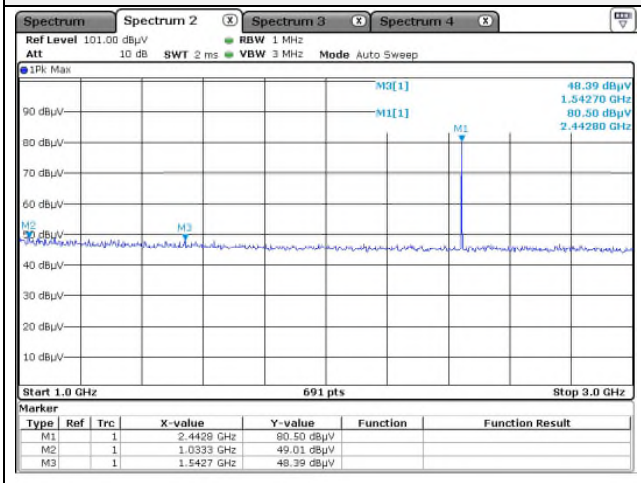
1. No spurious emission were detected above 3 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	39
ANT #1	Dipole Antenna

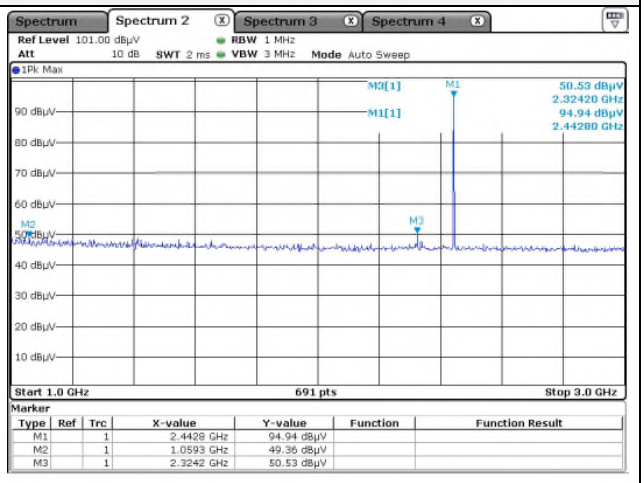
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1033.30	49.01	Peak	H	-11.31	-	37.70	74.00	36.30
1542.70	48.39	Peak	H	-8.40	-	39.99	74.00	34.01
1059.30	49.36	Peak	V	-11.30	-	38.06	74.00	35.94
2324.20	50.53	Peak	V	-6.81	-	43.72	74.00	30.28

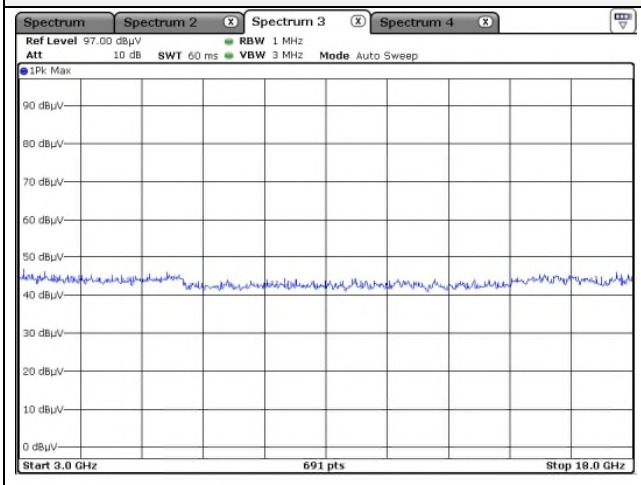
Horizontal // Peak for 1 ㎓ to 3 ㎓



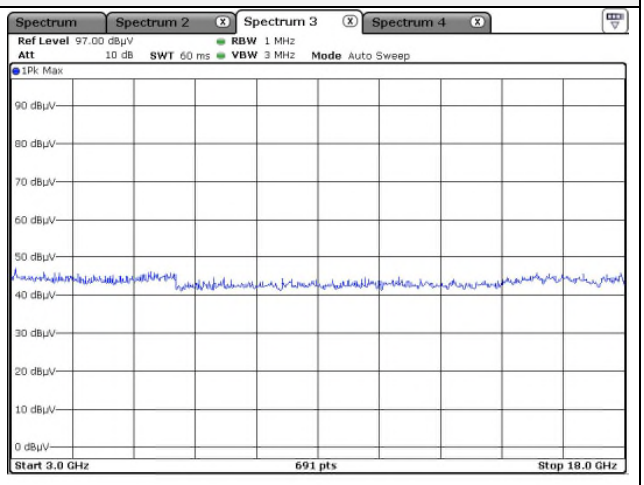
Vertical // Peak for 1 ㎓ to 3 ㎓



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:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	78
ANT #1	Dipole Antenna

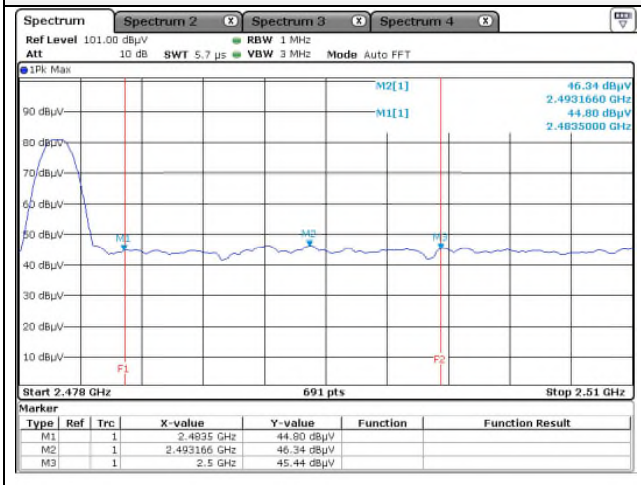
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1143.30	48.82	Peak	H	-11.27	-	37.55	74.00	36.45
2639.70	46.25	Peak	H	-3.07	-	43.18	74.00	30.82
1128.80	48.74	Peak	V	-11.27	-	37.47	74.00	36.53
2581.80	47.32	Peak	V	-3.17	-	44.15	74.00	29.85

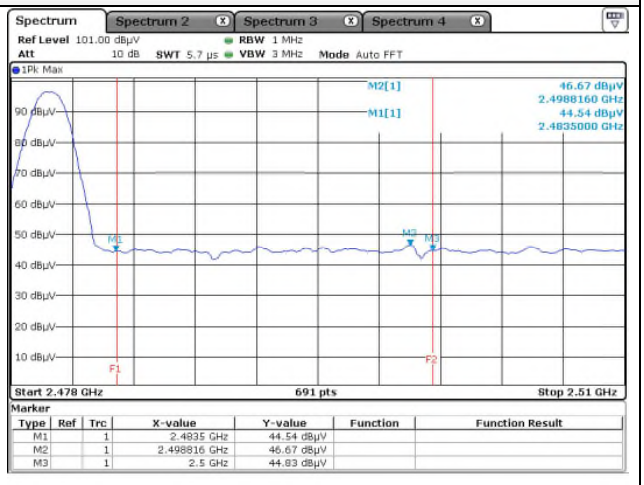
- **Band edge**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2493.17	46.34	Peak	H	-7.59	-	38.75	74.00	35.25
2498.82	46.67	Peak	V	-7.62	-	39.05	74.00	34.95

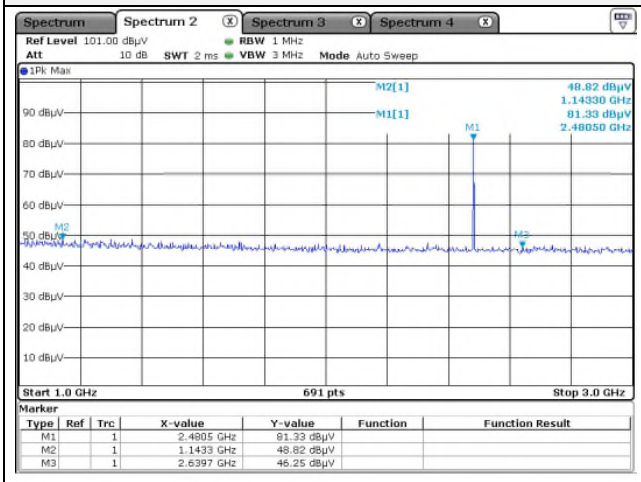
Restricted band // Horizontal // Peak



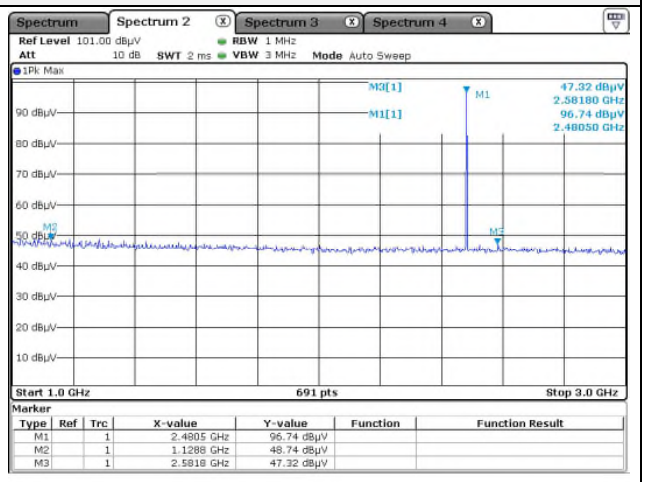
Restricted band // Vertical // Peak



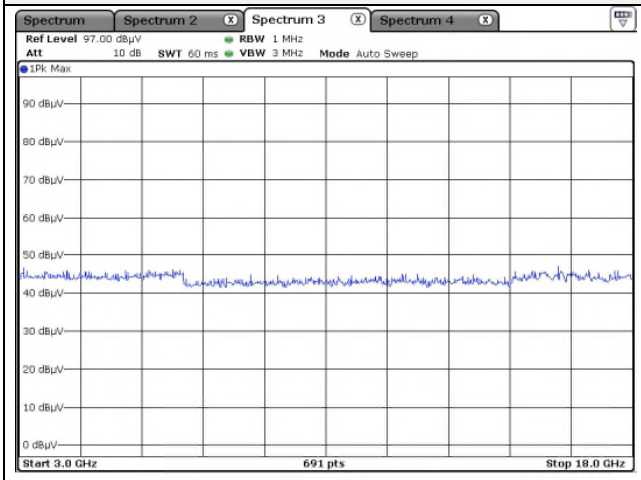
Horizontal // Peak for 1 ㎓ to 3 ㎓



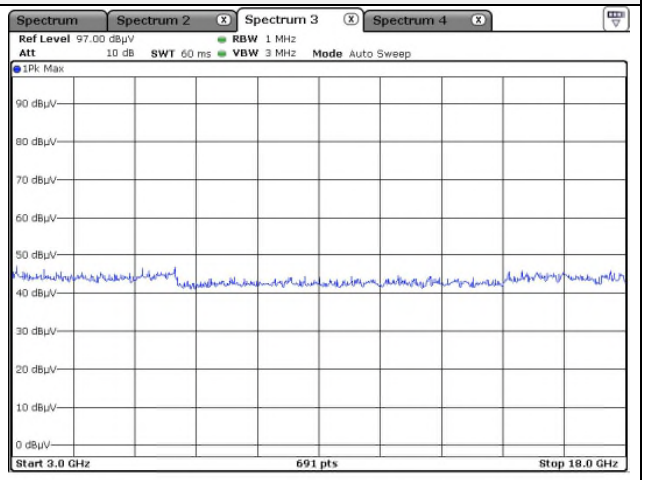
Vertical // Peak for 1 ㎓ to 3 ㎓



Horizontal // Peak for 3 ㎓ to 18 ㎓



Vertical // Peak for 3 ㎓ to 18 ㎓

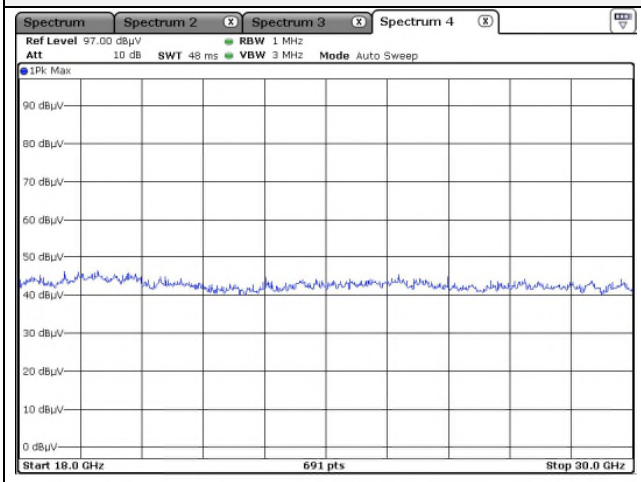
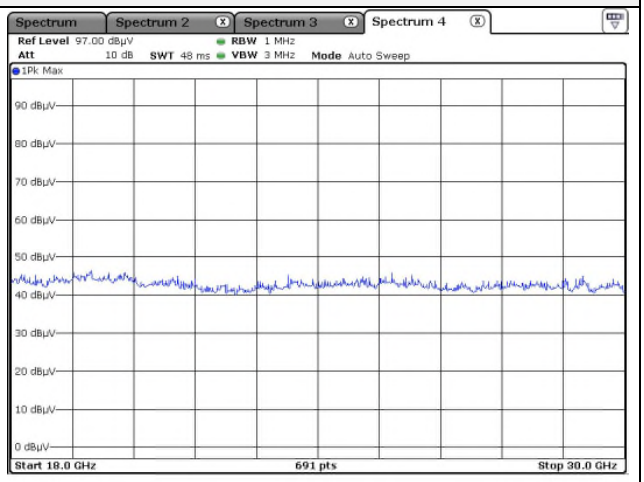


Note.

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

Test results (18 ㎓ to 30 ㎓)

Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	78(Worst case)
ANT #1	Dipole Antenna

Horizontal	Vertical
	

Note.

1. No spurious emission were detected above 18 ㎓.

Test results (Above 1 000 ㎒)

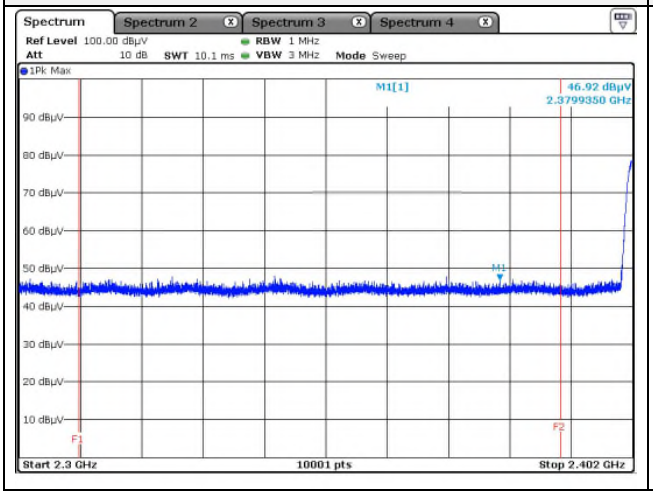
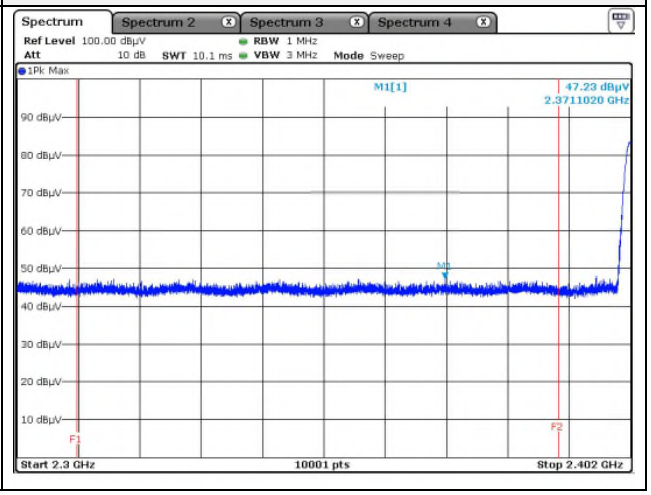
Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	00
ANT #2	PCB Antenna(Top)

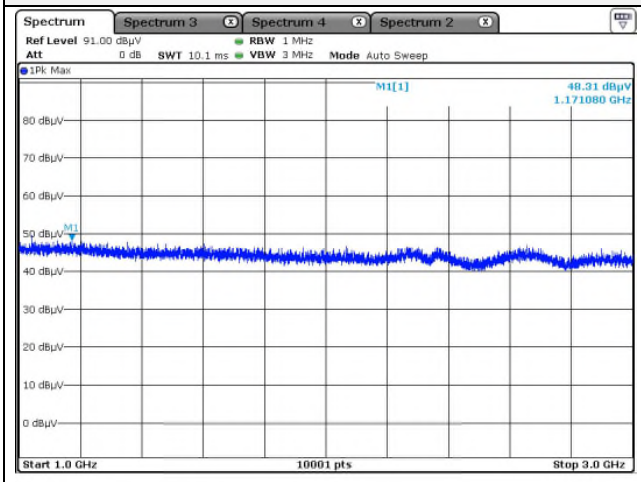
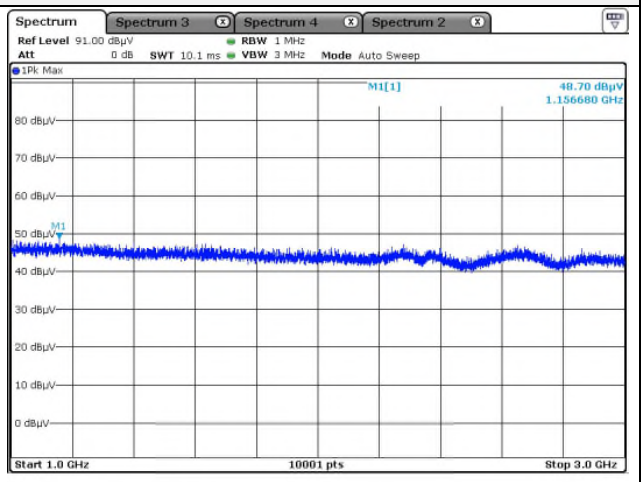
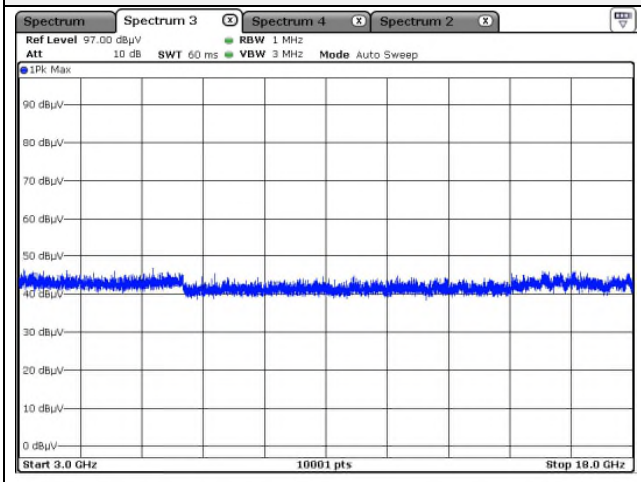
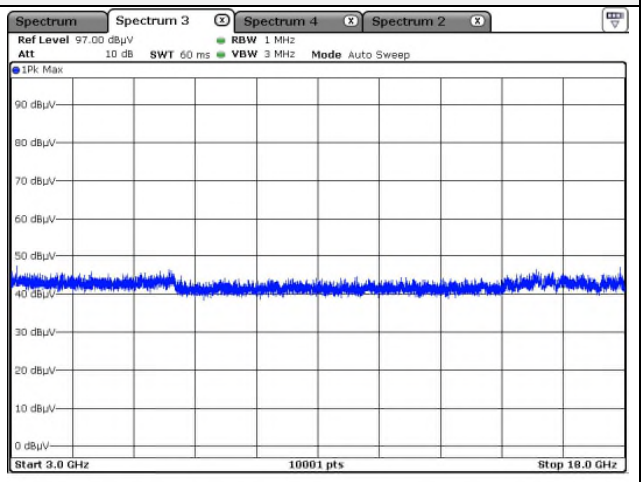
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1171.08	48.31	Peak	H	-11.26	-	37.05	74.00	36.95
1156.68	48.70	Peak	V	-11.27	-	37.43	74.00	36.57

- **Band edge**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2379.94	46.92	Peak	H	-7.06	-	39.86	74.00	34.14
2371.10	47.23	Peak	V	-7.02	-	40.21	74.00	33.79

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.

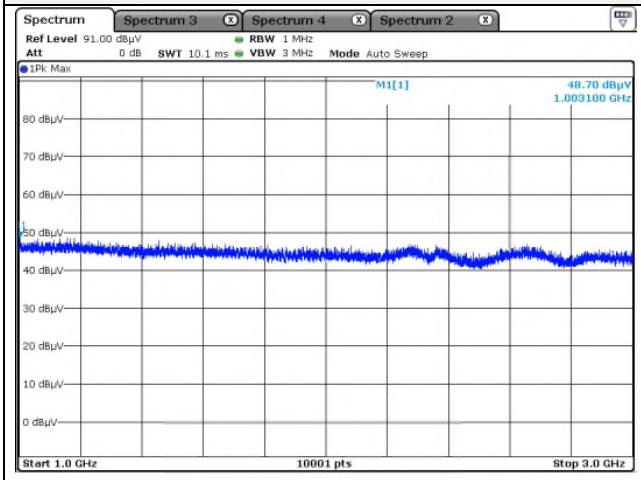
1. No spurious emission were detected above 3 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	39
ANT #2	PCB Antenna(Top)

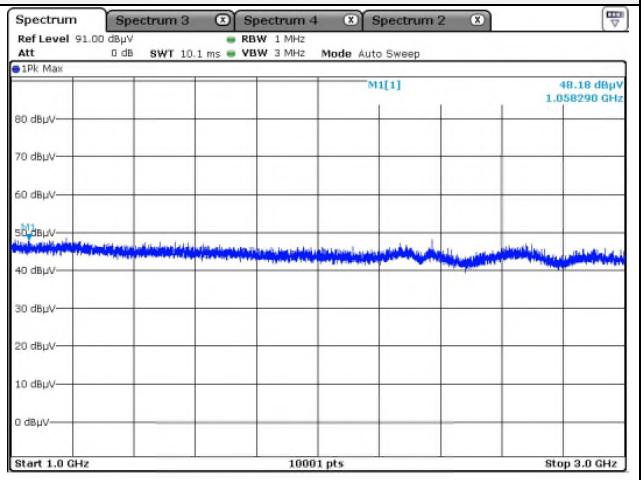
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1003.10	48.70	Peak	H	-11.32	-	37.38	74.00	36.62
1058.29	48.18	Peak	V	-11.30	-	36.88	74.00	37.12

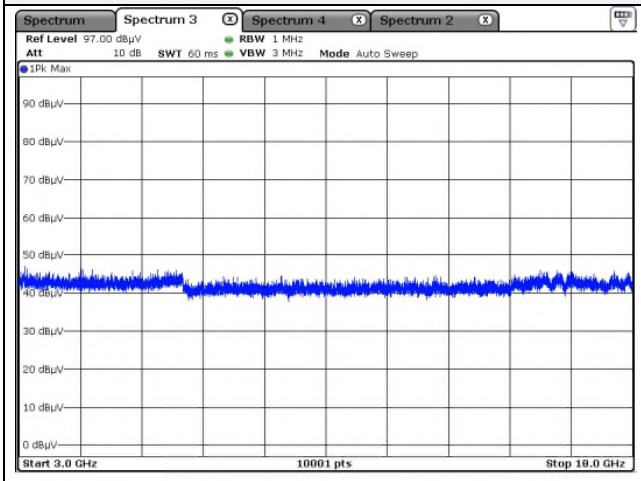
Horizontal // Peak for 1 ㎓ to 3 ㎓



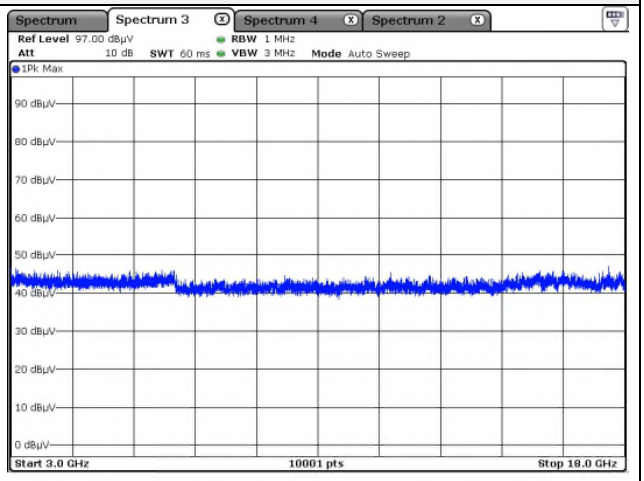
Vertical // Peak for 1 ㎓ to 3 ㎓



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:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	78
ANT #2	PCB Antenna(Top)

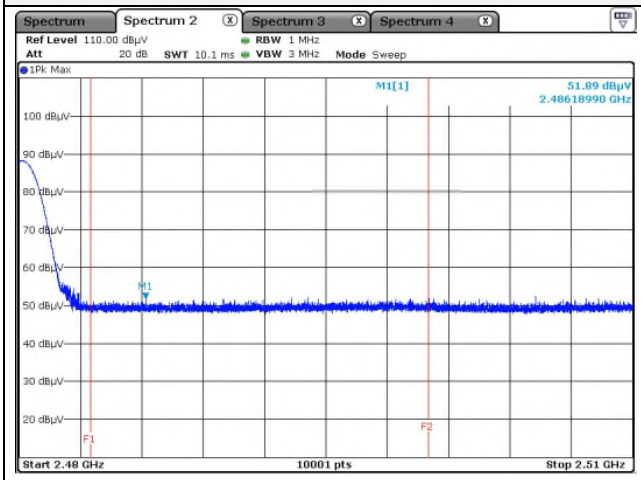
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1016.50	49.18	Peak	H	-11.31	-	37.87	74.00	36.13
1167.08	47.84	Peak	V	-11.26	-	36.58	74.00	37.42

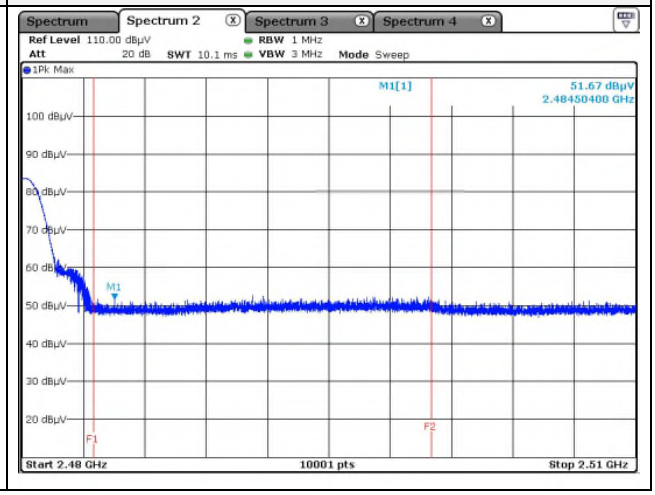
- **Band edge**

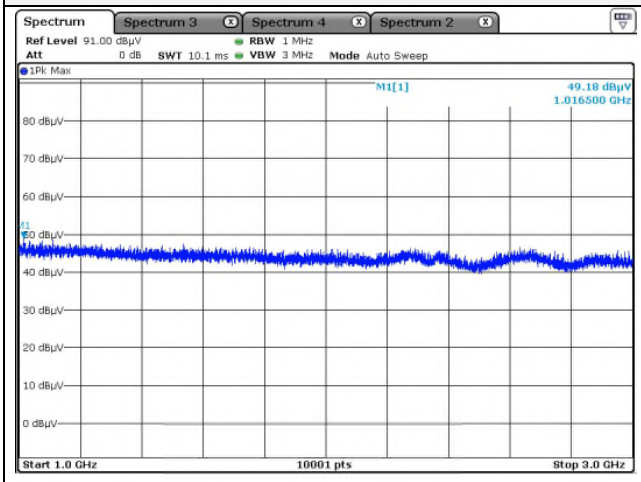
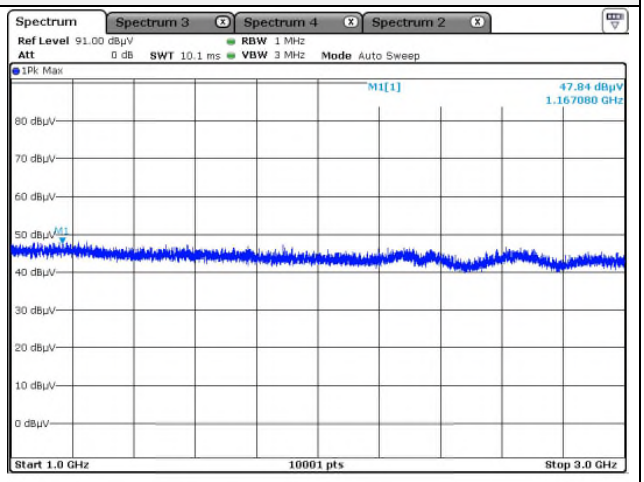
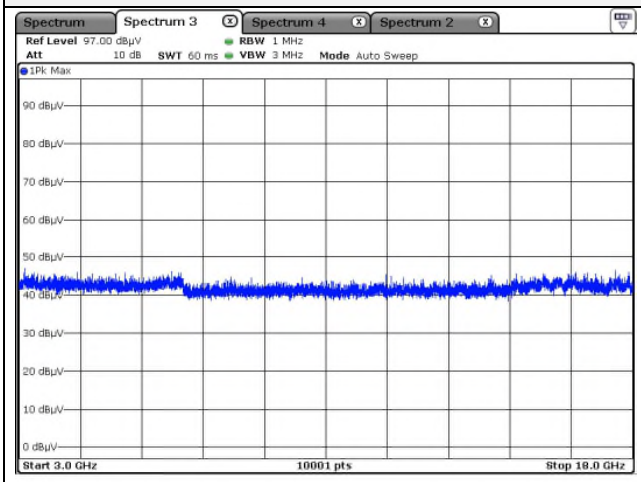
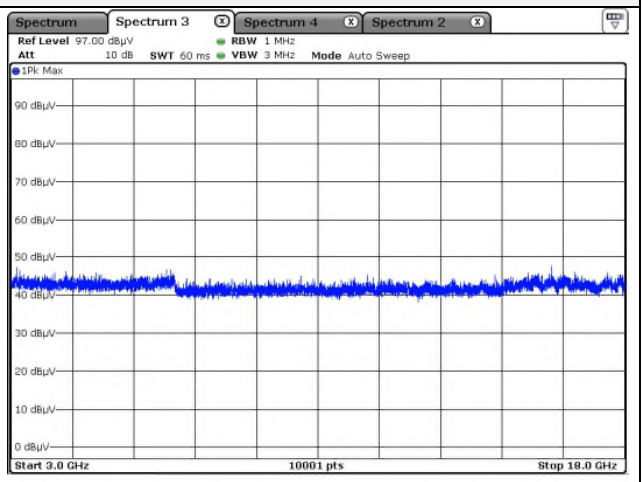
Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2486.19	51.89	Peak	H	-7.56	-	44.33	74.00	29.67
2484.50	51.67	Peak	V	-7.55	-	44.12	74.00	29.88

Restricted band // Horizontal // Peak



Restricted band // Vertical // Peak



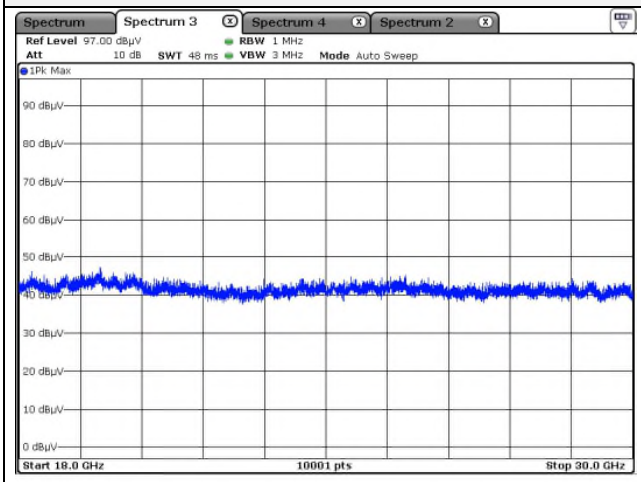
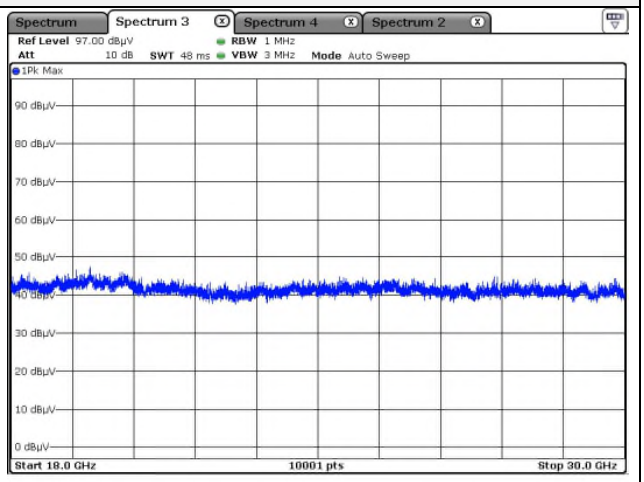
Horizontal // Peak for 1 ㎓ to 3 ㎓	Vertical // Peak for 1 ㎓ to 3 ㎓
	
Horizontal // Peak for 3 ㎓ to 18 ㎓	**Vertical // Peak for 3 ㎓ to 18 ㎓**
	

Note.

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

Test results (18 ㎓ to 30 ㎓)

Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	78(Worst case)
ANT #2	PCB Antenna(Top)

Horizontal	Vertical
	

Note.

1. No spurious emission were detected above 18 ㎓.

Test results (Above 1 000 ㎒)

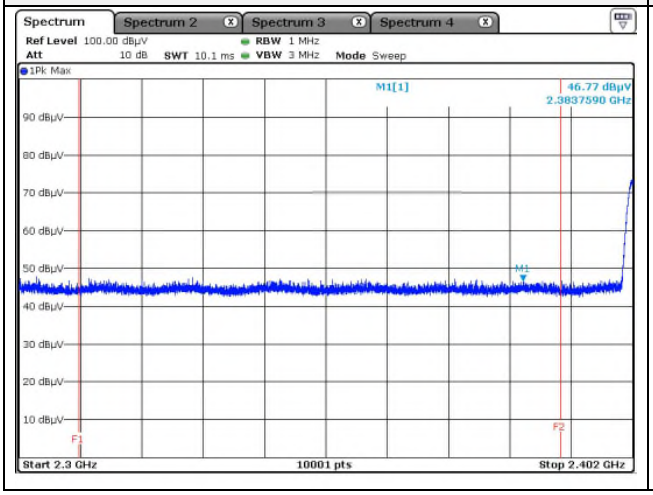
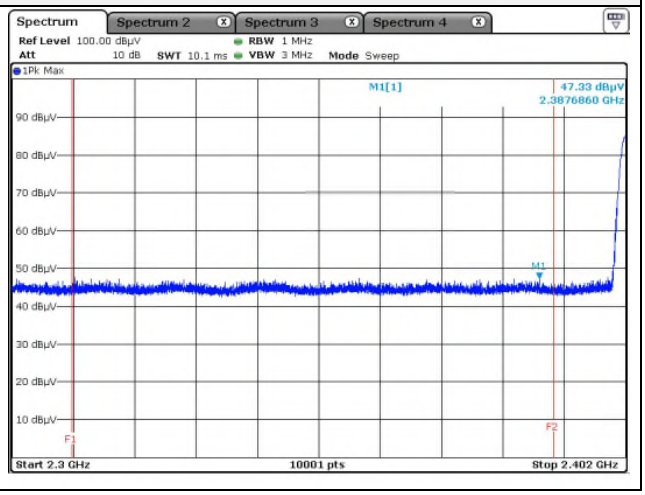
Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	00
ANT #3	PCB Antenna(Side)

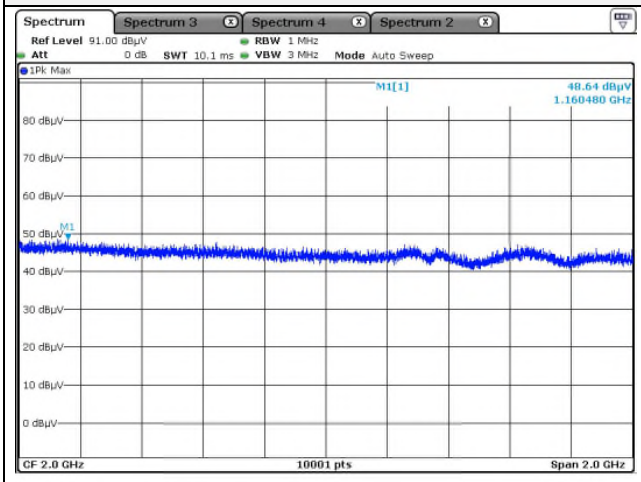
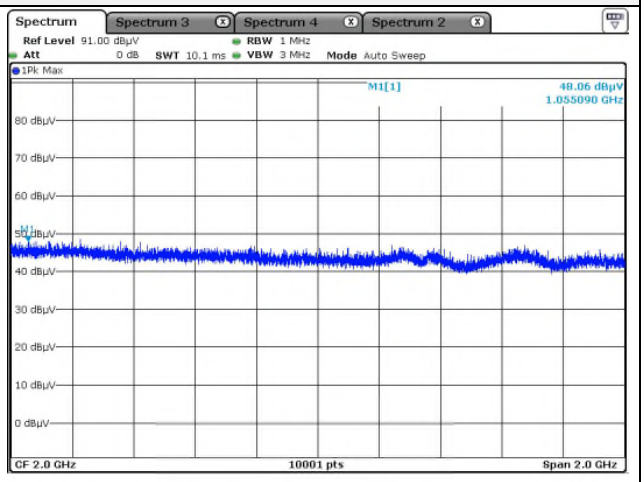
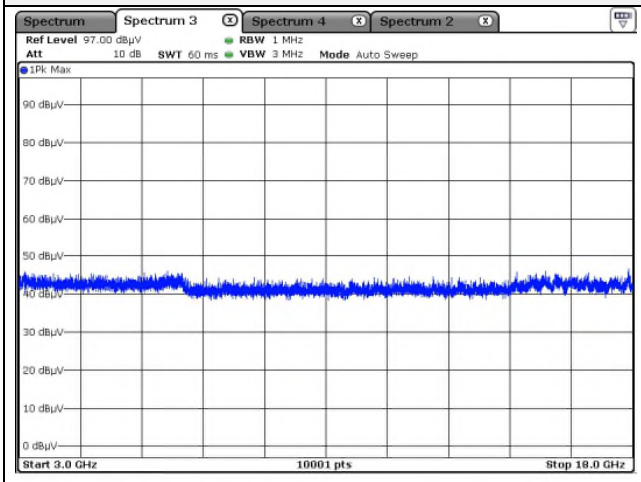
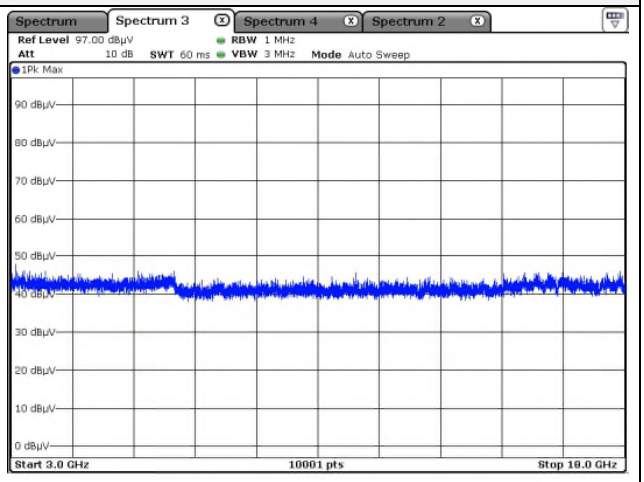
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1160.48	48.64	Peak	H	-11.27	-	37.37	74.00	36.63
1055.09	48.06	Peak	V	-11.30	-	36.76	74.00	37.24

- **Band edge**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2383.76	46.77	Peak	H	-7.07	-	39.70	74.00	34.30
2387.69	47.33	Peak	V	-7.09	-	40.24	74.00	33.76

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.

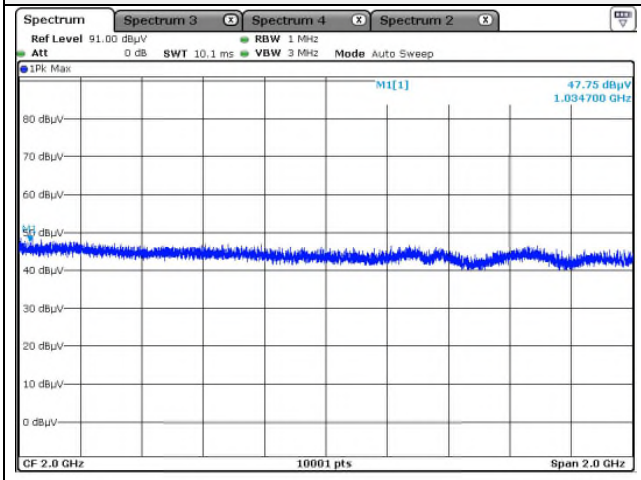
1. No spurious emission were detected above 3 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	39
ANT #2	PCB Antenna(Top)

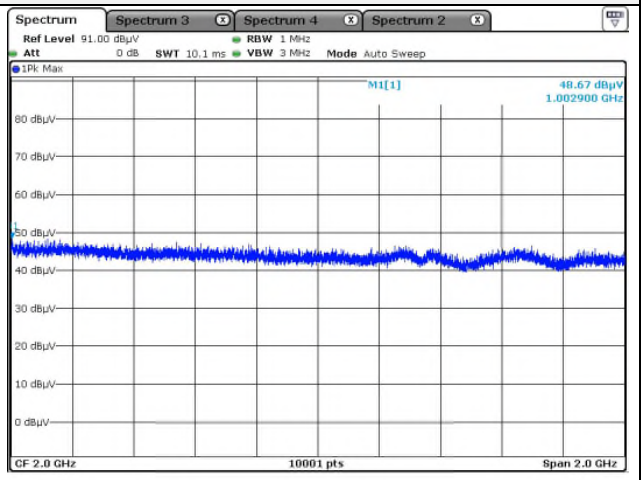
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1034.70	47.75	Peak	H	-11.30	-	36.45	74.00	37.55
1002.90	48.67	Peak	V	-11.32	-	37.35	74.00	36.65

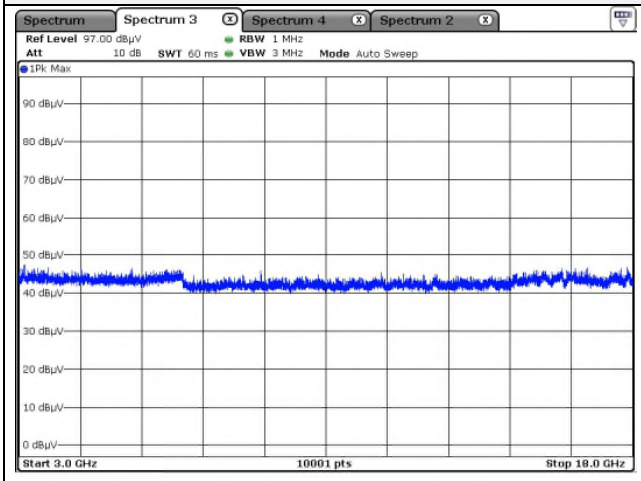
Horizontal // Peak for 1 ㎓ to 3 ㎓



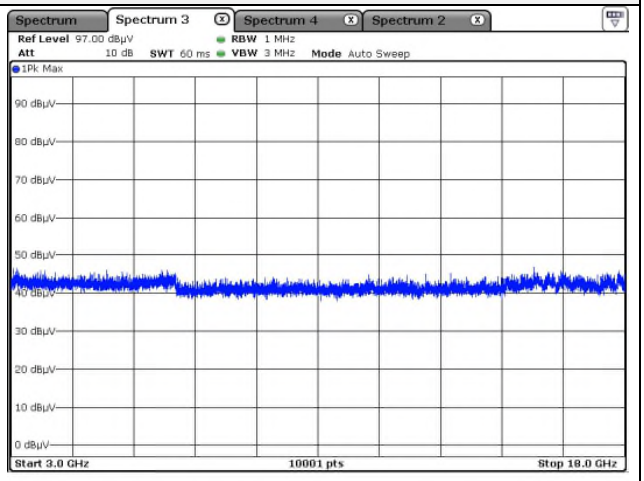
Vertical // Peak for 1 ㎓ to 3 ㎓



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:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	78
ANT #3	PCB Antenna(Side)

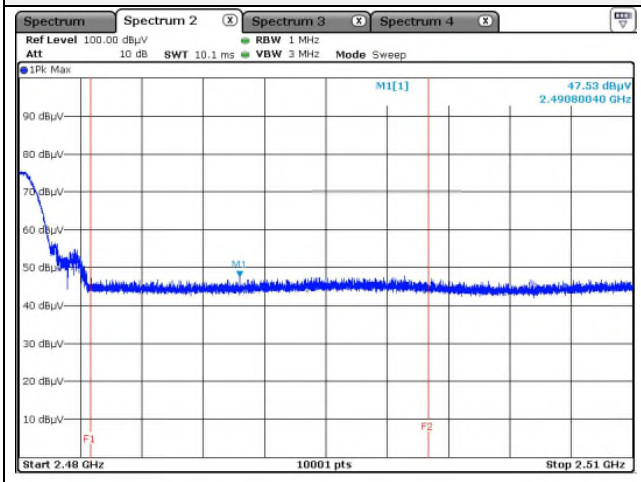
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1176.68	47.54	Peak	H	-11.26	-	36.28	74.00	37.72
1204.88	48.16	Peak	V	-11.25	-	36.91	74.00	37.09

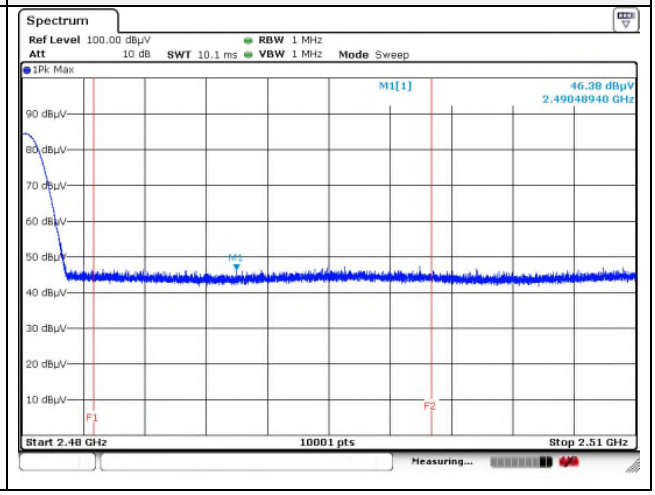
- **Band edge**

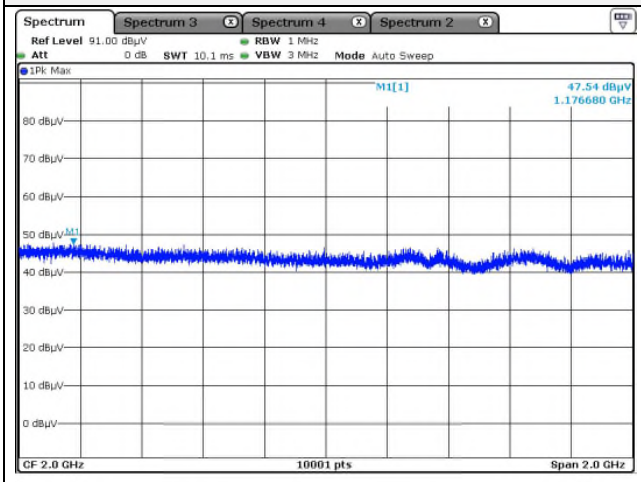
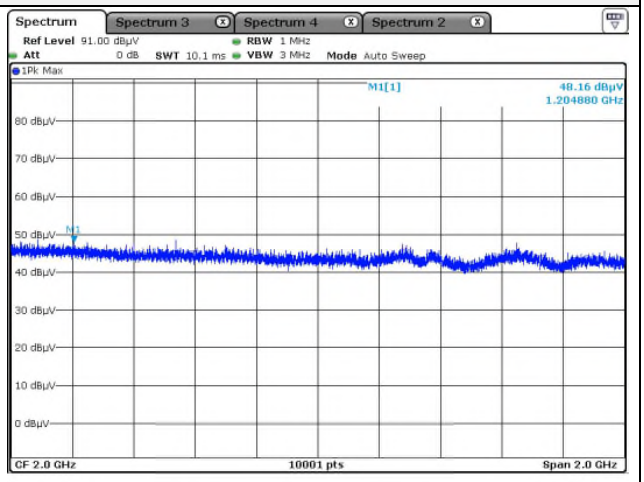
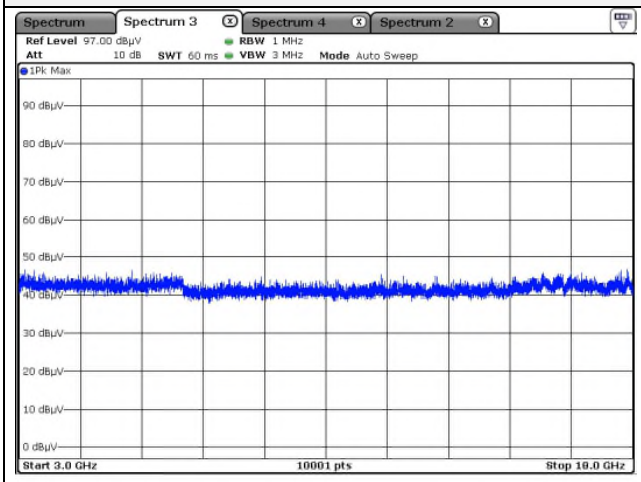
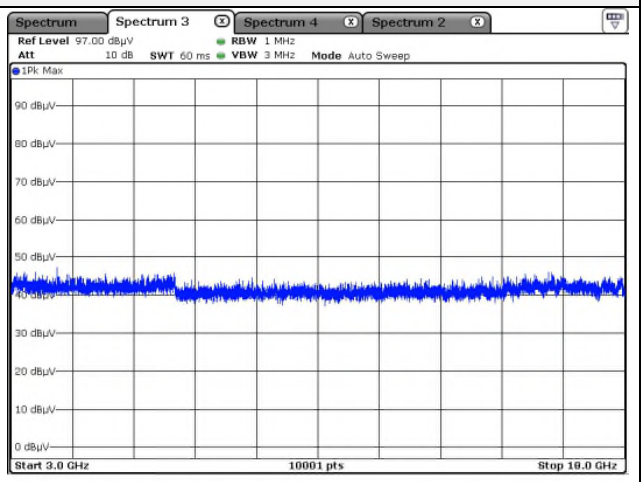
Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2490.80	47.53	Peak	H	-7.58	-	39.95	74.00	34.05
2490.49	46.38	Peak	V	-7.58	-	38.80	74.00	35.20

Restricted band // Horizontal // Peak



Restricted band // Vertical // Peak



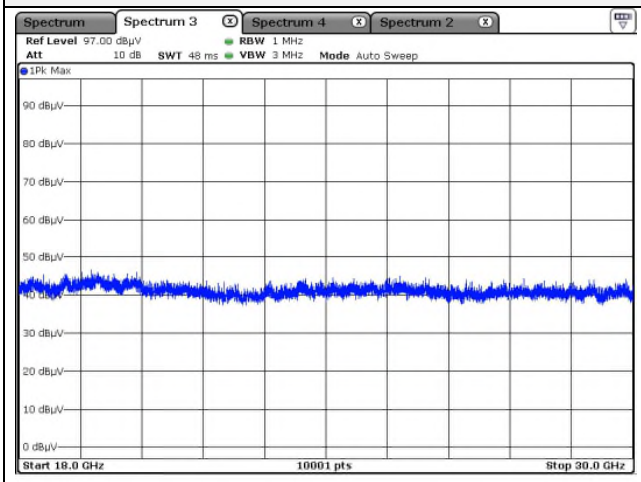
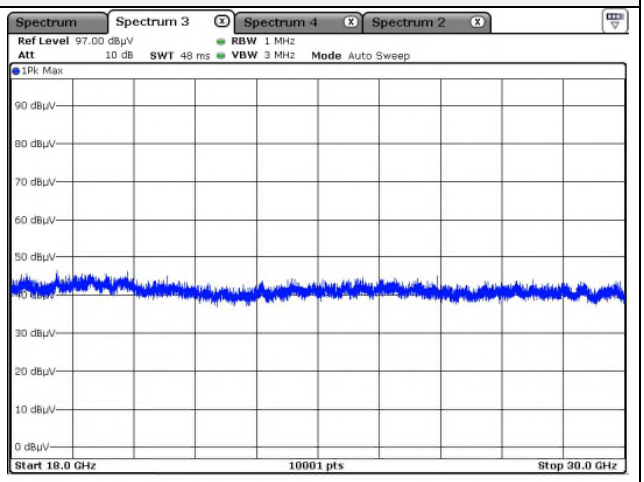
Horizontal // Peak for 1 ㎓ to 3 ㎓	Vertical // Peak for 1 ㎓ to 3 ㎓
	
Horizontal // Peak for 3 ㎓ to 18 ㎓	**Vertical // Peak for 3 ㎓ to 18 ㎓**
	

Note.

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

Test results (18 ㎓ to 30 ㎓)

Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	78(Worst case)
ANT #3	PCB Antenna(Side)

Horizontal	Vertical
	

Note.

1. No spurious emission were detected above 18 ㎓.

Test results (Above 1 000 ㎒)

Mode: Bluetooth + WLAN

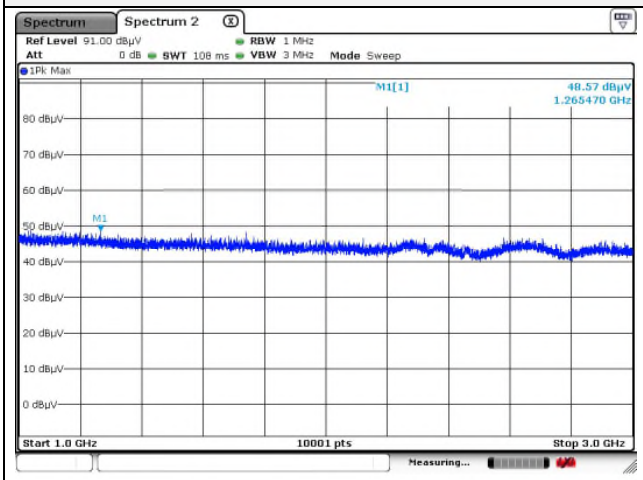
Distance of measurement: 3 meter

ANT #1 Dipole Antenna

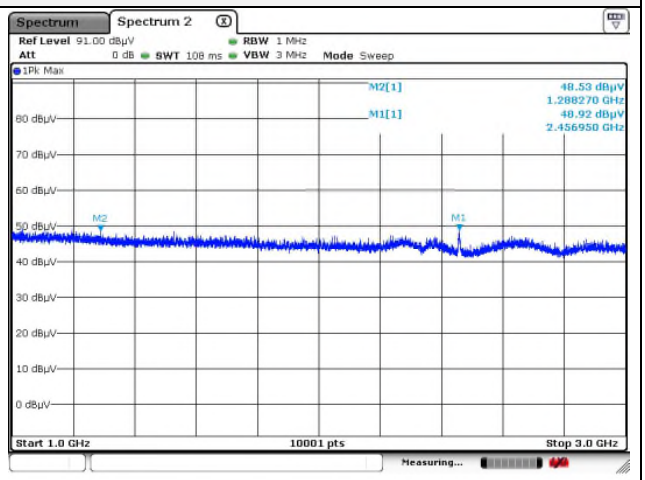
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1265.47	48.57	Peak	H	-11.23	-	37.34	74.00	36.66
1288.27	48.53	Peak	V	-11.22	-	37.31	74.00	36.69

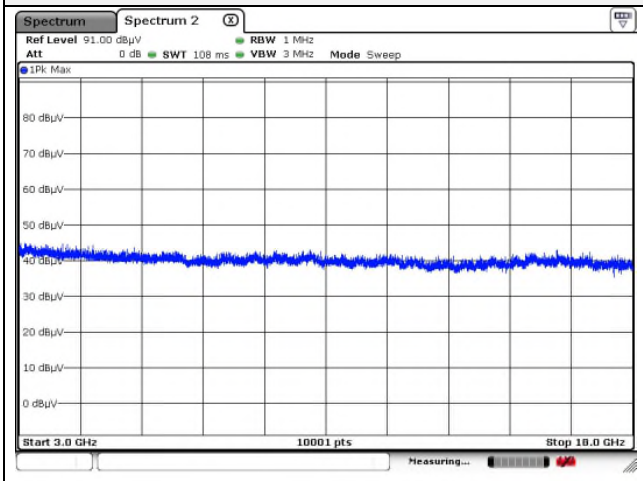
Horizontal // Peak for 1 ㎓ to 3 ㎓



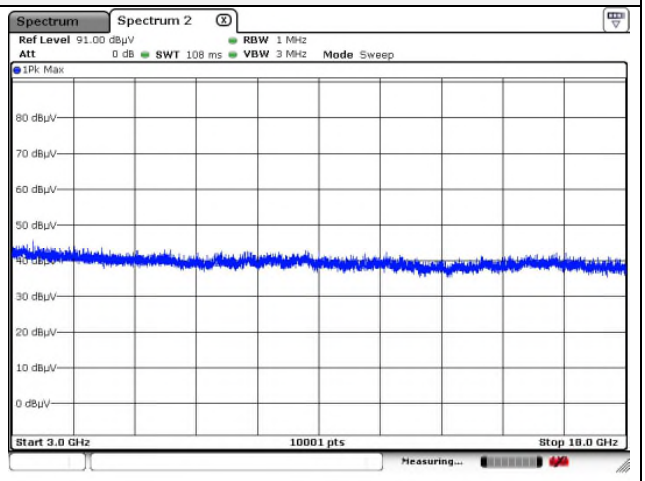
Vertical // Peak for 1 ㎓ to 3 ㎓

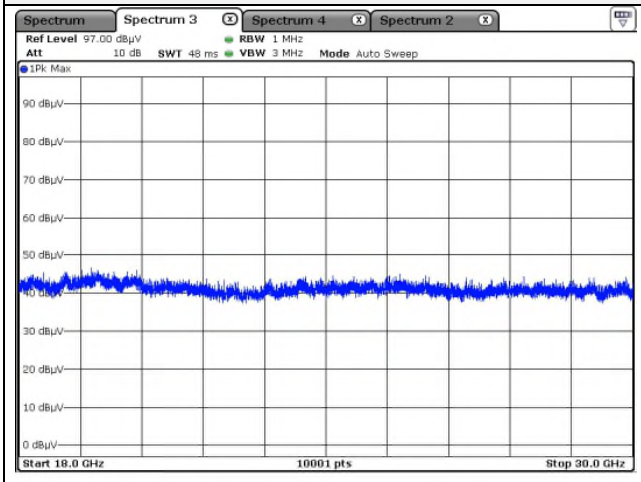
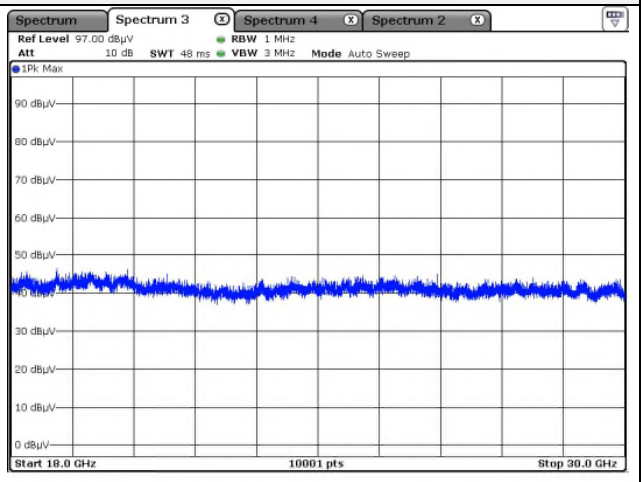


Horizontal // Peak for 3 ㎓ to 18 ㎓



Vertical // Peak for 3 ㎓ to 18 ㎓



Horizontal	Vertical
	

Note.

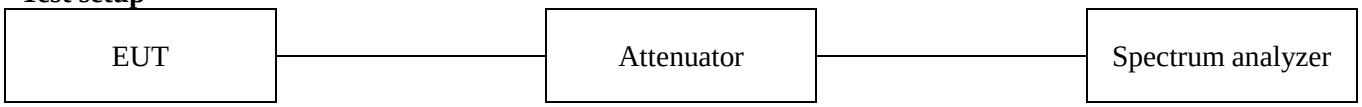
1. This product can operate both bluetooth and wlan at the same time, so it additionally performs spurious measurements in the simultaneous operation state.
2. No spurious emission were detected above 3 ㎓.
3. No spurious emission were detected above 18 ㎓.
4. Average test would be performed if the peak result were greater than the average limit.

3.7. Conducted band edge and out of band emissions

Test procedure

ANSI C63.10-2013 - Section 7.8.4 and 7.8.8

Test setup



Test setting

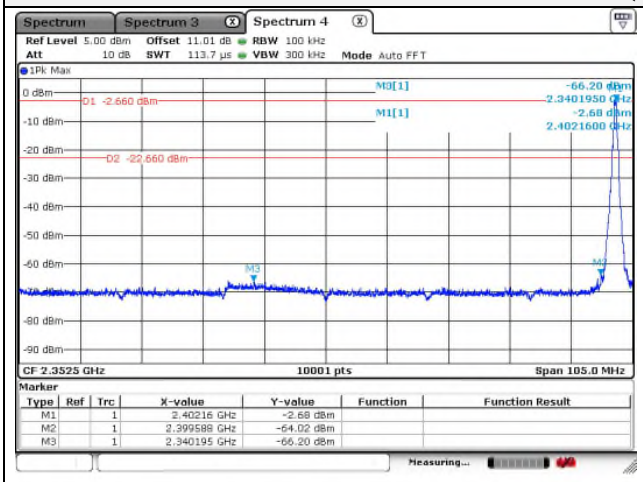
1. Span = wide enough to capture the peak level of the in-band emission and all spurious emissions(e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic.
2. RBW = 100 ㎑
3. VBW ≥ 300 ㎑
4. Detector = Peak
5. Number of sweep points ≥ 2 × Span/RBW
7. Trace mode = max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

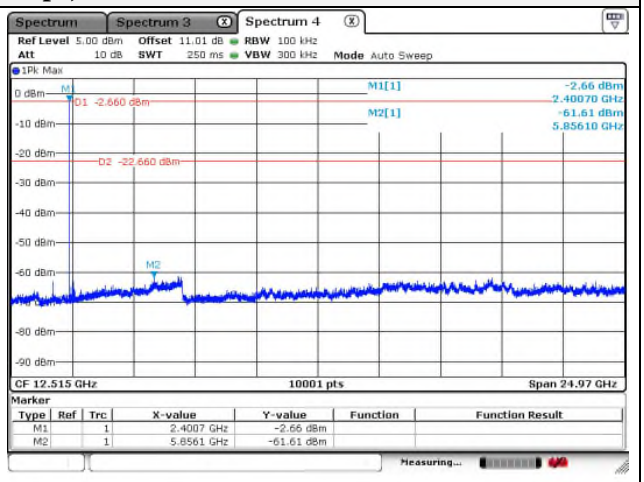
Limit

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))

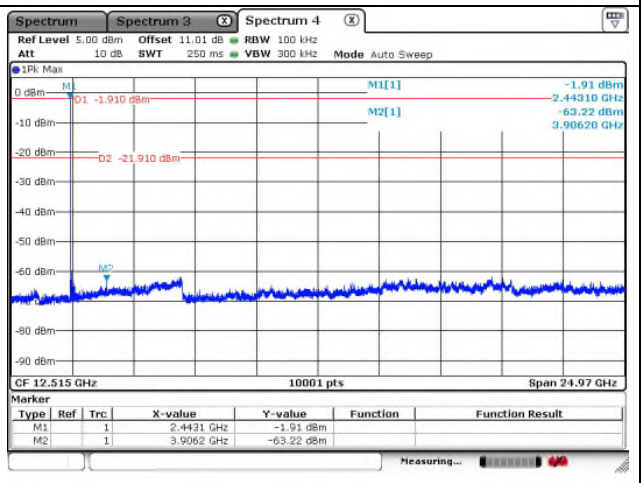
Test results

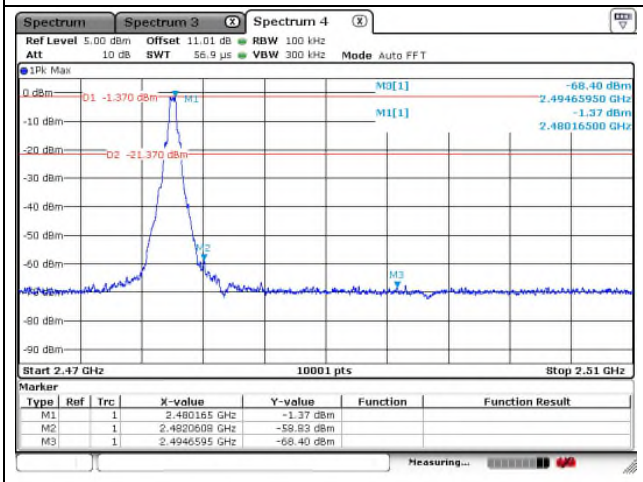
BDR(1Mbps)

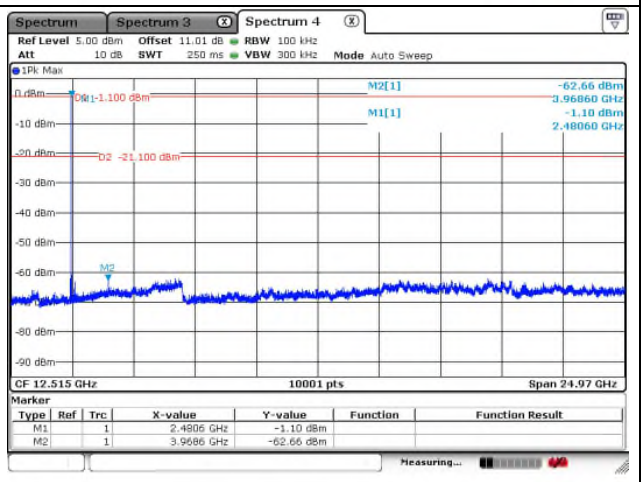




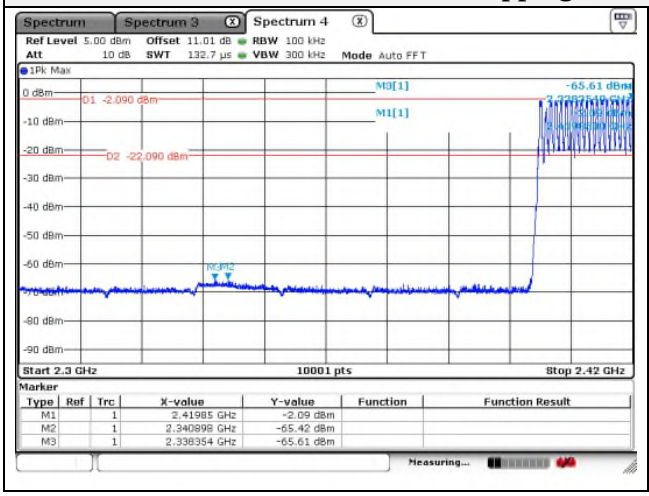
Blank

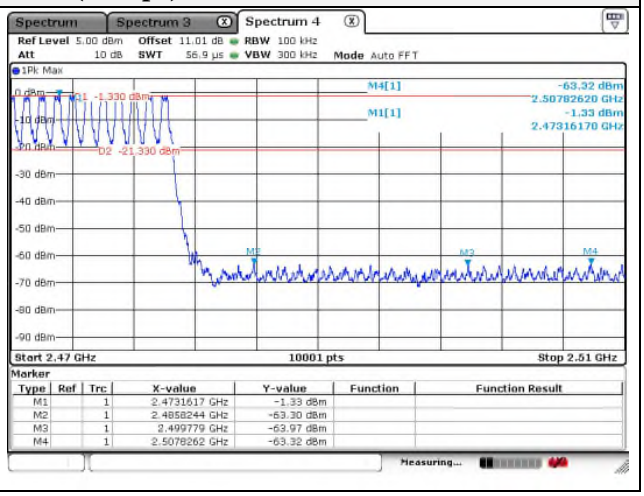






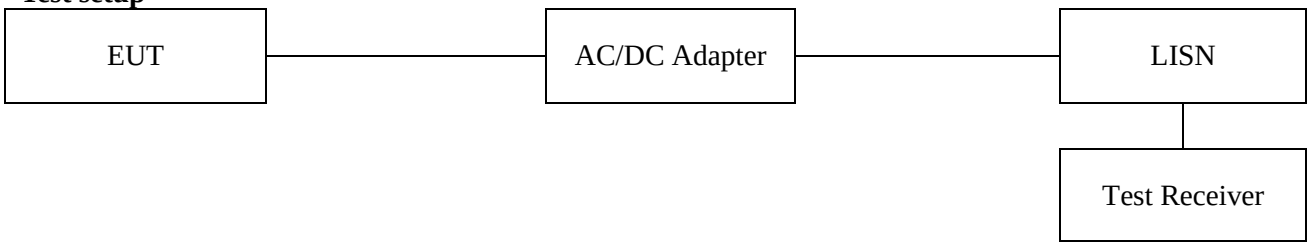
Hopping mode_BDR(1Mbps)





3.8. AC conducted emissions

Test setup



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

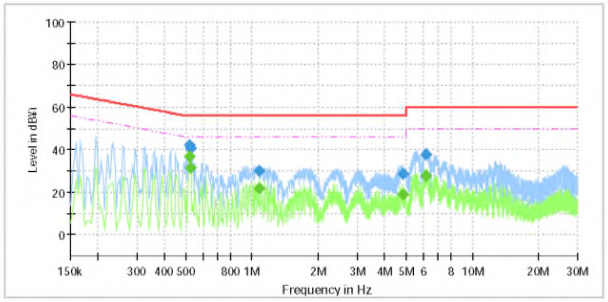
Note:

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

Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	78(Worst case)
ANT #1	Dipole Antenna(Worst case)

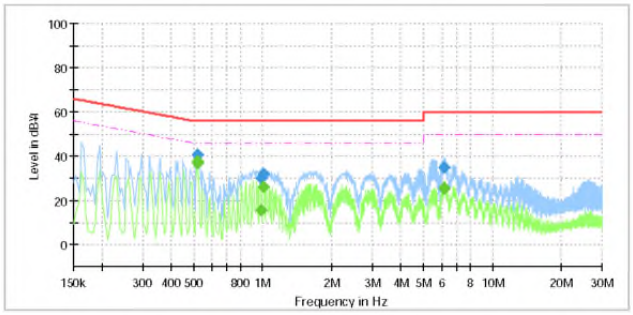
Hot Line



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.522000	---	36.67	46.00	9.33	1000.0	9.000	L1	19.7
0.522000	41.94	---	56.00	14.06	1000.0	9.000	L1	19.7
0.526000	---	31.63	46.00	14.37	1000.0	9.000	L1	19.7
0.526000	40.53	---	56.00	15.47	1000.0	9.000	L1	19.7
1.078000	---	21.65	46.00	24.35	1000.0	9.000	L1	19.8
1.078000	29.85	---	56.00	26.15	1000.0	9.000	L1	19.8
4.826000	---	18.81	46.00	27.19	1000.0	9.000	L1	19.9
4.826000	28.83	---	56.00	27.17	1000.0	9.000	L1	19.9
6.142000	---	27.50	50.00	22.50	1000.0	9.000	L1	20.1
6.142000	37.60	---	60.00	22.40	1000.0	9.000	L1	20.1
6.178000	---	27.63	50.00	22.37	1000.0	9.000	L1	20.1
6.178000	37.73	---	60.00	22.27	1000.0	9.000	L1	20.1

Neutral Line



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.518000	---	37.85	46.00	8.15	1000.0	9.000	N	19.7
0.518000	40.56	---	56.00	15.44	1000.0	9.000	N	19.7
0.522000	---	36.68	46.00	9.32	1000.0	9.000	N	19.7
0.522000	40.46	---	56.00	15.54	1000.0	9.000	N	19.7
0.986000	---	15.66	46.00	30.34	1000.0	9.000	N	19.7
0.986000	29.92	---	56.00	26.08	1000.0	9.000	N	19.7
1.010000	---	26.01	46.00	19.99	1000.0	9.000	N	19.7
1.010000	31.80	---	56.00	24.20	1000.0	9.000	N	19.7
6.158000	---	25.71	50.00	24.29	1000.0	9.000	N	20.1
6.158000	34.66	---	60.00	25.34	1000.0	9.000	N	20.1
6.182000	---	25.25	50.00	24.75	1000.0	9.000	N	20.1
6.182000	34.63	---	60.00	25.37	1000.0	9.000	N	20.1

Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
EMI TEST RECEIVER	ESU26	Rohde & Schwarz	100552	1 year	2021.04.01
SPECTRUM ANALYZER	R&S	FSV40	101725	1 year	2021.06.22
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2021.01.15
SIGNAL GENERATOR	KEYSIGHT	N5182B	MY59100115	1 year	2021.05.12
Power Meter	Anritsu	ML2495A	1438001	1 year	2021.05.12
Pulse Power Sensor	Anritsu	MA2411B	1339205	1 year	2021.05.12
DC POWER SUPPLY	SORENSEN	DCS40-75E	1408A02745	1 year	2021.01.15
ATTENUATOR	Mini-Circuits	BW-S10-2W263+	1	1 year	2021.01.17
Loop Antenna	Schwarzbeck	FMZB1513	225	2 years	2021.02.15
BILOG ANTENNA	VULB 9168	SCHWARZBECK	9168-461	2 years	2022.05.26
HORN ANTENNA	A.H.	SAS-571	414	1 years	2021.01.31
BAND REJECT FILTER	MICRO-TRONICS	BRM50702	G272	1 year	2021.01.15
BAND REJECT FILTER	MICRO-TRONICS	BRM50716	G199	1 year	2021.01.15
AMPLIFIER	310N	SONOMA INSTRUMENT	401123	1 year	2021.06.08
PREAMPLIFIER	8449B	AGILENT	8008A01640	1 year	2021.04.01
ATTENUATOR	F04-C1206-01	SRT	20022403	1 year	2021.05.06
EMI Test Receiver	R&S	ESR3	101781	1 year	2021.01.20
EMI Test Receiver	R&S	ESU26	100552	1 year	2021.04.01
Pulse Limiter	R&S	ESH3-Z2	101915	1 year	2021.01.02
LISN	R&S	ENV216	101787	1 year	2021.01.02

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
Notebook computer	LG Electronics Inc.,	15UD590	904QCSF564006
Test Jig Board	N/A	N/A	N/A