TEST REPORT

Part 15 Subpart C 15.247

Equipment under test	Bluetooth class 1 Module
Model name	SBM-2715-C2
FCC ID	2AS8T-SBM-2715-C2
Applicant	sangshin elecom co.,LTD.
Manufacturer	sangshin elecom co.,LTD.
Date of test(s)	2019.05.14 ~ 2019.05.22
Date of issue	2019.06.04

Issued to
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Test and report completed by :	**Report approval by :**
	
Yeong-Jun, Cho Test engineer	Hyeon-Su, Jang Technical manager

Revision history

Revision	Date of issue	Test report No.	Description
-	2019.06.04	KES-RF-19T0065	Initial

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1. General information

Applicant:	sangshin elecom co.,LTD.
Applicant address:	30049 507, Dangsan-ro, yeonseo-myeon, Sejong-si, Republic of Korea
Test site:	KES Co., Ltd.
Test site address:	3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea 473-21, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea
Test Facility	FCC Accreditation Designation No.: KR0100, Registration No.: 444148
FCC rule part(s):	15.247
FCC ID:	2AS8T-SBM-2715-C2
Test device serial No.:	☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test	Bluetooth class 1 Module
Frequency range	2 402 ㎒ ~ 2 480 ㎒ (BDR)
Model:	SBM-2715-C2
Modulation technique	BT : GFSK
Number of channels	2 402 ㎒ ~ 2 480 ㎒ (BDR) : 79 ch
Antenna specification	1. Antenna type : Dipole antenna, Peak gain : 5 dBi 2. Antenna type : Dipole antenna, Peak gain : 3 dBi
Power source	DC 3.3 V

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

15.247(g): 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): 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 **sangshin elecom co.,LTD. SBM-2715-C2 FCC ID: 2AS8T-SBM-2715-C2** 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
ANSI C63.4-2014

1.3. Device modifications

N/A

1.4. Frequency/channel operations

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

1.5. Accessory information

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

1.6. Software and Firmware description

The software and firmware installed in the EUT is version 0.9

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(㏈).
= 1.52 + 10 = 11.52 (㏈)

1.8. Measurement Uncertainty

Test Item		Uncertainty
Uncertainty for Conduction emission test		2.62 dB
Uncertainty for Radiation emission test (include Fundamental emission)	9kHz - 30MHz	4.54 dB
	30MHz - 1GHz	4.36 dB
	Above 1GHz	5.00 dB
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
15.207, 15.247(d)	Conducted band edge and out of band emissions	Pass
15.207	AC conducted emissions	Pass

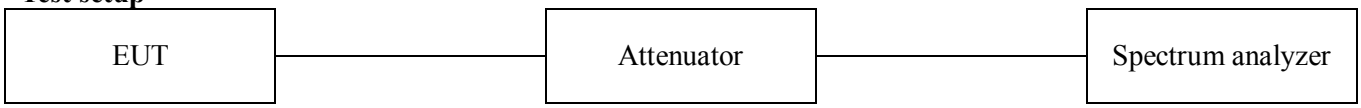
3. Test results

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

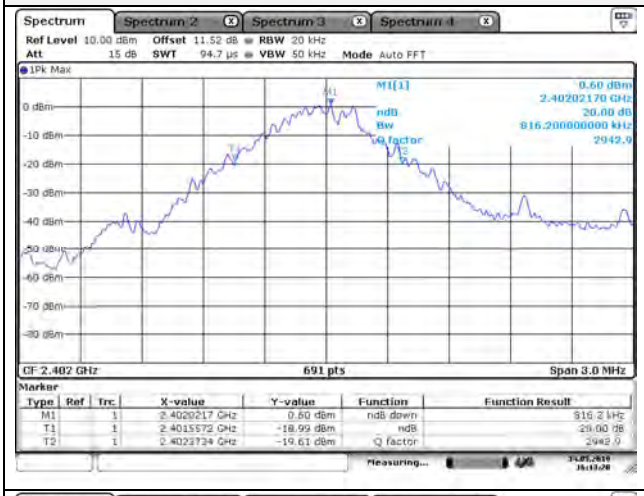
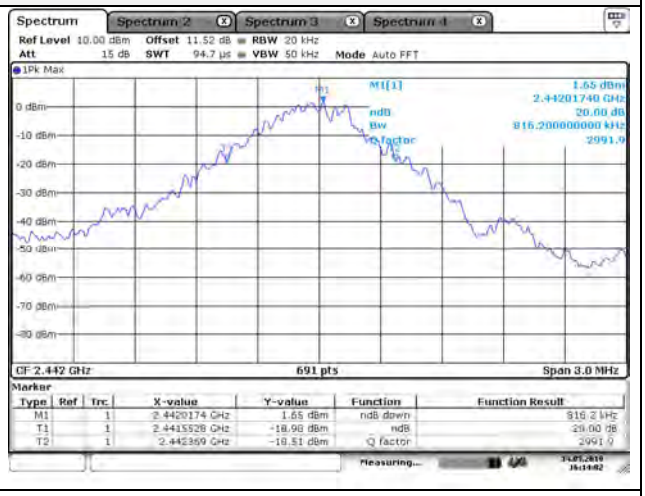
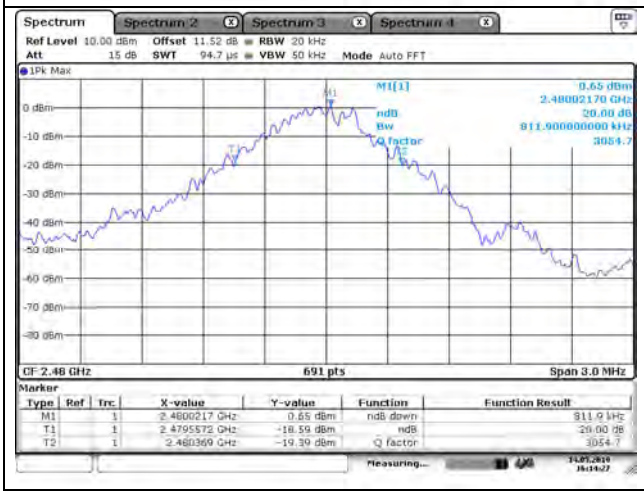
Limit

Not applicable

Test Result

Frequency(㎒)	Channel no.	Data rate(Mbps)	Measured bandwidth(㎒)
2 402	00	1	0.816
2 442	40		0.816
2 480	78		0.812

Test Result

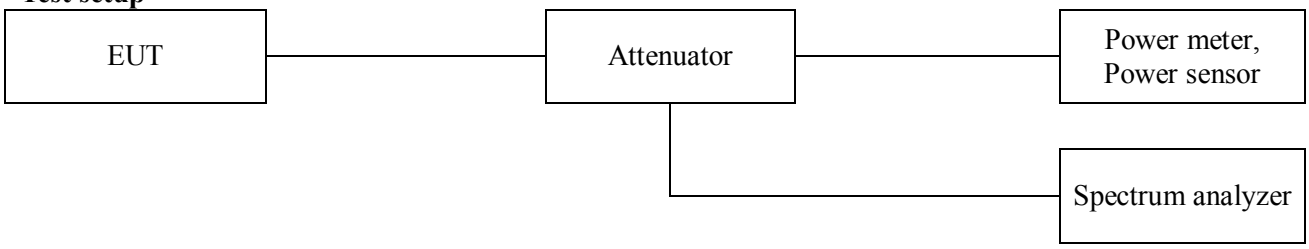
BDR(1Mbps)	
	
	Blank

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 Result

Frequency(㎒)	Channel no.	Data rate(Mbps)	Peak Power (dBm)	Average Power (dBm) Notel	Power Limit (dBm)
2 402	00	1	4.65	4.16	20.97
2 442	40		6.05	5.64	20.97
2 480	78		5.09	4.62	20.97

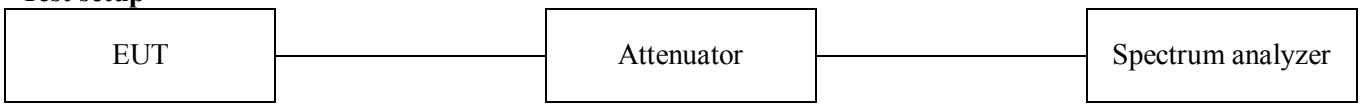
Note.
1. The output power was tested using an power meter.

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 ㎽.

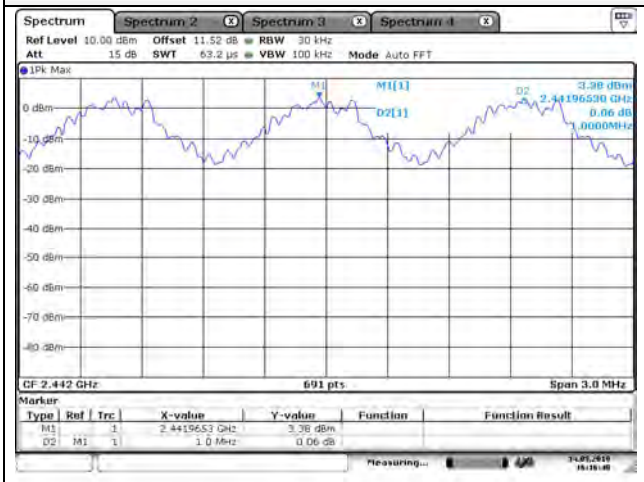
Test Result

Frequency(㎒)	Channel no.	Data rate(Mbps)	Channel Separation (㎒)
2 442	40	1	1.000

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.

Test Result

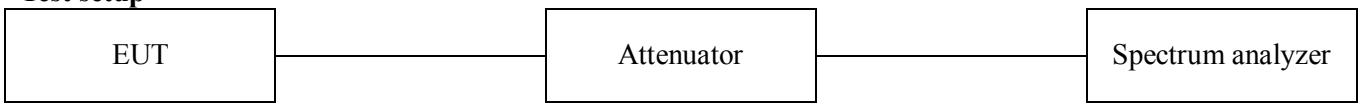
Hopping mode_BDR(1Mbps)	
	Blank

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

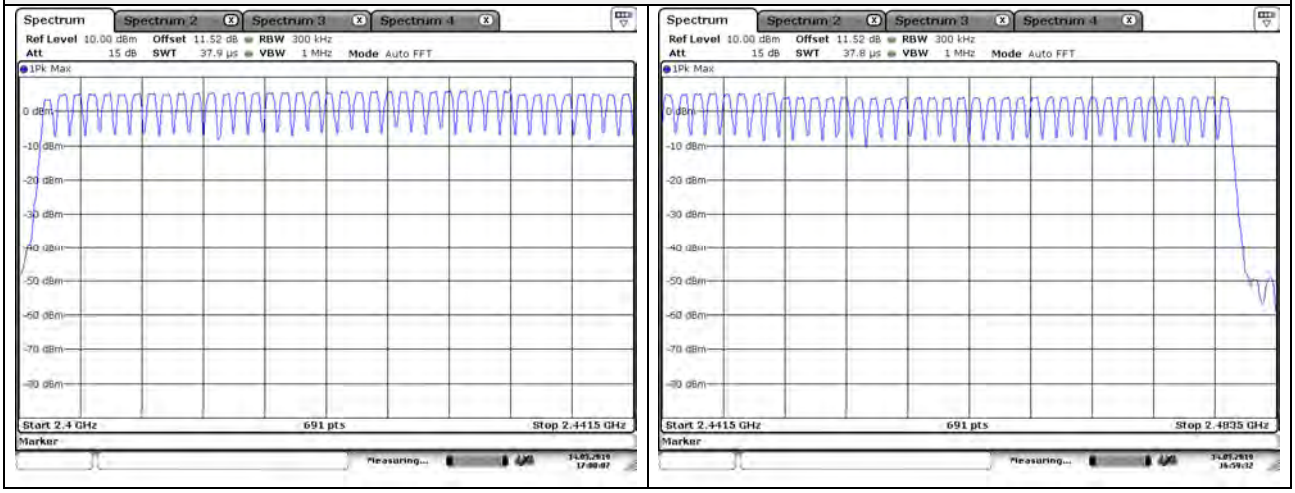
All the trace to stabilize.

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 Result

Hopping mode_BDR(1Mbps)

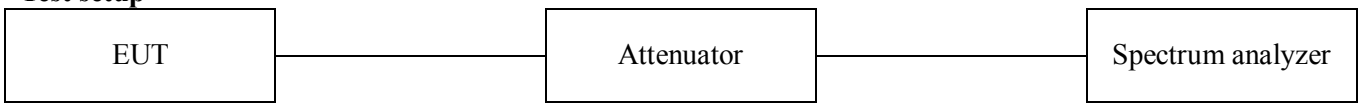


3.5. Time of occupancy

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 Result

Operation mode: GFSK

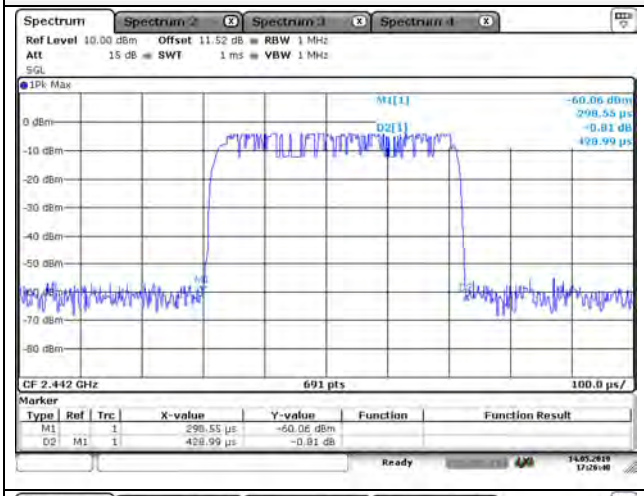
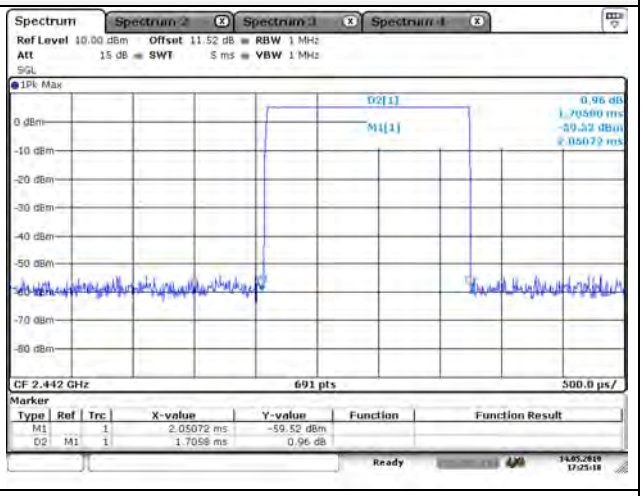
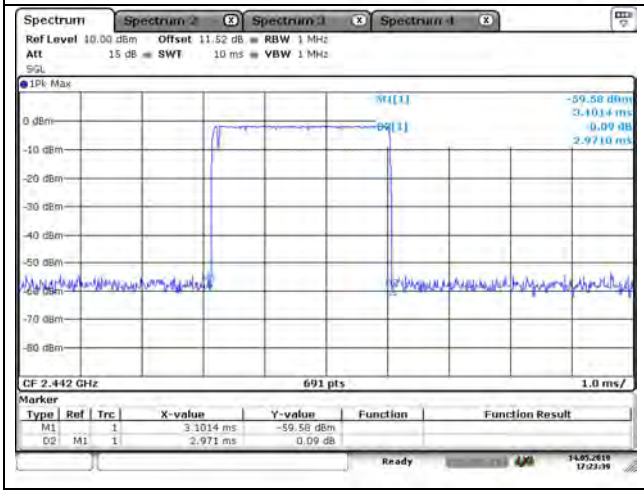
Packet type	Frequency (㎒)	Dwell time (ms)	Time of occupancy on the Tx channel in 31.6 sec (ms)	Limit for time of occupancy on the Tx channel in 31.6 sec (ms)
DH1	2 442	0.429	137.28	400
DH3	2 442	1.706	272.96	400
DH5	2 442	2.971	316.91	400

Note:

Normal Mode

DH1: Dwell time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 137.28 (ms)
DH3: Dwell time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 272.96 (ms)
DH5: Dwell time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 316.91 (ms)

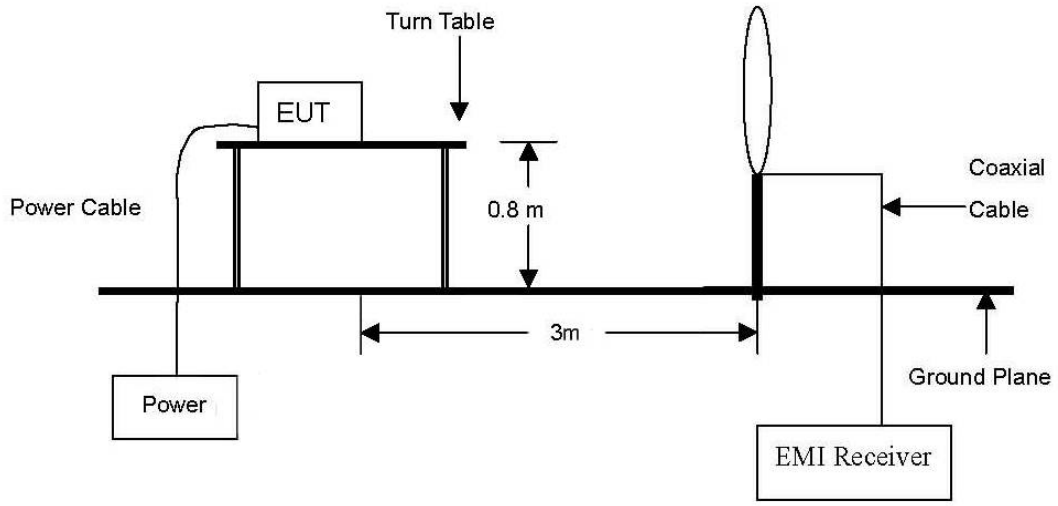
Test Result

BDR(1Mbps)	
	
	Blank

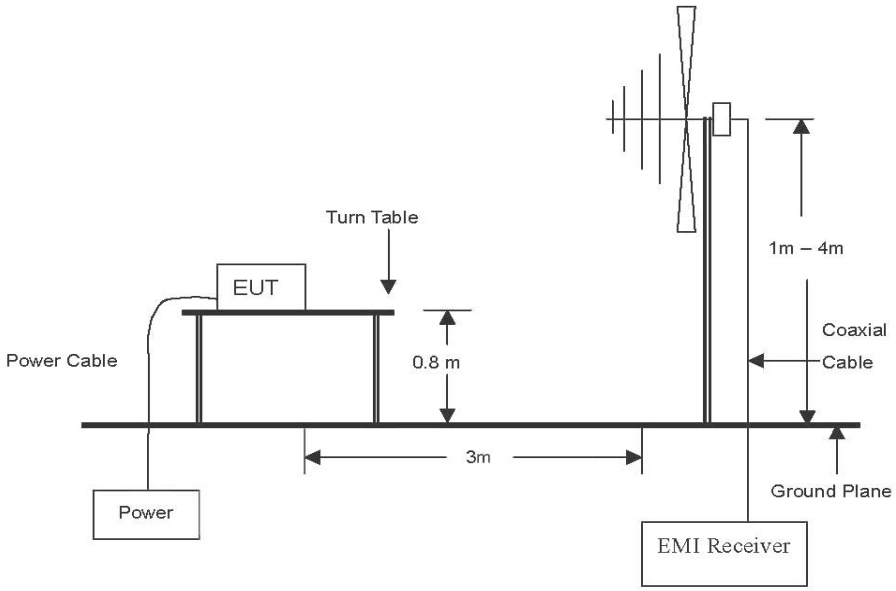
3.6. Radiated restricted band and emissions

Test setup

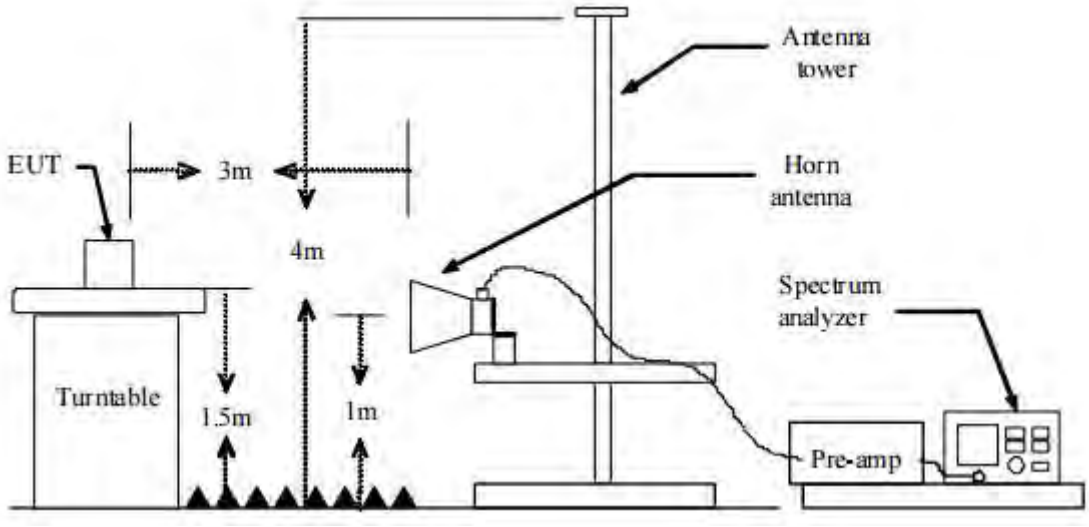
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



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

All measurements were performed using a Loop antenna, Trilog-broadband antenna, Horn antenna. The antenna was investigated with three polarizations, and horizontal and vertical polarizations were reported as the worst case**.**

1. The EUT is placed on a turntable, which is 0.8 m (below 1 ㎓) and 1.5 m (above 1 ㎓) 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. Below 30 ㎒ : 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 and perpendicular of the antenna are set to make the measurement.
6. Above 30 ㎒ : Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. Repeat above procedures until the measurements for all frequencies are complete.
8. Peak emission levels are measured by setting the instrument as follows:
   Span = wide enough to fully capture the emission being measured
   RBW = as specified in Table 9
   VBW ≥ [3 × RBW]
   Detector = peak
   Sweep time = auto
   Trace mode = max hold.

   Table 9—RBW as a function of frequency

Frequency	RBW
9 kHz to 150 kHz	200 Hz to 300 Hz
0.15 MHz to 30 MHz	9 kHz to 10 kHz
30 MHz to 1000 MHz	100 kHz to 120 kHz
>1000 MHz	1 MHz

   If the peak-detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement.
9. The EUT shall be configured to operate at the maximum achievable duty cycle.
   Measure the duty cycle D of the transmitter output signal as described in 11.6.
   RBW = 1 MHz (unless otherwise specified).
   VBW ≥ [3 × RBW].
   Detector = RMS (power averaging), 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.
   Averaging type = power (i.e., rms):
   Sweep time = auto.
   Perform a trace average of at least 100 traces.
10. Duty Cycle Correction Factor (79 channel hopping)
    a. Time to cycle through all channels = Δt=τ[㎳] × 79 channels = 234.709 ㎳, where τ = pulse width
    b. 100 ㎳/ Δt[㎳] = H → Round up to next highest integer, H '=1
    c. Worst Case Dwell Time = τ[㎳] × H' = 2.971 ㎳
    d. Duty Cycle Correction = 20log (Worst Case Dwell Time/ 100㎳) ㏈ = -30.54 ㏈

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. BDR, EDR), and modulations/data rates were investigated among DSS band.
   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

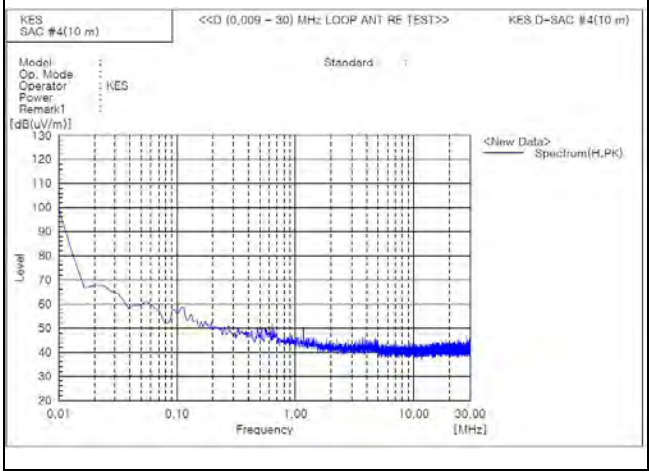
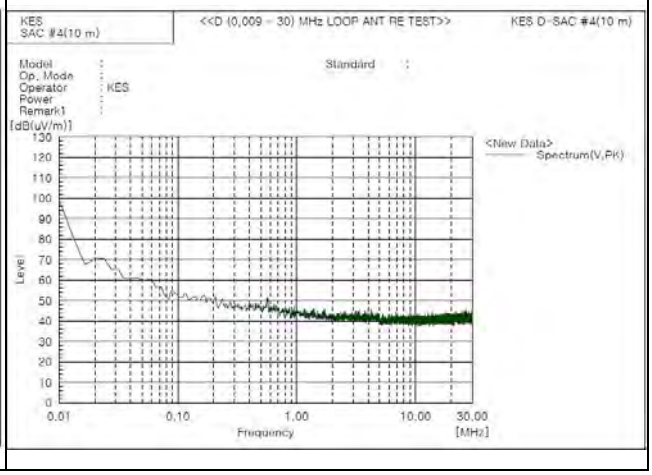
According to 15.209(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values：

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:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	00(Worst case)

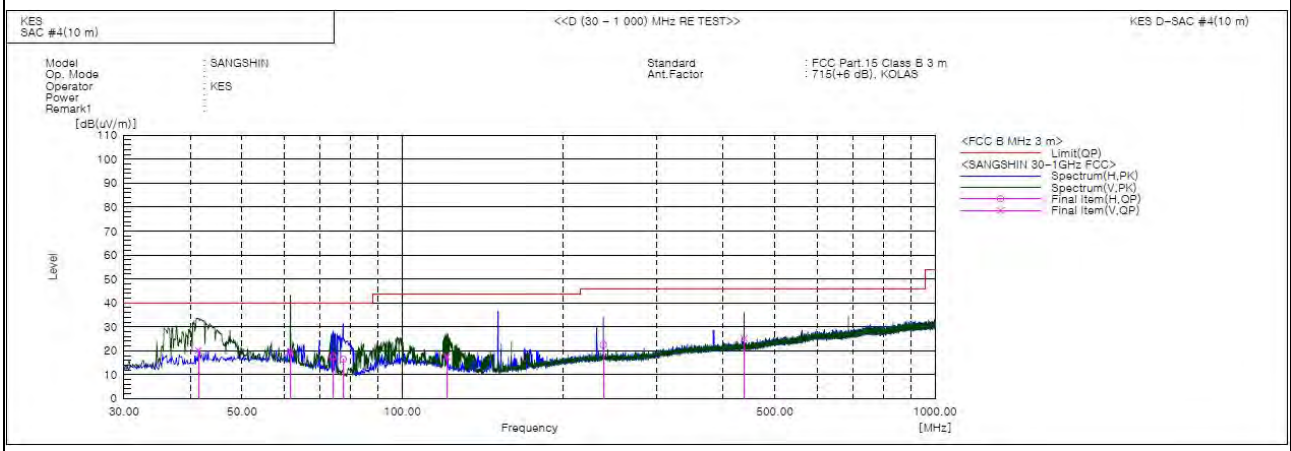
Horizontal	Vertical
	

- No spurious emissions were detected

Test results (Below 1 000 ㎒) – Worst case

Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	00(Worst case)

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	41.398	V	43.1	-23.0	20.1	40.0	19.9	142.0	150.0	
2	61.646	V	42.8	-23.4	19.4	40.0	20.6	133.0	66.0	
3	74.135	H	44.6	-27.2	17.4	40.0	22.6	351.0	87.0	
4	77.409	H	44.5	-28.1	16.4	40.0	23.6	366.0	127.0	
5	121.059	V	42.6	-25.0	17.6	43.5	25.9	155.0	3.0	
6	238.429	H	43.8	-21.3	22.5	46.0	23.5	326.0	337.0	
7	438.249	V	41.3	-16.2	25.1	46.0	20.9	100.0	66.0	

Test results (Above 1 000 ㎒)

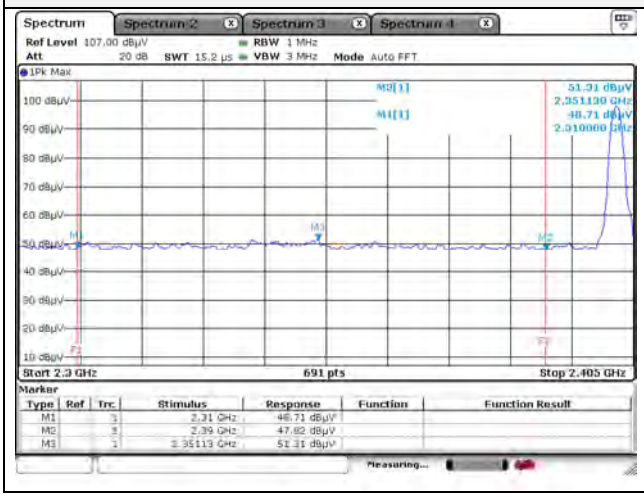
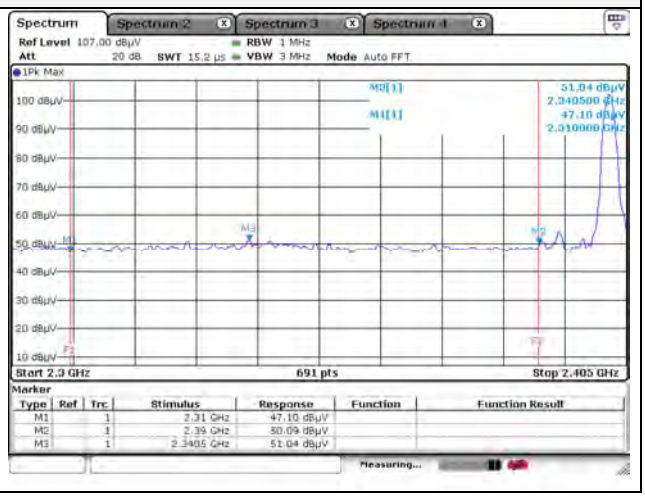
Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	00

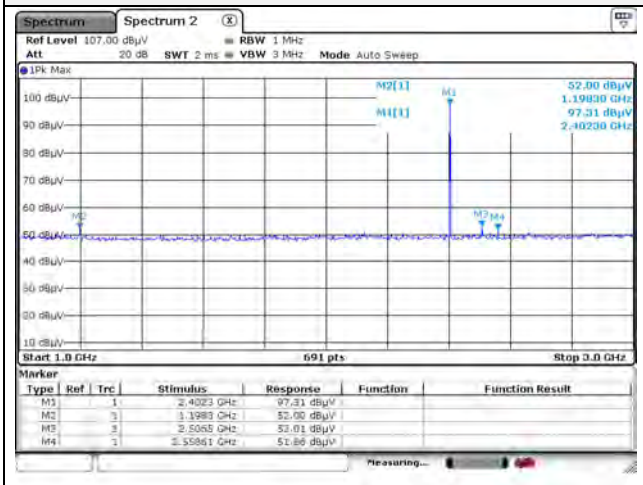
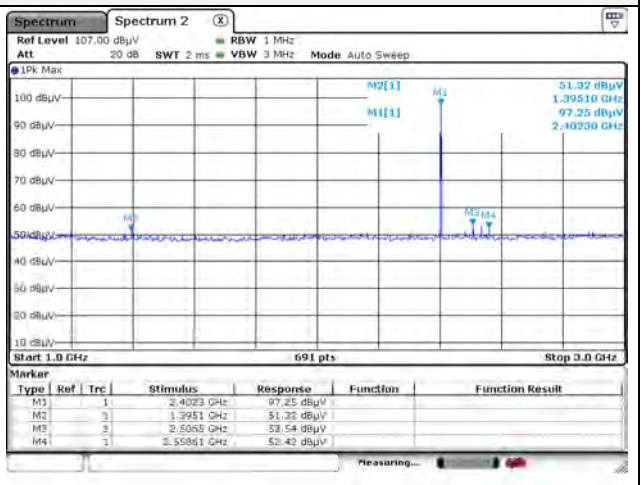
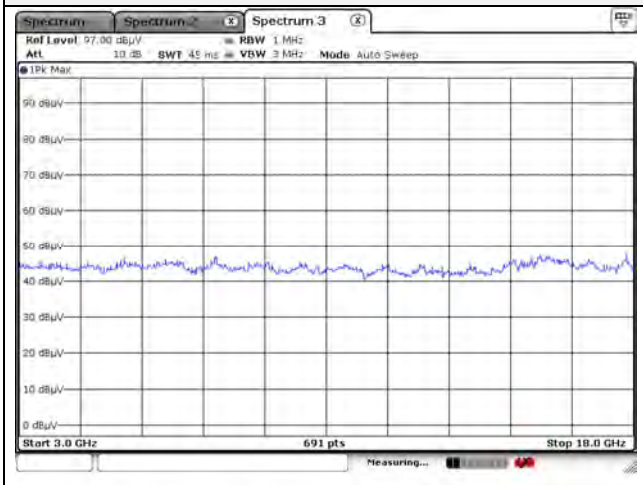
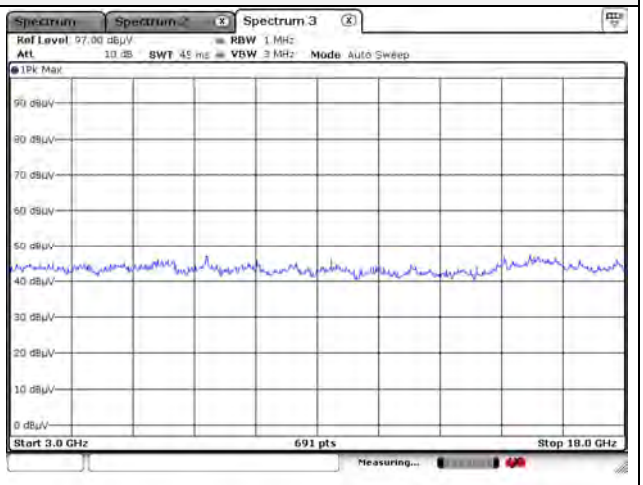
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1198.00	52.00	Peak	H	-7.87	-	44.13	74.00	29.87
2507.00	53.01	Peak	H	0.01	-	53.02	74.00	20.98
2559.00	51.86	Peak	H	0.20	-	52.06	74.00	21.94
1395.00	51.32	Peak	V	-6.61	-	44.71	74.00	29.29
2507.00	53.54	Peak	V	0.01	-	53.55	74.00	20.45
2559.00	52.42	Peak	V	0.20	-	52.62	74.00	21.38

- **Band edge**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2351.00	51.31	Peak	H	-0.29	-	51.02	74.00	22.98
2341.00	51.04	Peak	V	-0.31	-	50.73	74.00	23.27

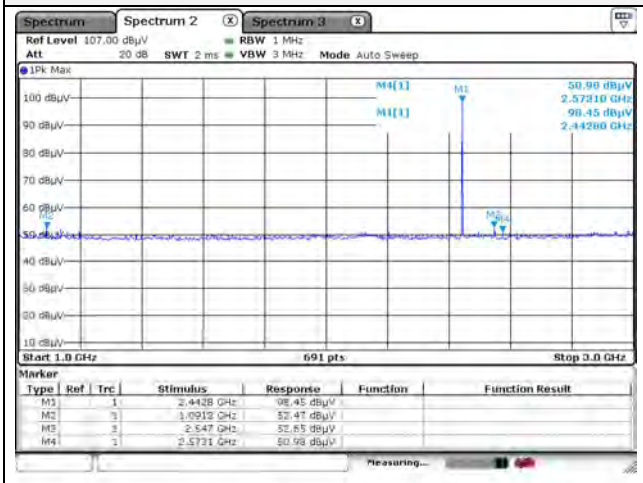
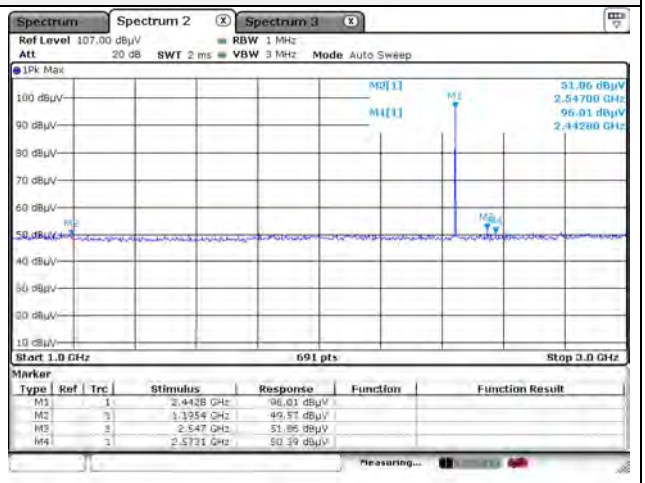
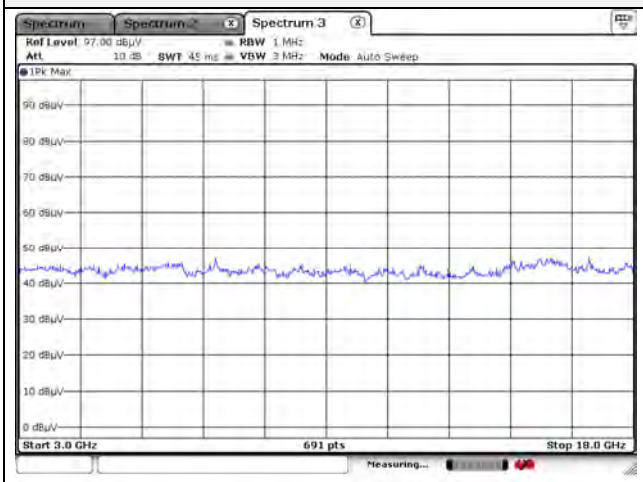
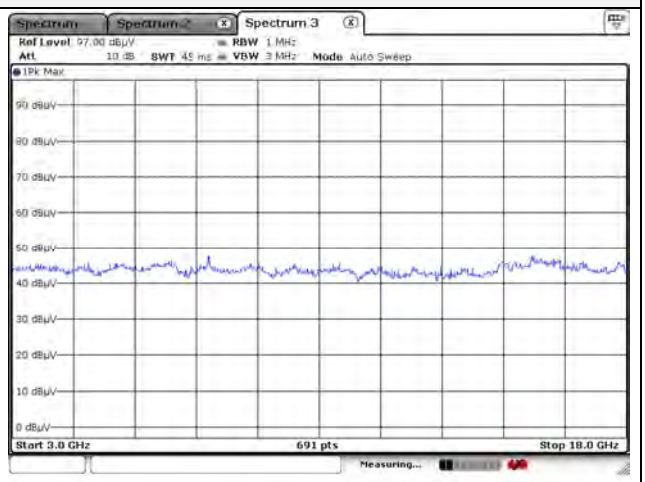
Restricted band // Horizontal // Peak	Restricted band // Vertical // Peak
	

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:	40

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1091.00	52.47	Peak	H	-8.56	-	43.91	74.00	30.09
2547.00	52.65	Peak	H	0.16	-	52.81	74.00	21.19
2573.00	50.98	Peak	H	0.25	-	51.23	74.00	22.77
1195.00	49.57	Peak	V	-7.89	-	41.68	74.00	32.32
2547.00	51.86	Peak	V	0.16	-	52.02	74.00	21.98
2573.00	50.39	Peak	V	0.25	-	50.64	74.00	23.36

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 ㎓.
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

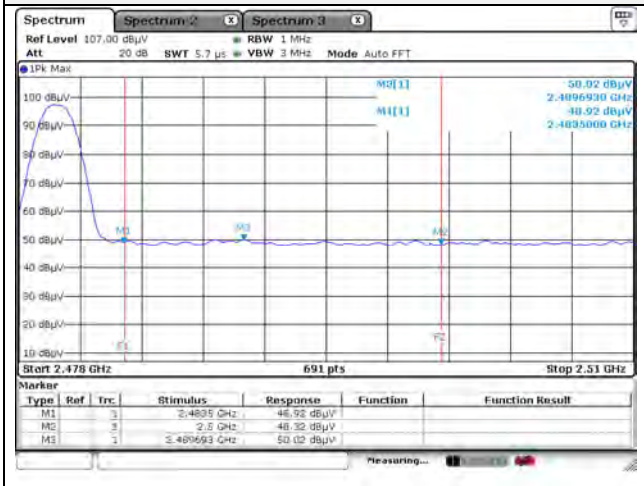
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1097.00	52.91	Peak	H	-8.52	-	44.39	74.00	29.61
1195.00	53.07	Peak	H	-7.89	-	45.18	74.00	28.82
2585.00	51.00	Peak	H	0.29	-	51.29	74.00	22.71
1187.00	50.88	Peak	V	-7.94	-	42.94	74.00	31.06
1974.00	50.09	Peak	V	-1.24	-	48.85	74.00	25.15
2585.00	53.47	Peak	V	0.29	-	53.76	74.00	20.24

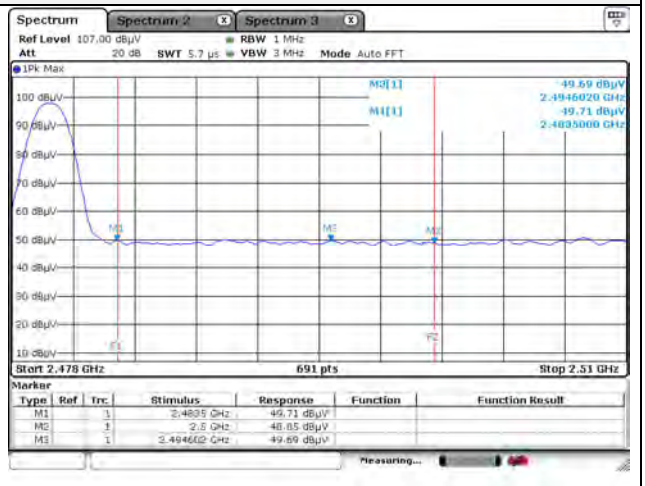
- **Band edge**

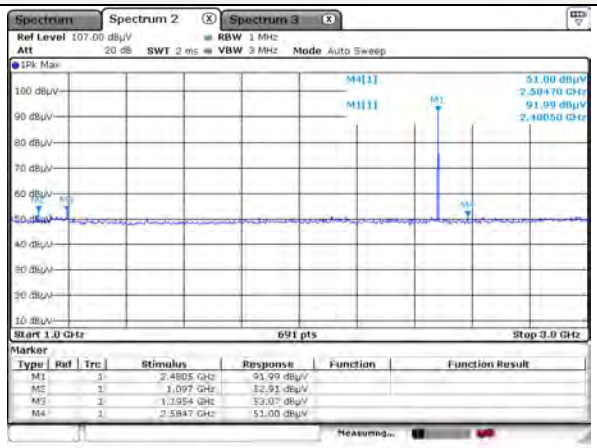
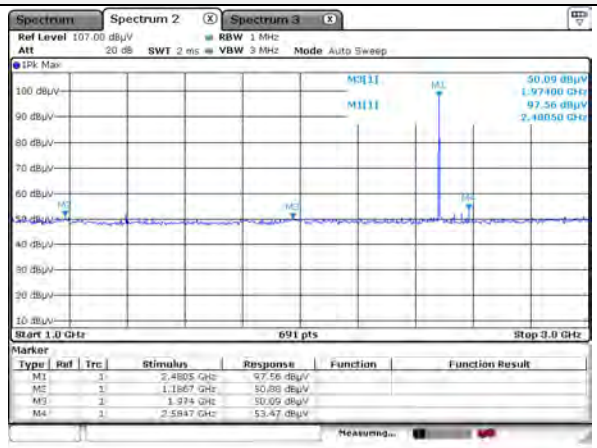
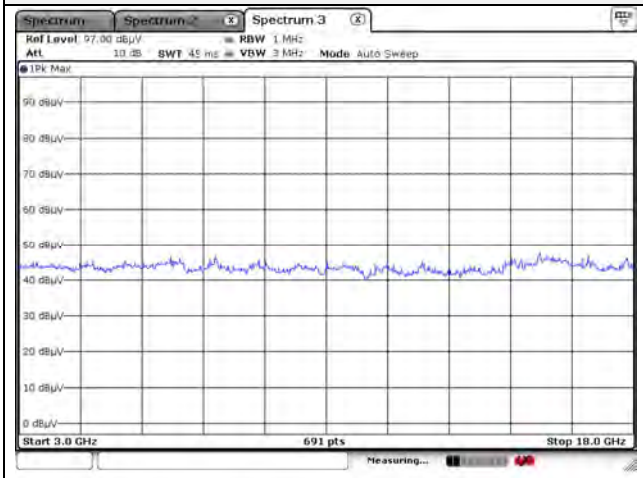
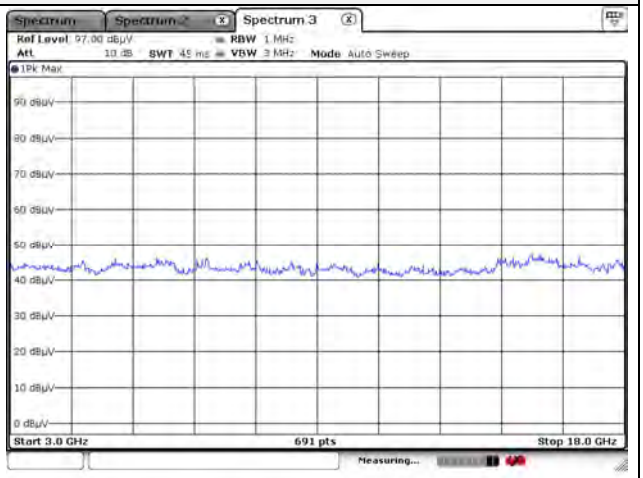
Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2490.00	50.02	Peak	H	-0.03	-	49.99	74.00	24.01
2495.00	49.69	Peak	V	-0.02	-	49.67	74.00	24.33

Restricted band // Horizontal // Peak



Restricted band // Vertical // Peak

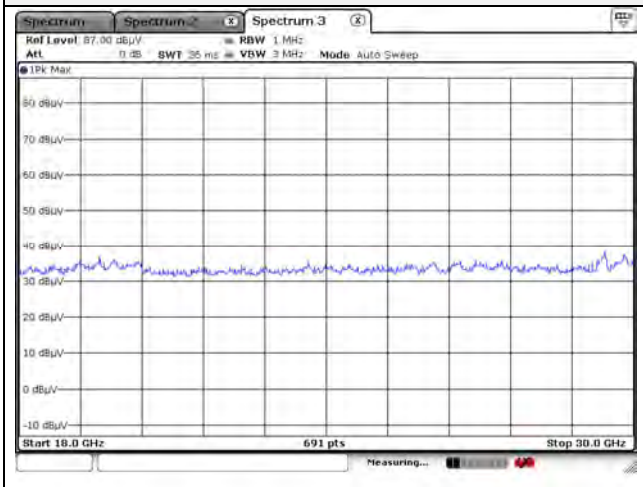
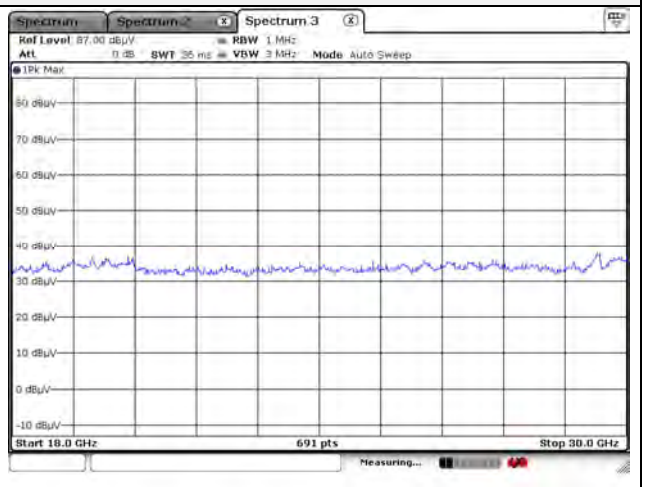


Horizontal // Peak for 1 ㎓ to 3 ㎓	Vertical // Peak for 1 ㎓ to 3 ㎓
	
Horizontal // Peak for 3 ㎓ to 18 ㎓	**Vertical // Peak for 3 ㎓ to 18 ㎓**
	

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 ㎓) – Worst case

Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	00(Worst case)

Horizontal	Vertical
	

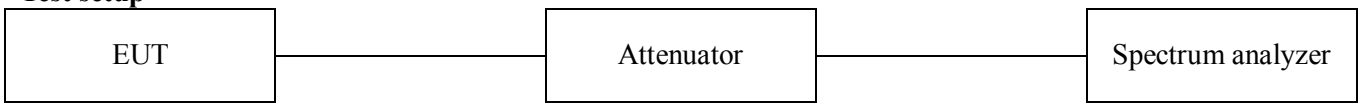
Note.
1. No spurious emission were detected above 18 ㎓.

3.7. Conducted band edge and out of band emissions

Test procedure

ANSI C63.10-2013 - Section 7.8.4 and 7.8.8

Test setup



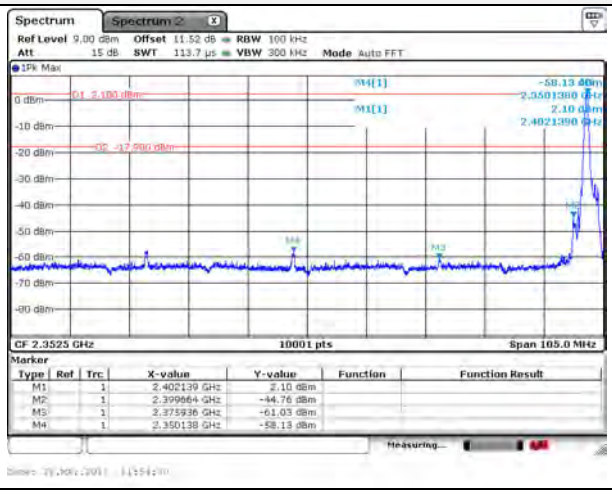
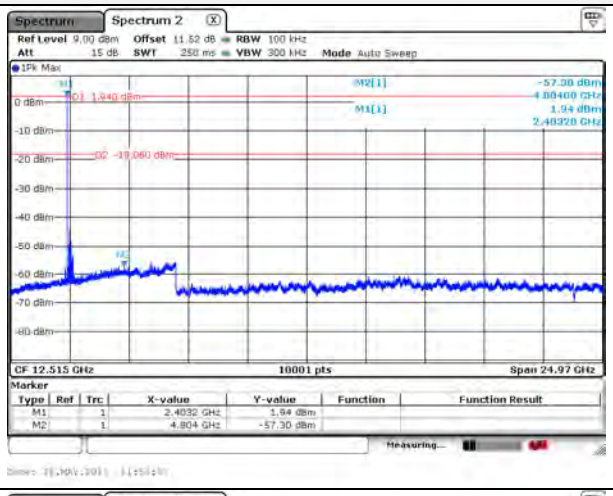
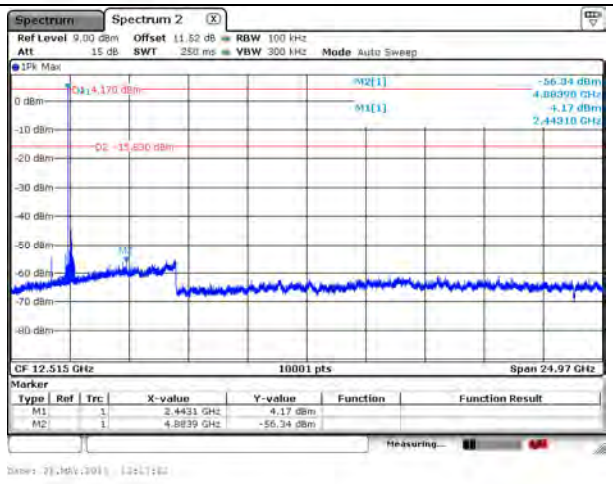
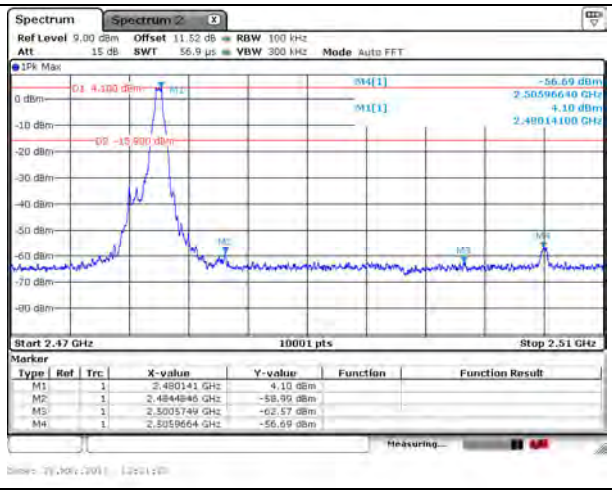
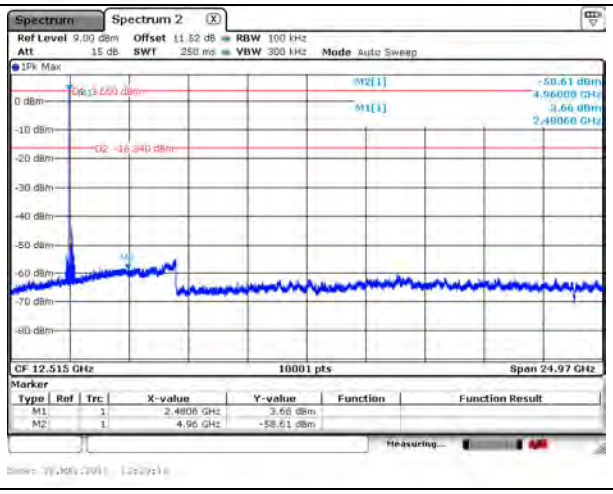
Test setting

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

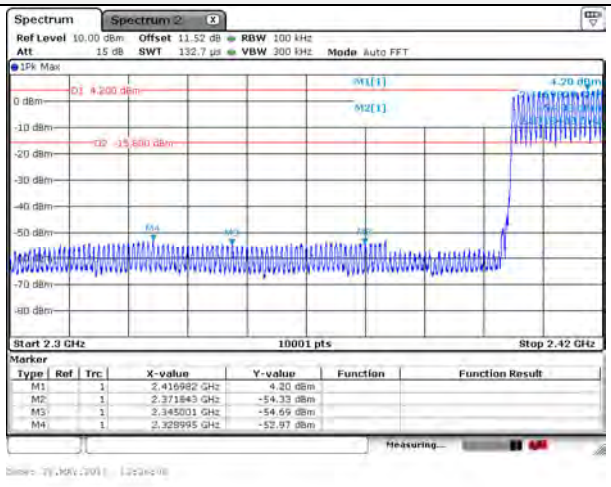
Limit

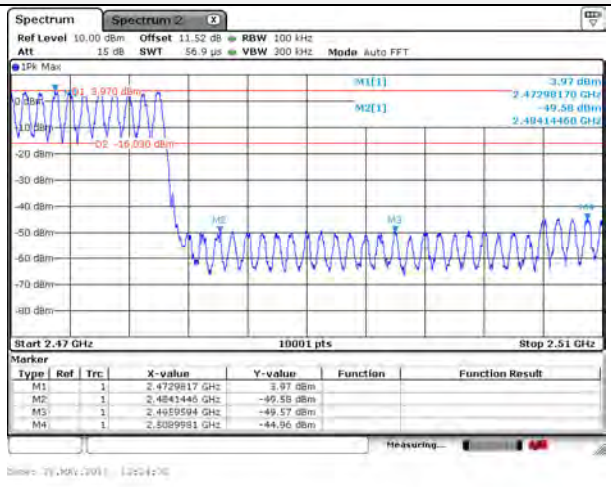
According to 15.247(d), in any 100 ㎑ bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 ㏈ below that in the 100 ㎑ bandwidth within the band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

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.

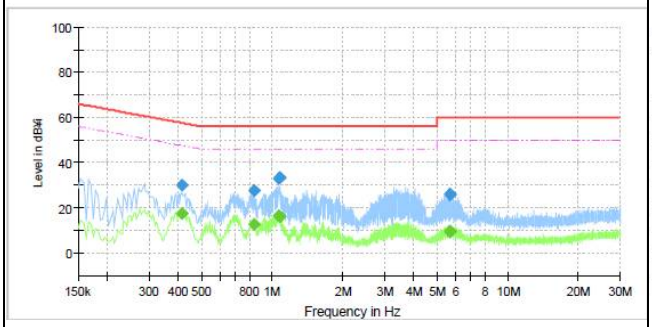
Frequency of Emission (㎒)	Conducted limit (dB㎶/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

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.
2. Both Cable loss and LISN factor are included in measurement level(QP Level or AV Level)

Test results

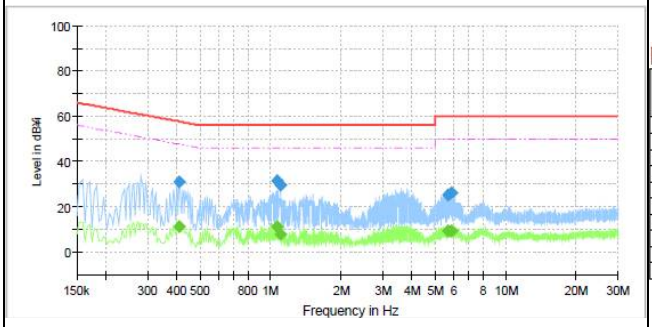
Hot Line



Final_Result

Frequency (MHz)	MaxPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.414000	---	17.68	47.57	29.89	1000.0	9.000	L1	19.9
0.414000	30.22	---	57.57	27.35	1000.0	9.000	L1	19.9
0.834000	---	12.71	46.00	33.29	1000.0	9.000	L1	20.3
0.834000	27.83	---	56.00	28.17	1000.0	9.000	L1	20.3
1.066000	---	16.41	46.00	29.59	1000.0	9.000	L1	20.5
1.066000	32.82	---	56.00	23.18	1000.0	9.000	L1	20.5
1.074000	---	16.01	46.00	29.99	1000.0	9.000	L1	20.5
1.074000	33.39	---	56.00	22.61	1000.0	9.000	L1	20.5
5.678000	---	9.50	50.00	40.50	1000.0	9.000	L1	19.9
5.678000	25.59	---	60.00	34.41	1000.0	9.000	L1	19.9
5.690000	---	9.66	50.00	40.34	1000.0	9.000	L1	19.9
5.690000	26.07	---	60.00	33.93	1000.0	9.000	L1	19.9

Neutral Line



Final_Result

Frequency (MHz)	MaxPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.410000	---	11.01	47.65	36.64	1000.0	9.000	N	19.8
0.410000	31.10	---	57.65	26.55	1000.0	9.000	N	19.8
1.066000	---	11.36	46.00	34.64	1000.0	9.000	N	20.4
1.066000	31.69	---	56.00	24.31	1000.0	9.000	N	20.4
1.106000	---	7.69	46.00	38.31	1000.0	9.000	N	20.4
1.106000	29.77	---	56.00	26.23	1000.0	9.000	N	20.4
5.658000	---	9.22	50.00	40.78	1000.0	9.000	N	19.9
5.658000	25.29	---	60.00	34.71	1000.0	9.000	N	19.9
5.886000	---	9.23	50.00	40.77	1000.0	9.000	N	20.0
5.886000	26.36	---	60.00	33.64	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	100736	1 year	2020.01.09
Spectrum Analyzer	R&S	FSV40	101002	1 year	2019.06.29
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2020.01.15
DC Power Supply	Agilent	6632B	US36351824	1 year	2020.01.15
Power Meter	Anritsu	ML2495A	1438001	1 year	2020.01.15
Pulse Power Sensor	Anritsu	MA2411B	1339205	1 year	2020.01.15
Attenuator	HP	8491A	35496	1 year	2020.03.11
Loop Antenna	Schwarzbeck	FMZB1513	225	2 years	2021.02.15
Trilog-broadband antenna	SCHWARZBECK	VULB 9163	715	2 years	2020.09.20
Horn Antenna	A.H	SAS-571	414	2 years	2021.02.11
Horn Antenna	SCHWARZBECK	BBHA9170	BBHA 9170550	2 years	2021.02.19
High Pass Filter	Wainwright Instrument Gmbh	WHJS3000-10TT	1	1 year	2019.06.29
Preamplifier	R&S	SCU01	100603	1 year	2019.11.26
Preamplifier	AGILENT	8449B	3008A01742	1 year	2020.01.08
EMI Test Receiver	R&S	ESU26	100551	1 year	2020.04.09
Attenuator	HP	8491A	32173	1 year	2020.03.11
EMI TEST RECEIVER	R & S	ESR3	101781	1 year	2020.04.22
LISN	R & S	ENV216	101787	1 year	2020.01.04
PULSE LIMITER	R & S	ESH3-Z2	101915	1 year	2019.11.26
RF Cable 1	Woken	-	# 6	-	2019.05.14 (Cal. date)
RF Cable 2	Woken	-	# 21	-	2019.05.14 (Cal. date)

* The RF cable cal. is measured every time before the test.

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
Notebook computer	LG Electronics Inc.,	LGS53	306QCZP560949
AC/DC adapter	Flextronics Power Systems(Dongguan)Co., Ltd.	A1487	HU10692-13049