TEST REPORT

Part 15 Subpart C 15.247

Equipment under test LOAA Analyzer

Model name On-Point

FCC ID 2AYU4LOAA-ONPOINT

Applicant OPTOLANE Technologies, Inc.

Manufacturer OPTOLANE Technologies, Inc.

Date of test(s) 2021.02.08 ~ 2021.03.05

Date of issue 2021.03.10

Issued to

OPTOLANE Technologies, Inc.

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Revision history

Revision	Date of issue	Test report No.	Description
-	2021.03.10	KES-RF1-21T0020	Initial

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1. General information

Applicant:	OPTOLANE Technologies, Inc.
Applicant address:	6F, 20, Pangyoyeok-ro 241 beon-gil, Bundang-gu, Seongnam-si, Gyeonggi-do, 13494, S.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:	2AYU4LOAA-ONPOINT
Test device serial No.:	☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test	LOAA Analyzer	
Frequency range		**2 402 ㎒ ~ 2 480 ㎒ (BDR/EDR)**
		2 412 ㎒ ~ 2 462 ㎒ (11b/g/n_HT20)
		2 422 ㎒ ~ 2 452 ㎒ (11n_HT40)
	UNII-1	5 180 ㎒ ~ 5 240 ㎒ (11a/n_HT20/ac_VHT20)
		5 190 ㎒ ~ 5 230 ㎒ (11n_HT40/ac_VHT40)
		5 210 ㎒ (11ac_VHT80)
	UNII-2A	5 260 ㎒ ~ 5 320 ㎒ (11a/n_HT20/ac_VHT20)
		5 270 ㎒ ~ 5 310 ㎒ (11n_HT40/ac_VHT40)
		5 290 ㎒ (11ac_VHT80)
	UNII-2C	5 500 ㎒ ~ 5 700 ㎒ (11a/n_HT20/ac_VHT20)
		5 510 ㎒ ~ 5 670 ㎒ (11n_HT40/ac_VHT40)
		5 530 ㎒ ~ 5 610 ㎒ (11ac_VHT80)
	UNII-3	5 745 ㎒ ~ 5 825 ㎒ (11a/n_HT20/ac_VHT20)
		5 755 ㎒ ~ 5 795 ㎒ (11n_HT40/ac_VHT40)
		5 775 ㎒ (11ac_VHT80)
Model:	On-Point	
Modulation technique	WIFI : DSSS, OFDM	
	BT : GFSK, π/4DQPSK, 8DPSK	
Antenna specification	2.4 ㎓_ WIFI&BT // Dipole Antenna & 3.18 ㏈i	
	5 ㎓_UNII 1 // Dipole Antenna & 3.52 ㏈i	
	5 ㎓_UNII 2A // Dipole Antenna & 4.35 ㏈i	
	5 ㎓_UNII 2C // Dipole Antenna & 4.25 ㏈i	
	5 ㎓_UNII 3 // Dipole Antenna & 3.14 ㏈i	

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Power source	AC 220 V
Number of channels	**2 402 ㎒ ~ 2 480 ㎒ (BDR/EDR) : 79ch**
	2 412 ㎒ ~ 2 462 ㎒ (11b/g/n_HT20) : 11ch
	2 422 ㎒ ~ 2 452 ㎒ (11n_HT40) : 7ch
	5 180 ㎒ ~ 5 240 ㎒ (11a/n_HT20/ac_VHT20) : 4ch
	5 190 ㎒ ~ 5 230 ㎒ (11n_HT40/ac_VHT40) : 2ch
	5 210 ㎒ (11ac_VHT80) : 1ch
	5 260 ㎒ ~ 5 320 ㎒ (11a/n_HT20/ac_VHT20) : 4ch
	5 270 ㎒ ~ 5 310 ㎒ (11n_HT40/ac_VHT40) : 2ch
	5 290 ㎒ (11ac_VHT80) : 1ch
	5 500 ㎒ ~ 5 700 ㎒ (11a/n_HT20/ac_VHT20) : 11ch
	5 510 ㎒ ~ 5 670 ㎒ (11n_HT40/ac_VHT40) : 5ch
	5 530 ㎒ ~ 5 610 ㎒ (11ac_VHT80) : 2ch
	5 745 ㎒ ~ 5 825 ㎒ (11a/n_HT20/ac_VHT20) : 5ch
	5 755 ㎒ ~ 5 795 ㎒ (11n_HT40/ac_VHT40) : 2ch
	5 775 ㎒ (11ac_VHT80) : 1ch

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.

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.

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1.2. Test configuration

The **OPTOLANE Technologies, Inc. LOAA Analyzer FCC ID: 2AYU4LOAA-ONPOINT** 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	1,2,3
⋮	⋮	⋮
39	2441	1,2,3
⋮	⋮	⋮
78	2480	1,2,3

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 3.0.0

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(㏈).
= 1.56 + 10 = 11.56

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.		

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2. Summary of tests

Reference	Test description	Test results
15.247(a)(1)	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

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3. Test results

3.1. 20 dB bandwidth

Test procedure

ANSI C63.10-2013 clause 6.9.2 and 6.9.3

Test setup

EUT	—	Attenuator	—	Spectrum analyzer

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

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Test results

Frequency(㎒)	Channel no.	Data rate(Mbps)	Measured bandwidth(㎒)
2 402	00	1	0.933
2 441	39		0.933
2 480	78		0.933
2 402	00	2	1.339
2 441	39		1.339
2 480	78		1.346
2 402	00	3	1.295
2 441	39		1.303
2 480	78		1.303

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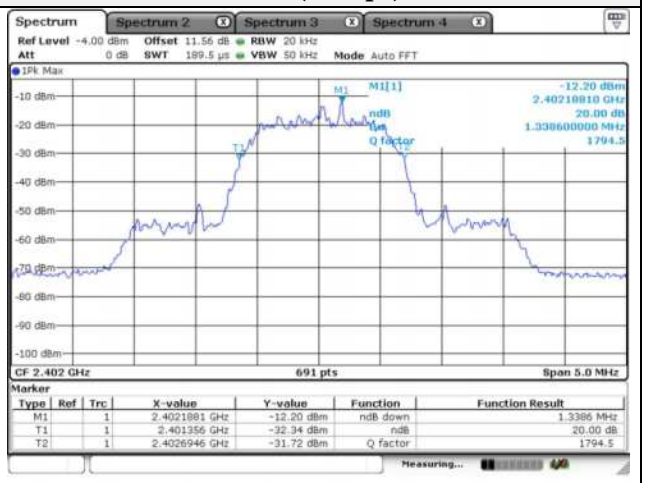
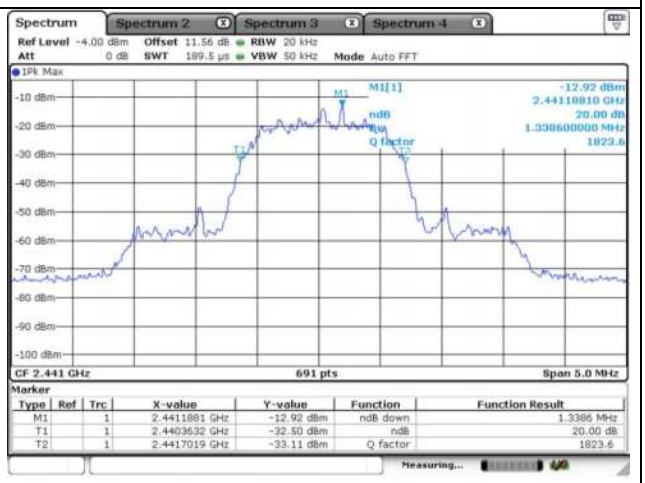
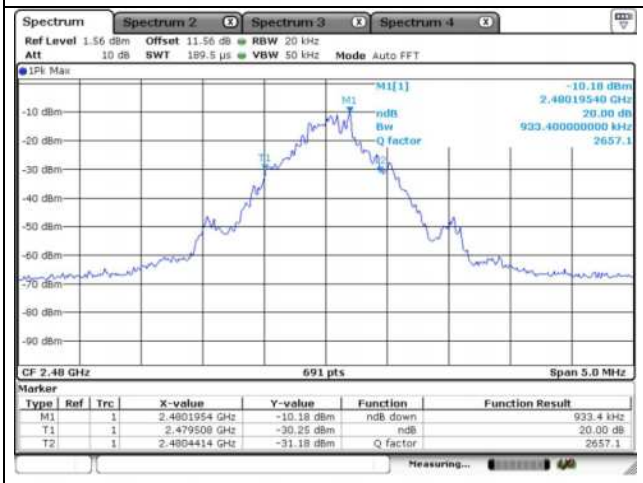
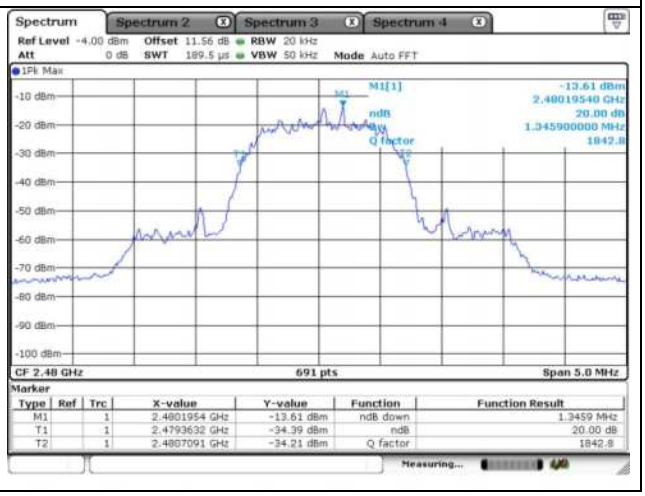
BDR(1Mbps)	EDR(2Mbps)









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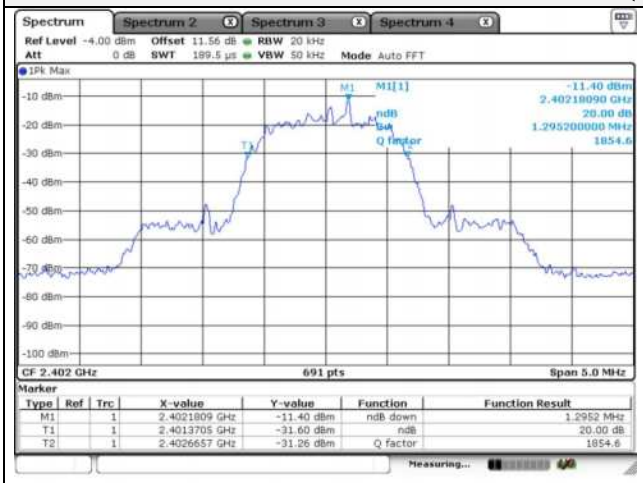
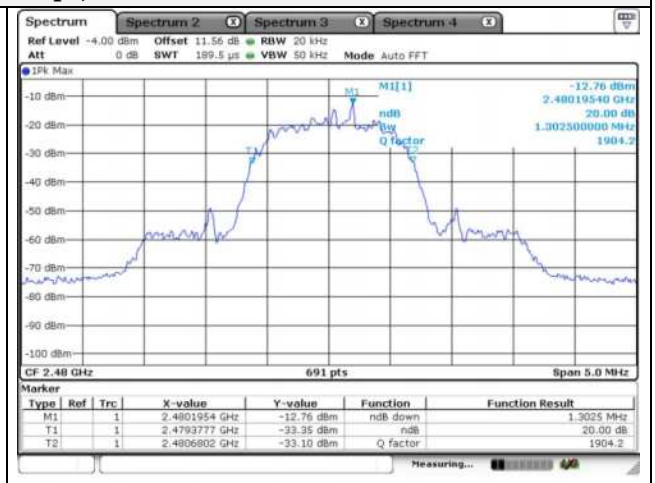
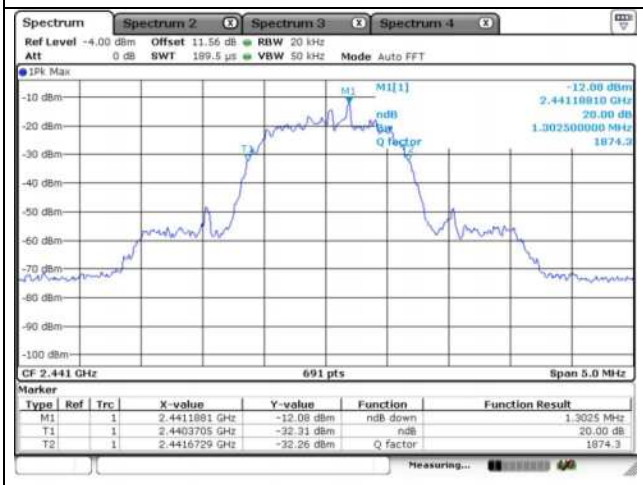
EDR(3Mbps)







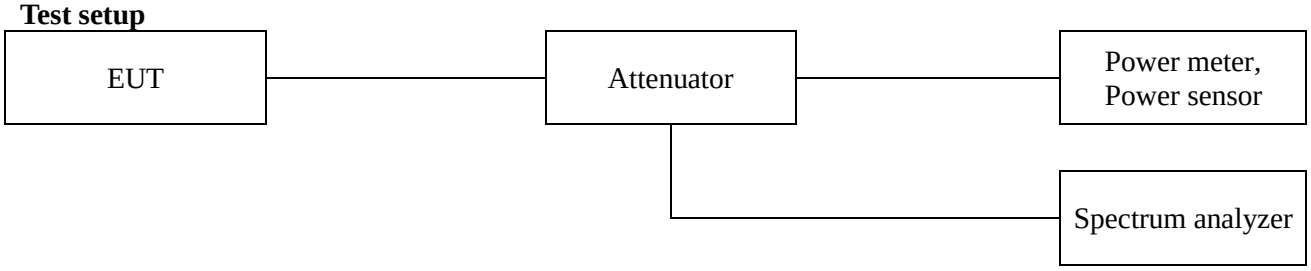
Blank

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

Allow trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power, after any corrections for external attenuators and cables. A plot of the test results and setup description shall be included in the test report.

-A peak responding power meter may be used, where the power meter and sensor system video bandwidth is greater than the occupied bandwidth of the unlicensed wireless device, rather than a spectrum analyzer.

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.

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Test results

Frequency(㎒)	Channel no.	Data rate (Mbps)	Peak Power (dBm) Note1	Average Power (dBm) Note1	Power Limit (dBm)
2 402	00	1	-5.12	-6.01	20.97
2 441	39		-5.50	-6.50	20.97
2 480	78		-6.56	-7.97	20.97
2 402	00	2	-5.56	-8.67	20.97
2 441	39		-6.39	-9.46	20.97
2 480	78		-7.01	-9.99	20.97
2 402	00	3	-5.59	-8.67	20.97
2 441	39		-6.24	-9.43	20.97
2 480	78		-6.77	-9.96	20.97

Note.
1. The peak power and average power were tested using power meter, power sensor.

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3.3. Carrier frequency separation

Test procedure

ANSI C63.10-2013 - Section 7.8.2

Test setup

EUT	Attenuator	Spectrum analyzer

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. 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. Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

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 ㎽.

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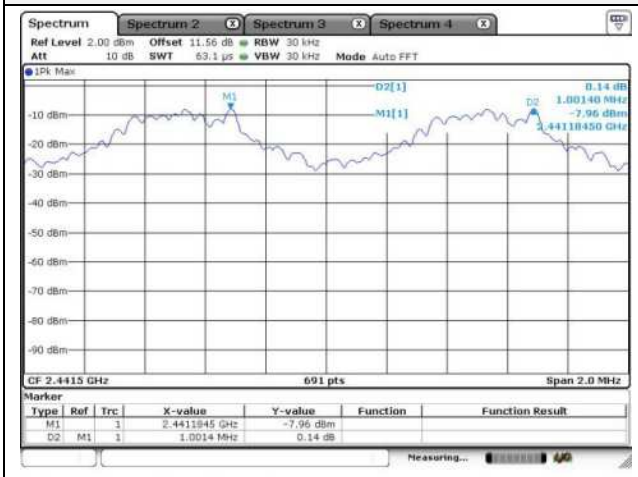
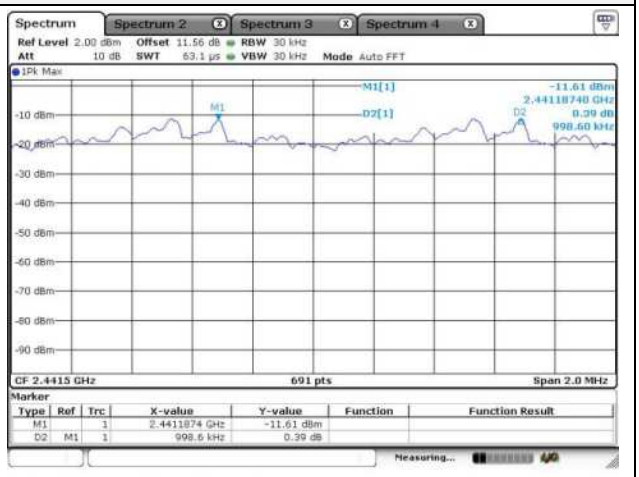
Test results

Frequency(㎒)	Channel no.	Data rate(Mbps)	Channel Separation (㎒)
2 441	39	1	1.001
2 441	39	3	0.999

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

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3.4. Number of hopping frequency

Test procedure

ANSI C63.10-2013 - Section 7.8.3

Test setup

EUT	—	Attenuator	—	Spectrum analyzer

Test setting

1. The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:
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

Allow the trace to stabilize. It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies. Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A plot of the data shall be included in the test report.

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.

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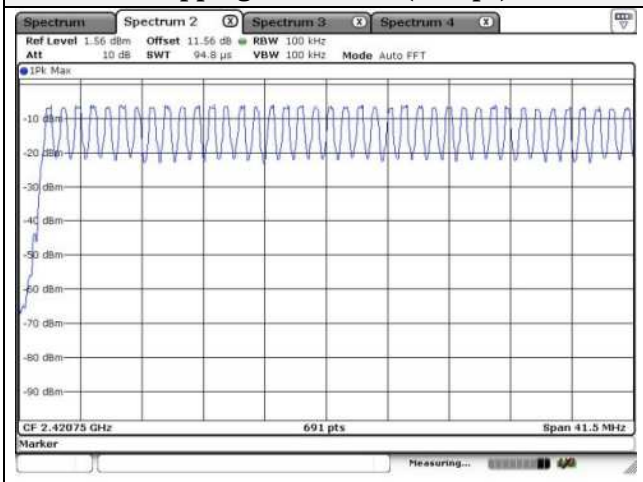
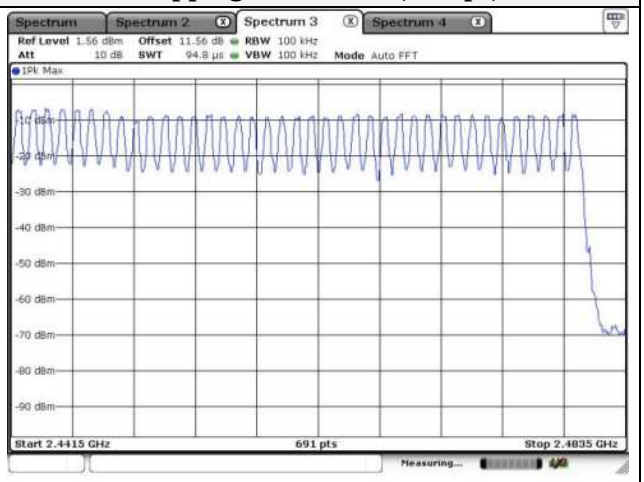
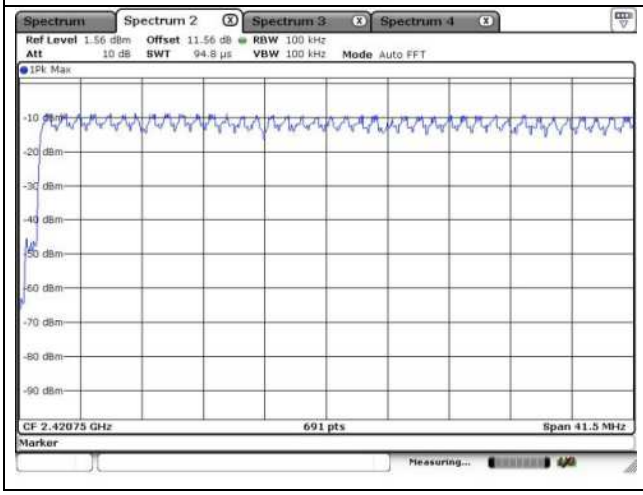
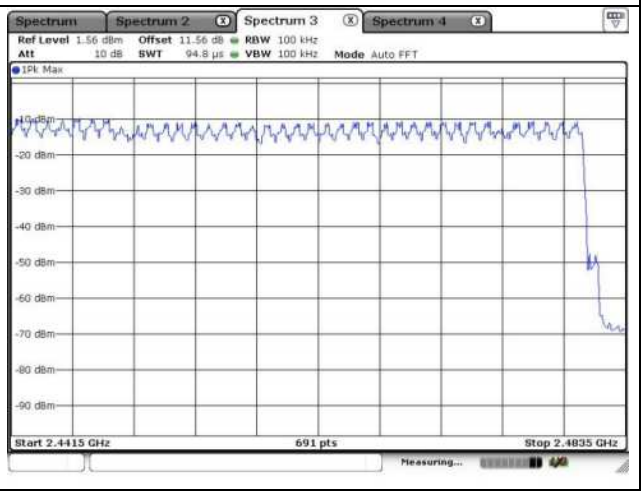
Test results

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

3.5. Time of occupancy

Test procedure

ANSI C63.10-2013 - Section 7.8.4

Test setup

EUT	—	Attenuator	—	Spectrum analyzer

Test setting

1. The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:
2. Span = zero span, centered on a hopping channel
4. RBW = shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
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

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

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 period of 0.4 seconds multiplied by the number of hopping channels employed.

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(s)

Time of occupancy on the TX channel in 8 sec
= time domain slot length × (hop rate ÷ number of hop per channel) × 8

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Test results

Packet type		Frequency (㎒)	Dwell time (ms)	A period time (s)	Time of occupancy on the Tx channel	Limit for time of occupancy on the Tx channel
DH1	Non-AFH	2441	0.383	31.6	122.56	400
	AFH	2441	0.383	8	61.28	400
DH3	Non-AFH	2441	1.639	31.6	262.24	400
	AFH	2441	1.639	8	131.12	400
DH5	Non-AFH	2441	2.886	31.6	307.84	400
	AFH	2441	2.891	8	154.19	400
2-DH1	Non-AFH	2441	0.388	31.6	124.16	400
	AFH	2441	0.388	8	62.08	400
2-DH3	Non-AFH	2441	1.641	31.6	262.56	400
	AFH	2441	1.641	8	131.28	400
2-DH5	Non-AFH	2441	2.893	31.6	308.59	400
	AFH	2441	2.893	8	154.29	400
3-DH1	Non-AFH	2441	0.390	31.6	124.80	400
	AFH	2441	0.390	8	62.40	400
3-DH3	Non-AFH	2441	1.638	31.6	262.08	400
	AFH	2441	1.642	8	131.36	400
3-DH5	Non-AFH	2441	2.890	31.6	308.27	400
	AFH	2441	2.890	8	154.13	400

Note:

1.Non-AFH

DH1: Dwell time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 122.56
DH3: Dwell time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 262.24
DH5: Dwell time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 307.84
2-DH1: Dwell time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 124.16
2-DH3: Dwell time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 262.56
2-DH5: Dwell time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 308.59
3-DH1: Dwell time (ms) × [(1 600 ÷ 2) ÷ 79] × 31.6(s) = 124.80
3-DH3: Dwell time (ms) × [(1 600 ÷ 4) ÷ 79] × 31.6(s) = 262.08
3-DH5: Dwell time (ms) × [(1 600 ÷ 6) ÷ 79] × 31.6(s) = 308.27

2.AFH

DH1: Dwell time (ms) × [(800 ÷ 2) ÷ 20] × 8(s) = 61.28
DH3: Dwell time (ms) × [(800 ÷ 4) ÷ 20] × 8(s) = 131.12
DH5: Dwell time (ms) × [(800 ÷ 6) ÷ 20] × 8(s) = 154.19
2-DH1: Dwell time (ms) × [(800 ÷ 2) ÷ 20] × 8(s) = 62.08
2-DH3: Dwell time (ms) × [(800 ÷ 4) ÷ 20] × 8(s) = 131.28
2-DH5: Dwell time (ms) × [(800 ÷ 6) ÷ 20] × 8(s) = 154.29
3-DH1: Dwell time (ms) × [(800 ÷ 2) ÷ 20] × 8(s) = 62.40
3-DH3: Dwell time (ms) × [(800 ÷ 4) ÷ 20] × 8(s) = 131.36
3-DH5: Dwell time (ms) × [(800 ÷ 6) ÷ 20] × 8(s) = 154.13

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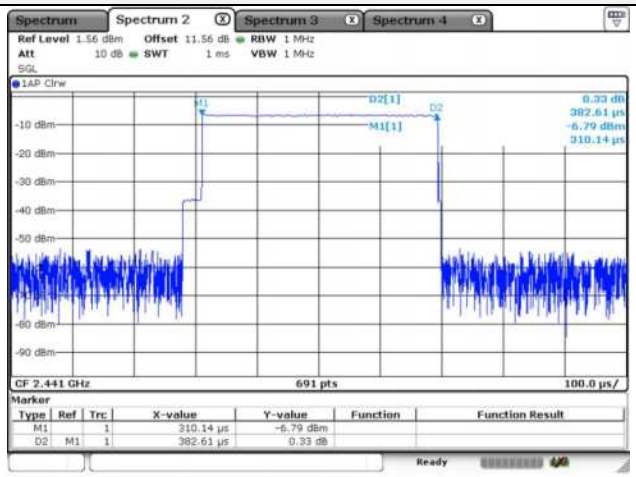
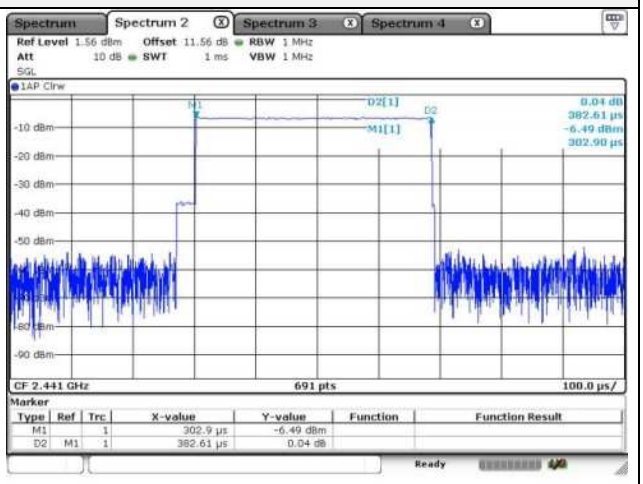
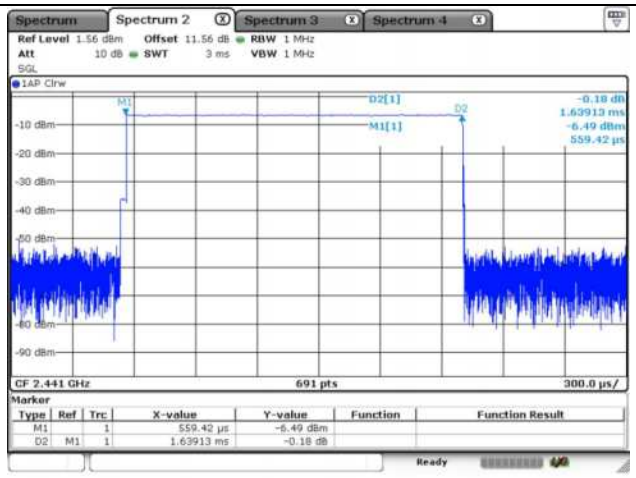
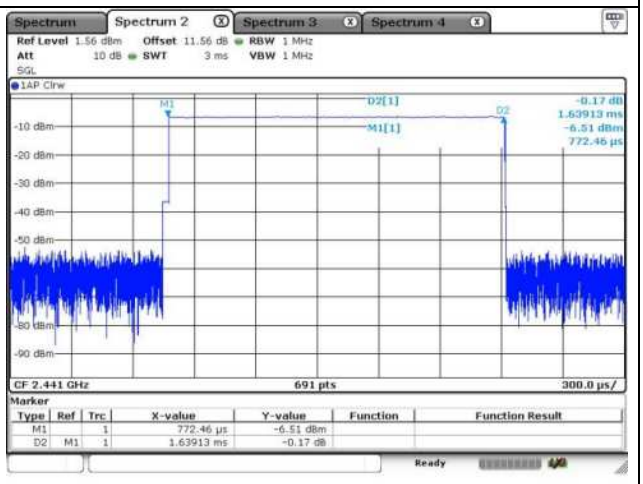
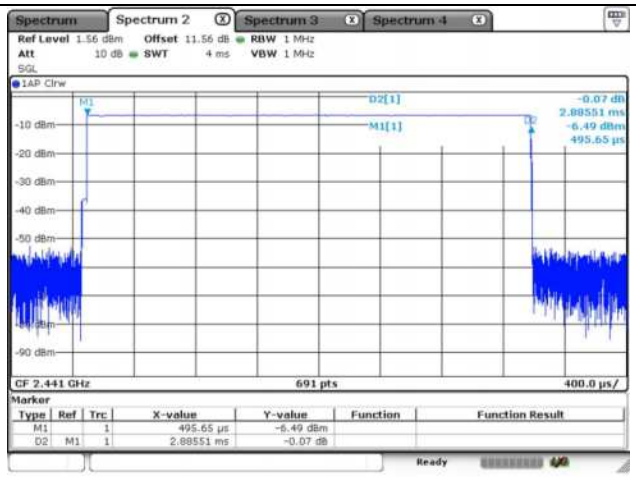
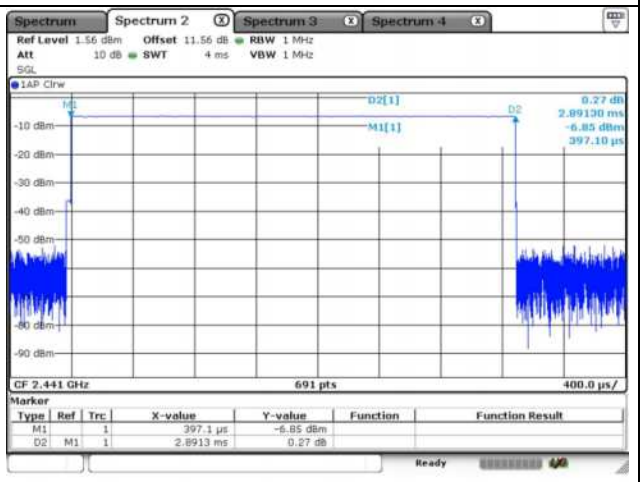
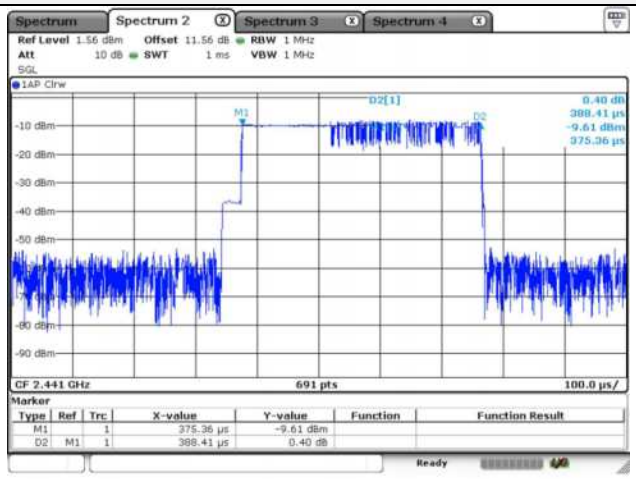
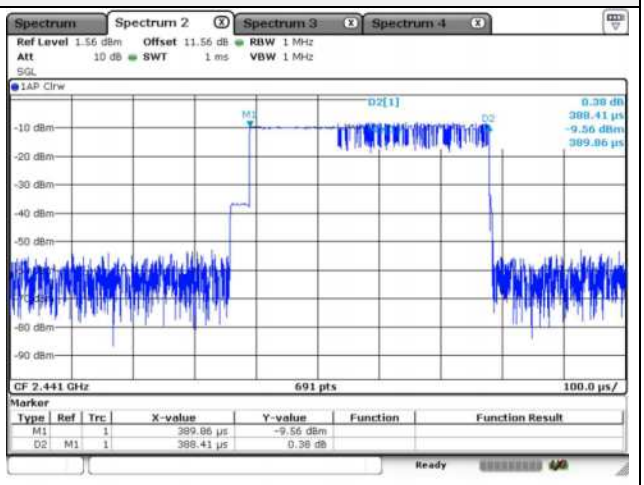
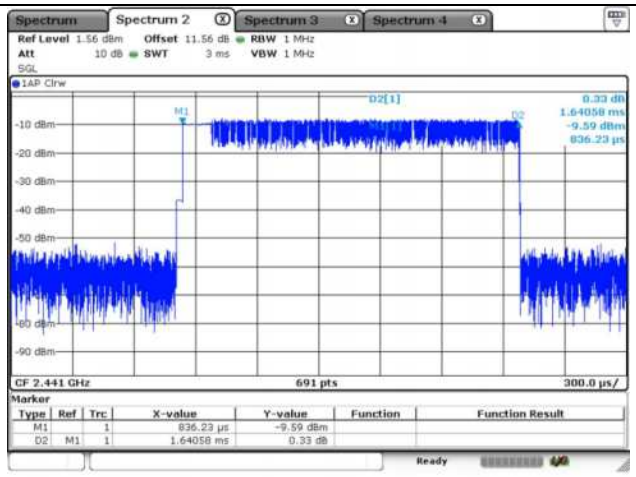
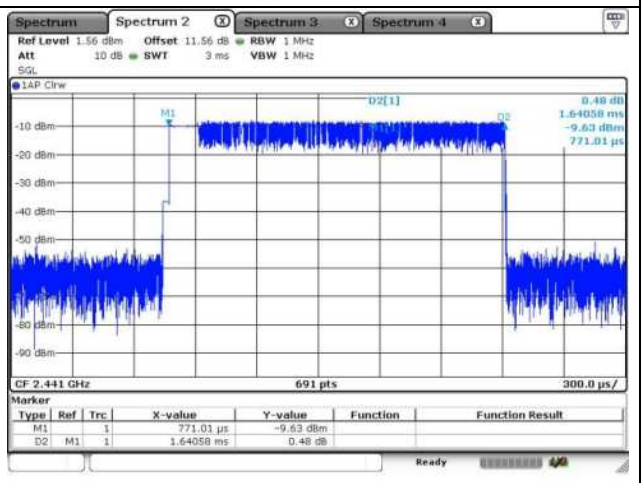
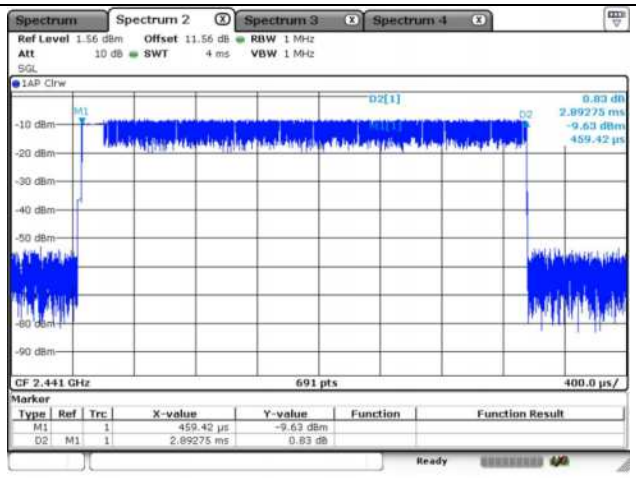
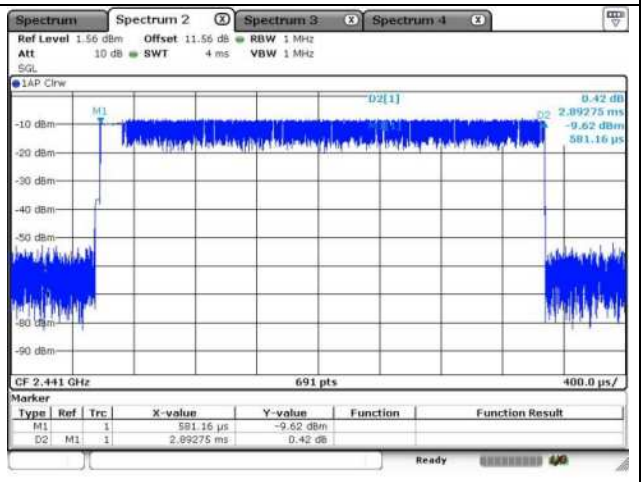
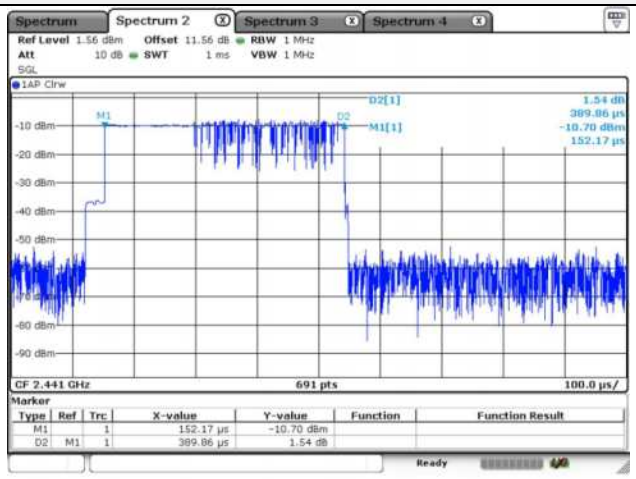
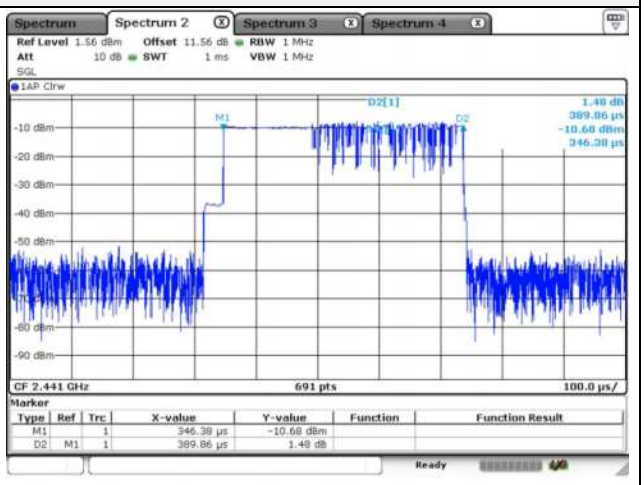
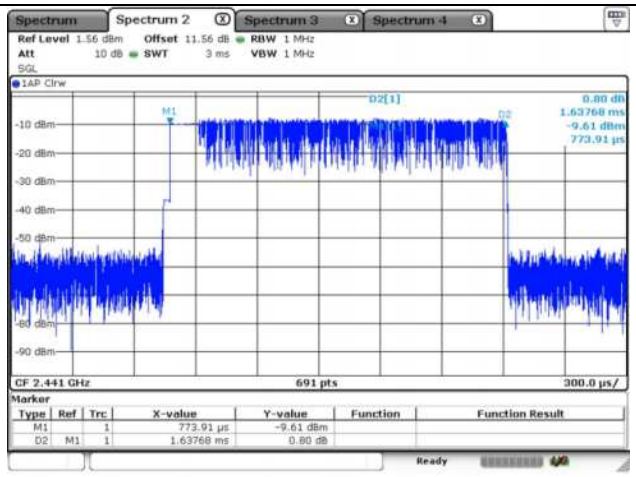
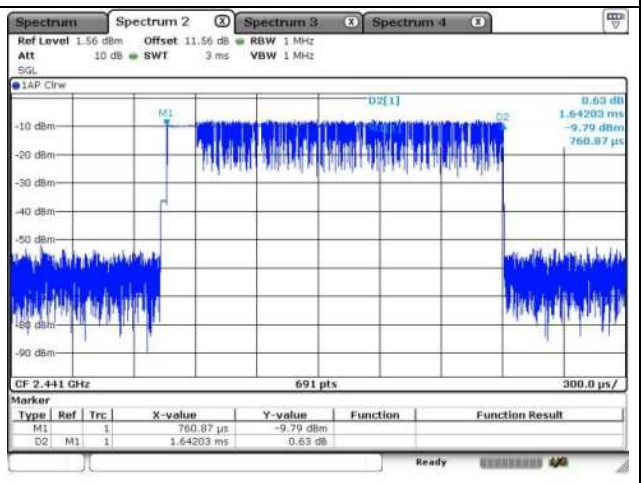
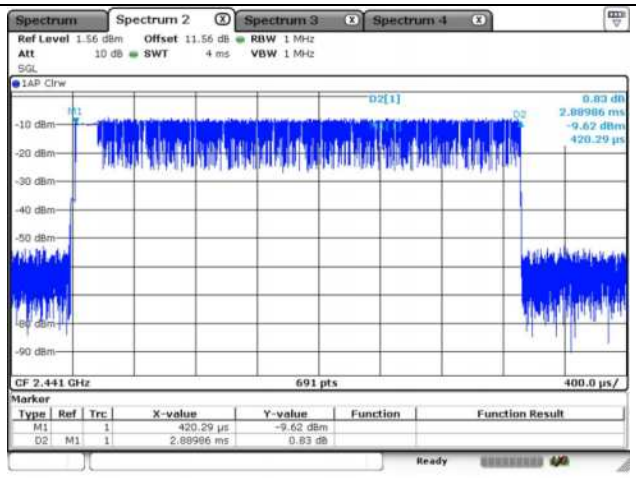
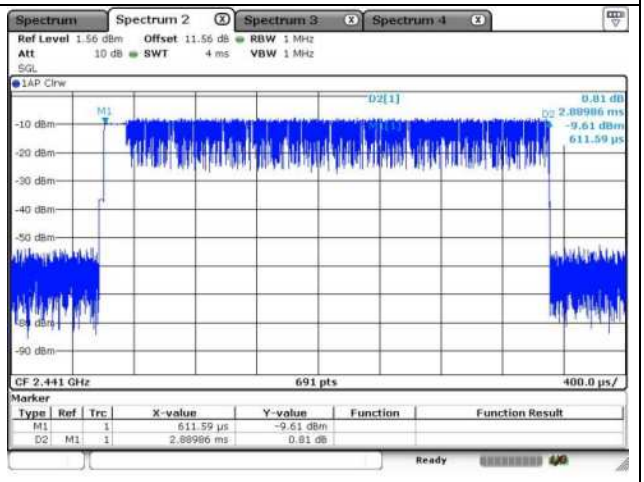
Packet type	BDR(1Mbps)	
	Non-AFH	AFH
DH1		
DH3		
DH5		

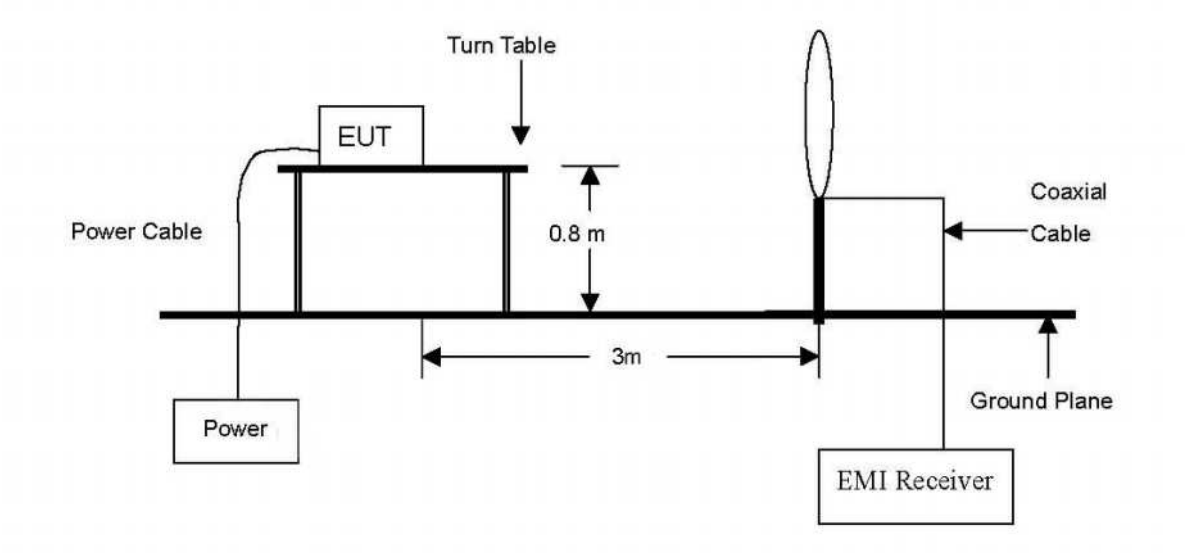
Packet type	EDR(2Mbps)	
	Non-AFH	AFH
DH1		
DH3		
DH5		

Packet type	EDR(3Mbps)	
	Non-AFH	AFH
DH1		
DH3		
DH5		

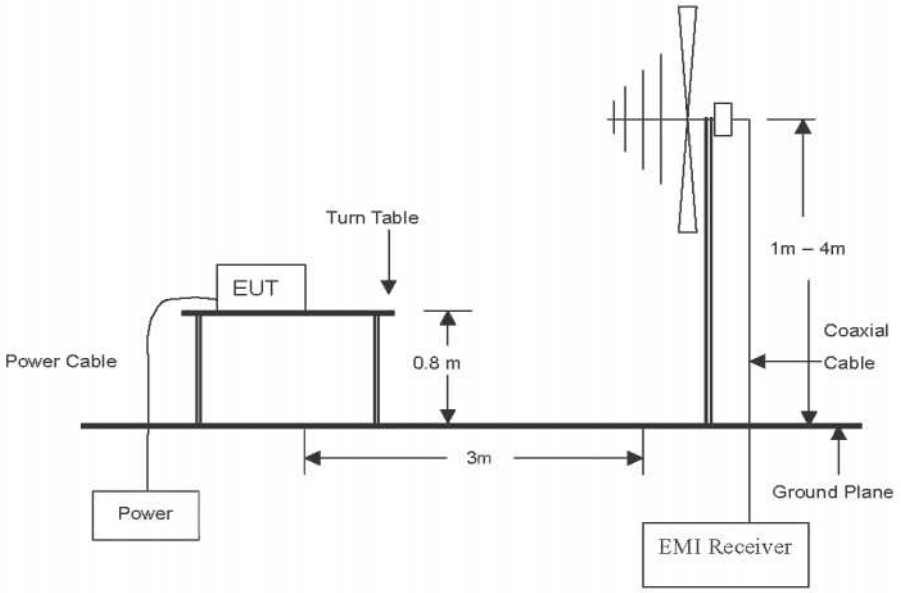
3.6. Radiated restricted band and emissions

Test setup

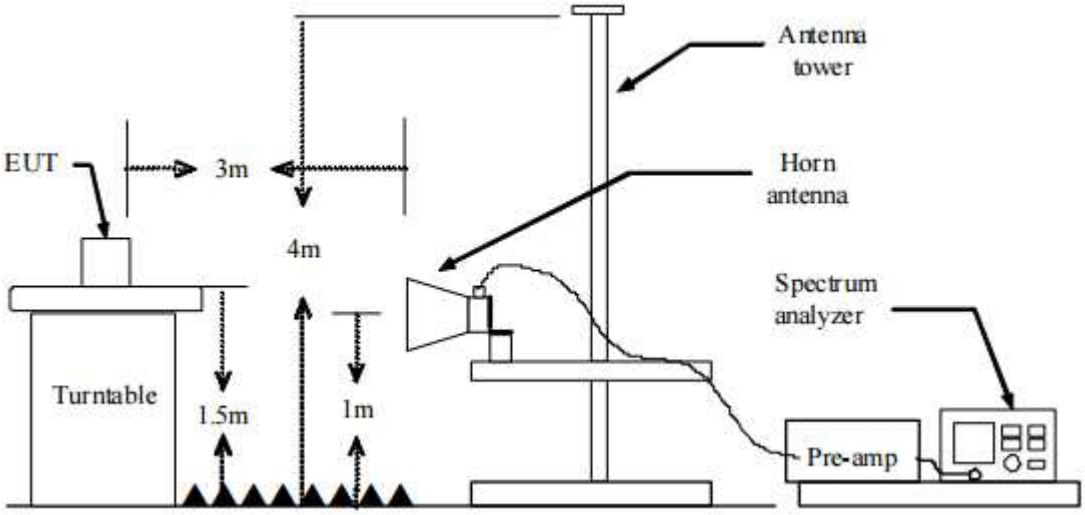
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



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



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



Test procedure

1. The EUT is placed on a turntable, which is 0.8 m (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. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.
7. Spectrum analyzer settings for f < 1 ㎓:
   Span = wide enough to fully capture the emission being measured
   RBW = 100 ㎑
   VBW ≥ RBW
   Sweep = auto
   Detector function = quasi peak
   Trace = max hold
8. Spectrum analyzer settings for f ≥1 ㎓: Peak
   Span = wide enough to fully capture the emission being measured
   RBW = 1 ㎒
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold
9. Spectrum analyzer settings for f ≥1 ㎓: Average
   Average value of pulsed emissions.
   Unless otherwise specified, when the radiated emission limits are expressed in terms of the average value of the emission and pulsed operation is employed, the average measurement shall determined from the peak field strength after correcting for the worst-case duty cycle as described in 7.5 in ANSI 63.10-2013 & Procedure 9(b) in the KDB 558074 v05r02.
10. Duty Cycle Correction Factor (20 channel hopping in AFH mode)
    a. Time to cycle through all channels = $\Delta t = \tau$[㎳] × 20 channels = 58.00 ㎳, where τ = pulse width
    b. 100 ㎳/ Δt[㎳] = H → Round up to next highest integer, H =2, where H = number of hops
    c. Worst Case Dwell Time = τ[㎳] × H = 5.80 ㎳
    d. Duty Cycle Correction = 20log (Worst Case Dwell Time/ 100㎳) ㏈ = -24.73 ㏈
11. Both 2Mbps & 3Mbps data rate were investigated. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

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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. The loop antenna was investigated with three polarizations, and horizontal and vertical polarizations were reported as the worst case**.**
3. 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 ㎳)
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.
5. Average test would be performed if the peak result were greater than the average limit.
6. Field strength(㏈㎶/m) = Level(㏈㎶) + Correction factors(㏈/m) + Cable loss(㏈) + or F_d(㏈)
7. Correction factors(㏈/m) = Antenna factor(㏈/m) + Cable loss(㏈) + or Amp. gain(㏈)
8. Margin(㏈) = Limit(㏈㎶/m) - Field strength(㏈㎶/m)
9. 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.
10. The worst-case emissions are reported however emissions whose levels were not within 20 ㏈ of respective limits were not reported.
11. According to exploratory test no any obvious emission were detected from 9 ㎑ to 30 ㎒. Although these tests were performed other than open field test site, adequate comparison measurements were confirmed against 30 m open field 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.
12. 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

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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.

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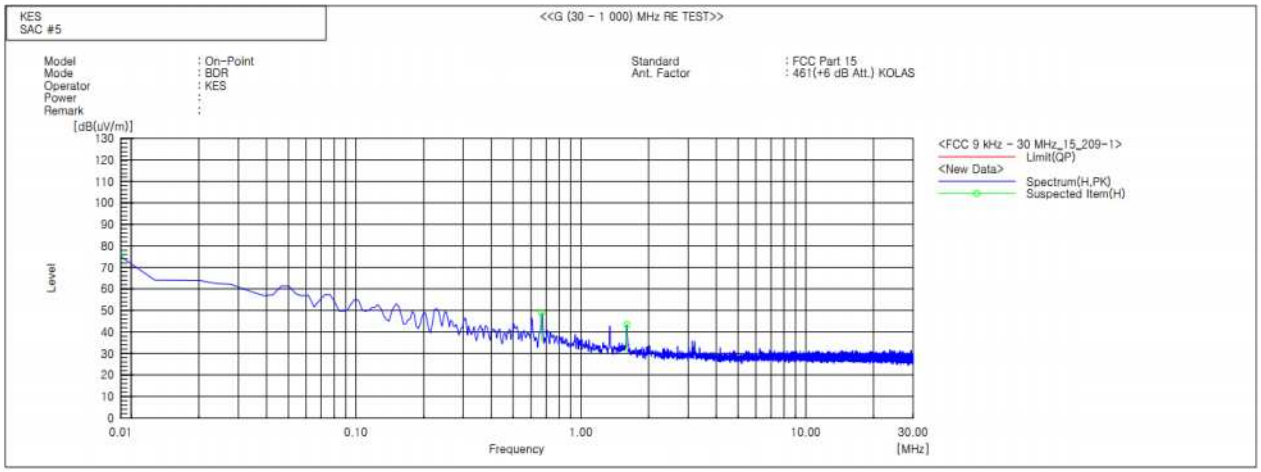
Test results (Below 30 ㎒)

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

Frequency (㎒)	Level (dBμV)	Ant. Pol. (H/V)	CF (dB)	Distance factor (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
0.009	55.70	H	19.30	-80.00	-5.00	48.50	53.50
0.669	28.50	H	20.40	-40.00	8.90	31.10	22.20
1.602	22.70	H	20.70	-40.00	3.40	23.50	20.10

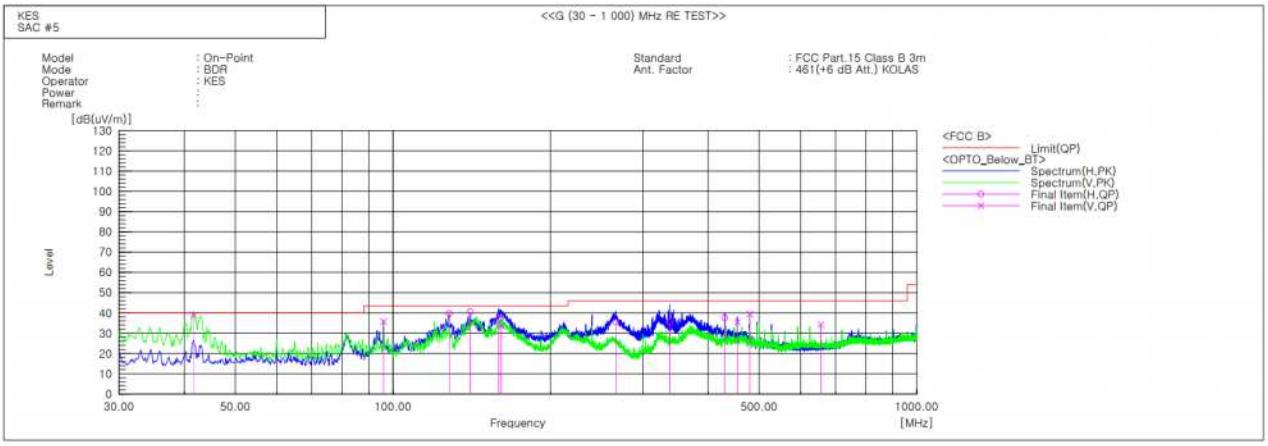
Horizontal



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	127.970	H	54.0	-14.3	39.7	43.5	3.8	250.0	106.2	
2	140.459	H	53.6	-13.0	40.6	43.5	2.9	250.0	256.5	
3	159.131	H	50.2	-12.7	37.5	43.5	6.0	250.0	245.1	
4	266.316	H	48.5	-13.0	35.5	46.0	10.5	100.0	244.5	
5	337.369	H	46.8	-11.4	35.4	46.0	10.6	100.0	146.2	
6	430.004	H	46.4	-8.7	37.7	46.0	8.3	99.7	81.6	
7	41.640	V	51.9	-13.0	38.9	40.0	1.1	100.0	314.4	
8	95.960	V	53.8	-18.0	35.8	43.5	7.7	100.0	260.6	
9	161.071	V	46.4	-12.8	33.6	43.5	9.9	100.0	20.6	
10	454.618	V	43.5	-8.1	35.4	46.0	10.6	100.0	102.0	
11	479.959	V	47.0	-7.6	39.4	46.0	6.6	100.0	88.7	
12	656.014	V	38.8	-4.5	34.3	46.0	11.7	100.0	205.9	

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Test results (Above 1 000 ㎒)

Mode: BDR

Transfer rate: 1 Mbps

Distance of measurement: 3 meter

Channel: 00

- **Spurious**

Frequency (㎒)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 198.30	51.03	Peak	H	-8.09	-	42.94	74.00	31.06
1 198.30	51.90	Peak	V	-8.09	-	43.81	74.00	30.19
1 835.00	49.56	Peak	V	-3.07	-	46.49	74.00	27.51

- **Band edge**

Frequency (㎒)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 355.69	48.77	Peak	H	-0.50	-	48.27	74.00	25.73
2 376.96	49.05	Peak	V	-0.45	-	48.60	74.00	25.40

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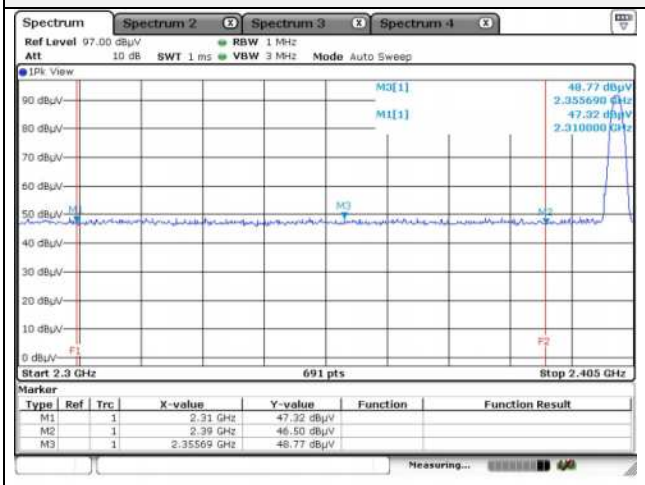
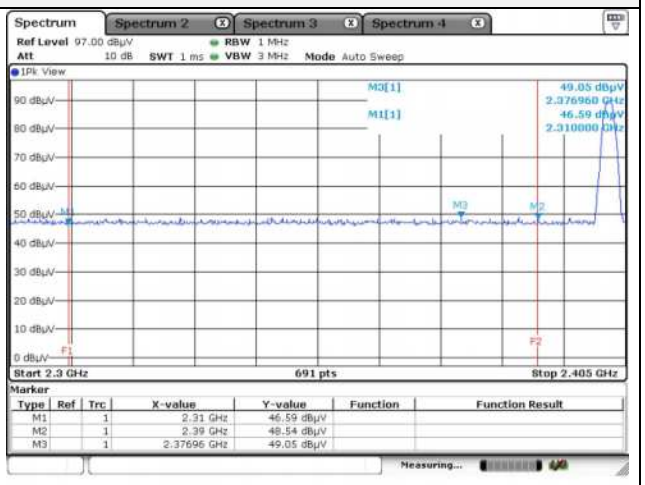
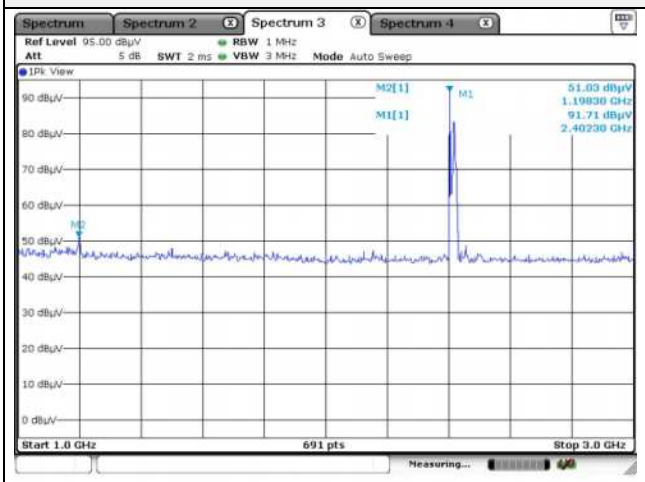
Restricted band // Horizontal // Peak



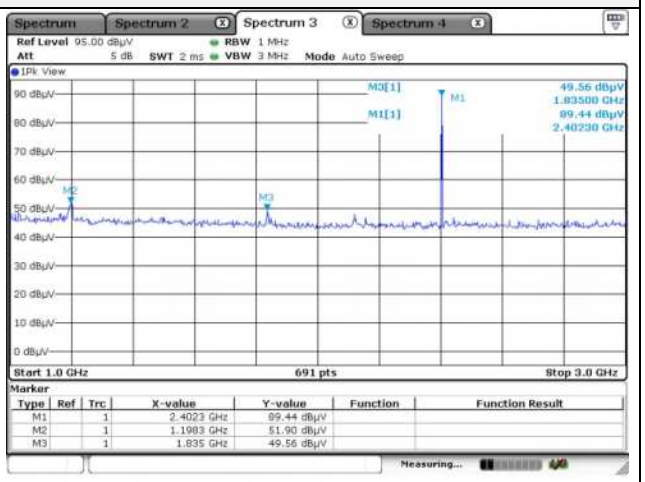
Restricted band // Vertical // Peak



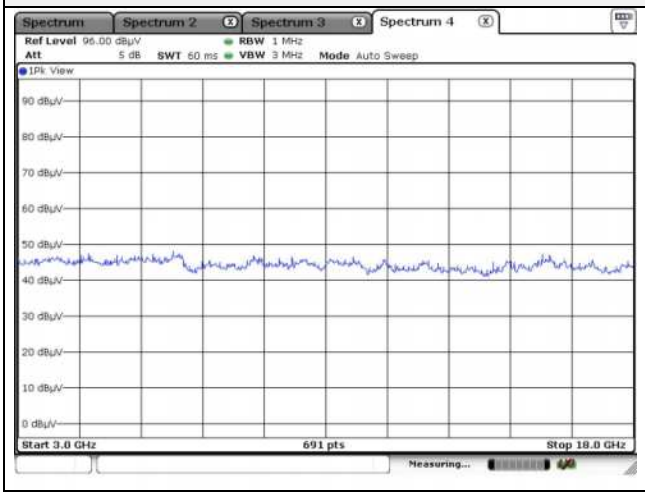
Horizontal // Peak for 1 ㎓ to 3 ㎓



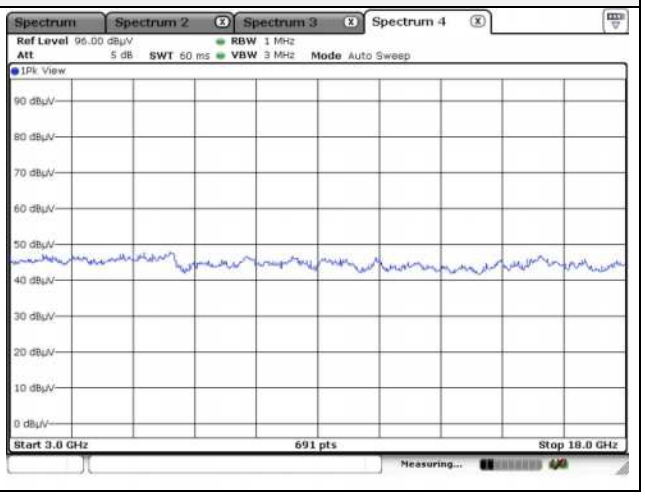
Vertical // Peak for 1 ㎓ to 3 ㎓



Horizontal // Peak for 3 ㎓ to 18 ㎓



Vertical // Peak for 3 ㎓ to 18 ㎓



Note.

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

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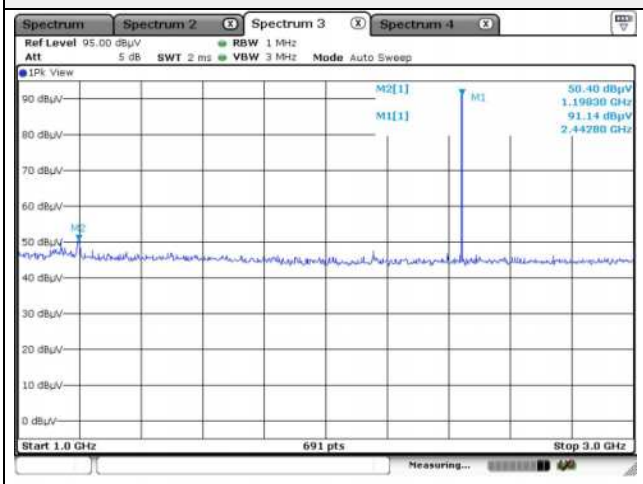
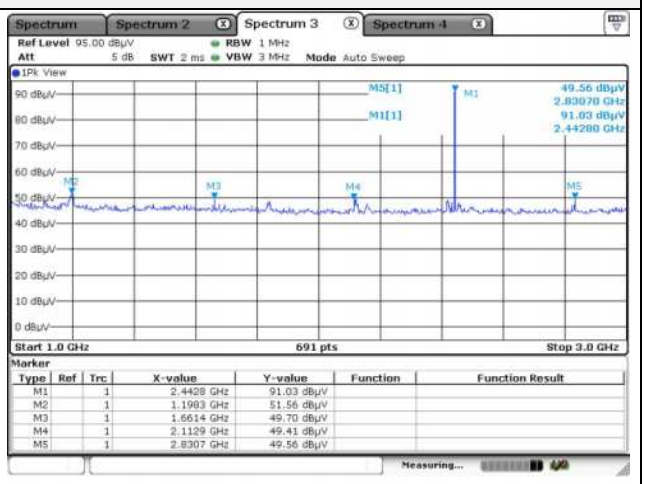
Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	39

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1 198.30	50.40	Peak	H	-8.09	-	42.31	74.00	31.69
1 198.30	51.46	Peak	V	-8.09	-	43.47	74.00	30.53
1 661.40	49.70	Peak	V	-4.86	-	44.84	74.00	29.16
2 112.90	49.41	Peak	V	-1.02	-	48.39	74.00	25.61
2 830.70	49.56	Peak	V	0.77	-	50.33	74.00	23.67

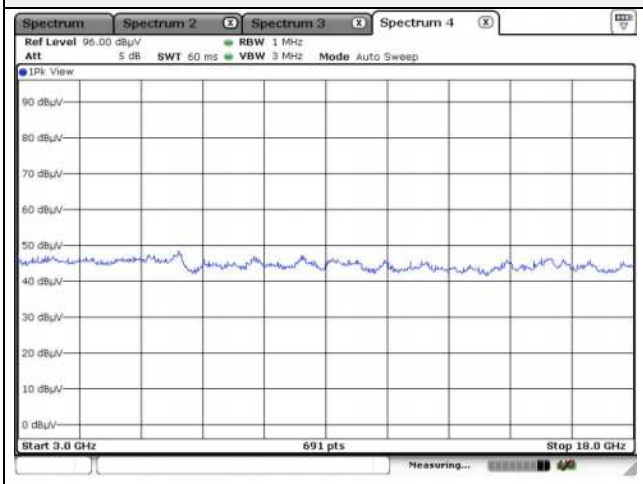
Horizontal // Peak for 1 ㎓ to 3 ㎓



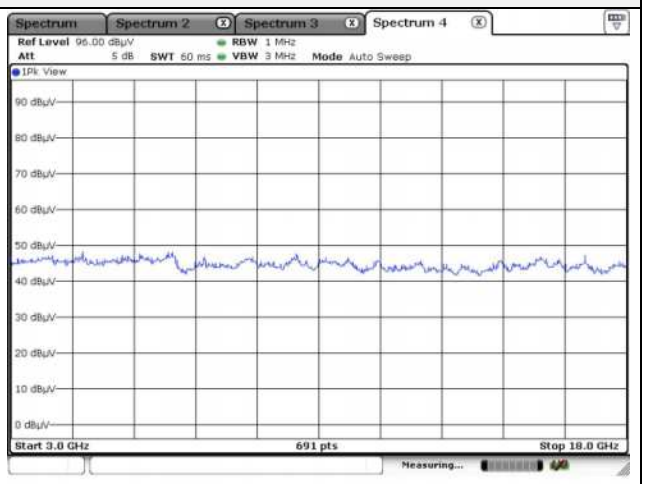
Vertical // Peak for 1 ㎓ to 3 ㎓



Horizontal // Peak for 3 ㎓ to 18 ㎓



Vertical // Peak for 3 ㎓ to 18 ㎓



Note.

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

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Mode: BDR

Transfer rate: 1 Mbps

Distance of measurement: 3 meter

Channel: 78

- **Spurious**

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 201.20	50.20	Peak	H	-8.08	-	42.12	74.00	31.88
1 201.20	52.17	Peak	V	-8.08	-	44.09	74.00	29.91
1 840.80	50.32	Peak	V	-3.00	-	47.32	74.00	26.68
2 118.70	50.59	Peak	V	-1.01	-	49.58	74.00	24.42

- **Band edge**

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 499.19	50.02	Peak	H	-0.25	-	49.77	74.00	24.23
2 486.80	49.64	Peak	V	-0.27	-	49.37	74.00	24.63

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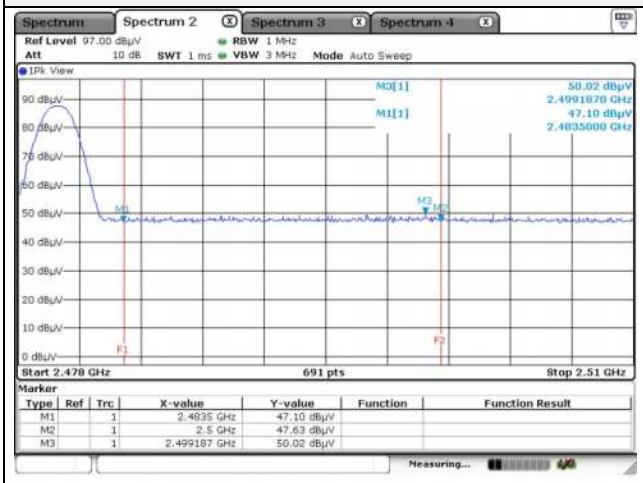
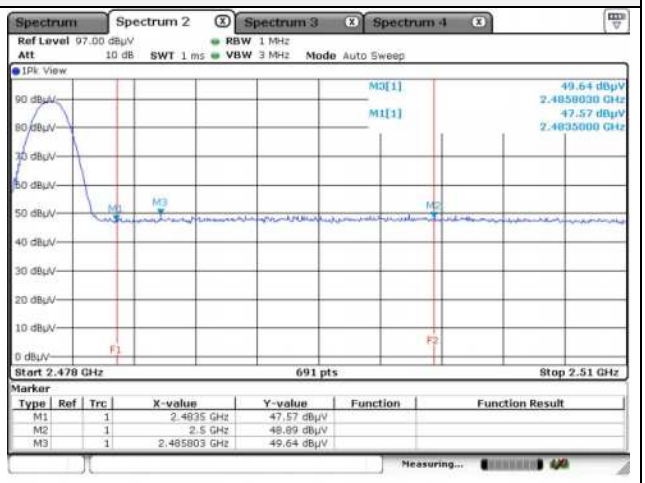
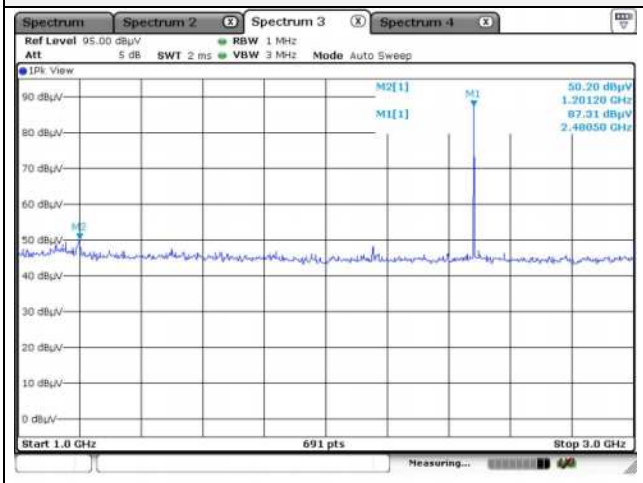
Restricted band // Horizontal // Peak



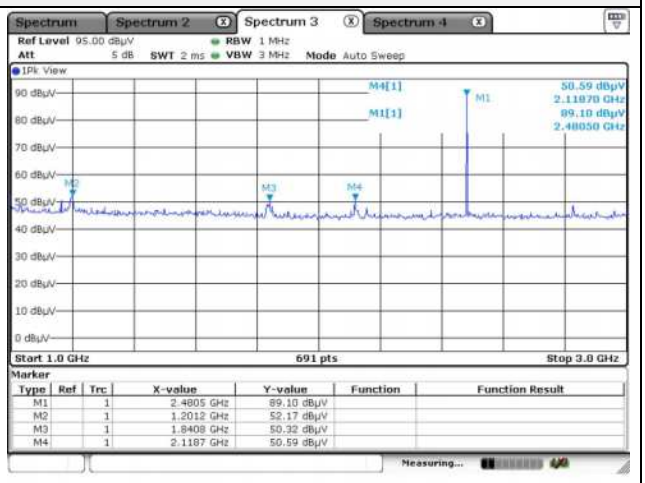
Restricted band // Vertical // Peak



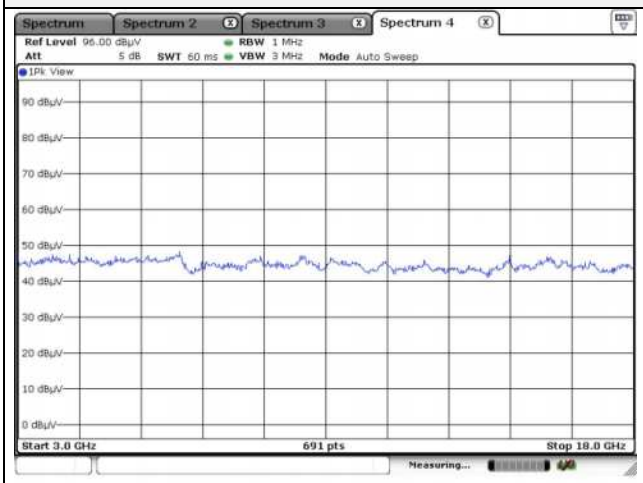
Horizontal // Peak for 1 ㎓ to 3 ㎓



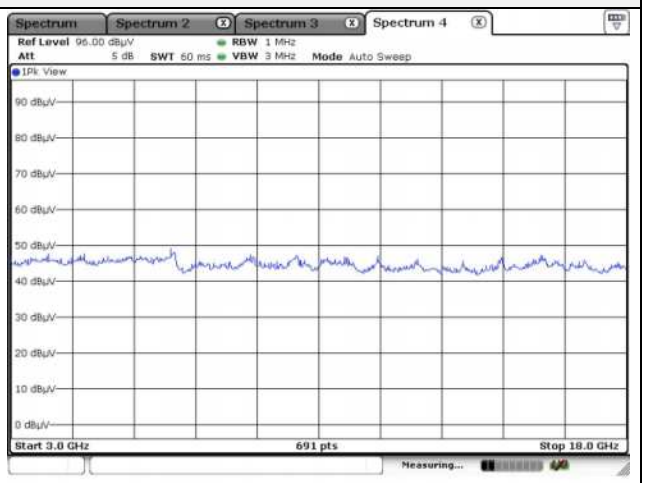
Vertical // Peak for 1 ㎓ to 3 ㎓



Horizontal // Peak for 3 ㎓ to 18 ㎓



Vertical // Peak for 3 ㎓ to 18 ㎓



Note.

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

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

- **Spurious**

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 198.30	50.20	Peak	H	-8.09	-	42.11	74.00	31.89
1 192.50	51.59	Peak	V	-8.12	-	43.47	74.00	30.53
1 661.40	50.43	Peak	V	-4.86	-	45.57	74.00	28.43
2 118.70	50.20	Peak	V	-1.01	-	49.19	74.00	47.81

- **Band edge**

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 346.88	48.70	Peak	H	-0.52	-	48.18	74.00	25.82
2 321.35	48.92	Peak	V	-0.58	-	48.34	74.00	25.66

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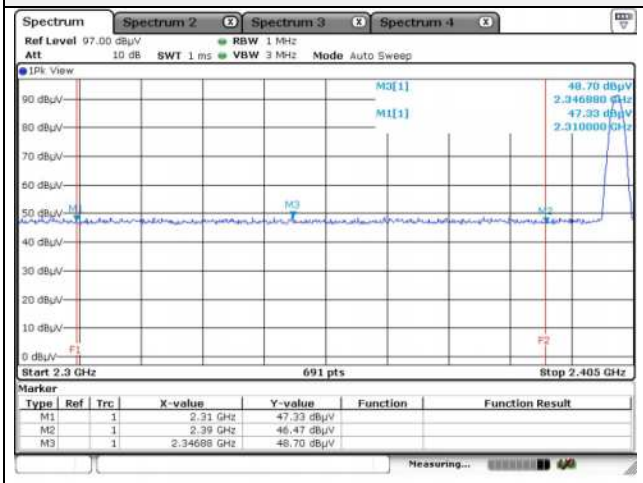
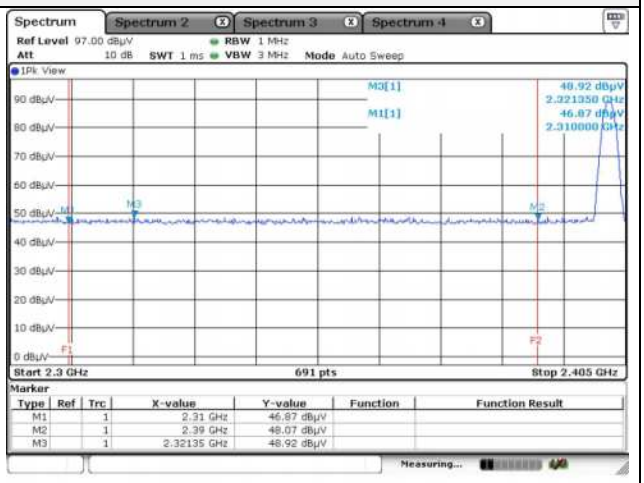
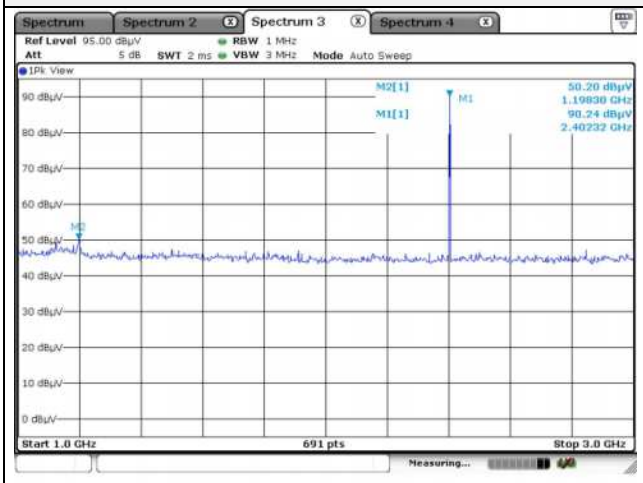
Restricted band // Horizontal // Peak



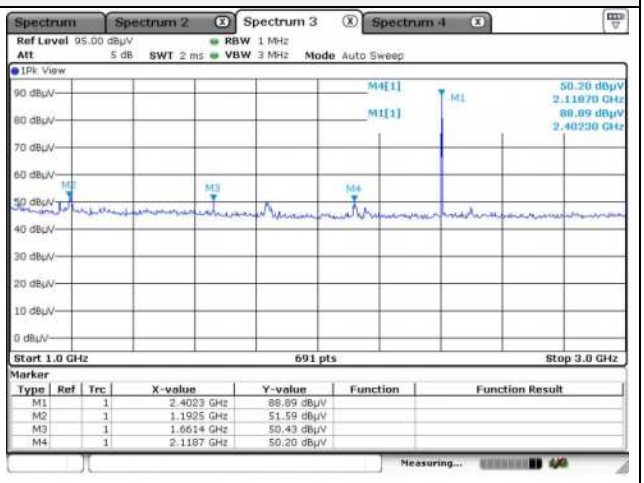
Restricted band // Vertical // Peak



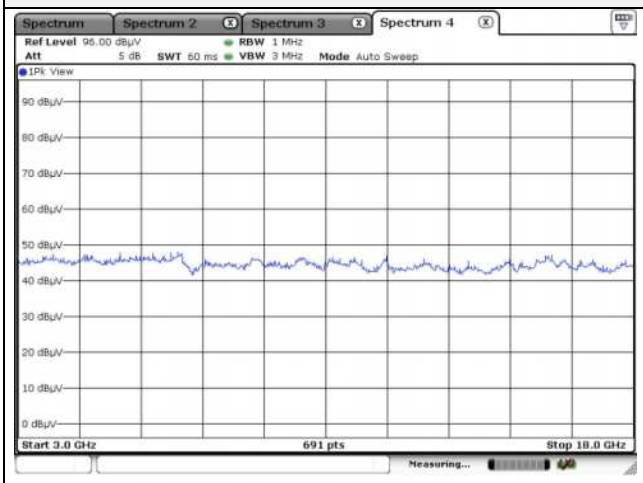
Horizontal // Peak for 1 ㎓ to 3 ㎓



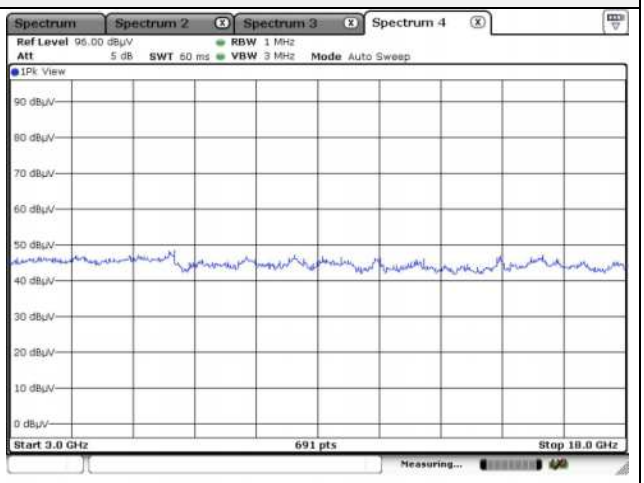
Vertical // Peak for 1 ㎓ to 3 ㎓



Horizontal // Peak for 3 ㎓ to 18 ㎓



Vertical // Peak for 3 ㎓ to 18 ㎓



Note.

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

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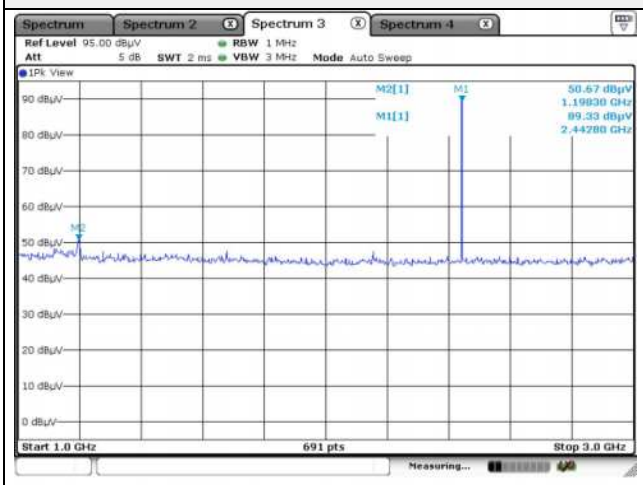
Mode:	EDR
Transfer rate:	3 Mbps(Worst case)
Distance of measurement:	3 meter
Channel:	39

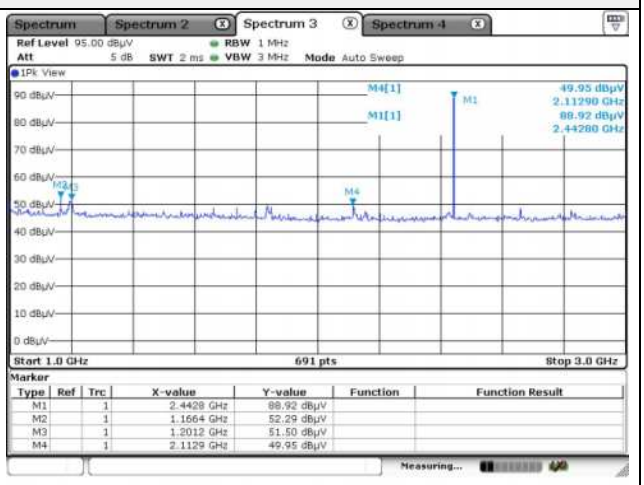
- **Spurious**

Frequency (㎒)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 198.30	50.67	Peak	H	-8.09	-	42.58	74.00	31.42
1 166.40	52.29	Peak	V	-8.25	-	44.04	74.00	29.96
1 201.20	51.50	Peak	V	-8.08	-	43.42	74.00	30.58
2 112.90	49.95	Peak	V	-1.02	-	48.93	74.00	25.07

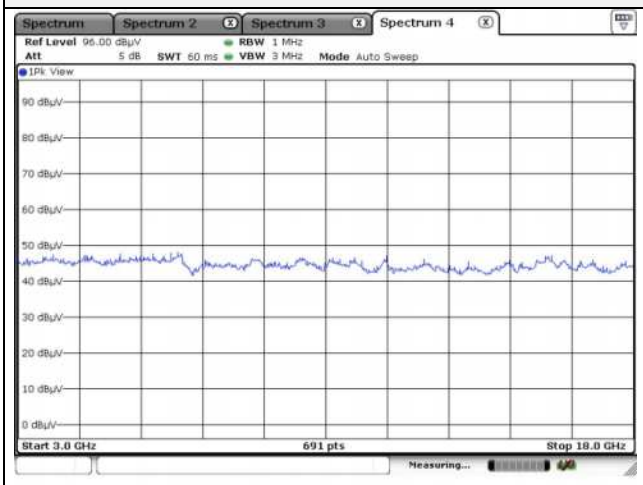
Horizontal // Peak for 1 ㎓ to 3 ㎓



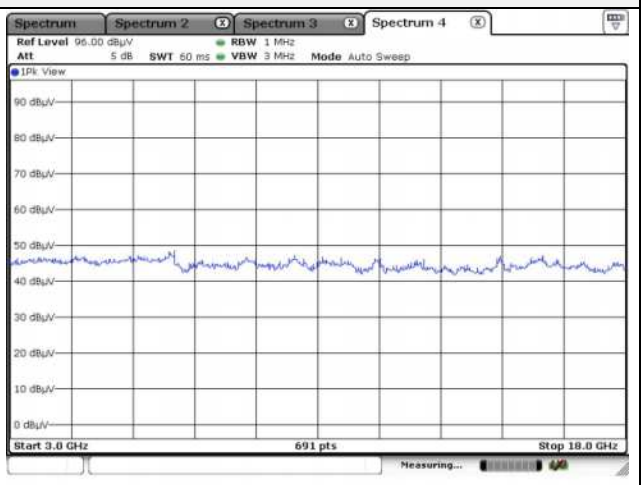
Vertical // Peak for 1 ㎓ to 3 ㎓



Horizontal // Peak for 3 ㎓ to 18 ㎓



Vertical // Peak for 3 ㎓ to 18 ㎓



Note.

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2. No spurious emission were detected above 3 ㎓.

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Mode: EDR

Transfer rate: 3 Mbps(Worst case)

Distance of measurement: 3 meter

Channel: 78

- **Spurious**

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 198.30	50.11	Peak	H	-8.09	-	42.02	74.00	31.98
1 201.20	50.93	Peak	H	-8.08	-	42.85	74.00	31.15
2 822.00	49.71	Peak	V	0.74	-	50.45	74.00	23.55

- **Band edge**

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 484.78	49.38	Peak	H	-0.27	-	49.11	74.00	24.89
2 495.11	49.40	Peak	V	-0.25	-	49.15	74.00	24.85

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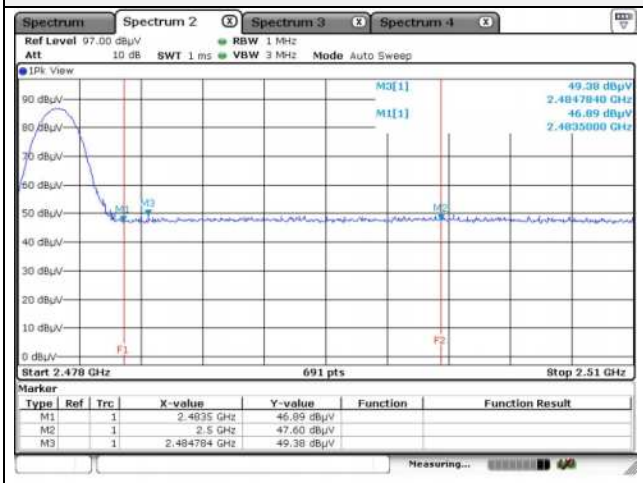
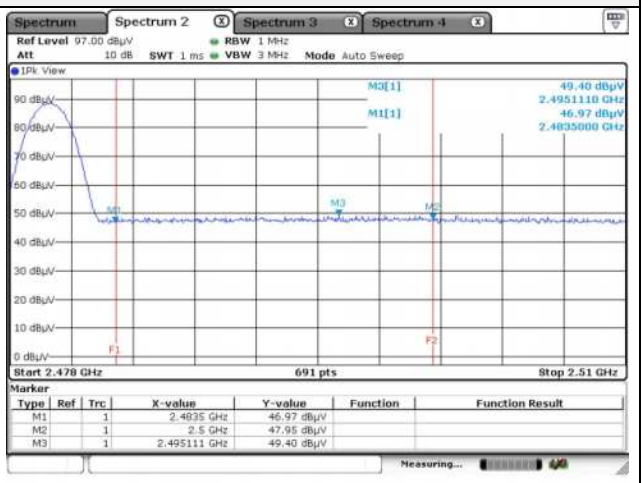
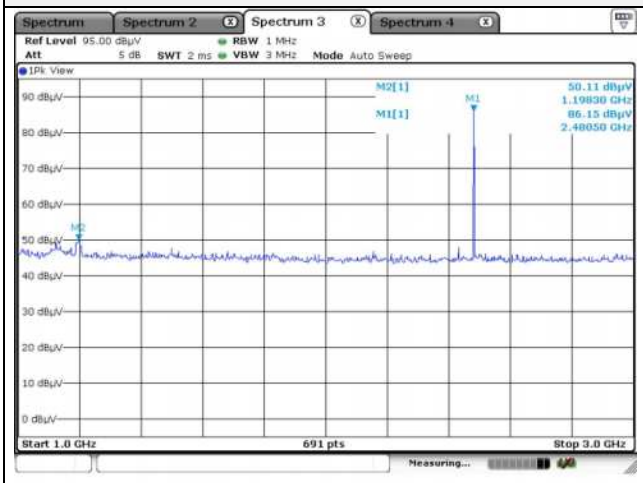
Restricted band // Horizontal // Peak



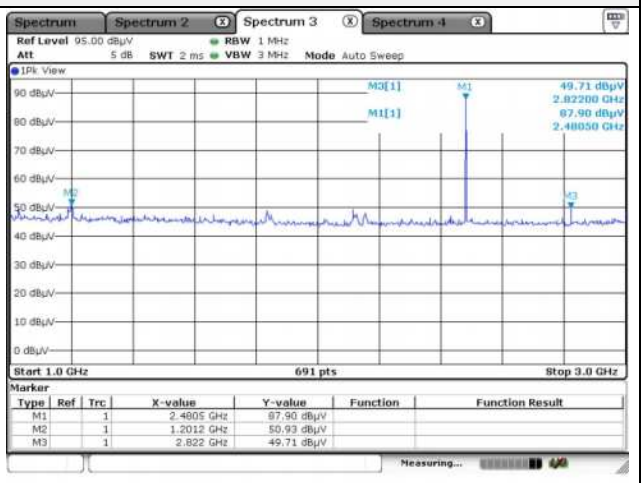
Restricted band // Vertical // Peak



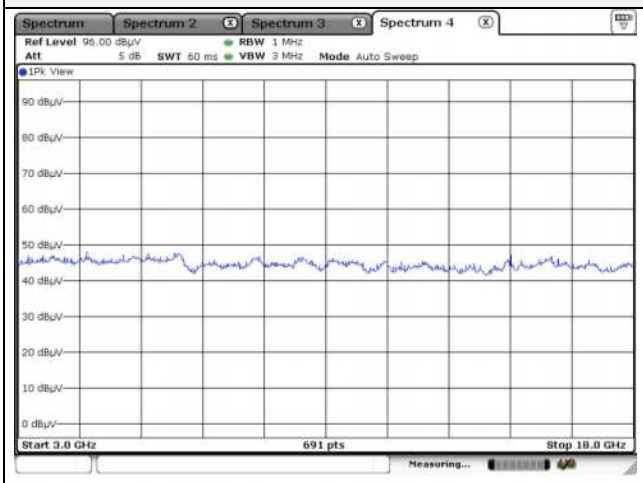
Horizontal // Peak for 1 ㎓ to 3 ㎓



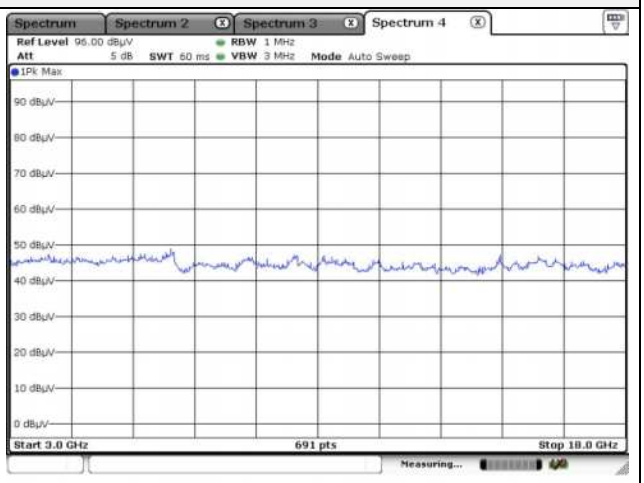
Vertical // Peak for 1 ㎓ to 3 ㎓



Horizontal // Peak for 3 ㎓ to 18 ㎓



Vertical // Peak for 3 ㎓ to 18 ㎓



Note.

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

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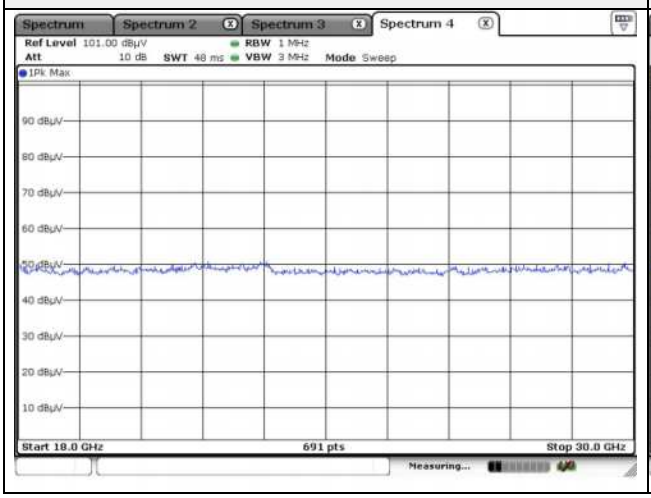
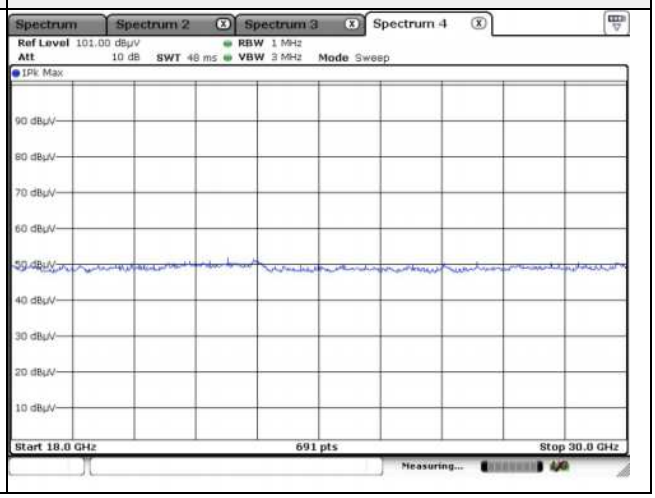
Test results (18 ㎓ to 30 ㎓) – Worst case

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 ㎓.

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3.7. Conducted band edge and out of band emissions

Test procedure

ANSI C63.10-2013 - Section 7.8.6 and 7.8.8

Test setup

EUT	—	Attenuator	—	Spectrum analyzer

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
6. Trace mode = max hold
7. Sweep time = auto couple
8. 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))

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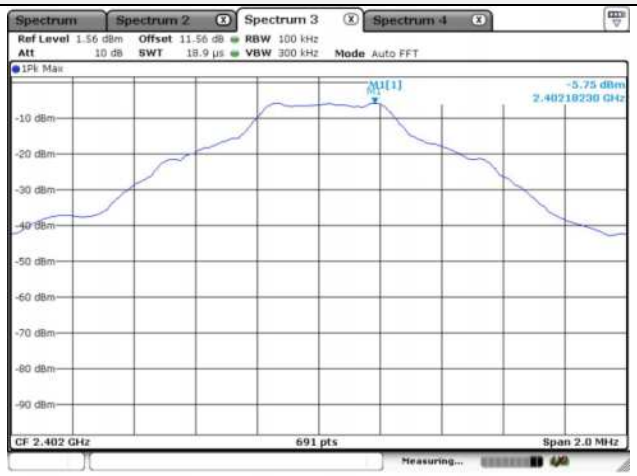
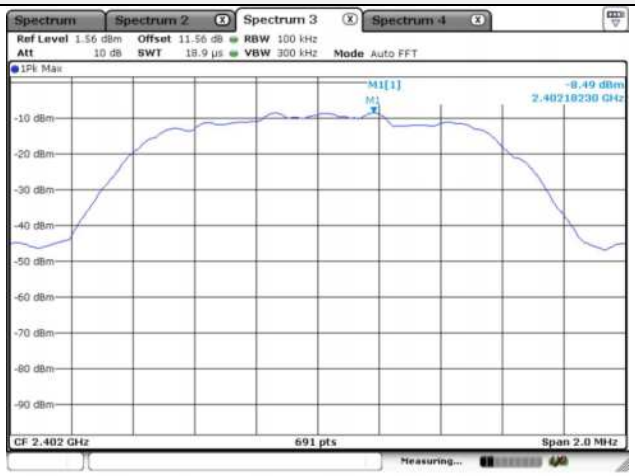
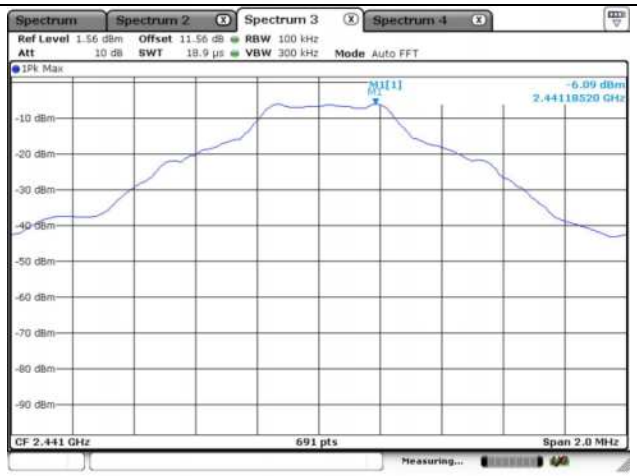
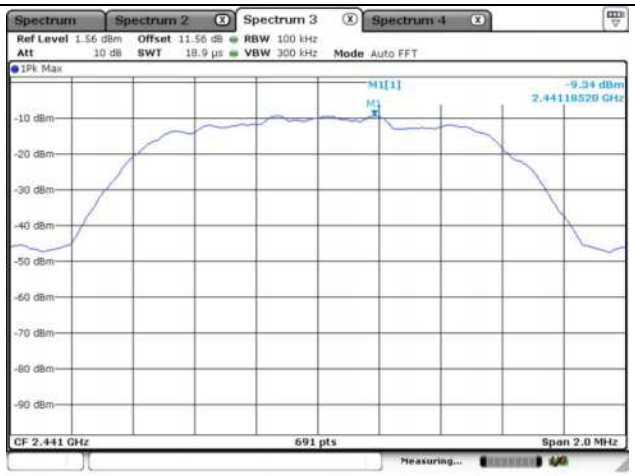
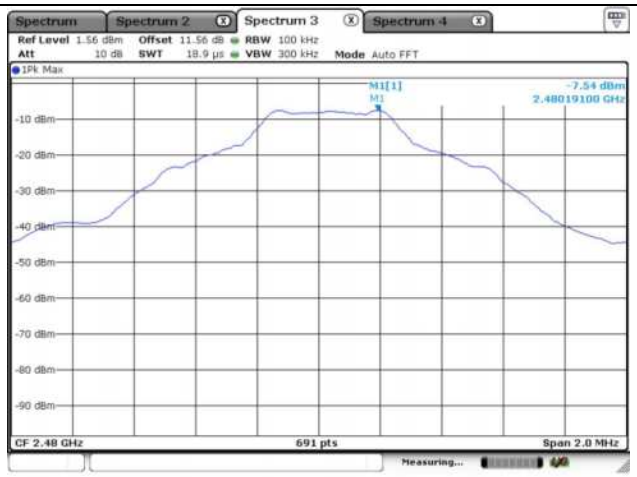
Test results

CH	Reference level	
	BDR(1Mbps)	EDR(3Mbps)
00		
39		
78		

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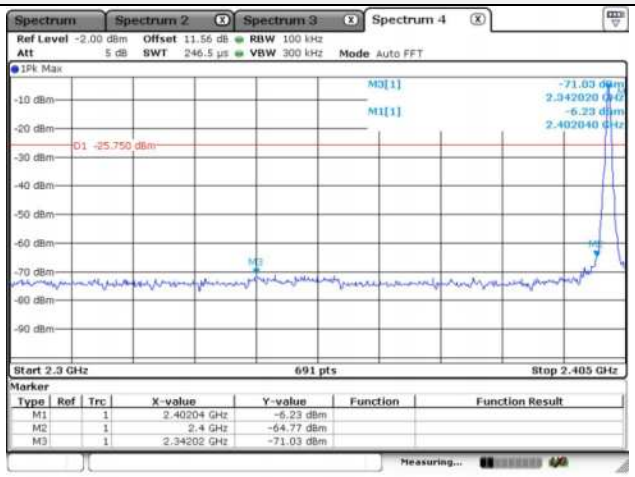
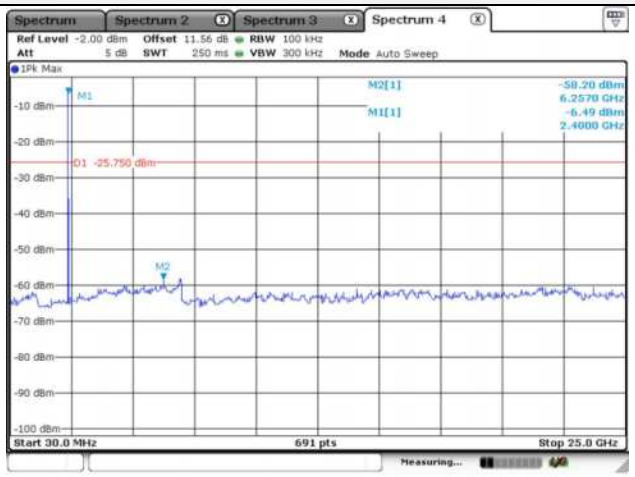
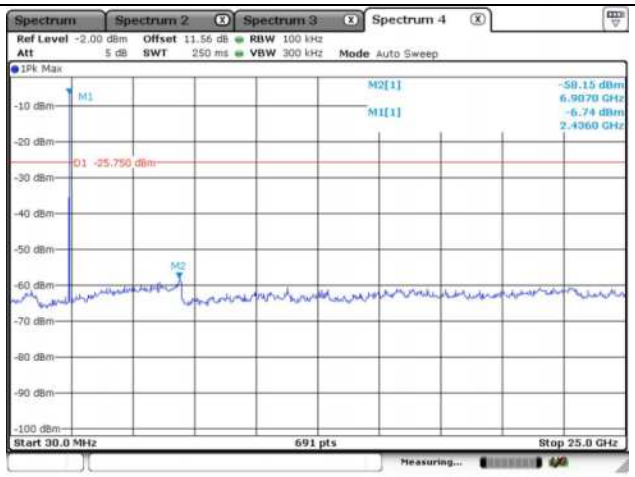
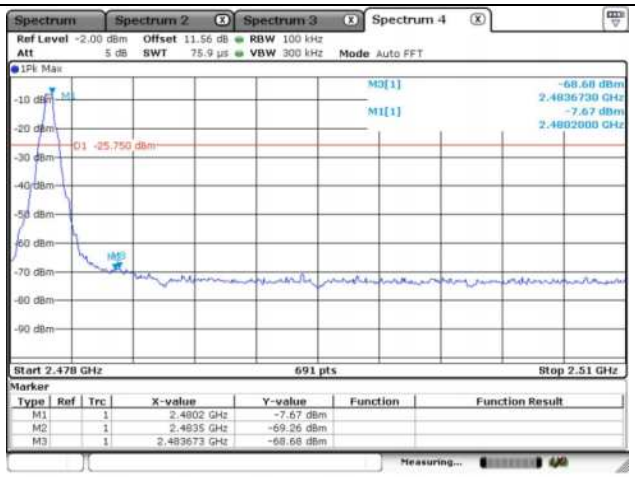
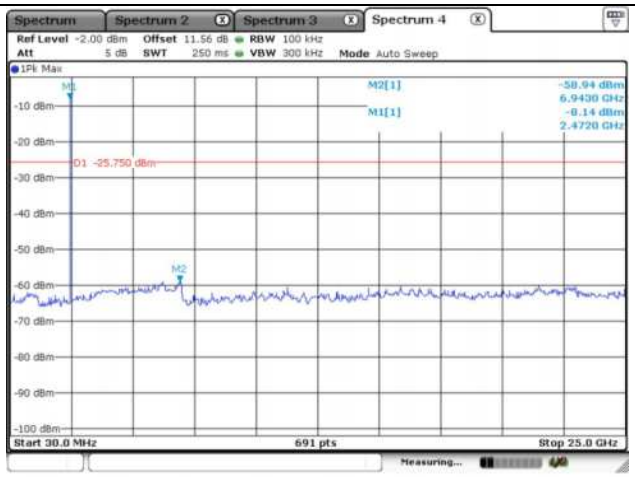
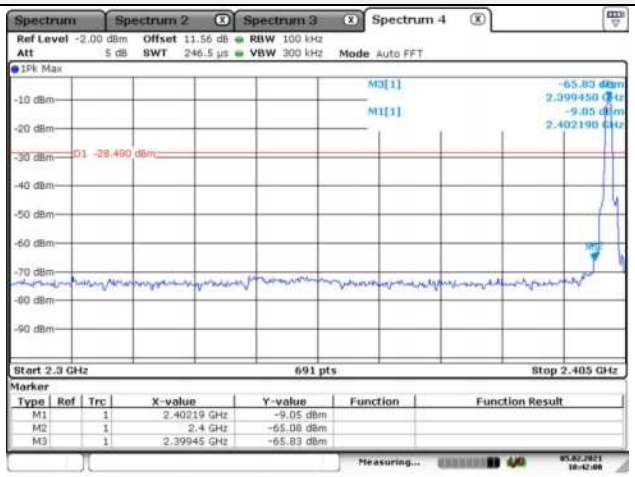
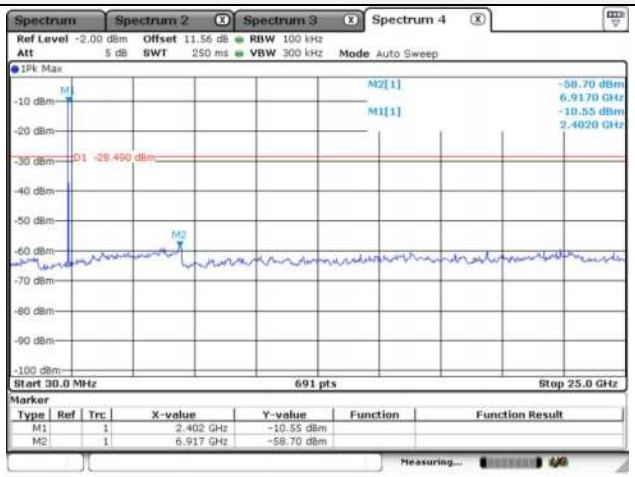
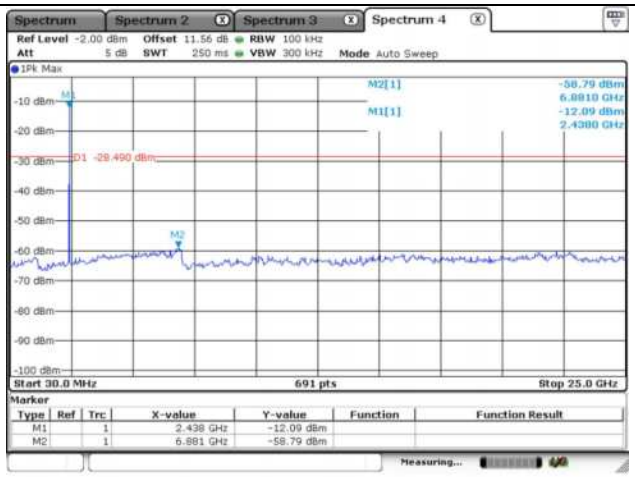
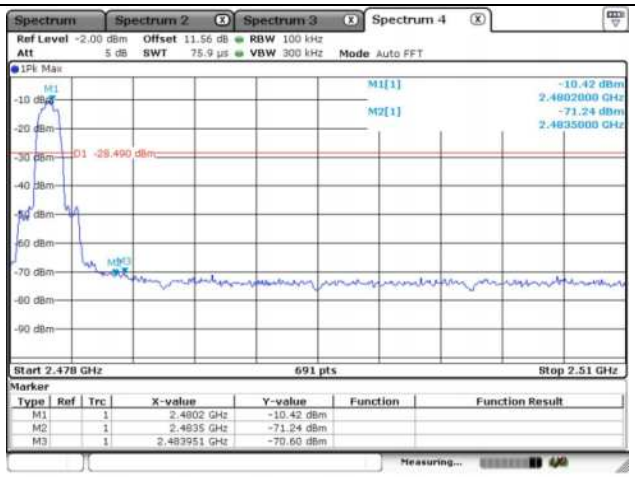
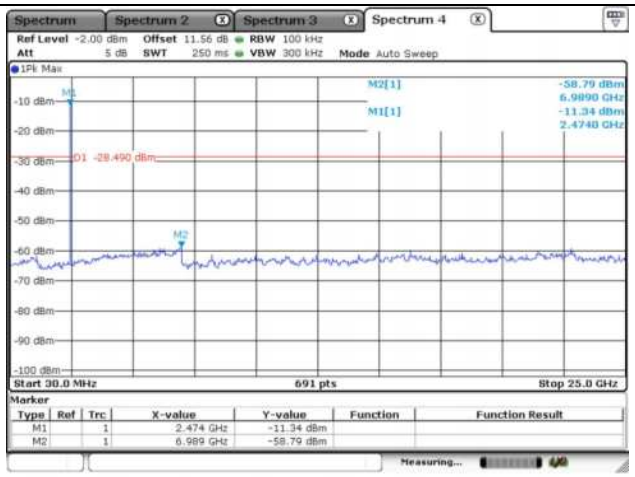
CH	BDR(1Mbps)	
00		
39	Blank	
78		

Note:

1. The channel found to contain the maximum PSD level can be used to establish the reference level.

CH	EDR(3Mbps)	
00		
39	Blank	
78		

Note:

1. The channel found to contain the maximum PSD level can be used to establish the reference level.

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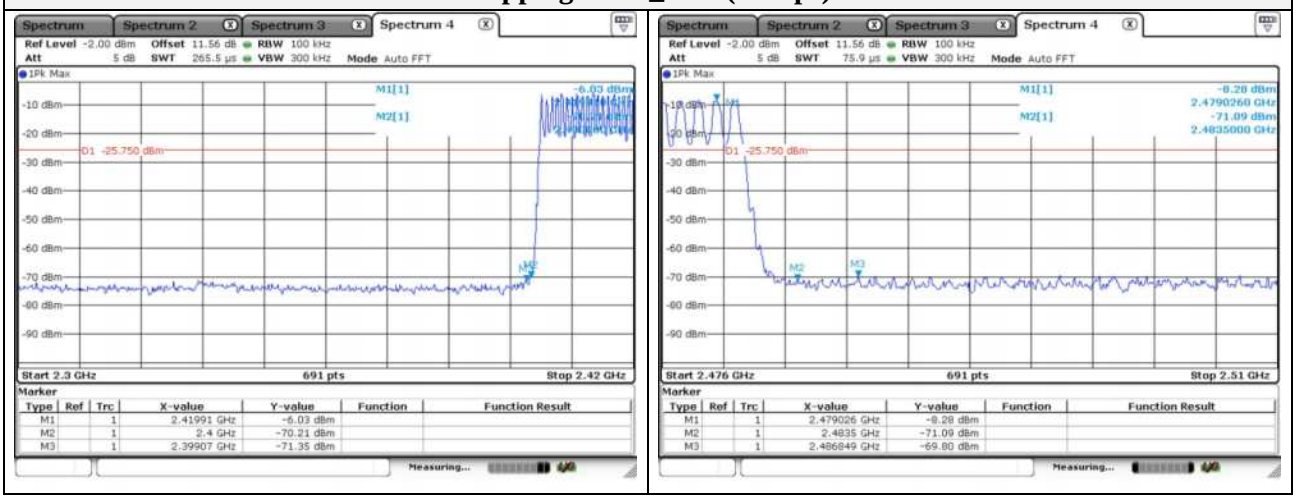
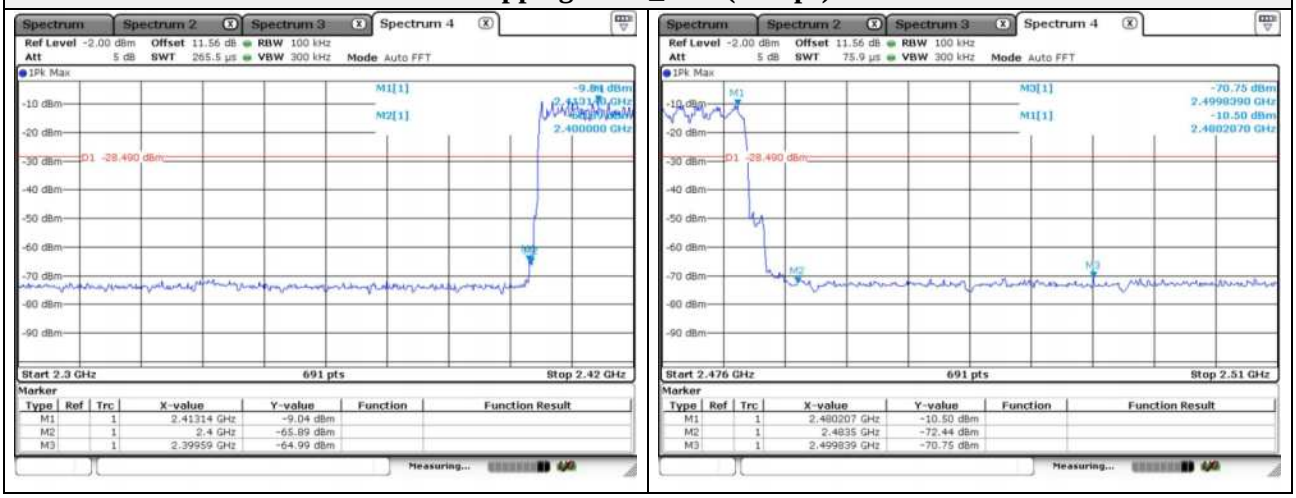
Hopping mode_BDR(1Mbps)



Hopping mode_EDR(3Mbps)



Note:

1. The channel found to contain the maximum PSD level can be used to establish the reference level.

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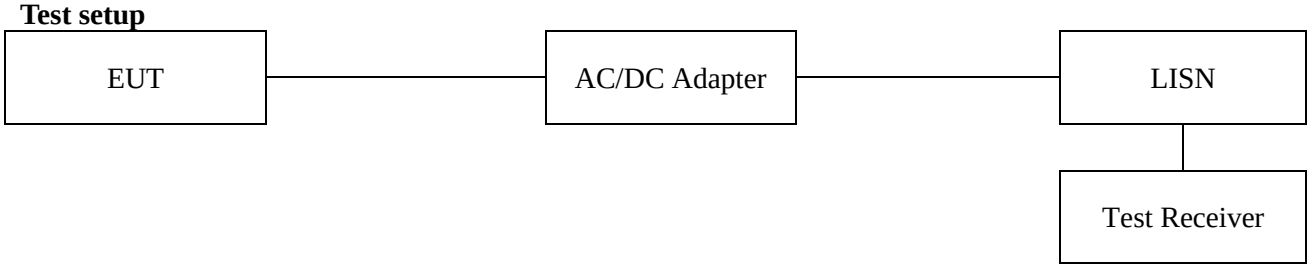
3.8 AC conducted emissions

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 (dBμV/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).

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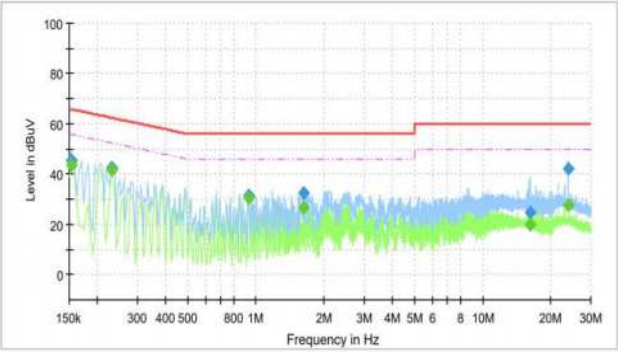
Test results

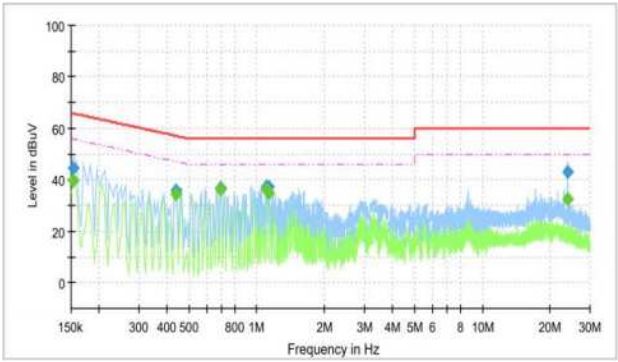
Hot Line



Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	Average (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.154000	45.59	---	65.78	20.19	1000.0	9.000	L1	19.8
0.154000	---	43.62	55.78	12.16	1000.0	9.000	L1	19.8
0.230000	42.62	---	62.45	19.83	1000.0	9.000	L1	19.8
0.230000	---	41.45	52.45	11.00	1000.0	9.000	L1	19.8
0.926000	31.48	---	56.00	24.52	1000.0	9.000	L1	20.3
0.926000	---	30.64	46.00	15.36	1000.0	9.000	L1	20.3
1.614000	32.31	---	56.00	23.69	1000.0	9.000	L1	20.5
1.614000	---	26.76	46.00	19.24	1000.0	9.000	L1	20.5
16.174000	24.50	---	60.00	35.50	1000.0	9.000	L1	20.6
16.174000	---	19.73	50.00	30.27	1000.0	9.000	L1	20.6
23.898000	42.06	---	60.00	17.94	1000.0	9.000	L1	21.1
23.902000	---	27.65	50.00	22.35	1000.0	9.000	L1	21.1

Neutral Line



Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	Average (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.154000	44.68	---	65.78	21.10	1000.0	9.000	N	19.7
0.154000	---	39.51	55.78	16.27	1000.0	9.000	N	19.7
0.438000	---	34.22	47.10	12.88	1000.0	9.000	N	19.9
0.438000	35.68	---	57.10	21.42	1000.0	9.000	N	19.9
0.694000	---	36.18	46.00	9.82	1000.0	9.000	N	20.2
0.694000	37.03	---	56.00	18.97	1000.0	9.000	N	20.2
1.102000	---	36.48	46.00	9.52	1000.0	9.000	N	20.3
1.102000	37.44	---	56.00	18.56	1000.0	9.000	N	20.3
1.130000	---	34.76	46.00	11.24	1000.0	9.000	N	20.3
1.130000	37.37	---	56.00	18.63	1000.0	9.000	N	20.3
23.946000	---	32.39	50.00	17.61	1000.0	9.000	N	21.1
23.946000	43.22	---	60.00	16.78	1000.0	9.000	N	21.1

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Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum Analyzer	R&S	FSV40	101002	1 year	2021.07.02
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2022.01.15
AC POWER SOURCE/ ANALYZER	HP	6813A	3729A00754	1 year	2022.01.15
Power Meter	Anritsu	ML2495A	1438001	1 year	2022.01.14
Pulse Power Sensor	Anritsu	MA2411B	1339205	1 year	2022.01.14
Loop Antenna	Schwarzbeck	FMZB1513	225	2 years	2023.02.15
Trilog-broadband antenna	SCHWARZBECK	VULB 9163	715	2 years	2022.12.08
Horn Antenna	A.H.	SAS-571	781	2 years	2021.05.13
Horn Antenna	A.H SYSTEMS	SAS-571	414	2 years	2022.02.11
AMPLIFIER	SONOMA INSTRUMENT	310N	401123	1 year	2021.06.08
Preamplifier	AGILENT	8449B	8008A01640	1 year	2021.04.01
EMI Test Receiver	R&S	ESU26	100551	1 year	2021.04.01
EMI TEST RECEIVER	R&S	ESR3	101781	1 year	2021.12.29
LISN	R&S	ENV216	101787	1 year	2022.01.02
BLUETOOTH TESTER	TESCOM	TC-3000C	3000C000868	1 year	2022.01.15

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
-	-	-	-

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