

TEST REPORT



CTK Co., Ltd.
The Prime Leader of Global Regulatory Certification

CTK Co., Ltd.

(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
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Report No.:
CTK-2019-02419
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1. Client

- Name : KAONMEDIA Co., Ltd.
- Address : KAONMEDIA Building, 884-3 Seongnam-daero, Bundang-gu, Seongnam-si, Gyeonggi-do, Korea
- Date of Receipt : 2019-05-31

2. Manufacturer

- Name : KAONMEDIA Co., Ltd.
- Address : KAONMEDIA Building, 884-3, Seongnam-daero, Bundang-gu, Seongnam-si, Gyeonggi-do, Korea

3. Use of Report : For FCC Certification

4. Test Sample / Model: WiFi Mesh Repeater / AR1031

5. Date of Test : 2019-06-11 to 2019-06-25

6. Test Standard(method) used : FCC 47 CFR part 15 subpart C 15.247

7. Testing Environment: Temp.: (25 ± 5) °C, Humidity: (50 ± 3) % R.H.

8. Test Results : Compliance

The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This Test Report cannot be reproduced, except in full.

Affirmation	Tested by Ji-Hye, Kim: (Signature) 	Technical Manager Won-Jae, Hwang: (Signature)
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2019-06-28

Republic of KOREA **CTK Co., Ltd.**



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REPORT REVISION HISTORY

Date	Revision	Page No
2019-06-28	Issued (CTK-2019-02419)	all

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1. General Product Description

1.1 Client Information

Company	KAONMEDIA Co., Ltd.
Contact Point	KAONMEDIA Building, 884-3 Seongnam-daero, Bundang-gu, Seongnam-si, Gyeonggi-do, Korea
Contact Person	Name : Kim Tae-Yong E-mail : tykim@kaonmedia.com Tel : +82-31-724-8904

1.2 Product Information

FCC ID	WQT-AR1031
Product Description	WiFi Mesh Repeater
Model name	AR1031
Variant Model name	-
Operating Frequency	2 412 MHz – 2 462 MHz
RF Output Power	802.11b : 24.89 dBm (308.32 mW) 802.11g : 20.60 dBm (114.82 mW) CDD Mode_802.11n_HT20 : 20.40 dBm (109.65 mW) CDD Mode_802.11n_HT40 : 19.33 dBm (85.70 mW) SDM Mode_802.11n_HT20 : 19.77 dBm (94.84 mW) SDM Mode_802.11n_HT40 : 19.30 dBm (85.11 mW)
Antenna Specification	ANT1, ANT2 type : Metal Antenna ANT1, ANT2 Peak Gain : 1.9 dBi
Number of channels	11
Type of Modulation	802.11b : DSSS 802.11g/n : OFDM
Data Rate	802.11b : 11 / 5.5 / 2 / 1 Mbps 802.11g : 54 / 48 / 36 / 24 / 18 / 12 / 9 / 6 Mbps 802.11n: up to 300 Mbps
Power Source	DC 12 V (Adapter)
Hardware Rev	Rev 1.0
Software Rev	v.2.00.80

1.3 Peripheral Devices

Device	Manufacturer	Model No.	Serial No.
Note Computer	HP	15-bs563TU	CND7253R6N
AC/DC Adapter	HP	HSTNN-CA40	-
AD/DC Adapter	SHENZHEN FRECOM ELECTRONICS CO., LTD.	F12L33-120100SPAU	-



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2. Facility and Accreditations

2.1 Test Facility

The measurement facility is located at (Ho-dong), 113, Yejik-ro, Cheoin-gu, Yong-in-si, Gyeonggi-do, Korea.

2.2 Laboratory Accreditations and Listings

Country	Agency	Registration Number
USA	FCC	805871
CANADA	ISED	8737A-2
KOREA	NRRA	KR0025

2.3 Calibration Details of Equipment Used for Measurement

Test equipment and test accessories are calibrated on regular basis. The maximum time between calibrations is one year or what is recommended by the manufacturer, whichever is less. All test equipment calibrations are traceable to the Korea Research Institute of Standards and Science (KRISS), therefore, all test data recorded in this report is traceable to KRISS.



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3. Test Specifications

3.1 Standards

FCC Part Section(s)	Requirement(s)	Status (Note 1)	Test Condition
15.247(a)	6 dB Bandwidth	C	Conducted
15.247(b)	Maximum Output Power	C	
15.247(d)	Conducted Spurious emission	C	
15.247(d)	Unwanted Emission(Conducted)	C	
15.247(e)	Power Spectral Density	C	
15.209	Radiated Emissions	C	Radiated
15.207	AC Conducted Emission	C	Line Conducted

Note 1: C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable

Note 2: The data in this test report are traceable to the national or international standards.

Note 3: The sample was tested according to the following specification: FCC Part 15.247, ANSI C63.10-2013

Note 4: The tests were performed according to the method of measurements prescribed in KDB No.558074.



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3.2 Mode of operation during the test

The EUT is operated in a manner representative of the typical of the equipments.
During at testing, system components were manipulated within the confines of typical usage to maximize each emission.
For WLAN function, the engineering test program was provided and enabled to make EUT continuous transmit.
All modulation modes were tests. The results are only attached worst cases.

Test Frequency

- 802.11b, 802.11g, 802.11n_HT20

Lowest channel	Middle channel	Highest channel
2 412 MHz	2 437 MHz	2 462 MHz

- 802.11n_HT40

Lowest channel	Middle channel	Highest channel
2 422 MHz	2 437 MHz	2 452 MHz

Test mode

- CDD mode

Test mode	Modulation	Data rate	Duty Cycle	Duty Cycle Factor
802.11b	DSSS	1 Mbps	99.2%	0 dB
802.11g	OFDM	6 Mbps	93.2%	0.31 dB
802.11n_HT20	OFDM	MCS 0	92.7%	0.33 dB
802.11n_HT40	OFDM	MCS 0	86.3%	0.64 dB

- SDM mode

Test mode	Modulation	Data rate	Duty Cycle	Duty Cycle Factor
802.11n_HT20	OFDM	MCS 8	86.8%	0.61 dB
802.11n_HT40	OFDM	MCS 8	77.3%	1.12 dB



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3.3 Maximum Measurement Uncertainty

The value of the measurement uncertainty for the measurement of each parameter.
Coverage factor $k = 2$, Confidence levels of 95 %

Description	Uncertainty
Conducted RF Output Power	± 1.5 dB
Power Spectral Density	± 1.5 dB
Occupied Bandwidth	± 0.1 MHz
Unwanted Emission(conducted)	± 3.0 dB
Radiated Emissions ($f \leq 1$ GHz)	± 4.0 dB
Radiated Emissions ($f > 1$ GHz)	± 5.0 dB

3.4 Test Software

Conducted Test	Ics Pro Ver. 6.0.3
Radiated Test	TOYO EMI software EP5RE Ver. 5.1.0
Line Conducted Test	ESCI7, ESCI3 : EMC32 Ver. 8.50.0 ESR7 : EMC32 Ver. 8.53.0



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4. Technical Characteristic Test

4.1 6dB Bandwidth

Test Procedures

KDB 558074 - Section 8.2

ANSI C63.10-2013 - Section 11.8.2

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Test Procedures

ANSI C63.10-2013 6.9.3

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

Use the 99% power bandwidth function of the instrument and report the measured bandwidth.

Test Settings :

Center frequency = the highest, middle and the lowest channels

- a) RBW = 100 kHz
- b) VBW $\geq 3 \times$ RBW
- c) Detector = peak
- d) Trace mode = Max hold
- e) Sweep = auto couple
- f) Allow trace to fully stabilize

g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Limit

6 dB Bandwidth > 500kHz



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Test Data:

ANT1

	6 dB Bandwidth and 99% Bandwidth (MHz)					
Mode	802.11b		802.11g		802.11n_HT20	
Frequency	6dB	99%	6dB	99%	6dB	99%
2 412 MHz	10.13	15.64	15.77	16.42	15.78	17.44
2 437 MHz	10.12	15.12	15.77	16.38	15.78	17.41
2 462 MHz	10.07	14.95	15.79	16.36	15.81	17.39

	6 dB Bandwidth and 99% Bandwidth (MHz)					
Mode	802.11n HT40					
Frequency	6dB			99%		
2 422 MHz	35.16			35.50		
2 437 MHz	35.16			35.49		
2 452 MHz	35.16			35.48		

ANT2

	6 dB Bandwidth and 99% Bandwidth (MHz)					
Mode	802.11b		802.11g		802.11n_HT20	
Frequency	6dB	99%	6dB	99%	6dB	99%
2 412 MHz	10.13	15.44	15.74	16.40	15.52	17.42
2 437 MHz	10.11	15.10	15.75	16.37	15.66	17.40
2 462 MHz	10.08	14.89	15.77	16.35	15.70	17.37

	6 dB Bandwidth and 99% Bandwidth (MHz)					
Mode	802.11n HT40					
Frequency	6dB			99%		
2 422 MHz	35.15			35.43		
2 437 MHz	35.14			35.42		
2 452 MHz	35.14			35.41		

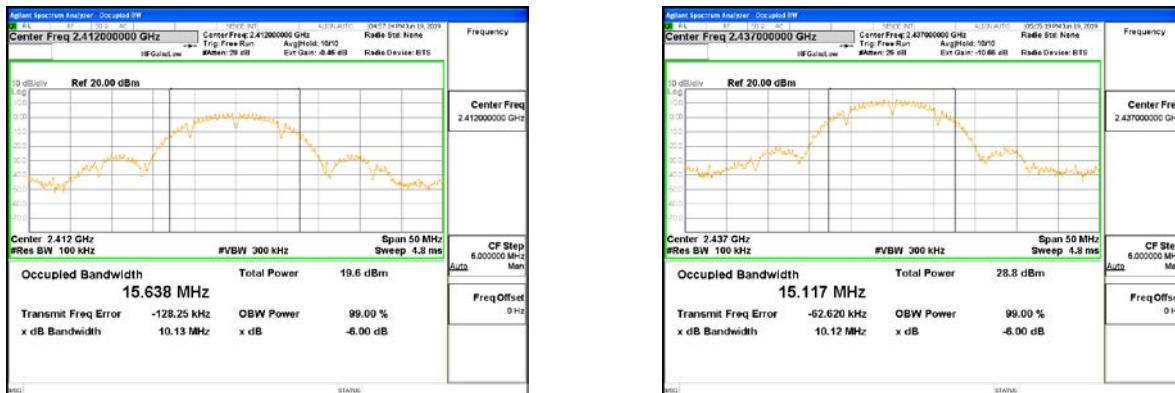
See next pages for actual measured spectrum plots.



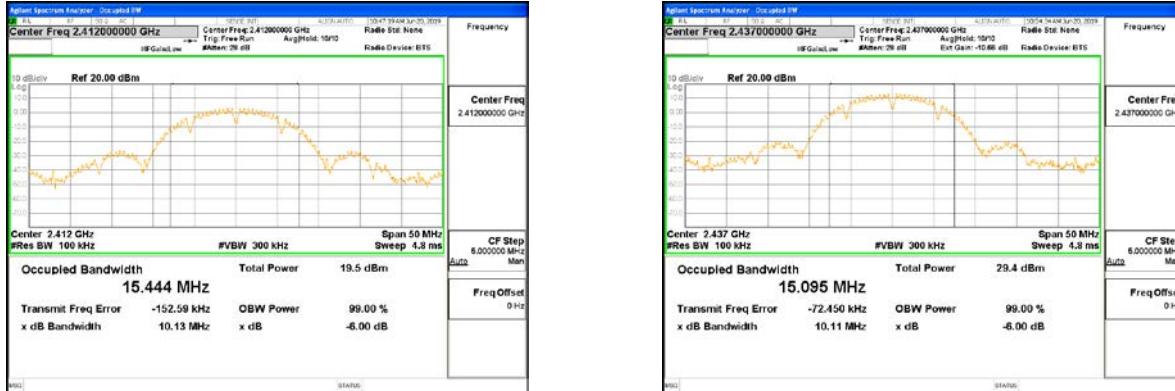
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802.11b_ANT1



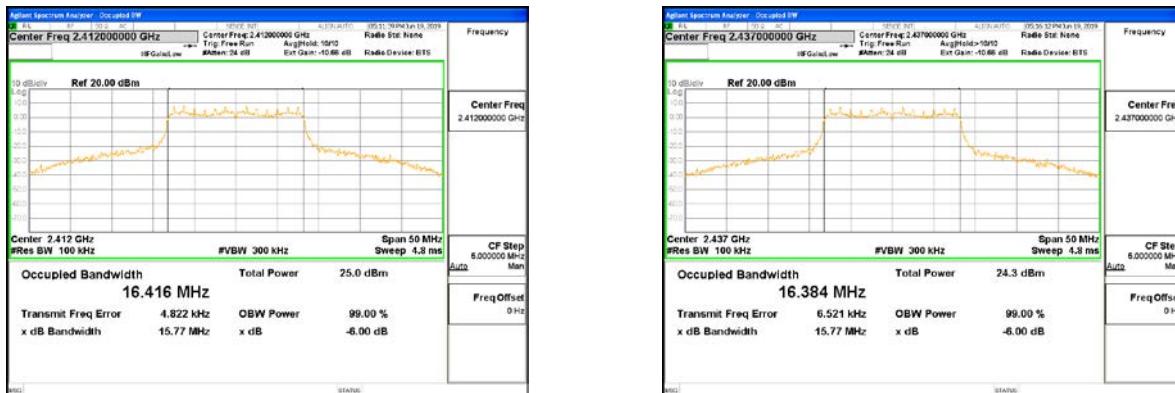
802.11b_ANT2



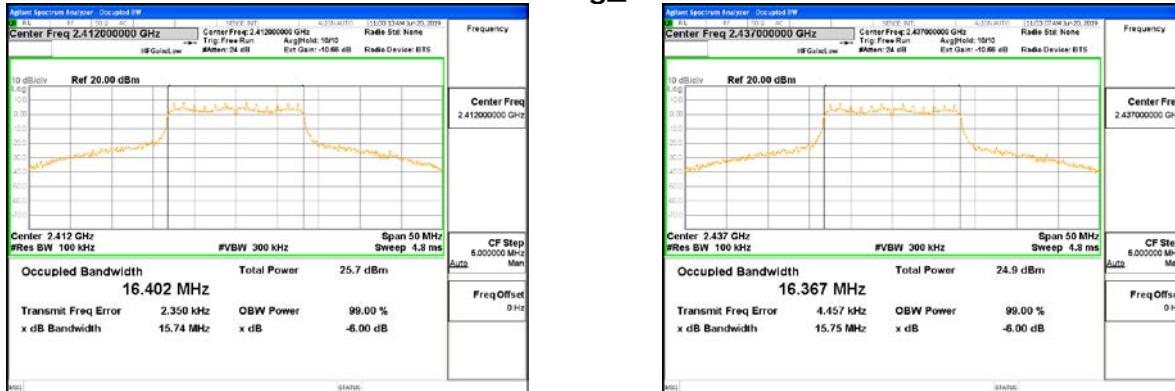
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802.11g_ANT1



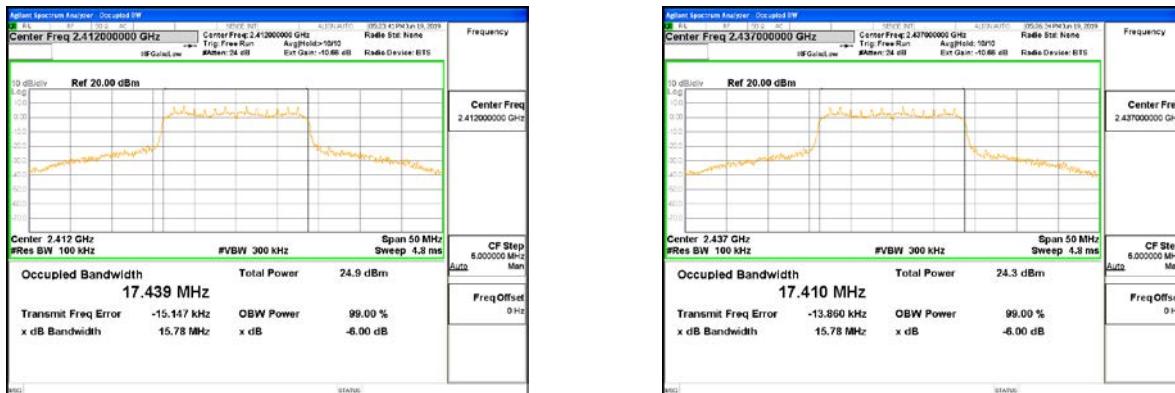
802.11g_ANT2



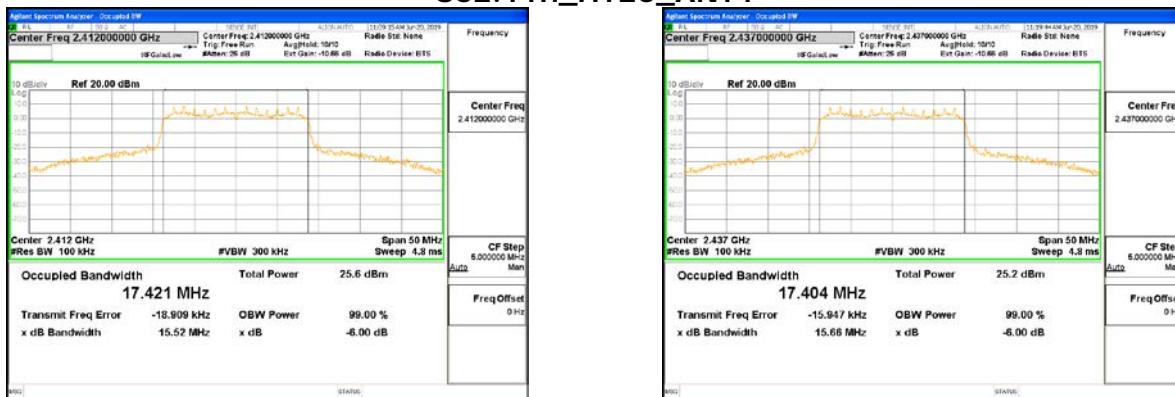
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802.11n_HT20_ANT1



802.11n_HT20_ANT2



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802.11n-HT40_ANT1



802.11n-HT40_ANT2

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4.2 OUTPUT POWER

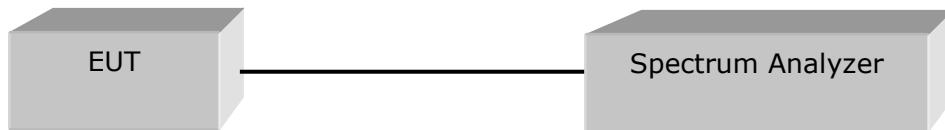
Test Procedures

KDB 558074 - Section 8.3.2.2 (Average Power)

ANSI C63.10-2013 - Section 11.9.2.2

KDB 662911 D01, D02 (Multiple Transmitter Output)

The transmitter output is connected to a spectrum analyzer and the analyzer's internal channel power integration function is used to integrate the power over a bandwidth greater than or equal to the 99% bandwidth.



Test Settings:

Center frequency = the highest, middle and the lowest channels

- | | |
|--------------------------------------|-------------------------|
| a) span $\geq 1.5 \times$ OBW | b) RBW = 1 MHz |
| c) VBW $\geq 3 \times$ RBW | d) Sweep time = auto |
| e) Detector = RMS | f) average at least 100 |
| g) Duty cycle factor = $10\log(1/x)$ | |

Test mode		Duty Cycle Factor (dB)
CDD Mode	802.11b	0.00
	802.11g	0.31
	802.11n_HT20	0.33
	802.11n_HT40	0.64
SDM Mode	802.11n_HT20	0.61
	802.11n_HT40	1.12

Limit

Operating Mode	Mode	ANT Configuration	ANT Gain (dBi)	Limit (dBm)
SISO	802.11b/g/n	ANT1	1.90	30.00
SISO	802.11b/g/n	ANT2	1.90	30.00
MIMO (2Tx)	802.11g/n	ANT1 + ANT2	4.91	30.00

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Test Data**CDD Mode_ANT1**

Test Mode	Frequency (MHz)	Measured Output Power (dBm)	Duty cycle Factor (dB)	Result Output Power (dBm)	Limit (dBm)	Margin (dB)
802.11b	2 412	21.67	0.00	21.67	30.00	8.33
	2 437	20.75	0.00	20.75	30.00	9.25
	2 462	20.26	0.00	20.26	30.00	9.74
802.11g	2 412	16.93	0.31	17.24	30.00	12.76
	2 437	16.13	0.31	16.44	30.00	13.56
	2 462	15.52	0.31	15.83	30.00	14.17
802.11n _HT20	2 412	16.74	0.33	17.07	30.00	12.93
	2 437	16.12	0.33	16.45	30.00	13.55
	2 462	15.46	0.33	15.79	30.00	14.21
802.11n _HT40	2 422	15.27	0.64	15.91	30.00	14.09
	2 437	14.91	0.64	15.55	30.00	14.45
	2 452	14.51	0.64	15.15	30.00	14.85

CDD Mode_ANT2

Test Mode	Frequency (MHz)	Measured Output Power (dBm)	Duty cycle Factor (dB)	Result Output Power (dBm)	Limit (dBm)	Margin (dB)
802.11b	2 412	22.08	0.00	22.08	30.00	7.92
	2 437	21.35	0.00	21.35	30.00	8.65
	2 462	20.82	0.00	20.82	30.00	9.18
802.11g	2 412	17.60	0.31	17.91	30.00	12.09
	2 437	16.89	0.31	17.20	30.00	12.80
	2 462	15.98	0.31	16.29	30.00	13.71
802.11n _HT20	2 412	17.35	0.33	17.68	30.00	12.32
	2 437	16.92	0.33	17.25	30.00	12.75
	2 462	15.97	0.33	16.30	30.00	13.70
802.11n _HT40	2 422	16.06	0.64	16.70	30.00	13.30
	2 437	15.55	0.64	16.19	30.00	13.81
	2 452	15.14	0.64	15.78	30.00	14.22

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CDD Mode_ANT1 + ANT2

Test Mode	Frequency (MHz)	Measured Output Power (dBm)	Duty cycle Factor (dB)	Result Output Power (dBm)	Limit (dBm)	Margin (dB)
802.11b	2 412	24.89	0.00	24.89	30.00	5.11
	2 437	24.07	0.00	24.07	30.00	5.93
	2 462	23.56	0.00	23.56	30.00	6.44
802.11g	2 412	20.29	0.31	20.60	30.00	9.40
	2 437	19.54	0.31	19.85	30.00	10.15
	2 462	18.77	0.31	19.08	30.00	10.92
802.11n _HT20	2 412	20.07	0.33	20.40	30.00	9.60
	2 437	19.55	0.33	19.88	30.00	10.12
	2 462	18.73	0.33	19.06	30.00	10.94
802.11n _HT40	2 422	18.69	0.64	19.33	30.00	10.67
	2 437	18.25	0.64	18.89	30.00	11.11
	2 452	17.85	0.64	18.49	30.00	11.51

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SDM Mode_ANT1

Test Mode	Frequency (MHz)	Measured Output Power (dBm)	Duty cycle Factor (dB)	Result Output Power (dBm)	Limit (dBm)	Margin (dB)
802.11n _HT20	2 412	15.77	0.61	16.38	30.00	13.62
	2 437	14.89	0.61	15.50	30.00	14.50
	2 462	14.00	0.61	14.61	30.00	15.39
802.11n _HT40	2 422	14.72	1.12	15.84	30.00	14.16
	2 437	14.61	1.12	15.73	30.00	14.27
	2 452	14.90	1.12	16.02	30.00	13.98

SDM Mode_ANT2

Test Mode	Frequency (MHz)	Measured Output Power (dBm)	Duty cycle Factor (dB)	Result Output Power (dBm)	Limit (dBm)	Margin (dB)
802.11n _HT20	2 412	16.49	0.61	17.10	30.00	12.90
	2 437	15.21	0.61	15.82	30.00	14.18
	2 462	14.43	0.61	15.04	30.00	14.96
802.11n _HT40	2 422	15.58	1.12	16.70	30.00	13.30
	2 437	15.13	1.12	16.25	30.00	13.75
	2 452	14.72	1.12	15.84	30.00	14.16

SDM Mode_ANT1 + ANT2

Test Mode	Frequency (MHz)	Measured Output Power (dBm)	Duty cycle Factor (dB)	Result Output Power (dBm)	Limit (dBm)	Margin (dB)
802.11n _HT20	2 412	19.16	0.61	19.77	30.00	10.23
	2 437	18.06	0.61	18.67	30.00	11.33
	2 462	17.23	0.61	17.84	30.00	12.16
802.11n _HT40	2 422	18.18	1.12	19.30	30.00	10.70
	2 437	17.89	1.12	19.01	30.00	10.99
	2 452	17.82	1.12	18.94	30.00	11.06

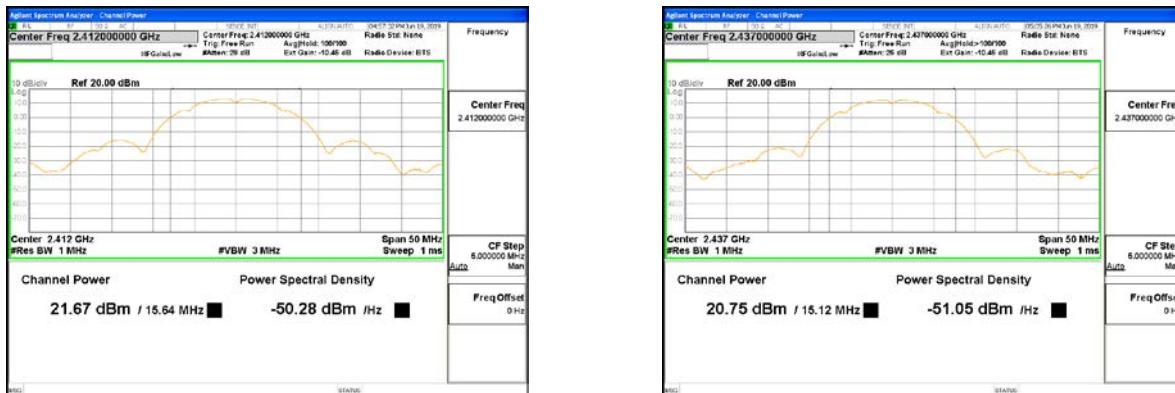
See next pages for actual measured spectrum plots.



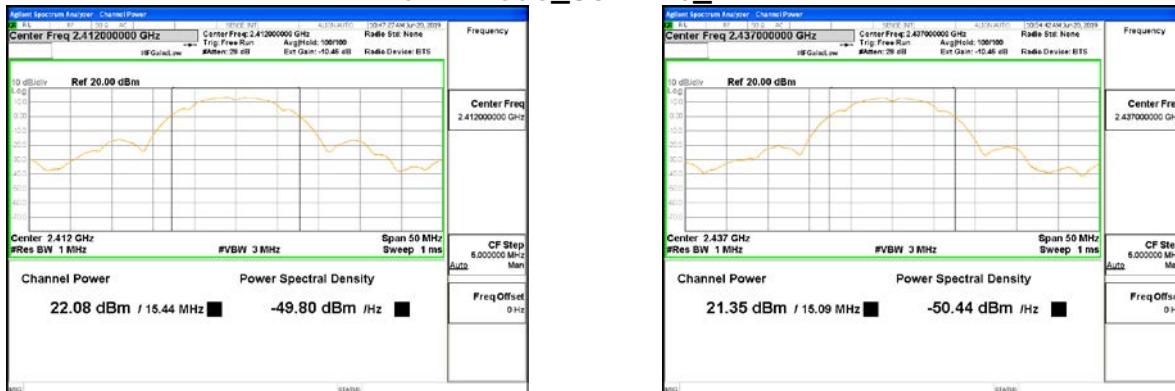
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CDD Mode_802.11b_ANT1



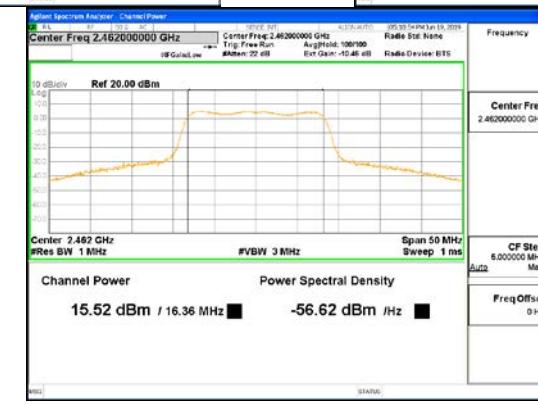
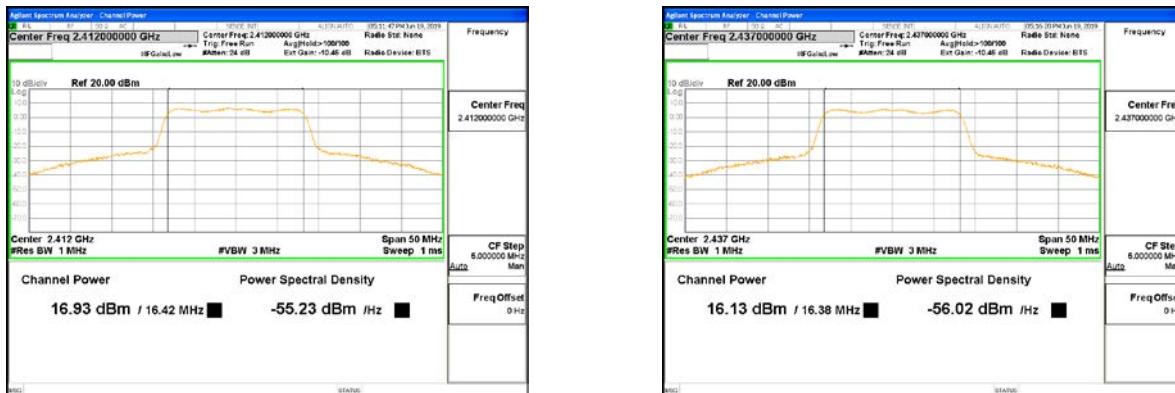
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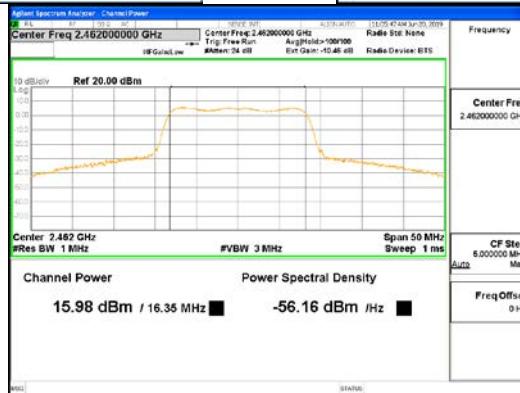
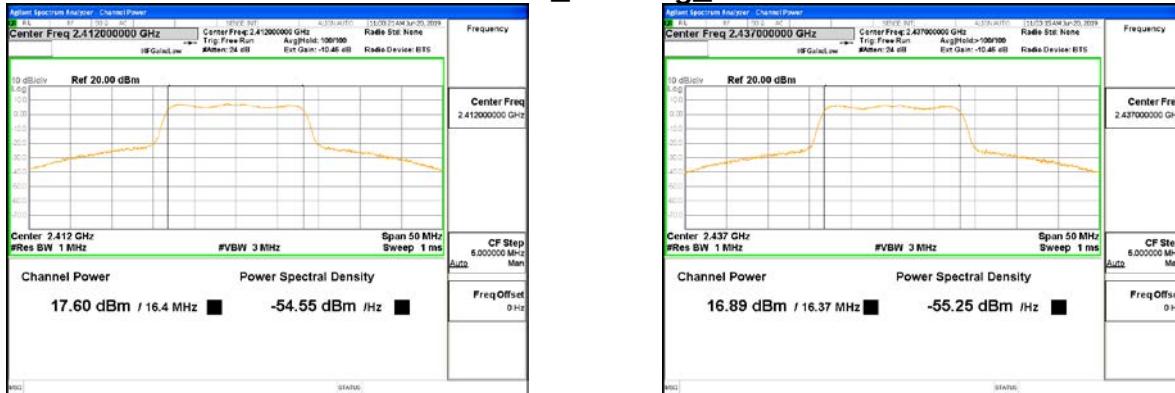
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CDD Mode_802.11g_ANT1



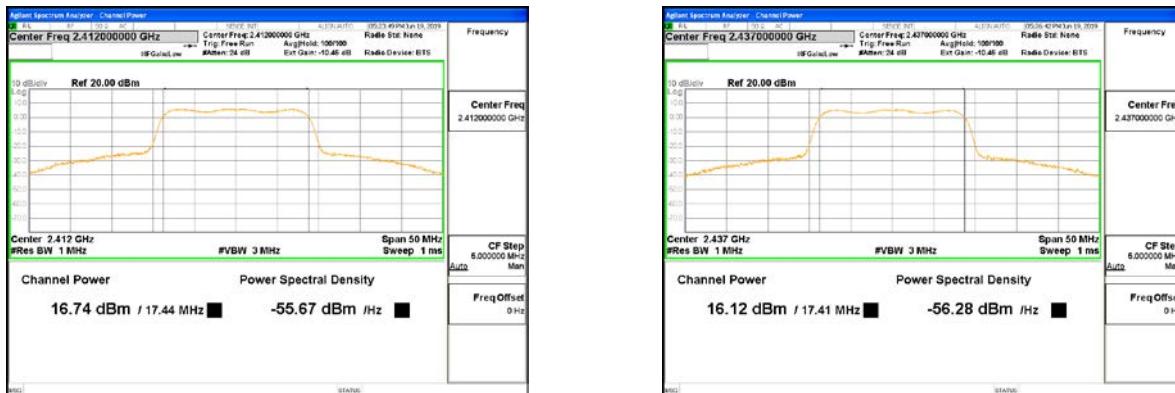
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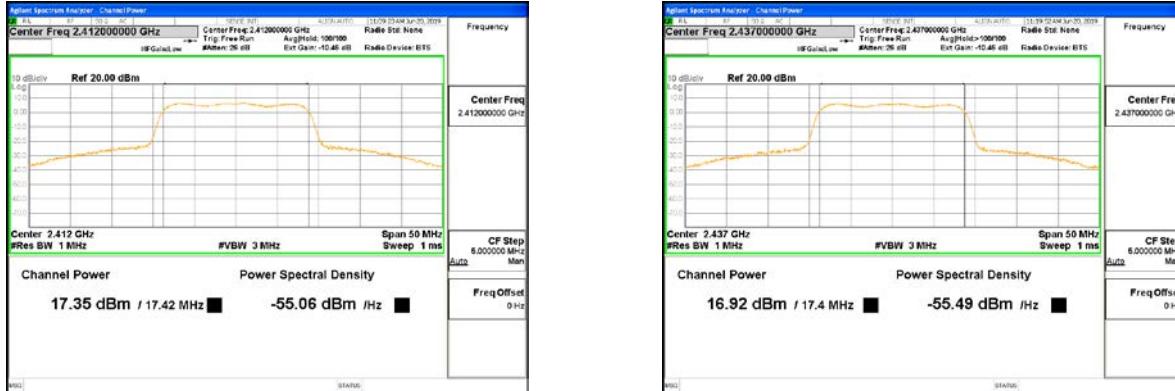
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CDD Mode_802.11n_HT20_ANT1



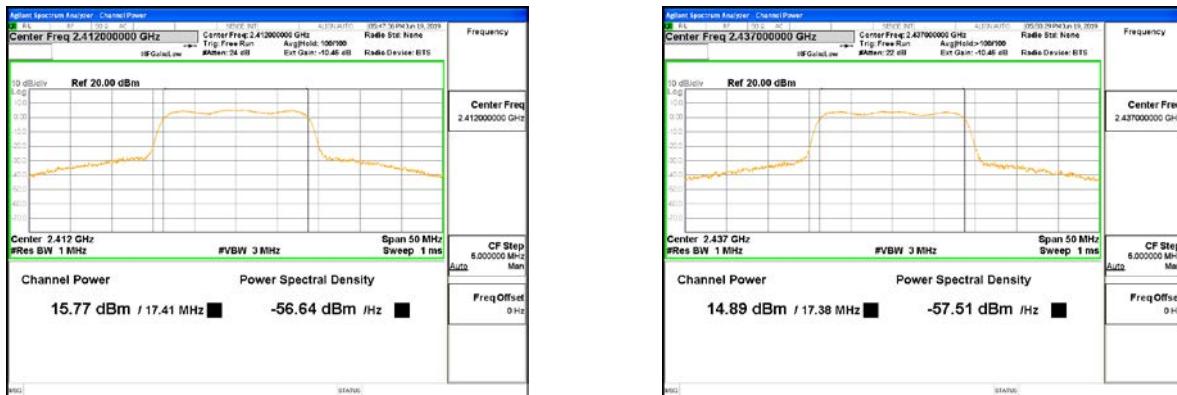
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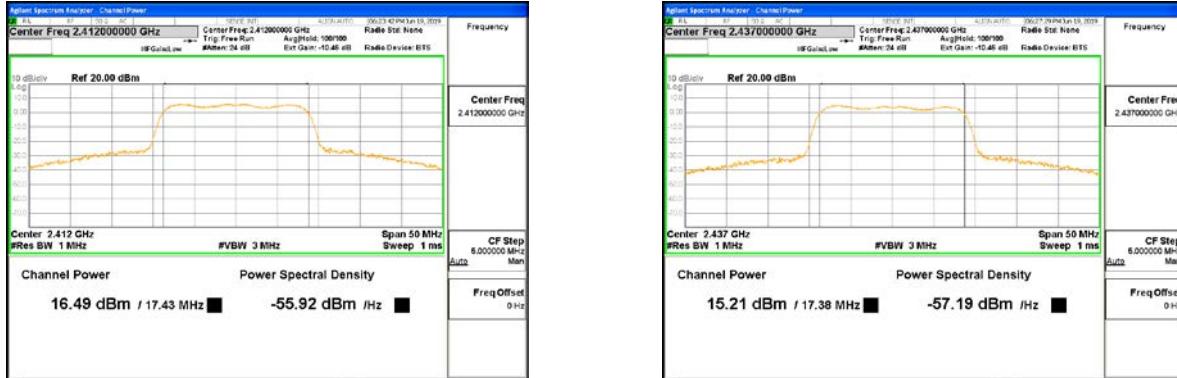
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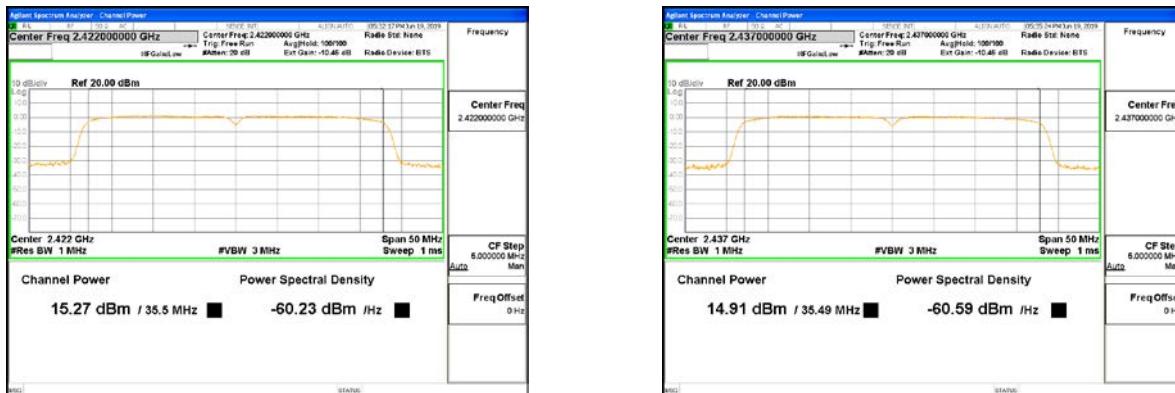
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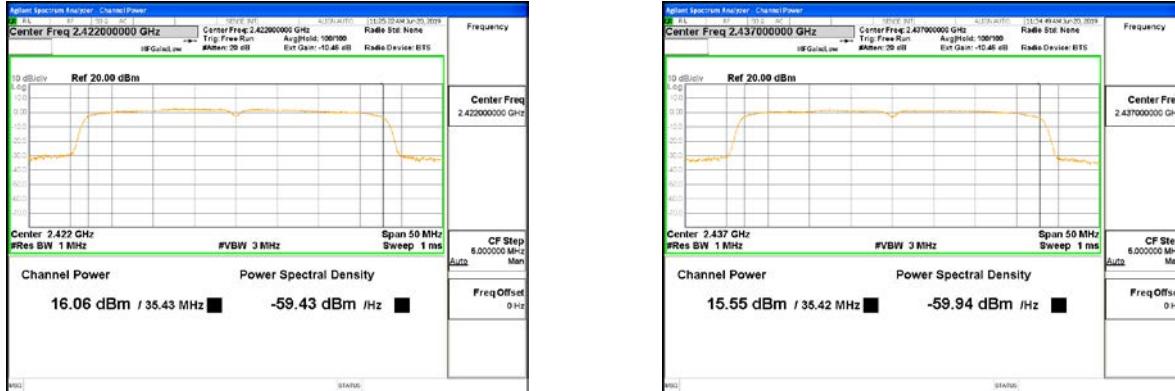
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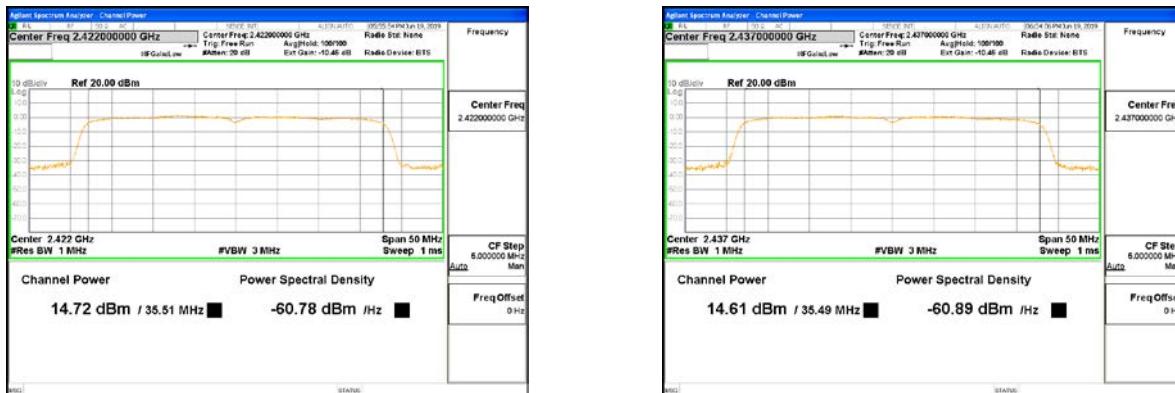
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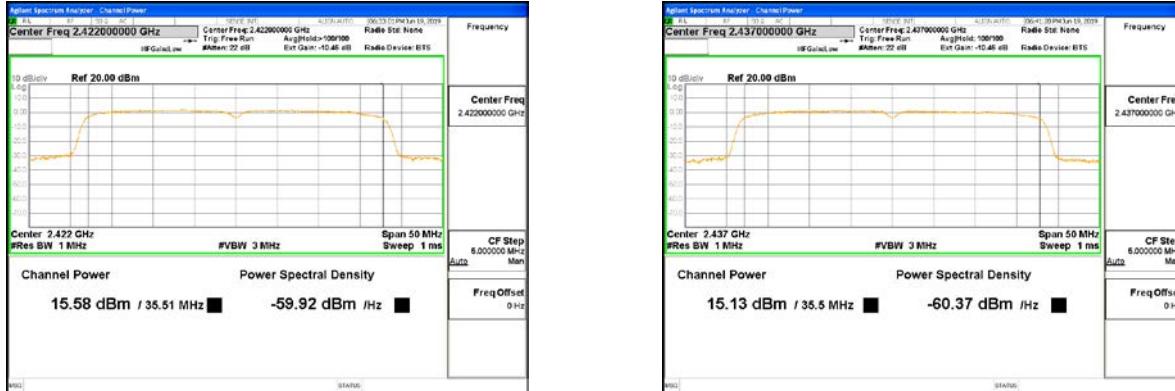
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SDM Mode_802.11n_HT40_ANT1



SDM Mode_802.11n_HT40_ANT2



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4.3 Power Spectral Density

Test Procedures

KDB 558074 - Section 8.4

ANSI C63.10-2013 - Section 11.10.2

KDB 662911 D01, D02 (Multiple Transmitter Output)

The peak power density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.

Test Settings:

Center frequency = the highest, middle and the lowest channels

- | | |
|--|-----------------------------------|
| a) RBW : $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ | b) VBW $\geq 3 \times \text{RBW}$ |
| c) span $\geq 1.5 \times \text{DTS bandwidth}$ | d) Sweep time = auto couple |
| e) Detector = peak | f) Trace mode= max hold |
| g) Allow trace to fully stabilize | |
| h) Use the peak marker function to determine the maximum amplitude level within the RBW. | |

Limit

Operating Mode	Mode	ANT Configuration	ANT Gain (dBi)	Limit (dBm)
SISO	802.11b/g/n	ANT1	1.90	8.00
SISO	802.11b/g/n	ANT2	1.90	8.00
MIMO (2Tx)	802.11g/n	ANT1 + ANT2	4.91	8.00

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Test Data

CDD Mode_ANT1

Test Mode	Frequency (MHz)	Measured Power Density (dBm)	Limit (dBm)	Margin(dB)
802.11b	2 412	-1.86	8.00	9.86
	2 437	-2.82	8.00	10.82
	2 462	-3.24	8.00	11.24
802.11g	2 412	-5.78	8.00	13.78
	2 437	-6.39	8.00	14.39
	2 462	-6.88	8.00	14.88
802.11n_HT20	2 412	-5.85	8.00	13.85
	2 437	-6.26	8.00	14.26
	2 462	-7.12	8.00	15.12
802.11n_HT40	2 422	-12.24	8.00	20.24
	2 437	-12.75	8.00	20.75
	2 452	-13.11	8.00	21.11

CDD Mode_ANT2

Test Mode	Frequency (MHz)	Measured Power Density (dBm)	Limit (dBm)	Margin(dB)
802.11b	2 412	-1.19	8.00	9.19
	2 437	-1.52	8.00	9.52
	2 462	-2.45	8.00	10.45
802.11g	2 412	-5.55	8.00	13.55
	2 437	-6.23	8.00	14.23
	2 462	-7.04	8.00	15.04
802.11n_HT20	2 412	-5.43	8.00	13.43
	2 437	-6.23	8.00	14.23
	2 462	-6.85	8.00	14.85
802.11n_HT40	2 422	-7.72	8.00	15.72
	2 437	-7.37	8.00	15.37
	2 452	-8.53	8.00	16.53

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CDD Mode_ANT1+ANT2

Test Mode	Frequency (MHz)	Measured Power Density (dBm)	Limit (dBm)	Margin(dB)
802.11b	2 412	1.50	8.00	6.50
	2 437	0.89	8.00	7.11
	2 462	0.18	8.00	7.82
802.11g	2 412	-2.65	8.00	10.65
	2 437	-3.30	8.00	11.30
	2 462	-3.95	8.00	11.95
802.11n_HT20	2 412	-2.62	8.00	10.62
	2 437	-3.23	8.00	11.23
	2 462	-3.97	8.00	11.97
802.11n_HT40	2 422	-6.41	8.00	14.41
	2 437	-6.26	8.00	14.26
	2 452	-7.23	8.00	15.23

SDM Mode_ANT1

Test Mode	Frequency (MHz)	Measured Power Density (dBm)	Limit (dBm)	Margin(dB)
802.11n_HT20	2 412	-6.05	8.00	14.05
	2 437	-6.94	8.00	14.94
	2 462	-7.64	8.00	15.64
802.11n_HT40	2 422	-6.26	8.00	14.26
	2 437	-6.41	8.00	14.41
	2 452	-6.61	8.00	14.61

SDM Mode_ANT2

Test Mode	Frequency (MHz)	Measured Power Density (dBm)	Limit (dBm)	Margin(dB)
802.11n_HT20	2 412	-7.07	8.00	15.07
	2 437	-8.58	8.00	16.58
	2 462	-8.83	8.00	16.83
802.11n_HT40	2 422	-8.35	8.00	16.35
	2 437	-8.53	8.00	16.53
	2 452	-9.10	8.00	17.10



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SDM Mode_ANT1+ANT2

Test Mode	Frequency (MHz)	Measured Power Density (dBm)	Limit (dBm)	Margin(dB)
802.11n_HT20	2 412	-3.52	8.00	11.52
	2 437	-4.67	8.00	12.67
	2 462	-5.18	8.00	13.18
802.11n_HT40	2 422	-4.17	8.00	12.17
	2 437	-4.33	8.00	12.33
	2 452	-4.67	8.00	12.67

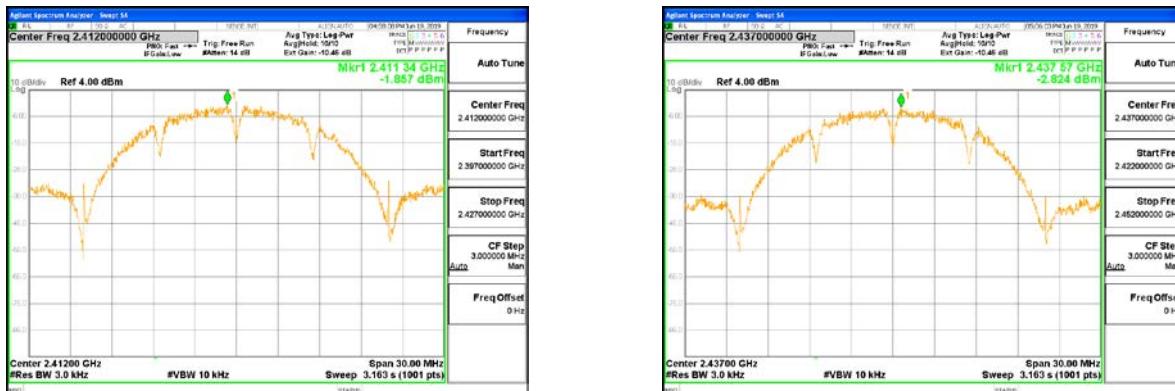
See next pages for actual measured spectrum plots.



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CDD Mode_802.11b_ANT1



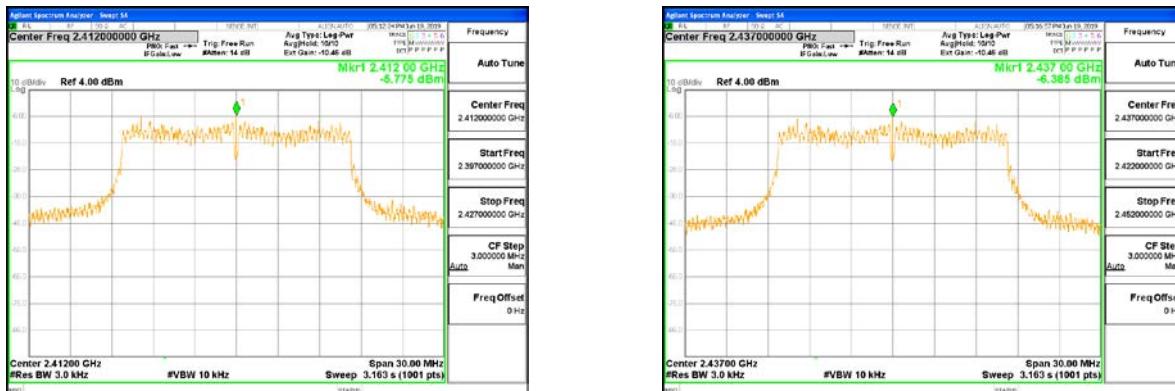
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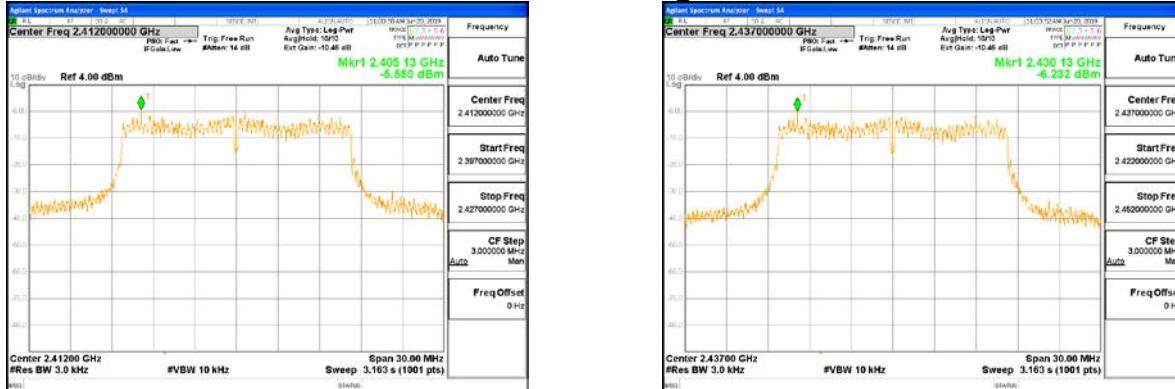
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CDD Mode_802.11g_ANT1



CDD Mode_802.11g_ANT2



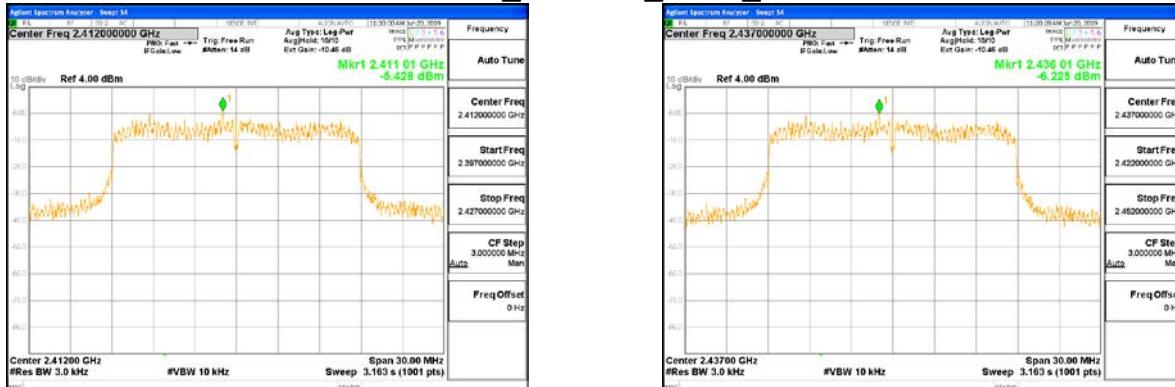
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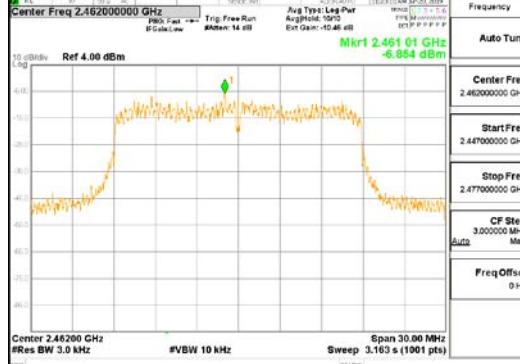
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CDD Mode_802.11n_HT20_ANT1



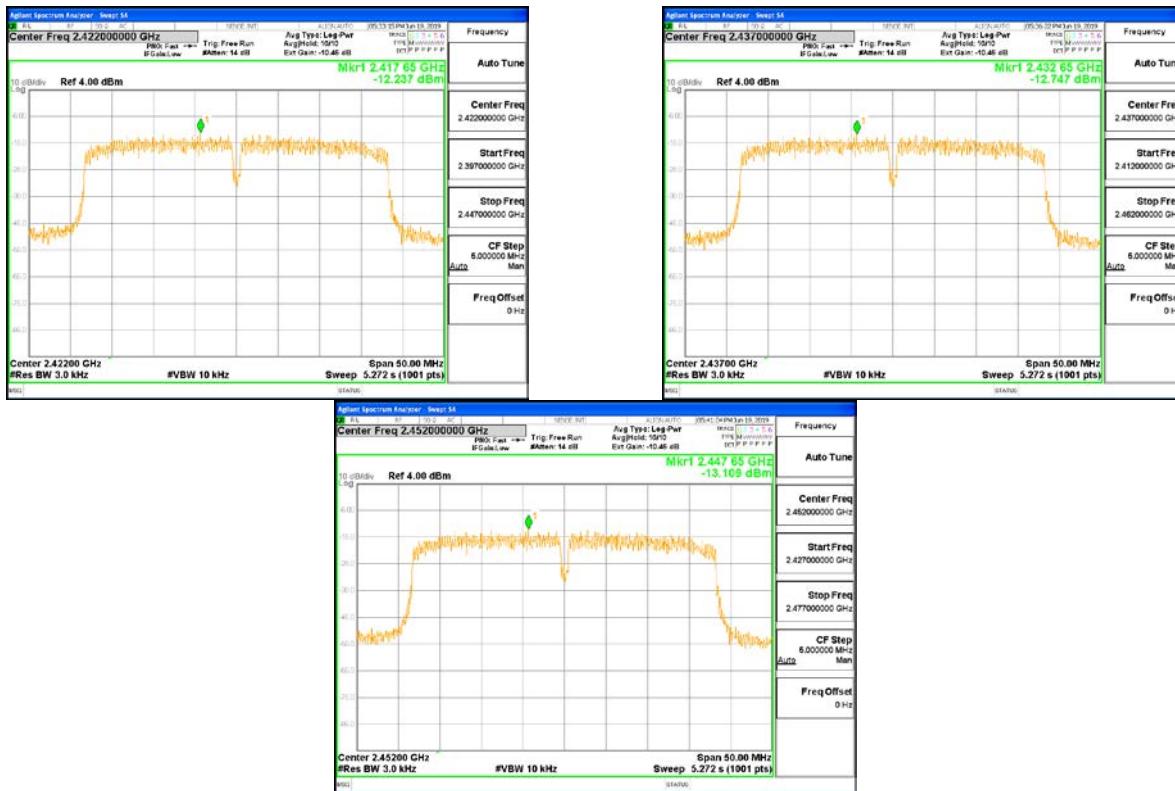
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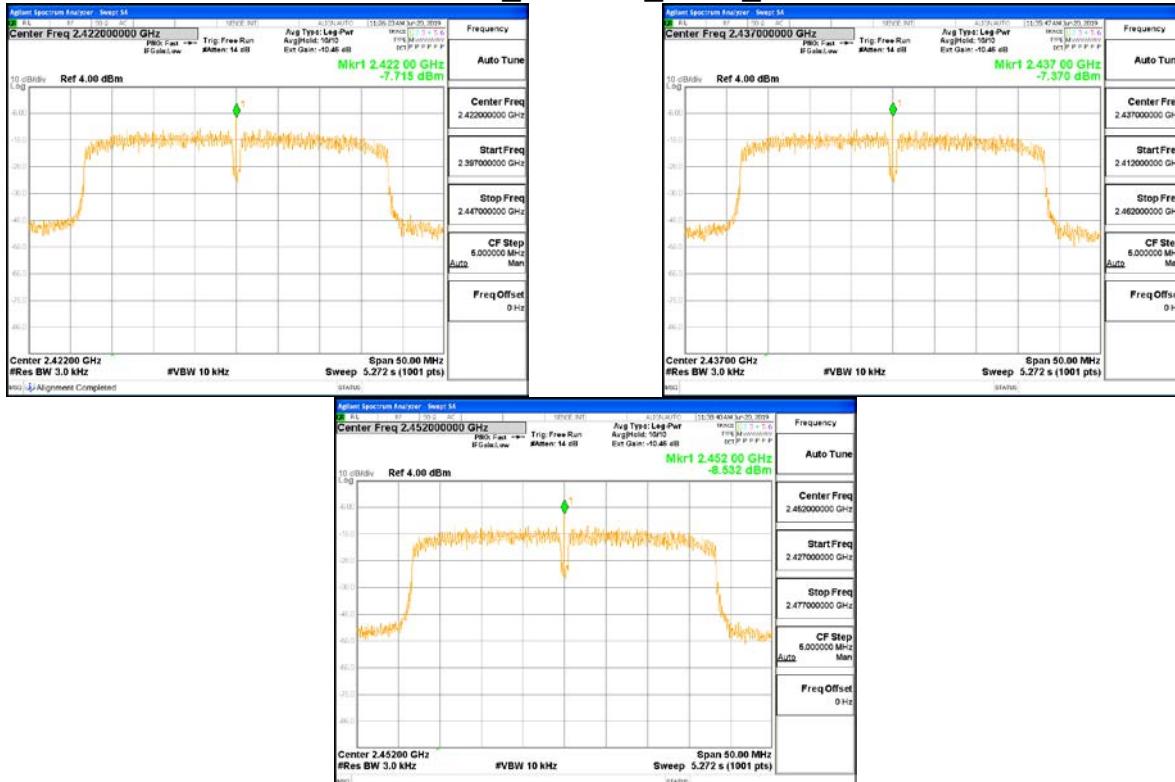
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CDD Mode_802.11n_HT40_ANT1



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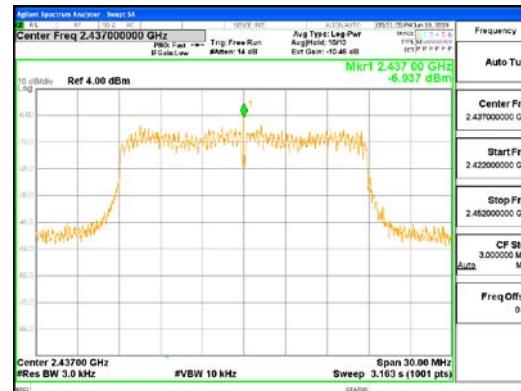
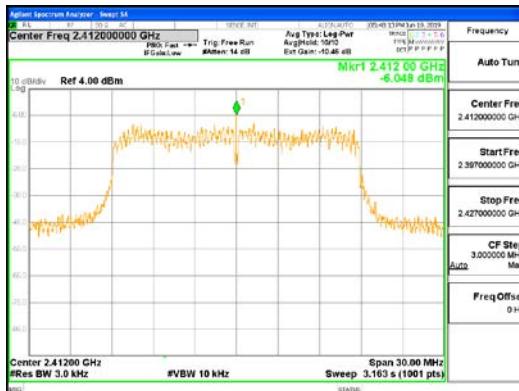


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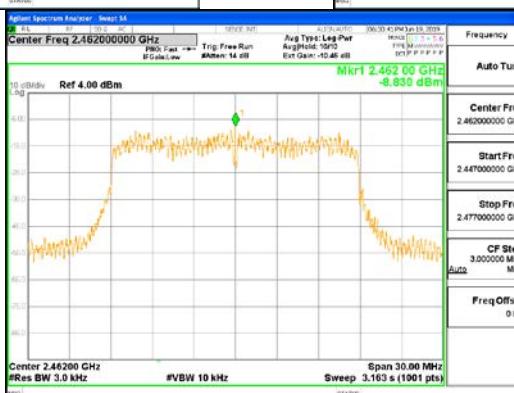
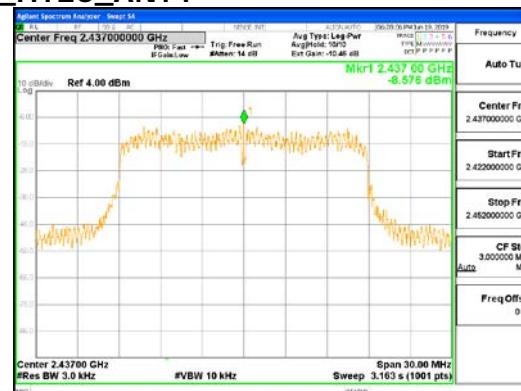
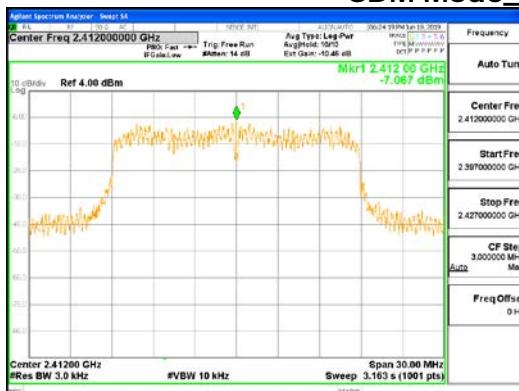
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SDM Mode_802.11n_HT20_ANT1



SDM Mode_802.11n_HT20_ANT2

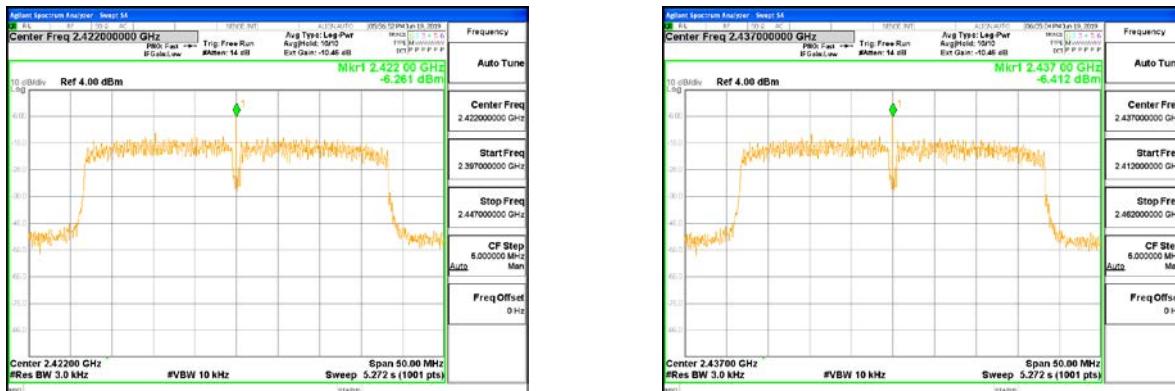


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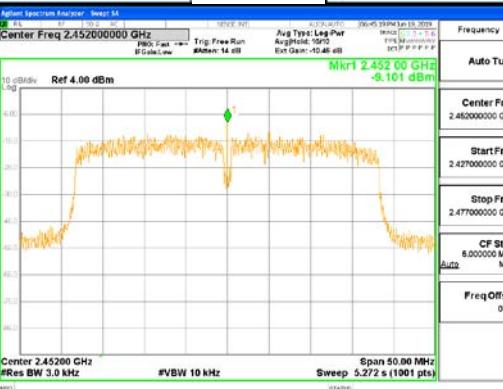
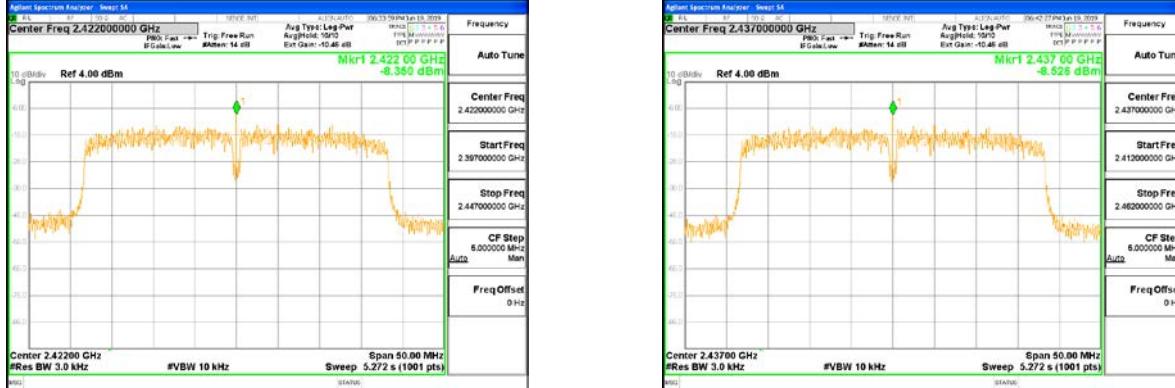
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SDM Mode_802.11n_HT40_ANT1



SDM Mode_802.11n_HT40_ANT2



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4.4 Conducted Spurious emission

Test Procedures

KDB 558074 - Section 8.5

ANSI C63.10-2013 - Section 11.11.3

The bandwidth at 20dB down from the highest inband spectral density is measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate frequencies.

After the trace being stable, Use the marker-to-peak function to measure 20 dB down both sides of the intentional emission.

Test Settings:

Center frequency = the highest, middle and the lowest channels

- | | |
|---|-----------------------------|
| a) RBW = 100 kHz | b) VBW \geq 3 x RBW |
| c) Detector = peak | d) Sweep time = auto couple |
| e) Trace mode= max hold | |
| f) Allow trace to fully stabilize | |
| g) Use the peak marker function to determine the maximum amplitude level. | |

Limit :

Emission level < 30 dBc

Test Data: Complies

- All conducted emission in any 100 kHz bandwidth outside of the spread spectrum band was at least 30dB lower than the highest inband spectral density. Therefore the applying equipment meets the requirement.

See next pages for actual measured spectrum plots.



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802.11b_ANT1



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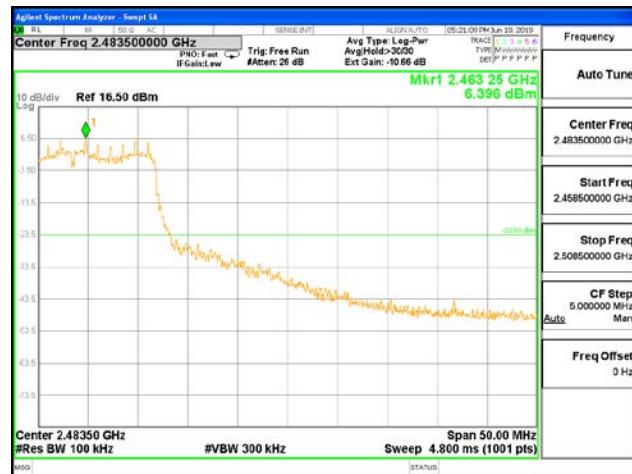
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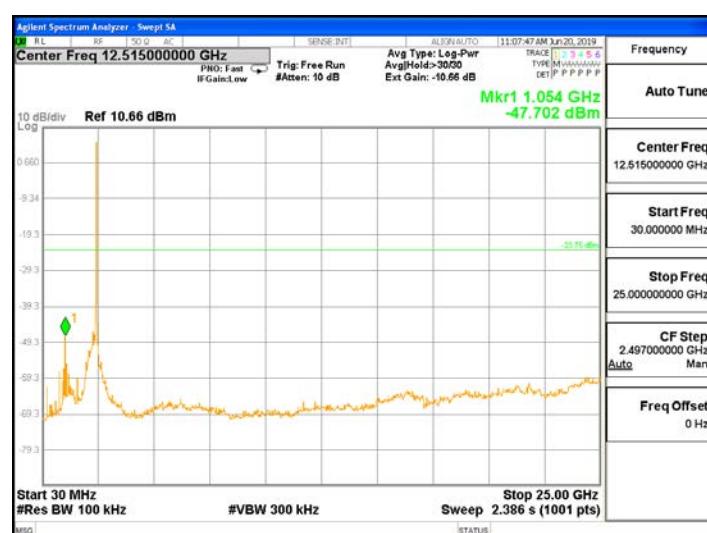
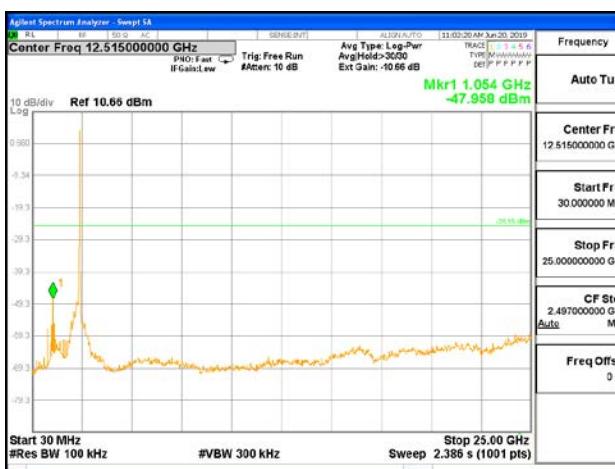
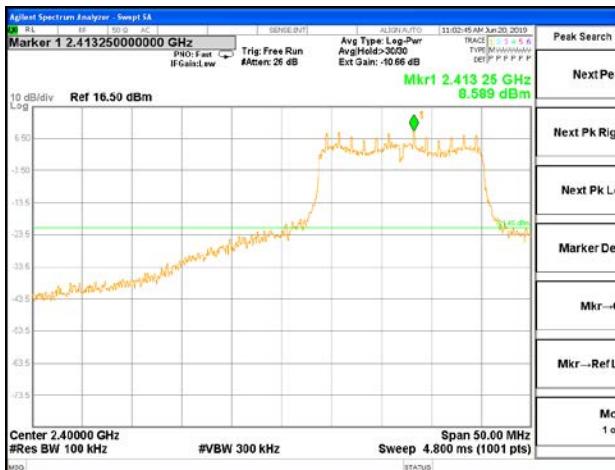
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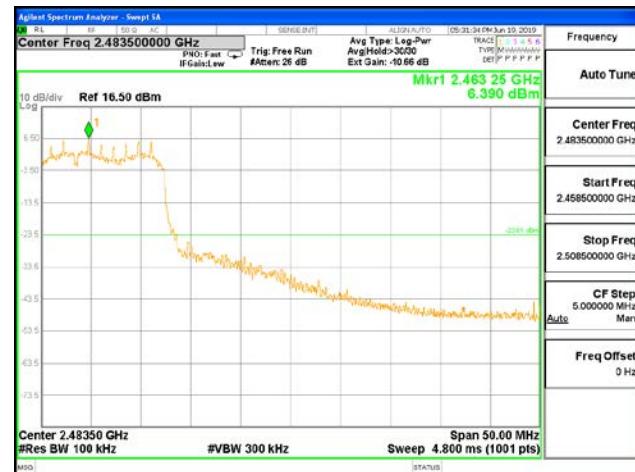
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802.11n_HT20_ANT1



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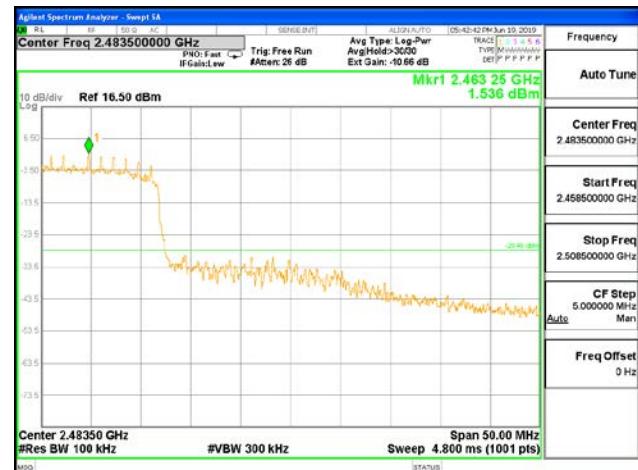
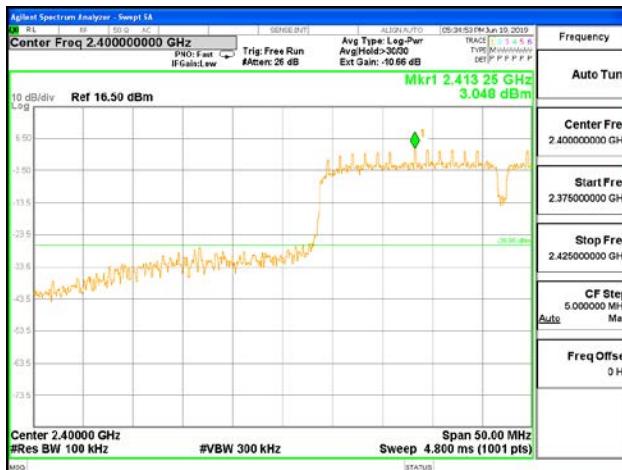
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802.11n_HT40_ANT1

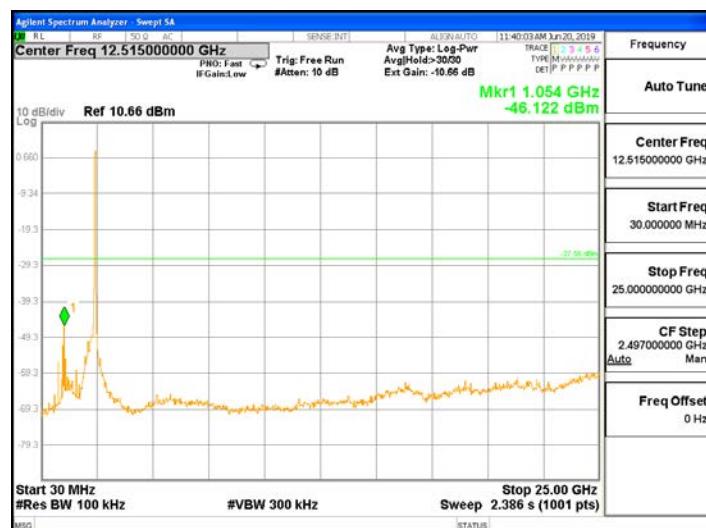
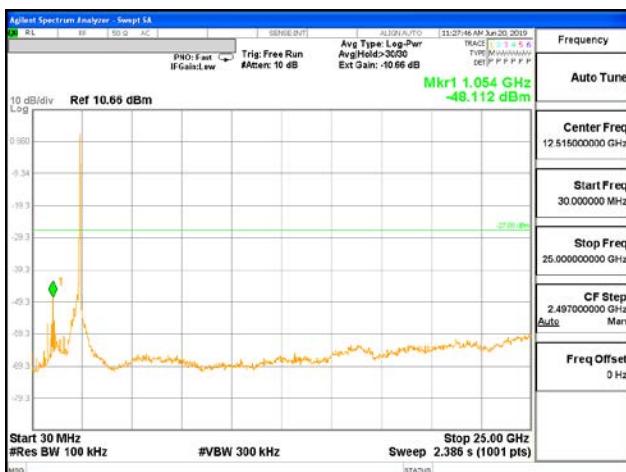
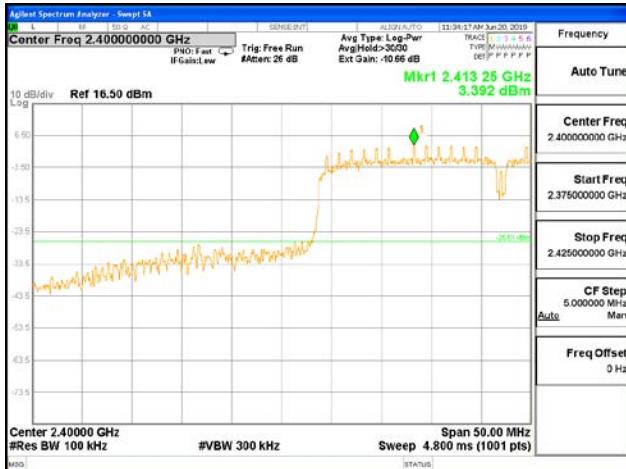


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4.5 Radiated Emission

Test Location

- 10 m SAC (test distance : 10 m, 3 m)
- 3 m SAC (test distance : 3 m)

Test Procedures

KDB 558074 - Section 8.5, 8.6

ANSI C63.10-2013 - Section 11.11, 11.12

- 1) In the frequency range of 9 kHz to 30 MHz, magnetic field is measured with Loop Antenna. The center of the Loop Test Antenna is 1m above the ground. During the measurement the Loop Test Antenna rotates about its vertical axis for maximum response at each azimuth about the EUT.
- 2) In the frequency rage above 30 MHz, Bi-Log Test Antenna(30 MHz to 1 GHz) and Horn Test Antenna(above 1 GHz) are used. Test Antenna is 3m away from the EUT. Test Antenna height is carried from 1m to 4m above the ground to determine the maximum value of the field strength. The emissions levels at both horizontal and vertical polarizations should be tested.

Test Settings:

Frequency Range = 9 kHz ~ 1 GHz

- a) RBW = 100 kHz for f < 1 GHz, 9 kHz for f < 30 MHz
- b) VBW \geq RBW
- c) Detector = CISPR Quasi-peak
- d) Sweep time = auto couple

- Peak

Frequency Range = 1 GHz ~ 25 GHz (2.4 GHz 10th harmonic)

- a) RBW = 1 MHz
- b) VBW \geq 3 x RBW
- c) Detector = Peak
- d) Sweep time = auto
- e) Trace mode = max hold

- Average (duty cycle \geq 98%)

Frequency Range = 1 GHz ~ 25 GHz (2.4 GHz 10th harmonic)

- a) RBW = 1 MHz
- b) VBW \geq 3 x RBW
- c) Detector = RMS
- d) Sweep time = auto
- e) Averaging type = power (i.e., RMS)
- f) Trace mode = average (at least 100 traces)

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- Average (duty cycle < 98%, duty cycle variations are less than $\pm 2\%$)

Frequency Range = 1 GHz ~ 25 GHz (2.4 GHz 10th harmonic)

a) RBW = 1 MHz

b) VBW \geq 3 x RBW

c) Detector = RMS

d) Sweep time = auto

e) Averaging type = power (i.e., RMS)

f) Trace mode = average (at least 100 traces)

A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 % duty cycle.

If power averaging (RMS) mode, then the applicable correction factor is $10 \log(1/x)$, where x is the duty cycle.

Test mode		Duty Cycle Factor (dB)
CDD Mode	802.11b	0.00
	802.11g	0.31
	802.11n_HT20	0.33
	802.11n_HT40	0.64
SDM Mode	802.11n_HT20	0.61
	802.11n_HT40	1.12

Limit :

FCC Part 15 § 15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	MHz	MHz	GHz
0.09-0.11	8.37626-8.38675	73-74.6	399.9-410	2690-2900	10.6-12.7
¹ 0.495-0.505	8.41425-8.41475	74.8-75.2	608-614	3260-3267	13.25-13.4
2.1735-2.1905	12.29-12.293	108-121.94	960-1240	3332-3339	14.47-14.5
4.125-4.128	12.51975-12.52025	123-138	1300-1427	3345.8-3358	15.35-16.2
4.17725-4.17775	12.57675-12.57725	149.9-150.05	1435-1626.5	3600-4400	17.7-21.4
4.20725-4.20775	13.36-13.41	156.52475-156.52525	1645.5-1646.5	4500-5150	22.01-23.12
6.215-6.218	16.42-16.423	156.7-156.9	1660-1710	5350-5460	23.6-24
6.26775-6.26825	16.69475-16.69525	162.0125-167.17	1718.8-1722.2	7250-7750	31.2-31.8
6.31175-6.31225	16.80425-16.80475	167.72-173.2	2200-2300	8025-8500	36.43-36.5
8.291-8.294	25.5-25.67	240-285	2310-2390	9000-9200	² Above 38.6
8.362-8.366	37.5-38.25	322-335.4	2483.5-2500	9300-9500	

¹ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

² Above 38.6

§ 15.205 (b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions.



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The provisions in Section 15.35 apply to these measurements.

FCC Part 15 § 15.209 (a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table :

Frequency(MHz)	Field Strength uV/m@3m	Field Strength dBuV/m@3m	Deasurement Distance (meters)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705-30	30	-	30
30-88	100**	40	3
88-216	150**	43.5	3
216-960	200**	46	3
Above 960	500	54	3

** Except as provided in 15.209(g).fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72MHz, 76-88MHz, 174-216MHz, 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g.15.231 and 15.241.

Note :

- 1) For above 1 GHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit.
- 2) For above 1 GHz, limit field strength of harmonics : 54 dBuV/m@3m (AV) and 74 dBuV/m@3m (PK)

We have done all test mode.

The worst-case antenna configuration and Test mode are determined to be as follows.

802.11b mode : ANT1 + ANT2 (MIMO)

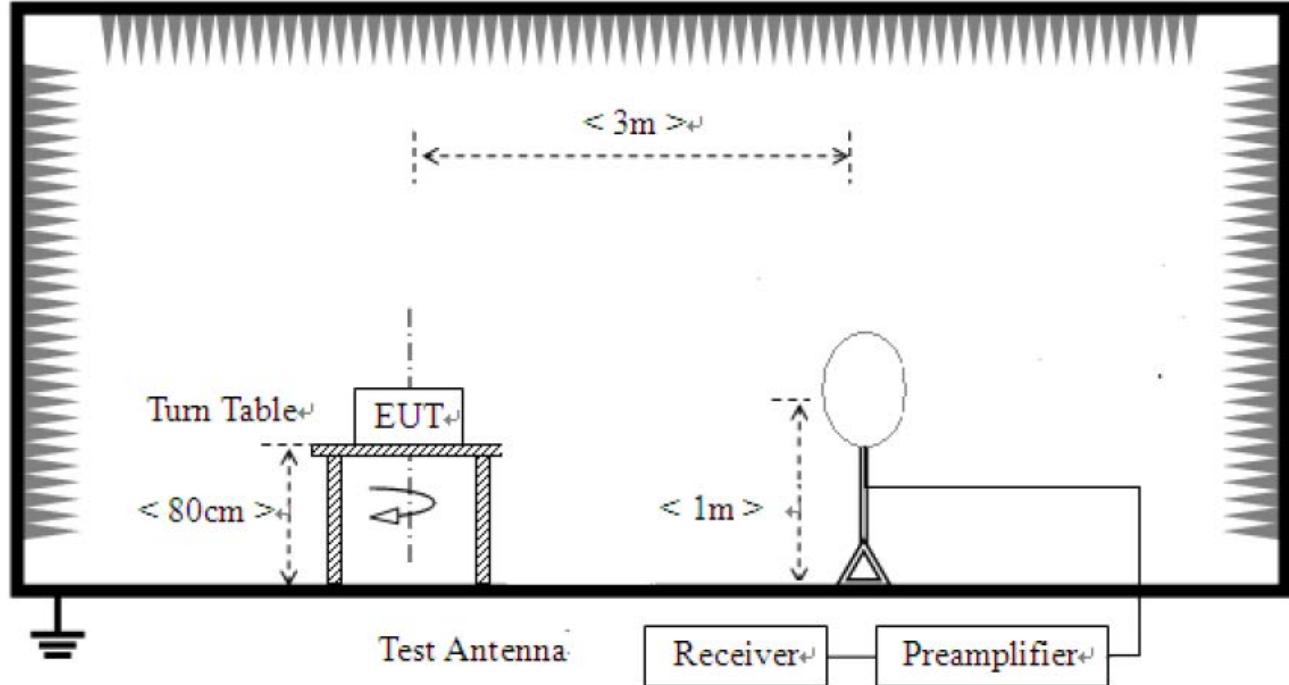
802.11g mode : ANT1 + ANT2 (MIMO)

802.11n CDD mode : ANT1 + ANT2 (MIMO)

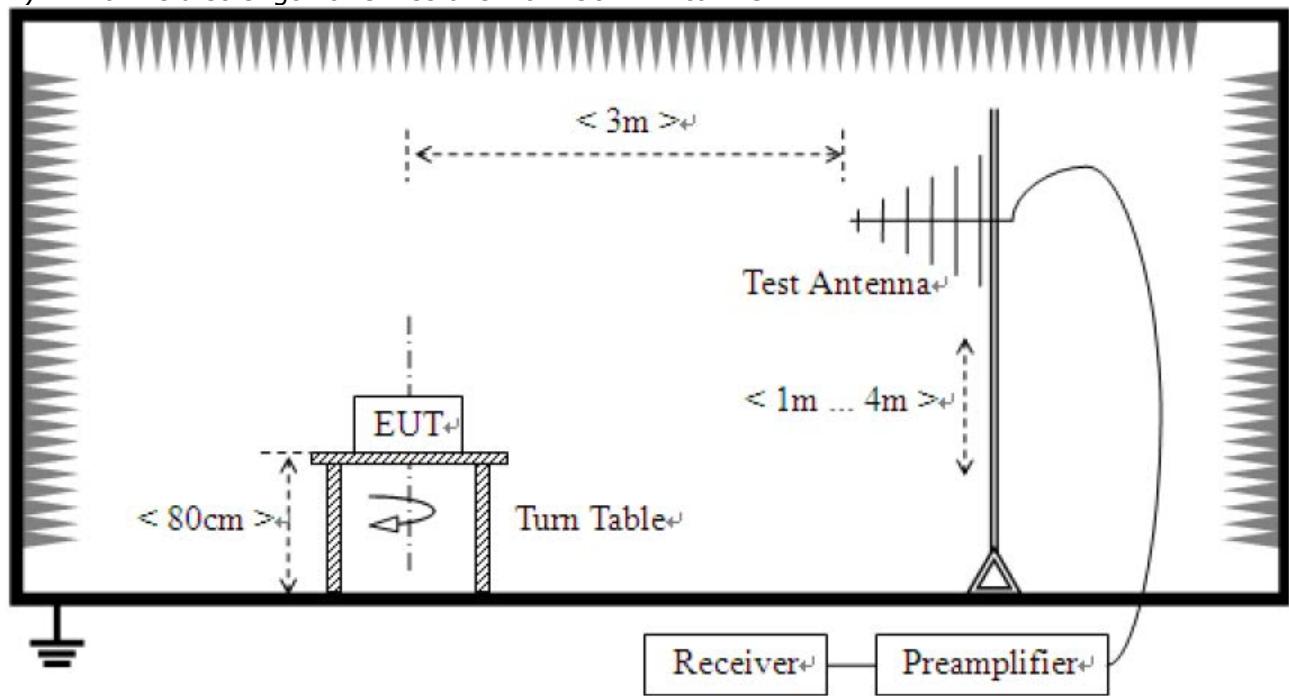
So the results are only attached worst cases.

Test Setup:

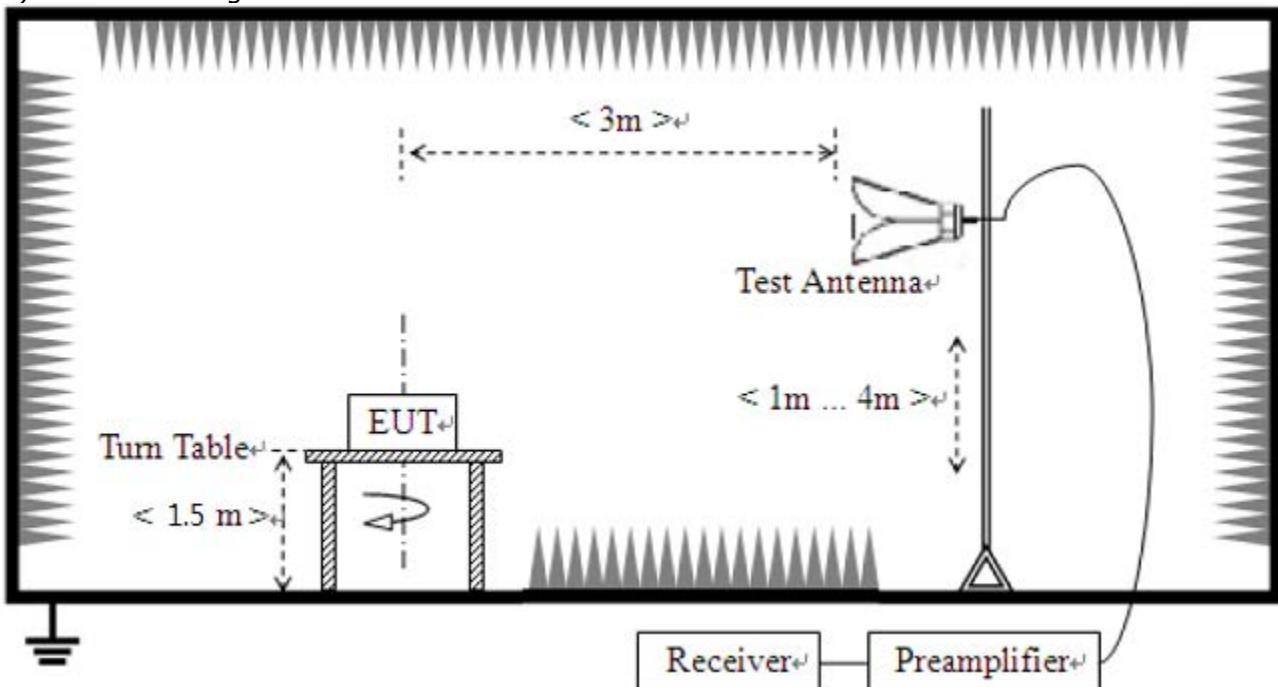
- 1) For field strength of emissions from 9 kHz to 30 MHz



- 2) For field strength of emissions from 30 MHz to 1 GHz



3) For field strength of emissions above 1 GHz



Test results

1) 9 kHz to 30 MHz

Test mode : 802.11b, 802.11g, 802.11n (Worst case)

The requirements are:

Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
-	-	-	See note

Note :

The amplitude of spurious emissions that are attenuated by more than 20 dB below the permissible value has no need to be reported.

Distance extrapolation factor = $40 \log (\text{specific distance} / \text{test distance})$ (dB)

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2) 30 MHz to 1 GHz

Test mode : 802.11b, Middle Channel(Worst Case)

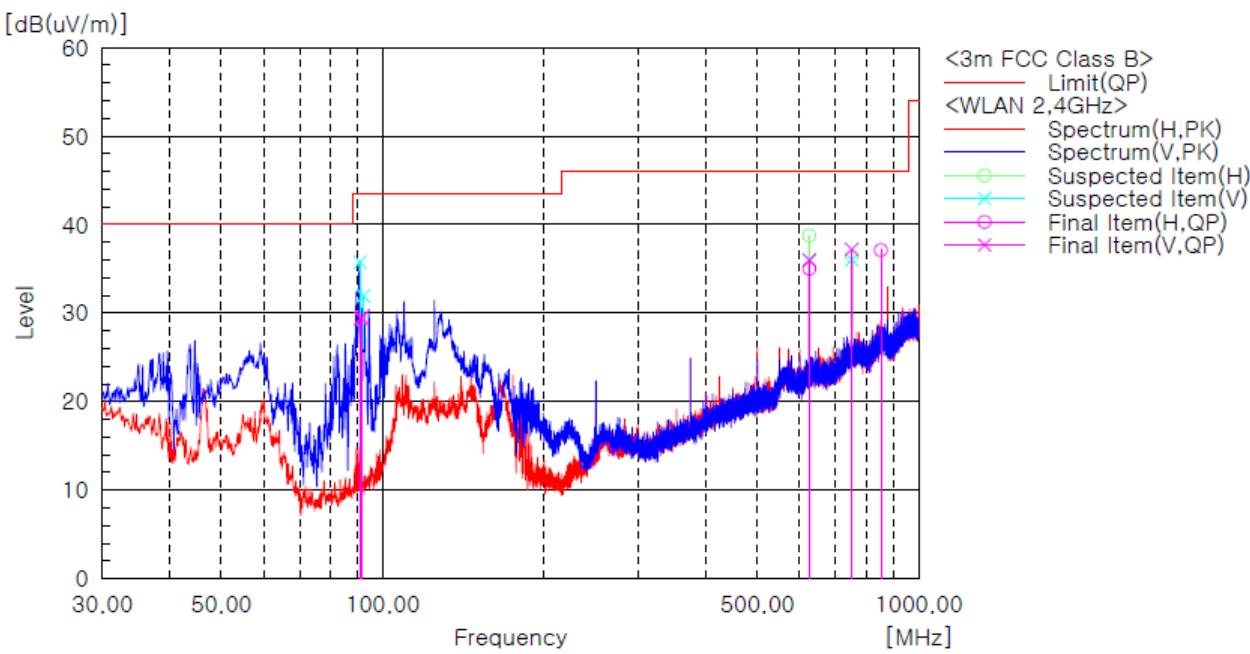
The requirements are:

Complies

Test Data

Test Model : AR1031
Test Mode : WLAN 2.4GHz
Tester : kim ji hye
:
:

Manufacturer : GAON
:
:
:



Final Result

No.	Frequency [MHz]	(P) V	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]
1	90.952	V	44.0	-14.6	29.4	43.5	14.1	101.0	82.0
2	91.487	V	44.0	-14.5	29.5	43.5	14.0	101.0	29.0
3	624.974	H	34.4	0.6	35.0	46.0	11.0	300.0	251.0
4	624.974	V	35.4	0.6	36.0	46.0	10.0	101.0	0.0
5	850.002	H	32.3	4.8	37.1	46.0	8.9	101.0	305.0
6	749.980	V	34.2	3.0	37.2	46.0	8.8	101.0	214.0

Remark :

1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in lie-down position(X axis) and the worst case was recorded.
2. Result = Reading + c.f(Correction factor)
3. Correction factor = Antenna factor + Cable loss + 6 dB attenuator - Amp Gain
4. We have done all test mode. The results are only attached worst cases.

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3) above 1 GHz

Test mode : 802.11b

The requirements are:

Complies

Test Data

Low(2 412 MHz)

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
2 132.22	H	54.00	74.00	36.60	53.30	17.40	20.70
2 132.22	V	54.00	74.00	34.70	45.70	19.30	28.30
4 824.06	V	54.00	74.00	37.80	47.00	16.20	27.00
9 647.48	H	54.00	74.00	39.60	50.20	14.40	23.80
9 647.48	V	54.00	74.00	41.40	50.40	12.60	23.60
2 386.18	H	54.00	74.00	42.50	56.40	11.50	17.60
2 386.42	V	54.00	74.00	42.60	56.20	11.40	17.80

Mid(2 437 MHz)

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
2 132.22	H	54.00	74.00	35.90	48.70	18.10	25.30
2 132.22	V	54.00	74.00	34.50	45.60	19.50	28.40
4 874.34	V	54.00	74.00	35.70	44.70	18.30	29.30
9 747.48	H	54.00	74.00	39.60	48.80	14.40	25.20
9 747.48	V	54.00	74.00	43.70	50.70	10.30	23.30

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High(2 462 MHz)

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
2 132.22	H	54.00	74.00	36.20	53.70	17.80	20.30
2 131.33	V	54.00	74.00	34.70	50.30	19.30	23.70
4 923.73	V	54.00	74.00	34.00	44.60	20.00	29.40
9 847.48	H	54.00	74.00	40.10	48.90	13.90	25.10
9 847.48	V	54.00	74.00	45.20	51.20	8.80	22.80
2 487.85	H	54.00	74.00	40.10	60.40	13.90	13.60
2 487.94	V	54.00	74.00	41.10	60.90	12.90	13.10

Remarks

1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in lie-down position(X axis) and the worst case was recorded.
2. Result = Reading + c.f(Correction factor)
3. Correction factor = Antenna factor + Cable loss - Amp Gain

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Test mode : 802.11g

The requirements are:

 Complies**Test Data****Low(2 412 MHz)**

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
2 132.22	H	54.00	74.00	35.81	48.80	18.19	25.20
2 132.22	V	54.00	74.00	34.71	51.30	19.29	22.70
9 647.48	H	54.00	74.00	39.81	49.70	14.19	24.30
9 647.48	V	54.00	74.00	41.31	50.80	12.69	23.20
2 389.88	H	54.00	74.00	40.61	68.90	13.39	5.10
2 389.91	V	54.00	74.00	41.51	64.10	12.49	9.90

Mid(2 437 MHz)

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
2 132.22	H	54.00	74.00	35.91	55.40	18.09	18.60
2 132.22	V	54.00	74.00	34.21	46.80	19.79	27.20
9 747.48	H	54.00	74.00	41.01	49.00	12.99	25.00
9 747.48	V	54.00	74.00	43.91	50.80	10.09	23.20

High(2 462 MHz)

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
2 132.22	H	54.00	74.00	35.41	49.60	18.59	24.40
2 132.22	V	54.00	74.00	33.91	52.60	20.09	21.40
9 847.48	H	54.00	74.00	40.41	48.90	13.59	25.10
9 847.48	V	54.00	74.00	45.21	51.00	8.79	23.00
2 487.80	H	54.00	74.00	39.01	62.10	14.99	11.90
2 483.50	V	54.00	74.00	39.41	60.80	14.59	13.20

Remarks

1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in lie-down position(X axis) and the worst case was recorded.
2. Result = Reading + c.f(Correction factor)
3. Correction factor = Antenna factor + Cable loss - Amp Gain

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Test mode : 802.11n_CDD Mode_HT20

The requirements are:

 Complies**Test Data**

Low(2 412 MHz)

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
2 132.22	H	54.00	74.00	35.43	52.60	18.57	21.40
2 132.22	V	54.00	74.00	33.83	50.10	20.17	23.90
9 647.48	H	54.00	74.00	39.93	49.00	14.07	25.00
9 647.48	V	54.00	74.00	41.23	50.50	12.77	23.50
2 389.29	H	54.00	74.00	40.93	61.50	13.07	12.50
2 389.66	V	54.00	74.00	42.13	69.50	11.87	4.50

Mid(2 437 MHz)

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
2 132.22	H	54.00	74.00	35.53	54.00	18.47	20.00
2 132.22	V	54.00	74.00	33.83	44.90	20.17	29.10
9 747.48	H	54.00	74.00	39.83	49.00	14.17	25.00
9 747.48	V	54.00	74.00	43.63	50.00	10.37	24.00

High(2 462 MHz)

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
2 132.22	H	54.00	74.00	35.43	50.40	18.57	23.60
2 132.22	V	54.00	74.00	34.13	51.40	19.87	22.60
9 847.48	H	54.00	74.00	40.13	49.40	13.87	24.60
9 847.48	V	54.00	74.00	44.93	51.60	9.07	22.40
2 487.79	H	54.00	74.00	39.13	61.20	14.87	12.80
2 483.59	V	54.00	74.00	39.73	62.70	14.27	11.30

Remarks

1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in lie-down position(X axis) and the worst case was recorded.
2. Result = Reading + c.f(Correction factor)
3. Correction factor = Antenna factor + Cable loss - Amp Gain

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Test mode : 802.11n_CDD Mode_HT40

The requirements are:

 Complies**Test Data**

Low(2 422 MHz)

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
2 132.22	H	54.00	74.00	34.54	47.10	19.46	26.90
9 687.89	H	54.00	74.00	40.54	48.20	13.46	25.80
9 687.89	V	54.00	74.00	44.44	49.90	9.56	24.10
2 389.37	H	54.00	74.00	41.04	66.60	12.96	7.40
2 382.59	V	54.00	74.00	41.74	64.90	12.26	9.10

Mid(2 437 MHz)

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
2 131.33	H	54.00	74.00	35.64	55.40	18.36	18.60
2 132.22	V	54.00	74.00	34.44	49.30	19.56	24.70
9 747.48	H	54.00	74.00	40.54	50.50	13.46	23.50
9 747.48	V	54.00	74.00	43.84	51.80	10.16	22.20

High(2 452 MHz)

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
2 132.22	H	54.00	74.00	35.64	48.00	18.36	26.00
2 132.22	V	54.00	74.00	34.54	48.60	19.46	25.40
9 808.09	H	54.00	74.00	40.34	49.20	13.66	24.80
9 808.09	V	54.00	74.00	44.54	50.40	9.46	23.60
2 487.70	H	54.00	74.00	40.74	63.10	13.26	10.90
2 487.82	V	54.00	74.00	41.24	63.90	12.76	10.10

Remarks

1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in lie-down position(X axis) and the worst case was recorded.
2. Result = Reading + c.f(Correction factor)
3. Correction factor = Antenna factor + Cable loss - Amp Gain



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4.6 AC Power Line Conducted Emissions

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz-30 MHz, shall not exceed the limits.

Instrument Settings

IF Band Width: 9 kHz

Test Procedures

The EUT was placed on a non-metallic table 0.8m above the metallic, grounded floor and 0.4m from the reference ground plane wall. The distance to other metallic surfaces was at least 0.8m.

Amplitude measurements were performed with a quasi-peak detector and an average detector.

Limit

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average**
0.15 ~ 0.5	66 to 56*	56 to 46*
0.5 ~ 5	56	46
5 ~ 30	60	50

* The level decreases linearly with the logarithm of the frequency.

** A linear average detector is required.

Test Results

The requirements are:

Complies



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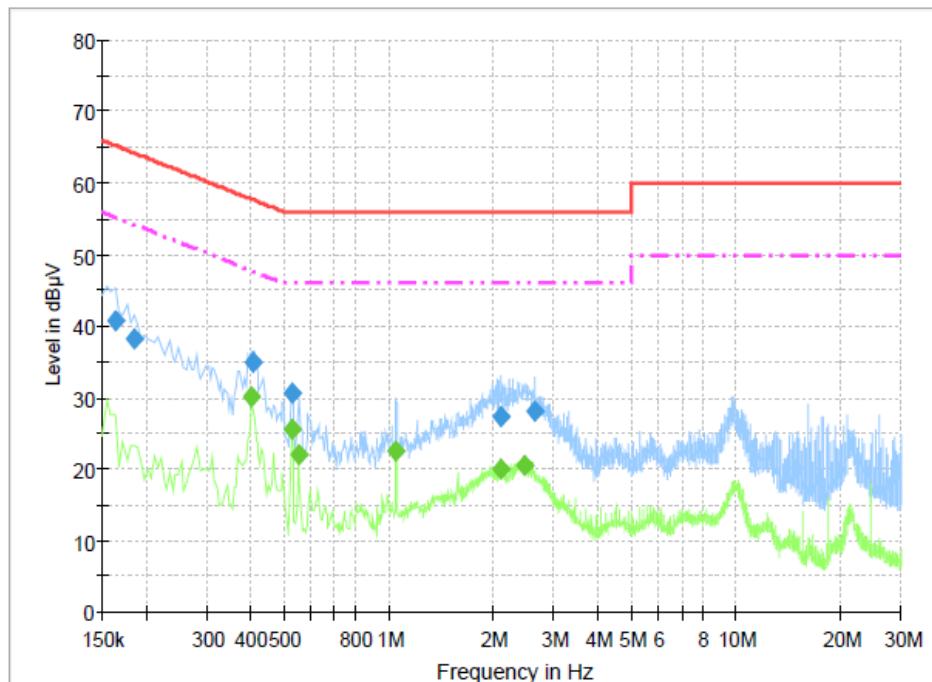
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Test Data

[LINE]

(with EC)3CE_Class B_L1



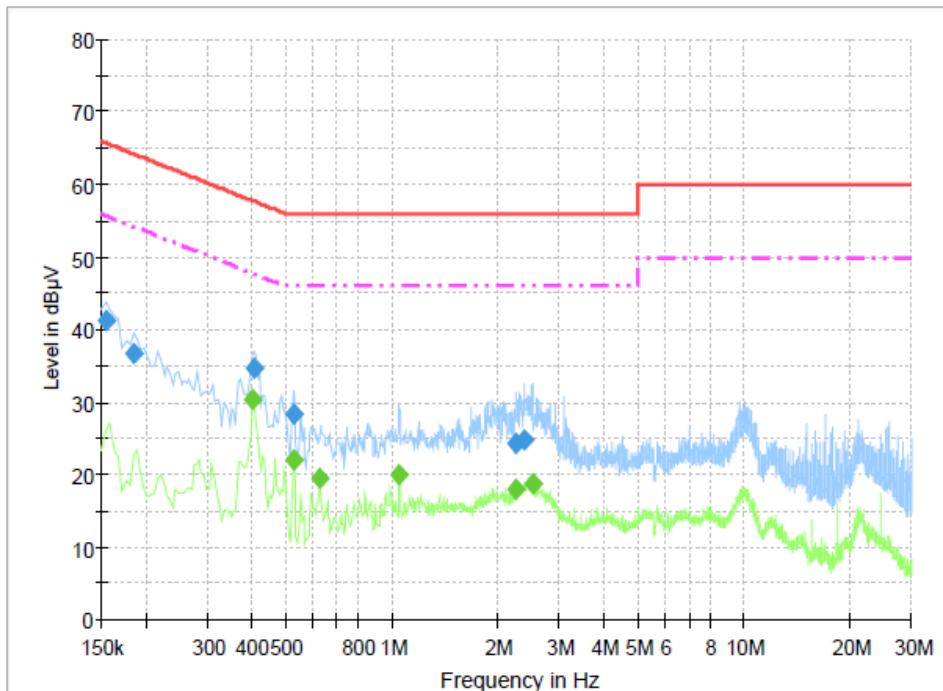
Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.163500	40.6	1000.0	9.000	On	L1	10.2	24.6	65.3
0.186000	38.3	1000.0	9.000	On	L1	10.2	25.9	64.2
0.406500	34.9	1000.0	9.000	On	L1	10.0	22.8	57.7
0.528000	30.6	1000.0	9.000	On	L1	10.0	25.4	56.0
2.116500	27.4	1000.0	9.000	On	L1	9.9	28.6	56.0
2.638500	28.0	1000.0	9.000	On	L1	9.9	28.0	56.0

Final Result 2

Frequency (MHz)	CAverage (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.402000	30.2	1000.0	9.000	On	L1	10.0	17.6	47.8
0.528000	25.6	1000.0	9.000	On	L1	10.0	20.4	46.0
0.550500	21.9	1000.0	9.000	On	L1	10.0	24.1	46.0
1.054500	22.6	1000.0	9.000	On	L1	9.9	23.4	46.0
2.116500	19.9	1000.0	9.000	On	L1	9.9	26.1	46.0
2.481000	20.6	1000.0	9.000	On	L1	9.9	25.4	46.0

[NEUTRAL]
 (with EC)3CE_Class B_N



Final Result 1

Frequency (MHz)	QuasiPeak (dB μ V)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.154500	41.3	1000.0	9.000	On	N	10.0	24.5	65.8
0.186000	36.7	1000.0	9.000	On	N	10.2	27.5	64.2
0.406500	34.6	1000.0	9.000	On	N	10.0	23.1	57.7
0.528000	28.3	1000.0	9.000	On	N	10.0	27.7	56.0
2.260500	24.4	1000.0	9.000	On	N	9.9	31.6	56.0
2.382000	24.8	1000.0	9.000	On	N	9.9	31.2	56.0

Final Result 2

Frequency (MHz)	CAverage (dB μ V)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.402000	30.3	1000.0	9.000	On	N	10.0	17.5	47.8
0.528000	22.1	1000.0	9.000	On	N	10.0	23.9	46.0
0.627000	19.4	1000.0	9.000	On	N	10.0	26.6	46.0
1.054500	20.1	1000.0	9.000	On	N	9.9	25.9	46.0
2.256000	17.9	1000.0	9.000	On	N	9.9	28.1	46.0
2.521500	18.8	1000.0	9.000	On	N	9.9	27.2	46.0

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APPENDIX A – Test Equipment Used For Tests

	Name of Equipment	Manufacturer	Model No.	Serial No.	Cal Date	Due Date
1	Signal Analyzer	Agilent	N9020A	MY48011598	2018-10-25	2019-10-25
2	Signal Generator	Rohde & Schwarz	SMB100A	175528	2018-10-24	2019-10-24
3	EMI Test Receiver	Rohde & Schwarz	ESCI7	100814	2018-10-25	2019-10-25
4	Bilog Antenna	Schaffner	CBL6111C	2551	2018-05-10	2020-05-10
5	Active Loop Antenna	SCHWARZBECK	FMZB 1513	1513-126	2018-05-27	2020-05-27
6	6dB Attenuator	R&S	DNF	272.4110.50-2	2018-10-25	2019-10-25
7	AMPLIFIER	SONOMA	310	291721	2019-01-28	2020-01-28
8	EMI Test Receiver	Rohde & Schwarz	ESU40	100336	2019-01-29	2020-01-29
9	Preamplifier	Agilent	8449B	3008A02011	2018-12-03	2019-12-03
10	Horn Antenna	ETS-Lindgren	3116	00062504	2017-12-04	2019-12-04
11	Horn Antenna	ETS-Lindgren	3117	00154525	2019-02-22	2021-02-22
12	Band Reject Filter	Micro Tronics	BRM50702	G233	2019-01-28	2020-01-28
13	EMI Test Receiver	R&S	ESCI3	100032	2019-01-29	2020-01-29
14	LISN	Rohde & Schwarz	ENV216	101236	2018-10-29	2019-10-29
15	Signal Conditioning Unit	R&S	SCU-40	10023	2018-10-24	2019-10-24

	Cable	Manufacturer	Model No.	Serial No.	Check Date
1	RF Cable	Canare Corporation	L-5D2W	N/A	2018-12-19
2	RF Cable	Junkosha Inc.	MWX221	1510S087	2019-05-23
3	RF Cable	HUBER+SUHNER	SUCOFLEX 102	MY073/2	2018-12-19
4	RF Cable	HUBER+SUHNER	SUCOFLEX 102	MY4728/2	2018-12-19
5	RF Cable	HUBER+SUHNER	SUCOFLEX 104	MY27558/4	2018-12-19
6	RF Cable	HUBER+SUHNER	SUCOFLEX 104	N/A	2018-12-19
7	RF Cable	HUBER+SUHNER	SUCOFLEX 104	MY27573/4	2018-12-19
8	RF Cable	HUBER+SUHNER	SUCOFLEX 106	N/A	2018-12-19