



TEST REPORT

KCTL Inc. 65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea TEL: 82-31-285-0894 FAX: 82-505-299-8311 www.kctl.co.kr		Report No.: KR20-SRF0051 Page (1) of (205)	
1. Client - Name : HYUNDAI MOBIS CO., LTD. - Address : 203, Teheran-ro, Gangnam-gu, Seoul, 06141, Korea - Date of Receipt : 2019-09-20			
2. Use of Report : Certification			
3. Name of Product and Model : WIDE AVN / ATC32HYAN			
4. Manufacturer and Country of Origin : Hyundai Mobis., Ltd. / Korea			
5. FCC ID : TQ8-ATC32HYAN			
6. Date of Test : 2019-10-01 to 2019-10-31			
7. Test Standards : FCC Part 15 Subpart E, 15.407			
8. Test Results : Refer to the test result in the test report			
Affirmation	Tested by Name : MyeongJun Kwon (Signature)		Technical Manager Name : Heesu Ahn (Signature)
2020-02-09			
KCTL Inc.			
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Report revision history

Date	Revision	Page No
2020-02-09	Initial report	-

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CONTENTS

1.	General information	4
2.	Device information	4
2.1.	Simultaneously transmission condition	5
2.2.	Information about derivative model	5
2.3.	Frequency/channel operations	5
2.4.	Duty Cycle Correction Factor	7
3.	Antenna requirement	10
4.	Summary of tests	11
5.	Measurement uncertainty	12
6.	Measurement results explanation example	13
7.	Test results	14
7.1.	Maximum conducted output power	14
7.2.	Maximum Power Spectral Density	30
7.3.	26 dB Bandwidth & 99% Occupied Bandwidth	46
7.4.	6 dB Bandwidth	73
7.5.	Spurious Emission, Band Edge and Restricted bands	78
8.	Measurement equipment	205

1. General information

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Manufacturer : Hyundai Mobis Co., Ltd.
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Accreditations : FCC Site Designation No: KR0040, FCC Site Registration No: 687132
VCCI Registration No. : R-20080, G-20078, C-20059, T-20056
Industry Canada Registration No. : 8035A
KOLAS No.: KT231

2. Device information

Equipment under test : WIDE AVN
Model : ATC32HYAN
Derivative model : ATC32HCAN, ATC35HCAN
Frequency range : 2 402 MHz ~ 2 480 MHz (Bluetooth(BDR/EDR))
2 412 MHz ~ 2 462 MHz (802.11b/g/n_HT20)
UNII-1: 5 180 MHz ~ 5 240 MHz (802.11a/n_HT20/ac_VHT20)
UNII-1: 5 190 MHz ~ 5 230 MHz (802.11n_HT40/ac_VHT40)
UNII-1: 5 210 MHz (802.11ac_VHT80)
UNII-2A: 5 260 MHz ~ 5 320 MHz (802.11a/n_HT20/ac_VHT20)
UNII-2A: 5 270 MHz ~ 5 310 MHz (802.11n_HT40/ac_VHT40)
UNII-2A: 5 290 MHz (802.11ac_VHT80)
UNII-2C: 5 500 MHz ~ 5 720 MHz (802.11a/n_HT20/ac_VHT20)
UNII-2C: 5 510 MHz ~ 5 710 MHz (802.11n_HT40/ac_VHT40)
UNII-2C: 5 530 MHz ~ 5 690 MHz (802.11ac_VHT80)
UNII-3: 5 745 MHz ~ 5 825 MHz (802.11a/n_HT20/ac_VHT20)
UNII-3: 5 755 MHz ~ 5 795 MHz (802.11n_HT40/ac_VHT40)
UNII-3: 5 775 MHz (802.11ac_VHT80)
Modulation technique : Bluetooth(BDR/EDR)_GFSK, $\pi/4$ DQPSK, 8DPSK
WIFI(802.11a/b/g/n20/n40/ac20/ac40/ac80)_DSSS, OFDM
Number of channels : Bluetooth(BDR/EDR)_79ch
2.4GHz WIFI (802.11b/g/n_HT20)_11ch
UNII-1: 4 ch (20 MHz), 2 ch (40 MHz), 1 ch (80 MHz)
UNII-2A: 4 ch (20 MHz), 2 ch (40 MHz), 1 ch (80 MHz)
UNII-2C: 9 ch (20 MHz), 5 ch (40 MHz), 2 ch (80 MHz)
UNII-3: 5 ch (20 MHz), 2 ch (40 MHz), 1 ch (80 MHz)
Power source : DC 14.4 V

UNII-1

Ch.	Frequency (MHz)
36	5 180
40	5 200
48	5 240

UNII-2A

Ch.	Frequency (MHz)
52	5 260
56	5 280
64	5 320

UNII-2C

Ch.	Frequency (MHz)
100	5 500
116	5 580
144	5 720

UNII-3

Ch.	Frequency (MHz)
149	5 745
157	5 785
165	5 825

Table 2.3.1. 802.11a/n/ac HT20/VHT20 mode

UNII-1

Ch.	Frequency (MHz)
38	5 190
46	5 230

UNII-2A

Ch.	Frequency (MHz)
54	5 270
62	5 310

UNII-2C

Ch.	Frequency (MHz)
102	5 510
110	5 550
142	5 710

UNII-3

Ch.	Frequency (MHz)
151	5 755
159	5 795

Table 2.3.2. 802.11n/ac_HT40/VHT40 mode

UNII-1

Ch.	Frequency (MHz)
42	5 210

UNII-2A

Ch.	Frequency (MHz)
58	5 290

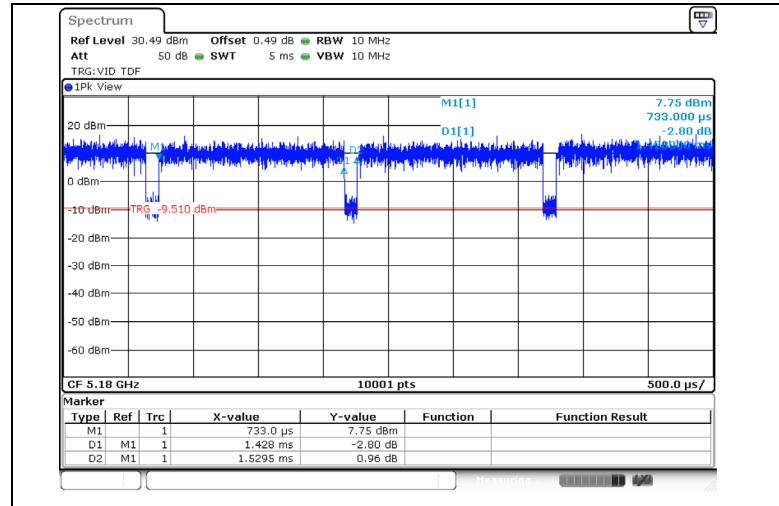
UNII-2C

Ch.	Frequency (MHz)
106	5 530
138	5 690

UNII-3

Ch.	Frequency (MHz)
155	5 775

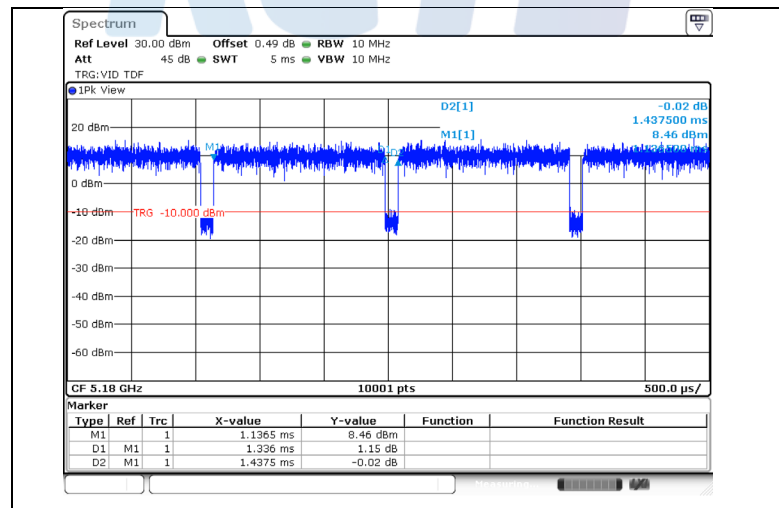
Table 2.3.3. 802.11ac_VHT80 mode

2.4. Duty Cycle Correction Factor**- 802.11a**

Note1) : Period : 1.529 5 ms, On time : 1.428 ms

Note2) : DCCF = $10\log(1/x) = 10\log(1/0.93) = 0.30$ dB, $x = 1.428/1.529\ 5 = 0.93$

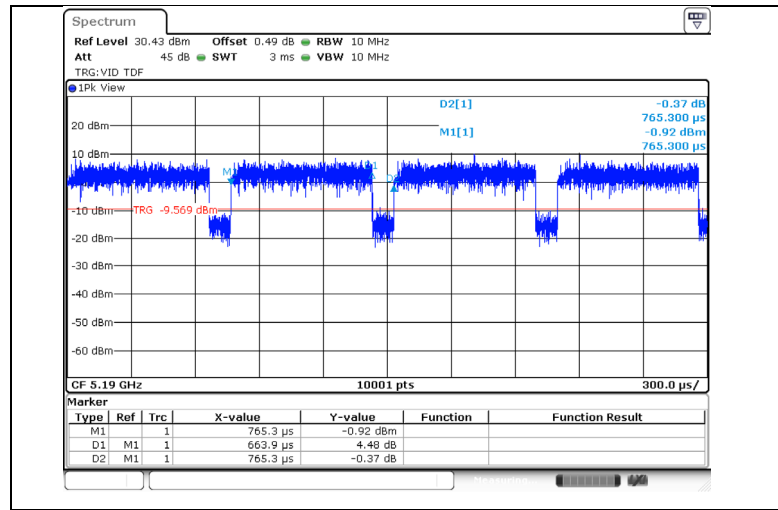
Note3) : 802.11a is a non-continuous transmission (duty cycle < 98%)

- 802.11n HT20

Note1) : Period : 1.437 5 ms, On time : 1.336 ms

Note2) : DCCF = $10\log(1/x) = 10\log(1/0.93) = 0.32$ dB, $x = 1.336/1.437\ 5 = 0.93$

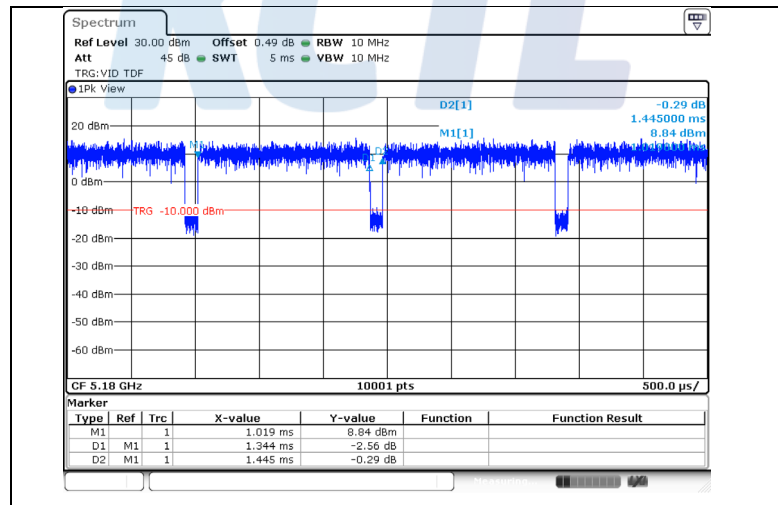
Note3) : 802.11n HT20 is a non-continuous transmission (duty cycle < 98%)

- 802.11n HT40

Note1) : Period : 0.765 3 ms, On time : 0.663 9 ms

Note2) : DCCF = $10\log(1/x) = 10\log(1/0.87) = 0.62$ dB, $x = 0.663\ 9/0.765\ 3 = 0.87$

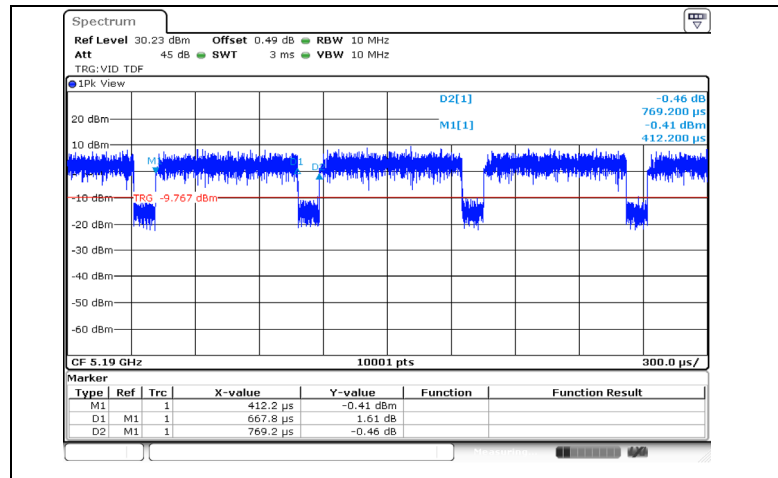
Note3) : 802.11n HT40 is a non-continuous transmission (duty cycle < 98%)

- 802.11ac VHT20

Note1) : Period : 1.445 ms, On time : 1.344 ms

Note2) : DCCF = $10\log(1/x) = 10\log(1/0.93) = 0.32$ dB, $x = 1.344/1.445 = 0.93$

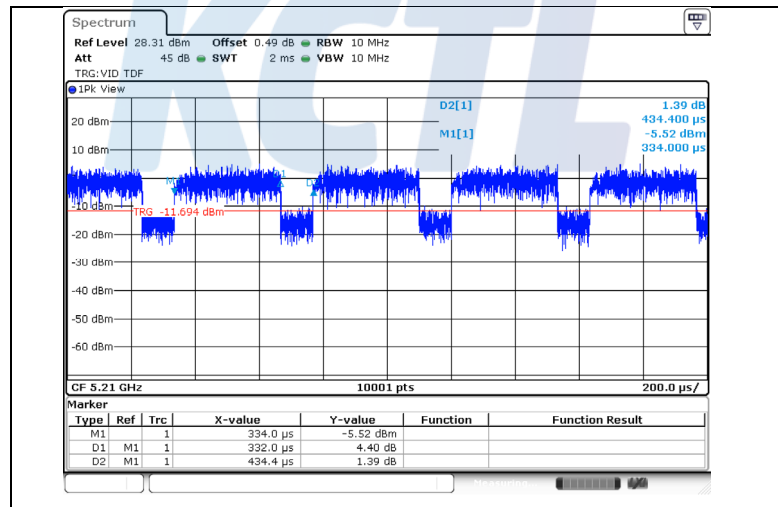
Note3) : 802.11ac VHT20 is a non-continuous transmission (duty cycle < 98%)

- 802.11ac VHT40

Note1) : Period : 0.769 2 ms, On time : 0.667 8 ms

Note2) : DCCF = $10\log(1/x) = 10\log(1/0.87) = 0.61$ dB, $x = 0.667\ 8/0.769\ 2 = 0.87$

Note3) : 802.11ac VHT40 is a non-continuous transmission (duty cycle < 98%)

- 802.11ac VHT80

Note1) : Period : 0.434 4 ms, On time : 0.332 ms

Note2) : DCCF = $10\log(1/x) = 10\log(1/0.76) = 1.17$ dB, $x = 0.332/0.434\ 4 = 0.76$

Note3) : 802.11ac VHT80 is a non-continuous transmission (duty cycle < 98%)

3. Antenna requirement

Requirement of FCC part section 15.203, 15.407:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

- The transmitter has permanently attached Pattern Antenna (internal antenna) on board.
- The E.U.T Complies with the requirement of §15.203, §15.407

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4. Summary of tests

FCC Part section(s)	Parameter	Test results
15.407(a)	Maximum conducted output power	Pass
15.407(a)	Maximum power spectral density	Pass
15.407(e)	6 dB Channel Bandwidth	Pass
15.407(a)	26 dB Channel Bandwidth	Pass
-	Occupied Bandwidth	
15.407(b), 15.205(a), 15.209(a)	Spurious emission	Pass
	Band-edge, restricted band	Pass
15.207(a)	Conducted Emissions	N/A ^(Note1)

Notes:

1. All modes of operation and data rates were investigated. The test results shown in the following sections represent the worst case emissions.
2. This test is not applicable because the EUT falls into the automotive device and it's not to be connected to the public utility(AC) power line.
3. According to exploratory test no any obvious emission were detected from 9 kHz to 30 MHz. Although these tests were performed other than open field site, adequate comparison measurements were confirmed against 30 m open field site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.
4. 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
5. This product do not use Terminal Doppler Weather Radar (TDWR) Channel.
6. The test procedure(s) in this report were performed in accordance as following.
 - ANSI C63.10-2013
 - KDB 789033 D02 v02r01
7. The worst-case data rates were:
 - 802.11a mode : 1Mbps
 - 802.11n HT20 mode : MCS0
 - 802.11n HT40 mode : MCS0
 - 802.11n VHT20 mode : MCS0
 - 802.11n VHT40 mode : MCS0
 - 802.11n VHT80 mode : MCS0

5. Measurement uncertainty

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of $k=2$ to indicated a 95 % level of confidence. The measurement data shown herein meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded uncertainty(±)	
Conducted RF power	1.76 dB	
Conducted spurious emissions	4.03 dB	
Radiated spurious emissions	9 kHz ~ 30 MHz:	2.28 dB
	30 MHz ~ 300 MHz	4.98 dB
	300 MHz ~ 1 000 MHz	5.14 dB
	1 GHz ~ 6 GHz	6.70 dB
	Above 6 GHz	6.60 dB
Conducted emissions	9 kHz ~ 150 kHz	3.66 dB
	150 kHz ~ 30 MHz	3.26 dB

6. Measurement results explanation example

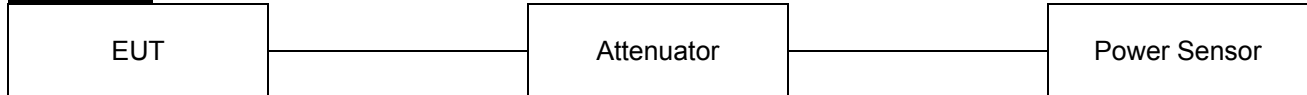
The offset level is set in the spectrum analyzer to compensate the RF cable loss factor between EUT conducted output port and spectrum analyzer.

With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Frequency (MHz)	Factor(dB)	Frequency (MHz)	Factor(dB)
30	10.06	16 000	12.39
50	10.15	17 000	12.81
100	10.24	18 000	12.93
200	10.40	19 000	13.05
300	10.55	20 000	13.32
400	10.65	21 000	13.19
500	10.76	22 000	13.39
600	10.83	23 000	13.50
700	10.98	24 000	13.43
800	11.06	25 000	13.93
900	11.23	26 000	13.53
1 000	11.09	26 500	13.74
2 000	12.51	27000	12.88
3 000	12.44	28000	12.96
4 000	12.27	29000	13.01
5 000	12.22	30000	14.33
6 000	12.16	31000	13.24
7 000	12.29	32000	12.68
8 000	12.24	33000	13.24
9 000	12.22	34000	13.29
10 000	12.18	35000	13.00
11 000	12.31	36000	12.78
12 000	12.24	37000	13.45
13 000	12.31	38000	13.26
14 000	12.38	39000	12.99
15 000	12.22	40000	12.69

Notes:

Offset(dB) = RF cable loss(dB) + Attenuator(dB)

7. Test results**7.1. Maximum conducted output power****Test setup****Limit**

According to §15.407(a)

Band	EUT category		Conducted output power limit
UNII-1		Outdoor access point	1 W (30 dBm)
		Indoor access point	
		Fixed point-to-point access point	
	√	Client device	250 mW (23.98 dBm)
UNII-2A	√		250 mW or 11 dBm + 10logB ¹⁾
UNII-2C	√		250 mW or 11 dBm + 10logB ¹⁾
UNII-3	√		1 W (30 dBm)

Note:

1) Conducted output power limit B is the 26 dB emission bandwidth.

Test procedure

ANSI C63.10-2013-Section 12.3.2.4

KDB 789033 D02 v02r01 - Section E.2.d) or e)

Test settings**Used test method is Section E.2.d)****◆ KDB 789033 D02 v02r01****Section E.2.d)****Method SA-2 (trace averaging across on and off times of the EUT transmissions, followed by duty cycle correction):**

- (i) Measure the duty cycle, x , of the transmitter output signal as described in II.B..
- (ii) Set span to encompass the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal.
- (iii) Set $RBW = 1 \text{ MHz}$
- (iv) Set $RBW \geq 3 \text{ MHz}$
- (v) Number of points in sweep $\geq 2 \times \text{span} / RBW$. (This ensures that bin-to-bin spacing is $\leq RBW/2$, so that narrowband signals are not lost between frequency bins.)
- (vi) Sweep time = auto.
- (vii) Detector = power averaging (rms), if available. Otherwise use sample detector mode.
- (viii) Do not use sweep triggering. Allow the sweep to "free run."
- (ix) Trace average at least 100 traces in power averaging (rms) mode; however, the number of traces to be averaged shall be increased above 100 as needed to ensure that the average accurately represents the true average over the on and off periods of the transmitter.
- (x) Compute power by integrating the spectrum across the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal using the instrument's band power measurement function with band limits set equal to the EBW (or occupied bandwidth) band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at 1 MHz intervals extending across the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal.
- (xi) Add $10 \log(1/x)$, where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times (because the measurement represents an average over both the on and off times of the transmission). For example, add $10 \log(1/0.25) = 6 \text{ dB}$ if the duty cycle is 25%.

Section E.2.e)**Method SA-2 Alternative (power averaging(rms) detection with slow sweep with each spectrum bin averaging across on and off times of the EUT transmissions, followed by duty cycle correction):**

- (i) Measure the duty cycle, x , of the transmitter output signal as described in II.B..
- (ii) Set span to encompass the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal.
- (iii) Set $RBW = 1 \text{ MHz}$
- (iv) Set $RBW \geq 3 \text{ MHz}$
- (v) Number of points in sweep $\geq 2 \times \text{span} / RBW$. (This ensures that bin-to-bin spacing is $\leq RBW/2$, so that narrowband signals are not lost between frequency bins.)
- (vi) Manually set sweep time $\geq 10 \times (\text{number of points in sweep}) \times (\text{total on/off period of the transmitted signal})$.
- (vii) Set detector = power averaging (rms)
- (viii) Perform a single sweep.
- (ix) Compute power by integrating the spectrum across the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal using the instrument's band power measurement function with band limits set equal to the EBW (or occupied bandwidth) band edges. If

the instrument does not have a band power function, sum the spectrum levels (in power units) at 1 MHz intervals extending across the EBW (or, alternatively, the entire 99% occupied bandwidth) of the spectrum.

- (x) Add $10 \log (1/x)$, where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times (because the measurement represents an average over both the on and off times of the transmission). For example, add $10 \log (1/0.25) = 6 \text{ dB}$ if the duty cycle is 25%.

Section E.3.a)**Method PM (Measurement using an RF average power meter):**

- (xi) Measurements may be performed using a wideband RF power meter with a thermocouple detector or equivalent if all of the conditions listed below are satisfied.
- The EUT is configured to transmit continuously or to transmit with a constant duty cycle.
 - At all times when the EUT is transmitting, it must be transmitting at its maximum power control level.
 - The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five
- (xii) If the transmitter does not transmit continuously, measure the duty cycle, x , of the transmitter output signal as described in II
- (xiii) Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.
- (xiv) Adjust the measurement in dBm by adding $10 \log (1/x)$ where x is the duty cycle (e.g., $10 \log (1/0.25)$ if the duty cycle is 25%).

Section E.3.b)**Method PM-G (Measurement using a gated RF average power meter):**

Measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

Test results

Test mode	Band	Freq (MHz)	Measured power (dBm)	DCCF (dB)	Conducted output power (dBm)	Conducted Power Limit (dBm)
802.11a	UNII-1	5180	8.86	0.30	9.16	23.98
		5200	8.81	0.30	9.11	
		5240	8.91	0.30	9.21	
	UNII-2A	5260	9.08	0.30	9.38	23.98
		5280	9.20	0.30	9.50	
		5320	9.19	0.30	9.49	
	UNII-2C	5500	9.26	0.30	9.56	23.98
		5580	9.17	0.30	9.47	
		5720	8.77	0.30	9.07	22.93
	UNII-3	5745	8.90	0.30	9.20	30.00
		5785	8.88	0.30	9.18	
		5825	8.80	0.30	9.10	
802.11n HT20	UNII-1	5180	8.85	0.32	9.17	23.98
		5200	8.77	0.32	9.09	
		5240	8.77	0.32	9.09	
	UNII-2A	5260	9.05	0.32	9.37	23.98
		5280	9.16	0.32	9.48	
		5320	9.01	0.32	9.33	
	UNII-2C	5500	9.05	0.32	9.37	23.98
		5580	9.11	0.32	9.43	
		5720	8.55	0.32	8.87	22.94
	UNII-3	5745	8.78	0.32	9.10	30.00
		5785	8.74	0.32	9.06	
		5825	8.76	0.32	9.08	
802.11n HT40	UNII-1	5190	3.87	0.62	4.49	23.98
		5230	3.69	0.62	4.31	
	UNII-2A	5270	8.57	0.62	9.19	23.98
		5310	8.56	0.62	9.18	
	UNII-2C	5510	8.69	0.62	9.31	23.98
		5550	8.73	0.62	9.35	
		5710	8.62	0.62	9.24	
	UNII-3	5755	8.41	0.62	9.03	30.00
		5795	8.37	0.62	8.99	

Test mode	Band	Freq (MHz)	Measured power (dBm)	DCCF (dB)	Conducted output power (dBm)	Conducted Power Limit (dBm)
802.11ac VHT20	UNII-1	5180	8.72	0.31	9.03	23.98
		5200	8.73	0.31	9.04	
		5240	8.73	0.31	9.04	
	UNII-2A	5260	8.94	0.31	9.25	23.98
		5280	9.17	0.31	9.48	
		5320	8.99	0.31	9.30	
	UNII-2C	5500	9.09	0.31	9.40	23.98
		5580	9.06	0.31	9.37	
		5720	8.61	0.31	8.92	22.97
	UNII-3	5745	8.82	0.31	9.13	30.00
		5785	8.83	0.31	9.14	
		5825	8.79	0.31	9.10	
802.11ac VHT40	UNII-1	5190	3.88	0.61	4.49	23.98
		5230	3.86	0.61	4.47	
	UNII-2A	5270	8.44	0.61	9.05	23.98
		5310	8.62	0.61	9.23	
	UNII-2C	5510	8.67	0.61	9.28	23.98
		5550	8.74	0.61	9.35	
		5710	8.62	0.61	9.23	
	UNII-3	5755	8.42	0.61	9.03	30.00
		5795	8.15	0.61	8.76	
802.11ac VHT80	UNII-1	5210	3.16	1.17	4.33	23.98
	UNII-2A	5290	6.93	1.17	8.10	23.98
	UNII-2C	5530	8.29	1.17	9.46	23.98
		5690	8.13	1.17	9.30	
	UNII-3	5775	7.79	1.17	8.96	30.00

Note:

1. Conducted Output power Calculation:

$$\text{Conducted Output power} = \text{Measured power(dB m)} + \text{DCCF (dB)}$$

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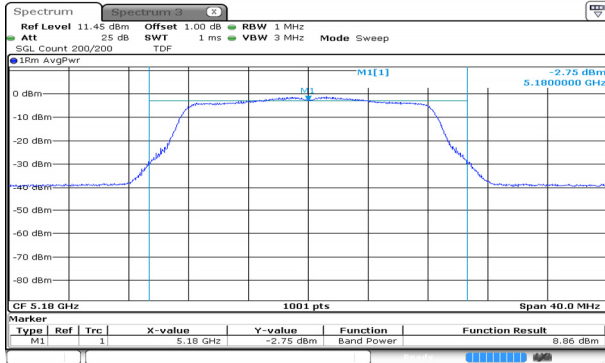
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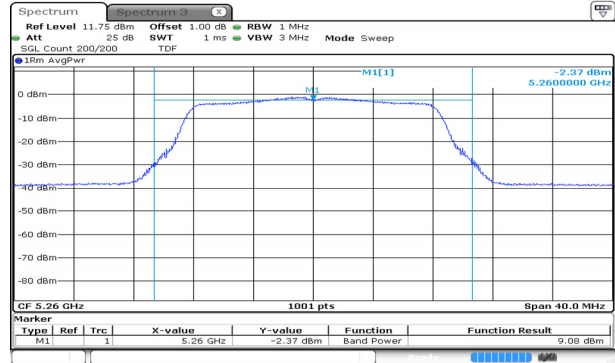
Page (19) of (205)



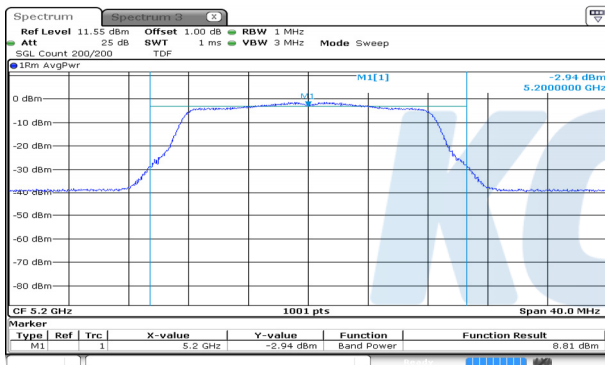
UNII-1 / 802.11a / Low ch.



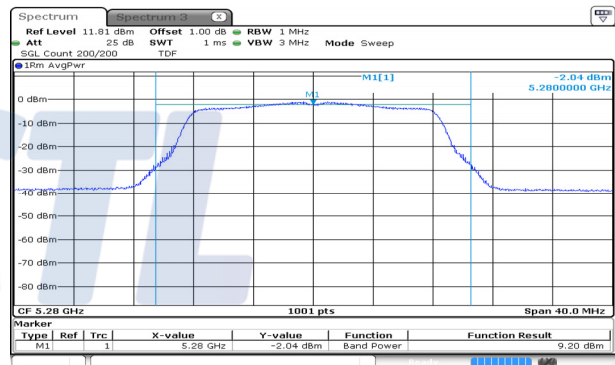
UNII-2A / 802.11a / Low ch.



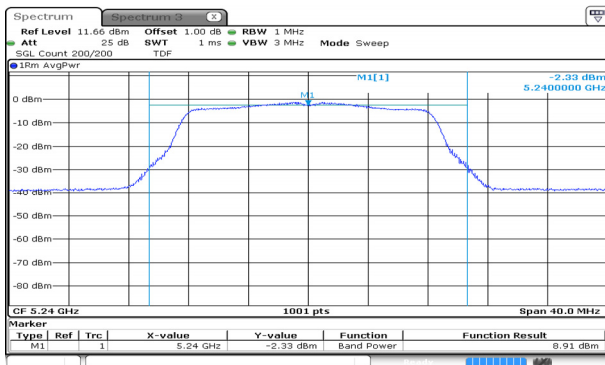
UNII-1 / 802.11a / Mid ch.



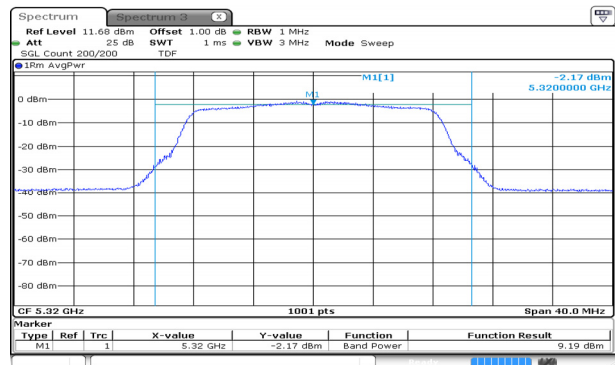
UNII-2A / 802.11a / Mid ch.



UNII-1 / 802.11a / High ch.



UNII-2A / 802.11a / High ch.



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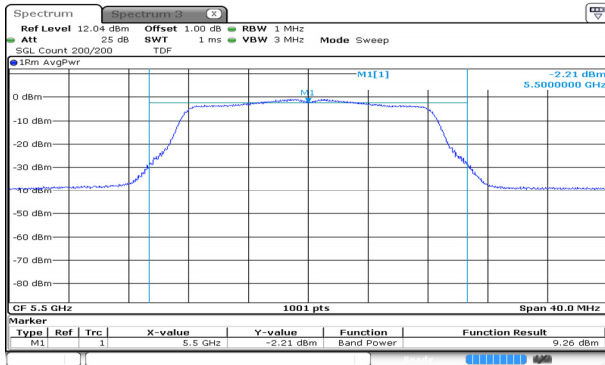
65, Sinwon-ro, Yeongtong-gu,
Suwon-si, Gyeonggi-do, 16677, Korea
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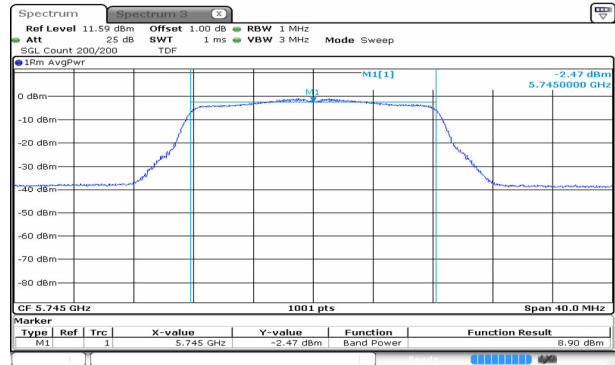
Page (20) of (205)

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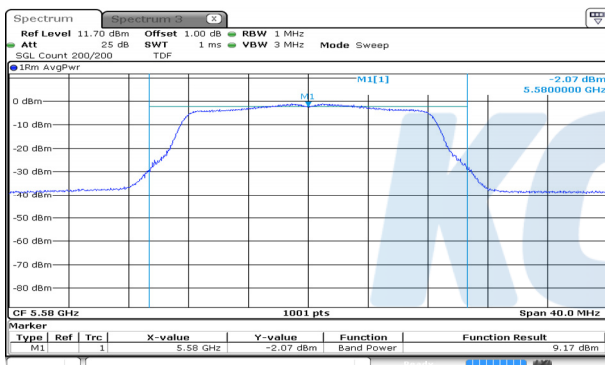
UNII-2C / 802.11a / Low ch.



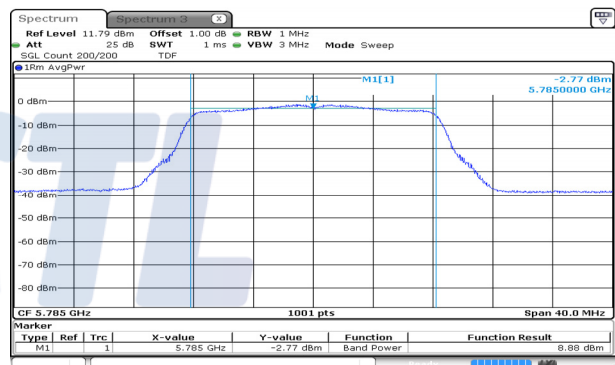
UNII-3 / 802.11a / Low ch.



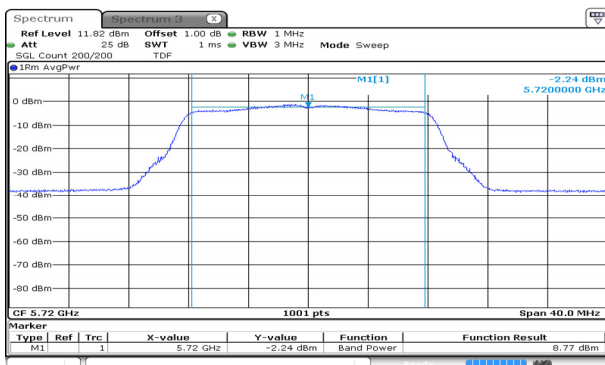
UNII-2C / 802.11a / Mid ch.



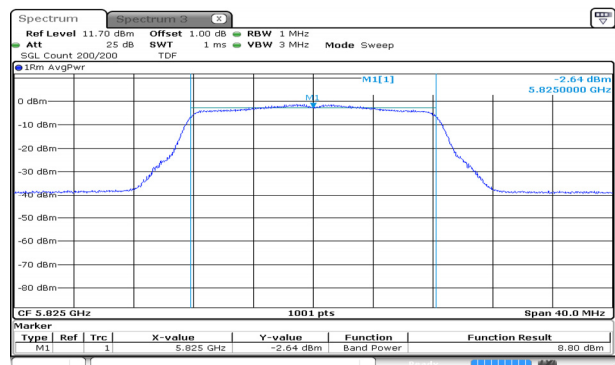
UNII-3 / 802.11a / Mid ch.



UNII-2C / 802.11a / High ch.



UNII-3 / 802.11a / High ch.



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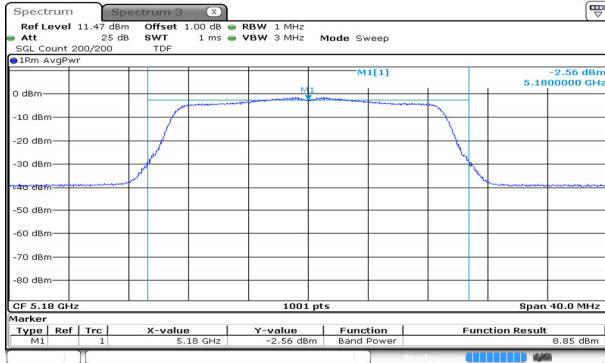
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Suwon-si, Gyeonggi-do, 16677, Korea
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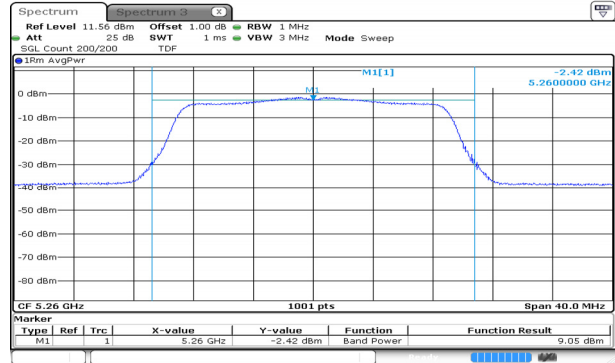
Page (21) of (205)



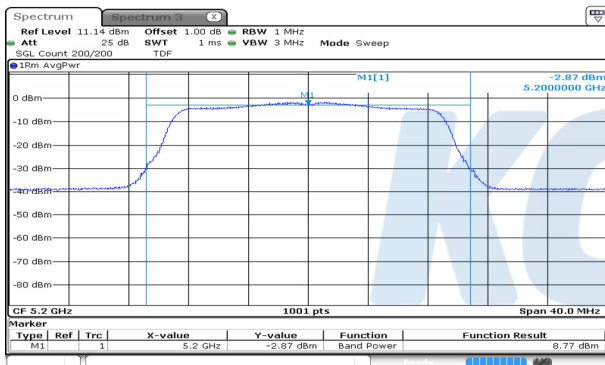
UNII-1 / 802.11n HT20 / Low ch.



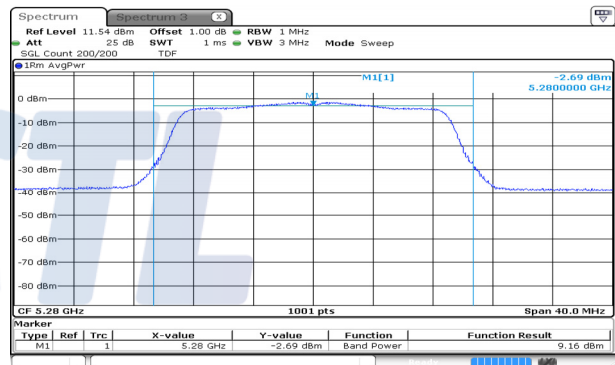
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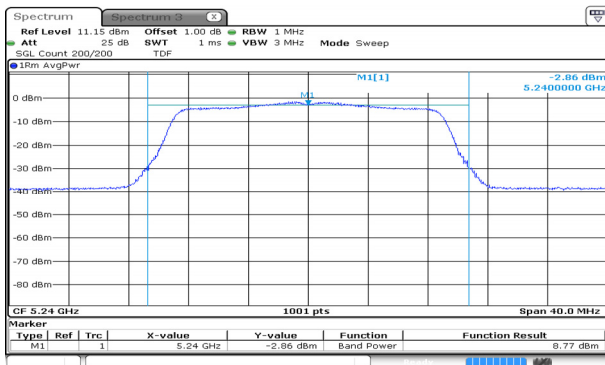
UNII-1 / 802.11n HT20 / Mid ch.



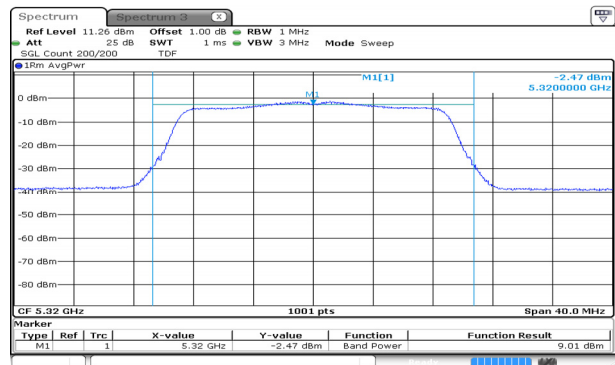
UNII-2A / 802.11n HT20 / Mid ch.



UNII-1 / 802.11n HT20 / High ch.



UNII-2A / 802.11n HT20 / High ch.



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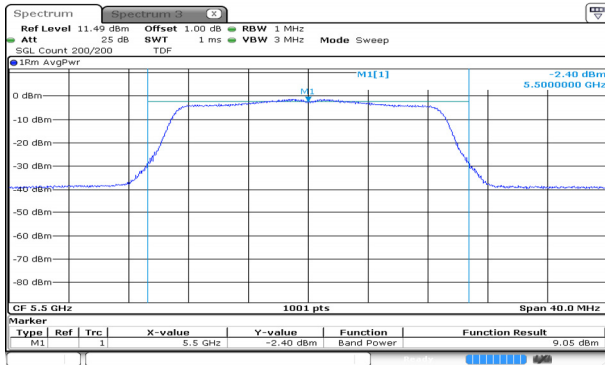
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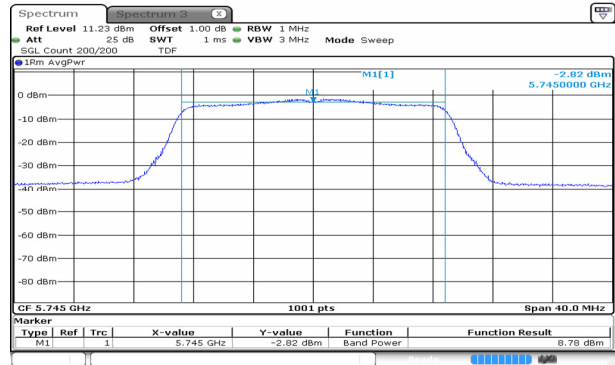
Page (22) of (205)



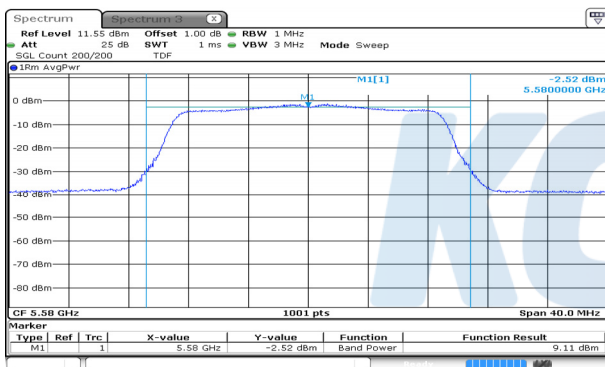
UNII-2C / 802.11n HT20 / Low ch.



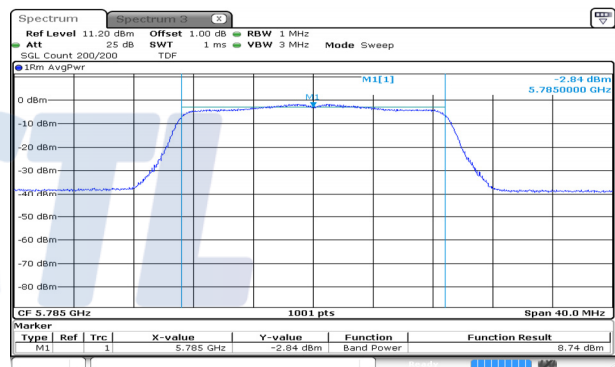
UNII-3 / 802.11n HT20 / Low ch.



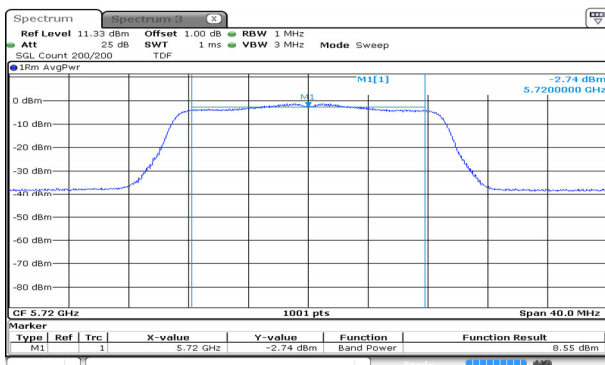
UNII-2C / 802.11n HT20 / Mid ch.



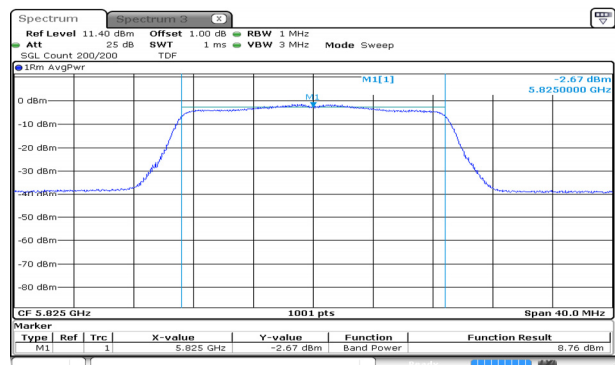
UNII-3 / 802.11n HT20 / Mid ch.



UNII-2C / 802.11n HT20 / High ch.



UNII-3 / 802.11n HT20 / High ch.



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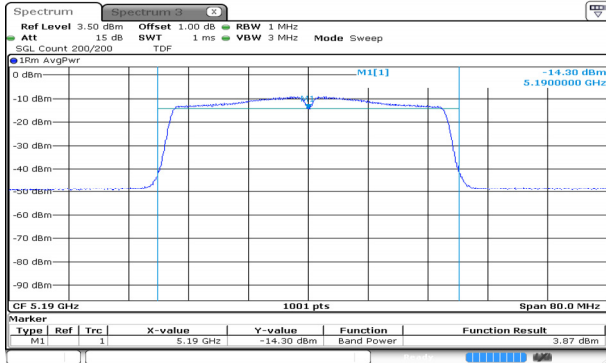
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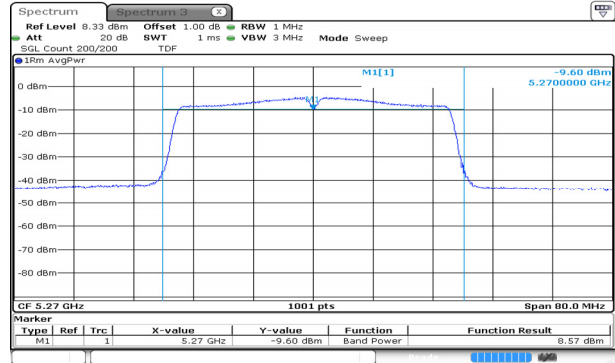
Page (23) of (205)



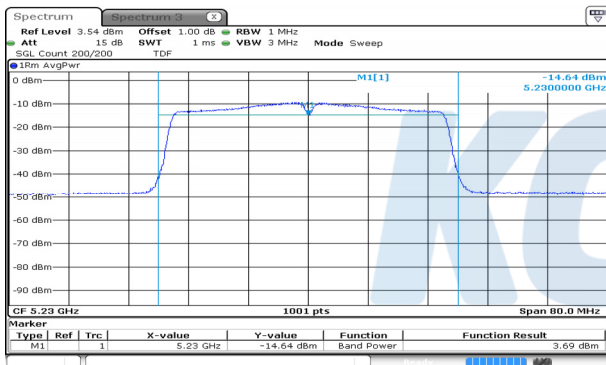
UNII-1 / 802.11n HT40 / Low ch.



UNII-2A / 802.11n HT40 / Low ch.



UNII-1 / 802.11n HT40 / High ch.



UNII-2A / 802.11n HT40 / High ch.

