TEST REPORT

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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	Technical Manager
	Name : MyeongJun Kwon (Signature)	Name : Heesu Ahn (Signature)

2020-02-09

KCTL Inc.

Report revision history

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

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1. General information

Client	:	HYUNDAI MOBIS CO., LTD.
Address	:	203, Teheran-ro, Gangnam-gu, Seoul, 06141, Korea
Manufacturer	:	Hyundai Mobis Co., Ltd.
Address	:	95, Sayang 2-Gil, Munbaek-Myeon, Jincheon-Gun, Chungcheongbuk-Do 27862 Korea
Laboratory	:	KCTL Inc.
Address	:	65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea
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 ㎒ ~ 2 480 ㎒ (Bluetooth(BDR/EDR)
		2 412 ㎒ ~ 2 462 ㎒ (802.11b/g/n_HT20)
		UNII-1: 5 180 ㎒ ~ 5 240 ㎒ (802.11a/n_HT20/ac_VHT20)
		UNII-1: 5 190 ㎒ ~ 5 230 ㎒ (802.11n_HT40/ac_VHT40)
		UNII-1: 5 210 ㎒ (802.11ac_VHT80)
		UNII-2A: 5 260 ㎒ ~ 5 320 ㎒ (802.11a/n_HT20/ac_VHT20)
		UNII-2A: 5 270 ㎒ ~ 5 310 ㎒ (802.11n_HT40/ac_VHT40)
		UNII-2A: 5 290 ㎒ (802.11ac_VHT80)
		UNII-2C: 5 500 ㎒ ~ 5 720 ㎒ (802.11a/n_HT20/ac_VHT20)
		UNII-2C: 5 510 ㎒ ~ 5 710 ㎒ (802.11n_HT40/ac_VHT40)
		UNII-2C: 5 530 ㎒ ~ 5 690 ㎒ (802.11ac_VHT80)
		UNII-3: 5 745 ㎒ ~ 5 825 ㎒ (802.11a/n_HT20/ac_VHT20)
		UNII-3: 5 755 ㎒ ~ 5 795 ㎒ (802.11n_HT40/ac_VHT40)
		UNII-3: 5 775 ㎒ (802.11ac_VHT80)
Modulation technique	:	Bluetooth(BDR/EDR)_ GFSK, π/4DQPSK, 8DPSK
		WIFI(802.11a/b/g/n20/n40/ac20/ac40/ac80)_DSSS, OFDM
Number of channels	:	Bluetooth(BDR/EDR)_79ch
		2.4㎓ WIFI (802.11b/g/n_HT20)_11ch
		UNII-1: 4 ch (20 ㎒), 2 ch (40 ㎒), 1 ch (80 ㎒)
		UNII-2A: 4 ch (20 ㎒), 2 ch (40 ㎒), 1 ch (80 ㎒)
		UNII-2C: 9 ch (20 ㎒), 5 ch (40 ㎒), 2 ch (80 ㎒)
		UNII-3: 5 ch (20 ㎒), 2 ch (40 ㎒), 1 ch (80 ㎒)
Power source	:	DC 14.4 V

Antenna specification	:	WIFI/Bluetooth(BDR/EDR)_Pattern Antenna
Antenna gain	:	2.4㎓ WIFI (802.11b/g/n_HT20) : -0.70 dBi
		Bluetooth(BDR/EDR) : 0.29 dBi
		UNII-1 : 3.51 dBi, UNII-2A : 3.12 dBi
		UNII-2C : 2.28 dBi, UNII-3 : -0.84 dBi
Software version	:	MQ4.USA.0000.V028.001.190821
Hardware version	:	MQ4.USA.STD_AVN_G5_WIDE.004.001
Test device serial No.	:	N/A
Operation temperature	:	-20 ℃ ~ 70 ℃

2.1. Simultaneously transmission condition

Technology	Modulation	Test mode	Tested Chanel.
WLAN 5 ㎓	OFDM	802.11a / UNII-2C	5 500
Bluetooth	GFSK	BDR	2 441

2.2. Information about derivative model

The difference between basic model and derivative models is:

The derivative models have a different product identification number.

ATC32HCAN(96560 P4720), ATC35HCAN(96560 P4920)

2.3. Frequency/channel operations

This device contains the following capabilities:
WIFI(2.4㎓ band 802.11b/g/n(HT20), 5㎓ band 802.11a/n(HT20/HT40)/ac(VHT/20/40/80)), Bluetooth(BDR/EDR)

UNII-1		UNII-2A		UNII-2C		UNII-3	
Ch.	Frequency (㎒)	Ch.	Frequency (㎒)	Ch.	Frequency (㎒)	Ch.	Frequency (㎒)
36	5 180	52	5 260	100	5 500	149	5 745
40	5 200	56	5 280	116	5 580	157	5 785
48	5 240	64	5 320	144	5 720	165	5 825

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

UNII-1		UNII-2A		UNII-2C		UNII-3	
Ch.	Frequency (㎒)	Ch.	Frequency (㎒)	Ch.	Frequency (㎒)	Ch.	Frequency (㎒)
38	5 190	54	5 270	102	5 510	151	5 755
46	5 230	62	5 310	110	5 550	159	5 795
				142	5 710		

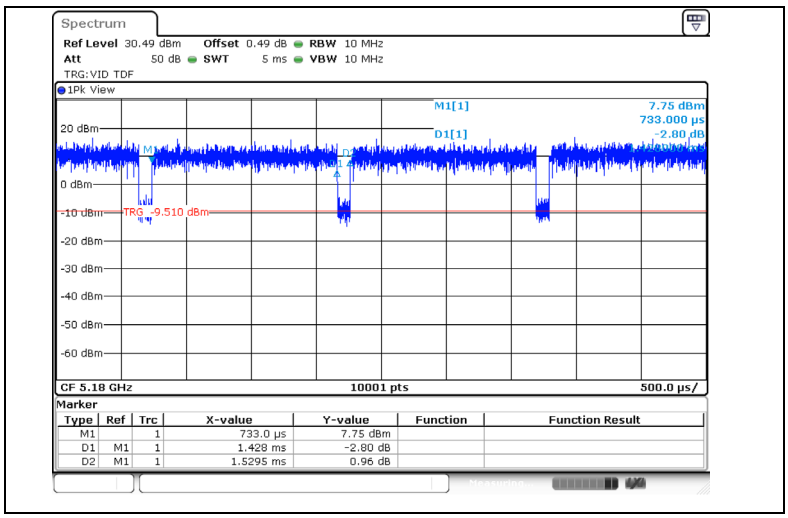
Table 2.3.2. 802.11n/ac_HT40/VHT40 mode

UNII-1		UNII-2A		UNII-2C		UNII-3	
Ch.	Frequency (㎒)	Ch.	Frequency (㎒)	Ch.	Frequency (㎒)	Ch.	Frequency (㎒)
42	5 210	58	5 290	106	5 530	155	5 775
				138	5 690		

Table 2.3.3. 802.11ac_VHT80 mode

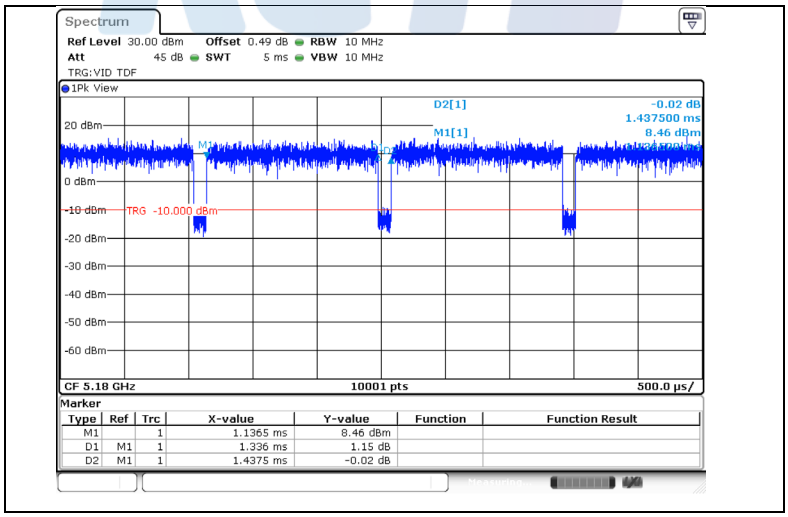
2.4. Duty Cycle Correction Factor

- 802.11a



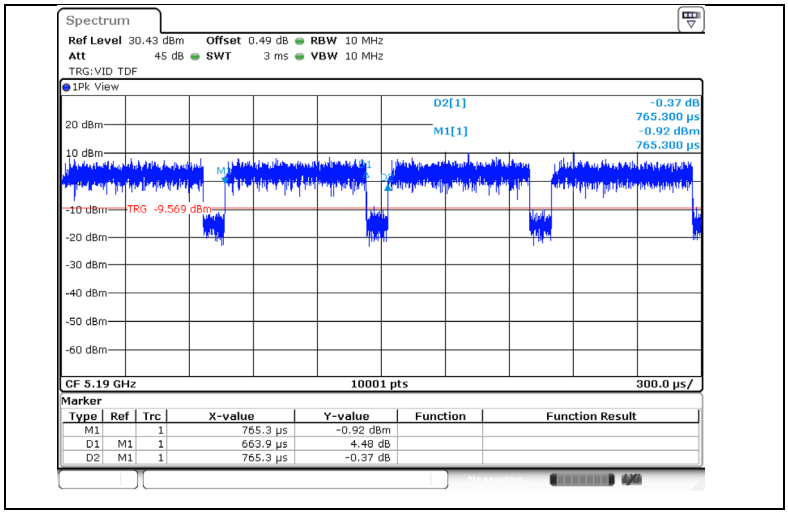
Note1) : Period : 1.529 5 ms, On time : 1.428 ms
Note2) : DCCF = 10log(1/x) = 10log(1/0.93) = 0.30 dB, x = 1.428/1.529 5 = 0.93
Note3) : 802.11a is a non-continuous transmission (duty cycle < 98%)

- 802.11n HT20



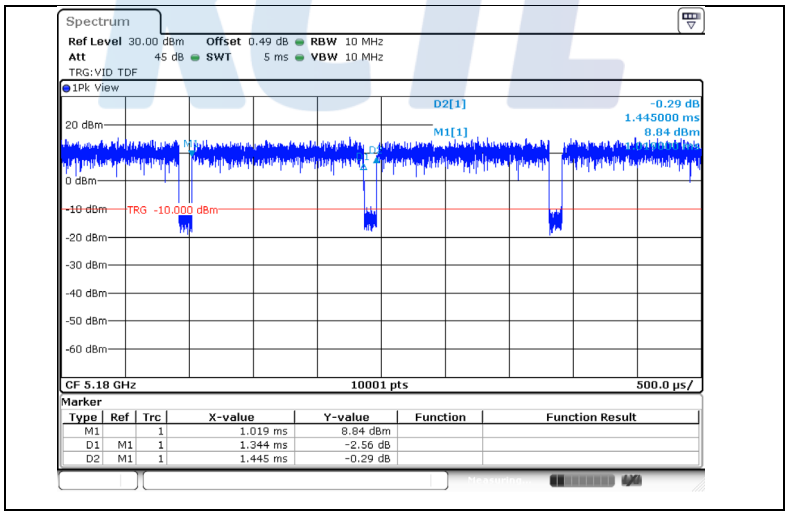
Note1) : Period : 1.437 5 ms, On time : 1.336 ms
Note2) : DCCF = 10log(1/x) = 10log(1/0.93) = 0.32 dB, x = 1.336/1.437 5 = 0.93
Note3) : 802.11n HT20 is a non-continuous transmission (duty cycle < 98%)

- 802.11n HT40



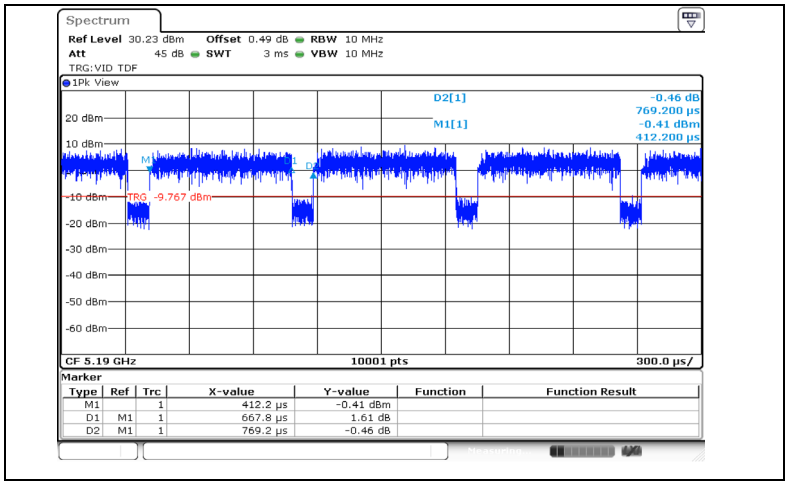
Note1) : Period : 0.765 3 ms, On time : 0.663 9 ms
Note2) : DCCF = 10log(1/x) = 10log(1/0.87) = 0.62 dB, x = 0.663 9/0.765 3 = 0.87
Note3) : 802.11n HT40 is a non-continuous transmission (duty cycle < 98%)

- 802.11ac VHT20



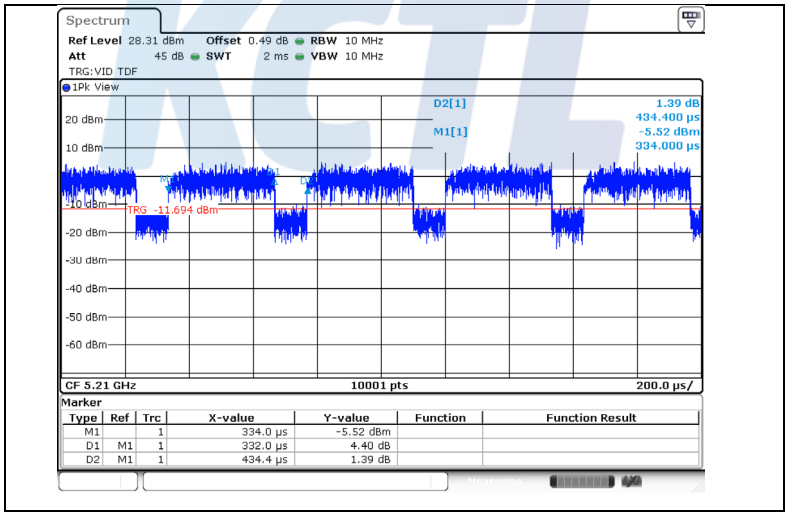
Note1) : Period : 1.445 ms, On time : 1.344 ms
Note2) : DCCF = 10log(1/x) = 10log(1/0.93) = 0.32 dB, x = 1.344/1.445 = 0.93
Note3) : 802.11ac VHT20 is a non-continuous transmission (duty cycle < 98%)

- 802.11ac VHT40



Note1) : Period : 0.769 2 ms, On time : 0.667 8 ms
Note2) : DCCF = 10log(1/x) = 10log(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 = 10log(1/x) = 10log(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

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 ㎑ to 30 ㎒. Although these tests were performed other than open field site, adequate comparison measurements were confirmed against 30 m open field site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.
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 of 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.

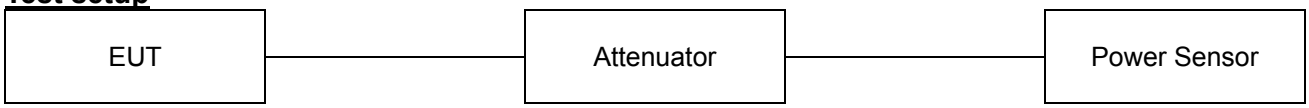
Frequency (㎒)	Factor(㏈)	Frequency (㎒)	Factor(㏈)
30	10.06	16 000	12.39
50	10.15	17 000	12.81
100	10.24	18 000	12.93
200	10.40	19 000	13.05
300	10.55	20 000	13.32
400	10.65	21 000	13.19
500	10.76	22 000	13.39
600	10.83	23 000	13.50
700	10.98	24 000	13.43
800	11.06	25 000	13.93
900	11.23	26 000	13.53
1 000	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(㏈) = RF cable loss(㏈) + Attenuator(㏈)

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 ㎒
(iv) Set RBW ≥ 3 ㎒
(v) Number of points in sweep ≥ 2×span/RBW. (This ensures that bin-to-bin spacing is ≤ 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 ㎒ 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 ㏈ 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 ㎒
(iv) Set RBW ≥ 3 ㎒
(v) Number of points in sweep ≥ 2×span/RBW. (This ensures that bin-to-bin spacing is ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)
(vi) Manually set sweep time ≥ 10 × (number of points in sweep) × (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 ㎒ 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 ㏈ 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 ㏈m 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%).

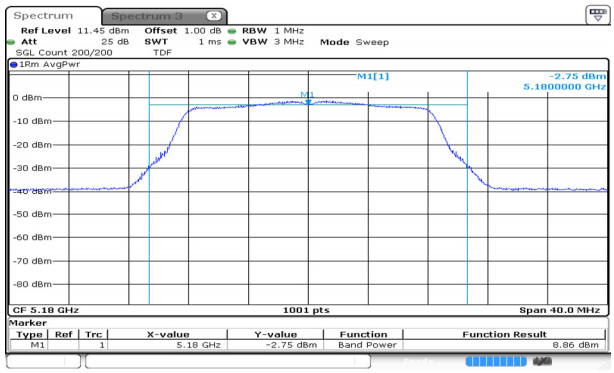
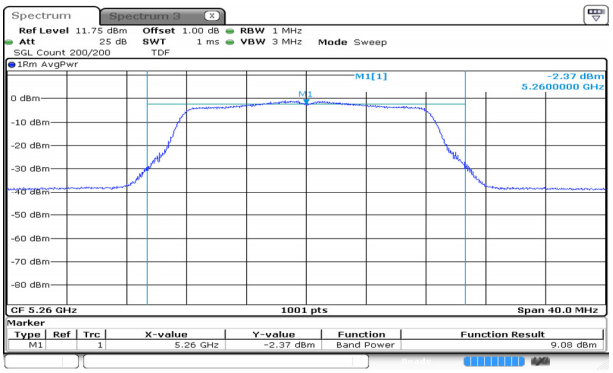
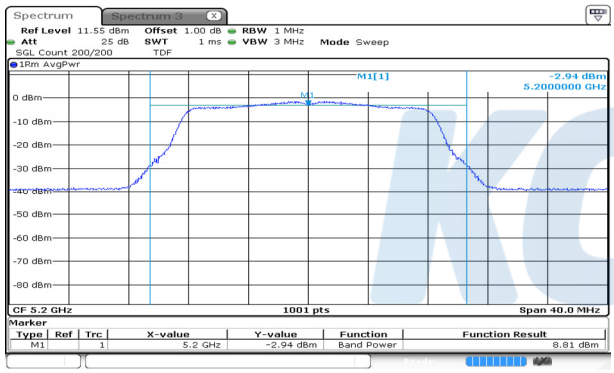
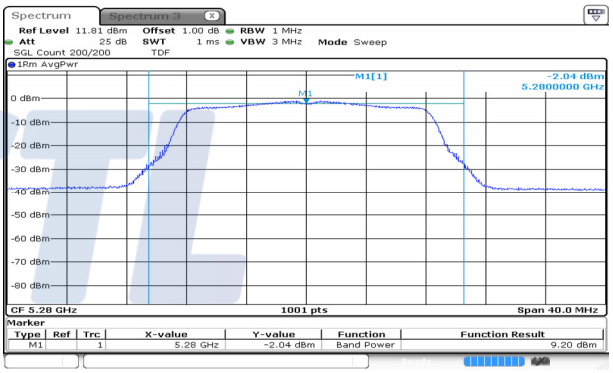
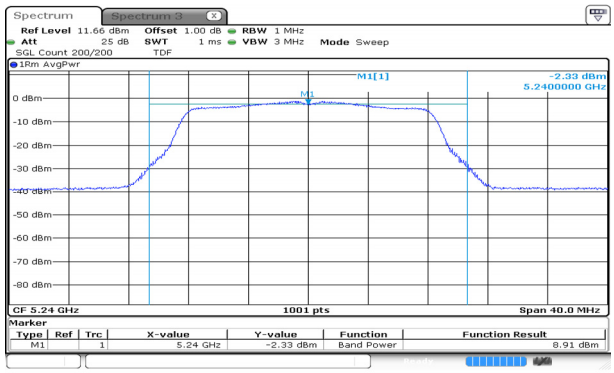
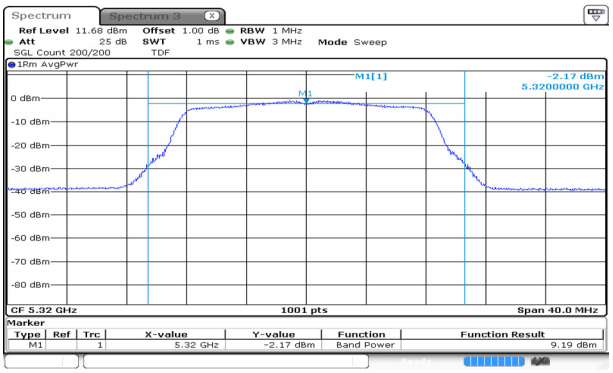
Section E.3.b)
Method PM-G (Measurement using a gated RF average power meter):
Measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

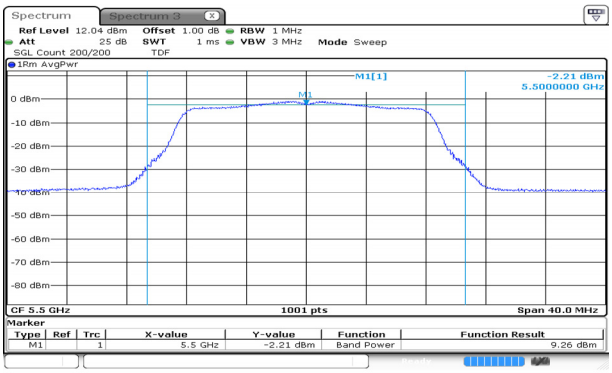
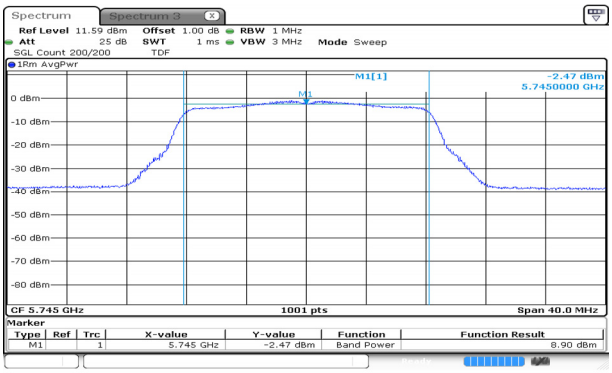
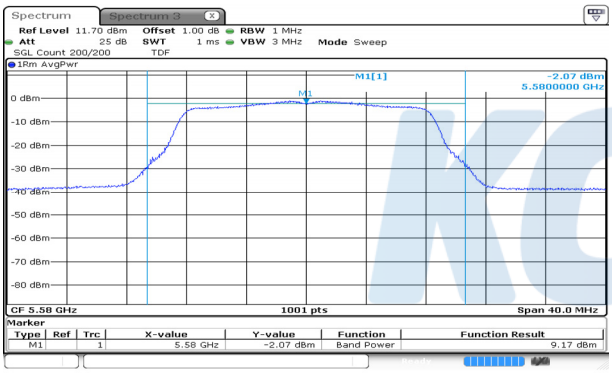
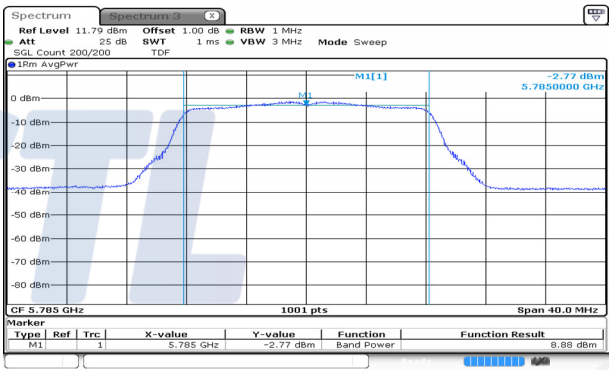
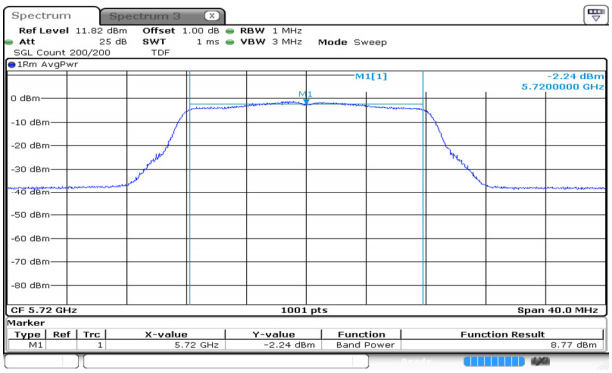
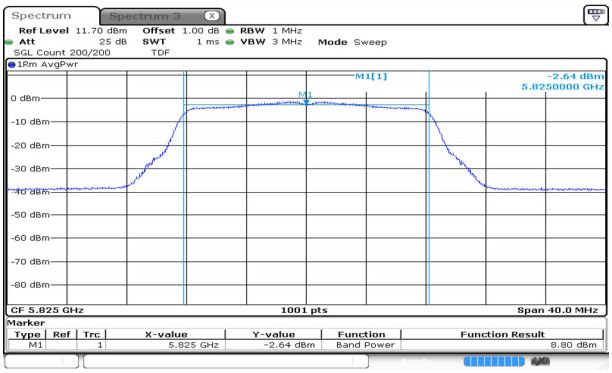
Test results

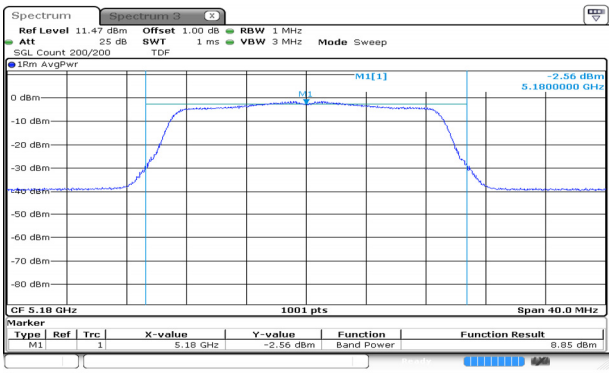
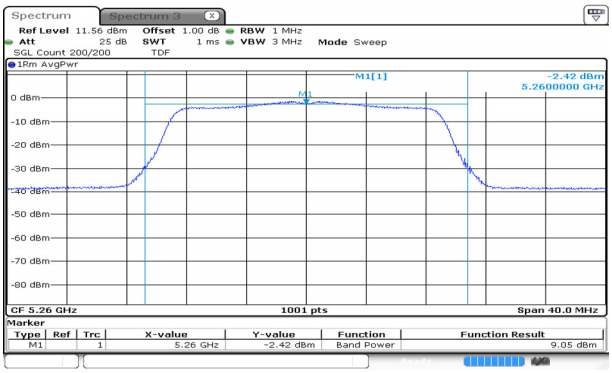
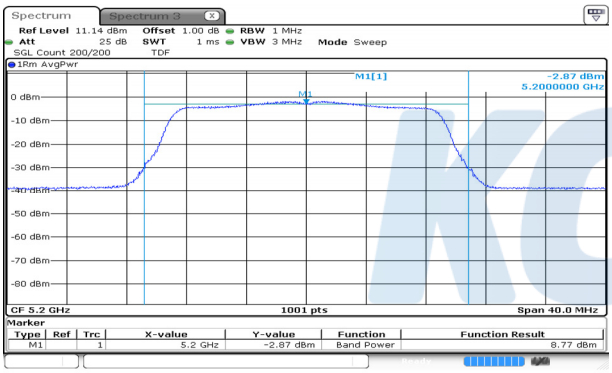
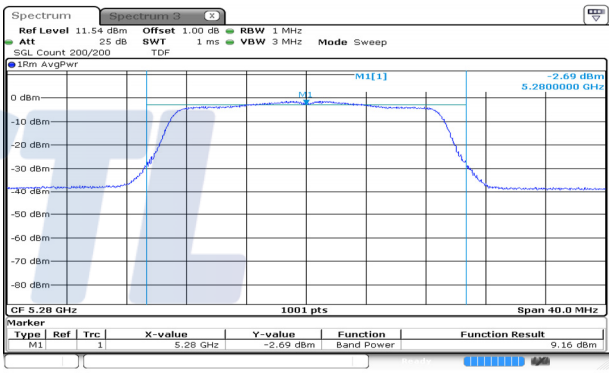
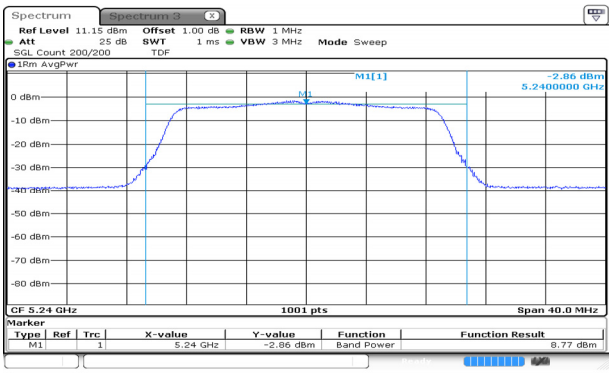
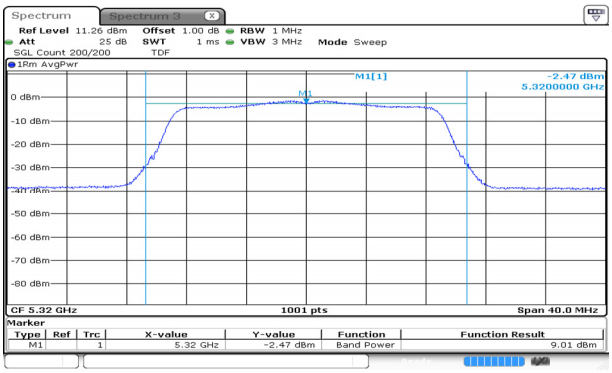
Test mode	Band	Freq (㎒)	Measured power (dBm)	DCCF (dB)	Conducted output power (dBm)	Conducted Power Limit (dBm)
802.11a	UNII-1	5180	8.86	0.30	9.16	23.98
		5200	8.81	0.30	9.11	
		5240	8.91	0.30	9.21	
	UNII-2A	5260	9.08	0.30	9.38	23.98
		5280	9.20	0.30	9.50	
		5320	9.19	0.30	9.49	
	UNII-2C	5500	9.26	0.30	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	

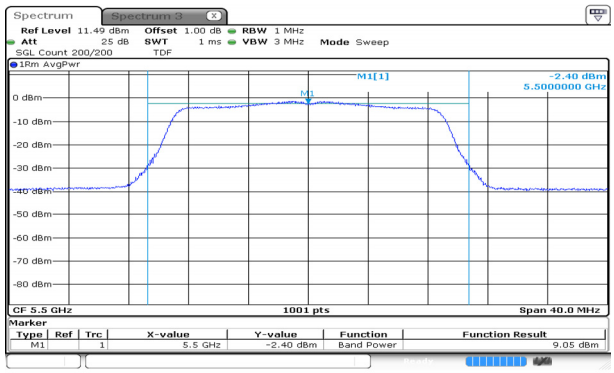
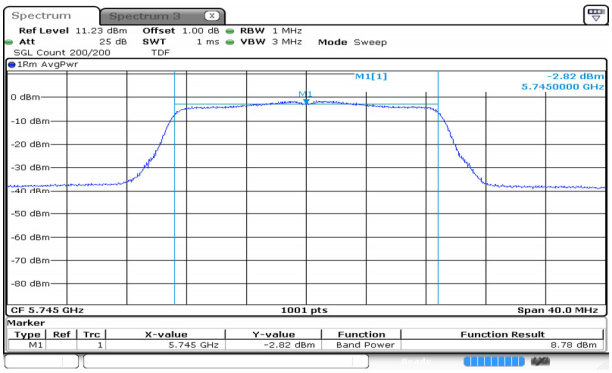
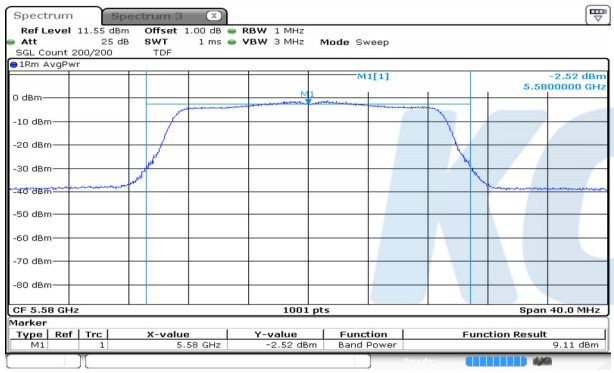
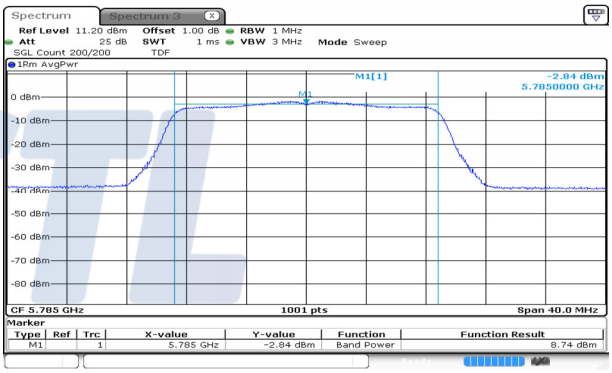
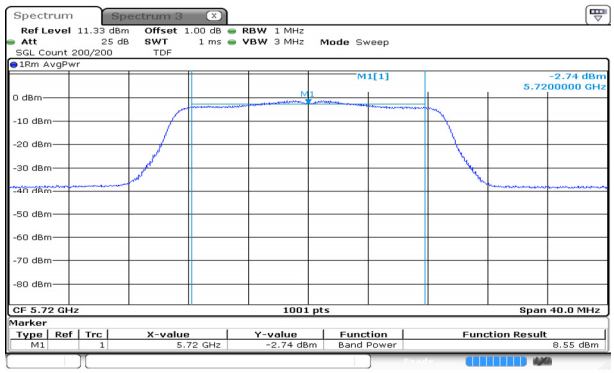
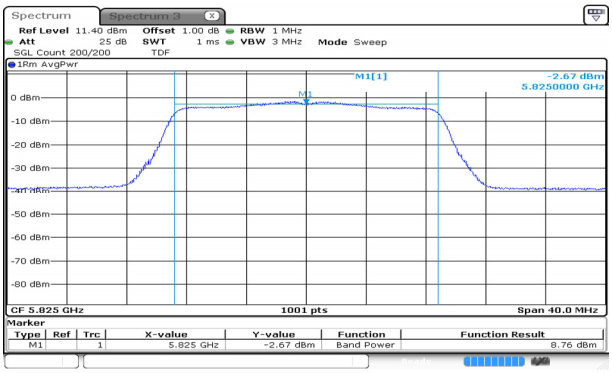
Test mode	Band	Freq (㎒)	Measured power (dBm)	DCCF (dB)	Conducted output power (dBm)	Conducted Power Limit (dBm)
802.11ac VHT20	UNII-1	5180	8.72	0.31	9.03	23.98
		5200	8.73	0.31	9.04	
		5240	8.73	0.31	9.04	
	UNII-2A	5260	8.94	0.31	9.25	23.98
		5280	9.17	0.31	9.48	
		5320	8.99	0.31	9.30	
	UNII-2C	5500	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

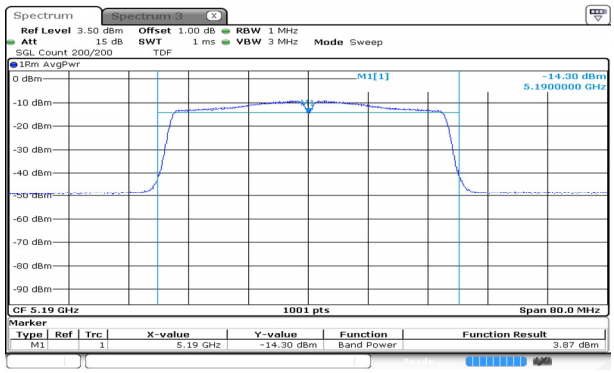
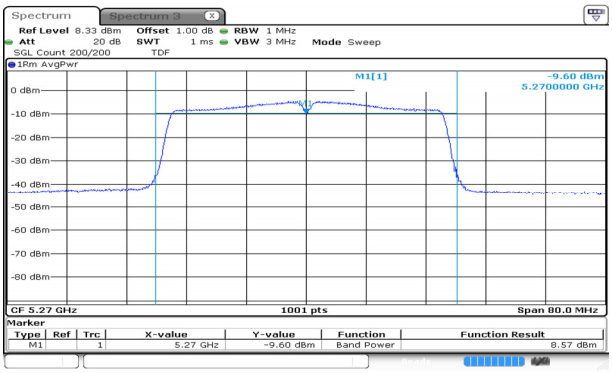
Note:
1. Conducted Output power Calculation:
Conducted Output power = Measured power(㏈ ㎷) + DCCF (㏈)

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.**
	

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.**
	

UNII-1 / 802.11n HT20 / Low ch.	UNII-2A / 802.11n HT20 / Low ch.
	
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.**
	

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.**
	

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.**