TEST REPORT

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Report No.: KR20-SRF0049

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 C, 15.247

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.

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., 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	Frequency (㎒)
WLAN 2.4 ㎓	OFDM	802.11g	2 412
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

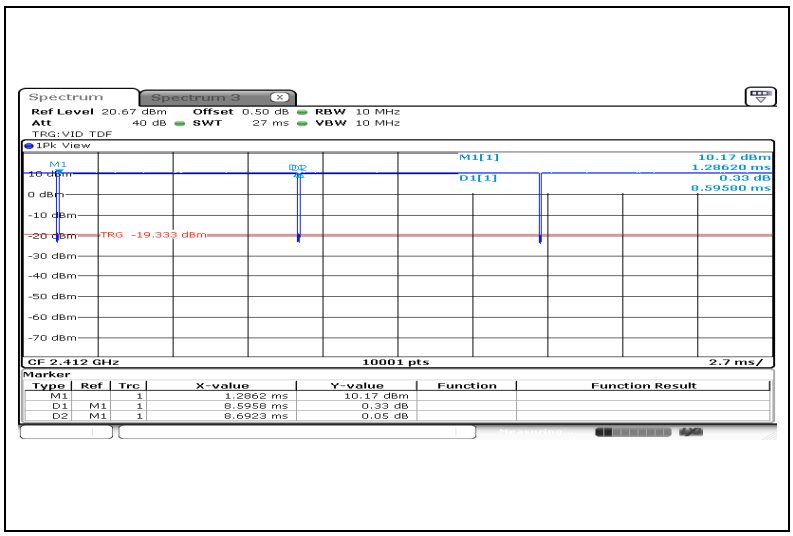
This device contains the following capabilities:
WIFI(2.4㎓ band 802.11b/g/n(HT20), 5㎓ band 802.11a/n(HT20/HT40)/ac(VHT/20/40/80)), Bluetooth(BDR/EDR)

Ch.	Frequency (㎒)
01	2 412
.	.
.	.
06	2 437
.	.
.	.
11	2 462

Table 2.3.1. 802.11b/g/n HT20 mode

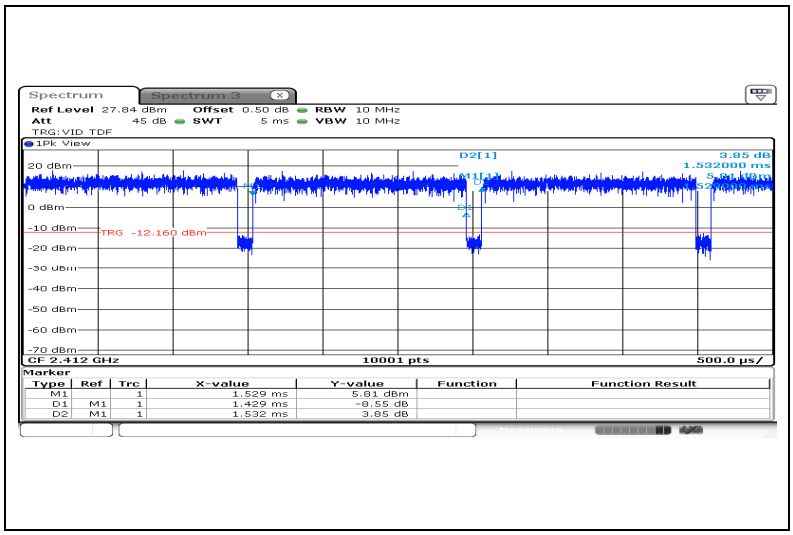
2.4. Duty Cycle Correction Factor

- 802.11b



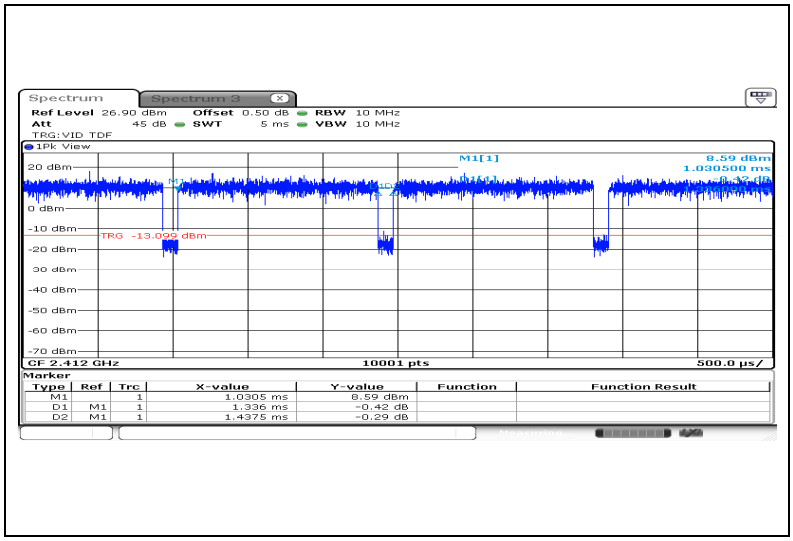
Note1) : Period : 8.692 3 ms, On time : 8.595 8 ms
Note2) : DCCF = 10log(1/x) = 10log(1/0.99) = 0.05, x = 8.595 8/8.692 3 = 0.99
Note3) : 802.11 b is a continuous transmission (duty cycle ≥ 98%)

- 802.11g



Note1) : Period : 1.532 ms, On time : 1.429 ms
Note2) : DCCF = 10log(1/x) = 10log(1/0.93) = 0.30 dB, x = 1.429/1.532 = 0.93
Note3) : 802.11 g 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 = 1.34/1.44 = 0.93
Note3) : 802.11n HT20 is a non-continuous transmission (duty cycle < 98%)

3. Antenna requirement

Requirement of FCC part section 15.203:
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, §15.247.

4. Summary of tests

FCC Part section(s)	Parameter	Test results
15.247(b)(3)	Maximum Peak Output Power	Pass
15.247(e)	Peak Power Spectral Density	Pass
15.247(a)(2)	6 dB Channel Bandwidth	Pass
-	Occupied Bandwidth	
15.247(d), 15.205(a), 15.209(a)	Spurious emission	Pass
	Band-edge, restricted band	Pass
15.207(a)	Conducted Emissions	N/A(Note2)

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. The test procedure(s) in this report were performed in accordance as following.
   - ANSI C63.10-2013
   - KDB 558074 D01 V05r02
6. The worst-case data rate were:
   802.11b mode : 1Mbps
   802.11g mode : 6Mbps
   802.11n HT20 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.

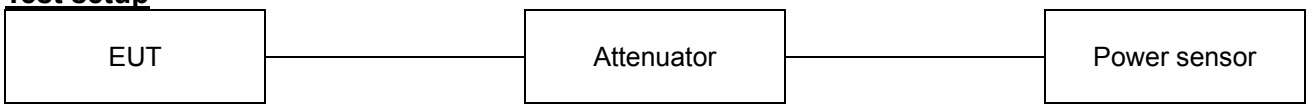
Frequency (㎒)	Factor(㏈)	Frequency (㎒)	Factor(㏈)
30	10.06	9 000	12.22
50	10.15	10 000	12.18
100	10.24	11 000	12.31
200	10.40	12 000	12.24
300	10.55	13 000	12.31
400	10.65	14 000	12.38
500	10.76	15 000	12.22
600	10.83	16000	12.37
700	10.98	17000	12.37
800	11.06	18000	12.28
900	11.23	19000	12.13
1 000	11.09	20000	12.37
2 000	12.51	21000	12.16
3 000	12.44	22000	11.28
4 000	12.27	23000	12.77
5 000	12.22	24000	14.52
6 000	12.16	25000	14.46
7 000	12.29	26000	13.05
8 000	12.24	26500	12.77

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

7. Test results

7.1. Maximum peak output power

Test setup



Limit

According to §15.247(b)(3), For systems using digital modulation in the 902-928 ㎒, 2 400-2 483.5 ㎒, and 5 725-5 850 ㎒ bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

According to §15.247(b)(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 ㏈i. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 ㏈i are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

Test procedure

ANSI C63.10-2013 - Section 11.9

Test settings

General

Section 15.247 permits the maximum conducted (average) output power to be measured as an alternative to the maximum peak conducted output power for demonstrating compliance to the limit. When this option is exercised, the measured power is to be referenced to the OBW rather than the DTS bandwidth (see ANSI C63.10 for measurement guidance).

When using a spectrum analyzer or EMI receiver to perform these measurements, it shall be capable of utilizing a number of measurement points in each sweep that is greater than or equal to twice the span/RBW to set a bin-to-bin spacing of ≤ RBW/2 so that narrowband signals are not lost between frequency bins.

If possible, configure or modify the operation of the EUT so that it transmits continuously at its maximum power control level. The intent is to test at 100 % duty cycle; however a small reduction in duty cycle (to no lower than 98 %) is permitted, if required by the EUT for amplitude control purposes. Manufacturers are expected to provide software to the test lab to permit such continuous operation.

If continuous transmission (or at least 98 % duty cycle) cannot be achieved due to hardware limitations (e.g., overheating), the EUT shall be operated at its maximum power control level, with the transmit duration as long as possible, and the duty cycle as high as possible during which sweep triggering/signal gating techniques may be used to perform the measurement over the transmission duration.

11.9.1. Maximum peak conducted output power

One of the following procedures may be used to determine the maximum peak conducted output power of a DTS EUT.

11.9.1.1. RBW ≥ DTS bandwidth

The following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement:

a) Set the RBW ≥ DTS bandwidth.
b) Set VBW ≥ [3 × RBW].
c) Set span ≥ [3 × RBW].
d) Sweep time = auto couple.
e) Detector = peak.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use peak marker function to determine the peak amplitude level.

11.9.1.3. PKPM1 Peak power meter method

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall use a fast-responding diode detector.

11.9.2.3.1. Measurement using a power meter (PM)

Method AVGPM is a measurement using an RF average power meter, as follows:

a) As an alternative to spectrum analyzer or EMI receiver measurements, 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:
   1) The EUT is configured to transmit continuously, or to transmit with a constant duty cycle.
   2) At all times when the EUT is transmitting, it shall be transmitting at its maximum power control level.
   3) The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.

b) If the transmitter does not transmit continuously, measure the duty cycle, D, of the transmitter output signal as described in 11.6.

c) Measure the average power of the transmitter. This measurement is an average over both the ON and OFF periods of the transmitter.

d) Adjust the measurement in dBm by adding [10 log(1/D)], where D is the duty cycle

Notes:

A peak responding power sensor is used, where the power sensor system video bandwidth is greater than the occupied bandwidth of the EUT.

Test results

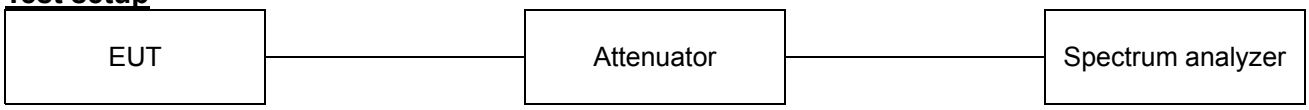
Test mode	Frequency(㎒)	Measured output power(dBm)		Limit(dBm)
		Peak	Average	
802.11b	2 412	9.96	6.32	30.00
	2 437	8.96	5.41	
	2 462	8.76	5.41	
802.11g	2 412	19.18	8.36	30.00
	2 437	18.18	7.36	
	2 462	18.18	7.17	
802.11n HT20	2 412	19.28	7.05	30.00
	2 437	18.28	6.15	
	2 462	18.28	6.18	

Note:

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

7.2. Peak Power Spectral Density

Test setup



Limit

According to §15.247(e), For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 ㎑ band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Test procedure

ANSI C63.10-2013 - Section 11.10.2

Test settings

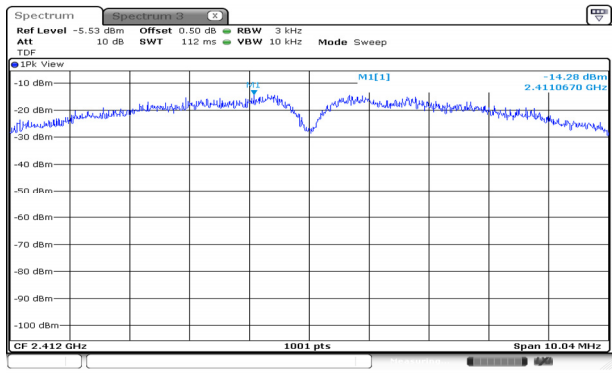
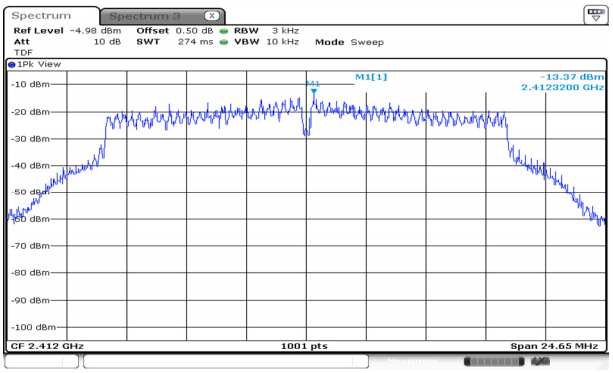
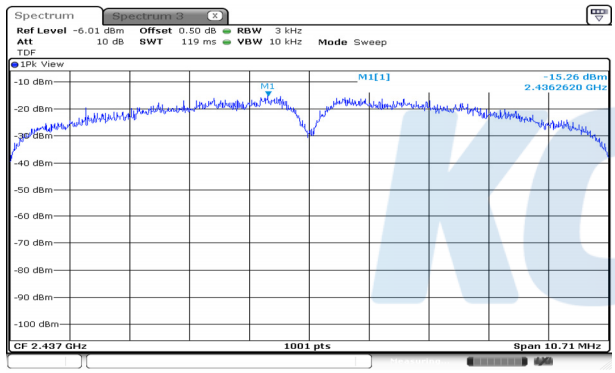
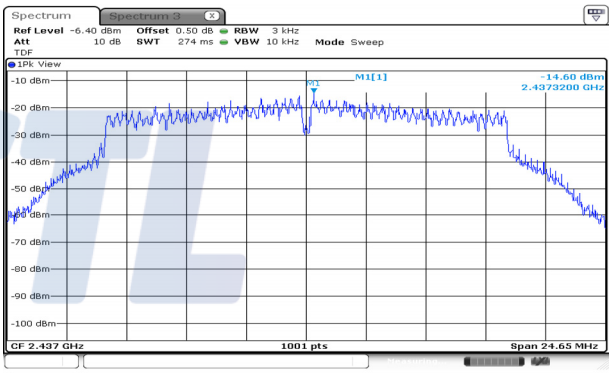
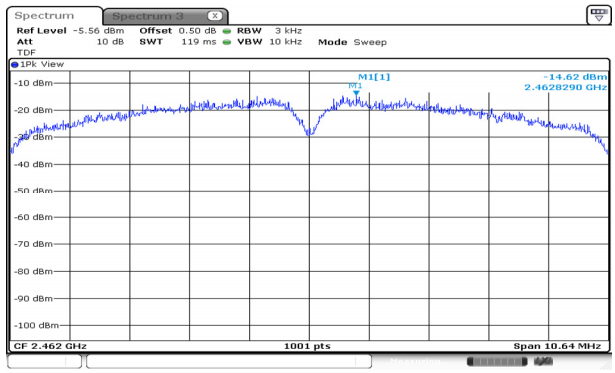
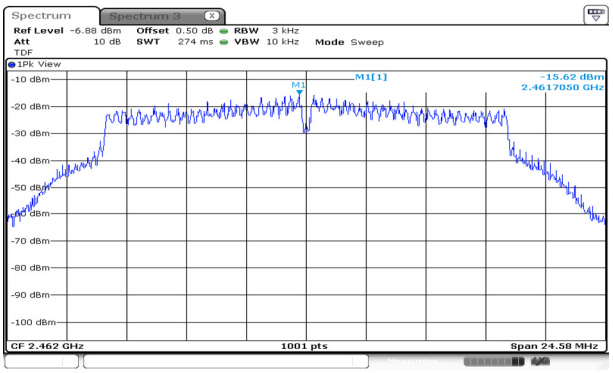
Method PKPSD (peak PSD)

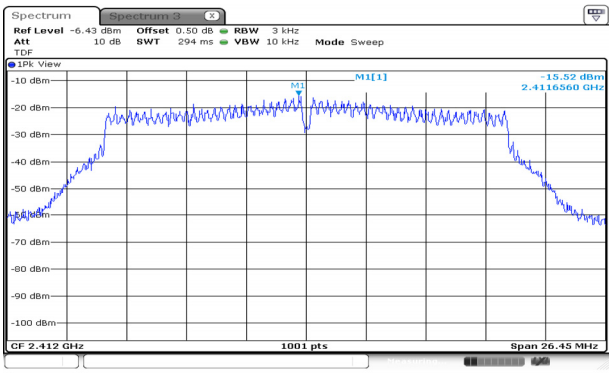
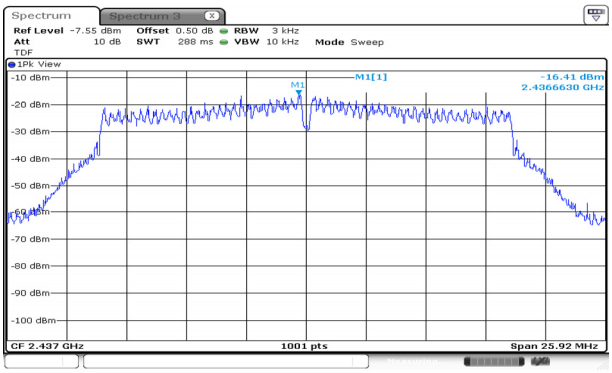
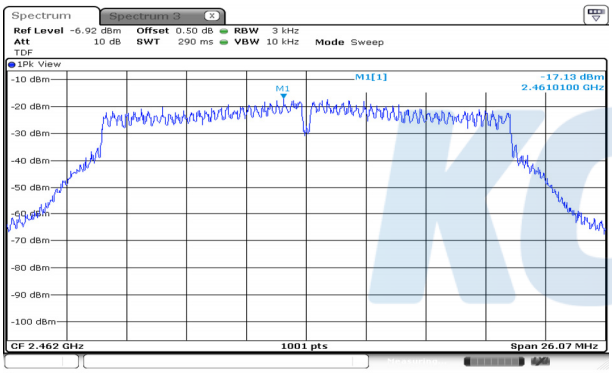
The following procedure shall be used if maximum peak conducted output power was used to determine compliance, and it is optional if the maximum conducted (average) output power was used to determine compliance:

1) Set analyzer center frequency to DTS channel center frequency.
2) Set the span to 1.5 times the DTS bandwidth.
3) Set the RBW to: 3 ㎑ ≤ RBW ≤ 100 ㎑.
4) Set the VBW ≥ 3 x RBW.
5) Detector = peak.
6) Sweep time = auto couple.
7) Trace mode = max hold.
8) Allow trace to fully stabilize.
9) Use the peak marker function to determine the maximum amplitude level within the RBW.
10) If measured value exceeds limit, reduce RBW (no less than 3 ㎑) and repeat.

Test results

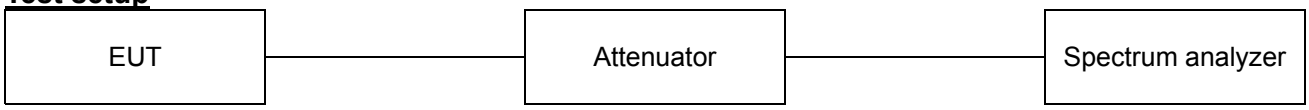
Test mode	Frequency(㎒)	Result(dBm) (RBW = 3 ㎑)	Limit(dBm / 3㎑)
802.11b	2 412	-14.28	8.00
	2 437	-15.26	
	2 462	-14.62	
802.11g	2 412	-13.37	
	2 437	-14.60	
	2 462	-15.62	
802.11n HT20	2 412	-15.52	
	2 437	-16.41	
	2 462	-17.13	

802.11b / Low ch.	802.11g / Low ch.
	
802.11b / Mid ch.	**802.11g / Mid ch.**
	
802.11b / High ch.	**802.11g / High ch.**
	

802.11n HT20 / Low ch.	802.11n HT20 / Mid ch.
	
802.11n HT20 / High ch.	
	Blank

7.3. 6 dB Bandwidth(DTS Channel Bandwidth) & 99 % bandwidth

Test setup



Limit

According to §15.247(a)(2), For Systems using digital modulation techniques may operate in the 902–928 ㎒, 2 400–2 483.5 ㎒, and 5 725–5 850 ㎒ bands. The minimum 6 ㏈ bandwidth shall be at least 500 ㎑.

Test procedure

ANSI C63.10-2013 - Section 11.8

Test settings

DTS bandwidth

One of the following procedures may be used to determine the modulated DTS bandwidth.

Option 1

1) Set RBW = 100 ㎑.
2) Set the video bandwidth (VBW) ≥ 3 x RBW.
3) Detector = Peak.
4) Trace mode = max hold.
5) Sweep = auto couple.
6) Allow the trace to stabilize.
7) 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 ㏈ relative to the maximum level measured in the fundamental emission.

Option 2

The automatic bandwidth measurement capability of an instrument may be employed using the X ㏈ bandwidth mode with X set to 6 ㏈, if the functionality described in 11.8.1 (i.e., RBW = 100 ㎑, VBW ≥ 3 × RBW, and peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥6 ㏈.

Test results

Test mode	Frequency(㎒)	6 dB bandwidth(㎒)	99 % bandwidth(㎒)
802.11b	2 412	6.69	10.14
	2 437	7.14	10.14
	2 462	7.09	10.09
802.11g	2 412	16.43	16.43
	2 437	16.43	16.38
	2 462	16.38	16.38
802.11n HT20	2 412	17.63	17.63
	2 437	17.28	17.58
	2 462	17.38	17.63