

# TEST REPORT

of

FCC Part 15 Subpart C §15.247

FCC ID: TQ8-AVB40F2AN

Equipment Under Test : DISPLAY CAR SYSTEM

Model Name : AVB40F2AN

Applicant : Hyundai MOBIS Co., Ltd.

Manufacturer : Hyundai MOBIS Co., Ltd.

Date of Test(s) : 2015.04.10 ~ 2015.04.19

Date of Issue : 2015.04.20

In the configuration tested, the EUT complied with the standards specified above.

Tested By:



Date:

2015.04.20

Jaeha Chung

Approved By:



Date:

2015.04.20

Hyunchae You

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## 1. General Information

### 1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)

- Wireless Div. 2FL, 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 435-837

All SGS services are rendered in accordance with the applicable SGS conditions of service available on request and accessible at <http://www.sgs.com/en/Terms-and-Conditions.aspx>.

Telephone : +82 31 688 0901

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### 1.2. Details of Applicant

Applicant : Hyundai MOBIS Co., Ltd.  
Address : 203, Teheran-ro, Gangnam-gu, Seoul, 135-977, Korea  
Contact Person : Choi, Seung-Hoon  
Phone No. : + 82 31 260 0098

### 1.3. Description of EUT

Kind of Product	DISPLAY CAR SYSTEM
Model Name	AVB40F2AN
Power Supply	DC 14.4 V (Vehicle Battery)
Frequency Range	2 402 MHz ~ 2 480 MHz (BT), 2 412 MHz ~ 2 462 MHz (11b/g/n_HT20), 5 745 MHz ~ 5 825 MHz (Band 3: 11a/n_HT20, 11ac_VHT20), 5 755 MHz ~ 5 795 MHz (Band 3: 11n_HT40, 11ac_VHT40), 5 775 MHz (Band 3: 11ac_VHT80), 5 180 MHz ~ 5 240 MHz (Band 1: 11a/n_HT20, 11ac_VHT20), 5 190 MHz ~ 5 230 MHz (Band 1: 11n_HT40, 11ac_VHT40), 5 210 MHz (Band 1: 11ac_VHT80), 5 260 MHz ~ 5 320 MHz (Band 2A: 11a/n_HT20, 11ac_VHT20), 5 270 MHz ~ 5 310 MHz (Band 2A: 11n_HT40, 11ac_VHT40), 5 290 MHz (Band 2A: 11ac_VHT80), 5 500 MHz ~ 5 700 MHz (Band 2C: 11a/n_HT20, 11ac_VHT20), 5 510 MHz ~ 5 670 MHz (Band 2C: 11n_HT40, 11ac_VHT40), 5 530 MHz (Band 2C: 11ac_VHT80)
Modulation Technique	DSSS, OFDM, GFSK, π/4DQPSK, 8DPSK
Number of Channels	79 channel (BT), 11 channel (11b/g/n_HT20), 5 channel (Band 3: 11a/n_HT20, 11ac_VHT20), 2 channel (Band 3: 11n_HT40, 11ac_VHT40), 1 channel (Band 3: 11ac_VHT80), 4 channel (Band 1: 11a/n_HT20, 11ac_VHT20), 2 channel (Band 1: 11n_HT40, 11ac_VHT40), 1 channel (Band 1: 11ac_VHT80), 4 channel (Band 2A: 11a/n_HT20, 11ac_VHT20), 2 channel (Band 2A: 11n_HT40, 11ac_VHT40), 1 channel (Band 2A: 11ac_VHT80), 8 channel (Band 2C: 11a/n_HT20, 11ac_VHT20), 3 channel (Band 2C: 11n_HT40, 11ac_VHT40), 1 channel (Band 2C: 11ac_VHT80)
Operation Temperature	-20 °C ~ 70 °C
Antenna Type	Internal type (SISO)
Antenna Gain	2 402 MHz ~ 2 480 MHz: 2.29 dB i, 2 412 MHz ~ 2 462 MHz: 4.67 dB i, 5 180 MHz ~ 5 320 MHz: 2.89 dB i, 5 500 MHz ~ 5 700 MHz: 2.51 dB i, 5 745 MHz ~ 5 825 MHz: 5.78 dB i

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## 1.4. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal Date	Cal Interval	Cal Due.
Signal Generator	R&S	SMBV100A	255834	Jun. 25, 2014	Annual	Jun. 25, 2015
Signal Generator	R&S	SMR40	100272	Jul. 18, 2014	Annual	Jul. 18, 2015
Spectrum Analyzer	Agilent	N9030A	US53120526	Jul. 17, 2014	Annual	Jul. 17, 2015
Spectrum Analyzer	R&S	FSW43	100637	Jul. 24, 2014	Annual	Jul. 24, 2015
Attenuator	MCLI	FAS-23-20	25574	Jul. 01, 2014	Annual	Jul. 01, 2015
High Pass Filter	Wainwright	WHK3.0/18G-10SS	344	Jun. 10, 2014	Annual	Jun. 10, 2015
High Pass Filter	Wainwright	WHNX7.5/26.5G-6SS	15	Jul. 02, 2014	Annual	Jul. 02, 2015
Low Pass Filter	Mini circuits	NLP-1200+	V 8979400903-2	Mar. 12, 2015	Annual	Mar. 12, 2016
Power Sensor	R&S	NRP-Z81	100669	Mar. 12, 2015	Annual	Mar. 12, 2016
DC Power Supply	Agilent	U8002A	MY50060028	Mar. 23, 2015	Annual	Mar. 23, 2016
Preamplifier	H.P.	8447D	2727A05143	Aug. 13, 2014	Annual	Aug. 13, 2015
Preamplifier	R&S	SCU-18	10070	Apr. 02, 2015	Annual	Apr. 02, 2016
Preamplifier	MITEQ Inc.	JS44-18004000-35-8P	1546891	Apr. 28, 2014	Annual	Apr. 28, 2015
Test Receiver	R&S	ESU8	100128	Feb. 05, 2015	Annual	Feb. 05, 2016
Bilog Antenna	TESEQ	CBL6112D	25232	Oct. 24, 2013	Biennial	Oct. 24, 2015
Loop Antenna	SCHWARZBECK MESSELEKTRONIK	FMZB 1519	1519-039	Jul. 09, 2013	Biennial	Jul. 09, 2015
Horn Antenna	R&S	HF906	100564	Dec. 11, 2013	Biennial	Dec. 11, 2015
Horn Antenna	SCHWARZBECK MESSELEKTRONIK	BBHA 9170	BBHA9170431	May 15, 2014	Biennial	May 15, 2016
Antenna Master	INN-CO	MM4000	N/A	N.C.R.	N/A	N.C.R.
Turn Table	INN-CO	DS 1200S	N/A	N.C.R.	N/A	N.C.R.
Anechoic Chamber	SY Corporation	L x W x H (9.6 m x 6.4 m x 6.6 m)	N/A	N.C.R.	N/A	N.C.R.

### ► Support equipment

Description	Manufacturer	Model	Serial Number
N/A	-	-	-

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**SGS Korea Co., Ltd. (Gunpo Laboratory)** 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 435-040 <http://www.sgsgroup.kr>

RTT5041-20(2014.01.20)(2) Tel. +82 31 428 5700 / Fax. +82 31 427 2370 A4(210 mm x 297 mm)

## 1.5. Declaration by the manufacturer

- WLAN & BT do not transmit simultaneously.

## 1.6. Summary of Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARD: FCC Part15 Subpart C §15.247		
Standard section	Test Item(s)	Result
15.205 15.209 15.247(d)	Transmitter Radiated Spurious Emissions Conducted Spurious Emission	Complied
15.247(a)(2)	6 dB Bandwidth	Complied
15.247(b)(3)	Maximum Conducted Output Power	Complied
15.247(e)	Power Spectral Density	Complied

## 1.7. Test Procedure(s)

The measurement procedures described in the American National Standard for Methods of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2003) and the guidance provided in KDB 558074\_v03r02 were used in the measurement of the DUT.

## 1.8. Sample calculation

Where relevant, the following sample calculation is provided:

### 1.8.1. Conducted test

Offset value (dB) = Attenuator (dB) + Cable loss (dB)

### 1.8.2. Radiation test

Field strength level (dB $\mu$ V/m) = Measured level (dB $\mu$ V) + Antenna factor (dB) + Cable loss (dB) - amplifier gain(dB)

## 1.9. Test report revision

Revision	Report number	Date of Issue	Description
0	F690501/RF-RTL008620	2015.04.20	Initial

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Tel. +82 31 428 5700 / Fax. +82 31 427 2370

A4(210 mm x 297 mm)

## 1.10. Duty Cycle of EUT

Regarding to KDB558074 v03r02, 6.0, the maximum duty cycles of all modes were investigated and set the spectrum analyzer as below

Set RBW  $\geq$  OBW if possible; otherwise, set RBW to the largest available value, Set VBW  $\geq$  RBW. Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are  $> 50/T$  and the number of sweep points across duration T exceeds 100.

Mode	Data Rate (Mbps)							
	1	2	5.5	11				
11b	1	2	5.5	11				
Duty Cycle (%)	99	98	94	90	-	-	-	-
Correction factor (dB)	0.04	0.09	0.27	0.46	-	-	-	-
11g	6	9	12	18	24	36	48	54
Duty Cycle (%)	93	89	86	82	77	69	63	61
Correction factor (dB)	0.32	0.51	0.66	0.86	1.14	1.61	2.01	2.15
11n_HT20	MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
Duty Cycle (%)	92	86	81	77	69	63	61	59
Correction factor (dB)	0.36	0.66	0.92	1.14	1.61	2.01	2.15	2.29

Remark:

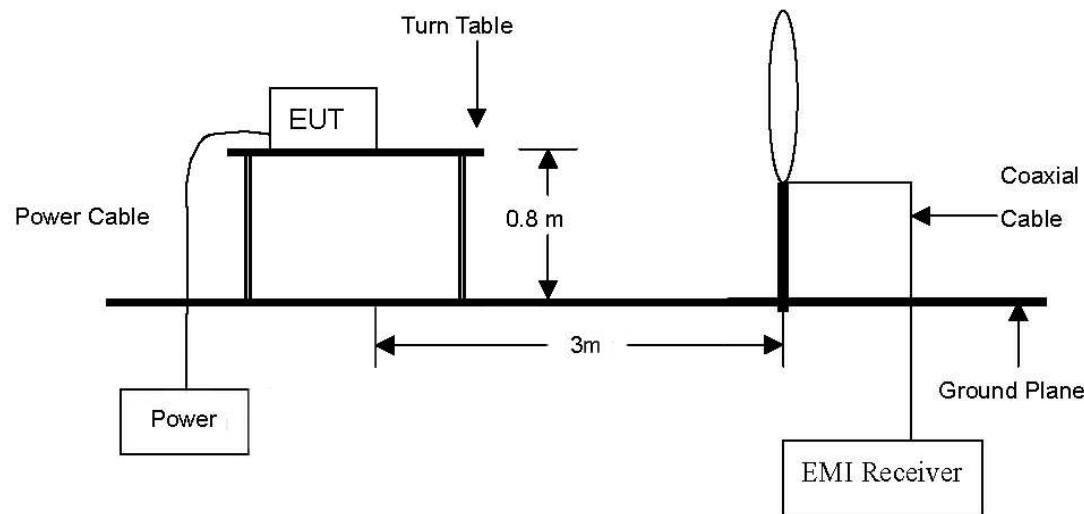
1. As measured duty cycles of EUT, all of mode and data rate keep constant period and are converted to log scale (power averaging) to compensate correction factor to result of average test items.
2. Duty cycle (%) = (Tx on time / Tx on + off time) x 100
3. Correction factor (dB) = 10 log (1 / duty cycle)

## 2. Transmitter Radiated Spurious Emissions and Conducted Spurious Emission

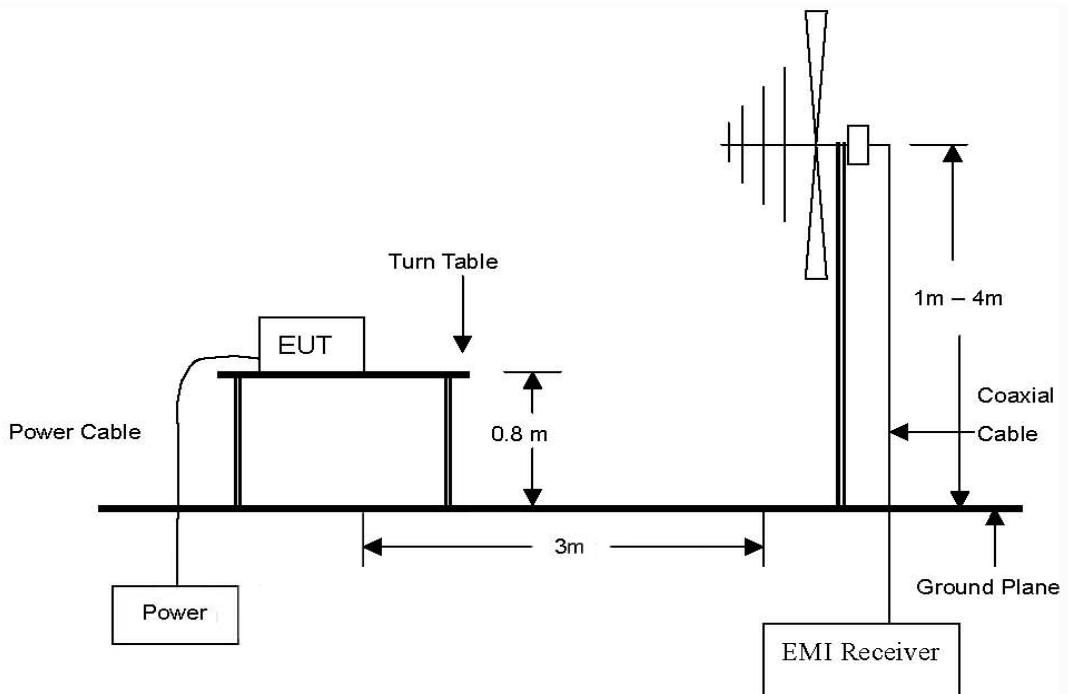
### 2.1. Test Setup

#### 2.1.1. Transmitter Radiated Spurious Emissions

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

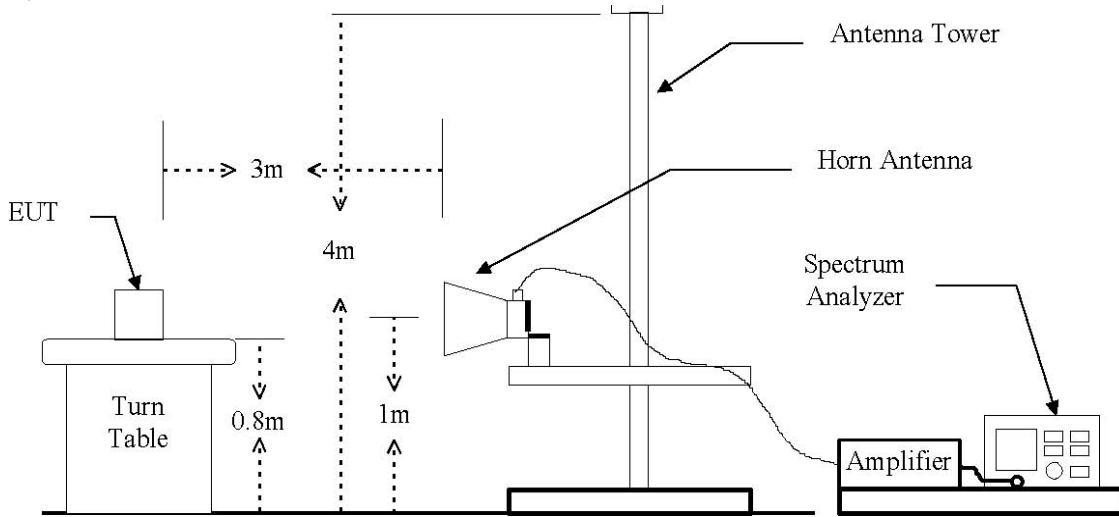


The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz Emissions.



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The diagram below shows the test setup that is utilized to make the measurements for emission. The spurious emissions were investigated from 1 GHz to the 10th harmonic of the highest fundamental frequency or 40 GHz, whichever is lower.



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### 2.1.2. Conducted Spurious Emission



### 2.2. Limit

According to §15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement , provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval , as permitted under paragraph(b)(3) of this section , the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in section §15.209(a) is not required. In addition, radiated emission which in the restricted band, as define in section §15.205(a), must also comply the radiated emission limits specified in section §15.209(a) (see section §15.205(c))

According to § 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)	Distance (Meters)	Field Strength (dB $\mu$ N/m)	Field Strength ( $\mu$ N/m)
0.009 – 0.490	300	20 log (2 400/F(kHz))	2 400/F(kHz)
0.490 – 1.705	30	20 log (24 000/F(kHz))	24 000/F(kHz)
1.705 – 30.0	30	29.54	30
30 - 88	3	40.0	100
88 – 216	3	43.5	150
216 – 960	3	46.0	200
Above 960	3	54.0	500

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## 2.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates in section 11.0 & 12.0 of KDB 558074\_v03r02 and ANSI C63.4-2003.

### 2.3.1. Test Procedures for emission below 30 MHz

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
3. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test-receiver system was set to average or quasi peak detect function and Specified Bandwidth with Maximum Hold Mode.

### 2.3.2. Test Procedures for emission from above 30 MHz

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1 GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 GHz, the EUT was set 3 meter away from the interference-receiving antenna.
3. The antenna is a bi-log antenna, a horn antenna and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. If the emission level of the EUT in peak mode was 10 dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

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## NOTE:

All data rates and modes were investigated for radiated spurious emissions. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

### 1. Unwanted Emissions into Non-Restricted Frequency Bands

- The Reference Level Measurement refer to section 11.2

Set analyzer center frequency to DTS channel center frequency, SPAN  $\geq$  1.5 times the DTS bandwidth, the RBW = 100 kHz and VBW  $\geq$  3 x RBW, Detector = Peak, Sweep time = Auto couple, Trace = Max hold.

- Unwanted Emissions Level Measurement refer to section 11.3

Set the center frequency and span to encompass frequency range to be measured, the RBW = 100 kHz and VBW  $\geq$  3 x RBW, Detector = Peak, Sweep time = Auto couple, Trace = Max hold.

### 2. Unwanted Emissions into Restricted Frequency Bands

- Peak Power measurement procedure refer to section 12.2.4

Set RBW = as specified in Table 1, VBW  $\geq$  3 x RBW, Detector = Peak, Sweep time = auto, Trace = Max hold.

**Table 1- RBW as a function of frequency**

Frequency	RBW
9 – 150 kHz	200 – 300 Hz
0.15 – 30 MHz	9 – 10 kHz
30 – 1 000 MHz	100 – 120 kHz
>1 000 MHz	1 MHz

-Average Power measurements procedure refer to section 12.2.5.2

The EUT shall be configured to operate at the maximum achievable duty cycle.

Measure the duty cycle, x, of the transmitter output signal as described in section 6.0.

Set RBW = 1 MHz, VBW  $\geq$  3 x RBW, Detector = RMS, if span / (# of points in sweep)  $\leq$  (RBW/2).

Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied then the detector mode shall be set to peak,

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

As an alternative the detector and averaging type may be set for linear voltage averaging.

Some instruments require linear display mode in order to use linear voltage averaging. Log or dB averaging shall not be used. Sweep time = auto, Perform a trace average of 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 percent duty cycle. The correction factor is computed as follows:

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

### 3. To get a maximum emission level from the EUT, the EUT is manipulated through three orthogonal planes.

Definition of DUT three orthogonal planes were described in the test setup photo.

Worst orthogonal plan of EUT is X – axis during radiation test.

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### 2.3.3. Test Procedures for Conducted Spurious Emissions

All data rates and modes were investigated for conducted spurious emissions. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.

Per the guidance of KDB 558074\_v03r02, section 11.1 & 11.2 & 11.3, the reference level for out of band emissions is established from the plots of this section since the band edge emissions are measured with a RBW of 100 kHz. This reference level is then used as the limit in subsequent plots for out of band spurious emissions shown in section 2.4.3. The limit for out of band spurious emission at the band edge is 20 dB below the fundamental emission level measured in a 100 kHz bandwidth.

#### 1. Reference level measurement

- The Measurement refer to section 11.2

Set instrument center frequency to DTS channel center frequency, set the span to  $\geq 1.5$  times the DTS bandwidth, the RBW = 100 kHz and VBW  $\geq 3 \times$  RBW, Detector = Peak, Sweep time = Auto couple, Trace = Max hold, The trace was allowed to stabilize.

#### 2. Conducted Emissions at Band Edge

- The Measurement refer to section 11.3

Set the center frequency and span to encompass frequency range to be measured, the RBW = 100 kHz and VBW  $\geq 3 \times$  RBW, Detector = Peak, Sweep time = Auto couple, Trace = Max hold, Ensure that the number of measurement points  $\geq$  span/RBW, The trace was allowed to stabilize.

#### 3. Conducted Spurious Emissions

- The Measurement refer to section 11.3

Start frequency was set to 30 MHz and stop frequency was set to 26.5 GHz (separated into two plots per channel), RBW = 100 kHz, VBW  $\geq 3 \times$  RBW, Detector = Peak, Sweep time = Auto couple, Trace = Max hold, The trace was allowed to stabilize.

#### 4. Correction function

- For plots showing conducted spurious emissions from 30 MHz to 26.5 GHz, all path loss of wide frequency range was investigated and compensated to spectrum analyzer as Correction function.  
So, the reading values shown in plots were final result.

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## 2.4. Test Results

Ambient temperature : (23 ± 1) °C

Relative humidity : 47 % R.H.

### 2.4.1. Radiated Spurious Emission

The frequency spectrum from 9 kHz to 1 000 MHz was investigated. All reading values are applied for peak values per frequency band.

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (MHz)	Reading (dB $\mu$ N)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dB $\mu$ N/m)	Limit (dB $\mu$ N/m)	Margin (dB)
106.92	45.84	Peak	V	11.89	-25.25	32.48	43.50	11.02
213.23	44.88	Peak	V	11.28	-24.39	31.77	43.50	11.73
266.87	49.43	Peak	V	14.60	-24.10	39.93	46.00	6.07
267.17	47.92	Peak	H	13.87	-24.10	37.69	46.00	8.31
333.32	40.44	Peak	H	14.95	-24.23	31.16	46.00	14.84
399.96	39.28	Peak	H	17.01	-24.50	31.79	46.00	14.21
466.60	39.04	Peak	V	18.38	-24.97	32.45	46.00	13.55
466.69	38.71	Peak	H	18.54	-24.97	32.28	46.00	13.72
Above 500.00	Not detected	-	-	-	-	-	-	-

Remark:

1. Spurious emissions for all channels and modes were investigated and almost the same below 1 GHz.
2. Reported spurious emissions are in **11n HT20 / MCS1 / Middle channel** as worst case among other modes.
3. Radiated spurious emission measurement as below  
(Actual = Reading + Antenna Factor + Amp + CL)

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## 2.4.2. Spurious Radiated Emission

The frequency spectrum above 1 000 MHz was investigated. All reading values are peak and average values.

### DSSS: 802.11b (1 Mbps)

Low Channel (2 412 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	FCC Limit	
Frequency (MHz)	Reading (dB $\mu$ N)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Duty (dB)	Actual (dB $\mu$ N/m)	Limit (dB $\mu$ N/m)	Margin (dB)
*2 310.00	22.99	Peak	V	28.07	5.72	-	56.78	74.00	17.22
*2 310.00	13.99	Average	V	28.07	5.72	0.04	47.82	54.00	6.18
*2 385.76	26.47	Peak	V	28.14	5.87	-	60.48	74.00	13.52
*2 385.76	16.37	Average	V	28.14	5.87	0.04	50.42	54.00	3.58
*2 390.00	25.09	Peak	V	28.15	5.88	-	59.12	74.00	14.88
*2 390.00	15.57	Average	V	28.15	5.88	0.04	49.64	54.00	4.36

Radiated Emissions			Ant.	Correction Factors			Total	FCC Limit	
Frequency (MHz)	Reading (dB $\mu$ N)	Detect Mode	Pol.	AF (dB/m)	AMP+ CL (dB)	Duty (dB)	Actual (dB $\mu$ N/m)	Limit (dB $\mu$ N/m)	Margin (dB)
*4 823.56	40.27	Peak	V	32.86	-35.46	-	37.67	74.00	36.33
*4 823.56	32.50	Average	V	32.86	-35.46	0.04	29.94	54.00	24.06
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

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## Middle Channel (2 437 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	FCC Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+ CL (dB)	Duty (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*4 874.38	40.68	Peak	V	33.04	-35.50	-	38.22	74.00	35.78
*4 874.38	33.25	Average	V	33.04	-35.50	0.04	30.83	54.00	23.17
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

## High Channel (2 462 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	FCC Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Duty (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*2 483.50	23.96	Peak	V	28.24	6.07	-	58.27	74.00	15.73
*2 483.50	15.57	Average	V	28.24	6.07	0.04	49.92	54.00	4.08
*2 491.67	26.06	Peak	V	28.25	6.08	-	60.39	74.00	13.61
*2 491.67	16.06	Average	V	28.25	6.08	0.04	50.43	54.00	3.57
*2 500.00	23.66	Peak	V	28.26	6.10	-	58.02	74.00	15.98
*2 500.00	14.27	Average	V	28.26	6.10	0.04	48.67	54.00	5.33

Radiated Emissions			Ant.	Correction Factors			Total	FCC Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+ CL (dB)	Duty (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*4 924.01	45.47	Peak	V	33.22	-35.54	-	43.15	74.00	30.85
*4 924.01	40.09	Average	V	33.22	-35.54	0.04	37.81	54.00	16.19
Above 5 000.00	Not detected	-	-	-	-	-	-	-	-

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**OFDM: 802.11g (6 Mbps)**

Low Channel (2 412 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	FCC Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Duty (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*2 310.00	24.18	Peak	V	28.07	5.72	-	57.97	74.00	16.03
*2 310.00	14.05	Average	V	28.07	5.72	0.32	48.16	54.00	5.84
*2 348.16	25.96	Peak	V	28.11	5.80	-	59.87	74.00	14.13
*2 348.16	15.85	Average	V	28.11	5.80	0.32	50.08	54.00	3.92
*2 390.00	24.66	Peak	V	28.15	5.88	-	58.69	74.00	15.31
*2 390.00	15.59	Average	V	28.15	5.88	0.32	49.94	54.00	4.06

Radiated Emissions			Ant.	Correction Factors			Total	FCC Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Duty (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*4 826.16	39.24	Peak	V	32.87	-35.46	-	36.65	74.00	37.35
*4 826.16	30.60	Average	V	32.87	-35.46	0.32	28.33	54.00	25.67
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

Middle Channel (2 437 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	FCC Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Duty (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*4 871.99	39.57	Peak	V	33.03	-35.49	-	37.11	74.00	36.89
*4 871.99	30.78	Average	V	33.03	-35.49	0.32	28.64	54.00	25.36
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

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## High Channel (2 462 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	FCC Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Duty (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*2 483.50	24.78	Peak	V	28.24	6.07	-	59.09	74.00	14.91
*2 483.50	14.93	Average	V	28.24	6.07	0.32	49.56	54.00	4.44
*2 485.66	26.99	Peak	V	28.25	6.07	-	61.31	74.00	12.69
*2 485.66	15.47	Average	V	28.25	6.07	0.32	50.11	54.00	3.89
*2 500.00	26.55	Peak	V	28.26	6.10	-	60.91	74.00	13.09
*2 500.00	14.67	Average	V	28.26	6.10	0.32	49.35	54.00	4.65

Radiated Emissions			Ant.	Correction Factors			Total	FCC Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Duty (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*4 922.07	42.03	Peak	V	33.21	-35.53	-	39.71	74.00	34.29
*4 922.07	32.06	Average	V	33.21	-35.53	0.32	30.06	54.00	23.94
Above 5 000.00	Not detected	-	-	-	-	-	-	-	-

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A4(210 mm x 297 mm)

**OFDM: 802.11n HT20 (MCS0)**

Low Channel (2 412 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	FCC Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Duty (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*2 310.00	23.84	Peak	V	28.07	5.72	-	57.63	74.00	16.37
*2 310.00	14.09	Average	V	28.07	5.72	0.36	48.24	54.00	5.76
*2 389.92	28.72	Peak	V	28.15	5.88	-	62.75	74.00	11.25
*2 389.92	16.28	Average	V	28.15	5.88	0.36	50.67	54.00	3.33
*2 390.00	28.33	Peak	V	28.15	5.88	-	62.36	74.00	11.64
*2 390.00	15.99	Average	V	28.15	5.88	0.36	50.38	54.00	3.62

Radiated Emissions			Ant.	Correction Factors			Total	FCC Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Duty (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*4 822.73	40.54	Peak	V	32.86	-35.46	-	37.94	74.00	36.06
*4 822.73	30.55	Average	V	32.86	-35.46	0.36	28.31	54.00	25.69
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

Middle Channel (2 437 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	FCC Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Duty (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*4 872.09	40.85	Peak	V	33.03	-35.49	-	38.39	74.00	35.61
*4 872.09	30.62	Average	V	33.03	-35.49	0.36	28.52	54.00	25.48
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

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A4(210 mm x 297 mm)

## High Channel (2 462 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	FCC Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Duty (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*2 483.50	25.69	Peak	V	28.24	6.07	-	60.00	74.00	14.00
*2 483.50	15.59	Average	V	28.24	6.07	0.36	50.26	54.00	3.74
*2 484.03	26.74	Peak	V	28.24	6.07	-	61.05	74.00	12.95
*2 484.03	15.86	Average	V	28.24	6.07	0.36	50.53	54.00	3.47
*2 500.00	24.72	Peak	V	28.26	6.10	-	59.08	74.00	14.92
*2 500.00	14.99	Average	V	28.26	6.10	0.36	49.71	54.00	4.29

Radiated Emissions			Ant.	Correction Factors			Total	FCC Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Duty (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*4 924.78	42.26	Peak	V	33.22	-35.54	-	39.94	74.00	34.06
*4 924.78	32.51	Average	V	33.22	-35.54	0.36	30.55	54.00	23.45
Above 5 000.00	Not detected	-	-	-	-	-	-	-	-

## Remarks:

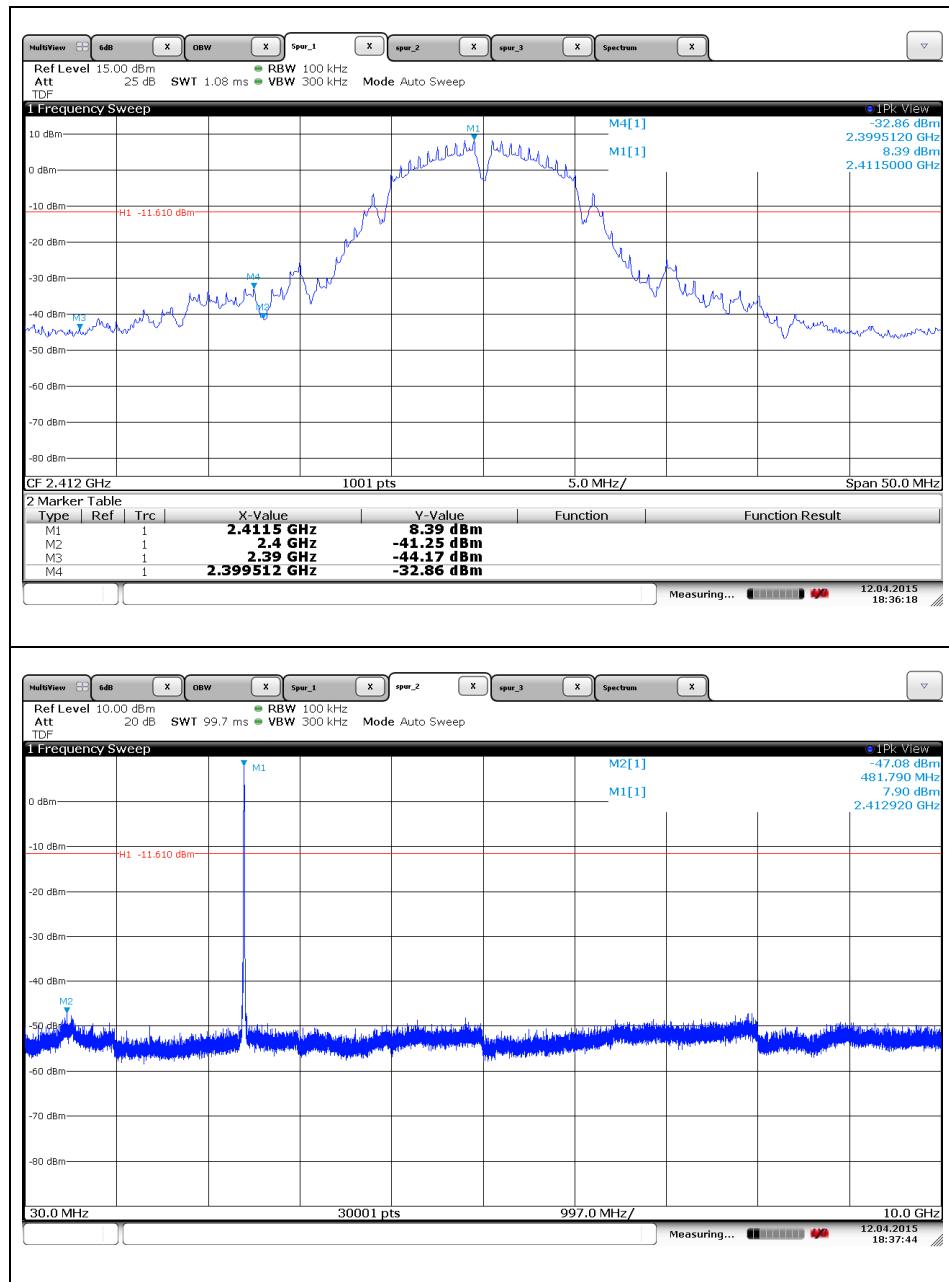
- “\*” means the restricted band.
- Measuring frequencies from 1 GHz to the 10<sup>th</sup> harmonic of highest fundamental frequency.
- Radiated emissions measured in frequency above 1 000 MHz were made with an instrument using peak/average detector mode.
- Actual = Reading + AF + AMP + CL

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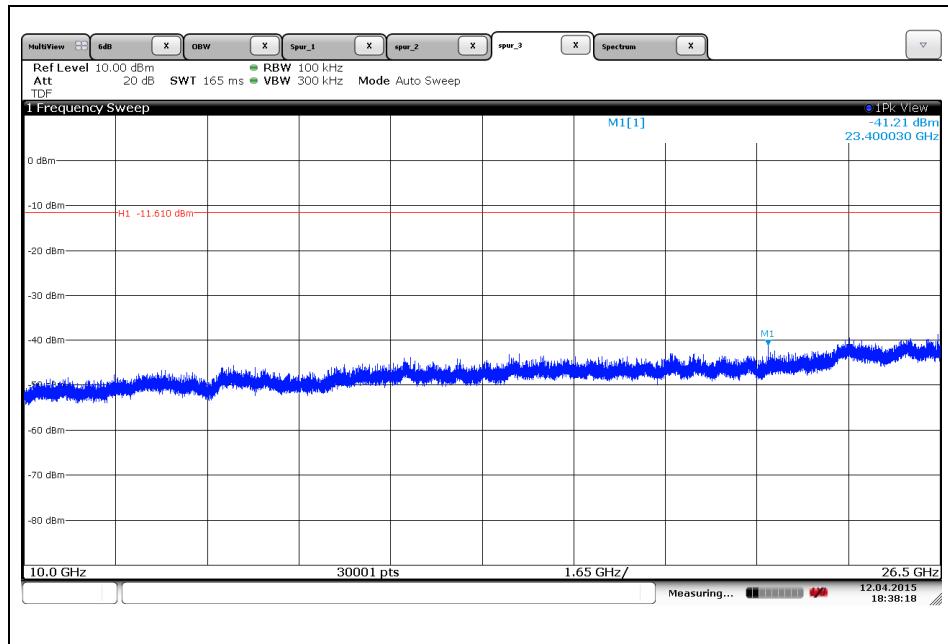
### 2.4.3. Spurious RF Conducted Emissions: Plot of Spurious RF Conducted Emission

#### DSSS: 802.11b (1 Mbps)

Low Channel



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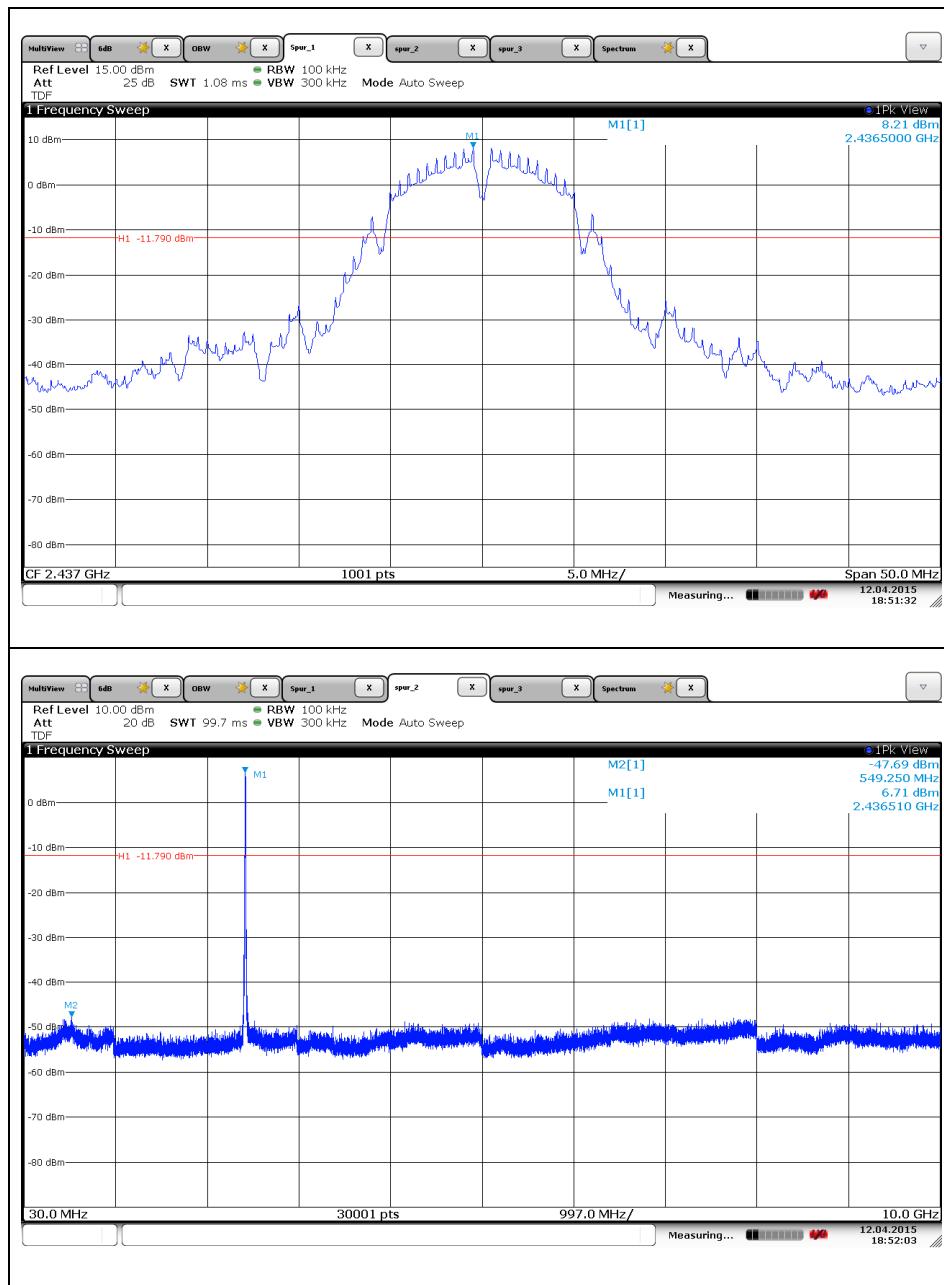
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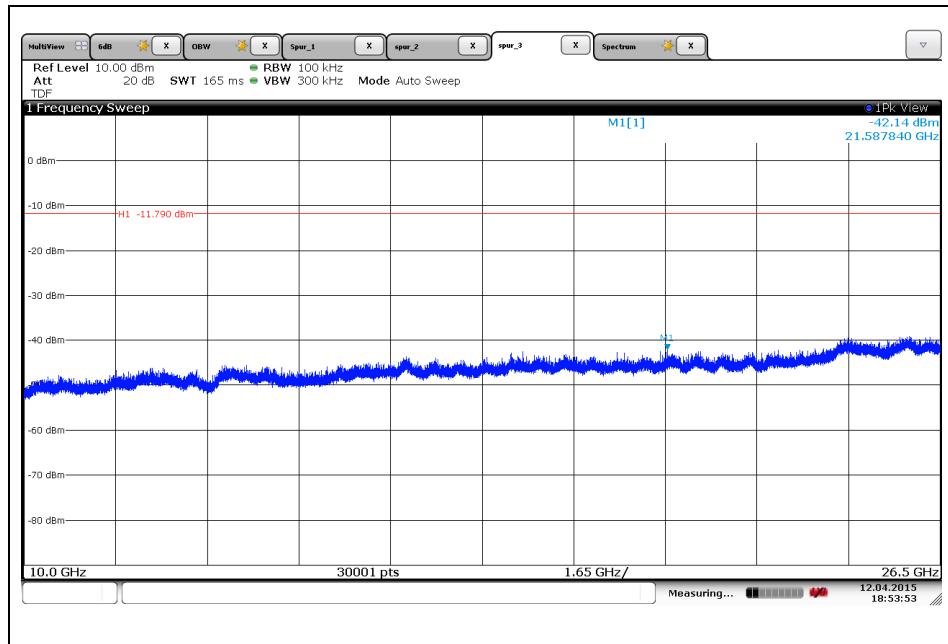
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A4(210 mm x 297 mm)

## Middle Channel



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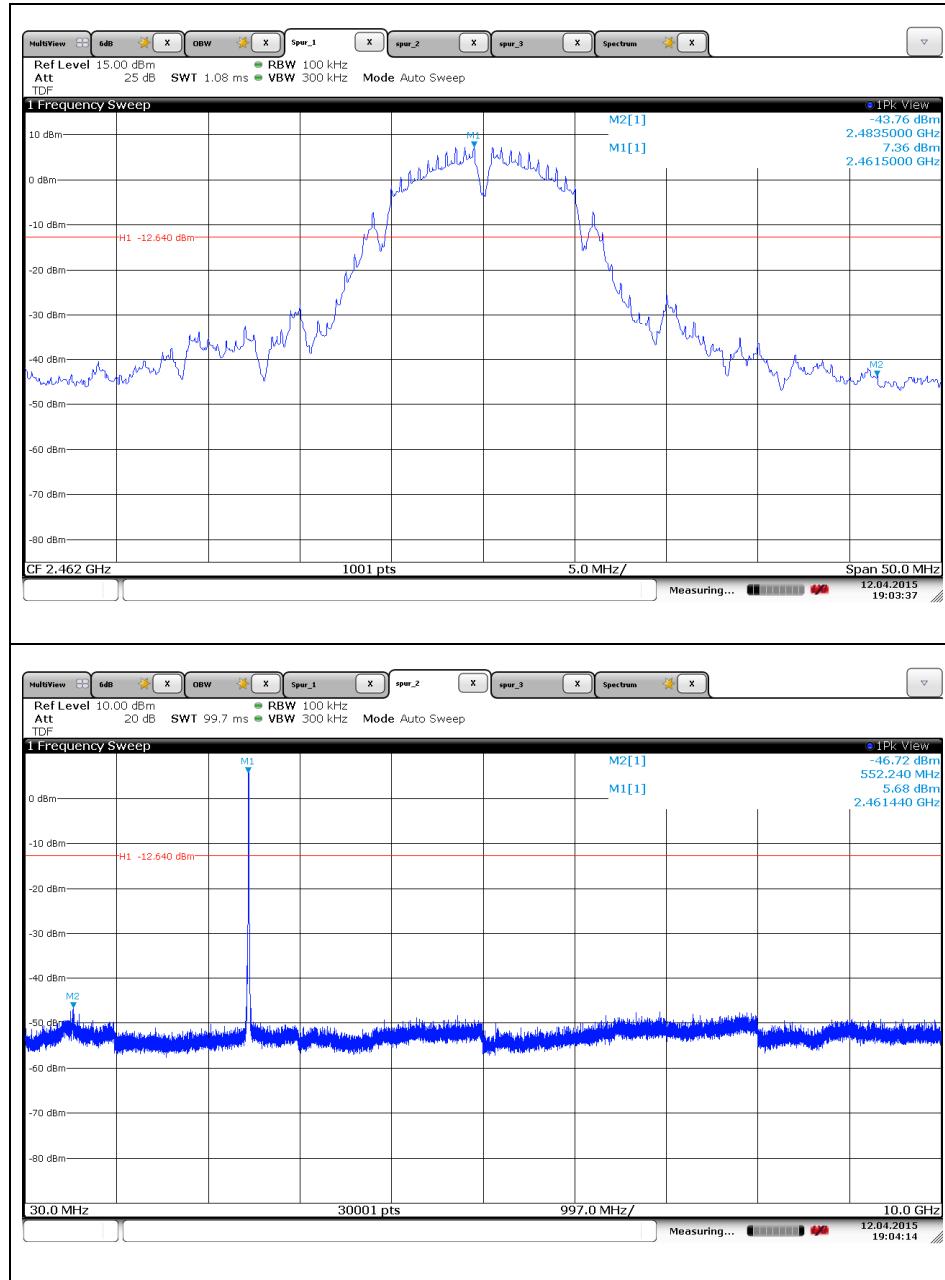
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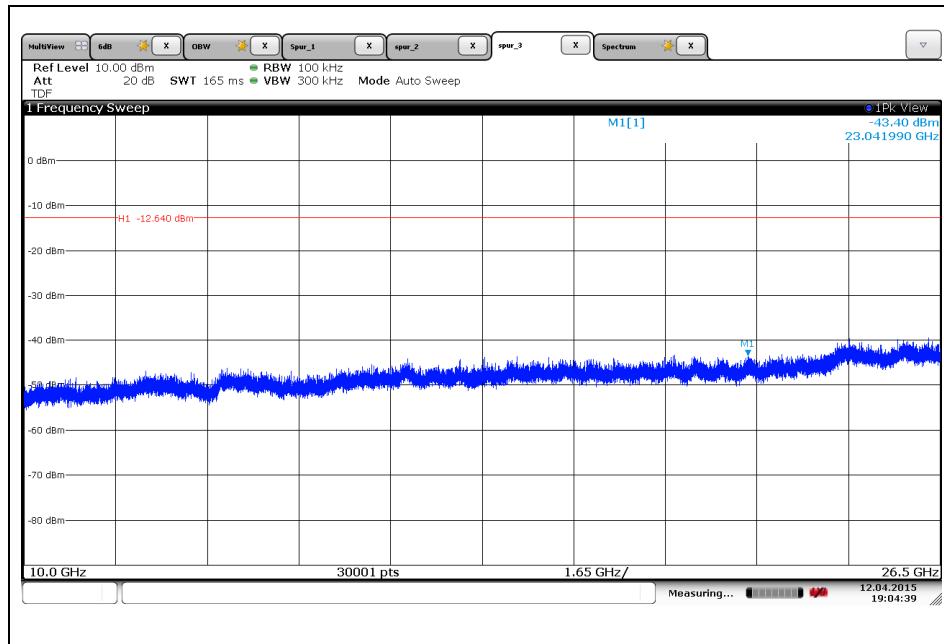
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A4(210 mm x 297 mm)

## High Channel



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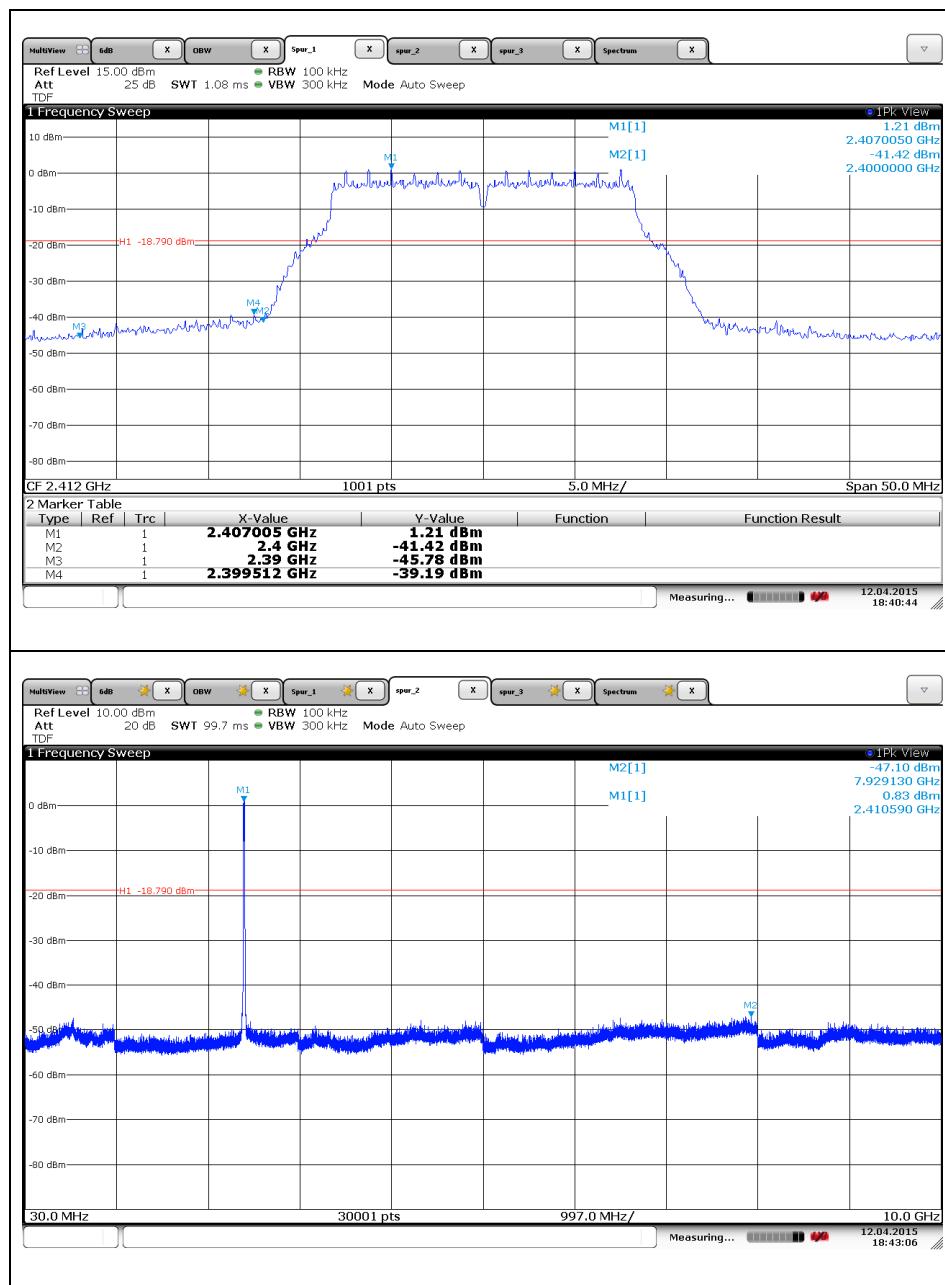
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A4(210 mm x 297 mm)

**OFDM: 802.11g (6 Mbps)**

Low Channel



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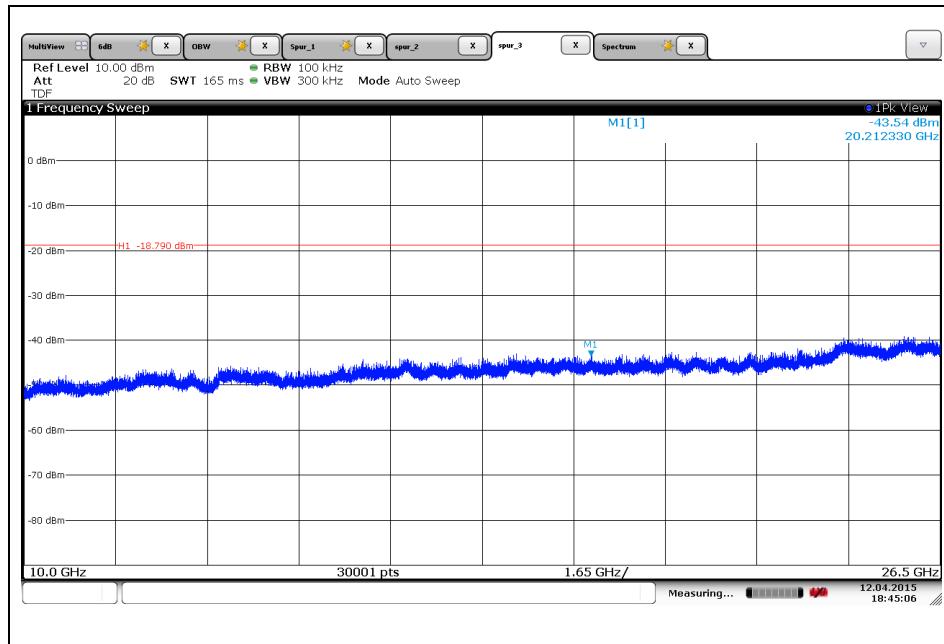
4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 435-040

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A4(210 mm x 297 mm)



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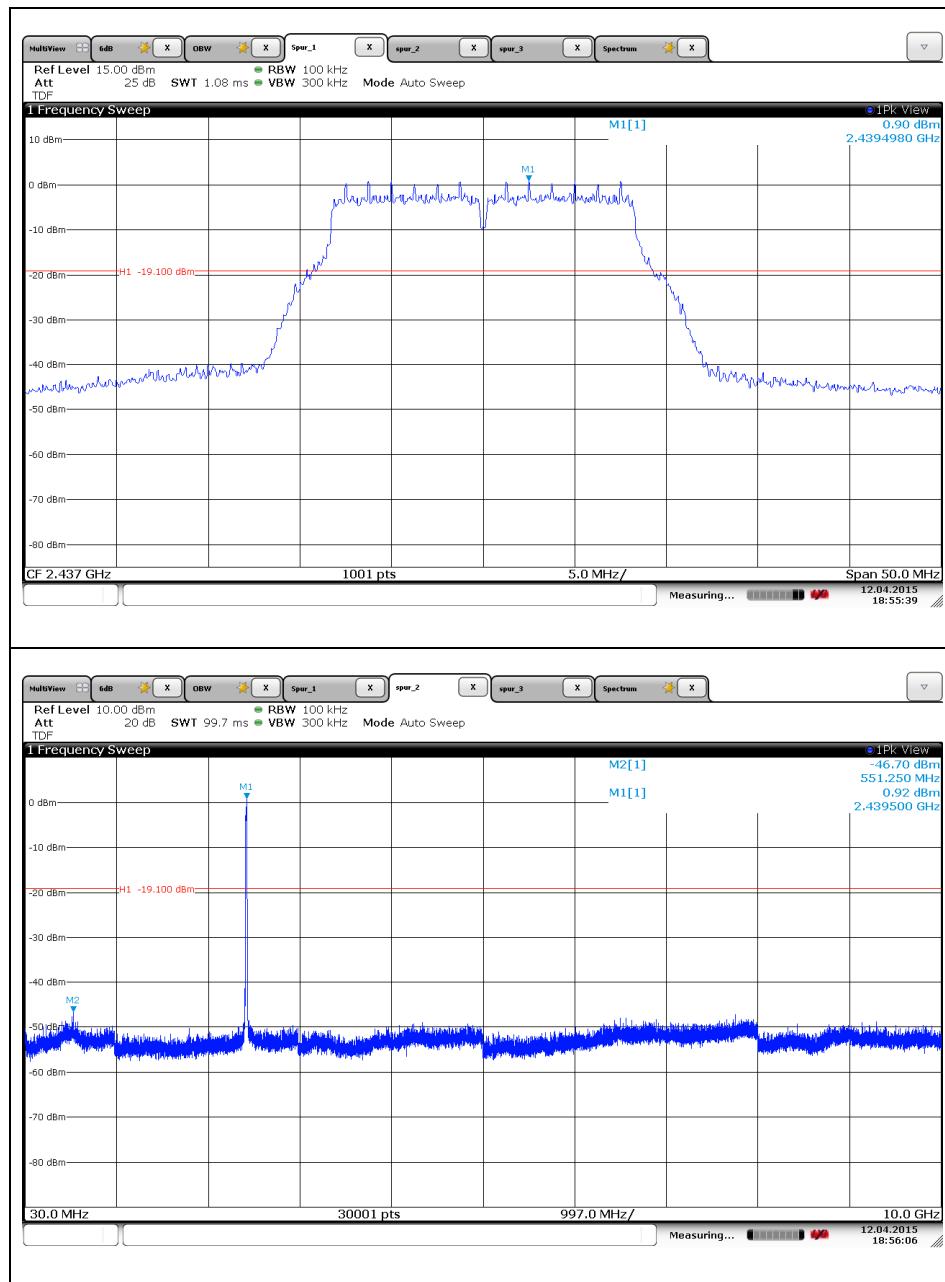
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A4(210 mm x 297 mm)

## Middle Channel



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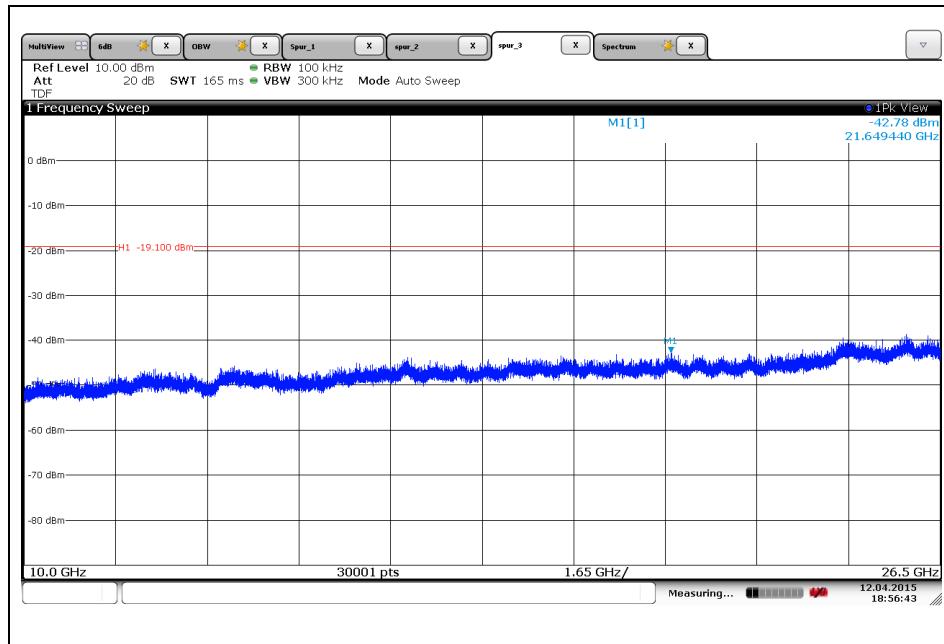
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A4(210 mm x 297 mm)



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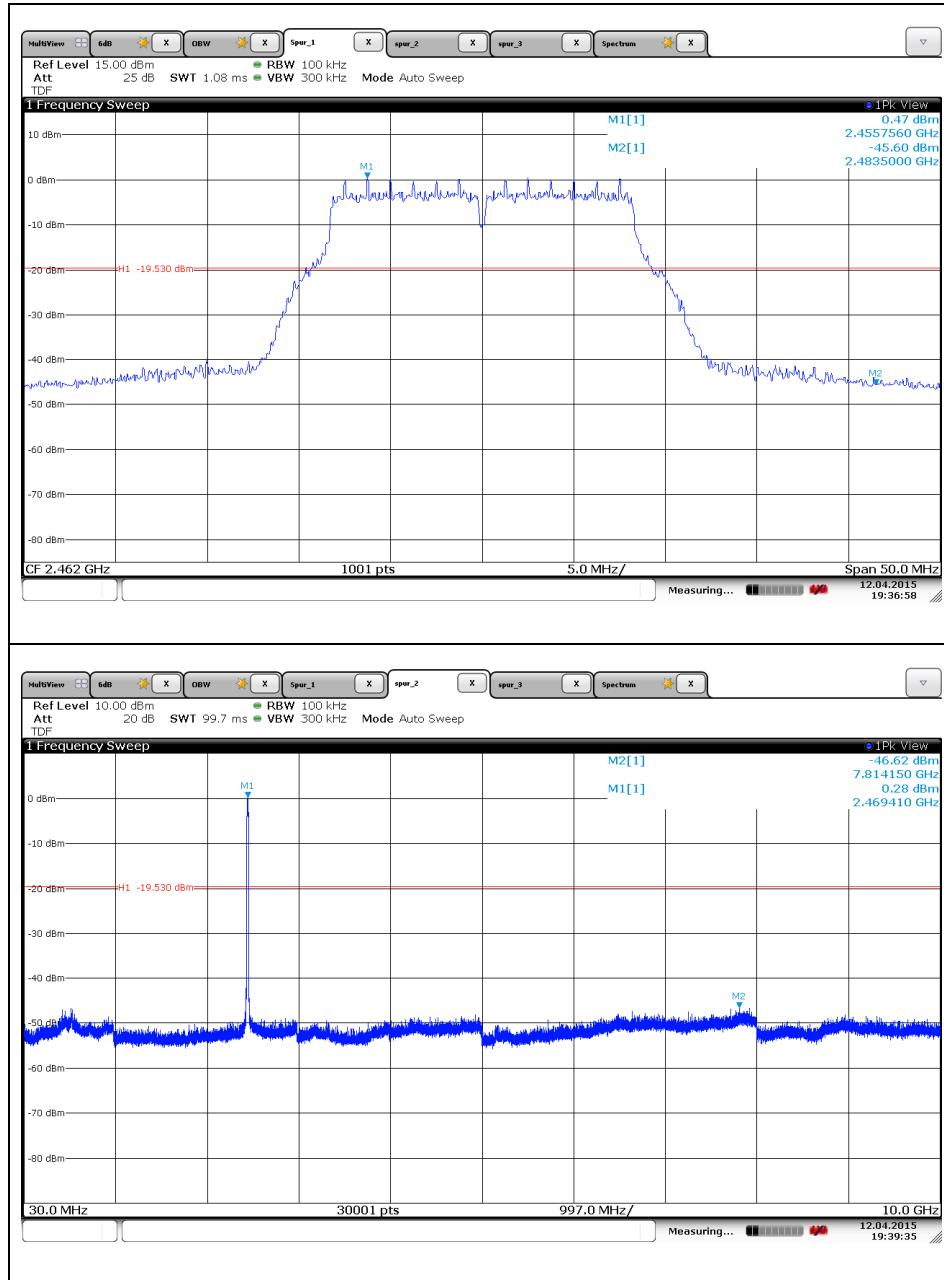
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RTT5041-20(2014.01.20)(2)

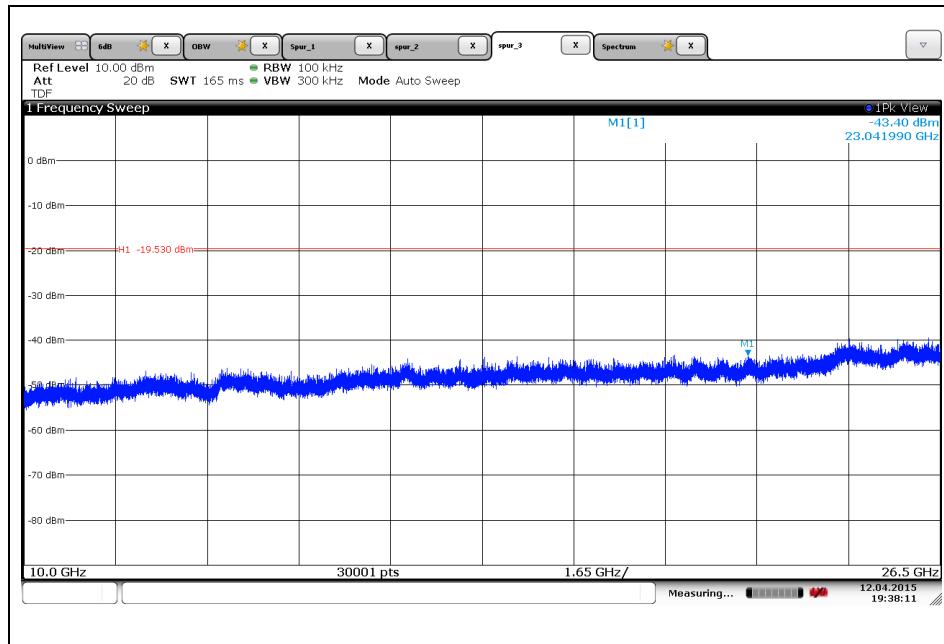
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A4(210 mm x 297 mm)

## High Channel



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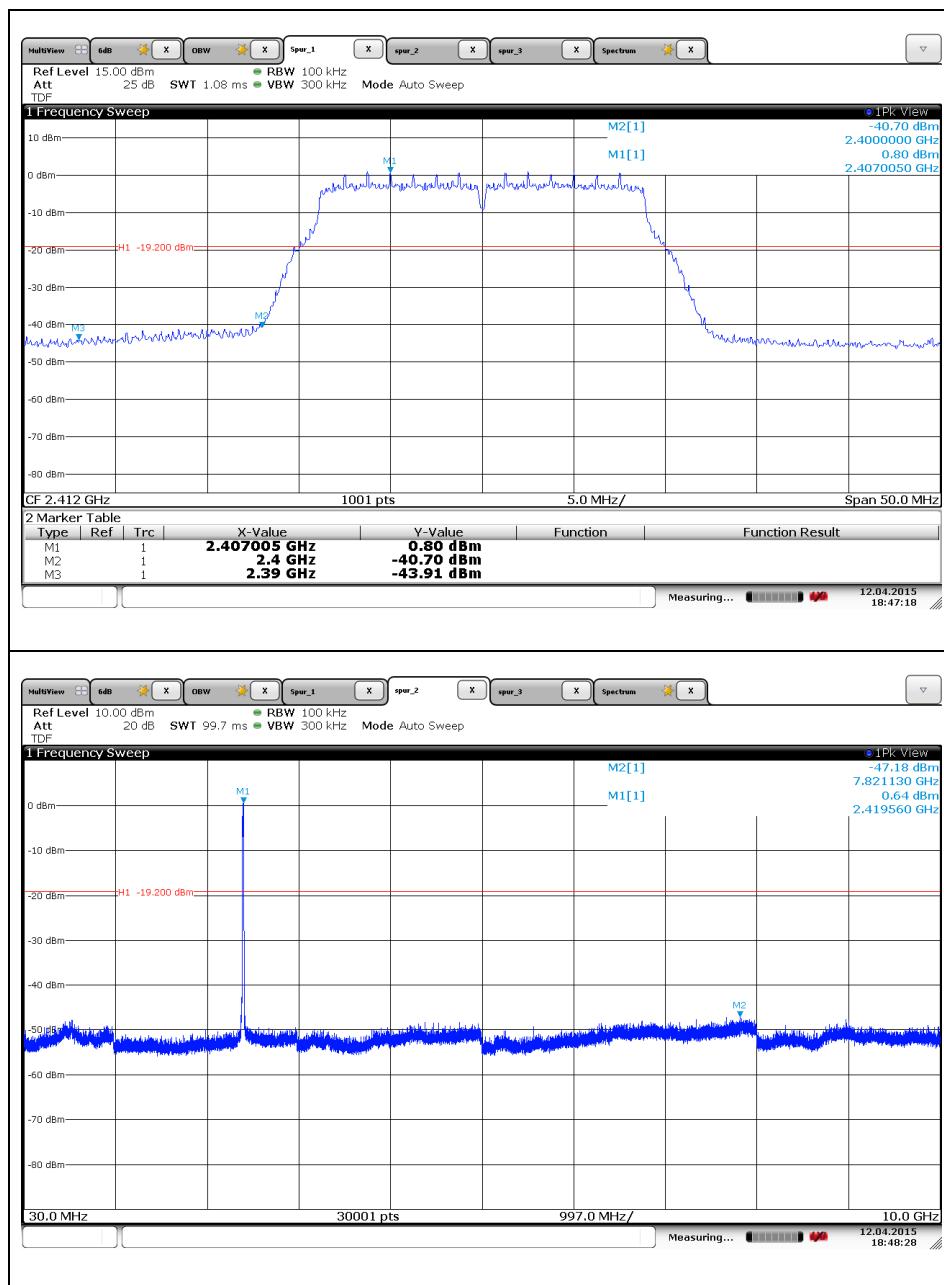
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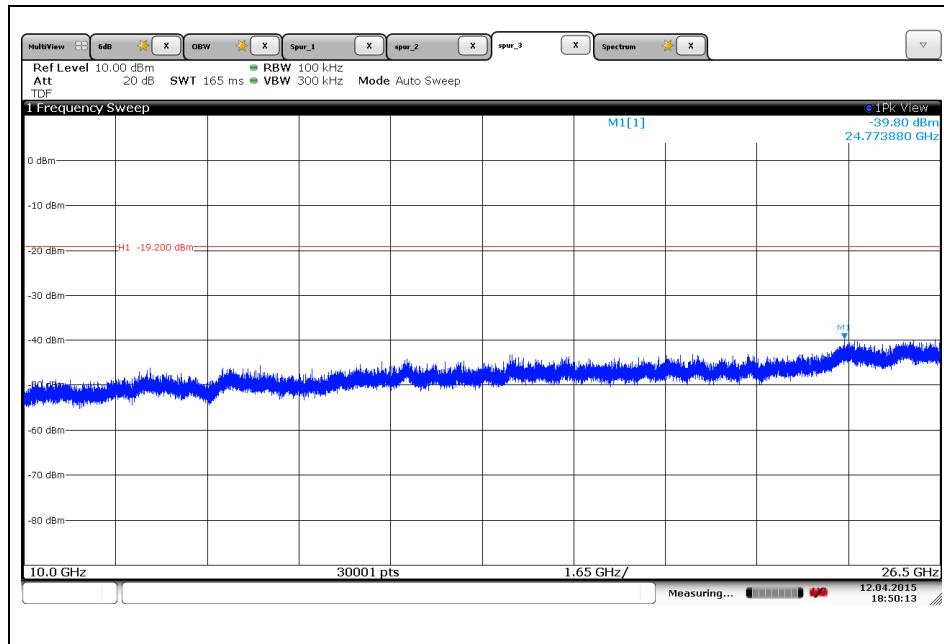
A4(210 mm x 297 mm)

**OFDM: 802.11n HT20 (MCS0)**

Low Channel



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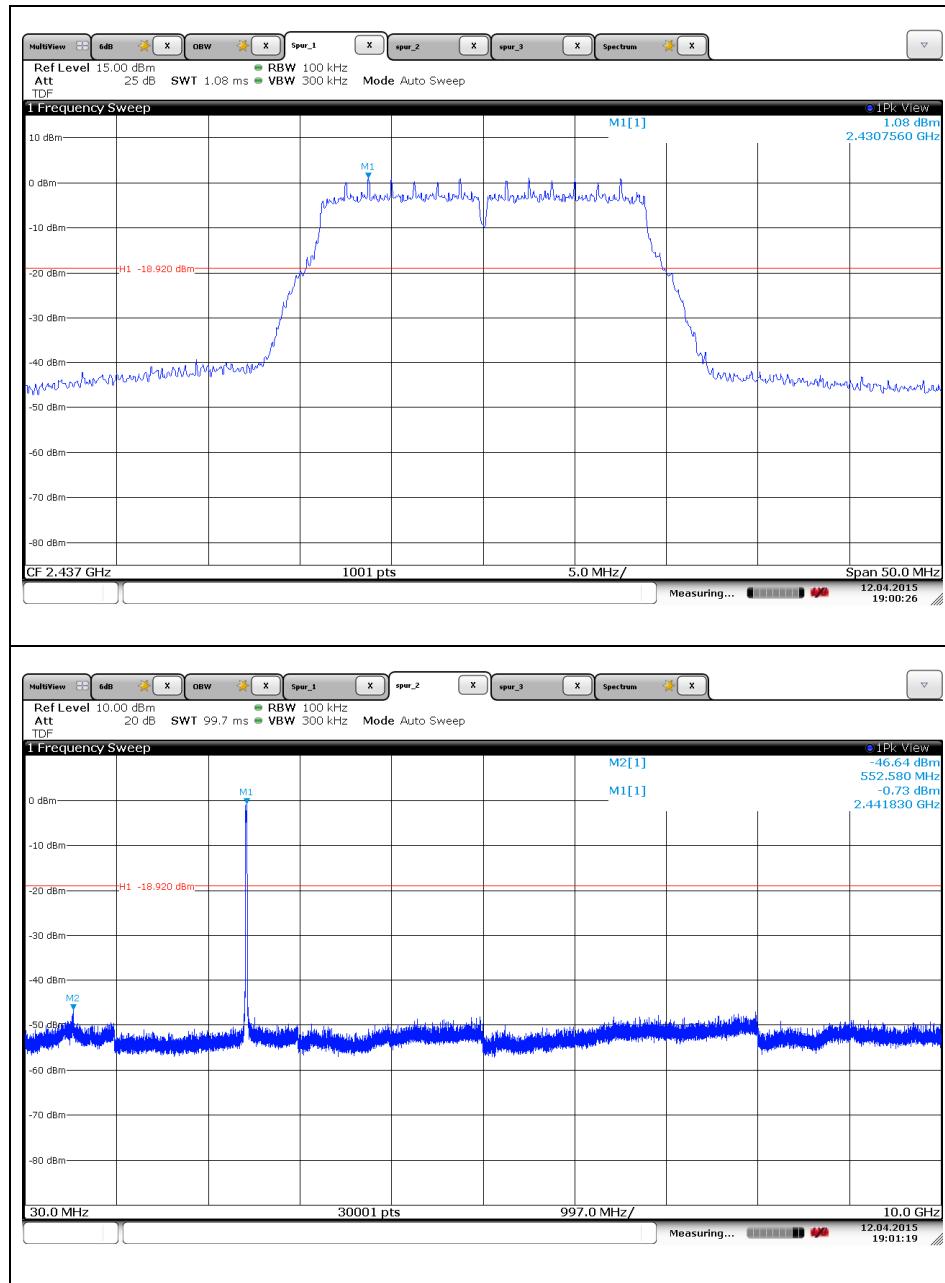
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A4(210 mm x 297 mm)

## Middle Channel



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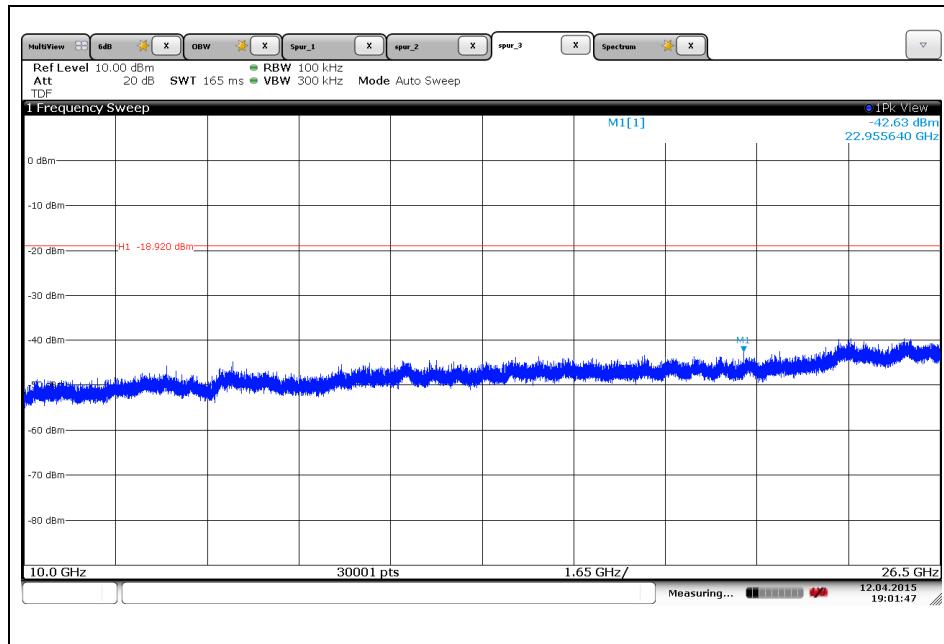
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A4(210 mm x 297 mm)



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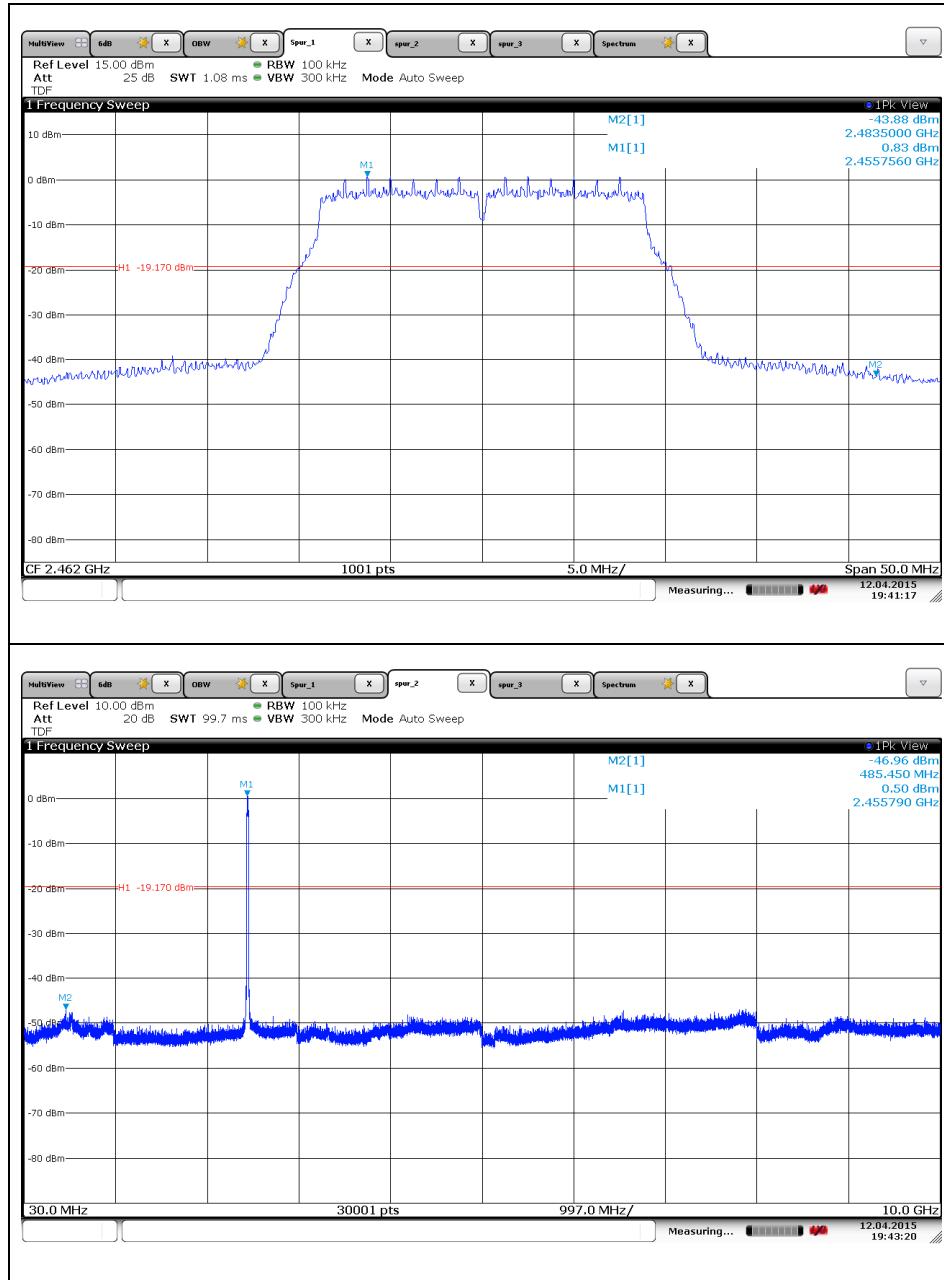
<http://www.sgsgroup.kr>

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A4(210 mm x 297 mm)

## High Channel



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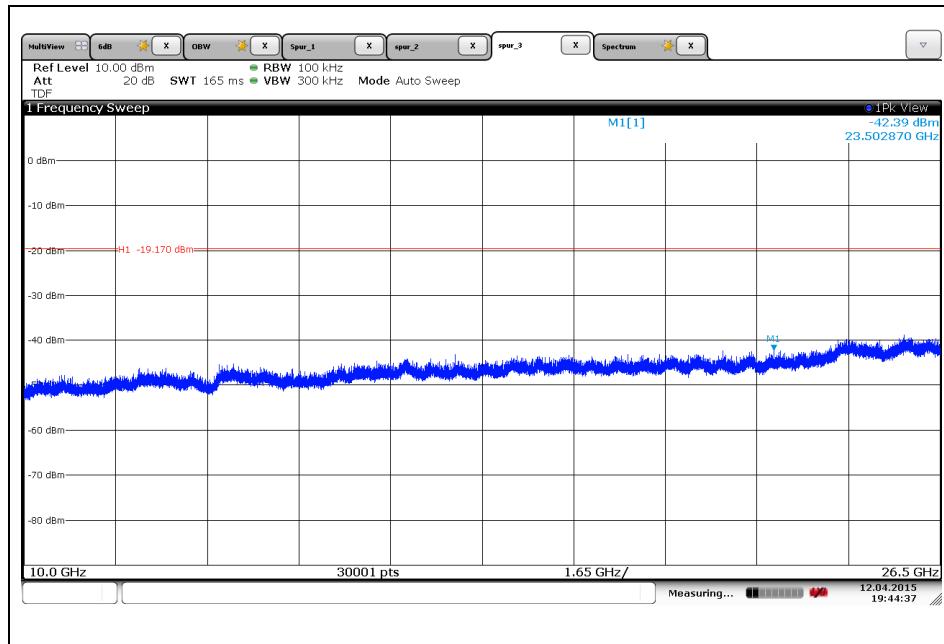
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A4(210 mm x 297 mm)



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A4(210 mm x 297 mm)

## 3. 6 dB Bandwidth Measurement

### 3.1. Test Setup



### 3.2. Limit

According to §15.247(a)(2), systems using digital modulation techniques may operate in the 902 ~928 MHz, 2 400 ~ 2 483.5 MHz, and 5 725 ~ 5 825 MHz bands. The minimum of 6 dB Bandwidth shall be at least 500 kHz

### 3.3. Test Procedure

#### 3.3.1. 6 dB Bandwidth

All data rates and modes were investigated for this test. The full data for the worst case data rate are reported in this section.

The test follows section 8.0 of FCC KDB Publication 558074\_v03r02.

Tests performed using section 8.1 Option 1

- Option 1:

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW)  $\geq 3 \times$  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 point (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

### 3.4. Test Results

Ambient temperature : (23 ± 1) °C

Relative humidity : 47 % R.H.

Operation Mode	Data Rate (Mbps)	Channel	Channel Frequency (MHz)	6 dB Bandwidth (MHz)
DSSS (802.11b)	1	Low	2 412	8.071
		Middle	2 437	8.071
		High	2 462	8.048
OFDM (802.11g)	6	Low	2 412	16.367
		Middle	2 437	16.329
		High	2 462	16.379
OFDM (802.11n_HT20)	MCS0	Low	2 412	17.616
		Middle	2 437	17.604
		High	2 462	17.641

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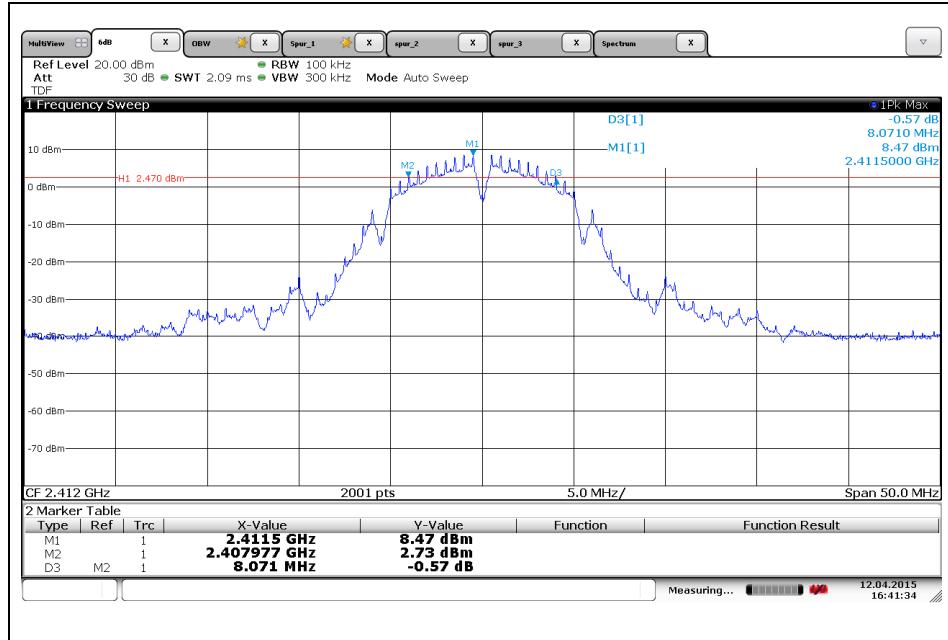
Tel. +82 31 428 5700 / Fax. +82 31 427 2370

A4(210 mm × 297 mm)

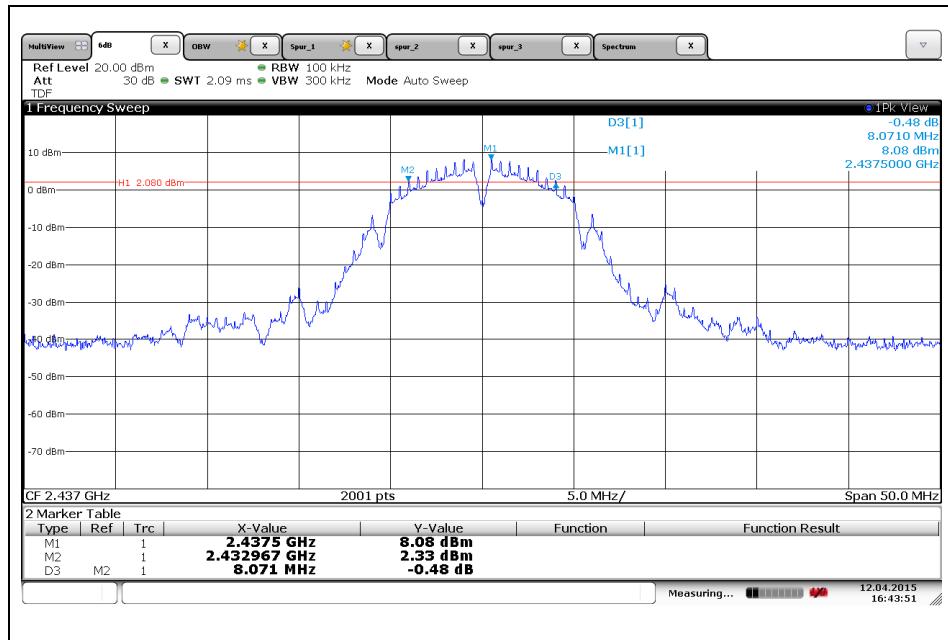
## 6 dB Bandwidth

DSSS: 802.11b

Low Channel



Middle Channel



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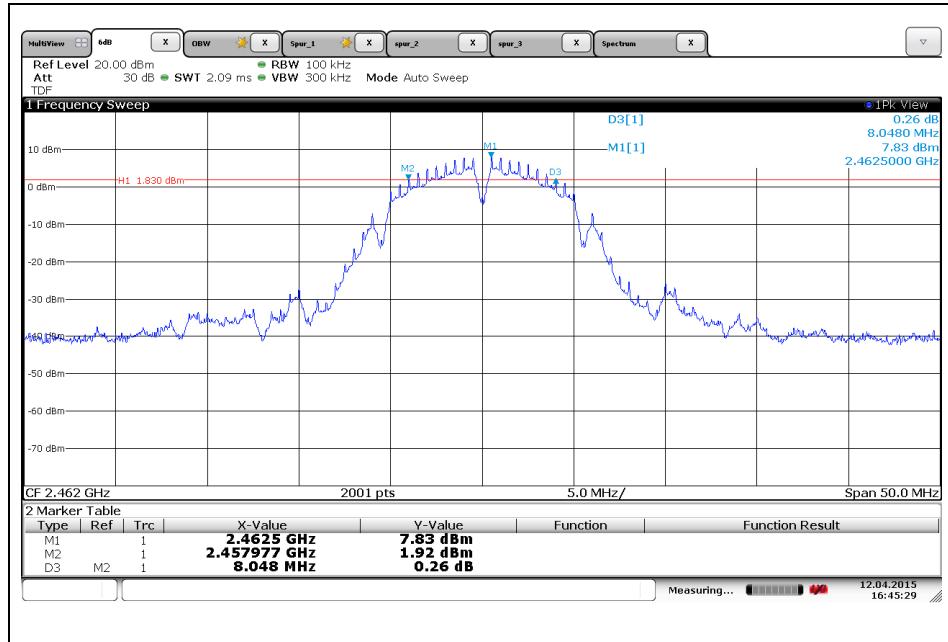
<http://www.sgsgroup.kr>

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Tel. +82 31 428 5700 / Fax. +82 31 427 2370

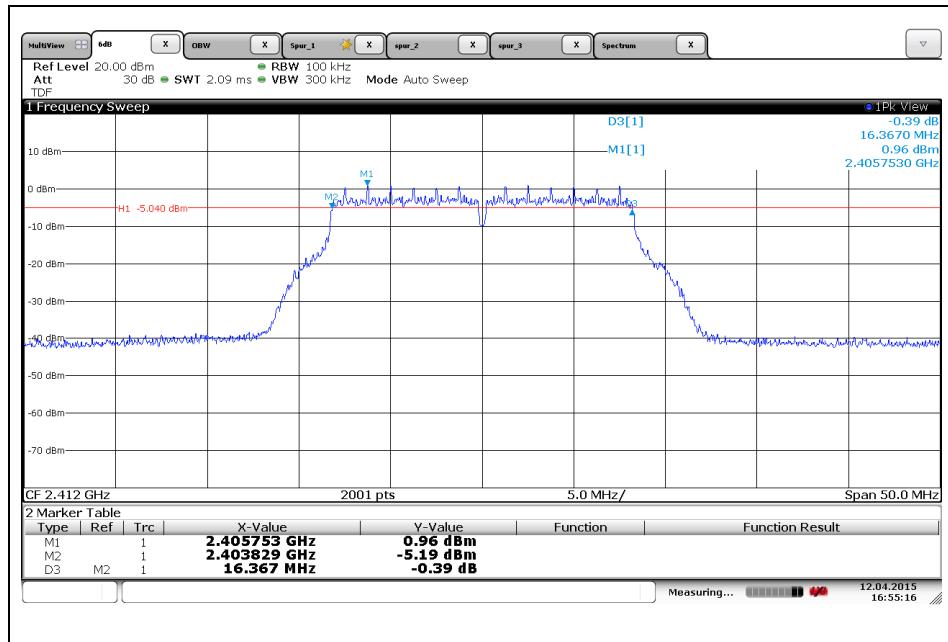
A4(210 mm x 297 mm)

## High Channel



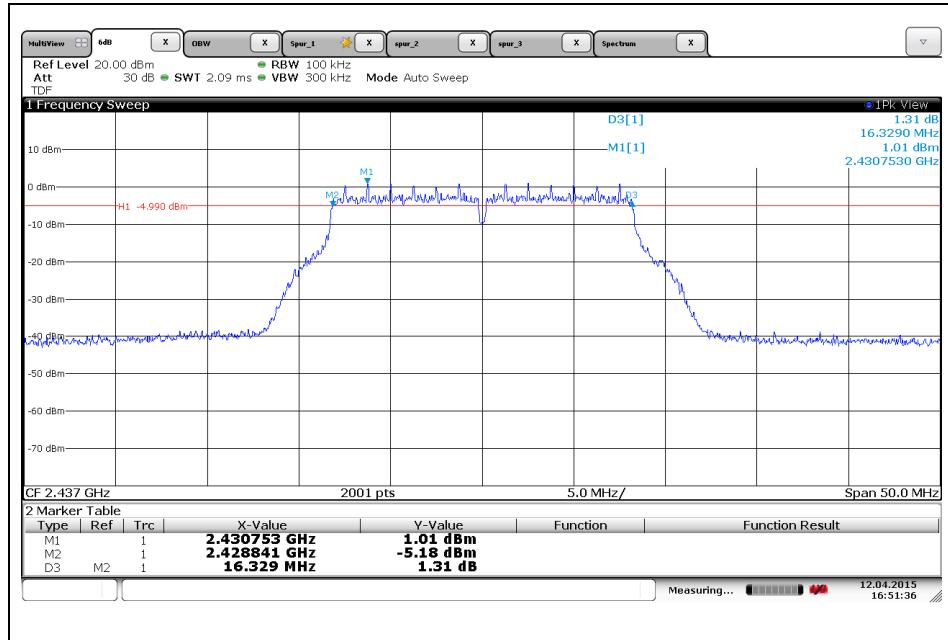
## OFDM: 802.11g

## Low Channel

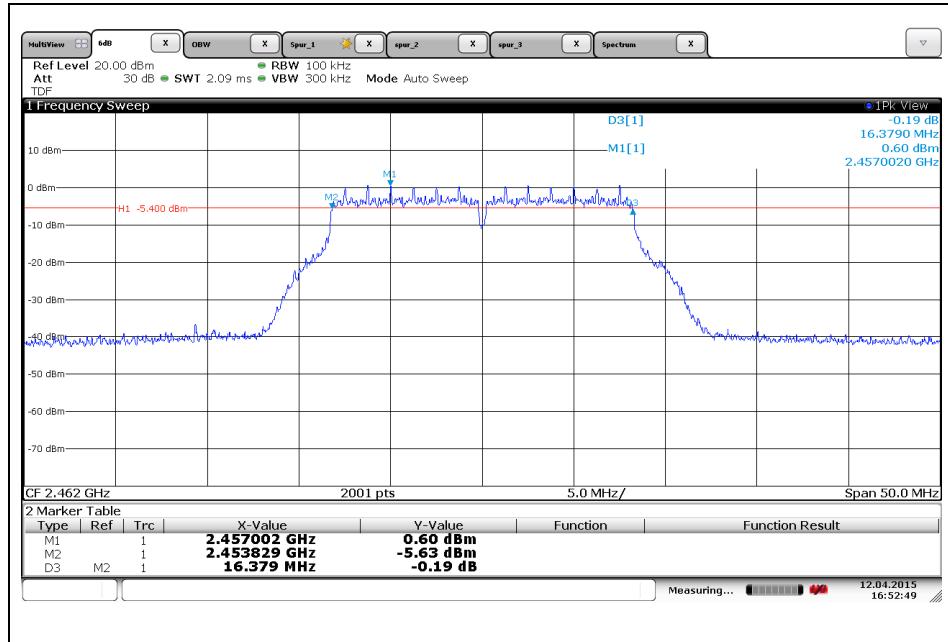


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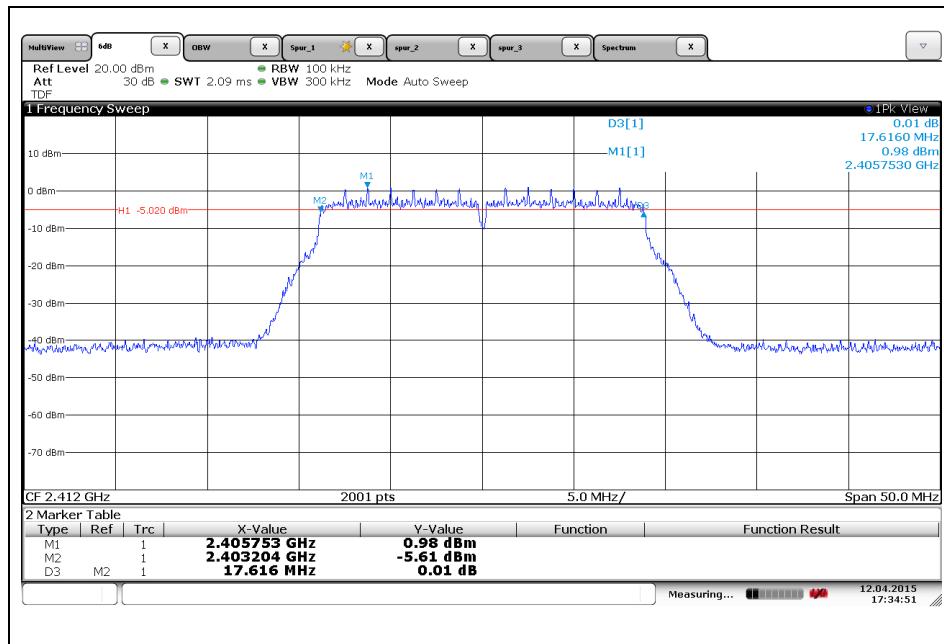
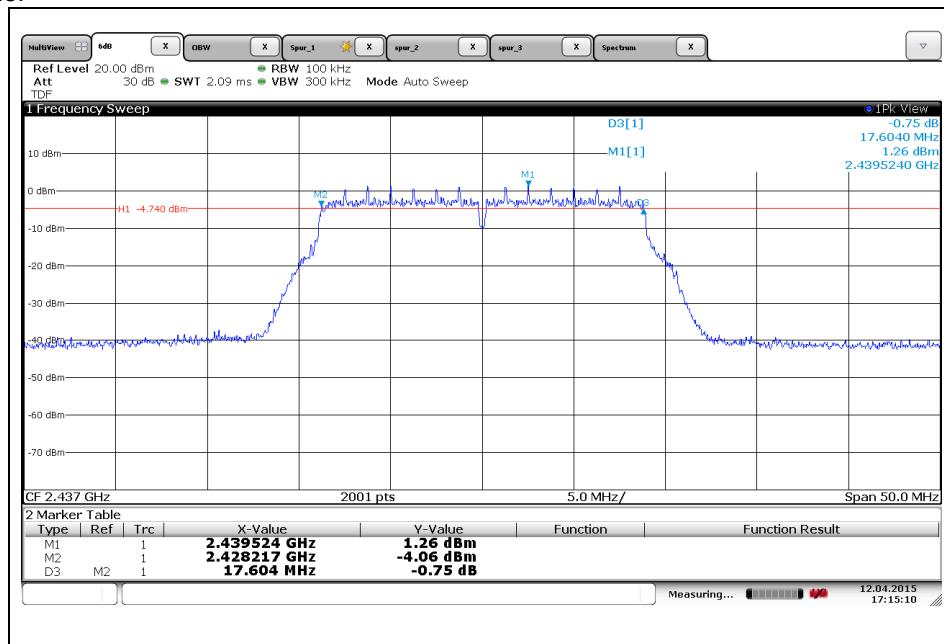
## Middle Channel



## High Channel

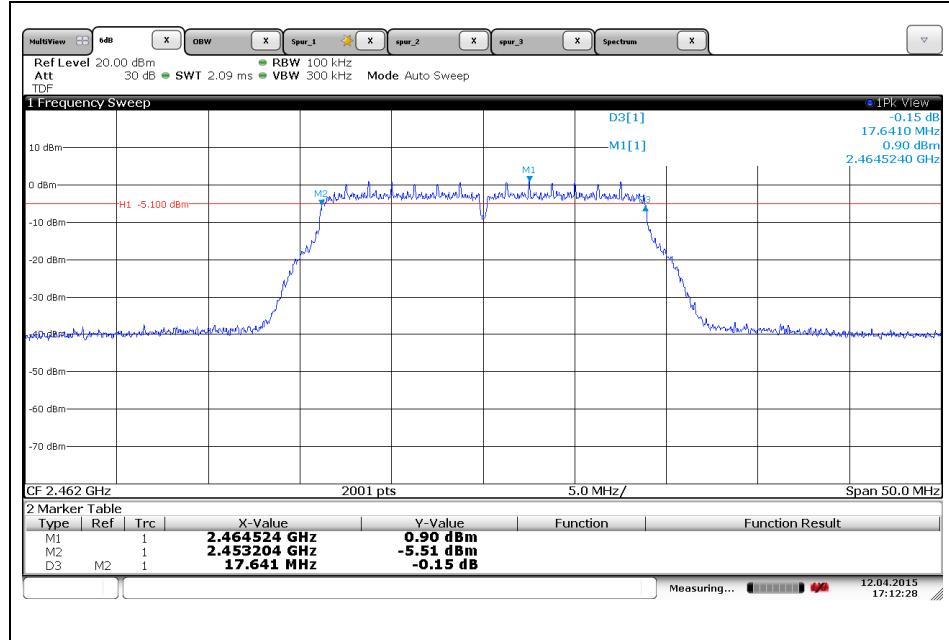


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**OFDM: 802.11n HT20**
**Low Channel**

**Middle Channel**


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## High Channel



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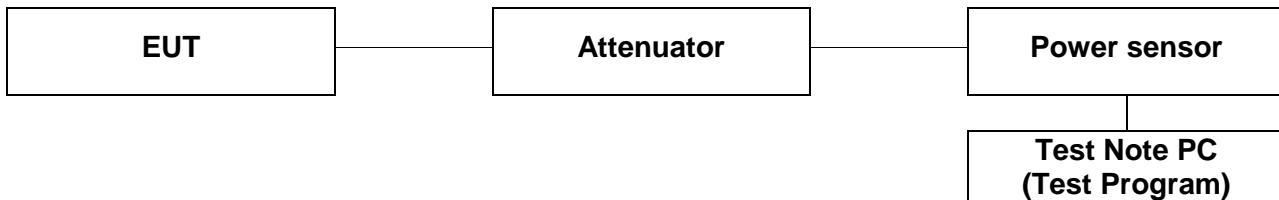
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A4(210 mm x 297 mm)

## 4. Maximum Conducted Output Power Measurement

### 4.1. Test Setup



### 4.2. Limit

According to §15.247(b)(3), for systems using digital modulation in the 902 ~ 928 MHz, 2 400 ~ 2 483.5 MHz, and 5 725 ~ 5 850 MHz band: 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 antenna elements. The average must not include any 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 antenna with directional gains that do not exceed 6 dBi. Except as shown in paragraph(c) of this section, if transmitting antenna of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraph (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6dBi.

### 4.3. Test Procedure

All data rates and modes were investigated for this test. The full data for the worst case data rate are reported in this section.

The test follows section 9.1.2 of FCC KDB Publication 558074\_v03r02.

#### - Peak power meter method

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

1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the Power sensor.
3. Test program : (S/W name : R&S Power Viewer, Version : 3.2.0)
4. Measure peak power for each channel.

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#### 4.4. Test Results

Ambient temperature : (23 ± 1) °C

Relative humidity : 47 % R.H.

Mode	Channel	Channel Frequency (MHz)	Data Rate (Mbps)	Attenuator + Cable offset (dB)	Peak Power Result (dB m)
DSSS (802.11b)	Low	2 412	1	21.70	19.05
			2		19.51
			5.5		19.60
			11		19.90
	Middle	2 437	1	21.74	19.47
			2		19.56
			5.5		19.70
			11		19.81
	High	2 462	1	21.80	19.09
			2		19.31
			5.5		19.27
			11		19.41
OFDM (802.11g)	Low	2 412	6	21.70	20.04
			9		19.82
			12		19.72
			18		19.88
			24		21.90
			36		21.69
			48		22.39
			54		21.75
	Middle	2 437	6	21.74	20.16
			9		19.90
			12		20.37
			18		19.80
			24		22.00
			36		21.88
			48		22.01
			54		21.61
	High	2 462	6	21.80	19.66
			9		20.08
			12		20.34
			18		19.69
			24		21.45
			36		21.55
			48		21.92
			54		21.61

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Mode	Channel	Channel Frequency (MHz)	Data rate (Mbps)	Attenuator + Cable offset (dB)	Peak Power Result (dB m)
OFDM (802.11n_HT20)	Low	2 412	MCS0	21.70	20.91
			MCS1		22.84
			MCS2		22.80
			MCS3		22.57
			MCS4		22.32
			MCS5		22.39
			MCS6		22.37
			MCS7		22.20
	Middle	2 437	MCS0	21.74	20.91
			MCS1		22.93
			MCS2		22.85
			MCS3		22.71
			MCS4		22.51
			MCS5		22.33
			MCS6		22.42
			MCS7		22.34
	High	2 462	MCS0	21.80	20.40
			MCS1		22.57
			MCS2		22.45
			MCS3		22.14
			MCS4		21.98
			MCS5		21.77
			MCS6		21.97
			MCS7		21.97

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## 5. Power Spectral Density Measurement

### 5.1. Test Setup



### 5.2. Limit

§15.247(e) For digitally modulated system, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dB m in any 3 kHz band 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.

### 5.3. Test Procedure

All data rates and modes were investigated for this test. The full data for the worst case data rate are reported in this section.

The measurements are recorded using the PKPSD measurement procedure in section 10.2 of KDB 558074\_v03r02.

- This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance, and is optional if the maximum conducted (average) output power was used to demonstrate compliance.
- a). Set analyzer center frequency to DTS channel center frequency.
- b). Set the span to at least 1.5 times the DTS bandwidth.
- c). Set the RBW to :  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ .
- d). Set the VBW  $\geq 3 \times \text{RBW}$ .
- e). Detector = Peak.
- f). Sweep time = auto couple.
- g). Trace mode = max hold.
- h). Allow trace to fully stabilize.
- i). Use the peak marker function to determine the maximum amplitude level within the RBW.
- j). If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

## 5.4. Test Results

Ambient temperature : (23 ± 1) °C

Relative humidity : 47 % R.H.

Operation Mode	Data Rate (Mbps)	Channel	Frequency (MHz)	Measured PSD (dB m)	Maximum Limit (dB m)
DSSS (802.11b)	1	Low	2 412	-2.20	8
		Middle	2 437	-2.61	8
		High	2 462	-2.74	8
OFDM (802.11g)	6	Low	2 412	-9.74	8
		Middle	2 437	-10.13	8
		High	2 462	-9.88	8
OFDM (802.11n_HT20)	MCS0	Low	2 412	-8.86	8
		Middle	2 437	-9.57	8
		High	2 462	-8.53	8

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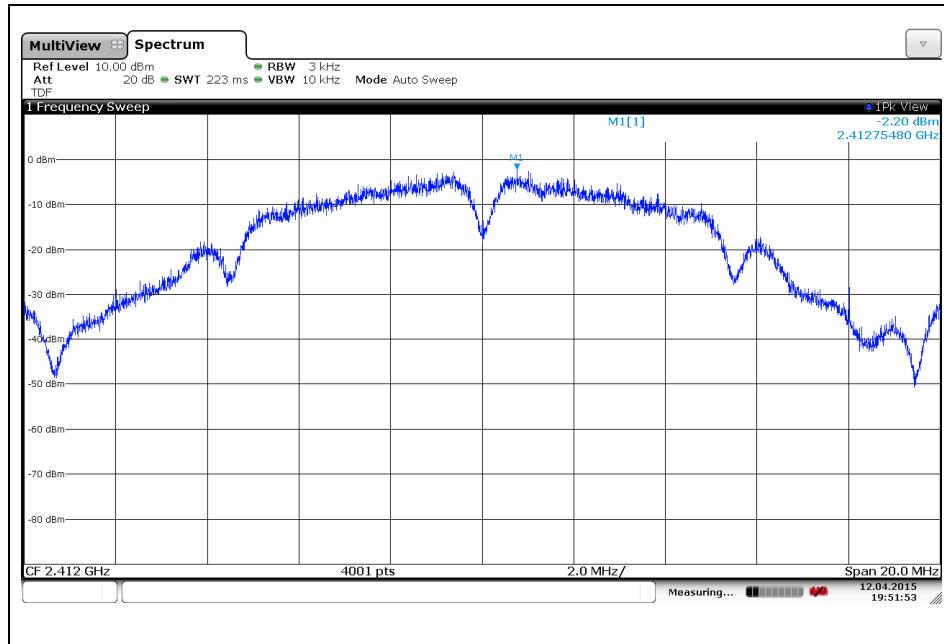
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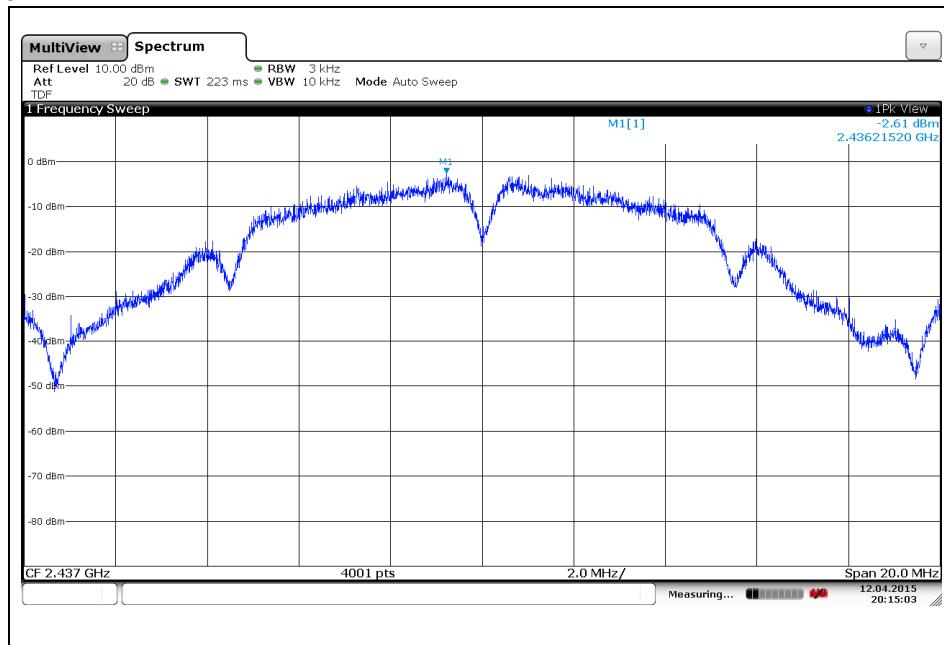
A4(210 mm × 297 mm)

**DSSS: 802.11b**

## Low Channel

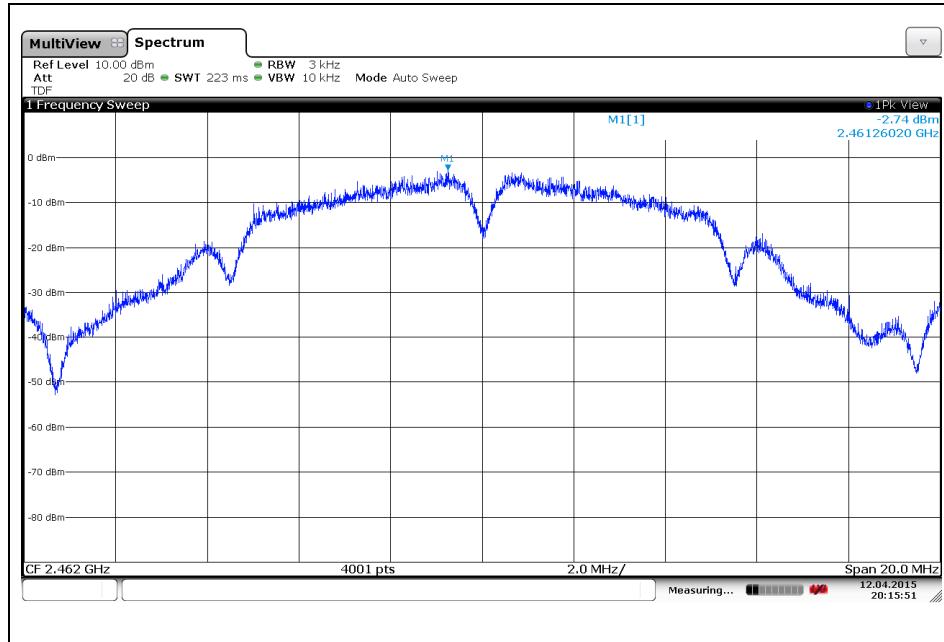


## Middle Channel



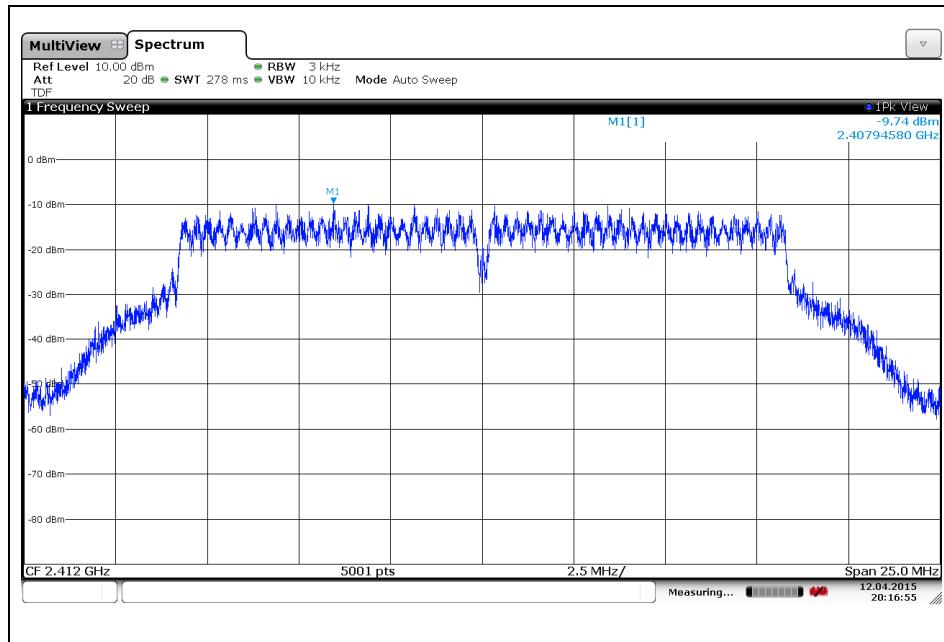
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## High Channel



## OFDM: 802.11g

## Low Channel



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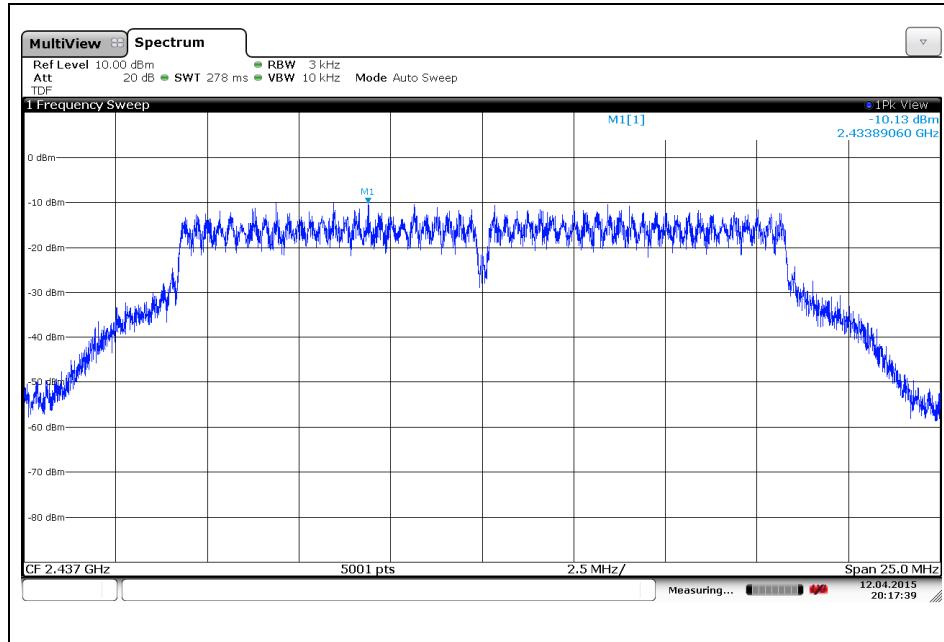
<http://www.sgsgroup.kr>

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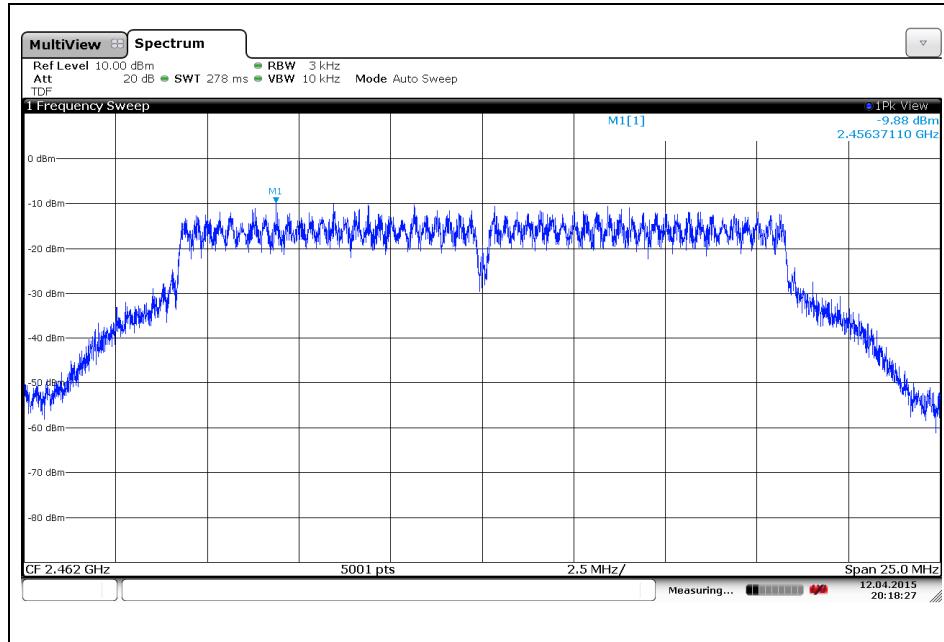
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A4(210 mm x 297 mm)

## Middle Channel



## High Channel



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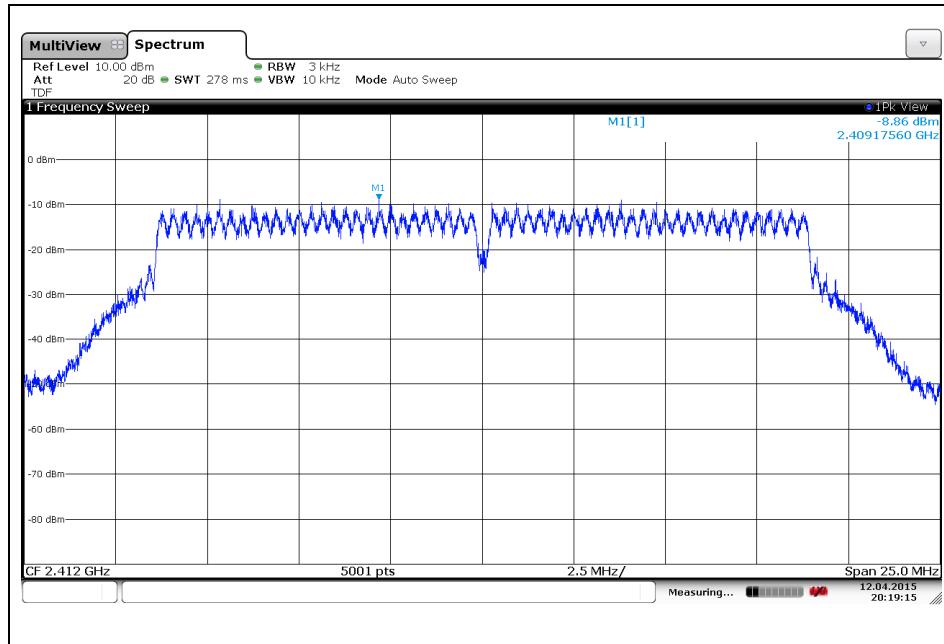
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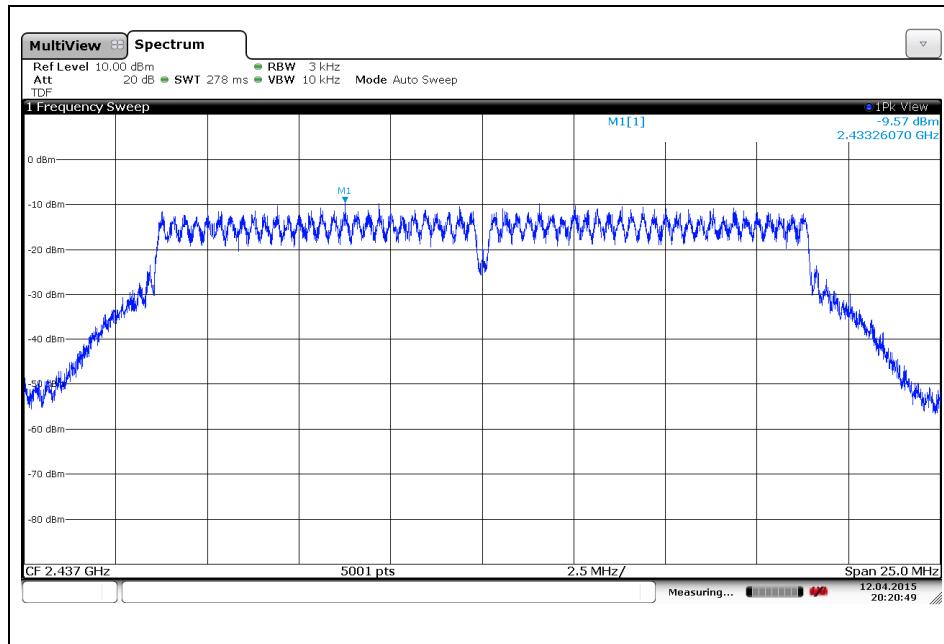
A4(210 mm x 297 mm)

**OFDM: 802.11n HT20**

## Low Channel



## Middle Channel



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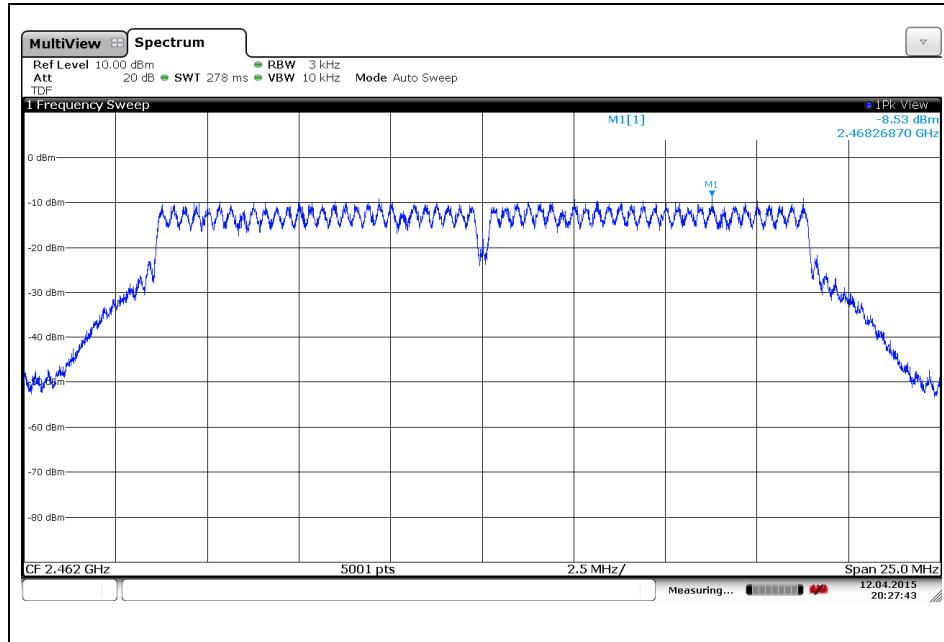
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A4(210 mm x 297 mm)

## 6. Antenna Requirement

### 6.1. Standard Applicable

For intentional device, according to FCC 47 CFR 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. And according to FCC 47 CFR Section §15.247 (b) if transmitting antennas of directional gain greater than 6 dB i are used, the power shall be reduced by the amount in dB that the gain of the antenna exceeds 6 dB i.

### 6.2. Antenna Connected Construction

Antenna used in this product is Integral antenna and peak max gain of antenna as below.

<b>Band</b>	2 412 MHz – 2 462 MHz
<b>Mode</b>	11b/g/n_HT20
<b>Gain</b>	4.67 dB i

---

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