TEST REPORT

Part 15 Subpart E 15.407

Equipment under test mini-PCIe WiFi Module

Model name WiMi300A

FCC ID ZD7-WIMI300A

Applicant Nimbus, Inc.

Manufacturer Nimbus, Inc.

Date of test(s) 2016.03.15 ~ 2016.03.28 ,04.07

Date of issue 2016.04.08

Issued to
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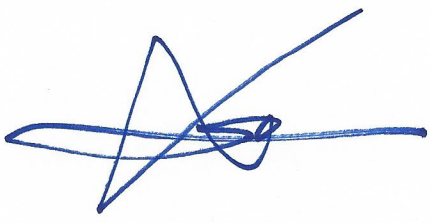
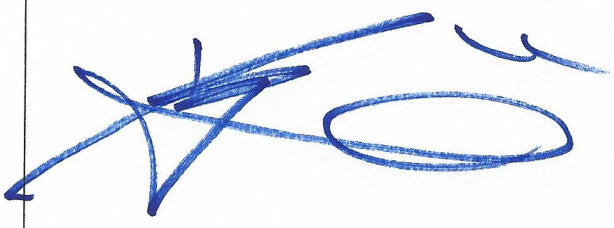
Test and report completed by :	**Report approval by :**
	
Kwon-se Kim Test engineer	Jeff Do Technical manager

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Revision history

Revision	Date of issue	Test report No.	Description
-	2016.04.01	KES-RF-16T0038	Initial
1	2016.04.08	KES-RF-16T0038-R1	Retest a restricted band and emission.

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1. General information

Applicant:	Nimbus, Inc.
Applicant address:	Suit 619 Hanshin S-meca, 1359 Gwanpyeong-dong, Yuse Dajeon, 305-509, South Korea
Test site:	KES Co., Ltd.
Test site address:	C-3701, Simin-daero 365-40, Dongan-gu, Anyang-si, Gyeonggi-do,14057, Korea 473-29, Gayeo-ro, Yeoju-si, Gyeonggi-do, 12658, Korea
FCC rule part(s):	15.407
FCC ID:	ZD7-WIMI300A
Test device serial No.:	☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test	mini-PCIe WiFi Module
Frequency range	UNII-1: 5 180 ㎒ ~ 5 240 ㎒(HT20), 5 745 ㎒ ~ 5 825 ㎒(HT40) UNII-3: 5 190 ㎒ ~ 5 230 ㎒(HT40), 5 755 ㎒ ~ 5 795 ㎒(HT40)
Model:	WiMi300A
Derivative model	-
Modulation technique	OFDM
Number of channels	5180 ㎒ ~ 5240 ㎒ : 4 ch, 5745 ㎒ ~ 5825 ㎒ : 5ch 5190 ㎒ ~ 5230 ㎒ : 2 ch, 5755 ㎒ ~ 5795 ㎒ : 2ch
Antenna specification	UNII-1: Dipole antenna UNII-3: Dipole antenna
Power source	DC 3.3 V

1.2. Test configuration

The **Nimbus WiFi Module FCC ID: ZD7-WIMI300A** was tested per the guidance of KDB 789033 D02 v01r01 and KDB 662911 D01 v02r01. ANSI C63.10-2009 was used to reference the appropriate EUT setup for radiated spurious emissions testing

This report contains the worst case data from the following mode of the test in 20/40 MHz signal bandwidth.

1.3. Antenna information

Mode	Antenna 1	Antenna 2	Antenna 3	Antenna 1+2+3
UNII-1	-	-	-	✔
UNII-3	–	–	–	✔

Note.

1. Antenna 1+2+3 is multiple transmitting.

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1.4. Directional antenna gain(worst-case)

Band	Antenna 1(dBi)	Antenna 2(dBi)	Antenna 3(dBi)	Directional gain(dBi)
UNII-1	5.62	5.62	5.62	5.62 Note2
UNII-3	6.15	6.15	6.15	6.15 Note2

Note.

1. Directional gain(Corrected signal with unequal antenna gain and equal transmit power)
   $10\log[(10^{G1/20}+10^{G2/20}+\ldots+10^{GN/20})^2/N^{Ant}]$ dBi
2. Directional gain(completely uncorrelated signal with unequal antenna gain and equal transmit power)
   $10\log[(10^{G1/10}+10^{G2/10}+\ldots+10^{GN/10})/N^{Ant}]$ dBi
3. Directional gain(Spatial multiplexing)
   $G_{ANT\ Max}+10\log(N_{ANT}/N_{SS})$ dBi

1.5. Frequency/channel operations

Ch.	Frequency (㎒)	Mode
36	5 180	11n (HT 20)
44	5 220	11n (HT 20)
48	5 240	11n (HT 20)

Ch.	Frequency (㎒)	Mode
38	5 190	11n (HT 40)
46	5 230	11n (HT 40)

Ch.	Frequency (㎒)	Mode
149	5 745	11n (HT 20)
157	5 785	11n (HT 20)
165	5 825	11n (HT 20)

Ch.	Frequency (㎒)	Mode
151	5 755	11n (HT 40)
159	5 795	11n (HT 40)

Note.
This device does not support legacy mode.

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1.6. Accessory information

Applicant	Equipment	Manufacturer	Model	Power source
-	-	-	-	-

1.7. Device modifications

N/A

1.8. Derivation model information

N/A

1.9. Maximum peak output power

Refer to the peak output power.

Note.

1. Radiated emission and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.
2. Worst-case data rates as provided by the client were: **MCS 0 for UNII-1 and UNII-3**

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2. Summary of tests

Reference	Parameter	Test results
15.407(a)	26 dB bandwidth	Pass
15.407(e)	6 dB bandwidth	Pass
15.407(a)	Maximum conducted output power	Pass
15.407(a)	Power spectral density	Pass
15.407(g)	Frequency stability	Pass
15.205 15.209	Radiated restricted band and emission	Pass
15.407(d)	General field strength limit (Restricted bands and radiated emission limit)	Pass
15.207	AC power line conducted emissions	Pass

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3. Test results

3.1. Emission bandwidth (26 dB bandwidth)

Test procedure

KDB 789033 D02 v01r01– Section C.1

1. Set RBW = approximately 1% of the emission bandwidth.
2. Set the VBW > RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

Limit

N/A

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Test results

Antenna	Frequency(㎒)	Mode	26 ㏈ bandwidth(㎒)
1	5 180	HT20	19.18
	5 220		19.10
	5 240		19.18
	5 745		19.10
	5 785		19.25
	5 825		19.25
	5 190	HT40	38.55
	5 230		38.44
	5 755		38.44
	5 795		38.32
2	5 180	HT20	19.25
	5 220		19.39
	5 240		19.18
	5 745		19.03
	5 785		19.18
	5 825		19.18
	5 190	HT40	38.44
	5 230		38.32
	5 755		38.44
	5 795		38.55
3	5 180	HT20	19.47
	5 220		19.18
	5 240		19.25
	5 745		19.18
	5 785		19.10
	5 825		19.18
	5 190	HT40	38.32
	5 230		38.21
	5 755		38.44
	5 795		38.32

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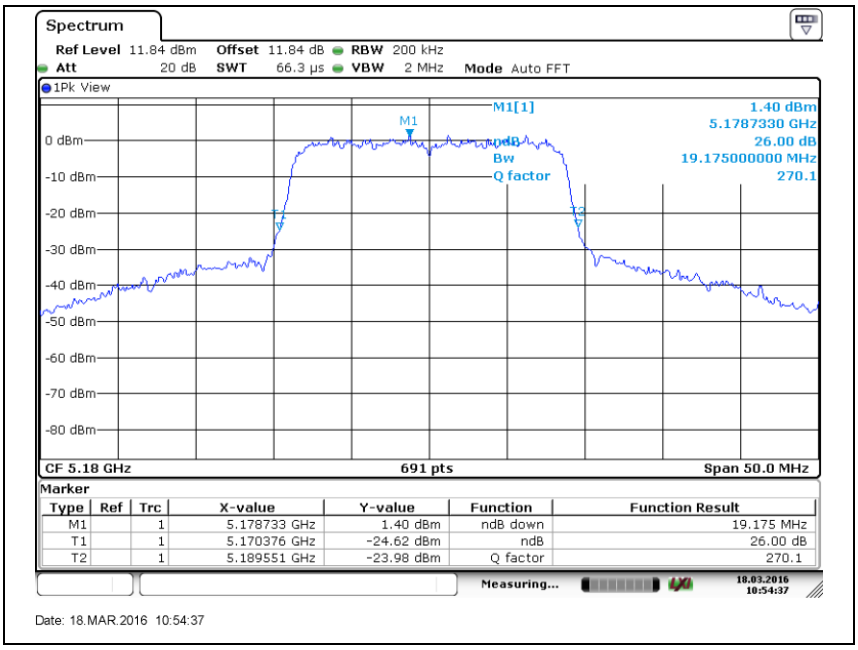
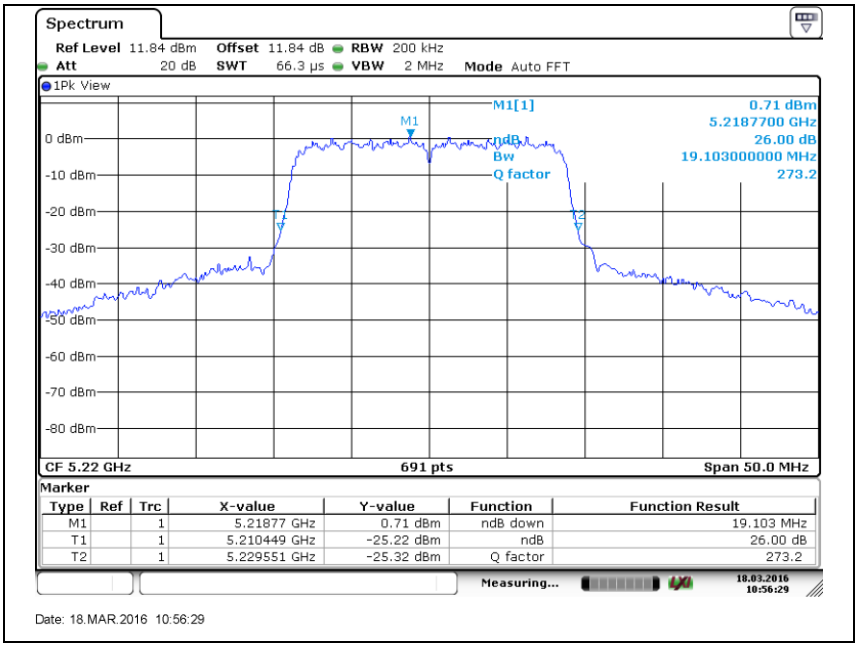
- Antenna port 1

Channel 36



Channel 44



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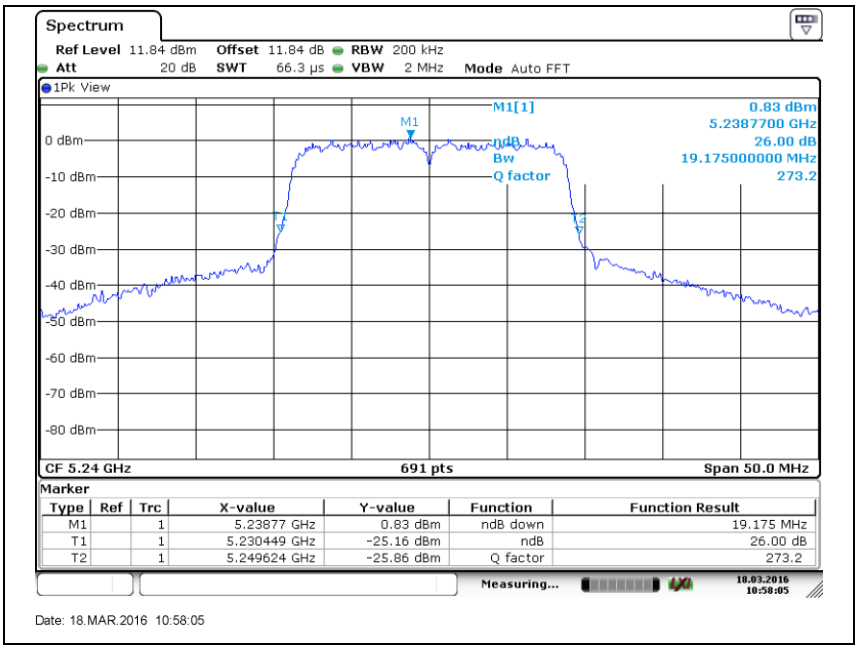

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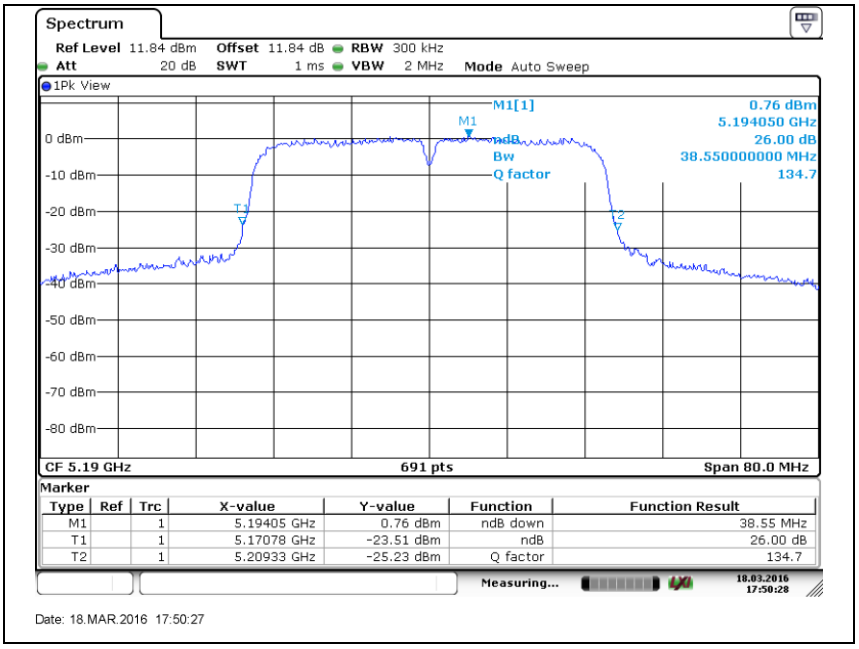

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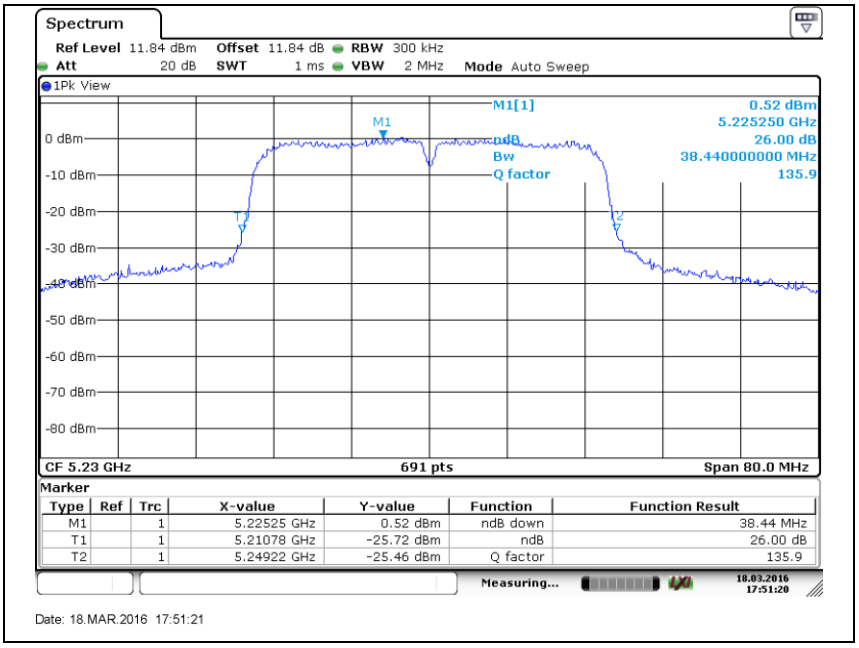

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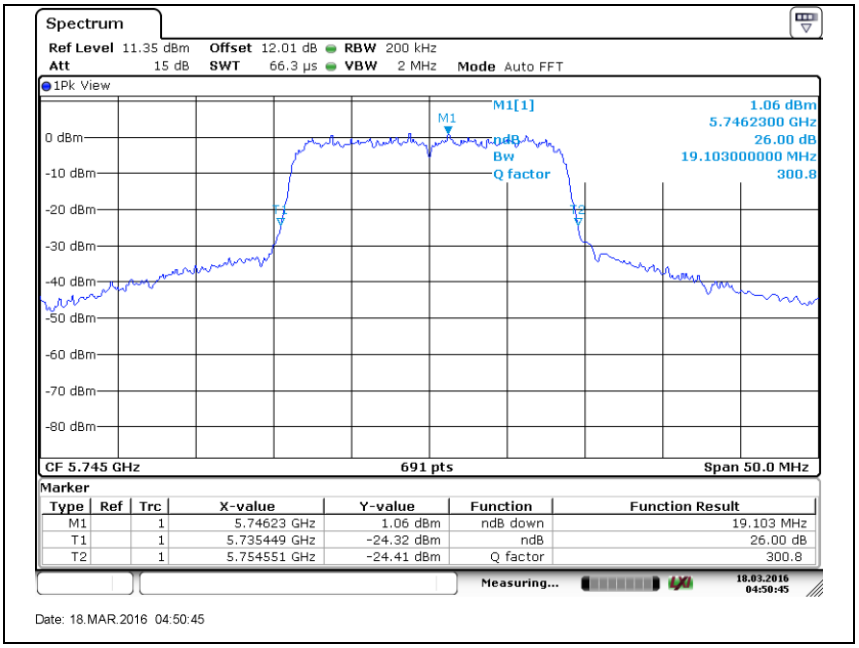

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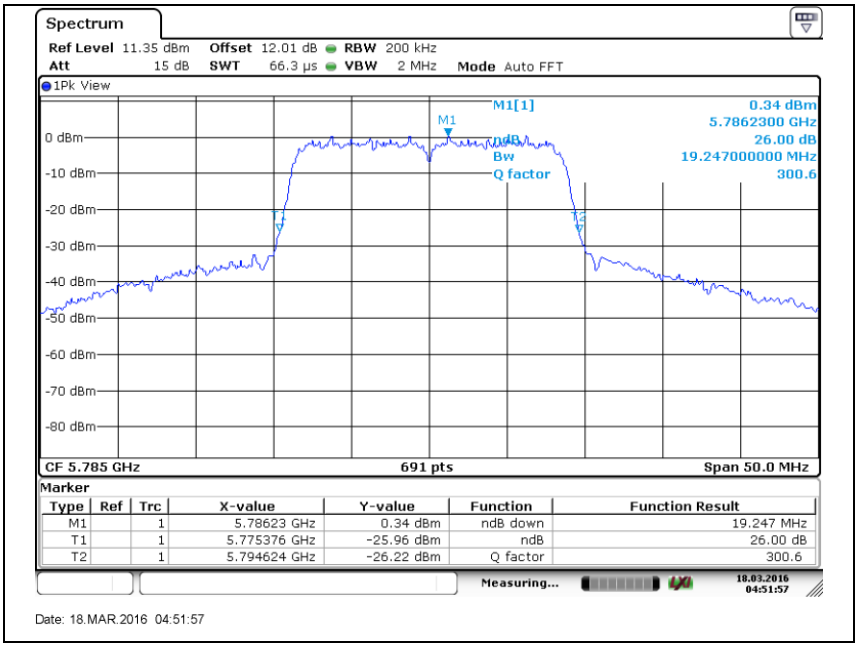

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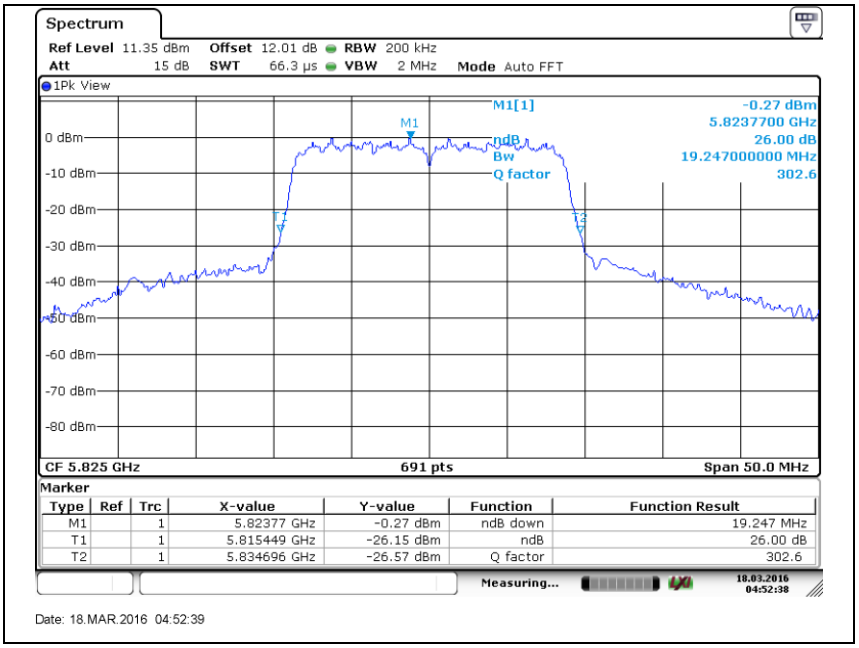

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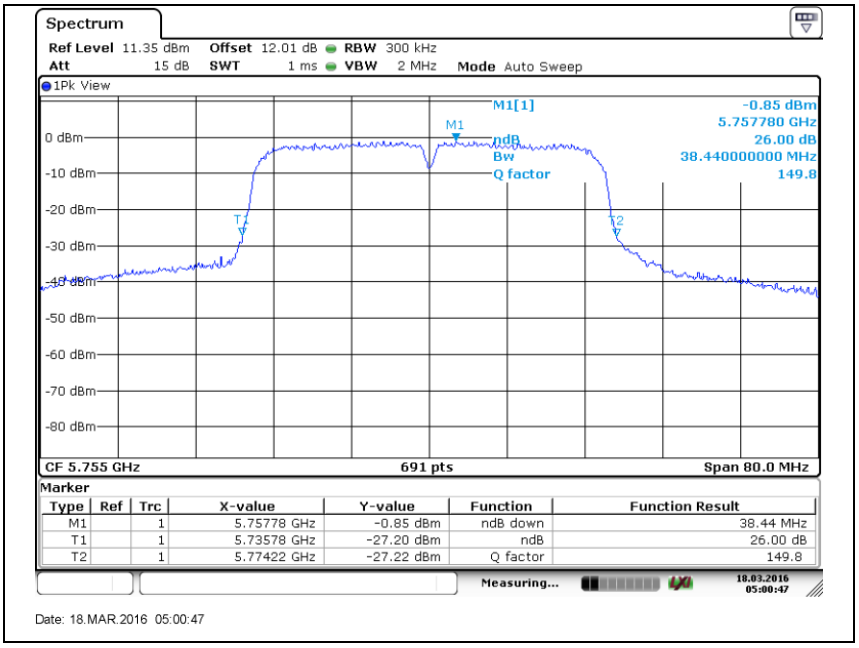

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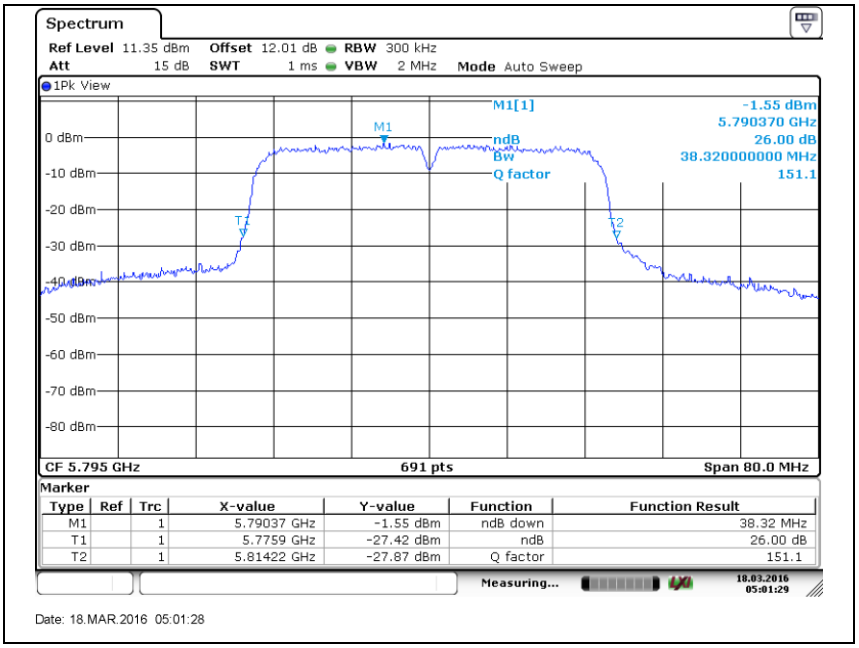

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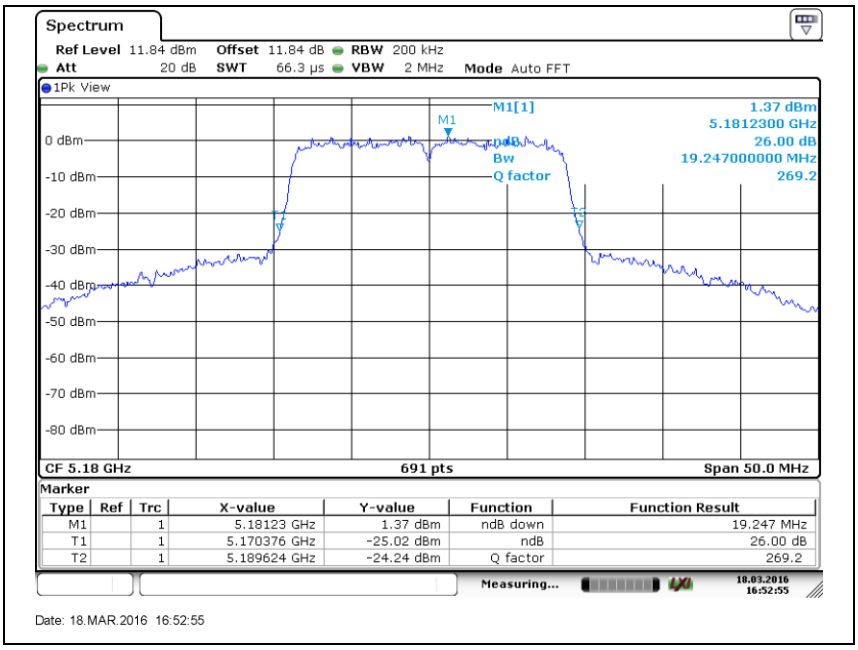
- Antenna port 2

Channel 36



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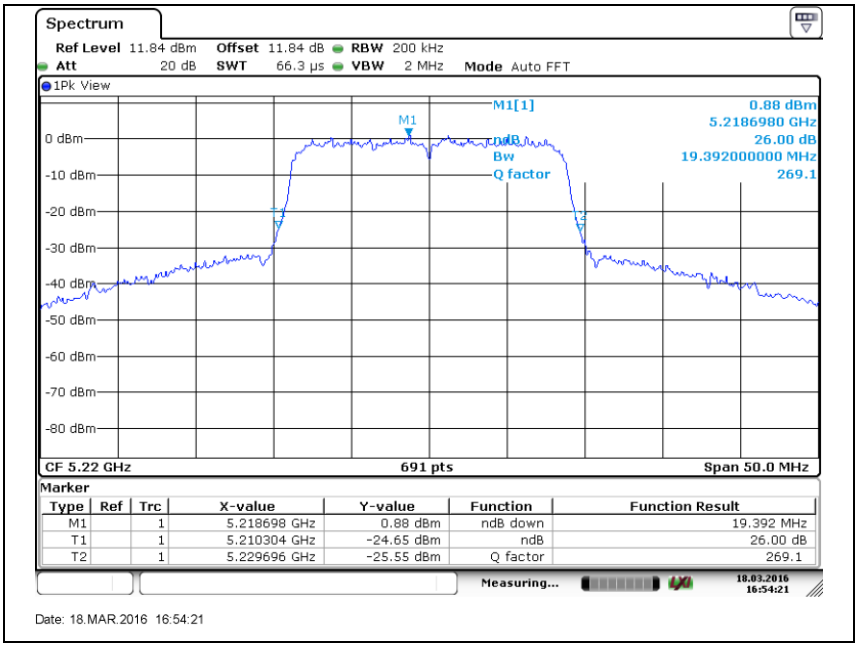

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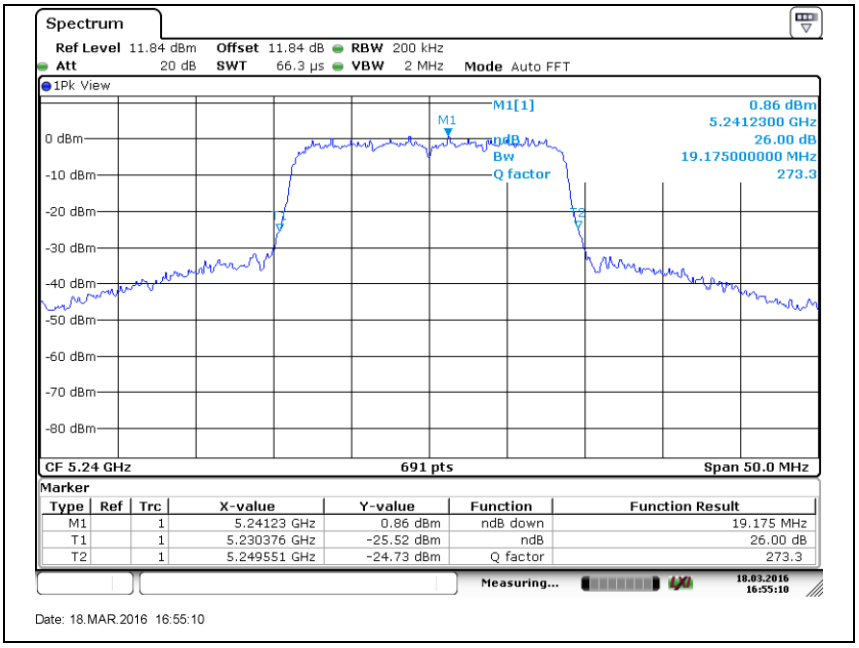

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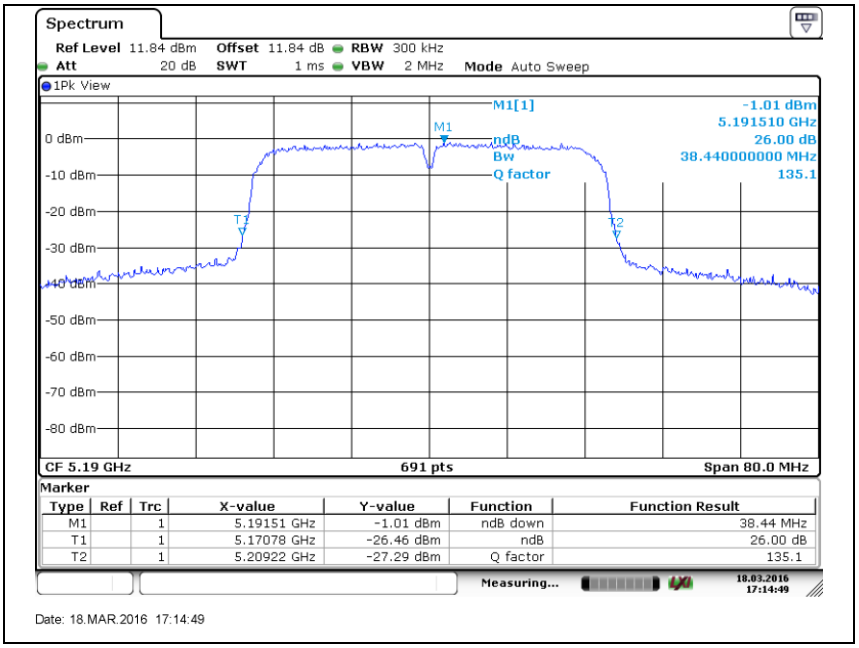

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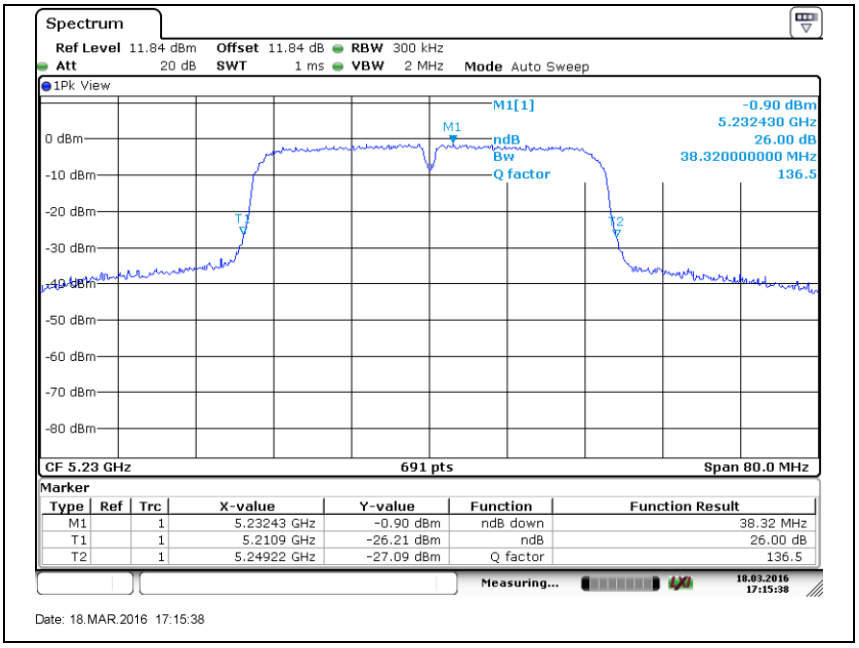

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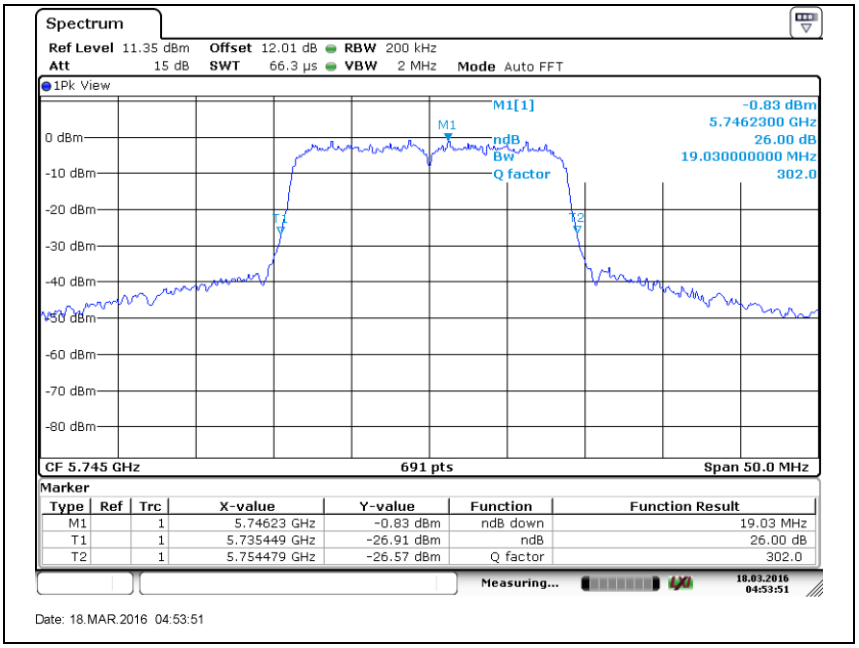

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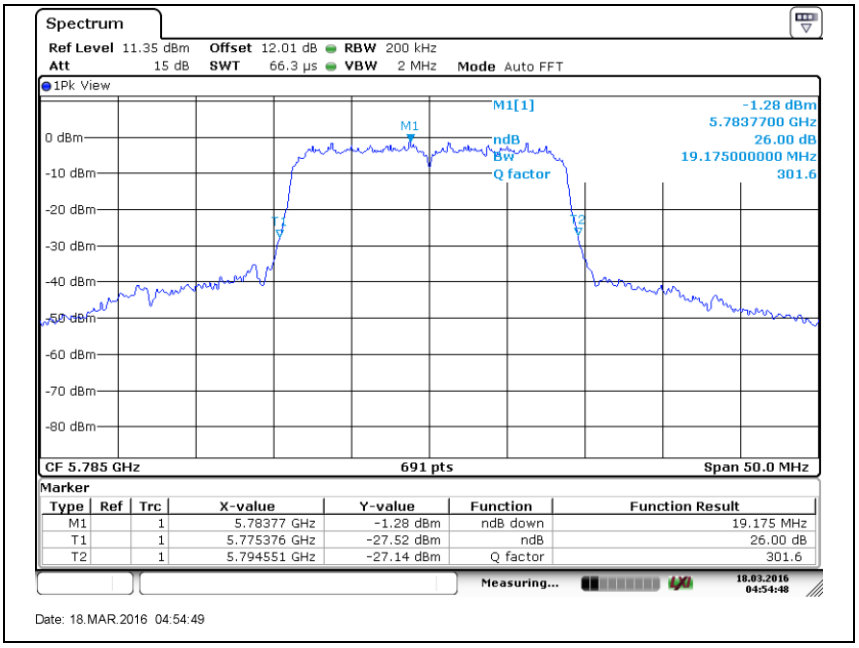

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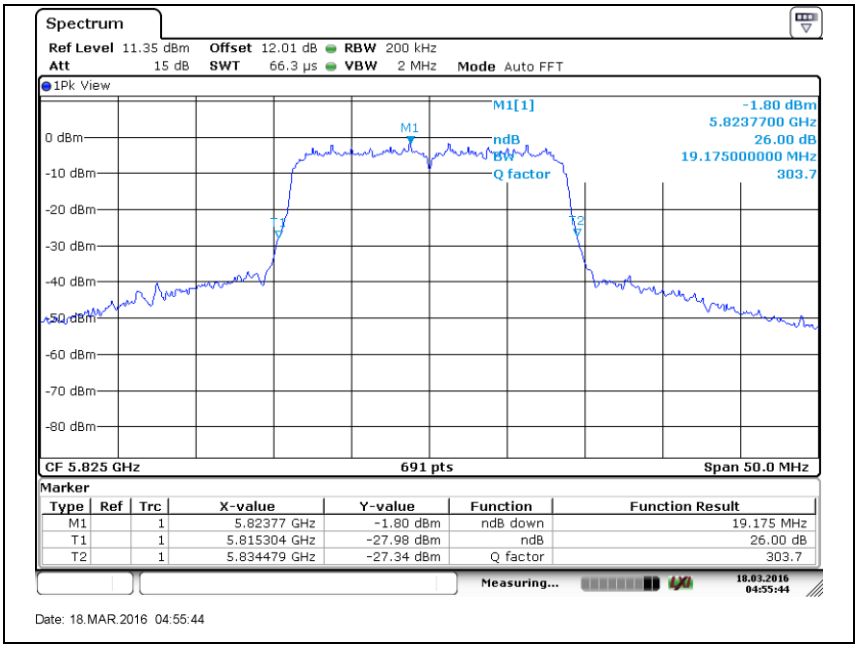

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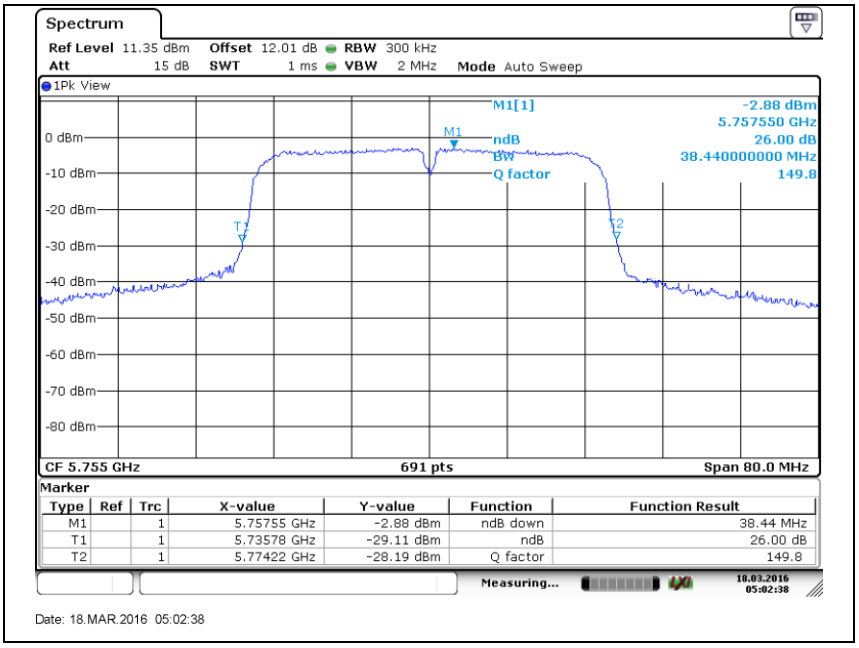

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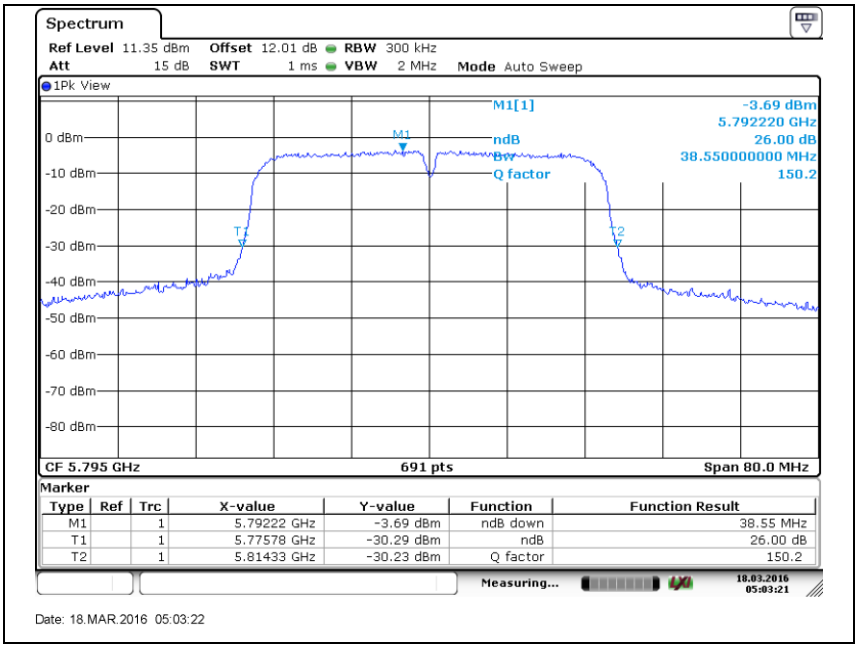

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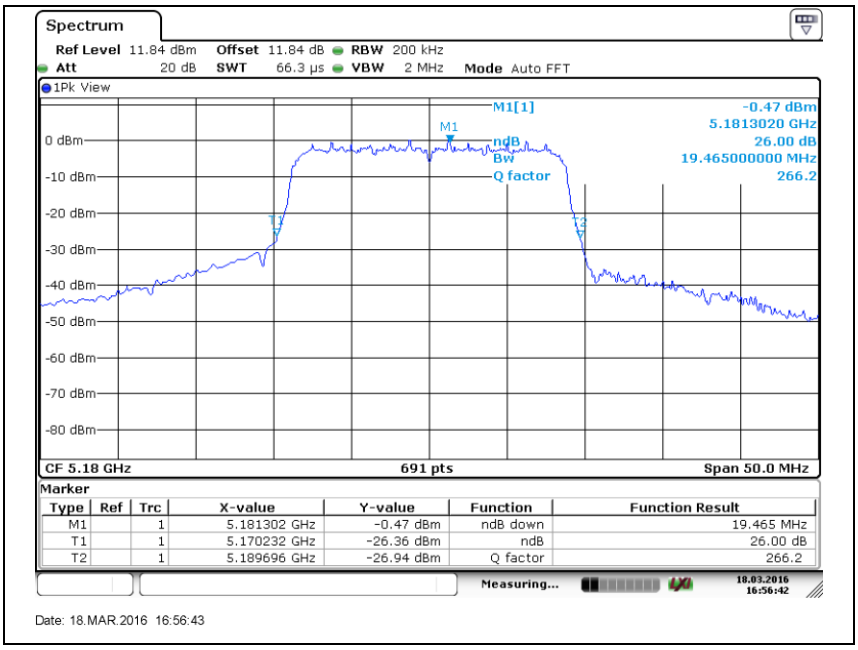
- Antenna port 3

Channel 36



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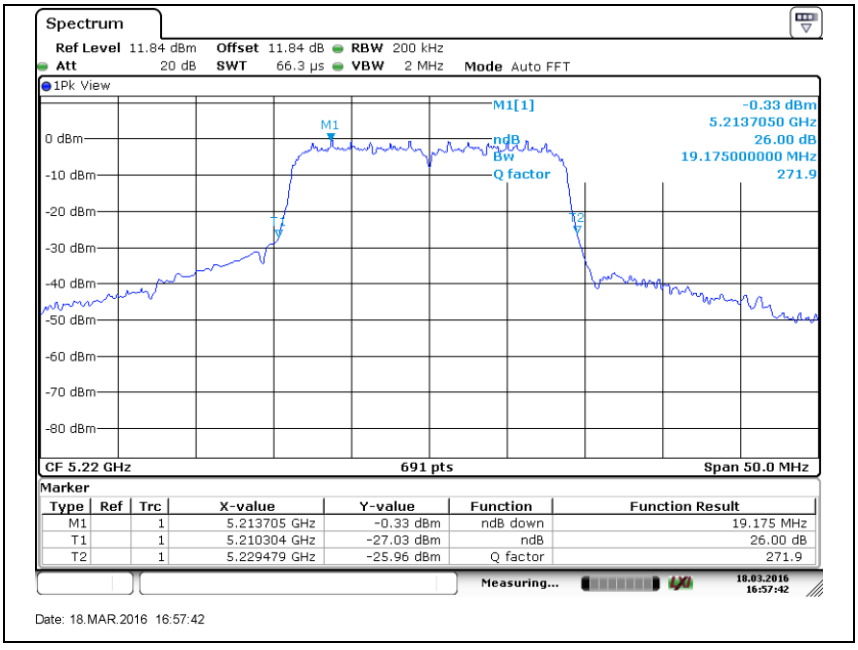

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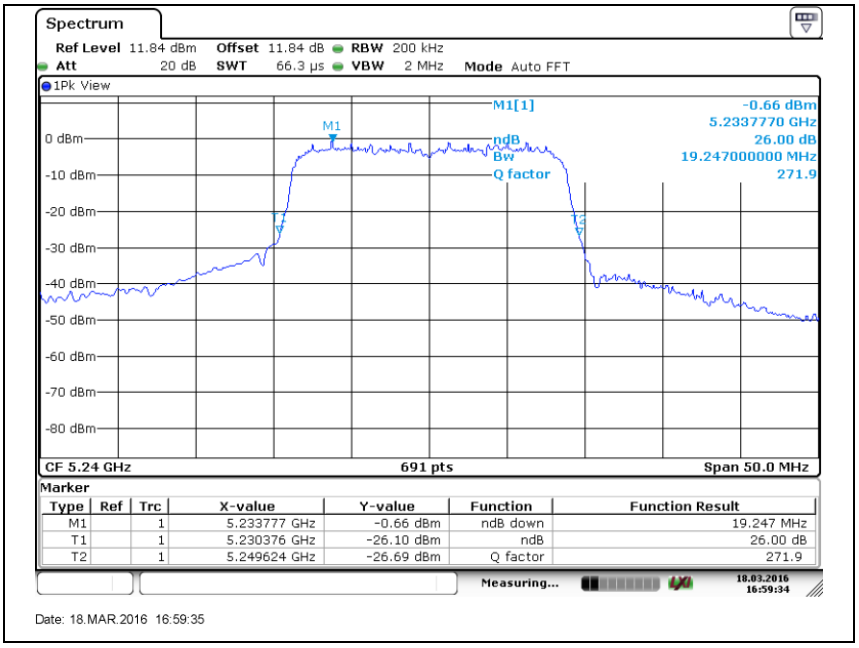

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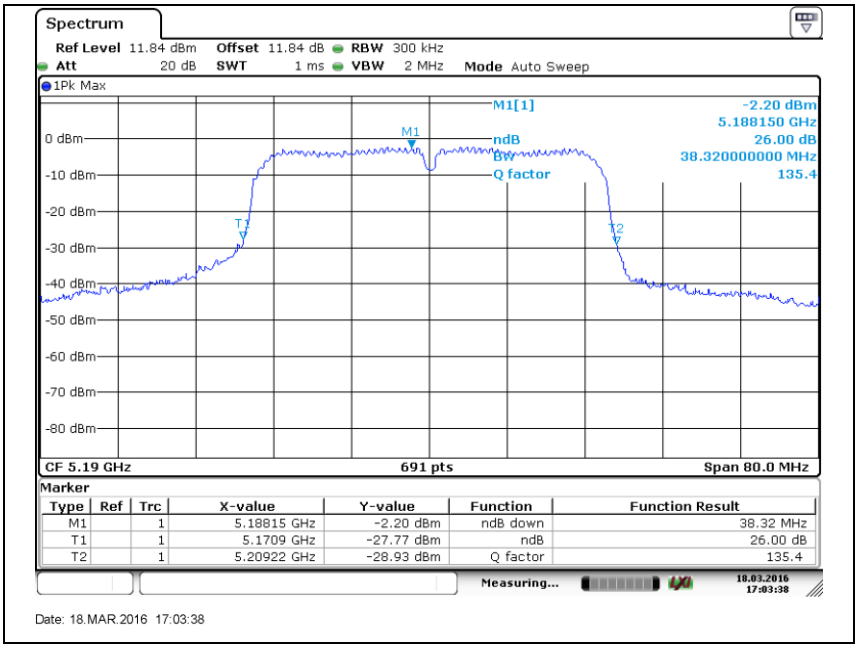

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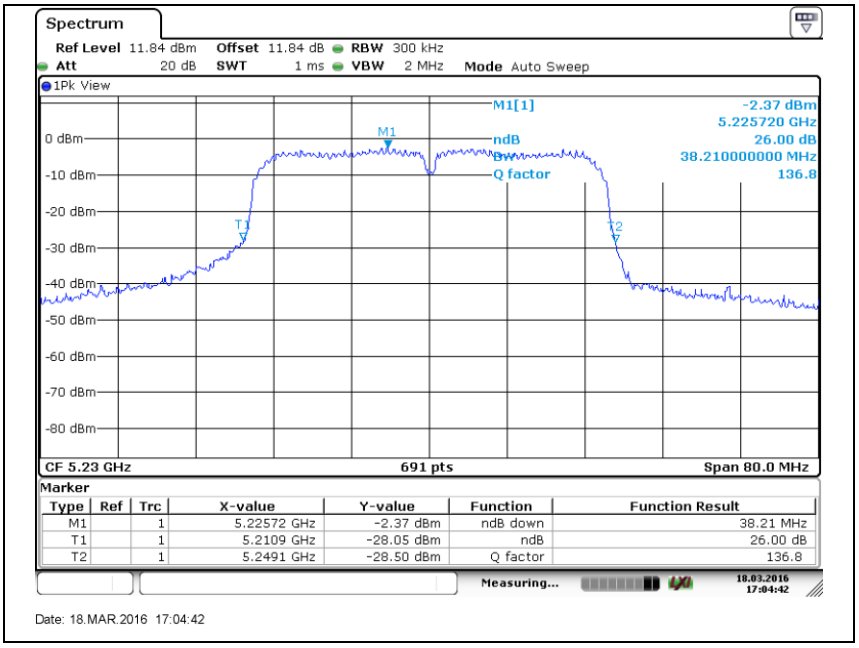

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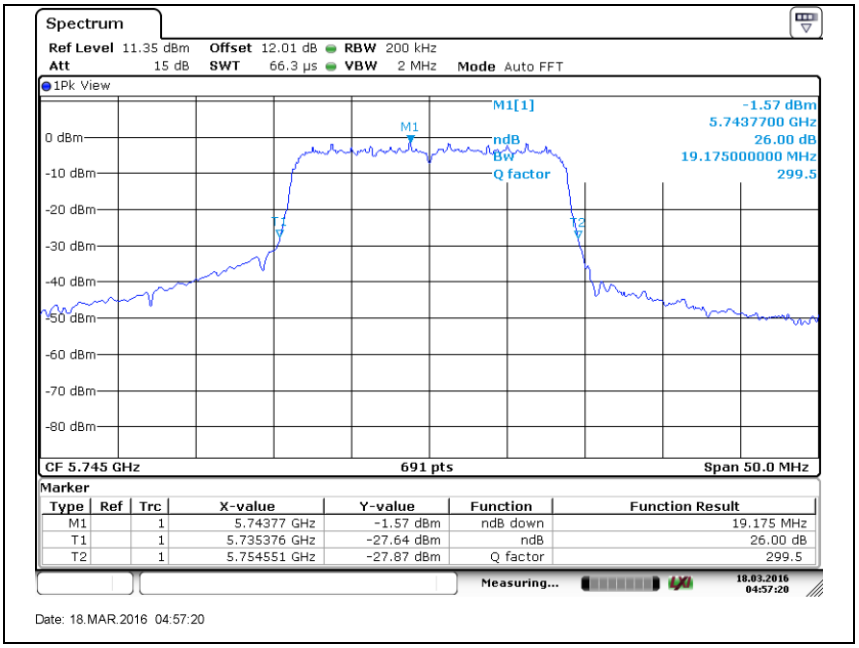

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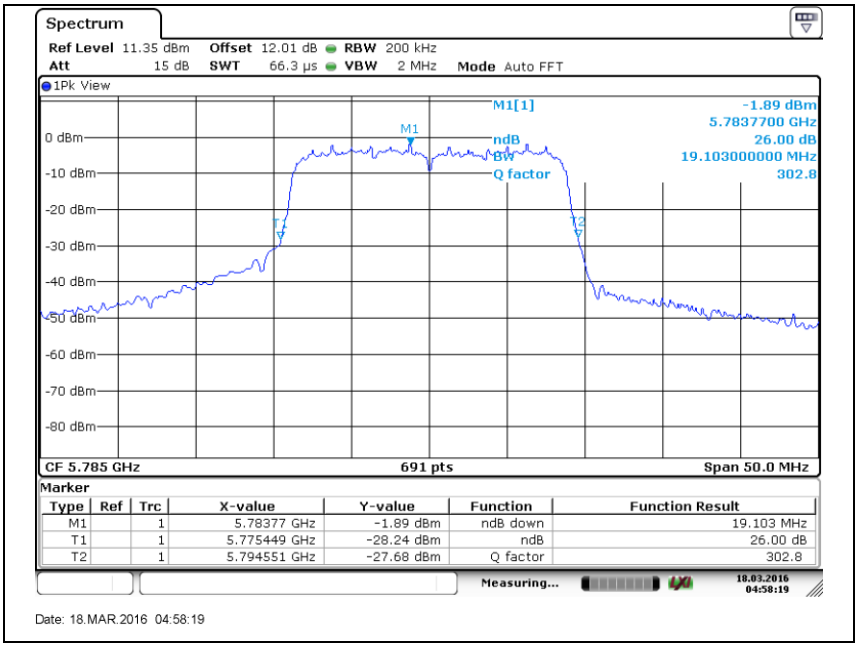

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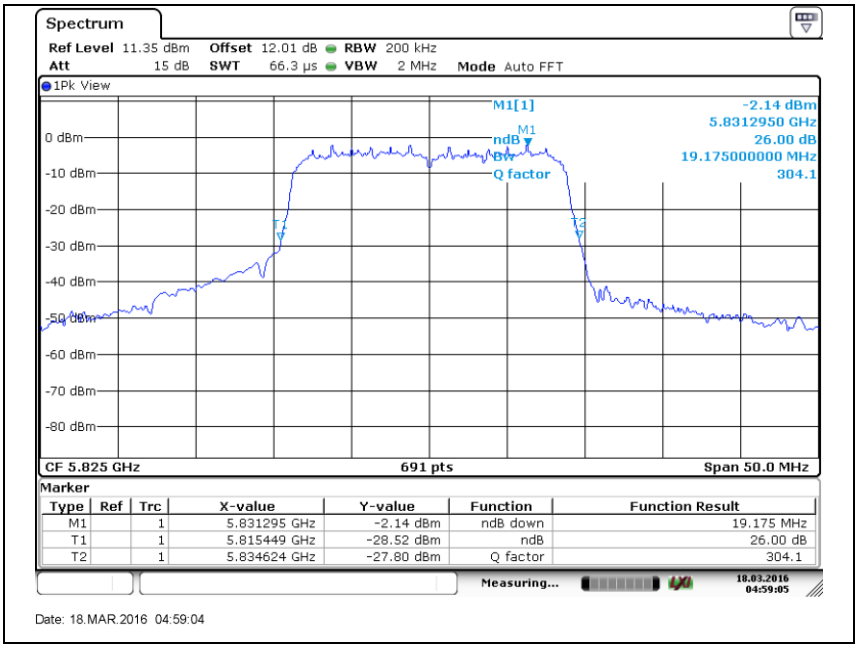

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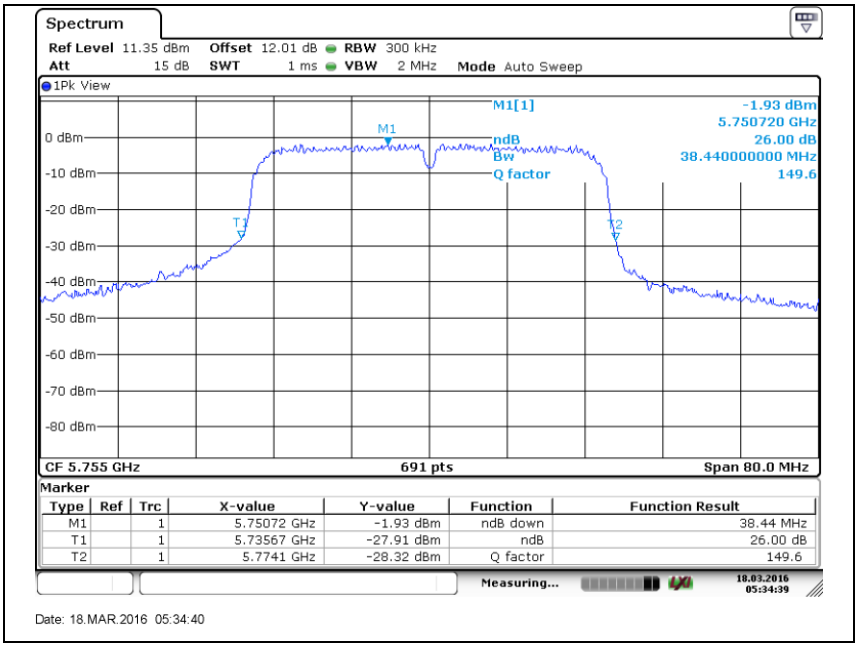
Channel 151



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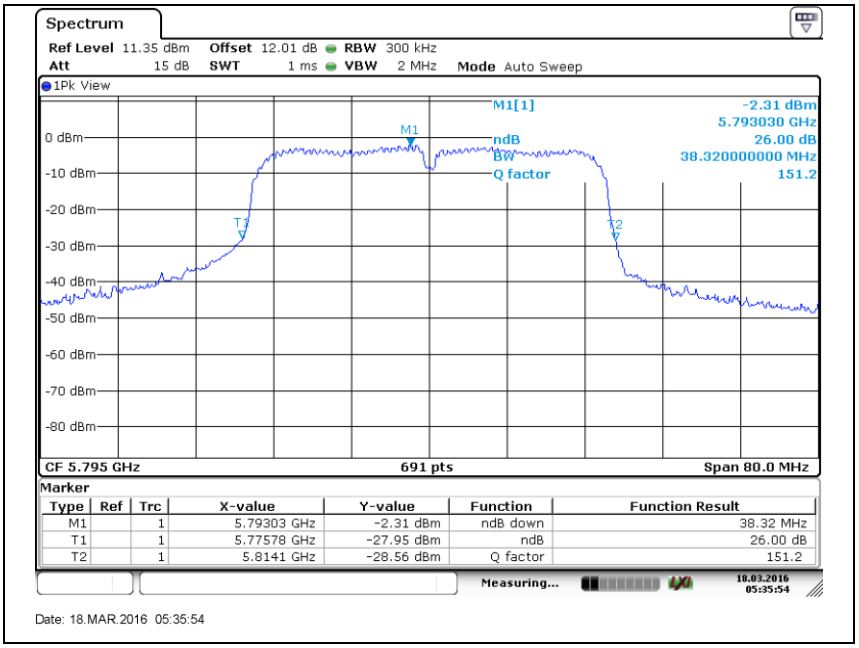

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3.2. 6 dB bandwidth

Test procedure

KDB 789033 D02 v01r01– Section C.2

1. Set RBW = 100 ㎑
2. Set the video bandwidth (VBW) ≥ 3 × RBW.
3. Detector = peak.
4. Sweep = auto couple.
5. Allow the trace to stabilize
6. 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.

Limit

Within the 5.725-5.85 ㎓ band, the minimum 6 ㏈ bandwidth of U-NII devices shall be at least ㎑.

Test results

Antenna	Frequency(㎒)	Mode	6 ㏈ bandwidth(㎒)
1	5 745	HT20	16.28
	5 785		16.21
	5 825		16.14
	5 755	HT40	34.04
	5 795		34.15
2	5 745	HT20	16.35
	5 785		16.35
	5 825		16.35
	5 755	HT40	34.15
	5 795		34.04
3	5 745	HT20	16.35
	5 785		16.28
	5 825		16.28
	5 755	HT40	33.92
	5 795		34.04

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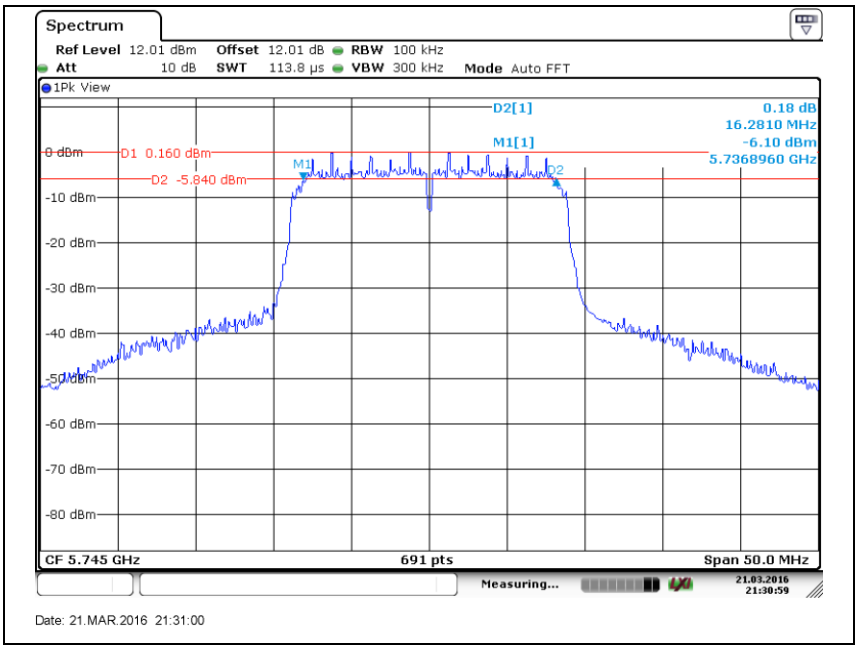
- Antenna port 1

Channel 149



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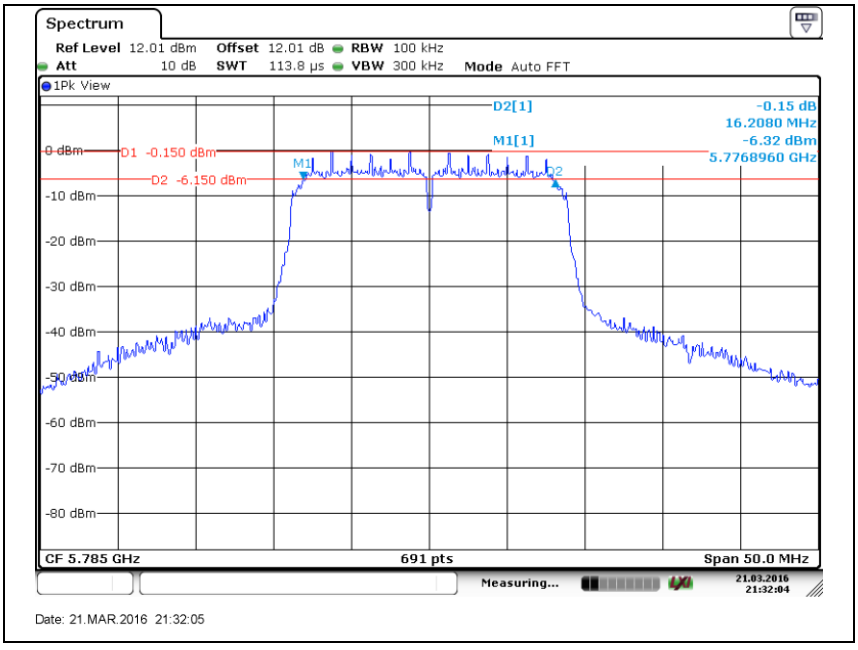

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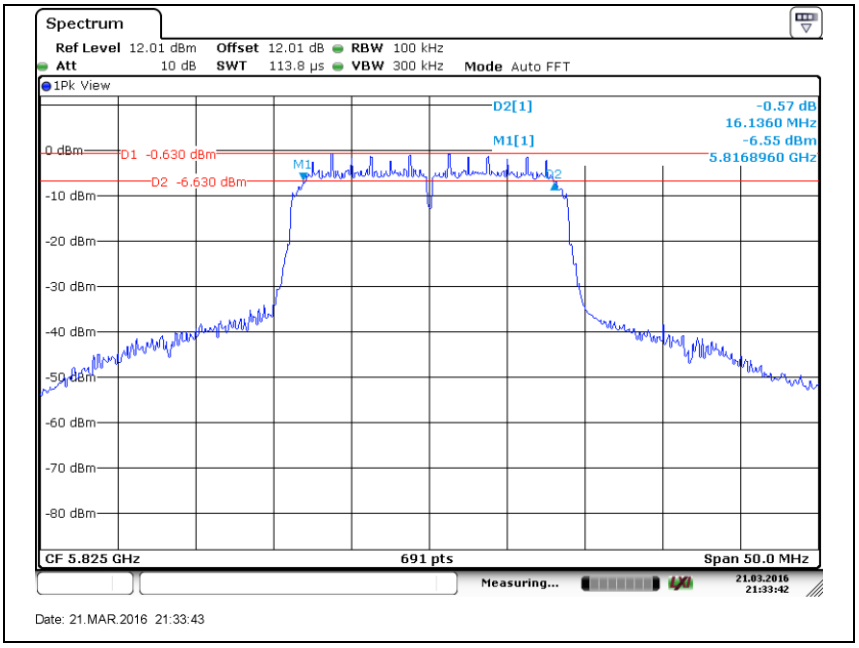
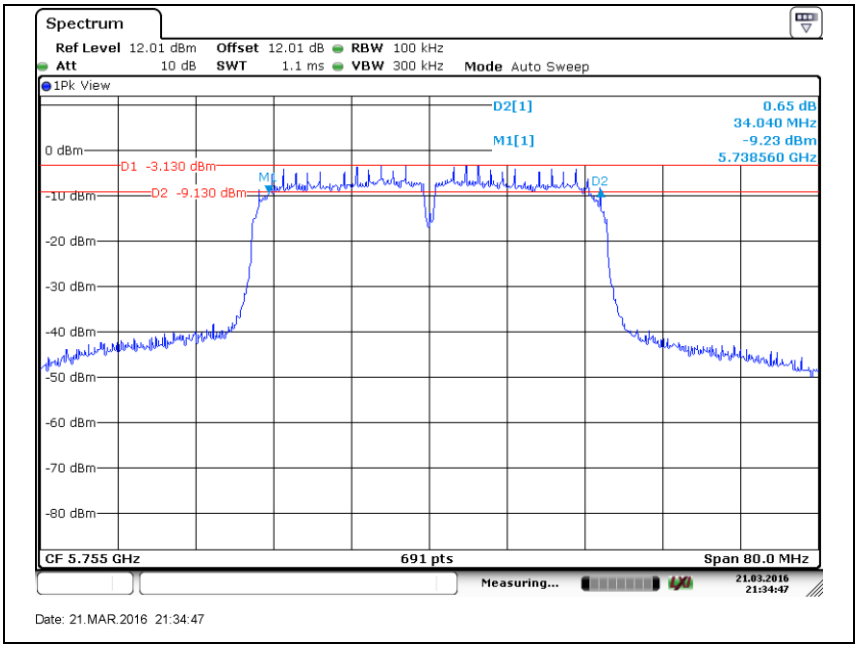
Channel 165



Channel 151



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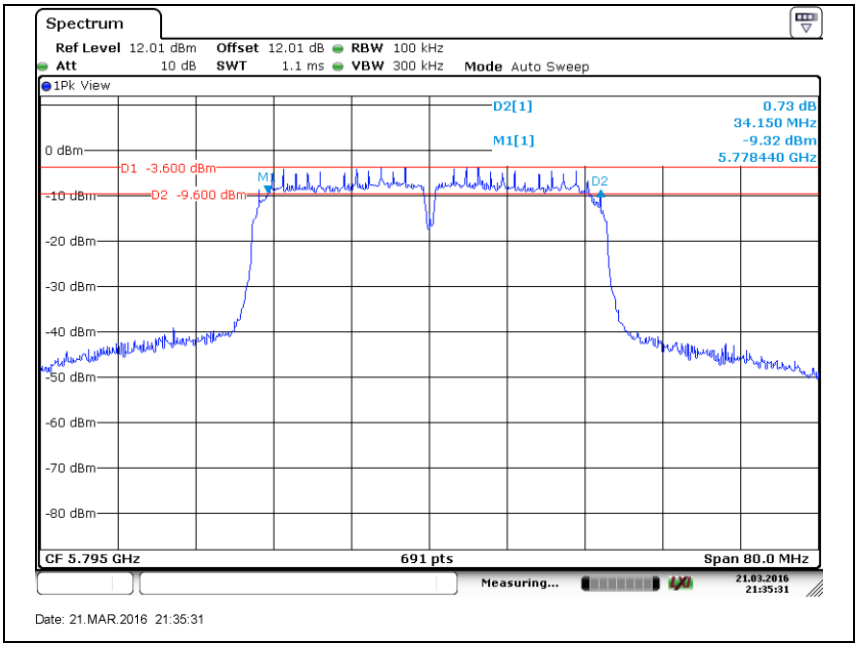
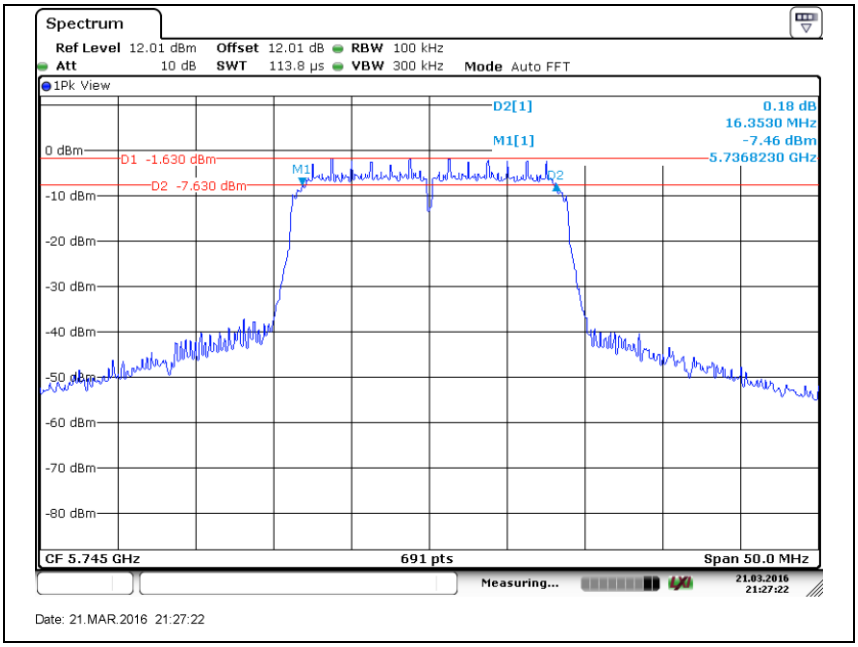
Channel 159



- Antenna port 2

Channel 149



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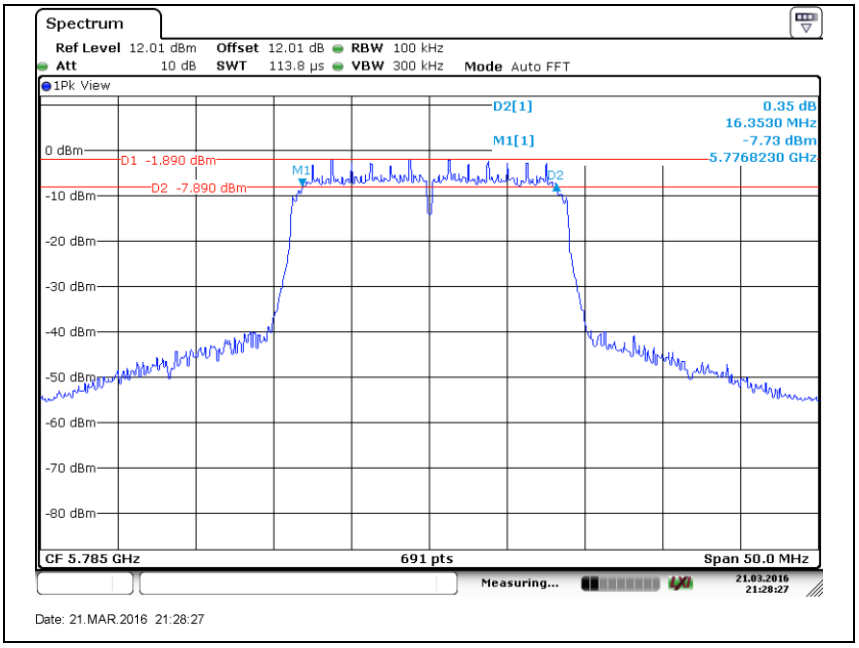
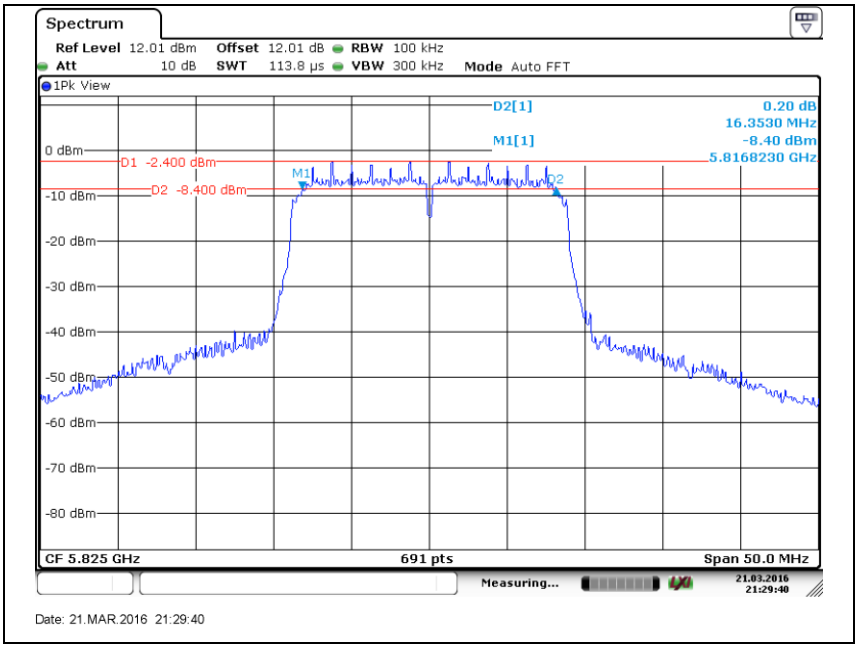
Channel 157



Channel 165



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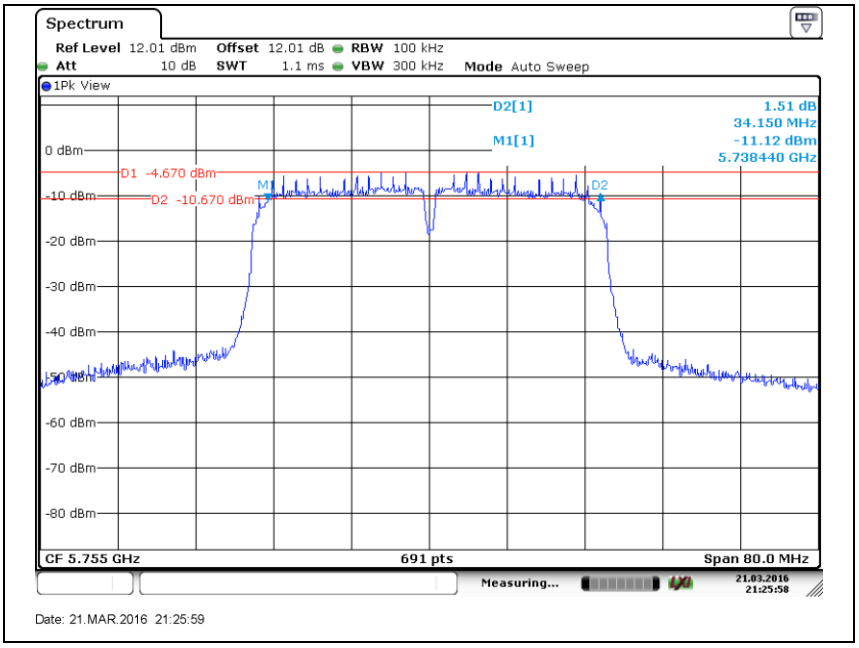
Channel 151



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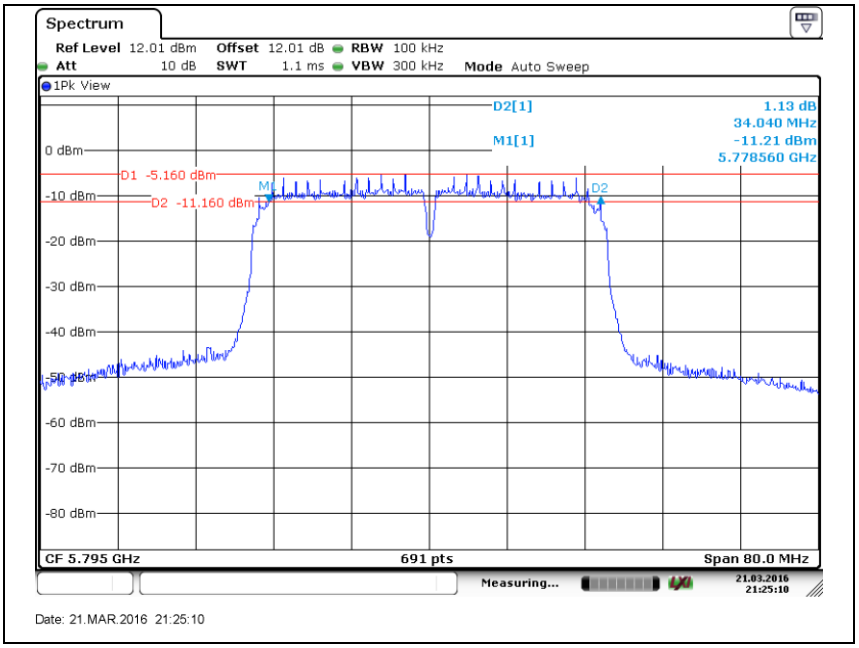

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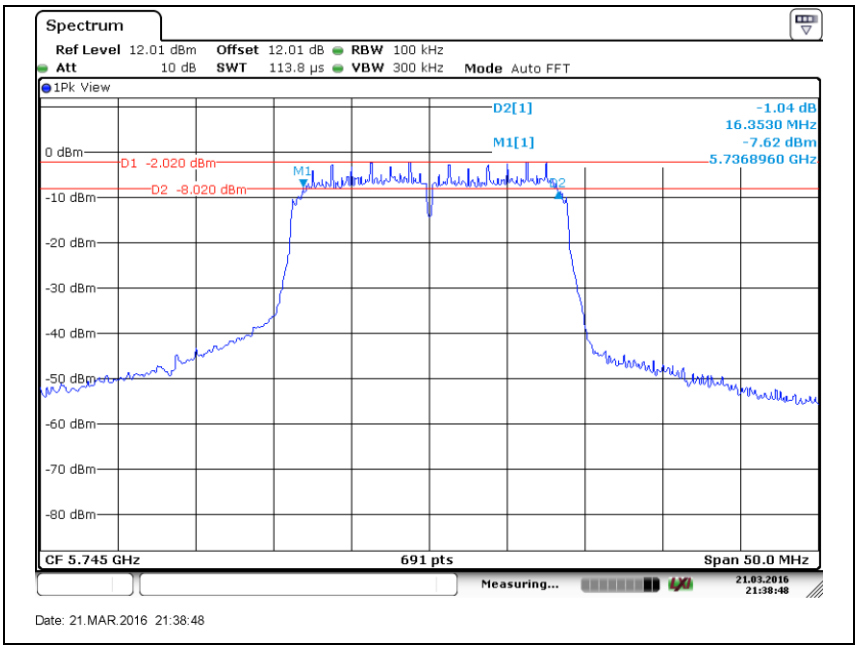
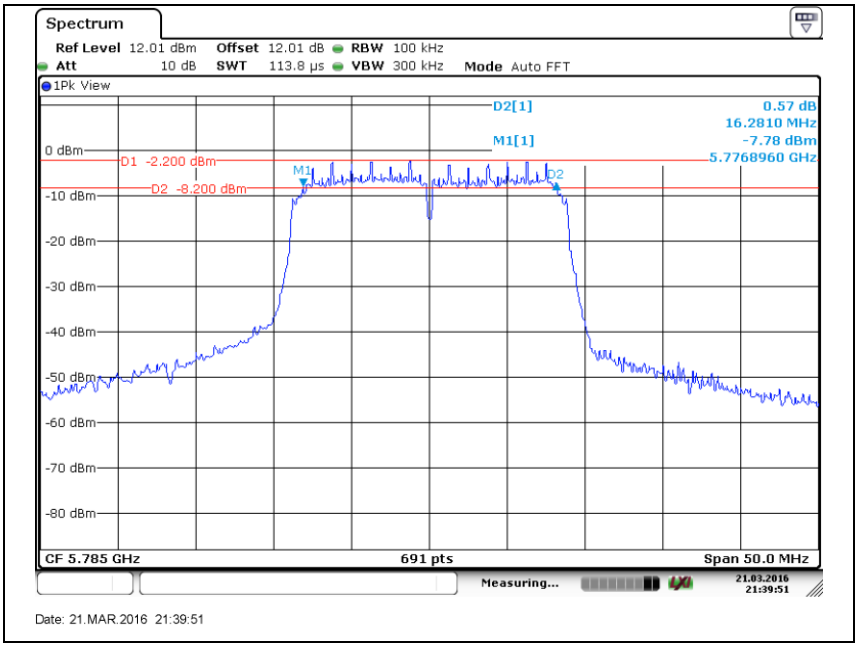
- Antenna port 3

Channel 149



Channel 157



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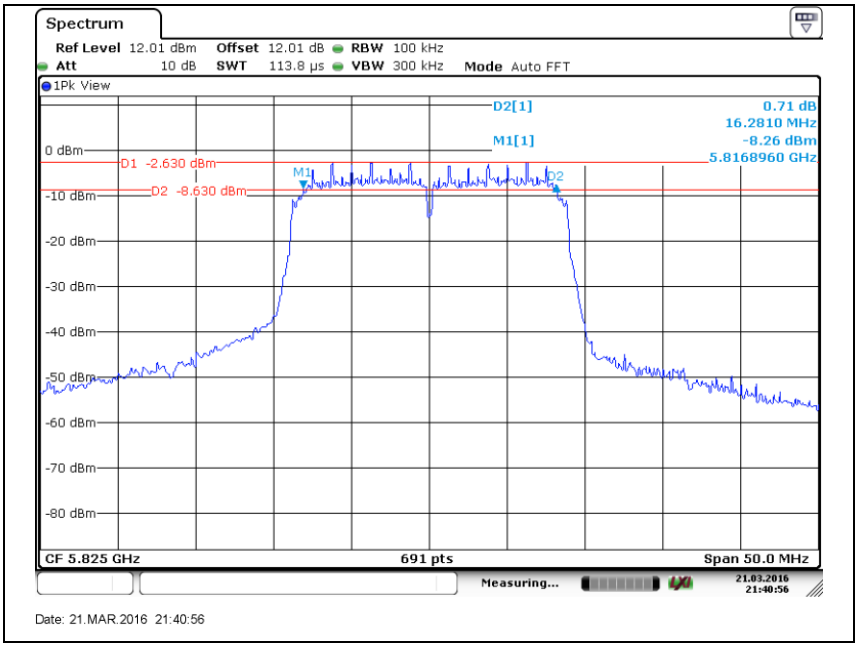
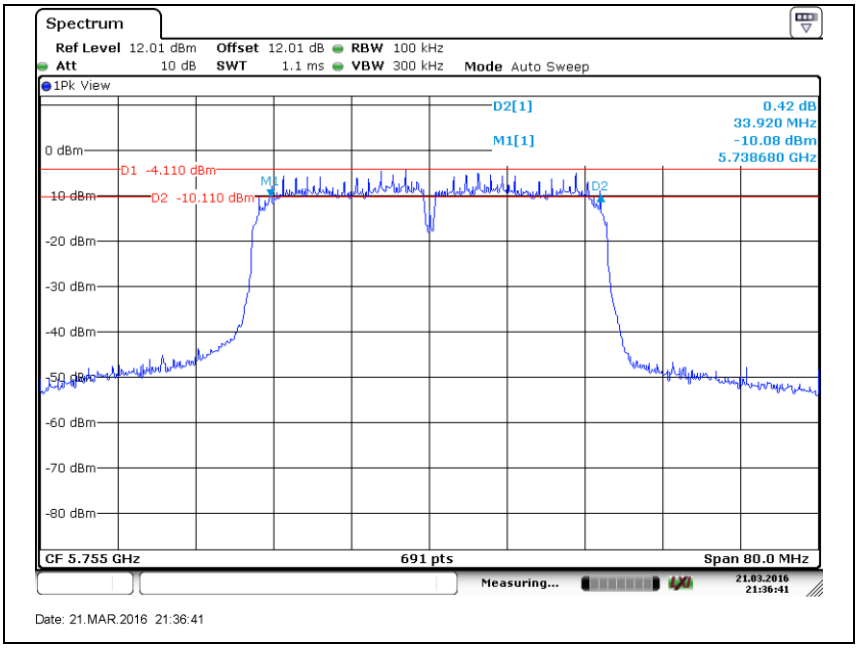
Channel 165



Channel 151



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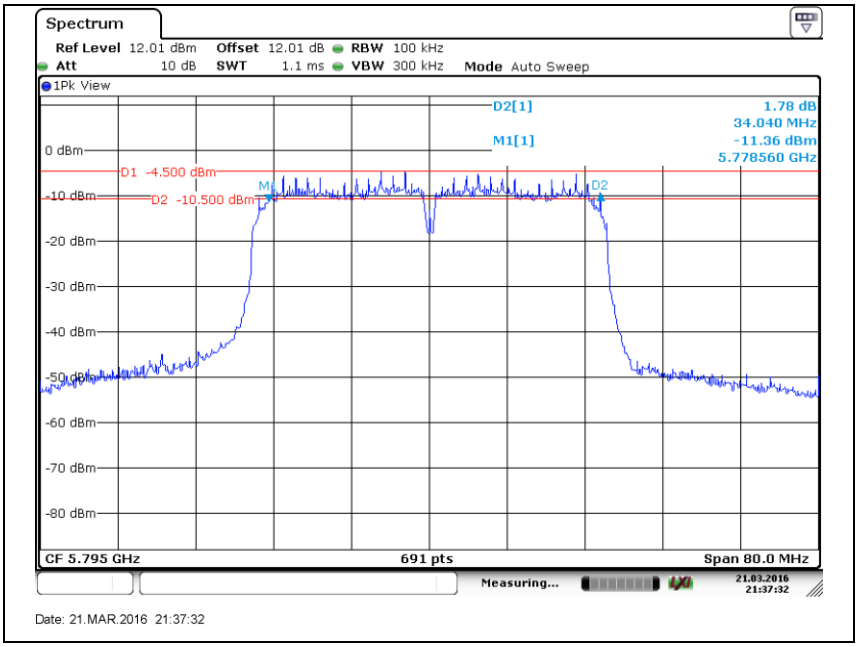
Channel 159



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3.3. Maximum conducted output power

Test procedure

KDB 789033 D02 v01r01– Section E.3.a) or b)

Method PM (Measurement using an RF average power meter):

i. 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.

ii. If the transmitter does not transmit continuously, measure the duty cycle, x, of the transmitter output signal as described in section II.B.

iii. Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.

iv. Adjust the measurement in dBm by adding 10 log (1/x) where x is the duty cycle (e.g., 10 log (1/0.25) if the duty cycle is 25 %).

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.

Limit

Band	EUT Category		Limit
UNII-1		Outdoor access point	1 W (30 dBm)
		Indoor access point	
		Fixed point-to-point access point	
	✓	Mobile and portable client device	250 mW(24 dBm)
UnII-2A			250 mW or 11 dBm + 10logB*
UNII-2C			250 mW or 11 dBm + 10logB*
UNII-3	✓		1 W (30 dBm)

Note.

1. B is the 26 dB emission bandwidth.

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Test results

Frequency (㎒)	Detector mode	Output power(㏈m)					Limit (㏈m)
		Antenna					
		1	2	3	DCF Note1	Sum 1+2+3 Note2	
5 180	AV	11.15	10.63	10.28	0.083	15.56	24
5 220	AV	10.59	10.59	10.01		15.26	
5 240	AV	10.52	10.70	9.36		15.09	
5 190	AV	10.72	9.73	9.55		14.89	
5 230	AV	10.26	10.01	8.75		14.58	
5 745	AV	11.37	10.15	10.21	0.246	15.63	29.85 Note3
5 785	AV	10.94	10.32	9.37		15.27	
5 825	AV	10.75	9.49	9.22		14.89	
5 755	AV	10.30	9.43	8.90		14.60	
5 795	AV	10.32	10.00	9.82		15.07	

Note.

1. Refer to the page 59 on this report.
2. $10\log(10^{\text{Antenna 1+DCF/10}} + 10^{\text{Antenna 2+DCF//10}} \cdots 10^{\text{Antenna N+DCF/10}})$
3. Limit is reduced by 0.15 ㏈ because, Directional gain greater than 6 ㏈i are used.

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3.4. Power spectral density

Test procedure

KDB 789033 D02 v01r01 – Section F

1. Create an average power spectrum for the EUT operating mode being tested by following the instructions in section II.E.2. for measuring maximum conducted output power using a spectrum analyzer or EMI receiver: select the appropriate test method (SA-1, SA-2, SA-3, or alternatives to each) and apply it up to, but not including, the step labeled, "Compute power…." (This procedure is required even if the maximum conducted output power measurement was performed using a power meter, method PM.)
2. Use the peak search function on the instrument to find the peak of the spectrum and record its value.
3. Make the following adjustments to the peak value of the spectrum, if applicable:
   a) If Method SA-2 or SA-2 Alternative was used, add 10 log (1/x), where x is the duty cycle, to the peak of the spectrum.
   b) If Method SA-3 Alternative was used and the linear mode was used in step II.E.2.g)(viii), add 1 ㏈ to the final result to compensate for the difference between linear averaging and power averaging.
4. The result is the Maximum PSD over 1 ㎒ reference bandwidth.
5. For devices operating in the bands 5.15-5.25 ㎓, 5.25-5.35 ㎓, and 5.47-5.725 ㎓, the above procedures make use of 1 ㎒ RBW to satisfy directly the 1 ㎒ reference bandwidth specified in § 15.407(a)(5). For devices operating in the band 5.725-5.85 ㎓, the rules specify a measurement bandwidth of 500 ㎑. Many spectrum analyzers do not have 500 ㎑ RBW, thus a narrower RBW may need to be used. The rules permit the use of a RBWs less than 1 ㎒, or 500 ㎑, "provided that the measured power is integrated over the full reference bandwidth" to show the total power over the specified measurement bandwidth (i.e., 1 ㎒, or 500 ㎑). If measurements are performed using a reduced resolution bandwidth (< 1 ㎒, or < 500 ㎑) and integrated over 1 ㎒, or 500 ㎑ bandwidth, the following adjustments to the procedures apply:

   a) Set RBW ≥ 1/T, where T is defined in section II.B.l.a)
   b) Set VBW ≥ 3 RBW.
   c) If measurement bandwidth of Maximum PSD is specified in 500 ㎑, add 10 log (500 ㎑/RBW) to the measured result, whereas RBW (< 500 ㎑) is the reduced resolution bandwidth of the spectrum analyzer set during measurement.
   d) If measurement bandwidth of Maximum PSD is specified in 1 ㎒, add 10 log (1 ㎒/RBW) to the measured result, whereas RBW (< 1 ㎒) is the reduced resolution bandwidth of spectrum analyzer set during measurement.
   e) Care must be taken to ensure that the measurements are performed during a period of continuous transmission or are corrected upward for duty cycle.

Note.

As a practical matter, it is recommended to use reduced RBW of 100 ㎑ for the sections 5.c) and 5.d) above, since RBW=100 ㎑ is available on nearly all spectrum analyzers.

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Limit

Band	EUT Category		Limit
UNII-1		Outdoor access point	17 dBm/㎒
		Indoor access point	
		Fixed point-to-point access point	
	✓	Mobile and portable client device	11 dBm/㎒
UNII-2A			11 dBm/㎒
UNII-2C			11 dBm/㎒
UNII-3	✓		30 dBm/500 ㎑

Test results

Frequency (㎒)	PSD(dBm)					
	Antenna					
	1	2	3	RBWF Note1	DCF Note2	Sum 1+2+3
5 180	-0.70	-0.10	-0.24	-	0.083	4.52
5 220	-0.71	-0.28	-0.67	-		4.31
5 240	-0.56	-0.17	-1.16	-		4.24
5 190	-3.73	-3.86	-4.24	-		0.92
5 230	-3.73	-3.90	-4.53	-		0.81
5 745	-3.38	-3.97	-5.07	-	0.246	0.93
5 785	-3.74	-4.32	-5.15	-		0.65
5 825	-4.09	-4.89	-5.60	-		0.20
5 755	-6.10	-7.39	-8.58	-		-2.22
5 795	-6.62	-7.82	-8.27	-		-2.50

Note.

1. UNII-1 = 10log(1 ㎒/1 ㎒)
   UNII-3 = 10log(500 ㎑ /500 ㎑)
2. Refer to the page 58 on this report.
3. Limit is reduced by 0.15 dB because, Directional gain greater than 6 dBi are used.
   Therefore, UNII-3 limit is 29.85dBm/500 ㎑
4. Sum 1+2+3 = $10\log[(10^{\text{Antenna 1+DCF/10}} + 10^{\text{Antenna 2+DCF/10}} + 10^{\text{Antenna 3+DCF/10}})]$+ RBWF

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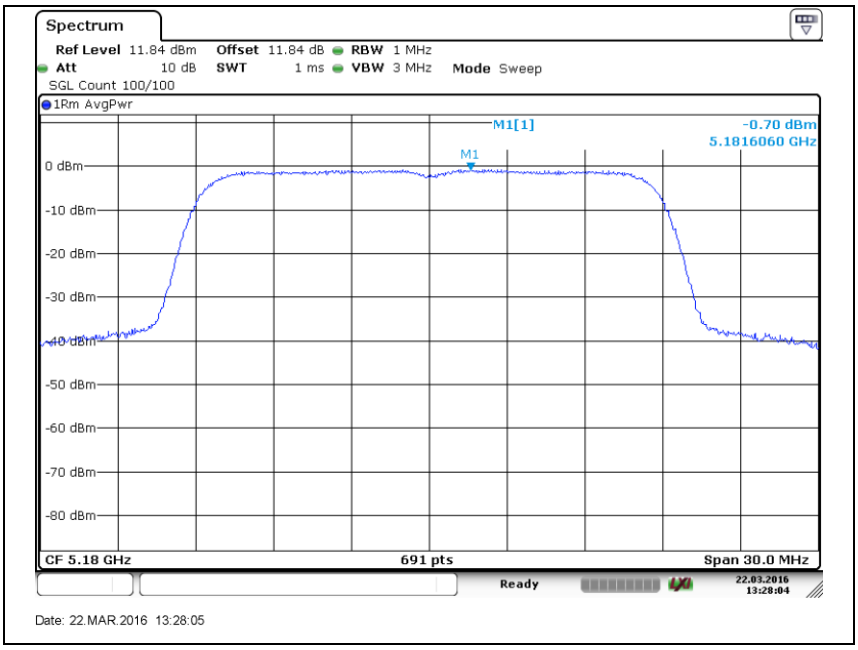
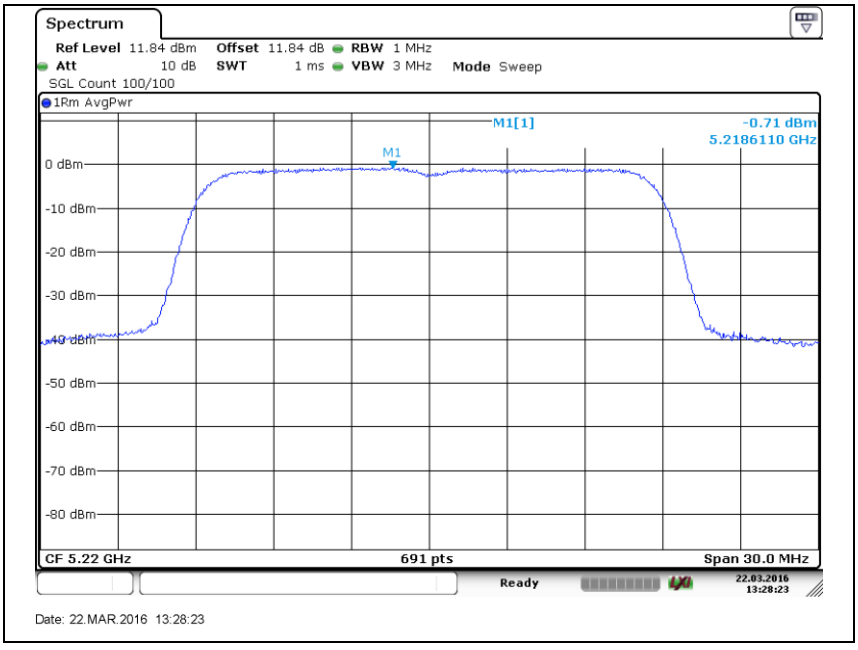
- Antenna port 1

Channel 36



Channel 44



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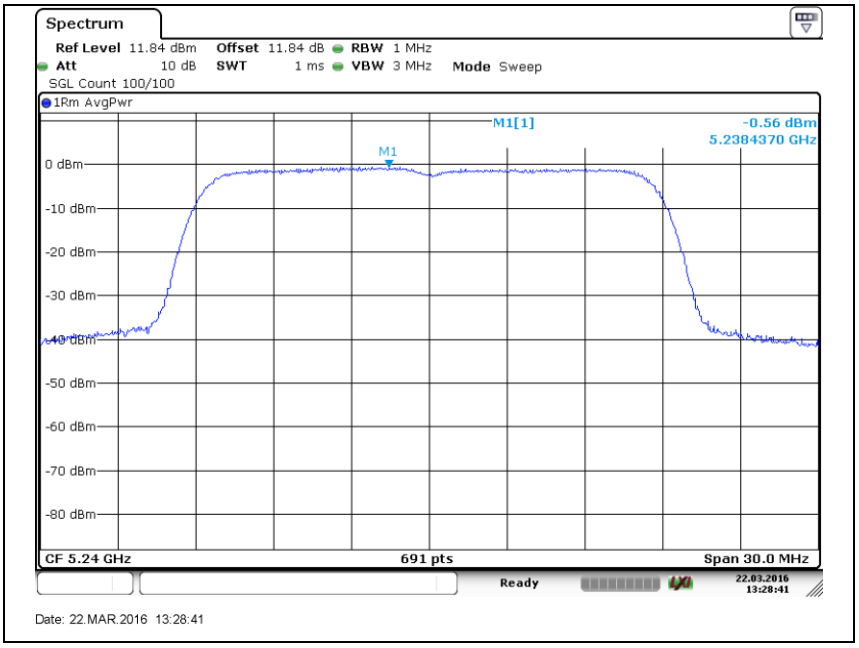
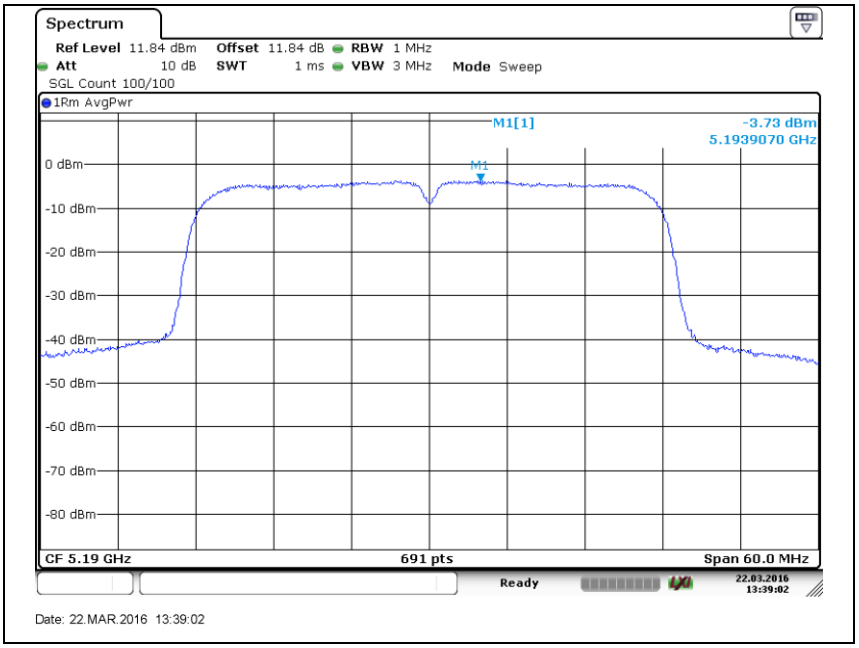
Channel 48



Channel 38



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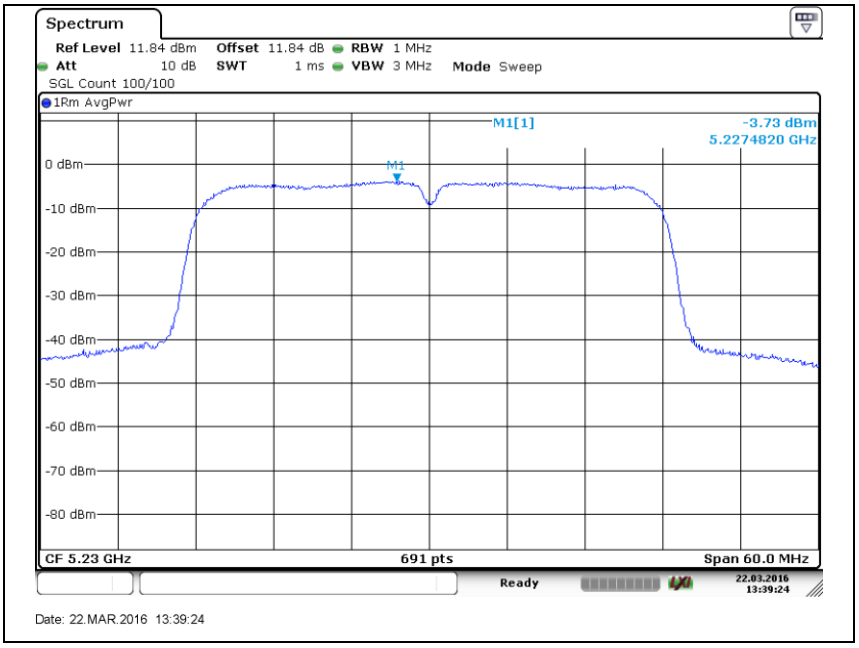
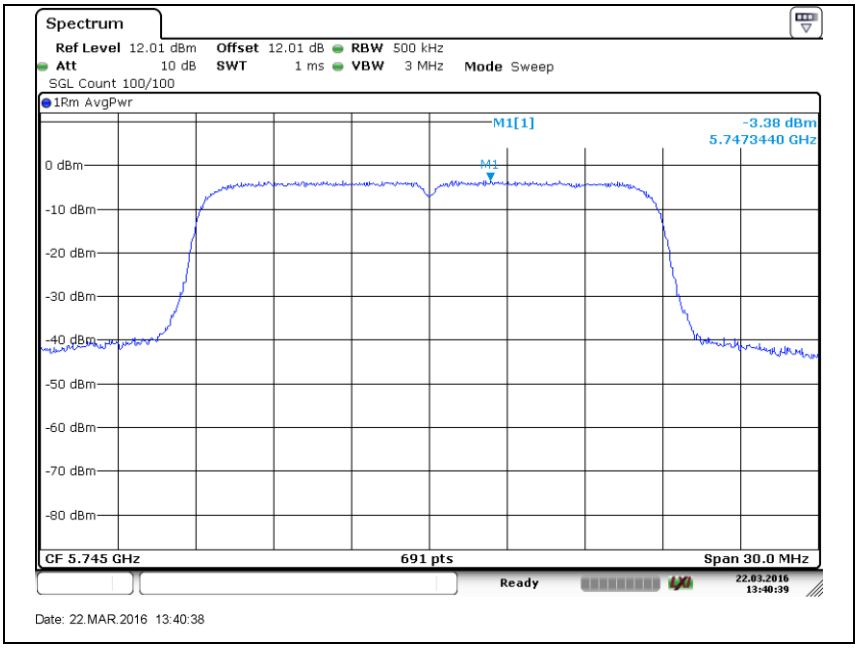
Channel 46



Channel 149



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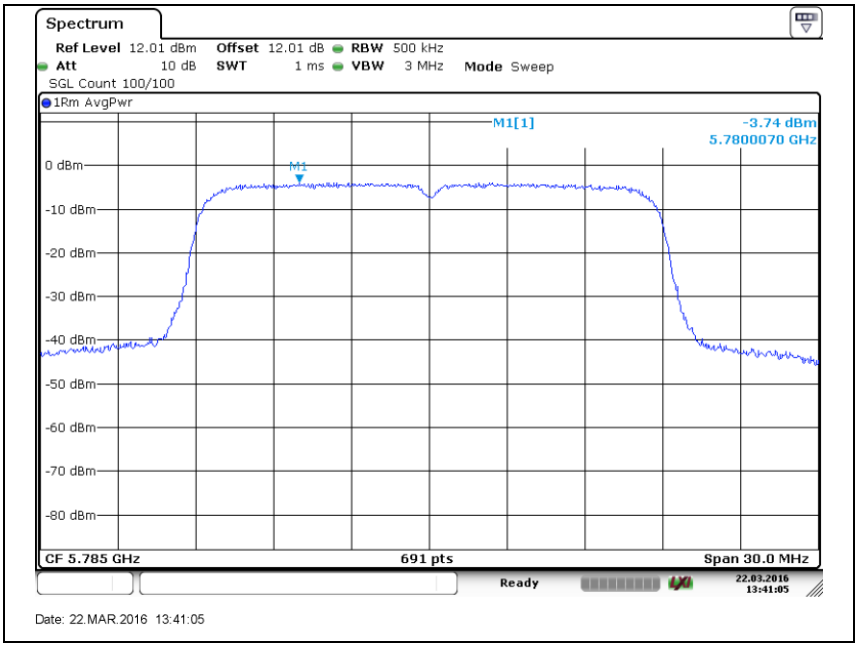
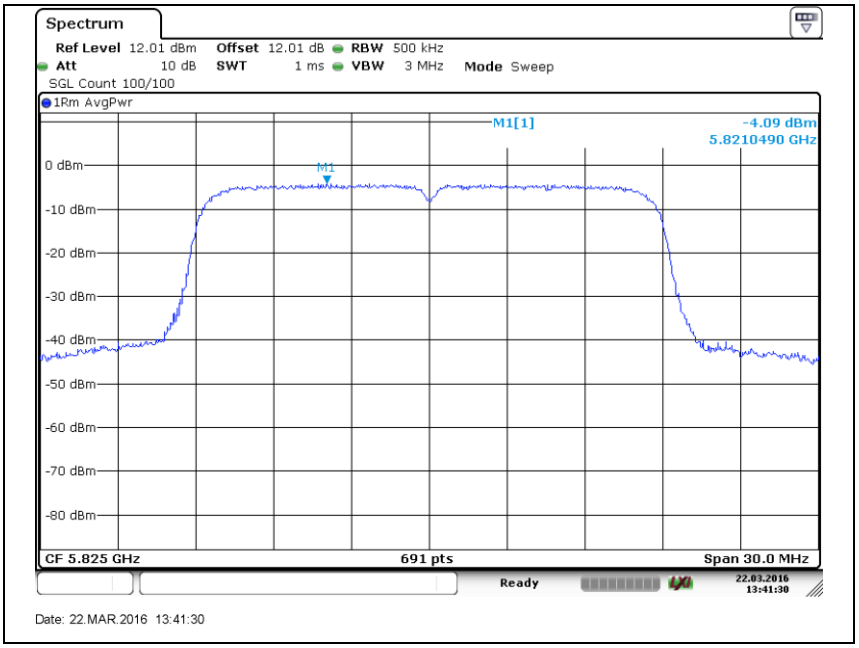
Channel 157



Channel 165



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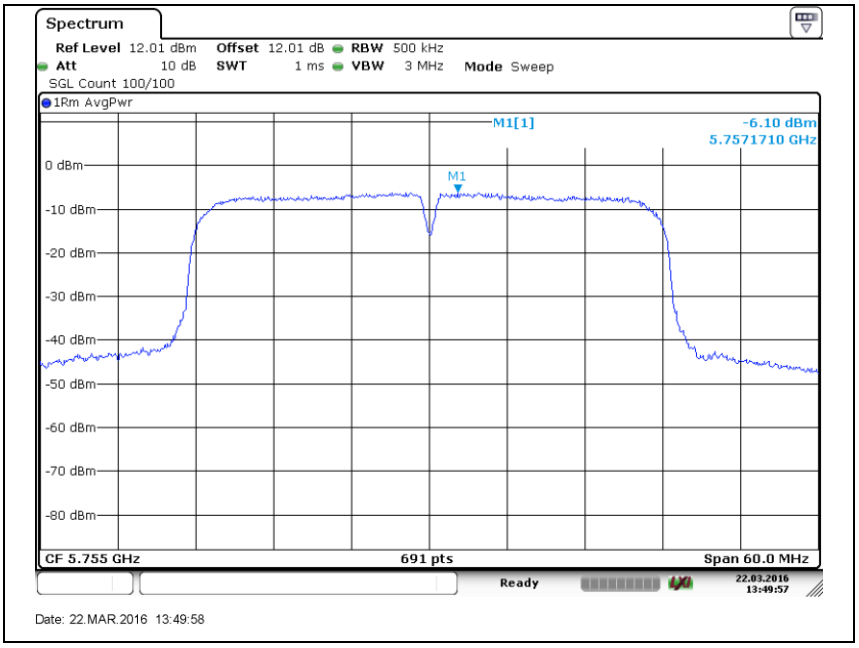
Channel 151



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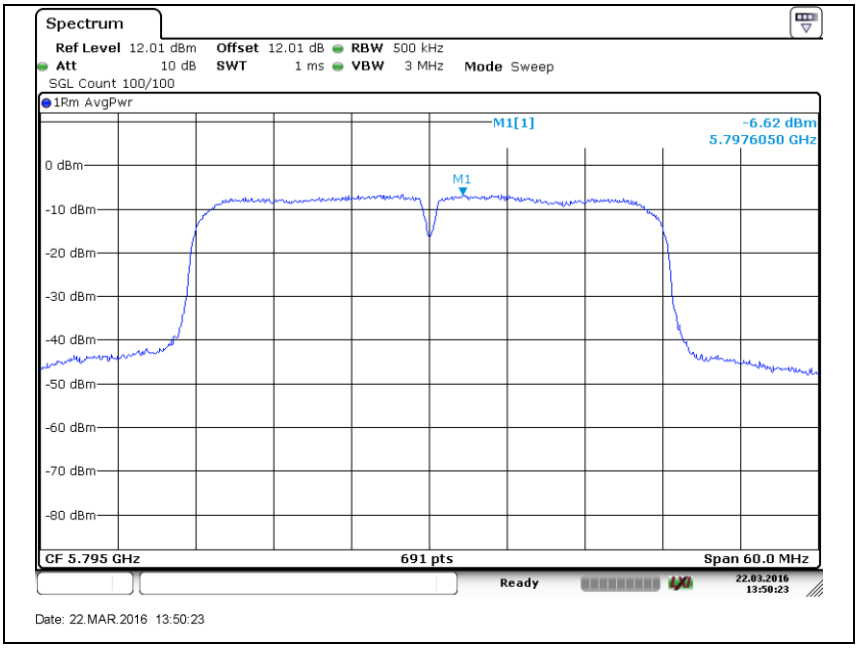

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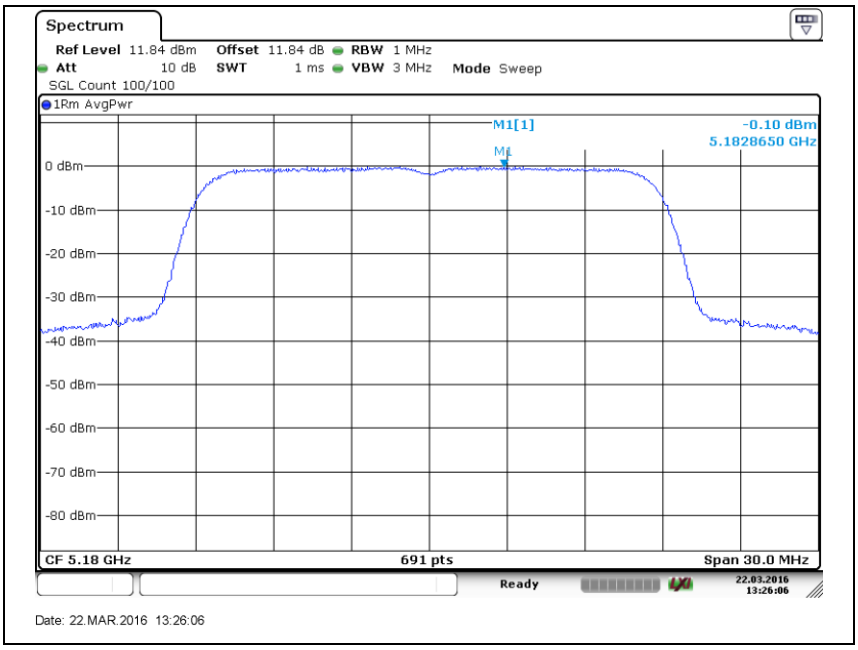
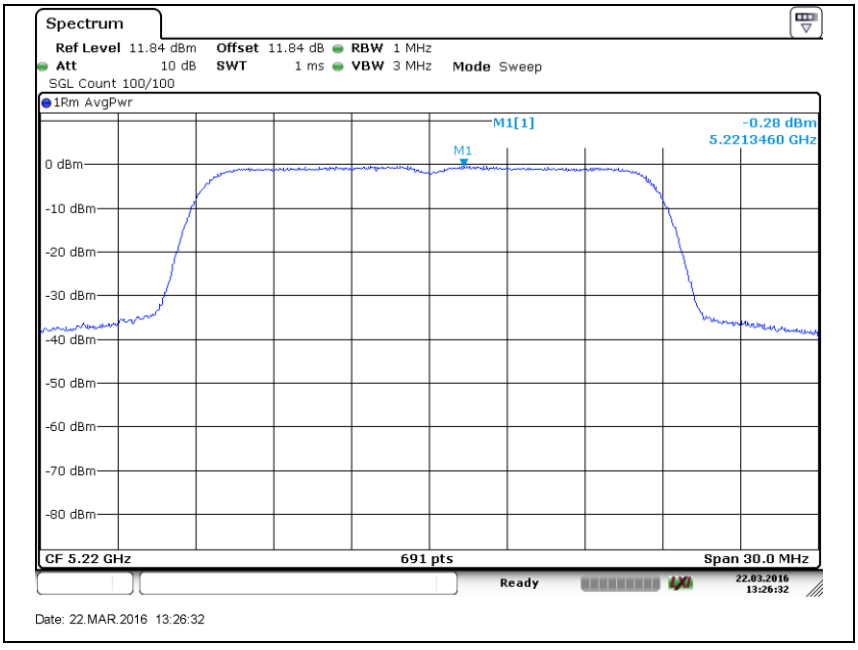
- Antenna port 2

Channel 36



Channel 44



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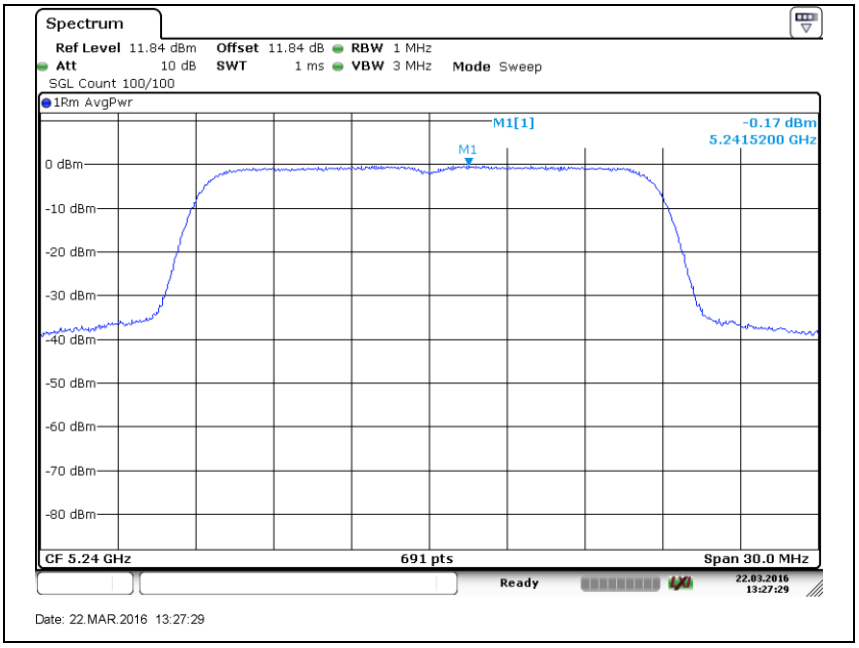
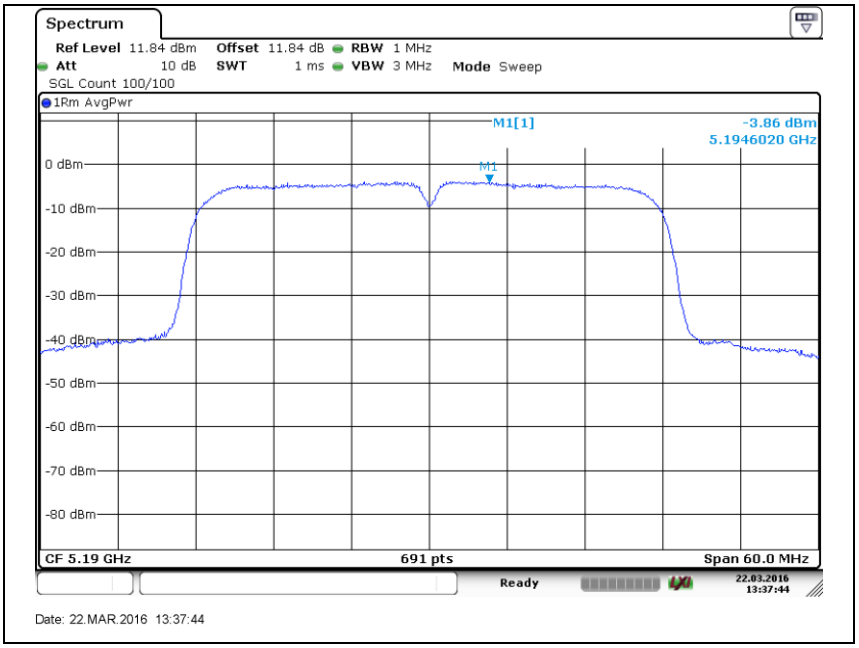
Channel 48



Channel 38



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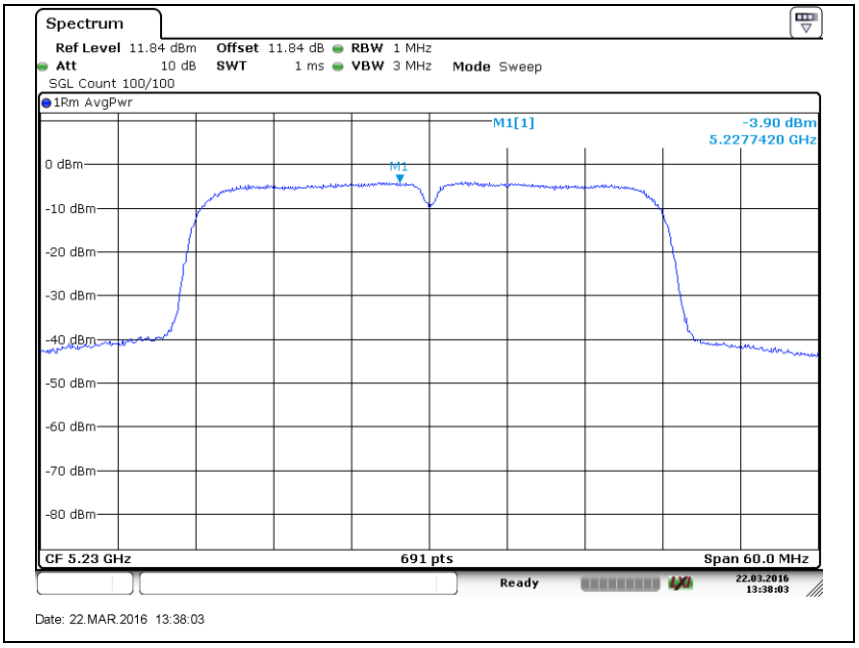
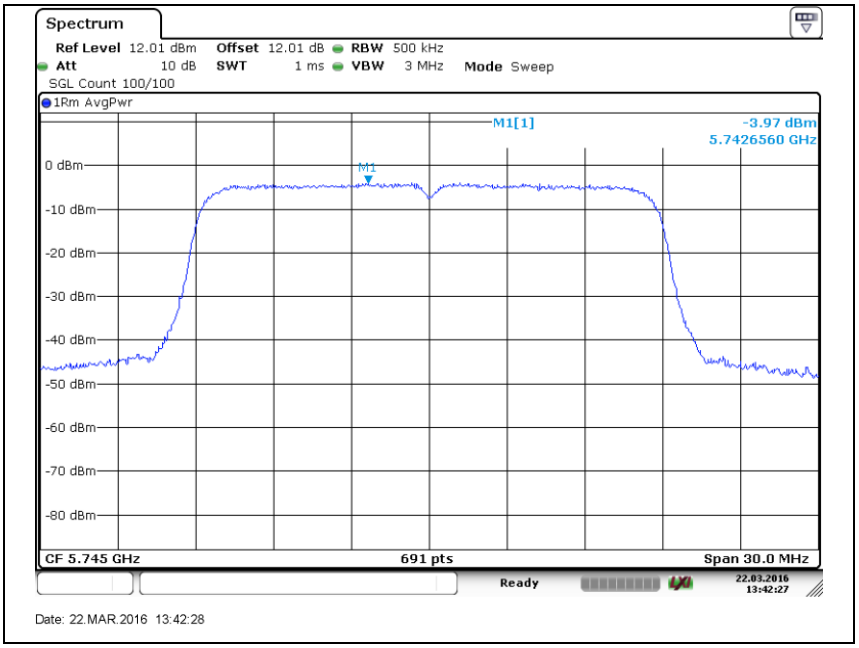
Channel 46



Channel 149



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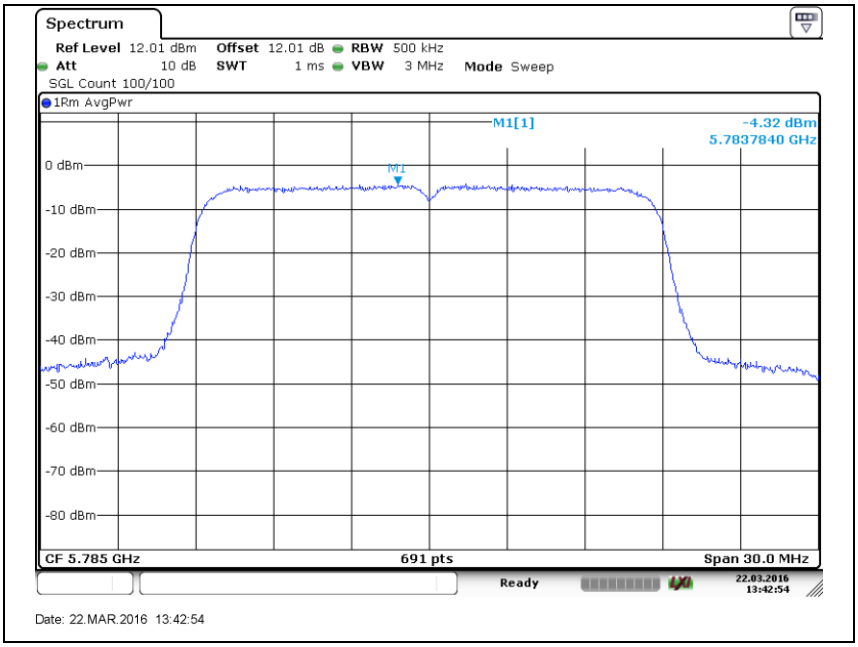
Channel 157



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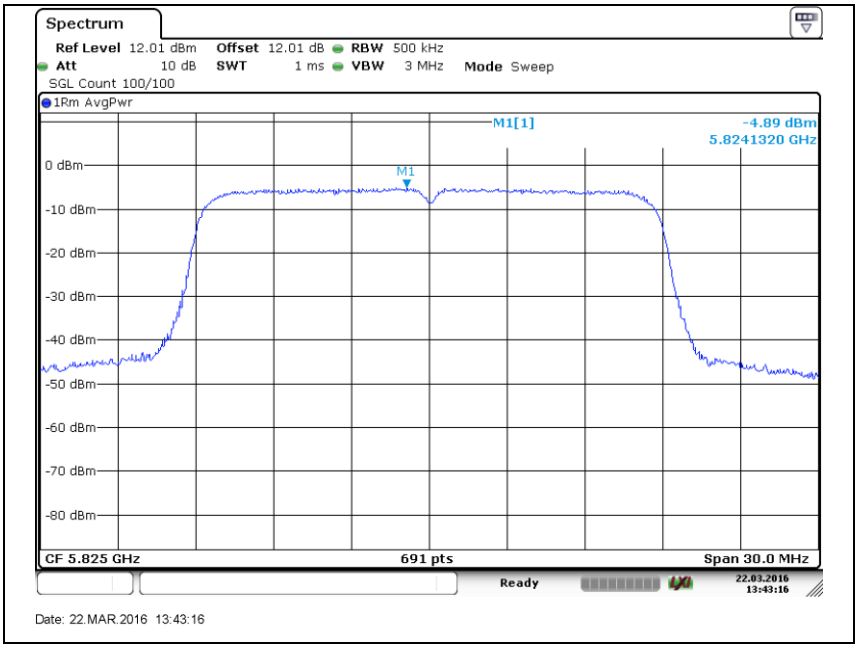

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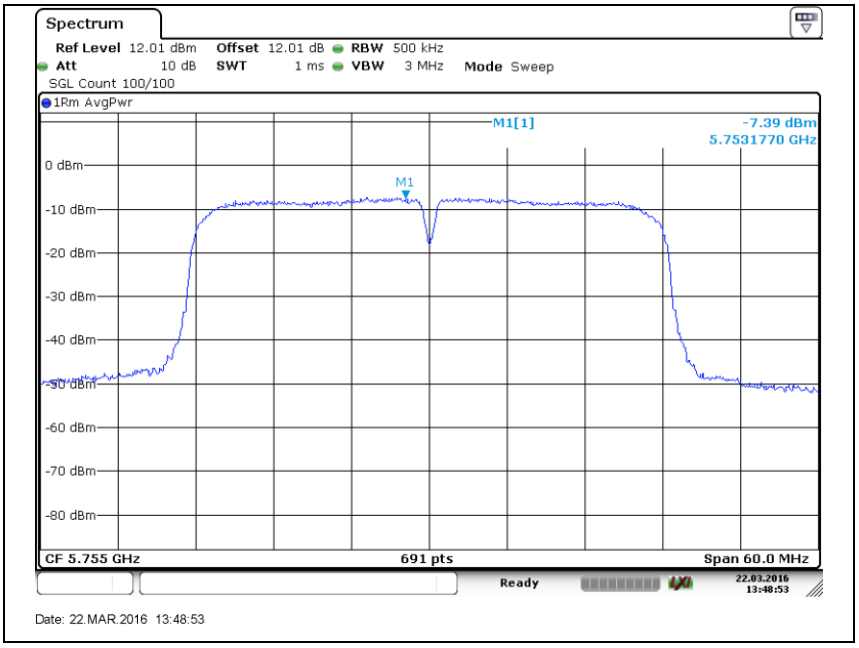
Channel 151



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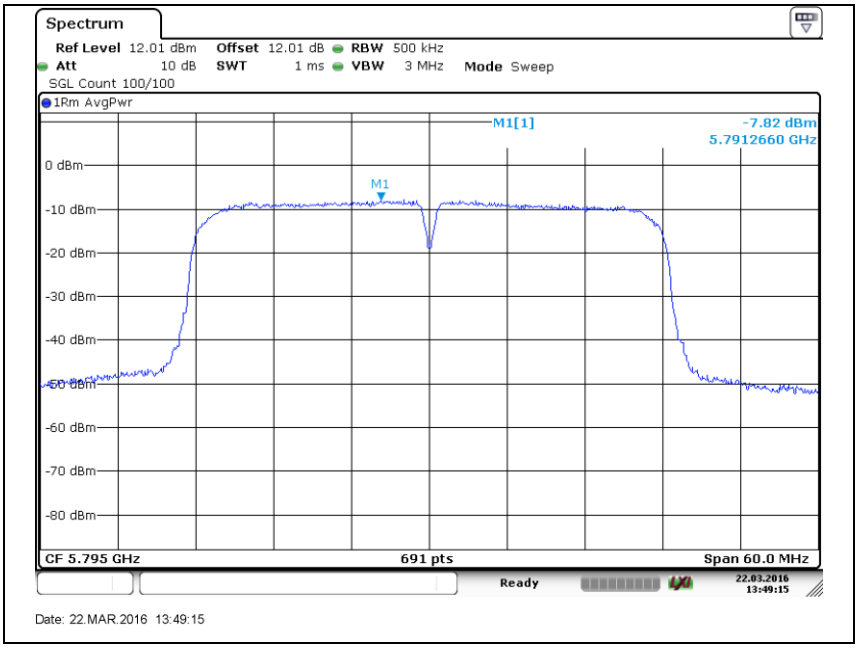

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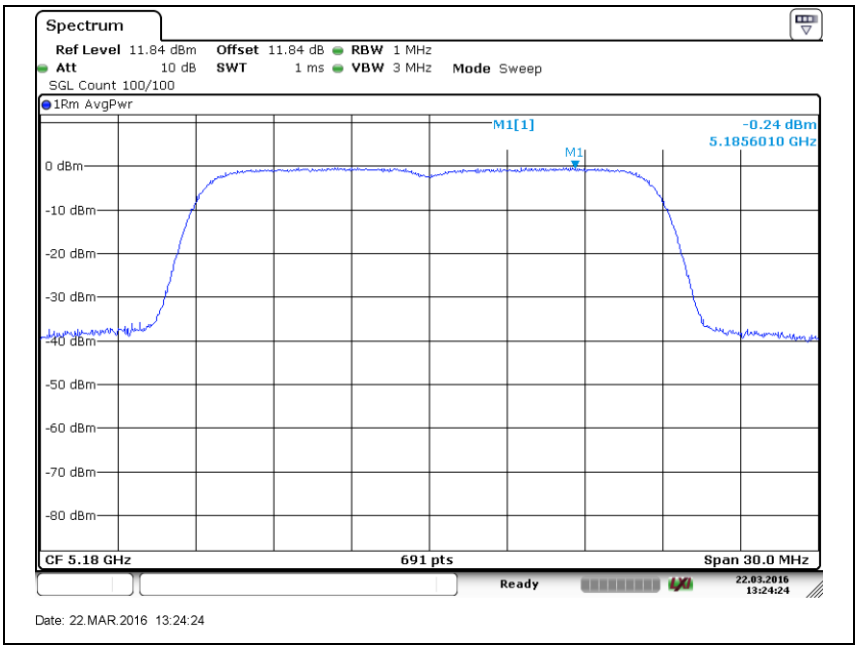
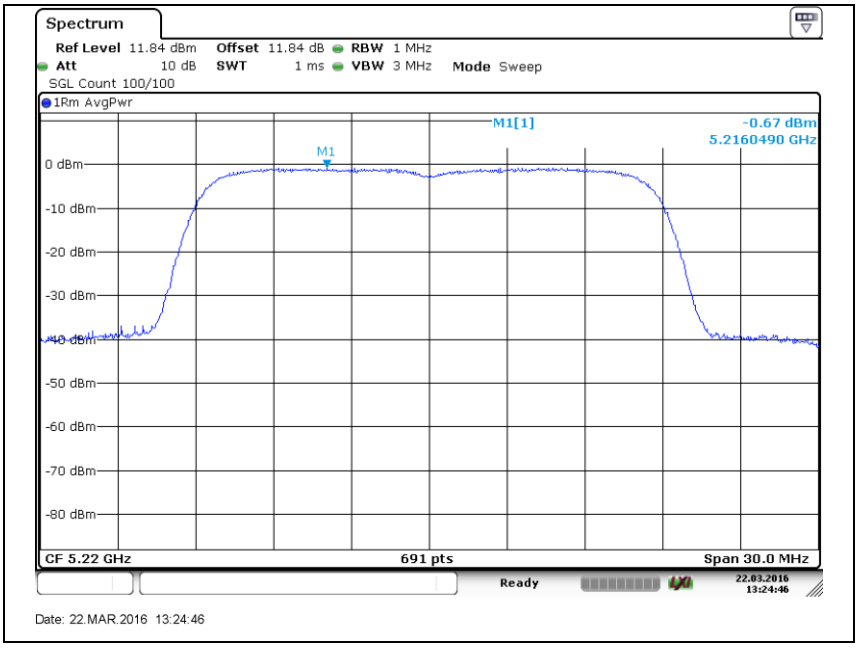
- Antenna port 3

Channel 36



Channel 44



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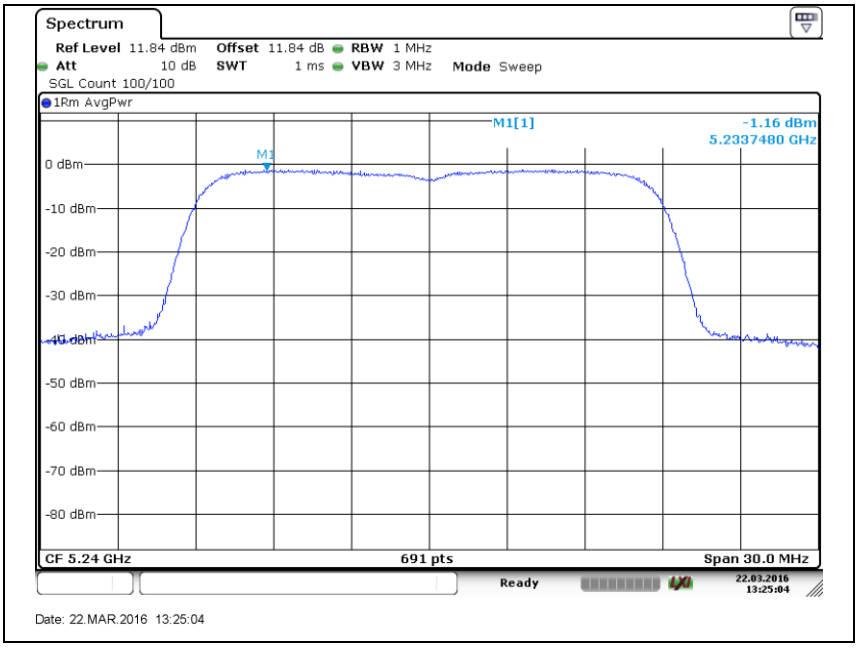
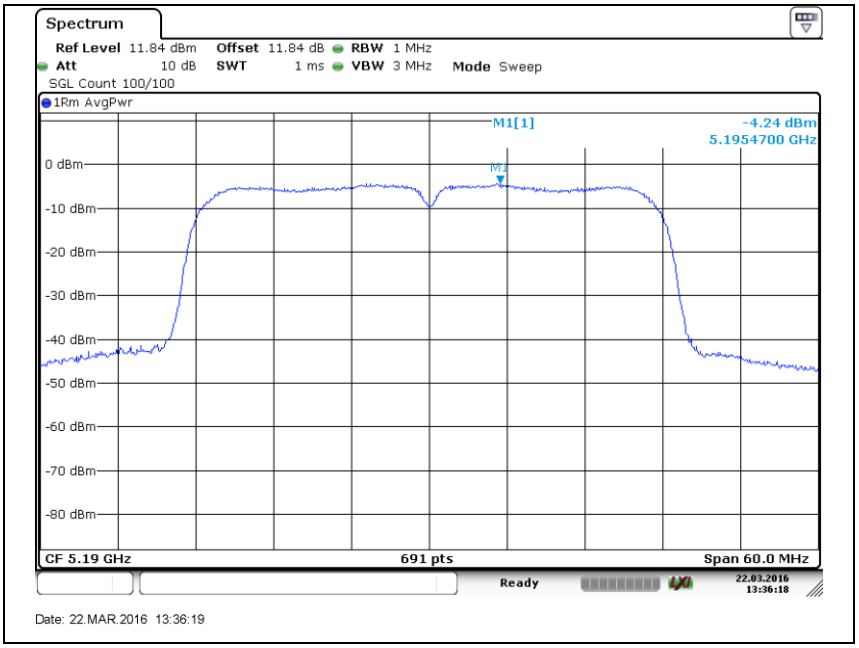
Channel 48



Channel 38



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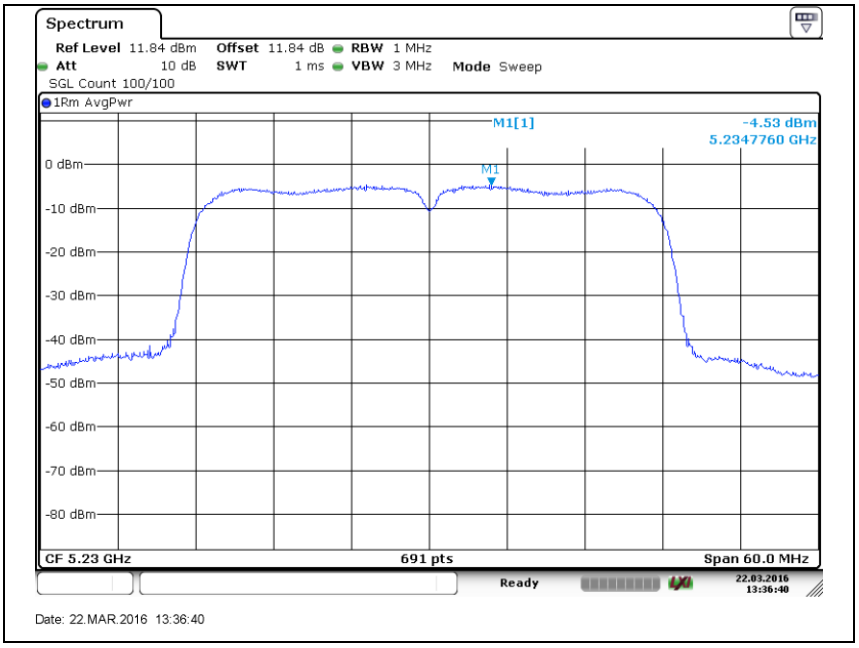
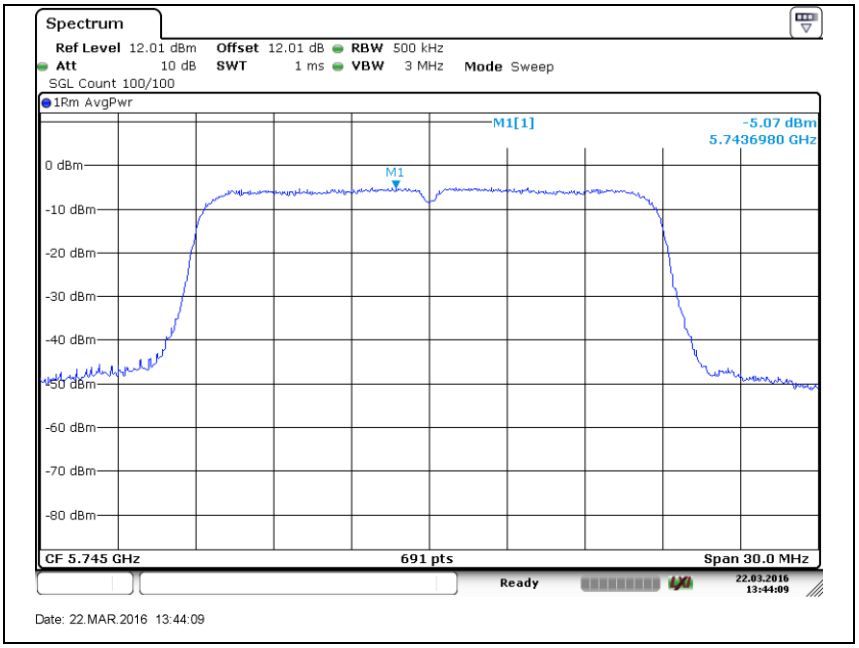
Channel 46



Channel 149



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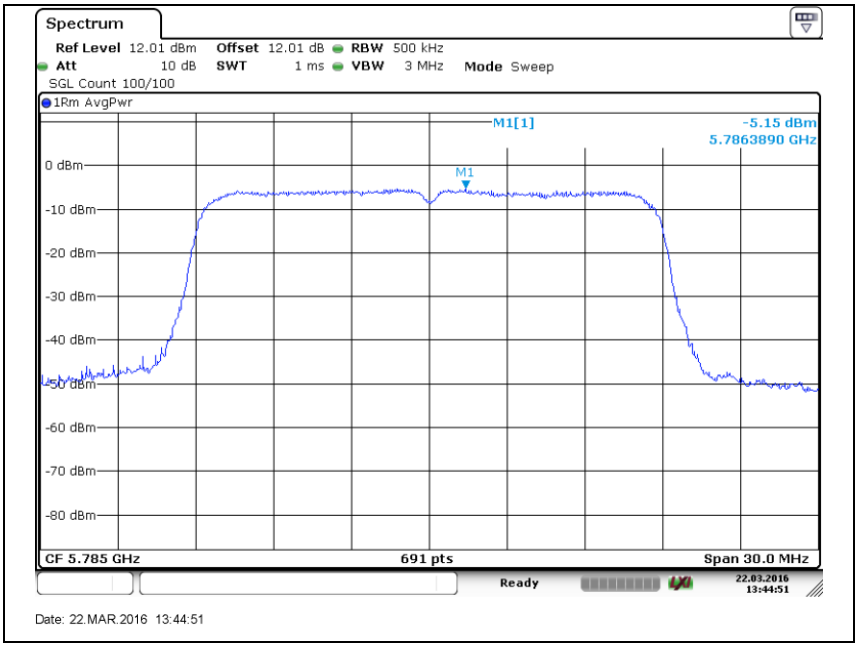
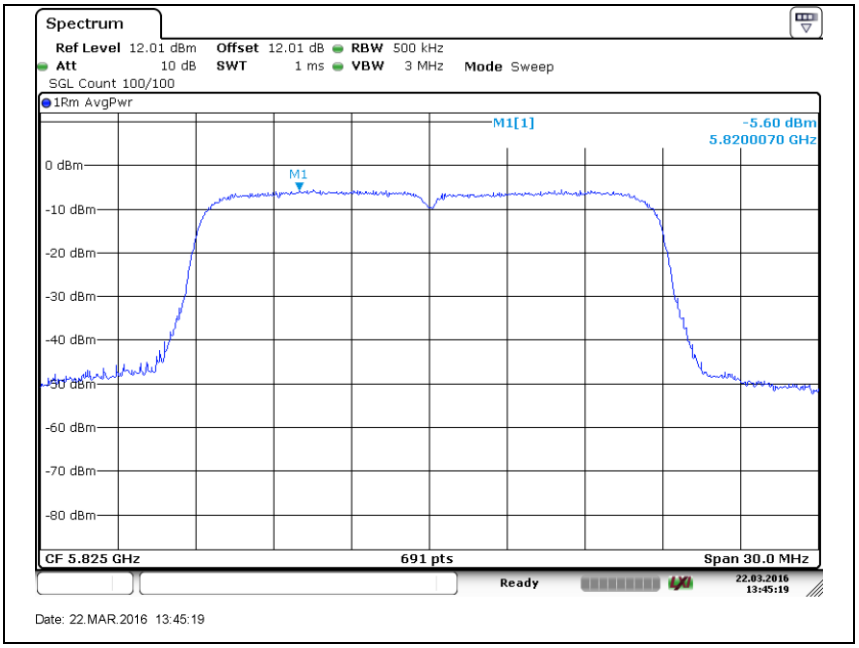
Channel 157



Channel 165



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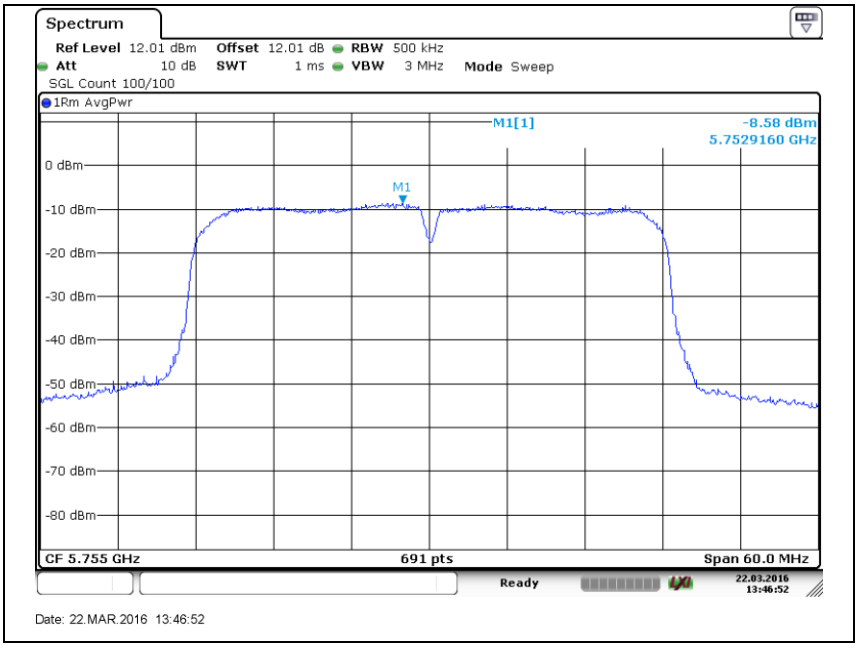
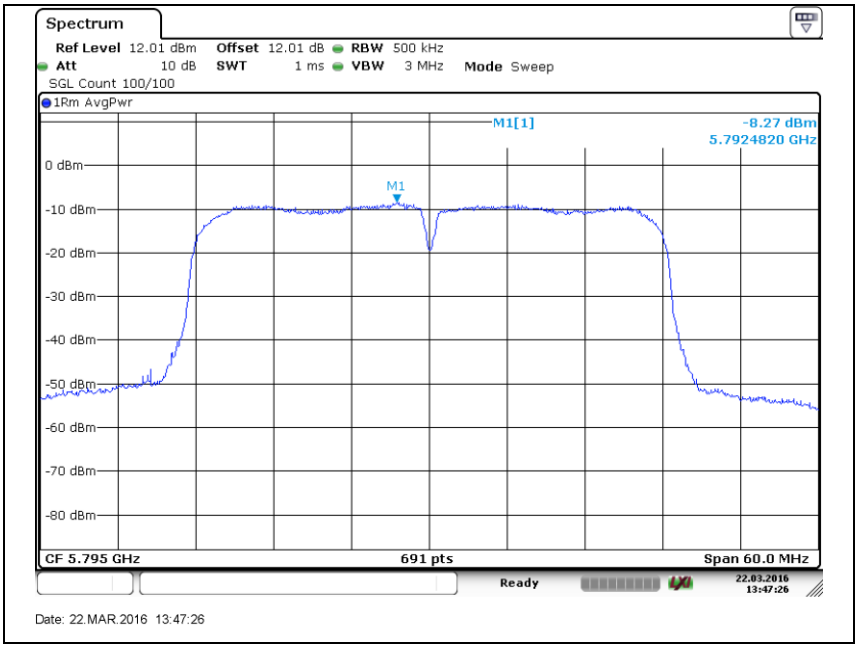
Channel 151



Channel 159



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3.5. Frequency Stability

Test procedure

1. The EUT was placed inside the environmental test chamber and powered by nominal DC voltage.
2. Turn the EUT on and couple its output to a spectrum analyzer.
3. Turn the EUT off and set the chamber to the highest temperature specified.
4. Allow sufficient time (approximately 30 min) for the temperature of the chamber to stabilize, turn the EUT on and measure the operating frequency.
5. Repeat step 2 and 3 with the temperature chamber set to the lowest temperature.
6. The test chamber was allowed to stabilize at +20 degree C for a minimum of 30 minutes. The supply voltage was then adjusted on the EUT from 85% to 115% and the frequency record.

Limit
N/A

Test results

Mode: UNII-1 (HT20)

Operating frequency: 5 180 ㎒

Antenna: 1

Test voltage (%)	Test voltage (V)	Temperature (℃)	Measure frequency (㎒)	Frequency deviation (㎐)	Deviation (%)
100 %	DC 3.30	25	5179.979132	-20868	-0.000403
100 %		0	5179.981736	-18264	-0.000353
100 %		10	5179.971055	-28945	-0.000559
100 %		20	5179.974758	-25242	-0.000487
100 %		30	5179.976250	-23750	-0.000458
100 %		40	5180.006541	6541	0.000126
100 %		50	5180.031896	31896	0.000616
85 %	DC 2.81	25	5179.980552	-19448	-0.000375
115 %	DC 3.80	25	5179.980653	-19347	-0.000373

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Mode: UNII-3 (HT20)
Operating frequency: 5 745㎒
Antenna: 1

Test voltage (%)	Test voltage (V)	Temperature (℃)	Measure frequency (㎒)	Frequency deviation (㎐)	Deviation (%)
100 %	DC 3.30	25	5744.977745	-22255	-0.000387
100 %		0	5744.971292	-28708	-0.000500
100 %		10	5744.969146	-30854	-0.000537
100 %		20	5744.971955	-28045	-0.000488
100 %		30	5744.983935	-16065	-0.000280
100 %		40	5745.004747	4747	0.000083
100 %		50	5745.030509	30509	0.000531
85 %	DC 2.81	25	5744.976876	-23124	-0.000403
115 %	DC 3.80	25	5744.977050	-22950	-0.000399

Mode: UNII-1 (HT40)
Operating frequency: 5 190 ㎒
Antenna: 1

Test voltage (%)	Test voltage (V)	Temperature (℃)	Measure frequency (㎒)	Frequency deviation (㎐)	Deviation (%)
100 %	DC 3.30	25	5189.980983	-19017	-0.000366
100 %		0	5189.982055	-17945	-0.000346
100 %		10	5189.971747	-28253	-0.000544
100 %		20	5189.975401	-24599	-0.000474
100 %		30	5189.985758	-14242	-0.000274
100 %		40	5190.006686	6686	0.000129
100 %		50	5190.034583	34583	0.000666
85 %	DC 2.81	25	5189.979941	-20059	-0.000386
115 %	DC 3.80	25	5189.979767	-20233	-0.000390

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Mode: UNII-3 (HT40)

Operating frequency: 5 755㎒

Antenna: 1

Test voltage (%)	Test voltage (V)	Temperature (℃)	Measure frequency (㎒)	Frequency deviation (㎐)	Deviation (%)
100 %	DC 3.30	25	5754.980843	-19157	-0.000333
100 %		0	5754.970306	-29694	-0.000516
100 %		10	5754.969640	-30360	-0.000528
100 %		20	5754.973022	-26978	-0.000469
100 %		30	5754.986372	-13628	-0.000237
100 %		40	5755.003126	3126	0.000054
100 %		50	5755.037631	37631	0.000657
85 %	DC 2.81	25	5754.980148	-19852	-0.000345
115 %	DC 3.80	25	5754.980032	-19968	-0.000347

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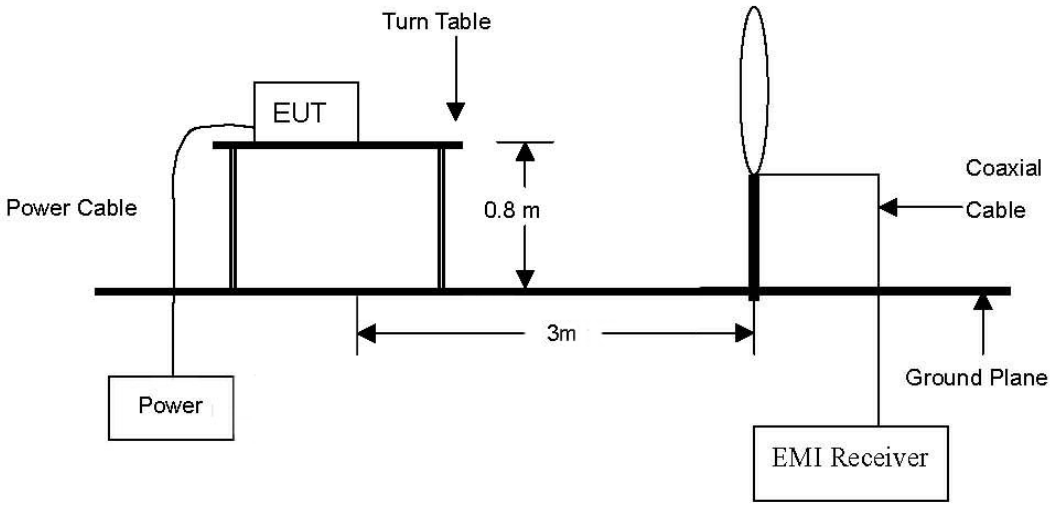
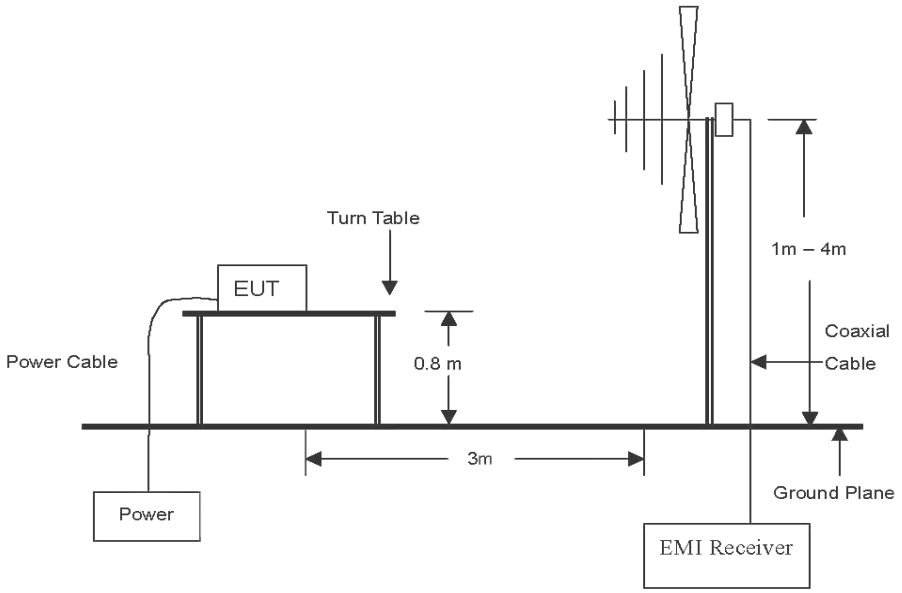
3.6. Radiated restricted band and emissions

Test setup

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



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



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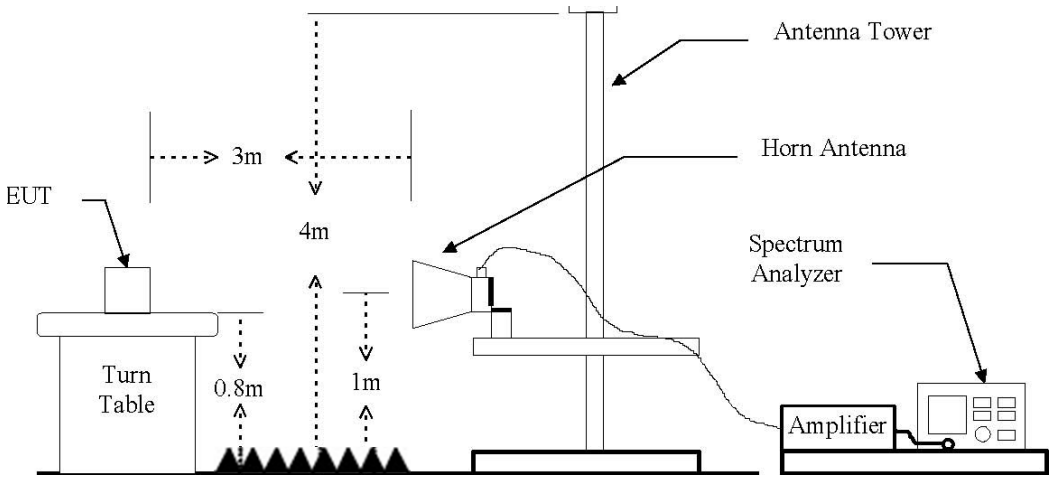
The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to the tenth harmonic of the highest fundamental frequency or to 40 ㎓ emissions, whichever is lower.



Test procedure below 30 ㎒

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.

Test procedure above 30 ㎒

1. Spectrum analyzer settings for f < 1 ㎓:
   ① Span = wide enough to fully capture the emission being measured
   ② RBW = 120 ㎑
   ③ VBW ≥ RBW
   ④ Detector = quasi peak
   ⑤ Sweep time = auto
   ⑥ Trace = max hold
2. Spectrum analyzer settings for f ≥1 ㎓: Peak
   ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
   ② RBW = 1 ㎒
   ③ VBW = 3 ㎒ (≥ 3 x RBW)
   ④ Detector = peak
   ⑤ Sweep time = auto
   ⑥ Trace = max hold
   ⑦ Trace was allowed to stabilize

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3. Spectrum analyzer settings for $f \geq 1$ ㎓: Average
   ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
   ② RBW = 1 ㎒
   ③ VBW = 3 ㎒ (≥ 3 x RBW)
   ④ Averaging type = power averaging (rms)
   ⑤ Detector function = power averaging (rms)
   ⑥ Sweep = auto
   ⑦ Trace = max hold
   ⑧ Trace was averaged over 100 sweeps.

Note.

1. f <30 ㎒, extrapolation factor of 40 ㏈/decade of distance. $F_d = 40\log(D_m/Ds)$
   $f \geq 30$ ㎒, extrapolation factor of 20 ㏈/decade of distance. $F_d = 20\log(D_m/Ds)$
   Where:
   F_d = Distance factor in ㏈
   D_m = Measurement distance in meters
   D_s = Specification distance in meters
2. CF(Correction factors(㏈)) = Antenna factor(㏈/m) + Cable loss(㏈) + or Amp. gain(㏈) + or F_d(㏈)
3. "*" means the restricted band.
4. Field strength(㏈㎶/m) = Level(㏈㎶) + Correction factors(㏈)
5. Margin(㏈) = Limit(㏈㎶/m) - Field strength(㏈㎶/m)
6. Emissions below 18 ㎓ were measured at a 3 meter test distance while emissions above 18 ㎓ were measured at a 1 meter test distance with the application of a distance correction factor.
7. The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z, it was determined that **Y orientation** was worst-case orientation; therefore, all final radiated testing was performed with the EUT in **Y orientation.**
8. The worst-case emissions are reported however emissions whose levels were not within 20 ㏈ of respective limits were not reported.

Limit

According to 15.209(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values：

Frequency (㎒)	Distance (Meters)	Radiated (㎶/m)
0.009 ~ 0.490	300	2 400 / F(㎑)
0.490 ~ 1.705	30	24 000 / F(㎑)
1.705 ~ 30.0	30	30
30 ~ 88	3	100**
88 ~ 216	3	150**
216 ~ 960	3	200**
Above 960	3	500

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

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According to 15.407(b), (b) Undesirable emission limits: Except as shown in paragraph (b)(7) of this section, the maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

(1) For transmitters operating in the 5.15–5.25 ㎓ band: all emissions outside of the 5.15–5.35 ㎓ band shall not exceed an e.i.r.p of –27 ㏈m/㎒.
(2) For transmitters operating in the 5.725–5.85 ㎓ band: all emissions within the frequency range from the band edge to 10 ㎒ above or below the band edge shall not exceed an e.i.r.p of –17 ㏈m/㎒; for frequencies 10 ㎒ or greater above or below the band edge, emissions shall not exceed an e.i.r.p of –27 ㏈m/㎒.
(3) The emission measurements shall be performed using a minimum resolution bandwidth of 1 ㎒.
A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 ㎒.
(4) Unwanted emissions below 1 ㎓ must comply with the general field strength limits set forth in § 15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in § 15.207.

Note:
1) If frequency was out of restricted band, the calculation method for peak limit is same as below.
68.23 ㏈㎶/m = EIRP – 20 log(d) + 104.77 = -27 -20 log(3) + 104.77
2) In case of the frequency between 5 715 ㎒ ~ 5 725 ㎒ and 5 850 ㎒ ~ 5 860 ㎒ the limits is determined as 78.23 ㏈㎶/m.
78.23 ㏈㎶/m = EIRP – 20 log(d) = 104.77 = -17 -20 log(3) + 104.77

Duty cycle
For the band 5.15-5.25 GHz

T_{on} time (㎳)	Period (㎳)	Duty cycle (Linear)	Duty cycle (%)	Minimum VBW (㎑)	Duty cycle correction factor (㏈)
1.304	1.329	0.981	98.1	0.767	0.083

For the band 5.725-5.85 GHz

T_{on} time (㎳)	Period (㎳)	Duty cycle (Linear)	Duty cycle (%)	Minimum VBW (㎑)	Duty cycle correction factor (㏈)
1.309	1.385	0.945	94.5	0.764	0.246

Note:
Duty cycle (Linear) = T_{on} time/Period
Minimum VBW(㎑) = $1/T_{on}$, where T is on time in second
Duty cycle correction factor (㏈) = 10log(1/duty cycle)

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Test results (Below 30 ㎒)

Mode:	UNII-3_HT20 (MIMO)
Transfer rate:	MCS0
Distance of measurement:	3 meter
Channel:	149 (Worst case)

Frequency (㎒)	Level (dB㎶)	Ant. Pol. (H/V)	CF (dB)	F_d (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
No spurious emissions were detected within 20 ㏈ of the limit							

Test results (Below 1 000 ㎒)

Mode:	UNII-3_HT20 (MIMO)
Transfer rate:	MCS0
Distance of measurement:	3 meter
Channel:	149 (Worst case)

Frequency (㎒)	Level (dB㎶)	Ant. Pol (H/V)	CF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
250.19	25.73	H	12.94	38.67	46.00	7.33
333.61	22.91	H	15.70	38.61	46.00	7.39
339.43	23.12	H	15.83	38.95	46.00	7.05
467.47	20.06	V	18.95	39.01	46.00	6.99
509.18	20.15	H	19.92	40.07	46.00	5.93
533.43	21.08	H	20.46	41.54	46.00	4.46

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Test results (Above 1 000 ㎒)

Mode: UNII-1_HT20 (MIMO)
Transfer rate: MCS0
Distance of measurement: 3 meter
Channel: 36

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*5146.90	44.76	Peak	H	9.91	-	54.67	74.00	19.33
*5146.90	31.20	Avg	H	9.91	0.08	41.19	54.00	12.81
*5141.70	42.37	Peak	V	9.90	-	52.27	74.00	21.73

Mode: UNII-1_ HT20 (MIMO)
Transfer rate: MCS0
Distance of measurement: 3 meter
Channel: 44

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
Emission levels are not reported much lower than the limits by over 20 ㏈								

Mode: UNII-1_HT20 (MIMO)
Transfer rate: MCS0
Distance of measurement: 3 meter
Channel: 48

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
Emission levels are not reported much lower than the limits by over 20 ㏈								

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Mode: UNII-1_HT40 (MIMO)
Transfer rate: MCS0
Distance of measurement: 3 meter
Channel: 38

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*5147.90	40.75	Peak	H	9.92	-	50.67	74.00	23.33
*5147.90	38.11	Peak	V	9.92	-	48.03	74.00	25.97

Mode: UNII-1_HT40 (MIMO)
Transfer rate: MCS0
Distance of measurement: 3 meter
Channel: 46

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
Emission levels are not reported much lower than the limits by over 20 dB								

Mode: UNII-3_HT20 (MIMO)
Transfer rate: MCS0
Distance of measurement: 3 meter
Channel: 149

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
5712.46	45.81	Peak	H	11.42	-	57.23	68.23	11.00
5713.73	41.69	Peak	V	11.42	-	53.11	68.23	15.12
5724.26	47.95	Peak	H	11.44	-	59.39	78.23	18.84
5724.26	45.31	Peak	V	11.44	-	56.75	78.23	21.48
*11480.00	40.59	Peak	H	25.07	-	65.66	74.00	8.34
*11501.00	22.50	Avg	H	25.09	0.25	47.84	54.00	6.16

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Mode: UNII-3_HT20 (MIMO)
Transfer rate: MCS0
Distance of measurement: 3 meter
Channel: 157

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
11562.00	43.07	Peak	H	25.27	-	68.34	74.00	5.66
11567.00	25.11	Avg	H	25.29	0.25	50.65	54.00	3.35

Mode: UNII-3_HT20 (MIMO)
Transfer rate: MCS0
Distance of measurement: 3 meter
Channel: 165

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
5850.61	45.41	Peak	H	11.71	-	57.12	78.23	21.11
5850.24	42.77	Peak	V	11.71	-	54.48	78.23	23.75
5862.06	43.43	Peak	H	11.73	-	55.16	68.23	13.07
5863.45	41.04	Peak	V	11.73	-	52.77	68.23	15.46
*11650.00	32.81	Peak	V	25.54	-	58.35	74.00	15.65
*11650.00	20.28	Avg	V	25.54	0.25	46.07	54.00	7.93

Mode: UNII-3_HT40 (MIMO)
Transfer rate: MCS0
Distance of measurement: 3 meter
Channel: 151

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
5713.88	44.44	Peak	H	11.42	-	55.86	68.23	12.37
5713.03	42.38	Peak	V	11.42	-	53.80	68.23	14.43
5723.45	52.04	Peak	H	11.44	-	63.48	78.23	14.75
5722.86	43.12	Peak	V	11.44	-	54.56	78.23	23.67
*11501.00	38.08	Peak	H	25.09	-	63.17	74.00	10.83
*11480.00	20.74	Avg	H	25.07	0.25	46.06	54.00	7.94

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Mode: UNII-3_HT40 (MIMO)
Transfer rate: MCS0
Distance of measurement: 3 meter
Channel: 159

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
5851.38	41.86	Peak	H	11.71	-	53.57	78.23	24.66
5852.56	41.41	Peak	V	11.71	-	53.12	78.23	25.11
5884.94	42.99	Peak	H	11.78	-	54.77	68.23	13.46
5880.28	41.93	Peak	V	11.77	-	53.70	68.23	14.53
*11610.00	36.48	Peak	H	25.42	-	61.90	74.00	12.10
*11610.00	23.27	Avg	H	25.42	0.25	48.94	54.00	5.06

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3.7. AC conducted emissions

Limit

According to 15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50uH/50 ohm line impedance stabilization network (LISN). Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequencies ranges.

Frequency of Emission (㎒)	Conducted limit (dB㎶/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

Note:

1. All AC line conducted spurious emission are measured with a receiver connected to a grounded LISN while the EUT is operating at its maximum duty cycle, at maximum power, and the appropriate frequencies. All data rates and modes were investigated for conducted spurious emission. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.
3. Both Cable loss and LISN factor are included in measurement level(QP Level or AV Level).

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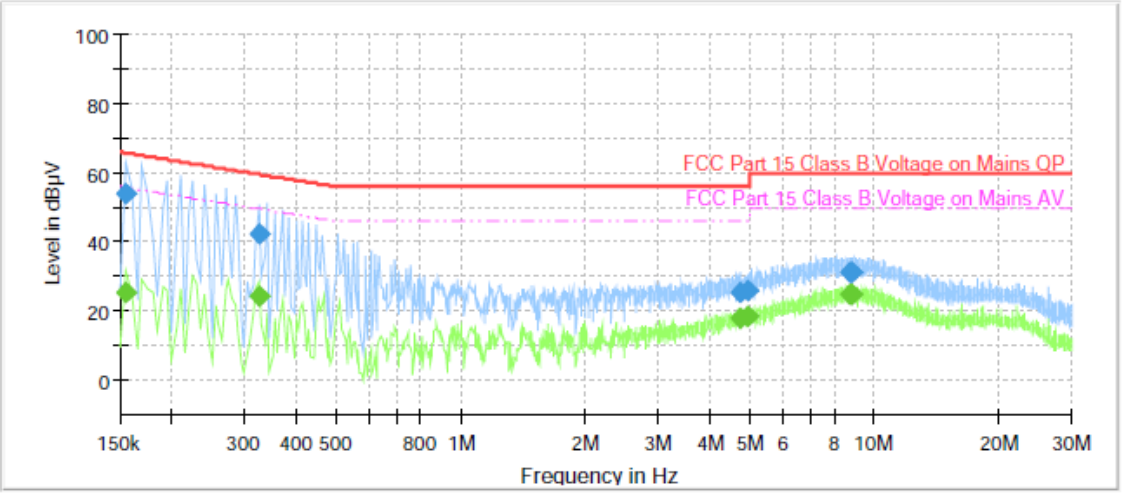
Test results

Test Report

Common Information

Test Description:	Conducted Emission
Model No.:	WiMi300
Mode	TX
Operator Name:	KES



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.155000	---	25.50	55.73	30.23	1000.0	9.000	L1	9.7
0.155000	54.03	---	65.73	11.70	1000.0	9.000	L1	9.7
0.325000	---	24.46	49.58	25.12	1000.0	9.000	L1	9.7
0.325000	42.43	---	59.58	17.15	1000.0	9.000	L1	9.7
4.720000	---	18.09	46.00	27.91	1000.0	9.000	L1	9.8
4.720000	25.58	---	56.00	30.42	1000.0	9.000	L1	9.8
4.970000	---	18.57	46.00	27.43	1000.0	9.000	L1	9.8
4.970000	25.84	---	56.00	30.16	1000.0	9.000	L1	9.8
8.755000	---	24.74	50.00	25.26	1000.0	9.000	L1	9.9
8.755000	31.31	---	60.00	28.69	1000.0	9.000	L1	9.9
8.810000	---	25.09	50.00	24.91	1000.0	9.000	L1	9.9
8.810000	31.50	---	60.00	28.50	1000.0	9.000	L1	9.9

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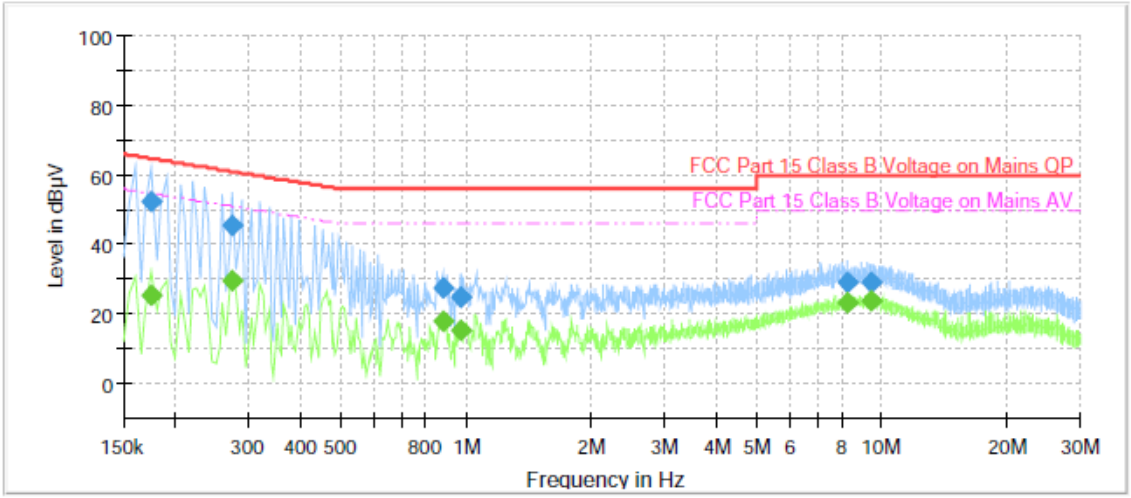
Test Report

Common Information

Test Description:	Conducted Emission
Model No.:	WiMi300
Mode	TX
Operator Name:	KES



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.175000	---	25.39	54.72	29.33	1000.0	9.000	N	9.6
0.175000	52.35	---	64.72	12.37	1000.0	9.000	N	9.6
0.275000	---	29.69	50.97	21.28	1000.0	9.000	N	9.6
0.275000	45.29	---	60.97	15.68	1000.0	9.000	N	9.6
0.885000	---	17.88	46.00	28.12	1000.0	9.000	N	9.7
0.885000	27.63	---	56.00	28.37	1000.0	9.000	N	9.7
0.970000	---	15.18	46.00	30.82	1000.0	9.000	N	9.7
0.970000	25.08	---	56.00	30.92	1000.0	9.000	N	9.7
8.245000	---	23.46	50.00	26.54	1000.0	9.000	N	9.9
8.245000	29.16	---	60.00	30.84	1000.0	9.000	N	9.9
9.440000	---	23.67	50.00	26.33	1000.0	9.000	N	9.9
9.440000	29.36	---	60.00	30.64	1000.0	9.000	N	9.9

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Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum analyzer	R&S	FSV30	101389	1 year	2017.01.25
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2017.01.25
Power Meter	Anritsu	ML2495A	1438001	1 year	2017.01.25
Pluse Power Sensor	Anritsu	MA2411B	1339205	1 year	2017.01.25
Loop antenna	R&S	HFH2-Z2.335.4711.52	826532	2 years	2017.03.03
Trilog-broadband antenna	Schwarzbeck	VULB 9168	9168-461	2 years	2017.04.03
Horn Antenna	A.H.	SAS-571	414	2 years	2017.02.09
Horn Antenna	Schwarzbeck	BBHA9170	BBHA9170550	2 years	2017.04.30
Preamplifier	SCHWARZBECK	BBV-9718	9718-246	1 year	2016.10.23
Broadband Amplifier	SCHWARZBECK	BBV-9721	PS9721-003	1 year	2017.01.25
Low Pass Filter	Wainwright Instrument	WHNK6.0/26.5G-6SS	1	1 year	2016.07.24
High Pass Filter	Wainwright Instrument	WHJS3000-10TT	1	1 year	2016.07.24
Attenuator	KEYSIGHT	8493C	82509	1 year	2017.01.25
EMI Test Receiver	R & S	ESR3	101781	1 year	2016.05.06
EMI Test Receiver	R & S	ESR3	101783	1 year	2016.05.06
DC Power supply	Aglient	6632B	US36351824	1 year	2017.01.21
Temperature & Humidity Chamber	Daehan Engineering	DH-1000	DH1000060628	1 year	2017.01.28
LISN	R & S	ENV216	101137	1 year	2017.02.04

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
Notebook Computer	Samsung Electronics Co., Ltd.	NT-R519	ZKPA93AS900167D
AC adaptor	Hipro Electronics Co., Ltd.	CPA09-004A	A060R001L

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