

# KCTL Inc.

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Report No.:  
KR20-SRF0051

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# KCTL

## UNII-2C / 802.11ac VHT20 / Low ch.



## UNII-3 / 802.11ac VHT20 / Low ch.



## UNII-2C / 802.11ac VHT20 / Mid ch.



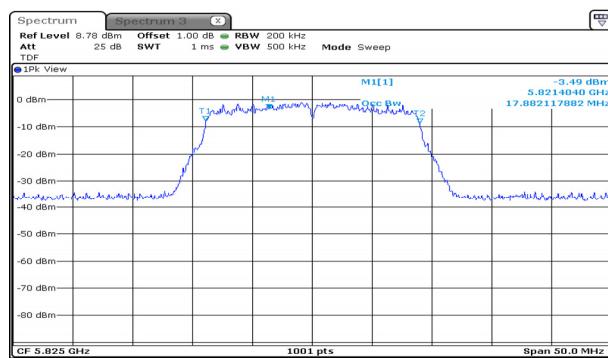
## UNII-3 / 802.11ac VHT20 / Mid ch.



## UNII-2C / 802.11ac VHT20 / High ch.



## UNII-3 / 802.11ac VHT20 / High ch.



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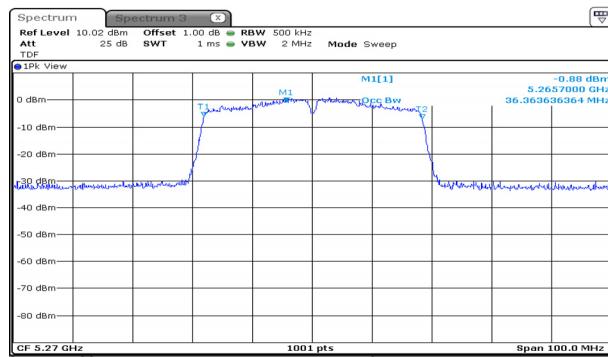
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# KCTL

## UNII-1 / 802.11ac VHT40 / Low ch.



## UNII-2A / 802.11ac VHT40 / Low ch.



## UNII-1 / 802.11ac VHT40 / High ch.



## UNII-2A / 802.11ac VHT40 / High ch.



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## UNII-2C / 802.11ac VHT40 / Low ch.



## UNII-3 / 802.11ac VHT40 / Low ch.



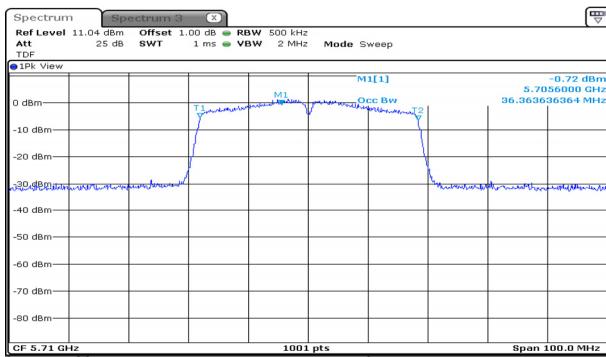
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## UNII-3 / 802.11ac VHT40 / High ch.



## UNII-2C / 802.11ac VHT40 / High ch.



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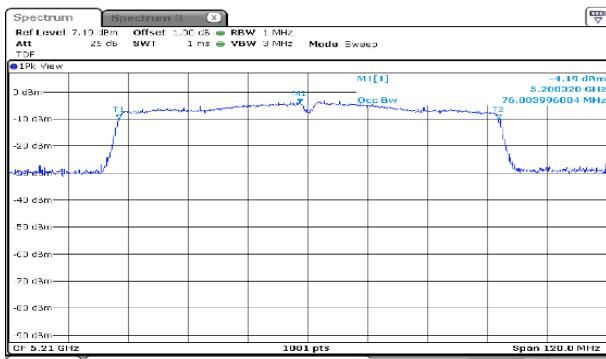
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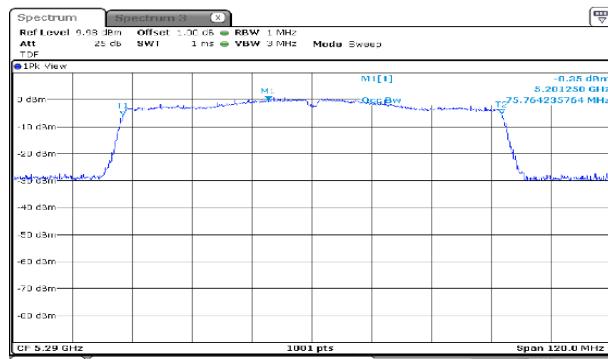
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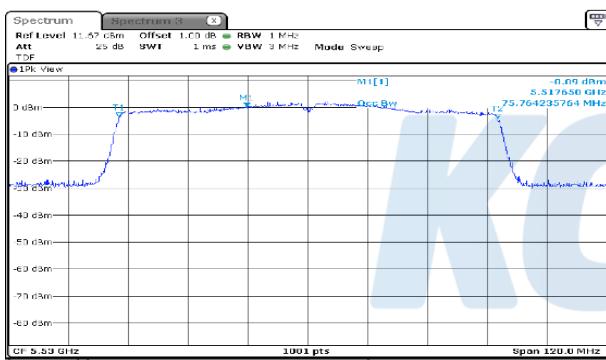
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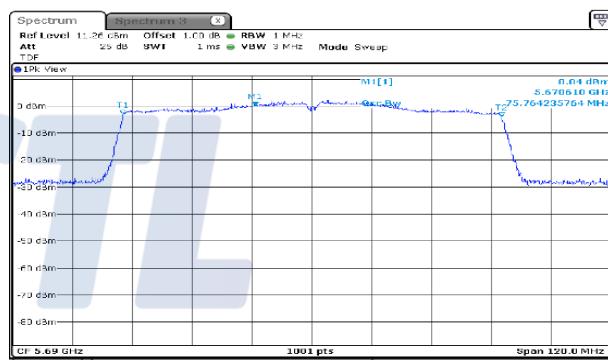
## UNII-2A / 802.11ac VHT80 / Low ch.



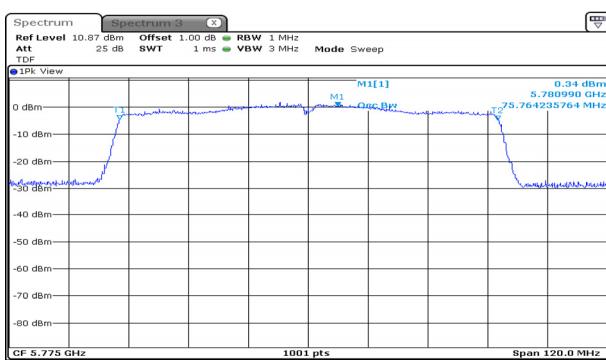
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## UNII-2C / 802.11ac VHT80 / High ch.



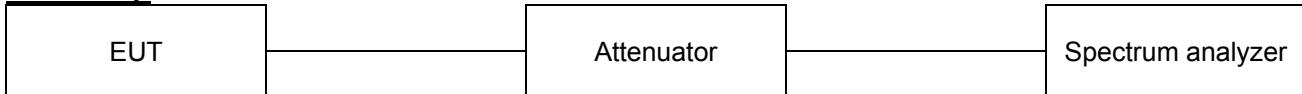
## UNII-3 / 802.11ac VHT80 / Low ch.



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## 7.4. 6 dB Bandwidth

### Test setup



### Limit

According to §15.407(e), Within the 5.725-5.85 GHz band, the minimum 6 dB bandwidth if U-NII devices shall be at least 500 kHz

### Test procedure

ANSI C63.10-2013 Section 6.9.2  
KDB 789033 D02 v02r01 - Section C.2

### Test settings

Minimum Emission Bandwidth for the band 5.725–5.85 GHz

Section 15.407(e) specifies the minimum 6 dB emission bandwidth of at least 500 kHz for the band 5.725–5.85 GHz. The following procedure shall be used for measuring this bandwidth:

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW)  $\geq 3$  RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

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**KCTL****Test results**

Test mode	Band	Frequency (MHz)	Measured Bandwidth (MHz)	Limit (MHz)
802.11a	UNII-3	5 745	16.43	0.50
		5 785	16.38	
		5 825	16.43	
802.11n HT20	UNII-3	5 745	17.63	0.50
		5 785	17.63	
		5 825	17.63	
802.11n HT40	UNII-3	5 755	35.76	0.50
		5 795	35.76	
802.11ac VHT20	UNII-3	5 745	17.63	0.50
		5 785	17.63	
		5 825	17.63	
802.11ac VHT40	UNII-3	5 755	35.46	0.50
		5 795	36.46	
802.11ac VHT80	UNII-3	5 775	75.76	

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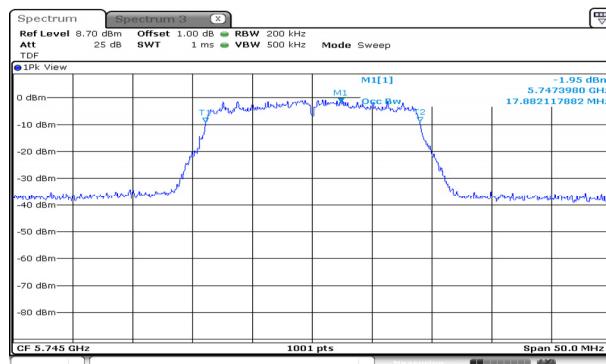
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## 6 dB bandwidth

**UNII-3 / 802.11a / Low ch.**



**UNII-3 / 802.11n HT20 / Low ch.**



**UNII-3 / 802.11a / Mid ch.**



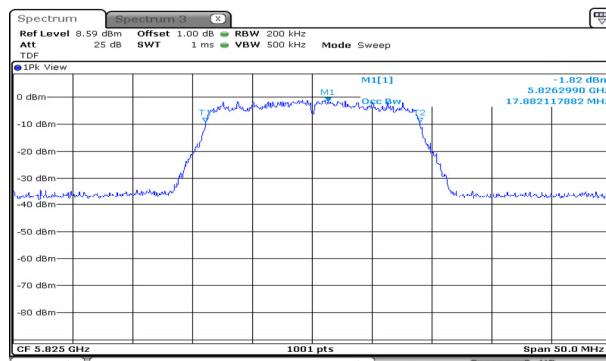
**UNII-3 / 802.11n HT20 / Mid ch.**



**UNII-3 / 802.11a / High ch.**



**UNII-3 / 802.11n HT20 / High ch.**



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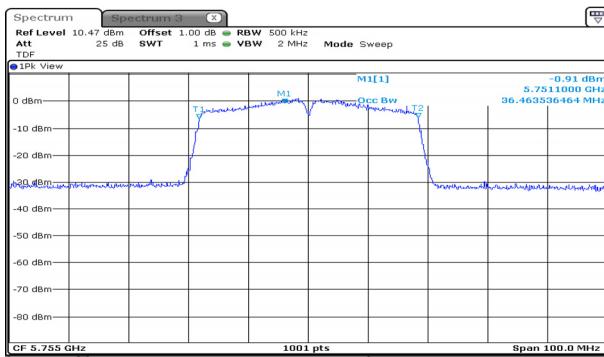
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## UNII-3 / 802.11n HT40 / Low ch.



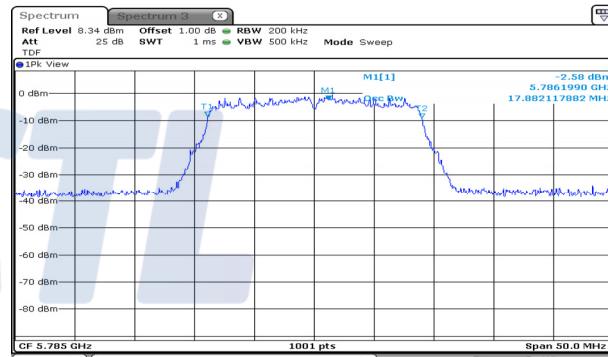
## UNII-3 / 802.11ac VHT20 / Low ch.



## UNII-3 / 802.11n HT40 / High ch.

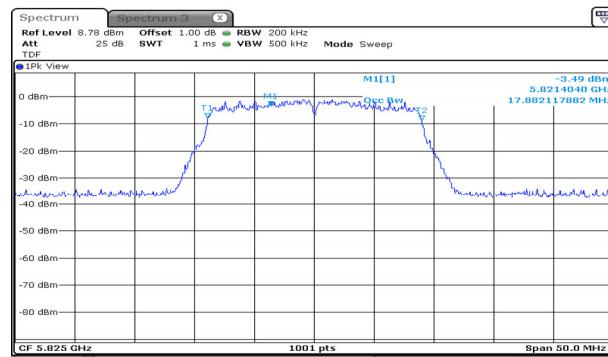


## UNII-3 / 802.11ac VHT20 / Mid ch.



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## UNII-3 / 802.11ac VHT20 / High ch.



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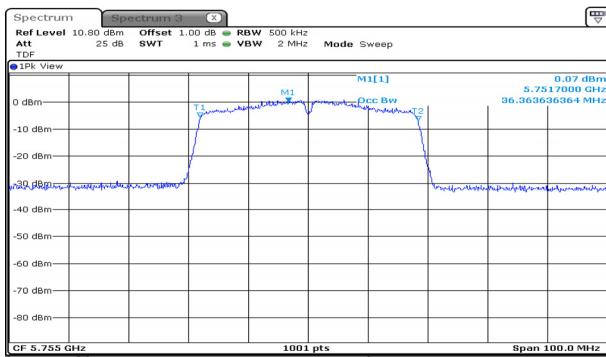
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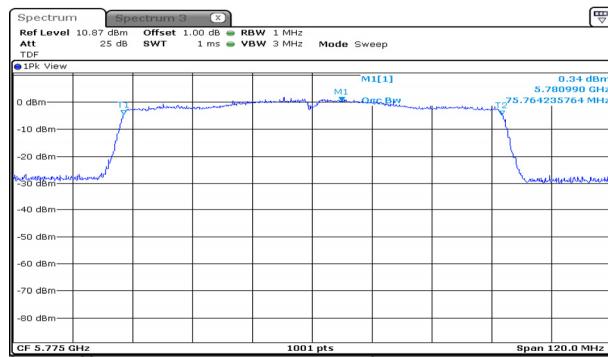
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# KCTL

## UNII-3 / 802.11ac VHT40 / Low ch.



## UNII-3 / 802.11ac VHT80 / Low ch.



## UNII-3 / 802.11ac VHT40 / High ch.

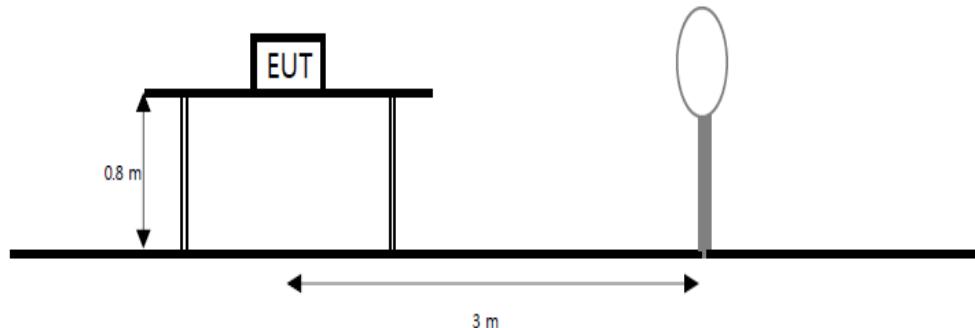


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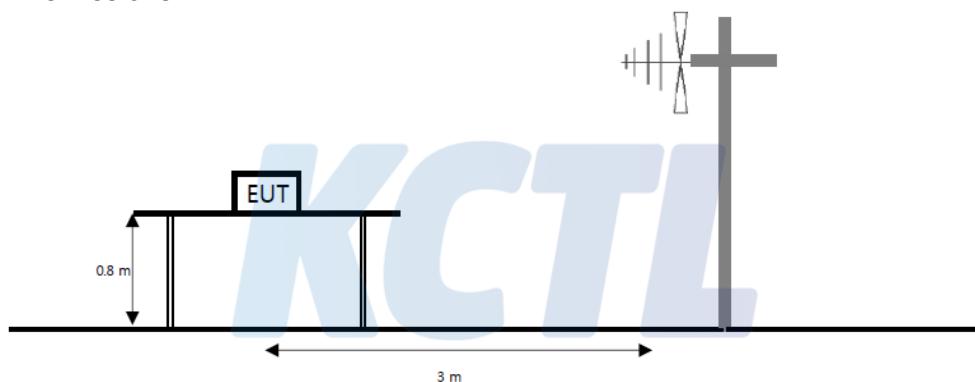
## 7.5. Spurious Emission, Band Edge and Restricted bands

### Test setup

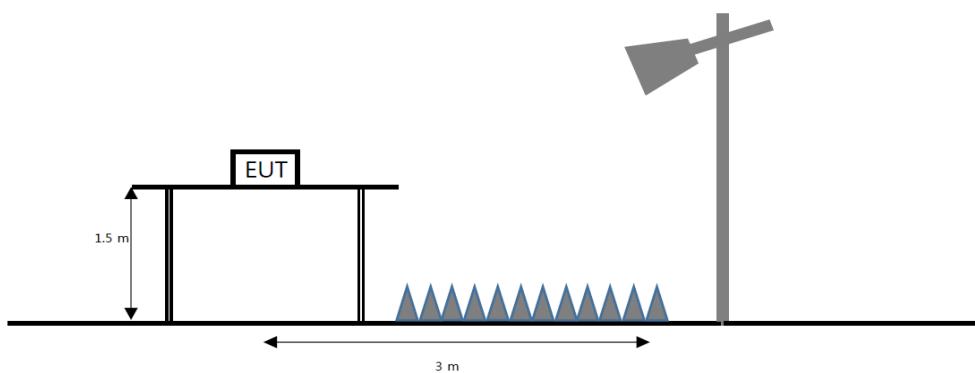
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions



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



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



**Limit**

According to section 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)	Field strength ( $\mu\text{V/m}$ )	Measurement distance (m)
0.009 - 0.490	2 400/F(kHz)	300
0.490 - 1.705	24 000/F(kHz)	30
1.705 - 30	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

\*\*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 MHz, 76–88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., Section 15.231 and 15.241.

According to section 15.205(a) and (b), only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.009 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.495 - 0.505	16.694 75 - 16.695 25	608 - 614	5.35 - 5.46
2.173 5 - 2.190 5	16.804 25 - 16.804 75	960 - 1 240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1 300 - 1 427	8.025 - 8.5
4.177 25 - 4.177 75	37.5 - 38.25	1 435 - 1 626.5	9.0 - 9.2
4.207 25 - 4.207 75	73 - 74.6	1 645.5 - 1 646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1 660 - 1 710	10.6 - 12.7
6.267 75 - 6.268 25	108 - 121.94	1 718.8 - 1 722.2	13.25 - 13.4
6.311 75 - 6.312 25	123 - 138	2 200 - 2 300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2 310 - 2 390	15.35 - 16.2
8.362 - 8.366	156.524 75 - 156.525	2 483.5 - 2 500	17.7 - 21.4
8.376 25 - 8.386 75	25	2 690 - 2 900	22.01 - 23.12
8.414 25 - 8.414 75	156.7 - 156.9	3 260 - 3 267	23.6 - 24.0
12.29 - 12.293	162.012 5 - 167.17	3 332 - 3 339	31.2 - 31.8
12.519 75 - 12.520 25	167.72 - 173.2	3 345.8 - 3 358	36.43 - 36.5
12.576 75 - 12.577 25	240 - 285	3 600 - 4 400	Above 38.6
13.36 - 13.41	322 - 335.4		

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in section 15.209. At frequencies equal to or less than 1 000 MHz, compliance with the limits in section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1 000 MHz, compliance with the emission limits in section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in section 15.35 apply to these measurements.

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According to section 15.407(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:

For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of -27 dBm/MHz

For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of -27 dBm/MHz.

For transmitters operating in the 5.725-5.85 GHz band: All emissions shall be limited to a level of -27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.



**Test procedure**

ANSI C63.10-2013 Section 12.7.5, 12.7.6, 12.7.7.2

**Test settings****Peak field strength measurements**

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = as specified in table
3. VBW  $\geq$  (3×RBW)
4. Detector = peak
5. Sweep time = auto
6. Trace mode = max hold
7. Allow sweeps to continue until the trace stabilizes

**Table. RBW as a function of frequency**

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

**Average field strength measurements****Trace averaging with continuous EUT transmission at full power**

If the EUT can be configured or modified to transmit continuously ( $D \geq 98\%$ ), then the average emission levels shall be measured using the following method (with EUT transmitting continuously):

1. RBW = 1 MHz (unless otherwise specified).
2. VBW  $\geq$  (3×RBW).
3. Detector = RMS (power averaging), if  $[\text{span} / (\# \text{ of points in sweep})] \leq (\text{RBW} / 2)$ . 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.
4. Averaging type = power (i.e., rms):
  - 1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
  - 2) Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.
5. Sweep time = auto.
6. Perform a trace average of at least 100 traces.

**Trace averaging across ON and OFF times of the EUT transmissions followed by duty cycle correction**

If continuous transmission of the EUT ( $D \geq 98\%$ ) cannot be achieved and the duty cycle is constant (duty cycle variations are less than  $\pm 2\%$ ), then the following procedure shall be used:

1. The EUT shall be configured to operate at the maximum achievable duty cycle.
2. Measure the duty cycle D of the transmitter output signal as described in 11.6.
3. RBW = 1 MHz (unless otherwise specified).
4. VBW  $\geq [3 \times \text{RBW}]$ .
5. Detector = RMS (power averaging), if  $[\text{span} / (\# \text{ of points in sweep})] \leq (\text{RBW} / 2)$ . 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.
6. Averaging type = power (i.e., rms):

- 1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
- 2) Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.
7. Sweep time = auto.
8. Perform a trace average of at least 100 traces.
9. A correction factor shall be added to the measurement results prior to comparing with the emission limit to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:
  - 1) If power averaging (rms) mode was used in step f), then the applicable correction factor is  $[10 \log (1 / D)]$ , where D is the duty cycle.
  - 2) If linear voltage averaging mode was used in step f), then the applicable correction factor is  $[20 \log (1 / D)]$ , where D is the duty cycle.
  - 3) If a specific emission is demonstrated to be continuous ( $D \geq 98\%$ ) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission.

**Notes:**

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 1 kHz( $\geq 1/T$ ) for Average detection (AV) at frequency above 1 GHz. (where T = pulse width)
2.  $f < 30$  MHz, extrapolation factor of 40 dB/decade of distance.  $F_d = 40 \log(D_m/D_s)$   
 $f \geq 30$  MHz, extrapolation factor of 20 dB/decade of distance.  $F_d = 20 \log(D_m/D_s)$   
Where:
  - $F_d$ = Distance factor in dB
  - $D_m$ = Measurement distance in meters
  - $D_s$ = Specification distance in meters
3. Factors(dB) = Antenna factor(dB/m) + Cable loss(dB) + or Amp. gain(dB) + or  $F_d$ (dB)
4. The worst-case emissions are reported however emissions whose levels were not within 20 dB of respective limits were not reported.
5. Average test would be performed if the peak result were greater than the average limit.
6. <sup>1)</sup> means restricted band.
7. According to part 15.31(f)(2), an extrapolation factor of 40 dB/decade is applied because measured distance of radiated emission is 3 m.

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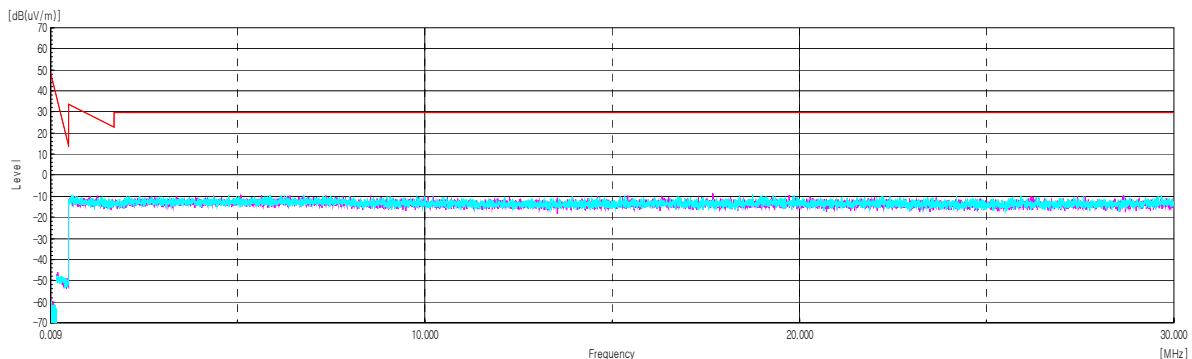
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**KCTL****Test results (Below 30 MHz) – Worst case: 802.11a / UNII-2C Highest frequency**

Frequency	Pol.	Reading	Ant. Factor	Amp.+Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB( $\mu$ V))	(dB)	(dB)	(dB)	(dB( $\mu$ V/m))	(dB( $\mu$ V/m))	(dB)
No spurious emissions were detected within 20 dB of the limit.								

**Horizontal/Vertical**

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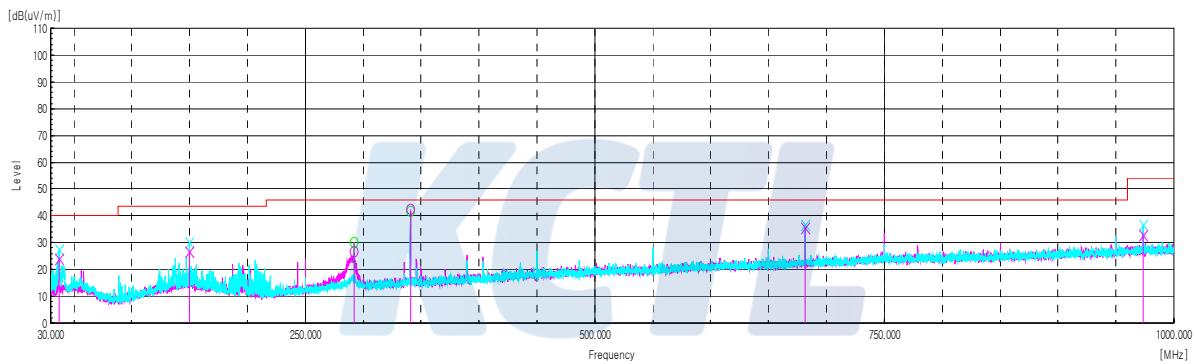
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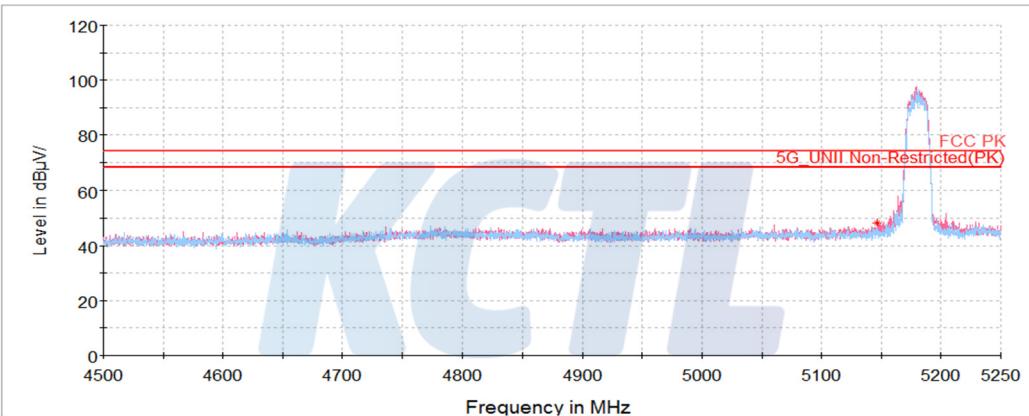
**Test results (Below 1 000 MHz) – Worst case: 802.11a / UNII-2C Highest frequency**

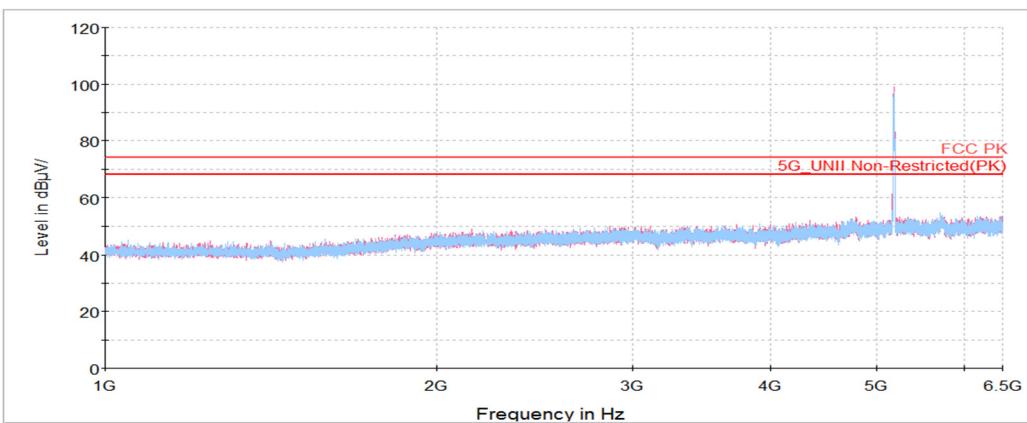
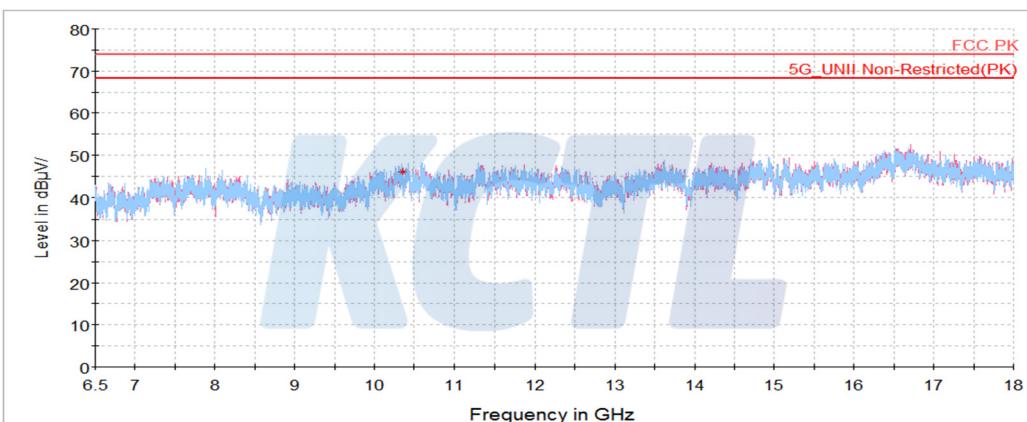
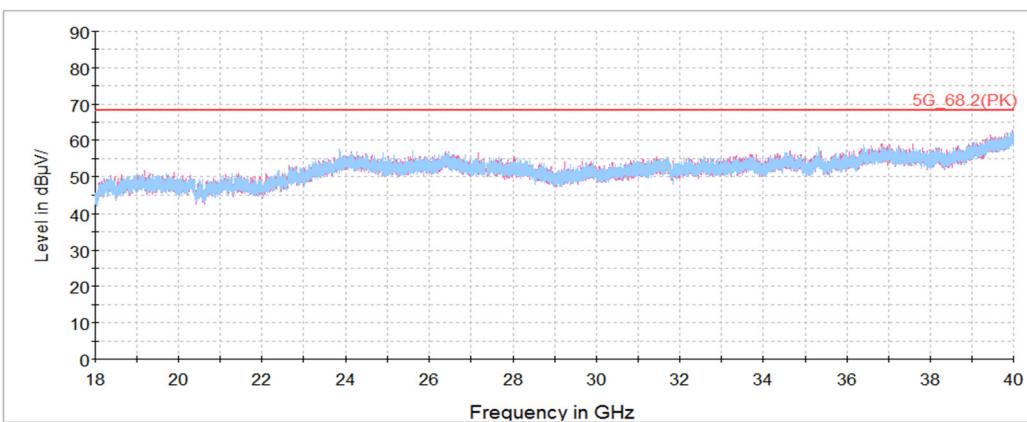
Frequency	Pol.	Reading	Ant. Factor	Amp.+Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB( $\mu$ V))	(dB)	(dB)	(dB)	(dB( $\mu$ V/m))	(dB( $\mu$ V/m))	(dB)
<b>Quasi peak data</b>								
37.40	V	36.40	17.88	-30.50	-	23.78	40.00	16.22
149.92	V	36.10	19.20	-28.81	-	26.49	43.50	17.01
292.02	H	35.40	19.14	-27.87	-	26.67	46.00	19.33
340.64	H	49.50	20.21	-27.50	-	42.21	46.00	3.79
681.48	V	34.30	26.53	-25.40	-	35.43	46.00	10.57
973.45	V	25.80	30.20	-23.05	-	32.95	54.00	21.05

**Horizontal/Vertical**


**Test results (Above 1 000 MHz)****802.11a UNII-1****Lowest Channel (5 180 MHz)**

Frequency	Pol.	Reading	Ant. Factor	Amp.+Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB( $\mu$ V))	(dB)	(dB)	(dB)	(dB( $\mu$ V/m))	(dB( $\mu$ V/m))	(dB)
<b>Peak data</b>								
5 146.66 <sup>1)</sup>	H	41.44	34.08	-27.1	-	48.42	74.00	25.58
10 359.33	H	57.55	37.32	-48.88	-	45.99	68.20	22.21
<b>Average Data</b>								
No spurious emissions were detected within 20 dB of the limit								

**Horizontal/Vertical for Band-edge**

**Horizontal/Vertical for 1 GHz ~ 6.5 GHz****Horizontal/Vertical for 6.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 40 GHz**

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**Middle Channel (5 200 MHz)**

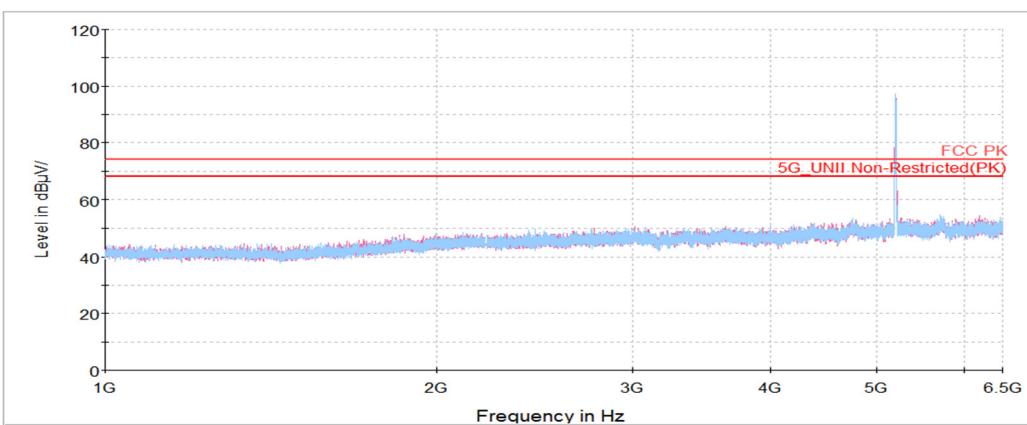
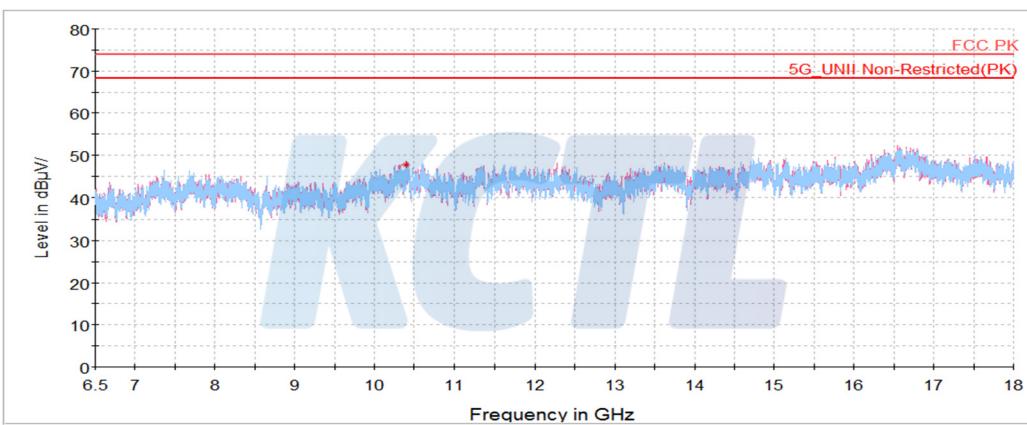
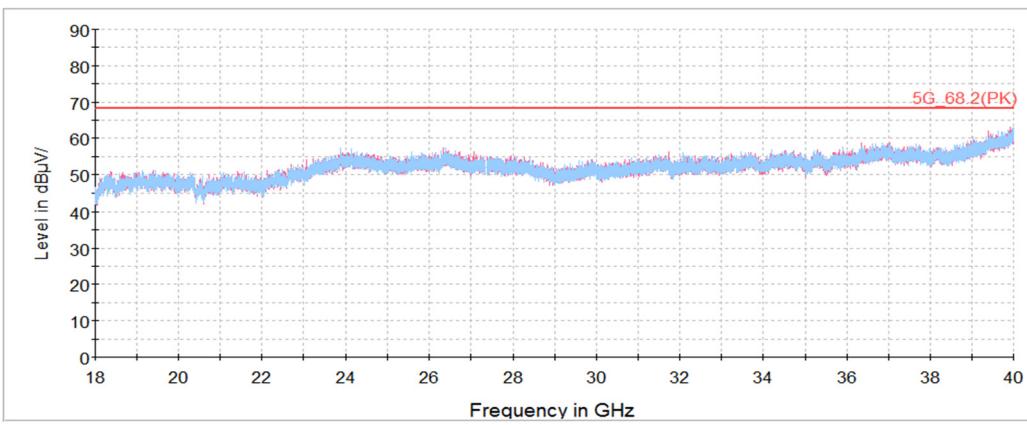
Frequency	Pol.	Reading	Ant. Factor	Amp.+Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(µV))	(dB)	(dB)	(dB)	(dB(µV/m))	(dB(µV/m))	(dB)
<b>Peak data</b>								
10 403.17	H	59.07	37.34	-48.63	-	47.78	68.20	20.42
<b>Average Data</b>								
No spurious emissions were detected within 20 dB of the limit								

**KCTL Inc.**

65, Sinwon-ro, Yeongtong-gu,  
Suwon-si, Gyeonggi-do, 16677, Korea  
TEL: 82-31-285-0894 FAX: 82-505-299-8311  
[www.kctl.co.kr](http://www.kctl.co.kr)

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**KCTL****Horizontal/Vertical for 1 GHz ~ 6.5 GHz****Horizontal/Vertical for 6.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 40 GHz**

**KCTL Inc.**

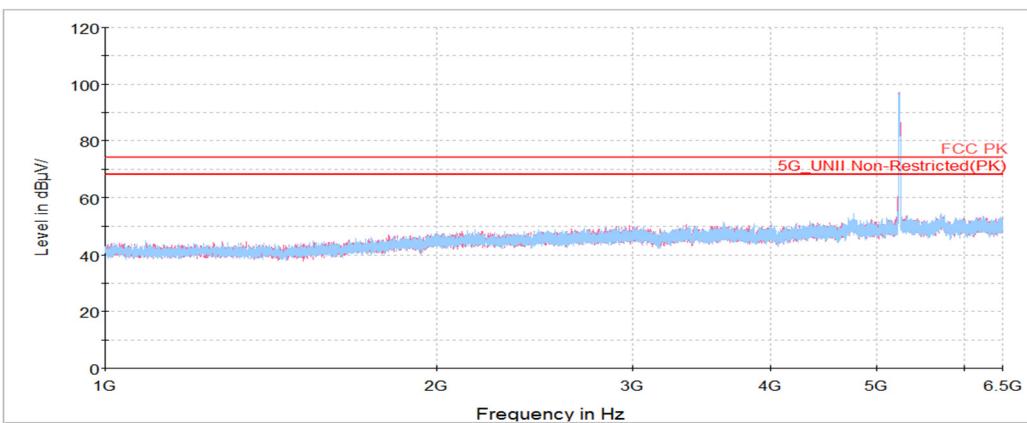
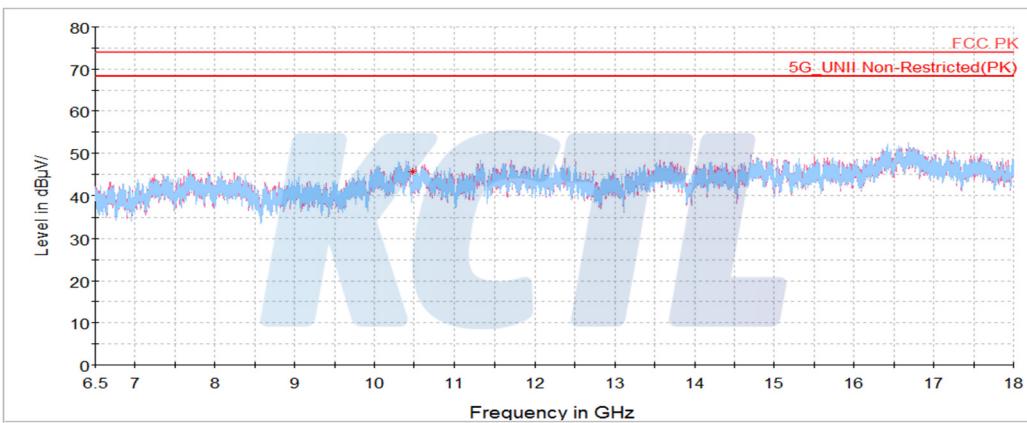
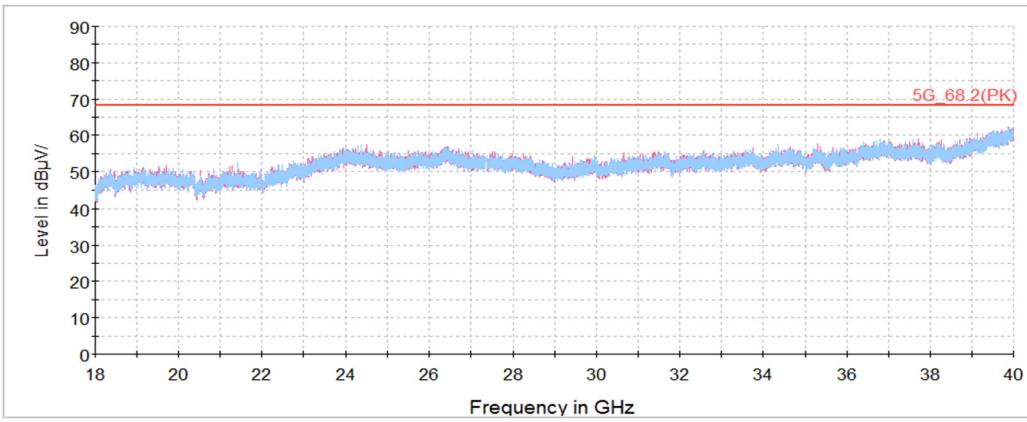
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**Highest Channel (5 240 MHz)**

Frequency (MHz)	Pol.	Reading (dB(µV))	Ant. Factor (dB)	Amp.+Cable (dB)	DCCF	Result (dB(µV/m))	Limit (dB(µV/m))	Margin (dB)
<b>Peak data</b>								
10 479.72	H	56.36	37.39	-48.19	-	45.56	68.20	22.64
<b>Average Data</b>								
No spurious emissions were detected within 20 dB of the limit								

**Horizontal/Vertical for 1 GHz ~ 6.5 GHz****Horizontal/Vertical for 6.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 40 GHz**

**802.11n HT20 UNII-1****Lowest Channel (5 180 MHz)**

Frequency (MHz)	Pol. (V/H)	Reading (dB( $\mu$ V))	Ant. Factor (dB)	Amp.+Cable (dB)	DCCF (dB)	Result (dB( $\mu$ V/m))	Limit (dB( $\mu$ V/m))	Margin (dB)
<b>Peak data</b>								
5 145.45 <sup>1)</sup>	V	42.29	34.07	-27.09	-	49.27	74.00	24.73
10 360.05	H	55.85	37.32	-48.88	-	44.29	68.20	23.91
<b>Average Data</b>								
<b>No spurious emissions were detected within 20 dB of the limit</b>								

**Horizontal/Vertical for Band-edge**