



## **Appendix D. CO-Location**

## Summary of Test Result

Co-location result			
Description	Measured	Limit	Result
Radiated Emissions	[dBuV]: 4824MHz 53.75 (Margin 0.25dB) - AV 57.76 (Margin 16.24dB) – PK	Non-Restricted Bands:≤ 30 dBc and -27dBm (68.3dBuV/m@3m) Restricted Bands: FCC 15.209	Complied

Note: There was no inter-modulation created

# 1 CO-LOCATION

## 1.1 Transmitter Radiated Unwanted Emissions

### 1.1.1 Transmitter Radiated Unwanted Emissions Limit

Restricted Band Emissions Limit			
Frequency Range (MHz)	Field Strength (uV/m)	Field Strength (dBuV/m)	Measure Distance (m)
0.009~0.490	2400/F(kHz)	48.5 - 13.8	300
0.490~1.705	24000/F(kHz)	33.8 - 23	30
1.705~30.0	30	29	30
30~88	100	40	3
88~216	150	43.5	3
216~960	200	46	3
Above 960	500	54	3

Note 1: Test distance for frequencies at or above 30 MHz, measurements may be performed at a distance other than the limit distance provided they are not performed in the near field and the emissions to be measured can be detected by the measurement equipment. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse of linear distance for field-strength measurements, inverse of linear distance-squared for power-density measurements).

Note 2: Test distance for frequencies at below 30 MHz, measurements may be performed at a distance closer than the EUT limit distance; however, an attempt should be made to avoid making measurements in the near field. When performing measurements below 30 MHz at a closer distance than the limit distance, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two or more distances on at least one radial to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade). The test report shall specify the extrapolation method used to determine compliance of the EUT.

Un-restricted Band Emissions Limit	
RF output power procedure	Limit (dB)
Peak output power procedure	20
Average output power procedure	30

Note 1: If the peak output power procedure is used to measure the fundamental emission power to demonstrate compliance to requirements, then the peak conducted output power measured within any 100 kHz outside the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum measured in-band peak PSD level.

Note 2: If the average output power procedure is used to measure the fundamental emission power to demonstrate compliance to requirements, then the power in any 100 kHz outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum measured in-band average PSD level.

### 1.1.2 Measuring Instruments

The following table is the setting of spectrum analyzer and receiver.

Spectrum Analyzer	Setting
Attenuation	Auto
Start Frequency	1GHz
Stop Frequency	10th carrier harmonic
RB / VB (Emission in restricted band)	1MHz / 3MHz for Peak, Dutycycle $\geq 98\%$ 1MHz / 10Hz for Average Dutycycle $< 98\%$ 1MHz / $\geq (1/T)$ for Average, where T is pulse time.
RB / VB (Emission in non-restricted band)	1MHz / 3MHz for peak
Detector	Peak
Trace mode	max hold.

Test Signal Duty Cycle (x) 2.4GHz	T(pulse time)	S.A. Video Bandwidth
100.00% - IEEE 802.11b	NA	10Hz
100.00% - IEEE 802.11g	NA	10Hz
100.00% - IEEE 802.11n 20MHz	NA	10Hz
100.00% - IEEE 802.11n 40MHz	NA	10Hz

Test Signal Duty Cycle (x) 5GHz	T(pulse time)	S.A. Video Bandwidth
100.00% - IEEE 802.11a	NA	10Hz
96.26% - IEEE 802.11ac (VHT20)	4.4783ms	300Hz
98.27% - IEEE 802.11ac (VHT40)	NA	10Hz
96.47% - IEEE 802.11ac (VHT80)	3.1739ms	1kHz

Note: According to KDB 789033 D02 G. 6. d) **Method VB**

- As an alternative, the analyzer may be set to linear detector mode. Ensure that video filtering is applied in linear voltage domain (rather than in a log or dB domain). Some analyzers require linear display mode in order to accomplish this. Others have a setting for Average-VBW Type, which can be set to "Voltage" regardless of the display mode.

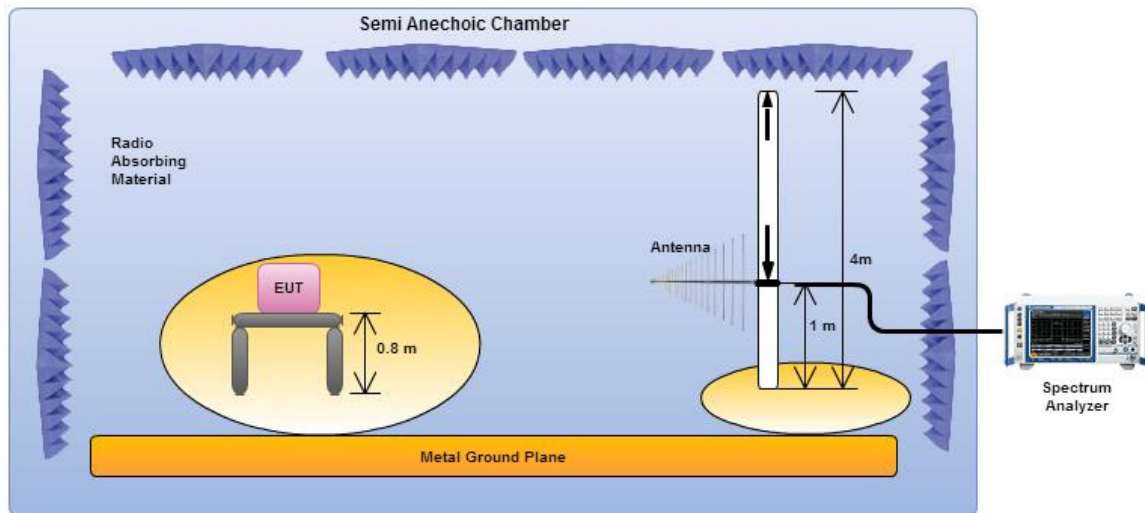
Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RB 200Hz for QP
Start ~ Stop Frequency	150kHz~30MHz / RB 9kHz for QP
Start ~ Stop Frequency	30MHz~1GHz / RB 120kHz for QP

### 1.1.3 Test Procedures

Test Method	
<input checked="" type="checkbox"/>	Measurements may be performed at a distance other than the limit distance provided they are not performed in the near field and the emissions to be measured can be detected by the measurement equipment. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse of linear distance for field-strength measurements, inverse of linear distance-squared for power-density measurements).
<input checked="" type="checkbox"/>	The average emission levels shall be measured in [duty cycle $\geq$ 98 or duty factor].
<input checked="" type="checkbox"/>	For the transmitter unwanted emissions shall be measured using following options below:
<input checked="" type="checkbox"/>	Refer as FCC KDB 558074, clause 11 for unwanted emissions into non-restricted bands.
<input checked="" type="checkbox"/>	Refer as FCC KDB 558074, clause 12 for unwanted emissions into restricted bands.
<input type="checkbox"/>	Refer as FCC KDB 558074, clause 12.2.5.1 and 9.2.1 Option 1 (spectral trace averaging)
<input type="checkbox"/>	Refer as FCC KDB 558074, clause 12.2.5.2 and 9.2.1 Option 2 (slow sweep speed).
<input checked="" type="checkbox"/>	Refer as ANSI C63.10, clause 4.1.4.2.3 (Reduced VBW). VBW $\geq$ 1/T, where T is pulse time.
<input type="checkbox"/>	Refer as ANSI C63.10, clause 4.1.4.2.4 average value of pulsed emissions.
<input checked="" type="checkbox"/>	Refer as FCC KDB 558074, clause 12.2.4 and 9.1.1 measurement procedure peak limit.
<input type="checkbox"/>	Refer as FCC KDB 558074, clause 12.2.3 measurement procedure Quasi-Peak limit.
<input checked="" type="checkbox"/>	For radiated measurement, refer as FCC KDB 558074, clause 12.1.
<input checked="" type="checkbox"/>	Refer as ANSI C63.10, clause 6.4 for radiated emissions below 30 MHz and test distance is 3m.
<input checked="" type="checkbox"/>	Refer as ANSI C63.10, clause 6.5 for radiated emissions 30 MHz to 1 GHz and test distance is 3m.
<input checked="" type="checkbox"/>	Refer as ANSI C63.10, clause 6.6 for radiated emissions above 1 GHz and test distance is 3m.
<input type="checkbox"/>	For conducted and cabinet radiation measurement, refer as FCC KDB 558074, clause 12.2.2.
<input type="checkbox"/>	For conducted unwanted emissions into non-restricted bands (relative emission limits). Devices with multiple transmit chains: Refer as FCC KDB 662911, when testing out-of-band and spurious emissions against relative emission limits, tests may be performed on each output individually without summing or adding 10 log(N) if the measurements are made relative to the in-band emissions on the individual outputs.
<input type="checkbox"/>	For conducted unwanted emissions into restricted bands (absolute emission limits). Devices with multiple transmit chains using options given below: (1) Measure and sum the spectra across the outputs or (2) Measure and add 10 log(N) dB

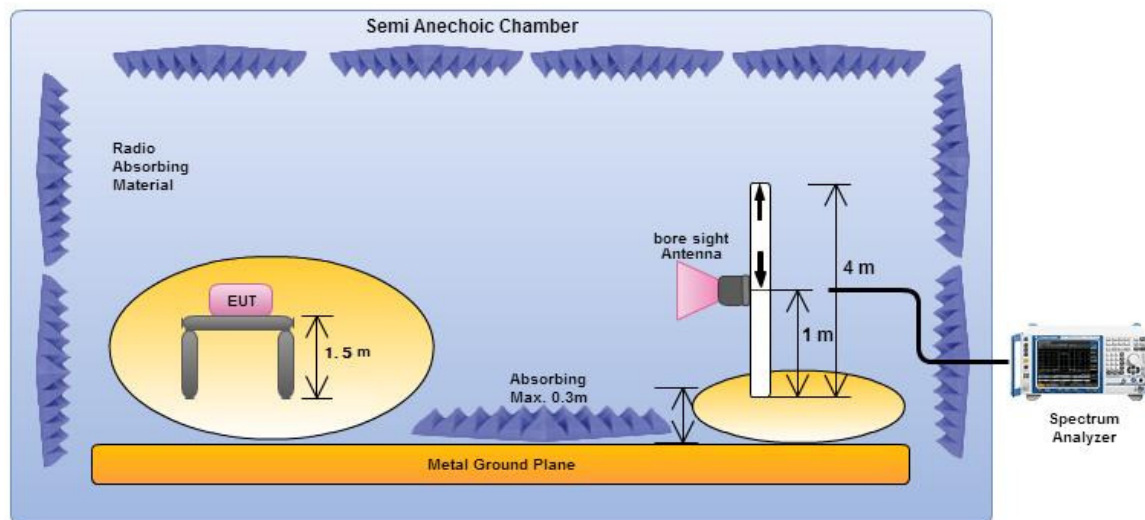
#### 1.1.4 Test Setup

##### Transmitter Radiated Unwanted Emissions (below 1GHz)



Magnetic field tests shall be performed in the frequency range of 9 kHz to 30 MHz using a calibrated loop antenna. Electric field tests shall be performed in the frequency range of 30 MHz to 1000 MHz using a calibrated bi-log antenna.

##### Transmitter Radiated Unwanted Emissions (Above 1GHz)



Electric field tests shall be performed in the frequency range of 1 GHz to 10th harmonic of highest fundamental frequency or 40 GHz using a calibrated horn antenna.

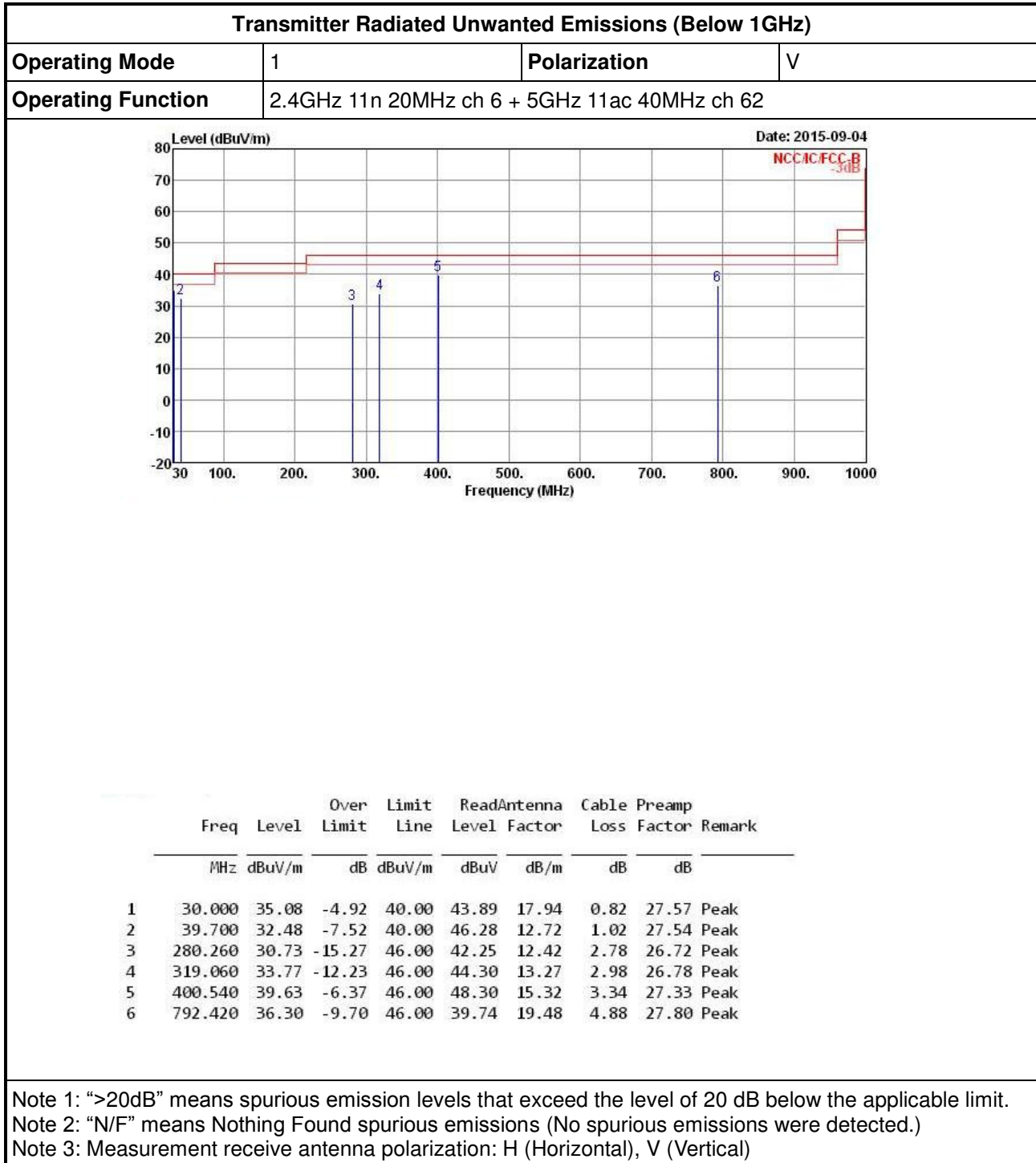
**1.1.5 Test Mode**

We select 2 combinations (Max. power and worst emission) based on preliminary evaluation of inter-modulation.

No.	Operating Band	Remark
1	2.4GHz 11n 20MHz ch 6 + 5GHz 11ac 40MHz ch 62	Max. power combination
2	2.4GHz 11B ch1 + 5GHz 11a ch60	Worst emission combination

**1.1.6 Transmitter Radiated Unwanted Emissions (Below 30MHz)**

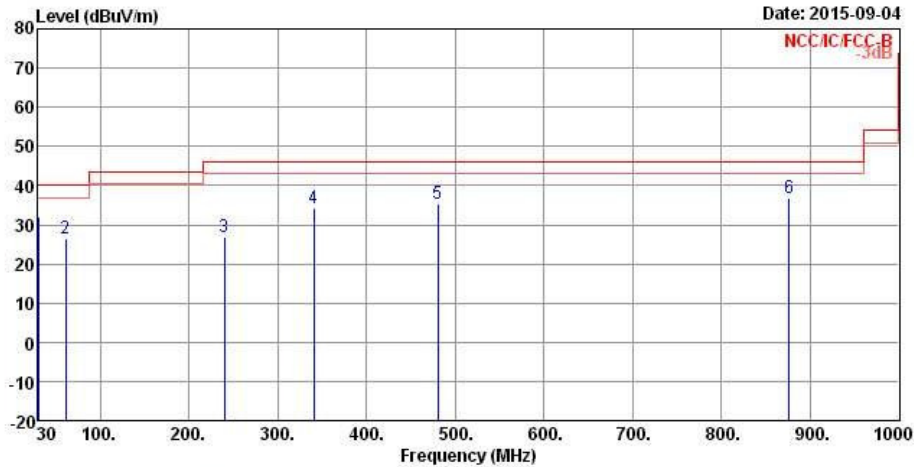
All amplitude of spurious emissions that are attenuated by more than 20 dB below the permissible value has no need to be reported.

**1.1.7 Results of Radiated Emissions (30MHz~1GHz)**




**Transmitter Radiated Unwanted Emissions (Below 1GHz)**

Operating Mode	1	Polarization	H
Operating Function	2.4GHz 11n 20MHz ch 6 + 5GHz 11ac 40MHz ch 62		

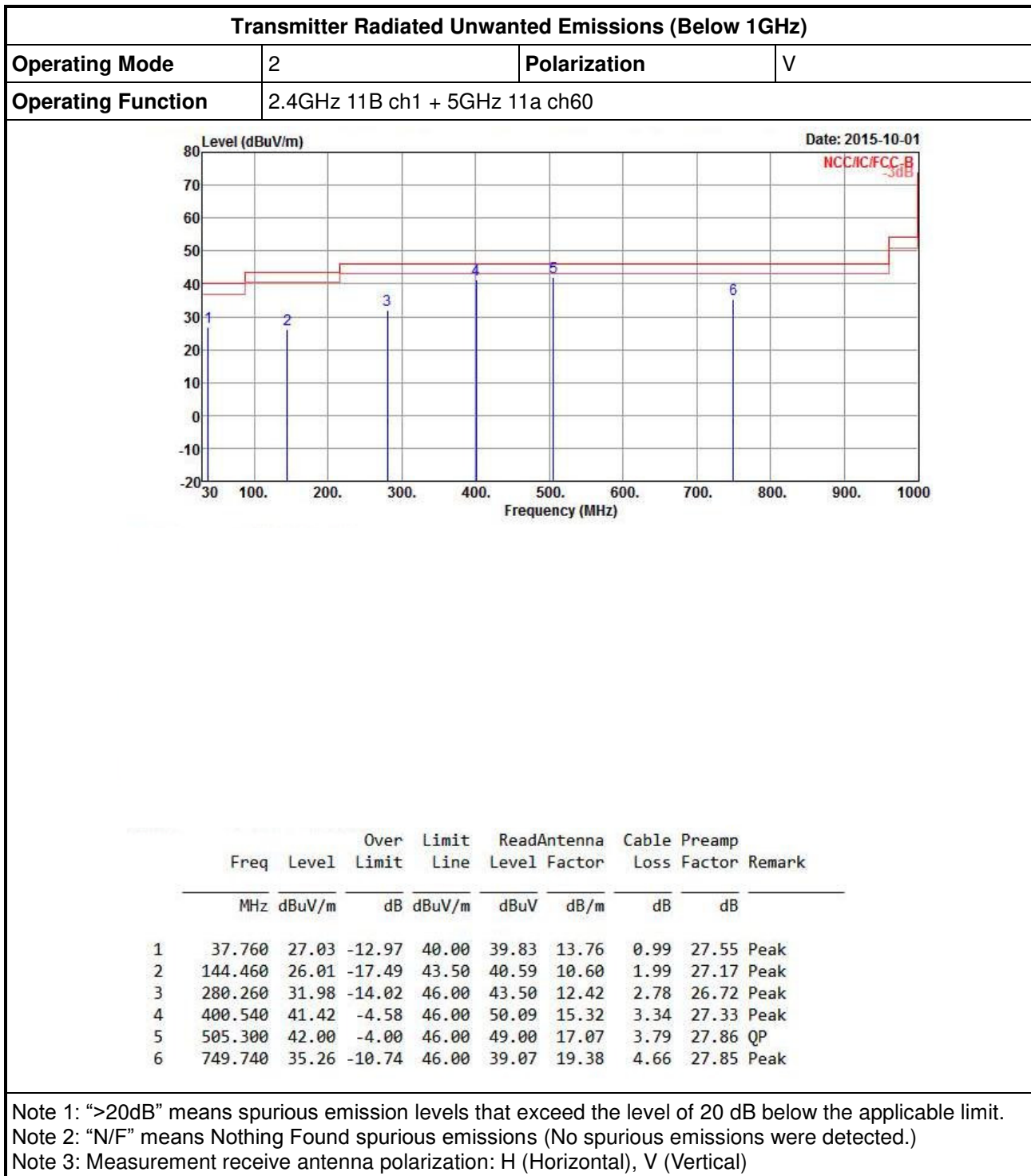


	Freq	Level	Over Limit	Limit Line	ReadAntenna Level	Cable Factor	Preamp Loss	Remark
	MHz	dBuV/m	dB	dBuV/m	dBuV	dB/m	dB	dB
1	30.000	32.08	-7.92	40.00	40.89	17.94	0.82	27.57 Peak
2	61.040	26.38	-13.62	40.00	46.29	6.31	1.26	27.48 Peak
3	239.520	26.90	-19.10	46.00	40.05	11.14	2.55	26.84 Peak
4	340.400	34.22	-11.78	46.00	44.53	13.54	3.08	26.93 Peak
5	480.080	35.49	-10.51	46.00	42.75	16.81	3.67	27.74 Peak
6	875.840	36.72	-9.28	46.00	39.22	20.08	5.07	27.65 Peak

Note 1: ">20dB" means spurious emission levels that exceed the level of 20 dB below the applicable limit.

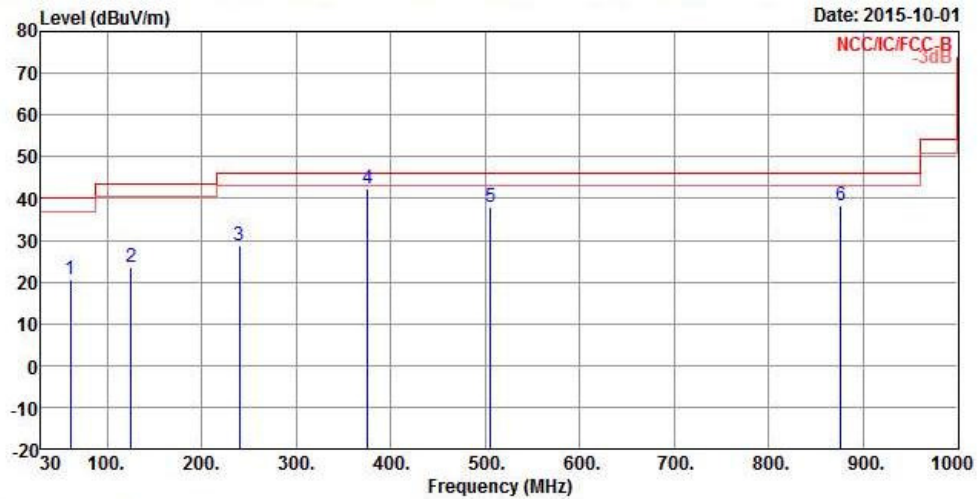
Note 2: "N/F" means Nothing Found spurious emissions (No spurious emissions were detected.)

Note 3: Measurement receive antenna polarization: H (Horizontal), V (Vertical)



**Transmitter Radiated Unwanted Emissions (Below 1GHz)**

Operating Mode	2	Polarization	H
Operating Function	2.4GHz 11B ch1 + 5GHz 11a ch60		



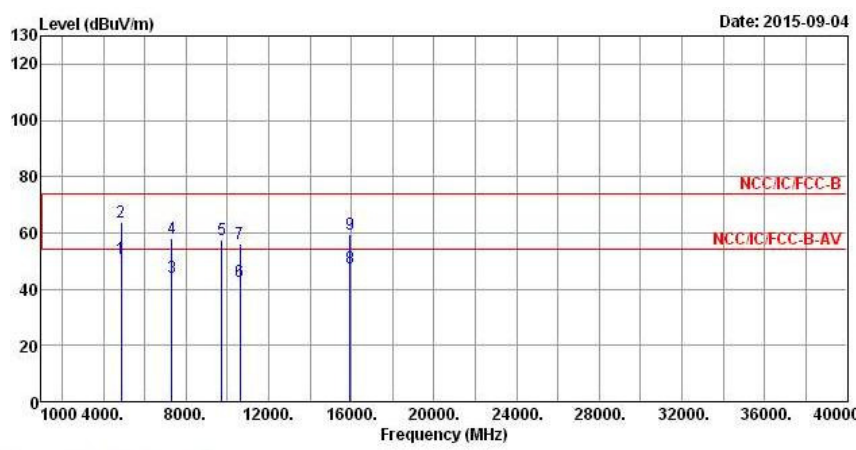
	Freq	Level	Over Limit	Limit Line	ReadAntenna Level	Antenna Factor	Cable Loss	Preamp Factor	Remark
	MHz	dBuV/m	dB	dBuV/m	dBuV	dB/m	dB	dB	
1	61.040	20.44	-19.56	40.00	40.35	6.31	1.26	27.48	Peak
2	125.060	23.61	-19.89	43.50	36.66	12.37	1.83	27.25	Peak
3	239.520	28.77	-17.23	46.00	41.92	11.14	2.55	26.84	Peak
4	375.320	42.20	-3.80	46.00	51.68	14.45	3.23	27.16	Peak
5	505.300	38.03	-7.97	46.00	45.03	17.07	3.79	27.86	Peak
6	875.840	38.32	-7.68	46.00	40.82	20.08	5.07	27.65	Peak

Note 1: ">20dB" means spurious emission levels that exceed the level of 20 dB below the applicable limit.

Note 2: "N/F" means Nothing Found spurious emissions (No spurious emissions were detected.)

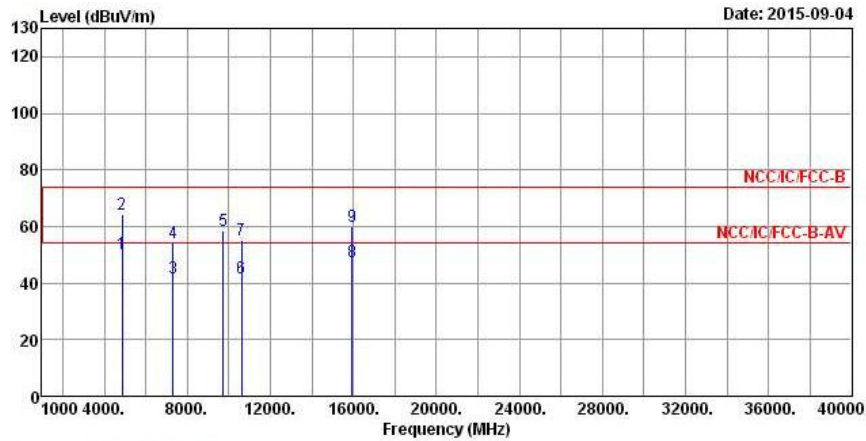
Note 3: Measurement receive antenna polarization: H (Horizontal), V (Vertical)

**1.1.8 Results for Radiated Emissions (1GHz~10<sup>th</sup> Harmonic)**

Transmitter Radiated Unwanted Emissions (Above 1GHz)																																																																																																																																	
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<div><div></div><div>Date: 2015-09-04</div></div>																																																																																																																																	
<table><tr><th></th><th>Freq</th><th>Level</th><th>Over Limit</th><th>Limit Line</th><th>ReadAntenna Level</th><th>Cable</th><th>Preamp</th><th colspan="2"></th></tr><tr><th></th><th>MHz</th><th>dBuV/m</th><th>dB</th><th>dBuV/m</th><th>dBuV</th><th>Factor</th><th>Loss</th><th>Factor</th><th>Remark</th></tr><tr><th></th><th></th><th></th><th></th><th></th><th>dB/m</th><th></th><th>dB</th><th>dB</th><th></th></tr><tr><td>1</td><td>4874.000</td><td>50.83</td><td>-3.17</td><td>54.00</td><td>43.33</td><td>33.16</td><td>6.79</td><td>32.45</td><td>Average</td></tr><tr><td>2</td><td>4874.000</td><td>63.80</td><td>-10.20</td><td>74.00</td><td>56.30</td><td>33.16</td><td>6.79</td><td>32.45</td><td>Peak</td></tr><tr><td>3</td><td>7311.000</td><td>43.99</td><td>-10.01</td><td>54.00</td><td>32.74</td><td>36.01</td><td>7.91</td><td>32.67</td><td>Average</td></tr><tr><td>4</td><td>7311.000</td><td>58.03</td><td>-15.97</td><td>74.00</td><td>46.78</td><td>36.01</td><td>7.91</td><td>32.67</td><td>Peak</td></tr><tr><td>5</td><td>9748.000</td><td>57.47</td><td></td><td></td><td>43.44</td><td>38.42</td><td>8.75</td><td>33.14</td><td>Peak</td></tr><tr><td>6</td><td>10620.000</td><td>42.90</td><td>-11.10</td><td>54.00</td><td>28.01</td><td>38.80</td><td>8.71</td><td>32.62</td><td>Average</td></tr><tr><td>7</td><td>10620.000</td><td>56.34</td><td>-17.66</td><td>74.00</td><td>41.45</td><td>38.80</td><td>8.71</td><td>32.62</td><td>Peak</td></tr><tr><td>8</td><td>15930.000</td><td>47.34</td><td>-6.66</td><td>54.00</td><td>33.11</td><td>37.04</td><td>9.56</td><td>32.37</td><td>Average</td></tr><tr><td>9</td><td>15930.000</td><td>59.44</td><td>-14.56</td><td>74.00</td><td>45.21</td><td>37.04</td><td>9.56</td><td>32.37</td><td>Peak</td></tr></table>											Freq	Level	Over Limit	Limit Line	ReadAntenna Level	Cable	Preamp				MHz	dBuV/m	dB	dBuV/m	dBuV	Factor	Loss	Factor	Remark						dB/m		dB	dB		1	4874.000	50.83	-3.17	54.00	43.33	33.16	6.79	32.45	Average	2	4874.000	63.80	-10.20	74.00	56.30	33.16	6.79	32.45	Peak	3	7311.000	43.99	-10.01	54.00	32.74	36.01	7.91	32.67	Average	4	7311.000	58.03	-15.97	74.00	46.78	36.01	7.91	32.67	Peak	5	9748.000	57.47			43.44	38.42	8.75	33.14	Peak	6	10620.000	42.90	-11.10	54.00	28.01	38.80	8.71	32.62	Average	7	10620.000	56.34	-17.66	74.00	41.45	38.80	8.71	32.62	Peak	8	15930.000	47.34	-6.66	54.00	33.11	37.04	9.56	32.37	Average	9	15930.000	59.44	-14.56	74.00	45.21	37.04	9.56	32.37	Peak
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<p>Note 1: "&gt;20dB" means spurious emission levels that exceed the level of 20 dB below the applicable limit.</p> <p>Note 2: "N/F" means Nothing Found spurious emissions (No spurious emissions were detected.)</p> <p>Note 3: Measurement receive antenna polarization: H (Horizontal), V (Vertical)</p> <p>Note 4: For restricted bands, the peak measurement is fully sufficient, as the max field strength as measured with the Peak-Detector meets the AV-Limit so that the AV level does not need to be reported in addition.</p> <p>Note 5: For un-restricted bands, unwanted emissions shall be attenuated by at least 20 dB relative to the maximum measured in-band level.</p>																																																																																																																																	

**Transmitter Radiated Unwanted Emissions (Above 1GHz)**

<b>Operating Mode</b>	1	<b>Polarization</b>	H
<b>Operating Function</b>	2.4GHz 11n 20MHz ch 6 + 5GHz 11ac 40MHz ch 62		



	Freq	Level	Over Limit	Limit Line	ReadAntenna Level	Antenna Factor	Cable Loss	Preamp Factor	Remark
	MHz	dBuV/m	dB	dBuV/m	dBuV	dB/m	dB	dB	
1	4874.000	50.37	-3.63	54.00	42.87	33.16	6.79	32.45	Average
2	4874.000	64.17	-9.83	74.00	56.67	33.16	6.79	32.45	Peak
3	7311.000	41.79	-12.21	54.00	30.54	36.01	7.91	32.67	Average
4	7311.000	53.99	-20.01	74.00	42.74	36.01	7.91	32.67	Peak
5	9748.000	58.40			44.37	38.42	8.75	33.14	Peak
6	10620.000	41.74	-12.26	54.00	26.85	38.80	8.71	32.62	Average
7	10620.000	55.01	-18.99	74.00	40.12	38.80	8.71	32.62	Peak
8	15930.000	47.67	-6.33	54.00	33.44	37.04	9.56	32.37	Average
9	15930.000	60.07	-13.93	74.00	45.84	37.04	9.56	32.37	Peak

Note 1: ">20dB" means spurious emission levels that exceed the level of 20 dB below the applicable limit.

Note 2: "N/F" means Nothing Found spurious emissions (No spurious emissions were detected.)

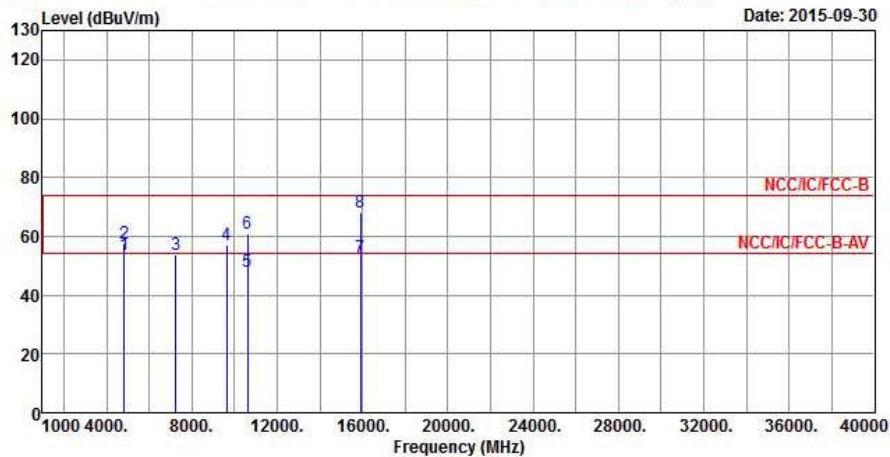
Note 3: Measurement receive antenna polarization: H (Horizontal), V (Vertical)

Note 4: For restricted bands, the peak measurement is fully sufficient, as the max field strength as measured with the Peak-Detector meets the AV-Limit so that the AV level does not need to be reported in addition.

Note 5: For un-restricted bands, unwanted emissions shall be attenuated by at least 20 dB relative to the maximum measured in-band level.

**Transmitter Radiated Unwanted Emissions (Above 1GHz)**

<b>Operating Mode</b>	2	<b>Polarization</b>	V
<b>Operating Function</b>	2.4GHz 11B ch1 + 5GHz 11a ch60		



	Freq	Level	Over Limit	Limit Line	ReadAntenna Level	Cable Loss	Preamplifier	Remark
	MHz	dBuV/m	dB	dBuV/m	dBuV	dB/m	dB	dB
1	4824.000	53.75	-0.25	54.00	46.46	33.06	6.77	32.54 Average
2	4824.000	57.76	-16.24	74.00	50.47	33.06	6.77	32.54 Peak
3	7236.000	53.64			42.69	35.83	7.90	32.78 Peak
4	9648.000	57.13			43.46	38.21	8.68	33.22 Peak
5	10600.000	48.05	-5.95	54.00	33.21	38.82	8.74	32.72 Average
6	10600.000	60.69	-13.31	74.00	45.85	38.82	8.74	32.72 Peak
7	15900.000	52.56	-1.44	54.00	38.35	37.11	9.55	32.45 Average
8	15900.000	68.20	-5.80	74.00	53.99	37.11	9.55	32.45 Peak

Note 1: ">20dB" means spurious emission levels that exceed the level of 20 dB below the applicable limit.

Note 2: "N/F" means Nothing Found spurious emissions (No spurious emissions were detected.)

Note 3: Measurement receive antenna polarization: H (Horizontal), V (Vertical)

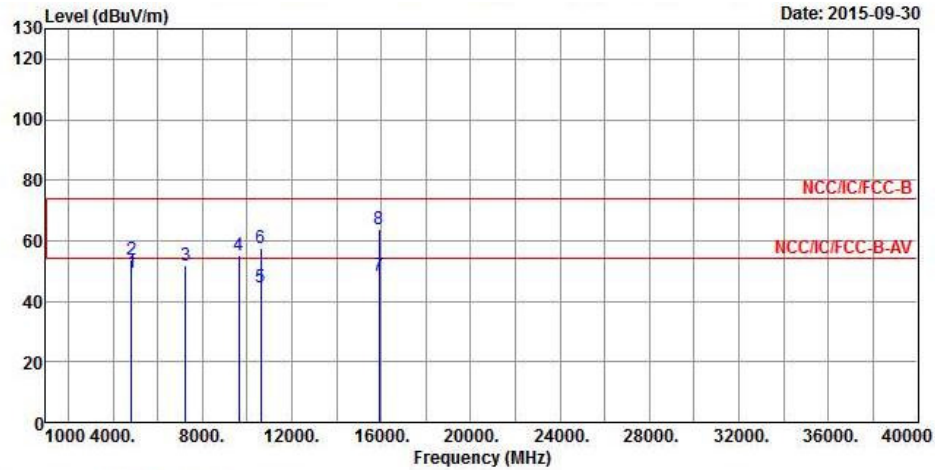
Note 4: For restricted bands, the peak measurement is fully sufficient, as the max field strength as measured with the Peak-Detector meets the AV-Limit so that the AV level does not need to be reported in addition.

Note 5: For un-restricted bands, unwanted emissions shall be attenuated by at least 20 dB relative to the maximum measured in-band level.



**Transmitter Radiated Unwanted Emissions (Above 1GHz)**

<b>Operating Mode</b>	2	<b>Polarization</b>	H
<b>Operating Function</b>	2.4GHz 11B ch1 + 5GHz 11a ch60		



	Freq	Level	Over Limit	Limit Line	ReadAntenna Level	Cable Preamp Loss	Factor	Remark
	MHz	dBuV/m	dB	dBuV/m	dBuV	dB/m	dB	dB
1	4824.000	49.55	-4.45	54.00	42.26	33.06	6.77	32.54 Average
2	4824.000	53.80	-20.20	74.00	46.51	33.06	6.77	32.54 Peak
3	7236.000	51.95			41.00	35.83	7.90	32.78 Peak
4	9648.000	55.29			41.62	38.21	8.68	33.22 Peak
5	10600.000	44.85	-9.15	54.00	30.01	38.82	8.74	32.72 Average
6	10600.000	57.49	-16.51	74.00	42.65	38.82	8.74	32.72 Peak
7	15900.000	48.22	-5.78	54.00	34.01	37.11	9.55	32.45 Average
8	15900.000	63.83	-10.17	74.00	49.62	37.11	9.55	32.45 Peak

Note 1: ">20dB" means spurious emission levels that exceed the level of 20 dB below the applicable limit.

Note 2: "N/F" means Nothing Found spurious emissions (No spurious emissions were detected.)

Note 3: Measurement receive antenna polarization: H (Horizontal), V (Vertical)

Note 4: For restricted bands, the peak measurement is fully sufficient, as the max field strength as measured with the Peak-Detector meets the AV-Limit so that the AV level does not need to be reported in addition.

Note 5: For un-restricted bands, unwanted emissions shall be attenuated by at least 20 dB relative to the maximum measured in-band level.

## 2 TEST EQUIPMENT AND CALIBRATION DATA

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Remark
3m Semi Anechoic Chamber	SIDT FRANKONIA	SAC-3M	03CH03-HY	30MHz ~ 1GHz 3m	Nov. 29, 2014	Radiation Emission
Amplifier	HP	8447D	2944A08033	10kHz ~ 1.3GHz	May 11, 2015	Radiated Emission
Amplifier	Agilent	8449B	3008A02602	1 GHz ~ 26.5 GHz	Oct. 20, 2014	Radiation Emission
Spectrum	R&S	FSP40	100004	9kHz ~ 40GHz	Apr. 02, 2015	Radiated Emission
Bilog Antenna	SCHAFFNER	CBL 6112D	22237	30MHz ~ 1GHz	Sep. 20, 2014	Radiation Emission
Horn Antenna	AARONIA AG	POWERLOG 70180	05192	1GHz ~ 18GHz	May 01, 2015	Radiated Emission
Horn Antenna	SCHWARZBECK	BBHA9170	BBHA9170154	18GHz ~ 40GHz	Jan. 27, 2015	Radiated Emission
RF Cable-R03m	Jye Bao	RG142	CB021	9kHz ~ 1GHz	Nov. 15, 2014	Radiation Emission
RF Cable-high	SUHNER	SUCOFLEX 106	03CH03-HY	1GHz ~ 40GHz	Dec. 12, 2014	Radiation Emission
Turn Table	EM Electronics	EM Electronics	060615	0 ~ 360 degree	N/A	Radiation Emission
Antenna Mast	MF	MF-7802	MF780208179	1 ~ 4 m	N/A	Radiation Emission

Note: Calibration Interval of instruments listed above is one year.

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Remark
Amplifier	EM	EM18G40G	060604	18GHz ~ 40GHz	Oct. 17, 2013	Radiation Emission
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100315	9kHz ~ 30MHz	Jul. 28, 2014	Radiation Emission

Note: Calibration Interval of instruments listed above is two years.