TEST REPORT

Part 15 Subpart E 15.407

Equipment under test	RF Module
Model name	PG11
FCC ID	2AWVMPG11
Applicant	PIXXGEN Corporation
Manufacturer	PIXXGEN Corporation
Date of test(s)	2020.07.27 ~ 2020.09.04
Date of issue	2020.09.07

Issued to

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Revision history

Revision	Date of issue	Test report No.	Description
-	2020.09.07	KES-RF1-20T0138	Initial

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1. General information

Applicant:	PIXXGEN Corporation
Applicant address:	5F, SMART BAY, 123, Beolmal-ro, Dongan-gu, Anyang-si, Gyeonggi-do, Republic of Korea
Test site:	KES Co., Ltd.
Test site address:	3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea 473-29, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea
Test Facility	FCC Accreditation Designation No.: KR0100, Registration No.: 444148
FCC rule part(s):	15.407
FCC ID:	2AWVMPG11
Test device serial No.:	☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test	RF Module
Frequency range	2 412 ㎒ ~ 2 462 ㎒ (11n_HT20) **UNII-1 5 180 ㎒ ~ 5 240 ㎒ (11ac_VHT20)**
Model:	PG11
Modulation technique	WIFI : OFDM 2 412 ㎒ ~ 2 462 ㎒ (11n_HT20) : 11 ch
Number of channels	**5 180 ㎒ ~ 5 240 ㎒ (11ac_VHT20) : 4ch** PG11
Antenna specification	2.4 ㎓ Antenna type : Dipole antenna, Peak gain : 3.67 ㏈i 5 ㎓ Antenna type : : Dipole antenna, Peak gain(UNII-1) : 5.62 ㏈i
Power source	DC 5.0 V
H/W version	v1.0
S/W version	v1.0

1.2. Test configuration

The **PIXXGEN Corporation // PG11// FCC ID: 2AWVMPG11** was tested per the guidance of KDB 789033 D02 v02r01. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing.

1.3. Device modifications

N/A

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1.4. Frequency/channel operations

UNII-1

Ch.	Frequency (㎒)
36	5 180
44	5 220
48	5 240

Table 1.7-1. 802.11ac_VHT20 mode

1.5. Maximum average output power

Refer to the average output power.

Note.

1. Radiated 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:
   UNII-1 ac_VHT 20 : **MCS8**

1.6. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
-	-	-	-	-

1.7. Antenna information

Mode	SISO		MIMO
	Antenna 0	Antenna 1	Antenna 0 + 1
802.11ac(VHT20)	✔	✔	✔

✔ = Support; ✕ = Not support

Antenna Model : WiFi Antenna (Dipole antenna)

Ant0 Gain (㏈i)	Ant1 Gain (㏈i)	Note
3.67	3.67	2 412 to 2 462 ㎒
5.62	5.62	5 180 to 5 240 ㎒

Antenna Model : Xls-857 (PCB antenna)

Ant0 Gain (㏈i)	Ant1 Gain (㏈i)	Note
2.27	2.27	2 412 to 2 462 ㎒
1.86	1.86	5 180 to 5 240 ㎒

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1.8. Measurement results explanation example

For all conducted test items :

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Offset(dB) = RF cable loss(dB) + attenuator factor(dB).
= 1.78 + 10 = 11.78 (dB)

1.9. Measurement Uncertainty

Test Item		Uncertainty
Uncertainty for Conduction emission test		2.46 dB
Uncertainty for Radiation emission test (include Fundamental emission)	Below 1㎓	4.40 dB
	Above 1㎓	5.94 dB
Note. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.		

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2. Summary of tests

Reference	Parameter	Test results
15.407(a)	26 ㏈ bandwidth & 99 % Occupied 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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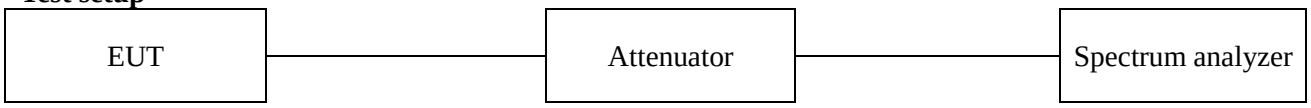
3. Test results

3.1. 26 dB bandwidth & 99% Occupied Bandwidth

Test procedure

KDB 789033 D02 v02r01– Section C.1

Test setup



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

<u>99 % bandwidth</u>

KDB 789033 D02 v02r01– Section D

1. Set span = 1.5 times to 5.0 times the OBW.
2. Set RBW = 1% to 5% of the OBW
3. Set the VBW > 3 x RBW.
4. Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak bandwidth function of the instrument (if available).
5. Use the 99% power bandwidth function of the instrument (if available).
6. If the instrument does not have a 99% power bandwidth function, the trace data points are recovered and directly summed in power units. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% occupied bandwidth is the difference between these two frequencies.

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Test results

Antenna port 0

Band	Frequency(㎒)	Mode	26 ㏈ bandwidth(㎒)	99% Bandwidth(㎒)
UNII-1	5 180	ac_ VHT20	20.28	17.72
	5 220		20.61	17.72
	5 240		19.55	17.72

Antenna port 1

Band	Frequency(㎒)	Mode	26 ㏈ bandwidth(㎒)	99% Bandwidth(㎒)
UNII-1	5 180	ac_ VHT20	20.88	17.76
	5 220		20.58	17.75
	5 240		20.45	17.75

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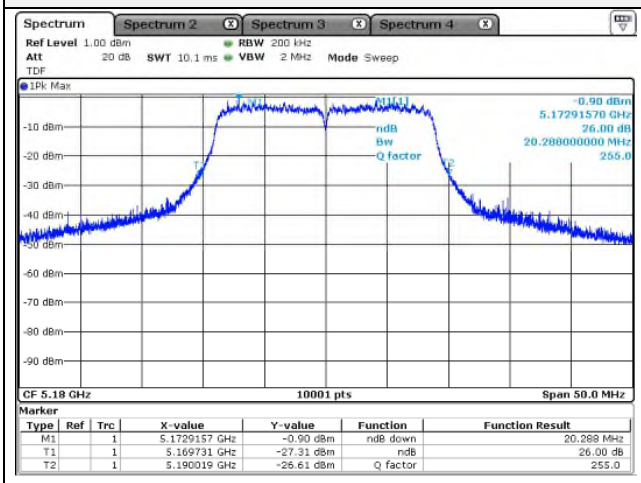
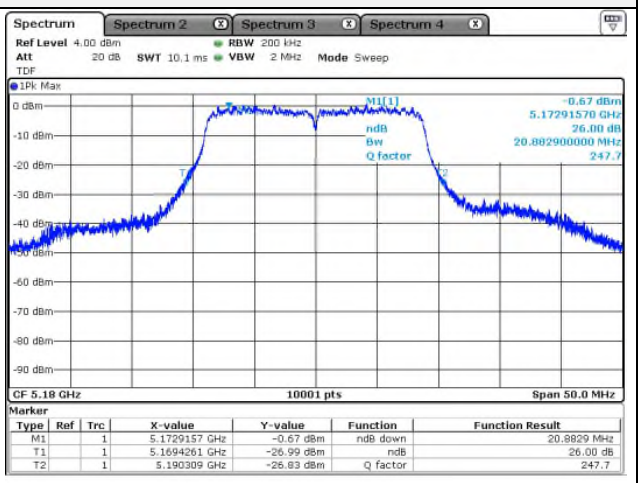
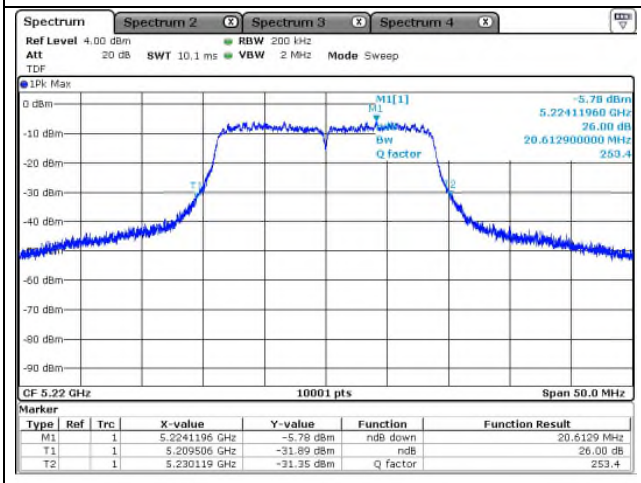
26 dB bandwidth

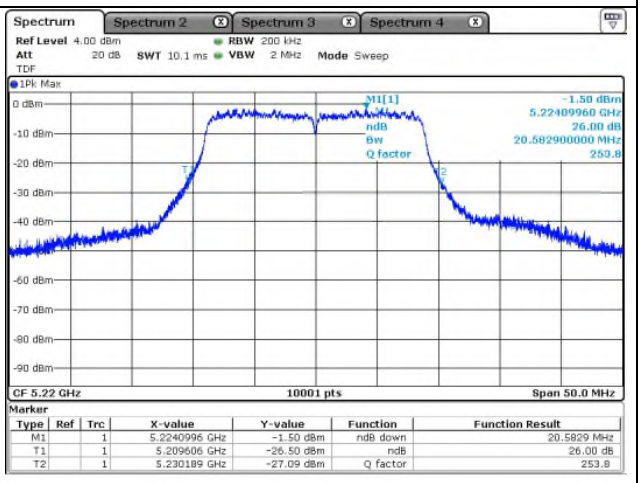
Test plots

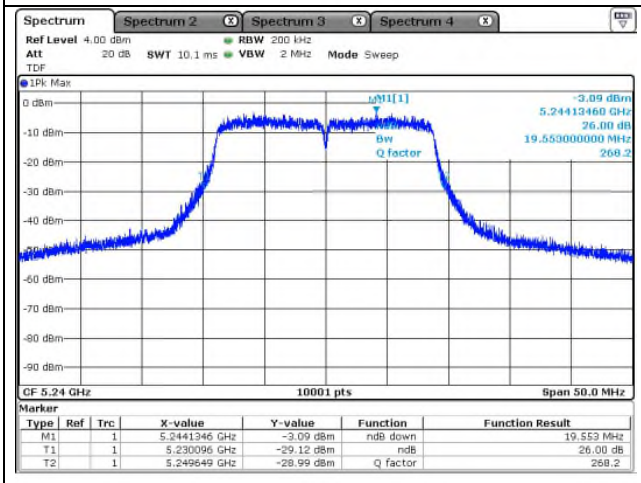
ac_VHT20 // ANT 0	ac_VHT20 // ANT 1

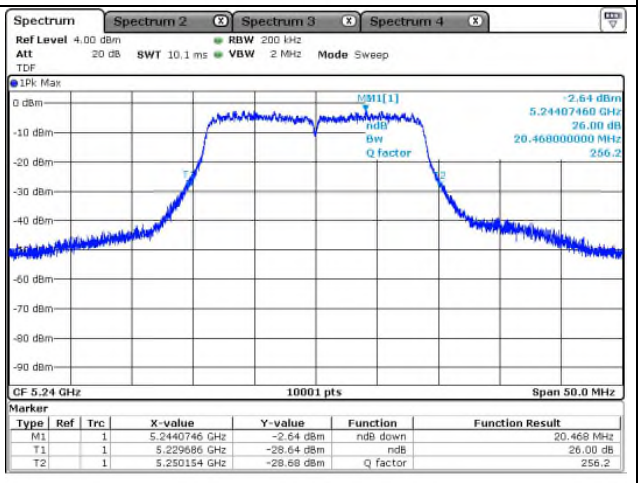












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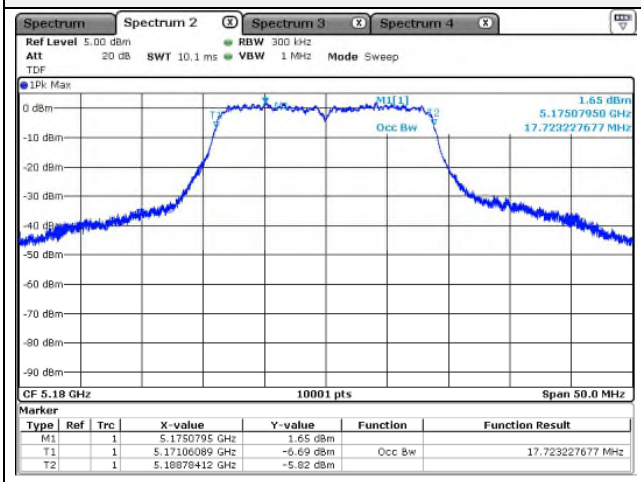
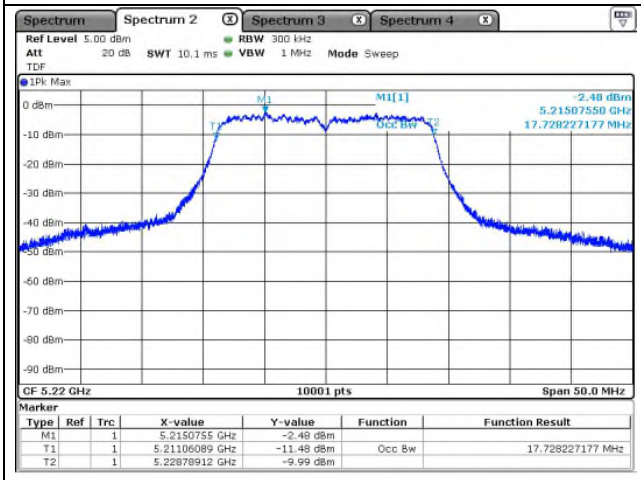
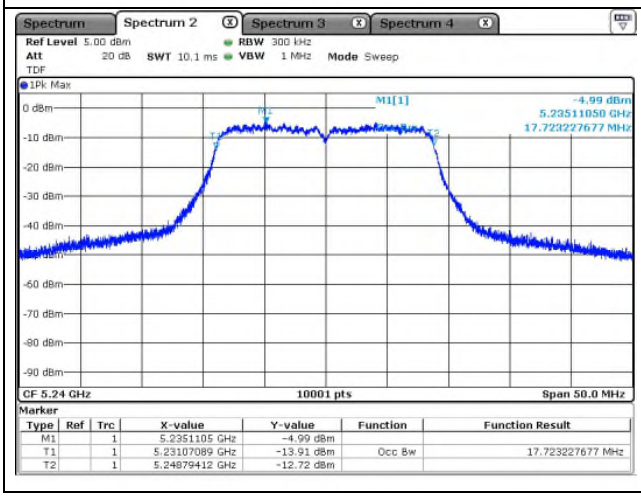
99% Occupied Bandwidth
Test plots

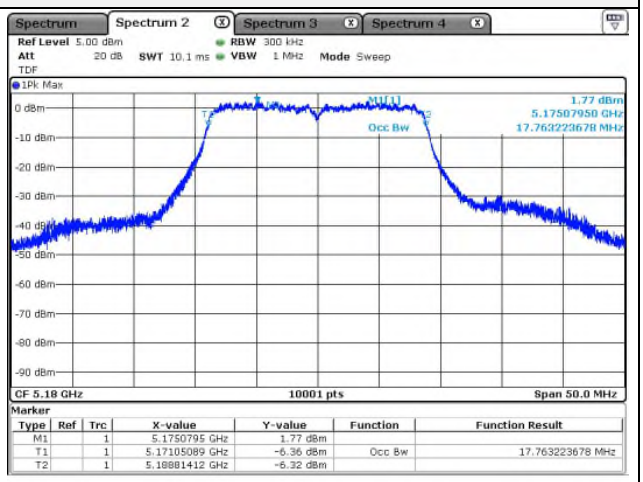
ac_VHT20 // ANT 0

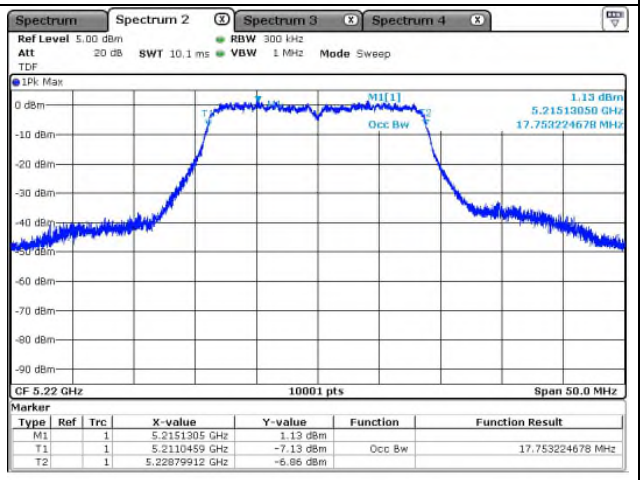


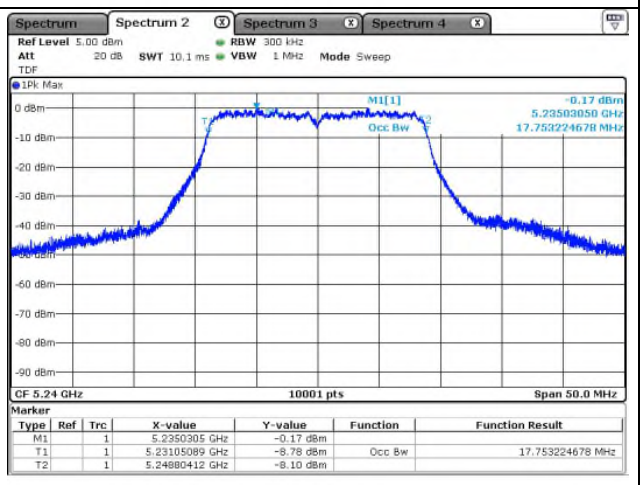




ac_VHT20 // ANT 1







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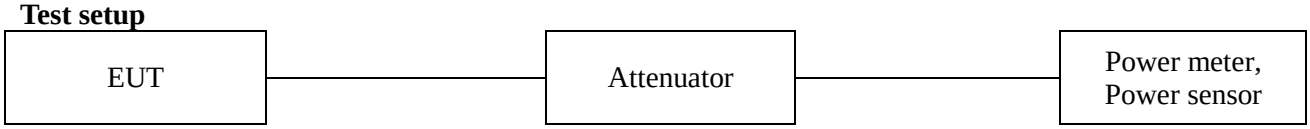
3.3. Maximum conducted output power

Test procedure

KDB 789033 D02 v02r01– Section E.3.a) or b)
Used test method is Section E.3.b)

Test setup



Section E.3.a)

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 %).

v. In case of band crossing channels 138, 142 and 144, the measurement is complied with section E.2.d of KDB 644545_D03 v01

Section E.3.b)

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.

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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. FCC Limit B is the 26 dB emission bandwidth.

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Test results

Band	mode	Frequency (㎒)	Detector mode	Output power(dBm)			Limit (dBm)
				ANT0	ANT1	SUM[1]	
UNII-1	ac_ VHT20	5 180	AV	5.10	6.11	8.65	24.00
		5 220	AV	4.97	6.19	8.63	
		5 240	AV	4.89	5.63	8.29	

Note.

1. Sum = 10log($10^{Ant0/10} + 10^{Ant1/10} \ldots 10^{Ant\ N/10}$)

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3.4. Maximum Power spectral density

Test procedure

KDB 789033 D02 v02r01 – Section F

Test setup

EUT	Attenuator	Spectrum analyzer

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 dB to the final result to compensate for the difference between linear averaging and power averaging.
4. The result is the Maximum PSD over 1 MHz reference bandwidth.
5. For devices operating in the bands 5.15-5.25 GHz, 5.25-5.35 GHz, and 5.47-5.725 GHz, the preceding procedures make use of 1 MHz RBW to satisfy directly the 1 MHz reference bandwidth specified in § 15.407(a)(5). For devices operating in the band 5.725-5.85 GHz, the rules specify a measurement bandwidth of 500 kHz. Many spectrum analyzers do not have 500 kHz RBW, thus a narrower RBW may need to be used. The rules permit the use of a RBWs less than 1 MHz, or 500 kHz, "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 MHz, or 500 kHz). If measurements are performed using a reduced resolution bandwidth (< 1 MHz, or < 500 kHz) and integrated over 1 MHz, or 500 kHz 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 kHz, add 10 log (500 kHz/RBW) to the measured result, whereas RBW (< 500 kHz) is the reduced resolution bandwidth of the spectrum analyzer set during measurement.
   d) If measurement bandwidth of Maximum PSD is specified in 1 MHz, add 10 log (1 MHz/RBW) to the measured result, whereas RBW (< 1 MHz) 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 kHz for the II.F.5.c) and II.F.5.d), since RBW=100 kHz 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 ㎑

Note.

1. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceed 6 dBi.

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Test results

Antenna port 0

Band	Frequency (㎒)	Mode	PSD (dBm/㎒)	RBWF Note1	DCF Note2	Sum Note3	Limit(dBm/㎒) FCC
UNII-1	5 180	ac_ VHT20	-4.89	-	0	-4.89	11.00
	5 220		-5.21			-5.21	
	5 240		-4.39			-4.39	

Antenna port 1

Band	Frequency (㎒)	Mode	PSD (dBm/㎒)	RBWF Note1	DCF Note2	Sum Note3	Limit(dBm/㎒) FCC
UNII-1	5 180	ac_ VHT20	-3.07	-	0	-3.07	11.00
	5 220		-0.93			-0.93	
	5 240		-1.06			-1.06	

Note.

1. UNII-1 = 10log(1 ㎒/1 ㎒)
2. Refer to the page 51 on this report.
3. Sum(dBm) = PSD(dBm) + RBWF + Duty correction factor (dB)

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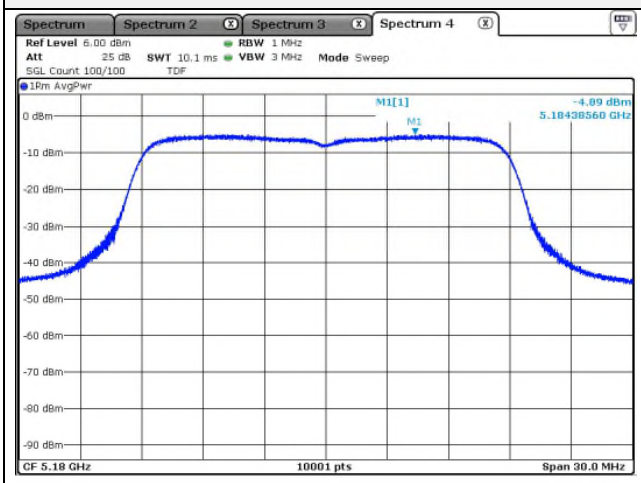
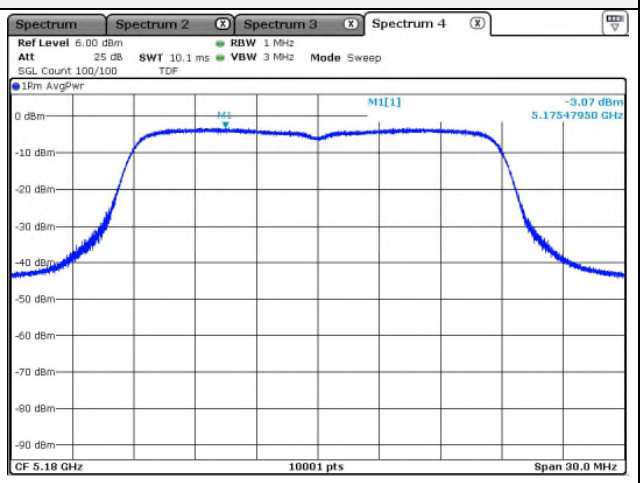
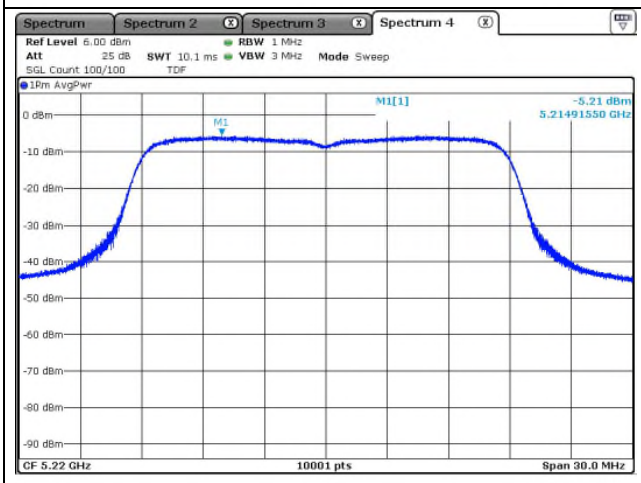
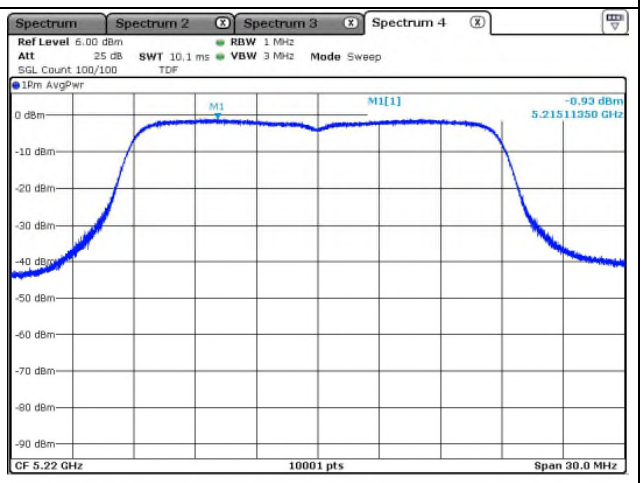
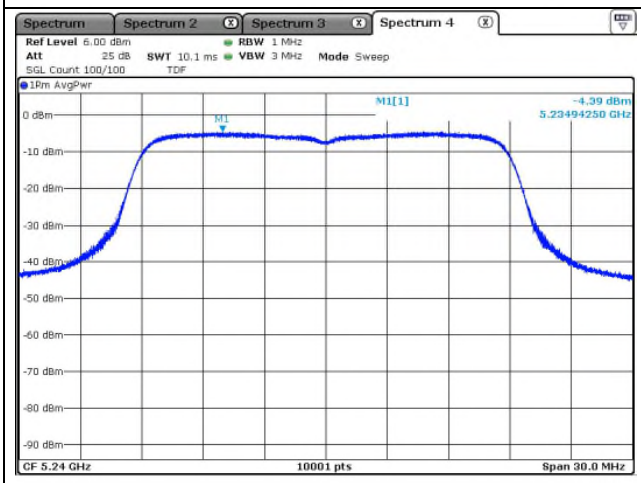
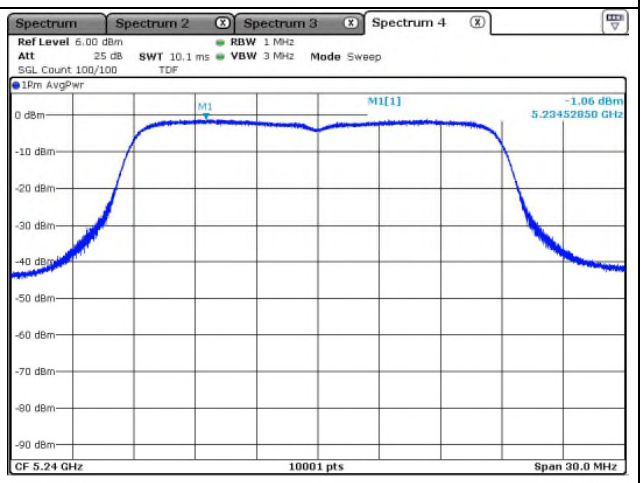
Test plots

ac_VHT20 // ANT 0	ac_VHT20 // ANT 1
	
	
	

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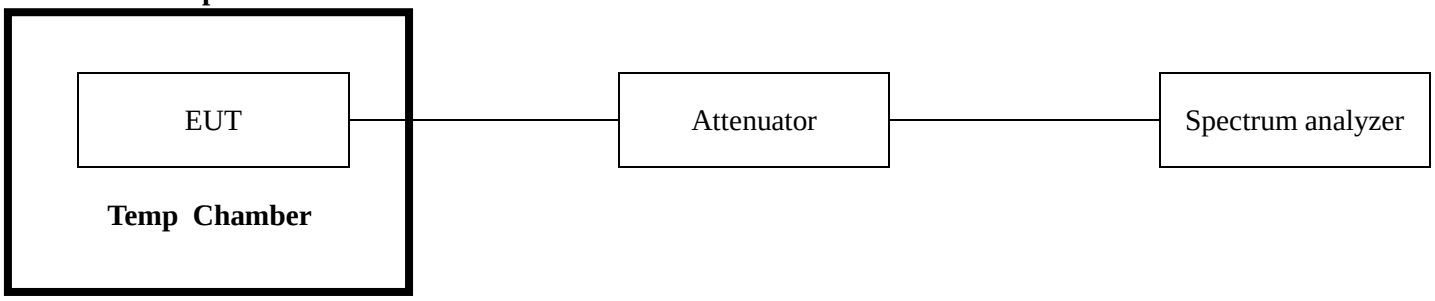
3.5. Frequency Stability

Test procedure
ANSI C63.10-2013, clause 6.8.1

Test setup



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.
7. While maintaining a constant temperature inside the environmental chamber, turn the EUT on and record the operating frequency at startup, and at 2 minutes, 5 minutes, and 10 minutes after the EUT is energized. Four measurements in total are made.

Limit
N/A

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Test results
Antenna port 0

Mode: ac_VHT20

Operating frequency: 5 180 ㎒

Test voltage (%)	Test voltage (V)	Temperature (℃)	Maintaining time	Measure frequency (㎒)	Frequency deviation (㎐)	Deviation (%)
100 %	DC 5.00	-40	Startup	5179.937670	-62330	-0.001203
			2 minutes	5179.939895	-60105	-0.001160
			5 minutes	5179.941576	-58424	-0.001128
			10 minutes	5179.942976	-57024	-0.001101
100 %		-30	Startup	5179.962144	-37856	-0.000731
			2 minutes	5179.962257	-37743	-0.000729
			5 minutes	5179.962326	-37674	-0.000727
			10 minutes	5179.962332	-37668	-0.000727
100 %		-20	Startup	5179.970307	-29693	-0.000573
			2 minutes	5179.970188	-29812	-0.000576
			5 minutes	5179.970107	-29893	-0.000577
			10 minutes	5179.969994	-30006	-0.000579
100 %		-10	Startup	5179.972307	-27693	-0.000535
			2 minutes	5179.972569	-27431	-0.000530
			5 minutes	5179.972544	-27456	-0.000530
			10 minutes	5179.972532	-27468	-0.000530
100 %		0	Startup	5179.971132	-28868	-0.000557
			2 minutes	5179.971150	-28850	-0.000557
			5 minutes	5179.971088	-28912	-0.000558
			10 minutes	5179.971075	-28925	-0.000558
100 %		10	Startup	5179.980652	-19348	-0.000374
			2 minutes	5179.983750	-16250	-0.000314
			5 minutes	5179.986914	-13086	-0.000253
			10 minutes	5179.986250	-13750	-0.000265
100 %		20	Startup	5179.985069	-14931	-0.000288
			2 minutes	5179.984250	-15750	-0.000304
			5 minutes	5179.983117	-16883	-0.000326
			10 minutes	5179.983245	-16755	-0.000323
100 %		23	Startup	5179.942513	-57487	-0.001110
			2 minutes	5179.942599	-57401	-0.001108
			5 minutes	5179.942623	-57377	-0.001108
			10 minutes	5179.942611	-57389	-0.001108
100 %		30	Startup	5179.941580	-58420	-0.00113
			2 minutes	5179.941564	-58436	-0.00113
			5 minutes	5179.941517	-58483	-0.00113
			10 minutes	5179.941439	-58561	-0.00113
100 %		40	Startup	5179.951798	-48202	-0.00093
			2 minutes	5179.952017	-47983	-0.00093
			5 minutes	5179.951892	-48108	-0.00093
			10 minutes	5179.951767	-48233	-0.00093
100 %		50	Startup	5179.976204	-23796	-0.00046
			2 minutes	5179.979954	-20046	-0.00039
			5 minutes	5179.971688	-28312	-0.00055
			10 minutes	5179.982626	-17374	-0.00034
100 %		60	Startup	5180.031015	31015	0.000599
			2 minutes	5180.032749	32749	0.000632
			5 minutes	5180.033265	33265	0.000642
			10 minutes	5180.036452	36452	0.000704

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Test voltage (%)	Test voltage (V)	Temperature (℃)	Maintaining time	Measure frequency (㎒)	Frequency deviation (㎐)	Deviation (%)
100 %	DC 5.00	70	Startup	5180.039511	39511	0.000763
			2 minutes	5180.044417	44417	0.000857
			5 minutes	5180.047911	47911	0.000925
			10 minutes	5180.050135	50135	0.000968
100 %		80	Startup	5180.087435	87435	0.001688
			2 minutes	5180.104231	104231	0.002012
			5 minutes	5180.109590	109590	0.002116
			10 minutes	5180.115356	115356	0.002227
100 %		85	Startup	5180.129246	129246	0.002495
			2 minutes	5180.142886	142886	0.002758
			5 minutes	5180.149277	149277	0.002882
			10 minutes	5180.154339	154339	0.002980
85 %	DC 4.25	23	Startup	5179.942899	-57101	-0.001102
			2 minutes	5179.942915	-57085	-0.001102
			5 minutes	5179.942730	-57270	-0.001106
			10 minutes	5179.942244	-57756	-0.001115
115 %	DC 5.75	23	Startup	5179.942366	-57634	-0.001113
			2 minutes	5179.942409	-57591	-0.001112
			5 minutes	5179.942170	-57830	-0.001116
			10 minutes	5179.942275	-57725	-0.001114

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Test results
Antenna port 1

Mode: ac_VHT20

Operating frequency: 5 180 ㎒

Test voltage (%)	Test voltage (V)	Temperature (℃)	Maintaining time	Measure frequency (㎒)	Frequency deviation (㎐)	Deviation (%)
100 %	DC 5.00	-40	Startup	5179937430	-62570	-0.001208
			2 minutes	5179938254	-61746	-0.001192
			5 minutes	5179940053	-59947	-0.001157
			10 minutes	5179939390	-60610	-0.001170
100 %		-30	Startup	5179962544	-37456	-0.000723
			2 minutes	5179962399	-37601	-0.000726
			5 minutes	5179962679	-37321	-0.000720
			10 minutes	5179962989	-37011	-0.000714
100 %		-20	Startup	5179971034	-28966	-0.000559
			2 minutes	5179971052	-28948	-0.000559
			5 minutes	5179971124	-28876	-0.000557
			10 minutes	5179971265	-28735	-0.000555
100 %		-10	Startup	5179972445	-27555	-0.000532
			2 minutes	5179972569	-27431	-0.000530
			5 minutes	5179972815	-27185	-0.000525
			10 minutes	5179972993	-27007	-0.000521
100 %		0	Startup	5179971263	-28737	-0.000555
			2 minutes	5179971466	-28534	-0.000551
			5 minutes	5179971600	-28400	-0.000548
			10 minutes	5179971642	-28358	-0.000547
100 %		10	Startup	5179980525	-19475	-0.000376
			2 minutes	5179983642	-16358	-0.000316
			5 minutes	5179985461	-14539	-0.000281
			10 minutes	5179986690	-13310	-0.000257
100 %		20	Startup	5179985444	-14556	-0.000281
			2 minutes	5179985613	-14387	-0.000278
			5 minutes	5179984179	-15821	-0.000305
			10 minutes	5179983962	-16038	-0.000310
100 %		23	Startup	5179942114	-57886	-0.001117
			2 minutes	5179942256	-57744	-0.001115
			5 minutes	5179942366	-57634	-0.001113
			10 minutes	5179942778	-57222	-0.001105
100 %		30	Startup	5179941449	-58551	-0.001130
			2 minutes	5179941479	-58521	-0.001130
			5 minutes	5179941490	-58510	-0.001130
			10 minutes	5179941603	-58397	-0.001127
100 %		40	Startup	5179952133	-47867	-0.000924
			2 minutes	5179952265	-47735	-0.000922
			5 minutes	5179952989	-47011	-0.000908
			10 minutes	5179953124	-46876	-0.000905
100 %		50	Startup	5179978453	-21547	-0.000416
			2 minutes	5179978026	-21974	-0.000424
			5 minutes	5179978606	-21394	-0.000413
			10 minutes	5179978143	-21857	-0.000422
100 %		60	Startup	5180032282	32282	0.000623
			2 minutes	5180032346	32346	0.000624
			5 minutes	5180033267	33267	0.000642
			10 minutes	5180034370	34370	0.000664

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Test voltage (%)	Test voltage (V)	Temperature (℃)	Maintaining time	Measure frequency (㎒)	Frequency deviation (㎐)	Deviation (%)
100 %	DC 5.00	70	Startup	5180046159	46159	0.000891
			2 minutes	5180048196	48196	0.000930
			5 minutes	5180047908	47908	0.000925
			10 minutes	5180049891	49891	0.000963
100 %		80	Startup	5180093612	93612	0.001807
			2 minutes	5180098663	98663	0.001905
			5 minutes	5180101425	101425	0.001958
			10 minutes	5180108463	108463	0.002094
100 %		85	Startup	5180122536	122536	0.002366
			2 minutes	5180137468	137468	0.002654
			5 minutes	5180140105	140105	0.002705
			10 minutes	5180142690	142690	0.002755
85 %	DC 4.25	23	Startup	5179942134	-57866	-0.001117
			2 minutes	5179942288	-57712	-0.001114
			5 minutes	5179942416	-57584	-0.001112
			10 minutes	5179942624	-57376	-0.001108
115 %	DC 5.75	23	Startup	5179942318	-57682	-0.001114
			2 minutes	5179942503	-57497	-0.001110
			5 minutes	5179942669	-57331	-0.001107
			10 minutes	5179942801	-57199	-0.001104

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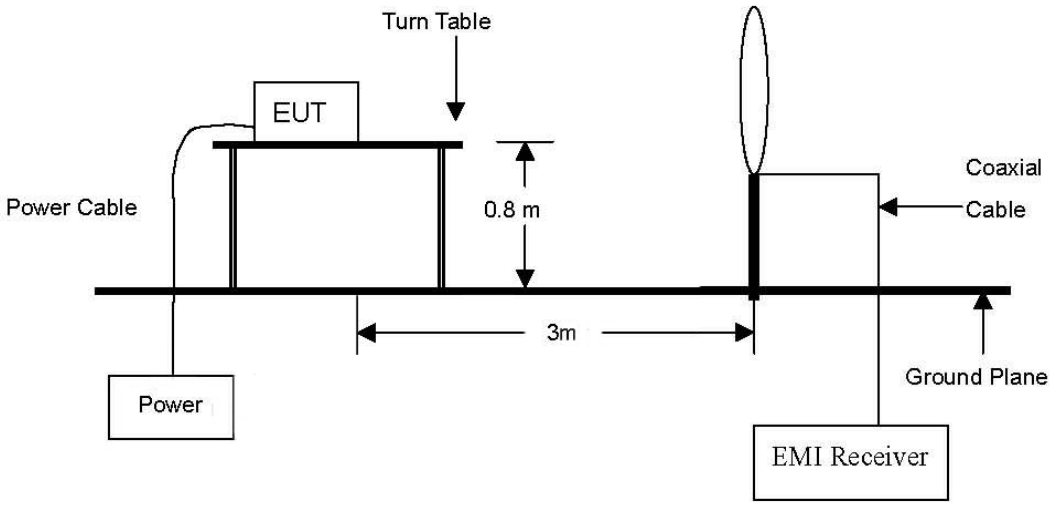
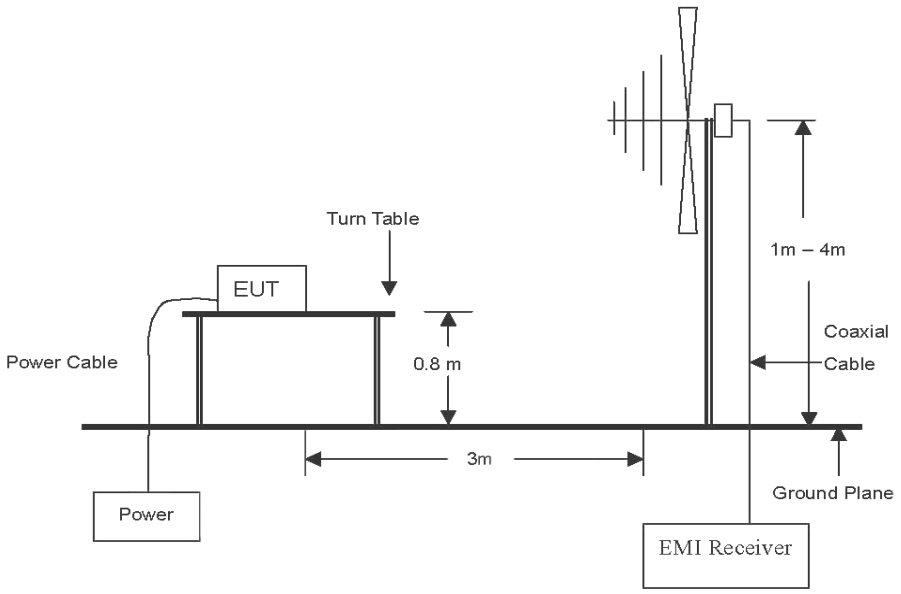
3.6. Radiated restricted band and emissions

Test setup

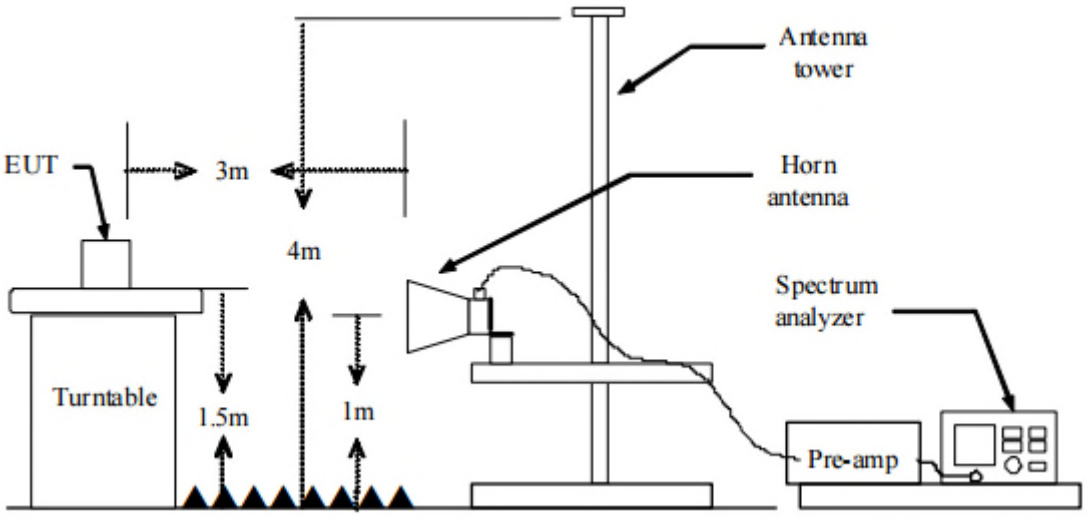
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



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



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. We have done x, y, z planes in EUT and horizontal and vertical polarization and Parallel to the ground plane in detecting antenna.
4. 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.
5. 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 ≥1 ㎓: Average
   ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
   ② RBW = 1 ㎒
   ③ VBW ≥ 3 × RBW
   ④ Detector = RMS, if span/(# of points in sweep) ≤ (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.
   ⑤ 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 in order to use linear voltage averaging. Log or ㏈ averaging shall not be used.
   ⑥ Sweep = auto
   ⑦ Trace = max hold
   ⑧ Perform a trace average of at least 100 traces.
   ⑨ A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:

      1) If power averaging (RMS) mode was used in step ⑤, then the applicable correction factor is 10 log(1/x), where x is the duty cycle.
      2) If linear voltage averaging mode was used in step ⑤, then the applicable correction factor is 20 log(1/x), where x is the duty cycle.
      3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

Note.

1. f <30 ㎒, extrapolation factor of 40 ㏈/decade of distance. $F_d = 40\log(D_m/Ds)$
   f ≥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(㏈)
4. Field strength(㏈㎶/m) = Level(㏈㎶) + CF (㏈) + or DCF(㏈)
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 **X orientation** was worst-case orientation; therefore, all final radiated testing was performed with the EUT in **X orientation.**
8. The worst-case emissions are reported however emissions whose levels were not within 20 ㏈ of respective limits were not reported.
9. According to exploratory test no any obvious emission were detected from 9 ㎑ to 30 ㎒. Although these tests were performed other than open field site, adequate comparison measurements were confirmed against 30 m open field site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.

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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	2400/F(㎑)
0.490 ~ 1.705	30	24000/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 5.25-5.35 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.
(3) For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
(4) For transmitters operating in the 5.725-5.85 GHz band:
i) 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.
ii) Devices certified before March 2, 2017 with antenna gain greater than 10 dBi may demonstrate compliance with the emission limits in §15.247(d), but manufacturing, marketing and importing of devices certified under this alternative must cease by March 2, 2018. Devices certified before March 2, 2018 with antenna gain of 10 dBi or less may demonstrate compliance with the emission limits in §15.247(d), but manufacturing, marketing and importing of devices certified under this alternative must cease before March 2, 2020.
(5) 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 ㎒.
(6) 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.
(7) The provisions of §15.205 apply to intentional radiators operating under this section.
(8) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency band edges as the design of the equipment permits.

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Duty cycle

Regarding to KDB 789033 D02 v02r01, B)2)b), the maximum duty cycles of all modes were investigated and set the spectrum analyzer as below.

Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value. Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T, where T is defined in II.B.1.a), and the number of sweep points across duration T exceeds 100.

For the band 5.15-5.25 ㎓

Test mode	T_{on} time (㎳)	Period (㎳)	Duty cycle (Linear)	Duty cycle (%)	Duty cycle correction factor (㏈)
802.11ac_VHT20	1	1	1	100	0

Note:

Duty cycle (Linear) = T_{on} time/Period

DCF(Duty cycle correction factor (㏈)) = 10log(1/duty cycle)

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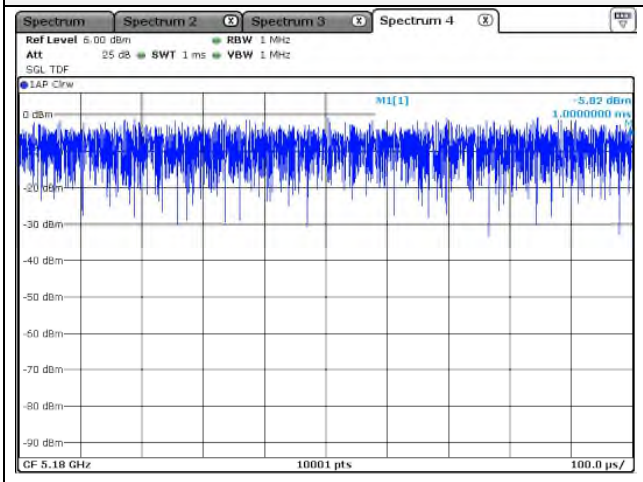
Test plots

ac_VHT20	-
	BLANK

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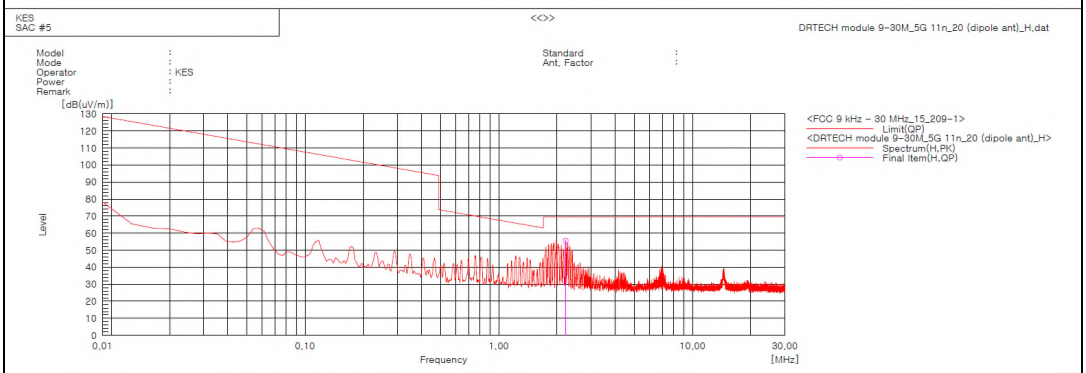
Test results (Below 30 ㎒) – Worst case

Mode:	ac_VHT20
Distance of measurement:	3 meter
Channel:	36 (Worst case)
ANT #1	Dipole Antenna

Horizontal



Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]	Remark
1	2.217	H	34.8	20.7	55.5	69.5	14.0	100.0	354.6	

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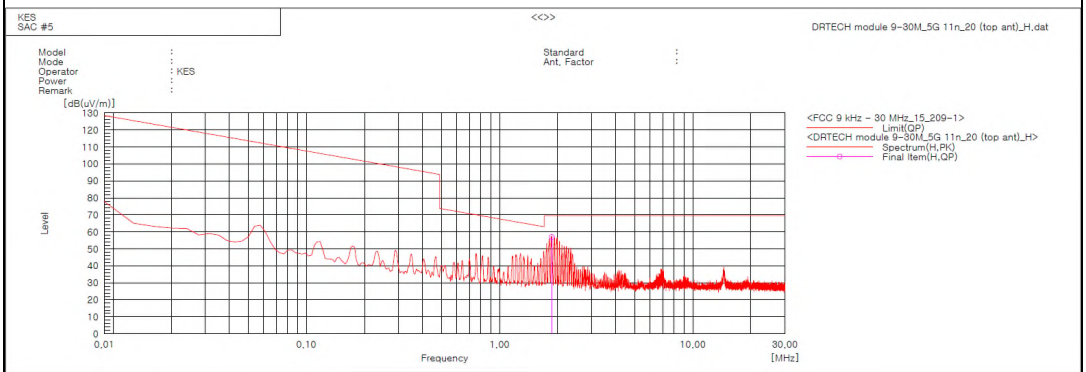
Mode:	ac_VHT20
Distance of measurement:	3 meter
Channel:	36 (Worst case)
ANT #2	PCB Antenna

Horizontal



Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]	Remark
1	1.865	H	36.3	20.7	57.0	69.5	12.5	100.0	5.0	

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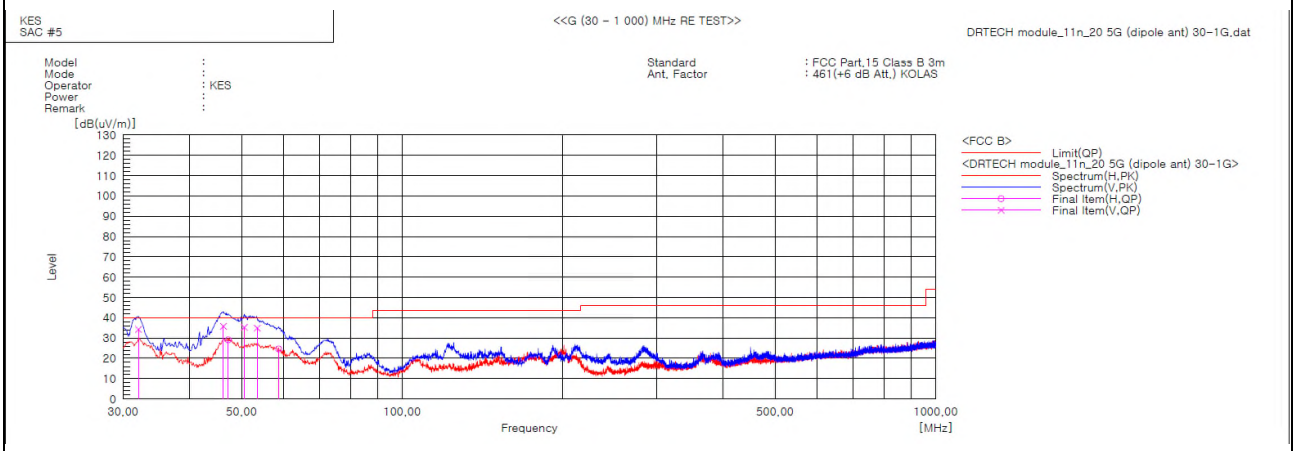
Test results (Below 1 000 ㎒) – Worst case

Mode:	ac_VHT20
Distance of measurement:	3 meter
Channel:	36 (Worst case)
ANT #1	Dipole Antenna

Horizontal // Vertical



Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]	Remark
1	32.061	V	48.5	-14.2	34.3	40.0	5.7	100.0	94.9	
2	46.248	V	48.6	-12.7	35.9	40.0	4.1	100.0	273.7	
3	47.218	H	41.9	-12.8	29.1	40.0	10.9	237.0	278.1	
4	50.613	V	48.3	-13.0	35.3	40.0	4.7	162.0	290.4	
5	53.523	V	48.0	-13.1	34.9	40.0	5.1	122.0	290.4	
6	58.736	H	38.0	-13.4	24.6	40.0	15.4	400.0	60.1	

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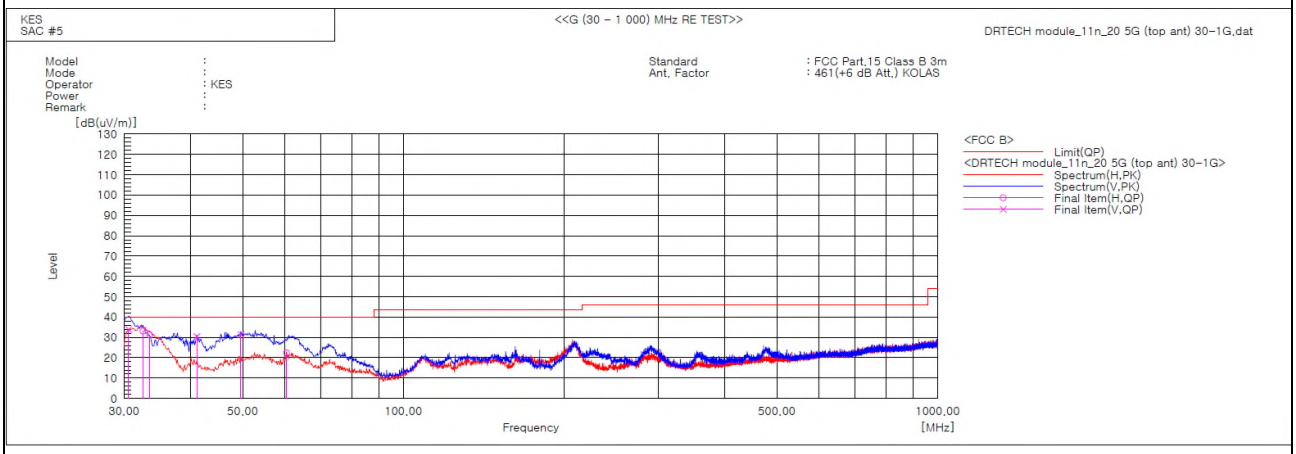
Mode:	ac_VHT20
Distance of measurement:	3 meter
Channel:	36 (Worst case)
ANT #2	PCB Antenna

Horizontal // Vertical



Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]	Remark
1	30.606	V	48.2	-14.3	33.9	40.0	6.1	100.0	162.7	
2	32.546	H	47.3	-14.1	33.2	40.0	6.8	377.0	217.3	
3	33.516	H	45.3	-14.0	31.3	40.0	8.7	400.0	139.2	
4	41.034	V	43.6	-13.2	30.4	40.0	9.6	100.0	289.2	
5	49.643	V	44.3	-12.9	31.4	40.0	8.6	125.0	284.7	
6	60.434	H	35.9	-13.5	22.4	40.0	17.6	400.0	55.8	

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Test results (Above 1 000 ㎒)

Mode:	UNII-1(ac_VHT20)
Distance of measurement:	3 meter
Channel:	36
ANT #1	Dipole Antenna

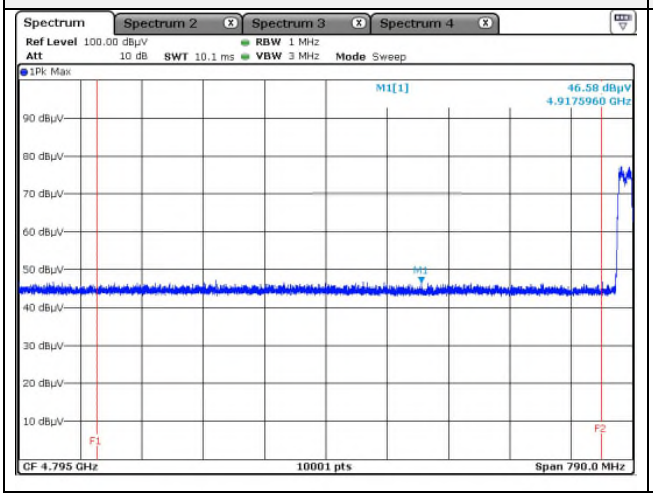
- **Spurious**

Frequency (㎒)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1020.75	49.35	Peak	H	-11.31	-	38.04	74.00	35.96
1176.73	50.24	Peak	V	-11.26	-	38.98	74.00	35.02

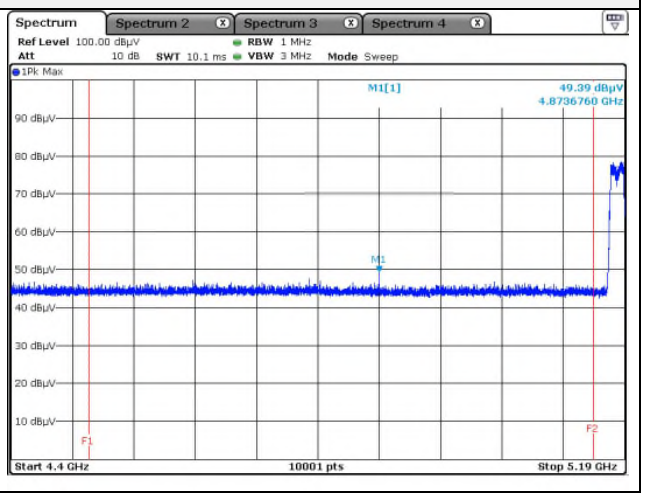
- **Band edge**

Frequency (㎒)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4917.60	46.58	Peak	H	4.31	-	50.89	74.00	23.11
4873.68	49.39	Peak	V	3.98	-	53.37	74.00	20.63

Restricted band // Horizontal // Peak



Restricted band // Vertical // Peak



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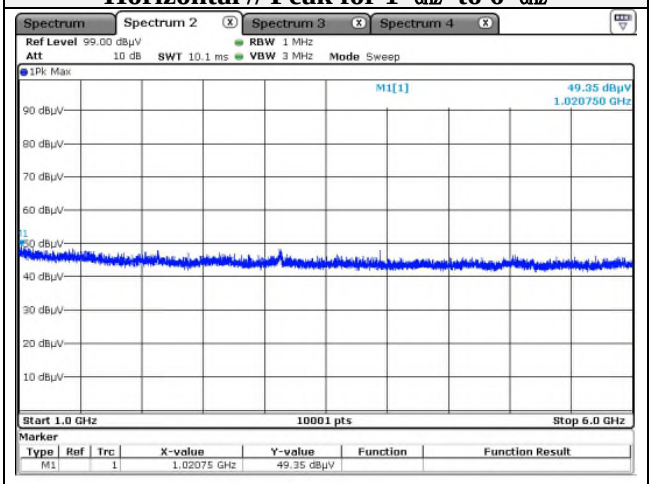
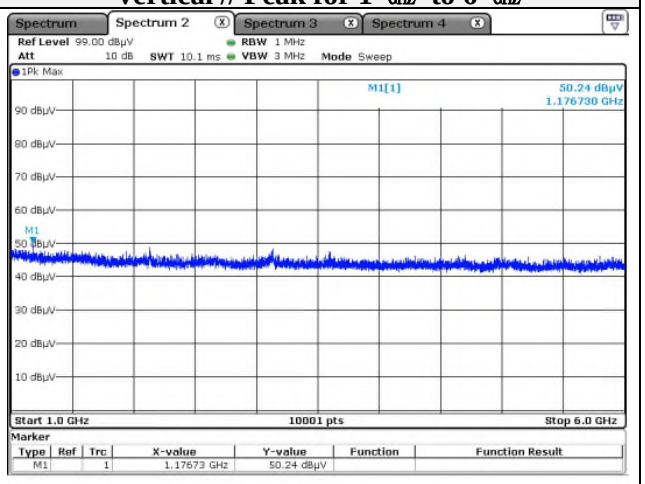
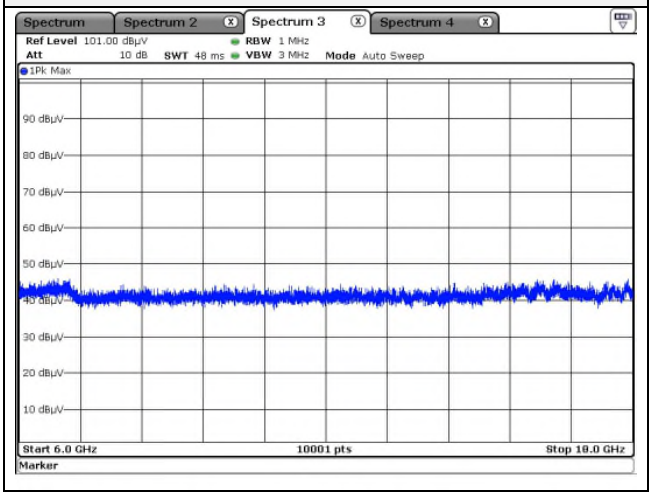
Horizontal // Peak for 1 ㎓ to 6 ㎓



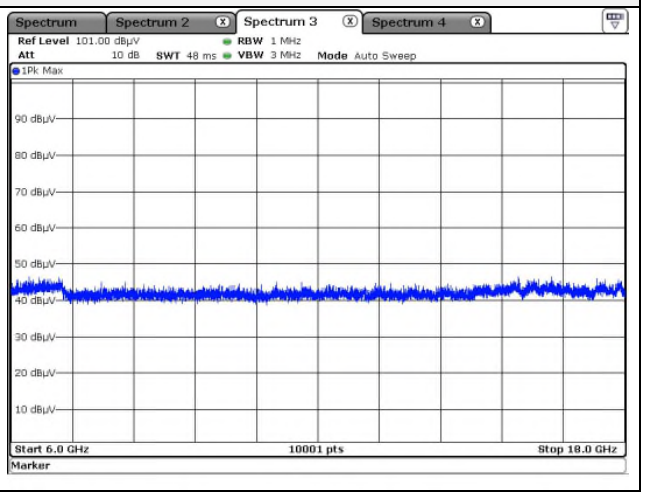
Vertical // Peak for 1 ㎓ to 6 ㎓



Horizontal // Peak for 6 ㎓ to 18 ㎓



Vertical // Peak for 6 ㎓ to 18 ㎓



Note.

1. No spurious emission were detected above 6 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

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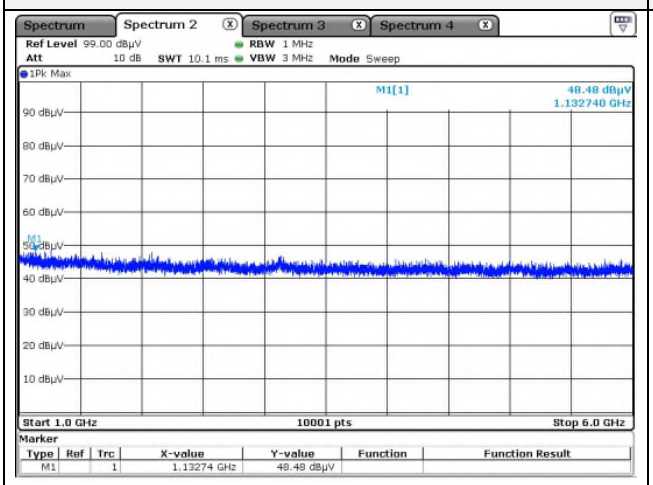
Mode:	UNII-1(ac_VHT20)
Distance of measurement:	3 meter
Channel:	44
ANT #1	Dipole Antenna

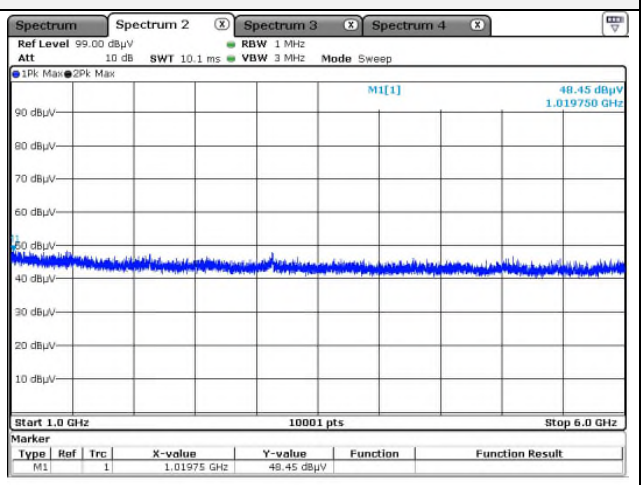
- **Spurious**

Frequency (㎒)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1132.74	48.48	Peak	H	-11.28	-	37.20	74.00	36.80
1019.75	48.45	Peak	V	-11.32	-	37.13	74.00	36.87

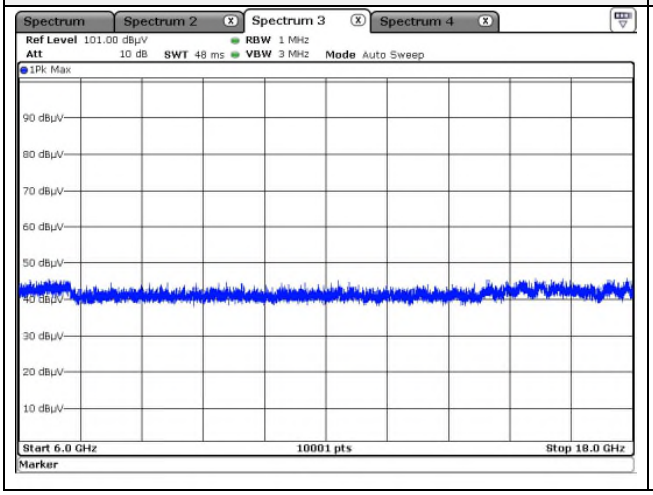
Horizontal // Peak for 1 ㎓ to 6 ㎓



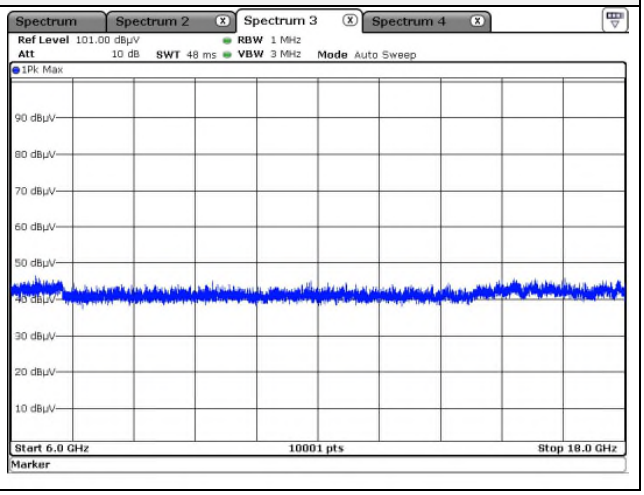
Vertical // Peak for 1 ㎓ to 6 ㎓



Horizontal // Peak for 6 ㎓ to 18 ㎓



Vertical // Peak for 6 ㎓ to 18 ㎓



Note.
1. No spurious emission were detected above 6 ㎓.

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Mode:	UNII-1(ac_VHT20)
Distance of measurement:	3 meter
Channel:	48
ANT #1	Dipole Antenna

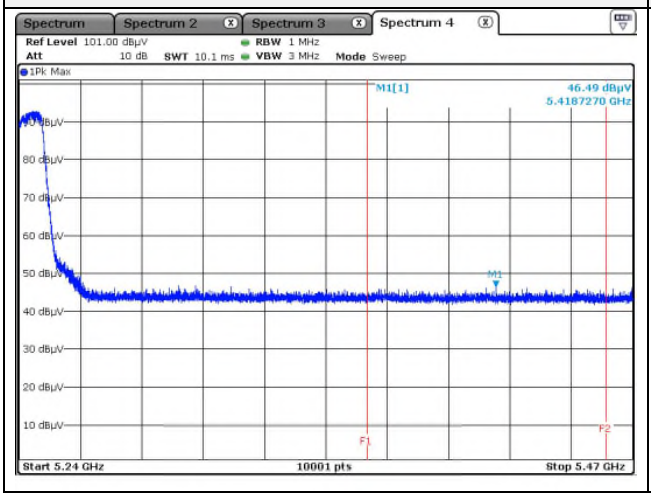
- **Spurious**

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1054.24	48.10	Peak	H	-11.30	-	36.80	74.00	37.20
1134.24	49.38	Peak	V	-11.27	-	38.11	74.00	35.89

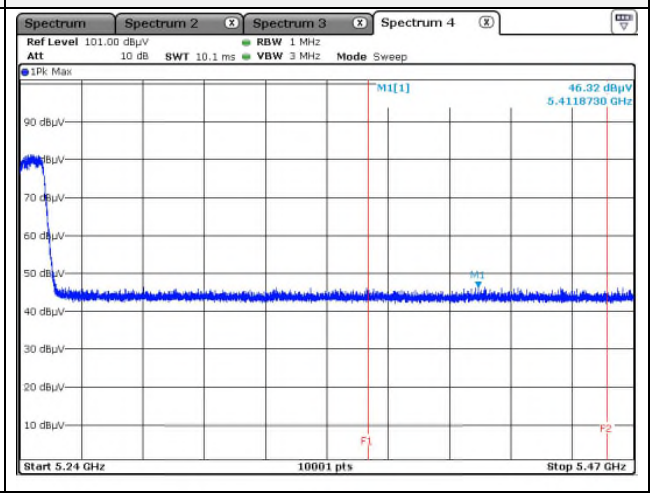
- **Band edge**

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
5418.73	46.49	Peak	H	2.88	-	49.37	74.00	24.63
5411.87	46.32	Peak	V	2.91	-	49.23	74.00	24.77

Restricted band // Horizontal // Peak



Restricted band // Vertical // Peak



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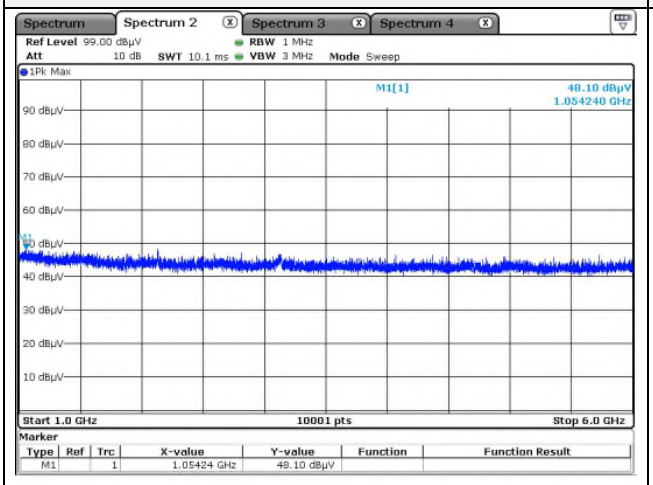
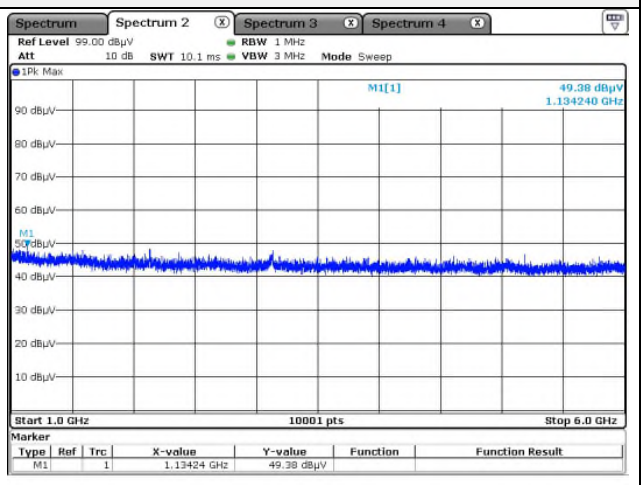
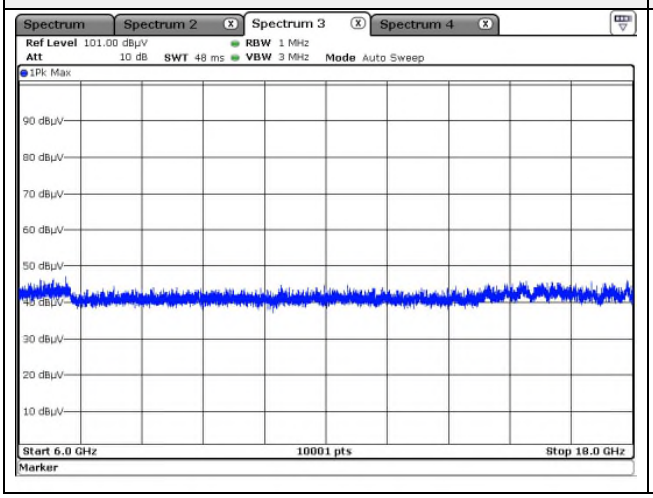
Horizontal // Peak for 1 ㎓ to 6 ㎓



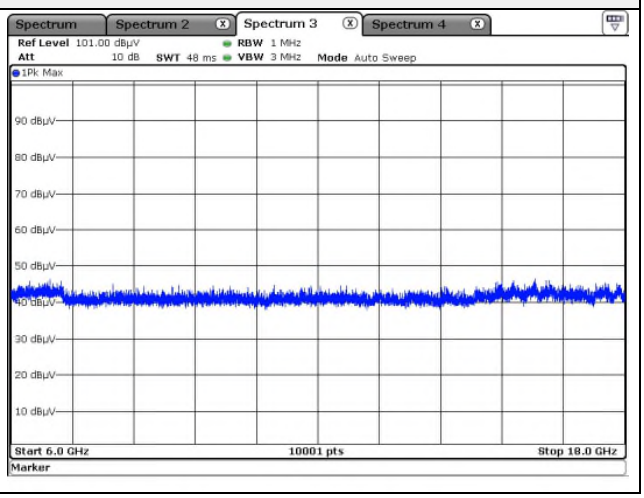
Vertical // Peak for 1 ㎓ to 6 ㎓



Horizontal // Peak for 6 ㎓ to 18 ㎓



Vertical // Peak for 6 ㎓ to 18 ㎓



Note.
1. No spurious emission were detected above 6 ㎓.

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Mode:	UNII-1(ac_VHT20)
Distance of measurement:	3 meter
Channel:	36
ANT #2	PCB Antenna

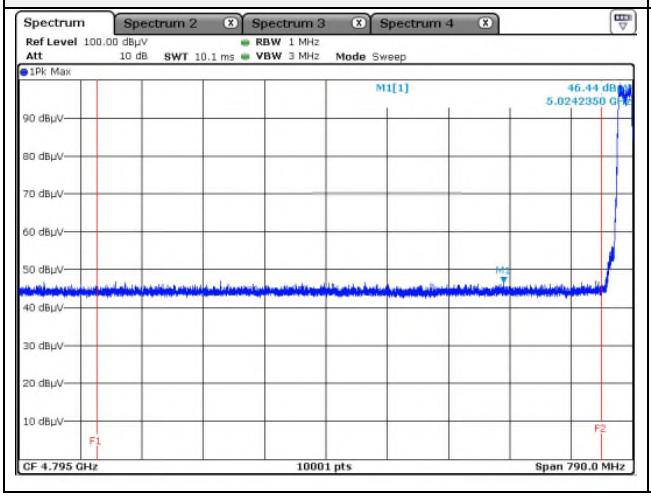
- **Spurious**

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1049.75	48.89	Peak	H	-11.30	-	37.59	74.00	36.41
1133.24	48.00	Peak	V	-11.28		36.72	74.00	37.28

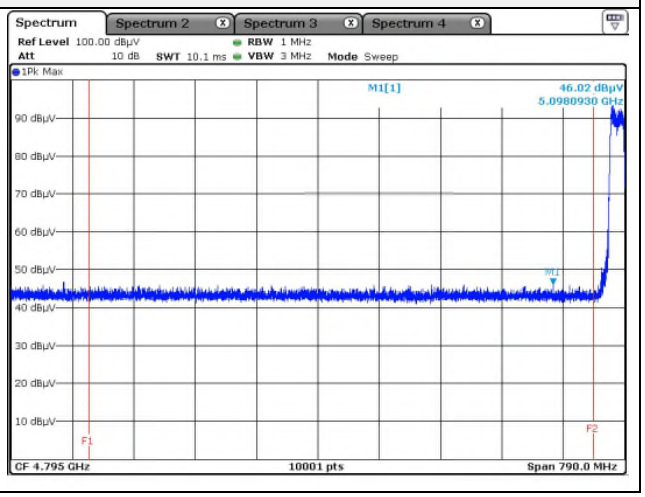
- **Band edge**

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
5024.24	46.44	Peak	H	4.80	-	51.24	74.00	22.76
5098.09	46.02	Peak	V	4.35	-	50.37	74.00	23.63

Restricted band // Horizontal // Peak



Restricted band // Vertical // Peak



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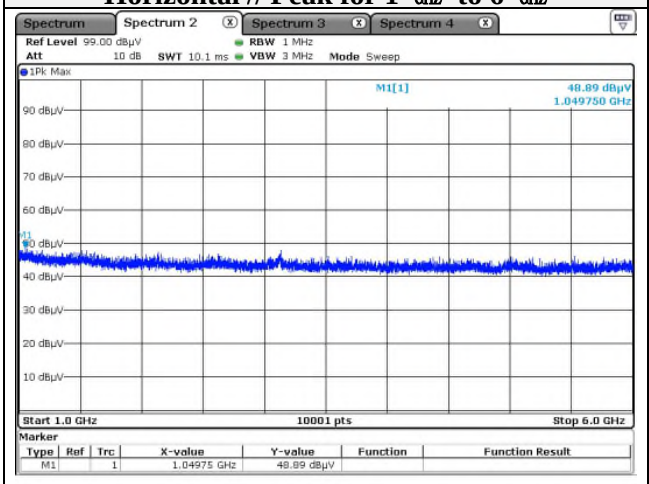
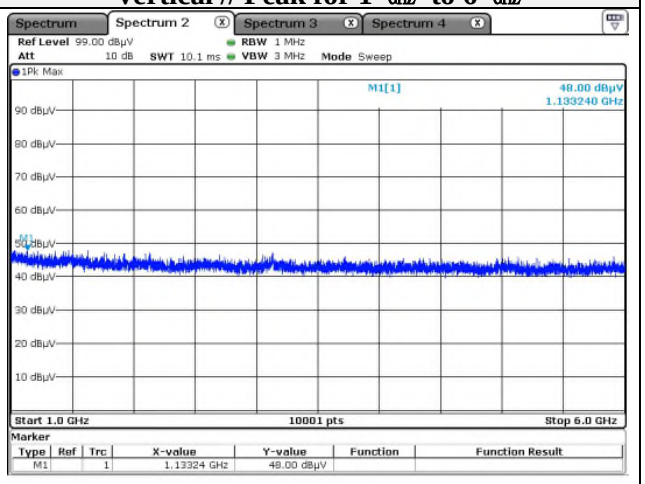
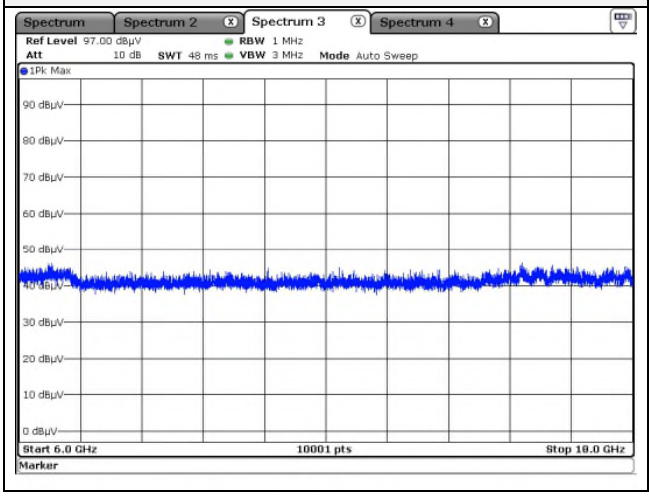
Horizontal // Peak for 1 ㎓ to 6 ㎓



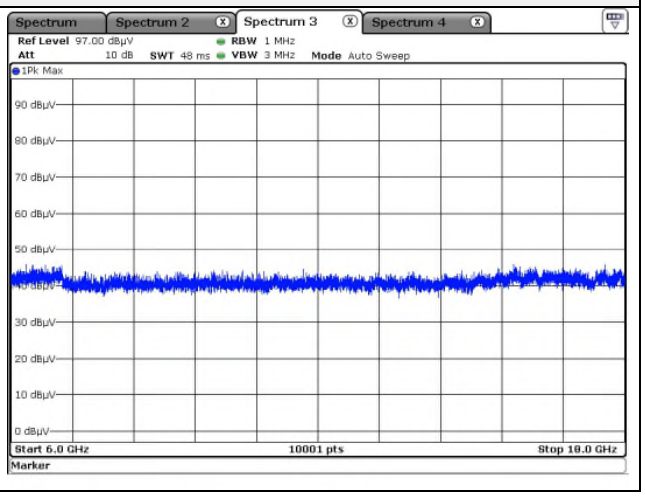
Vertical // Peak for 1 ㎓ to 6 ㎓



Horizontal // Peak for 6 ㎓ to 18 ㎓



Vertical // Peak for 6 ㎓ to 18 ㎓



Note.

1. No spurious emission were detected above 6 ㎓.
2. Average test would be performed if the peak result were greater than the average limit.

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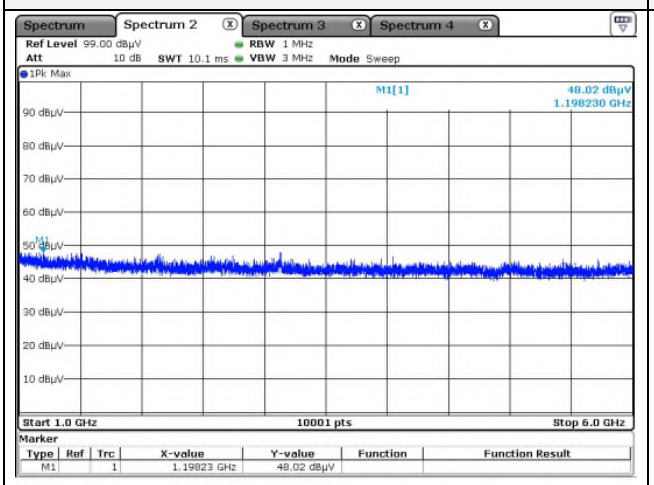
Mode:	UNII-1(ac_VHT20)
Distance of measurement:	3 meter
Channel:	44
ANT #2	PCB Antenna

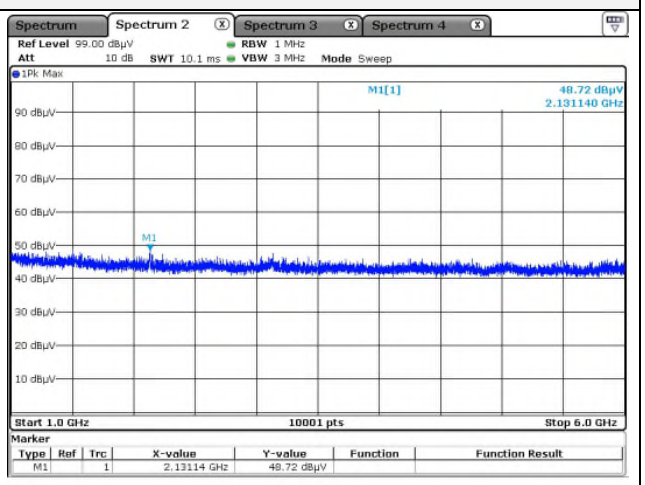
- **Spurious**

Frequency (㎒)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1198.23	48.02	Peak	H	-11.25	-	36.77	74.00	37.23
2131.14	48.72	Peak	V	-5.97	-	42.75	68.20	25.45

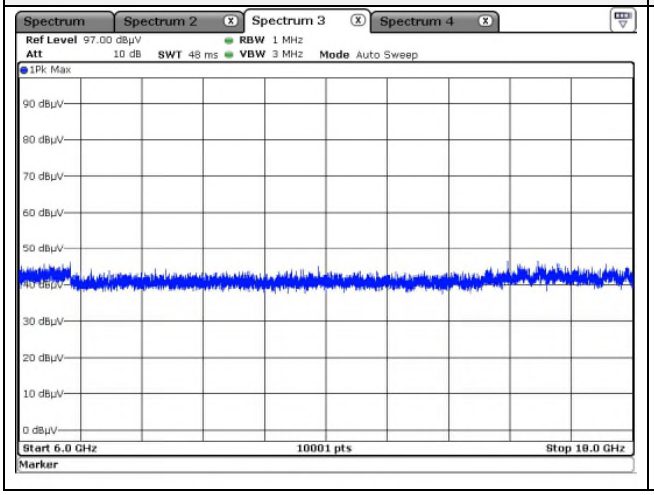
Horizontal // Peak for 1 ㎓ to 6 ㎓



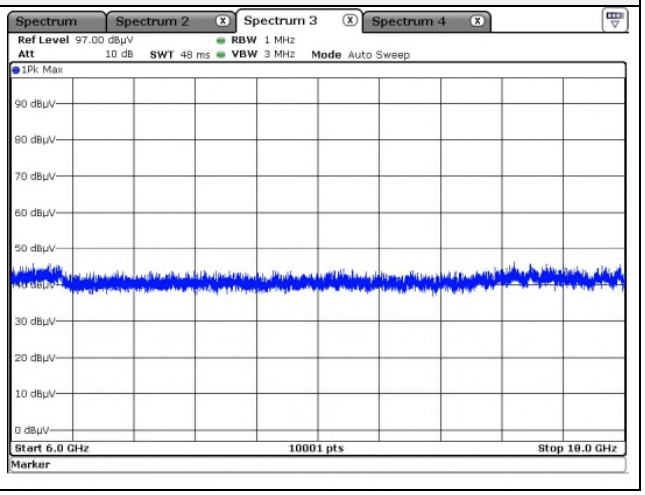
Vertical // Peak for 1 ㎓ to 6 ㎓



Horizontal // Peak for 6 ㎓ to 18 ㎓



Vertical // Peak for 6 ㎓ to 18 ㎓



Note.

1. No spurious emission were detected above 6 ㎓.

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Mode:	UNII-1(ac_VHT20)
Distance of measurement:	3 meter
Channel:	48
ANT #2	PCB Antenna

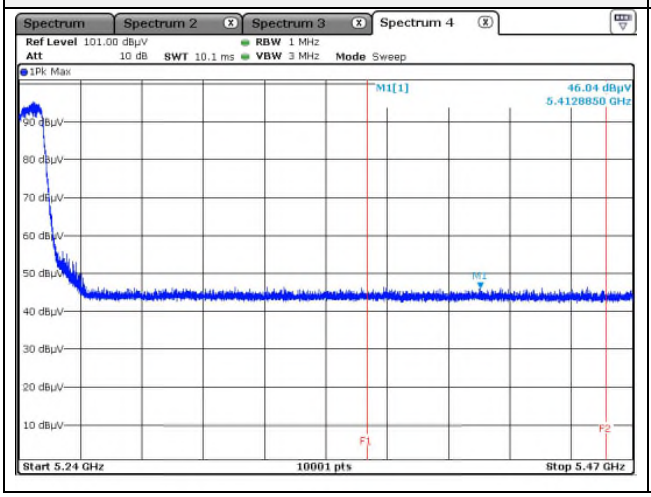
- **Spurious**

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1006.75	48.23	Peak	H	-11.32	-	36.91	74.00	37.09
2126.14	48.48	Peak	V	-5.94	-	42.54	68.20	25.66

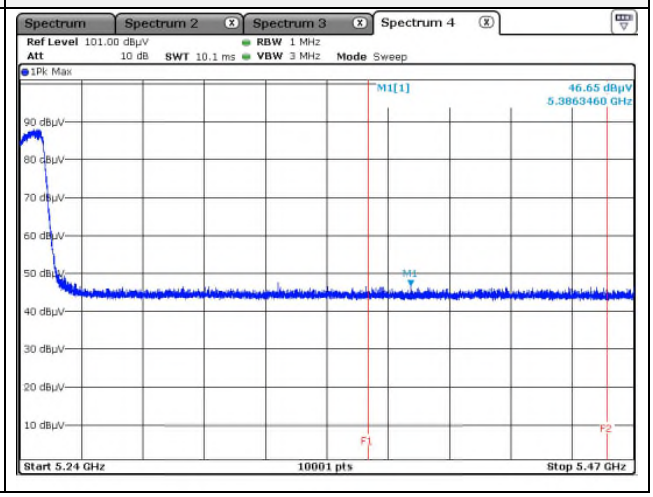
- **Band edge**

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
5412.90	46.04	Peak	H	2.91	-	48.95	74.00	25.05
5386.35	46.65	Peak	V	3.01	-	49.66	74.00	24.34

Restricted band // Horizontal // Peak



Restricted band // Vertical // Peak



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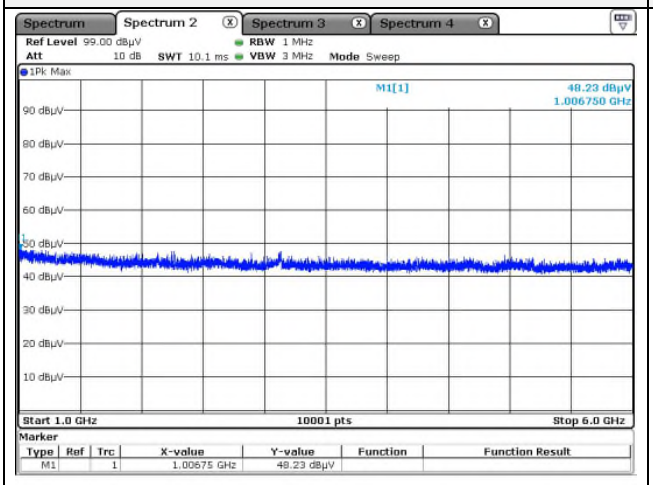
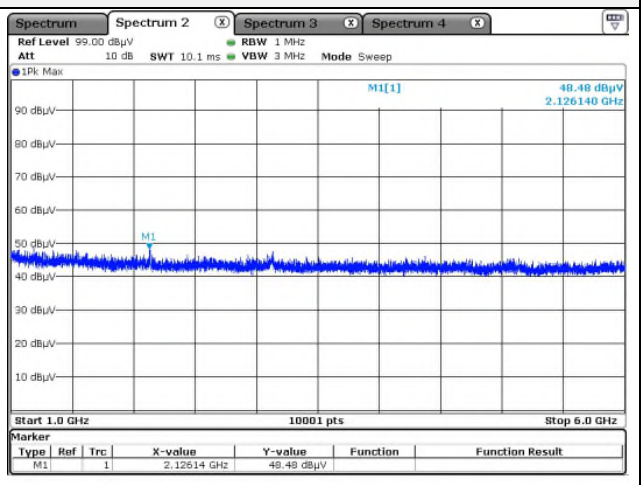
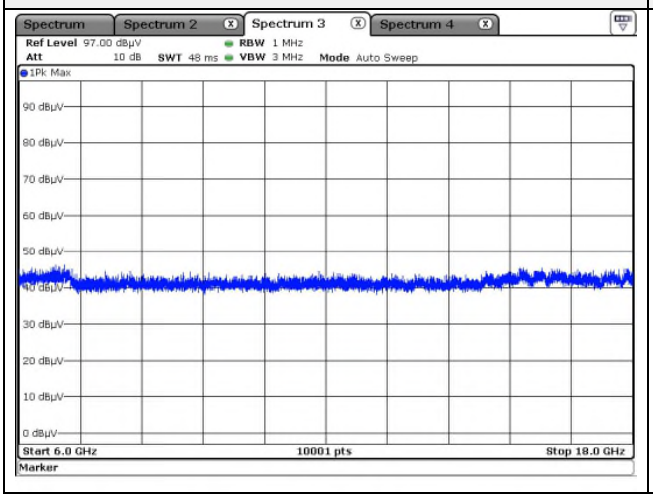
Horizontal // Peak for 1 ㎓ to 6 ㎓



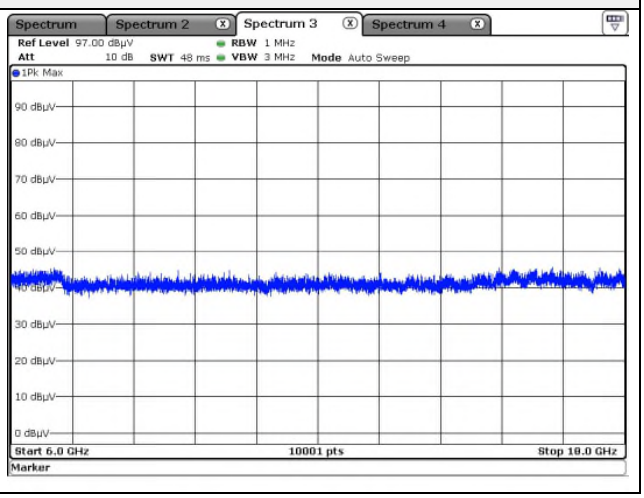
Vertical // Peak for 1 ㎓ to 6 ㎓



Horizontal // Peak for 6 ㎓ to 18 ㎓



Vertical // Peak for 6 ㎓ to 18 ㎓



Note.

1. No spurious emission were detected above 6 ㎓.

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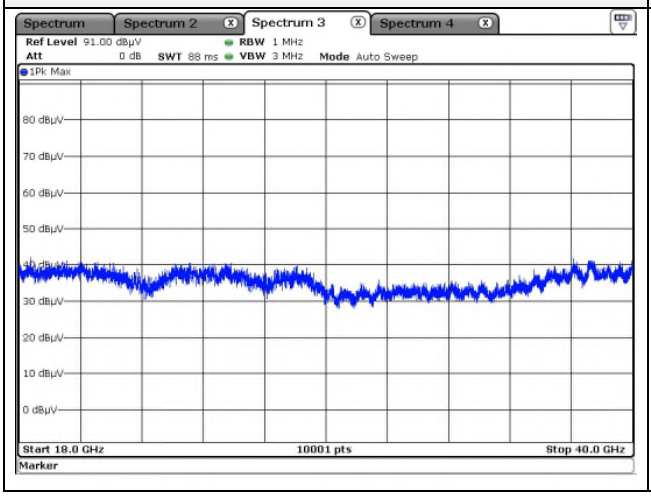
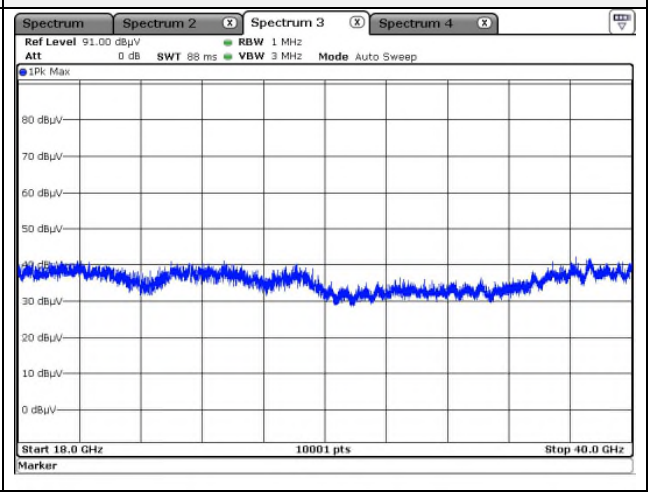
Test results (18 ㎓ to 40 ㎓) – Worst case

Mode:	UNII-1(ac_VHT20)
Distance of measurement:	3 meter
Channel:	36
ANT #1	Dipole Antenna

Horizontal	Vertical
	

Note.
1. No spurious emission were detected above 18 ㎓.

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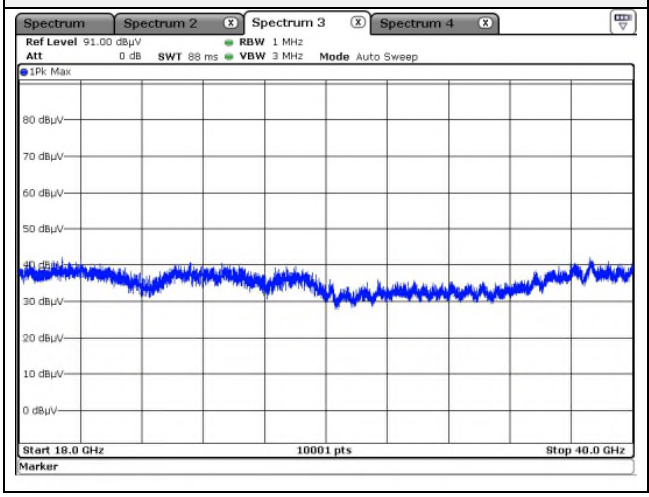
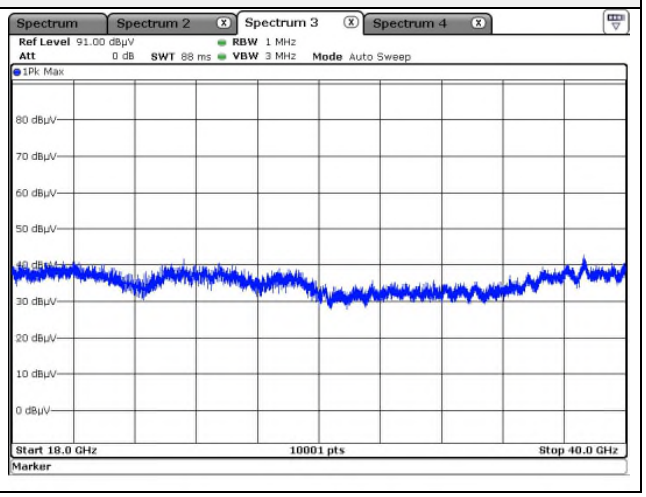
Mode:	UNII-1(ac_VHT20)
Distance of measurement:	3 meter
Channel:	36
ANT #2	PCB Antenna

Horizontal	Vertical
	

Note.
1. No spurious emission were detected above 18 ㎓.

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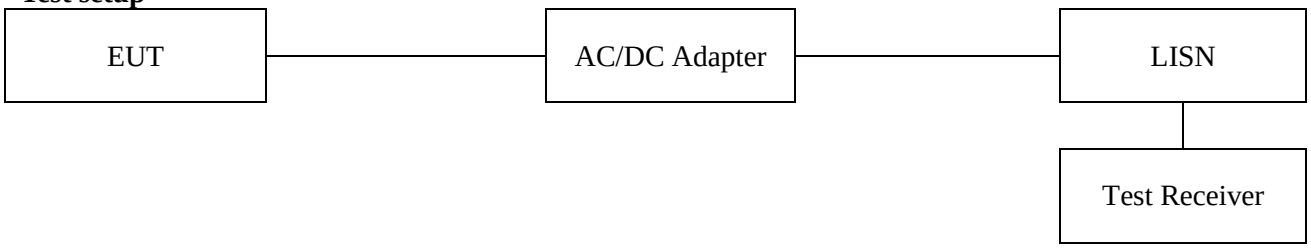
3.7 AC conducted emissions

Test setup



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 (dBμV/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.
2. Both Cable loss and LISN factor are included in measurement level(QP Level or AV Level).

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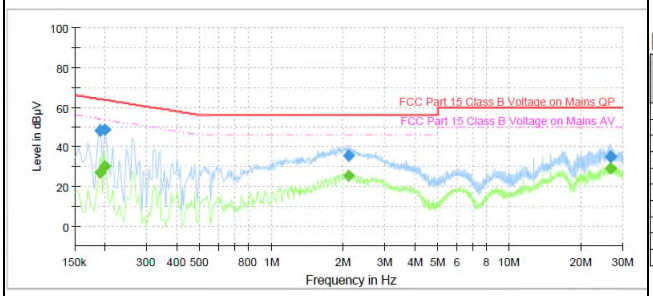
Test results

Mode:	UNII-1(ac_VHT20)
Distance of measurement:	3 meter
Channel:	36 (Worst case)
ANT #2	PCB Antenna(Worst case)

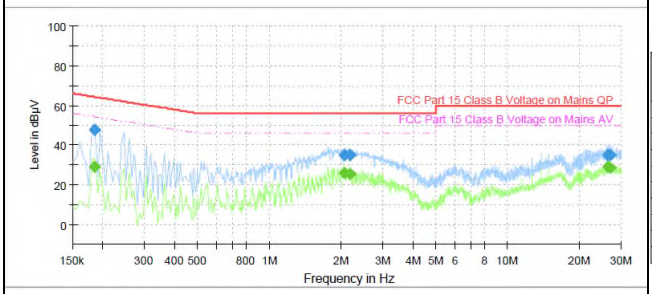
Hot Line



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.190000	---	26.91	54.04	27.13	1000.0	9.000	L1	9.6
0.190000	48.43	---	64.04	15.61	1000.0	9.000	L1	9.6
0.200000	---	30.31	53.61	23.30	1000.0	9.000	L1	9.6
0.200000	48.88	---	63.61	14.73	1000.0	9.000	L1	9.6
2.120000	---	25.45	46.00	20.55	1000.0	9.000	L1	10.2
2.120000	35.36	---	56.00	20.64	1000.0	9.000	L1	10.2
26.495000	---	29.02	50.00	20.98	1000.0	9.000	L1	10.1
26.495000	34.93	---	60.00	25.07	1000.0	9.000	L1	10.1
26.705000	---	29.31	50.00	20.69	1000.0	9.000	L1	10.1
26.705000	34.96	---	60.00	25.04	1000.0	9.000	L1	10.1

Neutral Line



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.185000	---	29.26	54.26	25.00	1000.0	9.000	L1	9.6
0.185000	47.88	---	64.26	16.38	1000.0	9.000	L1	9.6
2.065000	---	25.79	46.00	20.21	1000.0	9.000	L1	10.2
2.065000	35.14	---	56.00	20.86	1000.0	9.000	L1	10.2
2.180000	---	25.36	46.00	20.64	1000.0	9.000	L1	10.2
2.180000	34.70	---	56.00	21.30	1000.0	9.000	L1	10.2
26.390000	---	28.92	50.00	21.08	1000.0	9.000	L1	10.1
26.390000	34.74	---	60.00	25.26	1000.0	9.000	L1	10.1
26.975000	---	28.85	50.00	21.15	1000.0	9.000	L1	10.1
26.975000	34.78	---	60.00	25.22	1000.0	9.000	L1	10.1

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Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
EMI TEST RECEIVER	ESU26	Rohde & Schwarz	100552	1 year	2021.04.01
SPECTRUM ANALYZ ER	R&S	FSV40	101725	1 year	2021.06.22
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2021.01.15
SIGNAL GENERATOR	KEYSIGHT	N5182B	MY59100115	1 year	2021.05.12
Power Meter	Anritsu	ML2495A	1438001	1 year	2021.05.12
Pulse Power Sensor	Anritsu	MA2411B	1339205	1 year	2021.05.12
DC POWER SUPPLY	SORENSEN	DCS40-75E	1408A02745	1 year	2021.01.15
ATTENUATOR	Mini-Circuits	BW-S10-2W263+	1	1 year	2021.01.17
Loop Antenna	Schwarzbeck	FMZB1513	225	2 years	2021.02.15
BILOG ANTENNA	VULB 9168	SCHWARZBECK	9168-461	2 years	2022.05.26
HORN ANTENNA	A.H.	SAS-571	414	1 years	2021.01.31
BAND REJECT FILTER	MICRO-TRONICS	BRM50702	G272	1 year	2021.01.15
BAND REJECT FILTER	MICRO-TRONICS	BRM50716	G199	1 year	2021.01.15
AMPLIFIER	310N	SONOMA INSTRUMENT	401123	1 year	2021.06.08
PREAMPLIFIER	8449B	AGILENT	8008A01640	1 year	2021.04.01
ATTENUATOR	F04-C1206-01	SRT	20022403	1 year	2021.05.06
EMI Test Receiver	R&S	ESR3	101783	1 year	2021.01.20
EMI Test Receiver	R&S	ESU26	100552	1 year	2021.04.01
Pulse Limiter	R&S	ESH3-Z2	101915	1 year	2021.01.02
LISN	R&S	ENV216	101787	1 year	2021.01.02

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
Notebook computer	LG Electronics Inc.,	15UD590	904QCSF564006

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