TEST REPORT

Part 15 Subpart E 15.407

Equipment under test Shift RED Drone

Model name SHIFT Drone1

FCC ID 2AR74-SFD1D

Applicant this is engineering Inc.

Manufacturer this is engineering Inc.

Date of test(s) 2019.08.12 ~ 2019.08.30

Date of issue 2019.08.30

Issued to
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Test and report completed by :	Report approval by :
	
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Revision history

Revision	Date of issue	Test report No.	Description
-	2019.08.23	KES-RF-19T0112	Initial
R1	2019.08..0	KES-RF-19T0112-R1	Add Occupied Bandwidth and Frequency stability test

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1. General information

Applicant:	this is engineering Inc.
Applicant address:	352, Daewangpangyo-ro 815, Sujeong-gu, Seongnam-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:	2AR74-SFD1D
Test device serial No.:	☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test	Shift RED Drone
Frequency range	2 402 ㎒ ~ 2 480 ㎒ (LE) UNII-1 5 180 ㎒ ~ 5 240 ㎒ (11an_HT20/ac_VHT20)
Model:	SHIFT Drone1
Modulation technique	WIFI : DSSS, OFDM BT(LE) : GFSK
Number of channels	2 402 ㎒ ~ 2 480 ㎒ (LE) : 40 ch 5 180 ㎒ ~ 5 240 ㎒ (11an_HT20/ac_VHT20) : 4 ch
Antenna specification	2.4 ㎓ Antenna type : FPCB antenna, Peak gain : 1.49 ㏈i 5 ㎓ Antenna type : FPCB antenna, Peak gain : 2.07 ㏈i
Power source	DC 3.7 V (Internal Rechargeable Battery)

1.2. Test configuration

The **this is engineering Inc. // SHIFT Drone1 // FCC ID: 2AR74-SFD1D** was tested according to the specification of EUT, the EUT must comply with following standards and KDB documents.

FCC Part 15.407
KDB 789033 D02 v02r01
ANSI C63.10-2013

1.3. Device modifications

N/A

1.4. Frequency/channel operations

UNII-1

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

Table 1.4. 802.11n_HT20/ac_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 an_HT20 : **MCS 0** , ac_VHT20 : **MCS 0**

1.6. Accessory information

N/A

1.7. Software and Firmware description

The software and firmware installed in the EUT is version 1.0

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(㏈) = RF cable loss(㏈) + attenuator factor(㏈).

- UNII-1 : 1.73 + 10 = 11.73 (㏈)

1.9 Measurement Uncertainty

Test Item		Uncertainty
Uncertainty for Conduction emission test		2.62 ㏈
Uncertainty for Radiation emission test (include Fundamental emission)	9㎑ - 30㎒	4.54 ㏈
	30㎒ - 1㎓	4.36 ㏈
	Above 1㎓	5.00 ㏈
Note. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.		

2. Summary of tests

Reference	Parameter	Test results
15.407(a)	26 dB 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

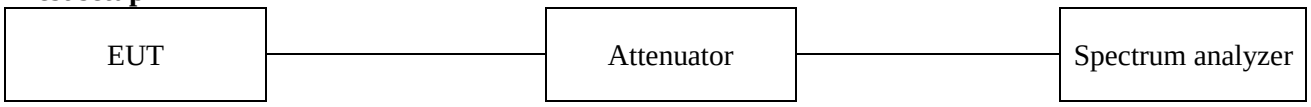
3. Test results

3.1. 26 dB bandwidth & 99% Occupied Bandwidth

Test procedure

KDB 789033 D02 v02r01– Section C.1

Test setup



Test procedure

26 dB bandwidth

KDB 789033 D02 v02r01– 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

99 % bandwidth

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.

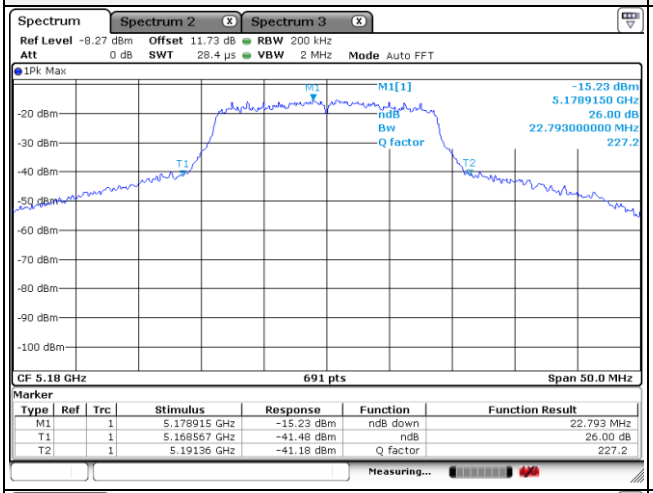
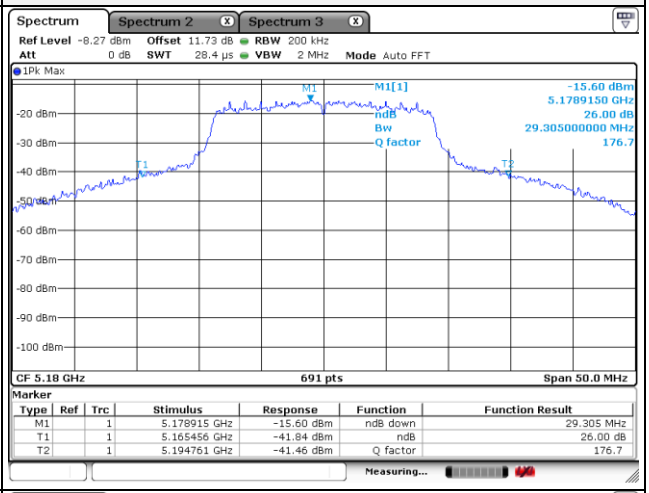
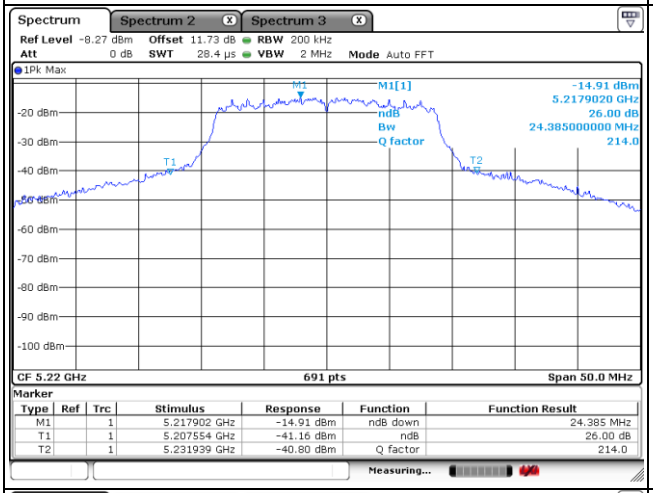
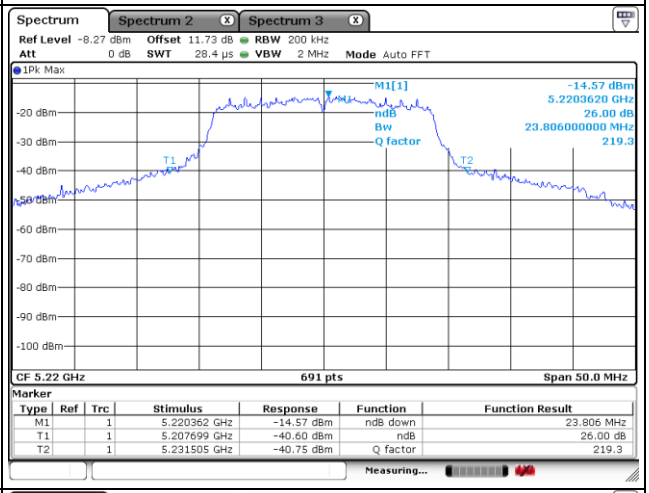
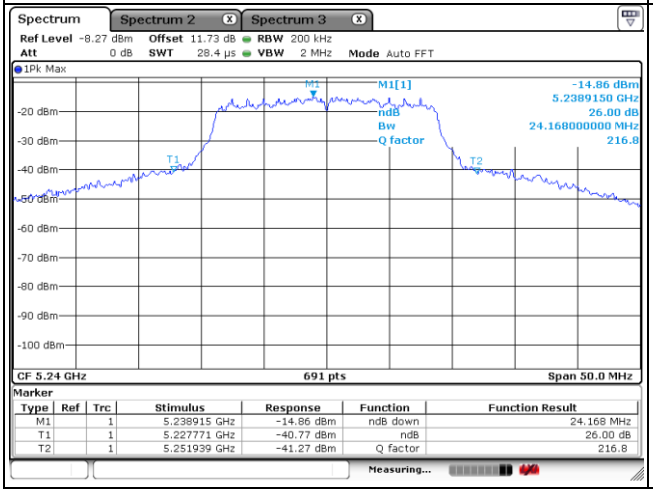
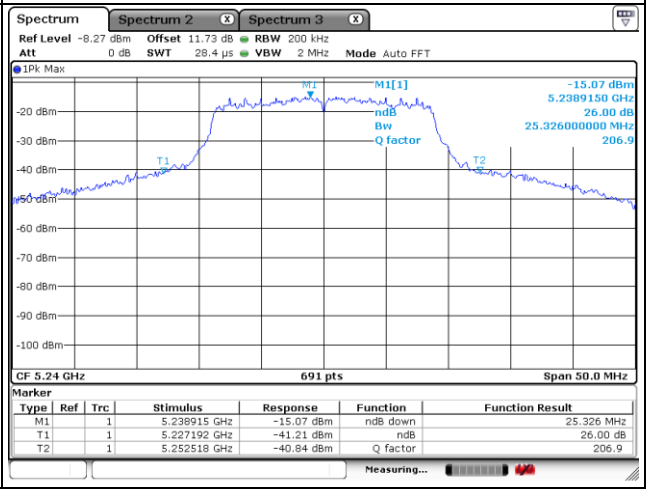
In the result,
-DFS requirements are not applicable in the 5 150 ㎒ ~ 5 250 ㎒.

Test results

Band	Frequency(㎒)	Mode	26 ㏈ bandwidth(㎒)	99% Occupied Bandwidth
UNII-1	5 180	HT20	22.793	-
	5 220		24.385	-
	5 240		24.168	18.017
	5 180	VHT20	29.305	-
	5 220		23.806	-
	5 240		25.326	18.017

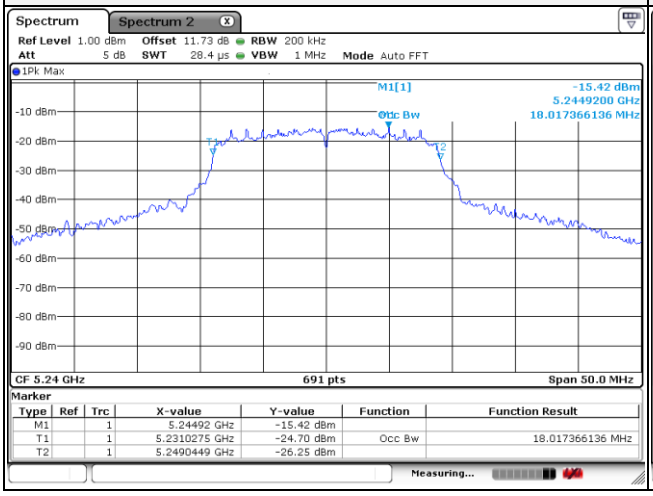
Test plots

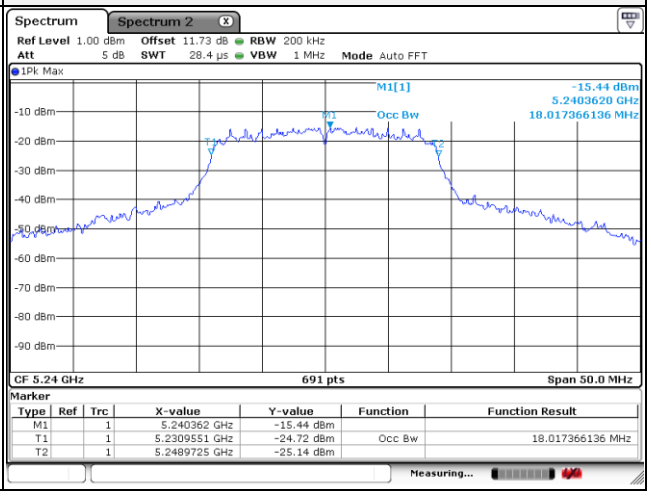
26 dB bandwidth

UNII-1 // an_HT20	UNII-1 // ac_VHT20
	
	
	

99% Occupied Bandwidth-5240 MHz

UNII-1 // an_HT20	UNII-1 // ac_VHT20



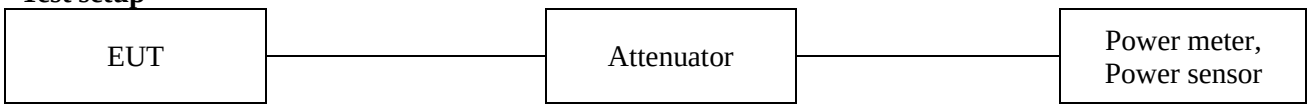


3.3. Maximum conducted output power

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.

Limit

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

Note.

1. B is the 26 dB emission bandwidth.

Test results

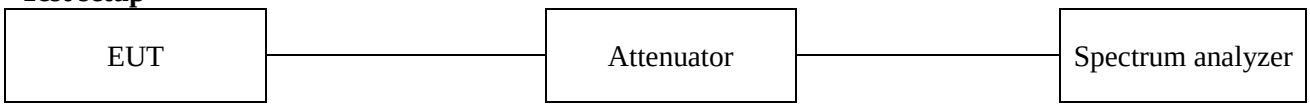
Band	mode	Frequency (㎒)	Detector mode	Output power(㏈m)	Limit (㏈m)
UNII-1	HT20	5 180	AV	-5.49	24.00
		5 220		-4.51	
		5 240		-4.59	
	VHT20	5 180		-5.54	
		5 220		-4.88	
		5 240		-4.65	

3.4. Maximum Power spectral density

Test procedure

KDB 789033 D02 v02r01 – Section F

Test setup



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 ㎒ reference bandwidth.
5. For devices operating in the bands 5.15-5.25 ㎓, 5.25-5.35 ㎓, and 5.47-5.725 ㎓, the preceding procedures make use of 1 ㎒ RBW to satisfy directly the 1 ㎒ reference bandwidth specified in § 15.407(a)(5). For devices operating in the band 5.725-5.85 ㎓, the rules specify a measurement bandwidth of 500 ㎑. Many spectrum analyzers do not have 500 ㎑ RBW, thus a narrower RBW may need to be used. The rules permit the use of a RBWs less than 1 ㎒, or 500 ㎑, "provided that the measured power is integrated over the full reference bandwidth" to show the total power over the specified measurement bandwidth (i.e., 1 ㎒, or 500 ㎑). If measurements are performed using a reduced resolution bandwidth (< 1 ㎒, or < 500 ㎑) and integrated over 1 ㎒, or 500 ㎑ bandwidth, the following adjustments to the procedures apply:

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

Note.

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

Limit

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

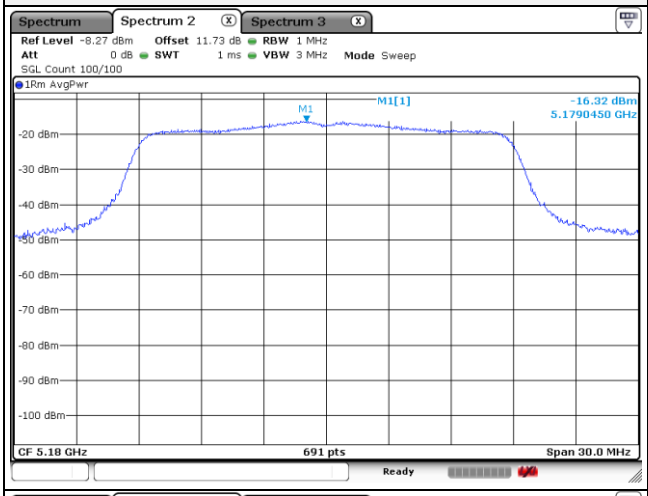
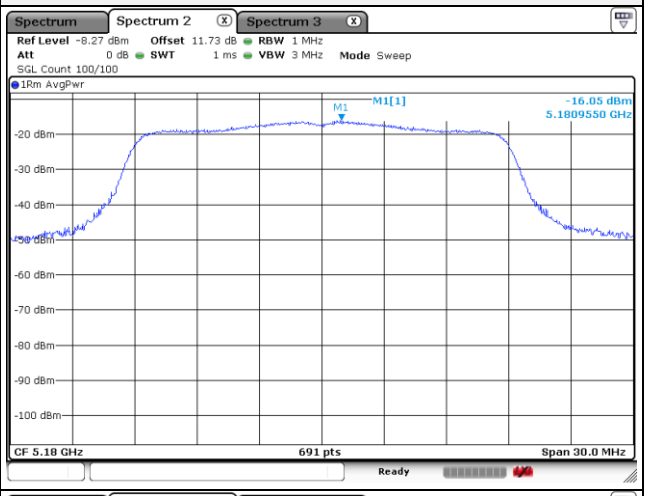
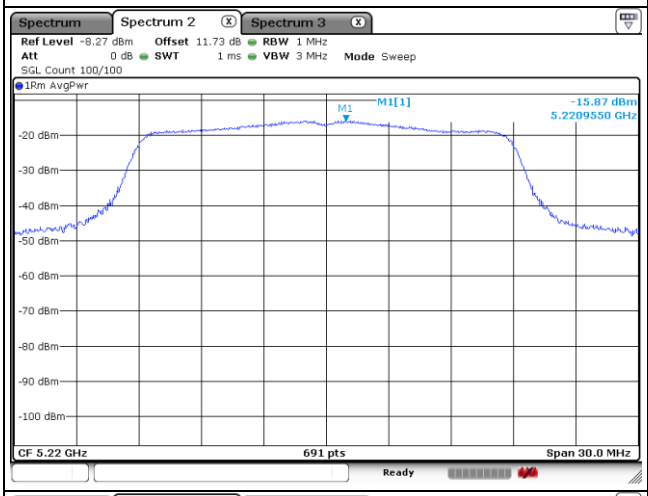
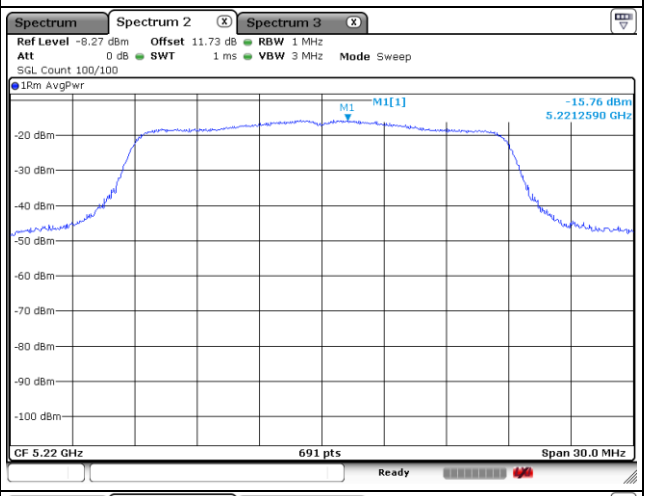
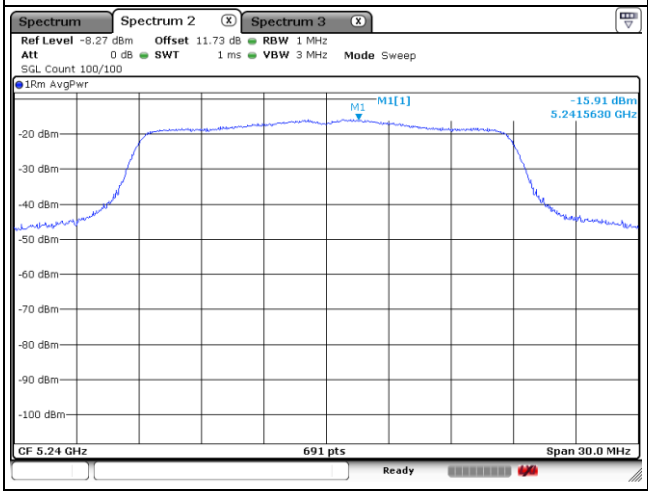
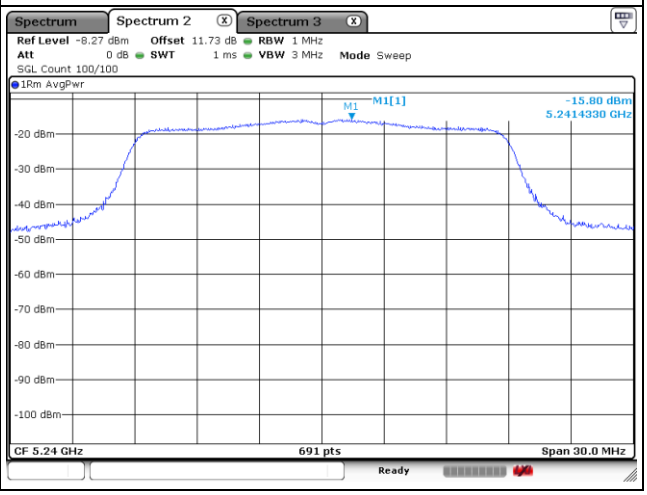
Test results

Band	mode	Frequency (㎒)	DCF Note1	RBWF Note2	Measured PSD (dBm/㎒) Note3	Limit (dBm/㎒)
UNII-1	HT20	5 180	0.42	-	-15.90	11.00
		5 220			-15.45	
		5 240			-15.49	
	VHT20	5 180	0.32	-	-15.73	
		5 220			-15.44	
		5 240			-15.48	

Note.

1. Refer to the page 21 on this report.
2. UNII-1 = 10log(1 ㎒/1 ㎒)
3. PSD(dBm) = RBWF + Duty correction factor (dB)

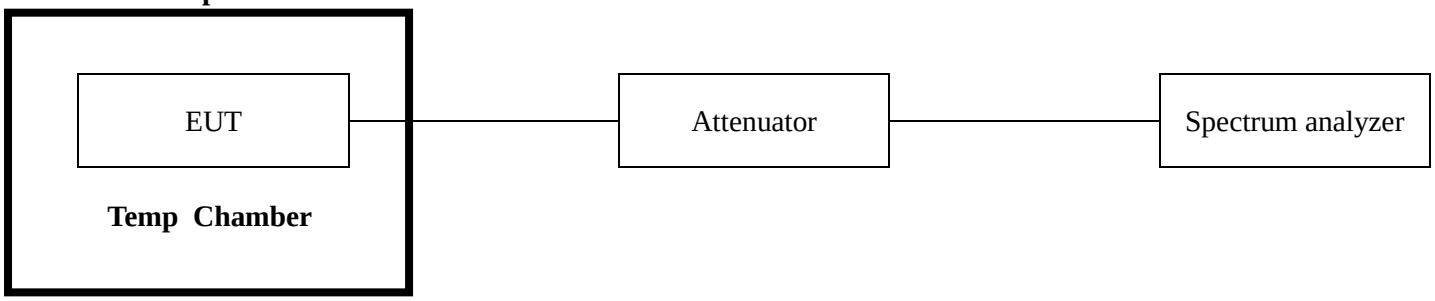
Test plots

UNII-1 // an_HT20	UNII-1 // ac_VHT20
	
	
	

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

Test results

Mode: UNII-1

Operating frequency: 5 180 ㎒

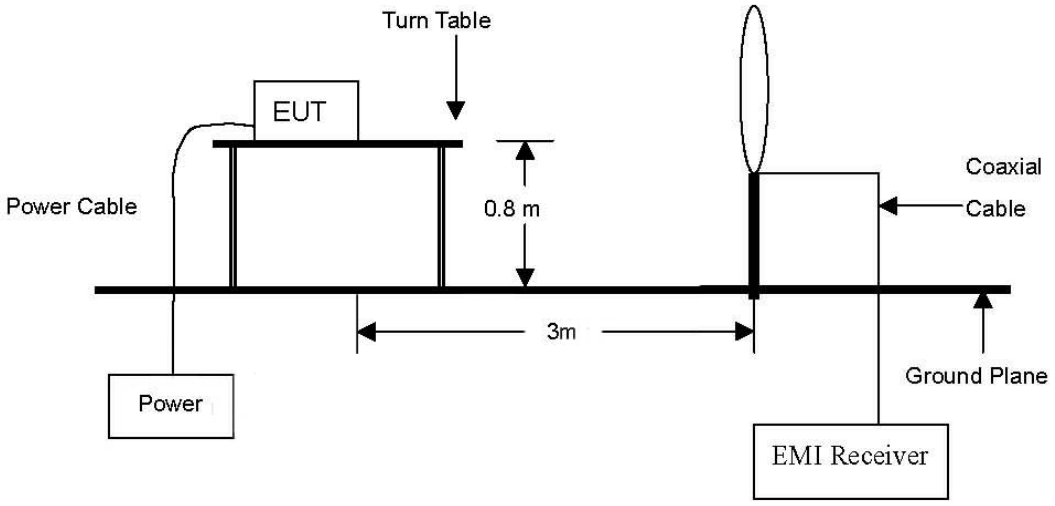
Test voltage (%)	Test voltage (V)	Temperature (℃)	Maintaining time	Measure frequency (㎒)	Frequency deviation (㎐)	Deviation (%)
100 %	DC 3.7	-30	Startup	5 179.968 847	-311 53	-0.000 601
			2 minutes	5 179.977 234	-227 66	-0.000 440
			5 minutes	5 179.980 047	-199 53	-0.000 385
			10 minutes	5 179.981 004	-189 96	-0.000 367
100 %		-20	Startup	5 179.975 969	-240 31	-0.000 464
			2 minutes	5 179.980 368	-196 32	-0.000 379
			5 minutes	5 179.981 642	-183 58	-0.000 354
			10 minutes	5 179.981 931	-180 69	-0.000 349
100 %		-10	Startup	5 179.982 648	-173 52	-0.000 335
			2 minutes	5 179.983 234	-167 66	-0.000 324
			5 minutes	5 179.982 597	-174 03	-0.000 336
			10 minutes	5 179.982 033	-179 67	-0.000 347
100 %		0	Startup	5 179.983 046	-169 54	-0.000 327
			2 minutes	5 179.978 299	-217 01	-0.000 419
			5 minutes	5 179.976 331	-236 69	-0.000 457
			10 minutes	5 179.975 231	-247 69	-0.000 478
100 %		10	Startup	5 179.972 438	-275 62	-0.000 532
			2 minutes	5 179.969 544	-304 56	-0.000 588
			5 minutes	5 179.967 937	-320 63	-0.000 619
			10 minutes	5 179.967 214	-327 86	-0.000 633
100 %		20	Startup	5 179.964 869	-351 31	-0.000 678
			2 minutes	5 179.962 091	-379 09	-0.000 732
			5 minutes	5 179.960 344	-396 56	-0.000 766
			10 minutes	5 179.959 428	-405 72	-0.000 783
100 %		24.4	Startup	5 179.957 012	-429 88	-0.000 830
			2 minutes	5 179.953 785	-462 15	-0.000 892
			5 minutes	5 179.953 250	-467 50	-0.000 903
			10 minutes	5 179.953 698	-463 02	-0.000 894
100 %		30	Startup	5 179.955 405	-445 95	-0.000 861
			2 minutes	5 179.955 839	-441 61	-0.000 853
			5 minutes	5 179.955 969	-440 31	-0.000 850
			10 minutes	5 179.955 796	-442 04	-0.000 853
100 %		40	Startup	5 179.954 031	-459 69	-0.000 887
			2 minutes	5 179.954 089	-459 11	-0.000 886
			5 minutes	5 179.955 088	-449 12	-0.000 867
			10 minutes	5 179.956 014	-439 86	-0.000 849
100 %		50	Startup	5 179.954 943	-450 57	-0.000 870
			2 minutes	5 179.962 208	-377 92	-0.000 730
			5 minutes	5 179.964 914	-350 86	-0.000 677
			10 minutes	5 179.967 611	-323 89	-0.000 625

Test voltage (%)	Test voltage (V)	Temperature (℃)	Maintaining time	Measure frequency (㎒)	Frequency deviation (㎐)	Deviation (%)
85 %	DC 3.145	24.4	Startup	5 179.956 888	-431 12	-0.000 832
			2 minutes	5 179.953 323	-466 77	-0.000 901
			5 minutes	5 179.953 111	-468 89	-0.000 905
			10 minutes	5 179.953 088	-469 12	-0.000 906
115 %	DC 4.255	24.4	Startup	5 179.957 121	-428 79	-0.000 828
			2 minutes	5 179.954 091	-459 09	-0.000 886
			5 minutes	5 179.954 018	-459 82	-0.000 888
			10 minutes	5 179.954 095	-459 05	-0.000 886

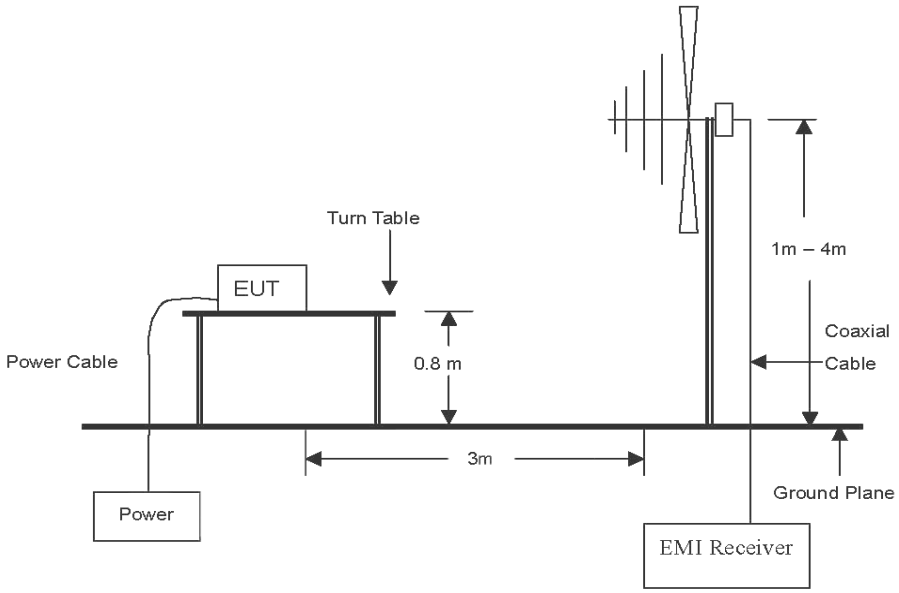
3.6. Radiated restricted band and emissions

Test setup

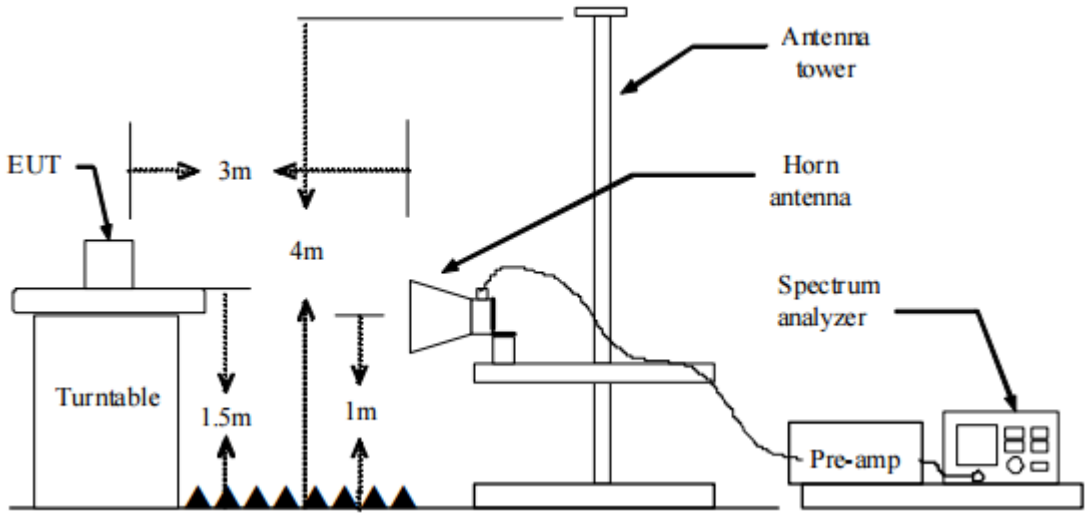
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



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

3. Spectrum analyzer settings for $f \geq 1$ ㎓: Average
   ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
   ② RBW = 1 ㎒
   ③ VBW ≥ 3 × 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. The loop antenna was investigated with three polarizations, and horizontal and vertical polarizations were reported as the worst case.
2. f <30 ㎒, extrapolation factor of 40 ㏈/decade of distance. $F_d = 40\log(D_m/Ds)$
   $f \geq$30 ㎒, extrapolation factor of 20 ㏈/decade of distance. $F_d = 20\log(D_m/Ds)$
   Where:
   F_d = Distance factor in ㏈
   D_m = Measurement distance in meters
   D_s = Specification distance in meters
3. 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.

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.

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.

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.

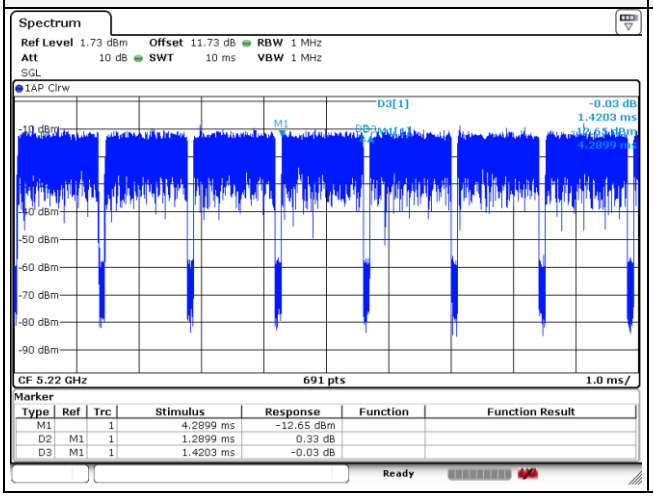
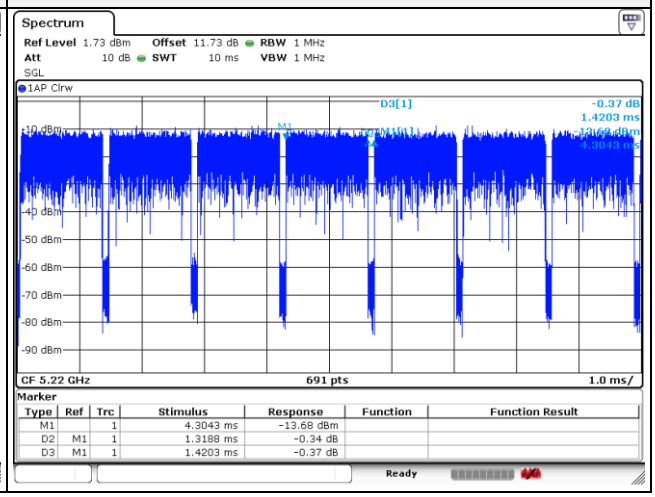
For the band 5.15-5.25 ㎓

Test mode	T_{on} time (㎳)	Period (㎳)	Duty cycle (Linear)	Duty cycle (%)	Duty cycle correction factor (dB)
802.11an_HT20	1.289 9	1.420 3	0.908 2	90.82	0.42
802.11ac_VHT20	1.318 8	1.420 3	0.928 5	92.85	0.32

Note:

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

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

UNII-1 // n_HT20	UNII-1 // ac_VHT20
	

Test results (Below 30 ㎒) – Worst case

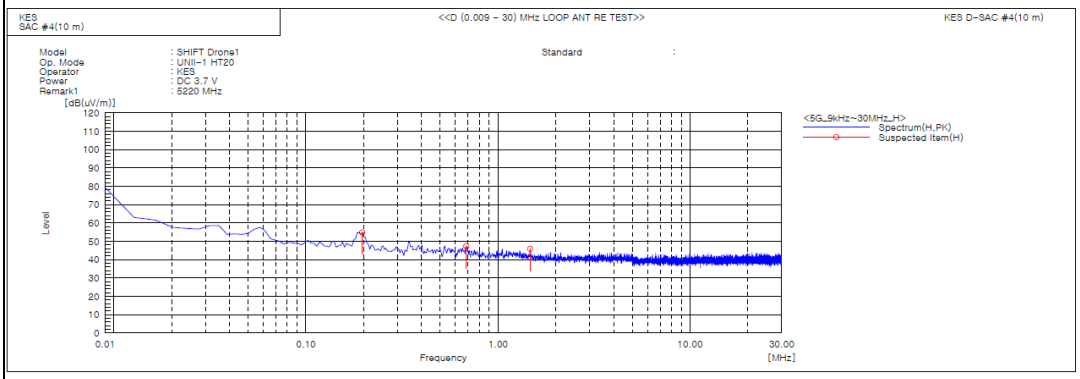
Mode: UNII-1 HT20

Distance of measurement: 3 meter

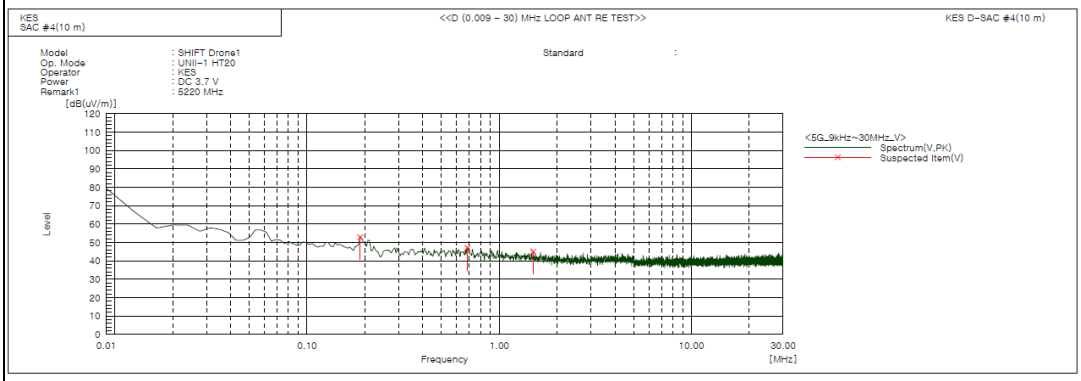
Channel: 44 (Worst case)

Frequency (㎒)	Level (dB㎶)	Ant. Pol. (H/V)	CF (dB)	Distance factor (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
0.196	35.70	H	19.20	- 80.00	-25.10	21.70	46.80
0.684	27.00	H	20.30	- 40.00	7.30	30.90	23.60
1.471	26.00	H	19.90	-40.00	5.90	24.30	18.40
0.189	33.70	V	19.20	-80.00	-27.10	22.10	49.20
0.684	26.70	V	20.30	-40.00	7.00	30.90	23.90
1.501	25.20	V	19.80	-40.00	5.00	24.10	19.10

Horizontal



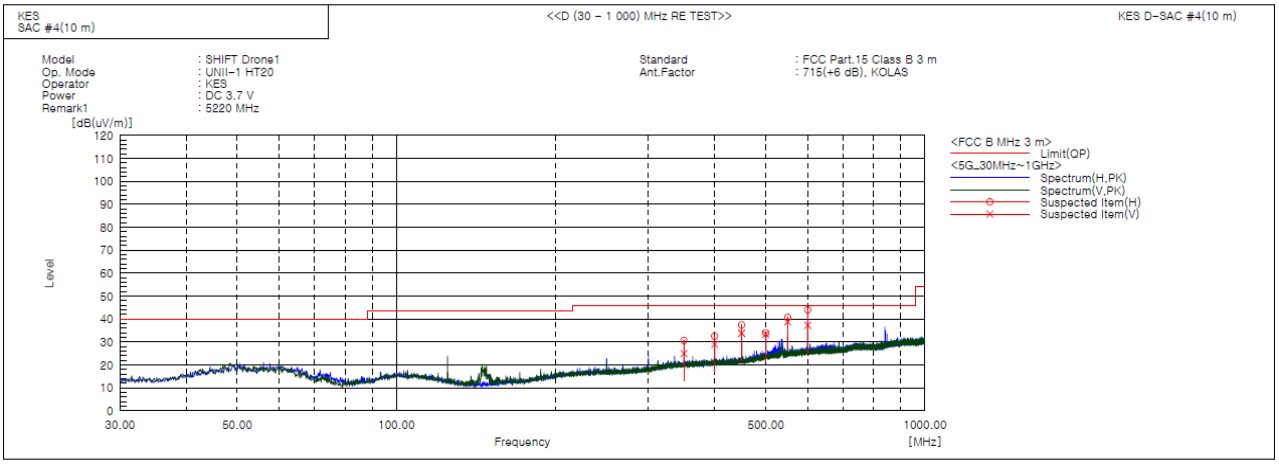
Vertical



Test results (Below 1 000 ㎒) – Worst case

Mode:	UNII-1 HT20
Distance of measurement:	3 meter
Channel:	44 (Worst case)

Horizontal // Vertical



No.	Frequency [MHz]	(P)	Reading [dB(uV)]	c.f [dB(1/m)]	Result PK [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]	Remark
1	599.996	H	55.6	-11.6	44.0	46.0	2.0	100.0	131.0	
2	550.041	H	54.1	-13.4	40.7	46.0	5.3	100.0	227.0	
3	450.010	H	53.6	-16.1	37.5	46.0	8.5	200.0	128.0	
4	400.055	H	49.3	-16.7	32.6	46.0	13.4	200.0	124.0	
5	349.979	H	48.3	-17.6	30.7	46.0	15.3	100.0	111.0	
6	499.965	H	48.4	-14.4	34.0	46.0	12.0	200.0	120.0	
7	599.996	V	48.9	-11.6	37.3	46.0	8.7	100.0	143.0	
8	550.041	V	52.3	-13.4	38.9	46.0	7.1	100.0	310.0	
9	499.965	V	47.8	-14.4	33.4	46.0	12.6	100.0	182.0	
10	450.010	V	49.9	-16.1	33.8	46.0	12.2	100.0	214.0	
11	400.055	V	45.7	-16.7	29.0	46.0	17.0	100.0	139.0	
12	349.979	V	42.6	-17.6	25.0	46.0	21.0	100.0	128.0	

Test results (Above 1 000 ㎒)

Mode: UNII-1 (an_HT20)

Distance of measurement: 3 meter

Channel: 36

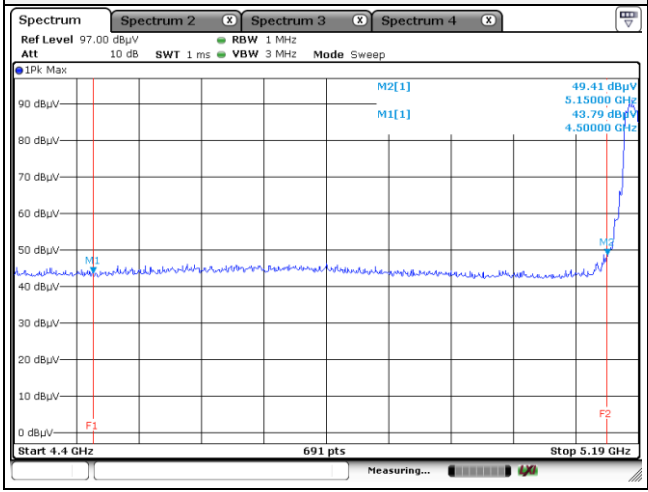
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1 799.60	52.33	Peak	H	-2.82	-	49.51	68.20	18.69
2 429.09	56.41	Peak	H	-0.05	-	56.36	68.20	11.84
1 799.60	37.16	Average	H	-2.82	0.42	34.76	58.20	23.44
1 199.00	54.17	Peak	V	-7.52	-	46.65	74.00	27.35
1 799.60	51.44	Peak	V	-2.82	-	48.62	68.20	19.58
2 117.90	55.87	Peak	V	-0.69	-	55.18	68.20	13.02
2 429.10	55.28	Peak	V	-0.05	-	55.23	68.20	12.97
1 141.10	36.86	Average	V	-7.84	0.42	29.44	54.00	24.56
2 125.20	36.00	Average	V	-0.67	0.42	35.75	58.20	22.45

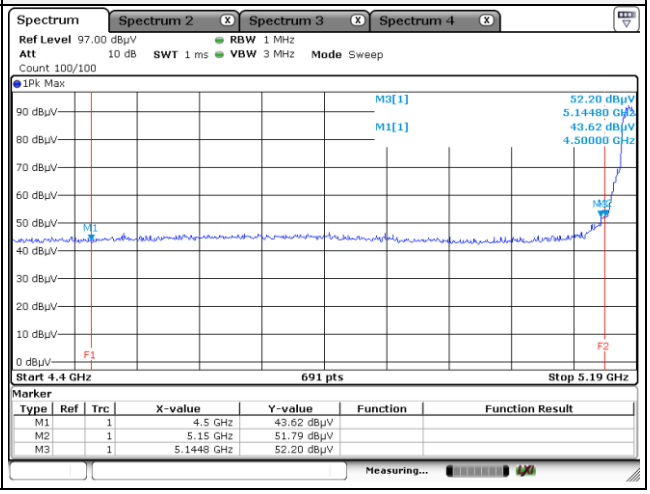
- **Band edge**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
5 150.00	49.41	Peak	H	8.22	-	57.63	74.00	16.37
5 150.00	37.19	Average	H	8.22	0.42	45.83	54.00	8.17
5 144.80	52.20	Peak	V	8.23	-	60.43	74.00	13.57
5 150.00	39.69	Average	V	8.22	0.42	48.33	54.00	5.67

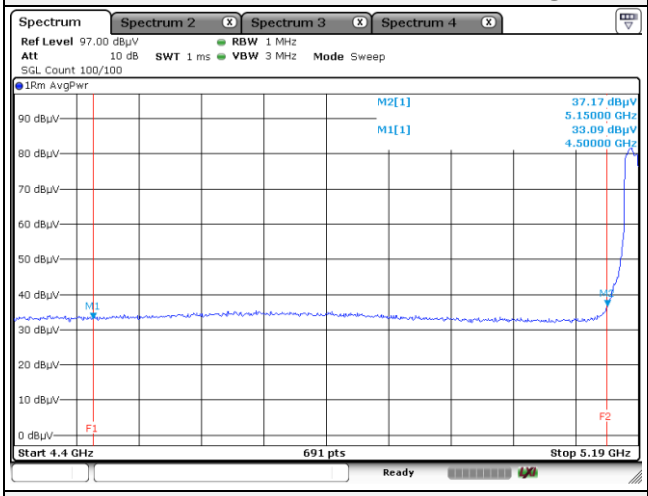
Restricted band // Horizontal // Peak



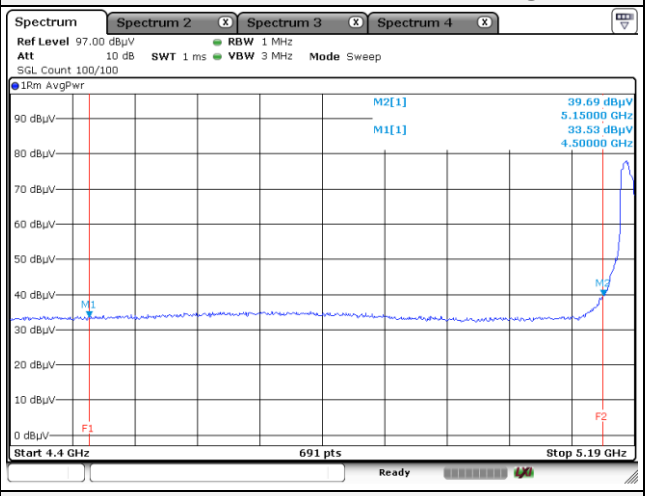
Restricted band // Vertical // Peak



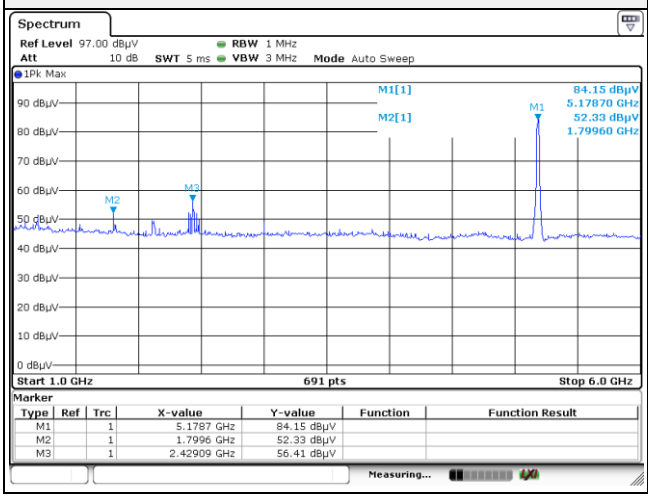
Restricted band // Horizontal // Average



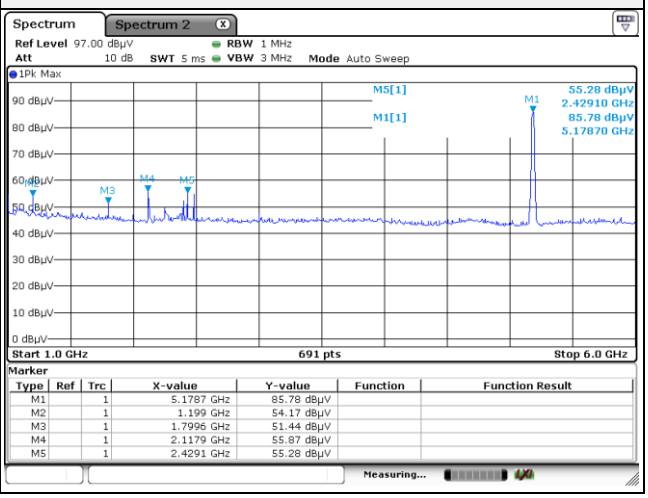
Restricted band // Vertical // Average



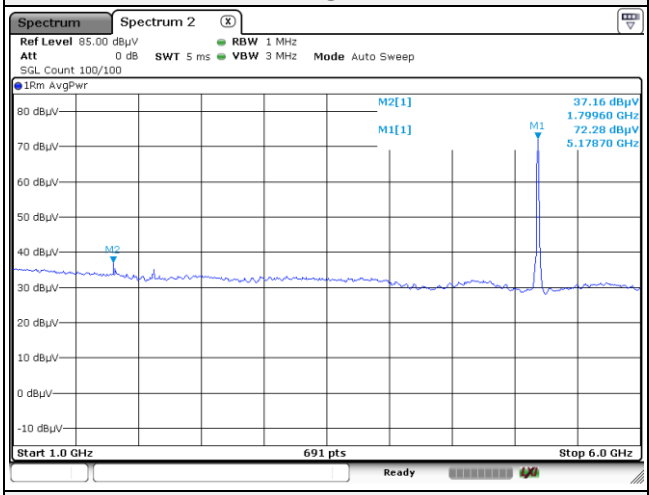
Horizontal // Peak for 1 ㎓ to 6 ㎓



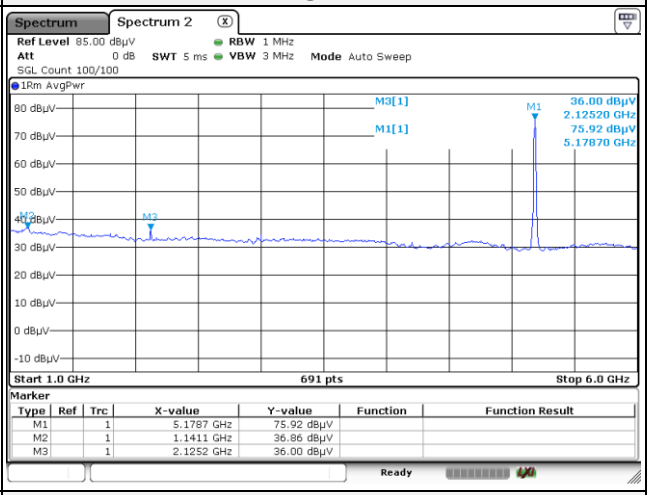
Vertical // Peak for 1 ㎓ to 6 ㎓



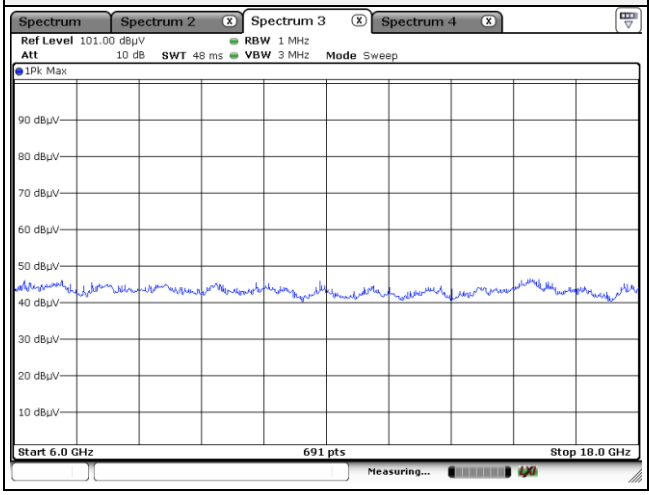
Horizontal // Average for 1 ㎓ to 6 ㎓



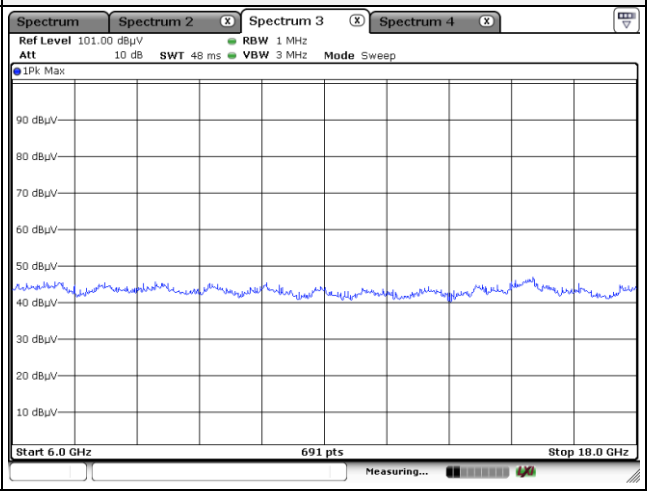
Vertical // Average for 1 ㎓ to 6 ㎓



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.

Mode: UNII-1 (an_HT20)

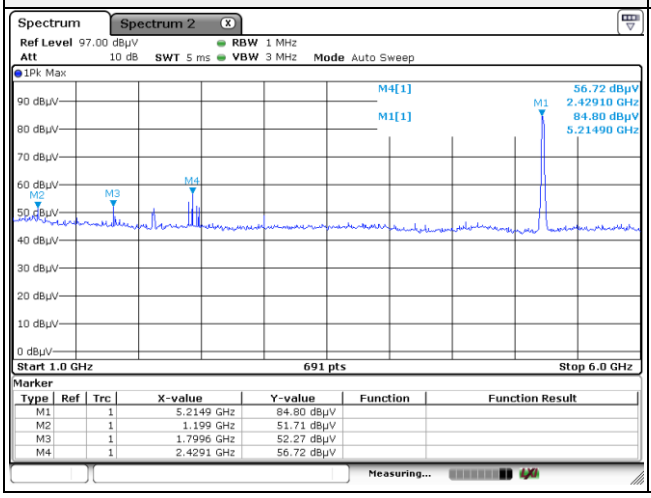
Distance of measurement: 3 meter

Channel: 44

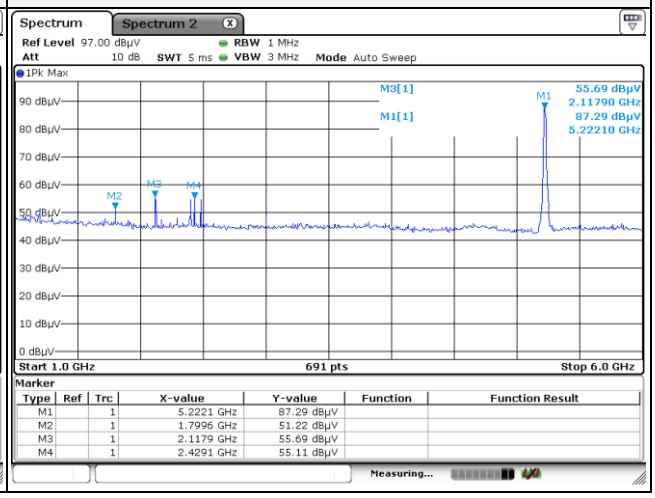
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1 199.00	51.71	Peak	H	-7.52	-	44.19	74.00	29.81
1 799.60	52.27	Peak	H	-2.82	-	49.45	68.20	18.75
2 429.10	56.72	Peak	H	-0.05	-	56.67	68.20	11.53
1 799.60	37.49	Average	H	-2.82	0.42	35.09	58.20	23.11
1 799.60	51.22	Peak	V	-2.82	-	48.40	68.20	19.80
2 117.90	55.69	Peak	V	-0.69	-	55.00	68.20	13.20
2 429.10	55.11	Peak	V	-0.05	-	55.06	68.20	13.14
2 125.20	41.01	Average	V	-0.67	0.42	40.76	58.20	17.44

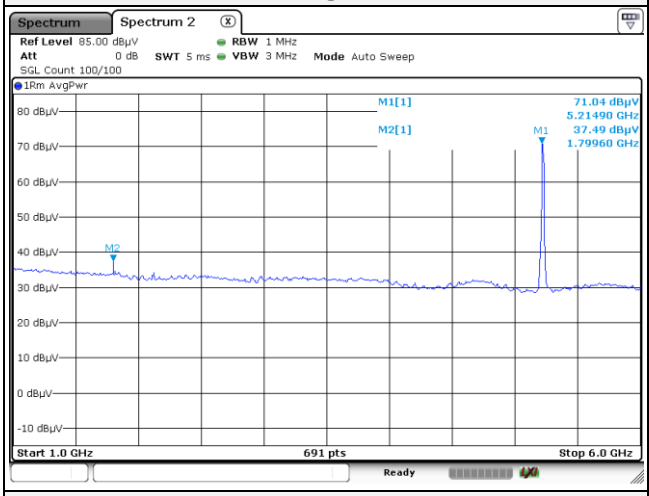
Horizontal // Peak for 1 ㎓ to 6 ㎓



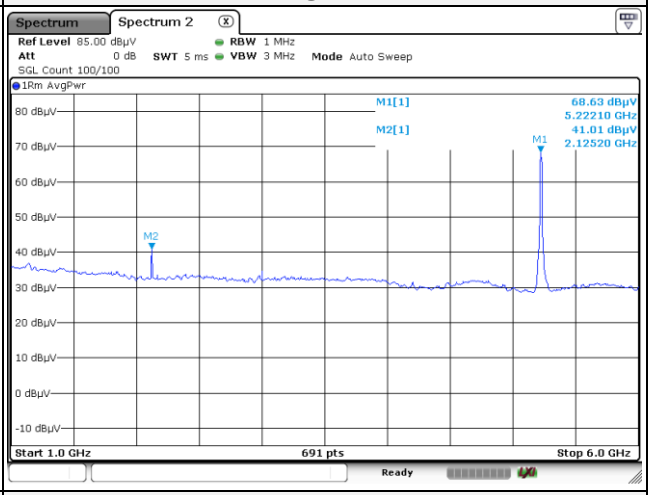
Vertical // Peak for 1 ㎓ to 6 ㎓



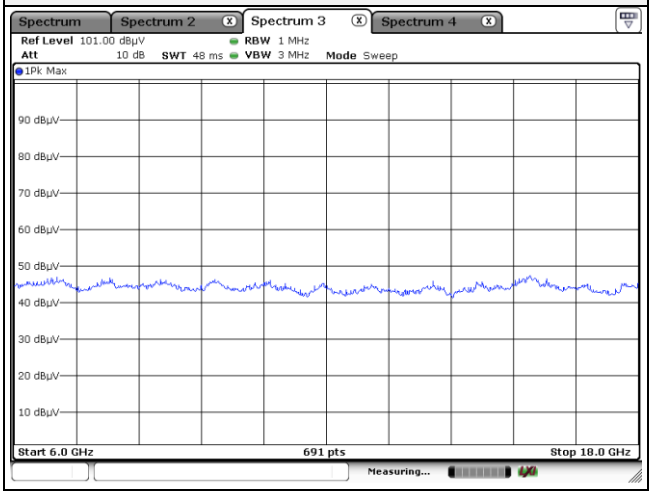
Horizontal // Average for 1 ㎓ to 6 ㎓



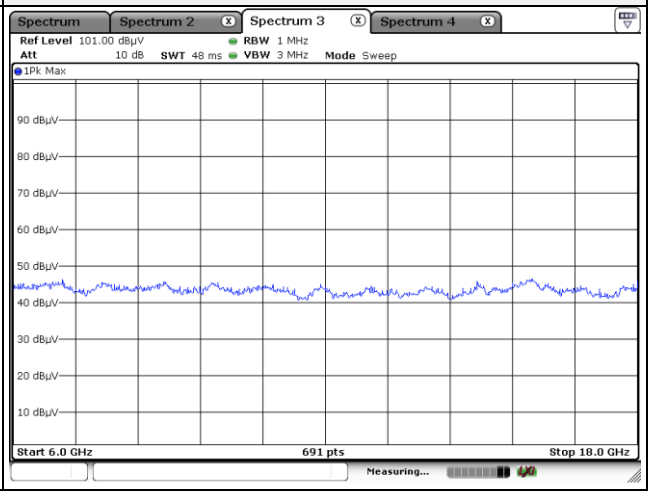
Vertical // Average for 1 ㎓ to 6 ㎓



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.

Mode: UNII-1 (an_HT20)

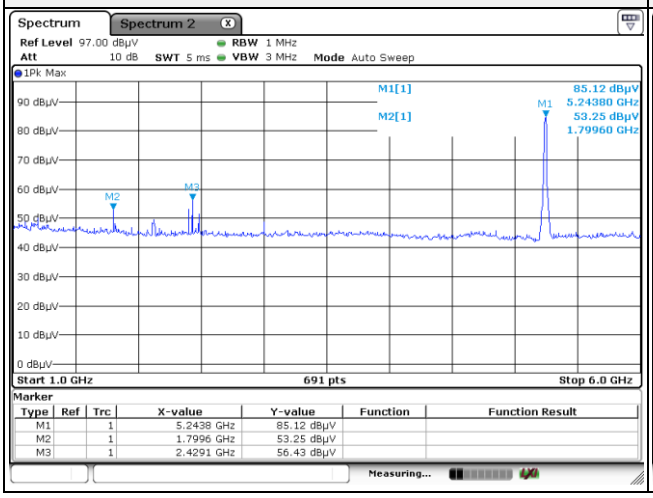
Distance of measurement: 3 meter

Channel: 48

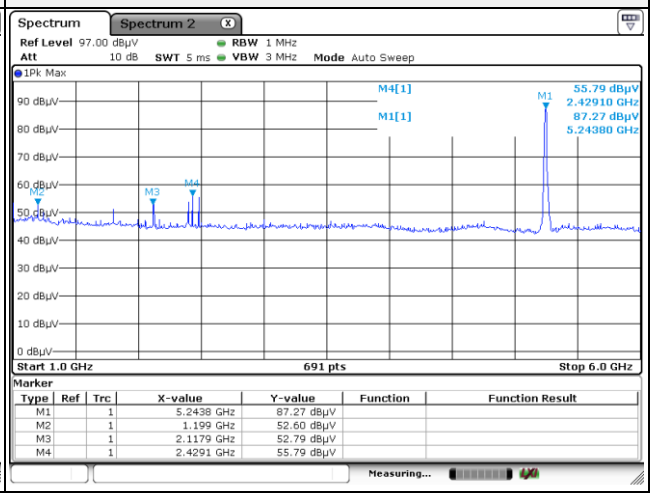
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1 799.60	53.25	Peak	H	-2.82	-	50.43	68.20	17.77
2 429.10	56.43	Peak	H	-0.05	-	56.38	68.20	11.82
1 799.60	37.64	Average	H	-2.82	0.42	35.24	58.20	22.96
1 199.00	52.60	Peak	V	-7.52	-	45.08	74.00	28.92
2 117.90	52.79	Peak	V	-0.69	-	52.10	68.20	16.10
2 429.10	55.79	Peak	V	-0.05	-	55.74	68.20	12.46
1 148.30	37.04	Average	V	-7.80	0.42	29.66	54.00	24.34
2 117.90	36.11	Average	V	-0.69	0.42	35.84	58.20	22.36

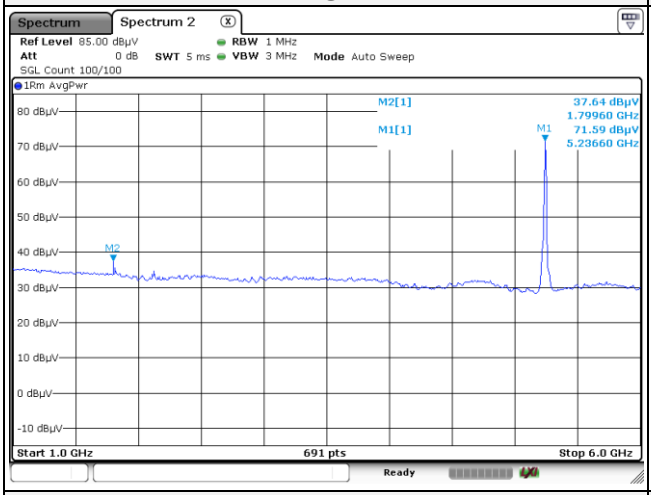
Horizontal // Peak for 1 ㎓ to 6 ㎓



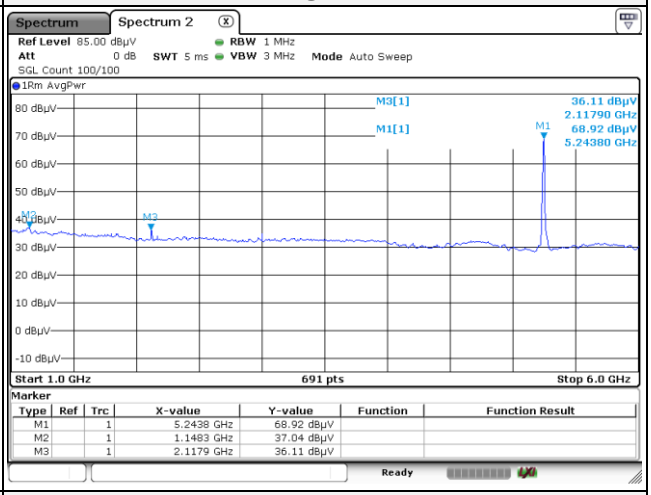
Vertical // Peak for 1 ㎓ to 6 ㎓



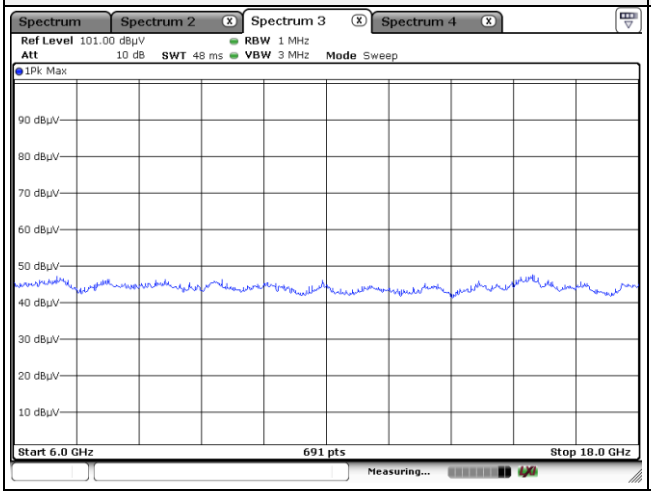
Horizontal // Average for 1 ㎓ to 6 ㎓



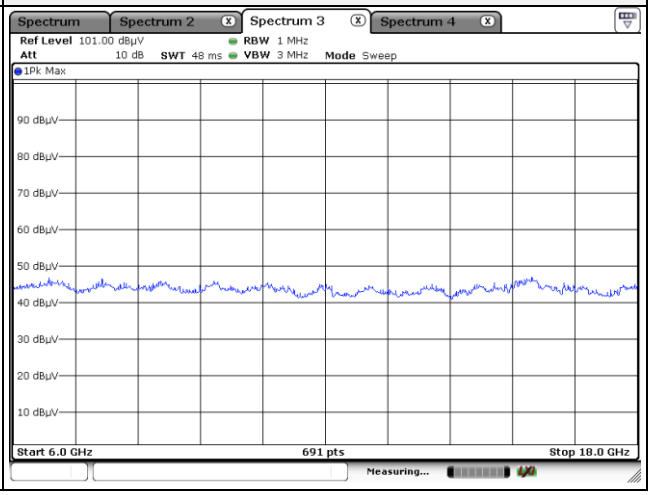
Vertical // Average for 1 ㎓ to 6 ㎓



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.

Mode: UNII-1 (ac_HT20)

Distance of measurement: 3 meter

Channel: 36

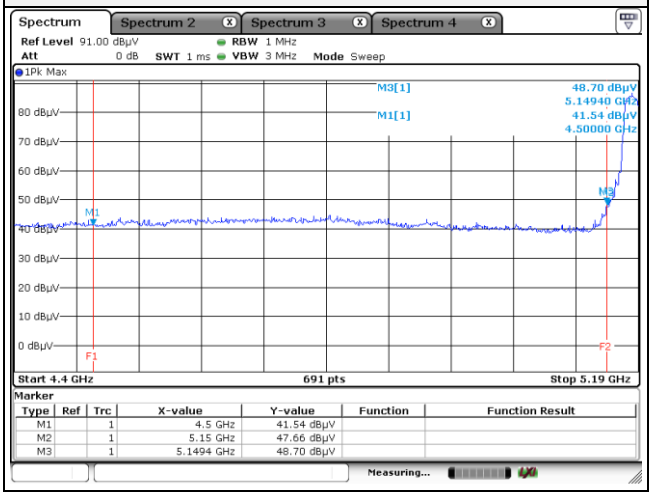
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1 799.60	52.08	Peak	H	-2.82	-	49.26	68.20	18.94
2 429.10	57.68	Peak	H	-0.05	-	57.63	68.20	10.57
2 125.20	37.78	Average	H	-0.67	0.32	37.43	58.20	20.77
1 799.60	52.58	Peak	V	-2.82	-	49.76	68.20	18.44
2 125.20	52.30	Peak	V	-0.67	-	51.63	68.20	16.57
2 429.10	56.39	Peak	V	-0.05	-	56.34	68.20	11.86
1 148.30	37.43	Average	V	-7.80	0.32	30.05	54.00	23.95
2 117.90	35.62	Average	V	-0.69	0.32	35.35	58.20	22.85

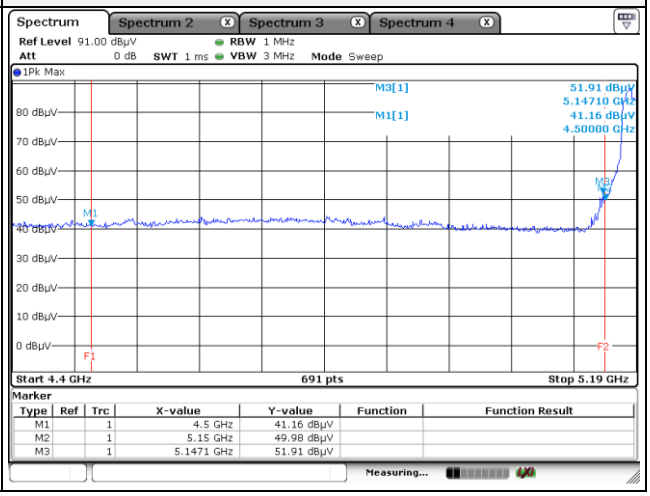
- **Band edge**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
5 149.40	48.70	Peak	H	8.22	-	56.92	74.00	17.18
5 150.00	34.17	Average	H	8.22	0.32	42.71	54.00	11.29
5 147.10	51.91	Peak	V	8.23	-	60.17	74.00	13.54
5 150.00	37.58	Average	V	8.22	0.32	46.12	54.00	7.88

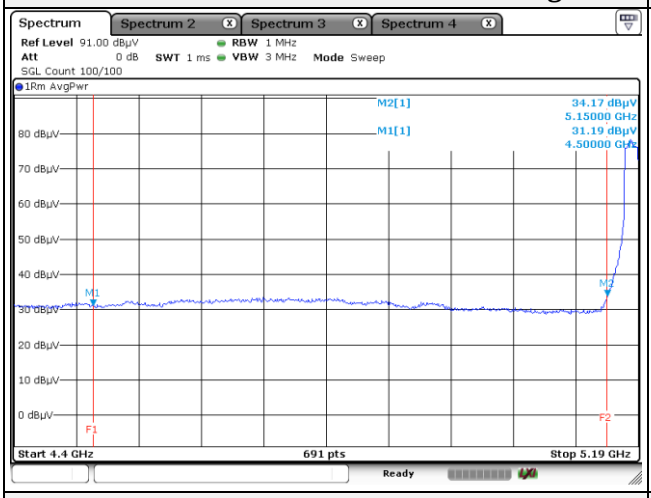
Restricted band // Horizontal // Peak



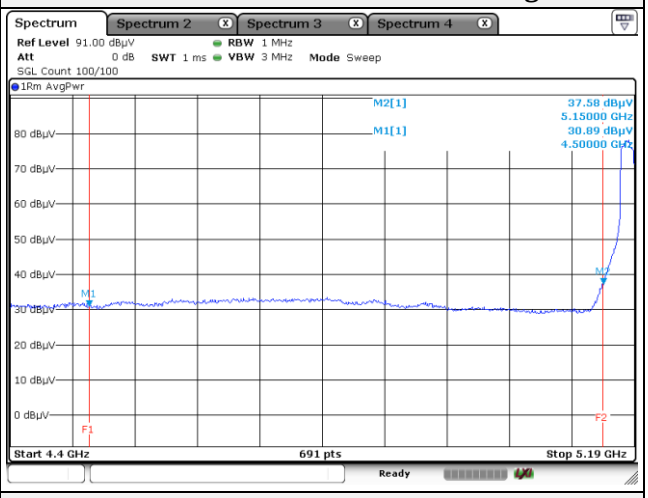
Restricted band // Vertical // Peak



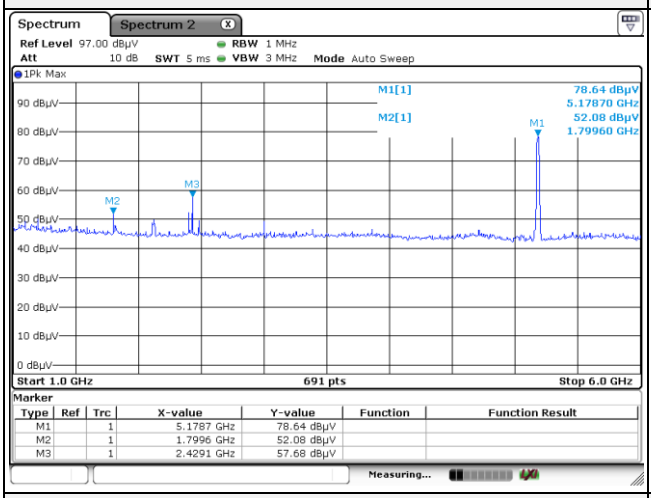
Restricted band // Horizontal // Average



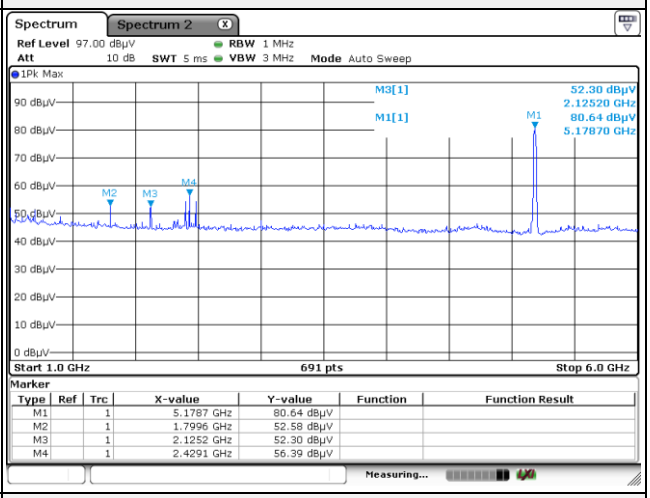
Restricted band // Vertical // Average



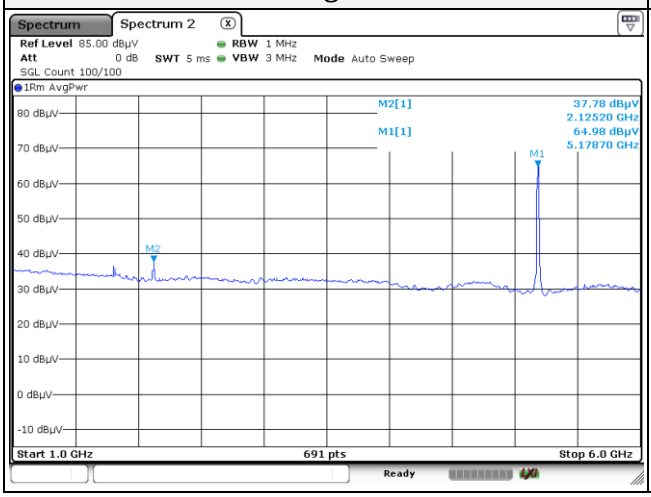
Horizontal // Peak for 1 ㎓ to 6 ㎓



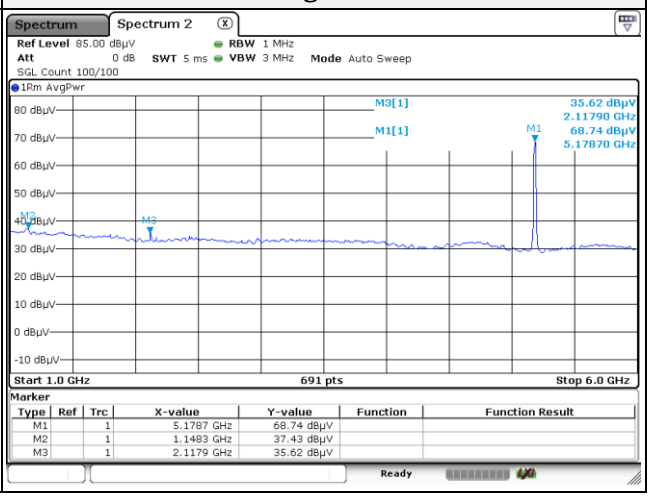
Vertical // Peak for 1 ㎓ to 6 ㎓

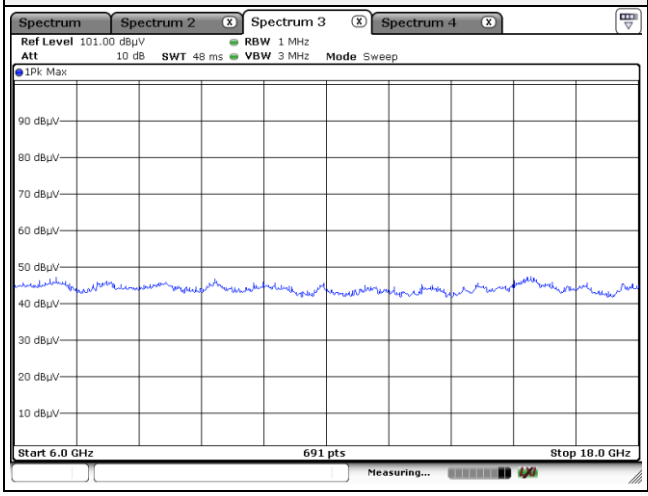
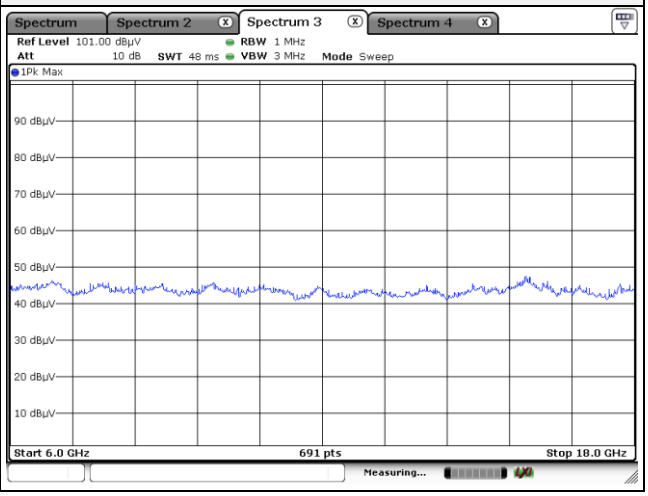


Horizontal // Average for 1 ㎓ to 6 ㎓



Vertical // Average 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.

Mode: UNII-1 (ac_VHT20)

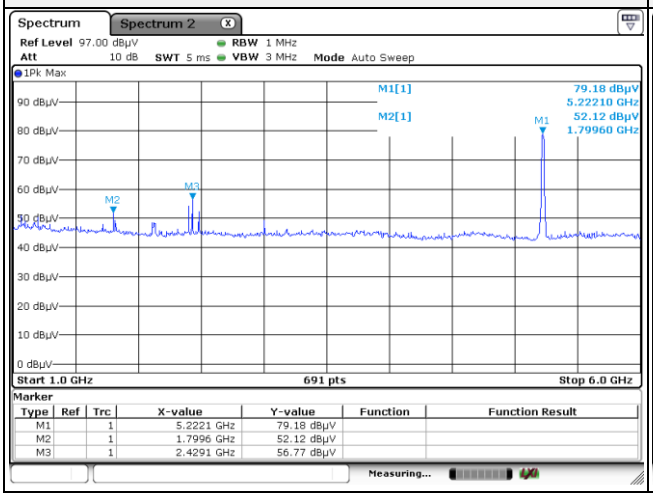
Distance of measurement: 3 meter

Channel: 44

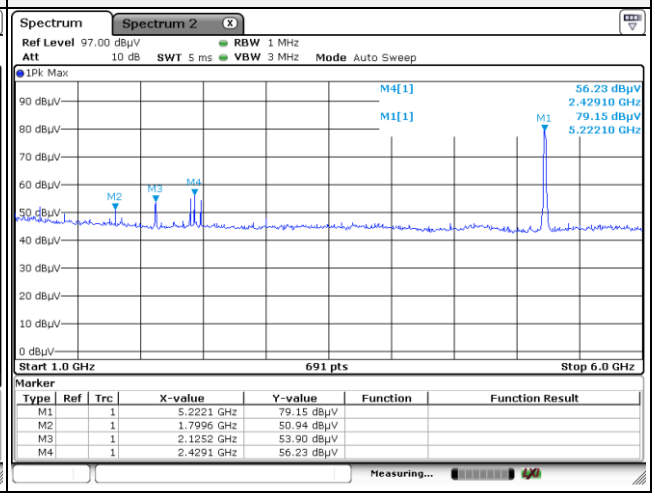
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1 799.60	52.12	Peak	H	-2.82	-	49.30	68.20	18.90
2 429.11	56.77	Peak	H	-0.05	-	56.72	68.20	11.48
1 799.60	37.10	Average	H	-2.82	0.32	34.60	58.20	23.60
1 799.60	50.94	Peak	V	-2.82	-	48.12	68.20	20.08
2 125.20	53.90	Peak	V	-0.67	-	53.23	68.20	14.97
2 429.10	56.23	Peak	V	-0.05	-	56.18	68.20	12.02
1 148.30	36.90	Average	V	-7.80	0.32	29.42	54.00	24.58
2 125.20	37.66	Average	V	-0.67	0.32	37.31	58.20	20.89

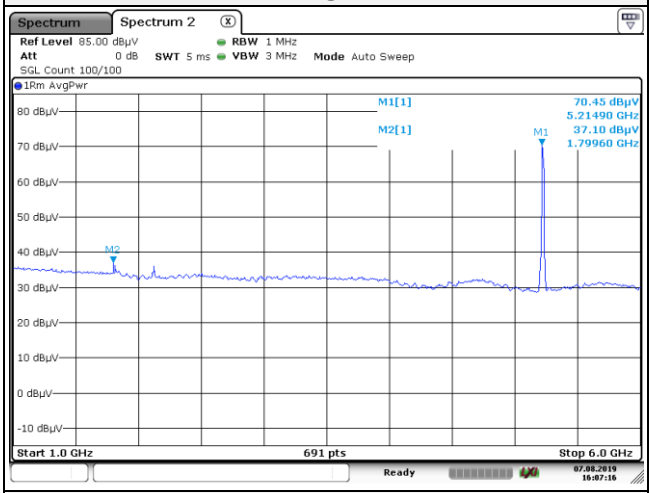
Horizontal // Peak for 1 ㎓ to 6 ㎓



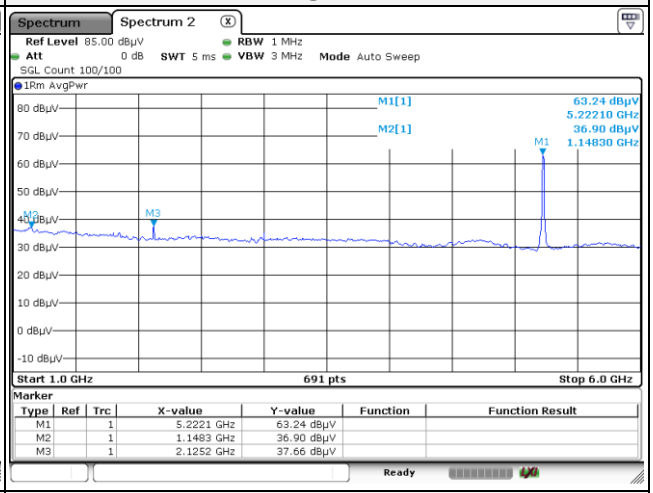
Vertical // Peak for 1 ㎓ to 6 ㎓



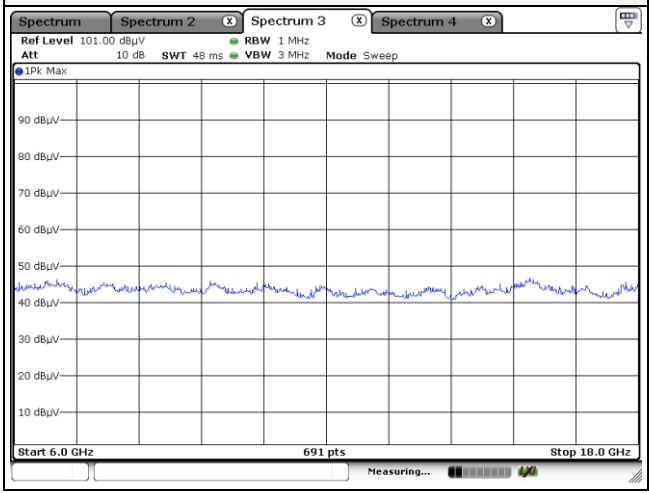
Horizontal // Average for 1 ㎓ to 6 ㎓



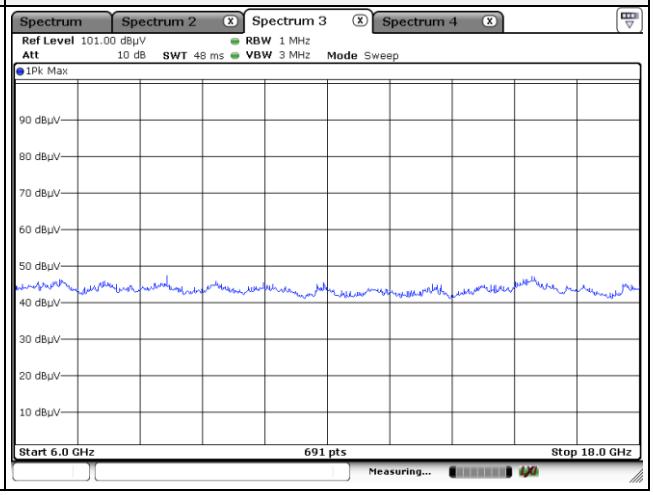
Vertical // Average for 1 ㎓ to 6 ㎓



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.

Mode: UNII-1 (ac_VHT20)

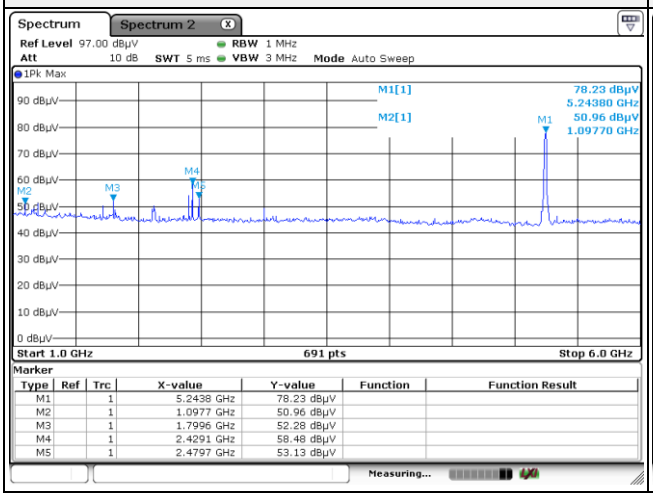
Distance of measurement: 3 meter

Channel: 48

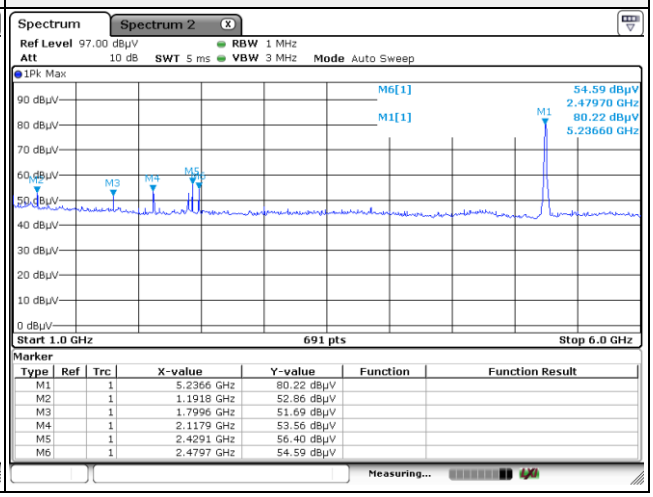
- **Spurious**

Frequency (㎒)	Level (dB㎶)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1 097.70	50.96	Peak	H	-8.09	-	42.87	74.00	31.13
1 799.60	52.28	Peak	H	-2.82	-	49.46	68.20	18.74
2 429.10	58.48	Peak	H	-0.05	-	58.43	68.20	9.77
2 479.70	53.13	Peak	H	0.06	-	53.19	68.20	15.01
1 799.60	36.57	Average	H	-2.82	0.32	34.07	58.20	24.13
2 125.20	37.01	Average	H	-0.67	0.32	36.66	58.20	21.54
1 191.80	52.86	Peak	V	-7.56	-	45.30	74.00	28.70
1 799.60	51.69	Peak	V	-2.82	-	48.87	68.20	19.33
2 117.90	53.56	Peak	V	-0.69	-	52.87	68.20	15.33
2 429.10	56.40	Peak	V	-0.05	-	56.35	68.20	11.85
2 479.70	54.59	Peak	V	0.06	-	57.65	68.20	13.55
1 148.30	37.05	Average	V	-7.80	0.32	29.57	54.00	24.43
2 117.90	37.02	Average	V	-0.69	0.32	36.65	58.20	21.55

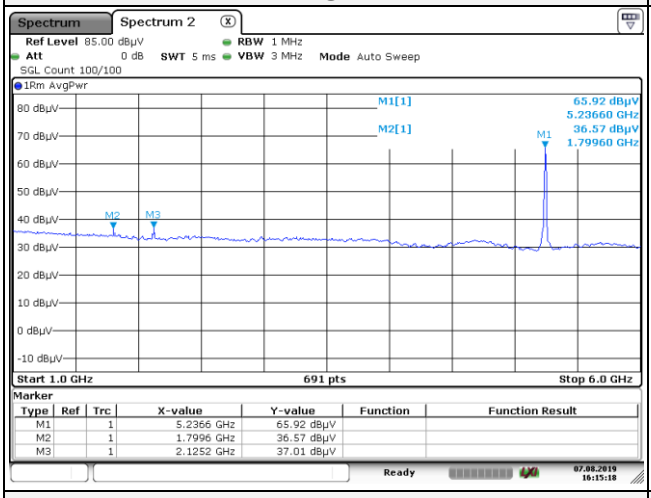
Horizontal // Peak for 1 ㎓ to 6 ㎓



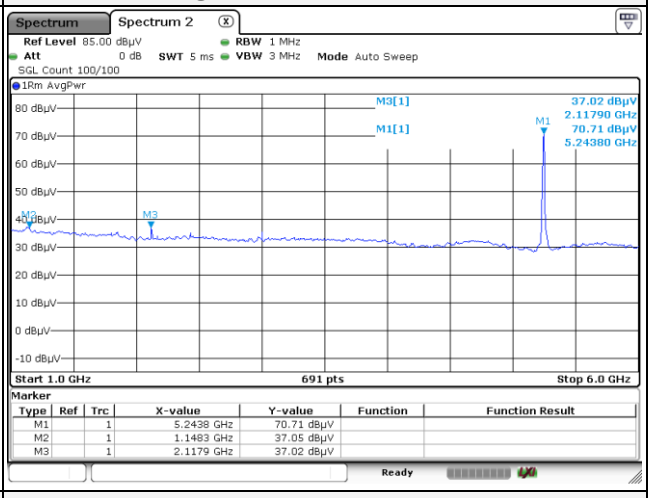
Vertical // Peak for 1 ㎓ to 6 ㎓



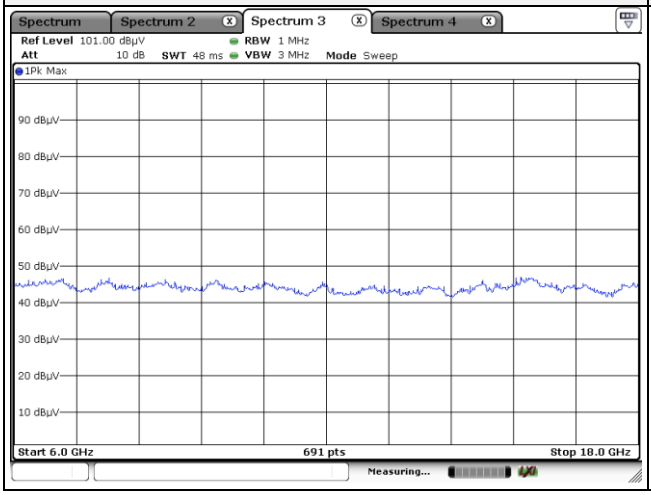
Horizontal // Average for 1 ㎓ to 6 ㎓



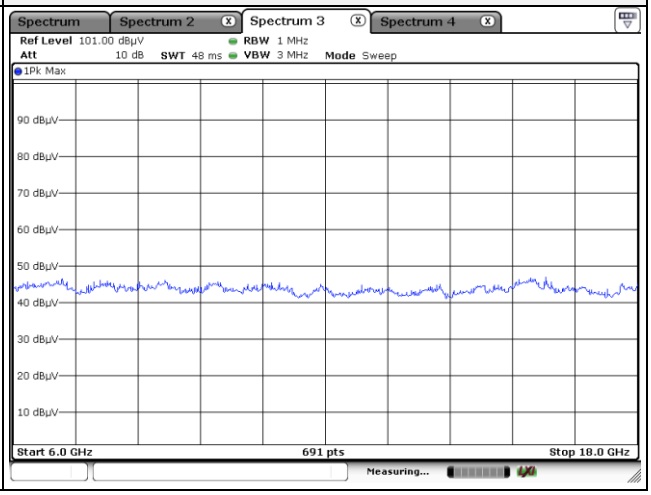
Average // Peak for 1 ㎓ to 6 ㎓



Horizontal // Peak for 6 ㎓ to 18 ㎓



Vertical // Peak for 6 ㎓ to 18 ㎓

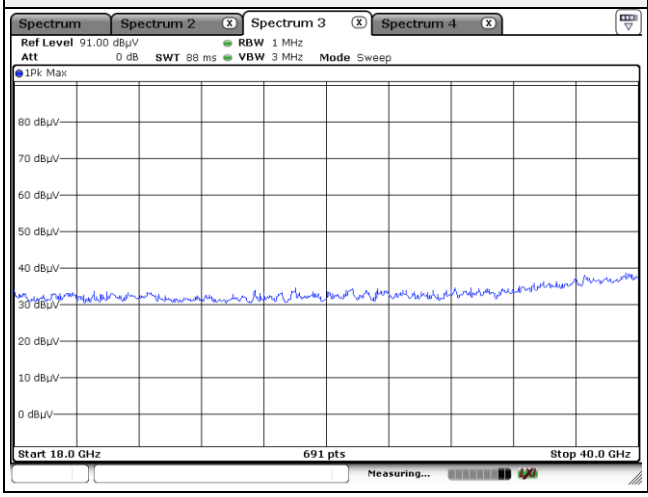
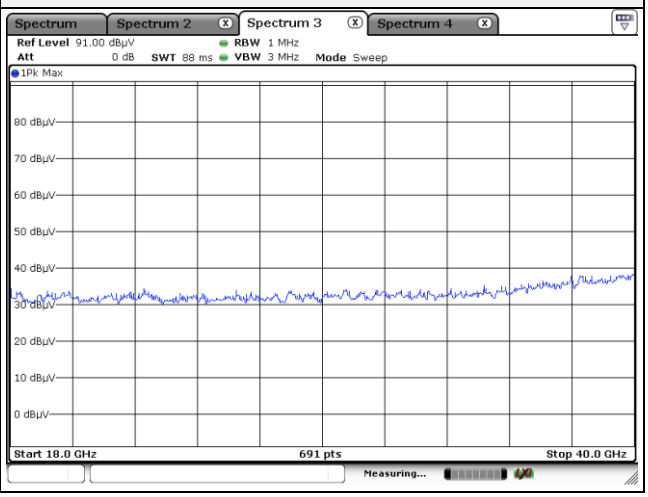


Note.

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

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

Mode:	UNII-1 (an_HT20)
Distance of measurement:	3 meter
Channel:	44 (Worst case)

Horizontal	Vertical
	

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

Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum Analyzer	R&S	FSV40	101002	1 year	2020.06.24
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2020.01.15
Power Meter	Anritsu	ML2495A	1438001	1 year	2020.01.15
Pulse Power Sensor	Anritsu	MA2411B	1339205	1 year	2020.01.15
Attenuator	HP	8494B	2630A12857	1 year	2020.01.15
Loop Antenna	Schwarzbeck	FMZB1513	225	2 years	2021.02.15
Trilog-broadband antenna	SCHWARZBECK	VULB 9163	714	2 years	2020.11.26
Horn Antenna	A.H	SAS-571	414	2 years	2021.02.11
Horn Antenna	SCHWARZBECK	BBHA9170	BBHA 9170550	2 years	2021.02.19
High Pass Filter	Wainwright Instrument Gmbh	WHJS3000-10TT	1	1 year	2020.06.24
Low Pass Filter	Wainwright Instrument Gmbh	WLK1.0/18G-10TT	1	1 year	2020.06.24
Broadband Amplifier	Schwarzbeck	BBV9721	PS9721-003	1 year	2020.01.16
Preamplifier	AGILENT	8449B	3008A00538	1 year	2020.06.24
Amplifier	R&S	SCU 01	100603	1 year	2019.11.26
EMI Test Receiver	R&S	ESU26	100551	1 year	2020.04.09
EMI Test Receiver	R&S	ESR3	101781	1 year	2020.04.22
DC Power supply	Agilent	6632B	MY43004130	1 year	2020.06.24
Pulse Limiter	R&S	ESH3-Z2	101915	1 year	2019.11.26
LISN	R&S	ENV216	101787	1 year	2020.01.04

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
Notebook computer	LG Electronics Inc.,	LGS53	306QCZP560949