TEST REPORT

of

FCC Part 15 Subpart C §15.209, §15.231
IC RSS-210 Issue 9, RSS-Gen Issue 4

FCC ID: TQ8-FOB-4F19
IC Certification: 5074A-FOB4F19

Equipment Under Test	:	Fob Smart Key
Model Name	:	FOB-4F19
Applicant	:	Hyundai Mobis Co., Ltd.
Manufacturer	:	ALPS Electric Korea Co., Ltd.
Date of Receipt	:	2017.10.17
Date of Test(s)	:	2017.11.01 ~ 2017.11.09
Date of Issue	:	2017.12.08

In the configuration tested, the EUT complied with the standards specified above.

Tested By: Jaeha Chung **Date:** 2017.12.08

Technical Manager: Harim Lee **Date:** 2017.12.08

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1. General Information

1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)
- Wireless Div. 2FL, 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807

All SGS services are rendered in accordance with the applicable SGS conditions of service available on request and accessible at http://www.sgs.com/en/Terms-and-Conditions.aspx.

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1.2. Details of applicant

Applicant : Hyundai Mobis Co., Ltd.
Address : 203, Teheran-ro, Gangnam-gu, Seoul, Republic of Korea
Contact Person : Choi, Seung-Hoon
Phone No. : +82 31 260 0098

1.3. Details of manufacturer

Company : ALPS Electric Korea Co., Ltd.
Address : 33, Hanamsandan 5beon-ro, Gwangsan-gu, Gwangju, Korea

1.3. Description of EUT

Kind of Product	Fob Smart Key
Model Name	FOB-4F19
Power Supply	DC 3.0 V (Lithium type of battery)
Frequency Range	Tx: 433.92 ㎒, Rx: 125.00 ㎑
Modulation Type	FSK
Number of Channel	1
Antenna Type	PCB Antenna

1.4. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Interval	Cal. Due
Signal Generator	R&S	SMBV100A	255834	Jun. 15, 2017	Annual	Jun. 15, 2018
Spectrum Analyzer	Agilent	N9020A	MY53421758	Sep. 25, 2017	Annual	Sep. 25, 2018
Spectrum Analyzer	R&S	FSV30	103454	Dec. 01, 2016	Annual	Dec. 01, 2017
Test Receiver	R&S	ESU26	100109	Feb. 17, 2017	Annual	Feb. 17, 2018
DC Power Supply	Agilent	U8002A	MY50060028	Mar. 16, 2017	Annual	Mar. 16, 2018
Preamplifier	H.P.	8447F	2944A03909	Aug. 11, 2017	Annual	Aug. 11, 2018
Preamplifier	R&S	SCU-18	10117	Apr. 08, 2017	Annual	Apr. 08, 2018
High Pass Filter	Wainwright Instrument GmbH	WHKX10-900-1000-18000-40SS	7	Mar. 30, 2017	Annual	Mar. 30, 2018
Loop Antenna	Schwarzbeck Mess-Elektronik	FMZB 1519	1519-0399	Aug. 23, 2017	Biennial	Aug. 23, 2018
Trilog Broadband Antenna	Schwarzbeck Mess-Elektronik	VULB9168	506	Nov. 25, 2016	Biennial	Nov. 25, 2018
Horn Antenna	R&S	HF906	100326	Feb. 01, 2016	Biennial	Feb. 01, 2018
Controller	Innco systems GmbH	CONTROLLER CO3000-4P	CO3000/963/38330516/L	N.C.R.	N/A	N.C.R.
Turn Table	Innco systems GmbH	DS 1200 S	N/A	N.C.R.	N/A	N.C.R.
Antenna Mast	Innco systems GmbH	MA4640-XP-ET	MA4640/536/38330516/L	N.C.R.	N/A	N.C.R.
Anechoic Chamber	SY Corporation	L × W × H (9.6 m × 6.4 m × 6.6 m)	N/A	N.C.R.	N/A	N.C.R.

1.5. Summary of Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARD			
Section in FCC Part 15	**Section in RSS-210, RSS-Gen**	**Test Item**	**Result**
15.209(a) 15.231(b)	RSS-210 Issue 9, A.1, Table A1 RSS-Gen Issue 4, 8.9	Radiated emission, Spurious Emission and Field Strength of Fundamental	Complied
15.231(c)	-	Bandwidth of Operation Frequency	Complied
15.231(a)	RSS-210 Issue 9, A1.1	Transmission Time	Complied
-	RSS-210 Issue 9, A1.3 RSS-Gen Issue 4, 6.6	Occupied Bandwidth	Complied

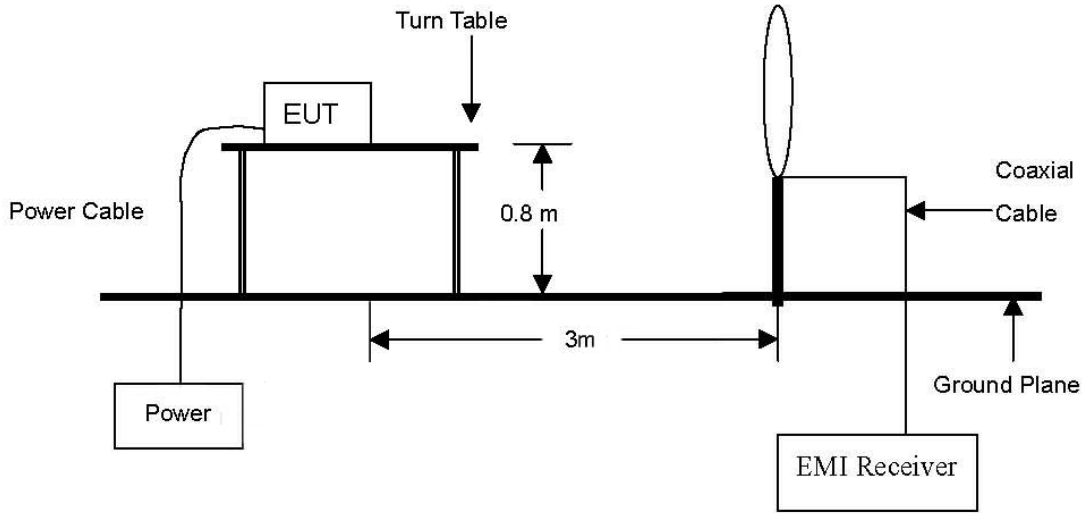
1.6. Test Report Revision

Revision	Report number	Date of issue	Description
0	F690501/RF-RTL012015	2017.11.17	Initial
1	F690501/RF-RTL012015-1	2017.12.08	Added Antenna Requirement

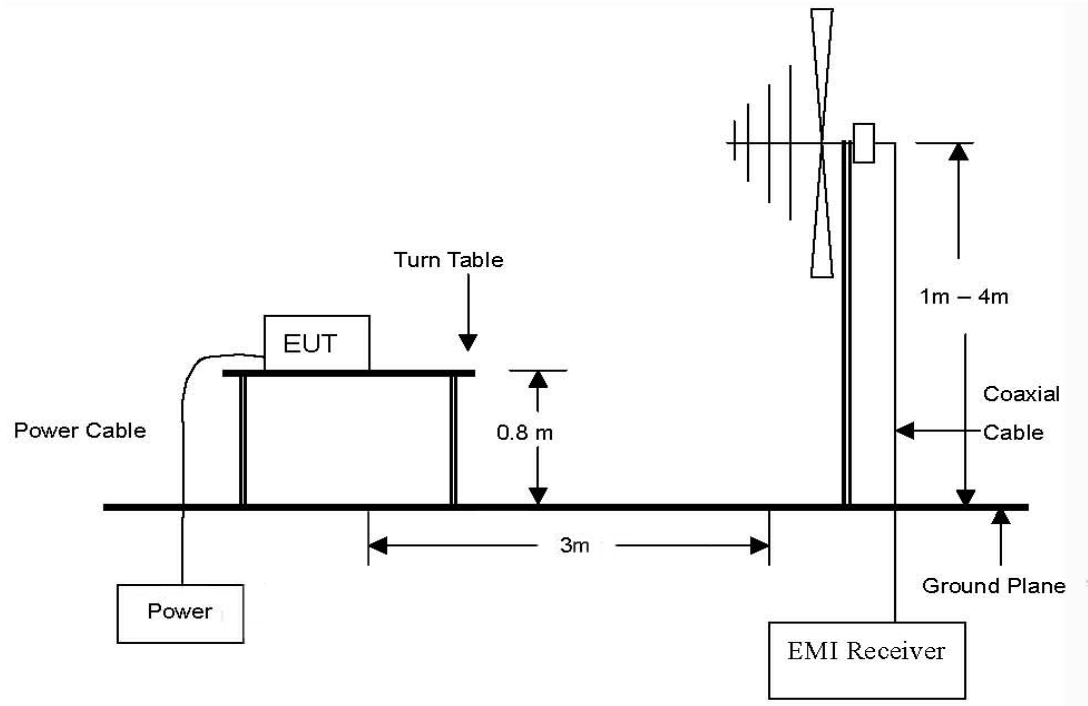
2. Field Strength of Fundamental and Spurious Emission

2.1. Test Setup

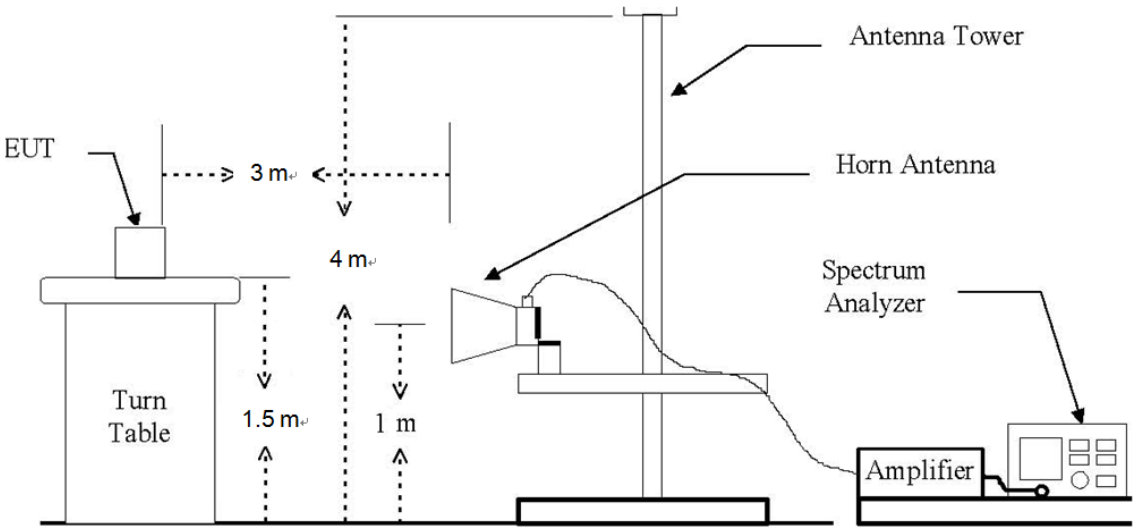
The diagram below shows the test setup that is utilized to make the measurements for emission below 30 ㎒ Emissions.



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. The spurious emissions were investigated form 1 ㎓ to the 10th harmonic of the highest fundamental frequency or 40 ㎓, whichever is lower.



2.2. Limit

2.2.1. FCC limits

2.2.1.1. Radiated emission limits; general requirements.

According to § 15.209(a), except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (㎒)	Field Strength (microvolts/meter)	Measurement Distance (meter)
0.009-0.490	2 400/F(㎑)	300
0.490-1.705	24 000/F(㎑)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

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

2.2.1.2. Periodic operation in the band 40.66-40.70 ㎒ and above 70 ㎒

According to § 15.231(b), in addition to the provisions of Section § 15.205, the field strength of emissions from intentional radiators operated under this Section shall not exceed the following:

Fundamental Frequency (㎒)	Field Strength of Fundamental (microvolts/meter)	Field Strength of Spurious Emissions (microvolts/meter)
40.66-40.70	2,250	225
70-130	1,250	125
130-174	[1]1,250 to 3,750 **	[1]125 to 375 **
174-260	3,750	375
260-470	[1]3,750 to 12,500 **	[1]375 to 1,250 **
Above 470	12,500	1,250

[1]linear interpolations

Where F is the frequency in ㎒, the formulas for calculating the maximum permitted fundamental field strengths are as follows: for the band 130-174 ㎒, ㎶/m at 3 meters = 56.81818(F) - 6136.3636; for the band 260-470 ㎒, ㎶/m at 3 meters = 41.6667(F) - 7083.3333. The maximum permitted unwanted emission level is 20 ㏈ below the maximum permitted fundamental level.

2.2.2. IC limits

2.2.2.1. Transmitter Emission Limits for Licence-Exempt Radio Apparatus

According to RSS-Gen Issue 4, Section 8.9, except when the requirements applicable to a given device state otherwise, the emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 4 or Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Table 4- General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Above 30 ㎒

Frequency (㎒)	Field Strength (㎶/m at 3 metres)
30-88	100
88-216	150
216-960	200
Above 960 *	500

* Unless otherwise specified, for all frequencies greater than 1 ㎓, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 ㎒. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 ㏈ above the average limit.

Note: Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the specific RSS.

Table 5- General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Below 30 ㎒

Frequency	Electric Field Strength (㎶/m)	Magnetic Field Strength (H-Field) (㎂/m)	Measurement Distance (metres)
9-490 ㎑	2,400/F (F in ㎑)	2,400/377F (F in ㎑)	300
490-1,705 ㎑	24,000/F (F in ㎑)	24,000/377F (F in ㎑)	30
1,705 - 30 ㎒	30	N/A	30

Note: The emission limits for the bands 9-90 ㎑ and 110-490 ㎑ are based on measurements employing a linear average detector. Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the relevant RSS.

2.2.2.2. Momentarily Operated Devices

According to A.1 of RSS-210 Issue 9, the frequency bands and field strength limits in tables A1 and A2 of this annex are reserved exclusively for the transmission of a control signal, such as that used with alarm systems, door openers, remote switches, etc. Data may be sent with a control signal. Radio control of toys or model aircraft, as well as continuous transmissions, such as voice or video, are not permitted, except as provided in Section A.1.4 below.

Table A1— Permissible Field Strength Limits for Momentarily Operated Devices

Fundamental Frequency (㎒), Excluding Restricted Frequency Bands Specified in RSS-Gen	Field Strength of the Fundamental Emissions (㎶/m at 3 m)
70-130	1,250
130-174	1,250 to 3,750
174-260(Note 1)	3,750
260-470(Note 1)	3,750 to 12,500
Above 470	12,500

* Linear interpolation with frequency, f, in ㎒:

For 130-174 ㎒: Frequency Strength (㎶/m) = (56.82 x f)-6136
For 260-470 ㎒: Frequency Strength (㎶/m) = (41.67 x f)-7083

Note 1: Frequency bands 225-328.6 ㎒ and 335.4-399.9 ㎒ are designated for the exclusive use of the Government of Canada. Manufacturers should be aware of possible harmful interference and degradation of their licence-exempt radio equipment in these frequency bands.

2.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.10:2013

2.3.1. Test Procedures for emission below 30 ㎒

a. 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.
b. 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.
c. 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.
d. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

Note;
Although these tests were performed other than open field test site, adequate comparison measurements were confirmed against 30 meter open field test 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 937606.

2.3.2. Test Procedures for emission from 30 ㎒ to 1 000 ㎒

a. 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.
b. During performing radiated emission below 1 ㎓, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 ㎓, the EUT was set 3 meter away from the interference-receiving antenna.
c. The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
f. If the emission level of the EUT in peak mode was 10 ㏈ lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 ㏈ margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

2.3.3. Test Procedures for emission above 1 ㎓

a. The EUT was placed on the top of a rotating table 1.5 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.
b. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 ㎒ for Peak detection at frequency above 1 ㎓.

2.4. Test Result

Ambient temperature	:	(23 ± 1) ℃
Relative humidity	:	47 % R.H.

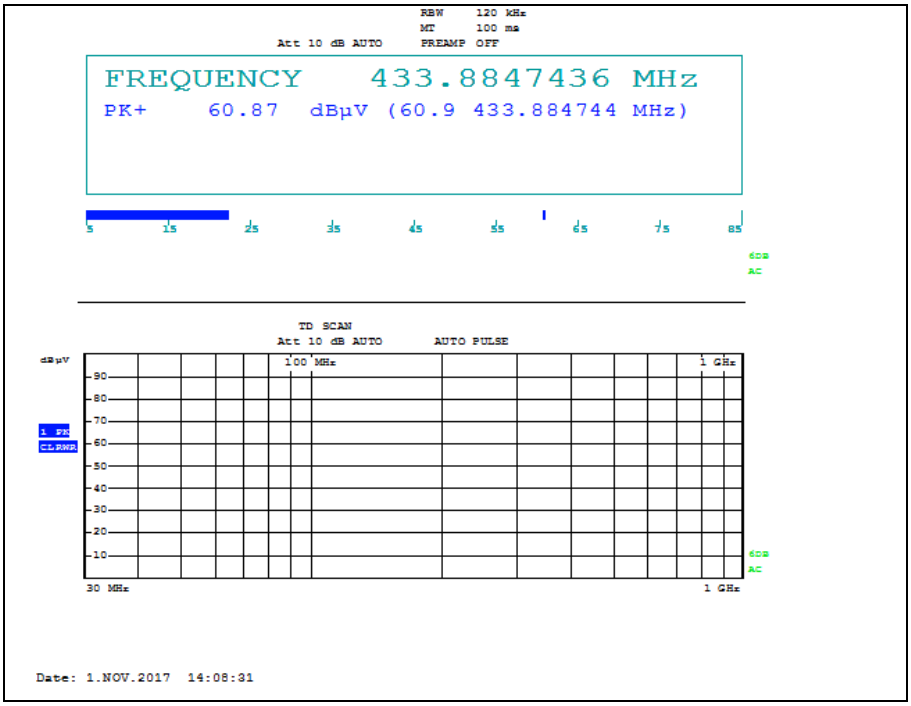
2.4.1. Field Strength of Fundamental

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical.

Freq. (㎒)	Detector	Ant. Pol.	Reading (dB㎶)	Antenna Factor (dB)	Cable Loss (dB)	Result (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
433.88	Peak	H	60.90	16.72	2.94	80.56	100.83	20.27
433.88	Average	H	53.26	16.72	2.94	72.92	80.83	7.91

Remark:
To get a maximum emission level from the EUT, the EUT was moved throughout the X-axis, Y-axis and Z-axis. Worst case is **X-axis**.
Definition of DUT for three orthogonal planes is described in the test setup photos.

Note:
1. 3 m Limit (dB㎶/m) = 20log[41.67($F_{(㎒)}$) - 7083] = 80.83
2. Result = Reading + Antenna Factor + Cable Loss
3. Average Reading = Peak Reading + Duty Cycle Correction Factor
4. Duty Cycle Correction Factor: 20log(T_{on} / 100 ㎳) = 20log(41.50 / 100) = -7.64
   - T_{on} time = 41.50 ㎳
   - T_{on+off} time = 100.00 ㎳ (pulse train is 100 ㎳ instead of 168.00 ㎳)



2.4.2. Spurious Emission

The following table shows the highest levels of radiated emissions on polarizations of horizontal.
The frequency spectrum from 9 ㎑ to 4 500 ㎒ was investigated.

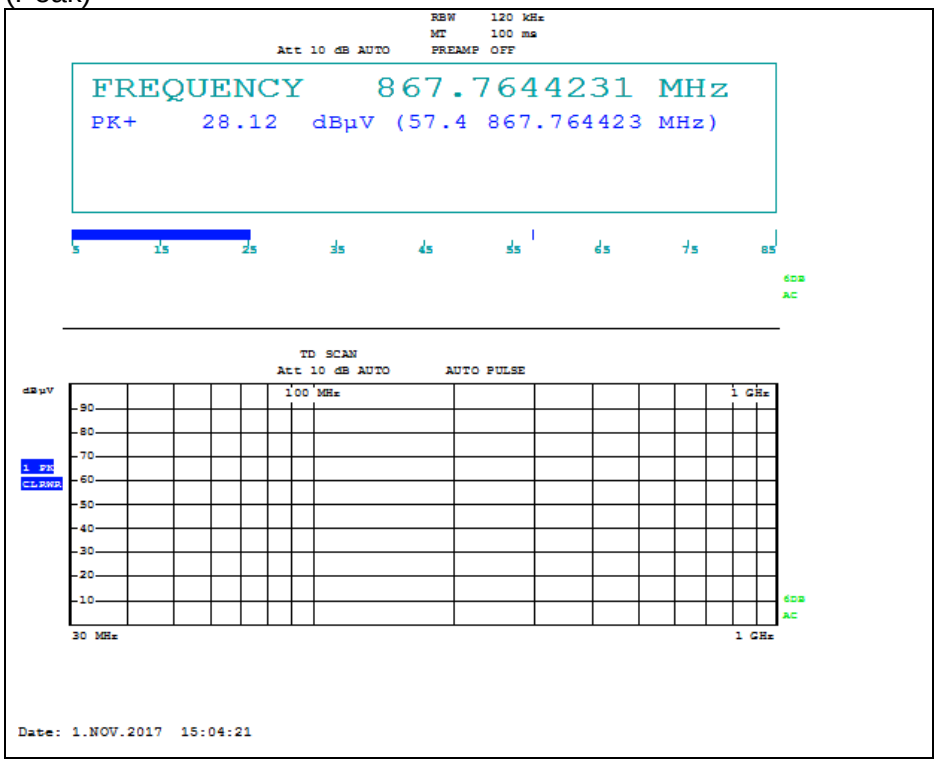
Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	Amp Gain + CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
867.76	57.40	Peak	H	22.98	-22.99	57.39	80.83	23.44
867.76	49.76	Average	H	22.98	-22.99	49.75	60.83	11.08
*1 301.69	66.02	Peak	H	24.58	-32.58	58.02	74.00	15.98
*1 301.69	58.38	Average	H	24.58	-32.58	50.38	54.00	3.62
1 375.55	63.60	Peak	H	24.75	-32.03	56.32	80.83	24.51
1 375.55	55.96	Average	H	24.75	-32.03	48.68	60.83	12.15
*4 339.58	49.47	Peak	H	31.93	-28.33	53.07	74.00	20.93
*4 339.58	41.83	Average	H	31.93	-28.33	45.43	54.00	8.57
Above 4 400.00	Not detected	-	-	-	-	-	-	-

Remark:

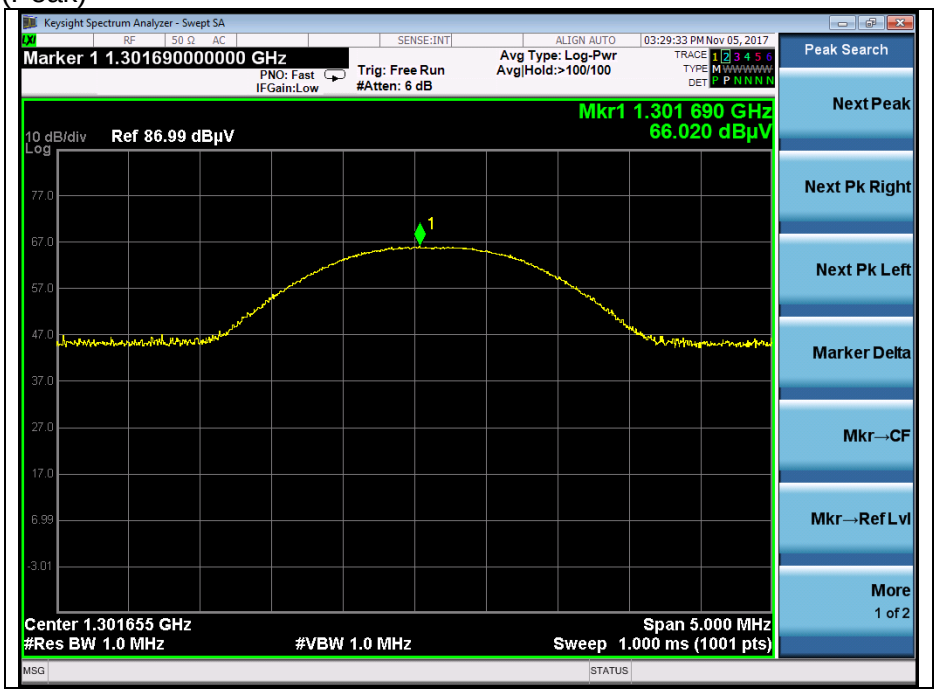
1. To get a maximum emission level from the EUT, the EUT was moved throughout the X-axis, Y-axis and Z-axis. Worst Case is **X-axis**.
   Definition of DUT for three orthogonal planes is described in the test setup photos.
2. 3 m Limit (dB㎶/m) = 20log[41.67($F_{(㎒)}$) – 7083] – 20 dB㎶/m = 60.83 dB㎶/m
3. Correction Factors = AF + Amp Gain + CL
4. Actual = Reading + AF + Amp Gain + CL
5. Average Reading = Peak Reading + Duty Cycle Correction Factor
6. Duty Cycle Correction Factor: 20log(T_{on} / 100 ㎳) = 20log(41.50 / 100) = -7.64
   - T_{on} time = 41.50 ㎳
   - T_{on+off} time = 100.00 ㎳ (pulse train is 100 ㎳ instead of 168.00 ㎳)
7. "*" means the restricted band.
8. Spurious Emission test results meet both peak and average limit.
9. According to § 15.31(o), Emission levels are not reported much lower than the limits by over 20 dB.

The Plots of Spurious Emission

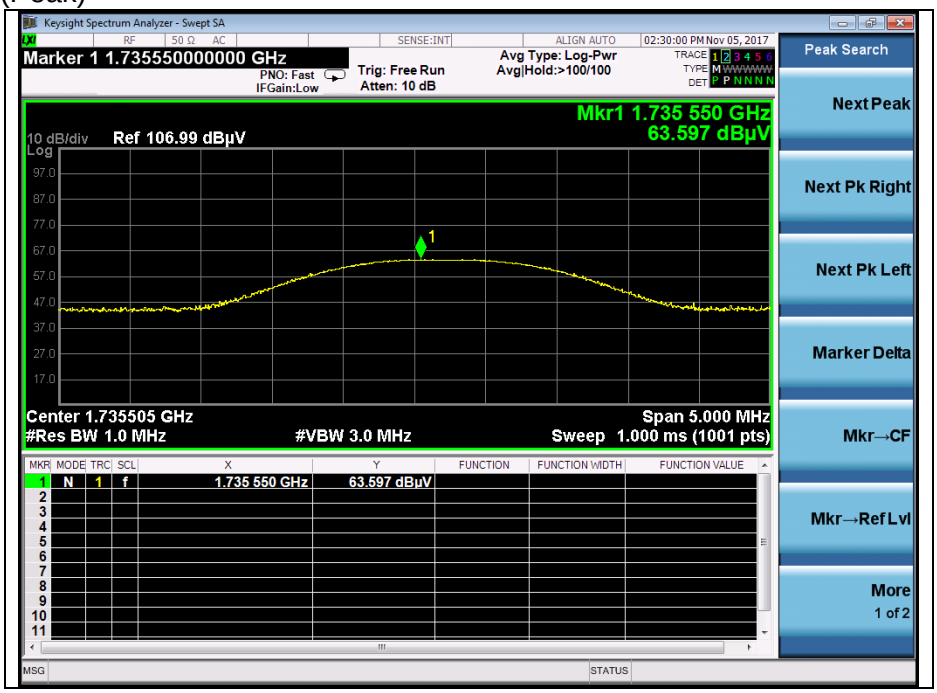
2nd Harmonic (Peak)



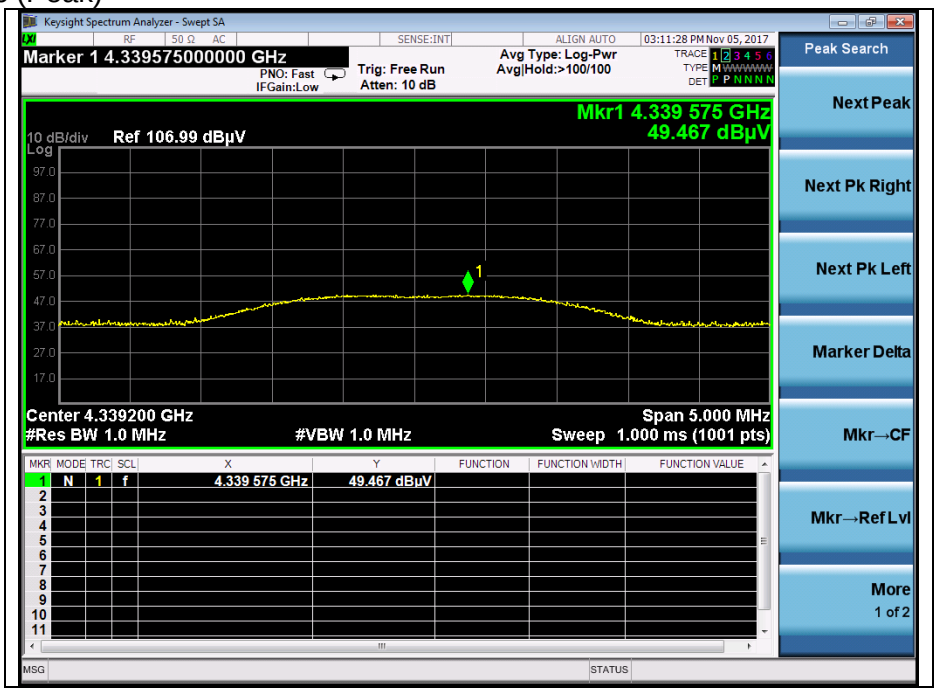
3rd Harmonic (Peak)



4th Harmonic (Peak)

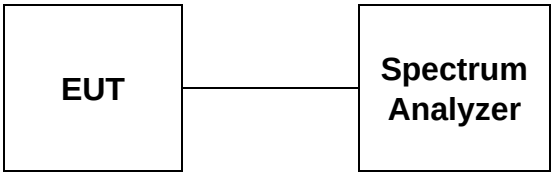


10th Harmonic (Peak)



3. Bandwidth of Operation Frequency

3.1. Test Setup



3.2. Limit

According to § 15.231(c), the bandwidth of the emission shall be no wider than 0.25 % of the center frequency for devices operating above 70 ㎒ and below 900 ㎒. For devices operating above 900 ㎒, the emission shall be no wider than 0.5 % of the center frequency. Bandwidth is determined at the points 20 ㏈ down from the modulated carrier.

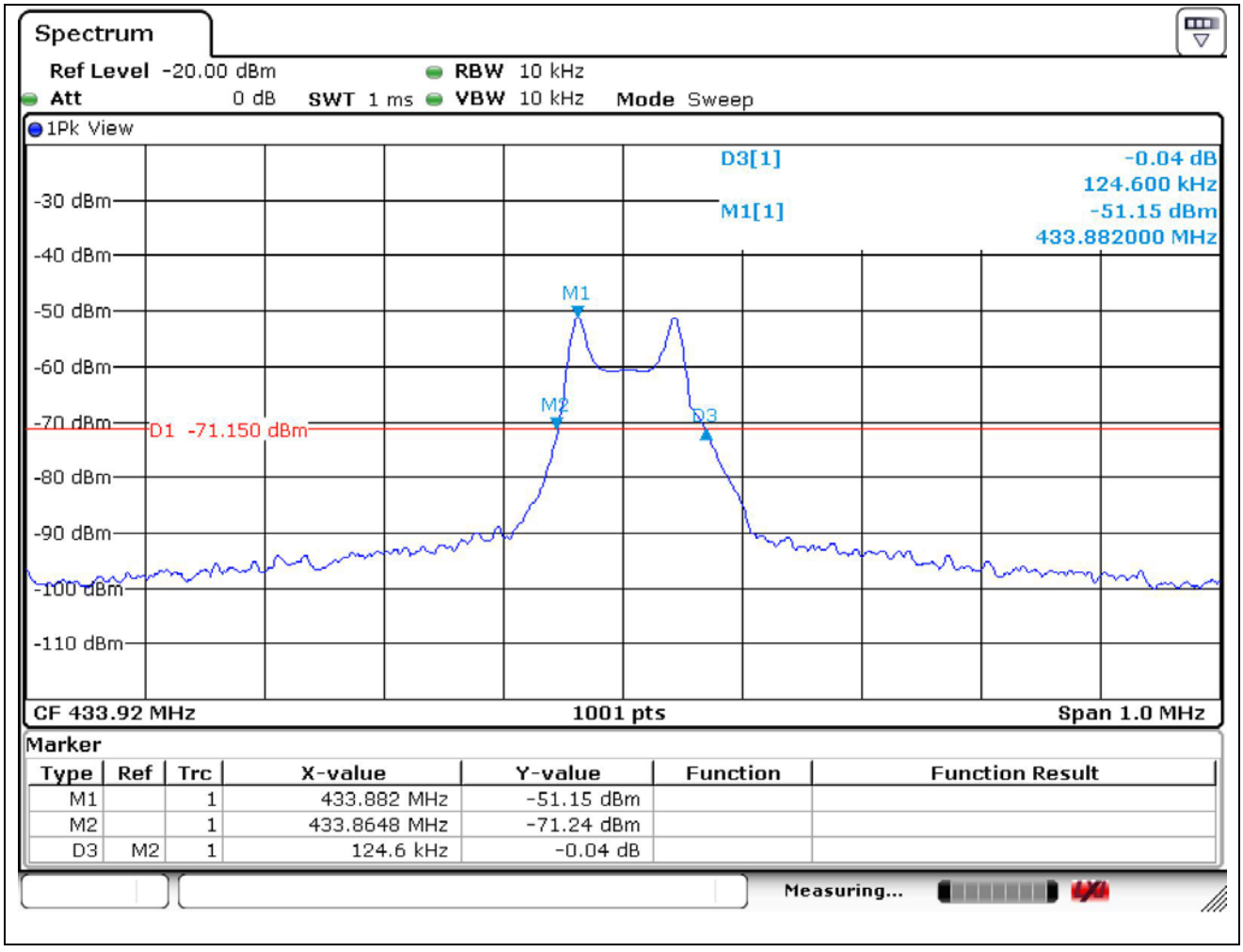
3.3. Test Procedure

1. The transmitter output is connected to the spectrum analyzer.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW = 10 ㎑, VBW = 10 ㎑ and Span = 1 ㎒.
3. The bandwidth of fundamental frequency was measured and recorded.

3.4. Test Result

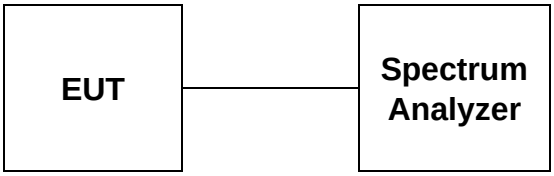
Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Carrier Frequency (㎒)	Bandwidth of Operation Frequency (㎑)	Limit (㎑)	Remark
433.92	124.60	1 084.80	The point 20 ㏈ down from the modulated carrier



4. Occupied Bandwidth

4.1. Test Setup



4.2. Limit

According to A.1.3 of RSS-210 Issue 9, the 99 % bandwidth of momentarily operated devices shall be less or equal to 0.25 % of the centre frequency for devices operating between 70 ㎒ and 900 ㎒. For devices operating above 900 ㎒, the 99 % bandwidth shall be less or equal to 0.5 % of the centre frequency.

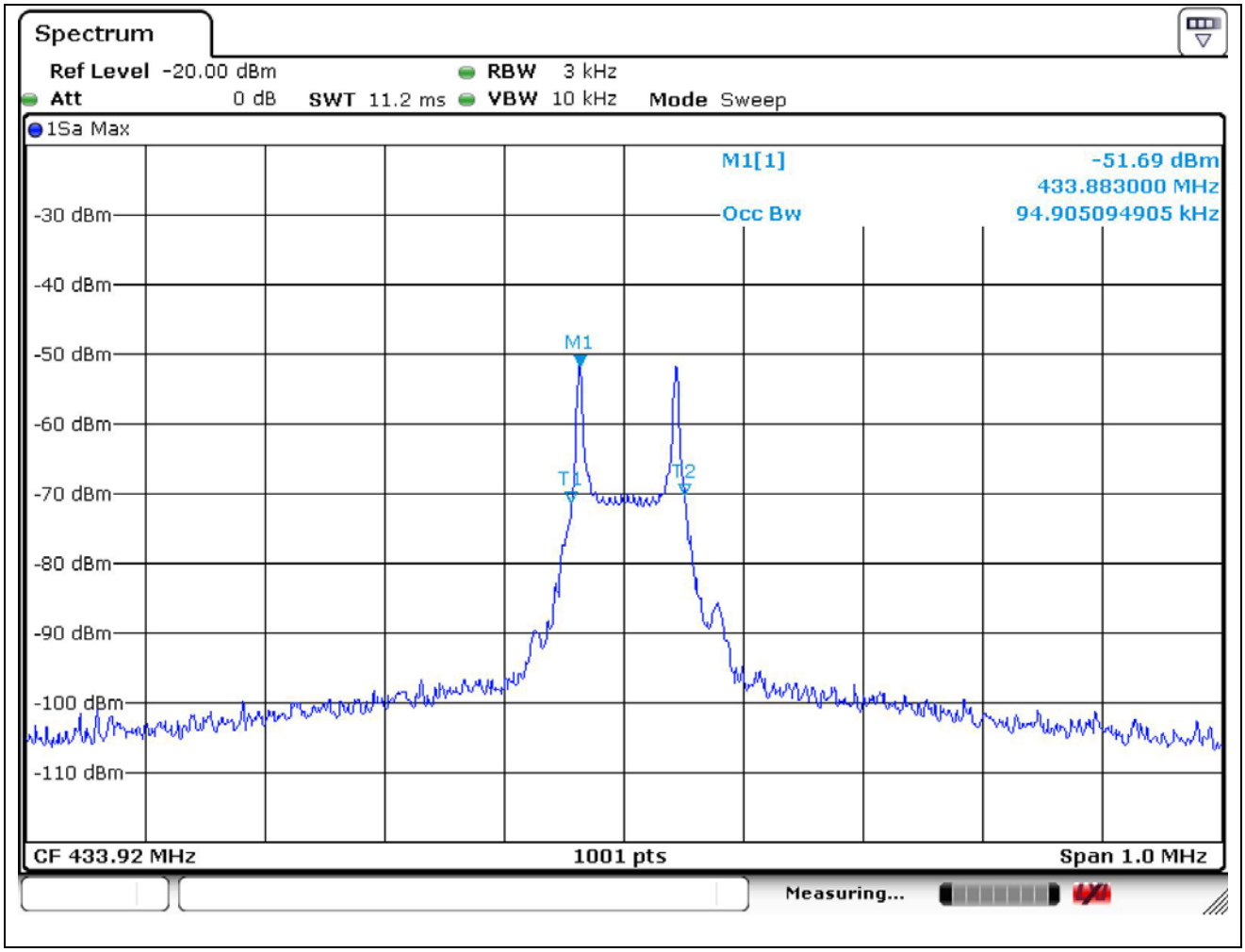
4.3. Test Procedure

1. The transmitter output is connected to the spectrum analyzer.
2. The resolution bandwidth (RBW) shall be in the range of 1 % to 5 % of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3 x RBW.
3. The bandwidth of fundamental frequency was measured and recorded.

4.4. Test Result

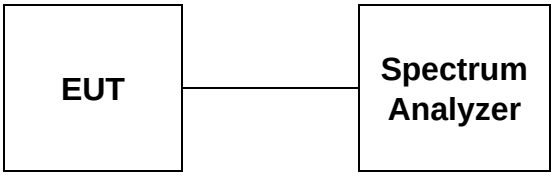
Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Carrier Frequency (㎒)	Occupied Bandwidth (㎑)	Limit (㎑)	Remark
433.92	94.905	1 084.80	99 % Occupied bandwidth



5. Transmission Time

5.1. Test Setup



5.2. Limit

5.2.1. FCC Limit

According to § 15.231(a)(1), a manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

5.2.2. IC Limit

According to A1.1 (a) of RSS-210 Issue 9, a manually operated transmitter shall be equipped with a push-to-operate switch and be under manual control at all times during transmission. When released, the transmitter shall cease transmission within no more than 5 seconds of being released.

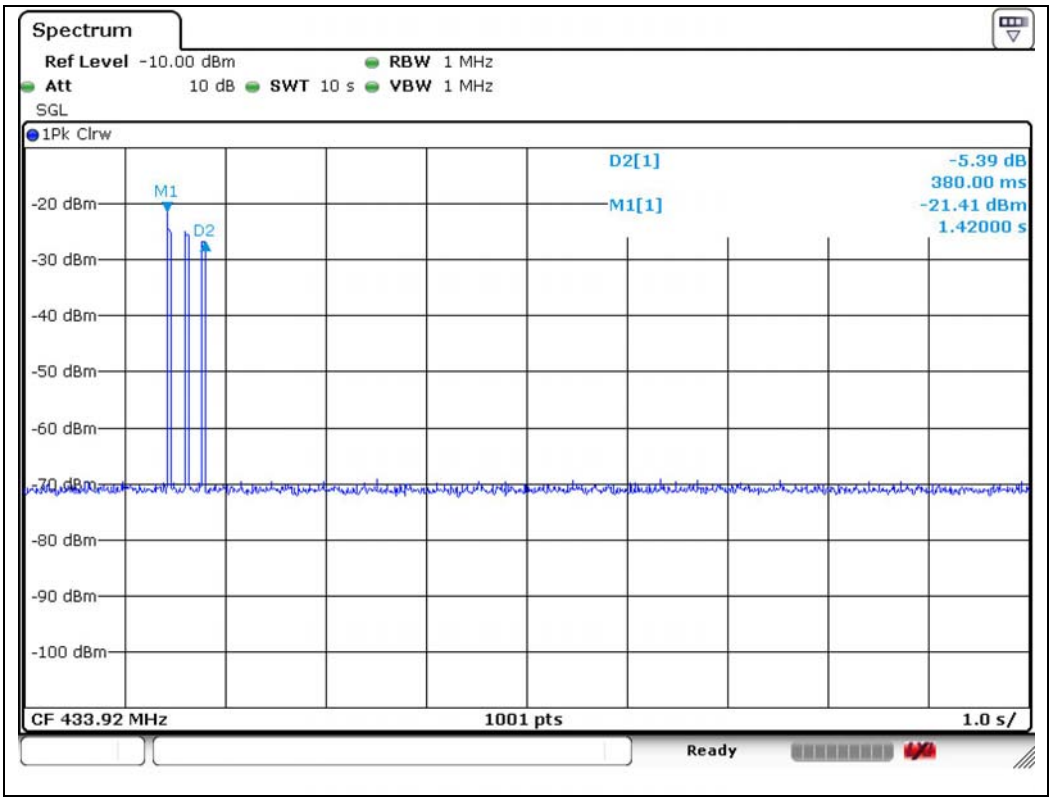
5.3. Test Procedure

1. The transmitter output is connected to the spectrum analyzer.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW = 1 ㎒, VBW = 1 ㎒, Span = 0 ㎐, Sweep Time = 10 sec.
3. The bandwidth of fundamental frequency was measured and recorded.

5.4. Test Result

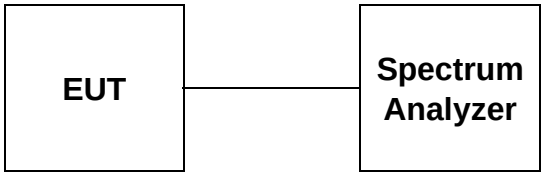
Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Carrier Frequency (㎒)	Transmission Time (sec)	Limit (sec)	Remark
433.92	0.38	Same or less than 5	Pass



6. Duty Cycle Correction Factor

6.1. Test Setup



6.2. Limit

None (No dedicated Limit specified in the Rules)

6.3. Test Procedure

1. The transmitter output is connected to the spectrum analyzer.
2. Set center frequency of spectrum analyzer = operating frequency.
3. Set the spectrum analyzer as RBW = 1 ㎒, VBW = Auto, Span = 0 ㎐, Sweep Time = 500 ㎳.

6.4. Test Result

Ambient temperature	:	(23 ± 1) ℃
Relative humidity	:	47 % R.H.

CALCULATION:

Average Reading = Peak Reading (dBμV/m) + 20log(Duty Cycle)

In order to determine possible Maximum Modulation percentage, alternations are made to the EUT.
We measured;

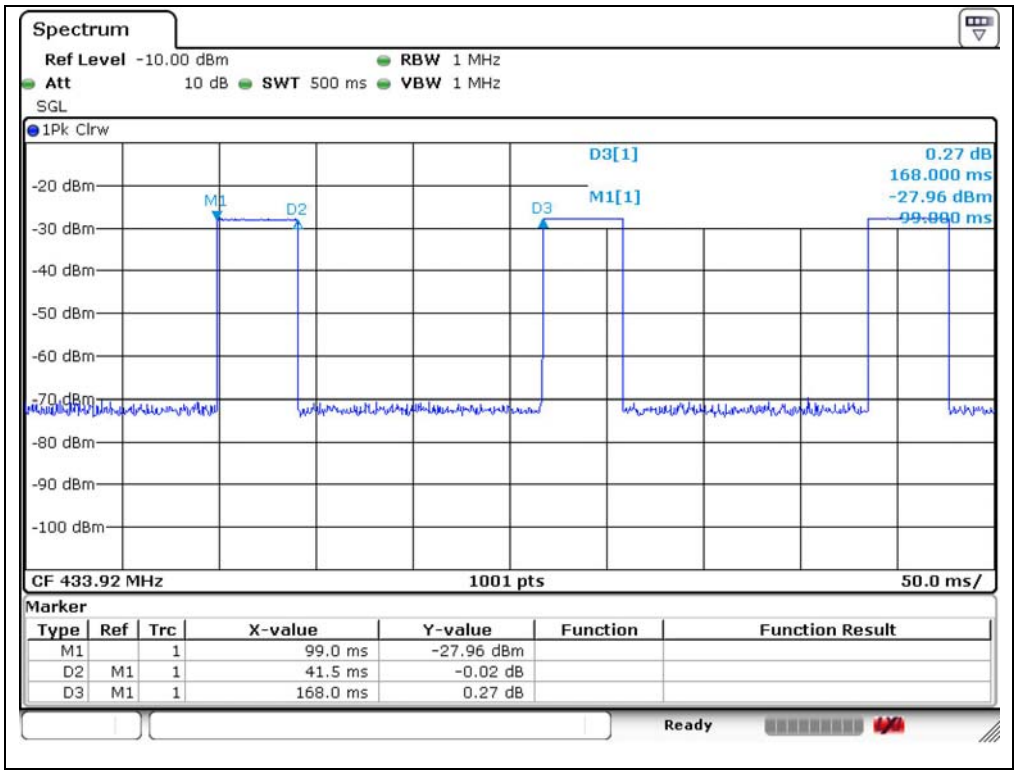
T_{on+off}	T_{on}	M % = (T_{on} / T_{on+off}) * 100 %	Duty Correction Factor
100 ㎳	41.50 ㎳	41.50	-7.64

T_{on+off} = 100 ㎳
T_{on} = 41.50 ㎳
Duty Cycle = 20log(T_{on} / T_{on+off}) = 20log(0.415) = -7.64

Remark:
- T_{on+off} > 100 ㎳. Use 100 ㎳ for calculation

6.5. Test Plot

-Duty Cycle of Continuous EUT



7. Antenna Requirement

7.1. Standard Applicable

For intentional device, according to FCC 47 CFR Section §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to FCC 47 CFR Section §15.247 (b) if transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the gain of the antenna exceeds 6 dBi.

7.2. Antenna Connected Construction

Antenna used in this product is PCB Pattern Antenna with gain of -12.60 dBi.

- End of the Test Report -