TEST REPORT

OF

FCC Part 15 Subpart C §15.209, §15.231
FCC ID : CQOFC00460

Equipment Under Test	:	Smart Key FOB
Model Name	:	FC00460
Applicant	:	DENSO KOREA ELECTRONICS CORPORATION
Manufacturer	:	DENSO KOREA ELECTRONICS CORPORATION
Date of Receipt	:	2017.02.07
Date of Test(s)	:	2017.02.17 ~ 2017.02.27
Date of Issue	:	2017.03.03

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

Tested By: **Aileen Jeong** **Date:** **2017.03.03**

Technical Manager: **Alvin Kim** **Date:** **2017.03.03**

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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 : DENSO KOREA ELECTRONICS CORPORATION
Address : 3, Chemdansaneop-ro, Masanhappo-gu, Changwon-si, Gyeongsangnam-do, Korea
Contact Person : Seong, Yun-Su
Phone No. : +82 55 220 9344

1.3. Description of EUT

Kind of Product	Smart Key FOB
Model Name	FC00460
Power Supply	DC 3.0 V (Lithium type of battery)
Frequency Range	Tx: 433.92 ㎒, Rx: 134.2 ㎑
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. 20, 2016	Annual	Jun. 20, 2017
Spectrum Analyzer	Agilent	N9020A	MY53421758	Sep. 23, 2016	Annual	Sep. 23, 2017
Spectrum Analyzer	R&S	FSW43	100637	Jul. 13, 2016	Annual	Jul. 13, 2017
Test Receiver	R&S	ESU26	100109	Feb. 17, 2017	Annual	Feb. 17, 2018
Preamplifier	H.P.	8447F	2944A03909	Aug. 11, 2016	Annual	Aug. 11, 2017
Preamplifier	R&S	SCU-18	10117	Apr. 07, 2016	Annual	Apr. 07, 2017
High Pass Filter	Wainwright Instrument GmbH	WHKX10-900-1000-18000-40SS	7	Apr. 06, 2016	Annual	Apr. 06, 2017
Loop Antenna	Schwarzbeck Mess-Elektronik	FMZB 1519	1519-0399	Aug. 19, 2015	Biennial	Aug. 19, 2017
Bilog Antenna	Schwarzbeck Mess-Elektronik	VULB9163	396	Jun. 18, 2015	Biennial	Jun. 18, 2017
Horn Antenna	R&S	HF906	100326	Feb. 01, 2016	Biennial	Feb. 01, 2018
Turn Table	Innco systems GmbH	DS 1200 S	N/A	N.C.R.	N/A	N.C.R.
Antenna Master	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	**Test Item**	**Result**
15.209(a) 15.231(b)	Radiated emission, Spurious Emission and Field Strength of Fundamental	Complied
15.231(c)	Bandwidth of Operation Frequency	Complied
15.231(a)	Transmission Time	Complied

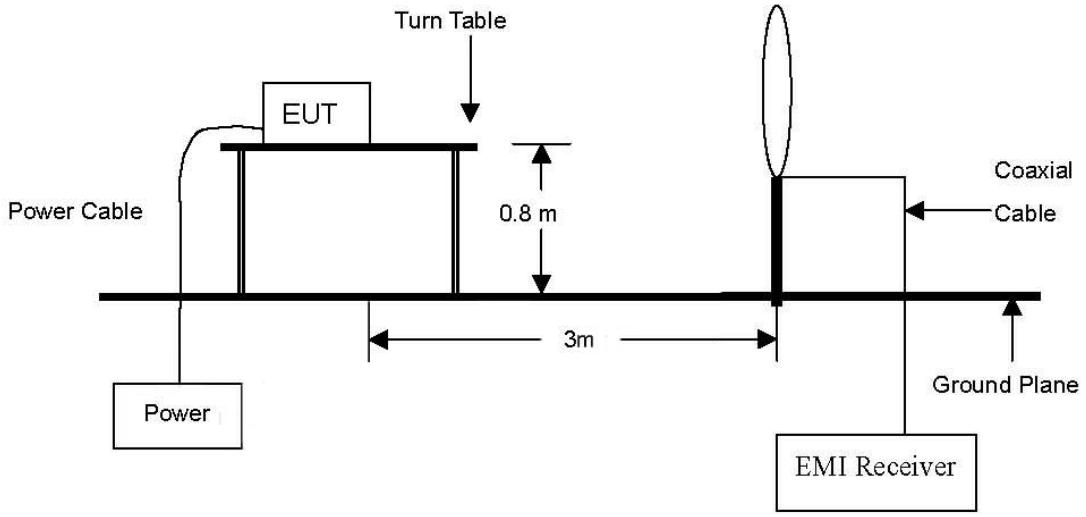
1.6. Test Report Revision

Revision	Report number	Date of issue	Description
0	F690501/RF-RTL010882	2017.03.03	Initial

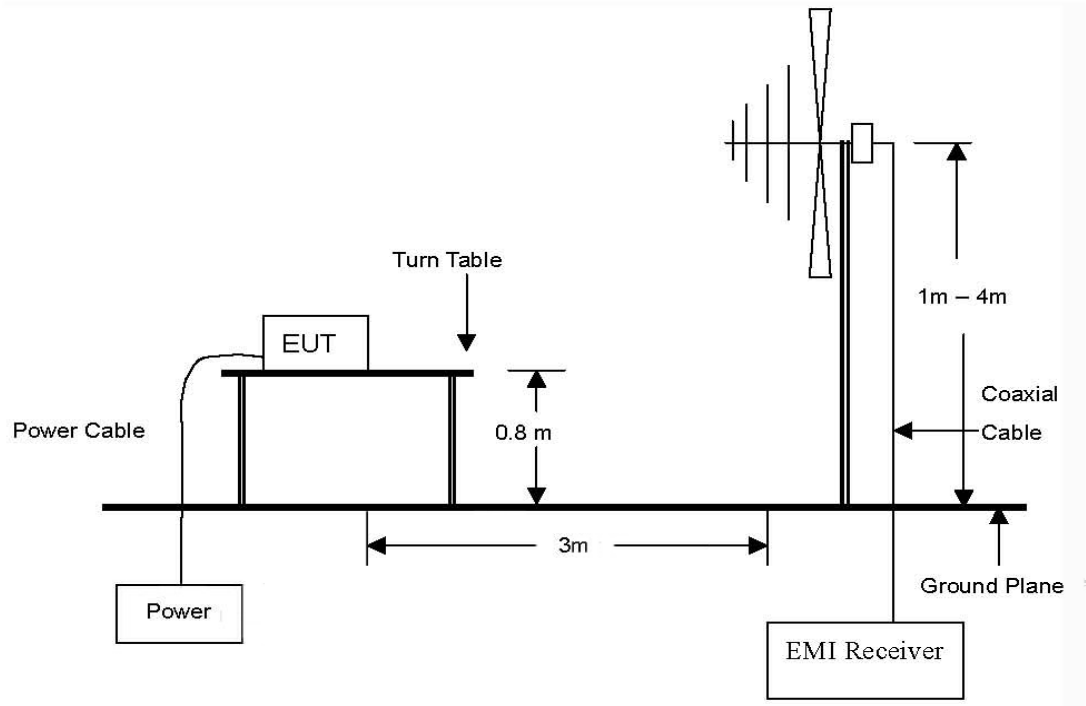
2. Field Strength of Fundamental and Spurious Emission

2.1. Test Setup

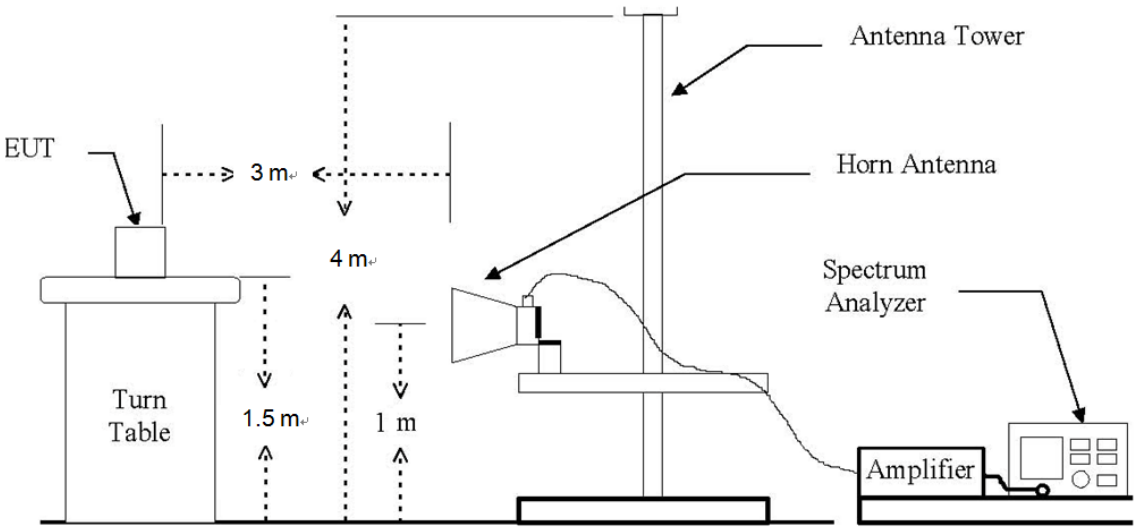
The diagram below shows the test setup that is utilized to make the measurements for emission below 30 ㎒ Emissions.



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. 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.

2.2.2. 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.

2.3. 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.

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 ㎓.
c. The resolution bandwidth of test receiver/spectrum analyzer is 1 ㎒ and the video bandwidth is 10 ㎐ for Average detection (AV) at frequency above 1 ㎓.

2.4. Test Result

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

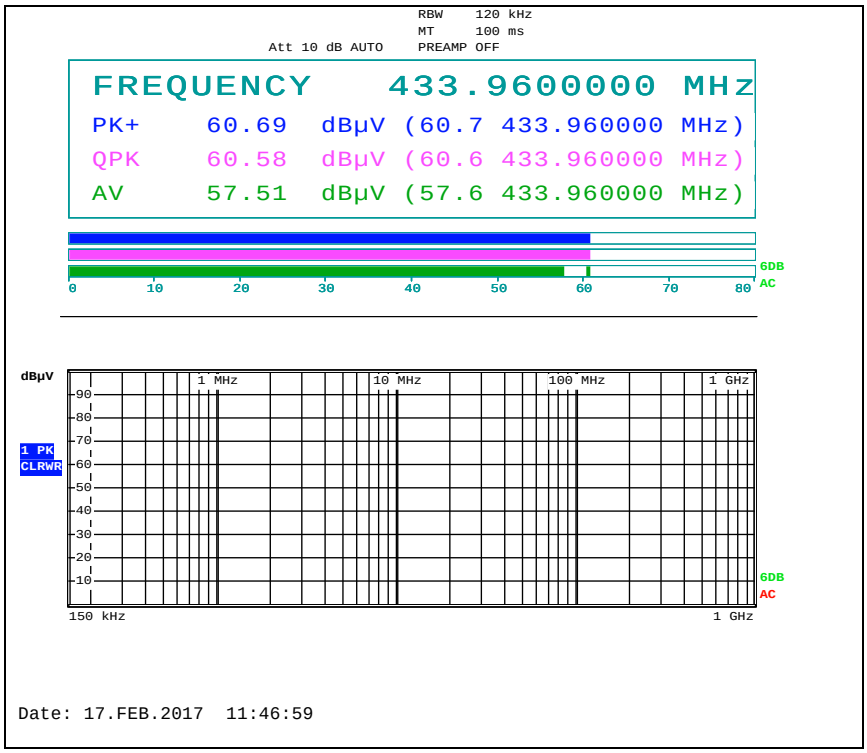
2.4.1. Field Strength of Fundamental

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)
433.96	Peak	V	60.70	17.12	2.58	80.40	100.83	20.43
433.96	Average	V	57.60	17.12	2.58	77.30	80.83	3.53

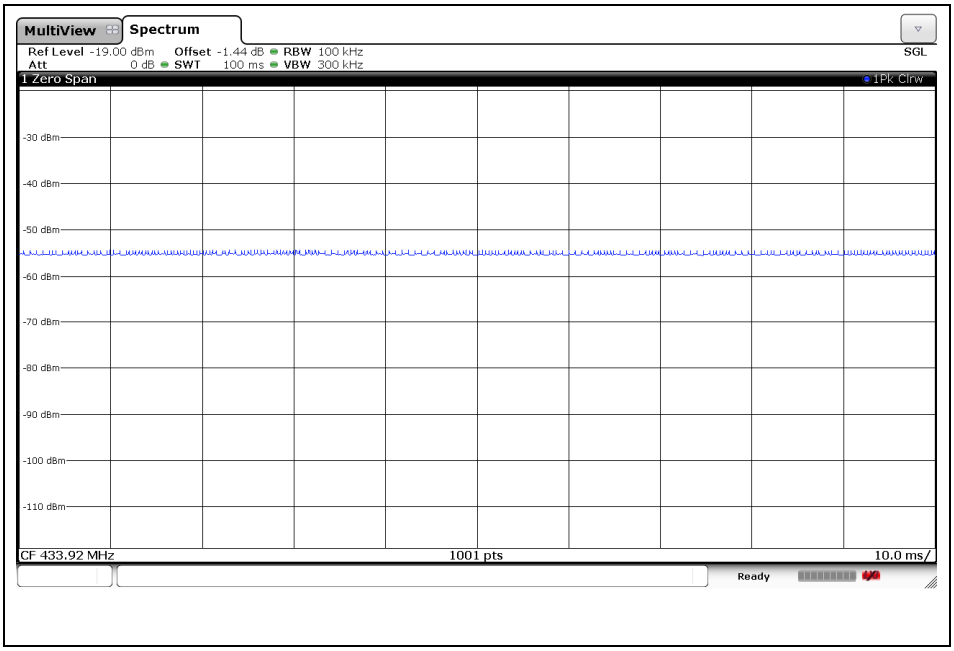
Remark:
To get a maximum emission level from the EUT, the EUT was moved throughout the X-axis, Y-axis and Z-axis. Worst case is Z-axis.
Definition of DUT for three orthogonal planes is described in the test setup photos.

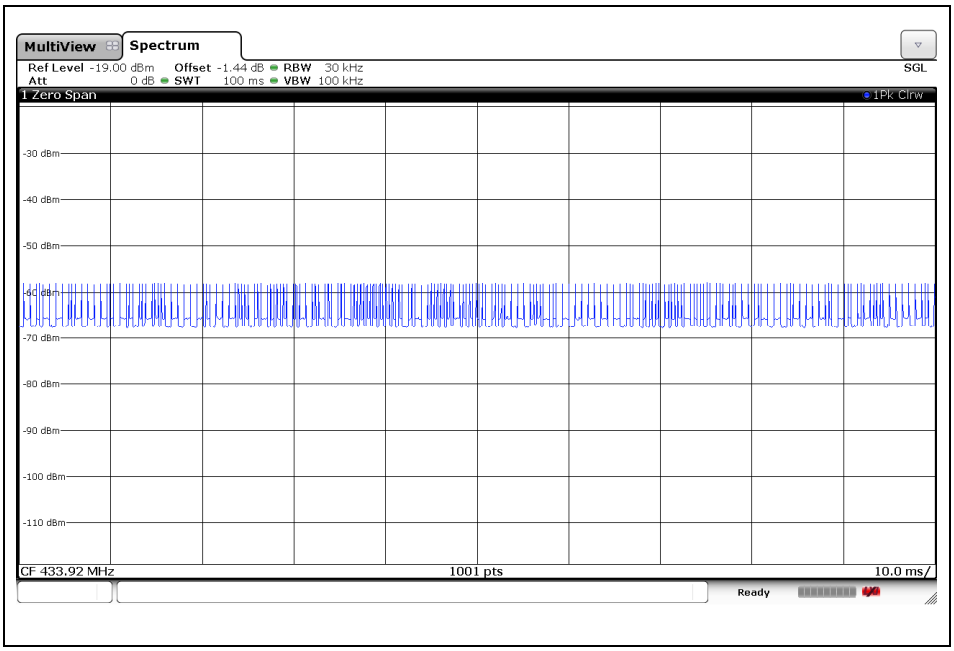
Note:
1. 3 m Limit (dB㎶/m) = 20log[41.67($F_{(㎒)}$) - 7083] = 80.83
2. Result = Reading + Antenna Factor + Cable Loss
3. Average Result = The average result was investigated due to Pulse train over 100 ㎳.



Remark;

-Although duty cycle is 100 %, there is 3.10 dB difference between peak and average because of ripple signal.





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.

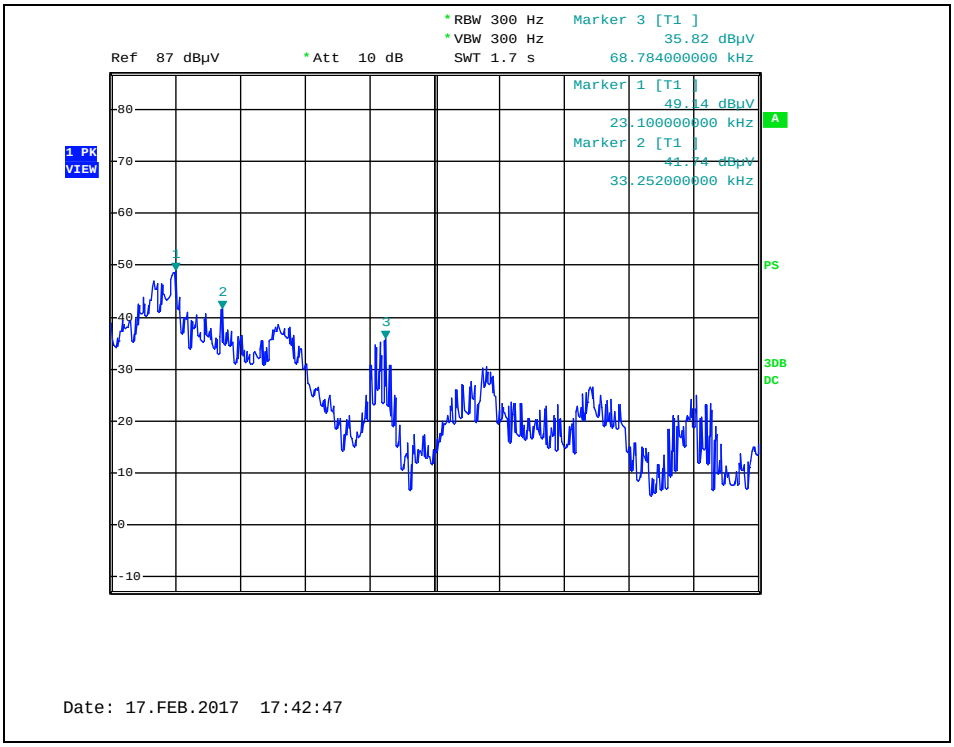
Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	Amp Gain + CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
3 471.57	47.62	Peak	H	30.98	-30.31	48.29	80.83	32.54
3 471.38	44.31	Average	H	30.98	-30.31	44.98	60.83	15.85
*3 905.18	48.42	Peak	H	31.91	-29.82	50.51	74.00	23.49
*3 905.27	45.42	Average	H	31.91	-29.82	47.51	54.00	6.49
*4 339.07	42.41	Peak	H	31.93	-31.01	43.33	74.00	30.67
*4 339.18	36.58	Average	H	31.93	-31.01	37.50	54.00	16.50

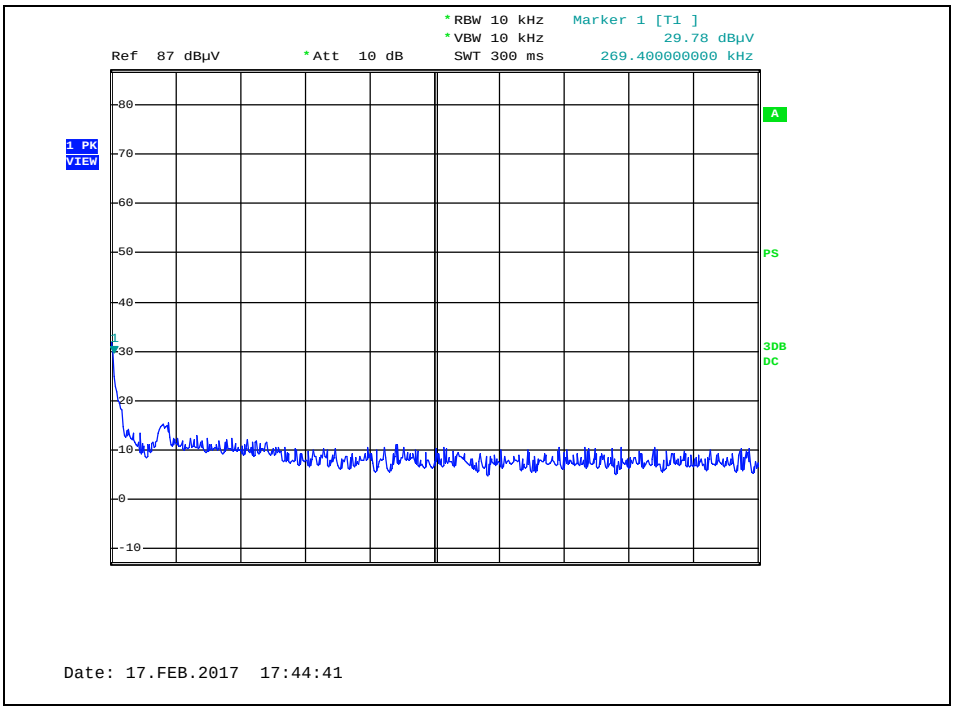
Remark:

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 Z-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. "*" means the restricted band.
6. Spurious Emission test results meet both peak and average limit.
7. According to § 15.31(o), Emission levels are not reported much lower than the limits by over 20 dB.

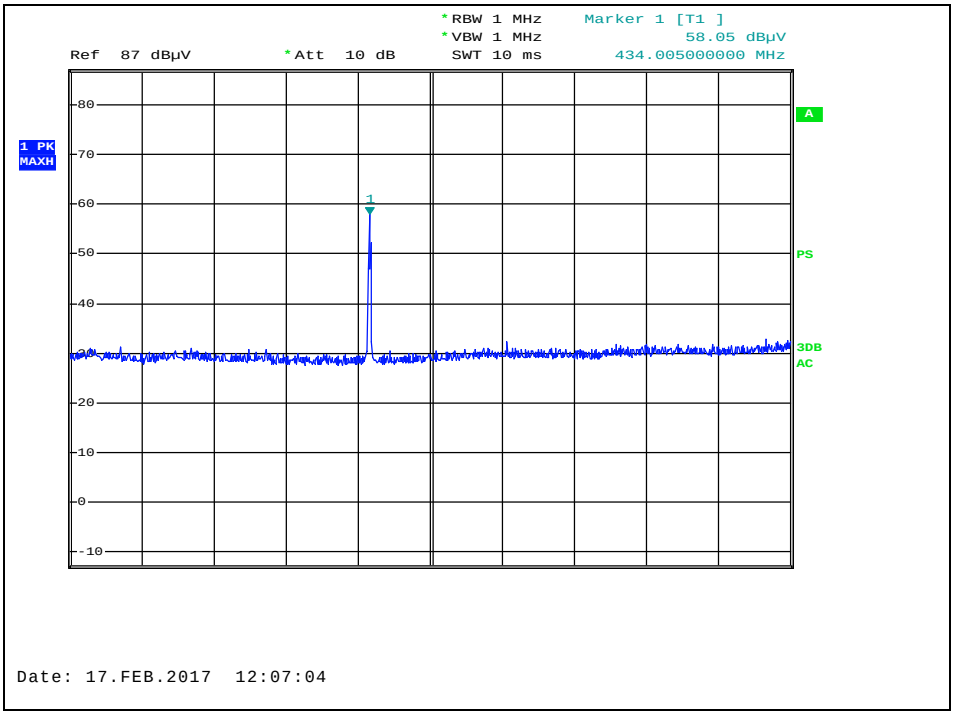
The Plots of Spurious Emission

Scanning plots below 30 ㎒



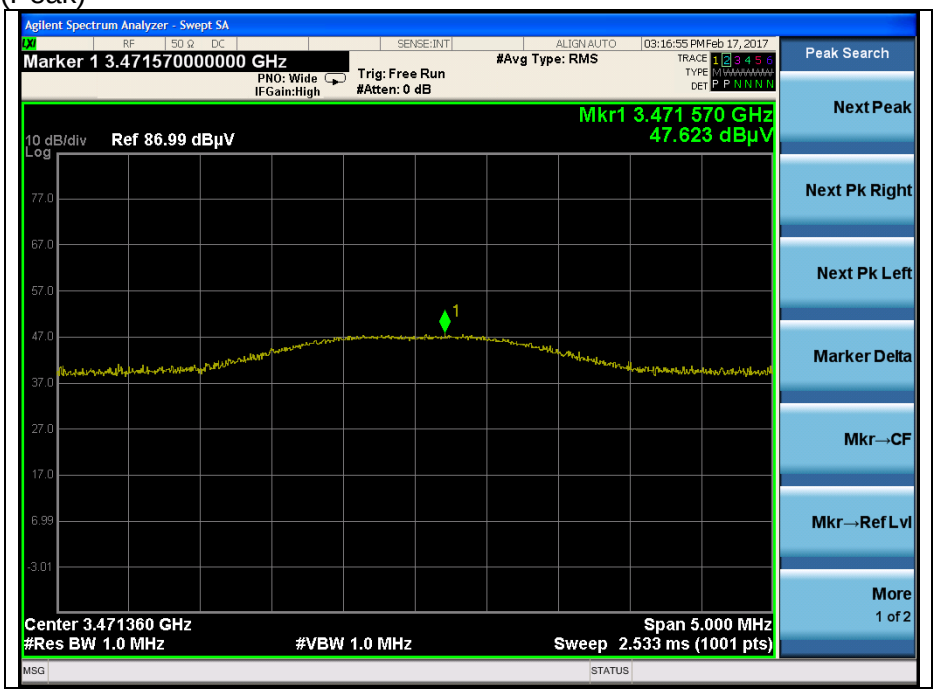


Scanning plots from 30 ㎒ to 1 000 ㎒

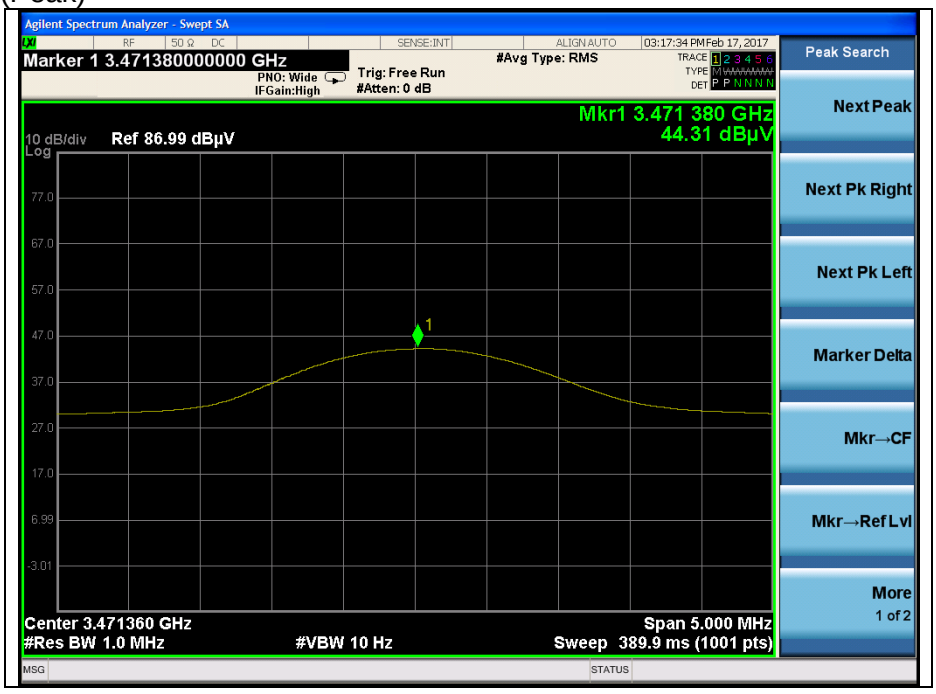


Scanning plots from 1 000 ㎒ to 4 500 ㎒

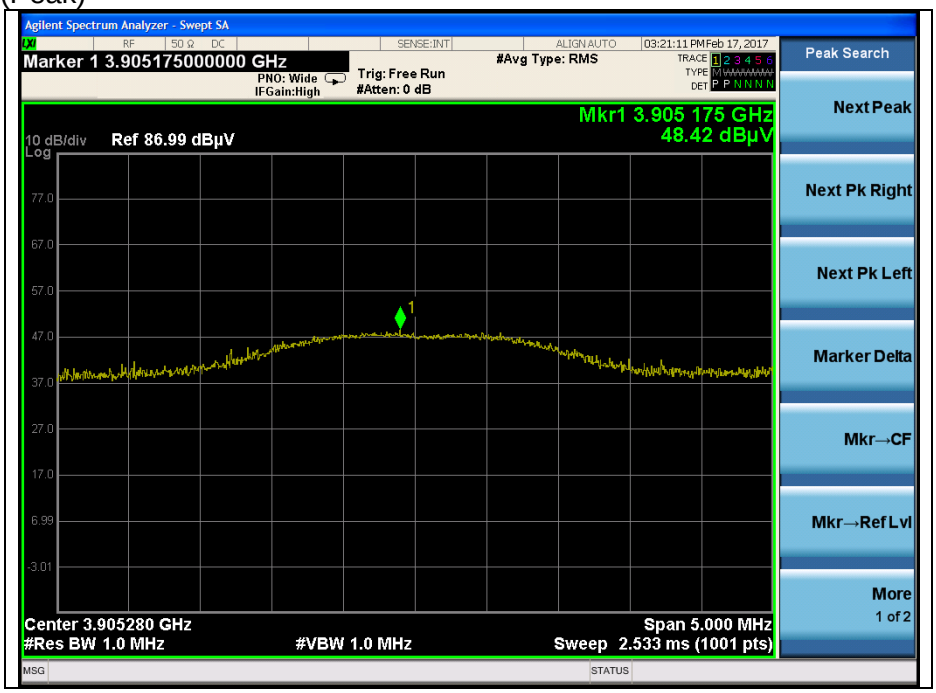
8th Harmonic (Peak)



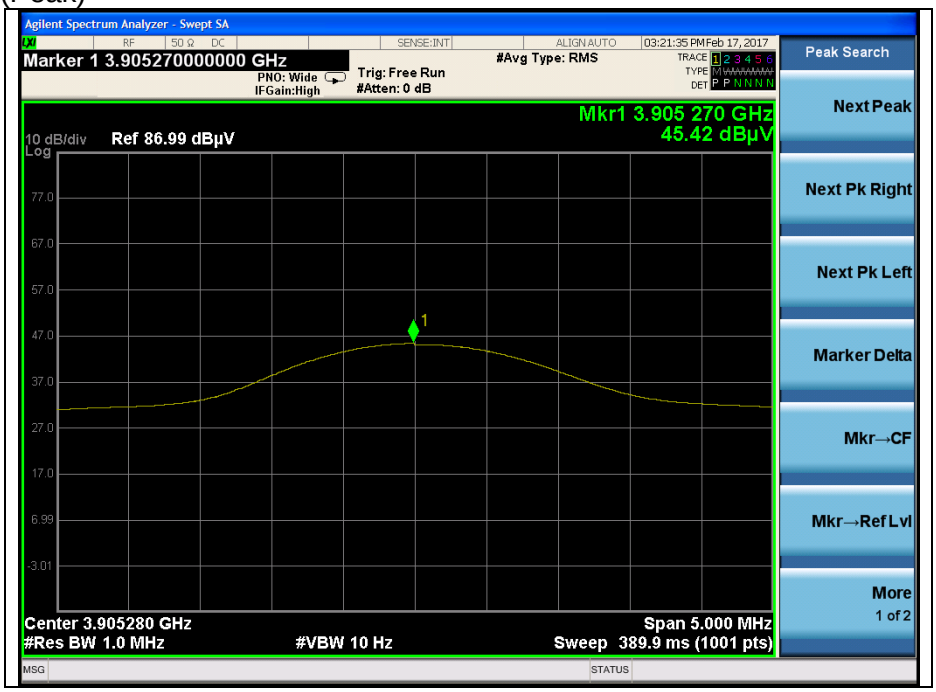
8th Harmonic (Peak)



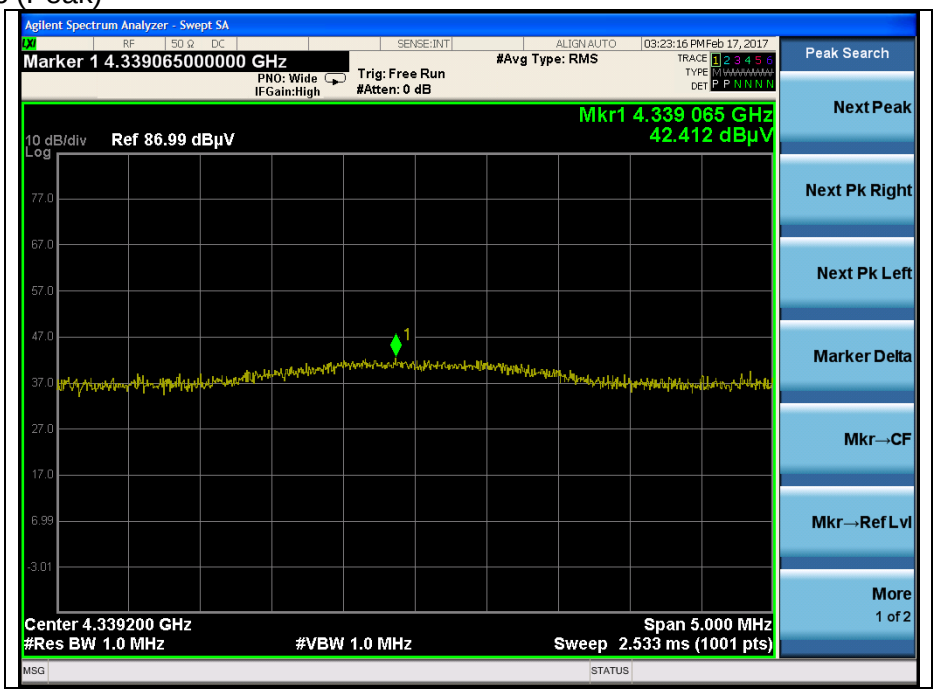
9th Harmonic (Peak)



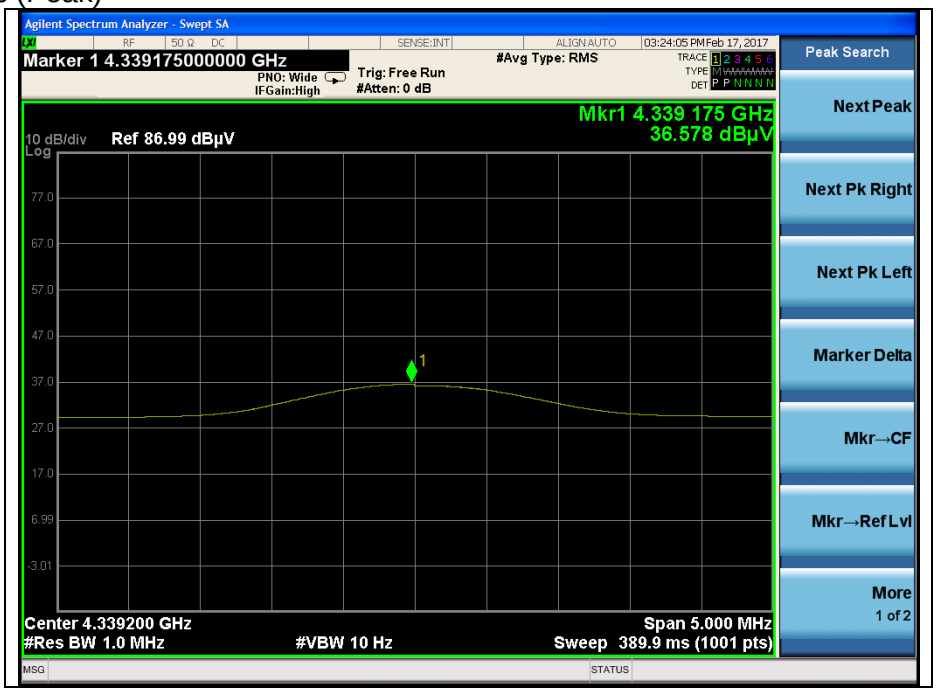
9th Harmonic (Peak)



10th Harmonic (Peak)

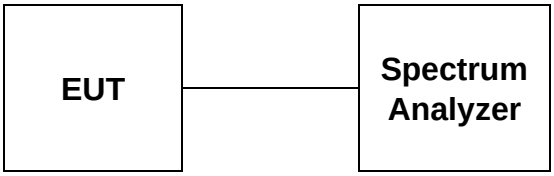


10th Harmonic (Peak)



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.

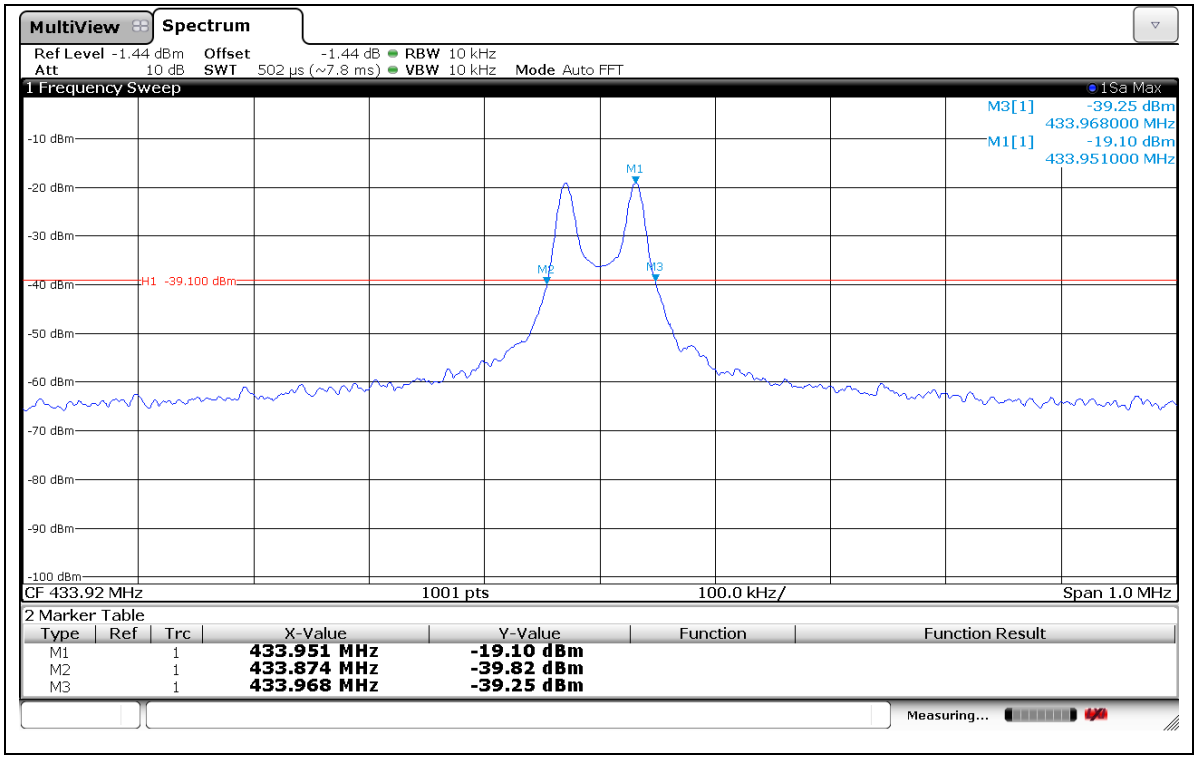
3.3. Test Procedure

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

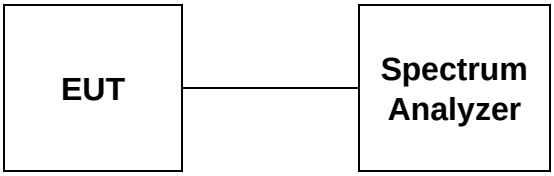
Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Carrier Frequency (㎒)	Bandwidth of Operation Frequency (㎑)	Limit (㎑)	Remark
433.92	94	1 084.80	The point 20 ㏈ down from the modulated carrier



4. Transmission Time

5.1. Test Setup



4.2. 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.

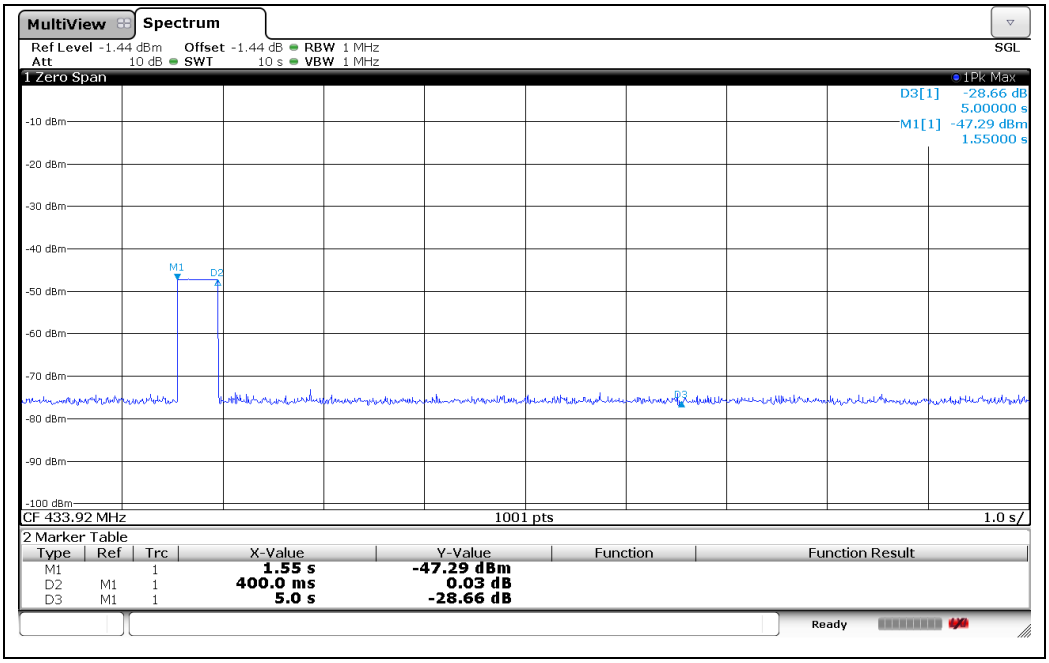
4.3. Test Procedure

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.

4.4. Test Result

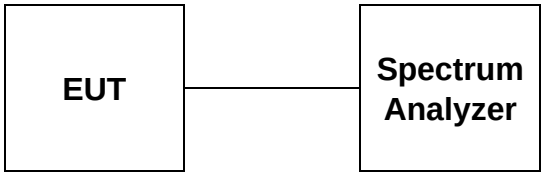
Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Carrier Frequency (㎒)	Transmission Time (sec)	Limit (sec)	Remark
433.92	0.40	Same or less than 5	Pass



5. Duty Cycle Correction Factor

5.1. Test Setup



5.2. Limit

None (No dedicated Limit specified in the Rules)

5.3. 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 = 1 ㎒, Span = 0 ㎐, Sweep Time = 100 ㎳.

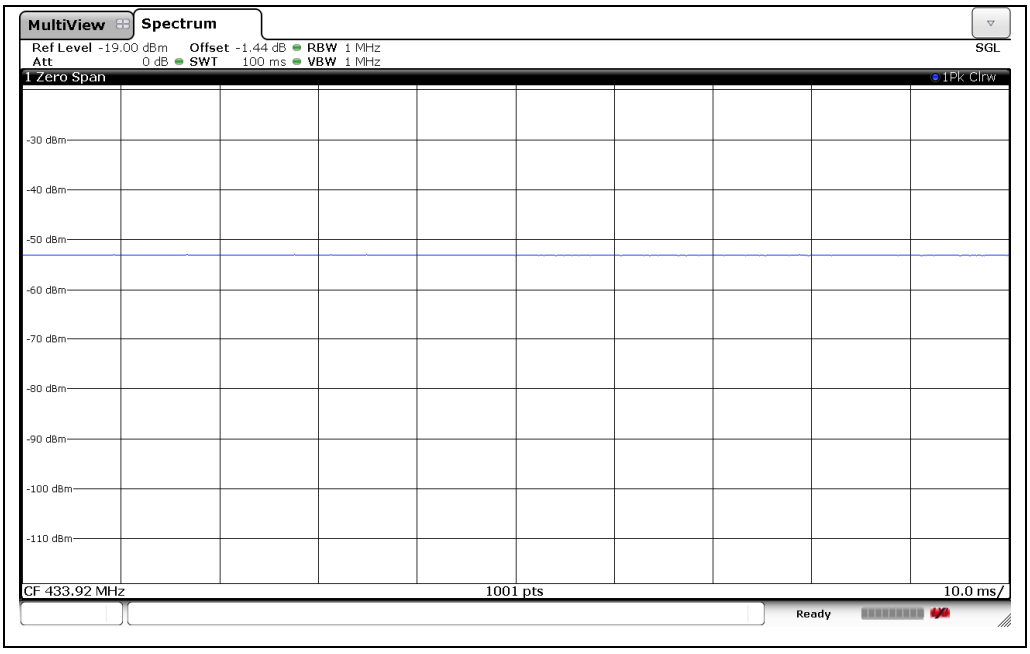
5.4. Test Result

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

Remark:

T_{on+off} > 100 ㎳. Use 100 ㎳ for calculation
T_{on} > 100 ㎳. Use 100 ㎳ for calculation
Duty Cycle Correction Factor = 20log (T_{on} / T_{on+off}) = 20log(1) = 0

Test Plot



- End of the Test Report -