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TEST REPORT

of

FCC Part 15 Subpart C §15.209 and §15.231
IC RSS-210 Issue 10 and RSS-Gen Issue 5

FCC ID: CQOFD01240
IC Certification: 1551E-FD01240

Equipment Under Test	:	Smart Key FOB
Model Name	:	FD01240
Variant Model Name(s)	:	-
Applicant	:	DENSO Korea Corporation
Manufacturer	:	DENSO Korea Corporation
Date of Receipt	:	2021.02.09
Date of Test(s)	:	2020.02.15 ~ 2021.02.25
Date of Issue	:	2021.03.03

In the configuration tested, the EUT complied with the standards specified above. This test report does not assure KOLAS accreditation.

1) The results of this test report are effective only to the items tested.
2) The SGS Korea is not responsible for the sampling, the results of this test report apply to the sample as received.
3) This test report cannot be reproduced, except in full, without prior written permission of the Company.

Tested by: Nancy Park

Technical Manager: Jinhyoung Cho

SGS Korea Co., Ltd. Gunpo Laboratory

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1. General Information

1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)
- 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- 4, LS-ro 182beon-gil. Gunpo-si, Gyeonggi-do, Korea, 15807
- Designation number: KR0150

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 Corporation
Address : 3, Cheomdansaneop-ro, Masanhappo-gu, Chang-won-si, Gyeongsangnam-do, Korea, 51176
Contact Person : Ha, Chang-su
Phone No. : +82 55 220 9321

1.3. Details of Manufacturer

Company : Same as above
Address : Same as above

1.4. Description of EUT

Kind of Product	Smart Key FOB
Model Name	FD01240
Serial Number	42000-01240
Power Supply	DC 3.0 V
Frequency Range	Tx: 433.92 ㎒, Rx: 125.00 ㎑
Modulation Type	FSK
Number of Channel	1
Antenna Type	PCB Pattern Antenna
Antenna Gain	-21.62 ㏈i
H/W Version	1.0
S/W Version	1.0

1.5. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Interval	Cal. Due
Signal Generator	R&S	SMBV100A	255834	Jun. 03, 2020	Annual	Jun. 03, 2021
Spectrum Analyzer	R&S	FSV30	100768	Mar. 04, 2020	Annual	Mar. 04, 2021
Spectrum Analyzer	Agilent	N9020A	MY53421758	Sep. 04, 2020	Annual	Sep. 04, 2021
DC Power Supply	Agilent	U8002A	MY50020026	Dec. 01, 2020	Annual	Dec. 01, 2021
Preamplifier	H.P.	8447F	2944A03909	Aug. 06, 2020	Annual	Aug. 06, 2021
Signal Conditioning Unit	R&S	SCU-18	10117	Jun. 10, 2020	Annual	Jun. 10, 2021
High Pass Filter	Mini-Circuits	NHP-800+	V8207600724	Mar. 04, 2020	Annual	Mar. 04, 2021
High Pass Filter	Wainwright Instrument GmbH	WHKX10-900-1000-18000-40SS	7	Mar. 04, 2020	Annual	Mar. 04, 2021
Loop Antenna	Schwarzbeck Mess-Elektronik	FMZB 1519	1519-039	Aug. 22, 2019	Biennial	Aug. 22, 2021
Bilog Antenna	Schwarzbeck Mess-Elektronik	VULB 9163	396	Mar. 21, 2019	Biennial	Mar. 21, 2021
Horn Antenna	R&S	HF906	100326	Feb. 04, 2021	Annual	Feb. 04, 2022
Test Receiver	R&S	ESU26	100368	Nov. 05, 2020	Annual	Nov. 05, 2021
Turn Table	Innco systems GmbH	DS 1200 S	N/A	N.C.R.	N/A	N.C.R.
Controller	Innco systems GmbH	CONTROLLER CO3000-4P	CO3000/963/38 330516/L	N.C.R.	N/A	N.C.R.
Antenna Mast	Innco systems GmbH	MA4640-XP-ET	MA4640/536/38 330516/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.
Coaxial Cable	RFONE	MWX221-NMSNMS (4 m)	J1023142	Dec. 01, 2020	Semi-annual	Jun. 01, 2021
Coaxial Cable	RFONE	PL520-NMNM-10M (10 m)	20200324001	Dec. 01, 2020	Semi-annual	Jun. 01, 2021
Coaxial Cable	Rosenberger	LA1-C006-1500	131014 01/20	Feb. 19, 2021	Semi-annual	Aug. 19, 2021

Note;

Operating software of EUT has integrated test interface. No additional software was used.

1.6. Summary of Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARD: FCC Part15 subpart C, IC RSS-210 Issue 10 and RSS-Gen Issue 5			
Section in FCC	**Section in IC**	**Test Item(s)**	**Result**
15.209(a) 15.231(b)	RSS-210 Issue 10 A.1, Table A1 RSS-Gen Issue 5 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 10 A.1.1	Transmission Time	Complied
-	RSS-210 Issue 10 A.1.3 RSS-Gen Issue 5 6.7	Occupied Bandwidth	Complied
15.207	RSS-Gen Issue 5 8.8	AC Power Line Conducted Emission	N/A[1)]

Note;

1) The AC power line test was not performed because the EUT use battery power for operation and which do not operate from the AC power lines.

1.7. Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

Parameter	Uncertainty	
Radiated Emission, 9 ㎑ to 30 ㎒	H	± 3.66 ㏈
	V	± 3.66 ㏈
Radiated Emission, below 1 ㎓	H	± 4.90 ㏈
	V	± 4.82 ㏈
Radiated Emission, above 1 ㎓	H	± 3.62 ㏈
	V	± 3.64 ㏈

Uncertainty figures are valid to a confidence level of 95 %.

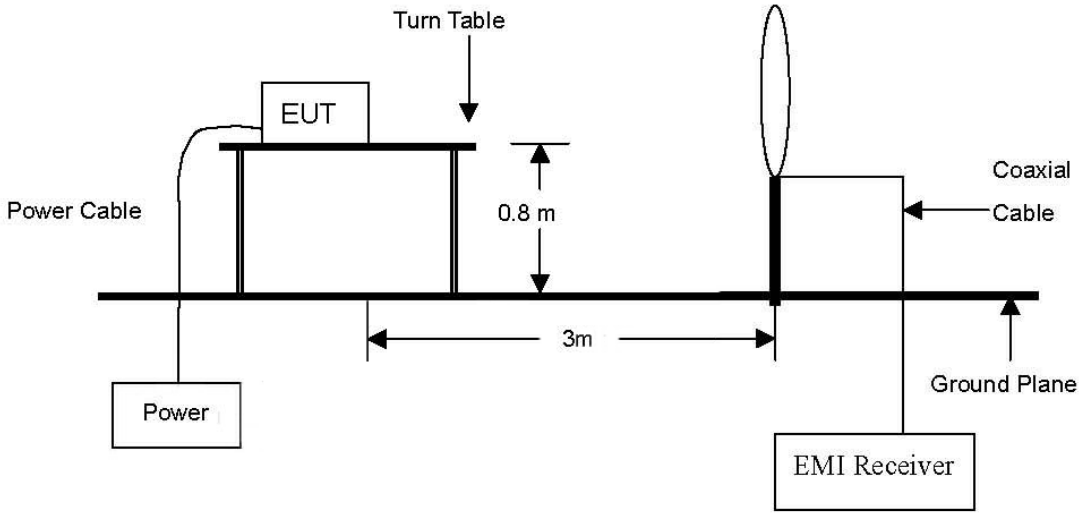
1.8. Test Report Revision

Revision	Report Number	Date of Issue	Description
0	F690501-RF-RTL001751	2021.03.03	Initial

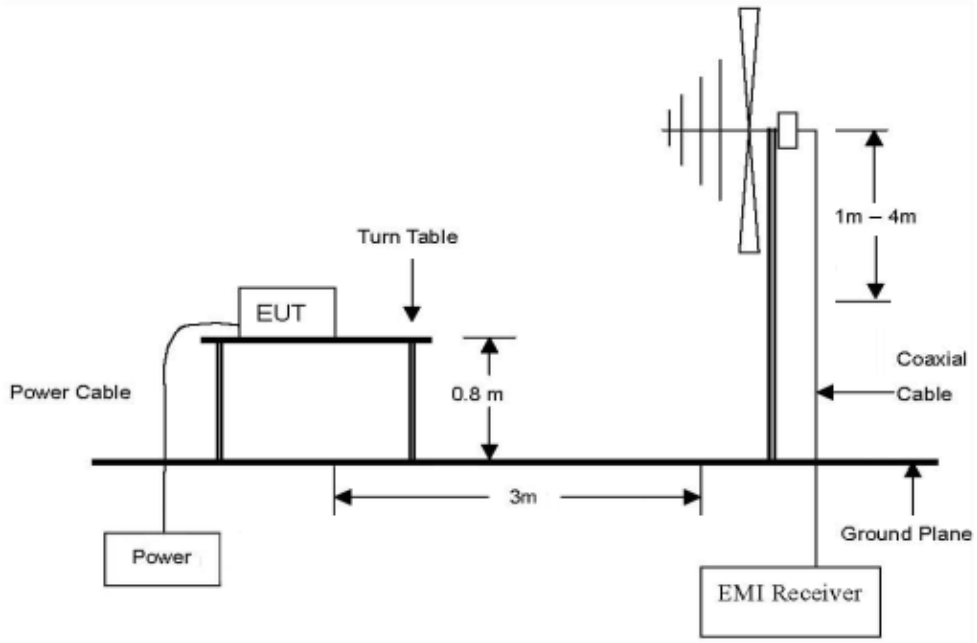
2. Field Strength of Fundamental and Spurious Emission

2.1. Test Setup

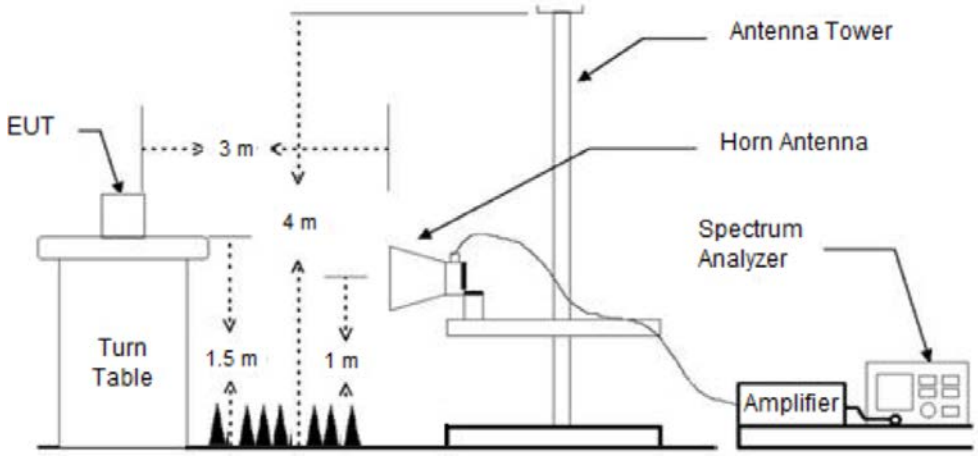
The diagram below shows the test setup that is utilized to make the measurements for emission below 30 ㎒.



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



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

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

2.2.2.1. Transmitter Emission Limits

According to RSS-Gen Issue 5, 8.9.
Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

Table 5 - General field strength limits at frequencies above 30 ㎒

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

Table 6 - General field strength limits at frequencies below 30 ㎒

Frequency	Magnetic Field Strength (H-Field) (㎂/m)	Measurement Distance (m)
9-490 ㎑ [1]	6.37/F (F in ㎑)	300
490-1 705 ㎑	63.7/F (F in ㎑)	30
1.705-30 ㎒	0.08	30

Note 1: The emission limits for the ranges 9-90 ㎑ and 110-490 ㎑ are based on measurements employing a linear average detector.

2.2.2.2. Momentarily Operated Devices

According to A.1 of RSS-210 Issue 10.
The operation of momentarily operated devices is permitted in the bands specified in tables A1 and A2 of this annex, but is prohibited in the restricted frequency bands listed in RSS-Gen.

The frequency bands and field strength limits in tables A1 and A2 are reserved exclusively for the transmission of a control signal, such as those 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**	3,750
260-470**	3,750 to 12,500*
Above 470	12,500

* Linear interpolation with frequency, f, in ㎒:

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

** Frequency bands 225-328.6 ㎒ and 335.4-399.9 MHz 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.

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.

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

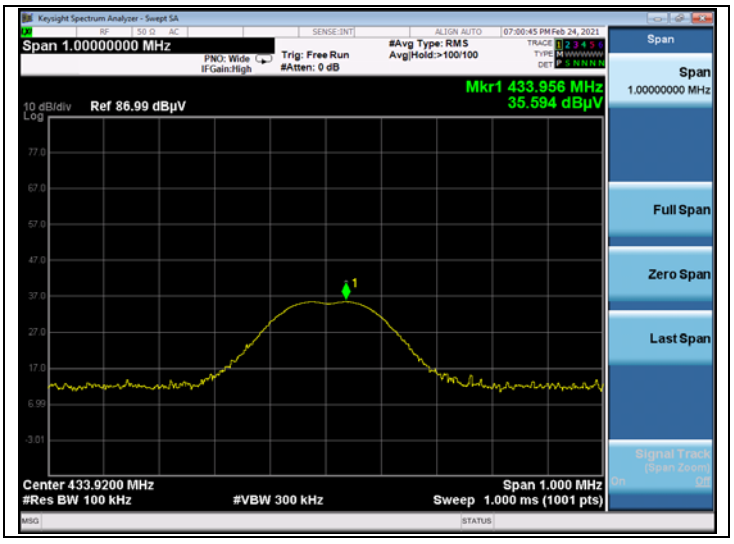
All emissions tested both horizontal and vertical. The following table shows the highest levels of radiated emissions on the worst polarization.

Frequency (㎒)	Reading (dB㎶)	Detect Mode	Ant. Pol.	AF (dB/m)	CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
433.96	35.59	Peak	H	22.18	2.58	60.35	100.83	40.48
433.96	-	Average	H	-	-	60.35	80.83	20.48

Remark;

1. To get a maximum emission level from the EUT, the EUT is manipulated through three orthogonal planes (X, Y, Z). Worst orthogonal plan of EUT 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] = 80.83
3. Peak Result = Reading + Antenna Factor + Cable Loss
4. Average Result = Peak Result + DF
5. DF (Duty Cycle Correction Factor): 20log (T_{on} / 100 ㎳) = 20log (100 / 100) = 0
   - T_{on} > 100 ㎳. Used 100 ㎳ for calculation.
   - T_{on+off} > 100 ㎳. Used 100 ㎳ for calculation.

- Test plot



2.4.2. Radiated Spurious Emission

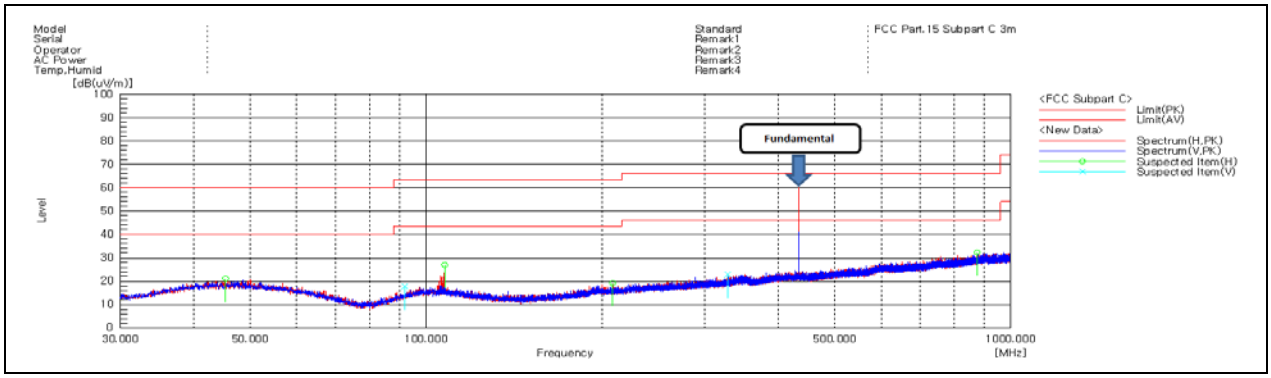
The following table shows the highest levels of radiated emissions.
The frequency spectrum from 9 ㎑ to 4 400 ㎒ was investigated.

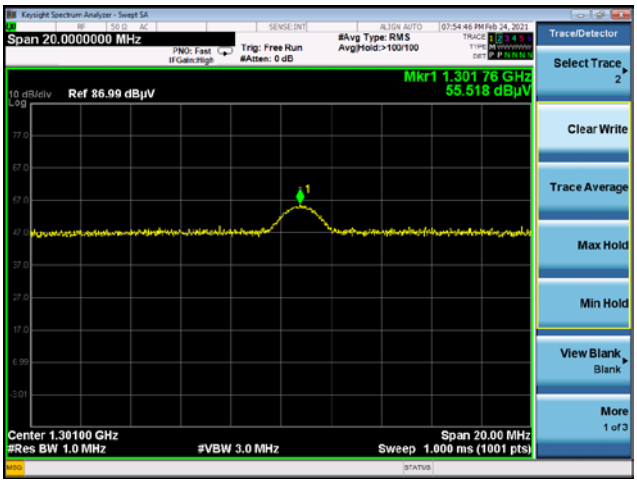
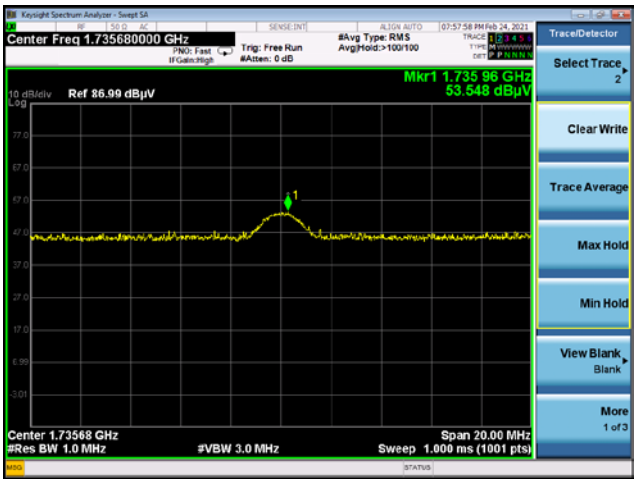
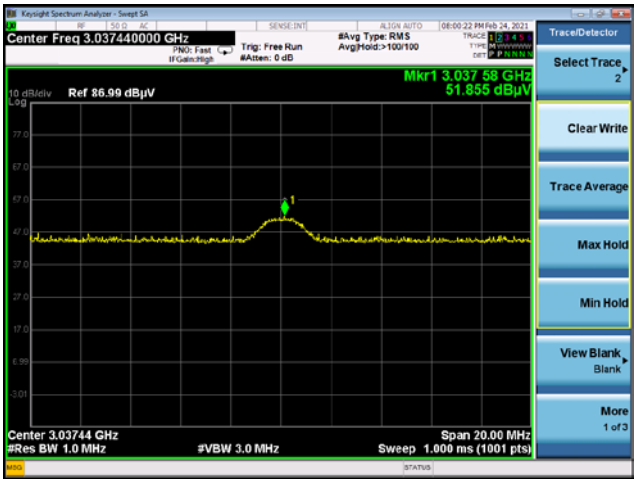
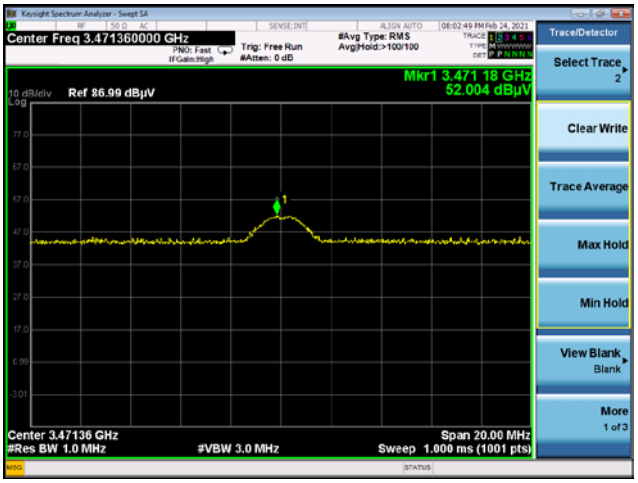
Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Ant. Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*1 301.76	55.52	Peak	H	25.00	-40.71	39.81	74.00	34.19
1 735.96	53.55	Peak	H	26.73	-39.89	40.39	80.83	40.44
3 037.58	51.86	Peak	V	29.93	-37.67	44.12	80.83	36.71
3 471.18	52.00	Peak	H	30.98	-37.54	45.44	80.83	35.39
*3 905.70	48.61	Peak	H	32.02	-36.90	43.73	74.00	30.27
*4 339.06	48.36	Peak	H	32.18	-36.26	**44.28**	74.00	29.72

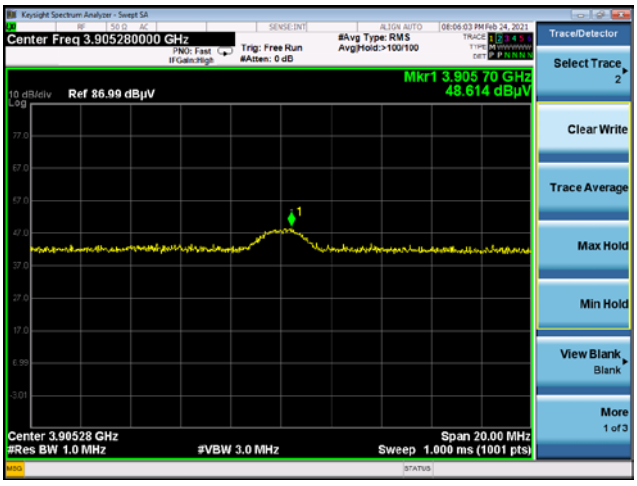
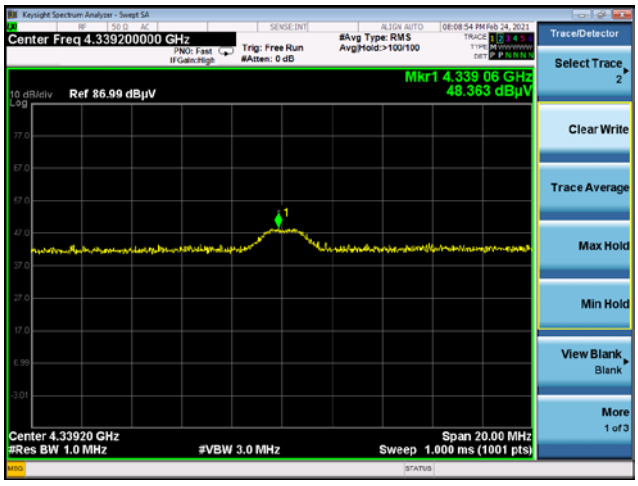
Remark;

1. To get a maximum emission level from the EUT, the EUT is manipulated through three orthogonal planes (X, Y, Z).
   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 + CL.
4. Peak Result = Reading + Correction Factors.
5. Average Result = Peak Result + DF.
6. DF (Duty Cycle Correction Factor): 20log (T_{on} / 100 ㎳) = 20log (100 / 100) = 0
   - T_{on} > 100 ㎳. Used 100 ㎳ for calculation.
   - T_{on+off} > 100 ㎳. Used 100 ㎳ for calculation.
7. "*" means the restricted band.
8. According to § 15.31(o), Emission levels are not reported much lower than the limits by over 20 dB.
9. The maximized peak measured value complies with the average limit, to perform an average measurement is unnecessary.

- Test plots

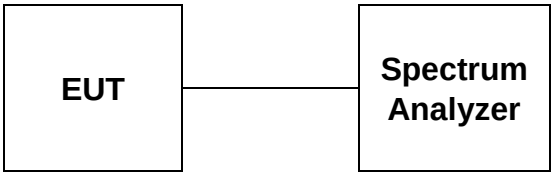


3rd harmonic	4th harmonic
	
7th harmonic	8th harmonic
	

9th harmonic	10th harmonic
	

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

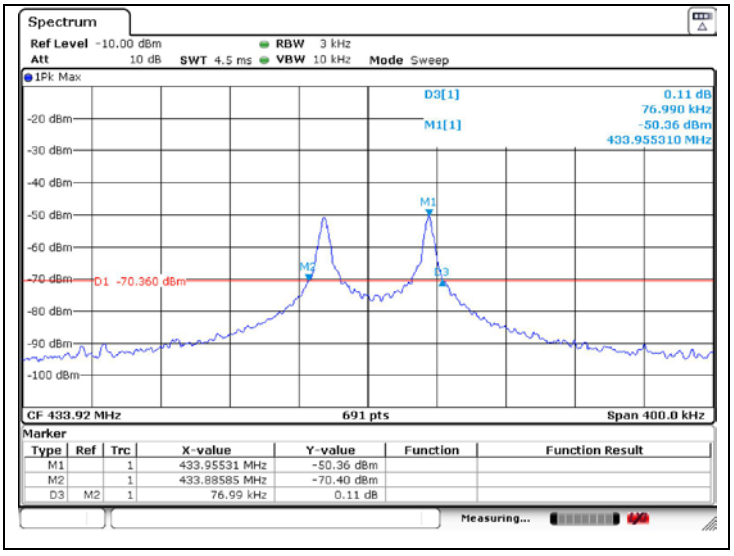
1. The transmitter output is connected to the spectrum analyzer.
2. The resolution bandwidth (RBW) shall be in the range of 1 % to 5 % of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3 x RBW.
3. The bandwidth of fundamental frequency was measured and recorded.

3.4. Test Result

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

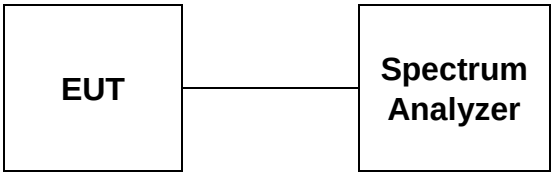
Frequency (㎒)	Bandwidth of Operation Frequency (㎑)	Limit (㎑)	Remark
433.92	76.99	1 084.80	The point 20 ㏈ down from the modulated carrier

- Test plot



4. Occupied Bandwidth

4.1. Test Setup



4.2. Limit

According to A.1.3 of RSS-210 Issue 10, the occupied bandwidth of momentarily operated devices shall be less than or equal to 0.25 % of the centre frequency for devices operating between 70 ㎒ and 900 ㎒. For devices operating above 900 ㎒, the occupied bandwidth shall be less than or equal to 0.5 % of the centre frequency.

4.3. Test Procedure

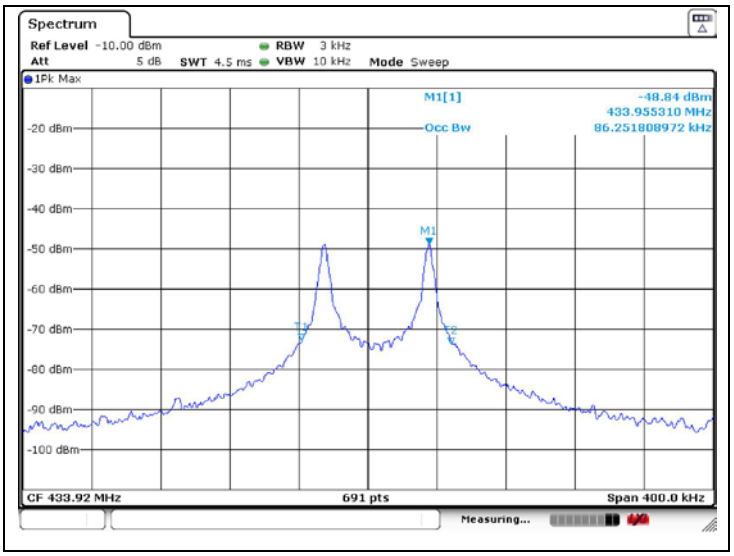
1. The transmitter output is connected to the spectrum analyzer.
2. The resolution bandwidth (RBW) shall be in the range of 1 % to 5 % of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3 x RBW.
3. The bandwidth of fundamental frequency was measured and recorded.

4.4. Test Result

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

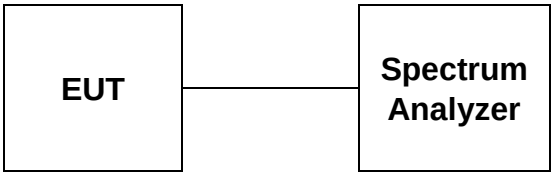
Frequency (㎒)	Occupied Bandwidth (㎑)	Limit (㎑)	Remark
433.92	86.25	1 084.80	99 % Occupied bandwidth

- Test plot



5. Transmission Time

5.1. Test Setup



5.2. Limit

5.2.1. FCC

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

According to A.1.1(a) of RSS-210 Issue 10, 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

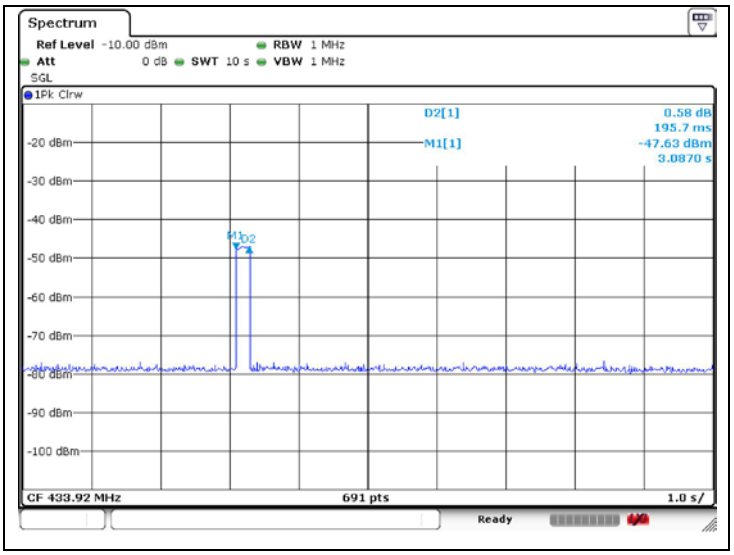
1. The transmitter output is connected to the spectrum analyzer.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW = 1 ㎒, VBW = 1 ㎒, Span = 0 ㎐, Sweep Time = 10 sec.
3. The bandwidth of fundamental frequency was measured and recorded.

5.4. Test Result

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

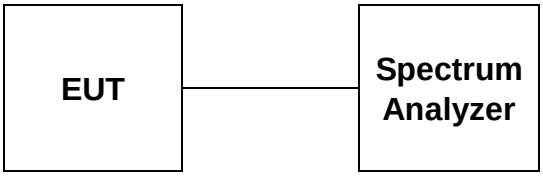
Frequency (㎒)	Transmission Time (sec)	Limit (sec)	Remark
433.92	0.20	Same or less than 5	Pass

- Test plot



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 = 1 sec.

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;

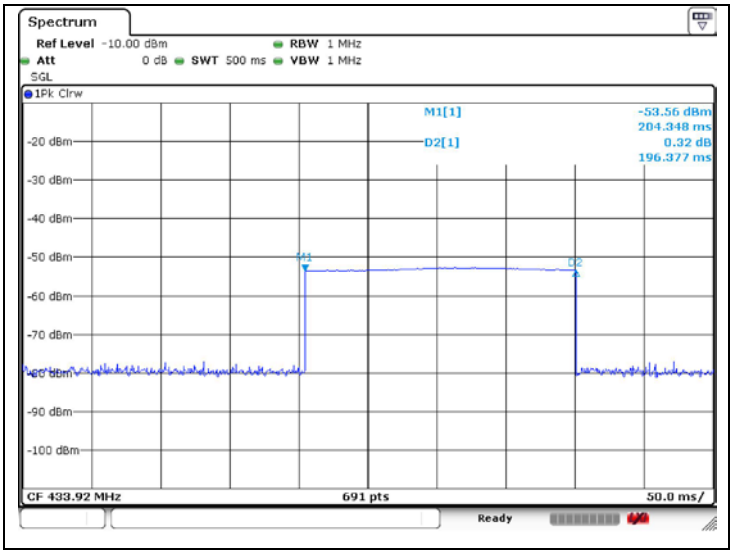
T_{on+off}	T_{on}	M % = (T_{on} / T_{on+off}) * 100 %	Duty Correction Factor
100 ㎳	100 ㎳	100	0

T_{on+off} = 100 ㎳.
T_{on} = 100 ㎳.
Duty Cycle = 20log (T_{on} / T_{on+off}) = 20log (1) = 0 dB.

Remark;

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

- Test plot



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.

7.2. Antenna Connected Construction

Antenna used in this product is PCB Pattern Antenna with gain of -21.62 dBi.

- End of the Test Report -