TEST REPORT

OF

FCC Part 15 Subpart C §15.209, §15.231
FCC ID: TQ8- FOB-4F04

Equipment Under Test	:	Remote Keyless Entry
Model Name	:	FOB-4F04
Applicant	:	Hyundai Mobis Co., Ltd.
Manufacturer	:	ALPS Electric Korea Co., Ltd.
Date of Test(s)	:	2014.06.25 ~ 2014.07.14
Date of Issue	:	2014.07.16

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

Tested By: **Youngmin Park** **Date:** **2014.07.16**

Approved By: **Hyunchae You** **Date:** **2014.07.16**

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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, 435-837

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.

Phone No. : + 82 31 688 0901
Fax No. : + 82 31 688 0921

1.2. Details of Applicant

Applicant	:	Hyundai Mobis Co., Ltd.
Address	:	203, Teheran-ro, Gangnam-gu, Seoul, 135-977 Republic of Korea
Contact Person	:	Choi, Seung-Hoon
Phone No.	:	+82 31 260 0098
Fax No.	:	+82 31 899 1788

1.3. Description of EUT

Kind of Product	Remote Keyless Entry
Model Name	FOB-4F04
Power Supply	DC 3.0 V (Lithium type of battery)
Frequency Range	Tx: 433.92 ㎒, Rx : 125.00 ㎑
Modulation Type	FSK
Number of Channels	1
Antenna Type	PCB Pattern Antenna

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1.4. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal Date	Cal Interval	Cal Due.
Signal Generator	Agilent	E4440A	MY43362142	Apr. 15, 2014	Annual	Apr. 15, 2015
Spectrum Analyzer	Agilent	N9030A	US51350132	Oct. 08, 2013	Annual	Oct. 08, 2014
Spectrum Analyzer	R&S	FSV30	100768	Mar. 27, 2014	Annual	Mar. 27, 2015
DC power Supply	Agilent	U8002A	MY48490027	Jan. 03, 2014	Annual	Jan. 03, 2015
Attenuator	Mini-Circuits	BW-N20W5+	0950-4	Jan. 08, 2014	Annual	Jan. 08, 2015
Preamplifier	H.P.	8447D	2944A07087	Jan. 06, 2014	Annual	Jan. 06, 2015
Preamplifier	R&S	SCU-18	10117	Jan. 14, 2014	Annual	Jan. 14, 2015
High Pass Filter	Mini-Circuits	NHP-800+	V8207600724	Mar. 24, 2014	Annual	Mar. 24, 2015
High Pass Filter	Wainwright	WHK3.0/18G-10SS	344	Jun. 10, 2014	Annual	Jun. 10, 2015
Test Receiver	R&S	ESU26	100109	Mar. 04, 2014	Annual	Mar. 04, 2015
Loop Antenna	R&S	HFH2-Z2	100118	Jul. 12, 2013	Biennial	Jul. 12, 2015
Bilog Antenna	SCHWARZBECK	VULB9163	396	Jun. 07, 2013	Biennial	Jun. 07, 2015
Horn Antenna	R&S	HF906	100326	Dec. 10, 2013	Biennial	Dec. 10, 2015
Antenna Master	INN-CO	MM4000	N/A	N.C.R.	N/A	N.C.R.
Turn Device	DE-3600-RH	INN-CO	N/A	N.C.R.	N/A.	N.C.R.
Turn Table	INN-CO	DS 1200S	N/A	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.

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1.5. Summary of Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARD : FCC Part 15 Subpart C §15.209, §15.231		
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
-	Occupied Bandwidth	Complied

1.6. Test Report Revision

Revision	Report number	Date of issue	Description
0	F690501/RF-RTL007821	2014.07.16	Initial

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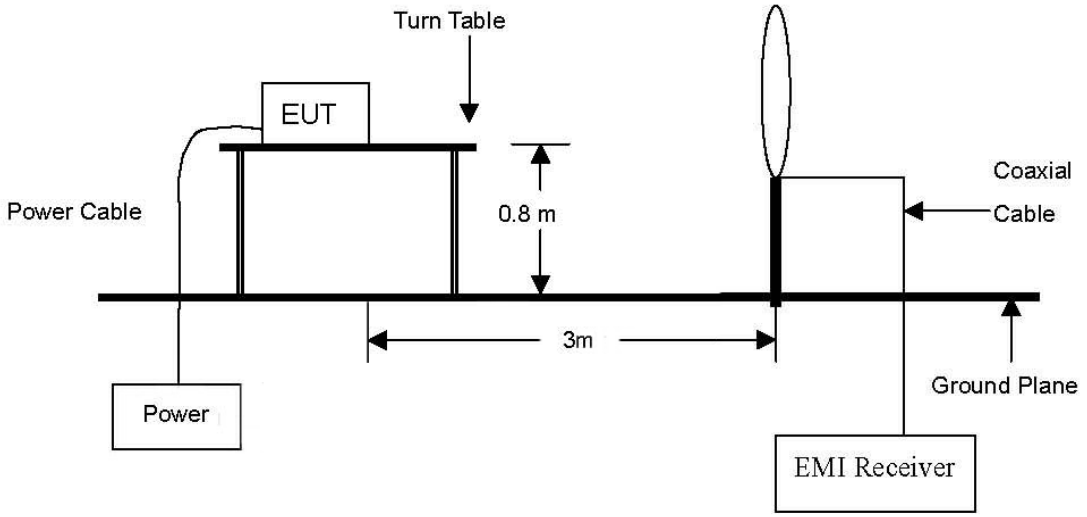
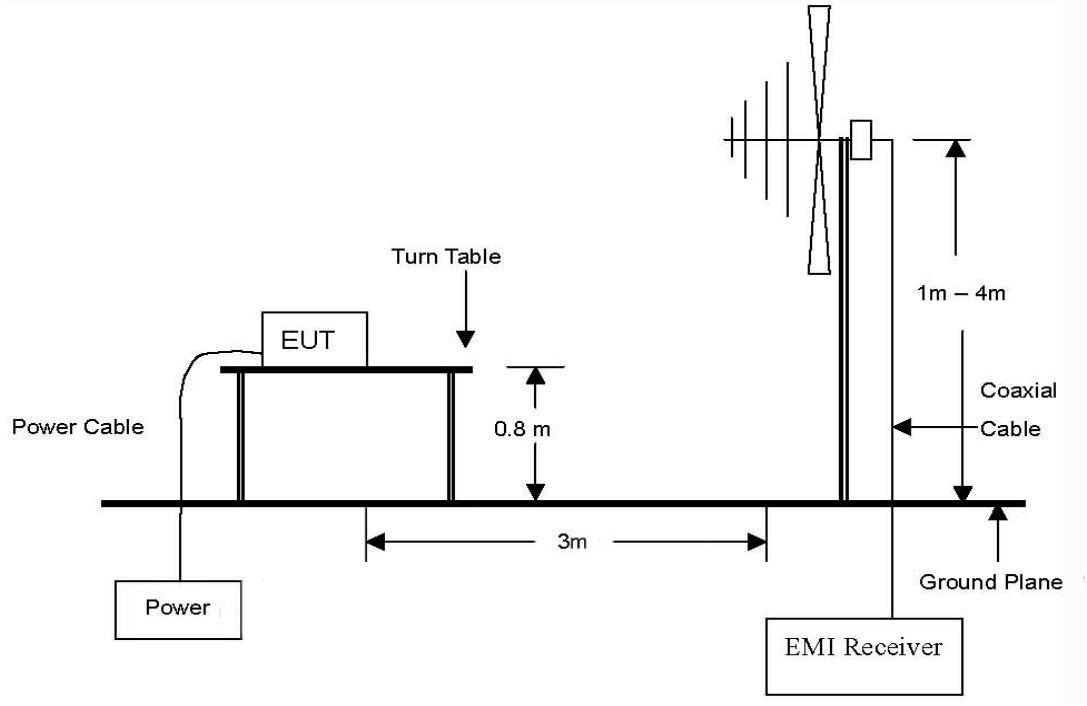
2. Field Strength of Fundamental

2.1. 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.



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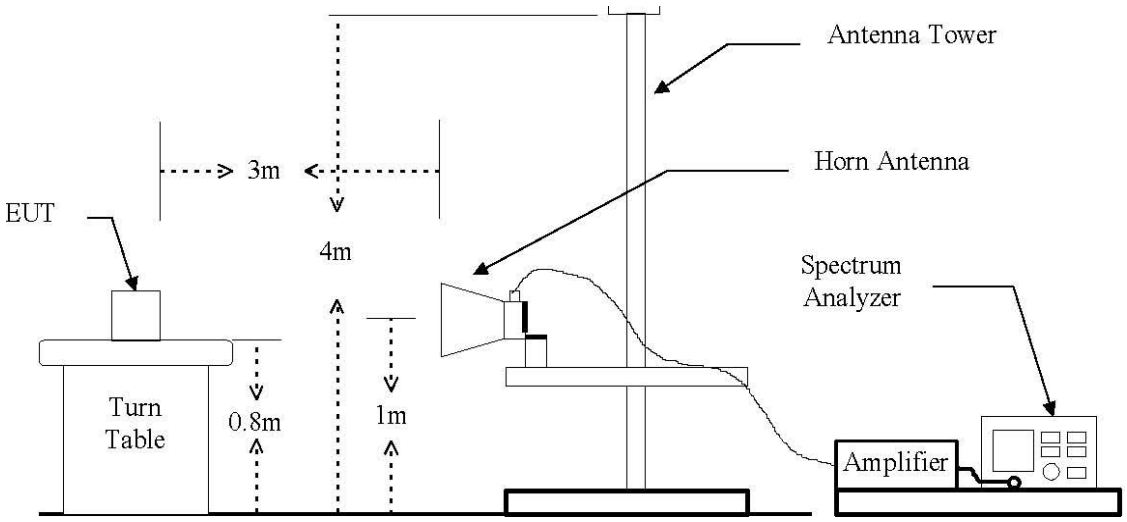
The diagram below shows the test setup that is utilized to make the measurements for emission .The spurious emissions were investigated form 1 ㎓ to the 10th harmonic of the highest fundamental frequency or 40 ㎓, whichever is lower.



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2.2. Limit

2.2.1. Radiated emission limits, general requirements

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	2400/F(㎑)	300
0.490 – 1.705	24000/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., Sections 15.231 and 15.241

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

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	1,250 to 3,750 **	125 to 375 **
174 – 260	3,750	375
260 – 470	3,750 to 12,500 **	375 to 1,250 **
Above 470	12,500	1,250

** 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)-7083.333. The maximum permitted unwanted emission level is 20 dB below the maximum permitted fundamental level.

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2.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.4:2003

2.3.1. Test Procedures for emission from 9 ㎑ to 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 dB 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 dB 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 resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 ㎒ for Peak detection and frequency above 1 ㎓.

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2.4. Test Result

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

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

Freq. (㎒)	Ant. Pol.	Reading (dB㎶)	Correction Factor (dB/m)	Result (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)	Detector
433.92	V	57.80	20.21	78.01	100.83	22.82	Peak
433.92	V	56.37	20.21	76.58	80.83	4.25	Average

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.

Note:
1. 3 m Limit (dB㎶/m) = 20log[41.6667($F_{(㎒)}$)-7083.3333] = 80.83
2. Correction Factor = Antenna Factor + Cable Loss
3. Average Reading = Peak Reading (dB㎶/m) + 20log(Duty Cycle)
4. Duty Cycle = 20log(T_{on} / T_{on+off}) = 20log(0.8 478) = -1.43 dB

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3. Spurious Emission

3.1. Test Setup

Same as section 2.1. of this report

3.2. Limit

Same as section 2.2. of this report

3.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.4:2003

3.3.1. Test Procedures for emission from 9 ㎑ to 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.

3.3.2. 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 dB 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 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

3.3.3. Test Procedures for emission above 1 ㎓

a. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 ㎒ for Peak detection and frequency above 1 ㎓.

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3.4. Test Result

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

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

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	Amp Gain +CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
Below 800.00	Not detected	-	-	-	-	-	-	-
867.82	50.60	Peak	V	22.72	-23.90	50.02	80.83	30.81
867.82	49.17	Average	V	22.72	-23.90	48.59	60.83	12.24
*1 301.89	62.19	Peak	V	25.17	-37.57	49.79	74.00	24.21
*1 301.89	60.76	Average	V	25.17	-37.57	48.36	54.00	5.64
1 735.90	65.02	Peak	V	26.94	-36.65	55.31	80.83	25.52
1 735.90	63.59	Average	V	26.94	-36.65	53.88	60.83	6.95
2 169.76	54.08	Peak	V	27.58	-35.87	45.79	80.83	35.04
2 169.76	52.65	Average	V	27.58	-35.87	44.36	60.83	16.47
2 603.49	63.04	Peak	V	28.59	-35.75	55.88	80.83	24.95
2 603.49	61.61	Average	V	28.59	-35.75	54.45	60.83	6.38
3 037.22	61.55	Peak	V	29.91	-35.50	55.96	80.83	24.87
3 037.22	60.12	Average	V	29.91	-35.50	54.53	60.83	6.30
3 471.07	54.11	Peak	V	31.03	-35.09	50.05	80.83	30.78
3 471.07	52.68	Average	V	31.03	-35.09	48.62	60.83	12.21
*3 904.93	52.67	Peak	V	32.37	-33.71	51.33	74.00	22.67
*3 904.93	51.24	Average	V	32.37	-33.71	49.90	54.00	4.10
*4 338.72	46.29	Peak	V	32.14	-33.65	44.78	74.00	29.22
*4 338.72	44.86	Average	V	32.14	-33.65	43.35	54.00	10.65

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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.
2. “*” means the restricted band.
3. Spurious Emission test results meet both peak and average limit
4. All reading value is peak detector.
5. Average reading = Peak reading + 20log(Duty cycle)

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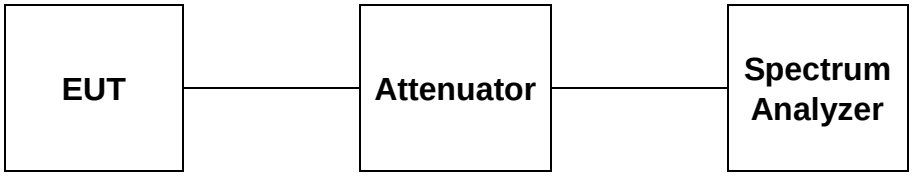
4. Bandwidth of Operation Frequency

4.1. Test Setup



4.2. Limit

The bandwidth of the emission shall be no wider than 0.25 % of the center frequency for devices operating above 70 ㎒ and below 900 ㎒. Bandwidth is determined at the points 20 dB down from the modulated carrier.

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=10 ㎑, VBW=10 ㎑ and Span=1 ㎒.
3. The bandwidth of fundamental frequency was measured and recorded.

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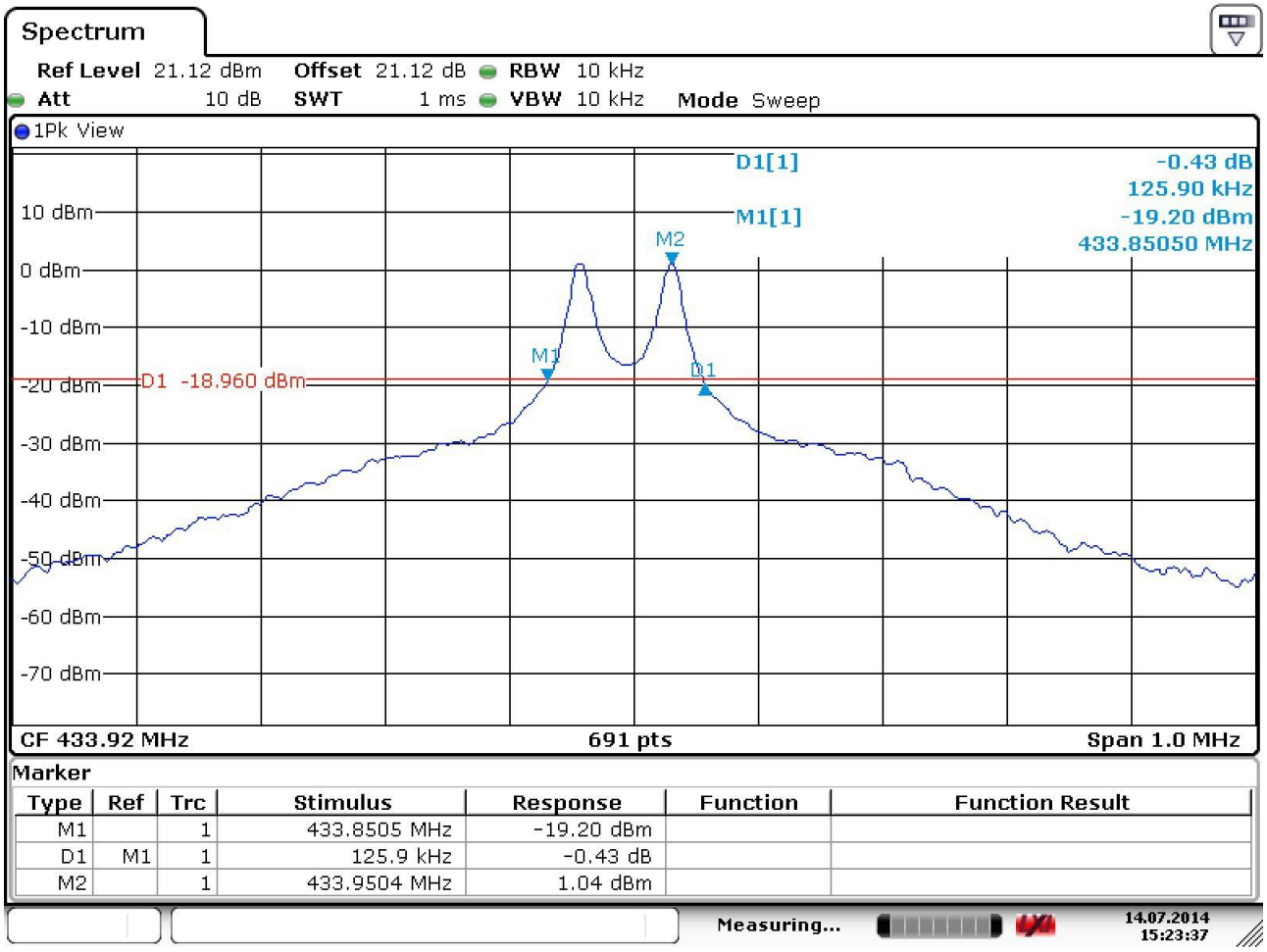
4.4. Test Result

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

Carrier Frequency (㎒)	Bandwidth of the emission (㎑)	Limit (㎑)	Remark
433.92	125.90	1 084.80	The point 20 dB down from the modulated carrier



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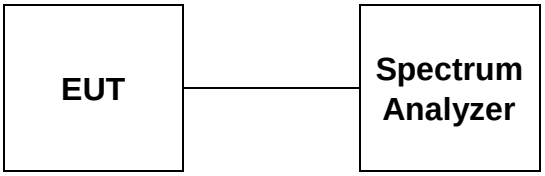
5. Transmission Time

5.1. Test Setup



5.2. Limit

A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not 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.

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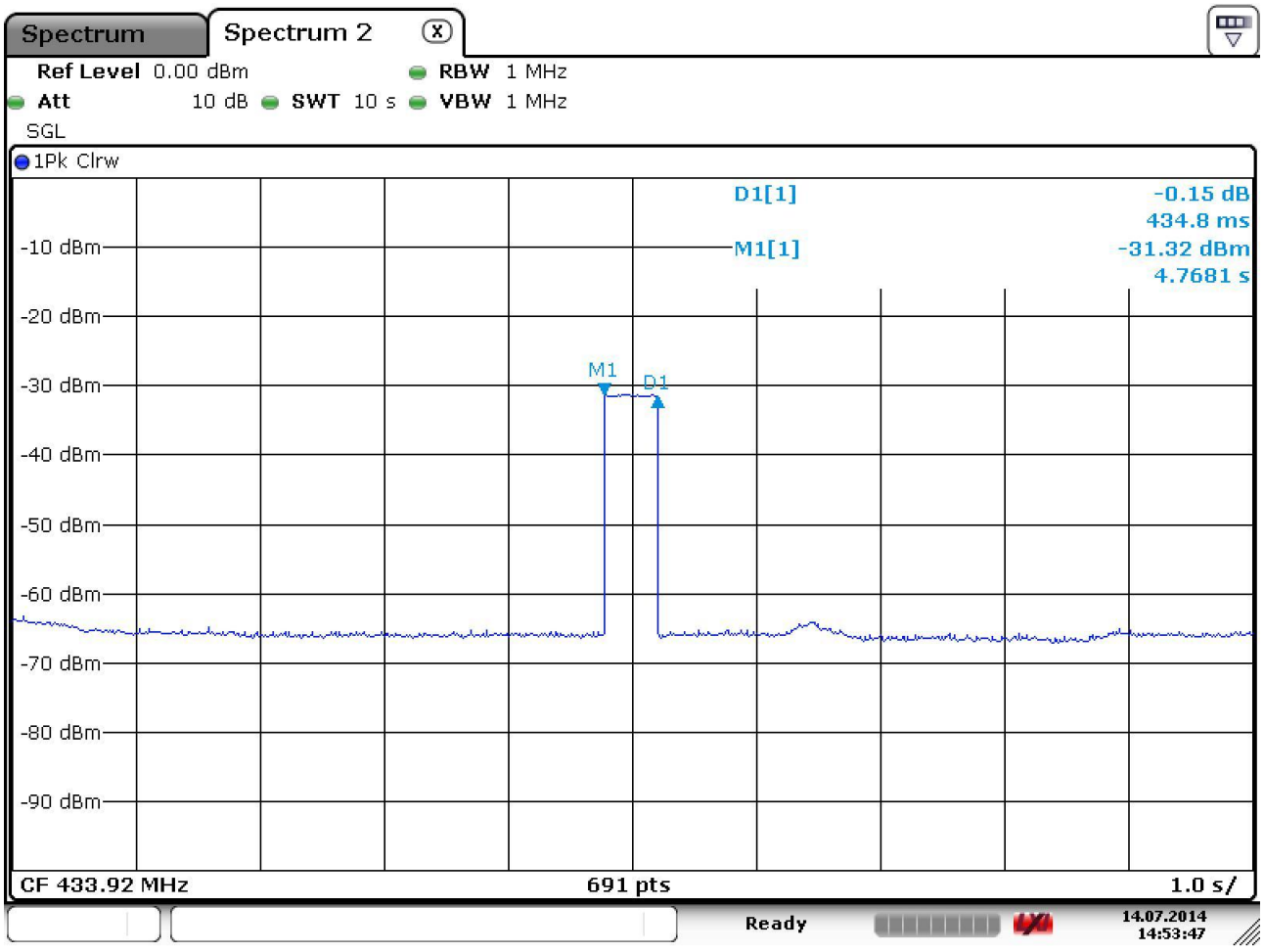
5.4. Test Result

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

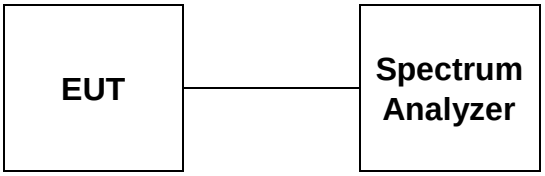
Carrier Frequency (㎒)	Transmission Time (sec)	Limit (sec)	Remark
433.92	0.43	Same or less than 5 s	Pass



Date: 14.JUL.2014 14:53:47

6. Maximum Modulation Percentage (M%)

6.1. Test Setup



6.2. Limit

Nil (No dedicated Limit specified in the Rules)

6.3. Test Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set center frequency of spectrum analyzer = operating frequency.
4. Set the spectrum analyzer as RBW = 1 ㎒, VBW = 1 ㎒, Span = 0 ㎐, Sweep Time = 1.5 s.
5. Repeat above procedure until all frequency measured were complete.

6.4. Test Result

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

CALCULATION :

Average Reading = Peak Reading (㏈㎶/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%	Correction Factor
100.000	84.78	84.78	-1.43 ㏈

T_{on+off} = 100 ㎳
T_{on} = 43.48 ㎳ + 41.30 ㎳ = 84.78 ㎳
Duty Cycle = 20log(T_{on} / T_{on+off}) = 20log(0.8 478) = -1.43 ㏈

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

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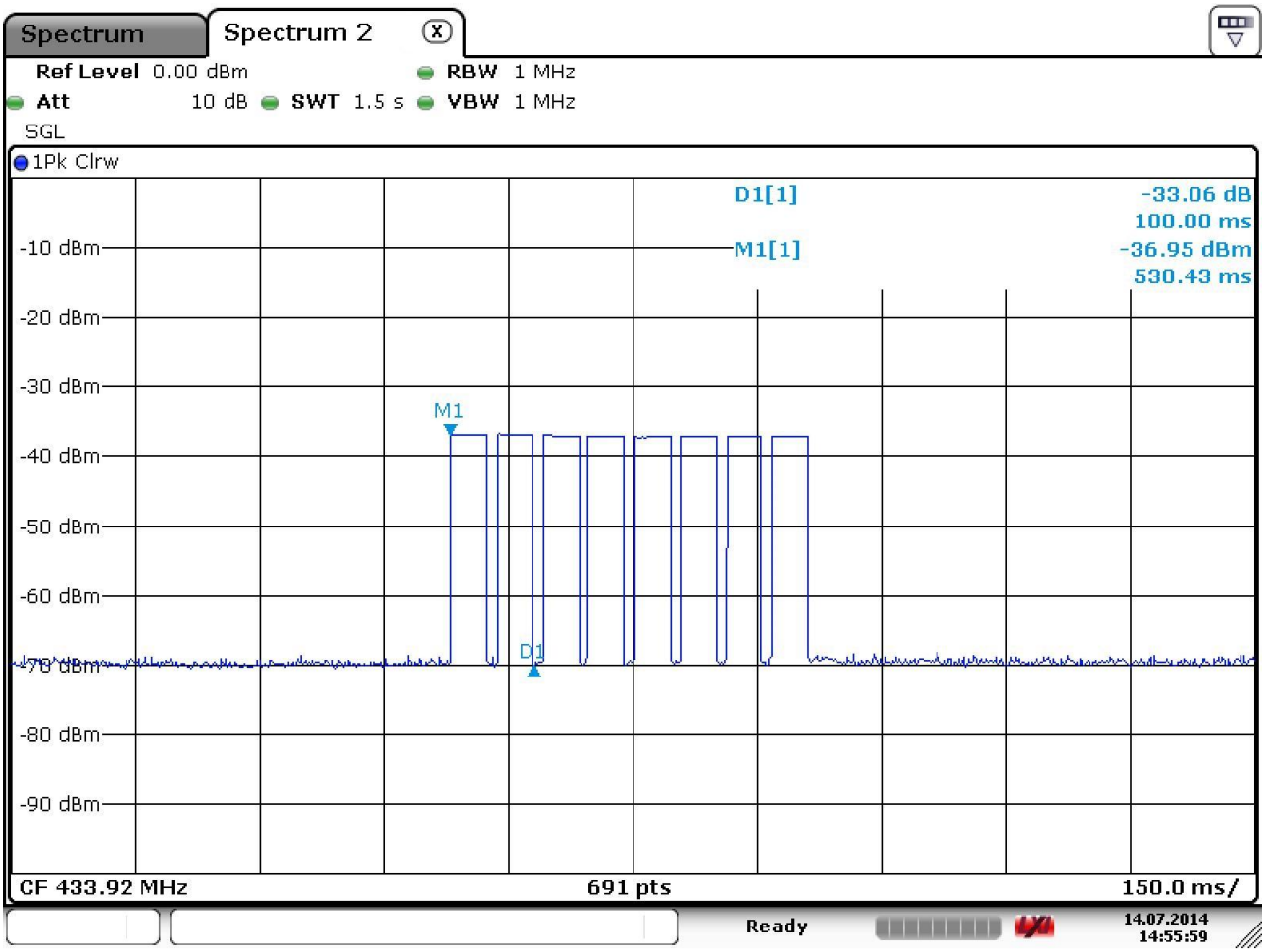
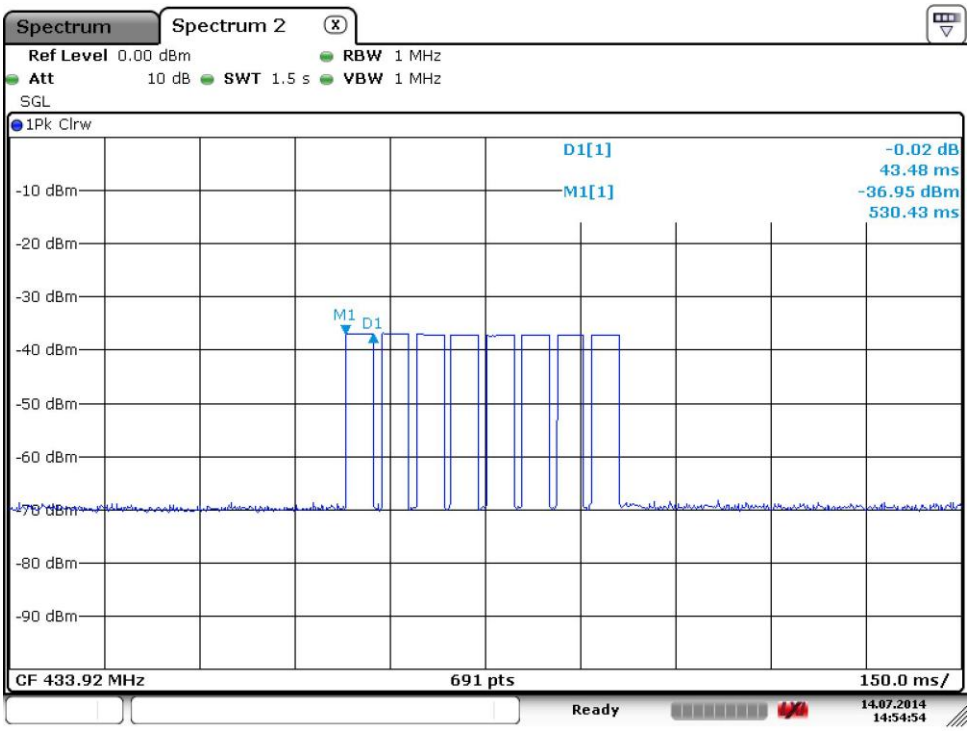
6.5. Test Plot

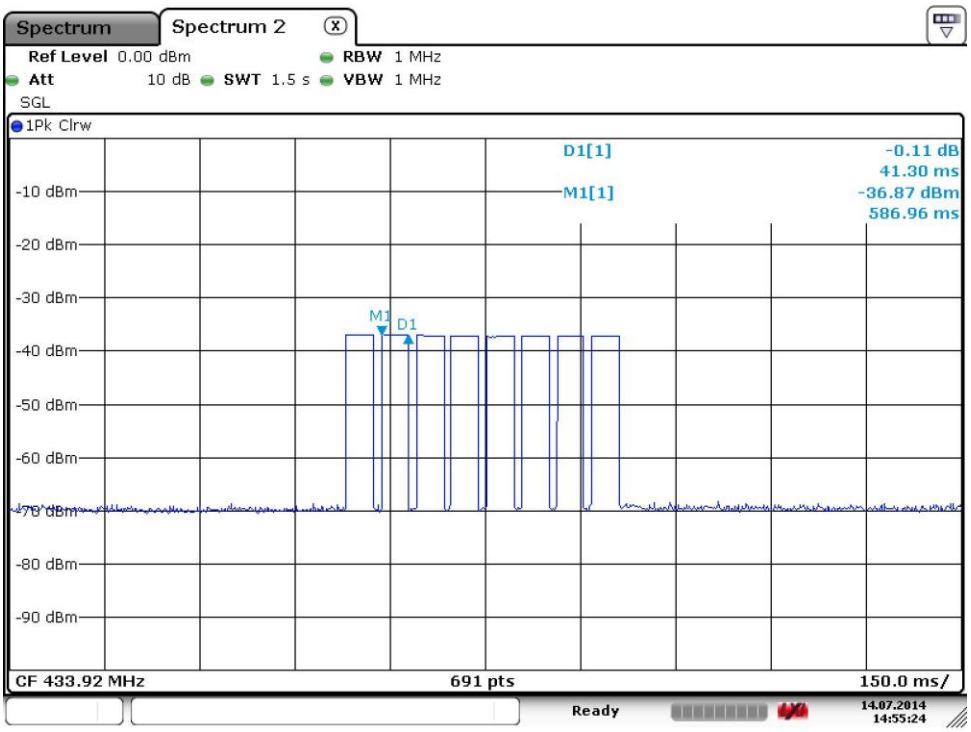


Date: 14.JUL.2014 14:55:59

(Pulse Train Period)



Date: 14.JUL.2014 14:54:54



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(Duty Cycle – Pulse Width)

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