

TEST REPORT

OF

FCC Part 15 Subpart C §15.209
FCC ID : TQ8-SMK-4E08

Equipment Under Test : SMART KEY ECU
Model Name : SMK-4E08 (Alt. : SMK-4E13)
Applicant : Hyundai Mobis Co., Ltd.
Manufacturer : Hyundai Mobis Co., Ltd.
Date of Test(s) : 2015. 05. 18 ~ 2015. 06. 03
Date of Issue : 2015. 06. 03

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

Tested By:



Date:

2015. 06. 03

Patrick Kang

Approved By:



Date:

2015. 06. 03

Hyunchae You

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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>.

Telephone : + 82 31 688 0901

FAX : + 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

1.3. Description of EUT

Kind of Product	SMART KEY ECU
Model Name	SMK-4E08 (Alt. : SMK-4E13)
Power Supply	DC 12 V (Used by Vehicle battery)
Frequency Range	Tx: 125.00 kHz (LF Antenna) Rx: 433.92 MHz (RF Antenna)
Modulation Technique	ASK
Number of Channels	1
Operating Conditions	-30 °C ~ 75 °C
Antenna Type	Internal Type (Coil Antenna)

1.4. Declarations by the manufacturer

- RF antenna is only Receiver antenna
- The EUT of antennas cannot operate at the same time.

1.5. Alternative models

Model name	Information
SMK-4E08	- Basic model
SMK-4E13	- Same to basic model, but receiver antenna type is different.

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1.6. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Interval	Cal. Due.
Spectrum Analyzer	R&S	FSV30	103100	Jul. 16, 2014	Annual	Jul. 16, 2015
Signal Generator	R&S	SMBV100A	255834	Jun. 25, 2014	Annual	Jun. 25, 2015
Loop Antenna	SCHWARZBECK	FMZB 1519	1519-039	Jul. 09, 2013	Biennial	Jul. 09, 2015
Bilog Antenna	SCHWARZBECK	VULB9163	396	Jun. 07, 2013	Biennial	Jun. 07, 2015
DC power Supply	Agilent	U8002A	MY50060028	Mar. 28, 2015	Annual	Mar. 28, 2016
Test Receiver	R&S	ESU26	100109	Mar. 03, 2015	Annual	Mar. 03, 2016
Preamplifier	H.P.	8447F	2944A03908	Aug. 27, 2014	Annual	Aug. 27, 2015
Antenna Master	MA 2000	INN-CO	N/A	N.C.R.	N.C.R.	N.C.R.
Turn Device	DE-3600-RH	INN-CO	N/A	N.C.R.	N.C.R.	N.C.R.
Anechoic Chamber	SY Corporation	L x W x H (9.6 m x 6.4 m x 6.6 m)	N/A	N.C.R.	N/A	N.C.R.

1.7. Test Report Revision

Revision	Report number	Date of Issue	Description
0	F690501/RF-RTL008786	2015. 06. 03	Initial

1.8. Summary of Test Results

The EUT has been tested according to the following specifications:

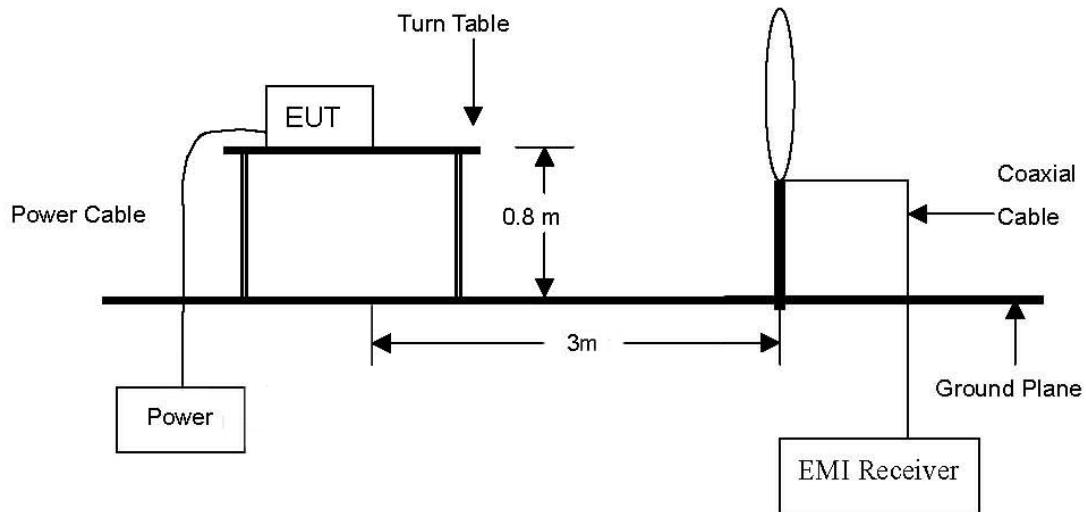
APPLIED STANDARD: FCC Part 15 Subpart C §15.209		
Section in FCC 15 Subpart C	Test Item	Result
15.209 15.209(a)	Radiated emission, Spurious Emission and Field Strength of Fundamental	Complied

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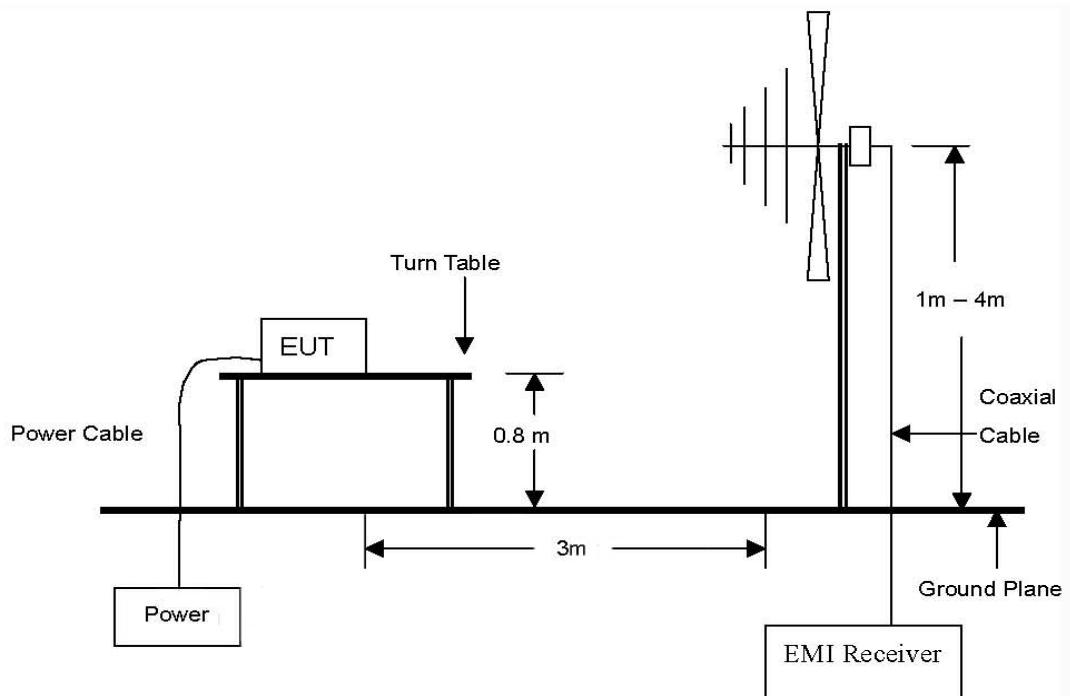
2. Field Strength of Fundamental

2.1. Test Setup

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



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



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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 (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meter)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	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 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241

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2.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.4:2009

2.3.1. Test Procedures for emission from 9 kHz to 30 MHz

- 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 average Detect Function and Specified Bandwidth with Maximum Hold Mode.

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

- 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 GHz, 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 GHz, 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.

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2.4. Test Result

Ambient temperature : (23 ± 1) °C

Relative humidity : 47 % R.H.

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

- AST ANT

Radiated Emissions			Ant	Correction Factors		Total		FCC Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB μ V/m) at 3 m	Actual (dB μ V/m) at 300 m	Limit (dB μ V/m)	Margin (dB)
0.125	62.80	Average	H	20.03	0.10	82.93	2.93	25.67	22.74

- BUM ANT

Radiated Emissions			Ant	Correction Factors		Total		FCC Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB μ V/m) at 3 m	Actual (dB μ V/m) at 300 m	Limit (dB μ V/m)	Margin (dB)
0.125	59.10	Average	H	20.03	0.10	79.23	-0.77	25.67	26.44

- DRV ANT

Radiated Emissions			Ant	Correction Factors		Total		FCC Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB μ V/m) at 3 m	Actual (dB μ V/m) at 300 m	Limit (dB μ V/m)	Margin (dB)
0.125	63.50	Average	H	20.03	0.10	83.63	3.63	25.67	22.04

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- INT1 ANT

Radiated Emissions			Ant	Correction Factors		Total		FCC Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB μ V/m) at 3 m	Actual (dB μ V/m) at 300 m	Limit (dB μ V/m)	Margin (dB)
0.125	62.90	Average	H	20.03	0.10	83.03	3.03	25.67	22.64

- INT2 ANT

Radiated Emissions			Ant	Correction Factors		Total		FCC Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB μ V/m) at 3 m	Actual (dB μ V/m) at 300 m	Limit (dB μ V/m)	Margin (dB)
0.125	58.90	Average	H	20.03	0.10	79.03	-0.97	25.67	26.64

- SSB ANT

Radiated Emissions			Ant	Correction Factors		Total		FCC Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB μ V/m) at 3 m	Actual (dB μ V/m) at 300 m	Limit (dB μ V/m)	Margin (dB)
0.125	67.60	Average	H	20.03	0.10	87.73	7.73	25.67	17.94

Note:

1. According to §15.31 (f)(2) 300 m Result(dB μ V/m) = 3 m Result(dB μ V/m) – 40log(300/3) (dB μ V/m)
2. According to §15.209 (d), the measurements were tested by using Quasi peak detector except for the frequency bands 9 – 90 kHz, 110 – 490 kHz and above 1 GHz in these three bands on measurements employing an average detector.
3. The limit above was calculated based on table of §15.209 (a).

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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 C63.4:2009

3.3.1. Test Procedures for emission from 9 kHz to 30 MHz

- 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 quasi-peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

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

- 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 GHz, 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 GHz, 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.

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3.4. Test Result

Ambient temperature : (24 ± 1) °C

Relative humidity : 47 % R.H.

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

3.4.1. Spurious emission from 9 kHz to 30 MHz

- AST ANT

Radiated Emissions			Ant	Correction Factors		Total		FCC Limit	
Frequency (kHz)	Reading (dB _u N)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB _u N/m) at 3 m	Actual ¹ (dB _u N/m) at 300 m	Limit (dB _u N/m)	Margin (dB)
89.98	11.00	Average	H	20.05	0.10	31.15	-48.85	28.52	77.37
97.76	20.50	Quasi-Peak	H	20.03	0.09	40.62	-39.38	27.80	67.18
105.59	26.30	Quasi-Peak	H	20.03	0.09	46.42	-33.58	27.13	60.71
144.67	21.00	Average	H	20.03	0.10	41.13	-38.87	24.40	63.27

- BUM ANT

Radiated Emissions			Ant	Correction Factors		Total		FCC Limit	
Frequency (kHz)	Reading (dB _u N)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB _u N/m) at 3 m	Actual ¹ (dB _u N/m) at 300 m	Limit (dB _u N/m)	Margin (dB)
94.92	10.10	Quasi-Peak	H	20.04	0.09	30.23	-49.77	28.06	77.83
97.76	23.70	Quasi-Peak	H	20.03	0.09	43.82	-36.18	27.80	63.98
105.61	30.00	Quasi-Peak	H	20.03	0.09	50.12	-29.88	27.13	57.01
144.70	21.40	Average	H	20.03	0.10	41.53	-38.47	24.39	62.86

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- DRV ANT

Radiated Emissions			Ant	Correction Factors		Total		FCC Limit	
Frequency (kHz)	Reading (dB μ V)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB μ V/m) at 3 m	Actual ¹ (dB μ V/m) at 300 m	Limit (dB μ V/m)	Margin (dB)
89.95	9.10	Average	H	20.05	0.10	29.25	-50.75	28.52	79.27
97.78	17.20	Quasi-Peak	H	20.03	0.09	37.32	-42.68	27.80	70.48
105.59	23.10	Quasi-Peak	H	20.03	0.09	43.22	-36.78	27.13	63.91
146.90	17.30	Average	H	20.03	0.10	37.43	-42.57	24.26	66.83

- INT1 ANT

Radiated Emissions			Ant	Correction Factors		Total		FCC Limit	
Frequency (kHz)	Reading (dB μ V)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB μ V/m) at 3 m	Actual ¹ (dB μ V/m) at 300 m	Limit (dB μ V/m)	Margin (dB)
89.95	11.90	Average	H	20.05	0.10	32.05	-47.95	28.52	76.47
97.78	21.00	Quasi-Peak	H	20.03	0.09	41.12	-38.88	27.80	66.68
105.60	26.80	Quasi-Peak	H	20.03	0.09	46.92	-33.08	27.13	60.21
144.71	22.00	Average	H	20.03	0.10	42.13	-37.87	24.39	62.26

- INT2 ANT

Radiated Emissions			Ant	Correction Factors		Total		FCC Limit	
Frequency (kHz)	Reading (dB μ V)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB μ V/m) at 3 m	Actual ¹ (dB μ V/m) at 300 m	Limit (dB μ V/m)	Margin (dB)
89.95	13.70	Average	H	20.05	0.10	33.85	-46.15	28.52	74.67
97.77	23.60	Quasi-Peak	H	20.03	0.09	43.72	-36.28	27.80	64.08
105.60	30.10	Quasi-Peak	H	20.03	0.09	50.22	-29.78	27.13	56.91
144.74	20.90	Average	H	20.03	0.10	41.03	-38.97	24.39	63.36

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- SSB ANT

Radiated Emissions			Ant	Correction Factors		Total		FCC Limit	
Frequency (kHz)	Reading (dB μ V)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB μ V/m) at 3 m	Actual ¹ (dB μ V/m) at 300 m	Limit (dB μ V/m)	Margin (dB)
99.61	15.30	Quasi-Peak	H	20.03	0.09	35.42	-44.58	27.64	72.22
107.54	15.60	Quasi-Peak	H	20.03	0.09	35.72	-44.28	26.97	71.25
142.79	9.90	Average	H	20.03	0.10	30.03	-49.97	24.51	74.48
375.09	24.60	Average	H	20.06	0.16	44.82	-35.18	16.12	51.30

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3.4.2. Spurious emission from 30 MHz to 1 000 MHz

The frequency spectrum from 30 MHz to 1 000 MHz was investigated. All reading values are peak values.

- AST ANT

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (MHz)	Reading (dB μ N)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dB μ N/m)	Limit (dB μ N/m)	Margin (dB)
50.01	34.73	Peak	H	14.54	-26.57	22.70	40.00	17.30
335.91	35.12	Peak	V	15.03	-23.95	26.20	46.00	19.80
379.89	34.65	Peak	H	16.64	-24.09	27.20	46.00	18.80
Above 400.00	Not detected	-	-	-	-	-	-	-

- BUM ANT

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (MHz)	Reading (dB μ N)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dB μ N/m)	Limit (dB μ N/m)	Margin (dB)
47.51	33.64	Peak	H	14.65	-26.69	21.60	40.00	18.40
382.07	34.49	Peak	V	16.54	-24.13	26.90	46.00	19.10
Above 400.00	Not detected	-	-	-	-	-	-	-

- DRV ANT

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (MHz)	Reading (dB μ N)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dB μ N/m)	Limit (dB μ N/m)	Margin (dB)
44.11	34.36	Peak	H	14.65	-26.71	22.30	40.00	17.70
340.68	35.19	Peak	V	15.17	-23.96	26.40	46.00	19.60
Above 400.00	Not detected	-	-	-	-	-	-	-

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- INT1 ANT

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
51.54	34.56	Peak	H	14.29	-26.55	22.30	40.00	17.70
63.22	36.50	Peak	H	12.06	-26.36	22.20	40.00	17.80
106.75	36.69	Peak	H	11.58	-25.77	22.50	43.50	21.00
258.84	35.60	Peak	V	13.57	-24.27	24.90	46.00	21.10
Above 300.00	Not detected	-	-	-	-	-	-	-

- INT2 ANT

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
37.96	41.69	Peak	H	13.80	-26.79	28.70	40.00	11.30
101.05	38.70	Peak	H	12.22	-25.82	25.10	43.50	18.40
Above 200.00	Not detected	-	-	-	-	-	-	-

- SSB ANT

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
44.43	32.61	Peak	V	16.10	-26.71	22.00	40.00	18.00
371.00	34.29	Peak	H	16.58	-24.07	26.80	46.00	19.20
Above 400.00	Not detected	-	-	-	-	-	-	-

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Note:

1. According to §15.31 (f)(2) 300 m Result($\text{dB}\mu\text{V}/\text{m}$) = 3 m Result($\text{dB}\mu\text{V}/\text{m}$) – 40log(300/3) ($\text{dB}\mu\text{V}/\text{m}$)
2. According to field strength table of general requirement in §15.209 (a), field strength limits below 1.705 MHz were calculated as below.
 - 9 kHz to 490 kHz : 20log(2 400 / F (kHz)) at 300 m ($\text{dB}\mu\text{V}/\text{m}$)
 - 490 kHz to 1 705 kHz : 20log(24 000 / F (kHz)) at 30 m ($\text{dB}\mu\text{V}/\text{m}$)
3. According to §15.209 (d), the measurements were tested by using Quasi peak detector except for the frequency bands 9 – 90 kHz, 110 – 490 kHz and above 1 GHz in these three bands on measurements employing an average detector.
4. All results above 30 MHz are peak detector.

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