TEST REPORT

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1. Client

- Name : HYUNDAI MOBIS CO., LTD.
- Address : 203, Teheran-ro, Gangnam-gu, Seoul, 06141, Korea
- Date of Receipt : 2019-07-26

2. Use of Report : -

3. Name of Product and Model : DISPLAY CAR SYSTEM
FCC: ADB20THAN / IC: ADB20THKN

4. Manufacturer and Country of Origin : HYUNDAI MOBIS CO., LTD. / Korea

5. FCC ID : TQ8-ADB20THAN

6. IC Certification : 5074A-ADB20THKN

7. Date of Test : 2019-08-12 to 2019-08-31

8. Test Standards : FCC Part 15 Subpart C, 15.247
RSS-247 Issue 2 February 2017
RSS-Gen Issue 5 March 2019

9. Test Results : Refer to the test result in the test report

Affirmation	Tested by Name : Myeongjun Kwon (Signature)	Technical Manager Name : Jaehyong Lee (Signature)

2019-11-21

KCTL Inc.

Report revision history

Date	Revision	Page No
2019-11-15	Initial report	-
2019-11-21	updated	11,12

CONTENTS

1. General information

Client	:	HYUNDAI MOBIS CO., LTD.
Address	:	203, Teheran-ro, Gangnam-gu, Seoul, 06141, Korea
Manufacturer	:	HYUNDAI MOBIS CO., LTD.
Address	:	95, Sayang 2-Gil, Munbaek-Myeon, Jincheon-Gun, Chungcheongbuk-Do 27862 Korea
Laboratory	:	KCTL Inc.
Address	:	65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea
Accreditations	:	FCC Site Designation No: KR0040, FCC Site Registration No: 687132
		VCCI Registration No. : R-20080, G-20078, C-20059, T-20056
		Industry Canada Registration No. : 8035A
		KOLAS No.: KT231

2. Device information

Equipment under test	:	DISPLAY CAR SYSTEM
Model	:	FCC: ADB20THAN / IC: ADB20THKN
Derivative model	:	FCC: ADB20THKN
Frequency range	:	2 402 ㎒ ~ 2 480 ㎒ : Bluetooth(BDR/EDR)
		UNII-1: 5 180 ㎒ ~ 5 240 ㎒ (802.11a/n_HT20/ac_VHT20)
		UNII-1: 5 190 ㎒ ~ 5 230 ㎒ (802.11n_HT40/ac_VHT40)
		UNII-1: 5 210 ㎒ (802.11ac_VHT80)
		UNII-3: 5 745 ㎒ ~ 5 825 ㎒ (802.11a/n_HT20/ac_VHT20)
		UNII-3: 5 755 ㎒ ~ 5 795 ㎒ (802.11n_HT40/ac_VHT40)
		UNII-3: 5 775 ㎒ (802.11ac_VHT80)
Modulation technique	:	Bluetooth(BDR/EDR)_ GFSK, π/4DQPSK, 8DPSK
		WIFI(802.11a/n20/n40/ac20/ac40/ac80)_OFDM
Number of channels	:	Bluetooth(BDR/EDR)_79ch
		UNII-1: 4 ch (20 ㎒), 2 ch (40 ㎒), 1 ch (80 ㎒)
		UNII-3: 5 ch (20 ㎒), 2 ch (40 ㎒), 1 ch (80 ㎒)
Power source	:	DC 14.4 V
Antenna specification	:	WIFI/Bluetooth(BDR/EDR)_Pattern Antenna
Antenna gain	:	Bluetooth(BDR/EDR) : -0.18 ㏈i
		UNII-1 : -0.61 ㏈i,, UNII-3 : -0.18 ㏈i
Software version	:	SP2.CAN.0000.076.000.190715
Hardware version	:	SP2.CAN.D-AUDIO_G2V.000.003
Test device serial No.	:	N/A
Operation temperature	:	-20 ℃ ~ 70 ℃

2.1. Information about derivative model

The basic and derivative model are electrically identical.
The derivative models is only for the simplified derivation based on buyer's model name.

2.2. Frequency/channel operations

This device contains the following capabilities:
Bluetooth(BDR/EDR), 5 ㎓ band 802.11a/n(HT20/HT40)/ac(VHT/20/40/80)),

Ch.	Frequency (㎒)
00	2 402
.	.
.	.
19	2 441
.	.
.	.
39	2 480

Table 2.2.1. Bluetooth(BDR/EDR) mode

UNII-1

Ch.	Frequency (㎒)
36	5 180
40	5 200
48	5 240

UNII-3

Ch.	Frequency (㎒)
149	5 745
157	5 785
165	5 825

Table 2.2-2. 802.11a/n/ac_HT20/VHT20 mode

UNII-1

Ch.	Frequency (㎒)
38	5 190
46	5 230

UNII-3

Ch.	Frequency (㎒)
151	5 755
159	5 795

Table 2.2-3. 802.11n/ac_HT40/VHT40 mode

UNII-1

Ch.	Frequency (㎒)
42	5 210

UNII-3

Ch.	Frequency (㎒)
155	5 775

Table 2.2-4 802.11ac_VHT80 mode

3. Measurement uncertainty

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of k=2 to indicated a 95 % level of confidence. The measurement data shown herein meets of exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded uncertainty (±)
Conducted RF power	1.76 dB

4. RF Exposure

FCC

Regulation

This document is prepared to show compliance with the RF Exposure requirements as required in §1.1310 of the FCC rules and Regulations.
The limit for Maximum Permissible Exposure (MPE), specified in FCC §1.1310, is listed in Table 1-1.
According to FCC §1.1310: the criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b).

Table 1 – Limits for Maximum Permissible Exposure (MPE)

Frequency Range (㎒)	Electric Field Strength [V/m]	Magnetic Field Strength [A/m]	Power Density [㎽/㎠]	Averaging Time [minute]
(A) Limits for Occupational / Controlled Exposure				
0.3 ~ 3.0	614	1.63	*100	6
3.0 ~ 30	1842/f	4.89/f	*900/f^2	6
30 ~ 300	61.4	0.163	1.0	6
300 ~ 1 500	/	/	f/300	6
1 500 ~ 15 000	/	/	5	6
(B) Limits for General Population / Uncontrolled Exposure				
0.3 ~ 1.34	614	1.63	*100	30
1.34 ~ 30	824/f	2.19/f	*180/f^2	30
30 ~ 300	27.5	0.073	0.2	30
300 ~ 1 500	/	/	f/1 500	30
1 500 ~ 15 000	/	/	1.0	30

*f=frequency in ㎒, *= plane-wave equivalent power density*

Per the guidance of KDB 680106, the E-field and H-field limits shown in the table above are extended down to 100 ㎑

IC

RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

According to RSS-102 Issue 5, Paragraph "4. Exposure Limits", Industry of Canada has adopted the RF field strength limits stablished in Healths Canada's RF exposure guideline, Safety code 6:

Frequency Range (㎒)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10^{21}	83	90	-	Instantaneous*
0.1-10	-	0.73/ f	-	6**
1.1-10	87/ $f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	58.07/ $f^{0.25}$	0.1540/ $f^{0.25}$	8.944/ $f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 f 0.3417	0.008335 f 0.3417	0.02619f0.6834	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ $f^{1.2}$
150000-300000	0.158 $f^{0.5}$	4.21 x 10^{-4} $f^{0.5}$	6.67 x 10^{-5} f	616000/ $f^{1.2}$

Note: f is frequency in ㎒.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

Exemption Limits for Routine Evaluation – RF Exposure Evaluation

According to RSS-102 Issue 5 section 2.5.2, RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 ㎝, except when the device operates as follows:

- Below 20 ㎒ and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1W (adjusted for tune-up tolerance);
- At or above 20 ㎒ and below 48 ㎒ and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 4.49/ $f^{0.5}$ W (adjusted for tune-up tolerance), where f is in ㎒;
- At or above 48 ㎒ and below 300 ㎒ and the source-bands, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- At or above 300 ㎒ and below 6 ㎓ and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1.31 x 10^{-2} $f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in ㎒;
- At or above 6 ㎓ and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance.)

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

4.1. Test results

FCC

MPE (Maximum Permissive Exposure) Prediction

Predication of MPE limit at a given distance: Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2 \quad \left(\Rightarrow R = \sqrt{PG/4\pi S}\right)$$

S = power density [㎽/㎠]
P = Power input to antenna [㎽]
G = Power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna [㎝]

IC

RF Exposure evaluation

At or above 300 ㎒ and below 6 ㎓ and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1.31 x 10^{-2} $f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in ㎒;

RF Exposure Compliance Issue

The information should be included in the user's manual:
This appliance and its antenna must not be co-located or operation is conjunction with any other antenna or transmitter. A minimum separation distance of 20 ㎝ must be maintained between the antenna and the person for this appliance to satisfy the RF exposure requirements.

Calculation Result of RF exposure (FCC)

Maximum tune-up tolerance

- 2.4㎓

Mode	Frequency [㎒]	Max Tune-up Power [dBm]	Max Tune-up Power [㎽]	Ant Gain [dBi]	Ant Gain [㎽]	Power density at 20 ㎝ [㎽/㎠]	Limit [㎽/㎠]
GFSK	2 480	2.00	1.58	-0.18	0.96	0.000 30	1.000 00

- UNII-1

Mode	Frequency [㎒]	Max Tune-up Power [dBm]	Max Tune-up Power [㎽]	Ant Gain [dBi]	Ant Gain [㎽]	Power density at 20 ㎝ [㎽/㎠]	Limit [㎽/㎠]
802.11a	5 200	10.00	10.00	-0.61	0.87	0.001 73	1.000 00
802.11an(HT20)	5 200	10.00	10.00	-0.61	0.87	0.001 73	1.000 00
802.11an(HT40)	5 230	6.00	3.98	-0.61	0.87	0.000 69	1.000 00
802.11ac(VHT20)	5 200	10.00	10.00	-0.61	0.87	0.001 73	1.000 00
802.11ac(VHT40)	5 190	6.00	3.98	-0.61	0.87	0.000 69	1.000 00
802.11ac(VHT80)	5 210	7.00	5.01	-0.61	0.87	0.000 87	1.000 00

- UNII-3

Mode	Frequency [㎒]	Max Tune-up Power [dBm]	Max Tune-up Power [㎽]	Ant Gain [dBi]	Ant Gain [㎽]	Power density at 20 ㎝ [㎽/㎠]	Limit [㎽/㎠]
802.11a	5 825	10.00	10.00	-0.18	0.96	0.001 91	1.000 00
802.11an(HT20)	5 825	10.00	10.00	-0.18	0.96	0.001 91	1.000 00
802.11an(HT40)	5 795	9.00	7.94	-0.18	0.96	0.001 52	1.000 00
802.11ac(VHT20)	5 825	10.00	10.00	-0.18	0.96	0.001 91	1.000 00
802.11ac(VHT40)	5 795	8.00	6.31	-0.18	0.96	0.001 20	1.000 00
802.11ac(VHT80)	5 775	8.00	6.31	-0.18	0.96	0.001 20	1.000 00

- Simultaneous Transmission

Mode	Frequency [㎒]	Max Tune-up Power [dBm]	Max Tune-up Power [㎽]	Ant Gain [dBi]	Ant Gain [㎽]	Power density at 20 ㎝ [㎽/㎠]	Limit [㎽/㎠]
802.11n HT20 / UNII-3 Highest(5 825 ㎒)+BT,GFSK Highest(2 480 ㎒)						0.002 21	1.000 00

Note.

1. The power density P_d (5th column) at a distance of 20 ㎝ calculated from the friis transmission Formula is far below the limit of 1 ㎽/㎠.

Calculation Results of RF exposure (IC)

Maximum tune-up tolerance

Mode	Frequency [㎒]	Max Tune-up Power [dBm]	Ant Gain [dBi]	E.I.R.P		Limit [㎽]	Ratio
				[dBm]	[㎽]		
GFSK	2 441	2.00	-0.18	1.82	1.52	2 706.05	0.000 6

- UNII-1

Mode	Frequency [㎒]	Max Tune-up Power [dBm]	Ant Gain [dBi]	E.I.R.P		Limit [㎽]	Ratio
				[dBm]	[㎽]		
802.11a	5 200	10.00	-0.61	9.39	8.69	4 537.20	0.001 9
802.11n(HT20)	5 200	10.00	-0.61	9.39	8.69	4 537.20	0.001 9
802.11n(HT40)	5 230	6.00	-0.61	5.39	3.46	4 555.07	0.000 8
802.11ac(VHT20)	5 200	10.00	-0.61	9.39	8.69	4 537.20	0.001 9
802.11ac(VHT40)	5 190	6.00	-0.61	5.39	3.46	4 531.24	0.000 8
802.11ac(VHT80)	5 210	7.00	-0.61	6.39	4.36	4 543.16	0.001 0

- UNII-3

Mode	Frequency [㎒]	Max Tune-up Power [dBm]	Ant Gain [dBi]	E.I.R.P		Limit [㎽]	Ratio
				[dBm]	[㎽]		
802.11a	5 825	10.00	-0.18	9.82	9.59	4 903.14	0.002 0
802.11n(HT20)	5 825	10.00	-0.18	9.82	9.59	4 903.14	0.002 0
802.11n(HT40)	5 795	9.00	-0.18	8.82	7.62	4 885.87	0.001 6
802.11ac(VHT20)	5 825	10.00	-0.18	9.82	9.59	4 903.14	0.002 0
802.11ac(VHT40)	5 795	8.00	-0.18	7.82	6.05	4 885.87	0.001 2
802.11ac(VHT80)	5 775	8.00	-0.18	7.82	6.05	4 874.34	0.001 2

- Simultaneous Transmission

Mode	Frequency [㎒]	Max Tune-up Power [dBm]	Ant Gain [dBi]	E.I.R.P		Limit [㎽]	Ratio
				[dBm]	[㎽]		
802.11n HT20 / UNII-3 Highest(5 825 ㎒)+BT,GFSK Highest(2 480 ㎒)				19.21	83.37	2 706.05	0.032 8

5. Measurement Equipment

Equipment Name	Manufacturer	Model No.	Serial No.	Next Cal. Date
Spectrum Analyzer	R&S	FSW50	101013	20.05.13
Wideband Power Sensor	R&S	NRP-Z81	102398	20.01.25
ATTENUATOR	R&S	DNF Dämpfungsglied 10 dB in N-50 Ohm	31212	20.05.13
ATTENUATOR	API Inmet	40AH2W-10	11	20.05.15

End of test report