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# TEST REPORT

**KCTL Inc.**
65, Sinwon-ro, Yeongtong-gu,
Suwon-si, Gyeonggi-do, 16677, Korea
TEL: 82-31-285-0894 FAX: 82-505-299-8311
www.kctl.co.kr



**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<br>Name : Myeongjun Kwon (Signature) | Technical Manager<br>Name : Jaehyong Lee (Signature) |

2019-11-21

## KCTL Inc.

As a test result of the sample which was submitted from the client, this report does not guarantee the whole product quality. This test report should not be used and copied without a written agreement by KCTL Inc.

**Report revision history**

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

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# 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 | 0.02619$f$0.6834 | 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.

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## 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.

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## 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 ㎽/㎠.

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## 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<br>Dämpfungsglied<br>10 dB in<br>N-50 Ohm | 31212 | 20.05.13 |
| ATTENUATOR | API Inmet | 40AH2W-10 | 11 | 20.05.15 |

## End of test report

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