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Test report No:
NIE: 56848RAN.004

Assessment report
RF EXPOSURE REPORT ACCORDING TO
IEEE Std C95.3™ -2002 (R2008)
FCC 47 CFR Part 2.1091
ISED RSS-102 Issue 5:2015

Identification of item tested	Automotive infotainment system
Trademark	Mercedes-Benz
Model and /or type reference	NTG6N HIGH
Other identification of the product	S/N: HBM249JB002144 HW Version: D4 SW Version: E412.007 FCC ID: T8GNTG6NH IC: 6434A-NTG6NH
Features	FM, AM, DAB, USB, Bluetooth, WLAN, GPS.
Manufacturer	HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH BECKER-GOERING-STR. 16; 76307. KARLSBAD GERMANY
Test method requested, standard	IEEE Std C95.3TM -2002 (R2008). IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to Such Fields, 100 kHz–300 GHz FCC 47 CFR Part 2.1091 Radiofrequency radiation exposure evaluation: mobile devices. ISED RSS-102 Issue 5 (2015-03) – Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Miguel Lacave Antennas Lab Manager  MIGUEL LACAVE GARCÍA 2019.05.14 15:41:45 +02'00'
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Data provided by the client

The sample consist of an automotive head unit to be installed in cars with the following features: FM, AM DAB, USB, Bluetooth, WLAN and GPS.

DEKRA declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

Identification of the client

HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH

BECKER-GOERING-STR. 16; 76307. KARLSBAD GERMANY

Document history

Report number	Date	Description
56848RAN.004	2019-05-13	First release

General description of the device under evaluation

The device under evaluation consists of an automotive head unit to be installed in cars with the following features: FM, AM DAB, USB, Bluetooth, WLAN and GPS.

According to the manufacturer, during its normal use, the separation distance between the device and the body of nearby users will be greater than 20 cm. In order to perform the assessment a conservative separation distance of 20 cm has been used.

The equipment specifications declared by the manufacturer for each supported technology and band are:

Technology / Mode	Band (MHz)	Maximum E.I.R.P. (dBm)
Wi-Fi SISO	2412-2472	20.0
Wi-Fi SISO	5150-5835	20.0
Wi-Fi MIMO	5735-5835	20.0
Bluetooth	2402-2480	10.0

Table 1: Equipment specifications

Assessment summary

Radiofrequency radiation exposure limits			
FCC 47 CFR § 2.1091 & ISED RSS-102 Issue 5 (2015-03)			
Assessment	**Technology**	**Band**	**VERDICT (Pass/Fail)**
1	Wi-Fi SISO	2.4 GHz	Pass
2	Wi-Fi SISO	5 GHz	Pass
3	Wi-Fi MIMO	5 GHz	Pass
4	Bluetooth	2.4 GHz	Pass
5	Simultaneous Transmission		Pass

Table 2: Assessment summary

Appendix A: FCC RF Exposure

FCC RF Exposure evaluation for mobile devices

Devices operating in standalone mobile device exposure conditions may contain a single transmitter or multiple transmitters that do not transmit simultaneously. A minimum test separation distance ≥ 20 cm is required between the antenna and radiating structures of the device and nearby persons to apply mobile device exposure limits. The distance must be at least 20 cm and fully supported by the operating and installation configurations of the transmitter and its antenna(s), according to the source-based time-averaged maximum power requirements of § 2.1091(d)(2). In cases where cable losses or other attenuations are applied to determine compliance, the most conservative operating configurations and exposure conditions must be evaluated. The minimum test separation distance required for a device to comply with mobile device exposure conditions must be clearly identified in the installation and operating instructions, for all installation and exposure conditions, to enable users and installers to comply with RF exposure requirements. For mobile devices that have the potential to operate in portable device exposure conditions, similar to the configurations described in § 2.1091(d)(4), a KDB inquiry is required to determine the SAR test requirements for demonstrating compliance.

When a device qualifies for the categorical exclusion provision of § 2.1091(c), the minimum test separation distance may be estimated, when applicable, by simple calculations according to plane-wave equivalent conditions, to ensure the transmitter and its antenna(s) can operate in manners that meet or exceed the estimated distance. The source-based time-averaged maximum radiated power, according to the maximum antenna gain, must be applied to calculate the field strength and power density required to establish the minimum test separation distance. When the estimated test separation distance becomes overly conservative and does not support compliance, MPE measurement or computational modeling may be used to determine the required minimum separation distance.

According to §1.1310 Radiofrequency radiation exposure limits, paragraph (e), the limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields are:

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(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
1,500–100,000			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/1500	30
1,500–100,000			1.0	30

f = frequency in MHz * = Plane-wave equivalent power density

FCC MPE Evaluation Results

Each supported transmission technology will be evaluated to determine if it is in compliance with limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields.

In order to perform the assessment, the following equations have been used for the calculations; these equations are accurate in the far-field of an antenna and will over-predict power density in the near field, where they could be used for making a "worst case" or conservative prediction:

Power density: $S[mW/cm^2] = \frac{P_{E.I.R.P.}[mW]}{4\Pi R[cm]^2}$

Minimum compliance distance: $R_{\min}[cm] = \sqrt{\frac{P_{E.I.R.P.}[mW]}{4\Pi S[mW/cm^2]}}$

Where:

S = power density

$P_{E.I.R.P.}$ = Equivalent isotropically radiated power

R = distance to the center of radiation of the antenna (evaluation distance)

$R_{\min}$ = distance to the center of radiation of the antenna

Assessment 1 – Wi-Fi SISO – 2450 MHz Band

Maximum EIRP (dBm):	20.0
Maximum EIRP (mW):	100
Minimum use distance (cm):	20.0
Worst Case Frequency (MHz):	2412.0
General population - Power density limit (mW/cm^2):	1.0

Power density at minimum use distance:

Power density (mW/cm^2):	0.02
General population - Power density limit (mW/cm^2):	1.0
Verdict for general population:	PASS

The power density level for this transmission mode is below general population exposure power density limit.

Assessment 2 – Wi-Fi SISO – 5 GHz Bands

Maximum EIRP (dBm):	20.0
Maximum EIRP (mW):	100
Minimum use distance (cm):	20.0
Worst Case Frequency (MHz):	5150.0
General population - Power density limit (mW/cm^2):	1.0

Power density at minimum use distance:

Power density (mW/cm^2):	0.02
General population - Power density limit (mW/cm^2):	1.0
Verdict for general population:	PASS

The power density level for this transmission mode is below general population exposure power density limit.

Assessment 3 – Wi-Fi MIMO – 5 GHz Bands

Maximum EIRP (dBm):	20.0
Maximum EIRP (mW):	100
Minimum use distance (cm):	20.0
Worst Case Frequency (MHz):	5150.0
General population - Power density limit (mW/cm^2):	1.0

Power density at minimum use distance:

Power density (mW/cm^2):	0.02
General population - Power density limit (mW/cm^2):	1.0
Verdict for general population:	PASS

The power density level for this transmission mode is below general population exposure power density limit.

Assessment 4 – Bluetooth – 2450 MHz Band

Maximum EIRP (dBm):	10
Maximum EIRP (mW):	10
Minimum use distance (cm):	20.0
Worst Case Frequency (MHz):	2402.0
General population - Power density limit (mW/cm^2):	1.0

Power density at minimum use distance:

Power density (mW/cm^2):	0.002
General population - Power density limit (mW/cm^2):	1.0
Verdict for general population:	PASS

The power density level for this transmission mode is below general population exposure power density limit.

Assessment 5 – Multiple frequencies assessment

When multiple sources are introduced into an environment, it becomes necessary to address the sources interdependently, since each source will contribute some percentage of the maximum exposure toward the total exposure at a fixed location. The sum of the ratios of the exposure from each source to the corresponding maximum exposure for the frequency of each source must be evaluated.

The exposure complies with the maximum permissible exposure if the sum of the ratios is less than unity:

$$\sum_{i=1}^{n} \frac{S_i}{MPE_i} < 1$$

Where
S_i is the power flux density of each source;
MPE_i is the power flux density basic restriction of each source.

The worst case multiple frequencies calculation will be as follow:

$$\frac{S_{WiFi2.4-SISO}}{MPE} + \frac{S_{WiFi5-SISO}}{MPE} + \frac{S_{WiFi5-MIMO}}{MPE}\frac{S_{BT}}{MPE} = \frac{0.02+0.02+0.02+0.002}{1} = 0.062 < 1 \text{ Limit}$$

Appendix B: ISED RF Exposure

ISED RF Exposure evaluation for mobile devices

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

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	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	$3.142f^{0.3417}$	$0.008335f^{0.3417}$	$0.02619f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

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

Table 6: RF Field Strength Limits for Controlled Use Devices (Controlled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[23]	170	180	-	Instantaneous*
0.1-10	-	$1.6/f$	-	6**
1.29-10	$193/f^{0.5}$	-	-	6**
10-20	61.4	0.163	10	6
20-48	$129.8/f^{0.25}$	$0.3444/f^{0.25}$	$44.72/f^{0.5}$	6
48-100	49.33	0.1309	6.455	6
100-6000	$15.60f^{0.25}$	$0.04138f^{0.25}$	$0.6455f^{0.5}$	6
6000-15000	137	0.364	50	6
15000-150000	137	0.364	50	$616000/f^{1.2}$
150000-300000	$0.354f^{0.5}$	$9.40 \times 10^{-4} f^{0.5}$	$3.33 \times 10^{-4} f$	$616000/f^{1.2}$

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

ISED MPE Evaluation Results

Each supported transmission technology will be evaluated to determine if it is in compliance with RSS-102 Issue 5, RF Field Strength Limits for devices used by the General Public.

In order to perform the assessment, the following equations have been used for the calculations; these equations are accurate in the far-field of an antenna and will over-predict power density in the near field, where they could be used for making a "worst case" or conservative prediction:

Power density: $S[W/m^2] = \frac{P_{E.I.R.P.}[W]}{4\Pi R[m]^2}$

Minimum compliance distance: $R_{\min}[m] = \sqrt{\frac{P_{E.I.R.P.}[W]}{4\Pi S[W/m^2]}}$

Where:

S = power density

$P_{E.I.R.P.}$ = Equivalent isotropically radiated power

R = distance to the center of radiation of the antenna (evaluation distance)

$R_{\min}$ = distance to the center of radiation of the antenna

Assessment 1 – Wi-Fi SISO – 2450 MHz Band

Maximum EIRP (dBm):	20.0
Maximum EIRP (W):	0.1
Minimum use distance (m):	0.2
Worst Case Frequency (MHz):	2412.0
General public - Power density limit (W/m²):	5.366

Power density at minimum use distance:

Power density (W/m²):	0.2
General public - Power density limit (W/m²):	5.366
Verdict for general public:	PASS

The power density level for this transmission mode is below general public power density limit.

Assessment 2 – Wi-Fi SISO – 5 GHz Bands

Maximum EIRP (dBm):	20.0
Maximum EIRP (W):	0.1
Minimum use distance (m):	0.2
Worst Case Frequency (MHz):	5150.0
General public - Power density limit (W/m²):	9.011

Power density at minimum use distance:

Power density (W/m²):	0.2
General public - Power density limit (W/m²):	9.035
Verdict for general public:	PASS

The power density level for this transmission mode is below general public power density limit.

Assessment 3 – Wi-Fi MIMO – 5 GHz Bands

Maximum EIRP (dBm):	20.0
Maximum EIRP (W):	0.1
Minimum use distance (m):	0.2
Worst Case Frequency (MHz):	5150.0
General public - Power density limit (W/m²):	9.011

Power density at minimum use distance:

Power density (W/m²):	0.2
General public - Power density limit (W/m²):	9.035
Verdict for general public:	PASS

The power density level for this transmission mode is below general public power density limit.

Assessment 4 – Bluetooth – 2450 MHz Band

Maximum EIRP (dBm):	10
Maximum EIRP (W):	0.01
Minimum use distance (m):	0.2
Worst Case Frequency (MHz):	2402.0
General public - Power density limit (W/m²):	5.35

Power density at minimum use distance:

Power density (W/m²):	0.02
General public - Power density limit (W/m²):	5.35
Verdict for general public:	PASS

The power density level for this transmission mode is below general public power density limit.

Assessment 5 – Multiple frequencies assessment

When multiple sources are introduced into an environment, it becomes necessary to address the sources interdependently, since each source will contribute some percentage of the maximum exposure toward the total exposure at a fixed location. The sum of the ratios of the exposure from each source to the corresponding maximum exposure for the frequency of each source must be evaluated.

The exposure complies with the maximum permissible exposure if the sum of the ratios is less than unity:

$$\sum_{i=1}^{n} \frac{S_i}{MPE_i} < 1$$

Where
S_i is the power flux density of each source;
MPE_i is the power flux density basic restriction of each source.

The worst case multiple frequencies calculation will be as follow:

$$\frac{S_{WiFi2.4-SISO}}{MPE} + \frac{S_{WiFi5-SISO}}{MPE} + \frac{S_{WiFi5-MIMO}}{MPE} + \frac{S_{BT}}{MPE} = \frac{0.2}{5.37} + \frac{0.2}{9.01} + \frac{0.2}{9.01} + \frac{0.02}{5.35} = 0.09 < 1 \text{ Limit}$$