

Test report No:
NIE: 60320RAN.002A1

Assessment report

RF EXPOSURE REPORT ACCORDING TO

FCC 47 CFR Part 2.1091
FCC 47 CFR Part 2.1093
ISED RSS-102 Issue 5:2015

(*) Identification of item under evaluation	Automotive infotainment System	
(*) Trademark	Mercedes-Benz	
(*) Model and /or type reference	NTG7RSU	
Other identification of the product	FCC ID: T8GNTG7RSU IC: 6434A-NTG7RSU HW Version: C0 SW Version: E13.205	
(*) Features	Bluetooth, WLAN	
Manufacturer	HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH BECKER-GOERING-STR. 16 76307 KARLSBAD GERMANY	
Test method requested, standard	FCC 47 CFR Part 2.1091 Radiofrequency radiation exposure evaluation: mobile devices. FCC 47 CFR Part 2.1093. Radiofrequency radiation exposure evaluation: portable devices. ISED RSS-102 Issue 5 (2015-03) – Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands) IEEE Std C95.3™ -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	
Summary	IN COMPLIANCE	
Approved by (name / position & signature)	José de la Plaza EMC Laboratory Director	JOSE DE LA PLAZA FERNÁNDEZ Firmado digitalmente por JOSE DE LA PLAZA FERNÁNDEZ Fecha: 2020.07.22 13:50:31 +02'00'
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Competences and guarantees

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Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").
2. Maximum output power, antenna gain and installation distance information for all carlines.
3. The sample consists of an Automotive Rear Seat Unit (RSU) for installation in cars. Features: BT, WLAN, Display interface, interface to Head Unit.

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

Identification of the client

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Document history

Report number	Date	Description
60320RAN.002	2019-10-25	First release.
60320RAN.002A1	2020-07-22	Second release. Maximum output power and antenna distances updated for all carlines installations. This modification test report cancels and replaces the test report 60320RAN.002.

General description of the device under evaluation

The device under evaluation consists of an Automotive Rear Seat Unit (RSU) for installation in cars. Features: BT, WLAN, Display interface, interface to Head Unit.

The rear seat unit contains two Bluetooth/WLAN module based on Broadcom's BCM89359 chip.

It provides the following features:

- WLAN 2.4 GHz
- WLAN 5 GHz (MIMO)
- BT 2.0 + EDR
- BT 3.0

The equipment specifications declared by the manufacturer for each supported technology are shown in the following table:

WLAN Chip	Technology	Band	Frequency (MHz)	Maximum Conducted Output Power (dBm)	Antenna peak gain (dBi)	Maximum E.I.R.P. (dBm)	Maximum E.I.R.P. (mW)
1	WLAN (SISO)	2.4 GHz	2402 - 2472	15.00	3.00	18.00	63.10
	WLAN (SISO)	5 GHz	5170 - 5835	15.00	4.50	19.50	89.13
	WLAN (MIMO)	5 GHz	5170 - 5835	15.00	4.50	19.50	89.13
	Bluetooth	2.4 GHz	2400 -2483.5	7.00	3.00	10.00	10.00
2	WLAN (SISO)	2.4 GHz	2402 - 2472	15.00	3.00	18.00	63.10
	WLAN (SISO)	5 GHz	5170 - 5835	15.00	4.50	19.50	89.13
	WLAN (MIMO)	5 GHz	5170 - 5835	15.00	4.50	19.50	89.13

Table 1: Equipment specifications

According to the manufacturer, this device will be installed into specific carlines, using four transmitting antennas with the following radiating technologies:

WLAN Chip	PIN	Antenna	Functionality
1	Pin1	WLAN1	SISO 2G4, MIMO 5G
	Pin2	BT1	BT, SISO 5G, MIMO 5G
2	Pin3	WLAN2	SISO 2G4, MIMO 5G
	Pin4	BT2	SISO 5G, MIMO 5G

Table 2: Antenna functionality

For all carlines, antennas will be installed into four specific locations of the car resulting in a distance much greater than 20 cm between them. WLAN1 and WLAN2 antennas will be installed always at a distance greater than 20 cm from any car passenger for all carlines, and BT1 and BT2 will be installed at distances between 14.5 cm and more than 20 cm to the closest car passenger depending on the carline model.

Therefore, each car passenger will only have one specific antenna near its seat at a distance between 14.5 cm and more than 20 cm, and the rest of the antennas at a distance much greater than 20 cm.

According to the manufacturer, all possible carlines installations are listed on the following table:

Carline	Antenna	Cable length, [mm]	PIN	DAG naming	Vehicle position	Functionality	Min. distance antenna - passenger
BR 223	WLAN1	2505	Pin1	WLAN1	parcel shelf right	SISO 2G4, MIMO 5G	> 20 cm
	BT1	2310	Pin2	BT1	parcel shelf mid	BT, SISO 5G, MIMO 5G	> 20 cm
	WLAN2	2120	Pin3	WLAN2	parcel shelf left	SISO 2G4, MIMO 5G	> 20 cm
	BT2	1815	Pin4	BT2	wheel body left	SISO 5G, MIMO 5G	16.7 cm
Carline	Antenna	Cable length, [mm]	PIN	DAG naming	Vehicle position	Functionality	Min. distance antenna - passenger
X296	WLAN1	5535	Pin1	WLAN1	boarding area right	SISO 2G4, MIMO 5G	> 20 cm
	BT1	5320	Pin2	BT1	C-pillar right	BT, SISO 5G, MIMO 5G	> 20 cm
	WLAN2	1920	Pin3	WLAN2	boarding area left	SISO 2G4, MIMO 5G	> 20 cm
	BT2	2370	Pin4	BT2	C-pillar left	SISO 5G, MIMO 5G	> 20 cm
Carline	Antenna	Cable length, [mm]	PIN	DAG naming	Vehicle position	Functionality	Min. distance antenna - passenger
V297	WLAN1	1155	Pin1	WLAN1	boarding area right	SISO 2G4, MIMO 5G	> 20 cm
	BT1	1400	Pin2	BT1	C-pillar right	BT, SISO 5G, MIMO 5G	17 cm
	WLAN2	4360	Pin3	WLAN2	boarding area left	SISO 2G4, MIMO 5G	> 20 cm
	BT2	3700	Pin4	BT2	C-pillar left	SISO 5G, MIMO 5G	17 cm
Carline	Antenna	Cable length, [mm]	PIN	DAG naming	Vehicle position	Functionality	Min. distance antenna - passenger
V167	WLAN1	3730	Pin1	WLAN1	boarding area right	SISO 2G4, MIMO 5G	> 20 cm
	BT1	4360	Pin2	BT1	C-pillar right	BT, SISO 5G, MIMO 5G	14.5 cm
	WLAN2	3725	Pin3	WLAN2	boarding area left	SISO 2G4, MIMO 5G	> 20 cm
	BT2	4350	Pin4	BT2	C-pillar left	SISO 5G, MIMO 5G	14.5 cm
Carline	Antenna	Cable length, [mm]	PIN	DAG naming	Vehicle position	Functionality	Min. distance antenna - passenger
C167	WLAN1	3710	Pin1	WLAN1	boarding area right	SISO 2G4, MIMO 5G	> 20 cm
	BT1	4265	Pin2	BT1	C-pillar right	BT, SISO 5G, MIMO 5G	15.55 cm
	WLAN2	3690	Pin3	WLAN2	boarding area left	SISO 2G4, MIMO 5G	> 20 cm
	BT2	4245	Pin4	BT2	C-pillar left	SISO 5G, MIMO 5G	15.55 cm
Carline	Antenna	Cable length, [mm]	PIN	DAG naming	Vehicle position	Functionality	Min. distance antenna - passenger
X167	WLAN1	-	Pin1	WLAN1	boarding area right	SISO 2G4, MIMO 5G	> 20 cm
	BT1	-	Pin2	BT1	C-pillar right	BT, SISO 5G, MIMO 5G	> 20 cm
	WLAN2	-	Pin3	WLAN2	boarding area left	SISO 2G4, MIMO 5G	> 20 cm
	BT2	-	Pin4	BT2	C-pillar left	SISO 5G, MIMO 5G	> 20 cm

Table 3: Carlines information

RF Exposure Assessment result and verdict

In order to cover all carlines installations the attenuation of the installation cable, which will depend on the cable length, was not taken into account to assess a more conservative worst-case condition.

Assessment for each antenna has been performed at a conservative evaluation distance of 20 cm for cases where all antennas are installed more than 20 cm away from any nearby passenger, and BT1 and BT2 antennas have been also assessed at the worst-case installation distance between all carlines.

FCC assessment:

1. Installed antennas with a distance greater than 20 cm from nearby car passengers

Limits for Maximum Permissible Exposure (MPE) to comply with FCC 47 CFR § 2.1091 are defined in “§1.1310 Radiation Exposure limits, paragraph (e)”:

Antenna	Technology	Band	Frequency (MHz)	Distance (cm)	Power density (mW/cm ²)	FCC General Population Limit (mW/cm ²)	Verdict
WLAN1	WLAN (SISO)	2.4 GHz	2402 - 2472	20.00	0.01	1.00	Pass
	WLAN (MIMO)	5 GHz	5170 - 5835	20.00	0.02	1.00	Pass
BT1	WLAN (SISO)	5 GHz	5170 - 5835	20.00	0.02	1.00	Pass
	WLAN (MIMO)	5 GHz	5170 - 5835	20.00	0.02	1.00	Pass
	Bluetooth	2.4 GHz	2400 - 2483.5	20.00	0.002	1.00	Pass
WLAN2	WLAN (SISO)	2.4 GHz	2402 - 2472	20.00	0.01	1.00	Pass
	WLAN (MIMO)	5 GHz	5170 - 5835	20.00	0.02	1.00	Pass
BT2	WLAN (SISO)	5 GHz	5170 - 5835	20.00	0.02	1.00	Pass
	WLAN (MIMO)	5 GHz	5170 - 5835	20.00	0.02	1.00	Pass

Table 4: MPE assessment result and verdict

2. Installed antennas within 20 cm from nearby car passenger

The following antennas will be installed at different distances depending on the carline, with distances between 14.5 cm and 20 cm to the closest passenger. The worst-case evaluation according to a conservative minimum installation distance of 14 cm according to KDB 447498 D01 General RF Exposure Guidance, see Appendix A for additional information, will be as follow:

Antenna	Technology	Band	Frequency (MHz)	Max. Conducted Output Power (dBm)	Distance (cm)	Max. Output Power (mW)	Limit 1-g SAR (mW)	SAR Test Exclusion
BT1	WLAN (SISO)	5 GHz	5170 - 5835	15.00	14.0	31.62	962.15	Pass
	WLAN (MIMO)	5 GHz	5170 - 5835	15.00	14.0	31.62	962.15	Pass
	Bluetooth	2.4 GHz	2400 - 2483.5	7.00	14.0	5.01	995.18	Pass
BT2	WLAN (SISO)	5 GHz	5170 - 5835	15.00	14.0	31.62	962.15	Pass
	WLAN (MIMO)	5 GHz	5170 - 5835	15.00	14.0	31.62	962.15	Pass

Table 5: KDB 447498 D01 SAR test exclusion evaluation result

3. Simultaneous Transmission assessment:

The device supports the following simultaneous transmission combinations:

1. Chip 1 [Pin1(SISO 2G4) & Pin2(SISO 5G)] + Chip 2 [Pin3(SISO 2G4) & Pin4(SISO 5G)]
2. Chip 1 [Pin1(SISO 2G4) & Pin2(SISO 5G)] + Chip 2 [Pin3(MIMO 5G) & Pin4(MIMO 5G)]
3. Chip 1 [Pin1(SISO 2G4) & Pin2(BT)] + Chip 2 [Pin3(MIMO 5G) & Pin4(MIMO 5G)]
4. Chip 1 [Pin1(SISO 2G4) & Pin2(BT)] + Chip 2 [Pin3(SISO 2G4)]

Worst-cases simultaneous transmission have been assessed for passengers close to Pin2-BT1 Antenna and Pin4-BT2 Antenna, taking into account a minimum separation distance of 14.0 cm to the respective antenna for each case, and 20 cm separation distance for the rest:

Simultaneous transmission assessment for passenger close to Pin2-BT1 Antenna	Result	Limit	Verdict
Chip 1 [Pin1(SISO 2G4) & Pin2(SISO 5G)] + Chip 2 [Pin3(SISO 2G4) & Pin4(SISO 5G)]	0.07	1	Pass
Chip 1 [Pin1(SISO 2G4) & Pin2(SISO 5G)] + Chip 2 [Pin3(MIMO 5G) & Pin4(MIMO 5G)]	0.08	1	Pass
Chip 1 [Pin1(SISO 2G4) & Pin2(BT)] + Chip 2 [Pin3(MIMO 5G) & Pin4(MIMO 5G)]	0.06	1	Pass
Chip 1 [Pin1(SISO 2G4) & Pin2(BT)] + Chip 2 [Pin3(SISO 2G4)]	0.03	1	Pass

Table 6: FCC simultaneous transmission assessment for passenger close to Pin2-BT1 Antenna

Simultaneous transmission assessment for passenger close to Pin4-BT2 Antenna	Result	Limit	Verdict
Chip 1 [Pin1(SISO 2G4) & Pin2(SISO 5G)] + Chip 2 [Pin3(SISO 2G4) & Pin4(SISO 5G)]	0.07	1	Pass
Chip 1 [Pin1(SISO 2G4) & Pin2(SISO 5G)] + Chip 2 [Pin3(MIMO 5G) & Pin4(MIMO 5G)]	0.07	1	Pass
Chip 1 [Pin1(SISO 2G4) & Pin2(BT)] + Chip 2 [Pin3(MIMO 5G) & Pin4(MIMO 5G)]	0.06	1	Pass
Chip 1 [Pin1(SISO 2G4) & Pin2(BT)] + Chip 2 [Pin3(SISO 2G4)]	0.05	1	Pass

Table 7: FCC simultaneous transmission assessment for passenger close to Pin4-BT2 Antenna

ISED assessment:

1. Installed antennas with a distance greater than 20 cm from nearby car passengers

Limits for RF Field Strength to comply with RSS-102 Issue 5 are defined in “Health Canada’s RF exposure guideline, Safety code 6”:

Antenna	Technology	Band	Frequency (MHz)	Distance (cm)	Power density (W/m ²)	ISED General Public Limit (W/m ²)	Verdict
WLAN1	WLAN (SISO)	2.4 GHz	2402 - 2472	20.00	0.13	5.35	Pass
	WLAN (SISO)	5 GHz	5170 - 5835	20.00	0.18	9.04	Pass
BT1	WLAN (SISO)	5 GHz	5170 - 5835	20.00	0.18	9.04	Pass
	WLAN (MIMO)	5 GHz	5170 - 5835	20.00	0.18	9.04	Pass
	Bluetooth	2.4 GHz	2400 - 2483.5	20.00	0.02	5.35	Pass
WLAN2	WLAN (SISO)	2.4 GHz	2402 - 2472	20.00	0.13	5.35	Pass
	WLAN (SISO)	5 GHz	5170 - 5835	20.00	0.18	9.04	Pass
BT2	WLAN (SISO)	5 GHz	5170 - 5835	20.00	0.18	9.04	Pass
	WLAN (MIMO)	5 GHz	5170 - 5835	20.00	0.18	9.04	Pass

Table 8: Field strength limits assessment results and verdict

2. Installed antennas within 20 cm from nearby car passenger

The following antennas will be installed at different distances depending on the carline with distances between 14.5 cm and 20 cm to the closest car passenger. The worst-case evaluation according to a conservative minimum installation distance of 14 cm according to “RSS-102 Issue 5 (2015-03), 2.5.1 Exemption Limits for Routine Evaluation – SAR Evaluation”, will be as follow:

Antenna	Technology	Band	Frequency (MHz)	Distance (cm)	Maximum E.I.R.P. (mW)	SAR Low-power exclusion level (mW)	SAR Test Exclusion
BT1	WLAN (SISO)	5 GHz	5170 - 5835	14.00	89.13	106.0	Pass
	WLAN (MIMO)	5 GHz	5170 - 5835	14.00	89.13	106.0	Pass
	Bluetooth	2.4 GHz	2400 - 2483.5	14.00	10.00	309.0	Pass
BT2	WLAN (SISO)	5 GHz	5170 - 5835	14.00	89.13	106.0	Pass
	WLAN (MIMO)	5 GHz	5170 - 5835	14.00	89.13	106.0	Pass

Table 9: ISED SAR exemption evaluation results

3. Simultaneous Transmission assessment:

The device supports the following simultaneous transmission combinations:

1. Chip 1 [Pin1(SISO 2G4) & Pin2(SISO 5G)] + Chip 2 [Pin3(SISO 2G4) & Pin4(SISO 5G)]
2. Chip 1 [Pin1(SISO 2G4) & Pin2(SISO 5G)] + Chip 2 [Pin3(MIMO 5G) & Pin4(MIMO 5G)]
3. Chip 1 [Pin1(SISO 2G4) & Pin2(BT)] + Chip 2 [Pin3(MIMO 5G) & Pin4(MIMO 5G)]
4. Chip 1 [Pin1(SISO 2G4) & Pin2(BT)] + Chip 2 [Pin3(SISO 2G4)]

Worst-cases simultaneous transmission have been assessed for passengers close to Pin2-BT1 Antenna and Pin4-BT2 Antenna, taking into account a minimum separation distance of 14.0 cm to the respective antenna for each case, and 20 cm separation distance for the rest:

Simultaneous transmission assessment for passenger close to Pin2-BT1 Antenna	Result	Limit	Verdict
Chip 1 [Pin1(SISO 2G4) & Pin2(SISO 5G)] + Chip 2 [Pin3(SISO 2G4) & Pin4(SISO 5G)]	0.91	1	Pass
Chip 1 [Pin1(SISO 2G4) & Pin2(SISO 5G)] + Chip 2 [Pin3(MIMO 5G) & Pin4(MIMO 5G)]	0.90	1	Pass
Chip 1 [Pin1(SISO 2G4) & Pin2(BT)] + Chip 2 [Pin3(MIMO 5G) & Pin4(MIMO 5G)]	0.10	1	Pass
Chip 1 [Pin1(SISO 2G4) & Pin2(BT)] + Chip 2 [Pin3(SISO 2G4)]	0.08	1	Pass

Table 10: ISED simultaneous transmission assessment for passenger close to Pin2-BT1 Antenna

Simultaneous transmission assessment for passenger close to Pin4-BT2 Antenna	Result	Limit	Verdict
Chip 1 [Pin1(SISO 2G4) & Pin2(SISO 5G)] + Chip 2 [Pin3(SISO 2G4) & Pin4(SISO 5G)]	0.91	1	Pass
Chip 1 [Pin1(SISO 2G4) & Pin2(SISO 5G)] + Chip 2 [Pin3(MIMO 5G) & Pin4(MIMO 5G)]	0.91	1	Pass
Chip 1 [Pin1(SISO 2G4) & Pin2(BT)] + Chip 2 [Pin3(MIMO 5G) & Pin4(MIMO 5G)]	0.89	1	Pass
Chip 1 [Pin1(SISO 2G4) & Pin2(BT)] + Chip 2 [Pin3(SISO 2G4)]	0.06	1	Pass

Table 11: ISED simultaneous transmission assessment for passenger close to Pin4-BT2 Antenna

Appendix A: FCC RF Exposure information

FCC SAR test exclusion considerations for portable devices

As stated by the FCC (47 CFR §2.1093), human exposure to RF emissions from portable devices, which are defined as transmitting devices to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user, must be evaluated with respect to the FCC-adopted limits for SAR.

According to FCC OET KDB 447498 D01 General RF Exposure Guidance:

Unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding SAR Test Exclusion Threshold condition is satisfied.

- For distances ≤ 50 mm

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot \sqrt{f(\text{GHz})} \leq 3.0 \text{ for 1-g SAR and } \leq 7.5 \text{ for 10-g extremity SAR}$$

Where

- f(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

Approximate SAR Test Exclusion Power Thresholds at Selected Frequencies and Test Separation Distances are illustrated in the following Table:

MHz	5	10	15	20	25	30	35	40	45	50	mm
150	39	77	116	155	194	232	271	310	349	387	SAR Test Exclusion Threshold (mW)
300	27	55	82	110	137	164	192	219	246	274	
450	22	45	67	89	112	134	157	179	201	224	
835	16	33	49	66	82	98	115	131	148	164	
900	16	32	47	63	79	95	111	126	142	158	
1500	12	24	37	49	61	73	86	98	110	122	
1900	11	22	33	44	54	65	76	87	98	109	
2450	10	19	29	38	48	57	67	77	86	96	
3600	8	16	24	32	40	47	55	63	71	79	
5200	7	13	20	26	33	39	46	53	59	66	
5400	6	13	19	26	32	39	45	52	58	65	
5800	6	12	19	25	31	37	44	50	56	62	

SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and ≤ 50 mm

- For distances > 50 mm

For 100 MHz to 6 GHz frequencies and for test separation distances > 50 mm, the SAR test exclusion threshold is determined according to the following:

1) [Power allowed at numeric threshold for 50 mm in table 1) + (test separation distance - 50 mm)·(f(MHz)/150)] mW, at 100 MHz to 1500 MHz

2) [Power allowed at numeric threshold for 50 mm in table 1) + (test separation distance - 50 mm)·10] mW, at > 1500 MHz and ≤ 6 GHz

Approximate SAR test exclusion power thresholds at selected frequencies and test separation distances are illustrated in the following table

MHz	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	mm
100	474	481	487	494	501	507	514	521	527	534	541	547	554	561	567	SAR Test Exclusion Threshold (mW)
150	387	397	407	417	427	437	447	457	467	477	487	497	507	517	527	
300	274	294	314	334	354	374	394	414	434	454	474	494	514	534	554	
450	224	254	284	314	344	374	404	434	464	494	524	554	584	614	644	
835	164	220	275	331	387	442	498	554	609	665	721	776	832	888	943	
900	158	218	278	338	398	458	518	578	638	698	758	818	878	938	998	
1500	122	222	322	422	522	622	722	822	922	1022	1122	1222	1322	1422	1522	
1900	109	209	309	409	509	609	709	809	909	1009	1109	1209	1309	1409	1509	
2450	96	196	296	396	496	596	696	796	896	996	1096	1196	1296	1396	1496	
3600	79	179	279	379	479	579	679	779	879	979	1079	1179	1279	1379	1479	
5200	66	166	266	366	466	566	666	766	866	966	1066	1166	1266	1366	1466	
5400	65	165	265	365	465	565	665	765	865	965	1065	1165	1265	1365	1465	
5800	62	162	262	362	462	562	662	762	862	962	1062	1162	1262	1362	1462	

SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and > 50 mm

- For frequencies below 100 MHz

The following may be considered for SAR test exclusion:

1) For test separation distances > 50 mm and < 200 mm, the power threshold at the corresponding test separation distance at 100 MHz in step b) is multiplied by [1 + log(100/f(MHz))]

2) For test separation distances ≤ 50 mm, the power threshold determined by the equation in c) 1) for 50 mm and 100 MHz is multiplied by ½

Approximate SAR test exclusion power thresholds at selected frequencies and test separation distances are illustrated in the following table

MHz	< 50	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	mm
100	237	474	481	487	494	501	507	514	521	527	534	541	547	554	561	567	mW
50	308	617	625	634	643	651	660	669	677	686	695	703	712	721	729	738	
10	474	948	961	975	988	1001	1015	1028	1041	1055	1068	1081	1095	1108	1121	1135	
1	711	1422	1442	1462	1482	1502	1522	1542	1562	1582	1602	1622	1642	1662	1682	1702	
0.1	948	1896	1923	1949	1976	2003	2029	2056	2083	2109	2136	2163	2189	2216	2243	2269	
0.05	1019	2039	2067	2096	2125	2153	2182	2211	2239	2268	2297	2325	2354	2383	2411	2440	
0.01	1185	2370	2403	2437	2470	2503	2537	2570	2603	2637	2670	2703	2737	2770	2803	2837	

SAR Test Exclusion Thresholds for frequencies < 100 MHz

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

Each supported transmission technology with a radiating antenna with a separation distance greater than 20 cm 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:

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

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)

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:

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

Where

S_i is the applicable contribution of each source.

Lim_i is the limit for the applicable contribution of each source.

Appendix B: ISED RF Exposure information

ISED SAR test exclusion considerations

According to “RSS-102 Issue 5 (2015-03) – Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)”, paragraph “2.5.1 Exemption Limits for Routine Evaluation – SAR Evaluation”, the device operates below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1:

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance^{4,5}

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

Output power level shall be the higher of the maximum conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power. For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 5. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 2.5. If the operating frequency of the device is between two frequencies located in Table 1, linear interpolation shall be applied for the applicable separation distance. For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required.

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	3.142 $f^{0.3417}$	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 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	15.60 $f^{0.25}$	0.04138 $f^{0.25}$	0.6455 $f^{0.5}$	6
6000-15000	137	0.364	50	6
15000-150000	137	0.364	50	616000/ $f^{1.2}$
150000-300000	0.354 $f^{0.5}$	9.40 x 10 ⁻⁴ $f^{0.5}$	3.33 x 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

Each supported transmission technology with a radiating antenna with a separation distance greater than 20 cm 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:

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

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)

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:

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

Where

S_i is the applicable contribution of each source.

Lim_i is the limit for the applicable contribution of each source.