MAXIMUM PERMISSIBLE EXPOSURE REPORT (Measurement)

FOR THE

Device: Gas Endpoint
Model: 500GR

Report No.: 99808-29

Date of issue: December 24, 2018

PREPARED FOR:
Itron, Inc.
2111 N. Molter Road
Liberty Lake WA 99019

PREPARED BY:
S. YAMAMOTO
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

The test data contained in this report documents the observed testing parameters pertaining to and are relevant for only the sample equipment tested in the agreed upon operational mode(s) and configuration(s) as identified herein. Compliance assessment remains the client's responsibility. This report may not be used to claim product endorsement by A2LA or any government agencies. This test report has been authorized for release under quality control from CKC Laboratories, Inc.

Steve Behm
Director of Quality Assurance & Engineering Services
CKC Laboratories, Inc.

Purpose:

To demonstrate compliance with United States, Canada, Australia and/or European Union RF Exposure requirements for Mobile Equipment (devices used >20cm from the body), where MPE measurements apply.

Device and Antenna Operating Configuration:

Device operating at maximum output power with continuous transmission of modulated data.

Test Procedure:

This equipment is evaluated in accordance with the guidelines set forth in KDB 447498 & ANSI C95.1 for the US, Health Canada Safety Code 6 & RSS 102 for Canada, ARPANSA RPS3 for AU and EN 62479 or EN 62311 for EU.

Other Considerations:

Report considers stand-alone configurations only. RF Exposure limits are calculated at the mid-point of each operating band. Multi-transmitter devices are assumed to permit simultaneous transmission, unless indicated otherwise. Simultaneous transmissions aggregated providing a worst case assessment.

Referenced Test Reports:

The following test reports were referenced in conjunction with this assessment: 99808-27 and 99808-28

MPE Measurements

Operational Details					
Power Reported is:	☒ Peak ☐ Average				
Limit Used is:	☒ General Population ☐ Occupational Exposure				
Operating Band MHz	**Power dBm**	**Ant Gain dBi**	**EIRP dBm**	**TX Simultaneous**	**Antenna Configuration**
902.3-926.9	26.8	Integral / 1.9	28.7	No	Integral
902.4-927.6	17.1	Integral / 0.3	17.4	No	Integral
902.4-927.6	26.86	Integral / 4.7	31.56	No	Integral

Test Equipment					
Asset	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
00638	Field Probe	Amplifier Research	FP2000	10/26/2017	10/26/2019
00636	Field Monitor	Amplifier Research	FM2000	10/26/2017	10/26/2019

MPE Measurements for Static Fields (Free Space Configuration)

For equipment where the fields are invariant in time, measurements are performed at a fixed height between 1.0m to 1.8m representing worst case measurements as determined by preliminary assessment.

FCC Part 2.1091

Distance (m)	Height (m)	Measured Exposure mW/cm^2 4.7 dBi antenna	Limit (worst case) mW/cm^2	Result
0.2	1.0	0.002	0.61	Pass
0.2	1.4	0.00004	0.61	Pass
0.2	1.8	0.0000004	0.61	Pass
0.3	1.0	0.001	0.61	Pass
0.3	1.4	0.00002	0.61	Pass
0.3	1.8	0.0000002	0.61	Pass
0.4	1.0	0.001	0.61	Pass
0.4	1.4	0.0001	0.61	Pass
0.4	1.8	0.0000001	0.61	Pass

Limits based on operating frequency

Transmitter	Highest power operating frequency range (MHz)	Limit (mW/cm^2)
Stand-alone	902.3-927.6	0.61

RSS-102 Issue 5

Distance (m)	Height (m)	Measured Exposure W/m^2 4.7 dBi antenna	Limit (worst case) W/m^2	Result
0.2	1.0	0.02	2.77	Pass
0.2	1.4	0.0004	2.77	Pass
0.2	1.8	0.000004	2.77	Pass
0.3	1.0	0.01	2.77	Pass
0.3	1.4	0.0002	2.77	Pass
0.3	1.8	0.000002	2.77	Pass
0.4	1.0	0.01	2.77	Pass
0.4	1.4	0.001	2.77	Pass
0.4	1.8	0.000001	2.77	Pass

Note:

Limits based on operating frequency

Transmitter	Highest power operating frequency range (MHz)	Limit (W/m^2)
Stand-alone	902.3-927.6	2.77

Summary:

MPE Calculation Results:

Equipment demonstrating compliance with MPE calculations have been evaluated, without further testing, for use under mobile RF exposure configurations as identified herein. Additional configurations including collocation or simultaneous transmission with other transmitters (including necessary separation distances) are subject to further assessment. It is assumed that the manufacturer shall design the equipment such that the minimum separation distance of 20cm (or greater, as listed above) is met or that the manufacturer provides a protection guide (e.g. installation instructions) to the end user such that the antenna(s) may be installed in accordance with the manufacturer's instructions in such a manor to maintain the minimum separation distance.

General Comments:

The absorption and distribution of Electromagnetic energy in the body is a very complex phenomena that depends on the mass, shape and physiological condition of the body; the orientation of the body with respect to the fields; and, the electrical properties of the body and the environment. Variables that may play a substantial role in possible biological effects are those that characterize the environment (including but not limited to: ambient temperature, air velocity, relative humidity and body insulation); and those that characterize the individual (including but not limited to: age, gender, activity level and existing debilitation or disease). Because innumerable factors may interact to determine specific biological effects of exposure to electromagnetic fields, any protection guide should consider both intended and unintended operational environments and provide guidance for installation and use of the product such that proper separation distances can be maintained. (ANSI C95.1)

APPENDIX A - Assessment Procedure

TEST CONFIGURATION

The EUT antenna is placed in a configuration typical of normal installation. Where antenna mounting is required, non-conductive materials are used for support structures. In the special case of magnetically mounted vehicle antennas, a reference ground plane is used to simulate actual installation. In order to limit external interference effects, the test is performed in a semi-anechoic chamber. The EUT equipment is setup in a configuration representative of normal use. Support equipment for the measurement instruments are located outside of the testing area.

TEST PROCEDURE

Measurements are performed using a broadband detector with three orthogonal measurement axes. Values recorded are RMS based on the maximum measurements. To determine the direction of the maximum measurement, the detector is moved throughout the RF field generated by the transmit antenna. The detector is positioned at a minimum of 12 radials and at varying distances from the antenna along each radial. The area of maximum RF energy determined during preliminary investigation shall be used for the remainder of the tests. In the case where a transmitter may have multiple frequency bands, the preliminary investigation shall be repeated for each band.

For time varying fields, the appropriate averaging time is used. For spatially uniform fields, the measurement height is selected based on maximum preliminary measurements.

For spatially non-uniform fields (e.g. distances close to a magnetically mounted vehicle antenna), spatial averaging may be performed. The method for performing spatially averaged measurements is as follows:

1. Determine the direction of the maximum measurement.
2. At a specific distance measure vertically from the floor 5 points comprising a linear cross section of an adult human body, beginning at 0.2m and at each 40cm up to 1.8m.
3. Calculate the average of the measurements and compare with the established limit.

Since the applicable limits exist in several different measurement units, the following outlines the most common calculations used for determining the spatially averaged field.

Case 1: Where limits are applied in electric field strength (V/m), the spatially averaged electric field strength along a grid of *n* points is calculated using:

$$E = \left[\frac{1}{n} \sum_{i=1}^{n} E_i^2 \right]^{\frac{1}{2}}$$

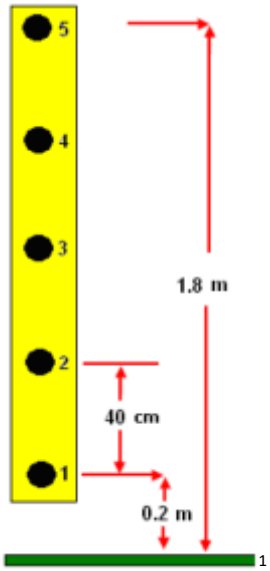
Case 2: Where limits are applied in units of power density (mW/cm^2), assuming measurements are made in the far field, where the E and H vectors are mutually orthogonal, power density is first calculated using:

$$S = \frac{E^2}{3770}$$

And the spatially averaged power density along a grid of n points is calculated using:

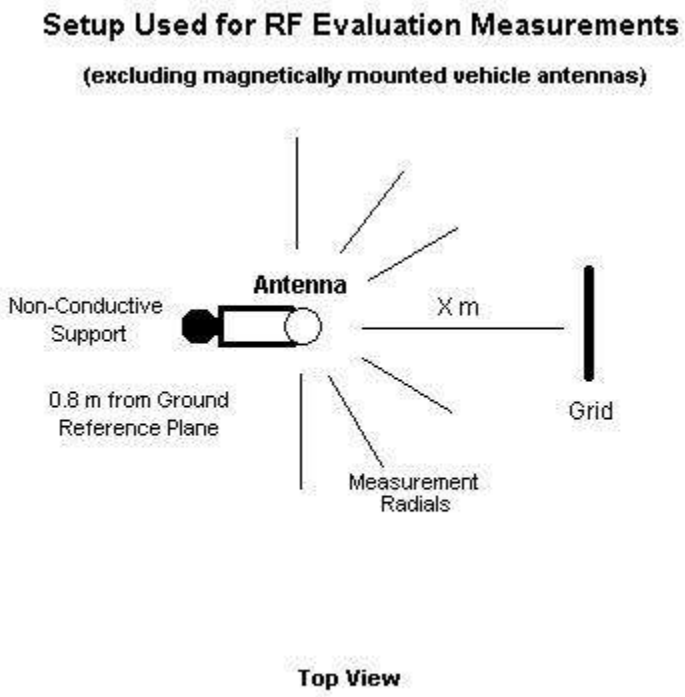
$$S = \frac{1}{n} \sum_{i=1}^{n} S_i$$

The following diagram is an example of the grid used to perform local measurements for RF exposure evaluation over a whole-body spatial average.



[1]

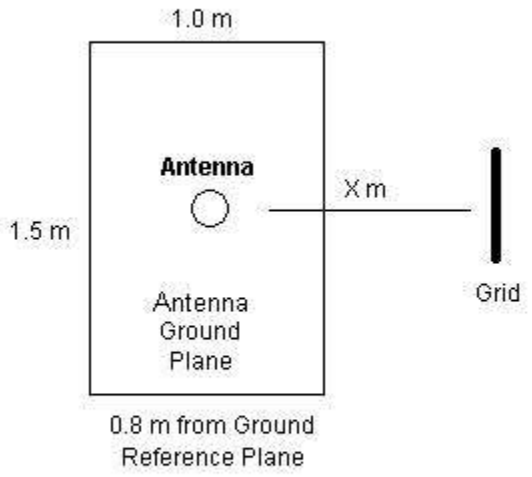
The following diagram is an example of the setup used for most tests, excluding magnetically mounted vehicle antennas.



[1] Source: IC GL-01

The following diagram is an example of the setup used for vehicle-mounted antennas. In the case where vehicle glass mounted antennas are used, this setup shall not apply. The letter X represents the test distance used for RF exposure measurements. The distance X is measured from the phase center of the transmitting antenna to the volumetric center of the measurement instrument. In order to more accurately simulate normal installation, the antenna ground plane is not bonded to the ground reference plane. The transmitting antenna is placed in the center of the antenna ground plane.

Setup Used for Vehicle-Mounted Antennas



Top View

APPENDIX B - RF Exposure Limits

United States Compliance Requirements (1.1310):

RF Exposure Evaluation Limits
Occupational / Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
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	6
300-1500	---	---	f/300	6
1500-100,000	---	---	5.0	6

RF Exposure Evaluation Limits
General Population / Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
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
300-1500	---	---	f/1500	30
1500-100,000	---	---	1.0	30

** Plane wave equivalent power density*
Limit is calculated based on the mid-band frequency used in the operating frequency range.

Stand-Alone Evaluation Exemption Levels:
In accordance with KDB 447498 D01 v05r02

	Max Output Power at Exemption Limit (mW)	
Frequency (MHz)	*d ≤ 50mm*	*50mm < d ≤ 20cm*
<100	$\frac{1}{2}\cdot\left(\frac{R\cdot 50}{\sqrt{0.1}}\right)\cdot\left(1+LOG\left(\frac{100}{f_{MHz}}\right)\right)$	$\left(\frac{R\cdot 50}{\sqrt{0.1}}+(d-50)\frac{100}{150}\right)\cdot\left(1+LOG\left(\frac{100}{f_{MHz}}\right)\right)$
100-1500	$\left(\frac{R\cdot d}{\sqrt{f_{GHz}}}\right)$	$\left(\frac{R\cdot 50}{\sqrt{f_{GHz}}}+(d-50)\frac{f_{MHz}}{150}\right)$
1500-6000		$\left(\frac{R\cdot 50}{\sqrt{f_{GHz}}}+(d-50)\cdot 10\right)$

R is the allowed ratio: 3 for 1-g SAR and 7.5 for 10-g extremity SAR.
d is distance in mm, rounded to the nearest mm.

Canadian Compliance Requirements (RSS-102):

RF Exposure Evaluation Limits
Occupational / Controlled Exposure:

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m^2)	Averaging Time (minutes)
0.003-10	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	$129.8 / f^{0.5}$	$0.3444 / f^{0.25}$	$44.72 / f^{0.5}$	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
15000-150,000	137	0.364	50	$616000/ f^{1.2}$
150,000-300,000	$0.354\ f^{0.5}$	$9.40x10^{-4}\ f^{0.5}$	$3.33x10^{-4}\ f$	$616000/ f^{1.2}$

RF Exposure Evaluation Limits
General Population / Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m^2)	Averaging Time (minutes)
0.003-10	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
15000-150,000	61.4	0.163	10	$616000/ f^{1.2}$
150,000-300,000	$0.158\ f^{0.5}$	$4.21x10^{-4}\ f^{0.5}$	$6.67x10^{-5}\ f$	$616000/ f^{1.2}$

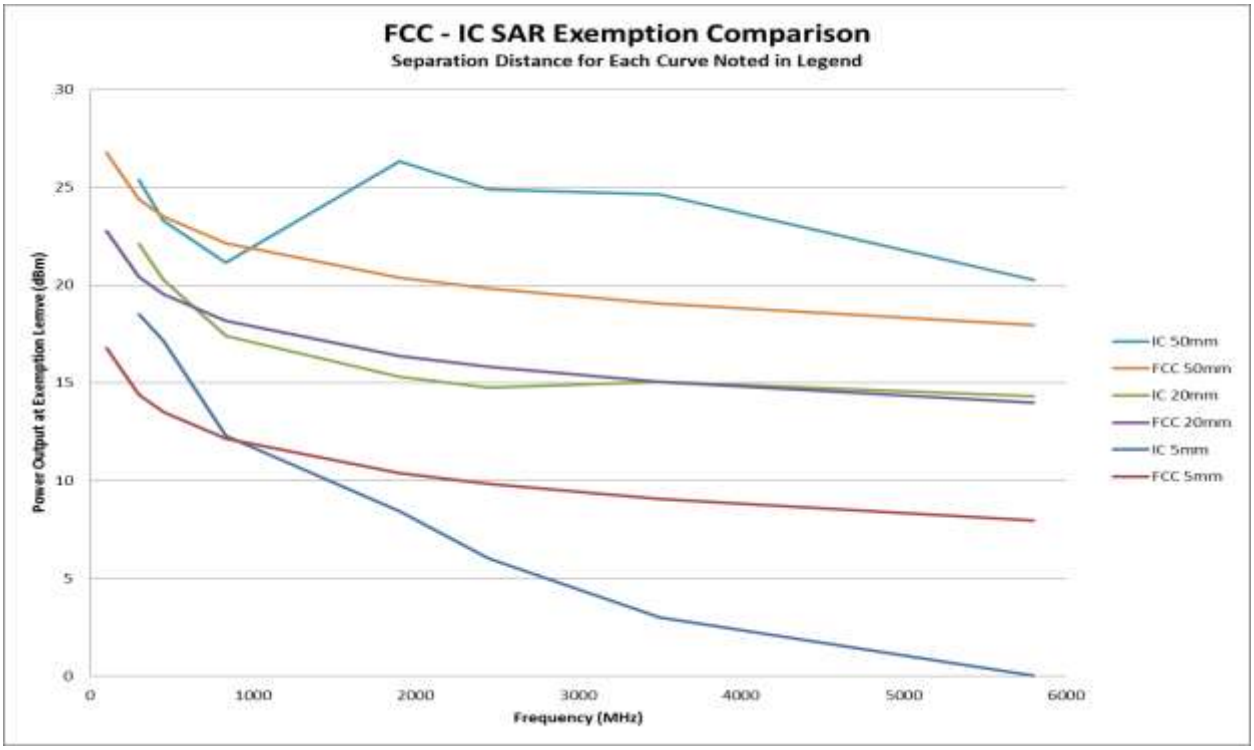
Stand-Alone Evaluation Exemption Levels:

Exemption Limits (mW) at Separation Distance (mm)										
Freq(MHz)	**≤5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**≥50**
≤300	71	101	132	162	193	223	254	284	315	345
450	52	70	88	106	123	141	159	177	195	213
835	17	30	42	55	67	80	92	105	117	130
1900	7	10	18	34	60	99	153	225	316	431
2450	4	7	15	30	52	83	123	173	235	309
3500	2	6	16	32	55	86	124	170	225	290
5800	1	6	15	27	41	56	71	85	97	106

Stand-Alone Evaluation Exemption Levels:

Frequency (MHz)	RF Exposure Exemption Limit (mW)
<20	1000
20-48	$22480 / f^{0.5}$
48-300	600
300-6000	$1310\ f^{0.6834}$
≥6000	5000

General[2] Comparison of FCC and IC Exemption Limits



[2] Non-Exhaustive

Australian Radiation Protection and Nuclear Safety Agency Requirements (ARPANSA):

RF Exposure Evaluation Limits
Occupational / Controlled Exposure:

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m^2)	Averaging Time (minutes)
0.1 – 1.0	614	1.63/f	---	6
1.0-10	614/f	1.63/f	$1000/f^2$	6
10-400	61.4	0.163	10	6
400-2000	$3.07 * f^{0.5}$	$0.00814 * f^{0.5}$	f/40	6
2000-10,000	137	0.36	50	6
10,000 – 300,000	137	0.36	50	$9.6x10^4 / f^{1.05}$

RF Exposure Evaluation Limits
General Population / Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m^2)	Averaging Time (minutes)
0.10-0.15	86.8	4.86	---	6
0.150-1.0	86.8	0.729/f	--	6
1.0-10	$86.8/f^{0.5}$	0.729/f	---	6
10-400	27.4	0.0729	2	6
400-2000	$1.37 f^{0.5}$	$0.00364*f^{0.5}$	f/200	6
2000-10,000	61.4	0.163	10	6
10,000 – 300,000	61.4	0.163	10	$9.6x10^4 / f^{1.05}$

**Power density limit applicable >100MHz*

Stand-Alone Evaluation Exemption Levels:

Occupational Exposure: 100mW
Portable - General Public: 20mW
Mobile – General Public: Separation distance >20cm and power < ARPANSA RPS3 Table S2
Or according to ARPANSA RPS3 Table S1

Table S2

Operating Frequency (MHz)	Nominal Mean Power Output (W)
0.1-450	7
450-2500	3150 / f

European Union Compliance Requirements (ICNIRP):

RF Exposure Evaluation Limits
Occupational / Controlled Exposure:

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m^2)	Averaging Time (minutes)
0.00082-0.065	610	24.4	---	6
0.065-1.0	610	1.6/f	---	
1.0-10	610/f	1.6/f	---	6
10-400	61	0.16	10	6
400-2000	$3.0 * f^{0.5}$	$0.008 * f^{0.5}$	f/40	6
2000-300,000	137	0.36	50	6

RF Exposure Evaluation Limits
General Population / Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m^2)	Averaging Time (minutes)
0.003-0.150	87	5.0	---	6
0.150-1.0	87	0.73/f	--	6
1.0-10	$87/f^{0.5}$	0.73/f	---	6
10-400	28	0.073	2	6
400-2000	$1.375\ f^{0.5}$	$0.0037*f^{0.5}$	f/200	6
2000-300,000	61	0.16	10	6

**Power density limit applicable >100MHz*

Stand-Alone Evaluation Exemption[3] Levels:

Head / Body: 20mW
Extremity: 40mW

[3] EN 62479 Annex A, General Public

APPENDIX C - References

1. ACMA Radiocommunications (Electromagnetic Radio – Human Exposure) Standard, 2014.
2. AS/NZS 2772.2, Radiofrequency fields – Principles and method of measurement and computation – 3 kHz to 300 GHz, 2011.
3. Australian Radiation Protection and Nuclear Safety Agency, ARPANSA RPS 3, Maximum Exposure Levels to Radiofrequency Fields 3 kHz to 300 GHz, 2002 (&Errata, 2003).
4. New Zealand Standard, NZS 2772.1, Radiofrequency Fields Part 1: Maximum Exposure Levels 3 kHz to 300 GHz, 2009.
5. Federal Communications Commission Knowledge Database (KDB) Publication 447498, "What are the RF exposure requirements and procedures for mobile and portable devices?" As in effect on the issue date of this report.
6. Title 47 Code of Federal Regulations, Part 1.1310, "Radiofrequency radiation exposure limits." As in effect on the issue date of this report.
7. Title 47 Code of Federal Regulations, Part 2.1091, "Radiofrequency radiation exposure evaluation: mobile devices." As in effect on the issue date of this report.
8. ANSI C95.1 (2005) IEEE Standard for Safety Level with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300 GHz, 2005.
9. Health Canada Safety Code 6 Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz, 2015.
10. Industry Canada GL-01 Guidelines for the Measurement of Radio Frequency Fields at Frequencies From 3 kHz to 300 GHz, Issue 3, March 2015.
11. Industry Canada RSS-102 Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands), Issue 5, March 2015.
12. EC Council Recommendation 1999/519/EC "On the limitation of exposure of the general public to electromagnetic fields (0Hz to 300GHz)," (1999).
13. European Committee for Electrotechnical Standardization. European Normative, EN 62311 Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz to 300 GHz), 2008.
14. European Committee for Electrotechnical Standardization. European Normative, EN 62479 Assessment of the compliance of low power electronic and electrical equipment with the basic restrictions related to human exposure to electromagnetic fields (10 MHz to 300 GHz), 2010.
15. International Commission on Non-Ionizing Radiation Protection. Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz). Health Physics 74 (4): 494-522; 1998.
16. International Commission on Non-Ionizing Radiation Protection Statement on the "Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz). Health Physics 97(3):257-259, 2009.