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Maximum Permissible Exposure
HERMES 2.0

Dear Mr. Voegele,

please find our Maximum Permissible Exposure calculations for the HERMES 2.0.

Best Regards

i.V.

A handwritten signature in blue ink, appearing to be 'C. Steinroeder', written over a light blue grid background.

Carsten Steinröder

Maximum Permissible Exposure

(as specified in Table 1B of 47 CFR 1.1310 – Limits for Maximum Permissible Exposure (MPE), Limits for General Population/Uncontrolled Exposure)

Frequency range (MHz)	Power density (mW/cm ²)
300 – 1500	f/1500
1,500 – 100000	1.0

Calculations 2.4 GHz and 5 GHz band

SAR Limit: 1 mW/cm²

Equation OET bulletin 65, page 18, edition 97-01: $S = P \cdot G / (4\pi R^2)$

S = power density

P = power input to the antenna

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the centre of radiation of the antenna

Operational Bands	Frequency (MHz)	Antenna Gain (dBi)	G		P		Limit (mW/cm ²)	S	
			Antenna Gain -numeric- (mW/cm ²)	Output Power -conducted- (dBm)	Output Power -conducted- (mW)	Output Power (EIRP) (mW)		Power Density value (mW/cm ²)	Margin to Limit (mW/cm ²)
WLAN - 802.11b	2412	5,2	3,3113	15,1	32,36	107,15	1,0000	0,0213	0,9787
WLAN - 802.11g	2462	5,2	3,3113	20,5	112,20	371,54	1,0000	0,0739	0,9261
WLAN - 802.11n (20 MHz BW MIMO)	2437	5,2	3,3113	23,9	245,47	812,83	1,0000	0,1617	0,8383
WLAN - 802.11n (20 MHz BW)	2462	5,2	3,3113	20,5	112,20	371,54	1,0000	0,0739	0,9261
WLAN - 802.11a	5825	4,4	2,7542	11,7	14,79	40,74	1,0000	0,0081	0,9919
WLAN - 802.11n (20 MHz BW MIMO)	5180	4,4	2,7542	14,1	25,70	70,79	1,0000	0,0141	0,9859
WLAN - 802.11n (20 MHz BW)	5785	4,4	2,7542	11,3	13,49	37,15	1,0000	0,0074	0,9926
WLAN - 802.11n (40 MHz BW MIMO)	5190	4,4	2,7542	12,8	19,05	52,48	1,0000	0,0104	0,9896
WLAN - 802.11n (40 MHz BW)	5755	4,4	2,7542	10,5	11,22	30,90	1,0000	0,0061	0,9939
WLAN - 802.11ac (20 MHz BW MIMO)	5180	4,4	2,7542	14,4	27,54	75,86	1,0000	0,0151	0,9849
WLAN - 802.11ac (20 MHz BW)	5785	4,4	2,7542	11,3	13,49	37,15	1,0000	0,0074	0,9926
WLAN - 802.11ac (40 MHz BW MIMO)	5190	4,4	2,7542	12,9	19,50	53,70	1,0000	0,0107	0,9893
WLAN - 802.11ac (40 MHz BW)	5755	4,4	2,7542	10,3	10,72	29,51	1,0000	0,0059	0,9941
WLAN - 802.11ac (80 MHz BW MIMO)	5210	4,4	2,7542	12,8	19,05	52,48	1,0000	0,0104	0,9896
WLAN - 802.11ac (80 MHz BW)	5775	4,4	2,7542	10,0	10,00	27,54	1,0000	0,0055	0,9945

Distance to Antenna (R) in cm:	20
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Note 1: only worst case values are listed in the table above

Note 2: the duty cycle correction factor is already included in the measurement values

Calculations GSM850/1900, FDD, eFDD Bands

Standards
OET Bulletin 65 Edition 97-01 August 1997
FCC 47 CFR §1.1307
FCC 47 CFR §1.1310
RSS-102 Issue 5 – March 2015

Test limits

As specified in Table 1B of 47 CFR 1.1310 – Limits for Maximum Permissible Exposure (MPE), Limits for General Population/Uncontrolled Exposure.

Frequency range (MHz)	Power density (mW/cm ²)
300 – 1,500	f/1500
1,500 – 100,000	1.0

Limits specified per RSS-102, Issue 5.

Frequency range (MHz)	Power density (W/m ²)	Power density (mW/cm ²)
300 – 6000	0.02619 f ^{0.6834}	mW/cm ² = W/m ² * 0.1

Equation OET bulletin 65, page 18, edition 97-01:
$$S = \frac{PG}{4\pi R^2} = \frac{EIRP}{4\pi R^2}$$

Where:

- S = power density
- P = power input to the antenna
- G = power gain of the antenna in the direction of interest relative to an isotropic radiator
- R = distance to the centre of radiation of the antenna

Maximum antenna gain to comply with EIRP limits for FCC and Industry Canada

Band	Mode	Duty Cycle (%)	Frequency (MHZ)	Maximum Conducted output power (dBm)	Maximum Conducted output power (mW)	Freq of highest power	FCC EIRP limit (mW)	Maximum antenna gain to meet EIRP Limit (dBi)
850	GSM	100,0%	836.2 - 848.8	33,5	2238,7211	836,20	11484	7,1
1900	GSM	100,0%	1850.2 - 1909.8	30,5	1122,0185	1850,20	2000	2,5
FDD 2	UMTS	100,0%	1850 - 1907.6	24	251,18864	1850,00	2000	9,0
FDD 4	UMTS	100,0%	1710 - 1752.6	24	251,18864	1710,00	1000	6,0
FDD 5	UMTS	100,0%	824 - 846.6	24,5	281,83829	824,00	11484	16,1
eFDD 2	LTE	100,0%	1850-1910	23,5	223,87211	1850,00	2000	9,5
eFDD 4	LTE	100,0%	1710-1755	23,5	223,87211	1710,00	1000	6,5
eFDD 5	LTE	100,0%	824 - 849	24	251,18864	824,00	11484	16,6
eFDD 7	LTE	100,0%	2500-2570	23	199,52623	2500,00	1000	7,0
eFDD13	LTE	100,0%	777-787	24	251,18864	777,00	4920	12,9
eFDD12	LTE	100,0%	698-716	24	251,18864	698,00	4921	12,9

Gains for section 3.1.2

Band	Max gain to be used to comply with EIRP Limits	Max gain to be used to comply with FCC MPE Limits	Max gain to be used to comply with IC MPE Limits	Maximum gain to be compliant with all limits
850	7,1	9,0	5,7	5,7
1900	2,5	14,5	11,0	2,5
FDD 2	9,0	13,0	9,5	9,0
FDD 4	6,0	13,0	9,3	6,0
FDD 5	16,1	9,9	6,6	6,6
eFDD 2	9,5	13,5	10,0	9,5
eFDD 4	6,5	13,5	9,8	6,5
eFDD 5	16,6	10,4	7,1	7,1
eFDD 7	7,0	14,0	11,4	7,0
eFDD13	12,9	10,2	6,9	6,9
eFDD12	12,9	10,1	7,1	7,1

FCC gains for mpe in section 3.2.2

Maximum antenna gain to comply with MPE limits for Industry Canada

Band	Mode	Duty Cycle	Frequency (MHZ)	Maximum Conducted output power (dBm)	Maximum Conducted output power (mW)	Equivalent conducted output power (mW)	MPE Limit (mW/cm ²)	Maximum antenna gain to meet MPE Limit (dBi)	Separation distance (cm)
850	GSM	50%	836,2	28,5	707,95	354,00	0,2602	5,7	20
1900	GSM	50%	1850,2	25,5	354,81	177,42	0,4477	11,0	20
FDD 2	UMTS	100%	1850,0	24,0	251,19	251,19	0,4476	9,5	20
FDD 4	UMTS	100%	1710,0	24,0	251,19	251,19	0,4242	9,3	20
FDD 5	UMTS	100%	824,0	24,5	281,84	281,84	0,2576	6,6	20
eFDD 2	LTE	100%	1850,0	23,5	223,87	223,87	0,4476	10,0	20
eFDD 4	LTE	100%	1710,0	23,5	223,87	223,87	0,4242	9,8	20
eFDD 5	LTE	100%	824,0	24,0	251,19	251,19	0,2576	7,1	20
eFDD 7	LTE	100%	2500,0	23,0	199,53	199,53	0,5499	11,4	20
eFDD13	LTE	100%	777,0	24,0	251,19	251,19	0,2474	6,9	20
eFDD12	LTE	100%	698,0	24,0	251,19	251,19	0,2299	7,1	21

IC gains for mpe in section 3.2.2

Maximum antenna gain to comply with MPE limits for FCC

Band	Mode	Duty Cycle	Frequency (MHZ)	Maximum Conducted output power (dBm)	Maximum Conducted output power (mW)	Equivalent conducted output power (mW)	MPE Limit (mW/cm ²)	Maximum antenna gain to meet MPE Limit (dBi)	Separation distance (cm)
850	GSM	50%	836,2	28,5	707,95	354,00	0,5575	9,0	20
1900	GSM	50%	1850,2	25,5	354,81	177,42	1,0000	14,5	20
FDD 2	UMTS	100,0%	1850,0	24	251,19	251,19	1,0000	13,0	20
FDD 4	UMTS	100,0%	1710,0	24	251,19	251,19	1,0000	13,0	20
FDD 5	UMTS	100,0%	824,0	24,5	281,84	281,84	0,5493	9,9	20
eFDD 2	LTE	100,0%	1850,0	23,5	223,87	223,87	1,0000	13,5	20
eFDD 4	LTE	100,0%	1710,0	23,5	223,87	223,87	1,0000	13,5	20
eFDD 5	LTE	100,0%	824,0	24	251,19	251,19	0,5493	10,4	20
eFDD 7	LTE	100,0%	2500,0	23	199,53	199,53	1,0000	14,0	20
eFDD13	LTE	100,0%	777,0	24	251,19	251,19	0,5180	10,2	20
eFDD12	LTE	100,0%	698,0	24	251,19	251,19	0,4653	10,1	21

Gain table section 3.2.2

Band	Max gain for FCC MPE Limits	Max gain for Industry Canada MPE Limits	Maximum gain to be compliant with all limits
850	9,0	5,7	5,7
1900	14,5	11,0	11,0
FDD 2	13,0	9,5	9,5
FDD 4	13,0	9,3	9,3
FDD 5	9,9	6,6	6,6
eFDD 2	13,5	10,0	10,0
eFDD 4	13,5	9,8	9,8
eFDD 5	10,4	7,1	7,1
eFDD 7	14,0	11,4	11,4
eFDD13	10,2	6,9	6,9
eFDD12	10,1	7,1	7,1

FCC MPE values using the maximum gain values obtained in section 3.3.4

Band	Mode	Duty Cycle (%)	Frequency (MHZ)	Maximum Conducted output power (dBm)	Max Conducted output power (mW)	FCC MPE Limit (mW/cm ²)	Power Density (mW/cm ²)	Separation distance (cm)	Verdict
850	GSM	50%	836,2	28,5	354,00	0,5575	0,5222	20	Pass
1900	GSM	50%	1850,2	25,5	177,42	1,0000	0,1990	20	Pass
FDD 2	UMTS	100%	1850,0	24	251,19	1,0000	0,3979	20	Pass
FDD 4	UMTS	100%	1710,0	24	251,19	1,0000	0,1989	20	Pass
FDD 5	UMTS	100%	824,0	24,5	281,84	0,5493	0,5115	20	Pass
eFDD 2	LTE	100%	1850,0	23,5	223,87	1,0000	0,3979	20	Pass
eFDD 4	LTE	100%	1710,0	23,5	223,87	1,0000	0,1989	20	Pass
eFDD 5	LTE	100%	824,0	24	251,19	0,5493	0,5115	20	Pass
eFDD 7	LTE	100%	2500,0	23	199,53	1,0000	0,1989	20	Pass
eFDD13	LTE	100%	777,0	24	251,19	0,5180	0,4906	20	Pass
eFDD12	LTE	100%	698,0	24	251,19	0,4653	0,4373	20	Pass

IC MPE values using the maximum gain values obtained in section 3.3.4

Band	Mode	Duty Cycle (%)	Frequency (MHZ)	Maximum Conducted output power (dBm)	Max Conducted output power (mW)	FCC MPE Limit (mW/cm ²)	Power Density (mW/cm ²)	Separation distance (cm)	Verdict
850	GSM	50%	836,2	28,5	354,00	0,2602	0,2333	20	Pass
1900	GSM	50%	1850,2	25,5	177,42	0,4477	0,1990	20	Pass
FDD 2	UMTS	100%	1850,0	24	251,19	0,4476	0,3979	20	Pass
FDD 4	UMTS	100%	1710,0	24	251,19	0,4242	0,1989	20	Pass
FDD 5	UMTS	100%	824,0	24,5	281,84	0,2576	0,2285	20	Pass
eFDD 2	LTE	100%	1850,0	23,5	223,87	0,4476	0,3979	20	Pass
eFDD 4	LTE	100%	1710,0	23,5	223,87	0,4242	0,1989	20	Pass
eFDD 5	LTE	100%	824,0	24	251,19	0,2576	0,2285	20	Pass
eFDD 7	LTE	100%	2500,0	23	199,53	0,5499	0,1989	20	Pass
eFDD13	LTE	100%	777,0	24	251,19	0,2474	0,2191	20	Pass
eFDD12	LTE	100%	698,0	24	251,19	0,2299	0,2045	20	Pass