NORBIT

Technical Note

Specific absorption rate and MPE

KU-180093-3_Part18

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1 Revision history for the document

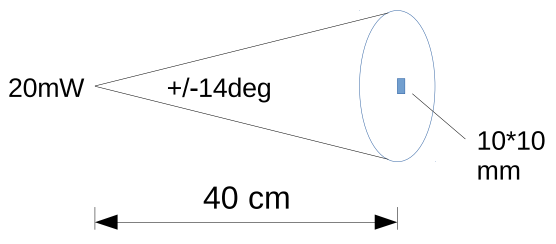
Rev1
- First revision.

Rev2
- Corrected date and document number

Rev 3
- Added MPE calculation

2 Calculating the SAR

The SAR figures are calculated from a model shown below including a 20mW source radiating over a +/-14deg beam:



Medium length antenna (403mm) in a long housing (583mm) ensures a minimum length of 0.4m to the antenna feed point:

Opening angle : +/-14deg

Radius of radiated area at 40cm distance from feeding point:

$$A = \pi \times (0.4\,m * \sin(14))^2 = 29.4 * 10^{-3}\,m^2$$

Applied RF power distributed over the area : 12dBm = <20mW

Reference volume:
- cube of 1g : Volume = 10mm^3
- exposed area : Area = 10mm^2

RF power over a 10*10mm square area:

$$P_{10x10mmsqare} = 20\,mW \frac{0.1 * 10^{-3}\,m^2}{29.4 * 10^{-3}\,m^2} = 68\,\mu W$$

Limits : 1.6W/kg / 1000 = 1.6mW

Margin:

$$Margin = 10 \log\left(\frac{68\,\mu W}{1.6\,mW}\right) = -13.7\,dB$$

This approximation assumes all RF power is absorbed by the tissue (no reflection).

3 Calculating MPE

MPE is calculated

$$S = \frac{PG}{4\pi R^2}$$

where
S = power density
P = 20mW = Power input to antenna
G = 16dBi = 40 = Power gain of the antenna relative to an isotropic radiator
R = Distance to the center of radiation of the antenna

Medium length antenna (403mm) in a long housing (583mm) ensures a minimum length of 0.4m to the antenna feed point:

$$S = \frac{PG}{4\pi R^2} = \frac{20\,mW * 40}{4\pi\ 0.4\,m} = 0.159\,mW/cm^2 = 1.59\,W/m^2$$

MPE limit : 1mW/cm^2

$$Margin\,of\ compliance = \frac{1\,mW/cm^2}{15.9\,uW/cm^2} = 8\,dB$$

Measurements of field strength

Using a dipole, the maximum level is found to be -12dBm, linear polarized along the rim of the antenna housing. Calculating the power density:

Area of isotropic antenna:

$$A = \frac{\lambda^2}{4\pi} = 0{,}0517\frac{m^2}{4\pi} = 213 * 10^{-6}\,m^2$$

Gain of dipole : 2.15dBi
Measured power : -12dBm
Isotropic power : -12dBm -2.15dB = -14.15dBm = 26uW
Power density:

$$P/A = \frac{26\,uW}{213 * 10^{-6}\,m^2} = 122\,mW/m^2$$

Calculating the power as received by area of 10*10mm (= 1g of tissue):

$$P_{10x10mmsqare} = 143.7\,mW/m^2 \times 0.1 * 10^{-3}\,m^2 = 12.2\,uW$$

SAR limits : 1.6W/kg / 1000 = 1.6mW

$$SAR\,margin = 10\log\left(\frac{1.6\,mW}{12.2\,\mu\,W}\right) = 21.2\,dB$$

This approximation assumes all RF power being absorbed by the tissue (no reflection).

MPE limits : 1mW/cm^2

$$MPE\,margin = 10\log\left(\frac{1\,mW}{12.2\,\mu W}\right) = 19.1\,dB$$

4 Concluding the SAR and MPE measurements

The measurements show less field strength than the theoretical cone calculations. This is expected, as the real radiated power is more spread/less focused.

In both cases the radiation is found to be far below the limit, even when for SAR measurements where the tissue is set to absorb all of the RF energy (no reflection).