Maximum Permissible Exposure (MPE) Estimation for MU203

1 Introduction

MU203 WCDMA/EDGE/GPRS/GSM dual mode 6 bands Wireless Module is subscriber equipment in the UMTS/GSM system. The WCDMA frequency is Band I, and Band VIII. The GSM/GPRS/EDGE frequency bands include GSM850, EGSM900, DCS1800 and PCS1900. MU203 implement such functions as Rsignal receiving/transmitting, WCDMA and EDGE/GPRS/GSM protocol processing, data service etc. Externally it provides BTB interface (to connect to the notebook etc.)

2 Limits and Guidelines on Exposure to Electromagnetic Fields

According to the FCC Part 2.1091(which reference the part1.1310), we know: mobile device (transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitters radiating structure(s) and the body of the user or nearby persons). And the Cellular radiotelephone service and PCS services are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use if they operate at frequencies of 1.5 GHz or below and their effective radiated power (ERP) is 1.5 watts or more, or if they operate at frequencies above 1.5 GHz and their ERP is 3 watts or more.

Uncontrolled limits are used for general public. General population/uncontrolled exposure apply in situations is which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure. The exposure levels can be expressed in terms of power density, electric field strength, or magnetic field strength, as averaged over 30 minutes for the general public and 6 minutes for trained personnel. The exposure criterion is frequency dependent, and a chart covering the range from 3 kHz to 100 GHz can be found in NCRP No.86 (references IEEE C95.1-1999). Below are the limits.

Limits for Occupational/Controlled Exposure			
Frequency Range (MHz)	**Electric Field Strength (E) (V/m)**	**Magnetic Field Strength (H) (A/m)**	**Power Density (S) (mW/cm^2)**

0.3-3.0 **3.0-30** **30-300** **300-1500** **15,00-100,000**	**614** **1842/f** **61.4** **--** **--**	**16.3/f** **16.3/f** **0.163** **--** **--**	**(100)*** **($900/f^2$)*** **1.0** **f/300** **5**

Limits for General Population/Uncontrolled Exposure			
Frequency Range (MHz)	**Electric Field Strength (E) (V/m)**	**Magnetic Field Strength (H) (A/m)**	**Power Density (S) (mW/cm^2)**
0.3-1.34 **1.34-30.0** **30-300** **300-1500** **15,00-100,000**	**614** **824/f** **27.5** **--** **--**	**1.63** **2.19/f** **0.073** **--** **--**	**(100)*** **($180/f^2$)*** **0.2** **f/1500** **1**

Power density S [mW/cm2] for controlled area at 850 MHz ， (TX: 824MHz – 849MHz)

$$S = \frac{f(MHz)}{300} = \frac{824}{300} = 2.75 \ \text{mW/cm}^2$$

Power density S [mW/cm2] for uncontrolled area at 824 MHz

$$S = \frac{f(MHz)}{1500} = \frac{824}{1500} = 0.55 \ \text{mW/cm}^2$$

Power density S [mW/cm2] for uncontrolled area at 1900 MHz

S=1 mW/cm^2

Reference levels are provided for exposure assessment to determine whether the basic restrictions on exposure of humans to electromagnetic fields are exceeded. The basic restrictions on exposure to electromagnetic fields are based directly on established health effects and biological considerations.

3 Location of EUT

The source of the radiation is mounted on terminal; generally the direction of the antenna position is uprightness tabletop. The highest level of emission would be expected in close vicinity of the antenna and in line of sight to the antenna.

4 Prediction of the Exposure to Electromagnetic Fields

Calculations can be made on a site by site basis to ensure the power density is below the limits given above, or guidelines can be done beforehand to ensure the minimum distances

from the antenna is maintained through the site planning. The calculations are based on FCC OET 65 Appendix B.

4.1 Calculation of the Safe Distance

Below method describes a theoretical approach to calculate possible exposure to electromagnetic radiation around a base station transceiver antenna. Precise statements are basically only possible either with measurements or complex calculations considering the complexity of the environment (e.g. soil conditions, near buildings and other obstacles) which causes reflections, scattering of electromagnetic fields.

The maximum output power (given in EIRP) of a base station is usually limited by license conditions of the network operator.

A rough estimation of the expected exposure in power flux density on a given point can be made with the following equation. The calculations are based on FCC OET 65 Appendix B.

$$S = \frac{P(W) * G_{numeric}}{4 * r^2(m) * \pi}$$

Whereas:

P = Maximum output power in W of the site

G numeric = Numeric gain of the antenna relative to isotropic antenna

R = distance between the antenna and the point of exposure in meters

4.2 Technical Description MU203

Technical Specification:

Cellular Band

Power at antenna connector BTS: **31.71 dBm (GSM850)**

Antenna-cable attenuation: **0 dB**

Input power to antenna: **31.71 dBm（1.48W）(GSM850)**

Antenna gain: **4.28 dBi (2.68)**

PCS Band

Power at antenna connector BTS: **30.48 dBm (PCS1900)**

Antenna-cable attenuation: **0 dB**

Input power to antenna: **30.48 dBm （1.12W）(PCS1900)**

Antenna gain: **2.1 dBi (1.62)**

4.3 Estimation of compliance boundary for indoor antenna

1) Cellular Band :

GSM850

For the final determination of the compliance boundary the model for far-field calculation is used since this overestimates the field strength in the near-field region. Thus the calculated compliance boundary should be rather more conservative and on the safe side. For EUT the following compliance boundary is calculated:

Compliance boundary

For GSM 850MHz band:

When r=20cm and GSM only use one timeslot, so

$$S_{\text{one timeslot}} = \frac{P(W) * G_{numeric}}{8 * 4 * r^2(m) * \pi}$$

$$S_{\text{one timeslot}} = \frac{1480 * 2.68}{8 * 4 * 20^2 * \pi} = 0.099\ \text{mW/cm}^2$$

For GPRS and EDGE, the transmitter support multi-timeslot, but the conducted ERP will decrease 2dB when add one uplink timeslot, so we can get the following conclusion:

The power(dB) decrease 2dB, the power(W) should be divide by 1.58($10^{2/10}$)

Uplink timeslot	Output Power(W)	duty cycle
1	P	0.125
2	P/1.58	0.25
3	P/2.51	0.375
4	P/4	0.5

Note: we assume the output power of GPRS which with one uplink is P(W)

For two timeslot（which duty cycle is 0.25）:

$S_{two\ timeslot}=\frac{P/1.58*G}{8*r^2*\pi}*2 = S_{one\ timeslot}*2/1.58=1.27\ S_{one\ timeslot}$

For three timeslot（which duty cycle is 0.375）:

$S_{three\ timeslot}=\frac{P/2.51*G}{8*r^2*\pi}*3 = S_{one\ timeslot}*3/2.51=1.2\ S_{one\ timeslot}$

For four timeslot（which duty cycle is 0.5）:

$S_{two\ timeslot}=\frac{P/4*G}{8*r^2*\pi}*4 = S_{one\ timeslot}*4/4= S_{one\ timeslot}$

The two timeslot's S is the biggest. And it is same in EDGE.

S_{max}=1.27 $S_{one\ timeslot}$=0.126 mW/cm^2< 0.55 mW/cm^2

Because the EDGE's output power is smaller than the GRPS's output power, so here the calculation is abbreviated.

2) <u>PCS Band</u>

PCS1900

For EUT the following compliance boundary is calculated:

$$S=\frac{1120*1.62}{8*4*20^2*\pi}=0.045\ \text{mW/cm}^2$$

S_{max}=1.27 $S_{one\ timeslot}$ =0.057mW/cm^2< 1 mW/cm^2

The S at the position which is 20cm far from the EUT is smaller than the uncontrolled exposure limit line. So the EUT also complies with the Limits for Occupational/Controlled Exposure.