Maximum Permissible Exposure (MPE) Estimation for EUT

1 Introduction

HUAWEI BM623m, a WiMAX CPE, is a proprietary product developed by HUAWEI based on IEEE 802.16e-2005, and works in range of 2.496-2.69GHz, The product is composed of two PCB boards, a WiMAX and gateway board, an antenna PCB board, providing two ports and WLAN wireless downlink for the user service.

1×RJ45:10/100M LAN port;

1×RJ11:TEL port for VOIP;

The WLAN module is subscriber equipment in the WLAN system, operated in CH1-CH9. It includes two modulations of type. One is DSSS and another is OFDM. Supports IEEE802.11b, g, n.

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	**614**	**16.3/f**	**(100)***
3.0-30	**1842/f**	**16.3/f**	**($900/f^2$)***
30-300	**61.4**	**0.163**	**1.0**
300-1500	**--**	**--**	**f/300**
15,00-100,000	**--**	**--**	**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	**614**	**1.63**	**(100)***
1.34-30.0	**824/f**	**2.19/f**	**($180/f^2$)***
30-300	**27.5**	**0.073**	**0.2**
300-1500	**--**	**--**	**f/1500**
15,00-100,000	**--**	**--**	**1**

Power density S [mW/cm2] for controlled area at 2.5GHz (TX: 2496M-2690MHz)

$S=5\ mW/cm^2$

Power density S [mW/cm2] for uncontrolled area at 2.5GHz (TX: 2496M-2690MHz)

$S=1\ mW/cm^2$

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

EIRP: =Maximum conducted power + Gain	33.60dBm =26.60dBm+7dBi
TX Frequency range:	2496M-2690MHz

Note: For WiMAX, the maximum conducted output power is 26.60dBm, and it's antenna's max gain is 7.0dBi, so we can get the max EIRP 33.60dBm.

4.3 Estimation of compliance boundary for indoor antenna

For EUT the following compliance boundary is calculated:

EIRP: **2290.87mW (33.60dBm)**

$$S = \frac{2290.87}{4 * 20^2 * \pi} = 0.46 \text{ mW/cm}^2$$

Modulation	MPE Limit (mW/cm^2)	Con Output Power (mW)	Duty cycle (%)	Max Anna Gain (dBi)	EIRP (dBm)	Pd at 20cm (mW/cm2)	% of limit
2496M-2690MHz							
802.16e	1	457.09	1	7.0	33.60	0.46	**46%**

The maximum power spectral density 20cm from the antenna relative to the limit is the highlighted row and the power density is **46**% of the limit.

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.