EMF Exposure Estimation for E960

1 Introduction

HUAWEI E960 Wireless gateway is subscriber equipment in the UMTS/GSM system, also provides wireless Internet accessing function, routing function, and network address translation (NAT) function. The GSM/GPRS/EDGE frequency band includes GSM850, PCS1900. Externally it provides one USB interface (to connect to the notebook or adapter etc.), one USIM card interface, one RJ11 interface (to connect to fixed telephone), four RJ45 interface (to connect to pc). It has four internal antennas as default.

In Gateway mode (powered by adapter), E960 supports the following function. E960 implements such functions as RF signal receiving/transmitting, HSDPA/WCDMA and EDGE/GPRS/GSM protocol processing, data service, etc. An 802.11 b/g-compliant WLAN AP interface is provided. Four 10/100 Mbit/s high-speed Ethernet interfaces are provided at the LAN side. The E960 provides the switching function for local networking and sharing of broadband network when it is connected to terminal devices. The voice service by directly connecting a telephone is supported.

In modem mode (powered by notebook/PC) it only provides data function with USB port, voice function with RJ11 port, and not provides WLAN, NAT and routing functions.

2 Limits and Guidelines on Exposure to Electromagnetic Fields

According to the FCC Part 2.1091, 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. The radiated power of 850M/1900M for E960 is 2W/1W, so for E960 only the 850M band is need to be subjected to routine the environmental evaluation for RF exposure.

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/cm2)**
0.003-0.1 **0.1-3.0** **3.0-30** **30-100** **100-300** **300-3000** **3000-15,000** **15,000-100,000**	**614** **614** **1842/f** **61.4** **61.4** **--** **--** **--**	**163** **16.3/f** **16.3/f** **16.3/f** **0.163** **--** **--** **--**	**(100)*** **(100)*** **(900/f2)*** **1.0** **1.0** **f/300** **10** **10**

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/cm2)**
0.003-0.1 **0.1-1.34** **1.34-3.0** **3.0-30** **30-100** **100-300** **300-3000** **3000-15,000** **15,000-100,000**	**614** **614** **823.8/f** **823.8/f** **27.5** **27.5** **--** **--** **--**	**163** **16.3/f** **16.3/f** **16.3/f** **158.3 / f1.668** **0.0729** **--** **--** **--**	**(100)*** **(100)*** **(180/f2)*** **((180/f2)*** **0.2** **0.2** **f/1500** **f/1500** **10**

Power density S [mW/cm2] for controlled area at 850 MHz

$$S = \frac{f(MHz)}{300} = \frac{850}{300} = 2.83 \ \text{mW/cm}^2$$

Power density S [mW/cm2] for uncontrolled area at 850 MHz

$$S = \frac{f(MHz)}{1500} = \frac{850}{1500} = 0.566 \text{ mW/cm}^2$$

S= 0.566 mW/cm2 = 5.66 W/m^2 for uncontrolled exposure

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.

We can get the max ERP in channel 192 TM1 in the RF report for GSM, the ERP is 32.45dBm. We retested the ERP in channel 192 with the WLAN is on. The results are 32.25dBm (802.11b) and 32.20dBm (802.11g). So they are all smaller than 32.45dBm and 33dBm, so in this report we calculate use the 33dBm is the worst case.

3 Location of EUT

The EUT uses one monopole antenna. 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 E960

Technical Specification:

Output power:	2W (33 dBm) for GSM850MHz
Transmitter frequency band	GSM850
Number of antenna ports:	1
Frequency range:	850M： Uplink:824 M~849M； Downlink:869 M~894M
Gain:	<1dBi （GSM850）
Mechanical specification (Height)	50mm for GSM850

4.3 Estimation of compliance boundary for indoor antenna

GSM 850M:

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:

Power at antenna connector BTS: **33 dBm**

Antenna-cable attenuation: **0 dB**

Input power to antenna: **33 dBm (2W)**

Antenna gain: **1 dBi (1.26)**

Compliance boundary

For GSM 850MHz band:

When r=20cm

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

$$S = \frac{2 * 1.26}{4 * 0.2^2 * \pi} = 5.01 \text{W/m}^2 < 5.66 \text{ W/m}^2$$

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.