Maximum Permissible Exposure (MPE) Estimation for

1 Introduction

The HUAWEI wireless gateway B681-54 (hereinafter referred to as the B681-54) is a wireless HSPA+3G gateway, which provides users with flexible and diversified 3G and 2G data access services, routing function, and network address translation (NAT) function. The WCDMA frequency is Band II and Band V. The GSM frequency is GSM850/ 1900.The WLAN frequency is 2.4G. GSM850 transmit frequency is 824-849MHZ,and Receive Frequency is 869-894MHZ ;GSM1900 transmit frequency is 1850-1910MHZ,and Receive Frequency is 1930-1990 MHZ;WCDMA 1900 transmit frequency is 1850-1910MHZ,and Receive Frequency is 1930-1990MHZ. The WLAN frequency range is 2400-2483.5MHZ。WCDMA 850 transmit frequency is 824-849MHZ .and Receive Frequency is 869-894MHz. B681-54 implements such functions as RF signal receiving/transmitting, HSPA+ / WCDMA / GPRS/EDGE protocol processing, data service, etc. Externally it provides USB type B interface（For power supply）, USIM card interface, two auto-sensing Ethernet interfaces and external antenna interface. And RJ11 interface (to connect to fixed telephone), provide voice service.

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 above and their effective radiated power (ERP) is 1.5 watts or more, or if they operate at frequencies below 1.5 GHz and their ERP is 3 watts or more. The maximum radiated power of 850MHz for B681-54 is 2.52W, the maximum radiated power of 1900MHz for B681-54 is 1.26W, and the maximum radiated power of 2400MHz for B681-54 is 0.1W. So the B681-54 is excluded from routine environmental evaluation for RF exposure according to the requirement of FCC Part 2.1091. The present document is given just only for reference.

Uncontrolled limits are used for general public. General population/uncontrolled exposure apply in situations in 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)**
0.3-3.0 **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/f2)*** **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/cm2)**
0.3-1.34 **1.34-30** **30-300** **300-15,00** **15,00-100,000**	**614** **824/f** **27.5** **--** **--**	**1.63** **2.19/f** **0.073** **--** **--**	**(100)*** **(180/f2)*** **0.2** **f/1500** **1.0**

For GSM/WCDMA 850M

Power density S [mW/cm2] for controlled area at 800 MHz

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

Power density S [mW/cm2] for uncontrolled area at 800 MHz

$$S = \frac{f(MHz)}{1500} = \frac{824}{1500} = 0.549 \text{ mW/cm}^2$$

S= 0.549 mW/cm^2= 5.49 W/m^2 for uncontrolled exposure

For GSM/WCDMA 1900M, WLAN2400M

Power density S [mW/cm2] for controlled area at 1900/2400 MHz

$S = 5$ mW/cm^2

Power density S [mW/cm2] for uncontrolled area at 1900/2400 MHz

$S = 1.0$ mW/cm^2

S= 1.0 mW/cm^2= 10 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.

3 Location of EUT

The EUT uses one omnidirectional antenna. The source of the radiation is mounted on board of the terminal. The highest level of emission would be expected in close vicinity of 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 B681-54

Technical Specification:

Output power:	2W (33dBm) for GSM850MHz 1W (30dBm) for GSM1900MHz 0.25W(24dBm)for WCDMA850/1900MHz
Transmitter frequency band	GSM850/1900 WCDMA850/1900 WLAN2400
Number of antenna ports:	1
Frequency range:	WCDMA/GSM/GPRS/EDGE 850MHz: 824-849 MHz WCDMA/GSM/GPRS/EDGE 1900MHz: 1850-1910 MHz WLAN 2400 MHz: 2400-2483.5 MHz
Gain:	850/1900M/2400M: 1 dBi (peak value) 2400M: 0 dBi (peak value)
Mechanical specification (Height)	32.39 mm

4.3 Estimation of compliance boundary for indoor antenna

GSM 850:

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: **1dBi (1.26)**

Compliance boundary

For GSM 850MHz band:

When r=20cm

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

$$S = \frac{2 * 1.26}{4 * 0.2^2 * \pi} = 5.0 W/m^2 < 5.49\ W/m^2$$

GSM 1900:

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: **30 dBm**

Antenna-cable attenuation: **0 dB**

Input power to antenna: **30 dBm (1W)**

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

Compliance boundary

For GSM 1900MHz band:

When r=20cm

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

$$S = \frac{1*1.26}{4*0.2^2*\pi} = 2.5 W/m^2 < 10\ W/m^2$$

WCDMA 850:

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: **24 dBm**

Antenna-cable attenuation: **0 dB**

Input power to antenna: **24 dBm (0.25W)**

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

Compliance boundary

For WCDMA 850MHz band:

When r=20cm

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

$$S = \frac{0.25*1.26}{4*0.2^2*\pi} = 0.625 W/m^2 < 5.49\ W/m^2$$

WCDMA 1900:

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: **24 dBm**

Antenna-cable attenuation: **0 dB**

Input power to antenna: **24 dBm (0.25W)**

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

Compliance boundary

For WCDMA 1900MHz band:

When r=20cm

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

$$S = \frac{0.25 * 1.26}{4 * 0.2^2 * \pi} = 0.625 W/m^2 < 10\ W/m^2$$

WLAN 2400:

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: **20 dBm**

Antenna-cable attenuation: **0 dB**

Input power to antenna: **16 dBm (0.04W)**

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

Compliance boundary

For WLAN 2400MHz band:

When r=20cm

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

$$S = \frac{0.04 * 1.26}{4 * 0.2^2 * \pi} = 0.1 W/m^2 < 10\ W/m^2$$

GSM 850 and WLAN 2.4 G synchronous transmit:

When r=20cm

$$\sum_{i=1}^{n} \frac{S_i}{MPE_i} \leqslant 1$$

$$\sum_{1}^{n} \frac{Si}{MPEi} = \frac{5}{5.49} + \frac{0.1}{10} = 0.921 < 1$$

GSM 1900 and WLAN 2.4 G synchronous transmit:

When r=20cm

$$\sum_{i=1}^{n}\frac{S_i}{MPE_i}\leqslant 1$$

$$\sum_{1}^{n}\frac{Si}{MPEi}=\frac{2.5}{10}+\frac{0.1}{10}=0.26\ <1$$

WCDMA 850 and WLAN 2.4 G synchronous transmit:

When r=20cm

$$\sum_{i=1}^{n}\frac{S_i}{MPE_i}\leqslant 1$$

$$\sum_{1}^{n}\frac{Si}{MPEi}=\frac{0.625}{5.49}+\frac{0.1}{10}=0.124\ <1$$

WCDMA 1900 and WLAN 2.4 G synchronous transmit:

When r=20cm

$$\sum_{i=1}^{n}\frac{S_i}{MPE_i}\leqslant 1$$

$$\sum_{1}^{n}\frac{Si}{MPEi}=\frac{0.625}{10}+\frac{0.1}{10}=0.0725\ <1$$

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 General Population/Uncontrolled Exposure.