MAXIMUM PERMISSIBLE EXPOSURE ESTIMATION For HUAWEI E272

1 Introduction

HUAWEI E272 is subscriber equipment in the GSM system. The frequency band is 850M and 1900M. The E272 implements such functions as RF signal receiving / Transmitting, HSDPA/WCDMA/EDGE/GPRS/GSM protocol processing and data service etc. Externally it provides USB interface (to connect to the notebook etc.), USIM card interface. It has one internal antenna as default. E272 uses Qualcomm MSM7200 chipset and Zero-IF technologies.

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 E272 is 2W/1W, so for E272 only the 850M band needs 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)**
0.3-3.0 **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 850MHz:

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 869 MHz

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

S= 0.566 mW/cm2 = 5.66 W/m2 for uncontrolled exposure

For 1900MHz:

Power density S [mW/cm2] for controlled area at 1850 MHz

S=5 mW/cm^2

Power density S [mW/cm2] for uncontrolled area at 1850 MHz

S=1 mW/cm^2

S= 1 mW/cm^2 = 10 W/m2 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 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 E272

850MHz Technical Specification:

Input power to antenna:	2.00W (RMS 33.01 dBm) for TM1: GSM/GPRS 850 MHz （one timeslot for GSM/GPRS） 0.421W (RMS 26.24 dBm) for TM2: EDGE 850 MHz （one timeslot） 0.208W (RMS 23.17 dBm) for TM 3: WCDMA 850 MHz
Transmitter frequency band：	850M
Number of antenna ports:	1
Antenna system and type (typical)	monopole
Frequency range:	Uplink:824 MHz~849 MHz； Downlink:869 MHz~894 MHz
Gain:	<1dBi （850 MHz）
Mechanical specification (Height)	38mm for 850 MHz

1900MHz Technical Specification:

Input power to antenna:	0.975W (RMS 29.89 dBm) for TM1: GSM/GPRS1900MHz （one timeslot for GSM/GRPS） 0.343W (RMS 25.35 dBm) for TM2: EDGE1900MHz （one timeslot） 0.209W (RMS 23.19 dBm) for TM3: WCDMA1900MHz
Transmitter frequency band	1900M
Number of antenna ports:	1
Antenna system and type (typical)	monopole
Frequency range:	Uplink:1850 M~1910M； Downlink:1930 M~1990M

Gain:	<2 dBi （1900M）
Mechanical specification (Height)	38mm for 1900M

4.3 Estimation of compliance boundary

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:

Input power to antenna: **33.01 dBm (one timeslot)**

Note：Here the power is for one timeslot, so the factual power should be divided by 8.

Antenna-cable attenuation: **0 dB**

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

Compliance boundary

For GSM / GRPS 850MHz band:

$$S = \frac{2 * 1.26}{8 * 4 * 0.2^2 (m) * \pi}$$

S=0.627 W/m^2 <5.66 W/m^2

For EDGE850MHz,

$$S = \frac{0.421 * 1.26}{8 * 4 * 0.2^2 (m) * \pi}$$

S=0.132 W/m^2 <5.66 W/m^2

For WCDMA850MHz,

$$S = \frac{0.208 * 1.26}{4 * 0.2^2 (m) * \pi}$$

S=0.522 W/m^2 <5.66 W/m2

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$^{2/10}$)

For two timeslot:

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

For three timeslot:

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

For four timeslot:

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

The two timeslot's S is the biggest.

For GPRS850:

$S_{two\ timeslot}$=1.27 $S_{one\ timeslot}$ =1.27*0.627=0.80 <5.66 W/m^2

For EDGE850:

$S_{two\ timeslot}$=1.27 $S_{one\ timeslot}$ =1.27*0.132=0.17 <5.66 W/m^2

So for 850MHz three timeslots and four timeslots also meet the limit.

GSM 1900M:

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:

Input power to antenna: **29.89 dBm (one timeslot)**

Note：Here the power is for one timeslot, so the factual power should be divided by 8.

Antenna-cable attenuation: **0 dB**

Antenna gain: **2dBi (1.59)**

Compliance boundary

For GSM / GRPS 1900MHz band:

$$S=\frac{0.975*1.59}{8*4*0.2^2(m)*\pi}$$

S=0.386 W/m² <10 W/m²

For EDGE1900MHz,

$$S=\frac{0.343*1.59}{8*4*0.2^2(m)*\pi}$$

S=0.136 W/m² <10 W/m²

For WCDMA1900MHz,

$$S=\frac{0.209*1.59}{4*0.2^2(m)*\pi}$$

S=0.661W/m² <10 W/m²

The timeslot's calculation is same with 850MHz.

The two timeslots S is the biggest.

For GPRS1900:

$S_{two\ timeslot}$=1.27 $S_{one\ timeslot}$ =1.27*0.386=0.49 <10 W/m^2

For EDGE1900:

$S_{two\ timeslot}$=1.27 $S_{one\ timeslot}$ =1.27*0.136=0.18 <10 W/m^2

So for 1900MHz three timeslots and four timeslots also meet the limit.

Final conclusion:

The equipment meets the limits.