Maximum Permissible Exposure (MPE) Estimation for B890-66

1 Introduction

HUAWEI LTE Wireless Gateway–B890-66 is subscriber equipment in the WCDMA/LTE system, also supports wireless Internet accessing function, routing function, network address translation (NAT) function. The HSPA+/WCDMA frequency band is Band 2/4/5. The LTE frequency band includes Band 2/4/5/7/12/13/17. And the TX/RX band is 2400MHz~2483MHz for WLAN. B890-66 implements such functions as RF signal receiving/sending, WCDMA and LTE protocol processing, voice and data service etc. Externally it provides USB port interface, SIM card interface, four auto-sensing Ethernet interfaces and external antenna interface.

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 800MHz for B890-66 is 1W, so the B890-66 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 WCDMA 850M/ LTE Band 5

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 LTE Band 12/ LTE Band 13/ LTE Band 17

Power density S [mW/cm2] for controlled area at LTE Band 12/ LTE Band 13/ LTE Band 17

$$S = \frac{f(MHz)}{300} = \frac{699}{300} = 2.33 \ \text{mW/cm}^2$$

Power density S [mW/cm2] for uncontrolled area at LTE Band 12/ LTE Band 13/ LTE Band 17

$$S = \frac{f(MHz)}{1500} = \frac{699}{1500} = 0.466 \text{ mW/cm}^2$$

S= 0.466 mW/cm^2= 4.66 W/m^2 for uncontrolled exposure

For WCDMA 1900M /AWS/WLAN2400/LTE Band2/LTE Band 4/ LTE Band 7

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

S=5mW/cm^2

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

S=1.0mW/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.

We can get the max ERP from the RF report, the ERP is 23dBm, which is less than 24dBm, so in this report we calculate by using the 24dBm as the worst case.

3 Location of EUT

The fixed wireless terminal uses a built-in antenna. The antenna is fixed on the main board. The antenna type is Isotropic, Linear Polarization.

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 of B890-66

Item	Description
Frequency range	LTE:1900/AWS/850/2600/NA700MHz WCDMA:1900/AWS/850MHz
Input impedance	50 Ohm
VSWR	<3.
Gain	1dBi (horizontal level peak value)
Max. power	25W
Polarization Type	Linear polarization

4.3 Estimation of compliance boundary for indoor antenna

WCDMA 850M/ LTE Band 5:

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 CDMA 800MHz band:

When r=20cm

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

$$S = \frac{0.25 * 1.26}{4 * 0.2^2 * \pi} = 0.63 W/m^2 < 5.5\ W/m^2$$

LTE Band 12/ LTE Band 13/ LTE Band 17:

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:

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WCDMA 1900M /AWS/WLAN2400/LTE Band2/LTE Band 4/ LTE Band 7:

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 CDMA 1900MHz band:

When r=20cm

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

$$S = \frac{0.25 * 1.26}{4 * 0.2^2 * \pi} = 0.63 \text{W/m}^2 < 10 \text{ W/m}^2$$

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 General Population/Uncontrolled Exposure.