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## **1.0 About Electromagnetic Radiation Exposure**

This Exposure Estimation Report apply to OUTDOOR BTS WITH DUAL-DENSITY TRX BTS3006C.

### **1.1 Introduction**

The BTS3006C is used for edge networks and hotspots in cities, where medium-volume traffic is required. The BTS3006C is a double-transceiver EDGE BTS. It has the features of fast deployment, low cost, and wide coverage.

A single BTS3006C cabinet can supports up to six TRXs. It supports functions such as transmit diversity, 4-way receive diversity, and AMR.

The BTS3006C has large power and large capacity. It is small and easy to install. It can save the cost on the equipment room. Especially, it uses the direct air cooling technology, which saves the cost on the heat exchanger, power consumption, and maintenance.

The BTS3006C has strong environment adaptability. It can work under the temperature of  $-40$  to  $+55^{\circ}\text{C}$ . It supports the outdoor application with IP55 protection level.

The BTS3006C supports  $-48\text{ V}$  DC power inputs or AC power inputs. It supports the SDH. The optical cable can directly connect to the BTS.

The BTS3006C can form a network with indoor double-transceiver BTSs and outdoor BTSs, thus proving a fast, economical and effective network construction.

Base Transceiver Station (BTS) emits RF radiation (Radiation Hazard). Although there is no scientific evidence of possible health risks to persons living near to base stations some recommendations are giving below for the installation and operation of base station transceivers. Operators of base station transceivers are required to obey the local regulation for erecting base station transceivers.

### **1.2 Limits and Guidelines on Exposure to Electromagnetic Fields**

There are a number of international and national regulations, standards and guidelines for exposure to electromagnetic fields. Several European countries have adapted the recommendation of the council of the European Union published on 12. July 1999 on the limitation of exposure of the general public to electromagnetic fields(1999/519/EC), the recommendation is based on the guideline published by the International Commission on

Non-ionizing Radiation protection (ICNIRP). Below table shows a comparison between different regulations and applied reference levels of some countries.

The HUAWEI BTS3006C support several frequency band, GSM850/DCS1900, limitation of exposure of the general public to electromagnetic fields(1999/519/EC) in different frequency band is different, here we choose the most rigorous limit(the E field strength is smallest ) in several limits. According to 1999/519/EC, the E field strength is smallest in GSM850 band.

Country	Limit 869 MHz E <sub>electric field</sub> strength	Limit 869 MHz S <sub>power flux density</sub>	Limit 1930 MHz E <sub>electric field strength</sub>	Limit 1930MHz S <sub>power flux density</sub>
ICNIRP International	41 V/m	4.35 W/m <sup>2</sup>	60 V/m	9.65 W/m <sup>2</sup>
<b>Europe (1999/519/EC)</b>	<b>41 V/m</b>	<b>4.35 W/m<sup>2</sup></b>	<b>60 V/m</b>	<b>9.65 W/m<sup>2</sup></b>

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.

### 1.3 Location of Base station antennas

Base stations antennas, the source of the radiation, are usually mounted on freestanding towers, with a height up to 30 m or on a tower on the top of buildings or in less cases to the side of the building. Generally the height of the antenna position does not fall below 10 m. The power usually is focused into a horizontal main beam and slightly downward tilted. The remaining power goes into the weaker beams on both side of the main beam. The main beam however does not reach ground level until the distance from the antenna position is around 50 – 200 m.

The highest level of emission would be expected in close vicinity of the antenna and in line of sight to the antenna.

#### 1.3.1 Exclusions Zones

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1. Antenna location should be designed so that the public cannot access areas where the RF radiation exceeds the levels as described above and calculate in section 1.5 below.
  2. If there are areas accessible to workers that exceed the levels as described above and calculated below, make sure that workers know where these areas are, and that they can (and do) power-down (or shut down) the transmitters when entering these areas. Such areas may not exist; but if they do, they will be confined to areas within 10 m of the antennas.
  3. Each Exclusion zone should be defined by a physical barrier and by a easy recognizable sign warning the public or workers that inside the exclusion zone the RF radiation might exceed national limits.

### 1.3.2 Guidelines on Arranging Antenna Sites

1. For roof-mounted antennas, elevate the transmitting antennas above the height of people who may have to be on the roof.
2. For roof-mounted antennas, keep the transmitting antennas away from the areas where people are most likely to be (e.g., roof access points, telephone service points, HVAC equipment).
3. For roof-mounted directional antennas, place the antennas near the periphery and point them away from the building.
4. Consider the trade off between large aperture antennas (lower maximum RF) and small aperture antennas (lower visual impact).
5. Take special precautions to keep higher-power antennas away from accessible areas.
6. Keep antennas at a site as far apart as possible; although this may run contrary to local zoning requirements.
7. Take special precautions when designing "co-location" sites, where multiple antennas owned by different companies are on the same structure. This applies particularly to sites that include high-power broadcast (FM/TV) antennas. Local zoning often favors co-location, but co-location can provide "challenging" RF safety problems.
8. Take special precautions for antenna sites near hospital and schools.
9. Obey the local regulation for erecting base station transceivers.

## 1.4 Location of Base Station Transceiver

The base station transceiver unit itself is shielded to minimize RF radiation hazards. The equipment has been tested to be in compliance with the radiated spurious emission requirements of EN 301 502. Those limits are far below the limits for RF radiation hazard. The

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base station transceiver should therefore not cause any danger to the public and workers under normal operation condition. However, it is still possible that because of imperfect antenna cables or other faults the limits set out above can be exceeded.

Sites of base station transceiver shall not be accessible by the public. Only authorized and trained workers shall access to sites or rooms.

Doors of the site or room shall be clearly marked with e.g. a sign warning the workers that inside the site or room the RF radiation might exceed national limits for radiation exposure.

Sites of base station transceivers should be regularly monitored and inspected after installation.

## **1.5 Calculation of Compliance Boundary for Base Transceiver Station according to EN 50385**

Below method describes a theoretical approach to calculate the compliance boundary according to EN 50383:2002 based on a typical configuration of the base station. Compliance is declared with EN 50385:2002. Below method applies only to a site with the configurations described below, should the site include other transmitters namely from other GSM network operators then those transmitters will affect the compliance boundaries for the antenna site. The method used for assessment is based on equations for far-field electromagnetic field calculation according to clause 8 of EN 50383. Those equations are accurate in the far-field of antennas but will over-predict in the near field, however it can be used for “worst case” or conservative prediction of electromagnetic fields or power densities radiated by antennas.

### **1.5.1 Typical Configuration of the Base Station Transceiver BTS**

The BTS3006C base station transceivers are a solution to increase network capacity and blind spots of macro cells for example inside buildings, cities and remote areas. The series consist of two transceiver types with maximal 60 W output power. (See also description below).

### **1.5.2 Technical Description Macro GSM BTS**

Technical Specification:

Output power:	60 W (47.8 dBm) / TRX
Transmitter frequency band	GSM850/PCS1900
Number of antenna ports:	3
Number of static power levels	6 (47.8, 45.8, 43.8, 41.8, 39.8, 37.8 dBm)
Number of TRX:	max:6

Antenna system and type (typical)	806/960MHz, Tongyu TDJ- 809018DM-65FT0 (beamed directional) ± 45 ° Polarization
	1710/2170MHz, Comba ODP-065R18DK (beamed directional) ± 45 ° Polarization
Frequency range:	806~960 MHz / 1710~2170 MHz
Gain:	18 dBi / 18.5dBi
Mechanical specification (Height)	2580 mm / 1312mm
Antenna cable: (length variable)	12 dB/100m; 13dB/100m

From the above table, we could decide that in the same condition the requirement of GSM850 band exposure is stricter than other band. So herein we could only analysis the GSM850 system. If GSM850 system is meet the requirement of 1999/519/EC, the other band system is default.

For consideration of the compliance boundary the E-field and H-field calculation method according to clause 8 of EN 50383:2002 has been chosen.

$$E = \sqrt{30PG_{(q,f)}} / r$$

Whereas:

*P* = input power of the antenna

*G* = antenna gain relative to an isotropic antenna

*q, f* = elevation and azimuth angles

*r* = distance from the antenna to the point of investigation

The wavelength for 869 MHz to 894 MHz is 0.35 m to 0.34 m. Above calculations are accurate when the point of investigation is in the far-field region and over-estimates in the radiating near-field. The far-field region is determined by :

$$r = \frac{2D^2}{\lambda} = 9.6 \text{ m}$$

Whereas:

$r$  = distance from the antenna to the point of investigation  
 $D$  = length of antenna  
 $\lambda$  = wavelength of transmitting frequency

The radiating near-field region is determined by:

$$\frac{\lambda}{4} < r \leq \frac{2D^2}{\lambda} = 0.08\text{m} < r \leq 9.6 \text{ m}$$

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 above base station transceiver the following compliance boundary is calculated:

Power at antenna connector BTS: **47.8 dBm**

Antenna-cable attenuation: 12 dB per 100 m, actual length = 5 m = **0.6 dB**

Input power to antenna: **47.2 dBm (52.5W)**

Antenna gain: **18 dBi (63.09)**

Reference level for 869 MHz based on recommendation 1999/519/EC: **41V/m**

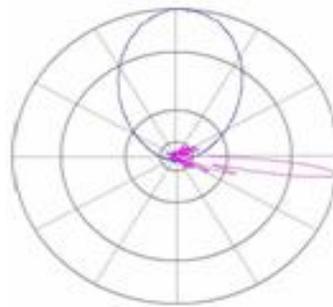
For any further assessment the value of 41 V/m is used.

### Compliance boundary

For GSM850 band:

$$r^2 = \frac{30 * P * G_{(q,f)}}{E^2} = r^2 = \frac{30 * 52.5 * 63.09}{41^2}$$

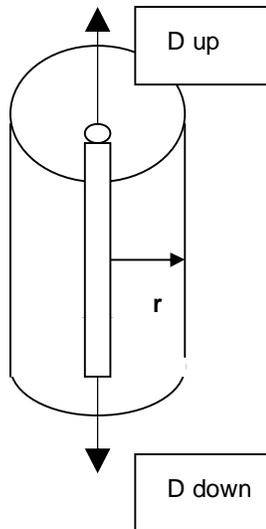
**r = 7.69 m for 869 MHz(GSM850M)**



806~890MHz

For the beamed antenna , the mostly safe way is that the cylindrical boundary model is chosen for simple description of the compliance boundaries of the site .

In fact , the power usually is focused into a main beam and the remaining power goes into the weaker beams on both side of the main beam.For the up and down direction the antenna is considered to have no gain as derived from the vertical pattern of the antenna. Thus for the calculation of the compliance boundary the gain is skipped.



So for vertical direction, the antenna gain could be looked as 1 meaning no gain, and the distance  $D_{UP}$  ,  $D_{DOWN}$  could be calculated as:

$$r^2 = \frac{30 * P * G_{(q,f)}}{E^2} = r^2 = \frac{30 * 52.5 * 1.00}{41^2}$$

**r = 0.968m for 869MHz**

The wavelength for 1930 MHz to 1990 MHz is 0.16 m to 0.15m. Above calculations are accurate when the point of investigation is in the far-field region and over-estimates in the radiating near-field. The far-field region is determined by :

$$r = \frac{2D^2}{\lambda} = 21.7 \text{ m}$$

Whereas:

*r = distance from the antenna to the point of investigation*

*D = length of antenna*

*\lambda = wavelength of transmitting frequency*

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The radiating near-field region is determined by:

$$\frac{l}{4} < r \leq \frac{2D^2}{l} = 0.08\text{m} < r \leq 21.7 \text{ m}$$

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 above base station transceiver the following compliance boundary is calculated:

Power at antenna connector BTS: **47.8 dBm**

Antenna-cable attenuation: 12 dB per 100 m, actual length = 5 m = **0.6 dB**

Input power to antenna: **47.2 dBm (52.5W)**

Antenna gain: **18.5 dBi (70.79)**

Reference level for 1930 MHz based on recommendation 1999/519/EC: **60V/m**

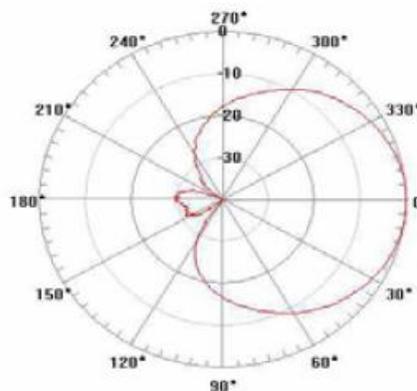
For any further assessment the value of 60 V/m is used.

### Compliance boundary

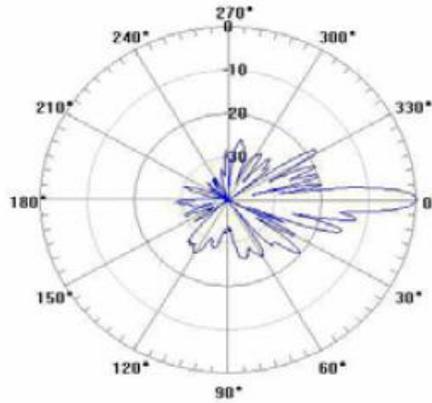
For PCS1900 band:

$$r^2 = \frac{30 * P * G_{(q,f)}}{E^2} = r^2 = \frac{30 * 52.5 * 70.79}{60^2}$$

**r = 5.56 m for 1930 MHz(PCS1900M)**



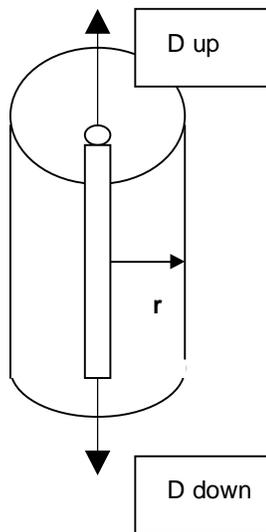
**Horizontal Pattern**



**Vertical Pattern**

For the beamed antenna , the mostly safe way is that the cylindrical boundary model is chosen for simple description of the compliance boundaries of the site .

In fact , the power usually is focused into a main beam and the remaining power goes into the weaker beams on both side of the main beam.For the up and down direction the antenna is considered to have no gain as derived from the vertical pattern of the antenna. Thus for the calculation of the compliance boundary the gain is skipped.



So for vertical direction, the antenna gain could be looked as 1 meaning no gain, and the distance  $D_{UP}$  ,  $D_{DOWN}$  could be calculated as:

$$r^2 = \frac{30 * P * G_{(q.f)}}{E^2} = r^2 = \frac{30 * 52.5 * 1.00}{60^2}$$

**r = 0.66m for 1930MHz**

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### 1.5.3 1.5.4 Uncertainty of Calculation

Above calculations do not consider possible reflections from the ground, neighboring buildings or other obstacles. If the antenna is mounted on the rooftop of a building the field strength in D down direction is reduced by the building by around 10-20 dB. Furthermore above calculations are assuming that the transceiver is operating at full power in every time slot.

### 1.5.4 Compliance with EN 50385

Based on above assessment compliance with EN 50385:2002 can be shown for any point of investigation outside the compliance boundary. However it must be mentioned again that in case of co-locating other antennas the compliance boundary determined above is not anymore applicable. Furthermore it is suggested to conduct measurements according EN 50383 after the installation of the base station transceiver to confirm above calculated compliance boundaries.