Technical Note

Subject:	**US Base Station 4 (BS4) RF Radiation Exposure Levels**	
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1   SUMMARY

This document outlines RF radiation exposure level calculations for the US Base Station 4 unit. Levels are specified as a power density.

Limits are those defined in FCC *§ 1.1310   Radio frequency radiation exposure limits*. Documents FCC KDB 447498 and IC RSS102 are also considered.

The calculations determine that:

1. Applicable RF radiation exposure limit for Occupational/Controlled Exposures is met at distances greater than 10.2 cm from the base station antenna.
2. Applicable RF radiation exposure limit for General Population/Uncontrolled Exposures is met at distances greater than 22.7 cm from the base station antenna.

In application the base station is used to control a network of street lamps over a radius of approximately 5km (3miles). The product is always mounted in an elevated position typically 8-10m (25-30ft) above the ground on a lamp post or utility pole. In this location there is no risk of the general population receiving RF radiation above the exposure limit. The equipment is professionally installed and installers are warned about the RF exposure risk that could occur during installation.

2   FCC § 1.1310 LIMITS

2.1   Limits for Occupational/Controlled Exposures

This is appropriate for the base stations since they are deployed by trained personnel and normally fixed to the top of streetlight luminaires.

Limit:

$$PD_{\mathrm{lim}} = \frac{f}{300}$$ mW/cm^2, where f is the frequency in MHz.

At the minimum frequency of 902.4 MHz, the limit is 3.008 mW/cm^2. This is equivalent to 30.08 W/m^2.

2.2 Limits for General Population/Uncontrolled Exposure

This limit is applicable when general public or untrained personnel are located near an operating base station.

Limit:

$$PD_{\lim} = \frac{f}{1500}$$ mW/cm^2, where f is the frequency in MHz.

At 902.4 MHz, the limit is 0.6016 mW/cm^2. This is equivalent to 6.016W/m^2.

3 RSS-102 LIMITS

3.1 RSS-102 § 2.5.2 Exemption Limits for Routine Evaluation

Industry Canada RSS-102 § 2.5 states that '*All transmitters are exempt from routine SAR and RF exposure evaluations provided that they comply with the requirements of sections 2.5.1 or 2.5.2'.*

For a device which operates at or above 300 MHz and below 6 GHz; RSS-102 § 2.5.2 explains that RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- the source based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$

The lowest limit, calculated at the lowest operating frequency of 902.4 MHz is:

PLim = $1.31 \times 10^{-2}\ 902.4^{0.6834}$ = 1.37 W

The base station tune-up procedure 2LR02401 describes a calibration method which limits the maximum conducted power at 100% duty cycle to 27.7 dBm (0.59 W).

Taking into account the 8 dBi gain of the specified Shakespeare SKP-794-8-915 antenna, the maximum transmitter e.i.r.p. at 100% duty cycle is calculated as:

EIRP$_{100\%}$ (dBm) = P$_{MAX}$ (dBm) + G$_T$ (dBi) = 27.7 + 8 = 35.7 dBm

it follows that:

EIRP$_{100\%}$ (W) = 3.72 W

In operation the transmitter maximum duty cycle is limited to a maximum of 33%. The maximum time averaged e.i.r.p. is therefore calculated as:

EIRP$_{33\%}$ (W) = EIRP$_{100\%}$ (W) x 0.33 = **1.23 W**

This is below the 1.37 W limit and so SAR and RF exposure evaluation is not required.

4 RF RADIATED EXPOSURE CALCULATIONS

4.1 Power Density Expression

The power density, *PD*, at a range *R* from the transmitter with an effective isotropic radiated power *EIRP*, is given by:

$$PD = \frac{EIRP}{4\pi R^2}$$

To calculate the closest range at which the power density reaches the FCC limits, the following expression is used.

$$R = \sqrt{\frac{EIRP}{4\pi PD_{\text{lim}}}}$$

where EIRP is the radiated power in W, PD_{lim} is the exposure limit in W/m^2 and R is the range in m.

4.2 Minimum Safe Operating Distances

4.2.1 *For Occupational/Controlled Exposure Conditions*

Assuming a worst case EIRP of 3.9 W and a duty cycle of 100%, the power density meets the FCC limit at a distance of 10.2 cm from the base station antenna.

4.2.2 *For General Population/Uncontrolled Exposure Conditions*

Assuming a worst case EIRP of 3.9 W and a duty cycle of 100%, the power density meets the FCC limit at a distance of 22.7 cm from the base station antenna.