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BreezeACCESS VL: Limitation on Human Exposure to Electromagnetic Fields

For the UK Market

Document Control

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Reference

(1) UK Radio Interface Requirement 2007 Fixed Broadband Services operating in the frequency range 5725-5850 MHz (Version 1.00)

(2) COUNCIL RECOMMENDATION of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz), (1999/519/EC)

(3) ENV 50166-2: 1995, Human exposure to electromagnetic fields. High frequency (10 kHz to 300 GHz)

(4) ICNIRP Guidelines, GUIDELINES FOR LIMITING EXPOSURE TO TIME-VARYING ELECTRIC, MAGNETIC, AND ELECTROMAGNETIC FIELDS (UP TO 300 GHz), International Commission on Non-Ionizing Radiation Protection

(5) Britain's Health and Safety Executive (HSE) web pages on non-ionising Radiation. http://www.hse.gov.uk/radiation/nonionising/hse.htm

(6) Britain’s Department of Health, DH home - Policy and guidance - Health and social care topics - Health and social care article Electromagnetic fields http://www.dh.gov.uk/PolicyAndGuidance/HealthAndSocialCareTopics/HealthAndSocialCareArticle/fs/en?CONTENT_ID=4089500&chk=nMzeXW

1 General

This document summarizes the limitation for non-ionizing radiation caused by the BreezeACCESS VL under UK's IR 2007 regulations (Reference (1)). This document is not a legal document and does not intend to replace any legal analysis, and cannot be construed as a representation of UK regulation regarding non-ionizing radiation limits.

This document solely presents the effect of exposure to non-ionizing radiation caused ONLY by the BreezeACCESS VL. In case the exposure is to multiple sources of non-ionizing radiation, this document does not apply.

This document does not provide any technical background regarding non-ionizing radiation but only the limits of such exposure.

2 Over view of Radiation Legislation

Public exposure to non-ionizing electromagnetic fields such as those associated with radar, broadcast transmitters, mobile phones, power lines and domestic equipment comes under guidelines incorporated into a European Recommendation (1999/519/EC). This Recommendation sets a framework that deals with limiting public exposure, providing public information and undertaking research. In the UK the National Radiological Protection Board (NRPB) advises on risks from radiations including electromagnetic fields

In March 2004, the NRPB published new advice on limiting public exposure to electromagnetic fields following an extensive review of the science and a public consultation on its web site. This new advice recommends the adoption of the levels in the EMF guidelines published by the International Commission on Non-ionizing Radiation Protection. The NRPB note that there have been some population studies that point to the possibility of effects below the guidelines, in particular for power frequency magnetic fields. It has therefore recommended that Government "consider the possible need for further precautionary measures." (Reference (6)).

There are no specific legal provisions covering non-ionizing radiation and control of exposure is governed by the general provisions of the Health and Safety at Work etc Act 1974 and the Management of Health and Safety at Work Regulations 1999 (Reference (5)).

The NRPB are currently reviewing their guidelines and HSE, in conjunction with other Government departments, will consider their new advice when it becomes available.

If the EU Directive currently under negotiation is adopted, then new regulations will have to be implemented. All Member States of the European Union should have at least three years from adoption in which to implement regulations.

3 Radiation Limits

The BreezeACCESS VL is running in the 5.8 GHz band, designated as SHF (Super High Frequency) by the ITU.

The exposure limitations shown in Table 1 below are taken from Reference (4).

Exposure characteristics	Frequency range	Current density for head and trunk (mA m^{-2}) (rms)	Whole-body average SAR (W kg^{-1})	Localized SAR (head and trunk) (W kg^{-1})	Localized SAR (limbs) (W kg^{-1})
Occupational exposure	up to 1 Hz	40	—	—	—
	1–4 Hz	40/*f*	—	—	—
	4 Hz–1 kHz	10	—	—	—
	1–100 kHz	*f*/100	—	—	—
	100 kHz–10 MHz	*f*/100	0.4	10	20
	10 MHz–10 GHz	—	0.4	10	20
General public exposure	up to 1 Hz	8	—	—	—
	1–4 Hz	8/*f*	—	—	—
	4 Hz–1 kHz	2	—	—	—
	1–100 kHz	*f*/500	—	—	—
	100 kHz–10 MHz	*f*/500	0.08	2	4
	10 MHz–10 GHz	—	0.08	2	4

Table 1: Basic restrictions for time varying electric and magnetic fields for frequencies up to 10 GHz.

Notes:

1. *f* is the frequency in hertz.
2. Because of electrical inhomogeneity of the body, current densities should be averaged over a cross-section of 1 cm2 perpendicular to the current direction.
3. For frequencies up to 100 kHz, peak current density values can be obtained by multiplying the rms value by u2 (;1.414). For pulses of duration tp the equivalent frequency to apply in the basic restrictions should be calculated as f 5 1/(2tp).
4. For frequencies up to 100 kHz and for pulsed magnetic fields, the maximum current density associated with the pulses can be calculated from the rise/fall times and the maximum rate of change of magnetic flux density. The induced current density can then be compared with the appropriate basic restriction.
5. All SAR values are to be averaged over any 6-min period.
6. Localized SAR averaging mass is any 10 g of contiguous tissue; the maximum SAR so obtained should be the value used for the estimation of exposure.

7. For pulses of duration tp the equivalent frequency to apply in the basic restrictions should be calculated as f 5 1/(2tp). Additionally, for pulsed exposures in the frequency range 0.3 to 10 GHz and for localized exposure of the head, in order to limit or avoid auditory effects caused by thermoelastic expansion, an additional basic restriction is recommended. This is that the SA should not exceed 10 mJ kg21 for workers and 2mJ kg21 for the general public, averaged over 10 g tissue.

Where appropriate, the reference levels are obtained from the basic restrictions by mathematical modeling and by extrapolation from the results of laboratory investigations at specific frequencies. They are given for the condition of maximum coupling of the field to the exposed individual, thereby providing maximum protection. Table 1 summarize the reference levels for occupational exposure and exposure of the general public, respectively, and the reference levels are illustrated in Figs. 1 and 2. The reference levels are intended to be spatially averaged values over the entire body of the exposed individual, but with the important proviso that the basic restrictions on localized exposure are not exceeded.

At frequencies above 10 MHz, the derived electric and magnetic field strengths were obtained from the whole-body SAR basic restriction using computational and experimental data. In the worst case, the energy coupling reaches a maximum between 20 MHz and several hundred MHz. In this frequency range, the derived reference levels have minimum values. The derived magnetic field strengths were calculated from the electric field strengths by using the far-field relationship between E and H (E/H = 377 ohms). In the near-field, the SAR frequency dependence curves are no longer valid; moreover, the contributions of the electric and magnetic field components have to be considered separately. For a conservative approximation, field exposure levels can be used for near-field assessment since the coupling of energy from the electric or magnetic field contribution cannot exceed the SAR restrictions. For a less conservative assessment, basic restrictions on the whole-body average and local SAR should be used.

In the high-frequency range 10 MHz–10 GHz, the general public reference levels for electric and magnetic fields are lower by a factor of 2.2 than those set for occupational exposure. The factor of 2.2 corresponds to the square root of 5, which is the safety factor between the basic restrictions for occupational exposure and those for general public.

Since measuring SAR, specifically whole body SAR is relatively difficult, the European Standard, EN50166, referenced in Reference (3), shows an alternative method to demonstrate compatibility by measuring power density, magnetic field strength and electric field strength. This standard sets two sets of levels, one for the general public and one for professional worker exposed for electromagnetic radiation as part of their normal environment.

The following two tables, taken from Reference (3), shows the radiation exposure derived reference levels for the general public and working personnel.

Frequency [MHz]	RMS – Value of electric field-strength [V/m]	RMS- value of magnetic field-strength [A/m]	Mean power density [W/m^2]
0.01 – 0.038	1000[(a)]	42	
0.038 – 0.61	1000[(a)]	1.6/ f	
0.61 – 10	614/f	1.6/ f	
10 – 400	61.4	0.16	10
400 – 2000	3.07	$8.14*10^{-3}* f^{½}$	f/40
2000 – 150000	137	0.364	50
150000 - 300000	$0.354* f^{½}$	$9.4*10^{-4}* f^{½}$	$3.334*10^{-4}* f$

Table 2: Reference levels for Field Strength and Power Density, Continuous Exposure for workers

(a) Reference values for exposures to only E or H fields. Exposure to both components (E, H) of single source should be considered as a simultaneous from both two independent sources.

Frequency [MHz]	RMS – Value of electric field-strength [V/m]	RMS- value of magnetic field-strength [A/m]	Mean power density [W/m^2]
0.01 – 0.042	400[(a)]	16.8[(a)]	
0.042 – 0.68	400[(a)]	0.7/ f[(a)]	
0.68 – 10	275/f	0.7/f	
10 – 400	27.5	0.07	2
400 – 2000	1.37* $f^{½}$	3.64*10^{-3}* $f^{½}$	f/200
2000 – 150000	61.4	0.163	10
150000 - 300000	0.158* $f^{½}$	4.21*10^{-4}* $f^{½}$	6.67*10^{-4}* f

Table 3: Reference levels for Field Strength and Power Density, Continuous Exposure for public

(a) Reference values for exposures to only E or H fields. Exposure to both components (E, H) of single source should be considered as a simultaneous from both two independent sources.

4 Calculations

The restrictions will be calculated based on constant exposure to the non-ionizing radiation. This would be an extreme case, specifically when considering the Occupational Exposure, as no one spends his entire time on the top of the pole or the rooftop.

4.1 Formulas

The following formulas are used to in order to evaluate the compatibility with the above standards:

$$P_{Density} = \frac{P_{Trans}}{4 \cdot \pi \cdot D^2}$$

Equation 1: Power Density Equation

Where P_{Trans} is the EIRP power, measured in [W] and D is the distance from the antenna, measured in [cm], the $P_{Desnsity}$, Power Density will be measure in W/cm^2.

The Electrical Field Strength is calculated according to the following equation:

$$E = 1 \cdot 10^6 \sqrt{\frac{377 \cdot P_{Trans}}{4 \cdot \pi \cdot D^2}}$$

Equation 2: Electrical Field Strength Equation

Where P_{Trans} is the EIRP power, measured in [W] and D is the distance from the antenna, measured in [cm], the $P_{Desnsity}$, The electrical Field Strength will be measure in V/m

The magnetic Field Strength is calculated according to the following equation:

$$H = \frac{E}{377\Omega}$$

Equation 3: Magnetic Field Strength Equation

4.2 Results

4.2.1 Basestation Antenna

The computational results of the exposure limits for the AN1261 (basestation antenna) are shown in Figure 1 and Figure 2. Figure 1 shows the exposure limits vs. general public limits, while Figure 2 show the exposure limits vs. professional workers limits.

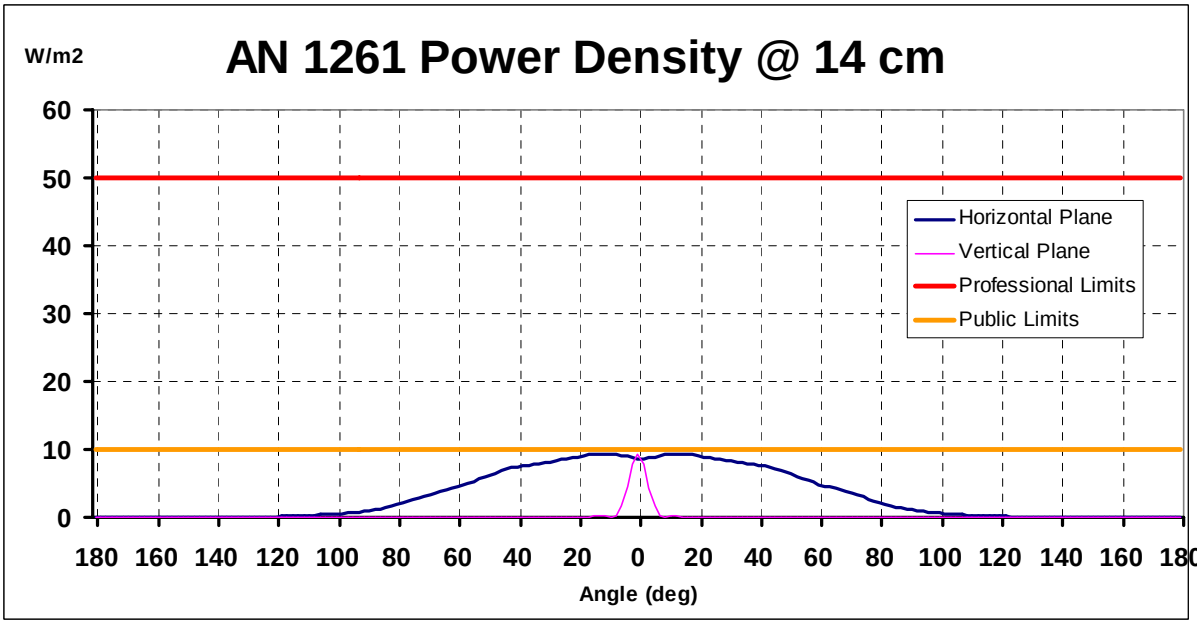

Figure 1: AN1261 Power Density under UK Regulations at 14 cm

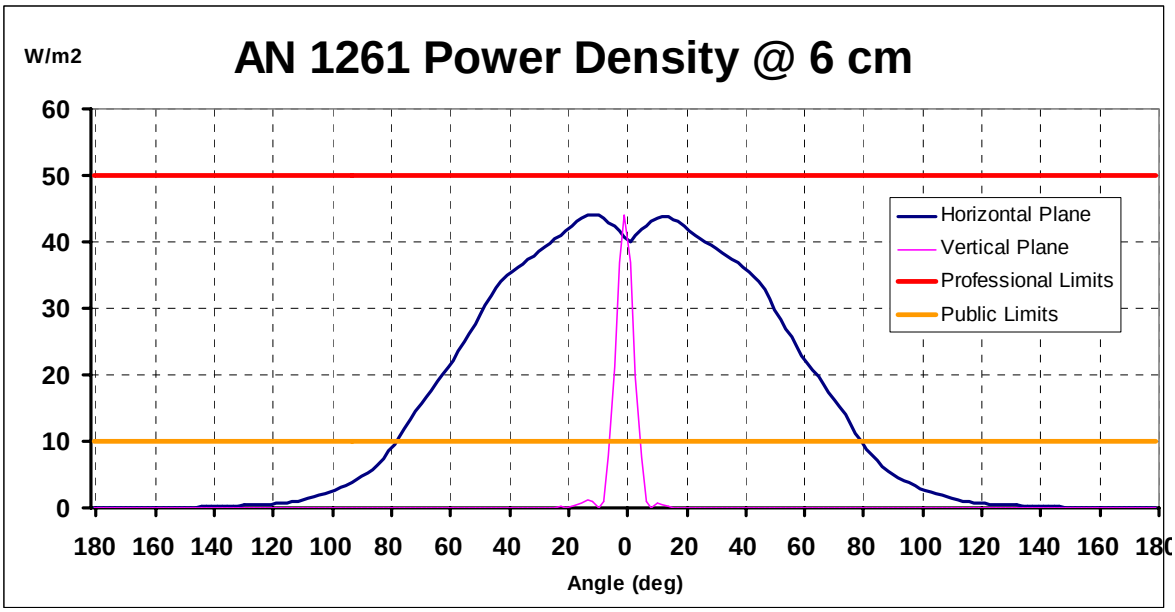

Figure 2: AN1261 Power Density under UK Regulations at 6 cm

4.2.2 CPE Antenna

The computational results of the exposure limits for the AN1248 (CPE antenna) are shown in Figure 3 and Figure 4. Figure 3 shows the exposure limits vs. general public limits, while Figure 4 show the exposure limits vs. professional workers limits.

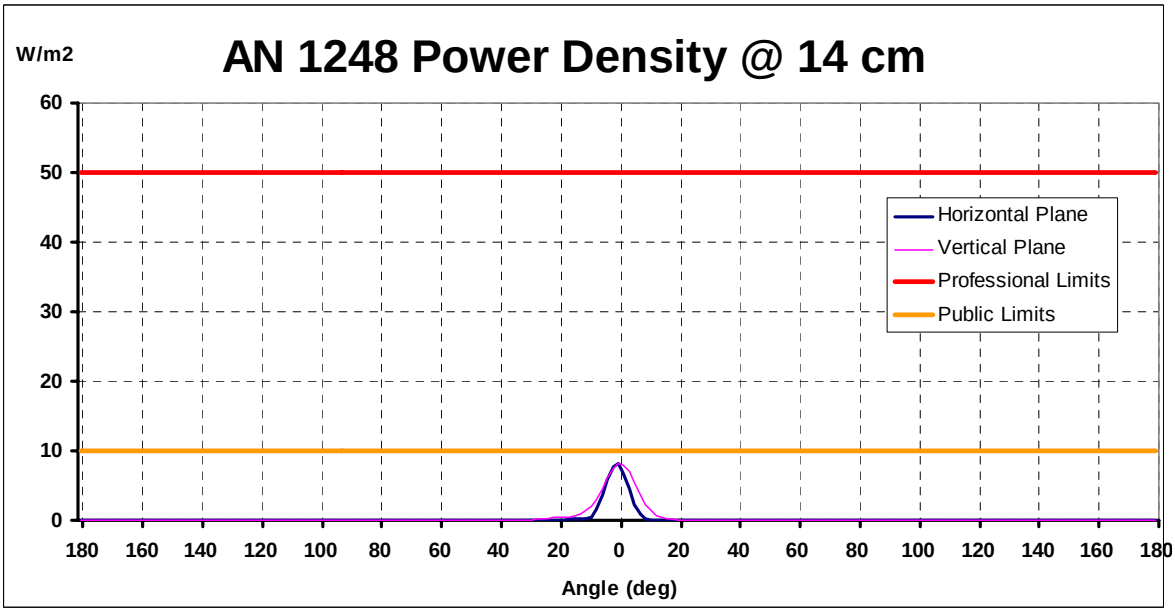

Figure 3: AN1248 Power Density under UK Regulations at 14 cm

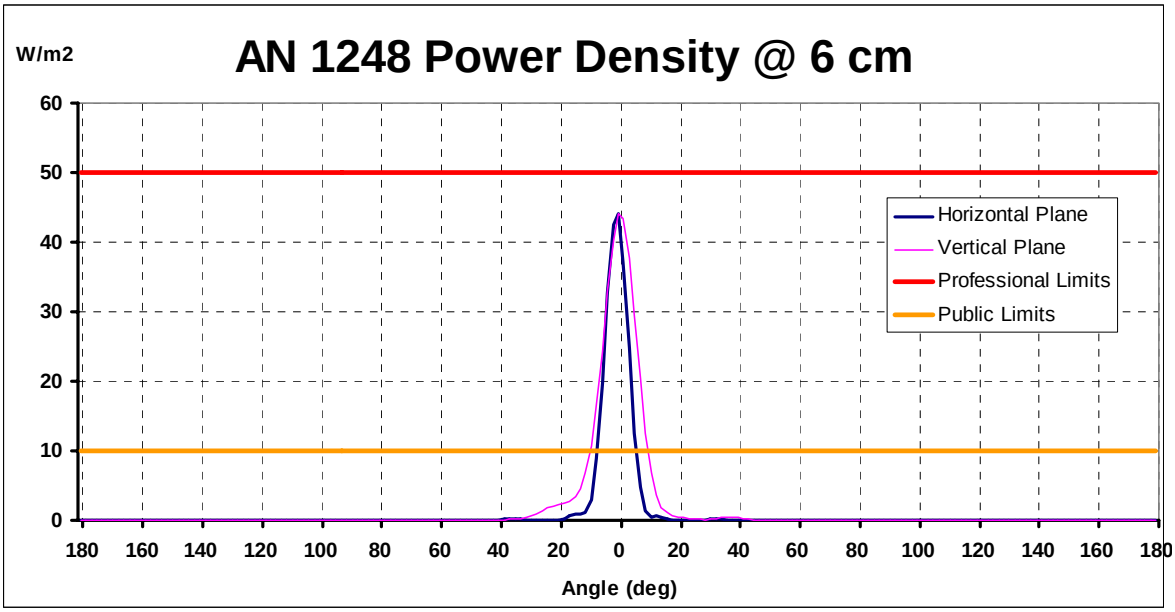

Figure 4: AN1248 Power Density under UK Regulations at 6 cm

5 Conclusions

Under the UK IR 2007 regulation, the BreezeACCESS VL complies with ENV50166-2 under the following conditions for basestation and CPE antennas:

- The BreezeACCESS VL complies with General Public exposure limits if the distance from the antenna is more than 14 cm for all sides of the antenna.
- The BreezeACCESS VL complies with Professional Workers exposure limits if the distance from the antenna is more than 6 cm for all sides of the antenna.

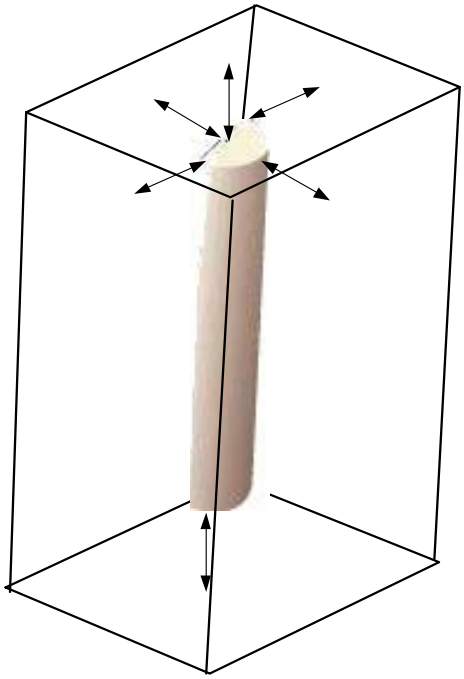

Figure 5: Basestation Antenna Exclusion Zone