EMF Exposure Assessment of 9M MediaFLO Antenna

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80-T1262-1 Rev A

Fang Han

QUALCOMM® | Wireless Business Solutions

QUALCOMM Incorporated
5775 Morehouse Drive
San Diego, CA 92121-1714
U.S.A.

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1. Introduction

This report assesses non-ionizing electromagnetic field radiation from a VertexRSI 9.0 meter antenna for MediaFLO operation system in Qualcomm facility pursuant to FCC OET Bulletin, No. 65, Edition 97-01 [1]. Power flux densities generated from the antenna at far field, near field, transition region, sub-reflector, and main reflector surface are calculated based on the method recommended by the FCC Bulletin.

Table 1 outlines the limits of exposure to EMF in the Ku-band in terms of power density specified by FCC and ICNIRP [2].

Table 1. Maximum permissible exposure (MPE) limits at Ku-band

Exposure environment	Power density (W/m^2)	Average time (min)	
		FCC	ICNIRP
General public/uncontrolled	10	30	4 (based on $68/f^{1.05}$)
Occupational/controlled	50	6	4 (based on $68/f^{1.05}$)

2. Antenna and System Parameters

The antenna and system specifications for power density assessment are listed in Table 2. Drawing of the antenna assembly and partition of power density are shown in Fig.1 and Fig.2 respectively. The worst case of simultaneous transmit of 13 carriers are considered in the analysis.

Table 2. Antenna and system specs

Main reflector diameter and area	$D = 9.0\,\mathrm{m}$, $A_a = \pi D^2/4 = 63.62\,\mathrm{m}^2$
Sub-reflector diameter and area	$D_S = 1.78\,\mathrm{m}$, $A_S = \pi D_S{}^2/4 = 2.49\,\mathrm{m}^2$
Wavelength at mid-band 14.25 GHz	$\lambda = 0.021\,\mathrm{m}$
Maximum feed power at antenna flange	$750/10^{2/10} = 473.22\,\mathrm{W}$
Antenna gain	$G = 60.1\,\mathrm{dBi} = 1.02\times10^6$
EIRP	$EIRP = 86.85\,\mathrm{dBW} = 4.84\times10^8\,\mathrm{W}$
Antenna aperture efficiency	$\eta = \left(G\lambda^2/4\pi A_a\right) = 0.57$
-15dB antenna beam-width	-15dB (0.032) at 0.34°

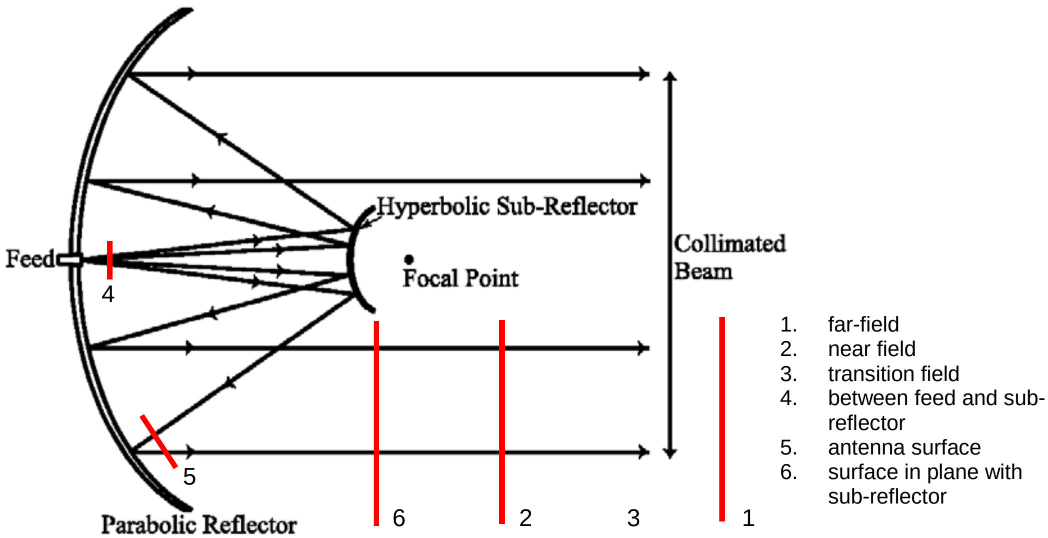

Figure 1. Radiation 4.8-meter ku-band antenna assembly – side view

3. On-Axis and Off-Axis Power Density Calculation

3.1 Far Field Calculations

The distance to the beginning of the far field can be calculated as follows [1]

$$R_{FF} = \frac{0.60D^2}{\lambda} = 2308.5\,\text{m}$$

The maximum on-axis power density in the far field can be calculated as follows

$$S_{FF} = \frac{G \times P_{\max}\ (\text{or } EIRP)}{4\pi R_{FF}^2} = 7.23\,\text{W/m}^2$$

The maximum off-axis (0.34°) power density in the far field can be calculated as

$$S_{FF\_Off} = 0.032 \times S_{FF} = 0.23\,\text{W/m}^2$$

3.2 Near Field Calculations

The distance to the extent of the near field can be calculated as follows

$$R_{NF} = \frac{D^2}{4\lambda} = 961.88\,\text{m}$$

The maximum on-axis power density in the near field can be determined by

$$S_{NF} = \frac{16\eta P_{\max}}{\pi D^2} = 16.88 \text{ W/m}^2$$

The maximum off-axis (>0.34°) power density in the near field can be calculated as

$$S_{NF\_Off} < 0.032 \times S_{NF} = 0.53 \text{ W/m}^2$$

3.3 Transition Region Calculations

The transition region will be the region extending from R_{NF} to R_{FF}. If the location falls within this transition region, the on-axis power density can be determined by the following equation:

$$S_{TF} = \frac{S_{NF} R_{NF}}{R}$$

The exposure level S_{TF} at the transition region R $(R_{NF} < R < R_{FF})$ would be less than near-field exposure level and greater than far field exposure level, i.e.,

$$S_{FF} < S_{TF} < S_{NF}$$

Therefore the average power density in transition region will not exceed 16.88 W/m^2.

3.4 Region between Power Feed and Sub-Reflector

The maximum on-axis power density between the RF power feed and sub-reflector can be determined by the following equation:

$$S_4 = \frac{P_{\max}}{A_S} = 190.17 \text{ W/m}^2$$

3.5 Antenna Surface (Main Reflector)

Assuming uniform illumination and full reflection of the reflector surface, the power density at the antenna surface (main reflector) can be calculated as follows:

$$S_5 = \frac{4P_{\max}}{A_a} = 29.75 \text{ W/m}^2$$

The maximum off-axis (>0.34°) power density at the antenna surface (main reflector) can be calculated as

$$S_{5\_\text{Off}} < 0.032 \times S_5 = 0.94 \text{ W/m}^2$$

3.6 Antenna Area in Plane with Sub-Reflector

Assuming uniform illumination of the reflector surface, the power density near the antenna surface in plane with sub-reflector can be calculated as follows:

$$S_6 = \frac{2.56P}{A_a} = 19.40 \text{ W/m}^2$$

The maximum off-axis (>0.34°) power density near the antenna surface in plane with sub-reflector can be calculated as

$$S_{6\_\text{Off}} < 0.032 \times S_6 = 0.60 \text{ W/m}^2$$

4. Conclusions

Table 3. Summary of expected RF exposure levels in beam and outside beam area

Region	On-axis maximum exposure level (W/m^2)	Off-axis (>0.34º) max exposure level (W/m^2)	RF Hazard assessment (off-axis area)
Far field (R>2308 m)	<7.23	<0.23	Meet FCC MPE limit for public exposure
Transition field (962m<R<2308m)	7.23 – 16.88	0.23 – 0.53	Meet FCC MPE limit for public exposure
Near field (R>273m)	<16.88	<0.53	Meet FCC MPE limit for public exposure
Between power feed and sub-reflector	**190.17**	N/A	N/A
Antenna surface (main reflector)	29.75	0.94	Meet FCC MPE limit for public exposure
Antenna area in plane with sub-reflector	19.04	0.60	Meet FCC MPE limit for public exposure

Table 3 summarizes the expected RF exposure levels based on the above analysis. Under the worst-case scenario, the EMF exposure level in all on-axis regions, except the area between the power feed and sub-reflector, would meet the occupational exposure limit specified by FCC and ICNIRP. At regions of off-axis (0.34°) from the main beam, the EMF exposure level would be below the limits for both public and occupational exposure specified by FCC and ICNIRP. Since the analysis is based on the worst case conditions, the actual exposure level would be even lower than the above conclusions.

The following measures will further assure the protection of public and occupational personnel from potential RF exposure:

- The antenna will be installed in an area where public access is restricted.
- The antenna of the earth station with will be isolated by a fence by at least 3 meters so the public access area will be in the off-axis area beyond 0.34 degree.
- The antenna beam will be elevated at least 30 degrees from the horizontal plane for normal operation.
- The transmitter will be turned off during antenna maintenance.
- The actual exposure level will be measured and evaluated routinely to ensure it would not exceed the level by this analysis.

5. Reference

[1] FCC OET Bullet No. 65, Edition 97-01, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", August 1997.

[2] ICNIRP Guidelines, "Guidelines for limiting exposure to time-varying electric magnetic, and electromagnetic fields", Health Physics, Vol.74, No.4, April 1998.

6. Engineering Declaration

I hereby certify that the information contained in this test report is complete and true to the best of my knowledge. All test and analysis were performed in accordance with good engineering practices.

Certified by: Fang Han
Regulatory Engineer, Senior Staff
Qualcomm Inc.

Date: August 7, 2006