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Report On

RF Exposure Assessment of the
F3507g Ericsson Mobile Broadband Module
Installed in DELL Precision M2400 Laptop Computer

Document 75903561 Report 09 Issue 4

August 2008



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This report has been up-issued to Issue 4 to correct minor typographical errors.



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SECTION 1

REPORT SUMMARY

RF Exposure Assessment of the
F3507g Ericsson Mobile Broadband Module
Installed in DELL Precision M2400 Laptop Computer



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1.1 INTRODUCTION

The information contained in this report is intended to show verification of the RF Exposure Assessment of the F3507g Ericsson Mobile Broadband Module Installed in DELL Precision M2400 Laptop Computer to the requirements of the applied test specifications. Consideration of co-location transmission with the fitted modules is described within section 4 of this report.

| | |
|-----------------|--|
| Objective | To perform RF Exposure Assessment to determine the Equipment Under Test's (EUT's) compliance of the applied rules. |
| Applicant | Ericsson AB |
| Manufacturer | Ericsson |
| Type of Product | Ericsson Mobile Broadband Module |
| Model Number | F3507g |
| FCC ID | VV7-MBMF3507G-D |

Test Specification/Issue/Date

1. EN50392:2004 - Generic standard to demonstrate the compliance of electronic and electrical apparatus with the basic restrictions related to human exposure to electromagnetic fields (0 Hz - 300 GHz).
2. OET Bulletin 65 Edition 97-01 August 1997 - Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields
3. RSS-102 Issue 2 November 2005 Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
4. Radiocommunications (Electromagnetic Radiation – Human Exposure) Standard 2003

Related Document(s)

5. Council Recommendation 1999/519/EC of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (Official Journal L 197 of 30 July 1999).
6. FCC Guidelines for Evaluating exposure to RF Emissions - 47 CFR § 1.1310; 47 CFR § 1.1307(b) & 47 CFR § 80.83.
7. Health Canada's Safety Code 6: Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 KHz to 300 GHz.
8. ARPANSA, 'Radiation Protection Standard – Maximum Exposure Levels to Radiofrequency Fields – 3KHz to 300GHz'
9. ICNIRP 1998, 'Guidelines for limiting exposure to time-varying electric magnetic, and electromagnetic fields (up to 300GHz). Guidelines of the International Commission on Non-Ionizing Radiation Protection', Health Physics, vol.74, no.4, pp.494-522.



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10. National Council on Radiation Protection and Measurements (NRP) - Report No. 86(1986) "Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields".
11. EN 50383:2002 - Basic standard for the calculation and measurement of electromagnetic field strength and SAR related to human exposure from radio base stations and fixed terminal stations for wireless telecommunication systems (110 MHz - 40 GHz).
12. IEEE Std C95.1-2005: IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3KHz to 300GHz.
13. Australian Standard 2772.2 – 1988, 'Radiofrequency Radiation Part 2 – Principles and Methods of Measurement – 300KHz to 10GHz'

1.2 BRIEF SUMMARY OF RESULTS

1.2.1 General Public Exposure Levels

| Antenna Gain (Numeric) | Peak Output Power (mW) | Field | Calculated RF Exposure at 0.200 m (20.0cm) | General Public Exposure Limit | Application |
|------------------------|------------------------|-------|--|-------------------------------|---------------------------|
| 1.445 | 2000 | S | 1.438 Wm-2 | 4.12 Wm-2 | ICNIRP |
| | | S | 0.1438 mW/cm ² | 0.55 mW/cm ² | FCC 47 CFR § 1.1310 |
| | | S | 1.438 Wm-2 | 5.49 Wm-2 | Canada's RF Safety Code 6 |
| | | S | 1.438 Wm-2 | 4.12 Wm-2 | ARPANSA |
| | | E | 23.282 V/m | 39.47 V/m | ICNIRP |
| | | E | 23.282 V/m | N/A | FCC 47 CFR § 1.1310 |
| | | E | 23.282 V/m | 45.50 V/m | Canada's RF Safety Code 6 |
| | | E | 23.282 V/m | 39.33 V/m | ARPANSA |
| | | H | 0.062 A/m | 0.106 A/m | ICNIRP |
| | | H | 0.062 A/m | N/A | FCC 47 CFR § 1.1310 |
| | | H | 0.062 A/m | 0.121 A/m | Canada's RF Safety Code 6 |
| | | H | 0.062 A/m | 0.105 A/m | ARPANSA |

The calculations have shown that they **meet** the General Public Exposure Levels described in the ICNIRP Guidelines, FCC 47 CFR § 1.1310 Guidelines, Health Canada's RF exposure guideline Safety Code 6 and the Australian ARPANSA limits at **20.0 cm**, the point of investigation.



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1.2.2 Occupational Exposure Levels

| Antenna Gain (Numeric) | Peak Output Power (mW) | Field | Calculated RF Exposure at 0.200 m (20.0cm) | Occupational Exposure Limit | Application |
|------------------------|------------------------|-------|--|-----------------------------|---------------------------|
| 1.445 | 2000 | S | 1.438 Wm-2 | 20.61 Wm-2 | ICNIRP |
| | | S | 0.1438 mW/cm ² | 2.75 mW/cm ² | FCC 47 CFR § 1.1310 |
| | | S | 1.438 Wm-2 | 27.47 Wm-2 | Canada's RF Safety Code 6 |
| | | S | 1.438 Wm-2 | 20.61 Wm-2 | ARPANSA |
| | | E | 23.282 V/m | 86.13 V/m | ICNIRP |
| | | E | 23.282 V/m | N/A V/m | FCC 47 CFR § 1.1310 |
| | | E | 23.282 V/m | 101.63 V/m | Canada's RF Safety Code 6 |
| | | E | 23.282 V/m | 88.14 V/m | ARPANSA |
| | | H | 0.062 A/m | 0.23 A/m | ICNIRP |
| | | H | 0.062 A/m | N/A A/m | FCC 47 CFR § 1.1310 |
| | | H | 0.062 A/m | 0.27 A/m | Canada's RF Safety Code 6 |
| | | H | 0.062 A/m | 0.234 A/m | ARPANSA |

The calculations have shown that they **meet** the Occupational Exposure Levels described in the ICNIRP Guidelines, FCC 47 CFR § 1.1310 Guidelines, Health Canada's RF exposure guideline Safety Code 6 and the Australian ARPANSA limits at **20.0 cm**, the point of investigation.



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1.3 PRODUCT INFORMATION

1.3.1 Attestation

The wireless device described within this report has been shown to be capable of compliance with the basic restrictions related to human exposure to electromagnetic fields (10 MHz - 300 MHz) - General public. The calculations shown in this report were made in accordance the procedures specified in the applied test specification(s)

1.3.2 Technical Description

The Equipment Under Test a F3507g Ericsson Mobile Broadband Module Installed in DELL Precision M2400 Laptop Computer. A full technical description can be found in the manufacturer's documentation.

1.4 SUMMARY

The information contained in this report is intended to show verification of the F3507g Ericsson Mobile Broadband Module Installed in DELL Precision M2400 Laptop Computer. The DELL Precision M2400 Laptop Computer can also be fitted with the following wireless device modules, described below. This section aims to show the co-transmission quotient value based upon the highest reported conducted power value for the co-located modules.

The RF exposure assessment is based upon the worst case analysis of the frequency bands, in which the Ericsson Mobile Broadband Module can operate:-

| | |
|-------------|----------------------------------|
| GSM 850: | 824 – 849MHz / 869 – 894 MHz |
| GSM 900: | 880 – 915MHz / 925 – 960 MHz |
| DCS 1800: | 1710 - 1785MHz / 1805 – 1880 MHz |
| PCS 1900: | 1850 – 1910MHz / 1930 – 1990 MHz |
| WCDMA FDD1: | 1920 – 1980 / 2110 – 2170 MHz |
| WCDMA FDD2: | 1850 – 1910 / 1930 – 1990 MHz |
| WCDMA FDD5: | 824 – 849 / 869 – 894 MHz |

For details of the location of the antenna and the modules that can be considered as co-located, see section 4 of this report.

| Display size | Antenna | Antenna location | Antenna to user distance (mm) | Antenna to WWAN Tx antenna distance (mm) | Co - located |
|--------------|-------------------|------------------|-------------------------------|--|--------------|
| 14.1 | WWAN Tx antenna | Top of the LCD | > 200 | - | - |
| | WLAN main | Top of the LCD | > 200 | < 200 | Yes |
| | WLAN aux | Top of the LCD | > 200 | < 200 | Yes |
| | WLAN MIMO | Top of the LCD | > 200 | < 200 | Yes |
| | Bluetooth antenna | Top of the LCD | > 200 | < 200 | Yes |
| | UWB antenna | Top of the LCD | > 200 | < 200 | Yes |

The numeric gain of the Mobile Broadband Module is 1.445.

The Mobile Broadband Module radio power is considered to be a worst case input power of 2 watts with a duty cycle of 25% (GPRS Multi-slot Class 10). Therefore for this assessment the maximum output power for the Ericsson Mobile Broadband Module is considered to be 500 Milliwatts. The point of investigation is 20 cm (0.200 m) with a maximum antenna gain of 1.6 dBi.



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SECTION 2

TEST DETAILS



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2.1 RATIONALE FOR ASSESSMENT OF THE RF EXPOSURE

The aim of this assessment report is to evaluate the compliance boundary for a set of given input power(s) according to the basic restrictions (directly or indirectly via compliance with reference levels) related to human exposure to radio frequency electromagnetic fields.

The chosen assessment method to establish the compliance boundary in the far-field region is the reference method as defined in BS EN50383:2002 Clause 5.2; E-filed or H-field calculation. The method of calculation used is defined in BS EN50383:2002; Clause 8.2.2, 8.2.3 and 8.2.4. The calculated values have been compared with limits provided in the ICNIRP guidelines. Calculations can be made in three separate regions, based on distance from the antenna. These are called:

- far-field region,
- radiating near-field region,
- reactive near-field region.

The theory that defines these regions is given in EN50383:2002 Annex A.

Far-field region

As shown in EN50383 Annex A, the far-field calculations are accurate when the distance, r , from an antenna of length D to a point of investigation is greater than:

$$r = \frac{2D^2}{\lambda}$$

Where, r is the distance from the antenna to the point of investigation.

Radiating near-field region

The radiating near-field region of an antenna of length D as shown in EN50383 Annex A, this region is defined by

$$\frac{\lambda}{4} < r > \frac{2D^2}{\lambda}$$

Reactive near-field region

The reactive near-field region of an antenna as shown in EN50383 Annex A, this region is defined by

$$r \leq \frac{\lambda}{4}$$

Where, r is the distance from the antenna to the point of investigation.

Recommend $\lambda/4$ as the boundary between the radiated near-field and reactive near-field for RF exposure compliance assessment.



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2.2 DEFINED LIMITS

Normative Reference: ICNIRP Advice on Limiting Exposure to Electromagnetic Fields (0-300GHz). Table A4, Reference Levels for General Public Exposure to Time Varying Electric & Magnetic Fields. Vol 15 No.2. 2004. The defined limits are in accordance with 47 CFR § 1.1310 Radiofrequency radiation exposure limits.

Reference levels for general public exposure to time-varying electric and magnetic fields (unperturbed rms values)

At 824.200 MHz

| | | |
|------------------------------------|---------|--|
| Power density (Wm-2) | = 4.12 | ICNIRP |
| Power density (mWcm ²) | = 0.55 | FCC 47 CFR § 1.1310 |
| Power density (Wm-2) | = 5.49 | Canada's RF Safety Code 6 |
| Power density (Wm-2) | = 4.12 | Australian Radiation Protection Series Publication No. 3 |
| E-Field (Vm-1) | = 39.47 | ICNIRP |
| E-Field (Vm-1) | = N/A | FCC 47 CFR § 1.1310 |
| E-Field (Vm-1) | = 45.50 | Canada's RF Safety Code 6 |
| E-Field (Vm-1) | = 39.33 | Australian Radiation Protection Series Publication No. 3 |
| H-Field (Am-1) | = 0.106 | ICNIRP |
| H-Field (Am-1) | = N/A | FCC 47 CFR § 1.1310 |
| H-Field (Am-1) | = 0.121 | Canada's RF Safety Code 6 |
| H-Field (Am-1) | = 0.105 | Australian Radiation Protection Series Publication No. 3 |

Reference levels for occupational exposure to time-varying electric and magnetic fields (unperturbed rms values)

At 824.200 MHz

| | | |
|------------------------------------|----------|--|
| Power density (Wm-2) | = 20.61 | ICNIRP |
| Power density (mWcm ²) | = 2.75 | FCC 47 CFR § 1.1310 |
| Power density (Wm-2) | = 27.47 | Canada's RF Safety Code 6 |
| Power density (Wm-2) | = 20.61 | Australian Radiation Protection Series Publication No. 3 |
| E-Field (Vm-1) | = 86.13 | ICNIRP |
| E-Field (Vm-1) | = N/A | FCC 47 CFR § 1.1310 |
| E-Field (Vm-1) | = 101.63 | Canada's RF Safety Code 6 |
| E-Field (Vm-1) | = 88.14 | Australian Radiation Protection Series Publication No. 3 |
| H-Field (Am-1) | = 0.23 | ICNIRP |
| H-Field (Am-1) | = N/A | FCC 47 CFR § 1.1310 |
| H-Field (Am-1) | = 0.27 | Canada's RF Safety Code 6 |
| H-Field (Am-1) | = 0.23 | Australian Radiation Protection Series Publication No. 3 |

2.3 ESTABLISHING WAVELENGTH AND 1/4 WAVELENGTH

| Frequency (MHz) | $\lambda = \frac{3 \times 10^8}{f}$ | | $\frac{\lambda}{4}$ | |
|--------------------|-------------------------------------|-------|---------------------|------|
| | m | cm | m | cm |
| 824.200 | 0.3640 | 36.40 | 0.0910 | 9.10 |
| 836.400 | 0.3587 | 35.87 | 0.0897 | 8.97 |
| 848.800 | 0.3534 | 35.34 | 0.0884 | 8.84 |



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2.4 FAR FIELD CALCULATIONS

The following calculations are based on: 1.6 dBi gain antenna

P = 0.500 (Power (Watts)) or 500 (Power milliwatts)

G = 1.445 (Numeric Gain)

r = 20 (Distance (centimetres)) or 0.200 (Distance (meters))

The power flux:

$$S = \frac{PG_{(\theta, \phi)}}{4\pi r^2} \quad S = 1.438 \text{ W/m}^2$$

$$S = 0.144 \text{ mW/cm}^2$$

The electric field strength:

$$E = \frac{\sqrt{30PG_{(\theta, \phi)}}}{r} \quad E = 23.282 \text{ V/m}$$

The magnetic field strength:

$$H = \frac{E}{\eta_0} \quad H = 0.062 \text{ A/m}$$

The calculations meet the General Public Exposure Levels described in the ICNIRP Guidelines.

The calculations meet the General Public Exposure Levels described in the FCC 47CFR§1.1310.

The calculations meet the General Public Exposure Levels described in the Canada's RF Safety Code 6.

The calculations meet the General Public Exposure Levels described in the Australian Radiation Protection Series Publication No. 3

The calculations meet the Occupational Exposure Levels described in the ICNIRP Guidelines.

The calculations meet the Occupational Exposure Levels described in the FCC 47CFR§1.1310

The calculations meet the Occupational Exposure Levels described in the Canada's RF Safety Code 6

The calculations meet the Occupational Exposure Levels described in the Australian Radiation Protection Series Publication No. 3

2.5 FIELD REPRESENTATIONS

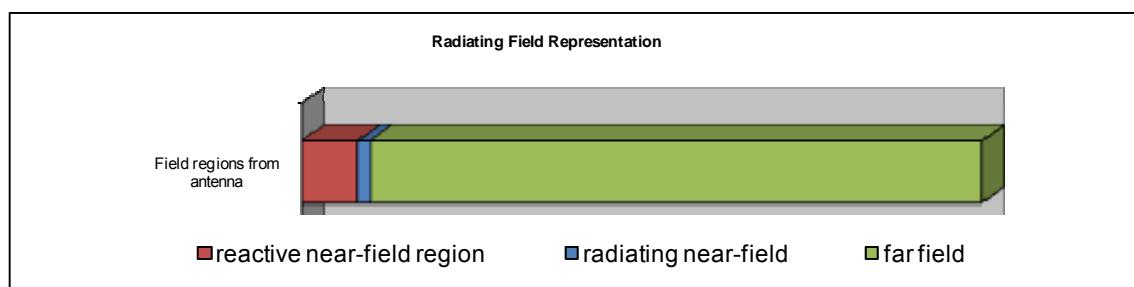


Figure 1: This graph shows the radiating field representation and is not to scale

Worst case frequency 824.200 MHz

The Reactive near-field region (from antenna) is less than : 0.091 m (9.100 cm)

The Radiating near-field region is greater than : 0.0198 m (1.98 cm)

The Radiating near-field region is less than : 0.0198 m (1.98cm)

The Far-field region is greater than : 0.091 m (9.100 cm)



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SECTION 3

FIGURES

3.1 FIELD REPRESENTATIONS: EUROPEAN – ICNIRP LIMITS

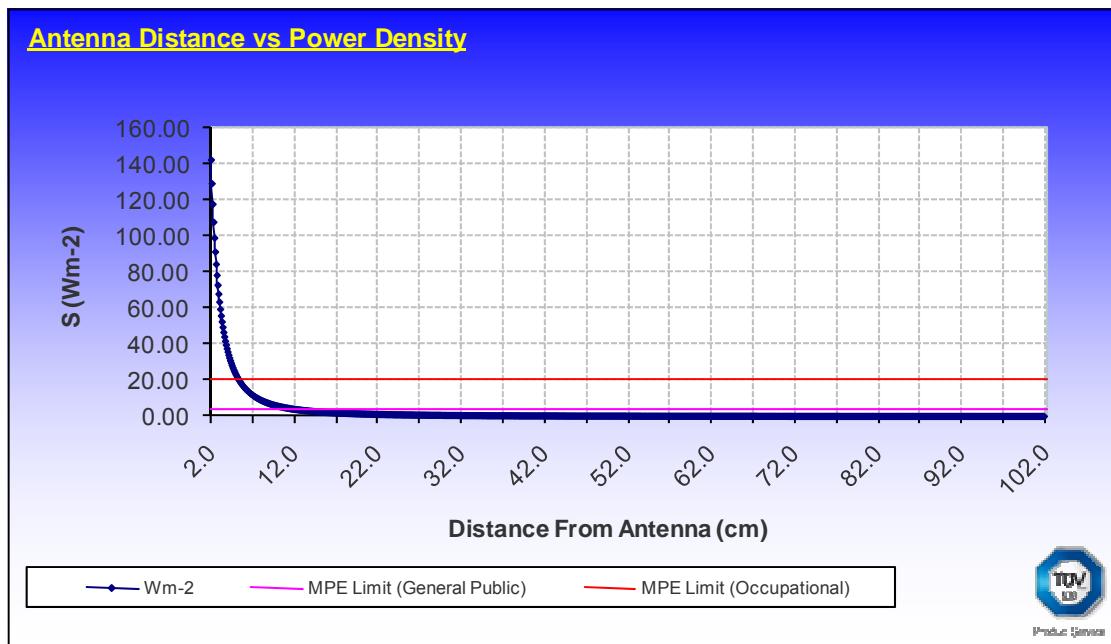


Figure 2 – This graph shows the S field (W/cm^2) strength value with regards to distance from the Antenna (cm)

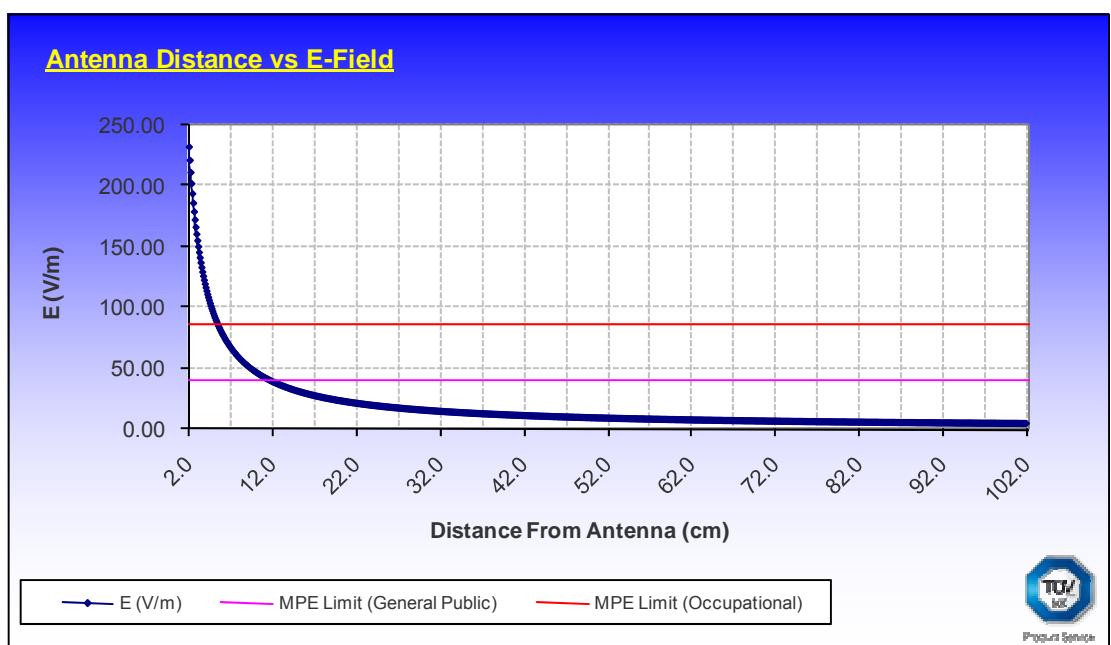


Figure 3 – This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm).

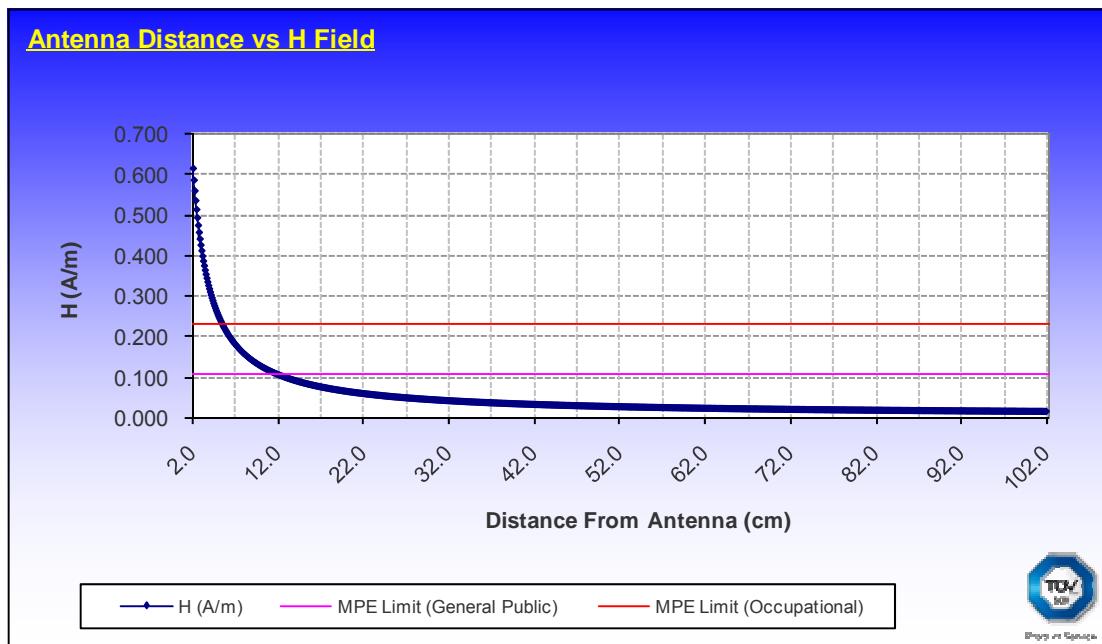


Figure 4 – This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm).

3.2 FIELD REPRESENTATIONS: AMERICAN – FCC LIMITS

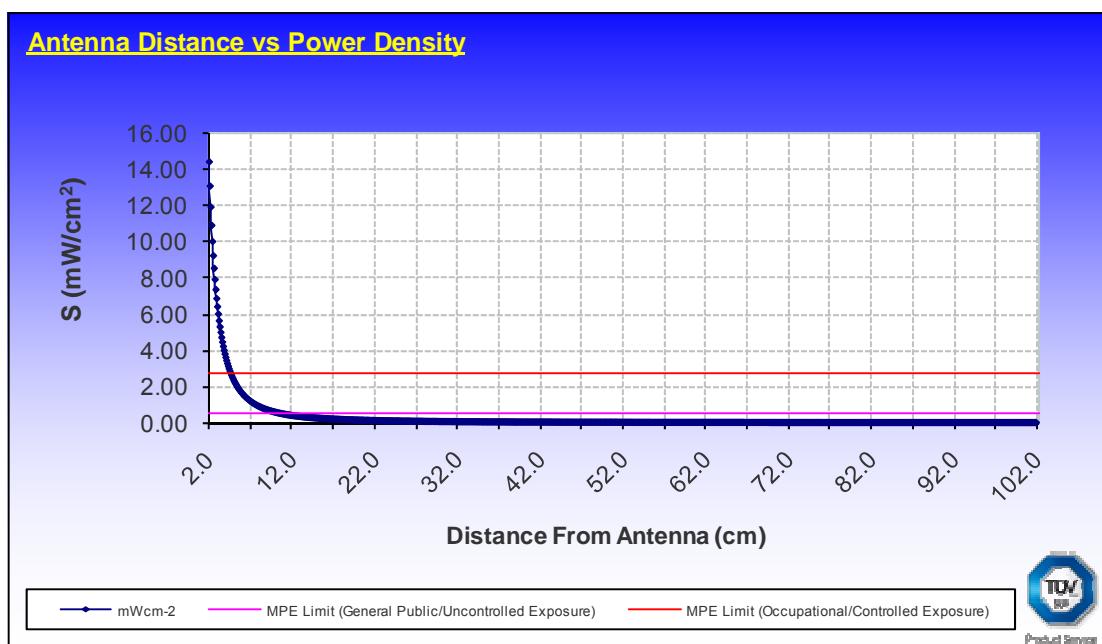


Figure 5 – This graph shows the S field (mW/cm²) strength value with regards to distance from the Antenna (cm).

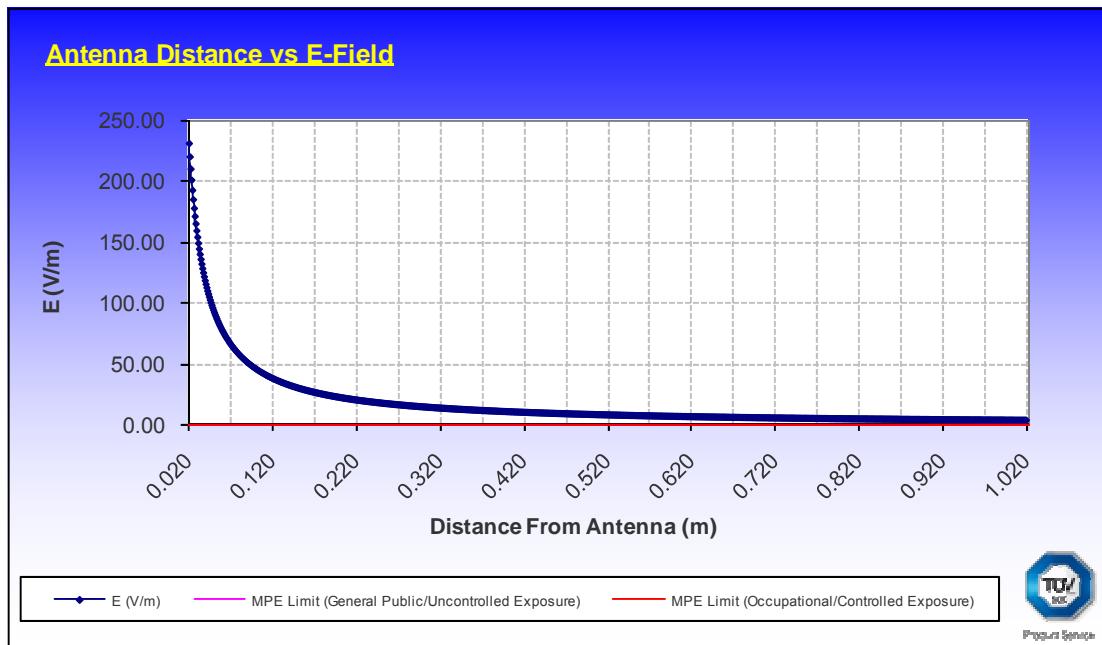


Figure 6 – This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm).

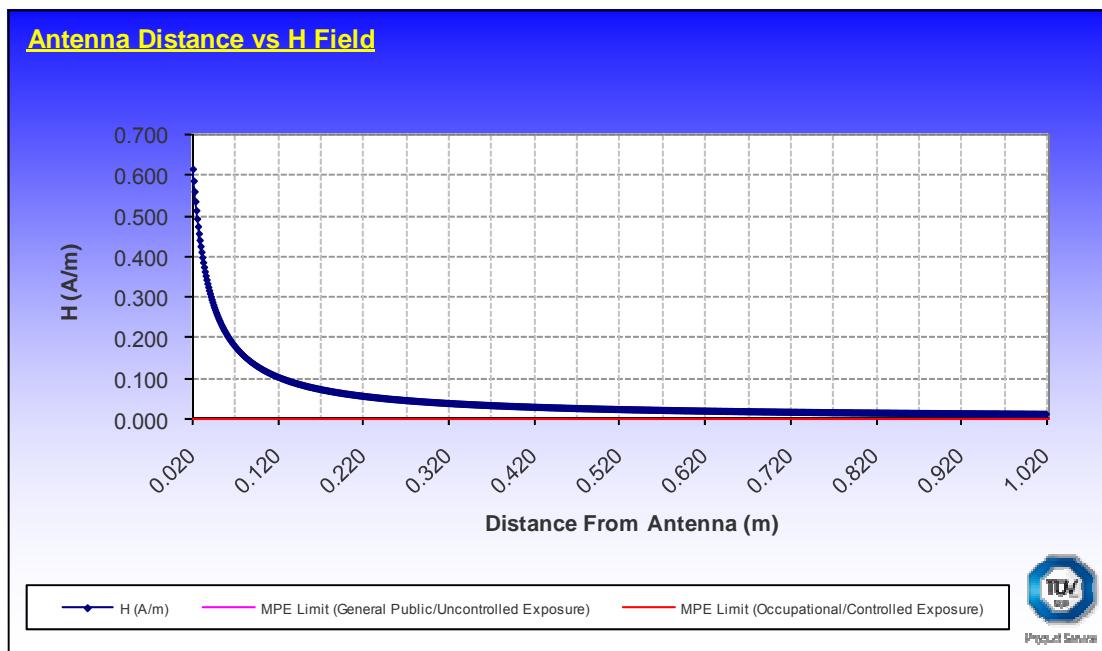


Figure 7 – This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm).

3.3 FIELD REPRESENTATIONS: CANADIAN – RF SAFETY CODE 6 LIMITS

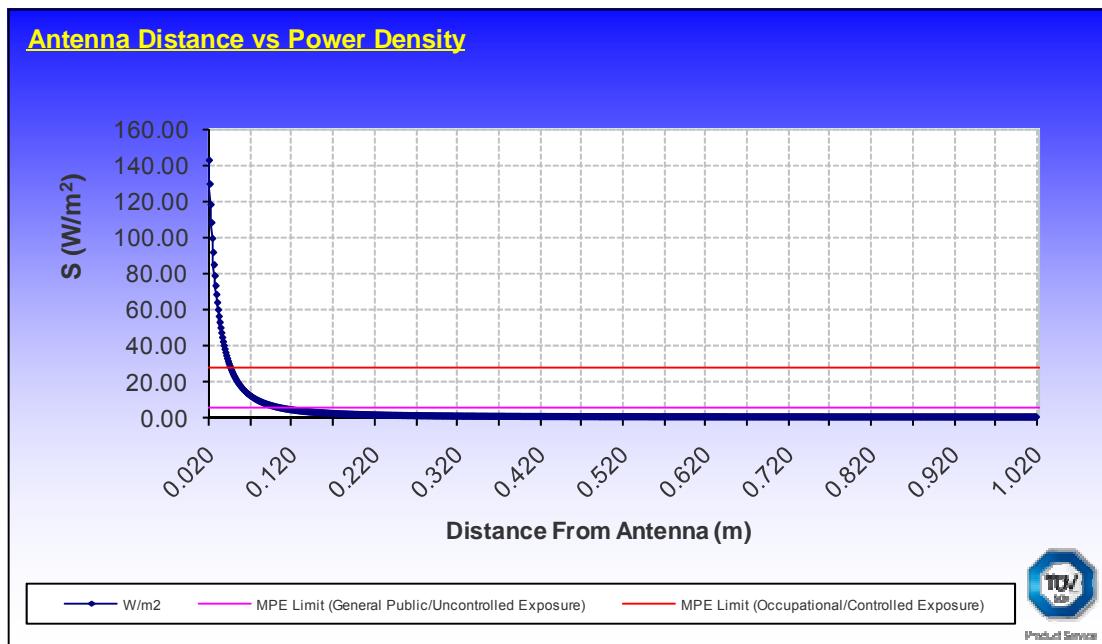


Figure 8 – This graph shows the S field (W/cm^2) strength value with regards to distance from the Antenna (cm)

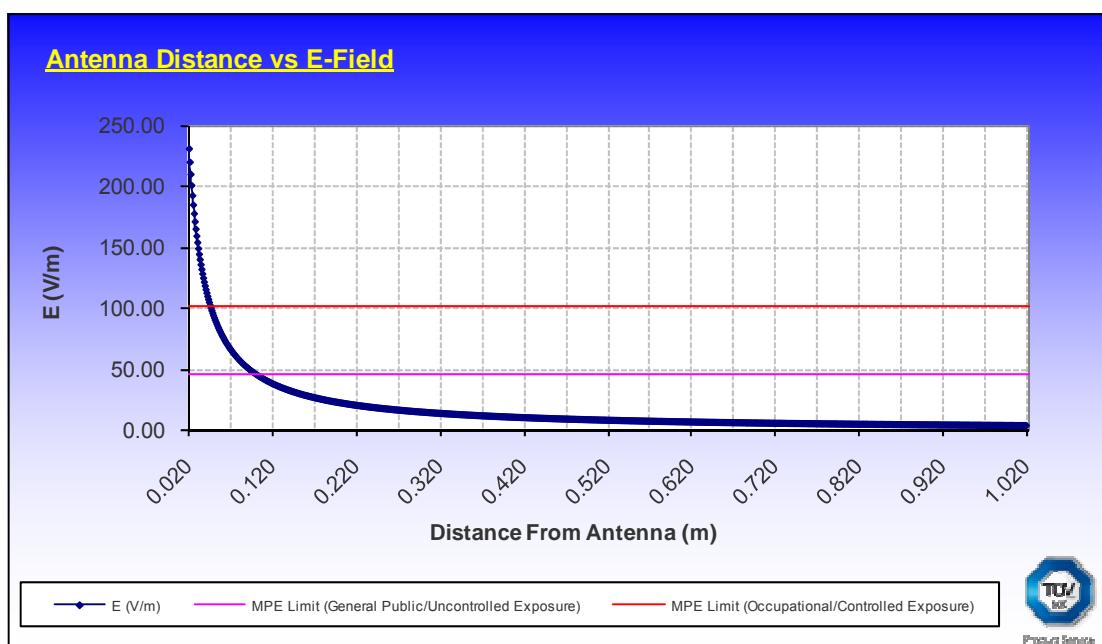


Figure 9 – This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm).

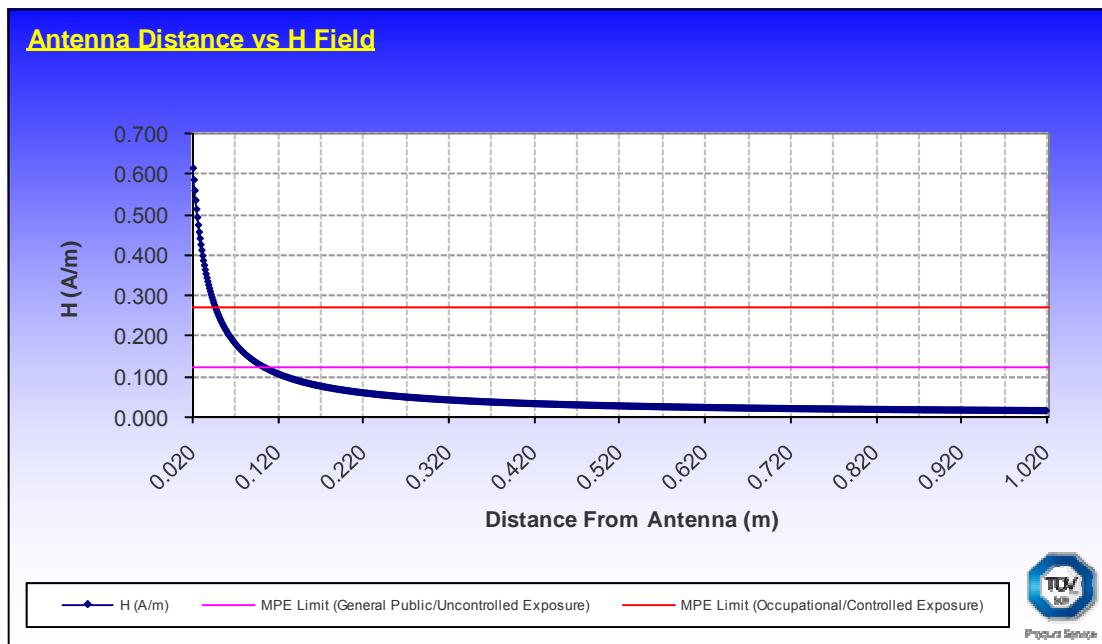


Figure 10 – This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm).

3.4 FIELD REPRESENTATIONS: AUSTRALIAN – ARPANSA LIMITS

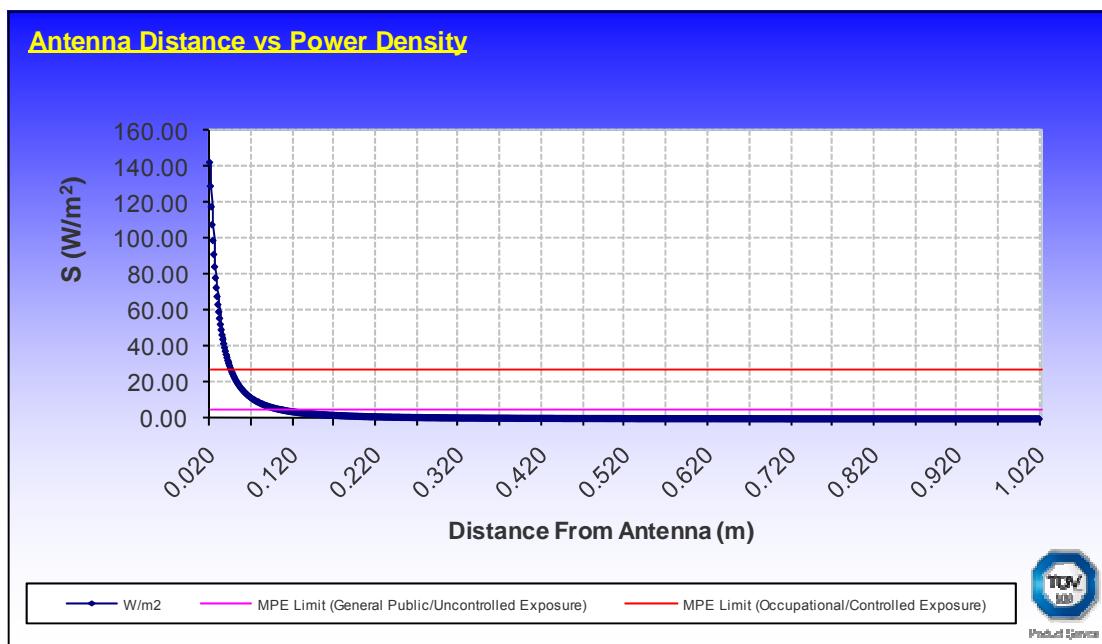


Figure 11 – This graph shows the S field (W/cm²) strength value with regards to distance from the Antenna (cm).

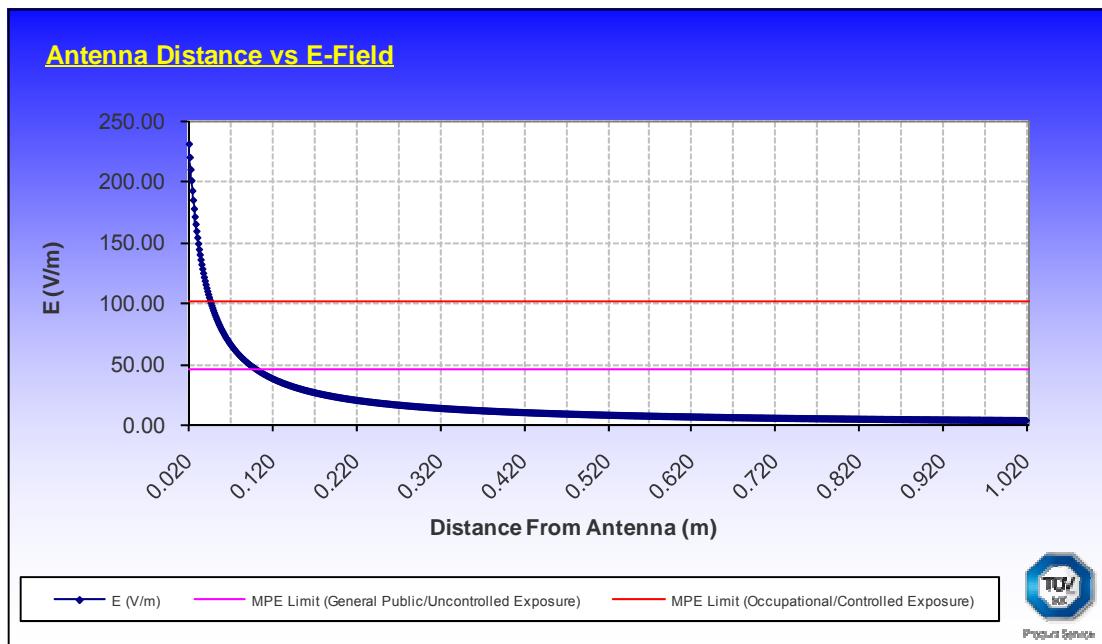


Figure 12 – This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm).

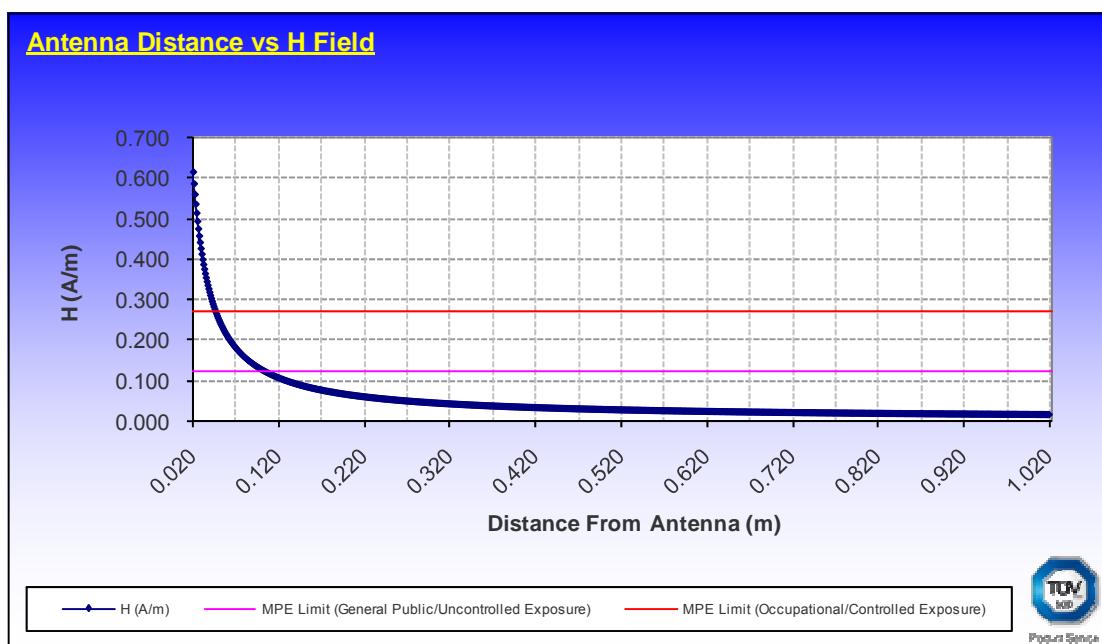


Figure 13 – This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm).



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SECTION 4

CO-TRANSMISSION CONSIDERATION



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4.1 CO-TRANSMISSION MODULE OPTIONS

The information contained in this report is intended to show verification of the F3507g Ericsson Mobile Broadband Module Installed in DELL Precision M2400 Laptop Computer. The DELL Precision M2400 Laptop Computer can also be fitted with the following wireless device modules, described below. This section aims to show the co-transmission quotient value based upon the highest reported conducted power value for the co-located modules.

The DELL Precision M2400 laptop can also be fitted with the following Wireless Module options:-

DELL Wireless 1397 WLAN Mini-Card 802.11g;
BroadCom BCM94312HMG
Frequency range (MHz): 2412.0 – 2462.0
FCCID: QDS-BRCM1030
Maximum Conducted Output power (W): 0.202

Dell Wireless 1510 WLAN Mini-Card 802.11n;
BroadCom BCM94322HMG
Frequency range (MHz): 2412.0 – 5795.0
FCCID: QDS-BRCM1031
Maximum Conducted Output power (W): 0.159

Dell Wireless 370 Bluetooth;
Frequency range (MHz): 2402.0 – 2480.0
FCCID: QDS-BRCM1034
Maximum Conducted Output power (W): 0.0027

Dell Wireless 410 Bluetooth + UWB
Frequency range (MHz): 2402.0 – 4800.0
FCCID: QDS-BRCM1021 TZQWQ110MC
Maximum Conducted Output power (W): 0.0043

Intel WiFi Link 5300 Module 802.11agn;
Frequency range (MHz): 2412.0 – 5825.0
FCCID: E2K533ANH
Maximum Conducted Output power (W): 0.441

Intel WiFi Link 5100 Module 802.11agn;
Frequency range (MHz): 2412.0 – 5825.0
FCCID: E2K512ANHMW
Maximum Conducted Output power (W): 0.072



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4.2

SOURCES CONTRIBUTING TO THE WORST-CASE QUOTIENT CALCULATION

The Ericsson Mobile Broadband Module
Intel WiFi Link 5300 Module 802.11agn
DELL Wireless 410 Module

| DIST(m) | FREQ. (MHz) | INPUT POWER (W) | GAIN (dBi) | FIELD (V/m) | FIELD (W/m) | REF. LEVEL | % QUOTIENT |
|-------------------------------------|----------------|-----------------------|---------------|----------------|----------------|---------------|------------|
| 0.2 | 824.2 | 0.500* | 1.6 | 23.28 | 1.438 | 4.12 | 34.89 |
| 0.2 | 5800 | 0.441 | 3 | 25.69 | 1.751 | 10.00 | 17.51 |
| 0.2 | 2480 | 0.0043 | 3 | 2.54 | 0.017 | 10.00 | 0.17 |
| TOTAL QUOTIENT (%) | | | | | | | 52.57 |
| FRACTION OF PUBLIC EXPOSURE LIMIT - | | | | | | | 1 / 2 |

*Note: Input power of 2 watts with a duty cycle of 25% (GPRS Multi-slot Class 10)



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SECTION 5

DISCLAIMERS AND COPYRIGHT



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5.1 DISCLAIMERS AND COPYRIGHT

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