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Report On

RF Exposure Assessment of the
Frontier Silicon Limited
Venice 8 FS2028 Radio Module

Document 75910757 Report 03 Issue 1 December 2010

Product Service

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SECTION 1

REPORT SUMMARY

RF Exposure Assessment of the
Frontier Silicon Limited
Venice 8 FS2028 Radio Module

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the RF Exposure Assessment of the Frontier Silicon Limited Venice 8 FS2028 Radio Module to the requirements of the applied test specifications.

Objective	To perform RF Exposure Assessment to determine the Equipment Under Test's (EUT's) compliance of the applied rules.
Applicant	Frontier Silicon Limited
Manufacturer	Frontier Silicon Limited
Manufacturing Description	Venice 8 FS2028 Radio Module
Model Number(s)	Venice 8 FS2028

Test Specification/Issue/Date

1. EN62311:2008 - Assessment of electronic and electrical equipment related to human exposure restrictions for 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 July1999).
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.

10. National Council on Radiation Protection and Measurements (NRPC) - 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
2.344	50	S	0.233 Wm-2	10.00 Wm-2	ICNIRP
		S	0.0233 mW/cm2	1.00 mW/cm2	FCC 47 CFR § 1.1310
		S	0.233 Wm-2	10.00 Wm-2	Canada's RF Safety Code 6
		S	0.233 Wm-2	10.00 Wm-2	ARPANSA
		E	9.376 V/m	61.00 V/m	ICNIRP
		E	9.376 V/m	N/A V/m	FCC 47 CFR § 1.1310
		E	9.376 V/m	61.40 V/m	Canada's RF Safety Code 6
		E	9.376 V/m	61.40 V/m	ARPANSA
		H	0.025 A/m	0.160 A/m	ICNIRP
		H	0.025 A/m	N/A A/m	FCC 47 CFR § 1.1310
		H	0.025 A/m	0.163 A/m	Canada's RF Safety Code 6
		H	0.025 A/m	0.163 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.

1.2.2 Occupational Exposure Levels

Antenna Gain (Numeric)	Peak Output Power (mW)	Field	Calculated RF Exposure at 0.200 m (20.0 cm)	Occupational Exposure Limit	Application
2.344	50	S	0.233 Wm-2	50.00 Wm-2	ICNIRP
		S	0.0233 mW/cm2	5.00 mW/cm2	FCC 47 CFR § 1.1310
		S	0.233 Wm-2	50.00 Wm-2	Canada's RF Safety Code 6
		S	0.233 Wm-2	50.00 Wm-2	ARPANSA
		E	9.376 V/m	137.00 V/m	ICNIRP
		E	9.376 V/m	N/A V/m	FCC 47 CFR § 1.1310
		E	9.376 V/m	137.00 V/m	Canada's RF Safety Code 6
		E	9.376 V/m	137.00 V/m	ARPANSA
		H	0.025 A/m	0.36 A/m	ICNIRP
		H	0.025 A/m	N/A A/m	FCC 47 CFR § 1.1310
		H	0.025 A/m	0.36 A/m	Canada's RF Safety Code 6
		H	0.025 A/m	0.364 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.

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 was a Frontier Silicon Limited Venice 8 FS2028 Radio Module. A full technical description can be found in the manufacturer's documentation.

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).

All reported calculations were carried out on the relevant information supplied for the Venice 8 FS2028 Radio Module to demonstrate compliance with the applied test specification(s) the sample assessed was found to comply with the requirements of the applied rules.

1.4 SUMMARY

The RF exposure assessment is based upon the following criteria:

The Venice 8 FS2028 Radio Module operates in the frequency range of
2400 – 2483.5 MHz
The gain of the Venice 8 FS2028 Radio Module is 3.7 dBi.
The Venice 8 FS2028 Radio Module radio power is a maximum 50 milliwatt.
The point of investigation is 0.200 m (20.0 cm).
The duty cycle is 100%.

The applicant declared two types of antenna

1. An Integral PIFA Antenna 2.365cm
2. An External Antenna 8.43cm

The calculations were performed at both antenna lengths but there were no difference in the exposure levels based on the antenna lengths.

SECTION 2

TEST DETAILS

2.1 RATIONALE FOR ASSESSMENT OF THE RF EXPOSURE

The aim of the 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 EN50383:2002 Clause 5.2; E-field or H-field calculation. The method of calculation used is defined in 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 λ/4 as the boundary between the radiated near-field and reactive near-field for RF exposure compliance assessment.

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 2400.000 MHz

Power density (Wm-2)	= 10.00	ICNIRP
Power density ($mWcm^2$)	= 1.00	FCC 47 CFR § 1.1310
Power density (Wm-2)	= 10.00	Canada's RF Safety Code 6
Power density (Wm-2)	= 10.00	Australian Radiation Protection Series Publication No. 3
E-Field (Vm-1)	= 61.00	ICNIRP
E-Field (Vm-1)	= N/A	FCC 47 CFR § 1.1310
E-Field (Vm-1)	= 61.40	Canada's RF Safety Code 6
E-Field (Vm-1)	= 61.40	Australian Radiation Protection Series Publication No. 3
H-Field (Am-1)	= 0.160	ICNIRP
H-Field (Am-1)	= N/A	FCC 47 CFR § 1.1310
H-Field (Am-1)	= 0.163	Canada's RF Safety Code 6
H-Field (Am-1)	= 0.163	Australian Radiation Protection Series Publication No. 3

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

At 2400.000 MHz

Power density (Wm-2)	= 50.00	ICNIRP
Power density ($mWcm^2$)	= 5.00	FCC 47 CFR § 1.1310
Power density (Wm-2)	= 50.00	Canada's RF Safety Code 6
Power density (Wm-2)	= 50.00	Australian Radiation Protection Series Publication No. 3
E-Field (Vm-1)	= 137.00	ICNIRP
E-Field (Vm-1)	= N/A	FCC 47 CFR § 1.1310
E-Field (Vm-1)	= 137.00	Canada's RF Safety Code 6
E-Field (Vm-1)	= 137.00	Australian Radiation Protection Series Publication No. 3
H-Field (Am-1)	= 0.36	ICNIRP
H-Field (Am-1)	= N/A	FCC 47 CFR § 1.1310
H-Field (Am-1)	= 0.36	Canada's RF Safety Code 6
H-Field (Am-1)	= 0.36	Australian Radiation Protection Series Publication No. 3

2.3 ESTABLISHING WAVELENGTH AND 1/4 WAVELENGTH

Frequency (MHz)	$\lambda = \frac{3x10^8}{f}$		$\frac{\lambda}{4}$	
	m	cm	m	cm
2400.000	0.1250	12.50	0.0313	3.13
2442.000	0.1229	12.29	0.0307	3.07
2483.500	0.1208	12.08	0.0302	3.02

2.4 FAR FIELD CALCULATIONS

The following calculations are based on: 3.7 dBi gain antenna

P = 0.05 (Power (Watts)) or 50 (Power milliwatts)
G = 2.344 (Numeric Gain)
r = 20.0 (Distance (centimetres)) or 0.200 (Distance (meters))

The power flux:

$$S = \frac{PG_{(\theta,\phi)}}{4\pi r^2}$$

S = 0.233 W/m2

S = 0.0233 mW/cm2

The electric field strength:

$$E = \frac{\sqrt{30PG}_{(\theta,\phi)}}{r}$$

E = V/m

The magnetic field strength:

$$H = \frac{E}{\eta_o}$$

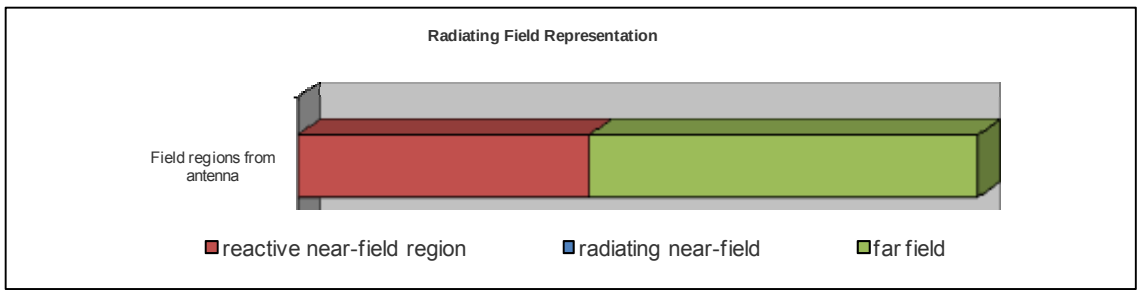
H = 0.025 A/m

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 REGIONS

Worst case frequency 2400.000 MHz



The Reactive near-field region (from antenna) is less than : 0.031 m (3.125 cm)
The Radiating near-field region is greater than : 0.031 m (3.125 cm)
The Radiating near-field region is less than : 0.009 m (0.89 cm)
The Far-field region is greater than : 0.009 m (0.89 cm)

SECTION 3

FIGURES

3.1 FIELD REPRESENTATIONS – ICNIRP

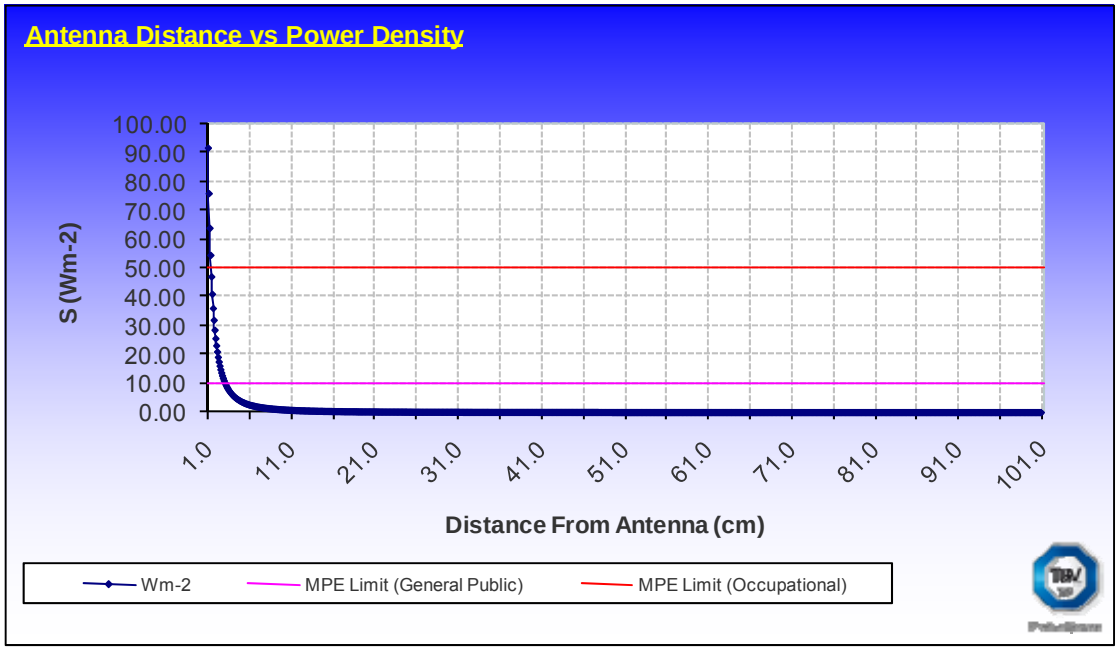


Figure 2 - This graph shows the S field (W/cm^2) strength value with regards to distance from the Antenna (cm)

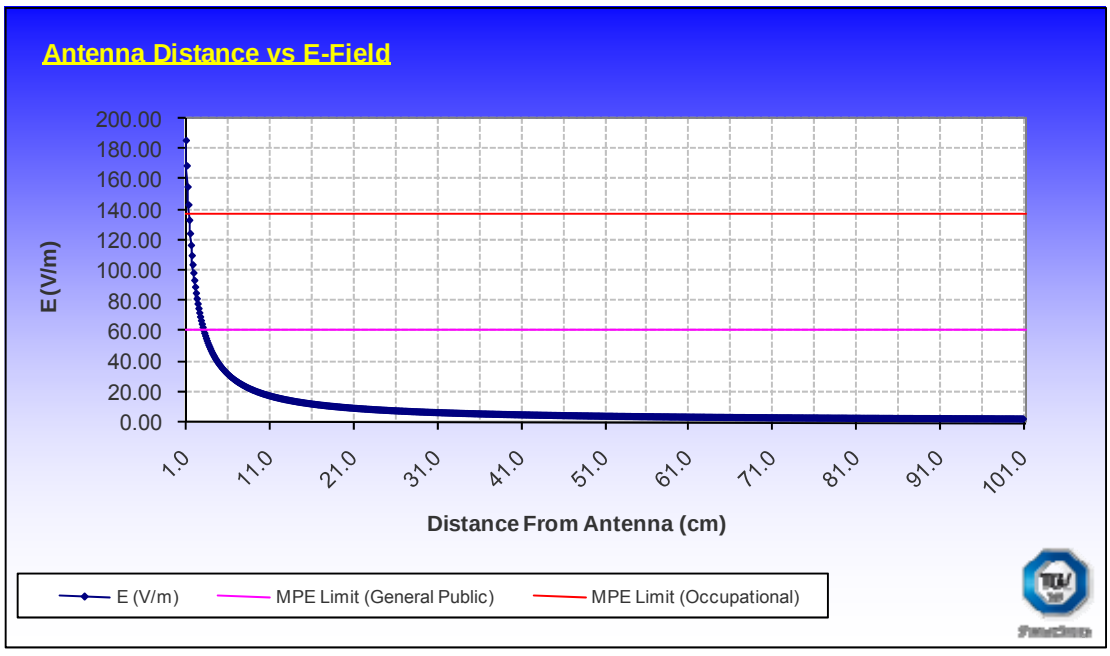


Figure 3 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm).

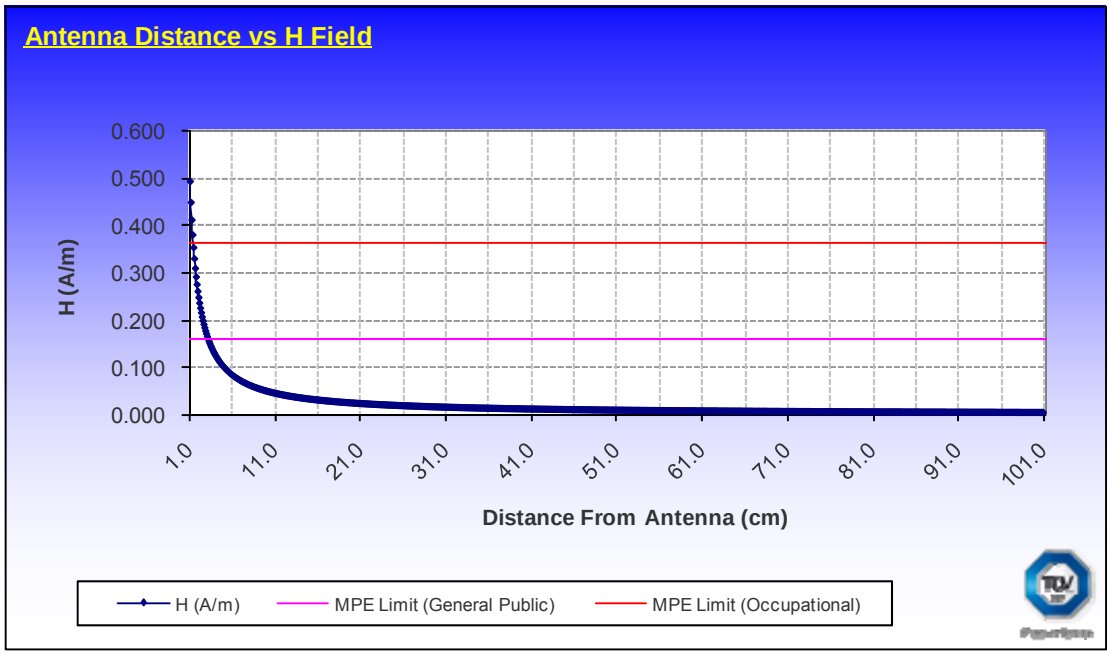


Figure 4 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm).

3.2 FIELD REPRESENTATIONS – FCC

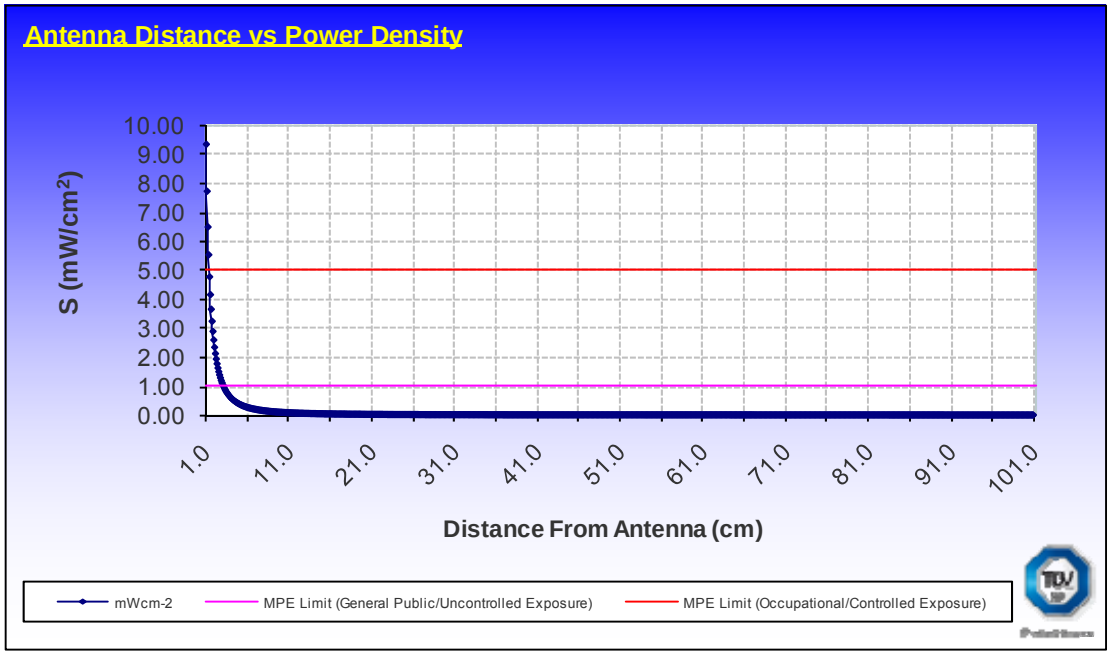


Figure 5 - This graph shows the S field (mW/cm^2) strength value with regards to distance from the Antenna (cm)

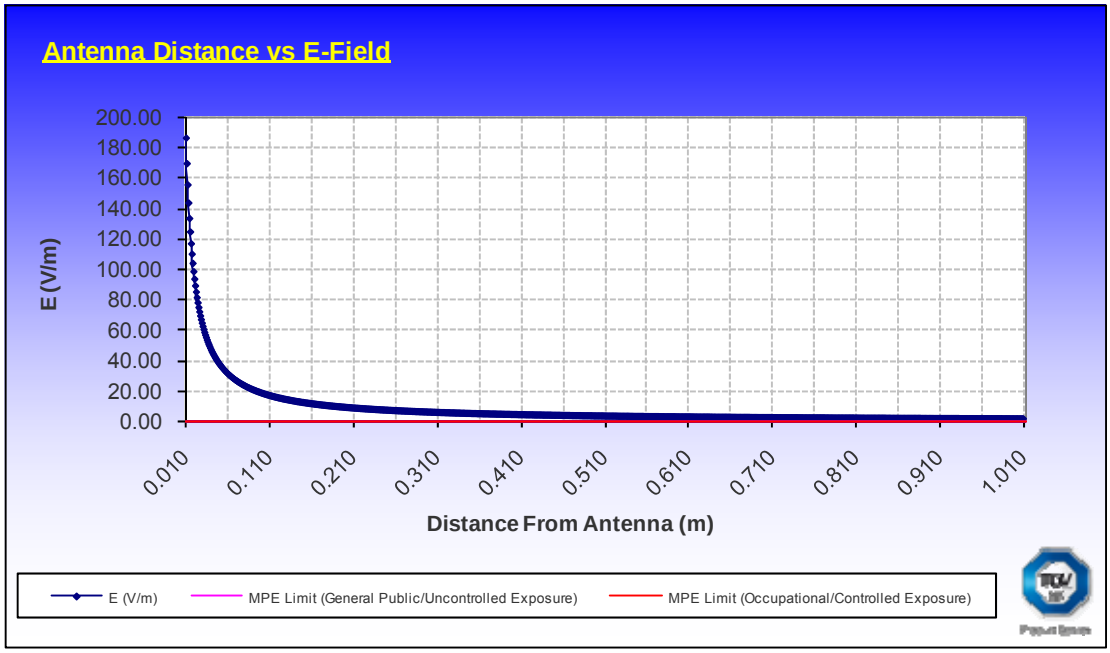


Figure 6 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm). Note: No applicable limit.

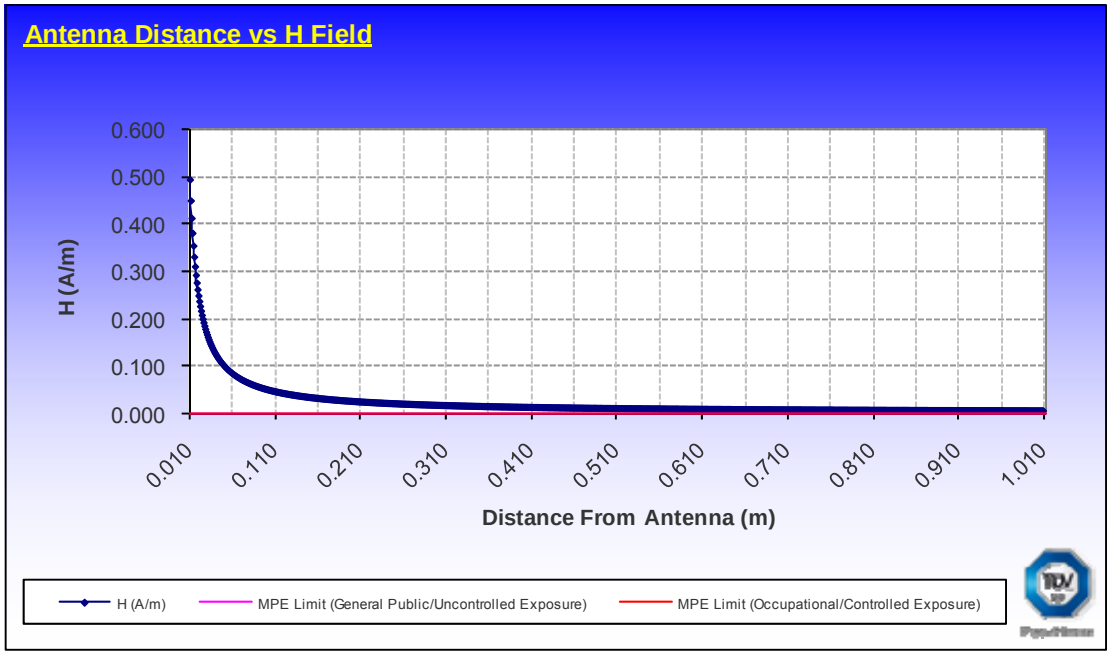


Figure 7 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm). Note: No applicable limit.

3.3 FIELD REPRESENTATIONS – IC

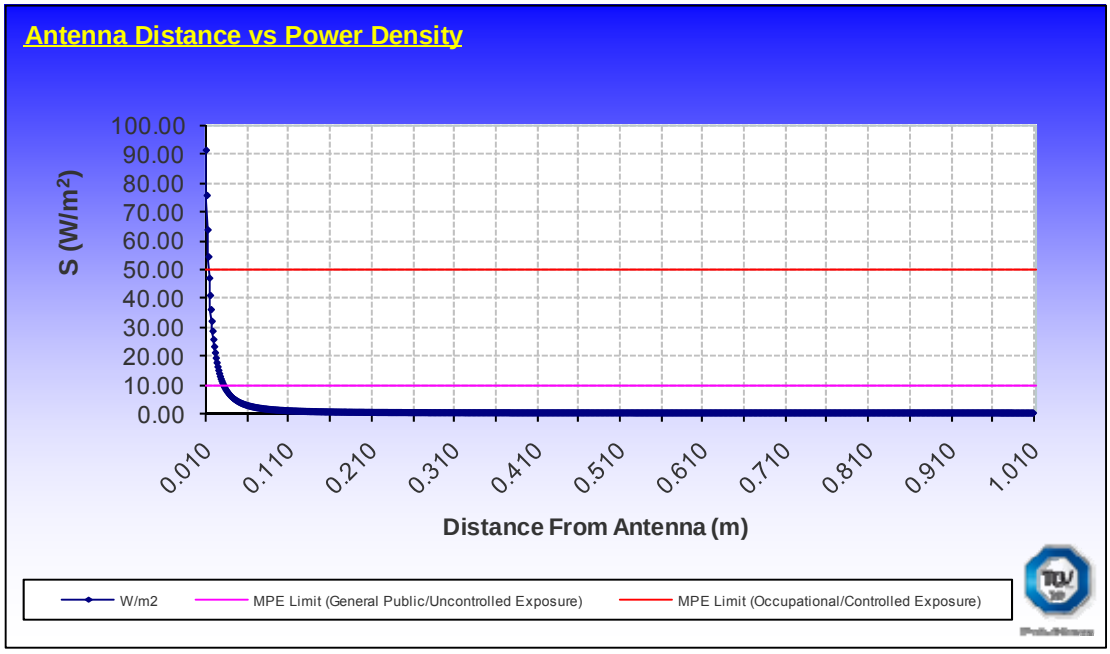


Figure 8 - This graph shows the S field (W/cm^2) strength value with regards to distance from the Antenna (cm)

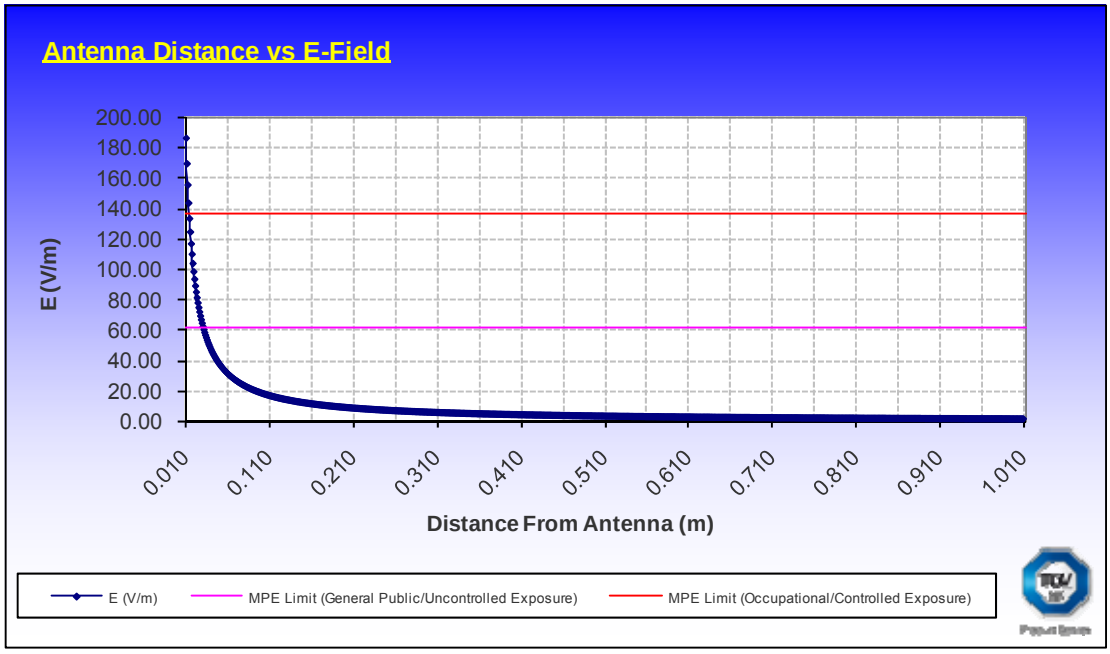


Figure 9 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm).

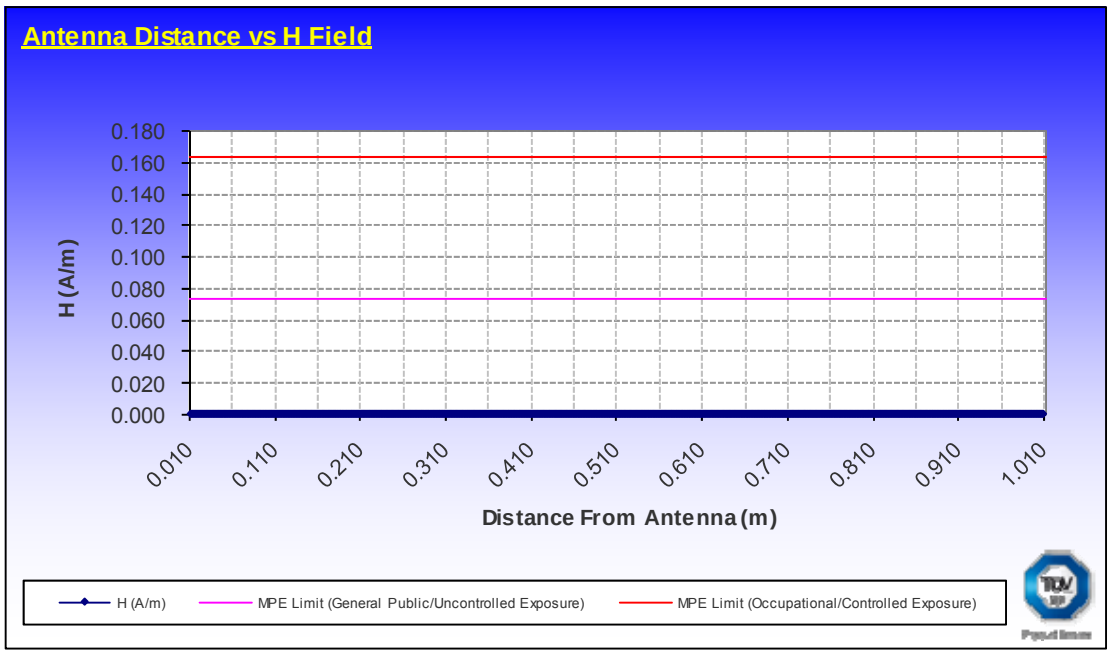


Figure 10 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm).

3.4 FIELD REPRESENTATIONS – ACMA

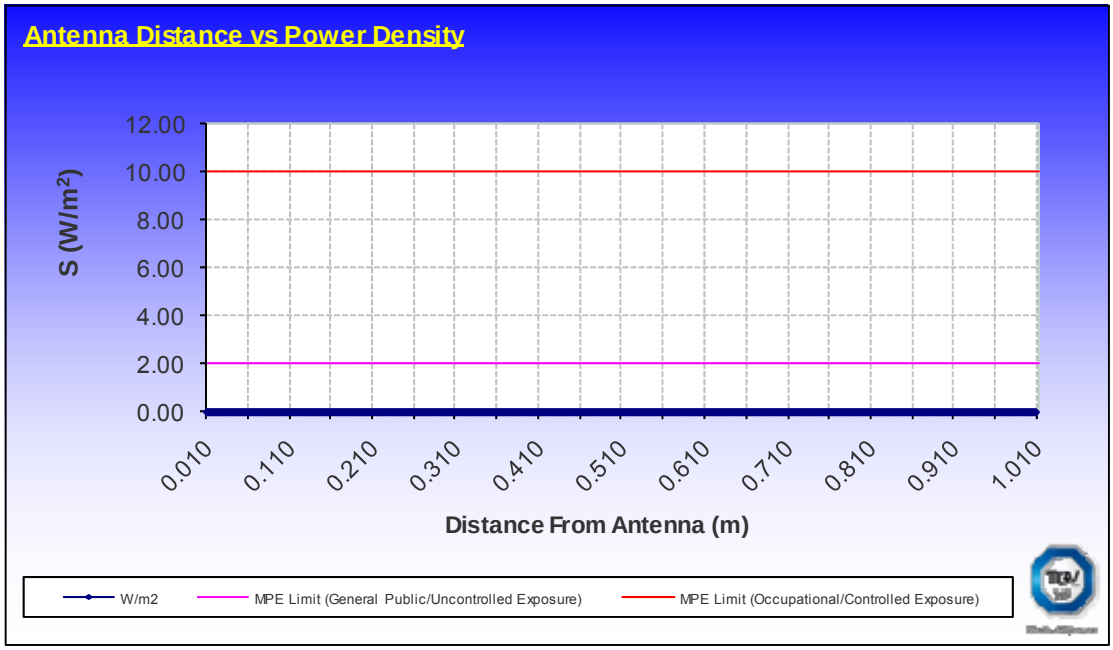


Figure 11 - This graph shows the S field (W/cm^2) strength value with regards to distance from the Antenna (cm)

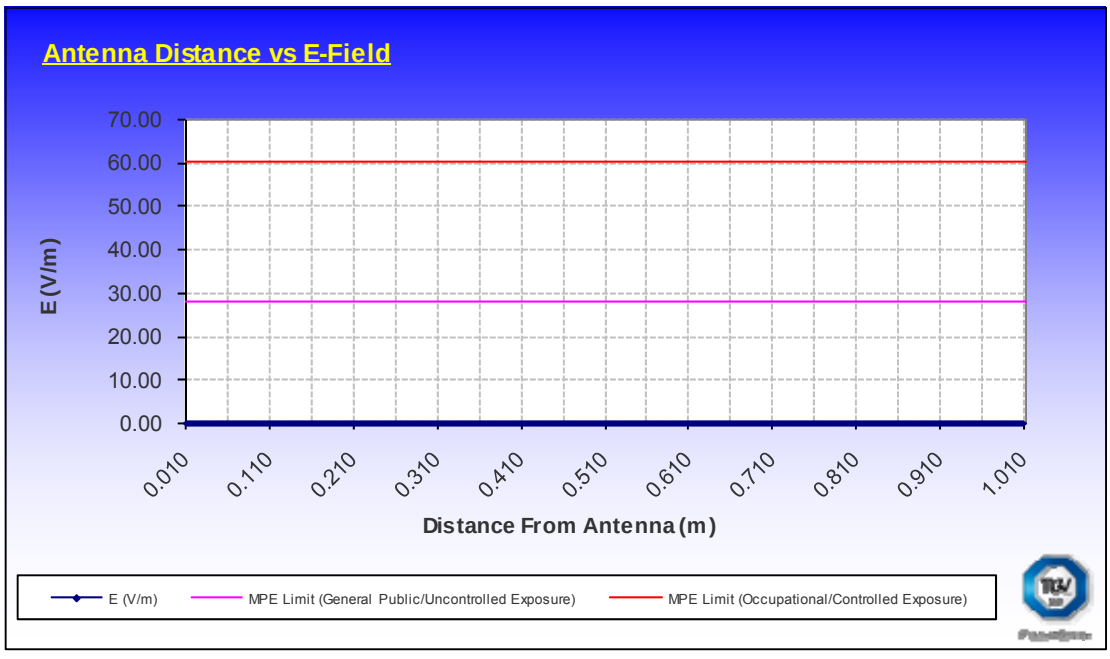


Figure 12 - This graph shows the E field (V/m) strength value with regards to distance from the Antenna (cm).

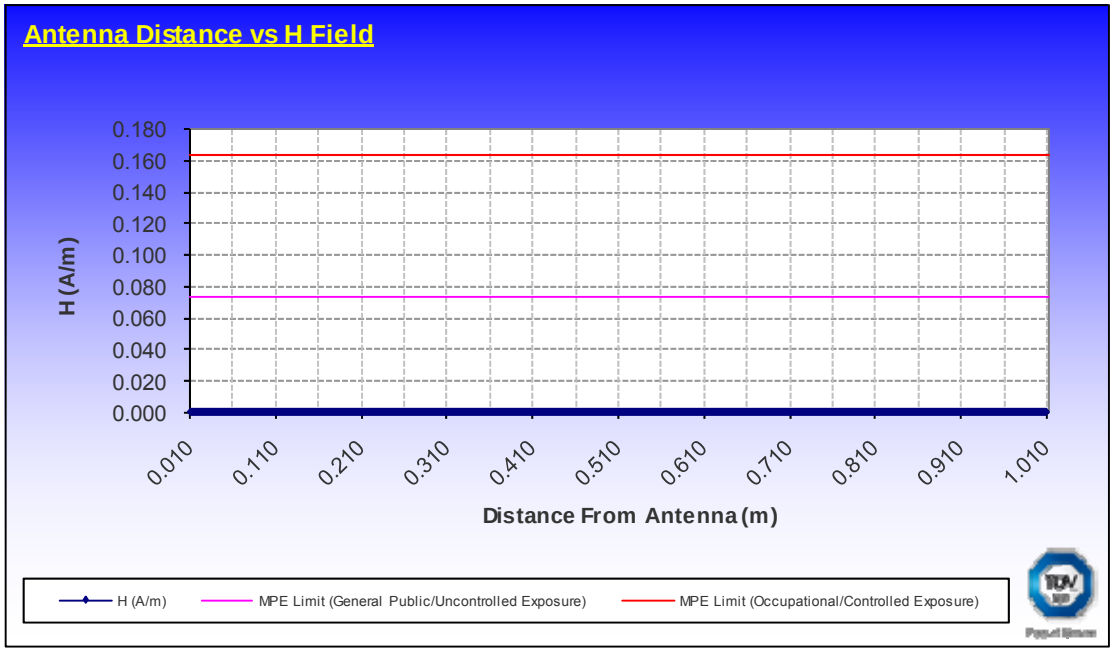


Figure 13 - This graph shows the H field (A/m) strength value with regards to distance from the Antenna (cm).

SECTION 4

DISCLAIMERS AND COPYRIGHT

4.1 DISCLAIMERS AND COPYRIGHT

This report relates only to the actual item/items tested.