

**TRaC Wireless Test Report : 0F3165WUS1**

**Applicant** : Bolton Electronics Ltd

**Apparatus** : MooMonitor

**Specification(s)** : CFR47 Part 15 July 2008

**Purpose of Test** : Certification

**FCCID** : Y9GTAG1-1

**Authorised by** :



: Radio Product Manager

**Issue Date** : 17<sup>th</sup> February 2011

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**Section 1:**

**Introduction**

**1.1 General**

This report contains an assessment of an apparatus against Electromagnetic Compatibility Standards based upon tests carried out on samples submitted to the Laboratory.

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## **1.2 Tests Requested By**

This testing in this report was requested by :

Bolton Electronics Ltd  
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100 Market St  
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BL5 3AZ  
United Kingdom

## **1.3 Manufacturer**

As Above.

## **1.4 Apparatus Assessed**

The following apparatus was assessed between 18<sup>th</sup> – 20<sup>th</sup> October 2010:

Moo Monitor

The EUT is a single frequency device operating in the 902MHz – 928MHz band at 915MHz.

## 1.5 Test Result Summary

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

The statements relating to compliance with the standards below apply ONLY as qualified in the notes and deviations stated in sections 1.6 to 1.7 of this test report.

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

Test Type	Regulation	Measurement standard	Result
Spurious Emissions Radiated <1000MHz	Title 47 of the CFR: Part 15 Subpart (c) 15.209	ANSI C63.10	Pass
Spurious Emissions Radiated >1000MHz	Title 47 of the CFR: Part 15 Subpart (c) 15.209 Part 15 Subpart (c) 15.249 (a),(e)	ANSI C63.10	Pass
AC Power conducted emissions	Title 47 of the CFR: Part 15 Subpart (c) 15.207	ANSI C63.10	N/A
Intentional Emission Frequency	Title 47 of the CFR: Part 15 Subpart (c) 15.249 (a)	ANSI C63.10	Pass
Intentional Emission Field Strength	Title 47 of the CFR: Part 15 Subpart (c) 15.249 (a)	ANSI C63.10	Pass
Intentional Emission Band Occupancy	Title 47 of the CFR: Part 15 Subpart (c) 15.215	ANSI C63.10	Pass
Intentional Emission ERP (mW)	Title 47 of the CFR: Part 15 Subpart (c) 15.	ANSI C63.10	N/A
Unintentional Radiated Spurious Emissions	Title 47 of the CFR: Part 15 Subpart (b) 15.109	ANSI C63.10	Pass
Antenna Arrangements Integral:	Title 47 of the CFR: Part 15 Subpart (c) 15.203	-	Pass
Antenna Arrangements External Connector	Title 47 of the CFR: Part 15 Subpart (c) 15.204	-	N/A
Restricted Bands	Title 47 of the CFR: Part 15 Subpart (c) 15.205	-	-
Maximum Frequency of Search	Title 47 of the CFR: Part 15 Subpart (c) 15.33	-	-
Extrapolation Factor	Title 47 of the CFR: Part 15 Subpart (c) 15.31(f)	-	-

Abbreviations used in the above table:

CFR : Code of Federal Regulations  
REFE : Radiated Electric Field Emissions

ANSI : American National Standards Institution  
PLCE : Power Line Conducted Emissions

## **1.6 Notes Relating To The Assessment**

With regard to this assessment, the following points should be noted:

The results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 1.7 of this test report (Deviations from Test Standards).

For emissions testing, throughout this test report, "Pass" indicates that the results for the sample as tested were below the specified limit (refer also to Section 2, Measurement Uncertainty).

Where relevant, the apparatus was only assessed using the monitoring methods and susceptibility criteria defined in this report.

All testing with the exception of testing at the Open Area Test Site was performed under the following environmental conditions:

Temperature	: 17 to 23 °C
Humidity	: 45 to 75 %
Barometric Pressure	: 86 to 106 kPa

All dates used in this report are in the format dd/mm/yy.

This assessment has been performed in accordance with the requirements of ISO/IEC 17025.

## **1.7 Deviations from Test Standards**

There were no deviations from the standards tested to.

**Section 2:****Measurement Uncertainty****2.1 Application of Measurement Uncertainty**

The following table contains the measurement uncertainties for measurements

The following procedure is used when determining the result of a measurement :

- (i) If specification limits are not exceeded by the measured result, extended by the positive component of the expanded uncertainty interval at a confidence level of 95%, then a pass result is recorded.
- (ii) Where a specification limit is exceeded by the result even when the result is decreased by the negative component of the expanded uncertainty interval, a fail result is recorded.
- (iii) Where measured result is below a limit, but by a margin less than the positive measurement uncertainty component, it is not possible to record a pass based on a 95% confidence level. However, the result indicates that a pass result is more probable than a fail result.
- (iv) Where a measured result is above a limit, but by a margin less than the negative measurement uncertainty component, it is not possible to record a fail based on a 95% confidence level. However the result indicates that a fail is more probable than a pass.

## 2.2 Measurement Uncertainty Values

For the test data recorded in accordance with note (iii) of Section 2.1 the following measurement uncertainty was calculated:

### Radio Testing – General Uncertainty Schedule

*All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95% confidence where no required test level exists.*

#### **[1] Adjacent Channel Power**

Uncertainty in test result = **1.86dB**

#### **[2] Carrier Power**

Uncertainty in test result (Equipment - TRLUH120) = **2.18dB**

Uncertainty in test result (Equipment – TRL05) = **1.08dB**

Uncertainty in test result (Equipment – TRL479) = **2.48dB**

#### **[3] Effective Radiated Power**

Uncertainty in test result = **4.71dB**

#### **[4] Spurious Emissions**

Uncertainty in test result = **4.75dB**

#### **[5] Maximum frequency error**

Uncertainty in test result (Equipment - TRLUH120) = **119ppm**

Uncertainty in test result (Equipment – TRL05) = **0.113ppm**

Uncertainty in test result (Equipment – TRL479) = **0.265ppm**

#### **[6] Radiated Emissions, field strength OATS 14kHz-18GHz Electric Field**

Uncertainty in test result (14kHz – 30MHz) = **4.8dB**, Uncertainty in test result (30MHz – 1GHz) = **4.6dB**, Uncertainty in test result (1GHz-18GHz) = **4.7dB**

#### **[7] Frequency deviation**

Uncertainty in test result = **3.2%**

#### **[8] Magnetic Field Emissions**

Uncertainty in test result = **2.3dB**

#### **[9] Conducted Spurious**

Uncertainty in test result (Equipment TRL479) Up to 8.1GHz = **3.31dB**

Uncertainty in test result (Equipment TRL479) 8.1GHz – 15.3GHz = **4.43dB**

Uncertainty in test result (Equipment TRL479) 15.3GHz – 21GHz = **5.34dB**

Uncertainty in test result (Equipment TRLUH120) Up to 26GHz = **3.14dB**

#### **[10] Channel Bandwidth**

Uncertainty in test result = **15.5%**

#### **[11] Amplitude and Time Measurement – Oscilloscope**

Uncertainty in overall test level = **2.1dB**, Uncertainty in time measurement = **0.59%**, Uncertainty in Amplitude measurement = **0.82%**

**[11] Power Line Conduction**

Uncertainty in test result = **3.4dB**

**[12] Spectrum Mask Measurements**

Uncertainty in test result = **2.59% (frequency)**  
Uncertainty in test result = **1.32dB (amplitude)**

**[13] Adjacent Sub Band Selectivity**

Uncertainty in test result = **1.24dB**

**[14] Receiver Blocking – Listen Mode, Radiated**

Uncertainty in test result = **3.42dB**

**[15] Receiver Blocking – Talk Mode, Radiated**

Uncertainty in test result = **3.36dB**

**[16] Receiver Blocking – Talk Mode, Conducted**

Uncertainty in test result = **1.24dB**

**[17] Receiver Threshold**

Uncertainty in test result = **3.23dB**

**[18] Transmission Time Measurement**

Uncertainty in test result = **7.98%**

**Section 3:**

**Modifications**

**3.1 Modifications Performed During Assessment**

No modifications were performed during the assessment

**Appendix A:****Formal Emission Test Results**

Abbreviations used in the tables in this appendix:

Spec	: Specification	ALSR	: Absorber Lined Screened Room
Mod	: Modification	OATS	: Open Area Test Site
		ATS	: Alternative Test Site
EUT	: Equipment Under Test		
SE	: Support Equipment	Ref	: Reference
L	: Live Power Line	Freq	: Frequency
N	: Neutral Power Line	MD	: Measurement Distance
E	: Earth Power Line	SD	: Spec Distance
Pk	: Peak Detector	Pol	: Polarisation
QP	: Quasi-Peak Detector	H	: Horizontal Polarisation
Av	: Average Detector	V	: Vertical Polarisation
CDN	: Coupling & decoupling network		

**A1 Transmitter Intentional Emission Radiated**

<b>Carrier power was verified with the EUT transmitting:</b>	
Regulation	Title 47 of the CFR: Part15 Subpart (c) 15.249(a)
Measurement standard	ANSI C63.10:2003
EUT sample number	01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	18°C
Photographs (Appendix F)	Photograph 1

FREQ. (MHz)	MEASUREMENT Rx. READING (dB $\mu$ V)	CABLE LOSS (dB)	ANT FACTOR (dB/m)	PRE AMP (dB)	FIELD STRENGTH (dB $\mu$ V/m)	FIELD STRENGTH (mV/m)
915.0	106.2	3.6	7.35	28.07	89.0	28.18
Limit value @ fc			<b>50 mV/m</b>			
Band occupancy @ -20 dBc			f lower		f higher	
			914.935897 MHz		915.148237 MHz	
			212.34kHz			

**Notes:**

- 1 Results quoted are extrapolated as indicated
- 2 Receiver detector @ fc = Quasi Peak 120kHz bandwidth.
- 3 When battery powered the EUT was powered with new batteries

**Test Method:**

- 1 As per Radio – Noise Emissions, ANSI C63.10
- 2 Measuring distances 3m
- 3 EUT 0.8 metre above ground plane
- 4 Emissions maximised by rotation of EUT, on an automatic turntable. Raising and lowering the receiver antenna between 1m & 4m. Horizontal and vertical polarisations, of the receive antenna. EUT orientation in three orthogonal planes. Maximum results recorded

## A2 Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The radiated electric field emission test applies to all spurious emissions and harmonics emissions. The maximum permitted field strength is listed in Section 15.209. The EUT was set to transmit as required.

The following test site was used for final measurements as specified by the standard tested to:

3m open area test site :

3m alternative test site :  X

The effect of the EUT set-up on the measurements is summarised in note (c) below.

Test Details:	
Regulation	Title 47 of the CFR, Part 15 Subpart (c) Clause 15.209
Measurement standard	ANSI C63.10:2003
Frequency range	30MHz – 10GHz
EUT sample number	01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	18°C
Photographs (Appendix F)	Photograph 1

The worst case radiated emission measurements for spurious emissions and harmonics that fall within the restricted bands are listed below:

Ref No.	Freq. (MHz)	Meas Rx (dB $\mu$ V)	Cable Loss (dB)	Ant Fact. (dB/m)	Pre Amp (dB)	Field St'gh (dB $\mu$ V/m)	Duty Cycle Corr (dB)	Field St'gh ( $\mu$ V/m)	Limit ( $\mu$ V/m)
1.	516.10	44.7	2.6	17.5	27.5	37.3	-	73.28	200
2.	545.60	41.7	2.7	18.6	27.6	35.4	-	58.88	200
3.	633.55	40.0	3.0	18.9	27.7	34.2	-	51.28	200
4.	884.75	39.9	3.3	20.6	28.1	35.7	-	60.95	200
5.	943.75	41.0	3.5	20.9	27.9	37.5	-	74.99	200
6.	973.25	40.6	3.3	21.3	27.7	37.5	-	74.99	500
7.	1830.036	55.28	2.3	26.0	36.7	56.88	-4.63	409.73	500
8.	2744.972	55.42	1.8	29.2	36.3	50.12	-4.63	188.15	500
9.	3660.052	42.46	1.9	32.0	36.0	40.36	-4.63	61.16	500
10.	4575.084	47.64	2.2	32.3	36.5	45.64	-4.63	112.33	500

<sup>1</sup>See section 2.2 Note (iii).

**Notes:**

- 1 Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10: section 4.5, Table 1 For emissions below 30MHz the cable losses are assumed to be negligible.
- 2 In accordance with 15.35(b), above 1 GHz, emissions measured using a peak detector shall not exceed a level 20 dB above the average limit.
- 3 Testing was performed with the EUT orientated in three orthogonal planes and the maximum emissions level recorded. In addition, the EUT antenna was varied within its range of motion in order to maximise emissions.
- 4 For Frequencies below 1 GHz, RBW= 120 kHz, testing was performed with CISPR16 compliant test receiver with QP detector. Above 1 GHz tests were performed using a spectrum analyser using the following settings:

Peak	RBW= 1MHz; VBW > RBW
Average	RBW= 1MHz; VBW > RBW

The upper and lower frequency of the measurement range was decided according to 47 CFR 15:2008 Clause 15.33(a) and 15.33(a)(1).

Radiated emission limits 47 CFR 15: Clause 15.209 for all emissions:

Frequency of emission (MHz)	Field strength $\mu$ V/m	Measurement Distance m	Field strength $\text{dB}\mu\text{V}/\text{m}$
30-88	100	3	40.0
88-216	150	3	43.5
216-960	200	3	46.0
Above 960	500	3	54.0

(a) Where results have been measured at one distance, and a signal level displayed at another, the results have been extrapolated using the following formula:

$$\text{Extrapolation (dB)} = 20 \log_{10} \left( \frac{\text{measurement distance}}{\text{specification distance}} \right)$$

(b) Where results have been corrected for duty cycle the correction factor is calculated using the following formula in appendix E

(c) The levels may have been rounded for display purposes.

(d) The following table summarises the effect of the EUT operating mode, internal configuration and arrangement of cables / samples on the measured emission levels :

	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels	✓			
Effect of EUT internal configuration on emission levels	✓			
Effect of Position of EUT cables & samples on emission levels				✓
(i) Parameter defined by standard and / or single possible, refer to Appendix D (ii) Parameter defined by client and / or single possible, refer to Appendix D (iii) Parameter had a negligible effect on emission levels, refer to Appendix D (iv) Worst case determined by initial measurement, refer to Appendix D				

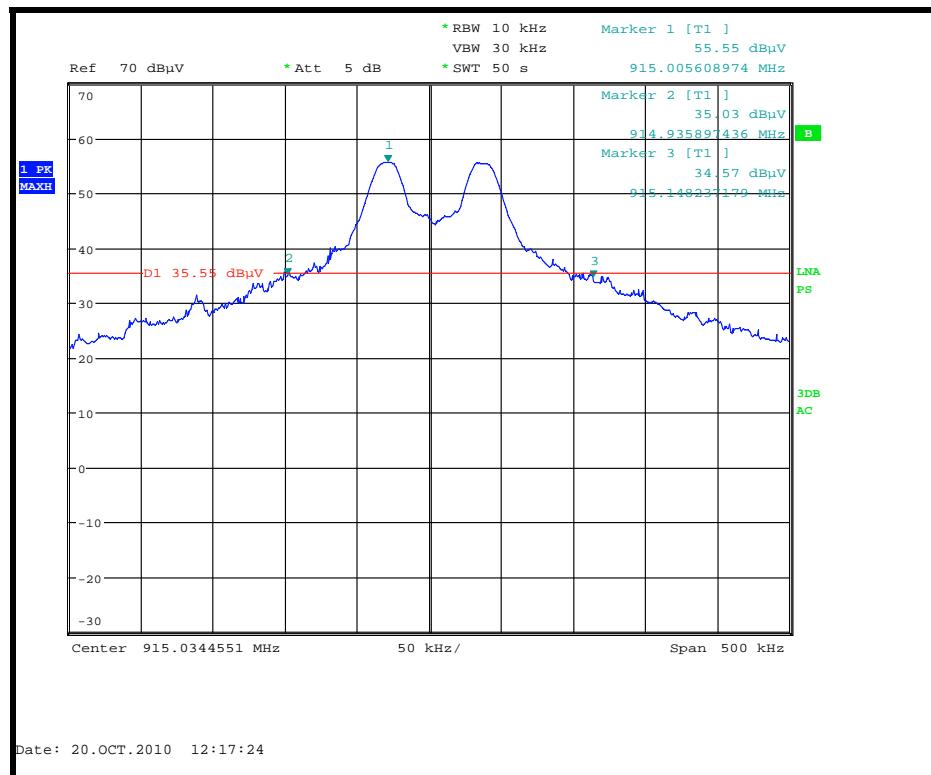
**Appendix B:**

**Supporting Graphical Data**

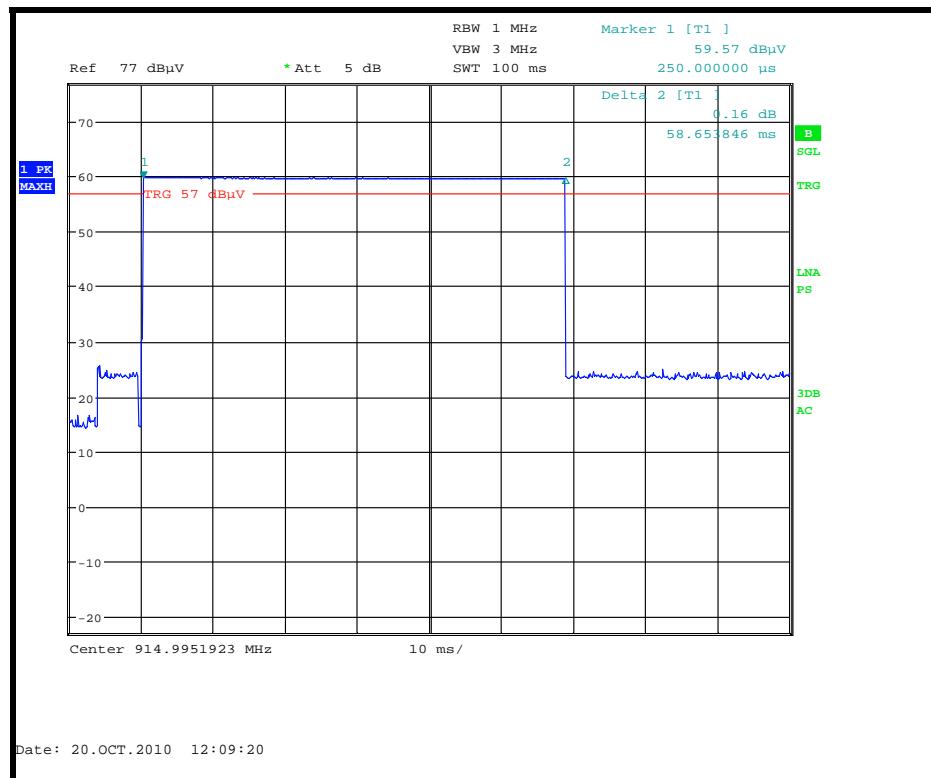
This appendix contains graphical data obtained during testing.

Notes:

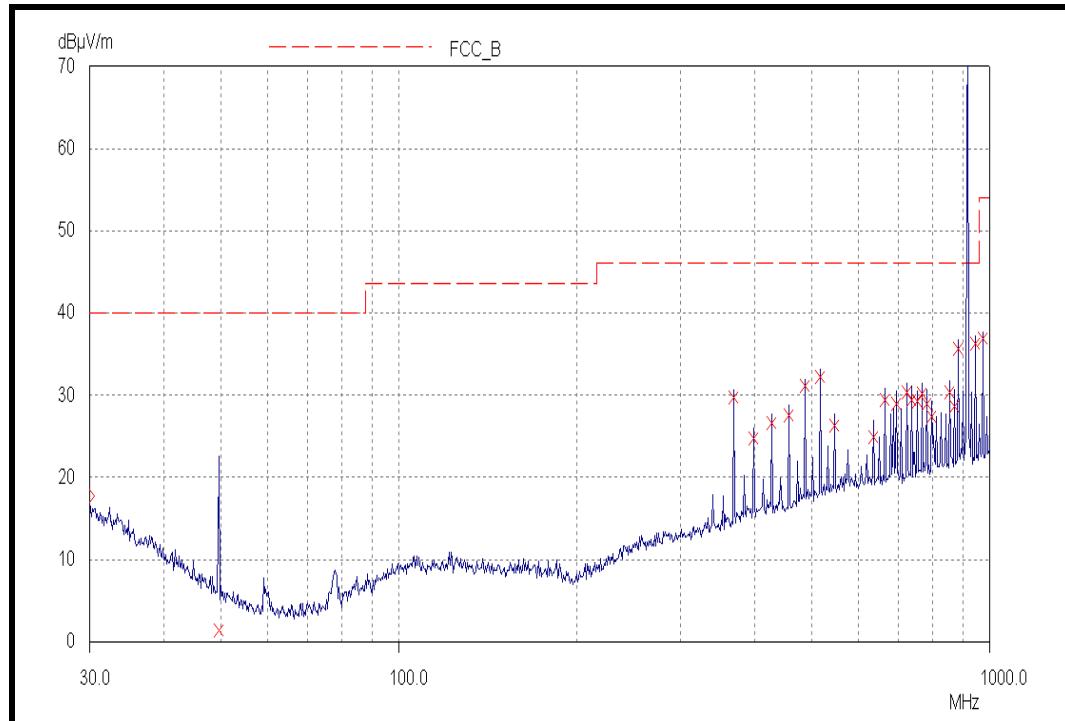
- (a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A and Appendix B.
- (b) The time and date on the plots do not necessarily equate to the time of the test.
- (c) Where relevant, on power line conducted emission plots, the limit displayed is the average limit, which is stricter than the quasi peak limit.
- (d) Appendix C details the numbering system used to identify the sample and its modification state.
- (e) The plots presented in this appendix may not be a complete record of the measurements performed, but are a representative sample, relative to the final assessment.



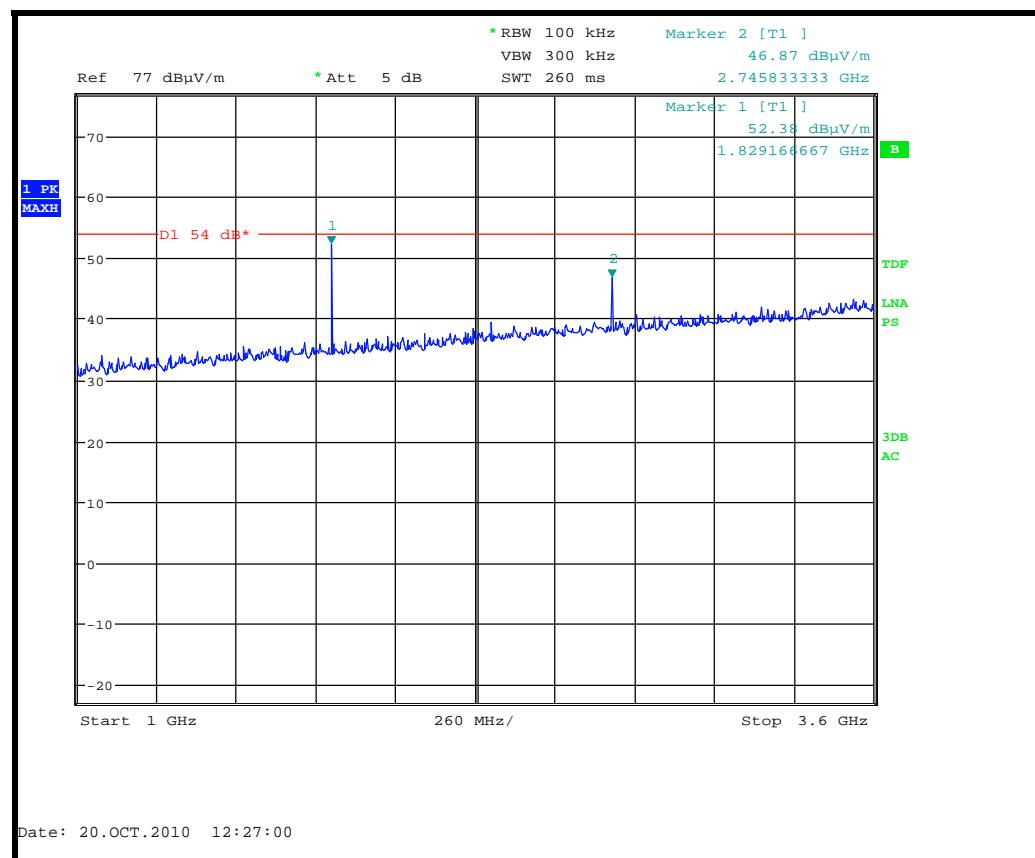
## 20dB Bandwidth



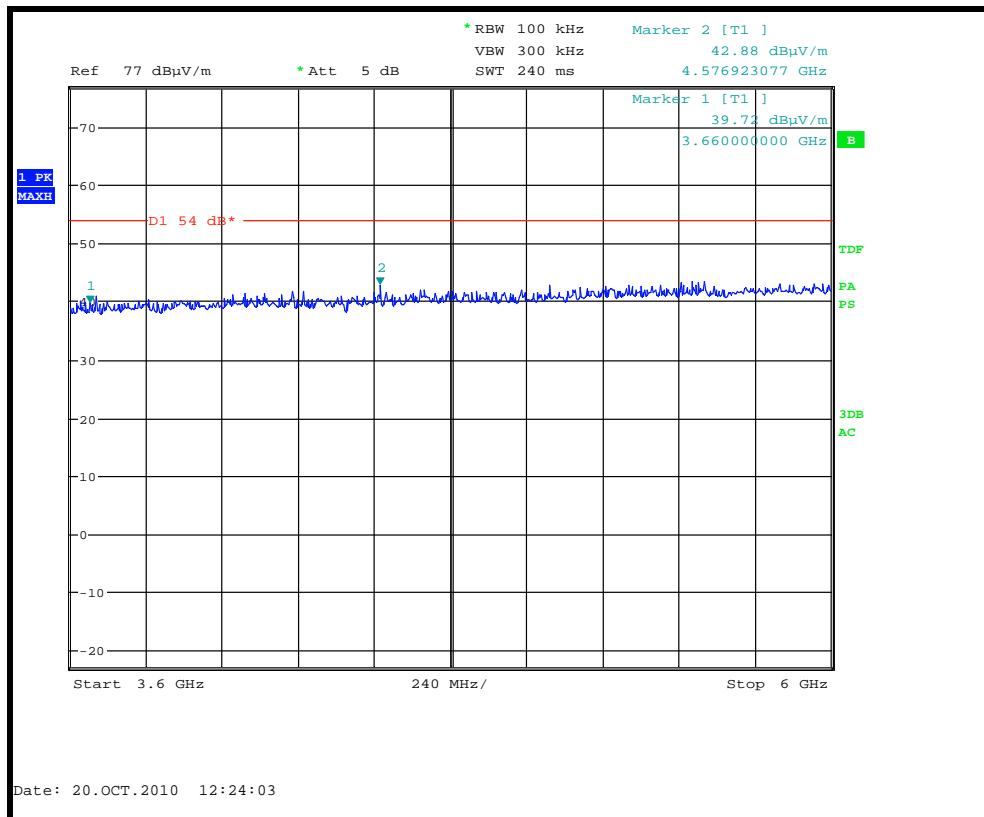
Ton in a 100ms period for Duty Cycle correction



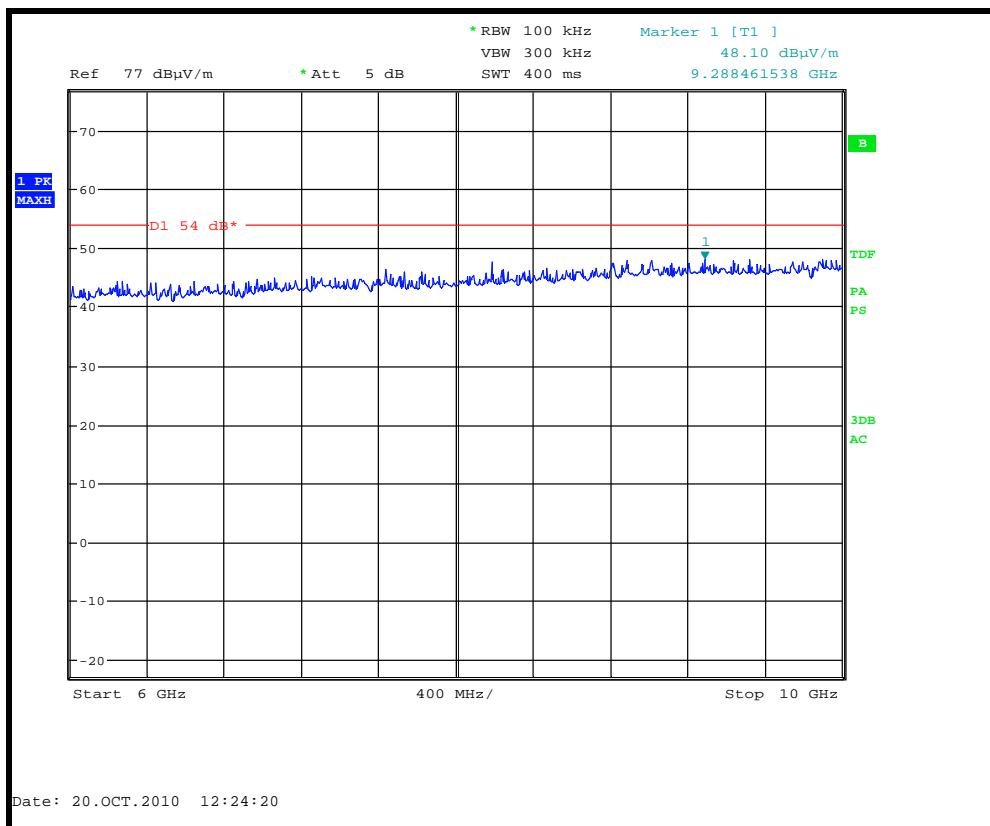
Radiated spurious emissions 30 MHz to 1 GHz



Radiated spurious emissions 1 GHz to 3 GHz



### Radiated spurious emissions 3 GHz to 6 GHz



### Radiated spurious emissions 6 GHz to 10 GHz

## Appendix C: Additional Test and Sample Details

This appendix contains details of:

1. The samples submitted for testing.
2. Details of EUT operating mode(s)
3. Details of EUT configuration(s) (see below).
4. EUT arrangement (see below).

Throughout testing, the following numbering system is used to identify the sample and its modification state:

**Sample No:** Sxx Mod w

where:

xx	= sample number	eg. S01
w	= modification number	eg. Mod 2

The following terminology is used throughout the test report:

**Support Equipment (SE)** is any additional equipment required to exercise the EUT in the applicable operating mode. Where relevant SE is divided into two categories:

SE in test environment: The SE is positioned in the test environment and is not isolated from the EUT (e.g. on the table top during REFE testing).

SE isolated from the EUT: The SE is isolated via filtering from the EUT. (e.g. equipment placed externally to the ALSR during REFE testing).

**EUT configuration** refers to the internal set-up of the EUT. It may include for example:

- Positioning of cards in a chassis.
- Setting of any internal switches.
- Circuit board jumper settings.
- Alternative internal power supplies.

Where no change in EUT configuration is **possible**, the configuration is described as “single possible configuration”.

**EUT arrangement** refers to the termination of EUT ports / connection of support equipment, and where relevant, the relative positioning of samples (EUT and SE) in the test environment.

For further details of the test procedures and general test set ups used during testing please refer to the related document "EMC Test Methods - An Overview", which can be supplied by TRaC Telecoms & Radio upon request.

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**C1) Test samples**

The following samples of the apparatus were submitted by the client for testing :

Sample No.	Description	Identification
01	MooMonitor	N/A

The following samples of apparatus were submitted by the client as host, support or drive equipment (auxiliary equipment):

Sample No.	Description	Identification
	None	

The following samples of apparatus were supplied by TRaC Telecoms & Radio as support or drive equipment (auxiliary equipment):

Identification	Description
	None

**C2) EUT Operating Mode During Testing.**

During testing, the EUT was exercised as described in the following tables :

Test	Description of Operating Mode
All tests detailed in this report	EUT Transmitting Modulated carrier using normal modulation rate.

**C3) EUT Configuration Information.**

The EUT was submitted for testing in one single possible configuration.

**C4) List of EUT Ports**

The tables below describe the termination of EUT ports:

Sample : 01  
Tests : Radiated Emissions

Port	Description of Cable Attached	Cable length	Equipment Connected
None	None	None	None

\* Only connected during setup.

## C5 Details of Equipment Used

For Radiated Measurements:

TRAC Ref	Type	Description	Manufacturer	Date Calibrated.
TRLUH281	FSU46	Spectrum Analyser	Rhode & Schwarz	29/01/2010
TRL138	3115	1-18GHz Horn Antenna	EMCO	10/09/2009
TRL139	3115	1-18GHz Horn Antenna	EMCO	17/08/2009
TRL572	8499B	1 – 26.5 GHz Pre Amplifier	Agilent	15/07/2009
TRLUH04	ESHS10	Receiver	Rhode & Schwarz	10/12/2009
TRLUH93	CBL6112	BiLog Periodic Antenna	Chase	03/06/2009
TRLUH372	6201-69	30MHz – 1 GHz Pre Amplifier	Watkins Johnson	14/04/2010

**Appendix D:**

**Additional Information**

No additional information is included within this test report.

**Appendix E:****Calculation of the duty cycle correction factor**

Using a spectrum analyser in zero span mode, centred on the fundamental carrier frequency with a RBW of 1MHz and a video Bandwidth of 1MHz the sweep time was set accordingly to capture the pulse train. The transmit pulsedwidths and period was measured. A plots of the pulse train is contained in Appendix B of this test report.

If the pulse train was less than 100 ms, including blanking intervals, the duty cycle was calculated by averaging the sum of the pulsedwidths over one complete pulse train. (The duty cycle is the value of the sum of the pulse widths in one period (or 100ms), divided by the length of the period (or 100ms). The duty cycle correction factor was then expressed in dB and the peak emissions adjusted accordingly to give an average value of the emission.

Correction factor dB =  $20 \times (\text{Log}_{10} \text{ Calculated Duty Cycle})$

Therefore the calculated duty cycle was determined:

The pulse train period was less than 100ms and in as shown from the plots in contained in appendix B of this test report.

Duty cycle = the sum of the highest average value pulsedwidths over 100ms  
100ms

e.g

$$= \frac{58.65\text{ms}}{100\text{ms}} = 0.5865$$

0.5865 or 58.65%

Correction factor (dB) =  $20 \times (\text{Log}_{10} 0.5865) = -4.63\text{dB}$

## **Appendix F:**

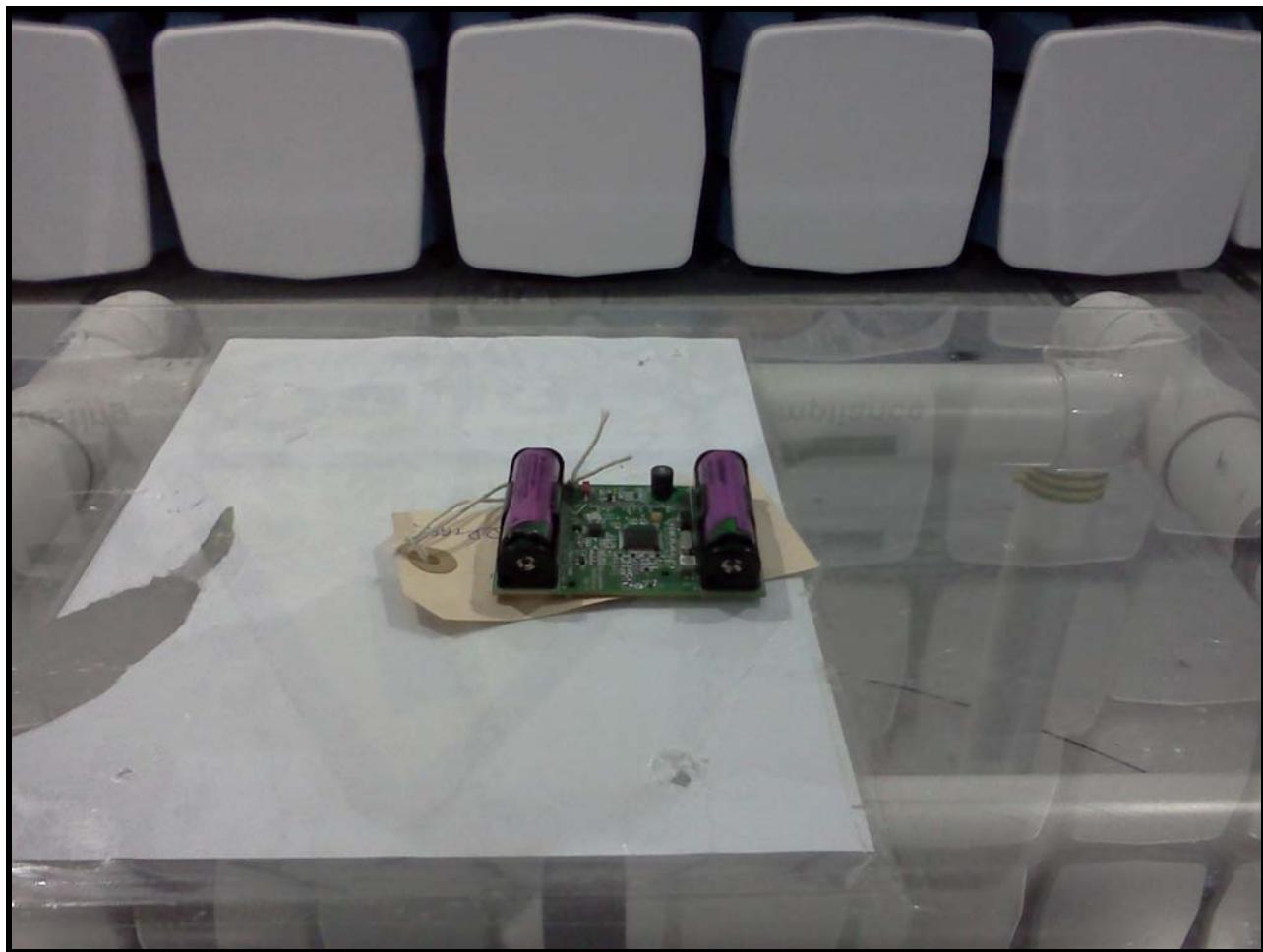
## **Photographs and Figures**

The following photographs were taken of the test samples:

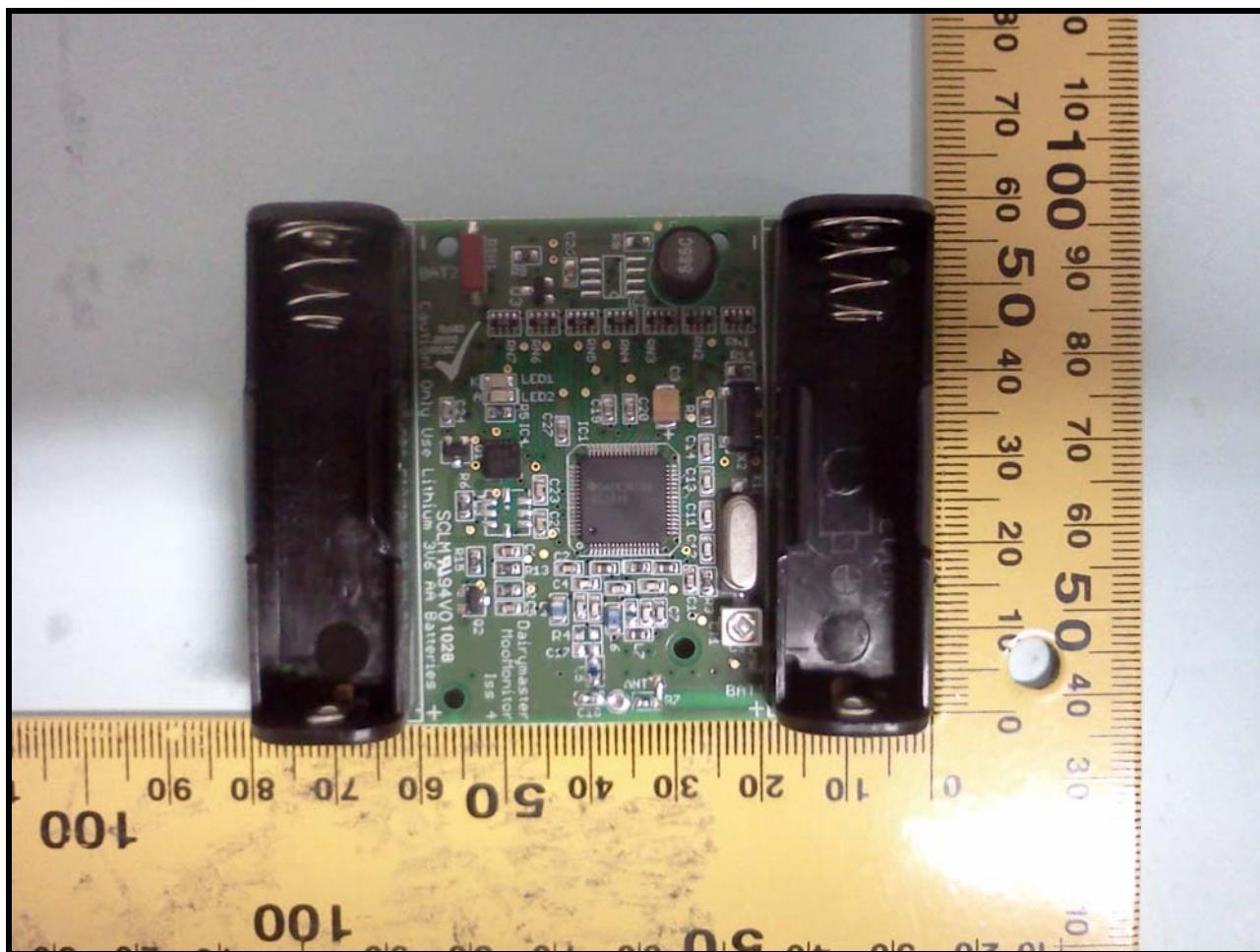
1. Radiated electric field emissions arrangement: front view.
2. Radiated electric field emissions arrangement: close up.
3. Photo of the PCB Track Side.
4. Photo of the PCB Component Side.



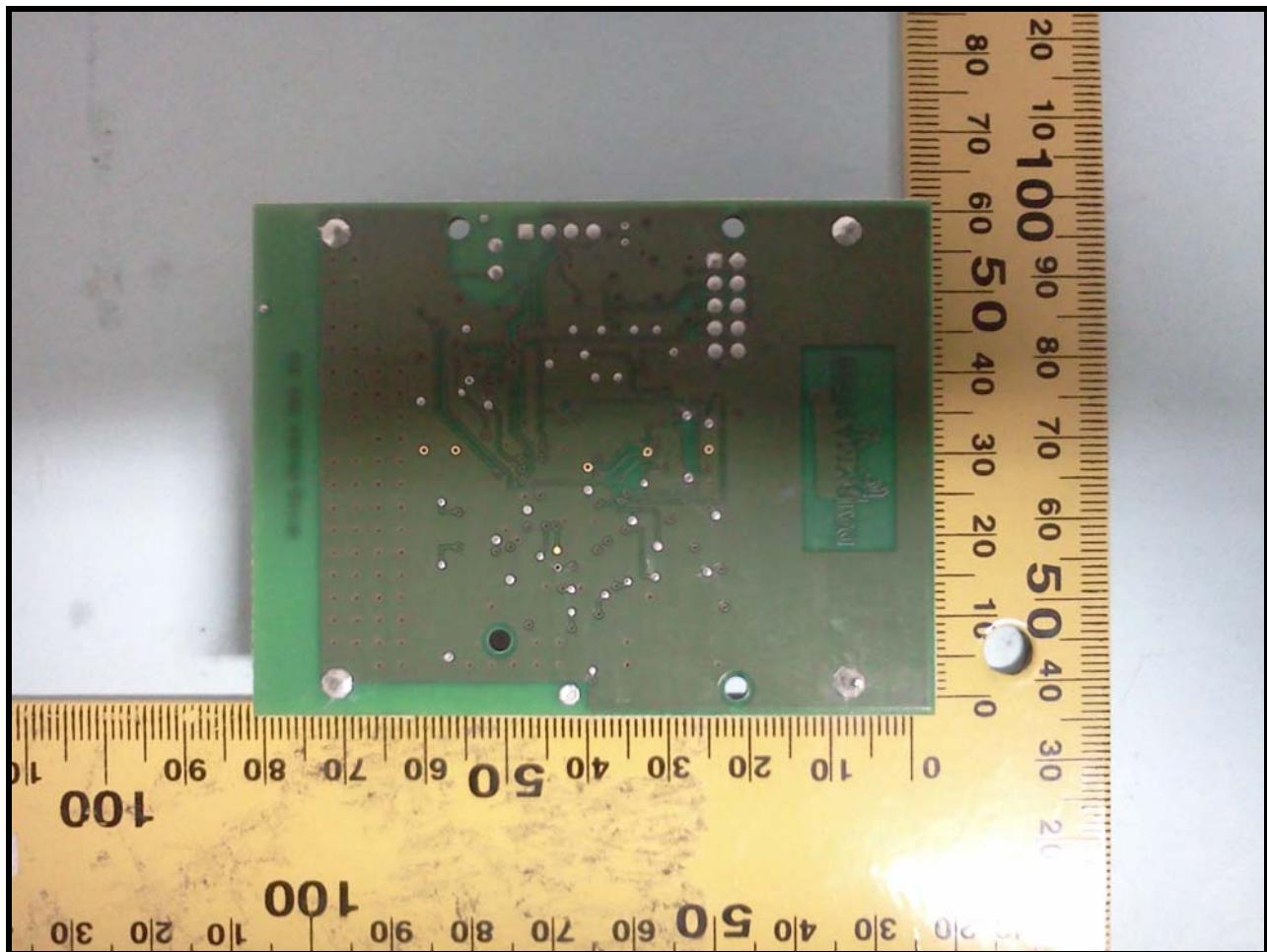
Photograph 1



Photograph 2



Photograph 3



Photograph 4

**Appendix G:****MPE Calculation**

OET Bulletin No. 65, Supplement C 01-01

**47 CFR §§1.1307 and 2.1091**

2.1091 Radio frequency radiation exposure evaluation: mobile devices.

For purposes of these requirements mobile devices are defined by the FCC as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimetres is normally maintained between radiating structures and the body of the user or nearby persons. These devices are normally evaluated for exposure potential with relation to the MPE limits. As the 20cm separation specified under FCC rules may not be achievable under normal operation of the EUT, an RF exposure calculation is needed to show the minimum distance required to be less than  $1\text{mW/cm}^2$  power density limit, as required under FCC rules.

**Prediction of MPE limit at a given distance**

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{ERP}{4 \pi R^2} \text{ re - arranged} \quad R = \sqrt{\frac{ERP}{S 4 \pi}}$$

where:

S = power density

R = distance to the centre of radiation of the antenna

EIRP = EUT Maximum power

Note:

The EIRP was calculated using the following formula.

**Formula:**

$$ERP = (E^*d/7.02)^2$$

E = Field Strength (V/m)

D = Test Distance

ERP = Radiated power (dBm)

**Result**

Prediction Frequency (MHz)	Field Strength V/m	Maximum ERP	Power density limit (S) (mW/cm <sup>2</sup> )	Distance (R) cm required to be less than 0.6.mW/cm <sup>2</sup>
914.5	28.18mV/m	0.14mW	$f(\text{MHz}) / 1500 = 0.61$	0.14

