




**KTL EMC Test Report** : 5G8729GUS1

**Applicant** : A M Bromley

**Apparatus** : TMS10 Tyre Pressure Sensor And Transmitter (433MHz)

**Authorised by** :   
N Parrott, Safety and EMC Group Manager

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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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Tests performed by:

M. E. Leach EMC and Radio Engineer

Report author: As above.

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## **1.2 Tests Requested By**

This testing in this report was requested by:

A M Bromley Limited  
West Road House  
26a West Road  
Derbyshire  
Buxton  
SK176HF  
United Kingdom

## **1.3 Apparatus Assessed**

The following apparatus was assessed between 11/08/05 and 16/08/05:

TMS10 Tyre Pressure Sensor And Transmitter (433MHz)

The above equipment was a battery operated FM 433.92MHz transmitter intended to operate as part of a tyre pressure and temperature monitoring system

#### 1.4 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
Transmitter Fundamental Field Strength	Title 47 of the CFR :2004, Part 15 Subpart (c) 15.231(e)	ANSI C63.4: 2003	PASS
Transmitter 20dB Bandwidth	Title 47 of the CFR : 2004, Part 15 Subpart (c) 15.231(c)	ANSI C63.4: 2003	PASS
Transmitter Silent Period And Transmission Duration	Title 47 of the CFR : 2004, Part 15 Subpart (c) 15.231(e)	ANSI C63.4: 2003	PASS
REFE	Title 47 of the CFR : 2004, Part 15 Subpart (c) 15.231(b)(e)	ANSI C63.4: 2003	PASS

Abbreviations used in the above table:

Mod : Modification  
CFR : Code of Federal Regulations  
REFE : Radiated Electric Field Emissions  
ANSI : American National Standards Institution

## 1.5 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.

KTL Hull is a listed electromagnetic compatibility Conformance Assessment Body (CAB) for EC access to the US market. (Decision No 3/2000 of the Joint Committee established under the Agreement on Mutual Recognition between the European Community and the United States of America. This decision was effective from 16<sup>th</sup> January 2001).

FCC Facility Registration number (3m semi anechoic chamber) : 90743

## **1.6 Deviations from Test Standards**

There were no deviations from the standards tested to.

## **Section 2:**

## **Measurement Uncertainty**

### **2.1 Introduction**

The standard ISO/IEC 17025 used for laboratory accreditation requires laboratories to estimate measurement uncertainty using accepted methods of analysis.

Where required, the reported expanded uncertainty is based on a standard uncertainty providing a confidence level of approximately 95%.

Measurement uncertainty is calculated using the methods defined in the NAMAS document NIS81: May 1994.

KTL measurement uncertainty is recorded in the KTL document UNC/RFG/001 Issue 16.

### **2.2 Application of Measurement Uncertainty**

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.

### **2.3 Measurement Uncertainty Values**

All results were recorded in accordance with Section 2.2(i).



## **Section 3:**

## **Modifications**

### **3.1 Modifications Performed During Assessment**

No modifications were performed during the assessment.

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

Abbreviations used in the tables in this appendix:

Spec	: Specification	ALSR	: Absorber Lined Screened Room
Mod	: Modification	OATS	: Open Area Test Site
EUT	: Equipment Under Test	ATS	: Alternative Test Site
SE	: Support Equipment	Ref	: Reference
Pol	: Polarisation	Freq	: Frequency
H	: Horizontal Polarisation	Av	: Average Detector
V	: Vertical Polarisation	SD	: Spec Distance
Pk	: Peak Detector	MD	: Measurement Distance
QP	: Quasi-Peak Detector	VBW	: Video Bandwidth
RBW	: Resolution Bandwidth		

## A1 Radiated Electric Field Emissions

Preliminary radiated electric field emissions testing was performed using a peak detector in an absorber lined screened room.

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

10m open area test site :

☐

3m alternative test site :

☒

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

Test Details	
Regulation	Title 47 of the CFR :2004, Part 15 Subpart (c) Clause 15.231(e)
Measurement standard	ANSI C63.4:2003
Frequency range	10 MHz to 5GHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix E)	Photograph 1

The worst case radiated emission measurements are listed below:

Ref No.	Freq (MHz)	Det.	Angle Deg.	Height (cm)	Pol	MD (m)	Result at MD (dB $\mu$ V/m)	Spec. Limit (dB $\mu$ V/m)	Margin (dB)	Summary
1	433.95	QP	165	100	H	3	68.1	72.9	-4.8	Pass
2	867.99	QP	134	100	H	3	47.6	54.0	-6.4	Pass
3	1301.84	Pk	0	100	H	3	6.7	74.0	-67.3	Pass
4	1301.84	Av <sup>2</sup>	0	100	H	3	5.0	54.0	-49.0	Pass
5	1735.20	Pk	0	100	H	3	7.0	74.0	-67.0	Pass
6	1735.20	Av <sup>2</sup>	0	100	H	3	5.2	54.0	-48.8	Pass
7	2169.39	Pk	0	100	H	3	10.9	74.0	-63.1	Pass
8	2169.39	Av <sup>2</sup>	0	100	H	3	8.8	54.0	-45.2	Pass
9	2603.50	Pk	0	100	H	3	11.0	74.0	-63.0	Pass
10	2603.50	Av <sup>2</sup>	0	100	H	3	9.2	54.0	-44.8	Pass

\*Fundamental Carrier power

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

<sup>2</sup>See section A2 for peak detector to average correction factor.

### Notes:

1. Testing below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.4:2003 section 8.2.1. Testing from 30MHz to 1GHz was in accordance with ANSI C63.4:2003 section 8.2.3 and testing above 1 GHz was in accordance with ANSI C63.4:2003 section 8.2.4
2. All other emissions in the restricted bands defined in 47CFR15.205(a) were greater than 10 dB below the 47CFR15.209 limit.
3. 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.

4. The lowest operating frequency of S01 was 13.56MHz and a declaration from the client is contained in Appendix D of this test report. Therefore the lowest measurement frequency range was decided according to 47 CFR 15:2004 part 15 (a) section15.33. Plots are contained in Appendix B of this test report
5. Example calculation of field strength from raw data (RD), cable loss (CL) and antenna factor (AF):

Freq (MHz)	Det	Angle Deg.	Height (cm)	Pol	MD (m)	RD (dB $\mu$ V)	CL (dB)	AF (dB/m)	Result at MD (dB $\mu$ V/m)	Spec. Limit (dB $\mu$ V/m)	Margin (dB)	Summary
433.95	QP	165	100	H	3	50.5	1.0	16.6	68.1	72.9	-4.8	Pass

The upper frequency of the measurement range was decided according to 47 CFR 15:2004 Clause 15.33.

Radiated emission limits (47 CFR 15:2004 Clause 15.209) for emissions falling within the restricted bands defined in 15.205(a):

Frequency of emission (MHz)	Field strength $\mu\text{V/m}$	Measurement Distance m	Field strength $\text{dB}\mu\text{V/m}$
0.009-0.490	$2400/F(\text{kHz})$	300	$67.6/F(\text{kHz})$
0.490-1.705	$24000/F(\text{kHz})$	30	$87.6/F(\text{kHz})$
1.705-30	30	30	29.5
30-88	100	3	40.0
88-216	150	3	43.5
216-960	210	3	46.4
Above 960	500	3	54.0

**Notes:**

- (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:

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

The results displayed take into account applicable antenna factors and cable losses.

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

**A2 Calculation of the duty cycle correction factor**

Note: As the EUT will transmit pulsed periodic transmissions; the radiated emission measurements requiring an average detector function above 1000MHz were made using a peak detector. The formal measured emissions were then corrected using a calculated duty cycle factor in accordance with ANSI 63.4-2003 Annex H.4j

To determine the length pulse train the EUT was configured so that the pulse train was transmitted continuously. Using a spectrum analyser in zero span mode, centred on the fundamental carrier frequency with a RBW of 300KHz and a video Bandwidth of 1MHz the sweep time was set accordingly to capture the pulse train. The transmit pulsewidths and period was measured and the sweep time was then extended to 20 seconds to determine if the silent period was greater than or equal to 10 seconds. Plots of the pulse train are 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 pulsewidths over one complete pulse train. However if the pulse train exceeds 100ms then the duty cycle was calculated by averaging the sum of the pulsewidths over the 100ms width with the highest average value. (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 greater than >100ms and in total measured 122.2ms as shown from the plots in contained in appendix B of this test report.

$$\begin{aligned} \text{Duty cycle} &= \frac{\text{the sum of the highest average value pulsewidths over 100ms}}{100\text{ms}} \\ &= \frac{(51.75 + 30.25)\text{ms}}{100\text{ms}} \\ &= 0.82 \text{ or } 82\% \end{aligned}$$

Correction factor (dB) =  $20 \times (\text{Log}_{10} 0.82) = -1.7\text{dB}$

**A3 Transmitter 20dB Bandwidth**

Title 47 of the CFR: 2004, Part 15 Subpart (c) 15.231(c) requires the measurement of the occupied bandwidth of the transmitted fundamental frequency. The bandwidth is determined at the point's 20dB down from the modulated carrier. To determine the occupied bandwidth a RBW of 10KHz and a VBW three times greater than the RBW (30KHz) was used. The spectrum analyser was then set to take a peak hold measurement. The peak level was found and set to a 0dB reference point and markers offset by -20dB determined the bandwidth. The formal measurements are detailed below:

Test Details: Conference Phone	
Regulation	Title 47 of the CFR :2004, Part 15 Subpart (c) 15.231(c)
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Measured 20 dB Bandwidth (MHz)	Limit (MHz)	Margin (MHz)	Result
0.1267	1.0848	0.9581	Pass

Plots of the 20 dB bandwidth are contained in Appendix B of this test report.

**A4 Transmitter Transmission Duration and Silent Period: Section**

Title 47 of the CFR: 2004, Part 15 Subpart (c) 15.231(e) requires the measurement of the transmission duration and the silent period between transmissions. Using a spectrum analyser in zero span mode, centred on the fundamental carrier frequency with a RBW of 300KHz and a video Bandwidth of 1MHz the sweep time was set to 20 seconds and 500 seconds to capture the transmission duration and silent period. The formal measurements are detailed below

<b>Test Details: Conference Phone</b>	
Regulation	Title 47 of the CFR :2004, Part 15 Subpart (c) 15.231(e)
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Transmission duration (Seconds)	Limit (Seconds)	Margin (Seconds)	Result
0.1222	1	0.8778	Pass

Silent Period (Seconds)	Limit (Seconds)	Margin (Seconds)	Result
287.5	$\geq 10^*$	277.5	Pass

\*Greater than thirty times the transmission duration but in no case less than ten seconds

Plots of the transmission duration and the silent period between transmissions are contained in Appendix B of this test report.

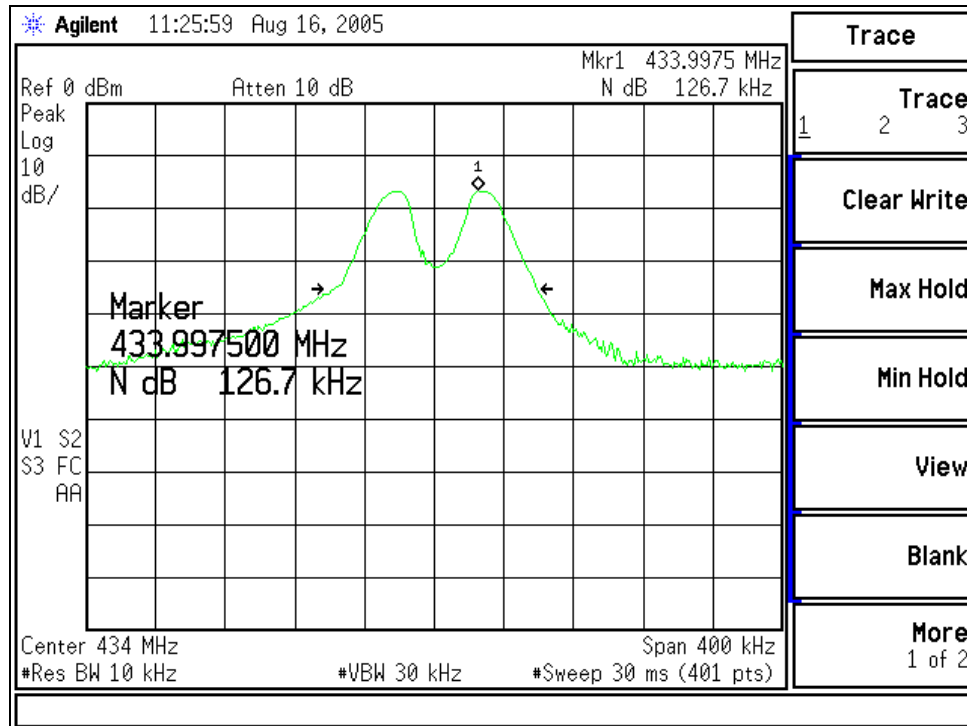


**Appendix B:****Supporting Graphical Data**

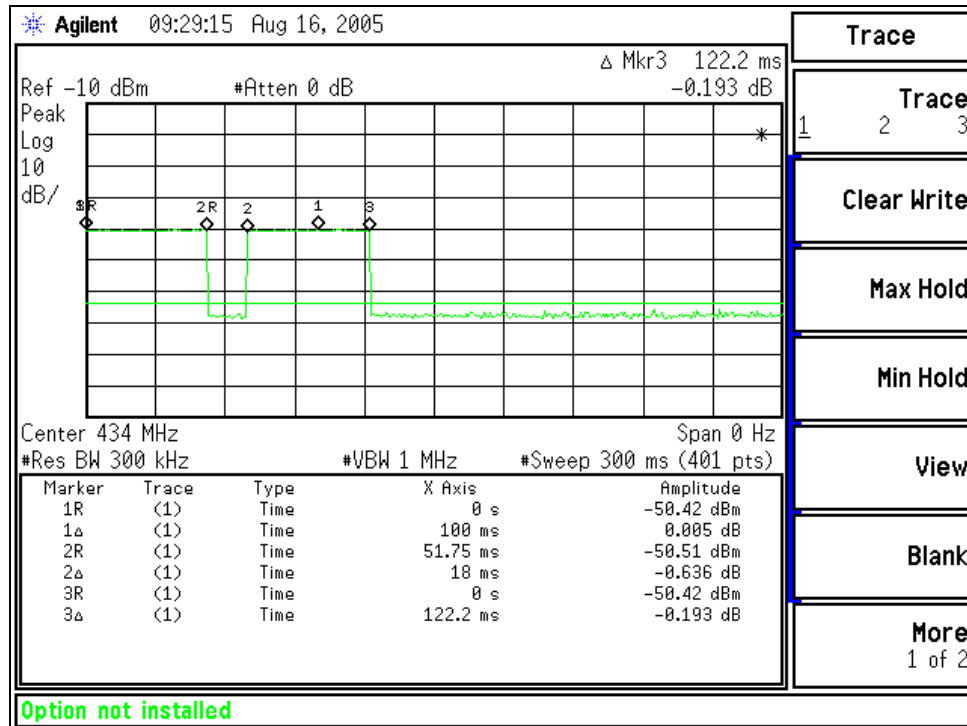
This appendix contains graphical data obtained during testing.

Notes:

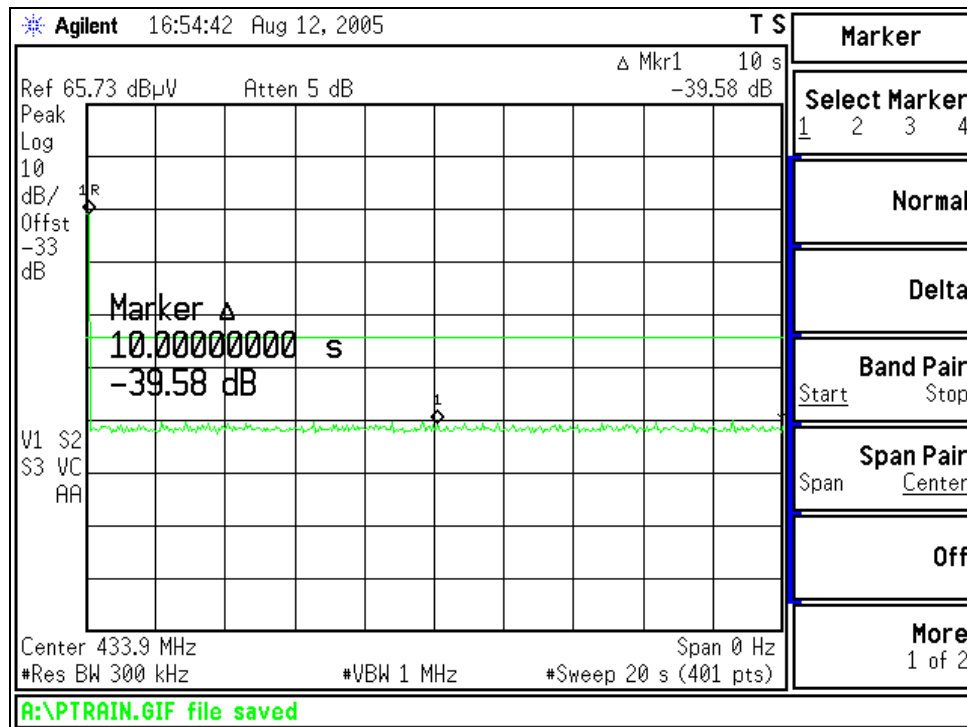
- (a) The radiated electric field emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A.
- (b) The time and date on the plots do not necessarily equate to the time of the test.
- (c) Where relevant, on power line conducted emission plots, the limit 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.
- (f) The limit line shown on the radiated emission plots is the 15.209 limit for general requirements; any emissions detected within the restricted bands of operation (defined in section 15.205) were formally assessed against the 15.209 limits. All emissions outside the restricted band were formally assessed against the limits in 15.231(e).

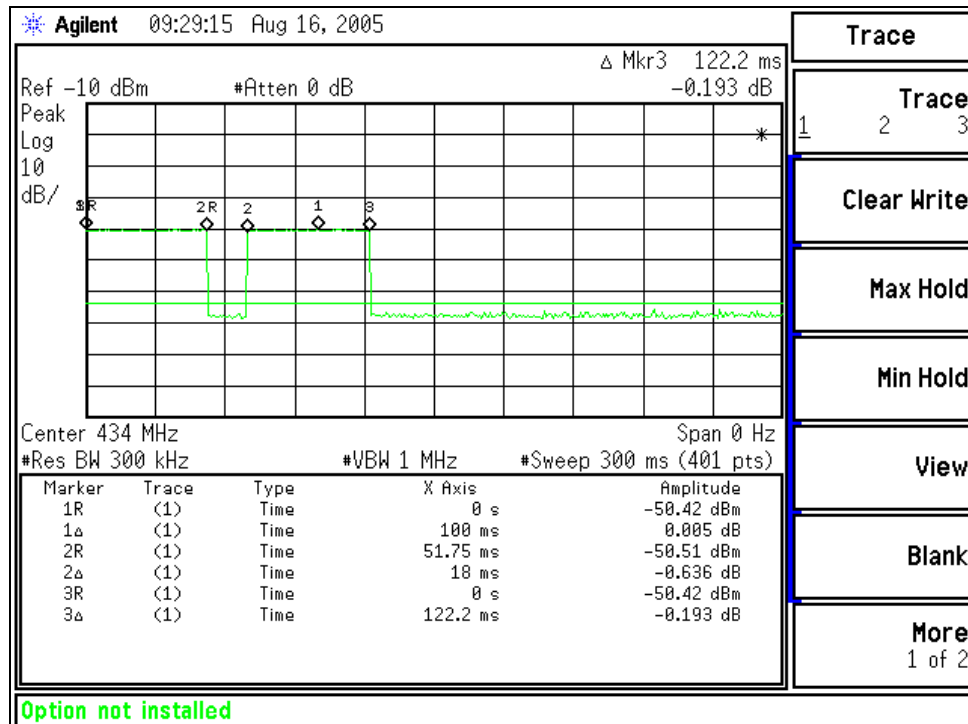


20 dB Bandwidth from the modulated carrier

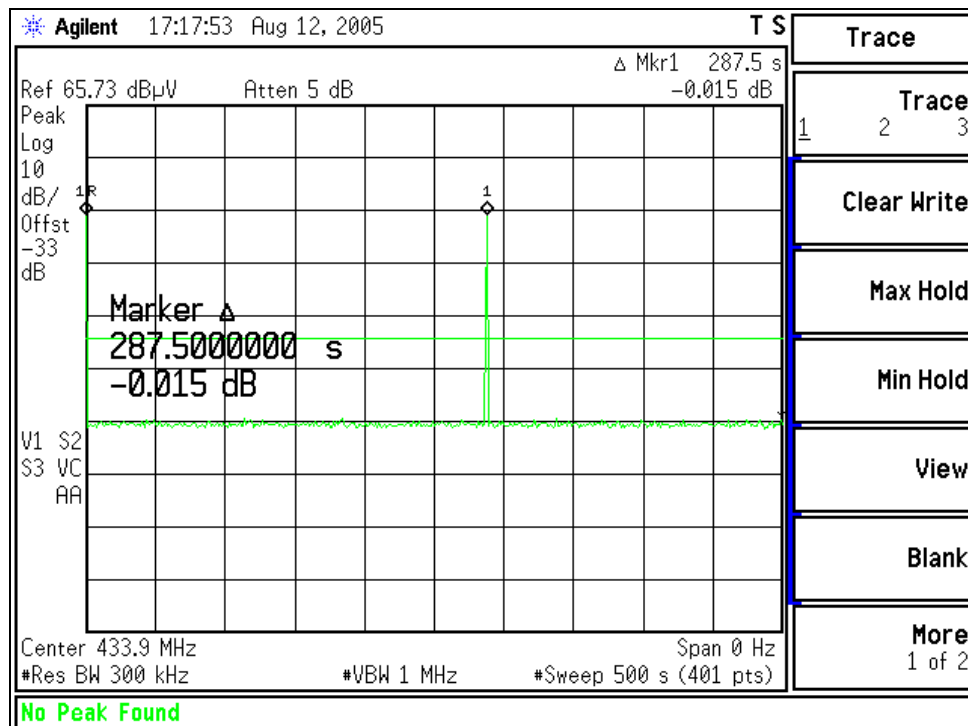


Pulse train pulsewidths and duty cycle

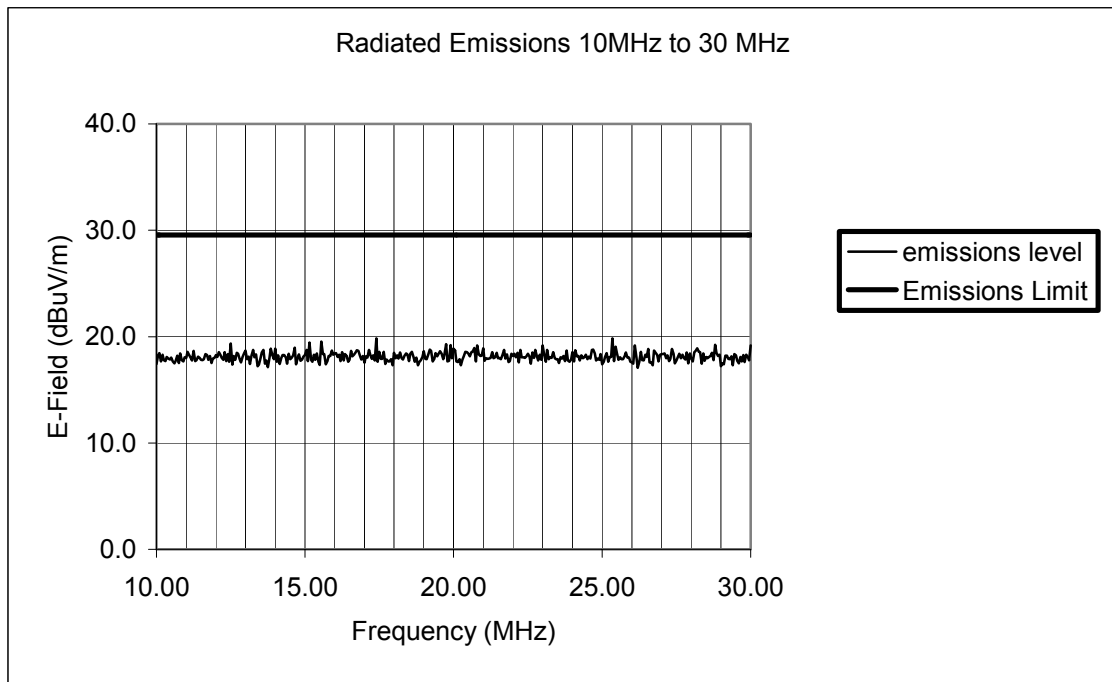
Number of transmission in  $\leq 10$  seconds



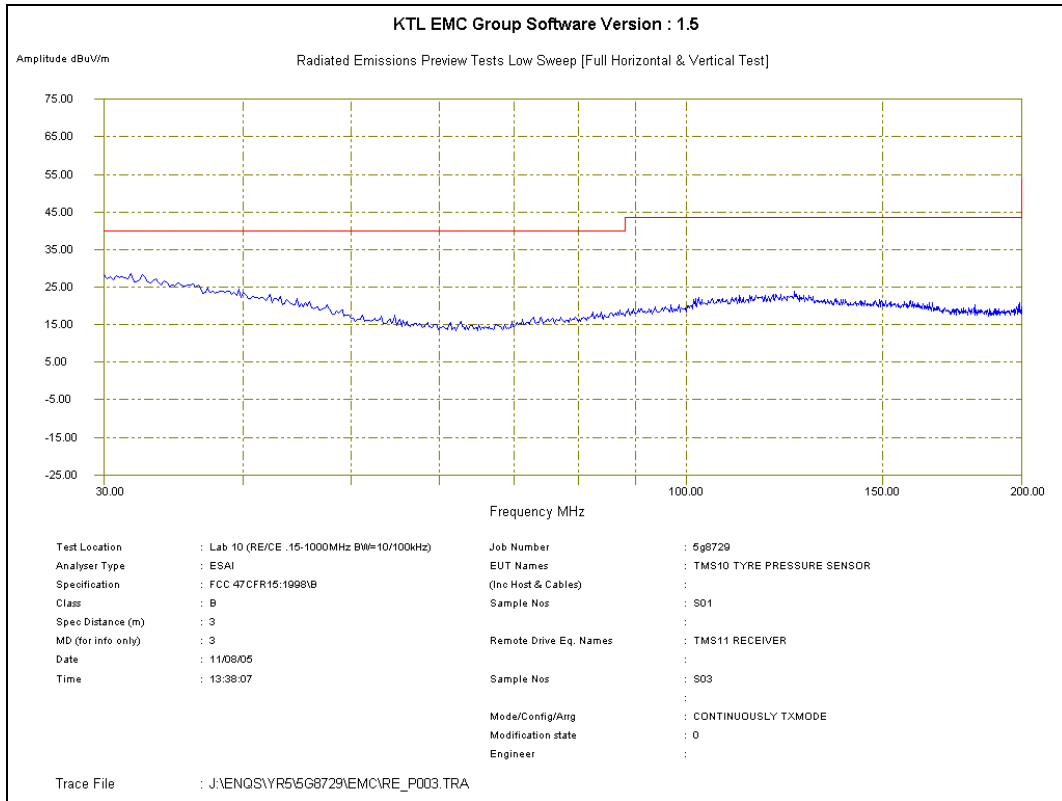
Transmission duration



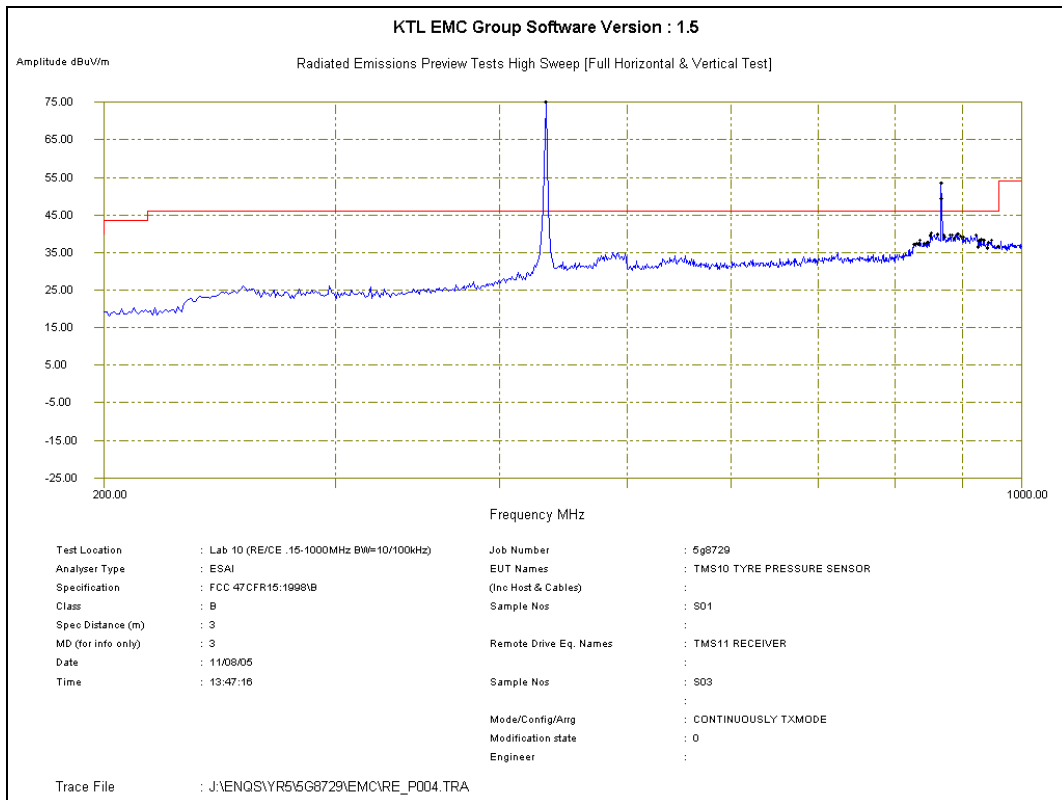
Transmitter silent period.



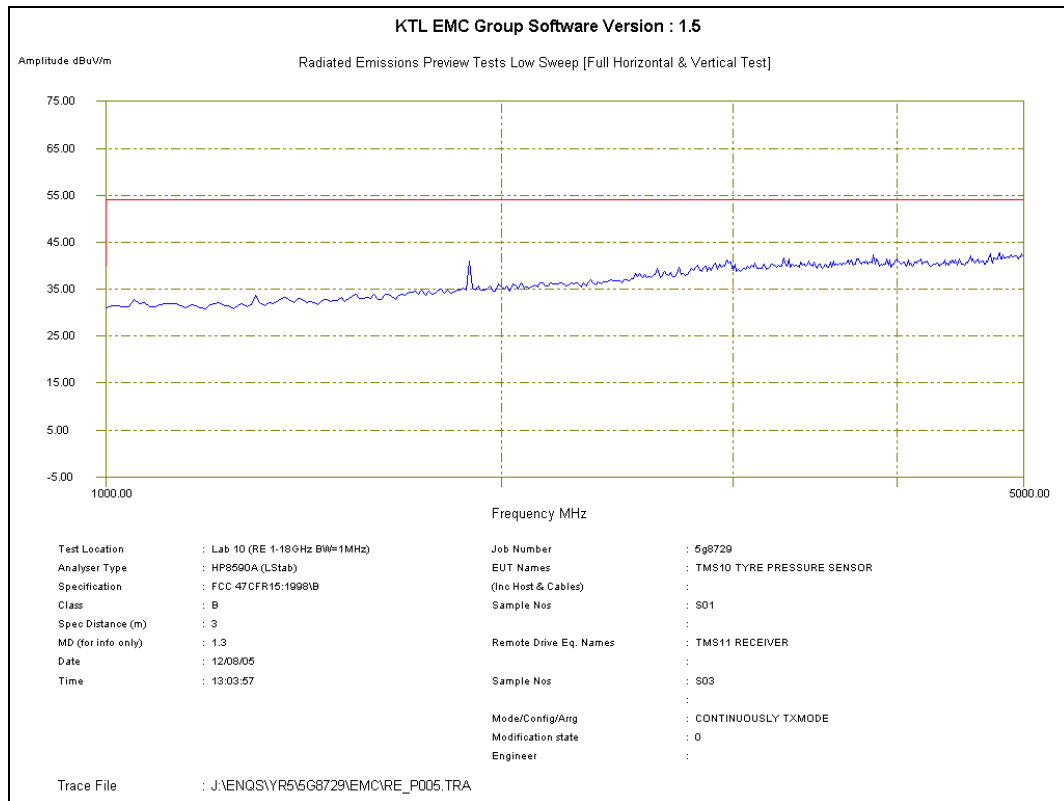
Radiated Emissions Plot 10MHz to 30MHz



Radiated Emissions Plot 30MHz to 200MHz



Radiated Emissions Plot 200MHz to 1000MHz



Radiated Emissions Plot 1GHz to 5GHz

**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 it's 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 KTL upon request.



**C1) Test samples**

The following samples of the apparatus were submitted for testing :

Sample No.	Description	Identification
S01	TMS 10 Tyre pressure Sensor And Transmitter (433MHz)	S0518
S02	TMS 10 Tyre pressure Sensor And Transmitter (433MHz)	S0520

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

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

Test	Description of Operating Mode S01
REFE	Continuous modulated transmission
20dB Occupied Bandwidth	Continuous modulated transmission
Duty Cycle	Continuous modulated transmission

Test	Description of Operating Mode S02
Transmission Duration	Transmitting every 287.5 seconds modulated transmission
Silent Period	Transmitting every 287.5 seconds modulated transmission

**C3) EUT Configuration Information.**

The EUT's were submitted for testing in one single possible configuration.

Test	Configuration
S01	EUT was submitted for testing in one single possible configuration.
S02	EUT was submitted for testing in one single possible configuration.

**C4) List of EUT Ports**

The EUT was an internal RF Module with no external ports and was powered from a CR ½ AA 3V Lithium Battery.

**C5) Details of test equipment used**

For Radiated Electric Field Emissions 10MHz to 1GHz:

RFG No	Type	Description	Manufacturer	Date Calibrated.
274	ATS	Ferrite Lined Chamber	KTL	24/05/05
231	CBL6111	Blue Bilog Antenna (0.03 - 1GHz)	Chase	10/05/00
023	HFH2-Z2	Magnetic Loop Antenna	R & S	03/04/02
214	ESAI	Spec Analyser/Test Rxer (LF/HF)	R & S	30/06/04
125	ESH10	EMI Test Receiver	R & S	19/07/05
249	N-type	RF coaxial cable (Lab 10)	KTL	12/08/05
255	N-type	RF coaxial cable (Lab 10)	KTL	12/08/05
270	N-type	RF coaxial cable (Lab 10)	KTL	12/08/05

For Radiated Electric Field Emissions 1GHz to 5GHz

RFG No	Type	Description	Manufacturer	Date Calibrated
274	ATS	Ferrite Lined Chamber	KTL	24/05/05
129	3115	Horn Antenna	EMCO	29/07/98
307	HP8449B	Microwave Pre-Amp (1-26.5GHz)	HP	09/02/04
311	-	Sucoflex uW Adapter Cable 1m	Suhner	21/12/04
139	N-104	Sucoflex uW Cable 2m	Suhner	21/12/04
158	N-106	Sucoflex uW Cable 6m	Suhner	21/12/04
404	E4407B	Spectrum Analyser	Agilent	22/12/04

For Transmitter 20dB Bandwidth

RFG No	Type	Description	Manufacturer	Date Calibrated
274	ATS	Ferrite Lined Chamber	KTL	24/05/05
231	CBL6111	Blue Bilog Antenna (0.03 - 1GHz)	Chase	10/05/00
249	N-type	RF coaxial cable (Lab 10)	KTL	12/08/05
255	N-type	RF coaxial cable (Lab 10)	KTL	12/08/05
270	N-type	RF coaxial cable (Lab 10)	KTL	12/08/05
404	E4407B	Spectrum Analyser	Agilent	22/12/04

For Transmission Duration and Silent Period

RFG No	Type	Description	Manufacturer	Date Calibrated
274	ATS	Ferrite Lined Chamber	KTL	24/05/05
231	CBL6111	Blue Bilog Antenna (0.03 - 1GHz)	Chase	10/05/00
249	N-type	RF coaxial cable (Lab 10)	KTL	12/08/05
255	N-type	RF coaxial cable (Lab 10)	KTL	12/08/05
270	N-type	RF coaxial cable (Lab 10)	KTL	12/08/05
404	E4407B	Spectrum Analyser	Agilent	22/12/04

For Duty Cycle correction factor

RFG No	Type	Description	Manufacturer	Date Calibrated
274	ATS	Ferrite Lined Chamber	KTL	24/05/05
231	CBL6111	Blue Bilog Antenna (0.03 - 1GHz)	Chase	10/05/00
249	N-type	RF coaxial cable (Lab 10)	KTL	12/08/05
255	N-type	RF coaxial cable (Lab 10)	KTL	12/08/05
270	N-type	RF coaxial cable (Lab 10)	KTL	12/08/05
404	E4407B	Spectrum Analyser	Agilent	22/12/04

## **Appendix D:**

## **Additional Information**

The following information is a copy of an E-Mail from the client confirming the lowest frequency used within the EUT.

Martin,

Following our conversation earlier, I confirm that there is a local oscillator on the TMS10 that runs at 13.56MHz.

Kind regards  
Andrew Bromley

A M Bromley Limited  
Phone 01298 77166  
Fax 01298 22044  
[www.ambromley.co.uk](http://www.ambromley.co.uk)

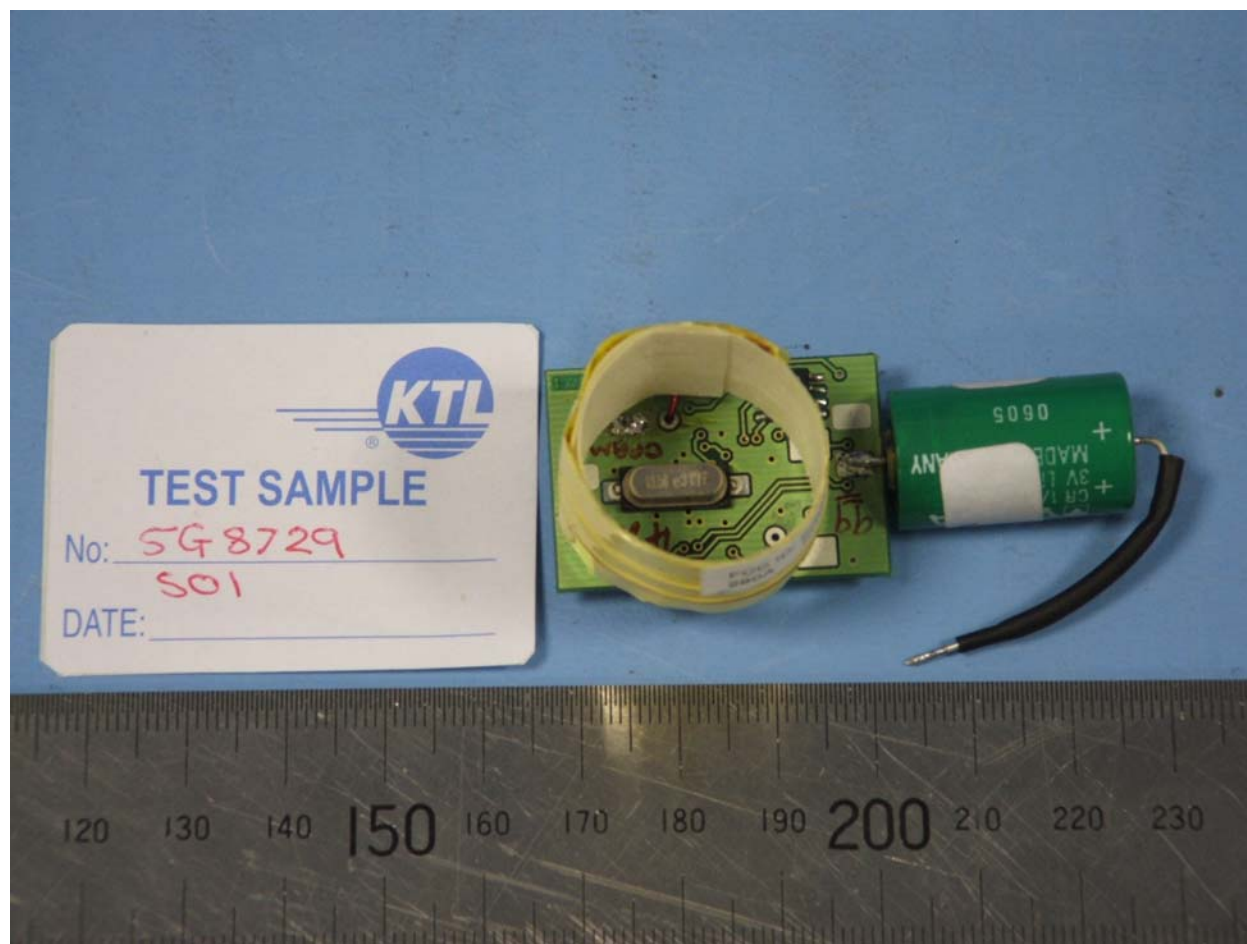
## **Appendix E:**

## **Photographs and Figures**

The following photographs were taken of the test samples:

1. Sample RF Module Top View
2. Sample RF Module Bottom View
3. Radiated electric field emissions arrangement: front view.
4. Radiated electric field emissions arrangement: rear view.
5. Radiated electric field emissions arrangement 10MHz to 30MHz
6. Radiated electric field emissions arrangement: 200MHz to 1000MHz
7. Radiated electric field emissions arrangement: 1000MHz to 5000MHz





Photograph 1



Photograph 2

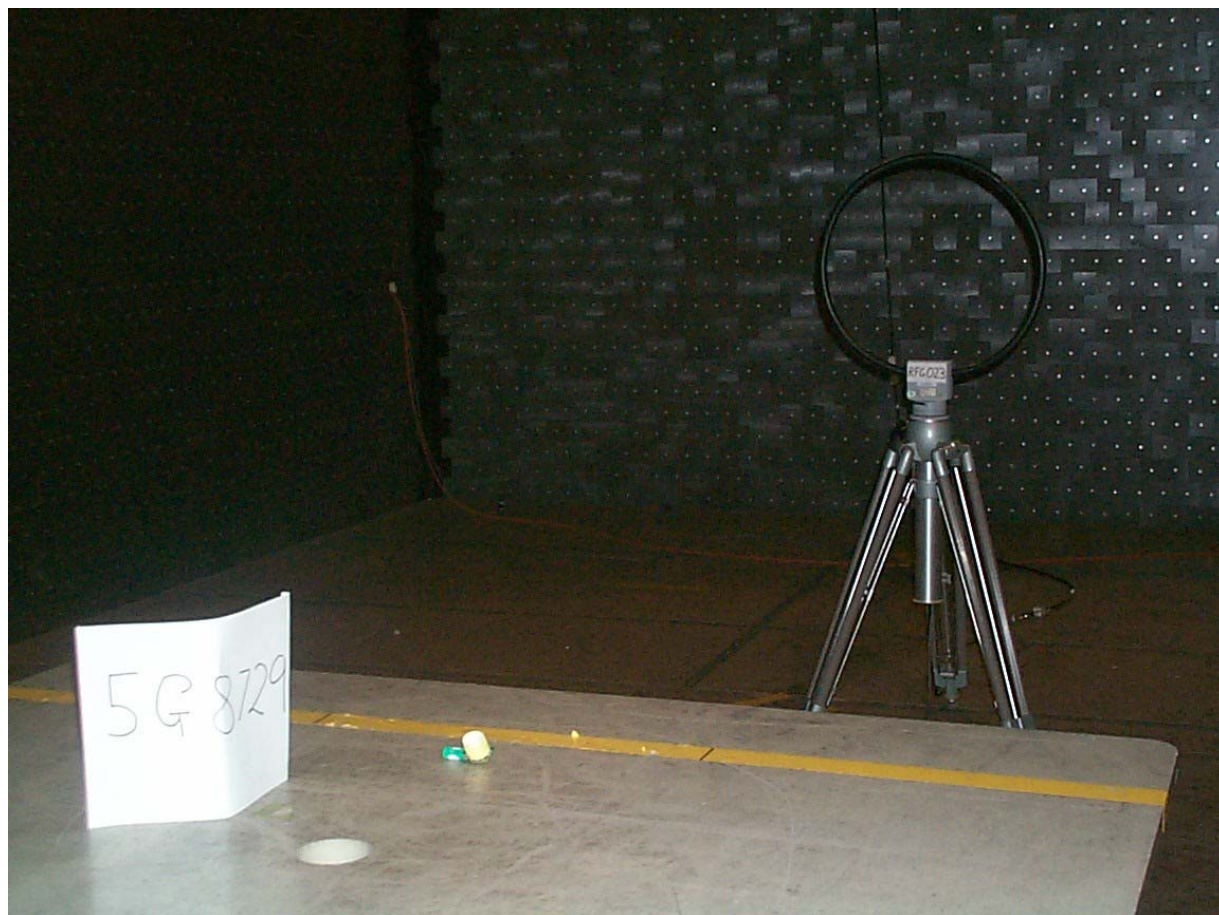


Photograph 3

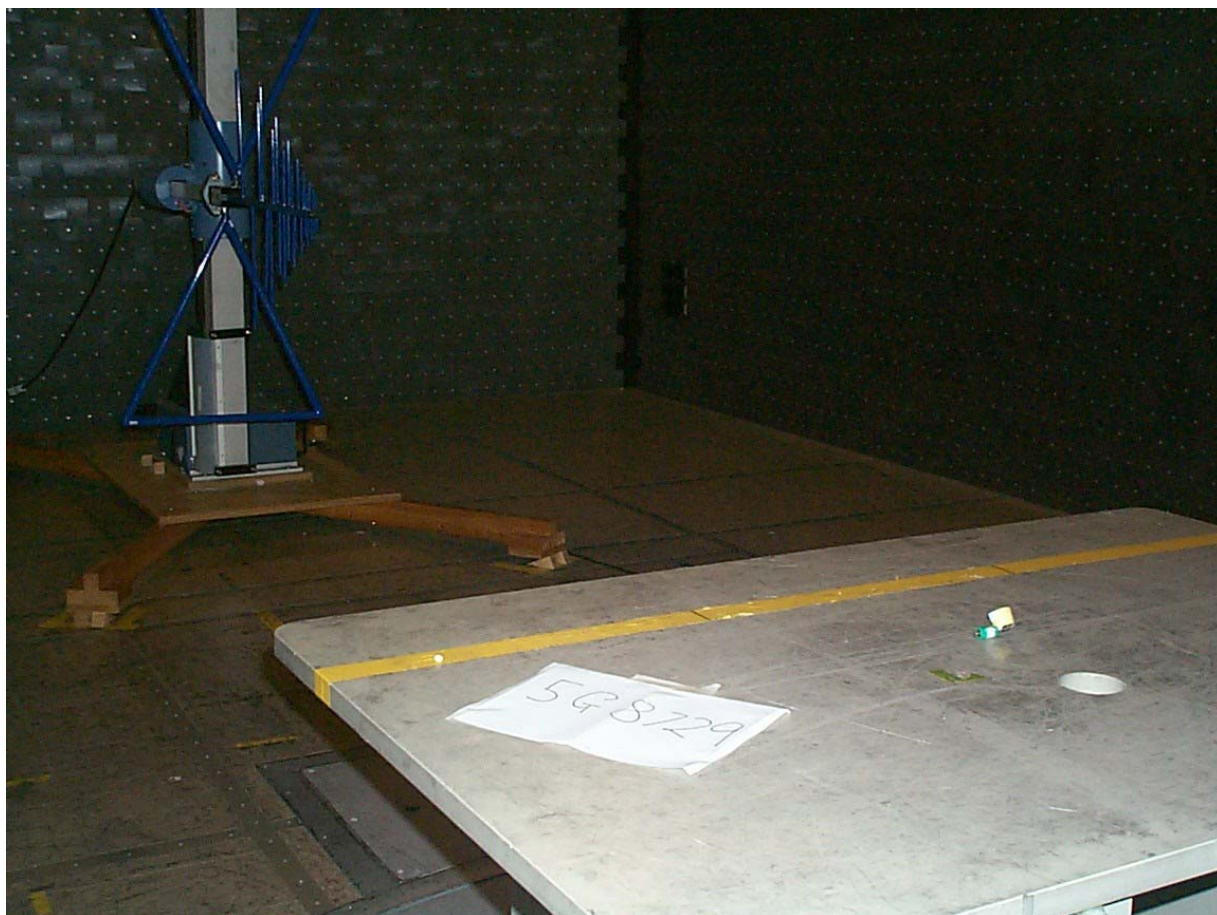


Photograph 4





Photograph 5



Photograph 6





Photograph 7