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Project Number: 12E4166-4a

Prepared for:

Schrader Electronics

By

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FCC Site Registration: 92592

Industry Canada Assigned Site Code: 8517A-2

FCC ID: MRXTMS4

IC: 2546A-TMS4

Date

30 October 2012

FCC EQUIPMENT AUTHORISATION

Test Report

EUT Description

Tyre Pressure and Temperature Sensor and Transmitter Module.

Authorised :

John McAuley

A handwritten signature in blue ink, reading 'John McAuley', written over a horizontal line.

TEST SUMMARY

The equipment complies with the requirements according to the following standards.

FCC Part Section(s)	RSS-210 Section	TEST PARAMETERS	Test Result
15.231(a)	A1.1.1(a)	MAXIMUM MODULATION PERCENTAGE (M%)	PASS
15.231(b)	A.1.1.2(1)	RADIATED EMISSIONS	PASS
15.231(c)	A1.1.3	20dB BANDWIDTH	PASS

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL, WITHOUT THE WRITTEN APPROVAL OF COMPLIANCE ENGINEERING IRELAND LTD

Exhibit A – Technical ReportTable of Contents

1.0	EUT DESCRIPTION	4
1.1	EUT OPERATION	5
1.2	MODIFICATIONS	5
1.3	DATE OF TEST	5
1.4.1	MEASUREMENT UNCERTAINTY	6
2.0	EMISSIONS MEASUREMENTS.....	7
2.1	CONDUCTED EMISSIONS MEASUREMENTS.....	7
2.2	RADIATED EMISSIONS MEASUREMENTS	7
2.3	TEST CRITERIA.....	9
3.0	MAXIMUM MODULATION PERCENTAGE (M%).....	10
4.0	FIELD STRENGTH OF SPURIOUS RADIATED EMISSIONS	13
5.0	LIST OF TEST EQUIPMENT	16

1.0 EUT Description

The EUT was a module using a short range 433 MHz band transceiver for reporting of tyre pressure and temperature in cars/trucks.

Model:	TMS truck 433MHz
Type:	433 MHz Tyre Pressure and Temperature Measurement System
FCC ID:	MRXTMS4
Company:	Schrader
Contact	Mr James Kyle
Address:	Schrader Electronics 11 Technology Park, Belfast Road, Antrim Northern Ireland BT41 1QS
Phone:	+44 28 9448 3067
e-mail:	jakyle@schrader.co.uk
Test Standards:	47 CFR, Part 15.231(a,e)
Type of radio:	Stand-alone
Transmitter Type:	ASK
Operating Frequency Range(s):	433 MHz +/- 0.1%
Number of Channels:	One
Antenna:	Integral
Transmitter power configuration:	3 VDC Lithium cell battery.
Oper. Temp Range:	-40° C to +85° C
Classification:	DSC
Test Methodology:	Measurements performed according to the procedures in ANSI C63.4-2003

1.1 EUT Operation

Operating Conditions during Test:

The equipment under test was operated during the measurement under the following conditions:

A new battery was used in the EUT for test.

The EUT was operated in test mode (EMC mode), where the EUT transmitted a burst of 4 frames of 9mS pulses separated by approx 130mS, every 2.2 secs for all tests except duty cycle.

The EUT was operated in normal operation (roll mode) for the duty cycle test.

Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Normal

Temperature: +15 to +35 ° C

Humidity: 20-75 %

1.2 Modifications

No modifications were required in order to pass the test specifications.

1.3 Date of Test

The tests were carried out on one sample of the EUT during the month of September 2012.

1.4 Electromagnetic Emissions Testing

The guidelines of CISPR 16-4 were used for all uncertainty calculations, estimates and expressions thereof for EMC testing. A copy of Compliance Engineering Ireland Ltd.'s policy for EMC Measurement Uncertainty is available on request.

RF Requirements: Spurious emissions in accordance with FCC CFR 15.107, 15.109 and 15.209. Tests were carried out to the requirements of CISPR 16-4 and ANSI C63.4-2009.

1.4.1 Measurement Uncertainty

The measurement uncertainty (with a 95% confidence level) for the conducted emissions test was ± 3.5 dB.

The measurement uncertainty (with a 95% confidence level) for the radiated emissions test was ± 5.3 dB (from 30 to 100 MHz), ± 4.7 dB (from 100 to 300 MHz), ± 3.9 dB (from 300 to 1000 MHz) and ± 3.8 dB (from 1 GHz to 40 GHz).

2.0 Emissions Measurements

2.1 Conducted Emissions Measurements

Test not performed as EUT is powered from 3 volt battery.

2.2 Radiated Emissions Measurements

Radiated Power measurements were made at the Compliance Engineering Ireland Ltd anechoic chamber located in Dunshaughlin, Co. Meath, Ireland to determine the radio noise radiated from the EUT. A "Description of Measurement Facilities" has been submitted to the FCC and approved pursuant to Section 2.948 of CFR 47 of the FCC rules.

The EUT was centred on a motorized turntable, which allows 360 degree rotation. A measurement antenna was positioned at a distance of 3 meters as measured from the closest point of the EUT. The radiated emissions were maximised by configuring the EUT, by rotating the EUT, and by raising and lowering the antenna from 1 to 4 meters.

Emissions below 1GHz were measured using a bi-log antenna. In this case the resolution bandwidth was 100kHz.

A prescan at antenna distance of 0metres and resolution bandwidth and video bandwidth of 10MHz with a slow scan of 600secs (i.e. 1.6MHz per second) ensured all peaks were caught on the scan.

Emissions above 1GHz were measured using a horn antenna located at 3 metres distance from the EUT. In this case the resolution bandwidth was 1MHz and video bandwidth was 1MHz.

A prescan at antenna distance of 0metres and resolution bandwidth and video bandwidth of 10MHz with a slow scan of 2400secs (i.e. 1.7MHz per second) ensured all peaks were caught on the scan.

2.3 Antenna Requirements

According to FCC 47 CFR 15.203:

“An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.”

* The antennas of this E.U.T are permanently attached.

*The E.U.T Complies with the requirement of 15.203

2.4 Test Criteria

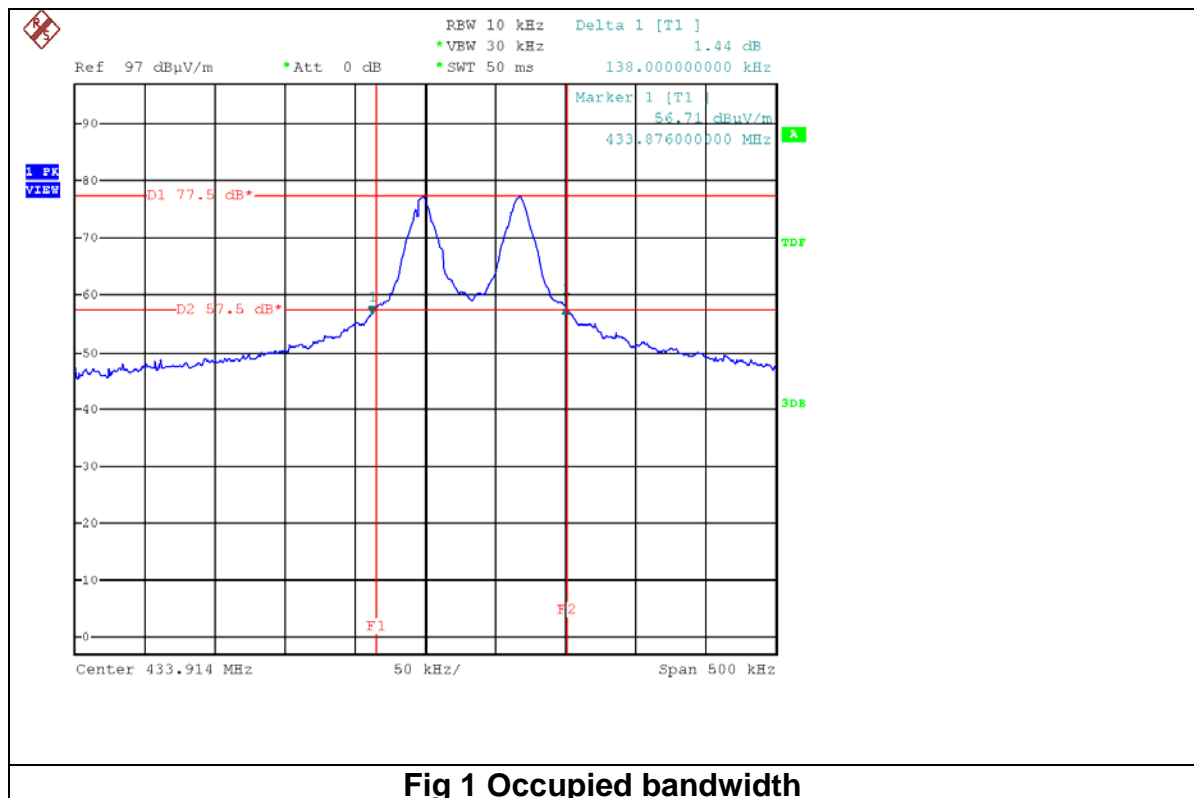
Requirement :-15.231 (c) & IC RSS-210 Issue 6 A1.1.3

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20dB down from the modulated carrier.

TEST PROCEDURE

The resolution bandwidth was set to 10 kHz. The video bandwidth was set to 30 kHz. Bandwidth is determined at the points 20 dB down from the modulated carrier.

RESULTS



Operating Frequency (MHz)	20dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
433.9	138	1084.75	946.75	Pass

3.0 MAXIMUM MODULATION PERCENTAGE (M%)

LIMIT

15.35 (c) & IC RSS-Gen Issue 1 4.3

The measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 seconds interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer or radiated field strength. The RBW is set to 100 kHz and the VBW is set to 300 kHz. The sweep time is coupled and the span is set to 0 Hz. The number of pulses is measured and calculated in a 100 ms scan.

RESULTS

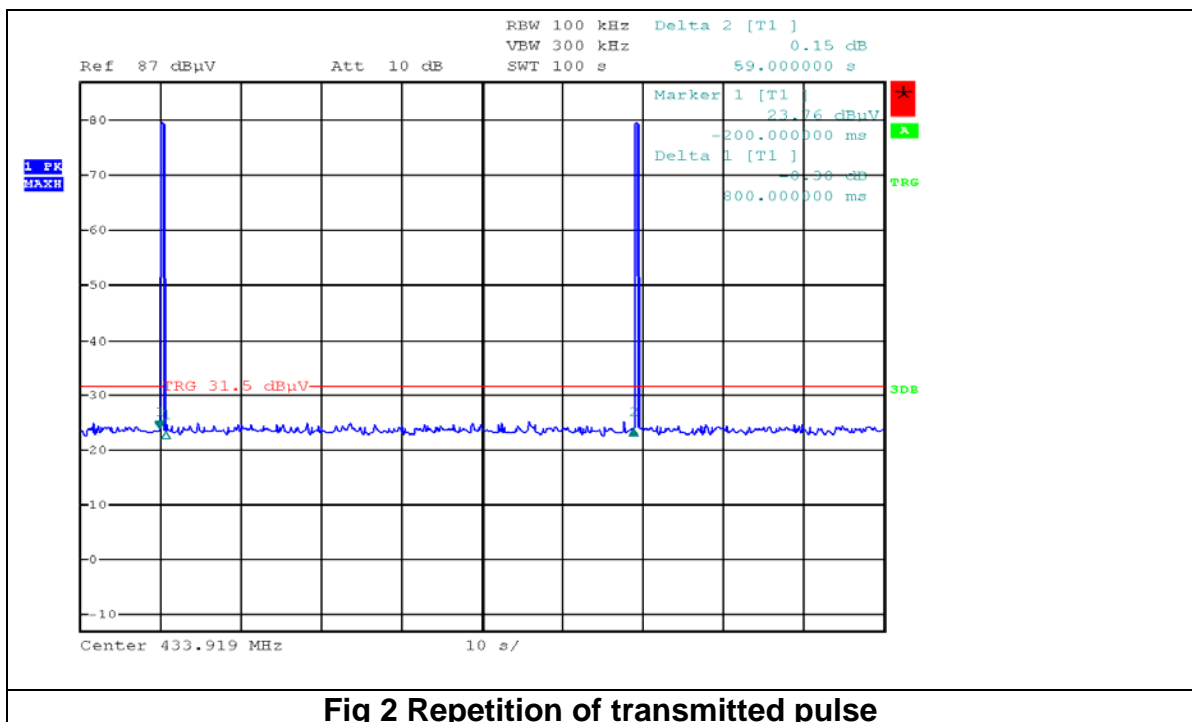


Fig 2 Repetition of transmitted pulse

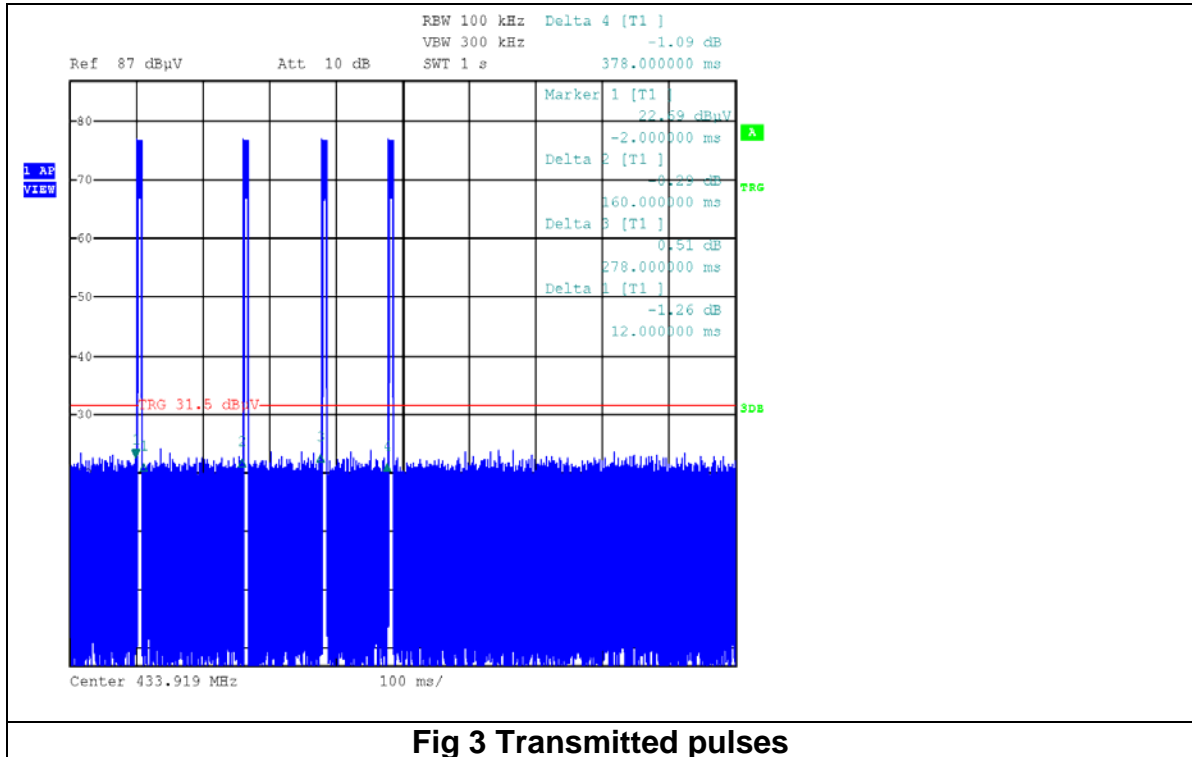


Fig 3 Transmitted pulses

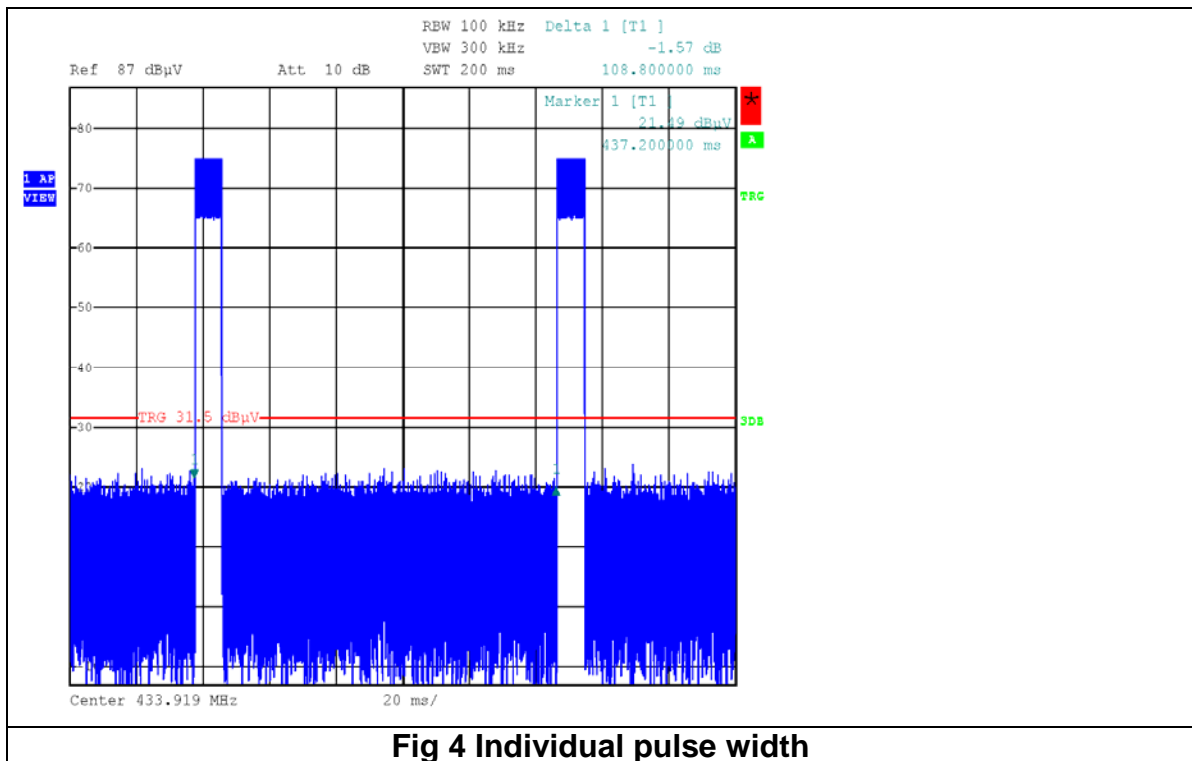
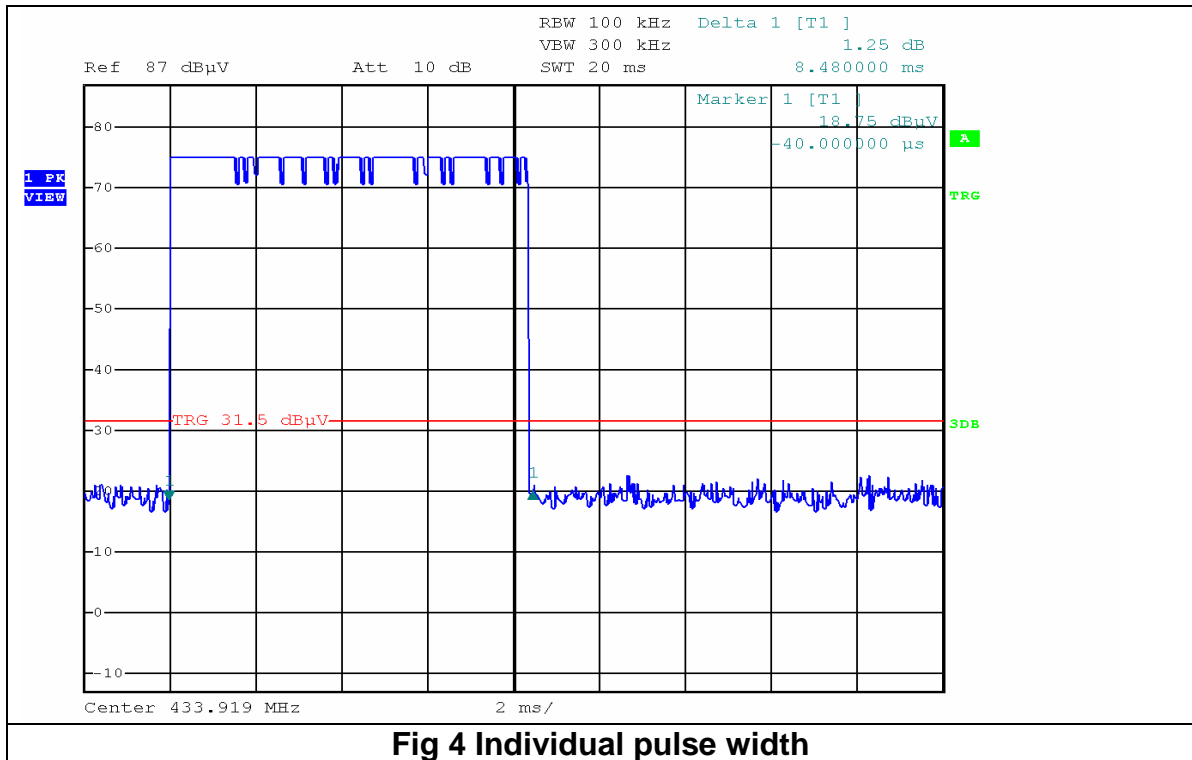


Fig 4 Individual pulse width



MAXIMUM MODULATION PERCENTAGE

One Period(mS)	Pulse Width (mS)	No of Pulses	Duty Cycle	Duty Cycle %	Test Result
100	8.48	1	0.0848	8.5	Pass

CALCULATION

Average Reading = Peak Reading dB(μV/m) +20log (Duty Cycle),

where Duty Cycle is (No of pulses*pulse width)/100 or T

Note correction for pulse mode operation is

20 log duty cycle (dB)
-21.4

4.0 Field Strength of Spurious Radiated Emissions

Test Specification: FCC PART 15, SECTION 47 CFR 15.231(e)

Fundamental Frequency (MHz)	Field Strength of fundamental ($\mu\text{V}/\text{m}$)	Strength of Spurious Emissions ($\mu\text{V}/\text{m}$).
40.66 ~ 40.70	22.50	225
70 ~ 130	1250	125
130 ~ 174	1250 to 3750 **	125 to 375 **
174 ~ 260	3750	375
260 ~ 470	3750 to 12500 **	375 to 1250 **
Above 470	12500	1250

** Linear interpolations

Interpolation Formula = $16.67 \times \text{Freq MHz} - 2833.33$

For operating frequency of 433.936 MHz the following limits apply (using interpolation formula above)

Fundamental Frequency	Field Strength of fundamental	Field Strength of fundamental	Field Strength of Spurious Emissions	Field Strength of Spurious Emissions
MHz	$\mu\text{V}/\text{m}$	$\text{dB}\mu\text{V}/\text{m}$	$\mu\text{V}/\text{m}$	$\text{dB}\mu\text{V}/\text{m}$
433.936	4400.7	72.87	440	52.87

Note this is the Average limit for 3 metre measurement.

Test Specification: FCC PART 15, SECTION 47 CFR 15.109

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

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., Sections 15.231 and 15.241

For the spurious and harmonics measurements, the EUT was set up in an anechoic chamber. The EUT was rotated 360 degrees azimuth and the search antenna height was varied 1 to 4m in order to maximize the emissions. Significant peaks from the EUT were then recorded to determine margin to the limits. Distance of EUT to the measurement antenna was 3m.

4.1 Results for Radiated emissions

Appendix A shows the results of the scans in the anechoic chamber.

Ref Appendix B Fig 9, 10,11 for EUT orientation

Result: Pass

4.1.1 Measurements with Bilog Antenna (30MHz to 1GHz)

Frequency MHz	Peak Level dBuV/m	EUT Orientation	Antenna Polarity	Antenna Loss dB	Cable loss dB	Final Field Strength Peak dBuV/m
433.936	67.1	O3	Horizontal	13.6	0.8	81.5
433.936	67.1	O1	Vertical	13.6	0.8	79.6
867.815	29.2	O3	Horizontal	24.5	2.4	56.1
867.815	29.2	O1	Vertical	24.5	2.4	55.0

Frequency MHz	Peak Level dBuV/m	EUT Orientation	Antenna Polarity	Average Level dBV/m	Average Limit dBuV/m	Margin dB
433.936	81.5	O3	Horizontal	60.0	73	13.0
433.936	79.6	O1	Vertical	58.1	73	14.9
867.815	56.1	O3	Horizontal	34.7	53	18.3
867.815	55.0	O1	Vertical	33.5	53	19.5

Result: Pass

4.1.2 Horn antenna measurements (1GHz - 5 GHz)

Frequency GHz	Measured Peak Level dBuV/m	Antenna Loss dB	Preamp Gain dB	Cable Loss	Antenna Polarity	EUT Orientation	Final Peak Level dBuV/m
1.302	59.4	24.2	40.8	1.5	Vertical	O1	44.3
1.735	64.5	25.4	40.8	1.8	Vertical	O1	50.9
2.167	66.6	27.4	38.3	2.1	Vertical	O1	57.8
2.598	72.8	28.7	38.3	2.5	Vertical	O1	65.7
3.031	70.0	30.4	38.3	2.6	Vertical	O1	64.7
3.464	60.0	30.4	38.3	2.6	Vertical	O1	54.7
3.905	63.8	31.3	38.3	3.8	Vertical	O1	60.6
4.33	65.6	32.6	37.9	4.0	Vertical	O1	64.3
1.302	56.0	24.2	40.8	1.5	Horizontal	O3	40.9
1.735	62.1	25.4	40.8	1.8	Horizontal	O3	48.5
2.167	77.3	27.4	38.3	2.1	Horizontal	O3	68.5
2.598	77.0	28.7	38.3	2.5	Horizontal	O3	69.9
3.031	66.6	30.4	38.3	2.6	Horizontal	O3	61.3
3.464	62.8	30.4	38.3	2.6	Horizontal	O3	57.5
3.905	68.7	31.3	38.3	3.8	Horizontal	O3	65.4
4.33	60.9	32.6	37.9	4.0	Horizontal	O3	59.6

Frequency GHz	Final Peak Level dBuV/m	EUT Orientation	Antenna Polarity	Average Level dBV/m	Average Limit dBuV/m	Margin dB
1.302	44.3	O1	Vertical	22.8	54	31.2
1.735	50.9	O1	Vertical	29.5	54	24.5
2.167	57.8	O1	Vertical	36.3	54	17.7
2.598	65.7	O1	Vertical	44.2	54	9.8
3.031	64.7	O1	Vertical	43.3	54	10.7
3.464	54.7	O1	Vertical	33.3	54	20.7
3.905	60.6	O1	Vertical	39.1	54	14.9
4.33	64.3	O1	Vertical	42.8	54	11.2
1.302	40.9	O3	Horizontal	19.5	54	34.5
1.735	48.5	O3	Horizontal	27.0	54	27.0
2.167	68.5	O3	Horizontal	47.0	54	7.0
2.598	69.9	O3	Horizontal	48.4	54	5.6
3.031	61.3	O3	Horizontal	39.8	54	14.2
3.464	57.5	O3	Horizontal	36.1	54	17.9
3.905	65.4	O3	Horizontal	44.0	54	10.0
4.33	59.6	O3	Horizontal	38.1	54	15.9

Result: Pass

5.0 List of Test Equipment

Instrument	Mfr.	Model	CEI Ref No.	Cal Due Date
Measuring Receiver	Rohde & Schwarz	ESVS30	607	19/04/2014
Bilog Antenna	Chase	CBL 6140	690	03/10/2015
Horn Antenna	EMCO	3115	655	26/10/2014
Preamplifier	Hewlett Packard	83017A	805	10/04/2013
Spectrum Analyser	Rohde & Schwarz	FSP 40	850	10/05/2013

Appendix A
Additional Test Results

RADIATED EMISSIONS

12. Sep 12 15:08

Op Cond: Normal
Operator: J McAuley
Test Spec:
Comment: ANT DIST 3METRE

Scan Settings (1 Range)

Frequencies			Receiver Settings					
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
25M	1000M	120k	120k	PK	5ms	0dB	BLN OFF	60dB

Transducer No.	Start	Stop	Name
4	11	20M	1000M CEI_BLA
19	25M	1000M	BILOG

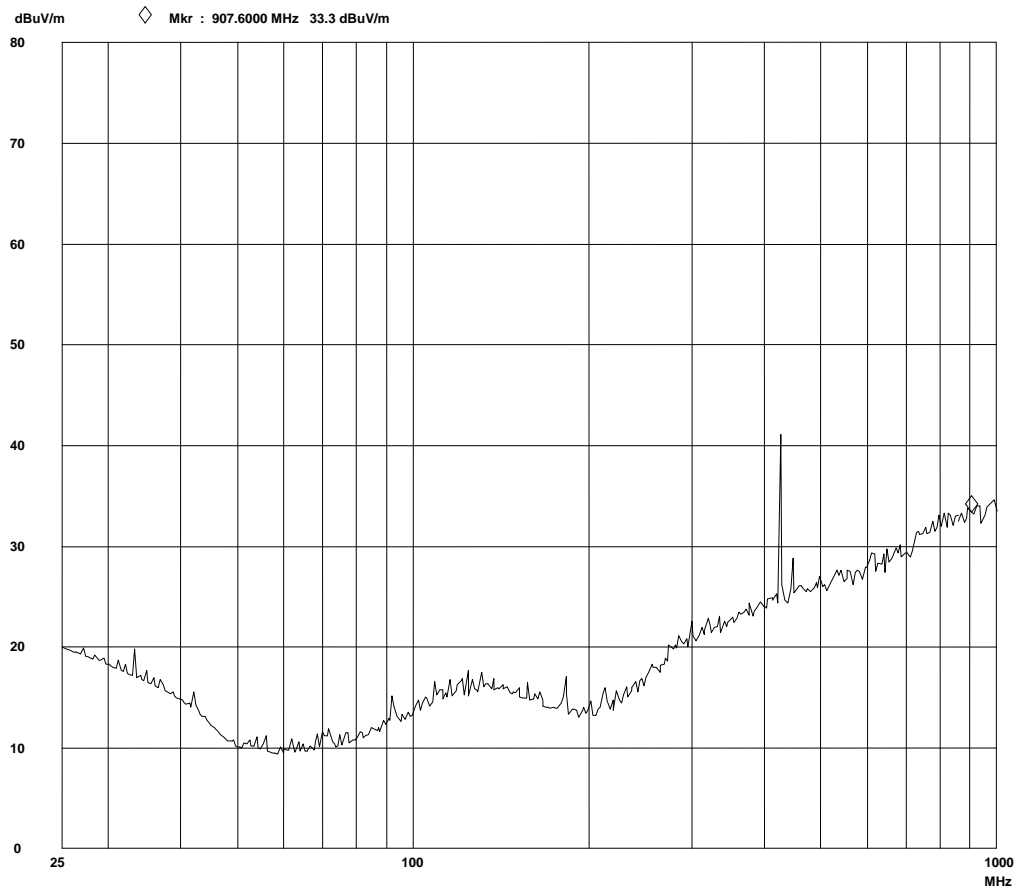


Fig 1 Radiated Emissions Vertical 30MHz -1GHz @ 3 metres Anechoic chamber

RADIATED EMISSIONS

12. Sep 12 14:58

Op Cond: Normal
Operator: J McAuley
Test Spec:
Comment: ANT DIST 3METRE

Scan Settings (1 Range)

----- Frequencies -----||----- Receiver Settings -----|
Start Stop Step IF BW Detector M-Time Atten Preamp OpRge
25M 1000M 120k 120k PK 5ms 0dBLN OFF 60dB

Transducer No.	Start	Stop	Name	
4	11	20M	1000M	CEL_BLA
19	25M	1000M	BILOG	

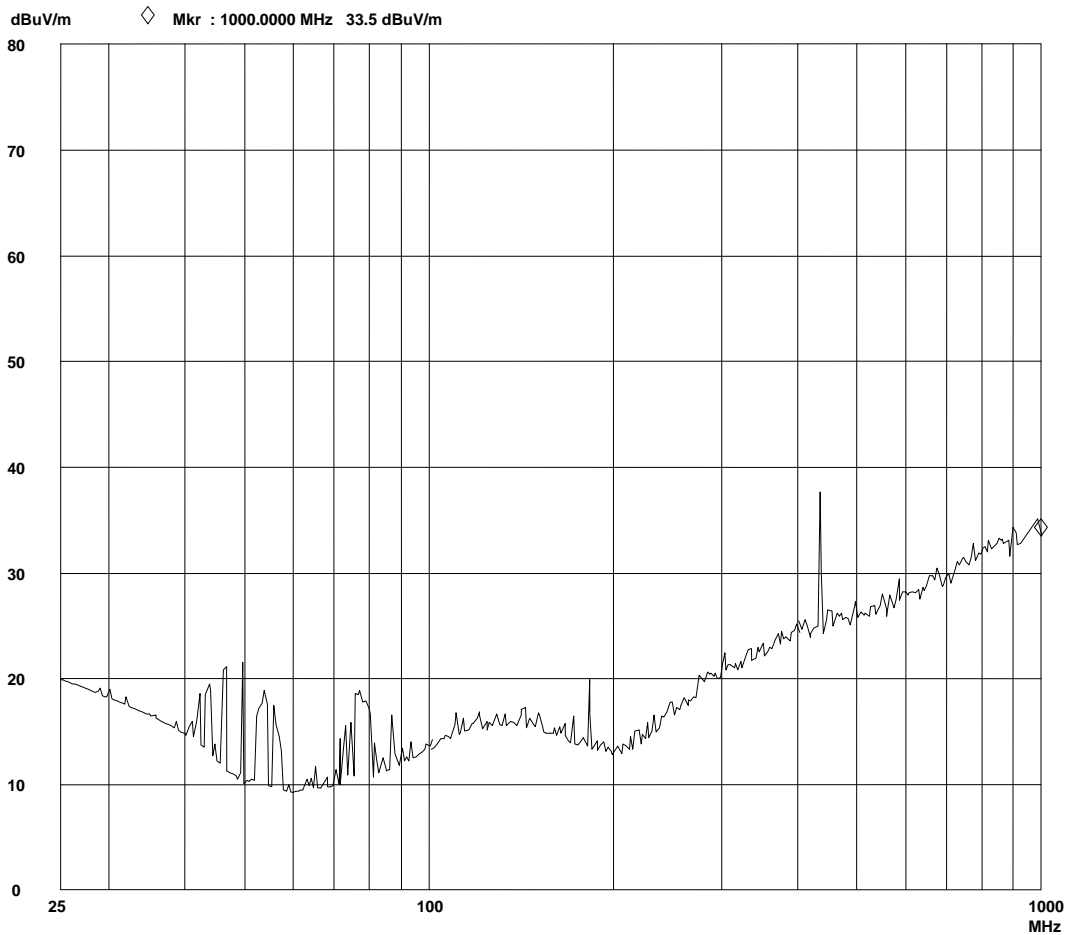
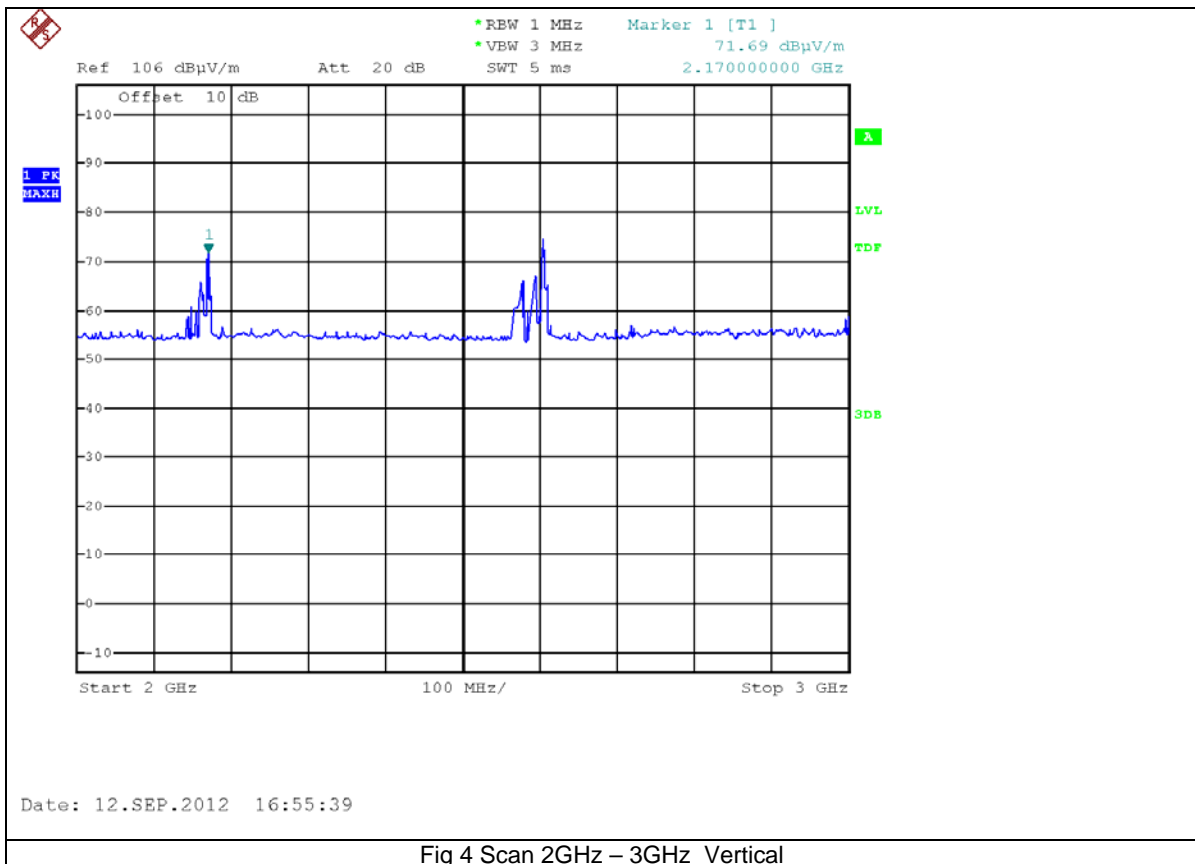
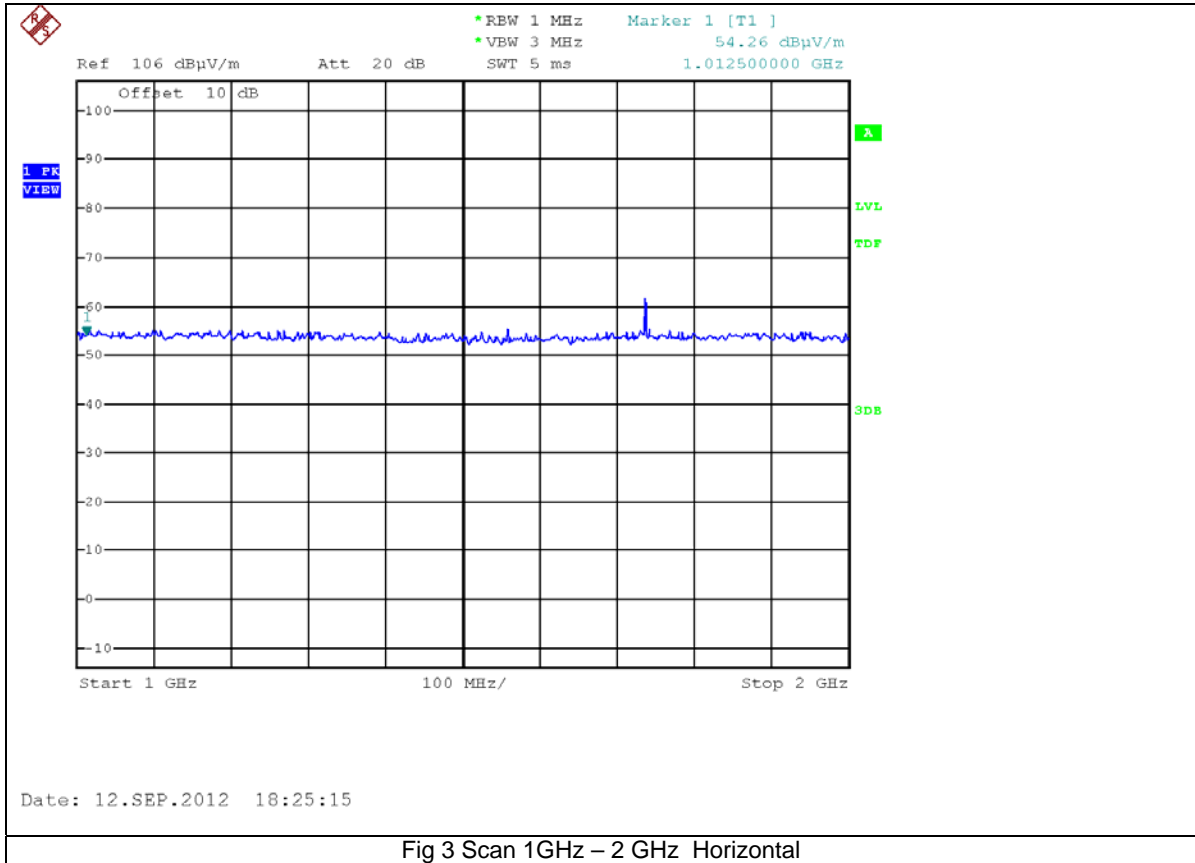
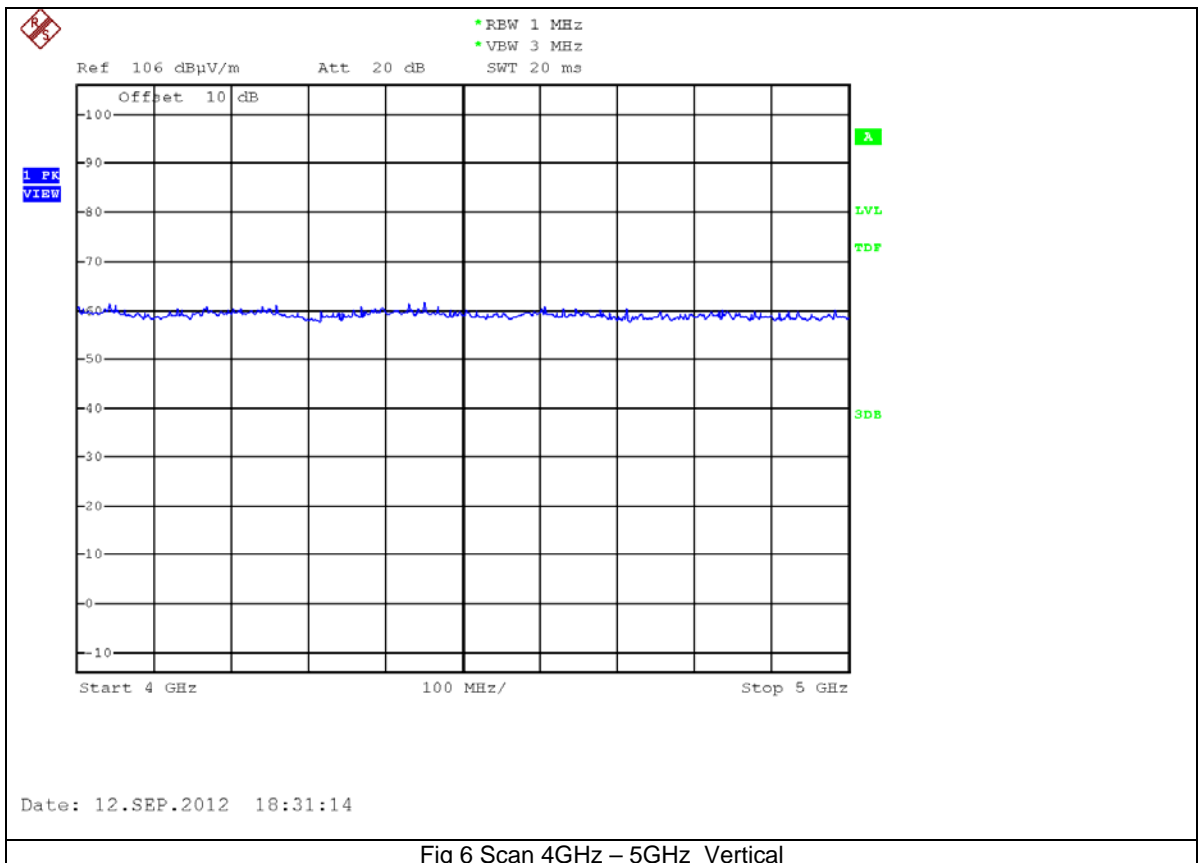
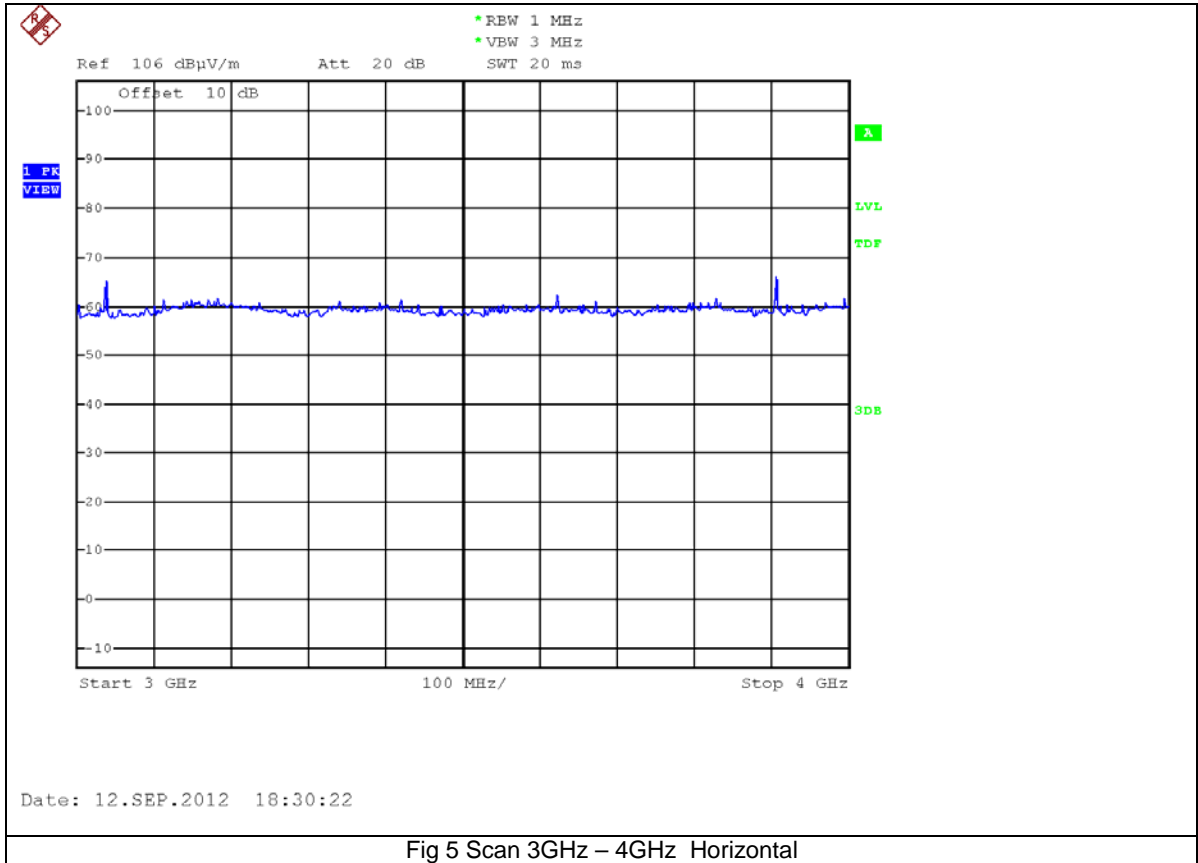


Fig 2 Radiated Emissions Horizontal 30MHz -1GHz @ 3 metres Anechoic chamber





Appendix B

Test Set up



Fig 7 Test setup

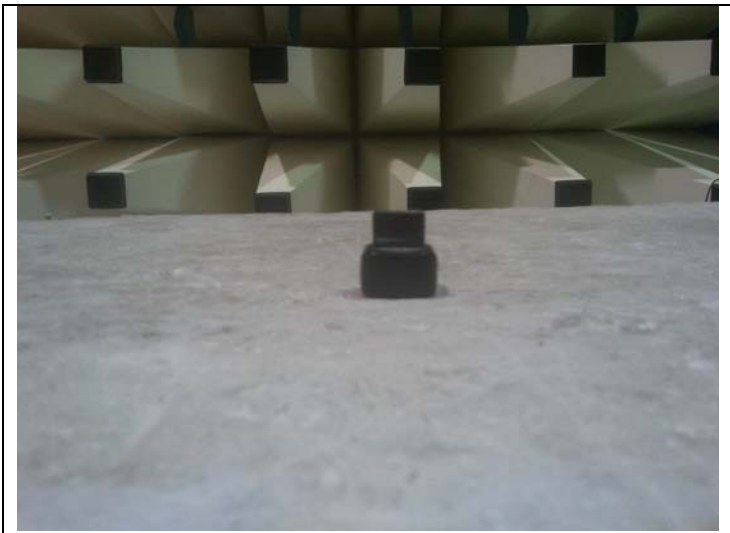


Fig 8 Test setup

EUT orientation



Fig 9 EUT orientation "O1"



Fig 10 EUT orientation "O2"



Fig 11 EUT orientation "O3"