

Radio Test Report

for

Fluke Precision Measurements Ltd

on

RF512

Document No: TRA-008456-00-W-US1

HULL

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TRaC Wireless Test Report : TRA-008456-00-W-US1

Applicant : Fluke Precision Measurements Ltd

Apparatus : RF512

Specification(s) : CFR47 Part 15.247, July 2008

FCCID : TVHRF512

Purpose of Test : Class II Change Certification

Authorised by :



K J Anderson, Authorised Signatory

Issue Date : 30th January 2012

Authorised Copy Number : *PDF*

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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:

Fluke Precision Measurements Ltd
Comark House
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1.3 Manufacturer

As above

1.4 Apparatus Assessed

The following apparatus was assessed between 17th and 27th January 2012:

RF512

The above device is an RF Gateway Instrument operating in the 2400 – 2483.5 MHz band.
The RF512 uses DSSS modulation and a single channel at 2405 MHz

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
Radiated Spurious Emissions	Title 47 of the CFR: Part 15 Subpart C; 15.247	ANSI C63.10	Pass
AC Power Conducted Emissions	Title 47 of the CFR: Part 15 Subpart C; 15.207	ANSI C63.10	Pass
Occupied Bandwidth	Title 47 of the CFR : Part 15 Subpart C; 15.247(a)(2)	ANSI C63.10	Pass
Conducted Carrier Power	Title 47 of the CFR : Part 15 Subpart C; 15.247(b)	ANSI C63.10	Pass
Transmitter Power Spectral Density	Title 47 of the CFR: Part15 Subpart (c) 15.247(e)	ANSI C63.10	Pass

Abbreviations used in the above table:

Mod	: Modification	ANSI	: American National Standards Institution
CFR	: Code of Federal Regulations	PLCE	: Power Line Conducted Emissions
REFE	: Radiated Electric Field 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 Measurement Uncertainty Values****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 (Power Meter) = **1.08dB**

Uncertainty in test result (Spectrum Analyser) = **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 (Power Meter) = **0.113ppm**

Uncertainty in test result (Spectrum Analyser) = **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 – Up to 8.1GHz = **3.31dB**

Uncertainty in test result – 8.1GHz – 15.3GHz = **4.43dB**

Uncertainty in test result – 15.3GHz – 21GHz = **5.34dB**

Uncertainty in test result – 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%**

[12] Power Line Conduction

Uncertainty in test result = **3.4dB**

[13] Spectrum Mask Measurements

Uncertainty in test result = **2.59% (frequency)**

Uncertainty in test result = **1.32dB (amplitude)**

[14] Adjacent Sub Band Selectivity

Uncertainty in test result = **1.24dB**

[15] Receiver Blocking – Listen Mode, Radiated

Uncertainty in test result = **3.42dB**

[16] Receiver Blocking – Talk Mode, Radiated

Uncertainty in test result = **3.36dB**

[17] Receiver Blocking – Talk Mode, Conducted

Uncertainty in test result = **1.24dB**

[18] Receiver Threshold

Uncertainty in test result = **3.23dB**

[19] 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
EUT	: Equipment Under Test	ATS	: Alternative Test Site
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 6 dB Bandwidth

Title 47 of the CFR: Part 15 Subpart (c) 15.247(a)(2) requires the measurement of the bandwidth of the transmission between the -6 dB points on the transmitted spectrum.

Test Details:	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) 15.247(a)(2)
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	S02
Temperature	20°C
EUT set up	Refer to Appendix C

Channel Frequency (MHz)	f _{lower} (MHz)	f _{higher} (MHz)	Bandwidth (kHz)	Limit	Result
2405.00	2404.1625	2405.8375	1675	>500kHz	Pass

Plots of the 6 dB bandwidth are contained in Appendix B of this test report.

Notes:

- Conducted measurements were carried out for the 6 dB Bandwidth test with the EUT transmitting on its only channel
- The conducted measurements were performed with the unique antenna connector on the equipment

A2 Transmitter Peak Output Power

Carrier power was verified with the EUT transmitting on its only channel.

Test Details:	
Regulation	Title 47 of the CFR: Part15 Subpart (c) 15.247(b)(3)
Measurement standard	ANSI C63.10
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	S02
EUT set up	Refer to Appendix C
Temperature	20°C

Channel Frequency (MHz)	Peak Reading (dBm)	Cable Loss (dB)	Antenna Gain (dBi)	Actual Peak Power (dBm)	Limit (dBm)	Result
2405.00	1.83	0.33	N/A	2.16	30	Pass

Notes:

- Conducted measurements were performed for the Transmitter Peak Output Power test
- The conducted measurements were performed with the unique antenna connector on the equipment

A3 Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100 kHz. The radiated electric field emission test applies to spurious emissions and harmonics that fall within the restricted bands listed in Section 15.205. The maximum permitted field strength is listed in Section 15.209. The EUT was set to transmit and receive on its only channel.

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 : ☒

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 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10
Frequency range	30MHz – 25GHz
EUT sample number	S01
Modification state	0
SE in test environment	S02
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C
Temperature	20°C
Photographs (Appendix F)	Photographs 1 & 2

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

Frequency (MHz)	Receive Level (dBµV)	Detector	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Field Strength (dBµV/m)	Extrap. Factor (dB)	Limit (dBµV/m)	Summary
4808.87	63.79	Peak	3.7	32.6	35.7	64.39	0	74	Pass
4808.87	32.59	Average	3.7	32.6	35.7	33.19	0	54	Pass

The setup details for the radiated measurements taken are as follows:

- Measurement distance: 3m
- EUT was mounted at 0.8m above ground plane
- Emissions were maximized by rotating the EUT on an automated turntable
- Receive antenna was raised and lowered between 1m & 4m
- Receive antenna was set in both horizontal and vertical polarizations
- Maximum results were recorded for EUT orientation in three orthogonal planes

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
- 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 Measurements at 2400 & 2483.5 MHz were made to ensure band edge compliance.
- 4 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.
- 5 For Frequencies below 1 GHz, RBW= 100 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=VBW= 1MHz
Average	RBW=VBW= 1MHz

These settings as per ANSI C63.10

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

Radiated emission limits (Title 47 of the CFR, Part 15: 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(kHz)	300	67.6/F (kHz)
0.490-1.705	24000/F(kHz)	30	87.6/F (kHz)
1.705-30	30	30	29.5
30-88	100	3	40.0
88-216	150	3	43.5
216-960	200	3	46.0
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				

A4 Power Line Conducted Emissions

Preview power line conducted emission measurements were performed with a peak detector in a screened room. The effect of the EUT set-up on the measurements is summarised in note (b). Where applicable formal measurements of the emissions were performed with a peak, average and/or quasi peak detector. The EUT was set to transmit and receive on its only channel. The formal measurements are detailed below:

Test Details	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.207
Measurement standard	ANSI C63.10
Frequency range	150kHz to 30MHz
EUT sample number	S01
Modification state	0
SE in test environment	S02
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photograph 3

The worst-case power line conducted emission measurements are listed below.

Results measured using the average detector compared to the average limit

Ref No.	Freq (MHz)	Conduct or	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
1	0.62	Live	42.38	46.00	3.62	Pass

Results measured using the quasi-peak detector compared to the quasi-peak limit

Ref No.	Freq (MHz)	Conduct or	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
1	0.63	Live	47.71	56.00	8.29	Pass

Specification limits:

Conducted emission limits (47 CFR, Part 15: Clause 15.207):

Conducted disturbance at the mains ports:

Frequency range (MHz)	Limits (dB μ V)	
	Quasi-peak	Average
0.15 to 0.5	66 to 56 ²	56 to 46 ²
0.5 to 5	56	46
5 to 30	60	50

Notes:

1. The lower limit shall apply at the transition frequency.
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15MHz to 0.5MHz.

Notes:

- (a) The levels may have been rounded for display purposes.
- (b) The following table summarises the effect of the EUT operating mode and internal configuration 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		✓		

(i) Parameter defined by standard and / or single possible, refer to Appendix C
(ii) Parameter defined by client and / or single possible, refer to Appendix C
(iii) Parameter had a negligible effect on emission levels, refer to Appendix C
(iv) Worst case determined by initial measurement, refer to Appendix C

A5 Transmitter Power Spectral Density

Transmitter Power Spectral Density was verified with the EUT transmitting on its only channel.

Test Details:	
Regulation	Title 47 of the CFR: Part15 Subpart (c) 15.247(e)
Measurement standard	ANSI C63.10
EUT sample number	S01
Modification state	0
SE in test environment	N/A
SE isolated from EUT	N/A
EUT set up	Refer to Appendix C
Temperature	20°C

Channel Frequency (MHz)	Peak Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)	Result
2405.00	-11.95	8	Pass

Notes:

- Conducted measurements were carried out for the Power Spectral Density test
- The conducted measurements were performed with the unique antenna connector on the equipment
- The resolution bandwidth on the analyser was set to 3kHz and trace set to max hold
- The span was set to 3MHz
- Sweep time = 1000 seconds (Span/3kHz)

Appendix B:

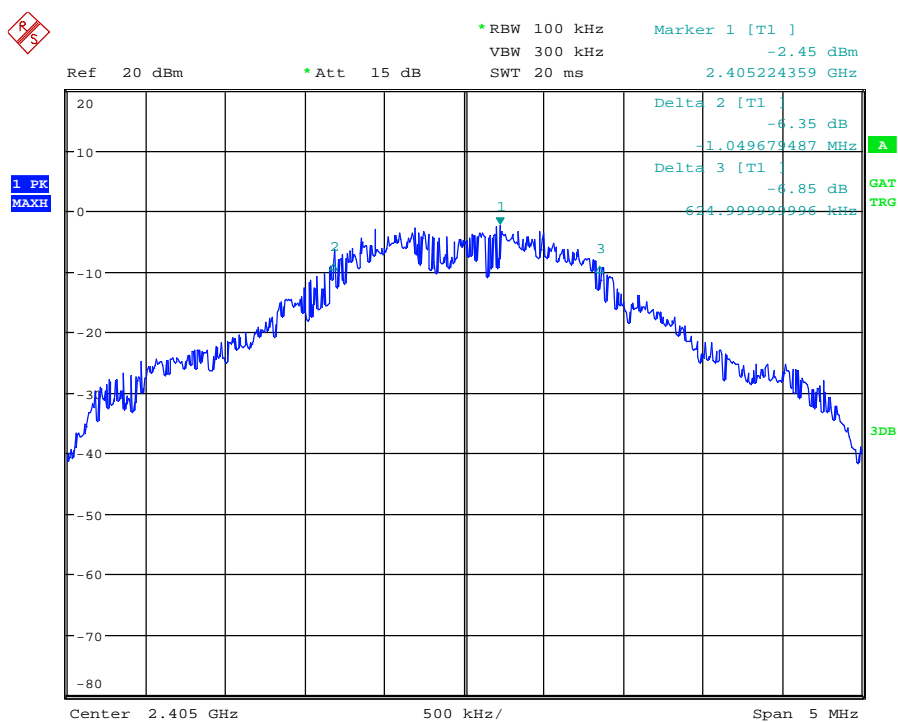
Supporting Graphical Data

This appendix contains graphical data obtained during testing.

Notes:

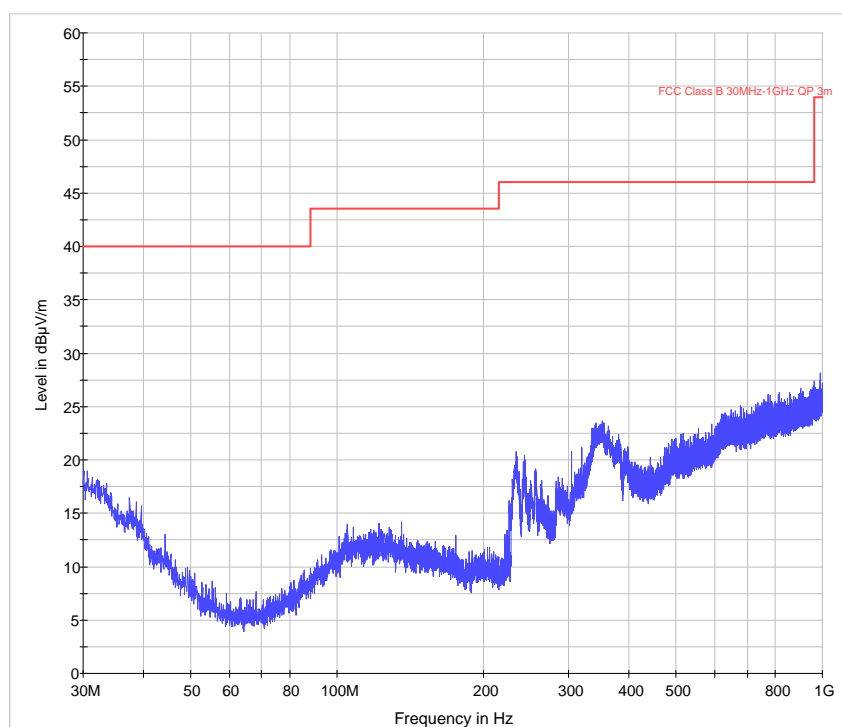
- (a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A and Appendix B.
- (b) The time and date on the plots do not necessarily equate to the time of the test.
- (c) Where relevant, on power 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.

6dB Bandwidth

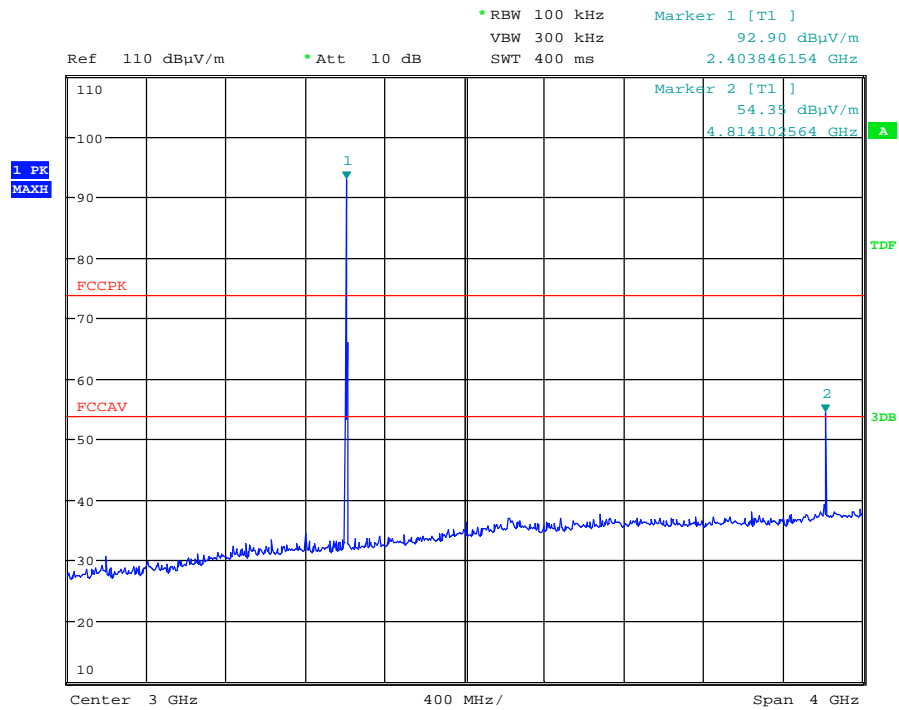


Date: 17.JAN.2012 16:12:53

Radiated spurious emissions 30 MHz to 1 GHz

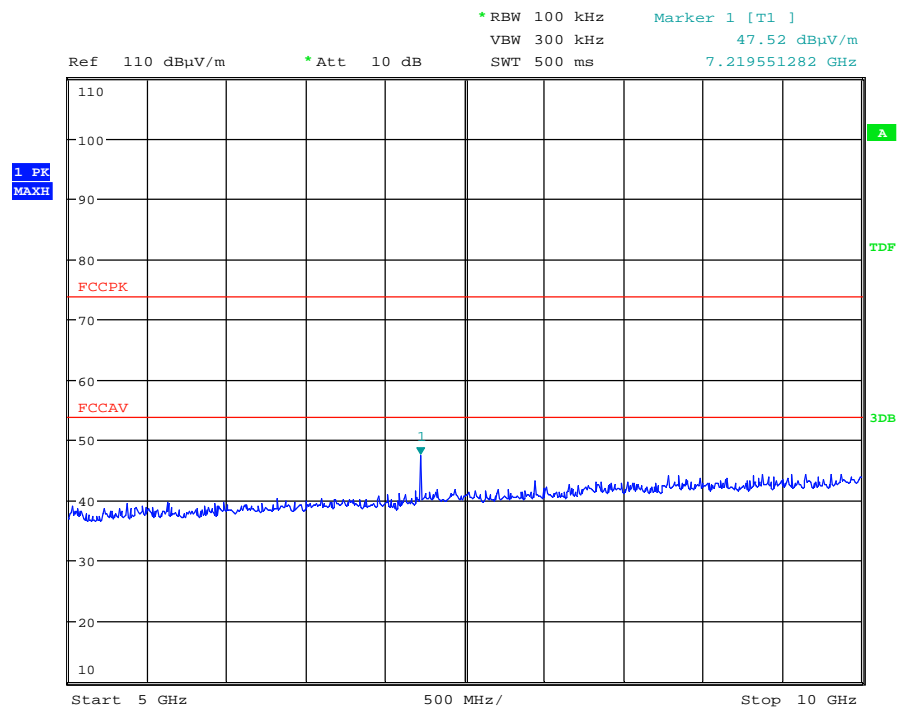


Radiated spurious emissions 1 GHz to 5 GHz

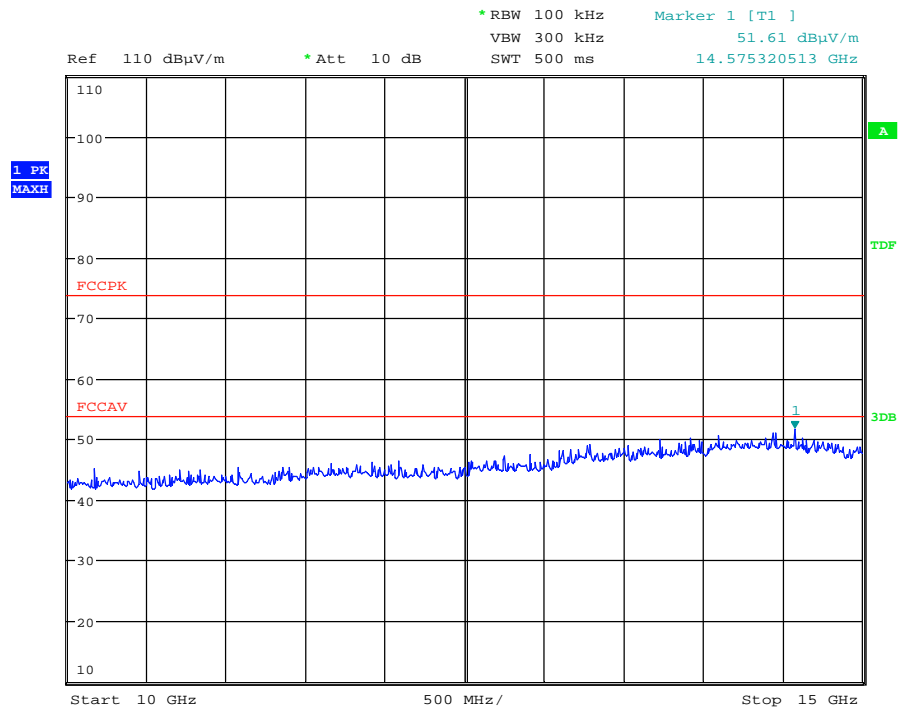


Date: 17.JAN.2012 10:54:50

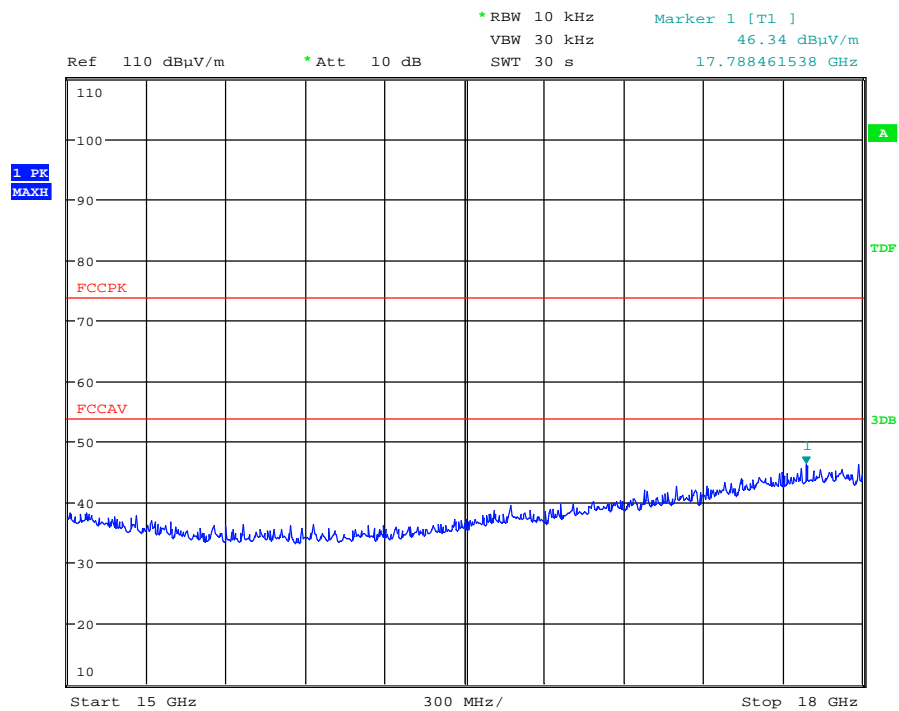
Radiated spurious emissions 5 GHz to 10 GHz



Date: 17.JAN.2012 10:56:15

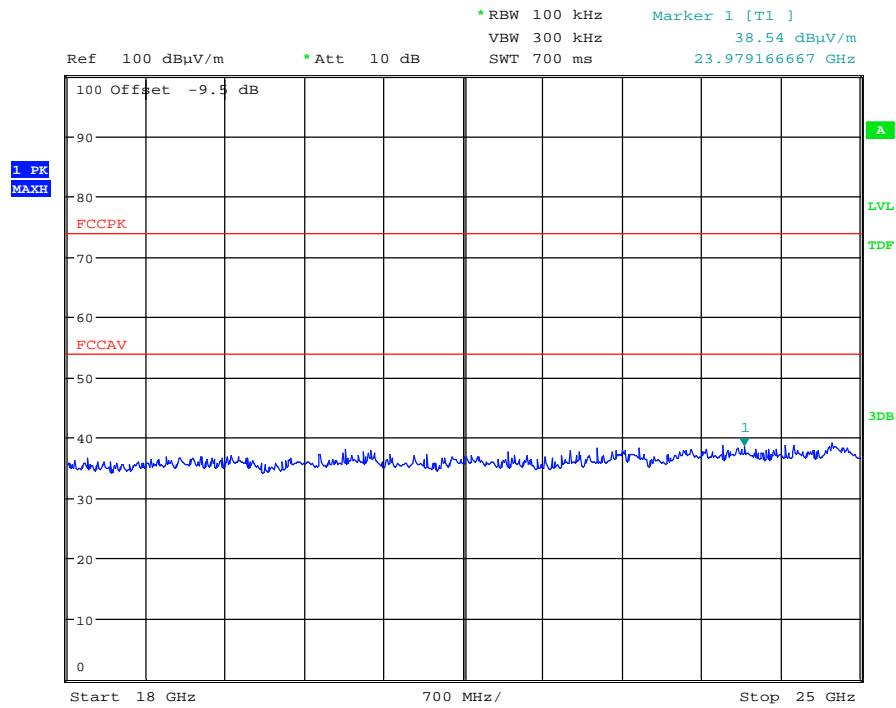
Radiated spurious emissions 10 GHz to 15 GHz

Date: 17.JAN.2012 10:59:06

Radiated spurious emissions 15 GHz to 18GHz

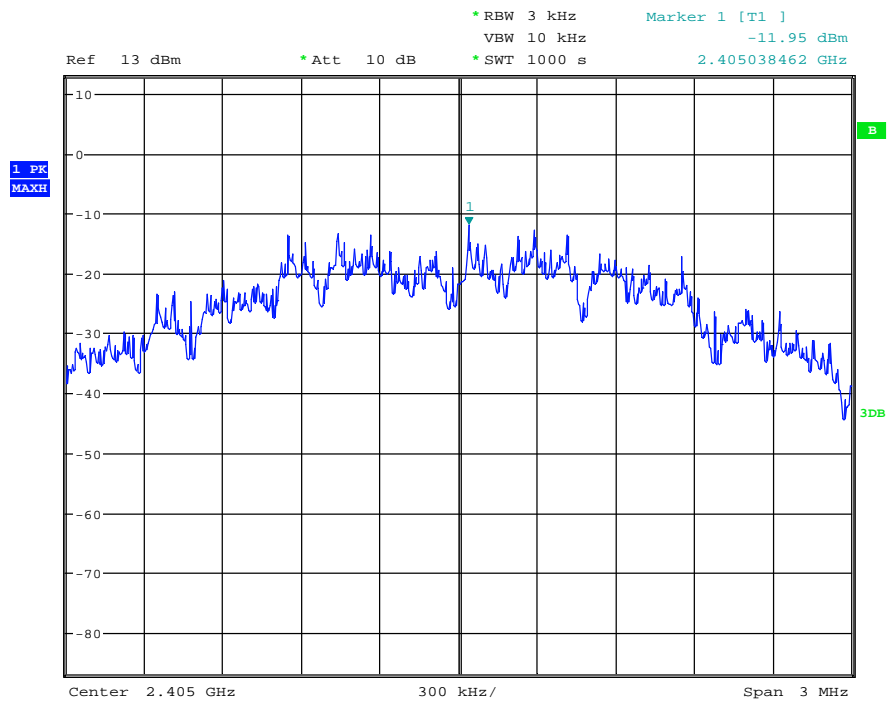
Date: 17.JAN.2012 11:00:55

Radiated spurious emissions 18 GHz to 25 GHz

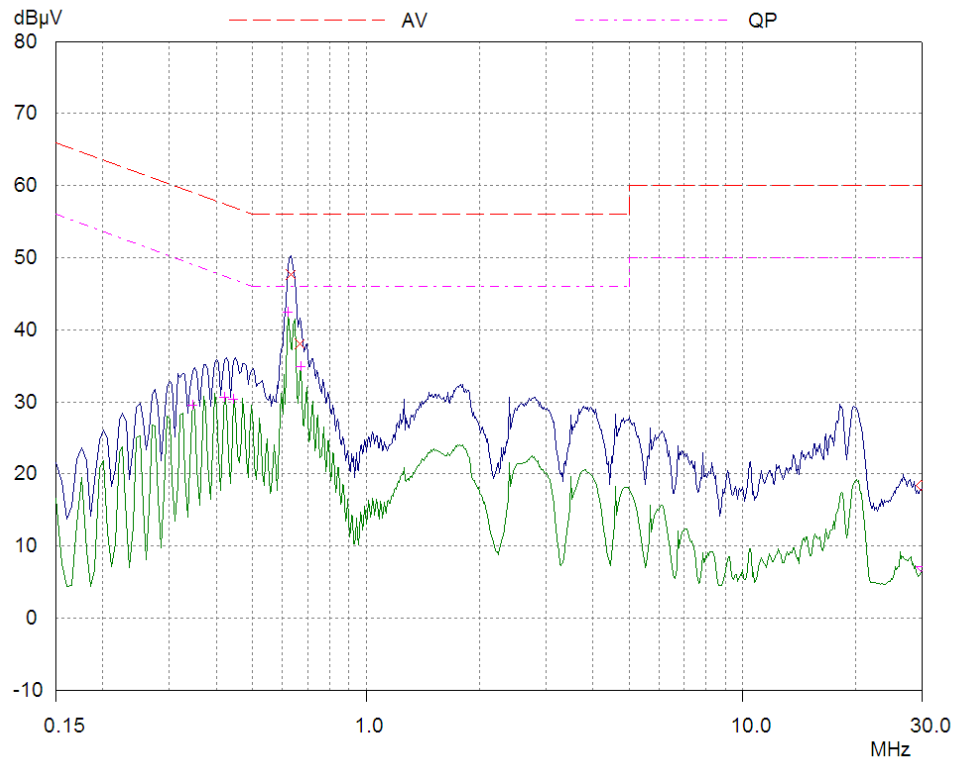
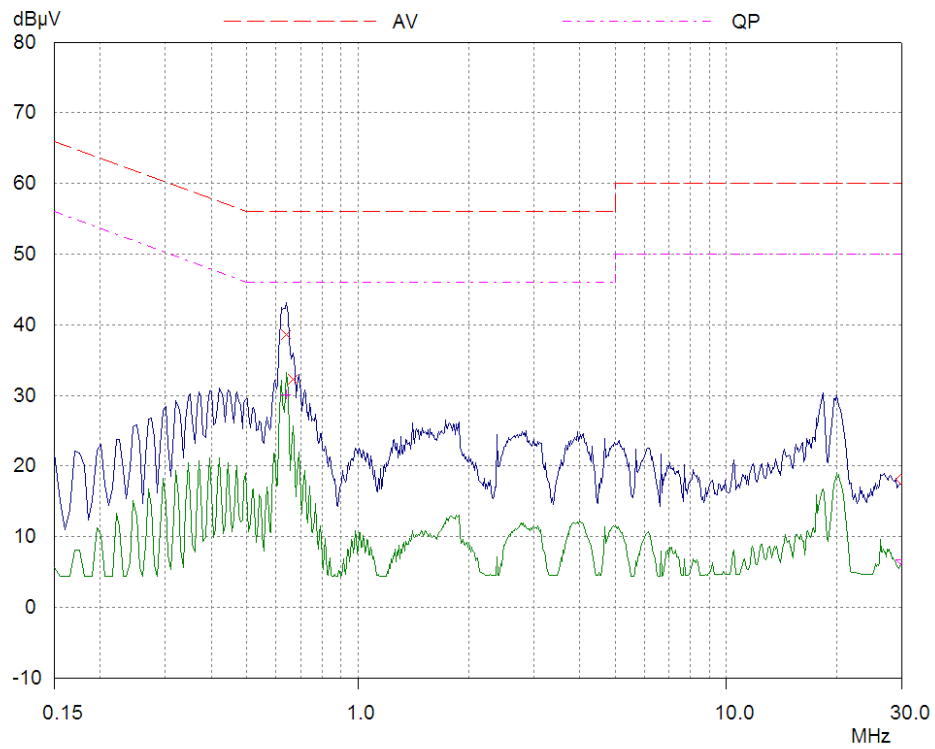


Date: 17.JAN.2012 13:04:53

Power Spectral Density



Date: 27.JAN.2012 09:19:43

Power Line Conducted Emissions - Neutral Line**Power Line Conducted Emissions - Live Line**

C1 Test samples

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

Sample No	Description	Identification
S01	RF512	None
S02	DC Power Supply	None

C2 EUT operating mode during testing

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

Ref No	Test	Description of Operating Mode
1	Conducted Spurious Emissions	EUT transmitting at 2405 MHz using DSSS
2	Radiated Spurious Emissions	
3	Power Line Conducted Emissions	

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 : S01
Tests : Conducted, Radiated emissions

Port	Description of port/cable attached	Cable length	Equipment Connected
Power	2 Pin SM Connector	1.5m	PSU
Switch	3 Pin SM Connector	Up to 29m	Door Switch
Sensor	Lumberg Connector	Up to 29m	Thermistor Sensor Probe

C5 Details of Equipment Used

TRaC Ref	Description	Manufacturer	Model No	Calibrated On
UH93	Bilog Antenna	Chase	CBL6112B	20/06/2011
UH04	UHF Receiver	R&S	ESVS10	12/01/2012
UH281	Spectrum Analyser	R&S	FSU 46	10/02/2011
REF936	0.5m Cable	Rosenberger	3.5mm type	09/11/2011
REF938	5m Cable	Rosenberger	3.5mm type	09/11/2011
TRL138	Horn Antenna	EMCO	3115	08/11/2011

Appendix D:

Additional Information

No additional information is included within this test report.

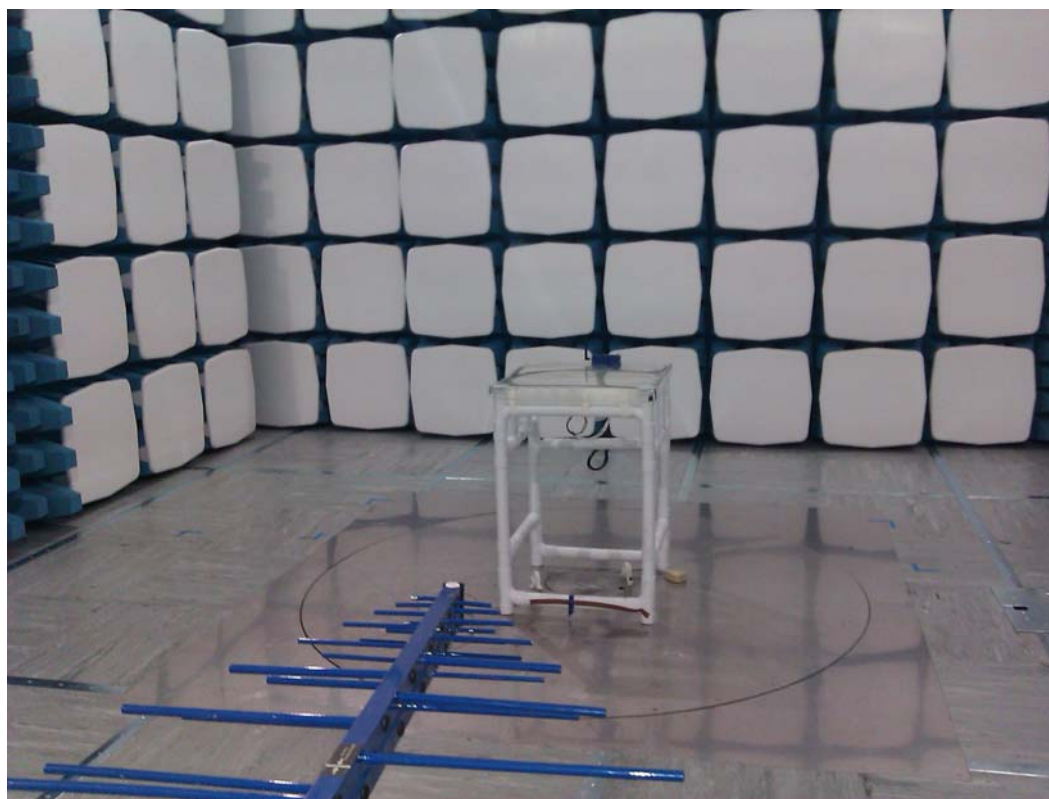
Appendix E:

Photographs and Figures

The following photographs were taken of the test samples:

1. Radiated E-field emissions arrangement: RF512 front view
2. Powerline Conducted emissions arrangement: RF512 setup

Photograph 1



Photograph 2



