

Radio Test report
FOR
WiMAC Ltd.
ON
GEN 2 RF board (Product ID XRFMODULE-GEN2-915A1)
DOCUMENT NO. TRA-013728-W-US-01

HULL

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TRaC Radio Test Report : TRA-013728-W-US-01

Applicant : WiMAC Ltd

Apparatus : GEN 2 RF board (Product ID XRFMODULE-GEN2-915A1)

FCC ID : YRURFMOD915

IC ID : 9215A-RFMOD915

Authorised by

: 

:Radio Product 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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1.2 Tests Requested By

This testing in this report was requested by :

WiMAC Ltd
Tyler Close
Normanton
Wakefield
WF6 1RL
WiMAC LTD

1.3 Manufacturer

Harvard Engineering PLC
Tyler Close
Normanton
Wakefield
WF6 1RL

1.4 Apparatus Assessed

The following apparatus was assessed between: 11/12/12 to 29/04/13

GEN 2 RF board (Product ID XRFMODULE-GEN2-915A1)

The above equipment was a FHSS transmitter operating in the 902.0MHz – 928.0MHz band

For the purposes of testing the EUT was incorporated into a Branchnode (WMBN-915USA).

In addition the EUT was tested for radiated spurious emissions as a stand-alone unit for the purpose of obtaining modular approval.

1.5 Results Test 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 (Restricted bands)	Title 47 of the CFR: Part 15 Subpart (c) 15.247	ANSI C63.10:2009	Pass
Conducted spurious emissions (Non-restricted bands)	Title 47 of the CFR: Part 15 Subpart (c) 15.247	ANSI C63.10:2009	Pass
AC Power conducted emissions	Title 47 of the CFR: Part 15 Subpart (c) 15.207	ANSI C63.10:2009	Pass
20dB Bandwidth and Channel Spacing	Title 47 of the CFR : Part 15 Subpart (c) 15.247(a)(1)(i)	ANSI C63.10:2009	Pass
Conducted Carrier Power	Title 47 of the CFR : Part 15 Subpart (c) 15.247(b)(2)	ANSI C63.10:2009	Pass
Hopping Frequencies	Title 47 of the CFR : Part 15 Subpart (c) 15.247(a)(1)	ANSI C63.10:2009	Pass
Channel Occupancy	Title 47 of the CFR : Part 15 Subpart (c) 15.247(a)(1)(i)	ANSI C63.10:2009	Pass
Unintentional Radiated Spurious Emissions	Title 47 of the CFR: Part 15 Subpart (b) 15.109	ANSI C63.10:2009	Pass

Abbreviations used in the above table:

ANSI C 63.10:2009 is outside the scope of the laboratories UKAS accreditation.

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**

The following page contains the measurement uncertainties for measurements

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.

Test type	Quantity	Quantity frequency range	Uncertainty
Radiated electric field emissions 3m alternative test site	Amplitude	30MHz to 300MHz Horizontal	±4.6dB
		30MHz to 300MHz Vertical	±5.1dB
		300MHz to 1000MHz Horizontal	±5.2dB
		300MHz to 1000MHz Vertical	±5.5dB
		1GHz to 26.5GHz Horizontal and Vertical	±4.1dB
Effective Radiated Power 3m alternative test site	Amplitude	N/A	±0.9 dB
Conducted emissions		N/A	±0.9 dB
Absolute RF power (via antenna connector)		N/A	±0.9 dB
PSD	Amplitude	N/A	±0.9 dB
Frequency Range	Frequency	dc to 26.5GHz	3.611kHz

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
		Freq	: Frequency
		MD	: Measurement Distance
		SD	: Spec Distance
L	: Live Power Line	Pol	: Polarisation
N	: Neutral Power Line	H	: Horizontal Polarisation
E	: Earth Power Line	V	: Vertical Polarisation
Pk	: Peak Detector	CDN	: Coupling & decoupling network
QP	: Quasi-Peak Detector		
Av	: Average Detector		

A1 Conducted Fundamental Carrier Power

The EUT transmitting on its lowest channel centre and highest carrier frequency in turn.

Test Details:	
Regulation	CFR 47 Part 15, Subpart (c) 15.247(b)(2)
Measurement standard	ANSI C63.10:2009
EUT sample number	TRA-011281S01, S02 and S07
Modification state	0
SE in test environment	None
SE isolated from EUT	None
SE in test environment	None

Channel No	Channel Frequency (MHz)	Measured Peak Conducted Carrier Power (dBm)	Measured Peak Conducted Carrier Power (mW)	Limit (W)	Result
0	905.20	14.56	28.58	1.0	Pass
31	910.47	14.56	28.58		Pass
63	915.91	14.58	28.71		Pass

Note: Channel 0 is the lowest operating frequency, and channel 63 is the highest operating frequency.

Conducted Measurement

Conducted measurements were performed with a temporary antenna connector provided by the client.

A2 RF Antenna Conducted Spurious Emissions

Measurement of conducted spurious emissions at the antenna port was performed using a peak detector with the RBW set to 100kHz the VBW>RBW. Frequencies were scanned up through to the 10th harmonic with the EUT transmitting on its lowest, centre and highest carrier frequency in turn.

Test Details CH0/CH31/CH63	
Regulation	CFR 47 Part 15Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2009
Frequency range	30MHz to 10 GHz
EUT sample number	TRA-011281S01, S02 and S07
Modification state	0
SE in test environment	None
SE isolated from EUT	None
SE in test environment	None

The worst case conducted lower band edge emission measurements at the antenna port are listed below with the transmitter at 905.2MHz (CH0) :

Conducted Emissions Channel 0 (Bottom 905.2MHz TX100% modulated)						
Ref No.	Measured Freq (MHz)	Det.	Is measured Frequency within the Restricted bands (Y/N)	Measured Peak Conducted power (RBW =100kHz) (dBuV)	15.247(d) Limit (dBuV)	Summary
1	9kHz to 10GHz	Pk	N	No Significant Emissions Within 20dB of the limit	101.75	Pass
2	1807.692	Pk	Y	63.18	101.75	Pass
3	2717.948	Pk	Y	62.51	101.75	Pass
4	901.615	Pk	N	76.01	101.75	Pass
5	901.615	(In-band Pk)-(ΔPk Outside the band or band edge)		-45.74dB	101.75	Pass

The worst case conducted emission measurements at the antenna port are listed below with the transmitter at 910.47MHz (CH31) :

Conducted Emissions Channel 31 (Middle 910.47MHz TX100% modulated)						
Ref No.	Measured Freq (MHz)	Det.	Is measured Frequency within the Restricted bands (Y/N)	Measured Peak Conducted power (RBW =100kHz) (dBuV)	15.247(d) Limit (dBuV)	Summary
1	9kHz to 10GHz	Pk	N	No Significant Emissions Within 20dB of the limit	101.68	Pass
2	1820.512	Pk	Y	63.23	101.68	Pass
3	2730.769	Pk	Y	63.41	101.68	Pass

RF Antenna Conducted Spurious Emissions continued:

The worst case conducted upper band edge emission measurements at the antenna port are listed below with the transmitter at 915.19MHz (CH63) :

Conducted Emissions Channel 63 (Top 915.29MHz TX100% modulated)						
Ref No.	Measured Freq (MHz)	Det.	Is measured Frequency within the Restricted bands (Y/N)	Measured Peak Conducted power (RBW =100kHz) (dBuV)	15.247(d) Limit (dBuV)	Summary
1	9kHz to 10GHz	Pk	N	No Significant Emissions Within 20dB of the limit	101.75	Pass
2	1833.333	Pk	Y	64.22	101.75	Pass
3	2750.000	Pk	Y	63.88	101.75	Pass
4	928.102	Pk	N	62.51	101.75	Pass
5	928.102	(In-band Pk)-(ΔPk Outside the band or band edge)		-59.25dB	101.75	Pass

Notes:

1. The conducted emission limit for emissions outside the restricted bands, defined in 47CFR15.205(a) are based on a transmitted carrier level of 15.247(b). With the EUT transmitting on its lowest, centre and highest carrier frequencies in turn, emissions from the EUT are required to be 20 dB below the level of the highest fundamental as measured within a 100 kHz RBW in accordance with 15.247(d) using a peak detector.
2. The RBW = 100 kHz, Video bandwidth (VBW) > RBW and the radio spectrum was investigated up to the 10th harmonic in accordance 15.33 (a)(1).
3. The measurements at 902.0 MHz and 928.0 MHz were made to ensure band edge compliance.
4. The carrier level was measured whilst varying the supply voltage between 85% and 105% of the nominal supply voltage as required by 15.31(e). No variation in carrier level was observed. All other emissions were at least 20dB below the test limit

The limit outside the restricted band in 100 kHz RBW is defined using the following formula in accordance with 15.247(d):

$$\text{The limit in 100 kHz RBW} = (\text{Maximum Peak Conducted Carrier}) - 20\text{dB}$$

Conducted emissions Limits Determined for each of the 3 Channels tested, CH0, CH31 & CH63					
Channel No.	Channel Frequency (MHz)	Measured Peak Carrier Power (mW)	Measured Peak Carrier (dBμV)	Measured Peak Carrier -20dB (dBμV)	Emission Limit In a 100 kHz RBW (dBμV)
0	905.20	30.55	121.75	121.75-20	101.75
31	910.47	30.06	121.68	121.68-20	101.68
63	915.91	30.55	121.75	121.75-20	101.75

A3 Radiated Electric Field Emissions 15.209 and within the Restricted Band 15.205

Transmit UHF Radio Module Only

Preliminary emission testing was performed using a peak detector with the RBW = 100kHz. 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 with its UHF radio module on its lowest, centre and highest carrier frequency in turn. The co-located Modem was not transmitting.

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: Transmit UHF Bottom Channel 0: (Transmit UHF Radio Only)	
Regulation	CFR 47 Part 15Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2009
Frequency range	30MHz to 10 GHz
EUT sample number	TRA-011281S09 and S10
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photograph 1 and 2

Radiated Electric Field Emissions (UHF Radio Module) 15.209 and within the Restricted Band 15.205 continued:

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 (dBμV)	Detector	PRE AMP (dB)	ANT FACT (dB/m)	CABLE LOSS (dB)	Duty cycle correction (dBm)	FIELD ST'GH (dBμV/m)	LIMIT (dBμV/m)
1.	93.500	59.7	Pk	31.6	8.5	1.4	None ²	38.0	66.0
2.	93.500	53.5	QP	31.6	8.5	1.4	None ²	31.8	46.0
3.	138.400	52.4	Pk	31.5	12.5	1.9	None ²	35.3	66.0
4.	138.400	46.6	QP	31.5	12.5	1.9	None ²	29.5	46.0
5.	225.000	48.2	Pk	31.5	10.4	1.9	None ²	29.0	66.0
6.	225.000	46.3	QP	31.5	10.4	1.9	None ²	27.1	46.0
7.	240.000	52.8	Pk	31.5	11.1	1.9	None ²	34.3	66.0
8.	240.000	52.4	Av	31.5	11.1	1.9	None ²	33.9	46.0
9	905.200*	89.2	Pk	0	22.1	4.3	None ²	115.6	137

Note

1. *Indicates the radiated carrier power as measured
2. No Duty cycle correction was applied to the final result.

Radiated Electric Field Emissions 15.209 and within the Restricted Band 15.205 continued:

Test Details: Transmit UHF Middle Channel 31: (Transmit UHF Radio Only)	
Regulation	CFR 47 Part 15Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2009
Frequency range	30MHz to 10 GHz
EUT sample number	TRA-011281S09 and S10
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photograph 1 and 2

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 (dBμV)	Detector	PRE AMP (dB)	ANT FACT (dB/m)	CABLE LOSS (dB)	Duty cycle correction (dBm)	FIELD ST'GH (dBμV/m)	LIMIT (dBμV/m)
1.	93.500	59.7	Pk	31.6	8.5	1.4	None ²	38.0	66.0
2.	93.500	53.5	QP	31.6	8.5	1.4	None ²	31.8	46.0
3.	138.400	52.4	Pk	31.5	12.5	1.9	None ²	35.3	66.0
4.	138.400	46.6	QP	31.5	12.5	1.9	None ²	29.5	46.0
5.	225.000	48.2	Pk	31.5	10.4	1.9	None ²	29.0	66.0
6.	225.000	46.3	QP	31.5	10.4	1.9	None ²	27.1	46.0
7.	240.000	52.8	Pk	31.5	11.1	1.9	None ²	34.3	66.0
8.	240.000	52.4	Av	31.5	11.1	1.9	None ²	33.9	46.0
9	910.470*	89.4	Pk	0	22.2	4.3	None ²	115.9	137

Note

1. *Indicates the radiated carrier power as measured
2. No Duty cycle correction was applied to the final result.

Radiated Electric Field Emissions 15.209 and within the Restricted Band 15.205 continued:

Test Details: Transmit UHF Top Channel 63: (Transmit UHF Radio Only)	
Regulation	CFR 47 Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2009
Frequency range	30MHz to 10 GHz
EUT sample number	TRA-011281S09 and S10
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photograph 1 and 2

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 (dBμV)	Detector	PRE AMP (dB)	ANT FACT (dB/m)	CABLE LOSS (dB)	Duty cycle correction (dBm)	FIELD ST'GH (dBμV/m)	LIMIT (dBμV/m)
1.	93.500	59.7	Pk	31.6	8.5	1.4	None ²	38.0	66.0
2.	93.500	53.5	QP	31.6	8.5	1.4	None ²	31.8	46.0
3.	138.400	52.4	Pk	31.5	12.5	1.9	None ²	35.3	66.0
4.	138.400	46.6	QP	31.5	12.5	1.9	None ²	29.5	46.0
5.	225.000	48.2	Pk	31.5	10.4	1.9	None ²	29.0	66.0
6.	225.000	46.3	QP	31.5	10.4	1.9	None ²	27.1	46.0
7.	240.000	52.8	Pk	31.5	11.1	1.9	None ²	34.3	66.0
8.	240.000	52.4	Av	31.5	11.1	1.9	None ²	33.9	46.0
9	915.510*	88.3	Pk	0	22.2	4.2	None ²	114.7	137

Note

1. *Indicates the radiated carrier power as measured
2. No Duty cycle correction was applied to the final result.

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 902.0 MHz and 928.0 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 and DA 00-705.

- 6 In accordance with DA 00-705, the average level of the spurious radiated emission may be reduced by the duty cycle correction factor. If the dwell time per channel (refer to the measured channel occupancy time, section A7 of this test report) of the hopping signal is less than 100ms then the average measurement may be further adjusted by the duty cycle correction factor which is derived from

$$20\log_{10}\left(\frac{\text{dwell time}}{100\text{ms}}\right)$$

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

Radiated emission limits (47 CFR 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 Unintentional Radiated Electric Field Emissions - 15.109

Preliminary scans were performed using a peak detector with the RBW = 100 kHz. The maximum permitted field strength is listed in Section 15.109. The EUT was set to receive mode only on its lowest, centre and highest carrier frequency in turn.

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 : ☒

Test Details: Device in Receive mode	
Regulation	CFR 47 Part 15 Subpart (b) Clause 15.109
Measurement standard	ANSI C63.10:2009
Frequency range	30MHz to 10 GHz
EUT sample number	TRA-011281S09 and S10
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photograph 1 and 2

Worse case results listed from the middle channels in receive mode.

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	Detector	PRE AMP (dB)	ANT FACT (dB/m)	CABLE LOSS (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)
1.	31.300	58.2	Pk	31.6	12.6	0.7	39.9	60.0
2.	31.300	46.7	QP	31.6	12.6	0.7	28.4	40.0
3.	35.100	58.9	Pk	31.6	12.2	0.7	40.2	60.0
4.	35.100	46.9	QP	31.6	12.2	0.7	28.2	40.0
5.	44.400	59.1	Pk	31.6	11	1	39.5	60.0
6.	44.400	51.1	QP	31.6	11	1	31.5	40.0
7.	48.900	58.9	Pk	31.6	10	1	38.3	60.0
8.	48.900	50.8	QP	31.6	10	1	30.2	40.0
9.	58.700	58.4	Pk	31.6	8.2	1.1	36.1	60.0
10.	58.700	50.3	QP	31.6	8.2	1.1	28.0	40.0
11.	68.900	59.2	Pk	31.6	8	1.2	36.8	60.0
12.	68.900	50.3	QP	31.6	8	1.2	27.9	40.0
13.	87.200	62.2	Pk	31.6	7.5	1.5	39.6	63.5
14.	87.200	55.8	QP	31.6	7.5	1.5	33.2	43.5
15.	93.500	59.7	Pk	31.6	8.5	1.4	38.0	66.0
16.	93.500	53.5	QP	31.6	8.5	1.4	31.8	46.0

Ref No.	FREQ. (MHz)	MEAS Rx (dBμV)	Detector	PRE AMP (dB)	ANT FACT (dB/m)	CABLE LOSS (dB)	FIELD ST'GH (dBμV/m)	LIMIT (dBμV/m)
17.	138.400	52.4	Pk	31.5	12.5	1.9	35.3	66.0
18.	138.400	46.6	QP	31.5	12.5	1.9	29.5	46.0

A5 ac Power Line Conducted Emissions 15.207

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 on its lowest, centre and highest carrier frequency in turn. The formal measurements are detailed below:

Test Details: Unit in Tx mode hopping all channels	
Regulation	CFR 47 Part 15 Subpart (c) Clause 15.207
Measurement standard	ANSI C63.10:2009
Frequency range	150kHz to 30MHz
EUT sample number	TRA-011281S01, S02 and S03
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photograph 3

The worst case was with the supply voltage set at 305Vac

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

Results measured using the peak detector compared to the average limit

Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
1	0.185	Live	39.8	54.3	-14.5	Pass
2	0.228	Live	36.7	52.5	-15.8	Pass
3	1.131	Live	28.7	46.0	-17.3	Pass
4	1.439	Live	27.1	46.0	-18.9	Pass
5	2.300	Live	29.2	46.0	-16.8	Pass
6	27.682	Live	31.1	50.0	-18.9	Pass
7	0.185	Neutral	45.5	54.3	-8.8	Pass
8	0.228	Neutral	43.6	52.5	-8.9	Pass
9	1.131	Neutral	30.0	46.0	-16.0	Pass
10	1.439	Neutral	34.7	46.0	-11.3	Pass
11	2.300	Neutral	33.6	46.0	-12.4	Pass
12	27.682	Neutral	30.4	50.0	-19.6	Pass

Specification limits:

Conducted emission limits (CFR 47 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 :
- (c) When the average limit was met using the peak detector, the EUT was deemed to meet both the average detector and quasi-peak detector limits, and measurement with the average detector and quasi-peak detector was not required

	See 1)	See 2)	See 3)	See 4)
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		✓		
1) Parameter defined by standard and / or single possible. 2) Parameter defined by client and / or single possible. 3) Parameter had a negligible effect on emission levels. 4) Worst case determined by initial measurement.				

A6 ac Power Line Conducted Emissions 15.107

Preview ac power line port 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) below.

Where applicable formal measurements of the emissions were performed with a peak, average and/or quasi peak detector. The formal measurements are detailed below:

Test Details: Device in Receive mode	
Regulation	Title 47 of the CFR:2010, Part 15 Subpart (b)
Measurement standard	ANSI C63.4:2009
Class	B – refer to specification limit table below.
Frequency range	150kHz to 30MHz
EUT sample number	TRA-011281S01, S02 and S03
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs	Photograph 3

The worst case was with the supply voltage set at 305Vac

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

Results measured using the peak detector compared to the average limit

Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
1	0.173	Live	44.0	54.8	-10.8	Pass
2	0.185	Live	45.5	54.3	-8.8	Pass
3	0.381	Live	38.1	48.3	-10.2	Pass
4	0.600	Live	34.0	46.0	-12.0	Pass
5	1.200	Live	28.2	46.0	-17.8	Pass
6	27.519	Live	28.9	50.0	-21.1	Pass
7	0.173	Neutral	47.1	54.8	-7.7	Pass
8	0.185	Neutral	46.0	54.3	-8.3	Pass
9	0.381	Neutral	38.4	48.3	-9.9	Pass
10	0.600	Neutral	36.2	46.0	-9.8	Pass
11	1.200	Neutral	33.5	46.0	-12.5	Pass
12	27.519	Neutral	27.6	50.0	-22.4	Pass

Specification limits :

ac power port conducted emission limits (47 CFR 15 Clause 15.107):

Conducted disturbance at the ac power line ports of Class B information technology equipment.

Frequency range MHz	Limits dB μ V	
	Quasi-peak	Average
0.15 to 0.5	66 to 56	56 to 46
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 :
- (c) When the average limit was met using the peak detector, the EUT was deemed to meet both the average detector and quasi-peak detector limits and measurement with the average detector and quasi-peak detector was not required

	See 1)	See 2)	See 3)	See 4)
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	✓			
1) Parameter defined by standard and / or single possible. 2) Parameter defined by client and / or single possible. 3) Parameter had a negligible effect on emission levels. 4) Worst case determined by initial measurement.				

A7 20 dB Bandwidth and Channel Spacing

Title 47 of the CFR: Part 15 Subpart (c) 15.247(a)(1)(i) requires the measurement of the bandwidth of the transmission between the -20 dB points on the transmitted spectrum. The results of this test determine the limits for channel spacing. The channel separation shall be a minimum of 25 kHz or the 20 dB bandwidth, whichever is the greater. The formal measurements are detailed below:

Test Details:	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) 15.247(a)(1)(i)
EUT sample number	TRA-011281S01, S02 and S07
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C

905.20MHz	FL (MHz)	FH (MHz)	Measured 20 dB Bandwidth (kHz)	Result
	905.1906750	905.209350	18.675	N/A

910.47MHz	FL (MHz)	FH (MHz)	Measured 20 dB Bandwidth (kHz)	Result
	910.460650	910.47940	18.750	N/A

915.91MHz	FL (MHz)	FH (MHz)	Measured 20 dB Bandwidth (kHz)	Result
	915.900710897	915.919535897	18.825	N/A

Measured Channel Spacing (kHz)	Limit	Result
169.615	(25kHz or $\geq$ Measured 20 dB Bandwidth kHz)	Pass

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

A8 Hopping frequencies

Hopping frequencies were verified using a spectrum analyser, while the EUT was operating in its normal frequency hopping mode.

Test Details:	
Regulation	Title 47 of the CFR : Part 15 Subpart (c) 15.247(a)(1)(i)
EUT sample number	TRA-011281S01, S02 and S07
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C

No. of Hopping Channels	Requirement	Result
64	For frequency hopping systems operating in the 902-928MHz band: The system shall use a minimum 50 hopping frequencies	Pass

Plots showing the hopping channels are contained in Appendix B

A9 Channel Occupancy

Channel occupancy time was verified using a spectrum analyser in zero span mode, centred on the middle hopping channel frequency (910.47MHz), while the EUT was operating in its normal frequency hopping mode. The other channels were then verified to ensure that the channel occupancy was identical for all channels.

Test Details:	
Regulation	Title 47 of the CFR : Part 15 Subpart (c) 15.247(a)(1)(i)
EUT sample number	TRA-011281S01, S02 and S07
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Packet Width(ms)
91.98

Plots showing the channel occupancy time are contained in Appendix B of this test report.

Please note that the client has declared compliance to Title 47 of the CFR : Part 15 Subpart (c) 15.247(a)(1)(i). Please refer to Appendix D of this test report.

A10 Antenna Gain

The antenna gain was determined by subtracting the maximum radiated carrier power (EIRP) – conducted carrier power.

Frequency (MHz) 905.2MHz

EIRP = equivalent (or effective) isotropically radiated power (dBm) = 17.34

Conducted carrier power = 14.56dBm

Calculated gain = 2.78dBi

Appendix B:

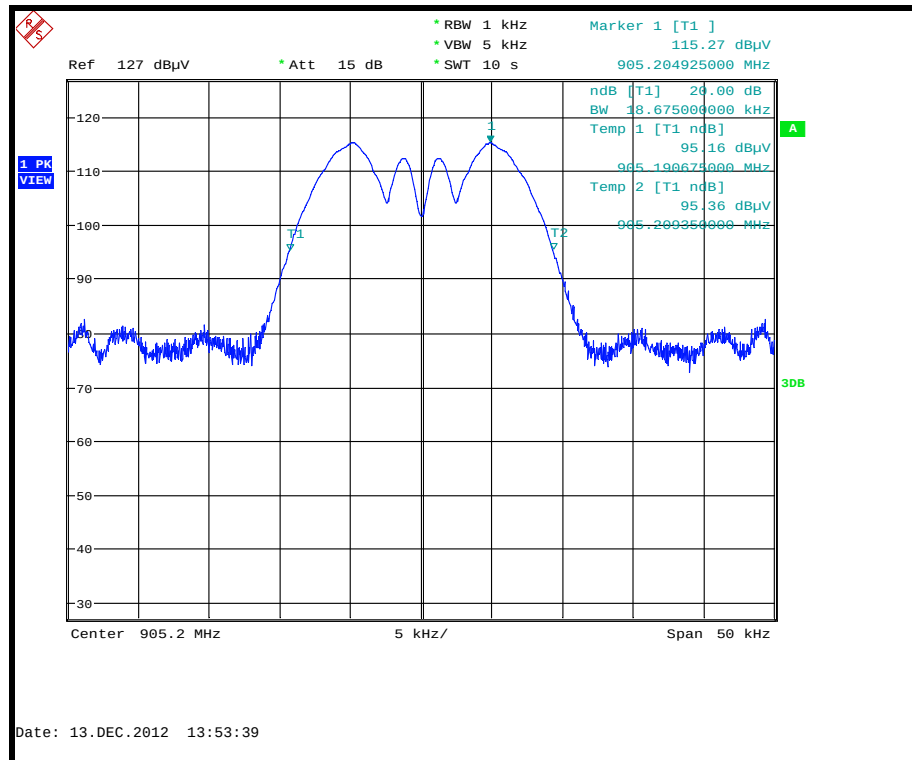
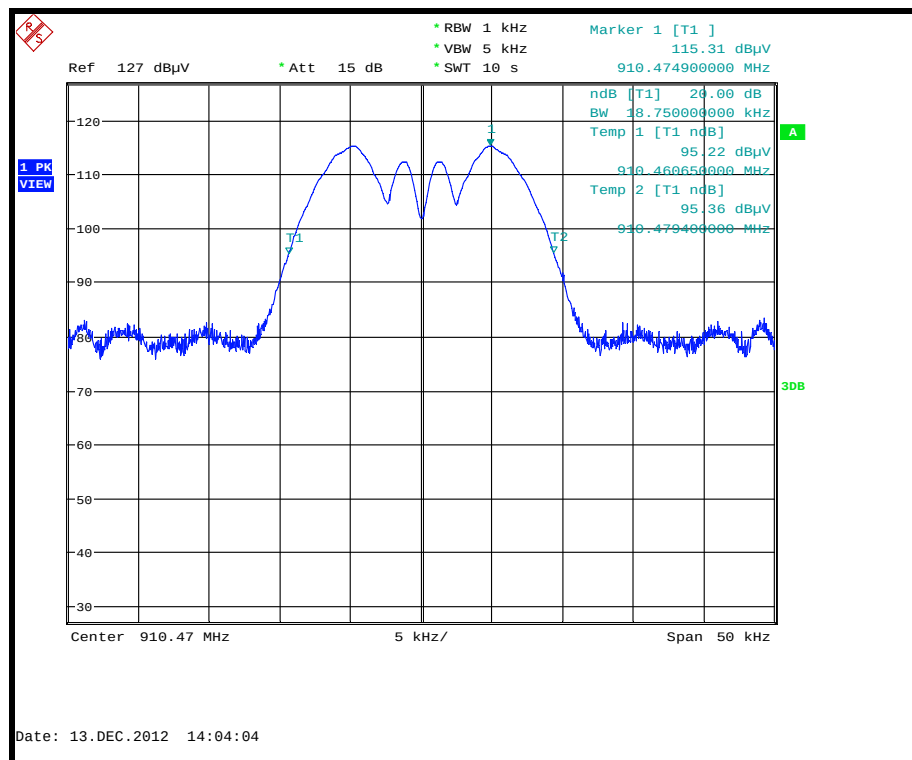
Supporting Graphical Data

This appendix contains graphical data obtained during testing.

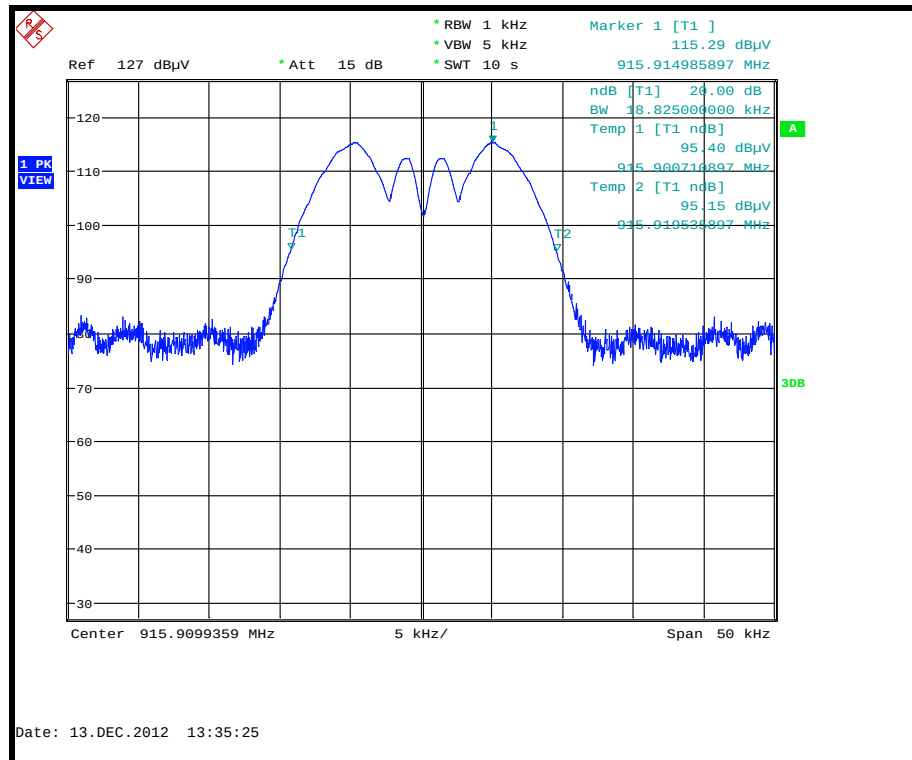
Notes:

- (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 Plots

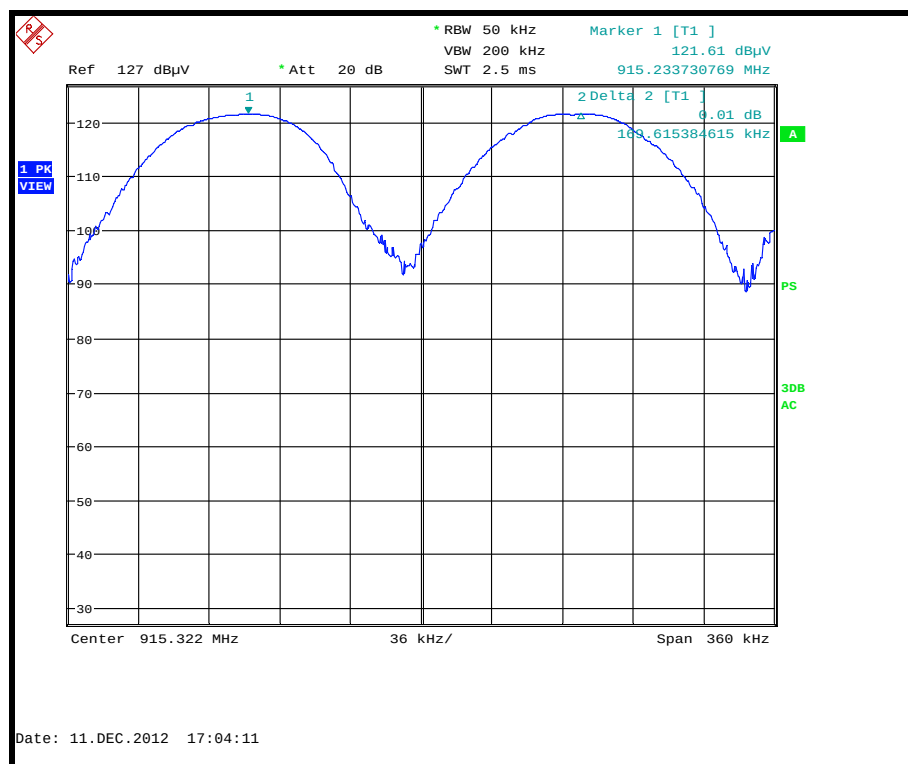
**20dB Bandwidth Bottom Channel 905.20MHz****20dB Bandwidth Middle Channel 910.47MHz**

20dB Bandwidth Plots continued:

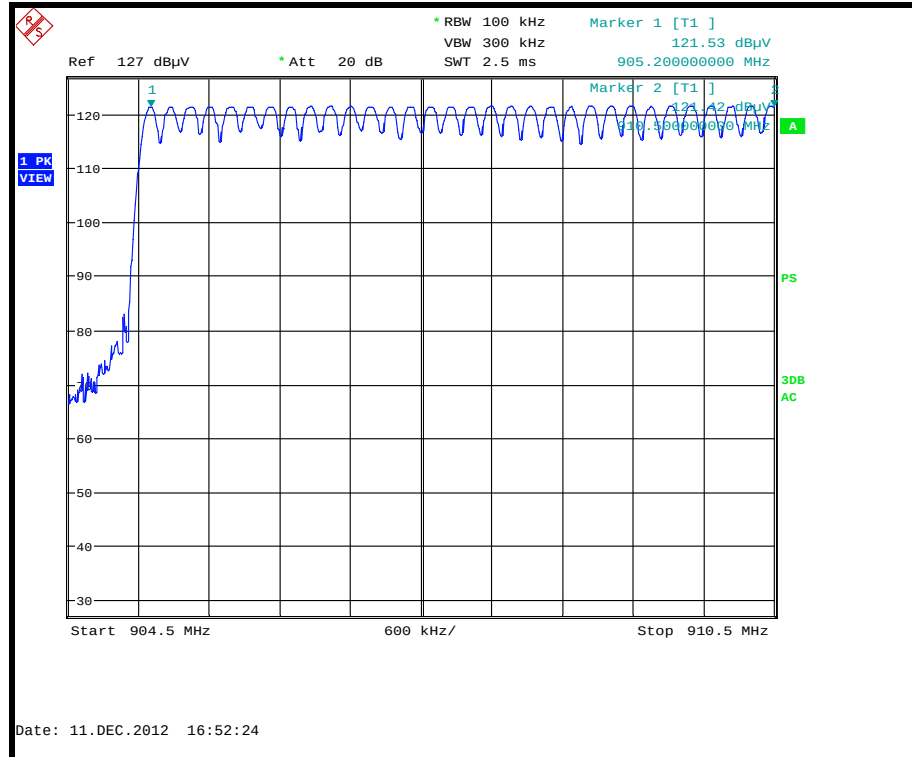


20dB Bandwidth Top Channel 915.91MHz

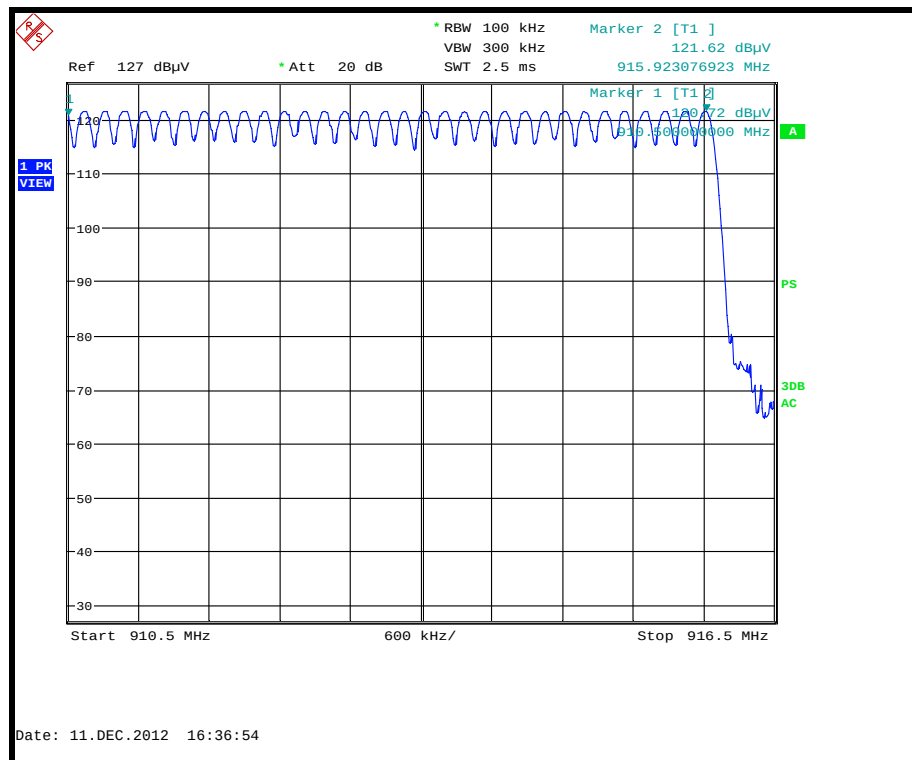
Channel Spacing Plot



Hopping Channels Plots

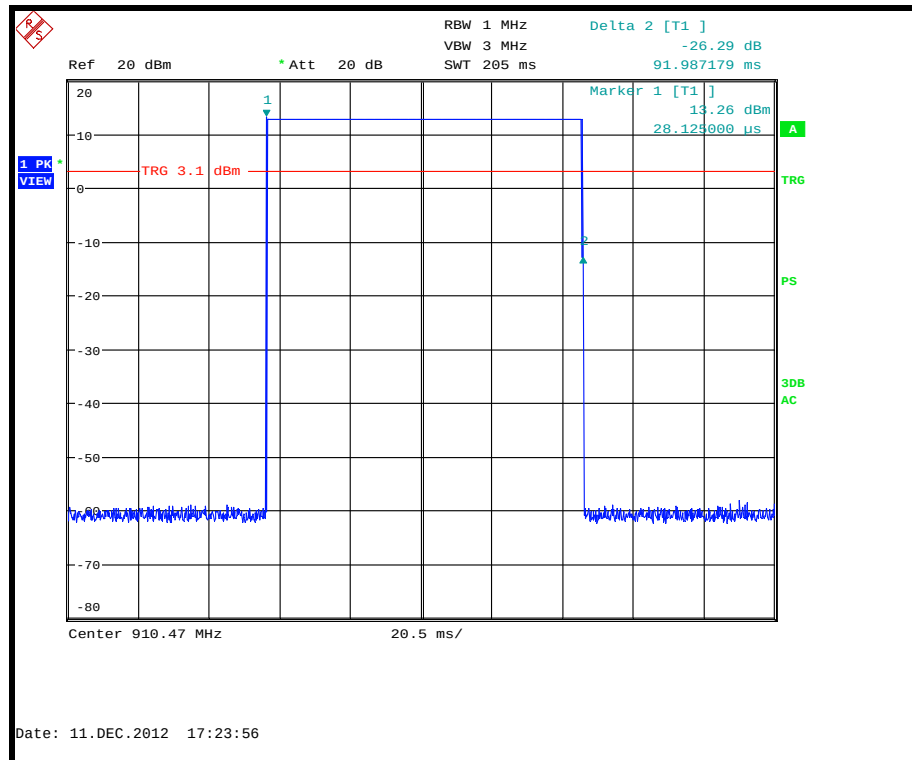


Number of Hopping Channels: 0-31



Number of Hopping Channels: 32 to 63

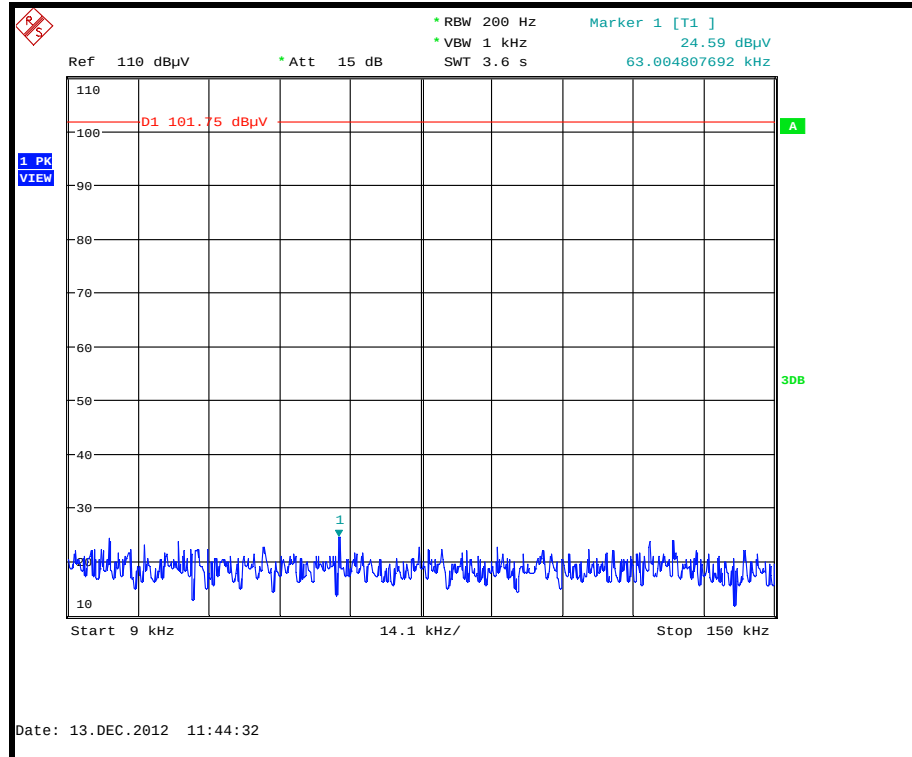
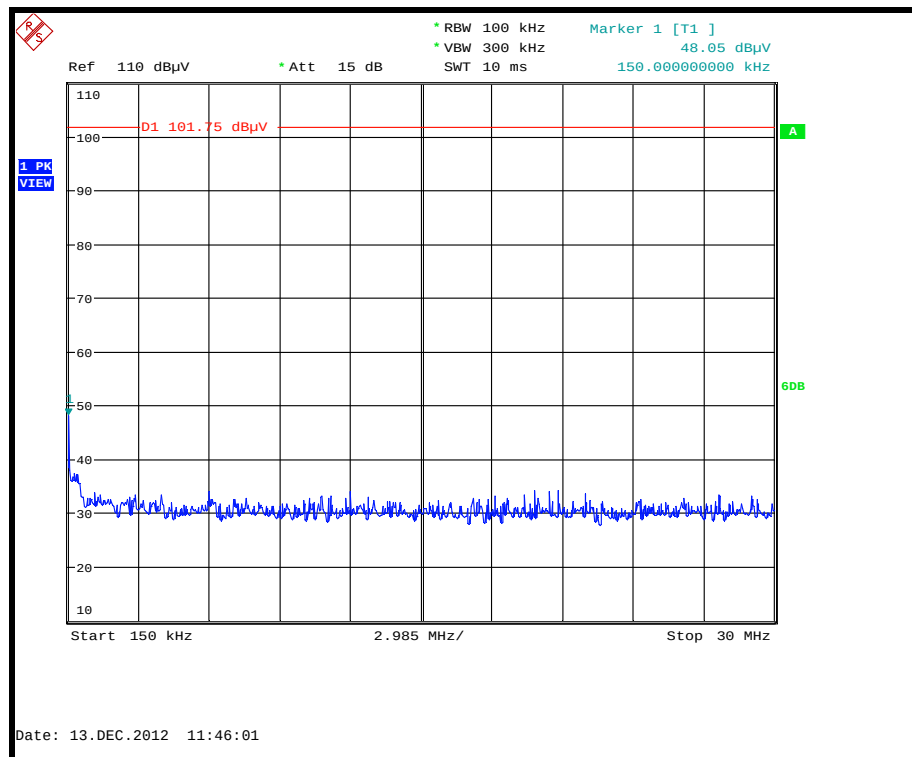
Channel Occupancy Time Plot

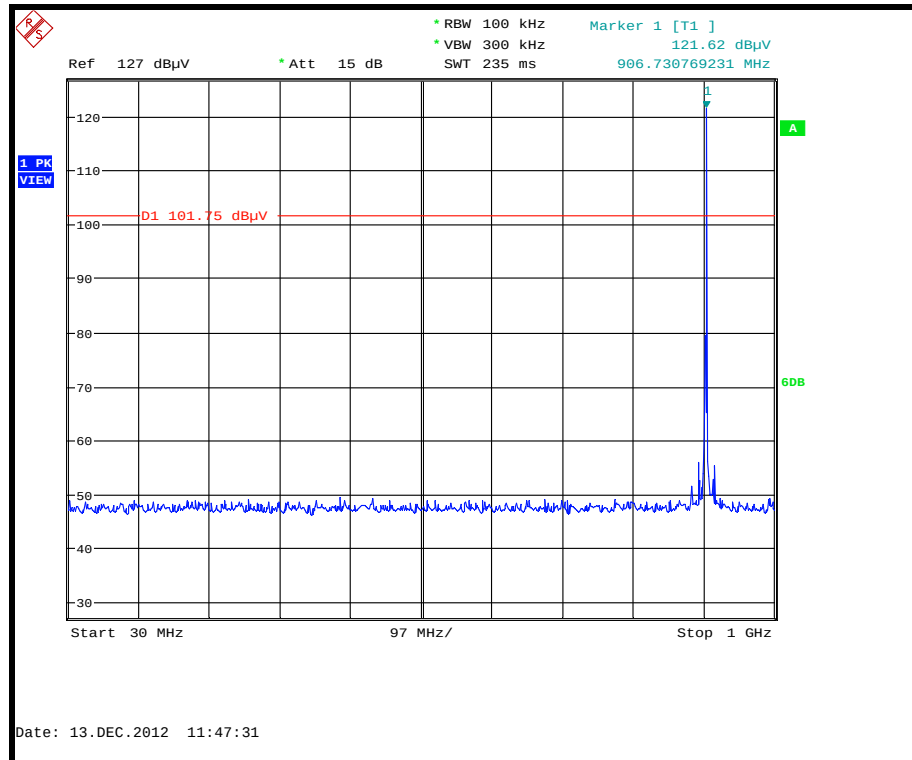
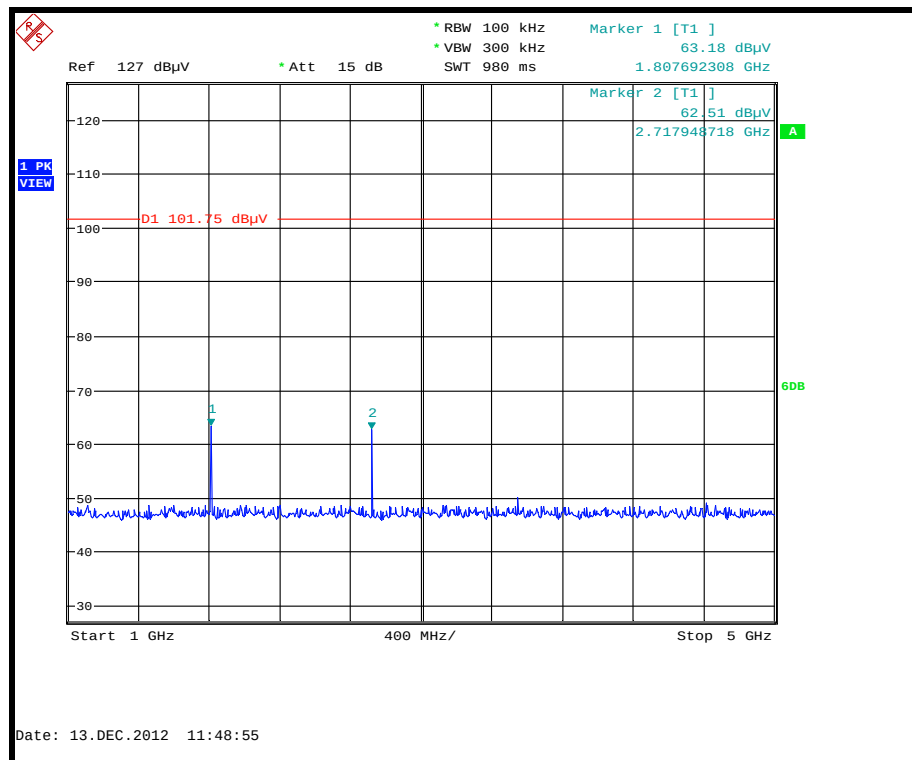


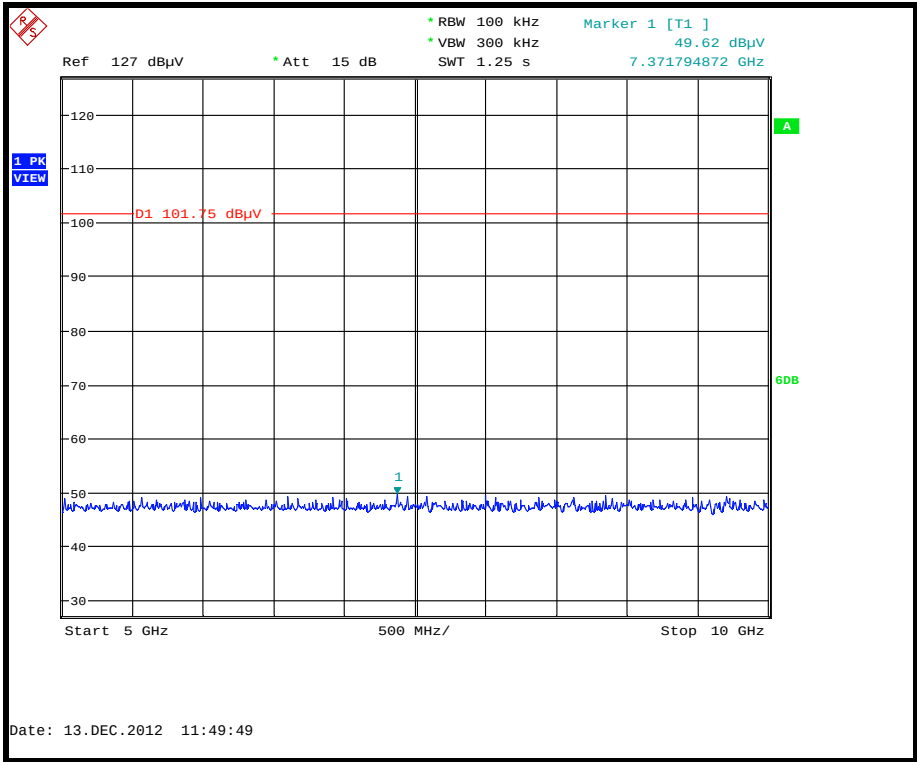
Channel Occupancy Time

Channel Repetition Time: See Client declaration in Annex D

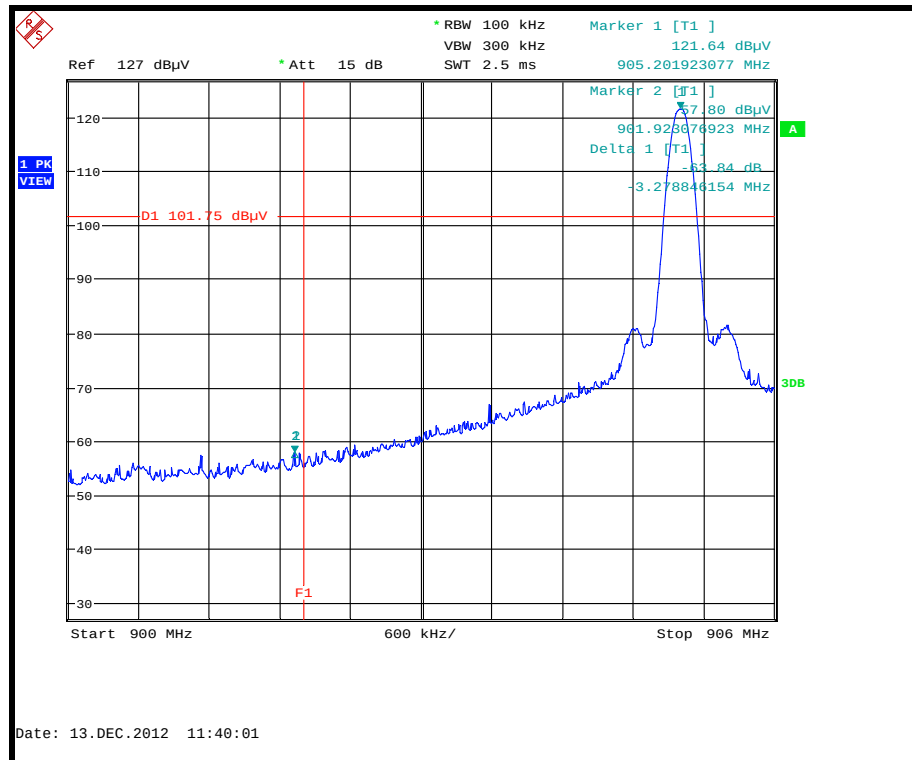
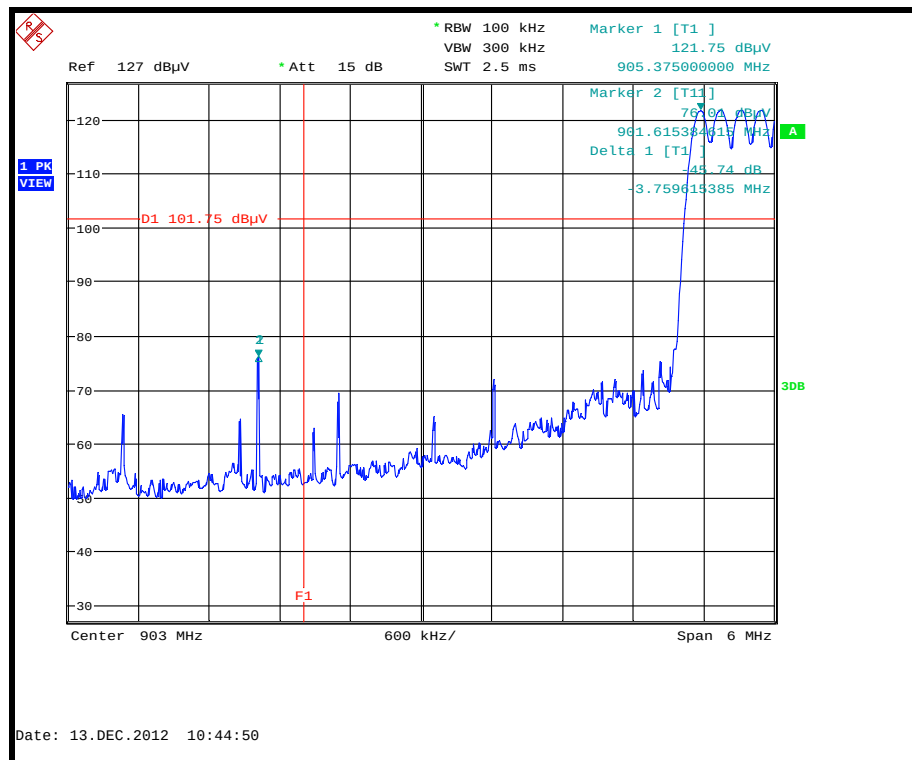
Conducted Emissions Plots

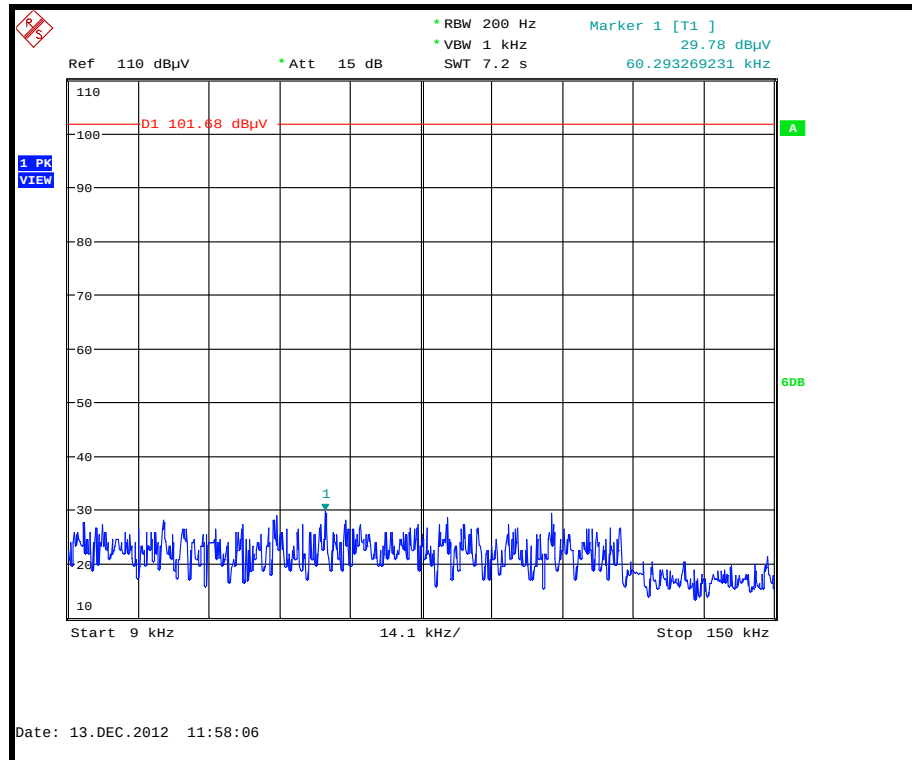
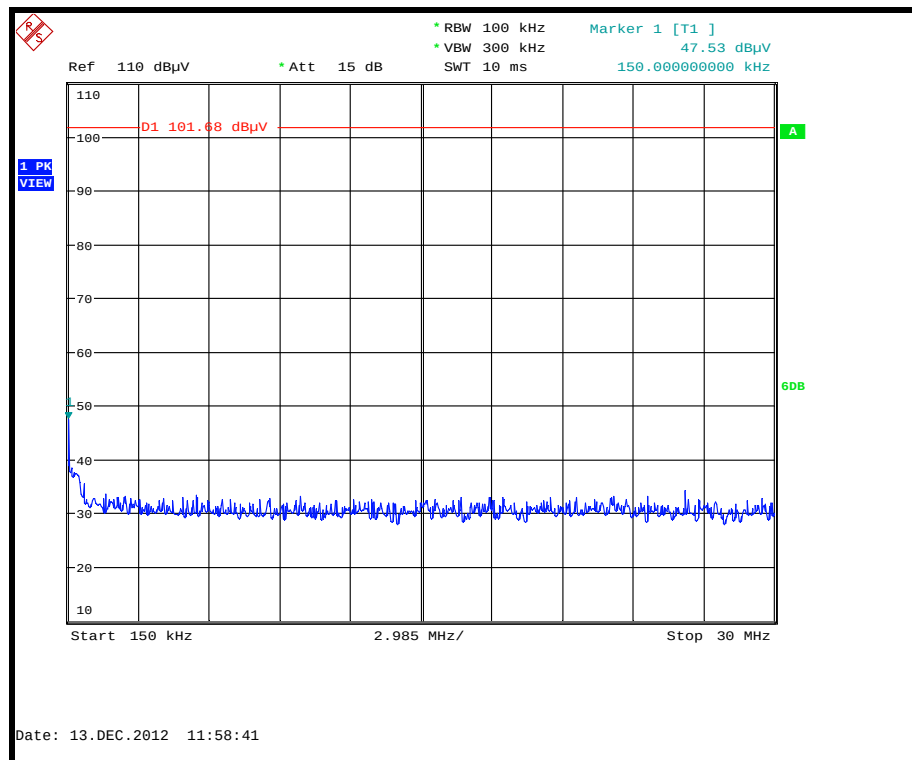
**Conducted Emissions: 9kHz to 150kHz Bottom Channel 0 905.2MHz****Conducted Emissions: 150kHz to 30MHz Bottom Channel 0 905.2MHz**

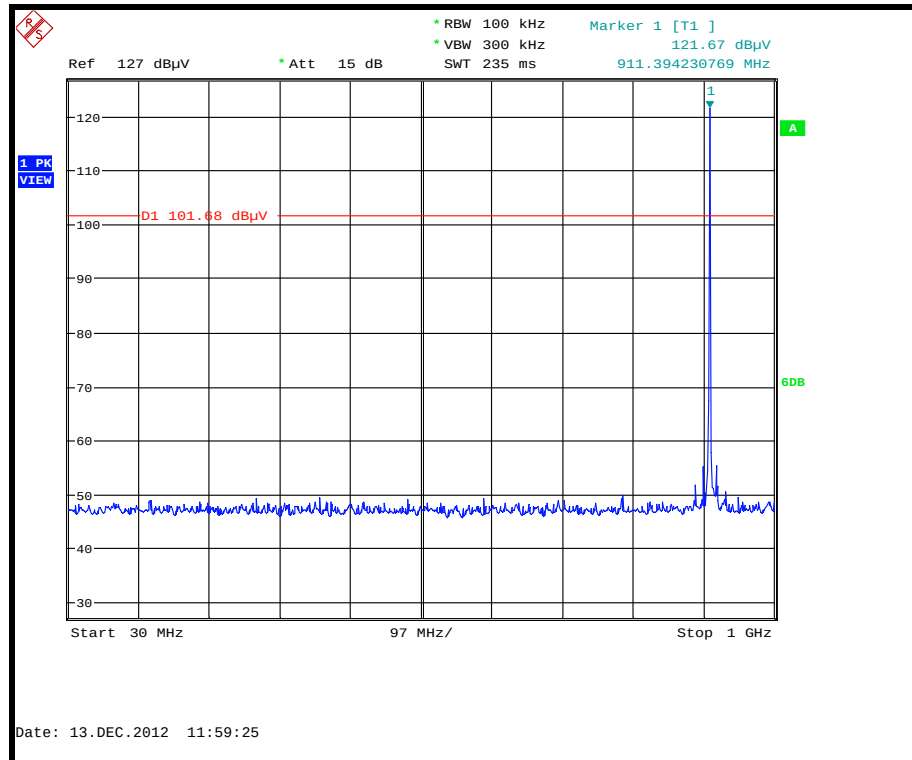
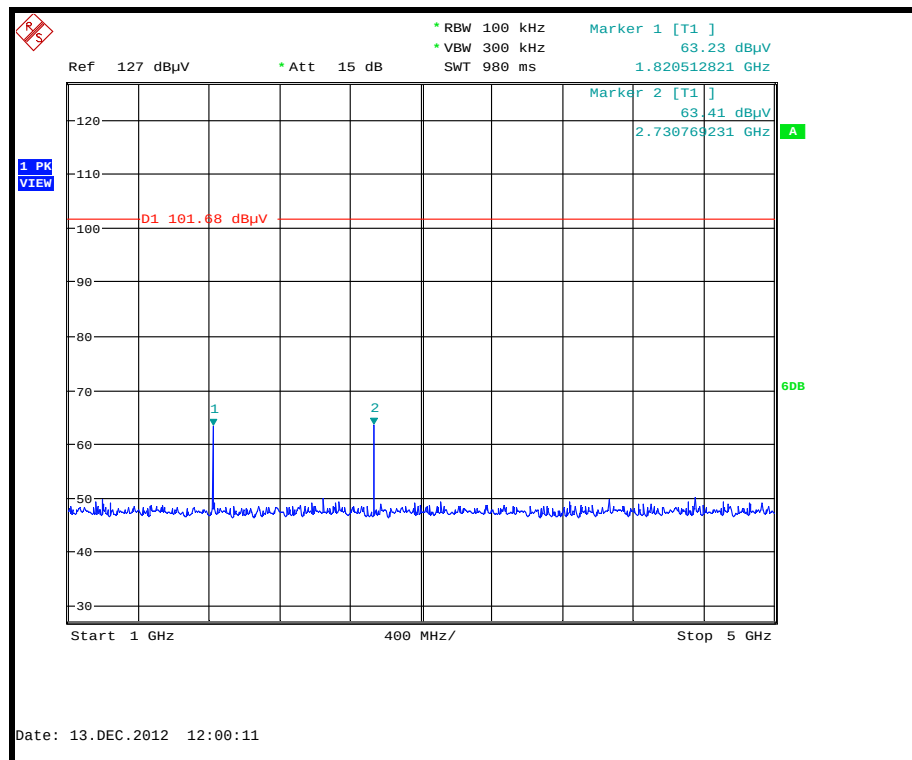
**Conducted Emissions: 30MHz to 1GHz Bottom Channel 0 905.2MHz****Conducted Emissions: 1GHz to 5GHz Bottom Channel 0 905.2MHz**

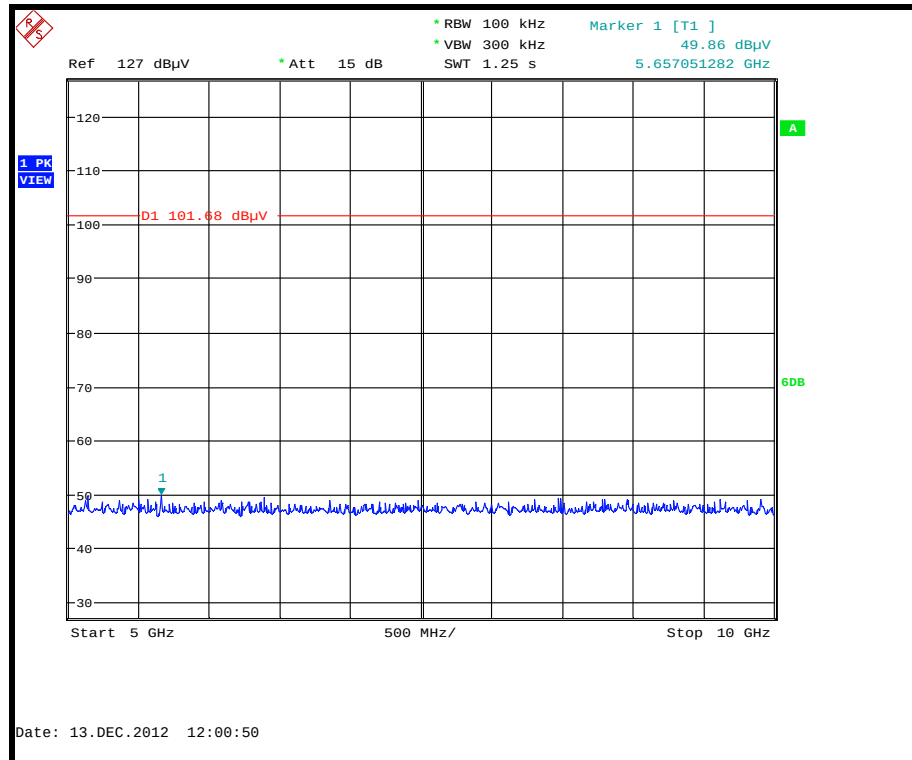
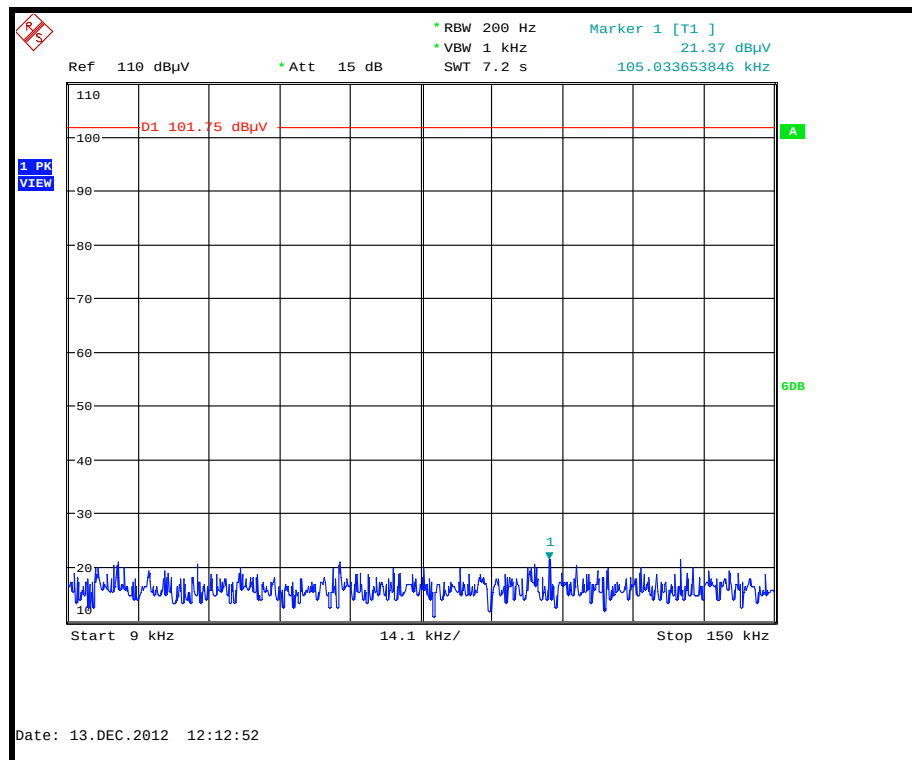


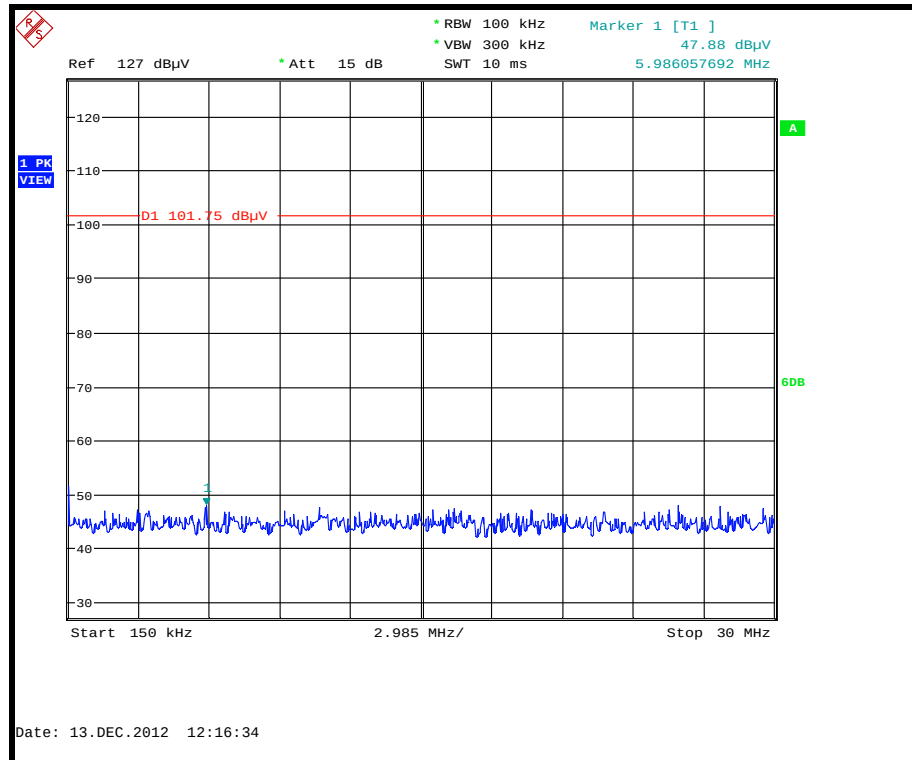
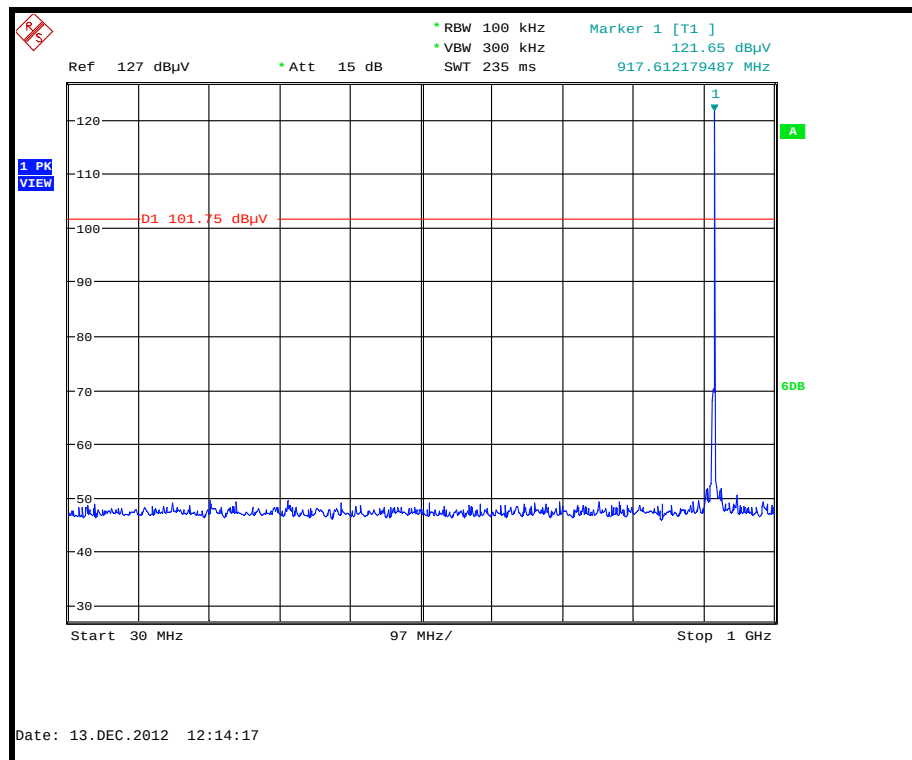
Conducted Emissions: 5GHz to 10GHz Bottom Channel 0 905.2MHz

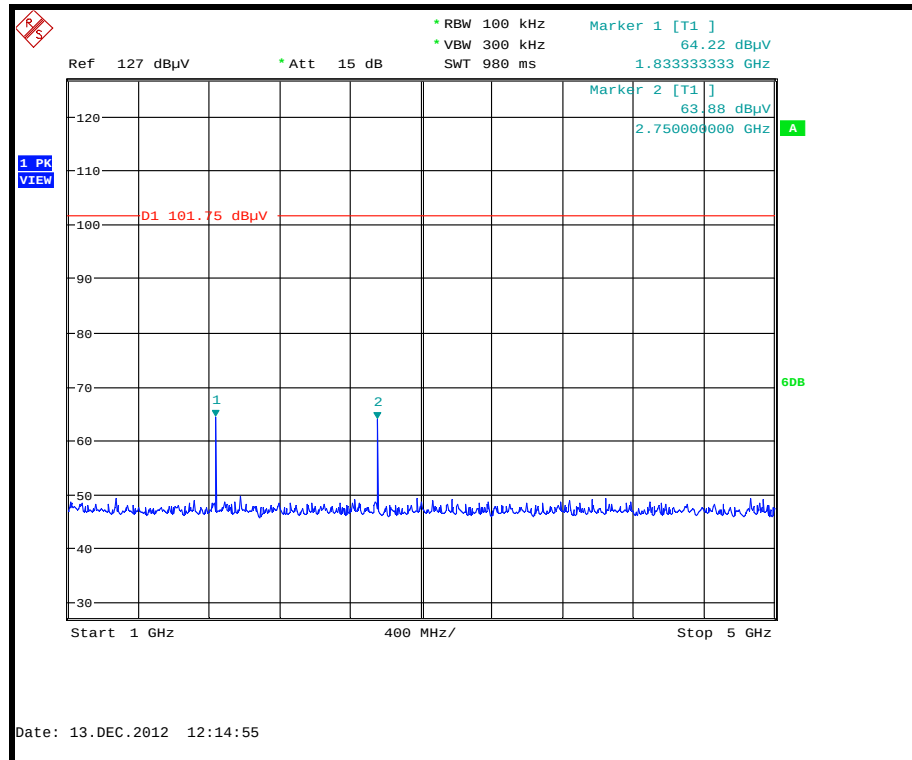
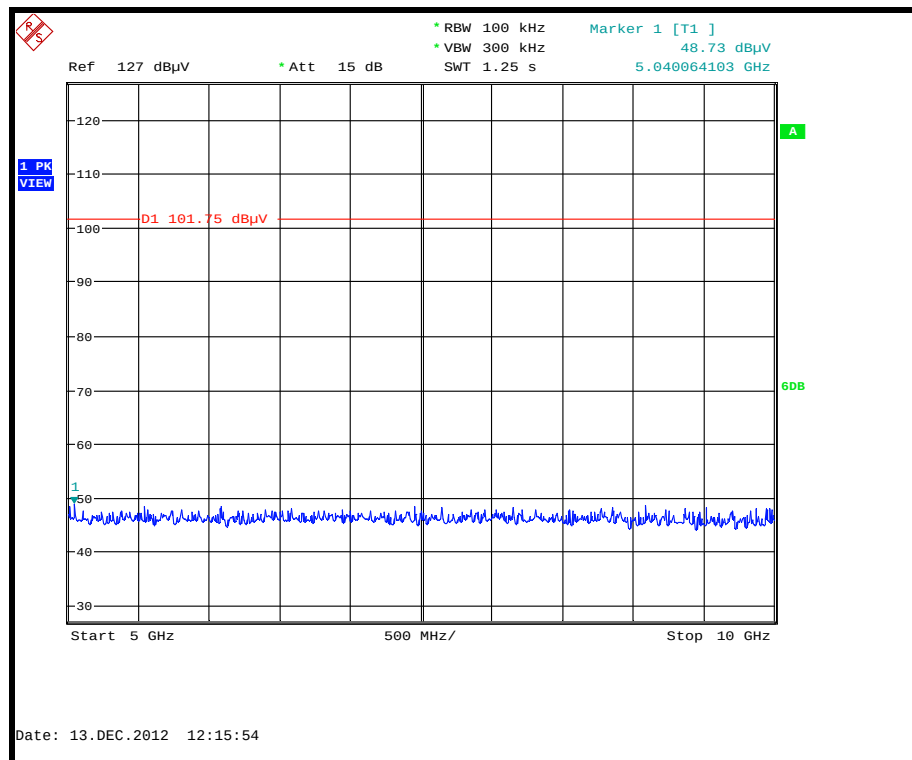
**Conducted Lower Band-edge Compliance: Channel 0 905.2MHz Non-hopping****Conducted Lower Band-edge Compliance: Channel 0 905.2MHz Hopping**

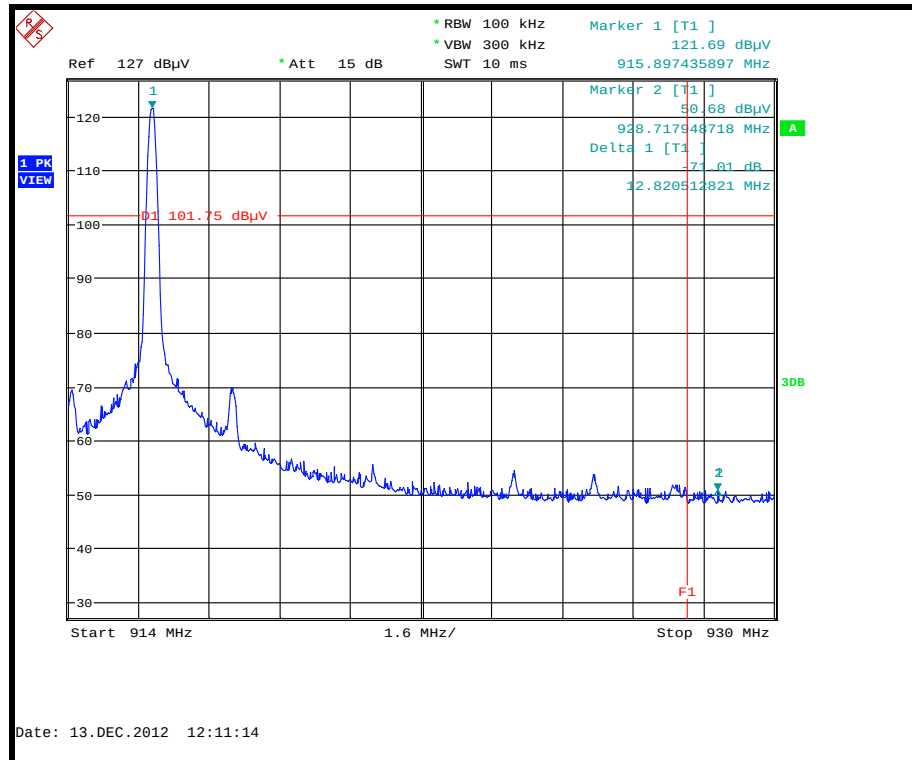
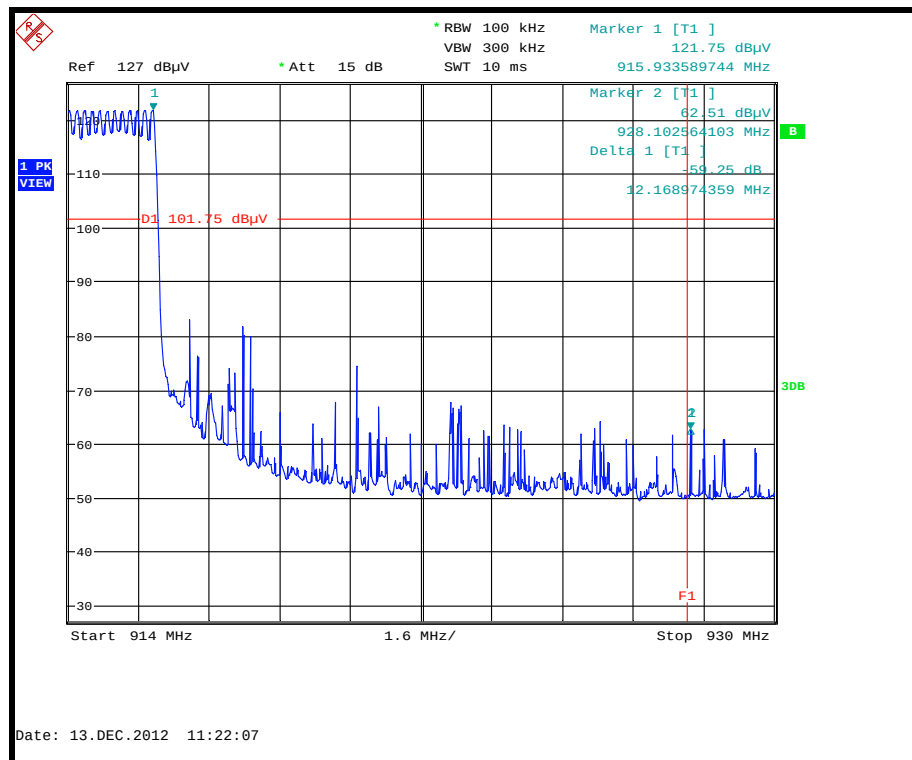
**Conducted Emissions: 9kHz to 150kHz Middle Channel 31 910.47MHz****Conducted Emissions: 150kHz to 30MHz Middle Channel 31 910.47MHz**

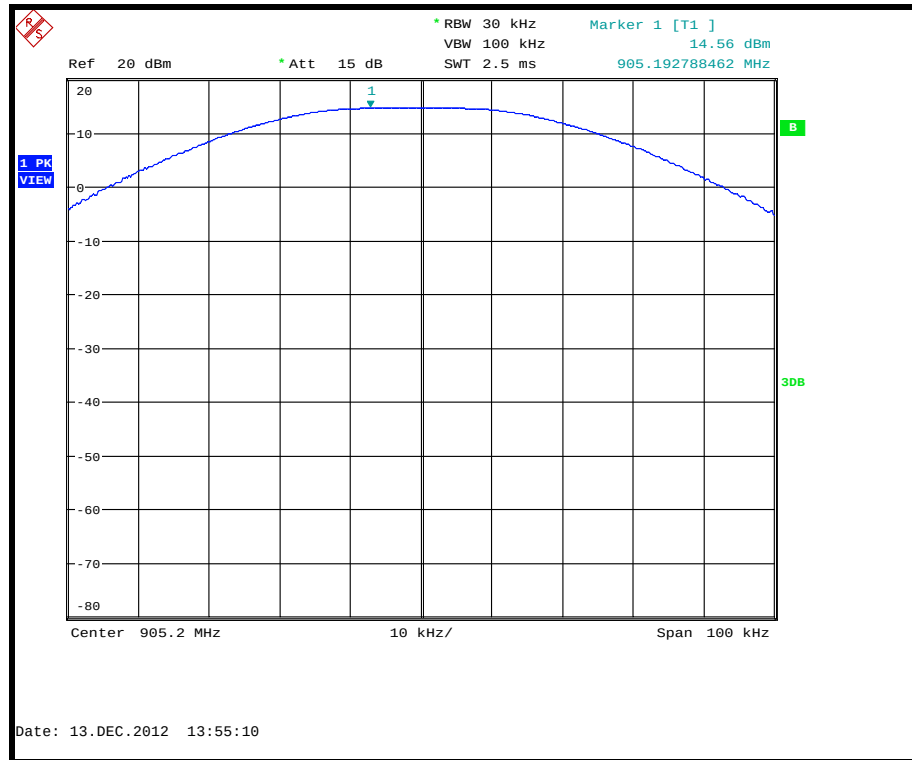
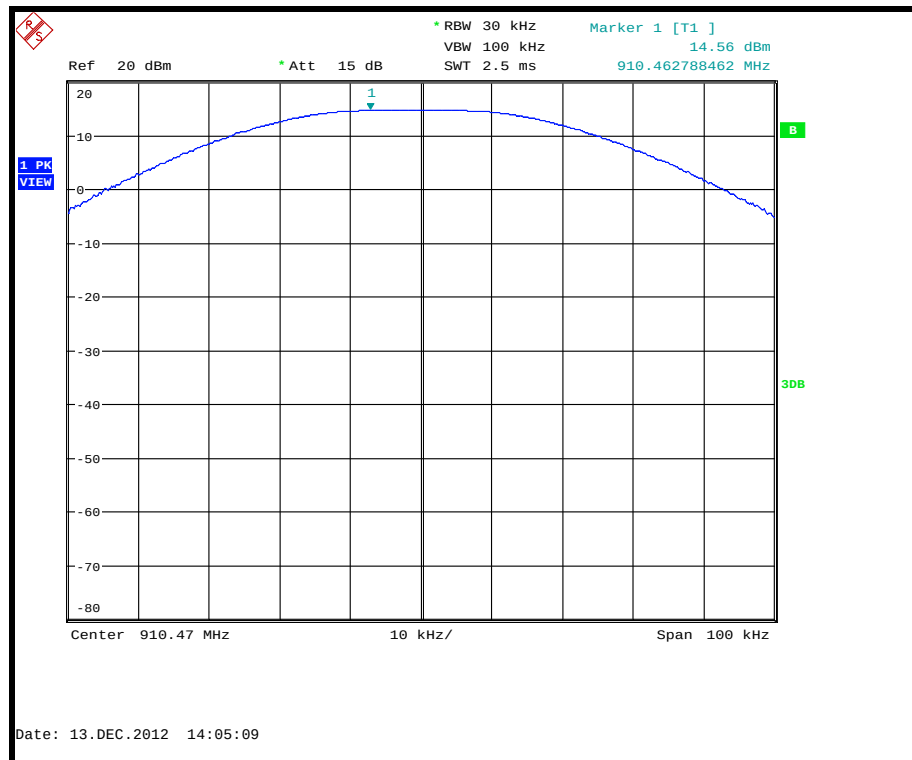
**Conducted Emissions: 30MHz to 1GHz Middle Channel 31 910.47MHz****Conducted Emissions: 1GHz to 5GHz Middle Channel 31 910.47MHz**

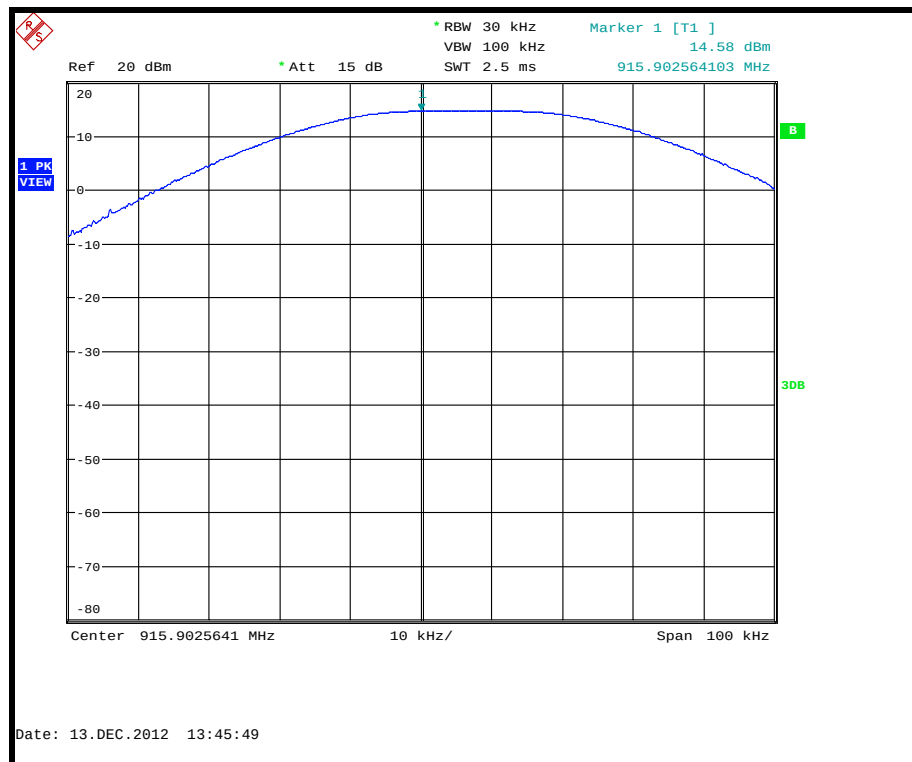
**Conducted Emissions: 5GHz to 10GHz Middle Channel 31 910.47MHz****Conducted Emissions: 9kHz to 150kHz Top Channel 63 915.19MHz**

**Conducted Emissions: 150kHz to 30MHz Top Channel 63 915.19MHz****Conducted Emissions: 30MHz to 1GHz Top Channel 63 915.19MHz**

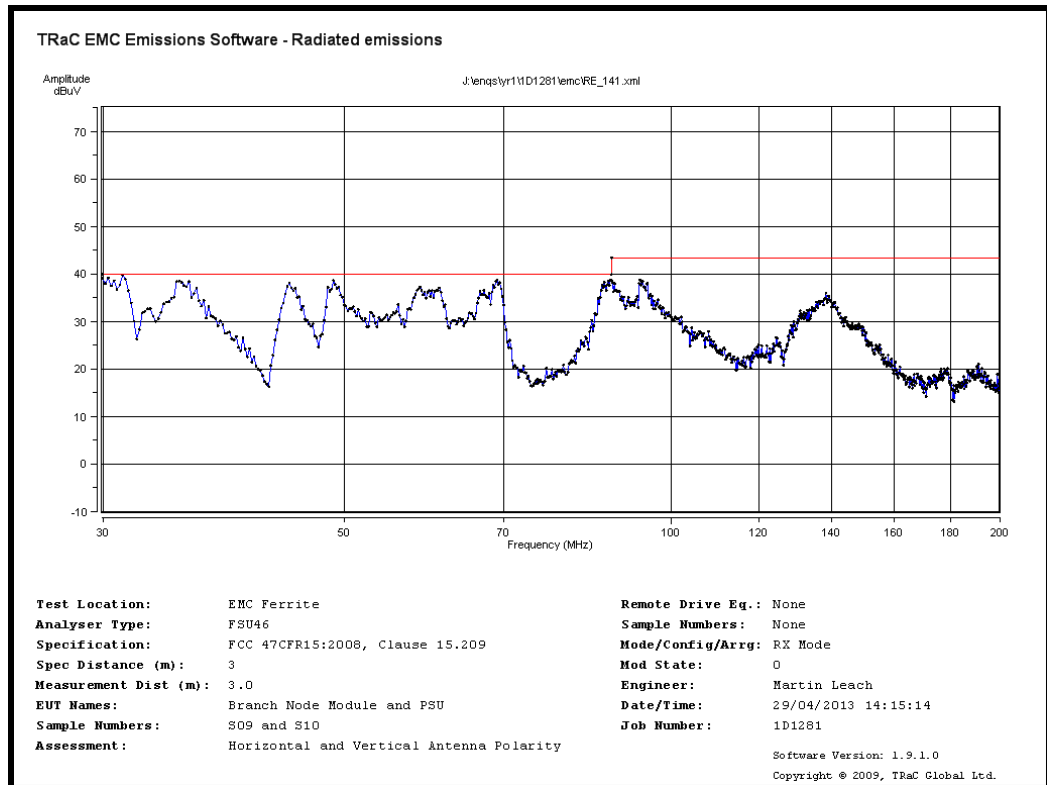
**Conducted Emissions: 1GHz to 5GHz Top Channel 63 915.19MHz****Conducted Emissions: 5GHz to 10GHz Top Channel 63 915.19MHz**

**Conducted Upper Band-edge Compliance: Channel 63 915.19MHz Non-hopping****Conducted Upper Band-edge Compliance: Channel 63 915.19MHz Hopping**

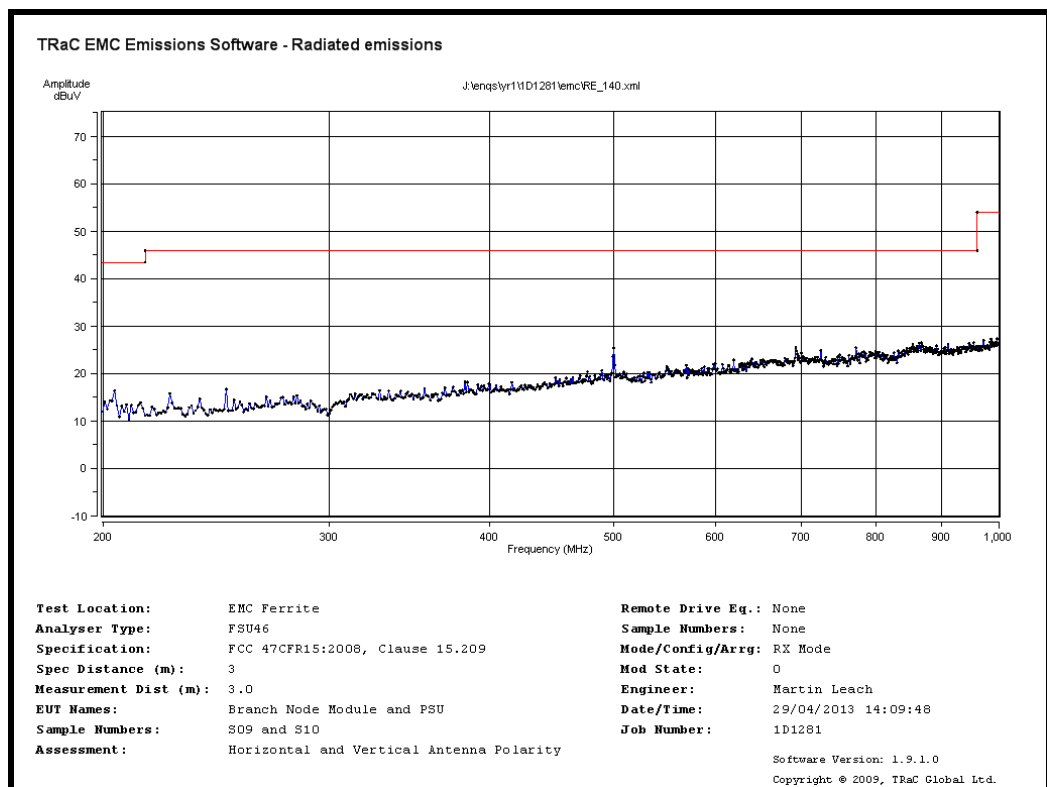
Conducted Carrier Power**Conducted Carrier Power Bottom: Channel 0 905.2MHz****Conducted Carrier Power Middle: Channel 31 910.47MHz**

Conducted Carrier Power continued**Conducted Carrier Power: Top Channel 63 915.19MHz**

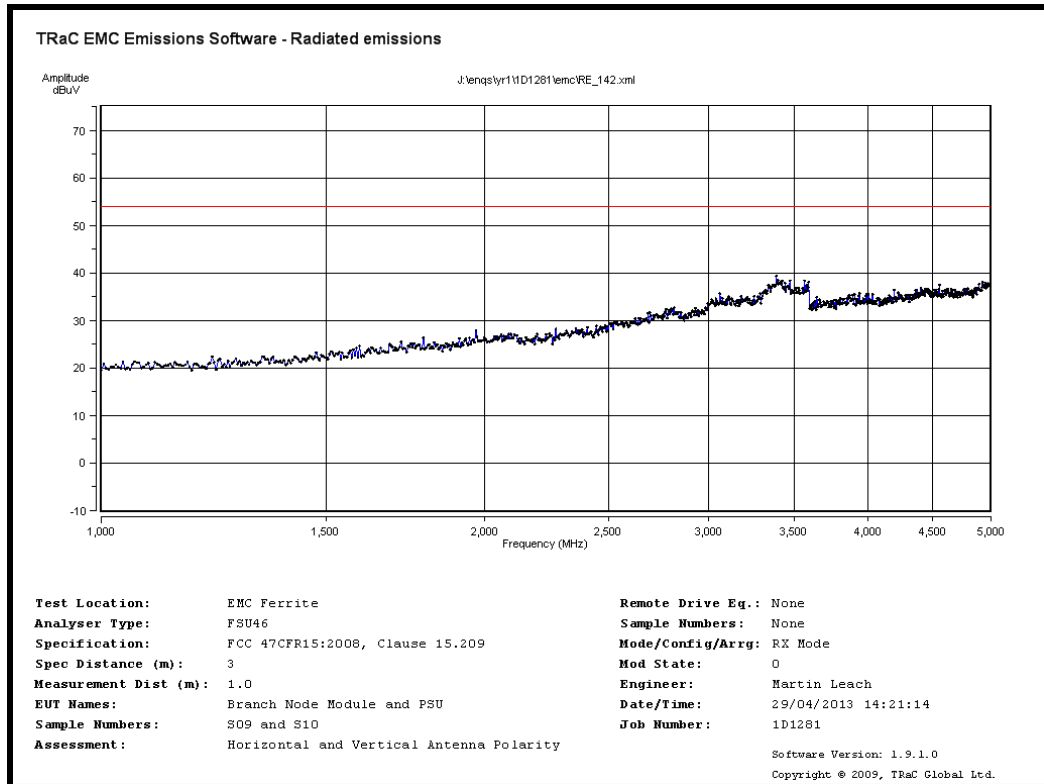
Preview Radiated Spurious emissions/receive mode (15.109)



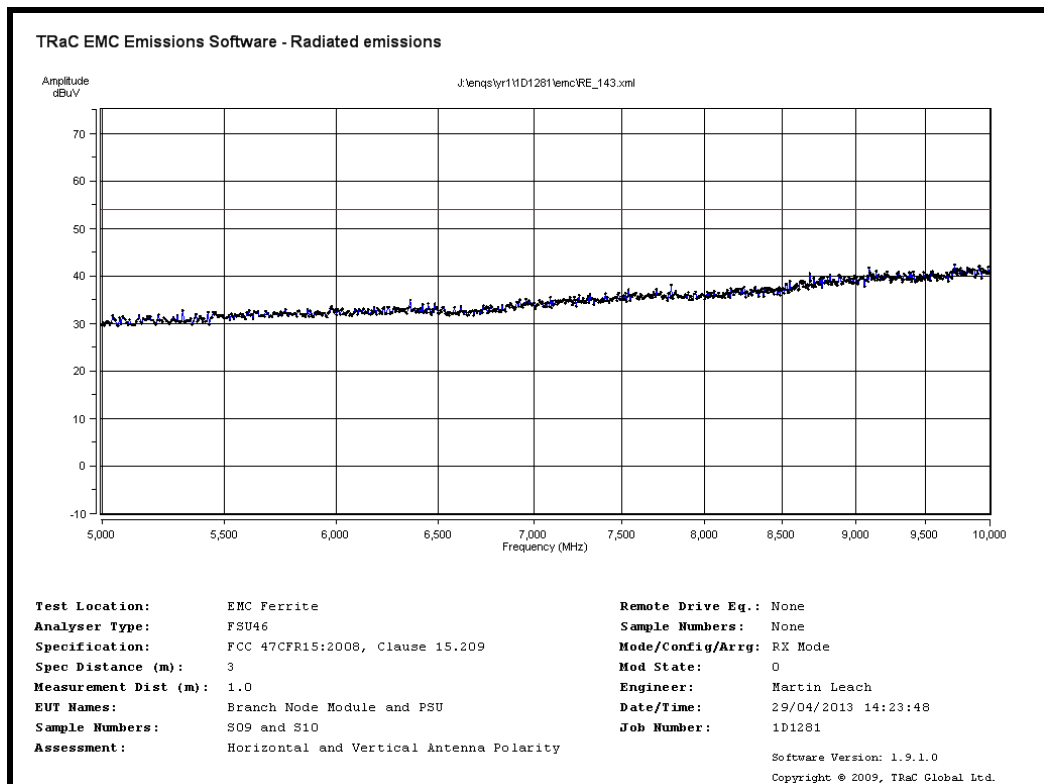
Radiated RX Mode Emissions (15.109)



Radiated RX Mode Emissions (15.109)

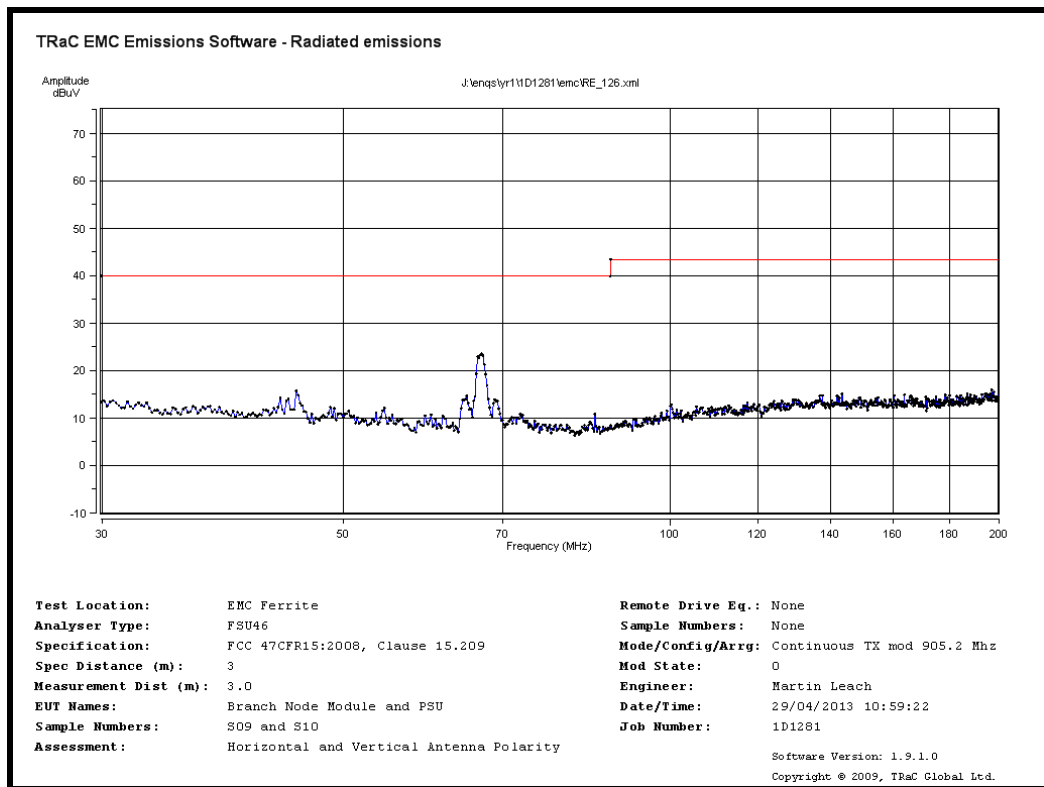


Radiated RX Mode Emissions (15.109)

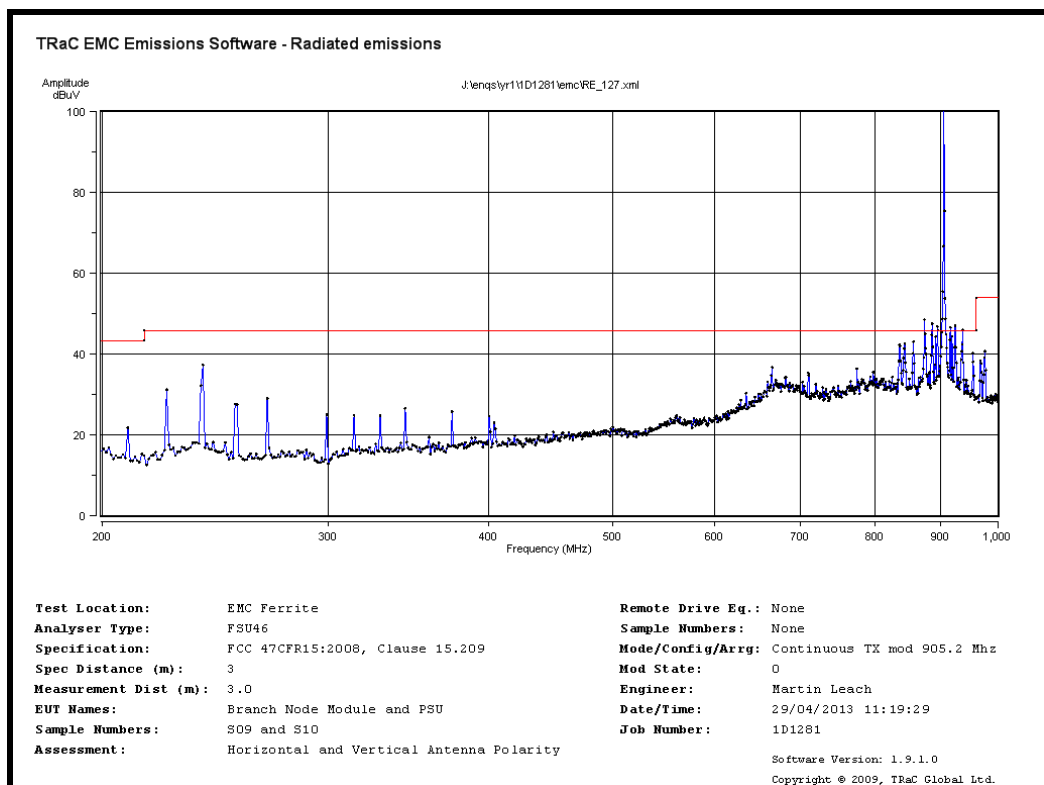


Radiated RX Mode Emissions (15.109)

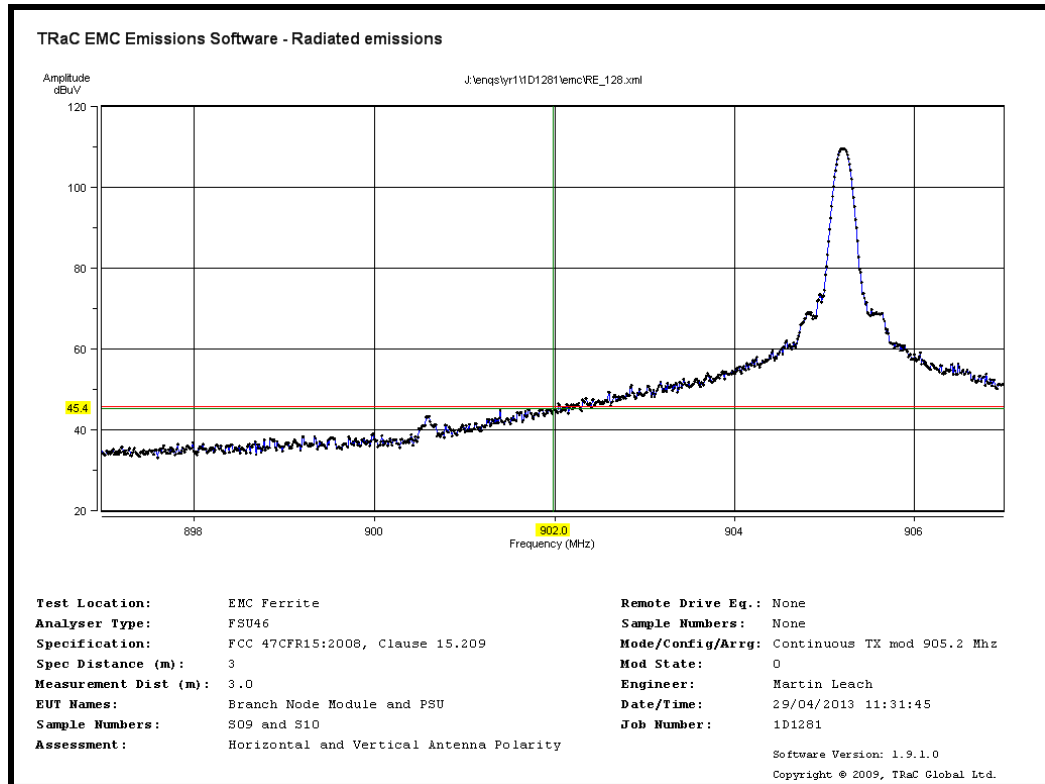
Preview Radiated Transmitter Spurious emissions (UHF radio module) (15.209)



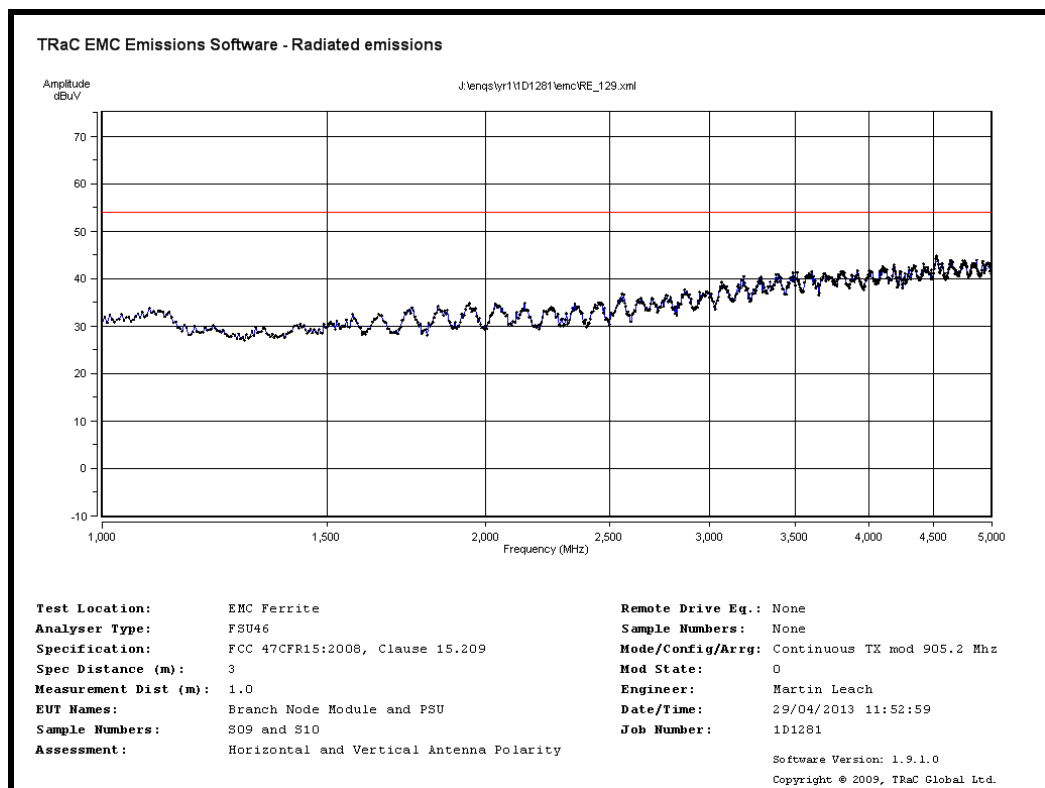
Radiated Transmitter Emissions UHF Radio only Channel 0 905.2MHz (15.209)



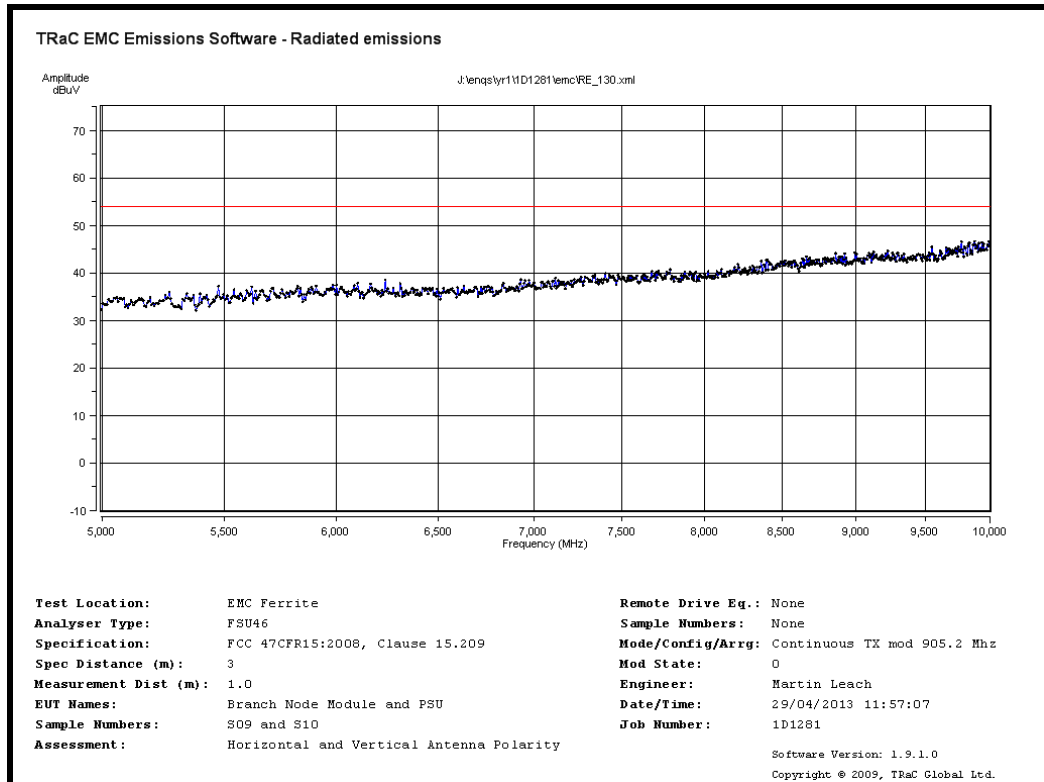
Radiated Transmitter Emissions UHF Radio only Channel 0 905.2MHz (15.209)



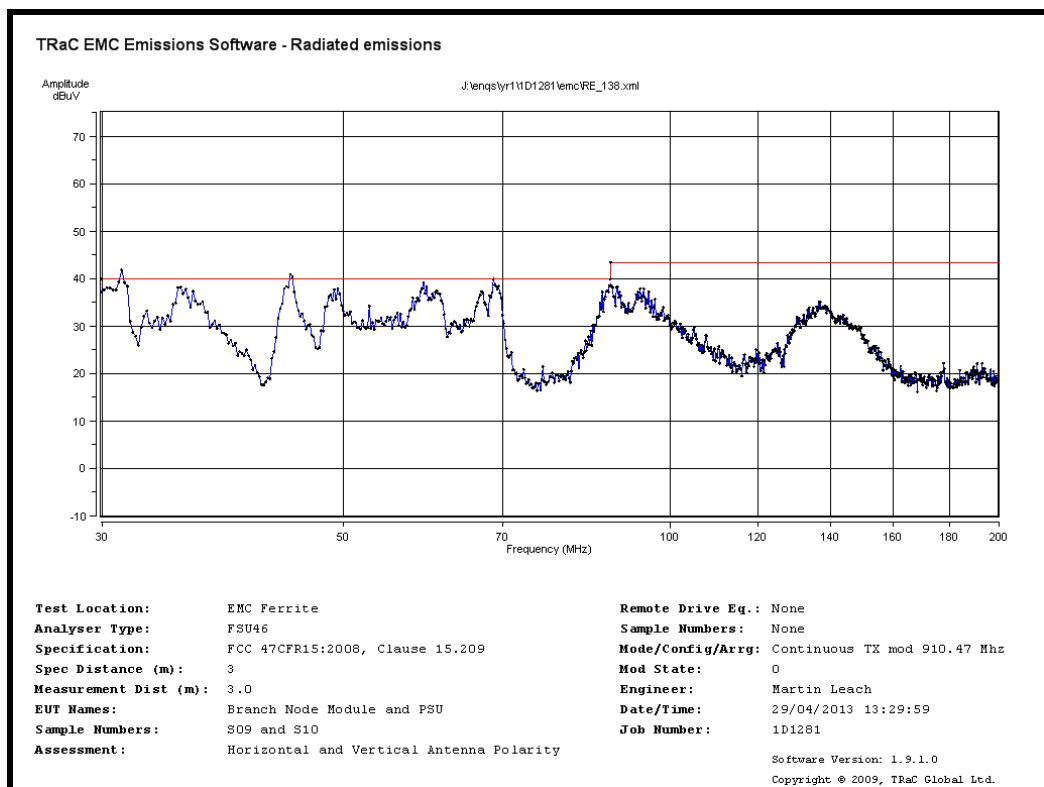
Radiated Transmitter Emissions UHF Radio only Channel 0 905.2MHz (15.209) Lower Band Edge Compliance RBW 100kHz



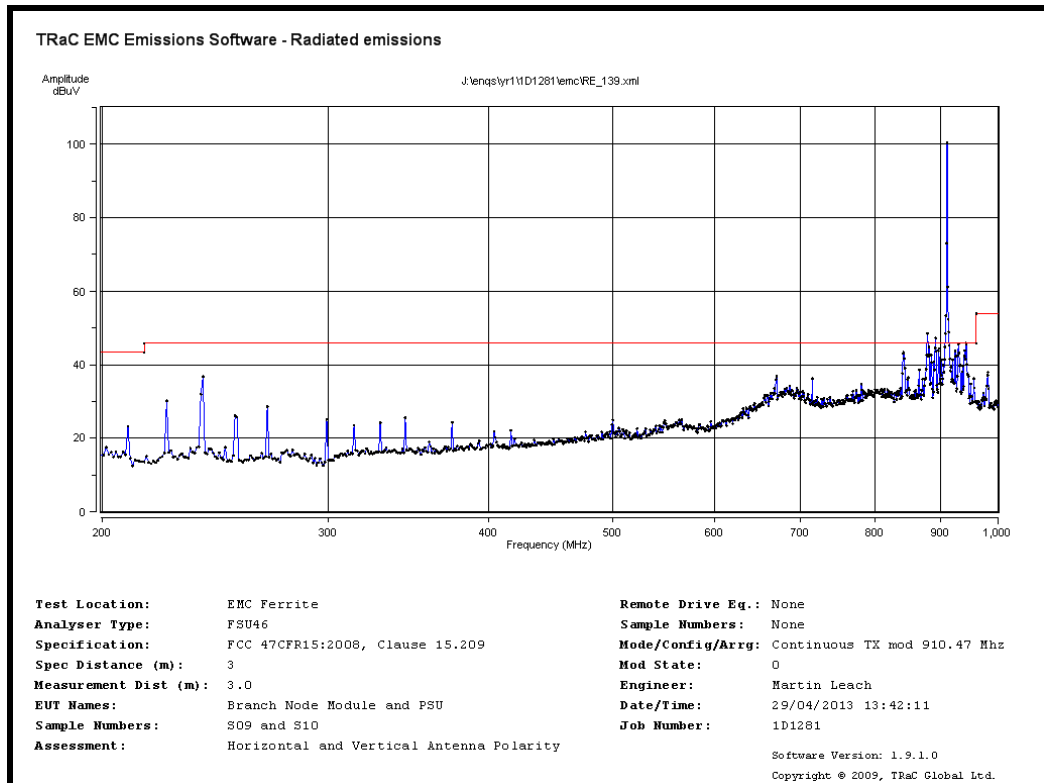
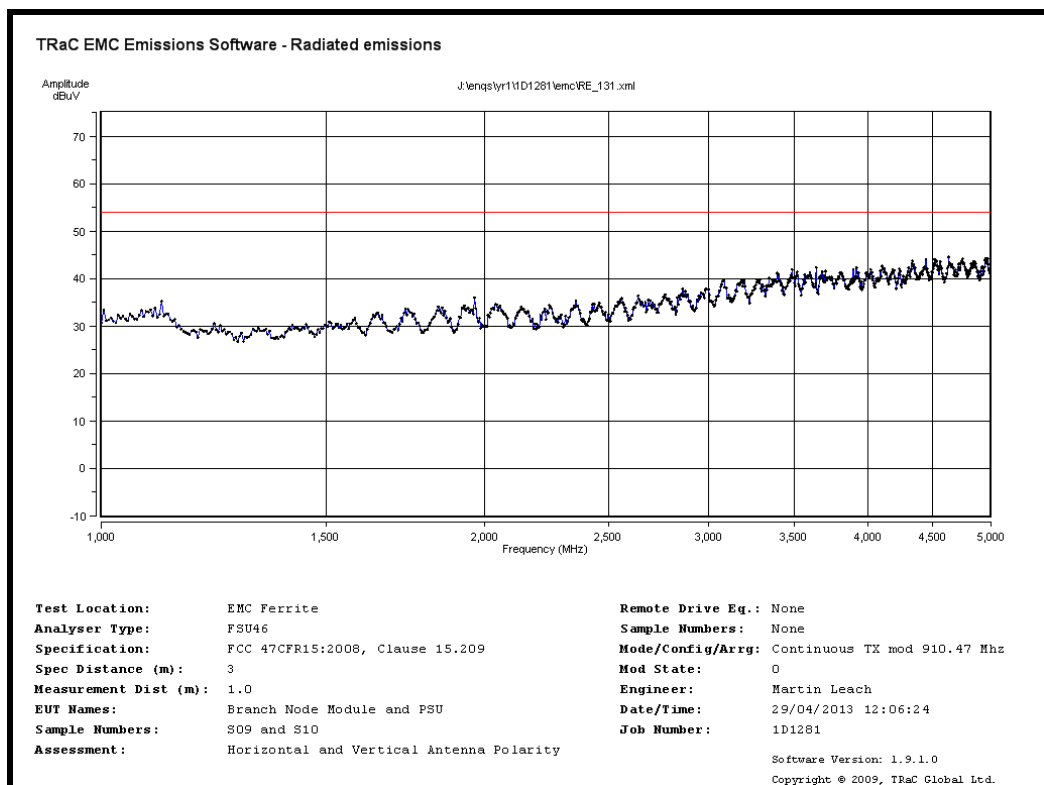
Radiated Transmitter Emissions UHF Radio only Channel 0 905.2MHz (15.209)

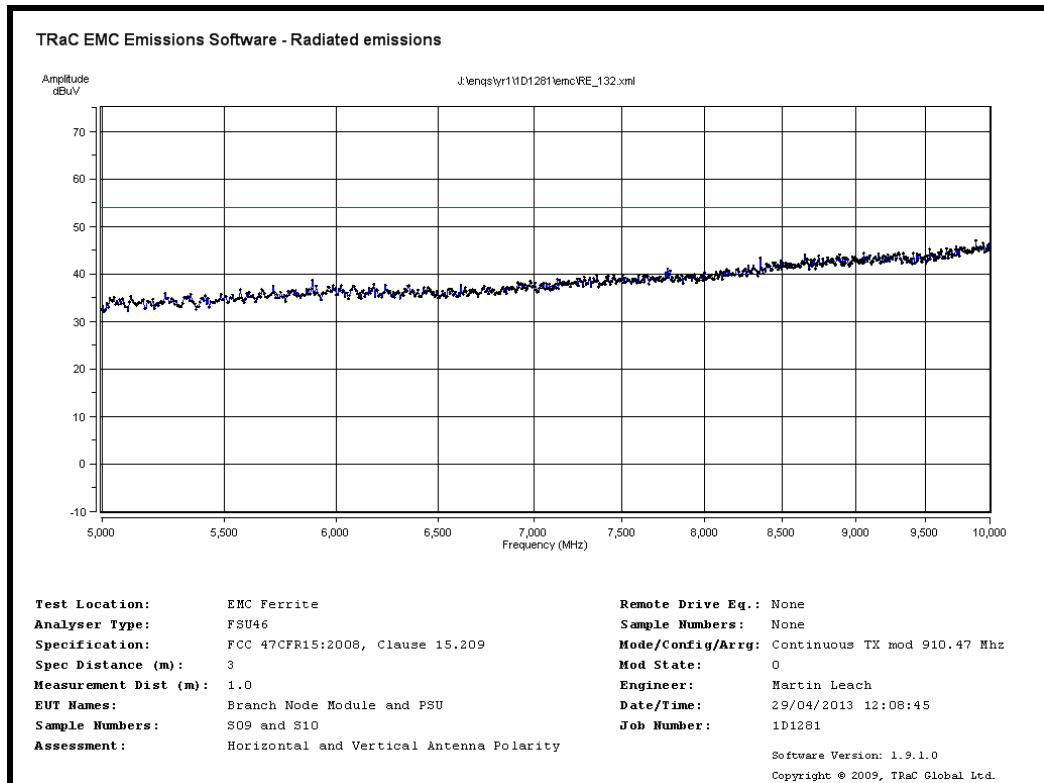
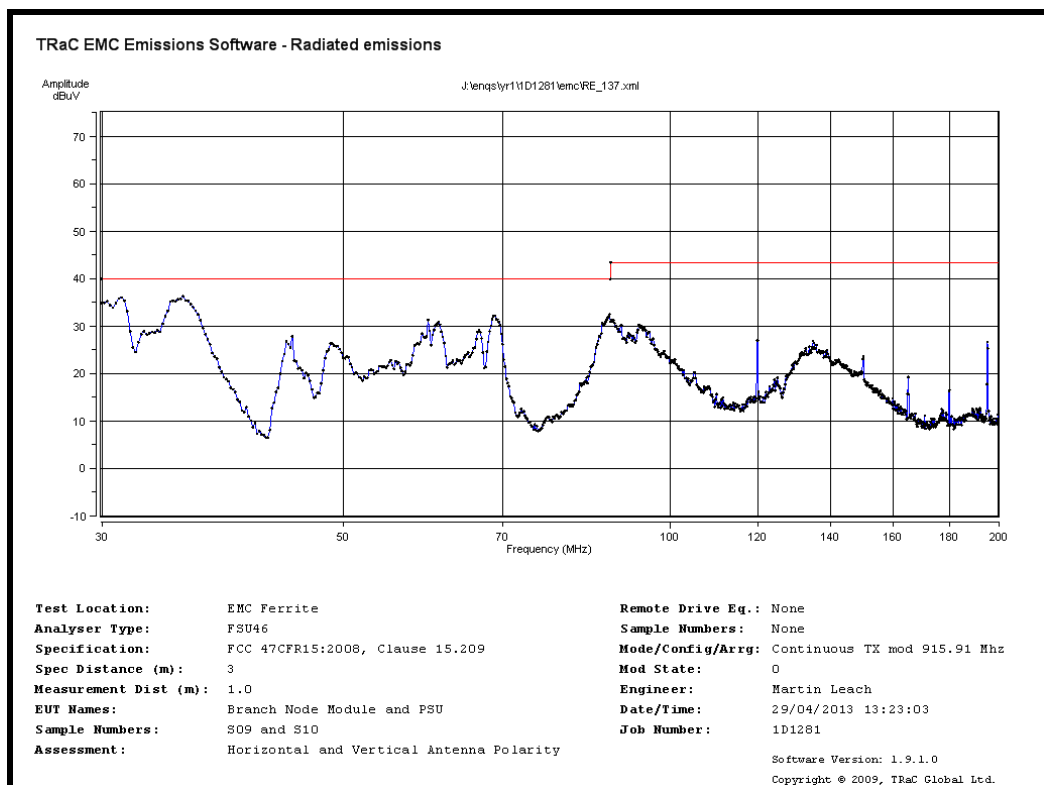


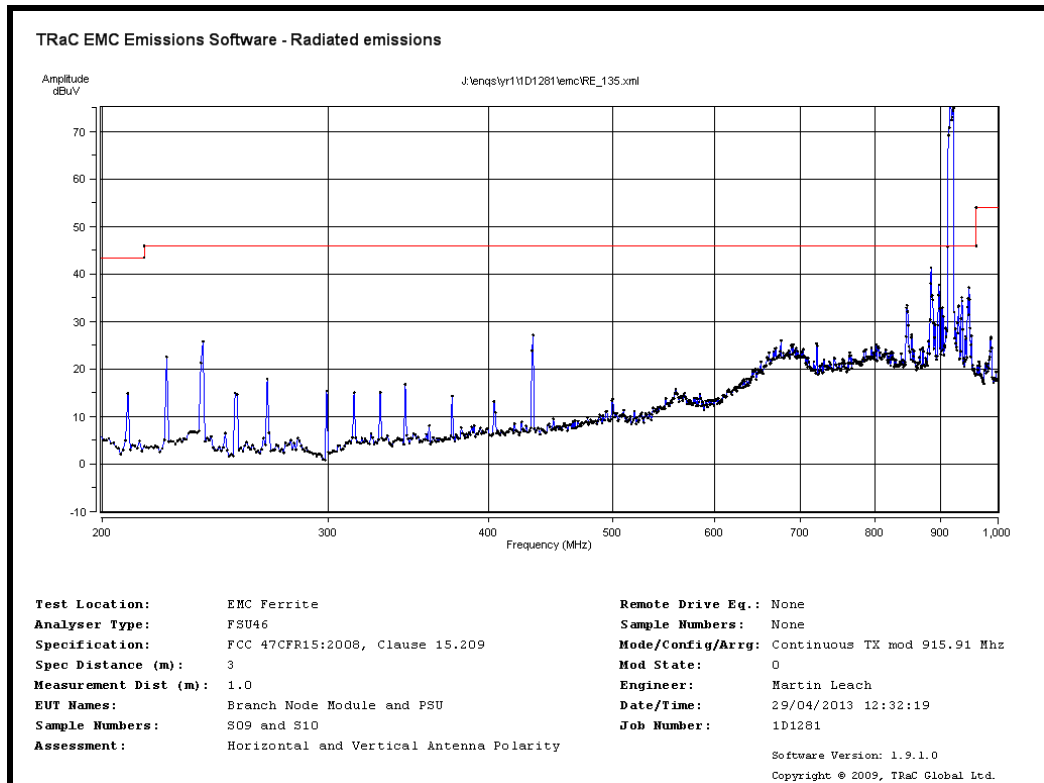
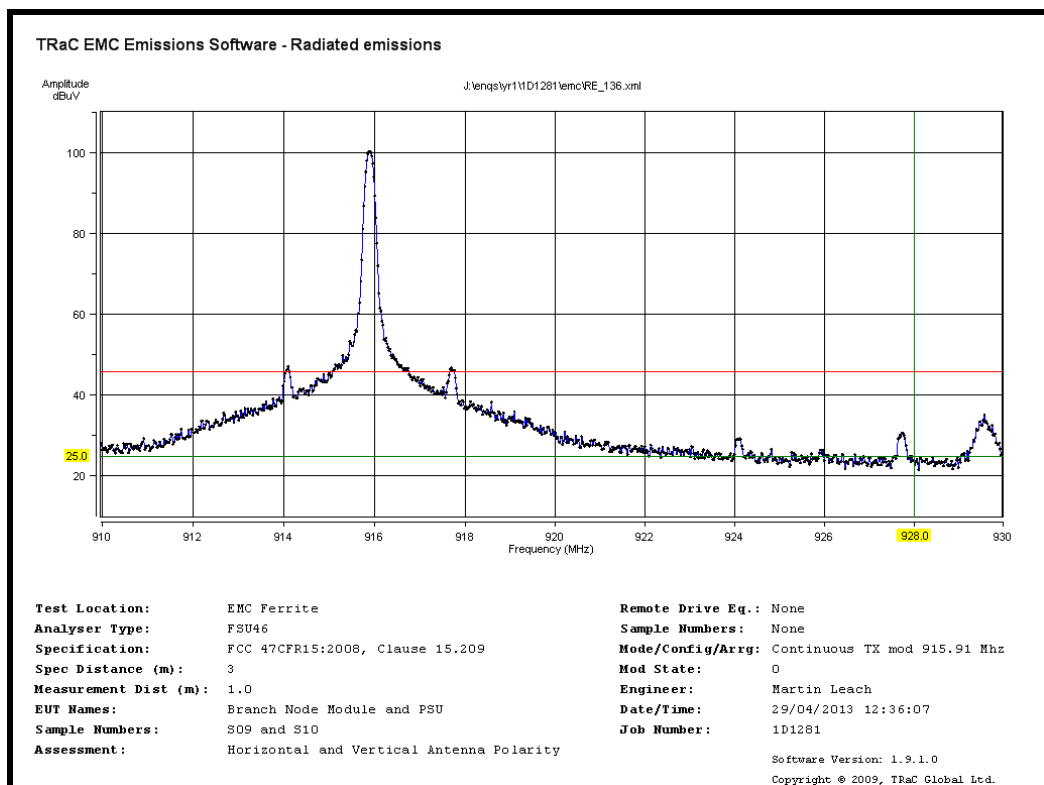
Radiated Transmitter Emissions UHF Radio only Channel 0 905.2MHz (15.209)

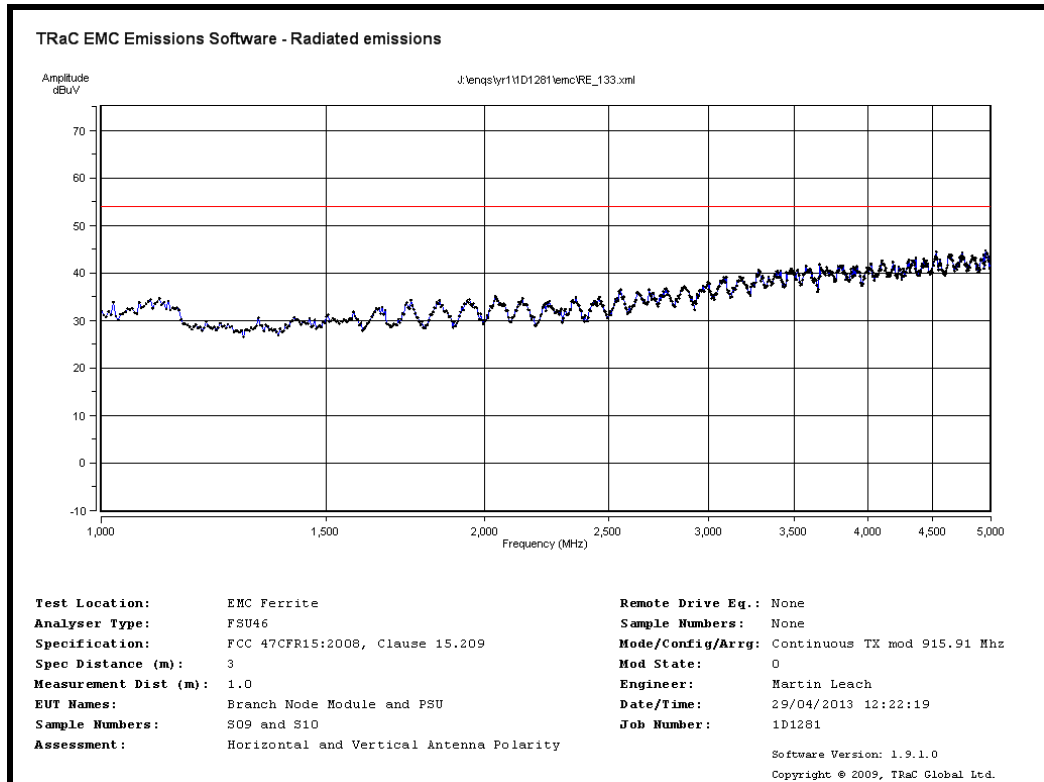
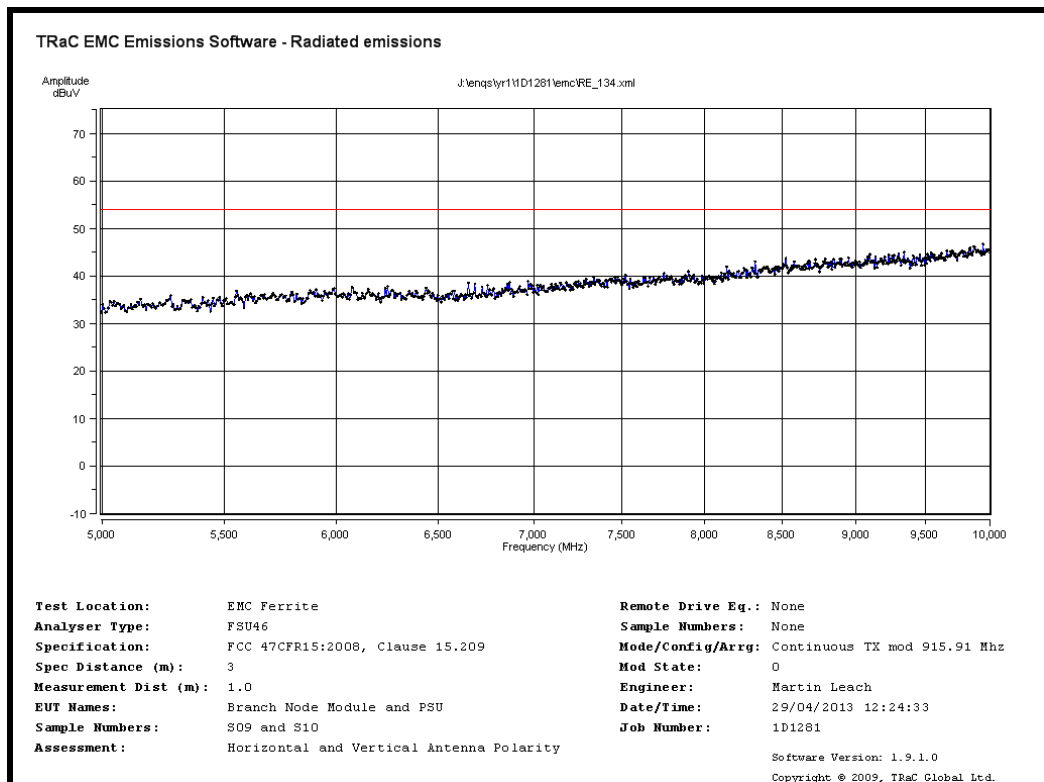


Radiated Transmitter Emissions UHF Radio only Channel 31 910.47MHz (15.209)

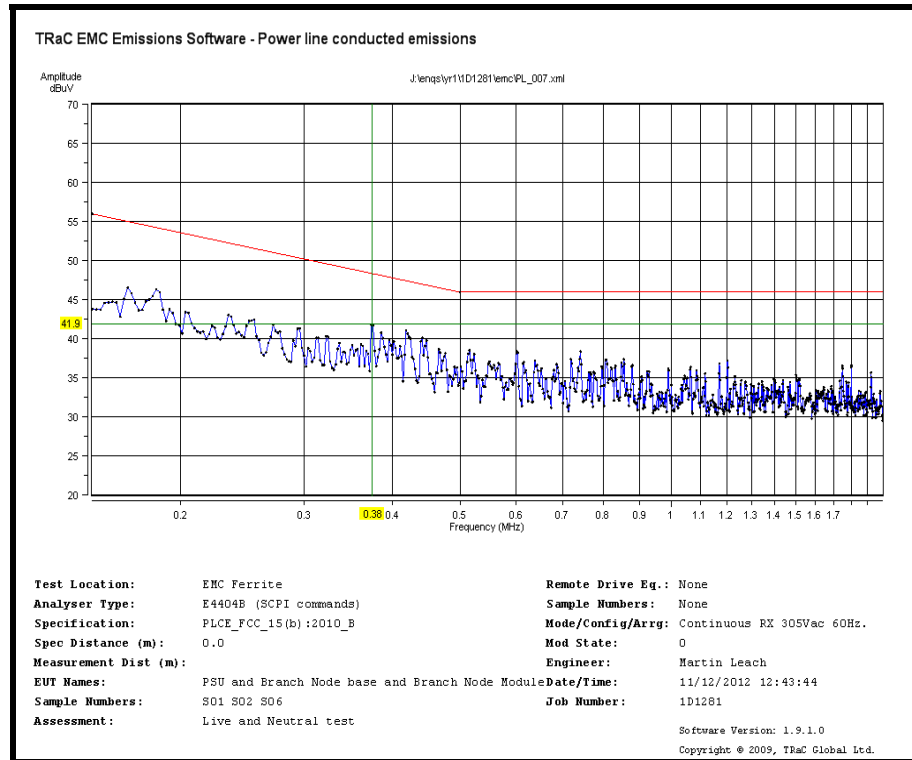
**Radiated Transmitter Emissions UHF Radio only Channel 31 910.47MHz (15.209)****Radiated Transmitter Emissions UHF Radio only Channel 31 910.47MHz (15.209)**

**Radiated Transmitter Emissions UHF Radio only Channel 31 910.47MHz (15.209)****Radiated Transmitter Emissions UHF Radio only Channel 63 915.19MHz (15.209)**

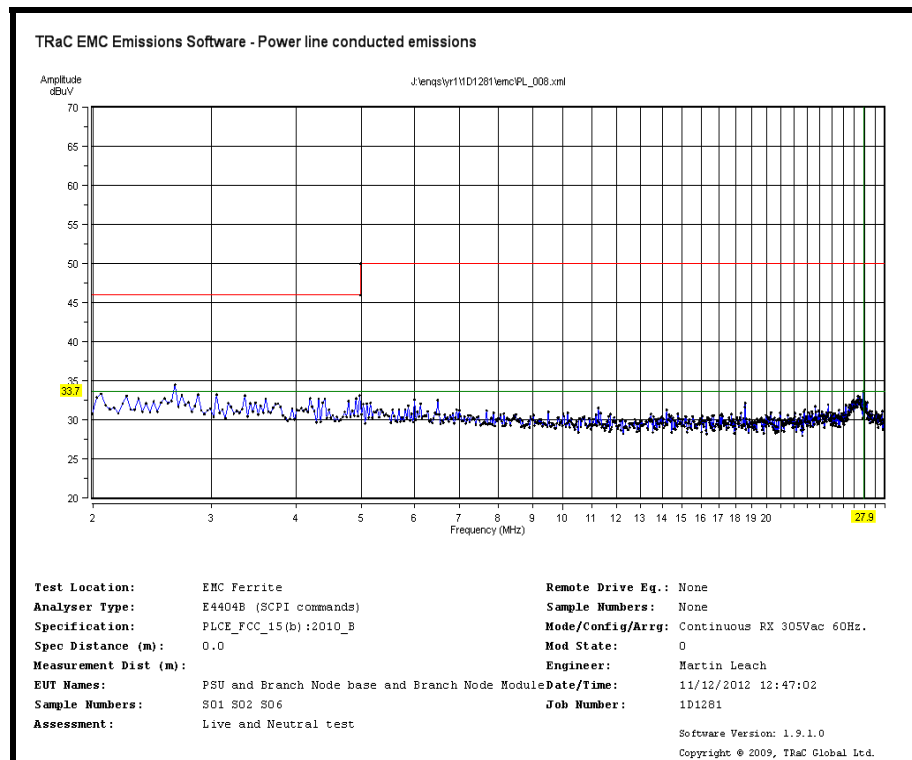
**Radiated Transmitter Emissions UHF Radio only Channel 63 915.19MHz (15.209)****Radiated Transmitter Emissions UHF Radio only Channel 63 915.19MHz (15.209) Upper Band Edge Compliance RBW 100kHz**

**Radiated Transmitter Emissions UHF Radio only Channel 63 915.19MHz (15.209)****Radiated Transmitter Emissions UHF Radio only Channel 63 915.19MHz (15.209)**

Preview Power Line Conducted Emissions (15.107)

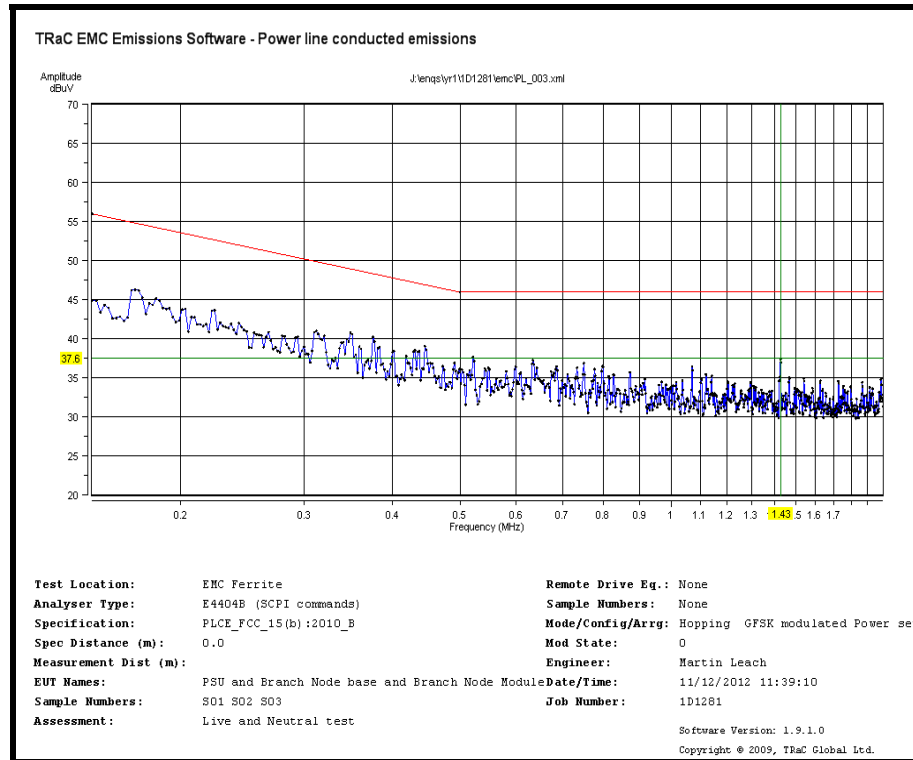


ac Power Line Conducted Emissions: FCC 15.107 requirements, 100% Continuous RX
305Vac/60Hz

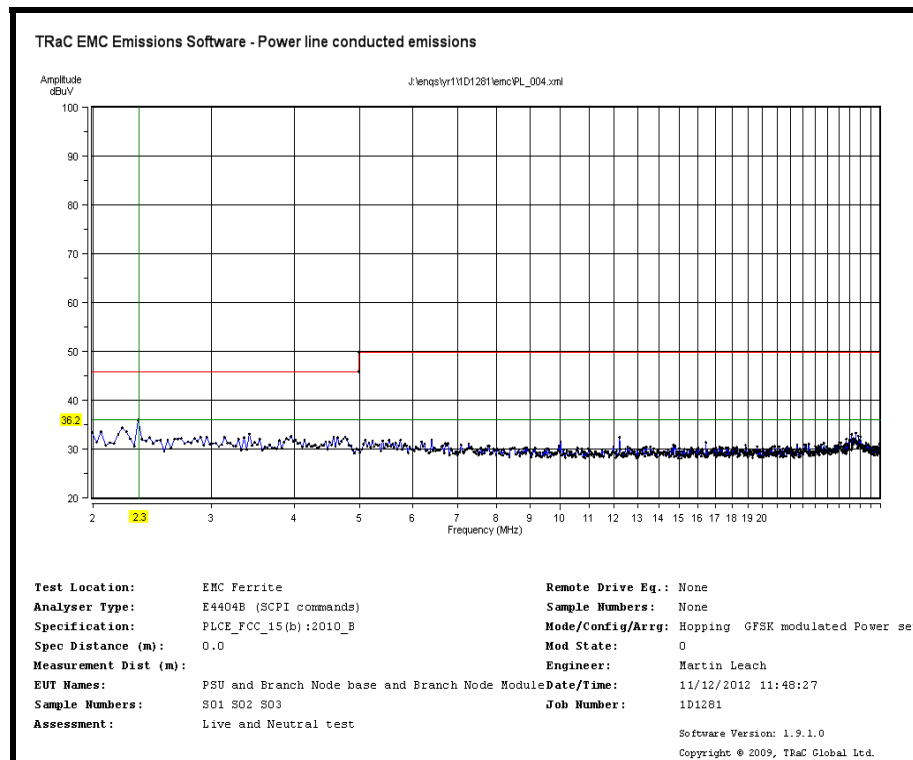


ac Power Line Conducted Emissions: FCC 15.107 requirements, 100% Continuous RX
305Vac/60Hz

Preview Power Line Conducted Emissions (15.207)



ac Power Line Conducted Emissions: FCC 15.207 requirements, Continuous TX hopping
305Vac/60Hz



ac Power Line Conducted Emissions: FCC 15.207 requirements, Continuous TX hopping
305Vac/60Hz

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.

C1) Test samples

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

Sample No.	Description	Identification
TRA-011281S01	Harvard Engineering In-line ac- dc PSU	LCMPUA-240-A
TRA-011281S02	Branchnode: EUT mother board	None
TRA-011281S03	Gen2 RF Board: EUT RF module (radiated)	XRFMODULE-GEN2-915A1
TRA-011281S07	Gen2 RF Board: EUT RF module (conducted)	XRFMODULE-GEN2-915A1
TRA-011281S08	Branchnode: EUT mother board	None
TRA-011281S09	Gen2 RF Board: EUT RF module (radiated)	XRFMODULE-GEN2-915A1
TRA-011281S10	PSU I.T.E. HK IP-15-A05	None

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

Sample No.	Description	Identification
RFG636	Schaffner NGS 1007 ac power source: 110Vac 60Hz power supply	RFG636

C2) EUT Operating Mode During Testing.

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

Test	Description of Operating Mode: Transmit UHF radio only (None-Hopping radiated testing)
Radiated Electric Field Emissions Restricted band 15.209	The EUT (UHF radio module: TRA-011281S03) was transmitting on maximum power (power setting 8) transmitting on the Bottom Channel 0 905.2MHz, Middle Channel 31 (910.47MHz) and Top Channel 63 (915.19MHz) in turn. Data was transmitted at a rate of 2400 baud, with GFSK modulation and a deviation of +-7kHz and power via TRA-011281S01 and S02

Test	Description of Operating Mode: Transmit UHF and Modem (None-Hopping radiated testing)
Radiated Electric Field Emissions Restricted band 15.209	The EUT (UHF radio module: TRA-011281S09) was transmitting on maximum power (power setting 8) transmitting on the Bottom Channel 0 905.2MHz, Middle Channel 31 (910.47MHz) and Top Channel 63 (915.19MHz) in turn. Data was transmitted at a rate of 2400 baud, with GFSK modulation and a deviation of +-7kHz and power via TRA-011281S01 and S08. The cellular Modem was continuously transmitting with the following bands and channel combinations:

EUT Operating Mode During Testing Continued:

Test	Description of Operating Mode: Transmit (None-Hopping conducted testing)
All tests detailed in this report excluding Radiated Electric Field Emissions Restricted band 15.209 and Radiated Electric Field Emissions 15.109 digital circuitry and PLCE 15.207 and 15.107	The EUT (UHF radio module: TRA-011281S07) was transmitting on maximum power (power setting 8) transmitting on the Bottom Channel 0 905.2MHz, Middle Channel 31 (910.47MHz) and Top Channel 63 (915.19MHz) in turn. Data was transmitted at a rate of 2400 baud, with GFSK modulation and a deviation of +- 7kHz and power via TRA-011281S01 and S02.

EUT Operating Mode During Testing Continued

Test	Description of Operating Mode: Transmit (Hopping mode)
PLCE 15.207	The EUT (UHF radio module: TRA-011281S03) was transmitting on maximum power (power setting 8) using FHSS over 64 channels. Data was transmitted at a rate of 2400 baud, with GFSK modulation and a deviation of +/- 7kHz and power via TRA-011281S01 and S02.

Test	Description of Operating Mode: Receive
Radiated Electric Field Emissions 15.109 digital circuitry and PLCE 15.107	The EUT (UHF radio module: TRA-011281S09) was continuously receiving on Channel 31 (910.47MHz). and power via TRA-011281S10

C3) EUT Configuration Information.

Sample	Internal Configuration Details
All	Single possible internal configuration

C4)List of EUT Ports

The table below describes the termination of EUT ports:

Sample : TRA-011281S01
Tests : All tests detailed in this report

Port	Description of Cable Attached	Cable length	Equipment Connected
ac power port	3 core unscreened	>1m	RFG636
dc power port	3 core unscreened	10cm	S02 or S08

Sample : TRA-011281S02
Tests : All tests detailed in this report

Port	Description of Cable Attached	Cable length	Equipment Connected
dc power port	3 core unscreened	30cm	S01
Gen2 RF Board	None-(Multi pin connectors)	N/A	S03 or S07

Sample : TRA-011281S08
Tests : Radiated Electric Field Emissions Restricted band 15.209 /15.205

Port	Description of Cable Attached	Cable length	Equipment Connected
dc power port	3 core unscreened	30cm	S01
Gen2 RF Board	None-(Multi pin connectors)	N/A	S09

C5 Details of Equipment Used

For Conducted Measurements

TRaC REF/RFG No	Type	Description	Manufacturer	Date Calibrated
636	NSG 1007	110Vac/60Hz supply	Schaffner	Cal before use
REF847	ESU	EMI Test Receiver (Spectrum analyser)	R & S	21/11/12

For Power Line Conducted Emissions

TRaC REF/RFG No	Type	Description	Manufacturer	Date Calibrated
n/a	Lab 7	Small Screened Chamber	TRaC	-
189	ESH3-Z5	Single-phase LISN	R & S	27/06/12
680	ESH3-Z2	Pulse Limiter	R & S	21/06/12
657	E4404B	Spectrum Analyser	Agilent	01/05/12
636	NSG 1007	110Vac/60Hz supply	Schaffner	Cal before use
REF1270		Variac	TRaC	Cal before use
REF528	34401A	Digital multimeter	HP	11/07/12
295	BNC	RF coaxial cable (Lab 7)	TRaC	22/10/12
299	BNC	RF coaxial cable (Lab 7)	TRaC	22/10/12
REF847	ESU	EMI Test Receiver (Spectrum analyser)	R & S	21/11/12

For Radiated Measurements:

TRaC REF/RFG No	Type	Description	Manufacturer	Date Calibrated
274	Lab 10	Ferrite Lined Chamber	TRaC	01/08/12
679	CBL6111	BILOG Antenna	Chase	05/05/11
682	HL050	Log P Antenna 0.85 to 26.5GHz	R & S	16/07/12
629	QSH20S20S	Horn antenna 18 to 26.5GHz	Q-Par	18/11/11
008	8447D	Pre Amp	HP	16/02/12
307	8449B	HF Pre Amp (1 to 26.5GHz)	HP	29/02/12
REF847	ESU	EMI Test Receiver (Spectrum analyser)	R & S	21/11/12
REF831	-	HF RF coaxial cable 3.0m	Teledyne & Reynolds	02/07/12
REF832	-	HF RF coaxial cable x.0m	Teledyne & Reynolds	02/07/12
643	-	48 inch HF coaxial cable	Sucoflex	22/10/12
651	-	7m HF coaxial cable	Sucoflex	
678	-	8m HF coaxial cable	Sucoflex	22/10/12
687	VHF1500+	High Pass Filter	Mini Circuits	22/10/12
445	-	High Pass Filter	BSC	15/05/12
REF528	34401A	Digital multimeter	HP	11/07/12
636	NSG 1007	110Vac/60Hz supply	Schaffner	Cal before use

Appendix D:**Additional Information**

Client declaration giving details of channel usage and channel repetition time.



CHANNEL USAGE DECLARATION

10th December 2012

Wimac Ltd
Tyler Close
Normanton
West Yorkshire
England
WF6 1RL

To Whom It May Concern:

I declare that the Wimac Branchnode WMBN-915 FCCID YRUWMBN-915, complies with the FCC requirement 15.247(a)(1)(i).

This is achieved by using a table generated using a 24 bit seed fed into a pseudo random number generator.
The devices will work through the table sequentially selecting the next channel for each communications slot.

The seed and generator have been chosen such that the hopping pattern adheres to the following criteria:

1. Any particular channel is not used for longer than 0.4 seconds in any 20 second period.
2. The 64 channels are all used equally.

The branchnode will transmit at a maximum rate of once every 2 seconds. When it is transmitting the branchnode transmitter will be active for 92ms.

There are 64 available channels, with channel 0 being at 905.2MHz. The channels are then equally spaced with 170kHz between adjacent channels, placing the top channel (63) at 915.91MHz and the mid channel (31) at 910.47MHz.

Data is transmitted at a rate of 2400 baud, with GFSK modulation and a deviation of +/- 7kHz.

Wimac Ltd


Paul Beech

Tyler Close, Normanton, Wakefield, WF6 1RL
Tel: +44 (0) 113 383 1000 Fax: +44 (0) 113 383 1010
E-mail: info@wimac.co.uk www.WiMAC.co.uk
Registered in England No. 5750361

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 pulsewidths 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 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 as shown from the plots in contained in appendix B of this test report.

Duty cycle = $\frac{\text{the sum of the highest average value pulsewidths over 100ms}}{100\text{ms}}$

e.g

$$= \frac{7.459\text{ms}}{100\text{ms}} = 0.07459$$

0.07459 or 7.459%

Correction factor (dB) = $20 \times (\text{Log}_{10} 0.07459) = -22.54\text{dB}$

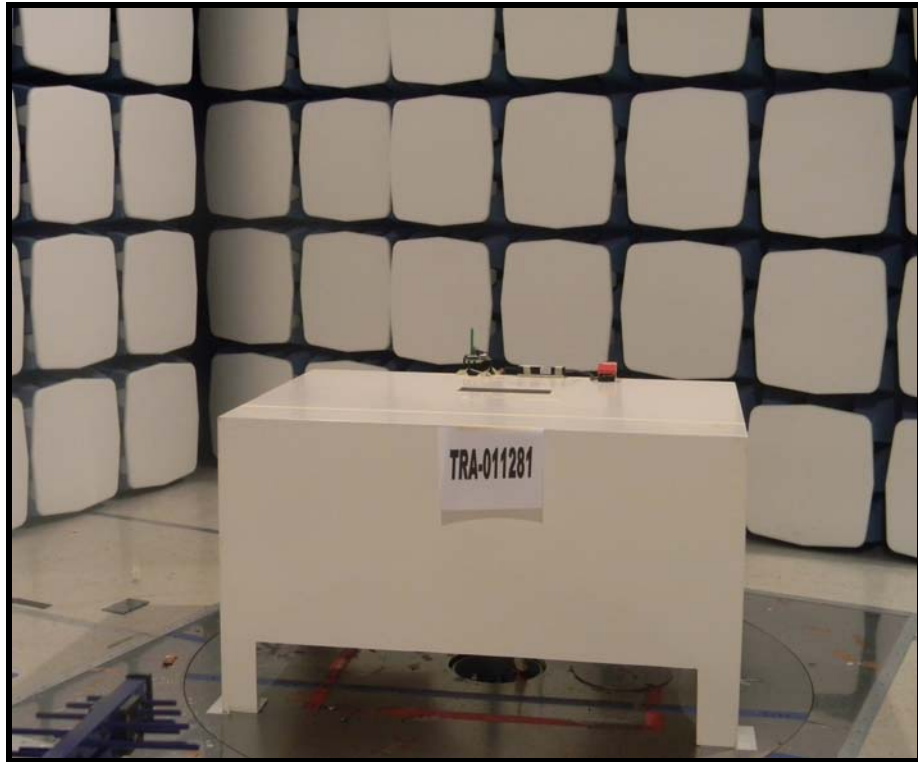
Please Note that no Duty cycle correction has been determined within this test report.

Appendix F:

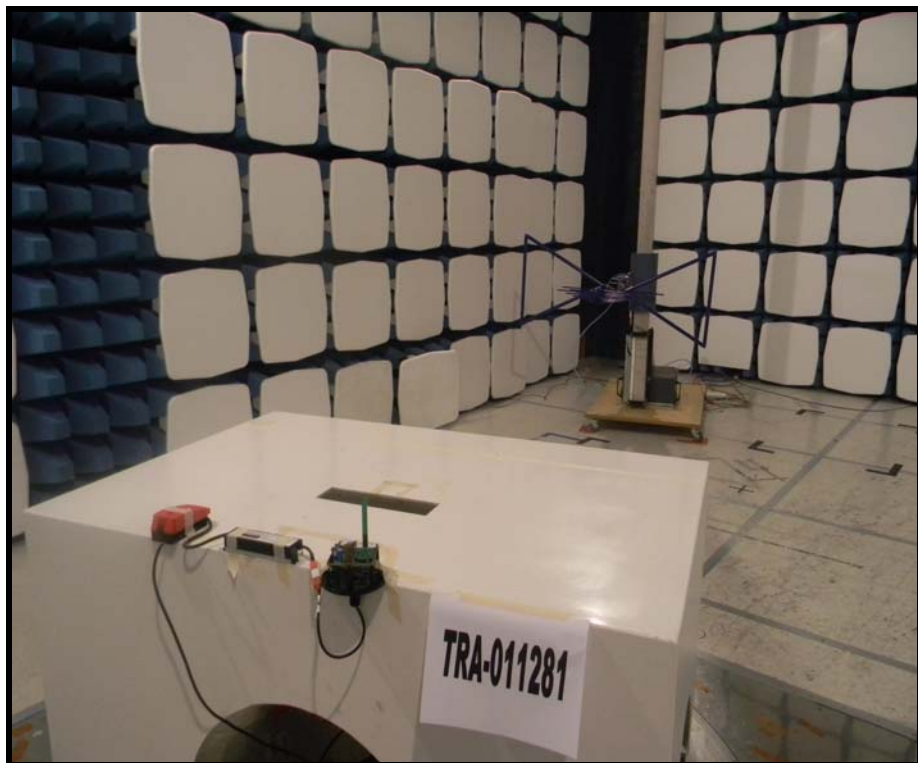
Photographs and Figures

The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: front view.
2. Radiated electric field emissions arrangement: rear view.
3. Power line conducted emissions
4. Power line conducted emissions
5. Radiated electric field emissions arrangement module only: front view.
6. Radiated electric field emissions arrangement module only: rear view.
7. Photo of the RF module (S03) removed from S02
8. Photo of the RF module (S03) Top view
9. Photo of the RF module (S03) Rear view
10. Photo of the RF module (S03) Rear view with Screened can removed
11. Photo of the RF module (S02) Top view
12. Photo of the RF module (S02) Rear view



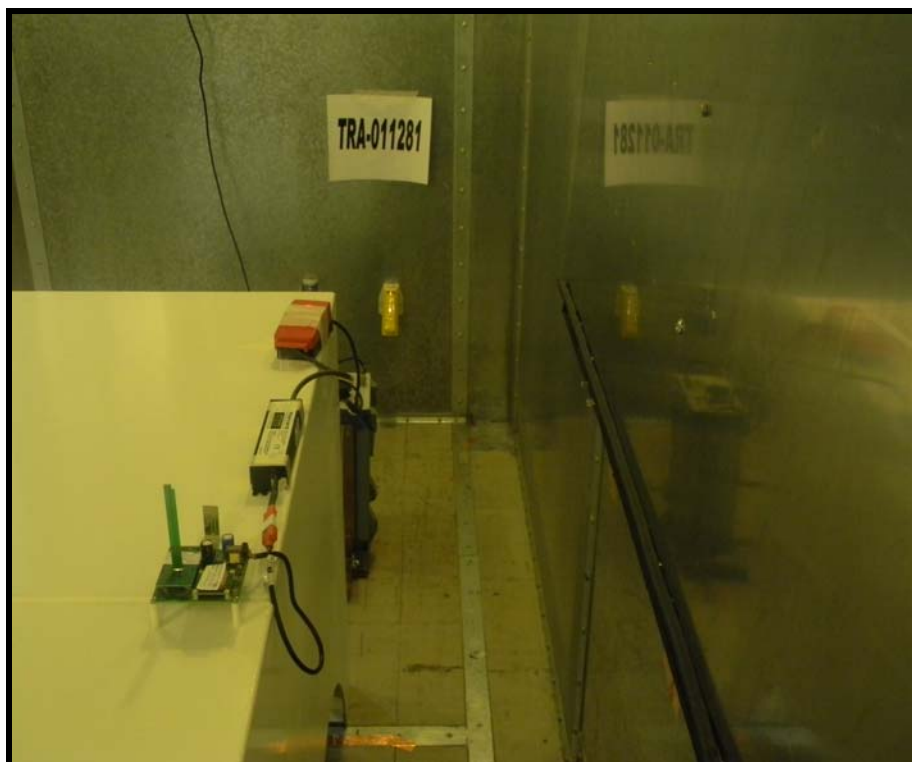
Photograph 1



Photograph 2



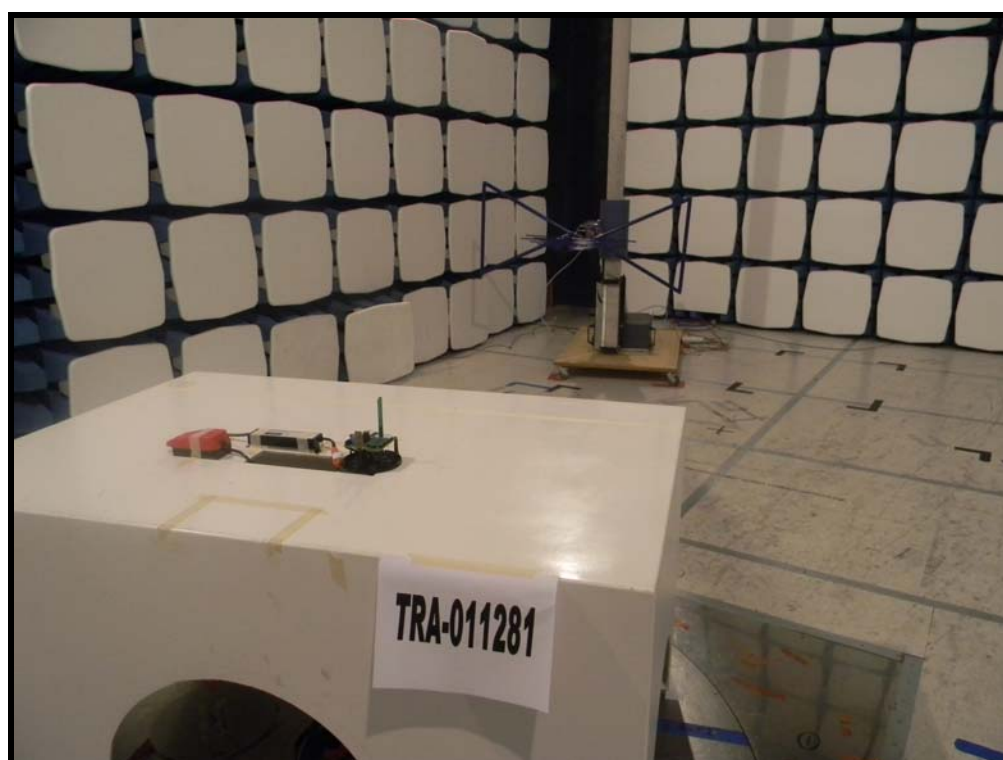
Photograph 3



Photograph 4



Photograph 5



Photograph 6



Photograph 7



Photograph 8



Photograph 9



Photograph 10



Photograph 11



Photograph 12

Appendix G:**MPE Calculation****MPE calculation for the GEN 2 RF board (Product ID XRFMODULE-GEN2-915A1) only**

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 1mW/cm² power density limit, as required under FCC rules.

Prediction of MPE limit at a given distance

Equation from page 19 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2} \text{ or } \frac{EIRP}{4\pi R^2} \text{ re-arranged} \quad R = \sqrt{\frac{PG}{S4\pi}} \text{ or } \sqrt{\frac{EIRP}{S4\pi}}$$

where:

S = power density (Limit) (in appropriate units, e.g. mW/cm²)

EIRP = equivalent (or effective) isotropically radiated power (mW)

R = distance to the center of radiation of the antenna (cm)

P = power input to the antenna (mW)

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

(*numeric* gain. = $G = 10^{\frac{dB}{10}}$)

Sample No.	S01, S02 and S07	
Maximum peak output power at the antenna terminal:	14.56	dBm
Maximum peak output power at the antenna terminal:	28.57590543	mW
Antenna gain (typical):	2.78	dBi
Maximum antenna gain:	1.896705921	numeric
Prediction distance:	20	cm
Prediction frequency:	905.2	MHz

Result

Prediction Frequency (MHz)	Maximum EIRP (mW)	Power density limit f/1500 (S) (mW/cm ²)	Distance (R) cm required to be less than 0.603467 mW/cm ²
905.2	54.2	0.603467	2.673427585

RSS-102 Issue 4 March 2010**MPE calculation for the GEN 2 RF board (Product ID XRFMODULE-GEN2-915A1) only**

Radio frequency radiation exposure evaluation:

For purposes of these requirements mobile devices are defined 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 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 6.035W/m² power density limit, as required.

Prediction of MPE limit at a given distance

Equation from page 19 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2} \text{ or } \frac{EIRP}{4\pi R^2} \text{ re - arranged} \quad R = \sqrt{\frac{PG}{S4\pi}} \text{ or } \sqrt{\frac{EIRP}{S4\pi}}$$

where:

S = power density (Limit) (in appropriate units, e.g. W/m²)

EIRP = equivalent (or effective) isotropically radiated power (W)

R = distance to the centre of radiation of the antenna (m)

P = power input to the antenna (W)

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

(*numeric* gain. = $G = 10^{\frac{dB}{10}}$)

Sample No.	S01, S02 and S07	
Maximum peak output power at the antenna terminal:	14.56	(dBm)
Maximum peak output power at the antenna terminal:	0.02857591	(W)
Antenna gain (typical):	2.78	(dBi)
Maximum antenna gain:	1.896705921	(numeric)
Prediction distance:	0.2	(m)
Prediction frequency:	905.2	(MHz)

Prediction Frequency (MHz)	Maximum EIRP (Watts)	Power density limit (S) (f/150) W/m ²	Distance (R) in meters required to be less than (f/150)W/m ²
905.2	0.05423	6.035	0.026733538

Appendix H: FCC CFR47 Part 15(c) / IC RSS-210 Comparison Table

The following table summarises the results of the assessment to RSS-210:

Test Type	Regulation	Regulation	Measurement standard	Result
Radiated spurious emissions	Title 47 of the CFR: Part 15 Subpart (c) 15.247	RSS – 210 Issue 8, December 2010 Annex 8, A8.5	RSS- GEN Issue 3, December 2010 ANSI C63.10	Pass
Conducted spurious emissions	Title 47 of the CFR: Part 15 Subpart (c) 15.247	RSS – 210 Issue 8, December 2010 Annex 8, A8.5	RSS- GEN Issue 3, December 2010 ANSI C63.10	Pass
ac Power Lines conducted emissions	Title 47 of the CFR: Part 15 Subpart (c) 15.207	RSS – 210 Issue 8, December 2010 Section 7.2.2	RSS- GEN Issue 3, December 2010 ANSI C63.10	Pass
20dB Bandwidth and Channel Spacing	Title 47 of the CFR : Part 15 Subpart (c) 15.247(a)(1)(i)	RSS – 210 Issue 8, December 2010 Annex 8, A8.1(b)	RSS- GEN Issue 3, December 2010 ANSI C63.10	Pass
Conducted Carrier Power	Title 47 of the CFR : Part 15 Subpart (c) 15.247(b)(2)	RSS – 210 Issue 8, December 2010 Annex 8, A8.4(2)	RSS- GEN Issue 3, December 2010 ANSI C63.10	Pass
Hopping Frequencies	Title 47 of the CFR : Part 15 Subpart (c) 15.247(a)(1)	RSS – 210 Issue 8, December 2010 Annex 8, A8.1(d)	ANSI C63.10	Pass
Channel Occupancy	Title 47 of the CFR : Part 15 Subpart (c) 15.247(a)(1)(i)	RSS – 210 Issue 8, December 2010 Annex 8, A8.1(d)	ANSI C63.10	Pass
Unintentional Radiated Spurious Emissions	Title 47 of the CFR: Part 15 Subpart (b) 15.109	RSS – 210 Issue 8, December 2010 Section 7.2.3	RSS- GEN Issue 3, December 2010 ANSI C63.10	Pass

