

A Radio Test Report

FOR

Renishaw Plc

ON

RMI-Q

DOCUMENT NO. TRA-006987-W-US-1

HULL

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TRaC Wireless Test Report : TRA-006987-W-US-1

Applicant : Renishaw Plc

Apparatus : RMI-Q

Specification(s) : CFR47 Part 15.247

FCCID : KQGRMI-Q

Purpose of Test : Certification

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 :

Renishaw Plc
New Mills
Wotton Under Edge
Gloucestershire
GL12 8JR

1.3 Manufacturer

As Above

1.4 Apparatus Assessed

The following apparatus was assessed between 19th – 24th September 2012:

RMI-Q

The RMI-Q (Radio Machine Interface) is a combined radio transceiver and machine interface for use on CNC (Computer Numerically Controlled) machine tools. It is capable of communicating with up to for Radio Machine Probes (and/or Radio Tool Setter) non-simultaneously using radio turn on / off methods ('M' code). The RMI-Q uses FHSS (Frequency Hopping Spread Spectrum) transmission, the communications are made across all 79 channels of the 2.4GHz ISM band using Frequency Hopping Spread Spectrum with GFSK modulation.

The RMI-Q contains 2 separate transceiver circuits.

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 (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	
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**

For the test data recorded the following measurement uncertainty was calculated :

Radio Testing – General Uncertainty Schedule

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

[1] Adjacent Channel Power

Uncertainty in test result = **1.86dB**

[2] Carrier Power

Uncertainty in test result (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 Transmitter Peak Output Power

Carrier power was verified with the EUT transmitting on its lowest, centre and highest carrier frequency in turn.

Test Details:	
Regulation	Title 47 of the CFR: Part15 Subpart (c) 15.247(b)(1)
Measurement standard	ANSI C63.10:2003
EUT sample number	S12
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	21°C
Photographs (Appendix F)	44

Test Details: Radio 1			
Channel Frequency (MHz)	Peak Carrier Power (W)	Limit (W)	Result
2403	0.001016	1	Pass
2442	0.001172		Pass
2481	0.001102		Pass

Test Details: Radio 2			
Channel Frequency (MHz)	Peak Carrier Power (W)	Limit (W)	Result
2403	0.000993	1	Pass
2442	0.001253		Pass
2481	0.001245		Pass

Notes:

Number of hopping channels employed is 79

Conducted Measurement

Measured Peak Carrier power does not include an antenna gain.

Highest Gain of any antenna to be used = 2.1 dBi

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 and 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: Radio 1	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2003
Frequency range	9 kHz to 25 GHz
EUT sample number	S12
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	21°C
Photographs (Appendix F)	44

The worst case conducted emission measurements at the antenna port are listed below:

Test Details: Radio 1, 2403 MHz						
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.	No Emissions within 10dB Limit					

Test Details: Radio 1, 2442 MHz						
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.	No Emissions within 10dB Limit					

Test Details: Radio 1, 2481 MHz						
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.	No Emissions within 10dB Limit					

Bandaged Plots for both Radio 1 and Radio 2 can be found in appendix B
 Conducted spurious emission plots for radio 2 can be found in appendix B
 Conducted spurious emission plots for radio 1 plots are available if required.

RF Antenna Conducted Spurious Emissions continued:

Test Details: Radio 2	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2003
Frequency range	9 kHz to 25 GHz
EUT sample number	S12
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	21°C
Photographs (Appendix F)	44

The worst case conducted emission measurements at the antenna port are listed below:

Test Details: Radio 2, 2403 MHz						
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.	No Emissions within 10dB Limit					

Test Details: Radio 2, 2442 MHz						
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.	No Emissions within 10dB Limit					

Test Details: Radio 2, 2481 MHz						
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.	No Emissions within 10dB Limit					

Bandaged Plots for both Radio 1 and Radio 2 can be found in appendix B
 Conducted spurious emission plots for radio 2 can be found in appendix B
 Conducted spurious emission plots for radio 1 plots are available if required.

Notes:

1. The conducted emission limit for emissions outside the restricted bands, defined in 47CFR Part15.205(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 accordance15.33 (a)(1).
3. The measurements at 2400 MHz and 2483.5 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):

The limit in 100 kHz RBW = (Maximum Peak Conducted Carrier)-20dB

A3 Radiated Electric Field Emissions Within The Restricted Bands of 15.205

Preliminary scans were 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 on its lowest, centre and highest carrier frequency.

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: Radio 1, 2403 MHz	
Regulation	Title 47 of the CFR, Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2003
Frequency range	30MHz – 25GHz
EUT sample number	S13
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	23°C
Photographs (Appendix F)	1 & 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)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	4806 _{Pk}	58.50	3.6	32.6	35.7	59.00	-	891.25	5000
2.	4806 _{Av}	51.87	3.6	32.6	35.7	52.37	-	415.43	500

Bandaged Plots for both radio 1 and radio 2 can be found in appendix B

Radiated spurious emission plots with radio 1 and radio 2 operating simultaneously can be found in appendix B.

Radiated Electric Field Emissions Within The Restricted Band 15.205 continued:

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

Test Details: Radio 1, 2442 MHz	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2003
Frequency range	30MHz to 25 GHz
EUT sample number	S13
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	23°C
Photographs (Appendix F)	1 & 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)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	4884 _{Pk}	57.27	3.8	32.9	35.7	58.27	-	819.41	5000
2.	4884 _{Av}	48.29	3.8	32.9	35.7	49.29	-	291.41	500

Bandaged Plots for both radio 1 and radio 2 can be found in appendix B

Radiated spurious emission plots with radio 1 and radio 2 operating simultaneously can be found in appendix B.

Radiated Electric Field Emissions Within The Restricted Band 15.205 continued:

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

Test Details: Radio 1, 2481 MHz	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2003
Frequency range	30MHz to 25 GHz
EUT sample number	S13
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	23°C
Photographs (Appendix F)	1 & 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)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	4962 _{Pk}	57.41	3.6	33.1	35.7	58.41	-	832.72	5000
2.	4962 _{Av}	50.41	3.6	33.1	35.7	51.41	-	371.96	500

Bandaged Plots for both radio 1 and radio 2 can be found in appendix B

Radiated spurious emission plots with radio 1 and radio 2 operating simultaneously can be found in appendix B.

Radiated Electric Field Emissions Within The Restricted Band 15.205 continued:

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

Test Details: Radio 2, 2403 MHz	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2003
Frequency range	30MHz to 25 GHz
EUT sample number	S13
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	23°C
Photographs (Appendix F)	1 & 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)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	4806 _{Pk}	58.50	57.49	32.6	35.7	57.99	-	793.41	5000
2.	4806 _{Av}	51.87	49.66	32.6	35.7	50.16	-	322.11	500

Bandaged Plots for both radio 1 and radio 2 can be found in appendix B

Radiated spurious emission plots with radio 1 and radio 2 operating simultaneously can be found in appendix B.

Radiated Electric Field Emissions Within The Restricted Band 15.205 continued:

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

Test Details: Radio 2, 2442 MHz	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2003
Frequency range	30MHz to 25 GHz
EUT sample number	S13
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	23°C
Photographs (Appendix F)	1 & 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)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	4884 _{Pk}	55.27	3.8	32.9	35.7	56.27	-	650.88	5000
2.	4884 _{Av}	47.75	3.8	32.9	35.7	48.75	-	273.84	500

Bandaged Plots for both radio 1 and radio 2 can be found in appendix B

Radiated spurious emission plots with radio 1 and radio 2 operating simultaneously can be found in appendix B.

Radiated Electric Field Emissions Within The Restricted Band 15.205 continued:

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

Test Details: Radio 2, 2481 MHz	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2003
Frequency range	30MHz to 25 GHz
EUT sample number	S13
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	23°C
Photographs (Appendix F)	1 & 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)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	4962 _{Pk}	56.93	3.6	33.1	35.7	57.93	-	787.95	5000
2.	4962 _{Av}	49.86	3.6	33.1	35.7	50.86	-	349.14	500

Bandaged Plots for both radio 1 and radio 2 can be found in appendix B

Radiated spurious emission plots with radio 1 and radio 2 operating simultaneously can be found in appendix B.

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 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

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

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

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

Frequency of emission (MHz)	Field strength $\mu\text{V}/\text{m}$	Measurement Distance m	Field strength $\text{dB}\mu\text{V}/\text{m}$
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 on its lowest, centre and highest carrier frequency in turn. The formal measurements are detailed below:

Test Details:	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.207
Measurement standard	ANSI C63.10:2003
Frequency range	150kHz to 30MHz
EUT sample number	S13
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 power line conducted emission measurements are listed below:

Results measured using the average detector compared to the average limit

Ref No.	Freq (MHz)	Result (dBuV)	Conductor	Spec Limit (dBuV)	Margin (dB)	Result Summary
1	0.24	34.9	TX -Neutral	52.1	17.2	Pass
2	0.485	30.02	RX -Neutral	46.25	16.23	Pass
3	0.605	26.26	RX -Neutral	46	19.74	Pass
4	0.845	28.87	RX -Neutral	46	17.13	Pass

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

Ref No.	Freq (MHz)	Result (dBuV)	Conductor	Spec Limit (dBuV)	Margin (dB)	Result Summary
No Significant Emissions						

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 20 dB Bandwidth and Carrier Frequency Separation

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	S12
Modification state	0
SE in test environment	None
SE isolated from EUT	None
Temperature	21°C
EUT set up	Refer to Appendix C

Radio 1			
Channel Frequency (MHz)	Measured 20 dB Bandwidth (kHz)	Limit	Result
2403	1110.577	<500kHz	Pass
2442	1192.307	<500kHz	Pass
2481	1259.616	<500kHz	Pass
Measured Channel Spacing (kHz)		Limit	Result
1000		(25kHz or \geq Measured 20 dB Bandwidth kHz)	Pass

Radio 2			
Channel Frequency (MHz)	Measured 20 dB Bandwidth (kHz)	Limit	Result
2403	1110.577	<500kHz	Pass
2442	1192.307	<500kHz	Pass
2481	1259.616	<500kHz	Pass
Measured Channel Spacing (kHz)		Limit	Result
1000		(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.

A6 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	S12
Modification state	0
SE in test environment	None
SE isolated from EUT	None
Temperature	21°C
EUT set up	Refer to Appendix C

Radio 1		
No. of Hopping Channels	Requirement	Result
79	>15	Pass

Radio 2		
No. of Hopping Channels	Requirement	Result
79	>15	Pass

Plots showing the hopping channels are contained in Appendix B

A7 Channel Occupancy

Channel occupancy time was verified using a spectrum analyser in zero span mode, centred on the middle hopping channel frequency (2442 MHz), 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: Part15 Subpart (c) 15.247(a)(1)
EUT sample number	S12
Modification state	0
SE in test environment	None
SE isolated from EUT	None
Temperature	21°C
EUT set up	Refer to Appendix C

Radio 1					
T_{occ} (ms)	MP (s)	MPTX	AOT (s)	Limit (s)	Result
0.286057	31.6	4	0.00114	0.4	PASS

Radio 2					
T_{occ} (ms)	MP (s)	MPTX	AOT (s)	Limit (s)	Result
0.289743	31.6	20	0.00579	0.4	PASS

Plots showing the channel occupancy time and time between successive transmissions are contained in Appendix B of this test report. These are identical for all modulation modes.

Average Channel Retention Time Calculation:

No. Of utilised hopping channels (N) = 79

Radio 1 Measured channel occupancy time (T_{occ}) = 286.057 μ s

Radio 2 Measured channel occupancy time (T_{occ}) = 289.743 μ s

Specified averaging period (SAP) =

$$0.4 * N = \text{SAP(Seconds)} \quad \therefore \quad 0.4 * 79 = 31.6$$

\therefore The Average Retention Time =

Total activation time T_{occ} x No. of transmission cycles in specified averaging period

Radio 1 Average Channel Occupancy Time = 286.057 μ s x 4 = 0.00114 seconds

Radio 2 Average Channel Occupancy Time = 289.743 μ s x 20 = 0.00579 seconds

A8 Antenna Gain

The maximum antenna gain for the antenna types to be used with the EUT, as declared by the client, is 2.1 dBi.

A9 Unintentional Radiated Electric Field Emissions - 15.109

Preliminary scans were performed using a peak detector with the RBW = 100kHz. 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: All Modes of operation	
Regulation	Title 47 of the CFR: Part 15 Subpart (b) Clause 15.109
Measurement standard	ANSI C63.10:2003
Frequency range	30MHz to 25 GHz
EUT sample number	S13
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	20°C
Photographs (Appendix F)	1 & 2

The worst case radiated emission measurements for spurious emissions are listed overleaf:

Radiated spurious emission plots with radio 1 and radio 2 operating simultaneously can be found in appendix B.

Ref No.	FREQ. (MHz)	MEAS Rx (dBμV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBμV/m)	EXTRAP FACT (dB)	FIELD ST'GH (μV/m)	LIMIT (μV/m)
1	88.25	17.05	1.30	8.35	-	26.7	-	21.63	150
2	88.75	17.95	1.30	8.45	-	27.7	-	24.27	150
3	89.25	18.75	1.30	8.55	-	28.6	-	26.92	150
4	89.75	20.45	1.30	8.65	-	30.4	-	33.11	150
5	90.25	20.25	1.30	8.75	-	30.3	-	32.73	150
6	90.75	19.55	1.30	8.85	-	29.7	-	30.55	150
7	91.25	17.15	1.30	8.95	-	27.4	-	23.44	150
8	136.25	11.52	1.60	11.28	-	24.4	-	16.60	150
9	136.75	12.57	1.60	11.23	-	25.4	-	18.62	150
10	137.25	13.42	1.60	11.18	-	26.2	-	20.42	150
11	140.25	12.32	1.60	10.98	-	24.9	-	17.58	150
12	140.75	12.47	1.60	10.93	-	25.0	-	17.78	150
13	141.25	14.45	1.60	10.85	-	26.9	-	22.13	150
14	141.75	14.75	1.60	10.75	-	27.1	-	22.65	150
15	144.75	13.97	1.60	10.53	-	26.1	-	20.18	150
16	145.25	14.52	1.60	10.48	-	26.6	-	21.38	150
17	145.75	15.27	1.60	10.43	-	27.3	-	23.17	150
18	848.05	5.10	3.40	20.30	-	28.8	-	27.54	200
19	912.05	9.55	3.55	20.80	-	33.9	-	49.55	200
20	944.05	1.74	3.66	20.90	-	26.3	-	20.65	200

A10 Radiated Bandedge Compliance – Delta Marker Method

Test Details:	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2003
EUT sample number	S13
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	23°C
Photographs (Appendix F)	1 & 2

Measurements are applied to the restricted band at the upper bandedge of 2483.5MHz only.

Radio 1 – 2403 Modulated Carrier		
	Peak	Average
Carrier power 2 MHz RBW (dBuV/m)	98.43	93.38
Carrier power 100K RBW (dBuV/m)	97.62	88.8
Level @ Bandedge 100K (dBuV/m)	57.45	26.84
Delta 100K (dB)	-40.17	-61.96
Actual Level @ bandedge (dBuV/m)	56.64	22.26

Radio 1 – 2403 Hopping		
	Peak	Average
Carrier power 2 MHz RBW (dBuV/m)	98.41	64.48
Carrier power 100K RBW (dBuV/m)	97.72	55.47
Level @ Bandedge 100K (dBuV/m)	57.3	20.41
Delta 100K (dB)	-40.42	-35.06
Actual Level @ bandedge (dBuV/m)	56.61	11.4

Modulated Carrier power in a 2MHz RBW and delta Marker plots in a 100 KHz RBW can be found in Appendix B

Radiated Bandedge Compliance – Delta Marker Method - Continued

Measurements are applied to the restricted band at the upper bandedge of 2483.5MHz only.

Radio 1 – 2403 Modulated Carrier		
	Peak	Average
Carrier power 2 MHz RBW (dBuV/m)	97.40	92.32
Carrier power 100K RBW (dBuV/m)	96.63	88.12
Level @ Bandedge 100K (dBuV/m)	56.59	26.76
Delta 100K (dB)	-40.04	-61.36
Actual Level @ bandedge (dBuV/m)	55.82	22.56

Radio 2 – 2403 Hopping		
	Peak	Average
Carrier power 2 MHz RBW (dBuV/m)	97.45	66.04
Carrier power 100K RBW (dBuV/m)	96.70	54.72
Level @ Bandedge 100K (dBuV/m)	55.92	20.33
Delta 100K (dB)	-40.78	-34.39
Actual Level @ bandedge (dBuV/m)	55.17	9.01

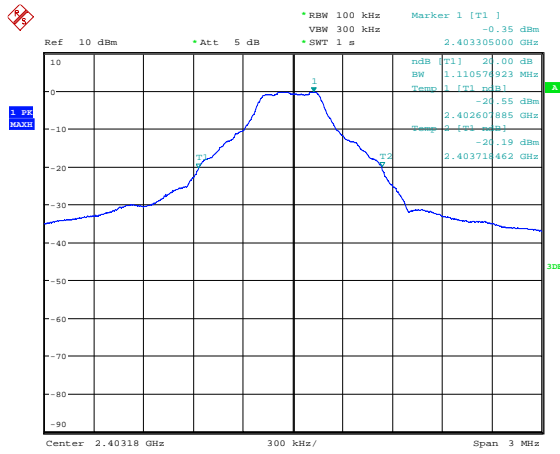
Modulated Carrier power in a 2MHz RBW and delta Marker plots in a 100 KHz RBW can be found in Appendix B

Appendix B: Supporting Graphical Data

This appendix contains graphical data obtained during testing.

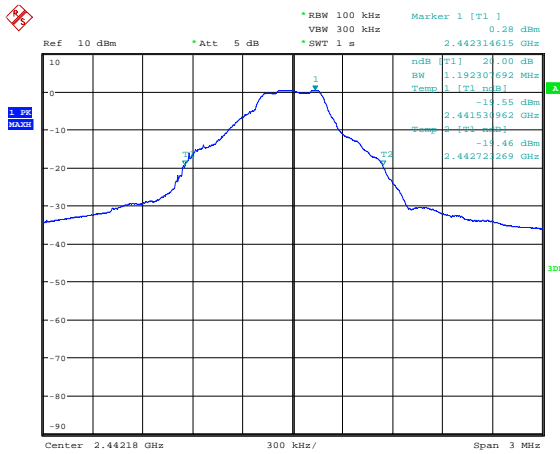
Notes:

- (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.



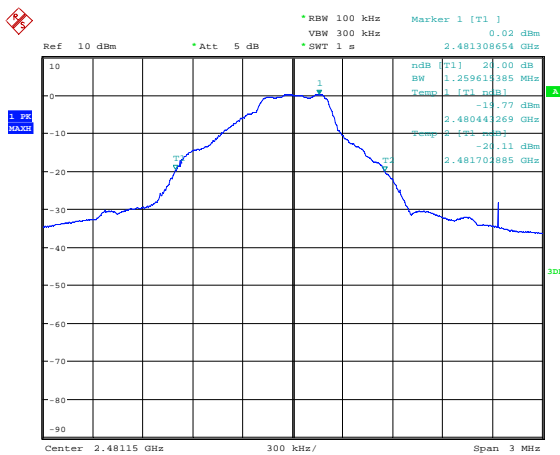
Date: 20.SEP.2012 11:14:09

20dB Bandwidth – 2403 MHz – Radio 1



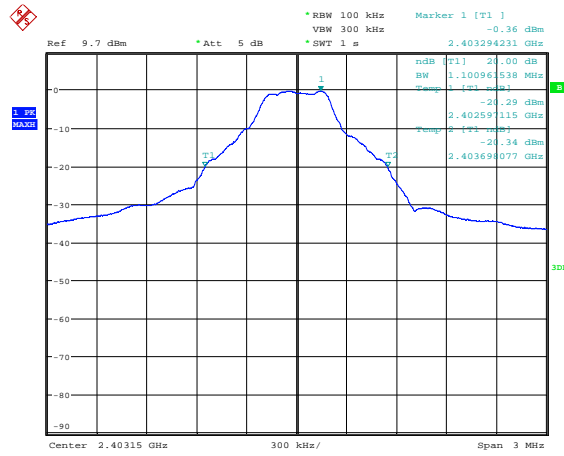
Date: 20.SEP.2012 11:15:23

20dB Bandwidth – 2442 MHz – Radio 1



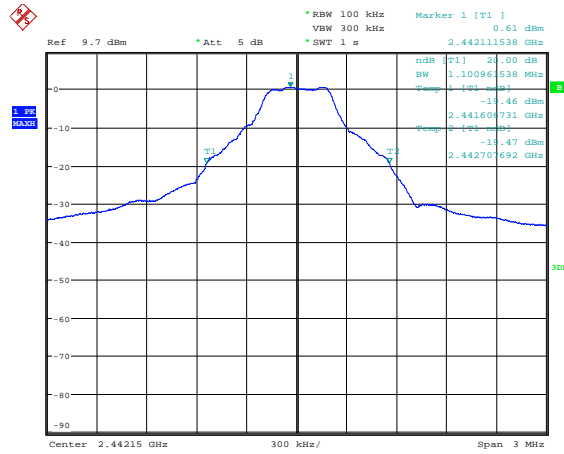
Date: 20.SEP.2012 11:12:27

20dB Bandwidth – 2481 MHz – Radio 1



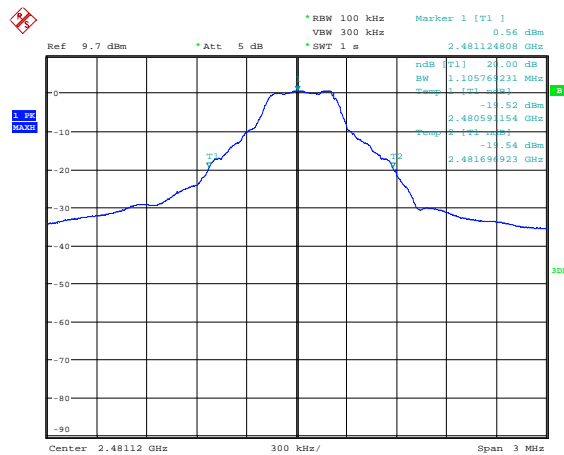
Date: 20.SEP.2012 11:38:29

20dB Bandwidth – 2403 MHz – Radio 2



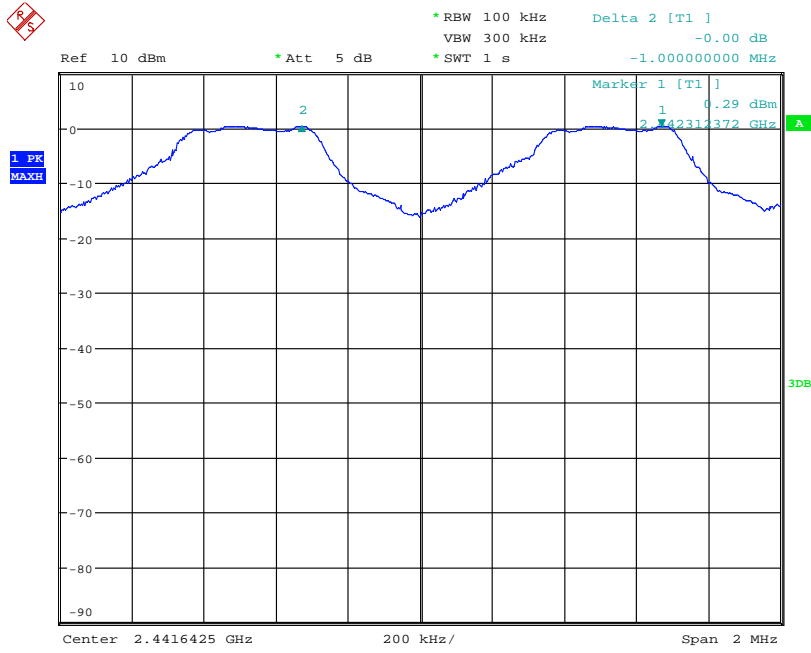
Date: 20.SEP.2012 11:39:38

20dB Bandwidth – 2442 MHz – Radio 2



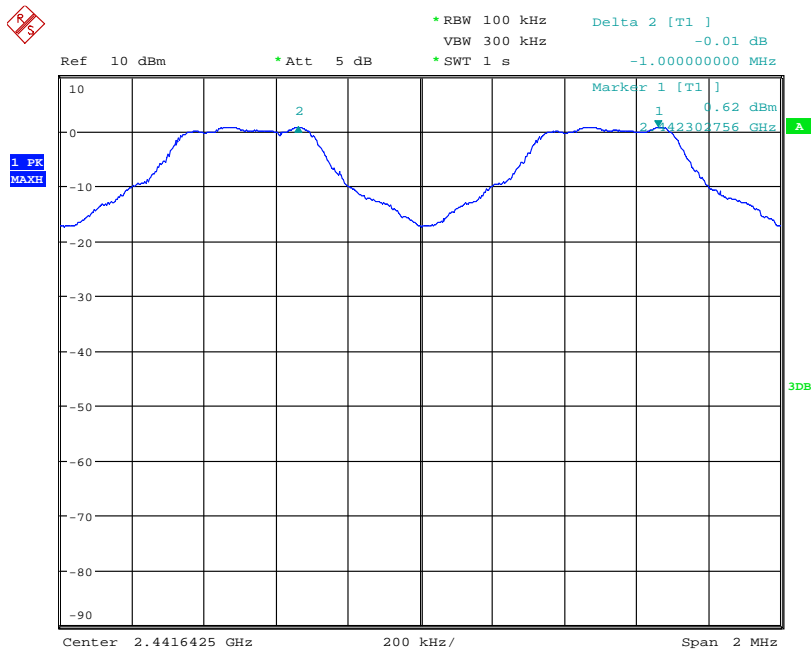
Date: 20.SEP.2012 11:43:04

20dB Bandwidth – 2481 MHz – Radio 2



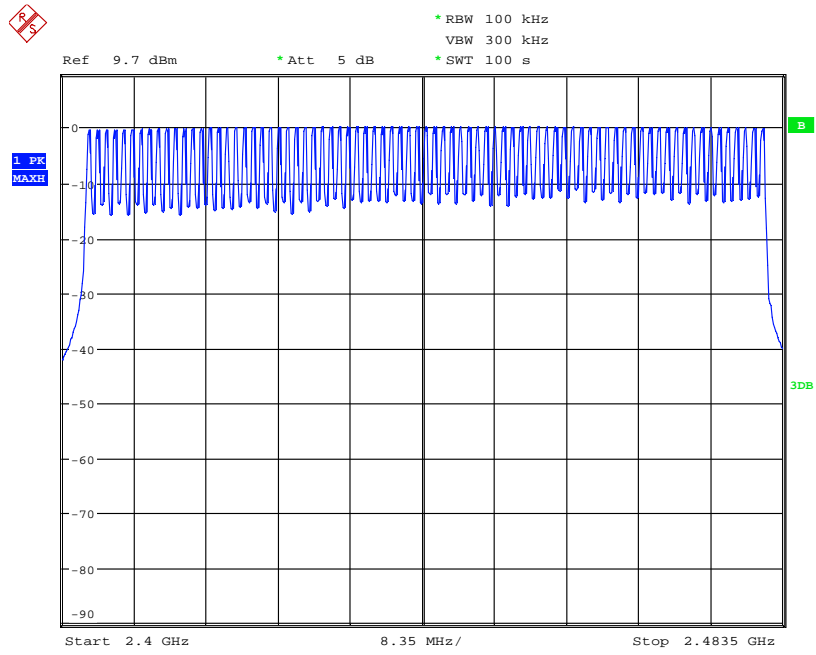
Date: 20.SEP.2012 11:21:08

Channel Spacing – Radio 1



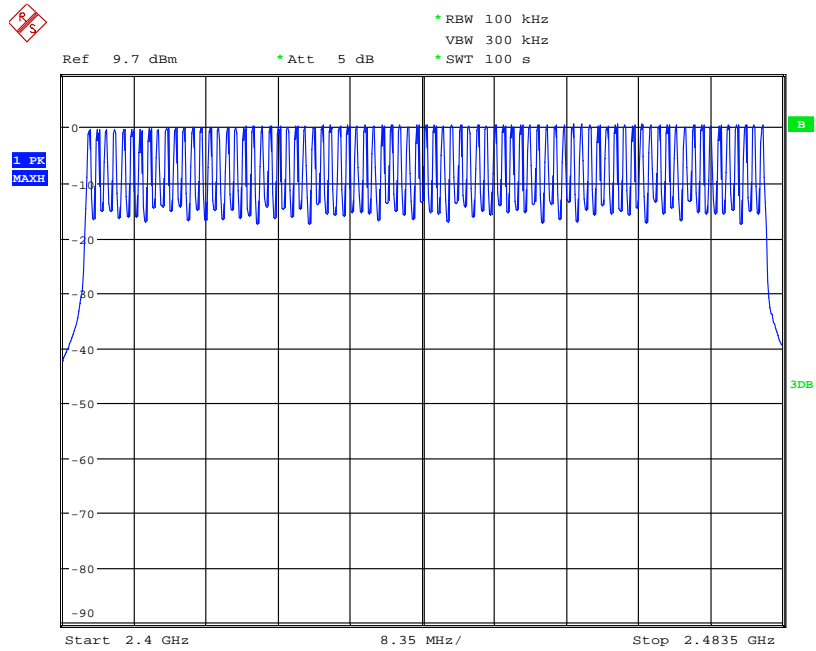
Date: 20.SEP.2012 11:26:12

Channel Spacing – Radio 2



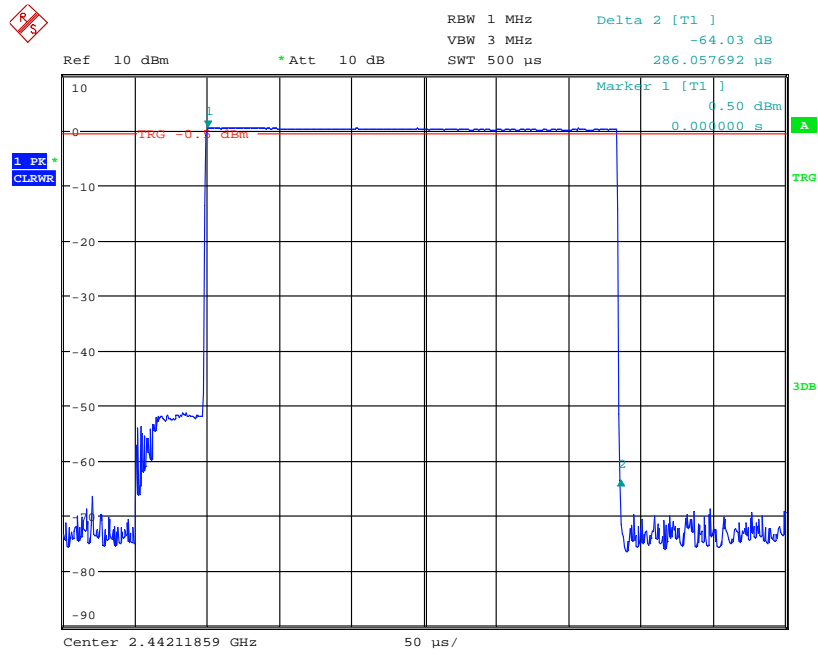
Date: 20.SEP.2012 11:56:58

Number of Hopping Channels – Radio 1



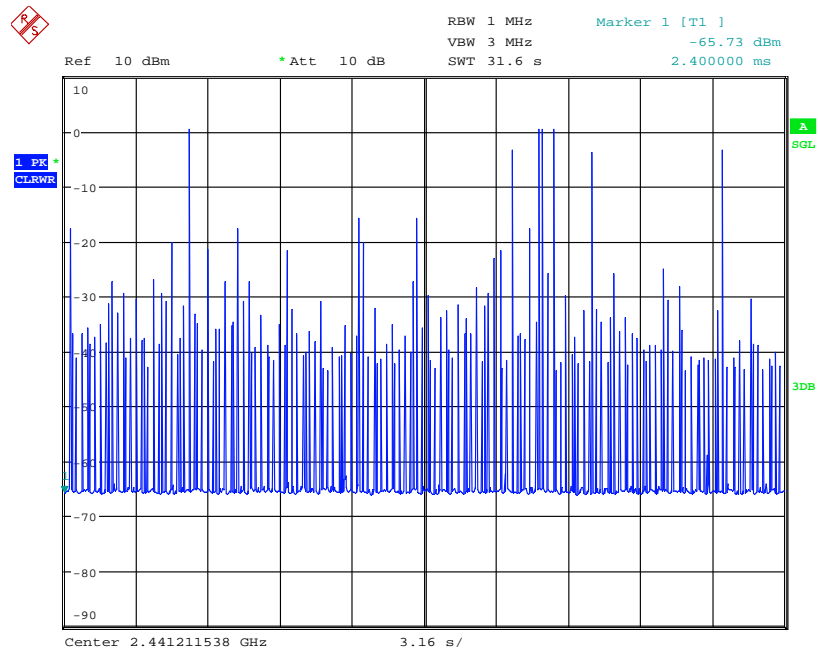
Date: 20.SEP.2012 11:47:18

Number of Hopping Channels – Radio 2



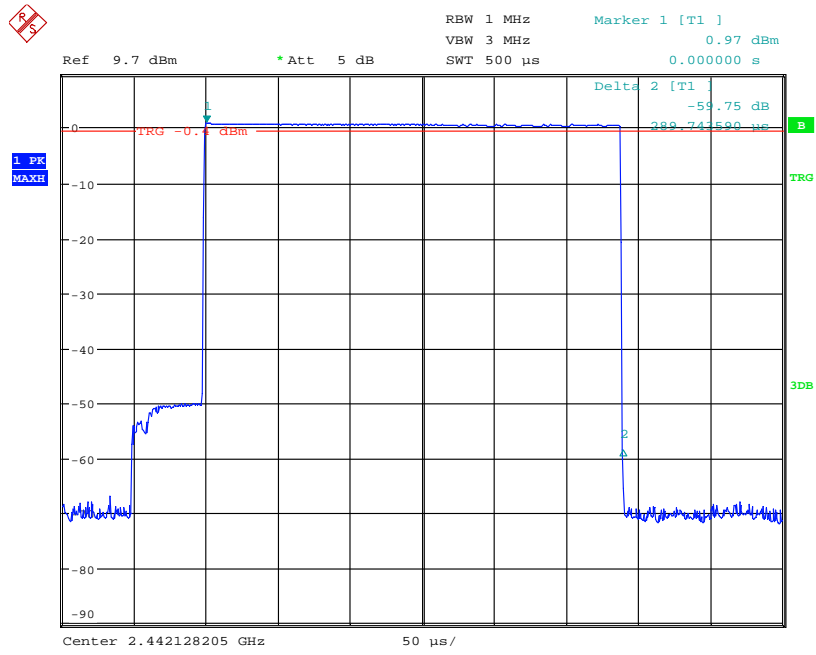
Date: 20.SEP.2012 16:11:15

Channel Occupancy Time – Radio 1



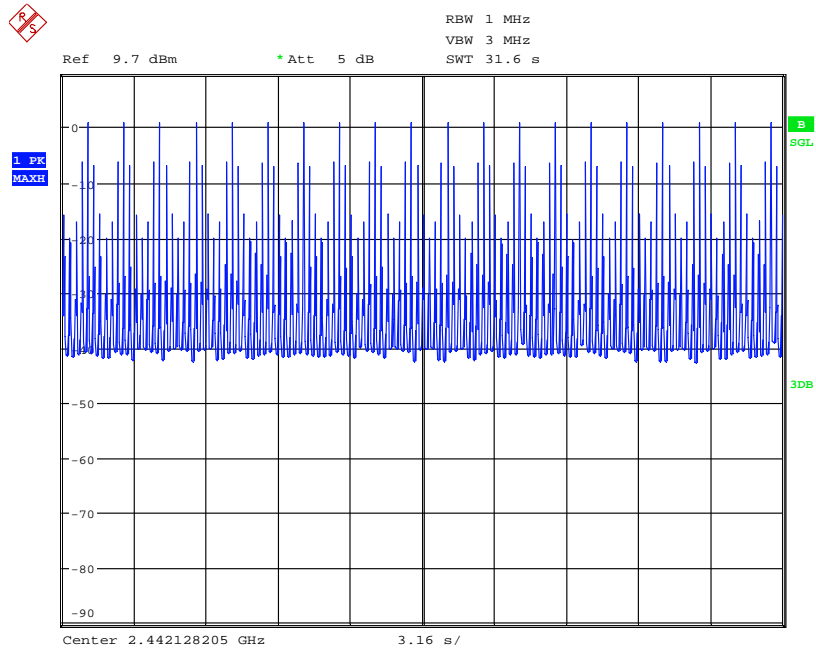
Date: 20.SEP.2012 16:28:38

Transmissions in Specified Averaging Period – Radio 1



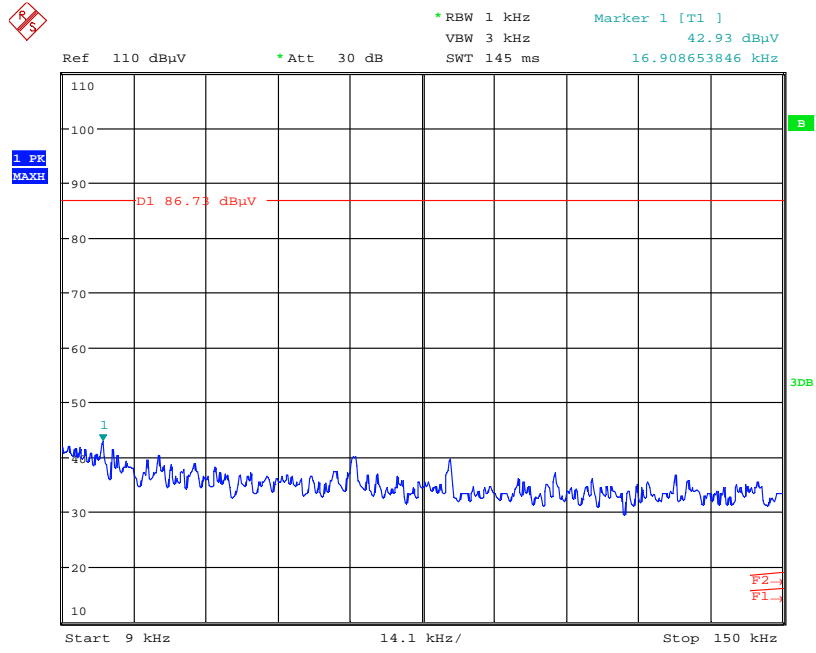
Date: 20.SEP.2012 14:02:11

Channel Occupancy Time – Radio 2



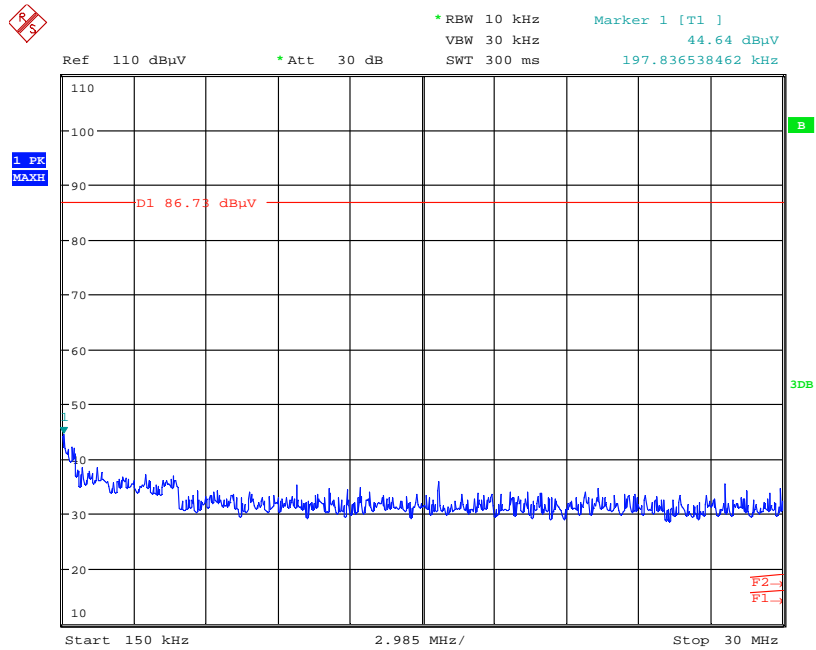
Date: 20.SEP.2012 14:04:41

Transmissions in Specified Averaging Period – Radio 2



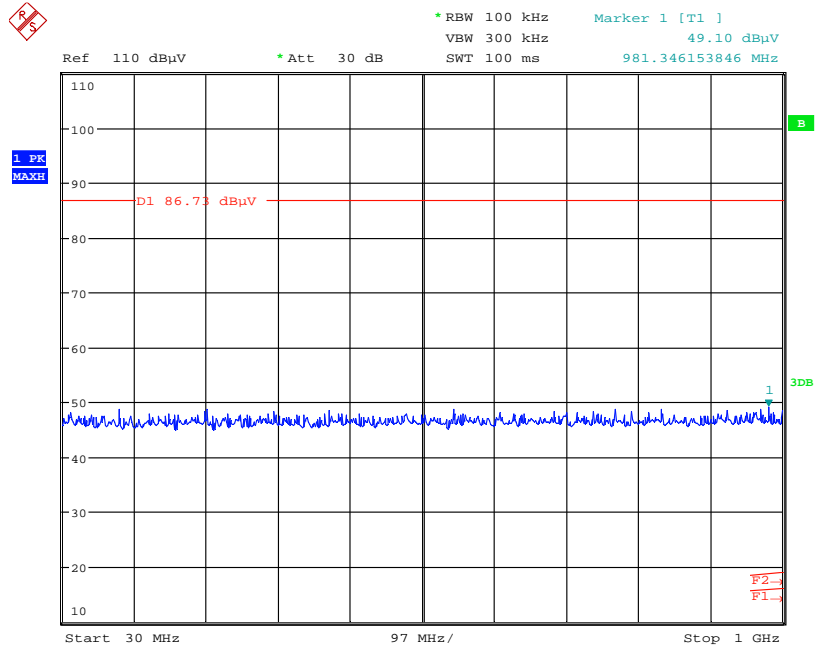
Date: 20.SEP.2012 15:32:44

Conducted Spurious emissions 9kHz to 150kHz – 2403MHz – Radio 1



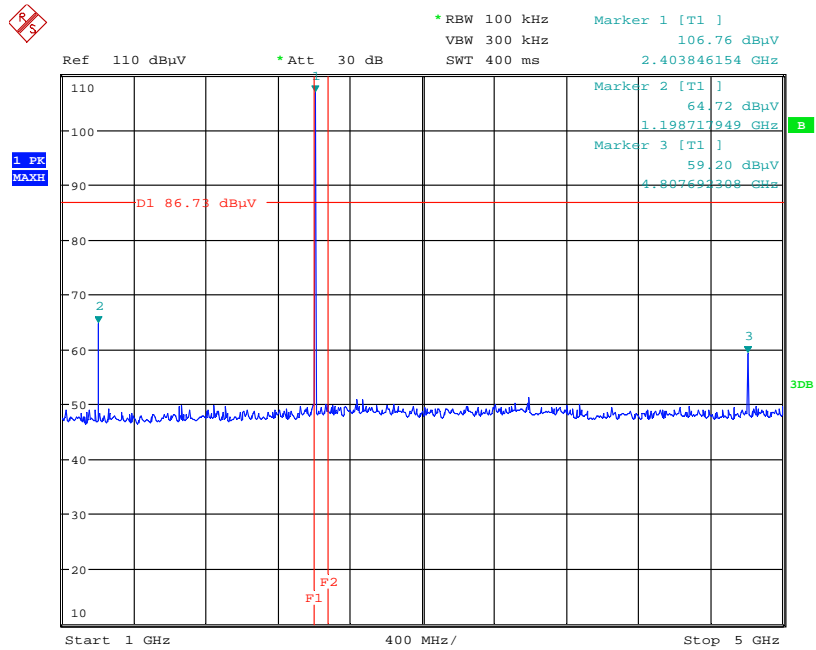
Date: 20.SEP.2012 15:33:04

Conducted Spurious emissions 150kHz to 30MHz – 2403MHz – Radio 1



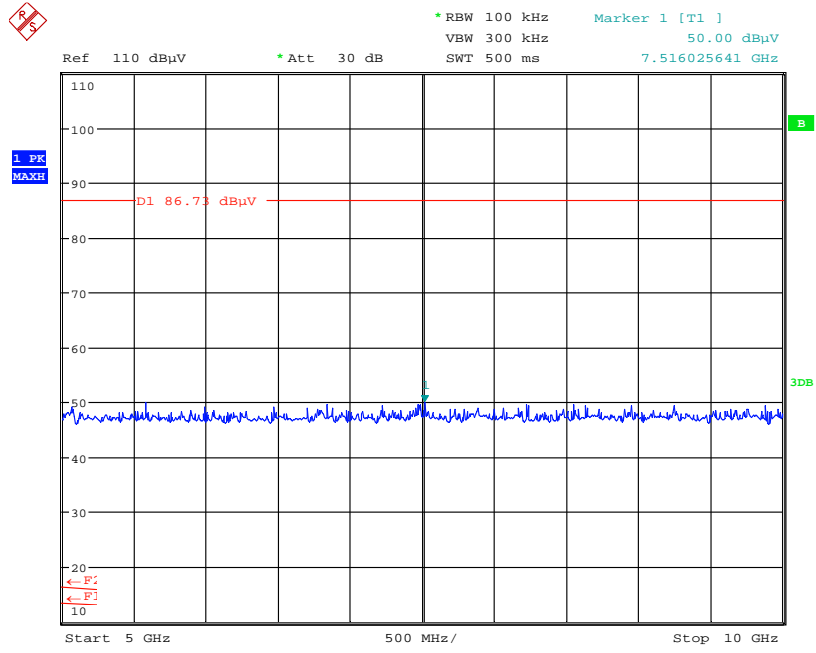
Date: 20.SEP.2012 15:33:27

Conducted Spurious emissions 30 MHz to 1 GHz – 2403MHz – Radio 1



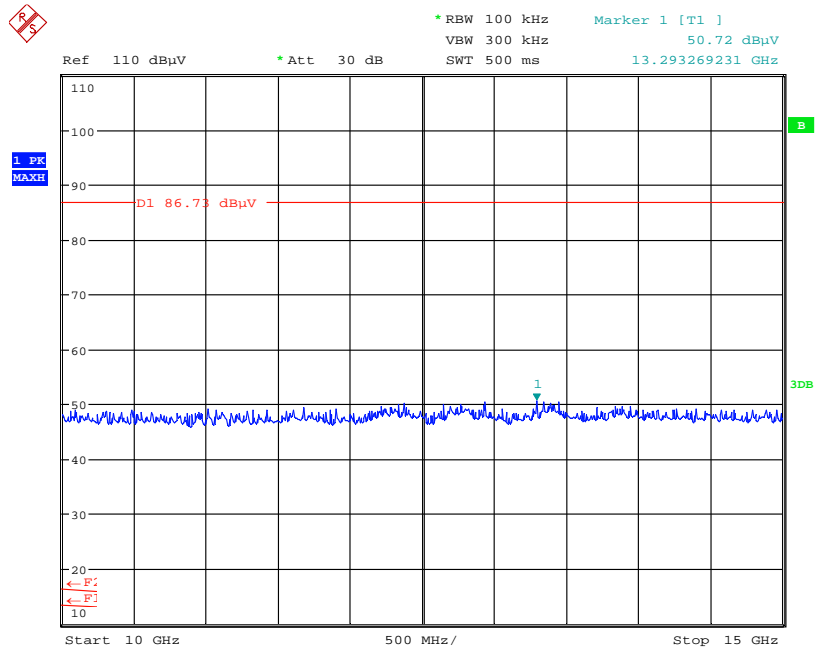
Date: 20.SEP.2012 15:31:28

Conducted Spurious emissions 1 GHz to 5 GHz – 2403MHz – Radio 1



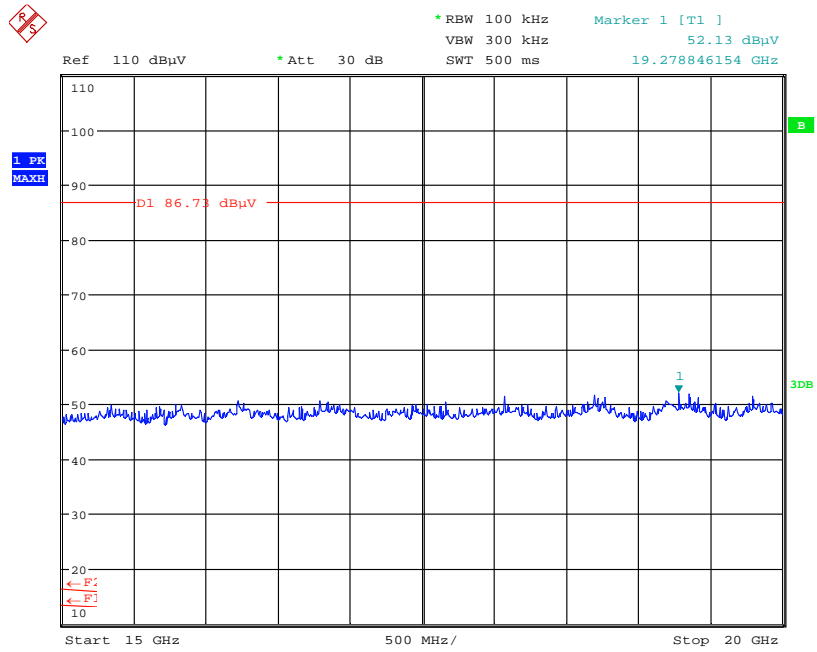
Date: 20.SEP.2012 15:31:43

Conducted Spurious emissions 5 GHz to 10 GHz – 2403MHz – Radio 1



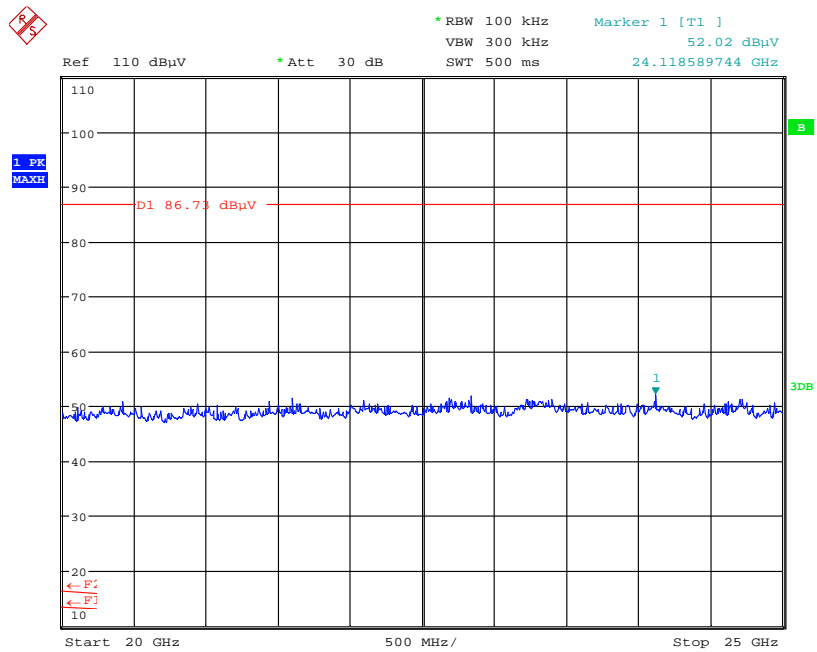
Date: 20.SEP.2012 15:31:58

Conducted Spurious emissions 10 GHz to 15 GHz – 2403MHz – Radio 1



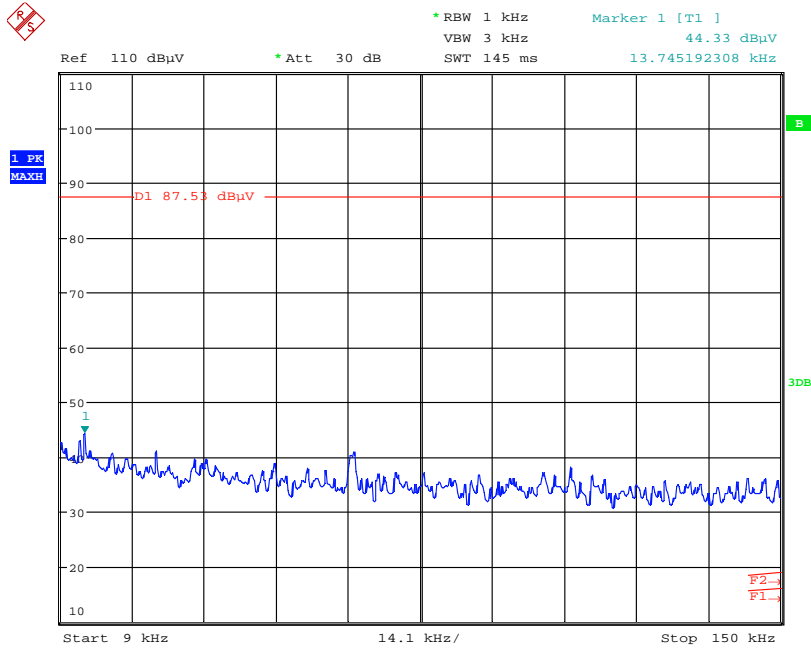
Date: 20.SEP.2012 15:32:12

Conducted Spurious emissions 15 GHz to 20 GHz – 2403MHz – Radio 1



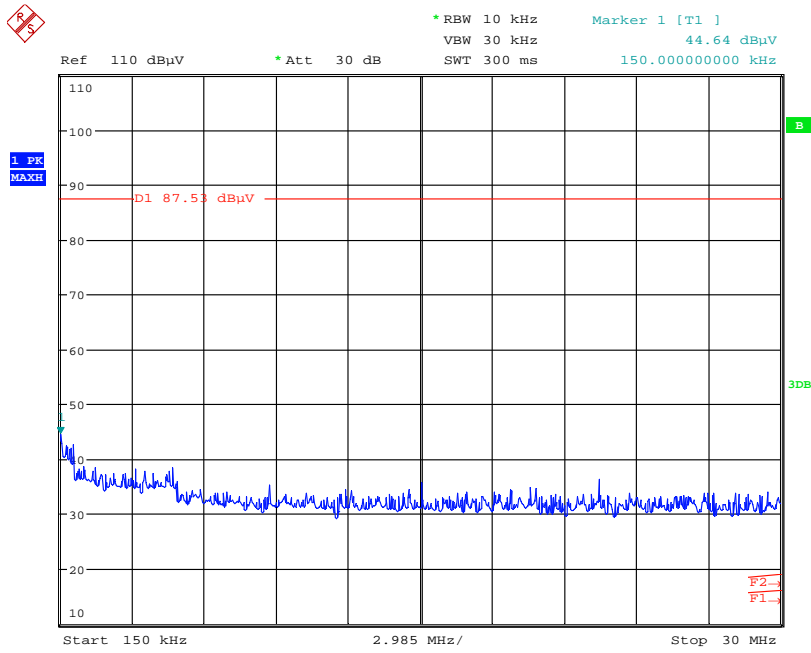
Date: 20.SEP.2012 15:32:28

Conducted Spurious emissions 20 GHz to 25 GHz – 2403MHz – Radio 1



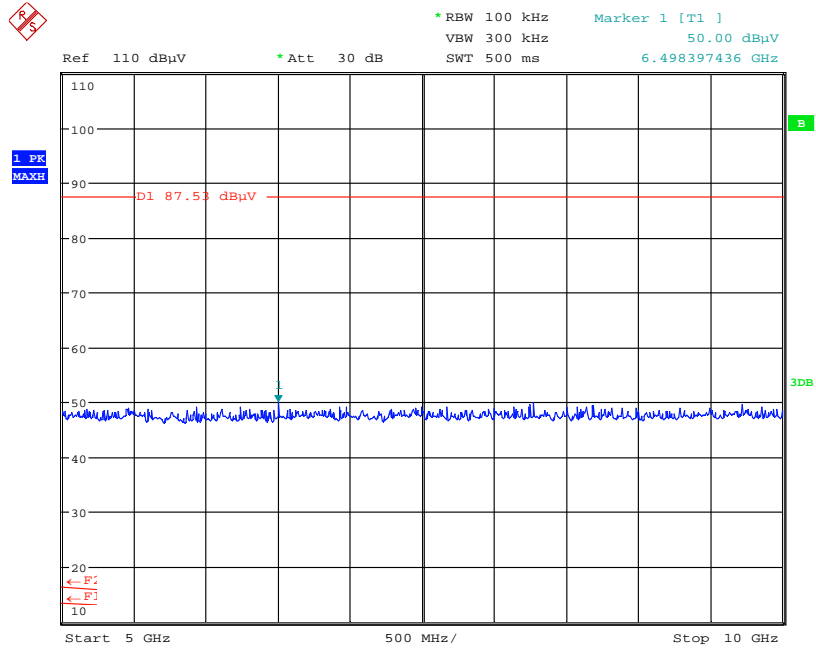
Date: 20.SEP.2012 15:35:28

Conducted Spurious emissions 9kHz to 150kHz – 2442MHz – Radio 1



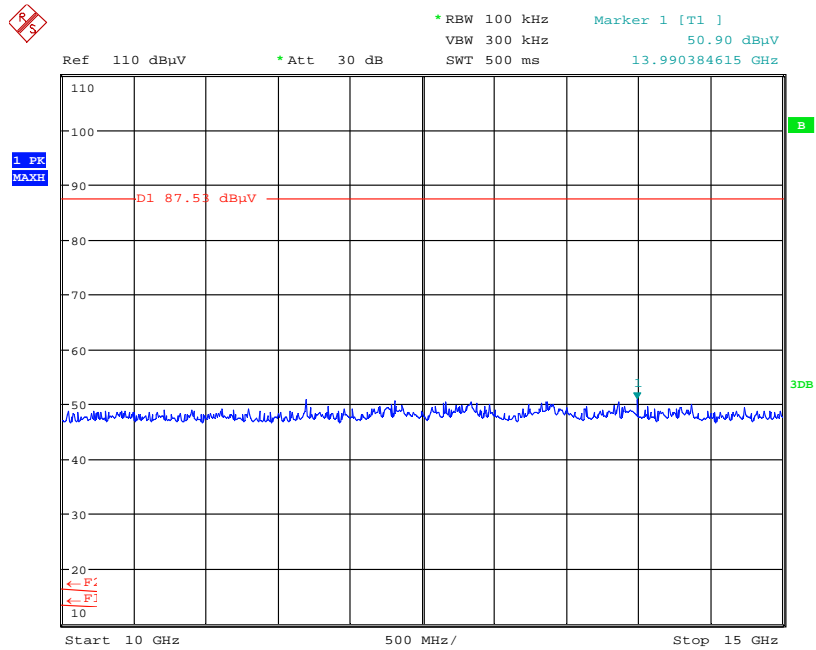
Date: 20.SEP.2012 15:35:54

Conducted Spurious emissions 150kHz to 30MHz – 2442MHz – Radio 1



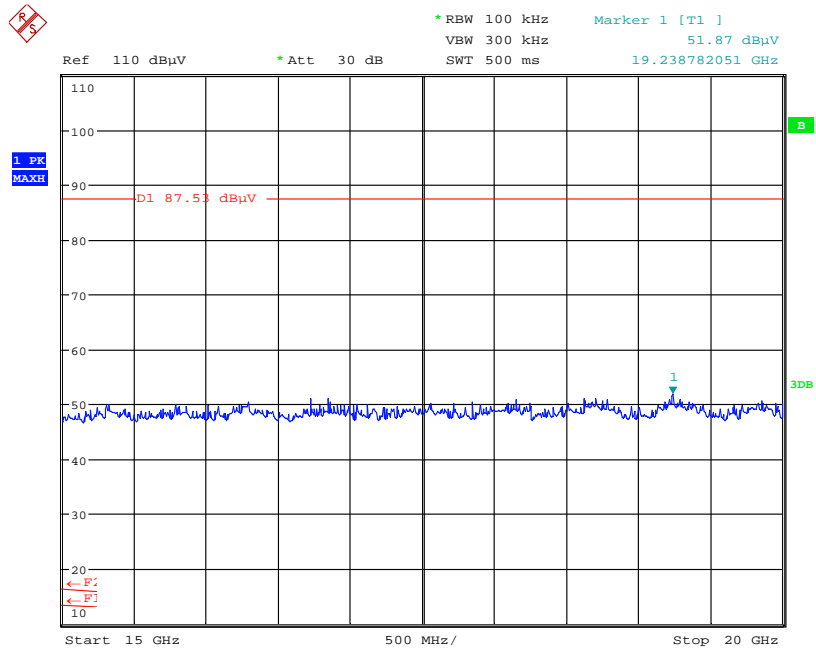
Date: 20.SEP.2012 15:34:19

Conducted Spurious emissions 5 GHz to 10 GHz – 2442 MHz – Radio 1



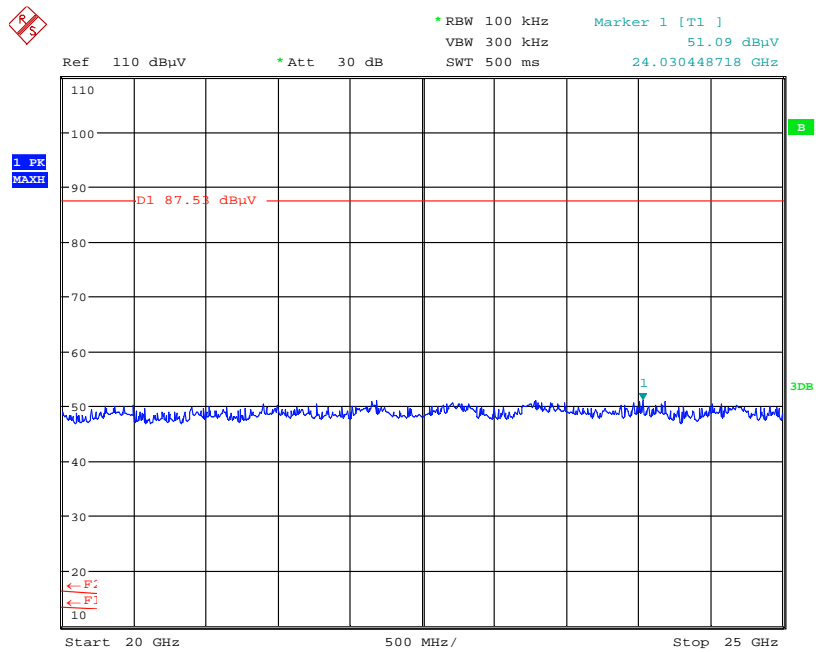
Date: 20.SEP.2012 15:34:39

Conducted Spurious emissions 10 GHz to 15GHz – 2442 MHz – Radio 1



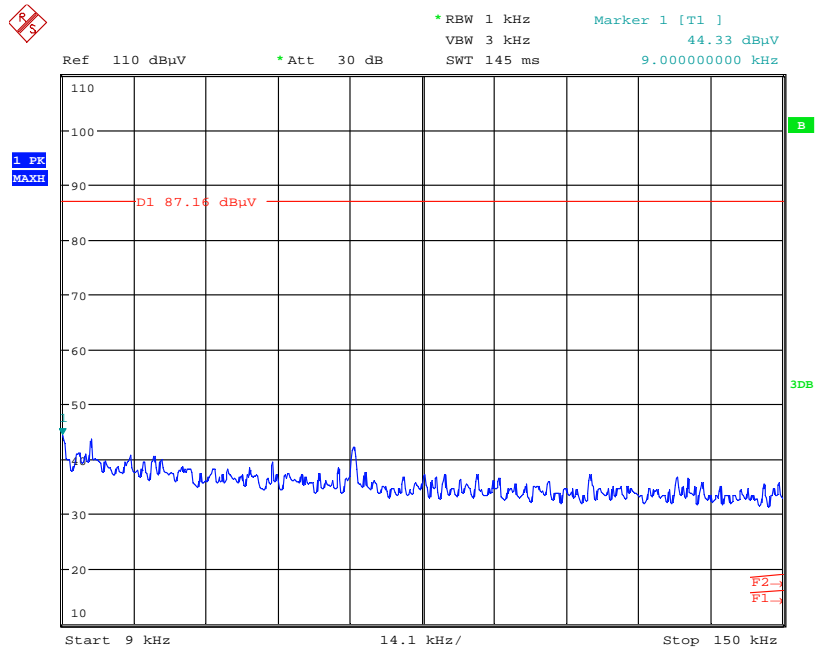
Date: 20.SEP.2012 15:34:56

Conducted Spurious emissions 15 GHz to 20GHz – 2442 MHz– Radio 1



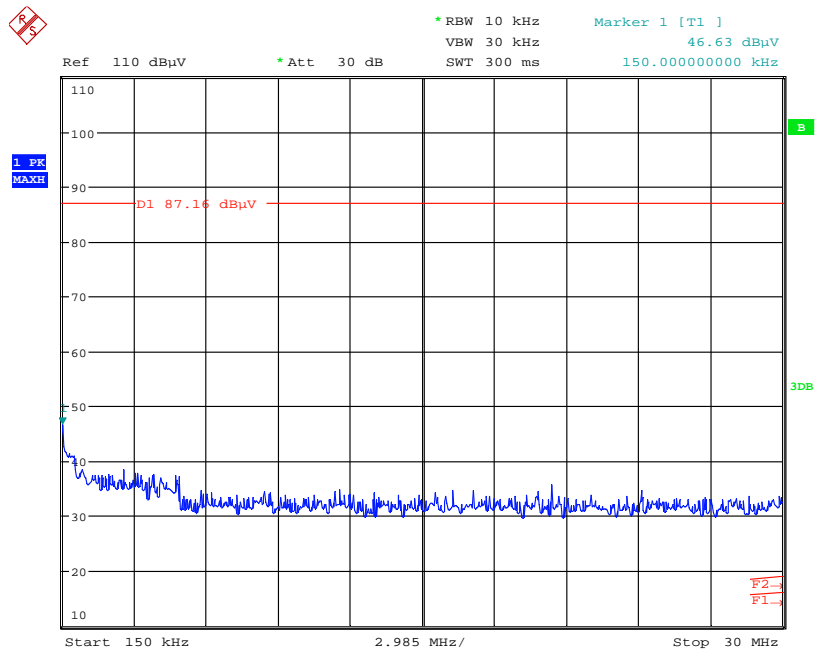
Date: 20.SEP.2012 15:35:09

Conducted Spurious emissions 20 GHz to 25GHz – 2442 MHz– Radio 1



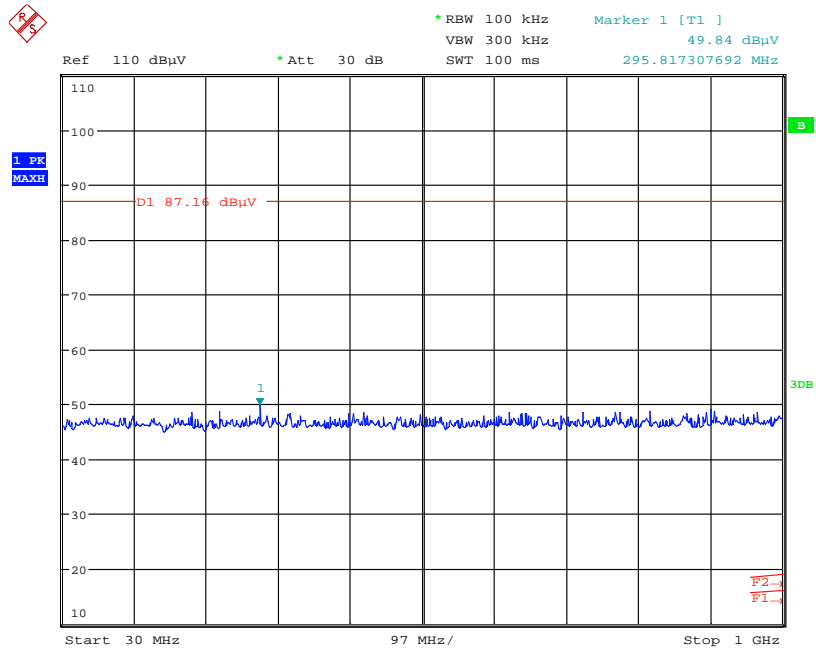
Date: 20.SEP.2012 15:38:10

Conducted Spurious emissions 9kHz to 150kHz – 2481MHz – Radio 1



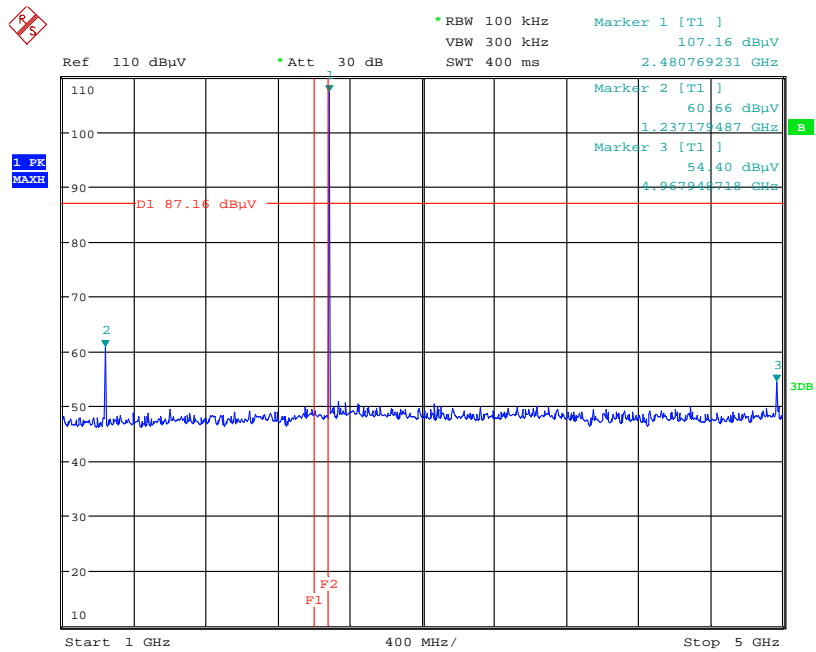
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Conducted Spurious emissions 150kHz to 30MHz – 2481MHz – Radio 1



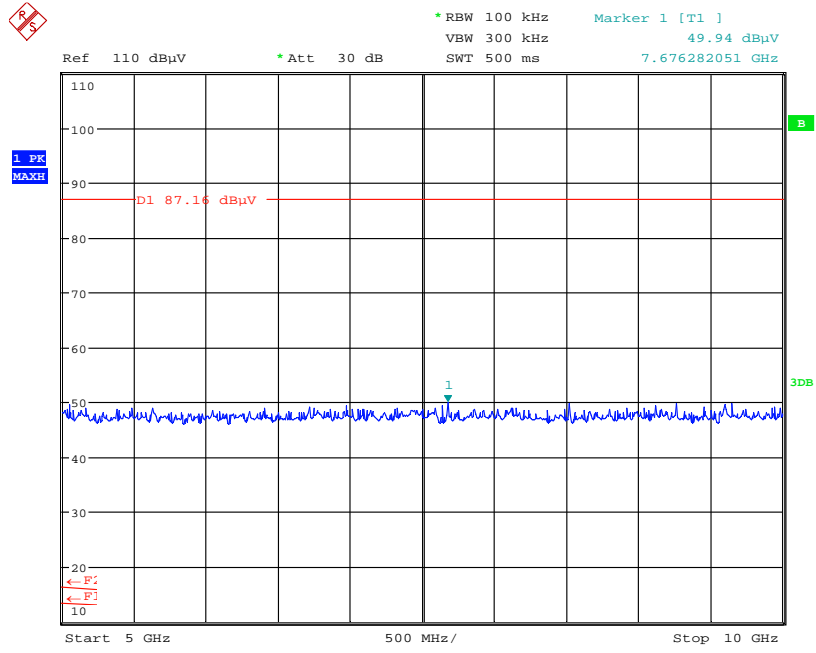
Date: 20.SEP.2012 15:38:53

Conducted Spurious emissions 30 MHz to 1 GHz – 2481MHz – Radio 1



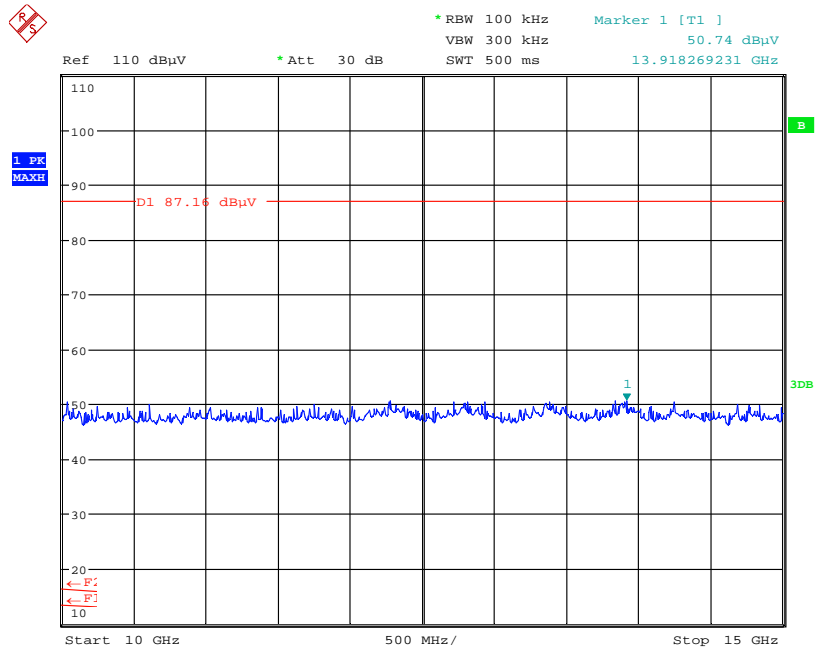
Date: 20.SEP.2012 15:36:39

Conducted Spurious emissions 1 GHz to 5 GHz – 2481MHz – Radio 1



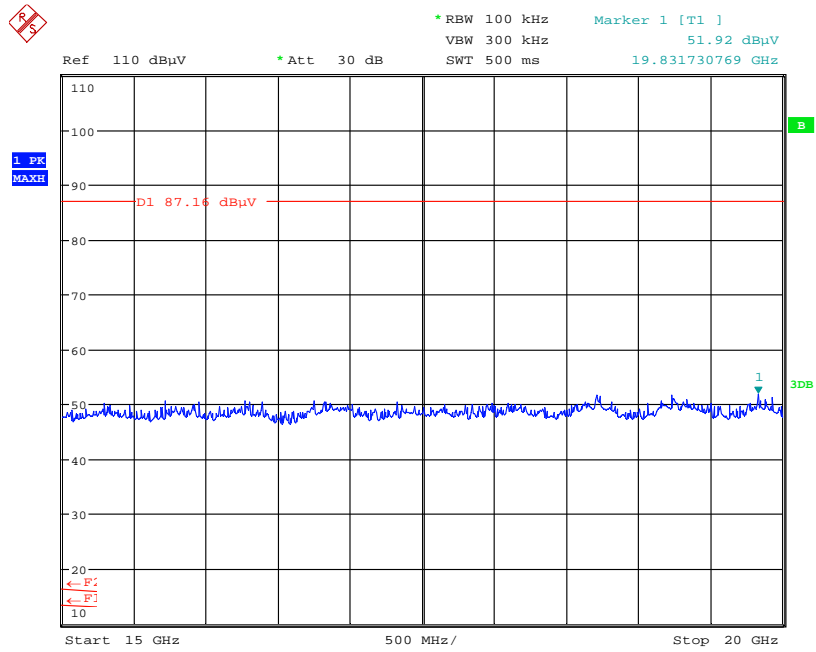
Date: 20.SEP.2012 15:36:56

Conducted Spurious emissions 5 GHz to 10 GHz – 2481MHz – Radio 1



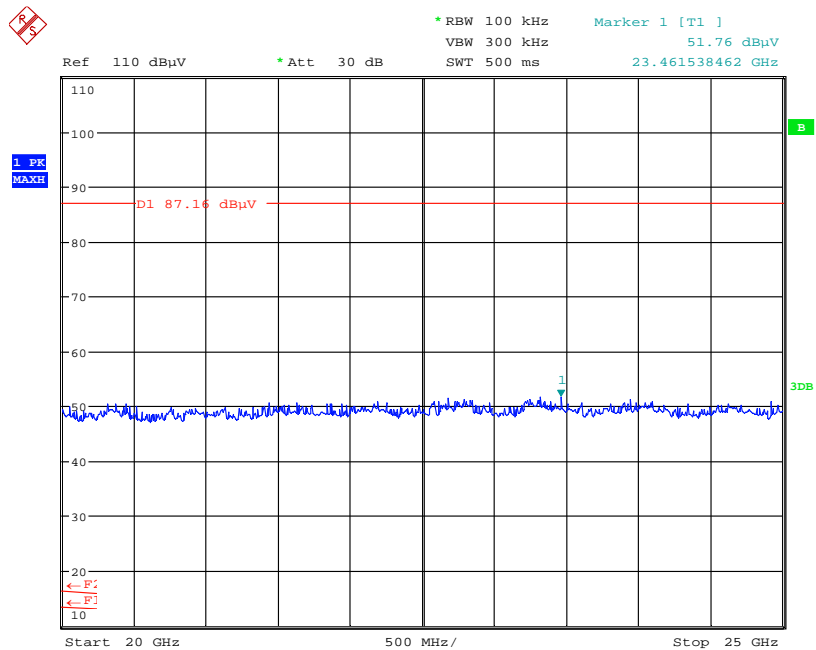
Date: 20.SEP.2012 15:37:12

Conducted Spurious emissions 10 GHz to 15 GHz – 2481MHz – Radio 1



Date: 20.SEP.2012 15:37:29

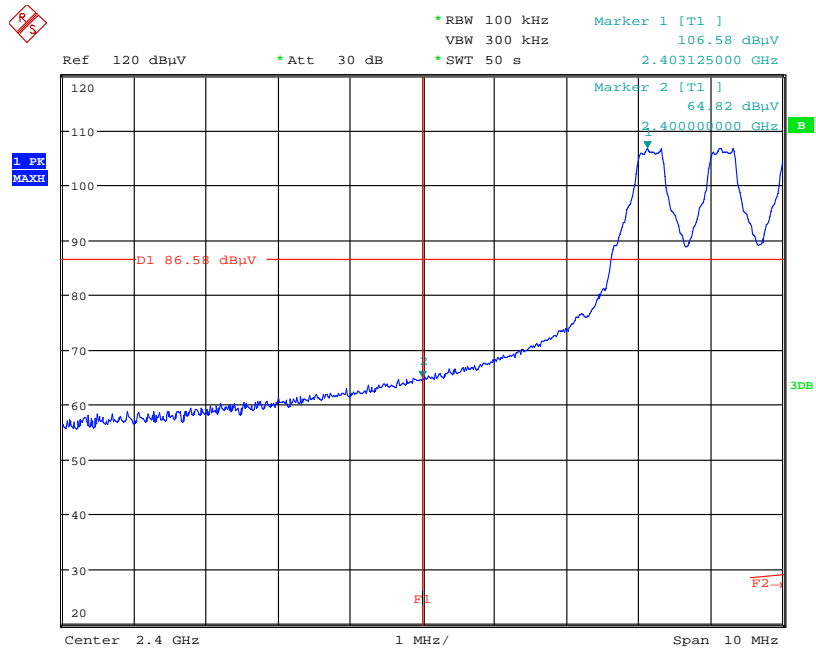
Conducted Spurious emissions 15 GHz to 20 GHz– 2481MHz – Radio 1



Date: 20.SEP.2012 15:37:49

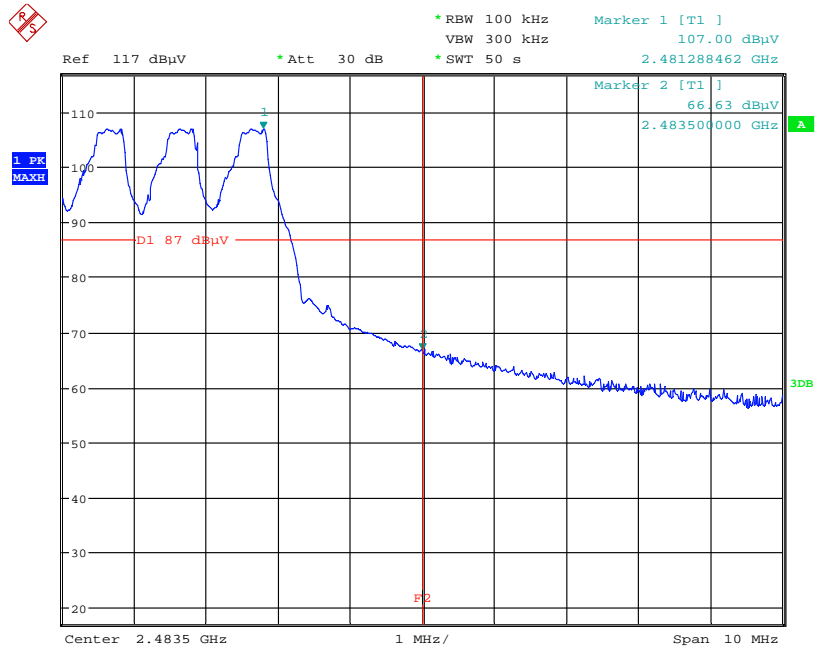
Conducted Spurious emissions 20 GHz to 25 GHz– 2481MHz – Radio 1

Conducted Bandedge Compliance– Radio 1



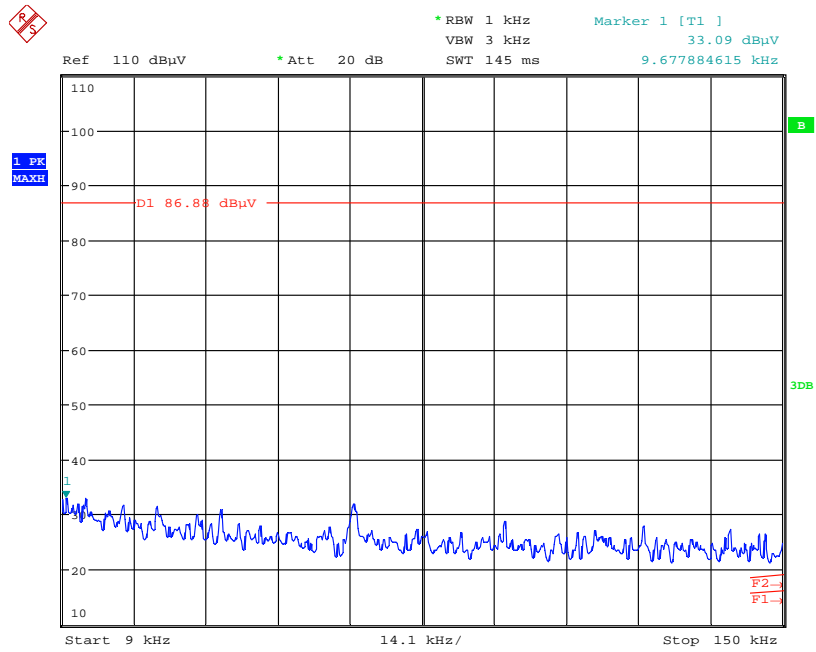
Date: 20.SEP.2012 15:43:49

Lower Bandedge



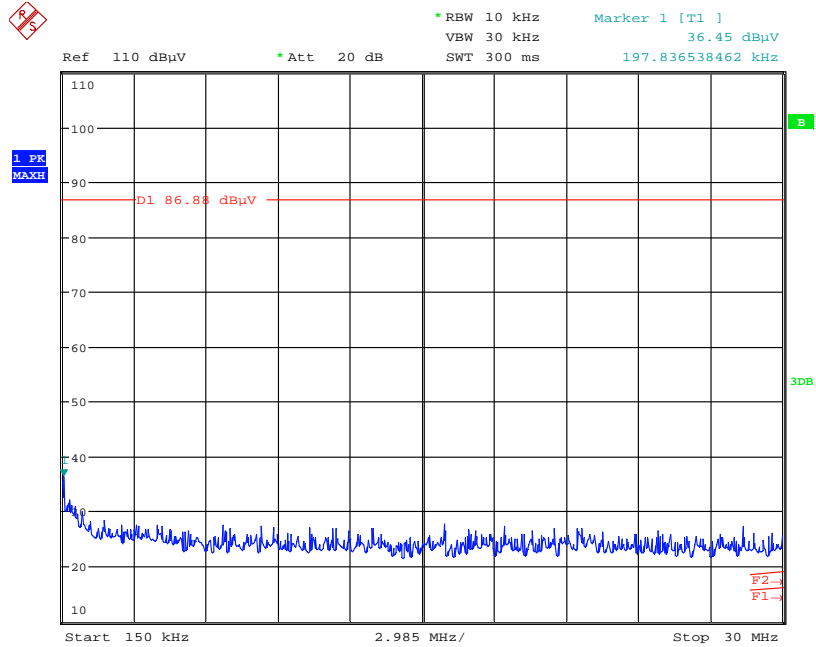
Date: 20.SEP.2012 15:45:04

Upper Bandedge



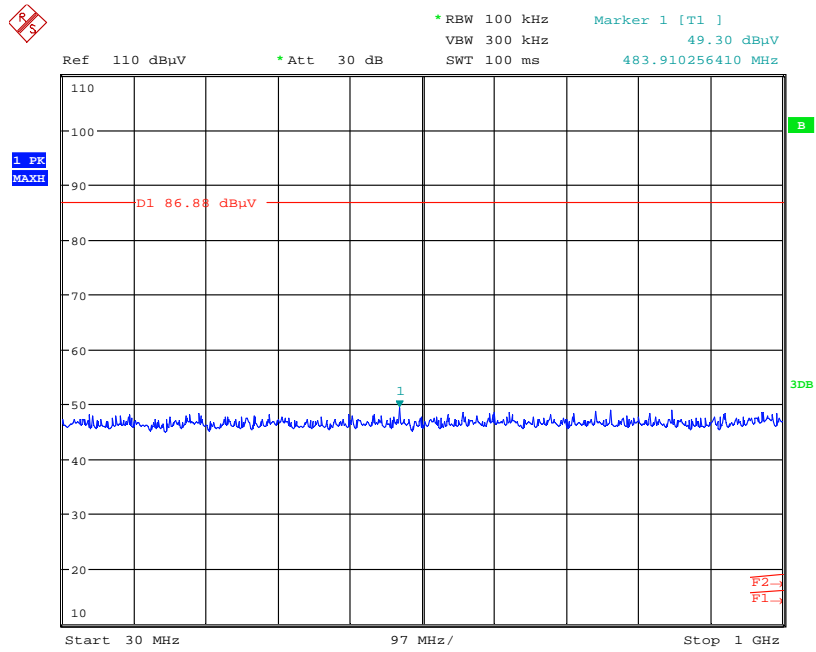
Date: 20.SEP.2012 15:23:24

Conducted Spurious emissions 9kHz to 150kHz – 2403MHz – Radio 2



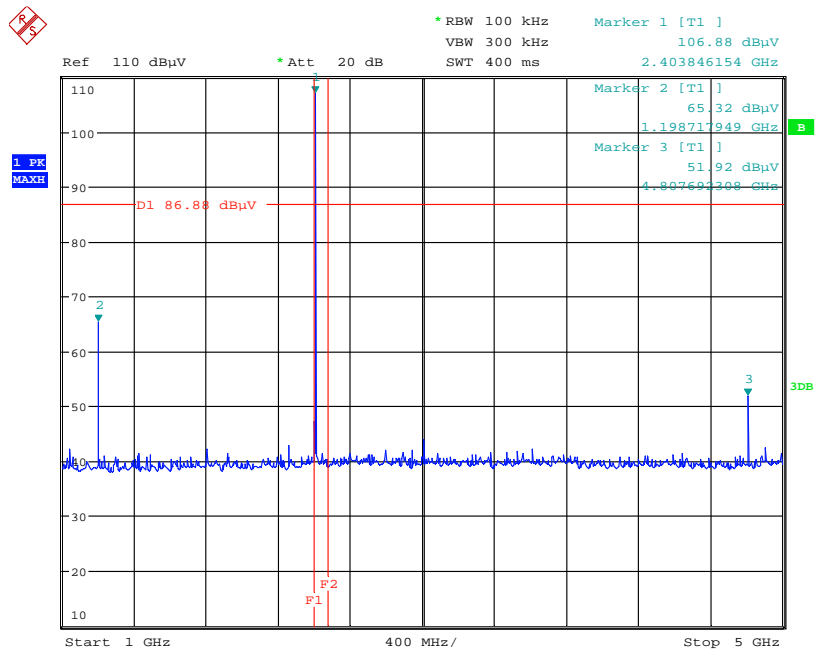
Date: 20.SEP.2012 15:23:43

Conducted Spurious emissions 150kHz to 30MHz – 2403MHz – Radio 2



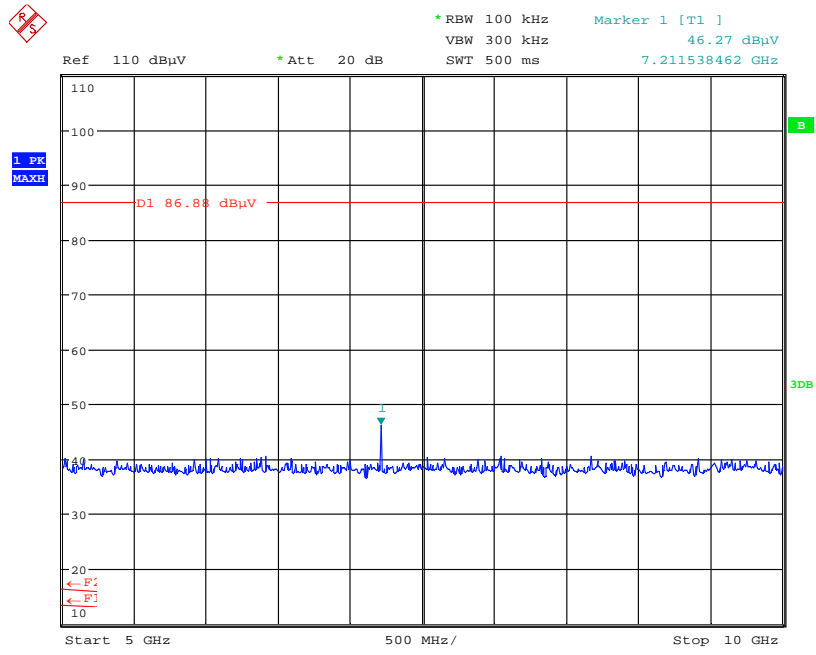
Date: 20.SEP.2012 15:24:15

Conducted Spurious emissions 30 MHz to 1 GHz – 2403MHz – Radio 2



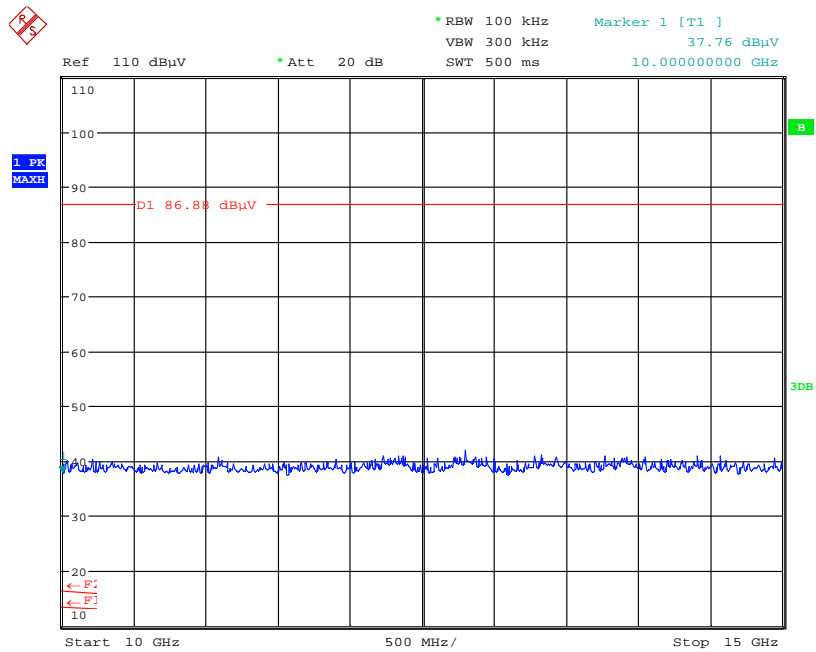
Date: 20.SEP.2012 15:21:27

Conducted Spurious emissions 1 GHz to 5 GHz – 2403MHz – Radio 2



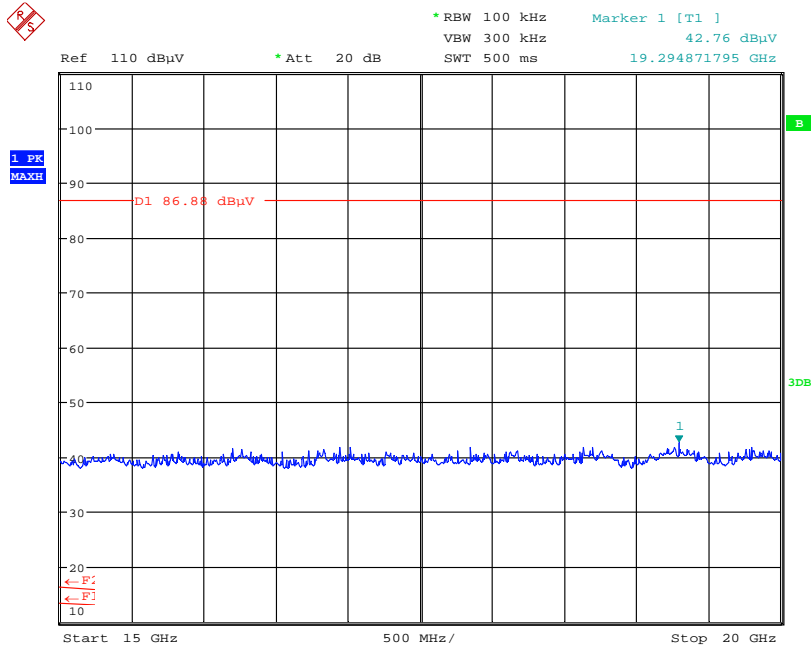
Date: 20.SEP.2012 15:21:45

Conducted Spurious emissions 5 GHz to 10 GHz – 2403MHz – Radio 2



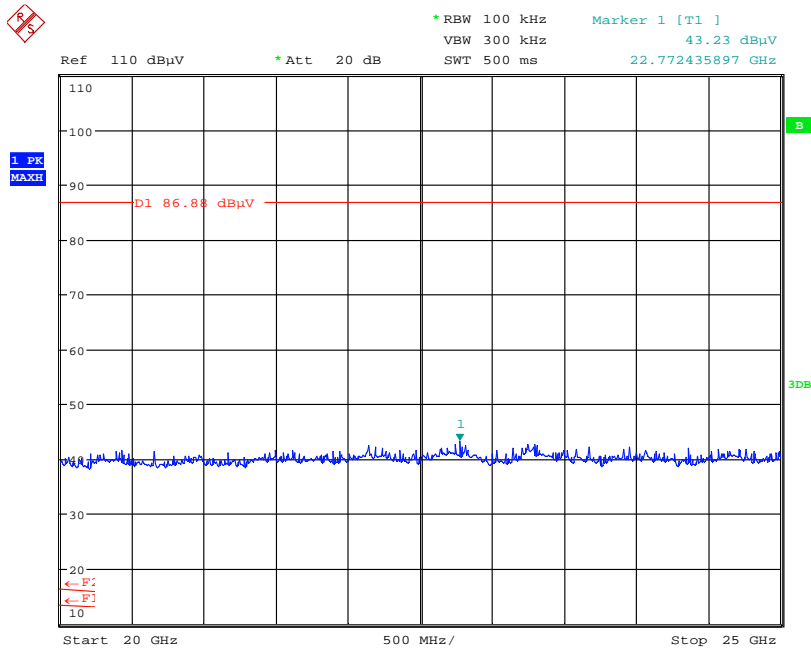
Date: 20.SEP.2012 15:22:16

Conducted Spurious emissions 10 GHz to 15 GHz – 2403MHz – Radio 2



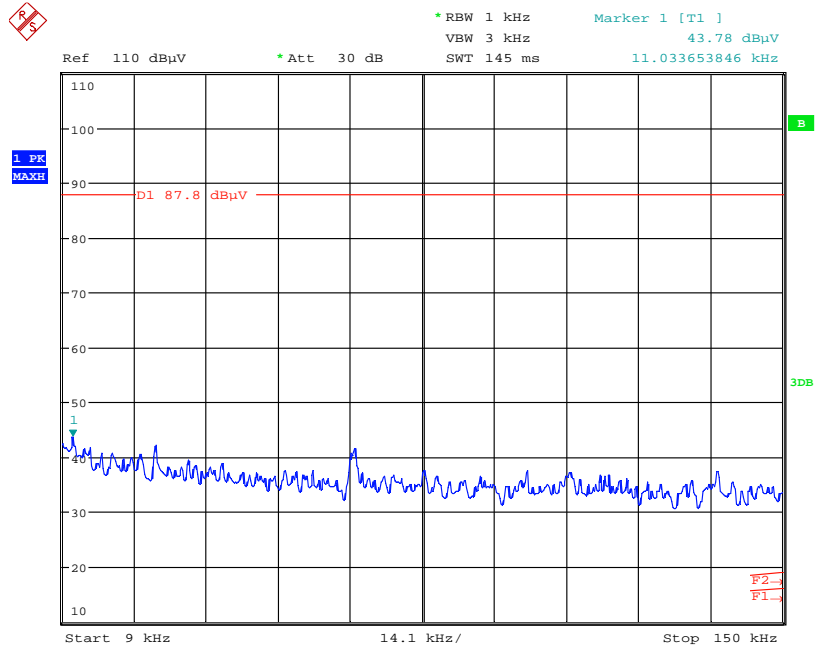
Date: 20.SEP.2012 15:22:40

Conducted Spurious emissions 15 GHz to 20 GHz – 2403MHz – Radio 2



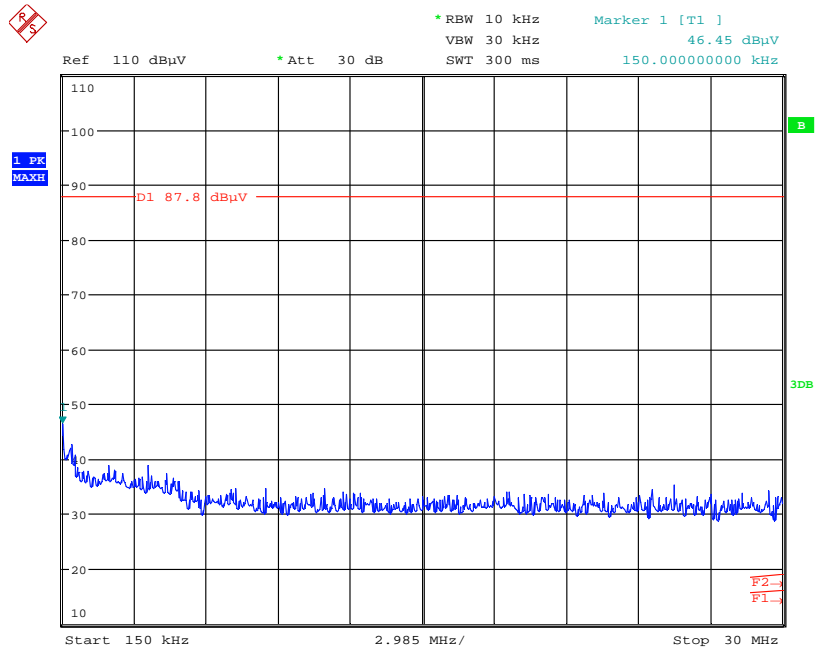
Date: 20.SEP.2012 15:23:05

Conducted Spurious emissions 20 GHz to 25 GHz – 2403MHz – Radio 2



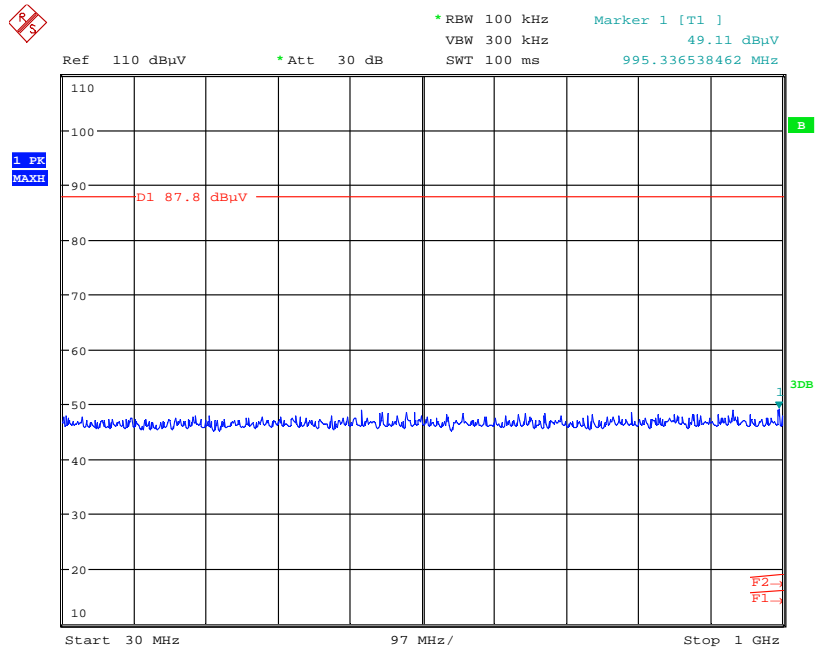
Date: 20.SEP.2012 15:26:54

Conducted Spurious emissions 9kHz to 150kHz – 2442MHz – Radio 2



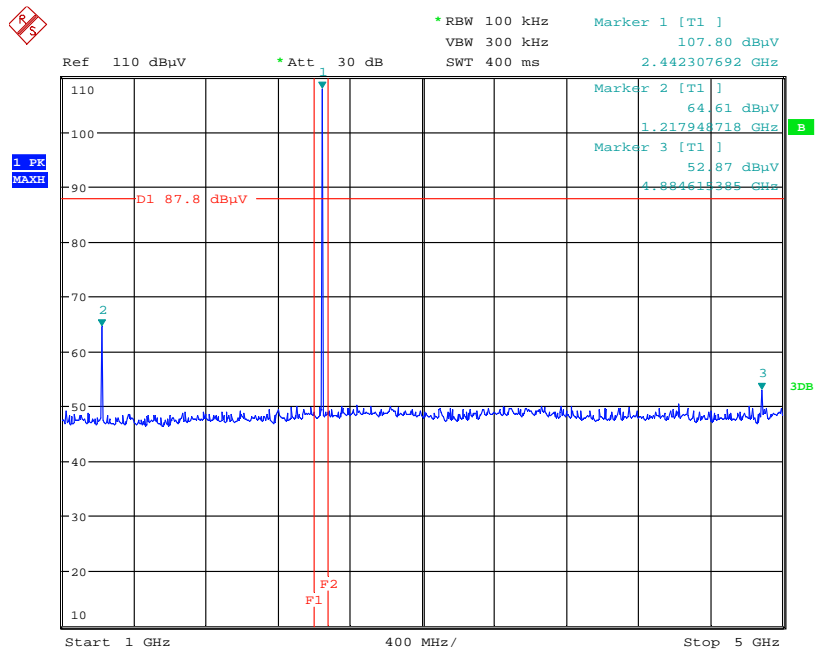
Date: 20.SEP.2012 15:27:14

Conducted Spurious emissions 150kHz to 30MHz – 2442MHz – Radio 2



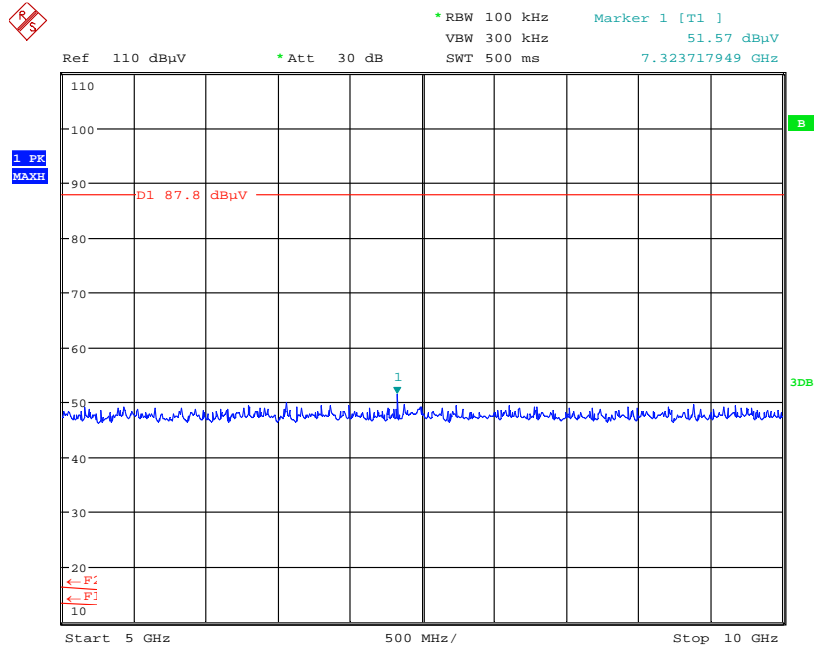
Date: 20.SEP.2012 15:27:40

Conducted Spurious emissions 30 MHz to 1 GHz – 2442 MHz – Radio 2



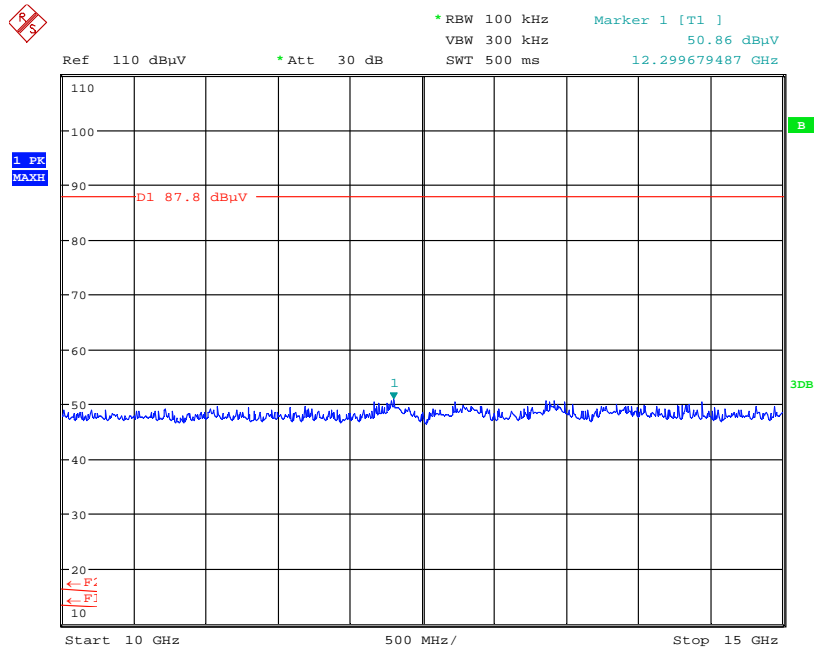
Date: 20.SEP.2012 15:24:56

Conducted Spurious emissions 1 GHz to 5 GHz – 2442 MHz – Radio 2



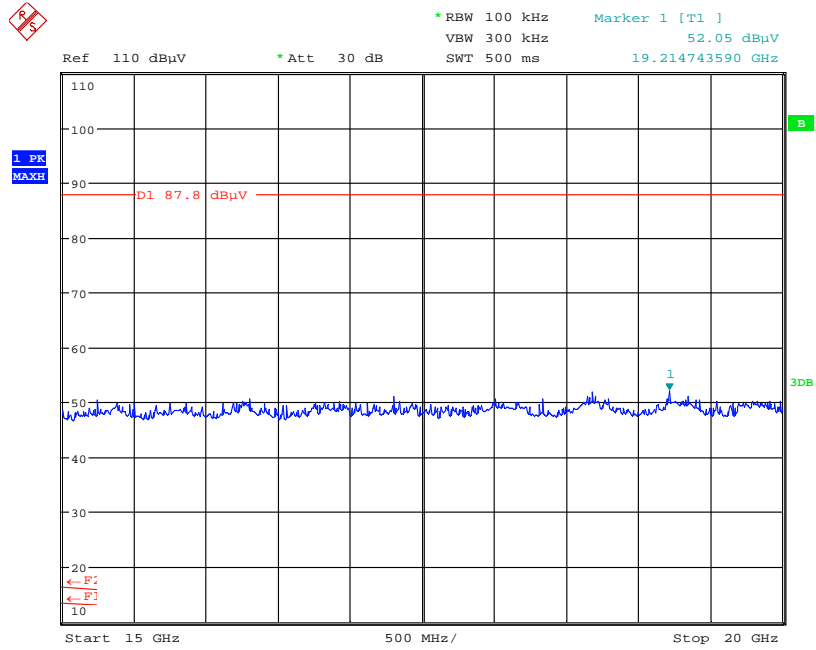
Date: 20.SEP.2012 15:25:16

Conducted Spurious emissions 5 GHz to 10 GHz – 2442 MHz – Radio 2



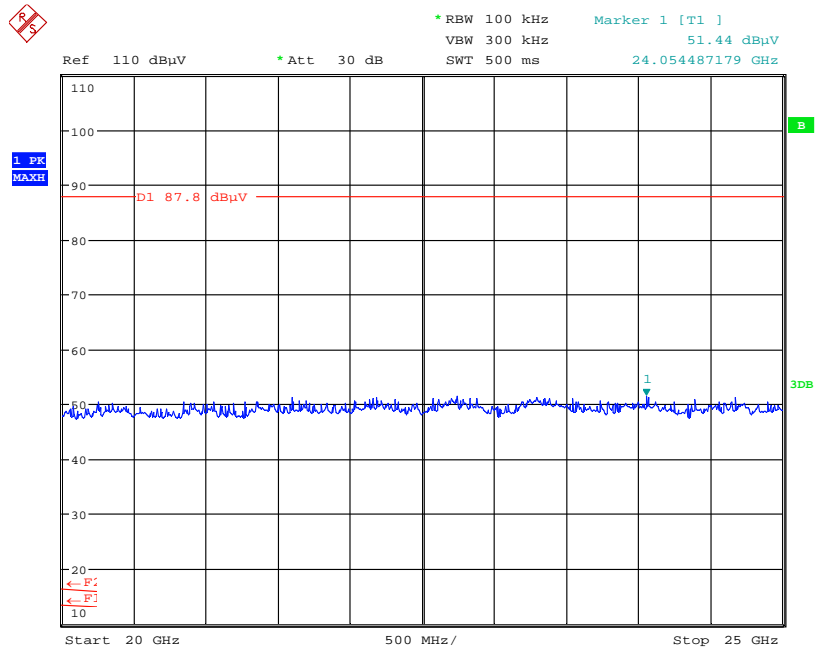
Date: 20.SEP.2012 15:25:40

Conducted Spurious emissions 10 GHz to 15GHz – 2442 MHz – Radio 2



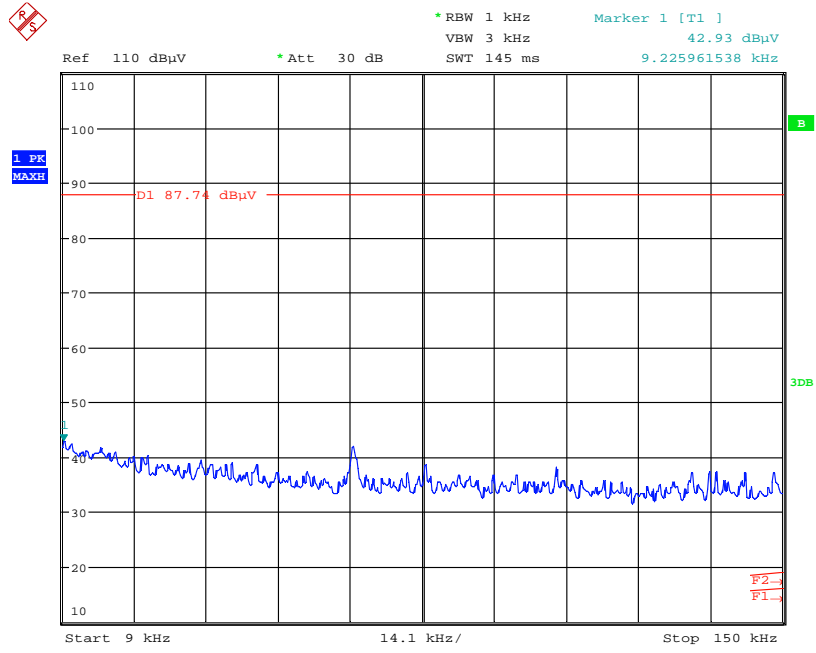
Date: 20.SEP.2012 15:25:57

Conducted Spurious emissions 15 GHz to 20GHz – 2442 MHz– Radio 2



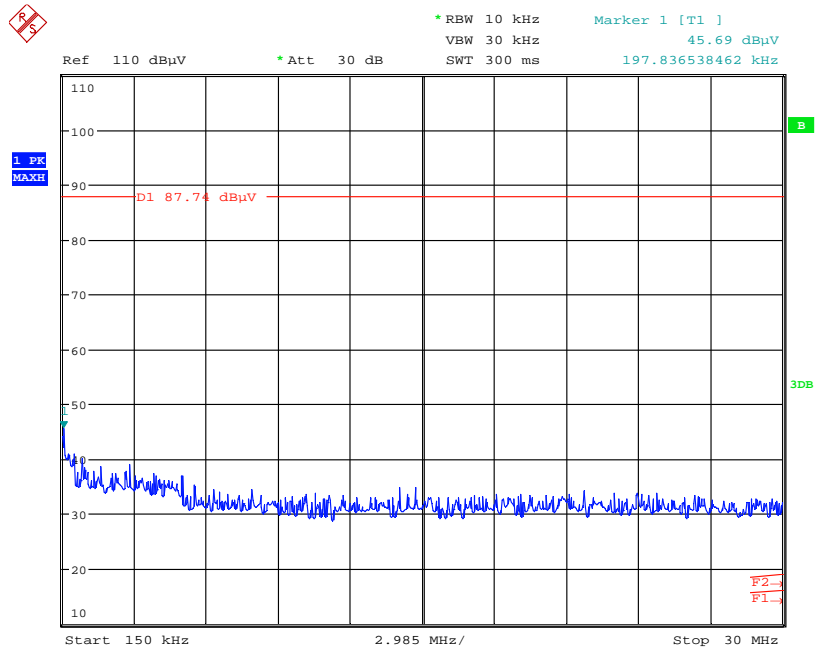
Date: 20.SEP.2012 15:26:17

Conducted Spurious emissions 20 GHz to 25GHz – 2442 MHz– Radio 2



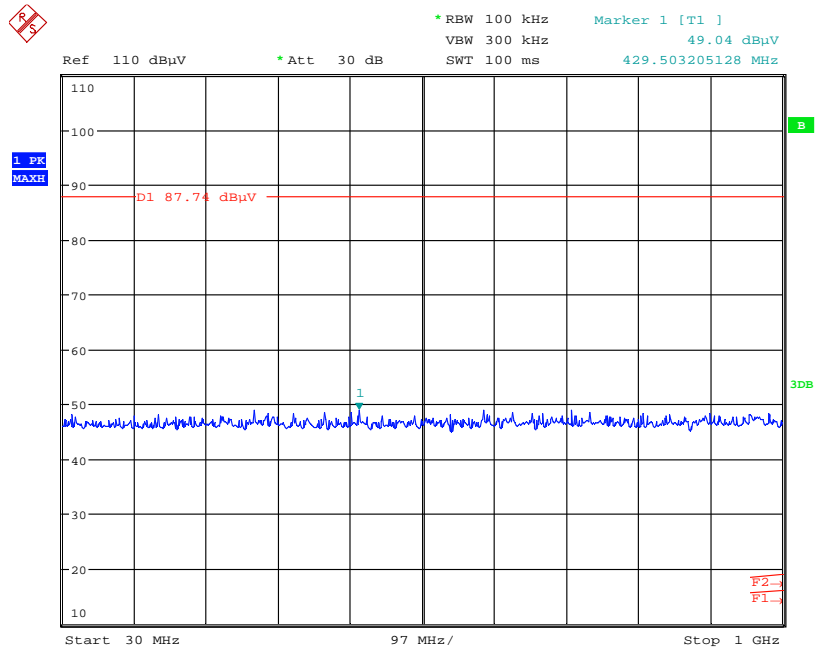
Date: 20.SEP.2012 15:29:41

Conducted Spurious emissions 9kHz to 150kHz – 2481MHz – Radio 2



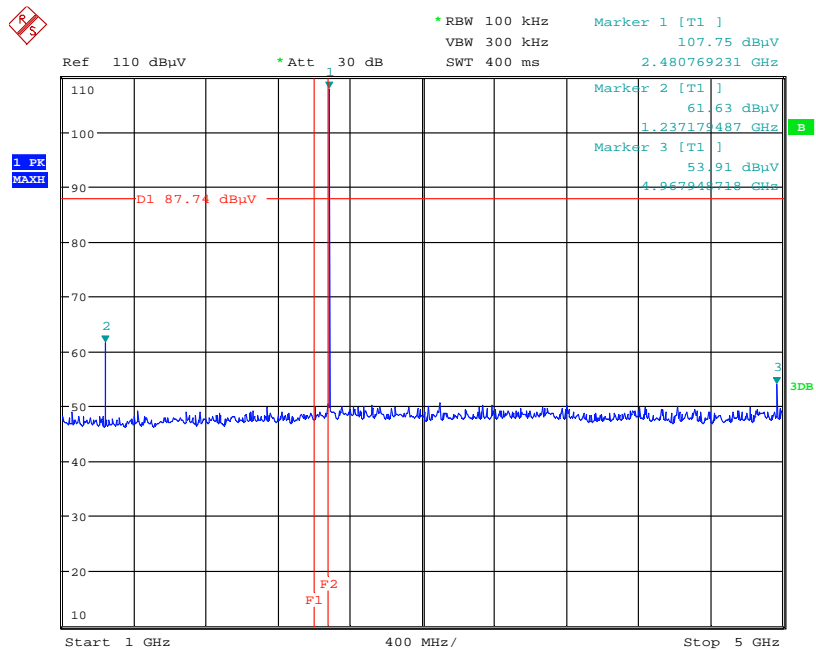
Date: 20.SEP.2012 15:29:59

Conducted Spurious emissions 150kHz to 30MHz – 2481MHz – Radio 2



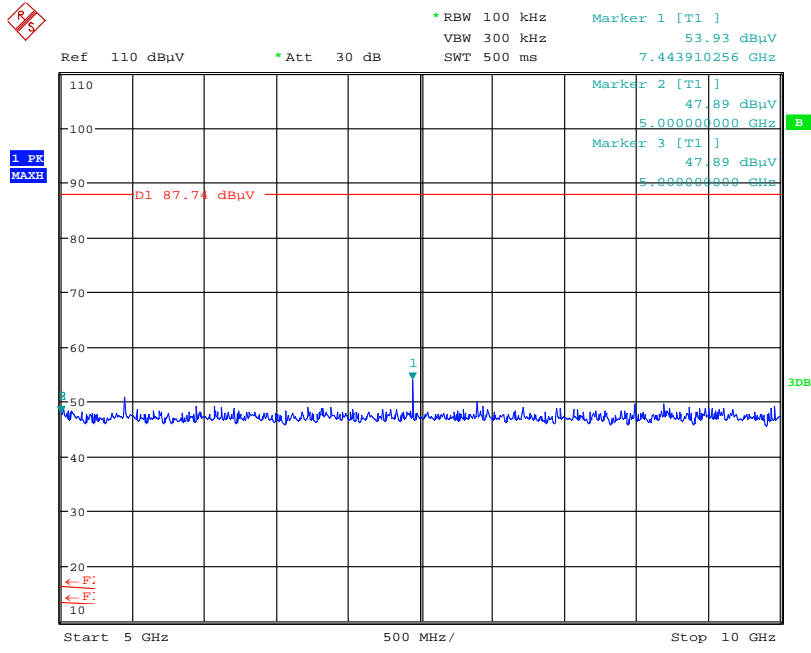
Date: 20.SEP.2012 15:30:17

Conducted Spurious emissions 30 MHz to 1 GHz – 2481MHz – Radio 2



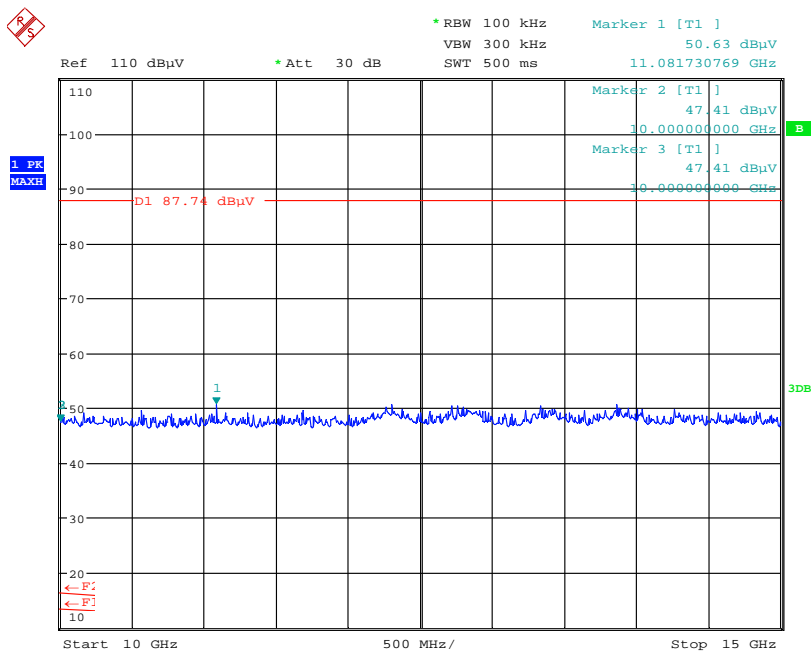
Date: 20.SEP.2012 15:28:10

Conducted Spurious emissions 1 GHz to 5 GHz – 2481MHz – Radio 2



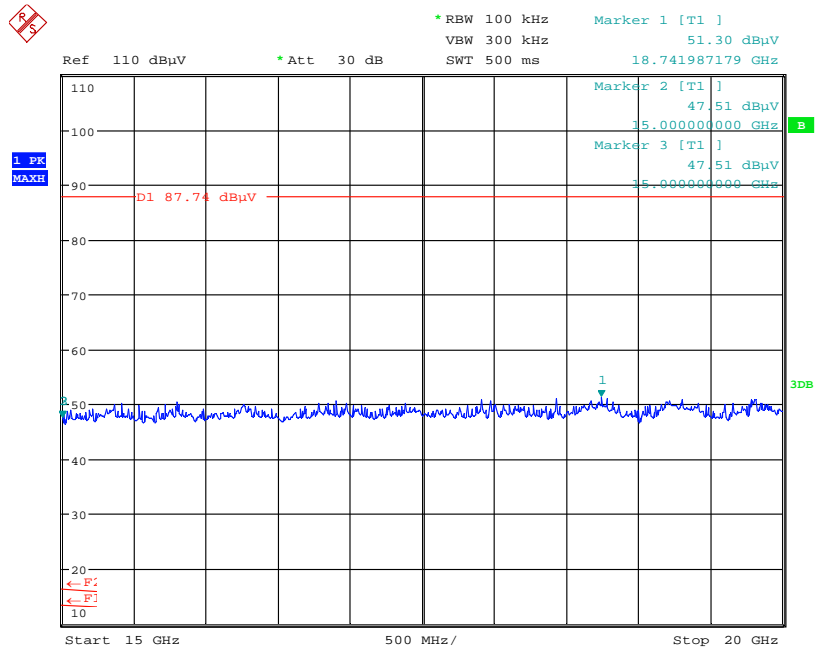
Date: 20.SEP.2012 15:28:25

Conducted Spurious emissions 5 GHz to 10 GHz – 2481MHz – Radio 2



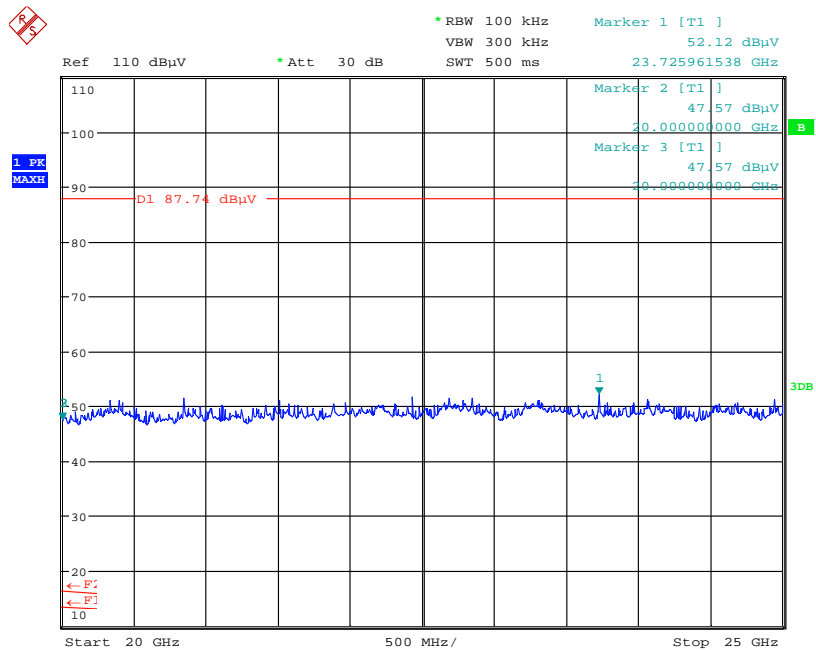
Date: 20.SEP.2012 15:28:42

Conducted Spurious emissions 10 GHz to 15 GHz – 2481MHz – Radio 2



Date: 20.SEP.2012 15:28:59

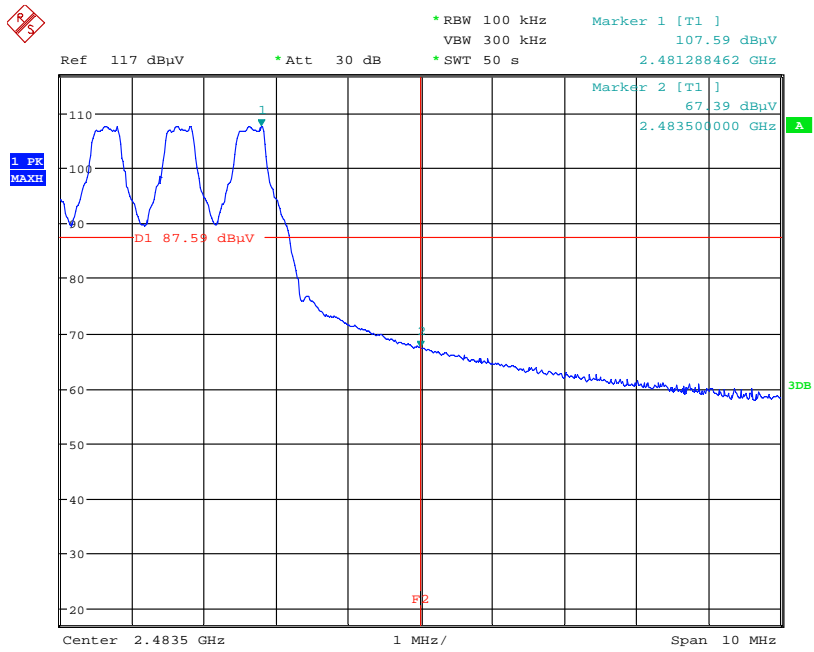
Conducted Spurious emissions 15 GHz to 20 GHz– 2481MHz – Radio 2



Date: 20.SEP.2012 15:29:16

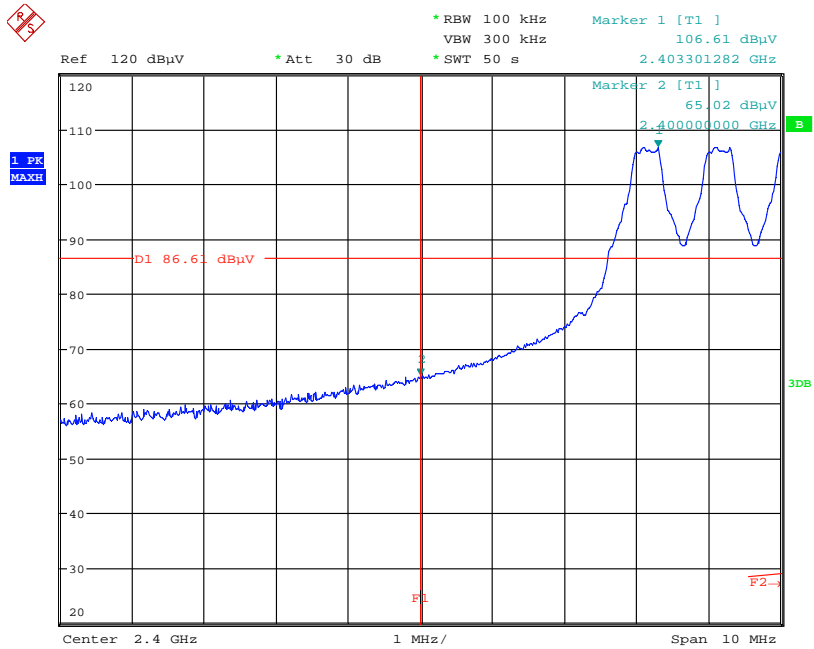
Conducted Spurious emissions 20 GHz to 25 GHz– 2481MHz – Radio 2

Conducted Bandedge Compliance– Radio 2



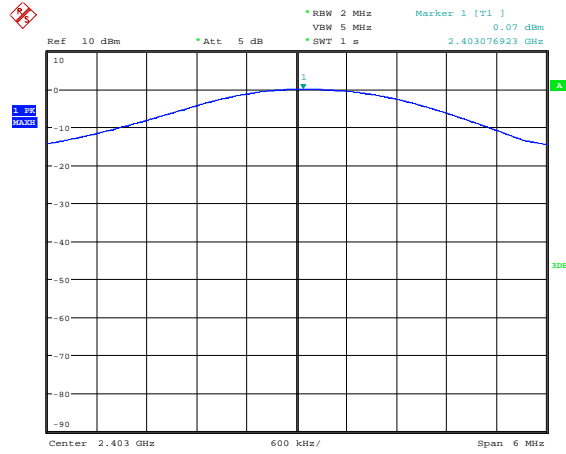
Date: 20.SEP.2012 15:53:21

Lower Bandedge



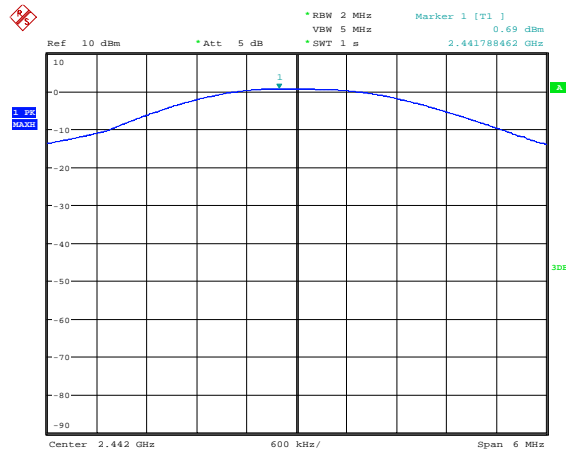
Date: 20.SEP.2012 15:49:57

Upper Bandedge



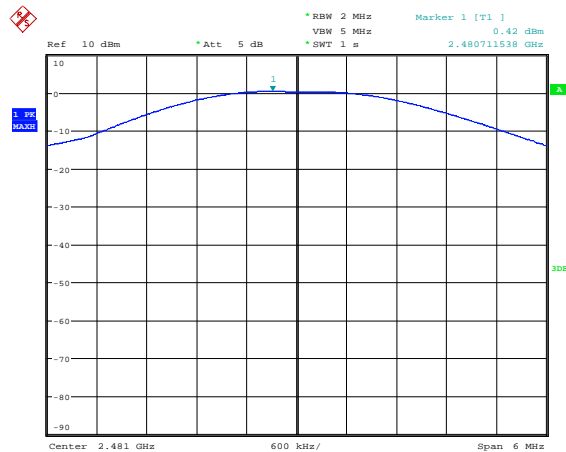
Date: 20.SEP.2012 11:07:24

Conducted carrier power 2403MHz – Radio 1



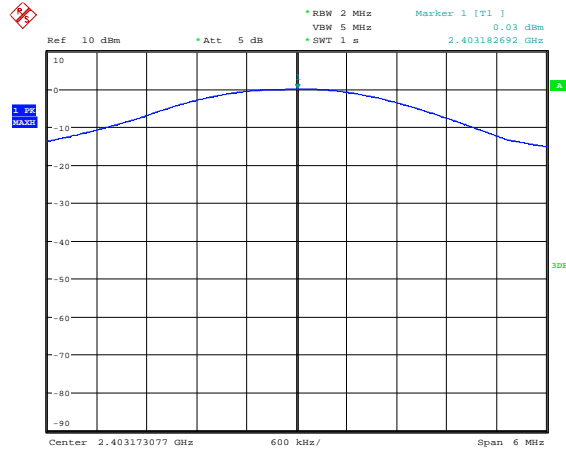
Date: 20.SEP.2012 11:08:15

Conducted carrier power 2442 MHz– Radio 1



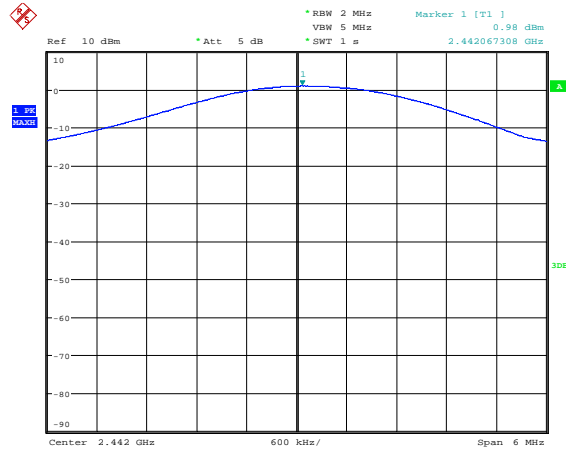
Date: 20.SEP.2012 11:08:46

Conducted carrier power 2481 MHz– Radio 1



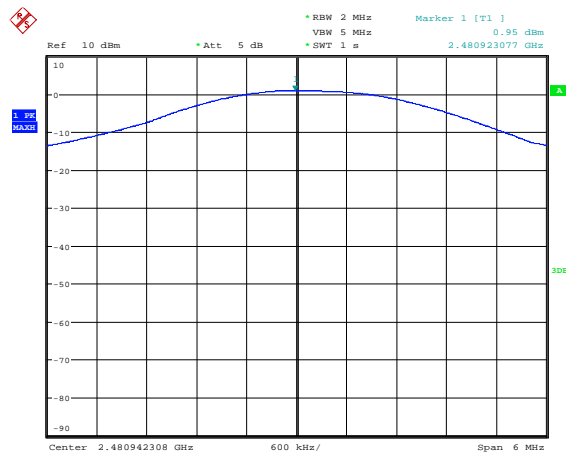
Date: 20.SEP.2012 11:29:25

Conducted carrier power 2403MHz – Radio 2



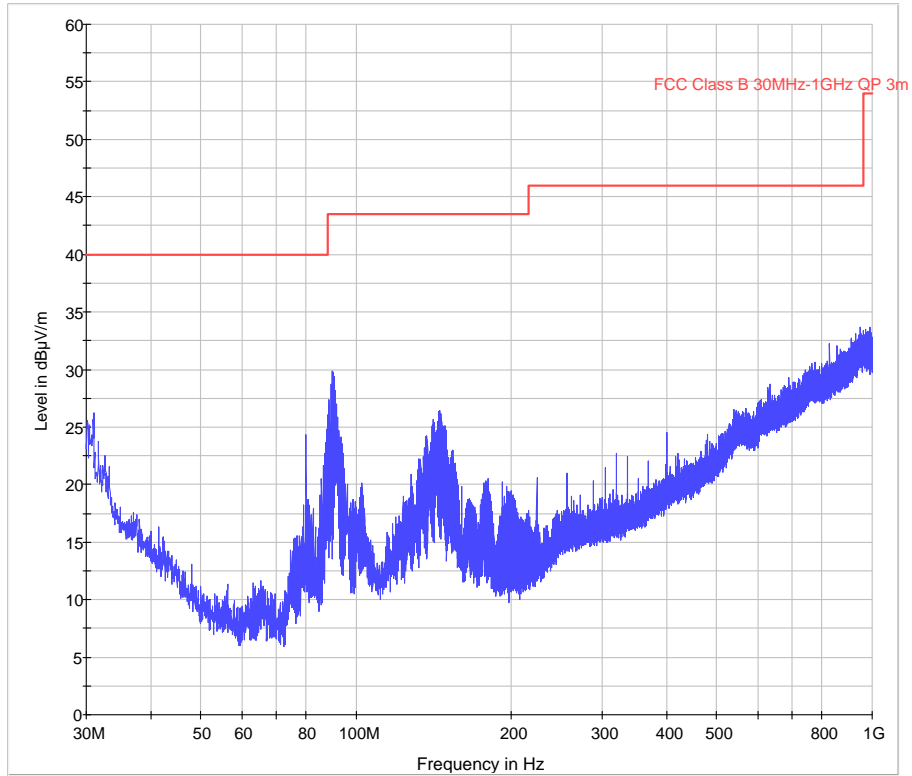
Date: 20.SEP.2012 11:40:29

Conducted carrier power 2442 MHz– Radio 2

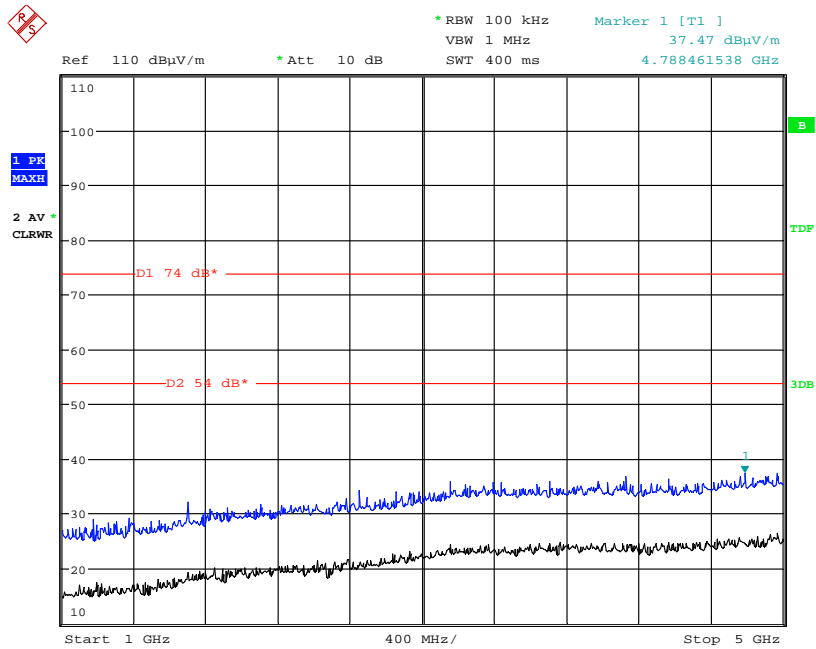


Date: 20.SEP.2012 11:41:15

Conducted carrier power 2481 MHz– Radio 2

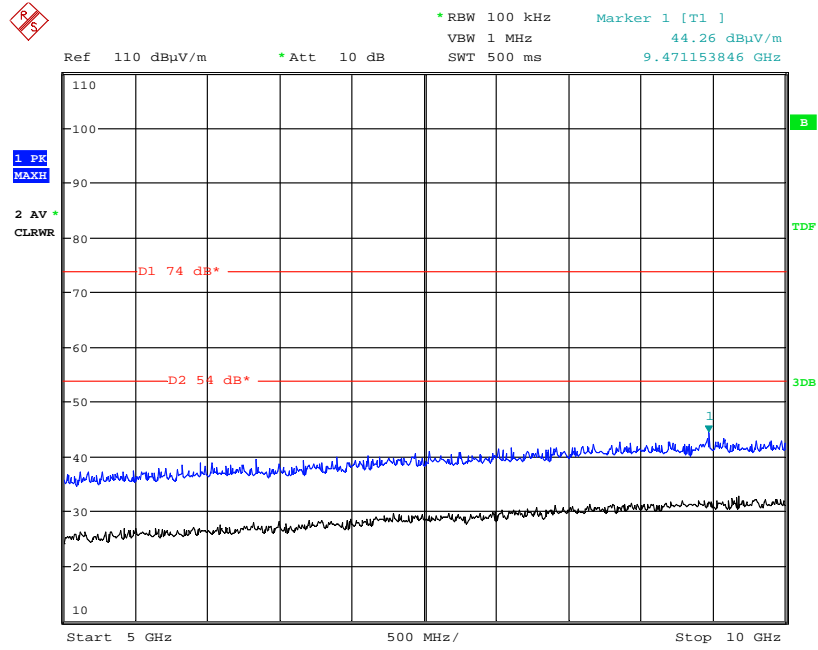


Radiated Spurious emissions 30 MHz to 1 GHz – 2403MHz



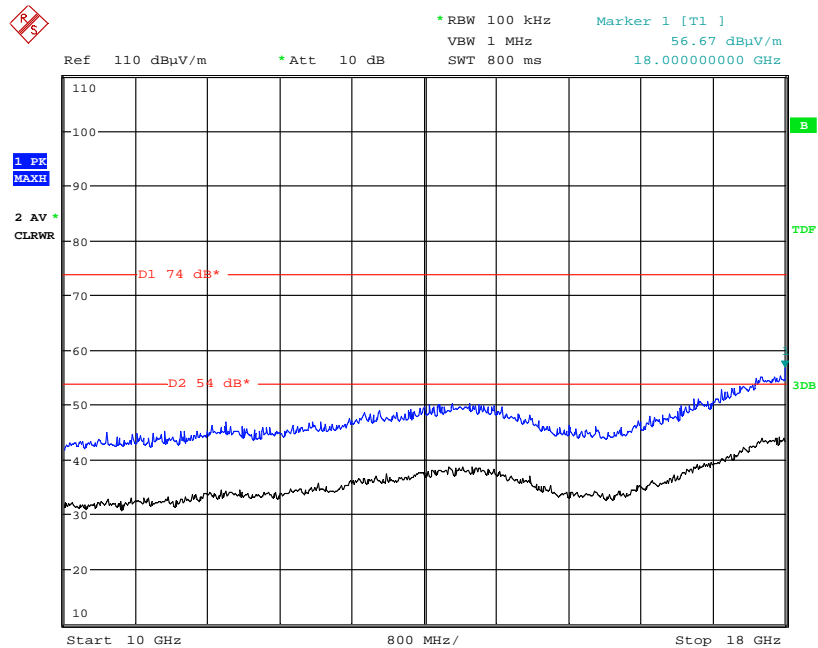
Date: 19.SEP.2012 11:41:51

Radiated Spurious emissions 1 GHz to 5 GHz – 2403MHz



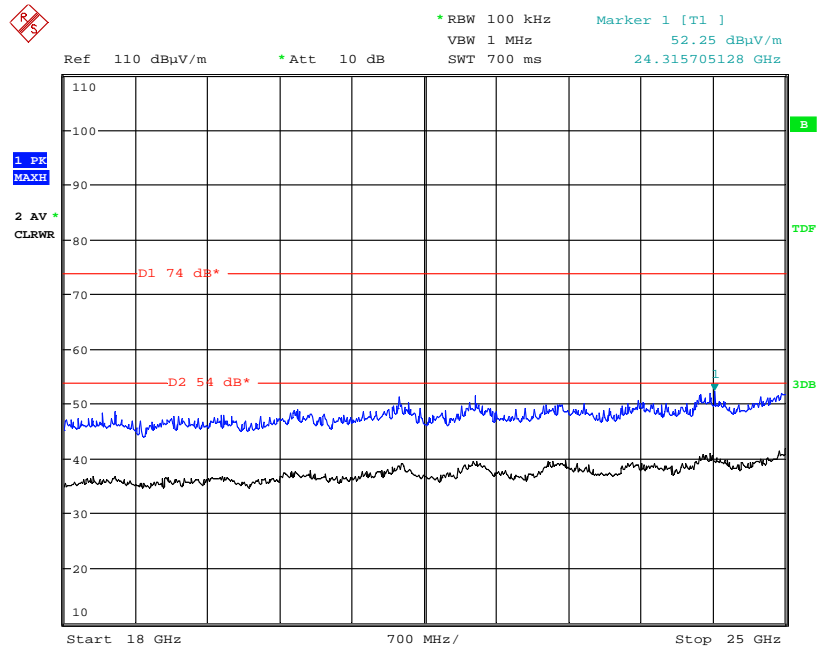
Date: 19.SEP.2012 11:41:29

Radiated Spurious emissions 5 GHz to 10 GHz – 2403MHz



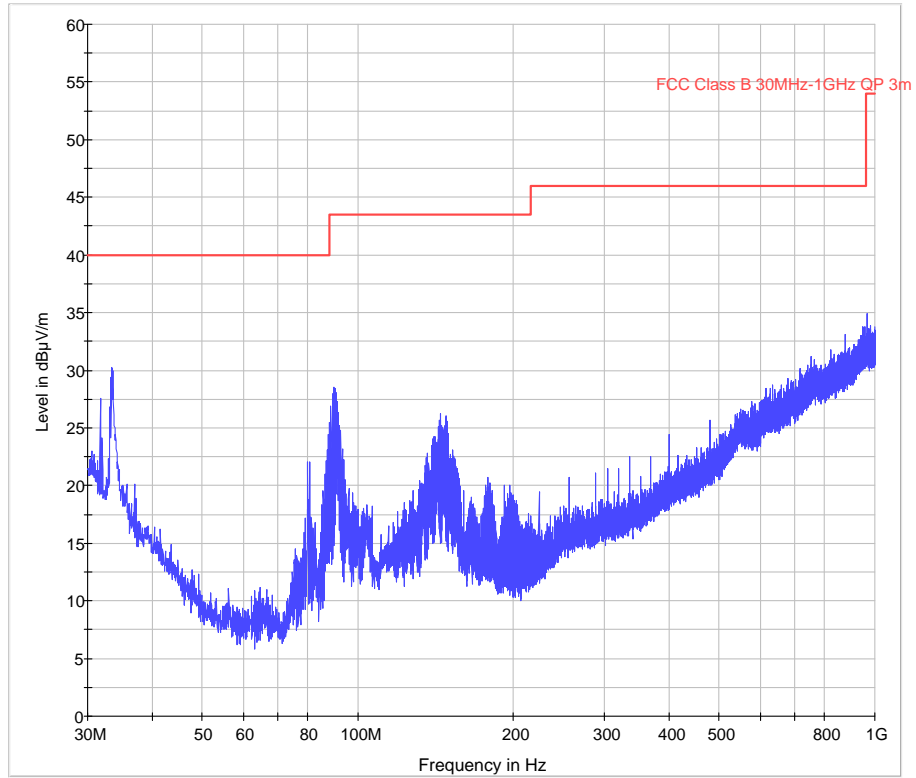
Date: 19.SEP.2012 11:41:11

Radiated Spurious emissions 10 GHz to 18 GHz – 2403MHz

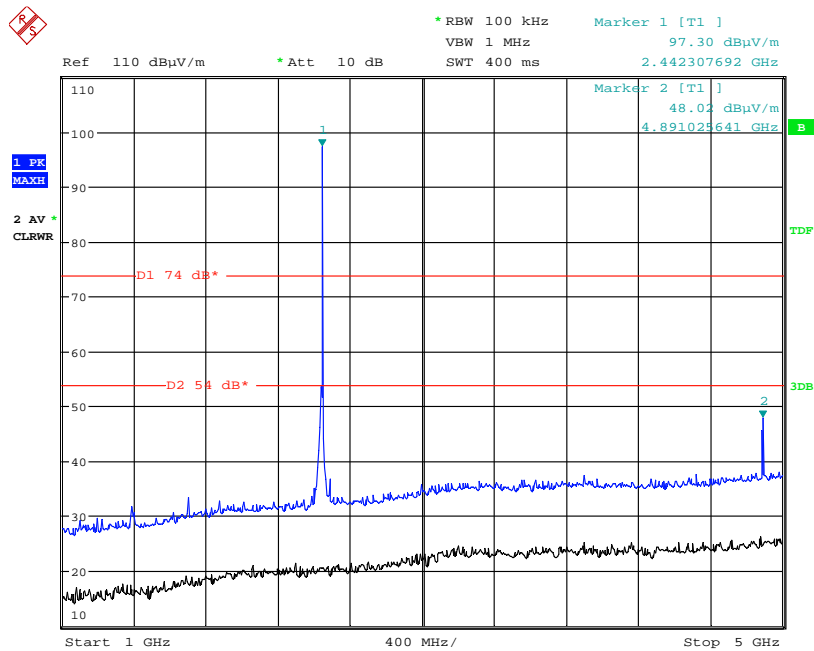


Date: 19.SEP.2012 11:57:10

Radiated Spurious emissions 18 GHz to 25 GHz – 2403MHz

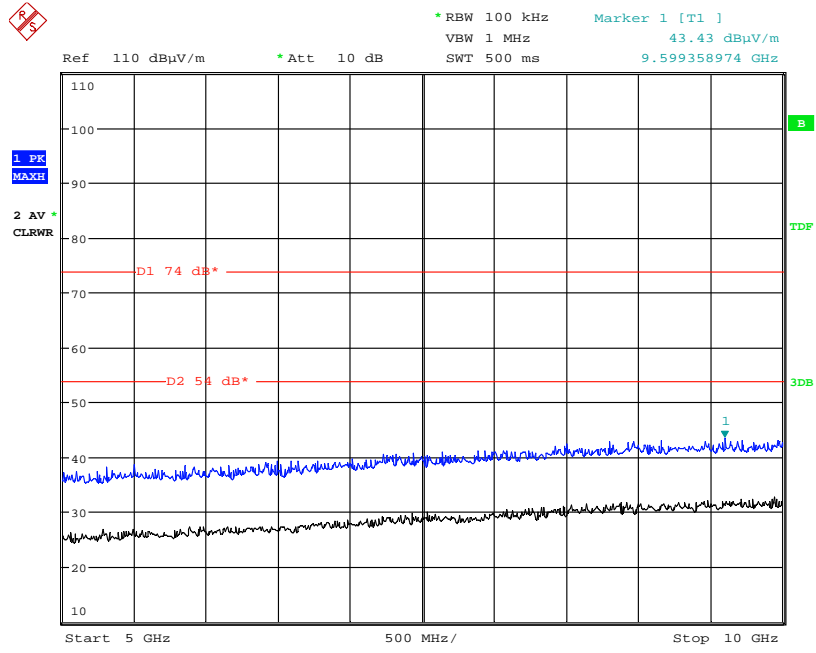


Radiated Spurious emissions 30 MHz to 1 GHz – 2442MHz



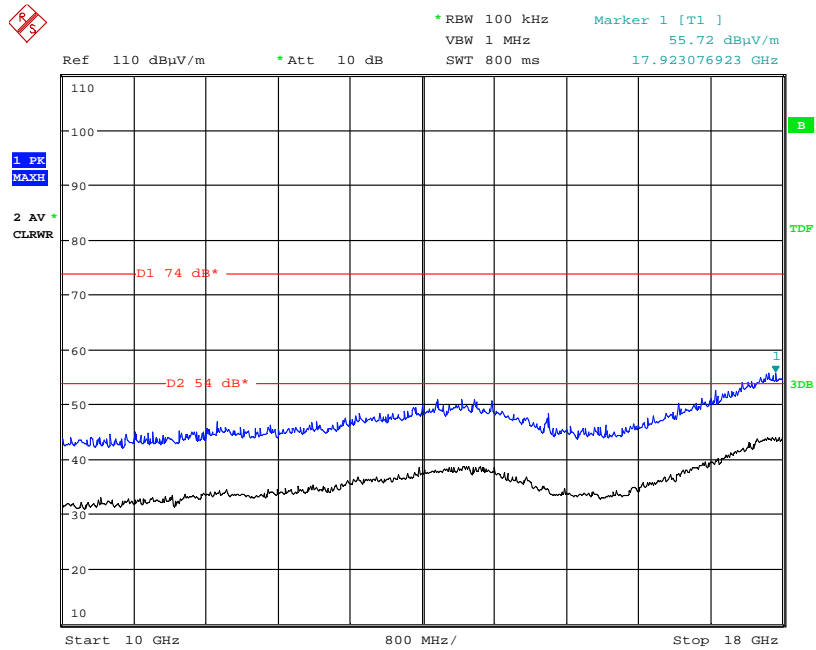
Date: 19.SEP.2012 11:30:45

Radiated Spurious emissions 1 GHz to 5 GHz – 2442MHz



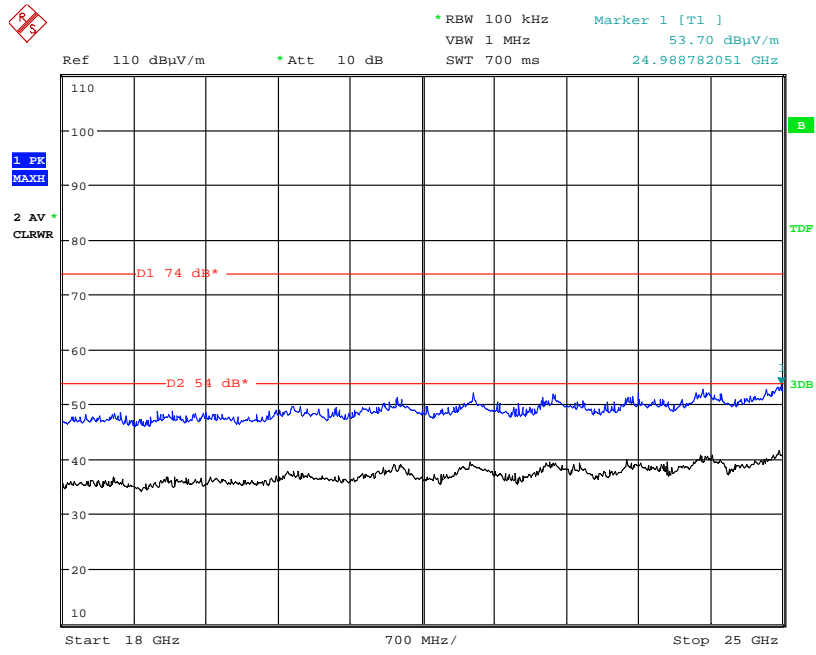
Date: 19.SEP.2012 11:26:07

Radiated Spurious emissions 5 GHz to 10 GHz – 2442MHz



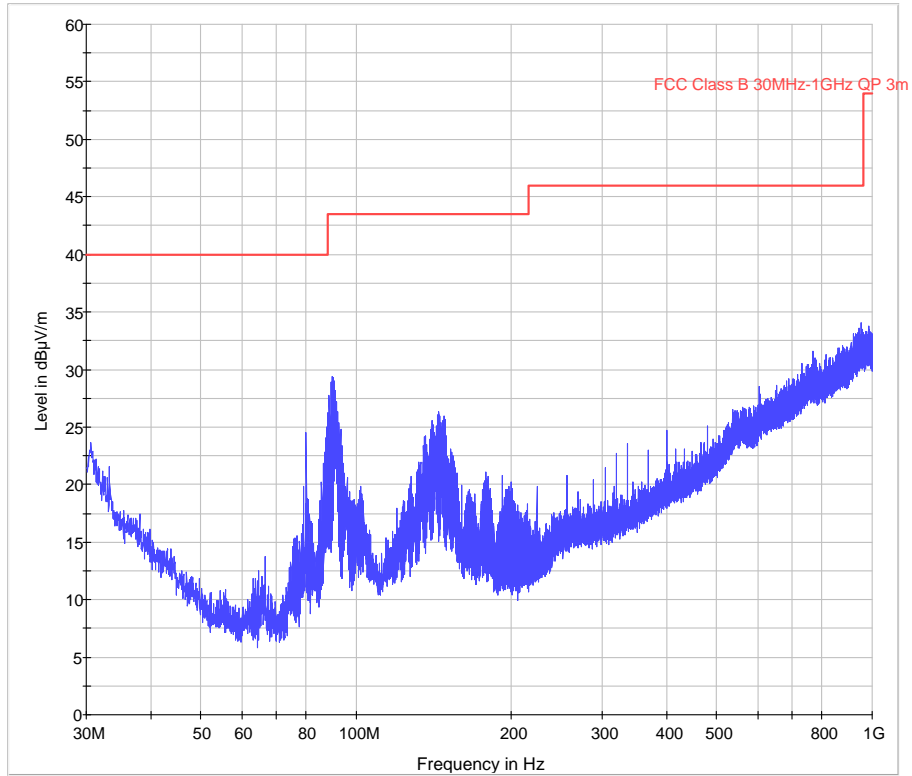
Date: 19.SEP.2012 11:25:47

Radiated Spurious emissions 10 GHz to 18 GHz – 2442MHz

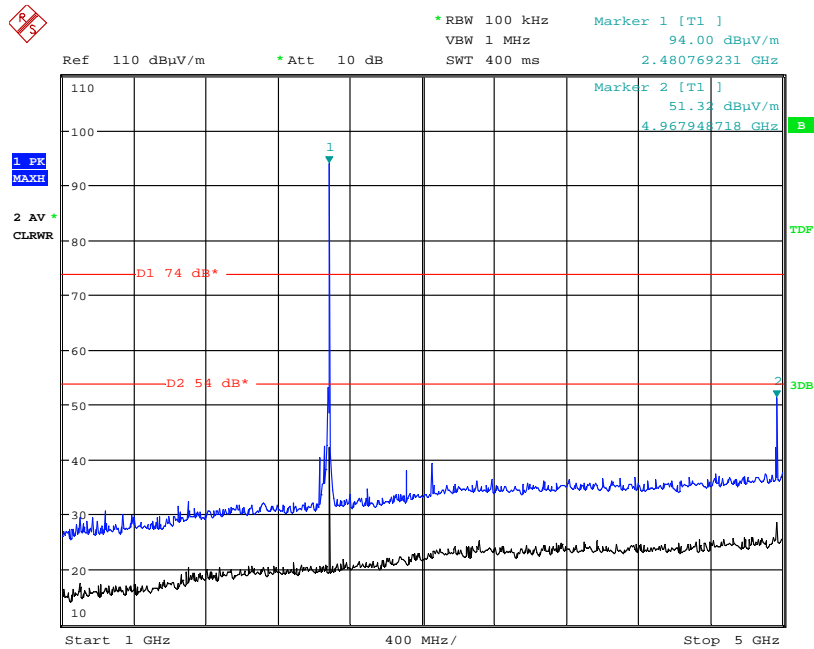


Date: 19.SEP.2012 12:00:31

Radiated Spurious emissions 18 GHz to 25 GHz – 2442MHz

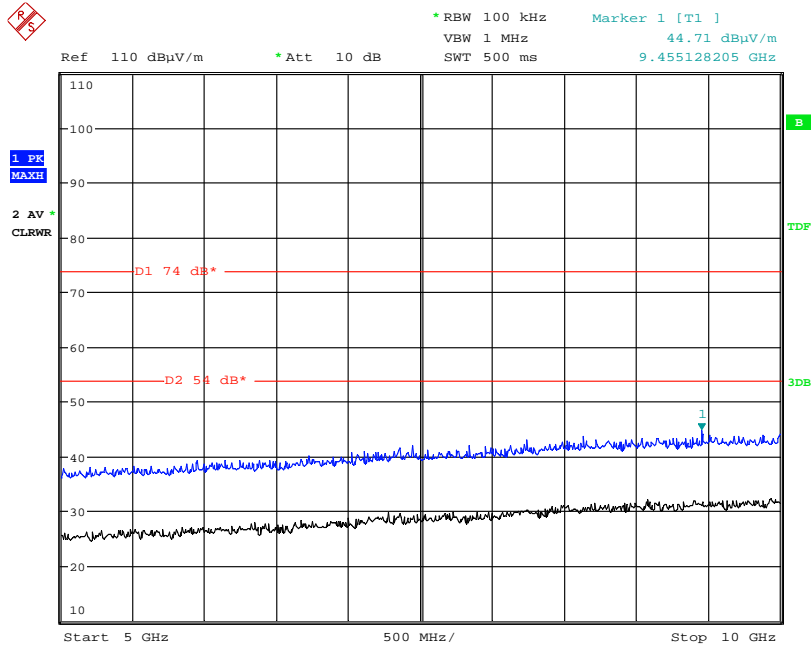


Radiated Spurious emissions 30 MHz to 1 GHz – 2481MHz



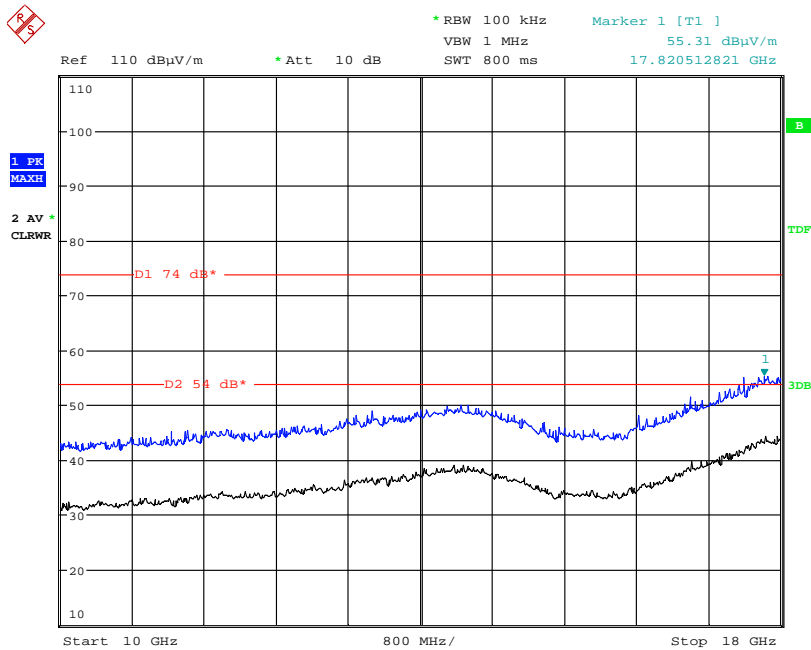
Date: 19.SEP.2012 11:32:38

Radiated Spurious emissions 1 GHz to 5 GHz – 2481MHz 1



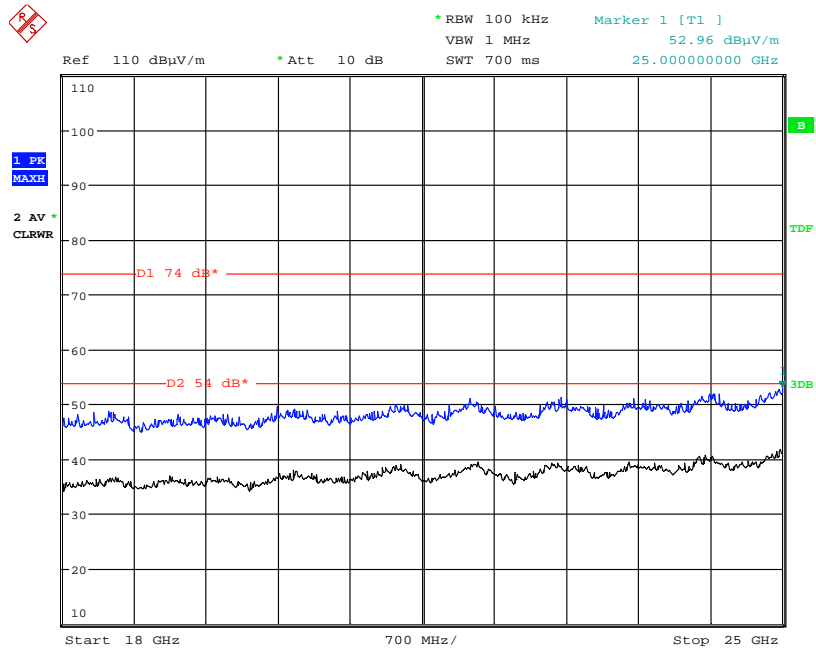
Date: 19.SEP.2012 11:34:00

Radiated Spurious emissions 5 GHz to 10 GHz – 2481MHz



Date: 19.SEP.2012 11:34:35

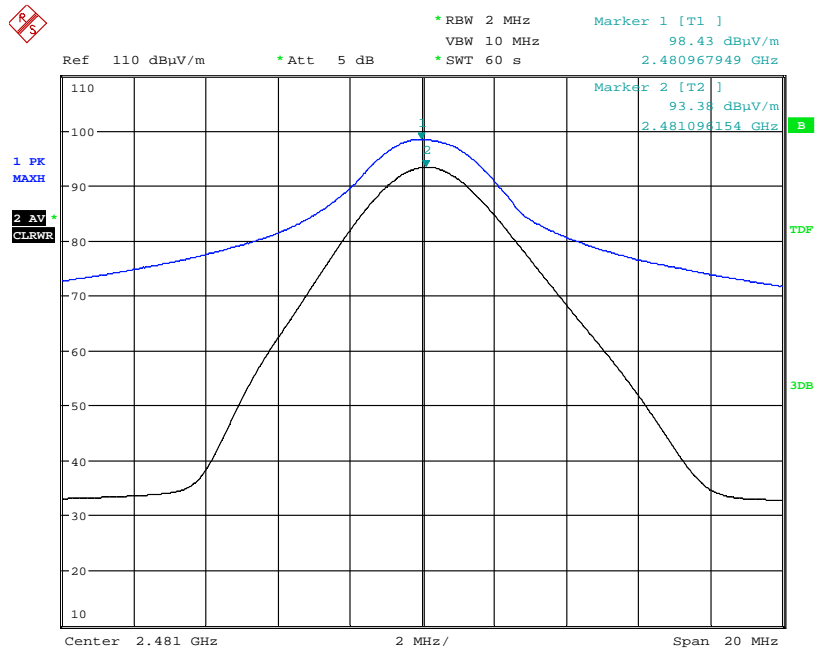
Radiated Spurious emissions 10 GHz to 18 GHz – 2481MHz



Date: 19.SEP.2012 12:01:52

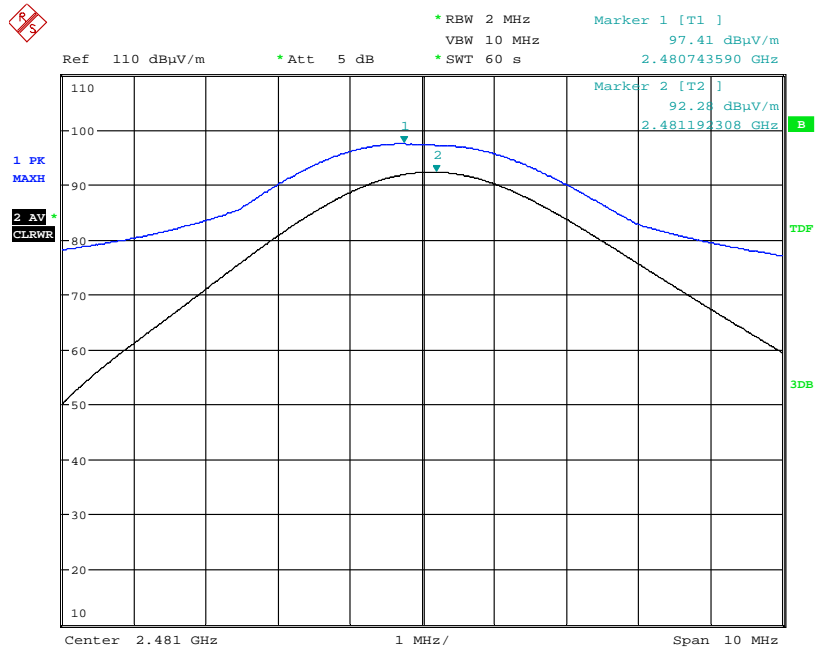
Radiated Spurious emissions 18 GHz to 25 GHz – 2481MHz

Radiated Bandedge Compliance – Carrier Power



Date: 24.SEP.2012 11:20:03

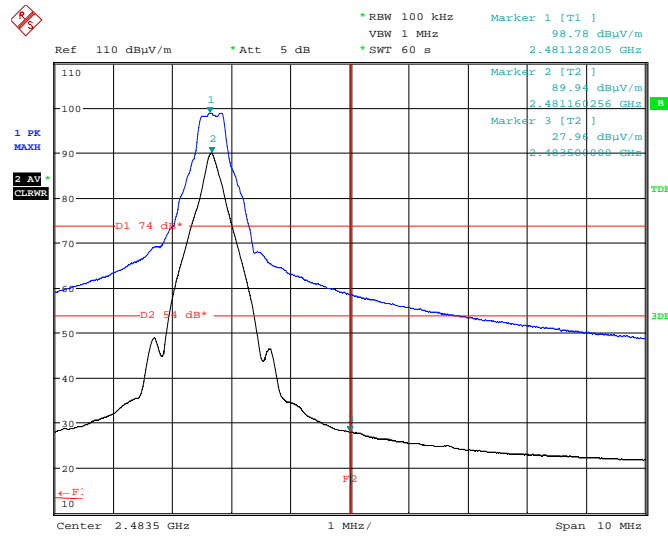
Radio 1



Date: 24.SEP.2012 13:02:12

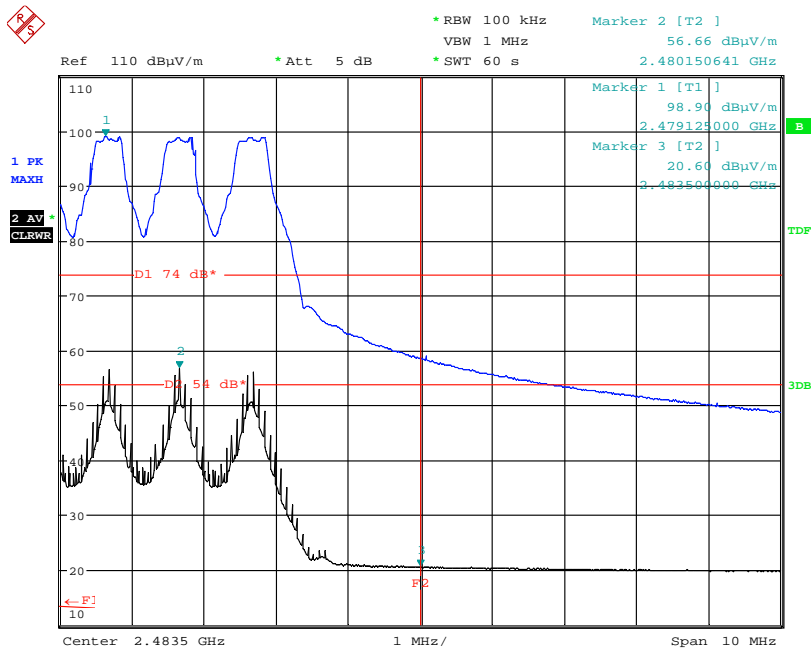
Radio 2

Radiated Bandedge Compliance – Radio 1 Only



Date: 24.SEP.2012 09:50:20

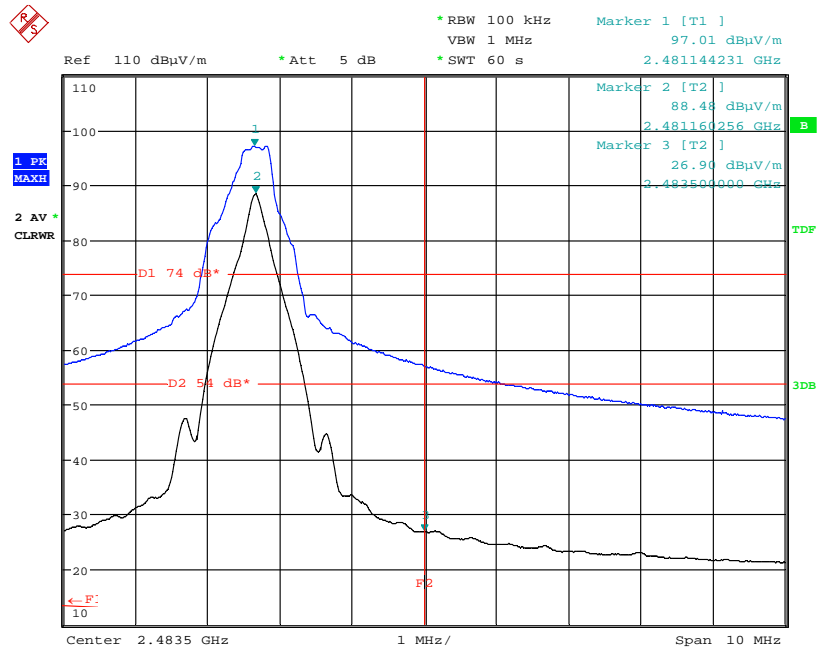
Delta Marker Measurements in 100 KHz – Modulated Carrier



Date: 24.SEP.2012 09:53:45

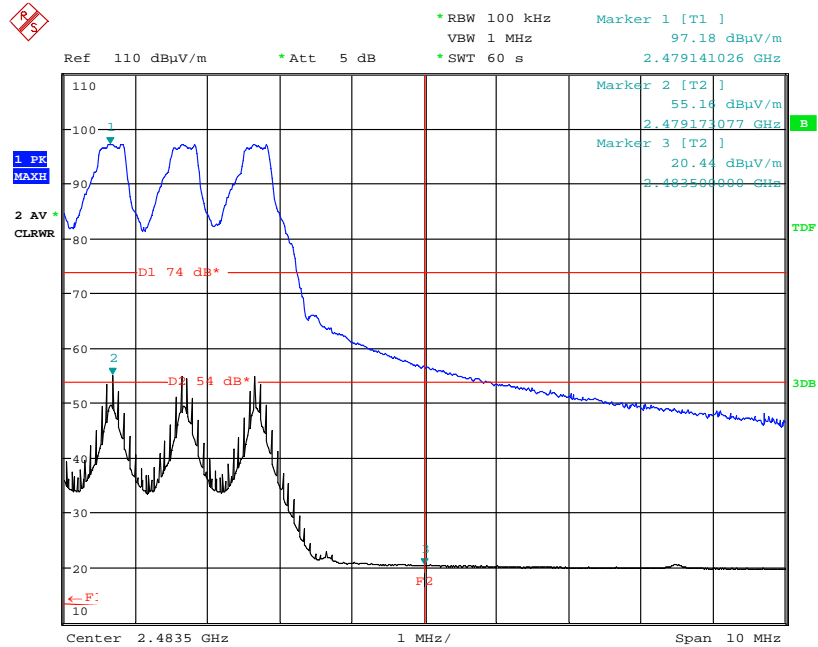
Delta Marker Measurements in 100 KHz - Hopping

Radiated Bandedge Compliance – Radio 2 Only



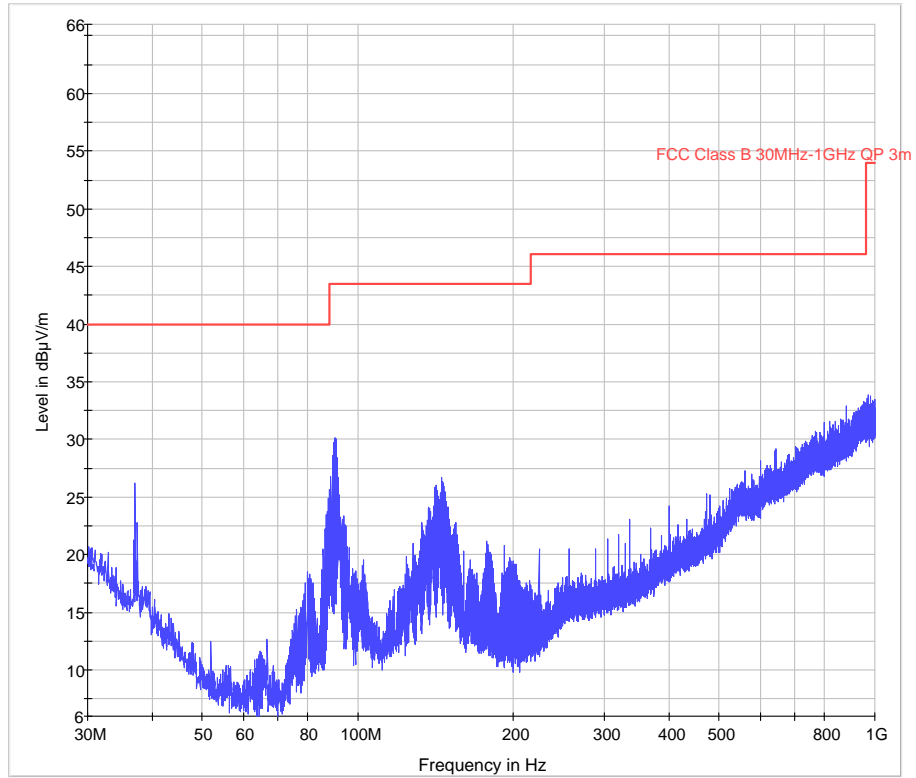
Date: 24.SEP.2012 10:18:22

Delta Marker Measurements in 100 KHz – Modulated Carrier

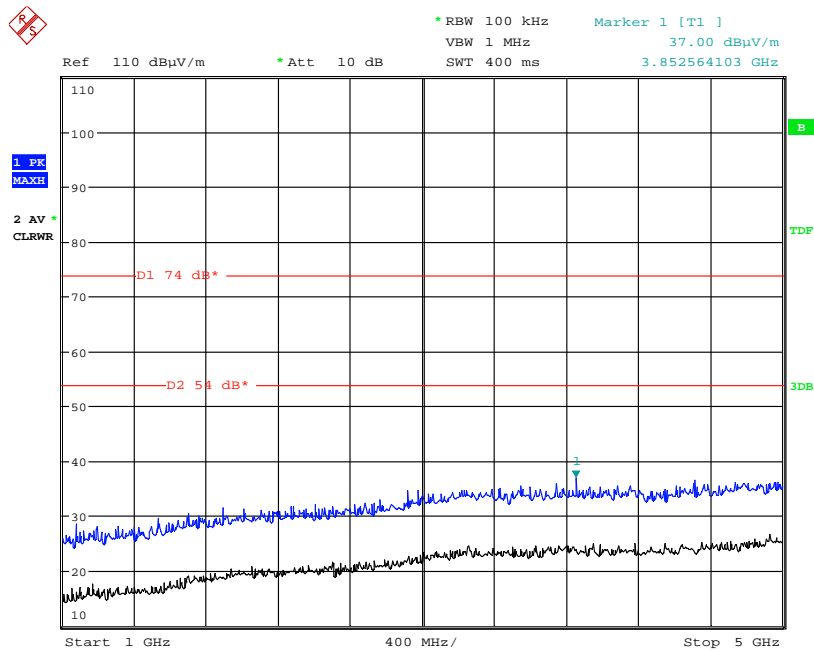


Date: 24.SEP.2012 10:13:05

Delta Marker Measurements in 100 KHz - Hopping

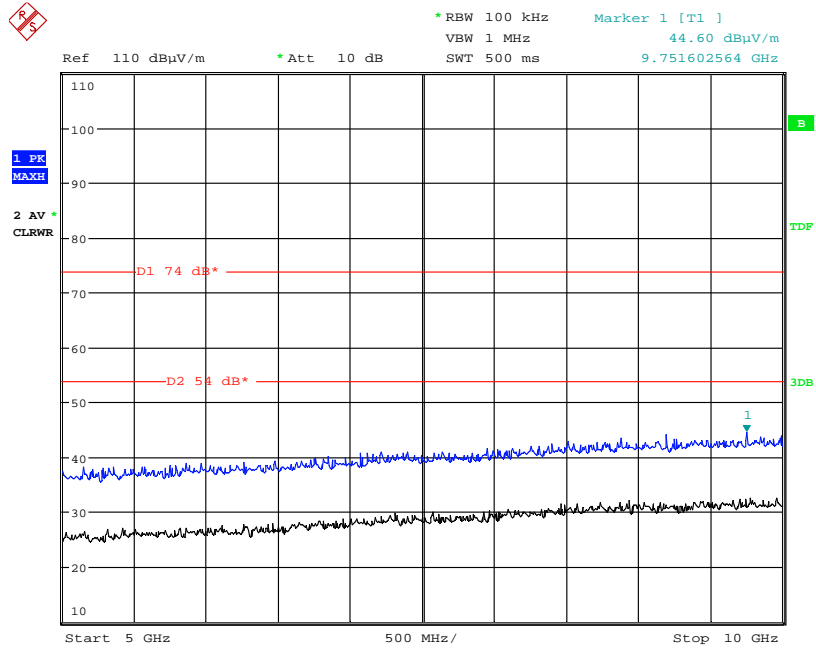


Unintentional Radiated Spurious emissions 30 MHz to 1 GHz – 2403MHz



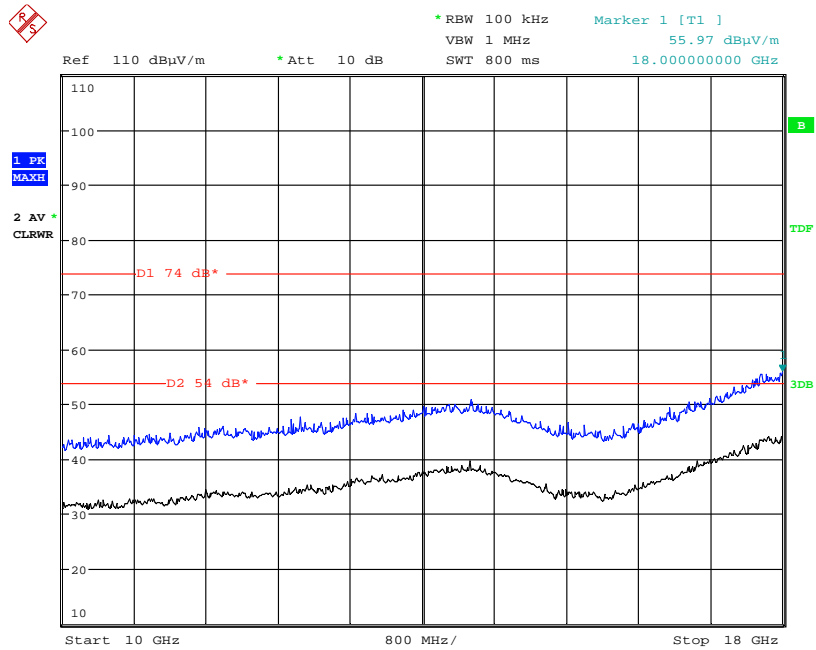
Date: 19.SEP.2012 11:48:14

Unintentional Radiated Spurious emissions 1 GHz to 5 GHz – 2403MHz



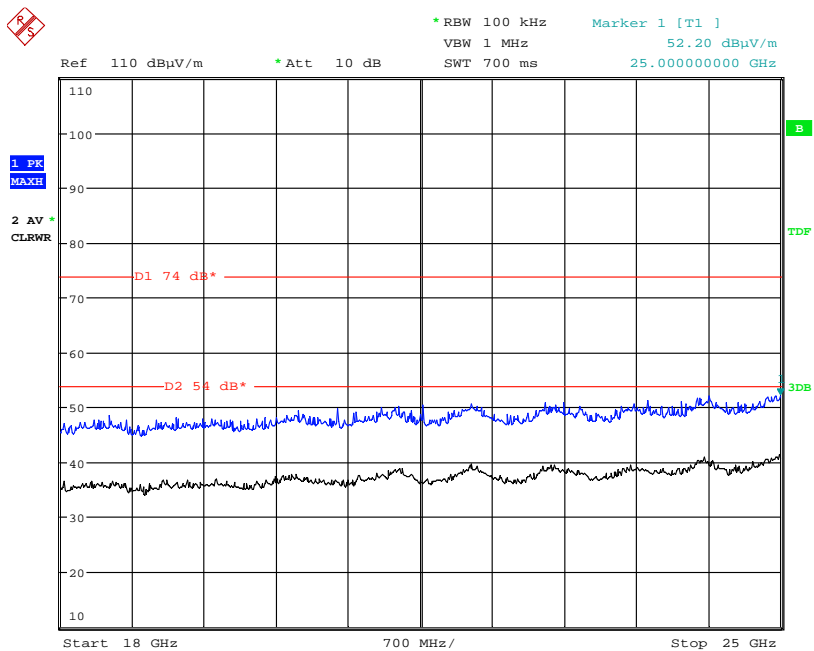
Date: 19.SEP.2012 11:47:40

Unintentional Radiated Spurious emissions 5 GHz to 10 GHz – 2403MHz



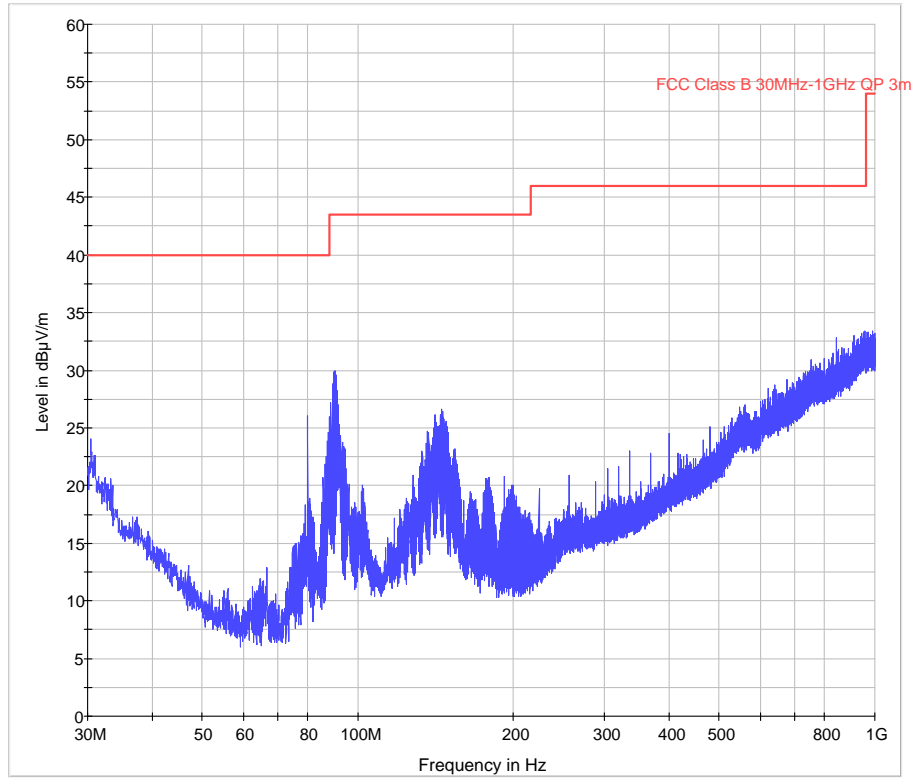
Date: 19.SEP.2012 11:46:56

Unintentional Radiated Spurious emissions 10 GHz to 18 GHz – 2403MHz

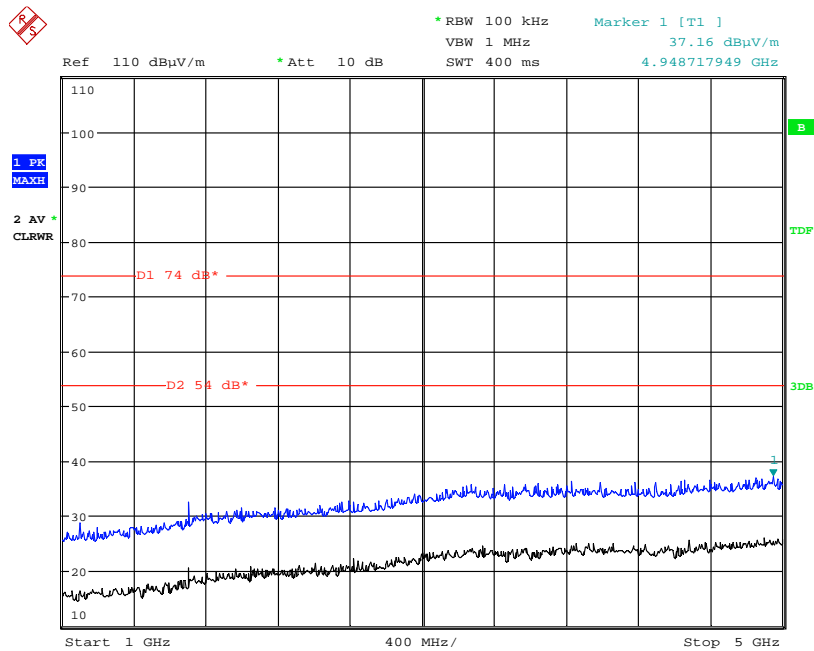


Date: 19.SEP.2012 11:56:02

Unintentional Radiated Spurious emissions 18 GHz to 25 GHz – 2403MHz

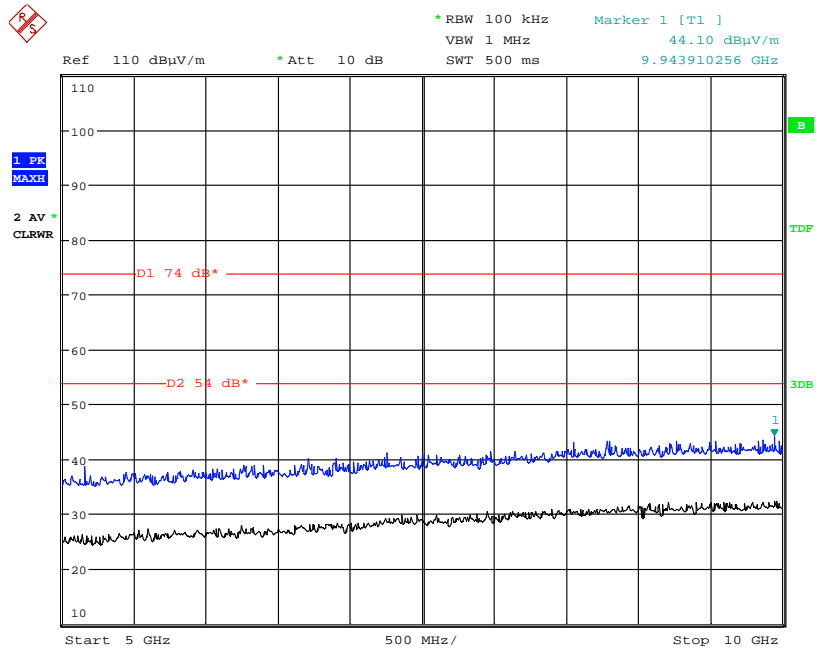


Unintentional Radiated Spurious emissions 30 MHz to 1 GHz – 2442MHz



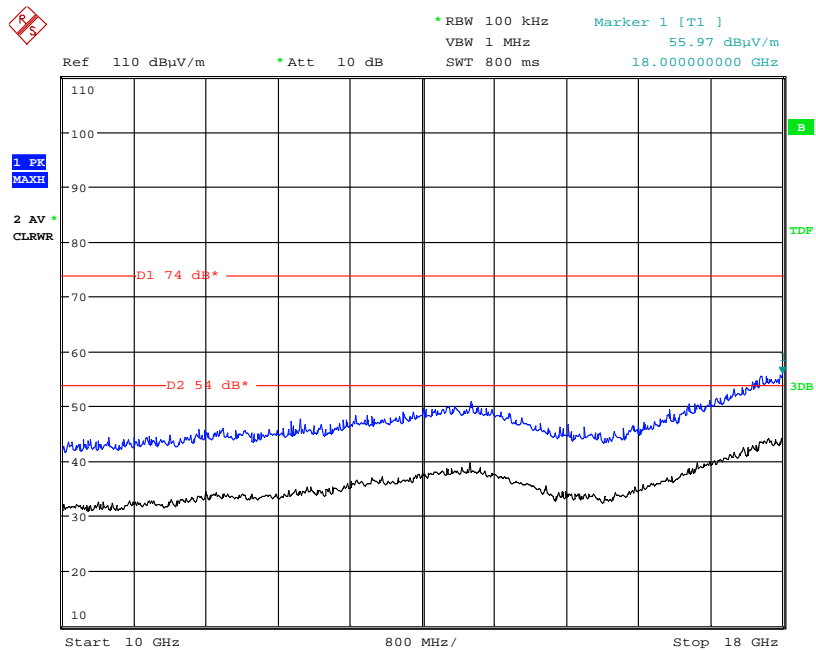
Date: 19.SEP.2012 11:43:18

Unintentional Radiated Spurious emissions 1 GHz to 5 GHz – 2442MHz



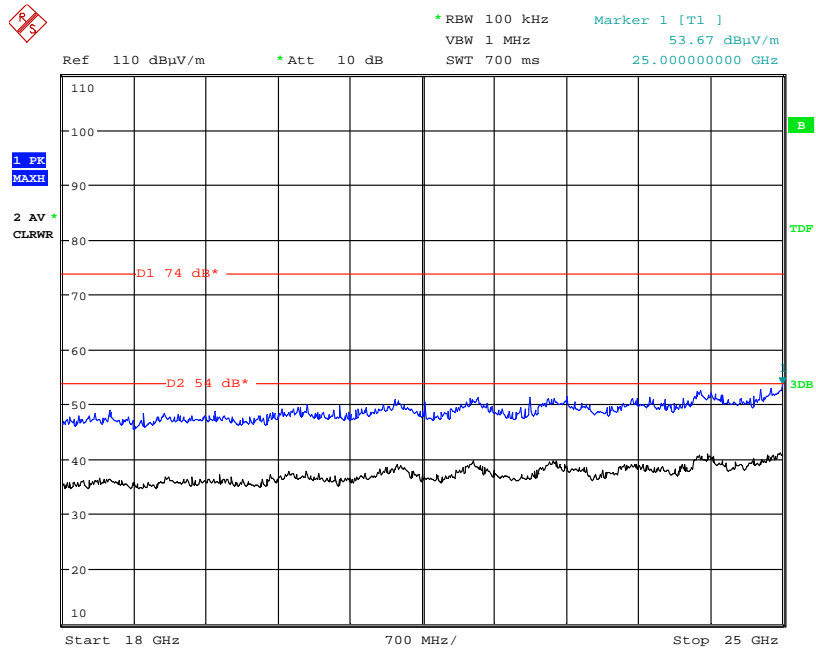
Date: 19.SEP.2012 11:46:18

Unintentional Radiated Spurious emissions 5 GHz to 10 GHz – 2442MHz



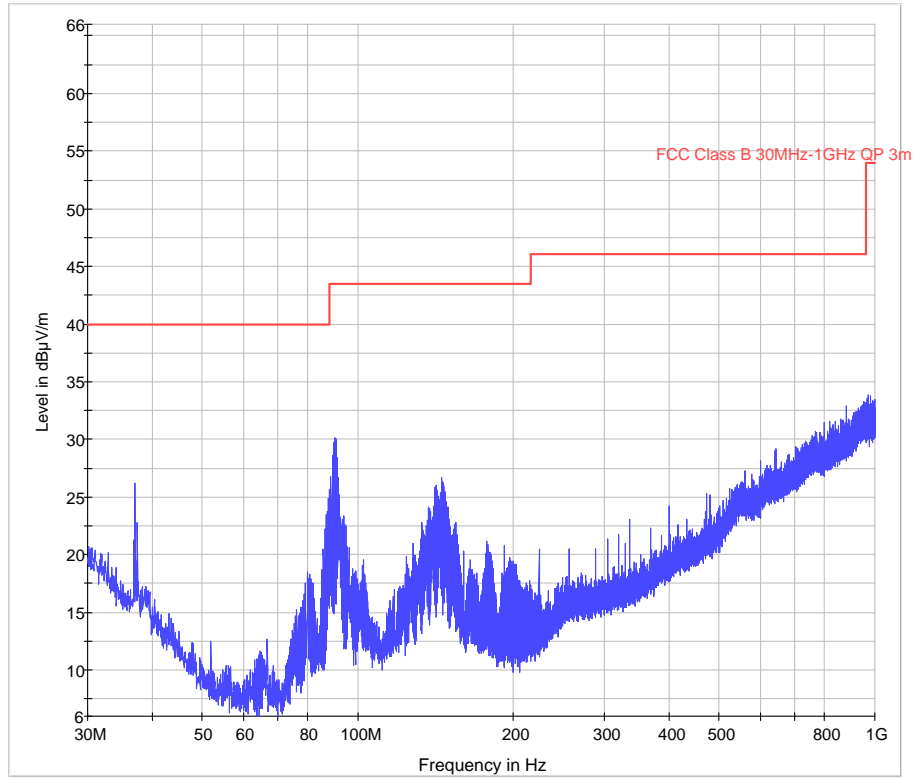
Date: 19.SEP.2012 11:46:56

Unintentional Radiated Spurious emissions 10 GHz to 18 GHz – 2442MHz

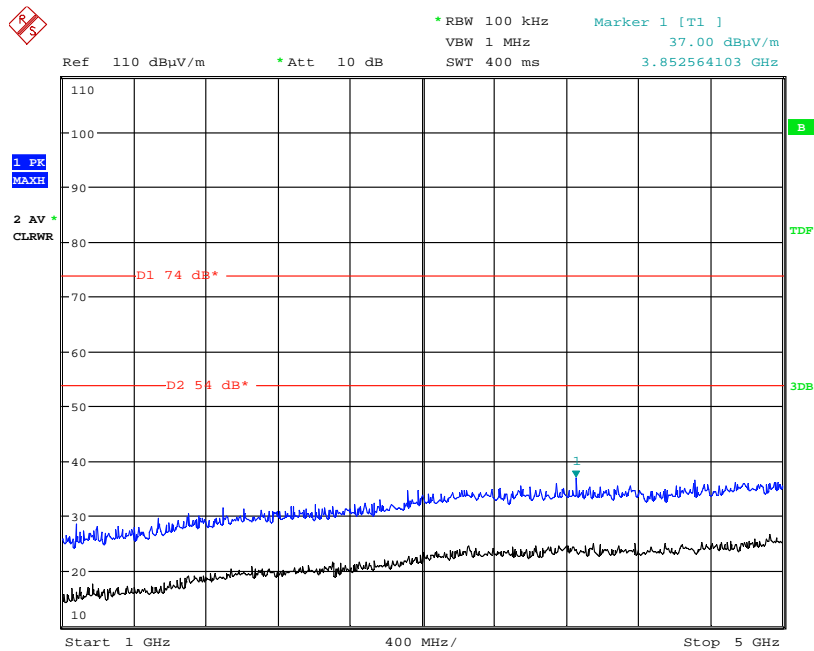


Date: 19.SEP.2012 11:56:55

Unintentional Radiated Spurious emissions 18 GHz to 25 GHz – 2442MHz

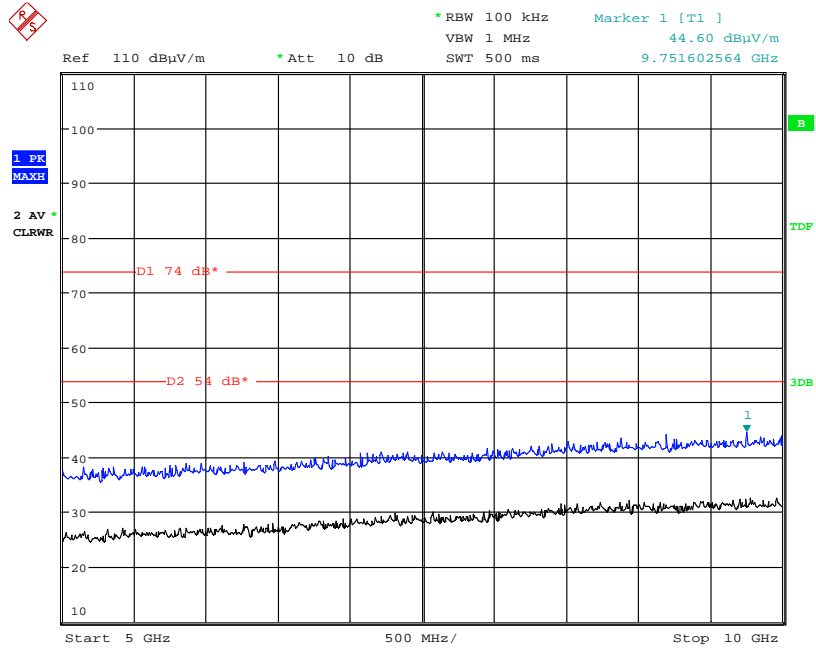


Unintentional Radiated Spurious emissions 30 MHz to 1 GHz – 2481MHz



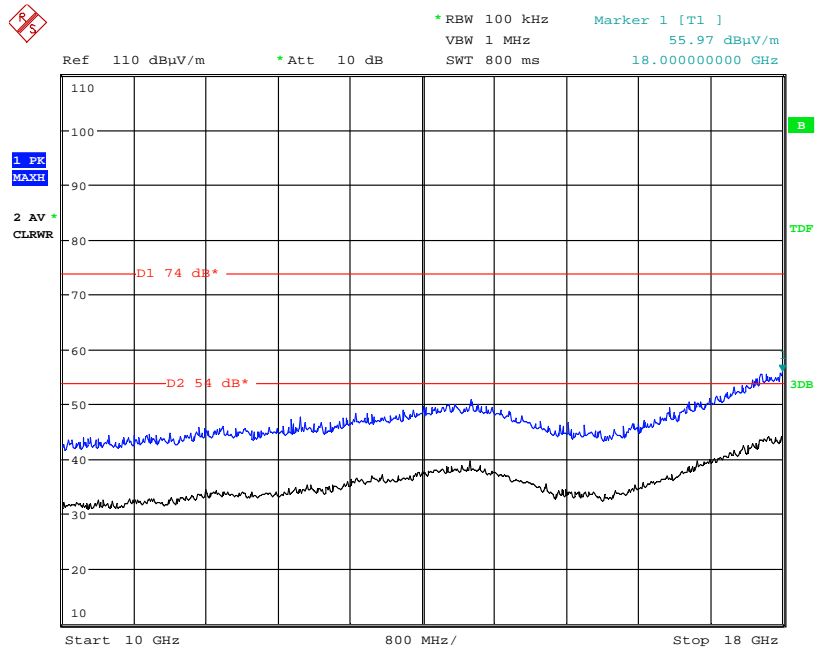
Date: 19.SEP.2012 11:48:14

Unintentional Radiated Spurious emissions 1 GHz to 5 GHz – 2481MHz



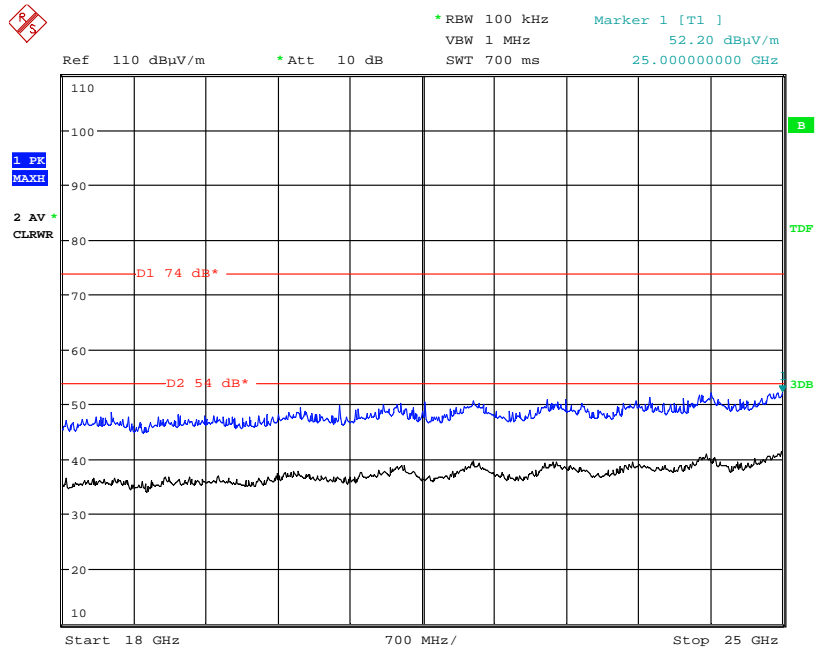
Date: 19.SEP.2012 11:47:40

Unintentional Radiated Spurious emissions 5 GHz to 10 GHz – 2481MHz



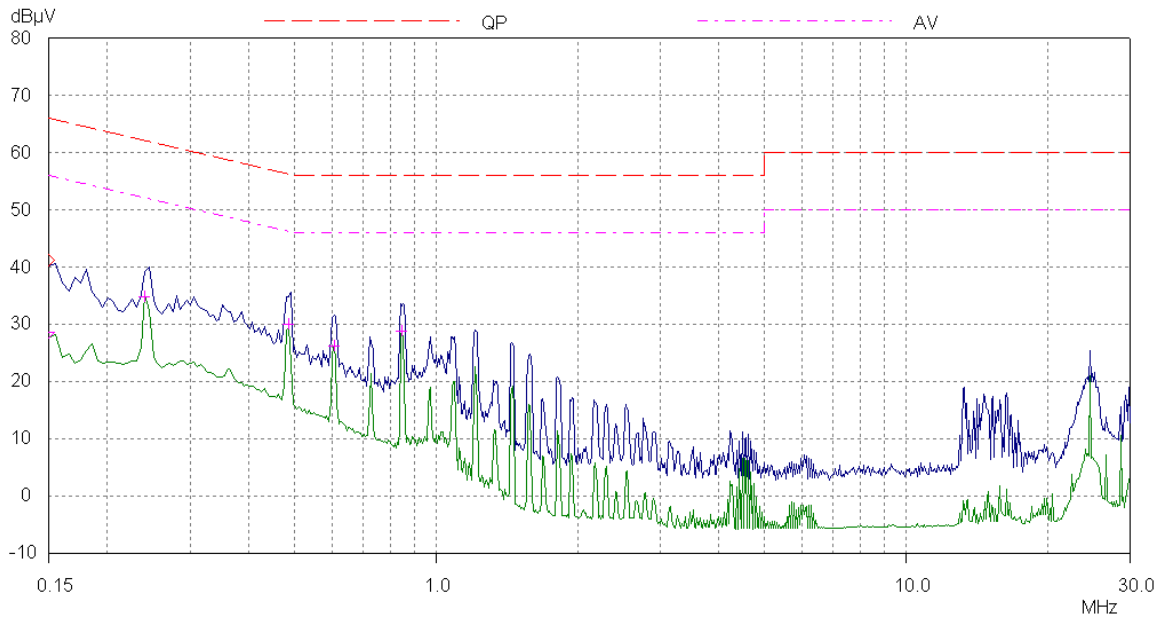
Date: 19.SEP.2012 11:46:56

Unintentional Radiated Spurious emissions 10 GHz to 18 GHz – 2481MHz



Date: 19.SEP.2012 11:56:02

Unintentional Radiated Spurious emissions 18 GHz to 25 GHz – 2481MHz



AC powerline Conduction

Appendix C: Additional Test and Sample Details

This appendix contains details of:

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

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

Sample No: Sxx Mod w

where:

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

The following terminology is used throughout the test report:

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

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

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

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

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

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

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

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

C1) Test samples

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

Sample No.	Description	Identification
S12	RMI-Q Conducted Sample	70C756
S13	RMI-Q Radiated Sample	70C791

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

Sample No.	Description	Identification
S14	RMP60	60J427
S12 (TRA-008786)	RMP60	74M648
S13 (TRA-008786)	RMP60	74M647
S14 (TRA-008786)	RMP60	74M642

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

Identification	Description
	None

C2) EUT Operating Mode During Testing.

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

Test	Description of Operating Mode:
All tests detailed in this report	EUT active & transmitting on top, middle and bottom operating frequencies in turn. Both radio set to same operating frequency for scans; measurements performed on individual radio devices required.

Test	Description of Operating Mode:
Receiver radiated spurious emissions	EUT active but non-transmitting. Both radio set to same operating frequency for scans, Measurements performed on individual radio devices, if required.

Test	Description of Operating Mode:
PLCE	

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 : S12
Tests : Conducted

Port	Description of Cable Attached	Cable length	Equipment Connected
Input / output	Multicore cable	> 5 meters	Switch box
Annena ports	Coaxial	30cm	Test System or 50 Ohm Load

Sample : S13
Tests : Radiated Emissions

Port	Description of Cable Attached	Cable length	Equipment Connected
Input / output	Multicore cable	> 5 meters	Power Supply

* Only connected during setup.

C5 Details of Equipment Used

TRaC No	Type	Description	Manufacturer	Last Cal Calibration	Calibration Period	Due For Calibration
UH028	UHALP 9108	Log Periodic Ant	Schwarbeck	17/06/2011	24	17/06/2013
UH029	VHBA 9123	Bicone Antenna	Schwarbeck	17/06/2011	24	17/06/2013
UH041	M3004	Multimeter	AVOmeter	16/03/2012	12	16/03/2013
UH093	CBL6112B	Bilog	Chase	20/06/2011	24	20/06/2013
UH096	6960B	Power meter	Marconi	15/11/2011	12	15/11/2012
UH129	6924	Power Sensor	Marconi	05/12/2011	12	05/12/2012
UH191	CBL611/A	Bilog	Chase	08/11/2010	24	08/11/2012
UH281	FSU46	Spectrum Analyser	R&S	09/02/2012	12	09/02/2013
UH387	ATS	Chamber 1	Rainford EMC	24/06/2012	12	24/06/2013
UH403	ESCI 7	Recevier	R&S	27/06/2012	12	27/06/2013
L138	3115	1-18GHz Horn	EMCO	08/11/2011	24	08/11/2013
L139	3115	1-18GHz Horn	EMCO	14/09/2011	24	14/09/2013
L193	VHA 9103 balu	Bicone Antenna	Chase	19/06/2012	24	19/06/2014
L203	UPA6108	Log Periodic Ant	Chase	19/06/2012	24	19/06/2014
L263/A	20240-20	Horn 18-26GHz	Flann	17/11/2011	24	17/11/2013
L300	20240-20	Horn 18-26GHz (&UH330)	Flann	17/11/2011	24	17/11/2013
L317	ESVS10	Receiver	R&S	21/12/2011	12	21/12/2012
L426	52 Series II	Temperature Indicator	Fluke	22/03/2012	12	22/03/2013
L572	8449B	Pre Amp	Agilent	24/11/2010	24	24/11/2012
REF909	FSU26	Spectrum Analyser	R&S	04/08/2011	12	04/08/2012
REF916	SMBV100A	Signal Generator	R&S	23/07/2012	12	23/07/2013
REF940	ATS	Radio Chamber - PP	Rainford EMC	26/06/2012	12	26/06/2013
REF976	34405a	Multimeter	Agilent	26/01/2012	12	26/01/2013

Appendix D:

Additional Information

No additional information is included within this test report.

Appendix E: Calculation of the duty cycle correction factor

Using a spectrum analyser in zero span mode, centred on the fundamental carrier frequency with a RBW of 1MHz and a video Bandwidth of 1MHz the sweep time was set accordingly to capture the pulse train. The transmit 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) = $20 \times (\text{Log}_{10} 0.07459) = -22.54\text{dB}$

Appendix F:

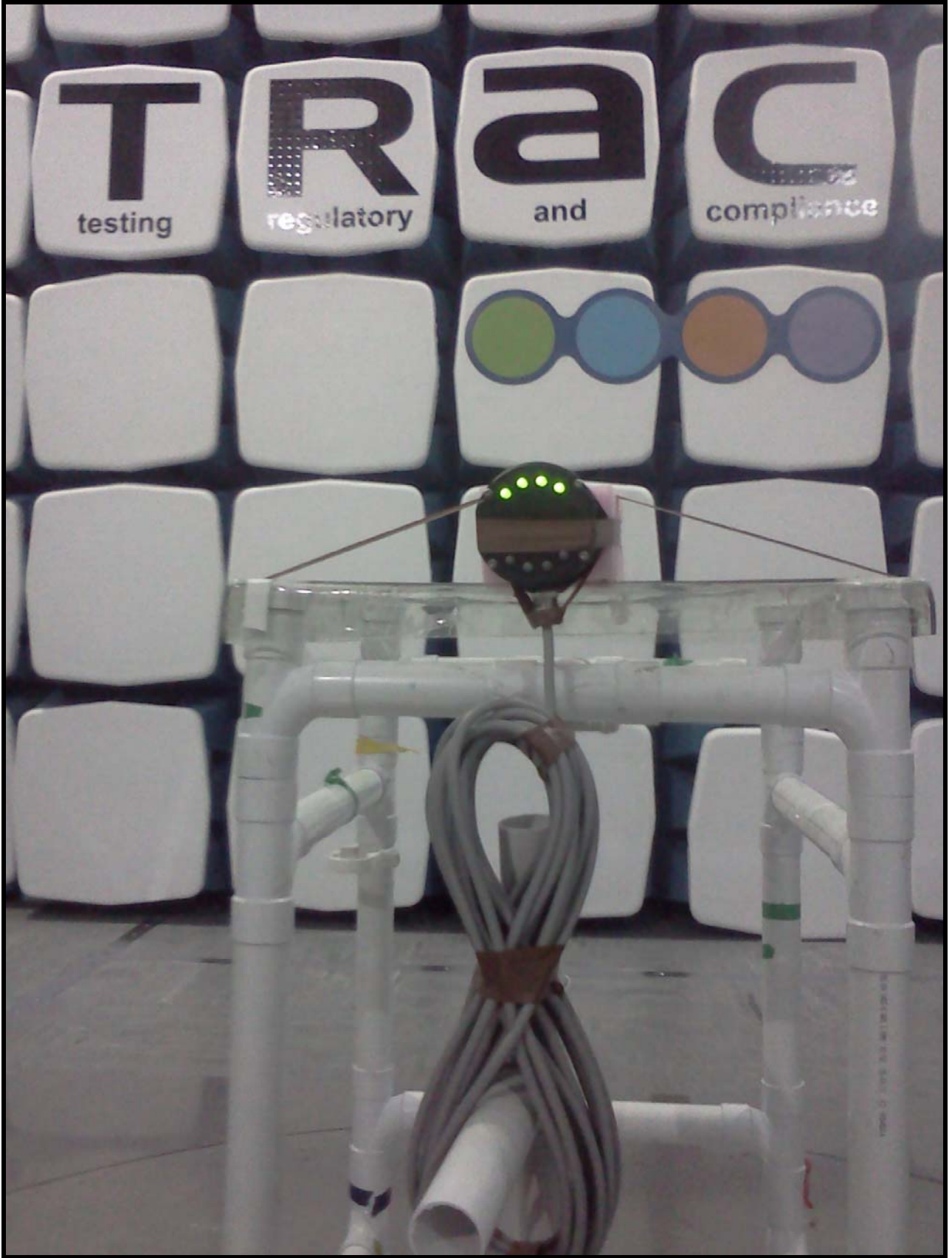
Photographs and Figures

The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: RMI-Q front view.
2. Radiated electric field emissions arrangement: RMI-Q close up.



Photograph 1



Photograph 2

Appendix G:**MPE Calculation**

OET Bulletin No. 65, Supplement C 01-01

47 CFR §§1.1307 and 2.1091

2.1091 Radio frequency radiation exposure evaluation: mobile devices.

For purposes of these requirements mobile devices are defined by the FCC as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimetres is normally maintained between radiating structures and the body of the user or nearby persons. These devices are normally evaluated for exposure potential with relation to the MPE limits. As the 20cm separation specified under FCC rules may not be achievable under normal operation of the EUT, an RF exposure calculation is needed to show the minimum distance required to be less than 1mW/cm² power density limit, as required under FCC rules.

Prediction of MPE limit at a given distance

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

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

where:

S = power density

R = distance to the centre of radiation of the antenna

EIRP = EUT Maximum power

Note:

The EIRP measurement was performed using a signal substitution method.

Result

Prediction Frequency (MHz)	Maximum EIRP	Power density limit (S) (mW/cm ²)	Distance (R) cm required to be less than 1mW/cm ²
2442	1.253	1	0.32

