A Radio Test Report

FOR

Timelox AB

ON

Endnode

DOCUMENT NO. TRA-011412-W-NA-1

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TRaC Wireless Test Report	**:** TRA-011412-W-NA-1
Applicant	**:** Timelox AB
Apparatus	**:** Endnode
Specification(s)	**:** CFR47 Part 15.247 July 2010 & RSS-210, Issue 8
FCCID	**:** WYV-EN110
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Contents

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 :

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1.3 Manufacturer

As Above

1.4 Apparatus Assessed

The following apparatus was assessed between 15th – 21st November 2012:

Endnode

The above product is a DSSS RF module operating in the 2.4 GHz ISM band. The device is to be used for door control at indoor commercial premises (e.g Hotels).

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)	RSS-210 Issue 8 December 2010 Annex 8, A8.5	Title 47 of the CFR: Part 15 Subpart C; 15.247	ANSI C63.10:2009	Pass
Conducted spurious emissions (Non-restricted bands)	RSS-210 Issue 8 December 2010 Annex 8.A4(4	Title 47 of the CFR: Part 15 Subpart C; 15.247	ANSI C63.10:2009	Pass
AC Power conducted emissions	RSS-GEN Issue 3 December 2010 Annex 7, 7.2.4	Title 47 of the CFR: Part 15 Subpart C; 15.207	ANSI C63.10:2009	N/A
Occupied Bandwidth	RSS-210 Issue 8 December 2010 Annex 8.A8.2a	Title 47 of the CFR : Part 15 Subpart C; 15.247(a)(2)	ANSI C63.10:2009	Pass
Conducted Carrier Power	RSS-210 Issue 8 December 2010 Annex 8.A4(4).	Title 47 of the CFR : Part 15 Subpart C; 15.247(b)	ANSI C63.10:2009	Pass
Power Spectral Density	RSS-210 Issue 8 December 2010 Annex 8.A8.2b	Title 47 of the CFR : Part 15 Subpart C; 15.247(d)	ANSI C63.10:2009	Pass
Unintentional Radiated Spurious Emissions	RSS-GEN Issue 3 December 2010 7.2.2(c)	Title 47 of the CFR: Part 15 Subpart B; 15.109	ANSI C63.10:2009	Pass
RF Safety	RSS-102	Title 47 of the CFR : Part 15 Subpart C; 15.247(b)(5)	-	Pass

The Endnode will only be powered by batteries

Abbreviations used in the above table:

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

Mod	: Modification	RSS	: Radio Standards Specification
CFR	: Code of Federal Regulations	ANSI	: American National Standards Institution
REFE	: Radiated Electric Field Emissions	PLCE	: Power Line Conducted 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 Application of Measurement Uncertainty

The following table contains the measurement uncertainties for measurements

The following procedure is used when determining the result of a measurement :

(i) If specification limits are not exceeded by the measured result, extended by the positive component of the expanded uncertainty interval at a confidence level of 95%, then a pass result is recorded.

(ii) Where a specification limit is exceeded by the result even when the result is decreased by the negative component of the expanded uncertainty interval, a fail result is recorded.

(iii) Where measured result is below a limit, but by a margin less than the positive measurement uncertainty component, it is not possible to record a pass based on a 95% confidence level. However, the result indicates that a pass result is more probable than a fail result.

(iv) Where a measured result is above a limit, but by a margin less than the negative measurement uncertainty component, it is not possible to record a fail based on a 95% confidence level. However the result indicates that a fail is more probable than a pass.

2.2 Measurement Uncertainty Values

For the test data recorded in accordance with note (iii) of Section 2.1 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
Mod	: Modification
EUT	: Equipment Under Test
SE	: Support Equipment
L	: Live Power Line
N	: Neutral Power Line
E	: Earth Power Line
Pk	: Peak Detector
QP	: Quasi-Peak Detector
Av	: Average Detector
CDN	: Coupling & decoupling network

ALSR	: Absorber Lined Screened Room
OATS	: Open Area Test Site
ATS	: Alternative Test Site
Ref	: Reference
Freq	: Frequency
MD	: Measurement Distance
SD	: Spec Distance
Pol	: Polarisation
H	: Horizontal Polarisation
V	: Vertical Polarisation

A1 6 dB Bandwidth

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

RSS-210 Issue 8 December 2010 requires the measurement of the bandwidth of the transmission between the -6 dB points on the transmitted spectrum.

Test Details:	
Regulation	Part 15 Subpart (c) 15.247(a)(2), RSS-210 Annex 8.A8.2a
Measurement standard	ANSI C63.10, KDB Document: 558074
EUT sample number	S05
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
Temperature	24^0C
EUT set up	Refer to Appendix C

Channel Frequency (MHz)	F_{lower}	F_{Higher}	Measured 20 dB Bandwidth (kHz)	Limit	Result
2405	2404.221154	2405.833333	1612.179	>500kHz	Pass
2440	2439.213141	2440.799679	1586.538	>500kHz	Pass
2480	2479.221154	2480.793269	1572.115	>500kHz	Pass

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

A2 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)(3)
Measurement standard	ANSI C63.10, KDB Document: 558074
EUT sample number	S05
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
Temperature	24^0C
EUT set up	Refer to Appendix C

Channel Frequency (MHz)	Conducted Peak Carrier Power (dBm)	Conducted Peak Carrier Power (mW)	Limit (W)	Result
2405	1.04	1.27	1	Pass
2440	0.70	1.17	1	Pass
2480	0.09	1.02	1	Pass

Notes:

Conducted Measurement

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

A3 Transmitter Power Spectral Density

Transmitter Power Spectral Density was verified with the EUT transmitting on its lowest, centre and highest carrier frequency in turn.

Test Details:	
Regulation	Part15 Subpart (c) 15.247(b)(3), RSS-210 Annex 8.A8.2b
Measurement standard	ANSI C63.10, KDB Document: 558074
EUT sample number	S05
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
Temperature	24^0C
EUT set up	Refer to Appendix C

Channel Frequency (MHz)	Conducted Peak Power Spectral Density	Limit (dBm)	Result
2405	-2.62	+8	Pass
2440	-3.24	+8	Pass
2480	-3.62	+8	Pass

Notes:

Conducted Measurement

Conducted measurements were performed on the unique antenna connector.

Measurements performed as per KDB Document:

558074 D01 DTS Meas Guidance v02
Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

A4 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.

Regulation	Part 15 Subpart (c) Clause 15.247(d), RSS-210 Annex 8.A8.5
Measurement standard	ANSI C63.10, KDB Document: 558074
Frequency range	9 kHz to 25 GHz
EUT sample number	S05
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
Temperature	24^0C
EUT set up	Refer to Appendix C

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

Test Details: 2405 MHz					
Ref No.	Measured Freq (MHz)	Det.	Measured Peak Conducted power (RBW =100kHz) (dBuV)	Limit (dBuV)	Summary
1.	592.000	Pk	46.20	84.49	Pass
2.	4809.022	Pk	67.26	84.49	Pass
3.	9618.012	Pk	43.63	84.49	Pass

Test Details: 2440 MHz					
Ref No.	Measured Freq (MHz)	Det.	Measured Peak Conducted power (RBW =100kHz) (dBuV)	Limit (dBuV)	Summary
1.	608.00	Pk	50.71	84.21	Pass
2.	4879.01	Pk	67.89	84.21	Pass
3.	9758.00	Pk	40.89	84.21	Pass

Test Details: 2480MHz					
Ref No.	Measured Freq (MHz)	Det.	Measured Peak Conducted power (RBW =100kHz) (dBuV)	Limit (dBuV)	Summary
1.	624.00	Pk	45.27	84.01	Pass
2.	4958.99	Pk	66.59	84.01	Pass
3.	9197.98	Pk	34.45	84.01	Pass

Notes:

1. The conducted emission limit for emissions are based on a transmitted carrier level of 15.247(b) / Annex 8, A8.4(2). 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) and Annex 8, A8.5 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) and RSS-GEN 4.9.
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 defined using the following formula in accordance with 15.247(d) and Annex 8, A8.5

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

Where:

The maximum peak conducted power was measured using a peak power meter. Please refer to section A1 of this test report.

Channel Frequency (MHz)	Measured Peak Carrier (dBμV)	Emission Limit In a 100 kHz RBW (dBμV)
2405	104.49	84.49
2440	104.21	84.21
2480	104.01	84.01

A5 Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The maximum permitted field strength is listed in Section 15.209 and per RSS – 210 Annex 8, A8.5. 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 : [X]

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

Test Details:	
Regulation	Part 15 Subpart (c) Clause 15.247(d), RSS – 210 Annex 8, A8.5
Measurement standard	ANSI C63.10, KDB Document: 558074
Frequency range	30MHz – 25GHz
EUT sample number	S05
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
Temperature	24^0C
EUT set up	Refer to Appendix 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:

Test Details: 2405 MHz									
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)**
No Significant Emissions Within 20 dB of the limit									

Test Details: 2440 MHz									
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)**
No Significant Emissions Within 20 dB of the limit									

Test Details: 2480 MHz									
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)**
No Significant Emissions Within 20 dB of the limit									

Radiated Electric Field Emissions – Bandedge Compliance

Lower Bandedge Compliance	
Measurement	PK
Carrier power (100kHz RBW)	94.14 dBuV/m
Power At Bandedge dBuV/m	98.20 dBuV/m
Power At Bandedge dBc	-40.61 dBC
Limit (@ -20 dBc)	74.14 dBuV/m
Margin	-20.61 dB
Result	Compliant

Upper Bandedge Compliance		
Measurement	PK	AV
Carrier power (5MHz RBW)	96.52 dBuV/m	95.09 dBuV/m
dBuV (100kHz RBW)	98.20 dBuV	88.86 dBuV
delta in 100kHz	-37.55 dB	-41.25 dB
Power At Bandedge dBuV/m	58.97 dBuV/m	53.84 dBuV/m
Limit dBuV/m	74.00 dBuV/m	54.00 dBuV/m
Margin	-15.03 dB	0.16 dB
Result	Compliant	Compliant

Upper Bandedge Compliance measurement made using the delta marker method as detailed in ANSI C63.10 and KDB Document: 558074

Plots are contained 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

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) and RSS-Gen 4.3.

Radiated emission limits (47 CFR Part 15: Clause 15.209) for emissions falling within the restricted bands defined in 15.205(a) and RSS-Gen 7.2.2:

Frequency of emission (MHz)	Field strength μV/m	Measurement Distance m	Field strength dBμV/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:

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

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

A6 Antenna Gain

The maximum antenna gain for the antenna types to be used with the EUT, as declared by the client, is 3.5 dBi.

A7 Unintentional Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The maximum permitted field strength is listed in Section 15.109 and in RSS- GEN Section 7.2.3. 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 : [X]

Test Details:	
Regulation	Part 15 Subpart (b) Clause 15.109, RSS – GEN Section 7.2.3
Measurement standard	ANSI C63.10
Frequency range	30MHz to 25 GHz
EUT sample number	S05
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
Temperature	24^0C
EUT set up	Refer to Appendix C
Photographs (Appendix F)	1 & 2

The worst case radiated emission measurements for spurious emissions:

Test Details: 2405 MHz									
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)
No Significant Emissions Within 20 dB of the limit									

Test Details: 2440 MHz									
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)
No Significant Emissions Within 20 dB of the limit									

Test Details: 2480 MHz									
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)
No Significant Emissions Within 20 dB of the limit									

Sample Plots for 2440 MHz operation 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 For emissions below 30MHz the cable losses are assumed to be negligible.
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 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.
4 For Frequencies below 1 GHz, RBW = 120 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= 1MHz, VBW ≥ RBW
Average	RBW= 1MHz, VBW ≥ RBW

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) and RSS-Gen 4.3.

Radiated emission limits 47 CFR Part 15: Clause 15.209 and RSS – GEN Section 7.2.3 for all emissions:

Frequency of emission (MHz)	Field strength μV/m	Measurement Distance m	Field strength dBμV/m
30-88	100	3	40.0
88-216	150	3	43.5
216-960	200	3	46.0
Above 960	500	3	54.0

(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:

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

(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

Appendix B: Supporting Graphical Data

This appendix contains graphical data obtained during testing.

Notes:

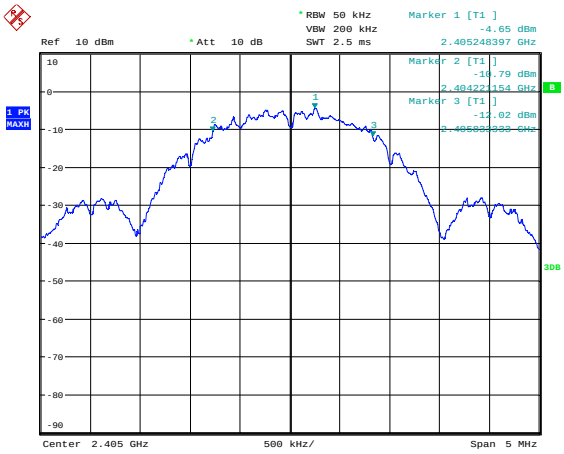
(a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A and Appendix B.

(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.

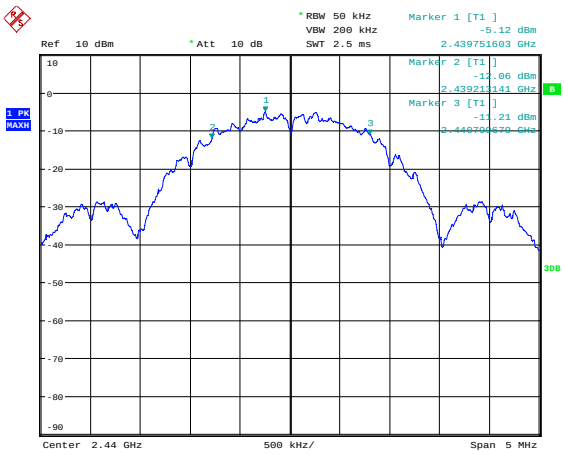
(d) Appendix C details the numbering system used to identify the sample and its modification state.

(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.



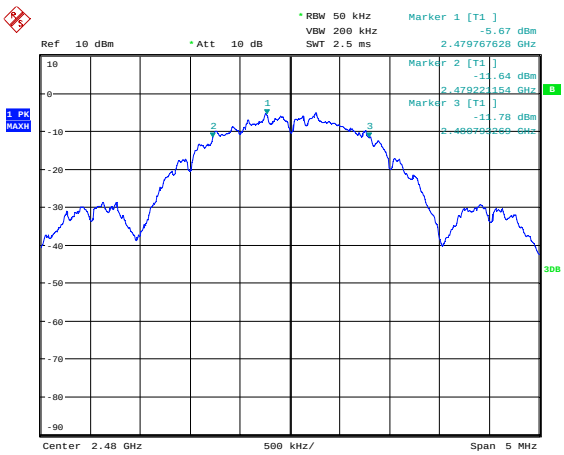
Date: 15.NOV.2012 10:15:33

6dB Bandwidth 2405 MHz



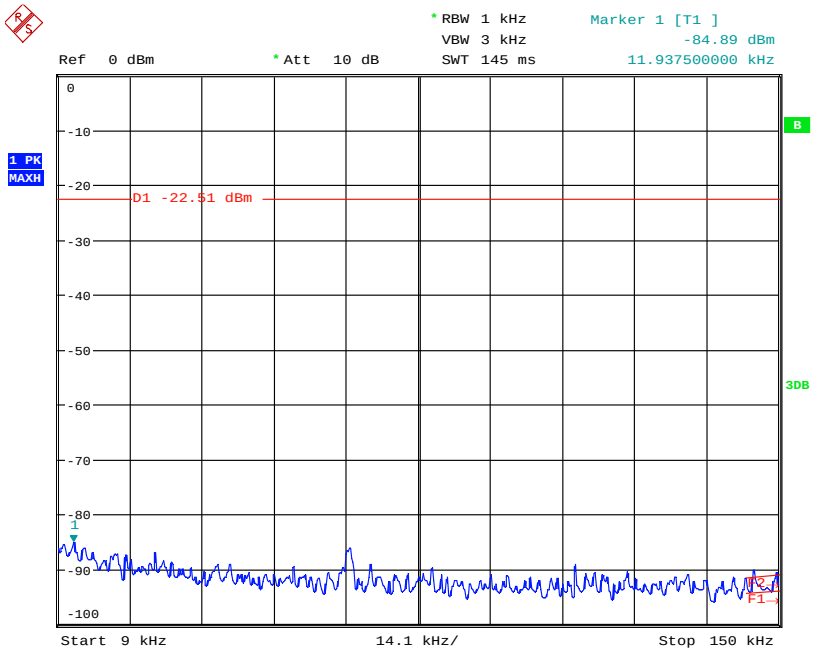
Date: 15.NOV.2012 10:07:20

6dB Bandwidth 2440 MHz



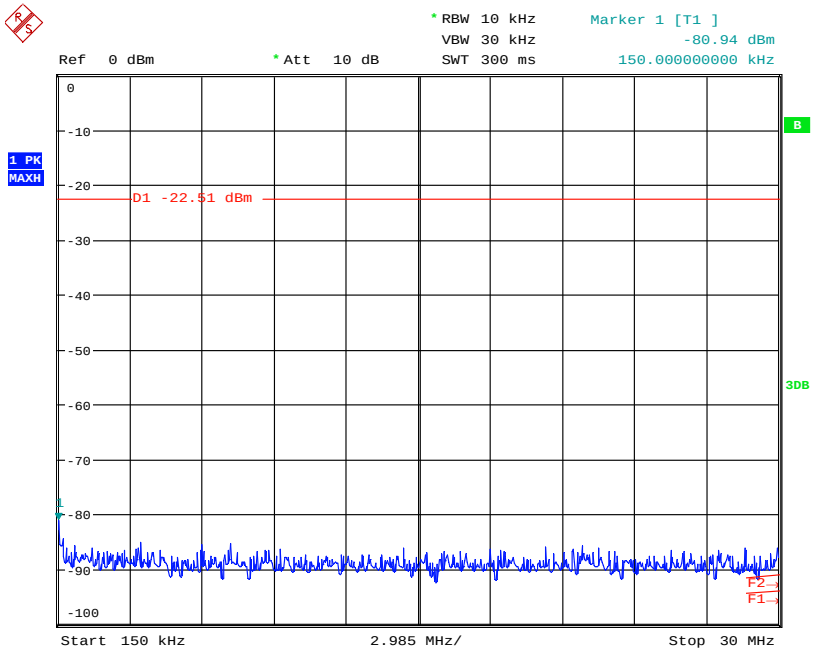
Date: 15.NOV.2012 10:05:37

6dB Bandwidth 2480 MHz



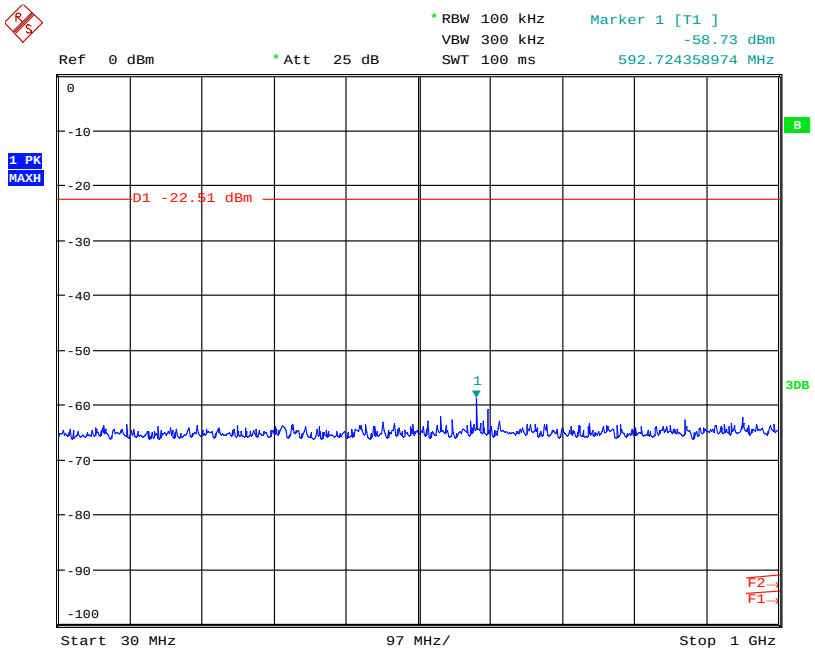
Date: 15.NOV.2012 10:42:38

Conducted Spurious emissions 9kHz to 150 MHz – 2405MHz

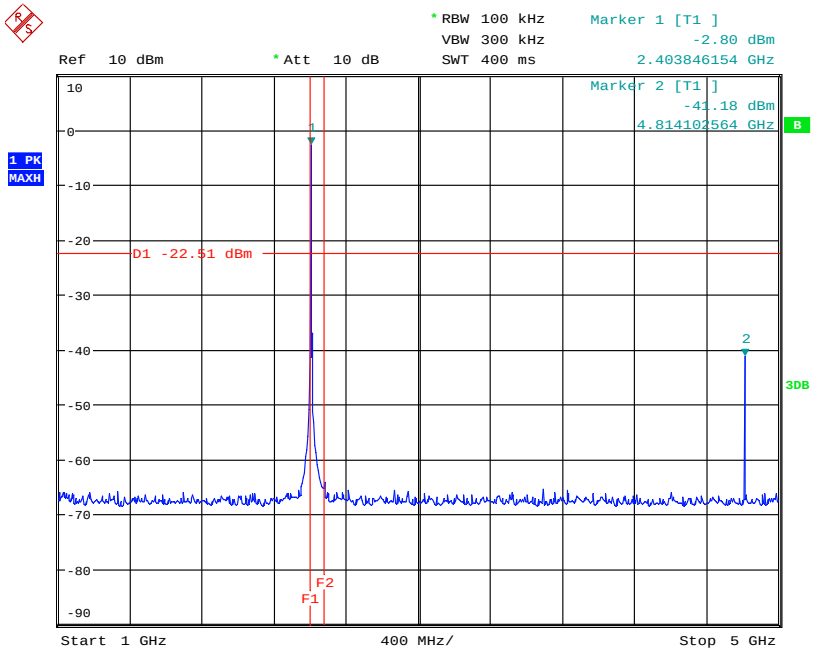


Date: 15.NOV.2012 10:42:57

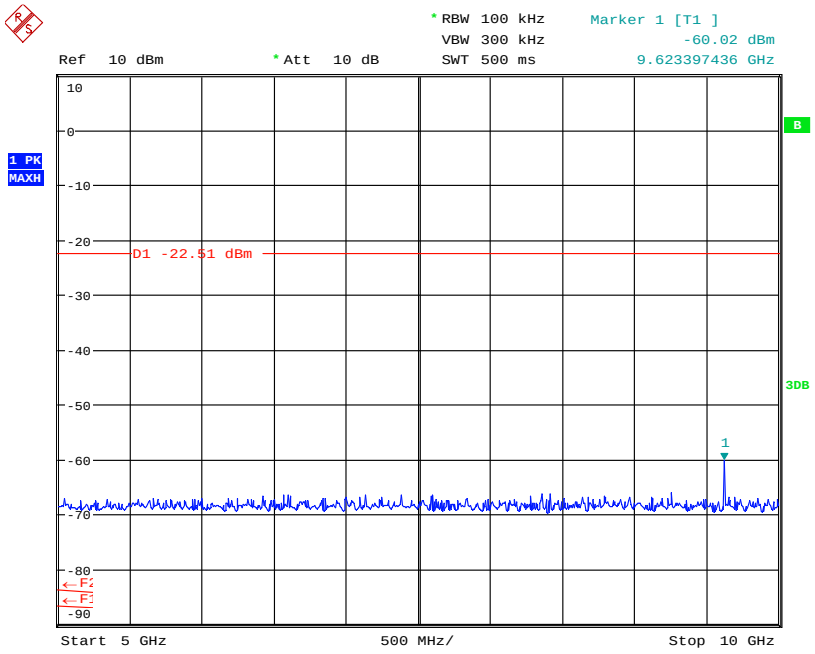
Conducted Spurious emissions 150kHz to 30 MHz – 2405MHz



Conducted Spurious emissions 30 MHz to 1 GHz – 2405MHz

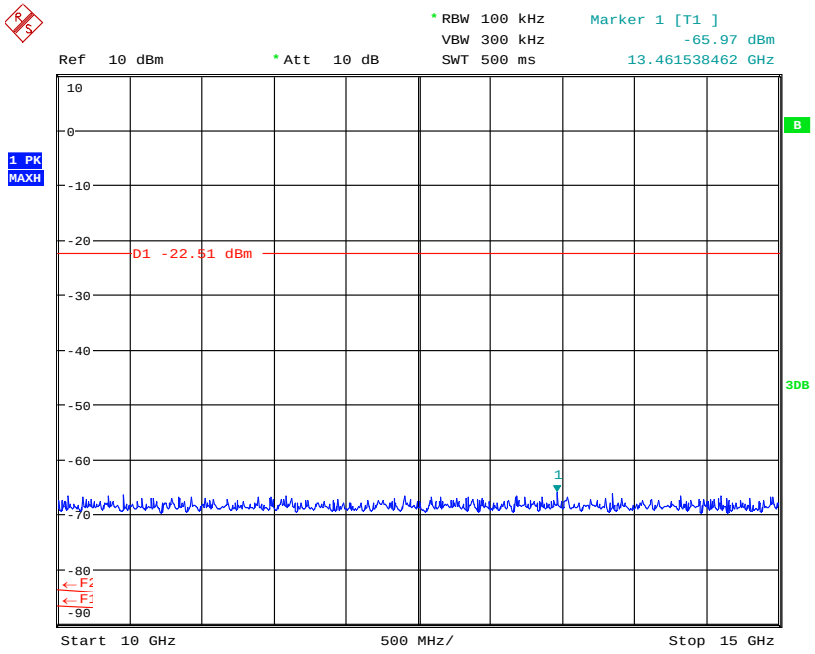


Conducted Spurious emissions 1 GHz to 5 GHz – 2405MHz



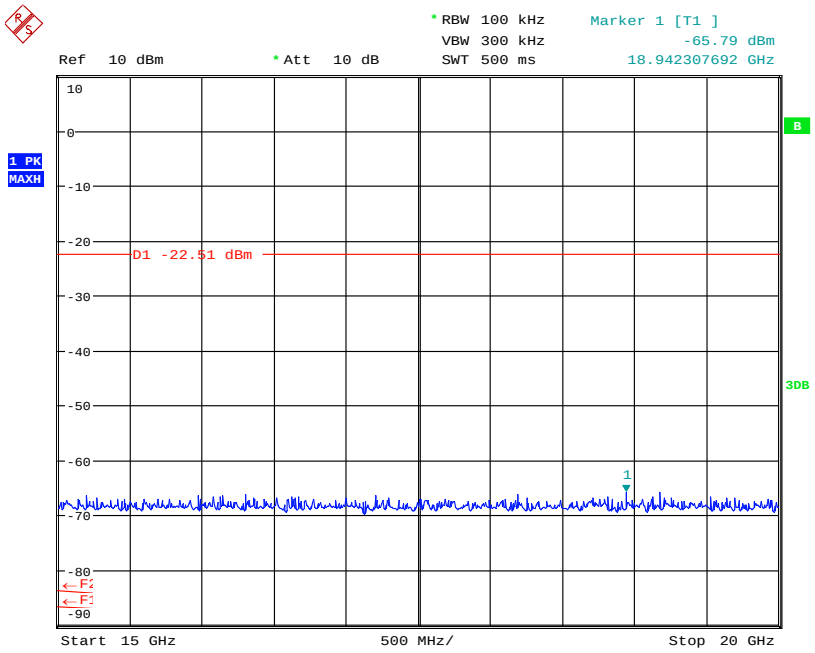
Date: 15.NOV.2012 10:41:26

Conducted Spurious emissions 5 GHz to 10 GHz – 2405MHz



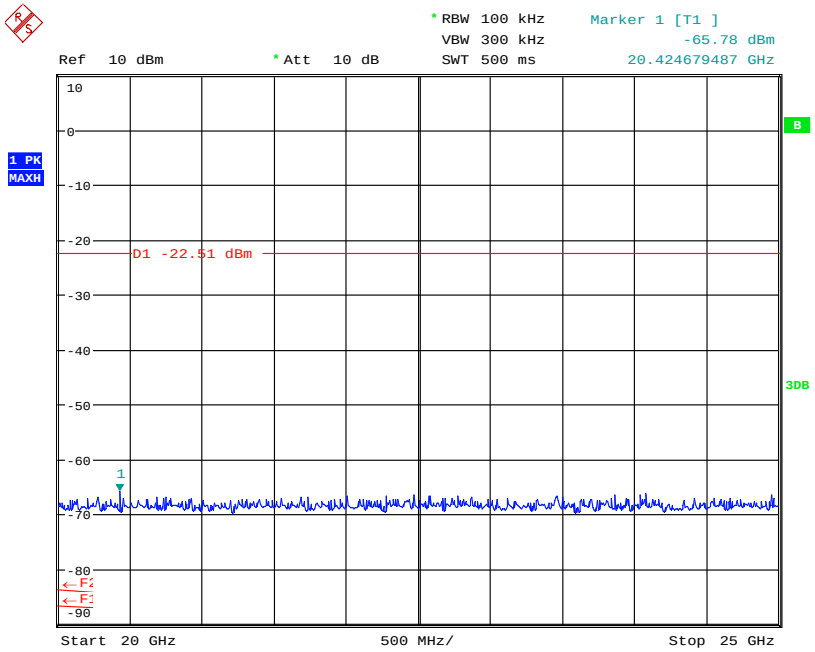
Date: 15.NOV.2012 10:41:41

Conducted Spurious emissions 10 GHz to 15GHz – 2405MHz



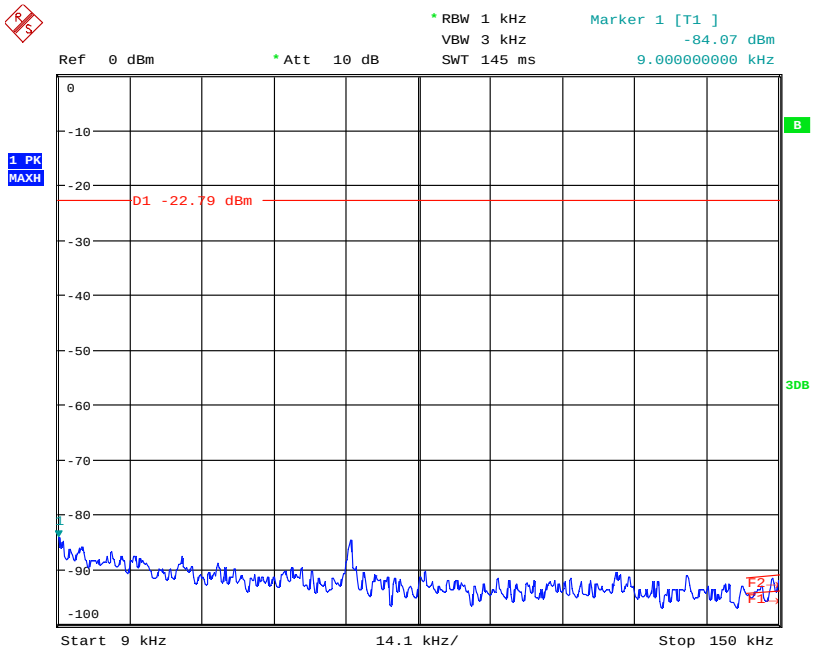
Date: 15.NOV.2012 10:41:59

Conducted Spurious emissions 15 GHz to 20 GHz – 2405MHz



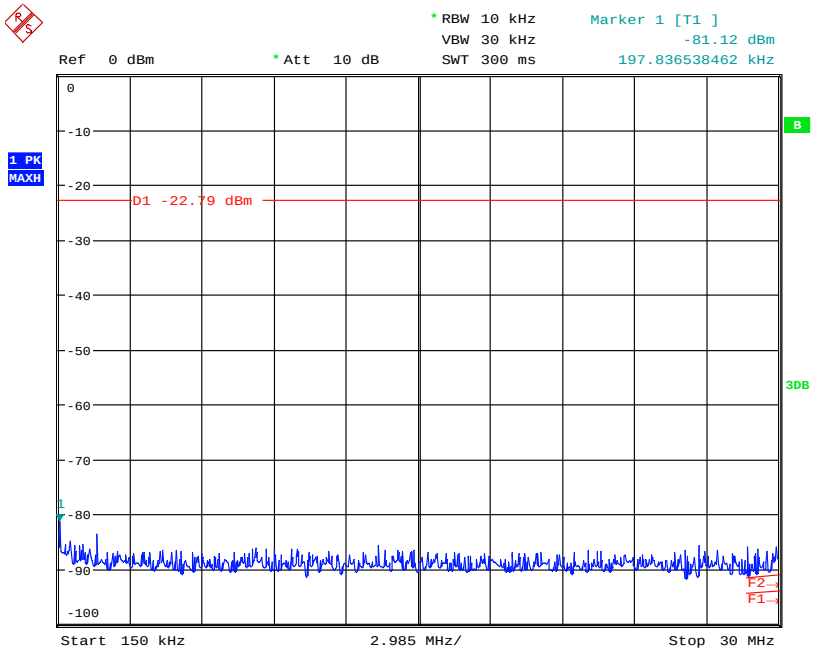
Date: 15.NOV.2012 10:42:17

Conducted Spurious emissions 20 GHz to 25 GHz – 2405MHz



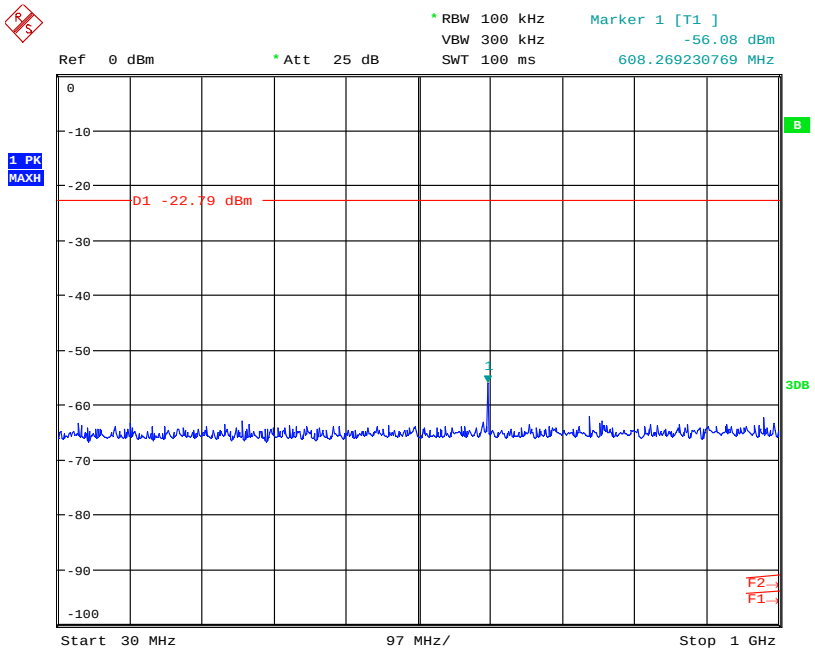
Date: 15.NOV.2012 10:54:43

Conducted Spurious emissions 9kHz to 150 MHz – 2440MHz

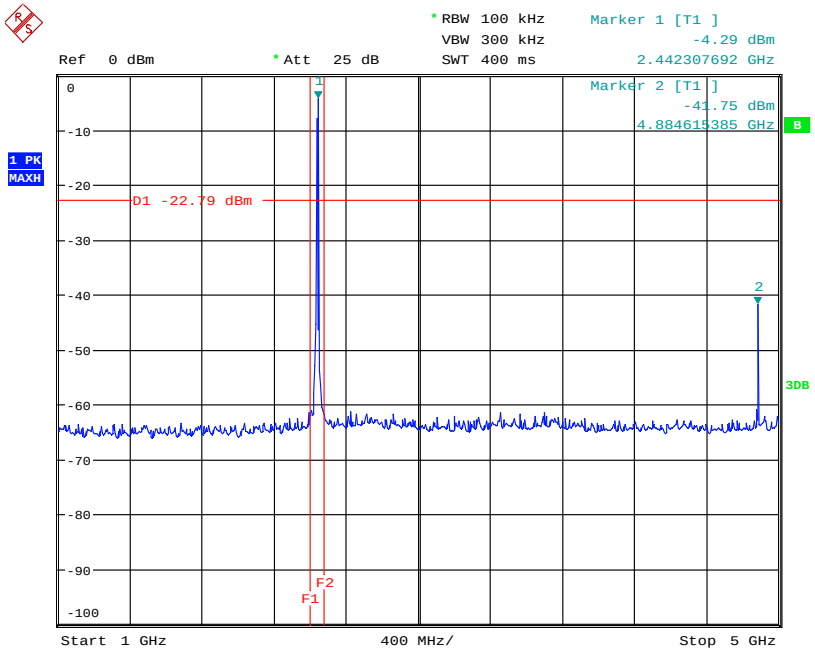


Date: 15.NOV.2012 10:55:05

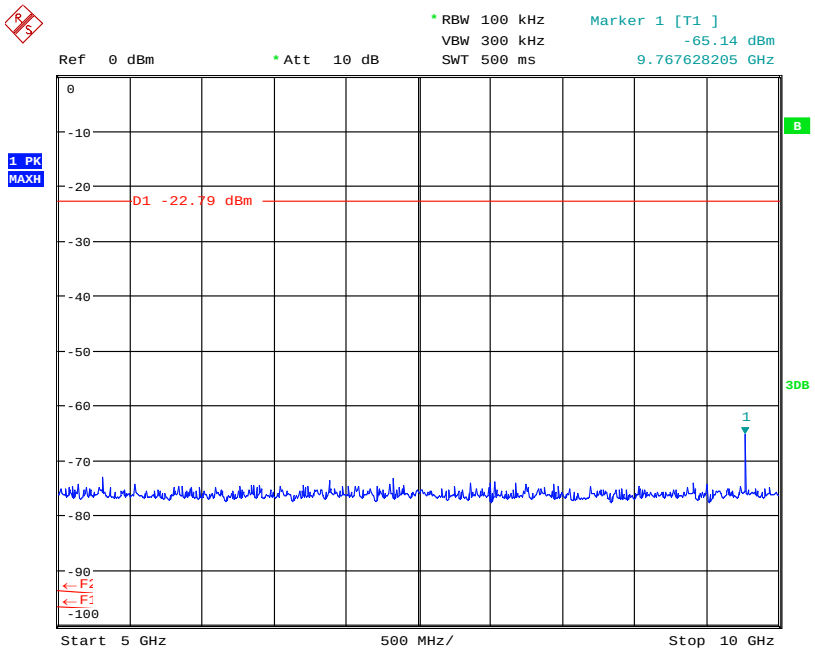
Conducted Spurious emissions 150kHz to 30 MHz – 2440 MHz



Conducted Spurious emissions 30 MHz to 1 GHz – 2440 MHz

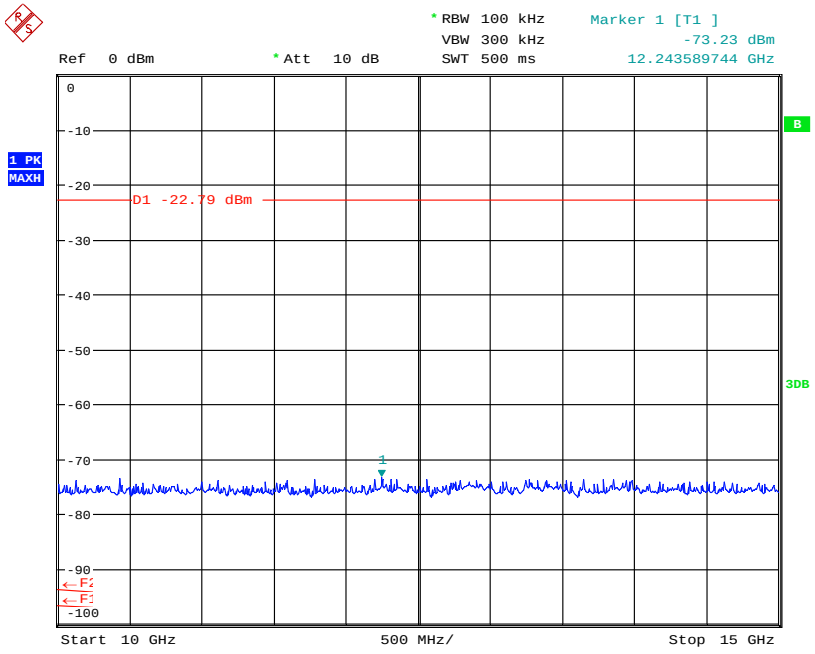


Conducted Spurious emissions 1 GHz to 5 GHz – 2440 MHz



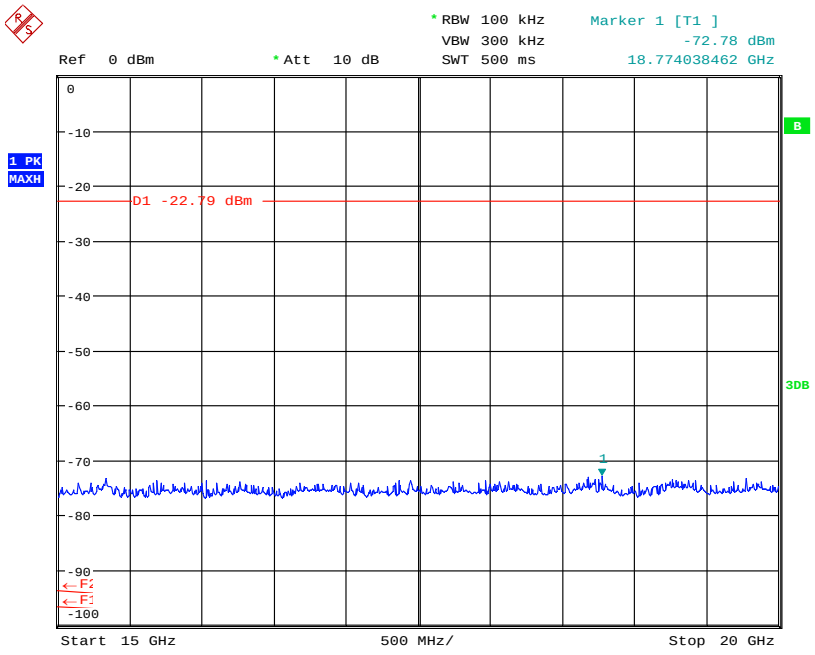
Date: 15.NOV.2012 10:49:51

Conducted Spurious emissions 5 GHz to 10 GHz – 2440 MHz



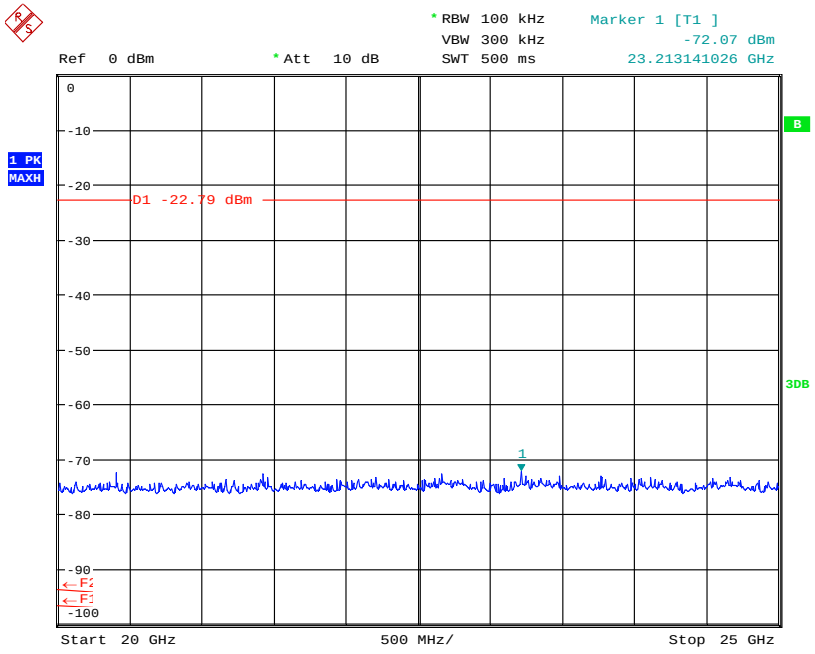
Date: 15.NOV.2012 10:53:39

Conducted Spurious emissions 10 GHz to 15GHz – 2440 MHz



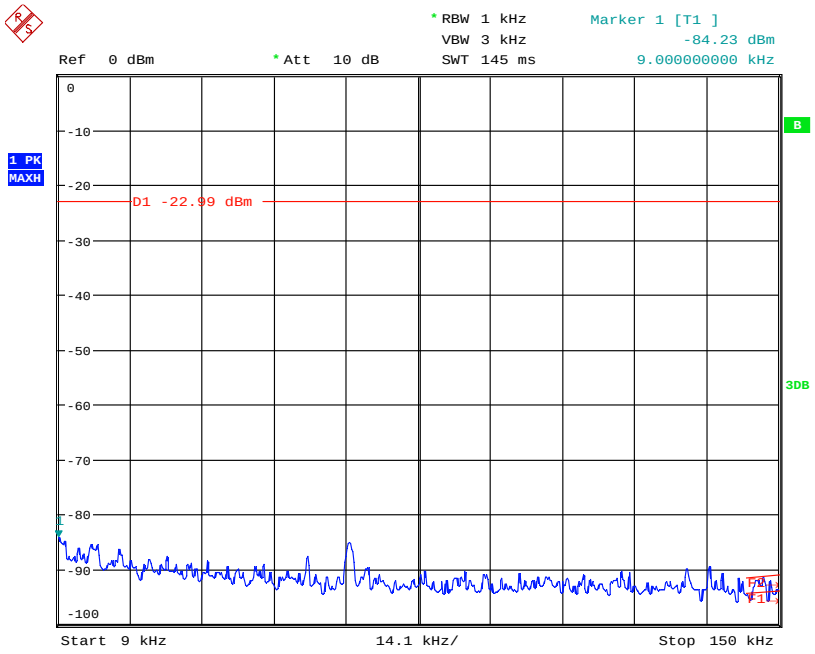
Date: 15.NOV.2012 10:53:59

Conducted Spurious emissions 15 GHz to 20GHz – 2440 MHz

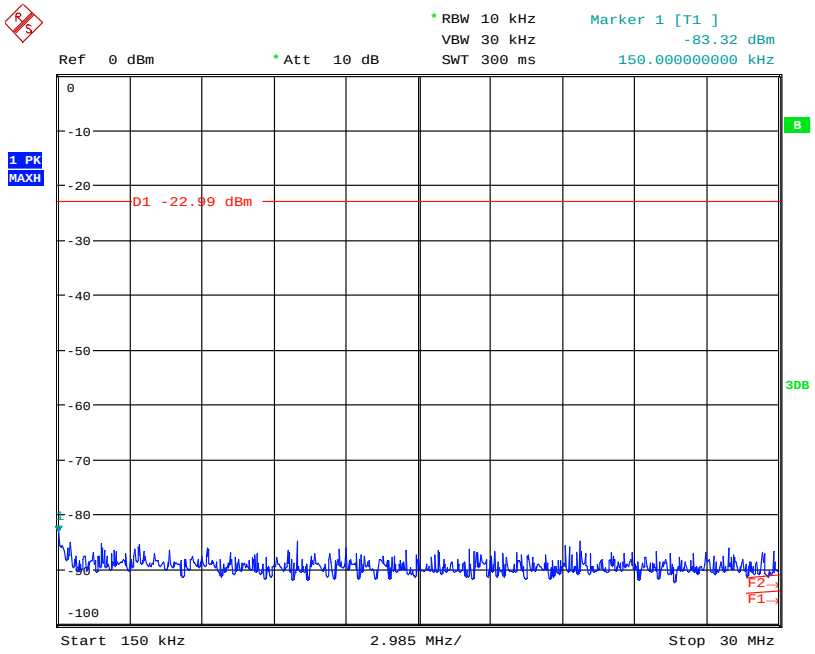


Date: 15.NOV.2012 10:54:25

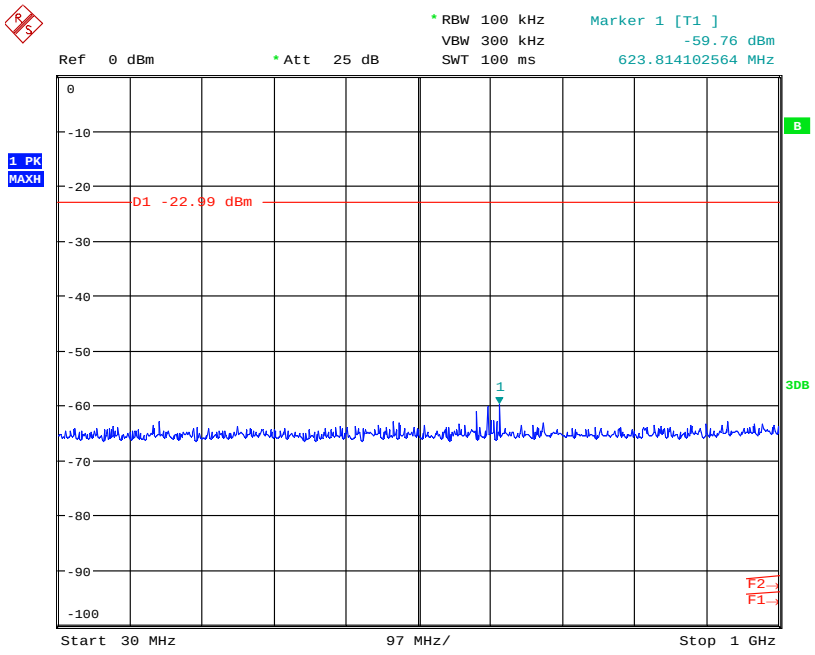
Conducted Spurious emissions 20 GHz to 25GHz – 2440 MHz



Conducted Spurious emissions 9kHz to 150 MHz – 2480MHz

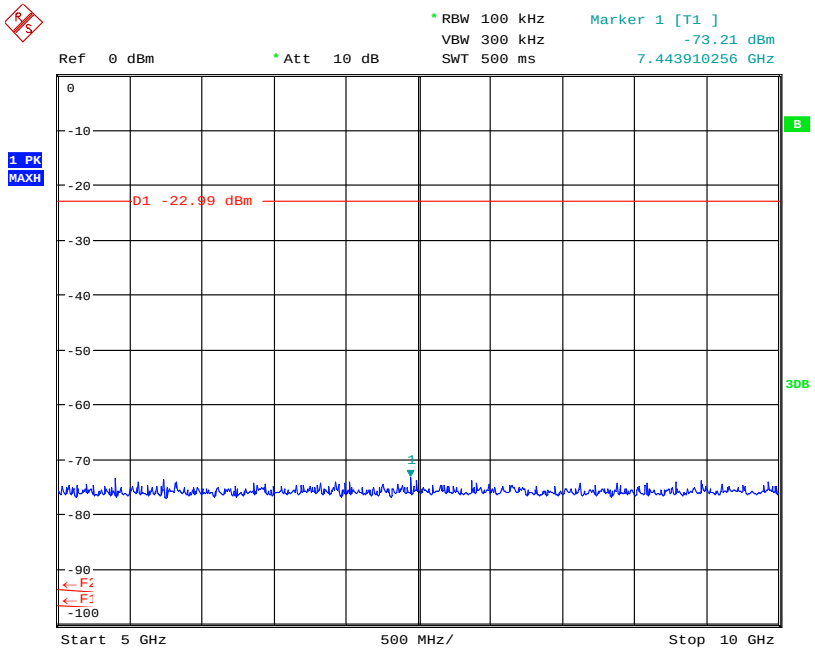


Conducted Spurious emissions 150 kHz to 30 MHz – 2480MHz



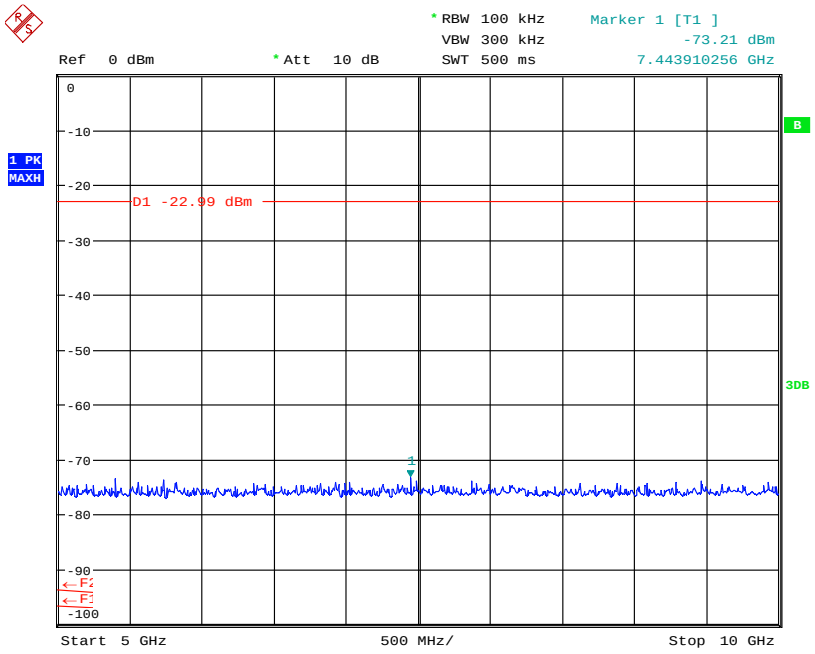
Date: 15.NOV.2012 11:06:57

Conducted Spurious emissions 30 MHz to 1 GHz – 2480MHz



Date: 15.NOV.2012 11:04:49

Conducted Spurious emissions 1 GHz to 5 GHz – 2480MHz



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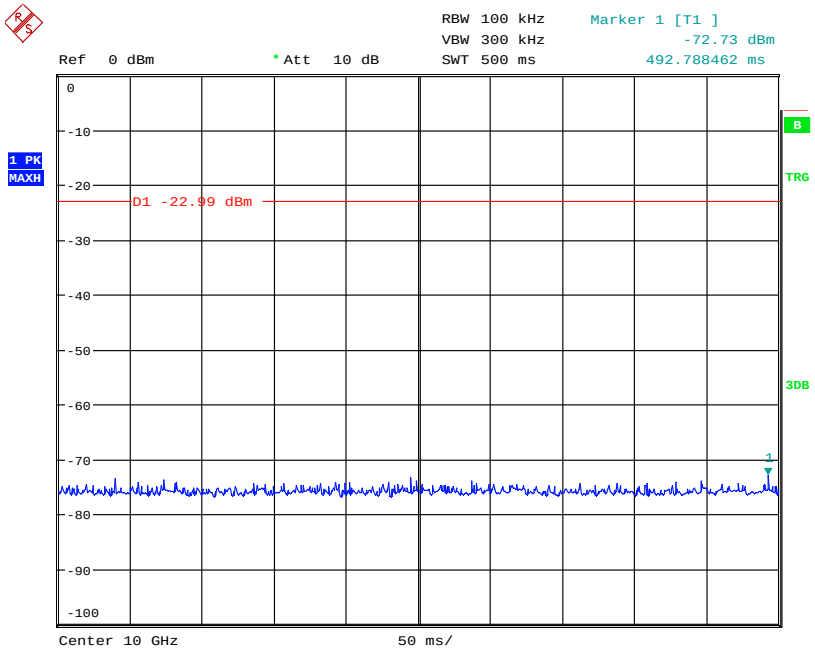
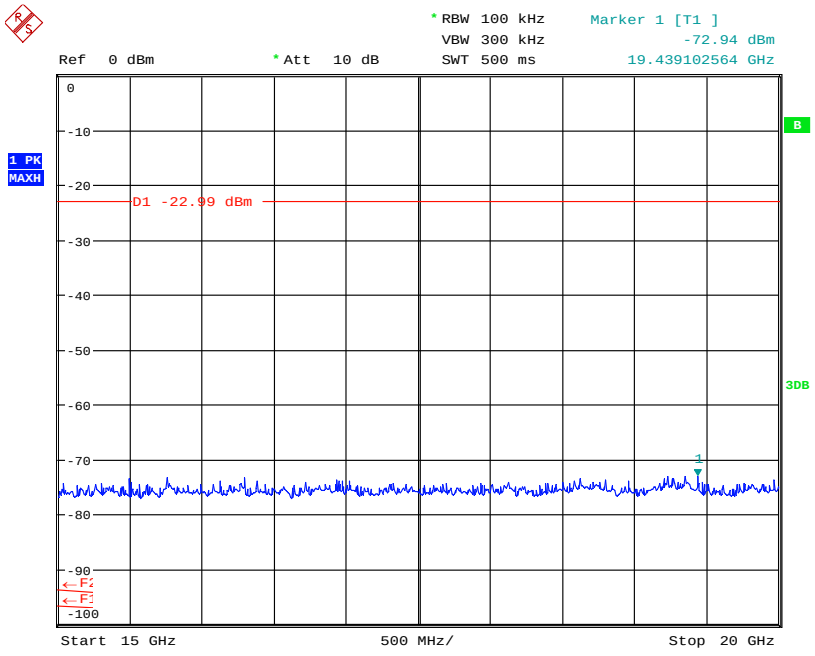
Conducted Spurious emissions 5 GHz to 10 GHz– 2480MHz



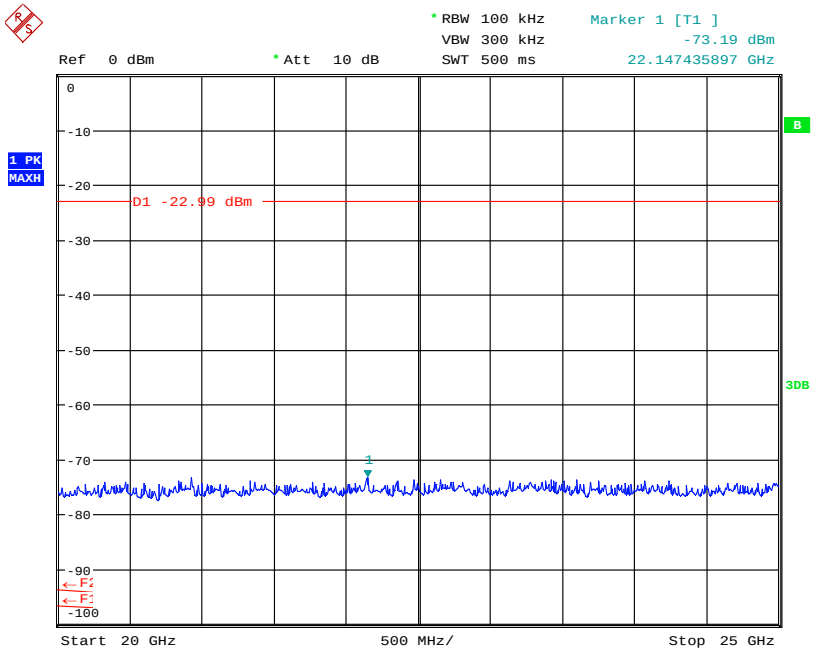
Date: 15.NOV.2012 11:05:08

Conducted Spurious emissions 10 GHz to 15 GHz– 2480MHz



Date: 15.NOV.2012 11:05:26

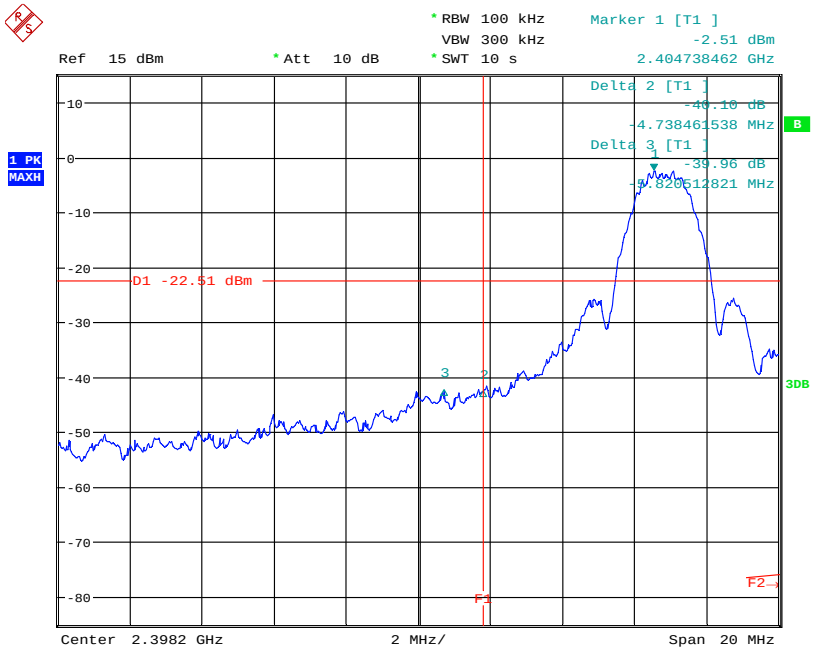
Conducted Spurious emissions 15 GHz to 20 GHz– 2480MHz



Date: 15.NOV.2012 11:05:41

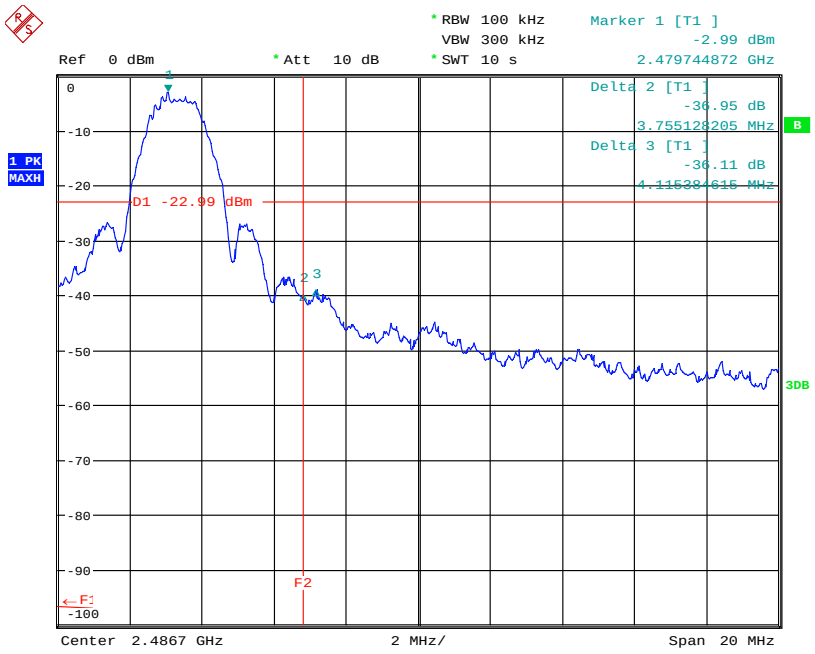
Conducted Spurious emissions 20 GHz to 25 GHz– 2480MHz

Conducted Bandedge Compliance



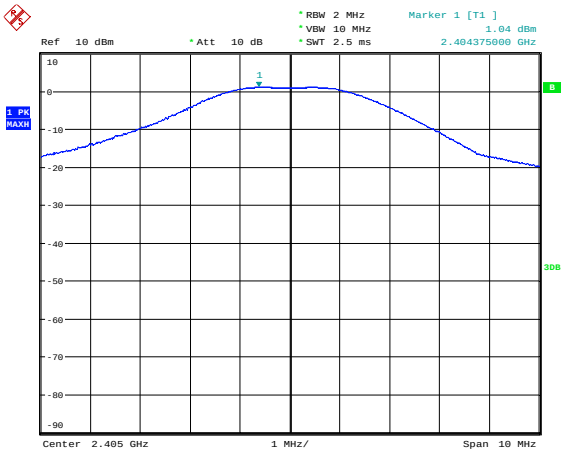
Date: 15.NOV.2012 10:37:02

Lower Bandedge

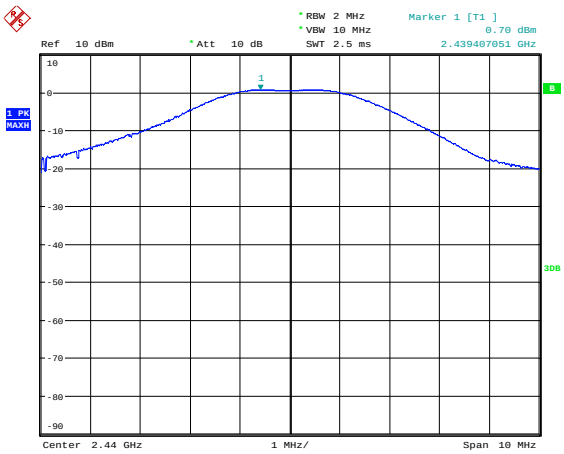


Date: 15.NOV.2012 11:03:56

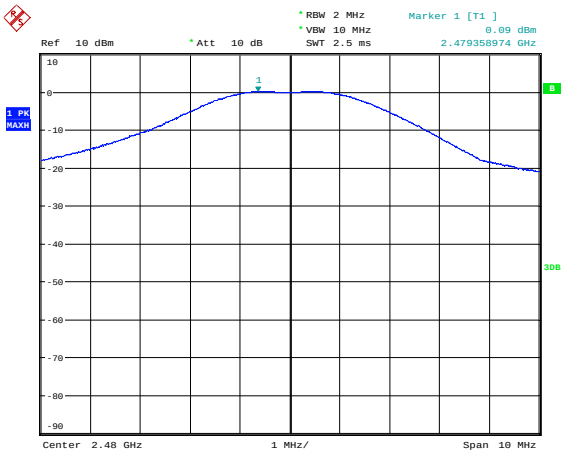
Upper Bandedge



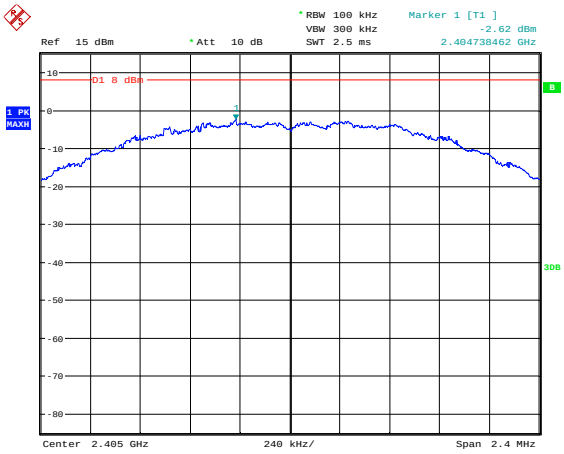
Conducted carrier power 2405MHz



Conducted carrier power 2440 MHz

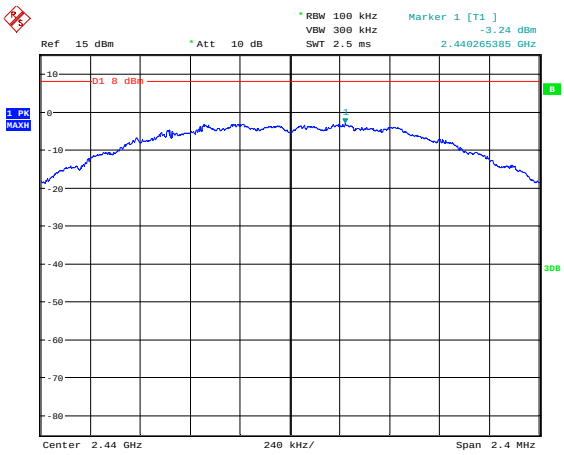


Conducted carrier power 2480 MHz



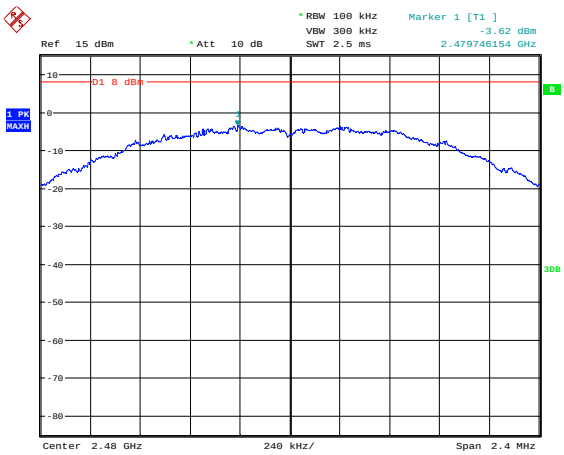
Date: 15.NOV.2012 10:33:47

Conducted power spectral density 2405MHz



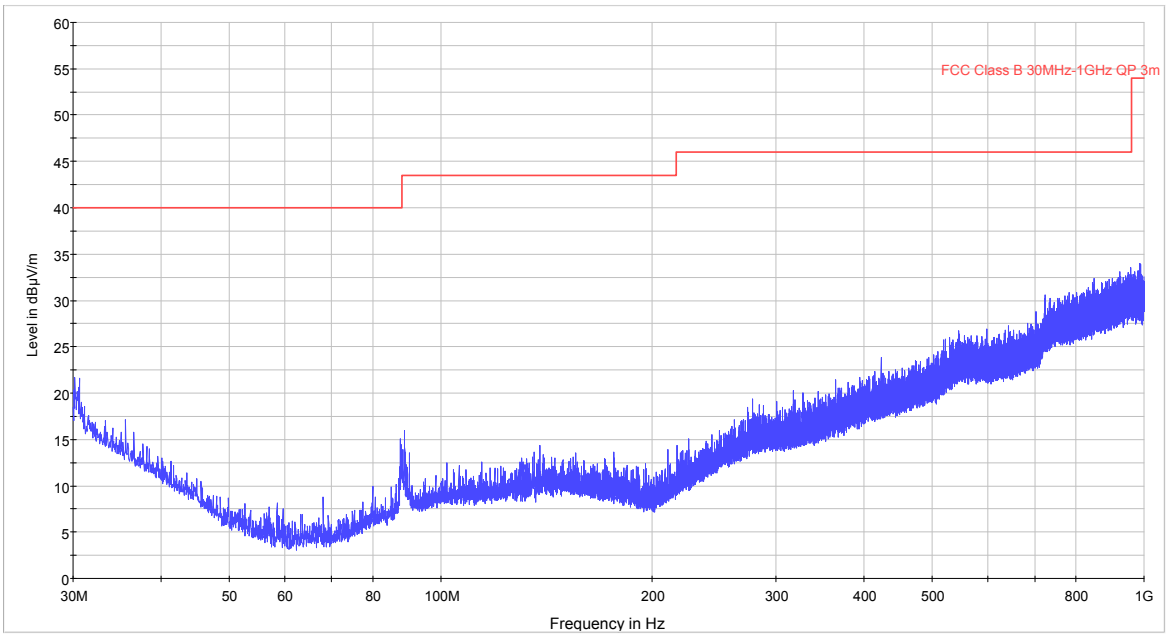
Date: 15.NOV.2012 10:32:47

Conducted power spectral density 2440 MHz

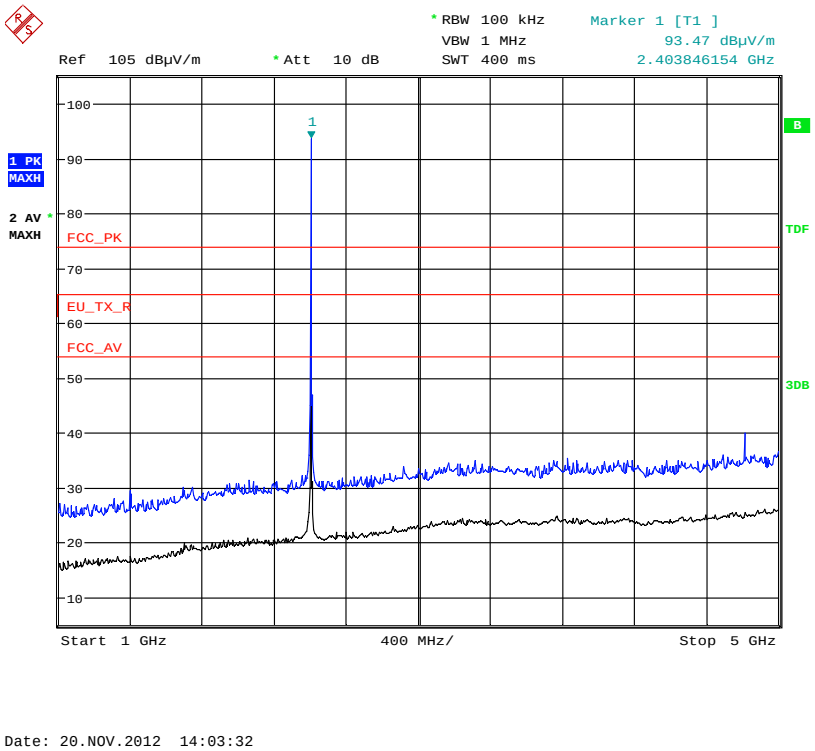


Date: 15.NOV.2012 10:31:20

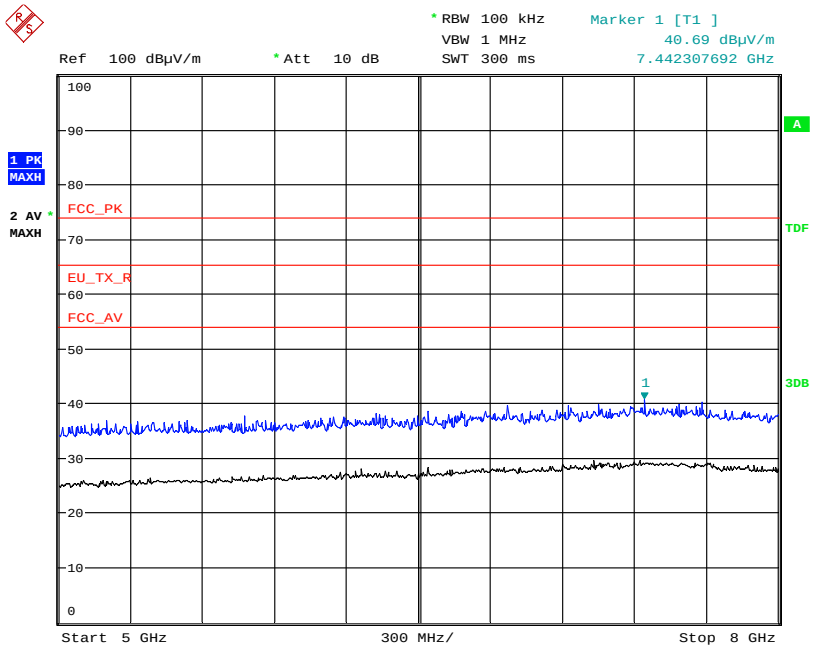
Conducted power spectral density 2480 MHz



Radiated Spurious emissions 30 MHz to 1 GHz – 2405MHz

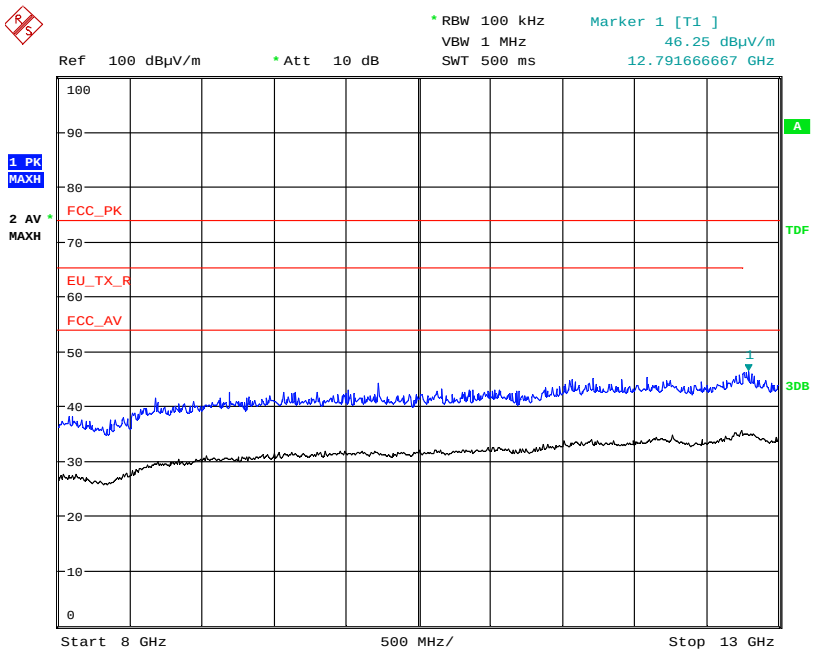


Radiated Spurious emissions 1 GHz to 5 GHz – 2405MHz



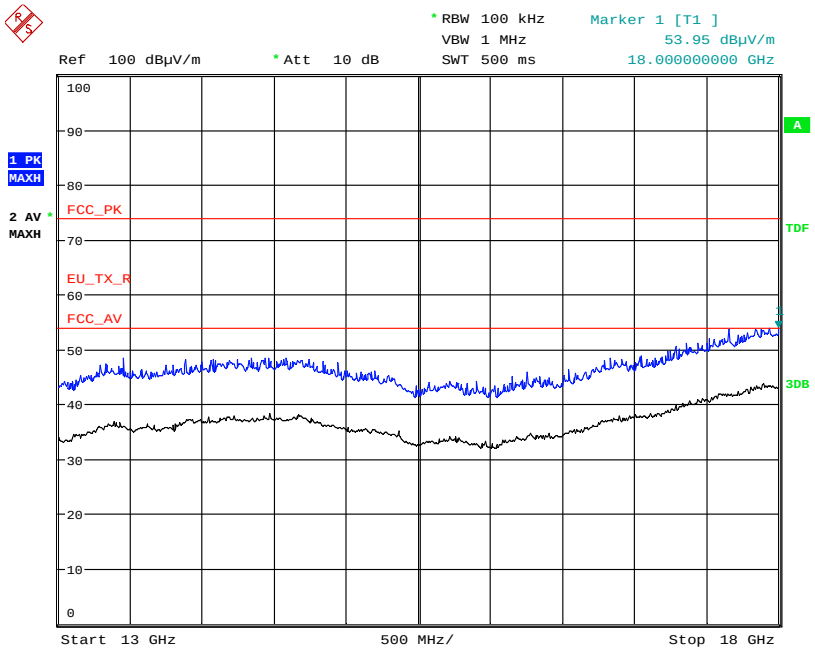
Date: 20.NOV.2012 14:03:18

Radiated Spurious emissions 5 GHz to 8 GHz – 2405MHz



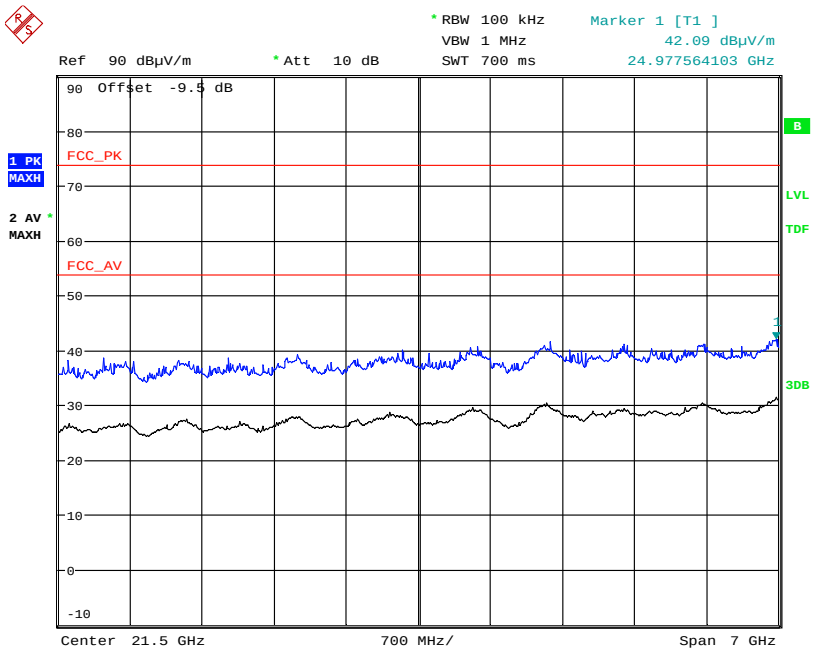
Date: 20.NOV.2012 14:02:52

Radiated Spurious emissions 8 GHz to 13 GHz – 2405MHz



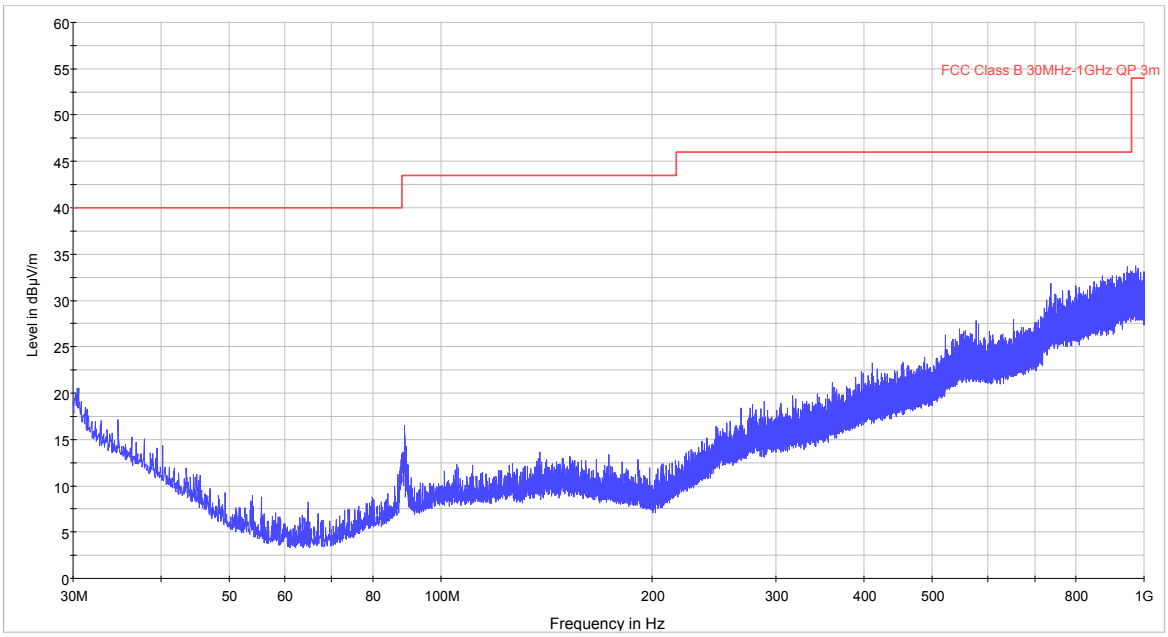
Date: 20.NOV.2012 14:02:32

Radiated Spurious emissions 13 GHz to 18GHz – 2405MHz

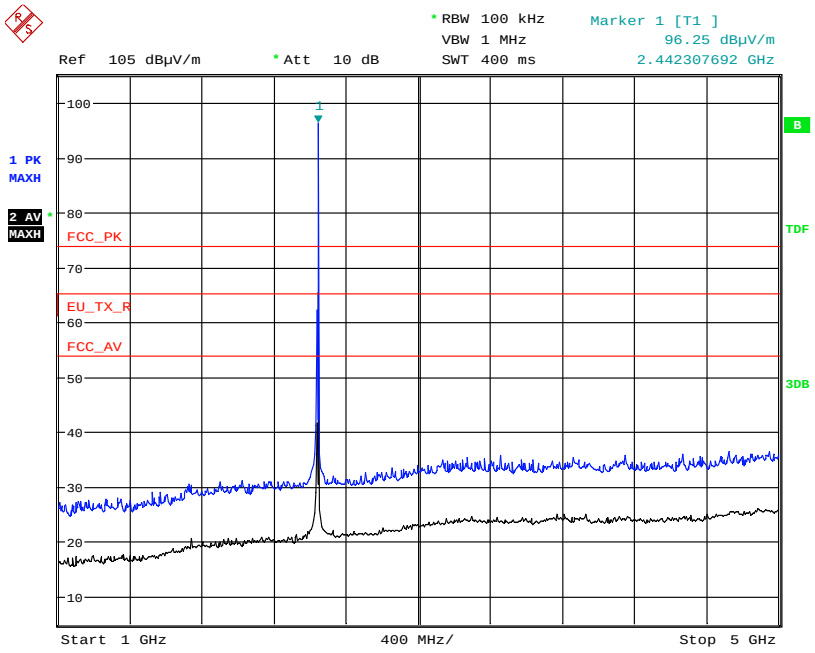


Date: 20.NOV.2012 15:21:29

Radiated Spurious emissions 18 GHz to 25 GHz – 2405MHz

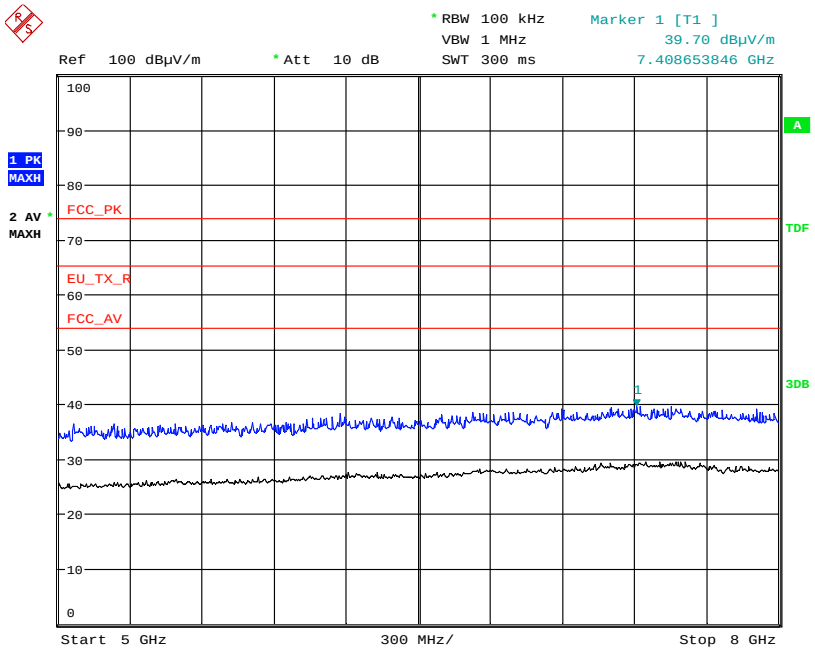


Radiated Spurious emissions 30 MHz to 1 GHz – 2440MHz

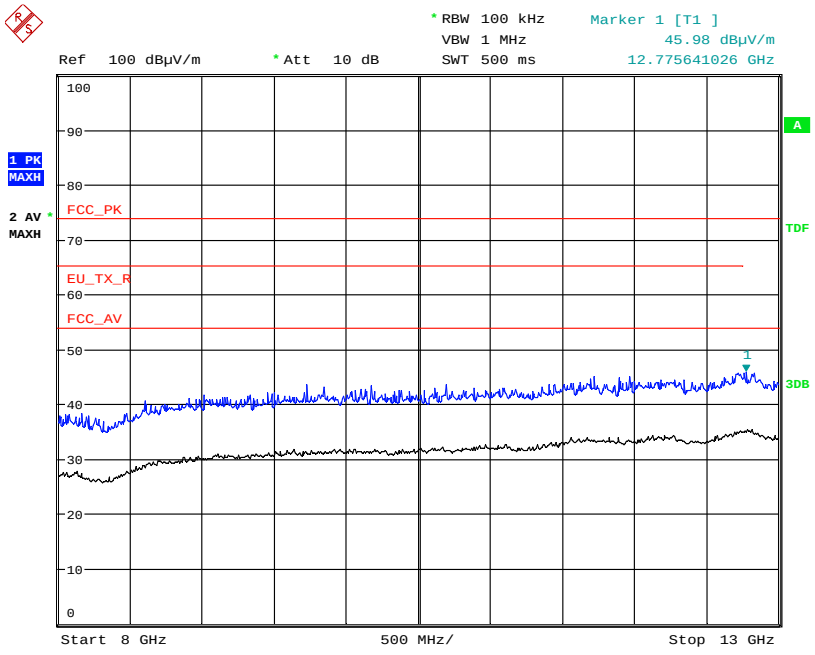


Date: 20.NOV.2012 13:52:50

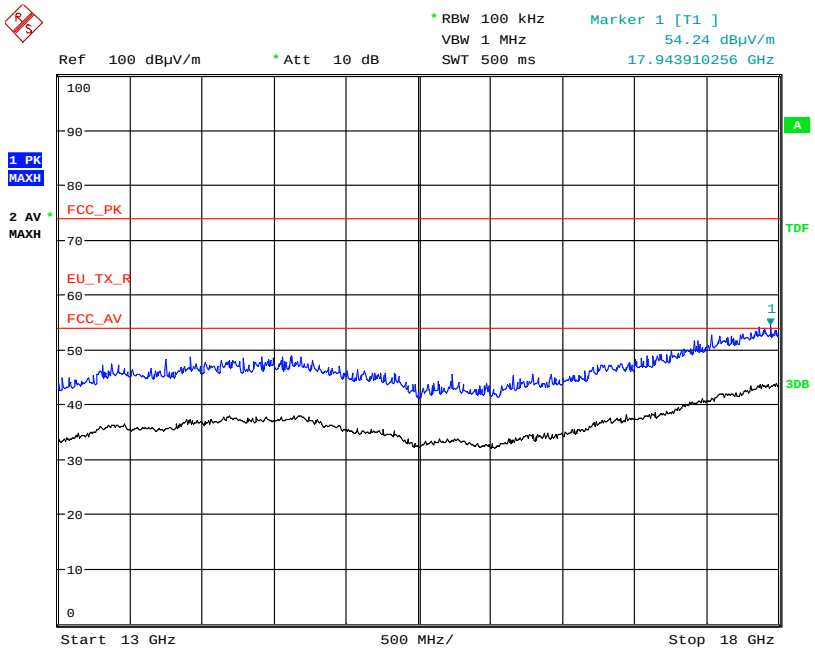
Radiated Spurious emissions 1 GHz to 5 GHz – 2440MHz



Radiated Spurious emissions 5 GHz to 8 GHz – 2440MHz

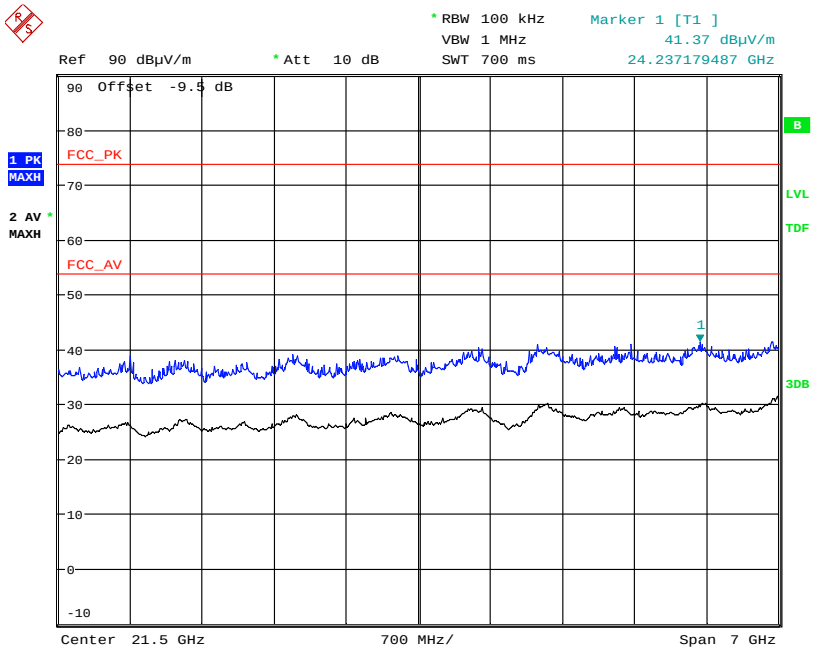


Radiated Spurious emissions 8 GHz to 13 GHz – 2440MHz



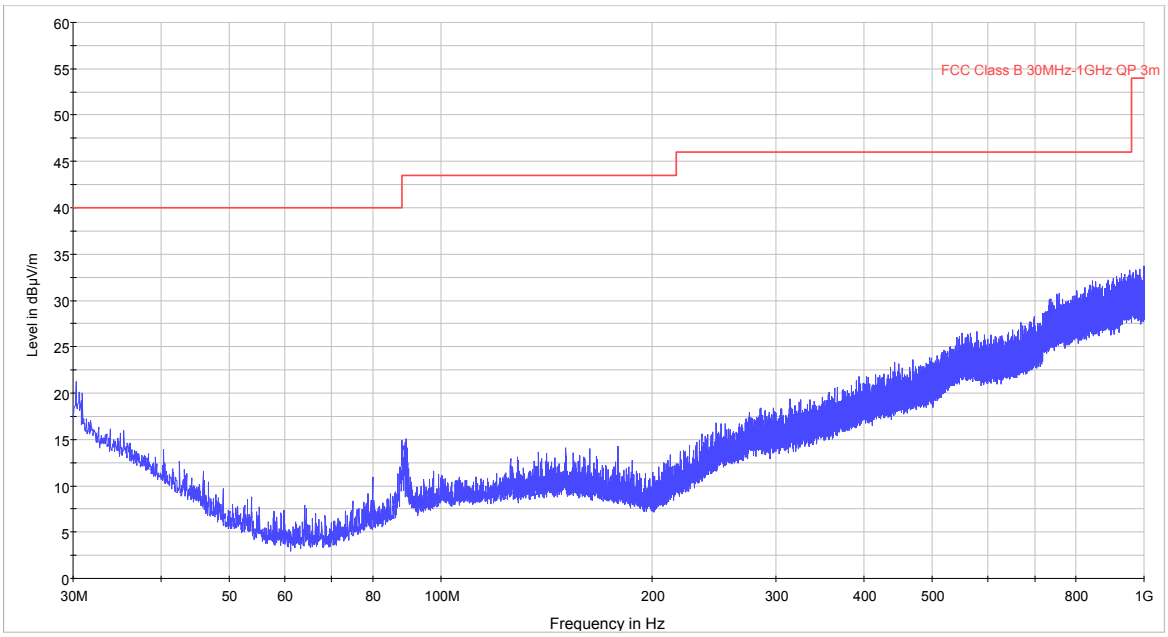
Date: 20.NOV.2012 13:51:39

Radiated Spurious emissions 13 GHz to 18GHz – 2440MHz

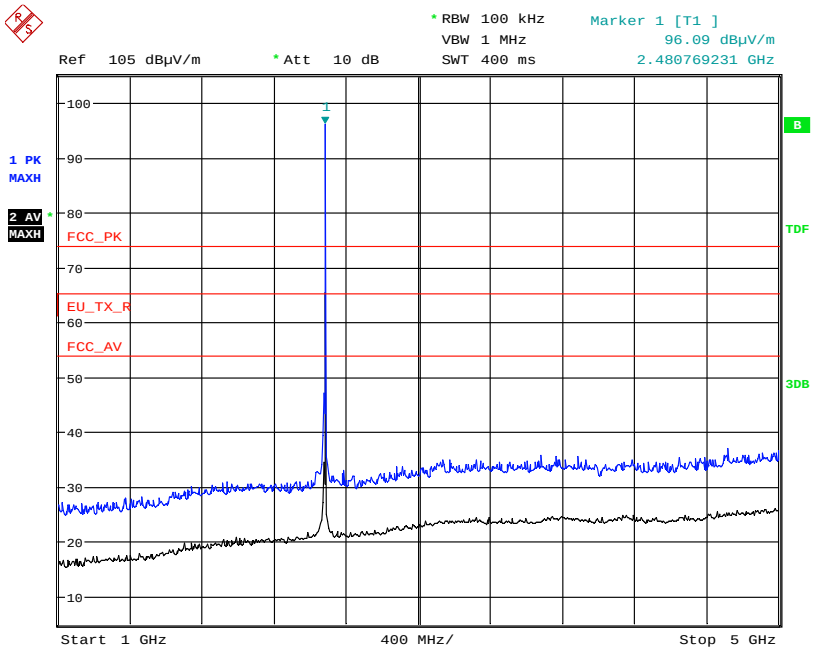


Date: 20.NOV.2012 15:20:38

Radiated Spurious emissions 18 GHz to 25 GHz – 2440MHz

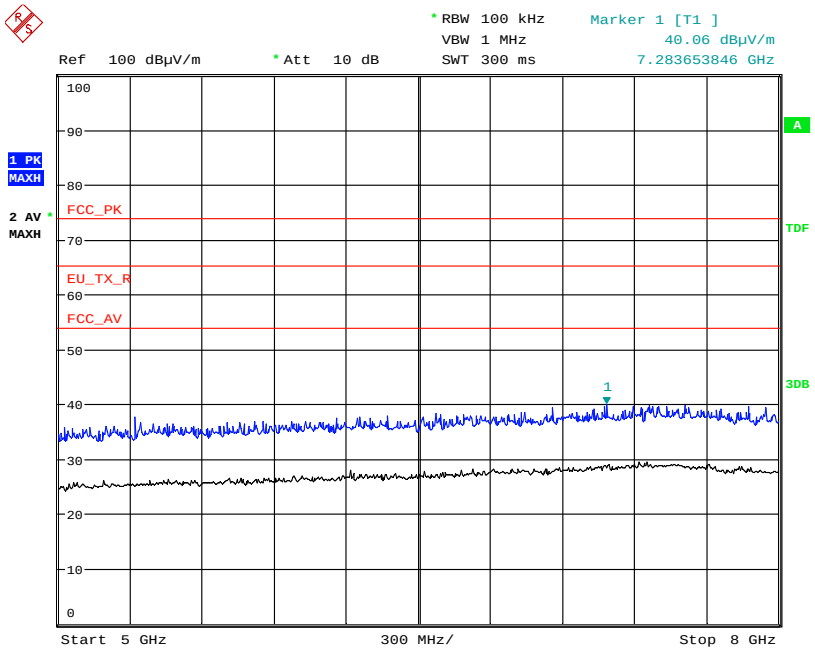


Radiated Spurious emissions 30 MHz to 1 GHz – 2480MHz



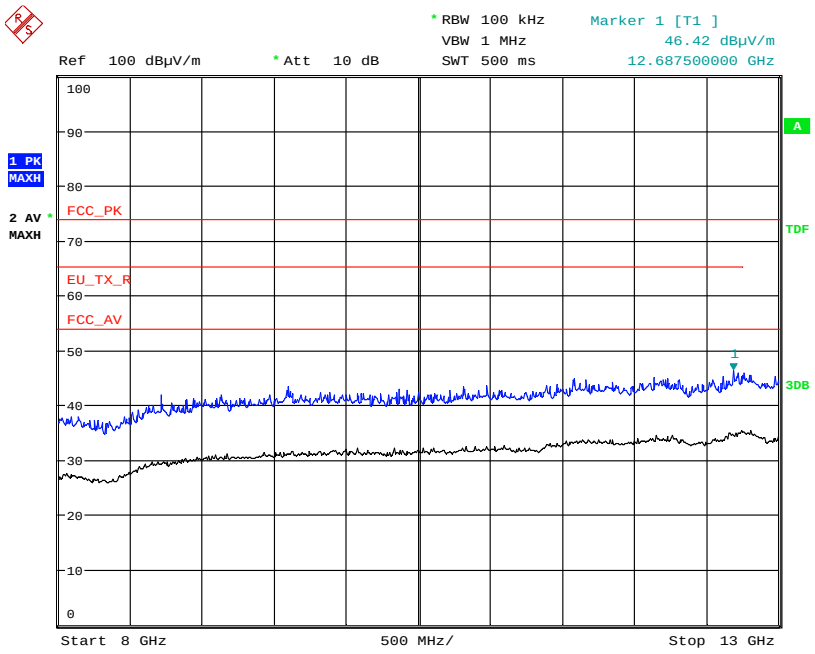
Date: 20.NOV.2012 13:53:17

Radiated Spurious emissions 1 GHz to 5 GHz – 2480MHz



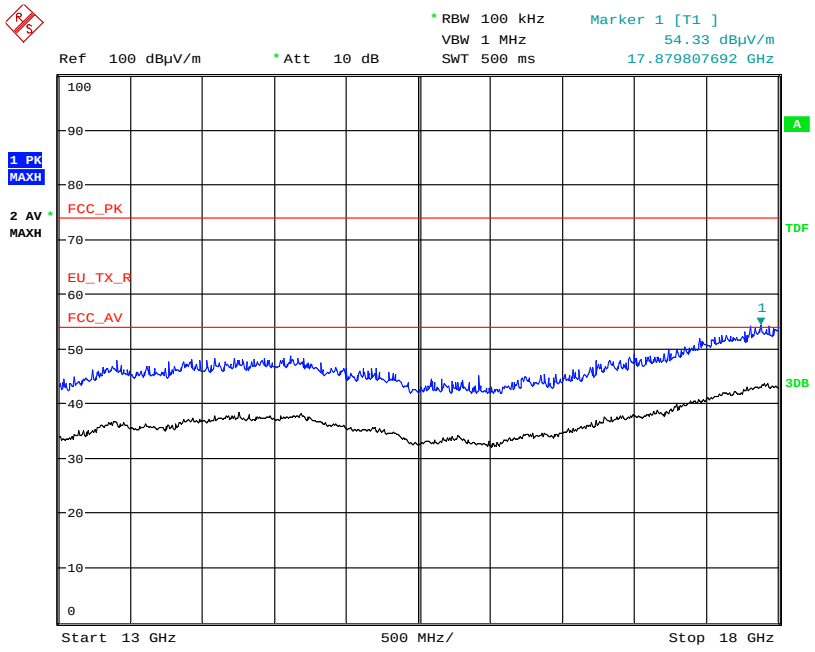
Date: 20.NOV.2012 13:53:59

Radiated Spurious emissions 5 GHz to 8 GHz – 2480MHz



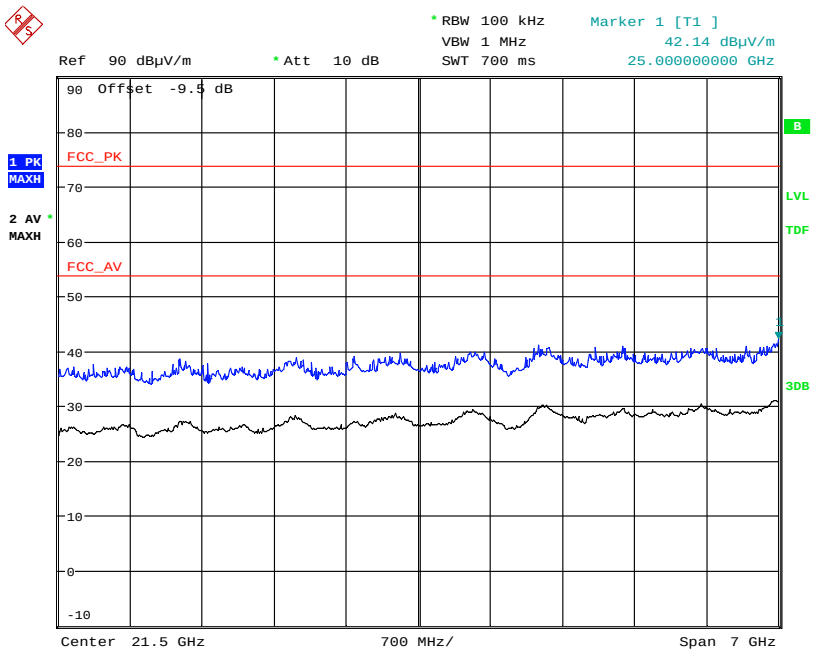
Date: 20.NOV.2012 13:54:19

Radiated Spurious emissions 8 GHz to 13 GHz – 2480MHz



Date: 20.NOV.2012 13:58:42

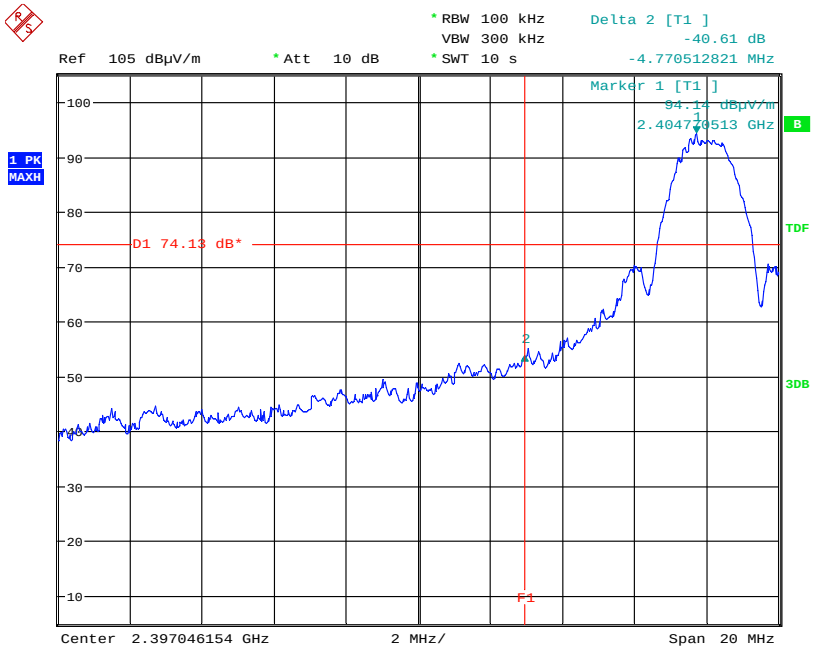
Radiated Spurious emissions 13 GHz to 18GHz – 2480MHz



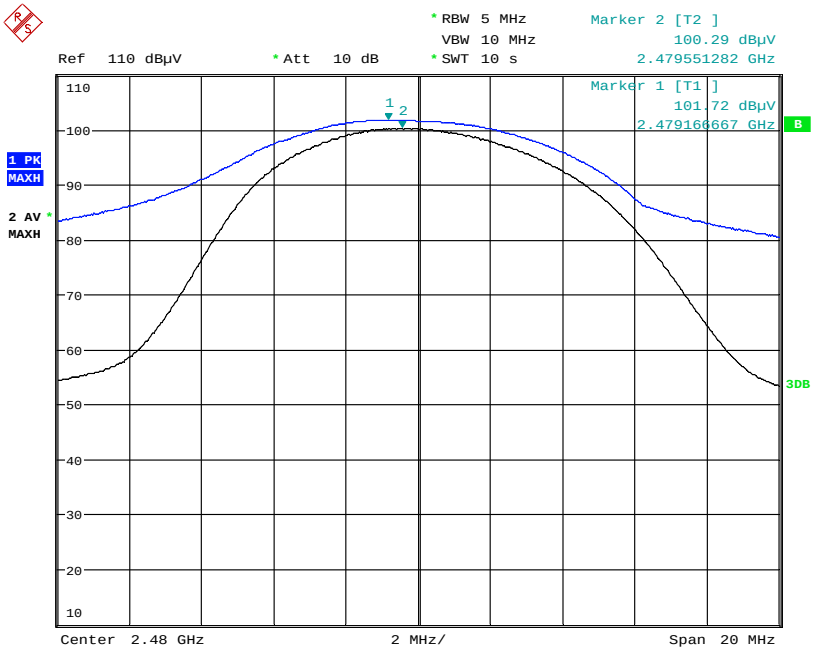
Date: 20.NOV.2012 15:20:15

Radiated Spurious emissions 18 GHz to 25 GHz – 2480MHz

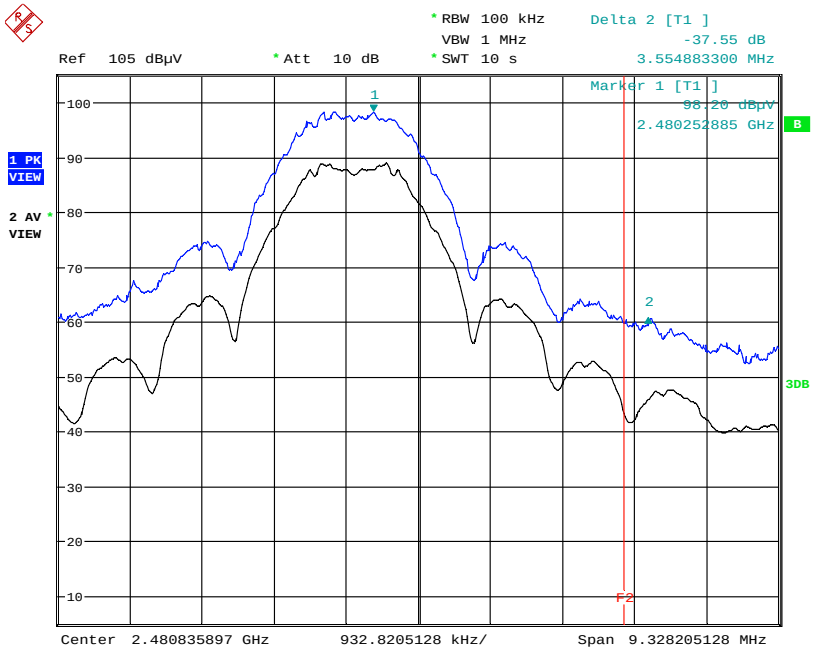
Radiated Bandedge Compliance



Lower Bandedge

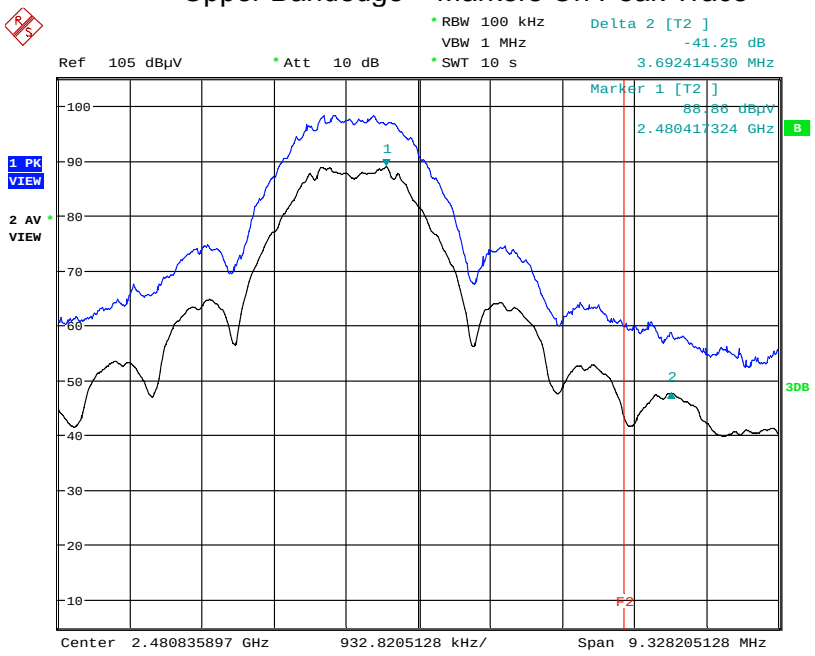


Carrier power For Delta Marker Method



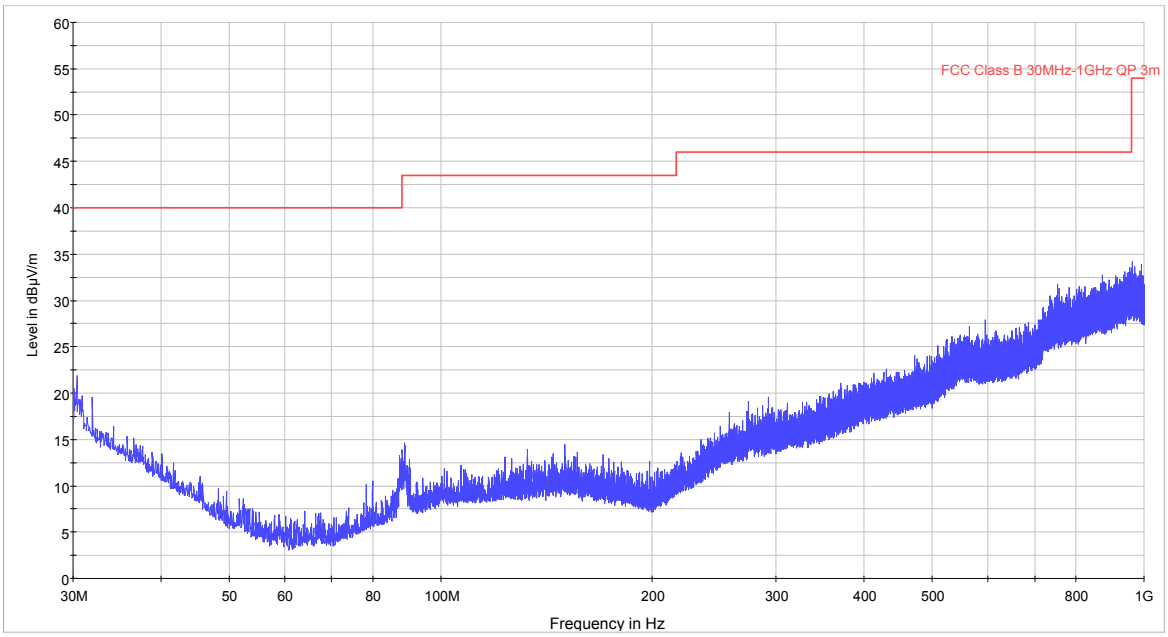
Date: 20.NOV.2012 14:21:50

Upper Bandedge – Markers On Peak Trace

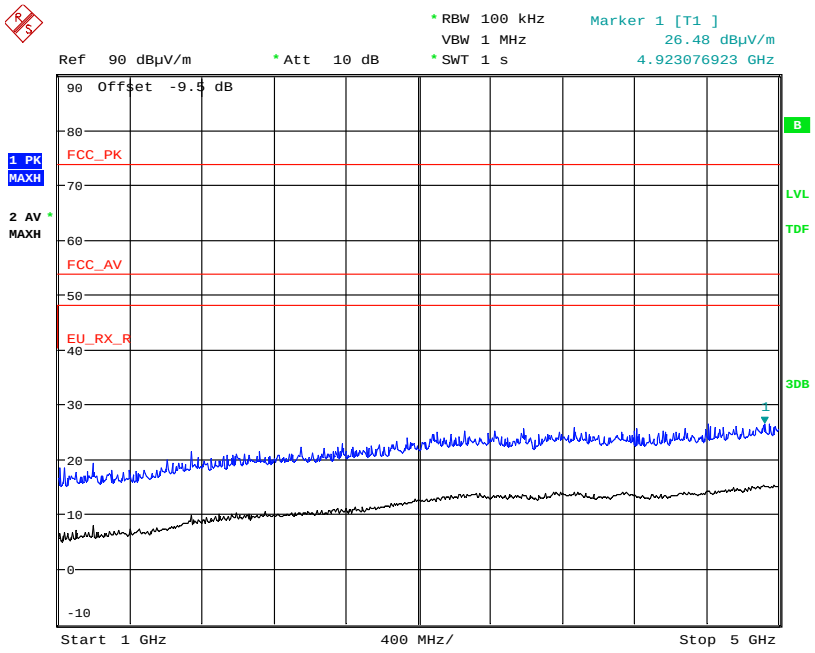


Date: 20.NOV.2012 14:22:38

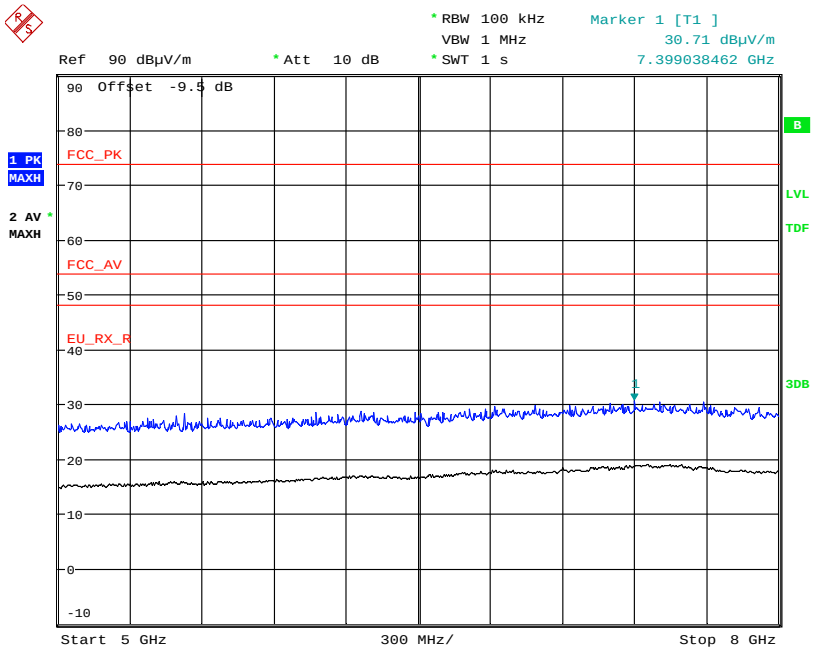
Upper Bandedge – Markers On Average Trace



Unintentional Radiated Spurious emissions 30 MHz to 1 GHz

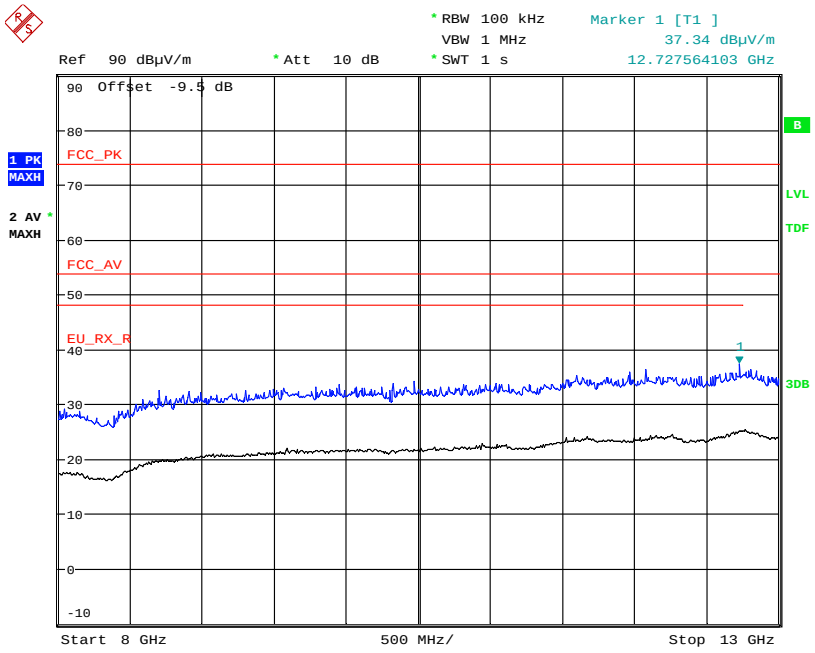


Unintentional Radiated Spurious emissions 1 GHz to 5 GHz



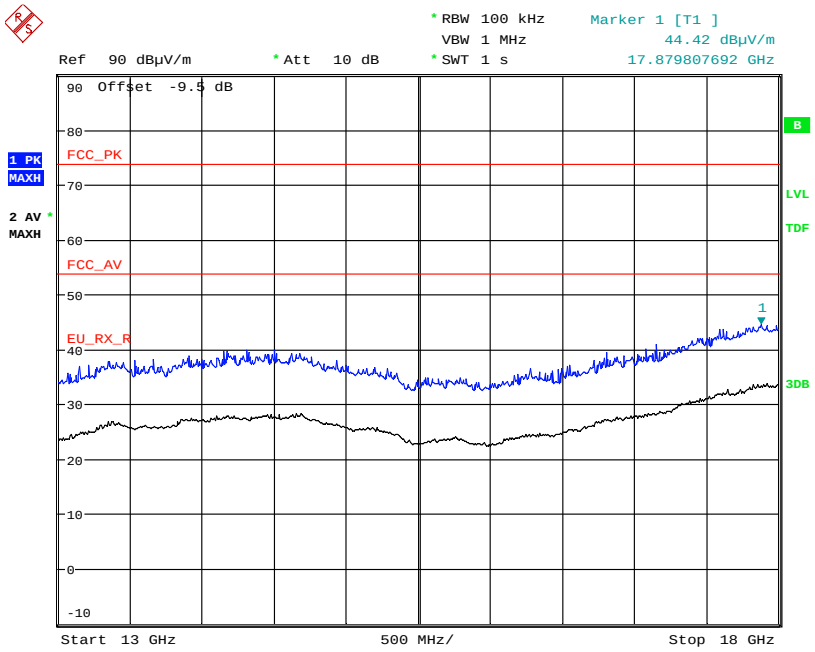
Date: 20.NOV.2012 15:07:43

Unintentional Radiated Spurious emissions 5 GHz to 8 GHz



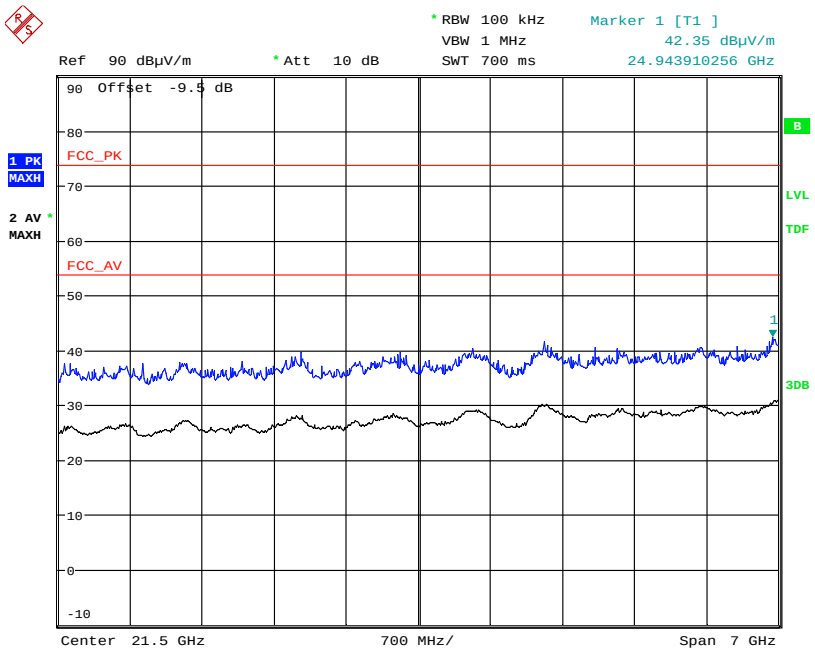
Date: 20.NOV.2012 14:55:07

Unintentional Radiated Spurious emissions 8 GHz to 13 GHz



Date: 20.NOV.2012 14:54:41

Unintentional Radiated Spurious emissions 13 GHz to 18GHz



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Unintentional Radiated Spurious emissions 18 GHz to 25 GHz

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
S01	USB – TTL Serial Cable	TTL-232-3V3
S02	Endnode Radiated Sample	
S05	Endnode with temporary Antenna Connector	

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

Sample No.	Description	Identification

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

Identification	Description
IT-0146	Test Laptop

C2) EUT Operating Mode During Testing.

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

Test	Description of Operating Mode:
All Transmitter tests detailed in this report	EUT transmitting modulated carrier for all formal measurements, CW signal for spurious emissions scans only

Test	Description of Operating Mode:
Receiver conducted and radiated (ERP) spurious emissions	EUT active in receive but non-transmitting.

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 : S05
Tests : Conducted

Port	Description of Cable Attached	Cable length	Equipment Connected
J1	6 Way Serial – USB cable	2m	Laptop

Sample : S02
Tests : Radiated Emissions

Port	Description of Cable Attached	Cable length	Equipment Connected
J1	6 Way Serial – USB cable	2m	Laptop

* Only connected during setup.

C5 Details of Equipment Used

TRAC Ref	Type	Description	Manufacturer	CalDate	Interval.	Cal Due
UH281	FSU46	Spectrum Analyser	R&S	09/02/2012	12	09/02/2013
L138	3115	1-18GHz Horn	EMCO	08/11/2011	24	08/11/2013
L572	8449B	Pre Amp	Agilent	24/11/2010	24	24/11/2012
L317	ESVS10	Receiver	R&S	21/12/2011	12	21/12/2012
UH191	CBL611/A	Bilog	Chase	08/11/2010	24	08/11/2012
L300	20240-20	18GHz - 26GHz Horn	Flann	17/11/2011	24	17/11/2013
REF940	ATS	Ferrite Lined Chamber	Rainford EMC	26/06/2012	12	26/06/2013

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 x (Log_{10} 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

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

0.07459 or 7.459%

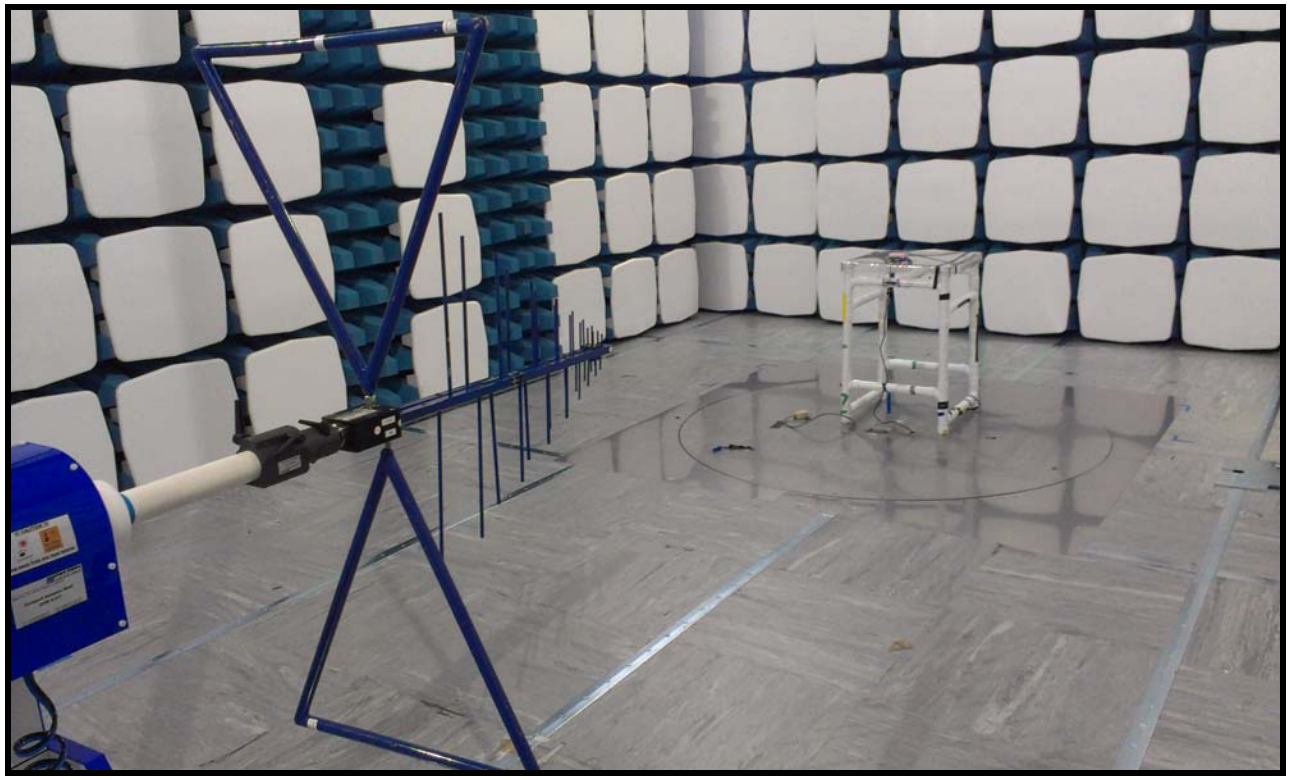
Correction factor (dB) = 20 x (Log_{10} 0.07459) = -22.54dB

Duty cycle correction may not be applicable / required by the device covered in this report.
The correction factor above is for example of how the correction is calculated.
Any applicable duty cycle used will be recorded in the relevant results sections of this report.

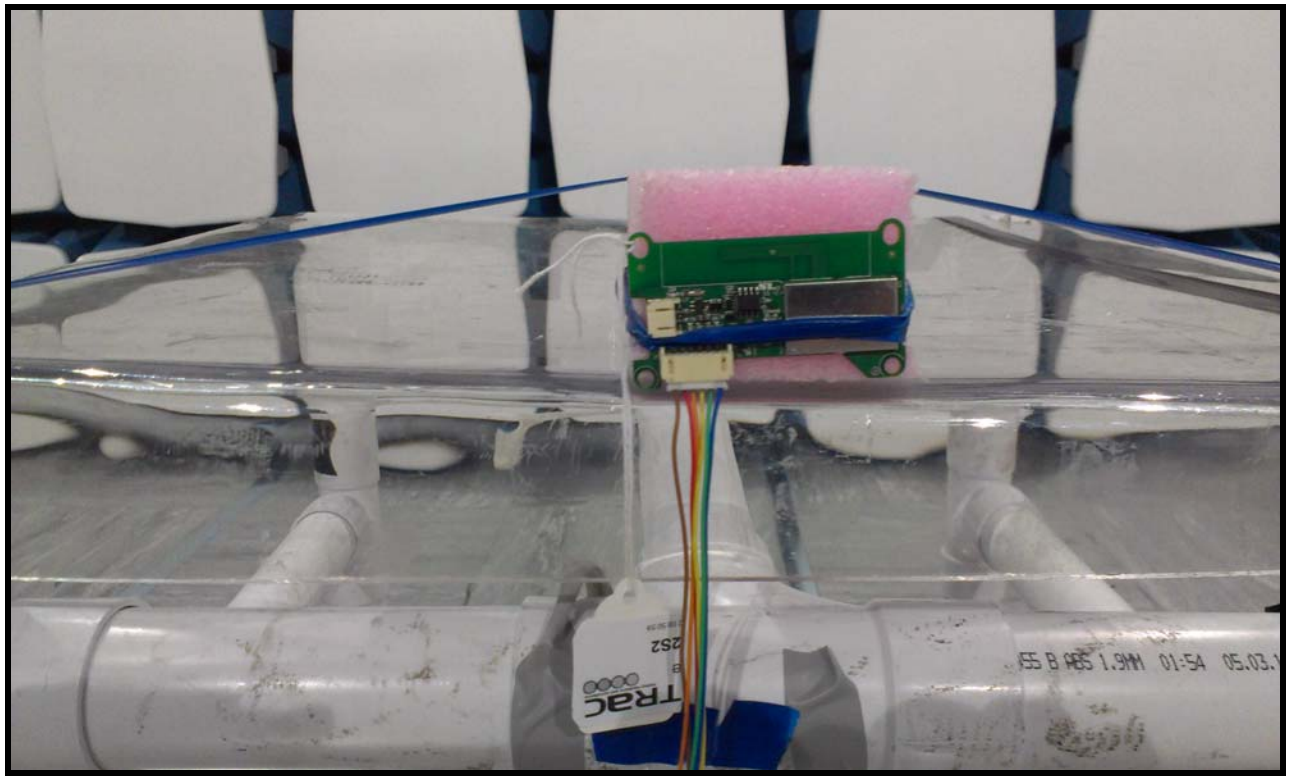
Appendix F: Photographs and Figures

The following photographs were taken of the test samples:

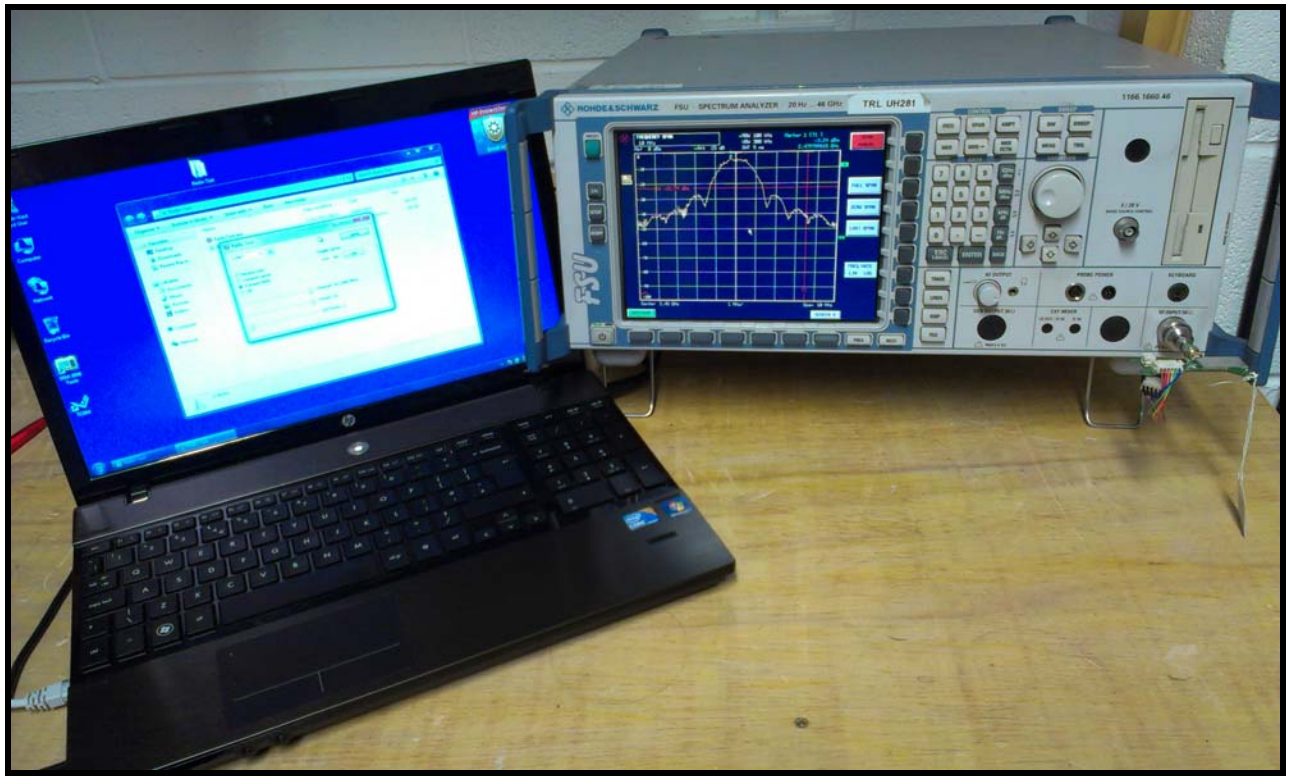
1. Radiated electric field emissions arrangement: Over view.
2. Radiated electric field emissions arrangement: close up.
3. Antenna port conducted test setup : Overview



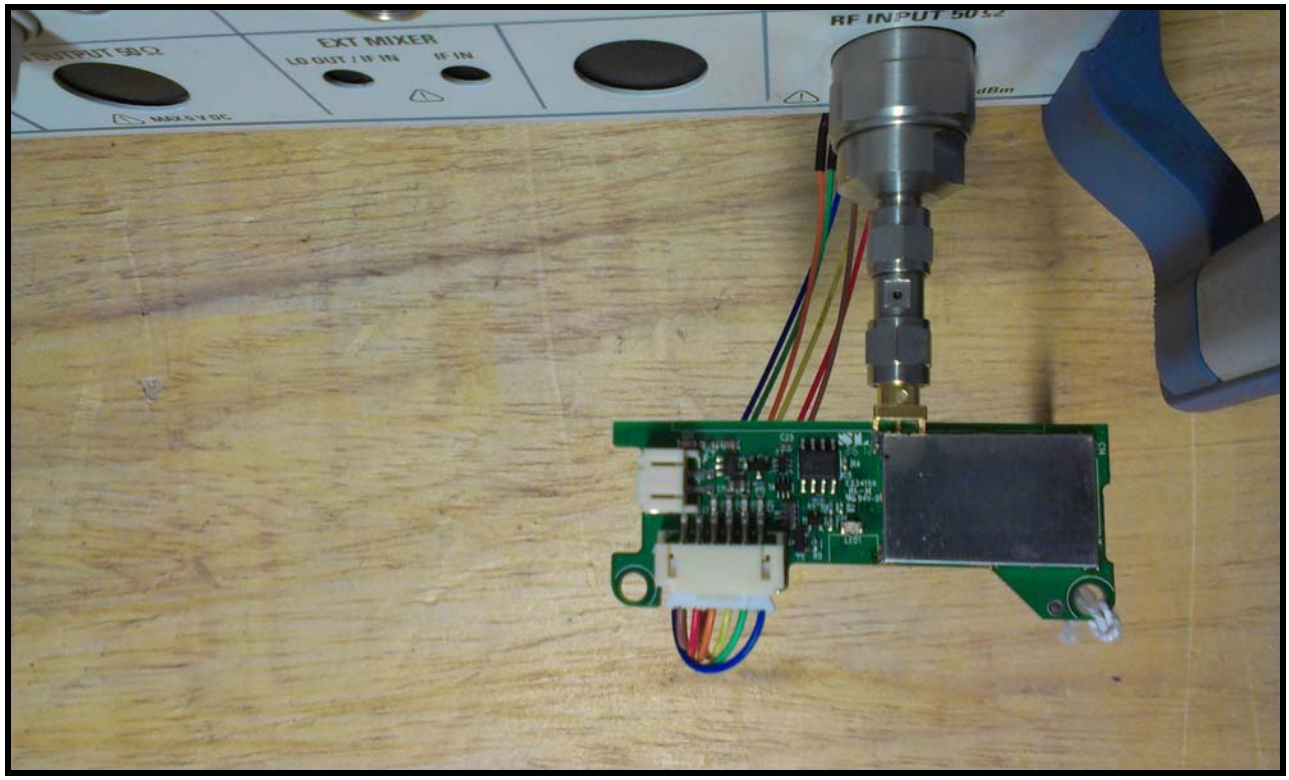
Photograph 1



Photograph 2



Photograph 3



Photograph 4

Appendix G: MPE Calculation

OET Bulletin No. 65, Supplement C 01-01

47 CFR §§1.1307 and 2.1091 & RSS - 102

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/cm^2 power density limit, as required under FCC rules and 10W/m^2 power density limit, as required under IC rules.

$$1\text{mW/cm}^2 \quad \equiv \quad 10\text{W/m}^2$$

Prediction of MPE limit at a given distance

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

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

where:

S = power density
R = distance to the centre of radiation of the antenna
EIRP = EUT Maximum power

Note:

The EIRP measurement was performed by adding the declared antenna gain to the maximum conducted output power.

EIRP = 1.04 dBm + 3.5 dBi

EIRP = 4.54 dBm 2.844

Result

Prediction Frequency (MHz)	Maximum EIRP	Power density limit (S) (mW/cm^2)	Distance (R) cm required to be less than 1mW/cm^2
2405	2.844 mW	1	0.48

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