TRaC Wireless Test Report	**:** 9F2925WUS2
Applicant	**:** Bluegiga
Apparatus	**:** WT41 Bluetooth Module
Specification(s)	**:** CFR47 Part 15.247 July 2008
FCCID	**: QOQWT41**
IC ID	**: 5123A-BGTWT41**
Purpose of Test	**:** Certification
Authorised by	: 
	: Radio Product Manager
Issue Date	**:11th March 2011**
Authorised Copy Number	**:** *PDF*

Total number of pages : 171

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.

Test performed by:

TRaC Telecoms & Radio [X]
Unit E
South Orbital Trading Park
Hedon Road
Hull, HU9 1NJ.
United Kingdom.

Telephone: +44 (0) 1482 801801
Fax: +44 (0) 1482 801806

TRaC Telecoms & Radio [ ]
Moss View
Nipe Lane
Up Holland
West Lancashire, WN8 9PY
United Kingdom

Telephone: +44 (0) 1695 556666
Fax: +44 (0) 1695 577077

Email: test@tracglobal.com
Web site: http://www.tracglobal.com

Tests performed by: Geoff Cruickshank

Report author: Geoff Cruickshank

1.2 Tests Requested By

This testing in this report was requested by :

Bluegiga
Sinikalliontie 5A
Espoo
FIN-02630
Finland

1.3 Manufacturer

as above

1.4 Apparatus Assessed

The following apparatus was assessed between

WT41 Bluetooth Module

The above equipment was a FHSS transmitter operating in the 2400 MHz to 2483.5 MHz band and is a Bluetooth module, designed for use internal to a laptop and used to enable Bluetooth wireless communication within personal computers and laptops. This report covers 2 variants, the WT41-N which was tested with an external Pulse W1010 antenna and the WT41-A tested with a Murata ANGC12G44SAA145 PCB Chip antenna. Data sheets of these antennas are reproduced in Appendix D of this report.

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

Abbreviations used in the above table:

Mod : Modification
CFR : Code of Federal Regulations
REFE : Radiated Electric Field Emissions
ANSI : American National Standards Institution
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 measured value related to the corresponding limit is used to decide whether equipment meets the requirements of the standard.
- The measurement uncertainty value for the measurement of each parameter is recorded in section 2.3 of this report.
- All values of measurement uncertainty are equal to or lower than the values in the table (section 2.2)below as required by the standard

2.2 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 = **0.9 dB**

[3] Effective Radiated Power

Uncertainty in test result = **4.1 dB**

[4] Spurious Emissions

Uncertainty in test result = **4.1dB**

[5] Maximum frequency error

Uncertainty in test result = **3.6kHz**

[6] Frequency deviation

Uncertainty in test result = **3.6 kHz**

[7] Magnetic Field Emissions

Uncertainty in test result = **2.1 dB**

[8] Conducted Spurious

Uncertainty in test result = **0.9 dB**

[9] Channel Bandwidth

Uncertainty in test result = **3.6 kHz**

[10] Power Line Conduction

Uncertainty in test result = **3.5 dB**

[11] Spectrum Mask Measurements

Uncertainty in test result = **3.6 kHz (frequency)**
Uncertainty in test result = **0.9 dB (amplitude)**

[12] Transmission Time Measurement

Uncertainty in test result = **5.8% ± 10ns**

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
		ATS	: Alternative Test Site
EUT	: Equipment Under Test		
SE	: Support Equipment	Ref	: Reference
		Freq	: Frequency
L	: Live Power Line		
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	Mbps	: Mega Bits Per Second

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	S18
Modification state	0
SE in test environment	None
SE isolated from EUT	TraC PC
EUT set up	Refer to Appendix C
Temperature	20°C

Data Rate = 1Mbps			
Channel Frequency (MHz)	Peak Carrier Power (W)	Limit (W)	Result
2402.0	0.041	1	Pass
2441.0	0.038		Pass
2480.0	0.040		Pass
Data Rate = 2Mbps			
Channel Frequency (MHz)	Peak Carrier Power (W)	Limit (W)	Result
2402.0	0.003	1	Pass
2441.0	0.002		Pass
2480.0	0.002		Pass
Data Rate = 3Mbps			
Channel Frequency (MHz)	Peak Carrier Power (W)	Limit (W)	Result
2402.0	0.003	1	Pass
2441.0	0.002		Pass
2480.0	0.002		Pass

Notes:

Number of hopping channels employed is 79

Conducted Measurement

Measured Peak Carrier power includes highest gain of any antenna to be used.
Highest Gain of any antenna to be used = 2.3 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 and operating at data rates of 1Mbps, 2Mbps & 3Mbps at each frequency. Plots were taken of all data rates and frequencies. Only plots of top middle and bottom frequencies for the data rate producing highest output power are contained in appendix B.

Test Details	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.247(d)
Measurement standard	ANSI C63.10:2003
Frequency range	9 kHz to 25 GHz
EUT sample number	S18
Modification state	0
SE in test environment	None
SE isolated from EUT	TraC PC
EUT set up	Refer to Appendix C
Temperature	20°C

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

Test Details : 1Mbps, 2402MHz, 2441MHZ & 2480MHz						
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
No significant emissions within 20 dB of the limit						

Test Details : 2Mbps, 2402MHz, 2441MHZ & 2480MHz						
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
No significant emissions within 20 dB of the limit						

Test Details : 3Mbps, 2402MHz, 2441MHZ & 2480MHz						
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
No significant emissions within 20 dB of the limit						

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 and operating at data rates of 1Mbps, 2Mbps & 3Mbps at each frequency. Plots were taken of all data rates and frequencies. Only plots of top middle and bottom frequencies for the data rate producing highest output power are contained in appendix B.

Notes:

1. The conducted emission limit for all emissions are based on a transmitted carrier level in a 100kHz RBW. 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/100kHz) - 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 filed 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 and operating at data rates of 1Mbps, 2Mbps & 3Mbps at each frequency. Plots were taken of all data rates and frequencies. Only plots of top, middle and bottom frequencies for the data rate producing highest output power are contained in appendix B.

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: 1Mbps	
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	S20
Modification state	0
SE in test environment	RFG464
SE isolated from EUT	REF829
EUT set up	Refer to Appendix C
Temperature	20°C
Photographs (Appendix F)	Photograph 1 and 2

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

2402 MHz – 1Mbps											
Ref No.	FREQ. (MHz)	Det.	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)	Margin (dB)
1	1601.635	Pk	62.6	5.1	26.2	33.73	60.2	0.0	60.2	74.0	-13.8
2	1601.635	AV	55.8	5.1	26.2	33.73	53.4	0.0	53.4	54.0	-0.6
3	2363.205	Pk	44.9	4.5	29.4	33.74	45.1	0.0	45.1	74.0	-28.9
4	2363.205	AV	31.2	4.5	29.4	33.74	31.4	0.0	31.4	54.0	-22.6
5	2401.907	Pk	54.6	4.0	29.5	N/A	88.1	0.0	88.1	137.0	-48.9
6	2973.962	Pk	50.3	5.7	31.6	33.96	53.6	0.0	53.6	74.0	-20.4
7	2973.962	AV	39.9	5.7	31.6	33.96	43.2	0.0	43.2	54.0	-10.8

2441 MHz – 1Mbps											
Ref No.	**FREQ. (MHz)**	**Det.**	**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)**	**Margin (dB)**
1	1627.721	Pk	62.8	5.2	26.3	33.72	60.6	0.0	60.6	74.0	-13.4
2	1627.721	AV	55.9	5.2	26.3	33.72	53.7	0.0	53.7	54.0	-0.3
3	2440.856	Pk	58.8	4.0	29.7	N/A	92.5	0.0	92.5	137.0	-44.5

2480 MHz – 1Mbps											
Ref No.	**FREQ. (MHz)**	**Det.**	**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)**	**Margin (dB)**
1	1652.369	Pk	61.7	5.2	26.4	33.72	59.6	0.0	59.6	74.3	-14.7
2	1652.369	AV	56.0	5.2	26.4	33.72	53.9	0.0	53.9	54.3	-0.4
3	2480.054	Pk	60.0	4.5	29.8	N/A	94.3	0.0	94.3	137.0	-42.7
4	2483.632	Pk	59.9	4.4	29.8	33.78	60.3	0.0	60.3	74.0	-13.7
5	2483.632	AV	35.5	4.4	29.8	33.78	35.9	0.0	35.9	54.0	-18.1

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

Test Details: 2Mbps	
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	S20
Modification state	0
SE in test environment	RFG464
SE isolated from EUT	REF829
EUT set up	Refer to Appendix C
Temperature	20°C
Photographs (Appendix F)	Photograph 1 and 2

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

2402 MHz – 2Mbps											
Ref No.	FREQ. (MHz)	Det.	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)	Margin (dB)
1	1601.611	Pk	60.7	5.1	26.2	33.73	58.3	0.0	58.3	74.0	-15.7
2	1601.611	AV	53.8	5.1	26.2	33.73	51.4	0.0	51.4	54.0	-2.6
3	2385.513	Pk	48.0	4.8	29.4	33.75	48.5	0.0	48.5	74.0	-25.5
4	2385.513	AV	31.4	4.8	29.4	33.75	31.9	0.0	31.9	54.0	-22.1
5	2401.939	Pk	63.6	4.0	29.5	N/A	97.1	0.0	97.1	137.0	-39.9
6	2974.046	Pk	50.3	5.7	31.6	33.96	53.6	0.0	53.6	77.1	-23.5
7	2974.046	AV	39.1	5.7	31.6	33.96	42.4	0.0	42.4	57.1	-14.7

2441 MHz – 2Mbps											
Ref No.	FREQ. (MHz)	Det.	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)	Margin (dB)
1	1627.675	Pk	62.4	5.2	26.3	33.72	60.2	0.0	60.2	81.9	-21.7
2	1627.675	AV	55.4	5.2	26.3	33.72	53.2	0.0	53.2	61.9	-8.7
3	2441.064	Pk	68.2	4.0	29.7	N/A	101.9	0.0	101.9	137.0	-35.1

2480 MHz – 2Mbps											
Ref No.	**FREQ. (MHz)**	**Det.**	**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)**	**Margin (dB)**
1	1653.715	Pk	62.3	5.2	26.4	33.72	60.2	0.0	60.2	82.9	-22.7
2	1653.715	AV	55.4	5.2	26.4	33.72	53.3	0.0	53.3	62.9	-9.6
3	2479.840	Pk	68.7	4.4	29.8	N/A	102.9	0.0	102.9	137.0	-34.1
4	2483.500	Pk	56.3	4.4	29.8	33.78	56.7	0.0	56.7	74.0	-17.3
5	2483.500	AV	35.8	4.4	29.8	33.78	36.2	0.0	36.2	54.0	-17.8
6	2496.032	Pk	53.3	4.7	29.9	33.78	54.1	0.0	54.1	74.0	-19.9
7	2496.032	AV	32.5	4.7	29.9	33.78	33.3	0.0	33.3	54.0	-20.7

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

Test Details: 3Mbps	
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	S20
Modification state	0
SE in test environment	RFG464
SE isolated from EUT	REF829
EUT set up	Refer to Appendix C
Temperature	20°C
Photographs (Appendix F)	Photograph 1 and 2

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

2402 MHz – 3Mbps											
Ref No.	FREQ. (MHz)	Det.	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)	Margin (dB)
1	1600.353	Pk	60.7	5.0	26.2	33.73	58.2	0.0	58.2	74.0	-15.8
2	1600.353	AV	54.8	5.0	26.2	33.73	52.3	0.0	52.3	54.0	-1.7
3	1650.923	Pk	61.2	5.0	26.4	33.72	58.9	0.0	58.9	77.1	-18.2
4	1650.923	AV	36.2	5.0	26.4	33.72	33.9	0.0	33.9	57.1	-23.2
5	2386.154	Pk	49.6	4.9	29.5	33.75	50.3	0.0	50.3	74.0	-23.7
6	2386.154	AV	31.7	4.9	29.5	33.75	32.4	0.0	32.4	54.0	-21.6
7	2401.872	Pk	63.6	4.0	29.5	N/A	97.1	0.0	97.1	137.0	-39.9
8	2974.016	Pk	50.2	5.7	31.6	33.96	53.5	0.0	53.5	77.1	-23.6
9	2974.016	AV	39.3	5.7	31.6	33.96	42.6	0.0	42.6	57.1	-14.5

2441 MHz – 3Mbps											
Ref No.	FREQ. (MHz)	Det.	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)	Margin (dB)
1	1626.337	Pk	57.5	5.1	26.3	33.72	55.2	0.0	55.2	74.0	-18.8
2	1626.337	AV	51.2	5.1	26.3	33.72	48.9	0.0	48.9	54.0	-5.1
3	1626.923	Pk	56.0	5.2	26.3	33.72	53.8	0.0	53.8	80.6	-26.8
4	1626.923	AV	33.3	5.2	26.3	33.72	31.1	0.0	31.1	60.6	-29.5
5	2440.928	Pk	66.9	4.0	29.7	N/A	100.6	0.0	100.6	137.0	-36.4

2480 MHz – 3Mbps											
Ref No.	**FREQ. (MHz)**	**Det.**	**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)**	**Margin (dB)**
1	1652.337	Pk	58.4	5.2	26.4	33.72	56.3	0.0	56.3	81.7	-25.4
2	1652.337	AV	52.4	5.2	26.4	33.72	50.3	0.0	50.3	61.7	-11.4
3	2479.944	Pk	67.4	4.5	29.8	N/A	101.7	0.0	101.7	137.0	-35.3
4	2483.500	Pk	56.0	4.4	29.8	33.78	56.4	0.0	56.4	74.0	-17.6
5	2483.500	AV	36.2	4.4	29.8	33.78	36.6	0.0	36.6	54.0	-17.4
6	2483.628	Pk	55.7	4.4	29.8	33.78	56.1	0.0	56.1	74.0	-17.9
7	2483.628	AV	35.3	4.4	29.8	33.78	35.7	0.0	35.7	54.0	-18.3
8	2495.987	Pk	53.1	4.7	29.9	33.78	53.9	0.0	53.9	74.0	-20.1
9	2495.987	AV	32.2	4.7	29.9	33.78	33.0	0.0	33.0	54.0	-21.0

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

Test Details: 1Mbps	
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	S21
Modification state	0
SE in test environment	RFG464
SE isolated from EUT	REF829
EUT set up	Refer to Appendix C
Temperature	20°C
Photographs (Appendix F)	Photograph 3 and 4

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

2402 MHz – 1Mbps											
Ref No.	FREQ. (MHz)	Det.	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)	Margin (dB)
1	1600.352	Pk	56.5	5.0	26.2	33.73	54.0	0	54.0	74.0	-20.0
2	1600.352	AV	53.1	5.0	26.2	33.73	50.6	0	50.6	54.0	-3.4
3	2376.030	Pk	59.0	4.5	29.4	33.75	59.2	0	59.2	74.0	-14.8
4	2376.030	AV	52.5	4.5	29.4	33.75	52.7	0	52.7	54.0	-1.3
5	2386.184	Pk	59.4	4.9	29.5	33.75	60.1	0	60.1	74.0	-13.9
6	2386.184	AV	50.1	4.9	29.5	33.75	50.8	0	50.8	54.0	-3.2
7	2401.814	Pk	82.0	4.0	29.5	N/A	115.5	0	115.5	137.0	-21.5
8	2974.009	Pk	49.9	5.7	31.6	33.96	53.2	0	53.2	95.5	-42.3
9	2974.009	AV	40.7	5.7	31.6	33.96	44.0	0	44.0	75.5	-31.5
10	4803.878	Pk	26.6	7.4	35.9	N/A	69.9	-9.5	60.4	74.0	-13.6
11	4803.878	AV	15.3	7.4	35.9	N/A	58.6	-9.5	49.1	54.0	-4.9
12	7205.497	Pk	56.3	10.3	38.9	34.37	71.1	-9.5	61.6	95.5	-33.9
13	7205.497	AV	43.5	10.3	38.9	34.37	58.3	-9.5	48.8	75.5	-26.7
14	12010.610	Pk	45.0	7.9	39.0	34.44	57.5	-9.5	48.0	74.0	-26.0
15	12010.610	AV	33.1	7.9	39.0	34.44	45.6	-9.5	36.1	54.0	-17.9

2441 MHz – 1Mbps											
Ref No.	FREQ. (MHz)	Det.	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)	Margin (dB)
1	1626.260	Pk	58.1	5.1	26.3	33.72	55.8	0	55.8	74.0	-18.2
2	1626.260	AV	52.9	5.1	26.3	33.72	50.6	0	50.6	54.0	-3.4
3	2441.146	Pk	82.1	4.0	29.7	N/A	115.8	0	115.8	137.0	-21.2
4	3051.887	Pk	48.6	6.6	31.9	33.99	53.1	0	53.1	95.8	-42.7
5	3051.887	AV	41.3	6.6	31.9	33.99	45.8	0	45.8	75.8	-30.0
6	4882.147	Pk	28.3	8.0	36.1	N/A	72.4	-9.5	62.9	74.0	-11.1
7	4882.147	AV	18.0	8.0	36.1	N/A	62.1	-9.5	52.6	54.0	-1.4
8	7323.539	Pk	54.1	10.5	39.1	34.42	69.3	-9.5	59.8	74.0	-14.2
9	7323.539	AV	41.3	10.5	39.1	34.42	56.5	-9.5	47.0	54.0	-7.0
10	12204.233	Pk	47.5	8.5	38.9	34.32	60.6	-9.5	51.1	74.0	-22.9
11	12204.233	AV	35.0	8.5	38.9	34.32	48.1	-9.5	38.6	54.0	-15.4

2480 MHz – 1Mbps											
Ref No.	**FREQ. (MHz)**	**Det.**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**FIELD ST'GH (dBµV/m)**	**EXTRAP FACT (dB)**	**FIELD ST'GH (dBµV/m)**	**LIMIT (dBµV/m)**	**Margin (dB)**
1	1652.330	Pk	57.2	5.2	26.4	33.72	55.1	0.0	55.1	98.1	-43.0
2	1652.330	AV	55.7	5.2	26.4	33.72	53.6	0.0	53.6	78.1	-24.5
3	2480.017	Pk	83.8	4.5	29.8	N/A	118.1	0.0	118.1	137.0	-18.9
4	2483.500	Pk	64.3	4.4	29.8	33.78	64.7	0.0	64.7	74.0	-9.3
5	2483.500	AV	51.8	4.4	29.8	33.78	52.2	0.0	52.2	54.0	-1.8
6	3130.019	Pk	45.0	6.8	32.2	34.03	50.0	0.0	50.0	98.1	-48.1
7	3130.019	AV	35.1	6.8	32.2	34.03	40.1	0.0	40.1	78.1	-38.0
8	4959.807	Pk	28.5	8.3	36.2	N/A	73.0	-9.5	63.5	74.0	-10.5
9	4959.807	AV	17.6	8.3	36.2	N/A	62.1	-9.5	52.6	54.0	-1.4
10	7440.524	Pk	58.2	10.8	39.3	34.46	73.8	-9.5	64.3	74.0	-9.7
11	7440.524	AV	45.6	10.8	39.3	34.46	61.2	-9.5	51.7	54.0	-2.3
12	12400.850	Pk	53.7	8.4	38.7	34.19	66.6	-9.5	57.1	74.0	-16.9
13	12400.850	AV	40.9	8.4	38.7	34.19	53.8	-9.5	44.3	54.0	-9.7

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

Test Details: 2Mbps	
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	S21
Modification state	0
SE in test environment	RFG464
SE isolated from EUT	REF829
EUT set up	Refer to Appendix C
Temperature	20°C
Photographs (Appendix F)	Photograph 3 and 4

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

2402 MHz – 2Mbps											
Ref No.	FREQ. (MHz)	Det.	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)	Margin (dB)
1	1600.320	Pk	58.1	5.0	26.2	33.73	55.6	0.0	55.6	74.0	-18.4
2	1600.320	AV	51.8	5.0	26.2	33.73	49.3	0.0	49.3	54.0	-4.7
3	2386.112	Pk	60.0	4.9	29.5	33.75	60.7	0.0	60.7	74.0	-13.3
4	2386.112	AV	39.2	4.9	29.5	33.75	39.9	0.0	39.9	54.0	-14.1
5	2401.824	Pk	76.3	4.0	29.5	N/A	109.8	0.0	109.8	137.0	-27.2
6	2974.029	Pk	49.7	5.7	31.6	33.96	53.0	0.0	53.0	99.8	-46.8
7	2974.029	AV	39.1	5.7	31.6	33.96	42.4	0.0	42.4	79.8	-37.4
8	7206.529	Pk	56.8	10.3	38.9	34.37	71.6	-9.5	62.1	99.8	-37.7
9	7206.529	AV	44.0	10.3	38.9	34.37	58.8	-9.5	49.3	79.8	-30.5

2441 MHz – 2Mbps											
Ref No.	FREQ. (MHz)	Det.	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)	Margin (dB)
1	1626.260	Pk	58.1	5.1	26.3	33.72	55.8	0.0	55.8	74.0	-18.2
2	1626.260	AV	52.9	5.1	26.3	33.72	50.6	0.0	50.6	54.0	-3.4
3	2441.146	Pk	82.1	4.0	29.7	N/A	115.8	0.0	115.8	137.0	-21.2
4	3051.887	Pk	48.6	6.6	31.9	33.99	53.1	0.0	53.1	95.8	-42.7
5	3051.887	AV	41.3	6.6	31.9	33.99	45.8	0.0	45.8	75.8	-30.0
6	7323.539	Pk	54.1	10.5	39.1	34.42	69.3	-9.5	59.8	74.0	-14.2
7	7323.539	AV	41.3	10.5	39.1	34.42	56.5	-9.5	47.0	54.0	-7.0

2480 MHz – 2Mbps											
Ref No.	**FREQ. (MHz)**	**Det.**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**FIELD ST'GH (dBµV/m)**	**EXTRAP FACT (dB)**	**FIELD ST'GH (dBµV/m)**	**LIMIT (dBµV/m)**	**Margin (dB)**
1	1652.330	Pk	57.2	5.2	26.4	33.72	55.1	0.0	55.1	98.1	-43.0
2	1652.330	AV	55.7	5.2	26.4	33.72	53.6	0.0	53.6	78.1	-24.5
3	2480.017	Pk	83.8	4.5	29.8	N/A	118.1	0.0	118.1	137.0	-18.9
4	2483.500	Pk	64.3	4.4	29.8	33.78	64.7	0.0	64.7	74.0	-9.3
5	2483.500	AV	51.8	4.4	29.8	33.78	52.2	0.0	52.2	54.0	-1.8
6	3130.019	Pk	45.0	6.8	32.2	34.03	50.0	0.0	50.0	98.1	-48.1
7	3130.019	AV	35.1	6.8	32.2	34.03	40.1	0.0	40.1	78.1	-38.0
8	7440.524	Pk	58.2	10.8	39.3	34.46	73.8	-9.5	64.3	74.0	-9.7
9	7440.524	AV	45.6	10.8	39.3	34.46	61.2	-9.5	51.7	54.0	-2.3

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

Test Details: 3Mbps	
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	S21
Modification state	0
SE in test environment	RFG464
SE isolated from EUT	REF829
EUT set up	Refer to Appendix C
Temperature	20°C
Photographs (Appendix F)	Photograph 3 and 4

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

2402 MHz – 3Mbps											
Ref No.	FREQ. (MHz)	Det.	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)	Margin (dB)
1	1600.320	Pk	58.9	5.0	26.2	33.73	56.4	0.0	56.4	74.0	-17.6
2	1600.320	AV	52.7	5.0	26.2	33.73	50.2	0.0	50.2	54.0	-3.8
3	2385.968	Pk	59.3	4.9	29.5	33.75	60.0	0.0	60.0	74.0	-14.0
4	2385.968	AV	38.5	4.9	29.5	33.75	39.2	0.0	39.2	54.0	-14.8
5	2402.067	Pk	76.3	4.0	29.5	N/A	109.8	0.0	109.8	137.0	-27.2
6	2973.962	Pk	50.1	5.7	31.6	33.96	53.4	0.0	53.4	99.8	-46.4
7	2973.962	AV	39.8	5.7	31.6	33.96	43.1	0.0	43.1	79.8	-36.7

2441 MHz – 3Mbps											
Ref No.	FREQ. (MHz)	Det.	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)	Margin (dB)
1	1626.352	Pk	57.3	5.1	26.3	33.72	55.0	0.0	55.0	74.0	-19.0
2	1626.352	AV	50.7	5.1	26.3	33.72	48.4	0.0	48.4	54.0	-5.6
3	2441.016	Pk	75.6	4.0	29.7	N/A	109.3	0.0	109.3	137.0	-27.7
4	3052.038	Pk	48.6	6.6	31.9	33.99	53.1	0.0	53.1	99.3	-46.2
5	3052.038	AV	37.1	6.6	31.9	33.99	41.6	0.0	41.6	79.3	-37.7

2480 MHz – 3Mbps											
Ref No.	**FREQ. (MHz)**	**Det.**	**MEAS Rx (dBµV)**	**CABLE LOSS (dB)**	**ANT FACT. (dB/m)**	**PRE AMP (dB)**	**FIELD ST'GH (dBµV/m)**	**EXTRAP FACT (dB)**	**FIELD ST'GH (dBµV/m)**	**LIMIT (dBµV/m)**	**Margin (dB)**
1	1652.288	Pk	57.3	5.2	26.4	33.72	55.2	0.0	55.2	99.6	-44.4
2	1652.288	AV	50.8	5.2	26.4	33.72	48.7	0.0	48.7	79.6	-30.9
3	2479.872	Pk	75.4	4.4	29.8	N/A	109.6	0.0	109.6	137.0	-27.4
4	2483.500	Pk	63.1	4.4	29.8	33.78	63.5	0.0	63.5	74.0	-10.5
5	2483.500	AV	44.4	4.4	29.8	33.78	44.8	0.0	44.8	54.0	-9.2
6	2496.042	Pk	55.9	4.7	29.9	33.78	56.7	0.0	56.7	74.0	-17.3
7	2496.042	AV	32.5	4.7	29.9	33.78	33.3	0.0	33.3	54.0	-20.7

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 do 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= 1 MHz, VBW = 10 Hz or using an average detector.

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 15:2008 Clause 15.33(a) and 15.33(a)(1).

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

Frequency of emission (MHz)	Field strength V/m	Measurement Distance m	Field strength dB V/m
0.009-0.490	2400/F(kHz)	300	67.6/F (kHz)
0.490-1.705	24000/F(kHz)	30	87.6/F (kHz
1.705-30	30	30	29.5
30-88	100	3	40.0
88-216	150	3	43.5
216-960	200	3	46.0
Above 960	500	3	54.0

Notes:

(a) Where results have been measured at one distance, and a signal level displayed at another, the results have been extrapolated using the following formula:

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

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

A4 20 dB Bandwidth

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.

Test Details:	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) 15.247(a)(1)
EUT sample number	S18
Modification state	0
SE in test environment	None
SE isolated from EUT	TRaC PC
Temperature	20°C
EUT set up	Refer to Appendix C

1Mbps	
Channel Frequency (MHz)	Measured 20 dB Bandwidth (kHz)
2402	1134
2441	1134
2480	1134
2Mbps	
Channel Frequency (MHz)	Measured 20 dB Bandwidth (kHz)
2402	1375
2441	1375
2480	1375
3Mbps	
Channel Frequency (MHz)	Measured 20 dB Bandwidth (kHz)
2402	1391
2441	1391
2480	1391

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

A5 Carrier Frequency Separation

For systems with an output power greater than 125mW the channel separation shall be a minimum of 25 kHz or the 20 dB bandwidth, whichever is the greater. For systems with output power less than 125mW the channel separation shall be a minimum of 25 kHz or $^2/_3$ of 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)
EUT sample number	S18
Modification state	0
SE in test environment	None
SE isolated from EUT	TRaC PC
Temperature	20°C
EUT set up	Refer to Appendix C

Operational Data Rate	Measured Channel Spacing (kHz)	Measured 20 dB Bandwidth (kHz)	Limit (kHz)	Result
1Mbps	1019	1134	756	Pass
2Mbps	1009	1375	917	Pass
3Mbps	1003	1391	927	Pass
Limit	25 kHz or $^2/_3$ of the 20 dB bandwidth of the hopping channel Whichever is greater			

Plots of the 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	S18
Modification state	0
SE in test environment	None
SE isolated from EUT	TRaC PC
Temperature	20°C
EUT set up	Refer to Appendix C

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 (2441.0 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	S18
Modification state	0
SE in test environment	None
SE isolated from EUT	TRaC PC
Temperature	20°C
EUT set up	Refer to Appendix C

T_{occ} (ms)	MP (s)	MPTX	AOT (s)	Limit (s)	Result
2.97	31.6	106	0.318	0.400	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 Occupancy Time

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

No. of utilised hopping channels (N) = 79
One channel occupancy time (T_{occ}) = 2.95ms
Measurement Period (MP) = 31.6 Seconds

Measurement Period = 0.4 x N
Measurement Period = 0.4 x 79
Measurement Period = 31.6 seconds

No. of transmission cycles in measurement period (MPTX) = 31.6/PRF
= 31.6/0.296
= 106

Average Occupancy Time (AOT) = T_{occ} x MPTX
Average Occupancy Time (AOT) = 2.97ms x 107
Average Occupancy Time (AOT) = 317.79ms

A8 Antenna Gain

The maximum antenna gain for the antenna types to be used with the EUT, as declared by the client, is 2.3 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.

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	Title 47 of the CFR: Part 15 Subpart (b) Clause 15.109
Measurement standard	ANSI C63.10:2003
Frequency range	30MHz to 25GHz
EUT sample number	S20
Modification state	0
SE in test environment	RFG464
SE isolated from EUT	REF829
EUT set up	Refer to Appendix C
Temperature	15°C
Photographs (Appendix F)	Photograph 1 and 2

The worst case radiated emission measurements for spurious emissions:

Ref No.	FREQ. (MHz)	Det.	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)	Margin (dB)
1	1650.923	Pk	61.2	5.0	26.4	33.72	58.9	0.0	58.9	74.0	-15.1
2	1650.923	AV	36.2	5.0	26.4	33.72	33.9	0.0	33.9	54.0	-20.1

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

Test Details:	
Regulation	Title 47 of the CFR: Part 15 Subpart (b) Clause 15.109
Measurement standard	ANSI C63.10:2003
Frequency range	30MHz to 25GHz
EUT sample number	S21
Modification state	0
SE in test environment	RFG464
SE isolated from EUT	REF829
EUT set up	Refer to Appendix C
Temperature	15°C
Photographs (Appendix F)	Photograph 3 and 4

The worst case radiated emission measurements for spurious emissions:

Ref No.	FREQ. (MHz)	Det.	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)	Margin (dB)
1	1618.166	Pk	57.3	-2.8	26.5	33.73	47.3	-9.5	37.8	74.0	-36.2
2	1618.166	AV	31.9	-2.8	26.5	33.73	21.9	-9.5	12.4	54.0	-41.6

A10 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: Transmit Mode	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.207
Measurement standard	ANSI C63.10
Frequency range	150kHz to 30MHz
EUT sample number	S21
Modification state	0
SE in test environment	RFG464
SE isolated from EUT	REF829
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)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
1	0.150	L1	4.0	56.0	-52.0	Pass
2	2.000	L1	2.4	46.0	-43.6	Pass
3	5.000	L1	2.6	50.0	-47.4	Pass
4	10.000	L1	3.7	50.0	-46.3	Pass
5	20.000	L1	6.6	50.0	-43.4	Pass
6	30.000	L1	6.5	50.0	-43.5	Pass
7	0.150	N	3.0	56.0	-53.0	Pass
8	2.000	N	2.4	46.0	-43.6	Pass
9	5.000	N	2.7	50.0	-47.3	Pass
10	10.000	N	4.2	50.0	-45.8	Pass
11	20.000	N	7.7	50.0	-42.3	Pass
12	30.000	N	6.0	50.0	-44.0	Pass

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

Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
1	0.150	L1	8.2	66.0	-57.8	Pass
2	2.000	L1	7.8	56.0	-48.2	Pass
3	5.000	L1	7.7	60.0	-52.3	Pass
4	10.000	L1	8.5	60.0	-51.5	Pass
5	20.000	L1	10.9	60.0	-49.1	Pass
6	30.000	L1	11.5	60.0	-48.5	Pass
7	0.150	N	7.7	56.0	-48.3	Pass
8	2.000	N	7.6	50.0	-42.4	Pass
9	5.000	N	7.6	60.0	-52.4	Pass
10	10.000	N	8.6	60.0	-51.4	Pass
11	20.000	N	11.8	60.0	-48.2	Pass
12	30.000	N	11.2	60.0	-48.8	Pass

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 not transmit. The formal measurements are detailed below:

Test Details: Receive Mode	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.107
Measurement standard	ANSI C63.10
Frequency range	150kHz to 30MHz
EUT sample number	S21
Modification state	0
SE in test environment	RFG464
SE isolated from EUT	REF829
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)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
1	0.150	L1	2.0	56.0	-54.0	Pass
2	2.000	L1	2.9	46.0	-43.1	Pass
3	5.000	L1	2.6	50.0	-47.4	Pass
4	10.000	L1	3.8	50.0	-46.2	Pass
5	20.000	L1	6.6	50.0	-43.4	Pass
6	30.000	L1	6.3	50.0	-43.7	Pass
7	0.150	N	3.1	56.0	-52.9	Pass
8	2.000	N	2.2	46.0	-43.8	Pass
9	5.000	N	2.5	50.0	-47.5	Pass
10	10.000	N	4.5	50.0	-45.5	Pass
11	20.000	N	6.9	50.0	-43.1	Pass
12	30.000	N	5.0	50.0	-45.0	Pass

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

Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
1	0.150	L1	7.7	66.0	-58.3	Pass
2	2.000	L1	8.1	56.0	-47.9	Pass
3	5.000	L1	7.1	60.0	-52.9	Pass
4	10.000	L1	8.0	60.0	-52.0	Pass
5	20.000	L1	11.0	60.0	-49.0	Pass
6	30.000	L1	11.2	60.0	-48.8	Pass
7	0.150	N	7.9	56.0	-48.1	Pass
8	2.000	N	7.2	50.0	-42.8	Pass
9	5.000	N	7.6	60.0	-52.4	Pass
10	10.000	N	8.7	60.0	-51.3	Pass
11	20.000	N	11.0	60.0	-49.0	Pass
12	30.000	N	10.2	60.0	-49.8	Pass

Specification limits :

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

Conducted disturbance at the mains ports.

Frequency range MHz	Limits dBμV	
	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				

Appendix B: Supporting Graphical Data

This appendix contains graphical data obtained during testing.

Notes:

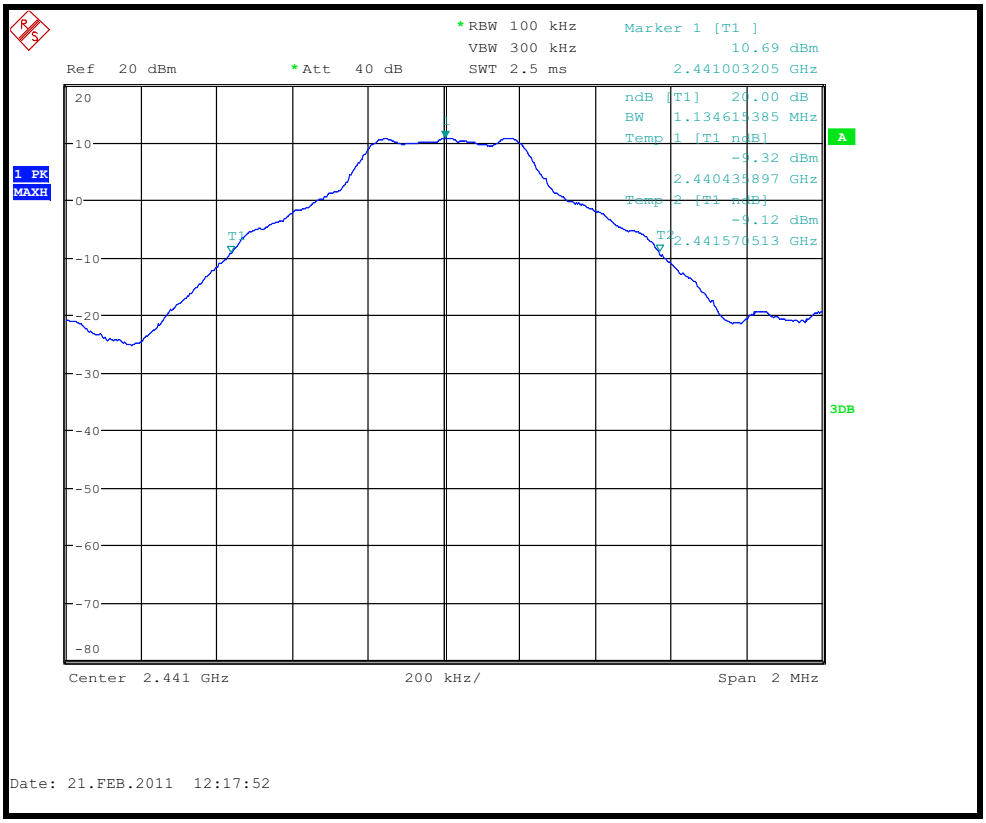
(a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A and Appendix B.

(b) The time and date on the plots do not necessarily equate to the time of the test.

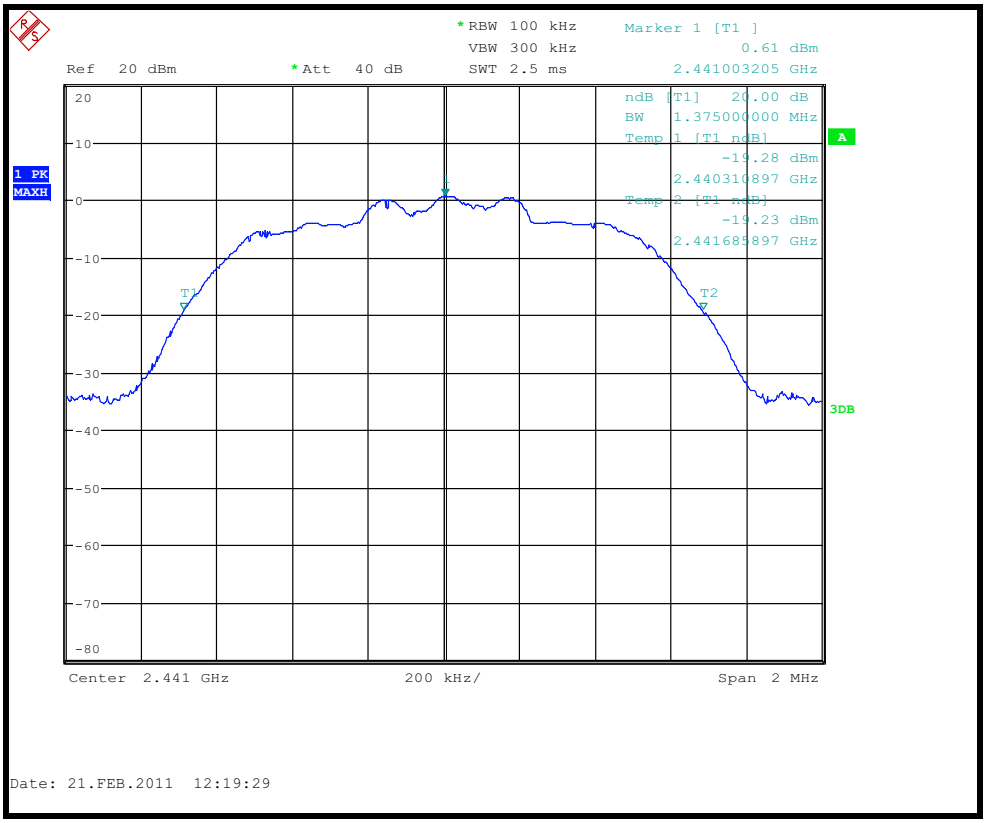
(c) Where relevant, on power line conducted emission plots, the limit displayed is the average limit, which is stricter than the quasi peak limit.

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

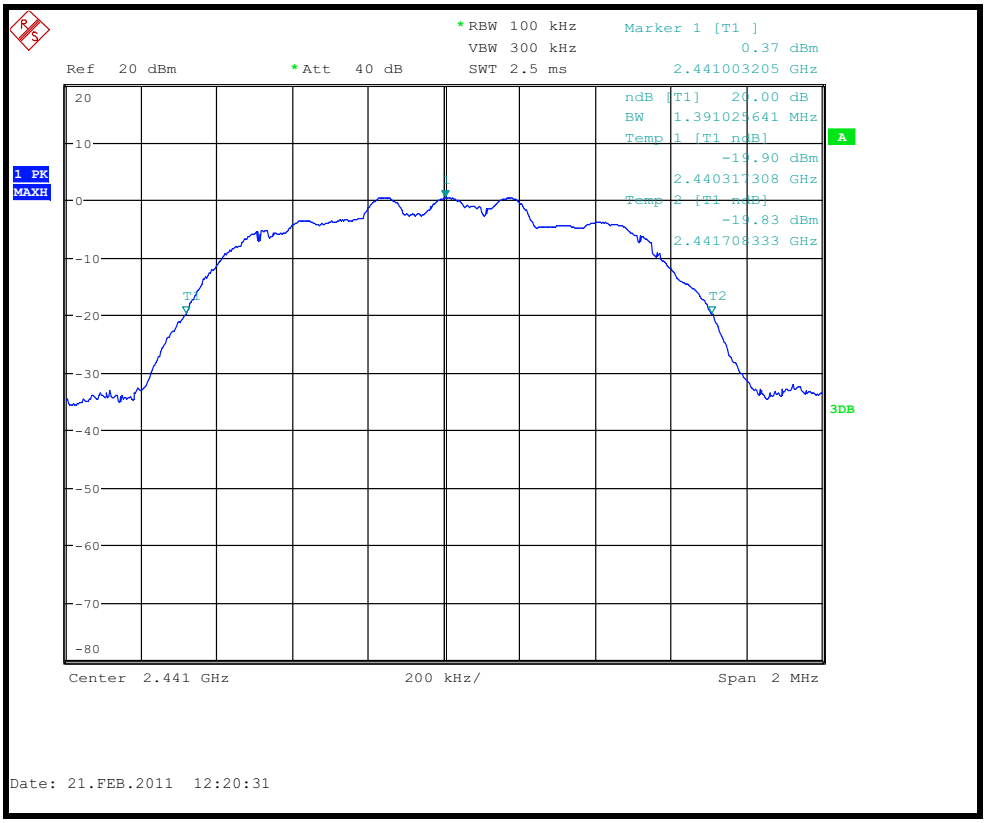
(e) The plots presented in this appendix may not be a complete record of the measurements performed, but are a representative sample, relative to the final assessment.



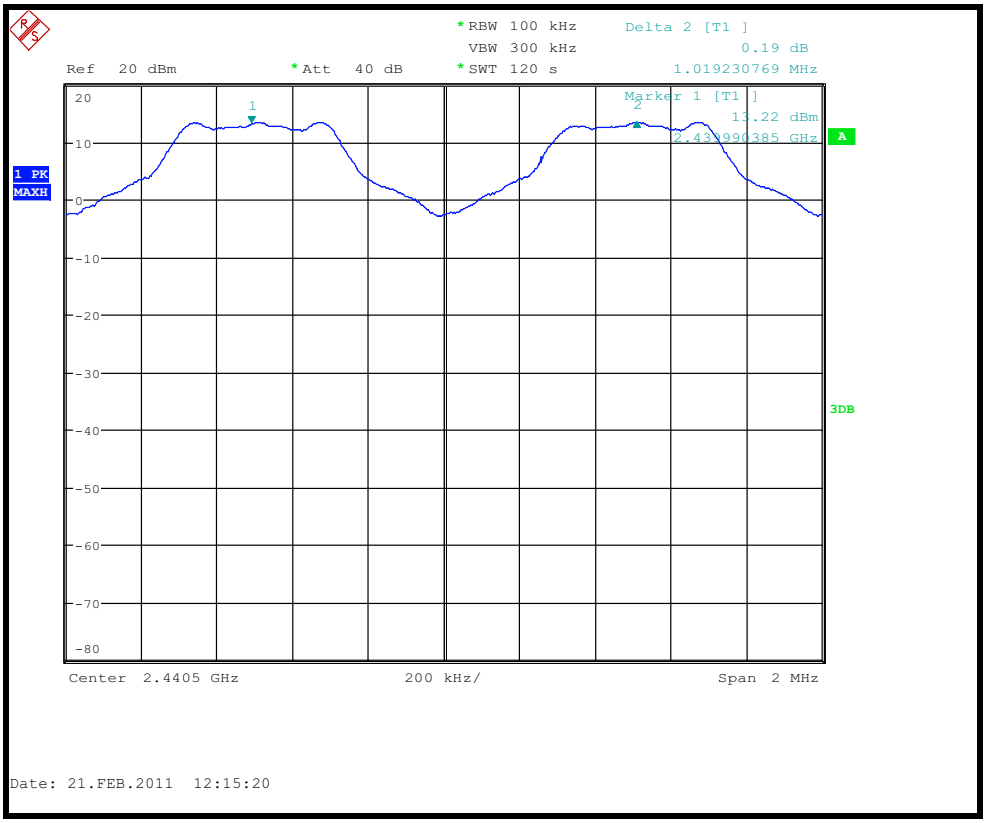
20dB Bandwidth – 1Mbps



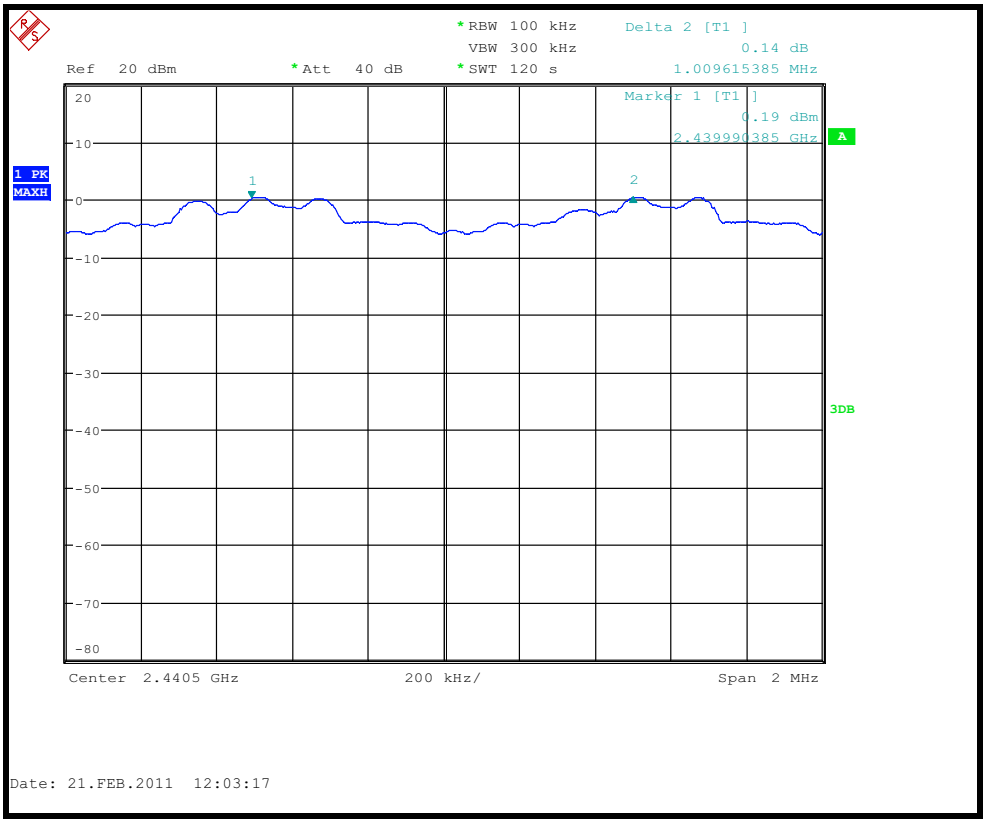
20dB Bandwidth – 2Mbps



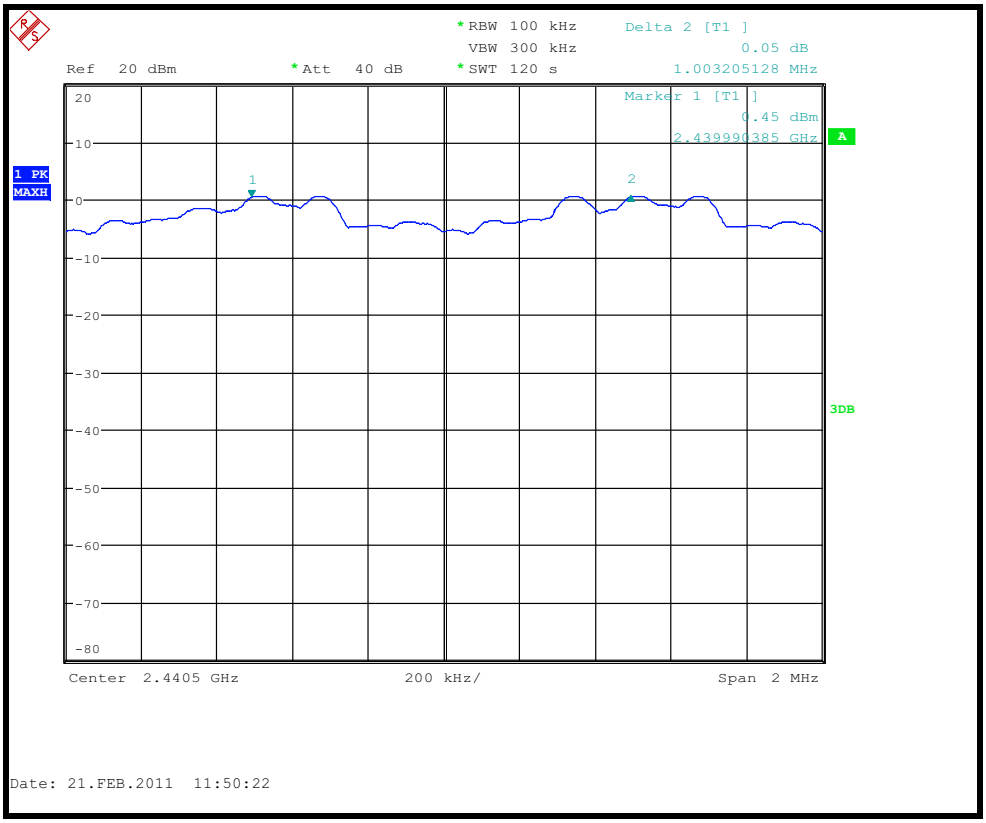
20dB Bandwidth – 3Mbps



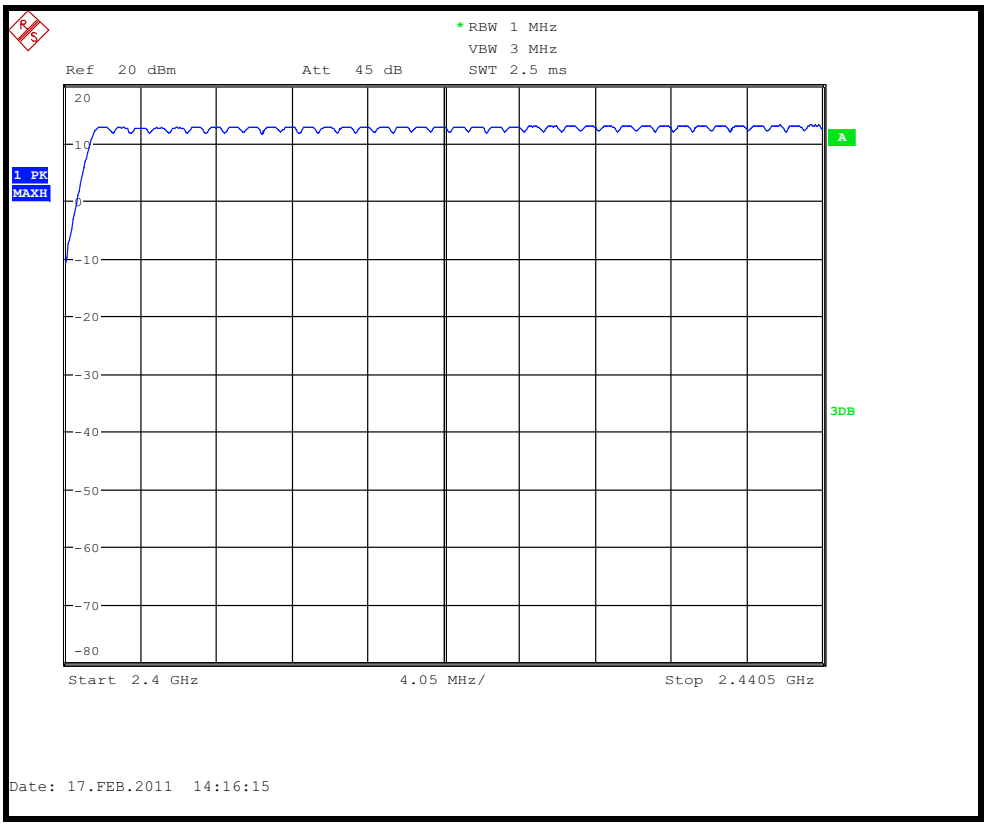
Channel Spacing – 1Mbps

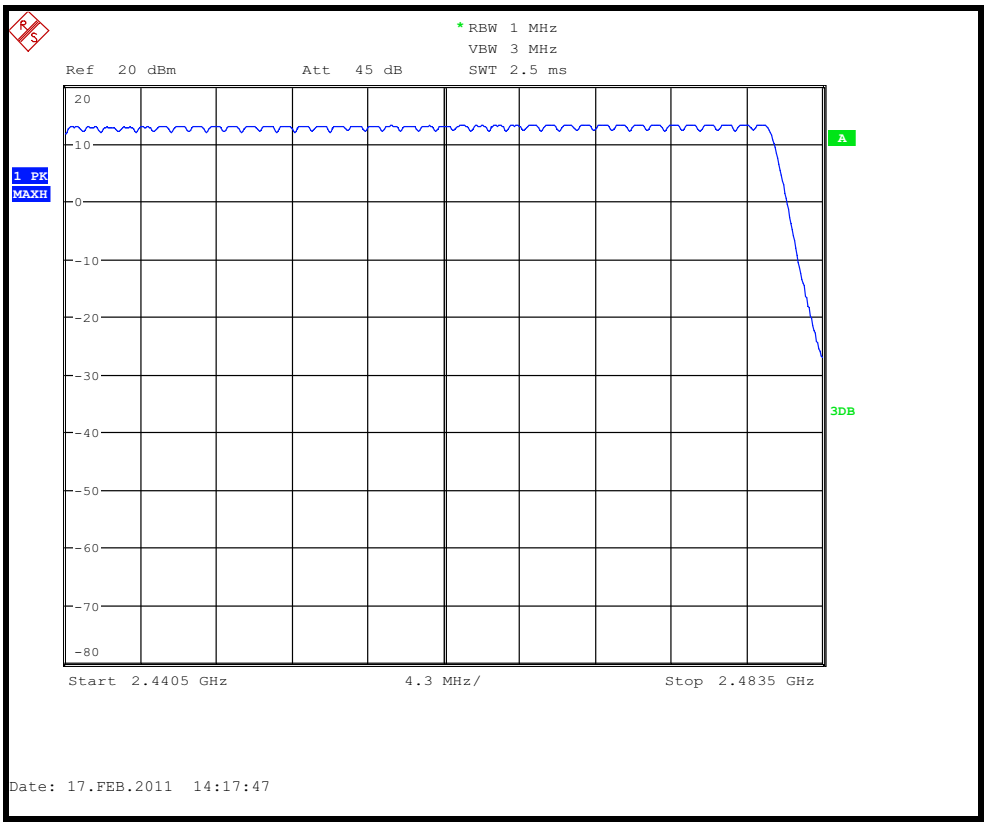


Channel Spacing – 2Mbps

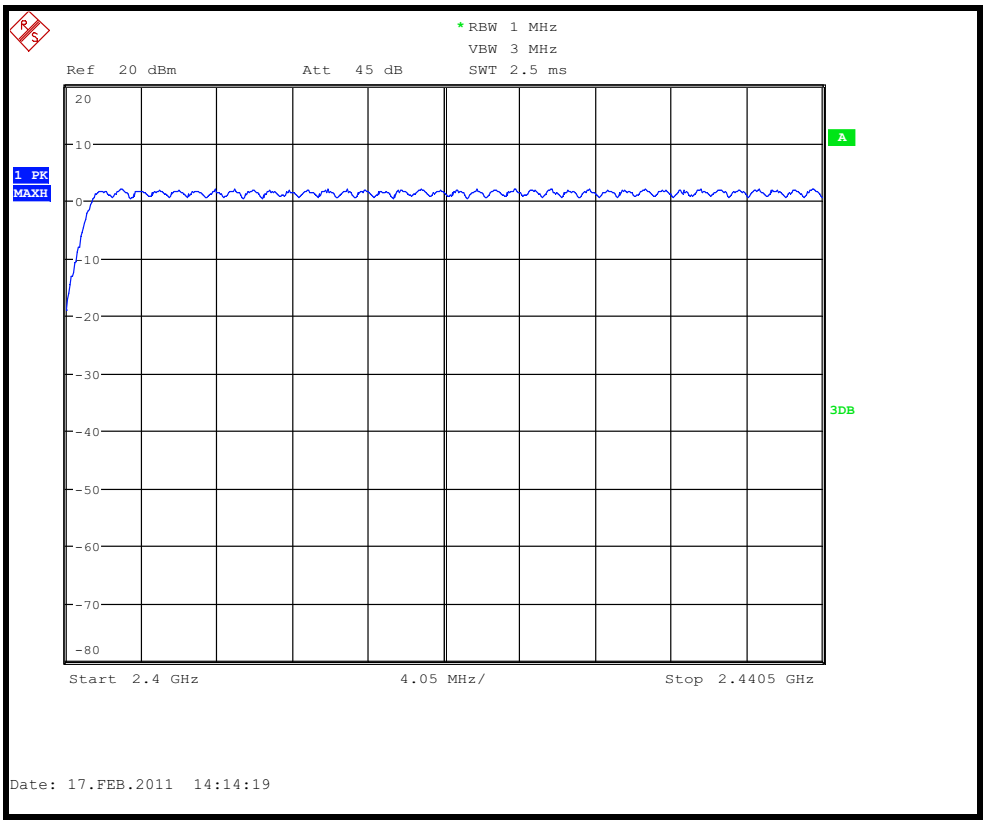


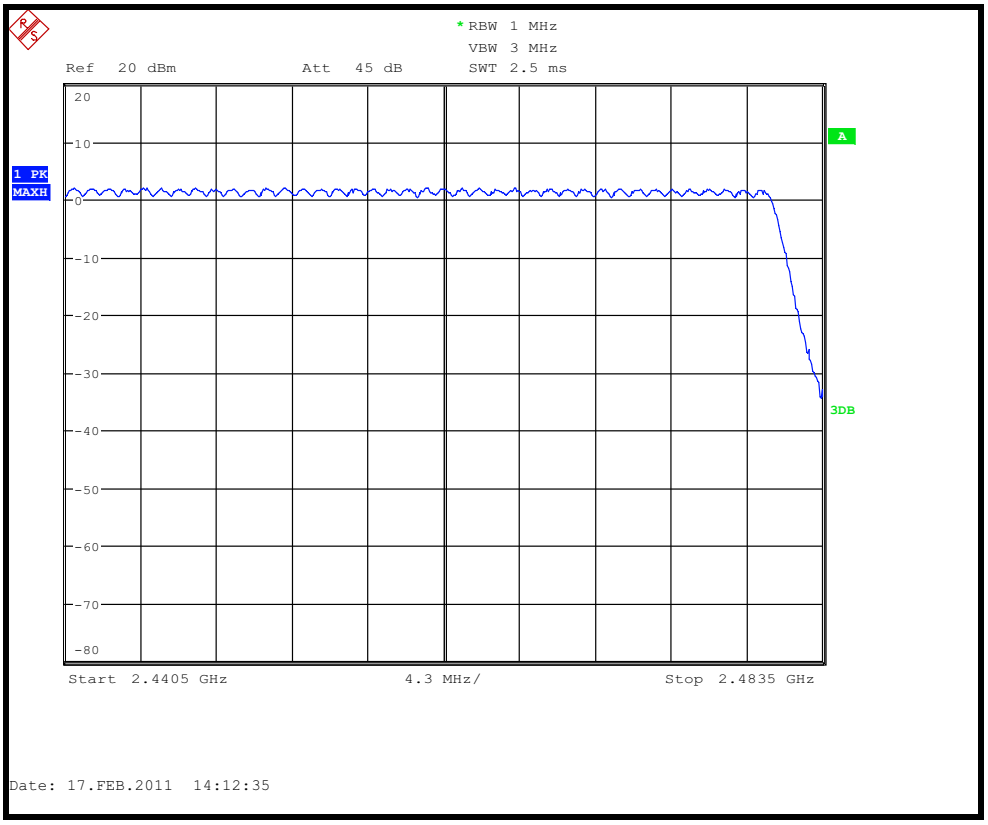
Channel Spacing – 3Mbps



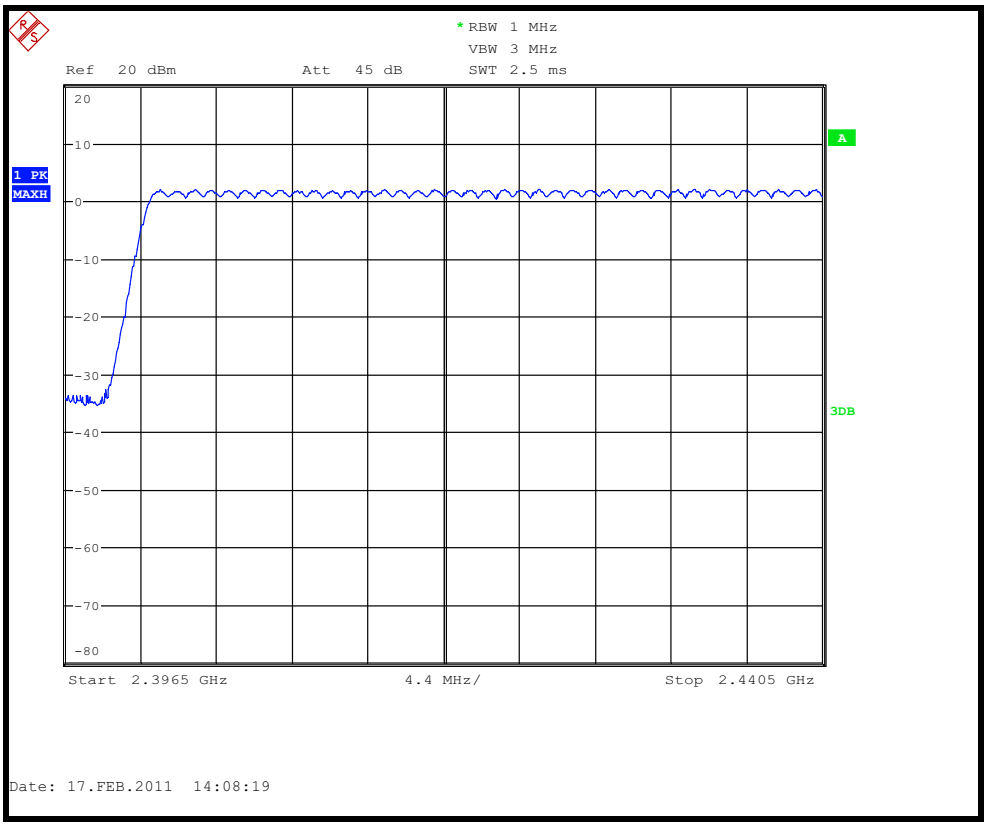


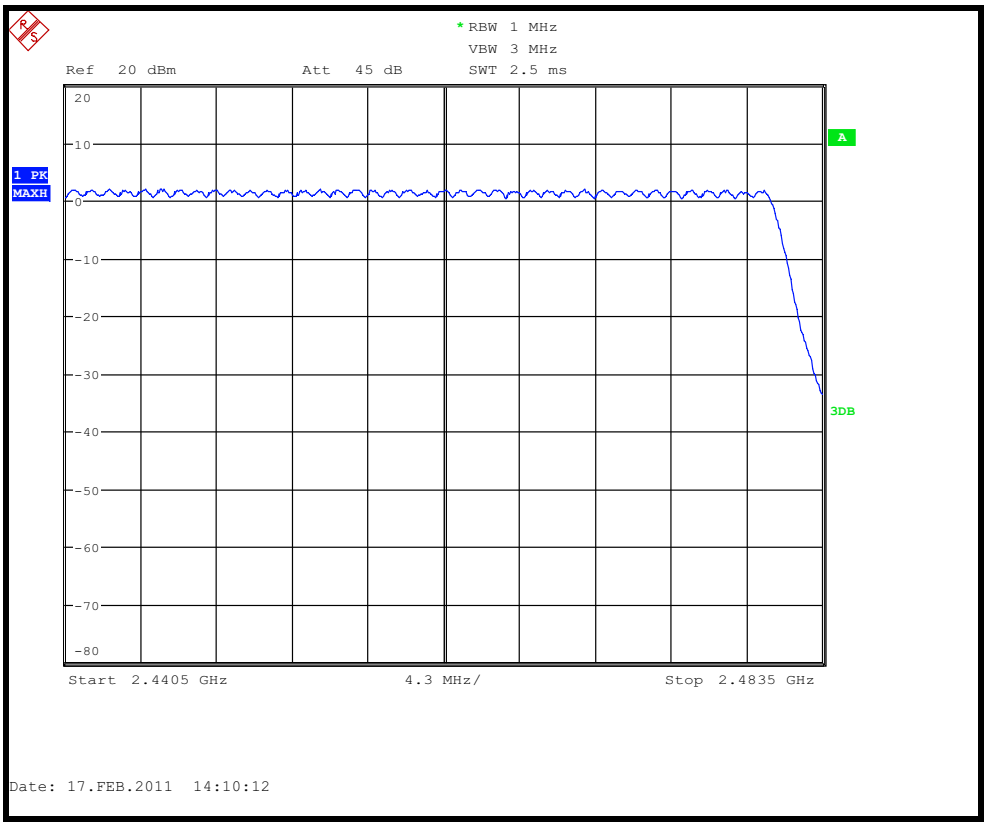
Number of Hopping Channels – 1Mbps



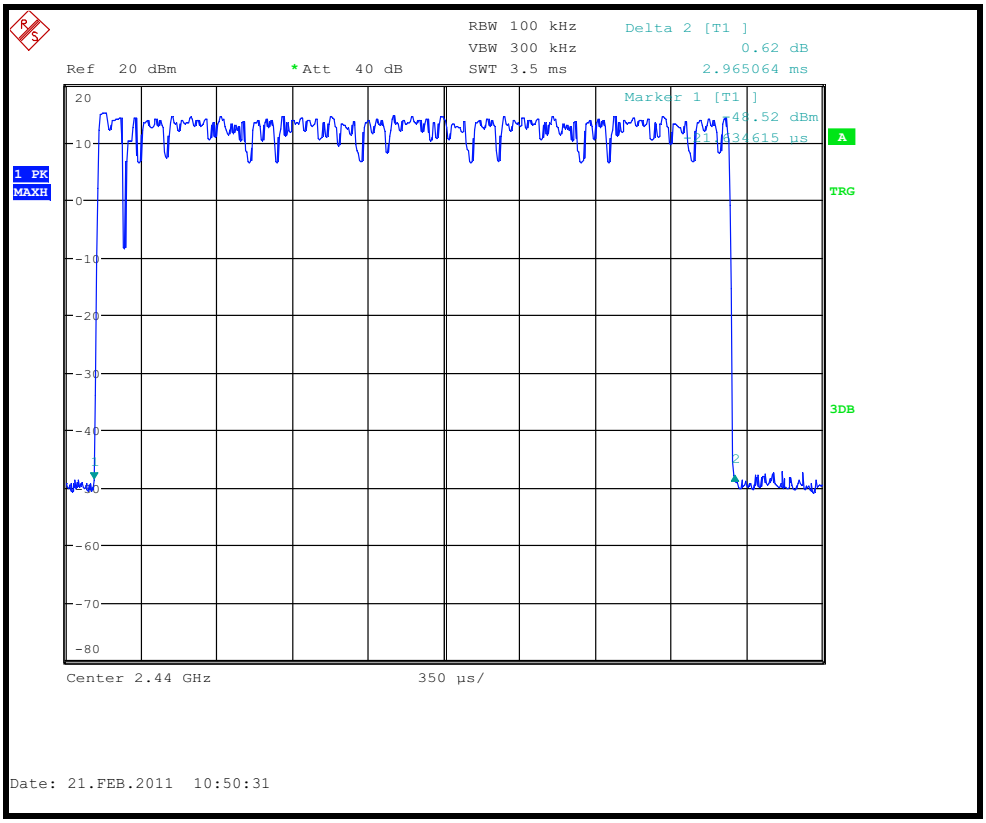


Number of Hopping Channels – 2Mbps

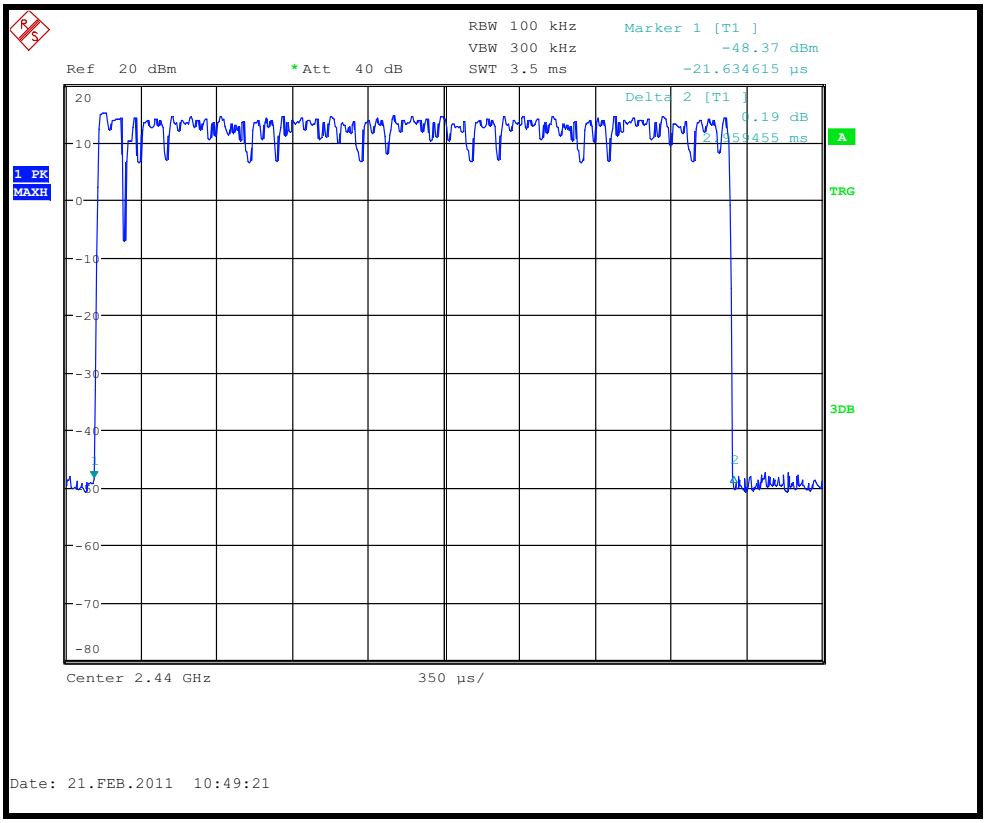




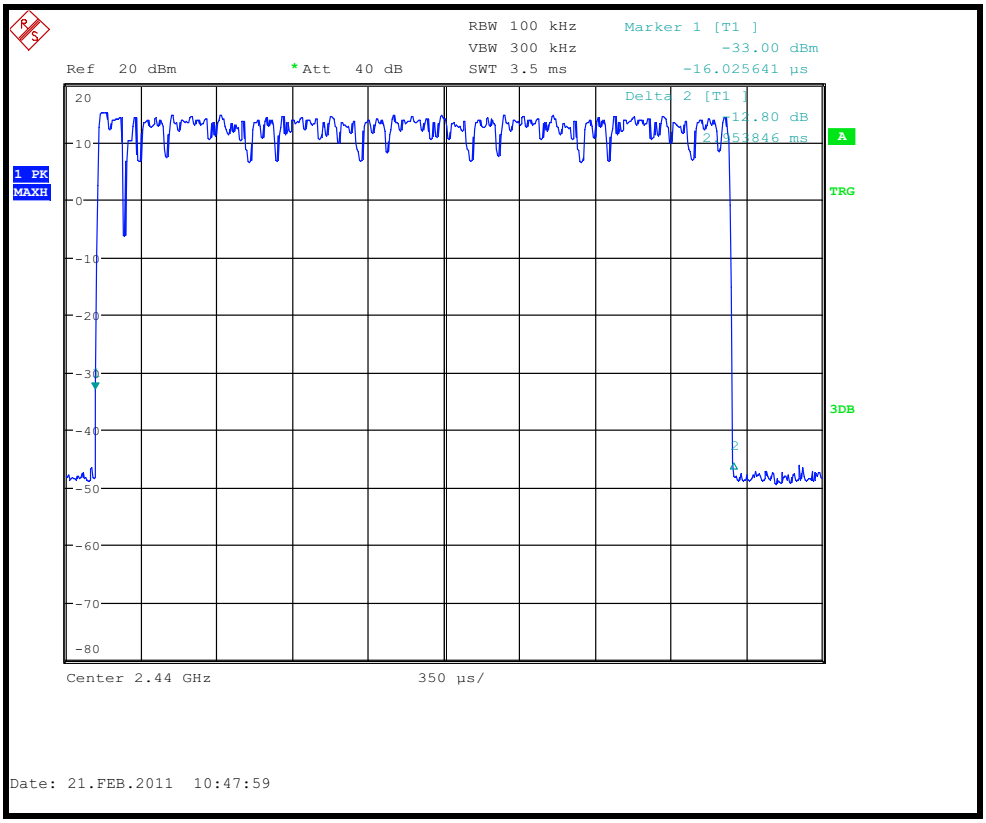
Number of Hopping Channels – 3Mbps



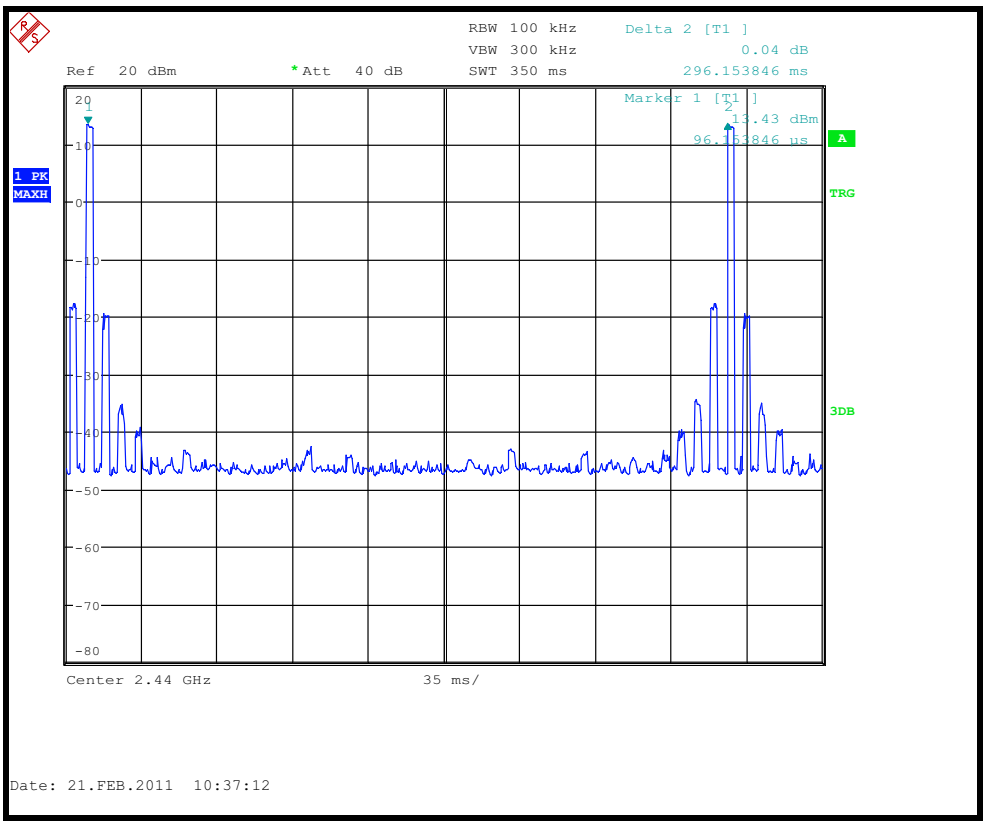
Channel Occupancy Time – 1Mbps



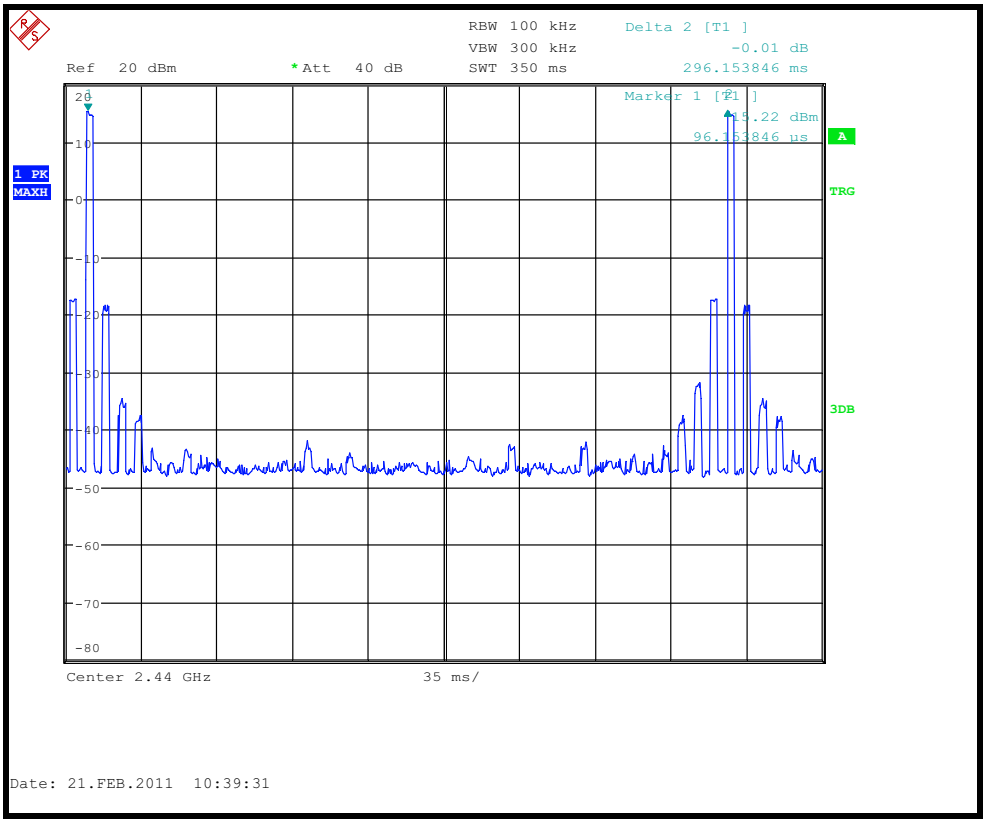
Channel Occupancy Time – 2Mbps



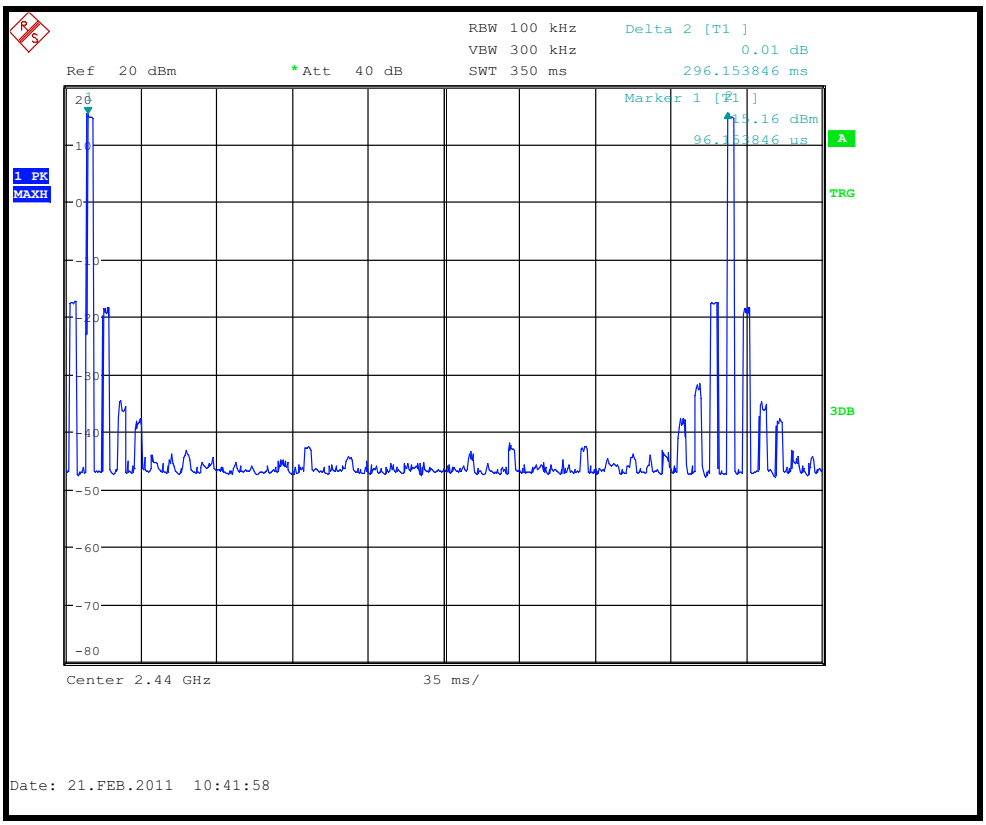
Channel Occupancy Time – 3Mbps



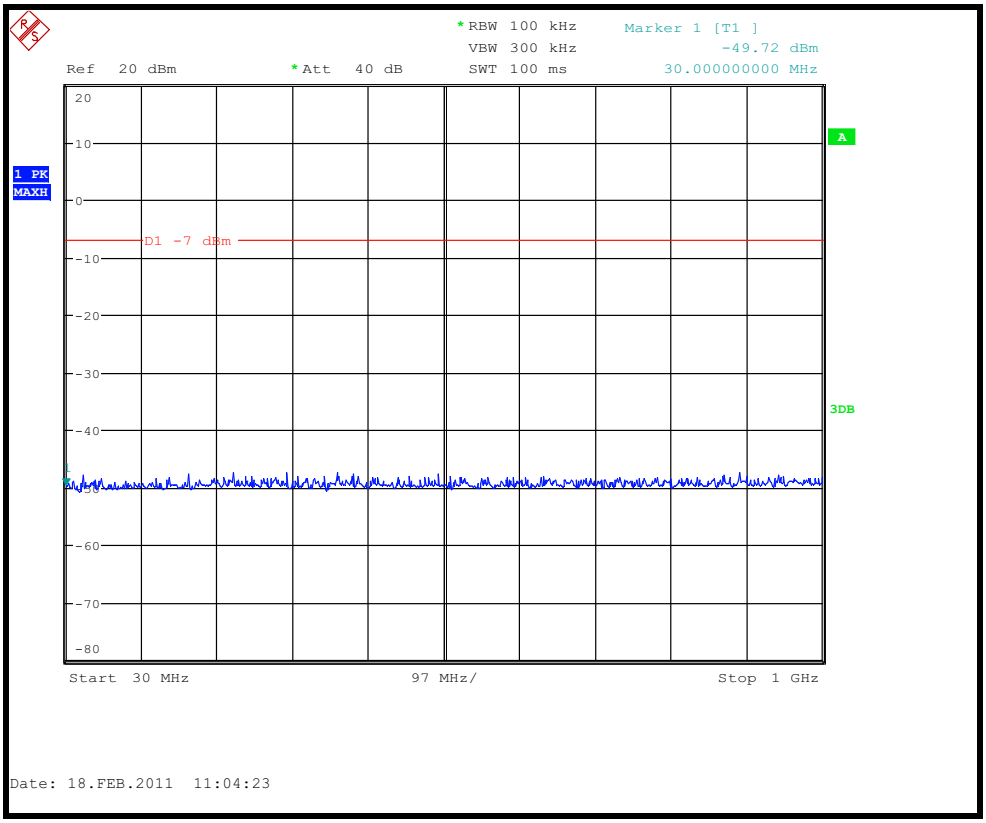
Channel repetition time – 1Mbps



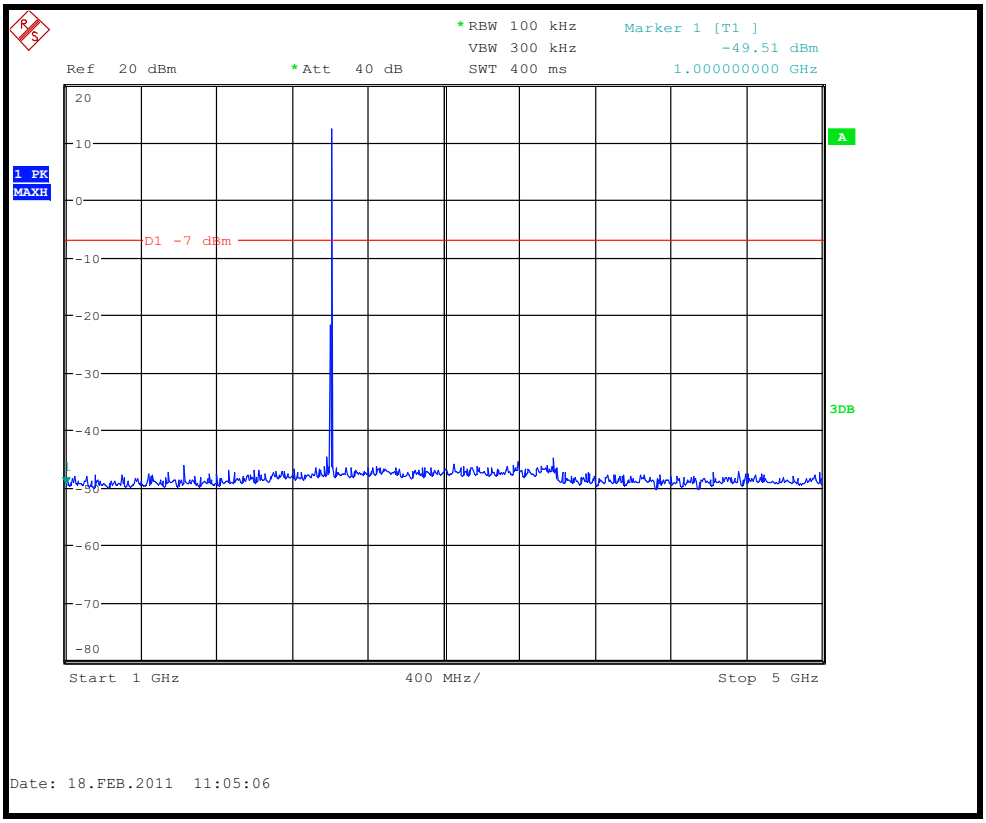
Channel repetition time – 1Mbps



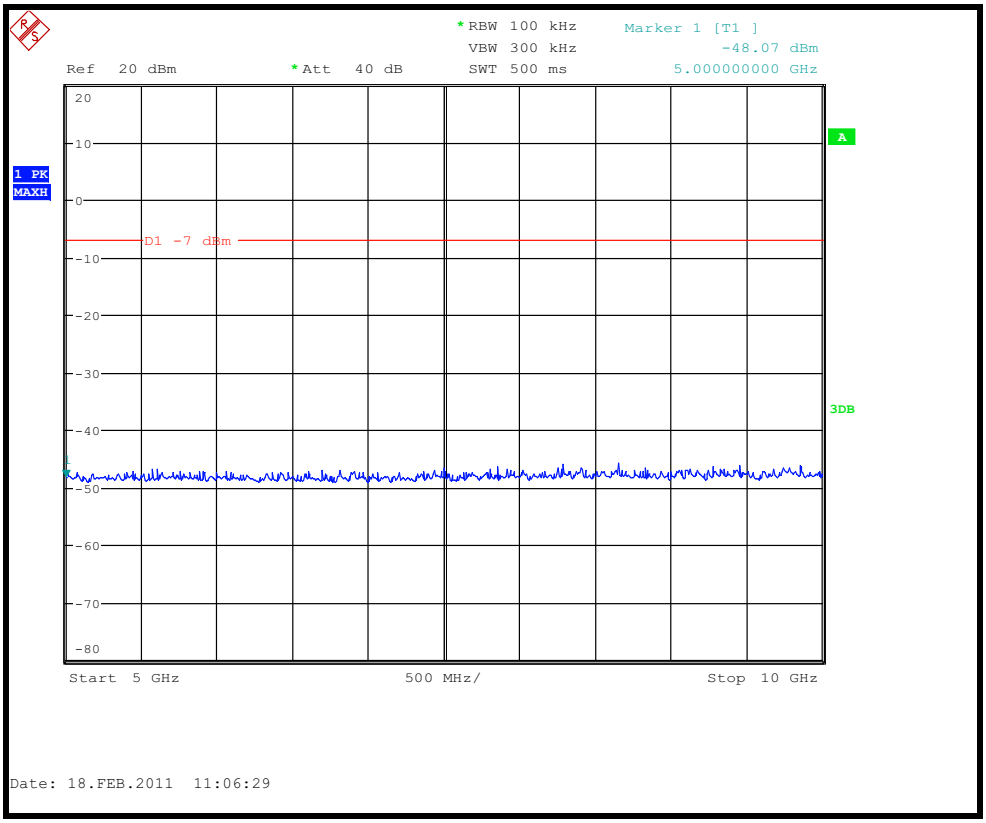
Channel repetition time – 1Mbps



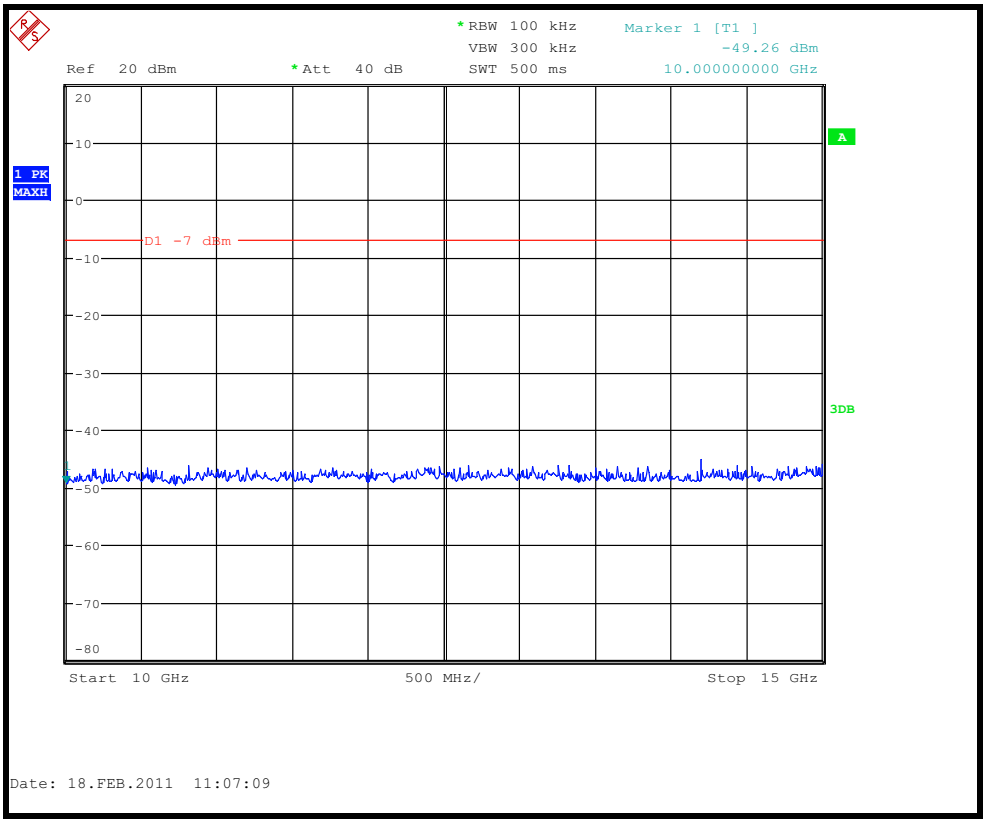
Conducted spurious emissions 30 MHz to 1 GHz – 2402.0MHz – 1Mbps



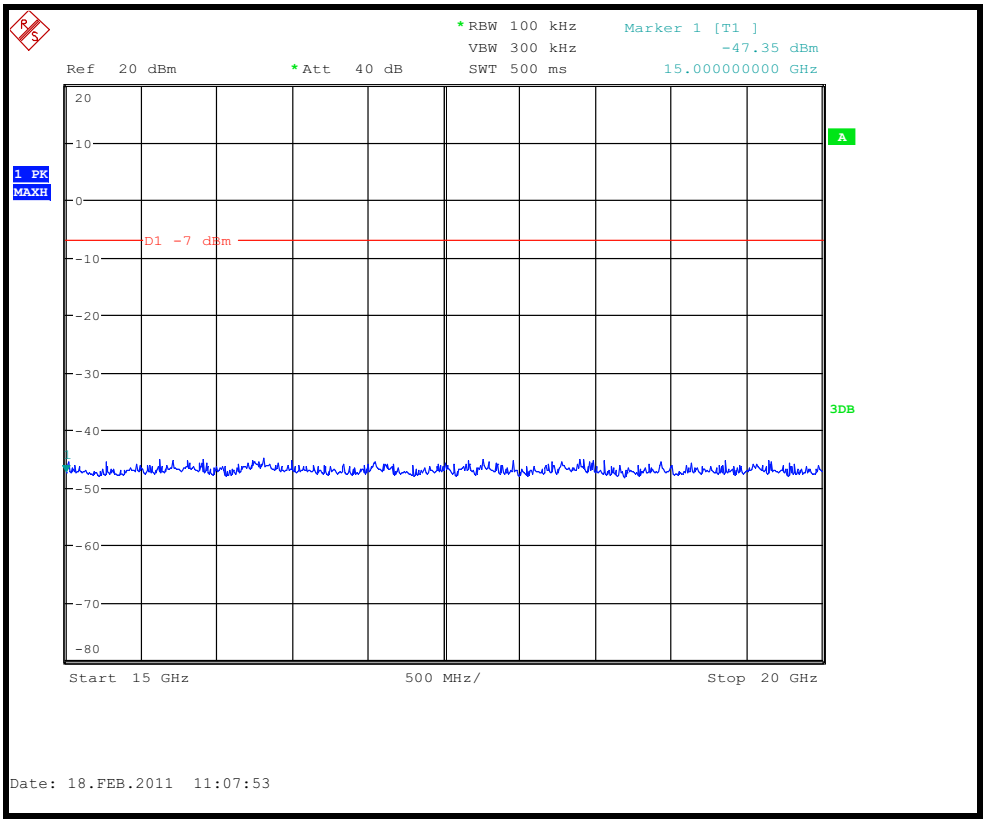
Conducted spurious emissions 1 GHz to 5 GHz – 2402.0MHz – 1Mbps



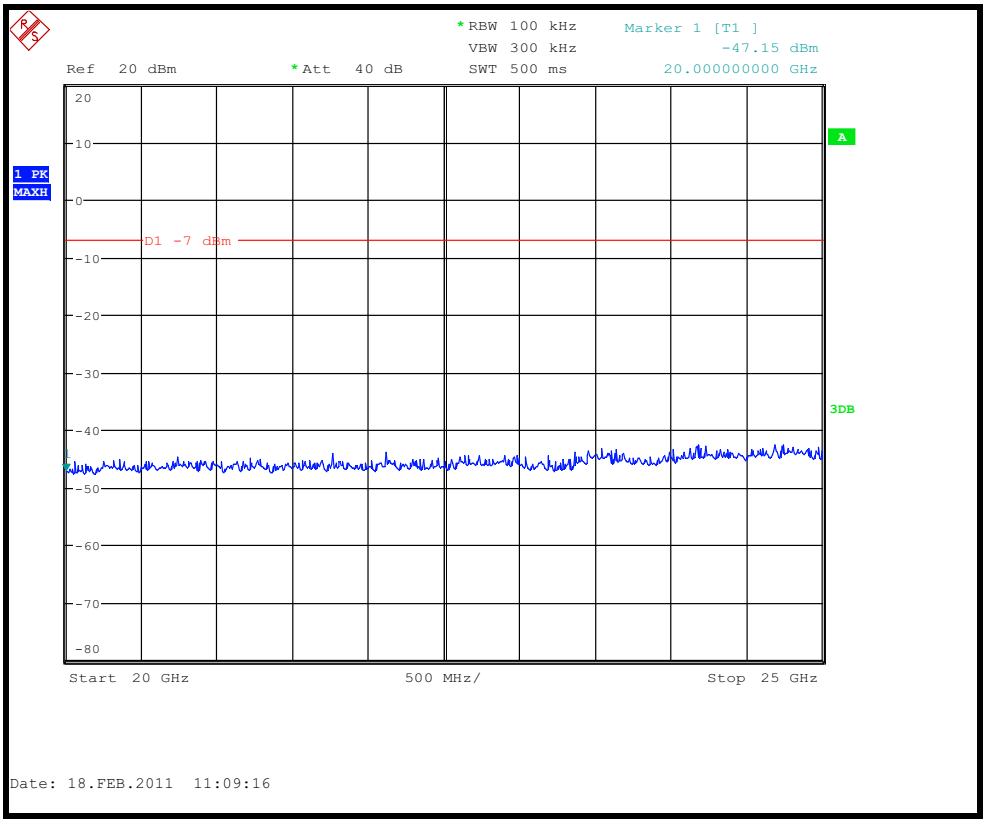
Conducted spurious emissions 5 GHz to 10 GHz – 2402.0MHz – 1Mbps



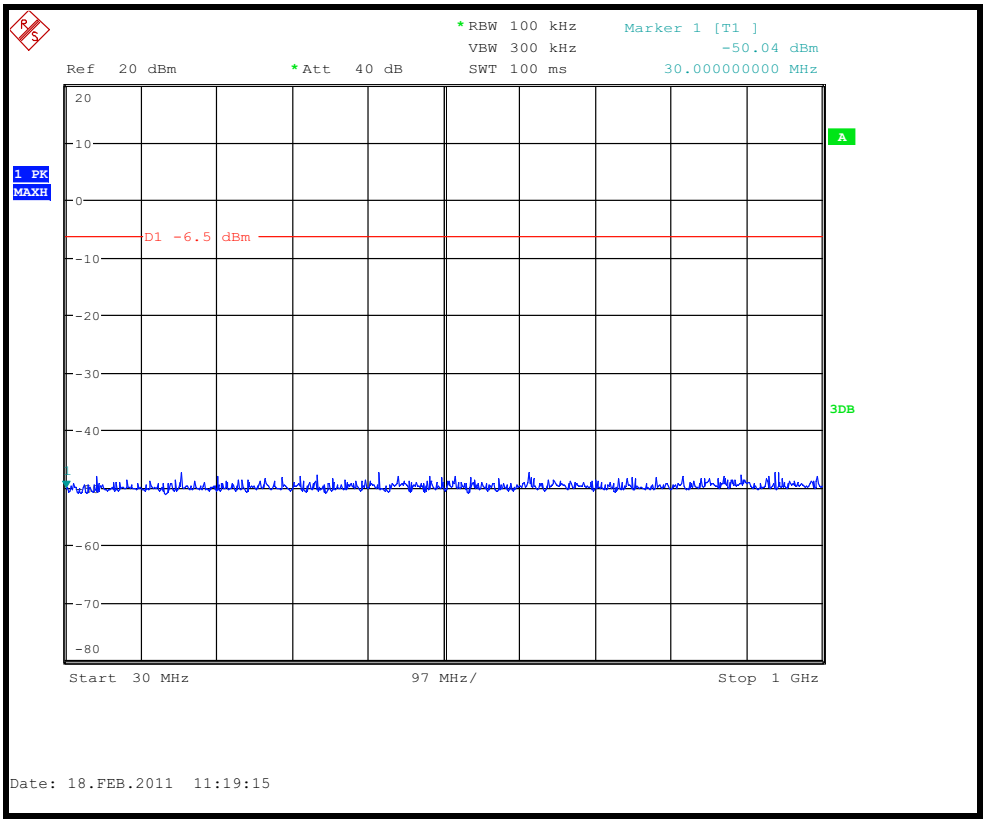
Conducted spurious emissions 10 GHz to 15 GHz – 2402.0MHz – 1Mbps



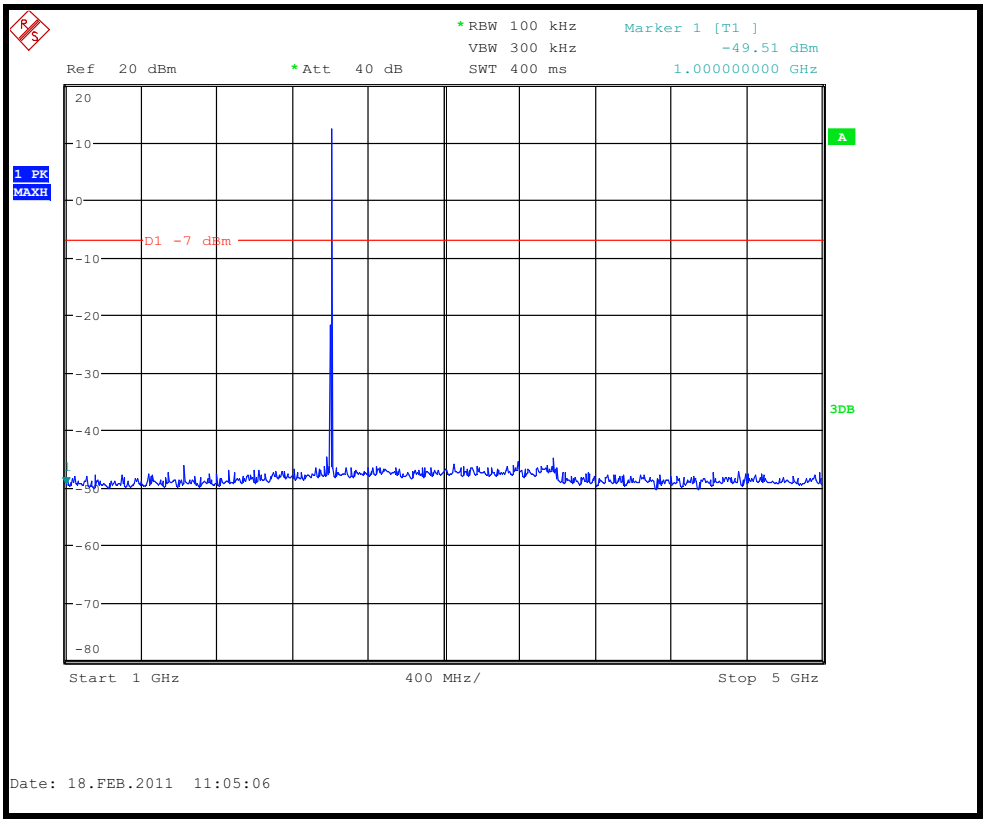
Conducted spurious emissions 15 GHz to 20 GHz – 2402.0MHz – 1Mbps



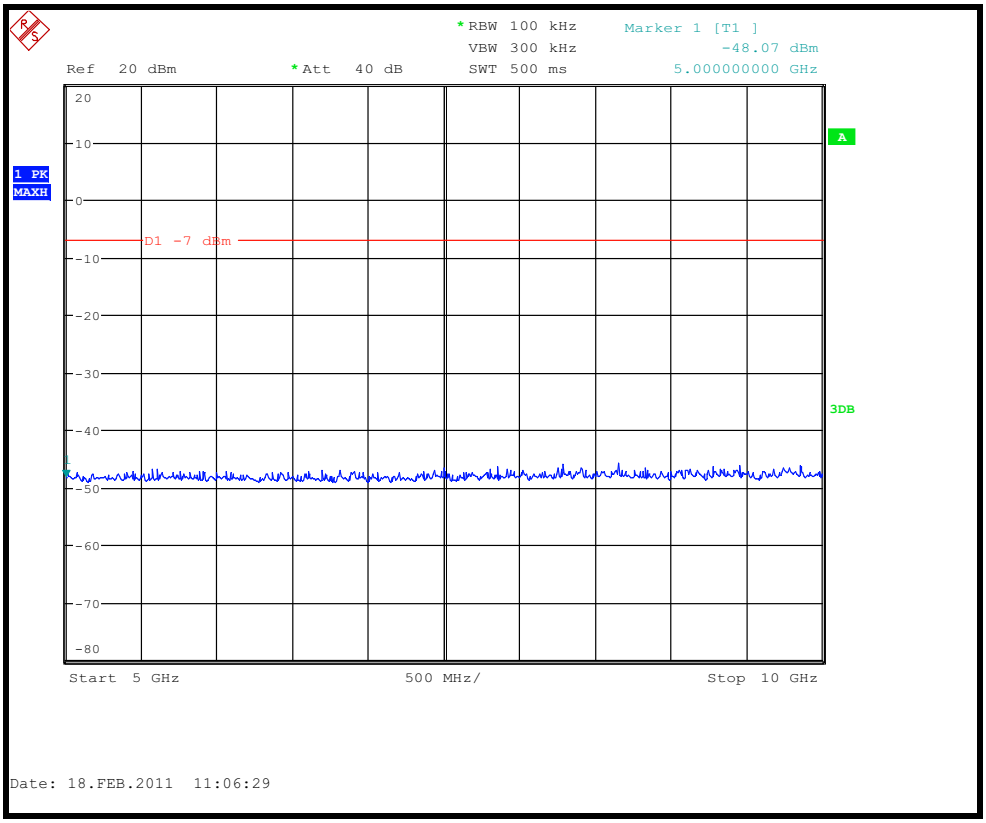
Conducted spurious emissions 20 GHz to 25 GHz – 2402.0MHz 1Mbps



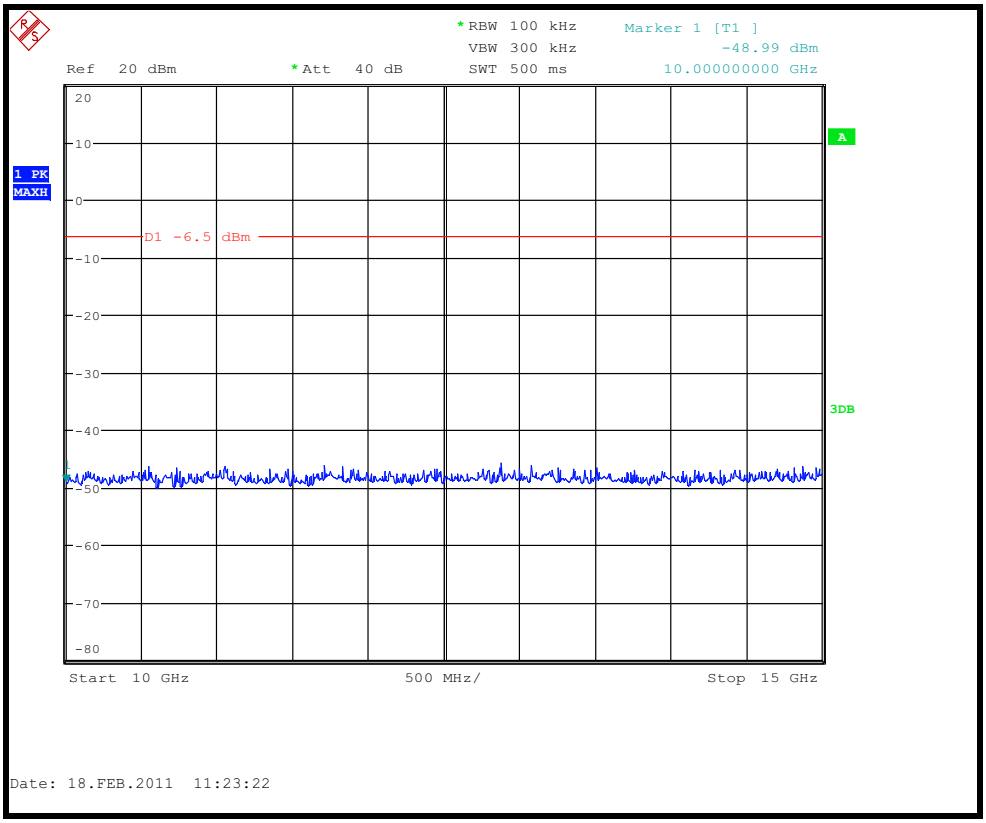
Conducted Spurious emissions 30 MHz to 1 GHz – 2441.0 MHz – 1Mbps



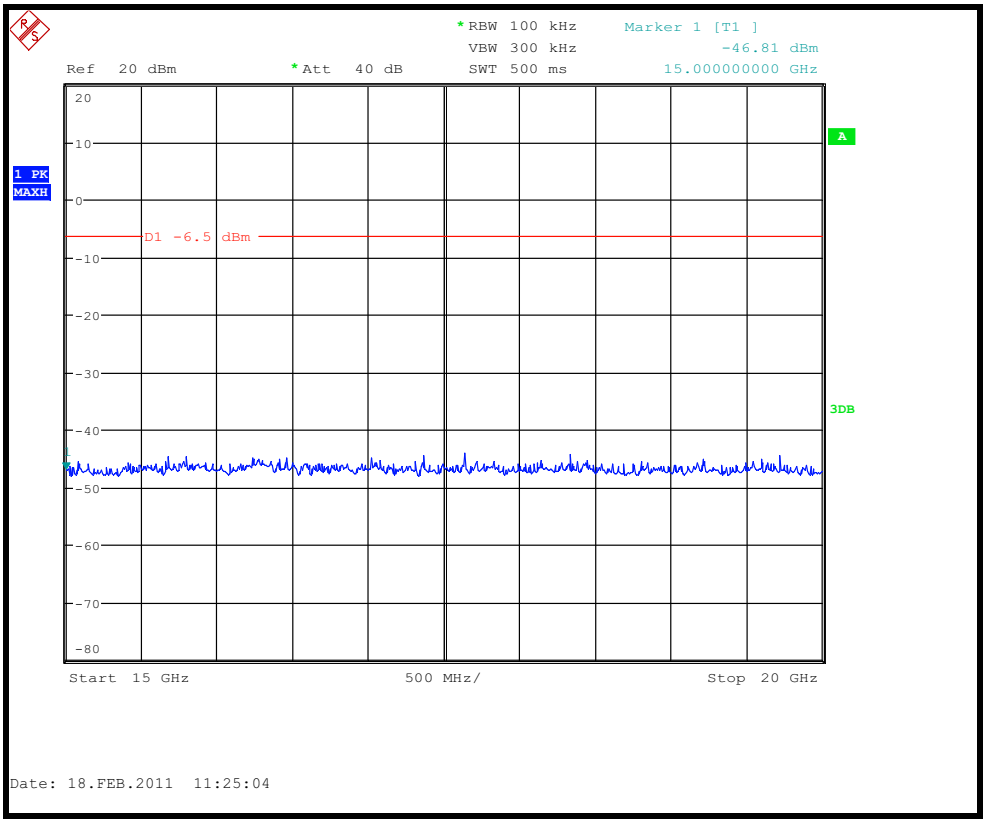
Conducted Spurious emissions 1 GHz to 5 GHz – 2441.0 MHz – 1Mbps



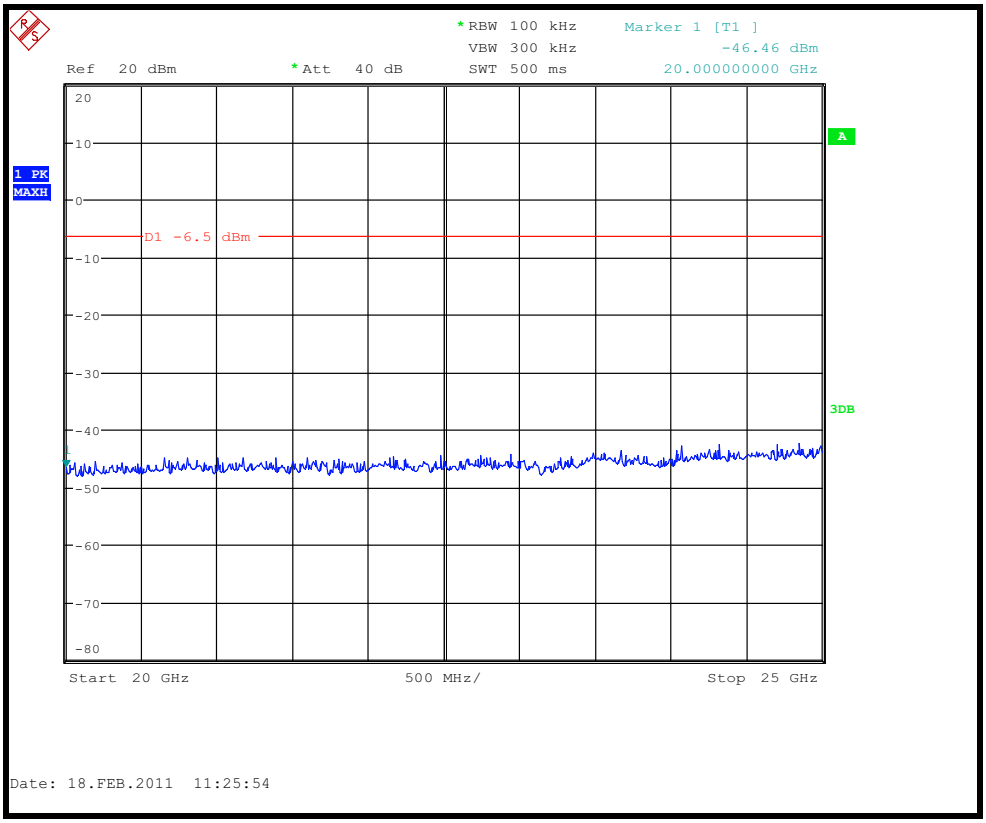
Conducted Spurious emissions 5 GHz to 10 GHz – 2441.0 MHz – 1Mbps



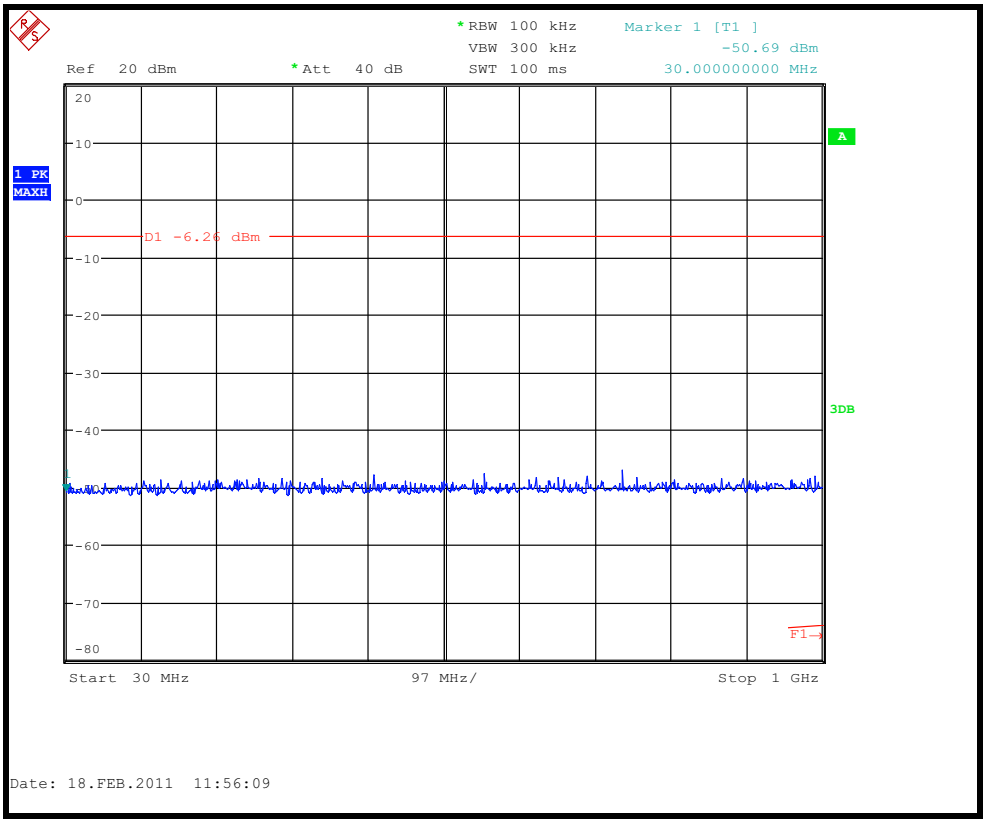
Conducted Spurious emissions 10 GHz to 15GHz – 2441.0 MHz – 1Mbps



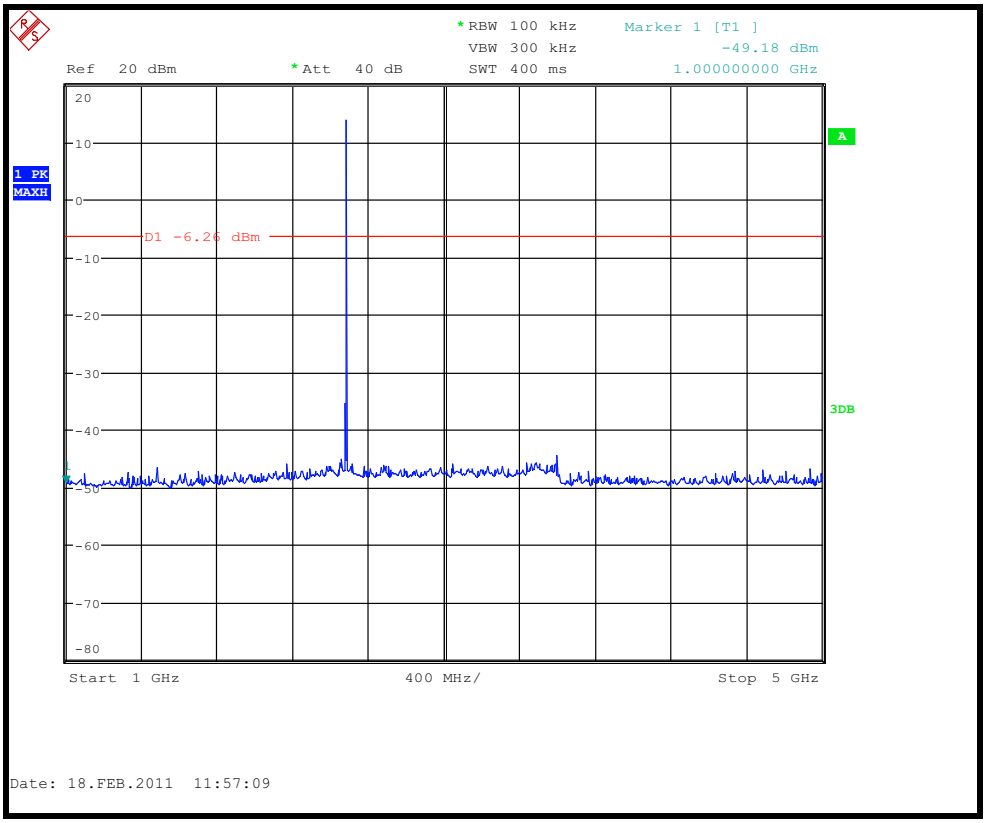
Conducted Spurious emissions 15 GHz to 20GHz – 2441.0 MHz – 1Mbps



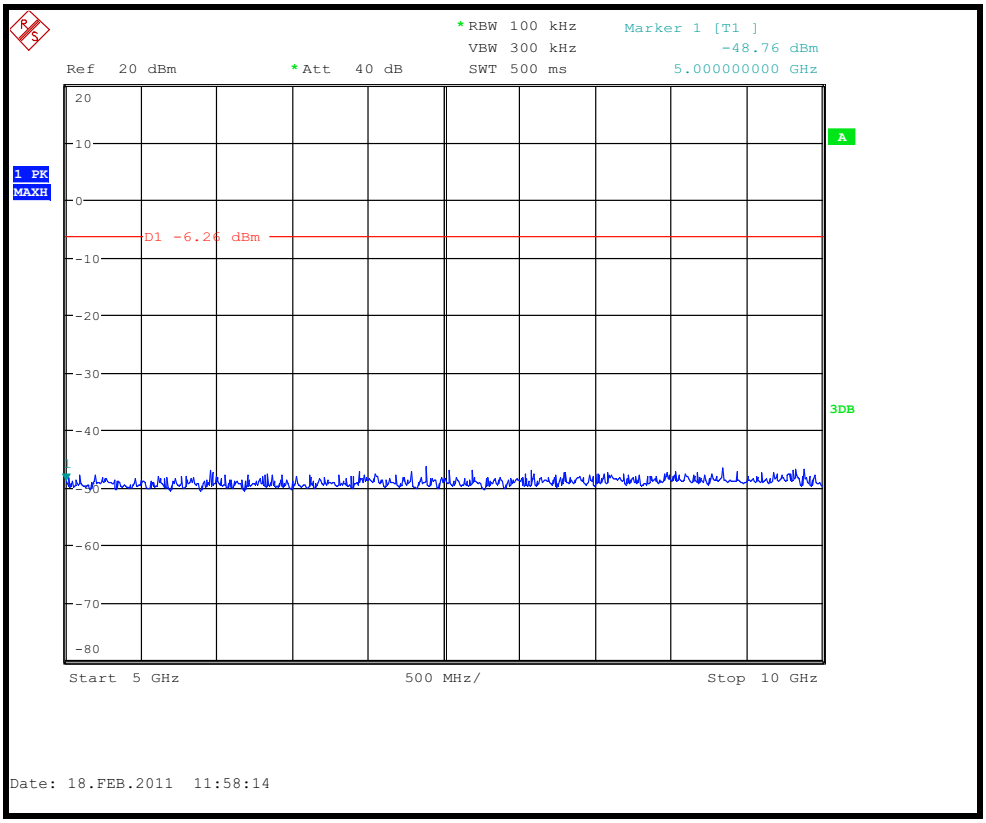
Conducted Spurious emissions 20 GHz to 25GHz – 2441.0 MHz – 1Mbps



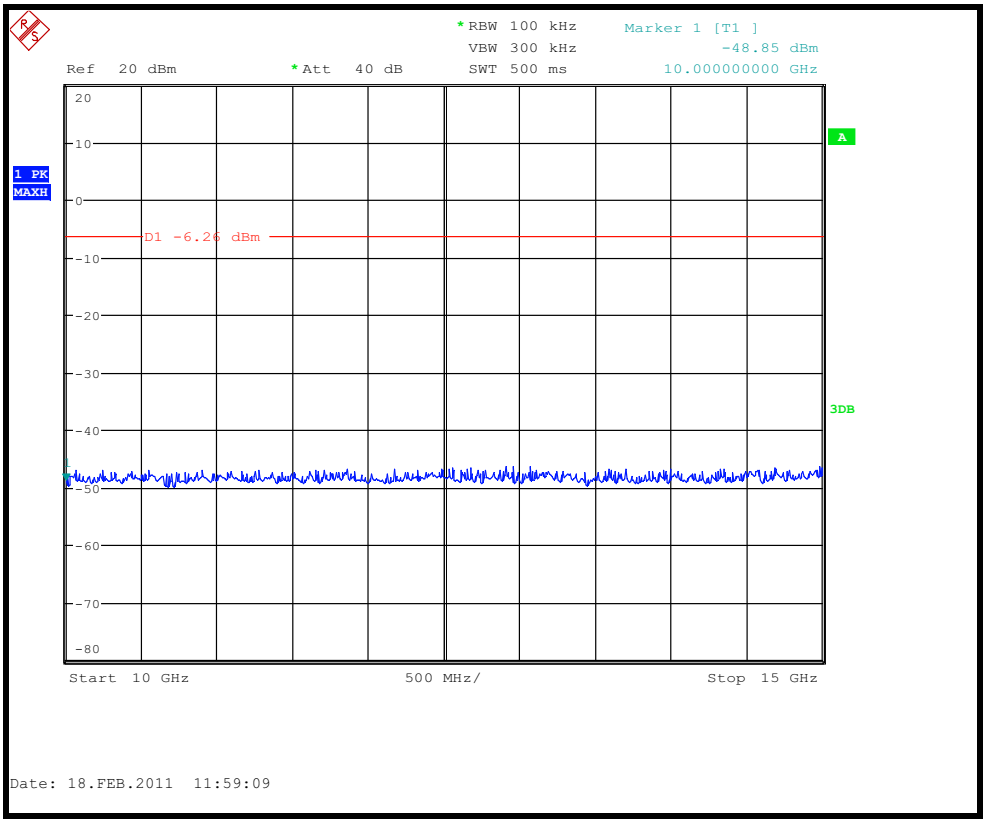
Conducted Spurious emissions 30 MHz to 1 GHz – 2480.0MHz – 1Mbps



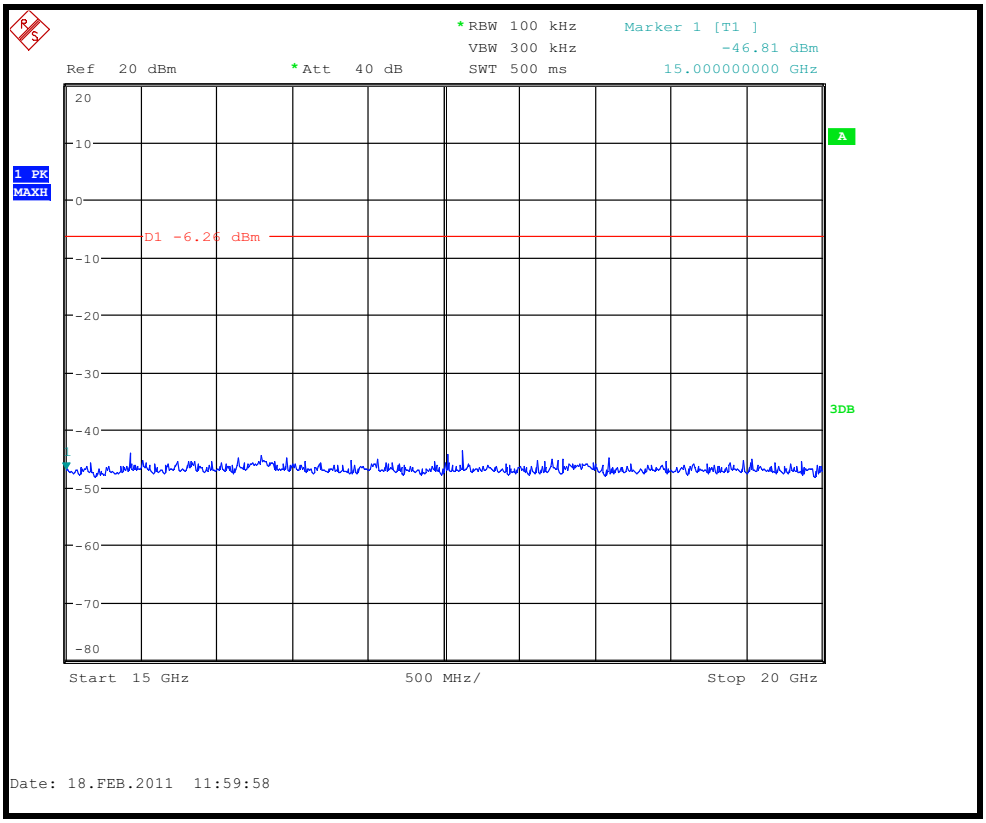
Conducted Spurious emissions 1 GHz to 5 GHz – 2480.0MHz – 1Mbps



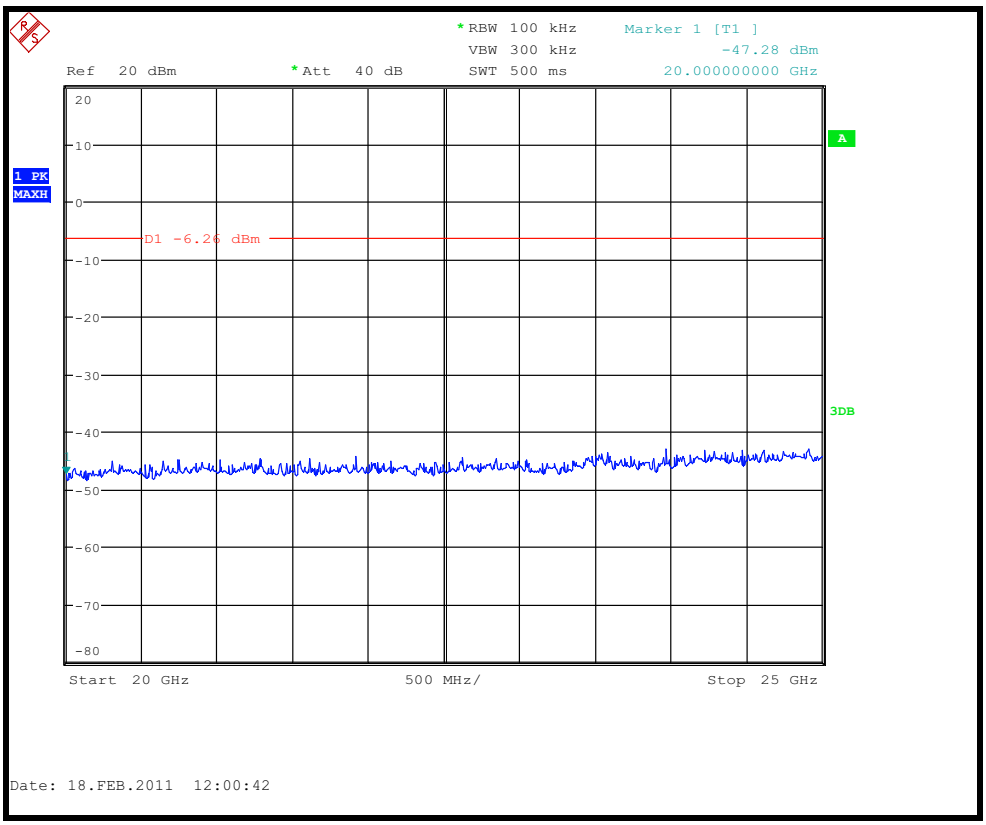
Conducted Spurious emissions 5 GHz to 10 GHz– 2480.0MHz – 1Mbps



Conducted Spurious emissions 10 GHz to 15 GHz– 2480.0MHz – 1Mbps

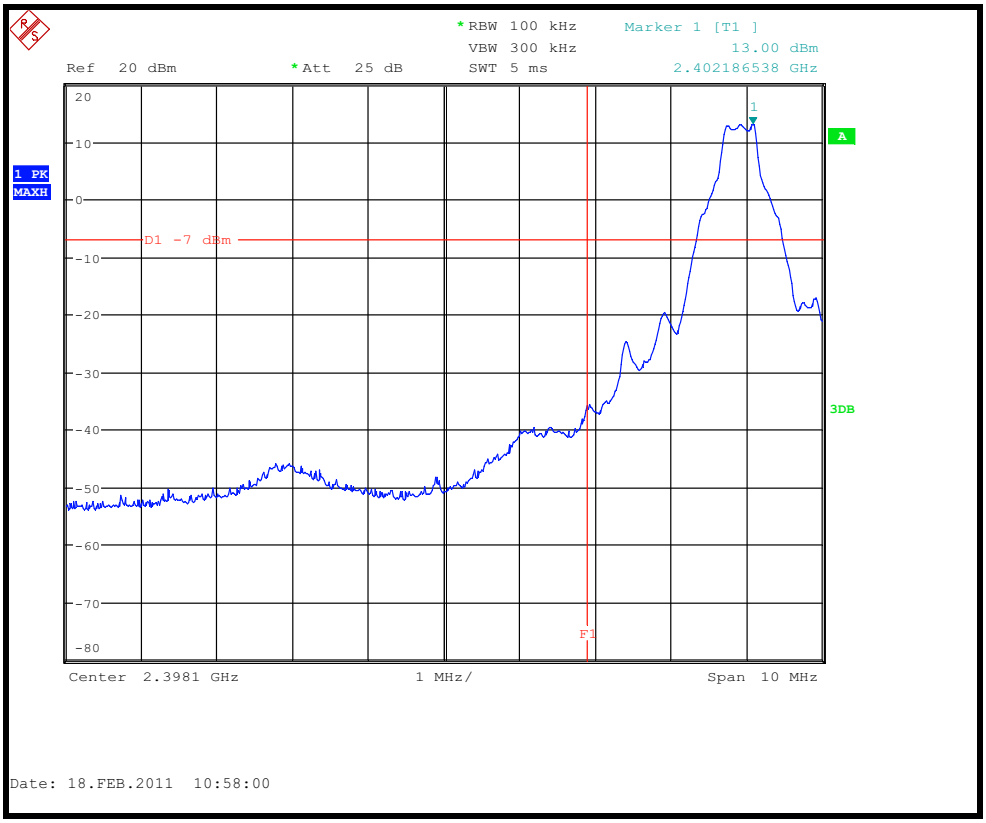


Conducted Spurious emissions 15 GHz to 20 GHz– 2480.0MHz – 1Mbps

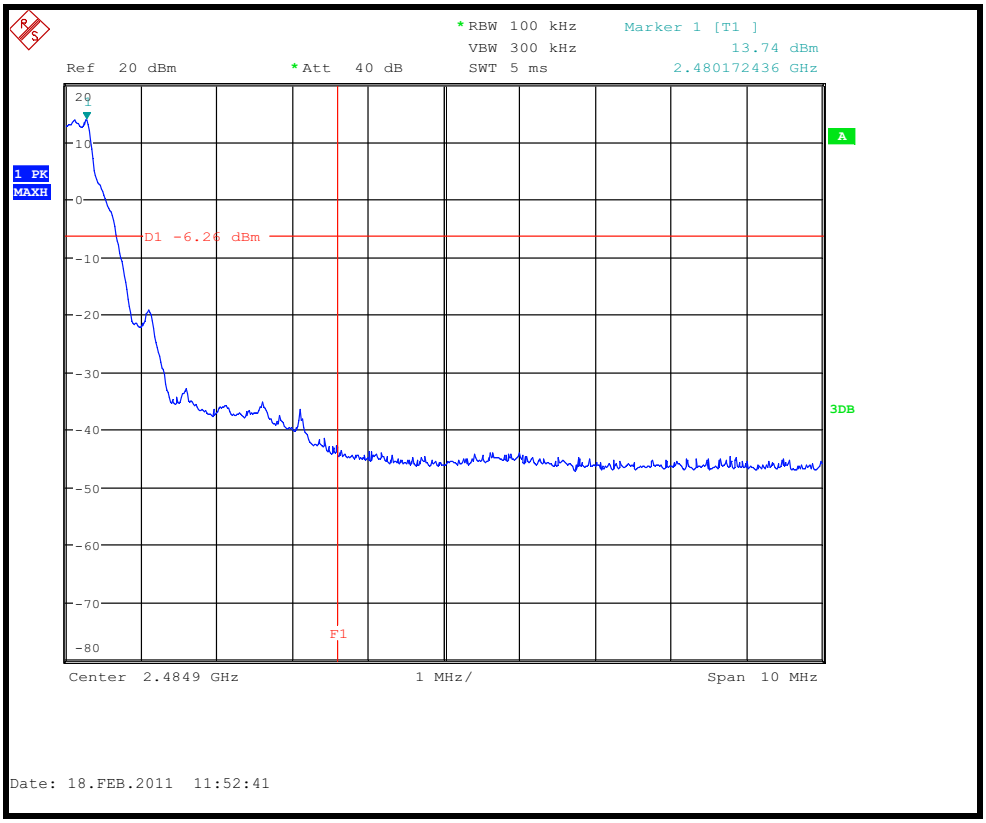


Conducted Spurious emissions 20 GHz to 25 GHz– 2480.0MHz – 1Mbps

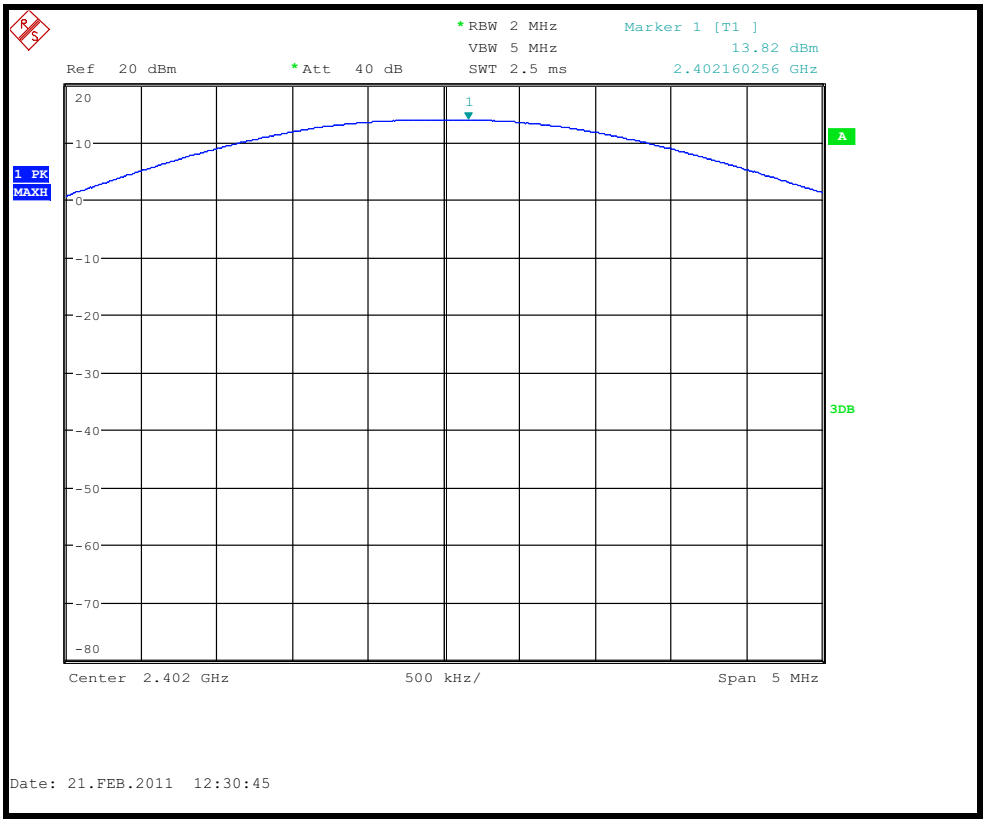
Conducted Bandedge Compliance



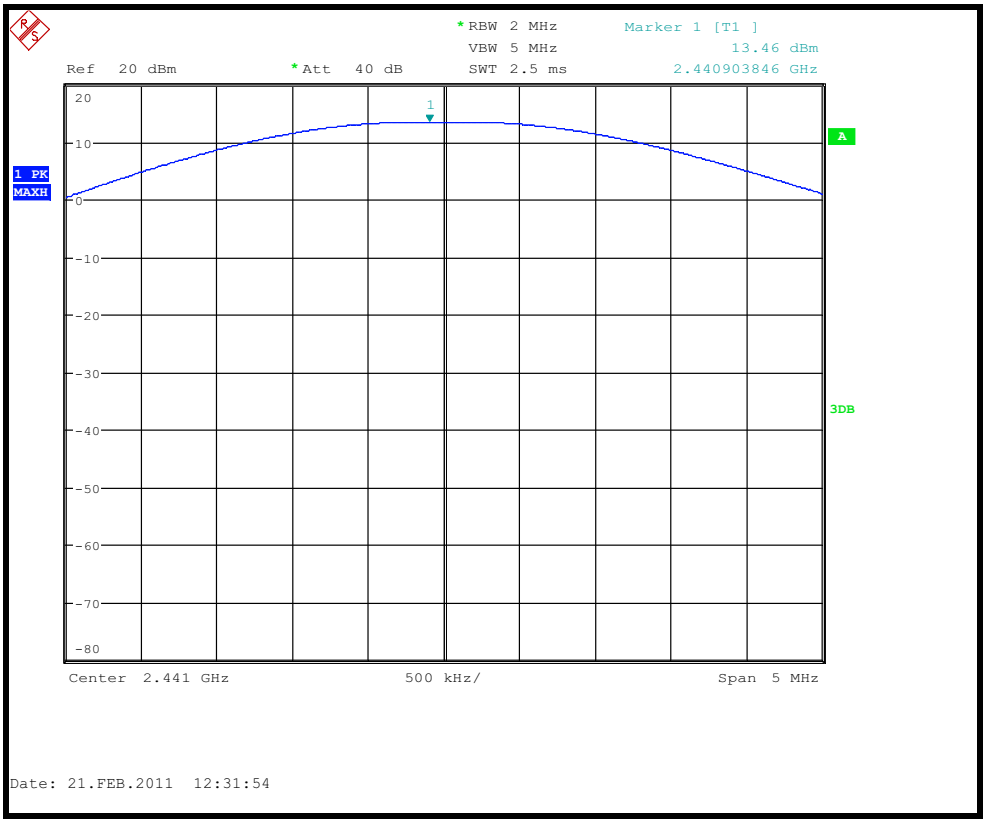
Lower Bandedge – 1Mbps



Upper Bandedge – 1Mbps

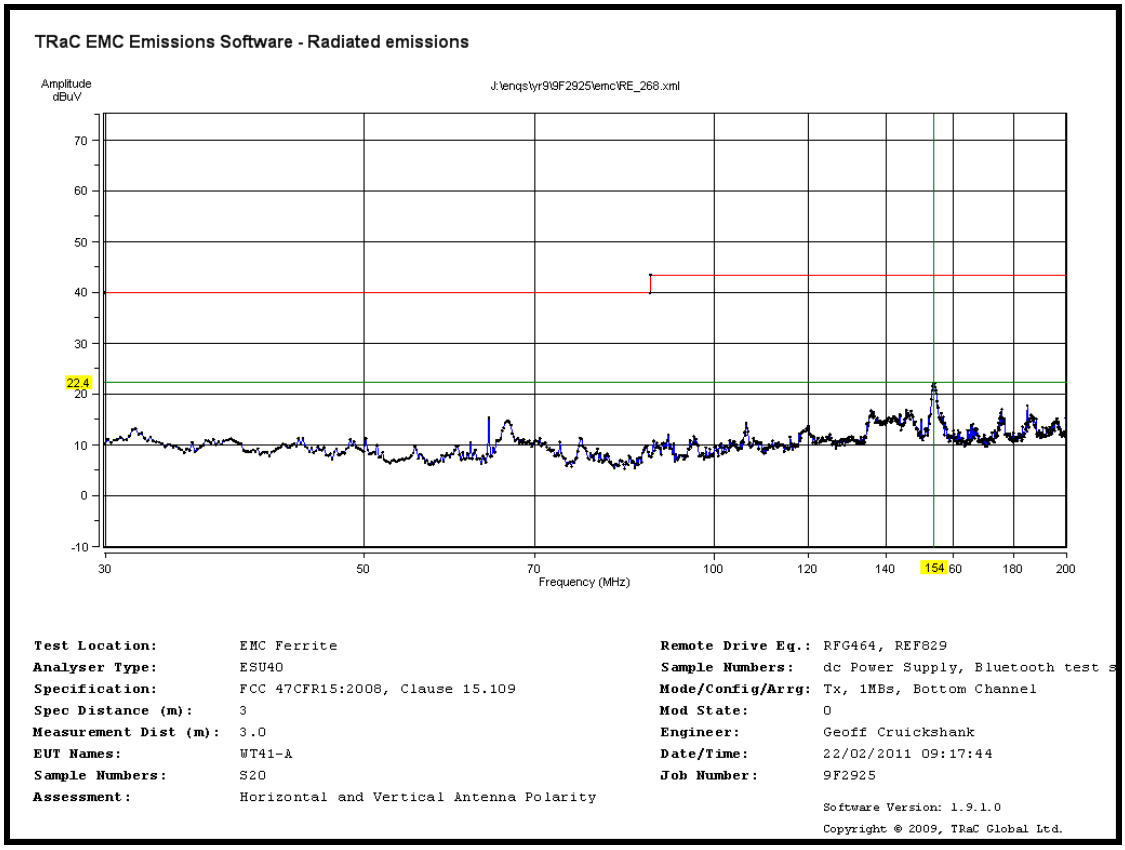


Conducted carrier power 2402.0MHz – 1Mbps

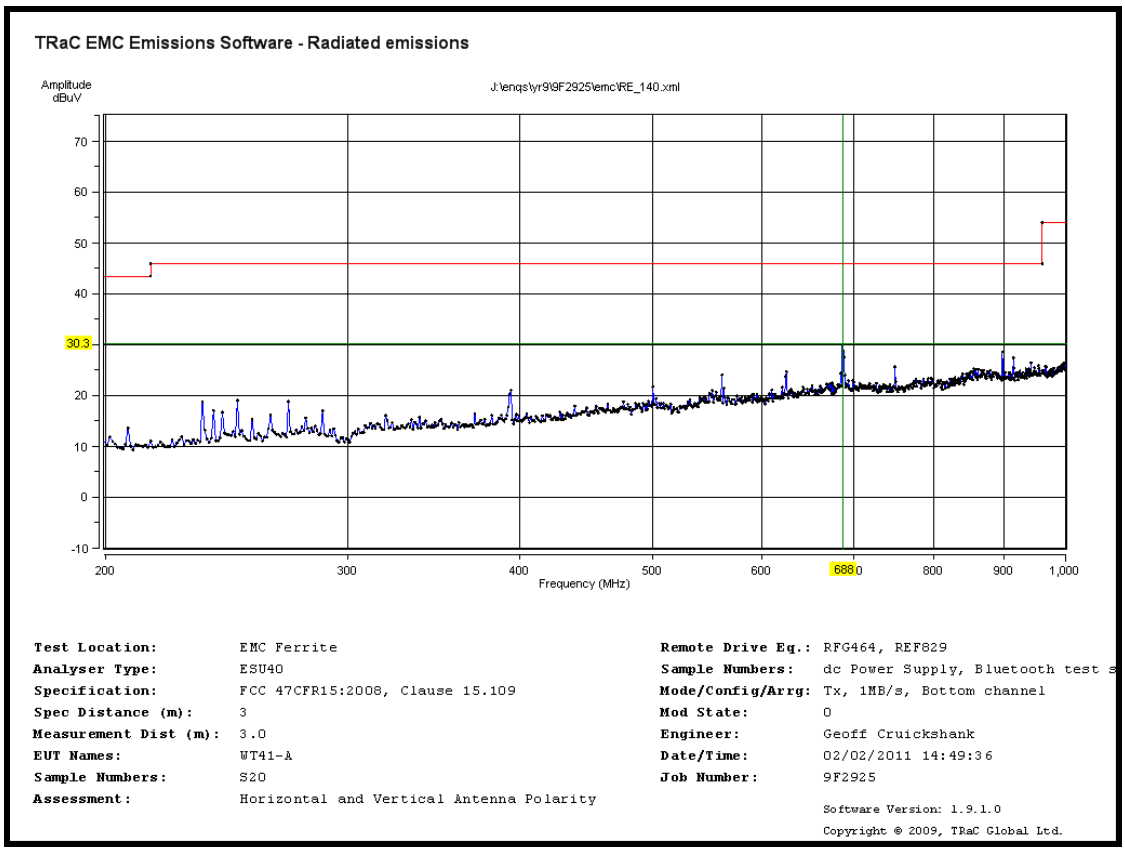


Conducted carrier power 2441.0 MHz – 1Mbps

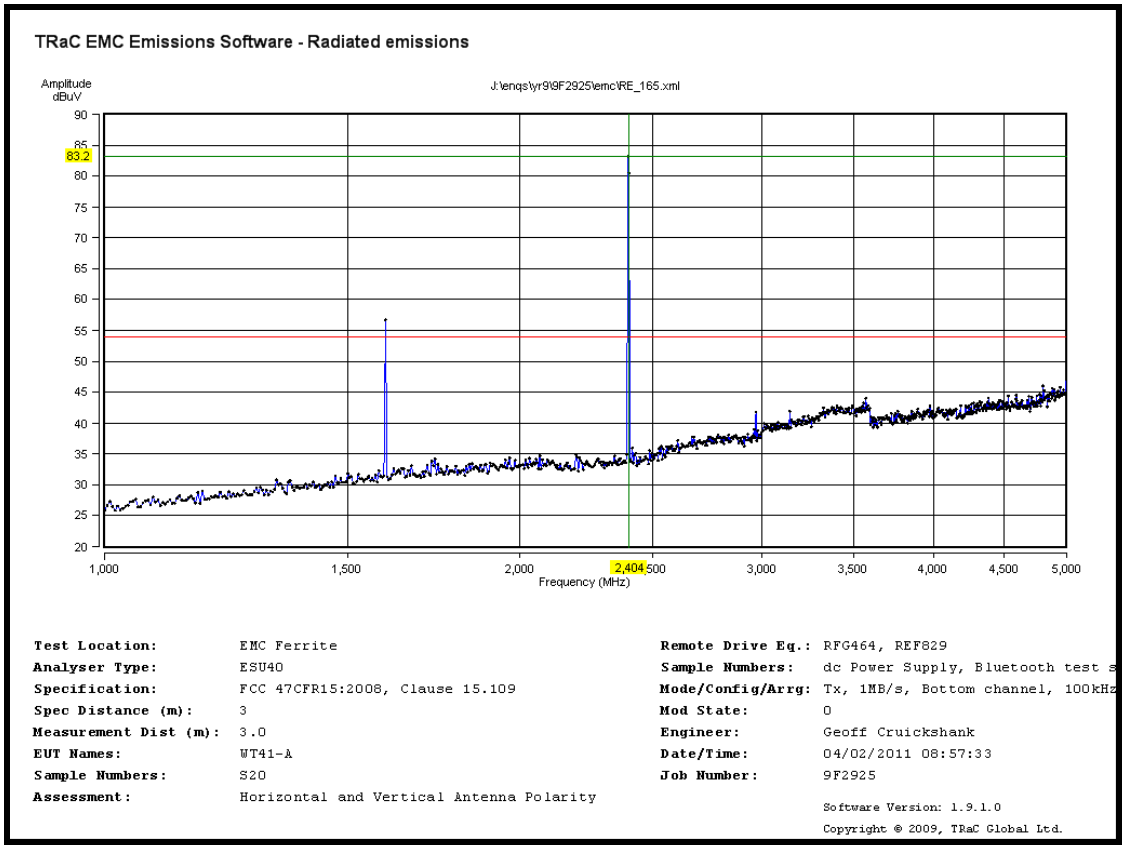
Conducted carrier power 2480.0 MHz – 1Mbps



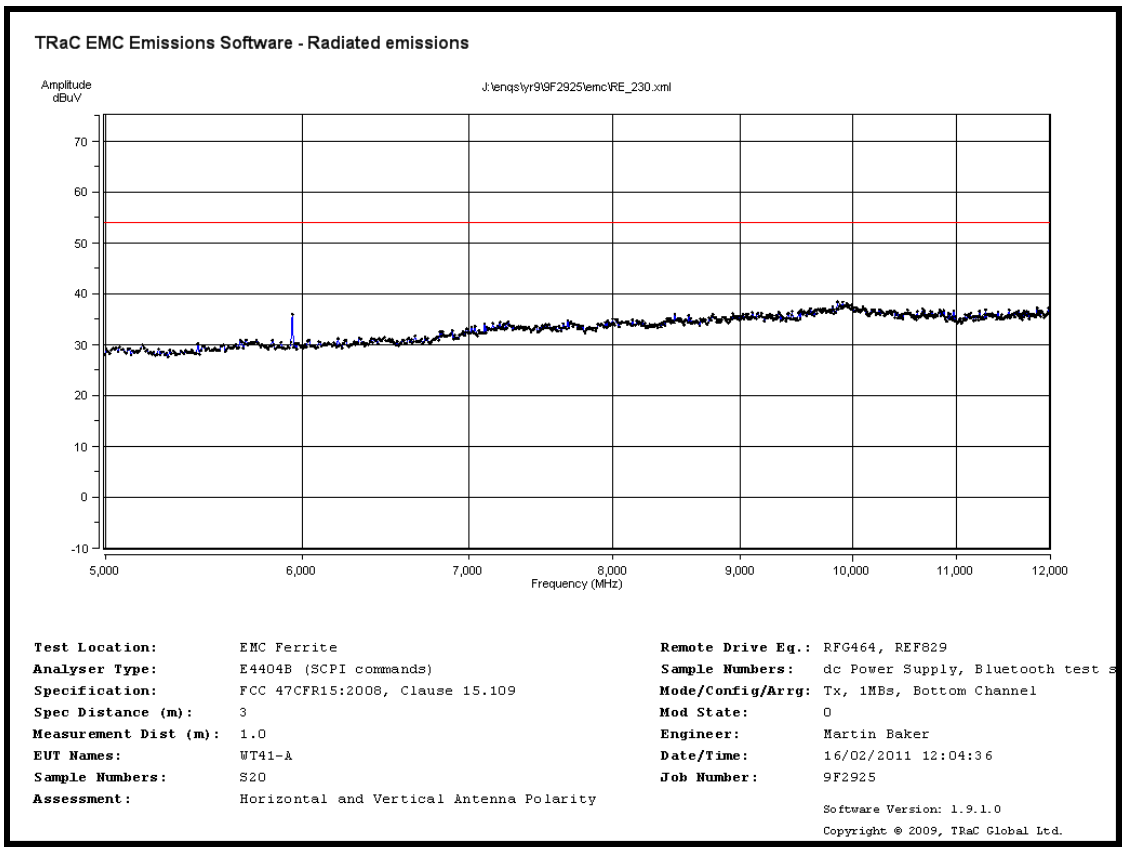
Radiated Spurious emissions 30 MHz to 200 MHz – 2402MHz – 1Mbps for S20



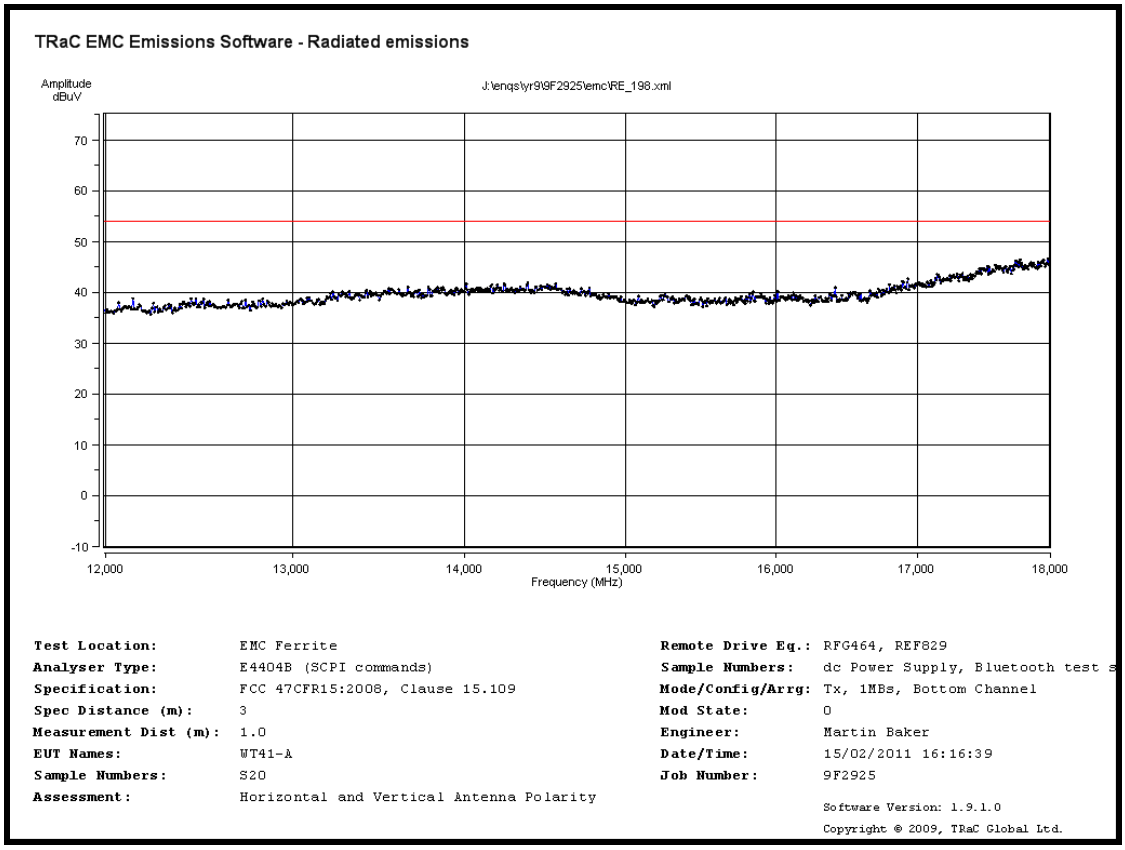
Radiated Spurious emissions 200 MHz to 1 GHz – 2402MHz – 1Mbps for S20



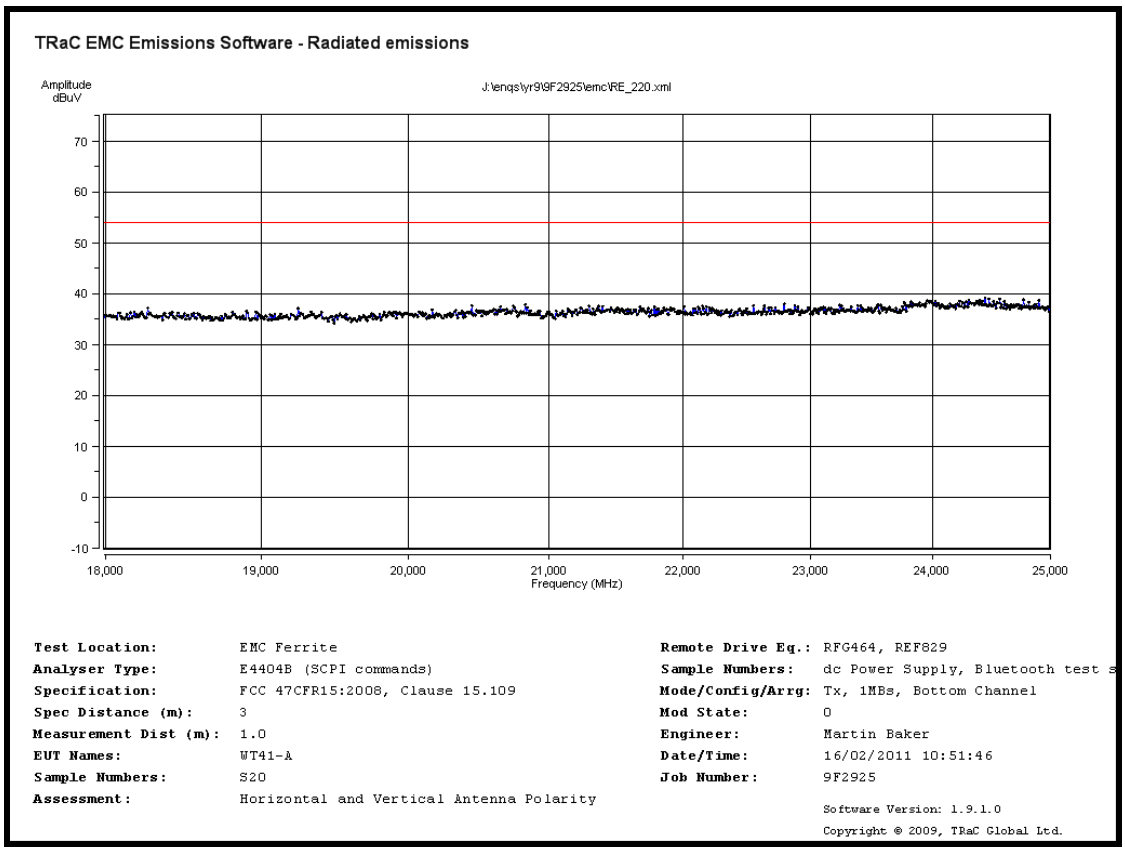
Radiated Spurious emissions 1 GHz to 5 GHz – 2402MHz – 1Mbps for S20



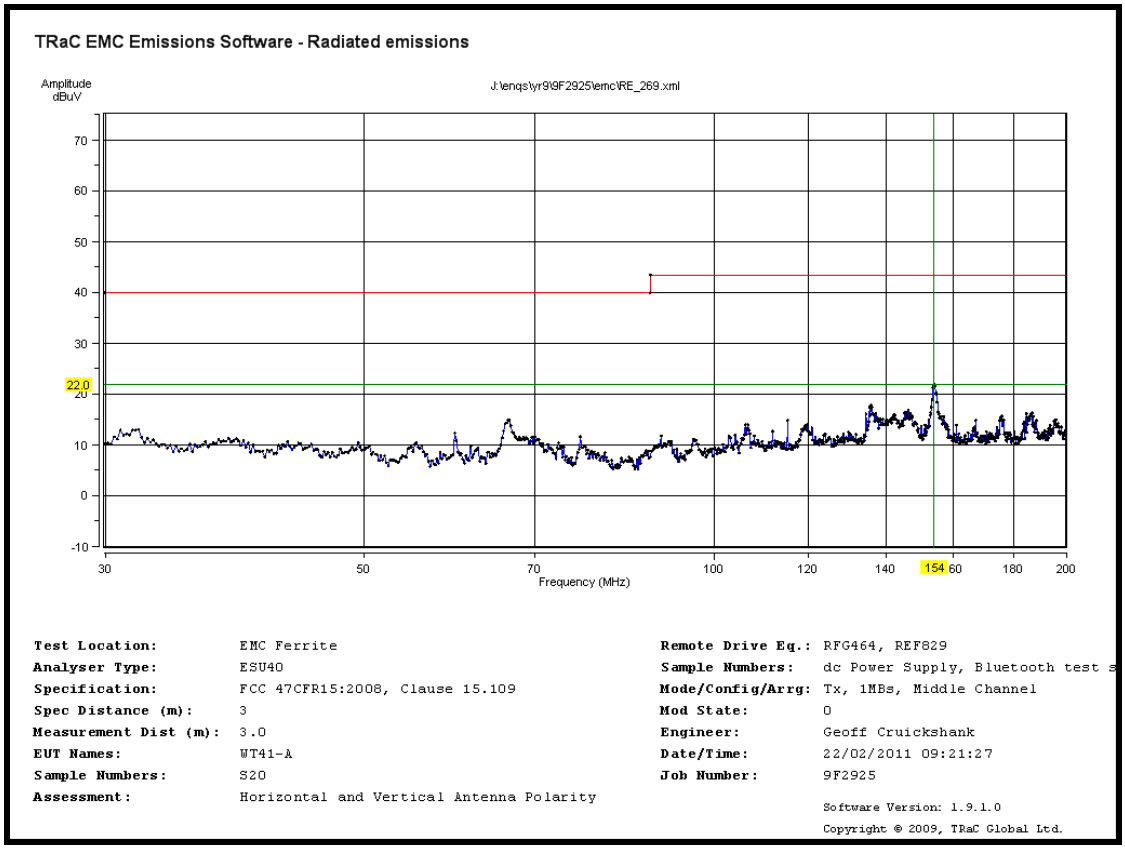
Radiated Spurious emissions 5 GHz to 12 GHz – 2402MHz – 1Mbps for S20



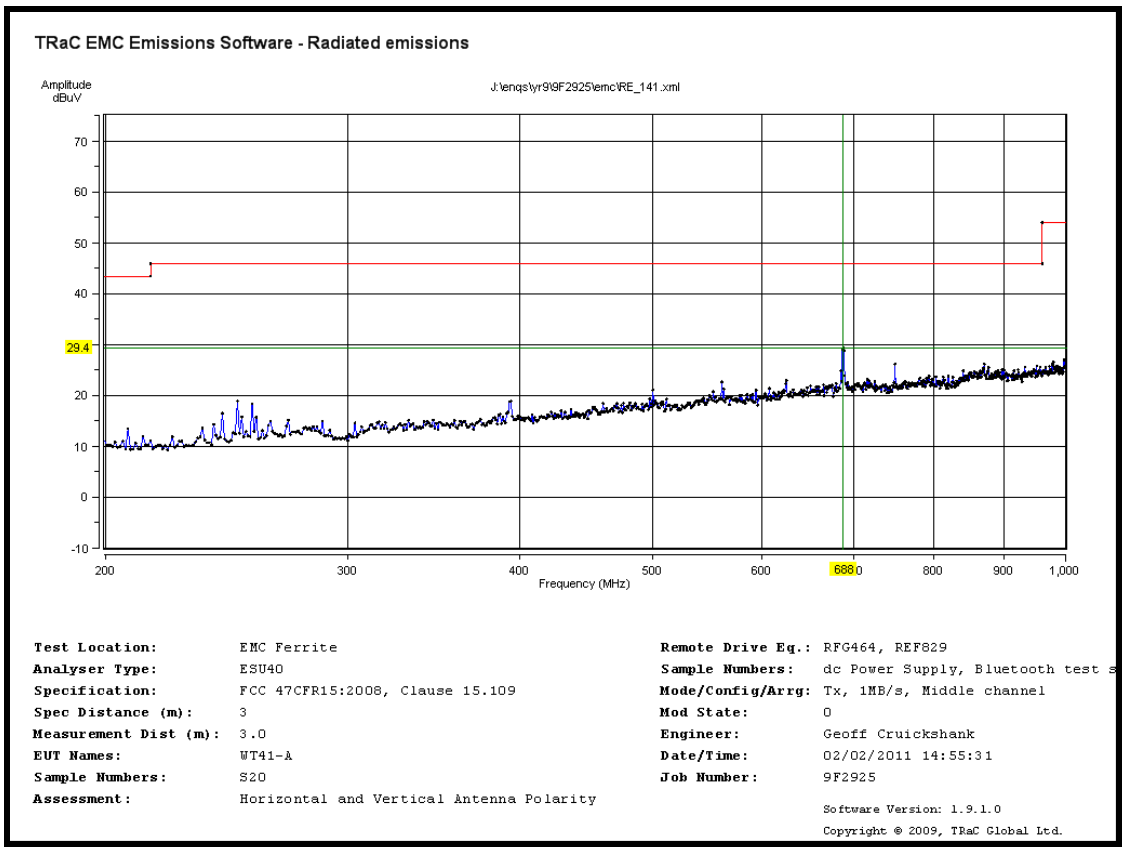
Radiated Spurious emissions 12 GHz to 18GHz – 2402MHz – 1Mbps for S20



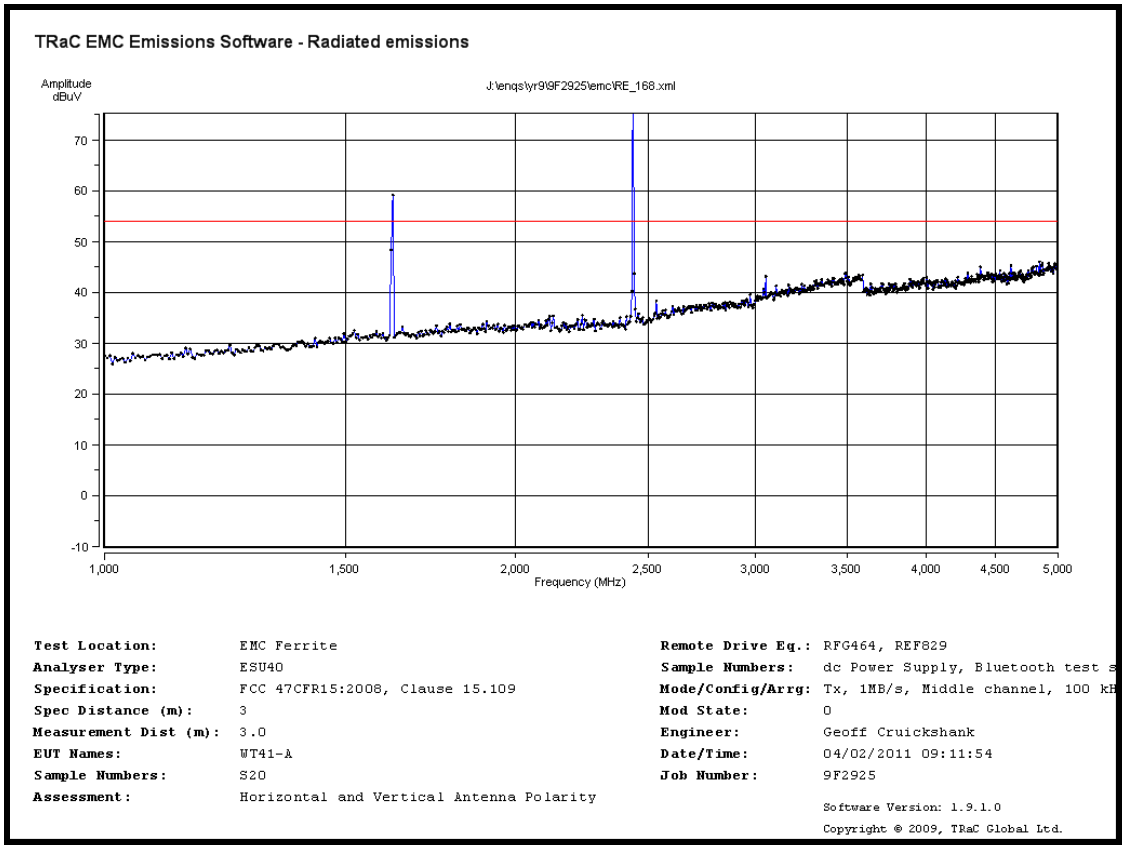
Radiated Spurious emissions 18 GHz to 25 GHz – 2402MHz – 1Mbps for S20



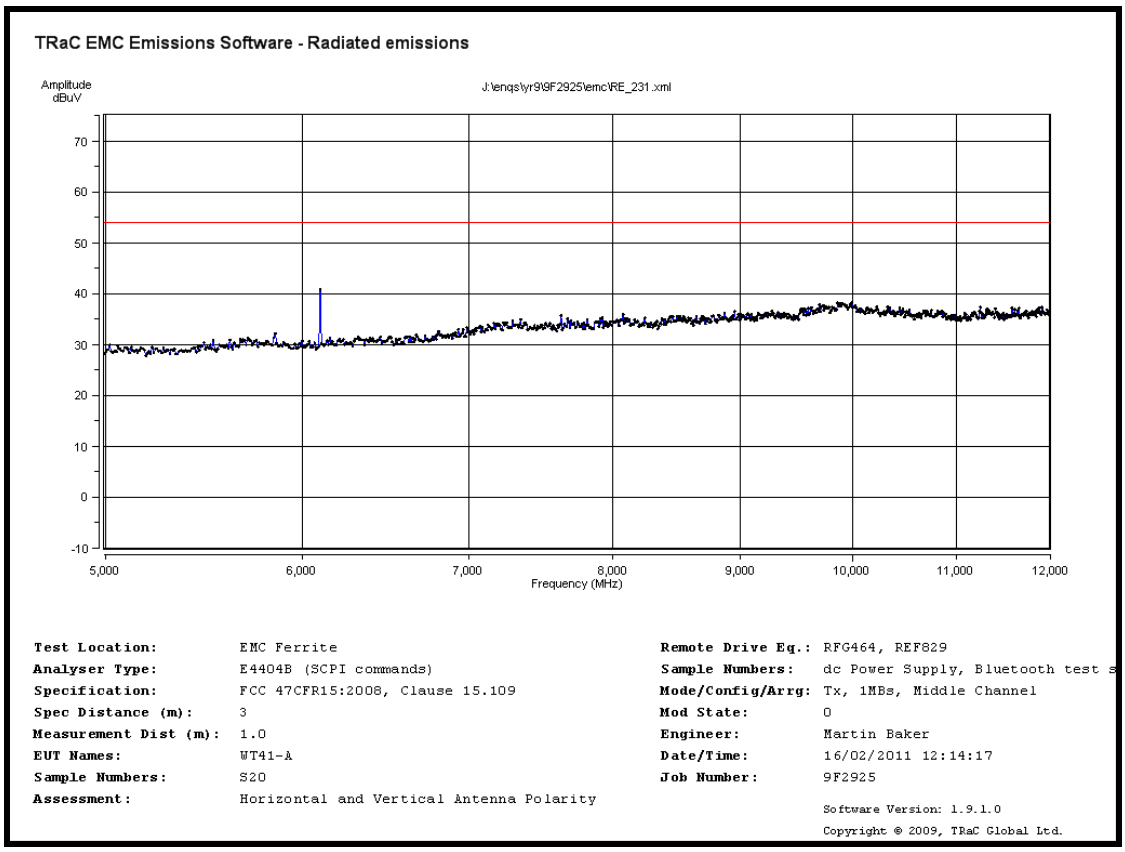
Radiated Spurious emissions 30 MHz to 200 MHz – 2441MHz – 1Mbps for S20



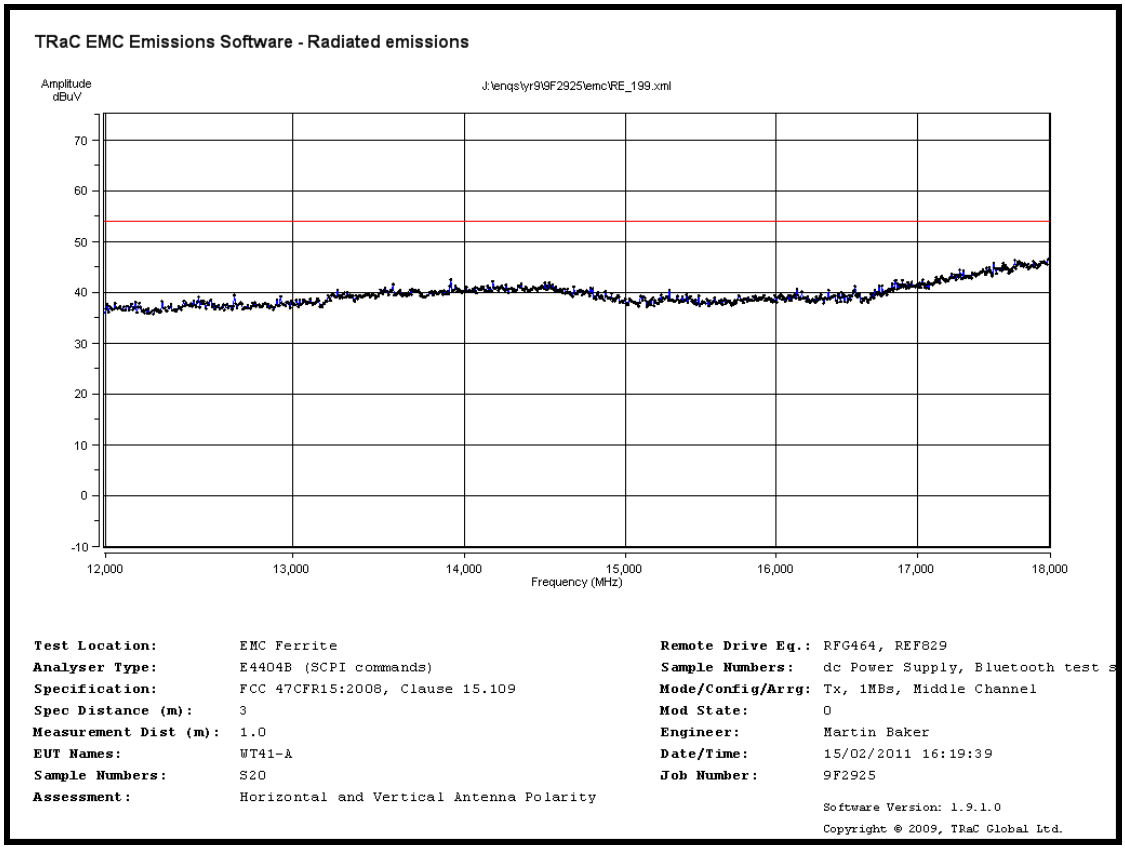
Radiated Spurious emissions 200 MHz to 1 GHz – 2441MHz – 1Mbps for S20



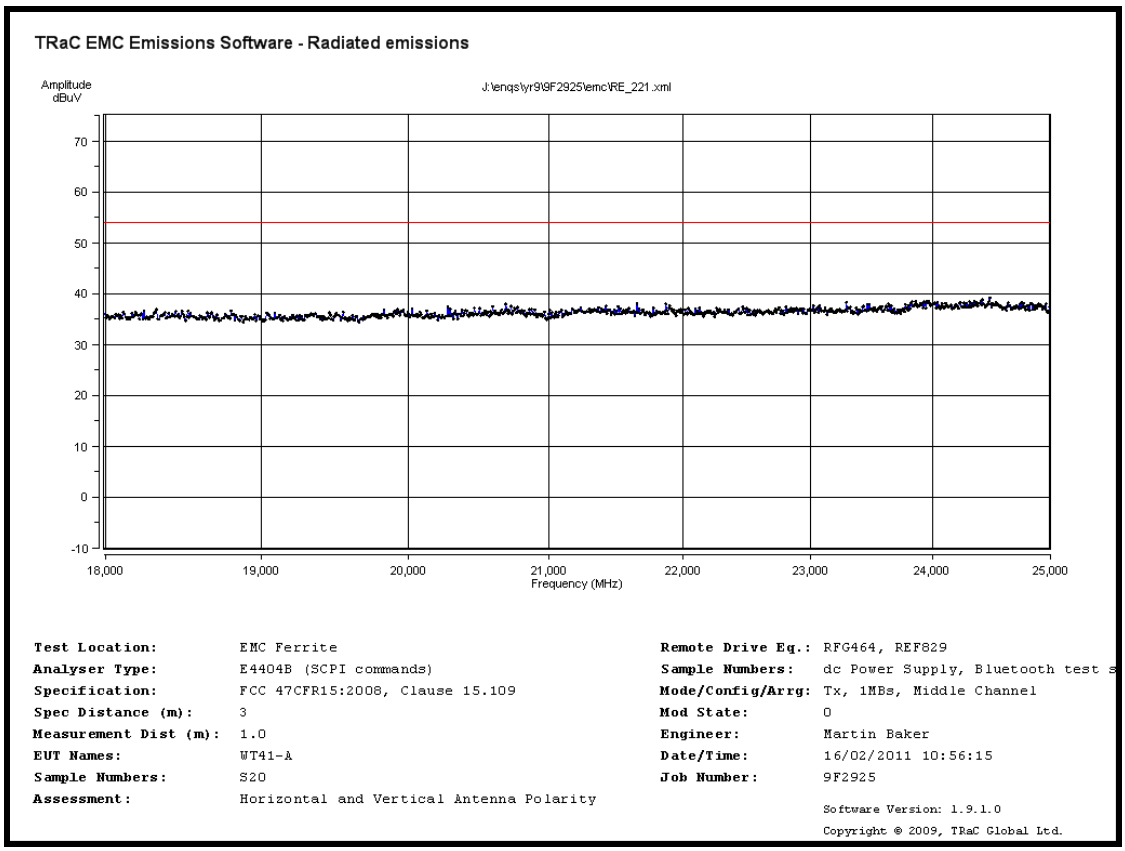
Radiated Spurious emissions 1 GHz to 5 GHz – 2441MHz – 1Mbps for S20



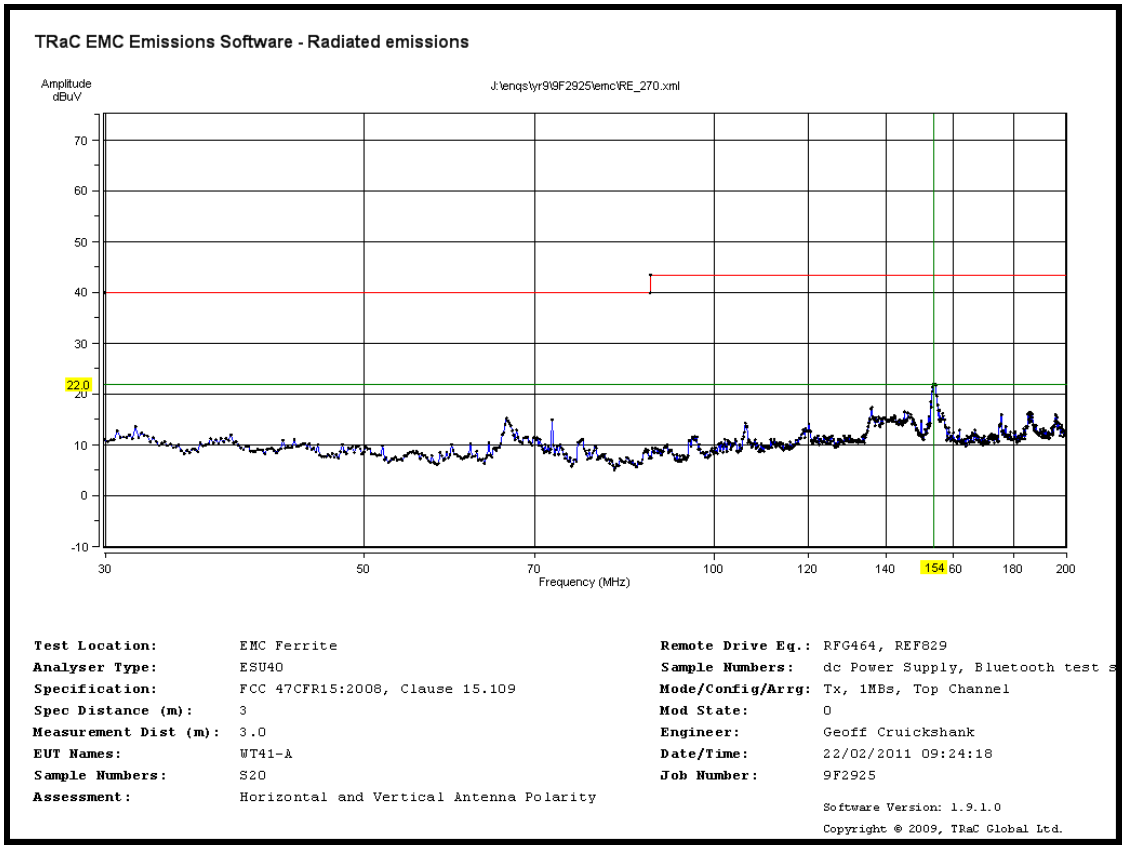
Radiated Spurious emissions 5 GHz to 12 GHz – 2441MHz – 1Mbps for S20



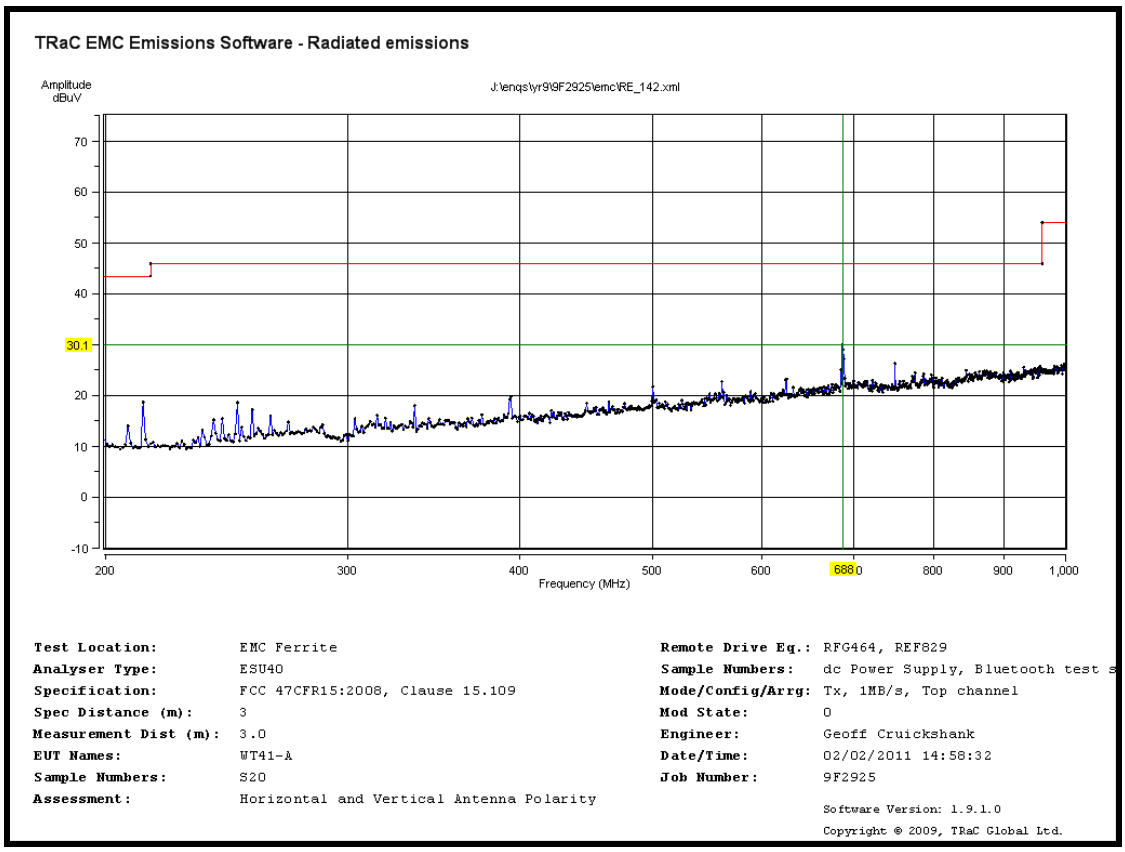
Radiated Spurious emissions 12 GHz to 18GHz – 2441MHz – 1Mbps for S20



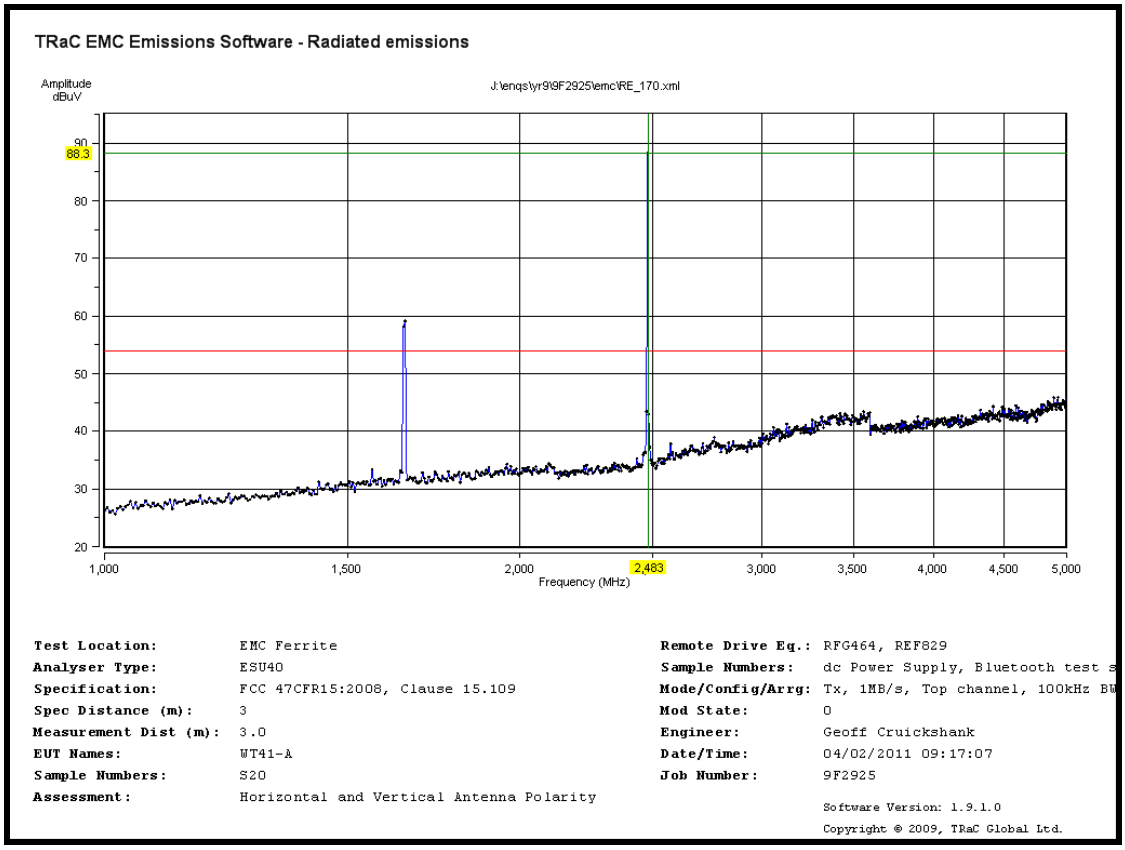
Radiated Spurious emissions 18 GHz to 25 GHz – 2441MHz – 1Mbps for S20



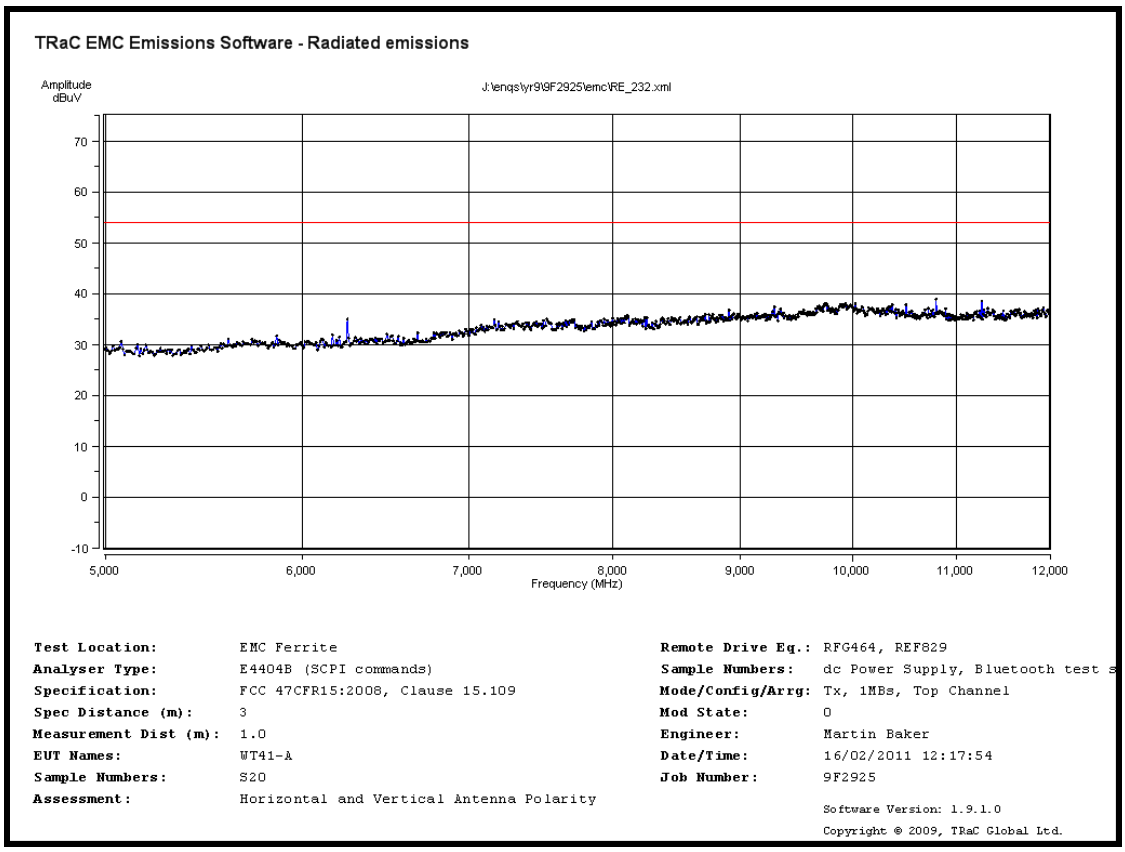
Radiated Spurious emissions 30 MHz to 200 MHz – 2480MHz – 1Mbps for S20



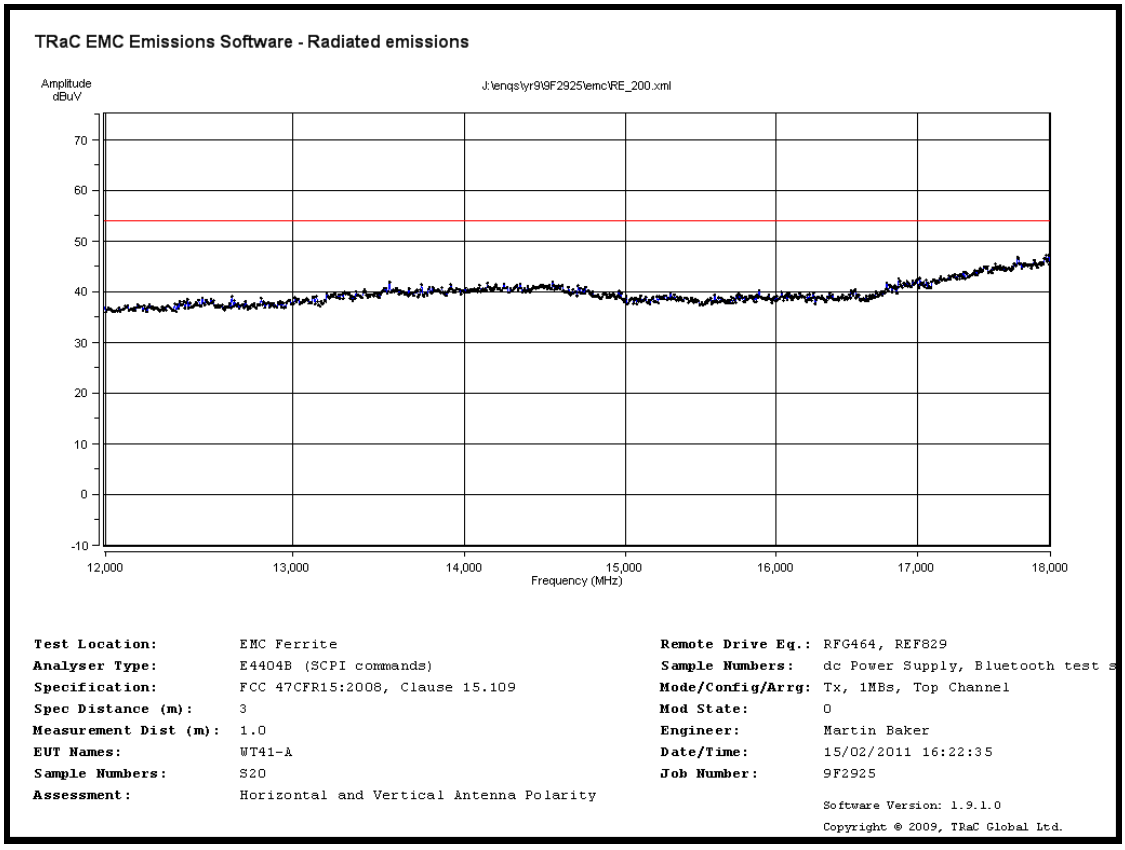
Radiated Spurious emissions 200 MHz to 1 GHz – 2480MHz – 1Mbps for S20



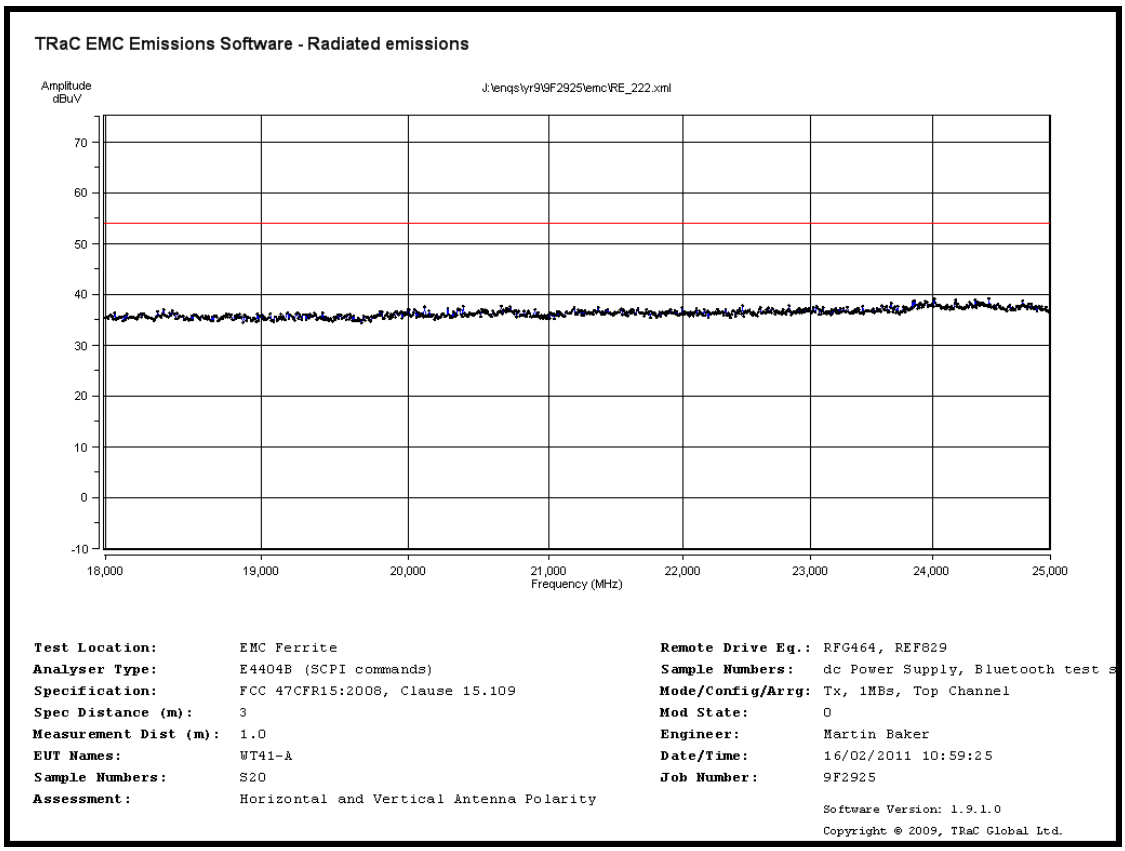
Radiated Spurious emissions 1 GHz to 5 GHz – 2480MHz – 1Mbps for S20



Radiated Spurious emissions 5 GHz to 12 GHz – 2480MHz – 1Mbps for S20

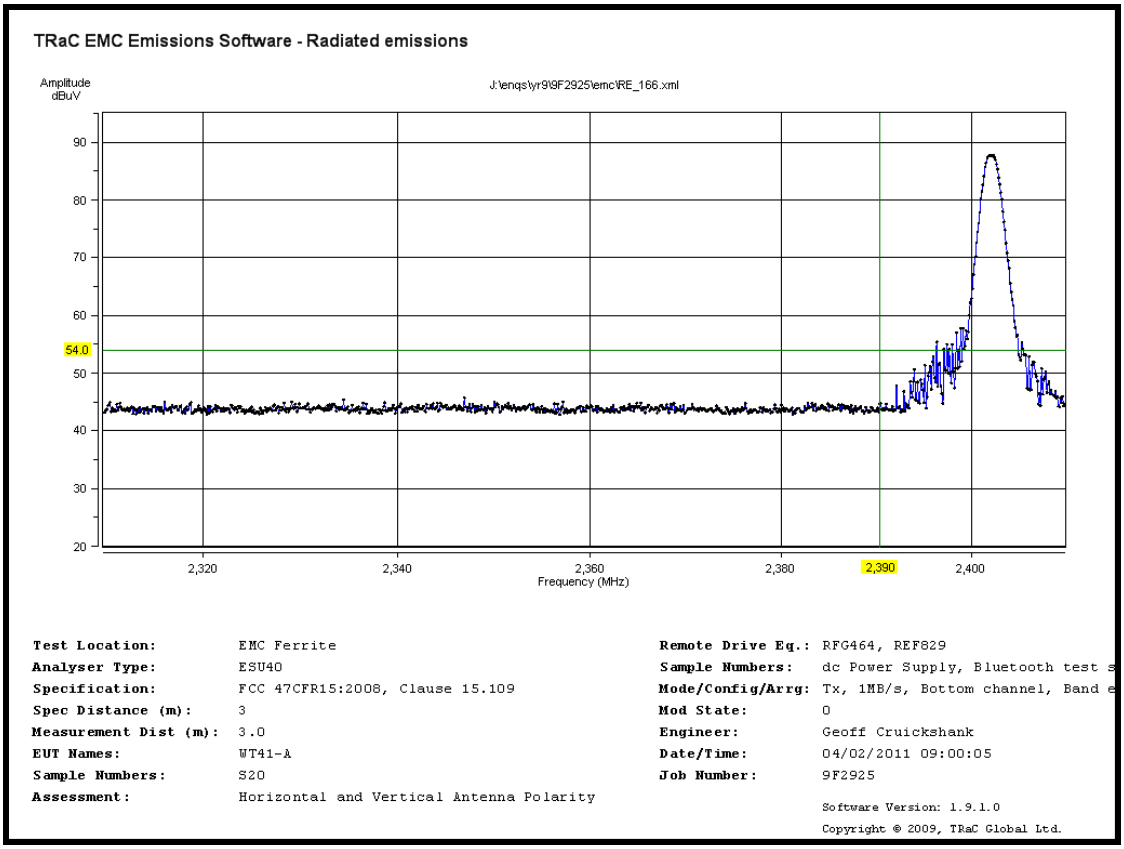


Radiated Spurious emissions 12 GHz to 18GHz – 2480MHz – 1Mbps for S20

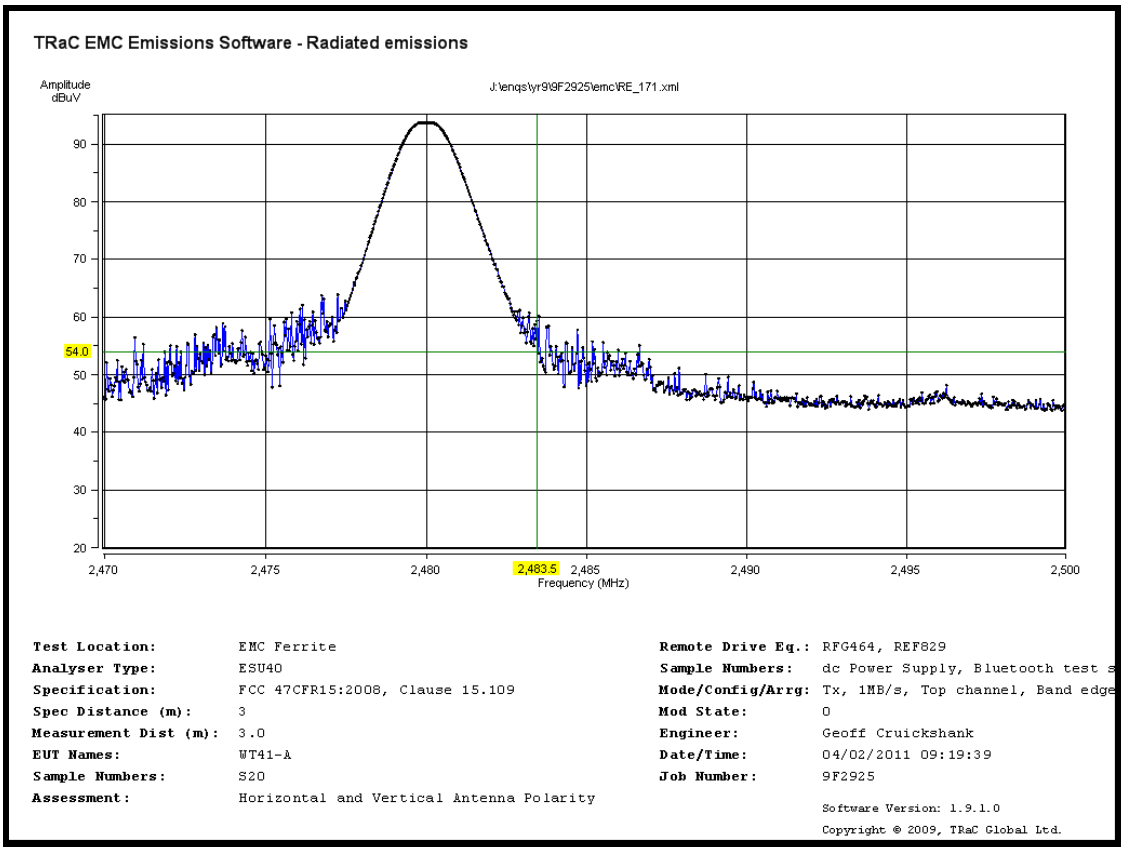


Radiated Spurious emissions 18 GHz to 25 GHz – 2480MHz – 1Mbps for S20

Radiated Bandedge Compliance – Peak plot to average limit

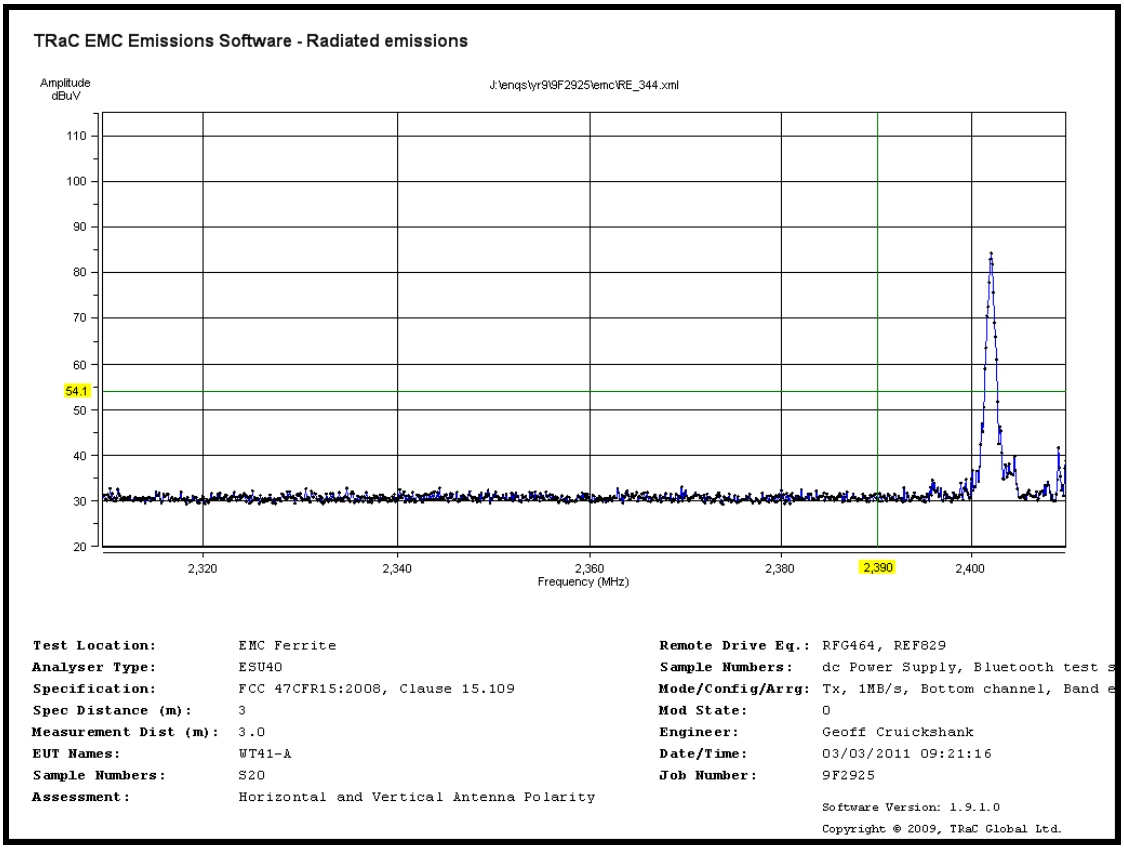


Lower Bandedge

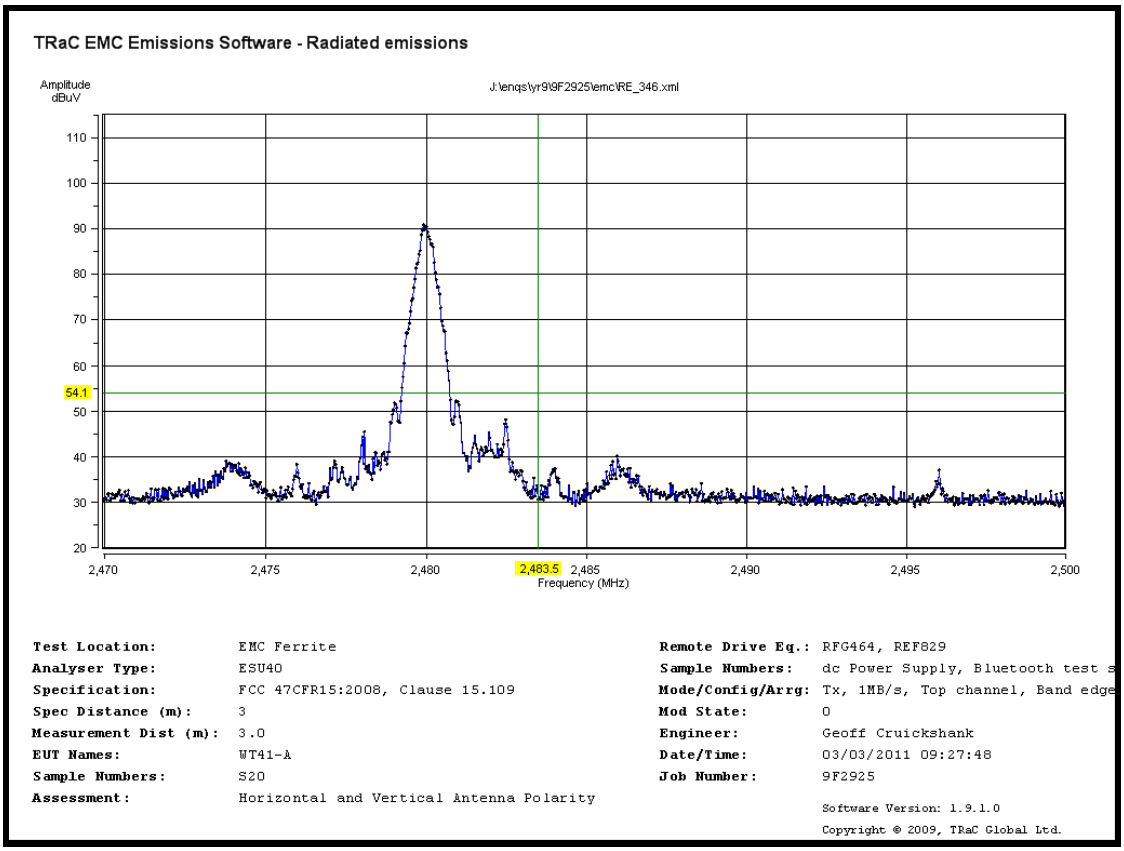


Upper Bandedge

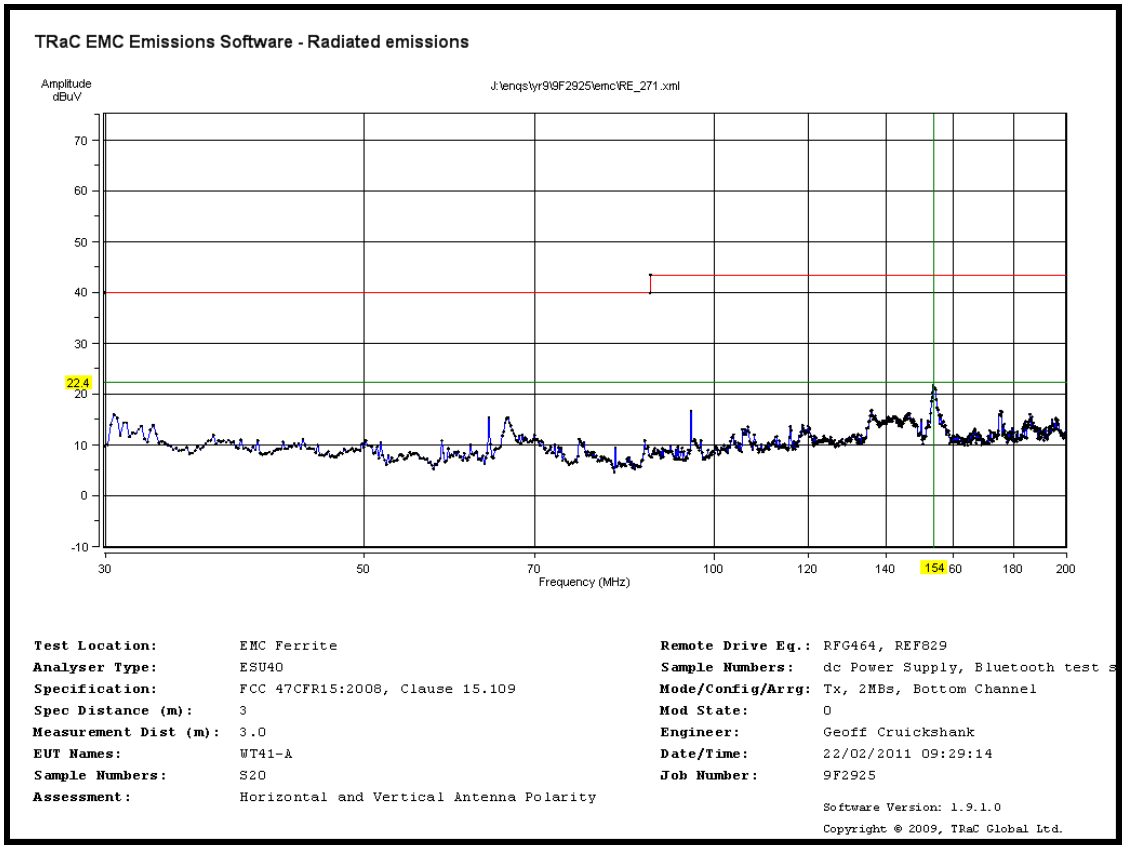
Radiated Bandedge Compliance – Average plot to average limit



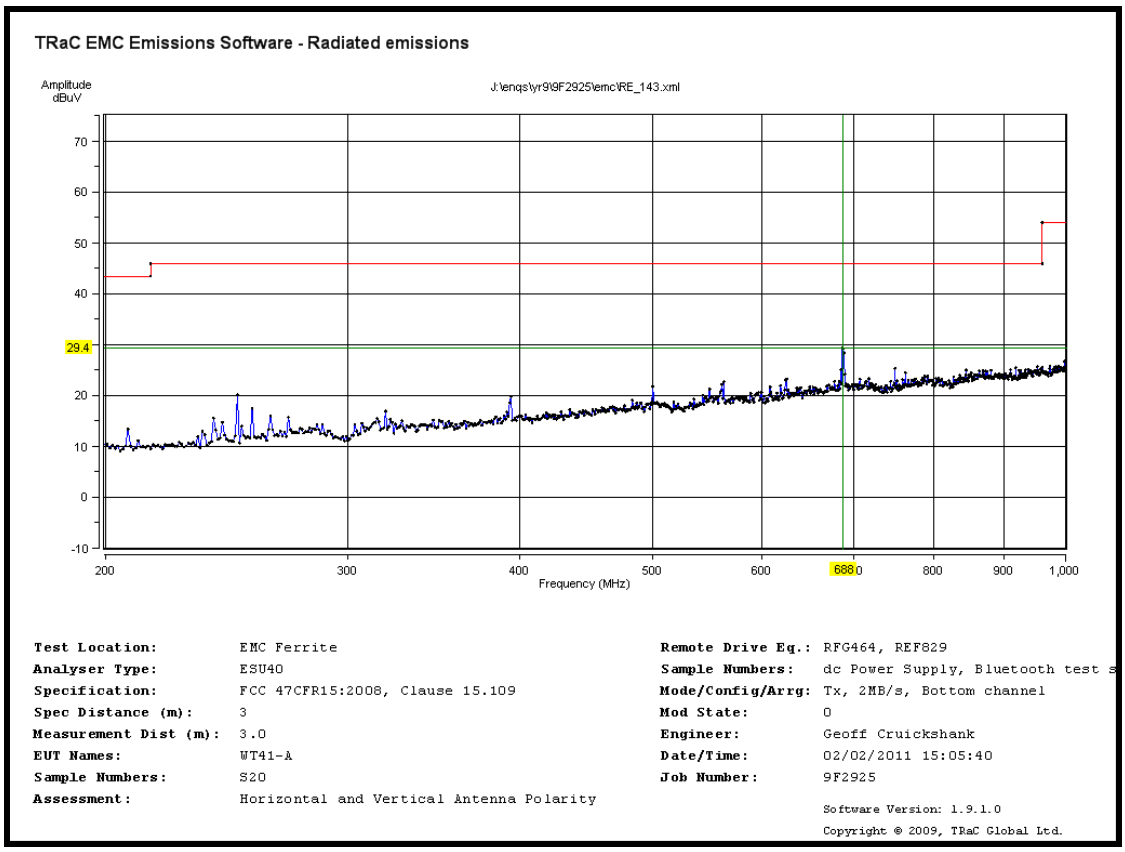
Lower Bandedge



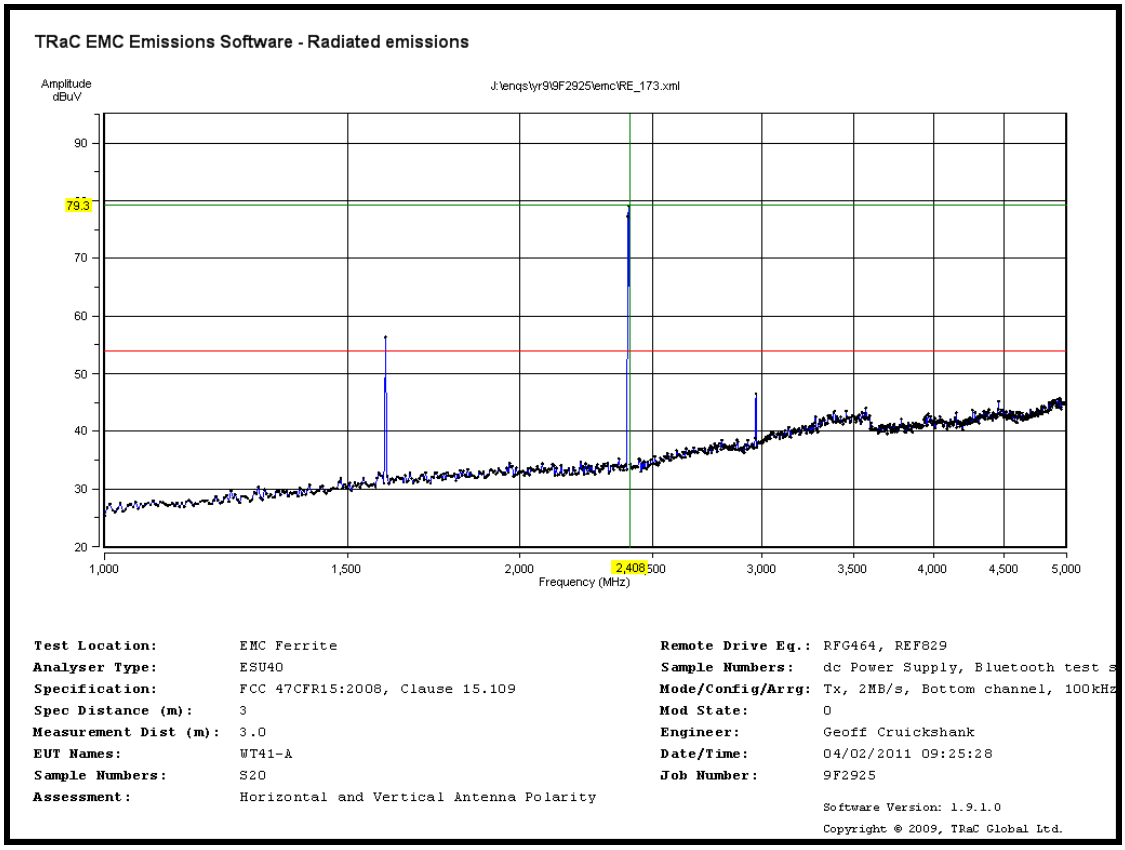
Upper Bandedge



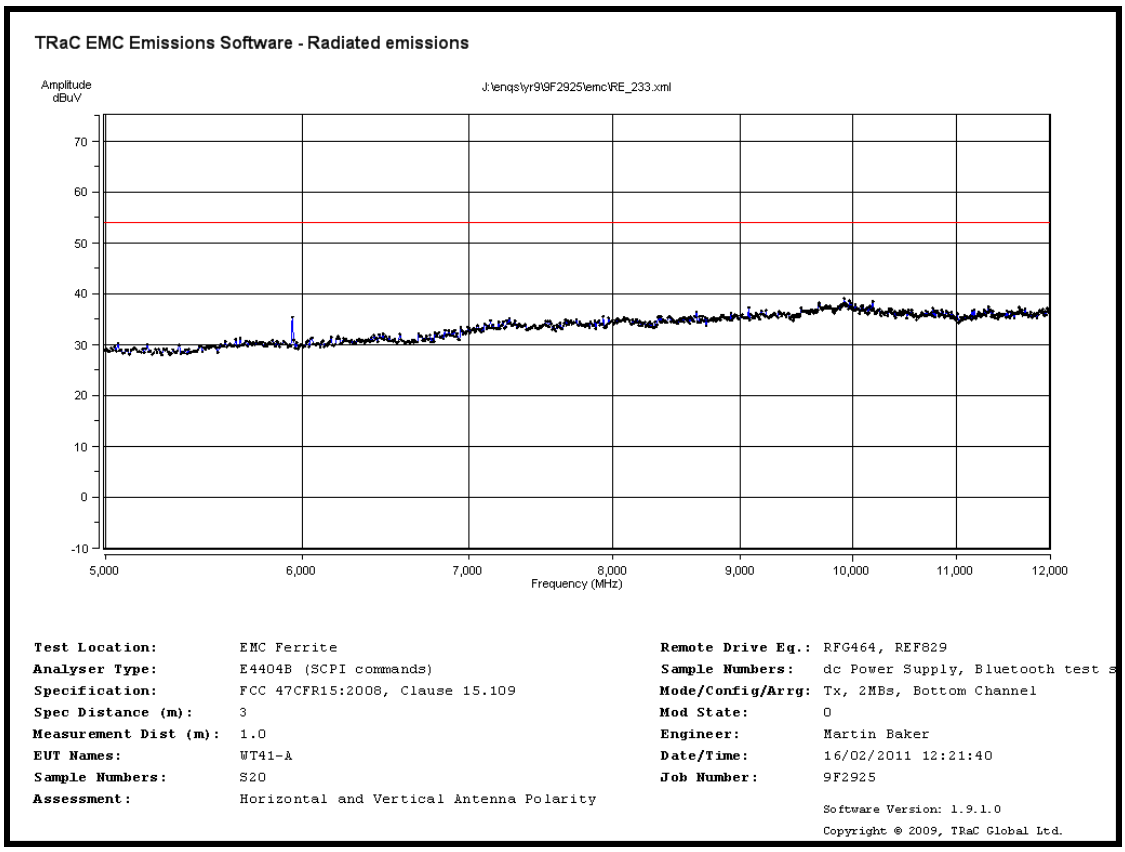
Radiated Spurious emissions 30 MHz to 200 MHz – 2402MHz – 2Mbps for S20



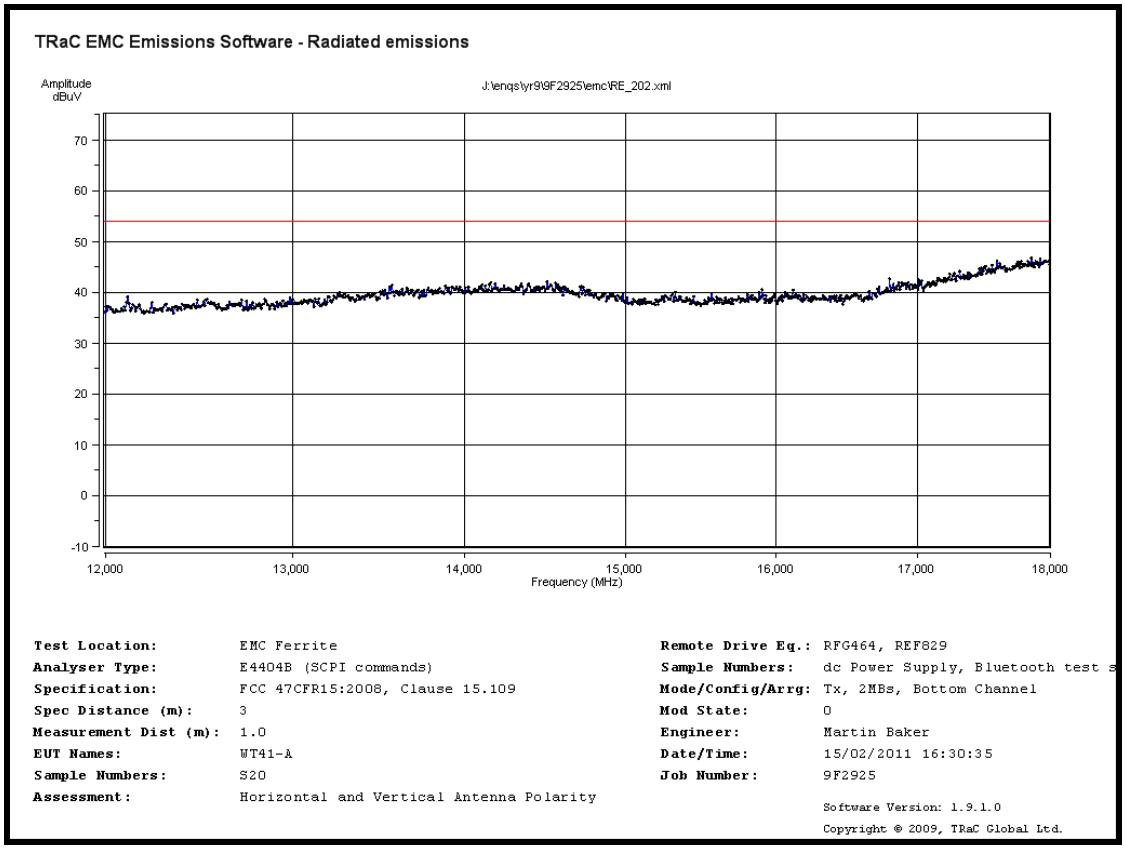
Radiated Spurious emissions 200 MHz to 1 GHz – 2402MHz – 2Mbps for S20



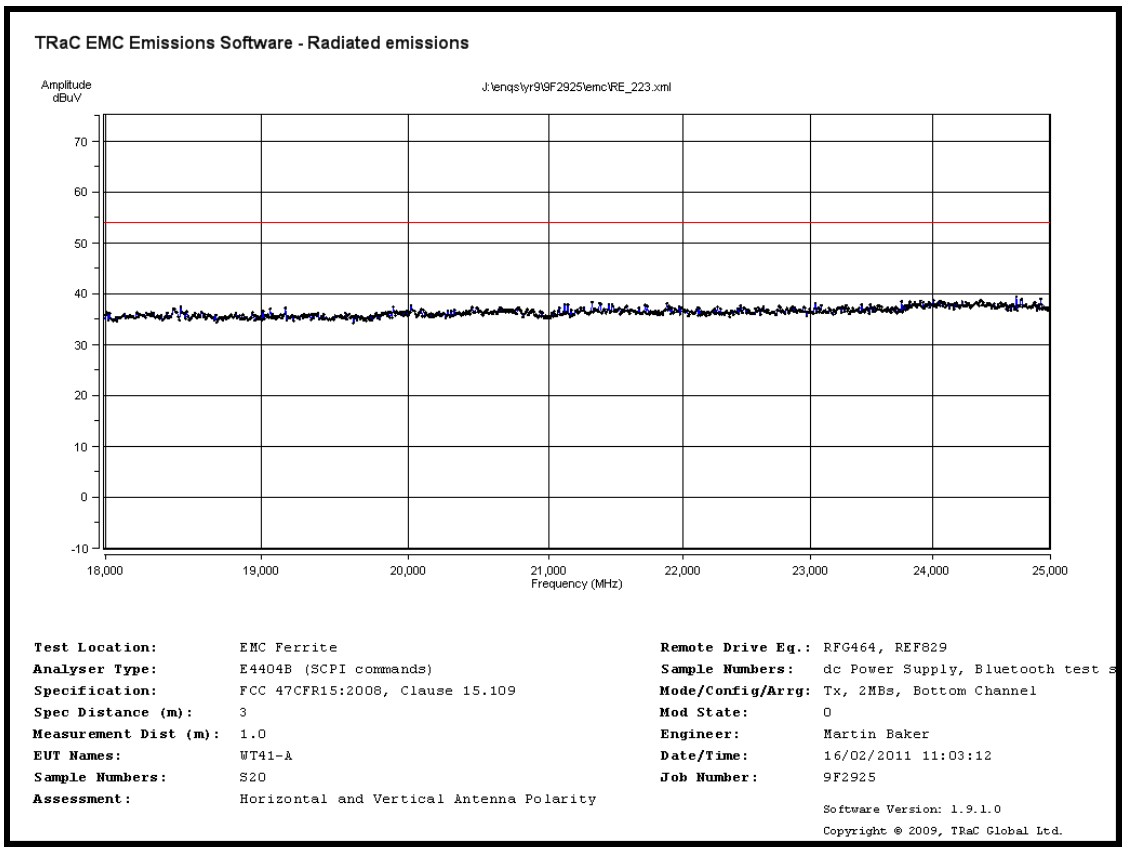
Radiated Spurious emissions 1 GHz to 5 GHz – 2402MHz – 2Mbps for S20



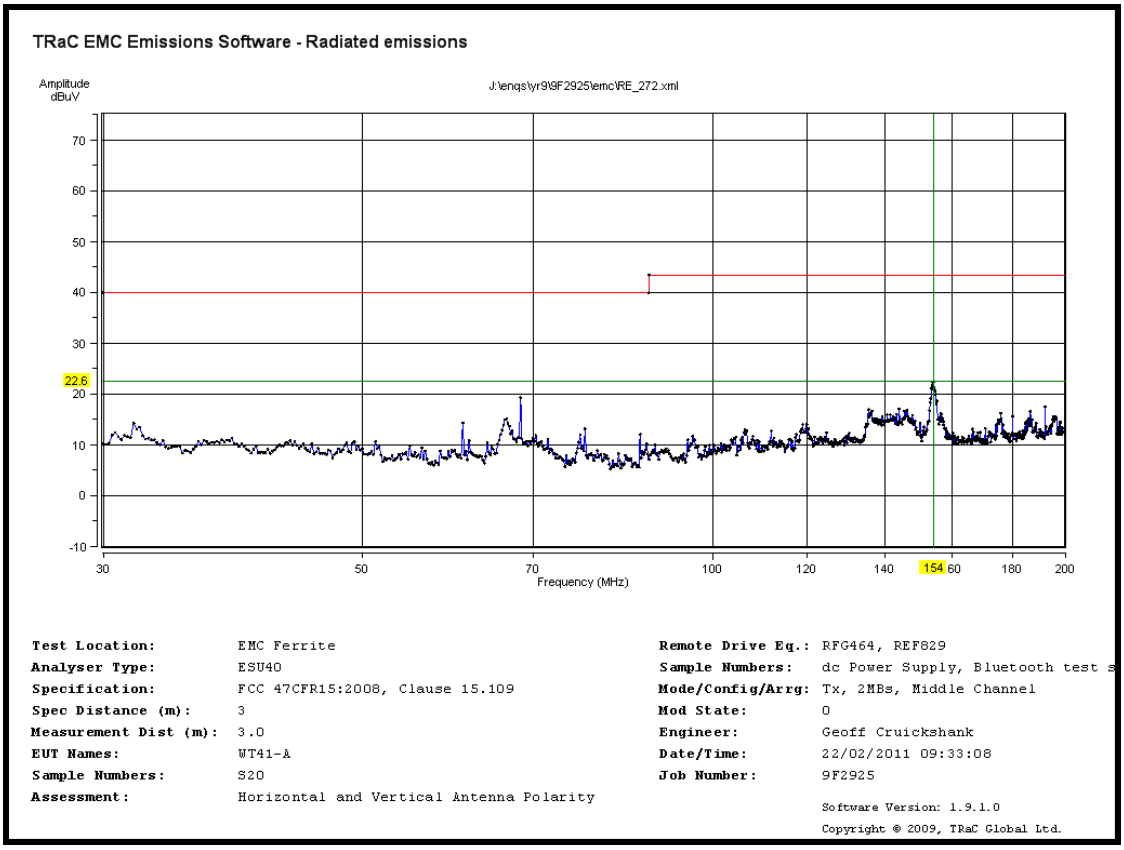
Radiated Spurious emissions 5 GHz to 12 GHz – 2402MHz – 2Mbps for S20



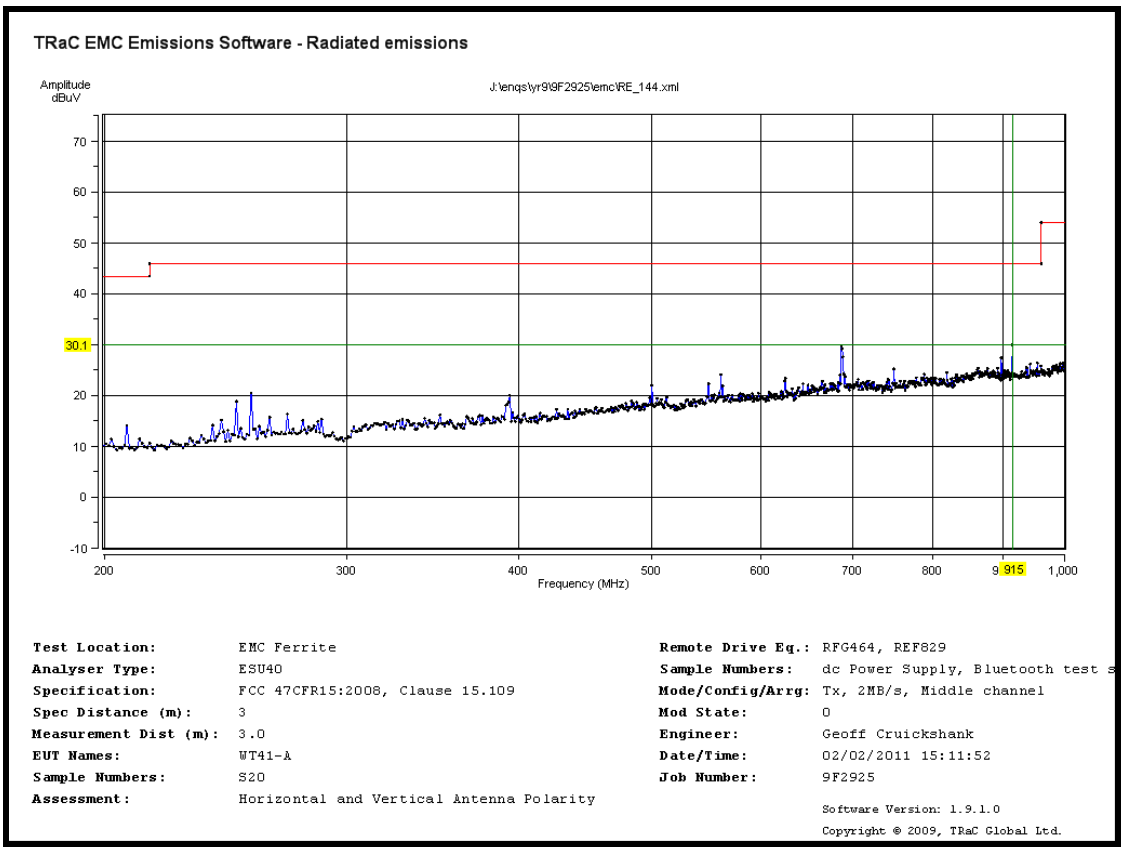
Radiated Spurious emissions 12 GHz to 18GHz – 2402MHz – 2Mbps for S20



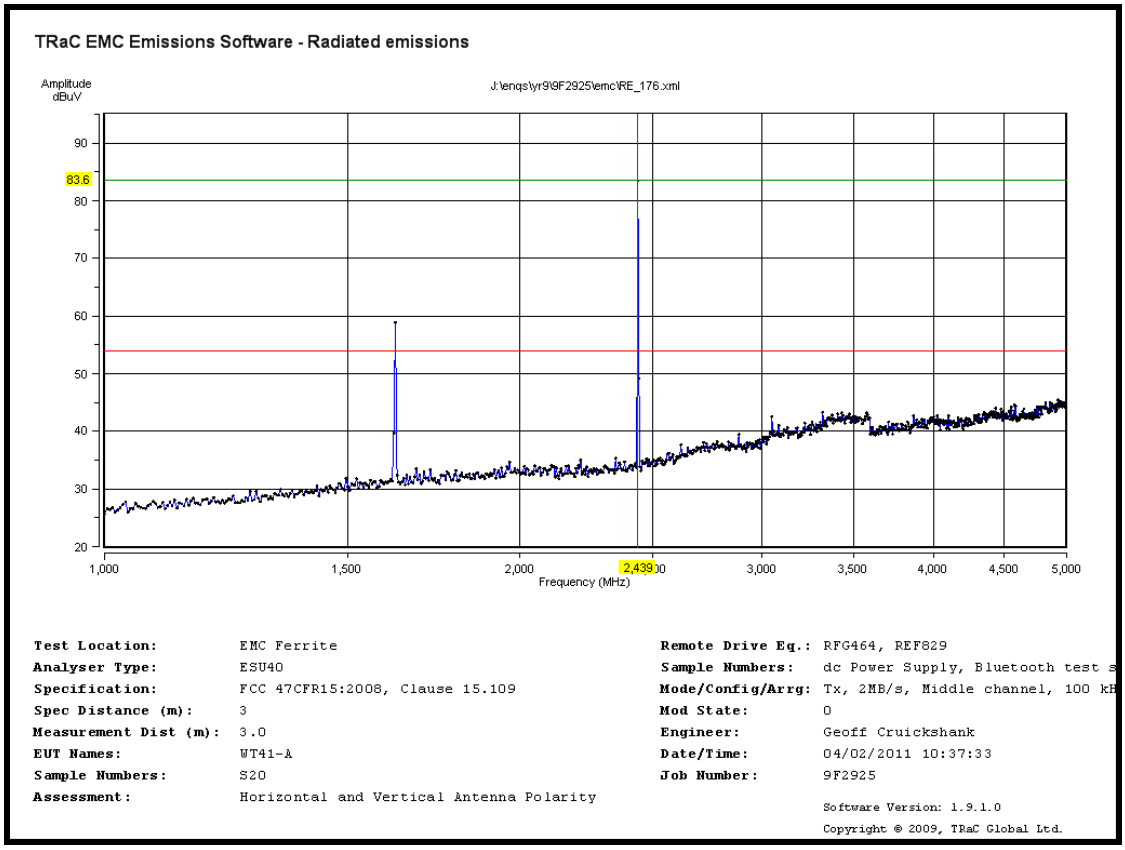
Radiated Spurious emissions 18 GHz to 25 GHz – 2402MHz – 2Mbps for S20



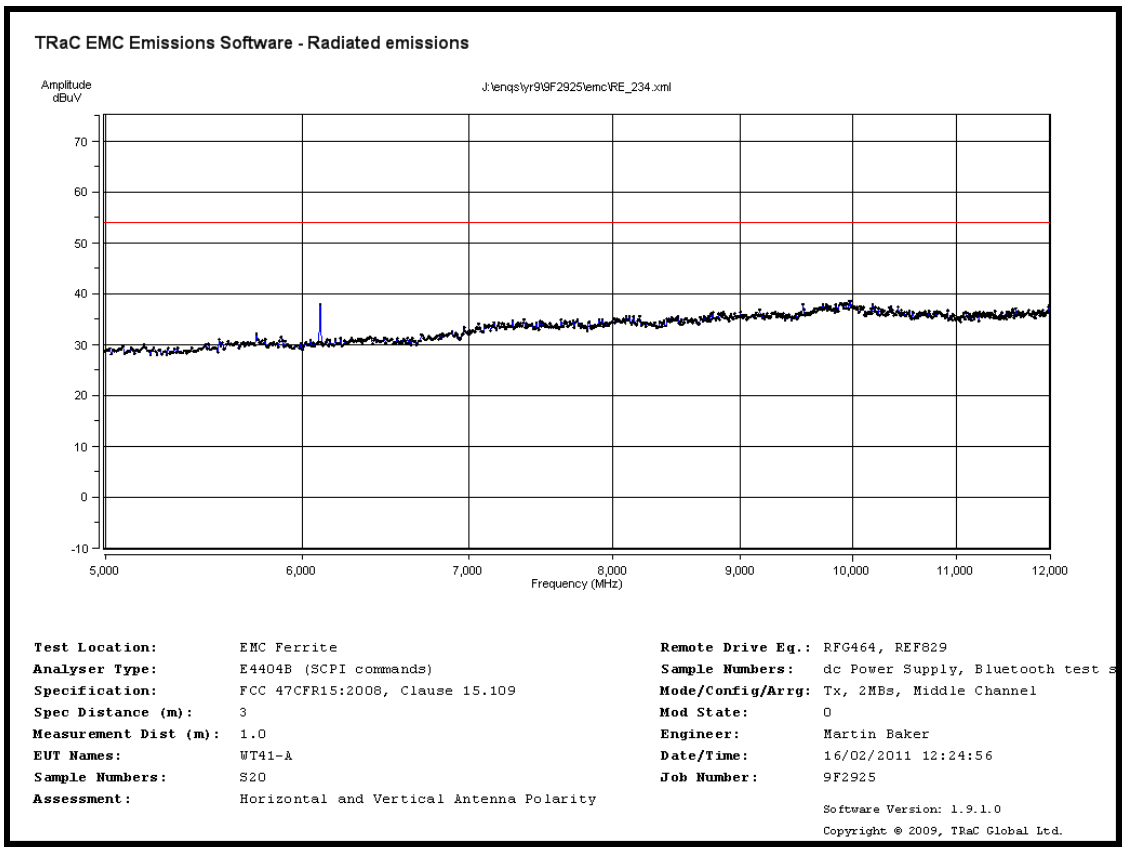
Radiated Spurious emissions 30 MHz to 200 MHz – 2441MHz – 2Mbps for S20



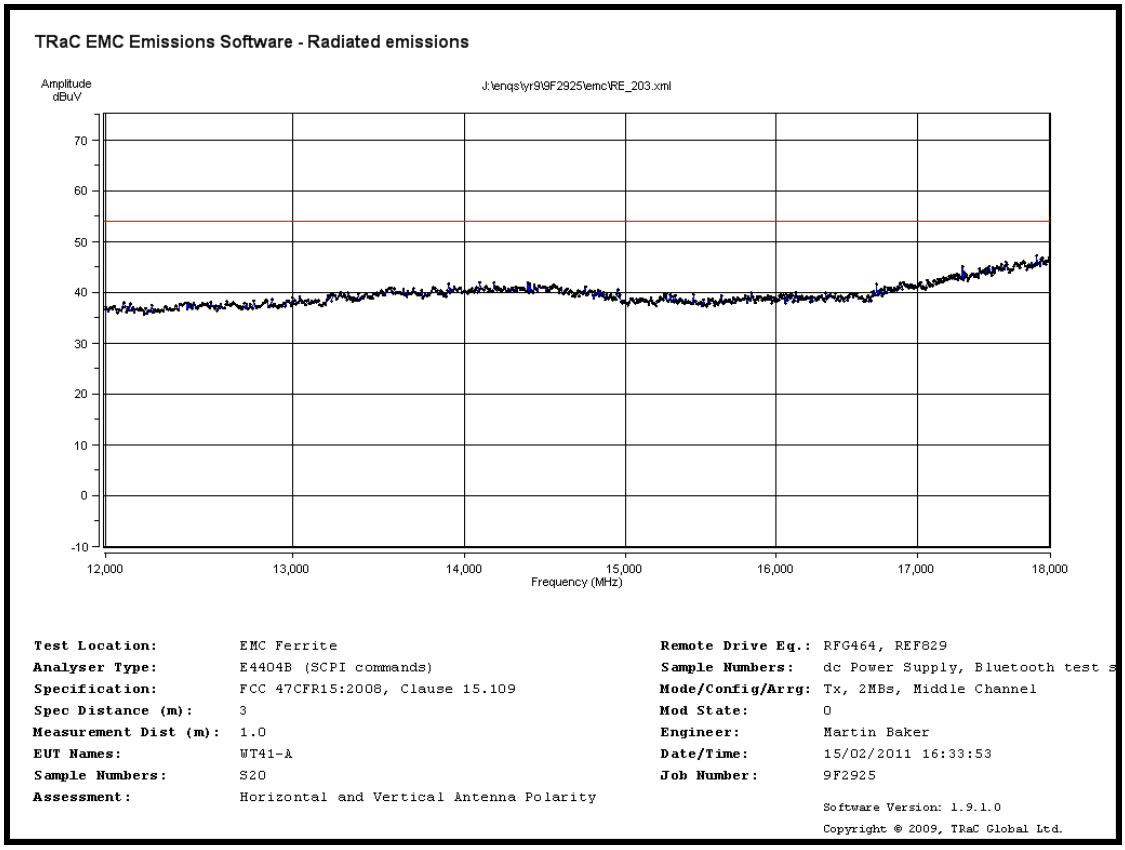
Radiated Spurious emissions 200 MHz to 1 GHz – 2441MHz – 2Mbps for S20



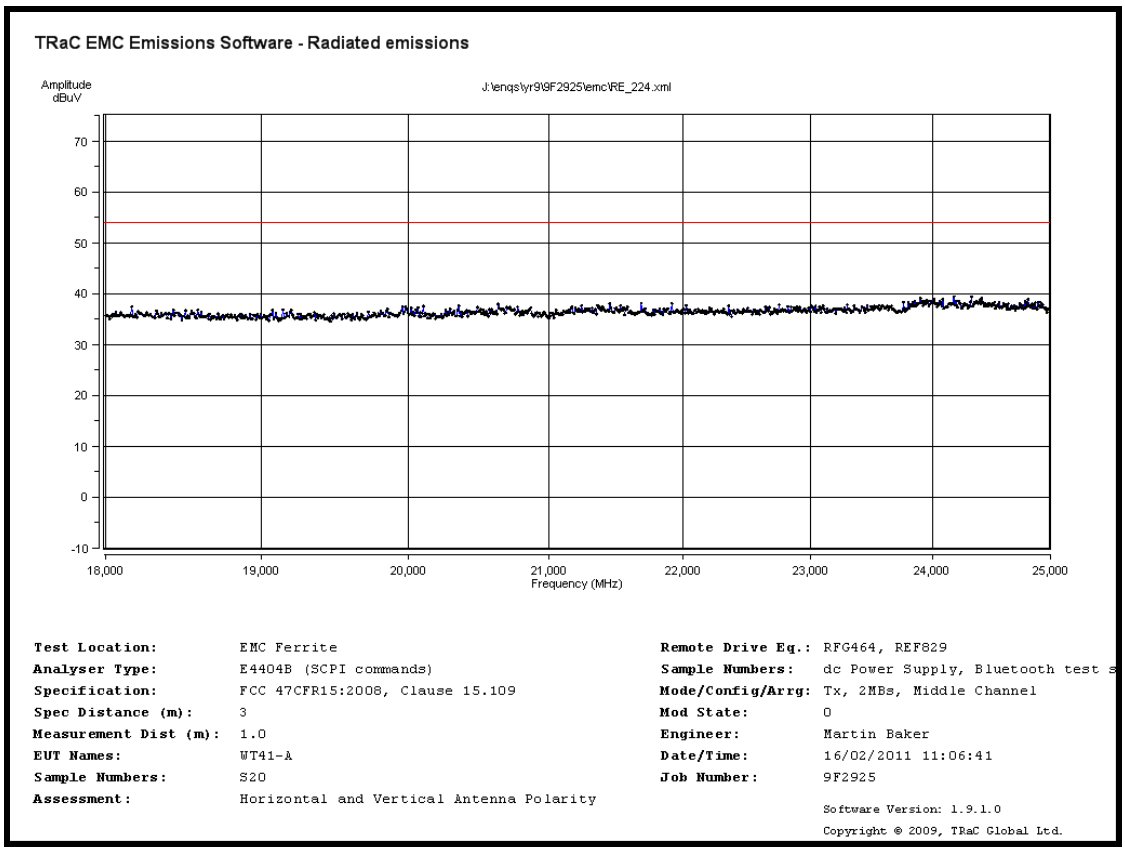
Radiated Spurious emissions 1 GHz to 5 GHz – 2441MHz – 2Mbps for S20



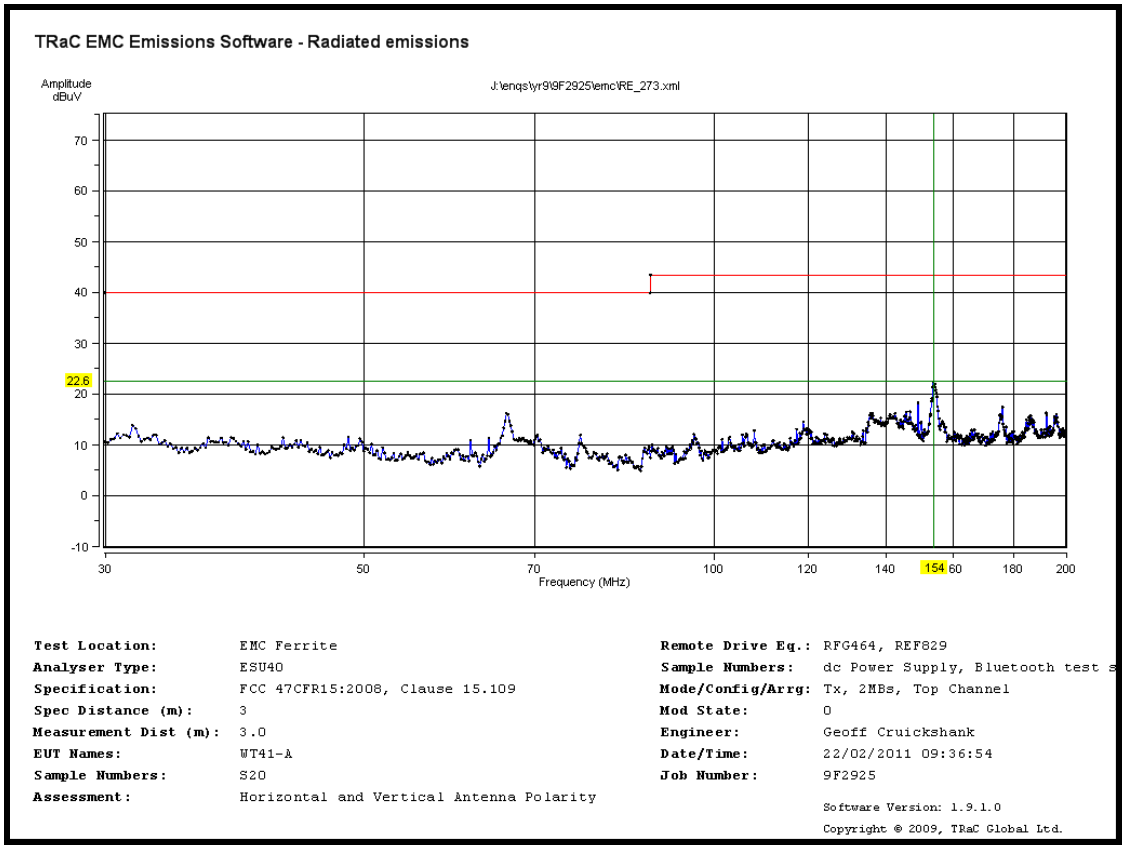
Radiated Spurious emissions 5 GHz to 12 GHz – 2441MHz – 2Mbps for S20



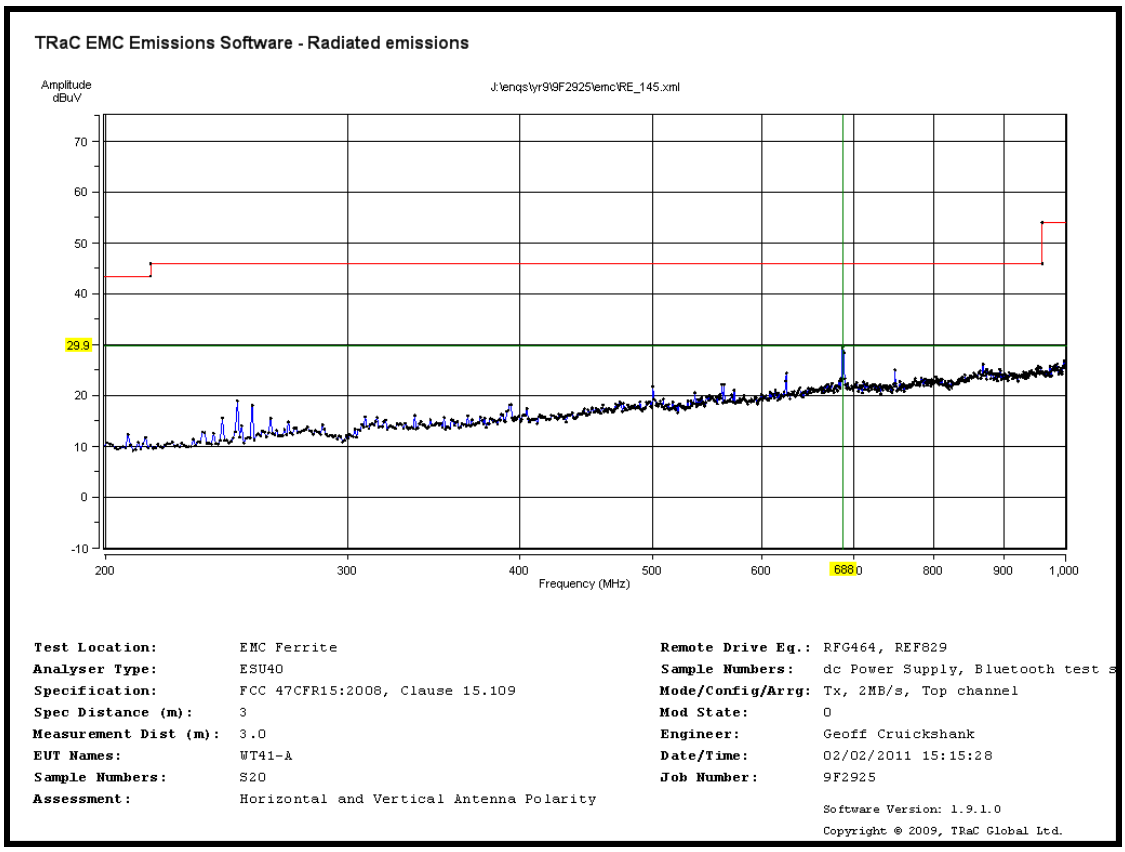
Radiated Spurious emissions 12 GHz to 18GHz – 2441MHz – 2Mbps for S20



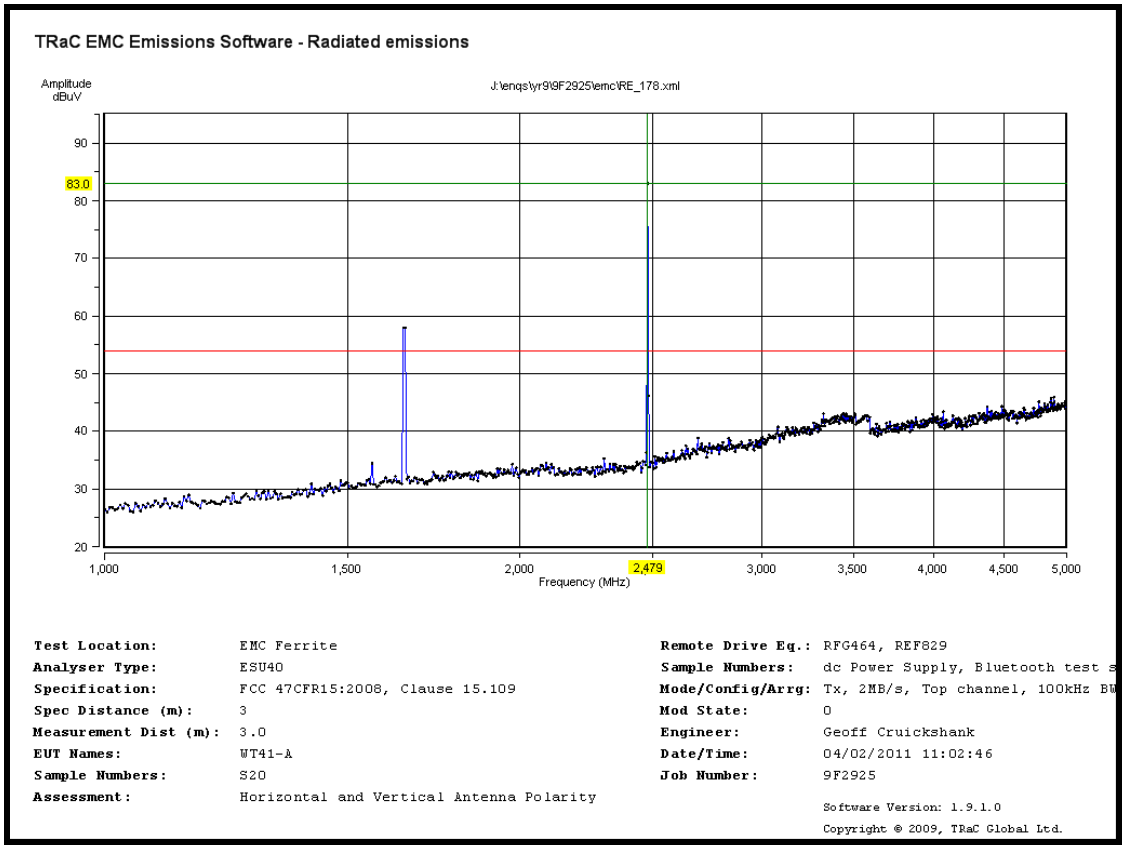
Radiated Spurious emissions 18 GHz to 25 GHz – 2441MHz – 2Mbps for S20



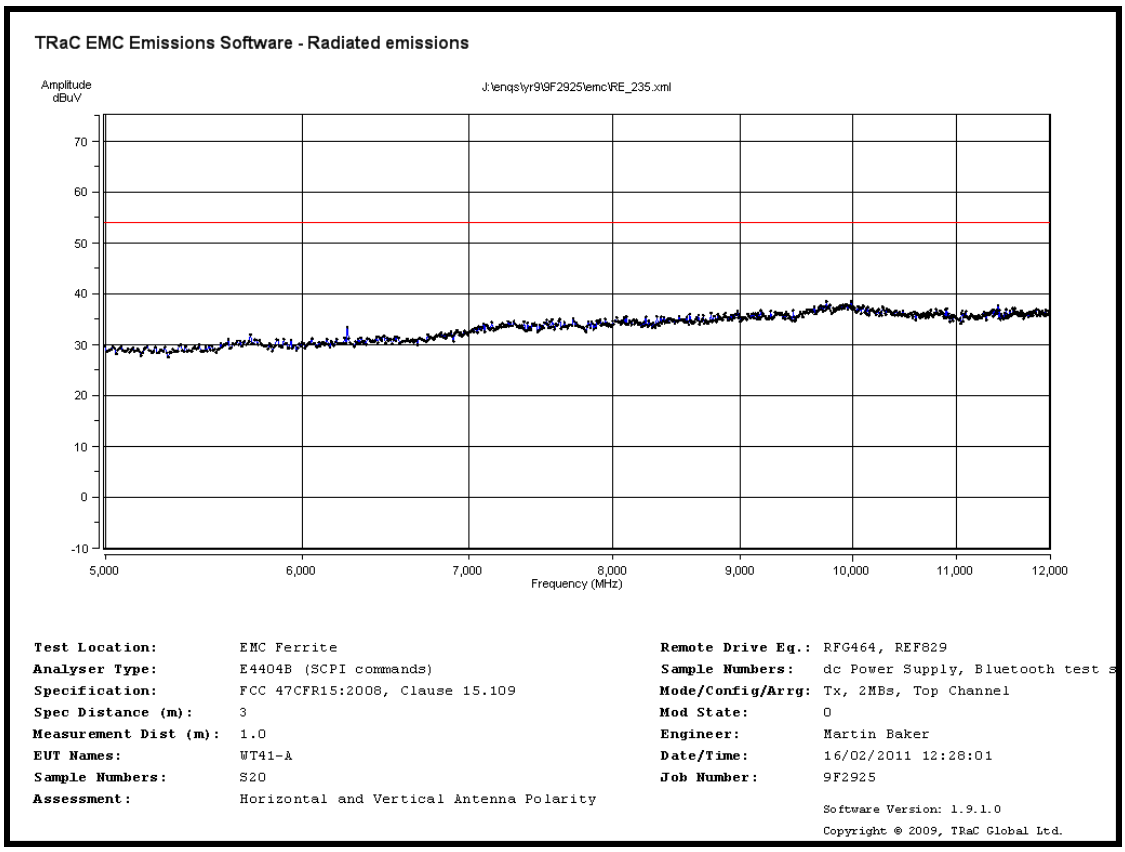
Radiated Spurious emissions 30 MHz to 200 MHz – 2480MHz – 2Mbps for S20



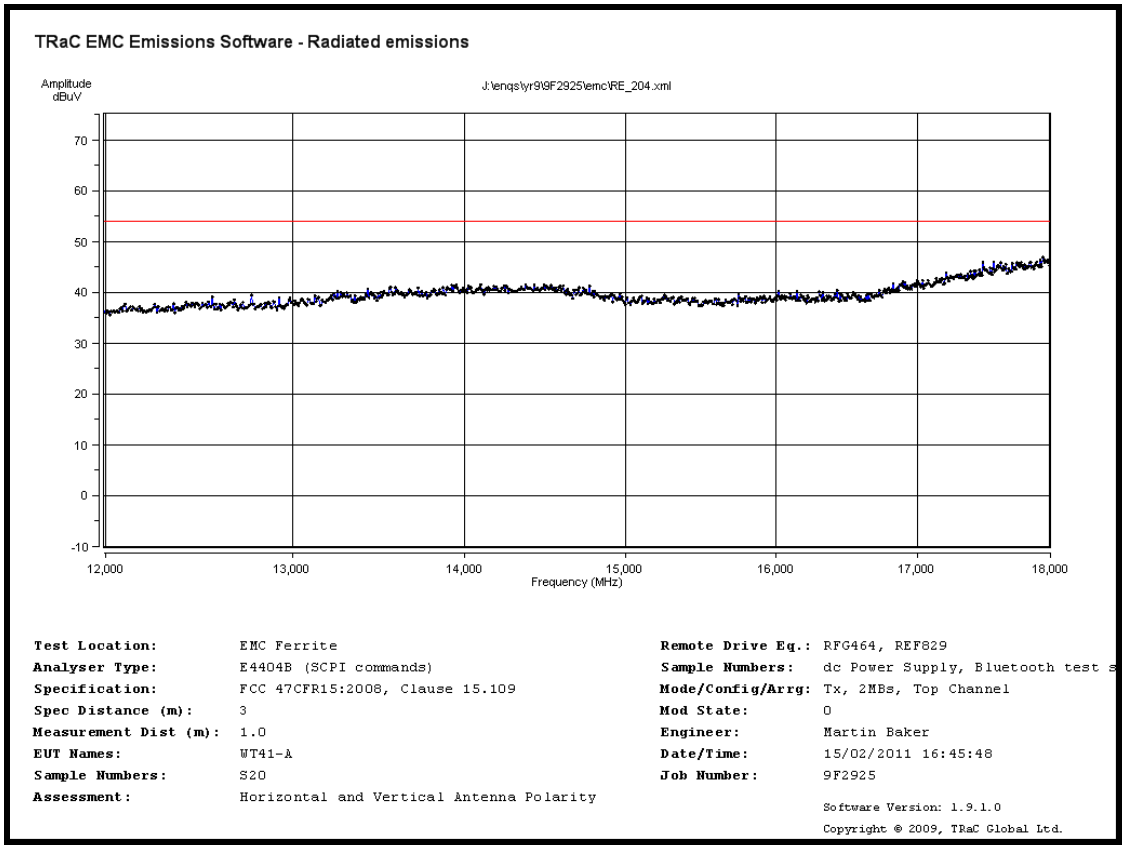
Radiated Spurious emissions 200 MHz to 1 GHz – 2480MHz – 2Mbps for S20



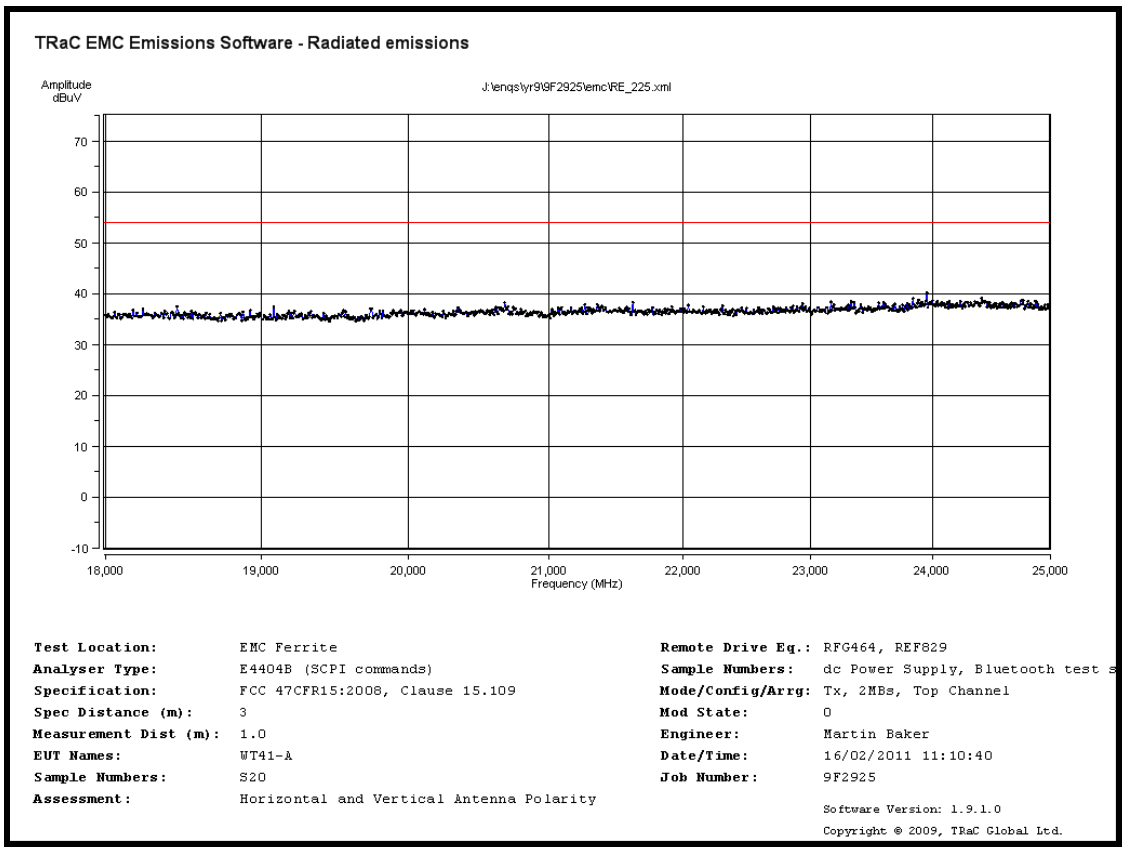
Radiated Spurious emissions 1 GHz to 5 GHz – 2480MHz – 2Mbps for S20



Radiated Spurious emissions 5 GHz to 12 GHz – 2480MHz – 2Mbps for S20

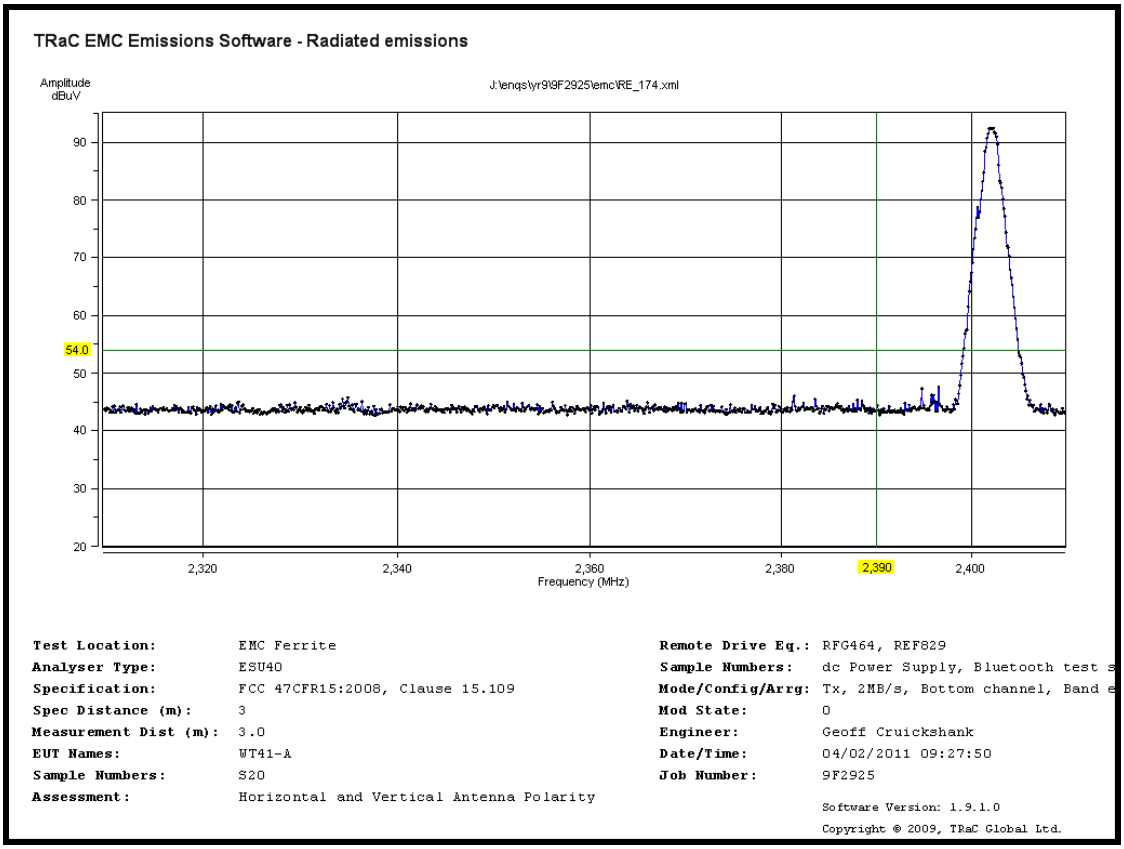


Radiated Spurious emissions 12 GHz to 18GHz – 2480MHz – 2Mbps for S20

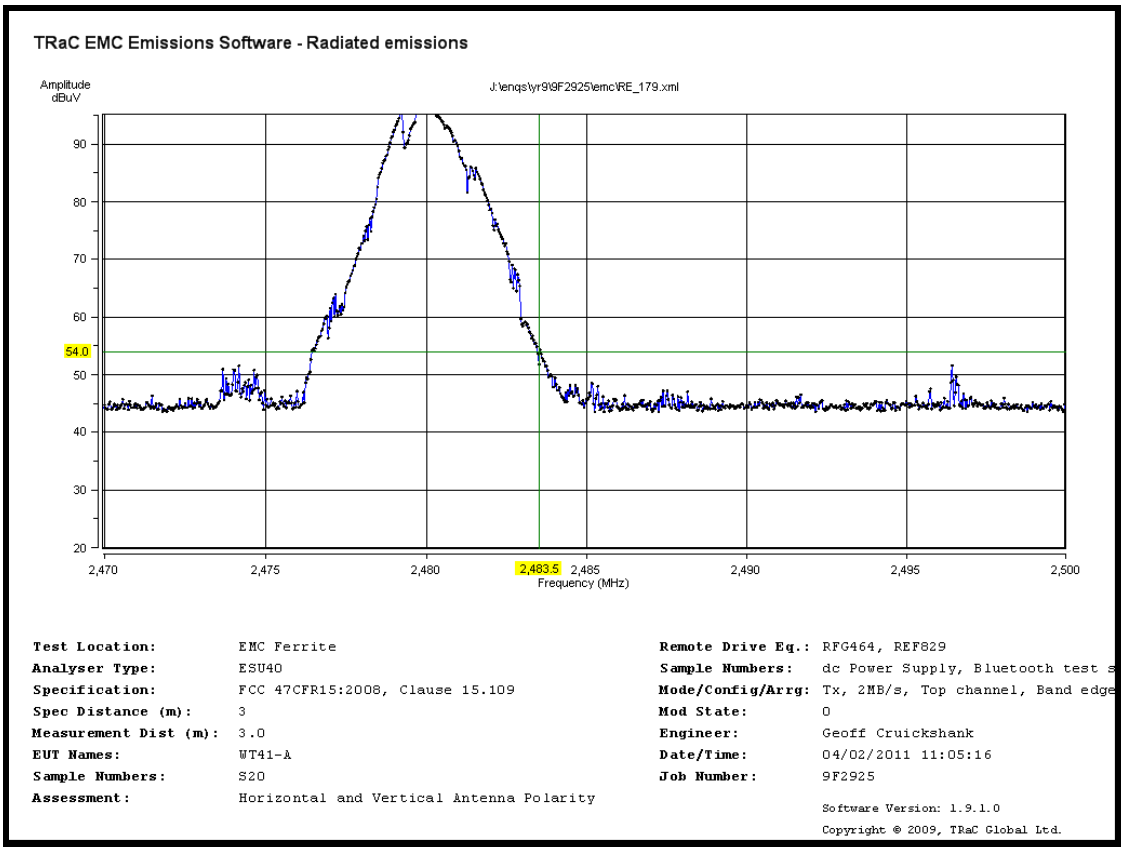


Radiated Spurious emissions 18 GHz to 25 GHz – 2480MHz – 2Mbps for S20

Radiated Bandedge Compliance – Peak plot to average limit

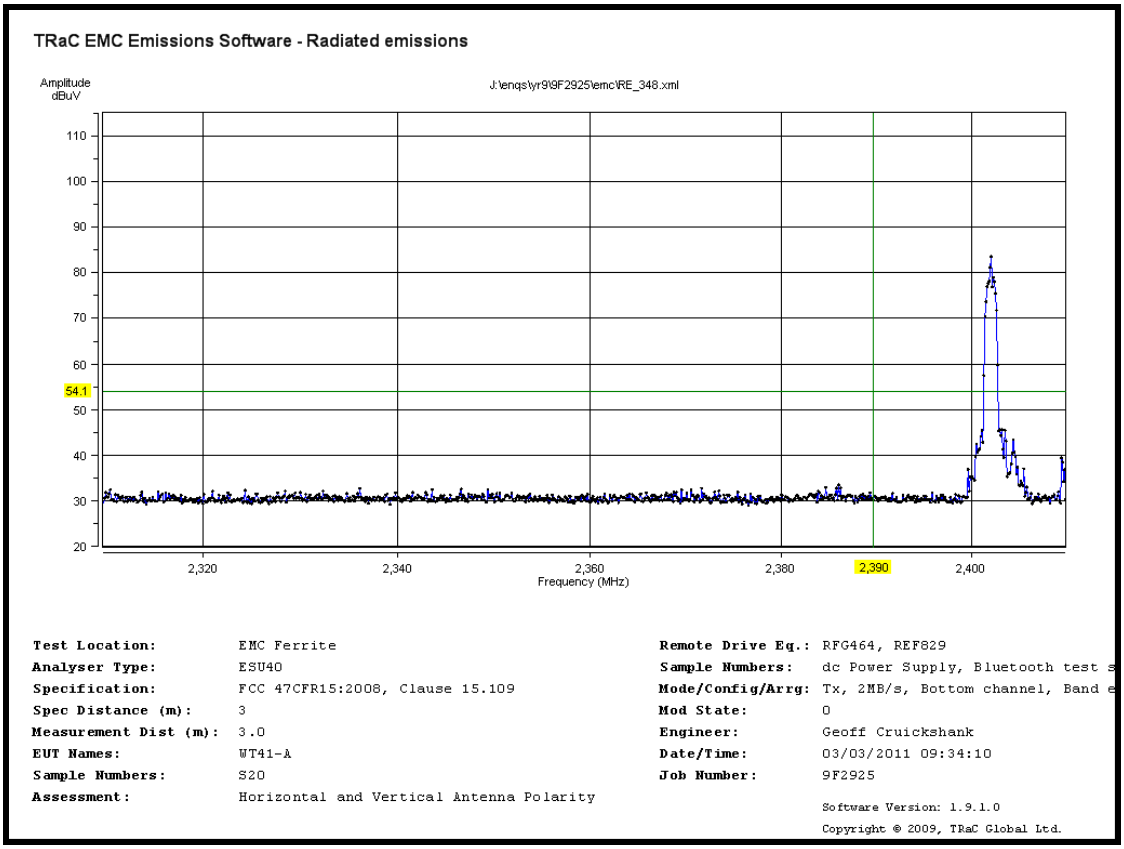


Lower Bandedge

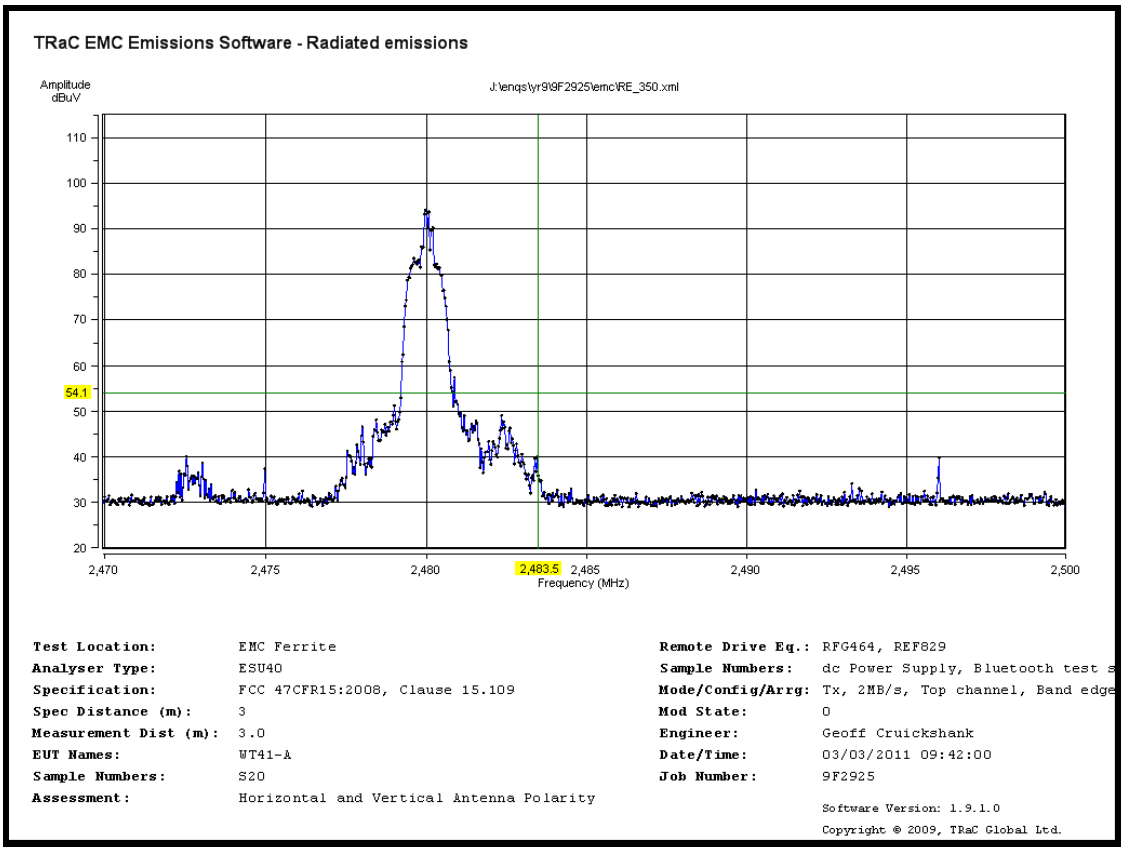


Upper Bandedge

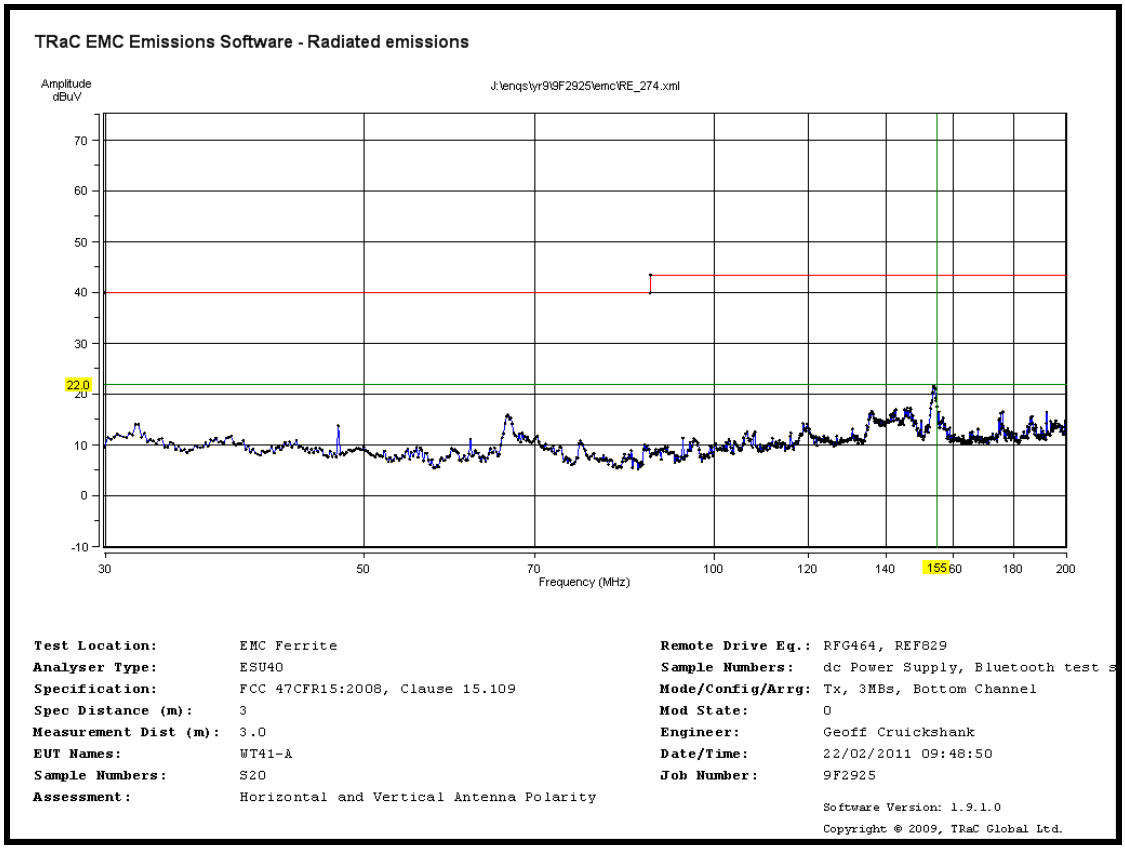
Radiated Bandedge Compliance – Average plot to average limit



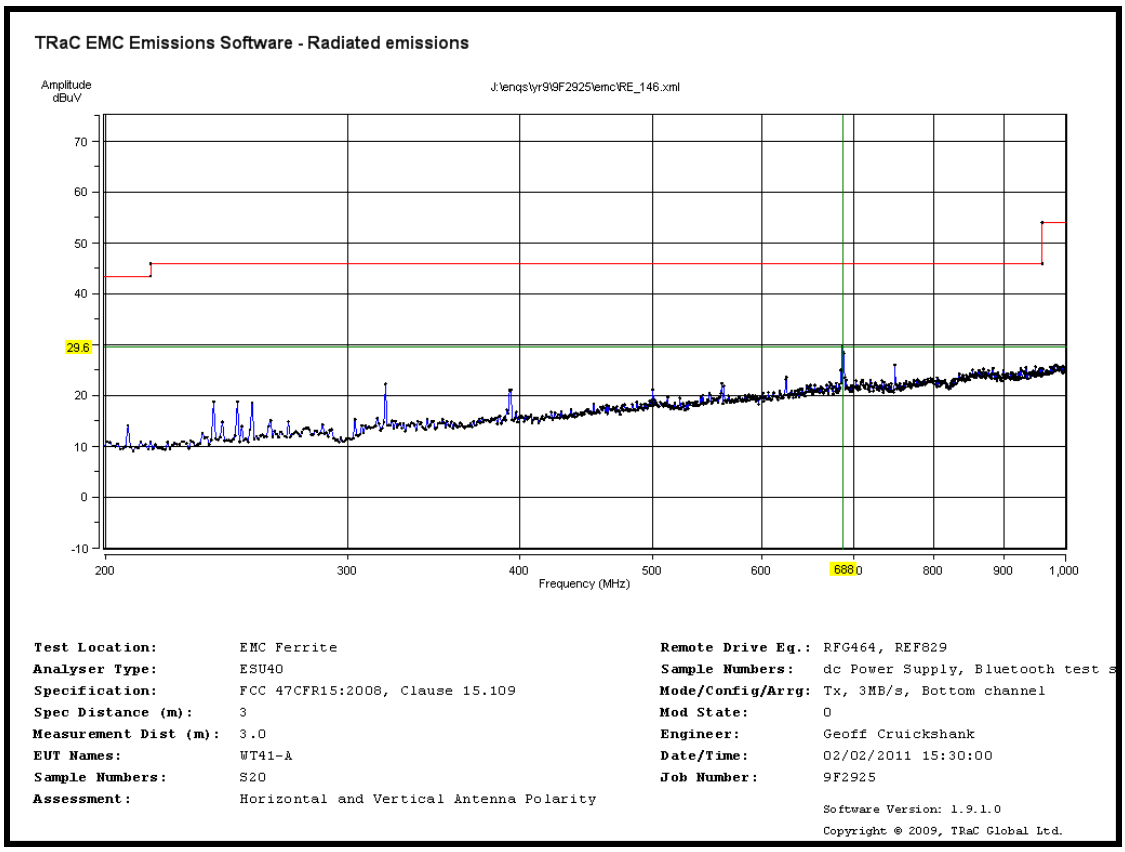
Lower Bandedge



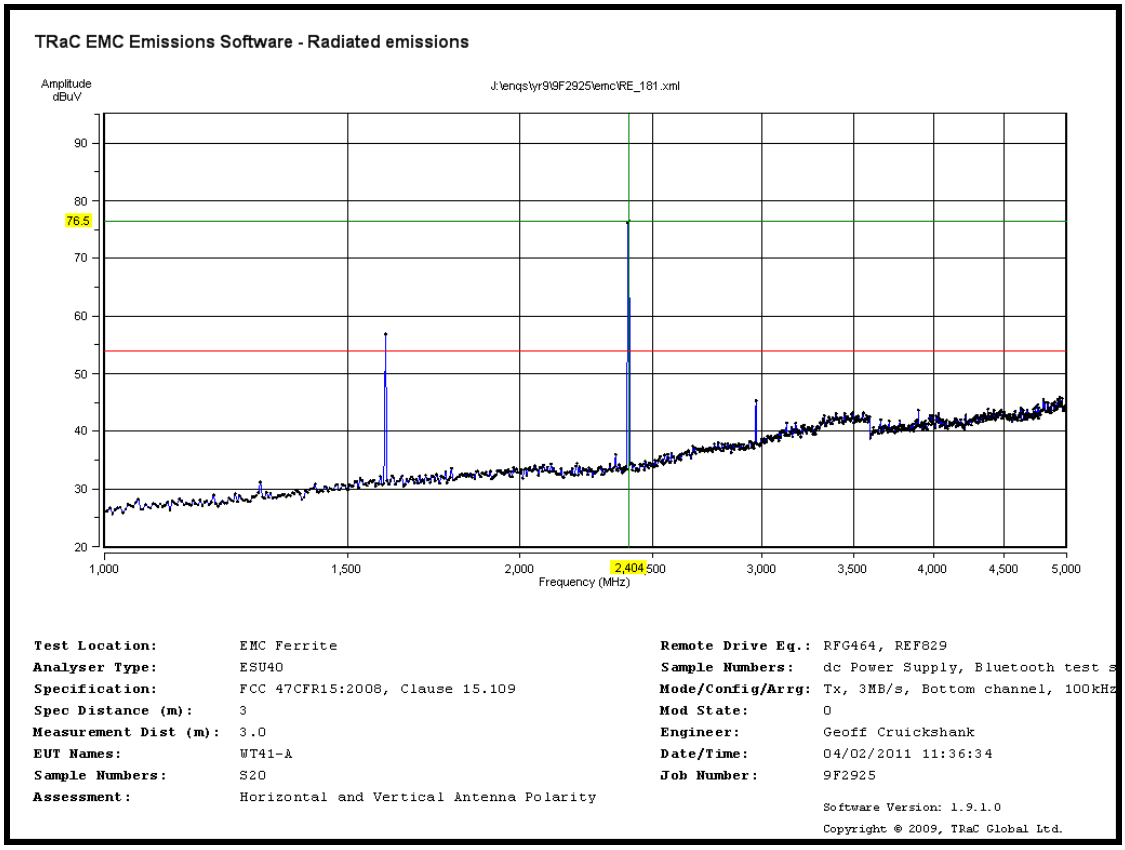
Upper Bandedge



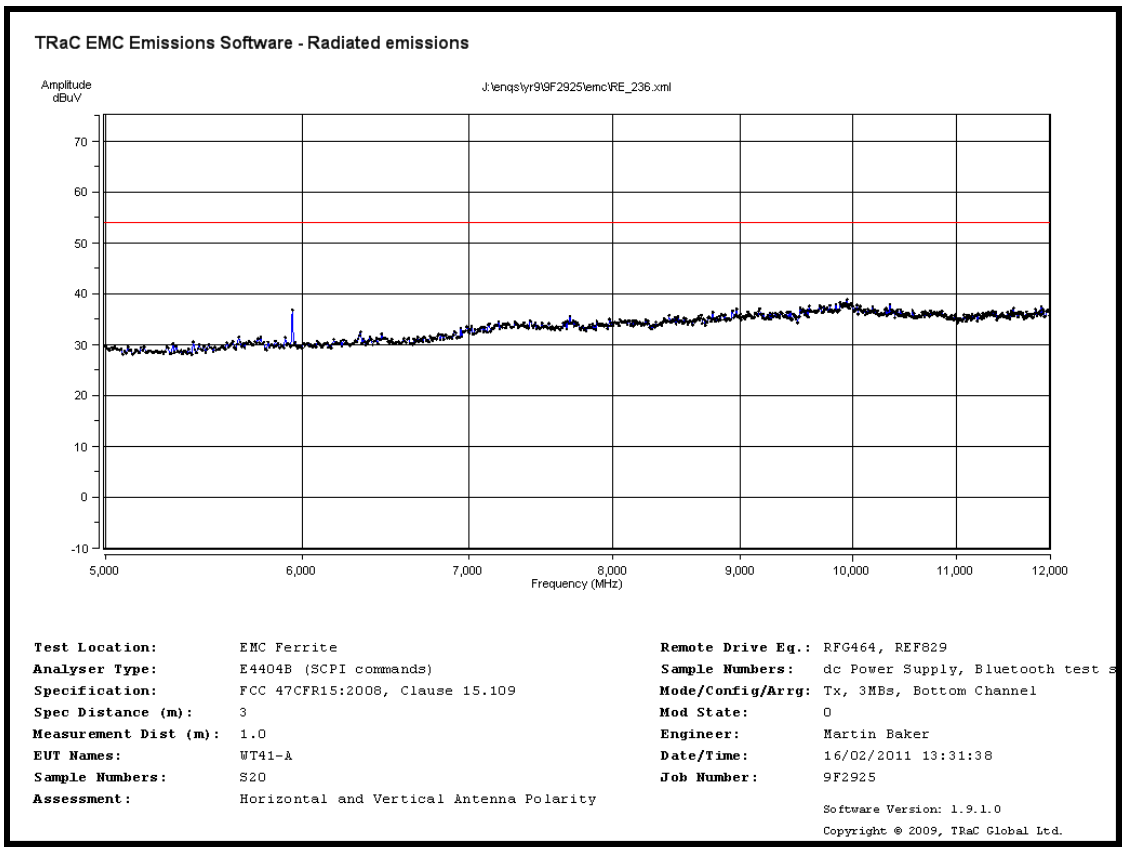
Radiated Spurious emissions 30 MHz to 200 MHz – 2402MHz – 3Mbps for S20



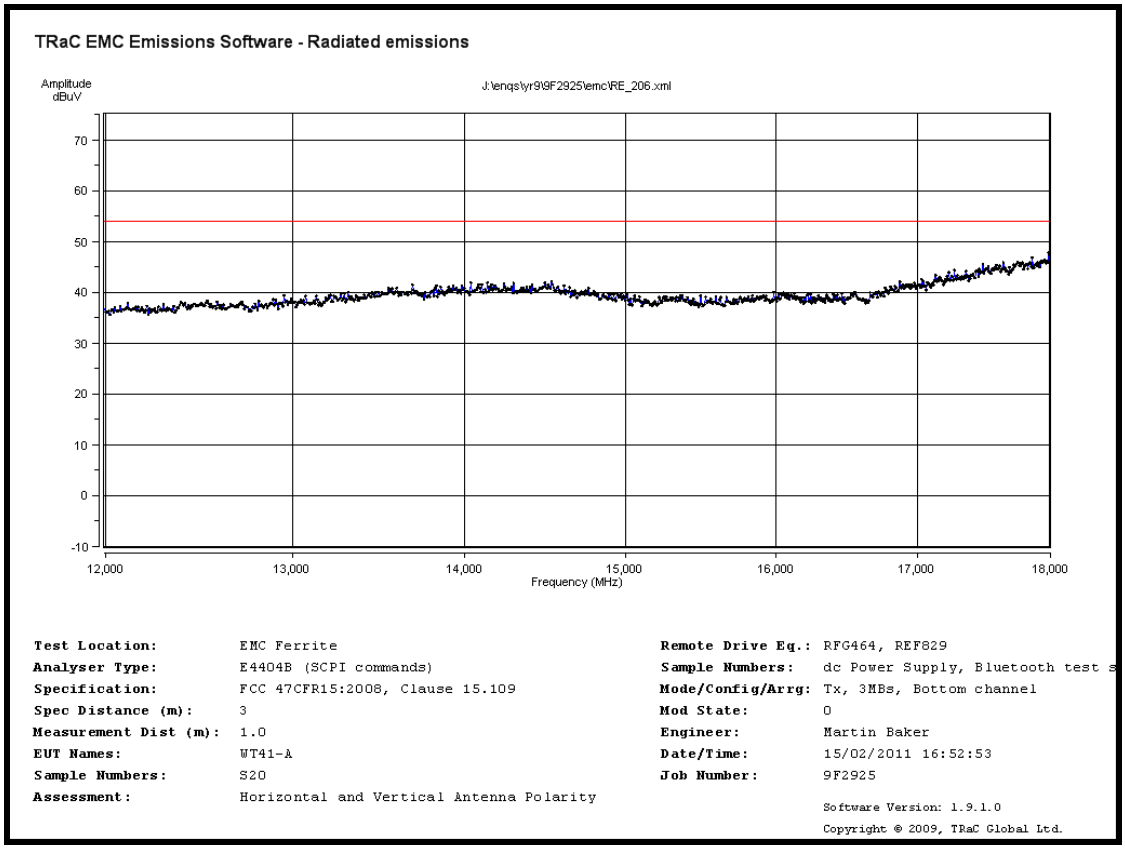
Radiated Spurious emissions 200 MHz to 1 GHz – 2402MHz – 3Mbps for S20



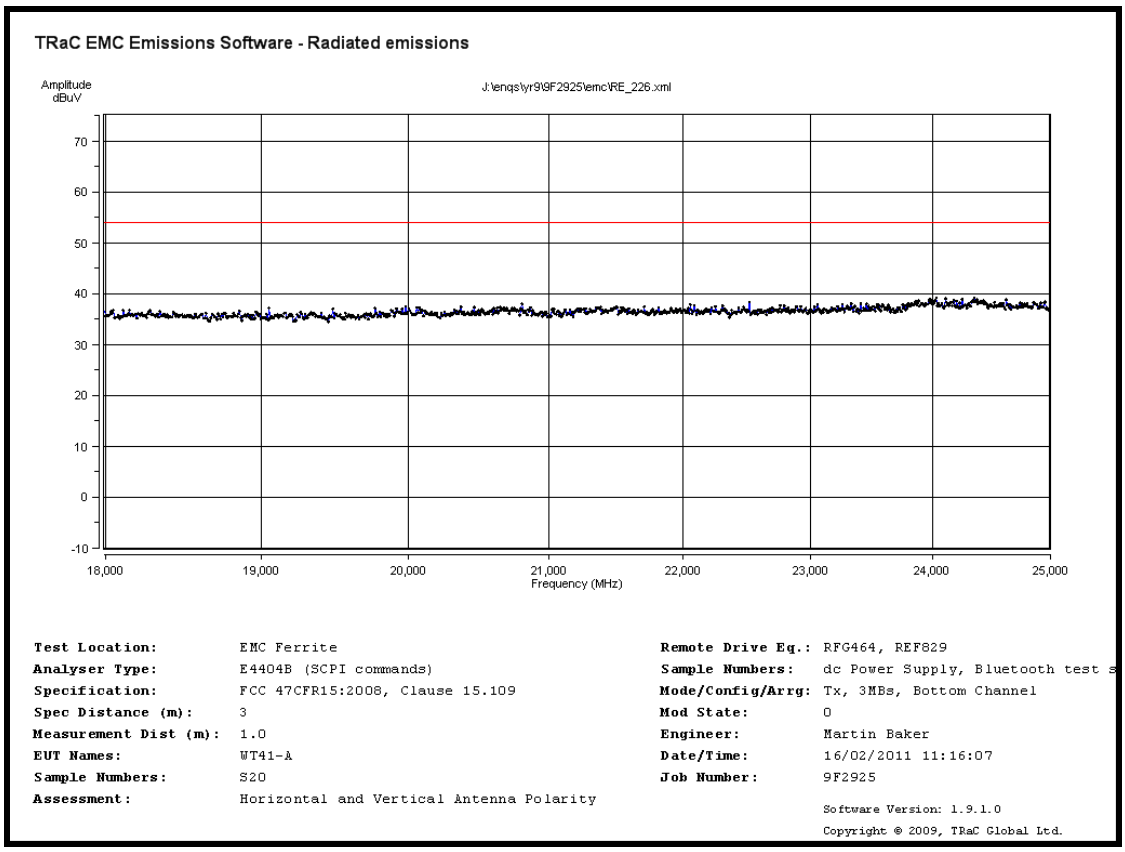
Radiated Spurious emissions 1 GHz to 5 GHz – 2402MHz – 3Mbps for S20



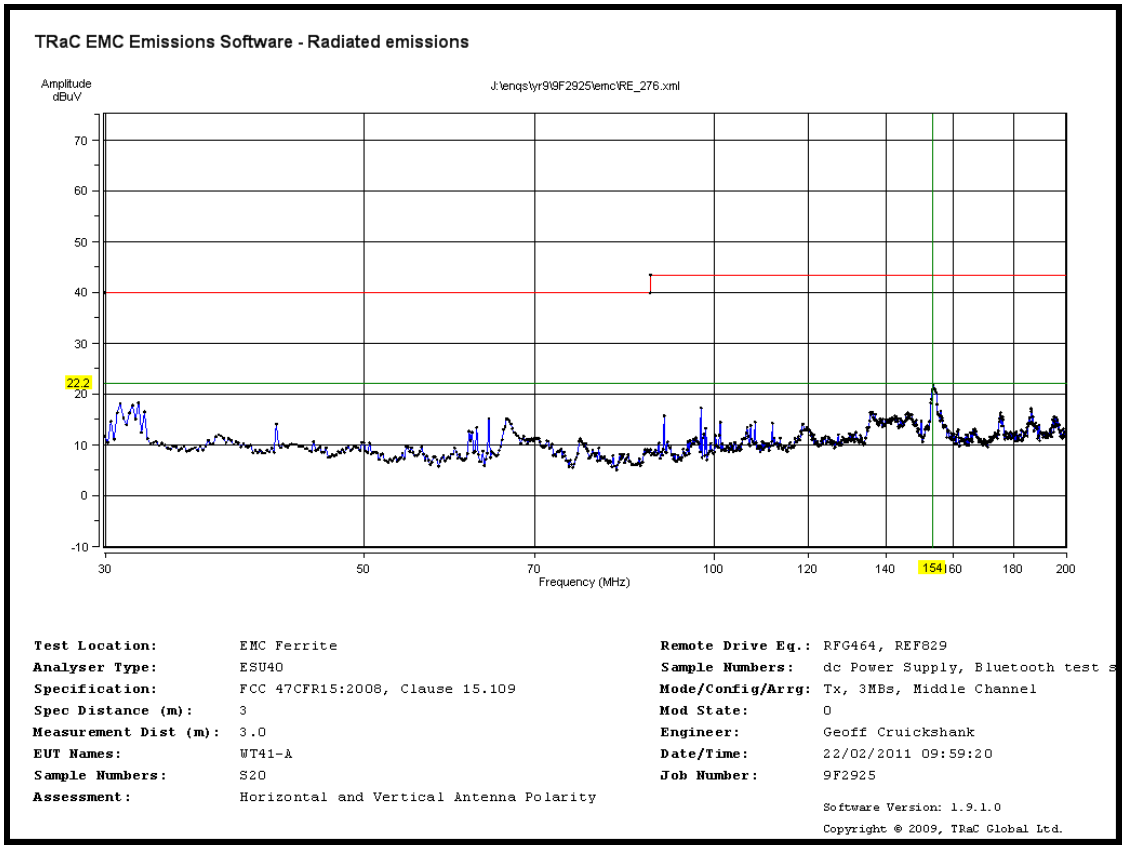
Radiated Spurious emissions 5 GHz to 12 GHz – 2402MHz – 3Mbps for S20



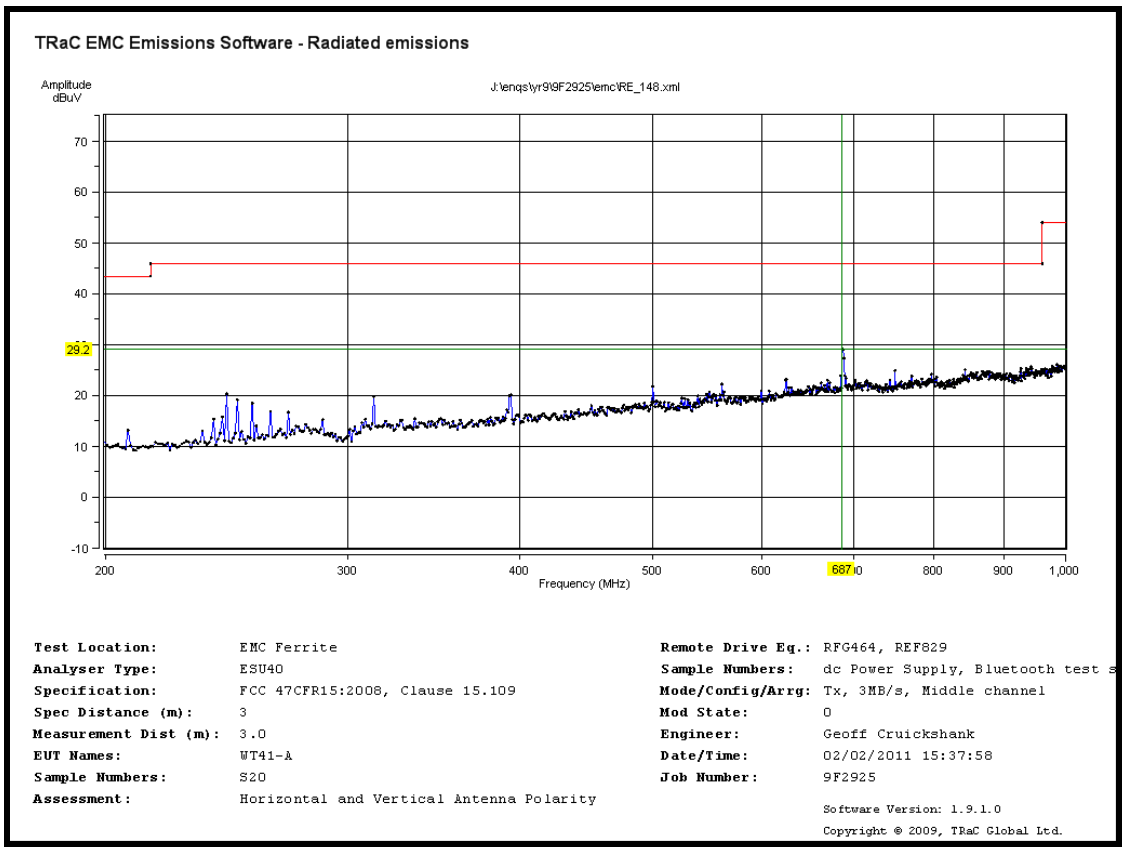
Radiated Spurious emissions 12 GHz to 18GHz – 2402MHz – 3Mbps for S20



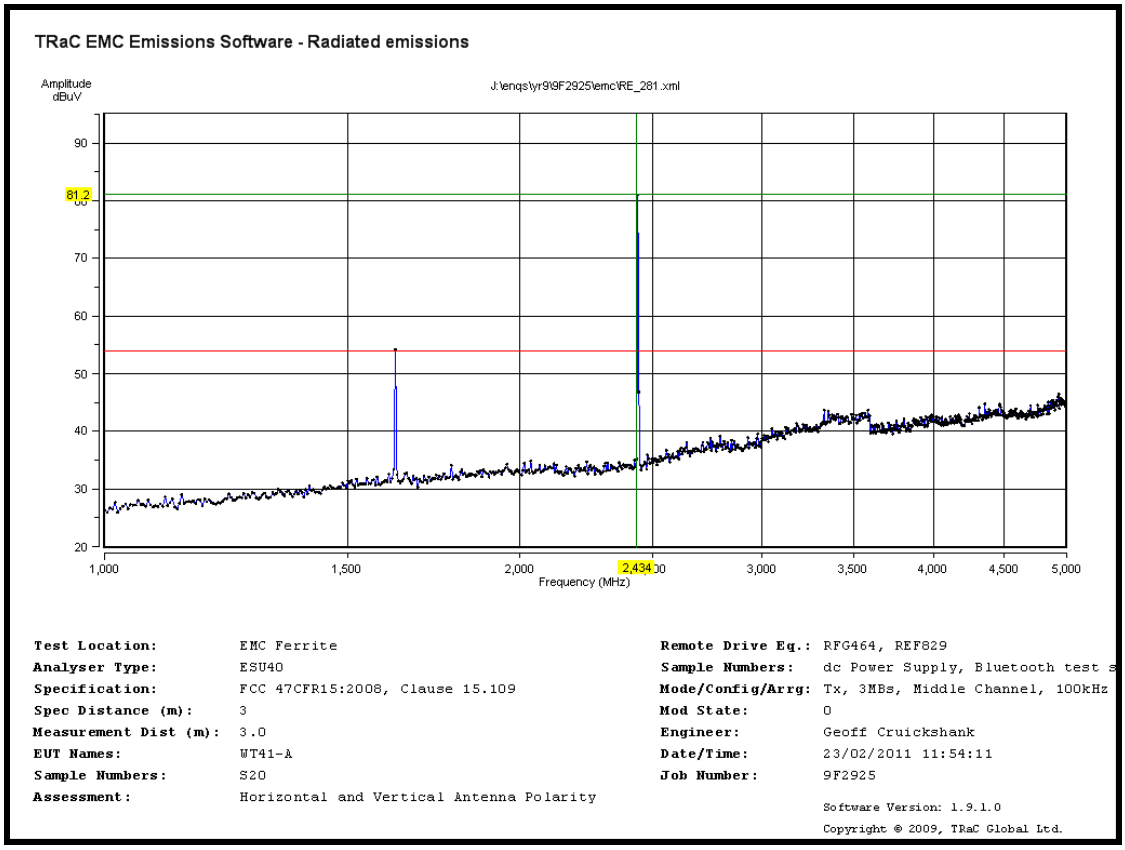
Radiated Spurious emissions 18 GHz to 25 GHz – 2402MHz – 3Mbps for S20



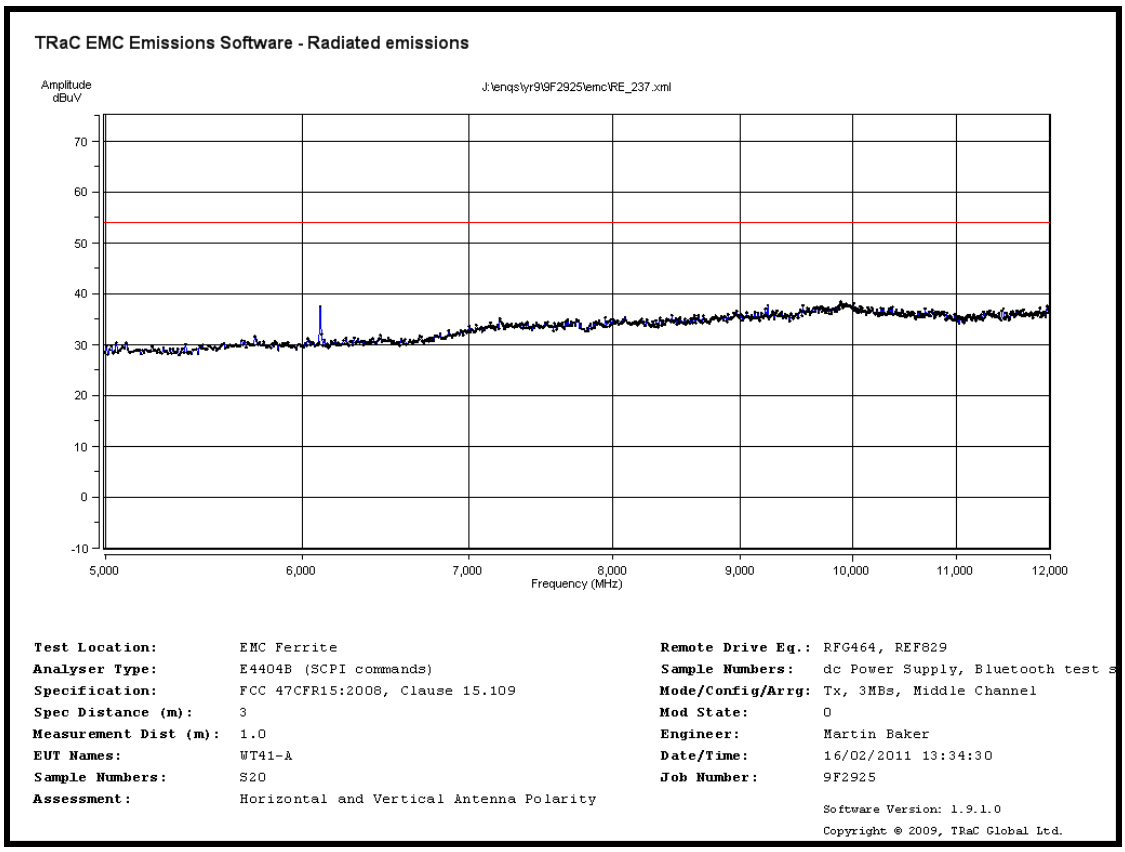
Radiated Spurious emissions 30 MHz to 200 MHz – 2441MHz – 3Mbps for S20



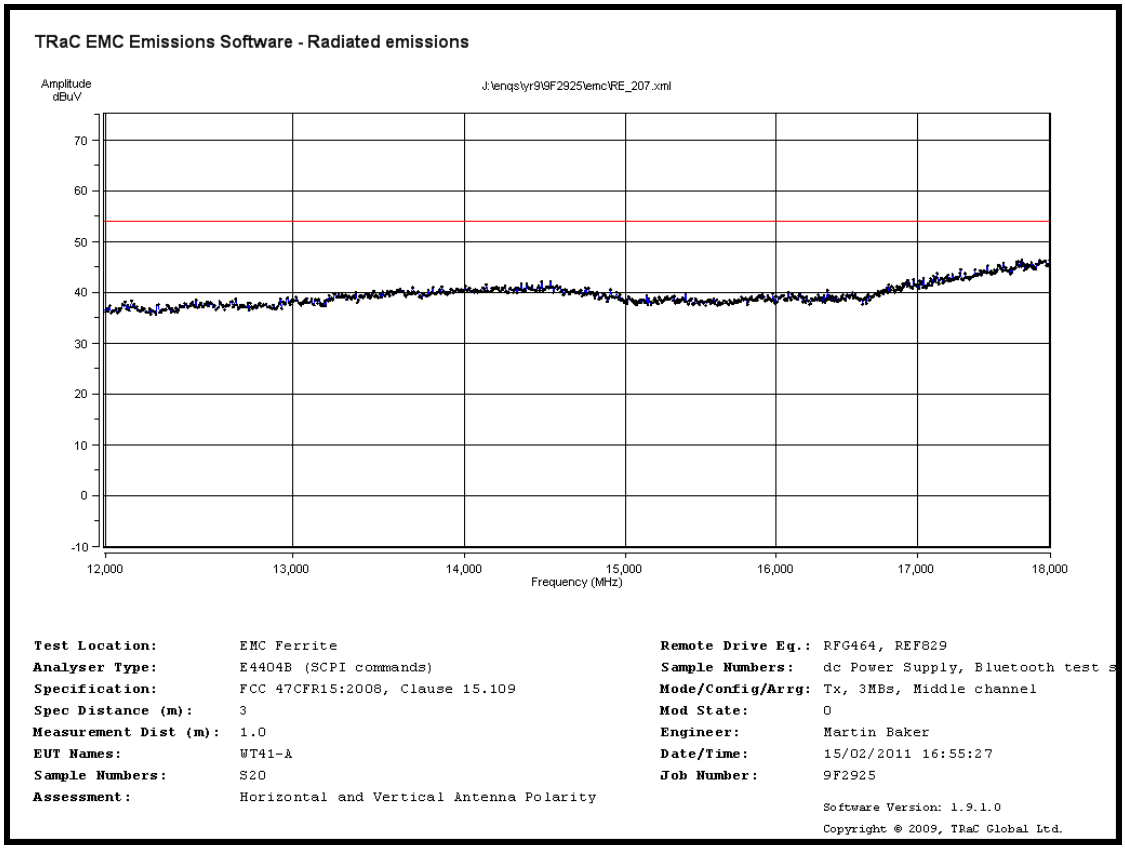
Radiated Spurious emissions 200 MHz to 1 GHz – 2441MHz – 3Mbps for S20



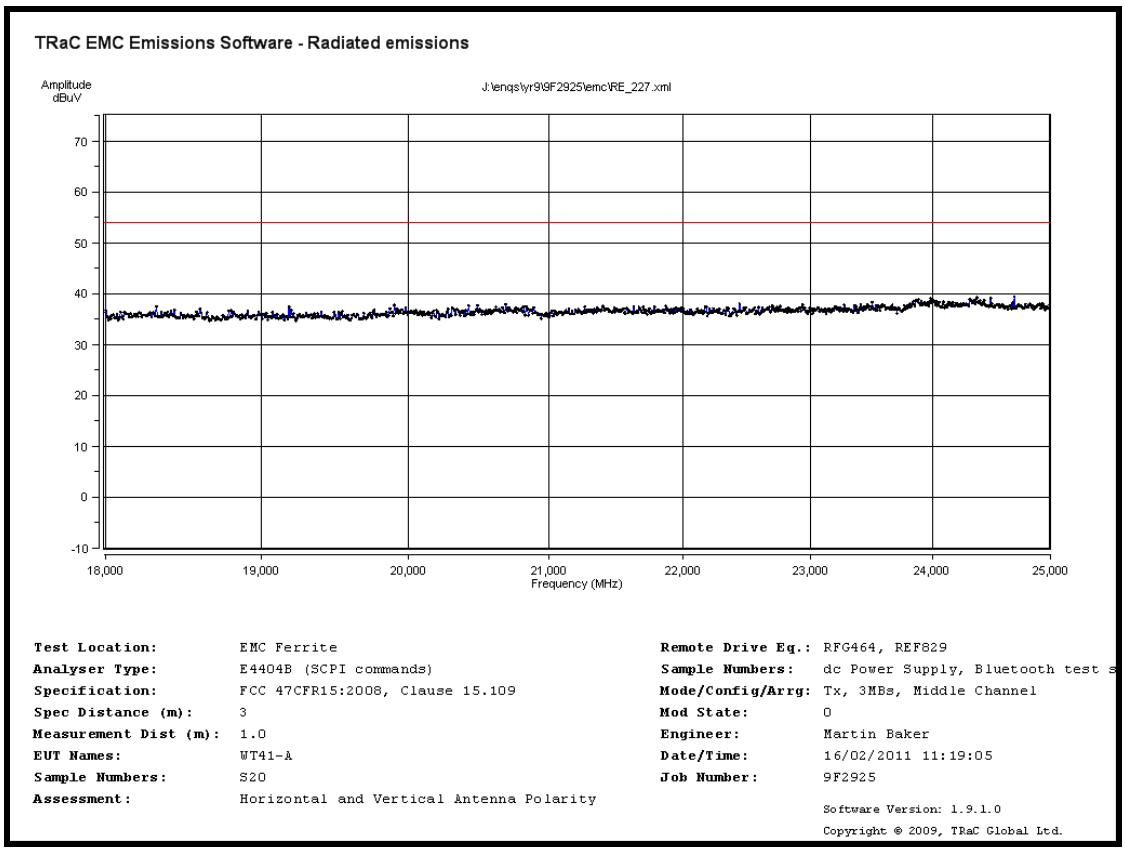
Radiated Spurious emissions 1 GHz to 5 GHz – 2441MHz – 3Mbps for S20



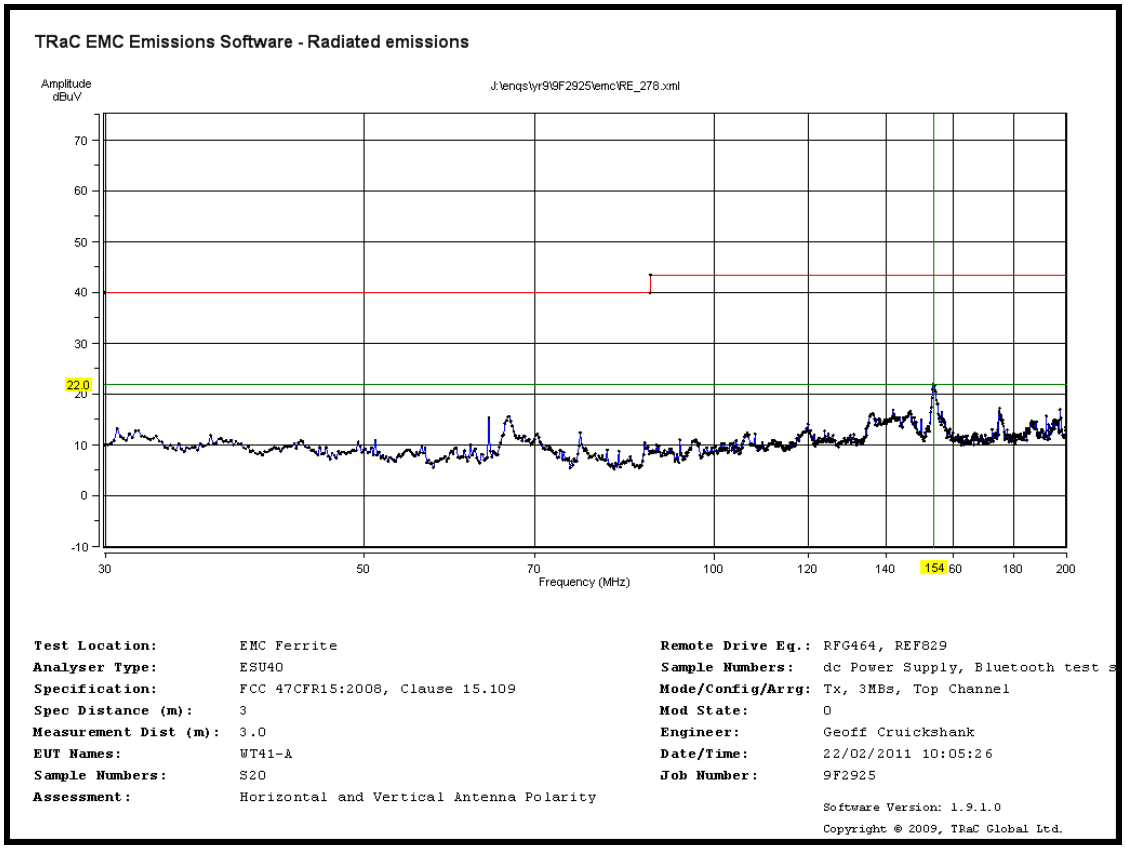
Radiated Spurious emissions 5 GHz to 12 GHz – 2441MHz – 3Mbps for S20



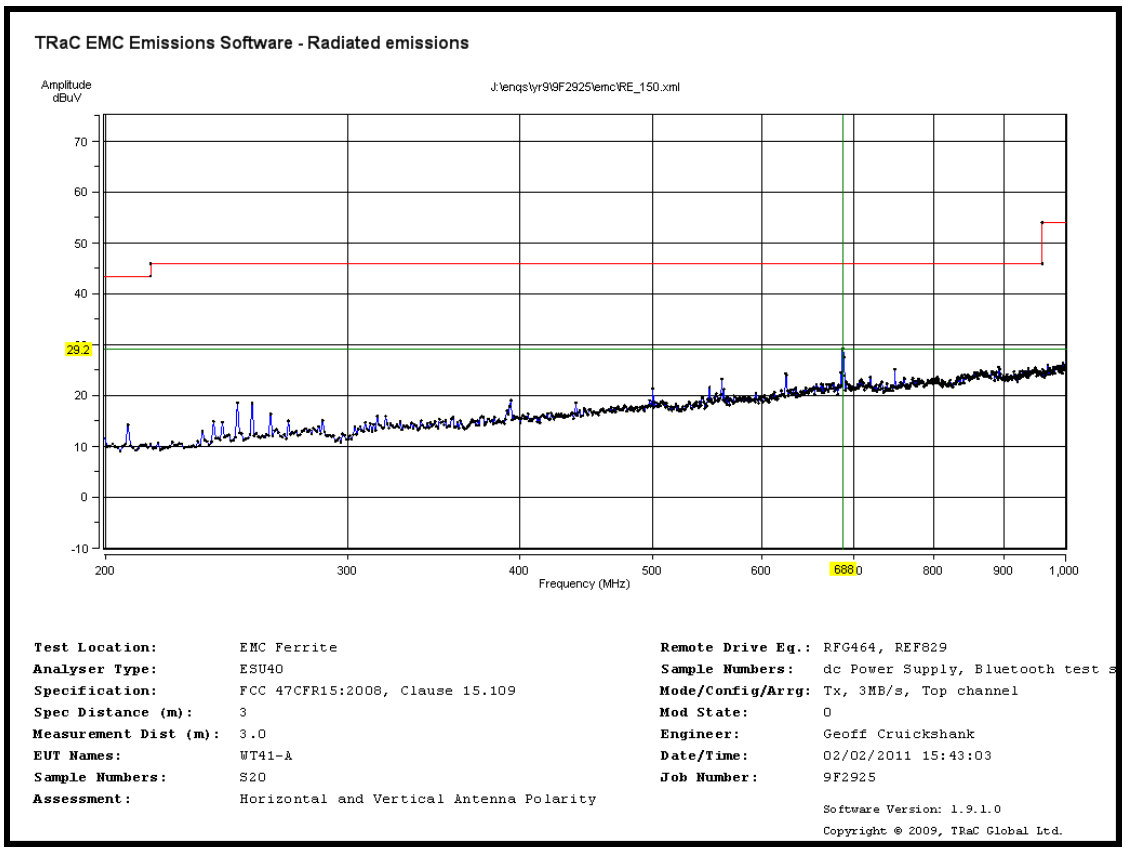
Radiated Spurious emissions 12 GHz to 18GHz – 2441MHz – 3Mbps for S20



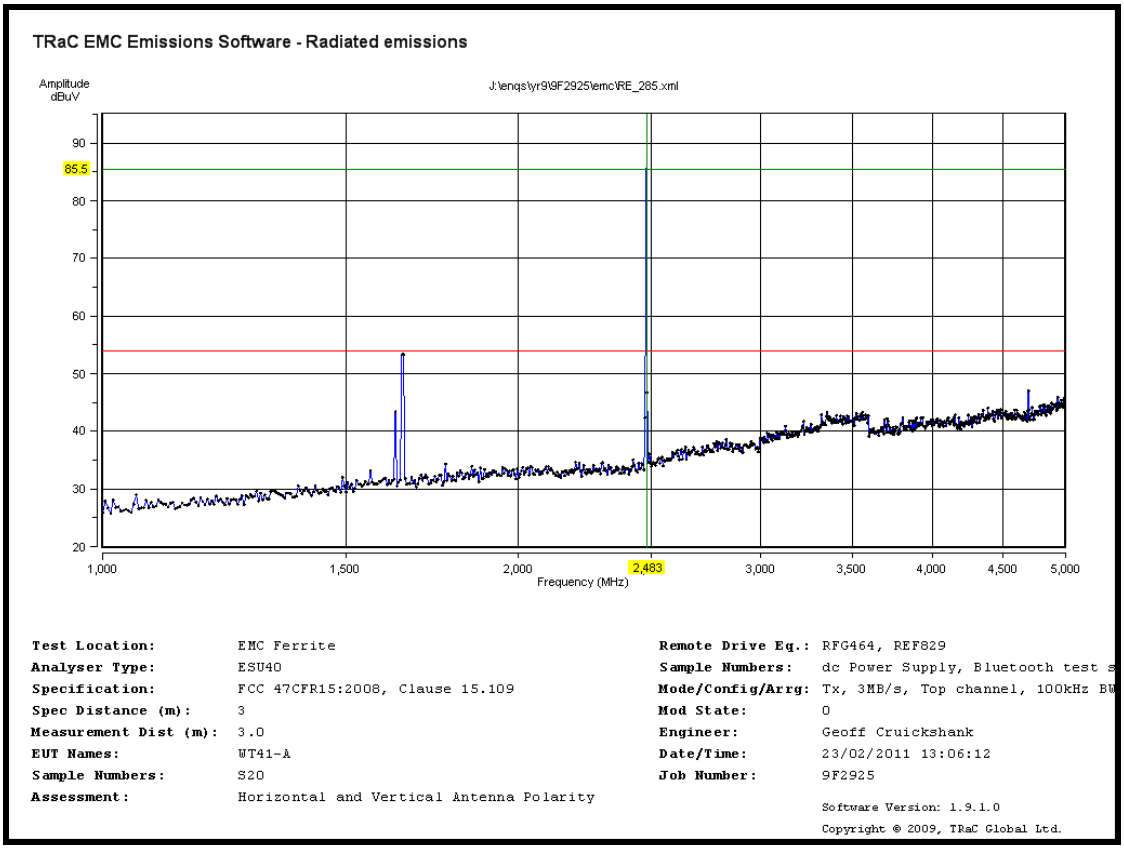
Radiated Spurious emissions 18 GHz to 25 GHz – 2441MHz – 3Mbps for S20



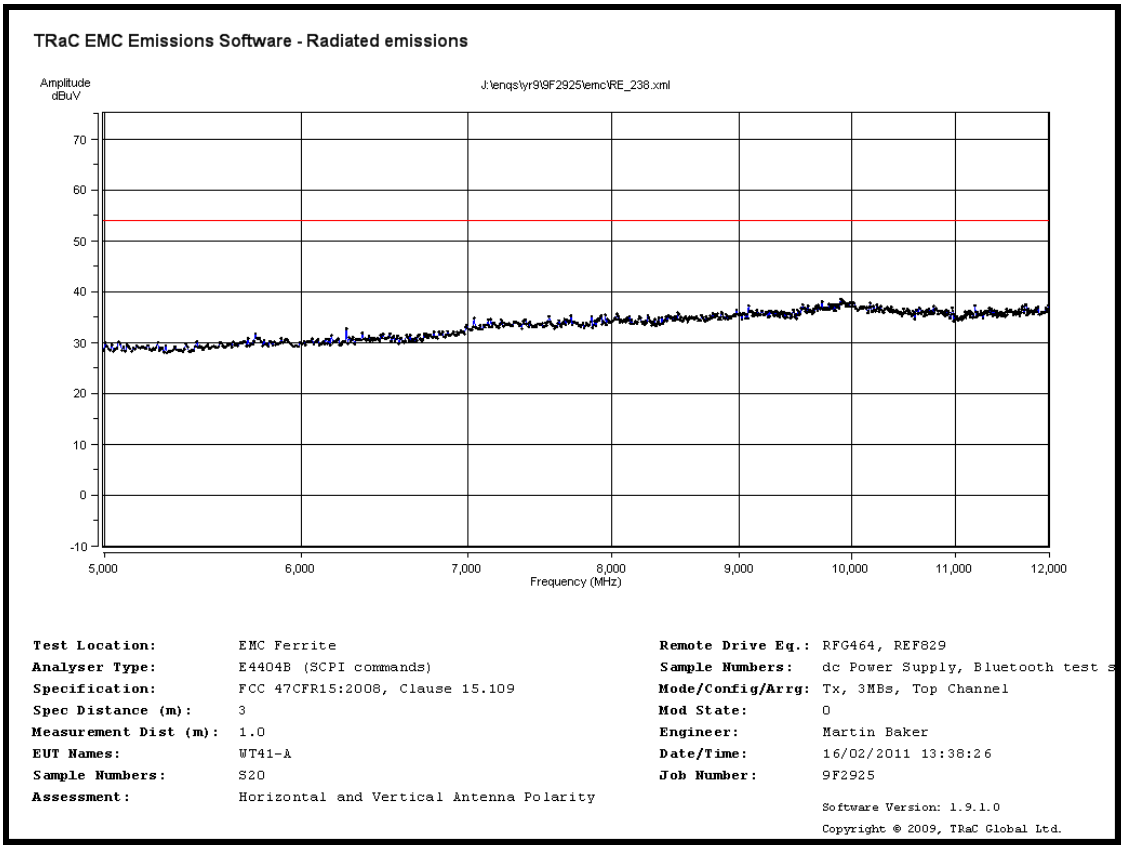
Radiated Spurious emissions 30 MHz to 200 MHz – 2480MHz – 3Mbps for S20



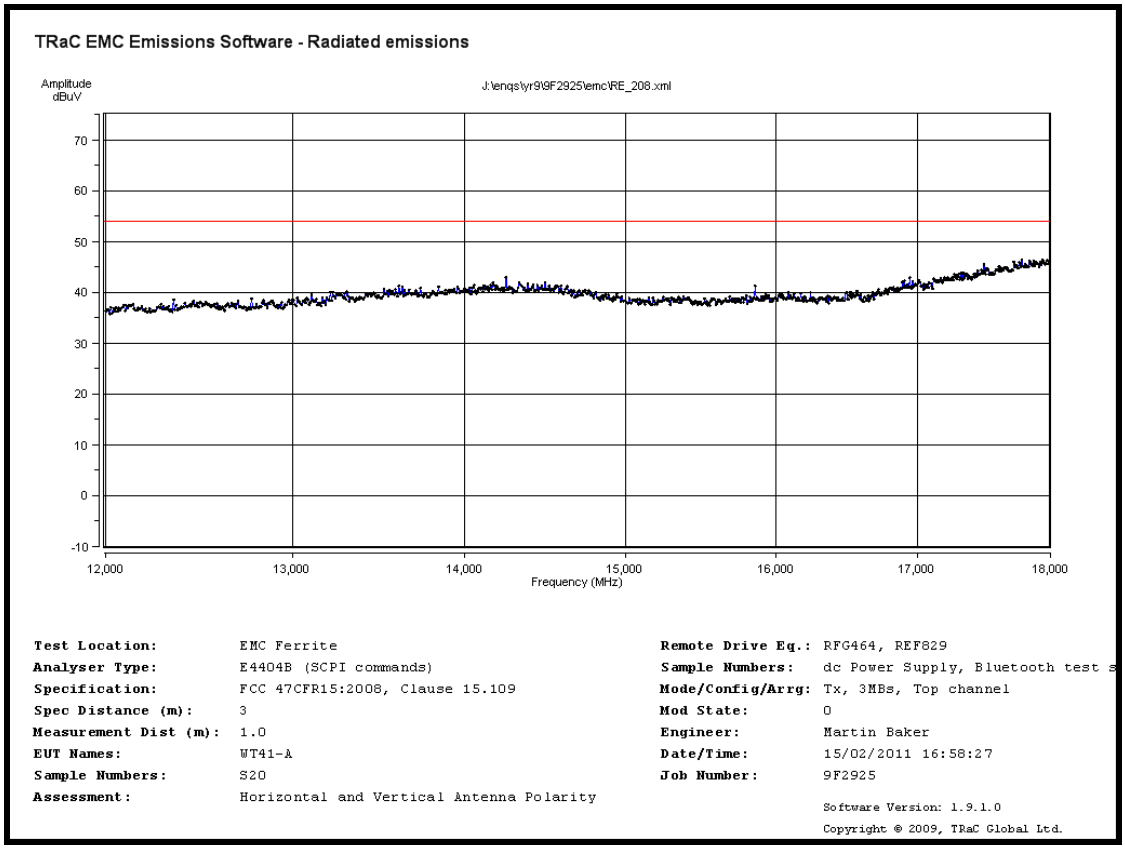
Radiated Spurious emissions 200 MHz to 1 GHz – 2480MHz – 3Mbps for S20



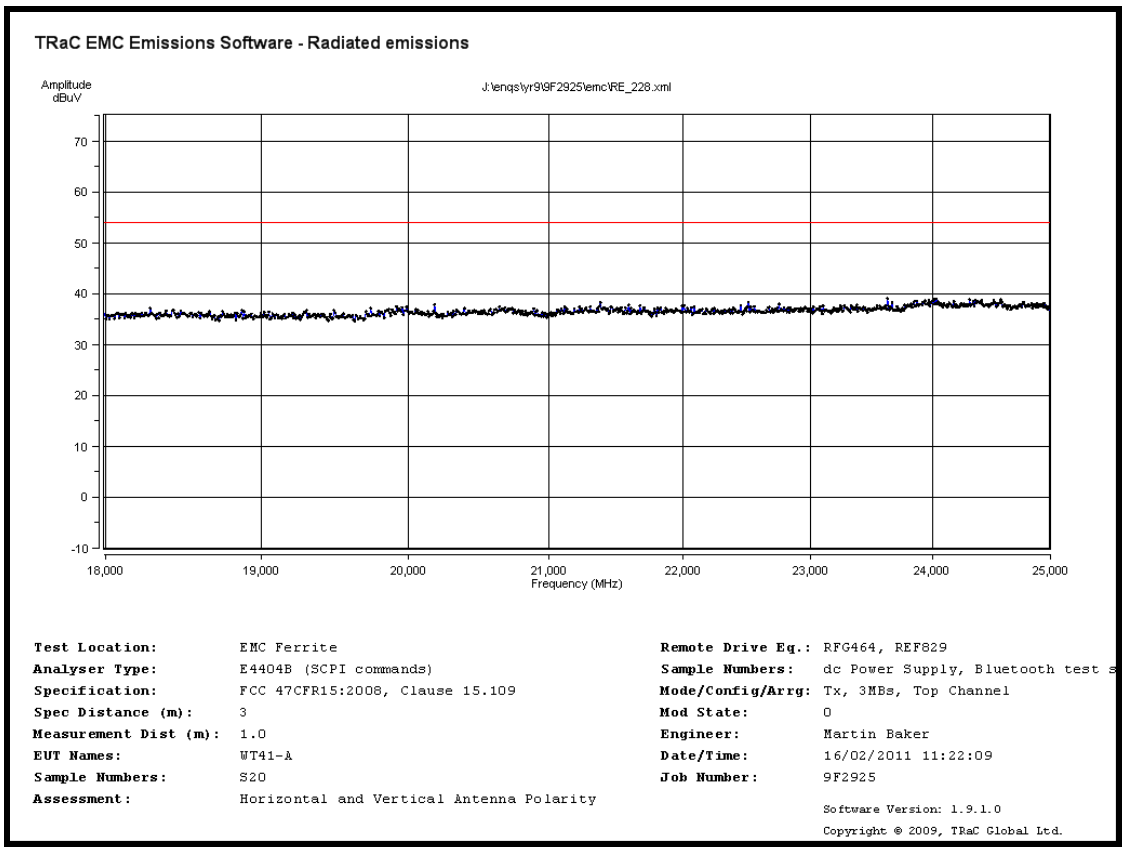
Radiated Spurious emissions 1 GHz to 5 GHz – 2480MHz – 3Mbps for S20



Radiated Spurious emissions 5 GHz to 12 GHz – 2480MHz – 3Mbps for S20

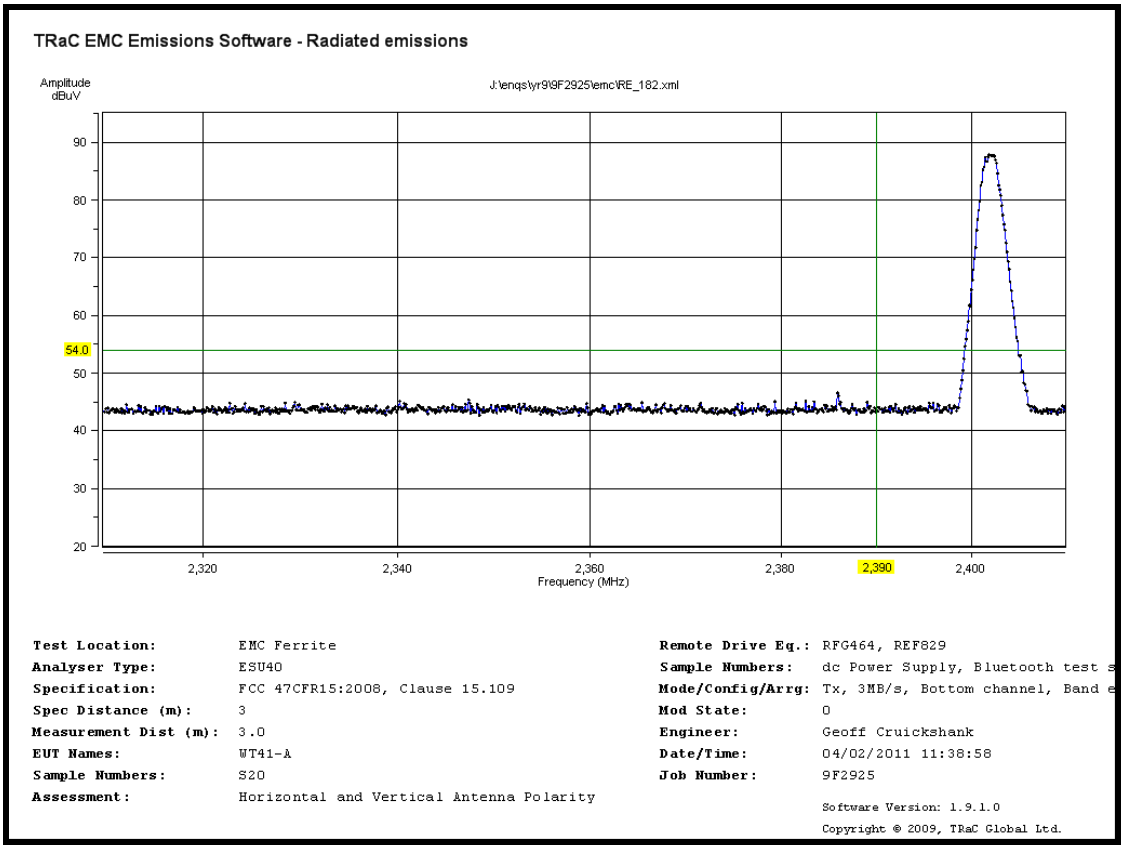


Radiated Spurious emissions 12 GHz to 18GHz – 2480MHz – 3Mbps for S20

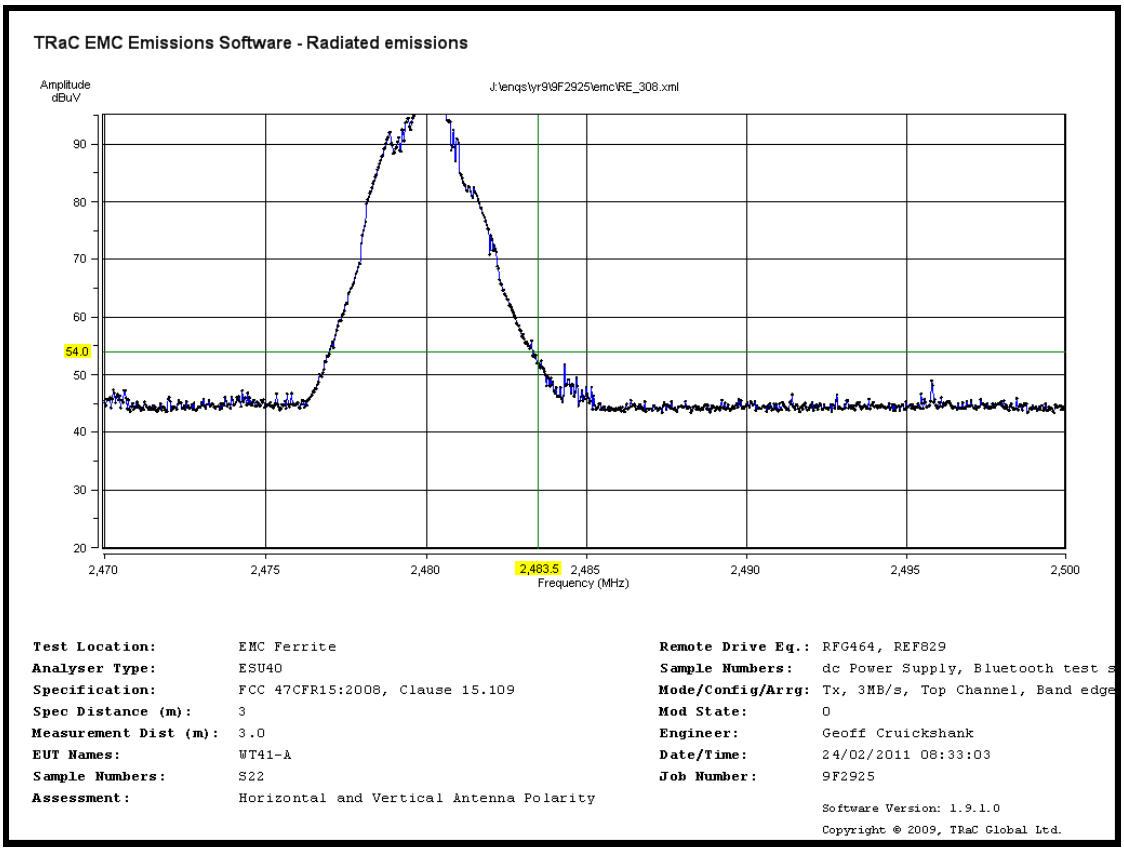


Radiated Spurious emissions 18 GHz to 25 GHz – 2480MHz – 3Mbps for S20

Radiated Bandedge Compliance – Peak plot to average limit

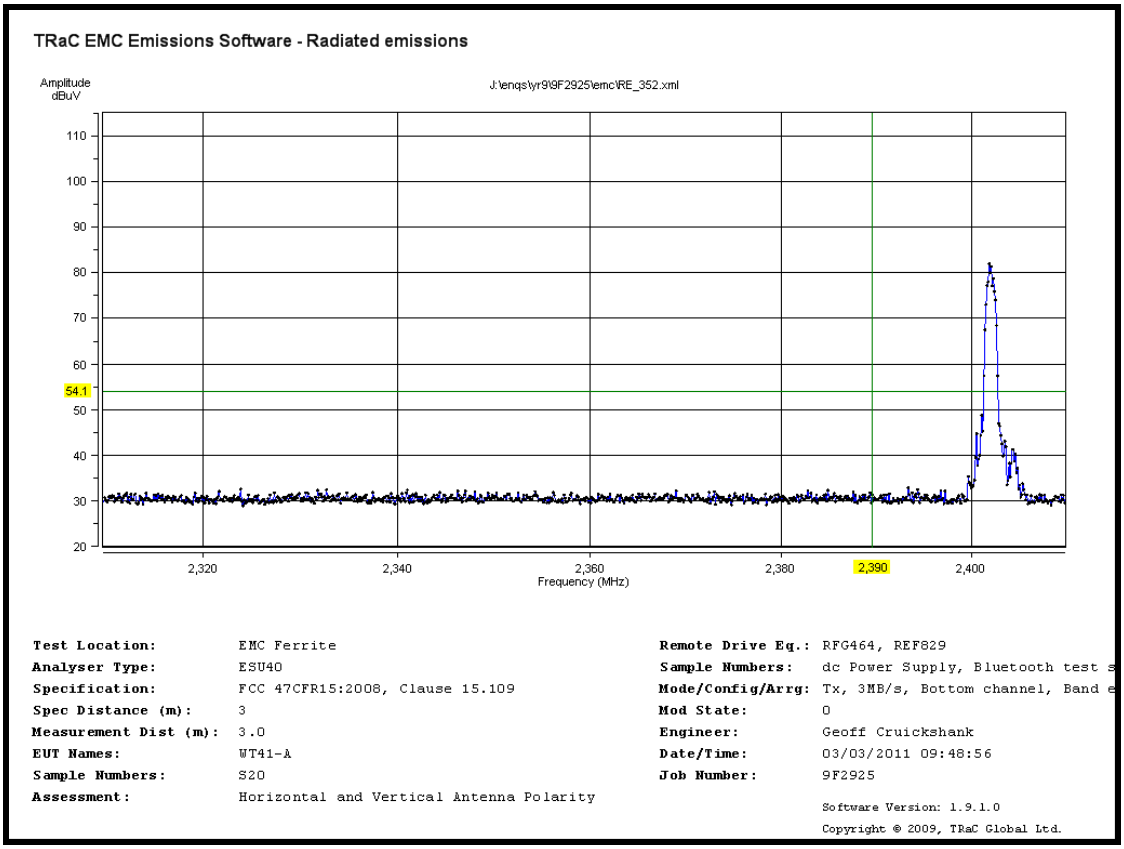


Lower Bandedge

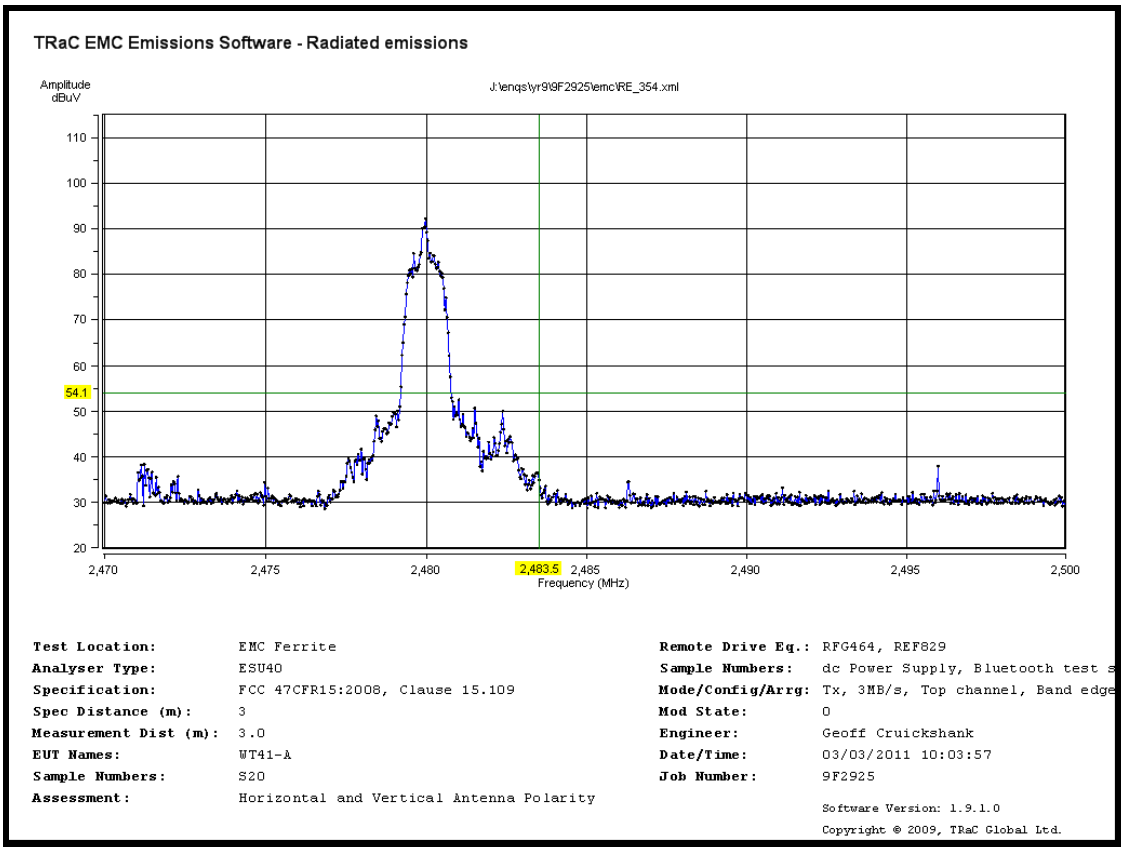


Upper Bandedge

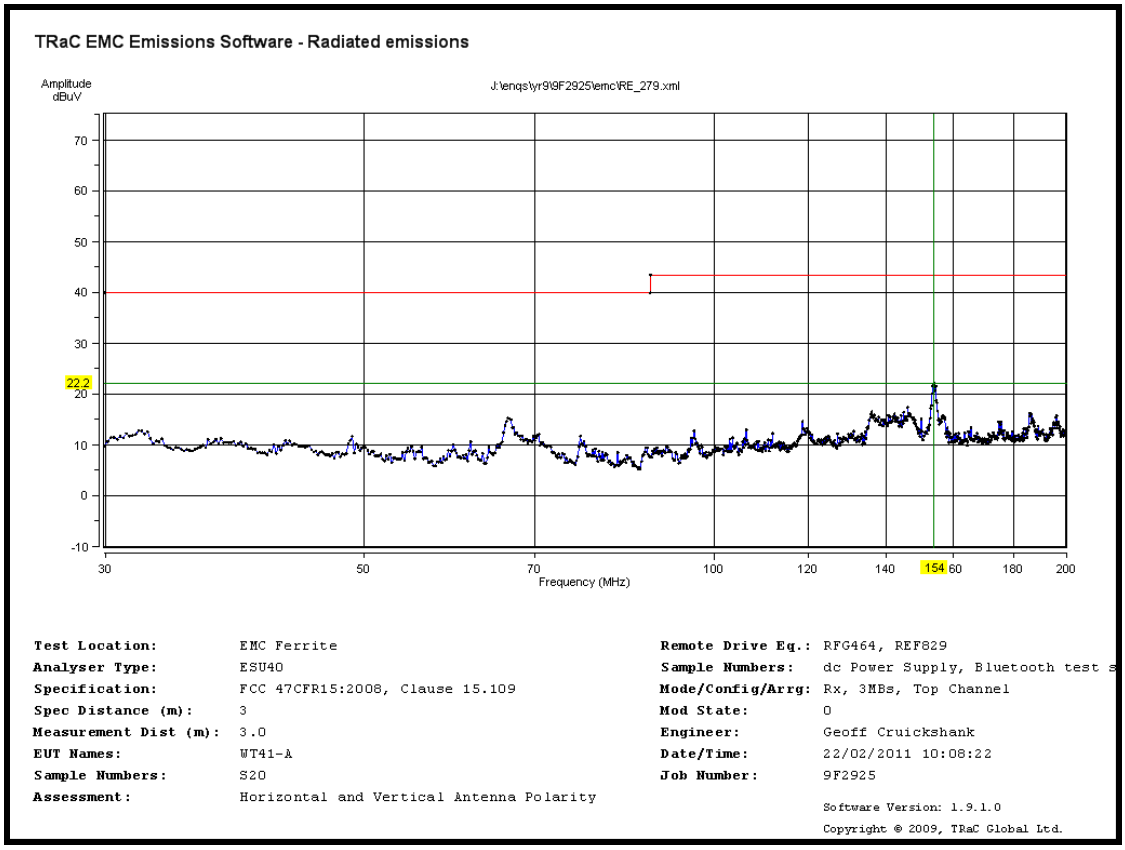
Radiated Bandedge Compliance – Average plot to average limit



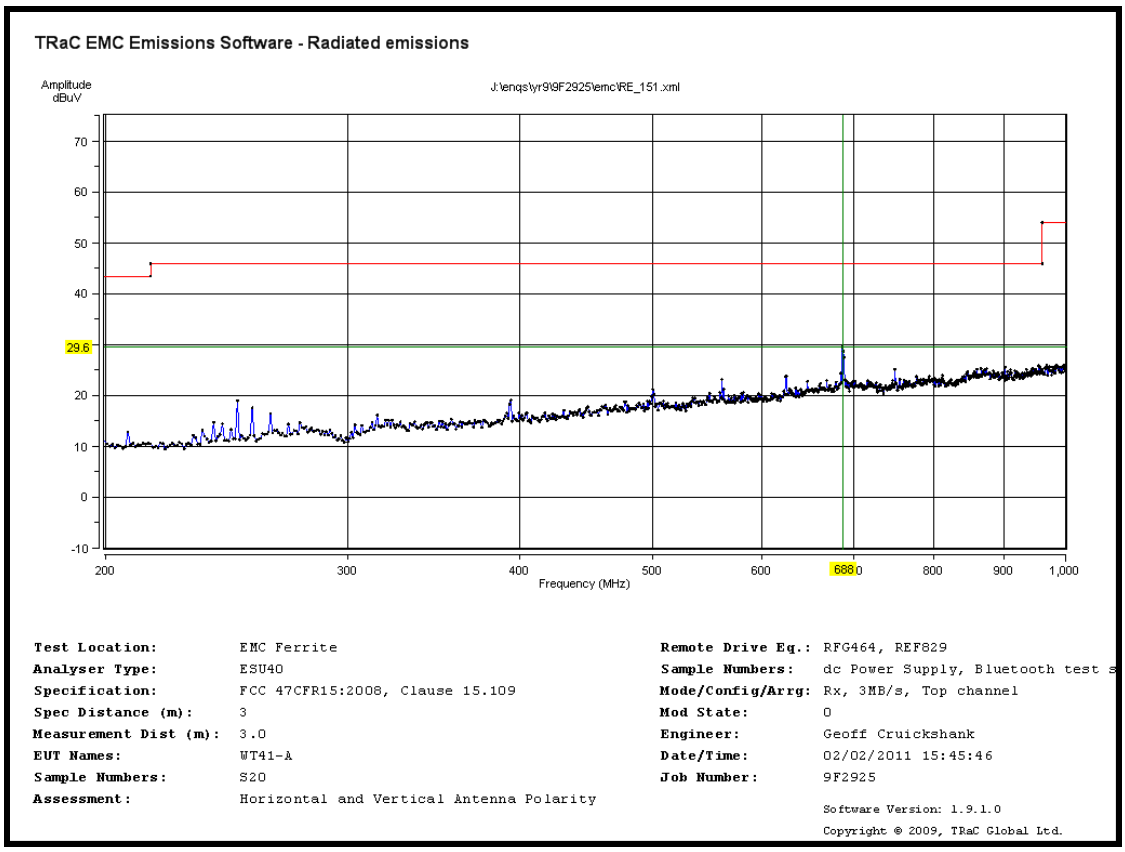
Lower Bandedge



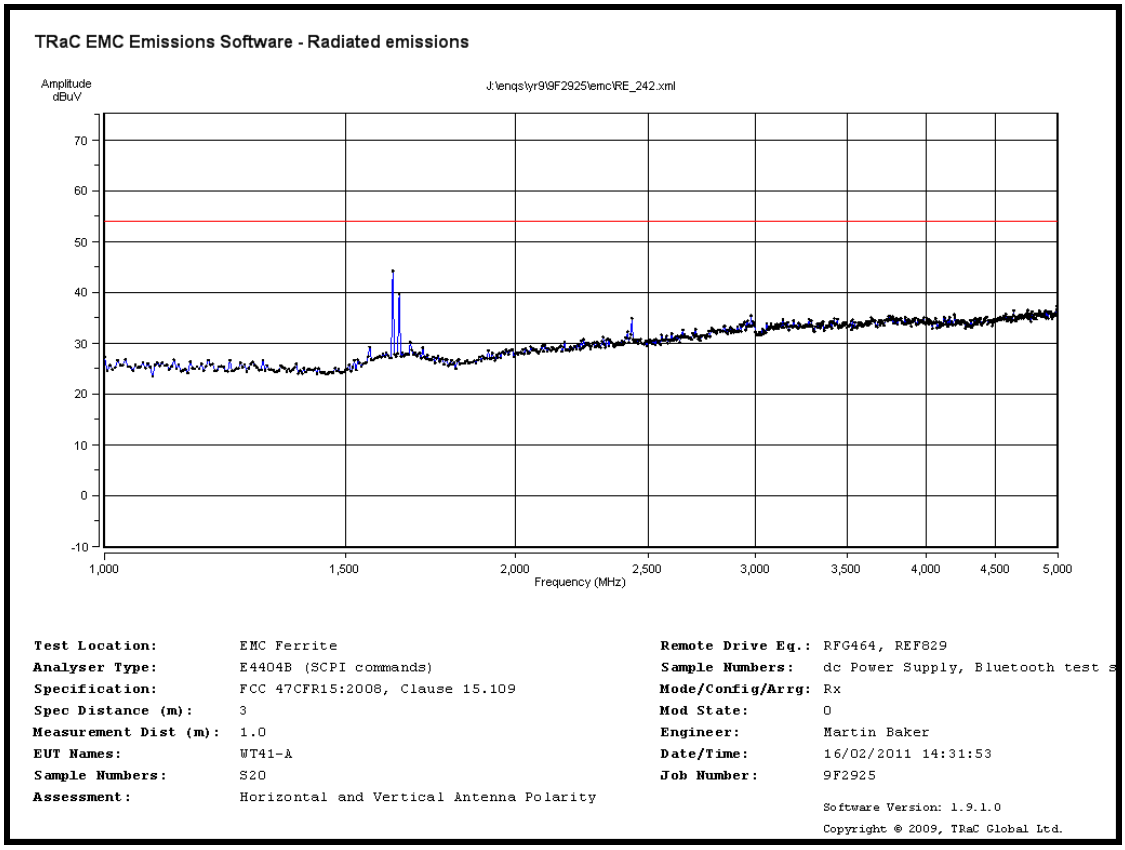
Upper Bandedge



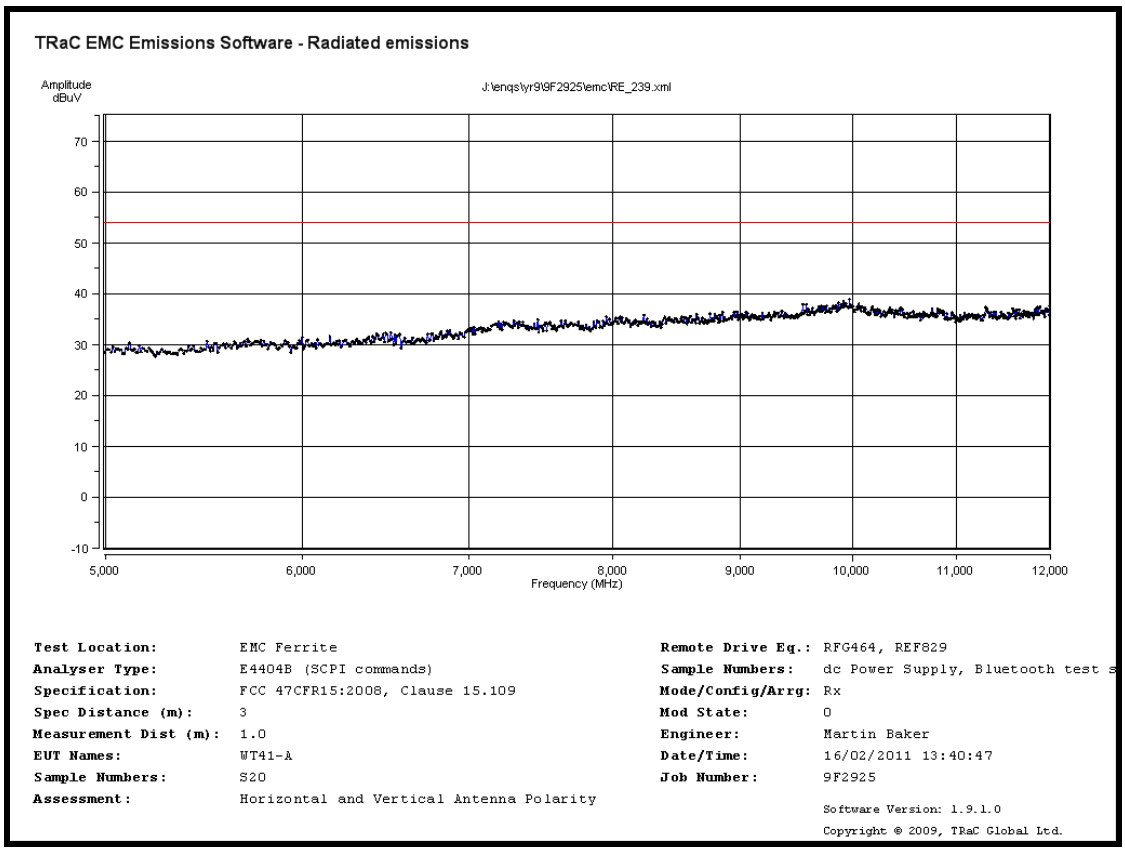
Unintentional Radiated Spurious emissions 30 MHz to 1 GHz for S20



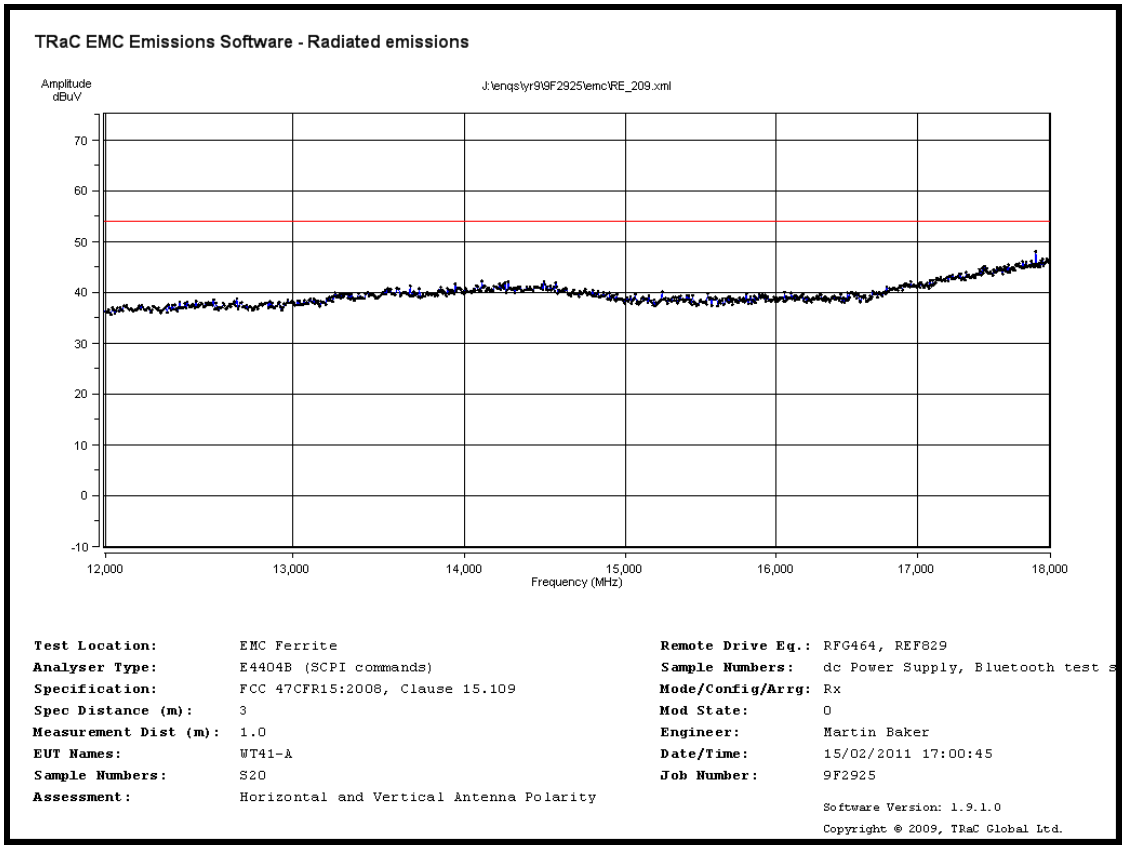
Unintentional Radiated Spurious emissions 200 MHz to 1000 MHz for S20



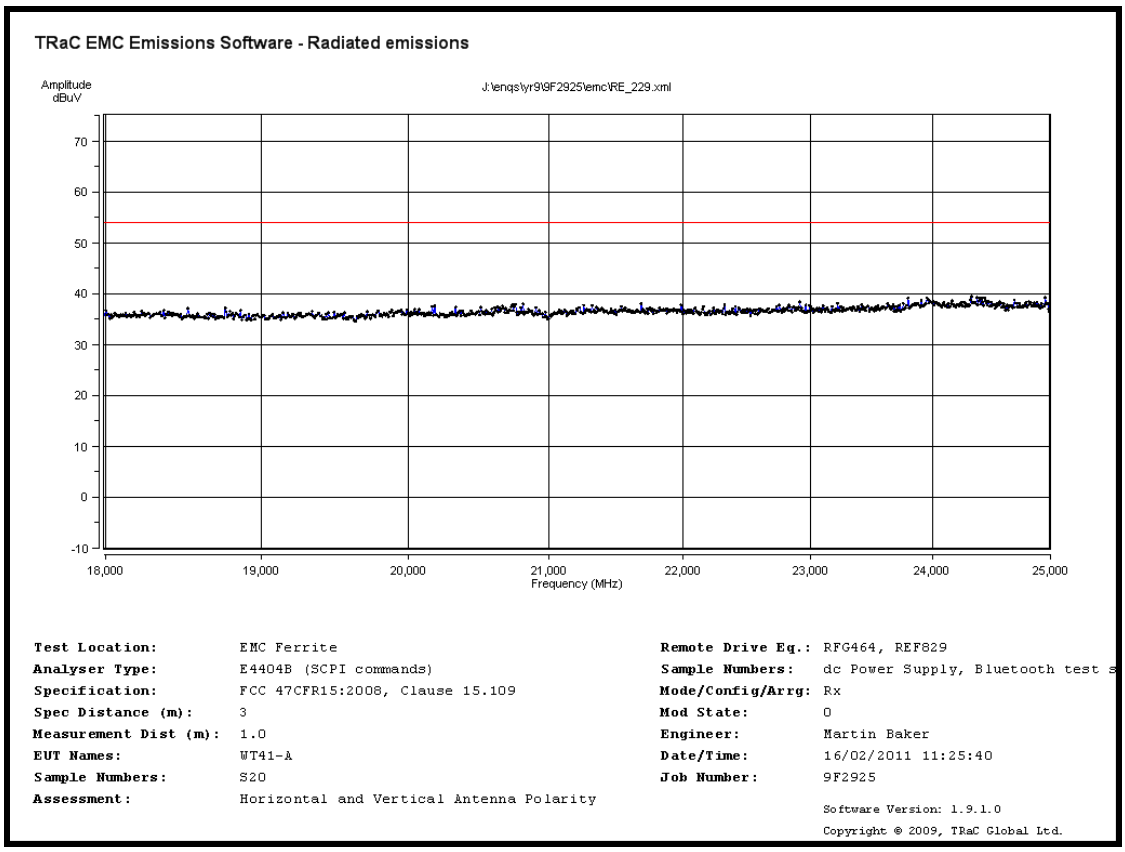
Unintentional Radiated Spurious emissions 1 GHz to 5 GHz for S20



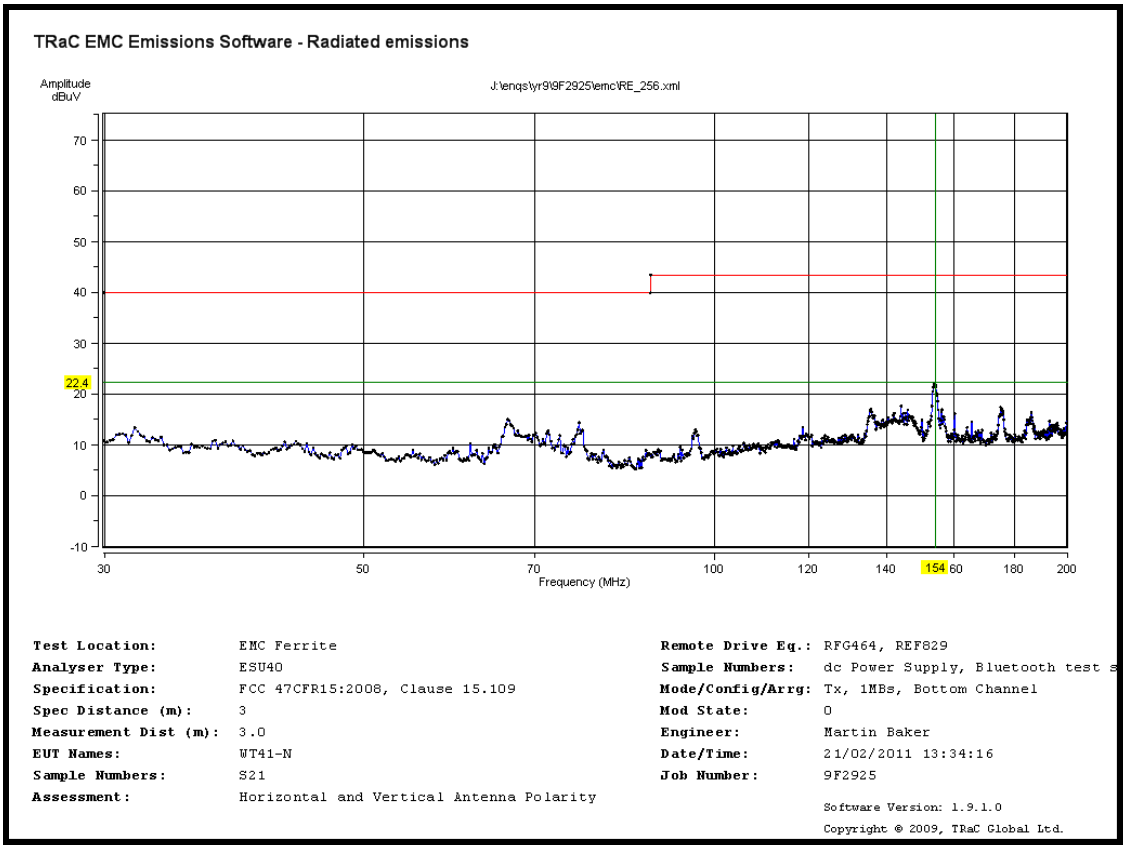
Unintentional Radiated Spurious emissions 5 GHz to 12 GHz for S20



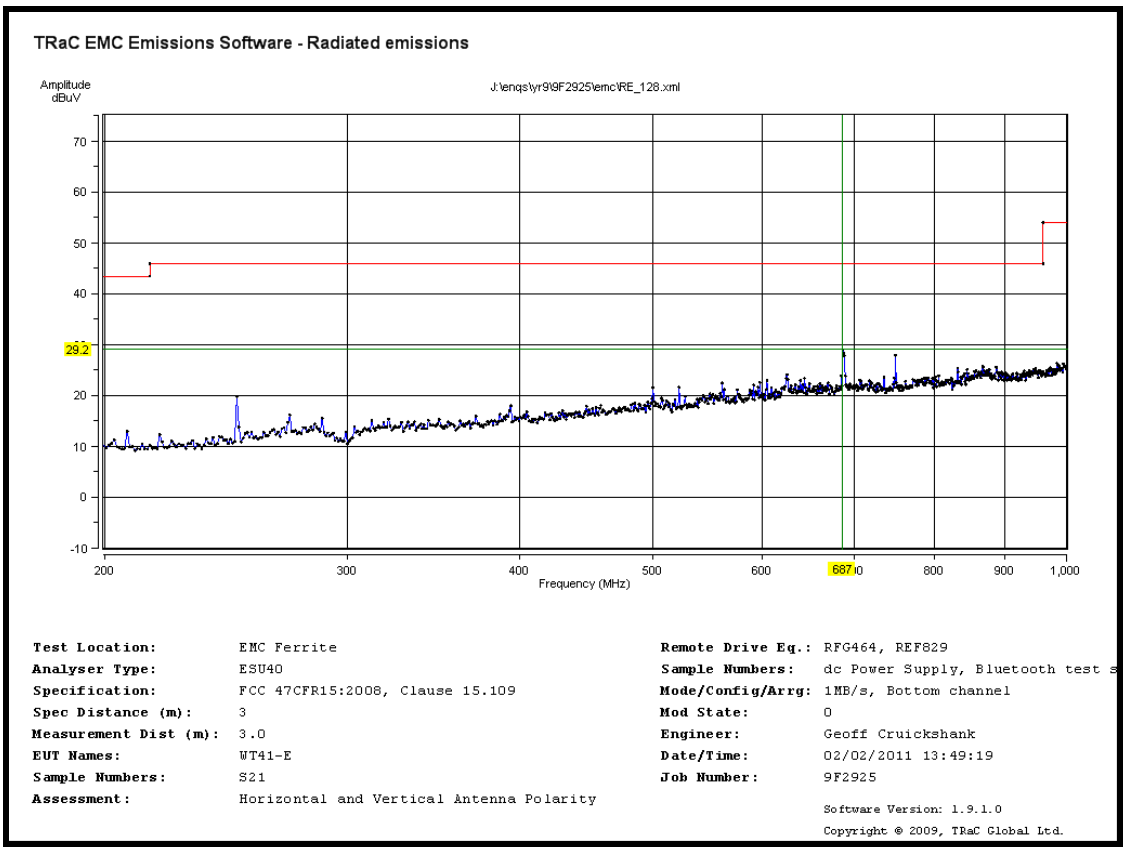
Unintentional Radiated Spurious emissions 12 GHz to 18GHz for S20



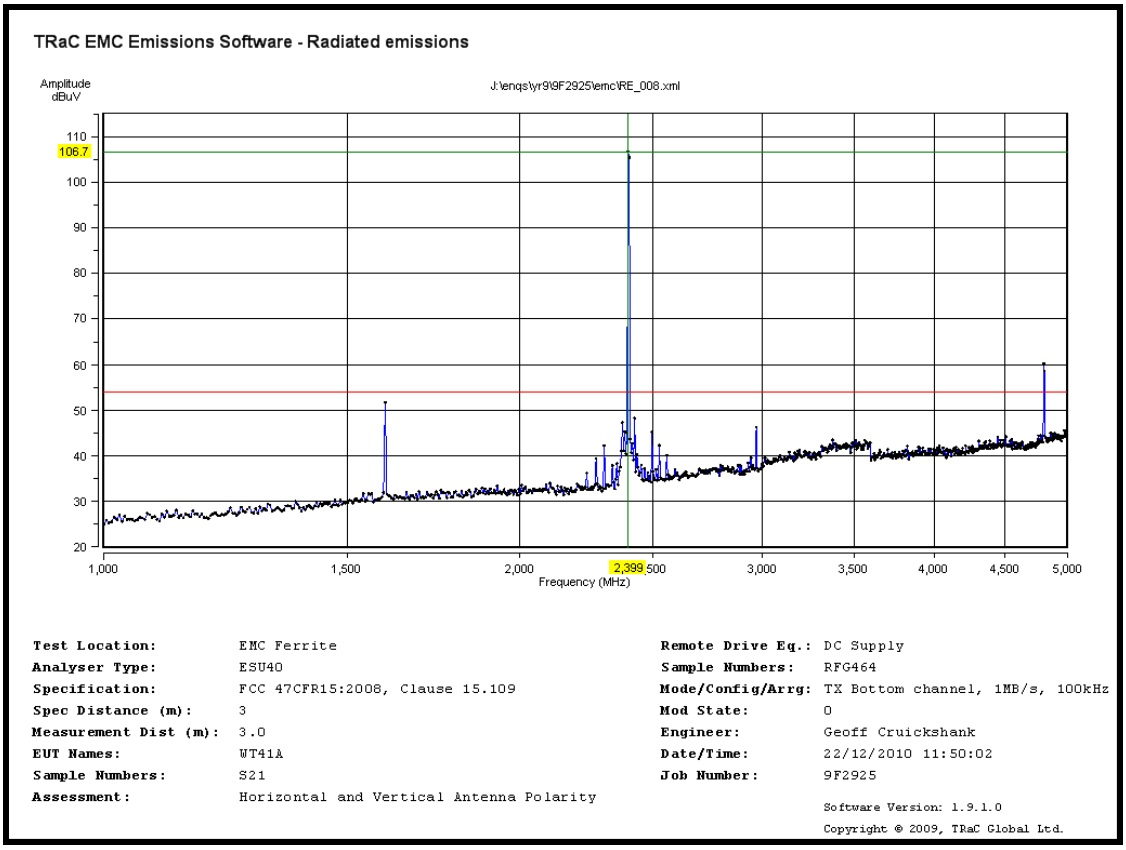
Unintentional Radiated Spurious emissions 18 GHz to 25 GHz for S20



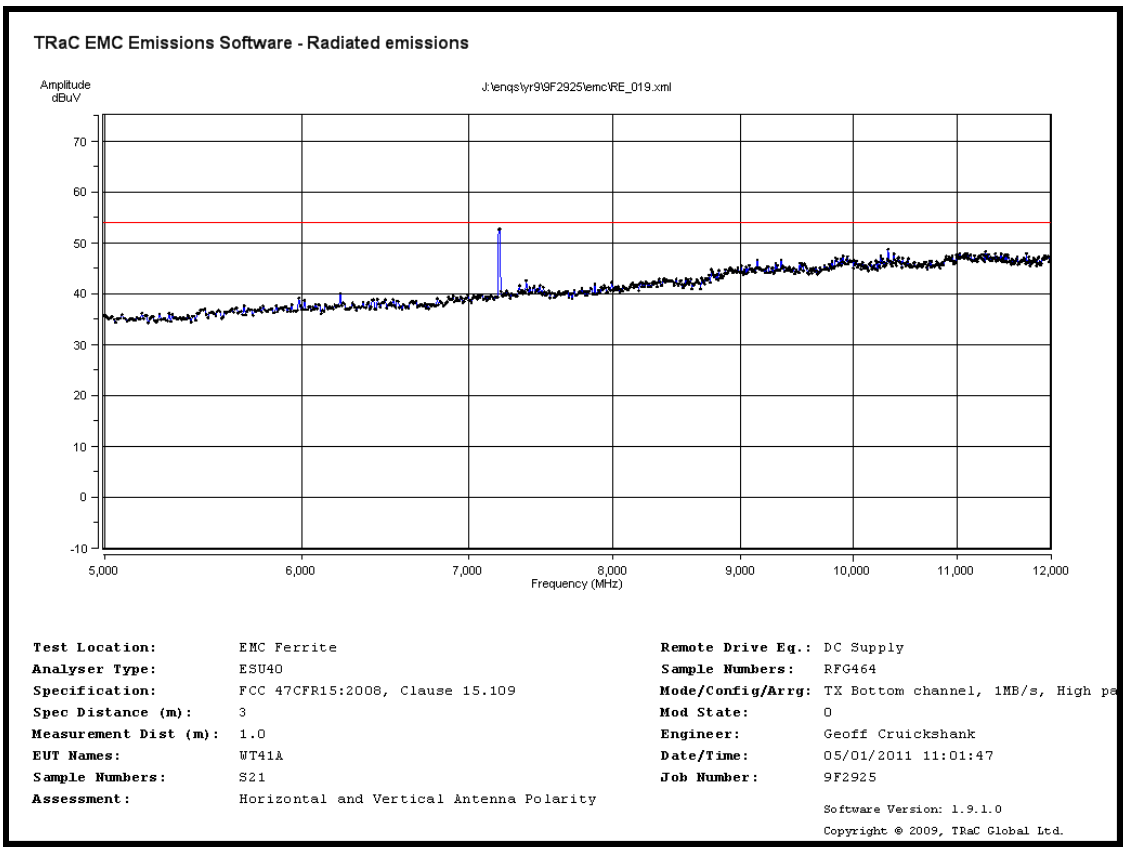
Radiated Spurious emissions 30 MHz to 200 MHz – 2402MHz – 1Mbps for S21



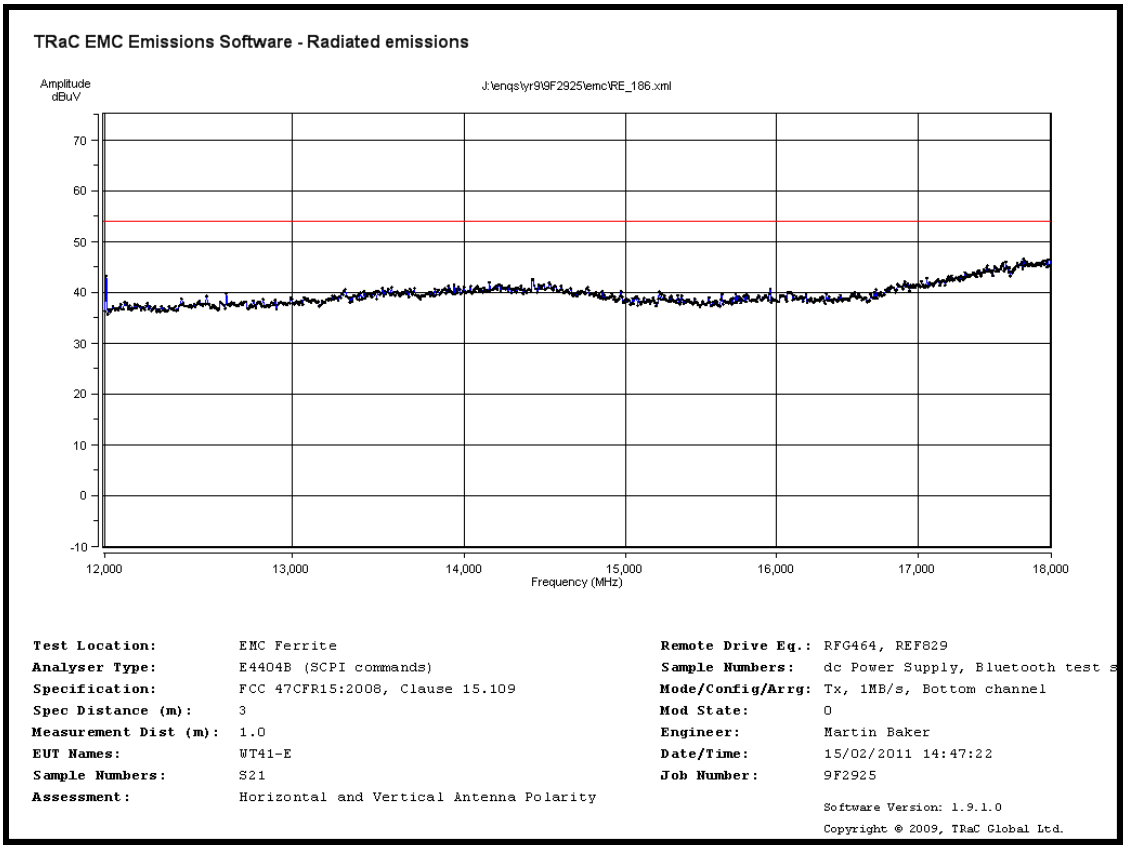
Radiated Spurious emissions 200 MHz to 1 GHz – 2402MHz – 1Mbps for S21



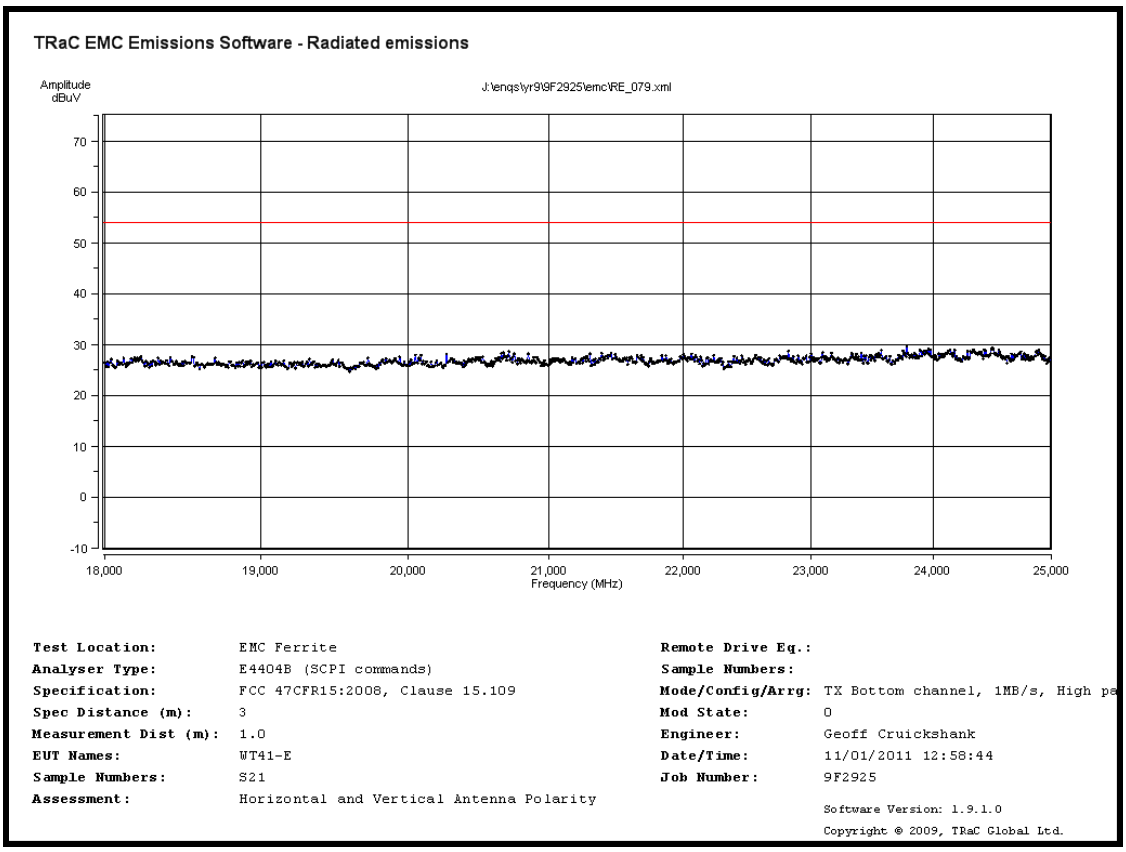
Radiated Spurious emissions 1 GHz to 5 GHz – 2402MHz – 1Mbps for S21



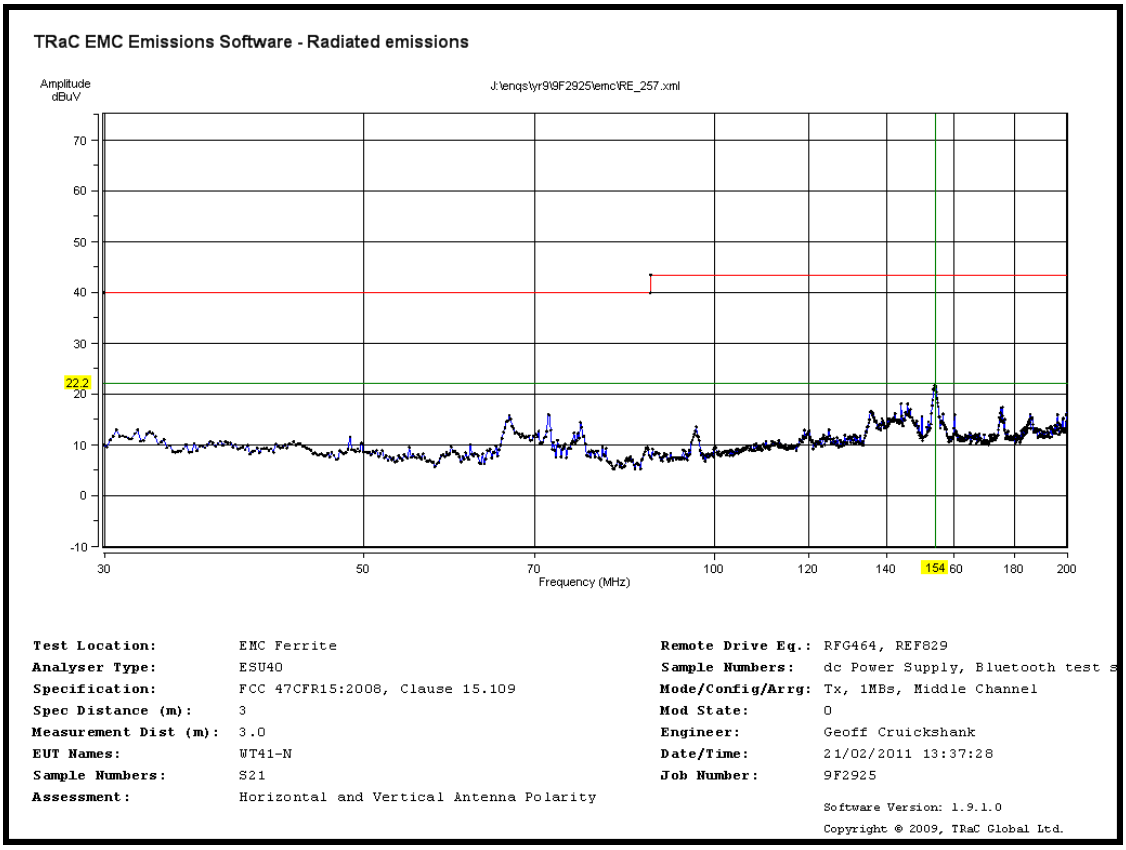
Radiated Spurious emissions 5 GHz to 12 GHz – 2402MHz – 1Mbps for S21



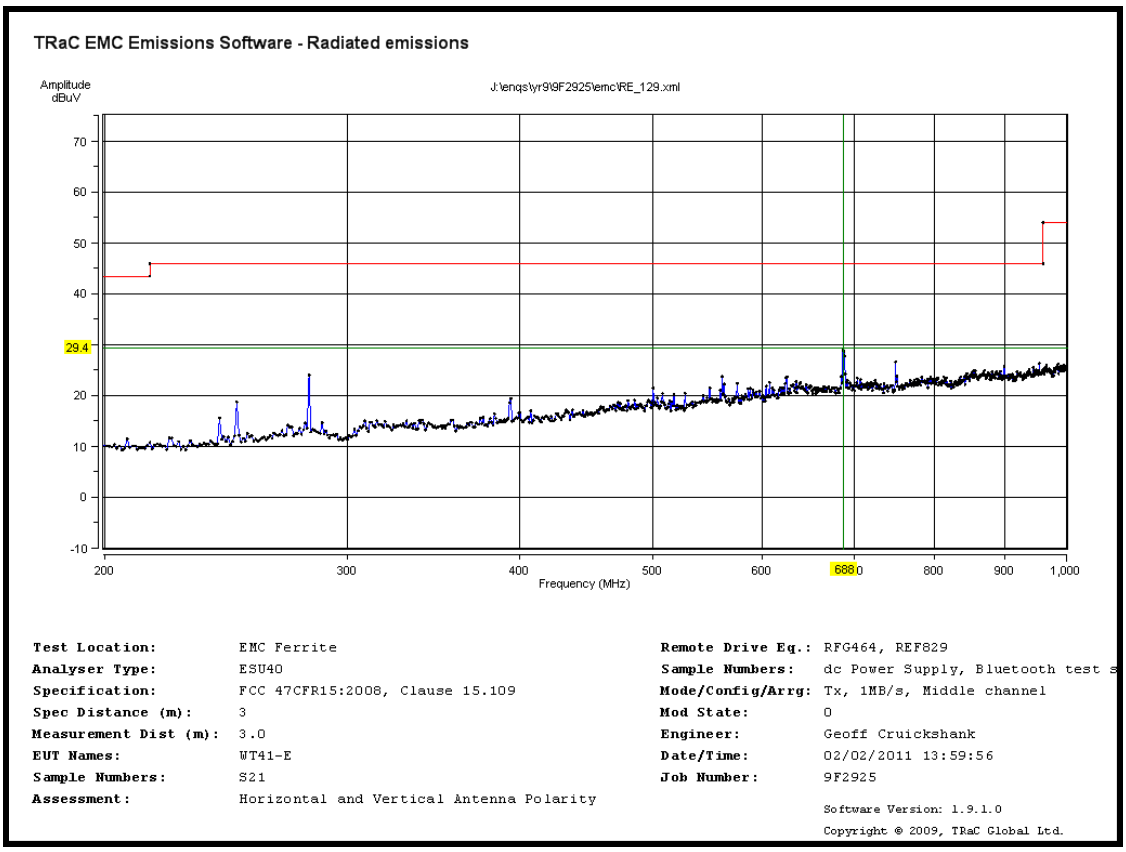
Radiated Spurious emissions 12 GHz to 18GHz – 2402MHz – 1Mbps for S21



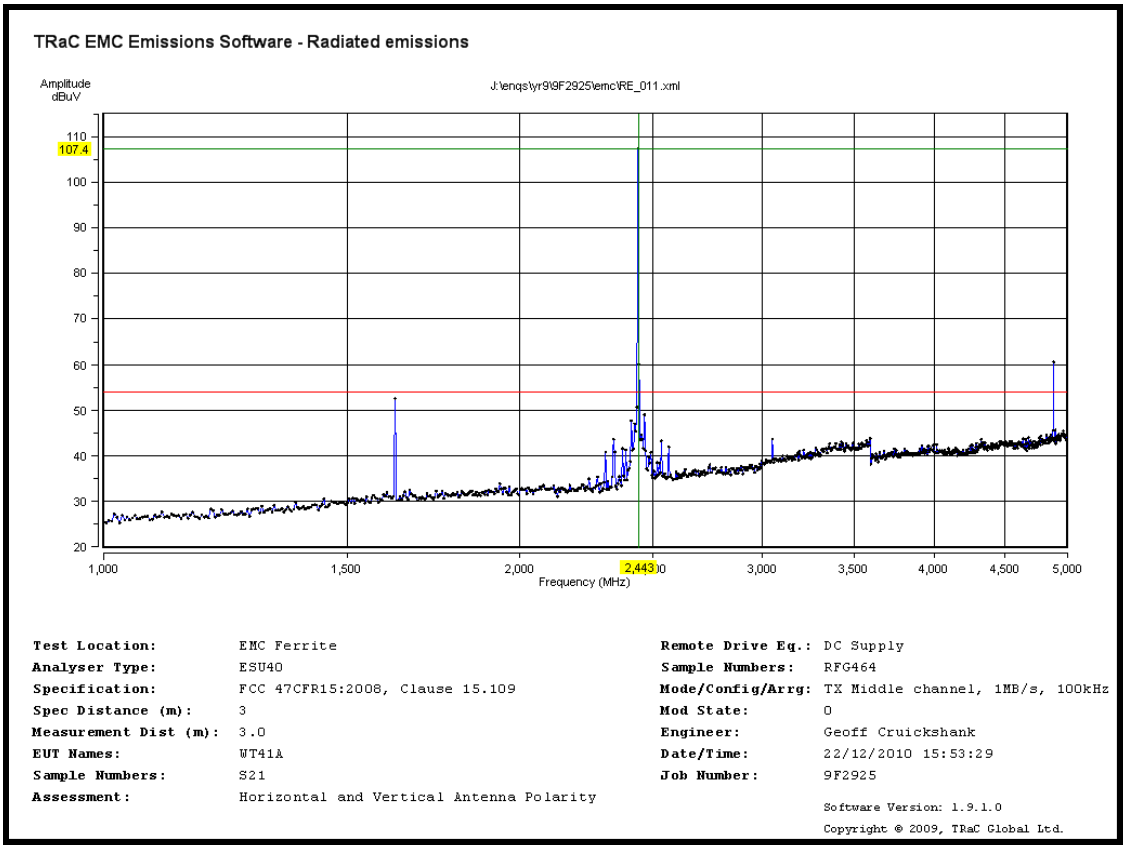
Radiated Spurious emissions 18 GHz to 25 GHz – 2402MHz – 1Mbps for S21



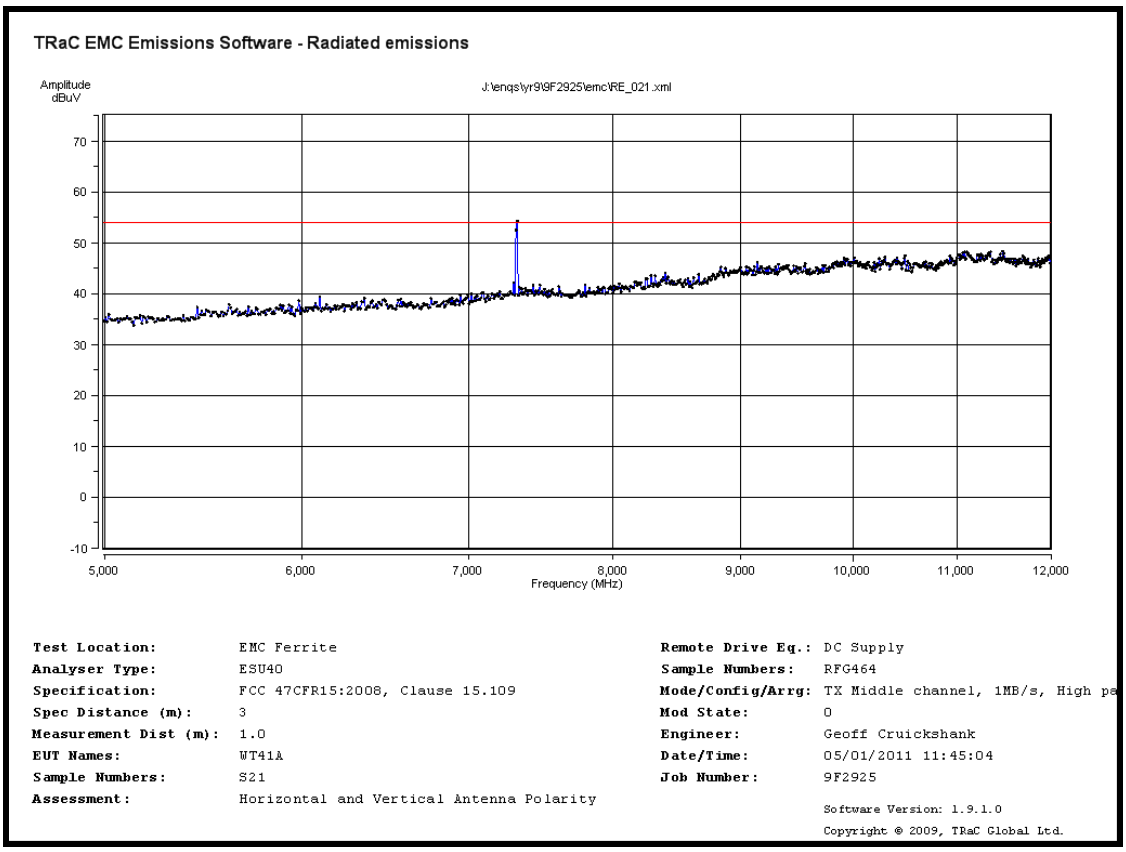
Radiated Spurious emissions 30 MHz to 200 MHz – 2441MHz – 1Mbps for S21



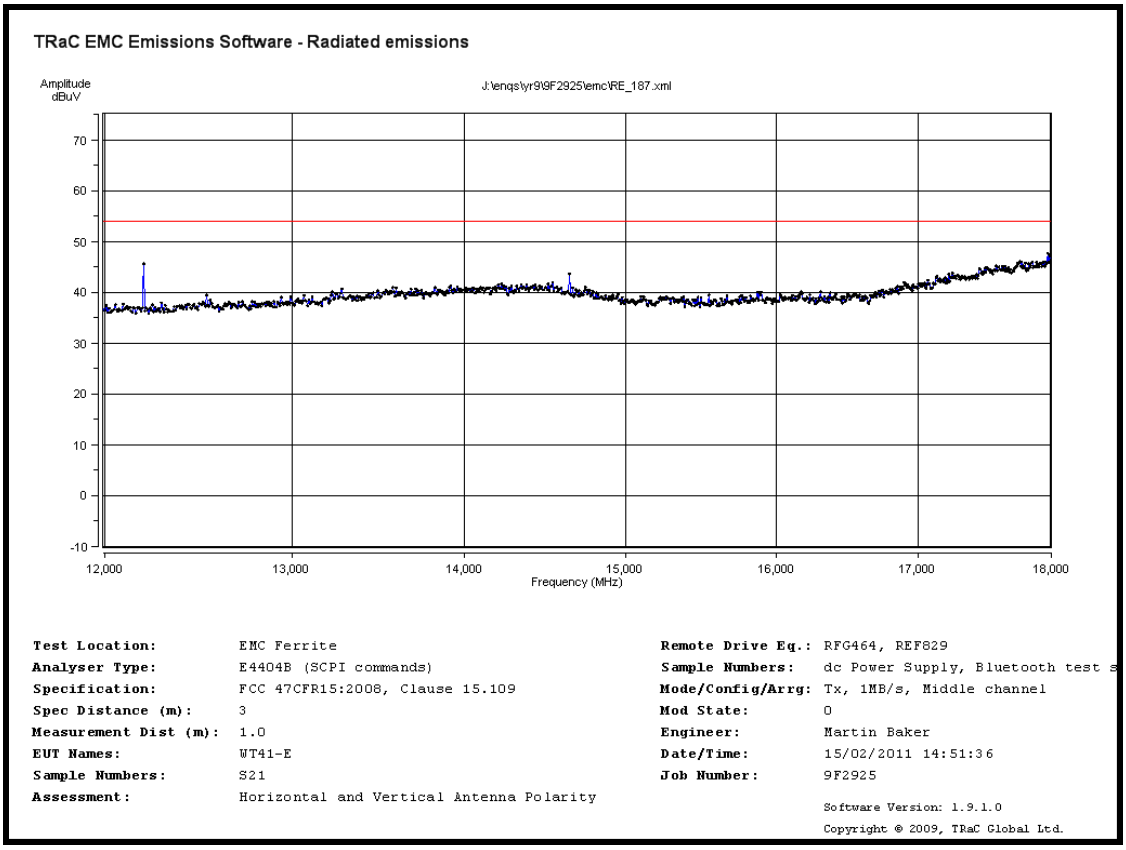
Radiated Spurious emissions 200 MHz to 1 GHz – 2441MHz – 1Mbps for S21



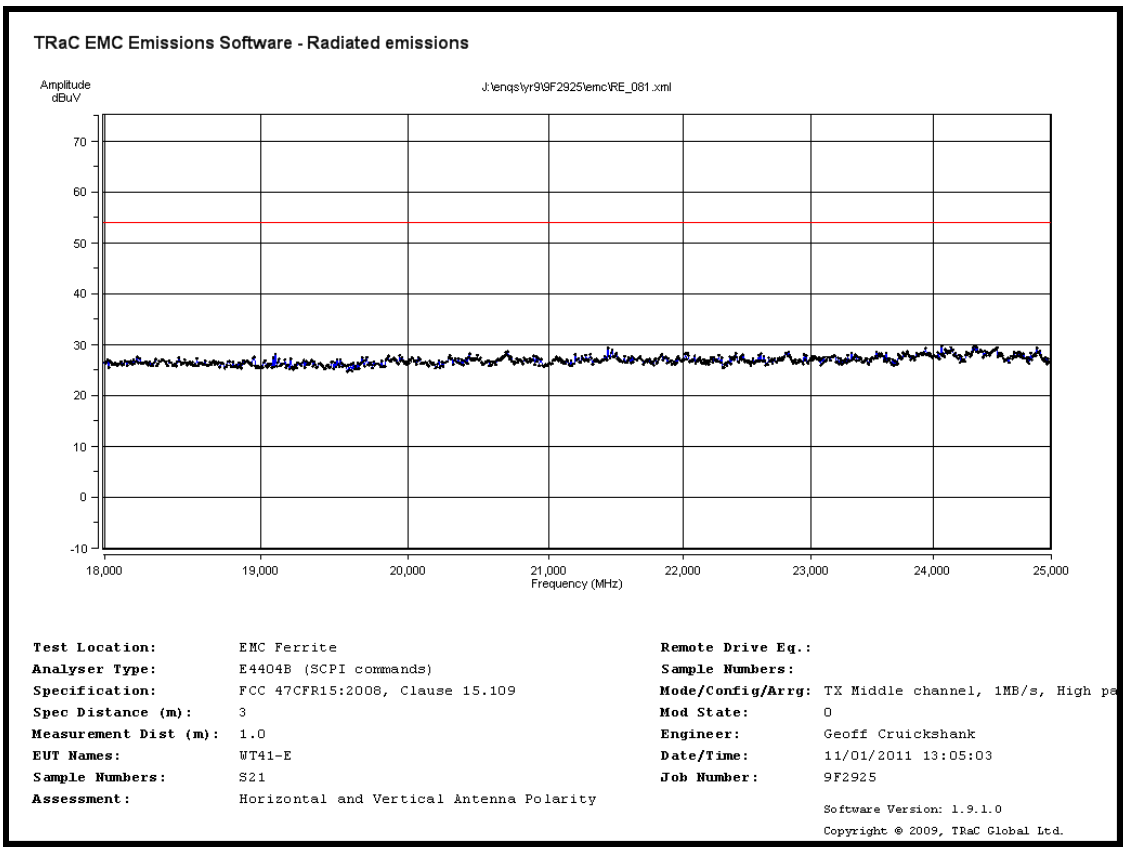
Radiated Spurious emissions 1 GHz to 5 GHz – 2441MHz – 1Mbps for S21



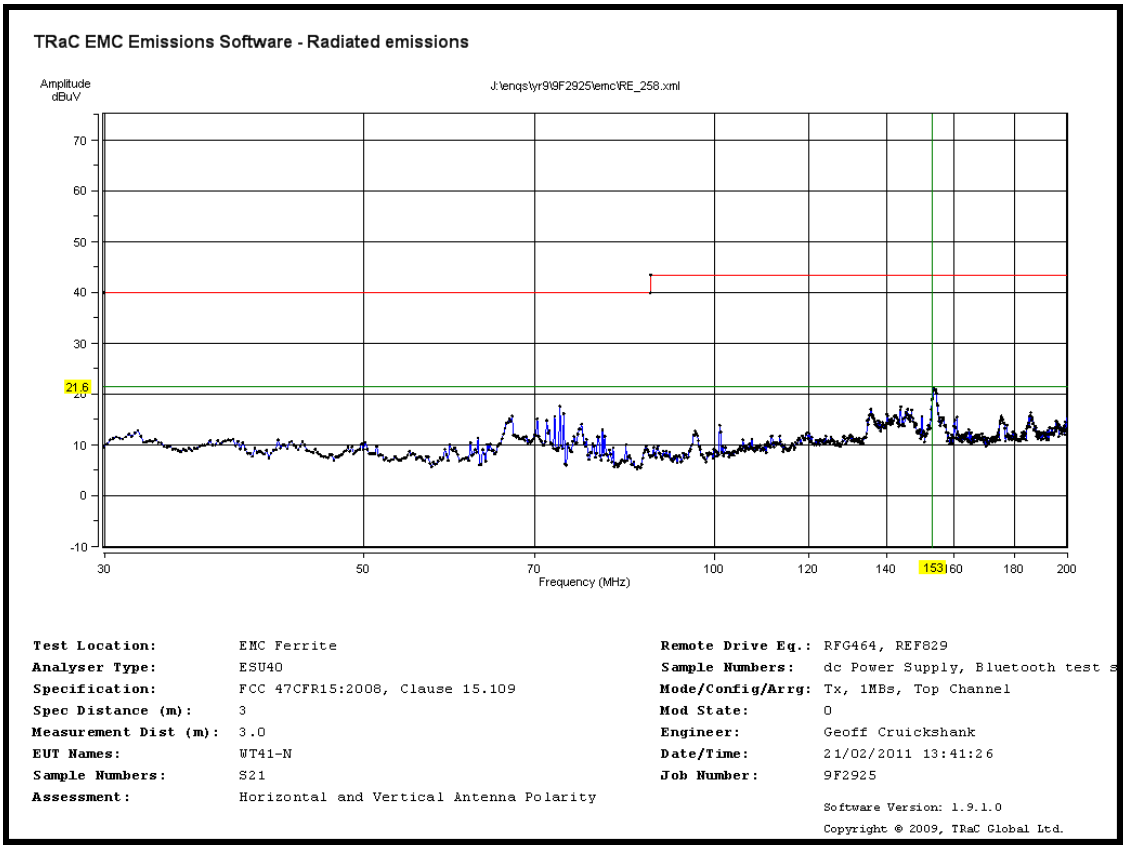
Radiated Spurious emissions 5 GHz to 12 GHz – 2441MHz – 1Mbps for S21



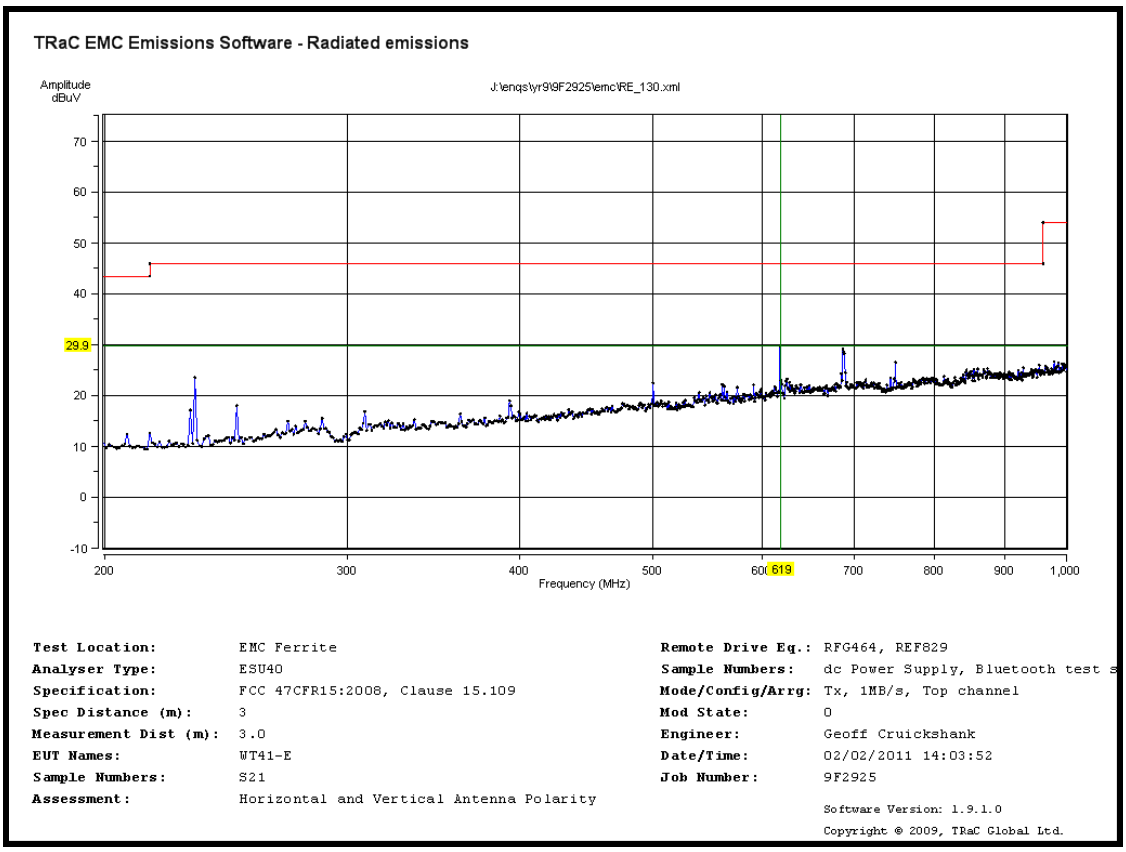
Radiated Spurious emissions 12 GHz to 18GHz – 2441MHz – 1Mbps for S21



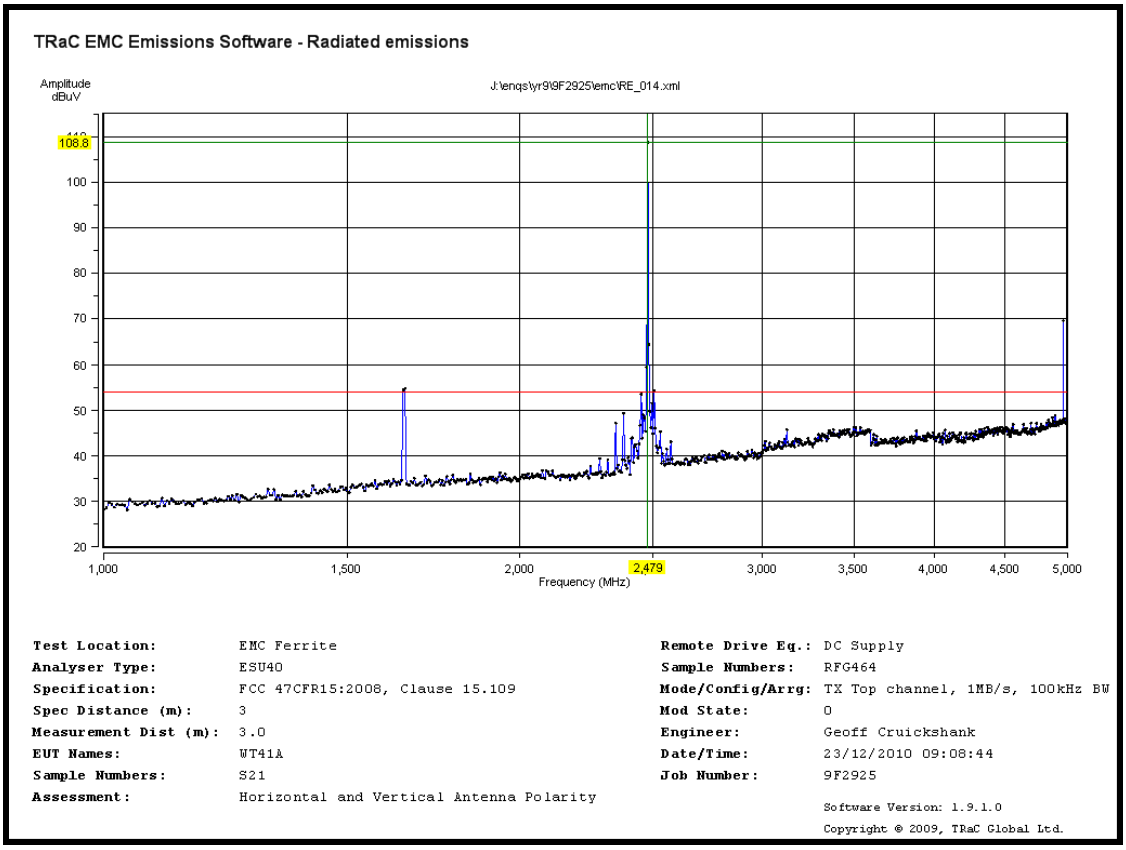
Radiated Spurious emissions 18 GHz to 25 GHz – 2441MHz – 1Mbps for S21



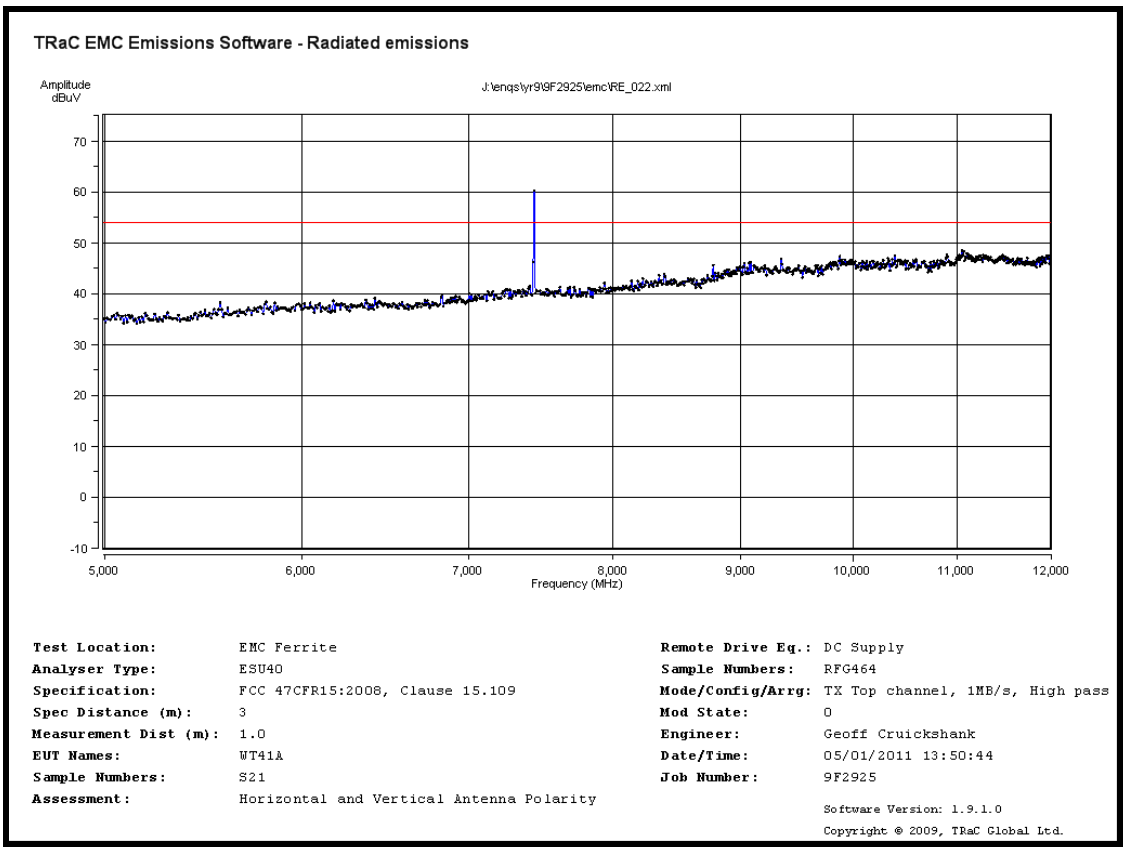
Radiated Spurious emissions 30 MHz to 200 MHz – 2480MHz – 1Mbps for S21



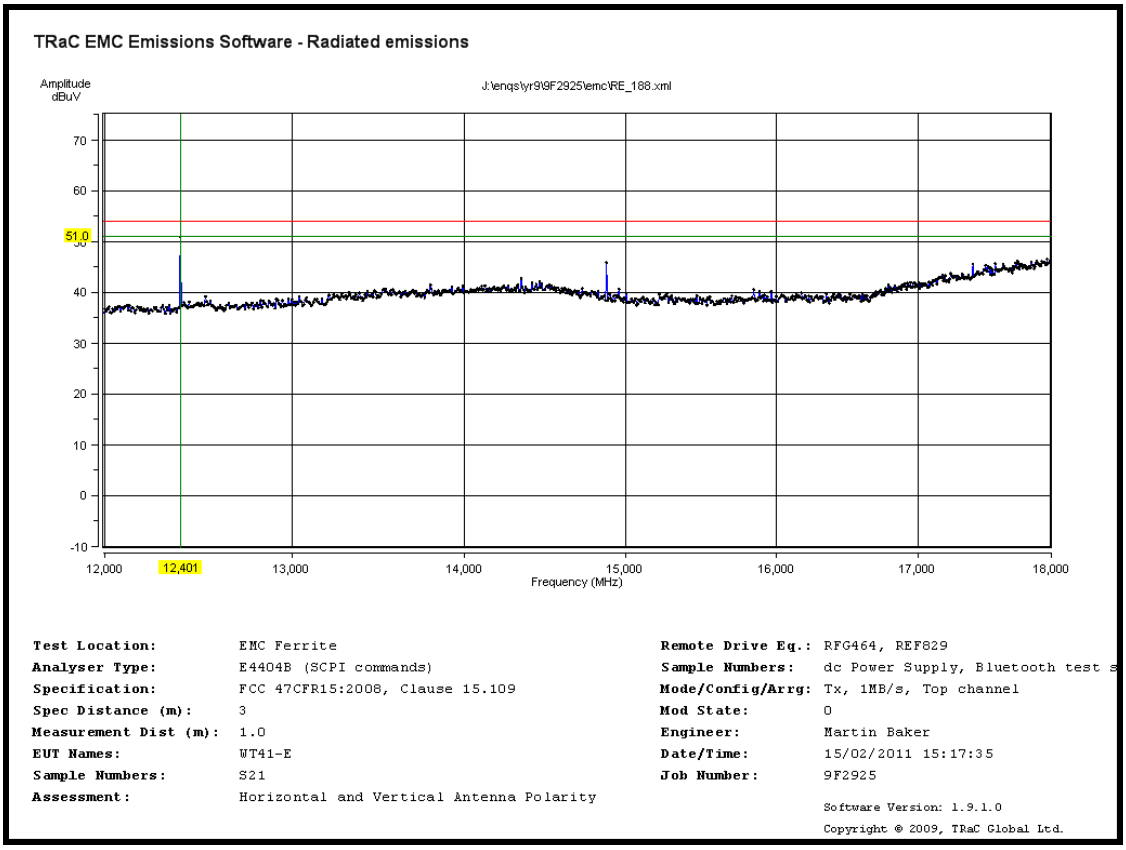
Radiated Spurious emissions 200 MHz to 1 GHz – 2480MHz – 1Mbps for S21



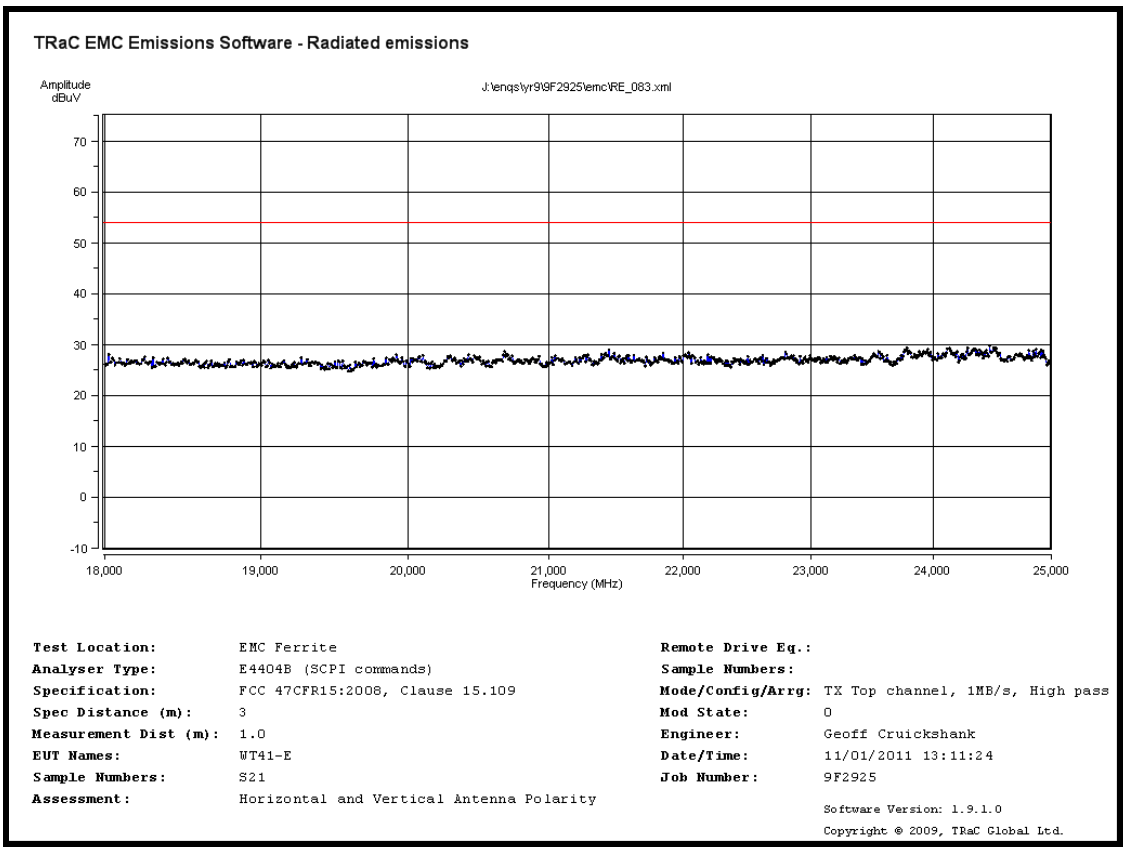
Radiated Spurious emissions 1 GHz to 5 GHz – 2480MHz – 1Mbps for S21



Radiated Spurious emissions 5 GHz to 12 GHz – 2480MHz – 1Mbps for S21

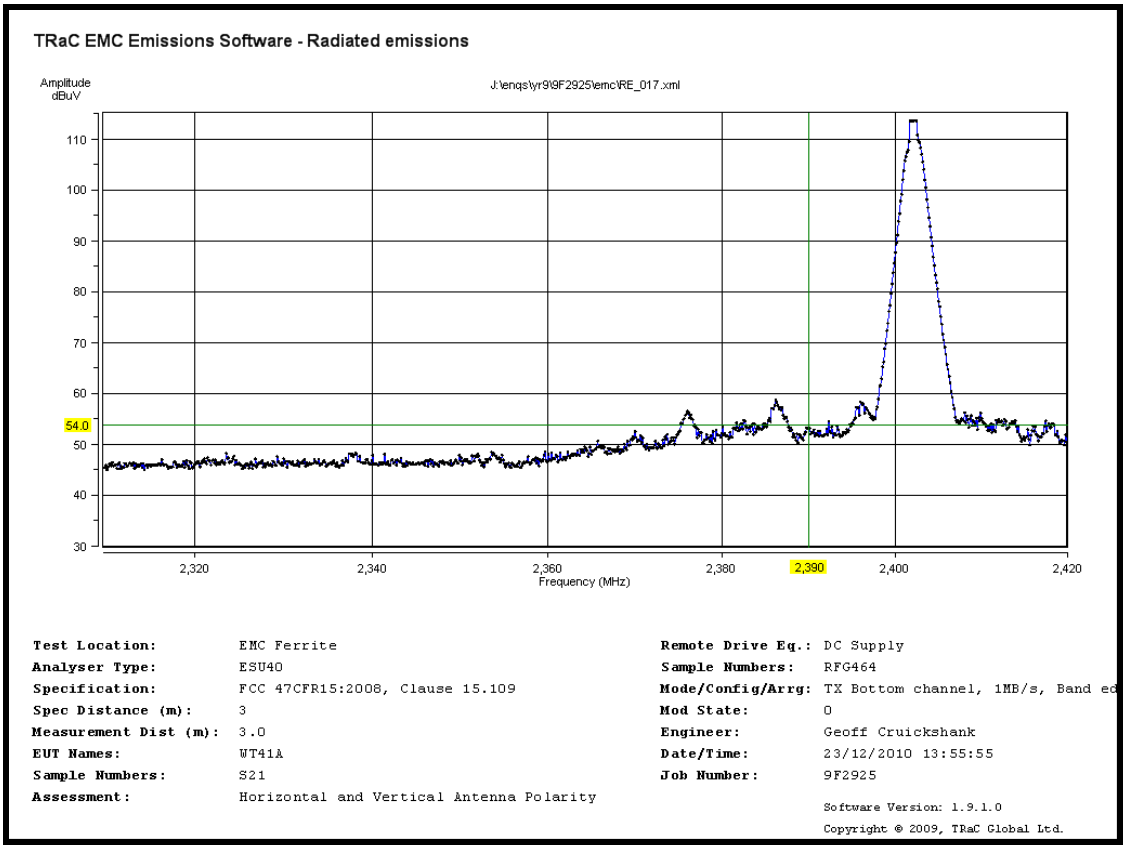


Radiated Spurious emissions 12 GHz to 18GHz – 2480MHz – 1Mbps for S21

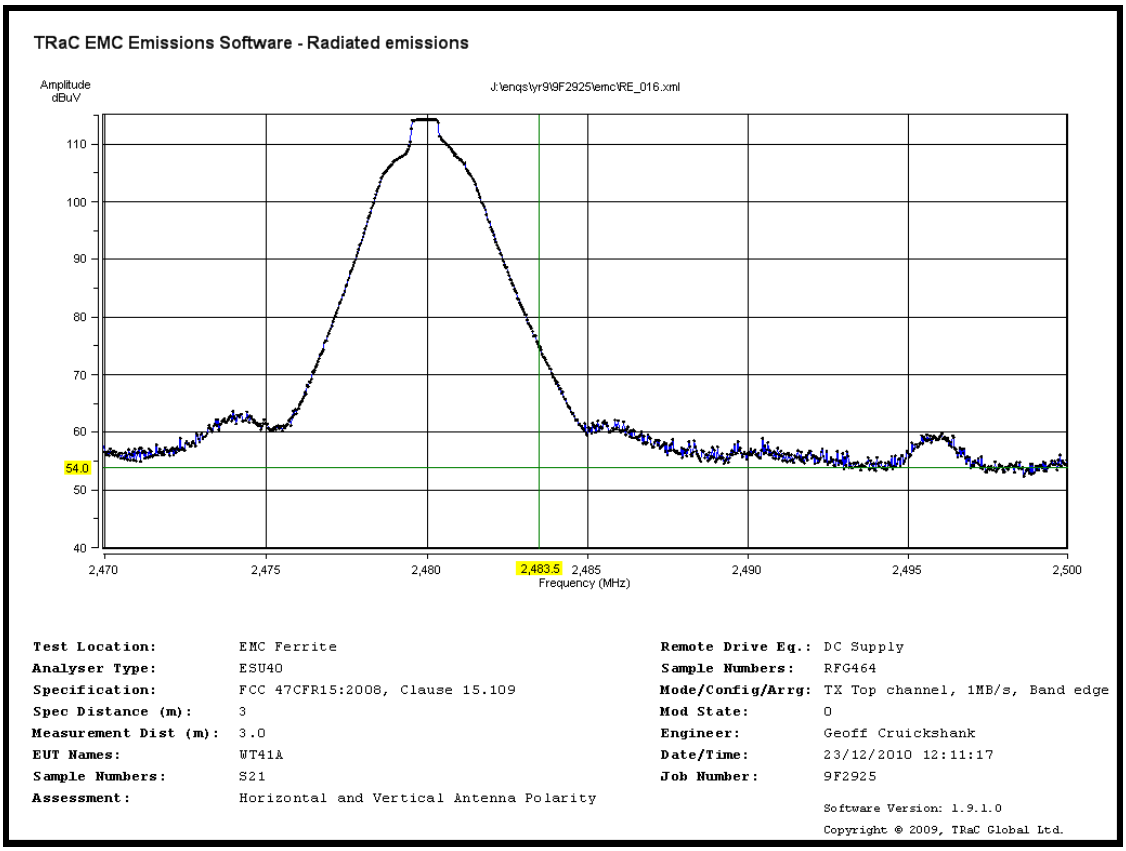


Radiated Spurious emissions 18 GHz to 25 GHz – 2480MHz – 1Mbps for S21

Radiated Bandedge Compliance – Peak plot to average limit

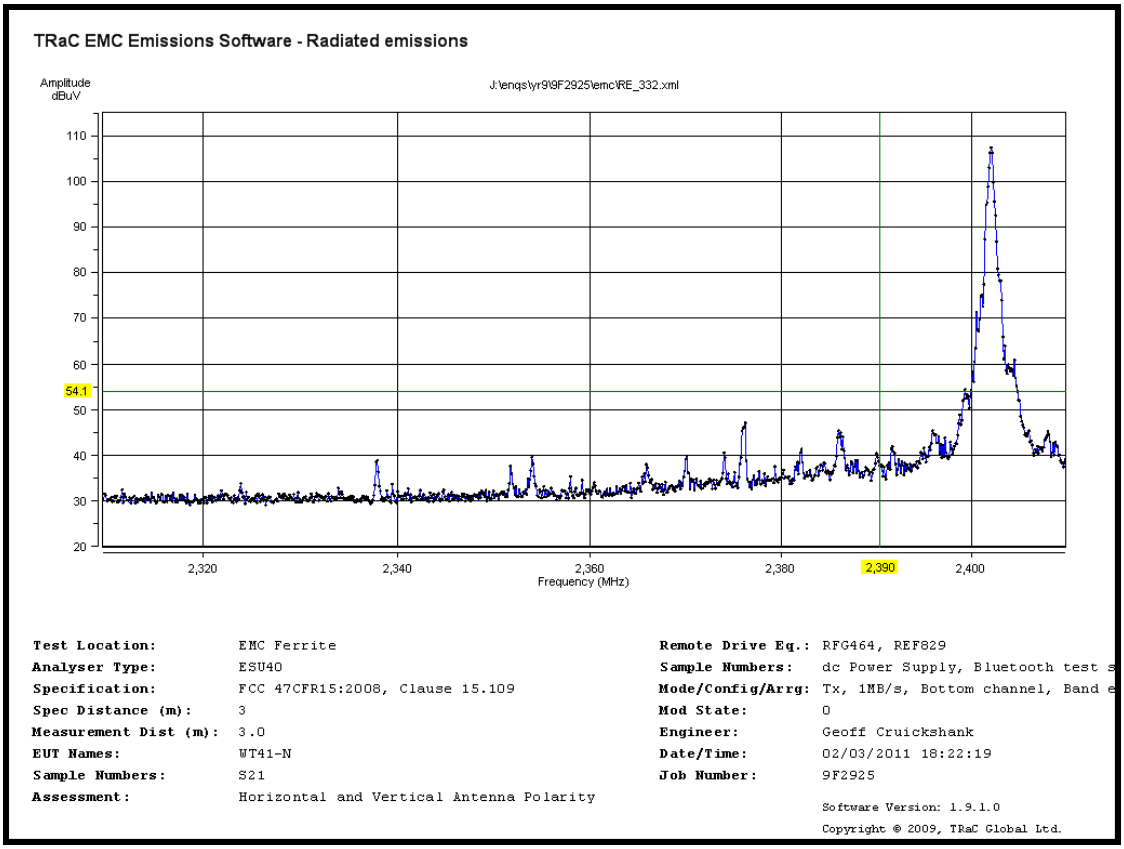


Lower Bandedge

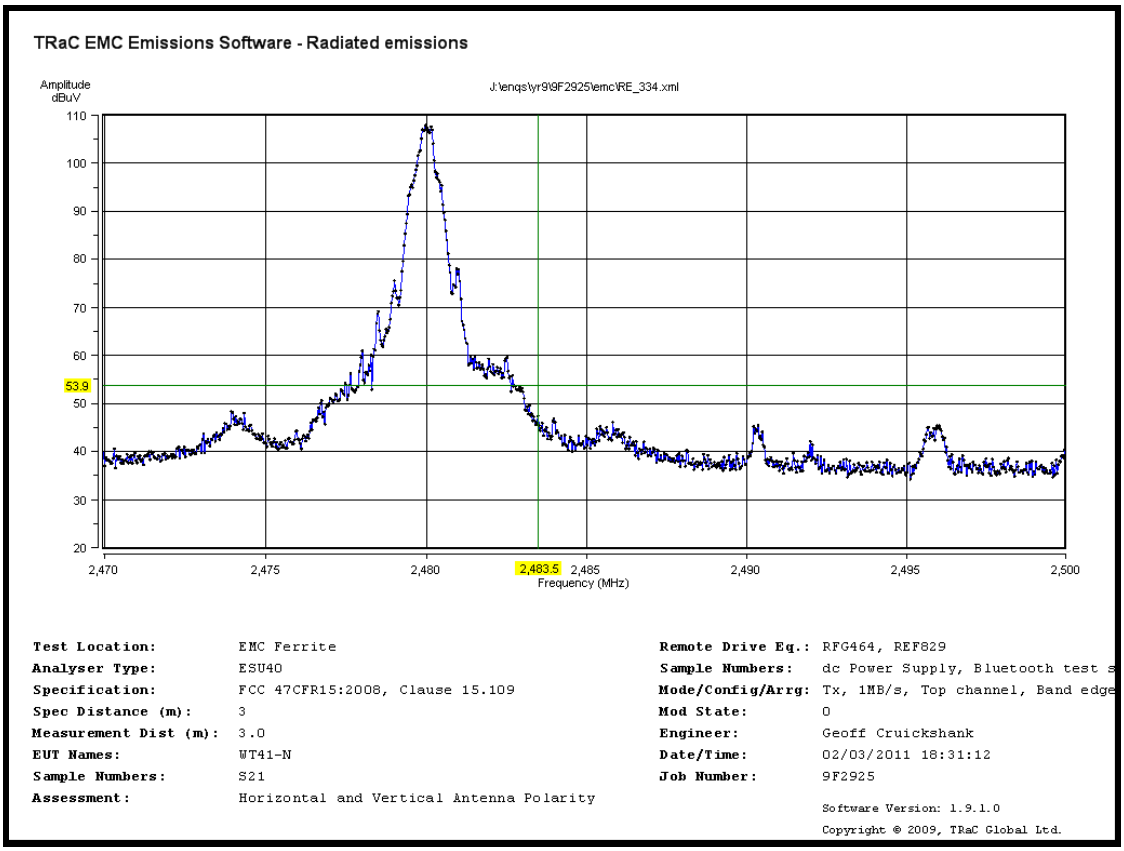


Upper Bandedge

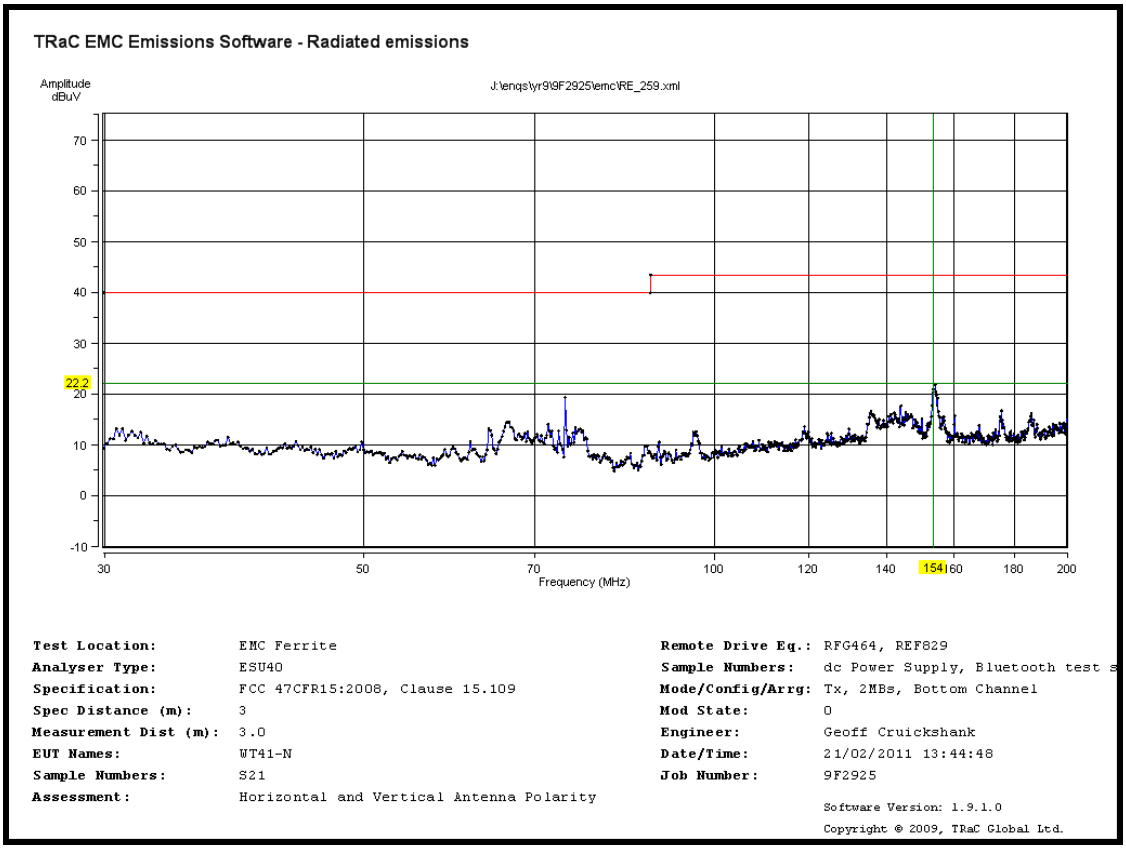
Radiated Bandedge Compliance – Average plot to Average limit



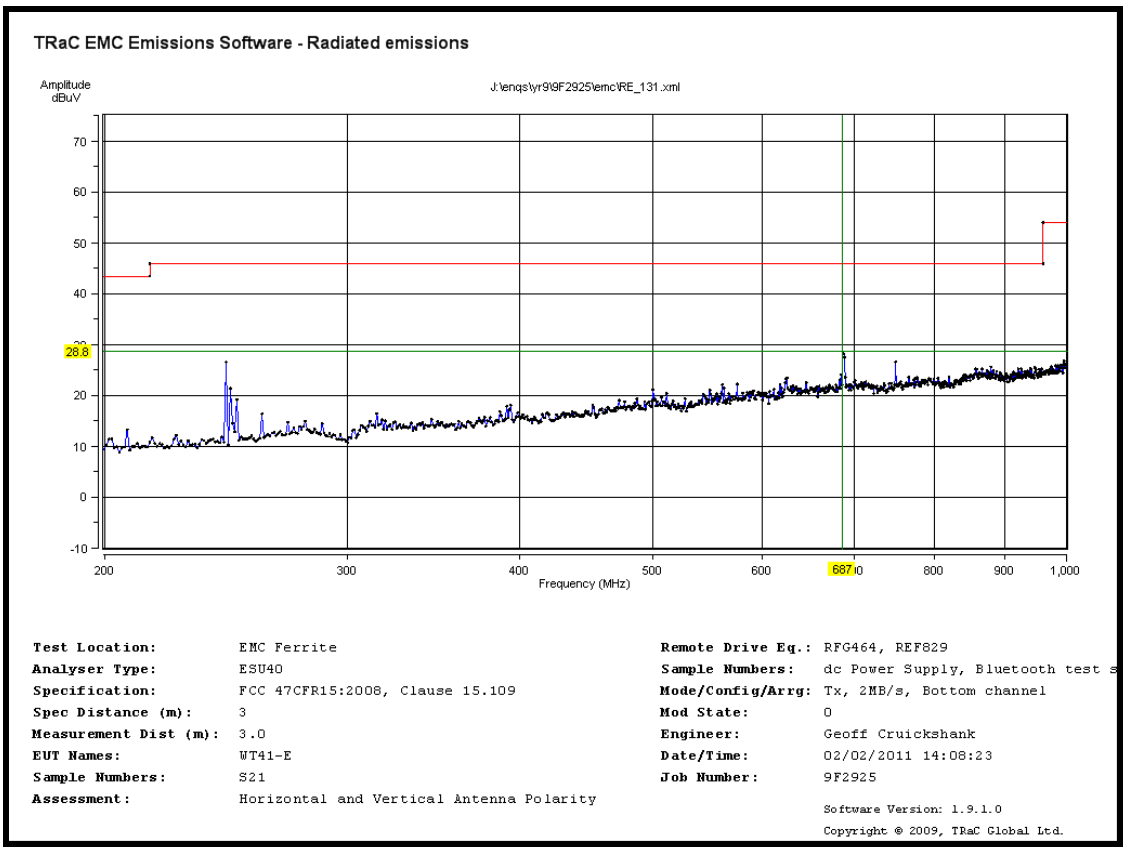
Lower Bandedge



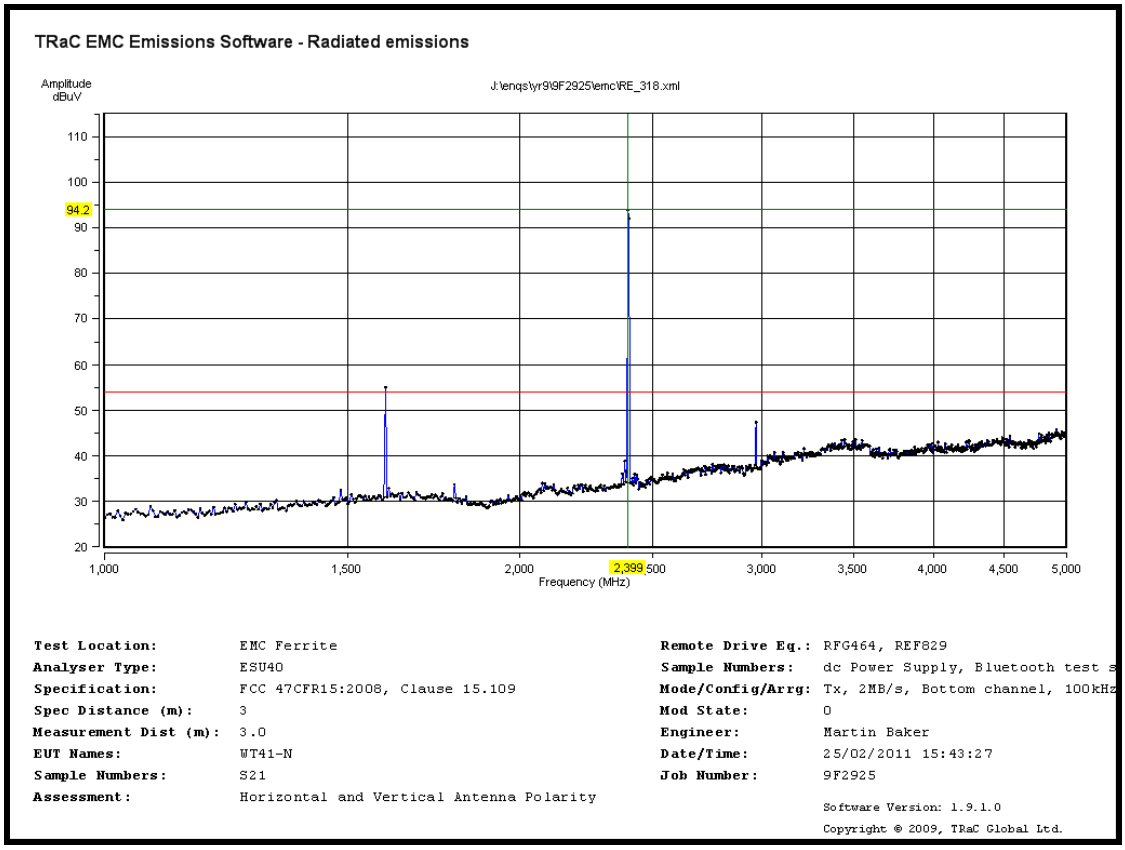
Upper Bandedge



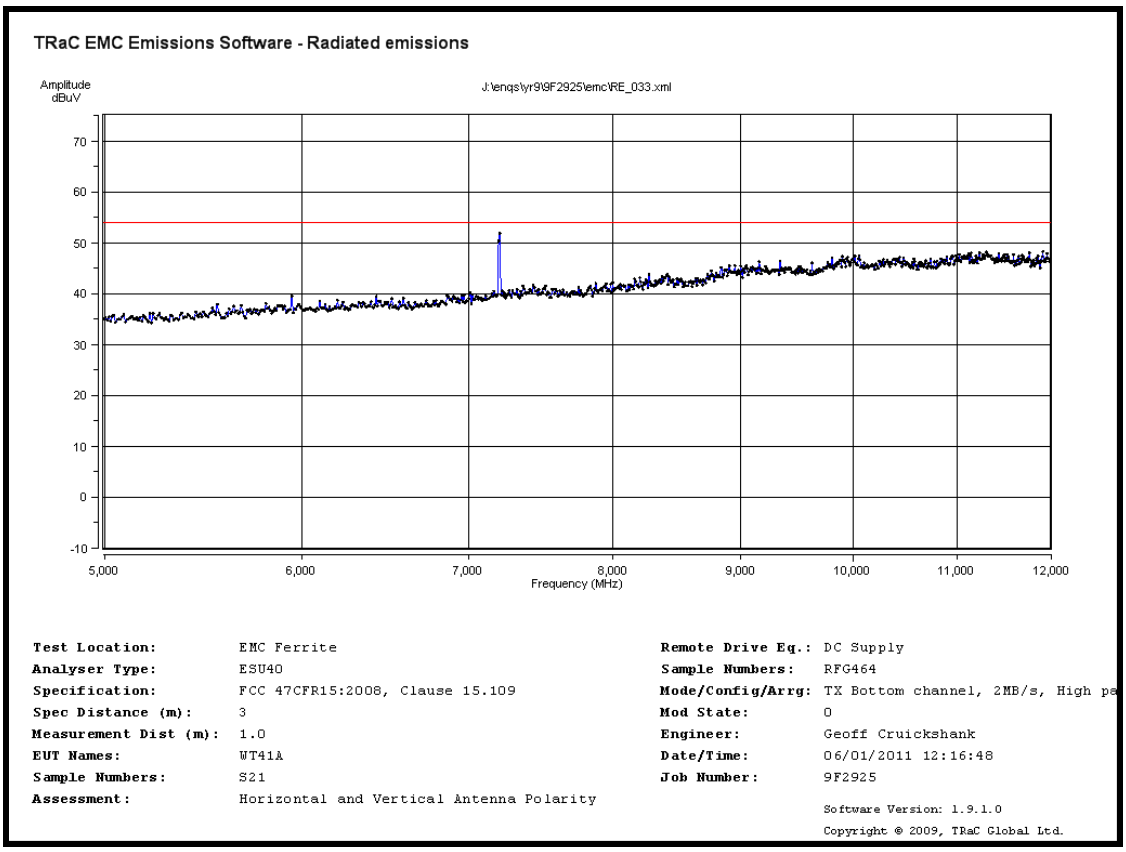
Radiated Spurious emissions 30 MHz to 200 MHz – 2402MHz – 2Mbps for S21



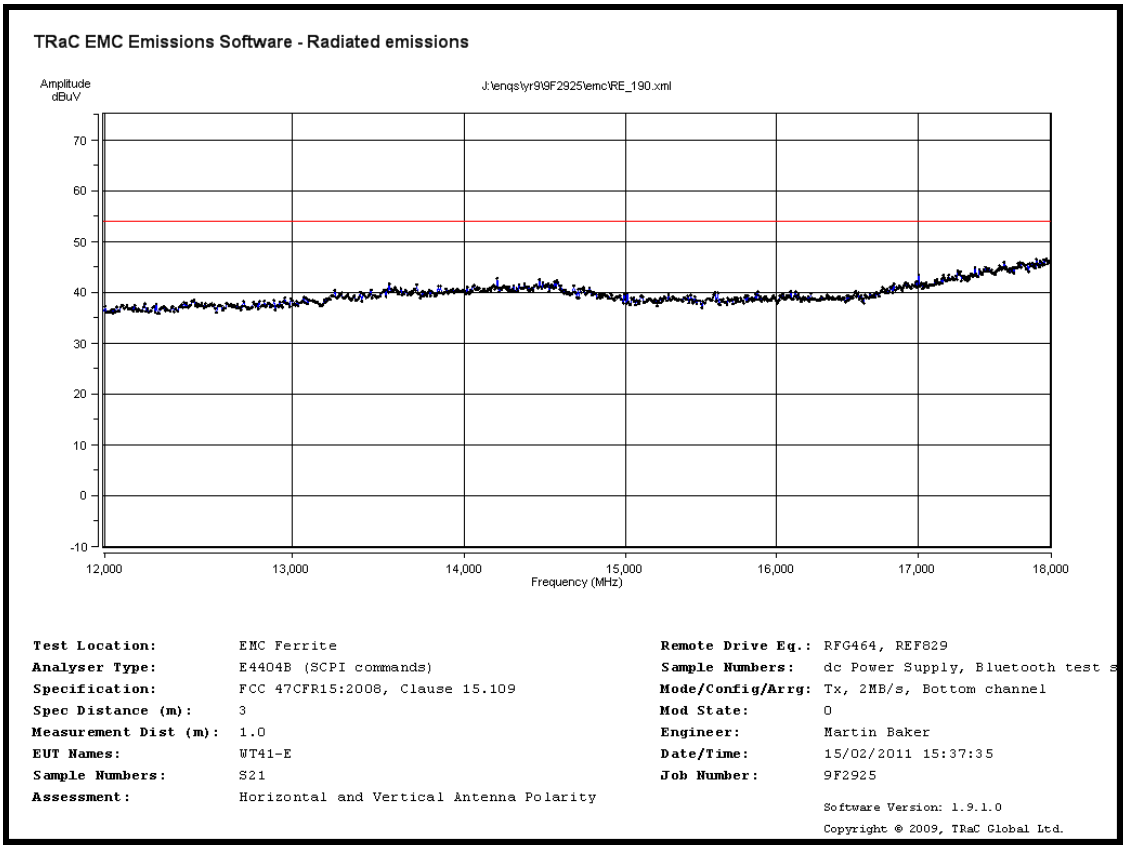
Radiated Spurious emissions 200 MHz to 1 GHz – 2402MHz – 2Mbps for S21



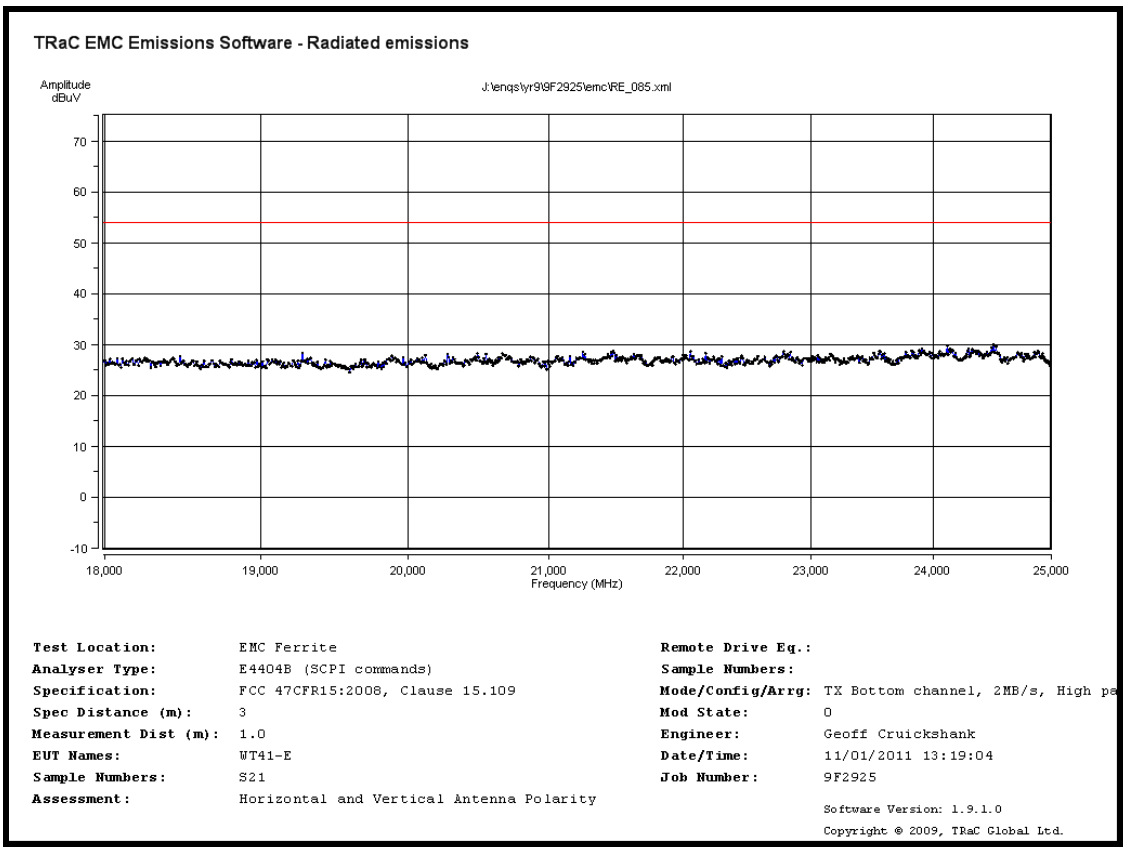
Radiated Spurious emissions 1 GHz to 5 GHz – 2402MHz – 2Mbps for S21



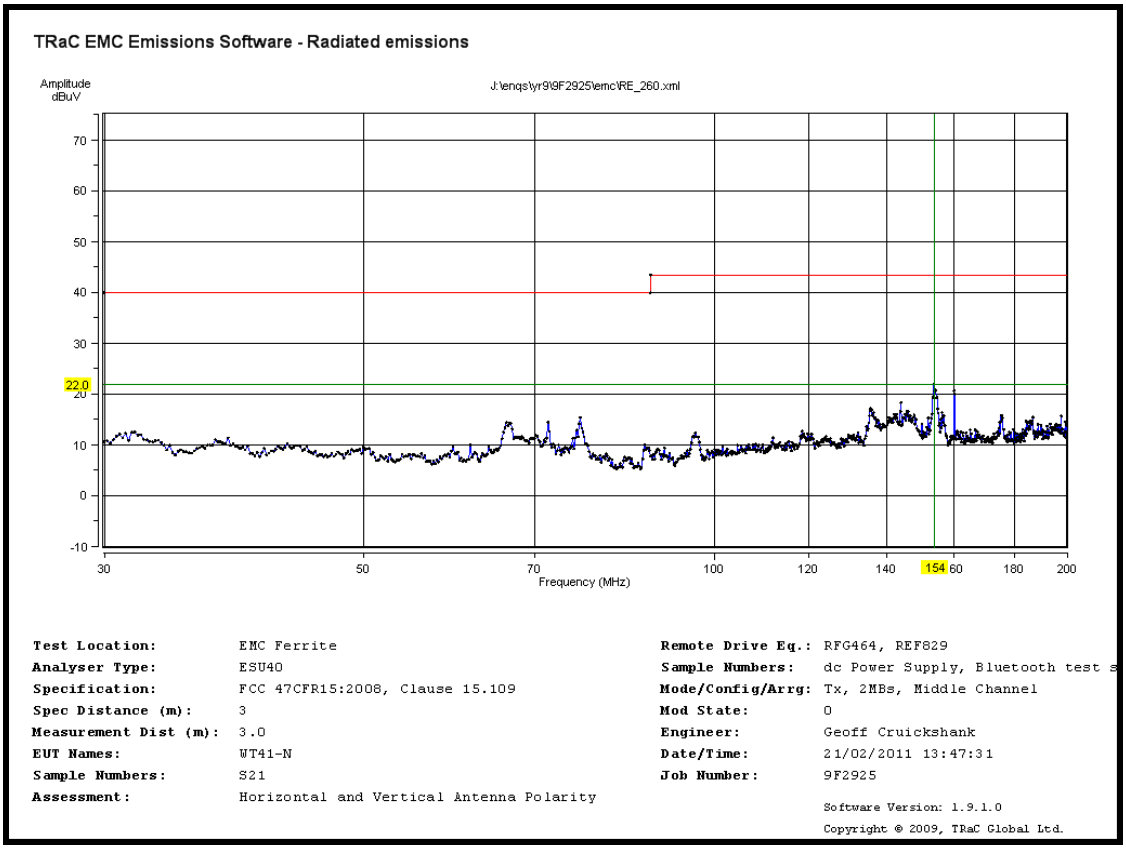
Radiated Spurious emissions 5 GHz to 12 GHz – 2402MHz – 2Mbps for S21



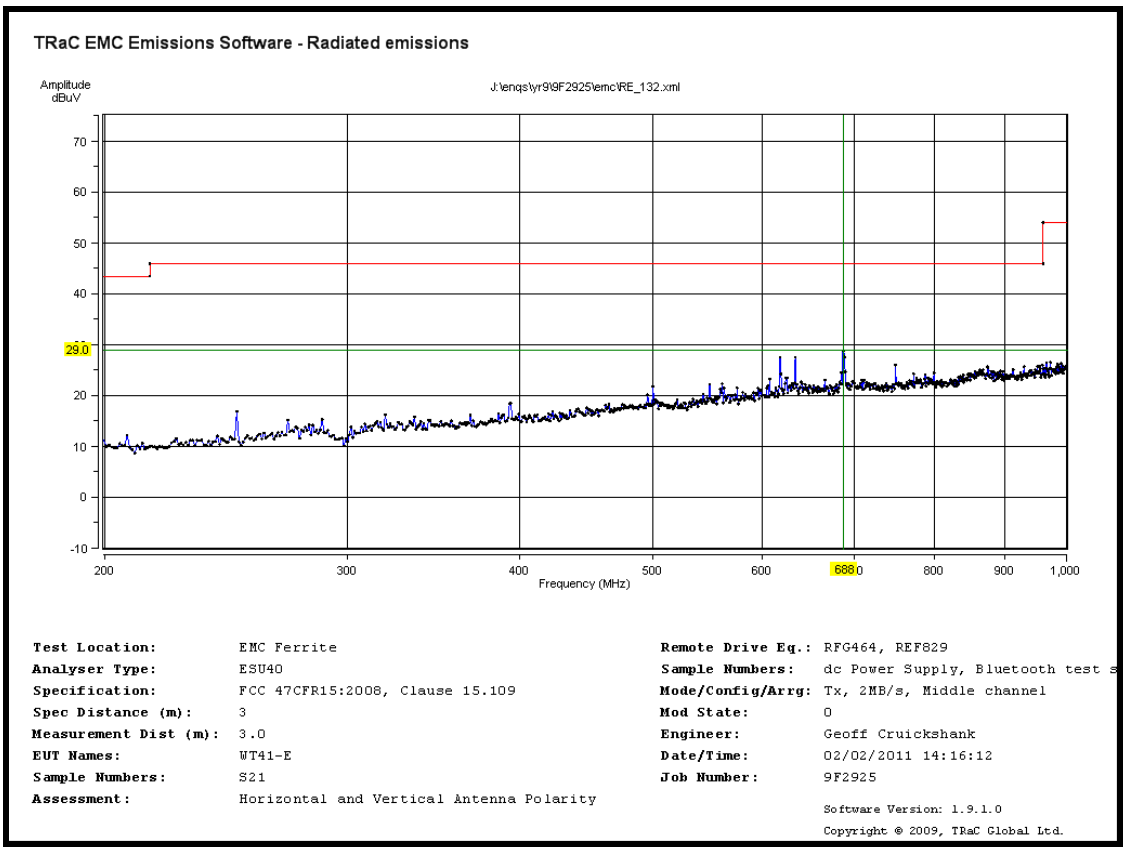
Radiated Spurious emissions 12 GHz to 18GHz – 2402MHz – 2Mbps for S21



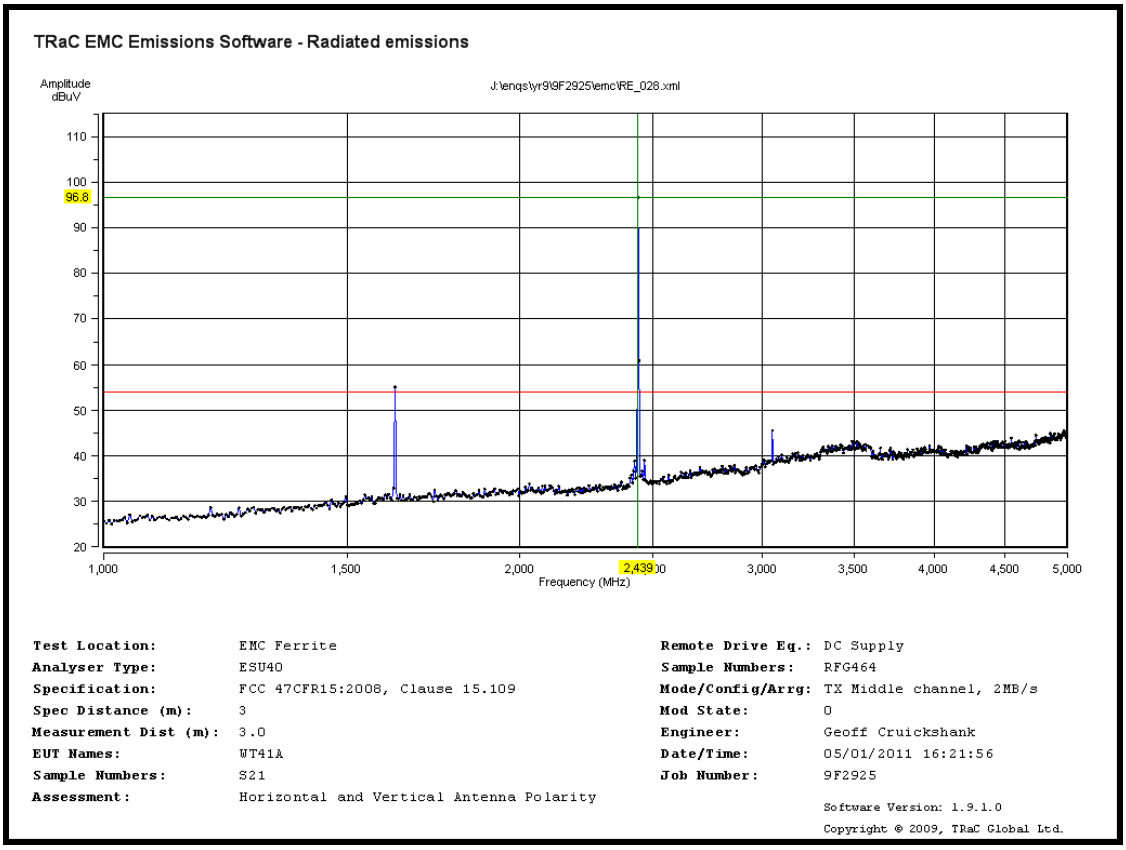
Radiated Spurious emissions 18 GHz to 25 GHz – 2402MHz – 2Mbps for S21



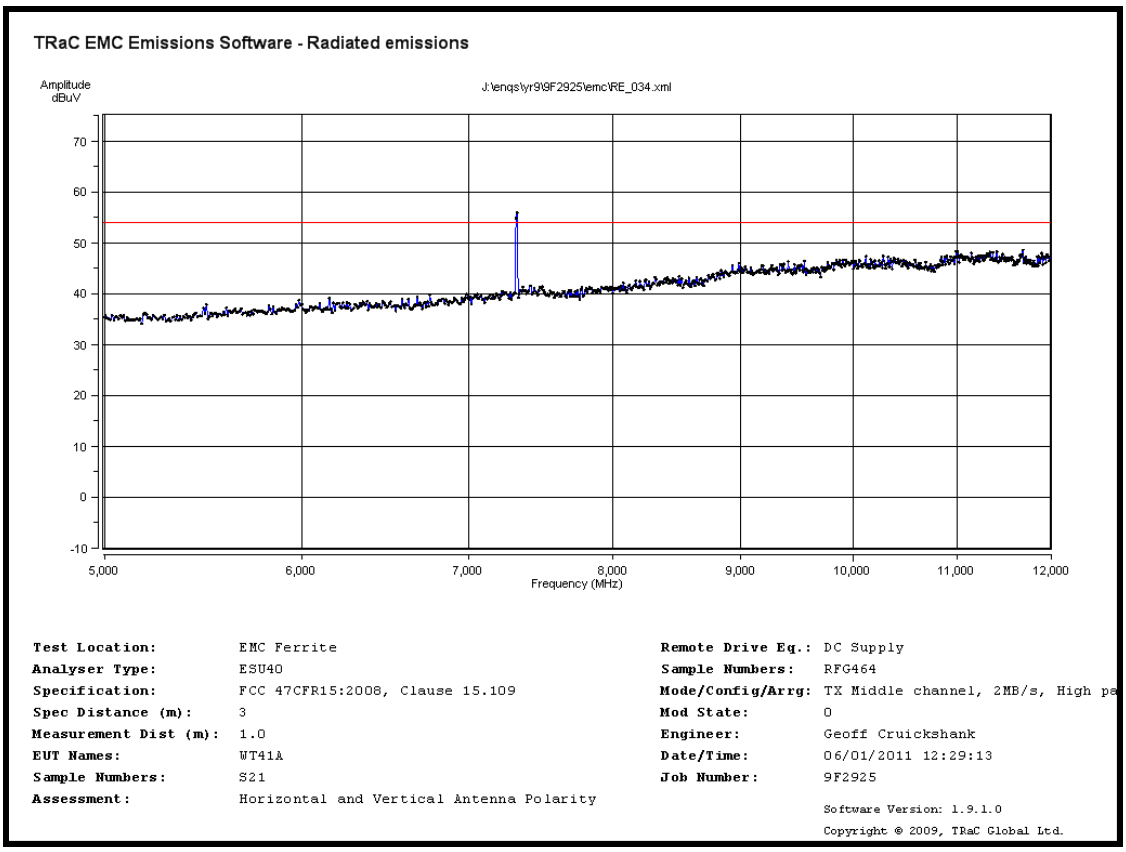
Radiated Spurious emissions 30 MHz to 200 MHz – 2441MHz – 2Mbps for S21



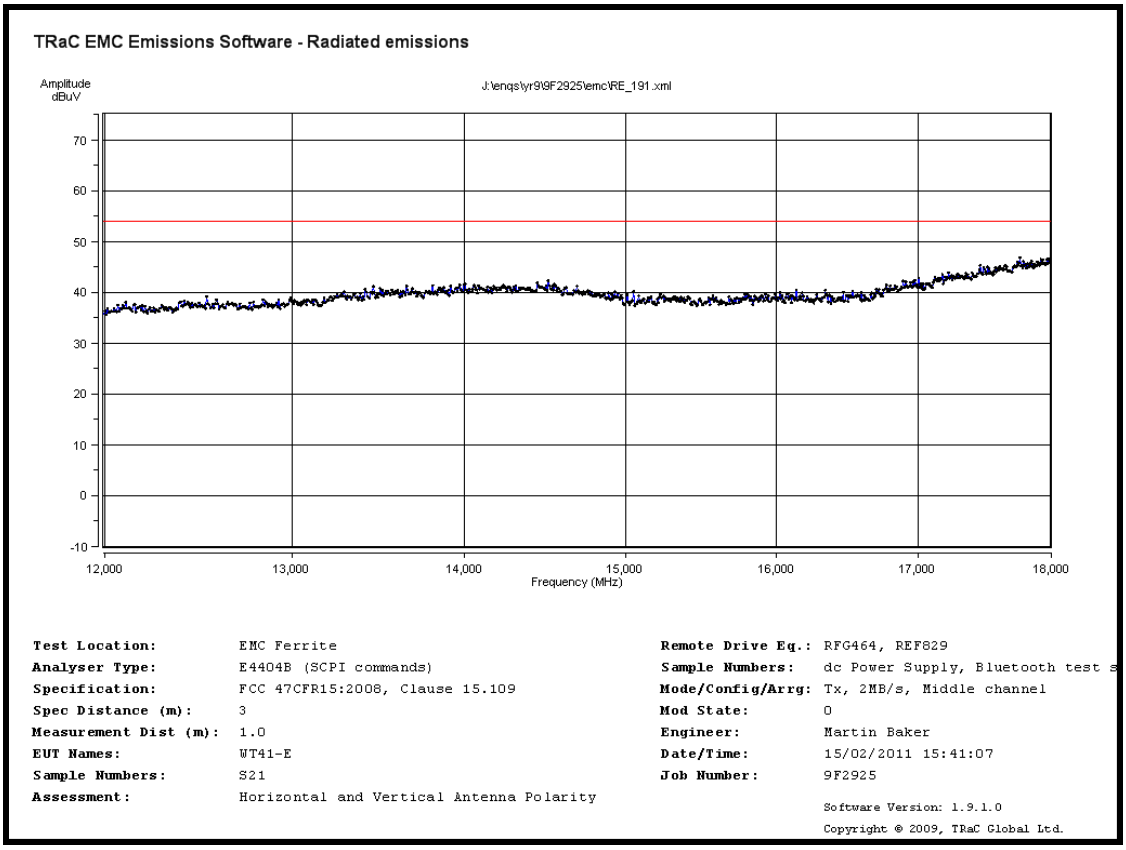
Radiated Spurious emissions 200 MHz to 1 GHz – 2441MHz – 2Mbps for S21



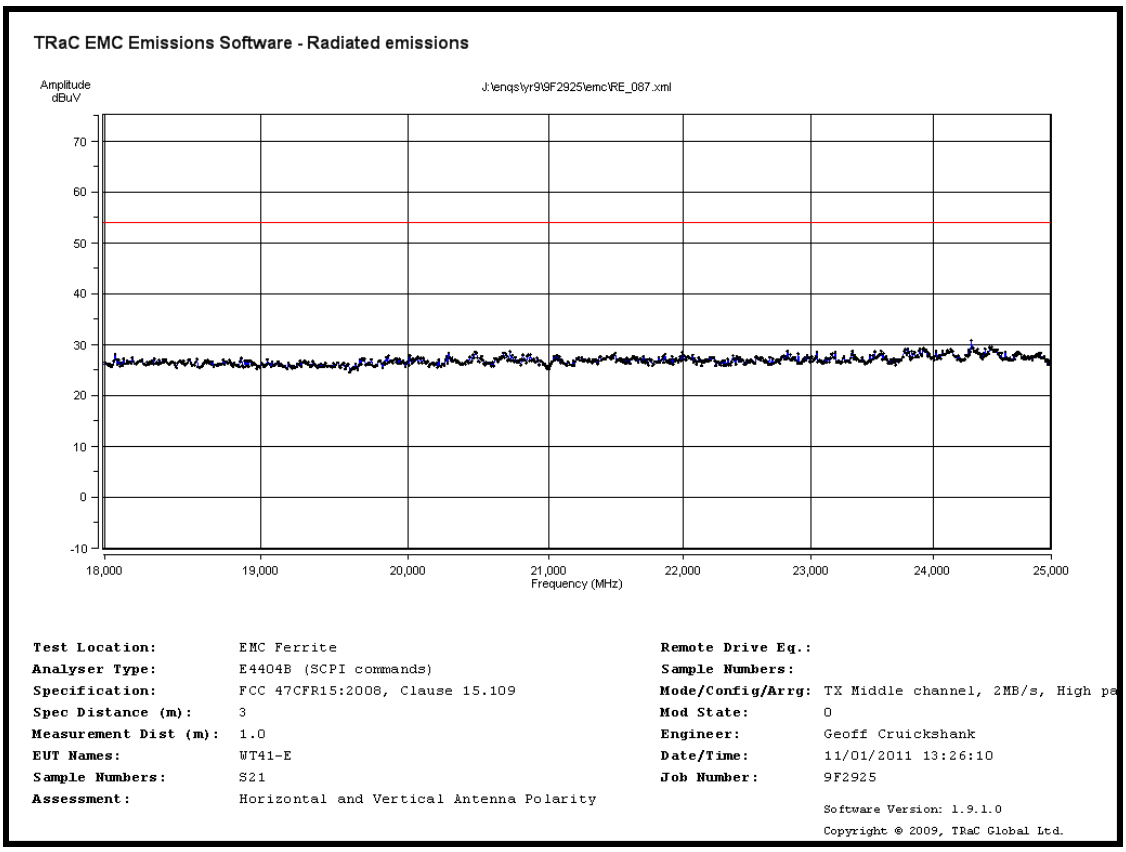
Radiated Spurious emissions 1 GHz to 5 GHz – 2441MHz – 2Mbps for S21



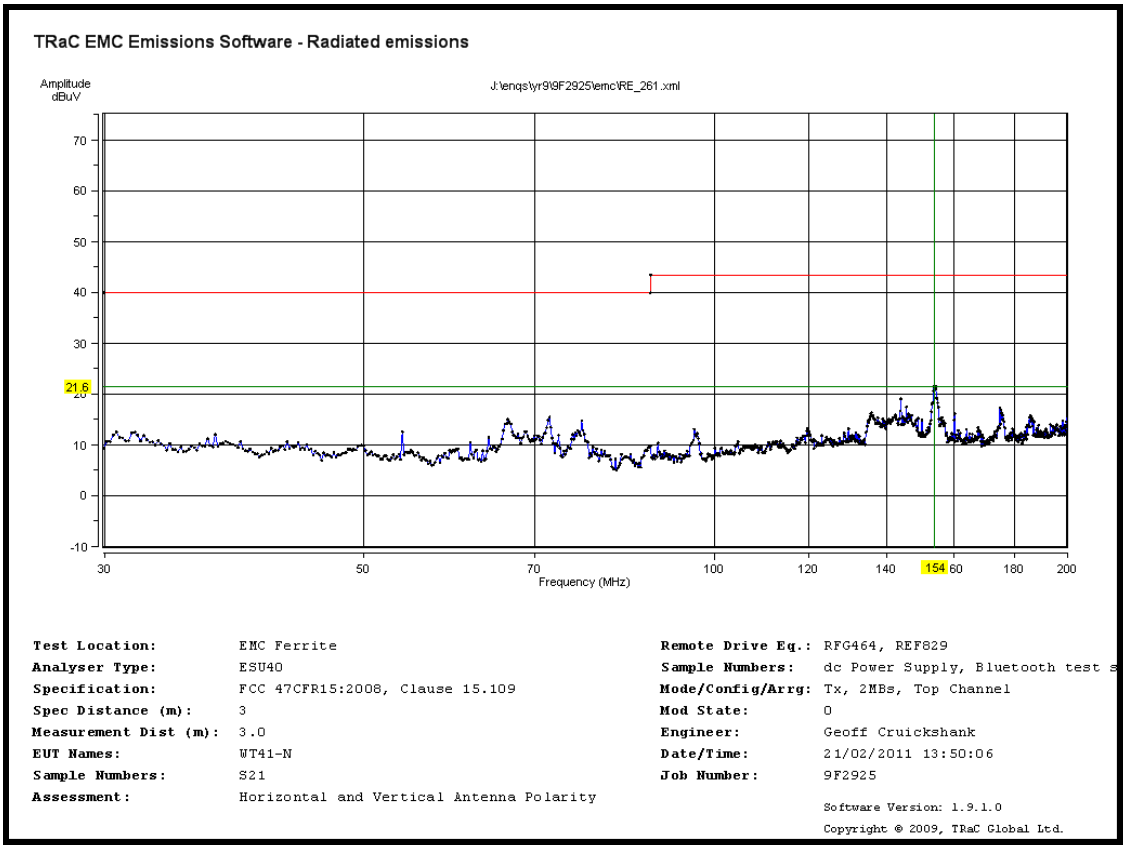
Radiated Spurious emissions 5 GHz to 12 GHz – 2441MHz – 2Mbps for S21



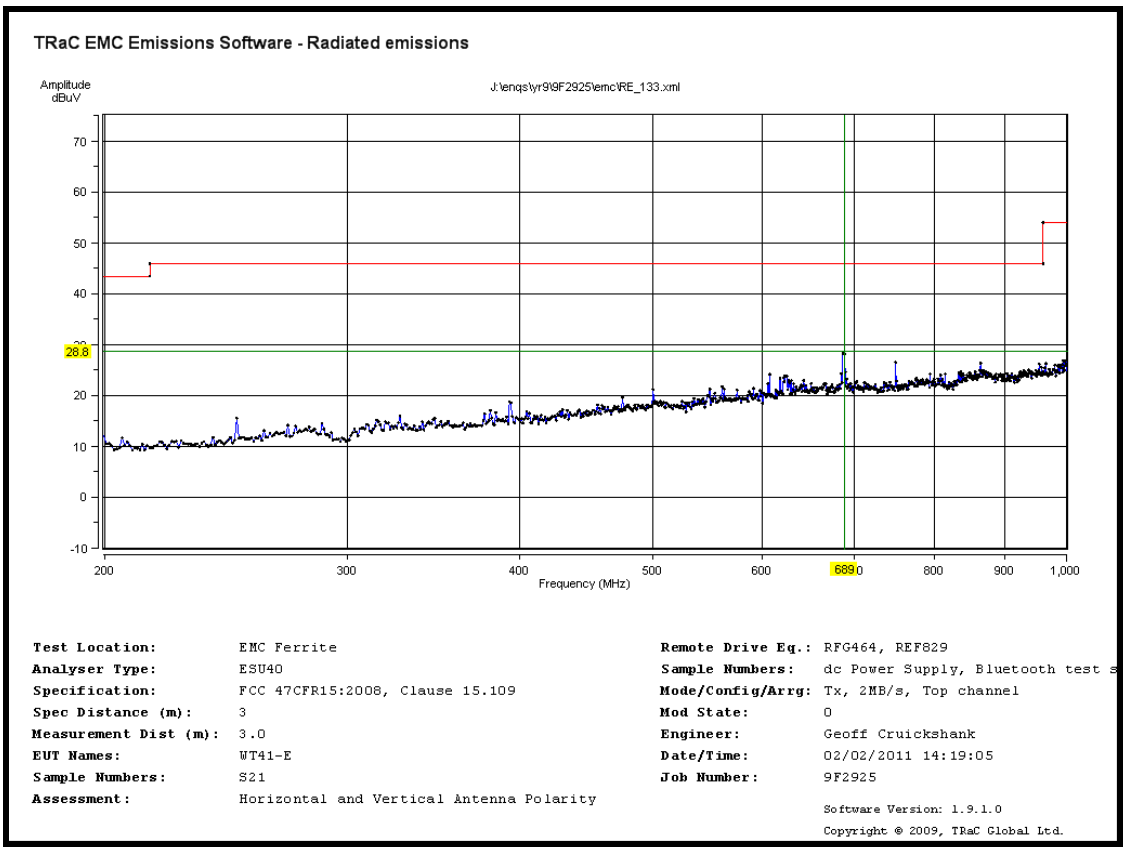
Radiated Spurious emissions 12 GHz to 18GHz – 2441MHz – 2Mbps for S21



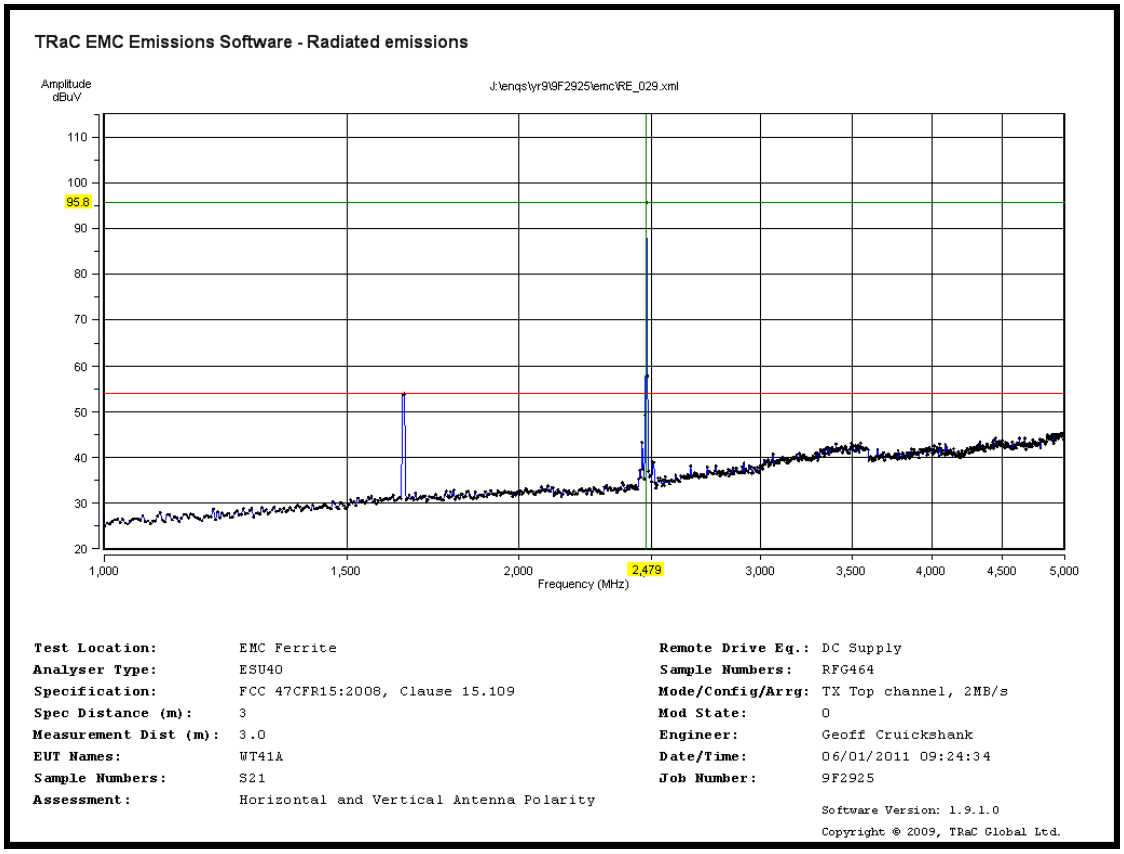
Radiated Spurious emissions 18 GHz to 25 GHz – 2441MHz – 2Mbps for S21



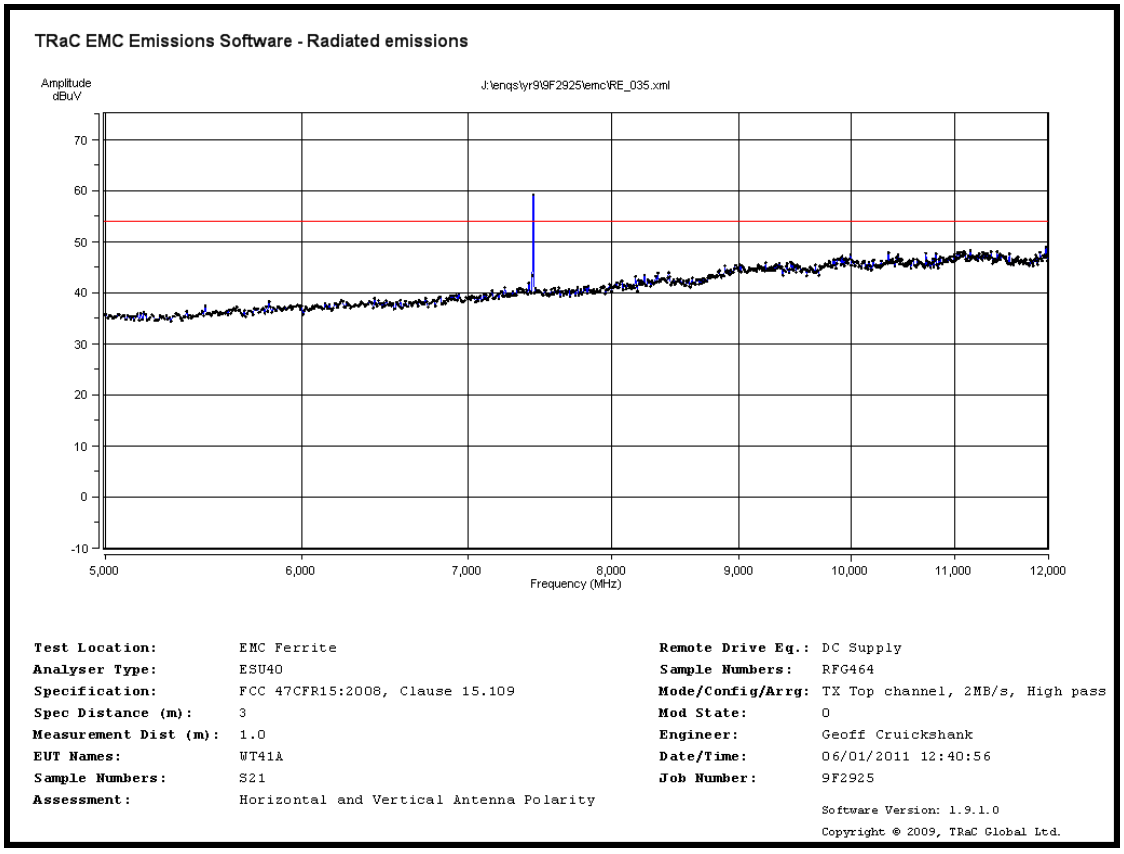
Radiated Spurious emissions 30 MHz to 200 MHz – 2480MHz – 2Mbps for S21



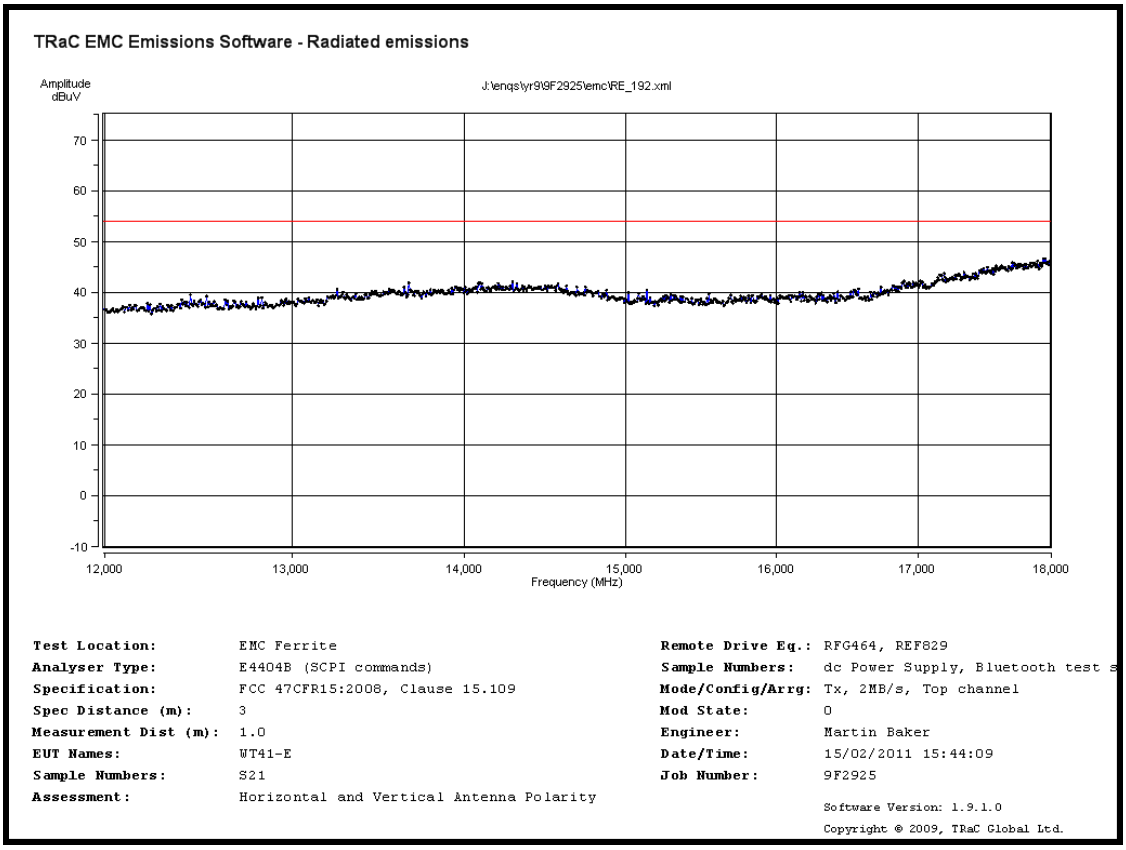
Radiated Spurious emissions 200 MHz to 1 GHz – 2480MHz – 2Mbps for S21



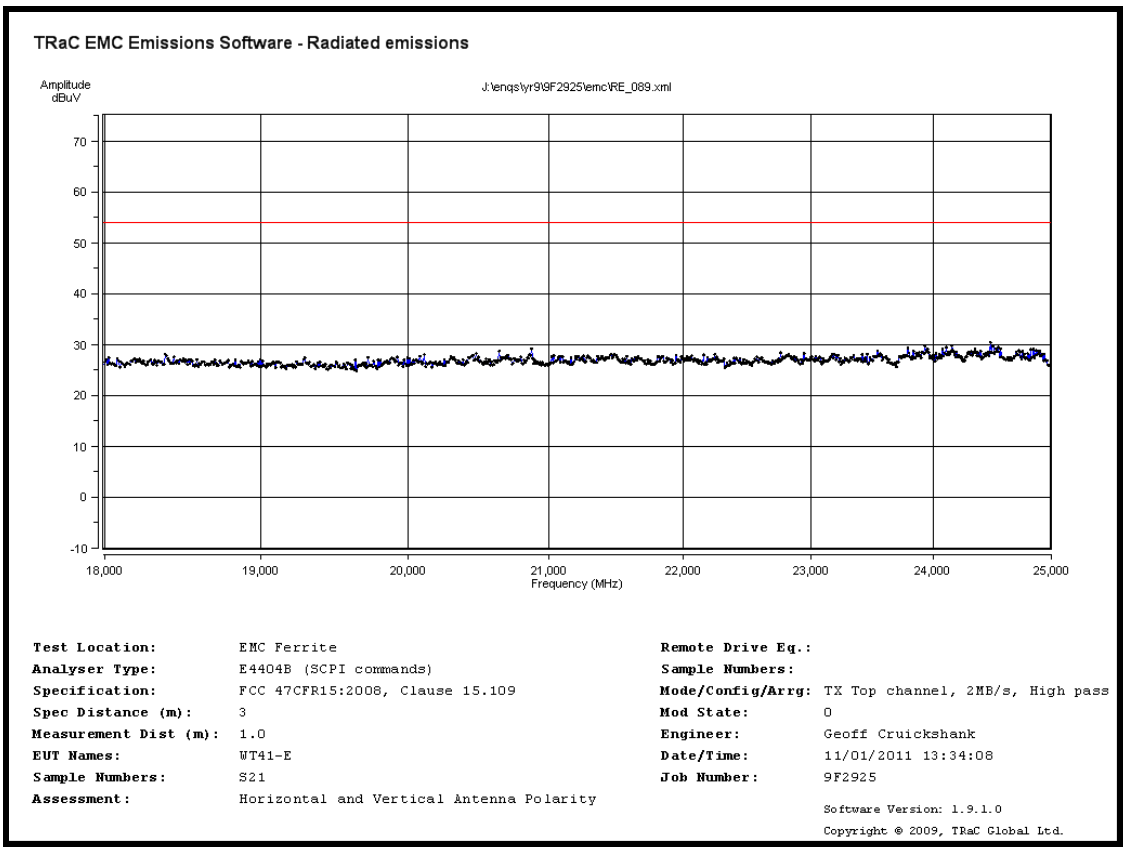
Radiated Spurious emissions 1 GHz to 5 GHz – 2480MHz – 2Mbps for S21



Radiated Spurious emissions 5 GHz to 12 GHz – 2480MHz – 2Mbps for S21

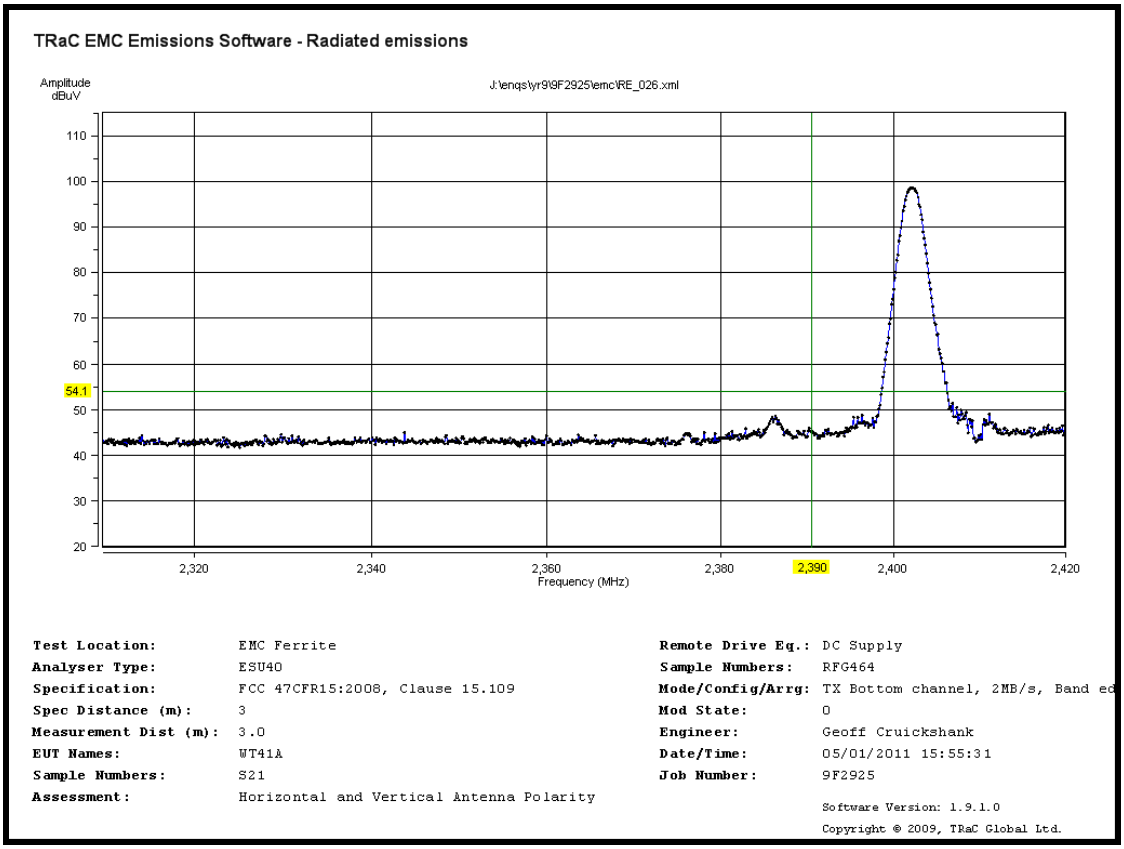


Radiated Spurious emissions 12 GHz to 18GHz – 2480MHz – 2Mbps for S21

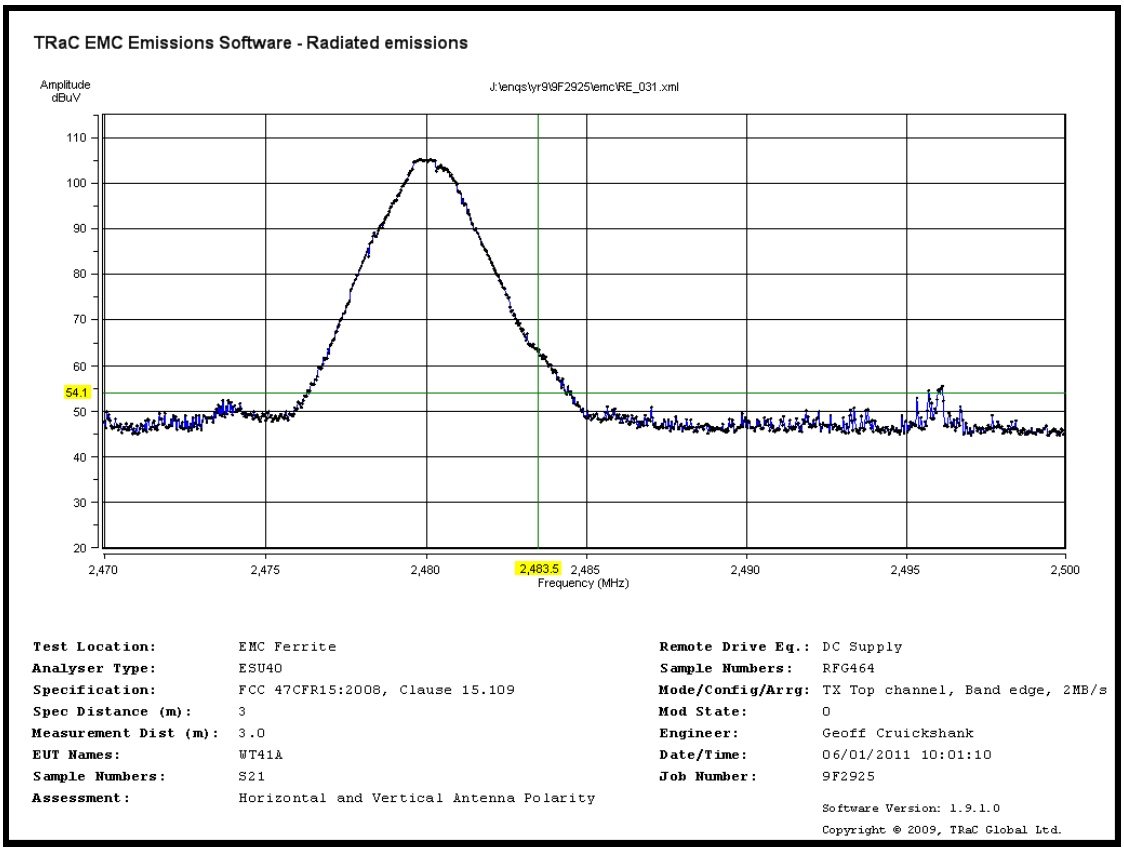


Radiated Spurious emissions 18 GHz to 25 GHz – 2480MHz – 2Mbps for S21

Radiated Bandedge Compliance – Peak plot to average limit

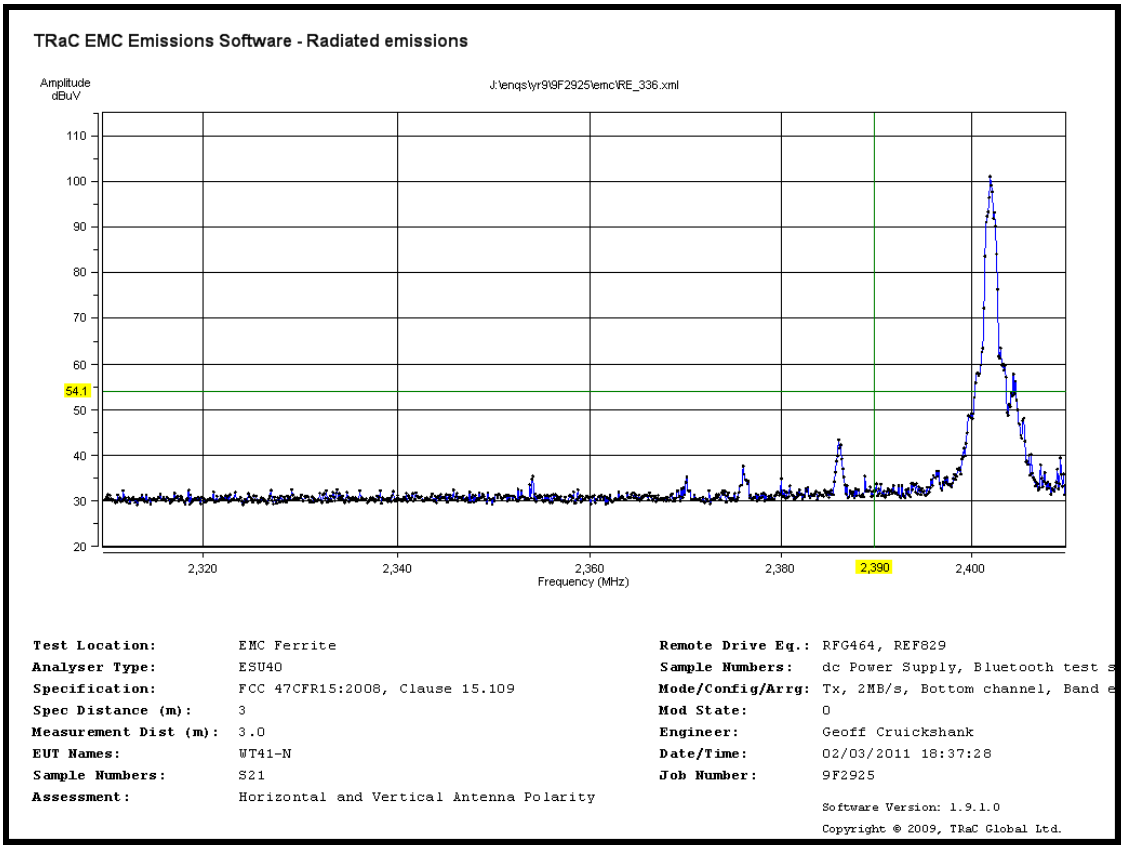


Lower Bandedge

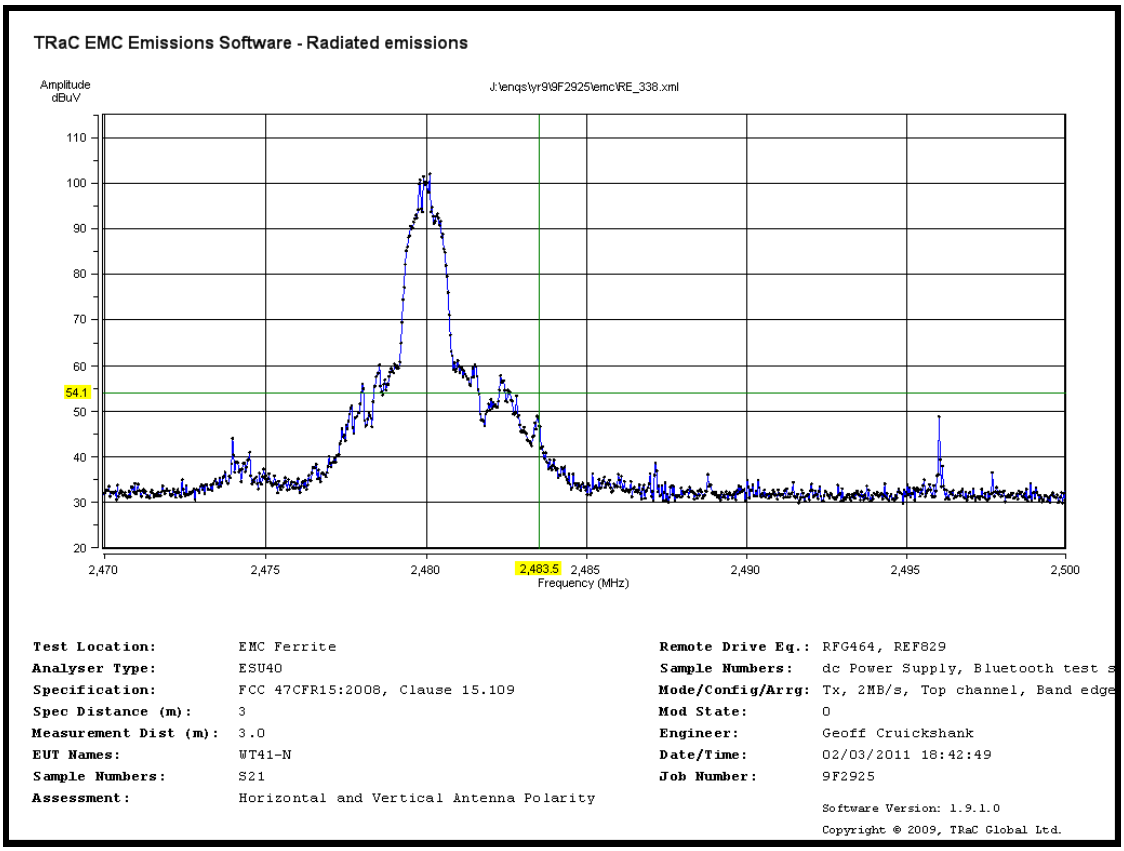


Upper Bandedge

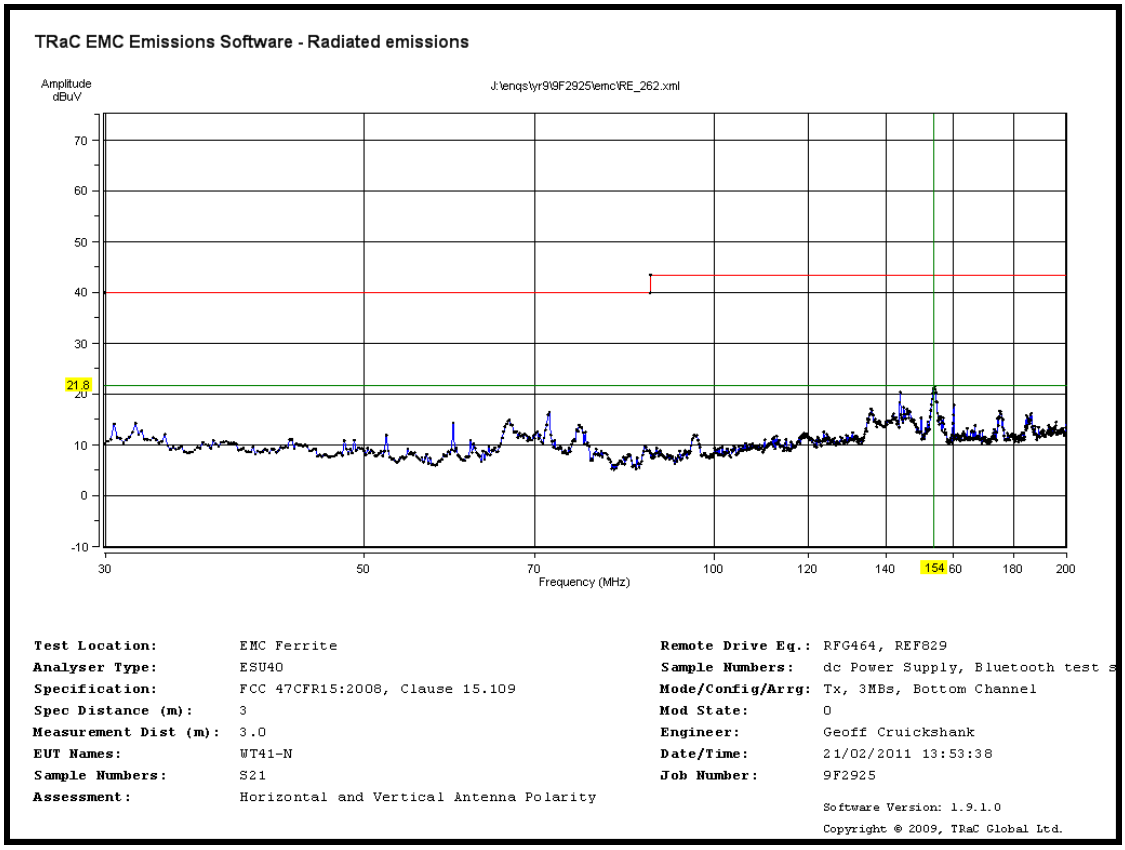
Radiated Bandedge Compliance – Average plot to average limit



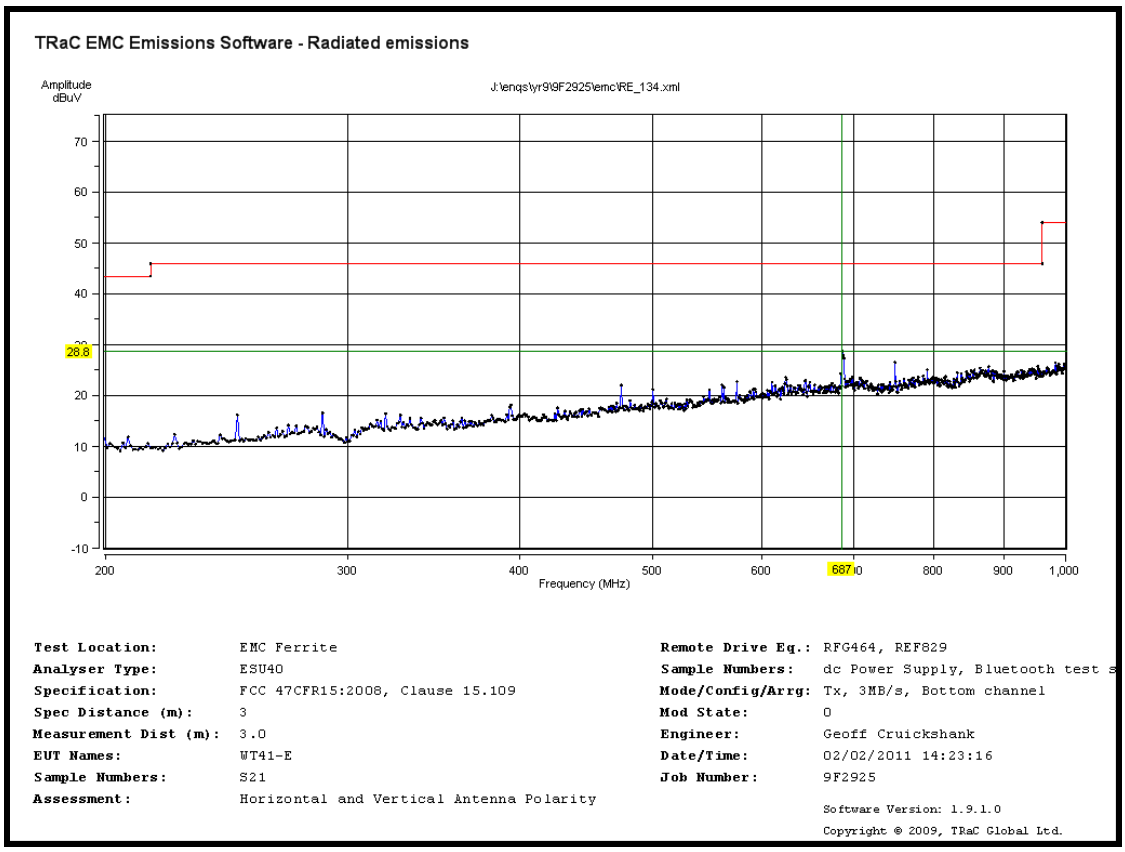
Lower Bandedge



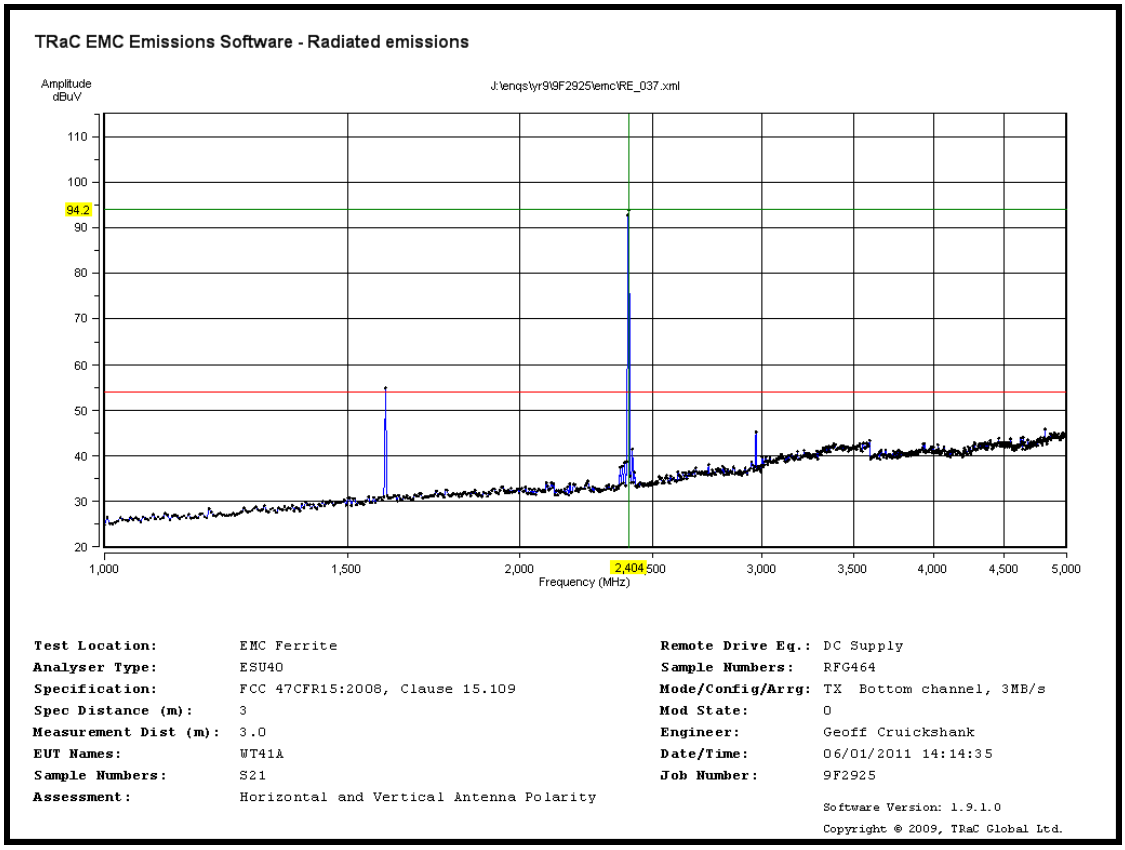
Upper Bandedge



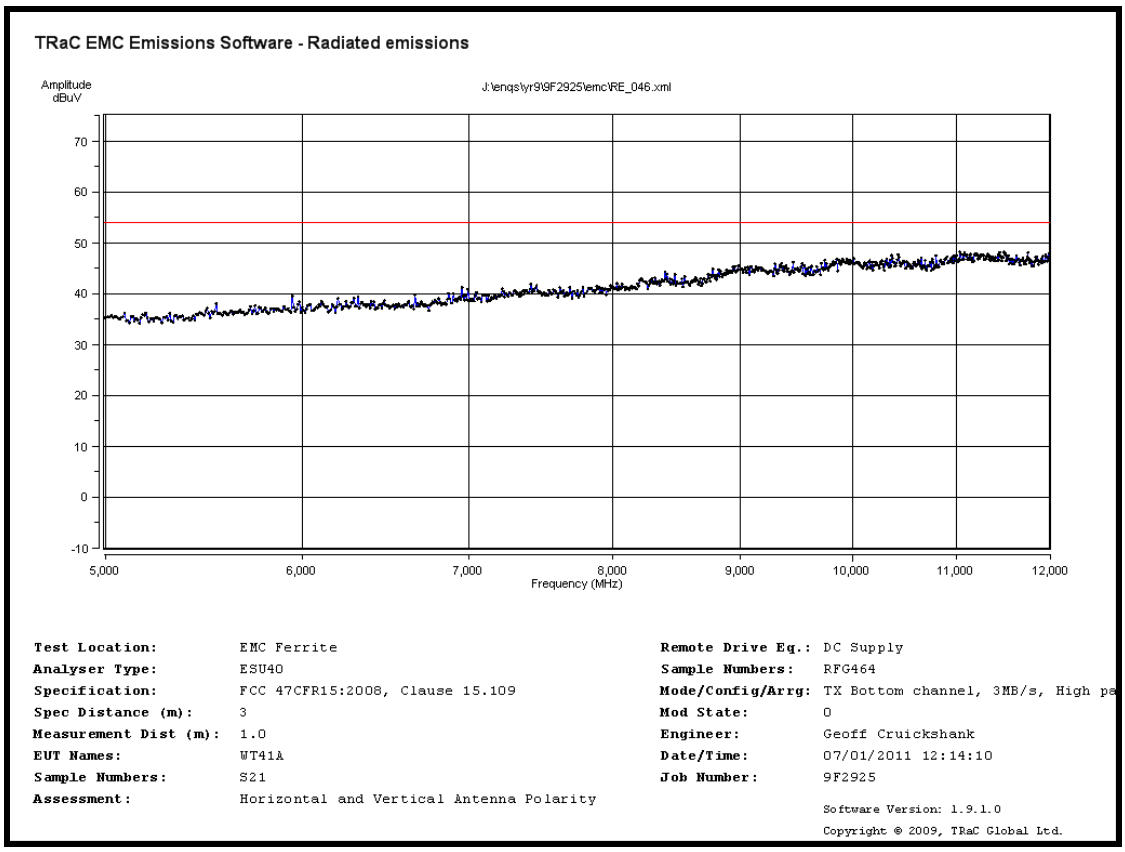
Radiated Spurious emissions 30 MHz to 200 MHz – 2402MHz – 3Mbps for S21



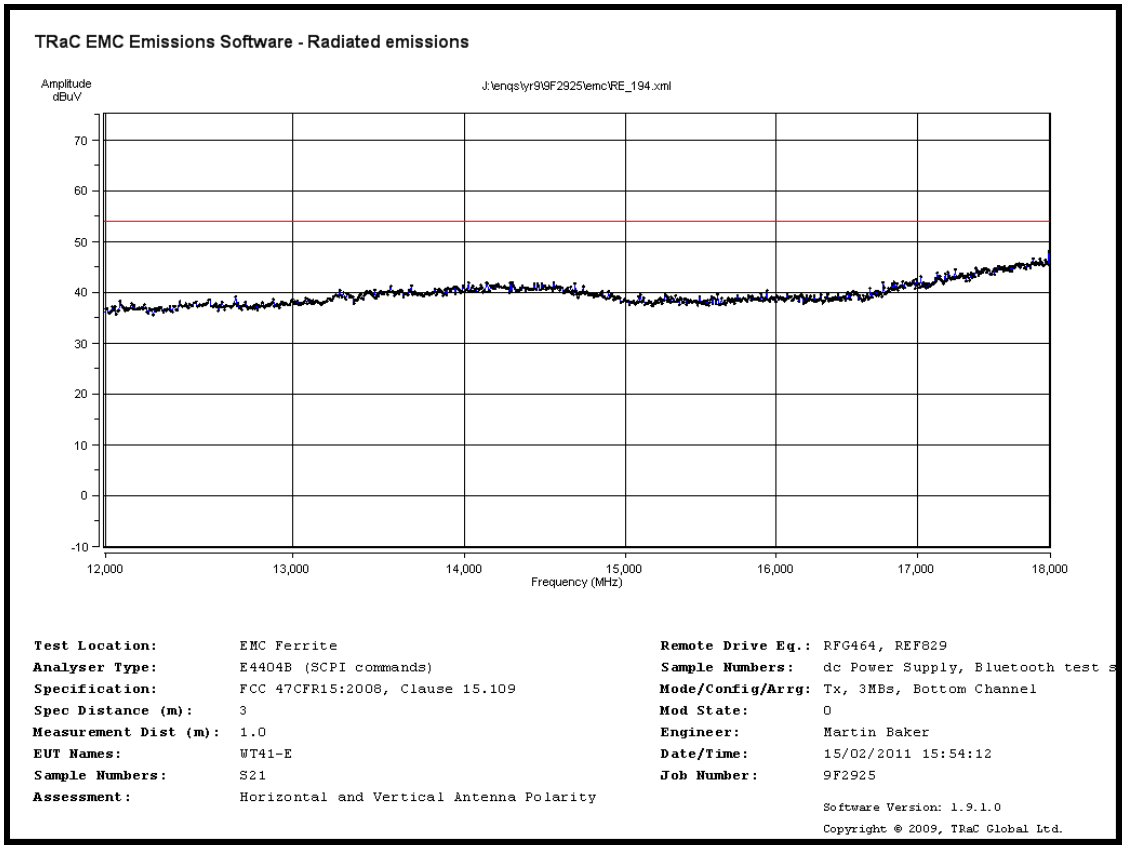
Radiated Spurious emissions 200 MHz to 1 GHz – 2402MHz – 3Mbps for S21



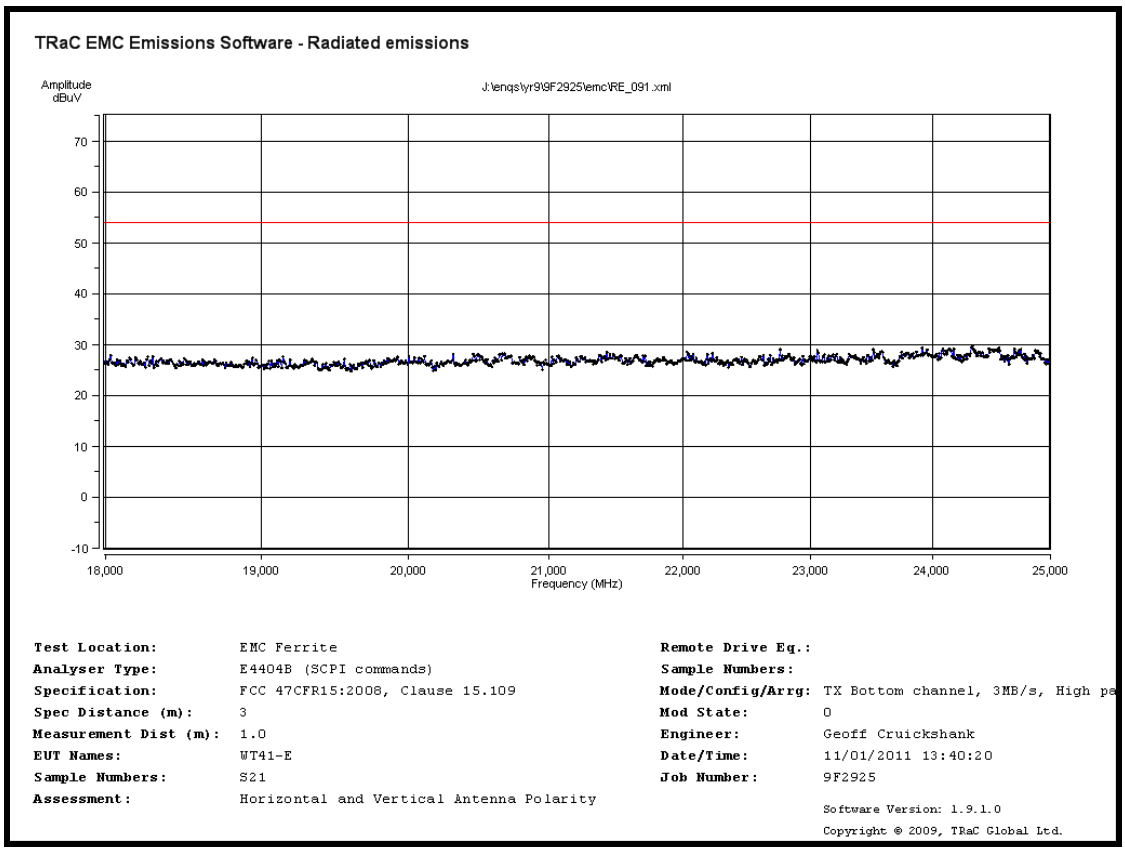
Radiated Spurious emissions 1 GHz to 5 GHz – 2402MHz – 3Mbps for S21



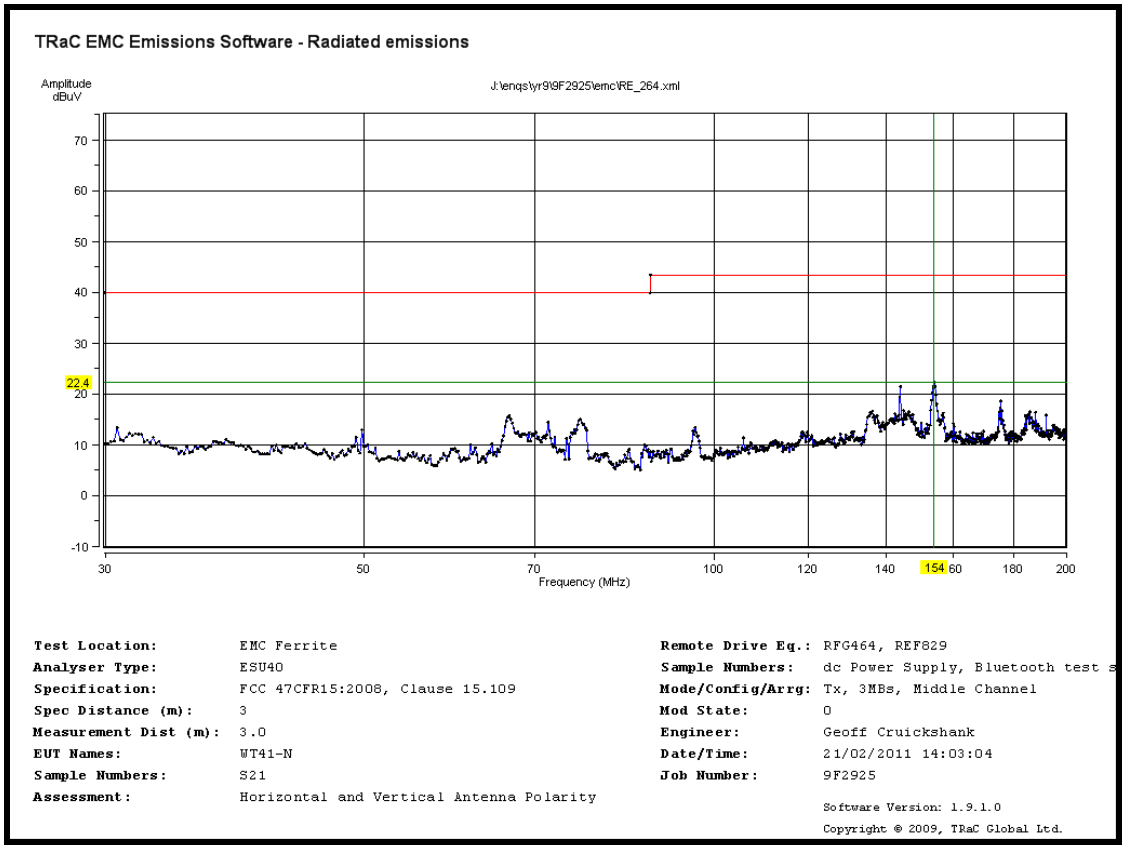
Radiated Spurious emissions 5 GHz to 12 GHz – 2402MHz – 3Mbps for S21



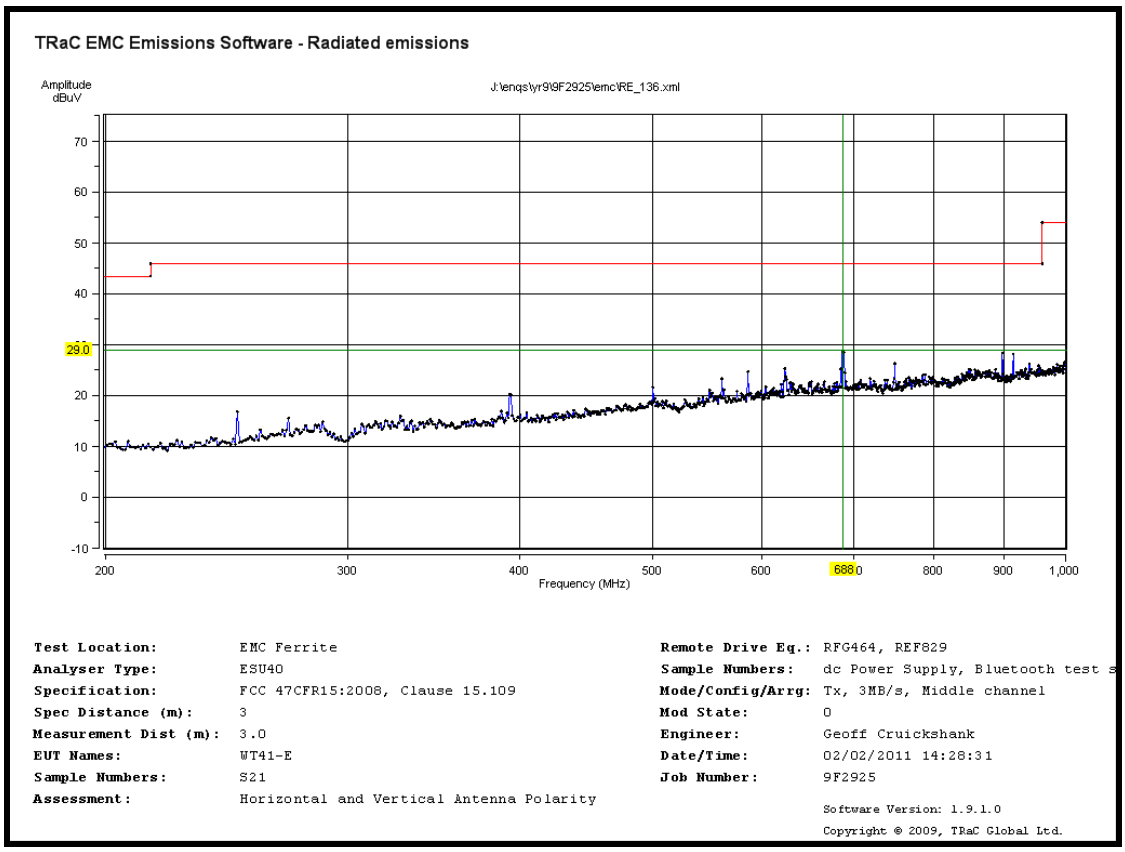
Radiated Spurious emissions 12 GHz to 18GHz – 2402MHz – 3Mbps for S21



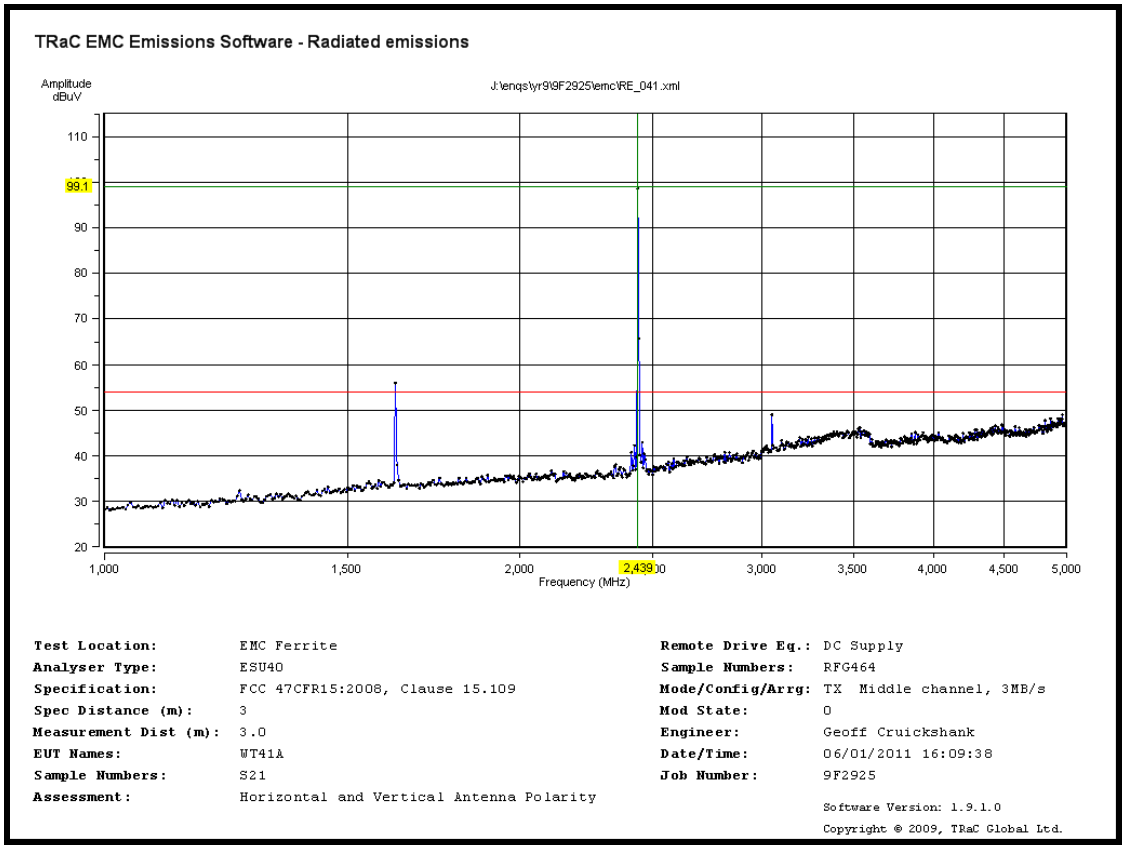
Radiated Spurious emissions 18 GHz to 25 GHz – 2402MHz – 3Mbps for S21



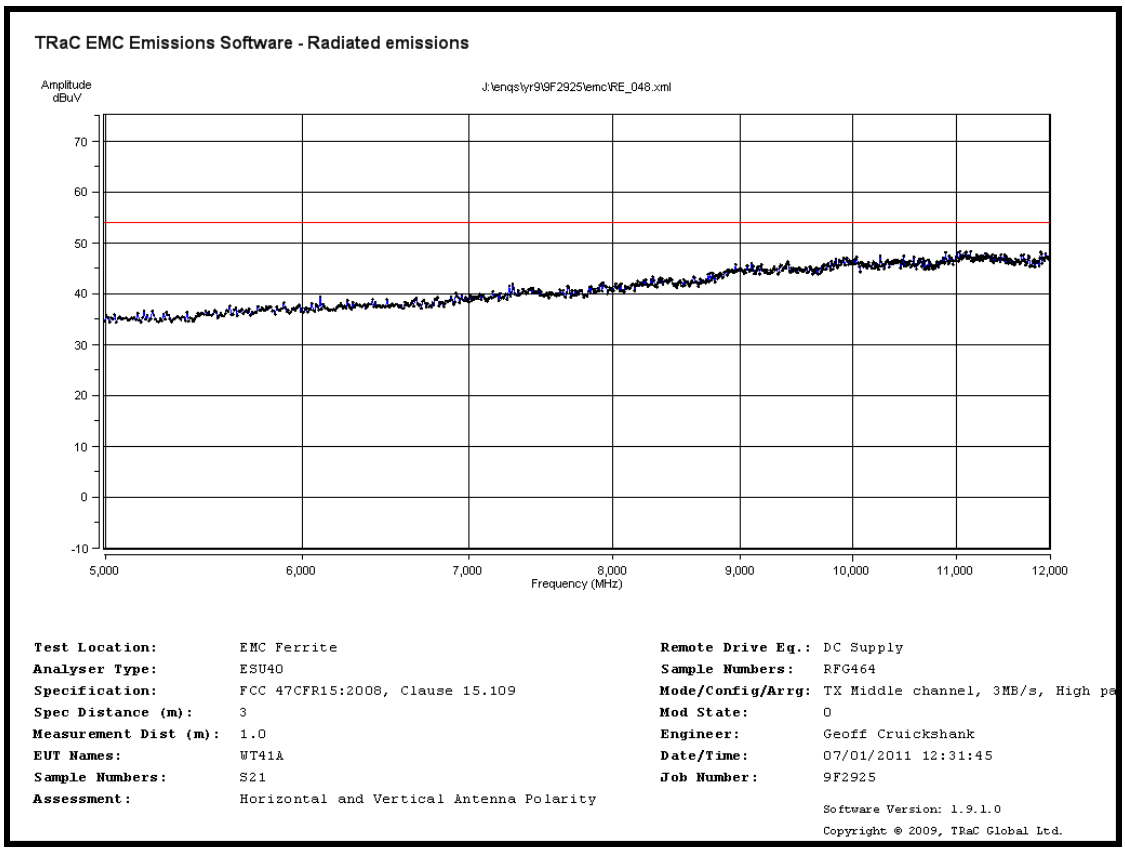
Radiated Spurious emissions 30 MHz to 200MHz – 2441MHz – 3Mbps for S21



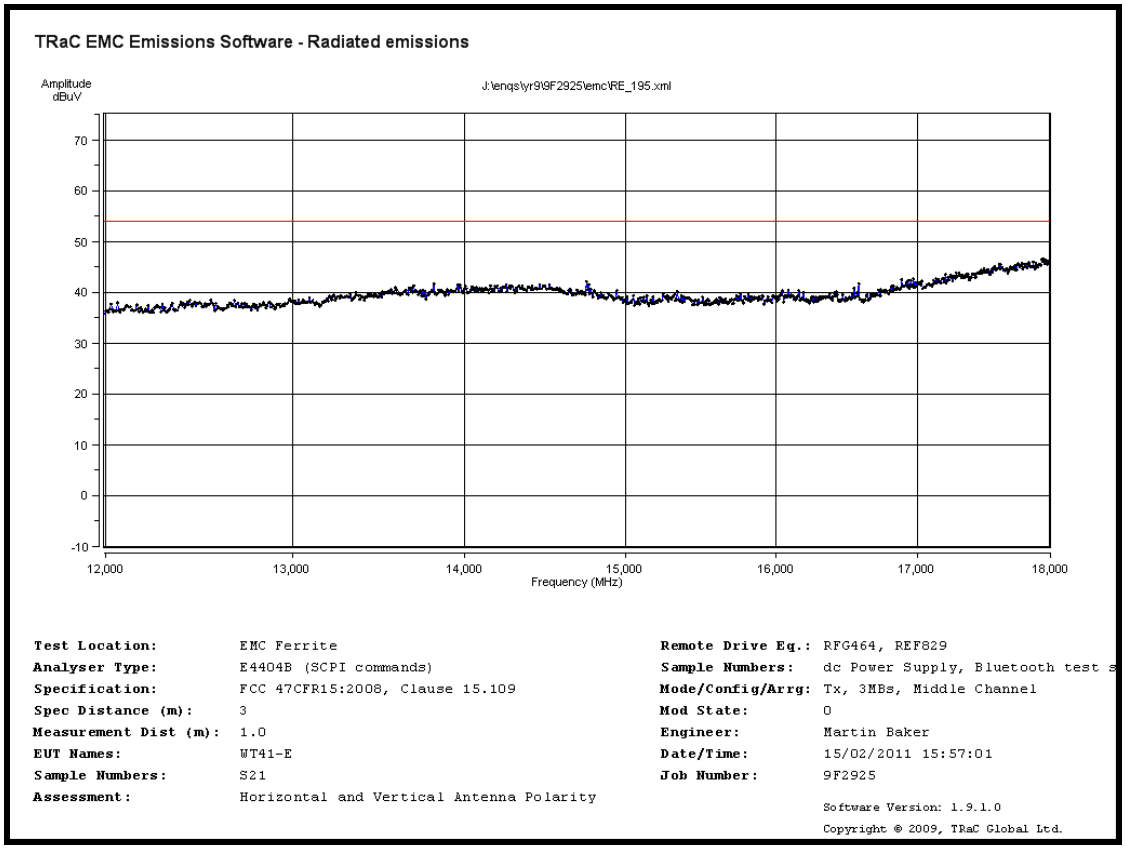
Radiated Spurious emissions 200 MHz to 1GHz – 2441MHz – 3Mbps for S21



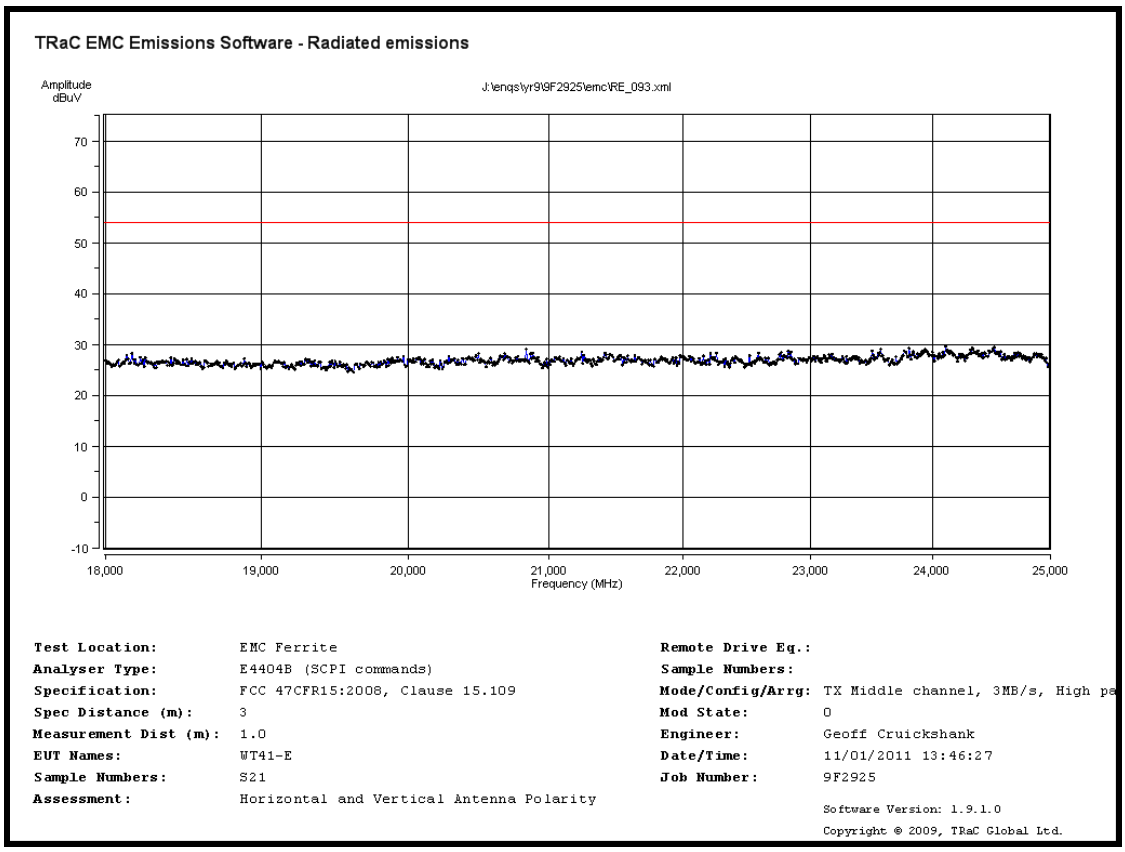
Radiated Spurious emissions 1 GHz to 5 GHz – 2441MHz – 3Mbps for S21



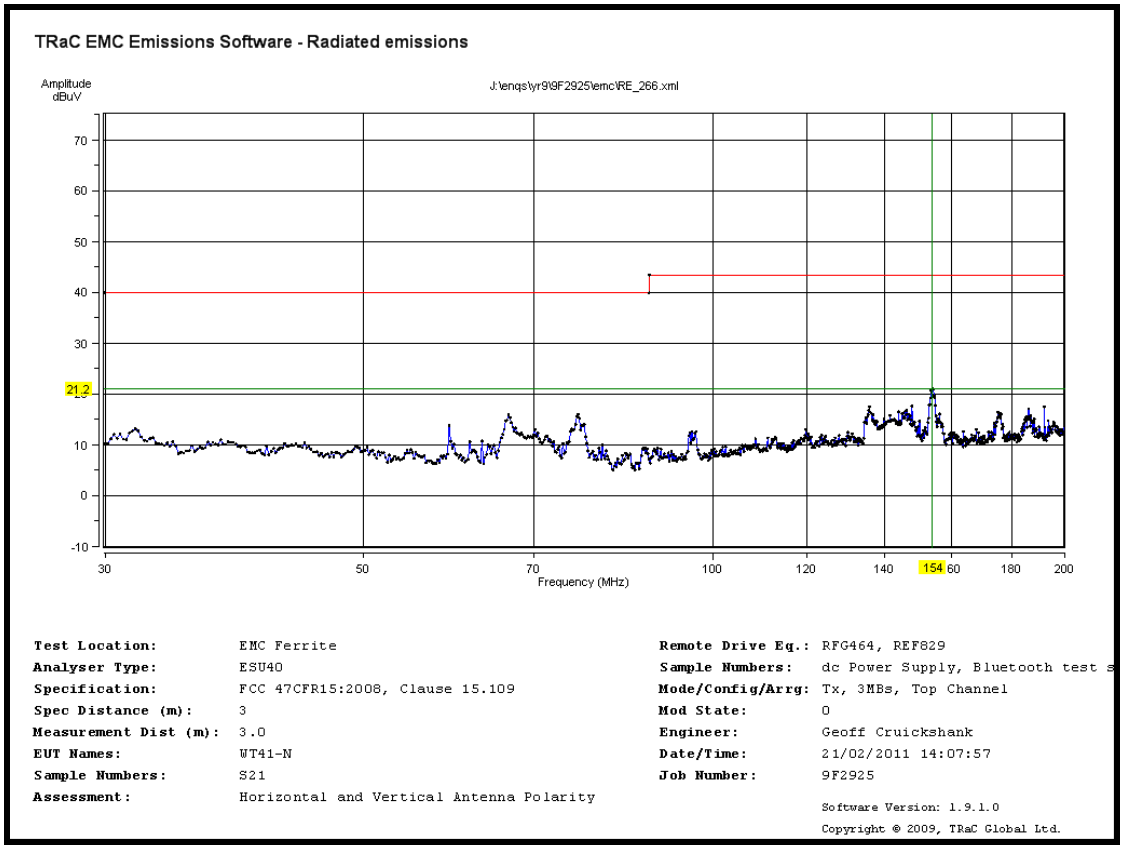
Radiated Spurious emissions 5 GHz to 12 GHz – 2441MHz – 3Mbps for S21



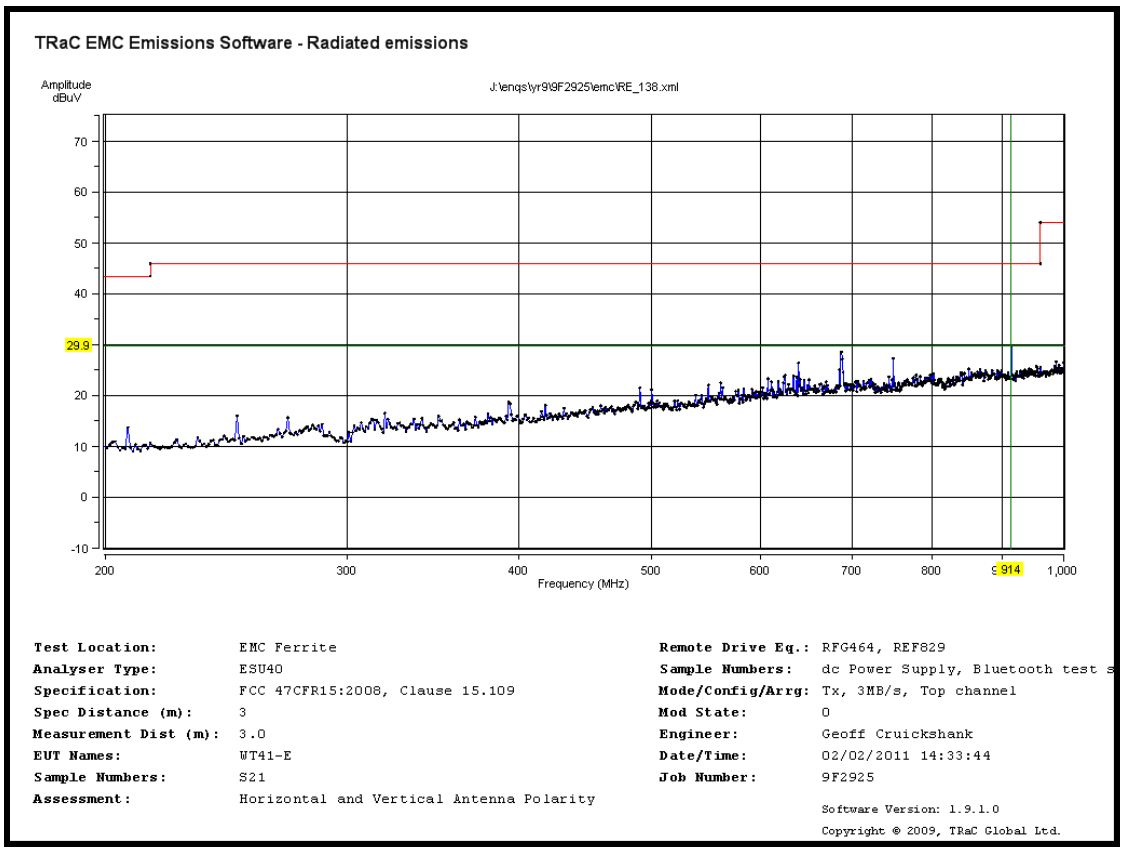
Radiated Spurious emissions 12 GHz to 18GHz – 2441MHz – 3Mbps for S21



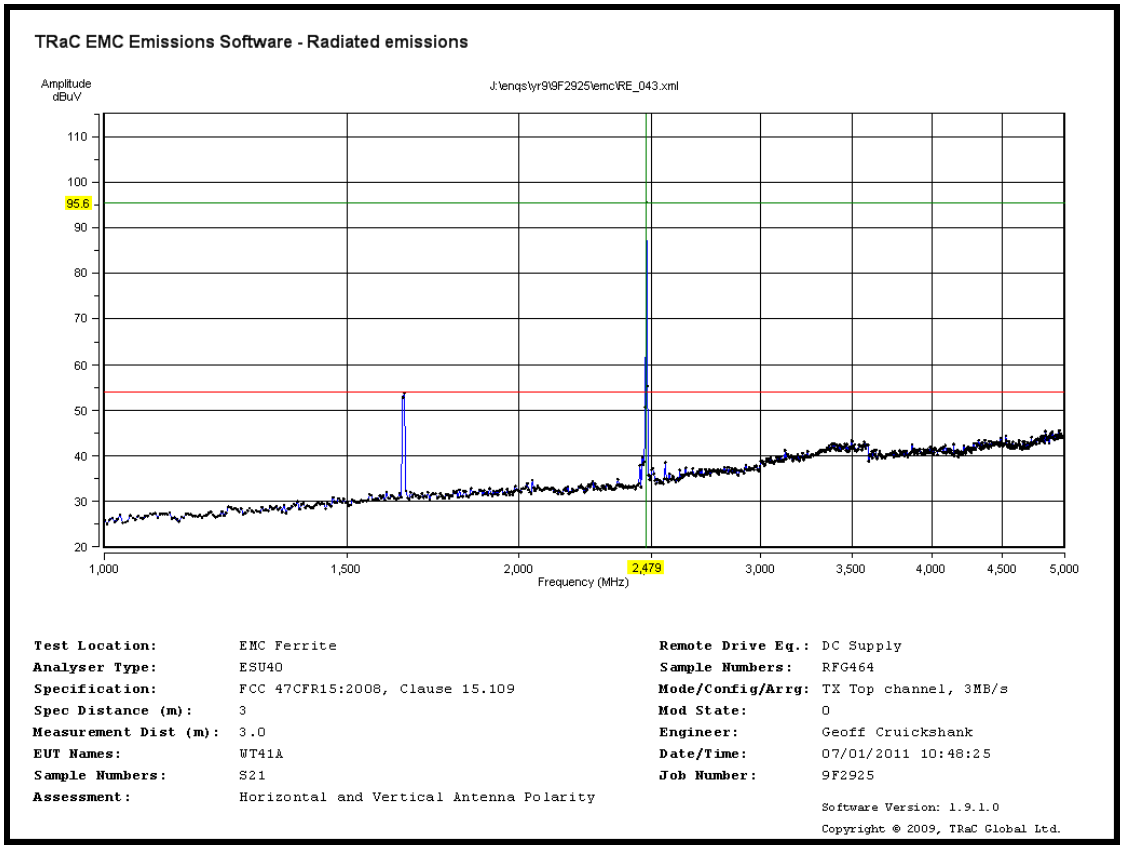
Radiated Spurious emissions 18 GHz to 25 GHz – 2441MHz – 3Mbps for S21



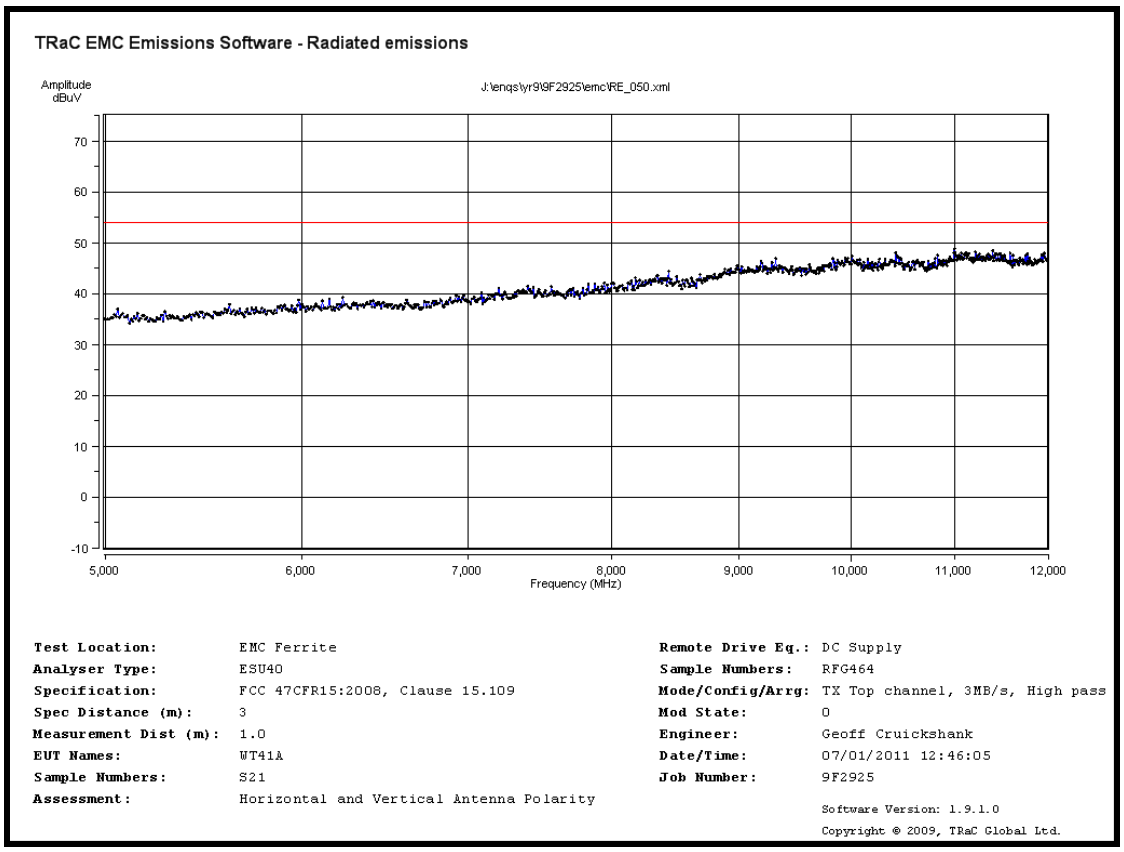
Radiated Spurious emissions 30 MHz to 200 MHz – 2480MHz – 3Mbps for S21



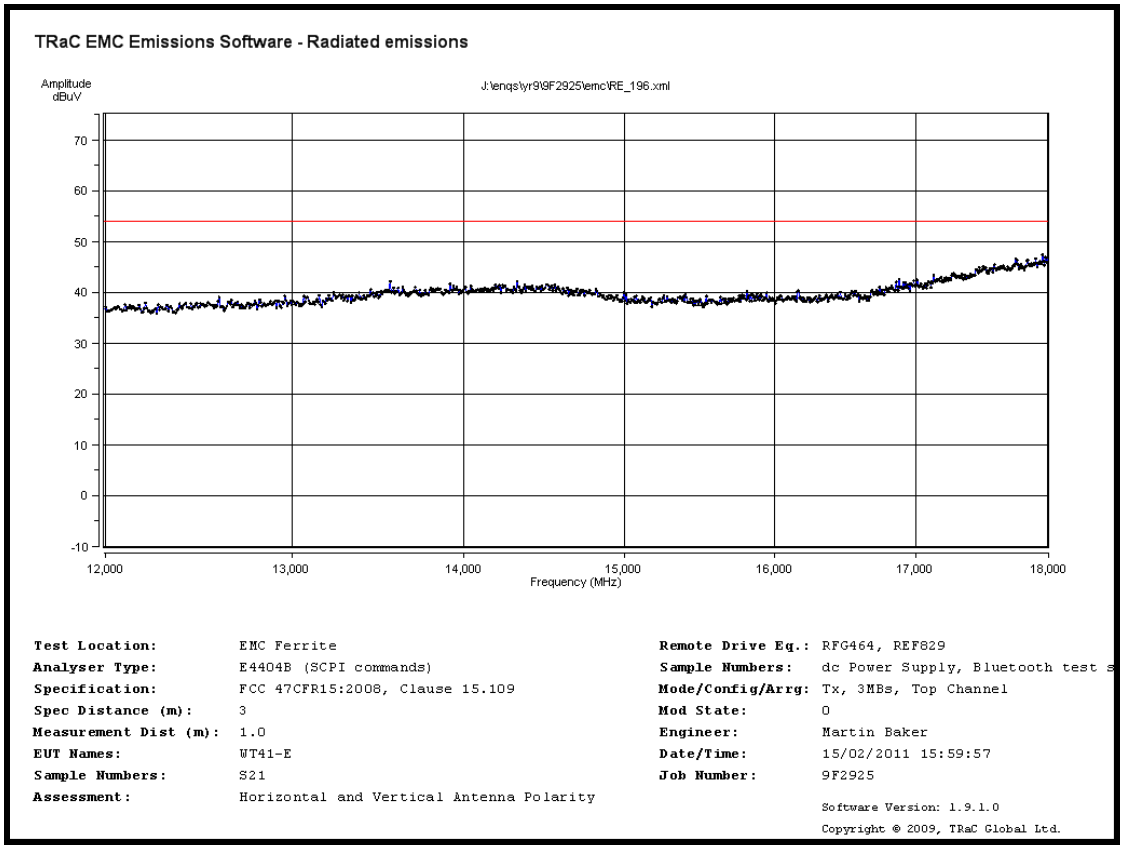
Radiated Spurious emissions 200 MHz to 1 GHz – 2480MHz – 3Mbps for S21



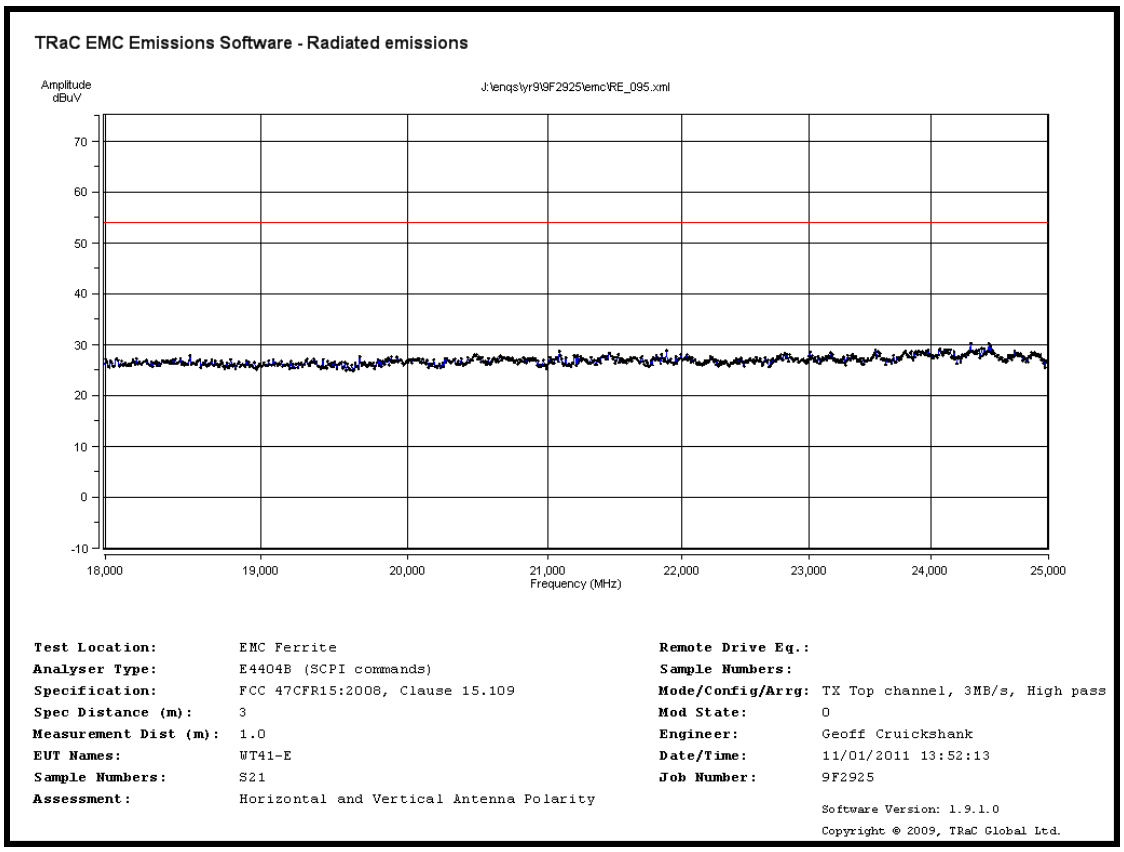
Radiated Spurious emissions 1 GHz to 5 GHz – 2480MHz – 3Mbps for S21



Radiated Spurious emissions 5 GHz to 12 GHz – 2480MHz – 3Mbps for S21

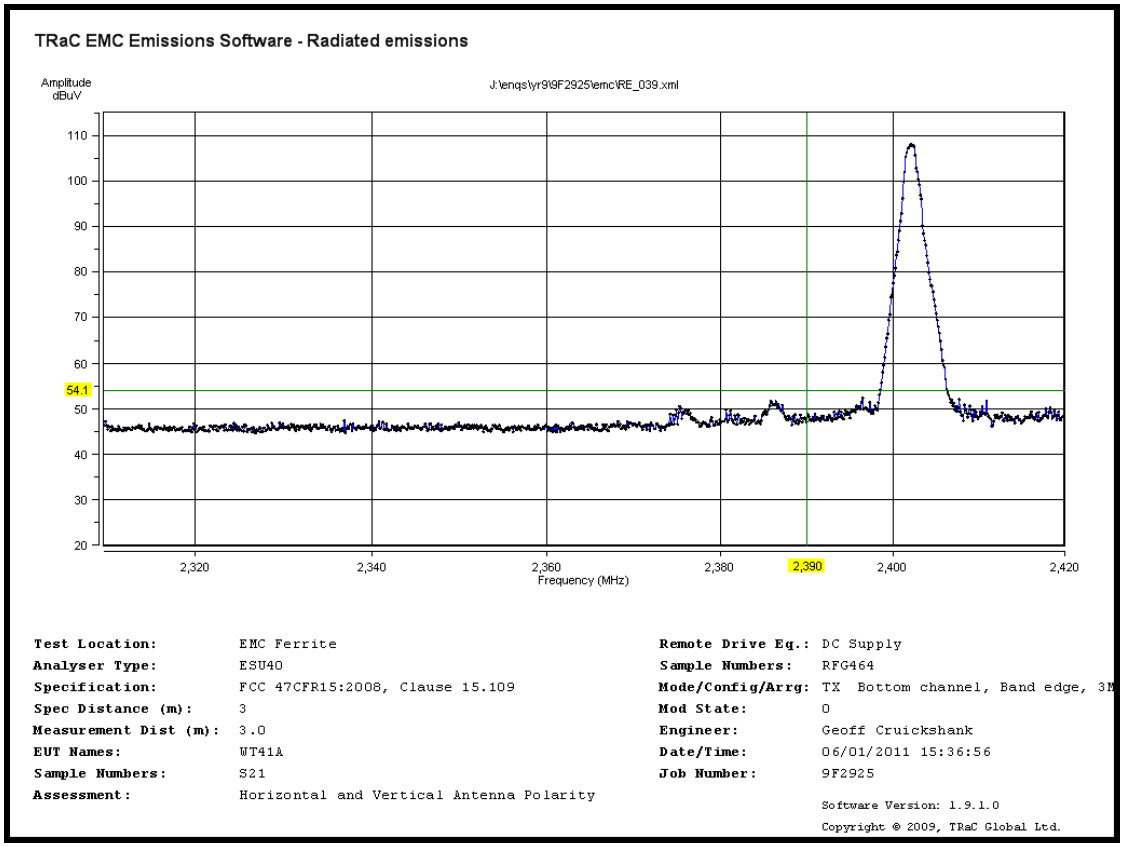


Radiated Spurious emissions 12 GHz to 18GHz – 2480MHz – 3Mbps for S21

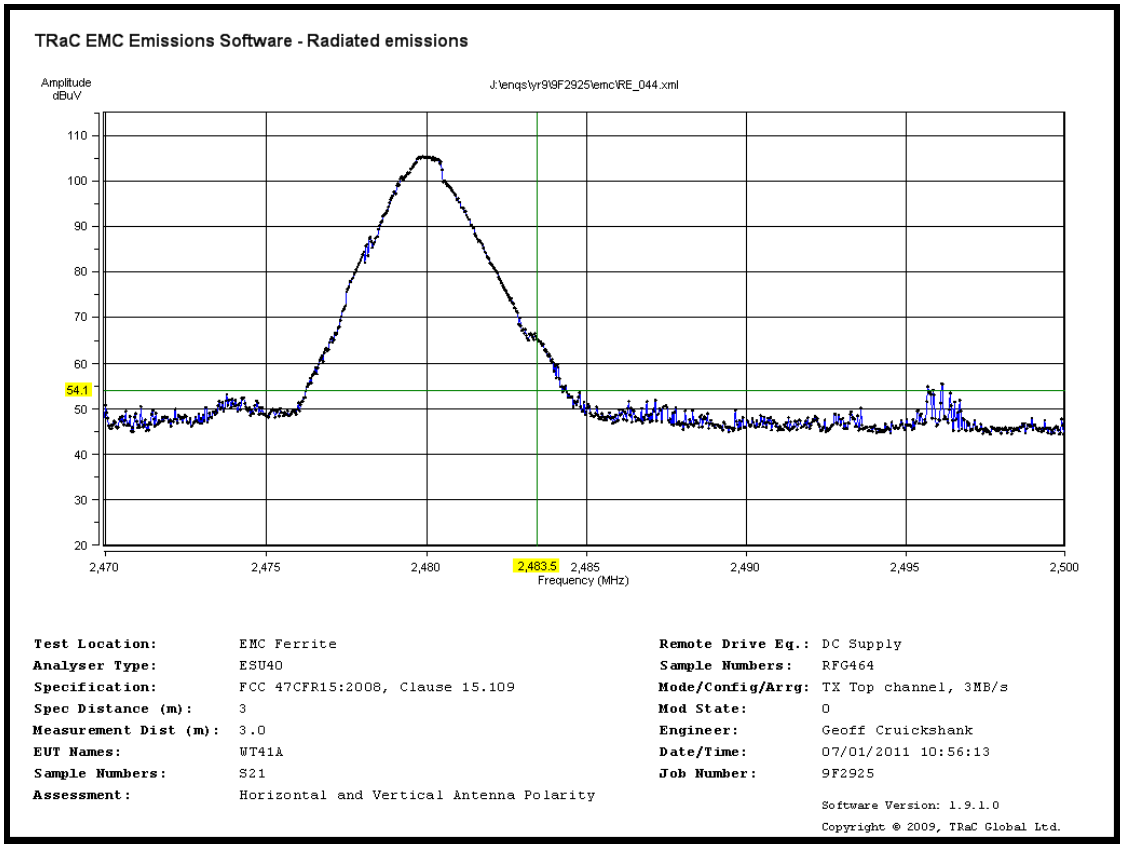


Radiated Spurious emissions 18 GHz to 25 GHz – 2480MHz – 3Mbps for S21

Radiated Bandedge Compliance – Peak plot to average limit

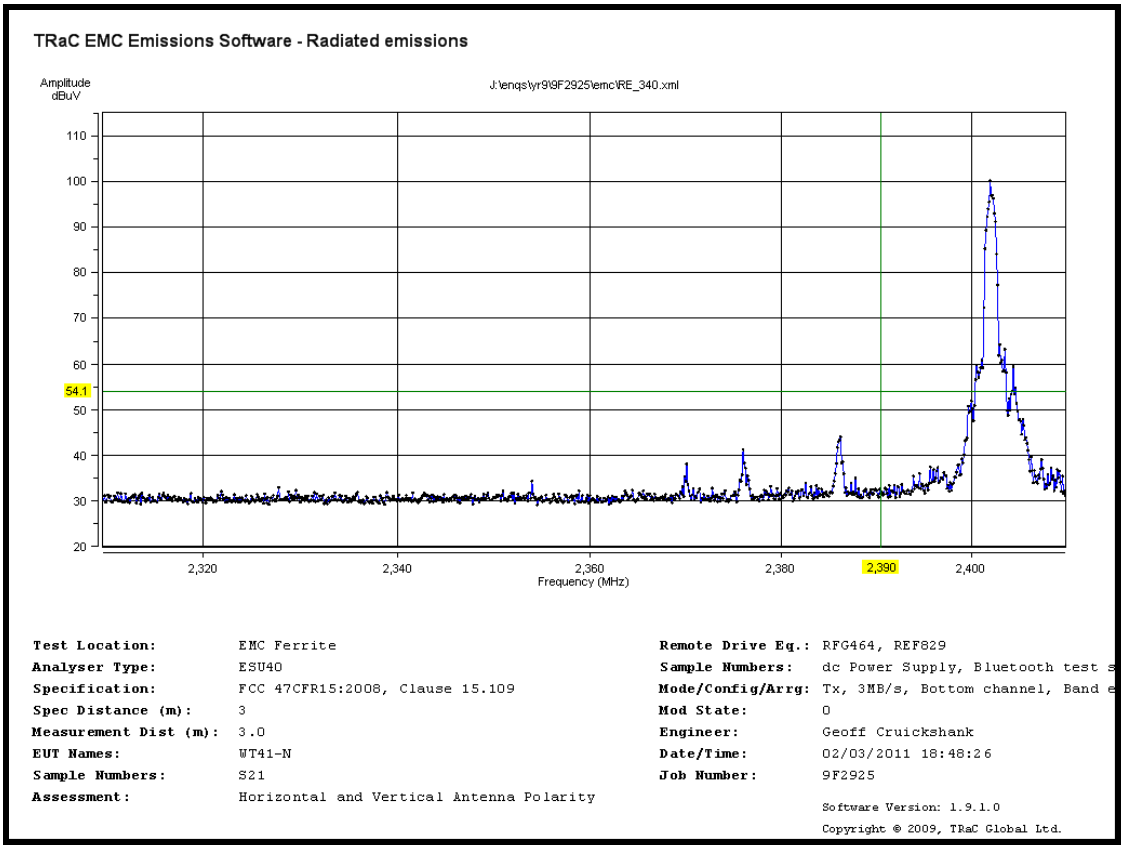


Lower Bandedge

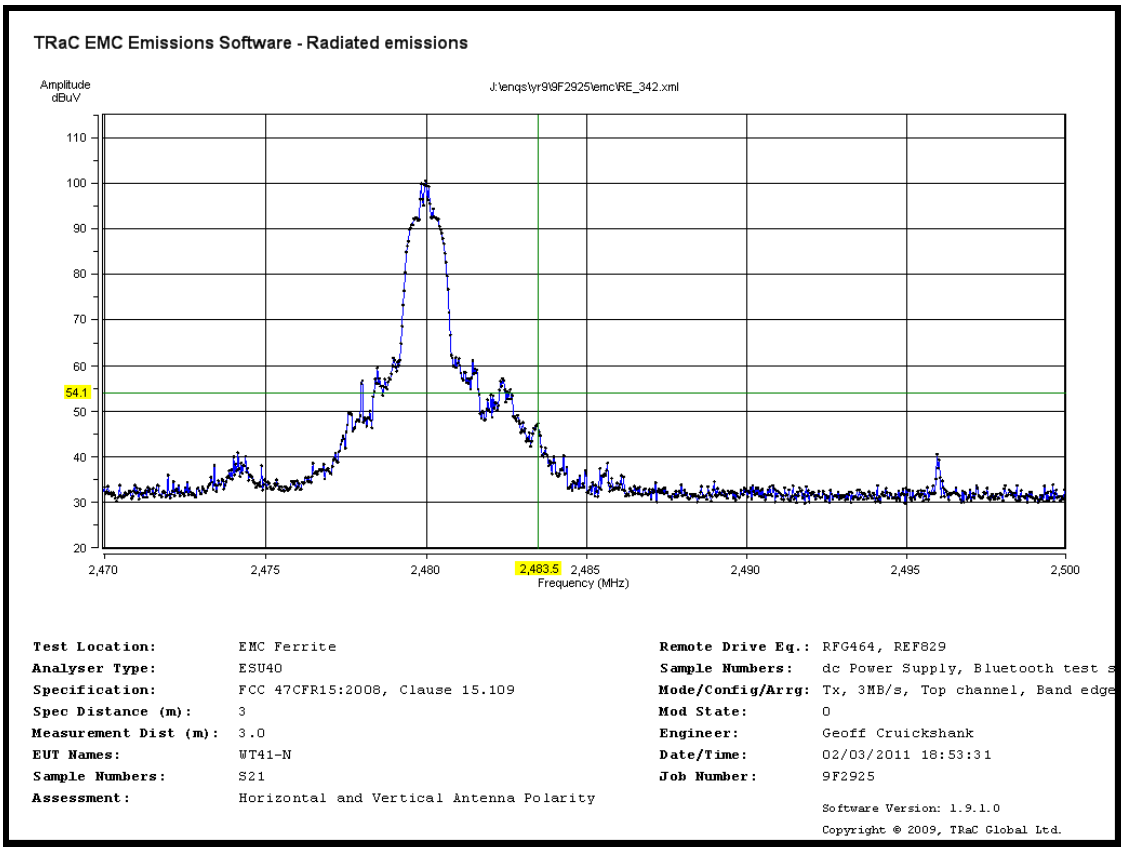


Upper Bandedge

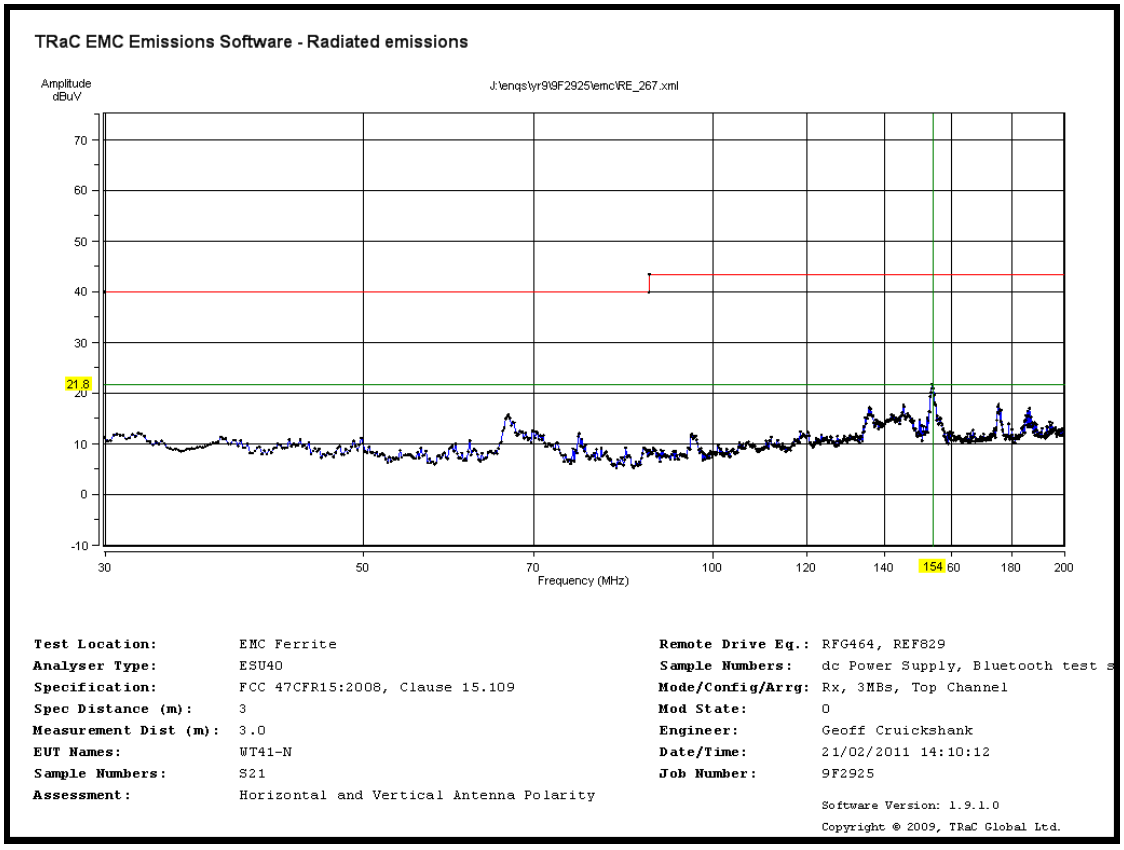
Radiated Bandedge Compliance – Average plot to average limit



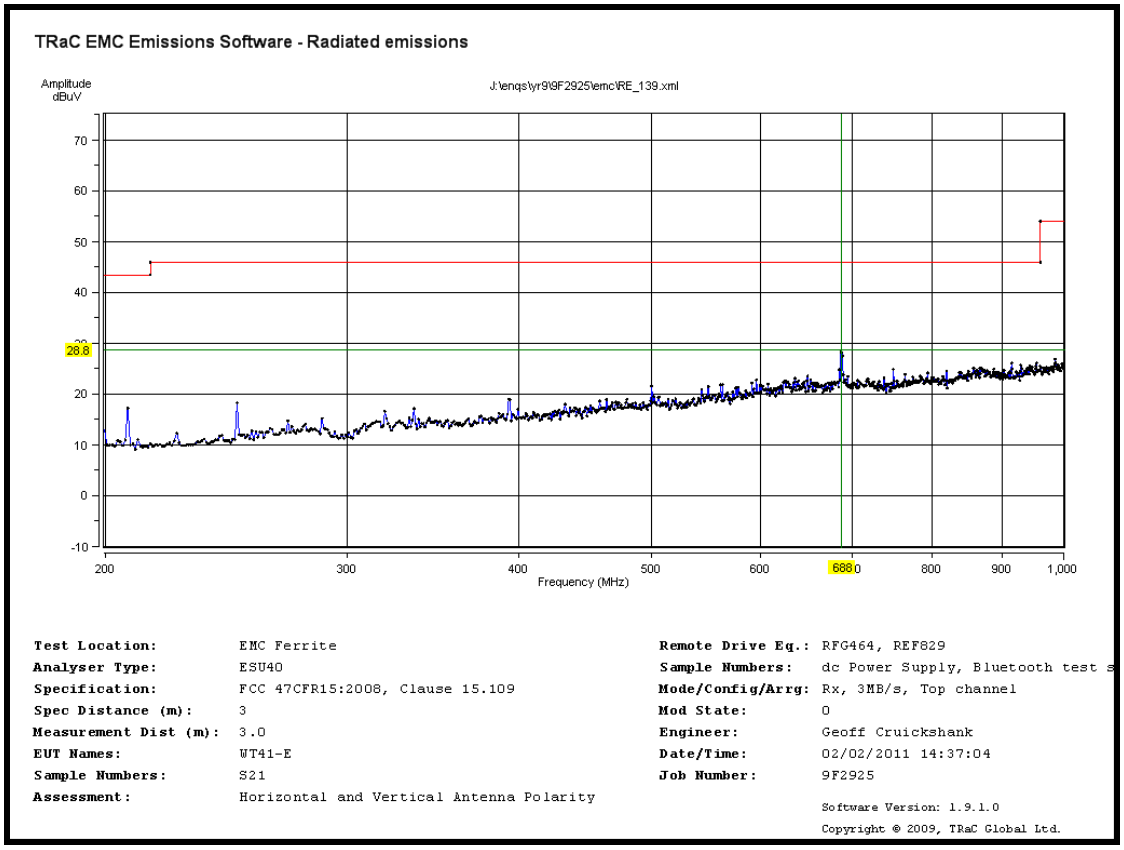
Lower Bandedge



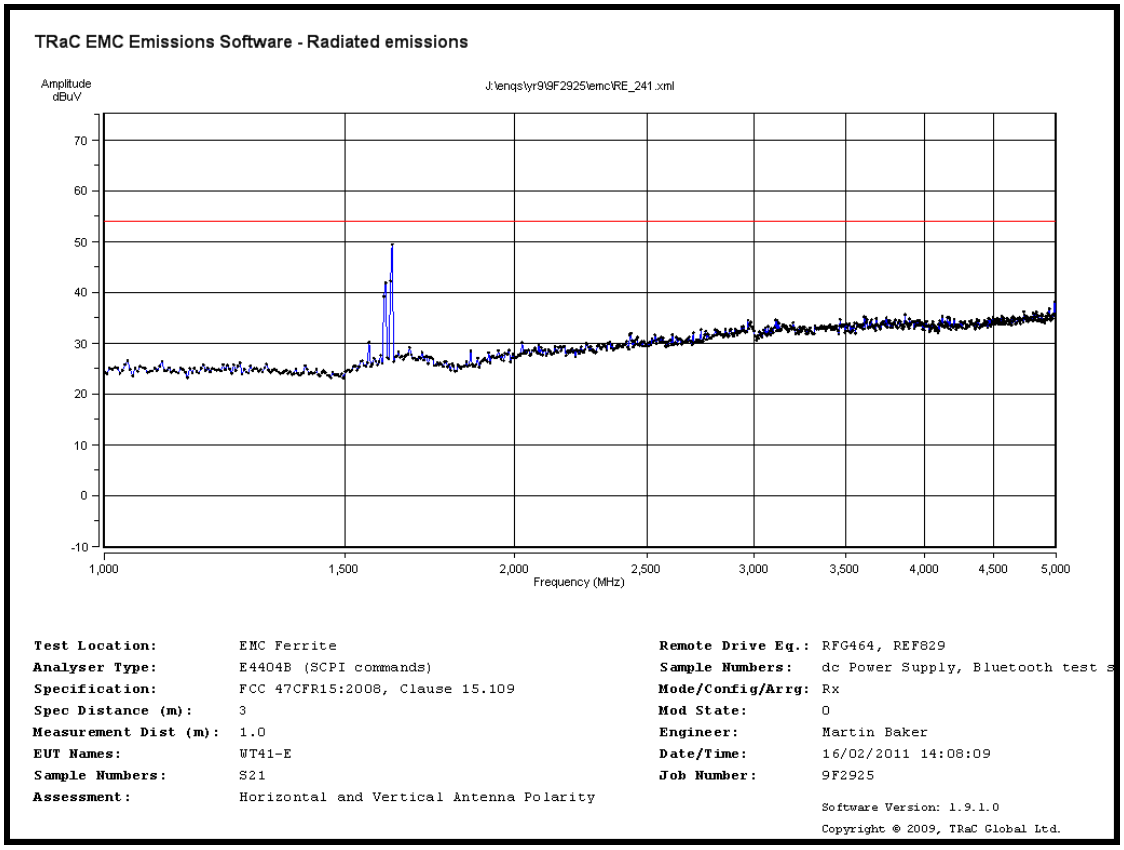
Upper Bandedge



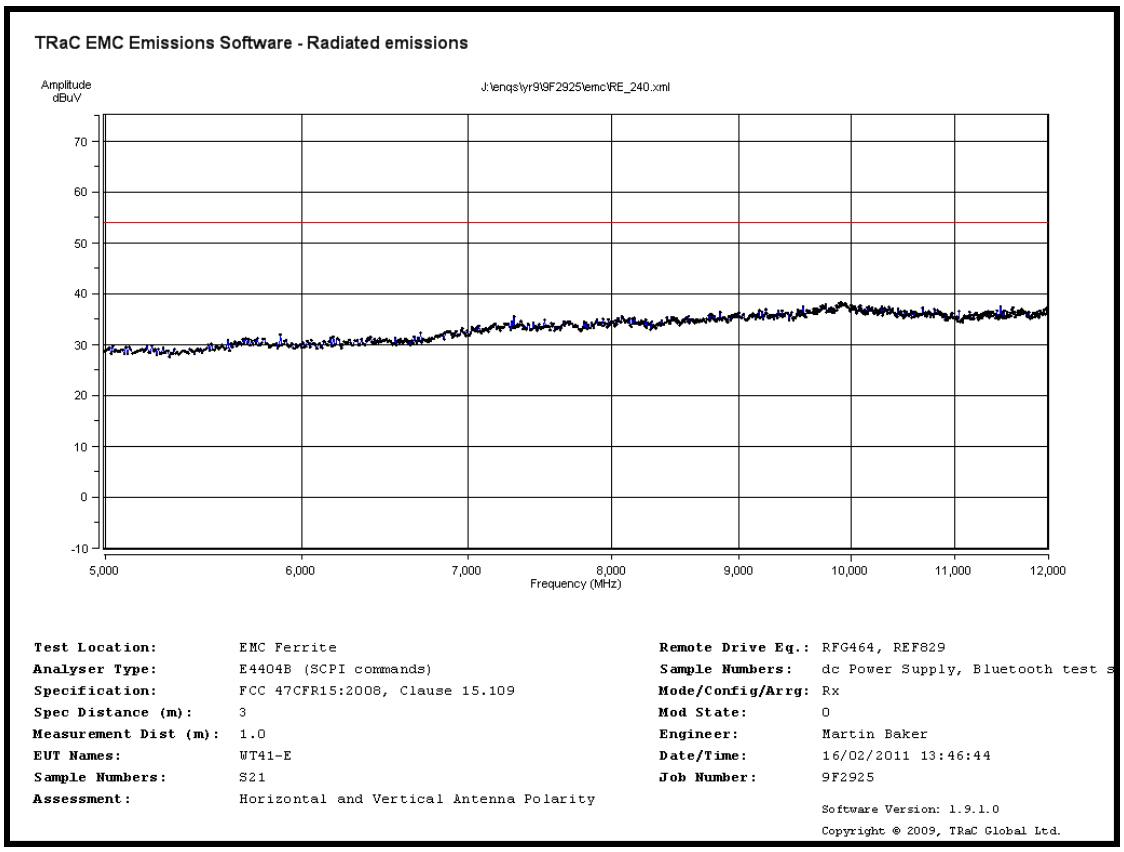
Unintentional Radiated Spurious emissions 30 MHz to 200 MHz for S21



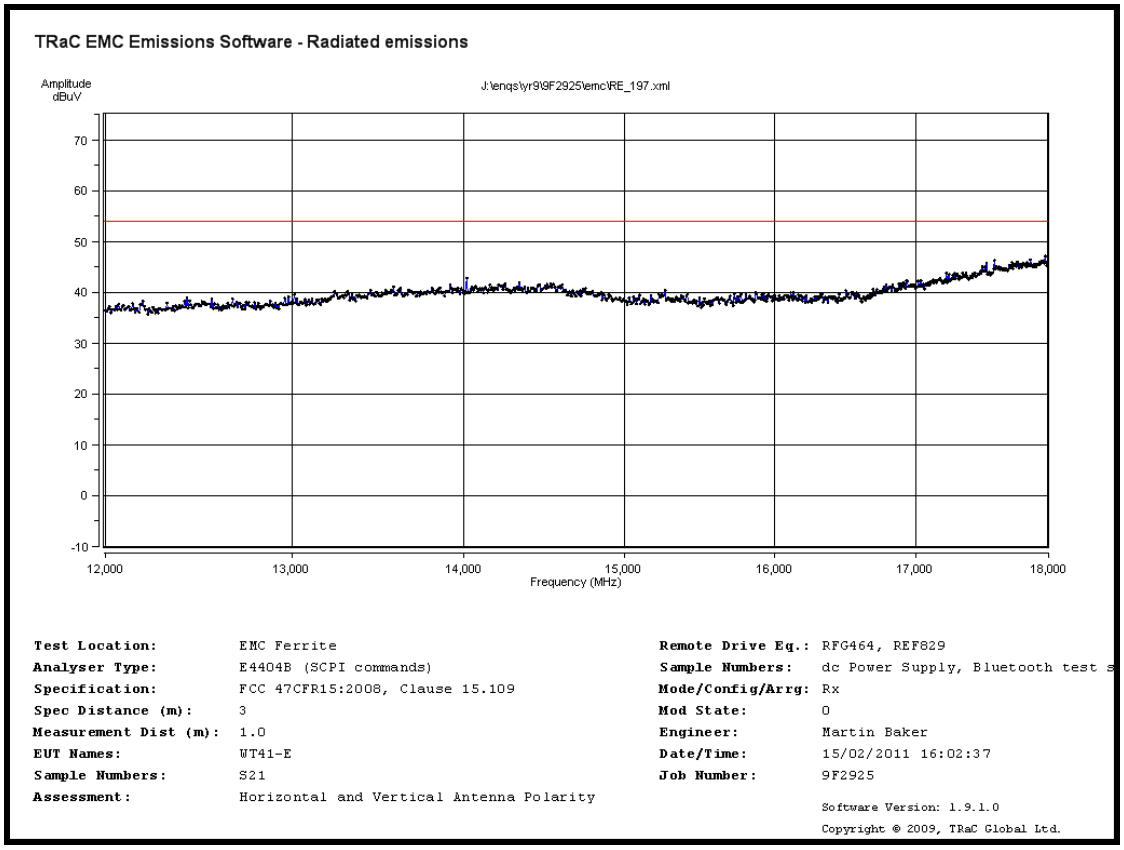
Unintentional Radiated Spurious emissions 200 MHz to 1 GHz for S21



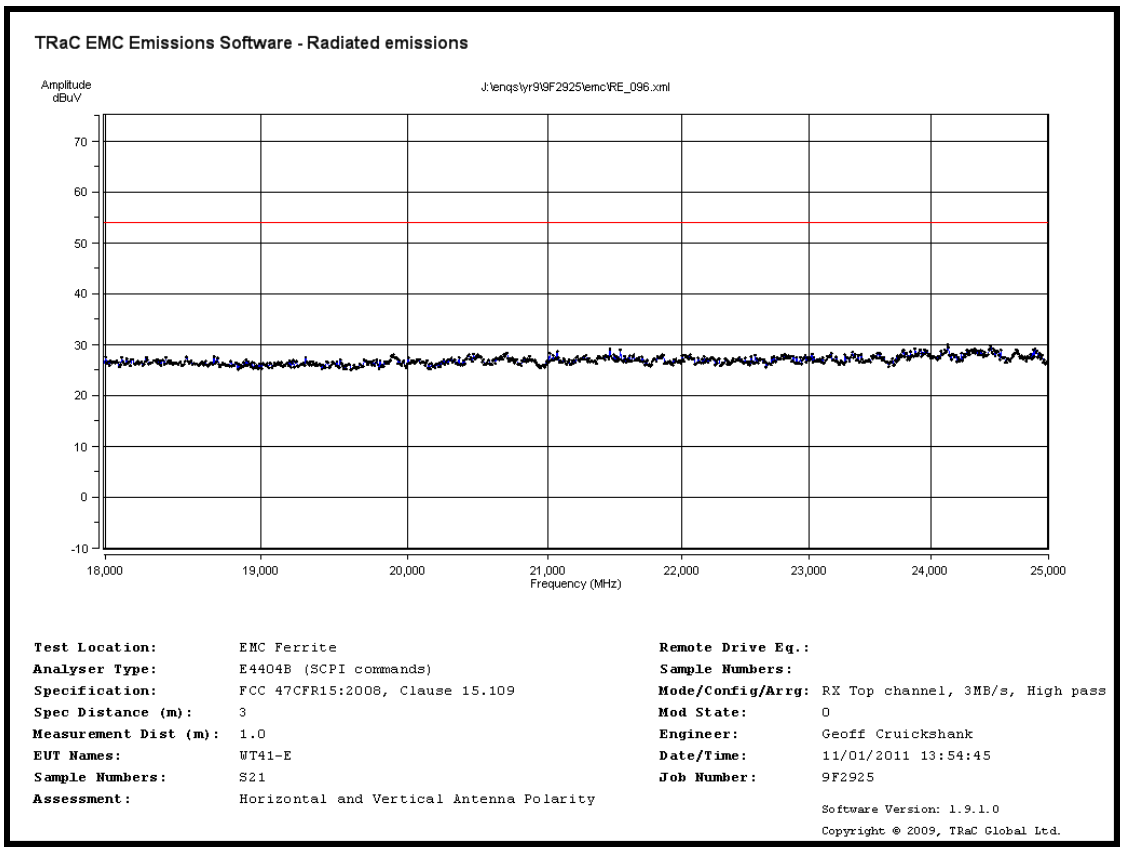
Unintentional Radiated Spurious emissions 1 GHz to 5 GHz for S21



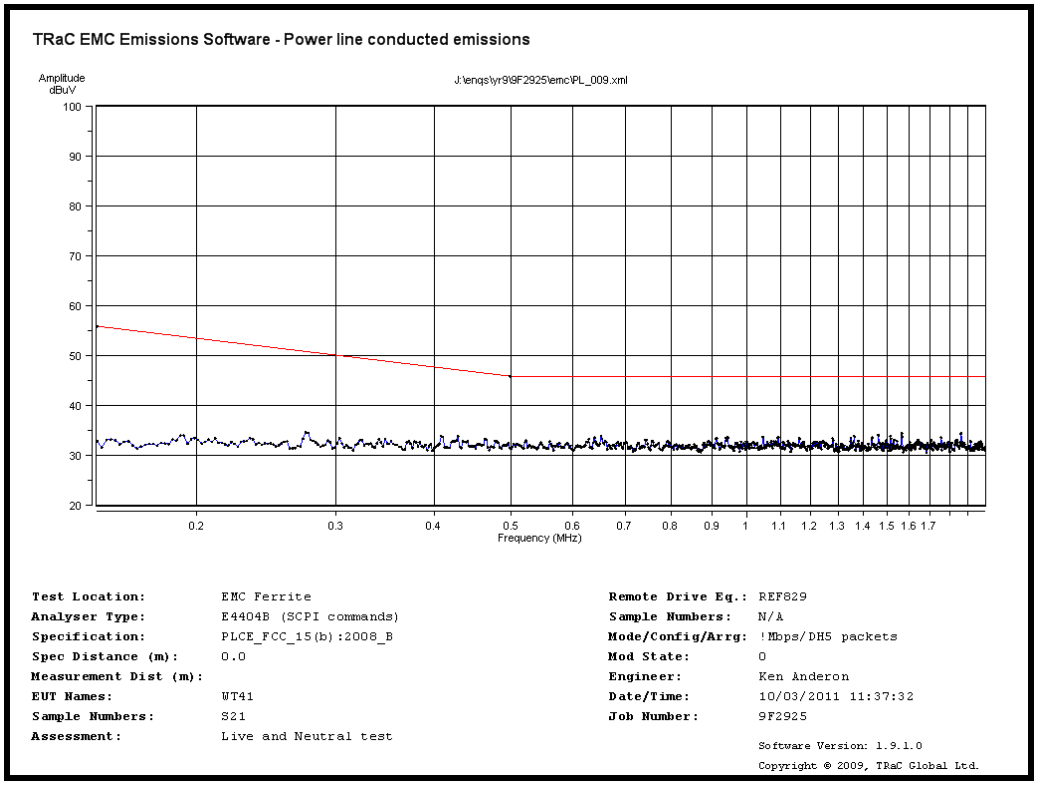
Unintentional Radiated Spurious emissions 5 GHz to 12 GHz for S21



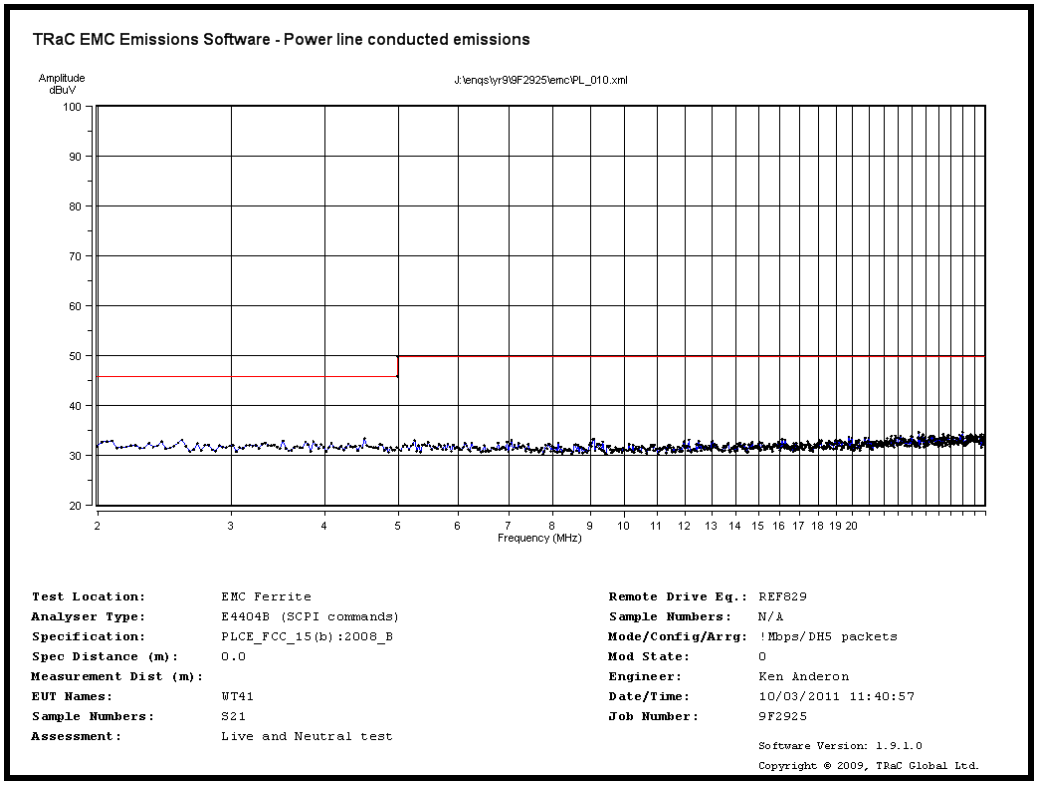
Unintentional Radiated Spurious emissions 12 GHz to 18GHz for S21



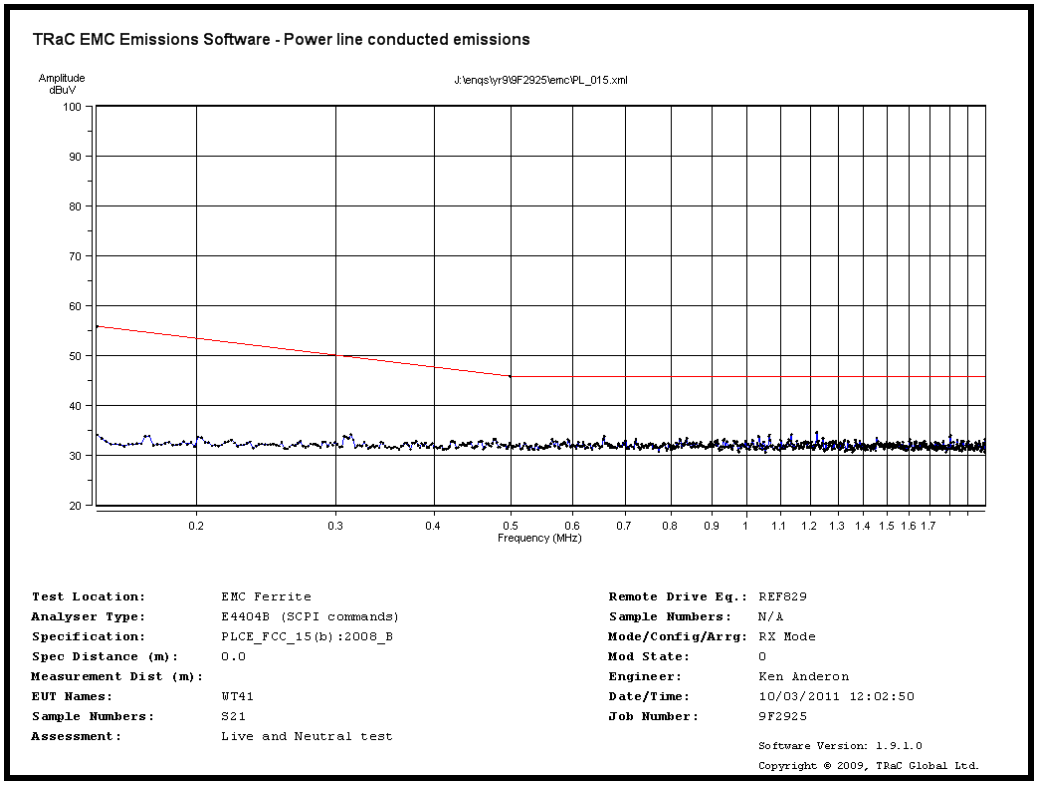
Unintentional Radiated Spurious emissions 18 GHz to 25 GHz for S21



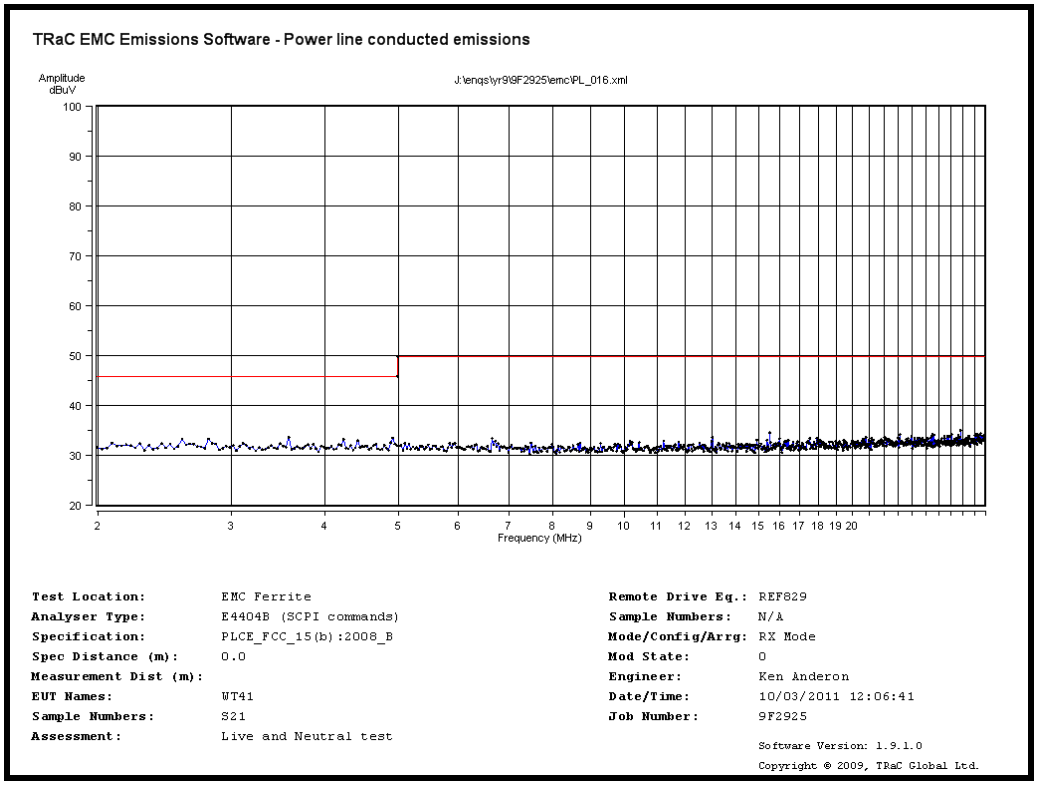
Power line conducted emissions Transmit Mode 0.15 MHz to 2 MHz



Power line conducted emissions Transmit Mode 2 MHz to 30 MHz



Power line conducted emissions Receive Mode 0.15 MHz to 2 MHz



Power line conducted emissions Receive Mode 2 MHz to 30 MHz