

**TRaC Radio Test Report** : TTR001087WUS1

**Applicant** : Telegesis (UK) Ltd

**Apparatus** : ETRX357-LR#2 Radio Module

**Specification(s)** : CFR47 Part 15.247 2008

**FCCID** : S4GEM35X2

**Purpose of Test** : Certification

**Authorised by** :



: Authorised Signatory

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**Section 1:****Introduction****1.1 General**

This report contains an assessment of an apparatus against Electromagnetic Compatibility Standards based upon tests carried out on samples submitted to the Laboratory.

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## **1.2 Tests Requested By**

This testing in this report was requested by :

Telegesis (UK) Ltd  
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## **1.3 Manufacturer**

Ryder Electronics (Shenzhen) Ltd  
139 Da Bao Road,  
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Shenzhen 518133  
China

#### **1.4 Apparatus Assessed**

The following apparatus was assessed between: 29/06/10 and 21/07/10

ETRX357-LR#2 Module

The ETRX357-LR#2 is a Long-Range (high power) Zigbee module fitted with an integral (Antenova Rufa 2.4GHz SMD) PCB mount antenna.

All radiated testing was performed using the integral antenna, the conducted tests were performed using an ETRX357-LR HR module fitted with a Hirose U.FL connector for connection to the appropriate test equipment.

Datasheets for the antenna is reproduced in Appendix D of this report

The family of products also include an ETRX351 series of modules that have identical RF circuitry to the ETRX357 range but with reduced on-board memory. No testing was performed on these modules. Details of the ETRX351 modules are contained within 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
Occupied Bandwidth	Title 47 of the CFR : Part 15 Subpart C; 15.247(a)(2)	ANSI C63.10	Pass
Conducted Carrier Power	Title 47 of the CFR : Part 15 Subpart C; 15.247(b)	ANSI C63.10	Pass
Power Spectral Density	Title 47 of the CFR : Part 15 Subpart C; 15.247(d)	ANSI C63.10	Pass
Unintentional Radiated Spurious Emissions	Title 47 of the CFR: Part 15 Subpart C; 15.109	ANSI C63.10	Pass
Digital Modulation	Title 47 of the CFR: Part 15 Subpart C; 15.403	-	Pass
RF Safety	Title 47 of the CFR : Part 15 Subpart C; 15.247(b)(5)	-	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 Measurement Uncertainty Values****Radiated Electric Field Emissions**

Quantity Range	Quantity	Expanded Uncertainty
9kHz to 150 kHz	Amplitude dB( $\mu$ V/m)	$\pm 1.6$ dB
150 kHz to 30 MHz	Amplitude dB( $\mu$ V/m)	$\pm 2.1$ dB
30MHz to 300MHz Horizontal	Amplitude dB( $\mu$ V/m)	$\pm 5.1$ dB
30MHz to 300MHz Vertical	Amplitude dB( $\mu$ V/m)	$\pm 5.2$ dB
300MHz to 1GHz Horizontal	Amplitude dB( $\mu$ V/m)	$\pm 5.4$ dB
300MHz to 1GHz Vertical	Amplitude dB( $\mu$ V/m)	$\pm 5.2$ dB
1GHz to 18GHz Horizontal	Amplitude dB( $\mu$ V/m)	$\pm 4.4$ dB
1GHz to 18GHz Vertical	Amplitude dB( $\mu$ V/m)	$\pm 4.4$ dB
18GHz to 26.5GHz Horizontal	Amplitude dB( $\mu$ V/m)	$\pm 4.2$ dB
18GHz to 26.5GHz Vertical	Amplitude dB( $\mu$ V/m)	$\pm 4.2$ dB
26.5GHz to 40GHz Horizontal	Amplitude dB( $\mu$ V/m)	$\pm 4.3$ dB
26.5GHz to 40GHz Vertical	Amplitude dB( $\mu$ V/m)	$\pm 4.3$ dB

**Power Line Conducted Emissions**

Quantity Range	Quantity	Expanded Uncertainty
9kHz to 150kHz	Amplitude dB( $\mu$ V)	$\pm 4.2$ dB
150kHz to 30MHz	Amplitude dB( $\mu$ V)	$\pm 3.1$ dB



**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		

**A1 6 dB Bandwidth**

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

Test Details:	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) 15.247(a)(2)
EUT sample number	S10
Modification state	0
SE in test environment	S05
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Channel Frequency (MHz)	F <sub>lower</sub>	F <sub>Higher</sub>	Measured 20 dB Bandwidth (kHz)	Limit (kHz)	Result
2405	2404.182	2405.769	1.586	>500	Pass
2440	2439.174	2440.777	1.602	>500	Pass
2480	2479.174	2480.761	1.586	>500	Pass

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

**A2 Transmitter Peak Output Power**

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

Test Details:	
Regulation	Title 47 of the CFR: Part15 Subpart (c) 15.247(b)(3)
Measurement standard	ANSI C63.10
EUT sample number	S10
Modification state	0
SE in test environment	S05
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Channel Frequency (MHz)	Peak Carrier Power (W)	Antenna Gain dBi	Radiated Power (W) (EIRP)	Limit (W)	Result
2405	0.0123W	2.1	0.0199	1.0000	Pass
2440	0.0111W	2.1	0.0179	1.0000	Pass
2480	0.000492W	2.1	0.000797	1.0000	Pass

**Notes:**

Conducted Measurement

Measured Peak Carrier power includes highest gain of any antenna to be used.

Highest Gain of any antenna to be used = 2.1 dBi

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

**A3 Transmitter Power Spectral Density**

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

<b>Test Details:</b>	
Regulation	Title 47 of the CFR: Part15 Subpart (c) 15.247(e)
Measurement standard	ANSI C63.10
EUT sample number	S10
Modification state	0
SE in test environment	S05
SE isolated from EUT	None
EUT set up	Refer to Appendix C

<b>Channel Frequency (MHz)</b>	<b>Peak Power Spectral Density (dBm/3kHz)</b>	<b>Limit (dBm/3kHz)</b>	<b>Result</b>
2405	-3.9	8.0	Pass
2440	-4.5	8.0	Pass
2480	-18.2	8.0	Pass

**Notes:**

Conducted Measurement

Measured Power Spectral Density includes highest gain of any antenna to be used.

Highest Gain of any antenna to be used = 2.1 dBi

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

The resolution bandwidth on the analyser was set to 3kHz and trace set to max hold.

The span is set to 2 MHz

The sweep time is 680 seconds (Span/3kHz).

**A4 RF Antenna Conducted Spurious Emissions**

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

<b>Test Details: 2405 MHz</b>	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10
Frequency range	9 kHz to 25 GHz
EUT sample number	S10
Modification state	0
SE in test environment	S05
SE isolated from EUT	None
EUT set up	Refer to Appendix C

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

Ref No.	Measured Freq (MHz)	Det.	Is measured Frequency within the Restricted bands (Y/N)	Measured Peak Conducted power (RBW =100kHz) (dBuV)	15.247(d) Limit (dBuV)	Summary
1.	4814	Pk	N	67.8	94.1	Pass

No further emissions were detected within 20 dB of the test limit.

**RF Antenna Conducted Spurious Emissions continued:**

Test Details: 2440 MHz	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10
Frequency range	9 kHz to 25 GHz
EUT sample number	S10
Modification state	0
SE in test environment	S05
SE isolated from EUT	None
EUT set up	Refer to Appendix C

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

Ref No.	Measured Freq (MHz)	Det.	Is measured Frequency within the Restricted bands (Y/N)	Measured Peak Conducted power (RBW =100kHz) (dBuV)	15.247(d) Limit (dBuV)	Summary
1.	4884	Pk	N	66.0	92.8	Pass

No further emissions were detected within 20 dB of the test limit.

**RF Antenna Conducted Spurious Emissions continued:**

Test Details: 2480 MHz	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10
Frequency range	9 kHz to 25 GHz
EUT sample number	S10
Modification state	0
SE in test environment	S05
SE isolated from EUT	None
EUT set up	Refer to Appendix C

No emissions were detected within 20 dB of the test limit.



**Notes:**

1. The conducted emission limit for emissions outside the restricted bands, defined in 47CFR15.205(a) are based on a transmitted carrier level of 15.247(b). With the EUT transmitting on its lowest, centre and highest carrier frequencies in turn, emissions from the EUT are required to be 20 dB below the level of the highest fundamental as measured within a 100 kHz RBW in accordance with 15.247(d) using a peak detector.
2. The RBW = 100 kHz, Video bandwidth (VBW) > RBW and the radio spectrum was investigated up to the 10th harmonic in accordance 15.33 (a)(1).
3. The measurements at 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 measured in 100kHz RBW)-20dB

Where:

The maximum peak conducted power was measured using a spectrum analyser using a 100kHz resolution bandwidth.

Channel No.	Channel Frequency (MHz)	Measured Peak Carrier (dB $\mu$ V)	Measured Peak Carrier -20dB (dB $\mu$ V)	Emission Limit In a 100 kHz RBW (dB $\mu$ V)
11	2405	114.1	94.1	94.1
19	2440	112.8	92.8	92.8
26	2480	99.1	79.1	79.1

**A5 Radiated Electric Field Emissions within the Restricted Bands of 15.205**

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

The following test site was used for final measurements as specified by the standard tested to:

3m open area test site :



3m alternative test site :



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

Test Details: 2405 MHz	
Regulation	Title 47 of the CFR: Part 15 Subpart (b) Clause 15.209
Measurement standard	ANSI C63.10
Frequency range	30MHz to 25 GHz
EUT sample number	S08
Modification state	0
SE in test environment	S05
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photographs 1 and 2

The worst case radiated emission measurements for spurious emissions:

Ref No.	FREQ. (MHz)	DETECTOR	FIELD ST'GH (dBµV/m)	Duty Cycle Fact (Note 3) (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)
1.	2400.000	Pk	73.7	0	73.7	90.1
2.	2400.000	Av	63.9	-11.4	52.5	70.1
3.	2399.615	Pk	73.7	0	73.7	90.1
4.	2399.615	Av	63.7	-11.4	52.3	70.1
5.	2389.286	Pk	55.7	0	55.7	74
6.	2389.286	Av	45	-11.4	33.6	54
7.	4809.050	Pk	66.7	0	66.7	74
8.	4809.050	Av	60	-11.4	48.6	54
9.	7213.481	Pk	66.7	0	66.7	90.1
10.	7213.481	Av	58.9	-11.4	47.5	70.1
11.	9618.010	Pk	69.1	0	69.1	90.1
12.	9618.010	Av	62.1	-11.4	50.6	70.1
13.	12027.371	Pk	65.8	0	65.8	74
14.	12027.371	Av	57	-11.4	45.6	54
15.	14437.500	Pk	61.4	0	61.4	90.1
16.	14437.500	Av	47.8	-11.4	36.4	70.1
17.	16854.000	Pk	59.7	0	59.7	90.1
18.	16854.000	Av	47	-11.4	35.6	70.1

Test Details: 2440 MHz	
Regulation	Title 47 of the CFR: Part 15 Subpart (b) Clause 15.209
Measurement standard	ANSI C63.10
Frequency range	30MHz to 25 GHz
EUT sample number	S08
Modification state	0
SE in test environment	S05
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photographs 1 and 2

The worst case radiated emission measurements for spurious emissions:

Ref No.	FREQ. (MHz)	DETECTOR	FIELD ST'GH (dBµV/m)	Duty Cycle Fact (Note 3) (dB)	FIELD ST'GH (dBµV/m)	LIMIT (dBµV/m)
1.	4879.004	Pk	65.6	0	65.6	74
2.	4879.004	Av	58.5	-11.4	47.1	54
3.	7318.517	Pk	69.8	0	69.8	74
4.	7318.517	Av	62.3	-11.4	50.9	54
5.	9761.901	Pk	73.9	0	73.9	89.3
6.	9761.901	Av	67.2	-11.4	55.8	69.3
7.	12197.482	Pk	64.5	0	64.5	74
8.	12197.482	Av	55.2	-11.4	43.8	54
9.	14636.746	Pk	60.9	0	60.9	89.3
10.	14636.746	Av	47.7	-11.4	36.3	74

Test Details: 2480 MHz	
Regulation	Title 47 of the CFR: Part 15 Subpart (b) Clause 15.209
Measurement standard	ANSI C63.10
Frequency range	30MHz to 25 GHz
EUT sample number	S08
Modification state	0
SE in test environment	S05
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photographs 1 and 2

The worst case radiated emission measurements for spurious emissions:

Ref No.	FREQ. (MHz)	DETECTOR	FIELD ST'GH (dBμV/m)	Duty Cycle Fact (Note 3) (dB)	FIELD ST'GH (dBμV/m)	LIMIT (dBμV/m)
1.	2483.500	Pk	62.9	0	62.9	74
2.	2483.500	Av	51.1	-11.4	39.7	54
3.	3416.000	Pk	55.3	0	55.3	72.5
4.	3416.000	Av	42.5	-11.4	31.1	52.5

#### Notes:

- Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10: section 4.5, Table 1
- In accordance with 15.35(b), above 1 GHz, emissions measured using a peak detector shall not exceed a level 20 dB above the average limit.
- For all the above tables, the average emissions results can be reduced by the 11.4 dB duty cycle correction factor calculated in Appendix E for comparison with the test limit.
- 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.
- For Frequencies below 1 GHz, RBW= 100 kHz, testing was performed with CISPR16 compliant test receiver with QP detector. Above 1 GHz tests were performed using a spectrum analyser using the following settings:  
     Peak              RBW=VBW= 1MHz  
     Average         RBW=VBW= 1MHz

These settings as per ANSI C63.10

The upper and lower frequency of the measurement range was decided according to 47 CFR 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 $\mu$ V/m	Measurement Distance m	Field strength dB $\mu$ V/m
0.009-0.490	2400/F(kHz)	300	67.6/F (kHz)
0.490-1.705	24000/F(kHz)	30	87.6/F (kHz)
1.705-30	30	30	29.5
30-88	100	3	40.0
88-216	150	3	43.5
216-960	200	3	46.0
Above 960	500	3	54.0

**Notes:**

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

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

The results displayed take into account applicable antenna factors and cable losses.

- (b) The levels may have been rounded for display purposes.
- (c) The following table summarises the effect of the EUT operating mode, internal configuration and arrangement of cables / samples on the measured emission levels :

	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels		✓		
Effect of EUT internal configuration on emission levels		✓		
Effect of Position of EUT cables & samples on emission levels	✓			
(i) Parameter defined by standard and / or single possible, refer to Appendix D (ii) Parameter defined by client and / or single possible, refer to Appendix D (iii) Parameter had a negligible effect on emission levels, refer to Appendix D (iv) Worst case determined by initial measurement, refer to Appendix D				

## A6 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	S08
Modification state	0
SE in test environment	S05 and Laptop
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photograph 3

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

### Results measured using the peak detector compared to the average limit

Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
1	0.15813	L	51.6	55.6	-4.0	Pass
2	0.17350	L	51.5	54.8	-3.3	Pass
3	0.18455	L	50.1	54.3	-4.2	Pass
4	0.20785	L	50.2	53.3	-3.1	Pass
5	11.2000	L	40.7	50.0	-9.3	Pass
6	14.8000	L	41.6	50.0	-8.4	Pass
7	0.15813	N	51.5	55.6	-4.1	Pass
8	0.17350	N	51.7	54.8	-3.1	Pass
9	0.18455	N	49.7	54.3	-4.6	Pass
10	0.20785	N	50.1	53.3	-3.2	Pass
11	11.2000	N	40.9	50.0	-9.1	Pass
12	14.8000	N	41.8	50.0	-8.2	Pass

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	S08
Modification state	0
SE in test environment	S05 and Laptop
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photograph 3

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

**Results measured using the peak detector compared to the average limit**

Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
1	0.15600	L	51.8	55.7	-3.9	Pass
2	0.16600	L	50.9	55.2	-4.2	Pass
3	0.21600	L	49.8	53.0	-3.2	Pass
4	0.22500	L	50.0	52.6	-2.6	Pass
5	11.3000	L	41.0	50.0	-9.0	Pass
6	14.7000	L	41.0	50.0	-9.0	Pass
7	0.15600	N	52.5	55.7	-3.2	Pass
8	0.16600	N	51.2	55.2	-4.0	Pass
9	0.21600	N	51.1	53.0	-1.9	Pass
10	0.22500	N	50.8	52.6	-1.8	Pass
11	11.3000	N	41.6	50.0	-8.4	Pass
12	14.7000	N	41.9	50.0	-8.1	Pass

**Specification limits :**

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

Conducted disturbance at the mains ports.

Frequency range MHz	Limits dB $\mu$ V	
	Quasi-peak	Average
0.15 to 0.5	66 to 56 <sup>2</sup>	56 to 46 <sup>2</sup>
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



**A7     Antenna Gain**

The maximum antenna gain for the antenna type to be used with the EUT, as declared by the client, is 2.1 dBi. (See Appendix D for the antenna data sheet)

**A8 Unintentional Radiated Electric Field Emissions - 15.109**

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

The following test site was used for final measurements as specified by the standard tested to :

3m open area test site :

☐

3m alternative test site :

☒

Test Details: 2405 MHz	
Regulation	Title 47 of the CFR: Part 15 Subpart (b) Clause 15.109
Measurement standard	ANSI C63.10
Frequency range	30MHz to 25 GHz
EUT sample number	S08
Modification state	0
SE in test environment	S05
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photographs 1 and 2

No Spurious emissions within 20 dB of the test limit were detected.

Test Details: 2440 MHz	
Regulation	Title 47 of the CFR: Part 15 Subpart (b) Clause 15.109
Measurement standard	ANSI C63.10
Frequency range	30MHz to 25 GHz
EUT sample number	S08
Modification state	0
SE in test environment	S05
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photographs 1 and 2

No Spurious emissions within 20 dB of the test limit were detected.

Test Details: 2480 MHz	
Regulation	Title 47 of the CFR: Part 15 Subpart (b) Clause 15.109
Measurement standard	ANSI C63.10
Frequency range	30MHz to 25 GHz
EUT sample number	S08
Modification state	0
SE in test environment	S05
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photographs 1 and 2

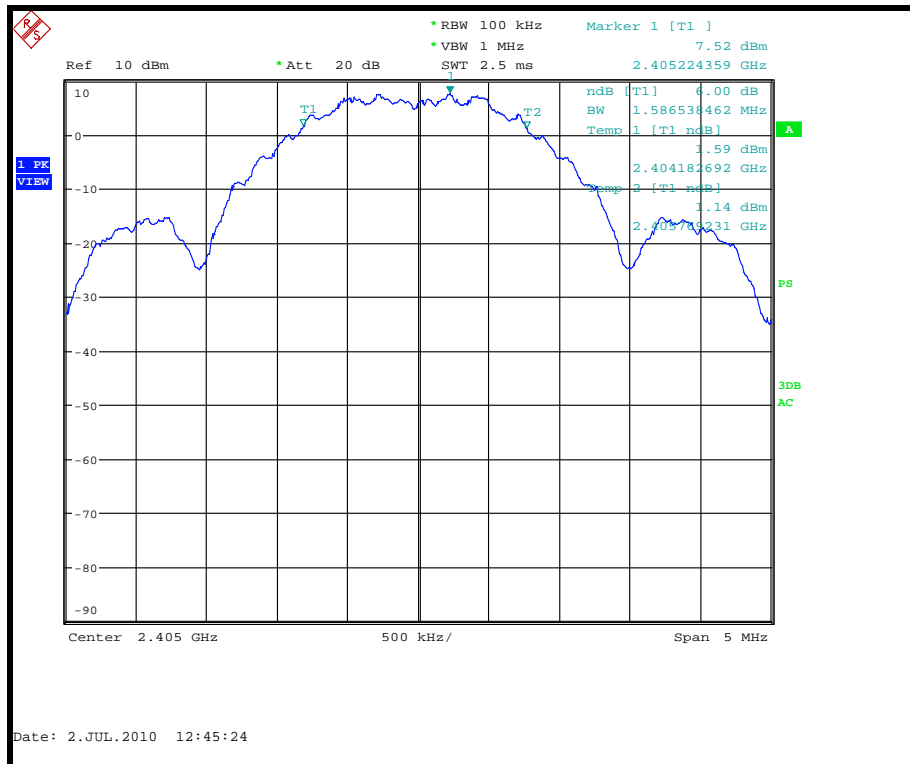
No Spurious emissions within 20 dB of the test limit were detected.

**Appendix B:****Supporting Graphical Data**

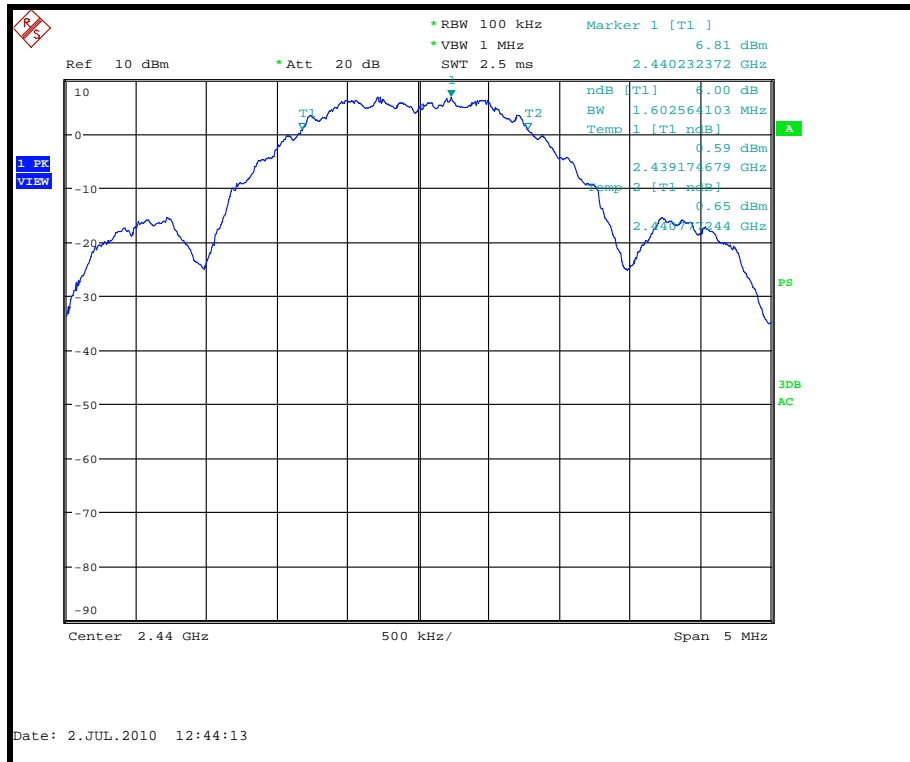
This appendix contains graphical data obtained during testing.

Notes:

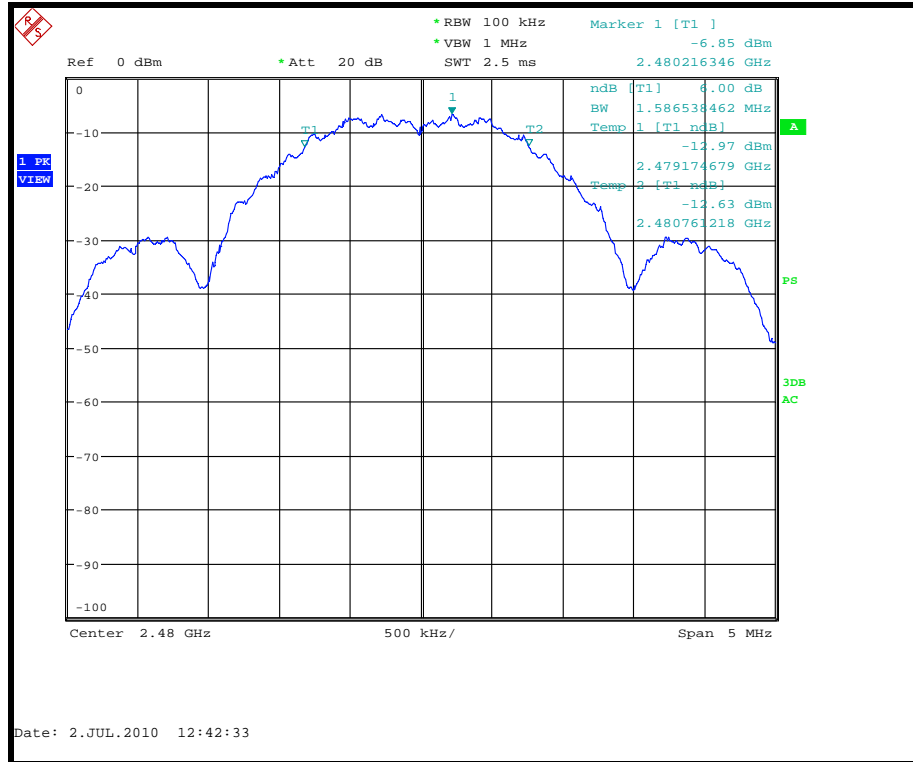
- (a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A and Appendix B.
- (b) The time and date on the plots do not necessarily equate to the time of the test.
- (c) Where relevant, on power line conducted emission plots, the limit displayed is the average limit, which is stricter than the quasi peak limit.
- (d) Appendix C details the numbering system used to identify the sample and its modification state.
- (e) The plots presented in this appendix may not be a complete record of the measurements performed, but are a representative sample, relative to the final assessment.



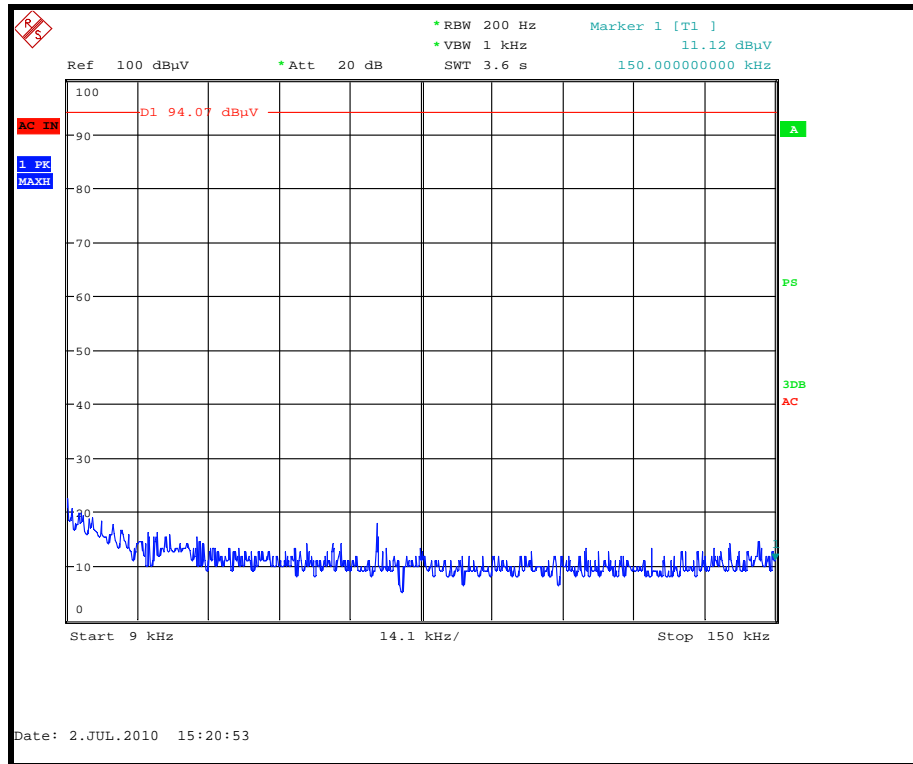
6dB Bandwidth –2405 MHz



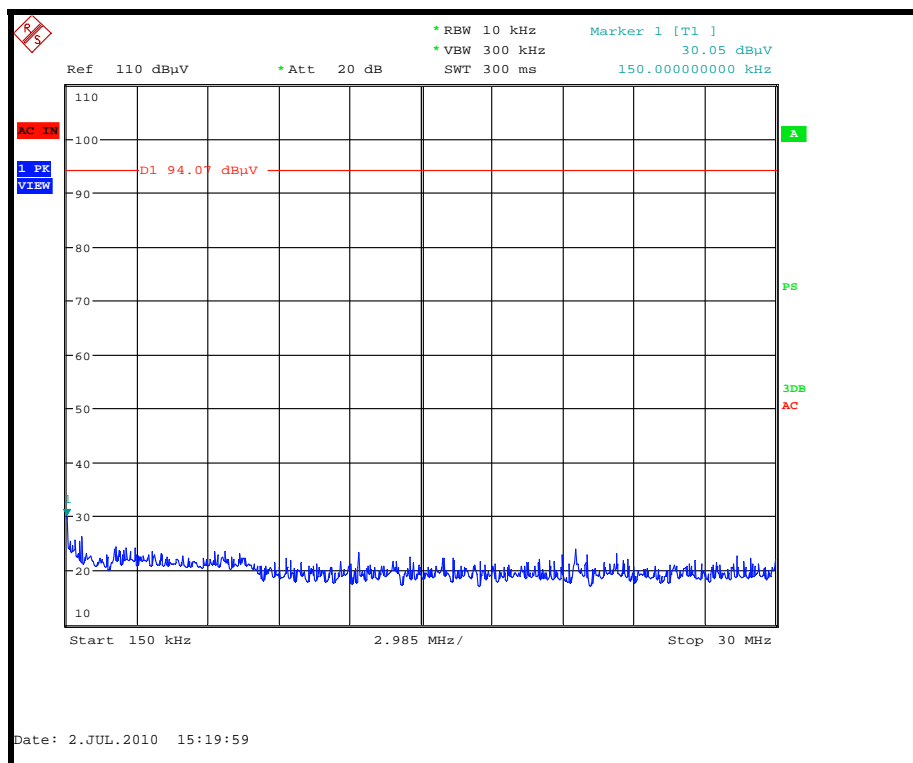
6dB Bandwidth – 2440 MHz



6dB Bandwidth - 2480 MHz

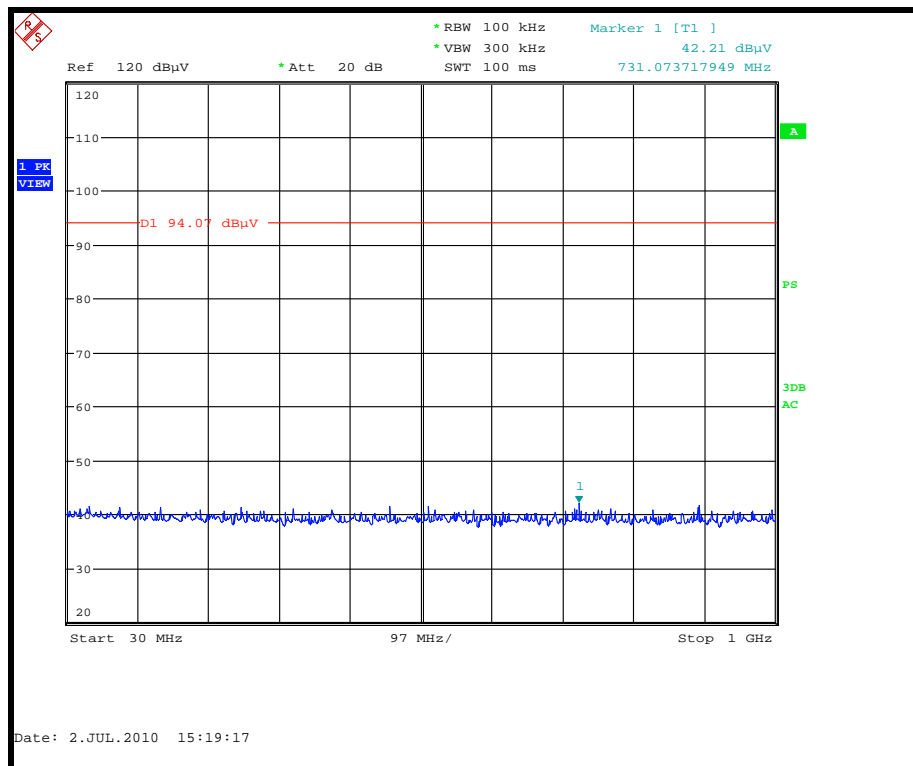


### Conducted Spurious emissions 9kHz to 150 kHz – 2405 MHz

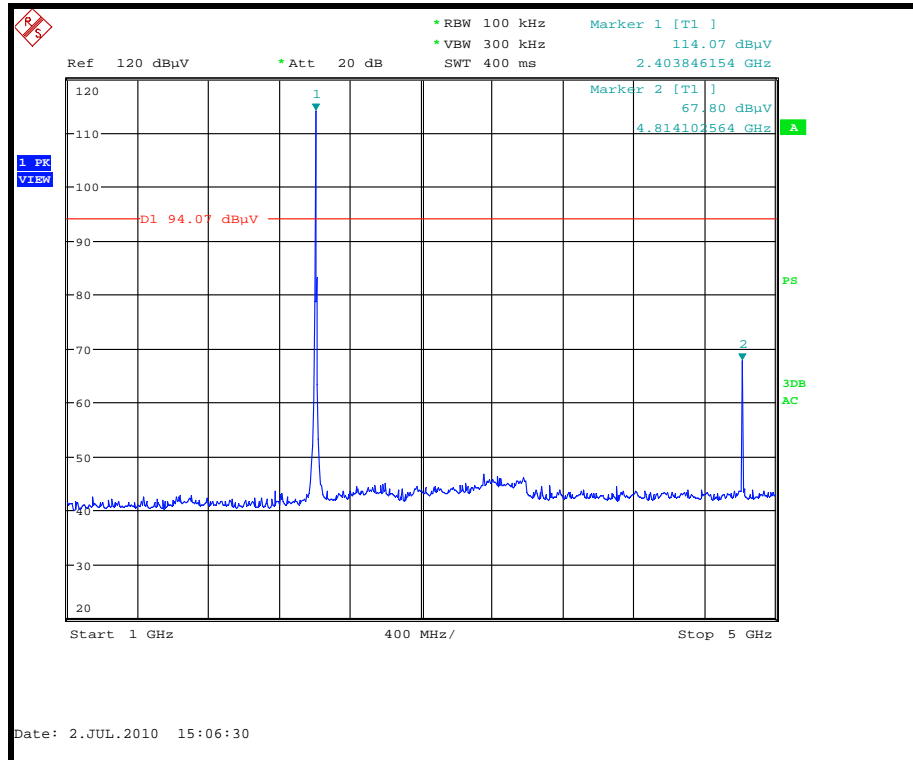


### Conducted Spurious emissions 150 kHz to 30 MHz – 2405 MHz

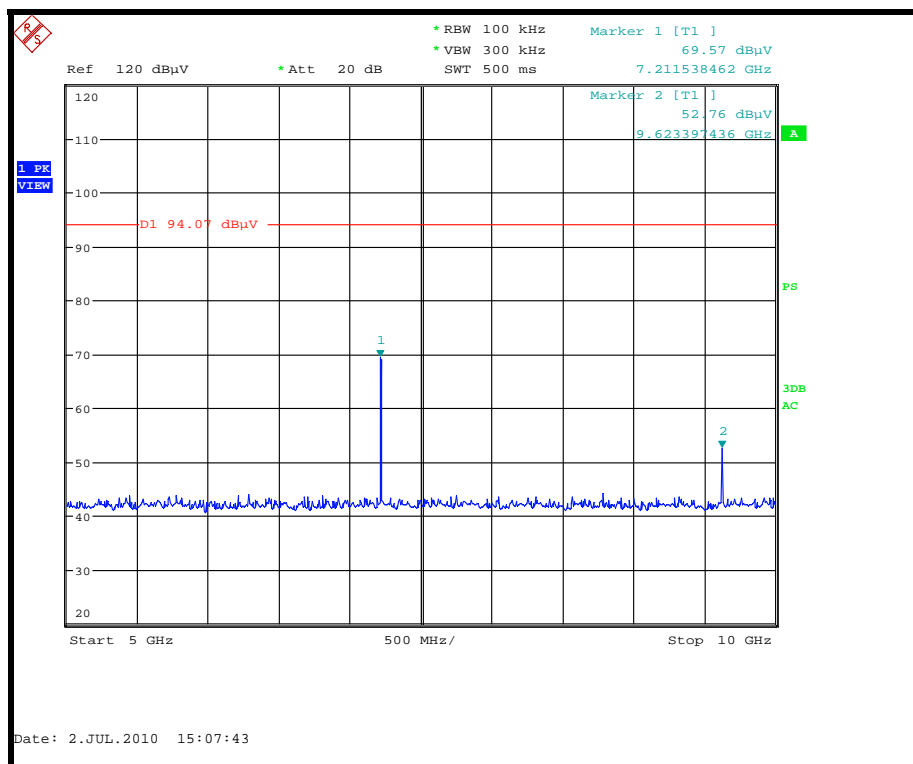




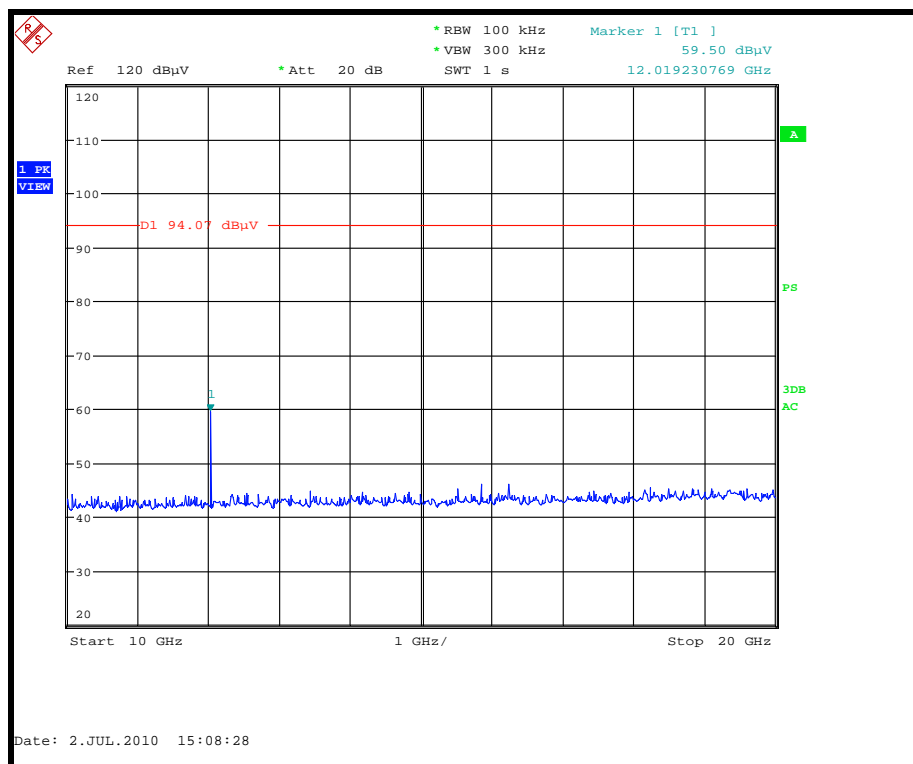
Conducted Spurious emissions 30 MHz to 1GHz - 2405 MHz



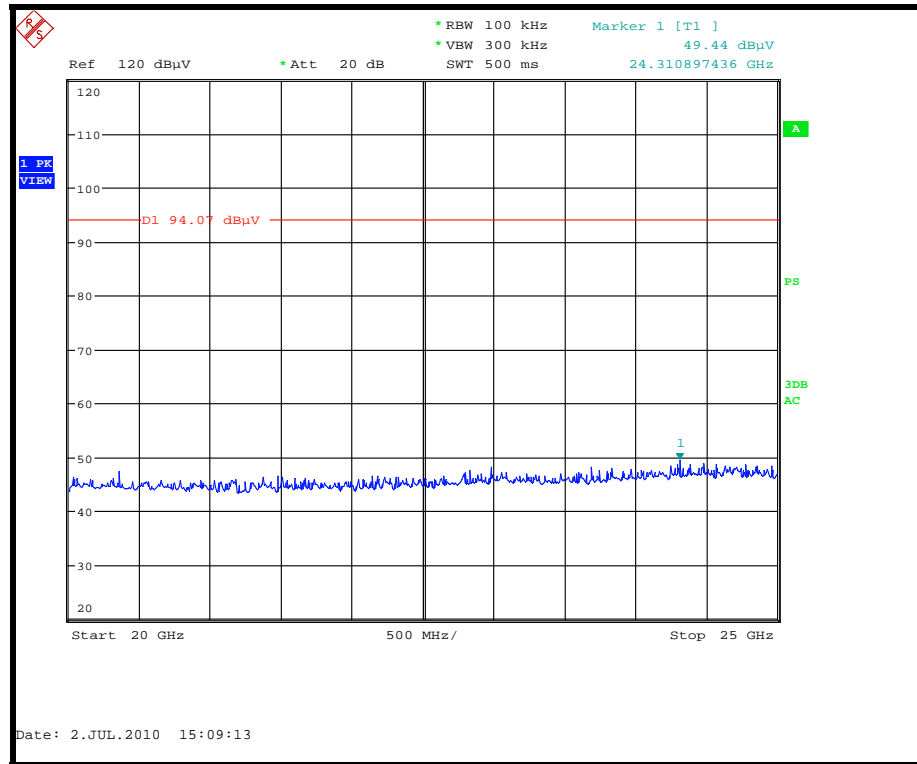
Conducted Spurious emissions 1 GHz to 5 GHz - 2405 MHz



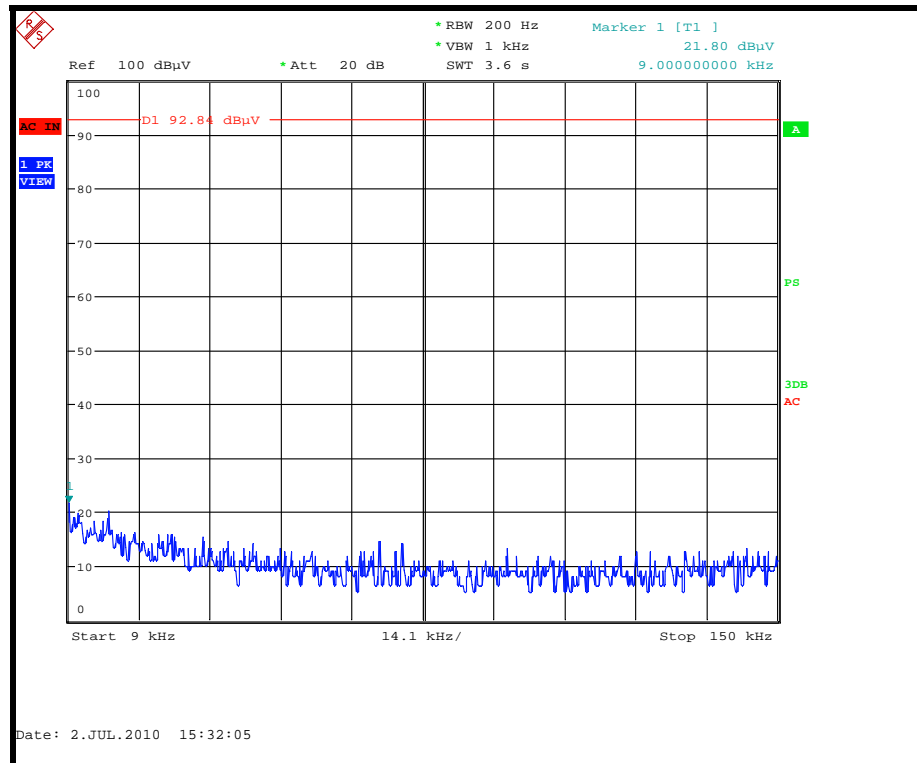
Conducted Spurious emissions 5 GHz to 10 GHz - 2405 MHz



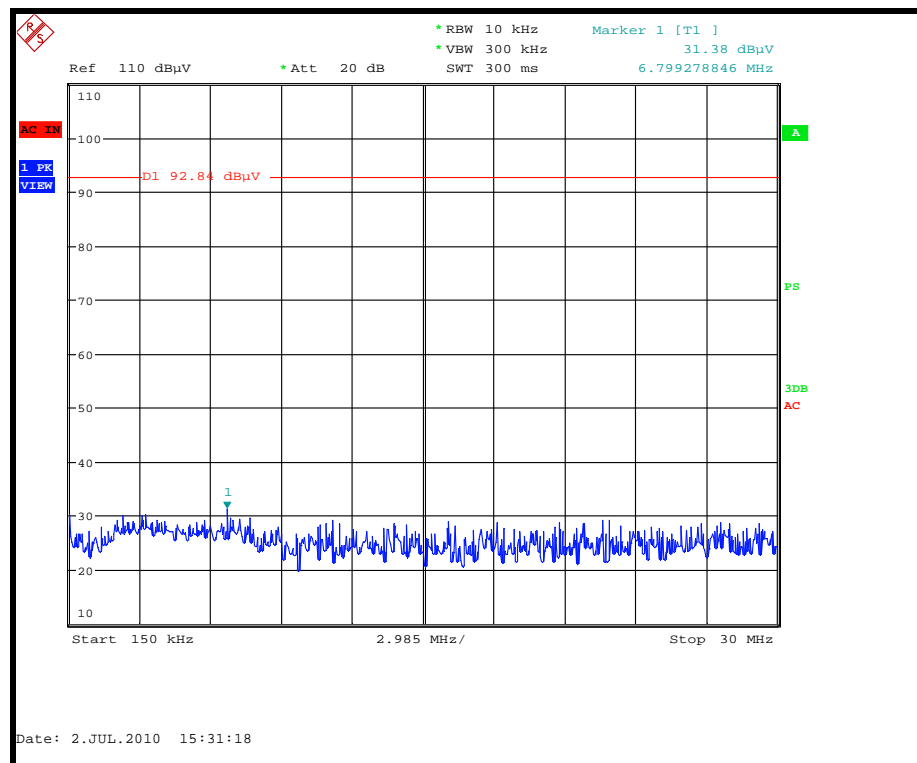
Conducted Spurious emissions 10 GHz to 20 GHz - 2405 MHz



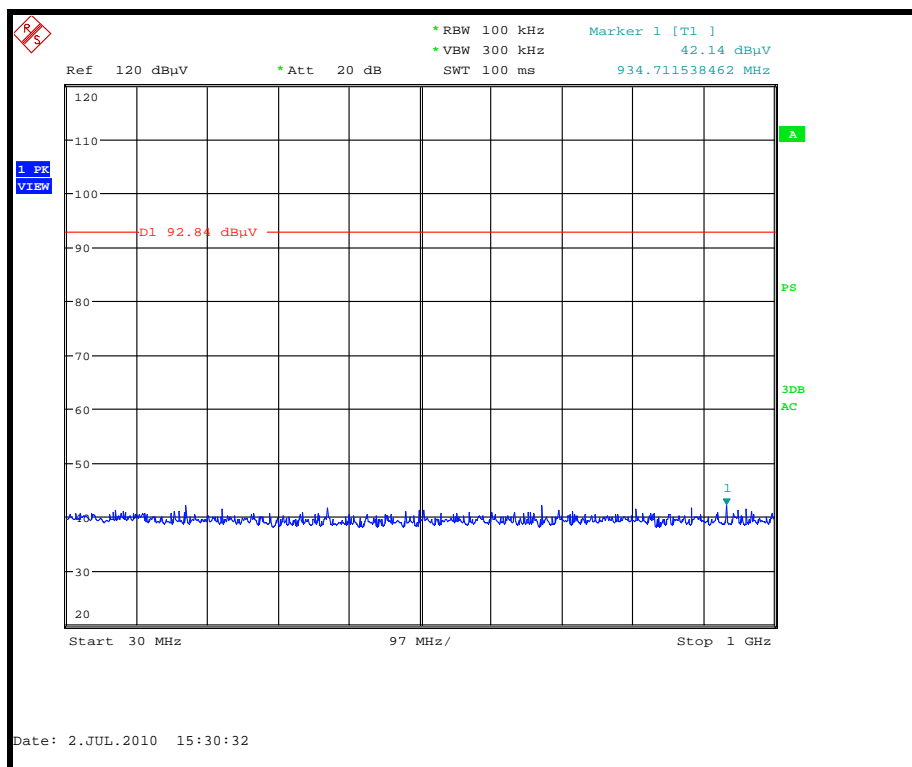
Conducted Spurious emissions 20 GHz to 25GHz - 2405 MHz



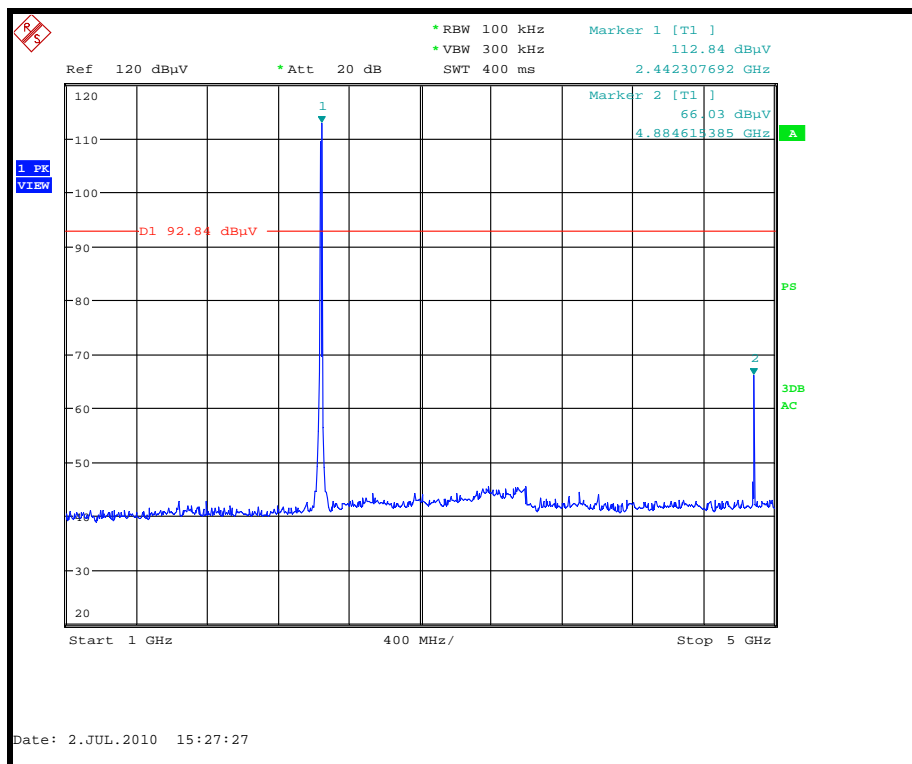
Conducted Spurious emissions 9kHz to 150 kHz – 2440 MHz



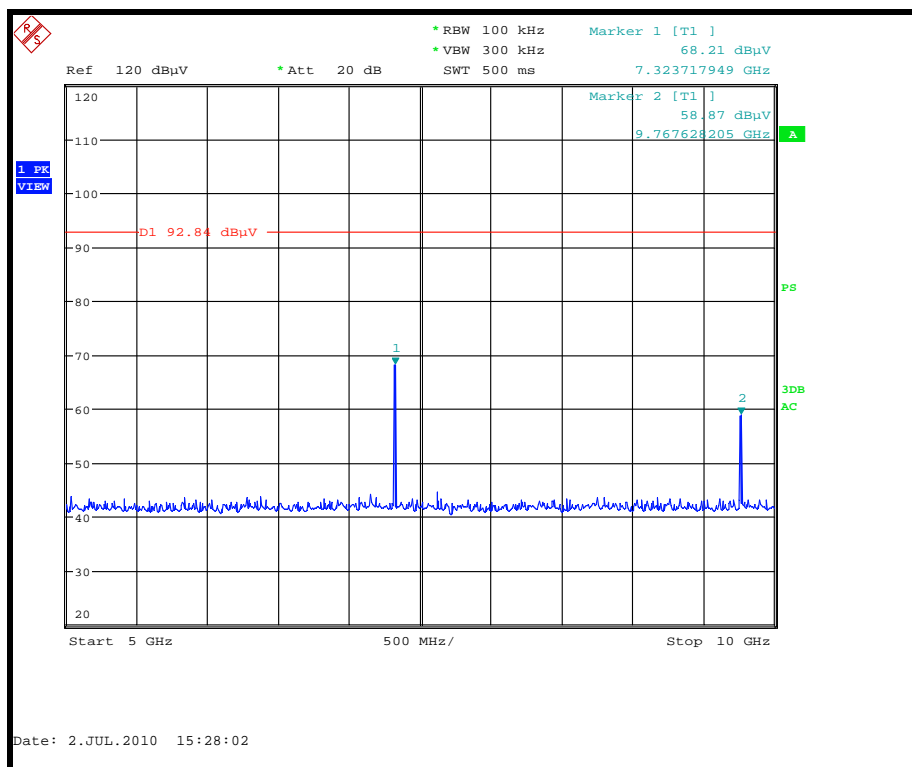
Conducted Spurious emissions 150 kHz to 30 MHz – 2440 MHz



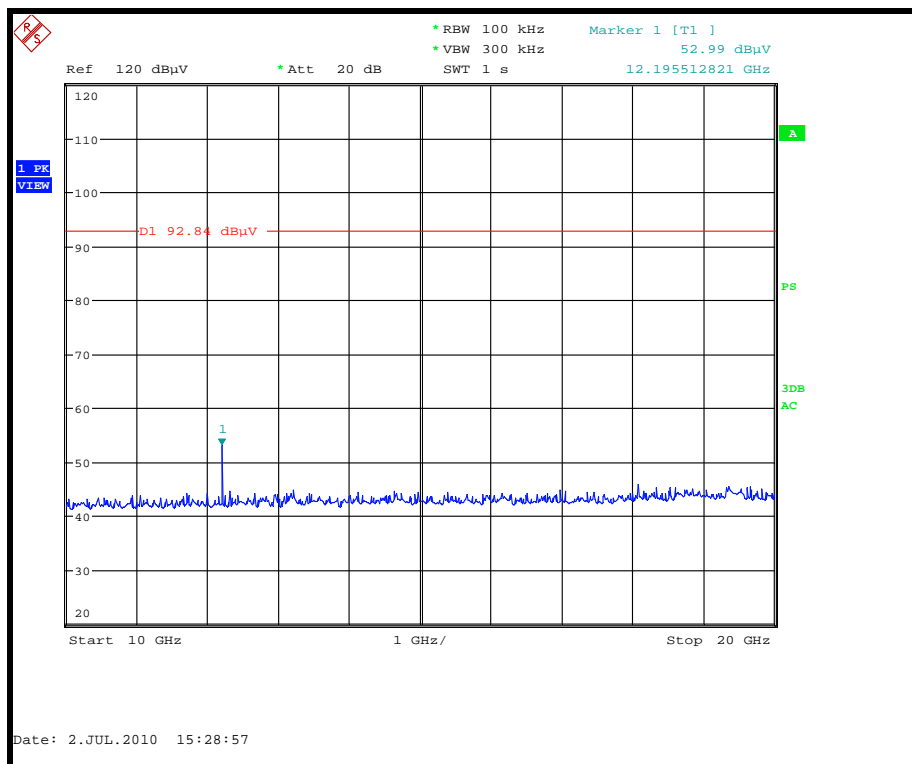
Conducted Spurious emissions 30 MHz to 1GHz - 2440 MHz



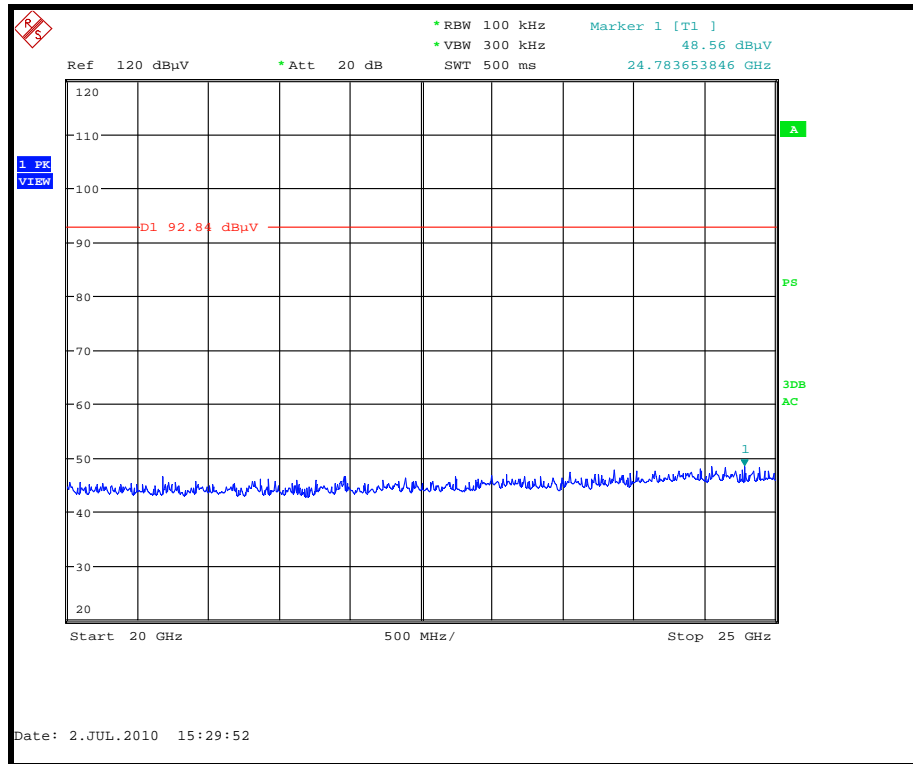
Conducted Spurious emissions 1 GHz to 5 GHz - 2440 MHz



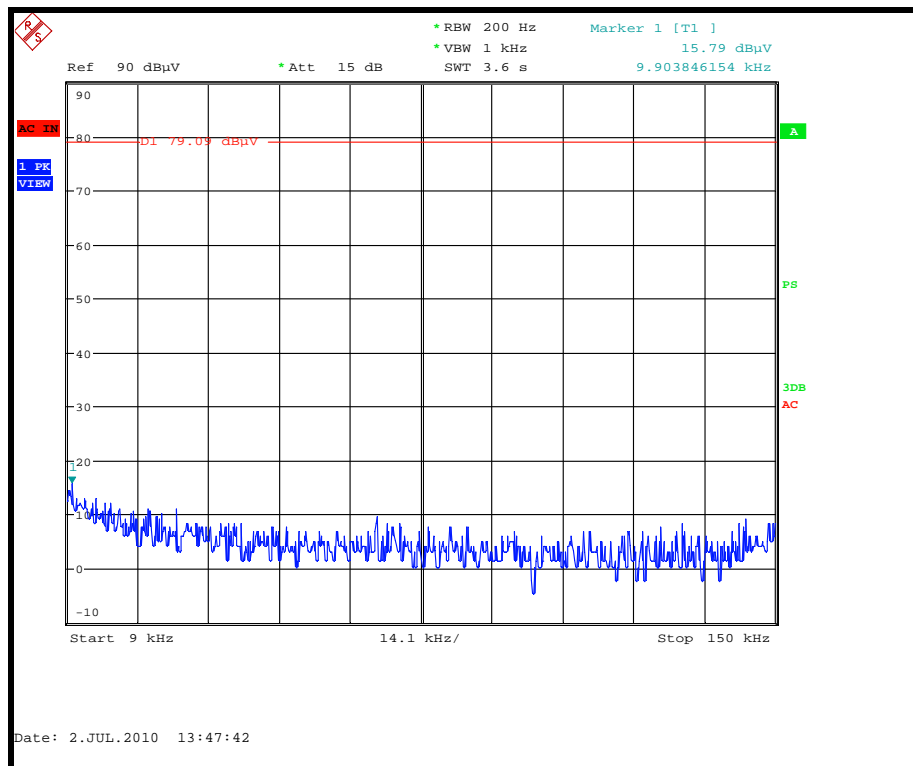
Conducted Spurious emissions 5 GHz to 10 GHz - 2440 MHz



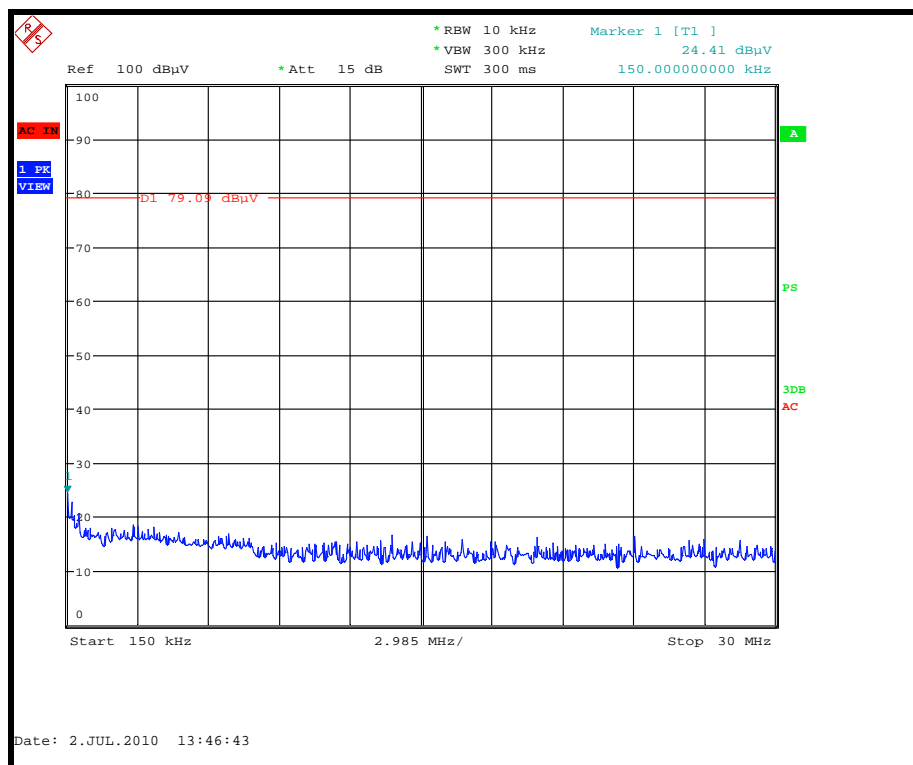
Conducted Spurious emissions 10 GHz to 20 GHz - 2440 MHz



Conducted Spurious emissions 20 GHz to 25 GHz - 2440 MHz

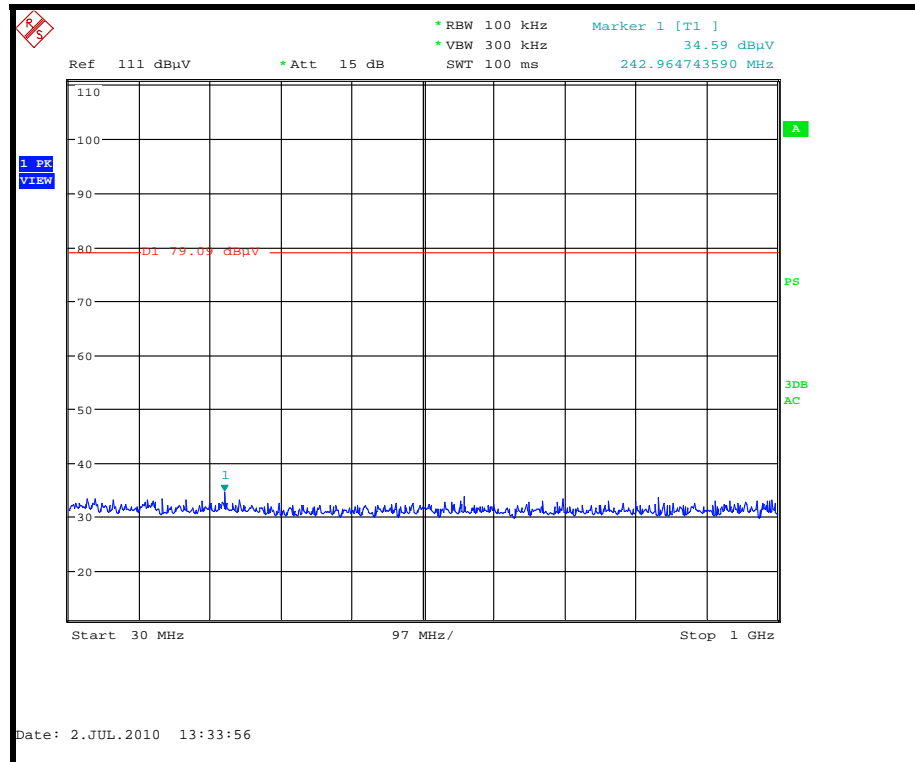


Conducted Spurious emissions 9kHz to 150 kHz – 2480 MHz

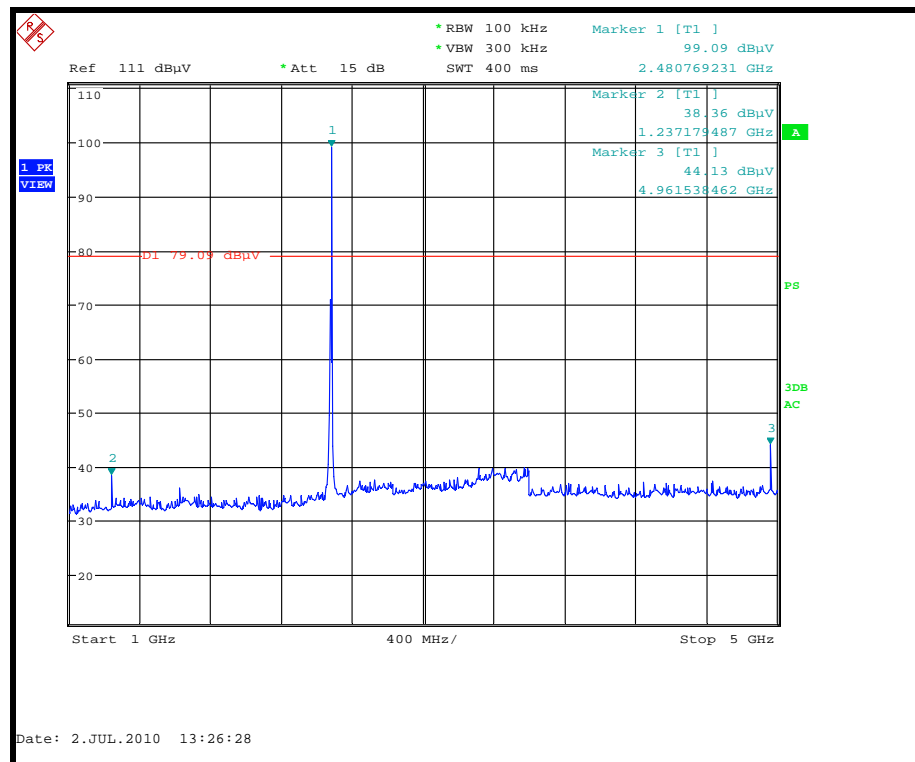


Conducted Spurious emissions 150 kHz to 30 MHz – 2480 MHz

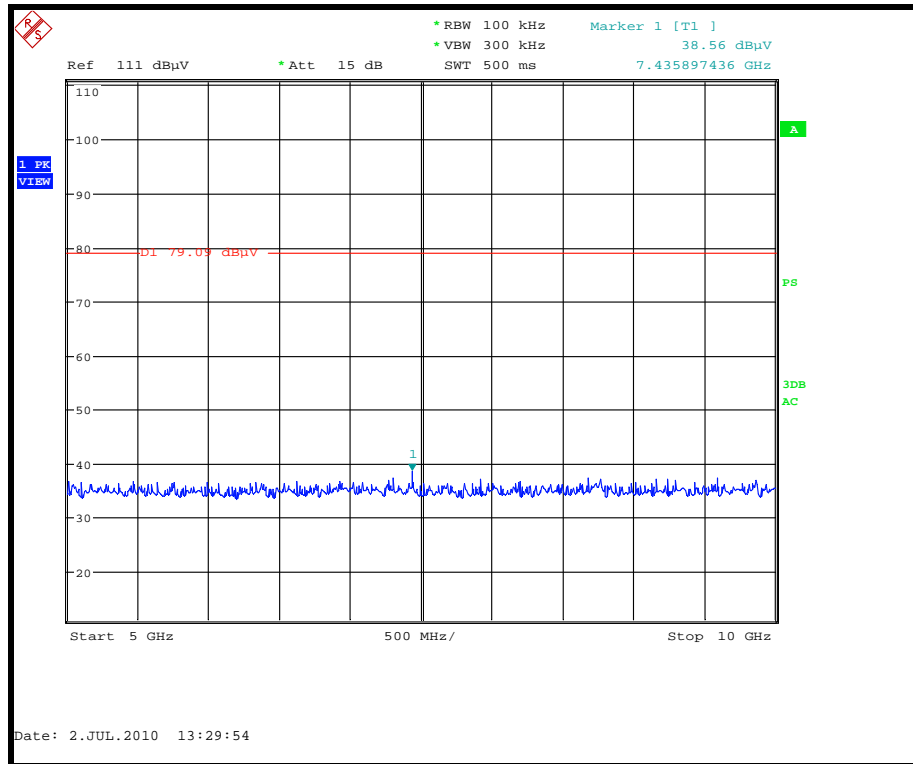




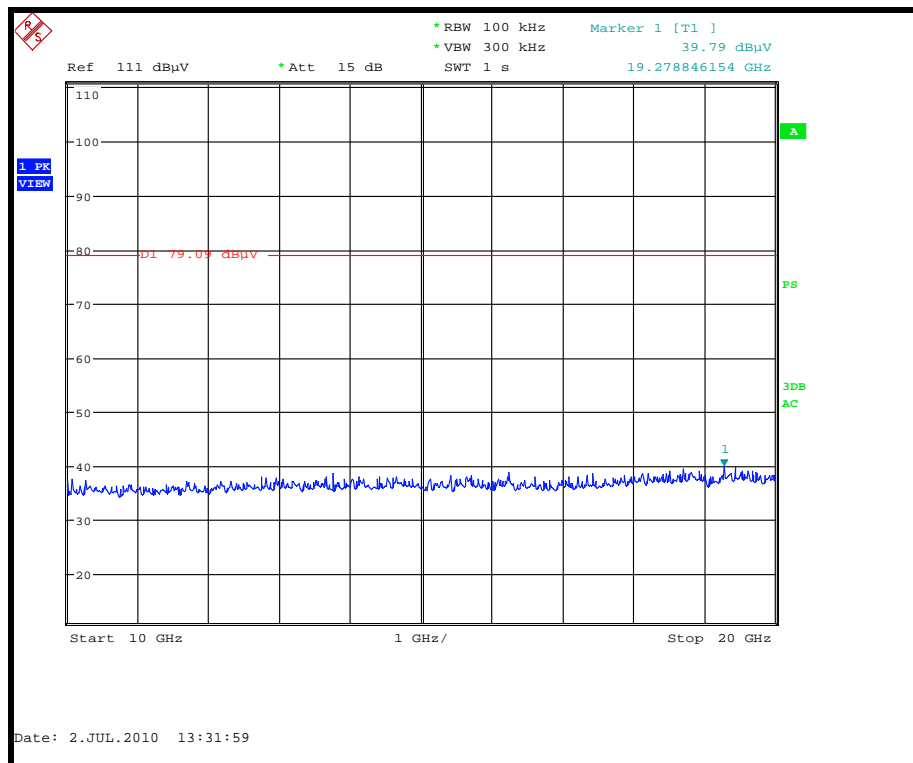
Conducted Spurious emissions 30 MHz to 1GHz - 2480 MHz



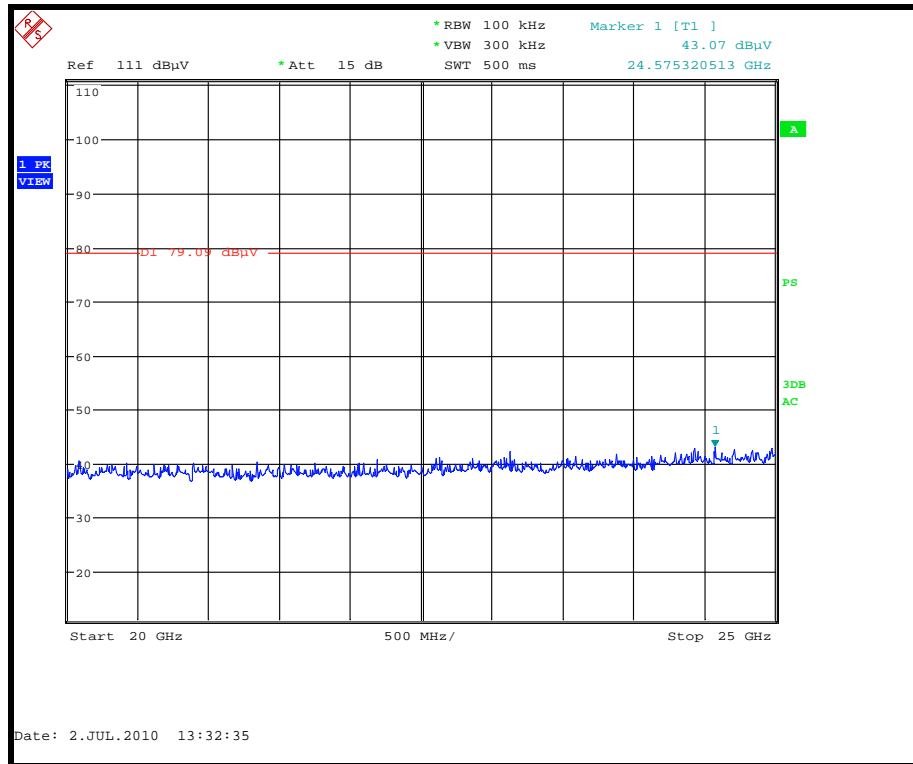
Conducted Spurious emissions 1 GHz to 5 GHz - 2480 MHz



Conducted Spurious emissions 5 GHz to 10 GHz - 2480 MHz

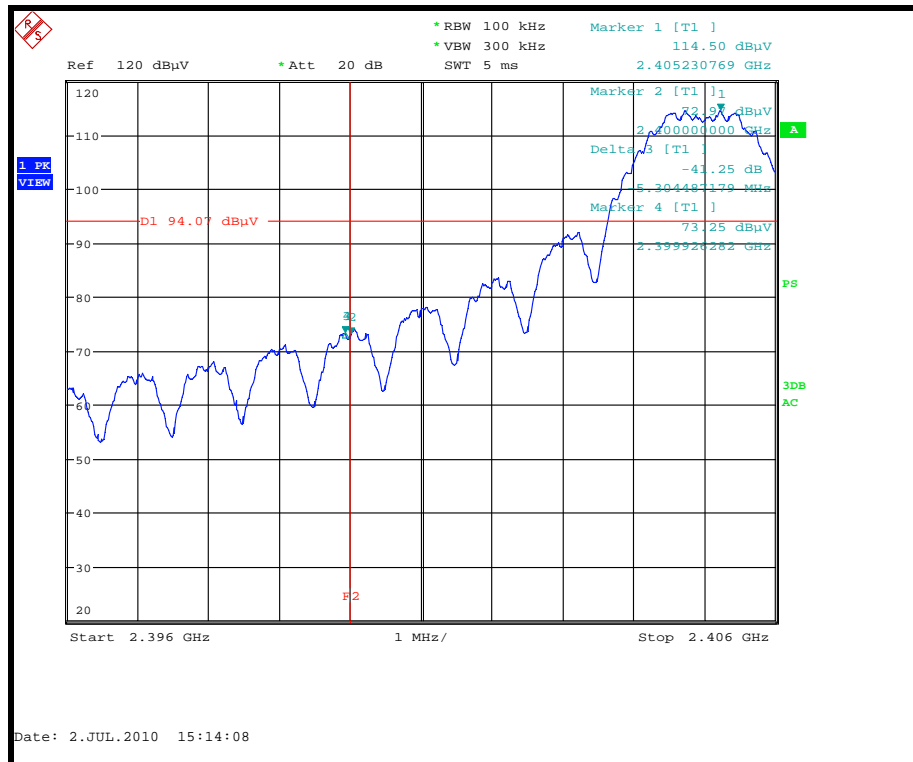


Conducted Spurious emissions 10 GHz to 20 GHz - 2480 MHz

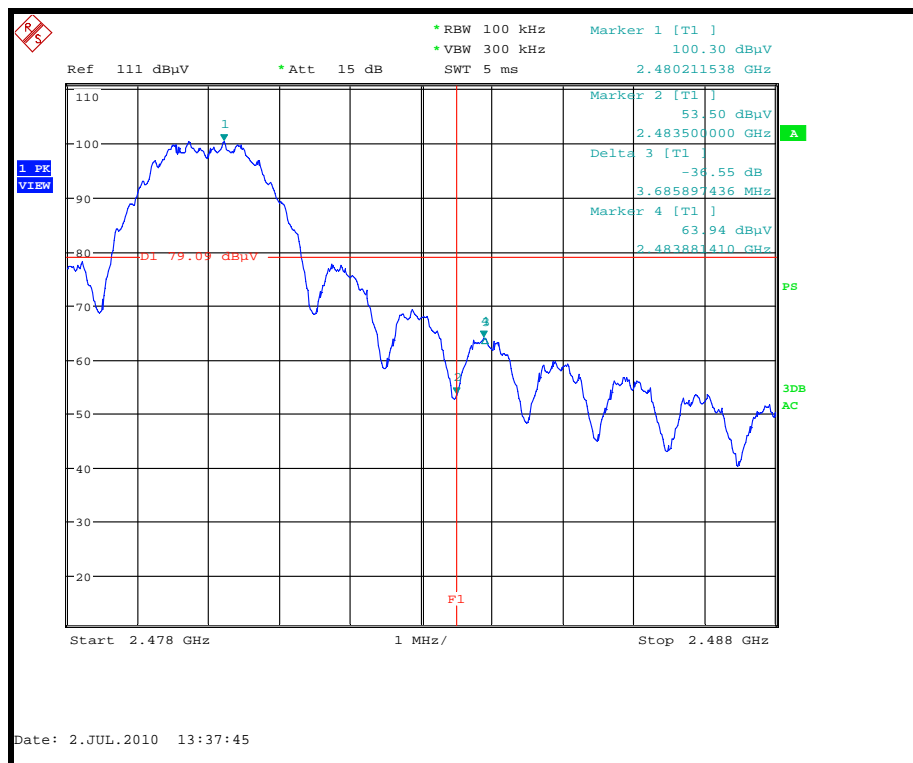


Conducted Spurious emissions 20 GHz to 25 GHz - 2480 MHz

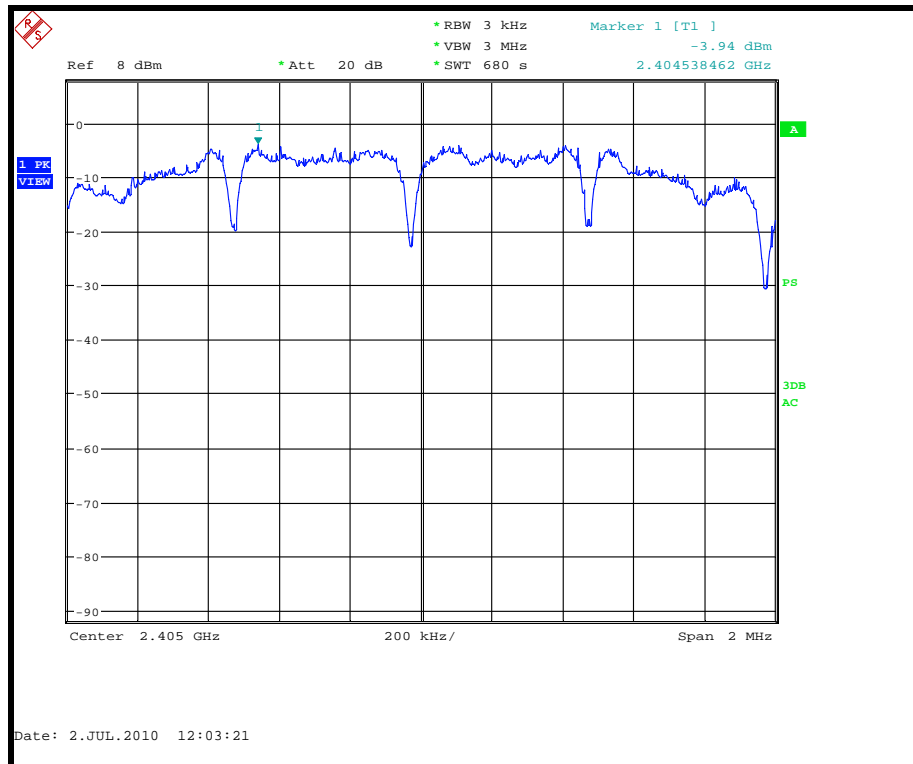
## Conducted Band Edge Compliance



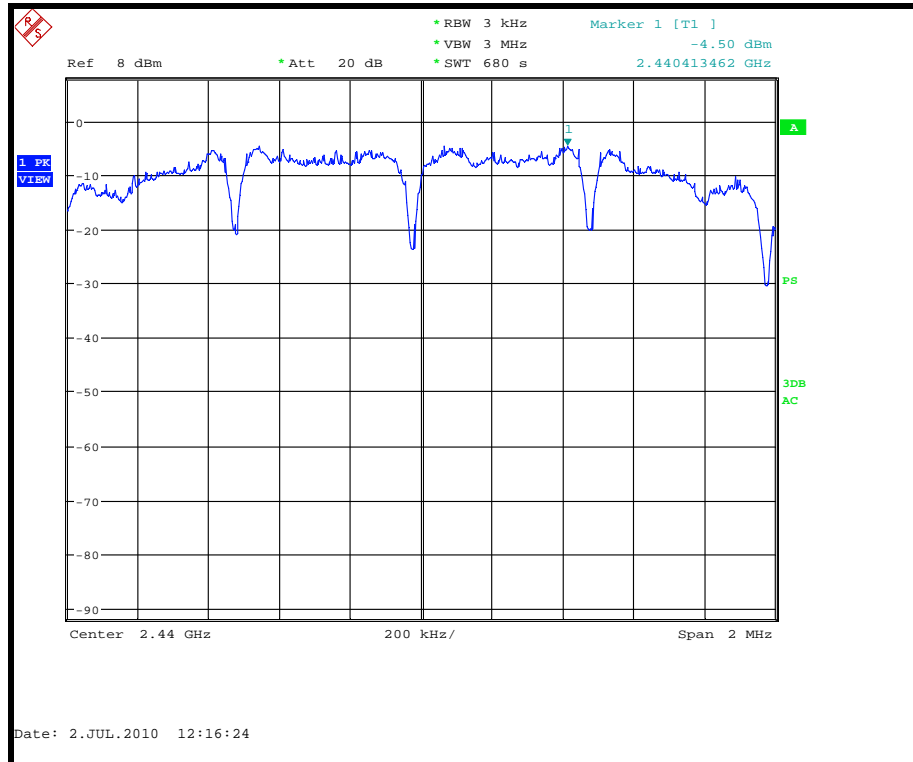
## Lower Band Edge



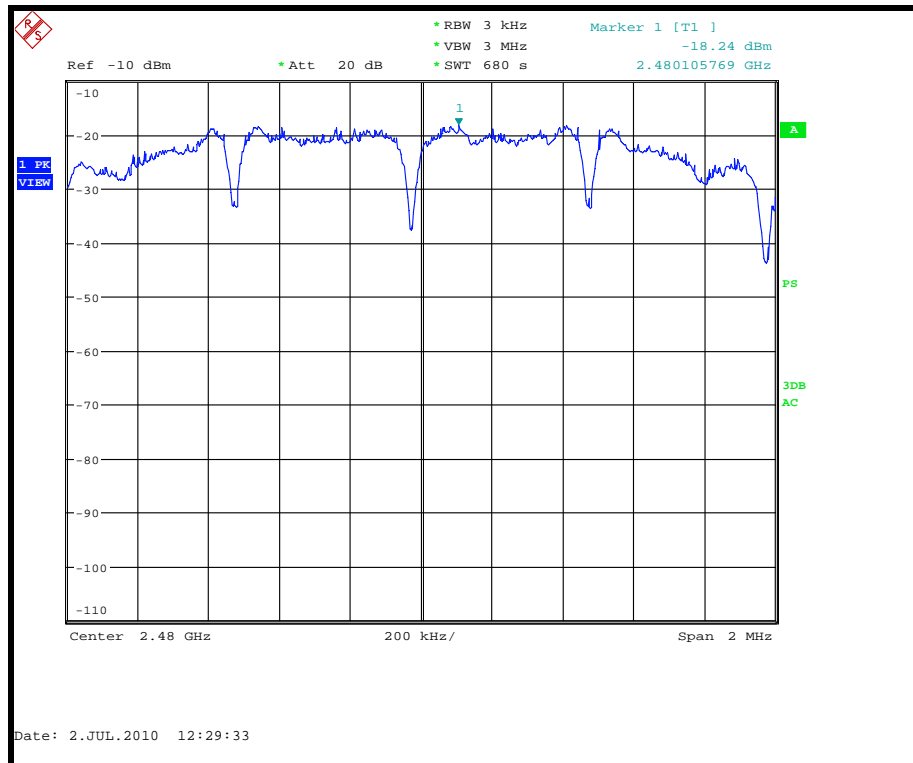
## Upper Band Edge



Conducted power spectral density – 2405 MHz

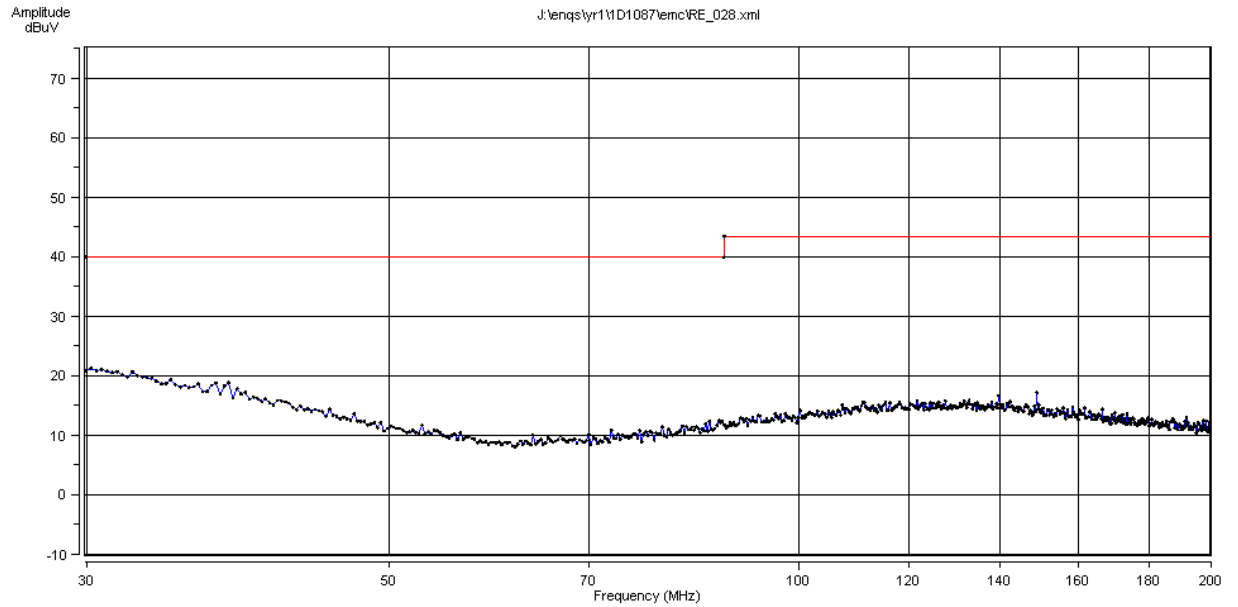


Conducted power spectral density - 2440 MHz



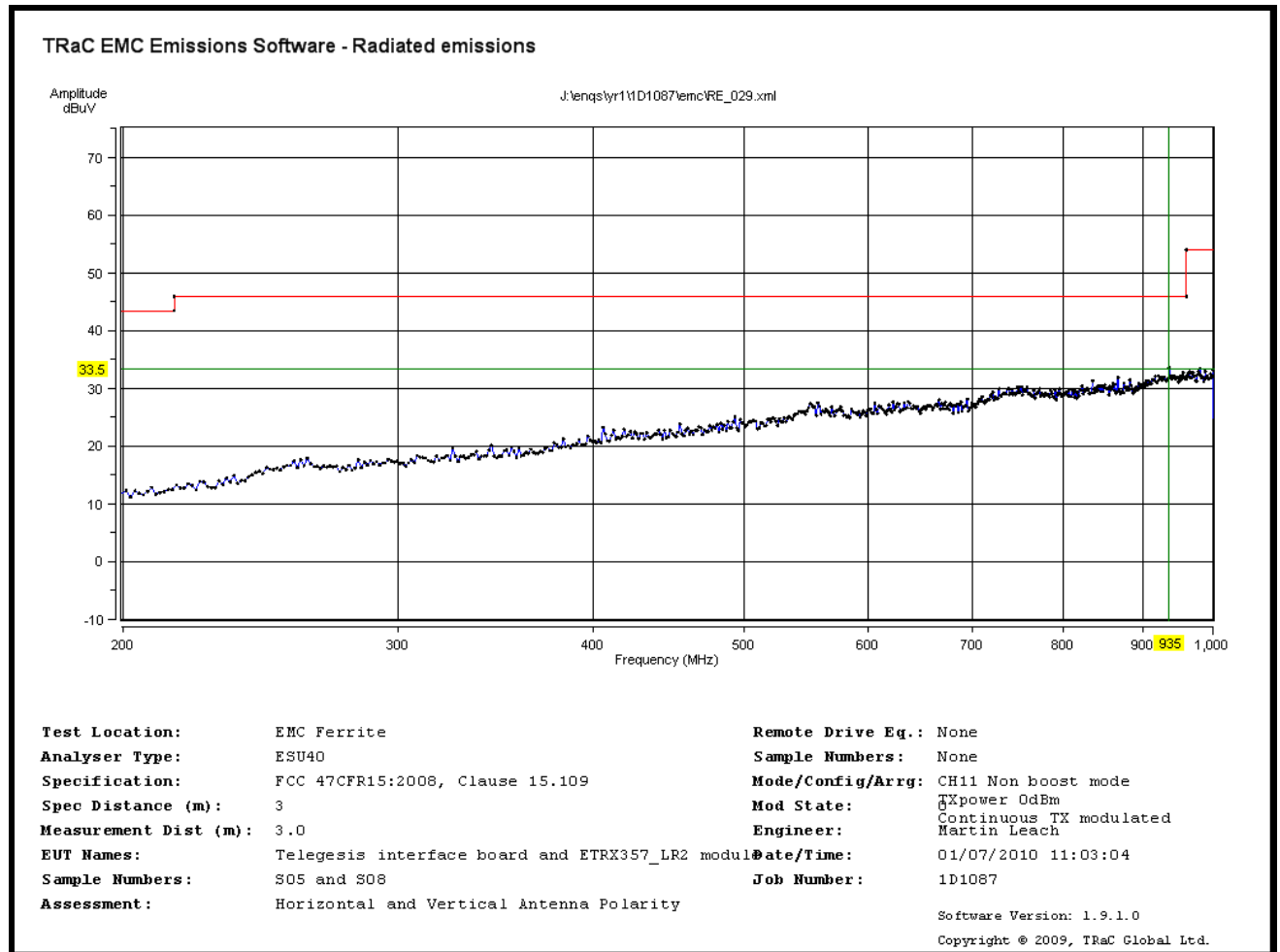
Conducted power spectral density - 2480 MHz

TRaC EMC Emissions Software - Radiated emissions



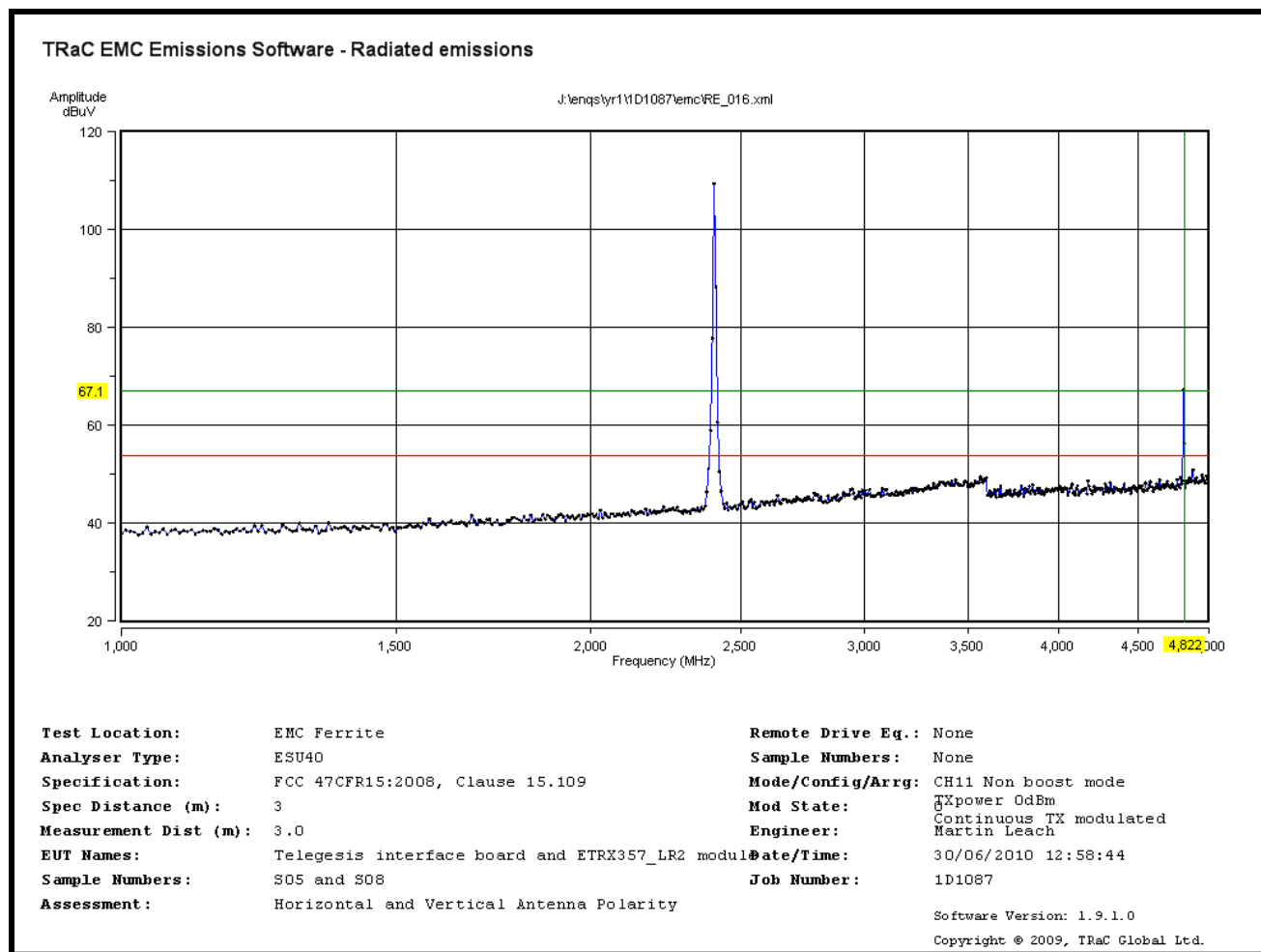
<b>Test Location:</b>	EMC Ferrite	<b>Remote Drive Eq.:</b>	None
<b>Analyser Type:</b>	ESU40	<b>Sample Numbers:</b>	None
<b>Specification:</b>	FCC 47CFR15:2008, Clause 15.109	<b>Mode/Config/Arrg:</b>	CH11 Non boost mode
<b>Spec Distance (m):</b>	3	<b>Mod State:</b>	TXpower OdBm
<b>Measurement Dist (m):</b>	3.0	<b>Engineer:</b>	Continuous TX modulated Martin Leach
<b>EUT Names:</b>	Telegesis interface board and ETRX357_LR2 modul	<b>Date/Time:</b>	01/07/2010 10:58:05
<b>Sample Numbers:</b>	S05 and S08	<b>Job Number:</b>	1D1087
<b>Assessment:</b>	Horizontal and Vertical Antenna Polarity		
		Software Version: 1.9.1.0	
		Copyright © 2009, TRaC Global Ltd.	

Radiated Transmitter Emissions Channel 11 2405MHz (15.209)



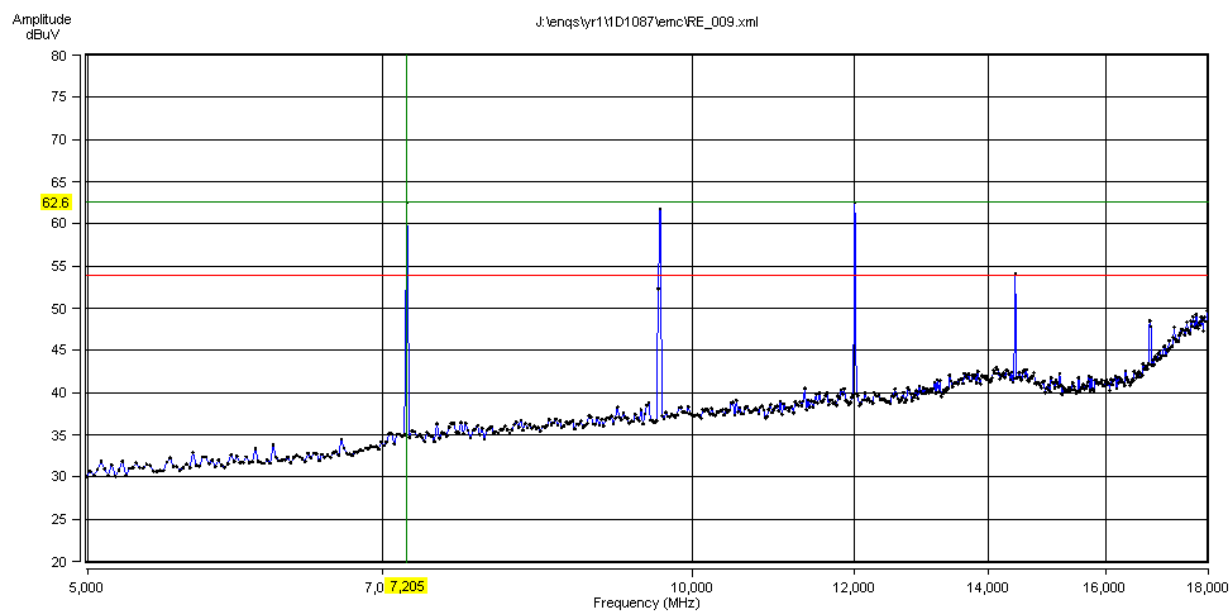
Radiated Transmitter Emissions Channel 11 2405MHz (15.209)





Radiated Transmitter Emissions Channel 11 2405MHz (15.209)

## TRaC EMC Emissions Software - Radiated emissions



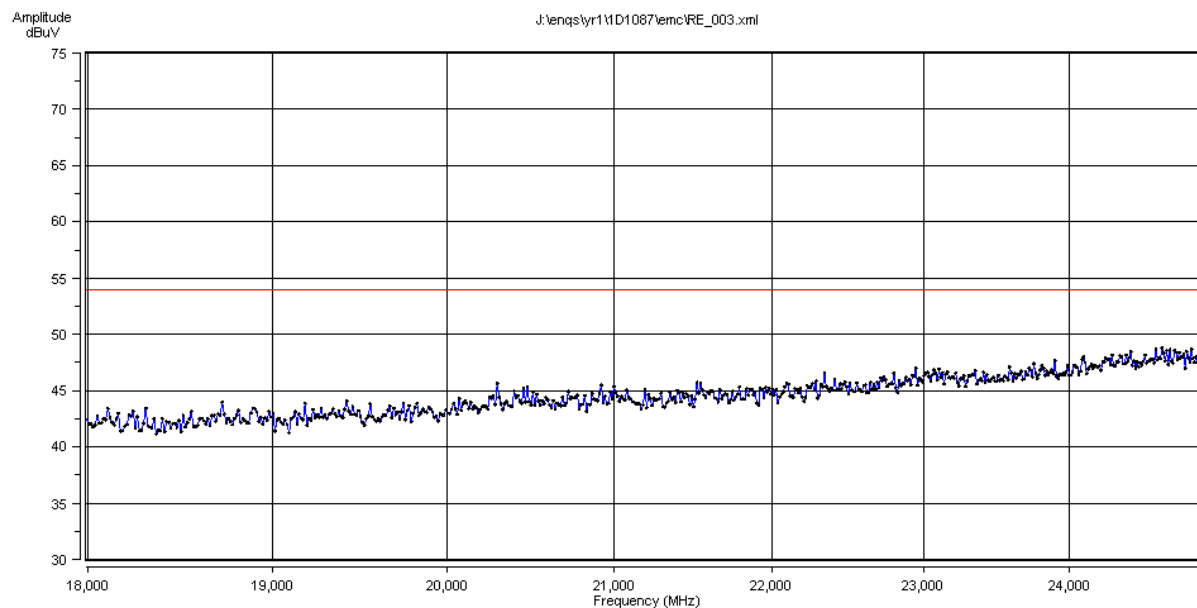
**Test Location:** EMC Ferrite  
**Analyser Type:** ESU40  
**Specification:** FCC 47CFR15:2008, Clause 15.109  
**Spec Distance (m):** 3  
**Measurement Dist (m):** 1  
**EUT Names:** Telegesis interface board and ETRX357\_LR2 modul  
**Sample Numbers:** S05 and S08  
**Assessment:** Horizontal and Vertical Antenna Polarity

**Remote Drive Eq.:** None  
**Sample Numbers:** None  
**Mode/Config/Arrg:** CH11 Non boost mode  
**Mod State:** TXpower OdBm  
Continuous TX modulated  
Martin Leach  
**Engineer:**  
**Date/Time:** 29/06/2010 16:23:38  
**Job Number:** 1D1087

Software Version: 1.9.1.0  
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Radiated Transmitter Emissions Channel 11 2405MHz (15.209)

## TRaC EMC Emissions Software - Radiated emissions

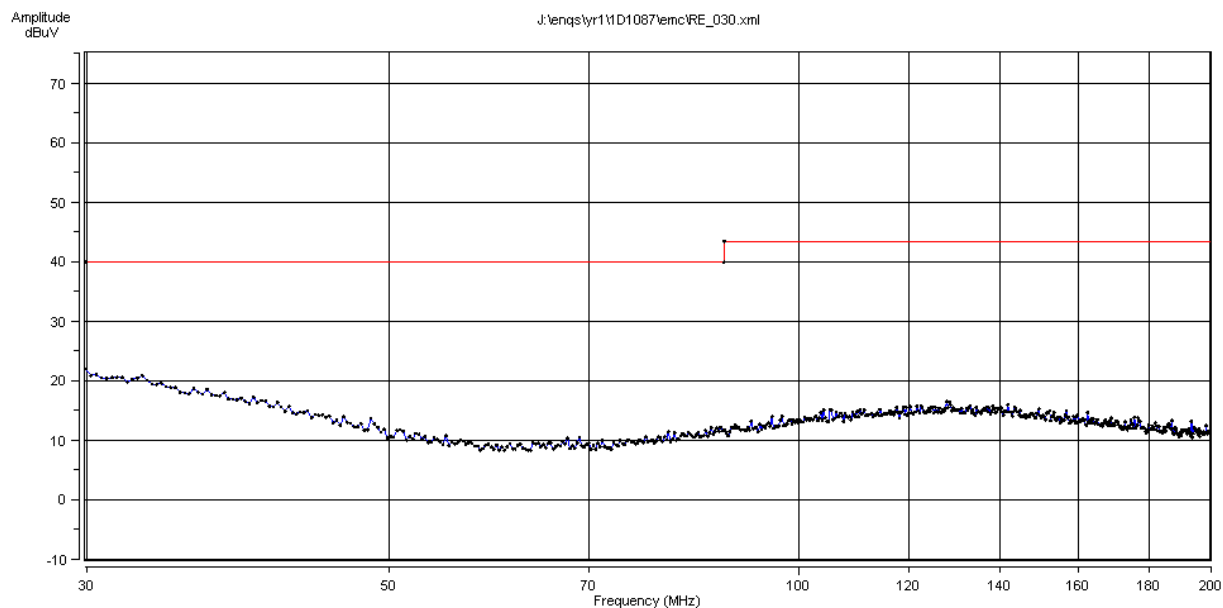
**Test Location:** EMC Ferrite**Analyser Type:** ESU40**Specification:** FCC 47CFR15:2008, Clause 15.109**Spec Distance (m):** 3**Measurement Dist (m):** 1**EUT Names:** Telegesis interface board and ETRX357\_LR2 module**Sample Numbers:** S05 and S08**Assessment:** Horizontal and Vertical Antenna Polarity**Remote Drive Eq.:** None**Sample Numbers:** None**Mode/Config/Arrg:** CH11 Non boost mode**Mod State:** TXpower OdBm**Engineer:** Continuous TX modulated**Date/Time:** 29/06/2010 14:47:40**Job Number:** 1D1087

Software Version: 1.9.1.0

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Radiated Transmitter Emissions Channel 11 2405MHz (15.209)

## TRaC EMC Emissions Software - Radiated emissions

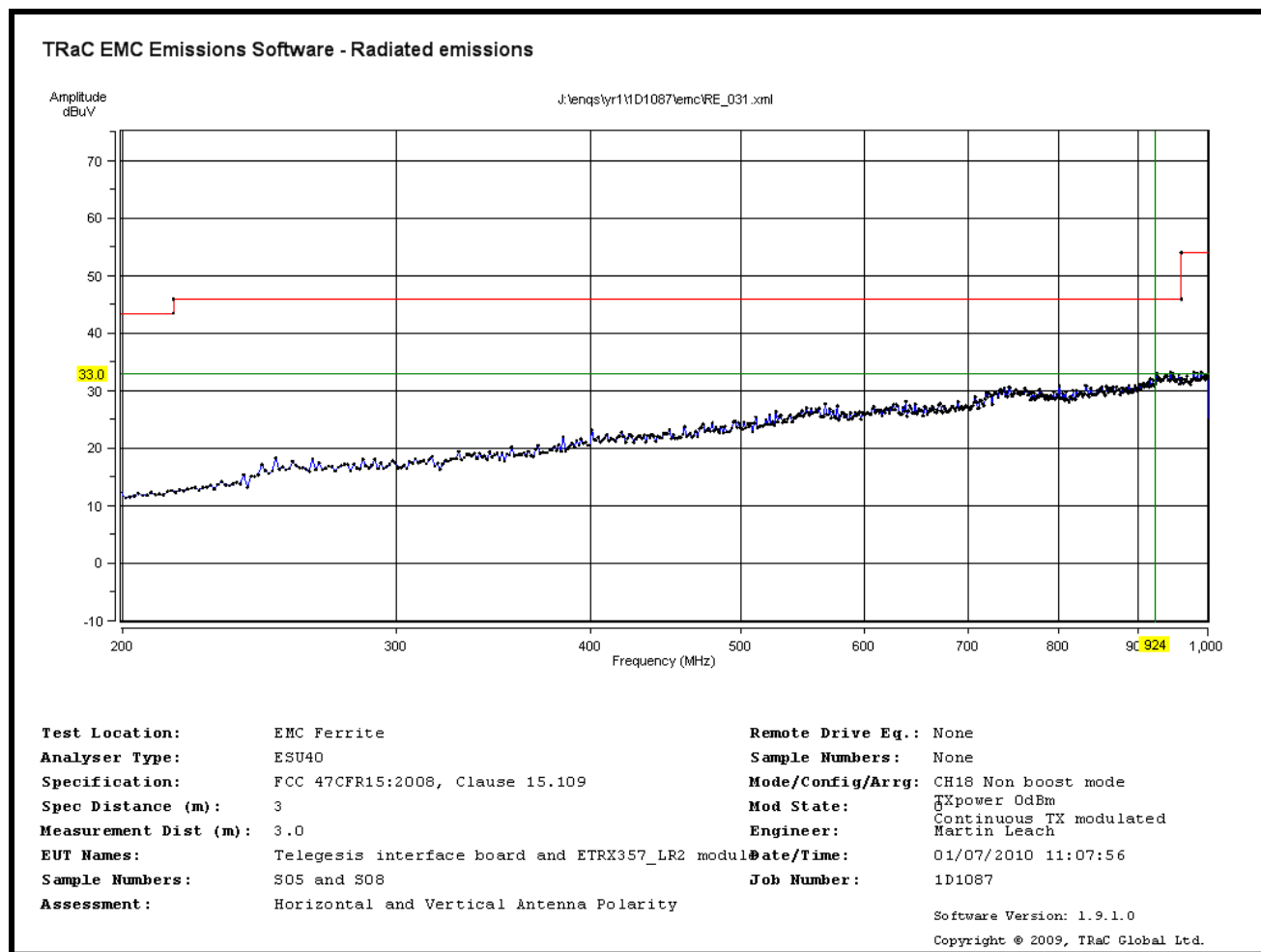


**Test Location:** EMC Ferrite  
**Analyser Type:** ESU40  
**Specification:** FCC 47CFR15:2008, Clause 15.109  
**Spec Distance (m):** 3  
**Measurement Dist (m):** 3.0  
**EUT Names:** Telegesis interface board and ETRX357\_LR2 module  
**Sample Numbers:** S05 and S08  
**Assessment:** Horizontal and Vertical Antenna Polarity

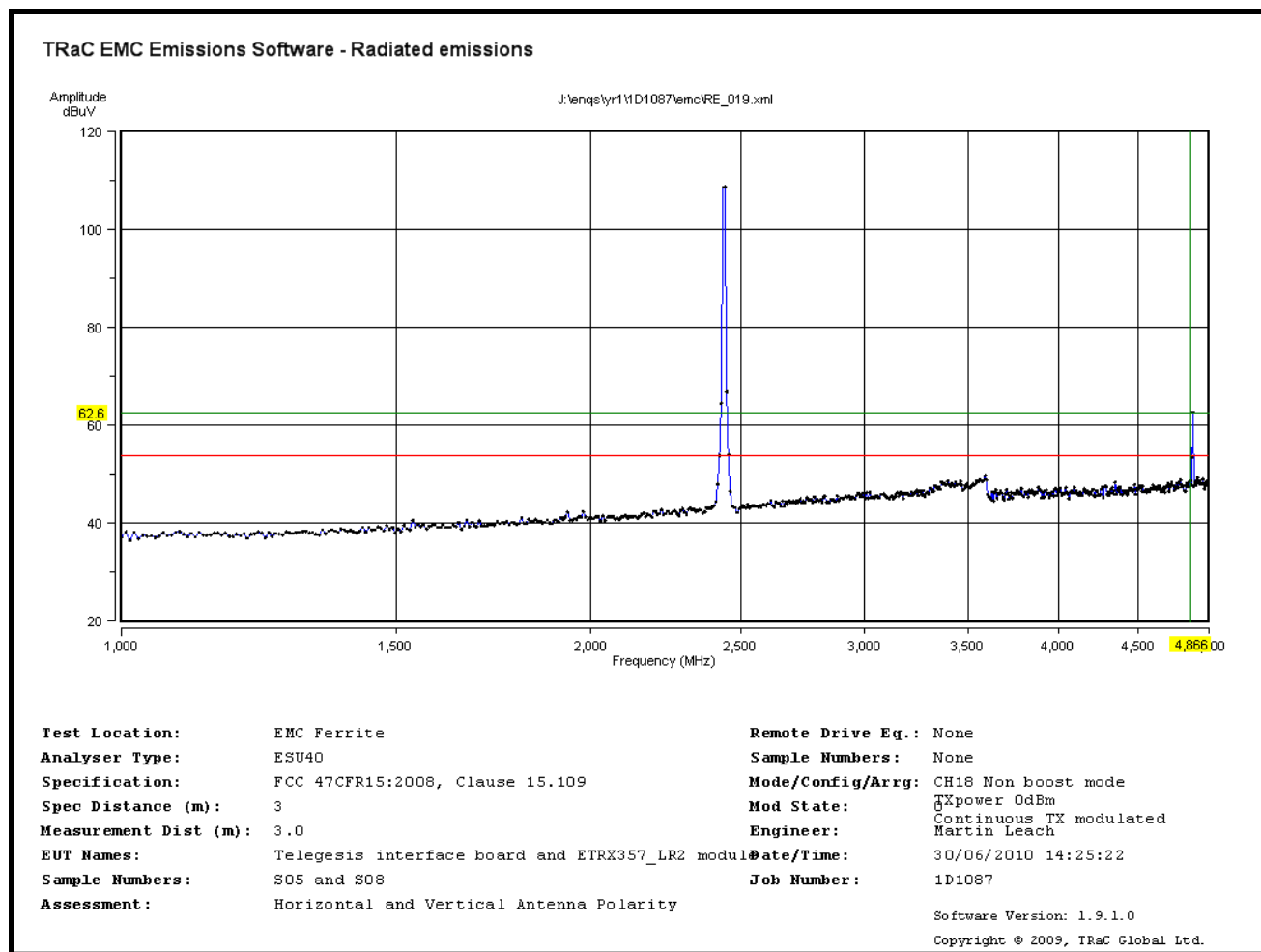
**Remote Drive Eq.:** None  
**Sample Numbers:** None  
**Mode/Config/Arrg:** CH18 Non boost mode  
**Mod State:** TXpower OdBm  
Continuous TX modulated  
Martin Leach  
**Engineer:**  
**Date/Time:** 01/07/2010 11:05:41  
**Job Number:** 1D1087

Software Version: 1.9.1.0  
Copyright © 2009, TRaC Global Ltd.

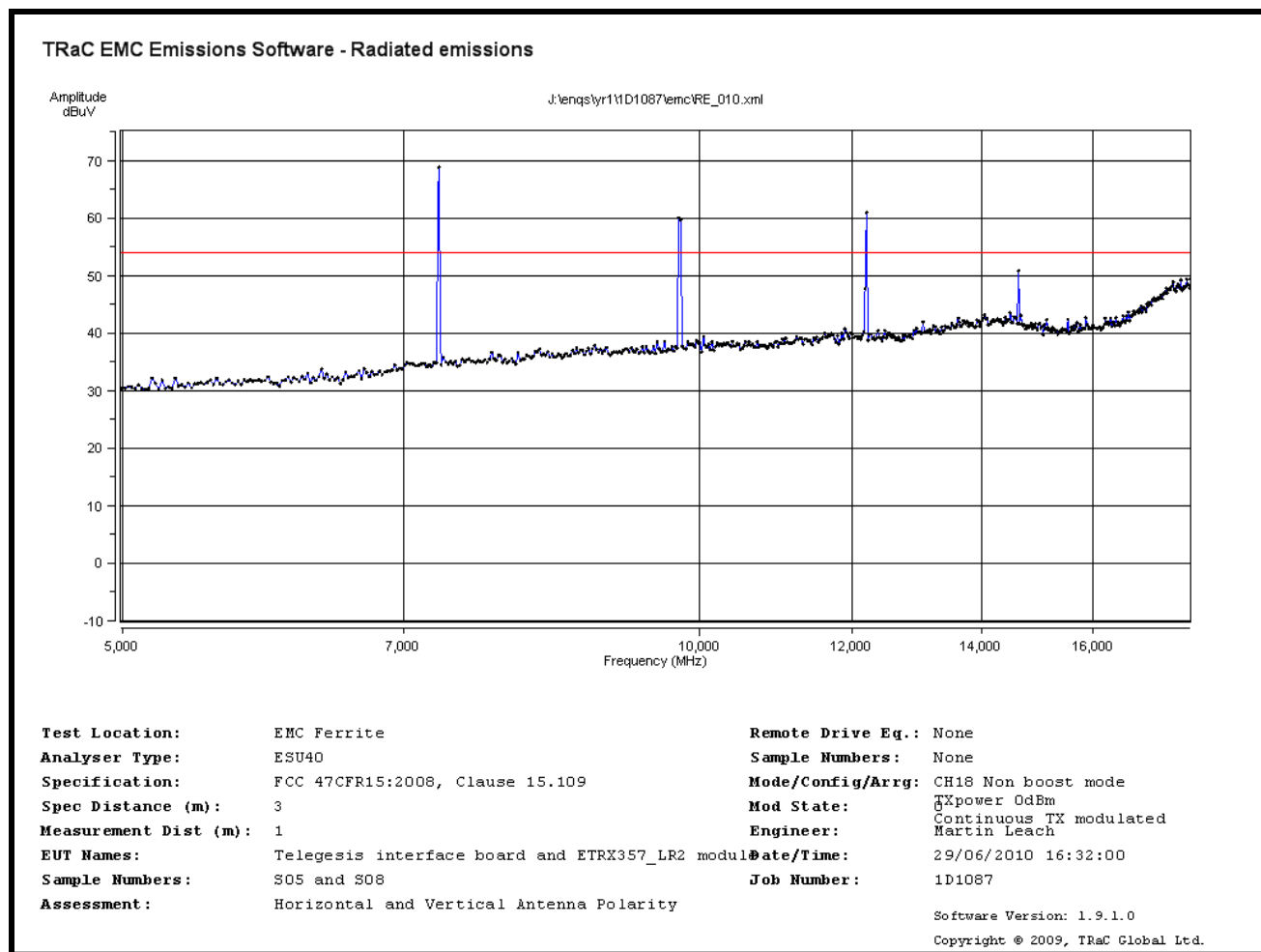
Radiated Transmitter Emissions Channel 18 2440MHz (15.209)



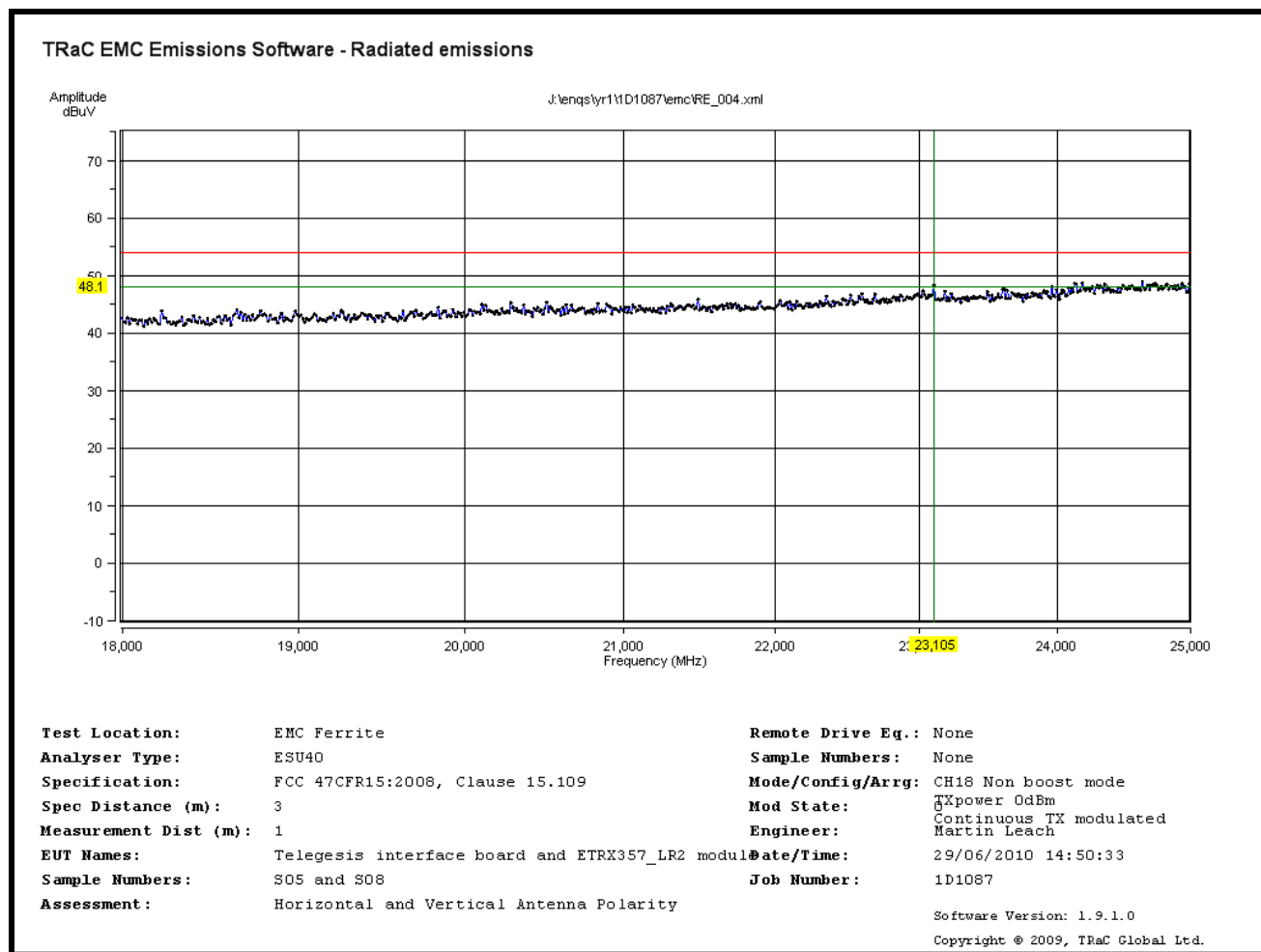
Radiated Transmitter Emissions Channel 18 2440MHz (15.209)



Radiated Transmitter Emissions Channel 18 2440MHz (15.209)



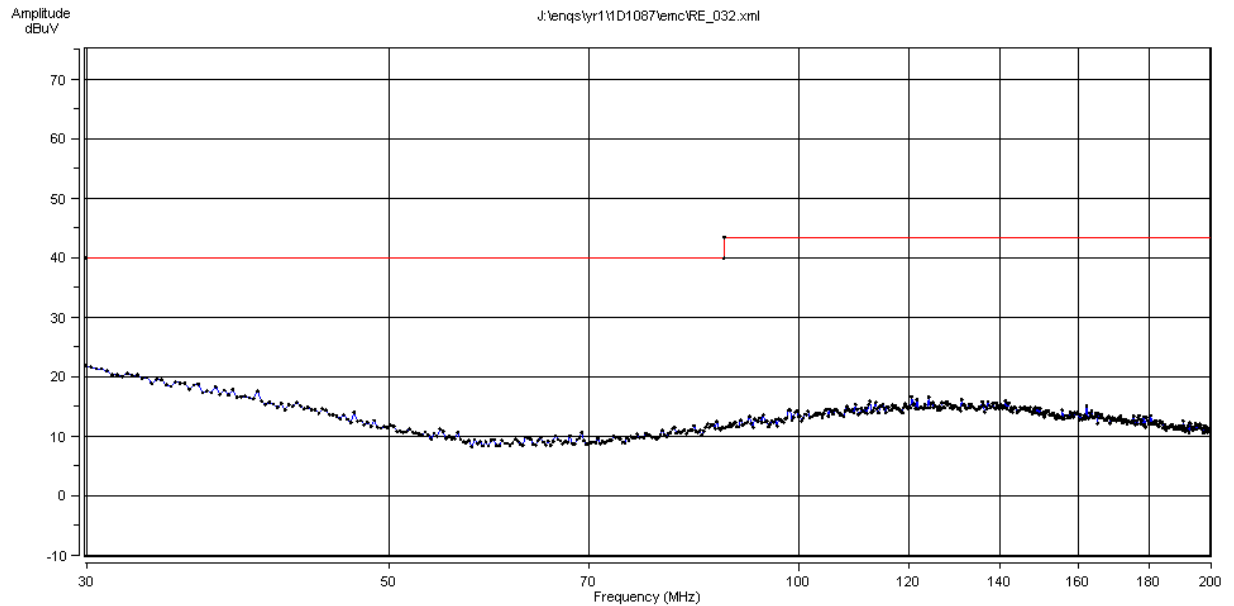
Radiated Transmitter Emissions Channel 18 2440MHz (15.209)



Radiated Transmitter Emissions Channel 18 2440MHz (15.209)



## TRaC EMC Emissions Software - Radiated emissions

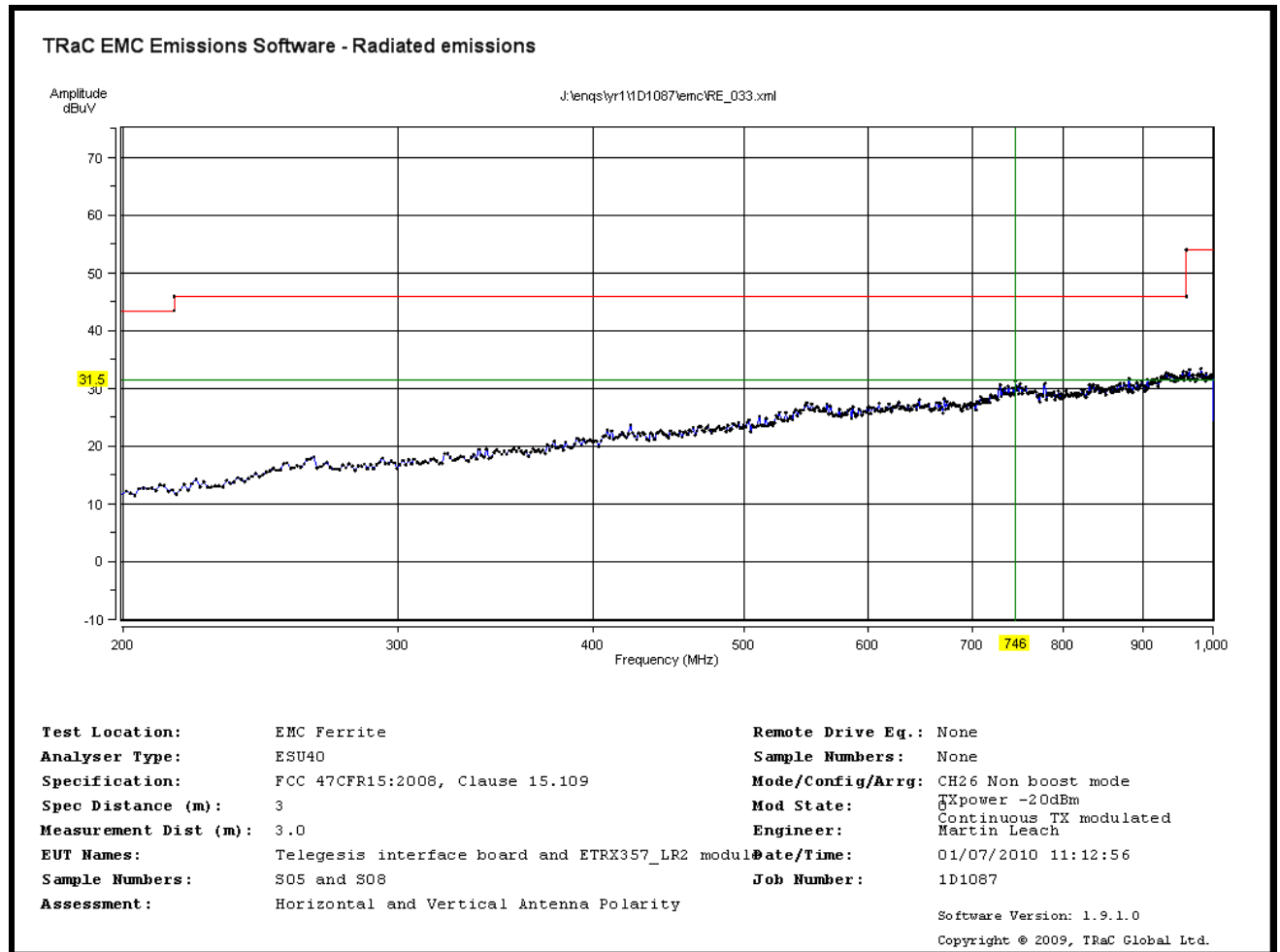


**Test Location:** EMC Ferrite  
**Analyser Type:** ESU40  
**Specification:** FCC 47CFR15:2008, Clause 15.109  
**Spec Distance (m):** 3  
**Measurement Dist (m):** 3.0  
**EUT Names:** Telegesis interface board and ETRX357\_LR2 module  
**Sample Numbers:** S05 and S08  
**Assessment:** Horizontal and Vertical Antenna Polarity

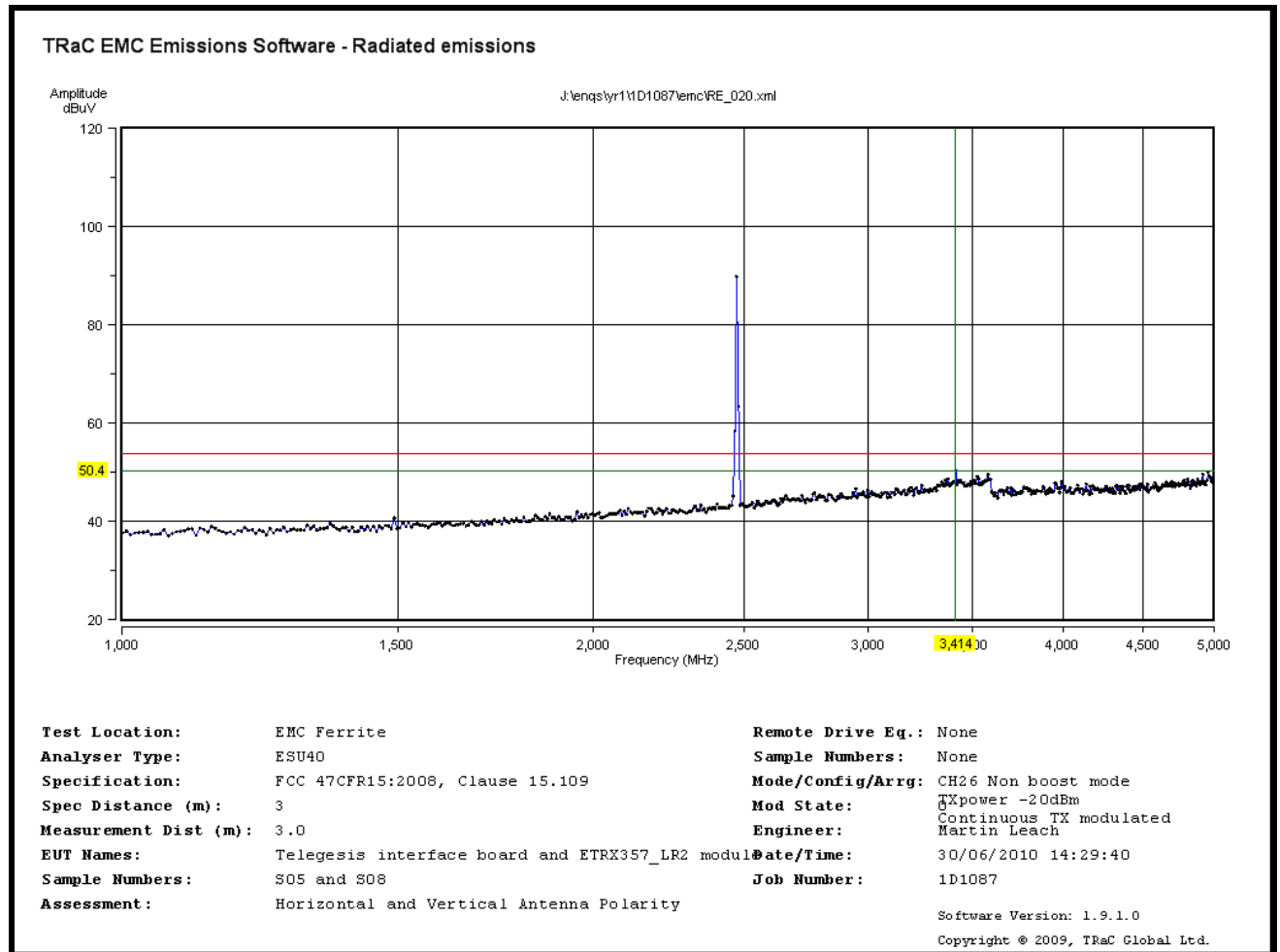
**Remote Drive Eq.:** None  
**Sample Numbers:** None  
**Mode/Config/Arrg:** CH26 Non boost mode  
**Mod State:** TXpower -20dBm  
Continuous TX modulated  
Martin Leach  
**Engineer:**  
**Date/Time:** 01/07/2010 11:10:36  
**Job Number:** 1D1087

Software Version: 1.9.1.0  
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Radiated Transmitter Emissions Channel 26 2480MHz (15.209)

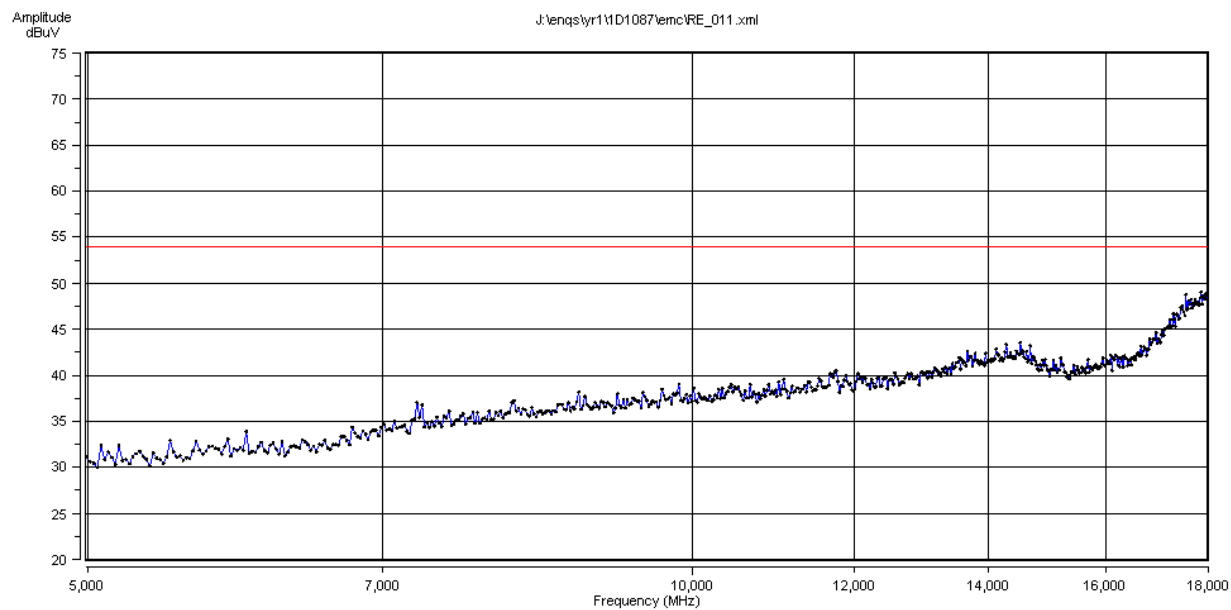


Radiated Transmitter Emissions Channel 26 2480MHz (15.209)



Radiated Transmitter Emissions Channel 26 2480MHz (15.209)

## TRaC EMC Emissions Software - Radiated emissions



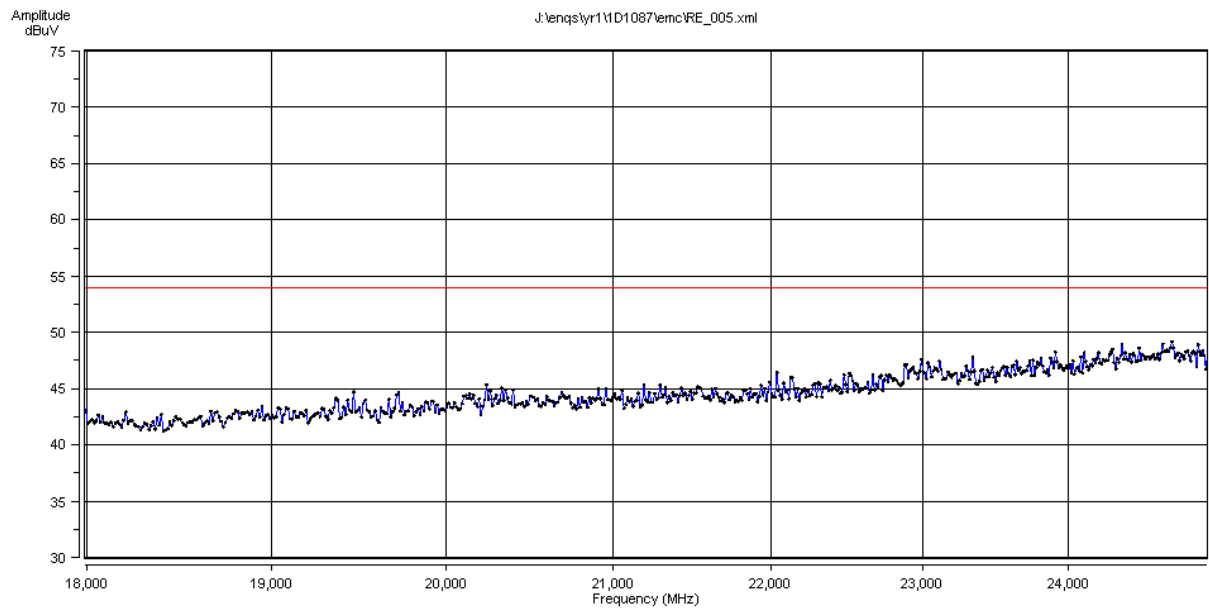
**Test Location:** EMC Ferrite  
**Analyser Type:** ESU40  
**Specification:** FCC 47CFR15:2008, Clause 15.109  
**Spec Distance (m):** 3  
**Measurement Dist (m):** 1  
**EUT Names:** Telegesis interface board and ETRX357\_LR2 modul  
**Sample Numbers:** S05 and S08  
**Assessment:** Horizontal and Vertical Antenna Polarity

**Remote Drive Eq.:** None  
**Sample Numbers:** None  
**Mode/Config/Arrg:** CH26 Non boost mode  
**Mod State:** TXpower -20dBm  
Continuous TX modulated  
Martin Leach  
**Engineer:**  
**Date/Time:** 29/06/2010 16:37:47  
**Job Number:** 1D1087

Software Version: 1.9.1.0  
Copyright © 2009, TRaC Global Ltd.

Radiated Transmitter Emissions Channel 26 2480MHz (15.209)

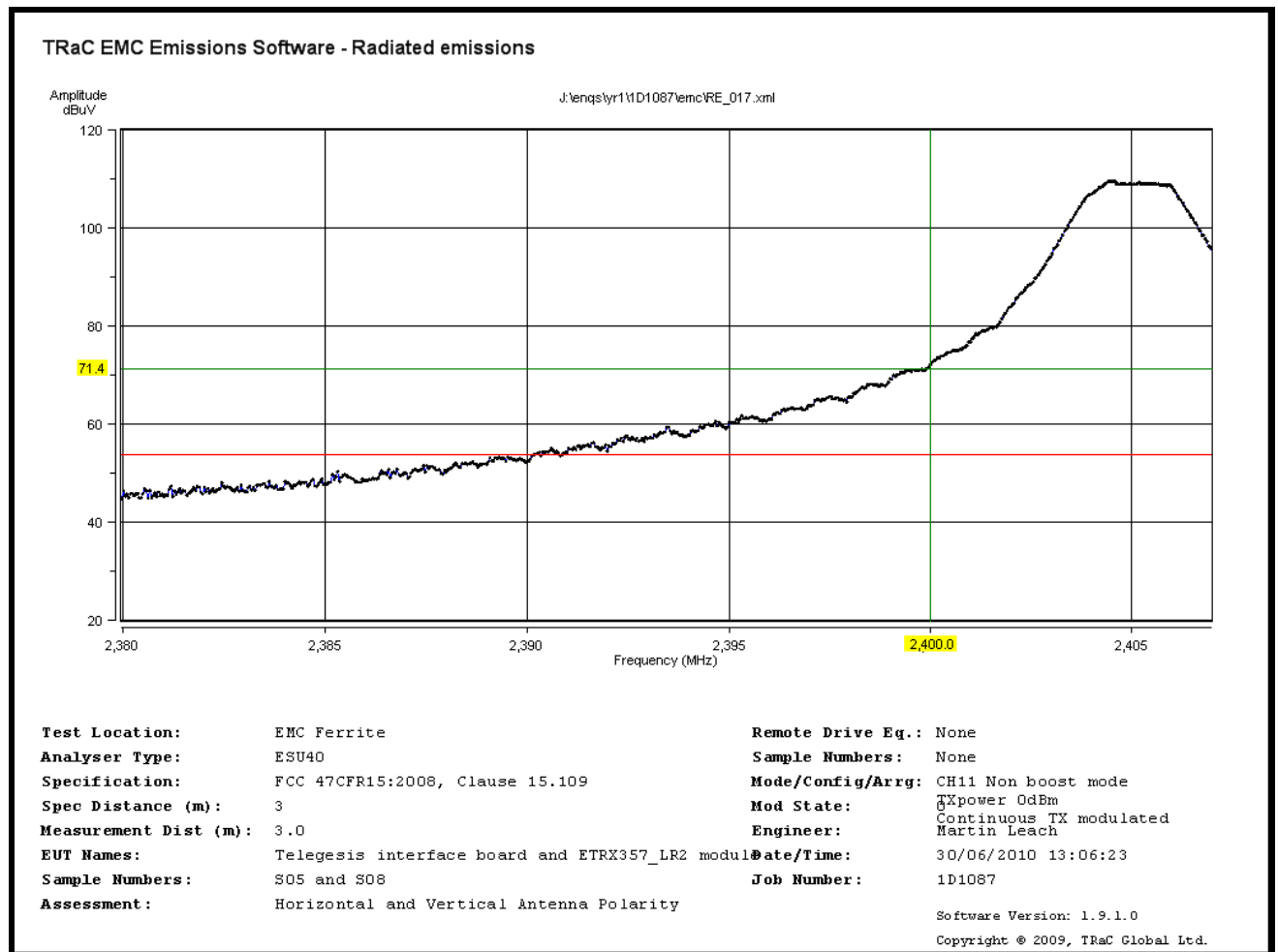
## TRaC EMC Emissions Software - Radiated emissions

**Test Location:** EMC Ferrite**Analyser Type:** ESU40**Specification:** FCC 47CFR15:2008, Clause 15.109**Spec Distance (m):** 3**Measurement Dist (m):** 1**EUT Names:** Telegesis interface board and ETRX357\_LR2 modul**Sample Numbers:** S05 and S08**Assessment:** Horizontal and Vertical Antenna Polarity**Remote Drive Eq.:** None**Sample Numbers:** None**Mode/Config/Arrg:** CH26 Non boost mode**Mod State:** TXpower -20dBm**Engineer:** Continuous TX modulated**Date/Time:** 29/06/2010 14:53:32**Job Number:** 1D1087

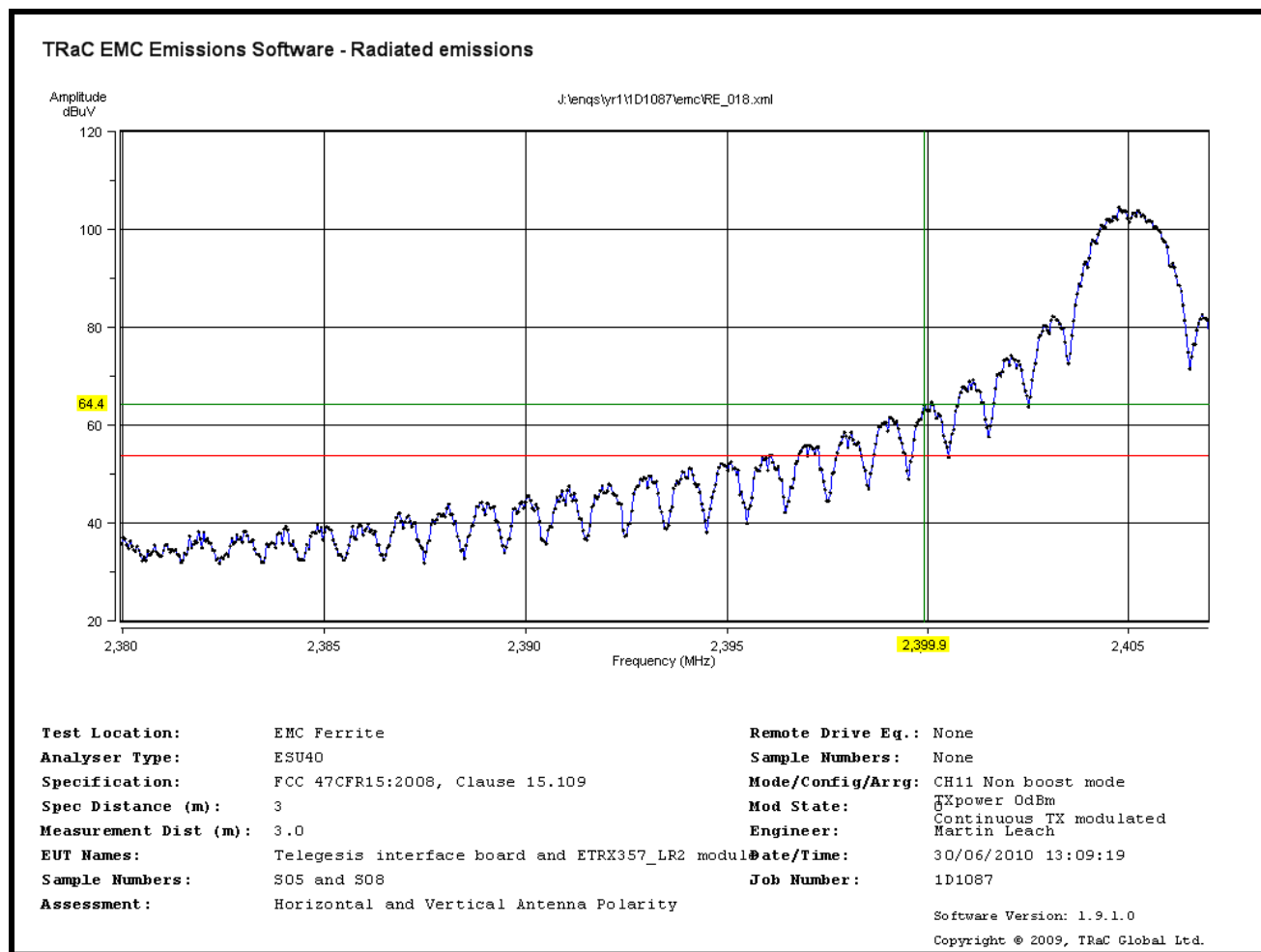
Software Version: 1.9.1.0

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Radiated Transmitter Emissions Channel 26 2480MHz (15.209)

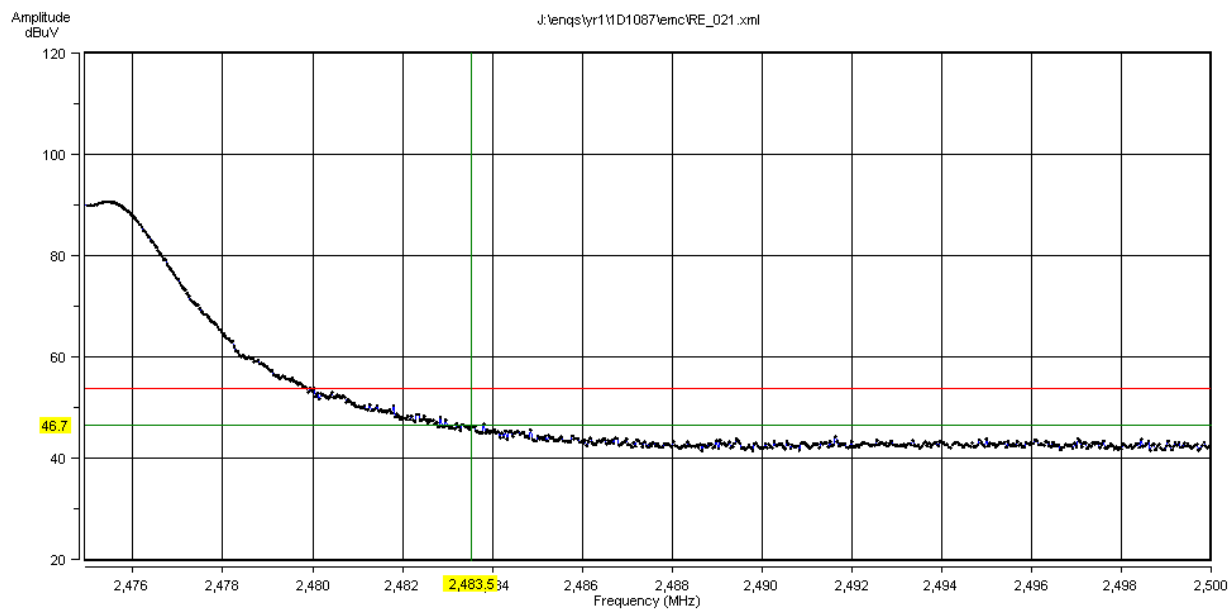


Radiated Transmitter Emissions Channel 11 2405MHz (15.209) Band Edge Compliance  
RBW 1MHz



Radiated Transmitter Emissions Channel 11 2405MHz (15.209) Band Edge Compliance  
RBW 100kHz

## TRaC EMC Emissions Software - Radiated emissions



**Test Location:** EMC Ferrite  
**Analyser Type:** ESU40  
**Specification:** FCC 47CFR15:2008, Clause 15.109  
**Spec Distance (m):** 3  
**Measurement Dist (m):** 3.0  
**EUT Names:** Telegesis interface board and ETRX357\_LR2 modul  
**Sample Numbers:** S05 and S08  
**Assessment:** Horizontal and Vertical Antenna Polarity

**Remote Drive Eq.:** None  
**Sample Numbers:** None  
**Mode/Config/Arrg:** CH26 Non boost mode  
**Mod State:** TXpower -20dBm  
Continuous TX modulated  
Martin Leach  
**Engineer:**  
**Date/Time:** 30/06/2010 14:33:05  
**Job Number:** 1D1087

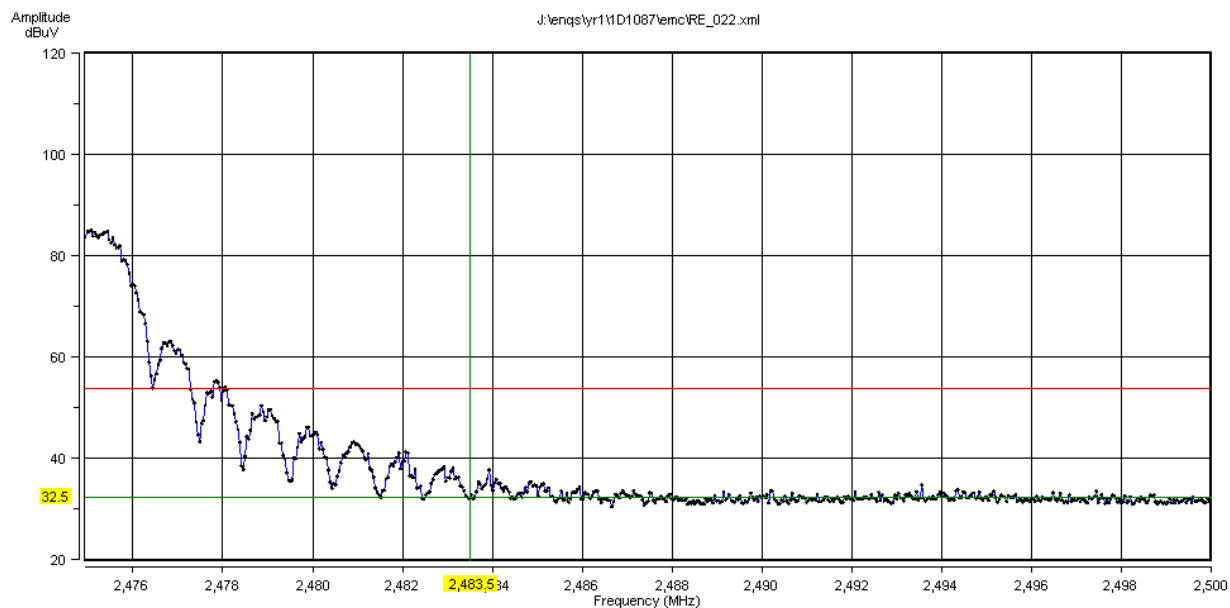
Software Version: 1.9.1.0

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Radiated Transmitter Emissions Channel 26 2480MHz (15.209) Band Edge Compliance  
RBW 1MHz



## TRaC EMC Emissions Software - Radiated emissions



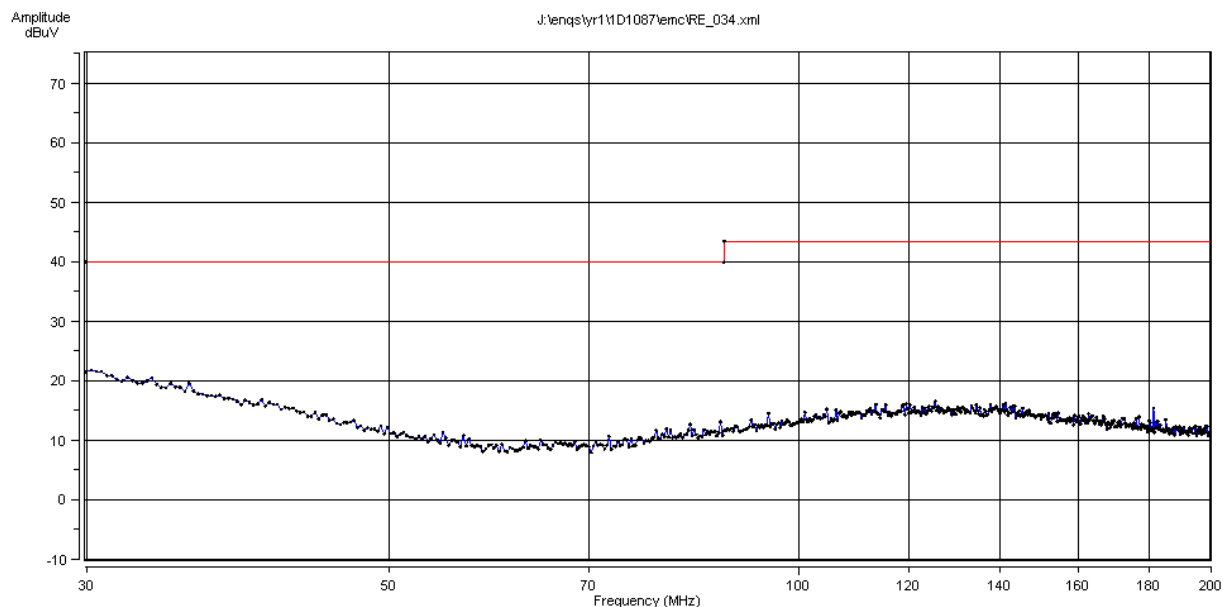
**Test Location:** EMC Ferrite  
**Analyser Type:** ESU40  
**Specification:** FCC 47CFR15:2008, Clause 15.109  
**Spec Distance (m):** 3  
**Measurement Dist (m):** 3.0  
**EUT Names:** Telegesis interface board and ETRX357\_LR2 modul  
**Sample Numbers:** S05 and S08  
**Assessment:** Horizontal and Vertical Antenna Polarity

**Remote Drive Eq.:** None  
**Sample Numbers:** None  
**Mode/Config/Arrg:** CH26 Non boost mode  
**Mod State:** TXpower -20dBm  
Continuous TX modulated  
Martin Leach  
**Engineer:**  
**Date/Time:** 30/06/2010 14:36:11  
**Job Number:** 1D1087

Software Version: 1.9.1.0  
Copyright © 2009, TRaC Global Ltd.

Radiated Transmitter Emissions Channel 26 2480MHz (15.209)Band Edge Compliance  
RBW 100kHz

## TRaC EMC Emissions Software - Radiated emissions



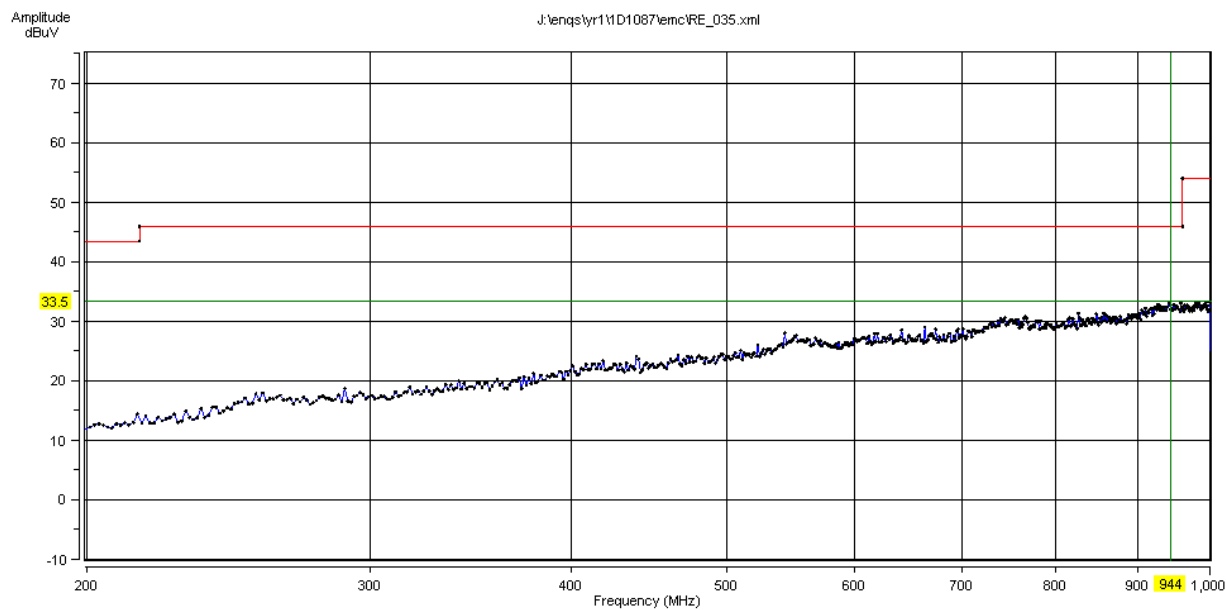
**Test Location:** EMC Ferrite  
**Analyser Type:** ESU40  
**Specification:** FCC 47CFR15:2008, Clause 15.109  
**Spec Distance (m):** 3  
**Measurement Dist (m):** 3.0  
**EUT Names:** Telegesis interface board and ETRX357\_LR2 module  
**Sample Numbers:** S05 and S08  
**Assessment:** Horizontal and Vertical Antenna Polarity

**Remote Drive Eq.:** None  
**Sample Numbers:** None  
**Mode/Config/Arrg:** CH11  
**Mod State:** Continuous RX mode  
**Engineer:** Martin Leach  
**Date/Time:** 01/07/2010 11:16:01  
**Job Number:** 1D1087

Software Version: 1.9.1.0  
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## CH11 Radiated RX Mode Emissions (15.109)

## TRaC EMC Emissions Software - Radiated emissions



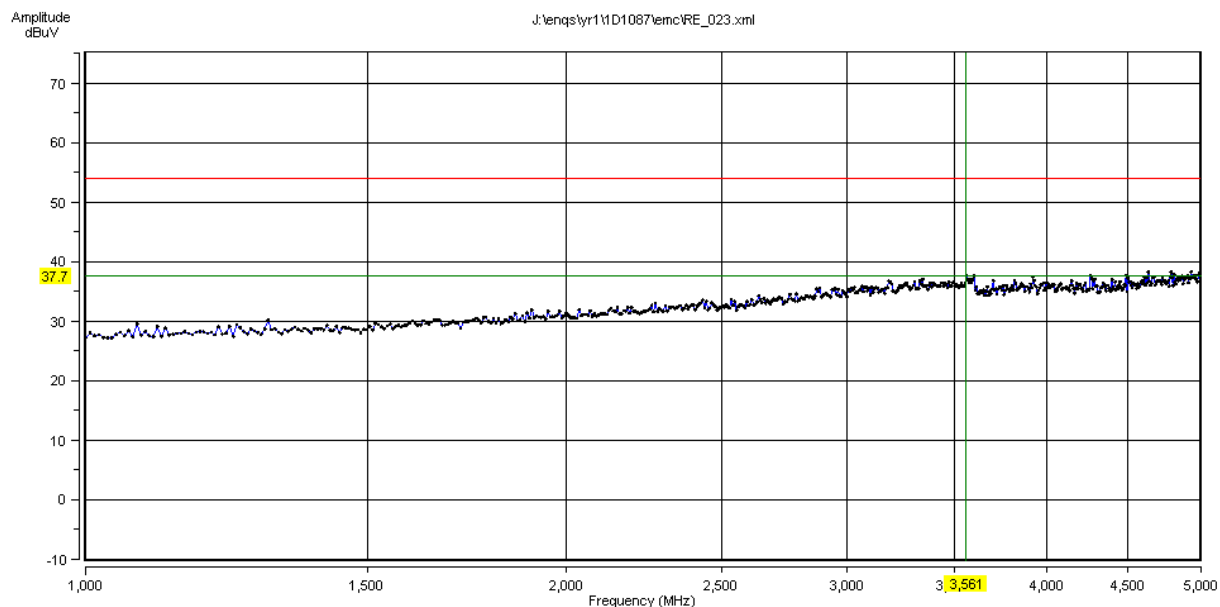
**Test Location:** EMC Ferrite  
**Analyser Type:** ESU40  
**Specification:** FCC 47CFR15:2008, Clause 15.109  
**Spec Distance (m):** 3  
**Measurement Dist (m):** 3.0  
**EUT Names:** Telegesis interface board and ETRX357\_LR2 module  
**Sample Numbers:** S05 and S08  
**Assessment:** Horizontal and Vertical Antenna Polarity

**Remote Drive Eq.:** None  
**Sample Numbers:** None  
**Mode/Config/Arrg:** CH11  
**Mod State:** Continuous RX mode  
**Engineer:** Martin Leach  
**Date/Time:** 01/07/2010 11:18:20  
**Job Number:** 1D1087

Software Version: 1.9.1.0  
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## CH11 Radiated RX Mode Emissions (15.109)

## TRaC EMC Emissions Software - Radiated emissions

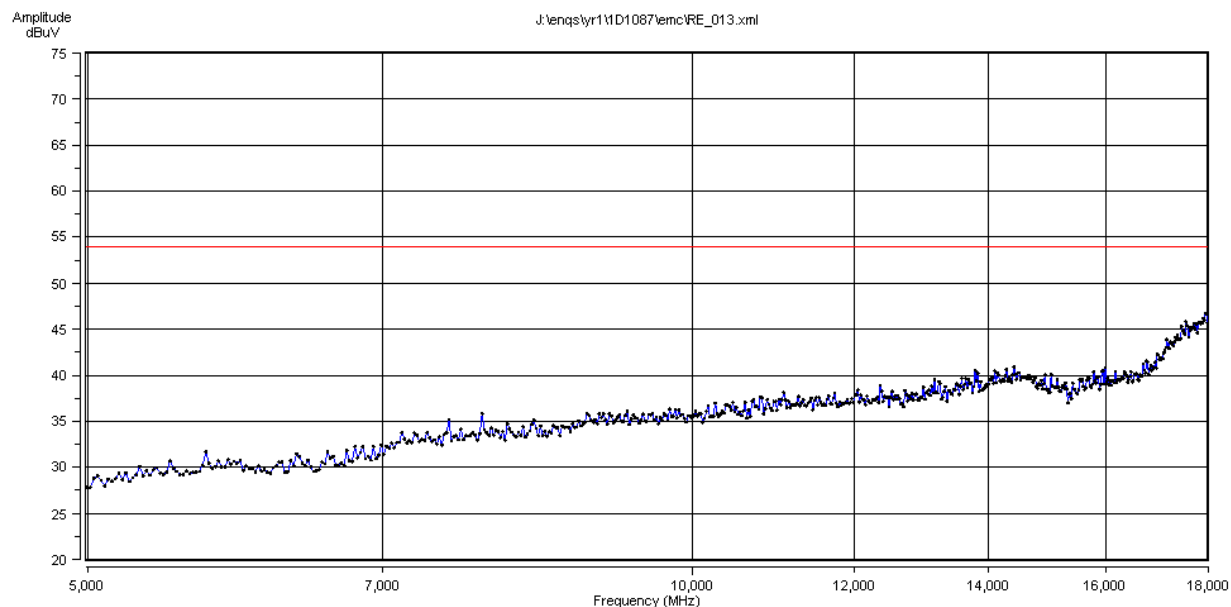


<b>Test Location:</b>	EMC Ferrite	<b>Remote Drive Eq.:</b>	None
<b>Analyser Type:</b>	ESU40	<b>Sample Numbers:</b>	None
<b>Specification:</b>	FCC 47CFR15:2008, Clause 15.109	<b>Mode/Config/Arrg:</b>	CH11 Continuous RX modulated
<b>Spec Distance (m):</b>	3	<b>Mod State:</b>	0
<b>Measurement Dist (m):</b>	1	<b>Engineer:</b>	Martin Leach
<b>EUT Names:</b>	Telegesis interface board and ETRX357_LR2 modul	<b>Date/Time:</b>	30/06/2010 16:24:37
<b>Sample Numbers:</b>	S05 and S08	<b>Job Number:</b>	1D1087
<b>Assessment:</b>	Horizontal and Vertical Antenna Polarity		

Software Version: 1.9.1.0  
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## CH11 Radiated RX Mode Emissions (15.109)

## TRaC EMC Emissions Software - Radiated emissions



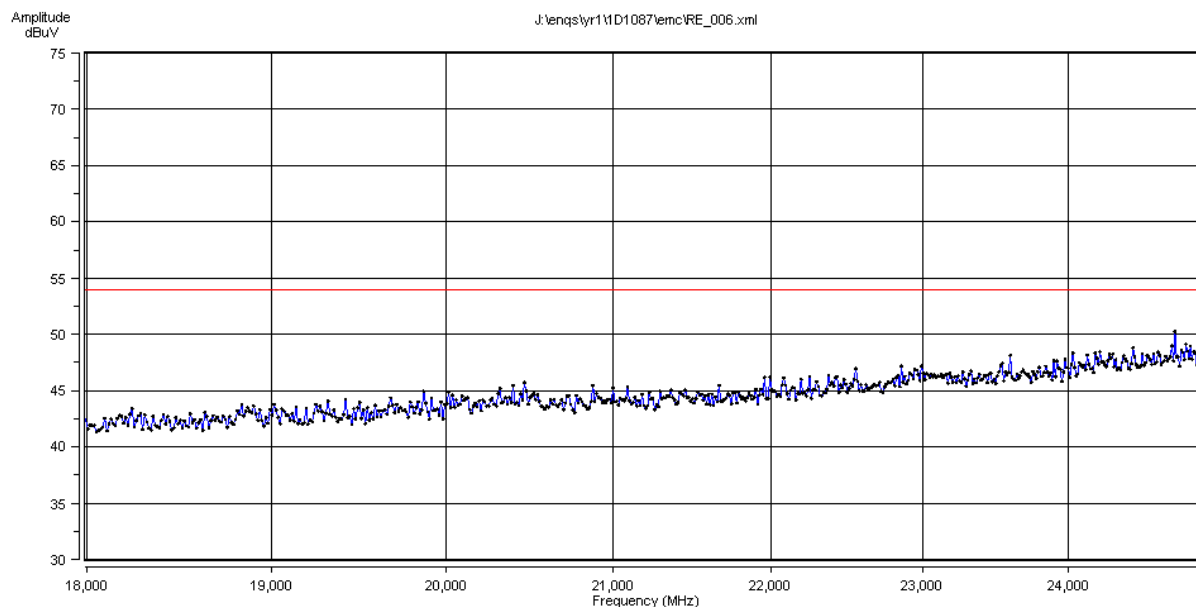
<b>Test Location:</b>	EMC Ferrite	<b>Remote Drive Eq.:</b>	None
<b>Analyser Type:</b>	ESU40	<b>Sample Numbers:</b>	None
<b>Specification:</b>	FCC 47CFR15:2008, Clause 15.109	<b>Mode/Config/Arrg:</b>	CH11 Continuous RX modulated
<b>Spec Distance (m):</b>	3	<b>Mod State:</b>	0
<b>Measurement Dist (m):</b>	1	<b>Engineer:</b>	Martin Leach
<b>EUT Names:</b>	Telegesis interface board and ETRX357_LR2 modul	<b>Date/Time:</b>	29/06/2010 17:04:28
<b>Sample Numbers:</b>	S05 and S08	<b>Job Number:</b>	1D1087
<b>Assessment:</b>	Horizontal and Vertical Antenna Polarity		

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## CH11 Radiated RX Mode Emissions (15.109)

## TRaC EMC Emissions Software - Radiated emissions



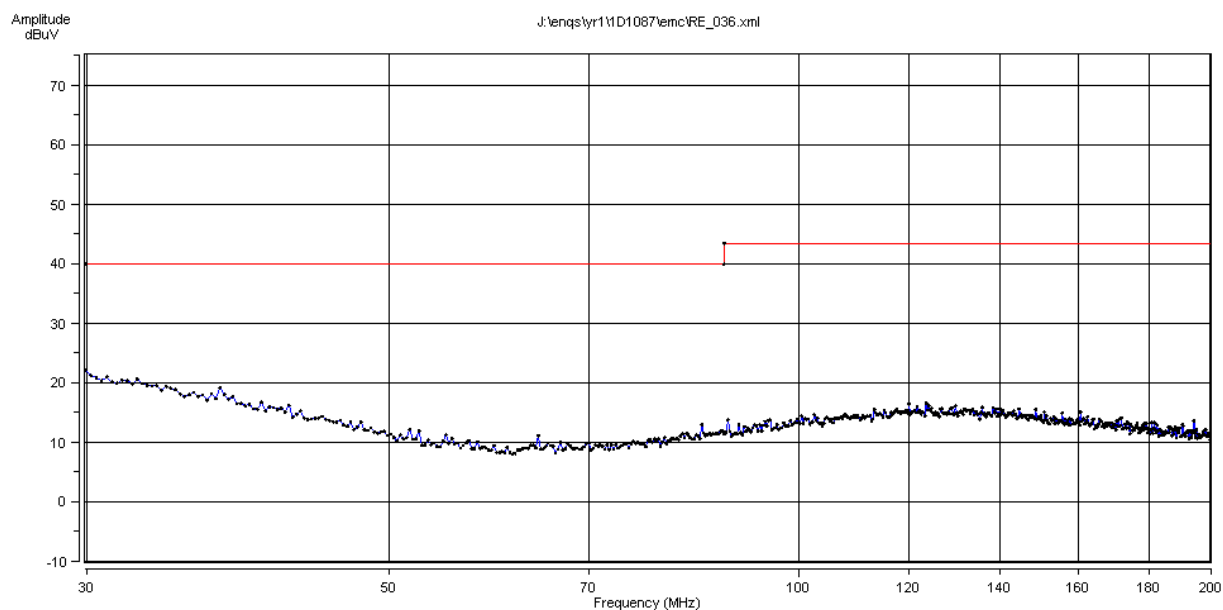
**Test Location:** EMC Ferrite  
**Analyser Type:** ESU40  
**Specification:** FCC 47CFR15:2008, Clause 15.109  
**Spec Distance (m):** 3  
**Measurement Dist (m):** 1  
**EUT Names:** Telegesis interface board and ETRX357\_LR2 modul  
**Sample Numbers:** S05 and S08  
**Assessment:** Horizontal and Vertical Antenna Polarity

**Remote Drive Eq.:** None  
**Sample Numbers:** None  
**Mode/Config/Arrg:** CH11  
**Mod State:** Continuous RX modulated  
**Engineer:** Martin Leach  
**Date/Time:** 29/06/2010 15:00:05  
**Job Number:** 1D1087

Software Version: 1.9.1.0  
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## CH11 Radiated RX Mode Emissions (15.109)

## TRaC EMC Emissions Software - Radiated emissions



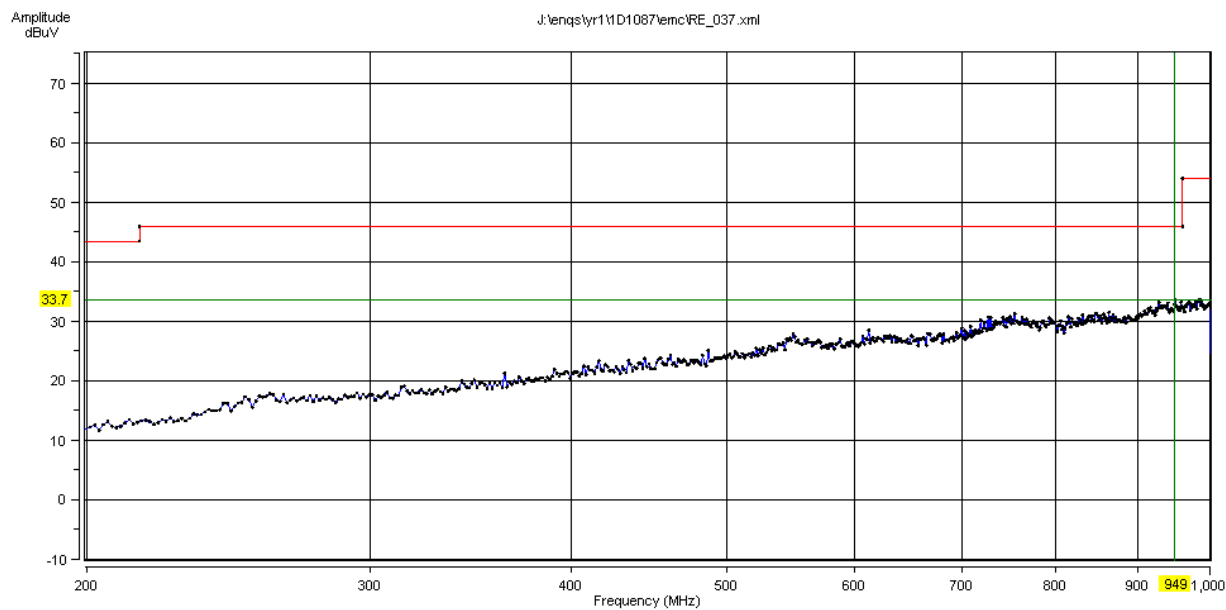
**Test Location:** EMC Ferrite  
**Analyser Type:** ESU40  
**Specification:** FCC 47CFR15:2008, Clause 15.109  
**Spec Distance (m):** 3  
**Measurement Dist (m):** 3.0  
**EUT Names:** Telegesis interface board and ETRX357\_LR2 module  
**Sample Numbers:** S05 and S08  
**Assessment:** Horizontal and Vertical Antenna Polarity

**Remote Drive Eq.:** None  
**Sample Numbers:** None  
**Mode/Config/Arrg:** CH18  
**Mod State:** Continuous RX mode  
**Engineer:** Martin Leach  
**Date/Time:** 01/07/2010 11:34:18  
**Job Number:** 1D1087

Software Version: 1.9.1.0  
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## CH18 Radiated RX Mode Emissions (15.109)

## TRaC EMC Emissions Software - Radiated emissions



**Test Location:** EMC Ferrite  
**Analyser Type:** ESU40  
**Specification:** FCC 47CFR15:2008, Clause 15.109  
**Spec Distance (m):** 3  
**Measurement Dist (m):** 3.0  
**EUT Names:** Telegesis interface board and ETRX357\_LR2 module  
**Sample Numbers:** S05 and S08  
**Assessment:** Horizontal and Vertical Antenna Polarity

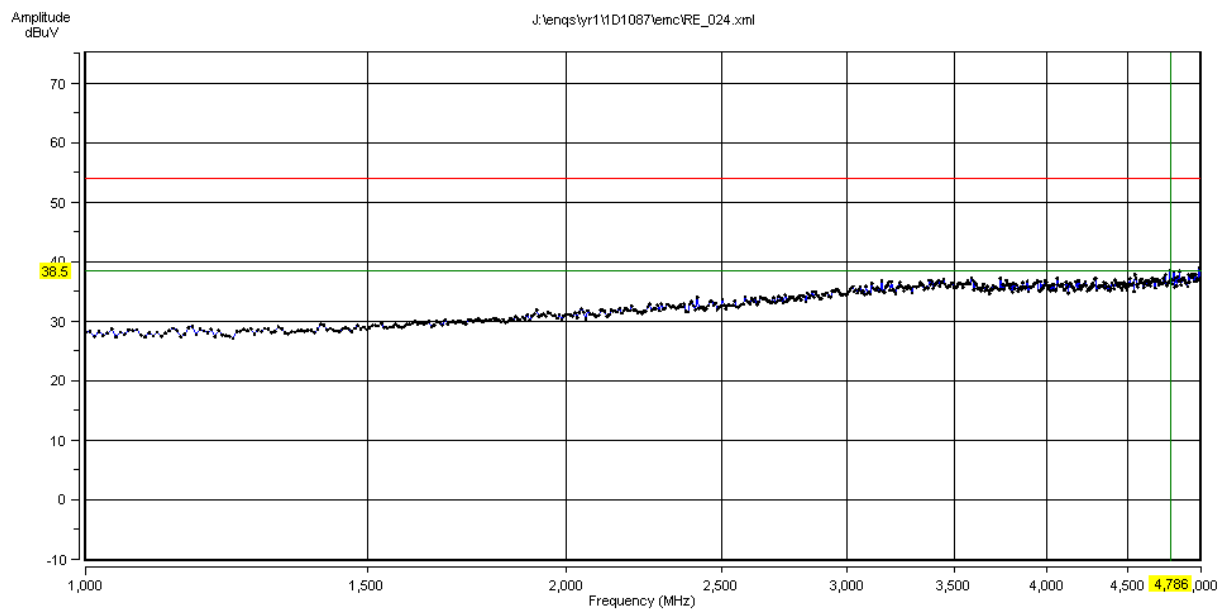
**Remote Drive Eq.:** None  
**Sample Numbers:** None  
**Mode/Config/Arrg:** CH18  
**Mod State:** Continuous RX mode  
**Engineer:** Martin Leach  
**Date/Time:** 01/07/2010 11:37:40  
**Job Number:** 1D1087

Software Version: 1.9.1.0  
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## CH18 Radiated RX Mode Emissions (15.109)



## TRaC EMC Emissions Software - Radiated emissions

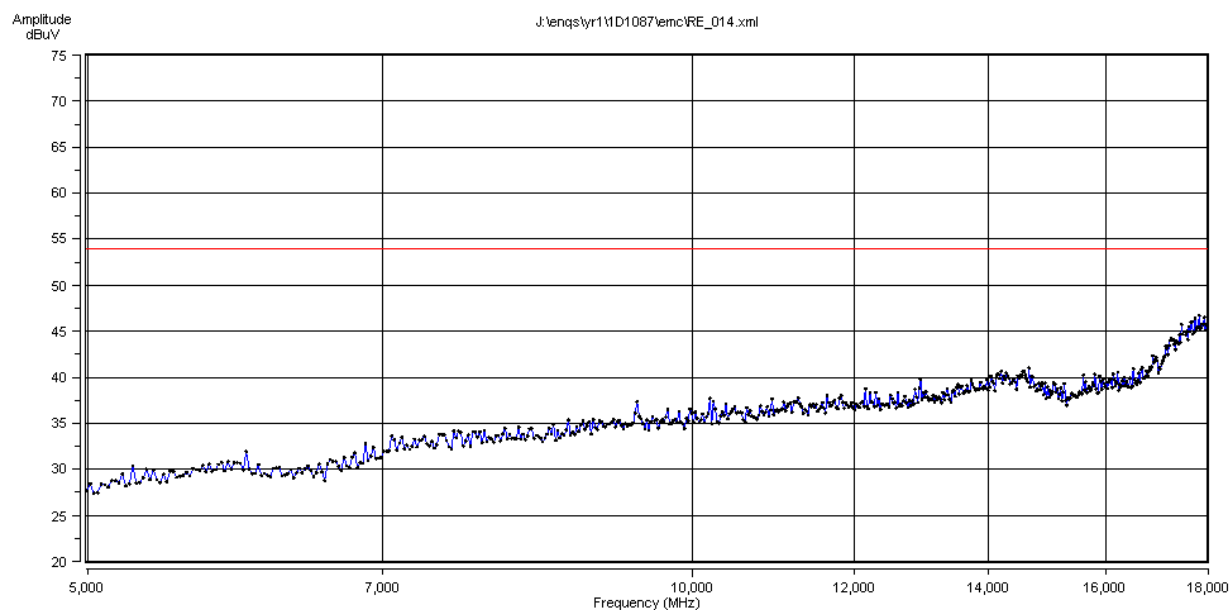


<b>Test Location:</b>	EMC Ferrite	<b>Remote Drive Eq.:</b>	None
<b>Analyser Type:</b>	ESU40	<b>Sample Numbers:</b>	None
<b>Specification:</b>	FCC 47CFR15:2008, Clause 15.109	<b>Mode/Config/Arrg:</b>	CH18 Continuous RX modulated
<b>Spec Distance (m):</b>	3	<b>Mod State:</b>	0
<b>Measurement Dist (m):</b>	1	<b>Engineer:</b>	Martin Leach
<b>EUT Names:</b>	Telegesis interface board and ETRX357_LR2 modul	<b>Date/Time:</b>	30/06/2010 16:26:58
<b>Sample Numbers:</b>	S05 and S08	<b>Job Number:</b>	1D1087
<b>Assessment:</b>	Horizontal and Vertical Antenna Polarity		

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## CH18 Radiated RX Mode Emissions (15.109)

## TRaC EMC Emissions Software - Radiated emissions



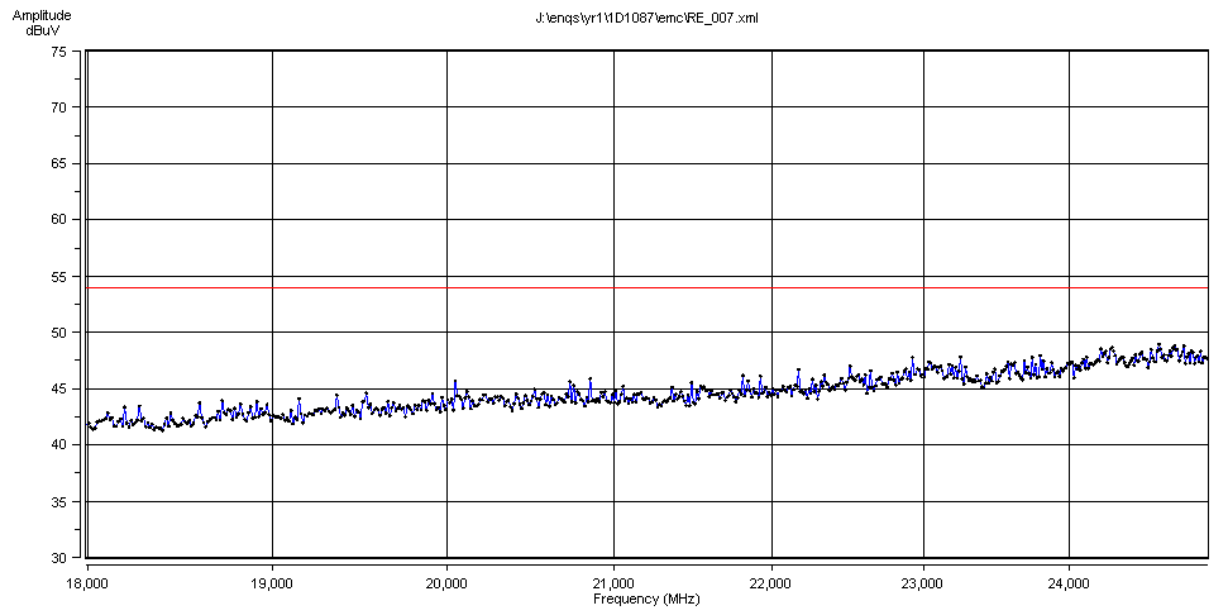
<b>Test Location:</b>	EMC Ferrite	<b>Remote Drive Eq.:</b>	None
<b>Analyser Type:</b>	ESU40	<b>Sample Numbers:</b>	None
<b>Specification:</b>	FCC 47CFR15:2008, Clause 15.109	<b>Mode/Config/Arrg:</b>	CH18 Continuous RX modulated
<b>Spec Distance (m):</b>	3	<b>Mod State:</b>	0
<b>Measurement Dist (m):</b>	1	<b>Engineer:</b>	Martin Leach
<b>EUT Names:</b>	Telegesis interface board and ETRX357_LR2 modul	<b>Date/Time:</b>	29/06/2010 17:07:47
<b>Sample Numbers:</b>	S05 and S08	<b>Job Number:</b>	1D1087
<b>Assessment:</b>	Horizontal and Vertical Antenna Polarity		

Software Version: 1.9.1.0

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## CH18 Radiated RX Mode Emissions (15.109)

## TRaC EMC Emissions Software - Radiated emissions

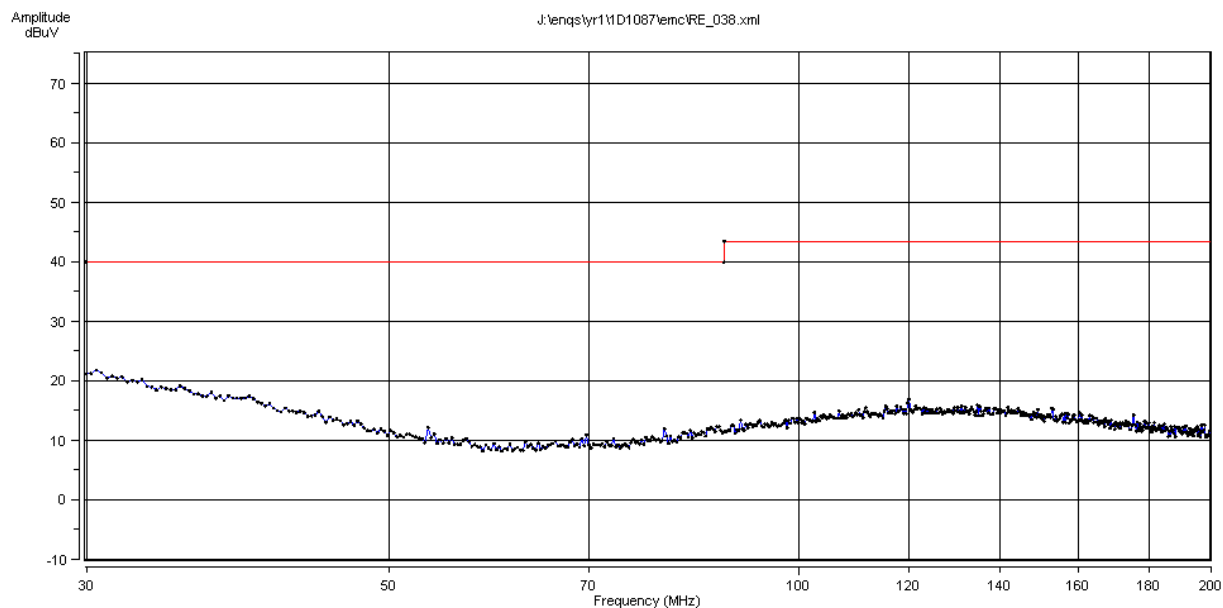


<b>Test Location:</b>	EMC Ferrite	<b>Remote Drive Eq.:</b>	None
<b>Analyser Type:</b>	ESU40	<b>Sample Numbers:</b>	None
<b>Specification:</b>	FCC 47CFR15:2008, Clause 15.109	<b>Mode/Config/Arrg:</b>	CH18
<b>Spec Distance (m):</b>	3	<b>Mod State:</b>	Continuous RX modulated
<b>Measurement Dist (m):</b>	1	<b>Engineer:</b>	Martin Leach
<b>EUT Names:</b>	Telegesis interface board and ETRX357_LR2 modul	<b>Date/Time:</b>	29/06/2010 15:02:14
<b>Sample Numbers:</b>	S05 and S08	<b>Job Number:</b>	1D1087
<b>Assessment:</b>	Horizontal and Vertical Antenna Polarity		

Software Version: 1.9.1.0  
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## CH18 Radiated RX Mode Emissions (15.109)

## TRaC EMC Emissions Software - Radiated emissions



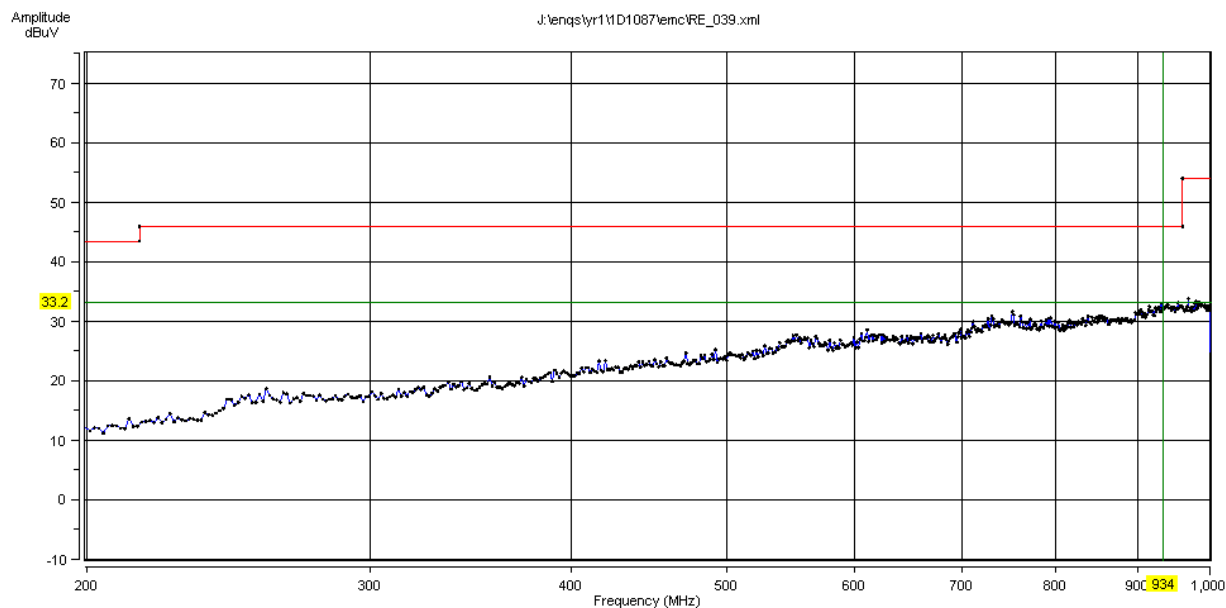
**Test Location:** EMC Ferrite  
**Analyser Type:** ESU40  
**Specification:** FCC 47CFR15:2008, Clause 15.109  
**Spec Distance (m):** 3  
**Measurement Dist (m):** 3.0  
**EUT Names:** Telegesis interface board and ETRX357\_LR2 module  
**Sample Numbers:** S05 and S08  
**Assessment:** Horizontal and Vertical Antenna Polarity

**Remote Drive Eq.:** None  
**Sample Numbers:** None  
**Mode/Config/Arrg:** CH26  
**Mod State:** Continuous RX mode  
**Engineer:** Martin Leach  
**Date/Time:** 01/07/2010 11:41:38  
**Job Number:** 1D1087

Software Version: 1.9.1.0  
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## CH26 Radiated RX Mode Emissions (15.109)

## TRaC EMC Emissions Software - Radiated emissions



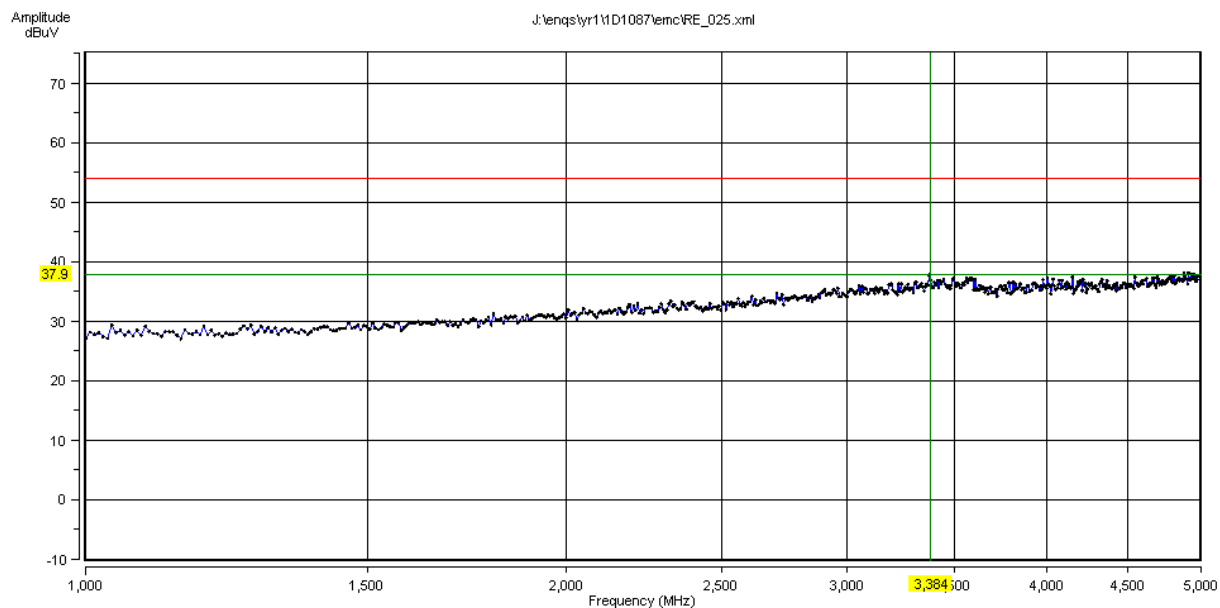
**Test Location:** EMC Ferrite  
**Analyser Type:** ESU40  
**Specification:** FCC 47CFR15:2008, Clause 15.109  
**Spec Distance (m):** 3  
**Measurement Dist (m):** 3.0  
**EUT Names:** Telegesis interface board and ETRX357\_LR2 module  
**Sample Numbers:** S05 and S08  
**Assessment:** Horizontal and Vertical Antenna Polarity

**Remote Drive Eq.:** None  
**Sample Numbers:** None  
**Mode/Config/Arrg:** CH26  
**Mod State:** Continuous RX mode  
**Engineer:** Martin Leach  
**Date/Time:** 01/07/2010 11:43:51  
**Job Number:** 1D1087

Software Version: 1.9.1.0  
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## CH26 Radiated RX Mode Emissions (15.109)

## TRaC EMC Emissions Software - Radiated emissions

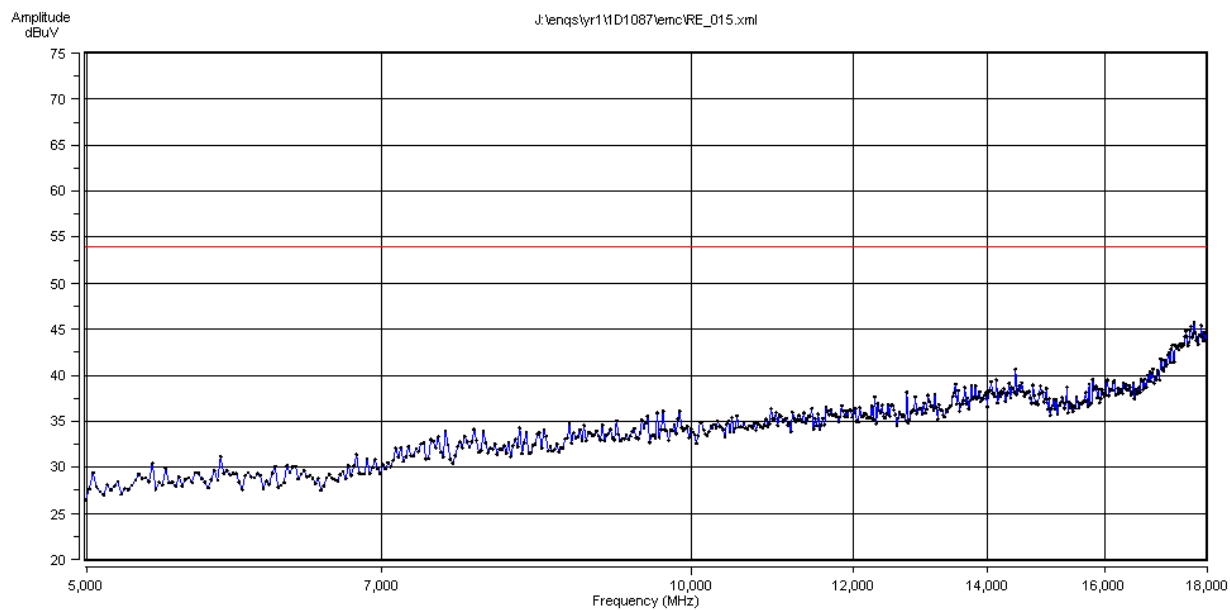


<b>Test Location:</b>	EMC Ferrite	<b>Remote Drive Eq.:</b>	None
<b>Analyser Type:</b>	ESU40	<b>Sample Numbers:</b>	None
<b>Specification:</b>	FCC 47CFR15:2008, Clause 15.109	<b>Mode/Config/Arrg:</b>	CH26 Continuous RX modulated
<b>Spec Distance (m):</b>	3	<b>Mod State:</b>	0
<b>Measurement Dist (m):</b>	1	<b>Engineer:</b>	Martin Leach
<b>EUT Names:</b>	Telegesis interface board and ETRX357_LR2 modul	<b>Date/Time:</b>	30/06/2010 16:38:14
<b>Sample Numbers:</b>	S05 and S08	<b>Job Number:</b>	1D1087
<b>Assessment:</b>	Horizontal and Vertical Antenna Polarity		

Software Version: 1.9.1.0  
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## CH26 Radiated RX Mode Emissions (15.109)

## TRaC EMC Emissions Software - Radiated emissions

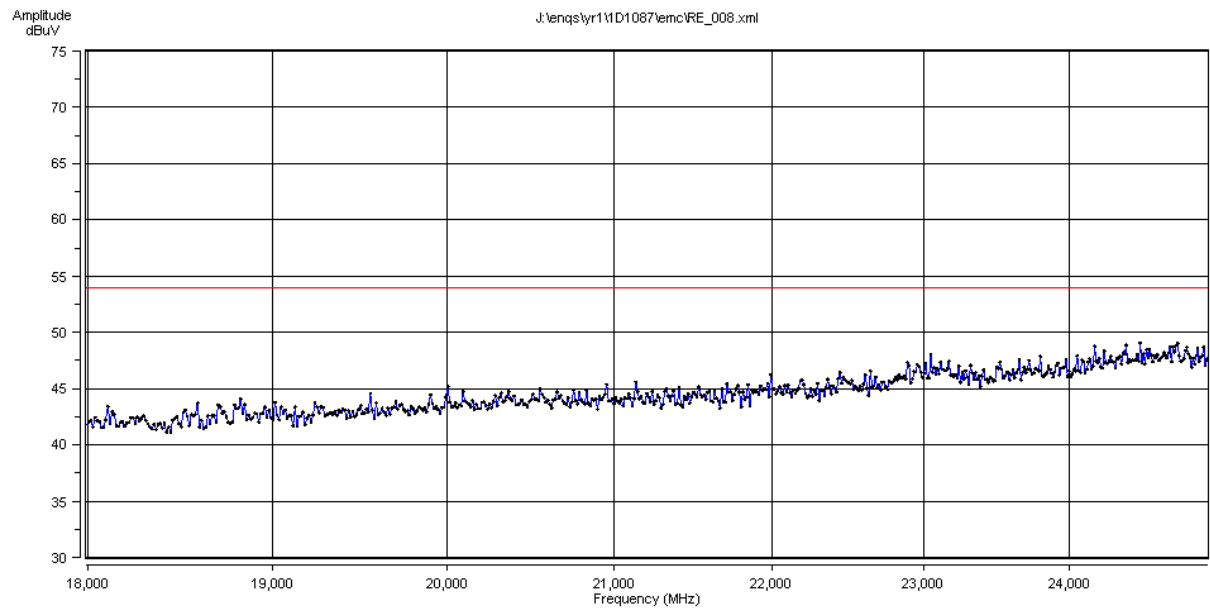


<b>Test Location:</b>	EMC Ferrite	<b>Remote Drive Eq.:</b>	None
<b>Analyser Type:</b>	ESU40	<b>Sample Numbers:</b>	None
<b>Specification:</b>	FCC 47CFR15:2008, Clause 15.109	<b>Mode/Config/Arrg:</b>	CH26 Continuous RX modulated
<b>Spec Distance (m):</b>	3	<b>Mod State:</b>	0
<b>Measurement Dist (m):</b>	1	<b>Engineer:</b>	Martin Leach
<b>EUT Names:</b>	Telegesis interface board and ETRX357_LR2 modul	<b>Date/Time:</b>	29/06/2010 17:09:52
<b>Sample Numbers:</b>	S05 and S08	<b>Job Number:</b>	1D1087
<b>Assessment:</b>	Horizontal and Vertical Antenna Polarity		

Software Version: 1.9.1.0  
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## CH26 Radiated RX Mode Emissions (15.109)

## TRaC EMC Emissions Software - Radiated emissions



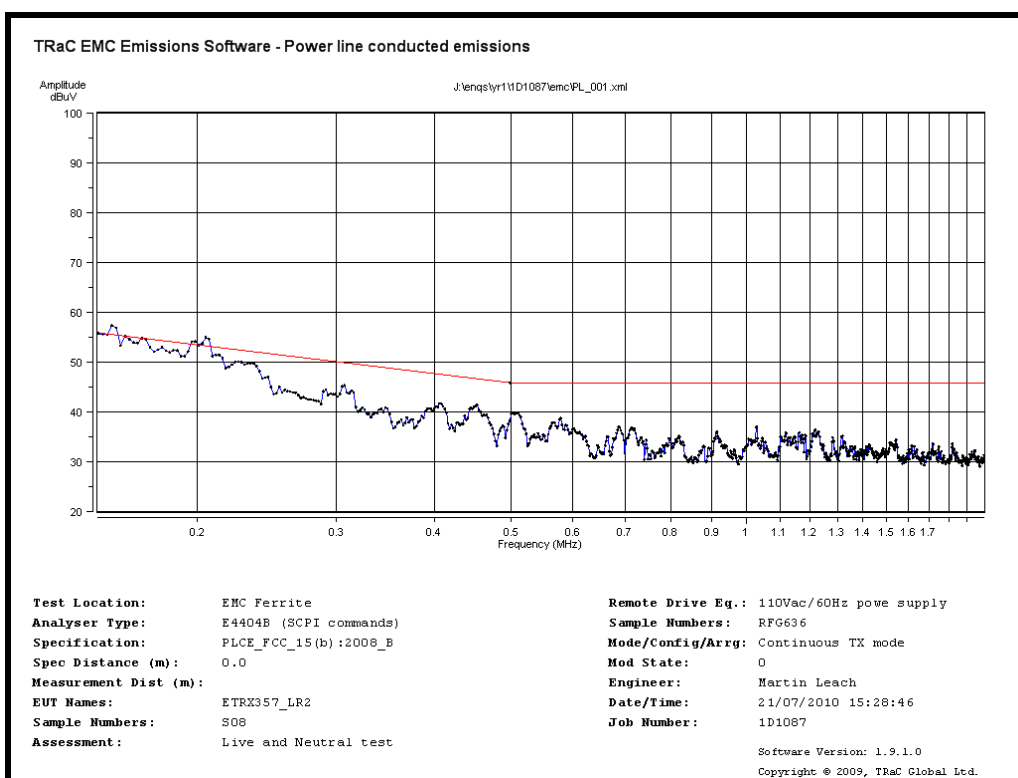
**Test Location:** EMC Ferrite  
**Analyser Type:** ESU40  
**Specification:** FCC 47CFR15:2008, Clause 15.109  
**Spec Distance (m):** 3  
**Measurement Dist (m):** 1  
**EUT Names:** Telegesis interface board and ETRX357\_LR2 module  
**Sample Numbers:** S05 and S08  
**Assessment:** Horizontal and Vertical Antenna Polarity

**Remote Drive Eq.:** None  
**Sample Numbers:** None  
**Mode/Config/Arrg:** CH26  
**Mod State:** Continuous RX modulated  
**Engineer:** Martin Leach  
**Date/Time:** 29/06/2010 15:08:01  
**Job Number:** 1D1087

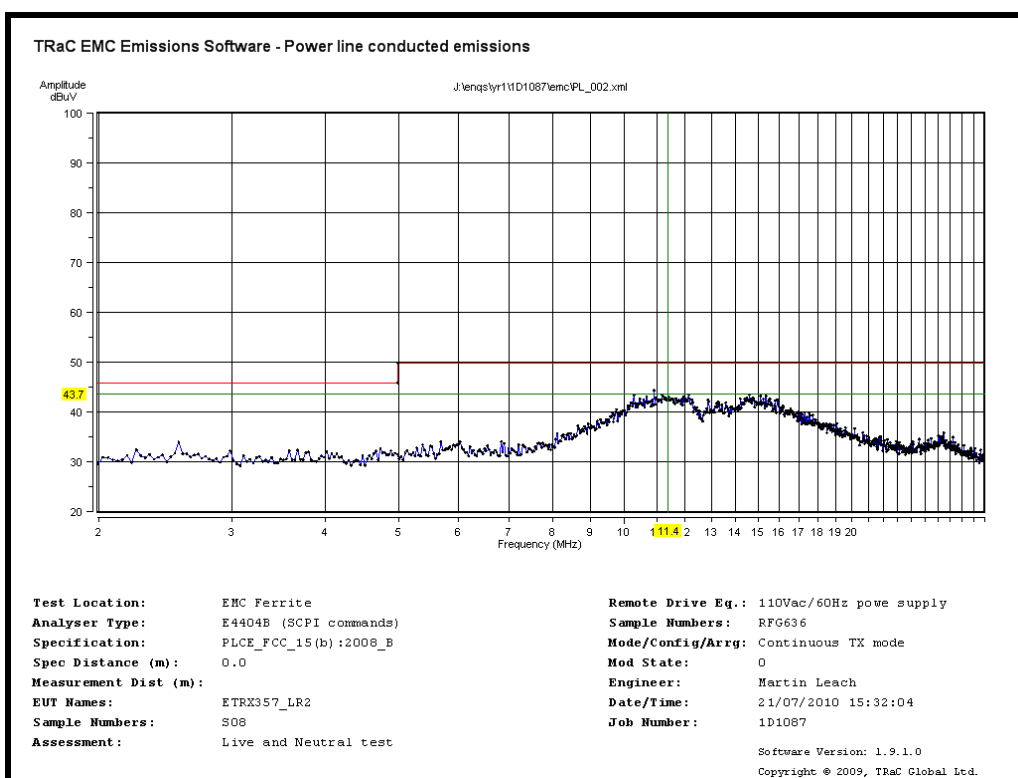
Software Version: 1.9.1.0  
Copyright © 2009, TRaC Global Ltd.

## CH26 Radiated RX Mode Emissions (15.109)

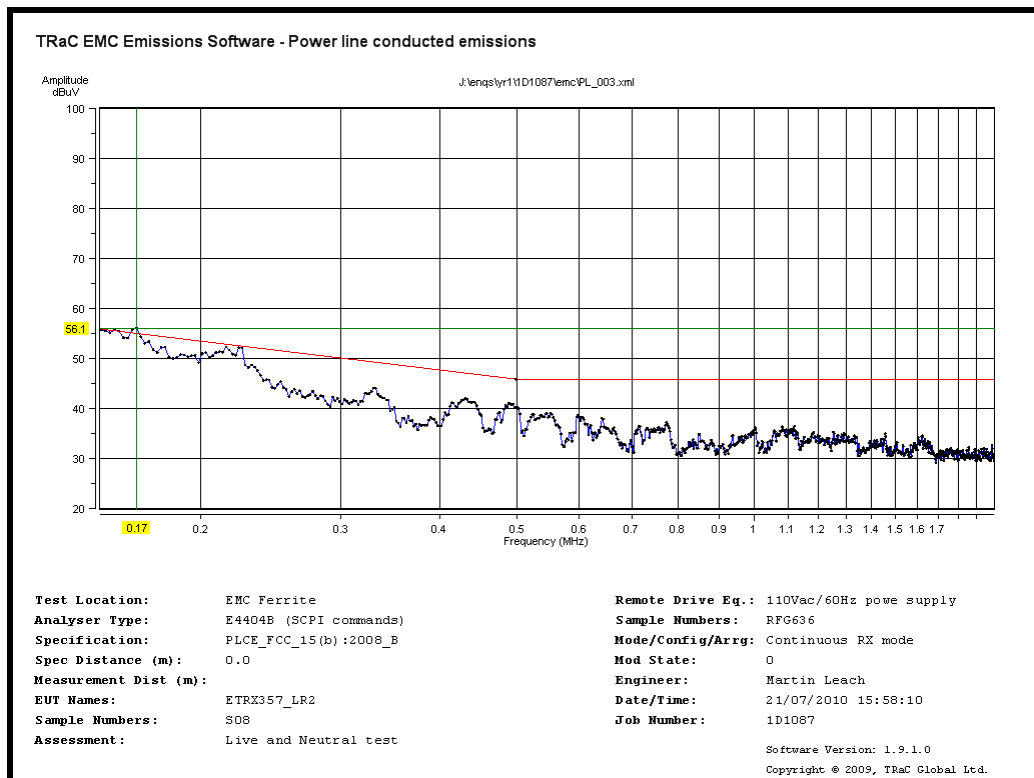




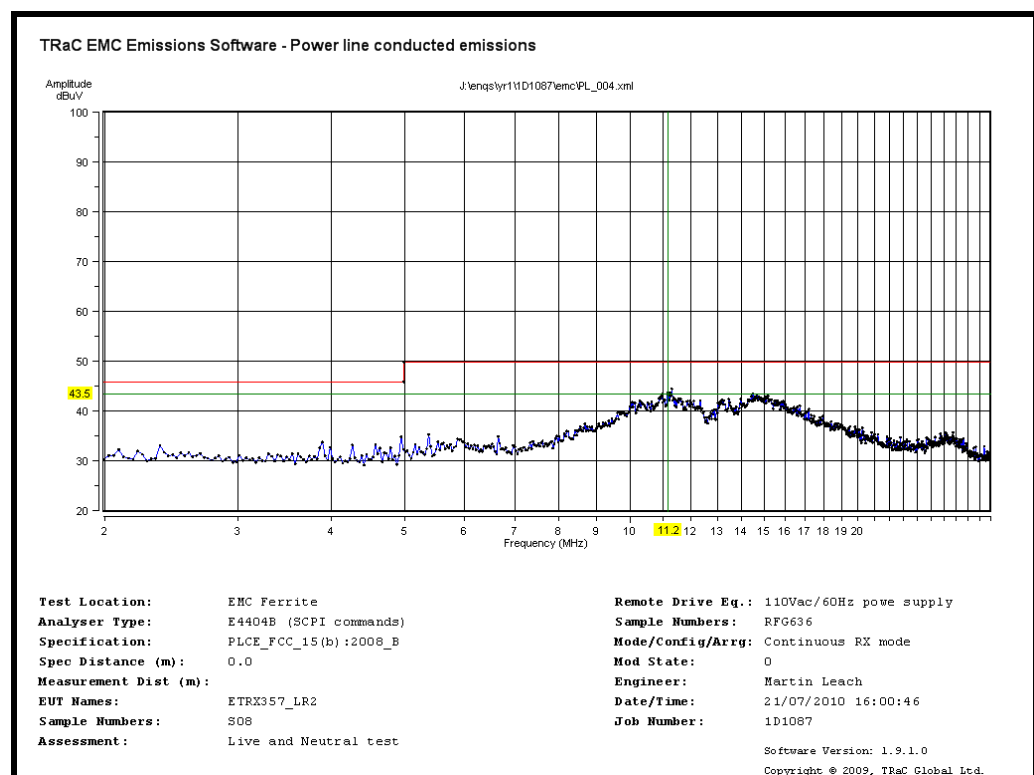
PLCE- EUT transmitting 0.15 to 2 MHz



PLCE - EUT transmitting 2 to 30 MHz



## PLCE - EUT Receiving 0.15 to 2 MHz



## PLCE - EUT Receiving 2 to 30 MHz

## Appendix C: Additional Test and Sample Details

This appendix contains details of:

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

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

**Sample No:** Sxx Mod w

where:

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

The following terminology is used throughout the test report:

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

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

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

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

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

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

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

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

**C1) Test samples**

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

Sample No.	Description	Identification
S08	ETRX357-LR#2 (Radiated sample)	None
S10	ETRX357-LR#2 (Conducted sample)	None

The following samples of the apparatus were submitted by the client as support equipment (SE)

Sample No.	Description	Identification
S05	Interface board (Support Equipment)	R303

The following samples of the apparatus were submitted by TRaC as support equipment (SE)

Sample No.	Description	Identification
N/A	Compaq Laptop	None

**C2) EUT Operating Mode During Testing.**

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

Test	Description of Operating Mode: Transmit
All tests, except as described below	The EUT was transmitting on maximum power using O-QPSK with half-sine pulse-shaping - 8-symbol listen-before send for CSMA-CA - Bit rate 250kb/s, symbol rate 62.5ksymbol/s with 4-bit 16-ary orthogonal symbols, chip rate 2000kchip/s) modulation at centre frequencies $F_c = 2405 + 5(k - 11)$ in MHz

Test	Description of Operating Mode: Receive/Standby mode
Receiver Radiated Spurious Emissions Receiver Power Line Conducted Emissions	The EUT was placed in continuous receive mode during the test.

**C3) EUT Configuration Information.**

The EUT was submitted for testing in one single possible configuration.

**C4) List of EUT Ports**

The tables below describe the termination of EUT ports:

The table below describes the termination of EUT ports:

Sample : S10

Tests : RF Antenna Port Conducted Spurious Emissions, 6dB Bandwidth, Power Spectral Density and Conducted Fundamental Carrier Power

Port	Description of Cable Attached	Cable length	Equipment Connected
Antenna port	50Ohm coax	N/A	REF847
Data port	None	N/A	S05

Sample : S08

Tests : Radiated Electric Field Emissions Restricted band 15.209 (15.205) and 15.109 digital circuitry

Port	Description of Cable Attached	Cable length	Equipment Connected
Antenna port	None	N/A	Antenna
Data port	None	N/A	S05

Sample : S05 (SE)

Tests : RF Antenna Port Conducted Spurious Emissions, 6dB Bandwidth, Power Spectral Density and Conducted Fundamental Carrier Power

Port	Description of Cable Attached	Cable length	Equipment Connected
Data port	None	N/A	S10
USB	None	N/A	N/A
Dc	None	N/A	N/A
Battery	2 x AAA 1.5V batteries	N/A	S05

Sample : S05 (SE)

Tests : Radiated Electric Field Emissions Restricted band 15.209 (15.205) and 15.109 digital circuitry

Port	Description of Cable Attached	Cable length	Equipment Connected
Data port	None	N/A	S08
USB	None	N/A	N/A
dc jack	None	N/A	N/A
Battery	2 x AAA 1.5V batteries	N/A	S05

Sample : S08  
Tests : Power Line Conducted Emissions 15.207

Port	Description of Cable Attached	Cable length	Equipment Connected
USB Port	4 core unscreened	1.87m	Laptop

Sample : Laptop(SE)  
Tests : Power Line Conducted Emissions 15.207

Port	Description of Cable Attached	Cable length	Equipment Connected
ac power port	Inline ac –dc power supply	0.8m	RFG636
USB Port	4 core unscreened	1.87m	S05



**C5 Details of Equipment Used**

For Radiated Measurements:

TRAC REF/RFG No.	Type	Description	Manufacturer	Date Calibrated.
274	Lab 10	Large anechoic chamber	TRaC	10/06/10
231	CBL6111	BILOG Antenna	Chase	12/08/08
129	3115	1-18GHz Horn Antenna	EMCO	11/08/08
630	QSH20S20S	18-26GHz Horn antenna	Q-PAR	02/11/06
008	8447D	Pre Amp (30 to 1000MHz)	HP	16/02/10
307	8449B	Microwave pre amp (1 to 26.5GHz)	HP	01/03/10
214	ESAI	Spec Analyser/Test Receiver (LF/HF)	R & S	22/03/10
RFG404	ESA-E	E4407B Spectrum Analyser	Agilent	10/05/10
REF847	ESU40	Spectrum Analyser/Receiver	Rhode & Schwarz	14/06/10
REF112	PL320	dc power supply	Thurlby	CAL date N/A
246	07212BD	4.5m N-Type cable	TRaC	22/09/09
270	30-05151-10	3m N-Type cable	TRaC	22/09/09
278	30-05156-10	1m N-Type cable	TRaC	22/09/09
643	ST18/Nm/Nm/48	48 inch Sucoflex cable	Huber & Suhner	22/09/09
650	N-106	3 meter HF Sucoflex cable	Huber & Suhner	22/09/09
651	N-106	7 meter HF Sucoflex cable	Huber & Suhner	22/09/09
REF831		5m K-Type M-M	Teleydyne Reynolds	04/05/10
REF833		2m K-Type M-M	Teleydyne Reynolds	09/07/10

For Conducted Measurements

TRAC REF/RFG No.	Type	Description	Manufacturer	Date Calibrated.
REF847	ESU40	Spectrum Analyser/Receiver	Rhode & Schwarz	14/06/10
835/836	N10149 N1911A	Power head and meter	Agilent	03/08/09
REF833		2m K-Type M-M	Teleydyne Reynolds	09/07/10


For Power Line Conducted Emissions

TRAC REF/RFG No.	Type	Description	Manufacturer	Date Calibrated.
n/a	Lab 7	Screened room 1	TRaC	CAL date N/A
189	ESH3-Z5	2-phase LISN	Rhode & Schwarz	17/06/10
232	ESH3-Z2	Pulse Limiter	Rhode & Schwarz	16/02/10
657	E4404B	Spectrum Analyser	Agilent	30/06/10
636	NSG1007	AC 110 /60Hz power supply	Schaffner	CAL date N/A

**Appendix D:****Additional Information**

The following additional information is included within this test report.

**D.1 Data sheet for Antenova Rufa 2.4GHz SMD Antenna**



## Rufa 2.4 GHz SMD Antenna

Part No. 3030A5839 / 3030A5887      Product Specification

### 1 Features

- Designed for 2.4 GHz applications: Bluetooth®, Wi-Fi® (802.11b/g), ZigBee®, etc.
- Easy to integrate
- Low profile design for use with no ground beneath the antenna
- High efficiency
- Light weight
- Intended for SMD mounting
- Supplied in tape on reel


### 2 Description

Rufa is intended for use with all 2.4 GHz applications. The antenna uses a ground plane in order to radiate efficiently, but this ground plane must not extend underneath the antenna itself.

The antenna is available in two versions with the feed locations on the right or left hand side of the antenna.

### 3 Applications

- Mobile phones
- PDAs
- PNDs
- Headsets
- PMPs / MP3s
- Laptops
- PC-Cards
- Sensors



## Integrated Antenna and RF Solutions

1  
Product Specification AE020157-M

Rufa 2.4 GHz SMD Antenna  
Part No. 3030A5839 / 3030A5887

#### 4 Part numbers

Rufa Left: 3030A5839-01



Rufa Right: 3030A5887-01



#### 5 General data

Product name	Rufa 2.4 GHz
Part Number	3030A5839-01 (Left)
	3030A5887-01 (Right)
Frequency	2.4 – 2.5 GHz
Polarization	Linear
Operating temperature	-40 °C to +85 °C
Impedance with matching	50 $\Omega$
Weight	0.1 g
Antenna type	SMD
Dimensions	12.8 x 3.9 x 1.1 [mm]

#### 6 Electrical characteristics

	Typical performance	Conditions
Peak gain	2.1 dBi	All data measured on Antenova's reference boards, part numbers AN-1-0543-1 and AN-1-0556-1  Data given for the 2.4 – 2.5 GHz frequency range
Average gain	-1.2 dBi	
Average efficiency	75%	
Maximum Return Loss	-11 dB	
Maximum VSWR	1.8:1	

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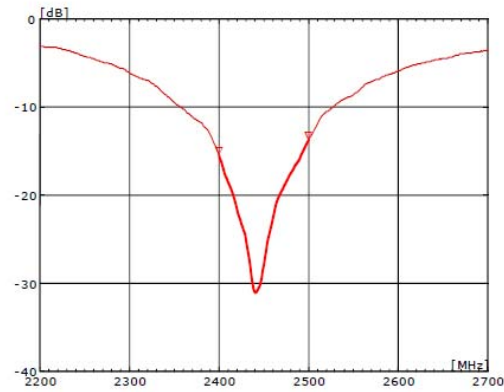
2

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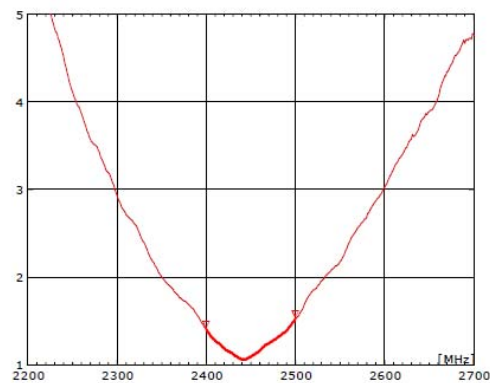
Rufa 2.4 GHz SMD Antenna  
Part No. 3030A5839 / 3030A5887

## 7 Electrical performance

### 7-1 Return Loss



### 7-2 VSWR

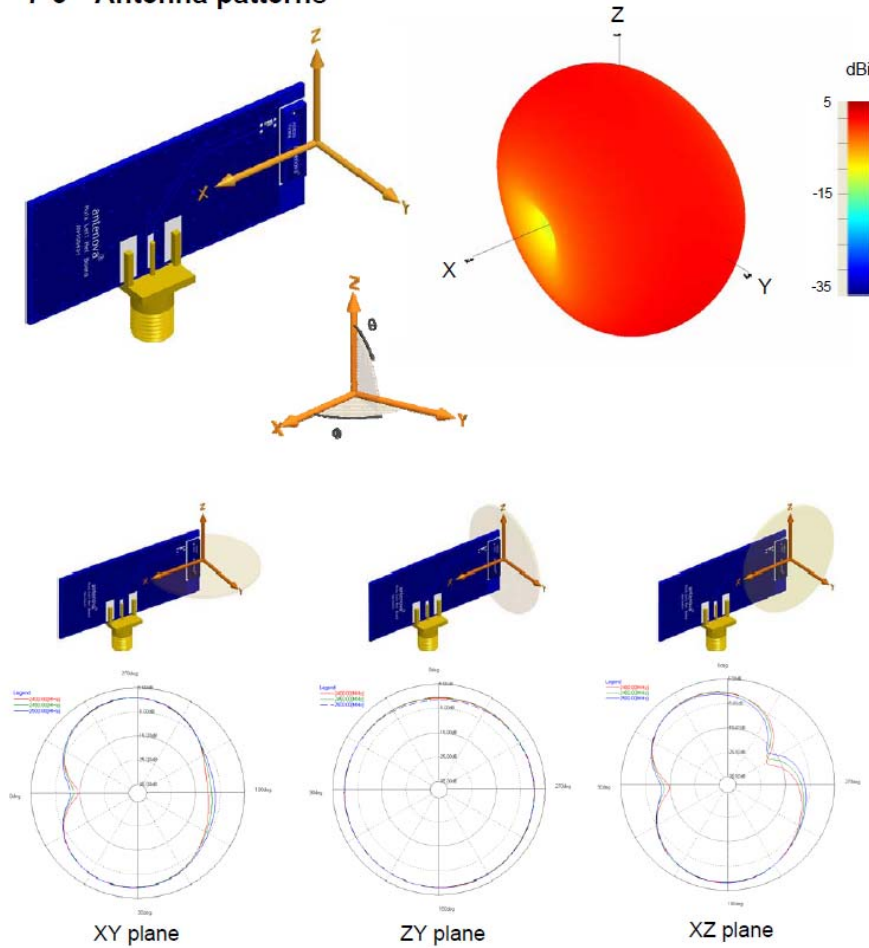


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### 7-3 Antenna patterns



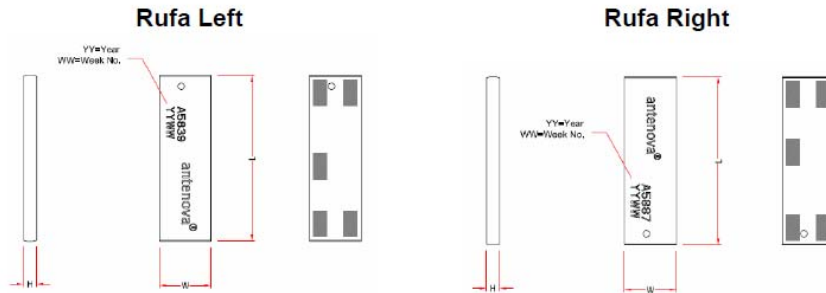
Patterns show combined polarisations  
measured on reference board AN-1-0556-1

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## 8 Antenna dimensions



L	W	H
Length	Width	Height
12.8 ± 0.2	3.9 ± 0.2	1.1 ± 0.2

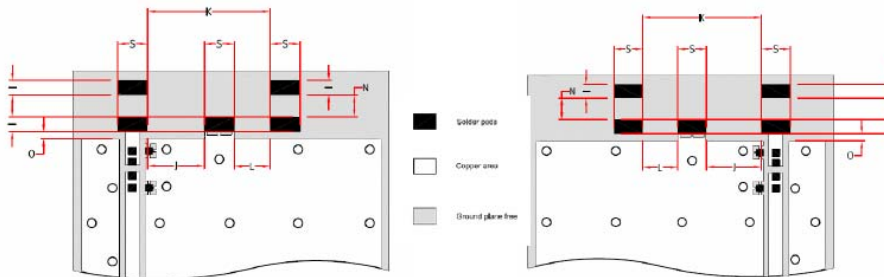
Dimensions in mm

## 9 Antenna footprint

Rufa Left (Part No: 3030A5839-01)

Rufa Right (Part No: 3030A5887-01)

\* CAD files of the antenna footprint are available from Antenova on request.



Please contact [info@antenova.com](mailto:info@antenova.com) for further details.

I	S	K	J	N	L	O
1.0 ± 0.1	2.0 ± 0.1	8.1 ± 0.1	3.7 ± 0.1	1.5 ± 0.1	2.4 ± 0.1	0.5 ± 0.1

Dimensions in mm

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## 10 Electrical interface

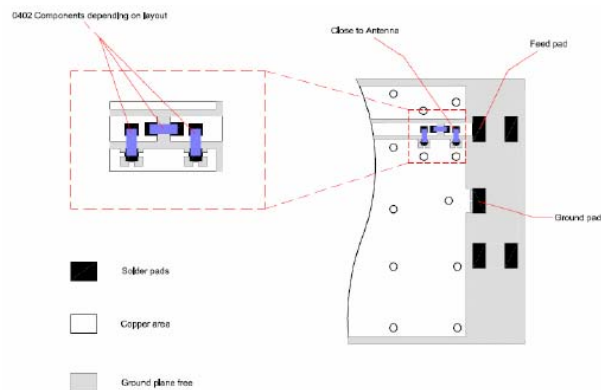
### 10-1 Transmission lines

- All transmission lines should be designed to have a characteristic impedance of 50  $\Omega$
- The length of the transmission lines should be kept to a minimum
- Any other parts of the RF system like transceivers, power amplifiers, etc, should also be designed to have an impedance of 50  $\Omega$

Once the material for the PCB has been chosen (PCB thickness and dielectric constant), a coplanar transmission line can easily be designed using any of the commercial software packages for transmission line design. For the chosen PCB thickness, copper thickness and substrate dielectric constant, the program will calculate the appropriate transmission line width and gaps on either side of the track so the characteristic impedance of the coplanar transmission line is 50  $\Omega$ .

### 10-2 Matching circuit

The antenna requires a matching circuit that must be optimized for each customer's product. The matching circuit will require up to three components and the following pad layout should be designed into the device so the correct circuit can be installed:



The antenna feed pad and the antenna ground pad are indicated in the drawing above. Additional pads are for mechanical attachment only and should not be grounded.

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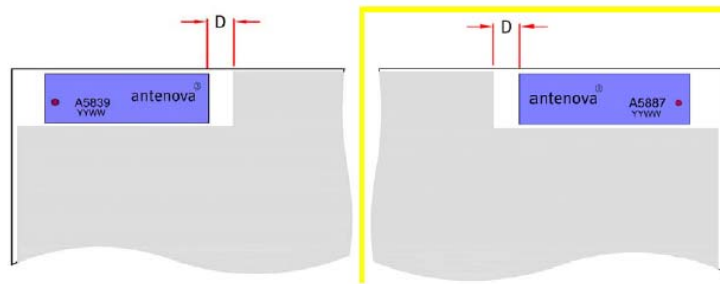
Rufa 2.4 GHz SMD Antenna  
Part No. 3030A5839 / 3030A5887

In addition to the matching circuit, a separate DC blocking capacitor will also be required between the radio and the antenna matching circuit.

**Note:** The component values for the matching circuit will vary depending on the size of the PCB and surrounding components. The impedance of the antenna should be measured before selecting suitable matching components. Antenova offers this service on request. Contact [info@antenova.com](mailto:info@antenova.com) for further information.

### 10-3 Antenna placement

Antenova strongly recommends placing the antenna near the edge of the board. Maximum antenna performance is achieved by placing the antenna towards one of the corners of the PCB and with the feed point of the antenna as close to same corner of the PCB as possible.



Additional ground and components near the antenna should be at a distance of at least 2 mm. Where possible the antenna should be clear of ground from both sides, although the antenna can work well with a minimum clearance of  $D \geq 2$  mm as shown in the drawing above.

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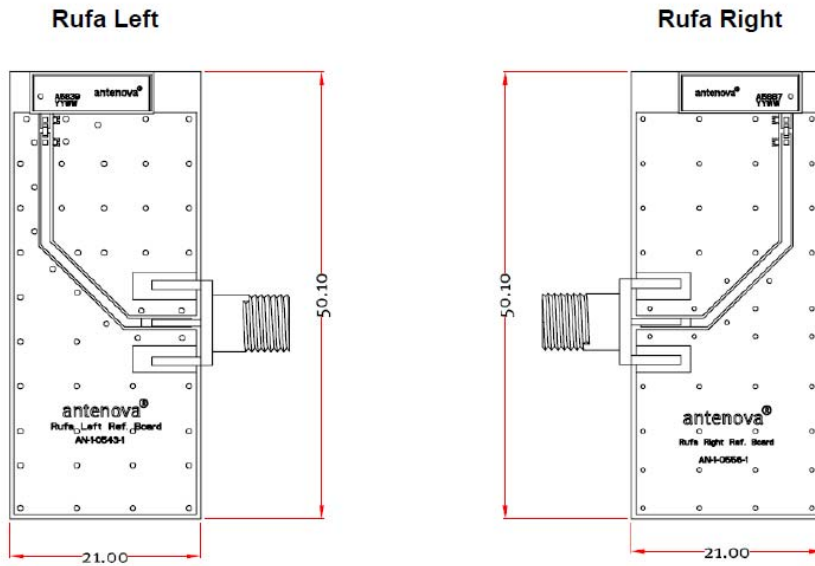
7  
Product Specification AE020157-M



Rufa 2.4 GHz SMD Antenna  
Part No. 3030A5839 / 3030A5887

#### 10-4 Reference boards

The reference boards have been designed for evaluation purposes of Rufa 2.4 GHz and they include a SMA female connector



Dimensions in mm

To order a reference board contact [info@antenova.com](mailto:info@antenova.com)

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Rufa 2.4 GHz SMD Antenna  
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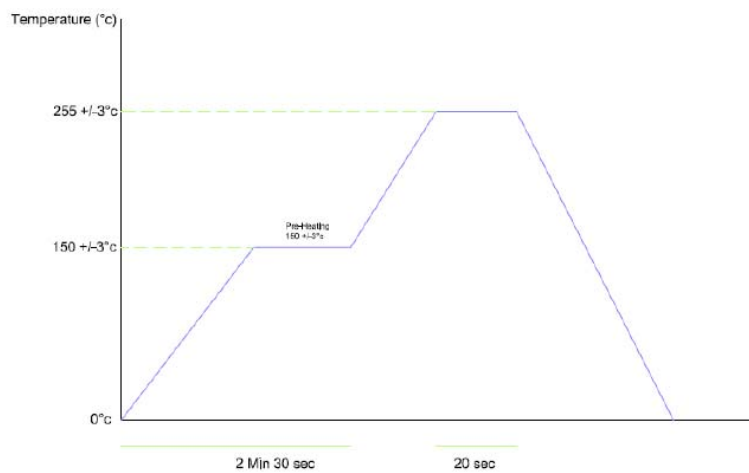
## 11 Soldering

This antenna is suitable for lead free soldering.

The reflow profile should be adjusted to suit the device, oven and solder paste, while observing the following conditions:

- The maximum temperature should not exceed 240 °C
- However for lead free soldering, a maximum temperature of 255 °C for no more than 20 seconds is permitted.
- The antenna should not be exposed to temperatures exceeding 120 °C more than 3 times during the soldering process.

Re-Flow Condition for PCB



## 12 Hazardous material regulation conformance

The antenna has been tested to conform to RoHS requirements. A certificate of conformance is available from Antenova's website.

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Rufa 2.4 GHz SMD Antenna  
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## 13 Packaging

### 13-1 Optimal storage conditions for packaged reels

Temperature	-10°C to 40°C
Humidity	Less than 75% RH
Shelf Life	18 Months
Storage place	Away from corrosive gas and direct sunlight
Packaging	Reels should be stored in unopened sealed manufacturer's plastic packaging.

Note: Storage of open reels of antennas is not recommended due to possible oxidization of pads on antennas. If short term storage is necessary, then it is highly recommended that the bag containing the antenna reel is re-sealed and stored in like storage conditions as in above table.

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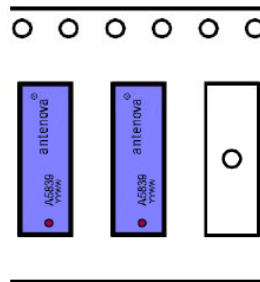
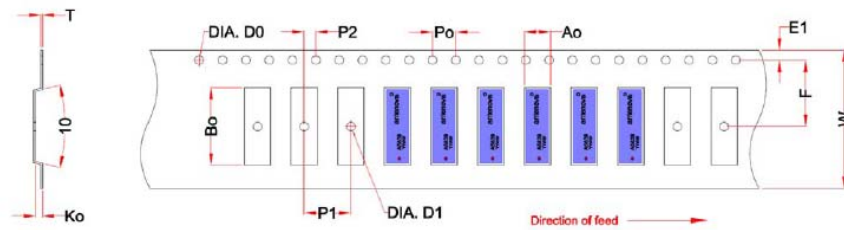
10

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Part No. 3030A5839 / 3030A5887

### 13-2 Tape characteristics

**Rufa Left**  
[Part Number: 3030A5839-01]



W	F	E1	P0	P1	P2	A0	B0	K0	T	D0	D1
24 ± 0.2	11.5 ± 0.1	1.75 ± 0.1	4 ± 0.1	8 ± 0.1	2 ± 0.1	4.3 ± 0.1	13.1 ± 0.1	1.4 ± 0.1	0.3 ± 0.05	Min 1.5	Min 1.5

Dimensions in mm

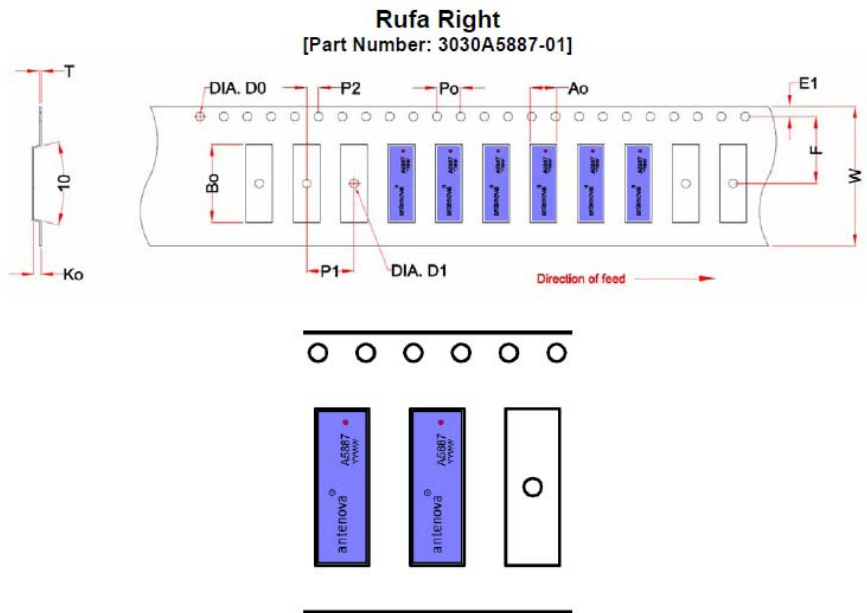
Quantity	Leading Space	Trailing Space
1000 pcs / reel	50 blank antenna holders	37 blank antenna holders

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W	F	E1	P0	P1	P2	A0	B0	K0	T	D0	D1
24 ± 0.2	11.5 ± 0.1	1.75 ± 0.1	4 ± 0.1	8 ± 0.1	2 ± 0.1	4.3 ± 0.1	13.1 ± 0.1	1.4 ± 0.1	0.3 ± 0.05	Min 1.5	Min 1.5

Dimensions in mm

Quantity	Leading Space	Trailing Space
1000 pcs / reel	50 blank antenna holders	37 blank antenna holders

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Rufa 2.4 GHz SMD Antenna  
Part No. 3030A5839 / 3030A5887

### 13-3 Reel dimensions



Width (W)	Reel Diameter (D)	Hub Diameter (H)	Shaft Diameter (C)
24 mm	180 mm (7")	60 mm (2")	13 mm

### 13-4 Box dimensions



Width (W)	Breadth (B)	Thickness (H)
203 mm	188 mm	40 mm

### 13-5 Bag properties

Reels are supplied in protective plastic packaging

### 13-6 Reel label information

#### Rufa Left



#### Rufa Right



Dimensions in mm

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Rufa 2.4 GHz SMD Antenna  
Part No. 3030A5839 / 3030A5887



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Certificate No: 4598

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## D.2 Declaration of difference between ETRX351 and ETRX 357 Series Modules

The following is an extract from a client email detailing the difference between the ETRX351 and ETRX357 series modules.

-----Original Message-----

From: Marius Munder [<mailto:marius.munder@telegesis.com>]

Sent: 16 March 2010 17:13

To: Geoff Cruickshank

Subject: Re: FW: RE: Other documents Telegesis

Hi Geoff,

"Both chips are identical with the one exception that the EM351 has 128kB of flash and the EM357 has 192kB of flash"

Would this be sufficient?

Best Regards,  
Marius



**Appendix E:****Calculation of the duty cycle correction factor**

The duty cycle correction factor to be applied to measurements made using an average detector is calculated in the Spreadsheet "**Duty\_Cycle\_for\_TX\_calc.xls**" presented as a separate exhibit to this report.

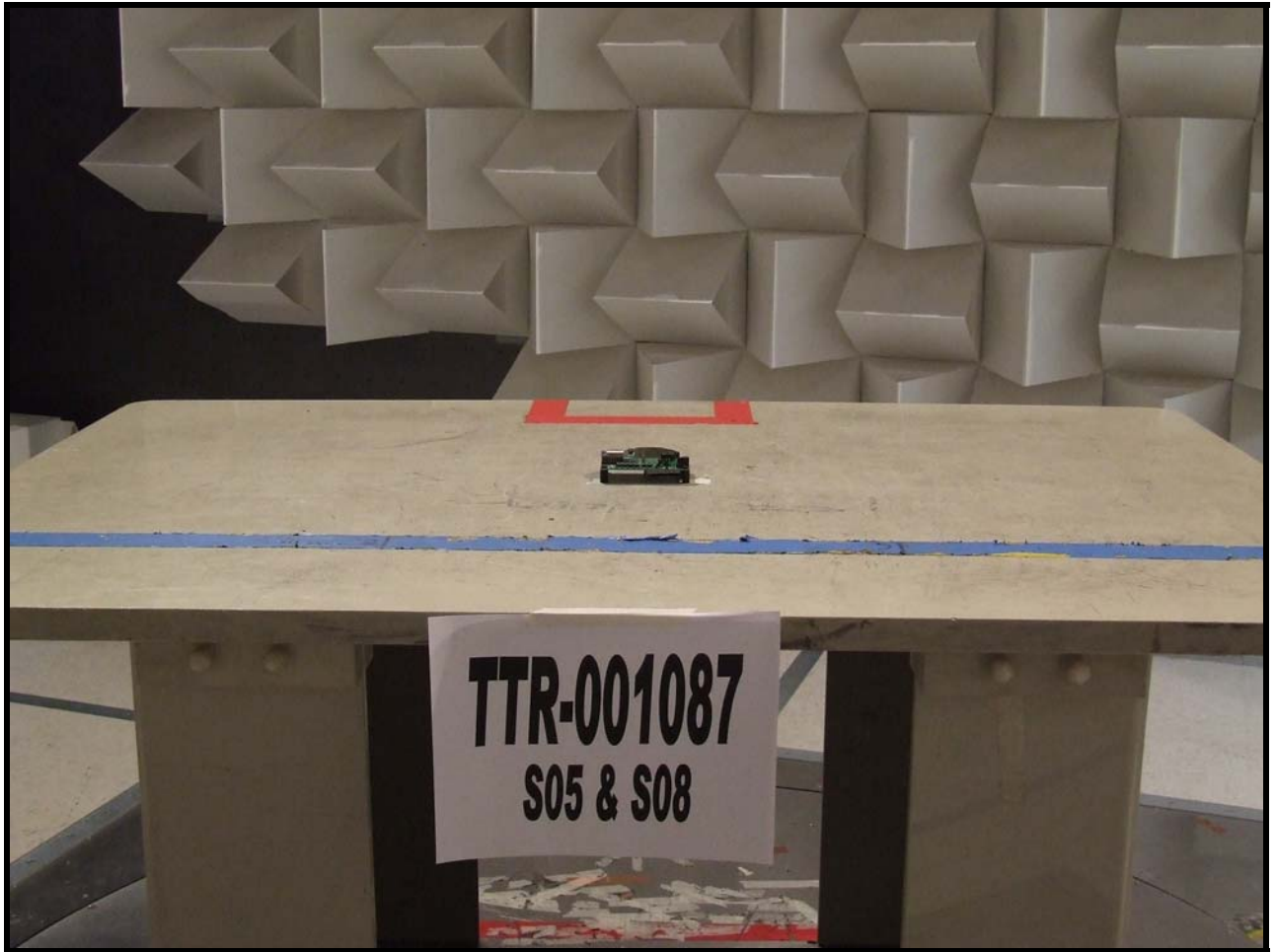
The calculated Correction factor (dB) =  $20 \times (\text{Log}_{10} 0.27) = -11.4\text{dB}$

## **Appendix F:**

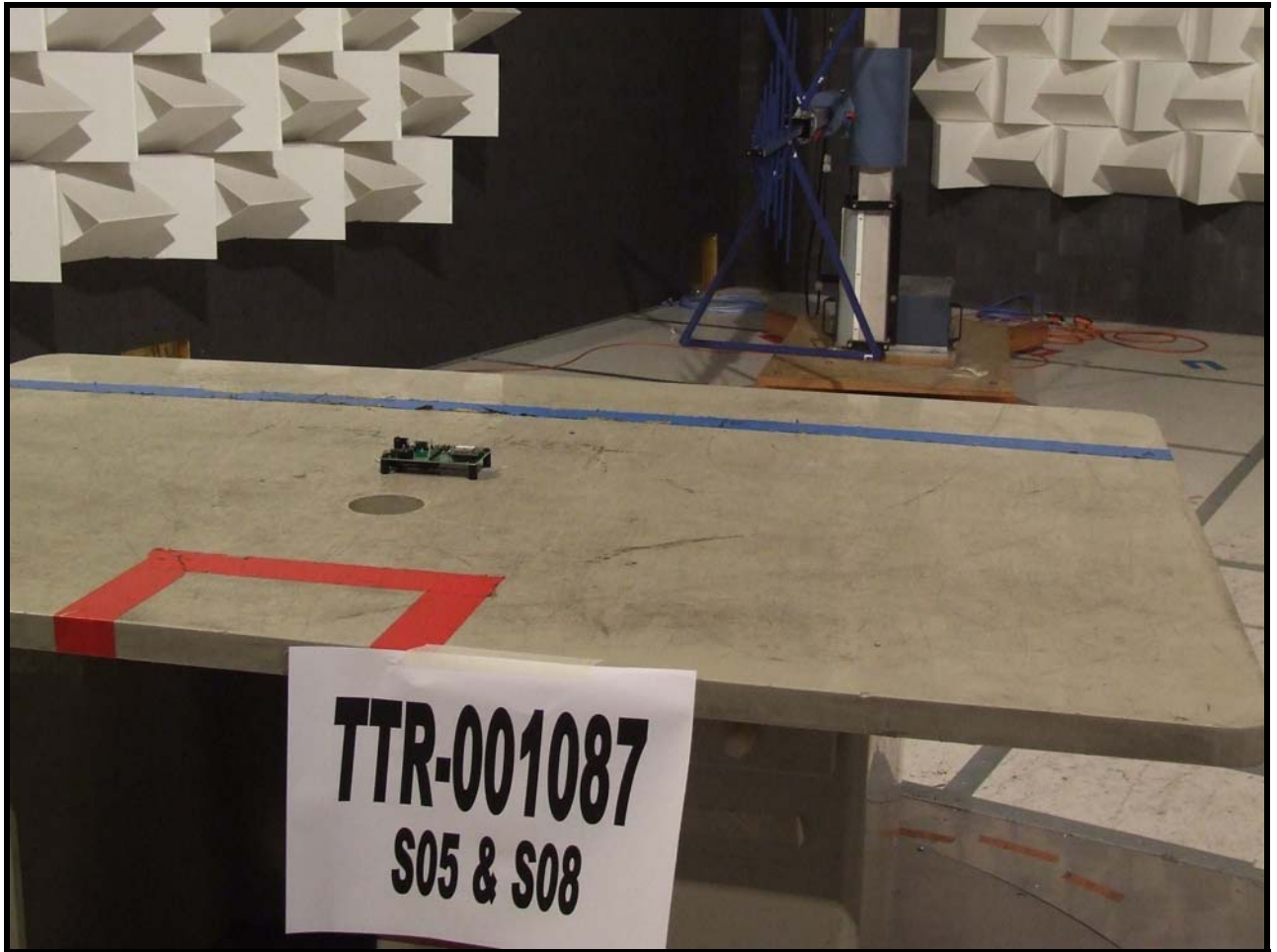
## **Photographs and Figures**

The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: front view.
2. Radiated electric field emissions arrangement: rear view.
3. Power line conducted emissions



Photograph 1



Photograph 2



Photograph 3

**Appendix G:****MPE Calculation**

OET Bulletin No. 65, Supplement C 01-01

**47 CFR §§1.1307 and 2.1091**

2.1091 Radio frequency radiation exposure evaluation: mobile devices.

For purposes of these requirements mobile devices are defined by the FCC as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimetres is normally maintained between radiating structures and the body of the user or nearby persons. These devices are normally evaluated for exposure potential with relation to the MPE limits. As the 20cm separation specified under FCC rules may not be achievable under normal operation of the EUT, an RF exposure calculation is needed to show the minimum distance required to be less than 1mW/cm<sup>2</sup> power density limit, as required under FCC rules.

**Prediction of MPE limit at a given distance**

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

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

where:

S = power density

R = distance to the centre of radiation of the antenna

EIRP = EUT Maximum power

Note:

The EIRP measurement was performed using the peak conducted power measurement in conjunction with the maximum declared antenna gain.

**Result**

Prediction Frequency (MHz)	Maximum EIRP (mW)	Power density limit (S) (mW/cm <sup>2</sup> )	Distance (R) cm required to be less than 1mW/cm <sup>2</sup> (cm)
2405	19.9	1	1.3

