A RADIO TEST REPORT

FOR

EMBEDDED TECHNOLOGY SOLUTIONS

ON

SILENT HEARDSMAN COLLAR

DOCUMENT NO. TRA-013983-00-47-00A

HULL
Unit E, South Orbital Trading Park, Hedon Road, Hull, HU9 1NJ, UK.
T +44 (0)1482 801801 **F** +44 (0)1482 801806 **E** test@tracglobal.com
www.tracglobal.com

UKAS TESTING
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TRaC Wireless Test Report	**:** TRA-013983-00-47-00A
Applicant	**:** Embedded Technology Solutions
Apparatus	**:** Silent Heardsman Collar
Specification(s)	**:** CFR47 Part 15.247 & RSS-210 Annex 8
Purpose of Test	**: Certification**
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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.

Test performed at:

TRaC Global [ ]
Unit E
South Orbital Trading Park
Hedon Road
Hull, HU9 1NJ.
United Kingdom.

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

TRaC Global [X]
Unit 1
Pendle Place
Skelmersdale
West Lancashire, WN8 9PN
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: A Tosif, D Winstanley

Report author: D Winstanley

1.2 Tests Requested By

This testing in this report was requested by :

Ladywell Business Centre
94 Duke Street
Glasgow
G4 0UW
Scotland

1.3 Manufacturer

As Above

1.4 Apparatus Assessed

The following apparatus was assessed between 4th and 7th November 2013

Silent Herdsman Collar

The above equipment was a DSSS transmitter operating in the 2400 MHz to 2483.5 MHz band. The equipment operates on 4 frequencies separated by 5MHz. These frequencies are 2455 MHz, 2460MHz, 2465 MHz and 2470 MHz.

1.5 Test Result Summary

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

The statements relating to compliance with the standards below apply ONLY as qualified in the notes and deviations stated in sections 1.6 to 1.7 of this test report.

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

Test Type	Regulation		Measurement standard	Result
Radiated spurious emissions (Restricted bands)	RSS-210 Issue 8 December 2010 Annex 8, A8.5	Title 47 of the CFR: Part 15 Subpart C; 15.247	ANSI C63.10:2009	Pass
Conducted spurious emissions (Non-restricted bands)	RSS-210 Issue 8 December 2010 Annex 8.A4(4)	Title 47 of the CFR: Part 15 Subpart C; 15.247	ANSI C63.10:2009	N/A
AC Power conducted emissions	RSS-GEN Issue 3 December 2010 Annex 7, 7.2.4	Title 47 of the CFR: Part 15 Subpart C; 15.207	ANSI C63.10:2009	N/A
Occupied Bandwidth	RSS-210 Issue 8 December 2010 Annex 8.A8.2a	Title 47 of the CFR : Part 15 Subpart C; 15.247(a)(2)	ANSI C63.10:2009	Pass
Conducted Carrier Power	RSS-210 Issue 8 December 2010 Annex 8.A4(4).	Title 47 of the CFR : Part 15 Subpart C; 15.247(b)	ANSI C63.10:2009	N/A
Power Spectral Density	RSS-210 Issue 8 December 2010 Annex 8.A8.2b	Title 47 of the CFR : Part 15 Subpart C; 15.247(d)	ANSI C63.10:2009	Pass
Unintentional Radiated Spurious Emissions	RSS-GEN Issue 3 December 2010 7.2.2(c)	Title 47 of the CFR: Part 15 Subpart B; 15.109	ANSI C63.10:2009	Pass
RF Safety	RSS-102	Title 47 of the CFR : Part 15 Subpart C; 15.247(b)(5)	-	Pass
Digital Modulation	-	Title 47 of the CFR: Part 15 Subpart C; 15.403	-	Pass

The Silent Heardsman Collar will only be powered by batteries

Abbreviations used in the above table:

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

Mod : Modification
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

For the test data recorded in accordance with note (iii) of Section 2.1 the following measurement uncertainty was calculated:

Radio Testing – General Uncertainty Schedule

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

[1] Adjacent Channel Power

Uncertainty in test result = **1.86dB**

[2] Carrier Power

Uncertainty in test result (Power Meter) = **1.08dB**
Uncertainty in test result (Spectrum Analyser) = **2.48dB**

[3] Effective Radiated Power

Uncertainty in test result = **4.71dB**

[4] Spurious Emissions

Uncertainty in test result = **4.75dB**

[5] Maximum frequency error

Uncertainty in test result (Power Meter) = **0.113ppm**
Uncertainty in test result (Spectrum Analyser) = **0.265ppm**

[6] Radiated Emissions, field strength OATS 14kHz-18GHz Electric Field

Uncertainty in test result (14kHz – 30MHz) = **4.8dB**,
Uncertainty in test result (30MHz – 1GHz) = **4.6dB**,
Uncertainty in test result (1GHz – 18GHz) = **4.7dB**

[7] Frequency deviation

Uncertainty in test result = **3.2%**

[8] Magnetic Field Emissions

Uncertainty in test result = **2.3dB**

[9] Conducted Spurious

Uncertainty in test result – Up to 8.1GHz = **3.31dB**
Uncertainty in test result – 8.1GHz – 15.3GHz = **4.43dB**
Uncertainty in test result – 15.3GHz – 21GHz = **5.34dB**
Uncertainty in test result – Up to 26GHz = **3.14dB**

[10] Channel Bandwidth

Uncertainty in test result = **15.5%**

[11] Amplitude and Time Measurement – Oscilloscope

Uncertainty in overall test level = **2.1dB**,
Uncertainty in time measurement = **0.59%,**
Uncertainty in Amplitude measurement = **0.82%**

[12] Power Line Conduction

Uncertainty in test result = **3.4dB**

[13] Spectrum Mask Measurements

Uncertainty in test result = **2.59% (frequency)**
Uncertainty in test result = **1.32dB (amplitude)**

[14] Adjacent Sub Band Selectivity

Uncertainty in test result = **1.24dB**

[15] Receiver Blocking – Listen Mode, Radiated

Uncertainty in test result = **3.42dB**

[16] Receiver Blocking – Talk Mode, Radiated

Uncertainty in test result = **3.36dB**

[17] Receiver Blocking – Talk Mode, Conducted

Uncertainty in test result = **1.24dB**

[18] Receiver Threshold

Uncertainty in test result = **3.23dB**

[19] Transmission Time Measurement

Uncertainty in test result = **7.98%**

Section 3: Modifications

3.1 Modifications Performed During Assessment

No modifications were performed during the assessment

Appendix A: Formal Emission Test Results

Abbreviations used in the tables in this appendix:

Spec	: Specification
Mod	: Modification
EUT	: Equipment Under Test
SE	: Support Equipment
L	: Live Power Line
N	: Neutral Power Line
E	: Earth Power Line
Pk	: Peak Detector
QP	: Quasi-Peak Detector
Av	: Average Detector
CDN	: Coupling & decoupling network

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

A1 6 dB Bandwidth

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

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

Test Details:	
Regulation	Part15 Subpart (c) 15.247(b)(3), RSS-210 Annex 8.A8.2b
Measurement standard	ANSI C63.10, KDB Document: 558074
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
Temperature	21˚C
EUT set up	Refer to Appendix C

Channel Frequency (MHz)	F_{lower} (MHz)	F_{Higher} (MHz)	Measured 20 dB Bandwidth (kHz)	Limit	Result
2455.0	2453.87981	2455.71955	1839.744	>500 kHz	Pass
2460.0	2458.99199	2460.71154	1719.551	>500 kHz	Pass
2465.0	2463.87500	2465.70673	1831.731	>500 kHz	Pass
2470.0	2468.87500	2470.70673	1831.731	>500 kHz	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 all operating frequencies in turn.

Test Details:	
Regulation	Part15 Subpart (c) 15.247(b)(3)
Measurement standard	ANSI C63.10, KDB Document: 558074
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	21˚C
Photographs	Appendix F

Channel Frequency (MHz)	Radiated Peak Carrier Power (dBuV/m)	EIRP (W)	Limit (W)	Result
2455.0	100.29	3.186 mW	1	Pass
2460.0	100.40	3.268 mW	1	Pass
2465.0	100.41	3.275 mW	1	Pass
2470.0	100.06	3.022 mW	1	Pass

EIRP calculated from Field Strength as Per ANSI C63.10

Notes:

Radiated Measurement

Measuring distances 3 meters.
EUT 0.8 metre above ground plane.
Emissions maximised by rotation of EUT, on an automatic turntable.
Raising and lowering the receiver antenna between 1m & 4m >30MHz
Horizontal and vertical polarisations, of the receive antenna.
EUT orientation in three orthagonal planes.
Maximum results recorded.

558074 D01 DTS Meas Guidance v03r01
Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

A3 Transmitter Power Spectral Density

Transmitter Power Spectral Density was verified with the EUT transmitting on all operating frequencies in turn.

Test Details:	
Regulation	Part15 Subpart (c) 15.247(b)(3), RSS-210 Annex 8.A8.2b
Measurement standard	ANSI C63.10, KDB Document: 558074
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	21˚C
Photographs	Appendix F

Channel Frequency (MHz)	Radiated Peak Power Spectral Density (dBuV/m)	PSD (dBm)	Limit (dBm)	Result
2455.0	99.92	4.66	1	Pass
2460.0	100.01	4.75	1	Pass
2465.0	99.96	4.70	1	Pass
2470.0	99.60	4.34	1	Pass

PSD calculated from Field Strength as Per ANSI C63.10

Notes:

Radiated Measurement

Measuring distances 3 meters.
EUT 0.8 metre above ground plane.
Emissions maximised by rotation of EUT, on an automatic turntable.
Raising and lowering the receiver antenna between 1m & 4m >30MHz
Horizontal and vertical polarisations, of the receive antenna.
EUT orientation in three orthagonal planes.
Maximum results recorded.

558074 D01 DTS Meas Guidance v03r01
Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

A4 Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The maximum permitted field strength is listed in Section 15.209 and per RSS – 210 Annex 8, A8.5. The EUT was set to transmit.

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: 2455.0 MHz	
Regulation	Part 15 Subpart (c) Clause 15.247(d), RSS – 210 Annex 8, A8.5
Measurement standard	ANSI C63.10, KDB Document: 558074
Frequency range	30MHz – 25GHz
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	21˚C
Photographs (Appendix F)	

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

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	2408.81_{Pk}	58.99	3.2	28.2	36.0	54.39	-	524.20	5000
2.	2408.81_{AV}	48.72	3.2	28.2	36.0	44.12	-	160.69	500
3.	2501.20_{Pk}	57.44	3.1	28.5	36.0	53.04	-	448.75	5000
4.	2501.20_{AV}	48.19	3.1	28.5	36.0	43.79	-	154.70	500
5.	4908.59_{Pk}	50.70	4.0	33.1	35.6	52.20	-	407.38	5000
6.	4908.59_{AV}	39.13	4.0	33.1	35.6	40.63	-	107.52	500
7.	9821.16_{Pk}	51.79	5.4	38.1	36.8	58.49	-	840.43	5000
8.	9821.16_{AV}	40.48	5.4	38.1	36.8	47.18	-	228.56	500

Radiated Electric Field Emissions continued:

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

Test Details: 2460.0 MHz	
Regulation	Part 15 Subpart (c) Clause 15.247(d), RSS – 210 Annex 8, A8.5
Measurement standard	ANSI C63.10, KDB Document: 558074
Frequency range	30MHz to 25 GHz
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	21˚C
Photographs (Appendix F)	

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

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	2403.38_{Pk}	58.42	3.2	28.2	36.0	53.82	-	490.91	5000
2.	2403.38_{AV}	47.69	3.2	28.2	36.0	43.09	-	142.72	500
3.	2515.41_{Pk}	56.56	3.1	28.5	36.0	52.16	-	405.51	5000
4.	2515.41_{AV}	46.49	3.1	28.5	36.0	42.09	-	127.20	500
5.	4919.59_{Pk}	51.03	3.9	33.1	35.7	52.33	-	413.52	5000
6.	4919.59_{AV}	43.95	3.9	33.1	35.7	45.25	-	183.02	500
7.	9841.16_{Pk}	51.62	5.4	38.2	36.8	58.42	-	833.68	5000
8.	9841.16_{AV}	40.24	5.4	38.2	36.8	47.04	-	224.91	500

Radiated Electric Field Emissions continued:

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

Test Details: 2465.0 MHz	
Regulation	Part 15 Subpart (c) Clause 15.247(d), RSS – 210 Annex 8, A8.5
Measurement standard	ANSI C63.10, KDB Document: 558074
Frequency range	30MHz to 25 GHz
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	21˚C
Photographs (Appendix F)	

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

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	2398.44_{Pk}	57.49	3.1	28.2	36.0	52.79	-	436.01	5000
2.	2398.44_{AV}	47.57	3.1	28.2	36.0	42.87	-	139.16	500
3.	2531.21_{Pk}	55.32	3.3	28.6	36.0	51.22	-	363.92	5000
4.	2531.21_{AV}	45.58	3.3	28.6	36.0	41.48	-	118.58	500
5.	4929.58_{Pk}	51.56	3.9	33.2	35.7	52.96	-	444.63	5000
6.	4929.58_{AV}	44.97	3.9	33.2	35.7	46.37	-	208.21	500
7.	9861.17_{Pk}	51.49	5.4	38.2	36.8	58.29	-	821.30	5000
8.	9861.17_{AV}	40.11	5.4	38.2	36.8	46.91	-	221.56	500

Radiated Electric Field Emissions continued:

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

Test Details: 2470.0 MHz	
Regulation	Part 15 Subpart (c) Clause 15.247(d), RSS – 210 Annex 8, A8.5
Measurement standard	ANSI C63.10, KDB Document: 558074
Frequency range	30MHz to 25 GHz
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	21˚C
Photographs (Appendix F)	

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

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	2398.44_{Pk}	49.79	3.1	28.2	36.0	45.09	-	179.68	5000
2.	2398.44_{AV}	40.24	3.1	28.2	36.0	35.54	-	59.84	500
3.	2531.21_{Pk}	55.43	3.3	28.6	36.0	51.33	-	368.55	5000
4.	2531.21_{AV}	47.09	3.3	28.6	36.0	42.99	-	141.09	500
5.	4929.58_{Pk}	51.49	3.9	33.2	35.7	52.89	-	441.06	5000
6.	4929.58_{AV}	44.83	3.9	33.2	35.7	46.23	-	204.88	500

Notes:

1 Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10: section 4.5, Table 1
2 In accordance with 15.35(b), above 1 GHz, emissions measured using a peak detector shall not exceed a level 20 dB above the average limit.
3 Measurements at 2400 & 2483.5 MHz were made to ensure band edge compliance.
4 Testing was performed with the EUT orientated in three orthogonal planes and the maximum emissions level recorded. In addition, the EUT antenna was varied within its range of motion in order to maximise emissions.
5 For Frequencies below 1 GHz, RBW= 100 kHz, testing was performed with CISPR16 compliant test receiver with QP detector. Above 1 GHz tests were performed using a spectrum analyser using the following settings:

Peak RBW=VBW= 1MHz
Average RBW=VBW= 1MHz

These settings as per ANSI C63.10

The upper and lower frequency of the measurement range was decided according to 47 CFR Part 15 Clause 15.33(a) and 15.33(a)(1) and RSS-Gen 4.3.

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

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

Notes:

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

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

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

(b) The levels may have been rounded for display purposes.

(c) The following table summarises the effect of the EUT operating mode, internal configuration and arrangement of cables / samples on the measured emission levels :

	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels	✓	✓	✓	✓
Effect of EUT internal configuration on emission levels	✓	✓	✓	✓
Effect of Position of EUT cables & samples on emission levels	✓	✓	✓	✓

(i) Parameter defined by standard and / or single possible, refer to Appendix D
(ii) Parameter defined by client and / or single possible, refer to Appendix D
(iii) Parameter had a negligible effect on emission levels, refer to Appendix D
(iv) Worst case determined by initial measurement, refer to Appendix D

A5 Antenna Gain

Not Applicable Radiated measurements only were performed.

A6 Unintentional Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The maximum permitted field strength is listed in Section 15.109 and in RSS- GEN Section 7.2.3. The EUT was set to receive mode only on its lowest, centre and highest carrier frequency in turn.

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

3m open area test site : [ ] 3m alternative test site : [X]

Test Details: 2455.0 MHz	
Regulation	Part 15 Subpart (b) Clause 15.109, RSS – GEN Section 7.2.3
Measurement standard	ANSI C63.10
Frequency range	30MHz to 25 GHz
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	21˚C
Photographs (Appendix F)	

The worst case radiated emission measurements for spurious emissions:

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	4909.59_{PK}	51.65	3.9	33.1	35.6	53.05	-	449.26	5000
2.	4909.59_{AV}	43.15	3.9	33.1	35.6	44.55	-	168.85	500

Unintentional Radiated Electric Field Emissions continued:

Test Details: 2460.0 MHz	
Regulation	Part 15 Subpart (b) Clause 15.109, RSS – GEN Section 7.2.3
Measurement standard	ANSI C63.10
Frequency range	30MHz to 25 GHz
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	21˚C
Photographs (Appendix F)	

The worst case radiated emission measurements for spurious emissions:

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	4919.59_{PK}	51.35	3.9	33.1	35.7	52.65	-	429.04	5000
2.	4919.59_{AV}	45.03	3.9	33.1	35.7	46.33	-	207.25	500

Unintentional Radiated Electric Field Emissions continued:

Test Details: 2465.0 MHz	
Regulation	Part 15 Subpart (b) Clause 15.109, RSS – GEN Section 7.2.3
Measurement standard	ANSI C63.10
Frequency range	30MHz to 25 GHz
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	21˚C
Photographs (Appendix F)	

The worst case radiated emission measurements for spurious emissions:

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	4929.59_{PK}	51.48	3.9	33.2	35.7	52.88	-	440.55	5000
2.	4929.59_{AV}	45.22	3.9	33.2	35.7	46.62	-	214.29	500

Unintentional Radiated Electric Field Emissions continued:

Test Details: 2470.0 MHz	
Regulation	Part 15 Subpart (b) Clause 15.109, RSS – GEN Section 7.2.3
Measurement standard	ANSI C63.10
Frequency range	30MHz to 25 GHz
EUT sample number	S02
Modification state	0
SE in test environment	None
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	21˚C
Photographs (Appendix F)	

The worst case radiated emission measurements for spurious emissions:

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	4939.59_{PK}	51.14	3.9	33.2	35.7	52.54	-	423.64	5000
2.	4939.59_{AV}	44.93	3.9	33.2	35.7	46.33	-	207.25	500

Notes:

1 Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10: section 4.5, Table 1 For emissions below 30MHz the cable losses are assumed to be negligible.
2 In accordance with 15.35(b), above 1 GHz, emissions measured using a peak detector shall not exceed a level 20 dB above the average limit.
3 Testing was performed with the EUT orientated in three orthogonal planes and the maximum emissions level recorded. In addition, the EUT antenna was varied within its range of motion in order to maximise emissions.
4 For Frequencies below 1 GHz, RBW = 120 kHz, testing was performed with CISPR16 compliant test receiver with QP detector. Above 1 GHz tests were performed using a spectrum analyser using the following settings:

Peak	RBW= 1MHz, VBW ≥ RBW
Average	RBW= 1MHz, VBW ≥ RBW

The upper and lower frequency of the measurement range was decided according to 47 CFR Part 15 Clause 15.33(a) and 15.33(a)(1) and RSS-Gen 4.3.

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

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

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

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

(b) The levels may have been rounded for display purposes.

(c) The following table summarises the effect of the EUT operating mode, internal configuration and arrangement of cables / samples on the measured emission levels :

	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels	✓			
Effect of EUT internal configuration on emission levels	✓			
Effect of Position of EUT cables & samples on emission levels			✓	

(i) Parameter defined by standard and / or single possible, refer to Appendix D
(ii) Parameter defined by client and / or single possible, refer to Appendix D
(iii) Parameter had a negligible effect on emission levels, refer to Appendix D
(iv) Worst case determined by initial measurement, refer to Appendix D

Appendix B: Supporting Graphical Data

This appendix contains graphical data obtained during testing.

Notes:

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

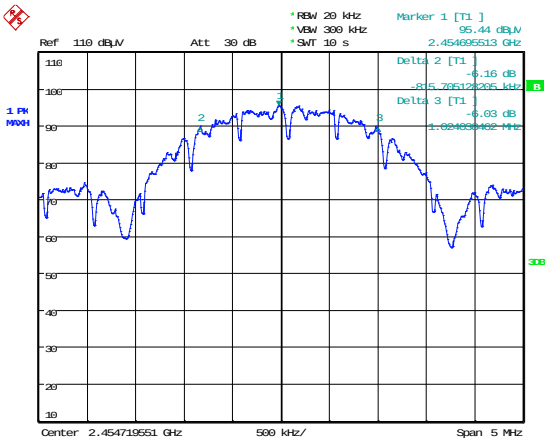
(b) The time and date on the plots do not necessarily equate to the time of the test.

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

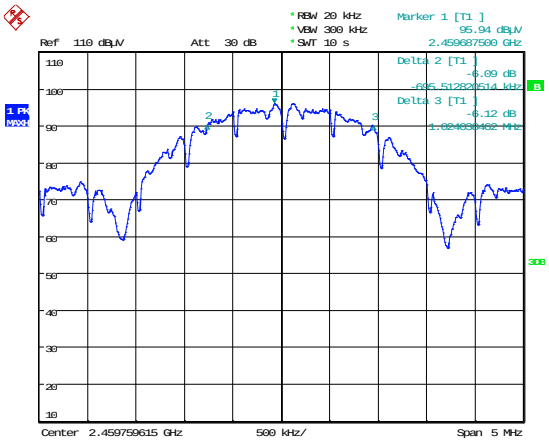
(d) Appendix C details the numbering system used to identify the sample and its modification state.

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

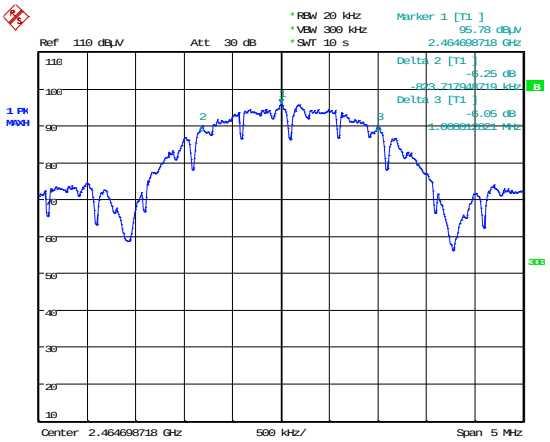
6dB Bandwidth



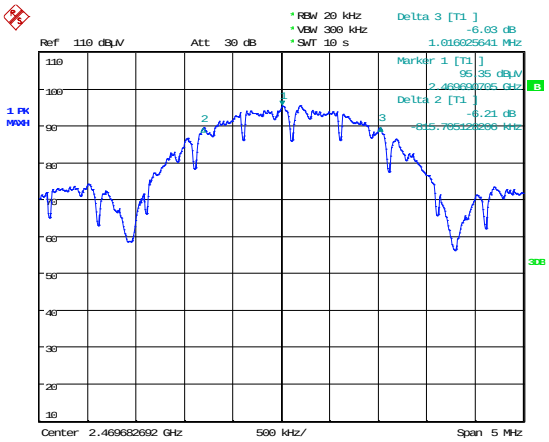
2455 MHz



2460 MHz

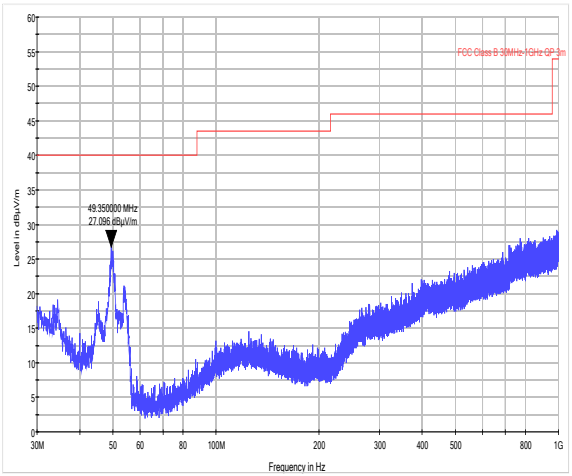


2465 MHz

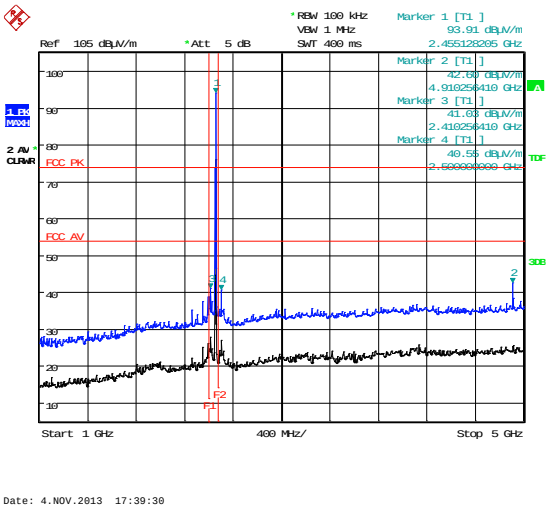


2470 MHz

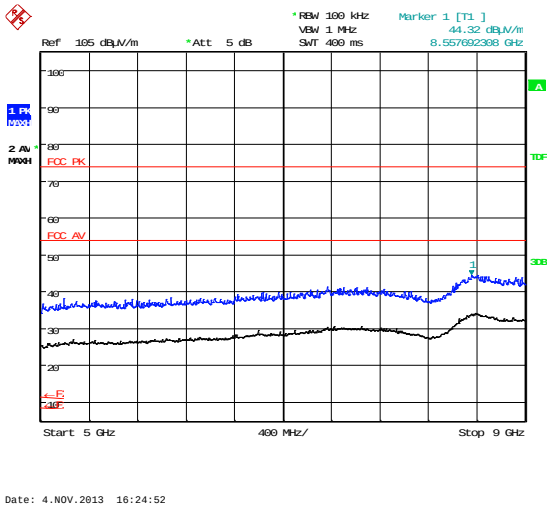
Radiated Spurious emissions– 2455.0MHz



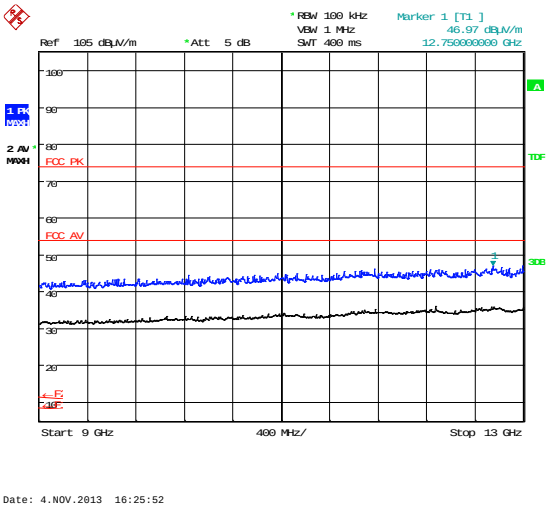
30 MHz to 1 GHz



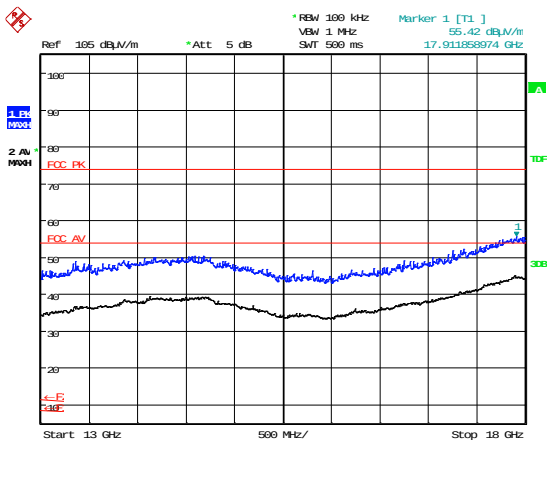
1 GHz to 5 GHz



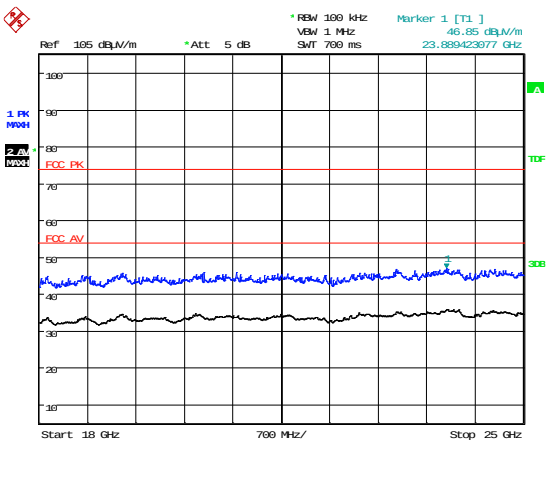
5 GHz to 9 GHz



9 GHz to 13 GHz

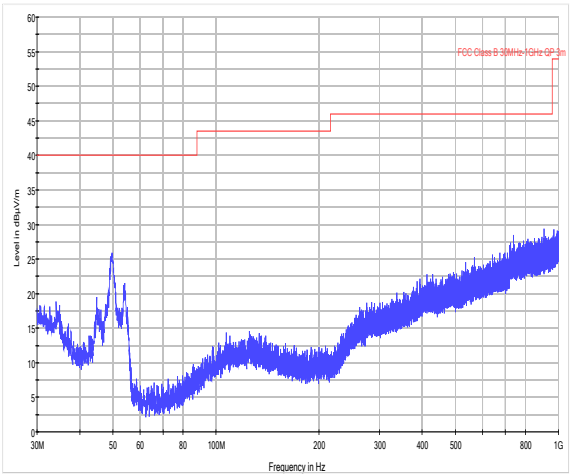


13 GHz to 18GHz

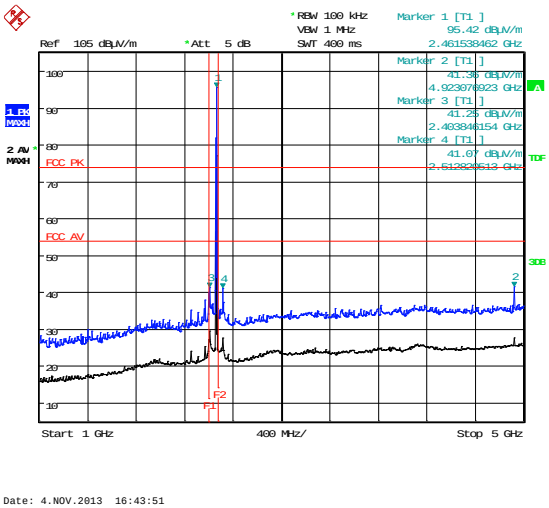


18 GHz to 25 GHz

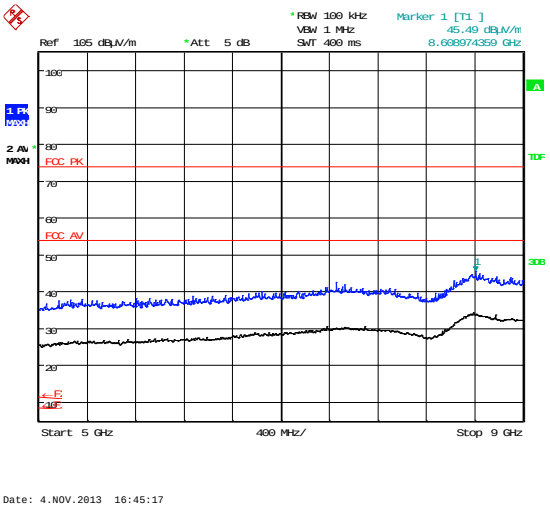
Radiated Spurious emissions– 2460.0MHz



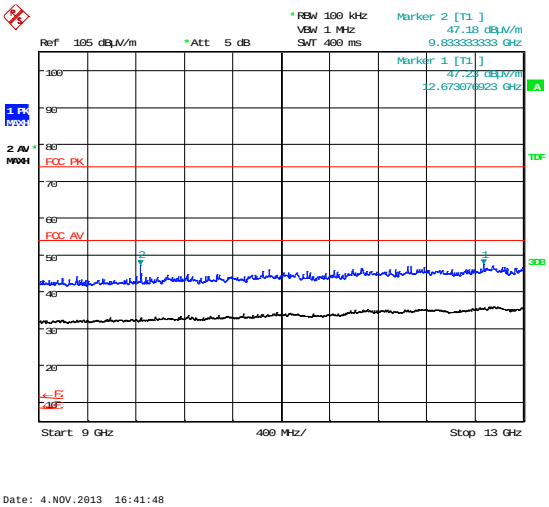
30 MHz to 1 GHz



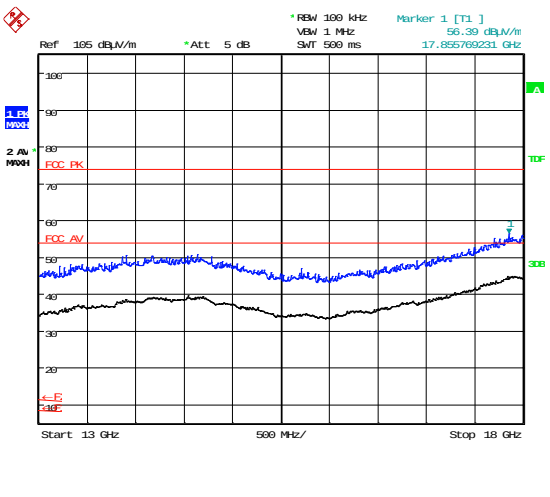
1 GHz to 5 GHz



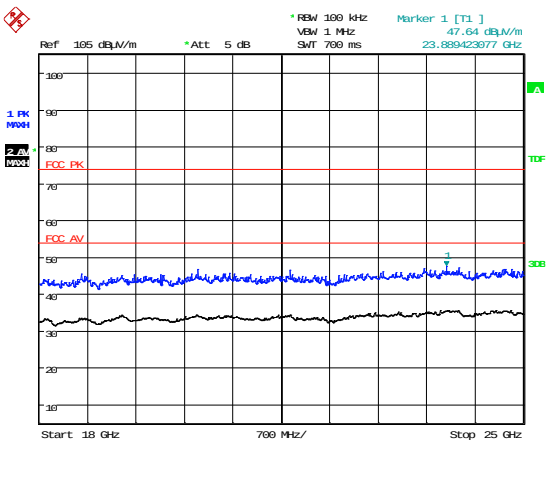
5 GHz to 9 GHz



9 GHz to 13 GHz

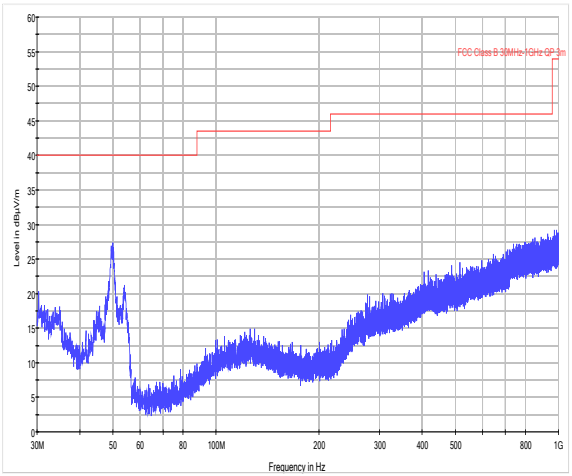


13 GHz to 18GHz

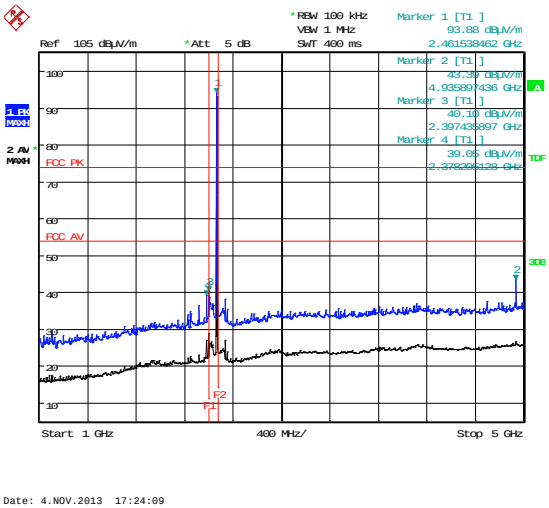


18 GHz to 25 GHz

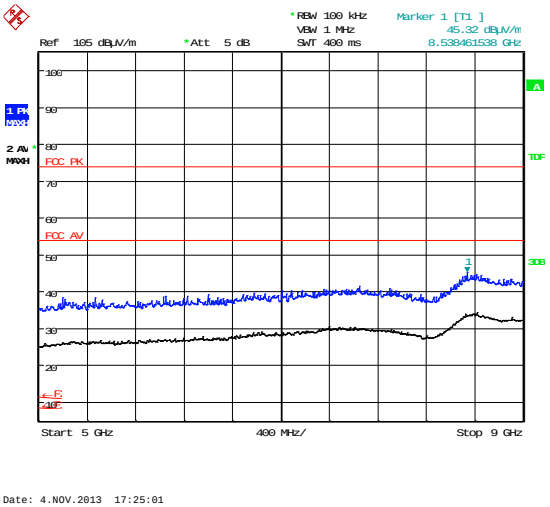
Radiated Spurious emissions– 2465.0MHz



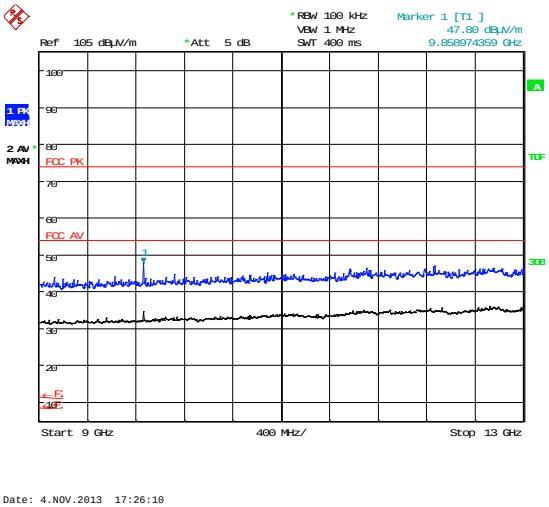
30 MHz to 1 GHz



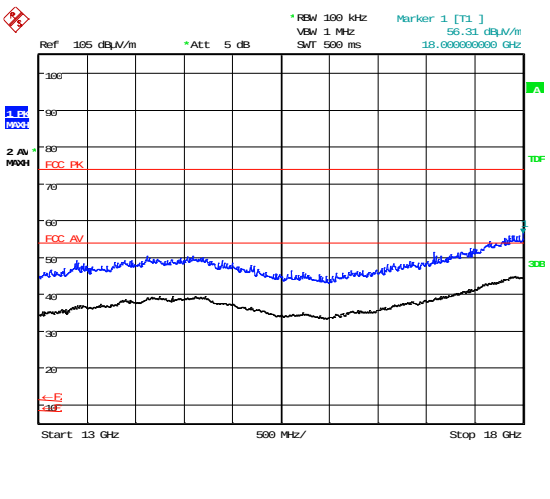
1 GHz to 5 GHz



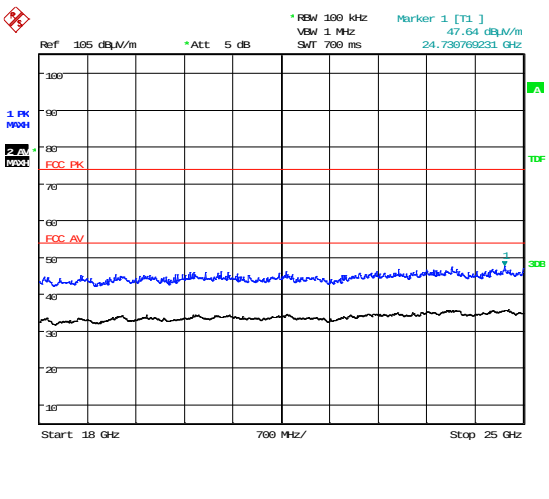
5 GHz to 9 GHz



9 GHz to 13 GHz

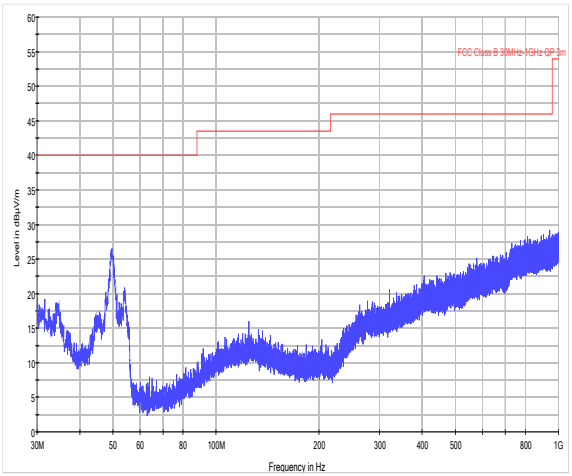


13 GHz to 18GHz

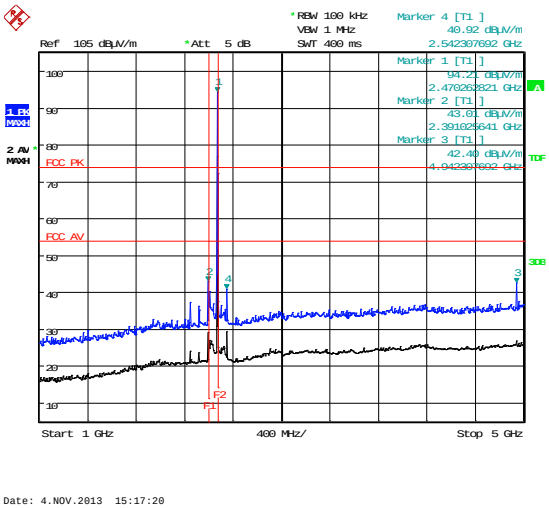


18 GHz to 25 GHz

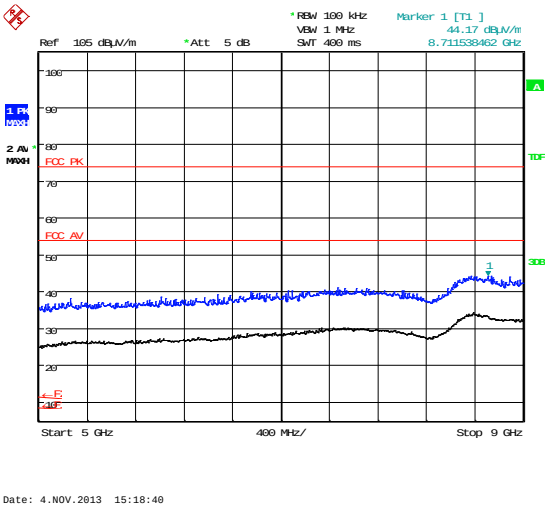
Radiated Spurious emissions– 2470.0MHz



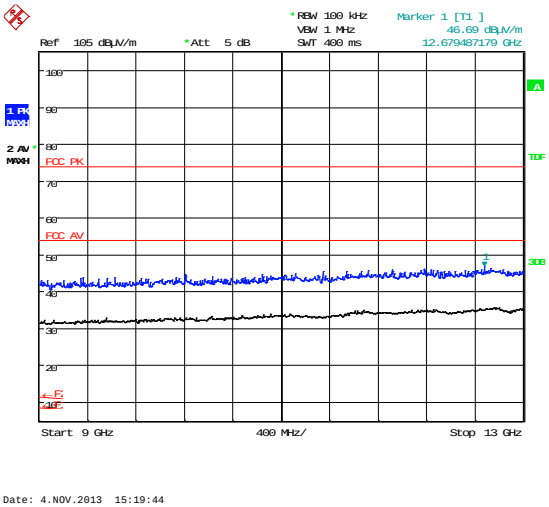
30 MHz to 1 GHz



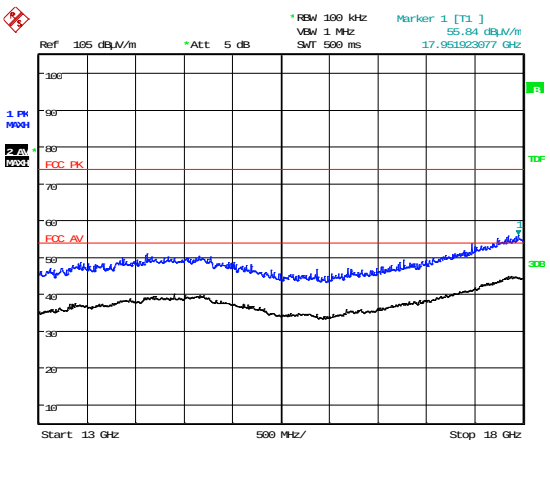
1 GHz to 5 GHz



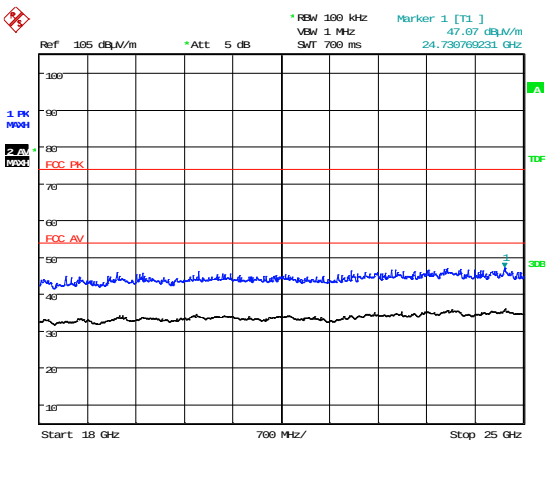
5 GHz to 9 GHz



9 GHz to 13 GHz

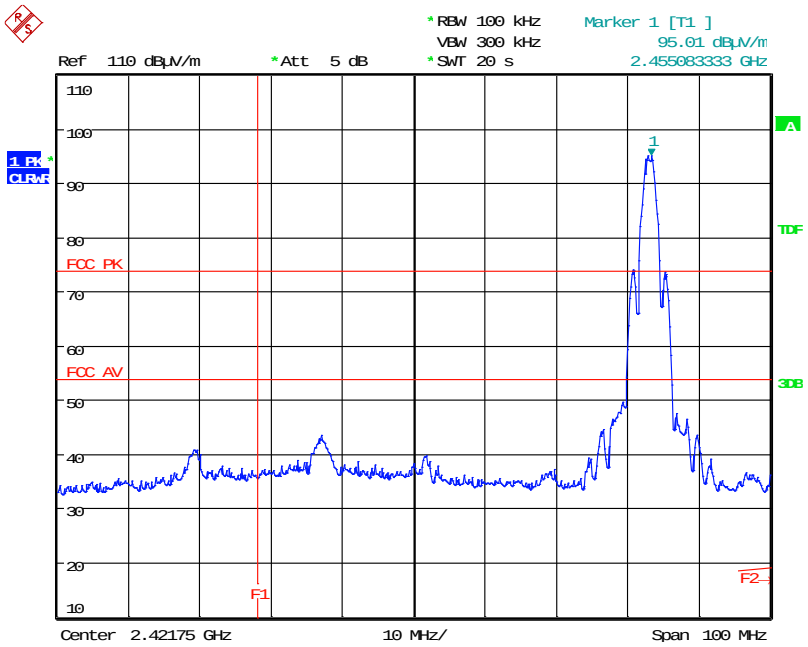


13 GHz to 18GHz



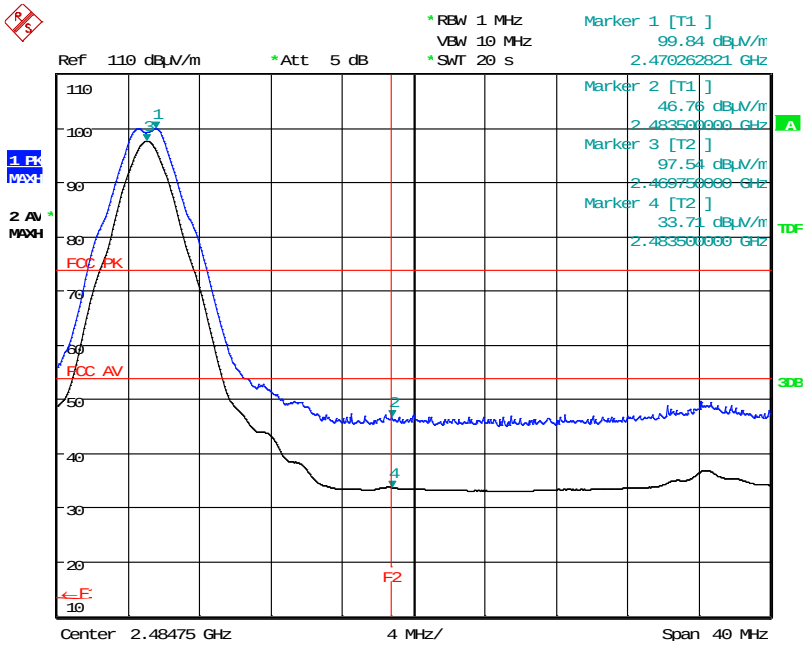
18 GHz to 25 GHz

Radiated Bandedge Compliance



Date: 4.NOV.2013 14:53:41

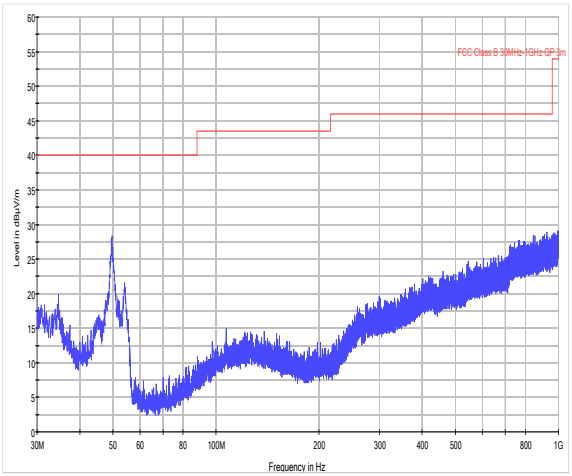
Lower Bandedge



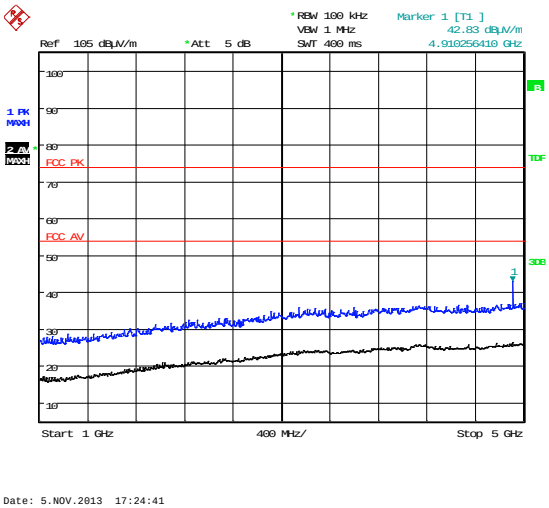
Date: 4.NOV.2013 15:12:37

Upper Bandedge

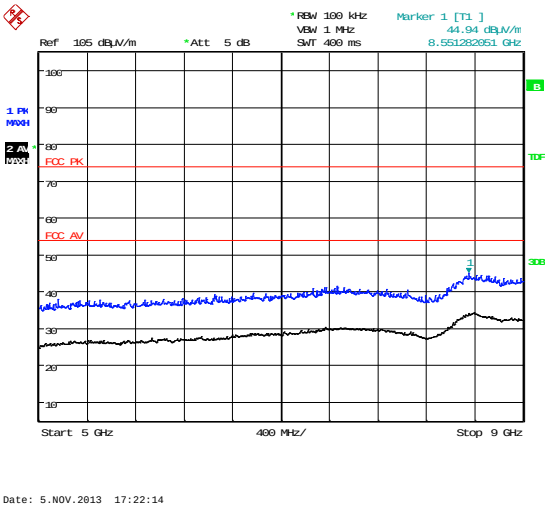
Unintentional Radiated Spurious emissions– 2455.0MHz



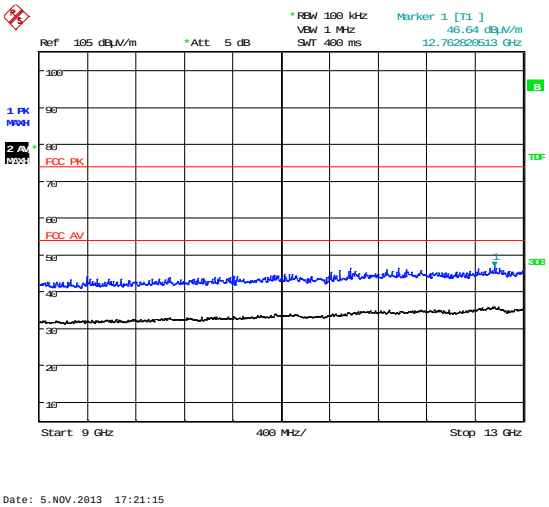
30 MHz to 1 GHz



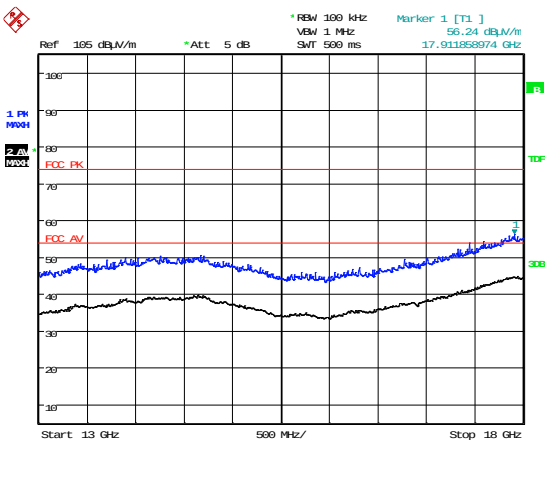
1 GHz to 5 GHz



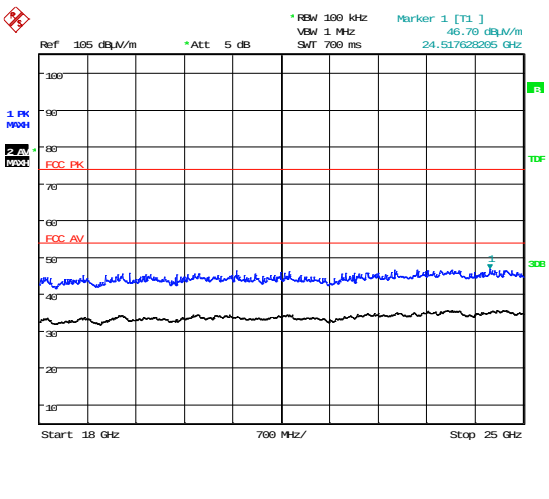
5 GHz to 9 GHz



9 GHz to 13 GHz

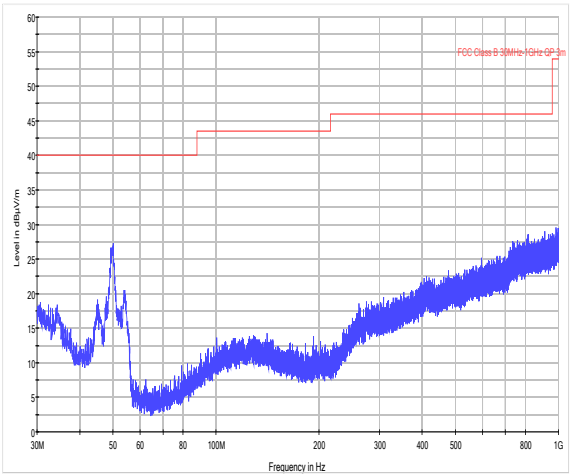


13 GHz to 18GHz

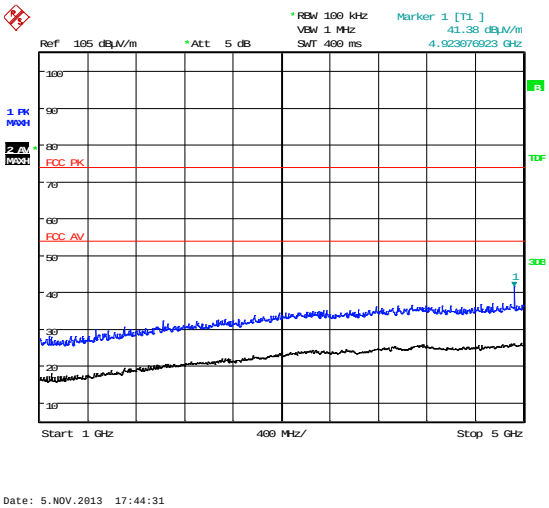


18 GHz to 25 GHz

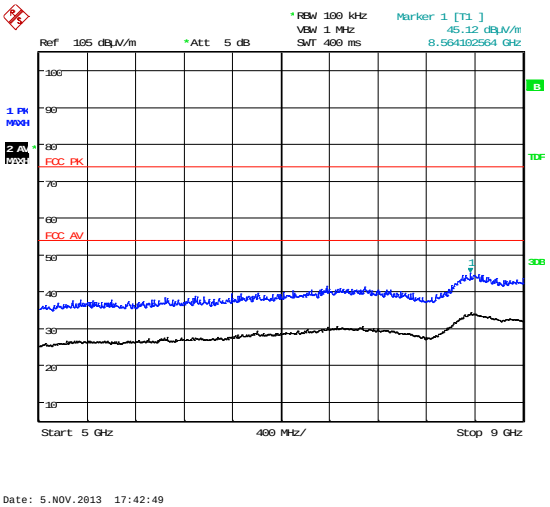
Unintentional Radiated Spurious emissions– 2460.0MHz



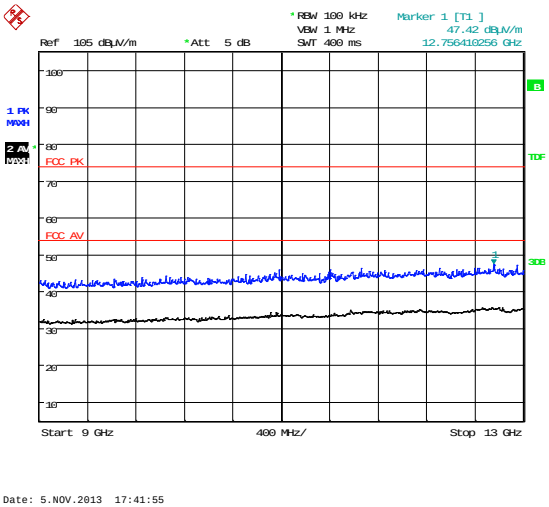
30 MHz to 1 GHz



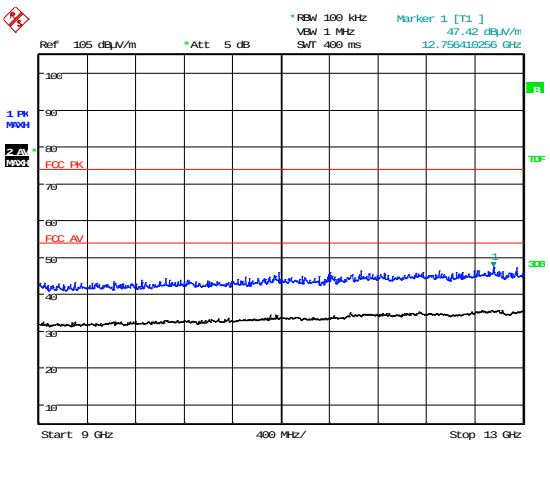
1 GHz to 5 GHz



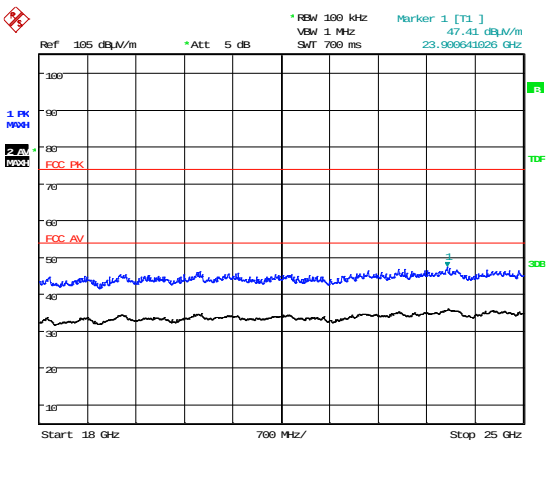
5 GHz to 9 GHz



9 GHz to 13 GHz

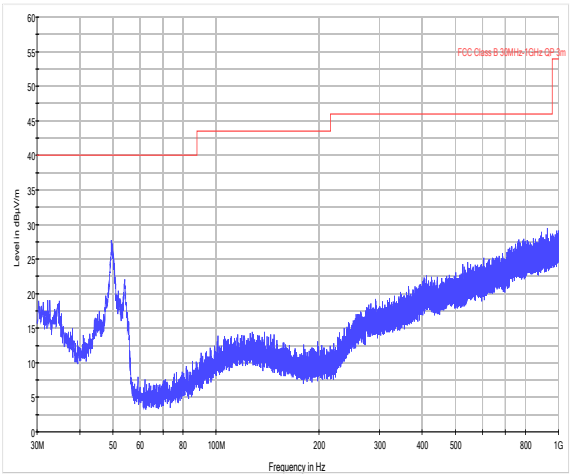


13 GHz to 18GHz

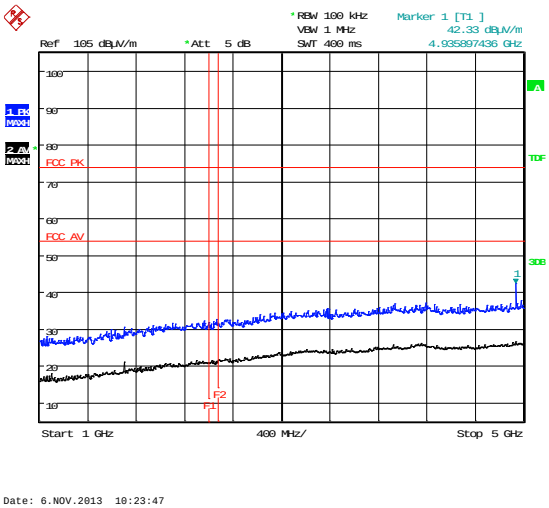


18 GHz to 25 GHz

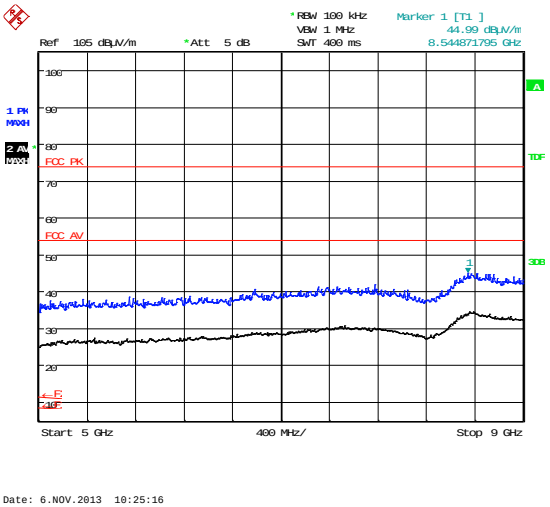
Unintentional Radiated Spurious emissions– 2465.0MHz



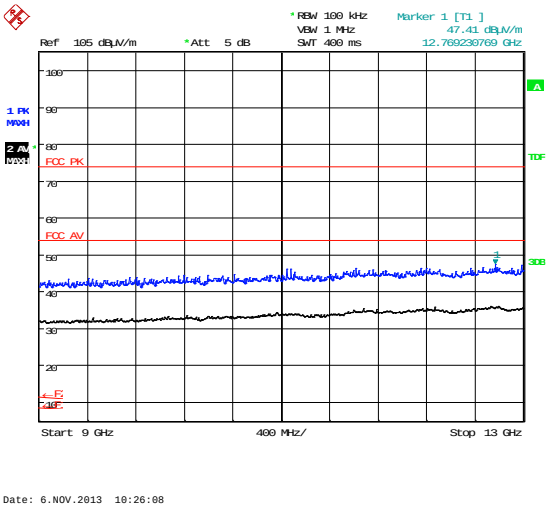
30 MHz to 1 GHz



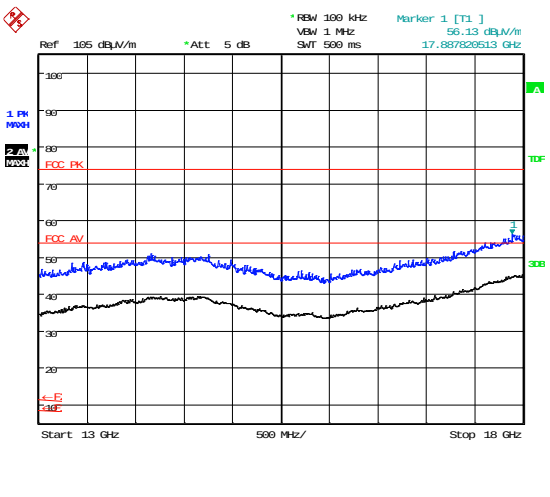
1 GHz to 5 GHz



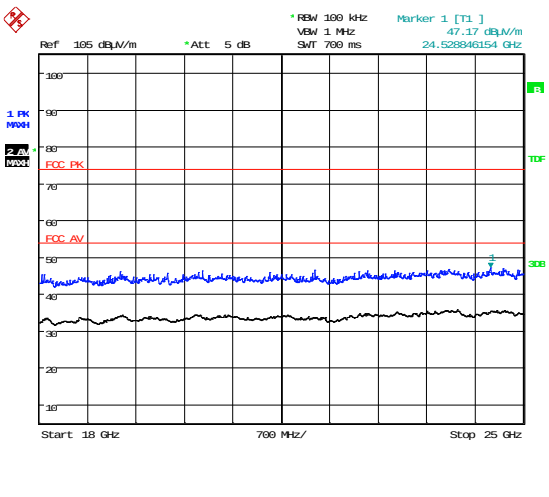
5 GHz to 9 GHz



9 GHz to 13 GHz

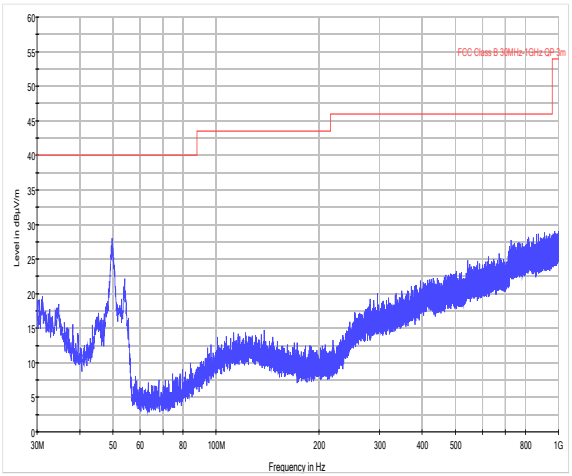


13 GHz to 18GHz

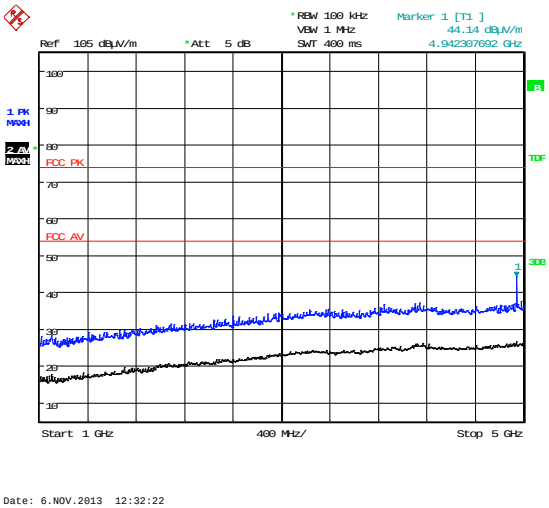


18 GHz to 25 GHz

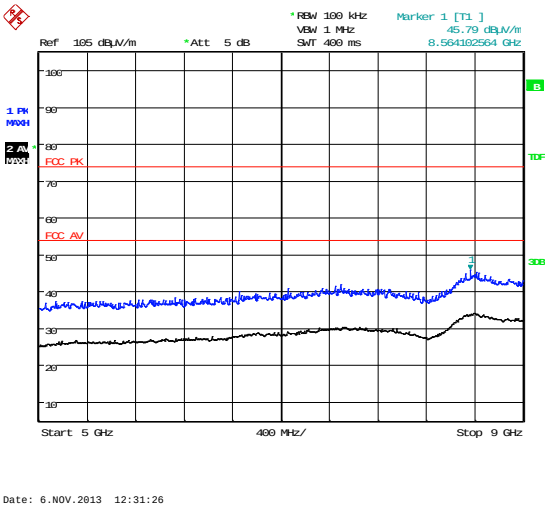
Unintentional Radiated Spurious emissions– 2470.0MHz



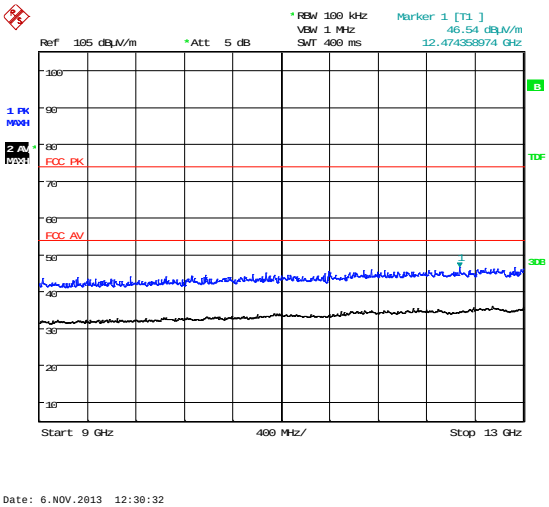
30 MHz to 1 GHz



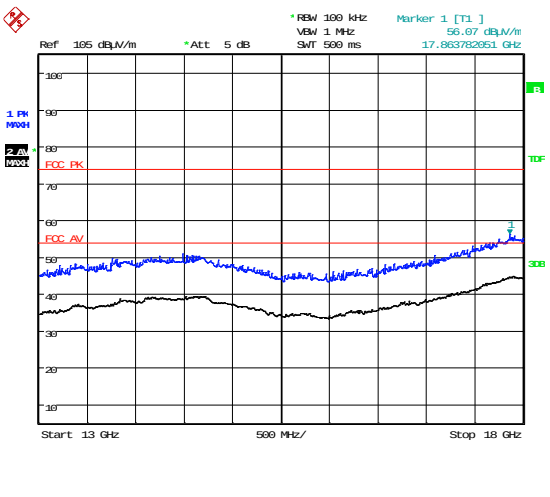
1 GHz to 5 GHz



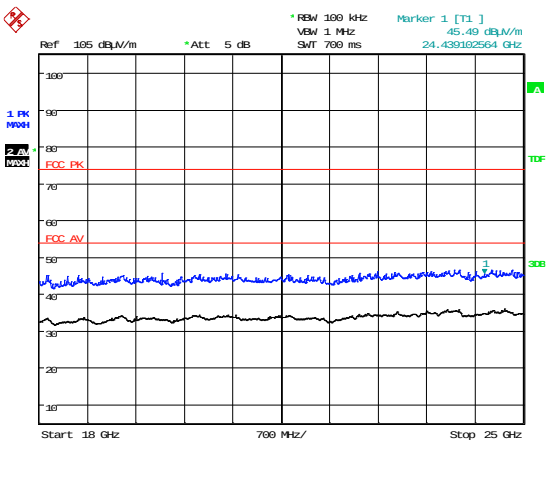
5 GHz to 9 GHz



9 GHz to 13 GHz



13 GHz to 18GHz



18 GHz to 25 GHz

Appendix C: Additional Test and Sample Details

This appendix contains details of:

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

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

Sample No: Sxx Mod w

where:

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

The following terminology is used throughout the test report:

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

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

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

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

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

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

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

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

C1) Test samples

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

Sample No.	Description	Identification
S02	Silent Heardsman Collar	None

C2) EUT Operating Mode During Testing.

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

Test	Description of Operating Mode
All tests detailed in this report	EUT transmitting a Modulated carrier

Test	Description of Operating Mode:
Receiver radiated spurious emissions	EUT active but non-transmitting.

C3) EUT Configuration Information.

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

C4) List of EUT Ports

The tables below describe the termination of EUT ports:

Sample : S02
Tests : Radiated Emissions

Port	Description of Cable Attached	Cable length	Equipment Connected
None			

* Only connected during setup.

C5 Details of Equipment Used

TRaC No	Equipment Type	Equipment Description	Manufacturer	Last Cal Calibration	Calibration Period	Due For Calibration
UH004	ESVS10	Receiver	R&S	11/02/2013	12	11/02/2014
UH028	UHALP 9108	Log Periodic Ant	Schwarbeck	08/07/2013	24	08/07/2015
UH029	VHBA 9123	Bicone Antenna	Schwarbeck	19/08/2013	24	19/08/2015
UH093	CBL6112B	Bilog	Chase	08/07/2013	24	08/07/2015
UH187	ESHS10	Receiver	R&S	11/02/2013	12	11/02/2014
UH191	CBL611/A	Bilog	Chase	13/12/2012	24	13/12/2014
UH281	FSU46	Spectrum Analyser	R&S	06/03/2013	12	06/03/2014
UH387	ATS	Chamber 1	Rainford EMC	04/07/2013	12	04/07/2014
UH388	ATS	Chamber 2	Rainford EMC	04/07/2013	12	04/07/2014
UH403	ESCI 7	Recevier	R&S	12/08/2013	12	12/08/2014
UH405	FSU26	Spectrum Analyser	R&S	20/03/2013	12	20/03/2014
UH420	CBL6112	Bilog	Chase	06/07/2012	24	06/07/2014
L138	3115	1-18GHz Horn	EMCO	17/10/2013	24	17/10/2015
L139	3115	1-18GHz Horn	EMCO	20/09/2013	24	20/09/2015
L193	VHA 9103 balu	Bicone Antenna	Chase	19/06/2012	24	19/06/2014
L203	UPA6108	Log Periodic Ant	Chase	19/06/2012	24	19/06/2014
L263/A	20240-20	Horn 18-26GHz	Flann	17/11/2011	24	17/11/2013
L290	CBL611/A	Bilog	Chase	13/12/2012	24	13/12/2014
L300	20240-20	Horn 18-26GHz (&UH330)	Flann	17/11/2011	24	17/11/2013
L317	ESVS10	Receiver	R&S	09/01/2013	12	09/01/2014
L415	ESVS20	Receiver	R&S	27/08/2013	12	27/08/2014
L572	8449B	Pre Amp	Agilent	12/12/2012	24	12/12/2014
L654	8563A	Spectrum Analyser	HP	18/10/2012	12	18/10/2013
REF940	ATS	Radio Chamber - PP	Rainford EMC	09/07/2013	12	09/07/2014
REF976	34405a	Multimeter	Agilent	26/04/2013	12	26/04/2014
REF977	SH4141	High Pass Filter	BSC	25/02/2013	24	25/02/2015

Appendix D: Additional Information

No additional information is included within this test report.

Appendix E: Calculation of the duty cycle correction factor

Using a spectrum analyser in zero span mode, centred on the fundamental carrier frequency with a RBW of 1MHz and a video Bandwidth of 1MHz the sweep time was set accordingly to capture the pulse train. The transmit pulsewidths and period was measured. A plots of the pulse train is contained in Appendix B of this test report.

If the pulse train was less than 100 ms, including blanking intervals, the duty cycle was calculated by averaging the sum of the pulsewidths over one complete pulse train. However if the pulse train exceeds 100ms then the duty cycle was calculated by averaging the sum of the pulsewidths over the 100ms width with the highest average value. (The duty cycle is the value of the sum of the pulse widths in one period (or 100ms), divided by the length of the period (or 100ms). The duty cycle correction factor was then expressed in dB and the peak emissions adjusted accordingly to give an average value of the emission.

Correction factor dB = 20 x (Log_{10} Calculated Duty Cycle)

Therefore the calculated duty cycle was determined:

The pulse train period was greater than >100ms and in as shown from the plots in contained in appendix B of this test report.

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

e.g

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

0.07459 or 7.459%

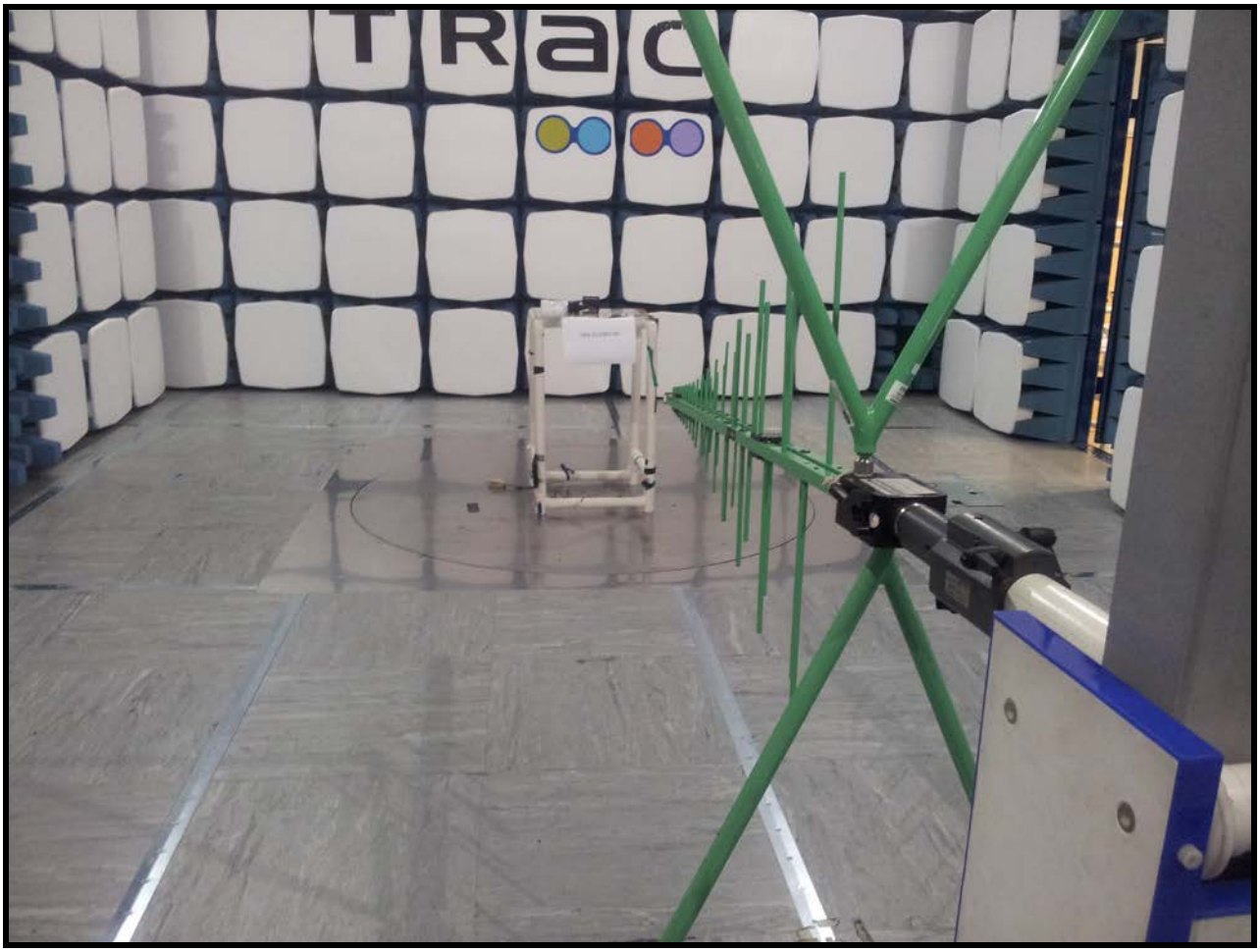
Correction factor (dB) = 20 x (Log_{10} 0.07459) = -22.54dB

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

Appendix F: Photographs and Figures

The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: overview.
2. Radiated electric field emissions arrangement: close up.



Photograph 1

Photograph 2

Appendix G: MPE Calculation

OET Bulletin No. 65, Supplement C 01-01

47 CFR §§1.1307, 2.1091 and RSS-102

Radio frequency radiation exposure evaluation: mobile devices.

For purposes of these requirements mobile devices are defined by the FCC and Industry Canada 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 and Industry Canada rules may not be achievable under normal operation of the EUT, an RF exposure calculation is needed to show the minimum distance required to be less than 1mW/cm^2 (10W/m^2 for Industry Canada) power density limit.

Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01, IEEE C95.1

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

where:

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

Note:

The EIRP measurement was performed using a signal substitution method.

Result

Prediction Frequency (MHz)	Maximum EIRP	Power density limit (S) (mW/cm^2)	Distance (R) cm required to be less than 1mW/cm^2
2465.0	3.275 mW	1	0.52

1mW/cm^2 ≡ 10W/m^2

HULL
Unit E, South Orbital Trading Park, Hedon Road, Hull, HU9 1NJ, UK.
T +44 (0)1482 801801 **F** +44 (0)1482 801806 **E** test@tracglobal.com
www.tracglobal.com