A RADIO TEST REPORT

FOR

ELSTAT GROUP

ON

ELSTAT ST BLUETOOTH MODULE

MODEL : 121-0184-01

DOCUMENT NO. TRA020619-47-00-A

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UKAS TESTING
0026

TRaC Wireless Test Report	**:** TRA-020619-47-00-A
Applicant	**:** Elstat Group
Apparatus	**:** Elstat ST Bluetooth Module
Specification(s)	**:** CFR47 Part 15.247 & RSS-210 Annex 8
FCCID	**:** 2ACHH121-0184
Purpose of Test	**:** Certification
Authorised by	**:** 
	: Radio Product Manager
Issue Date	**:**14th July 2014
Authorised Copy Number	**:** *PDF*

Total number of pages : 52

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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 :

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1.3 Manufacturer

As Above

1.4 Apparatus Assessed

The following apparatus was assessed between 11th – 20th June 2014

Elstat ST Bluetooth Module
Model 121-0184-01

The above equipment is a Bluetooth Low energy Module operating in the 2,4 GHz band

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
	RSS-210 Issue 8 December 2010	Title 47 of the CFR: Part 15 Subpart C;		
Radiated spurious emissions (Restricted bands)	Annex 8, A8.5	15.247	ANSI C63.10:2009 KDB 558074 D01	Pass
Radiated spurious emissions (Non-restricted bands)	Annex 8.A4(4)	15.247	ANSI C63.10:2009 KDB 558074 D01	Pass
AC Power conducted emissions	RSS-GEN Issue 3 December 2010 Annex 7, 7.2.4	15.207	ANSI C63.10:2009 KDB 558074 D01	N/A
Occupied Bandwidth	Annex 8.A8.2a	15.247(a)(2)	ANSI C63.10:2009 KDB 558074 D01	Pass
Carrier Power	Annex 8.A4 (4).	15.247(b)	ANSI C63.10:2009 KDB 558074 D01	Pass
Power Spectral Density	Annex 8.A8.2b	15.247(d)	ANSI C63.10:2009 KDB 558074 D01	Pass
Unintentional Radiated Spurious Emissions	RSS-GEN Issue 3 December 2010 7.2.2(c)	15.109	ANSI C63.10:2009 KDB 558074 D01	Pass
RF Safety	RSS-102	15.247(b)(5)	-	Pass
Digital Modulation	-	15.403	-	Pass

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

The Elstat LE Bluethoooh Module utilises an integral antenna.
As per 558074 D01 DTS Meas Guidance v03r02 June 14 section 3 radiated measurements were performed and where required converted to eirp as per ANSI C63.10

Section 2: Measurement Uncertainty

2.1 Measurement Uncertainty Values

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

Radio Testing – General Uncertainty Schedule

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

[1] Adjacent Channel Power

Uncertainty in test result = **1.86dB**

[2] Carrier Power

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

[3] Effective Radiated Power

Uncertainty in test result = **4.71dB**

[4] Spurious Emissions

Uncertainty in test result = **4.75dB**

[5] Maximum frequency error

Uncertainty in test result (Frequency Counter) = **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	S04
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
Temperature	23˚C
EUT set up	Refer to Appendix C

Channel Frequency (MHz)	F_{lower} (MHz)	F_{Higher} (MHz)	Measured 20 dB Bandwidth (kHz)	Limit (kHz)	Result
2402	2401.583333	2402.288462	705.129	>500	Pass
2440	2439.567308	2440.296474	729.166	>500	Pass
2480	2479.559295	2480.296474	737.179	>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	Part15 Subpart (c) 15.247(b)(3), RSS-GEN Annex 8.A4 (4).
Measurement standard	ANSI C63.10, KDB Document: 558074
EUT sample number	S04
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	24˚C
Photographs (Appendix F)	1 & 2

Channel Frequency (MHz)	Radiated Peak Carrier Power (dBuV/m)	EIRP (W)	Limit (W)	Result
2402	102.32	0.005	1	Pass
2440	100.97	0.004	1	Pass
2480	100.81	0.004	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 v03r02
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 its lowest, centre and highest carrier frequency in turn.

Test Details:	
Regulation	Part15 Subpart (c) 15.247(b)(3), RSS-210 Annex 8.A8.2b
Measurement standard	ANSI C63.10, KDB Document: 558074
EUT sample number	S04
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	24˚C

Channel Frequency (MHz)	Radiated Peak Carrier Power (dBuV/m)	PSD (dBm)	Limit (dBm)	Result
2402	101.26	6.03	8	Pass
2440	99.82	4.59	8	Pass
2480	99.69	4.46	8	Pass

EIRP calculated from Field Strength as Per ANSI C63.10

Notes:

Radiated Measurement

Measuring distances 3.
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 v03r02
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 = 100 kHz. The maximum permitted field strength are described in Section 15.247(d) 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 : ☒

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

Test Details: 2402 MHz	
Regulation	Part 15.109, RSS – GEN, Section 7.2.3
Measurement standard	ANSI C63.10:2009, RSS – GEN, ANSI C63.4:2003
Frequency range	30MHz – 25GHz
EUT sample number	S04
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	24˚C
Photographs (Appendix F)	1 & 2

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

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1	2369.9 Pk	58.06	4.1	29.3	36.0	55.46	-	592.93	5000
2	2369.9 Av	47.72	4.1	29.3	36.0	45.12	-	180.30	500
3	4803.75 Pk	51.76	6.4	35.7	35.6	58.26	-	818.46	5000
4	4803.75 Av	42.27	6.4	35.7	35.6	48.77	-	274.47	500
5	19213.6 Pk	51.8	13.7	37.3	34.7	68.10	-9.54	847.23	5000
6	19213.6 Av	37.83	13.7	37.3	34.7	54.13	-9.54	169.63	500

The worst case radiated emission measurements for spurious emissions and harmonics that fall in unrestricted 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)	LIMIT (dBµV/m)
7	7205.4 Pk	51.04	8.0	39	36.1	61.94	82.32
8	9606.9 Pk	53.28	9.4	41.8	36.9	67.58	82.32

Radiated Electric Field EmissionsContinued:

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

Test Details: 2440 MHz	
Regulation	Part 15.109, RSS – GEN, Section 7.2.3
Measurement standard	ANSI C63.10:2009, RSS – GEN, ANSI C63.4:2003
Frequency range	30MHz to 25 GHz
EUT sample number	S04
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	24˚C
Photographs (Appendix F)	1 & 2

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

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
9	4879.8 Pk	52.24	6.3	35.8	35.6	58.74	-	864.97	5000
10	4879.8 Av	43.39	6.3	35.8	35.6	49.89	-	312.25	500
11	7319.3 Pk	50.64	8.0	39.2	36.1	61.74	-	1221.80	5000
12	7319.3 Av	40.2	8.0	39.2	36.1	51.30	-	367.28	500
13	19517.6 Pk	53.11	13.5	37.2	35.2	68.61	-9.54	898.46	5000
14	19517.6 Av	38.92	13.5	37.2	35.2	54.42	-9.54	175.39	500

The worst case radiated emission measurements for spurious emissions and harmonics that fall in unrestricted 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)	LIMIT (dBµV/m)
15	9758.889 Pk	54.02	9.5	41.9	36.9	68.52	80.97

Radiated Electric Field EmissionsContinued:

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

Test Details: 2480 MHz	
Regulation	Part 15.109, RSS – GEN, Section 7.2.3
Measurement standard	ANSI C63.10:2009, RSS – GEN, ANSI C63.4:2003
Frequency range	30MHz to 25 GHz
EUT sample number	S04
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	24˚C
Photographs (Appendix F)	1 & 2

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

Ref No.	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
16	4959.8 Pk	57.45	6.4	33.3	35.6	61.55	-	1195.36	5000
17	4959.8 Av	49.72	6.4	33.3	35.6	53.82	-	490.91	500
18	7439.5 Pk	49.57	8.1	39.4	36.2	60.87	-	1105.35	5000
19	7439.5 Av	38.40	8.1	39.4	36.2	49.70	-	305.49	500
20	12398.4 Pk	46.12	10.9	43.9	36.1	64.82	-	1741.81	5000
21	12398.4 Av	32.67	10.9	43.9	36.1	51.37	-	370.25	500
22	19837.5 Pk	52.14	13.8	37.2	35.6	67.54	-9.54	794.33	5000
23	19837.5 Av	38.4	13.8	37.2	35.6	53.80	-9.54	163.31	500

The worst case radiated emission measurements for spurious emissions and harmonics that fall in unrestricted 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)	LIMIT (dBµV/m)
24	2511.9 Pk	55.09	4.3	29.9	36.0	53.29	80.81
25	9918.9 Pk	52.34	9.5	42	36.9	66.94	80.81

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).

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

Frequency of emission (MHz)	Field strength (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

Limit for Unrestricted Bands

Channel Frequency (MHz)	**Radiated Peak Carrier Power (dBuV/m)**	**Limit (dBuV/m)**
2402	102.32	82.32
2440	100.97	80.97
2480	100.81	80.81

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 Power Line Conducted Emissions

Preview power line conducted emission measurements were performed with a peak detector in a screened room. The effect of the EUT set-up on the measurements is summarised in note (b). Where applicable formal measurements of the emissions were performed with a peak, average and/or quasi peak detector. The EUT was set to transmit on its lowest, centre and highest carrier frequency in turn. The formal measurements are detailed below:

Test Details:	
Regulation	Part 15 Clause 15.207, RSS – GEN, Section 7.2.2
Measurement standard	ANSI C63.10
Frequency range	150kHz to 30MHz
EUT sample number	S04
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photograph 3

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

Results measured using the average detector compared to the average limit

Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
No Significant Emissions Within 20 dB of limit						

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

Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
No Significant Emissions Within 20 dB of limit						

Specification limits :

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

Conducted disturbance at the mains ports.

Frequency range MHz	Limits dBμV	
	Quasi-peak	Average
0.15 to 0.5	66 to 56[2]	56 to 46[2]
0.5 to 5	56	46
5 to 30	60	50

Notes:
1. The lower limit shall apply at the transition frequency.
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15MHz to 0.5MHz.

Notes:

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

(b) The following table summarises the effect of the EUT operating mode and internal configuration on the measured emission levels :

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

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

A6 Antenna Gain

Not Applicable as radiated measurements only were performed.

A7 Unintentional Radiated Electric Field Emissions

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The maximum permitted field strength is listed in Section 15.109 and 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: 2402 MHz	
Regulation	Part 15.109, RSS – GEN, Section 7.2.3
Measurement standard	ANSI C63.10:2009, RSS – GEN, ANSI C63.4:2003
Frequency range	30MHz to 25 GHz
EUT sample number	S04
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	24˚C
Photographs (Appendix F)	1 & 2

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.	260 QP	10.2	1.4	13.3	-	24.9	-	17.58	200
2.	4801.2 Pk	53.29	3.7	32.7	35.6	54.09	-9.54	168.85	5000
3.	4801.2 Av	49.27	3.7	32.7	35.6	50.07	-9.54	106.29	500
4.	9602.4 Pk	50.68	5	37.8	36.9	56.58	-9.54	224.91	5000
5.	9602.4 Av	42.27	5	37.8	36.9	48.17	-9.54	85.41	500

Unintentional Radiated Electric Field Emissions 15.109 continued:

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	S04
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	24˚C
Photographs (Appendix F)	1 & 2

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.	260 Qp	10.2	1.4	13.3	-	24.9	-	17.58	200
2.	4877.1 Pk	53.37	3.6	33	35.6	54.37	-9.54	174.38	5000
3.	4877.1 Av	48.77	3.6	33	35.6	49.77	-9.54	102.68	500
4.	9754.4 Pk	50.42	5.1	38	36.9	56.62	-9.54	225.94	5000
5.	9754.4 Av	41.62	5.1	38	36.9	47.82	-9.54	82.04	500

Unintentional Radiated Electric Field Emissions 15.109 continued:

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	S04
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	24˚C
Photographs (Appendix F)	1 & 2

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.	260 Qp	10.2	1.4	13.3	-	24.9	-	17.58	200
2.	4957.1 Pk	55.84	3.6	33.2	35.6	57.04	-9.54	237.14	5000
3.	4957.1 Av	52.61	3.6	33.2	35.6	53.81	-9.54	163.49	500
4.	9914.3 Pk	50.44	5.1	38.3	36.9	56.94	-9.54	234.42	5000
5.	9914.3 Av	41.42	5.1	38.3	36.9	47.92	-9.54	82.99	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 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= 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).

Radiated emission limits (47 CFR Part 15: Clause 15.109)

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

Appendix B: Supporting Graphical Data

This appendix contains graphical data obtained during testing.

Notes:

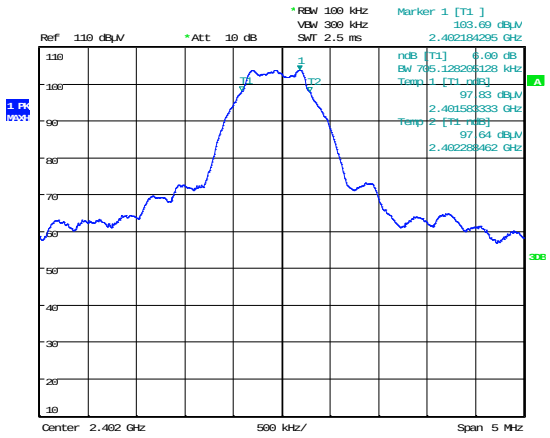
(a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A and Appendix B.

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

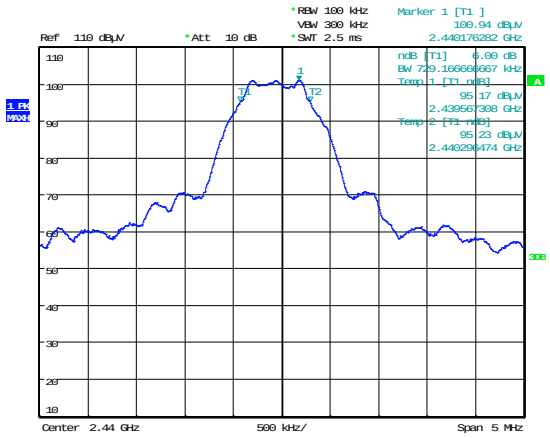
(c) Where relevant, on power line conducted emission plots, the limit displayed is the average limit, which is stricter than the quasi peak limit.

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

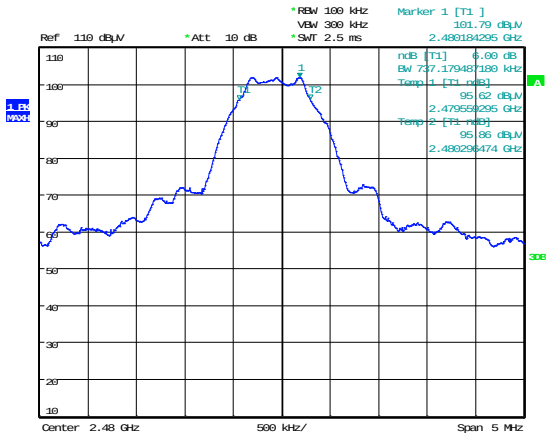
(e) The plots presented in this appendix may not be a complete record of the measurements performed, but are a representative sample, relative to the final assessment.



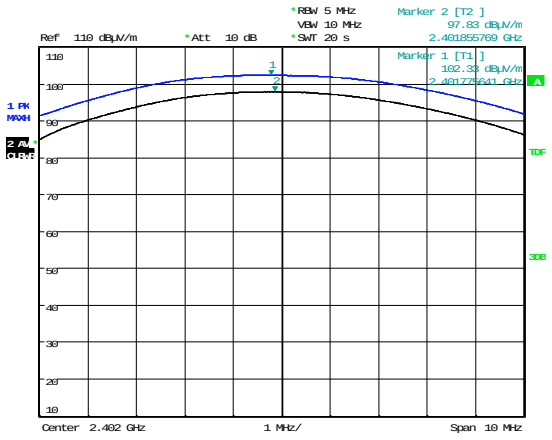
6dB Bandwidth 2402MHz



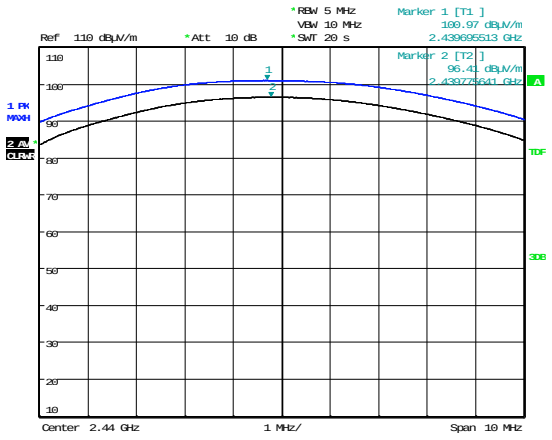
6dB Bandwidth 2440 MHz



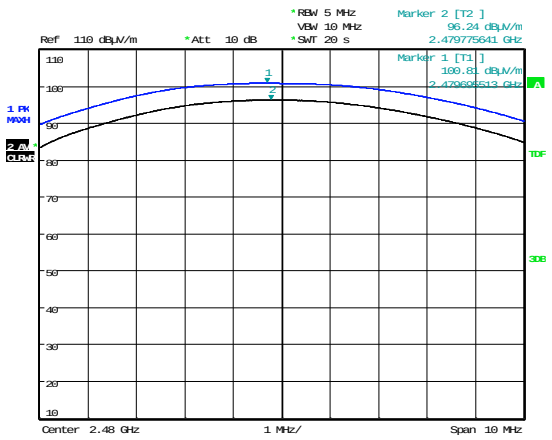
6dB Bandwidth 2480 MHz



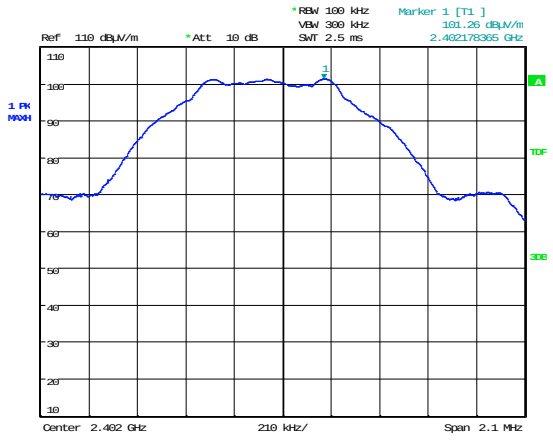
carrier power 2402MHz



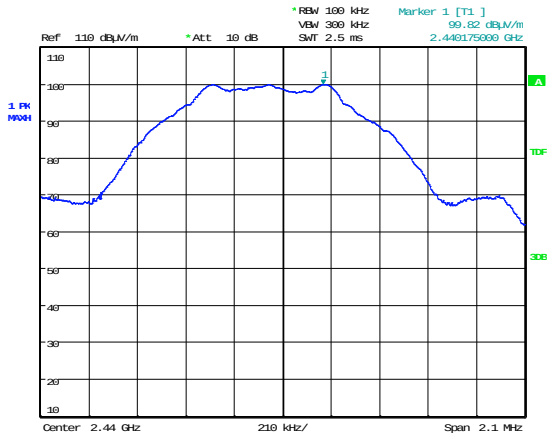
carrier power 2440 MHz



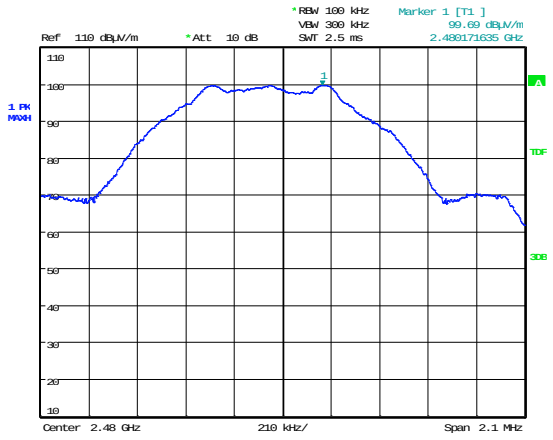
carrier power 2480 MHz



power spectral density 2402MHz

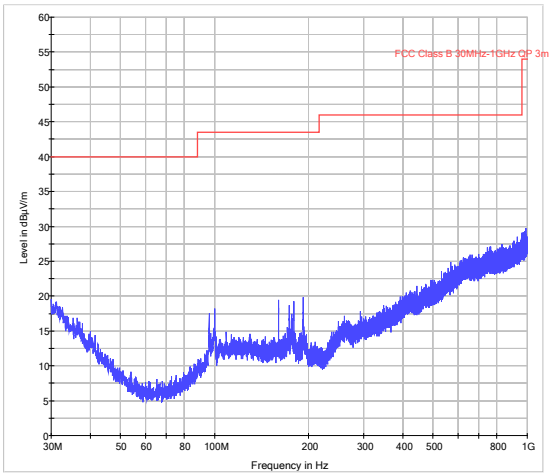


power spectral density 2440 MHz

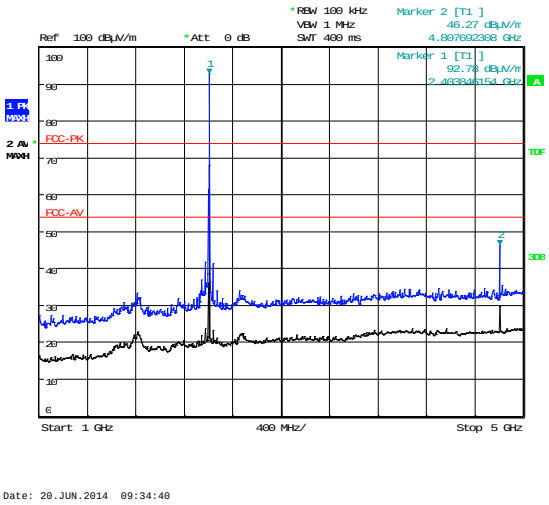


power spectral density 2480 MHz

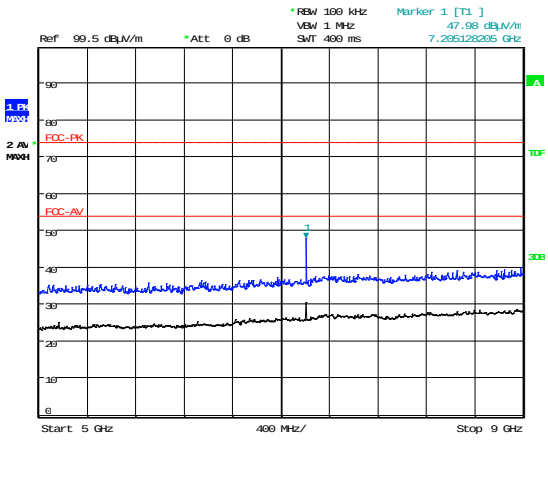
Radiated Spurious emissions– 2402MHz



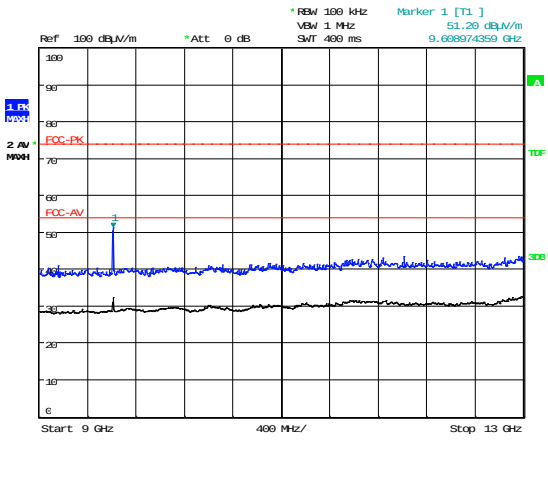
30 MHz to 1 GHz



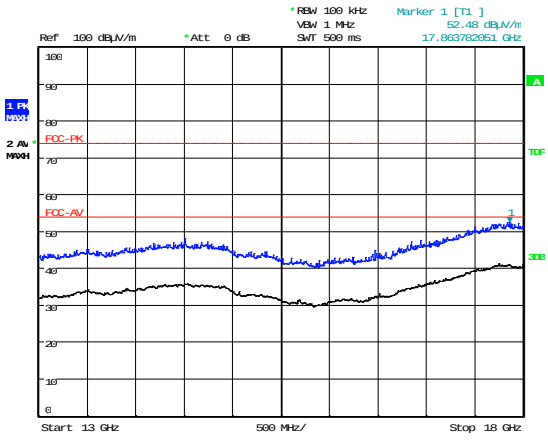
1 GHz to 5 GHz



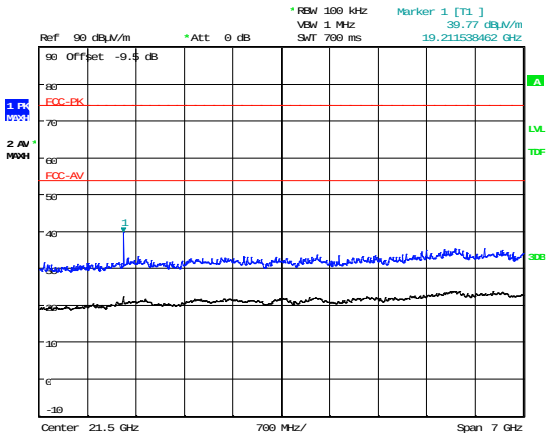
5 GHz to 9 GHz



9 GHz to 13 GHz

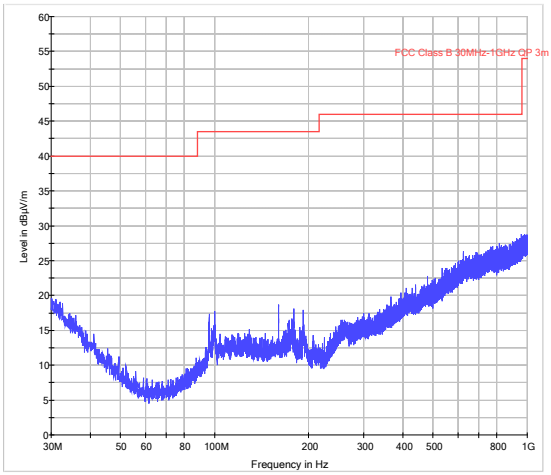


13 GHz to 18GHz

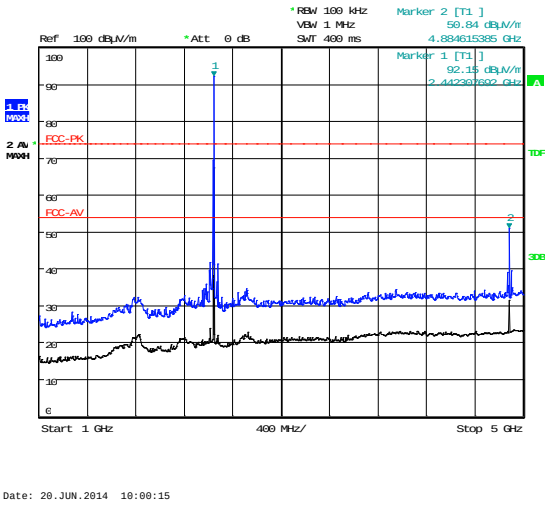


18 GHz to 25 GHz

Radiated Spurious emissions– 2440MHz



30 MHz to 1 GHz



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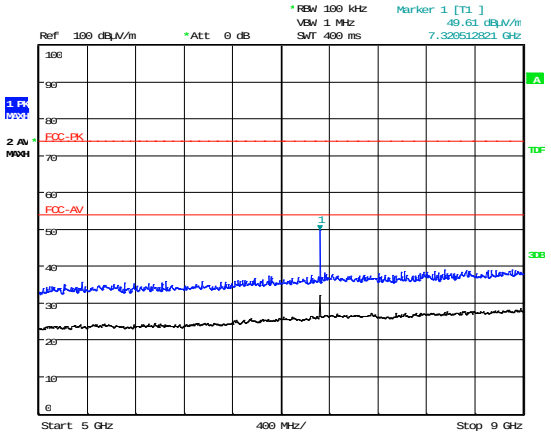
1 GHz to 5 GHz



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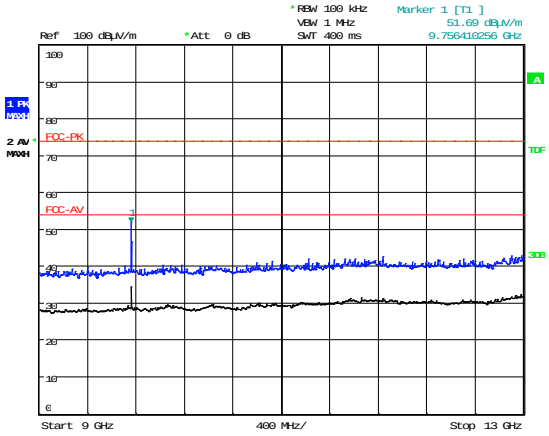
5 GHz to 9 GHz



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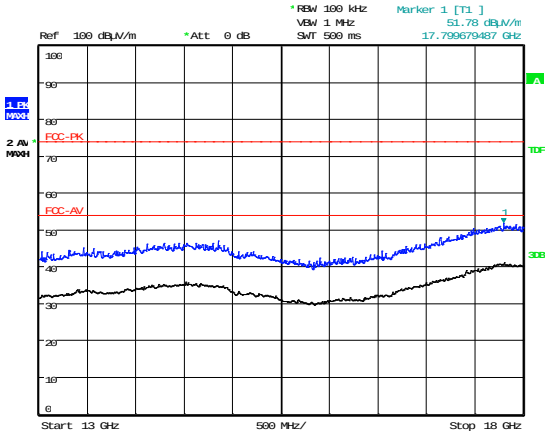
9 GHz to 13 GHz



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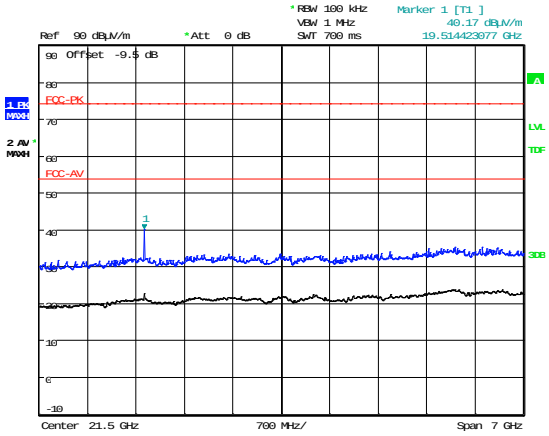
13 GHz to 18GHz



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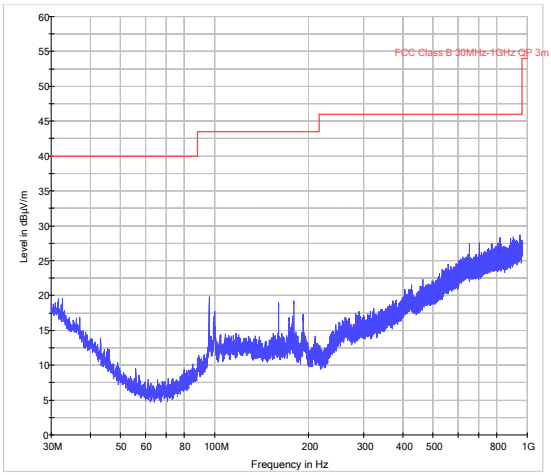
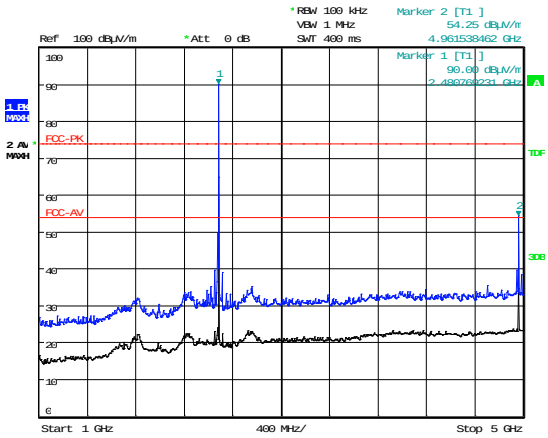
18 GHz to 25 GHz

Radiated Spurious emissions– 2480MHz



30 MHz to 1 GHz



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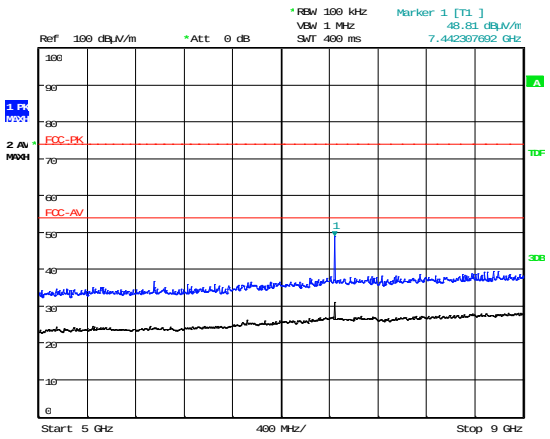
1 GHz to 5 GHz



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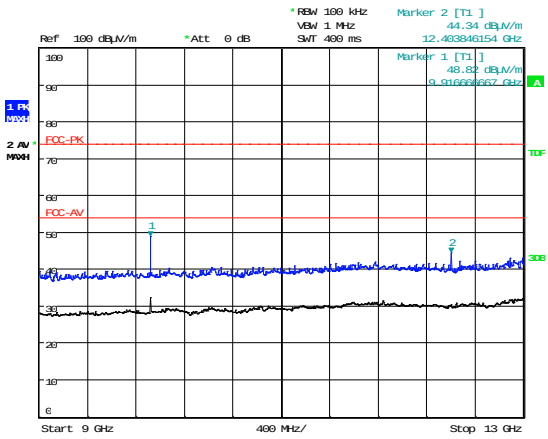
5 GHz to 9 GHz



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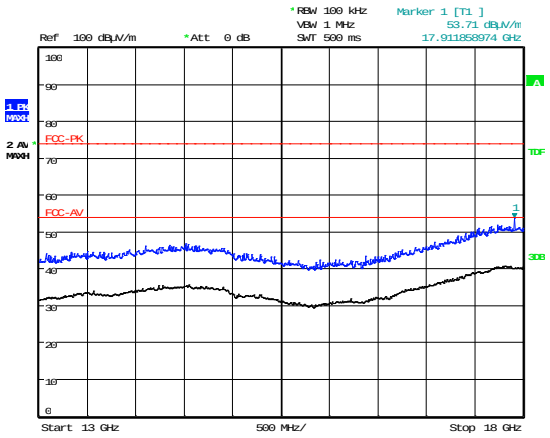
9 GHz to 13 GHz



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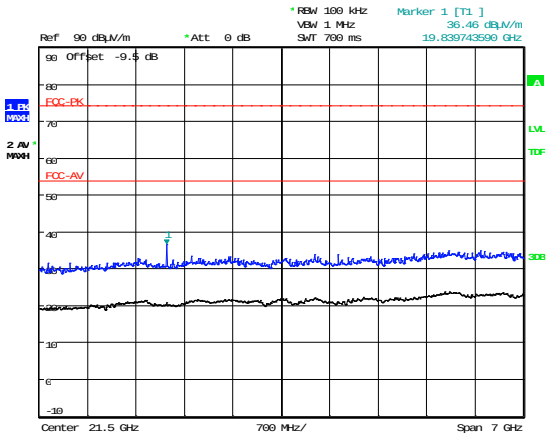
13 GHz to 18GHz



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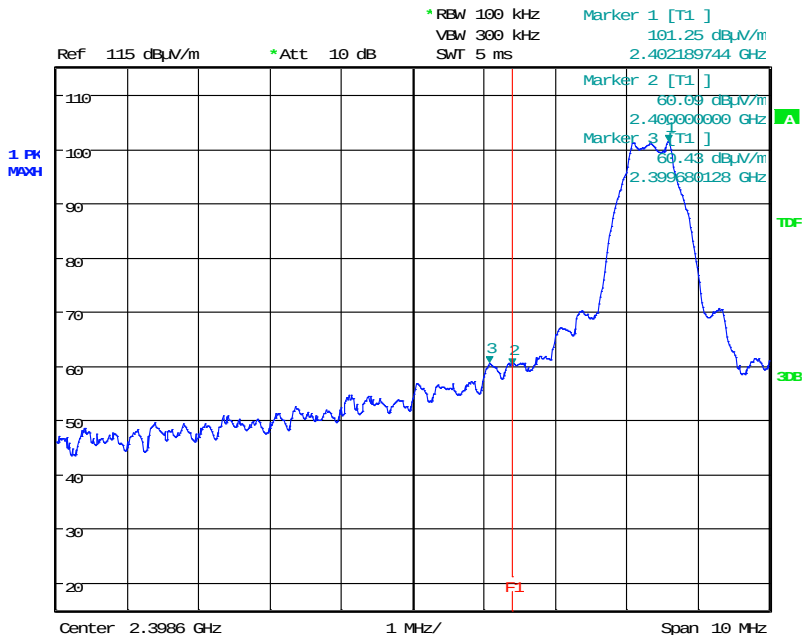
18 GHz to 25 GHz

Radiated Bandedge Compliance



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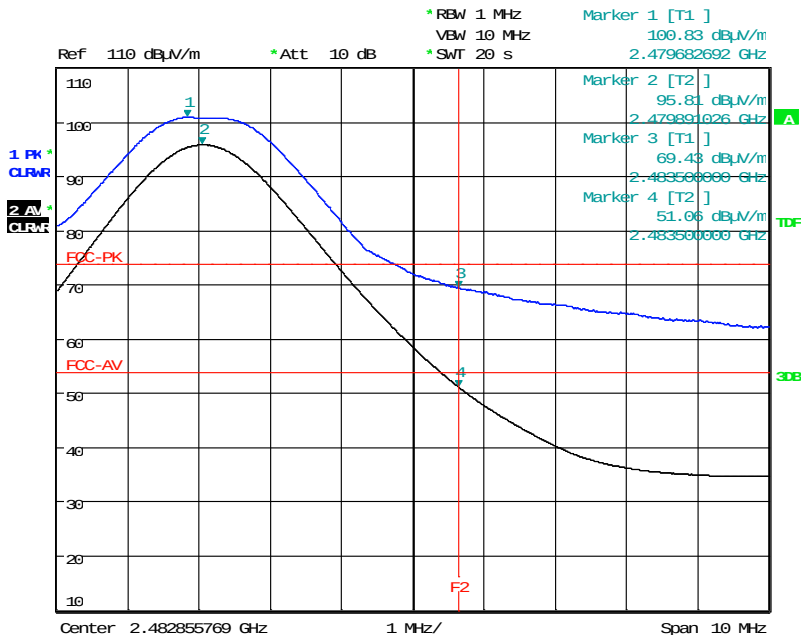
Lower Bandedge



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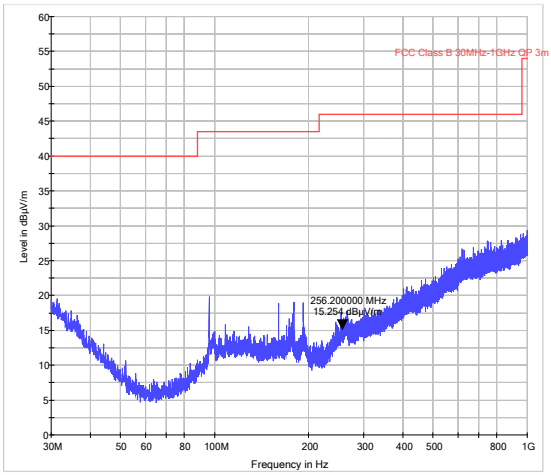
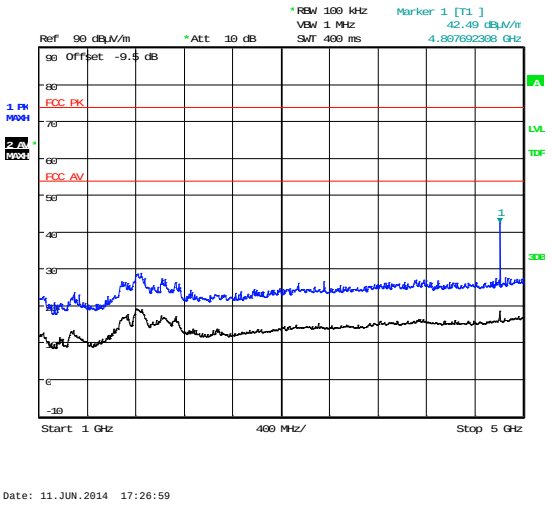
Upper Bandedge

Unintentional Radiated Spurious emissions– 2402MHz



30 MHz to 1 GHz



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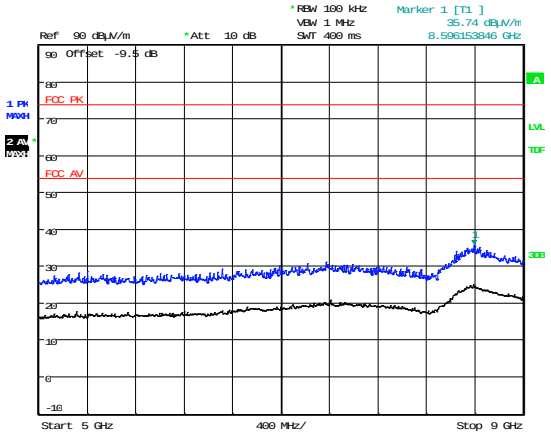
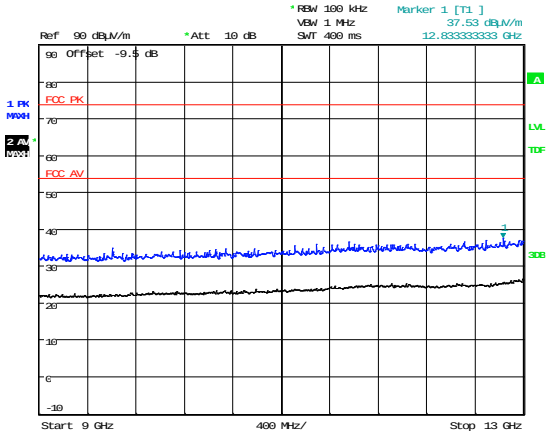
1 GHz to 5 GHz



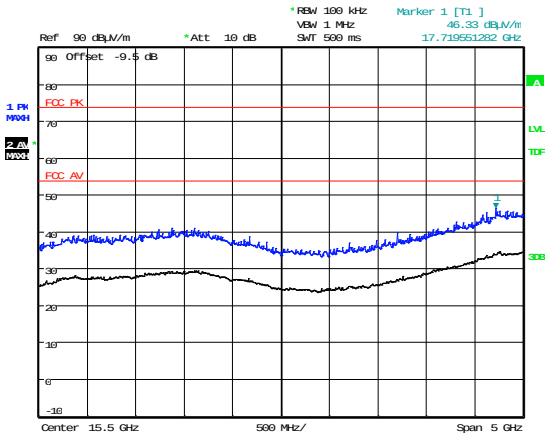
Date: 11.JUN.2014 17:26:11

5 GHz to 9 GHz



Date: 11.JUN.2014 17:25:52

9 GHz to 13 GHz



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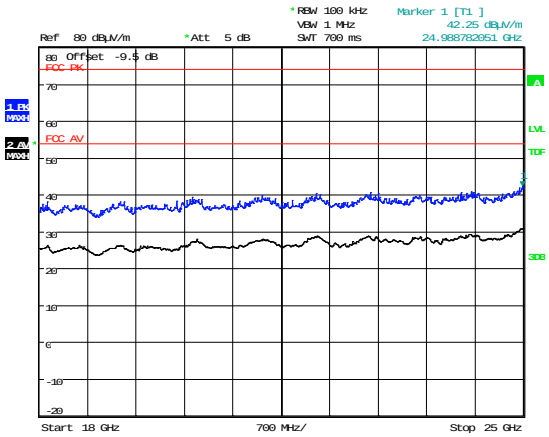
13 GHz to 18GHz



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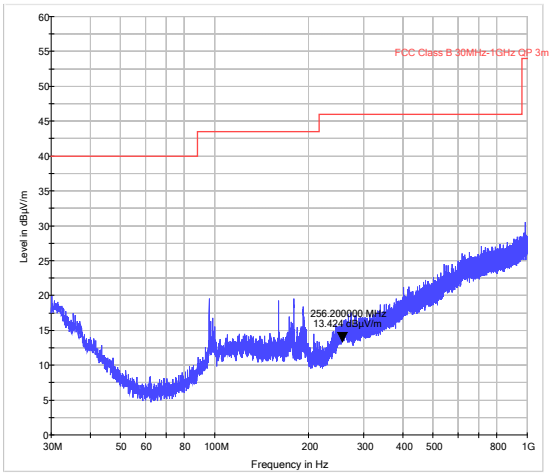
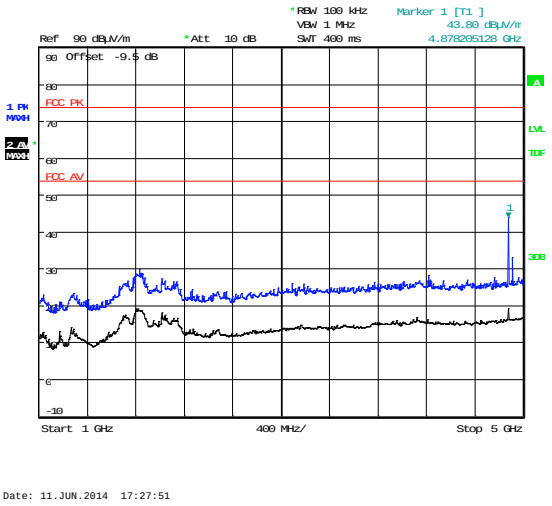
18 GHz to 25 GHz

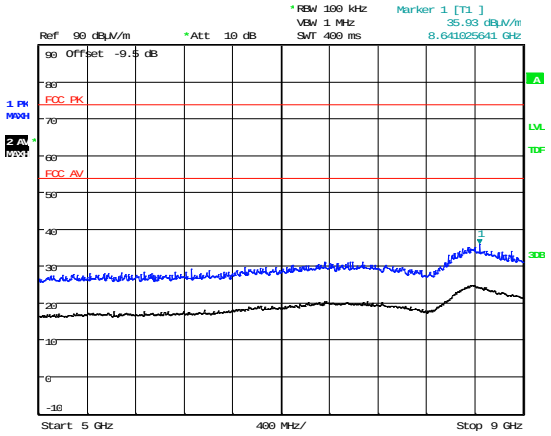
Unintentional Radiated Spurious emissions– 2440MHz



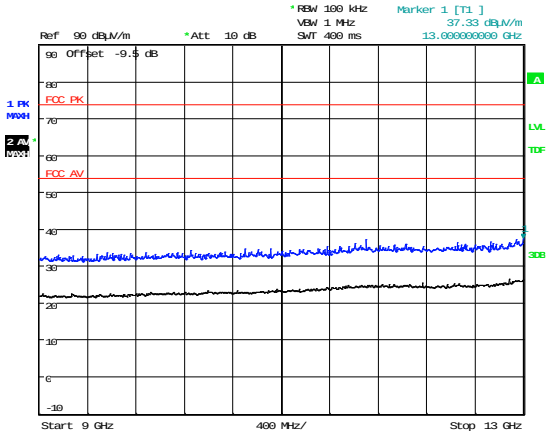
30 MHz to 1 GHz



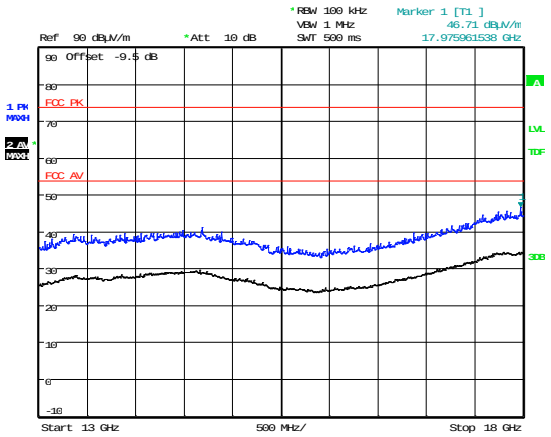
1 GHz to 5 GHz



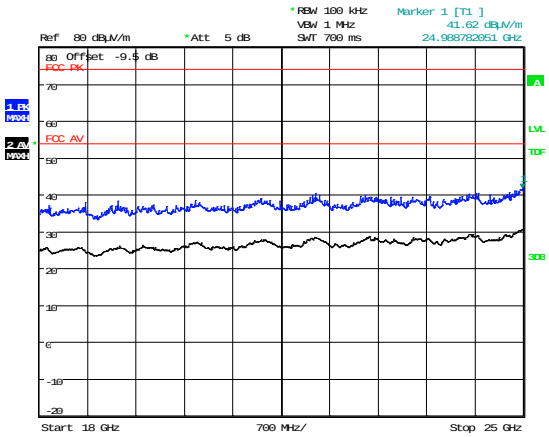
5 GHz to 9 GHz



9 GHz to 13 GHz

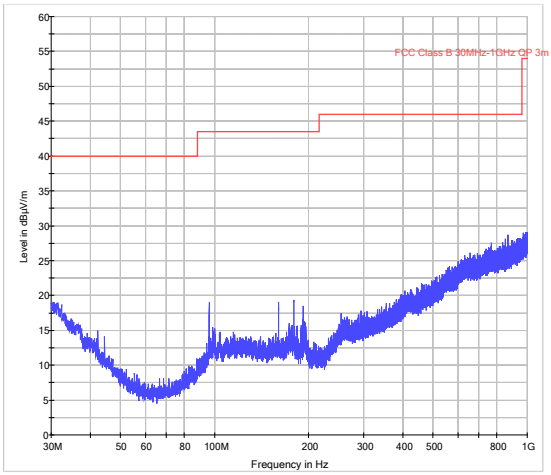


13 GHz to 18GHz

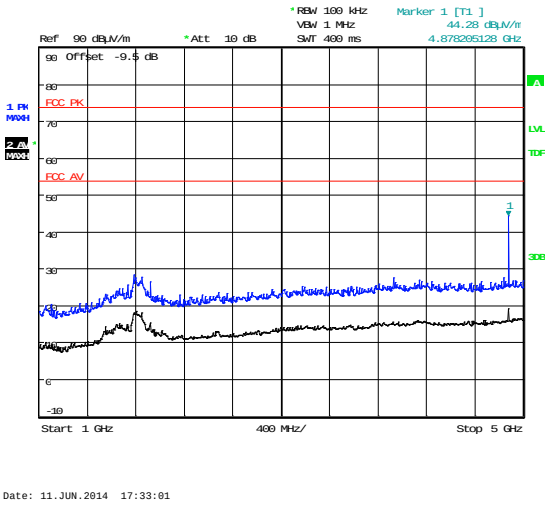


18 GHz to 25 GHz

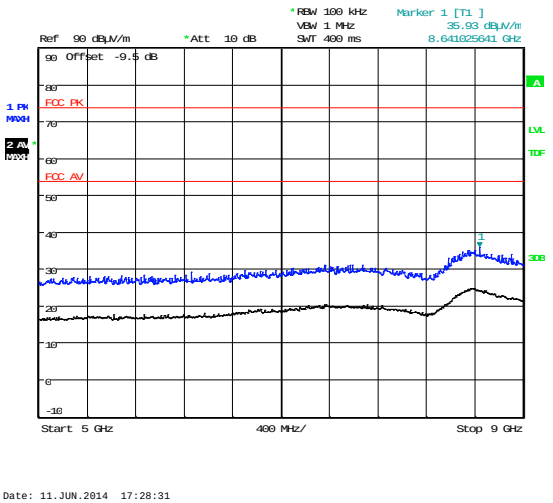
Unintentional Radiated Spurious emissions– 2480MHz



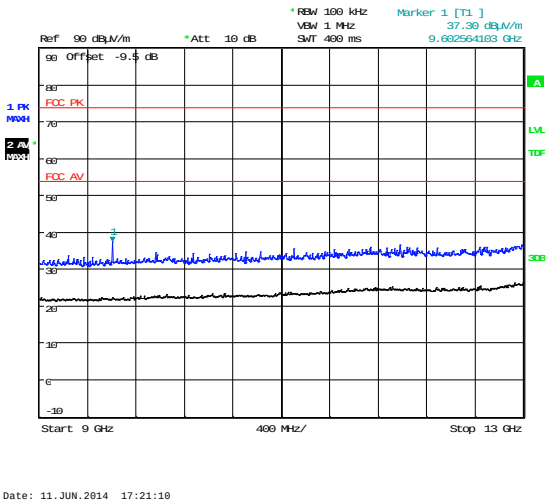
30 MHz to 1 GHz



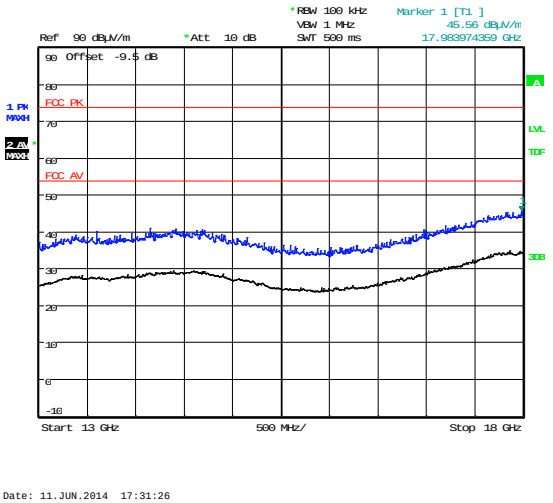
1 GHz to 5 GHz



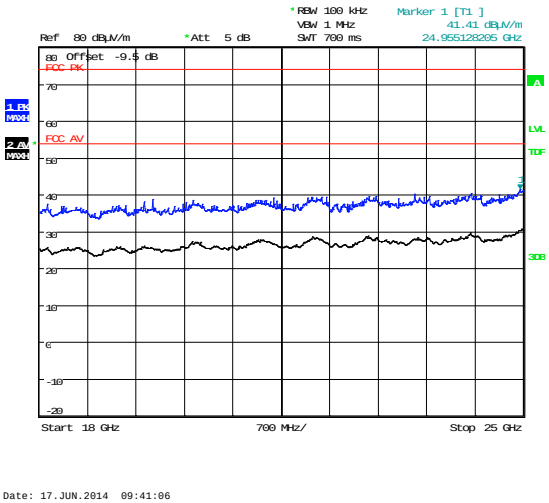
5 GHz to 9 GHz



9 GHz to 13 GHz

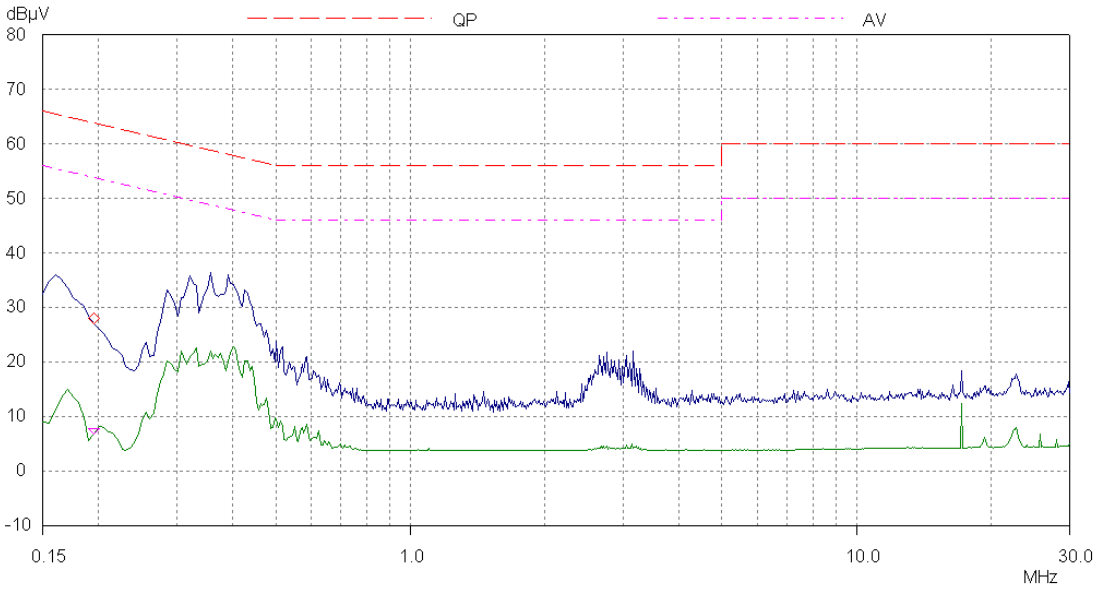


13 GHz to 18GHz

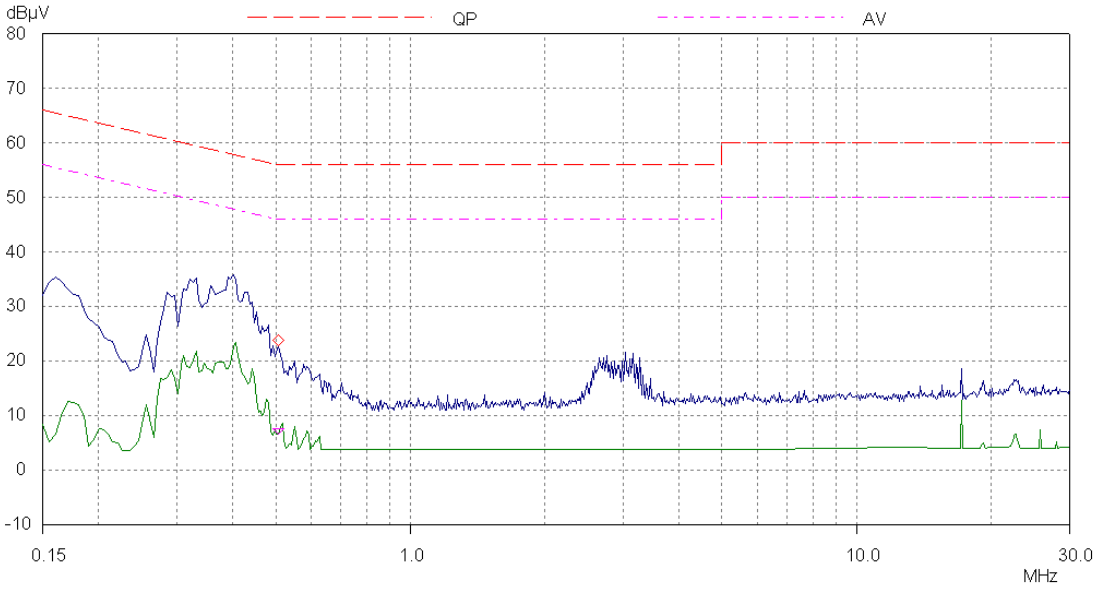


18 GHz to 25 GHz

AC Powerline Conducted Emissions



Transmit Mode



Rx Mode

Appendix C: **Additional Test and Sample Details**

This appendix contains details of:

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

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

Sample No: Sxx Mod w

where:

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

The following terminology is used throughout the test report:

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

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

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

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

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

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

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

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

C1) Test samples

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

Sample No.	Description	Identification
S01	Test interface PCB	None
S04	Bluetooth LE Module (Inc 15cm Ribbon Cable)	None

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

Sample No.	Description	Identification
S02	USB to Mini USB cable	None
S06	Laptop PSU	None
S07	Laptop	None

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

Identification	Description
	None

C2) EUT Operating Mode During Testing.

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

Test	Description of Operating Mode
All tests detailed in this report	EUT Transmitting modulated carrier at Power setting 0X06 The Test Data Length longest available 0x25

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

Test	Description of Operating Mode:
PLCE	EUT in TX mode or RX mode as required

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 : S04
Tests : Radiated Emissions

Port	Description of Cable Attached	Cable length	Equipment Connected
8 solder points	Ribbon Cable	10cm	Test Interface PCB

* Only connected during setup.

C5 Details of Equipment Used

TRaC No	Equipment Type	Equipment Description	Manufacturer	Last Cal Calibration	Calibration Period	Due For Calibration
UH191	CBL611/A	Bilog	Chase	13/12/2012	24	13/12/2014
UH387	ATS	Chamber 1	Rainford EMC	04/07/2013	12	04/07/2014
UH405	FSU26	Spectrum Analyser	R&S	16/04/2014	12	16/04/2015
UH281	FSU46	Spectrum Analyser	R&S	26/03/2014	12	26/03/2015
L138	3115	1-18GHz Horn	EMCO	17/10/2013	24	17/10/2015
L317	ESVS10	Receiver	R&S	12/02/2014	12	12/02/2015
REF940	ATS	Radio Chamber - PP	Rainford EMC	09/07/2013	12	09/07/2014
L572	8449B	Pre Amp	Agilent	11/02/2014	12	11/02/2015
L300	20240-20	Horn 18-26GHz (&UH330)	Flann	10/02/2014	24	10/02/2016

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.

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

e.g

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

0.07459 or 7.459%

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

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

Appendix F: Photographs and Figures

The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: Front View.
2. Radiated electric field emissions arrangement: Close Up.
3. AC Powerline Conducted Emissions arrangement: Overview.

Photograph 1

Photograph 2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Appendix G: MPE Calculation

KDB 447498

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 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 may not be achievable under normal operation of the EUT, an RF exposure calculation is needed to show the minimum distance required to be less than 1mW/cm^2 power density limit, as required.

Prediction of MPE limit at a given distance

Equation from KDB 447498

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

where:

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

Note:

The EIRP was calculated from the field strength as per ANSI C63.10.

Result

Prediction Frequency (MHz)	Maximum EIRP (mW)	Power density limit (S) (mW/cm^2)	Distance (R) cm required to be less than 1mW/cm^2
2402	5.0	1	0.7 cm

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