A RADIO TEST REPORT

FOR

INVISIBLE SYSTEMS

ON

ISL067R

DOCUMENT NO. TRA-017840-00-47-00-B

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

TRaC Wireless Test Report	**:** TRA-017840-00-47-00-B
Applicant	**:** Invisible Systems
Apparatus	**:** ISL067R
Specification(s)	**:** CFR47 Part 15.247 & RSS-210 Annex 8
FCCID	**: ZWZISL067R**
Certification Number	**: 12053A-ISL067R**
Purpose of Test	**: Certification**
Authorised by	**:**
	: Radio Product Manager
Issue Date	**:**4th July 2014
Authorised Copy Number	**:** *PDF*

Total number of pages : 66

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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 by:

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: D Winstanley

Report author: D Winstanley

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1.2 Tests Requested By

This testing in this report was requested by :

Invisible Systems
9 Beetham Road
Milnthorpe
Cumbria
LA7 7QL

1.3 Manufacturer

As Above

1.4 Apparatus Assessed

The following apparatus was assessed between 13th – 16th May 2014

ISL067R

The above equipment is a FHSS modular transmitter operating in the 902-928 MHz band. Testing was performed where required with the following antennas

PCB Antenna (0 dBi Gain)
External antenna (2dBi Gain
External antenna (5dBi Gain)

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
	Title 47 of the CFR: Part 15 Subpart (c)	RSS – 210 Issue 8, December 2010		
Radiated spurious emissions (Restricted bands)	15.247	Annex 8, A8.5	ANSI C63.10:2009	Pass
Conducted spurious emissions (Non-restricted bands)	15.247	Annex 8, A8.5	ANSI C63.10:2009	Pass
AC Power conducted emissions	15.207	Section 7.2.2	ANSI C63.10:2009	Pass
20dB Bandwidth and Channel Spacing	15.247(a)(1)(i)	Annex 8, A8.1(b)	ANSI C63.10:2009	Pass
Conducted Carrier Power	15.247(b)(2)	Annex 8, A8.4(2)	ANSI C63.10:2009	Pass
Hopping Frequencies	15.247(a)(1)	Annex 8, A8.1(d)	ANSI C63.10:2009	Pass
Channel Occupancy	15.247(a)(1)(i)	Annex 8, A8.1(d)	ANSI C63.10:2009	Pass
Unintentional Radiated Spurious Emissions	15.109	Section 7.2.3	ANSI C63.10:2009	Pass
Extrapolation Factor:	15.31(f)	RSS-Gen Issue 3 7.2.7	-	-
Maximum Frequency of Search:	15.33	RSS-Gen Issue 3 4.9	-	-
Antenna Arrangements Integral:	15.203	RSS-Gen Issue 3 7.1.2	-	-
Antenna Arrangements External Connector:	15.204	RSS-Gen Issue 3 7.1.2	-	-
Restricted Bands:	15.205	RSS-Gen Issue 3 7.2.2	-	-

Abbreviations used in the above table:

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

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

1.6 Notes Relating To The Assessment

With regard to this assessment, the following points should be noted:

The results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 1.7 of this test report (Deviations from Test Standards).

For emissions testing, throughout this test report, “Pass” indicates that the results for the sample as tested were below the specified limit (refer also to Section 2, Measurement Uncertainty).

Where relevant, the apparatus was only assessed using the monitoring methods and susceptibility criteria defined in this report.

All testing with the exception of testing at the Open Area Test Site was performed under the following environmental conditions:

Temperature	: 17 to 23 °C
Humidity	: 45 to 75 %
Barometric Pressure	: 86 to 106 kPa

All dates used in this report are in the format dd/mm/yy.

This assessment has been performed in accordance with the requirements of ISO/IEC 17025.

1.7 Deviations from Test Standards

There were no deviations from the standards tested to.

1.8 Test Site

Location	Registration Number	Site Type	Used For testing
Hull IC Number – 3483A	3483A-1	ATS	
	3483A-2	ATS	
Pendle Place IC Number 3930B	3930B-2	ATS	
	3930B-3	ATS	
	3930B-4	ATS	X

OATS – Open area test site
ATS - Alternative Test Site

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 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	Part 15.247(b)(1) RSS – 210, Annex 8, A8.4(2)
Measurement standard	ANSI C63.10:2009, RSS-GEN
EUT sample number	TRA-020030 S16
Modification state	0
SE in test environment	TRaC PSU
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Channel Frequency (MHz)	Peak Carrier Power (mW)	Limit (W)	Result
903.0	42.36	1	Pass
915.0	44.06		Pass
927.5	39.26		Pass

Notes:

Number of hopping channels employed is 50

Conducted Measurement

Measured Peak Carrier power includes highest gain of any antenna to be used.
Highest Gain of any antenna to be used = 5 dBi
Conducted measurements were performed sin the unique antenna connector and adaptor lead provided by the manufacturer.

A2 RF Antenna Conducted Spurious Emissions

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

Test Details:	
Regulation	Part 15.247(d) and Clause 15.205, RSS-210 Annex 8, A8.5
Measurement standard	ANSI C63.10:2009, RSS – GEN, ANSI C63.4:2003
Frequency range	9 kHz to 10 GHz
EUT sample number	TRA-020030 S16
Modification state	0
SE in test environment	TRaC PSU
SE isolated from EUT	None
EUT set up	Refer to Appendix C

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

Operating Frequency 903.0 MHz						
Ref No.	Measured Freq (MHz)	Det.	Is measured Frequency within the Restricted bands (Y/N)	Measured Peak Conducted power (RBW =100kHz) (dBuV)	15.247(d) Limit (dBuV)	Summary
No Significant Emissions Within 20 dB of the limit						

Operating Frequency 915.0 MHz						
Ref No.	Measured Freq (MHz)	Det.	Is measured Frequency within the Restricted bands (Y/N)	Measured Peak Conducted power (RBW =100kHz) (dBuV)	15.247(d) Limit (dBuV)	Summary
No Significant Emissions Within 20 dB of the limit						

Operating Frequency 927.5 MHz						
Ref No.	Measured Freq (MHz)	Det.	Is measured Frequency within the Restricted bands (Y/N)	Measured Peak Conducted power (RBW =100kHz) (dBuV)	15.247(d) Limit (dBuV)	Summary
No Significant Emissions Within 20 dB of the limit						

Notes:

1. The conducted emission limit for emissions are based on a transmitted carrier level of 15.247(b) and Annex 8, A8.4(2).. With the EUT transmitting on its lowest, centre and highest carrier frequencies in turn, emissions from the EUT are required to be 20 dB below the level of the highest fundamental as measured within a 100 kHz RBW in accordance with 15.247(d) and Annex 8, A8.5 using a peak detector.
2. The RBW = 100 kHz, Video bandwidth (VBW) > RBW and the radio spectrum was investigated in accordance with 15.33 (a)(1) and RSS – GEN 4.9.
3. The measurements at 2400 MHz and 2483.5 MHz were made to ensure band edge compliance.
4. The carrier level was measured whilst varying the supply voltage between 85% and 105% of the nominal supply voltage as required by 15.31(e). No variation in carrier level was observed.
5. The measurements at 2400 MHz and 2483.5 MHz were made to ensure band edge compliance. All other emissions were at least 20dB below the test limit

The limit outside the restricted band in 100 kHz RBW is defined using the following formula in accordance with 15.247(d) and Annex 8, A8.5:

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

A3 Radiated Electric Field Emissions

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

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

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

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

Test Details:	
Regulation	Part 15.247(d) and 15.205, RSS – 210, Annex 8, A8.5
Measurement standard	ANSI C63.10:2009, RSS – GEN, ANSI C63.4:2003
Frequency range	30 MHz – 10 GHz
EUT sample number	TRA-020030 S16, S17, S20
Modification state	0
SE in test environment	TRaC PSU
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photograph 1 and 2

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

Integral PCB Antenna									
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)
Bottom Channel									
Pk	1805.975	47.29	3.4	27.0	36.3	40.76	-	109.14	5000
Av	1805.975	43.83	3.4	27.0	36.3	37.30	-	73.28	500
Pk	2708.991	43.05	3.9	29.2	36.0	40.15	-	101.74	5000
Av	2708.991	33.92	3.9	29.2	36.0	31.02	-	35.56	500
Pk	5417.964	46.59	4.3	34.0	35.7	52.73	-	284.77	5000
Av	5417.964	50.23	4.3	34.0	35.7	49.09	-	433.01	500
Middle Channel									
Pk	1829.967	47.2	2.0	27.1	36.3	39.95	-	99.43	5000
Av	1829.967	43.49	2.0	27.1	36.3	36.24	-	64.86	500
Pk	2744.975	42.72	3.9	29.1	36.0	39.72	-	96.83	5000
Av	2744.975	34.62	3.9	29.1	36.0	31.62	-	38.11	500
Pk	5490.38	48.3	4.3	33.9	35.7	50.80	-	346.74	5000
Av	5490.38	43.67	4.3	33.9	35.7	46.17	-	203.47	500
Top Channel									
Pk	1855.02	48.19	3.2	27.3	36.2	42.47	-	132.89	5000
Av	1855.02	45.27	3.2	27.3	36.2	39.55	-	94.95	500
Pk	2782.55	44.07	3.8	29.1	36.0	40.97	-	111.81	5000
Av	2782.55	35.3	3.8	29.1	36.0	32.20	-	40.74	500
Pk	4637.509	44.57	3.8	32.3	35.6	45.07	-	179.27	5000
Av	4637.509	36.39	3.8	32.3	35.6	36.89	-	69.90	500
Pk	5565.044	44.57	3.8	32.3	35.6	45.07	-	179.27	5000
Av	5565.044	36.39	3.8	32.3	35.6	36.89	-	69.90	500

2dBi External PCB Antenna									
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)
Bottom Channel									
No Significant Emissions Within 20dB of Limit									
Middle Channel									
No Significant Emissions Within 20dB of Limit									
Top Channel									
No Significant Emissions Within 20dB of Limit									

5dBi External PCB Antenna									
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)
Bottom Channel									
No Significant Emissions Within 20dB of Limit									
Middle Channel									
No Significant Emissions Within 20dB of Limit									
Top Channel									
No Significant Emissions Within 20dB of Limit									

Notes:

1 Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10:2009: section 4.5, Table 1 and ANSI C63.4: 2003 section 8.2.1

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 Detector	RBW=VBW= 1MHz
Average Detector	RBW=VBW= 1MHz

These settings as per ANSI C63.10:2009 and DA 00-705.

6 In accordance with DA 00-705, the average level of the spurious radiated emission may be reduced by the duty cycle correction factor. If the dwell time per channel (refer to the measured channel occupancy time, section A7 of this test report) of the hopping signal is less than 100ms then the average measurement may be further adjusted by the duty cycle correction factor which is derived from

$$20\log_{10}\left(\frac{\text{dwell time}}{100ms}\right)$$

The upper and lower frequency of the measurement range was decided according to Part 15: Clause 15.33(a) and 15.33(a)(1) and RSS-GEN 4.9

Radiated emission limits for emissions falling within the restricted bands.

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:

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

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

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

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

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

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

A4 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 C63.10:2009, RSS – GEN, ANSI C63.4:2003
Frequency range	150kHz to 30MHz
EUT sample number	
Modification state	
SE in test environment	
SE isolated from EUT	
EUT set up	Refer to Appendix C
Photographs (Appendix F)	Photograph 3

The worst-case power line conducted emission measurements are listed below for the configuration producing the worst case radiated power and spurious emissions:

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 the 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 the limit						

Specification limits :

Conducted emission limits (47 CFR 15: Clause 15.207 and RSS – GEN, Section 7.2.2 Table 2:)

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

A5 20 dB Bandwidth and Carrier Frequency Separation

Title 47 of the CFR: Part 15 Subpart (c) 15.247(a)(1)(i) and RSS-210 Annex 8, A8.1(b) requires the measurement of the bandwidth of the transmission between the -20 dB points on the transmitted spectrum. The results of this test determine the limits for channel spacing. The channel separation shall be a minimum of 25 kHz or the 20 dB bandwidth, whichever is the greater. The formal measurements are detailed below:

Test Details:	
Regulation	Part 15.247(a)(1)(i). RSS-210 Annex 8, A8.1(b)
EUT sample number	TRA-020030 S16
Modification state	0
SE in test environment	TRaC PSU
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Channel Frequency (MHz)	Measured 20 dB Bandwidth (kHz)	Limit	Result
903.0	197.916	<500kHz	Pass
915.0	197.917	<500kHz	Pass
927.5	197.917	<500kHz	Pass

Measured Channel Spacing (kHz)	Limit	Result
501.6 kHz	(25kHz or ≥ Measured 20 dB Bandwidth kHz)	Pass

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

A6 Hopping frequencies

Hopping frequencies were verified using a spectrum analyser, while the EUT was operating in its normal frequency hopping mode.

Test Details:	
Regulation	Part 15.247(a)(1)(i), RSS – 210, Annex 8, A8.1(d)
EUT sample number	TRA-020030 S16
Modification state	0
SE in test environment	TRaC PSU
SE isolated from EUT	None
EUT set up	Refer to Appendix C

No. of Hopping Channels	Requirement	Result
50	50	Pass

Plots showing the hopping channels are contained in Appendix B

A7 Channel Occupancy

Channel occupancy time was verified using a spectrum analyser in zero span mode, centred on the middle hopping channel frequency (915.0 MHz), while the EUT was operating in its normal frequency hopping mode. The other channels were then verified to ensure that the channel occupancy was identical for all channels.

Test Details:	
Regulation	Part 15.247(a)(1), RSS – 210, Annex 8, A8.1(d)
EUT sample number	TRA-020030 S16
Modification state	0
SE in test environment	TRaC PSU
SE isolated from EUT	None
EUT set up	Refer to Appendix C

Measured Channel Occupancy Time (ms)	Measurement Period (seconds)	Number of Transmissions in Measurement period	Calculated Average Channel retention Time (s)	Average Channel Occupancy Time Limit (s)	Result
32.85	25	1	0.03285	0.4	PASS

Plots showing the channel occupancy time and time between successive transmissions are contained in Appendix B of this test report. These are identical for all modulation modes.

Calculated Average Channel retention Time - CACRT
Measured Channel Occupancy Time - MCOT
Number of Transmissions in Measurement period - NTMP

$$CACRT = MCOT \times NTMP$$

A8 Antenna Gain

The maximum antenna gain for the antenna types to be used with the EUT, as declared by the client, is 5 dBi.

A9 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:	
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 10 GHz
EUT sample number	TRA-020030 S15, S17, S20
Modification state	0
SE in test environment	TRaC PSU
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Photographs (Appendix F)	1 & 2

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

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)
Bottom Channel									
No Significant Emissions Within 20dB of Limit									
Middle Channel									
No Significant Emissions Within 20dB of Limit									
Top Channel									
No Significant Emissions Within 20dB of Limit									

Appendix B: Supporting Graphical Data

This appendix contains graphical data obtained during testing.

Notes:

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

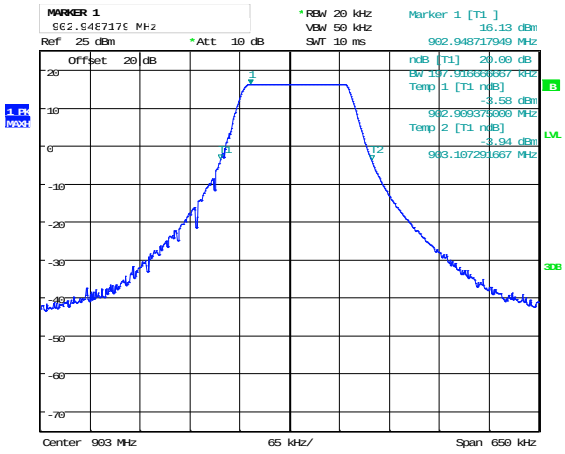
(b) The time and date on the plots do not necessarily equate to the time of the test.

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

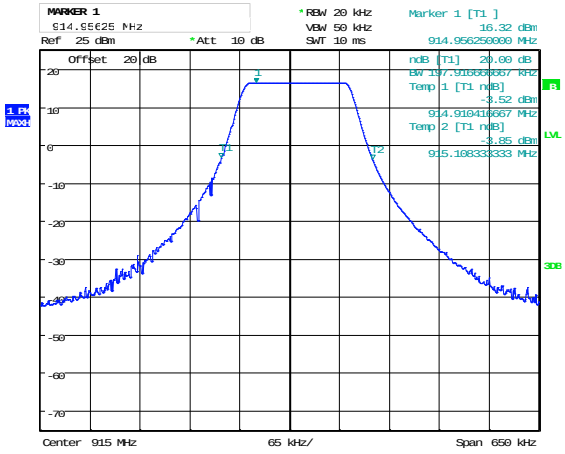
(d) Appendix C details the numbering system used to identify the sample and its modification state.

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

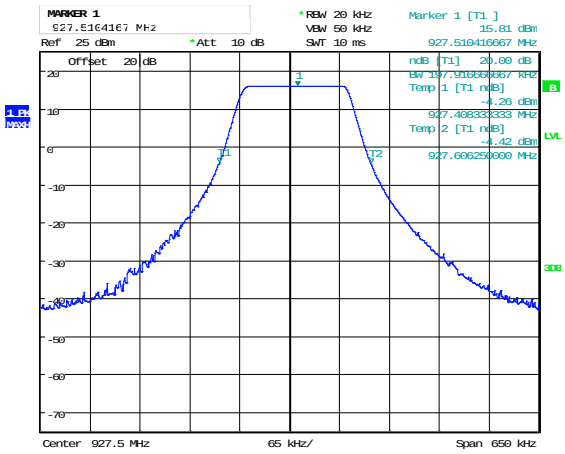
20dB Bandwidth



903.0MHz

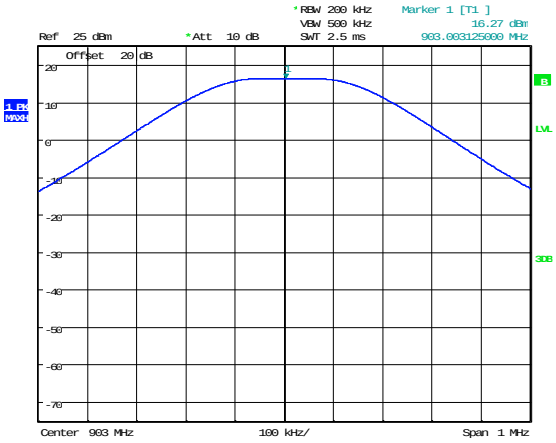


915.0 MHz



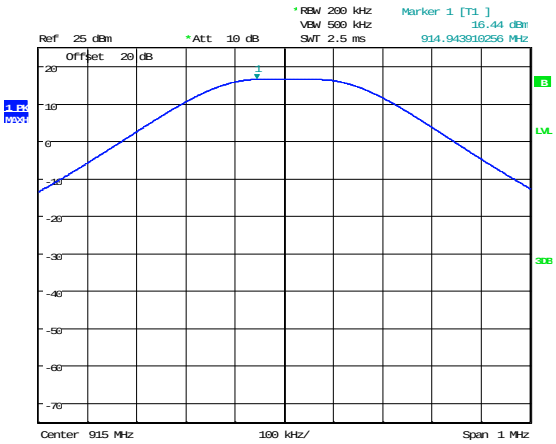
927.5 MHz

Conducted carrier power



Date: 13.MAY.2014 10:20:02

903.0MHz



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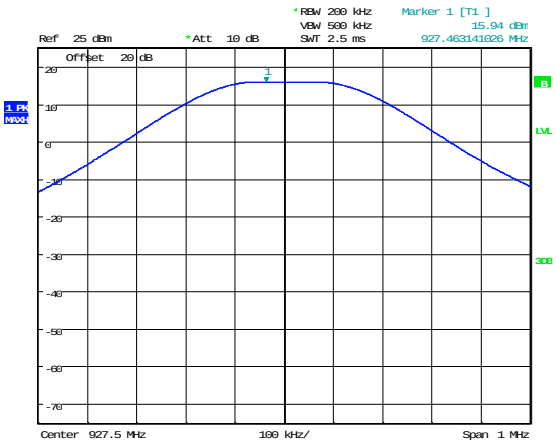
915.0 MHz



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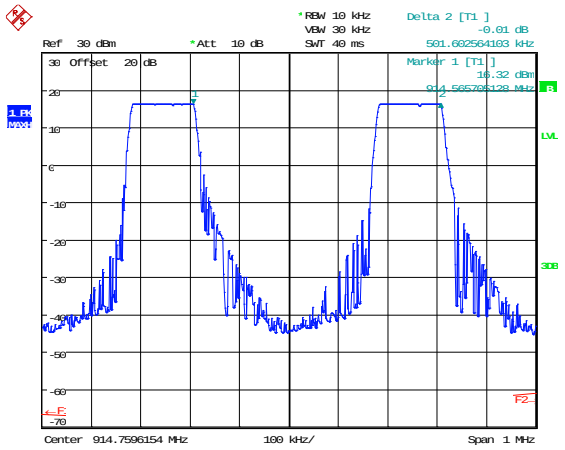
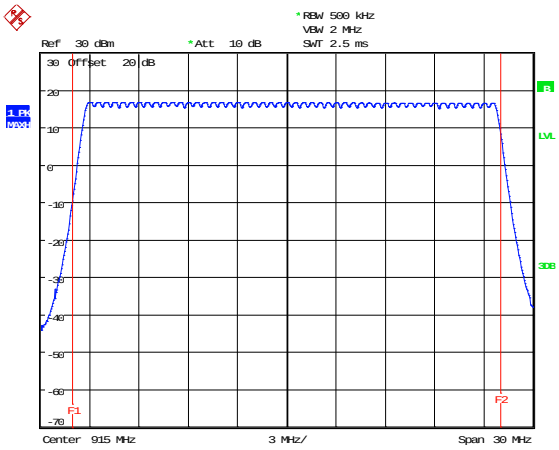
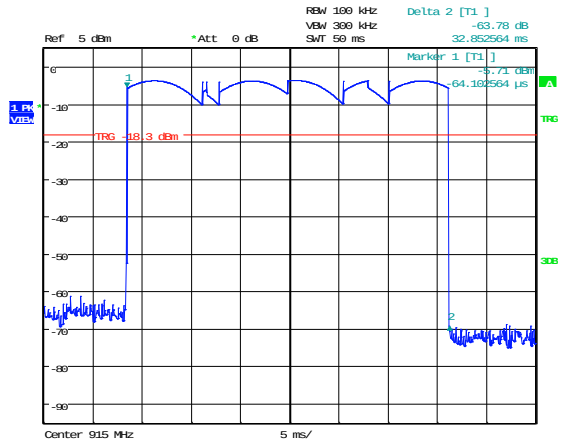
927.5 MHz



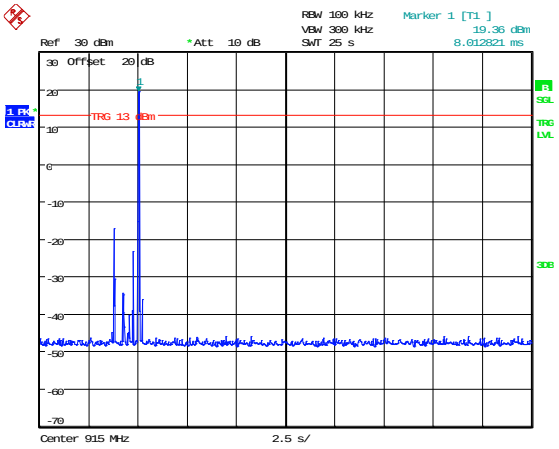
Channel Spacing



Number Of Hopping Channels

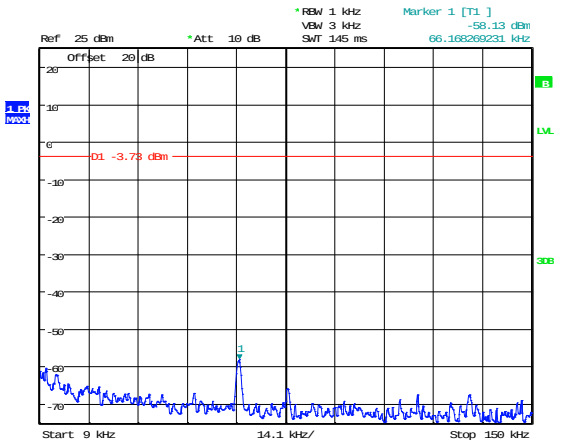


Channel Occupancy Time

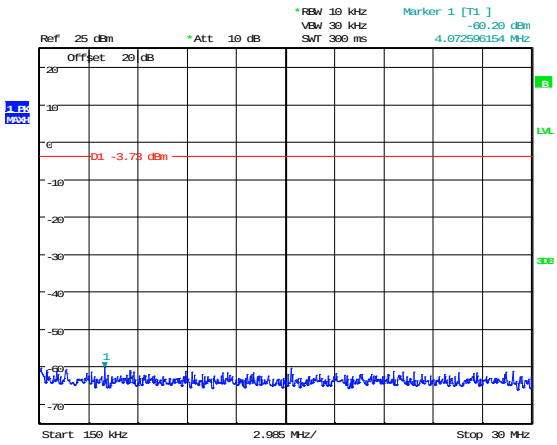


Channel repetition time

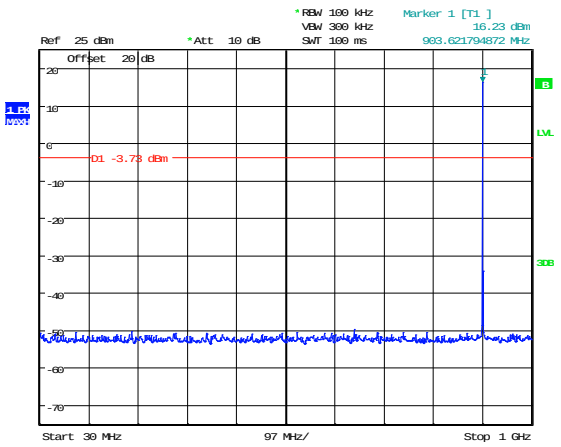
Conducted Spurious emissions – 903.0 MHz



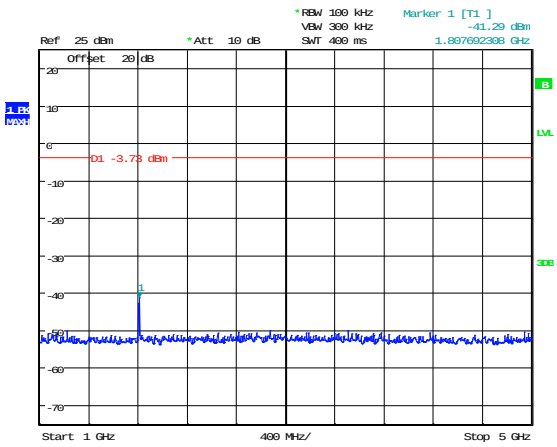
9 kHz to 150 kHz



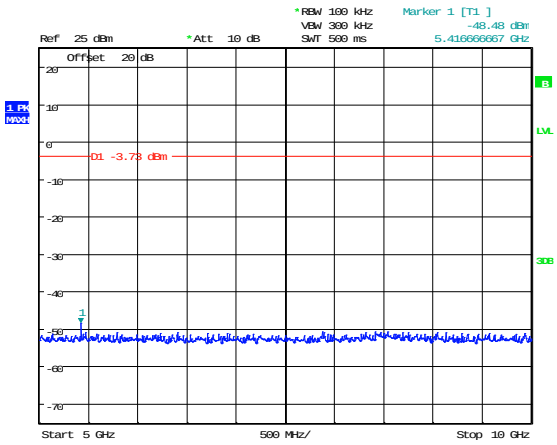
150kHz to 30 MHz



30 MHz to 1 GHz

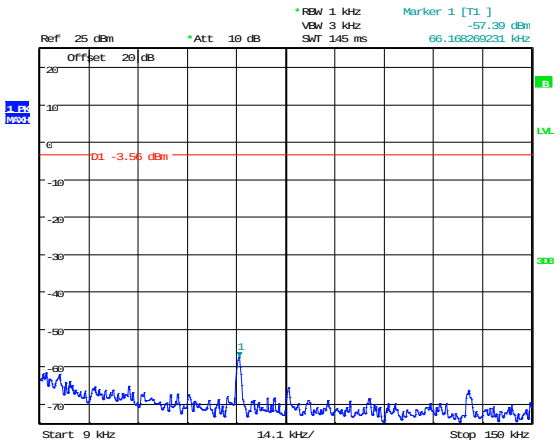


1 GHz to 5 GHz

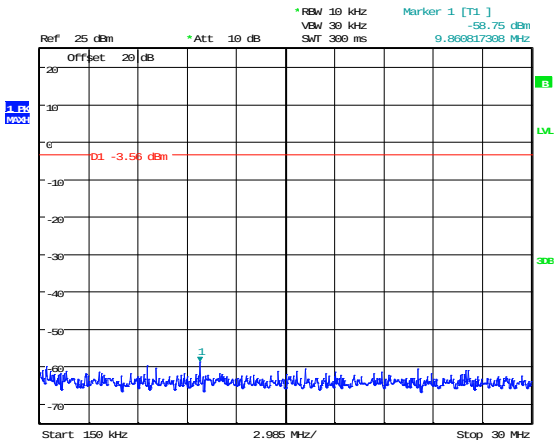


5 GHz to 10 GHz

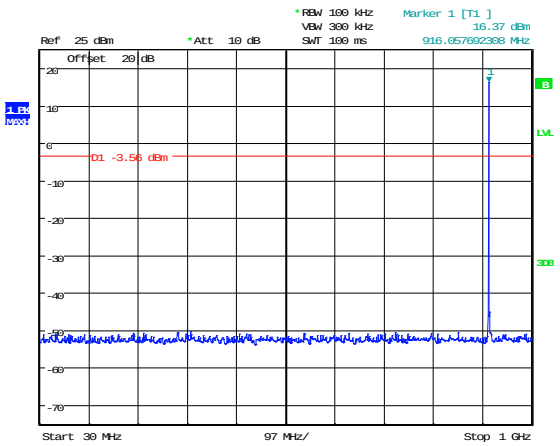
Conducted Spurious emissions – 915.0 MHz



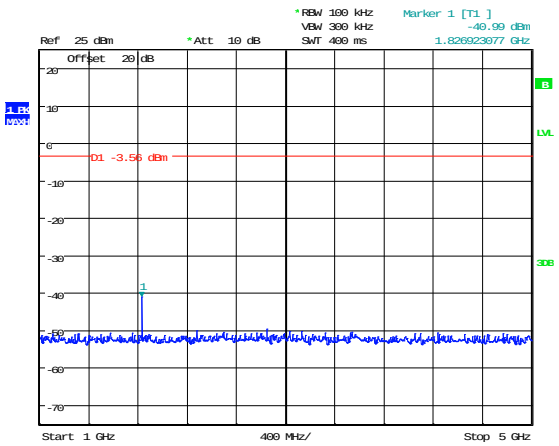
9 kHz to 150 kHz



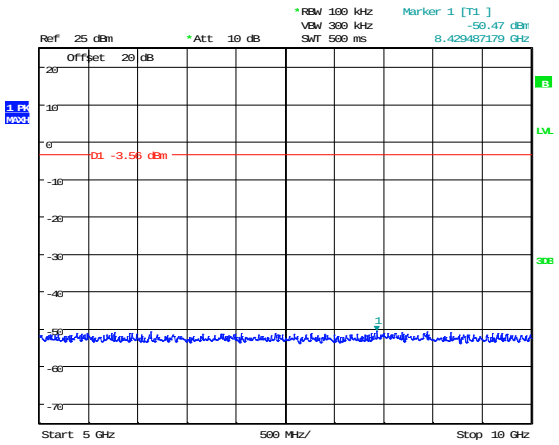
150kHz to 30 MHz



30 MHz to 1 GHz

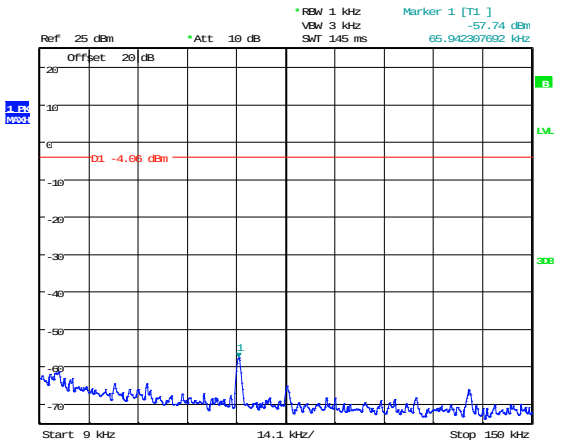


1 GHz to 5 GHz



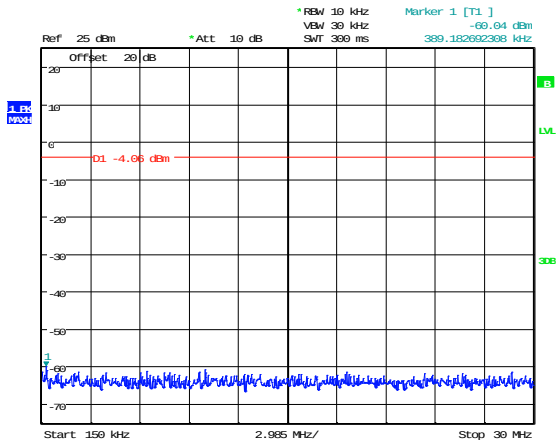
5 GHz to 10 GHz

Conducted Spurious emissions – 927.5 MHz



Date: 13.MAY.2014 11:15:09

9 kHz to 150 kHz



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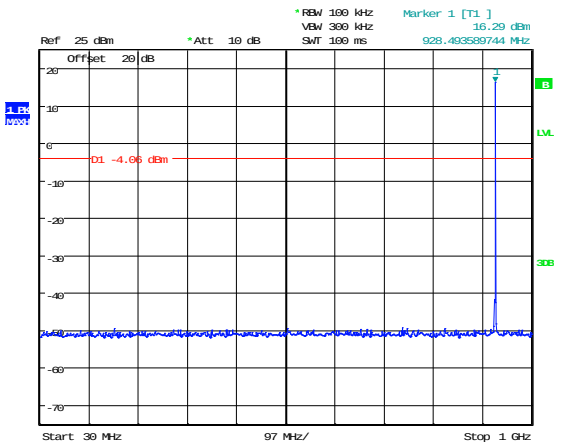
150 kHz to 30 MHz



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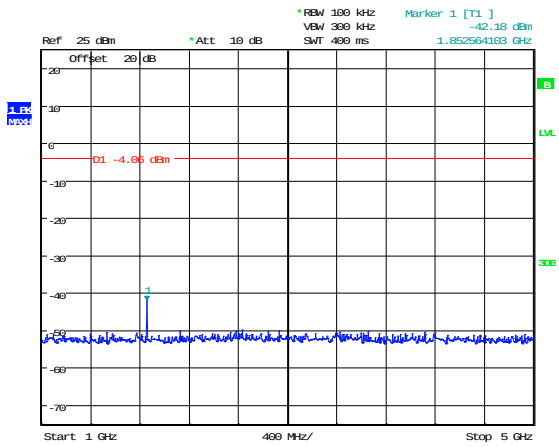
30 MHz to 1 GHz



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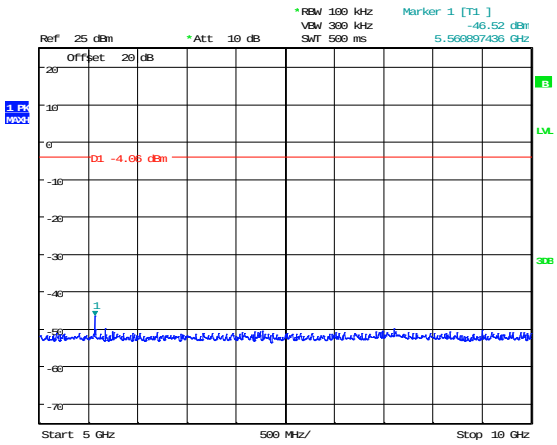
1 GHz to 5 GHz



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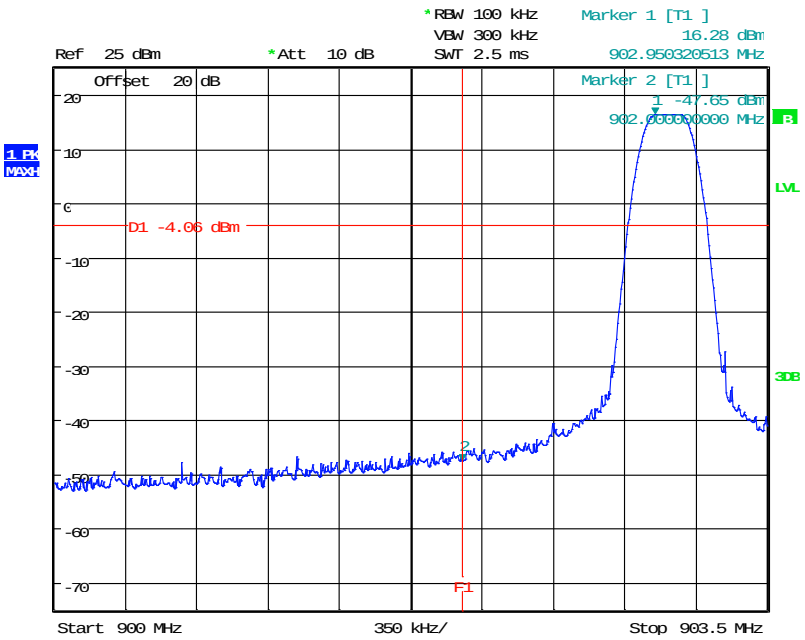
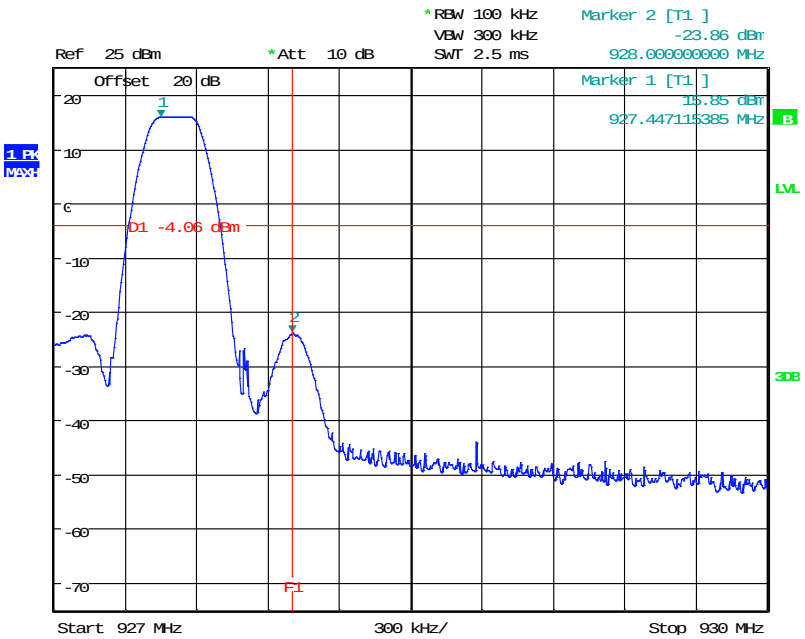
5 GHz to 10 GHz

Conducted Bandedge Compliance



Date: 13.MAY.2014 11:20:00

Lower Bandedge

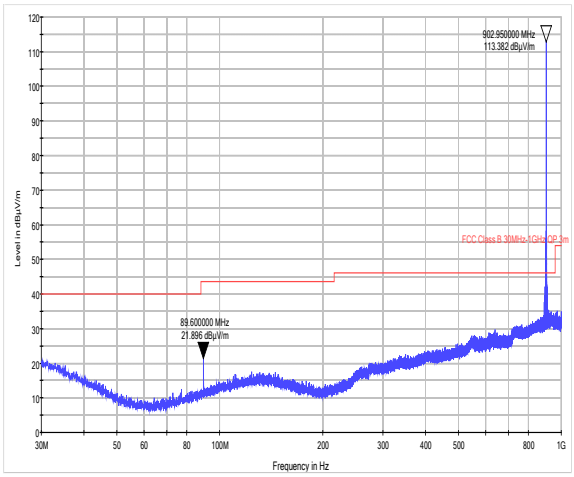


Date: 13.MAY.2014 11:17:50

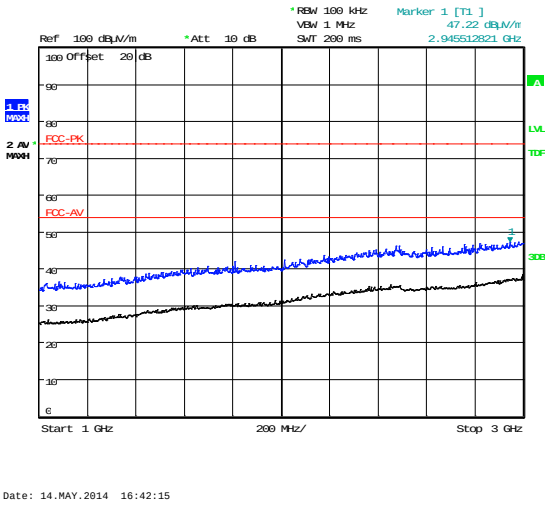
Upper Bandedge

Radiated Spurious emissions

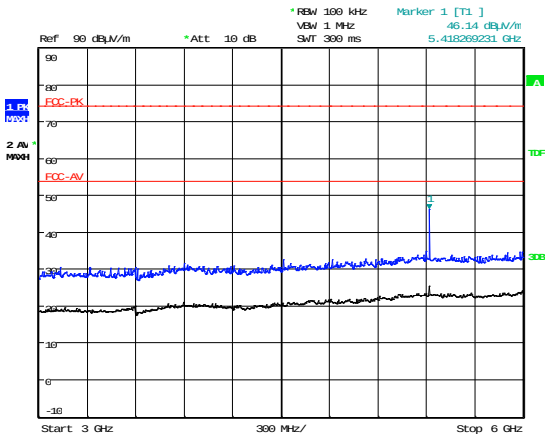
Integral PCB Antenna - 903.0MHz



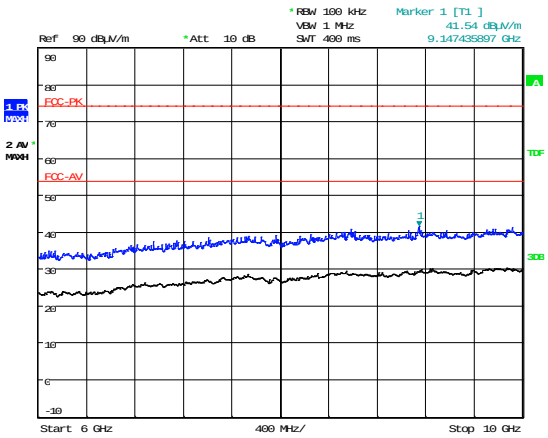
30 MHz to 1 GHz



1 GHz to 3 GHz



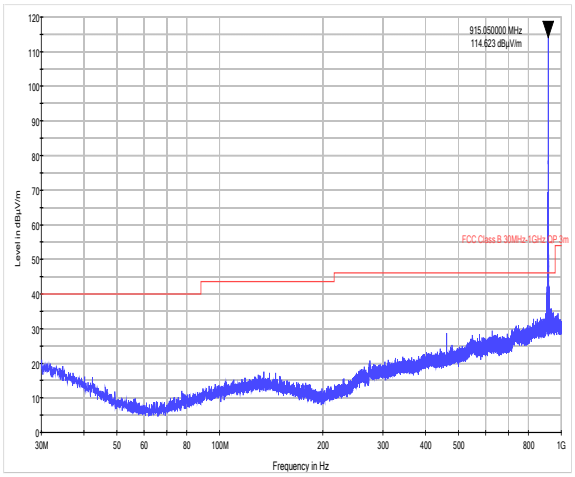
3 GHz to 6 GHz



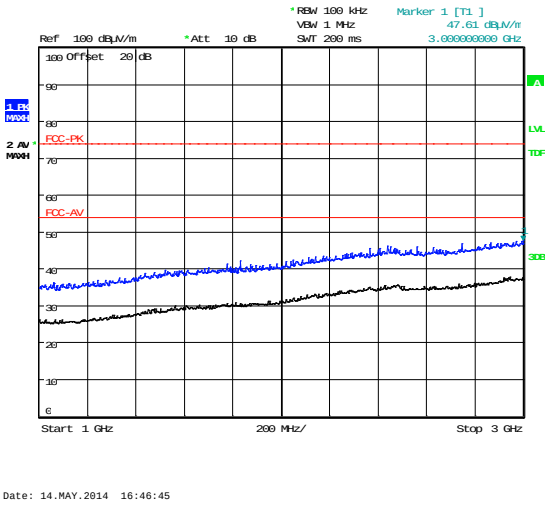
6 GHz to 10 GHz

Radiated Spurious emissions

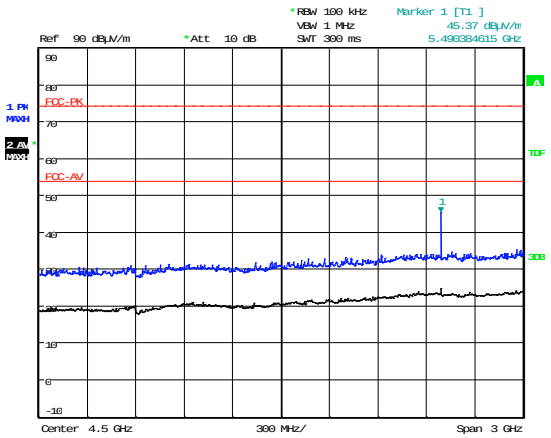
Integral PCB Antenna - 915.0MHz



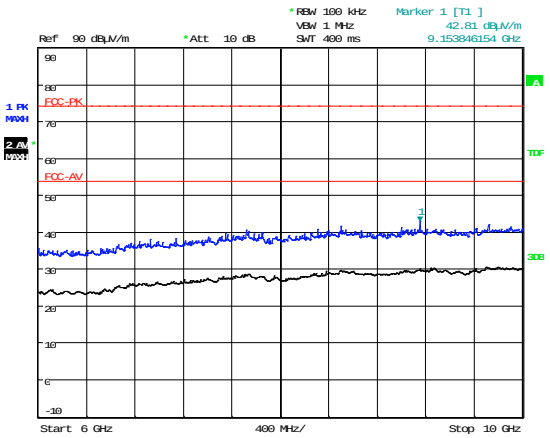
30 MHz to 1 GHz



1 GHz to 3 GHz



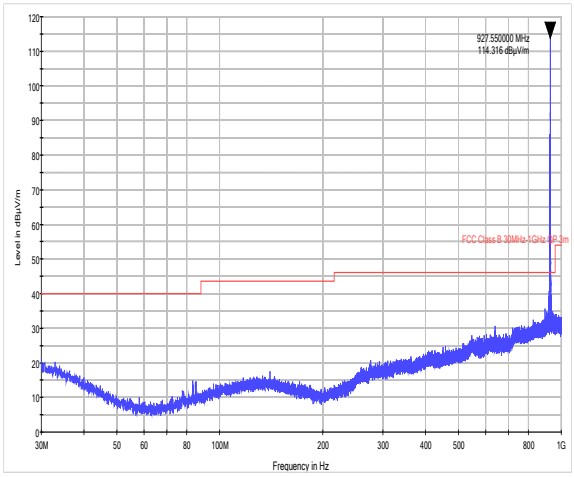
3 GHz to 6 GHz



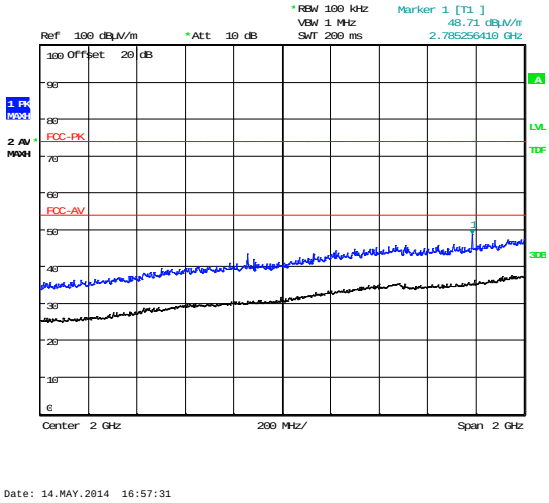
6 GHz to 10 GHz

Radiated Spurious emissions

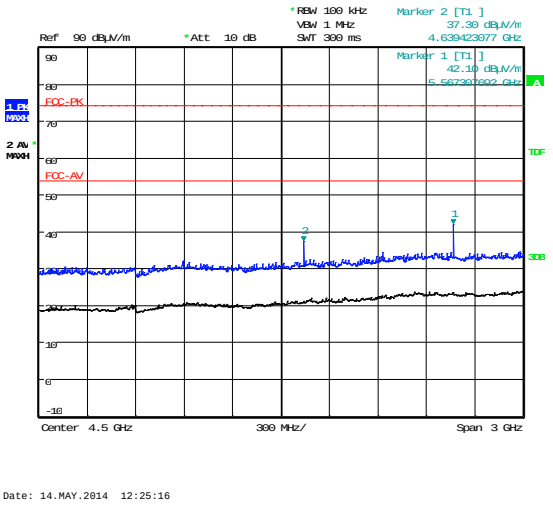
Integral PCB Antenna – 927.5MHz



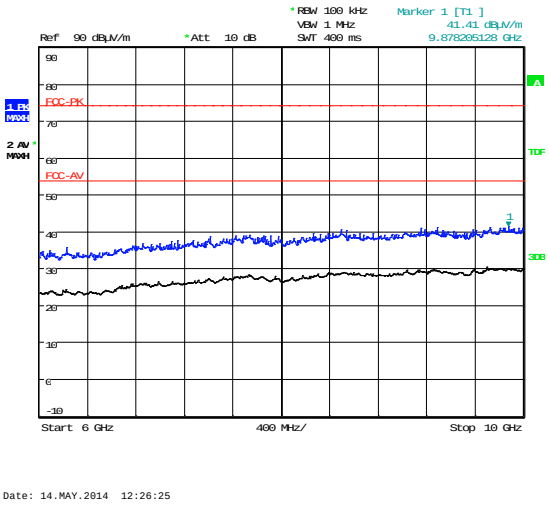
30 MHz to 1 GHz



1 GHz to 3 GHz

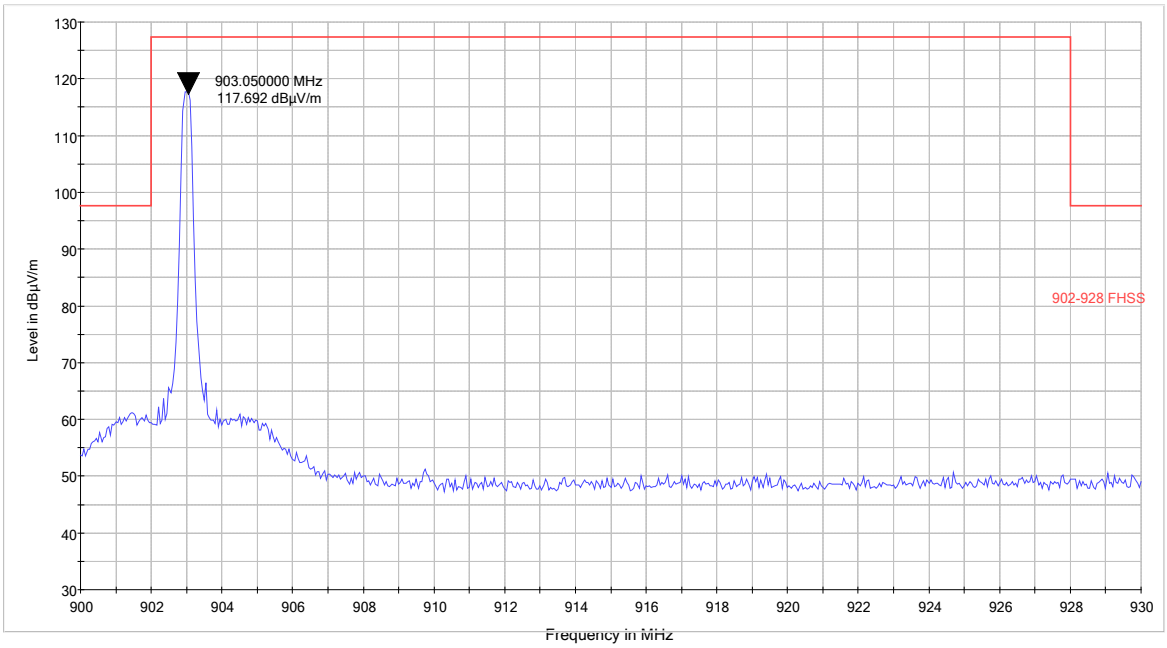


3 GHz to 6 GHz

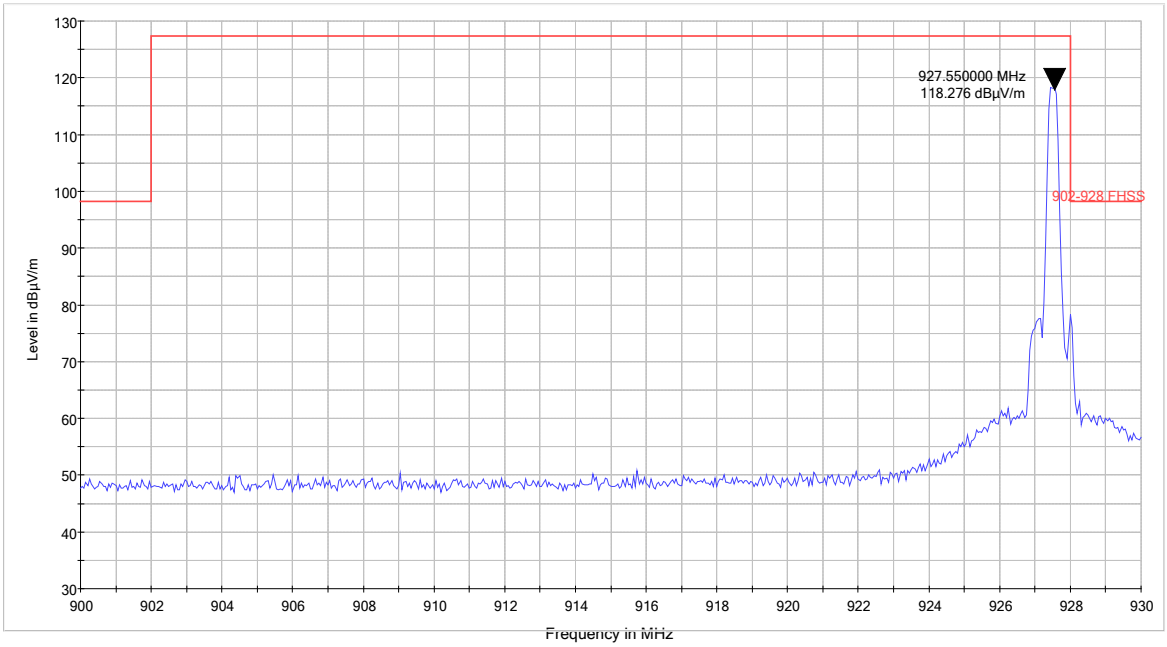


6 GHz to 10 GHz

Radiated Bandedge Compliance Integral PCB Antenna



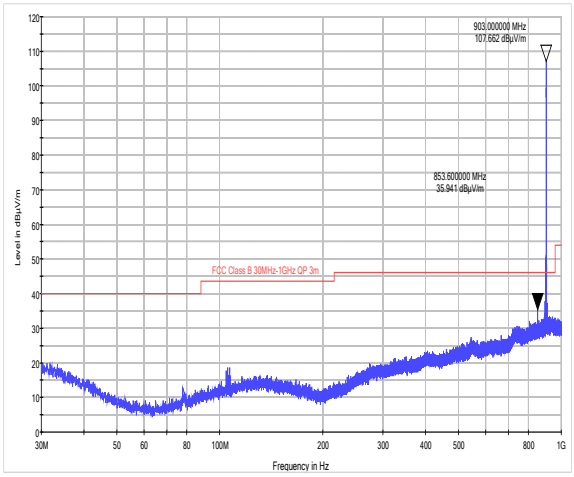
Lower Bandedge



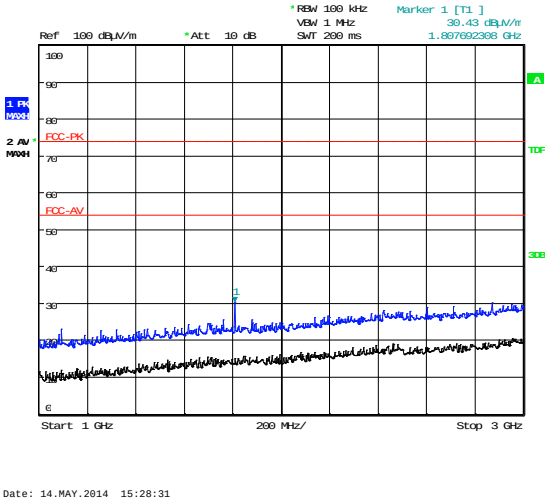
Upper Bandedge

Radiated Spurious emissions

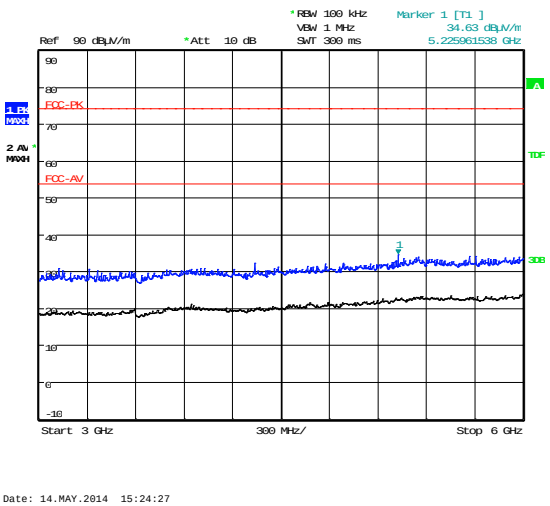
2 dBi External Antenna - 903.0MHz



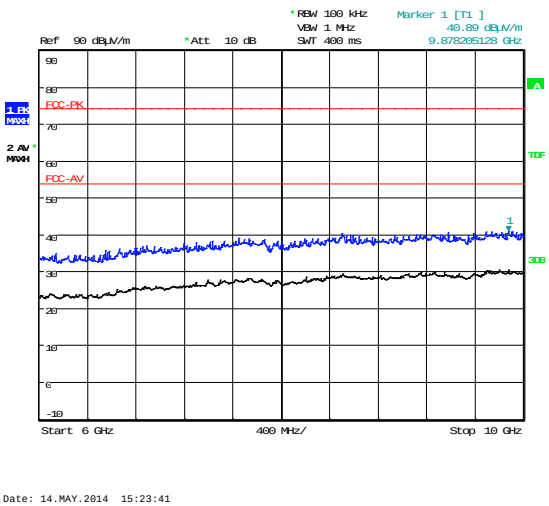
30 MHz to 1 GHz



1 GHz to 3 GHz

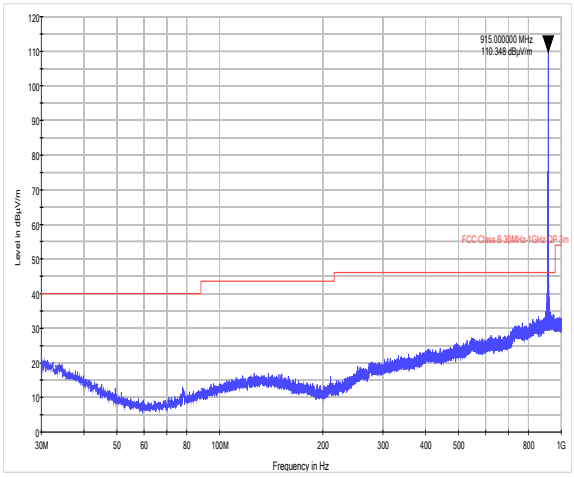


3 GHz to 6 GHz

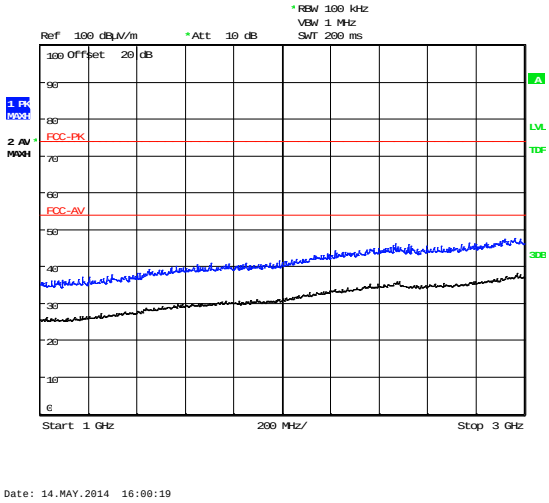


6 GHz to 10 GHz

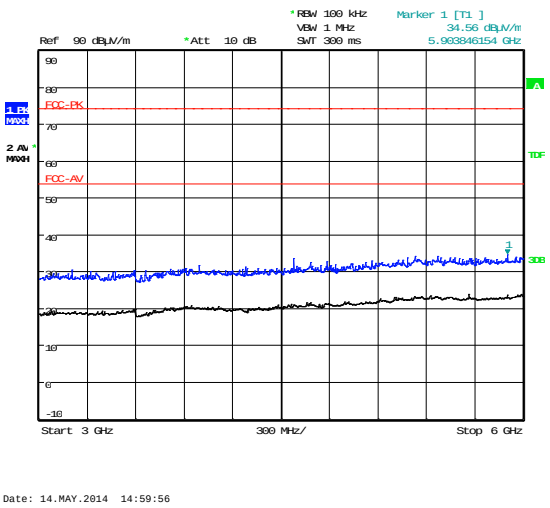
Radiated Spurious emissions 2 dBi External Antenna - 915.0MHz



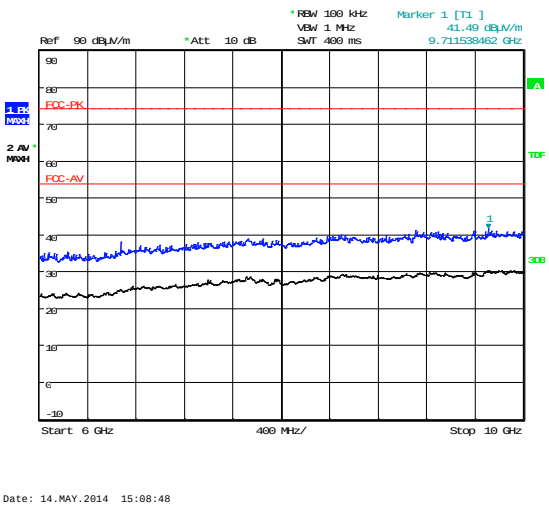
30 MHz to 1 GHz



1 GHz to 3 GHz



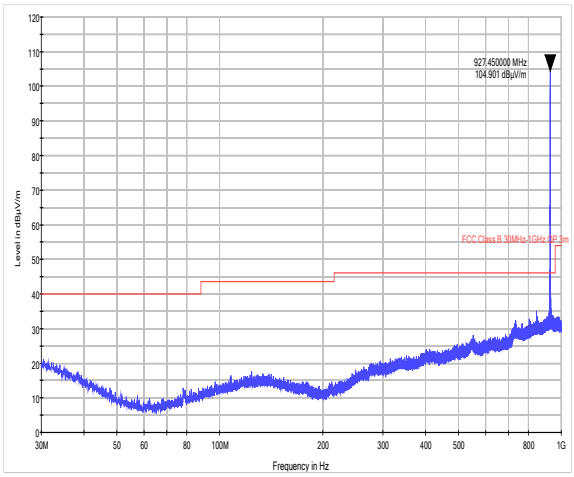
3 GHz to 6 GHz



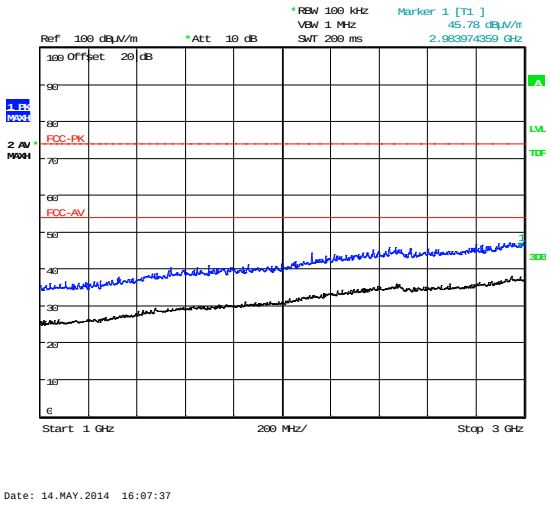
6 GHz to 10 GHz

Radiated Spurious emissions

2 dBi External Antenna – 927.5MHz



30 MHz to 1 GHz



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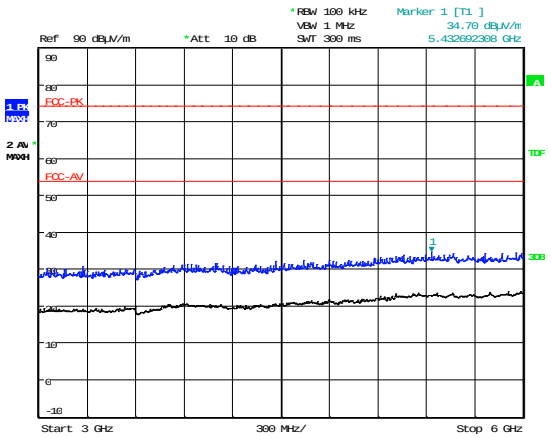
1 GHz to 3 GHz



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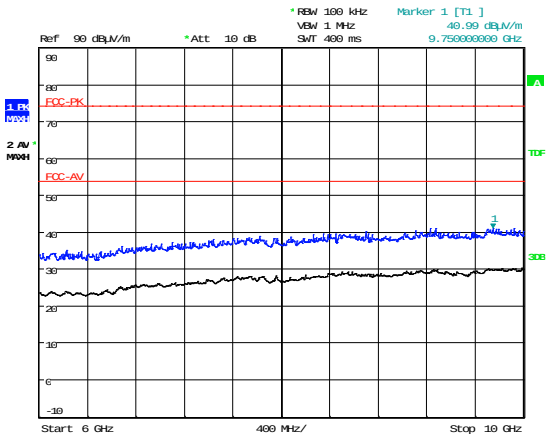
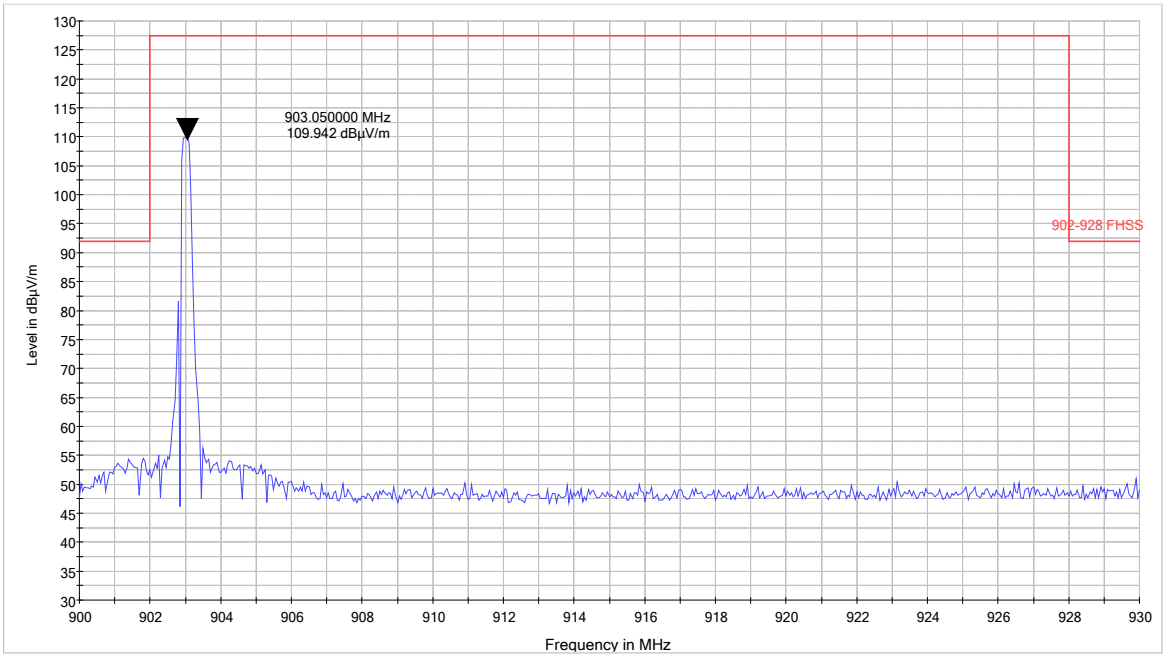
3 GHz to 6 GHz



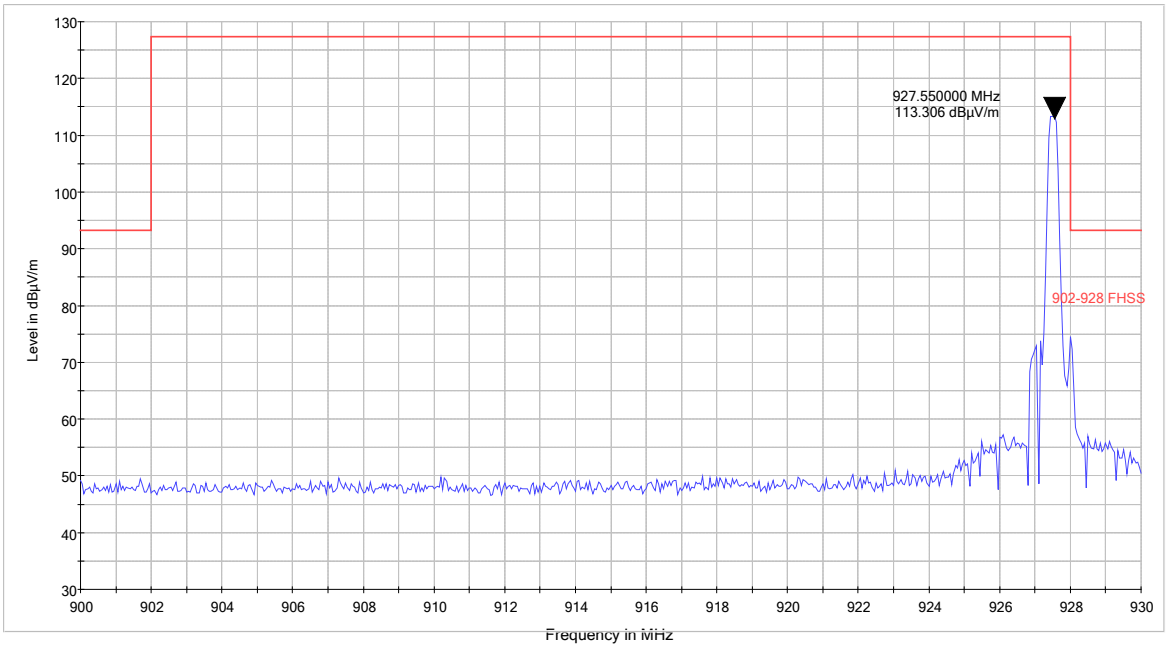
Date: 14.MAY.2014 14:56:49

6 GHz to 10 GHz

Radiated Bandedge Compliance 2 dBi External Antenna

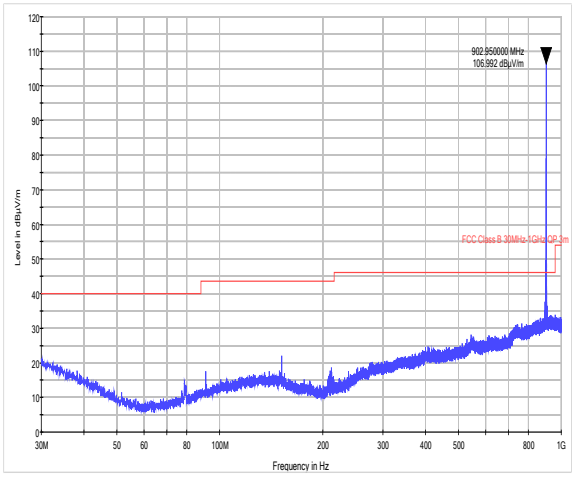


Lower Bandedge

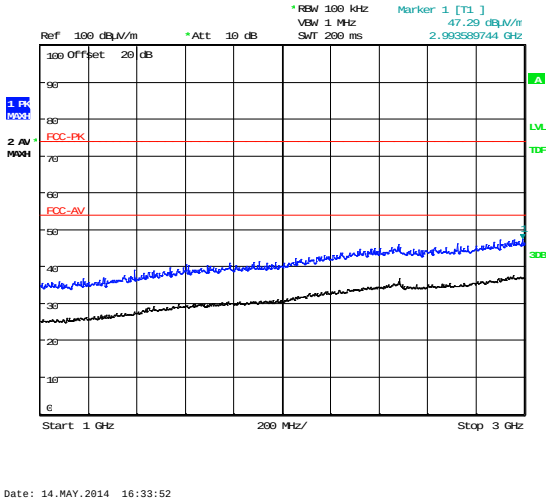


Upper Bandedge

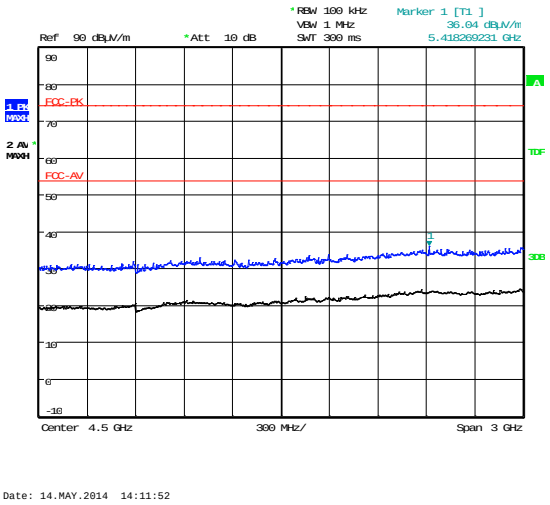
Radiated Spurious emissions 5 dBi External Antenna - 903.0MHz



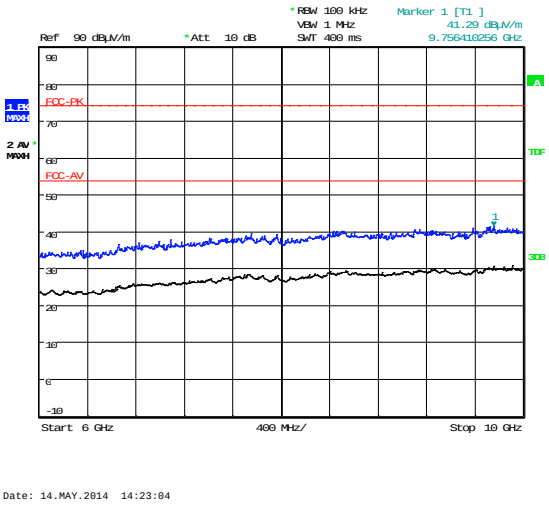
30 MHz to 1 GHz



1 GHz to 3 GHz

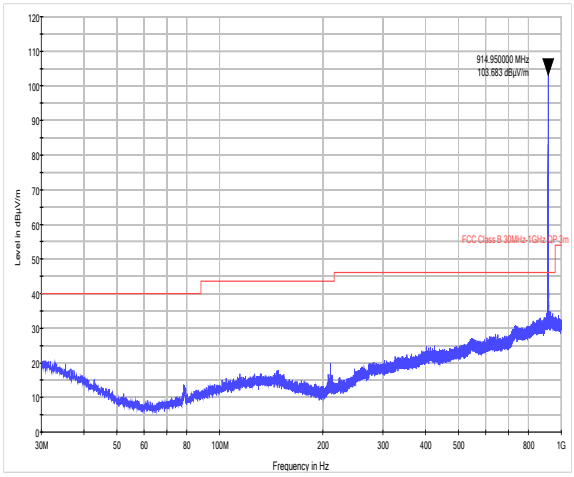


3 GHz to 6 GHz

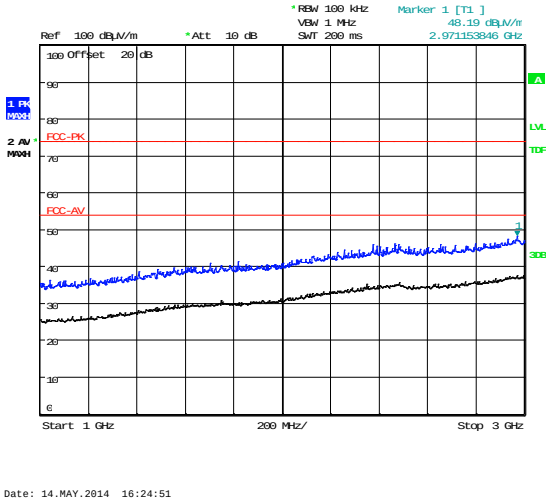


6 GHz to 10 GHz

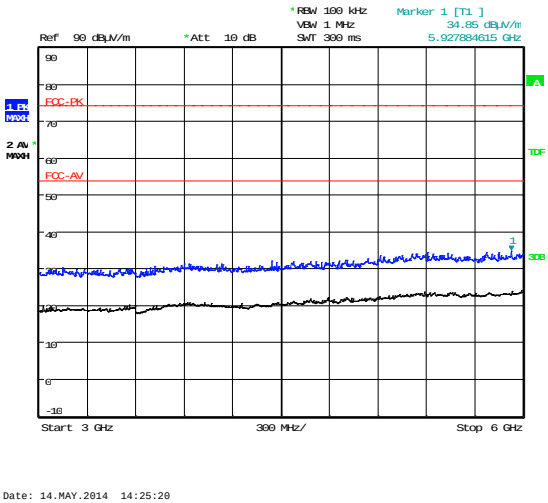
Radiated Spurious emissions 5 dBi External Antenna - 915.0MHz



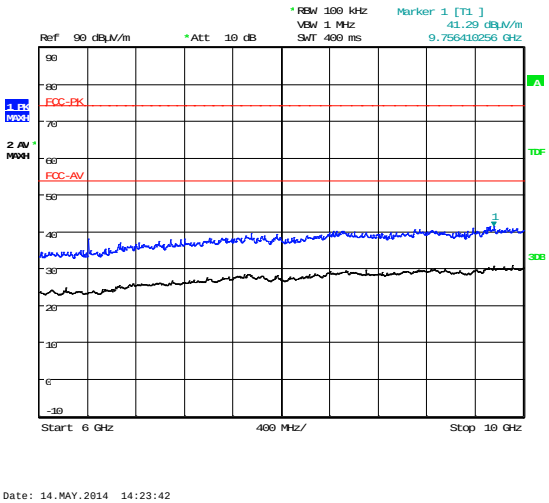
30 MHz to 1 GHz



1 GHz to 3 GHz

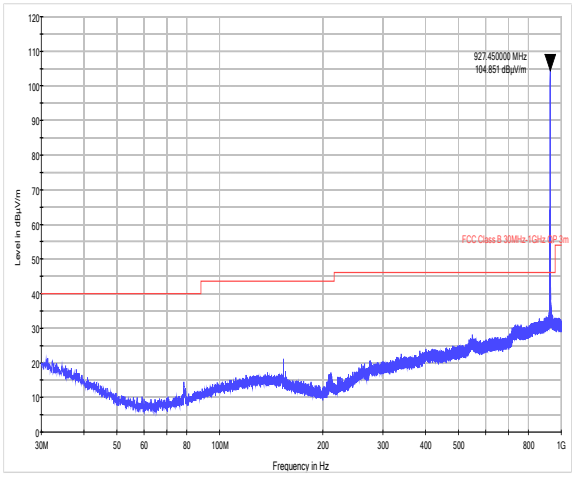


3 GHz to 6 GHz

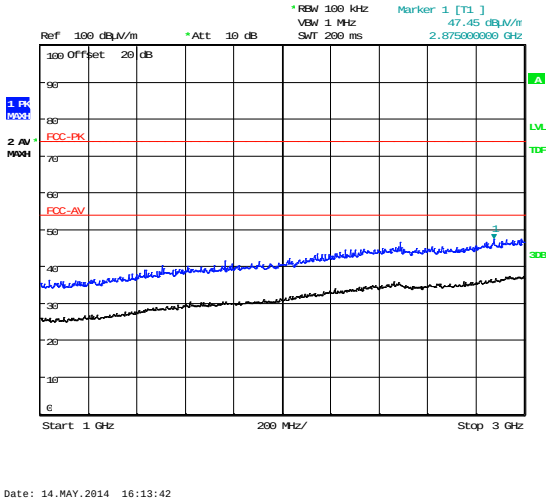


6 GHz to 10 GHz

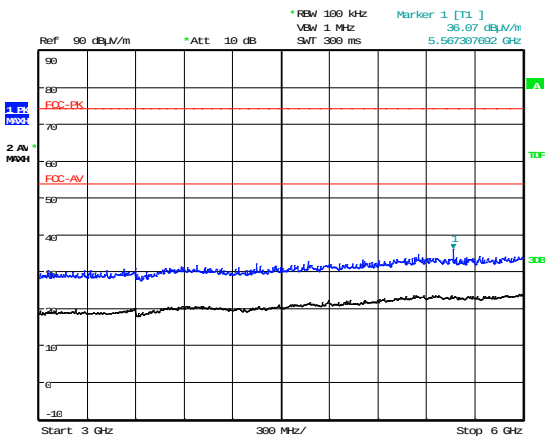
Radiated Spurious emissions 5 dBi External Antenna – 927.5MHz



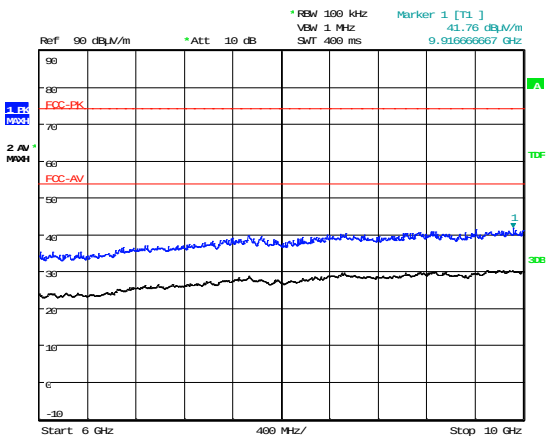
30 MHz to 1 GHz



1 GHz to 3 GHz

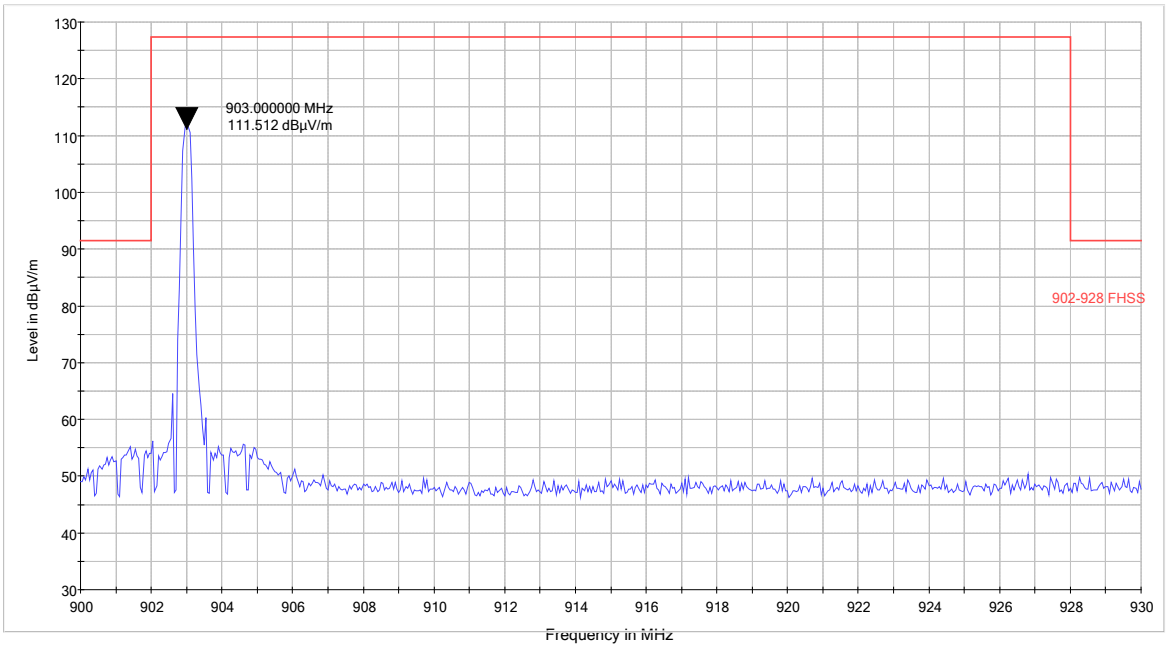


3 GHz to 6 GHz

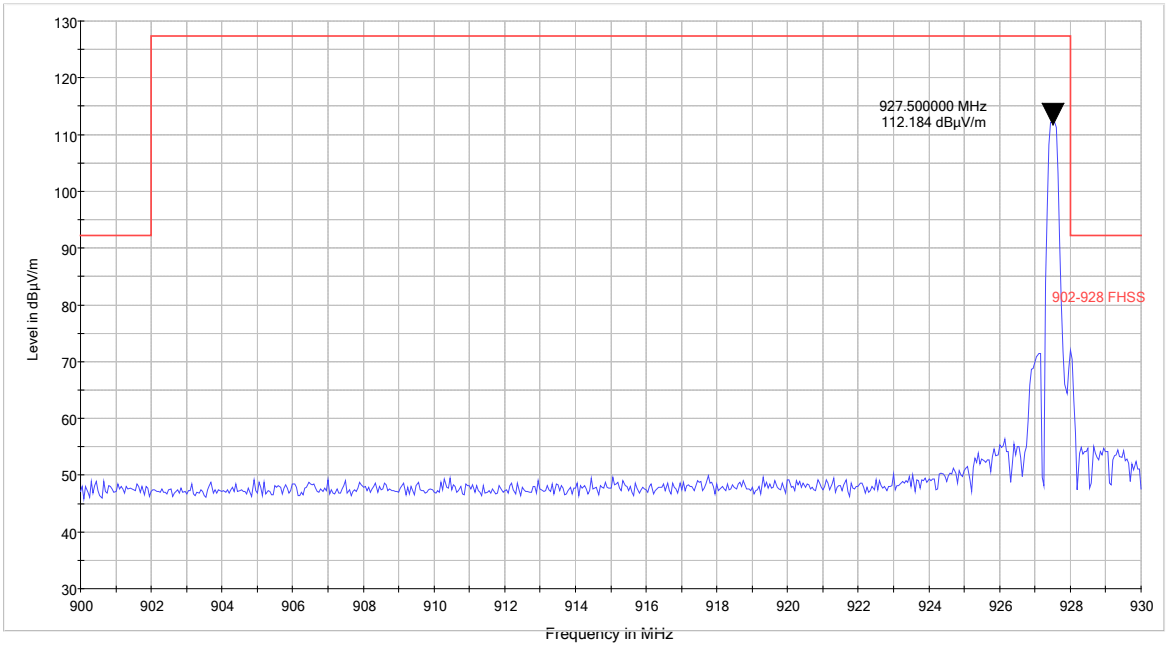


6 GHz to 10 GHz

Radiated Bandedge Compliance 5 dBi External Antenna

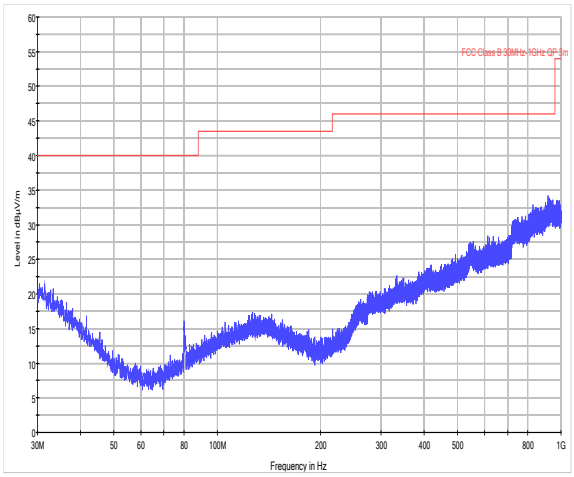


Lower Bandedge

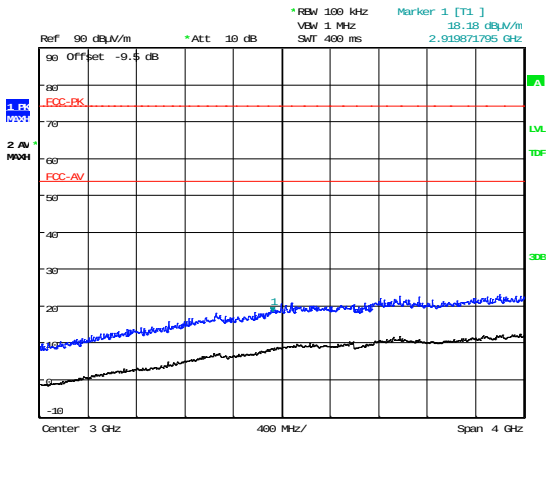


Upper Bandedge

Unintentional Radiated Spurious emissions 903.0MHz

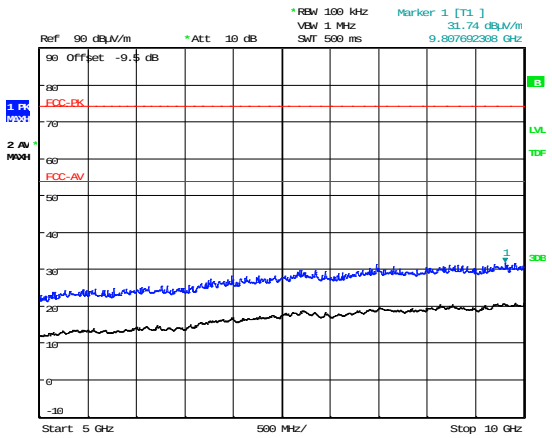


30 MHz to 1 GHz



Date: 15.MAY.2014 09:43:04

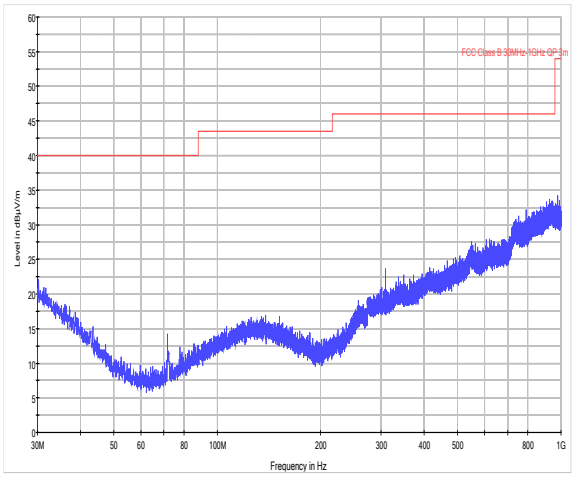
1 GHz to 5 GHz



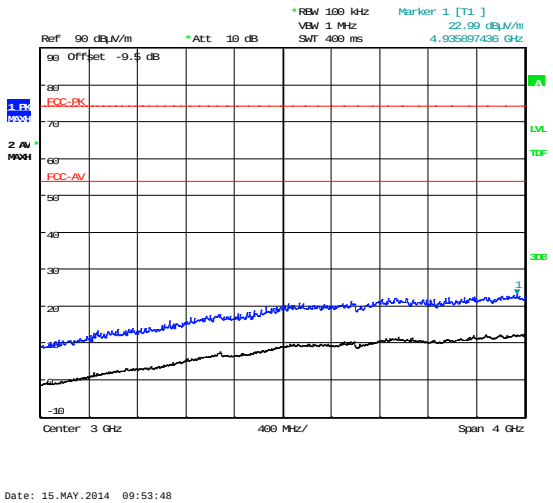
Date: 15.MAY.2014 09:41:10

5 GHz to 10 GHz

Unintentional Radiated Spurious emissions 915.0MHz



30 MHz to 1 GHz



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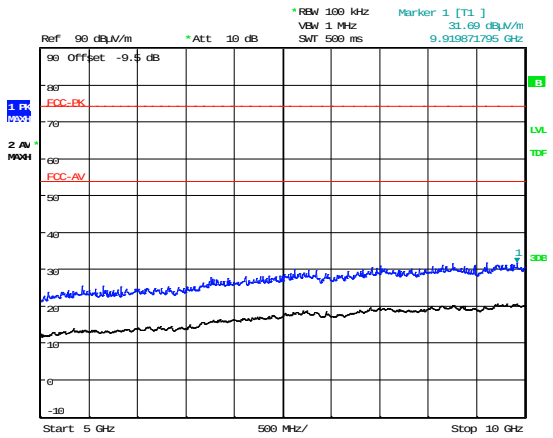
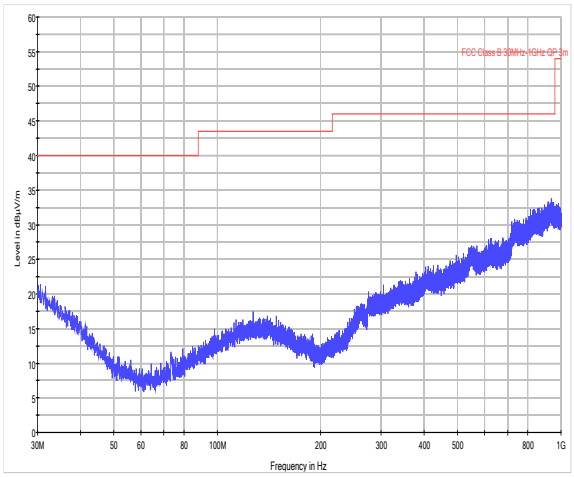
1 GHz to 5 GHz



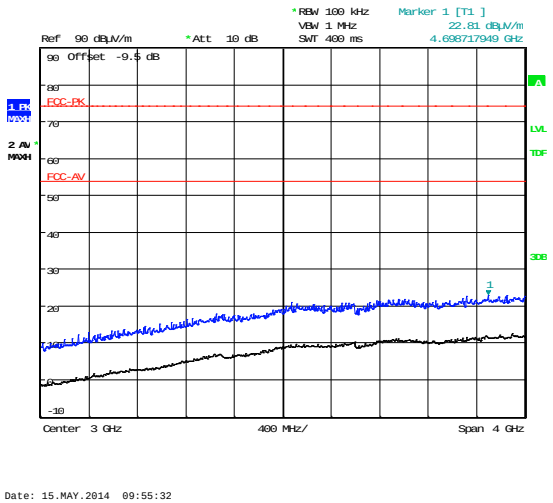
Date: 15.MAY.2014 09:51:40

5 GHz to 10 GHz

Unintentional Radiated Spurious emissions 972.5MHz



30 MHz to 1 GHz



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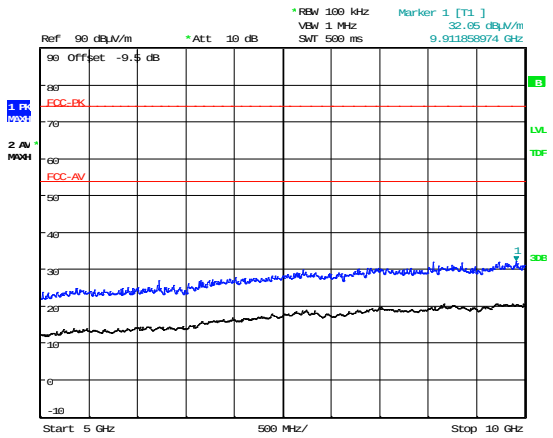
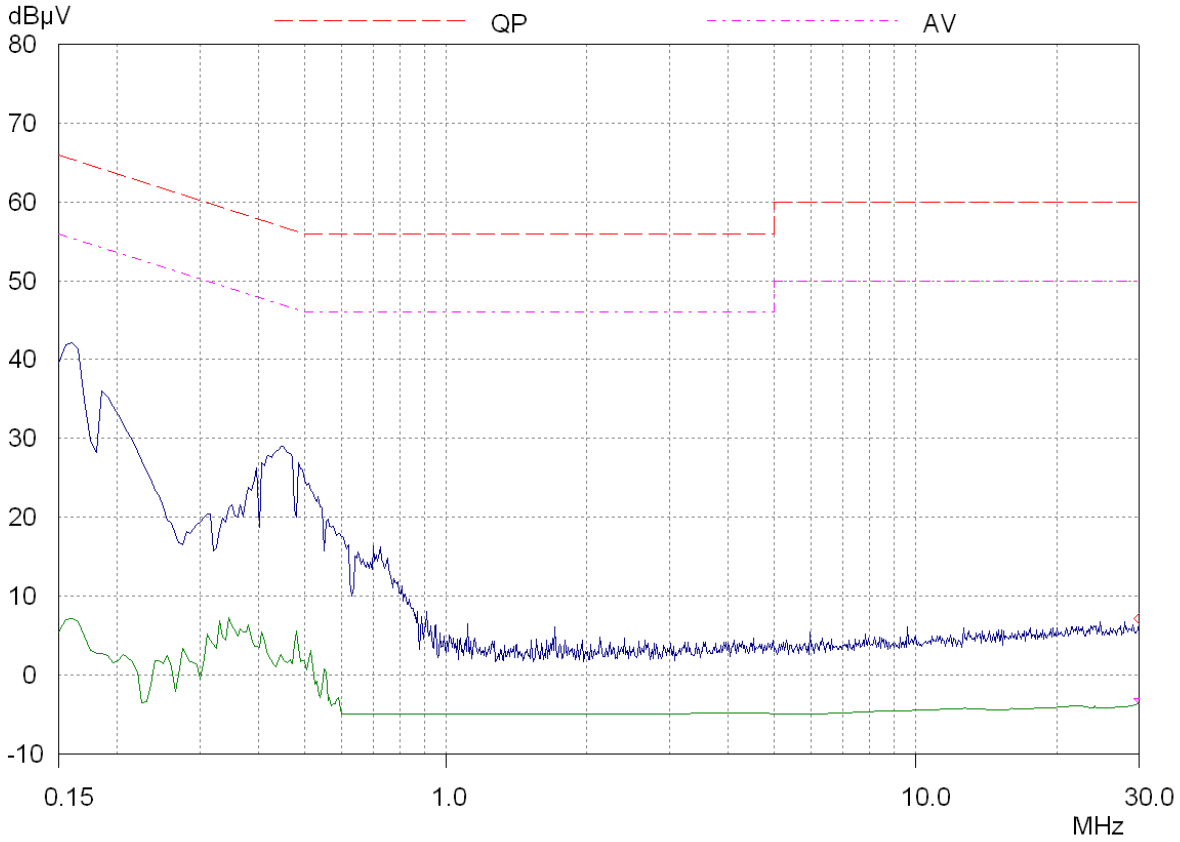
1 GHz to 5 GHz



Date: 15.MAY.2014 09:56:49

5 GHz to 10 GHz

AC Powerline Conducted Emissions



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
S16	ISL 067 TX mode (Top, Middle, Bottom and hopping (Internal & external antenna configurations)	None
S15	ISL 067 RX mode (Top, Middle, Bottom (Internal & external antenna configurations)	None
S17	2dBi Antenna	None
S20	2dBi Antenna	None

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

Sample No.	Description	Identification
None		

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

Identification	Description
None	PSU

C2) EUT Operating Mode During Testing.

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

Test	Description of Operating Mode:
All intentional Emission Testing	EUT operating in a transmit mode set to the top, middle or bottom operating frequencies or hopping across all as required.

Test	Description of Operating Mode:
Unintentional Radiated Emissions	EUT operating in a receive only mode set to the top, middle or bottom operating frequencies.

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 : S16
Tests : Conducted

Port	Description of Cable Attached	Cable length	Equipment Connected
Antenna	Coaxial	10 cm	Measurement System
Power	2-Wire	30 cm	Power Supply

Sample : S16
Tests : Radiated Emissions

Port	Description of Cable Attached	Cable length	Equipment Connected
Antenna	Coaxial	10 cm	External Antenna
	None	0	Integral Antenna
Power	2-Wire	30 cm	Power Supply

* 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	27/02/2014	12	27/02/2015
UH093	CBL6112B	Bilog	Chase	08/07/2013	24	08/07/2015
UH191	CBL611/A	Bilog	Chase	13/12/2012	24	13/12/2014
UH195	ESH3-Z5.831.5	Lisn	R&S	03/07/2013	12	03/07/2014
UH281	FSU46	Spectrum Analyser	R&S	26/03/2014	12	26/03/2015
UH405	FSU26	Spectrum Analyser	R&S	16/04/2014	12	16/04/2015
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
L317	ESVS10	Receiver	R&S	12/02/2014	12	12/02/2015
L352	ESVS10	Receiver	R&S	21/03/2014	12	21/03/2015
L572	8449B	Pre Amp	Agilent	11/02/2014	12	11/02/2015
REF909	FSU26	Spectrum Analyser	R&S	12/02/2014	12	12/02/2015
REF940	ATS	Radio Chamber - PP	Rainford EMC	09/07/2013	12	09/07/2014
REF977	SH4141	High Pass Filter	BSC	25/02/2013	24	25/02/2015
REF978	HL 050	Log Periodic Antenna	R&S	08/04/2014	24	08/04/2016

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.

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

e.g

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

0.07459 or 7.459%

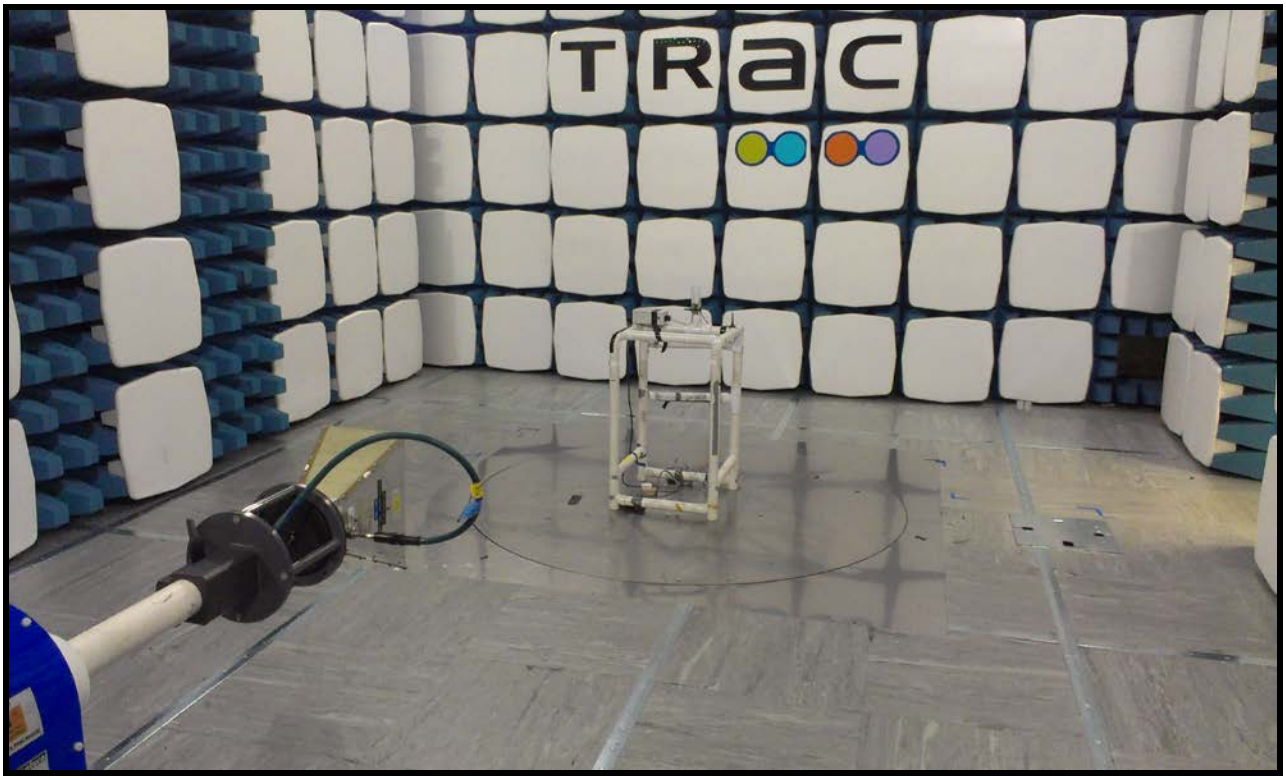
Correction factor (dB) = 20 x (Log_{10} 0.07459) = -22.54dB

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.

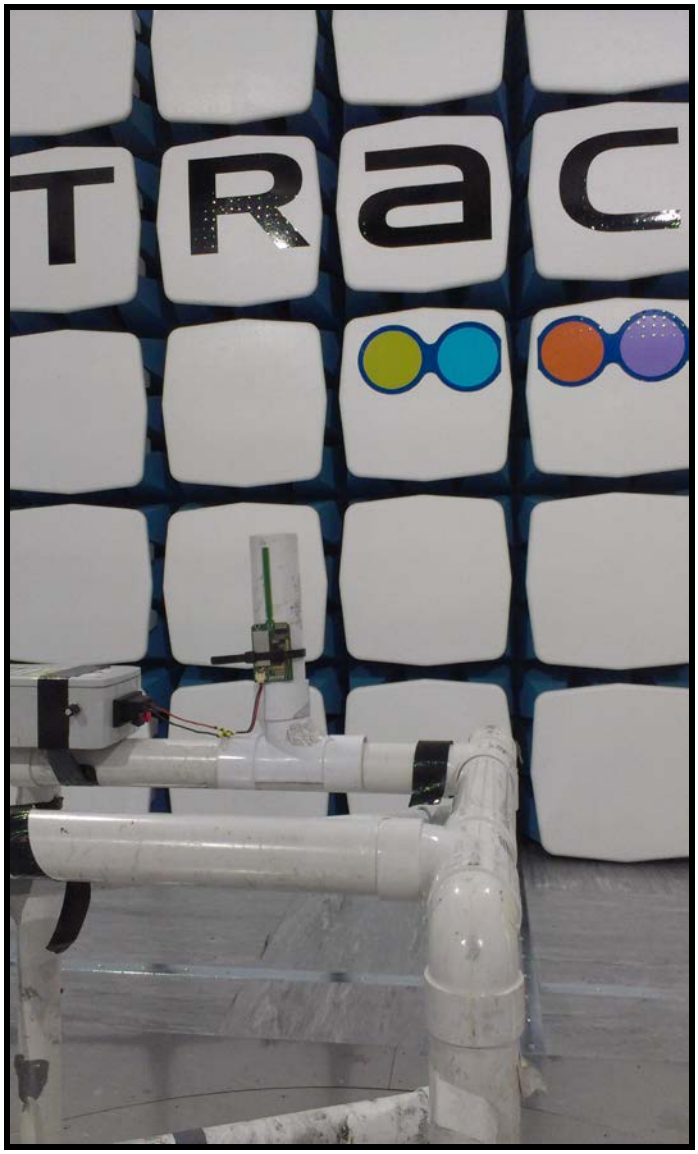
Appendix F: Photographs and Figures

The following photographs were taken of the test samples:

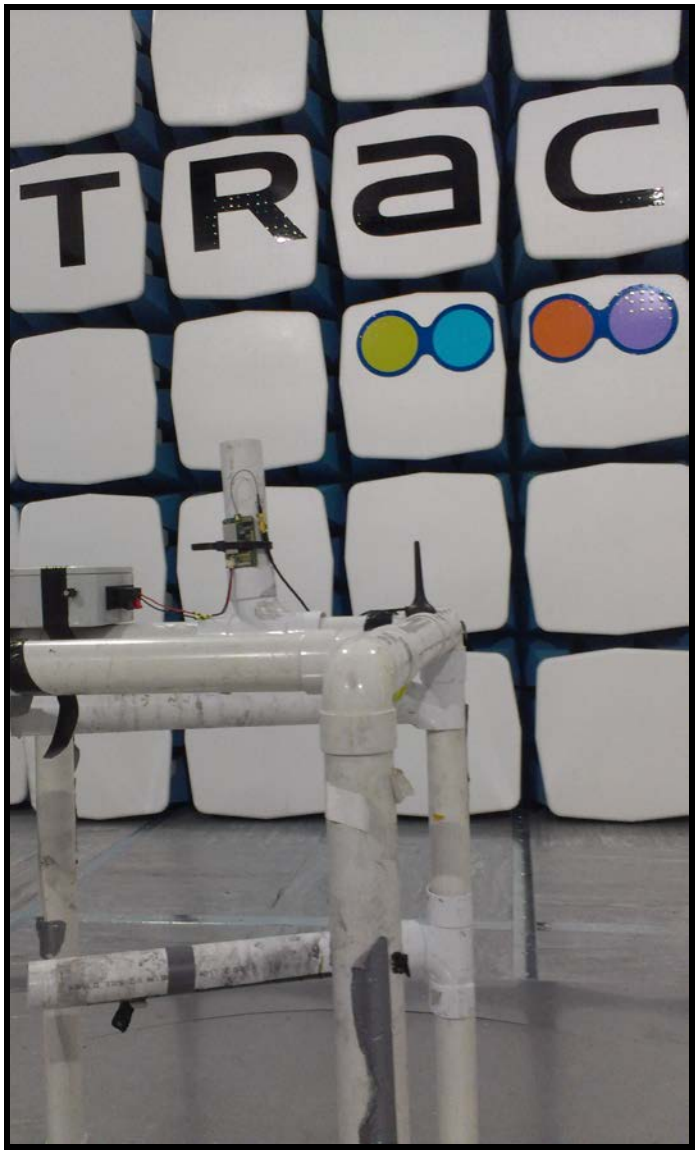
1. Radiated electric field emissions arrangement: Overview.
2. Radiated electric field emissions arrangement: PCB Antenna close up.
3. Radiated electric field emissions arrangement: 2 dBi Antenna close up.
4. Radiated electric field emissions arrangement: 5 dBi Antenna close up.
5. AC Powerline Conducted Emissions



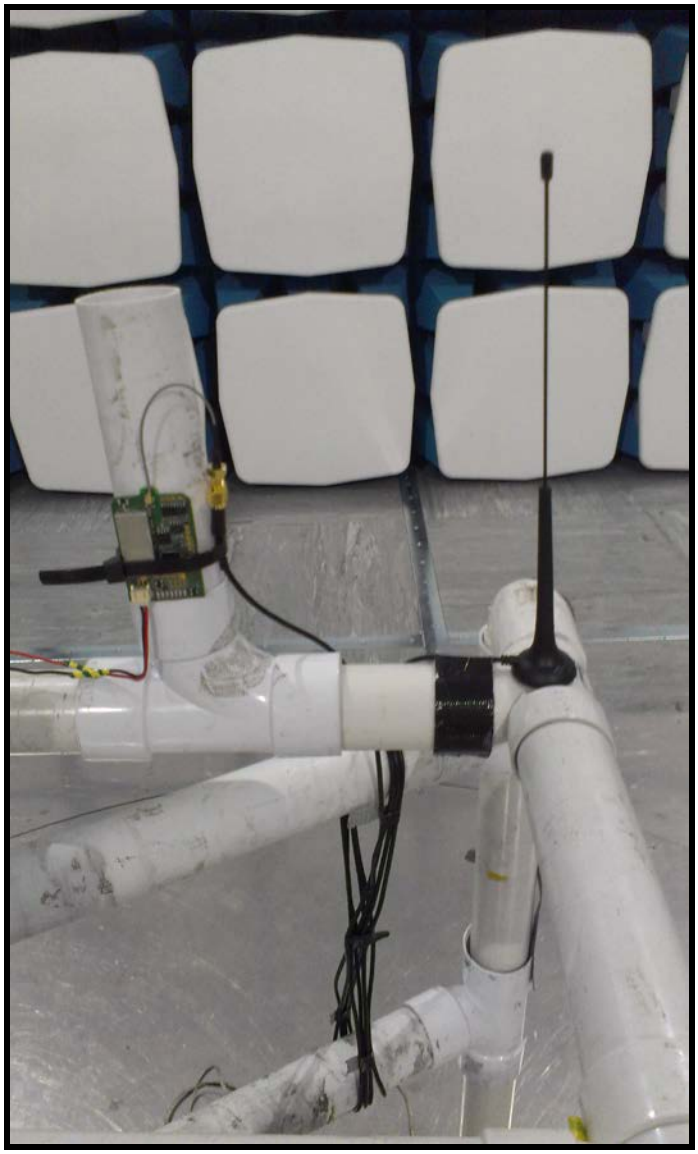
Photograph 1



Photograph 2



Photograph 3



Photograph 4

Photograph 5

Appendix G: MPE Calculation

KDB447498, RSS-102

47 CFR §§1.1307 and 2.1091

Radio frequency radiation exposure evaluation: mobile devices.

For purposes of these requirements mobile devices are defined by the FCC and IC 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 IC 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 power the density limit, as required.

Prediction of MPE limit at a given distance

Using KDB 44798 for guidance

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

where:

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

Note:

The EIRP measurement was calculated from the peak conducted carrier power plus the antenna gain.

Result

Prediction Frequency (MHz)	Maximum EIRP (Watts)	Power density limit (S) (W/m^2)	Distance (R) required to be less than (S) (cm)
915.0	0.139	6.1	4.3

$1mW/cm^2 \equiv 10W/m^2$