

**A RADIO TEST REPORT  
FOR  
TIMECODE SYSTEMS LTD  
ON  
RF TIMECODE BUDDY BOARD  
DOCUMENT NO. TRA-020136-00-47-00B**

**HULL**

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**TRaC Wireless Test Report** : TRA-020136-00-47-00B

**Applicant** : Timecode Systems Ltd

**Apparatus** : RF Timecode Buddy Board

**Specification(s)** : CFR47 Part 15.247& RSS-210 Annex 8

**FCCID** : AYV-TCB11

**Certification Number** : 10427A-TCB11

**Purpose of Test** : **Certification**

**Authorised by** :

: Radio Product Manager

**Issue Date** : 27<sup>th</sup> January 2015

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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 :

Timecode Systems Ltd  
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## **1.3 Manufacturer**

As Above

## **1.4 Apparatus Assessed**

The following apparatus was assessed between 17<sup>th</sup> November and 3<sup>rd</sup> December 2014:

RF Timecode Buddy Board

RF Transceiver Module utilising FHSS in the 902MHz to 928 MHz and 2.4GHz 802.11 b/g WiFi.

## 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 (d) 15.209	ANSI C63.10:2009	Pass
Conducted spurious emissions (Non-restricted bands)	Annex 8.A4(4)	15.247(d)	ANSI C63.10:2009	Pass
AC Power conducted emissions	RSS-Gen Issue 4 Annex 8.8	15.207	ANSI C63.10:2009	Pass
Occupied Bandwidth Channel Spacing	Annex 8.A8.2a	15.247(a)(1)(i) 15.247(a)(2)	ANSI C63.10:2009	Pass
Conducted Carrier Power	Annex 8.A4(4).	15.247(b)	ANSI C63.10:2009	Pass
Power Spectral Density	Annex 8.A8.2b	15.247(d)	ANSI C63.10:2009	Pass
Hopping Frequencies	Annex 8, A8.1(c)	15.247(a)(1)(i)	ANSI C63.10:2009	Pass
Channel Occupancy	Annex 8, A8.1(c)	15.247(a)(1)(i)	ANSI C63.10:2009	Pass
Unintentional Radiated Spurious Emissions	RSS-Gen Issue 4 Annex 7.1	Title 47 of the CFR: Part 15 Subpart B; 15.109	ANSI C63.10:2009	Pass
RF Safety	RSS-102	Title 47 of the CFR : Part 15 Subpart C; 15.247(b)(5)	-	Pass
Digital Modulation	-	Title 47 of the CFR: Part 15 Subpart C; 15.403	-	Pass

Abbreviations used in the above table:

Mod : Modification  
CFR : Code of Federal Regulations  
REFE : Radiated Electric Field Emissions

RSS : Radio Standards Specification  
ANSI : American National Standards Institution  
PLCE : Power Line Conducted Emissions

## 1.6 Notes Relating To The Assessment

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

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

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

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

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

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

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

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

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

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

## 1.7 Deviations from Test Standards

There were no deviations from the standards tested to.



**Section 2:****Measurement Uncertainty****2.1 Measurement Uncertainty Values**

For the test data recorded 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

## Section 4

## General Test Procedures

### 4.1 Radiated Test Setup and Procedures

Radiated electromagnetic emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked, using a peak detector and where applicable worst case determined for function, operation, orientation etc for both vertical and horizontal polarisations

If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.10 are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed, (see EUT setup photographs for more detail).

For devices with intentional emissions below 30 MHz, a shielded loop antenna is used as the test antenna. It is placed at a 1 meter receive height and appropriate low frequency magnetic field extrapolation to the regulatory limit distance is employed. The EUT is rotated through 360° in the azimuth.

Emissions between 30 MHz and 1 GHz are measured using calibrated broadband antennas. Emissions above 1 GHz are characterized using standard gain horn antennas. Pre-amplifiers and filters are used where required. Care is taken to ensure that test receiver resolution bandwidth, video bandwidth and detector type(s) meet the regulatory requirements.

For both horizontal and vertical polarizations, the EUT is then rotated through 360° in azimuth until the highest emission is detected. At the previously determined azimuth the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected, this maximum value is recorded.

Where regulations allow for direct measurement of field strength, power values measured on the test receiver / analyzer are converted to dBuV/m at the regulatory distance, using:

$$FS = PR + AF + CL - PA + KG + DC - CF \text{ (dBuV/m)}$$

Where:

PR is the power recorded on receiver / spectrum analyzer (dBuV),

AF is the test antenna factor in dB/m,

CL is the cable loss in dB,

PA is the pre-amplifier gain dB (when applicable),

DC is duty correction factor (when applicable) in dB, and

CF is a distance correction (employed only for measurements at alternate distance to limit) in dB.

This field strength value is then compared with the regulatory limit.

If effective radiated power (ERP) or effective isotropic radiated power (EIRP) is required, it is computed as per ANSI C63.10

$$P = \frac{(Ed)^2}{30G}$$

Where

$P$  is the power, in W

$E$  is the measured peak field strength, in V/m

$d$  is the distance at which the measurement was made, in m

$G$  is the numeric gain of the radiating element

If the gain of the radiating element is not known, then either the effective radiated power (ERP) or the effective isotropic radiated power (EIRP) may be calculated from the measured peak field strength, by using either  $G = 1.64$  or  $G = 1$ , respectively.

## 4.2 AC Powerline Conducted Emissions Test Setup and Procedures

AC Powerline Conducted Emissions from the EUT are checked first by preview scans with Peak and average detectors covering both live and neutral lines. A spectrum analyser is used to determine if any periodic emissions are present. Preview scans are performed in standby or receive mode if the device is subject to these requirements. For transmit mode of operation the device is set to one of the following modes.

- Transmitting operating at full power (single mode device)
- Transmitting at freq / modulation that gives highest output power (multi mode device)
- Transmitter operating in normal TX mode (e.g. FHSS, TDMA etc)

Formal measurements using the correct detector(s) and bandwidth are made on frequencies identified from the preview scans.

Battery Power devices are not subject to power line conducted emissions measurements when it is powered solely by its internal battery.

## 4.3 Antenna Port Conducted Emissions

Antenna port conducted emissions can include, but are not limited to, Carrier power, Power Spectral Density, Occupied bandwidth and spurious emission.

Spurious Emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked to identify frequencies to perform formal measurements on.

Formal measurements are made on frequencies identified from the preview scans and fundamental emission(s). Measurements are made using the correct instrumentation (inc. power meter, receiver, spectrum analyser) that operate with the required detector(s) and bandwidth.

Care is taken to ensure the measurement instrument is not overloaded by the presence of the transmitted signal by use of external attenuation and filtering where required.

Measured levels are corrected for cables, attenuators, and filters. If applicable, for the specific measurement, antenna gain is also taken into account.

#### 4.4 Power Supply Variation

Tests at extreme supply voltages are made if required by the procedures specified in the test standard, and results of this testing are detailed in this report.

In the case the EUT is designed for operation from a lead-acid battery power source, the extreme test voltages are evaluated between 90% and 130% of the nominal battery voltage declared by the manufacturer.

For float charge applications using gel-cell type batteries, extreme test voltages are evaluated between 85% and 115% of the nominal battery voltage declared.

For all battery operated equipment, worst case intentional and spurious emissions are re-checked employing a new (fully charged) battery.

#### 4.5 Thermal Variation

Tests at extreme temperatures are made if required by the procedures specified in the test standard, and results of this testing are detailed in this report.

Tests are performed at the upper and lower extremes as required and typically at 10° steps between.

Before any temperature measurements are made, the equipment is allowed to reach a thermal balance in the test chamber.

#### 4.6 Time Domain Measurements

Time domain measurements are made for (but not limited to) use in duty cycle correction, to ensure compliance with time restrictions on certain types of devices.

If measurements of a transmitter's on time are required these are performed with a spectrum analyser in the time domain or with an oscilloscope and RF detector. If time on a specific frequency is required ( e.g. FHSS timing) the measurement can only be made with a spectrum analyser.

The triggering, timescale and amplitude settings are adjusted according to the signal to be measured on a case by case basis.

For devices with sharp rise/fall times measurements are made between RF reaching full power ( $T_{on}$ ) and RF dropping to the measurement instrument noise floor ( $T_{off}$ ). For longer rise times measurements are made for  $T_{on}$  and  $T_{off}$  at the RF level required by the occupied bandwidth measurement (e.g. 6 dB, 20 dB etc).

**Appendix A: Formal Emission Test Results 2.4GHz Wi-Fi Operation**

Abbreviations used in the tables in this appendix:

Spec	: Specification	ALSR	: Absorber Lined Screened Room
Mod	: Modification	OATS	: Open Area Test Site
EUT	: Equipment Under Test	ATS	: Alternative Test Site
SE	: Support Equipment	Ref	: Reference
L	: Live Power Line	Freq	: Frequency
N	: Neutral Power Line	MD	: Measurement Distance
E	: Earth Power Line	SD	: Spec Distance
Pk	: Peak Detector	Pol	: Polarisation
QP	: Quasi-Peak Detector	H	: Horizontal Polarisation
Av	: Average Detector	V	: Vertical Polarisation
CDN	: Coupling & decoupling network		

**A1 6 dB Bandwidth**

Title 47 of the CFR: Part 15 Subpart (c) 15.247(a)(2) and RSS-210 Issue 8 December 2010 requires the measurement of the bandwidth of the transmission between the -6 dB points on the transmitted spectrum.

<b>Test Details:</b>	
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	S11
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
Temperature	25
EUT set up	Refer to Appendix C

<b>802.11b 1 Mbps Tx mode</b>					
Channel Frequency (MHz)	<b>F<sub>lower</sub></b> (MHz)	<b>F<sub>Higher</sub></b> (MHz)	Measured 20 dB Bandwidth (MHz)	Limit (KHz)	Result
2412	2405.846154	2418.121795	12.275641	> 500	Pass
2437	2430.846154	2443.121795	12.275641	> 500	Pass
2462	2455.846154	2468.121795	12.275641	> 500	Pass

<b>802.11b 11 Mbps Tx mode</b>					
Channel Frequency (MHz)	<b>F<sub>lower</sub></b> (MHz)	<b>F<sub>Higher</sub></b> (MHz)	Measured 20 dB Bandwidth (MHz)	Limit (KHz)	Result
2412	2405.317308	2418.554487	13.237179	> 500	Pass
2437	2430.317308	2443.682692	13.365384	> 500	Pass
2462	2455.317308	2468.634615	13.317307	> 500	Pass



<b>802.11g 6Mbps Tx mode</b>					
Channel Frequency (MHz)	<b>F<sub>lower</sub></b> (MHz)	<b>F<sub>Higher</sub></b> (MHz)	Measured 20 dB Bandwidth (MHz)	Limit	Result
2412	2403.762821	2420.044872	16.282051	> 500 kHz	Pass
2437	2428.762821	2445.285256	16.522435	> 500 kHz	Pass
2462	2453.762821	2470.285256	16.522435	> 500 kHz	Pass

<b>802.11g 54Mbps Tx mode</b>					
Channel Frequency (MHz)	<b>F<sub>lower</sub></b> (MHz)	<b>F<sub>Higher</sub></b> (MHz)	Measured 20 dB Bandwidth (MHz)	Limit	Result
2412	2403.762821	2420.125000	16.362179	> 500 kHz	Pass
2437	2428.762821	2445.092940	16.330119	> 500 kHz	Pass
2462	2453.682692	2470.205128	16.522436	> 500 kHz	Pass

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

**A2 Transmitter Peak Output Power**

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

<b>Test Details:</b>	
Regulation	Part15 Subpart (c) 15.247(b)(3), RSS-210 Annex 8 A4(4)
Measurement standard	ANSI C63.10, KDB Document: 558074
EUT sample number	S11
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
Temperature	25°C
EUT set up	Refer to Appendix C

<b>802.11b 1 Mbps Tx mode</b>				
Channel Frequency (MHz)	Peak Conducted Carrier Power		Limit (W)	Result
	dBm	mW		
2412	1.71	1.48	1	Pass
2437	1.44	1.39	1	Pass
2462	1.49	1.41	1	Pass

<b>802.11b 11 Mbps Tx mode</b>				
Channel Frequency (MHz)	Peak Conducted Carrier Power		Limit (W)	Result
	dBm	mW		
2412	1.85	1.53	1	Pass
2437	1.55	1.43	1	Pass
2462	1.55	1.43	1	Pass

<b>802.11g 6Mbps Tx mode</b>				
<b>Channel Frequency (MHz)</b>	<b>Peak Conducted Carrier Power</b>		<b>Limit (W)</b>	<b>Result</b>
	<b>dBm</b>	<b>mW</b>		
2412	7.70	5.89	1	Pass
2437	7.61	5.77	1	Pass
2462	7.61	5.77	1	Pass

<b>802.11g 54Mbps Tx mode</b>				
<b>Channel Frequency (MHz)</b>	<b>Peak Conducted Carrier Power</b>		<b>Limit (W)</b>	<b>Result</b>
	<b>dBm</b>	<b>mW</b>		
2412	7.95	6.24	1	Pass
2437	7.62	5.78	1	Pass
2462	7.68	5.86	1	Pass

## Notes:

1. Measured peak output power does not include the gain of any antenna being used
2. Measurements were performed as per section 5.2.1.2 of the OET guidance notes
3. Plots for operating mode producing highest output power included in appendix B

**A3 Transmitter Power Spectral Density**

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

<b>Test Details:</b>	
Regulation	Part15 Subpart (c) 15.247(b)(3), RSS-210 Annex 8.A8.2b
Measurement standard	ANSI C63.10, KDB Document: 558074
EUT sample number	S11
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
Temperature	25°C
EUT set up	Refer to Appendix C

<b>802.11b 1Mbps Tx mode</b>			
<b>Channel Frequency (MHz)</b>	<b>Conducted Peak Power Spectral Density (dBm/3kHz)</b>	<b>Limit (dBm/3kHz)</b>	<b>Result</b>
2412	-10.48	8	Pass
2437	-10.62	8	Pass
2462	-10.67	8	Pass

<b>802.11b 11Mbps Tx mode</b>			
<b>Channel Frequency (MHz)</b>	<b>Conducted Peak Power Spectral Density (dBm/3kHz)</b>	<b>Limit (dBm/3kHz)</b>	<b>Result</b>
2412	-11.63	8	Pass
2437	-11.74	8	Pass
2462	-11.76	8	Pass

<b>802.11g 6Mbps Tx mode</b>			
<b>Channel Frequency (MHz)</b>	<b>Conducted Peak Power Spectral Density (dBm/3kHz)</b>	<b>Limit (dBm/3kHz)</b>	<b>Result</b>
2412	-12.09	8	Pass
2437	-12.33	8	Pass
2462	-12.33	8	Pass

<b>802.11g 54Mbps Tx mode</b>			
<b>Channel Frequency (MHz)</b>	<b>Conducted Peak Power Spectral Density (dBm/3kHz)</b>	<b>Limit (dBm/3kHz)</b>	<b>Result</b>
2412	-12.06	8	Pass
2437	-12.27	8	Pass
2462	-12.27	8	Pass

## Notes:

1. Measured Power Spectral Density does not include the gain of any antenna being used
2. Measurements were performed as per section 5.3.1 of the OET guidance notes
3. Plots for operating mode producing highest output power included in appendix B

**A4 RF Antenna Conducted Spurious Emissions**

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

<b>Test Details: 2412 MHz 2437MHz 2462MHz</b>	
Regulation	Part 15 Subpart (c) Clause 15.247(d), RSS – 210 Annex 8, A8.5
Measurement standard	ANSI C63.10, KDB Document: 558074
Frequency range	9 kHz to 25 GHz
EUT sample number	S11
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
Temperature	25 °C
EUT set up	Refer to Appendix C

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

802.11b Tx mode						
Ref No.	Emission Freq (MHz)	Det.	Restricted band? (Y/N)	Emission power (RBW =100kHz) (dBm)	15.247(d) Limit (dBm)	Summary
No emissions detected within 20dB of the limit						

802.11g Tx mode						
Ref No.	Emission Freq (MHz)	Det.	Restricted band? (Y/N)	Emission power (RBW =100kHz) (dBm)	15.247(d) Limit (dBm)	Summary
No emissions detected within 20dB of the limit						

**Notes:**

1. The conducted emission limit for emissions outside the restricted bands, defined in 47CFR15.205(a) are based on a transmitted carrier level of 15.247(b). With the EUT transmitting on its lowest, centre and highest carrier frequencies in turn, emissions from the EUT are required to be 20 dB below the level of the highest fundamental as measured within a 100 kHz RBW in accordance with 15.247(d) using a peak detector.
2. The RBW = 100 kHz, Video bandwidth (VBW) > RBW and the radio spectrum was investigated up to the 10th harmonic in accordance 15.33 (a)(1).
3. The measurements at 2400 MHz and 2483.5 MHz were made to ensure band edge compliance.
4. The carrier level was measured whilst varying the supply voltage between 85% and 105% of the nominal supply voltage as required by 15.31(e). No variation in carrier level was observed.
5. The plots for operating mode producing the highest output power can be found in Appendix B

The limit outside the restricted band in 100 kHz RBW is defined using the following formula in accordance with 15.247(d):

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

**A5 Radiated Electric Field Emissions**

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

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

3m open area test site :

3m alternative test site :

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

<b>Test Details:</b>	
Regulation	Part 15 Subpart (c) Clause 15.247(d), RSS – 210 Annex 8, A8.5
Measurement standard	ANSI C63.10, KDB Document: 558074
Frequency range	30MHz – 25GHz
EUT sample number	S09
Modification state	0
SE in test environment	None
SE isolated from EUT	S01
EUT set up	Refer to Appendix C
Temperature	23°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:

<b>802.11b Tx mode</b>									
DET	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)
<b>2412 MHz</b>									
Pk	4823.943	53.61	3.6	32.8	35.58	54.43	0.00	526.62	5011
Av	4823.943	49.43	3.6	32.8	35.58	50.25	0.00	325.46	500
<b>2437 MHz</b>									
Pk	4873.887	53.78	3.6	33	35.57	54.81	0.00	550.17	5011
Av	4873.887	49.56	3.6	33	35.57	50.59	0.00	338.45	500
<b>2462 MHz</b>									
Pk	4923.942	54.28	3.5	33.1	35.56	55.32	0.00	583.45	5011
Av	4923.942	50.46	3.5	33.1	35.56	51.50	0.00	375.84	500



**Radiated Electric Field Emissions continued:**

<b>802.11g Tx mode</b>									
<b>DET</b>	<b>FREQ. (MHz)</b>	<b>MEAS Rx (dBµV)</b>	<b>CABLE LOSS (dB)</b>	<b>ANT FACT. (dB/m)</b>	<b>PRE AMP (dB)</b>	<b>FIELD ST'GH (dBµV/m)</b>	<b>EXTRAP FACT (dB)</b>	<b>FIELD ST'GH (µV/m)</b>	<b>LIMIT (µV/m)</b>
<b>2412 MHz</b>									
Pk	4823.943	54.02	3.6	32.8	35.58	54.84	0.00	552.08	5011
Av	4823.943	49.59	3.6	32.8	35.58	50.41	0.00	331.51	500
<b>2437 MHz</b>									
Pk	4873.887	53.89	3.6	33	35.57	54.92	0.00	557.19	5011
Av	4873.887	49.56	3.6	33	35.57	50.59	0.00	338.45	500
<b>2462 MHz</b>									
Pk	4923.942	54.53	3.5	33.1	35.56	55.57	0.00	600.48	5011
Av	4923.942	50.71	3.5	33.1	35.56	51.75	0.00	386.81	500

**Notes:**

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

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

These settings as per ANSI C63.10

The plots for worst case emissions on all modulation types can be found in Appendix B

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

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

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

**Notes:**

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

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

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

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

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

## A6 Antenna Gain

See data sheet for details of antenna to be used



## 2. Specification

### Electrical

	Penta-band Cellular				
	AMPS	GSM	DCS	PCS	UMTS
Communication System	AMPS	GSM	DCS	PCS	UMTS
Frequency	824 ~ 896	880 ~ 960	1710 ~ 1880	1850 ~ 1990	1710 ~ 2170
Efficiency (free space)*	21%	24%	23%	32%	31%
Gain (dBi, free space)*	2.0	2.0	-1.0	-0.4	-0.1
Efficiency (mounted on PCB)*	39%	31%	78%	75%	75%
Gain (dBi, mounted on PCB)*	1.0	-1.0	2.8	2.8	2.0
Impedance	50Ω				
Polarization	Linear				
Radiation Pattern	Omni-directional				
Input Power	10 W				

### Mechanical

Antenna Length	72 ± 1.5 mm
Antenna Diameter	10 ± 0.3 mm
Casing	POM
Connector	SMA Male (Brass)

### Environmental

Temperature Range	-40°C to 85°C
Storage Temperature	-40°C ~ +105°C
Humidity	Non-condensing 65°C 95% RH

\* Average efficiency and peak gain of antenna sitting 180° in free space and mounted at the side of the PCB. Please refer to section IV for testing detail.

**A7 Unintentional Radiated Electric Field Emissions - 15.109**

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

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

3m open area test site :

3m alternative test site :

<b>Test Details: 2412 MHz</b>	
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	S09
Modification state	0
SE in test environment	None
SE isolated from EUT	S01
EUT set up	Refer to Appendix C
Temperature	23 °C
Photographs (Appendix F)	1 & 2

DET	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)
<b>2412 MHz</b>									
Pk	4823.943	53.82	3.6	32.8	35.58	54.64	0.00	539.51	5011
Av	4823.943	50.17	3.6	32.8	35.58	50.99	0.00	354.41	500
Pk	9647.905	49.78	5.1	37.9	36.87	55.91	0.00	624.45	5011
Av	9647.905	38.86	5.1	37.9	36.87	44.99	0.00	177.62	500
<b>2437 MHz</b>									
Pk	4873.887	53.59	3.6	33	35.57	54.62	0.00	538.27	5011
Av	4873.887	49.78	3.6	33	35.57	50.81	0.00	347.14	500
Pk	9747.936	50.21	5	38	36.89	56.32	0.00	654.64	5011
Av	9747.936	40.23	5	38	36.89	46.34	0.00	207.49	500
<b>2462 MHz</b>									
Pk	4923.942	54.42	3.5	33.1	35.56	55.46	0.00	592.93	5011
Av	4923.942	50.67	3.5	33.1	35.56	51.71	0.00	385.03	500
Pk	9847.728	49.93	5.3	38.2	36.91	56.52	0.00	669.88	5011
Av	9847.728	40.72	5.3	38.2	36.91	47.31	0.00	232.01	500

**Notes:**

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

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

The upper and lower frequency of the measurement range was decided according to 47 CFR Part 15 Clause 15.33

Radiated emission limits 47 CFR Part 15: Clause 15.209 for all emissions:

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

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

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

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

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

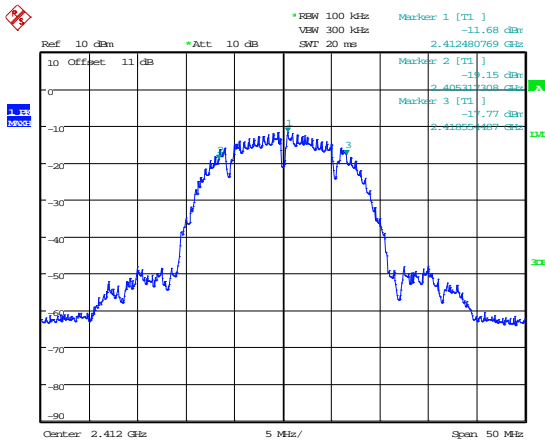
**Appendix B: Supporting Graphical Data 2.4GHz Wi-Fi Operation**

This appendix contains graphical data obtained during testing.

Notes:

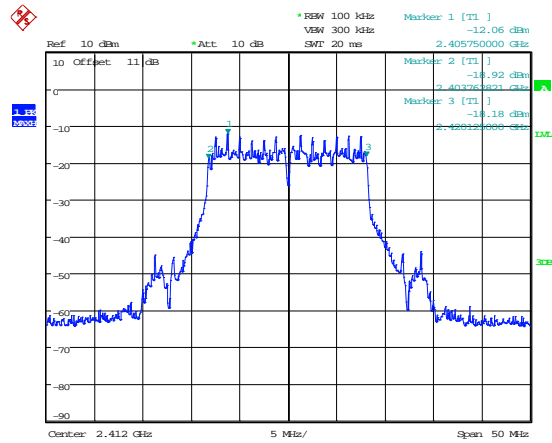
- (a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A and Appendix B.
- (b) The time and date on the plots do not necessarily equate to the time of the test.
- (c) Where relevant, on power 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



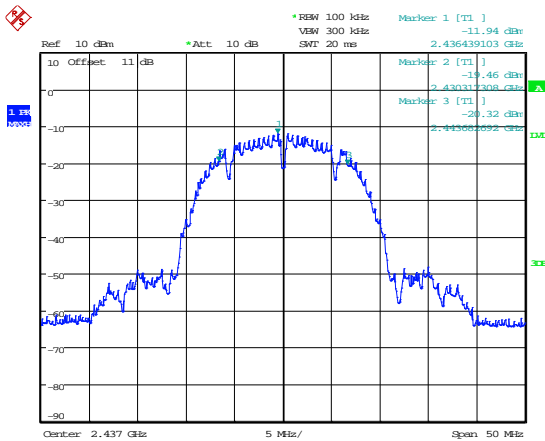
Date: 11.NOV.2014 10:23:34

802.11b Channel 1



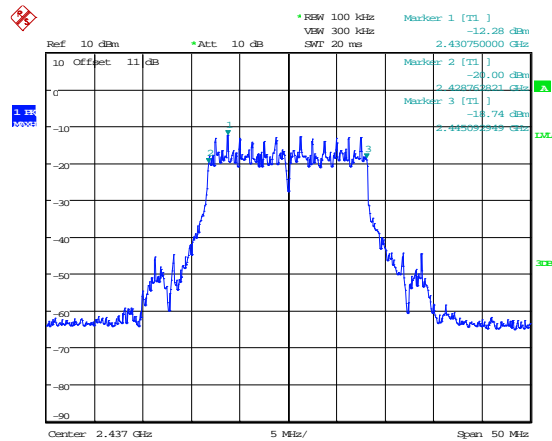
Date: 11.NOV.2014 11:28:24

802.11g Channel 1



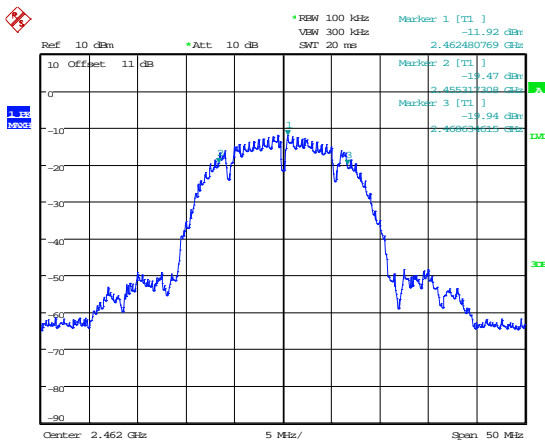
Date: 11.NOV.2014 10:25:35

802.11b Channel 6



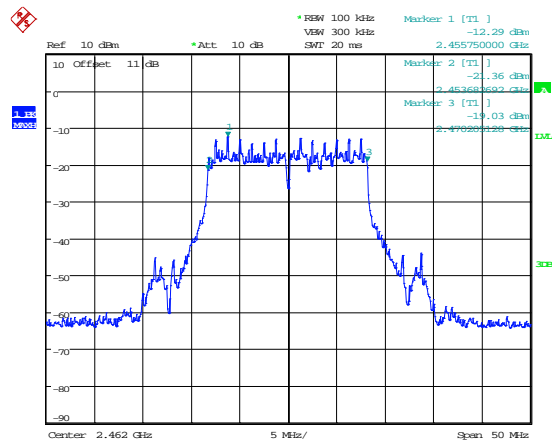
Date: 11.NOV.2014 11:30:17

802.11g Channel 6



Date: 11.NOV.2014 10:27:00

802.11b Channel 11



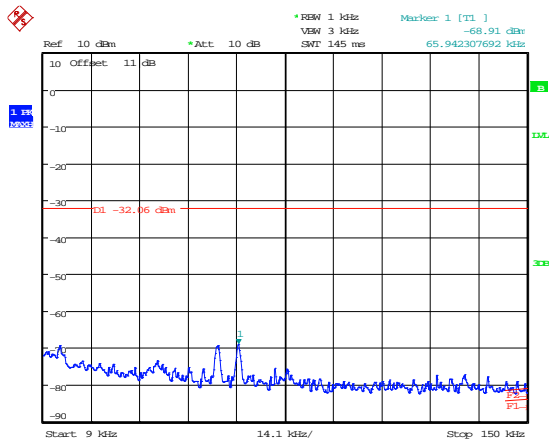
Date: 11.NOV.2014 11:34:53

802.11g Channel 11



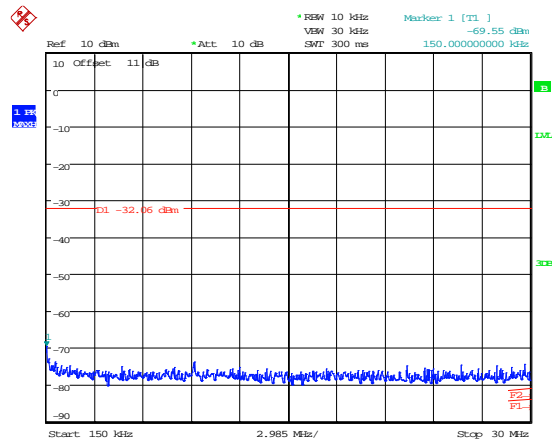
Conducted Spurious emissions

802.11g - 2412 MHz



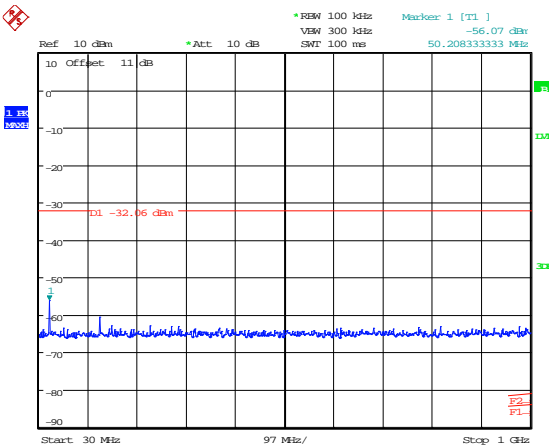
Date: 11.NOV.2014 14:25:02

9kHz – 150 kHz



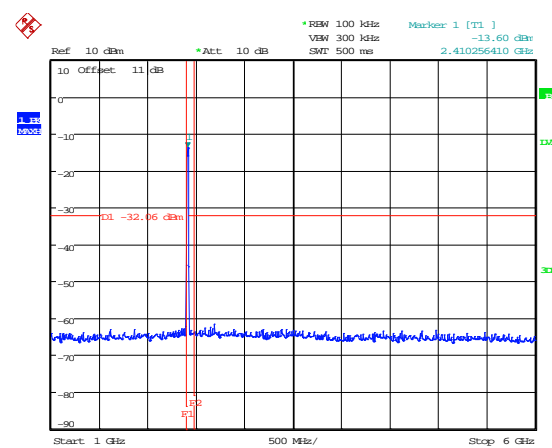
Date: 11.NOV.2014 14:39:46

150kHz – 30 MHz



Date: 11.NOV.2014 14:26:10

30 MHz to 1 GHz

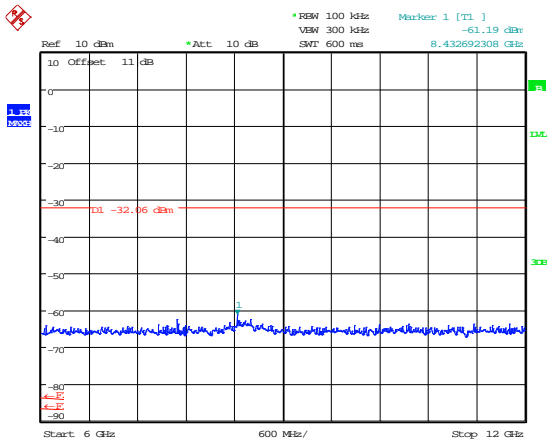


Date: 11.NOV.2014 14:26:30

1 GHz to 6 GHz

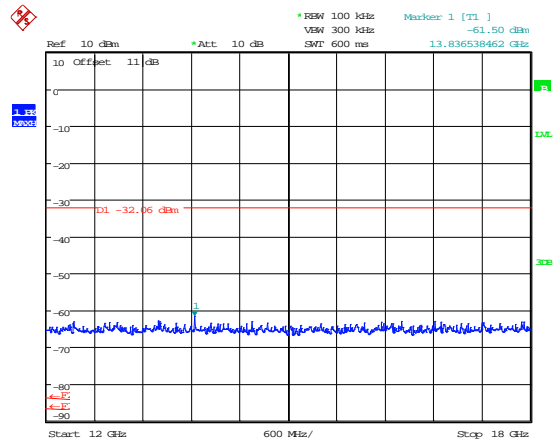
Conducted Spurious emissions

802.11g - 2412 MHz



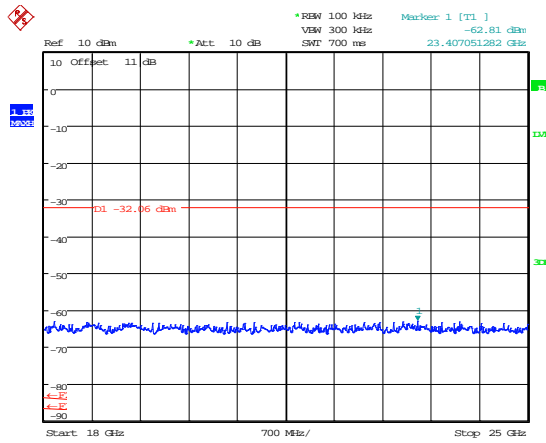
Date: 11.NOV.2014 14:26:42

6 GHz to 12 GHz



Date: 11.NOV.2014 14:26:57

12 GHz to 18 GHz

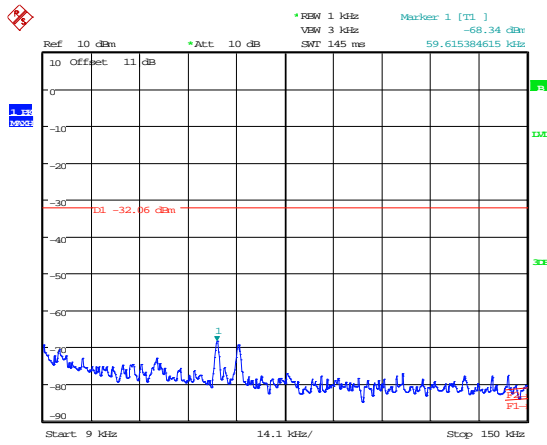


Date: 11.NOV.2014 14:29:31

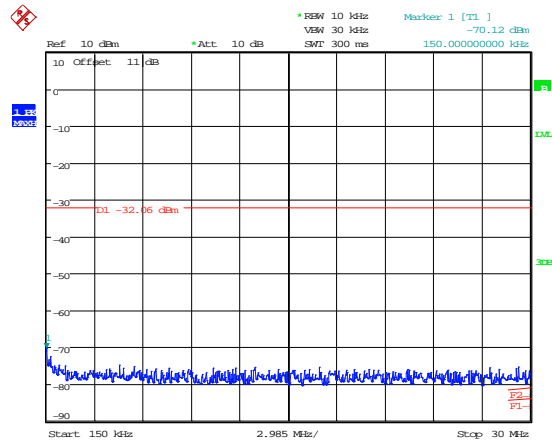
18 GHz to 25 GHz

Conducted Spurious emissions

802.11g - 2437 MHz



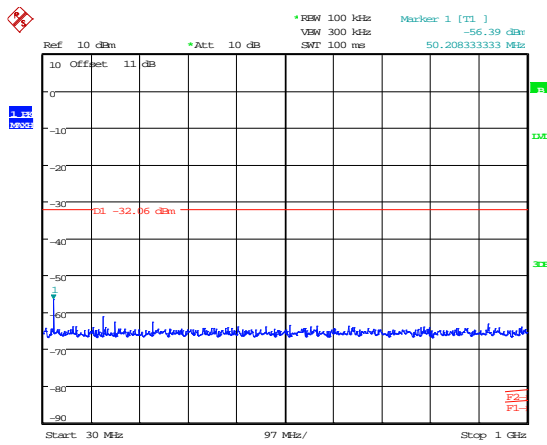
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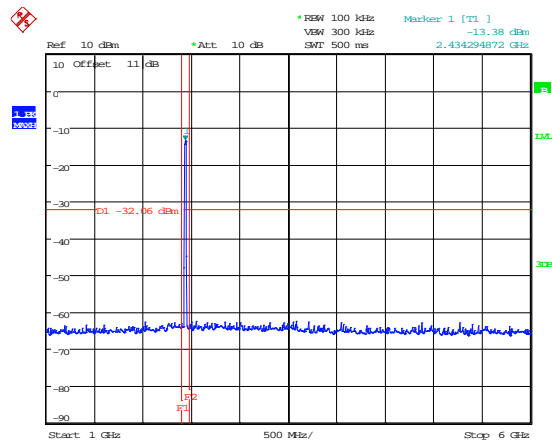
Date: 11.NOV.2014 14:32:33

9kHz – 150 kHz

150kHz – 30 MHz



Date: 11.NOV.2014 14:32:10



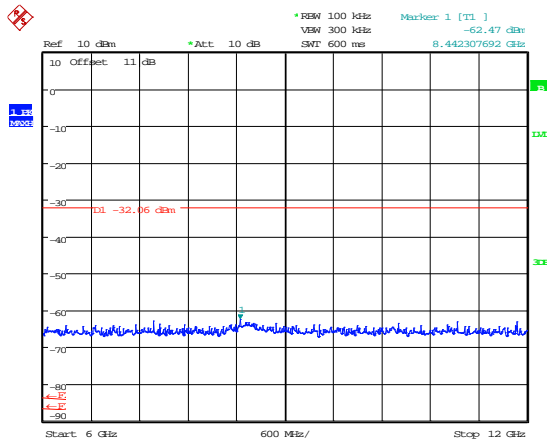
Date: 11.NOV.2014 14:31:54

30 MHz to 1 GHz

1 GHz to 6 GHz

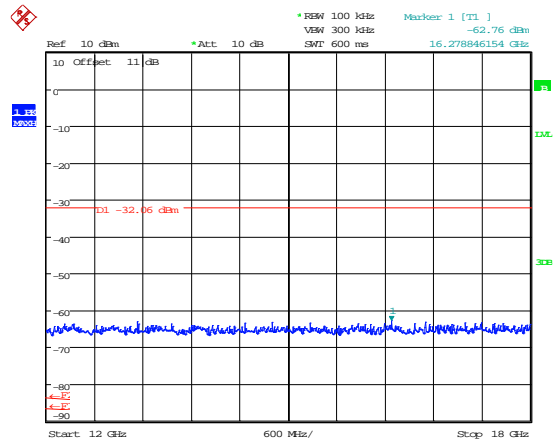
Conducted Spurious emissions

802.11g - 2437 MHz



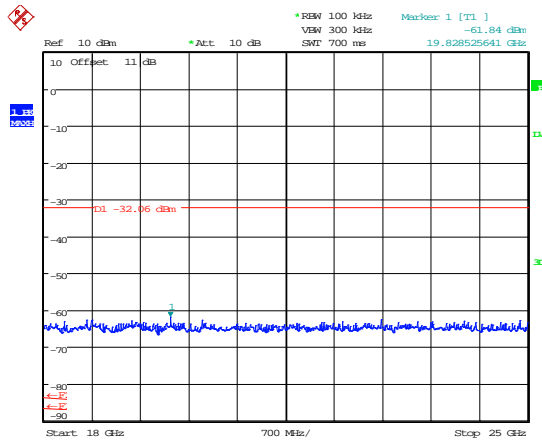
Date: 11.NOV.2014 14:31:29

6 GHz to 12 GHz



Date: 11.NOV.2014 14:31:18

12 GHz to 18 GHz

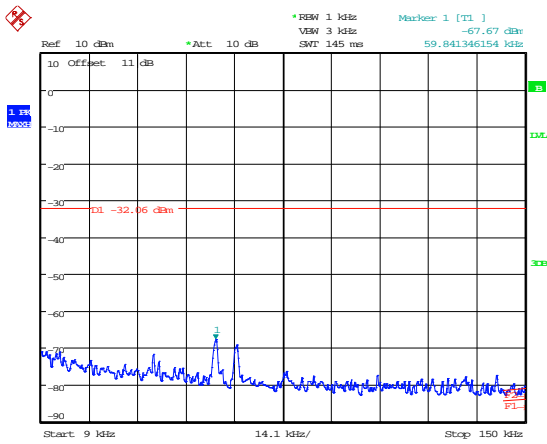


Date: 11.NOV.2014 14:31:02

18 GHz to 25 GHz

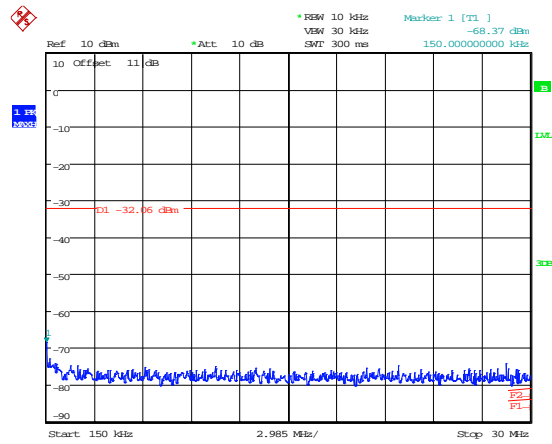
Conducted Spurious emissions

802.11g - 2462 MHz



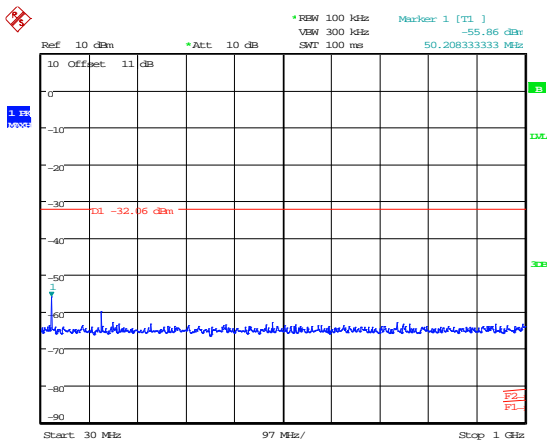
Date: 11.NOV.2014 14:33:25

9kHz – 150 kHz



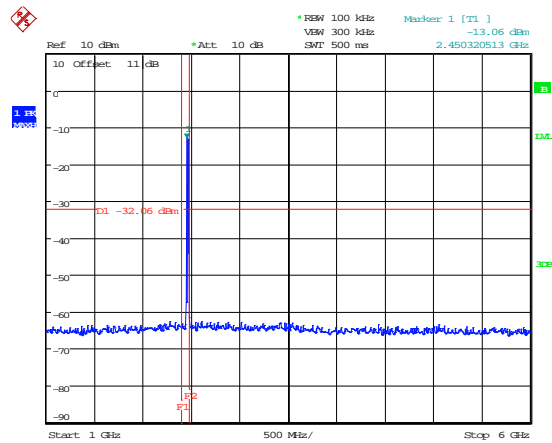
Date: 11.NOV.2014 14:33:53

150kHz – 30 MHz



Date: 11.NOV.2014 14:34:36

30 MHz to 1 GHz

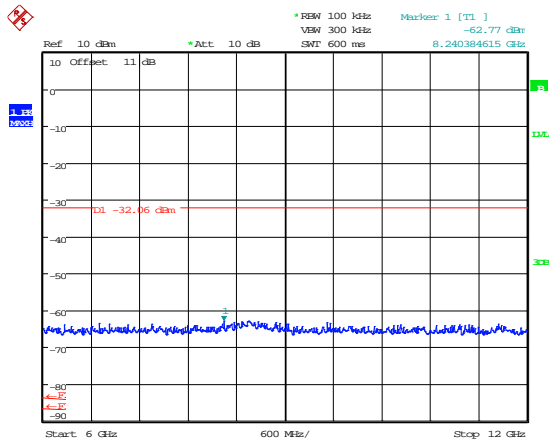


Date: 11.NOV.2014 14:35:01

1 GHz to 6 GHz

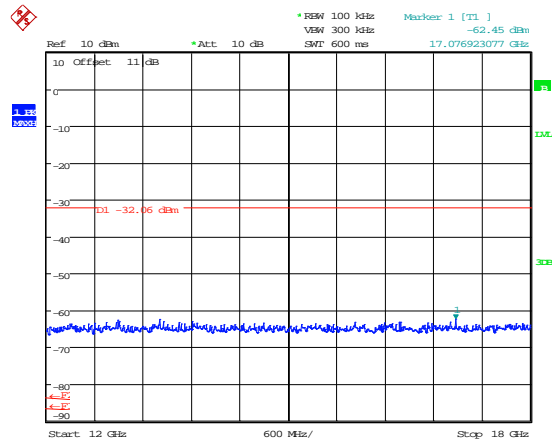
Conducted Spurious emissions

802.11g - 2462 MHz



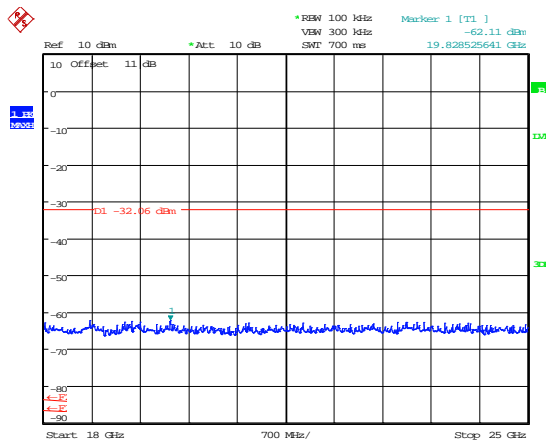
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6 GHz to 12 GHz



Date: 11.NOV.2014 14:35:37

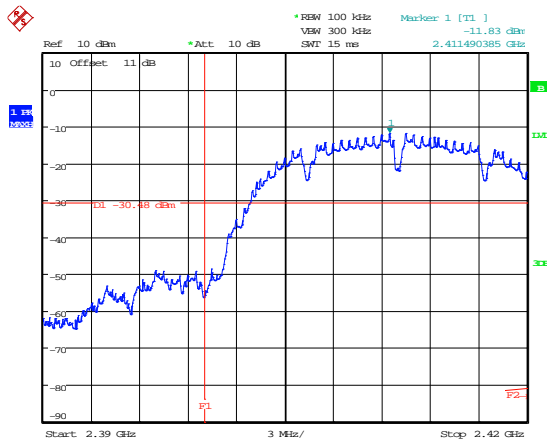
12 GHz to 18 GHz



Date: 11.NOV.2014 14:36:08

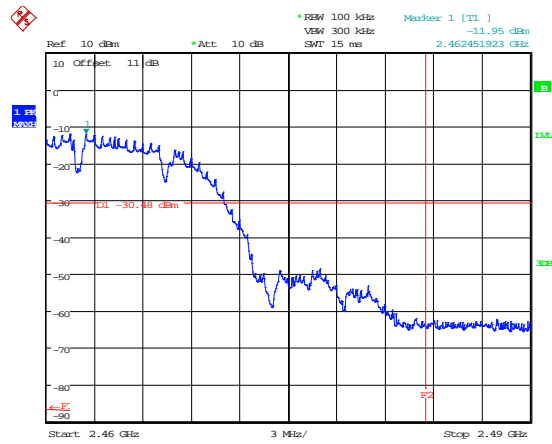
18 GHz to 25 GHz

Conducted band-edge compliance



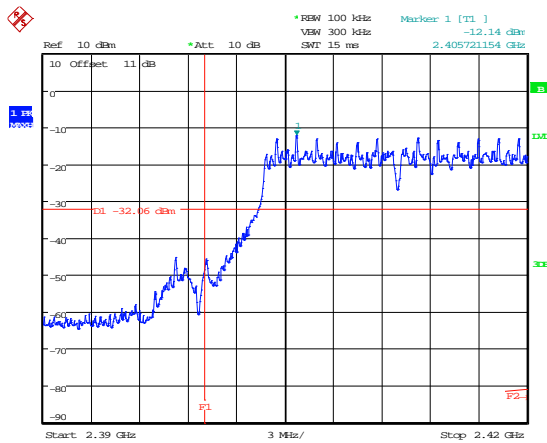
Date: 11.NOV.2014 14:57:54

lower band edge – 802.11b



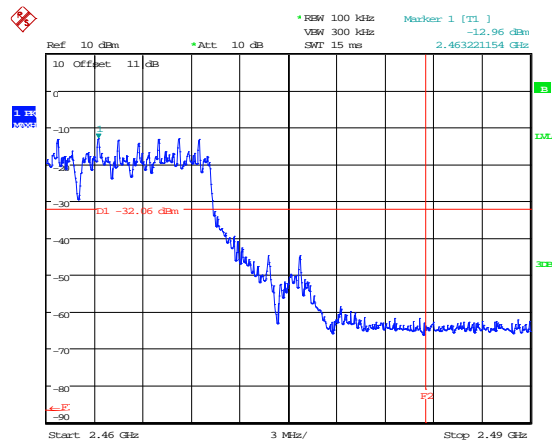
Date: 11.NOV.2014 14:57:00

upper band-edge– 802.11b



Date: 11.NOV.2014 14:47:47

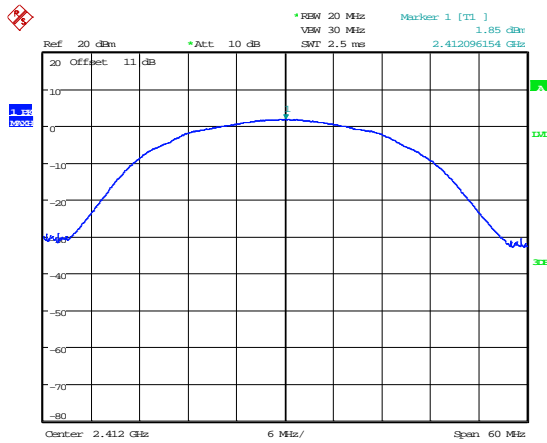
lower band edge – 802.11g



Date: 11.NOV.2014 14:54:38

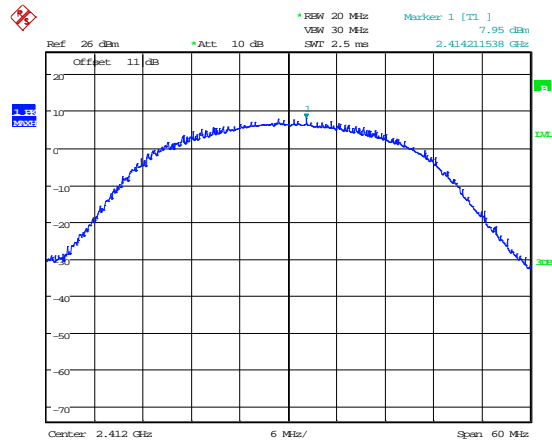
upper band-edge– 802.11g

Conducted carrier power



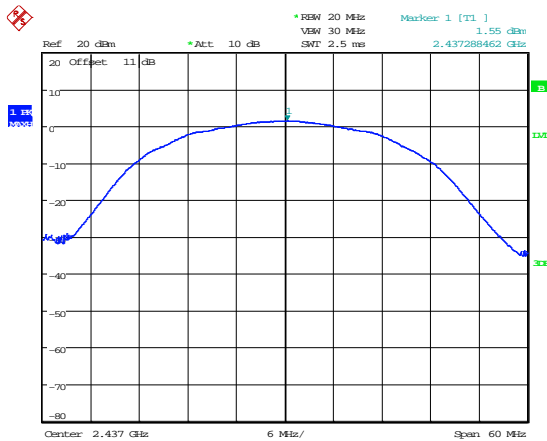
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802.11b Channel 1



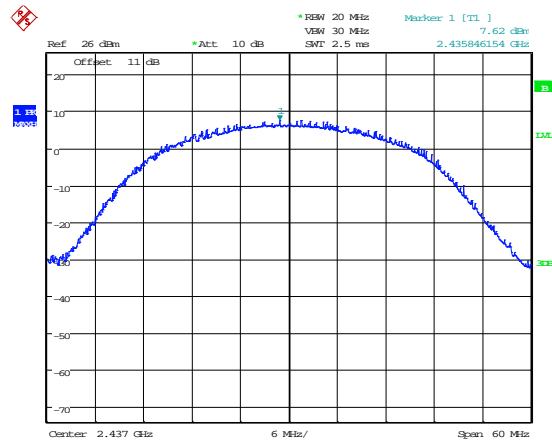
Date: 11.NOV.2014 11:46:54

802.11g Channel 1



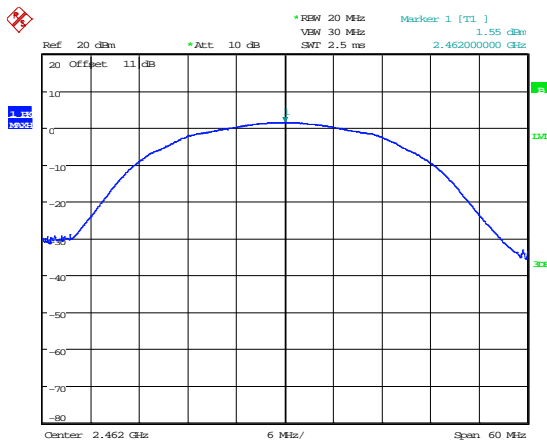
Date: 10.NOV.2014 17:58:44

802.11b Channel 6



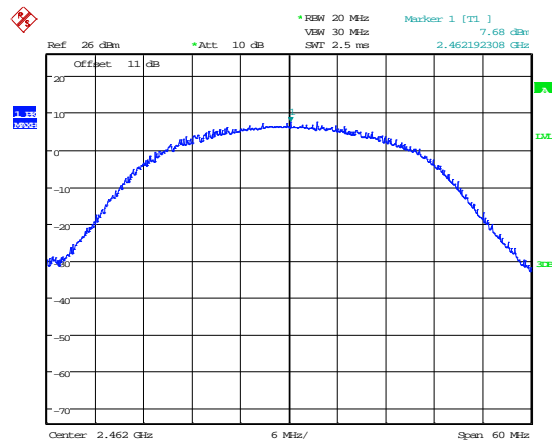
Date: 11.NOV.2014 11:44:37

802.11g Channel 6



Date: 10.NOV.2014 17:59:38

802.11b Channel 11

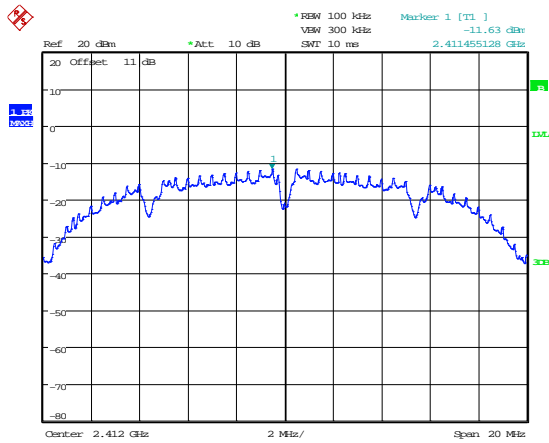


Date: 11.NOV.2014 13:04:59

802.11g Channel 11

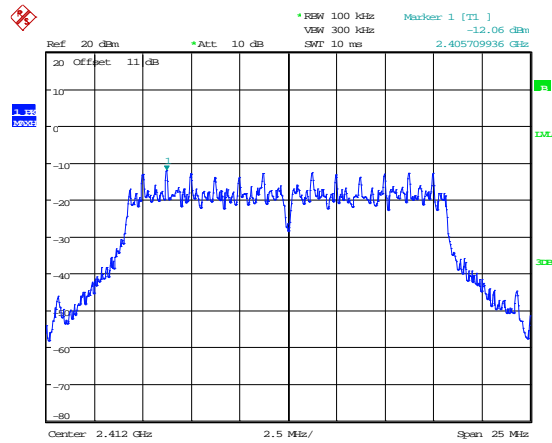


Conducted power spectral density



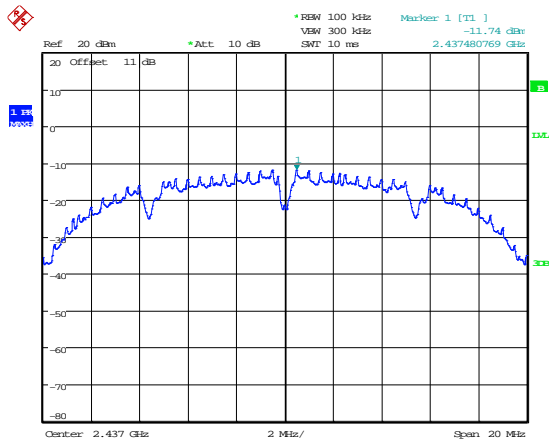
Date: 11.NOV.2014 09:31:01

802.11b Channel 1



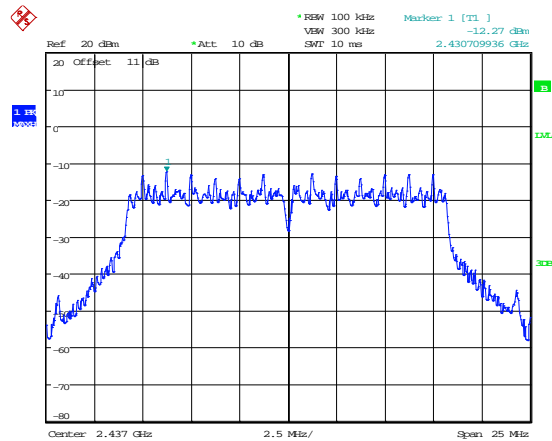
Date: 11.NOV.2014 11:42:36

802.11g Channel 1



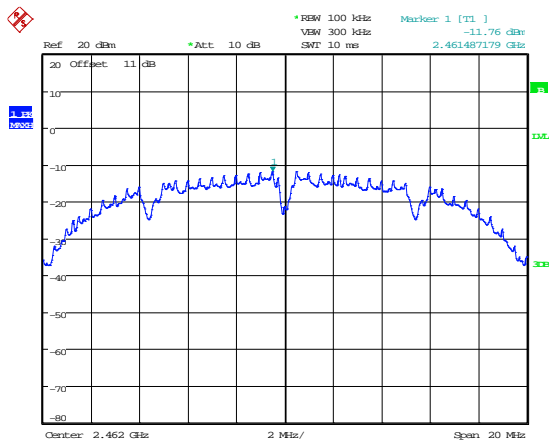
Date: 11.NOV.2014 09:31:43

802.11b Channel 6



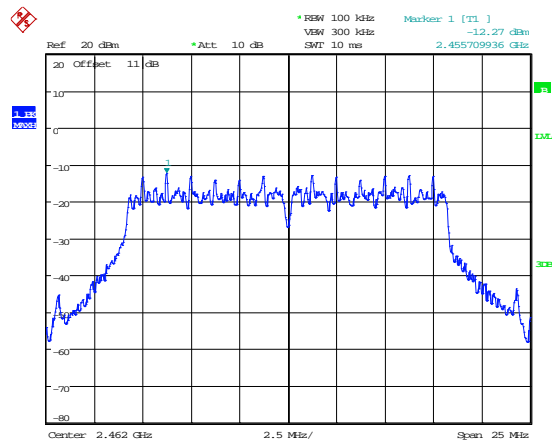
Date: 11.NOV.2014 11:43:32

802.11g Channel 6



Date: 11.NOV.2014 09:32:31

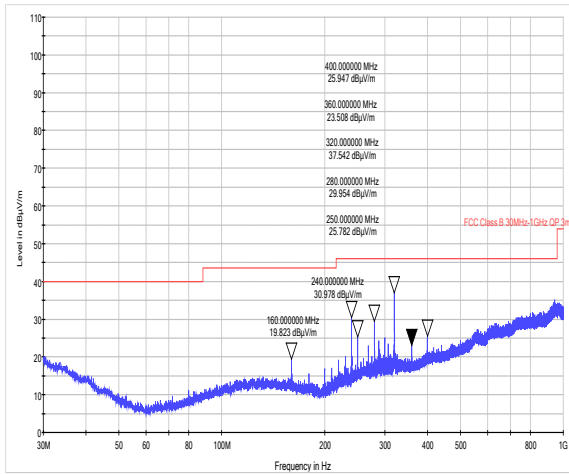
802.11b Channel 11



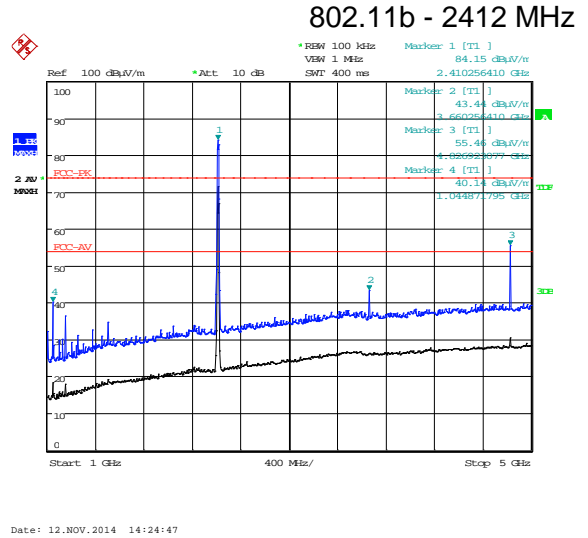
Date: 11.NOV.2014 11:41:52

802.11g Channel 11

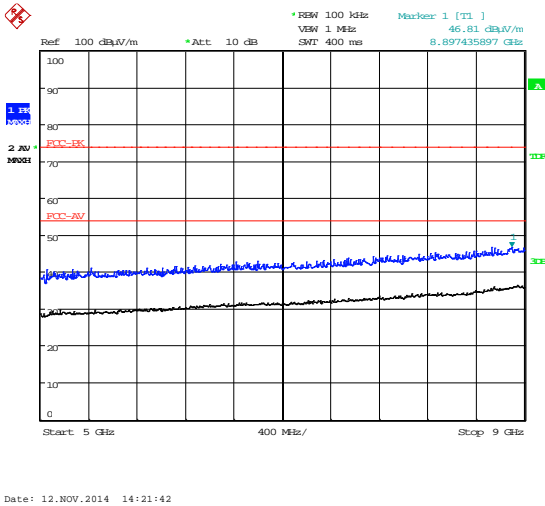
Radiated Spurious emissions



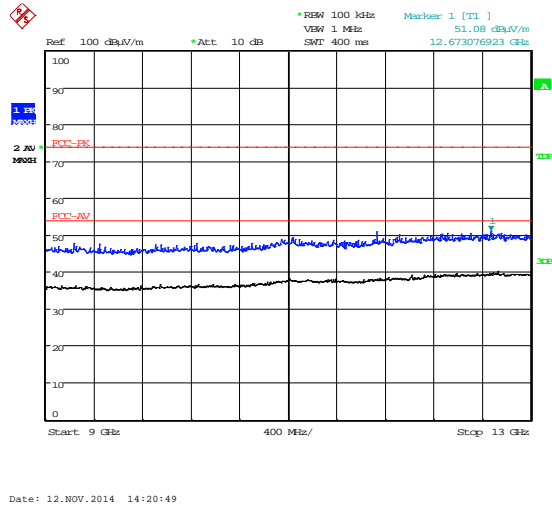
30 MHz to 1 GHz



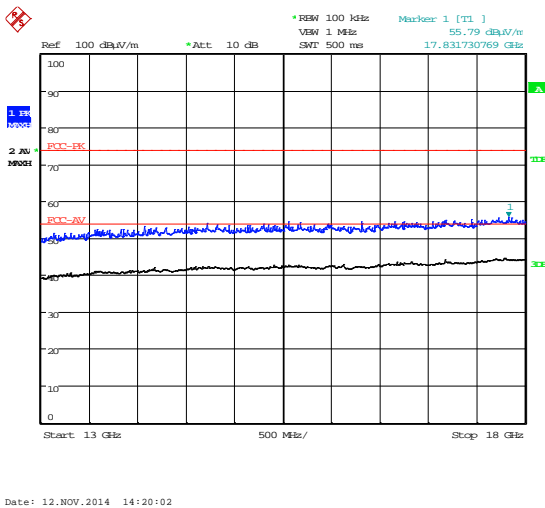
1 GHz to 5 GHz



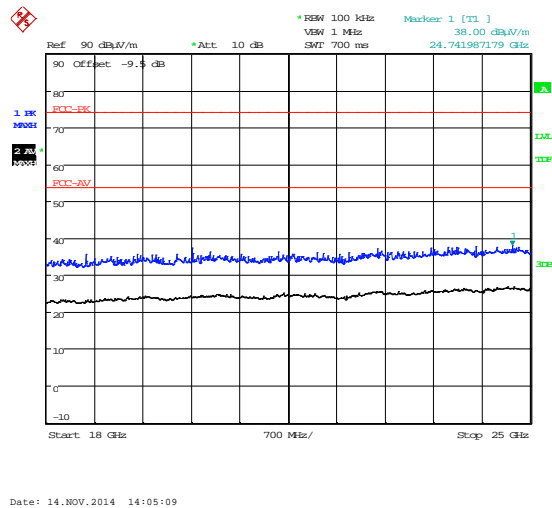
5 GHz to 9 GHz



9 GHz to 13 GHz



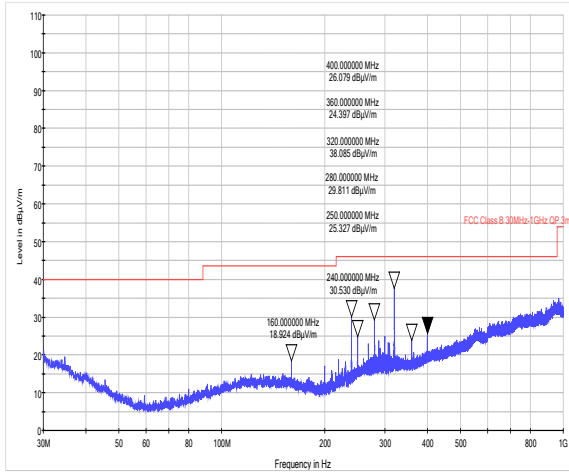
13 GHz to 18 GHz



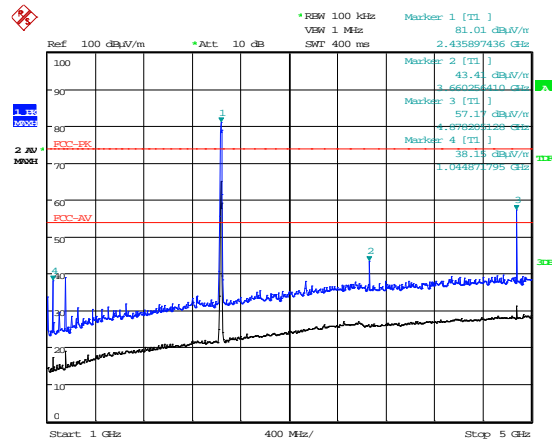
18 GHz to 25 GHz

Radiated Spurious emissions

802.11b - 2437 MHz

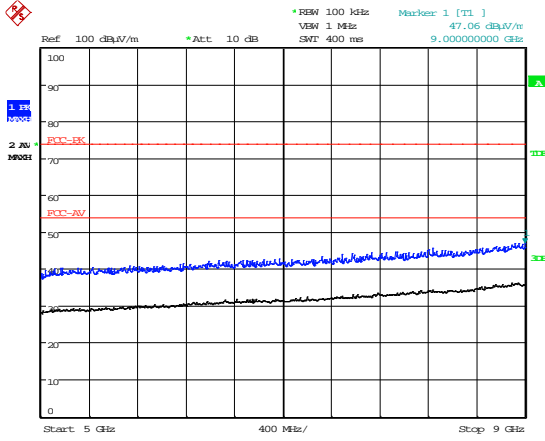


30 MHz to 1 GHz



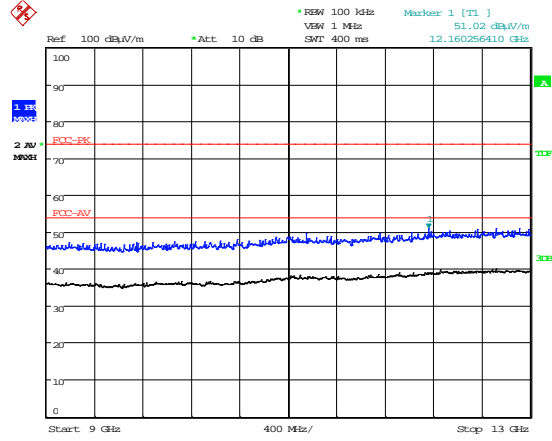
1 GHz to 5 GHz

Date: 12.NOV.2014 14:31:19



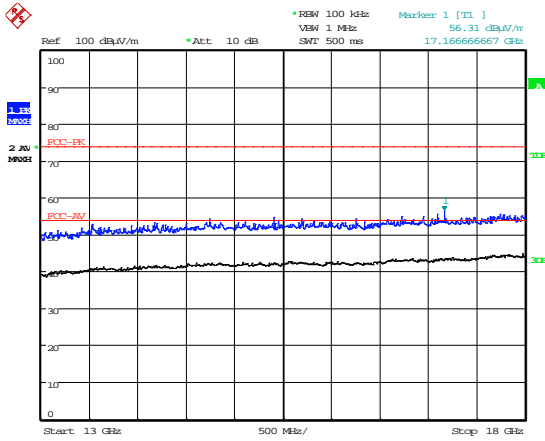
5 GHz to 9 GHz

Date: 12.NOV.2014 14:32:13



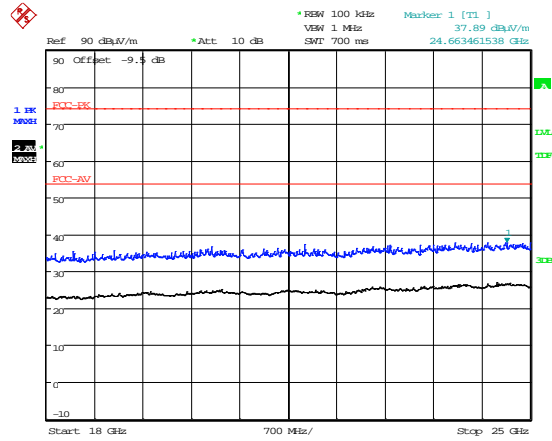
9 GHz to 13 GHz

Date: 12.NOV.2014 14:32:59



13 GHz to 18 GHz

Date: 12.NOV.2014 14:33:46

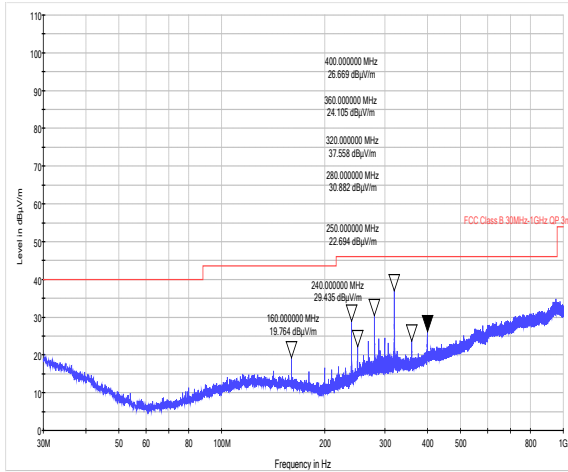


18 GHz to 25 GHz

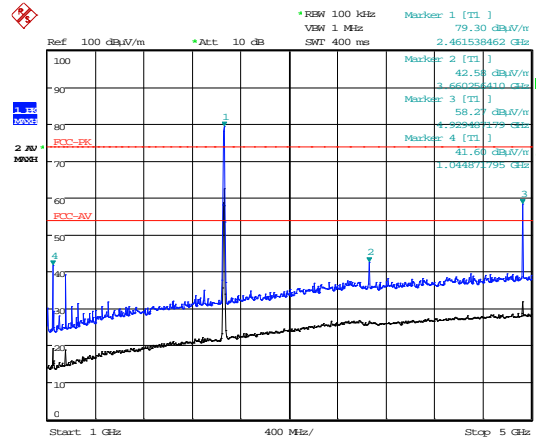
Date: 14.NOV.2014 14:06:34

Radiated Spurious emissions

802.11b - 2462 MHz

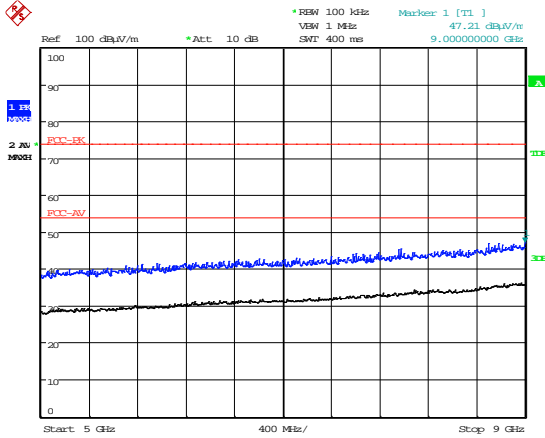


30 MHz to 1 GHz



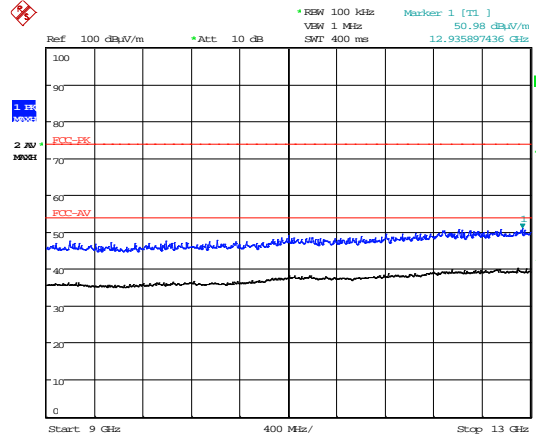
1 GHz to 5 GHz

Date: 12.NOV.2014 14:44:39



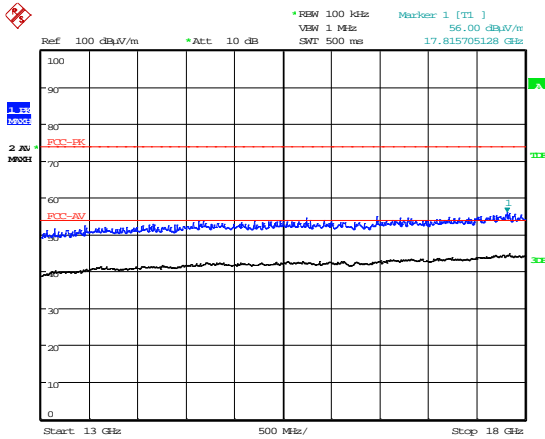
5 GHz to 9 GHz

Date: 12.NOV.2014 14:43:54



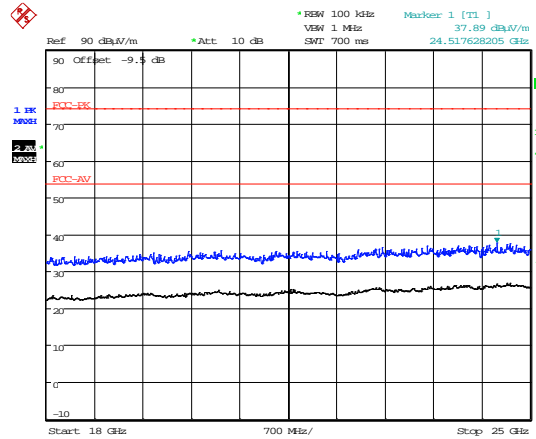
9 GHz to 13 GHz

Date: 12.NOV.2014 14:43:09



13 GHz to 18 GHz

Date: 12.NOV.2014 14:42:22

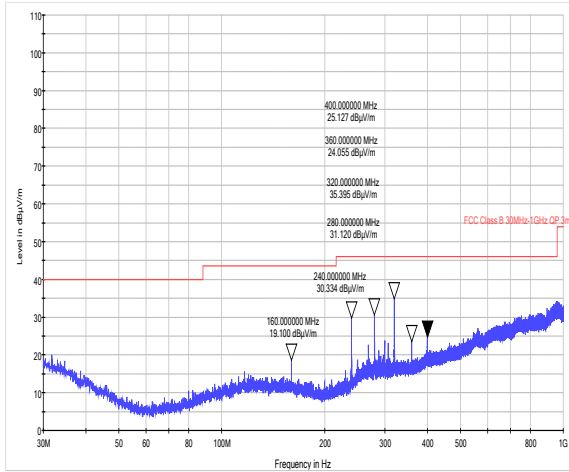


18 GHz to 25 GHz

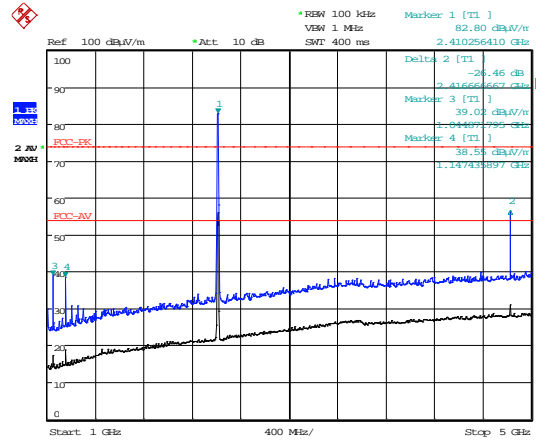
Date: 14.NOV.2014 14:08:31

Radiated Spurious emissions

802.11g - 2412 MHz

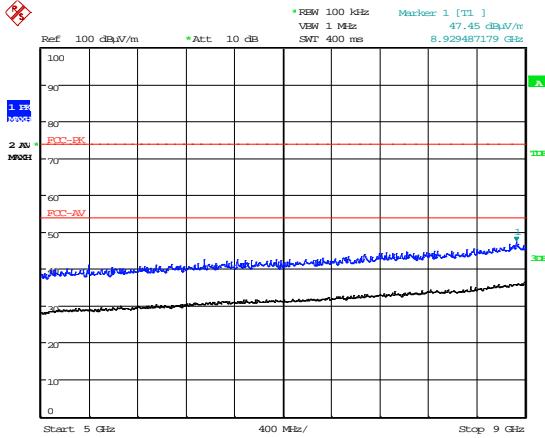


30 MHz to 1 GHz

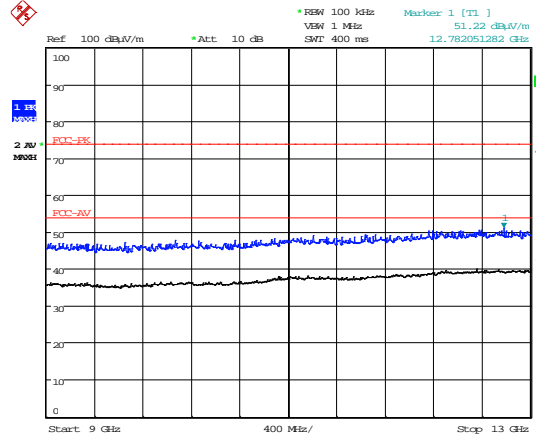


1 GHz to 5 GHz

Date: 12.NOV.2014 15:04:26

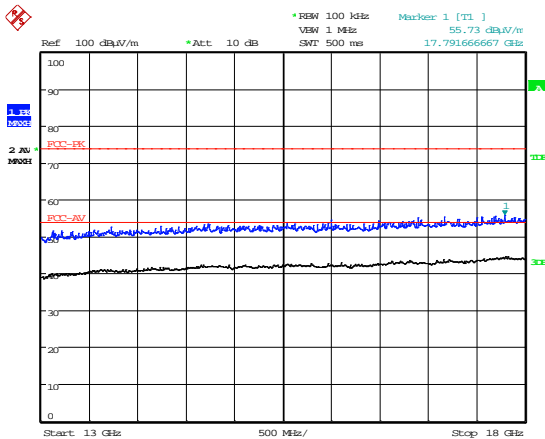


5 GHz to 9 GHz

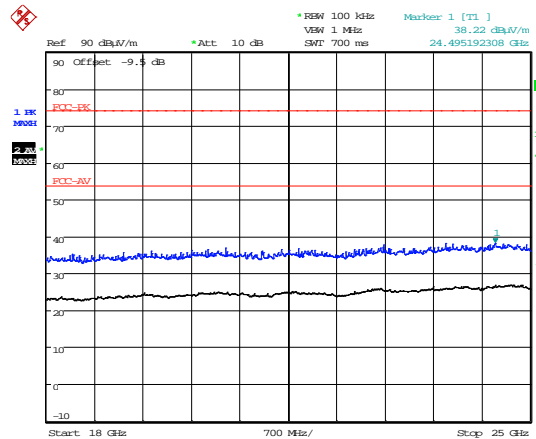


9 GHz to 13 GHz

Date: 12.NOV.2014 15:05:56



13 GHz to 18 GHz

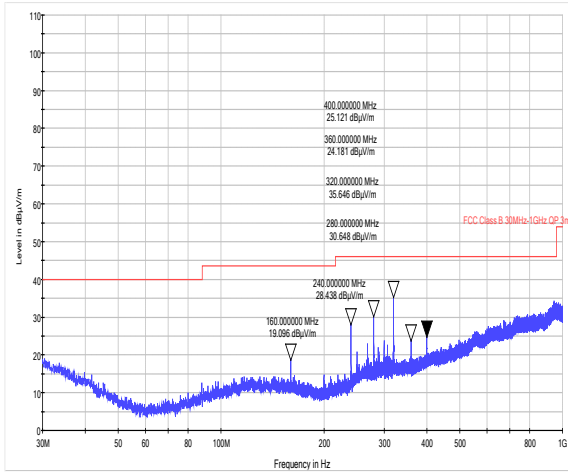


18 GHz to 25 GHz

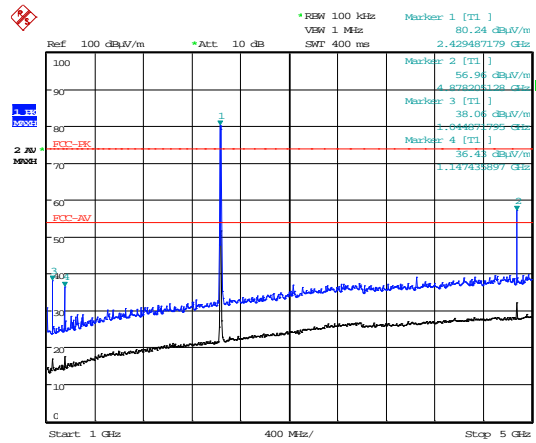
Date: 14.NOV.2014 13:46:30

Radiated Spurious emissions

802.11g - 2437 MHz

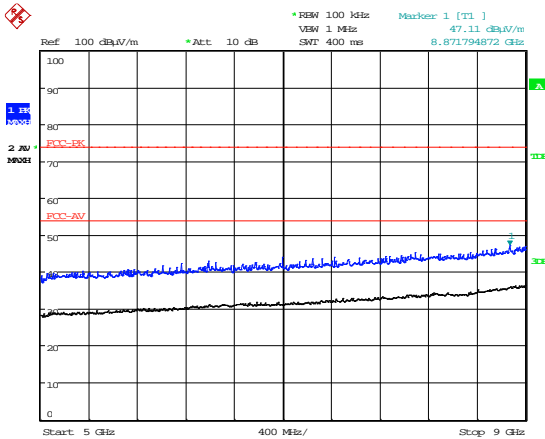


30 MHz to 1 GHz



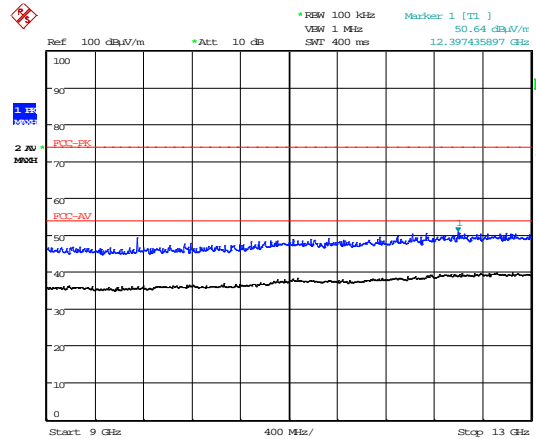
1 GHz to 5 GHz

Date: 12.NOV.2014 15:21:10



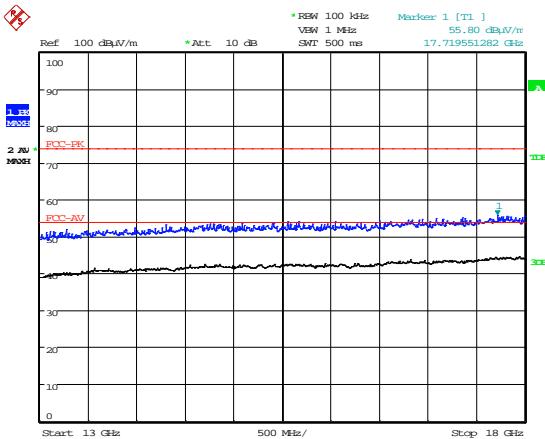
5 GHz to 9 GHz

Date: 12.NOV.2014 15:20:24



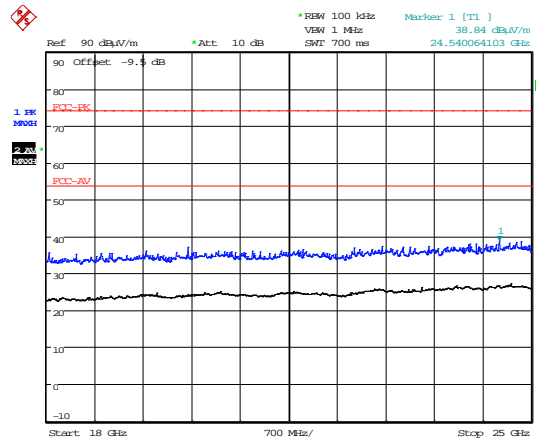
9 GHz to 13 GHz

Date: 12.NOV.2014 15:19:34



13 GHz to 18 GHz

Date: 12.NOV.2014 15:18:37

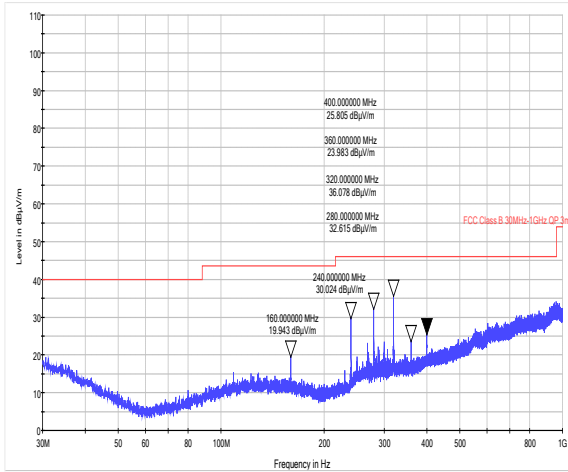


18 GHz to 25 GHz

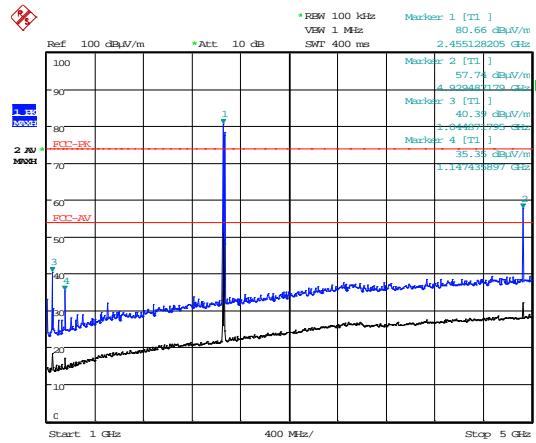
Date: 14.NOV.2014 13:50:04

Radiated Spurious emissions

802.11g - 2462 MHz

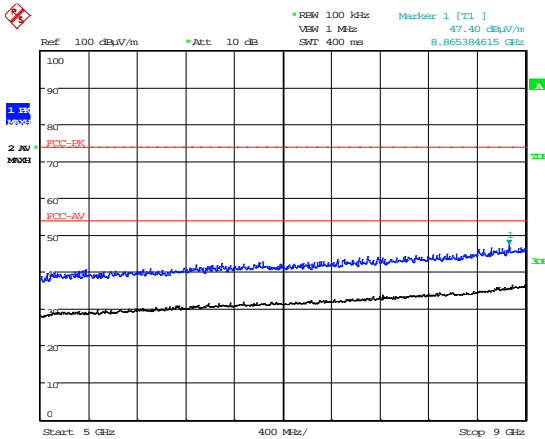


30 MHz to 1 GHz



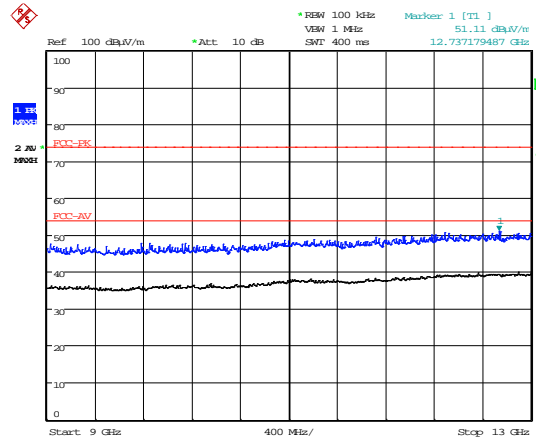
1 GHz to 5 GHz

Date: 12.NOV.2014 15:23:37



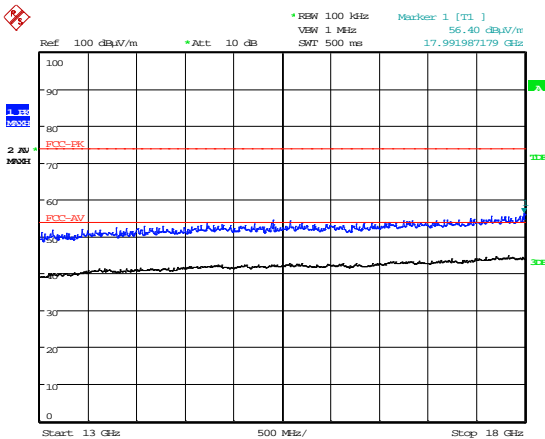
5 GHz to 9 GHz

Date: 12.NOV.2014 15:24:25



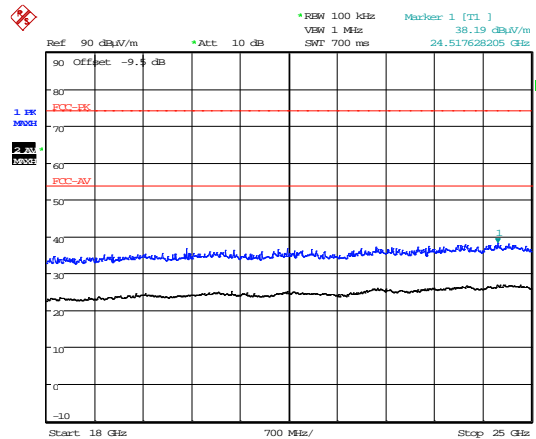
9 GHz to 13 GHz

Date: 12.NOV.2014 15:25:08



13 GHz to 18 GHz

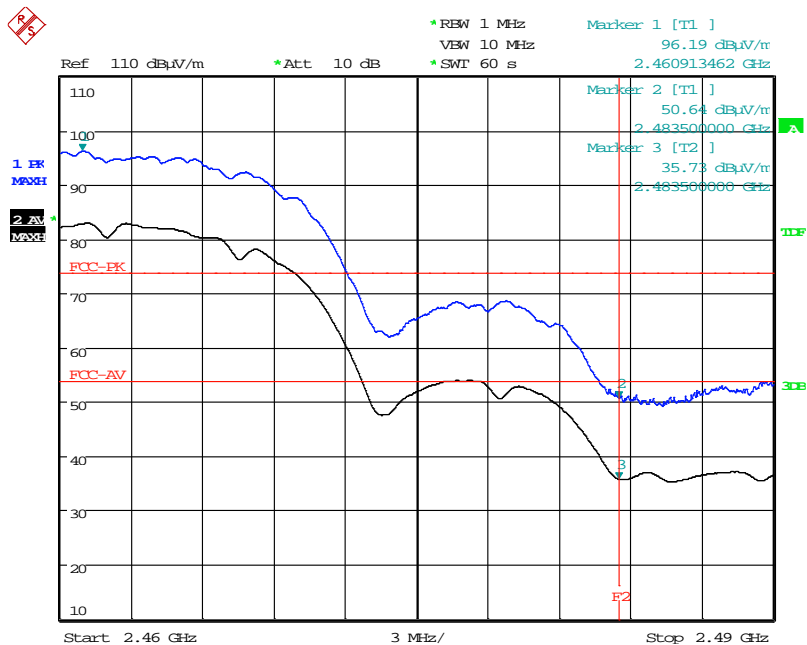
Date: 12.NOV.2014 15:25:54



18 GHz to 25 GHz

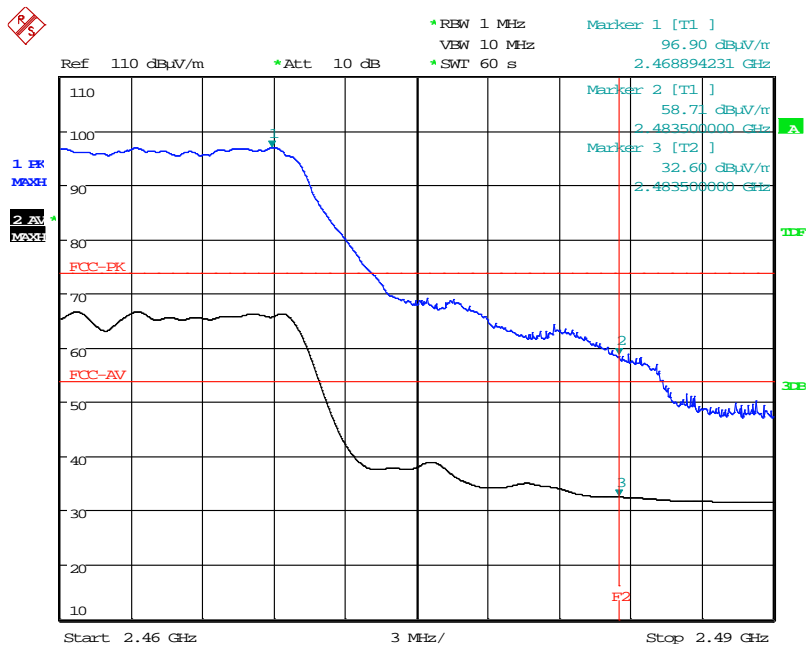
Date: 14.NOV.2014 13:51:34

Radiated band-edge compliance



Date: 14.NOV.2014 09:06:54

upper band-edge- 802.11b



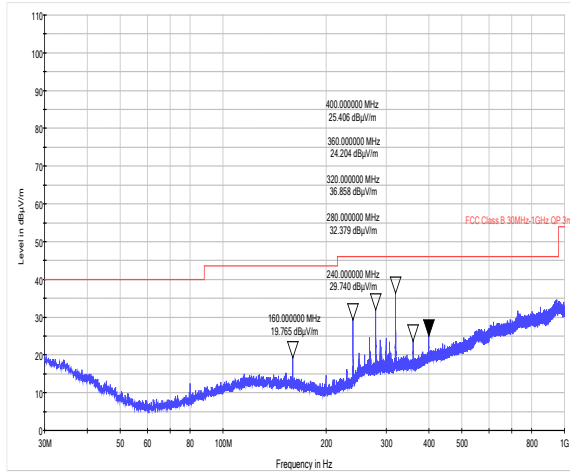
Date: 14.NOV.2014 08:53:23

upper band-edge- 802.11g

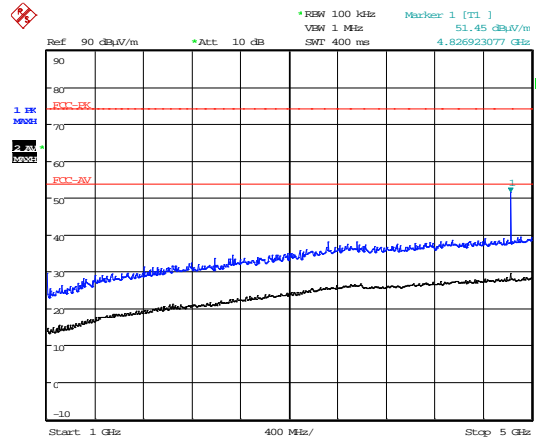


Unintentional Radiated Spurious emissions

2412 MHz

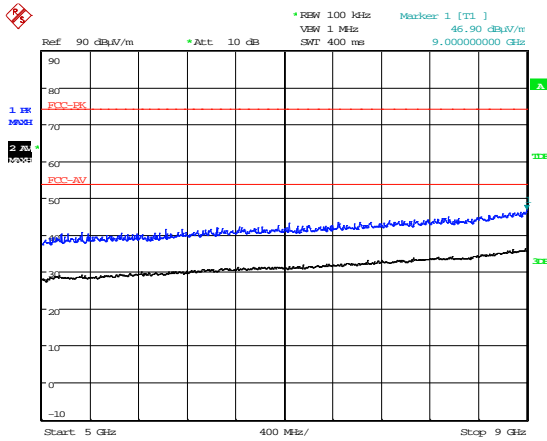


30 MHz to 1 GHz



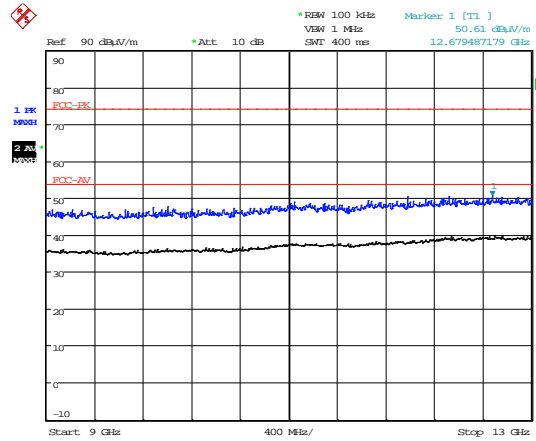
1 GHz to 5 GHz

Date: 13.NOV.2014 12:30:20



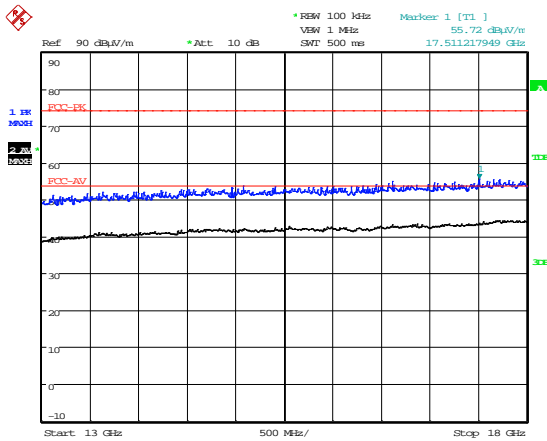
5 GHz to 9 GHz

Date: 13.NOV.2014 12:29:20



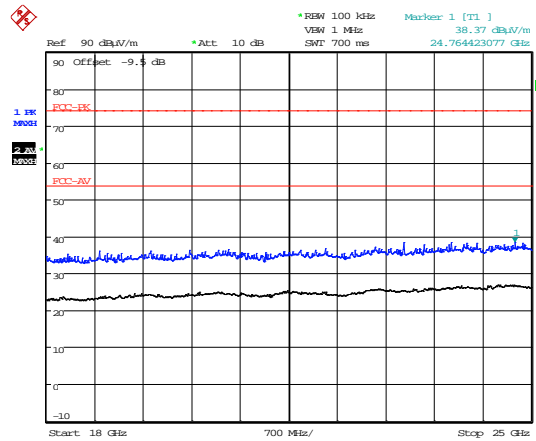
9 GHz to 13 GHz

Date: 13.NOV.2014 12:28:27



13 GHz to 18 GHz

Date: 13.NOV.2014 12:27:46

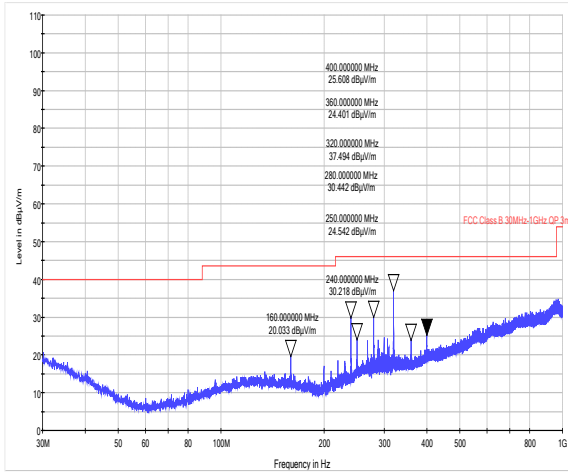


18 GHz to 25 GHz

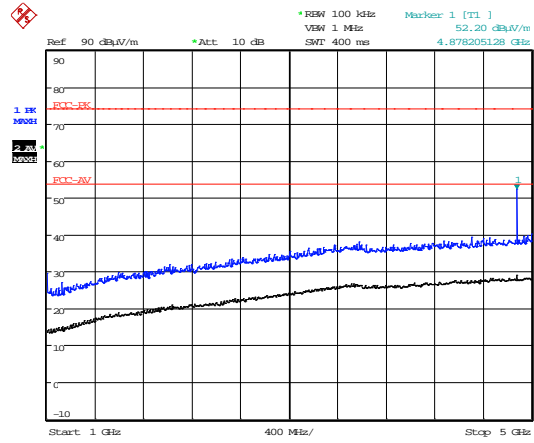
Date: 14.NOV.2014 13:37:17

Unintentional Radiated Spurious emissions

2437 MHz

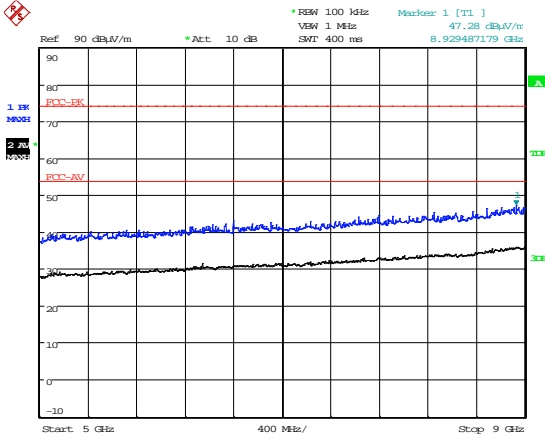


30 MHz to 1 GHz



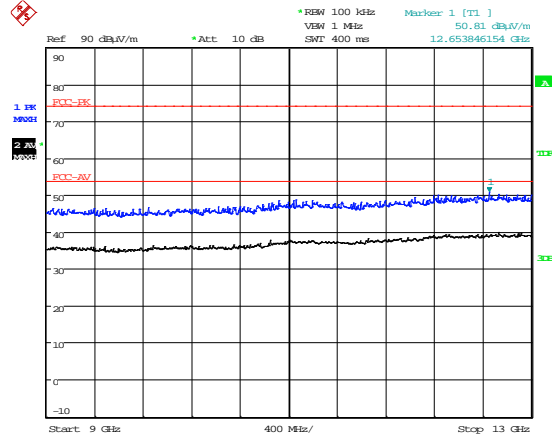
Date: 13.NOV.2014 12:32:08

1 GHz to 5 GHz



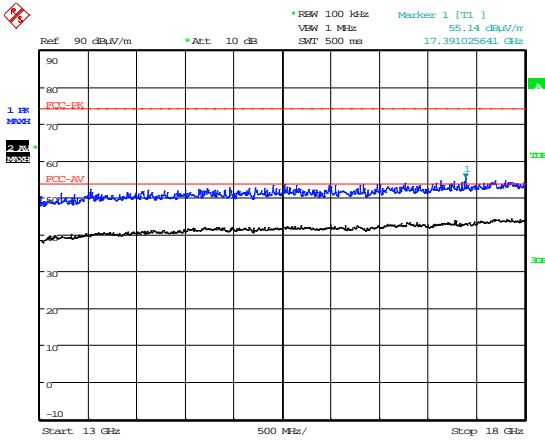
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5 GHz to 9 GHz



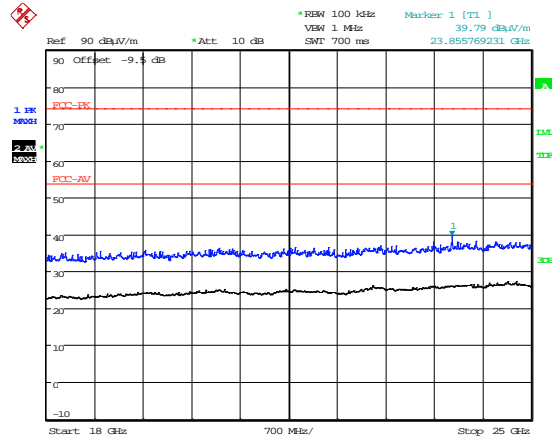
Date: 13.NOV.2014 12:33:17

9 GHz to 13 GHz



Date: 13.NOV.2014 12:33:33

13 GHz to 18 GHz

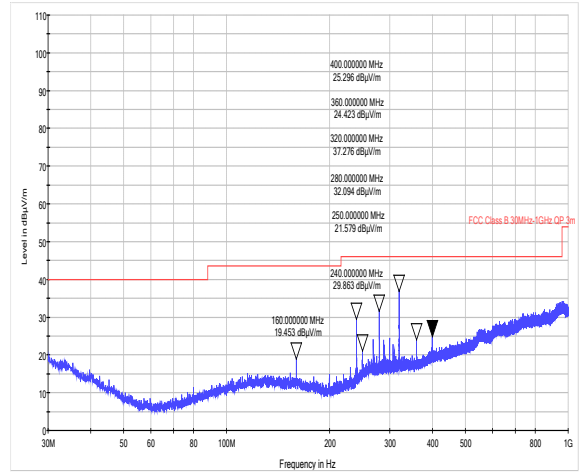
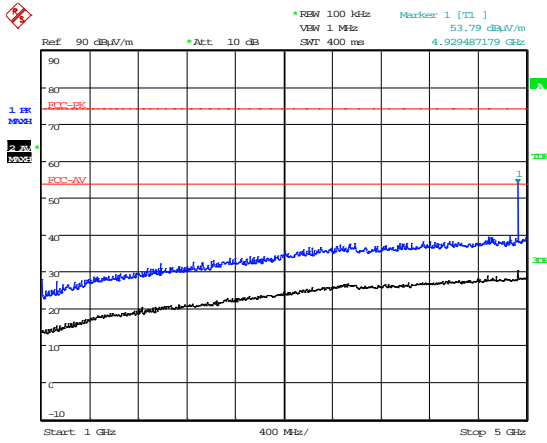


Date: 14.NOV.2014 13:39:10

18 GHz to 25 GHz

Unintentional Radiated Spurious emissions

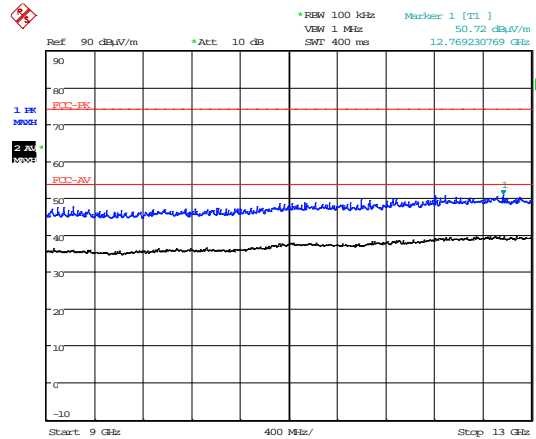
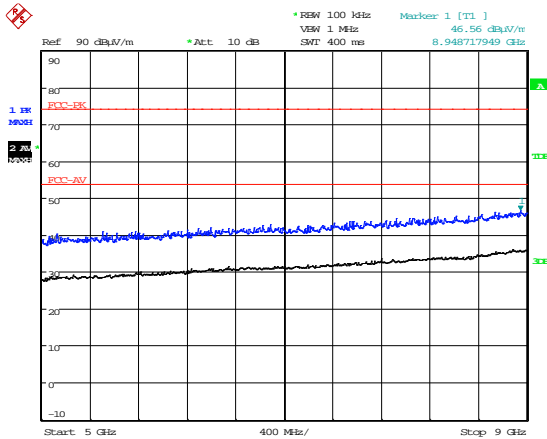
2462 MHz



Date: 13.NOV.2014 12:46:19

30 MHz to 1 GHz

1 GHz to 5 GHz

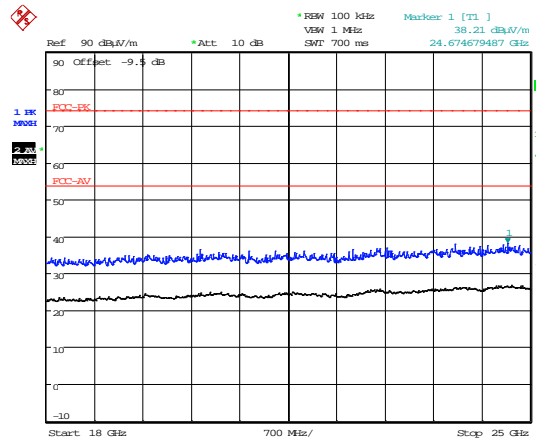
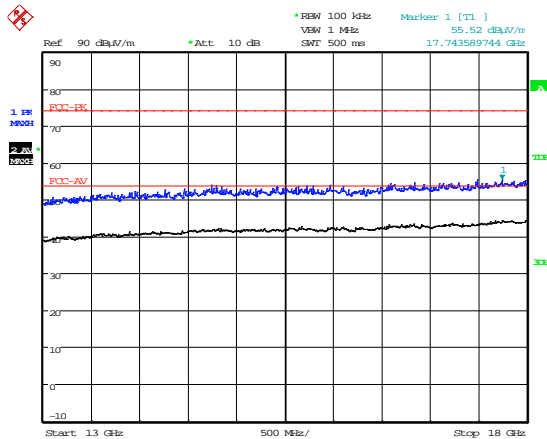


Date: 13.NOV.2014 12:45:26

5 GHz to 9 GHz

Date: 13.NOV.2014 12:44:31

9 GHz to 13 GHz



Date: 13.NOV.2014 12:43:29

13 GHz to 18 GHz

Date: 14.NOV.2014 13:41:54

18 GHz to 25 GHz

**Appendix C: Formal Emission Test Results 900MHz FHSS Operation**

Abbreviations used in the tables in this appendix:

Spec	: Specification	ALSR	: Absorber Lined Screened Room
Mod	: Modification	OATS	: Open Area Test Site
EUT	: Equipment Under Test	ATS	: Alternative Test Site
SE	: Support Equipment	Ref	: Reference
L	: Live Power Line	Freq	: Frequency
N	: Neutral Power Line	MD	: Measurement Distance
E	: Earth Power Line	SD	: Spec Distance
Pk	: Peak Detector	Pol	: Polarisation
QP	: Quasi-Peak Detector	H	: Horizontal Polarisation
Av	: Average Detector	V	: Vertical Polarisation
CDN	: Coupling & decoupling network		

**C1 Transmitter Peak Output Power**

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

<b>Test Details:</b>	
Regulation	Part 15.247(b)(1) RSS – 210, Annex 8, A8.4(2)
Measurement standard	ANSI C63.10:2009, RSS-GEN
EUT sample number	S11
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	25

Channel Frequency (MHz)	Peak Carrier Power (W)	Limit (W)	Result
915.8	0.00813	1	Pass
919.0	0.00771		Pass
922.1	0.00726		Pass

**Notes:**

Number of hopping channels employed is 50

Conducted Measurement

Conducted measurements were performed with the unique antenna connector.

**C2 RF Antenna Conducted Spurious Emissions**

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

<b>Test Details:</b>	
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 25 GHz
EUT sample number	S11
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	25

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

<b>Transmit 915.8 MHz</b>						
Ref No.	Measured Freq (MHz)	Det.	Restricted bands (Y/N)	Emission power (RBW =100kHz) (dBm)	15.247(d) Limit (dBuV)	Summary
No Significant Emissions within 20 dB of limit						

<b>Transmit 922.1 MHz</b>						
Ref No.	Measured Freq (MHz)	Det.	Restricted bands (Y/N)	Emission power (RBW =100kHz) (dBm)	15.247(d) Limit (dBuV)	Summary
No Significant Emissions within 20 dB of 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. 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

**C3 Radiated Electric Field Emissions**

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The radiated electric field emission test applies to spurious emissions and harmonics that fall within the restricted bands. 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 :

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	30MHz – 25GHz
EUT sample number	S11
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	25 °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:

Transmit 915.8 MHz									
DET	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)
Qp	965.80	7.1	4.6	25.7	N/A	37.4	-	73.96	500
Qp	975.85	9.8	4.6	25.5	N/A	39.9	-	98.97	500
Qp	985.80	6.1	4.6	25.0	N/A	35.7	-	61.24	500
Qp	995.75	9.7	4.7	24.6	N/A	39.0	-	88.72	500
Pk	2747.29	49.44	3.3	29.1	36.0	45.9	-	196.79	5012
Av	2747.29	38.73	3.3	29.1	36.0	35.2	-	57.35	500
Pk	3663.01	51.55	3.2	31.6	35.7	50.6	-	339.63	5012
Av	3663.01	44.47	3.2	31.6	35.7	43.5	-	150.31	500
Pk	4578.82	53.67	3.7	32.3	35.6	54.1	-	504.08	5012
Av	4578.82	49.14	3.7	32.3	35.6	49.5	-	299.23	500



<b>Transmit 922.1 MHz</b>									
<b>DET</b>	<b>FREQ. (MHz)</b>	<b>MEAS Rx (dBμV)</b>	<b>CABLE LOSS (dB)</b>	<b>ANT FACT. (dB/m)</b>	<b>PRE AMP (dB)</b>	<b>FIELD ST'GH (dBμV/m)</b>	<b>EXTRAP FACT (dB)</b>	<b>FIELD ST'GH (μV/m)</b>	<b>LIMIT (μV/m)</b>
Qp	962.10	11.3	4.6	25.6	N/A	41.5	-	118.58	500
Qp	972.10	9.7	4.6	25.6	N/A	39.9	-	98.86	500
Qp	982.10	10.8	4.6	25.1	N/A	40.5	-	106.17	500
Qp	992.15	8.4	4.6	24.7	N/A	37.7	-	77.09	500
Pk	2766.15	49.48	3.4	29.1	36.0	46.0	-	199.76	5012
Av	2766.15	39.61	3.4	29.1	36.0	36.1	-	64.12	500
Pk	3688.22	51.79	3.2	31.7	35.7	51.0	-	354.00	5012
Av	3688.22	44.85	3.2	31.7	35.7	44.0	-	159.22	500
Pk	4610.29	53.95	3.7	32.3	35.6	54.3	-	520.60	5012
Av	4610.29	49.79	3.7	32.3	35.6	50.2	-	322.48	500

**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 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 C63.10:2009 and DA 00-705.

- 5 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 ( $\mu\text{V}/\text{m}$ )	Measurement Distance (m)	Field strength ( $\text{dB}\mu\text{V}/\text{m}$ )
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:

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

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				

**C4 20 dB Bandwidth and Carrier Frequency Separation**

Title 47 of the CFR: Part 15 Subpart (c) 15.247(a)(1) 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	S11
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	25

Channel Frequency (MHz)	Measured 20 dB Bandwidth (kHz)	Limit	Result
915.8	91.827	<500kHz	Pass
919.0	91.347	<500kHz	Pass
922.1	91.346	<500kHz	Pass

Measured Channel Spacing (kHz)	Limit	Result
100	(25kHz or $\geq$ Measured 20 dB Bandwidth kHz)	Pass

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

**C5 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	S11
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	25

No. of Hopping Channels	Requirement	Result
50	50	Pass

Plots showing the hopping channels are contained in Appendix B

## C6 Channel Occupancy

Channel occupancy time was verified using a spectrum analyser in zero span mode, centred on the middle hopping channel frequency (919.0 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	S11
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	25

Low Data Rate					
Measured Channel Occupancy Time (µs)	Measurement Period (s)	Number of Transmissions in Measurement Period	Average on Time (s)	Limit (s)	Result
15.23	20	10	0.1523	0.4	PASS

High Data Rate					
Measured Channel Occupancy Time (µs)	Measurement Period (s)	Number of Transmissions in Measurement Period	Average on Time (s)	Limit (s)	Result
3.3	20	10	0.033	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.

## C7 Antenna Gain

See data sheet for details of antenna to be used



### 2. Specification

#### Electrical

Communication System	Penta-band Cellular				
	AMPS	GSM	DCS	PCS	UMTS
Frequency	824 ~ 896	880 ~ 960	1710 ~ 1880	1850 ~ 1990	1710 ~ 2170
Efficiency (free space)*	21%	24%	23%	32%	31%
Gain (dBi, free space)*	2.0	2.0	-1.0	-0.4	-0.1
Efficiency (mounted on PCB)*	39%	31%	78%	75%	75%
Gain (dBi, mounted on PCB)*	1.0	-1.0	2.8	2.8	2.0
Impedance	50Ω				
Polarization	Linear				
Radiation Pattern	Omni-directional				
Input Power	10 W				

#### Mechanical

Antenna Length	72 ± 1.5 mm
Antenna Diameter	10 ± 0.3 mm
Casing	POM
Connector	SMA Male (Brass)

#### Environmental

Temperature Range	-40°C to 85°C
Storage Temperature	-40°C ~ +105°C
Humidity	Non-condensing 65°C 95% RH

\* Average efficiency and peak gain of antenna sitting 180° in free space and mounted at the side of the PCB. Please refer to section IV for testing detail.

**C8 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 :

<b>Test Details: 915.8 MHz</b>	
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	S11
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	25
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:

DET	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)
<b>Emissions unrelated to Operating Frequency</b>									
Qp	30.05	4.1	0.7	18.2	N/A	23.0	-	14.09	100
Qp	34.20	4.3	0.7	16.0	N/A	21.0	-	11.25	100
Qp	35.15	4.2	0.7	15.6	N/A	20.5	-	10.60	100
Qp	240.00	18.0	2.2	10.4	N/A	30.6	-	33.77	200
Qp	280.00	15.6	2.4	12.6	N/A	30.6	-	33.69	200
Qp	300.00	10.9	2.4	13.0	N/A	26.3	-	20.65	200
Qp	320.00	19.0	2.5	13.8	N/A	35.3	-	58.01	200
Qp	400.00	7.8	2.9	16.2	N/A	26.9	-	22.03	200
Qp	550.30	4.8	3.4	20.5	N/A	28.7	-	27.23	200
Qp	571.00	5.2	3.3	20.3	N/A	28.8	-	27.64	200
Qp	649.55	5.6	3.7	20.5	N/A	29.8	-	30.97	200
Qp	680.00	6.9	3.8	20.9	N/A	31.6	-	37.89	200
Qp	748.65	6.0	3.9	22.7	N/A	32.6	-	42.51	200



DET	FREQ. (MHz)	MEAS Rx (dB $\mu$ V)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dB $\mu$ V/m)	EXTRAP FACT (dB)	FIELD ST'GH ( $\mu$ V/m)	LIMIT ( $\mu$ V/m)
<b>Operating Frequency 915.8 MHz</b>									
Pk	3661.256	50.71	2.9	31.5	35.74	49.37	-	294.1034	5011
Av	3661.256	43.04	2.9	31.5	35.74	41.70	-	121.6186	500
<b>Operating Frequency 922.1 MHz</b>									
Pk	3686.449	50.85	2.9	31.7	35.71	49.74	-	306.9022	5011
Av	3686.449	43.24	2.9	31.7	35.71	42.13	-	127.7909	500

**Notes:**

- 5 Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10: section 4.5, Table 1 For emissions below 30MHz the cable losses are assumed to be negligible.
- 6 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.
- 7 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.
- 8 For Frequencies below 1 GHz, RBW = 120 kHz, testing was performed with CISPR16 compliant test receiver with QP detector. Above 1 GHz tests were performed using a spectrum analyser using the following settings:

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

The upper and lower frequency of the measurement range was decided according to 47 CFR Part 15 Clause 15.33

Radiated emission limits 47 CFR Part 15: Clause 15.209 for all emissions:

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

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

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

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

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

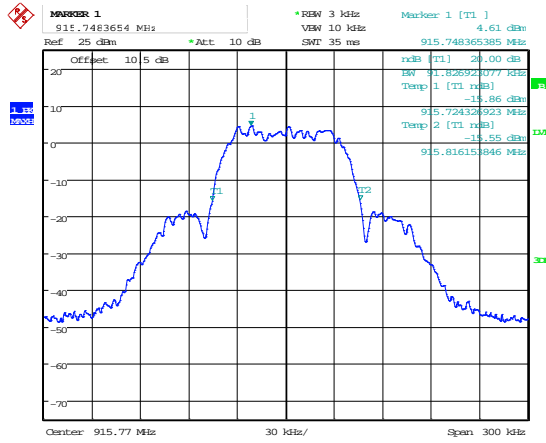
**Appendix D: Supporting Graphical Data 900MHz FHSS Operation**

This appendix contains graphical data obtained during testing.

Notes:

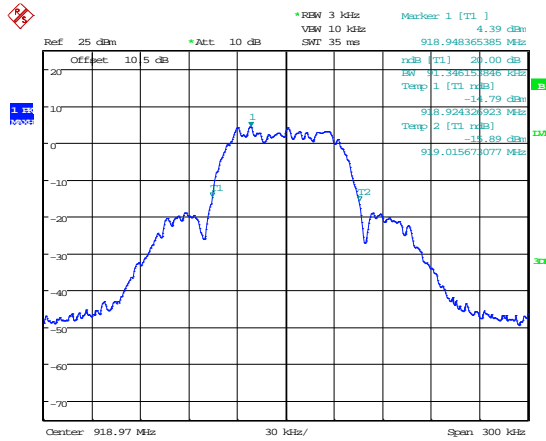
- (a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A and Appendix B.
- (b) The time and date on the plots do not necessarily equate to the time of the test.
- (c) Where relevant, on power 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.
- (f) 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



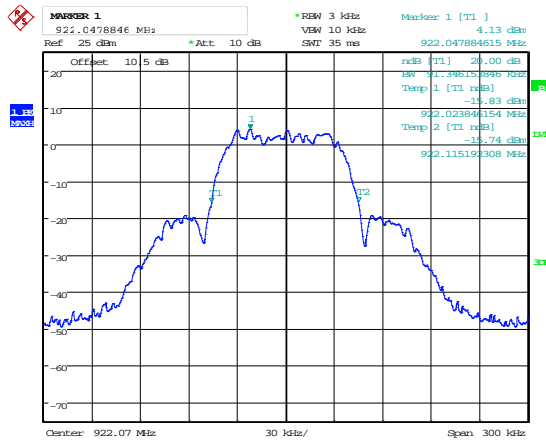
Date: 11.NOV.2014 16:26:58

### 915.8 MHz



Date: 11.NOV.2014 16:28:48

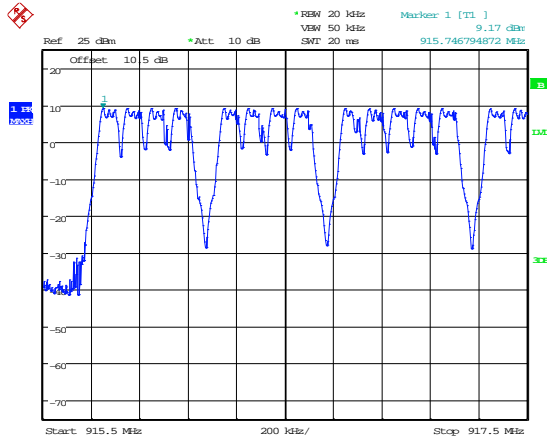
### 919.0 MHz



Date: 11.NOV.2014 16:30:37

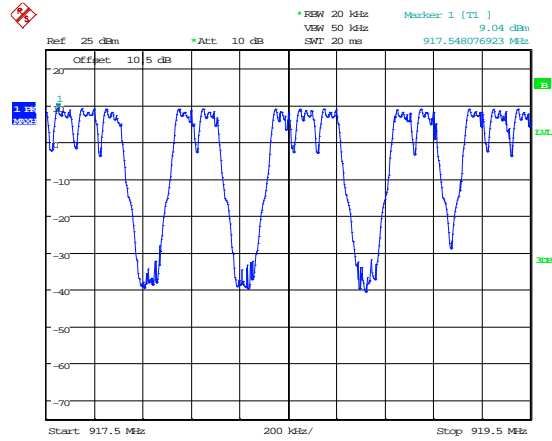
### 921.1 MHz

### Number of Hopping Channels



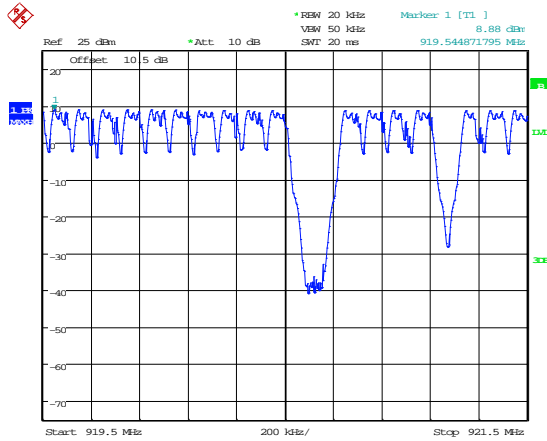
Date: 12.NOV.2014 11:45:12

Channels 1 to 15



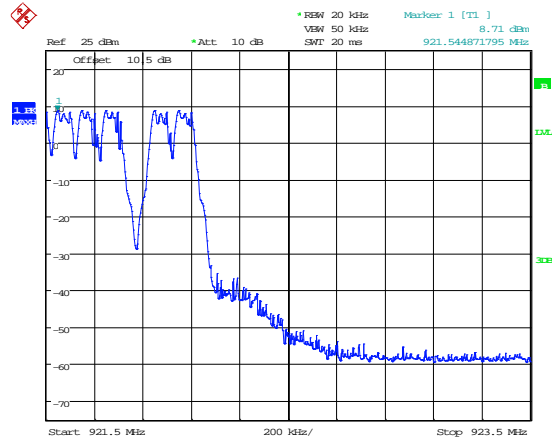
Date: 12.NOV.2014 12:09:16

Channels 16 to 28



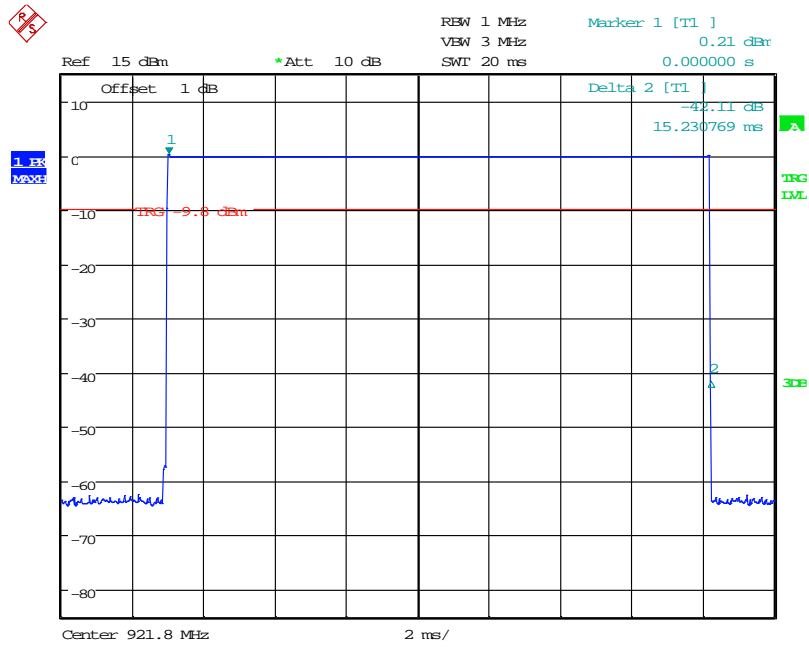
Date: 12.NOV.2014 12:18:29

Channels 29 to 45



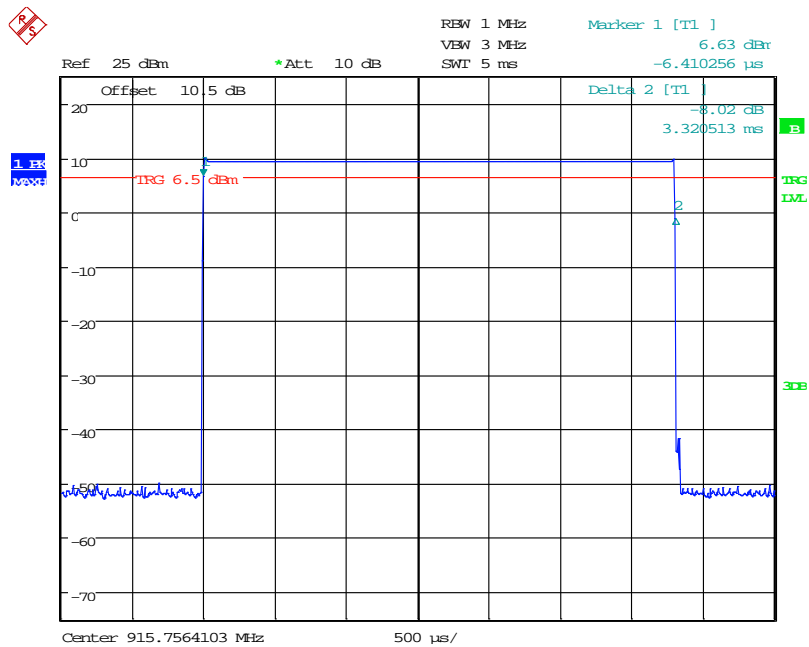
Date: 12.NOV.2014 12:24:40

Channels 46 to 50



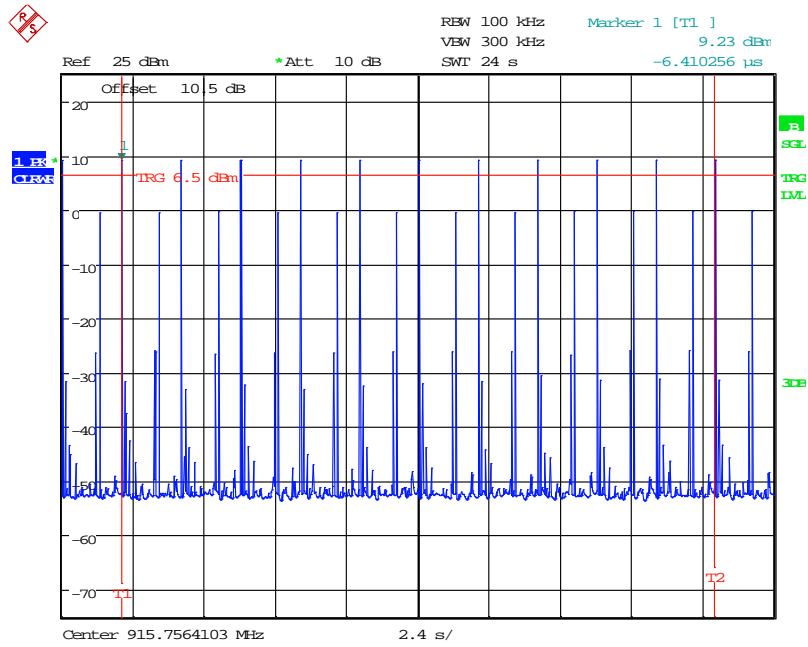
Date: 3.DEC.2014 08:54:21

### Low Data Rate Channel Occupancy Time



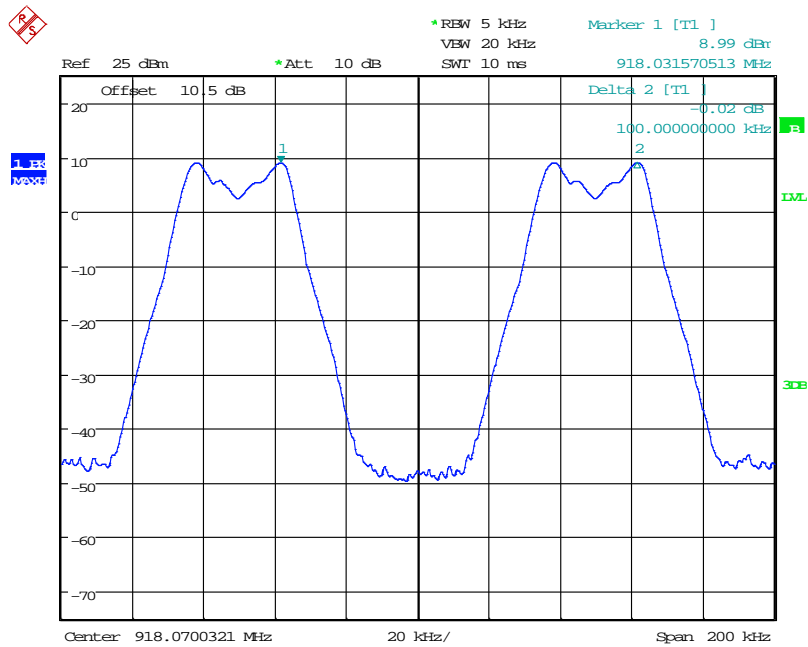
Date: 12.NOV.2014 10:35:22

### High Data Rate Channel Occupancy Time



Date: 12.NOV.2014 11:07:45

### Number of Transmission in Measurement period

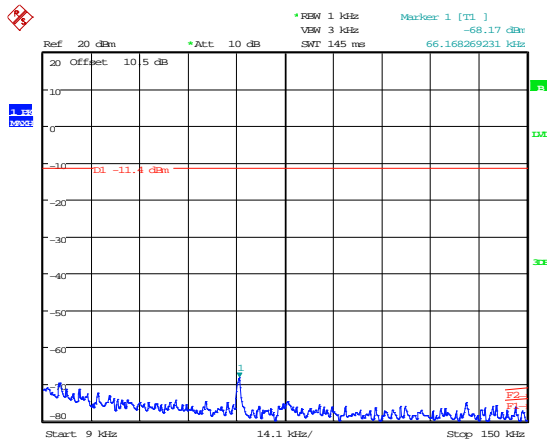


Date: 11.NOV.2014 16:52:06

### Channel Spacing

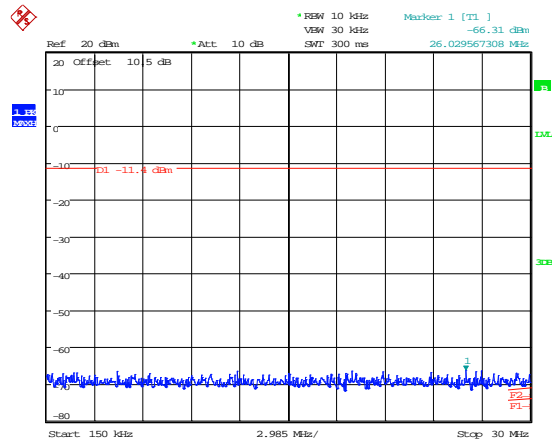
Conducted Spurious emissions

915.8MHz



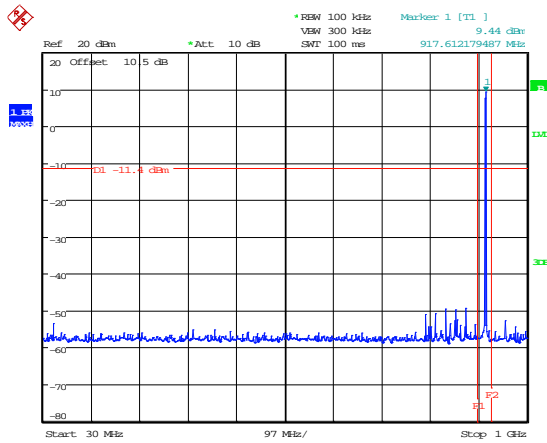
Date: 12.NOV.2014 08:52:11

9kHz – 150 kHz



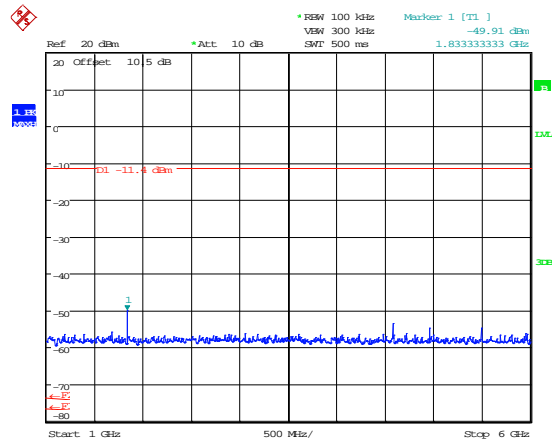
Date: 12.NOV.2014 08:52:34

150kHz – 30 MHz



Date: 12.NOV.2014 08:53:17

30 MHz to 1 GHz



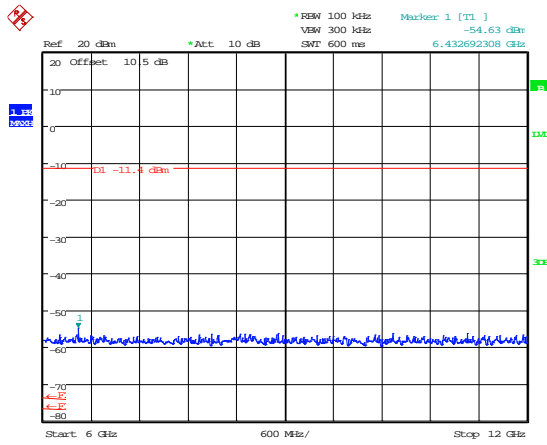
Date: 12.NOV.2014 08:53:40

1 GHz to 6 GHz

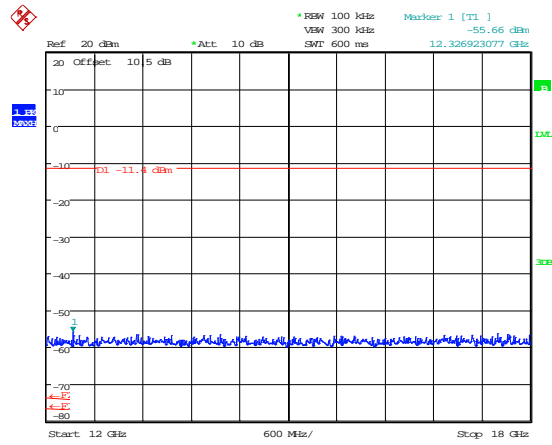


Conducted Spurious emissions

915.8MHz



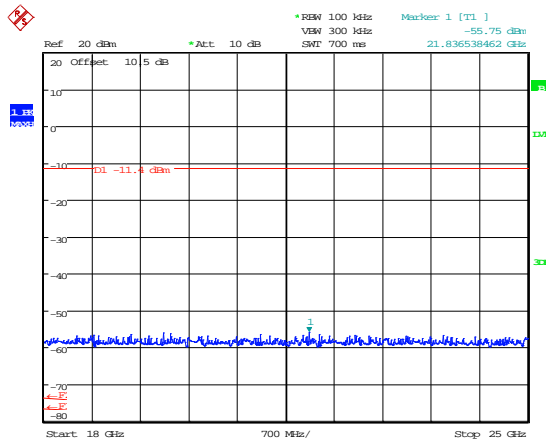
Date: 12.NOV.2014 08:56:06



Date: 12.NOV.2014 08:55:48

6 GHz to 12 GHz

12 GHz to 18 GHz

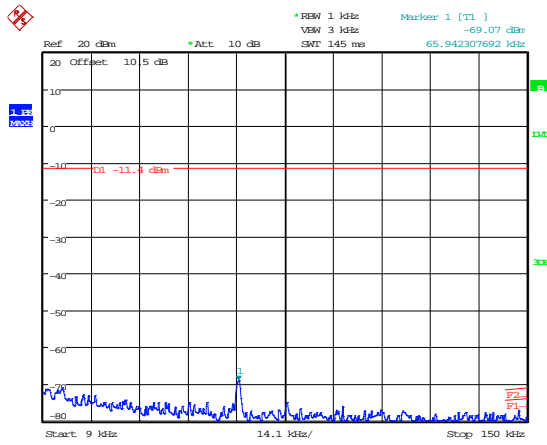


Date: 12.NOV.2014 08:55:07

18 GHz to 25 GHz

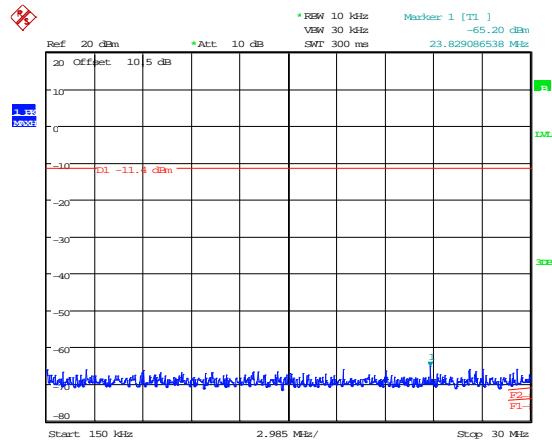
Conducted Spurious emissions

922.1MHz



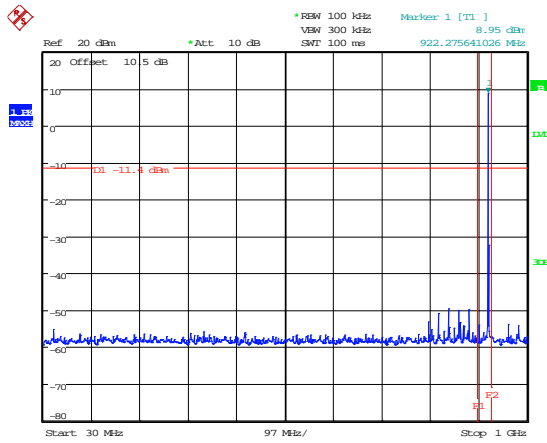
Date: 12.NOV.2014 08:59:14

9kHz – 150 kHz



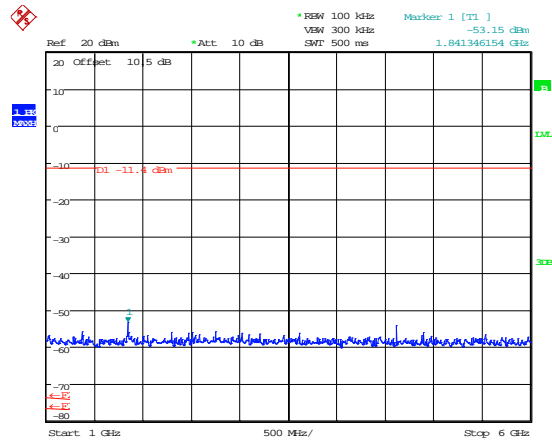
Date: 12.NOV.2014 08:59:40

150kHz – 30 MHz



Date: 12.NOV.2014 09:00:04

30 MHz to 1 GHz

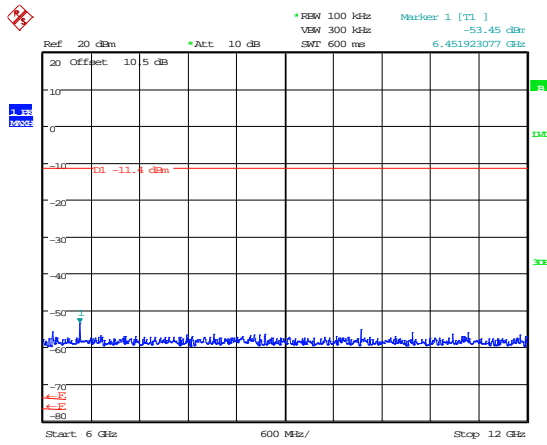


Date: 12.NOV.2014 09:00:18

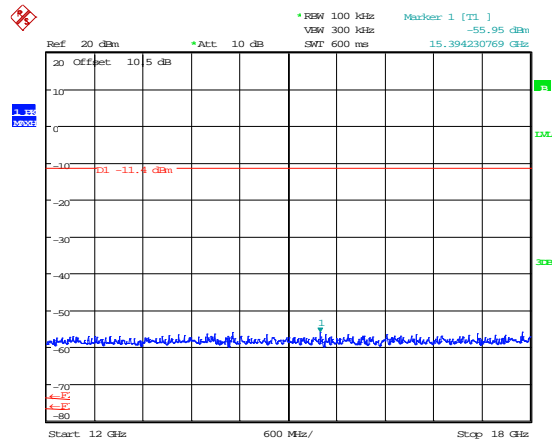
1 GHz to 6 GHz

Conducted Spurious emissions

922.1MHz



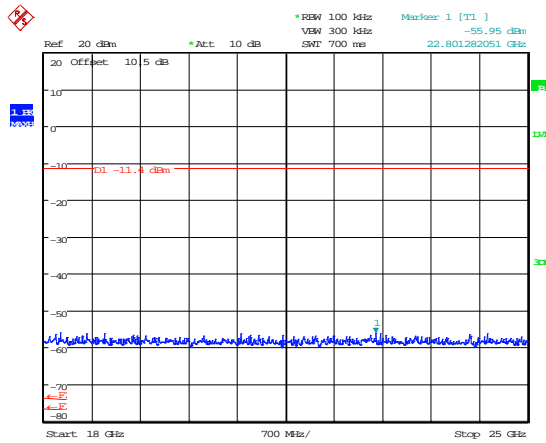
Date: 12.NOV.2014 09:00:32



Date: 12.NOV.2014 09:00:52

6 GHz to 12 GHz

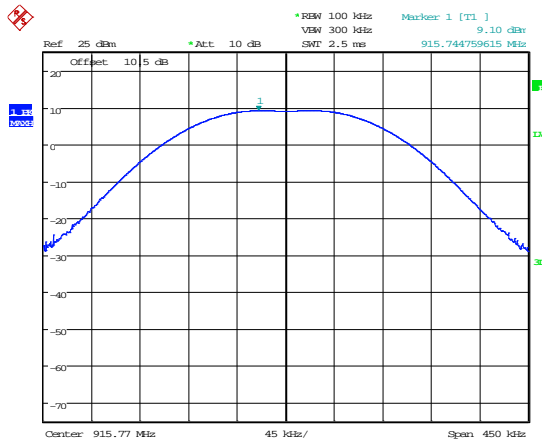
12 GHz to 18 GHz



Date: 12.NOV.2014 09:01:09

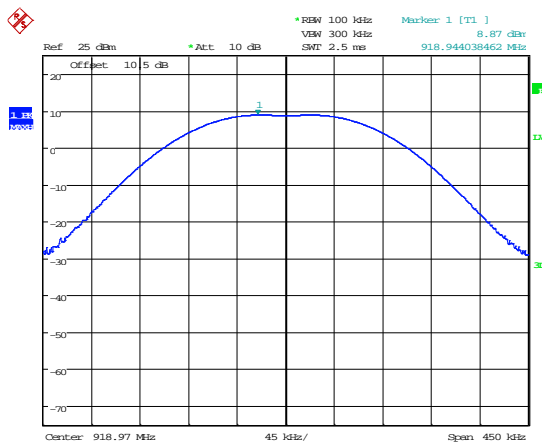
18 GHz to 25 GHz

Conducted carrier power



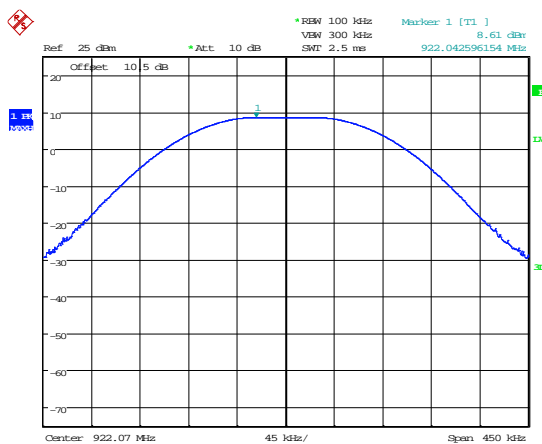
Date: 11.NOV.2014 16:44:48

915.8MHz



Date: 11.NOV.2014 16:43:29

919.0 MHz

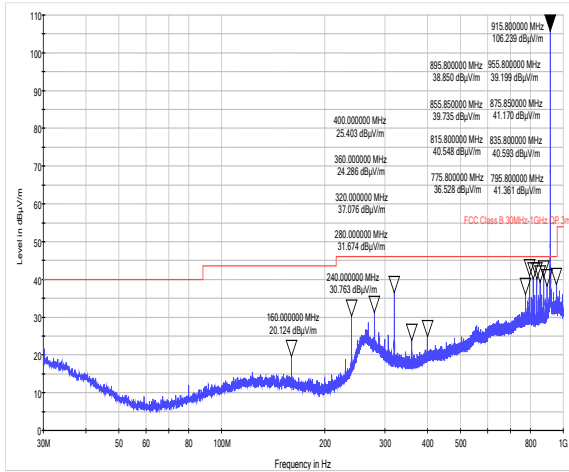


Date: 11.NOV.2014 16:44:06

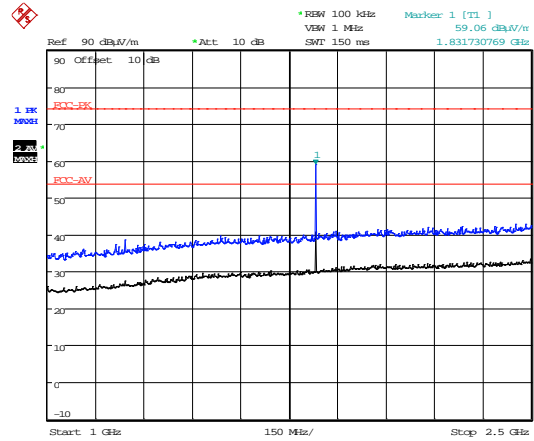
922.1 MHz

Radiated Spurious emissions

915.8MHz

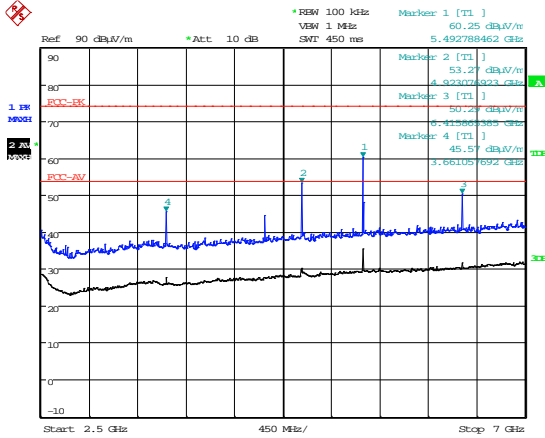


30 MHz to 1 GHz

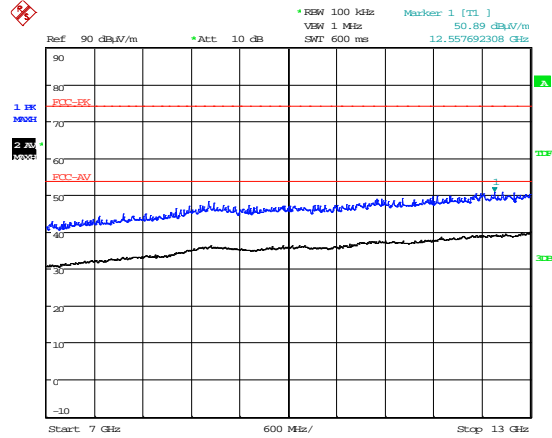


1 GHz to 2.5 GHz

Date: 13.NOV.2014 15:05:43

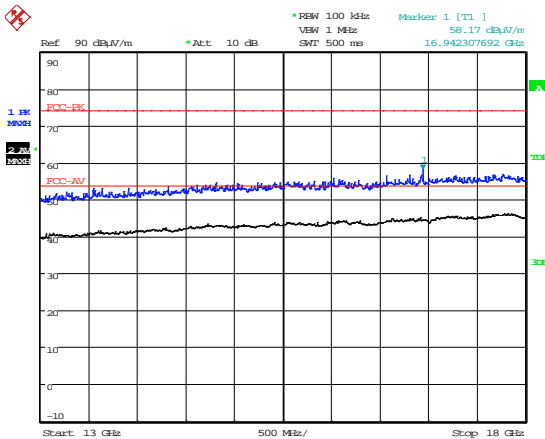


2.5 GHz to 7 GHz

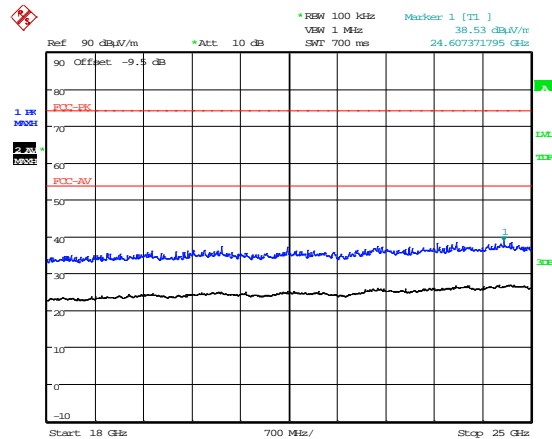


7 GHz to 13 GHz

Date: 13.NOV.2014 14:56:13



13 GHz to 18 GHz

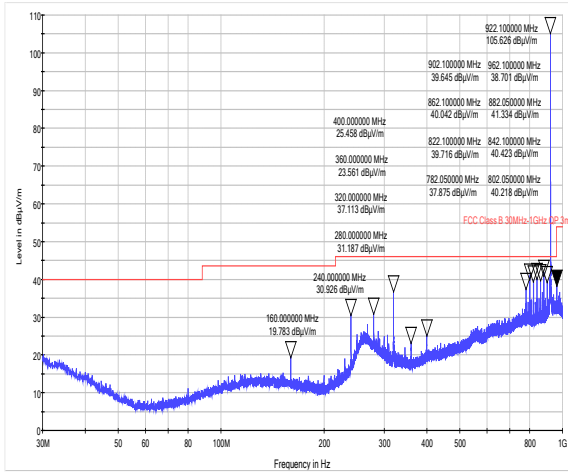


18 GHz to 25 GHz

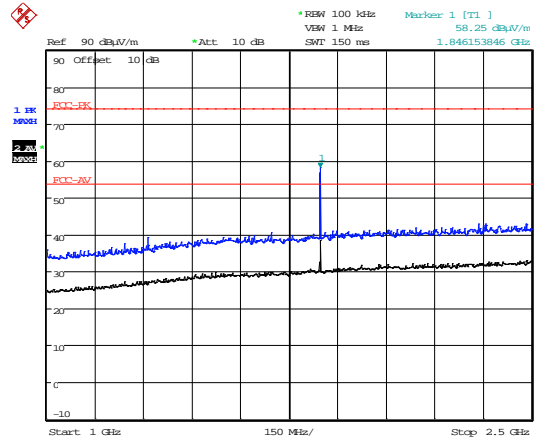
Date: 14.NOV.2014 14:10:54

Radiated Spurious emissions

922.1MHz

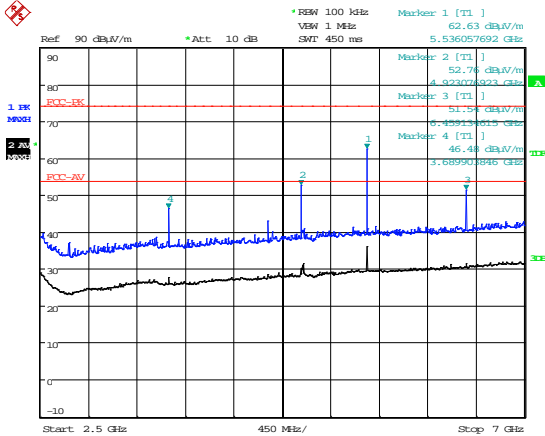


30 MHz to 1 GHz



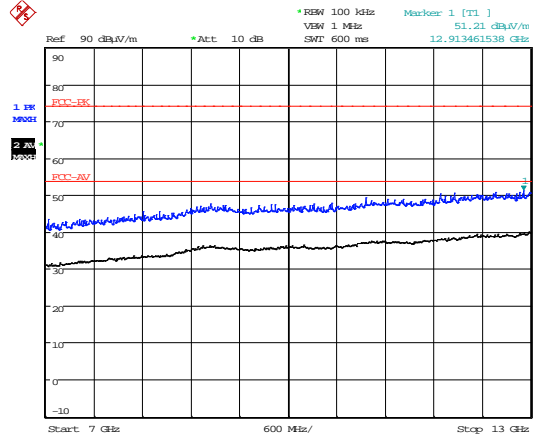
Date: 13.NOV.2014 15:06:54

1 GHz to 2.5 GHz



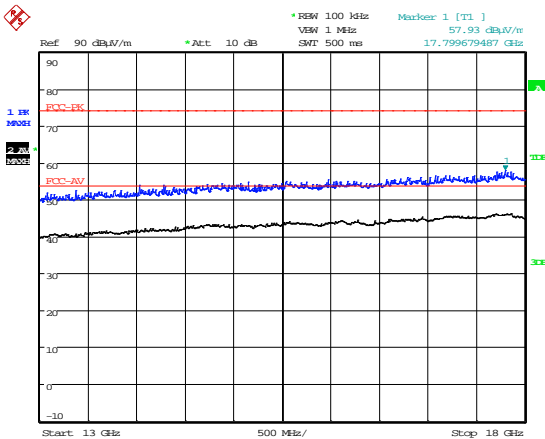
Date: 13.NOV.2014 14:47:09

2.5 GHz to 7 GHz



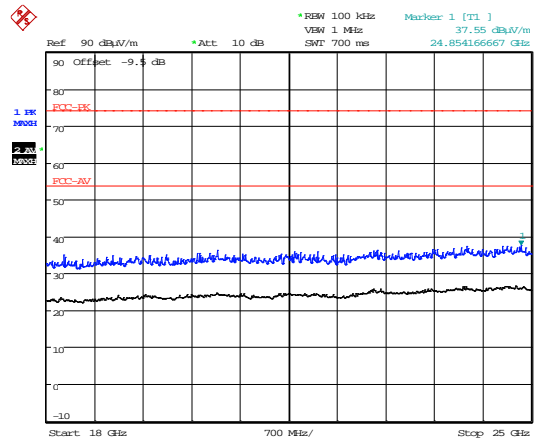
Date: 13.NOV.2014 14:48:04

7 GHz to 13 GHz



Date: 13.NOV.2014 14:48:55

13 GHz to 18 GHz

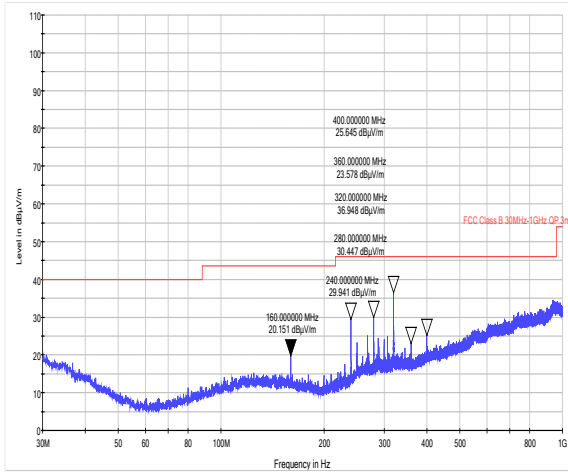


Date: 14.NOV.2014 14:12:33

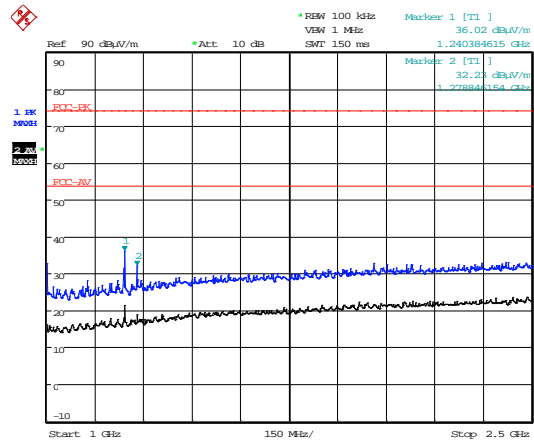
18 GHz to 25 GHz

Unintentional Radiated Spurious emissions

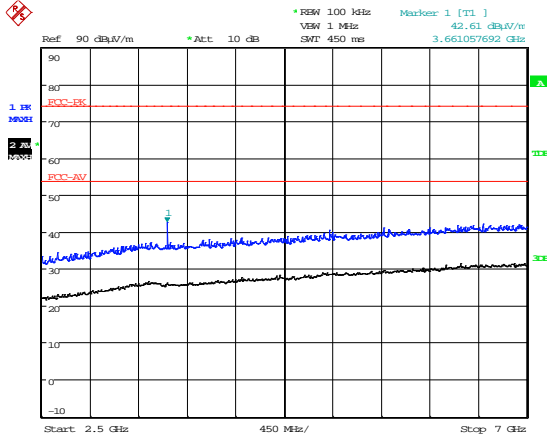
915.8MHz



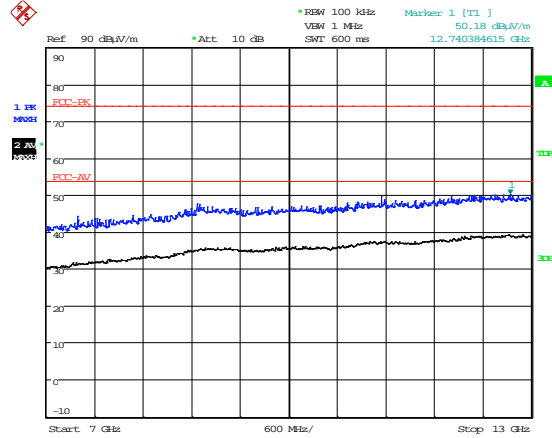
30 MHz to 1 GHz



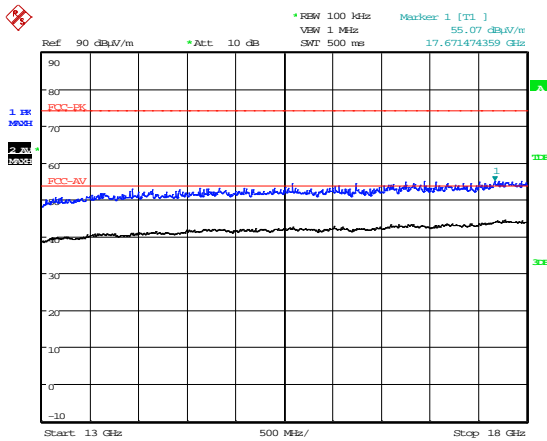
1 GHz to 2.5 GHz



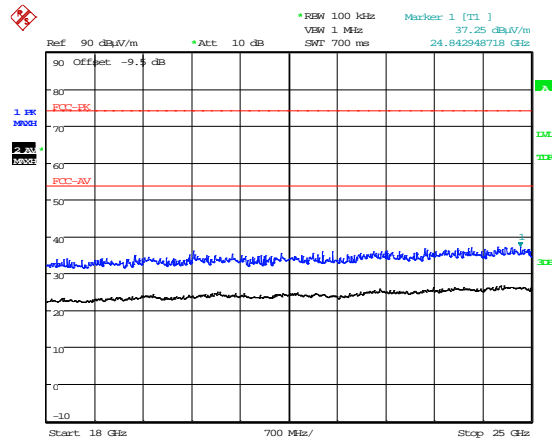
2.5 GHz to 7 GHz



7 GHz to 13 GHz



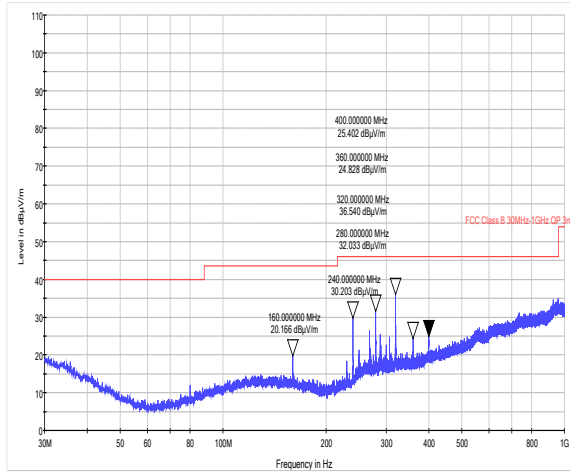
13 GHz to 18 GHz



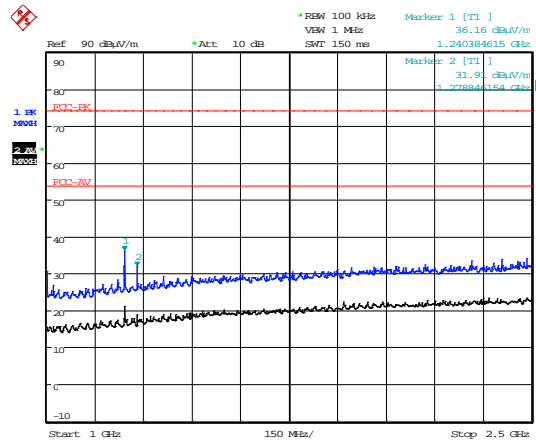
18 GHz to 25 GHz

Unintentional Radiated Spurious emissions

922.1MHz

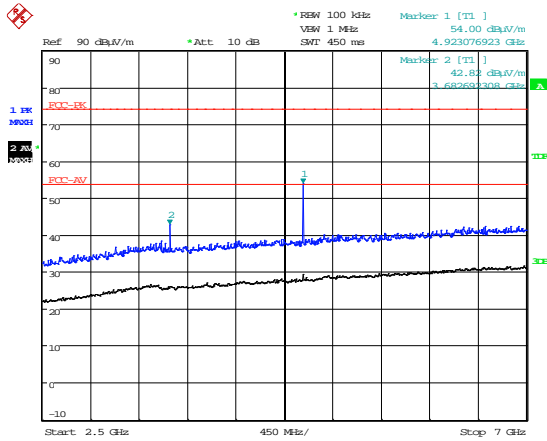


30 MHz to 1 GHz



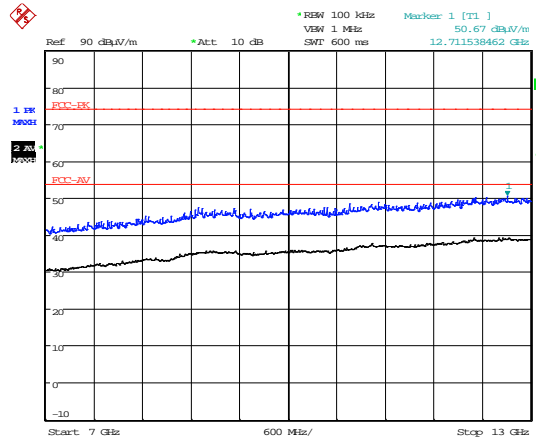
1 GHz to 2.5 GHz

Date: 13.NOV.2014 15:21:30



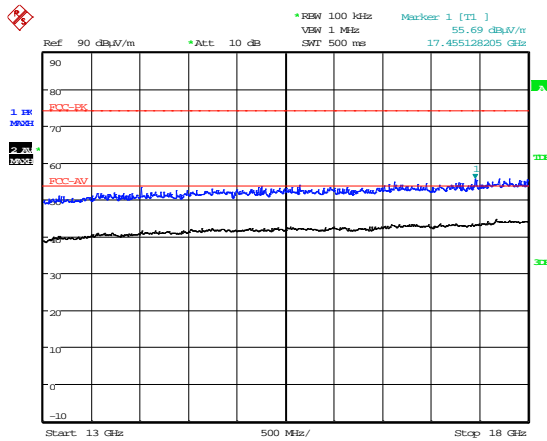
2.5 GHz to 7 GHz

Date: 13.NOV.2014 15:18:00



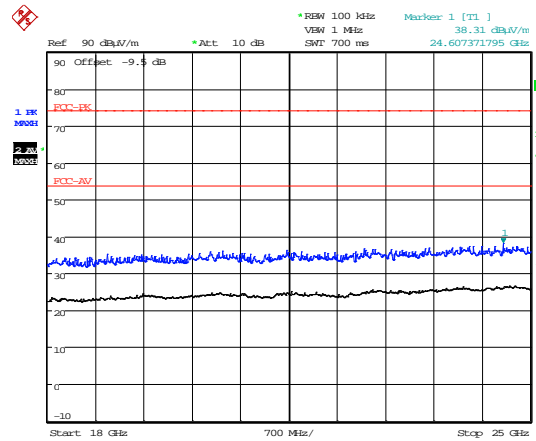
7 GHz to 13 GHz

Date: 13.NOV.2014 15:16:47



13 GHz to 18 GHz

Date: 13.NOV.2014 15:16:00



18 GHz to 25 GHz

Date: 14.NOV.2014 14:13:09



## Appendix E: Formal Emission Test Results Multi Transmitter Operation

Abbreviations used in the tables in this appendix:

Spec	: Specification	ALSR	: Absorber Lined Screened Room
Mod	: Modification	OATS	: Open Area Test Site
EUT	: Equipment Under Test	ATS	: Alternative Test Site
SE	: Support Equipment	Ref	: Reference
L	: Live Power Line	Freq	: Frequency
N	: Neutral Power Line	MD	: Measurement Distance
E	: Earth Power Line	SD	: Spec Distance
Pk	: Peak Detector	Pol	: Polarisation
QP	: Quasi-Peak Detector	H	: Horizontal Polarisation
Av	: Average Detector	V	: Vertical Polarisation
CDN	: Coupling & decoupling network		

**E1 Power Line Conducted Emissions**

Preview power line conducted emission measurements were performed with a peak detector in a screened room. Where applicable formal measurements of the emissions were performed with an average and/or quasi peak detector.

<b>Test Details:</b>	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.207
Measurement standard	ANSI C63.10
Frequency range	150kHz to 30MHz
EUT sample number	S11
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:

<b>Ac Power line Conducted Emissions Transmit Mode FHSS – Hopping ; Wifi 2437 MHz</b>						
<b>Results measured using the average detector</b>						
Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
No Significant Emissions within 20 dB of the Limit						
<b>Results measured using the Quasi Peak detector</b>						
Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
No Significant Emissions within 20 dB of the Limit						

<b>AC Power line Conducted Emissions Receive Mode</b>						
<b>Results measured using the average detector</b>						
Ref No.	Freq (MHz)	Conductor	Result (dBuV)	Spec Limit (dBuV)	Margin (dB)	Result Summary
No Significant Emissions within 20 dB of the Limit						
<b>Results measured using the Quasi Peak detector</b>						
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 Part 15: Clause 15.207):

Conducted disturbance at the mains ports.

Frequency range MHz	Limits dB $\mu$ V	
	Quasi-peak	Average
0.15 to 0.5	66 to 56 <sup>2</sup>	56 to 46 <sup>2</sup>
0.5 to 5	56	46
5 to 30	60	50

Notes:

- The lower limit shall apply at the transition frequency.
- 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

**E2 RF Antenna Conducted Spurious Emissions**

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

<b>Test Details:</b>	
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 25 GHz
EUT sample number	S11
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	25 °C

The worst case intermodulation products at the antenna port are listed below with the EUT operating on the following frequency combinations.

FHSS Operating Frequency	Wi Fi Operating Frequency
915.8 MHz	2412 MHz
	2437 MHz
	2462 MHz
922.1 MHz	2412 MHz
	2437 MHz
	2462 MHz

<b>FHSS Operating frequency 915.8 MHz</b>						
Ref No.	Measured Freq (MHz)	Det.	Restricted bands (Y/N)	Emission power (RBW =100kHz) (dBm)	15.247(d) Limit (dBuV)	Summary
No intermodulation products within 20 dB of limit						

<b>FHSS Operating frequency 922.1 MHz</b>						
Ref No.	Measured Freq (MHz)	Det.	Restricted bands (Y/N)	Emission power (RBW =100kHz) (dBm)	15.247(d) Limit (dBuV)	Summary
No intermodulation products within 20 dB of 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. 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

**E3 Radiated Electric Field Emissions**

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	30MHz – 25GHz
EUT sample number	S11
Modification state	0
SE in test environment	S01
SE isolated from EUT	None
EUT set up	Refer to Appendix C
Temperature	25 °C
Photographs (Appendix F)	Photograph 1 and 2

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 :

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The worst case intermodulation products at the antenna port are listed below with the EUT operating on the following frequency combinations.

FHSS Operating Frequency	Wi Fi Operating Frequency
915.8 MHz	2412 MHz
	2437 MHz
	2462 MHz
922.1 MHz	2412 MHz
	2437 MHz
	2462 MHz

FHSS Operating frequency 915.8 MHz									
DET	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)
No intermodulation products within 20 dB of limit									

FHSS Operating frequency 922.1 MHz									
DET	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)
No intermodulation products within 20 dB of limit									

## **Appendix F: Supporting Graphical Data Multi Transmitter Operation**

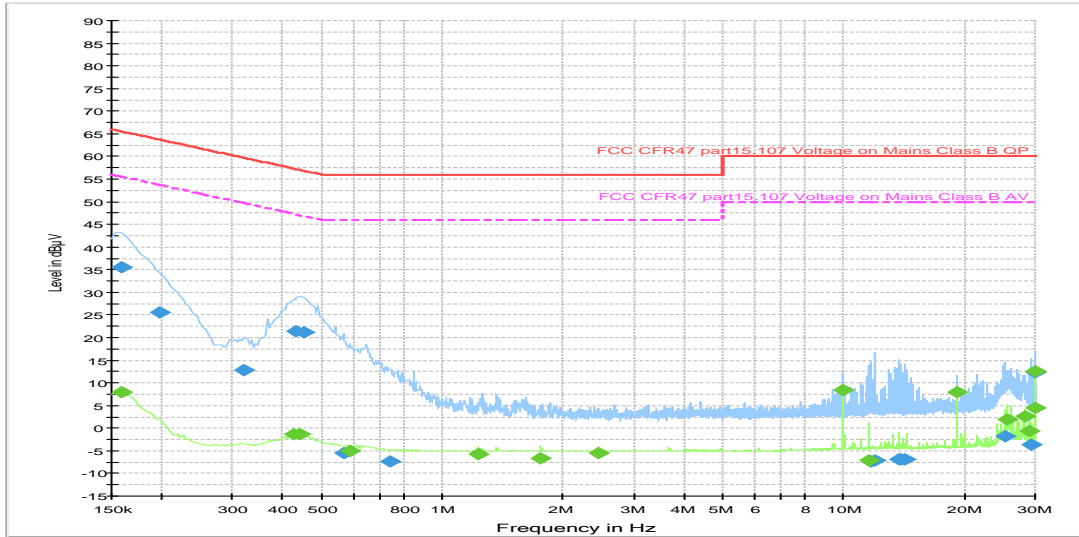
This appendix contains graphical data obtained during testing.

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.
- (g) 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.

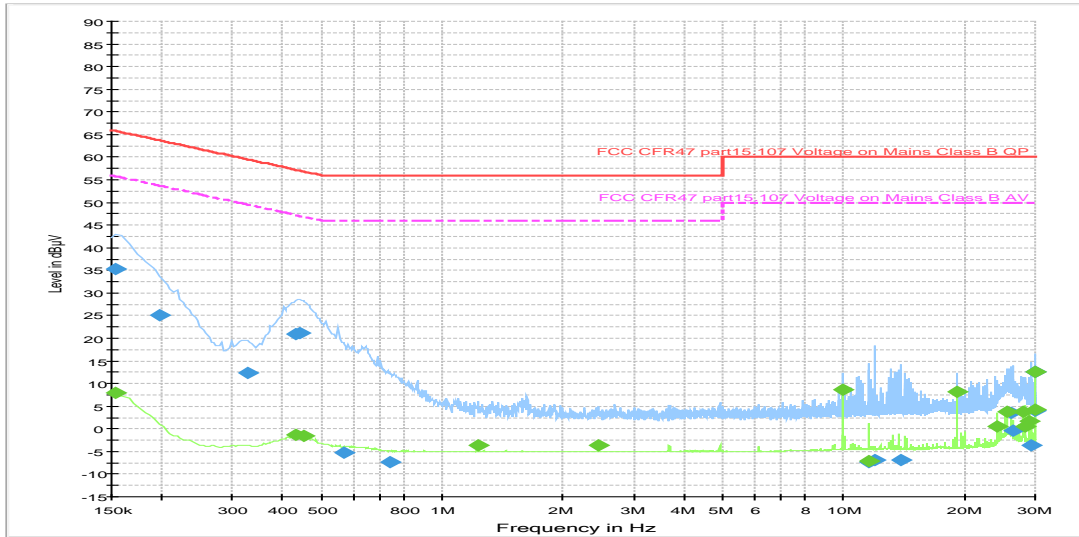
### AC Powerline Conducted Emissions

Fcc Class B Conducted emissions on Mains 150kHz-30MHz ESHS10 + UH195 Rx prescans



### FHSS – Hopping; WiFi 2437 MHz - Transmit mode

Fcc Class B Conducted emissions on Mains 150kHz-30MHz ESHS10 + UH195 Rx prescans

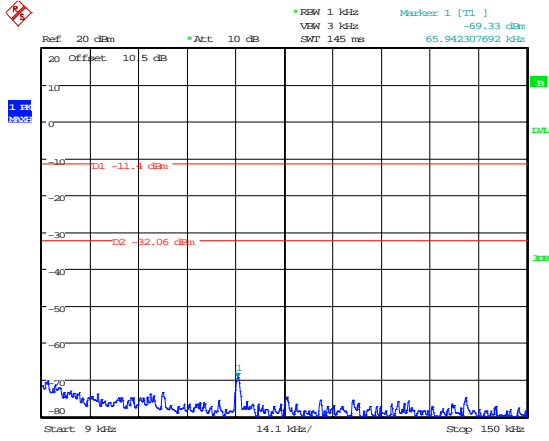


### FHSS and WiFi - Receive Mode



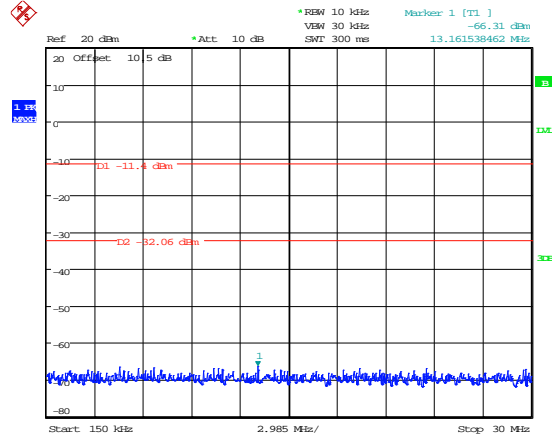
Conducted Spurious emissions

FHSS - 915.8MHz - Wifi 2437 MHz



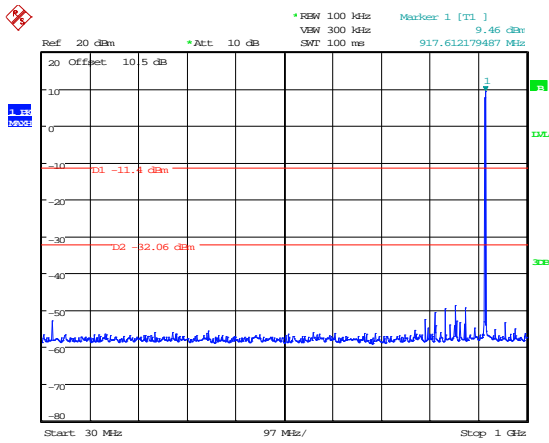
Date: 12.NOV.2014 09:28:14

9kHz – 150 kHz



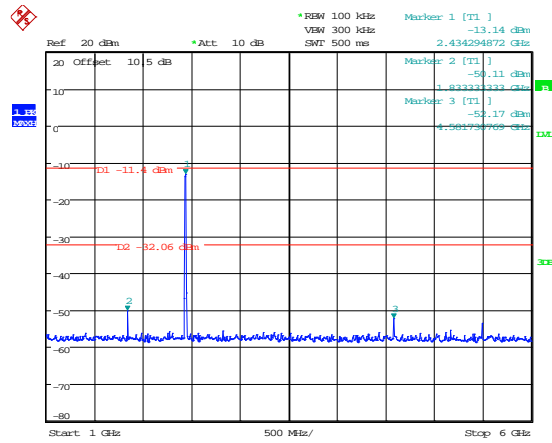
Date: 12.NOV.2014 09:27:50

150kHz – 30 MHz



Date: 12.NOV.2014 09:27:26

30 MHz to 1 GHz

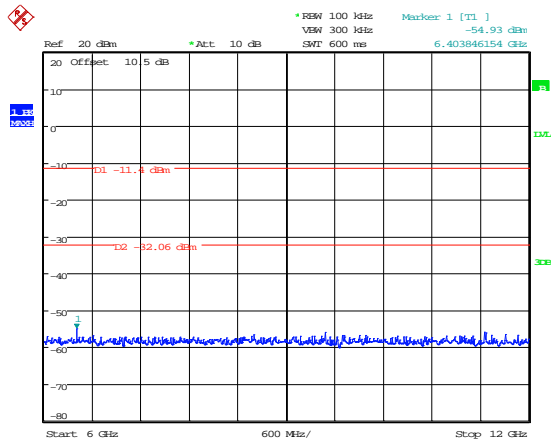


Date: 12.NOV.2014 09:26:59

1 GHz to 6 GHz

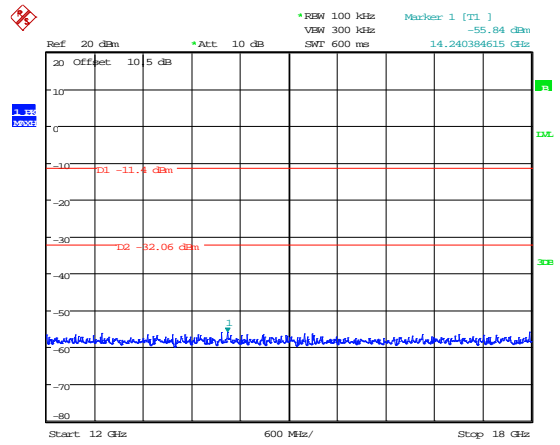
Conducted Spurious emissions

FHSS - 915.8MHz - Wifi 2437 MHz



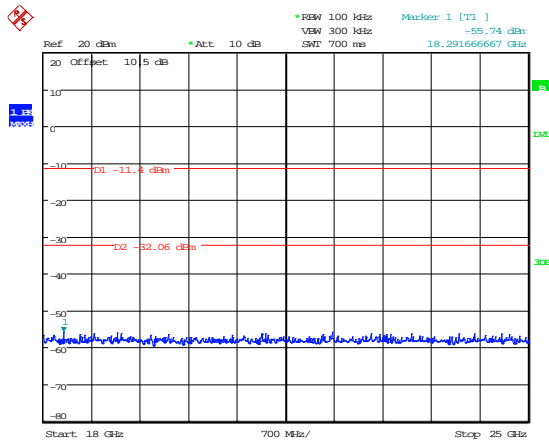
Date: 12.NOV.2014 09:26:12

6 GHz to 12 GHz



Date: 12.NOV.2014 09:25:58

12 GHz to 18 GHz

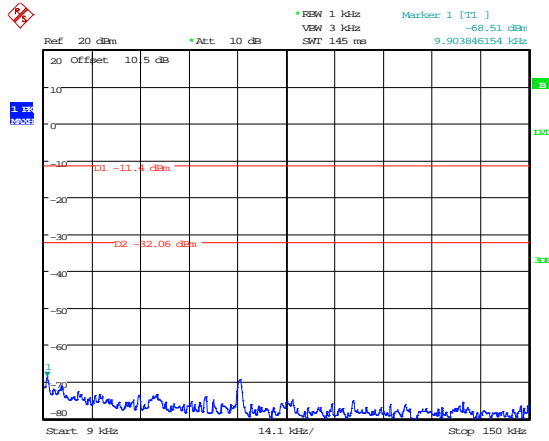


Date: 12.NOV.2014 09:25:40

18 GHz to 25 GHz

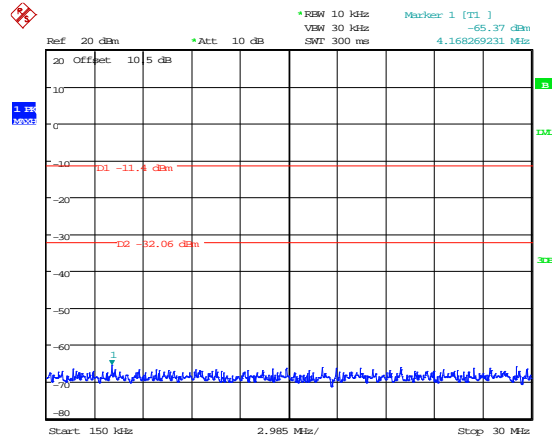
Conducted Spurious emissions

FHSS - 922.1MHz - Wifi 2437 MHz



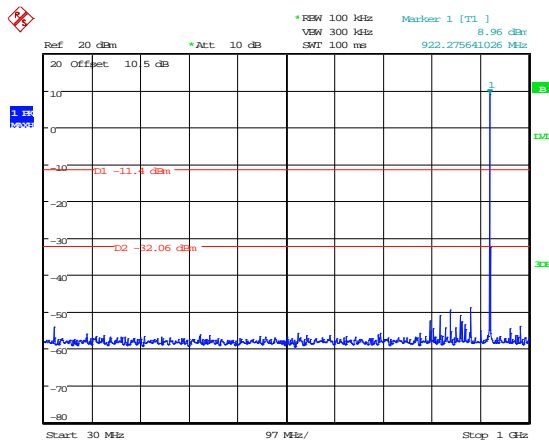
Date: 12.NOV.2014 09:42:40

9kHz – 150 kHz



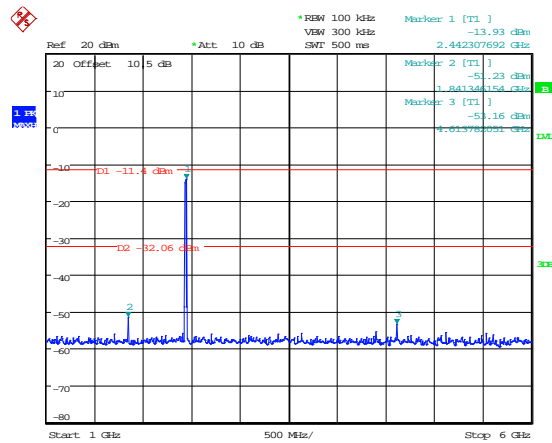
Date: 12.NOV.2014 09:42:06

150kHz – 30 MHz



Date: 12.NOV.2014 09:41:24

30 MHz to 1 GHz

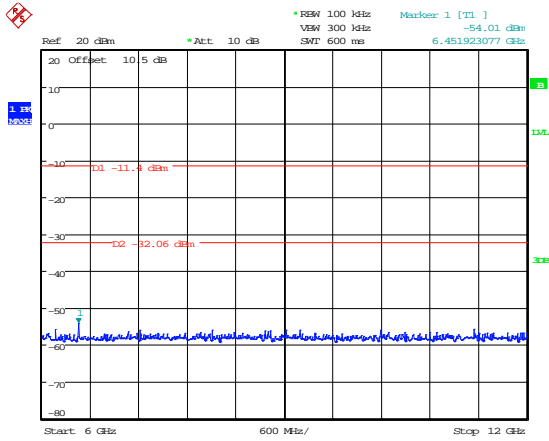


Date: 12.NOV.2014 09:41:05

1 GHz to 6 GHz

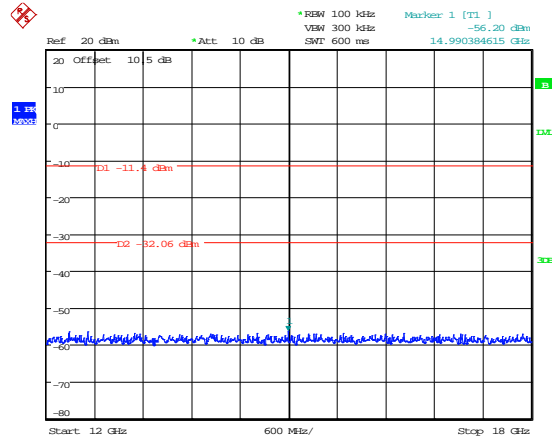
Conducted Spurious emissions

FHSS - 922.1MHz - Wifi 2437 MHz



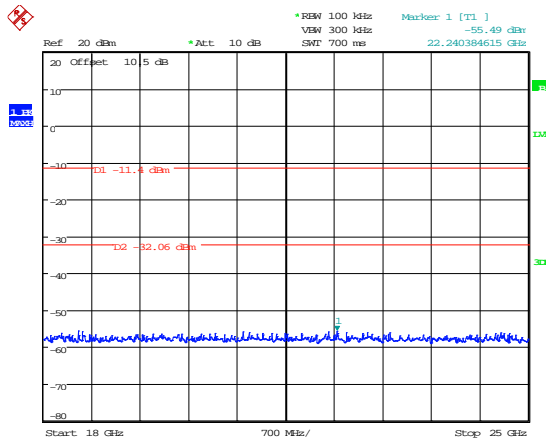
Date: 12.NOV.2014 09:40:41

6 GHz to 12 GHz



Date: 12.NOV.2014 09:40:19

12 GHz to 18 GHz

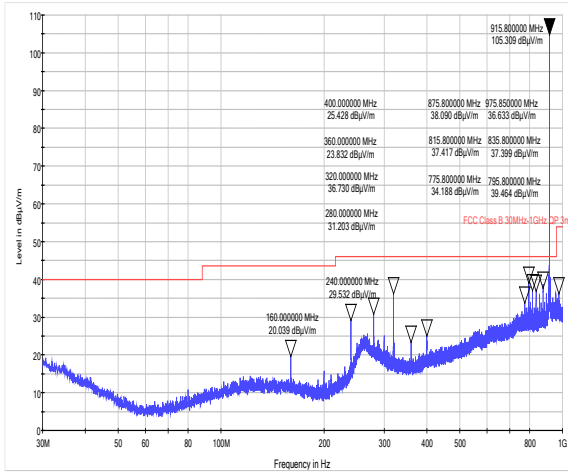


Date: 12.NOV.2014 09:39:52

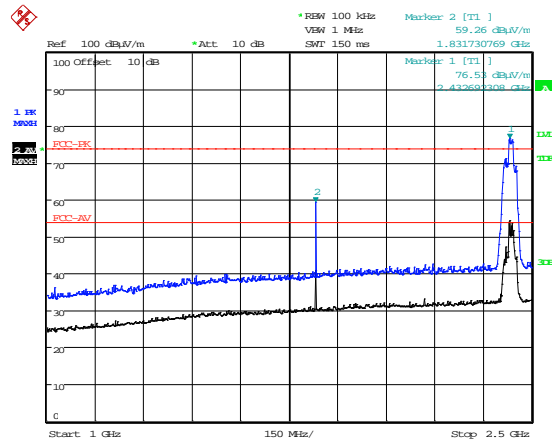
18 GHz to 25 GHz

Radiated Spurious emissions

FHSS - 915.8MHz - Wifi 2437 MHz

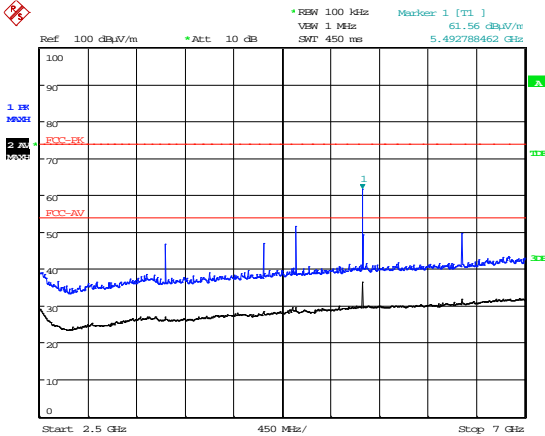


30 MHz to 1 GHz



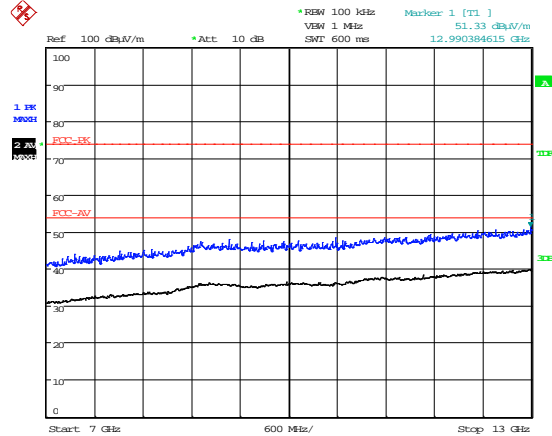
1 GHz to 2.5 GHz

Date: 14.NOV.2014 11:08:30



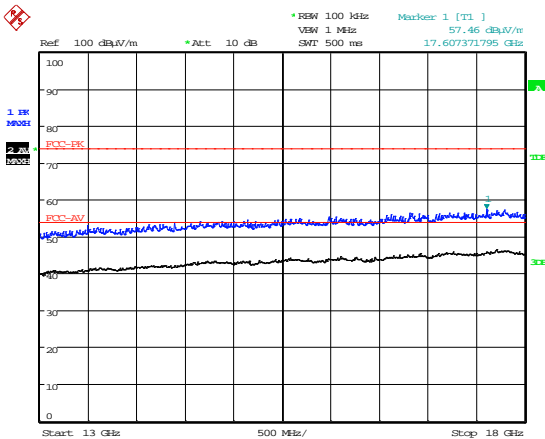
2.5 GHz to 7 GHz

Date: 14.NOV.2014 10:55:56



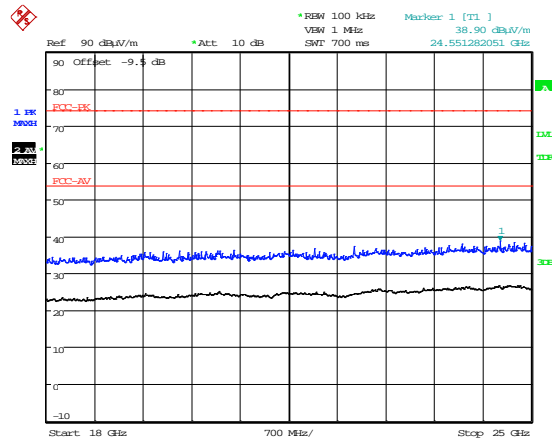
7 GHz to 13 GHz

Date: 14.NOV.2014 10:56:32



13 GHz to 18 GHz

Date: 14.NOV.2014 10:57:17

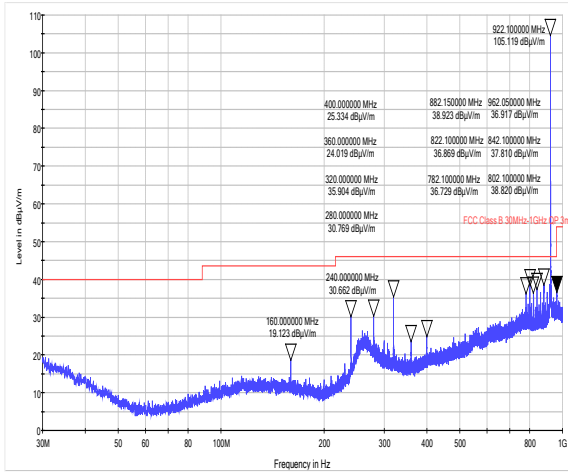


18 GHz to 25 GHz

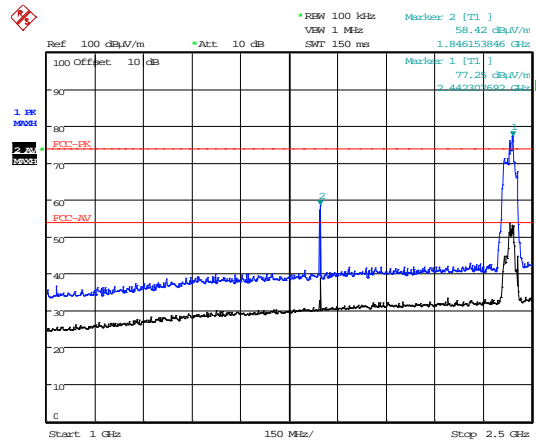
Date: 14.NOV.2014 14:23:05

Radiated Spurious emissions

FHSS - 922.1 MHz - Wifi 2437 MHz

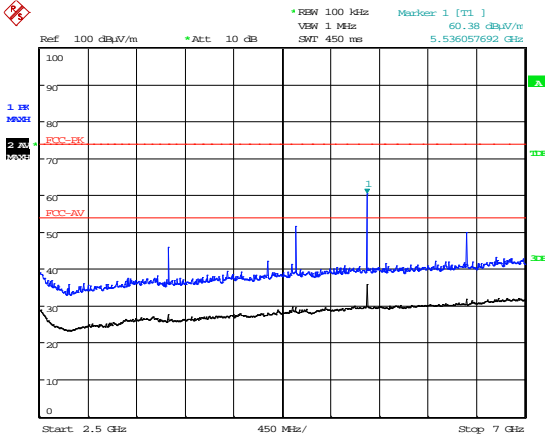


30 MHz to 1 GHz



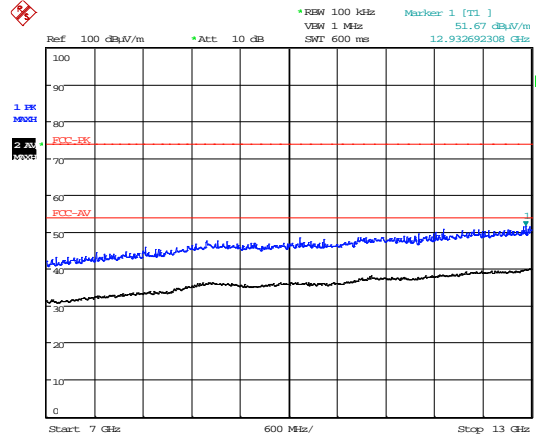
1 GHz to 2.5 GHz

Date: 14.NOV.2014 11:09:46



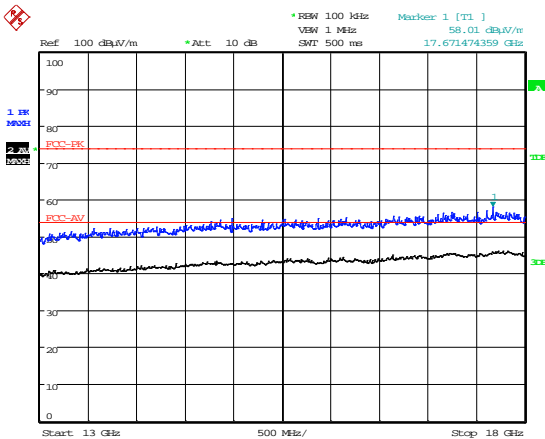
2.5 GHz to 7 GHz

Date: 14.NOV.2014 10:53:36



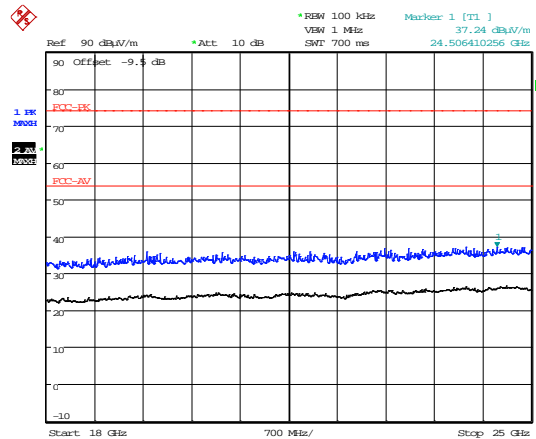
7 GHz to 13 GHz

Date: 14.NOV.2014 10:51:54



13 GHz to 18 GHz

Date: 14.NOV.2014 10:50:39



18 GHz to 25 GHz

Date: 14.NOV.2014 14:24:29

**Appendix G:****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.

**G1) Test samples**

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

Sample No.	Description	Identification
S01	RF Timecode Buddy Board	None

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

Sample No.	Description	Identification
S11	Timecode Buddy : Pulse	None
S01	Fujitsu laptop	YL9Q277776
S05	USB data cable	None

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

Identification	Description
None	



**G2) 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 Active and transmitting on the required FHSS or WiFi frequency as required

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

Test	Description of Operating Mode:
PLCE	FHSS and Wifi operating in TX mode or RX mode as required.

**G3) EUT Configuration Information.**

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

**G4) List of EUT Ports**

The tables below describe the termination of EUT ports:

Sample : S01  
Tests : Conducted

Port	Description of Cable Attached	Cable length	Equipment Connected
Header	Ribbon Cable	10 cm	S11

Sample : S01  
Tests : Radiated Emissions

Port	Description of Cable Attached	Cable length	Equipment Connected
Header	Ribbon Cable	10 cm	S11

\* Only connected during setup.

**G5 Details of Equipment Used**

TRaC No	Equipment Type	Equipment Description	Manufacturer	Last Cal Calibration	Calibration Period	Due For Calibration
UH003	ESHS10	Receiver	R&S	03/07/2014	12	03/07/2015
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	02/12/2014	24	02/12/2016
UH195	ESH3-Z5.831.5	Lisn	R&S	21/07/2014	12	21/07/2015
UH281	FSU46	Spectrum Analyser	R&S	26/03/2014	12	26/03/2015
UH387	ATS	Chamber 1	Rainford EMC	04/07/2013	24	04/07/2015
UH387	ATS	IC Reg - Chamber 1	Rainford EMC	19/11/2014	36	19/11/2017
UH388	ATS	Chamber 2	Rainford EMC	04/07/2013	24	04/07/2015
UH388	ATS	IC Reg Chamber 2	Rainford EMC	19/11/2014	36	19/11/2017
UH396	ENV216	Lisn	R&S	22/05/2014	12	22/05/2015
UH403	ESCI 7	Recevier	R&S	20/08/2014	12	20/08/2015
UH405	FSU26	Spectrum Analyser	R&S	16/04/2014	12	16/04/2015
UH420	CBL6112	Bilog	Chase	25/07/2014	24	25/07/2016
UH456	ESR7	EMI Receiver	R&S	16/04/2014	12	16/04/2015
L138	3115	1-18GHz Horn	EMCO	17/10/2013	24	17/10/2015
L139	3115	1-18GHz Horn	EMCO	20/09/2013	24	20/09/2015
L193	VHA 9103 balu	Bicone Antenna	Chase	25/06/2014	24	25/06/2016
L203	UPA6108	Log Periodic Ant	Chase	25/06/2014	24	25/06/2016
L290	CBL611/A	Bilog	Chase	13/12/2012	24	13/12/2014
L300	20240-20	Horn 18-26GHz (&UH330)	Flann	10/02/2014	24	10/02/2016
L352	ESVS10	Receiver	R&S	21/03/2014	12	21/03/2015
L426	52 Series II	Temperature Indicator	Fluke	22/05/2014	12	22/05/2015
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
REF910	FSU46	Spectrum Analyser	R&S	31/03/2014	12	31/03/2015
REF916	SMBV100A	Signal Generator	R&S	19/02/2014	12	19/02/2015
REF940	ATS	Radio Chamber - PP	Rainford EMC	08/09/2014	24	08/09/2016
REF940	ATS	IC Reg Radio Chamber - PP	Rainford EMC	19/11/2014	36	19/11/2017
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
REF2083	RPR3006W	Power Meter	DARE	13/11/2014	12	13/11/2015

Appendix H:

Antenna Datasheet

Additional Information



1. Introduction

The TG.09 Penta-band Cellular Hinged Rotatable SMA antenna is a high efficiency monopole antenna. Compared to other much larger antennas on the market, it has superior wide-band high efficiency characteristics.

This antenna is used by many of the leading wireless device providers in the world marketplace.

The unique rotatable hinge design enables the user to rotate the antenna to the best angle for an optimal cellular signal reception. As the upper antenna element can move in any direction, it also reduces damage from impact force from any angle to the antenna, compared to traditional hinged right angle or fixed right angle designs or straight antennas.

The tiny dimensions of this antenna coupled with excellent RF performance and an aesthetic high end design feel make it the ideal cellular antenna for routers, vehicle tracking devices, telematics devices, remote monitoring systems, POC devices.

The TG.09 as all monopole antennas works best connected directly to the ground-plane of the device main-board.

Please contact Taoglas regional support centre first if you wish to do PTCRB or network approvals with this antenna attached to your device, so we can check RF integration is correct and do

a pre-test first to ensure optimized passive and active performance and a smooth and quick certification approval process.

This antenna also comes in a white version TG.09.01.13W



If your device does not have a direct connection to ground-plane, please consider using our TG.30 Apex Wideband Dipole Cellular Antenna, which does not need a ground-plane to connect to.

TG.09.0113

Specification

Part No.	TG.09.0113
Product Name	Penta-band Cellular Hinged SMA Male Monopole
Feature	800 MHz to 2200MHz GSM/CDMA/HSPA/UMTS Rotatable hinge design for optimal reception Top quality housing with brass hinge and connector Extended operation temperature range RoHS Compliant

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2. Specification

Electrical	
Penta-band Cellular	
Communication System	AMPS GSM DCS PCS UMTS
Frequency	824 - 896 880 - 960 1710 - 1880 1850 - 1990 1710 - 2170
Efficiency (free space)*	21% 24% 23% 32% 31%
Gain (dBi, free space)*	2.0 2.0 -1.0 -0.4 -0.1
Efficiency (mounted on PCB)*	39% 31% 78% 75% 75%
Gain (dBi, mounted on PCB)*	1.0 -1.0 2.8 2.8 2.0
Impedance	50Ω
Polarization	Linear
Radiation Pattern	Omnis-directional
Input Power	10 W

Mechanical	
Antenna Length	72 ± 1.5 mm
Antenna Diameter	10 ± 0.3 mm
Casing	PCB
Connector	SMA Male (Brass)

Environmental	
Temperature Range	-40°C to 85°C
Storage Temperature	-40°C to +105°C
Humidity	Non-condensing 65°C 95% RH

\* Average efficiency and peak gain of antenna sitting 180° in free space and mounted at the side of the PCB. Please refer to section IV for testing detail.

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**Appendix I:****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 =  $20 \times (\text{Log}_{10} \text{ Calculated Duty Cycle})$

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

e.g

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

0.07459 or 7.459%

Correction factor (dB) =  $20 \times (\text{Log}_{10} 0.07459) = -22.54\text{dB}$

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 J:**

**Photographs and Figures**

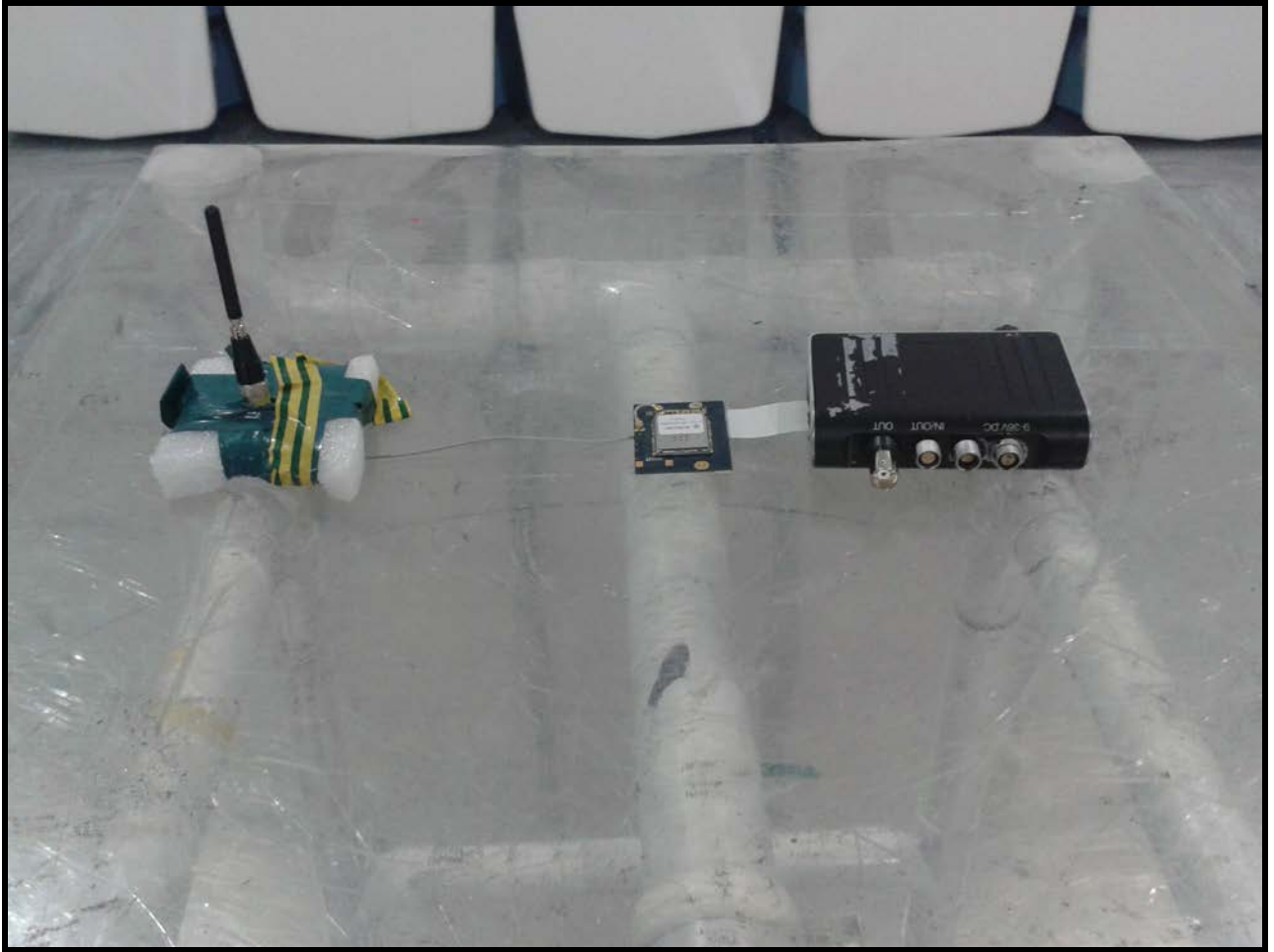
The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: Over view.
2. Radiated electric field emissions arrangement: Close up.
3. AC Powerline Conducted emissions arrangement: Over view.

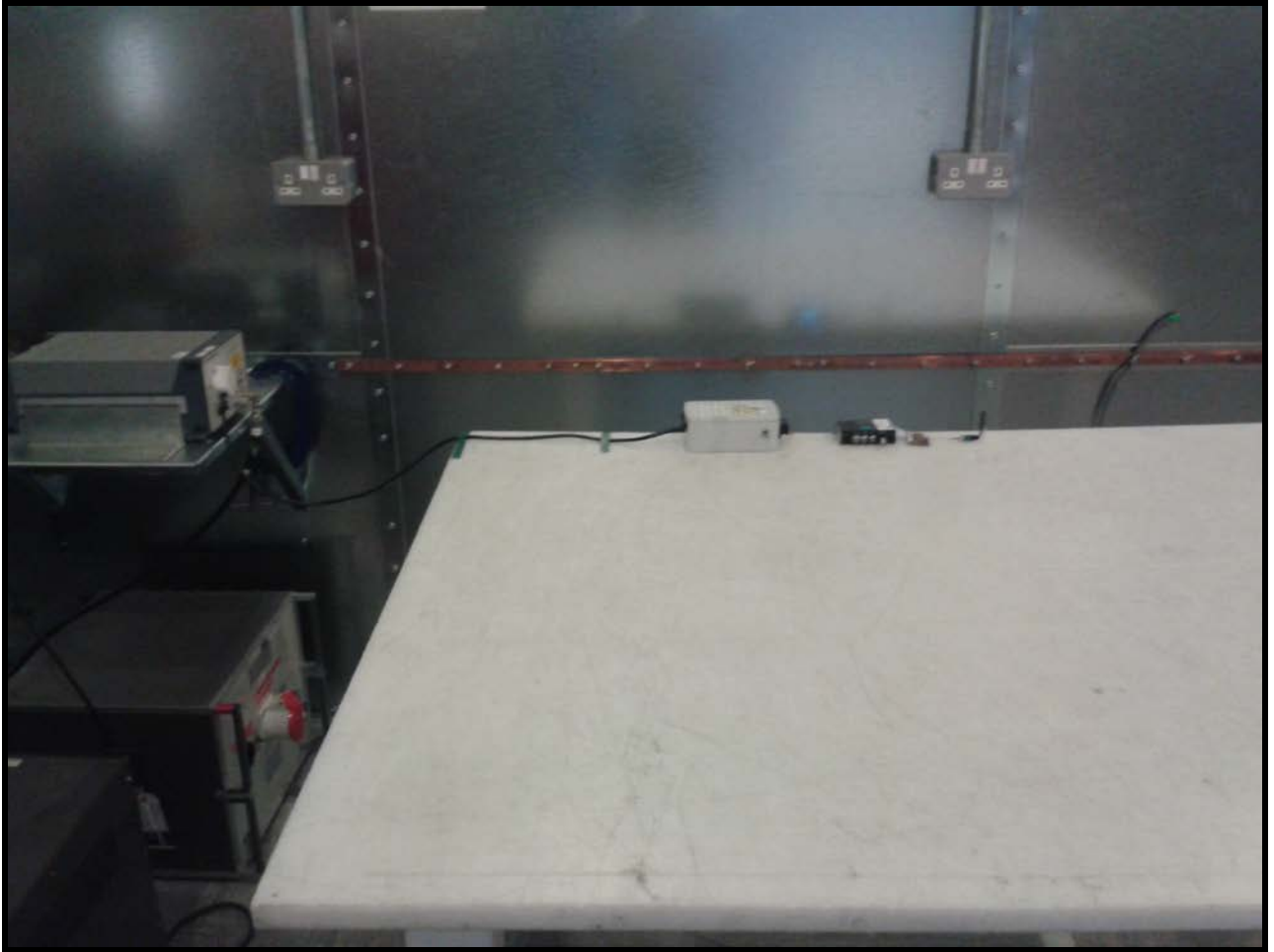


Photograph 1





Photograph 2



Photograph 3

## Appendix K: SAR Exclusion & MPE Calculation 2.4 GHz Wi-Fi Operation

### KDB 447498

Section 4.3 General SAR test reduction and exclusion guidance

For Standalone SAR exclusion consideration, when SAR exclusion Threshold requirement in KDB 447498 is satisfied, standalone SAR evaluation for general population exposure conditions by measurement or numerical simulation is not required.

In the frequency range below 100 MHz to 6 GHz and test separation distance of  $\leq 50\text{mm}$ , the SAR Test Exclusion Threshold will be determined as follows

SAR Exclusion Threshold (SARET)

SAR Exclusion Threshold = Step 1 + Step 2

#### Step 1

$$NT = [(MP/TSD^A) * \sqrt{f_{\text{GHz}}}]$$

NT = Numeric Threshold (3.0 for 1-g SAR and 7.5 for 10-g SAR)

MP = Max Power of channel (mW) (inc tune up)

TSD<sup>A</sup> = Min Test separation Distance or 50mm (whichever is lower) = 5mm (in this case)

We can transpose this formula to allow us to find the maximum power of a channel allowed and compare this to the measured maximum power.

$$= [(NT * TSD^A) / \sqrt{f_{\text{GHz}}}]$$

For Distances Greater than 50 mm Step 2 applies

#### Step 2

$$(TSD^B - 50\text{mm}) * 10\}$$

Where:

TSD<sup>B</sup> = Min Test separation Distance (mm) = 50

**Note:** Step 2 is not required here as the TSD<sup>A</sup> is less than 50mm.

**Operating Frequency 2.412 GHz**

$$\begin{aligned} \text{SARET} &= [(3.0 \times 5) / \sqrt{2.412}] \\ \text{SARET} &= 9.66\text{mW} \end{aligned}$$

**Operating Frequency 2.437 GHz**

$$\begin{aligned} \text{SARET} &= [(3.0 \times 5) / \sqrt{2.437}] \\ \text{SARET} &= 9.61\text{mW} \end{aligned}$$

**Operating Frequency 2.462 GHz**

$$\begin{aligned} \text{SARET} &= [(3.0 \times 5) / \sqrt{2.462}] \\ \text{SARET} &= 9.52\text{mW} \end{aligned}$$

Channel Frequency (MHz)	EIRP (mW)	SAR Exclusion Threshold	SAR Evaluation
2412	6.24	9.66	Not Required
2437	5.78	9.61	Not Required
2462	5.86	9.52	Not Required

Therefore standalone SAR evaluation for general population exposure conditions by measurement or numerical simulation is not required.

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

Equation from IEEE C95.1

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

Where:

S = power density

R = distance to the centre of radiation of the antenna

EIRP = EUT Maximum power

Note:

The EIRP was calculated by addition of the maximum conducted carrier power (7.95dBm) and the maximum antenna gain (0dBi).

Result

Prediction Frequency (MHz)	Maximum EIRP (mW)	Power density limit (S) (mW/cm <sup>2</sup> )	Distance (R) cm required to be less than 1 mW/cm <sup>2</sup>
2412	6.24	1	0.71

## Appendix L: SAR Exclusion & MPE Calculation 900MHz FHSS Operation

### KDB 447498

#### Section 4.3 General SAR test reduction and exclusion guidance

For Standalone SAR exclusion consideration, when SAR exclusion Threshold requirement in KDB 447498 is satisfied, standalone SAR evaluation for general population exposure conditions by measurement or numerical simulation is not required.

In the frequency range below 100 MHz to 6 GHz and test separation distance of  $\leq 50\text{mm}$ , the SAR Test Exclusion Threshold will be determined as follows

#### SAR Exclusion Threshold (SARET)

SAR Exclusion Threshold = Step 1 + Step 2

#### Step 1

$$NT = [(MP/TSD^A) * \sqrt{f_{\text{GHz}}}]$$

NT = Numeric Threshold (3.0 for 1-g SAR and 7.5 for 10-g SAR)

MP = Max Power of channel (mW) (inc tune up)

TSD<sup>A</sup> = Min Test separation Distance or 50mm (whichever is lower) = 5mm (in this case)

We can transpose this formula to allow us to find the maximum power of a channel allowed and compare this to the measured maximum power.

$$= [(NT * TSD^A) / \sqrt{f_{\text{GHz}}}]$$

For Distances Greater than 50 mm Step 2 applies

#### Step 2

$$(TSD^B - 50\text{mm}) * 10\}$$

Where:

TSD<sup>B</sup> = Min Test separation Distance (mm) = 50

**Note:** Step 2 is not required here as the TSD<sup>A</sup> is less than 50mm.

**Operating Frequency 915.8 MHz**

$$\begin{aligned} \text{SARET} &= [(3.0 \times 5) / \sqrt{0.9158}] \\ \text{SARET} &= 15.67\text{mW} \end{aligned}$$

**Operating Frequency 922.1 MHz**

$$\begin{aligned} \text{SARET} &= [(3.0 \times 5) / \sqrt{0.9221}] \\ \text{SARET} &= 15.62 \text{ mW} \end{aligned}$$

Channel Frequency (MHz)	EIRP (mW)	SAR Exclusion Threshold	SAR Evaluation
915.8	8.13	15.67	Not Required
922.1	7.26	15.62	Not Required

Therefore standalone SAR evaluation for general population exposure conditions by measurement or numerical simulation is not required.

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

Equation from IEEE C95.1

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

Where:

S = power density

R = distance to the centre of radiation of the antenna

EIRP = EUT Maximum power

Note:

The EIRP was calculated by addition of the maximum conducted carrier power (9.1dBm) and the maximum antenna gain (0dBi).

Result

Prediction Frequency (MHz)	Maximum EIRP (mW)	Power density limit (S) (mW/cm <sup>2</sup> )	Distance (R) cm Required to be less than 0.61 mW/cm <sup>2</sup>
915.8	8.13	0.61	1.03



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