



TEST REPORT

Test Report No. : UL-RPT-RP10874323JD06A V2.0

Manufacturer : ModCam AB
Model No. : MOD.01
FCC ID : 2AEV4-01
Technology : WLAN
Test Standard(s) : FCC Parts 15.207, 15.209(a) & 15.247

1. This test report shall not be reproduced in full or partial, without the written approval of UL VS LTD.
2. The results in this report apply only to the sample(s) tested.
3. The sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 2.0 supersedes all previous versions.

Date of Issue: 08 April 2016

Checked by:

Sarah Williams
Engineer, Radio Laboratory

Company Signatory:

Steven White
Service Lead, Radio Laboratory
UL VS LTD



This laboratory is accredited by UKAS.
The tests reported herein have been
performed in accordance with its terms
of accreditation.

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1. Customer Information

Company Name:	ModCam AB
Address:	Bredgatan 4 211 30 Malmö Sweden

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR15.247
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
Specification Reference:	47CFR15.207 and 47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.207 and 15.209
Site Registration:	209735
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	30 August 2015 to 06 February 2016

2.2. Summary of Test Results

Industry Canada Reference	Measurement	Result
Part 15.207	Transmitter AC Conducted Emissions	
Part 15.247(a)(2)	Transmitter Minimum 6 dB Bandwidth	
Part 15.35(c)	Transmitter Duty Cycle	Note 1
Part 15.247(e)	Transmitter Power Spectral Density	
Part 15.247(b)(3)	Transmitter Maximum (Average) Output Power	
Part 15.247(d) & 15.209(a)	Transmitter Radiated Emissions	
Part 15.247(d) & 15.209(a)	Transmitter Band Edge Radiated Emissions	
Key to Results  = Complied  = Did not comply		

Note(s):

1. The measurement was performed to assist in the calculation of the level of maximum conducted output power, power spectral density and emissions. The EUT cannot transmit continuously and sweep triggering/signal gating cannot be implemented.

2.3. Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	KDB 558074 D01 DTS Meas Guidance v03r04 January 7, 2016
Title:	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

2.4. Deviations from the Test Specification

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	ModCam
Model Name or Number:	MOD.01
Test Sample Serial Number:	MC000170 (<i>Radiated sample #1</i>)
Hardware Version:	2.0
Software Version:	114
FCC ID:	2AEV4-01

Brand Name:	ModCam
Model Name or Number:	MOD.01
Test Sample Serial Number:	0016D0 (<i>Radiated sample #2</i>)
Hardware Version:	2.0
Software Version:	114
FCC ID:	2AEV4-01

Brand Name:	ModCam
Model Name or Number:	MOD.01
Test Sample Serial Number:	MC000058 (<i>Conducted sample with RF port #1</i>)
Hardware Version:	2.0
Software Version:	114
FCC ID:	2AEV4-01

Brand Name:	ModCam
Model Name or Number:	MOD.01
Test Sample Serial Number:	0100174A (<i>Conducted sample with RF port #2</i>)
Hardware Version:	2.0
Software Version:	114
FCC ID:	2AEV4-01

3.2. Description of EUT

The equipment under test was an IP camera which incorporated the following wireless technologies; *Bluetooth, Bluetooth LE, GPS, WLAN* in 2.4 GHz and 5 GHz bands.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Technology Tested:	WLAN (IEEE 802.11b,g,n) / Digital Transmission System	
Type of Unit:	Transceiver	
Modulation Type:	DBPSK, DQPSK, BPSK, QPSK, 16QAM & 64QAM	
Data Rates:	802.11b	1, 2, 5.5 & 11 Mbps
	802.11g	6, 9, 12, 18, 24, 36, 48 & 54 Mbps
	802.11n HT20	MCS0 to MCS7
Power Supply Requirement(s):	Nominal	3.8 VDC via 120 VAC 60 Hz adaptor
Maximum Conducted Output Power:	17.1 dBm	
Declared Antenna Gain:	0.1 dBi	
Channel Spacing:	20 MHz	
Transmit Frequency Range:	2400 MHz to 2483.5 MHz	
Transmit Channels Tested:	Channel Number	Channel Frequency (MHz)
	1	2412
	6	2437
	11	2462

3.5. Support Equipment

The following support equipment was used to exercise the EUT during testing:

Description:	Test laptop
Brand Name:	Hewlett Packard
Model Name or Number:	Compaq 6910p
Serial Number:	HUB7451SGN

Description:	USB Cable
Brand Name:	SONY
Model Name or Number:	EC450
Serial Number:	132112D80289990

Description:	AC Charger
Brand Name:	SONY
Model Name or Number:	EP880
Serial Number:	8512W32 101946 SEM0600

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

The EUT was tested in the following operating mode(s):

- Continuously transmitting with a modulated carrier at maximum power on the bottom, middle and top channels as required using the supported data rates/modulation types.

4.2. Configuration and Peripherals

The EUT was tested in the following configuration(s):

- Controlled using a terminal application on the laptop PC along with instructions provided by the customer. The document was called "*How to set to WLAN continuous signal.docx*".
- The application was used to enable a continuous transmission mode and to select the test channels, data rates and modulation schemes and power settings as required.
- In order for all test cases to meet their respective limits, the power settings have been specified in section 4.3 of this report. When the EUT was placed in closed loop it was set to the maximum possible power that it would support.
- All supported modes and channel widths were initially investigated on one channel. The modes that produced the highest power and widest bandwidth for all bands were:
 - o Highest power and highest power spectral density
 - o 802.11b – DQPSK / 5.5 Mbps
 - o 802.11g – BPSK / 9 Mbps
 - o 802.11n HT20 – 16QAM / MCS3
 - o Narrowest bandwidth
 - o 802.11b – DBPSK / 1 Mbps
 - o 802.11g – BPSK / 6 Mbps
 - o 802.11n HT20 – 16QAM / MCS4
 - o Widest bandwidth
 - o 802.11b – DQPSK / 5.5 Mbps
 - o 802.11g – BPSK / 9 Mbps
 - o 802.11n HT20 – 16QAM / MCS3
- Transmitter spurious emissions were performed with the EUT transmitting with a data rate of 5.5 Mbps. This was found to be the worst case modulation scheme with regards to emissions after preliminary investigations and, as this mode emits the highest output power level, it was deemed to be the worst case.
- Transmitter radiated spurious emissions tests were performed with the AC Charger and USB cable connected to the EUT. The AC charger was power by 120 VAC 60 Hz.
- The conducted sample with serial number MC000058 was used for minimum 6 dB bandwidth and duty cycle tests.
- The conducted sample with serial number 0100174A was used for maximum output power and power spectral density tests.
- The radiated sample with serial number 0016D0 was used Band Edge emissions.
- The radiated sample with serial number MC000170 was used for all other tests.

Operation and Monitoring of the EUT during Testing (continued)**4.3. Power settings**

Mode	Bottom Channel	Middle Channel	Top Channel
802.11b	Closed loop	Closed loop	Closed loop
802.11g	10 dBm	Closed loop	10 dBm
802.11n	10 dBm	Closed loop	10 dBm

5. Measurements, Examinations and Derived Results

5.1. General Comments

Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to *Section 6. Measurement Uncertainty* for details.

In accordance with UKAS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

5.2. Test Results

5.2.1. Transmitter AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	Andrew Edwards	Test Date:	22 September 2015
Test Sample Serial Number:	MC000170		

FCC Reference:	Part 15.207
Test Method Used:	ANSI C63.10 Section 6.2

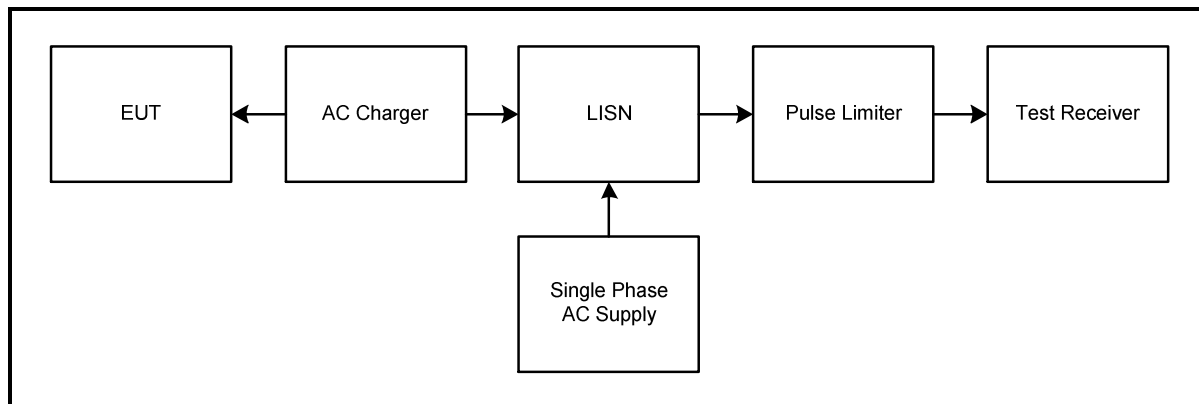
Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	52

Note(s):

1. The EUT was plugged into a USB cable which is connected to an AC charger. The AC charger was connected to 120 VAC 60 Hz single phase supply via a LISN.
2. Pre-scans were performed and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered into the tables below.
3. A pulse limiter was fitted between the LISN and the test receiver.

Test setup:



Transmitter AC Conducted Spurious Emissions (continued)**Results: Live / Quasi Peak**

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.159	Live	46.3	65.5	19.2	Complied
0.195	Live	44.7	63.8	19.1	Complied
0.272	Live	39.4	61.1	21.7	Complied
0.497	Live	37.6	56.1	18.5	Complied
0.911	Live	32.4	56.0	23.6	Complied
1.235	Live	32.7	56.0	23.3	Complied

Results: Live / Average

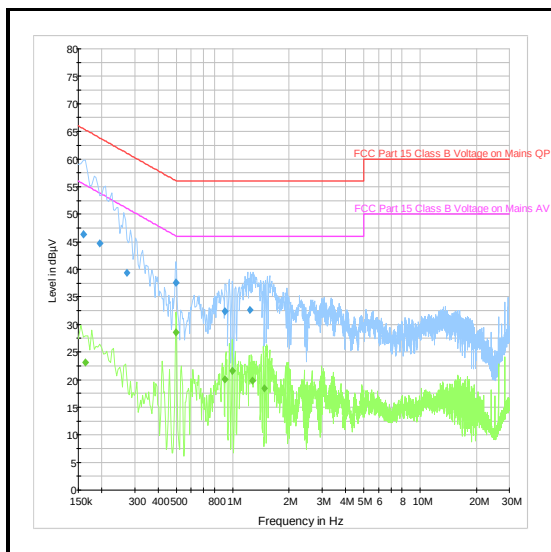
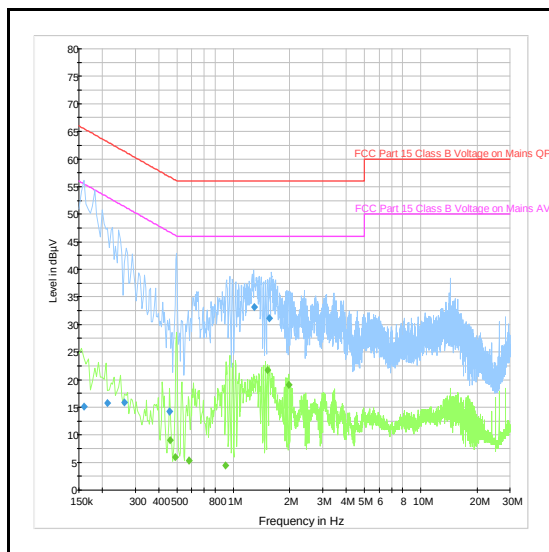
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.164	Live	23.1	55.3	32.2	Complied
0.497	Live	28.5	46.1	17.6	Complied
0.911	Live	20.1	46.0	25.9	Complied
0.992	Live	21.5	46.0	24.5	Complied
1.271	Live	19.8	46.0	26.2	Complied
1.478	Live	18.4	46.0	27.6	Complied

Transmitter AC Conducted Spurious Emissions (continued)**Results: Neutral / Quasi Peak**

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.159	Neutral	15.1	65.5	50.4	Complied
0.213	Neutral	15.8	63.1	47.3	Complied
0.263	Neutral	15.9	61.4	45.5	Complied
0.456	Neutral	14.2	56.8	42.6	Complied
1.293	Neutral	33.1	56.0	22.9	Complied
1.563	Neutral	31.2	56.0	24.8	Complied

Results: Neutral / Average

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.461	Neutral	9.0	46.7	37.7	Complied
0.488	Neutral	6.0	46.2	40.2	Complied
0.578	Neutral	5.3	46.0	40.7	Complied
0.911	Neutral	4.4	46.0	41.6	Complied
1.523	Neutral	21.7	46.0	24.3	Complied
1.982	Neutral	19.1	46.0	26.9	Complied

Transmitter AC Conducted Spurious Emissions (continued)**Live****Neutral**

Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1625	Thermohygrometer	JM Handelspunkt	30.5015.06	None stated	07 Jan 2016	12
A649	LISN	Rohde & Schwarz	ESH3-Z5	825562/008	14 Jul 2016	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	02 Mar 2016	12
M1263	Test Receiver	Rohde & Schwarz	ESIB7	100265	14 Oct 2015	12

5.2.2. Transmitter Minimum 6 dB Bandwidth**Test Summary:**

Test Engineer:	Andrew Edwards	Test Date:	12 September 2015
Test Sample Serial Number:	MC000058		

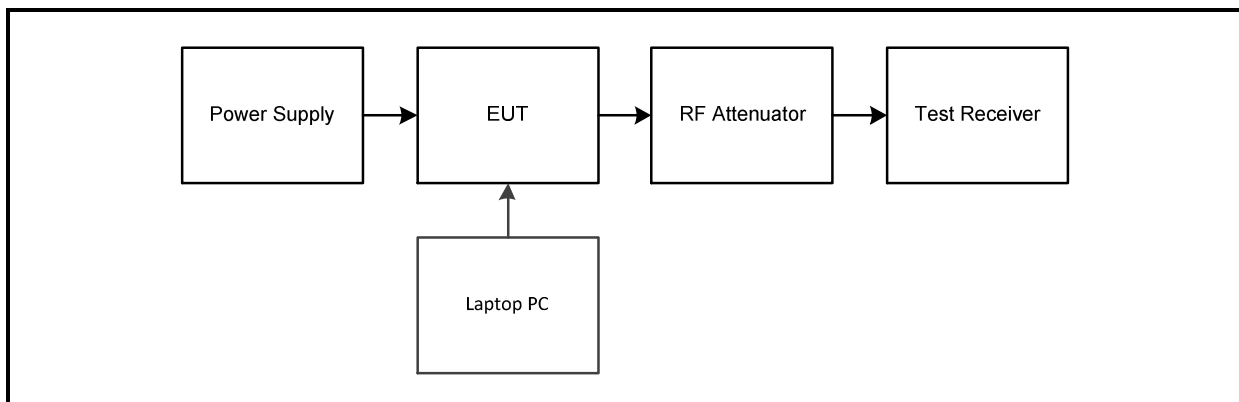
FCC Reference:	Part 15.247(a)(2)
Test Method Used:	FCC KDB 558074 Section 8.1

Environmental Conditions:

Temperature (°C):	26
Relative Humidity (%):	35

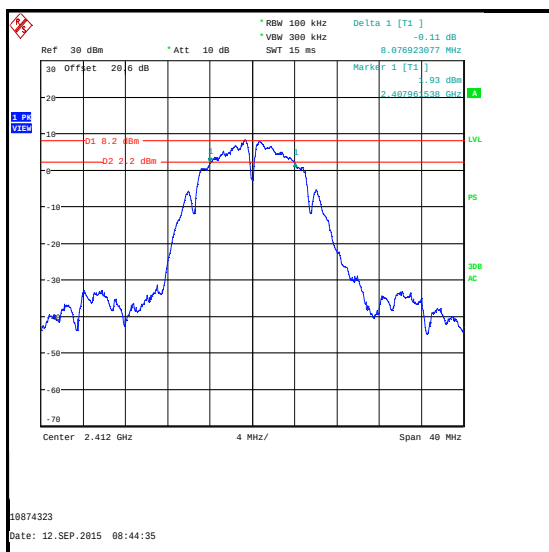
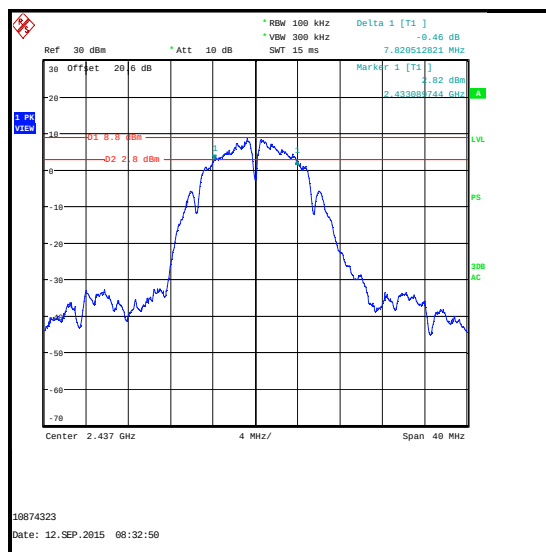
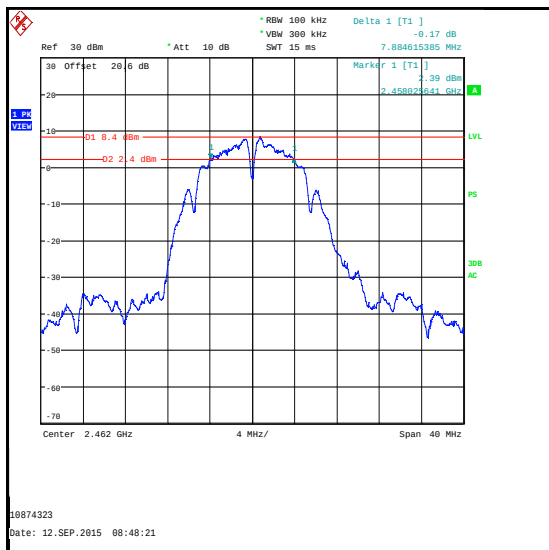
Note(s):

1. All configurations supported by the EUT were investigated on one channel in accordance with KDB 558074 Section 8.1 Option 1 measurement procedure. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 40 MHz. The DTS bandwidth was measured at 6 dB down from the peak of the signal. The data rates that produced the narrowest bandwidth and therefore deemed worst case were:
 - o 802.11b – DBPSK / 1 Mbps
 - o 802.11g – BPSK / 6 Mbps
 - o 802.11n HT20 – 16QAM / MCS4
2. Final measurements were performed using the above configurations on the bottom, middle and top channels in accordance with KDB 558074 Section 8.1 Option 1 measurement procedure.
3. Plots for all data rates are archived on the Company server and available for inspection upon request.
4. The test receiver was connected to the RF port on the EUT using suitable attenuation and RF cable.

Test setup:

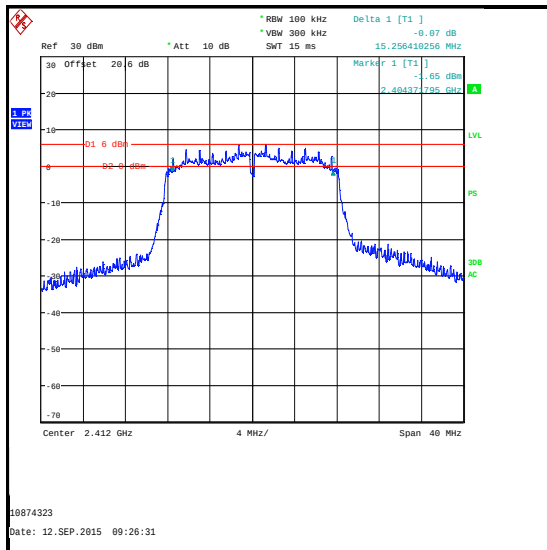
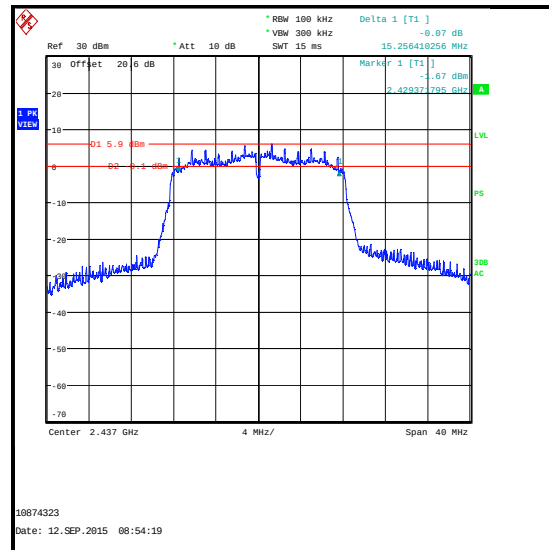
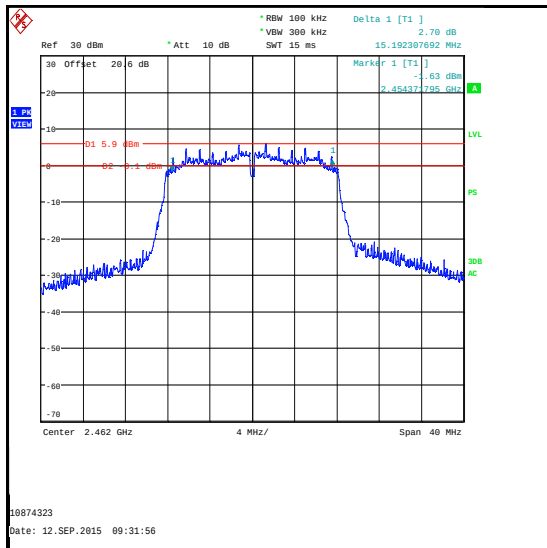
Transmitter Minimum 6 dB Bandwidth (continued)**Results: 802.11b / DBPSK / 1 Mbps**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	8076.923	≥500	7576.923	Complied
Middle	7820.513	≥500	7320.513	Complied
Top	7884.615	≥500	7384.615	Complied

**Bottom Channel****Middle Channel****Top Channel**

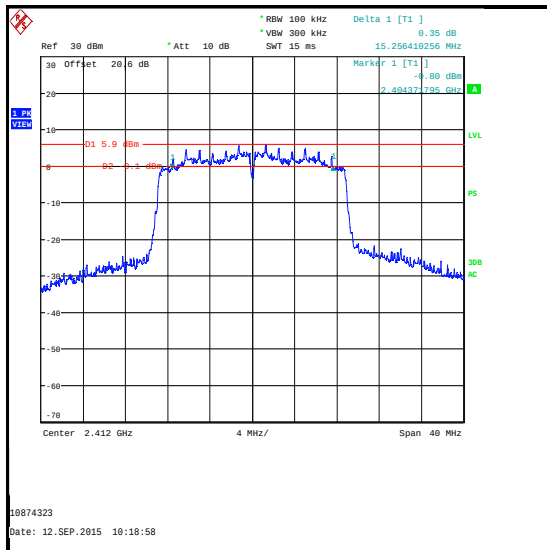
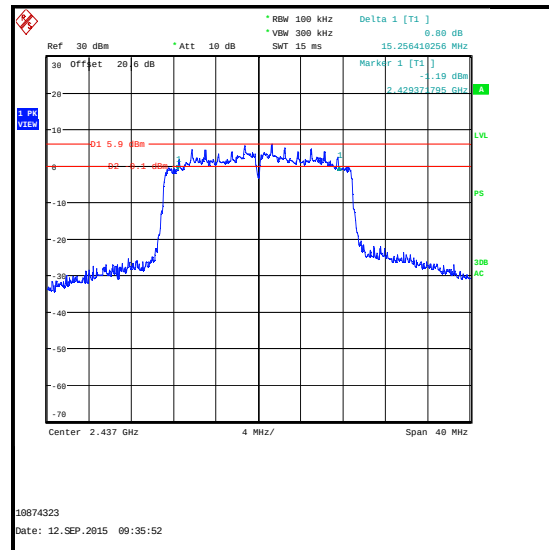
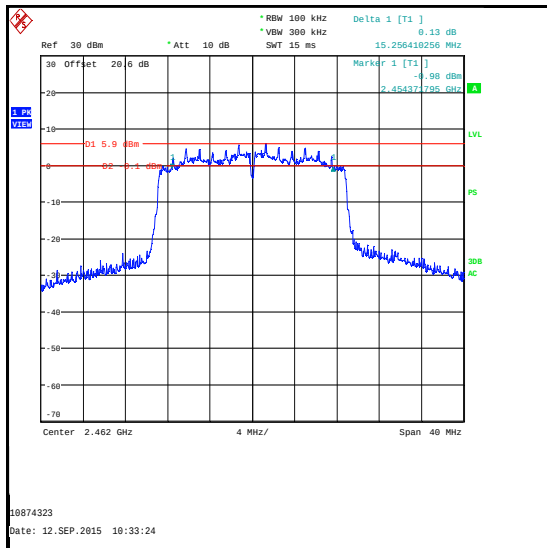
Transmitter Minimum 6 dB Bandwidth (continued)**Results: 802.11g / BPSK / 6 Mbps**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	15256.410	≥500	14756.410	Complied
Middle	15256.410	≥500	14756.410	Complied
Top	15192.308	≥500	14692.308	Complied

**Bottom Channel****Middle Channel****Top Channel**

Transmitter Minimum 6 dB Bandwidth (continued)**Results: 802.11n / HT20 / 16QAM / MCS4**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	15256.410	≥500	15256.410	Complied
Middle	15256.410	≥500	15256.410	Complied
Top	15256.410	≥500	15256.410	Complied

**Bottom Channel****Middle Channel****Top Channel**

Transmitter Minimum 6 dB Bandwidth (continued)**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1785	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	23 Apr 2016	12
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	21 May 2016	12
A2522	Attenuator	AtlanTecRF	AN18-20	832797#3	Calibrated before use	-
S0537	DC Power Supply	TTI	EL302D	249928	Calibrated before use	-
M1269	Multimeter	Fluke	179	90250210	26 May 2016	12

5.2.3. Transmitter Duty Cycle**Test Summary:**

Test Engineer:	Andrew Edwards	Test Date:	08 September 2015
Test Sample Serial Number:	MC000058		

FCC Reference:	Part 15.35(c)
Test Method Used:	FCC KDB 558074 Section 6.0

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	40

Note(s):

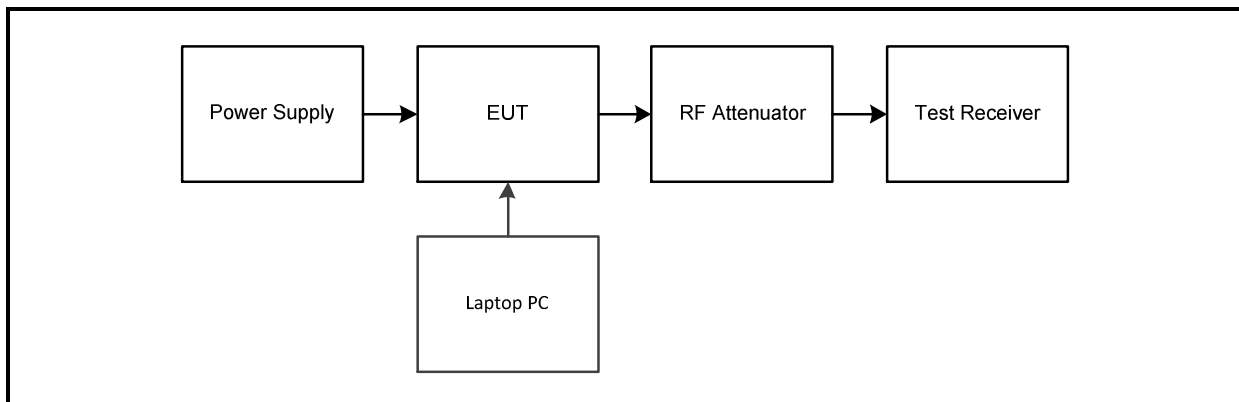
1. In order to assist with the determination of the average level of fundamental and spurious emissions field strength, measurements were made of duty cycle to determine the transmission duration and the silent period time of the transmitter. The transmitter duty cycle was measured using a spectrum analyser in the time domain and calculated by using the following calculation:

$$10 \log (1 / (\text{On Time} / [\text{Period or } 100 \text{ ms whichever is the lesser}])).$$

$$802.11b / 5.5 \text{ Mbps duty cycle } 10 \log (1 / (1.588 \text{ ms} / 1.694 \text{ ms})) = 0.3 \text{ dB}$$

$$802.11g / 9 \text{ Mbps duty cycle: } 10 \log (1 / (939.103 \mu\text{s} / 1042.468 \mu\text{s})) = 0.5 \text{ dB}$$

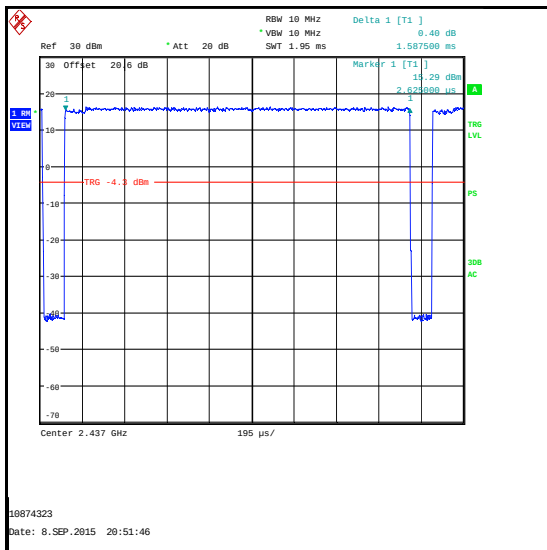
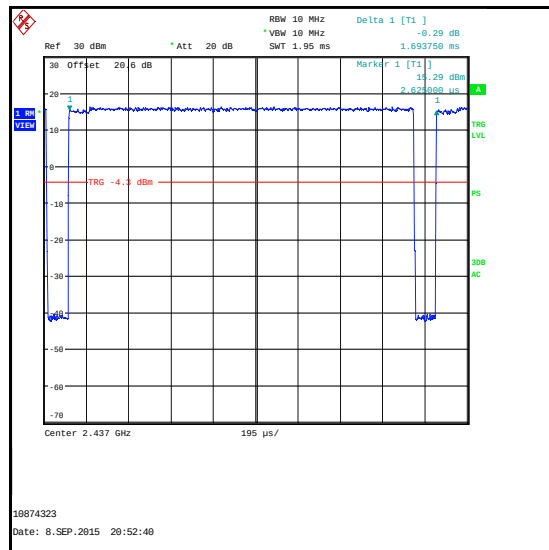
$$802.11n / HT20 / MCS3 \text{ duty cycle: } 10 \log (1 / (325.567 \mu\text{s} / 426.080 \mu\text{s})) = 1.2 \text{ dB}$$

Test setup:

Transmitter Duty Cycle (continued)**Results: 802.11b / 5.5 Mbps**

Pulse Duration (ms)	Duty Cycle (dB)
1.588	0.3

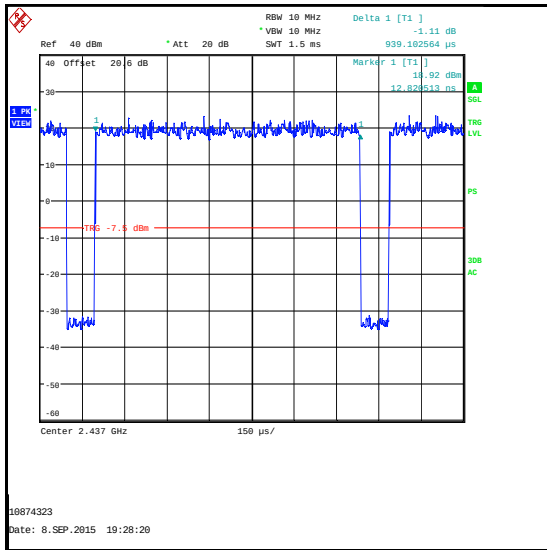
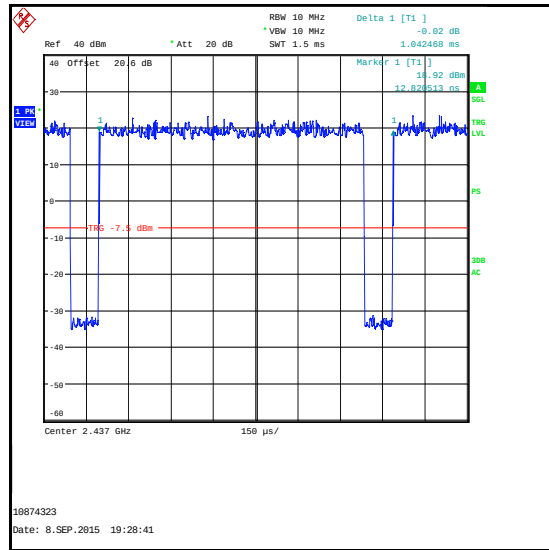
Period (ms)
1.694

**TX on time****TX on + off time / period**

Transmitter Duty Cycle (continued)**Results: 802.11g / 9 Mbps**

Pulse Duration (μ s)	Duty Cycle (dB)
939.103	0.5

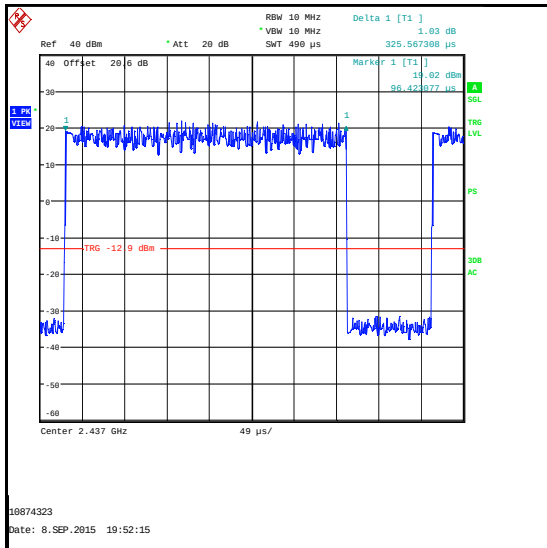
Period (μ s)
1042.468

**TX on time****TX on + off time / period**

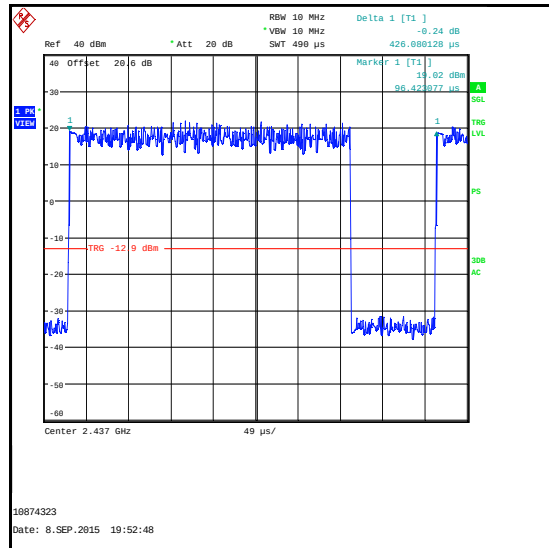
Transmitter Duty Cycle (continued)**Results: 802.11n / HT20 / MCS3**

Pulse Duration (μ s)	Duty Cycle (dB)
325.567	1.2

Period (μ s)
426.080



TX on time



TX on + off time / period

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelpunkt	30.5015.13	None stated	23 Apr 2016	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	12 Jun 2016	12
A2522	Attenuator	AtlanTecRF	AN18-20	832797#3	Calibrated before use	-
S0537	DC Power Supply	TTI	EL302D	249928	Calibrated before use	-
M1269	Multimeter	Fluke	179	90250210	26 May 2016	12

5.2.4. Transmitter Power Spectral Density**Test Summary:**

Test Engineer:	Keith Tucker	Test Date:	03 February 2016
Test Sample Serial Number:	0100174A		

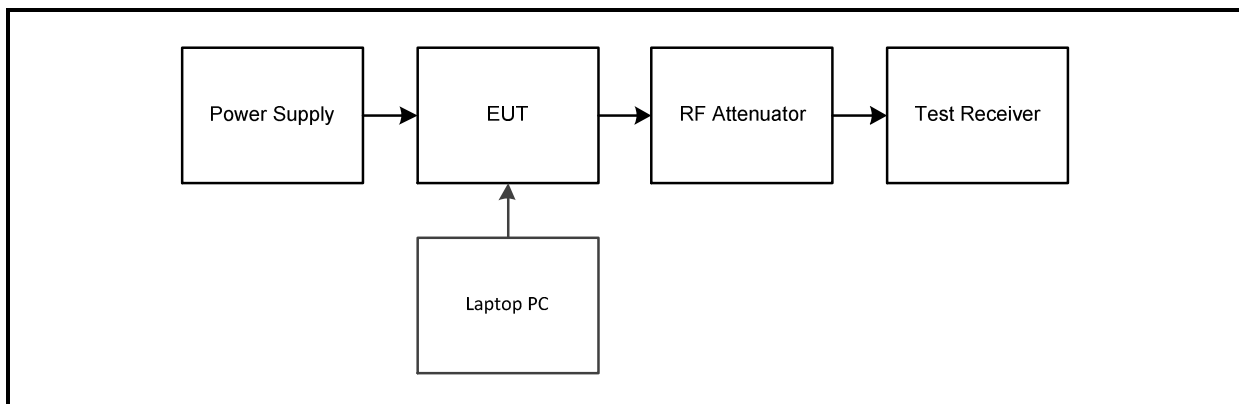
FCC Reference:	Part 15.247(e)
Test Method Used:	FCC KDB 558074 Section 10.6

Environmental Conditions:

Temperature (°C):	27
Relative Humidity (%):	27

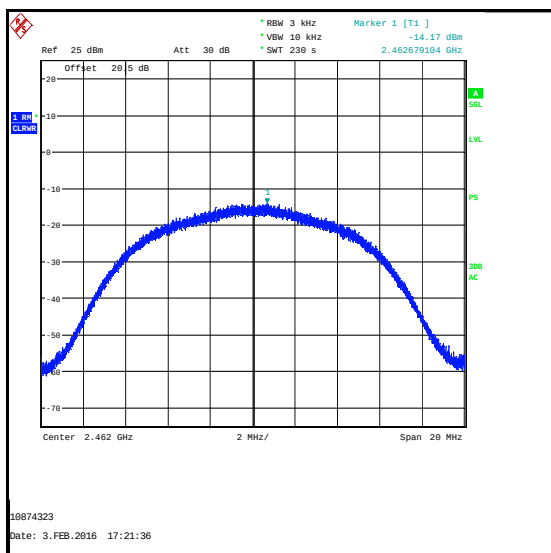
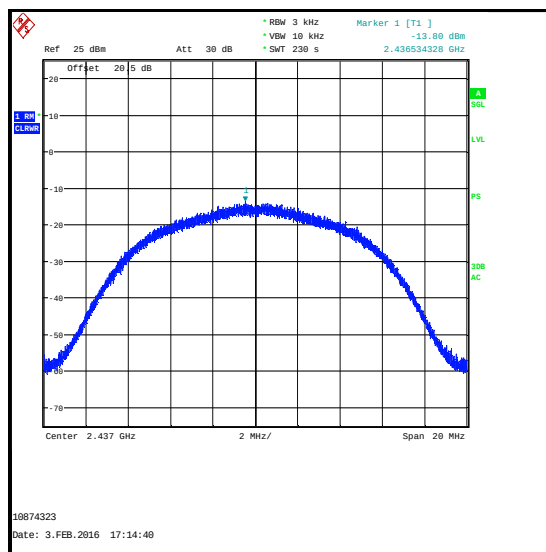
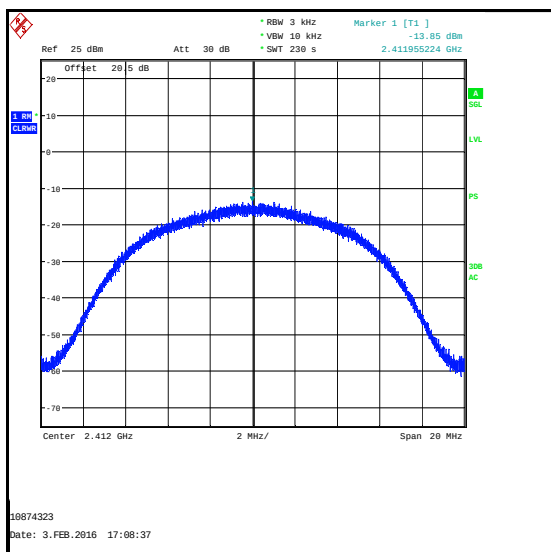
Note(s):

1. All configurations supported by the EUT were investigated on one channel in accordance with KDB 558074 Section 10.6 measurement procedure AVGPST-2 Alternative. The data rates that produced the highest power and therefore deemed worst case were:
 - o 802.11b – DQPSK / 5.5 Mbps
 - o 802.11g – BPSK / 9 Mbps
 - o 802.11n HT20 – 16QAM / MCS3
2. Final measurements were performed using the above configurations on the bottom, middle and top channels.
3. The EUT was transmitting at <98% duty cycle. Testing was performed in accordance with KDB 558074 Section 10.6 Method AVGPST-2 Alternative. The test receiver resolution bandwidth was set to 3 kHz and video bandwidth 10 kHz. An RMS detector was used. Number of sweep points was more than 2 times Span/RBW. The sweep time was set to at least 10 times the number of sweep points multiplied by the period of the transmitted signal. The highest peak of the measured signal was recorded. The calculated duty cycle in section 5.2.3 was added to the measured average power spectral density in order to compute the average power spectral density during the actual transmission time.
4. The test receiver was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF level offset was entered on the test receiver to compensate for the loss of the attenuator and RF cable.

Test setup:

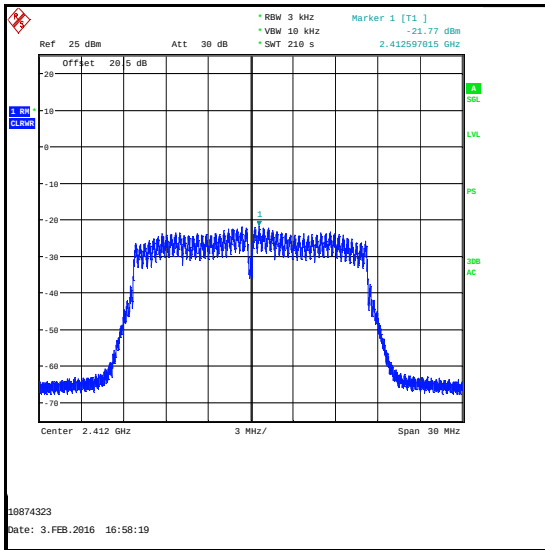
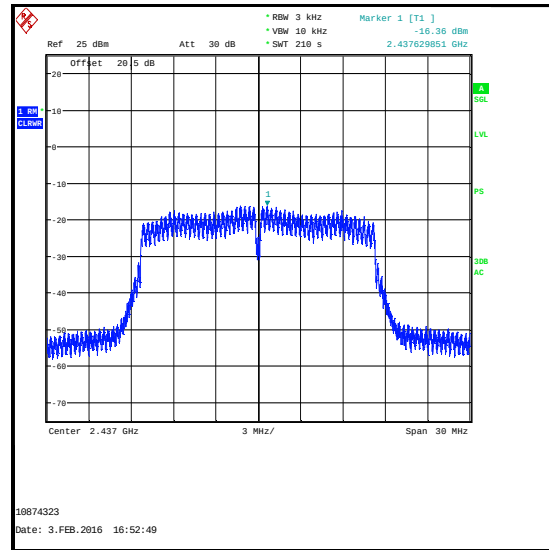
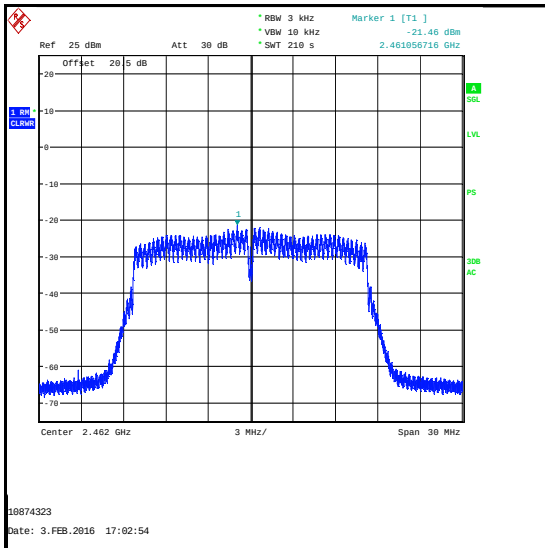
Transmitter Power Spectral Density (continued)**Results: 802.11b / DQPSK / 5.5 Mbps**

Channel	Output Power (dBm/3 kHz)	Duty Cycle Correction (dB)	Corrected Output Power (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
Bottom	-13.9	0.3	-13.6	8.0	21.6	Complied
Middle	-13.8	0.3	-13.5	8.0	21.5	Complied
Top	-14.2	0.3	-13.9	8.0	21.9	Complied



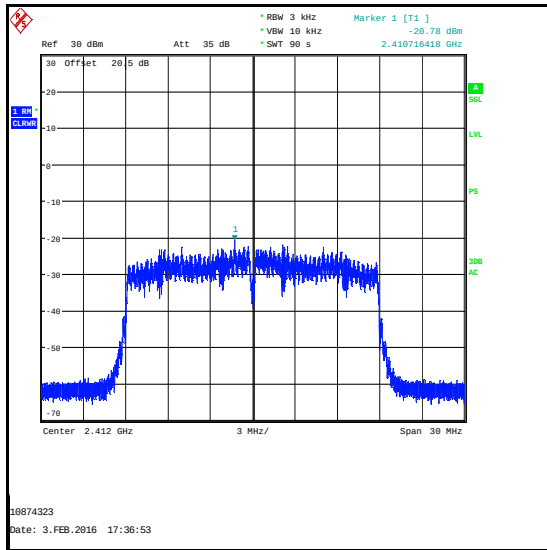
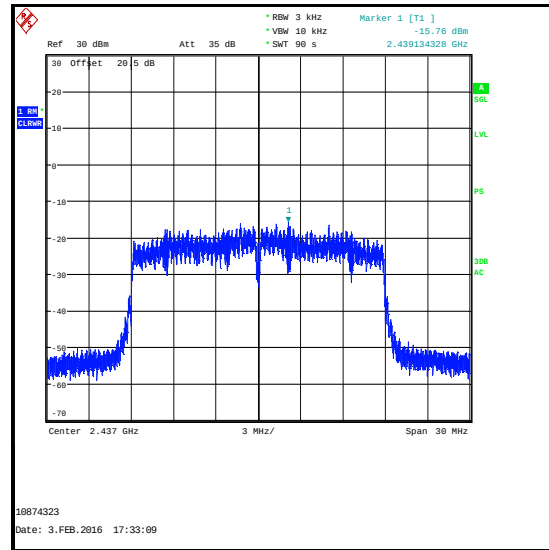
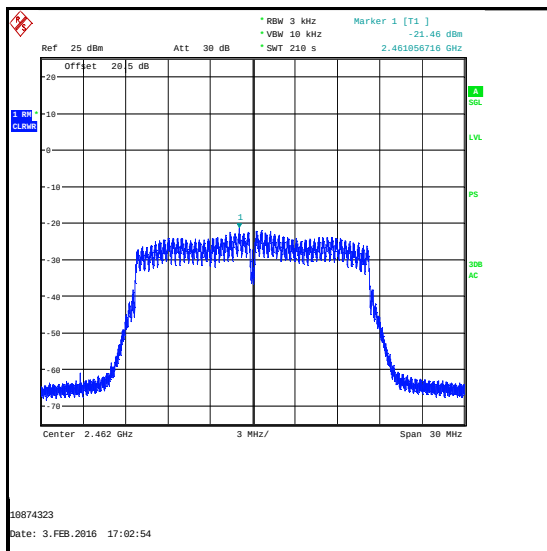
Transmitter Power Spectral Density (continued)**Results: 802.11g / BPSK / 9 Mbps**

Channel	Output Power (dBm/3 kHz)	Duty Cycle Correction (dB)	Corrected Output Power (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
Bottom	-21.8	0.5	-21.3	8.0	29.3	Complied
Middle	-16.4	0.5	-15.9	8.0	23.9	Complied
Top	-21.5	0.5	-21.0	8.0	29.0	Complied

**Bottom Channel****Middle Channel****Top Channel**

Transmitter Power Spectral Density (continued)**Results: 802.11n / HT20 / 16QAM / MCS3**

Channel	Output Power (dBm/3 kHz)	Duty Cycle Correction (dB)	Corrected Output Power (dBm/3 kHz)	Limit (dBm/3kHz)	Margin (dB)	Result
Bottom	-20.8	1.2	-19.6	8.0	27.6	Complied
Middle	-15.8	1.2	-14.6	8.0	22.6	Complied
Top	-21.5	1.2	-20.3	8.0	28.3	Complied

**Bottom Channel****Middle Channel****Top Channel**

Transmitter Power Spectral Density (continued)**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1785	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	23 Apr 2016	12
M1630	Test Receiver	Rohde & Schwarz	ESU40	100233	20 Feb 2016	12
A2142	Attenuator	AtlanTecRF	AN18-20	081120-23	14 May 2016	12
S0558	DC Power Supply	TTI	EL303R	395825	Calibrated before use	-
M1229	Multimeter	Fluke	179	87640015	23 Apr 2016	12
G0607	Signal Generator	Rohde & Schwarz	SMU200A	100943	18 Jul 2016	36
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	08 Apr 2016	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	23 Apr 2016	24

5.2.5. Transmitter Maximum (Average) Output Power**Test Summary:**

Test Engineer:	Keith Tucker	Test Date:	03 February 2016
Test Sample Serial Number:	0100174A		

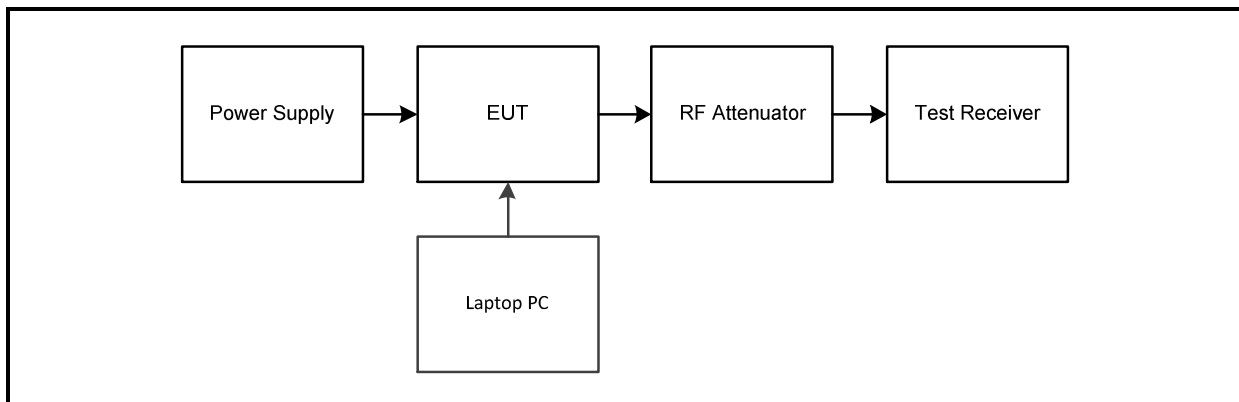
FCC Reference:	Part 15.247(b)(3)
Test Method Used:	FCC KDB 558074 Section 9.2.2.5

Environmental Conditions:

Temperature (°C):	27
Relative Humidity (%):	27

Note(s):

1. All configurations supported by the EUT were investigated on one channel in accordance with KDB 558074 Section 9.2.2.5 measurement procedure AVGSA-2 Alternative. The data rates that produced the highest power and therefore deemed worst case were:
 - o 802.11b – DQPSK / 5.5 Mbps
 - o 802.11g – BPSK / 9 Mbps
 - o 802.11n HT20 – 16QAM / MCS3
2. Final measurements were performed using the above configurations on the bottom, middle and top channels. The power has been integrated over the 99% emission bandwidth. Plots for the occupied bandwidth are archived on the company server and available for inspection upon request.
3. The EUT was transmitting at <98% duty cycle and testing was performed in accordance with KDB 558074 Section 9.2.2.5 Method AVGSA-2 Alternative. The test receiver's integration function was used to integrate across the 99% occupied bandwidth. The test receiver resolution bandwidth was set to 500 kHz and video bandwidth 2 MHz. An RMS detector was used and sweep time set manually to exceed 5000 (10 x sweep points) x transmission period . The span was set to greater than 1.5 times the 99% occupied emission bandwidth. The calculated duty cycle in section 5.2.3 was added to the measured power in order to compute the average power during the actual transmission time.
4. The test receiver was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF level offset was entered on the test receiver to compensate for the loss of the attenuator and RF cable.

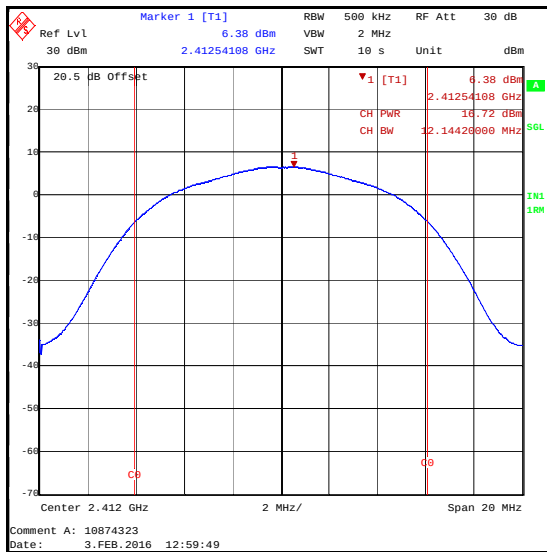
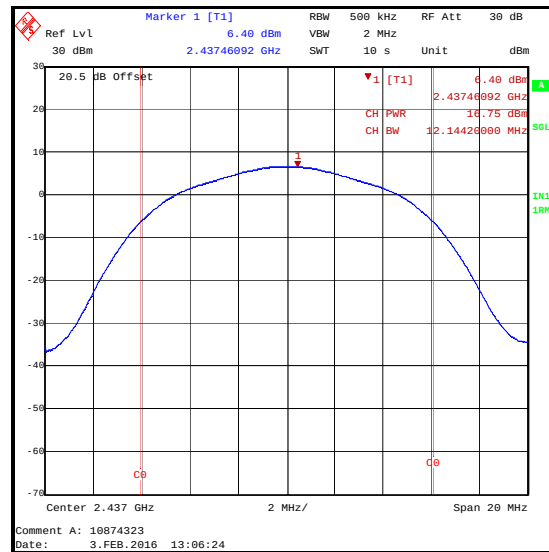
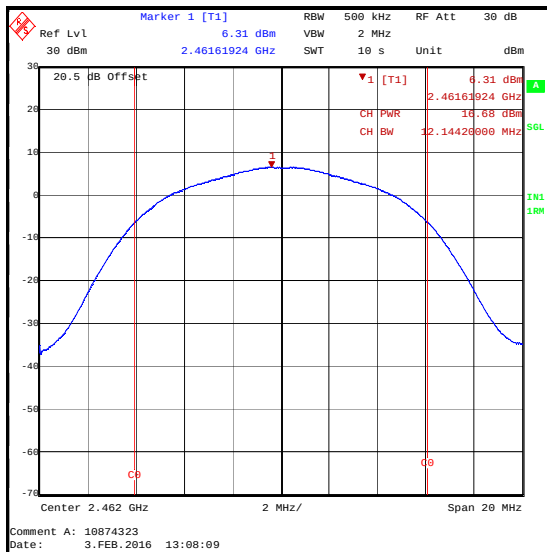
Test setup:

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11b / DQPSK / 5.5 Mbps****Conducted Limit Comparison**

Channel	Conducted Power (dBm)	Duty Cycle Correction (dB)	Corrected Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	16.7	0.3	17.0	30.0	13.0	Complied
Middle	16.8	0.3	17.1	30.0	12.9	Complied
Top	16.7	0.3	17.0	30.0	13.0	Complied

De Facto EIRP Limit Comparison

Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	17.0	0.1	17.1	36.0	18.9	Complied
Middle	17.1	0.1	17.2	36.0	18.8	Complied
Top	17.0	0.1	17.1	36.0	18.9	Complied

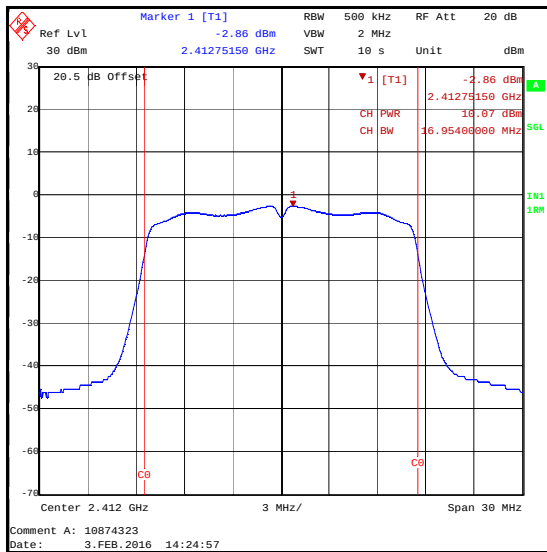
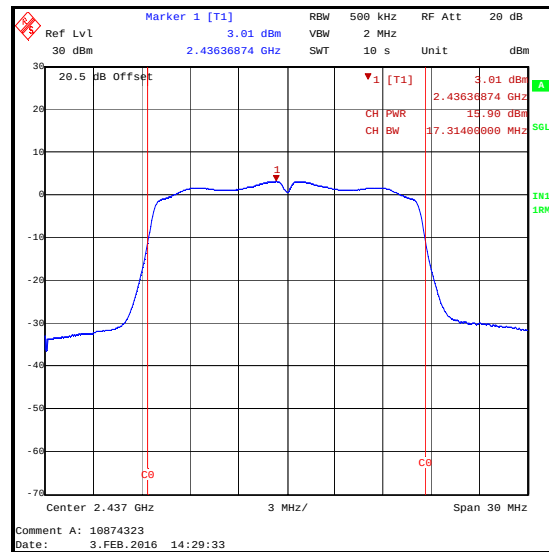
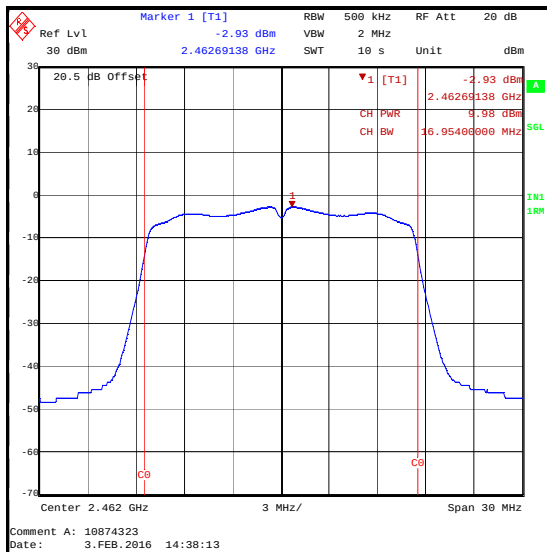
Transmitter Maximum (Average) Output Power (continued)**Results: 802.11b / DQPSK / 5.5 Mbps****Bottom Channel****Middle Channel****Top Channel**

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11g / BPSK / 9 Mbps****Conducted Limit Comparison**

Channel	Conducted Power (dBm)	Duty Cycle Correction (dB)	Corrected Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	10.1	0.5	10.6	30.0	19.4	Complied
Middle	15.9	0.5	16.4	30.0	13.6	Complied
Top	10.0	0.5	10.5	30.0	19.5	Complied

De Facto EIRP Limit Comparison

Channel	Corrected Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	10.6	0.1	10.7	36.0	25.3	Complied
Middle	16.4	0.1	16.5	36.0	19.5	Complied
Top	10.5	0.1	10.6	36.0	25.4	Complied

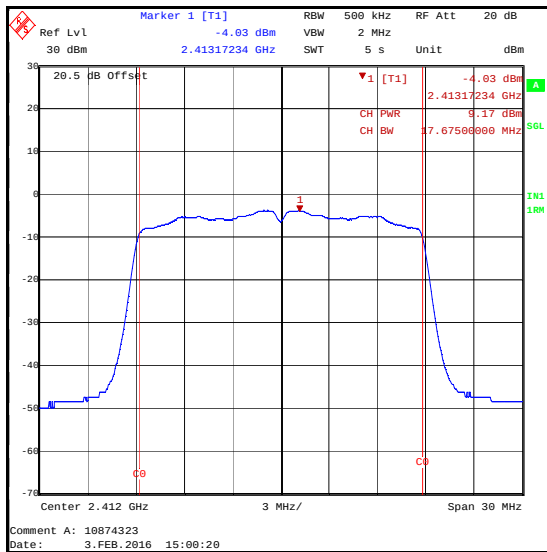
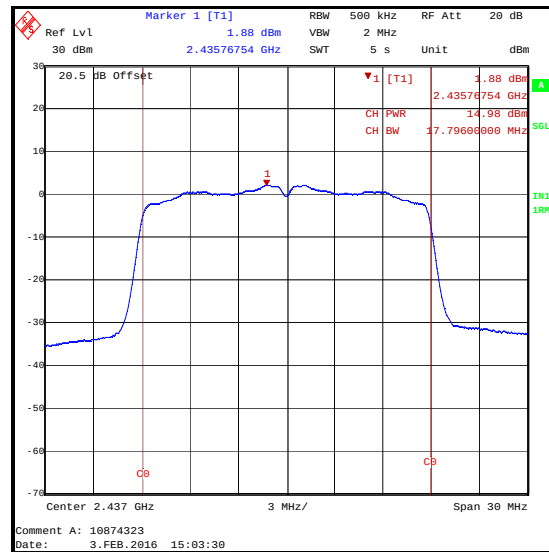
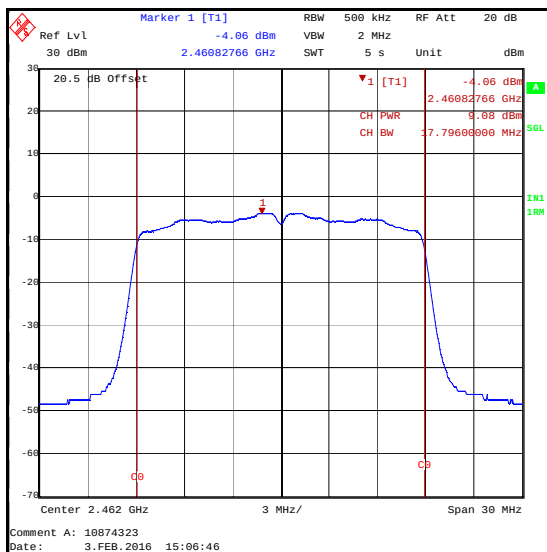
Transmitter Maximum (Average) Output Power (continued)**Results: 802.11g / BPSK / 9 Mbps****Bottom Channel****Middle Channel****Top Channel**

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / HT20 / 16QAM / MCS3****Conducted Limit Comparison**

Channel	Conducted Power (dBm)	Duty Cycle Correction (dB)	Corrected Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	9.2	1.2	10.4	30.0	19.6	Complied
Middle	15.0	1.2	16.2	30.0	13.8	Complied
Top	9.1	1.2	10.3	30.0	19.7	Complied

De Facto EIRP Limit Comparison

Channel	Corrected Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	10.4	0.1	10.5	36.0	25.5	Complied
Middle	16.2	0.1	16.3	36.0	19.7	Complied
Top	10.3	0.1	10.4	36.0	25.6	Complied

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / HT20 / 16QAM / MCS3****Bottom Channel****Middle Channel****Top Channel**

Transmitter Maximum (Average) Output Power (continued)**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1785	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	23 Apr 2016	12
M1124	Test Receiver	Rohde & Schwarz	ESIB26	100046	18 Nov 2016	12
A2142	Attenuator	AtlanTecRF	AN18-20	081120-23	14 May 2016	12
S0558	DC Power Supply	TTI	EL303R	395825	Calibrated before use	-
M1229	Multimeter	Fluke	179	87640015	23 Apr 2016	12
G0607	Signal Generator	Rohde & Schwarz	SMU200A	100943	18 Jul 2016	36
M199	Power Meter	Rohde & Schwarz	NRVS	827023/075	08 Apr 2016	24
M1267	Power Sensor	Rohde & Schwarz	NRV-Z52	100155	23 Apr 2016	24

5.2.6. Transmitter Radiated Emissions**Test Summary:**

Test Engineer:	Andrew Edwards	Test Date:	30 August 2015
Test Sample Serial Number:	MC000170		

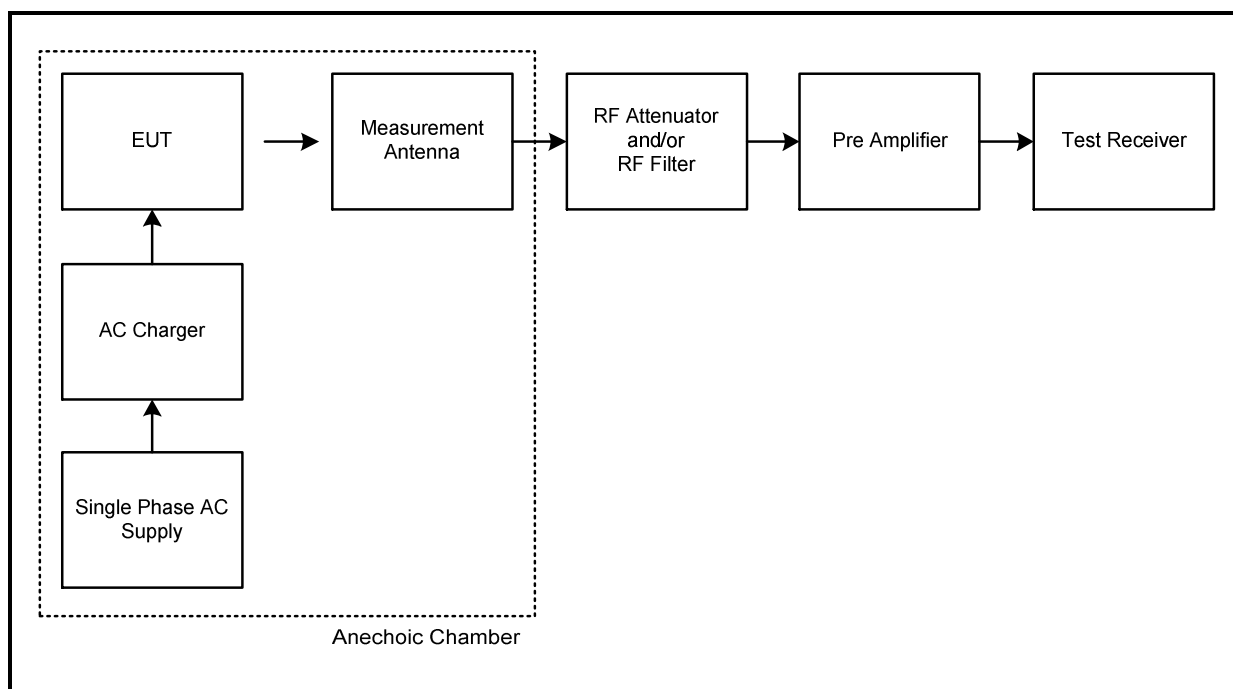
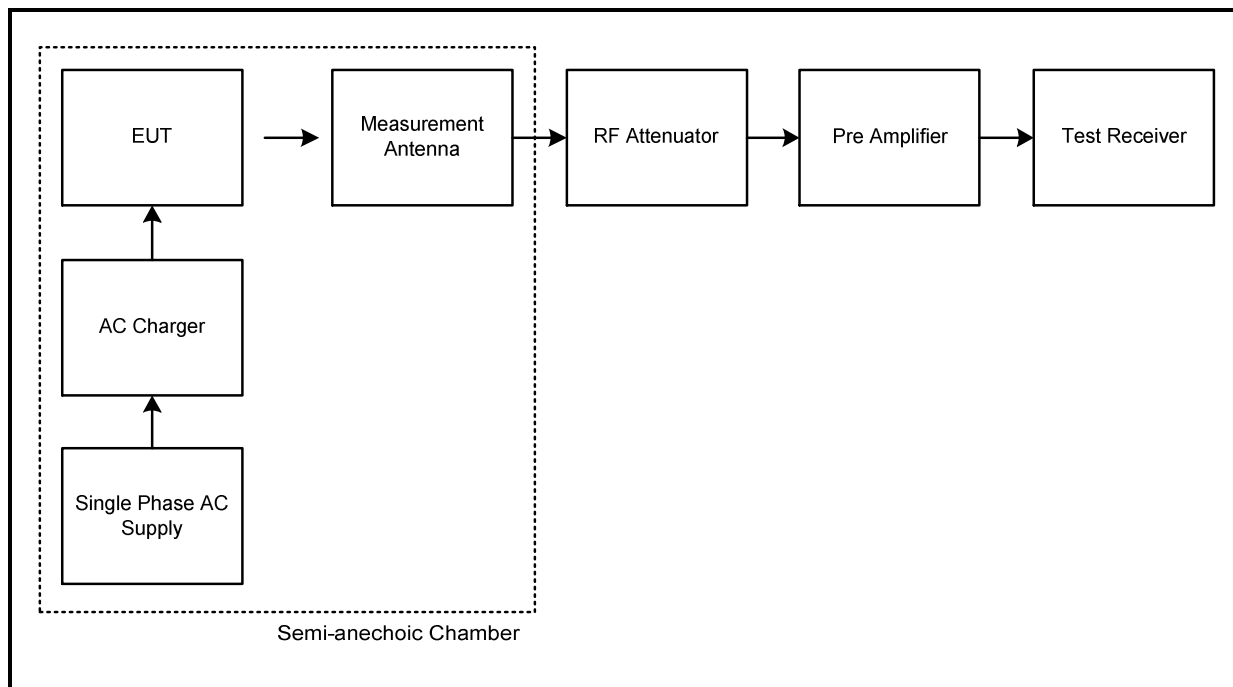
FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3 and 6.5
Frequency Range	30 MHz to 1000 MHz

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	42

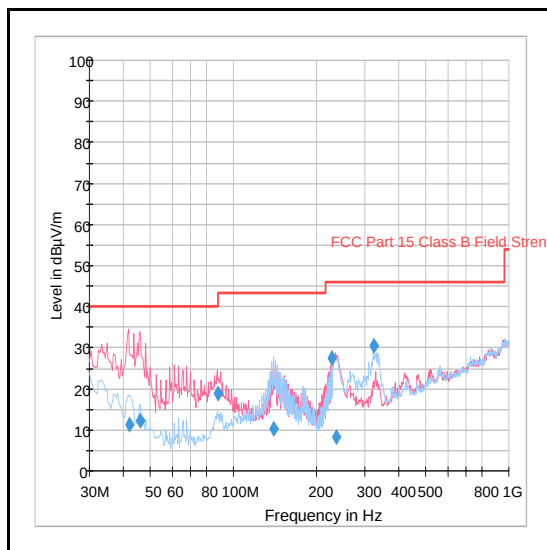
Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The preliminary scans showed similar emission levels below 1 GHz, for each channel of operation. Therefore final radiated emissions measurements were performed with the EUT set to the middle channel only.
3. All other emissions shown on the pre-scan plots were investigated and found to be ambient, or >20 dB below the applicable limit or below the measurement system noise floor.
4. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
5. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
6. Final measurements were performed on the marker frequencies and the results entered into the table below. The test receiver resolution bandwidth was set to 120 kHz, using a CISPR quasi-peak detector and span big enough to see the whole emission.

Transmitter Radiated Emissions (continued)**Test setup for radiated measurements:**

Transmitter Radiated Emissions (continued)**Results: Middle Channel / 802.11b / 5.5 Mbps**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
323.303	Horizontal	30.3	46.0	15.7	Complied



Note: This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying table.

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1945	Thermohygrometer	JM Handelspunkt	30.5015.01	0112	23 Apr 2016	12
K0001	5 m RSE Chamber	Rainford EMC	N/A	N/A	19 Mar 2016	12
M1273	Test Receiver	Rohde & Schwarz	ESIB26	100275	06 Oct 2015	12
A490	Antenna	Chase	CBL6111A	1590	30 Apr 2016	12
G0543	Amplifier	Sonoma	310N	230801	06 Nov 2015	3
A1834	Attenuator	Hewlett Packard	8491B	10444	05 Mar 2016	12

Transmitter Radiated Emissions (continued)**Test Summary:**

Test Engineers:	Andrew Edwards & Kiren Mistry	Test Date:	28 September 2015
Test Sample Serial Number:	MC000170		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3 and 6.6
Frequency Range	1 GHz to 25 GHz

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	41

Note(s):

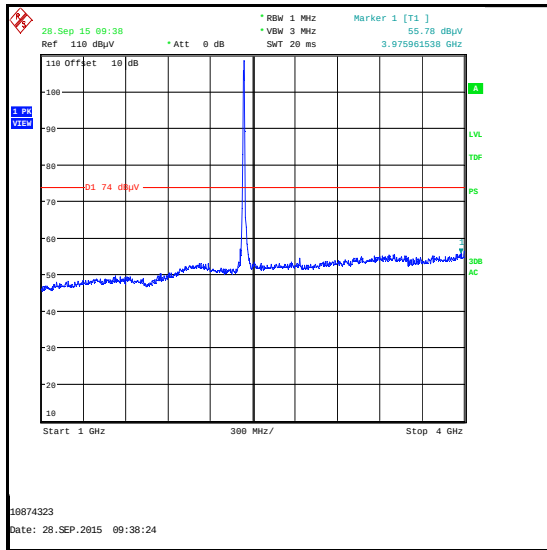
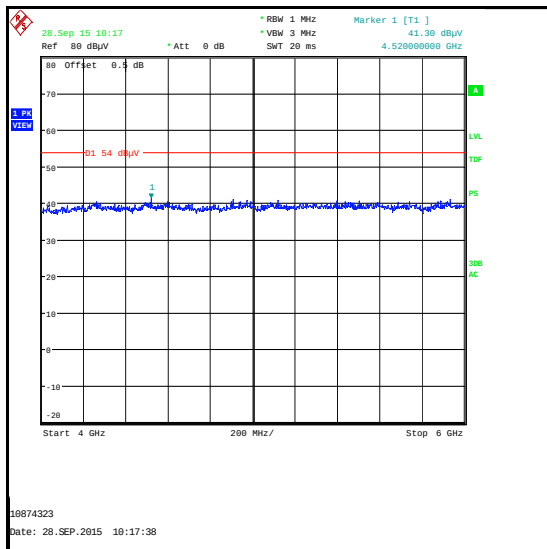
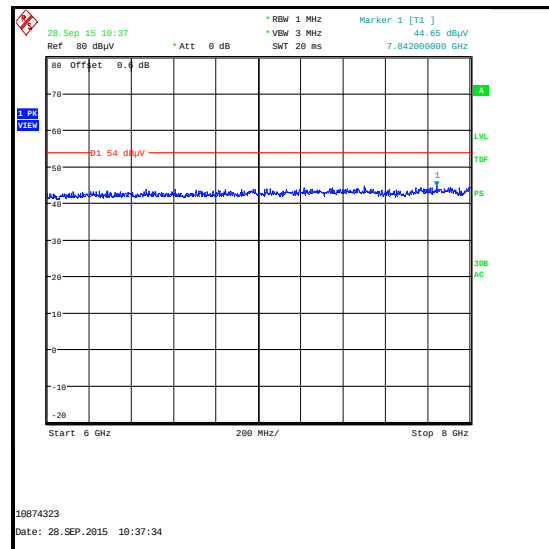
1. The final measured value, for the given emission, in the tables below incorporates the calibrated antenna factor and cable loss.
2. No spurious emissions were detected above the noise floor of the measuring receiver therefore the highest peak and average noise floor readings of the measuring receiver were recorded as shown in the tables below.
3. The emission shown approximately at 2437 MHz on the 1 GHz to 4 GHz plot is the EUT fundamental.
4. Pre-scans above 1 GHz were performed in a fully anechoic chamber (Asset Number K0002) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the test chamber floor in the centre of the chamber turntable. All measurement antennas were placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT.
5. Pre-scans were performed and a marker placed on the highest measured level of the appropriate plot. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. The sweep time was set to auto.

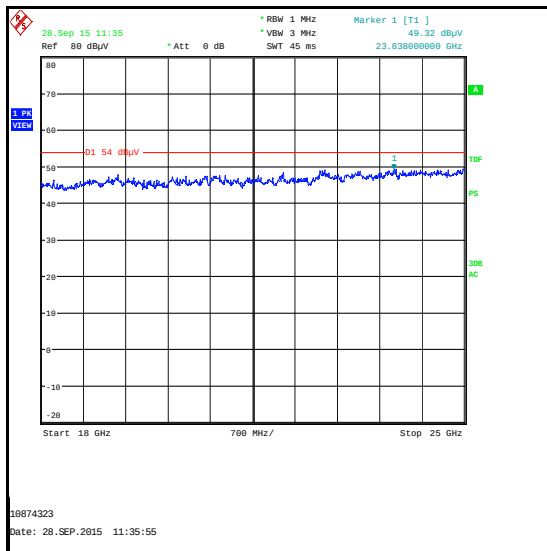
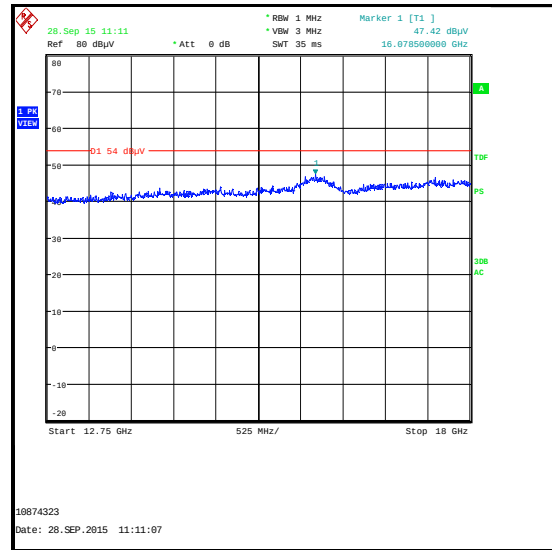
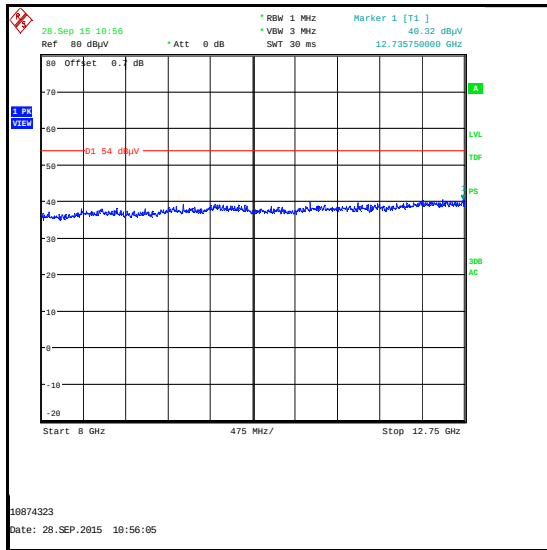
Results: Peak

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Result
3975.962	Horizontal	55.8	74.0	18.2	Complied

Results: Average

Frequency (MHz)	Antenna Polarity	Average Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
3601.000	Horizontal	46.5	54.0	7.5	Complied

Transmitter Radiated Emissions (continued)**Peak detector****Average detector**

Transmitter Radiated Emissions (continued)

Transmitter Radiated Emissions (continued)**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	23 Apr 2016	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	01 May 2016	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	12 Jun 2016	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	21 Dec 2015	12
A1818	Antenna	EMCO	3118	00075692	20 Dec 2015	12
A253	Antenna	Flann Microwave	12240-20	128	20 Dec 2015	12
A254	Antenna	Flann Microwave	14240-20	139	20 Dec 2015	12
A255	Antenna	Flann Microwave	16240-20	519	20 Dec 2015	12
A256	Antenna	Flann Microwave	18240-20	400	20 Dec 2015	12
A436	Antenna	Flann Microwave	20240-20	330	21 Dec 2015	12
A1396	Attenuator	Huber & Suhner	6810.17.B	757987	05 May 2016	12
A1975	High Pass Filter	AtlanTecRF	AFH-01000	090000283	17 Apr 2016	12

5.2.7. Transmitter Band Edge Radiated Emissions**Test Summary:**

Test Engineer:	Andrew Edwards	Test Date:	06 February 2016
Test Sample Serial Number:	0016D0		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Section 6.10 & FCC KDB 558074 Sections 11 & 12

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	39

Note(s):

1. All configurations supported by the EUT were investigated on one channel. The data rates that produced the highest power and widest bandwidth were therefore deemed worst case :
 - o Highest power and widest bandwidth:
 - o 802.11b – DQPSK / 5.5 Mbps
 - o 802.11g – BPSK / 9 Mbps
 - o 802.11n HT20 – 16QAM / MCS3

Final measurements were performed with the above configurations.

2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
3. As the lower band edge falls within a non-restricted band, only peak measurements are required. In accordance with FCC KDB 558074 Section 11.1, the test method in Section 11.3 was followed: the test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The test receiver was left to sweep for a sufficient length of time in order to maximise the carrier level and out-of-band emissions. A marker and corresponding reference level line were placed on the peak of the carrier. As the maximum conducted (average) output power was measured using an RMS detector in accordance with FCC KDB 558074 Section 9.2.2.5 an out-of-band limit line was placed 30 dB (FCC KDB 558074 Section 11.1(b)) below the peak level. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent non-restricted band of operation (where a higher level emission was present). Marker frequencies and levels were recorded.
4. As the upper band edge falls within a restricted band both peak and average measurements were recorded by placing a marker at the edge of the band. For peak measurements the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth 3 MHz. Peak and average detectors were used, sweep time was set to auto and trace mode was Max Hold. The test receiver was left to sweep for a sufficient length of time in order to maximise the carrier level and out-of-band emissions. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent restricted band of operation (where a higher level emission was present). Marker frequencies and levels were recorded.
5. The restricted band plot for 2310 MHz to 2390 MHz can be found under the results for 802.11b / 5.5 Mbps as this mode had the highest output power and was therefore deemed worst case.

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11b / DQPSK / 5.5 Mbps****Results: Lower Band Edge**

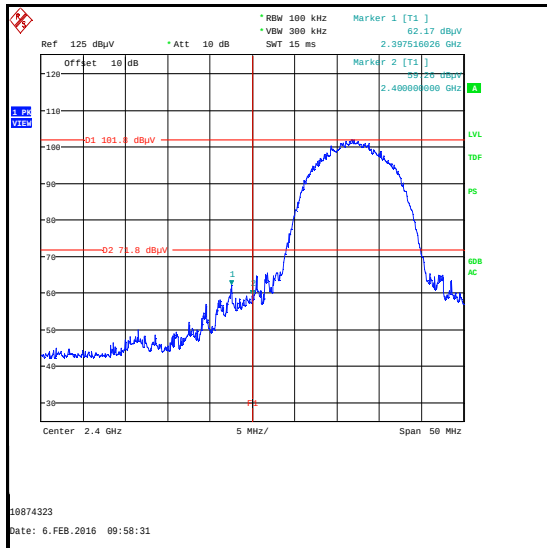
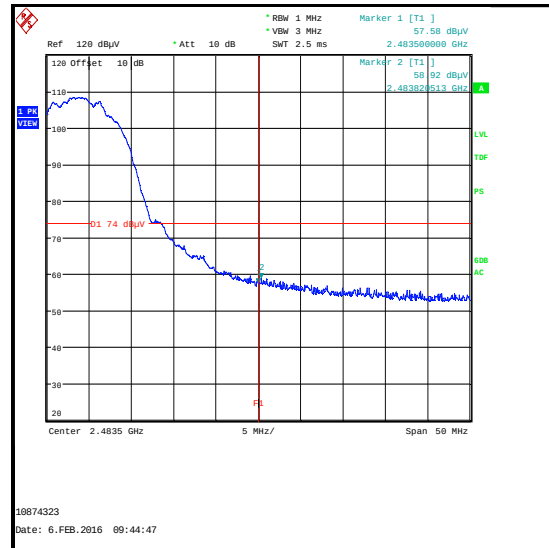
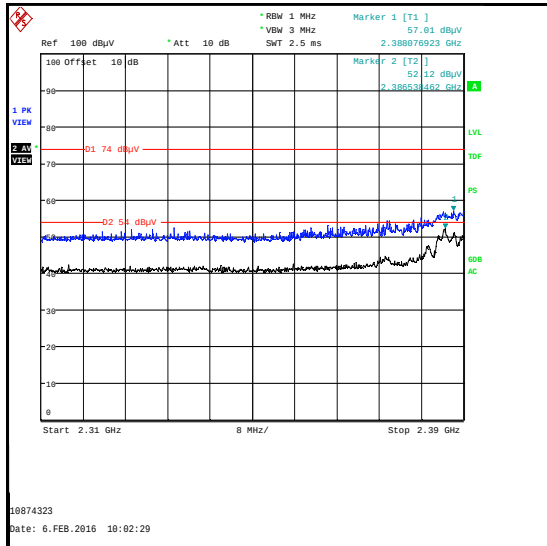
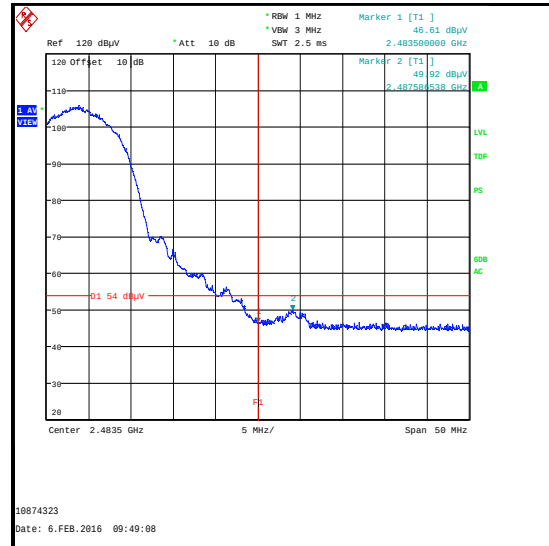
Frequency (MHz)	Level (dBμV/m)	-30 dBc Limit (dBμV/m)	Margin (dB)	Result
2397.516	62.2	71.8	9.6	Complied
2400	59.3	71.8	12.5	Complied

Results: Upper Band Edge / Restricted Band / Peak

Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
2388.077	57.0	74.0	17.0	Complied
2483.5	57.6	74.0	16.4	Complied
2483.821	58.9	74.0	15.1	Complied

Results: Upper Band Edge / Restricted Band / Average

Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
2386.538	52.1	54.0	1.9	Complied
2483.5	46.6	54.0	7.4	Complied
2487.587	49.9	54.0	4.1	Complied

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11b / DQPSK / 5.5 Mbps****Lower Band Edge Peak Measurement****Upper Band Edge Peak Measurement****2310 MHz to 2390 MHz Restricted Band Plot****Upper Band Edge Average Measurement**

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11g / BPSK / 9 Mbps****Results: Lower Band Edge**

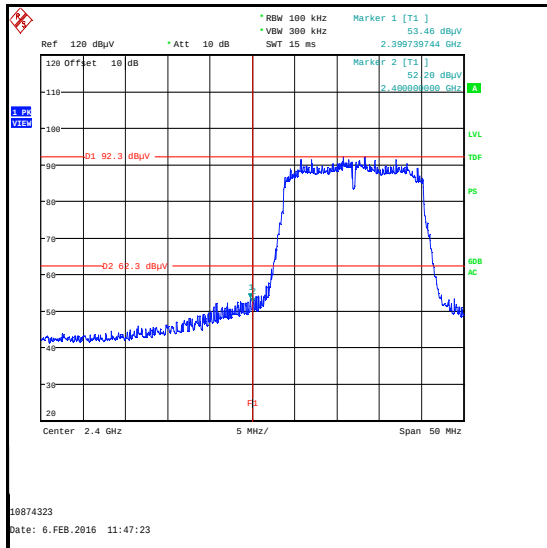
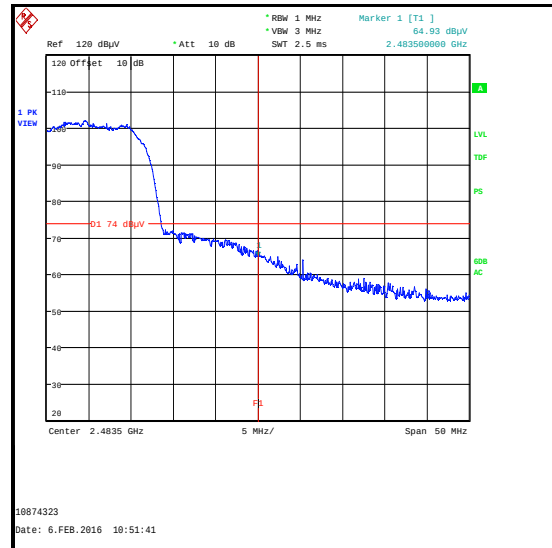
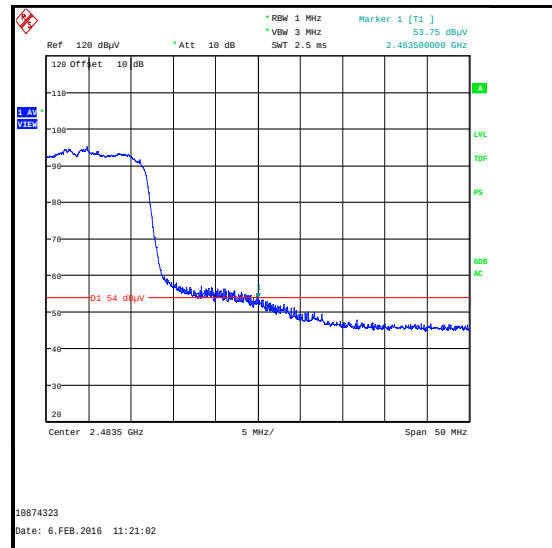
Frequency (MHz)	Level (dBµV/m)	-30 dBc Limit (dBµV/m)	Margin (dB)	Result
2399.740	53.5	62.3	8.8	Complied
2400	52.2	62.3	10.1	Complied

Results: Upper Band Edge / Restricted Band / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.5	64.9	74.0	9.1	Complied

Results: Upper Band Edge / Restricted Band / Average

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.5	53.8	54.0	0.2	Complied

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11g / BPSK / 9 Mbps****Lower Band Edge Peak Measurement****Upper Band Edge Peak Measurement****Upper Band Edge Average Measurement**

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11n HT20 / 16QAM / MCS3****Results: Lower Band Edge**

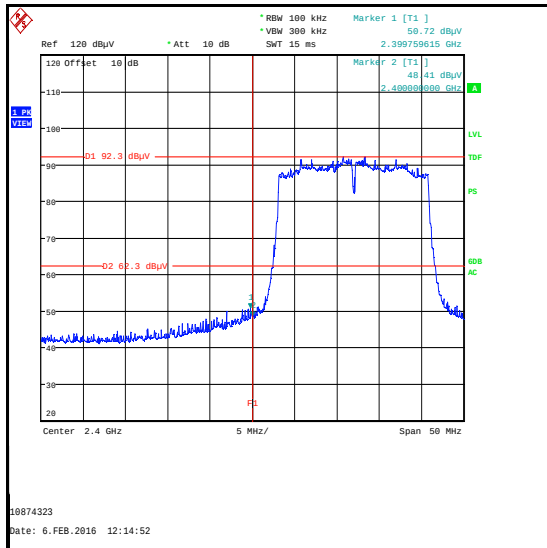
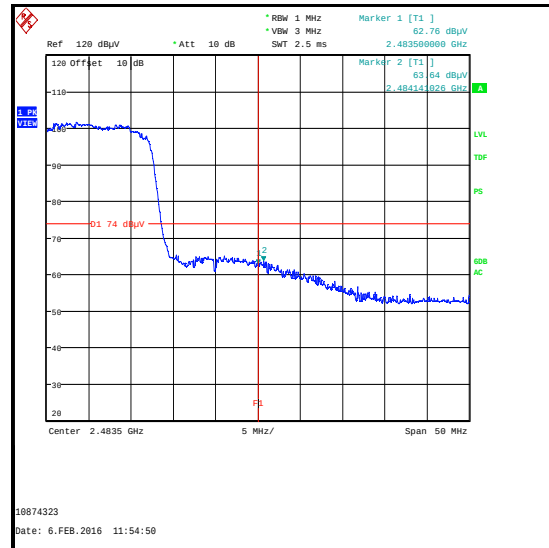
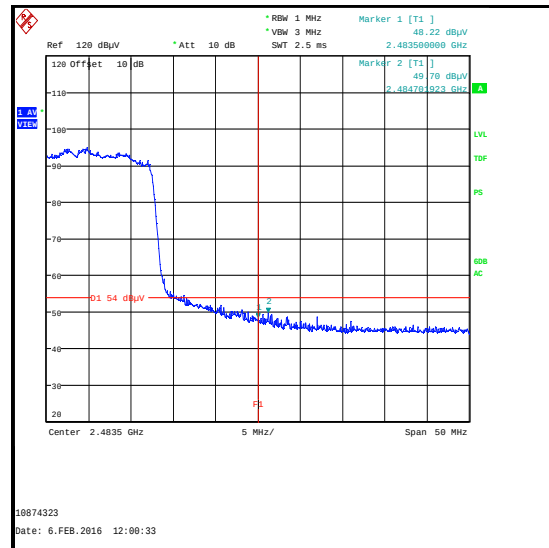
Frequency (MHz)	Level (dB μ V/m)	-30 dBc Limit (dB μ V/m)	Margin (dB)	Result
2399.760	50.7	62.3	11.6	Complied
2400	48.4	62.3	13.9	Complied

Results: Upper Band Edge / Restricted Band / Peak

Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.5	62.8	74.0	11.2	Complied
2484.141	63.6	74.0	10.4	Complied

Results: Upper Band Edge / Restricted Band / Average

Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
2483.5	48.2	54.0	5.8	Complied
2484.702	49.7	54.0	4.3	Complied

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11n HT20 / 16QAM / MCS3****Lower Band Edge Peak Measurement****Upper Band Edge Peak Measurement****Upper Band Edge Average Measurement****Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelpunkt	30.5015.13	None stated	23 Apr 2016	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	01 May 2016	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	12 Jun 2016	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	19 Dec 2016	12
A1818	Antenna	EMCO	3118	00075692	17 Dec 2016	12
A1396	Attenuator	Huber & Suhner	6810.17.B	757987	05 May 2016	12

6. Measurement Uncertainty

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document "approximately" is interpreted as meaning "effectively" or "for most practical purposes".

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±4.69 dB
Minimum 6 dB Bandwidth	2.4 GHz to 2.4835 GHz	95%	±3.92 %
Duty Cycle	2.4 GHz to 2.4835 GHz	95%	±1.14 %
Spectral Power Density	2.4 GHz to 2.4835 GHz	95%	±1.13 dB
Conducted Maximum Output Power	2.4 GHz to 2.4835 GHz	95%	±1.13 dB
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±5.65 dB
Radiated Spurious Emissions	1 GHz to 25 GHz	95%	±2.94 dB

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

7. Report Revision History

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0	-	-	Initial Version
2.0	-	-	FCC ID updated

--- END OF REPORT ---