



# TEST REPORT

**Test Report No. :** UL-RPT-RP10950538JD10A V2.0

**Manufacturer** : Sigma Connectivity AB  
**Model No.** : SSG-002  
**FCC ID** : 2AFCP-002  
**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:** 25 October 2016

**Checked by:**

Ian Watch  
Senior 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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## UL VS LTD

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**Table of Contents**

<b>1. Customer Information.....</b>	<b>4</b>
<b>2. Summary of Testing.....</b>	<b>5</b>
2.1. General Information	5
2.2. Summary of Test Results	5
2.3. Methods and Procedures	6
2.4. Deviations from the Test Specification	6
<b>3. Equipment Under Test (EUT) .....</b>	<b>7</b>
3.1. Identification of Equipment Under Test (EUT)	7
3.2. Description of EUT	7
3.3. Modifications Incorporated in the EUT	7
3.4. Additional Information Related to Testing	8
3.5. Support Equipment	8
<b>4. Operation and Monitoring of the EUT during Testing .....</b>	<b>9</b>
4.1. Operating Modes	9
4.2. Configuration and Peripherals	9
4.3. Power settings	10
<b>5. Measurements, Examinations and Derived Results.....</b>	<b>11</b>
5.1. General Comments	11
5.2. Test Results	12
5.2.1. Transmitter AC Conducted Spurious Emissions	12
5.2.2. Transmitter Minimum 6 dB Bandwidth	15
5.2.3. Transmitter Duty Cycle	20
5.2.4. Transmitter Power Spectral Density	24
5.2.5. Transmitter Maximum (Average) Output Power	29
5.2.6. Transmitter Radiated Emissions	37
5.2.7. Transmitter Band Edge Radiated Emissions	45
<b>6. Measurement Uncertainty .....</b>	<b>54</b>
<b>7. Report Revision History .....</b>	<b>55</b>

**1. Customer Information**









<b>Company Name:</b>	Sigma Connectivity AB
<b>Address:</b>	Mobilevägen 10 223 62 Lund Sweden

## **2. Summary of Testing**

### **2.1. General Information**

<b>Specification Reference:</b>	47CFR15.247
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
<b>Specification Reference:</b>	47CFR15.207 and 47CFR15.209
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.207 and 15.209
<b>Site Registration:</b>	209735
<b>Location of Testing:</b>	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
<b>Test Dates:</b>	03 February 2016 to 07 October 2016

### **2.2. Summary of Test Results**

<b>FCC Reference</b>	<b>Measurement</b>	<b>Result</b>
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	
<b>Key to Results</b>  = 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**

<b>Reference:</b>	ANSI C63.10 (2013)
<b>Title:</b>	American National Standard for Testing Unlicensed Wireless Devices
<b>Reference:</b>	KDB 558074 D01 DTS Meas Guidance v03r05, 08 April 2016
<b>Title:</b>	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)**

<b>Brand Name:</b>	Sensgate
<b>Model Name or Number:</b>	SSG-002
<b>Test Sample Serial Number:</b>	01001B8D ( <i>Conducted sample with RF port #1</i> )
<b>Hardware Version:</b>	Revision 2.0
<b>Software Version:</b>	Revision 219
<b>FCC ID:</b>	2AFCP -002

<b>Brand Name:</b>	Sensgate
<b>Model Name or Number:</b>	SSG-002
<b>Test Sample Serial Number:</b>	0100174A ( <i>Conducted sample with RF port #2</i> )
<b>Hardware Version:</b>	Revision 2.0
<b>Software Version:</b>	Revision 219
<b>FCC ID:</b>	2AFCP -002

<b>Brand Name:</b>	Sensgate
<b>Model Name or Number:</b>	SSG-002
<b>Test Sample Serial Number:</b>	02001-0354 ( <i>Radiated sample #1</i> )
<b>Hardware Version:</b>	Revision 2.0
<b>Software Version:</b>	Revision 219
<b>FCC ID:</b>	2AFCP-002

<b>Brand Name:</b>	Sensgate
<b>Model Name or Number:</b>	SSG-002
<b>Test Sample Serial Number:</b>	MC000170 ( <i>Radiated sample #2</i> )
<b>Hardware Version:</b>	Revision 2.0
<b>Software Version:</b>	Revision 219
<b>FCC ID:</b>	2AFCP-002

#### **3.2. Description of EUT**

The Equipment Under Test was a gateway in the SENS BY SIGMA system, collecting data from sensors and ensuring that all component parts are continuously under full control. The gateway communicates with the sensors via *Bluetooth* and is transmitting data to the Cloud via WiFi. SensGate is designed to be mounted in the ceiling or on the wall. It contains a battery for backup and is powered via the USB port.

#### **3.3. Modifications Incorporated in the EUT**

No modifications were applied to the EUT during testing.

**3.4. Additional Information Related to Testing**

<b>Technology Tested:</b>	WLAN (IEEE 802.11b,g,n) / Digital Transmission System	
<b>Type of Unit:</b>	Transceiver	
<b>Modulation Type:</b>	DBPSK, DQPSK, BPSK, QPSK, 16QAM & 64QAM	
<b>Data Rates:</b>	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
<b>Power Supply Requirement(s):</b>	Nominal	3.8 VDC via 120 VAC 60 Hz adaptor
<b>Channel Spacing:</b>	20 MHz	
<b>Transmit Frequency Range:</b>	2400 MHz to 2483.5 MHz	
<b>Transmit Channels Tested:</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>
	1	2412
	6	2437
	11	2462

**3.5. Support Equipment**

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

<b>Description:</b>	Laptop PC
<b>Brand Name:</b>	Hewlett Packard
<b>Model Name or Number:</b>	Compaq 6910p
<b>Serial Number:</b>	HUB7451SGN

<b>Description:</b>	USB Cable
<b>Brand Name:</b>	Not marked or stated
<b>Model Name or Number:</b>	Not marked or stated
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	Switching Power Supply
<b>Brand Name:</b>	Phihong
<b>Model Name or Number:</b>	PSA05E-050Q
<b>Serial Number:</b>	DE29003034A1

## **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:
  - Highest power and highest power spectral density
    - 802.11b – DQPSK / 5.5 Mbps
    - 802.11g – BPSK / 9 Mbps
    - 802.11n HT20 – 16QAM / MCS3
  - Narrowest bandwidth
    - 802.11b – DBPSK / 1 Mbps
    - 802.11g – BPSK / 6 Mbps
    - 802.11n HT20 – 16QAM / MCS4
  - Widest bandwidth
    - 802.11b – DQPSK / 5.5 Mbps
    - 802.11g – BPSK / 9 Mbps
    - 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 EUT connected to its AC/DC Power Supply and USB cable. The Power supply input was connected to a 120 VAC 60 Hz single phase supply.

**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:	Matthew Galbraith	Test Date:	07 October 2016
Test Sample Serial Number:	MC000170		

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

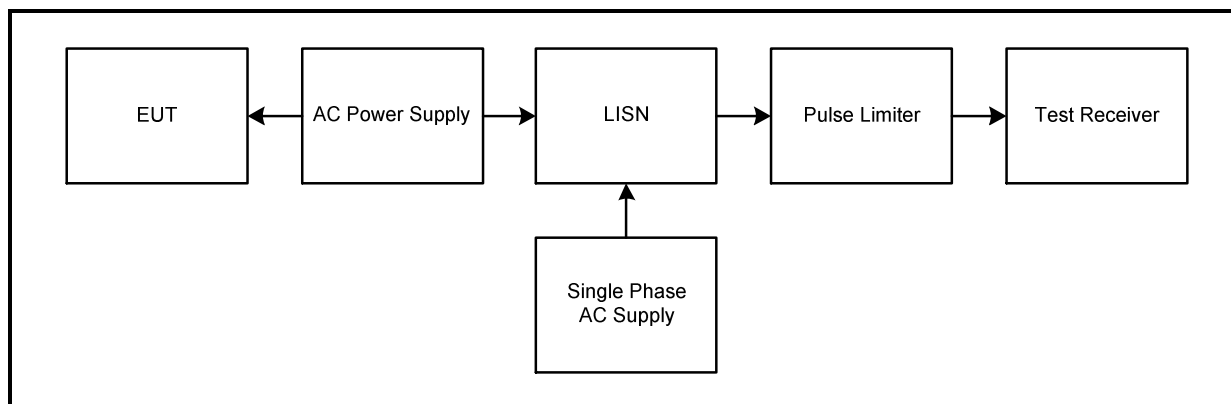
#### Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	43

#### Note(s):

1. The EUT was connected to an AC/DC power supply via USB cable. The AC/DC power supply input was connected to a 120 VAC 60 Hz single phase supply via a LISN.
2. Pre-scans were initially performed on all supported technologies/modes and found to produce identical results. Final measurements were therefore only performed on one test case on frequencies that resulted in the highest live/neutral levels 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
0.190500	Live	47.4	64.0	16.6	Complied
0.235500	Live	44.9	62.3	17.4	Complied
0.289500	Live	38.9	60.5	21.6	Complied
2.566500	Live	34.1	56.0	21.9	Complied
3.588000	Live	36.1	56.0	19.9	Complied
4.434000	Live	36.1	56.0	19.9	Complied

**Results: Live / Average**

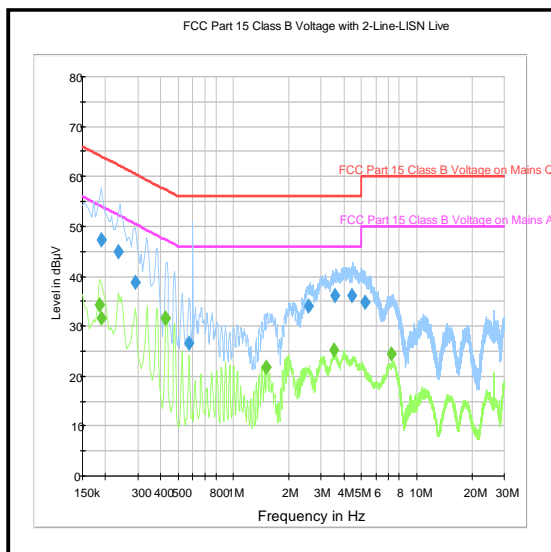
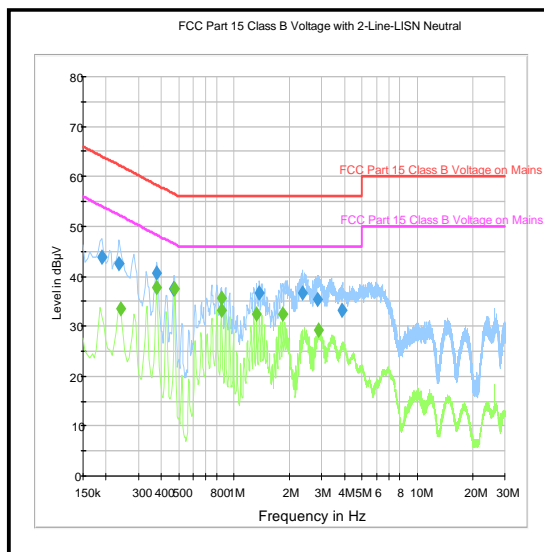
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.186000	Live	34.3	54.2	19.9	Complied
0.190500	Live	31.7	54.0	22.3	Complied
0.424500	Live	31.6	47.4	15.8	Complied
0.424500	Live	31.6	47.4	15.8	Complied
1.513500	Live	21.8	46.0	24.2	Complied
3.507000	Live	25.2	46.0	20.8	Complied

**Results: Neutral / Quasi Peak**

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.190500	Neutral	43.7	64.0	20.3	Complied
0.235500	Neutral	42.6	62.3	19.7	Complied
0.379500	Neutral	40.6	58.3	17.7	Complied
0.469500	Neutral	37.3	56.5	19.2	Complied
1.374000	Neutral	36.6	56.0	19.4	Complied
2.368500	Neutral	36.7	56.0	19.3	Complied

**Results: Neutral / Average**

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.379500	Neutral	37.6	48.3	10.7	Complied
0.474000	Neutral	37.4	46.4	9.0	Complied
0.852000	Neutral	35.6	46.0	10.4	Complied
0.852000	Neutral	33.3	46.0	12.7	Complied
1.324500	Neutral	32.5	46.0	13.5	Complied
1.846500	Neutral	32.5	46.0	13.5	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)
M2015	Thermohygrometer	Testo	608-H1	45046424	10 Jun 2017	12
A649	LISN	Rohde & Schwarz	ESH3-Z5	825562/008	09 Aug 2017	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	08 Mar 2017	12
M1379	Test Receiver	Rohde & Schwarz	ESIB7	100330	15 Dec 2016	12

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

<b>Test Engineer:</b>	Sandeep Bharat	<b>Test Date:</b>	04 October 2016
<b>Test Sample Serial Number:</b>	01001B8D		

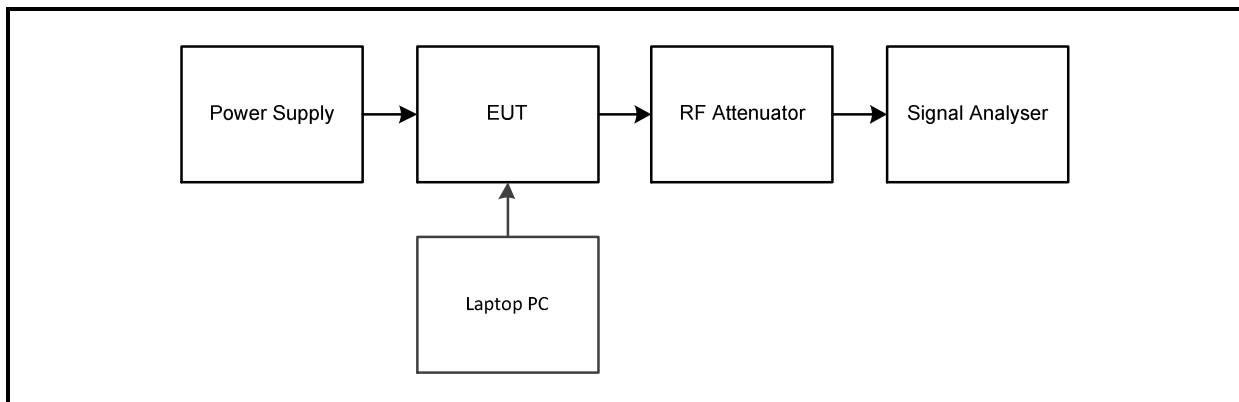
<b>FCC Reference:</b>	Part 15.247(a)(2)
<b>Test Method Used:</b>	FCC KDB 558074 Section 8.1

**Environmental Conditions:**

<b>Temperature (°C):</b>	25
<b>Relative Humidity (%):</b>	42

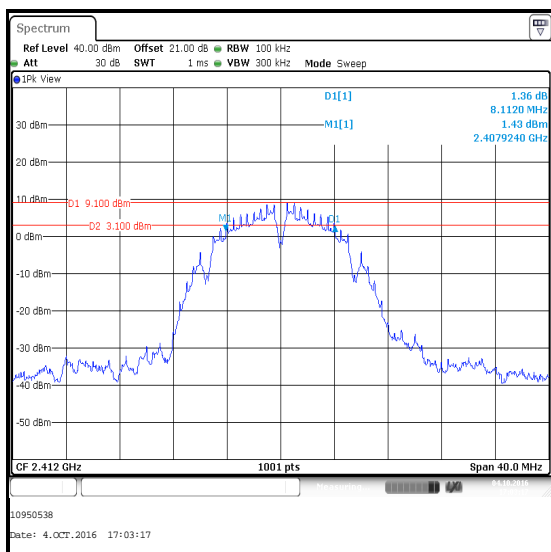
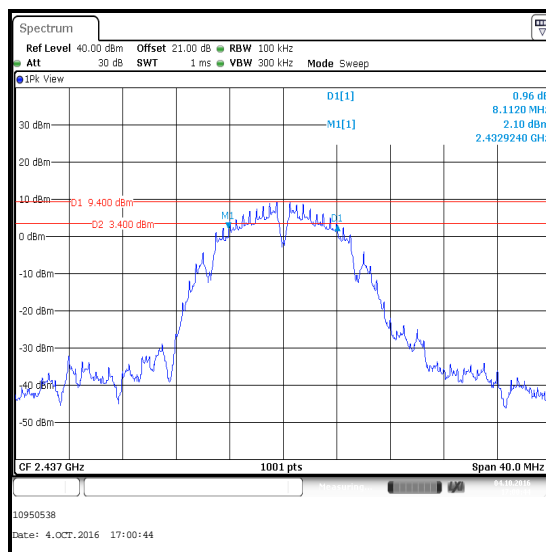
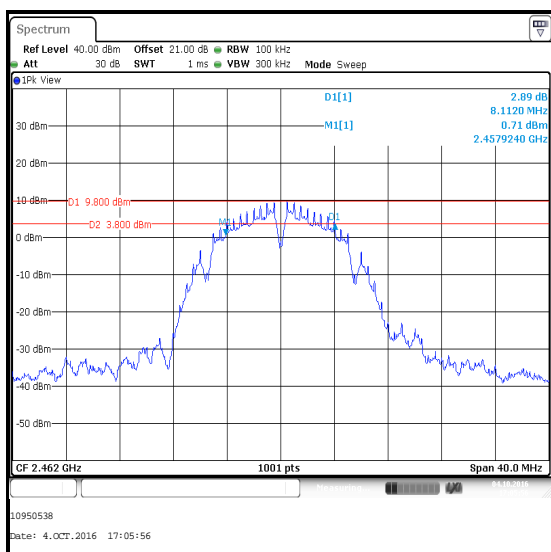
**Note(s):**

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 signal analyser 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 UL VS LTD IT server and available for inspection upon request.
4. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable.

**Test setup:**

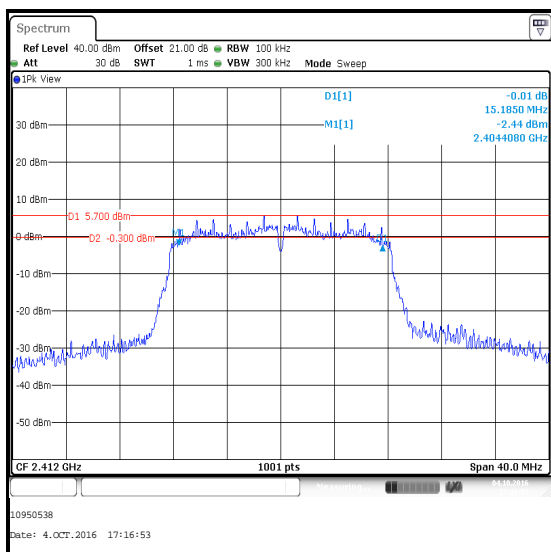
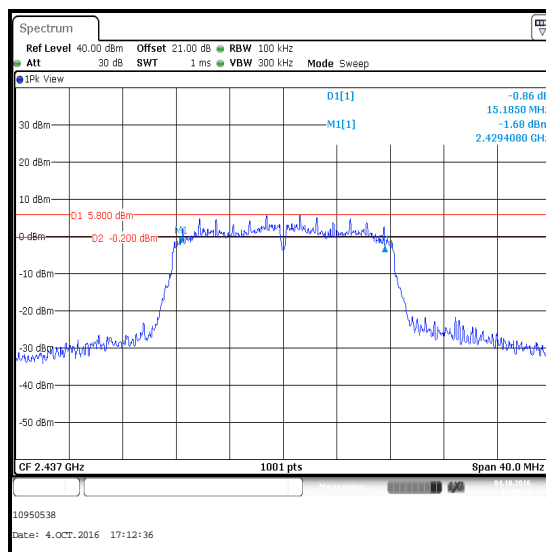
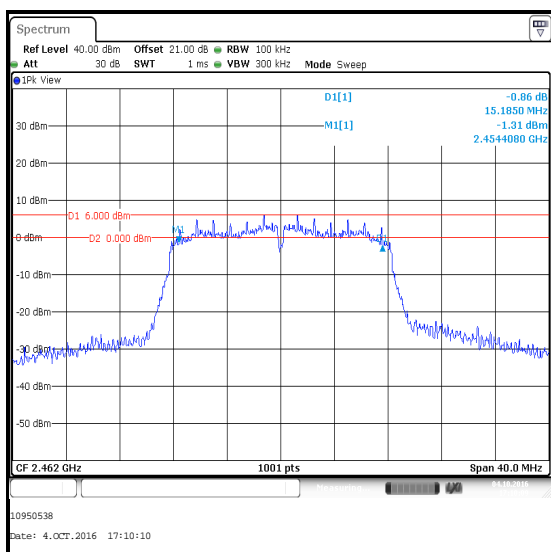
**Transmitter Minimum 6 dB Bandwidth (continued)****Results: 802.11b / DBPSK / 1 Mbps**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	8112.000	≥500	7612.000	Complied
Middle	8112.000	≥500	7612.000	Complied
Top	8112.000	≥500	7612.000	Complied

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

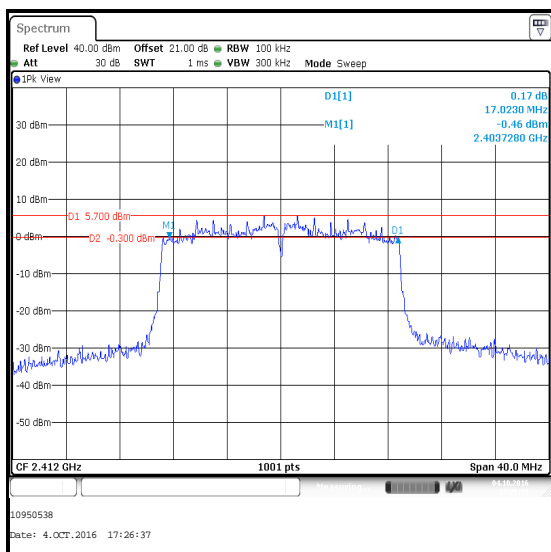
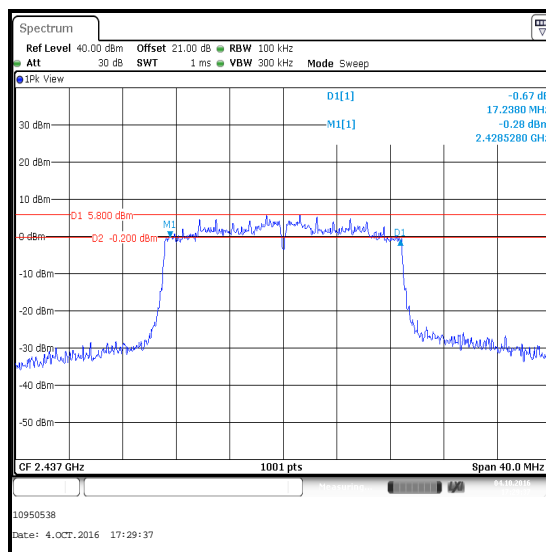
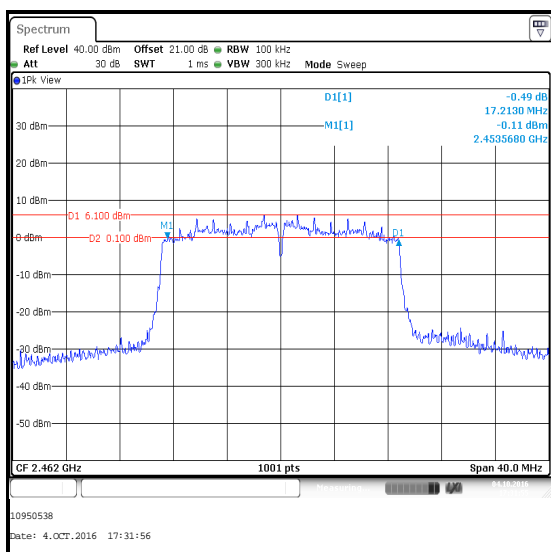
**Transmitter Minimum 6 dB Bandwidth (continued)****Results: 802.11g / BPSK / 6 Mbps**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	15185.000	≥500	14685.000	Complied
Middle	15185.000	≥500	14685.000	Complied
Top	15185.000	≥500	14685.000	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	17023.0	≥500	16523.000	Complied
Middle	17238.0	≥500	16738.000	Complied
Top	17213.0	≥500	16713.000	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)
M2002	Thermohygrometer	Testo	608-H1	45041825	02 Apr 2017	12
A2526	Attenuator	AtlanTecRF	AN18W5-20	832828#1	Calibrated before use	-
M1996	Signal Analyser	Rohde & Schwarz	FSV13	100975	02 Mar 2017	12
G0607	Signal Generator	Rohde & Schwarz	SMU200A	100943	10 May 2019	36
S0537	DC Power Supply	TTI	EL302D	249928	Calibrated before use	-
M1269	Multimeter	Fluke	179	90250210	13 May 2017	12

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

<b>Test Engineer:</b>	Sandeep Bharat	<b>Test Date:</b>	04 October 2016
<b>Test Sample Serial Number:</b>	01001B8D		

<b>FCC Reference:</b>	Part 15.35(c)
<b>Test Method Used:</b>	FCC KDB 558074 Section 6.0

**Environmental Conditions:**

<b>Temperature (°C):</b>	25
<b>Relative Humidity (%):</b>	42

**Note(s):**

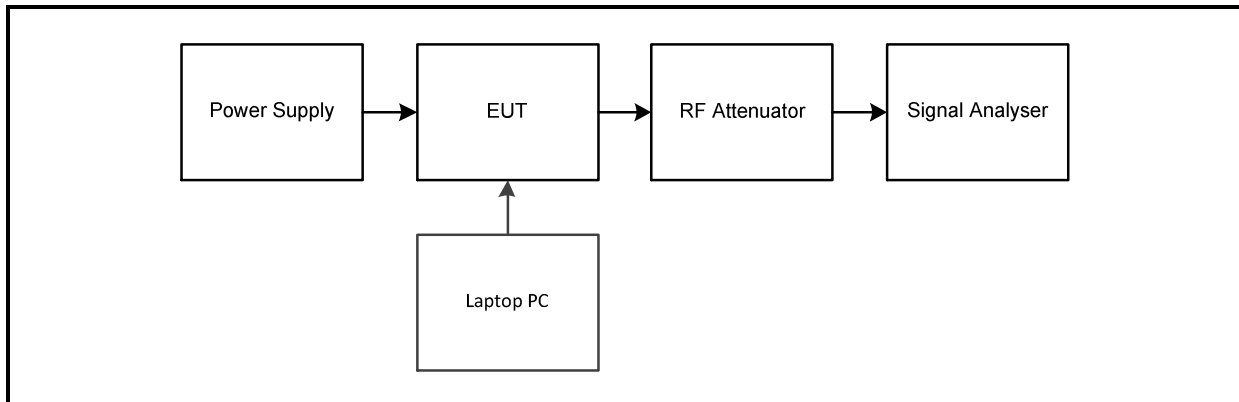
1. In order to assist with the determination of the average level of fundamental and spurious emissions field strength, measurements were made of duty cycle to determine the transmission duration and the silent period time of the transmitter. The transmitter duty cycle was measured using a signal analyser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

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

$$802.11b / 5.5 \text{ Mbps duty cycle } 10 \log (1 / (1.590 \text{ ms} / 1.695 \text{ ms})) = 0.3 \text{ dB}$$

$$802.11g / 9 \text{ Mbps duty cycle: } 10 \log (1 / (944.0 \mu\text{s} / 1043.0 \mu\text{s})) = 0.5 \text{ dB}$$

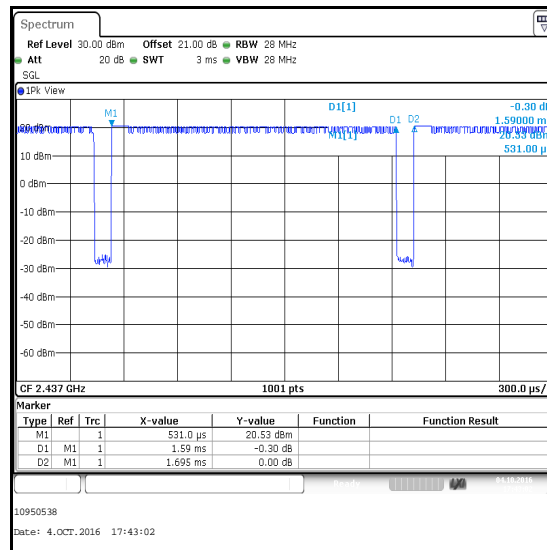
$$802.11n / HT20 / MCS3 \text{ duty cycle: } 10 \log (1 / (324.0 \mu\text{s} / 423.0 \mu\text{s})) = 1.2 \text{ dB}$$

**Test setup:**

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

Pulse Duration (ms)	Duty Cycle (dB)
1.590	0.3

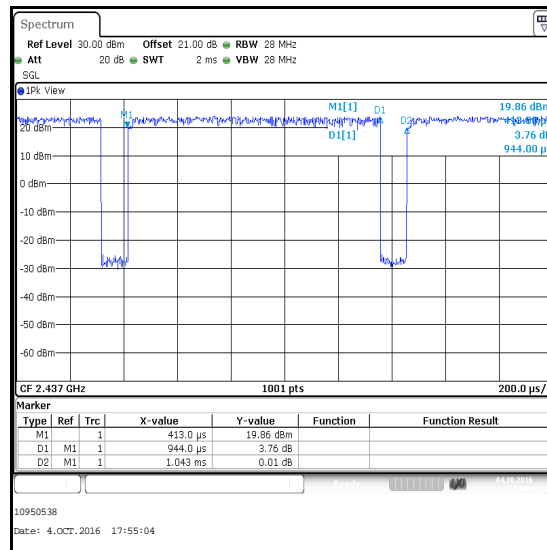
Period (ms)
1.695

**Pulse Duration & Period**

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

Pulse Duration ( $\mu$ s)	Duty Cycle (dB)
944.0	0.5

Period ( $\mu$ s)
1043.0

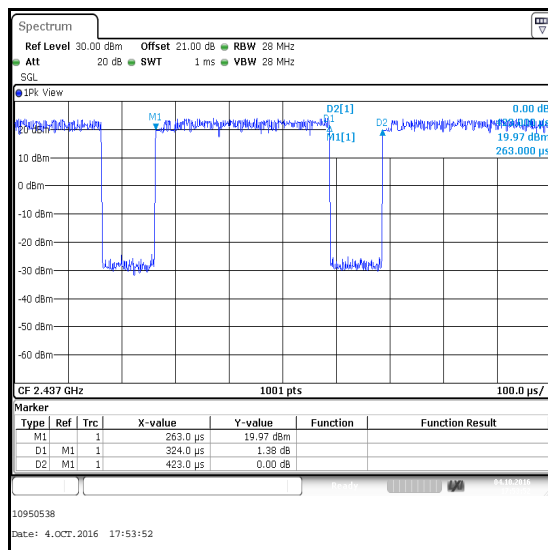
**Pulse Duration & Period**

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

Pulse Duration ( $\mu$ s)	Duty Cycle (dB)
324.0	1.2

Period ( $\mu$ s)
423.0

**Pulse Duration & Period****Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2002	Thermohygrometer	Testo	608-H1	45041825	02 Apr 2017	12
A2526	Attenuator	AtlanTecRF	AN18W5-20	832828#1	Calibrated before use	-
M1996	Signal Analyser	Rohde & Schwarz	FSV13	100975	02 Mar 2017	12
G0607	Signal Generator	Rohde & Schwarz	SMU200A	100943	10 May 2019	36
S0537	DC Power Supply	TTI	EL302D	249928	Calibrated before use	-
M1269	Multimeter	Fluke	179	90250210	13 May 2017	12

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

<b>Test Engineer:</b>	Keith Tucker	<b>Test Date:</b>	03 February 2016
<b>Test Sample Serial Number:</b>	0100174A		

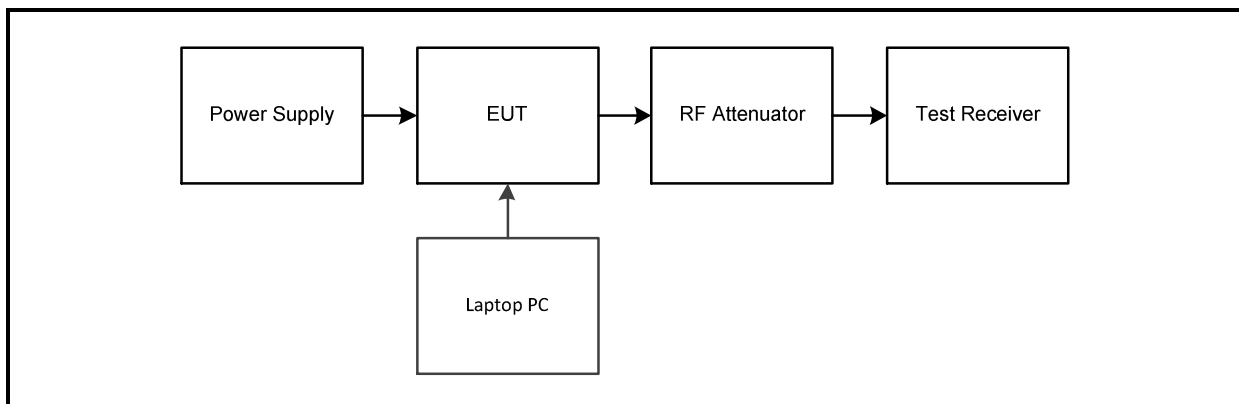
<b>FCC Reference:</b>	Part 15.247(e)
<b>Test Method Used:</b>	FCC KDB 558074 Section 10.6

**Environmental Conditions:**

<b>Temperature (°C):</b>	27
<b>Relative Humidity (%):</b>	27

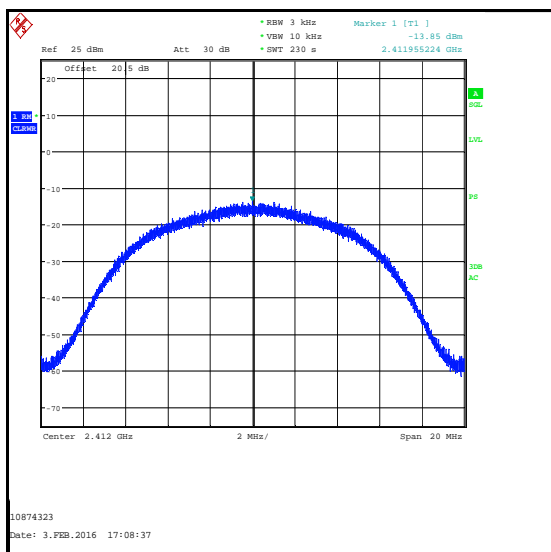
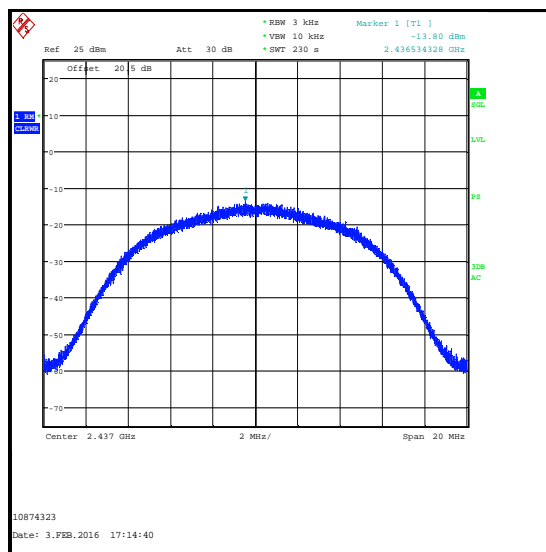
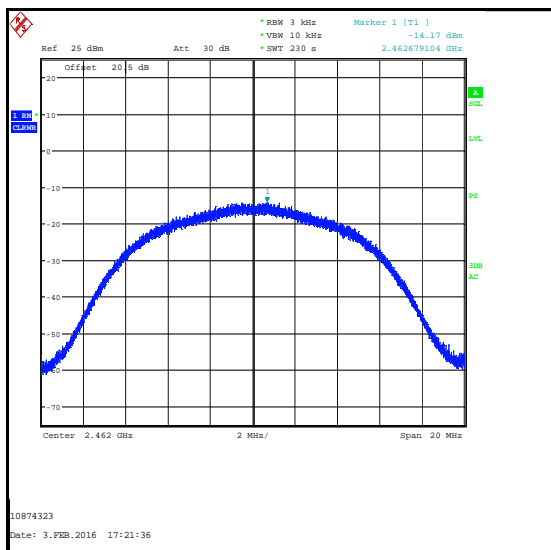
**Note(s):**

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:**

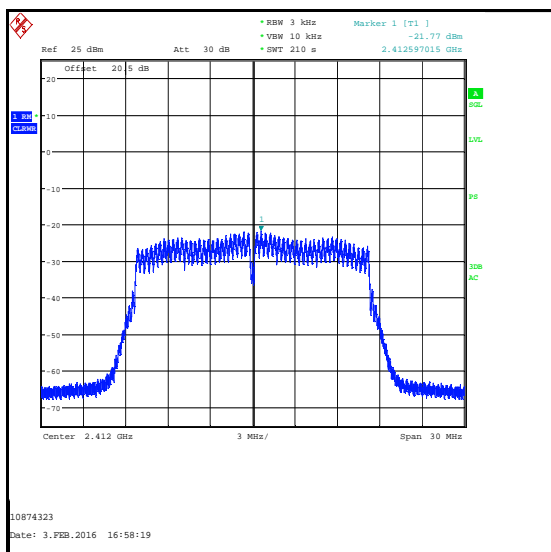
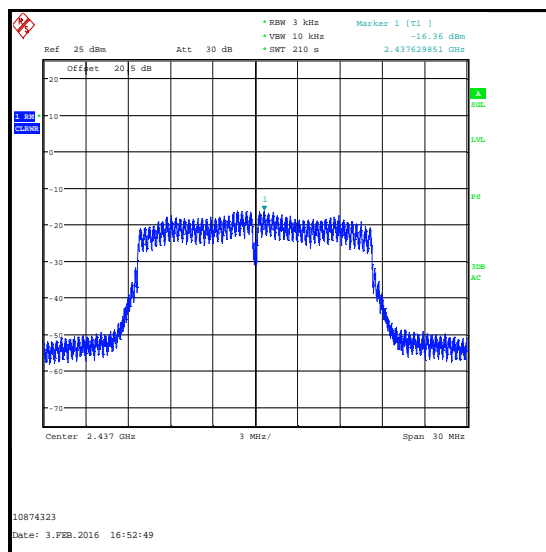
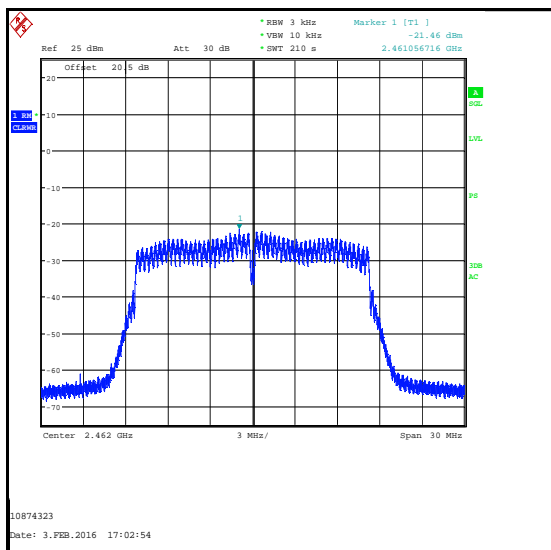
**Transmitter Power Spectral Density (continued)****Results: 802.11b / DQPSK / 5.5 Mbps**

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

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

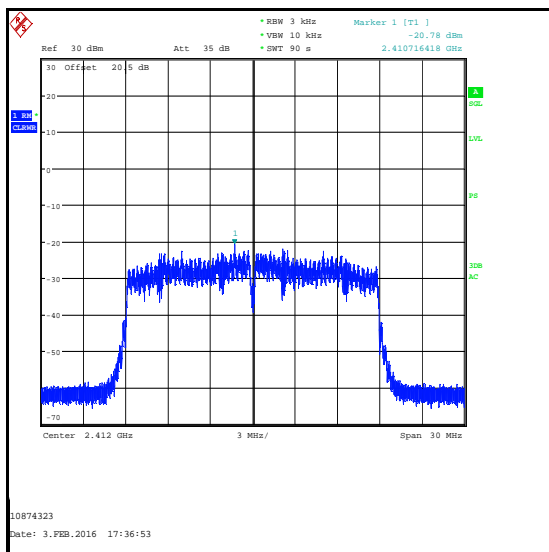
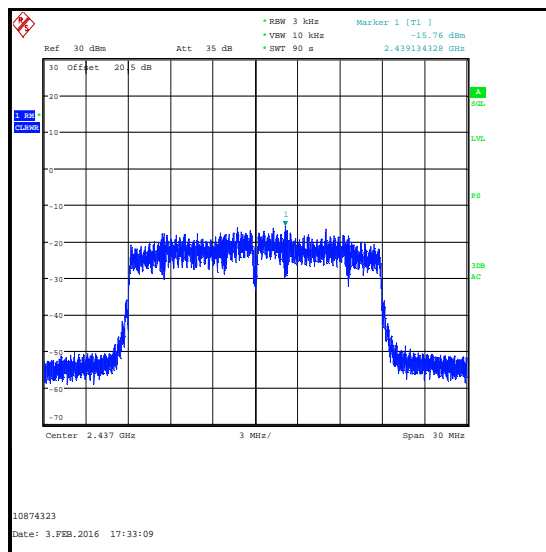
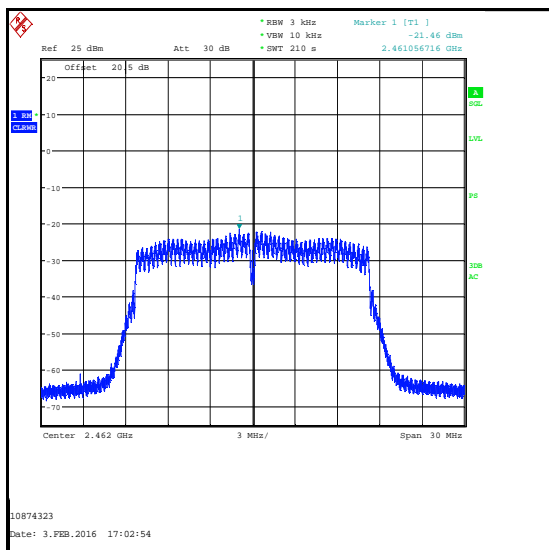
**Transmitter Power Spectral Density (continued)****Results: 802.11g / BPSK / 9 Mbps**

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:**

<b>Test Engineer:</b>	Keith Tucker	<b>Test Date:</b>	03 February 2016
<b>Test Sample Serial Number:</b>	0100174A		

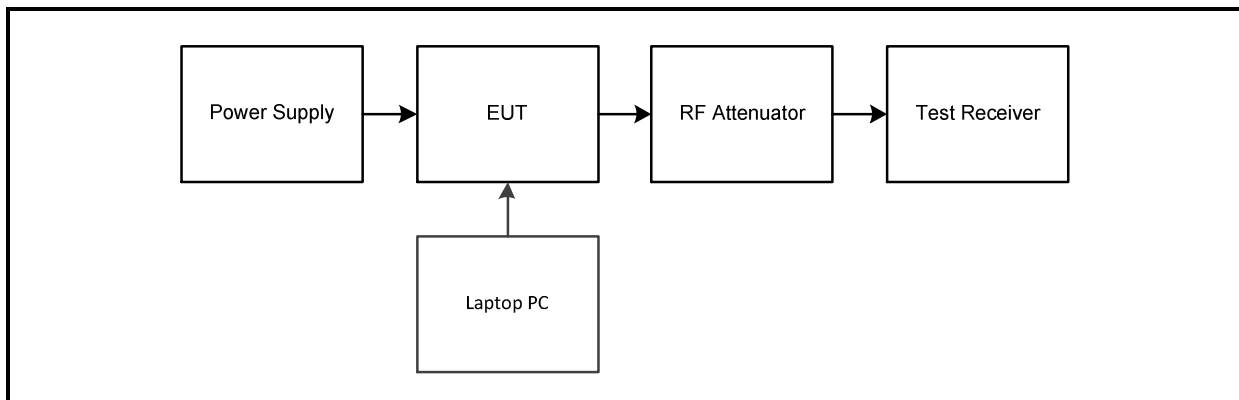
<b>FCC Reference:</b>	Part 15.247(b)(3)
<b>Test Method Used:</b>	FCC KDB 558074 Section 9.2.2.5

**Environmental Conditions:**

<b>Temperature (°C):</b>	27
<b>Relative Humidity (%):</b>	27

**Note(s):**

- 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:
  - 802.11b – DQPSK / 5.5 Mbps
  - 802.11g – BPSK / 9 Mbps
  - 802.11n HT20 – 16QAM / MCS3
- 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.
- 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 duty cycle calculated in Section 5.2.3 of this test report was added to the measured power in order to compute the average power during the actual transmission time.
- 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.

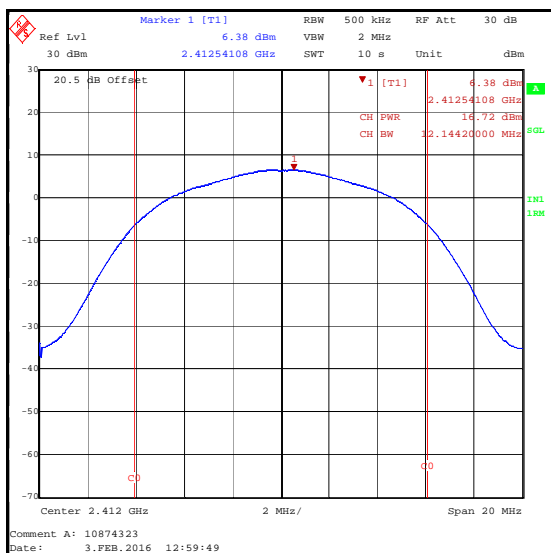
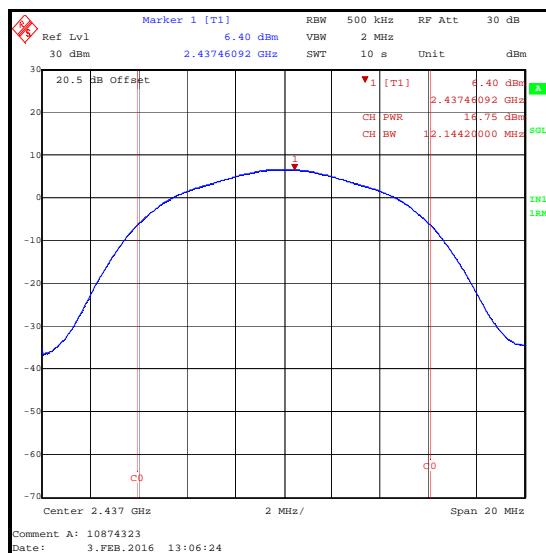
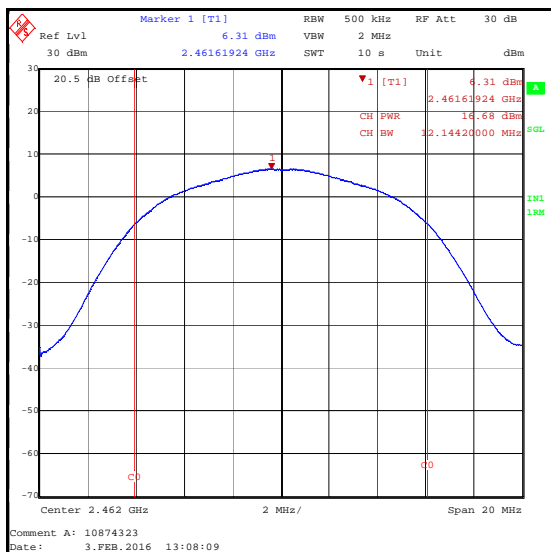
**Test setup:**

**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	2.0	19.0	36.0	17.0	Complied
Middle	17.1	2.0	19.1	36.0	16.9	Complied
Top	17.0	2.0	19.0	36.0	17.0	Complied

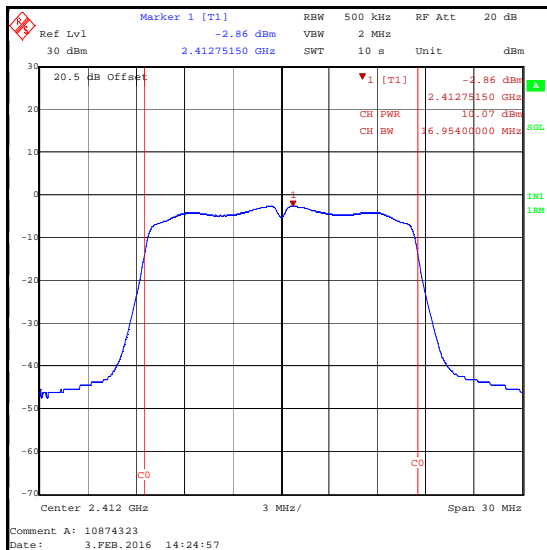
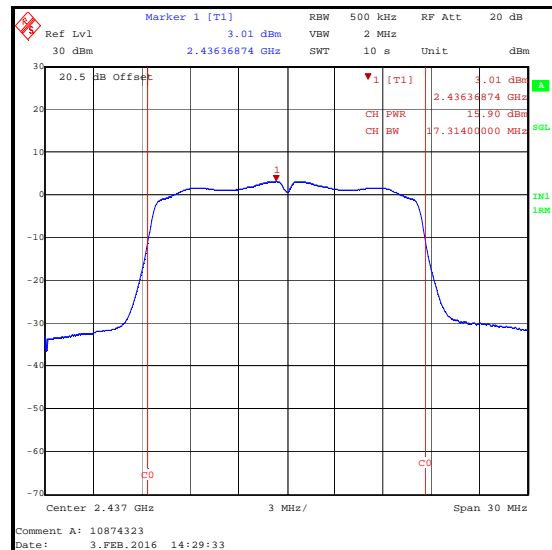
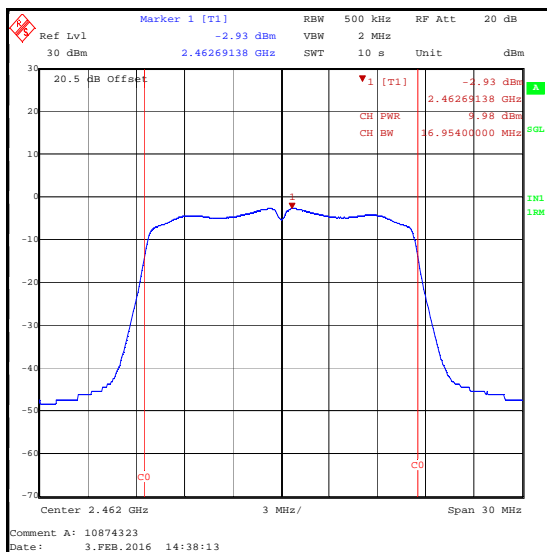
**Transmitter Maximum (Average) Output Power (continued)****Results: 802.11b / DQPSK / 5.5 Mbps****Bottom Channel****Middle Channel****Top Channel**

**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	2.0	12.6	36.0	23.4	Complied
Middle	16.4	2.0	18.4	36.0	17.6	Complied
Top	10.5	2.0	12.5	36.0	23.5	Complied

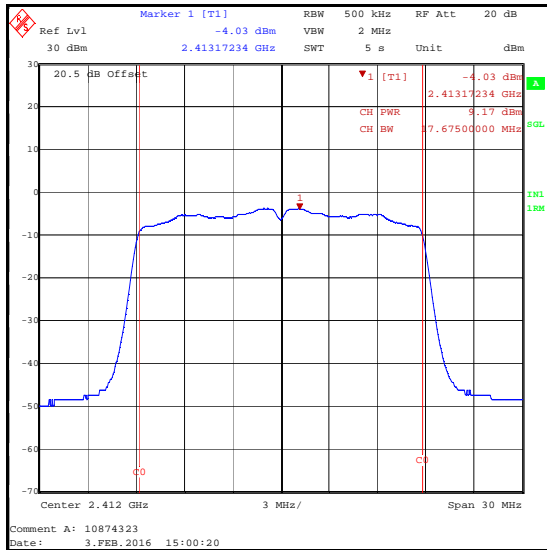
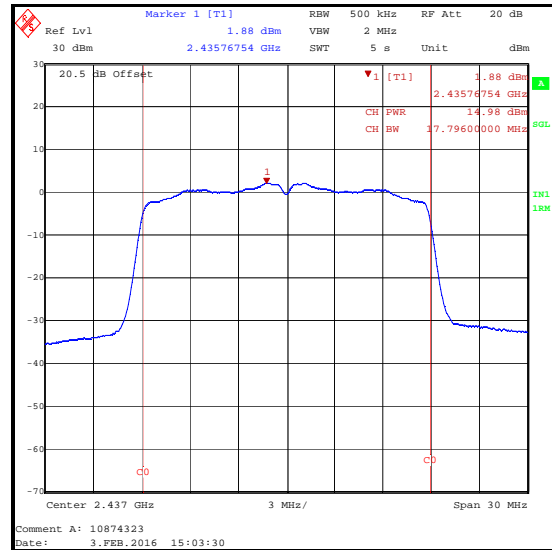
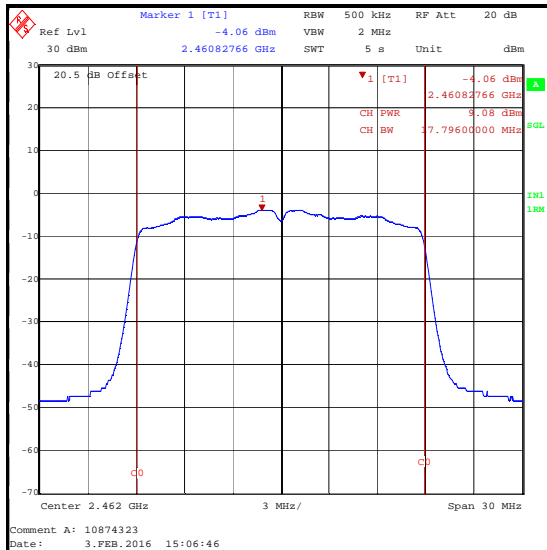
**Transmitter Maximum (Average) Output Power (continued)****Results: 802.11g / BPSK / 9 Mbps****Bottom Channel****Middle Channel****Top Channel**

**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	2.0	12.4	36.0	23.6	Complied
Middle	16.2	2.0	18.2	36.0	17.8	Complied
Top	10.3	2.0	12.3	36.0	23.7	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:**

<b>Test Engineer:</b>	Nick Steele	<b>Test Date:</b>	10 March 2016
<b>Test Sample Serial Number:</b>	02001-0354		

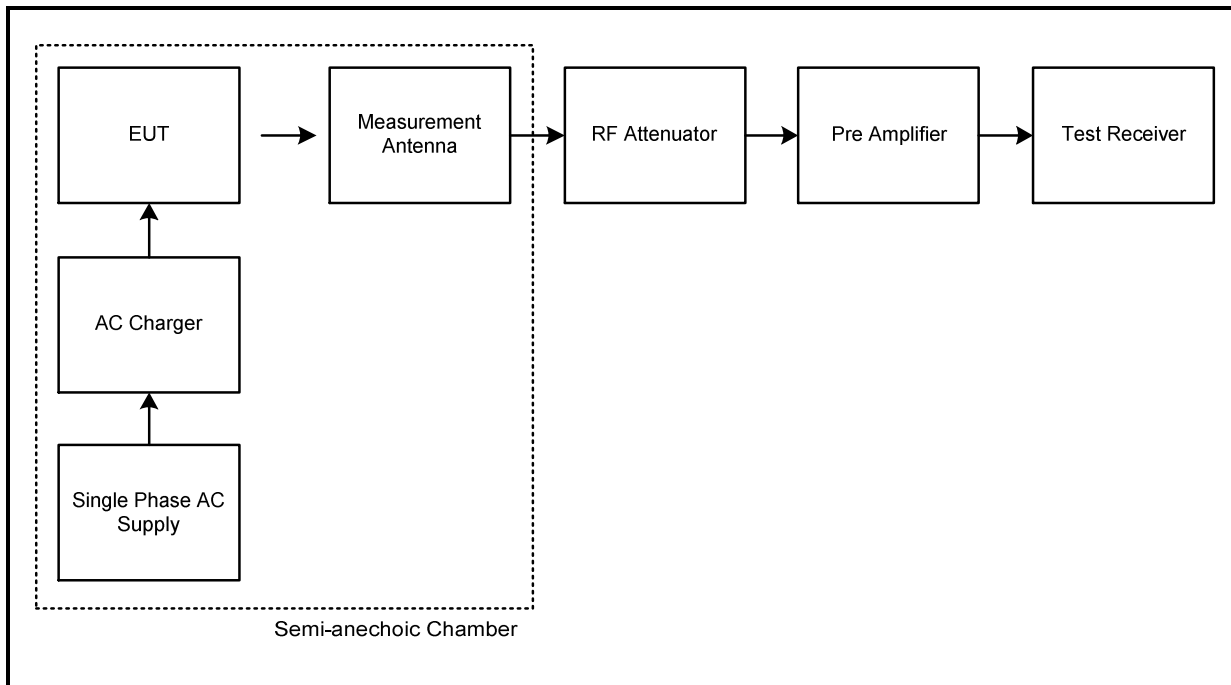
<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	ANSI C63.10 Sections 6.3 and 6.5
<b>Frequency Range</b>	30 MHz to 1000 MHz

**Environmental Conditions:**

<b>Temperature (°C):</b>	24
<b>Relative Humidity (%):</b>	31

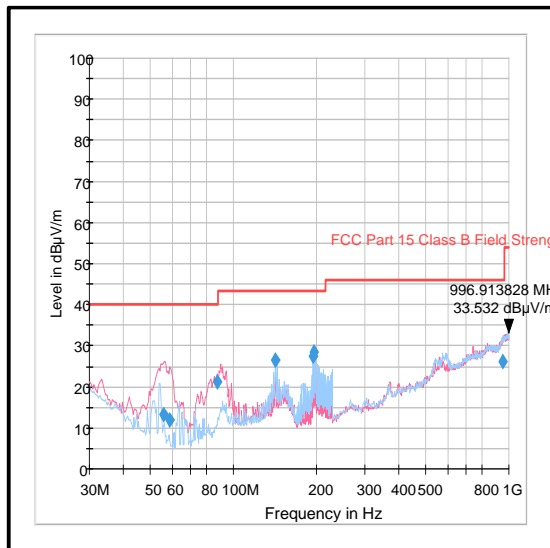
**Note(s):**

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 emissions shown on the pre-scan plot were investigated and found to be ambient or >20 dB below the applicable limit or below the measurement system noise floor. Therefore the highest level of noise floor has been recorded.
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.

**Transmitter Radiated Emissions (continued)****Test setup for radiated measurements: Semi-anechoic chamber**

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

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
996.913	Horizontal	33.5	54.0	20.5	Complied

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1627	Thermohygrometer	JM Handelspunkt	30.5015.10	Not stated	11 Jan 2017	12
K0001	5 m RSE Chamber	Rainford EMC	N/A	N/A	19 Mar 2016	12
M1273	Test Receiver	Rohde & Schwarz	ESIB26	100275	19 Mar 2016	12
A259	Antenna	Chase	CBL6111A	1513	09 Apr 2016	12
G0543	Amplifier	Sonoma	310N	230801	28 Feb 2017	12
A1834	Attenuator	Hewlett Packard	8491B	10444	28 Feb 2017	12

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

<b>Test Engineer:</b>	David Doyle	<b>Test Date:</b>	15 February 2016
<b>Test Sample Serial Number:</b>	02001-0354		

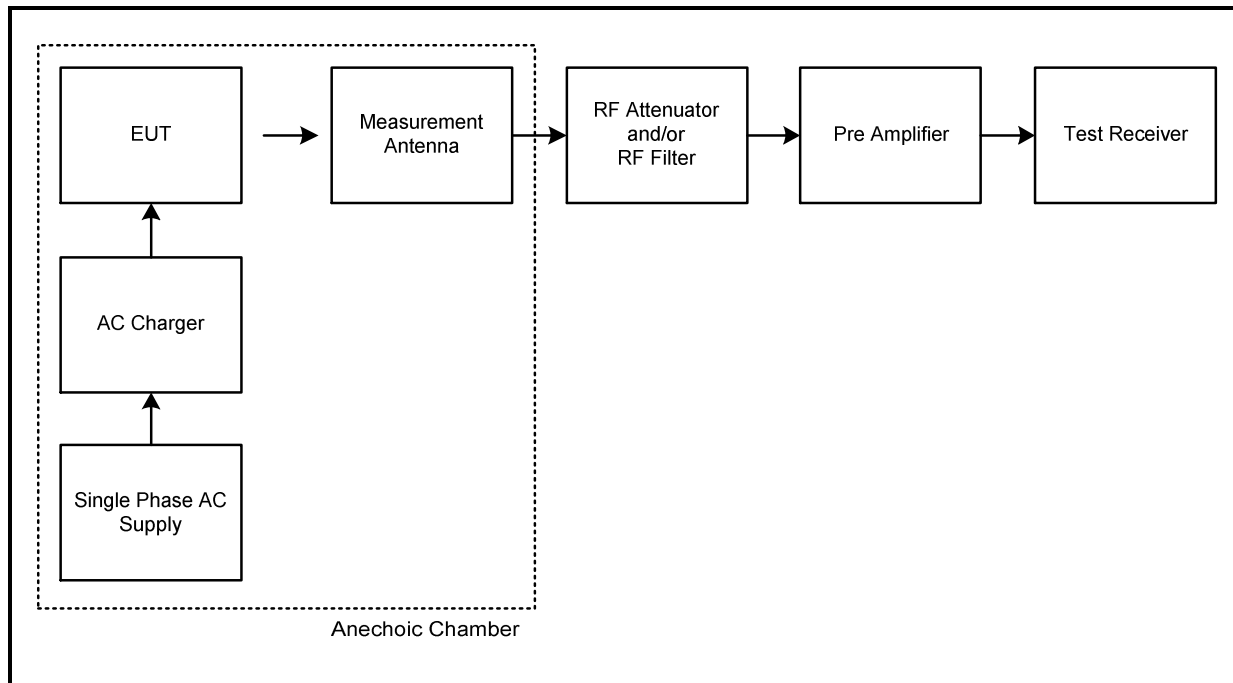
<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	ANSI C63.10 Sections 6.3 and 6.6
<b>Frequency Range</b>	1 GHz to 25 GHz

**Environmental Conditions:**

<b>Temperature (°C):</b>	22
<b>Relative Humidity (%):</b>	32

**Note(s):**

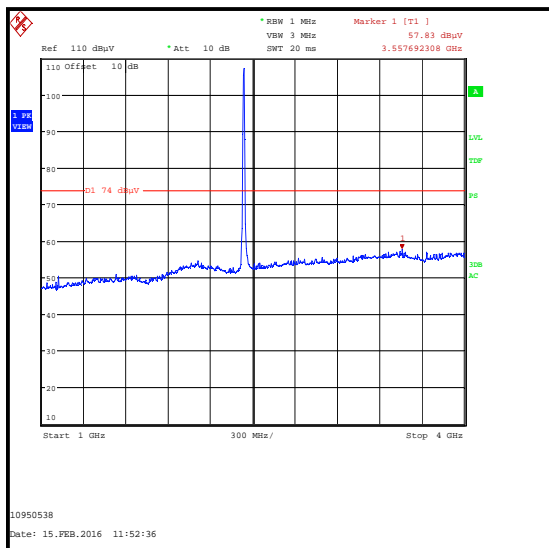
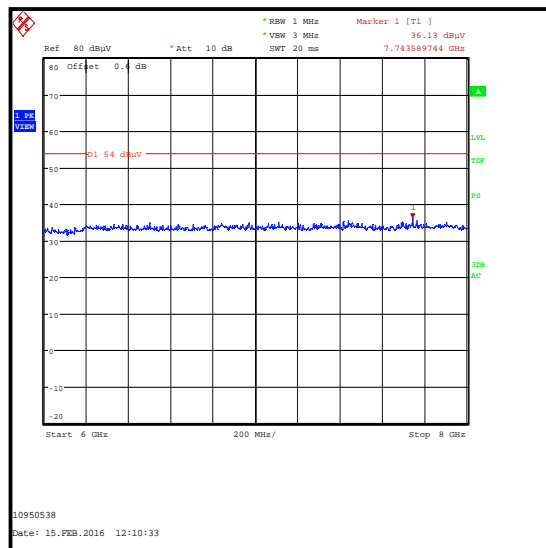
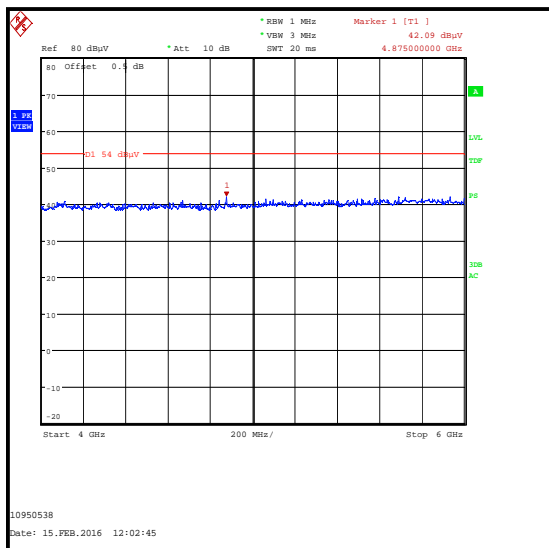
1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. No spurious emissions were detected above the noise floor of the measuring receiver therefore the highest peak and average noise floor readings of the measuring receiver 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.

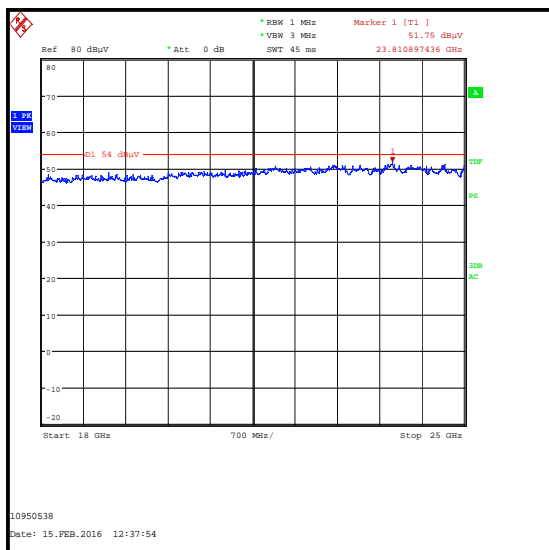
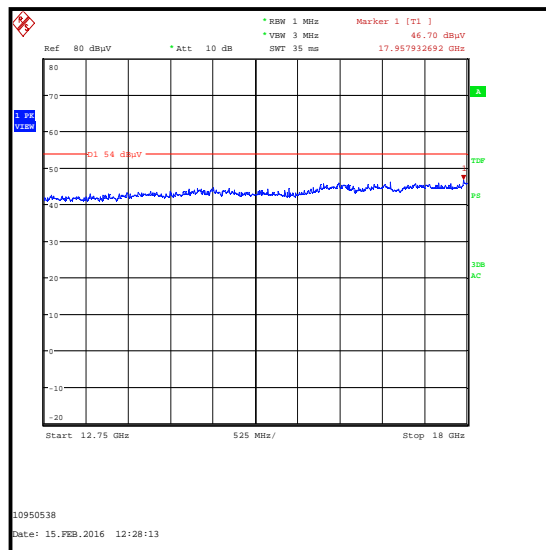
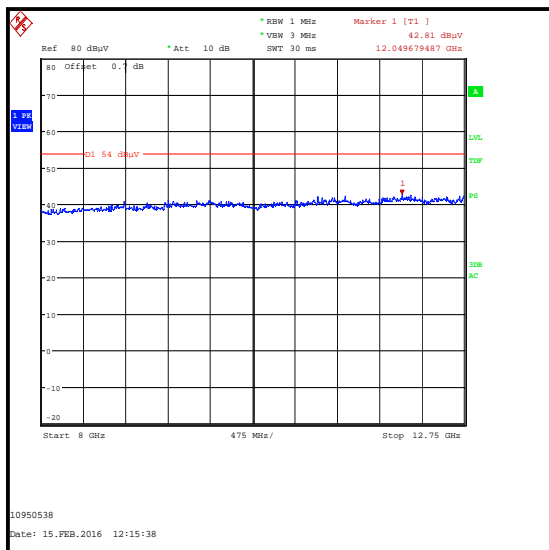
**Transmitter Radiated Emissions (continued)****Test setup for radiated measurements: Anechoic chamber****Results: Peak**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
3557.692	Horizontal	57.8	74.0	16.2	Complied

**Results: Average**

Frequency (MHz)	Antenna Polarity	Average Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
3990.385	Horizontal	46.9	54.0	7.1	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	21 Dec 2016	12
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	21 May 2016	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	19 Dec 2016	12
A1818	Antenna	EMCO	3115	00075692	17 Dec 2016	12
A253	Antenna	Flann Microwave	12240-20	128	17 Dec 2016	12
A254	Antenna	Flann Microwave	14240-20	139	17 Dec 2016	12
A255	Antenna	Flann Microwave	16240-20	519	17 Dec 2016	12
A256	Antenna	Flann Microwave	18240-20	400	17 Dec 2016	12
A436	Antenna	Flann Microwave	20240-20	330	19 Dec 2016	12
A1396	Attenuator	Huber & Suhner	6810.17.B	757987	05 May 2016	12
A1975	High Pass Filter	AtlanTecRF	AFH-03000	090424010	17 Apr 2016	12

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

<b>Test Engineer:</b>	David Doyle	<b>Test Date:</b>	15 February 2016
<b>Test Sample Serial Number:</b>	02001-0354		

<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	ANSI C63.10 Section 6.10 & FCC KDB 558074 Section 11 & 13.3.2

**Environmental Conditions:**

<b>Temperature (°C):</b>	22
<b>Relative Humidity (%):</b>	32

**Note(s):**

1. All configurations supported by the EUT had been previously investigated on one channel. The data rates that produced the highest power and widest bandwidth were therefore deemed worst case :

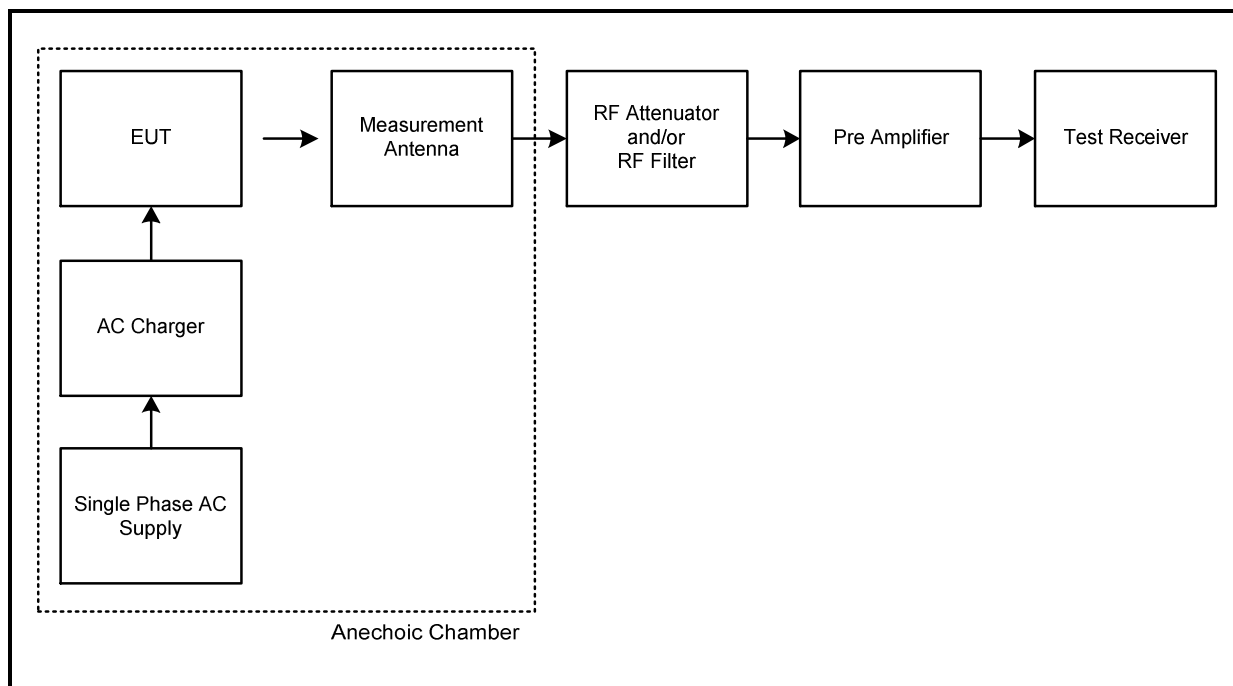
- Highest power and widest bandwidth:
  - 802.11b – DQPSK / 5.5 Mbps
  - 802.11g – BPSK / 9 Mbps
  - 802.11n HT20 – 16QAM / 28.9 Mbps / MCS3

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. The maximum conducted (average) output power was previously measured. In accordance with FCC KDB 558074 Section 11.1(b), the lower band edge measurement should be performed with a peak detector and the -30 dBc limit applied.
4. 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 9.2.2.4 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.
5. 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. A 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.

**Transmitter Radiated Emissions (continued)****Note(s):**

6. 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.
7. \*In accordance with ANSI C63.10 Section 6.6.4.3, Note 1, if the peak measured value complies with the average limit, it is unnecessary to perform an average measurement.

**Test setup for radiated measurements:Anechoic chamber**

**Transmitter Band Edge Radiated Emissions (continued)****Results: Peak / 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	51.5	66.0	14.5	Complied
2400	48.5	66.0	17.5	Complied

**Results: Upper Band Edge / Restricted Band / Peak**

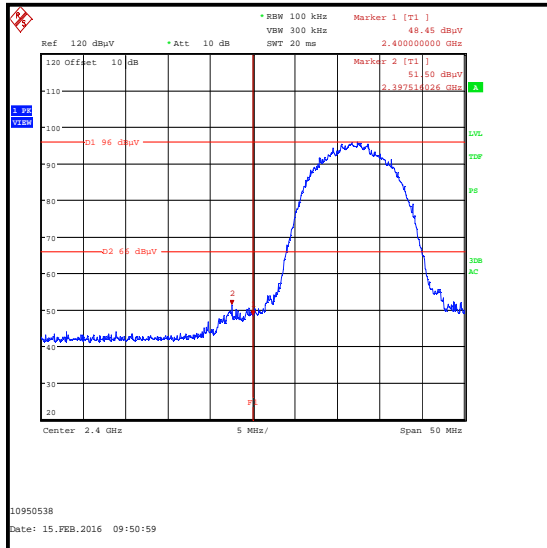
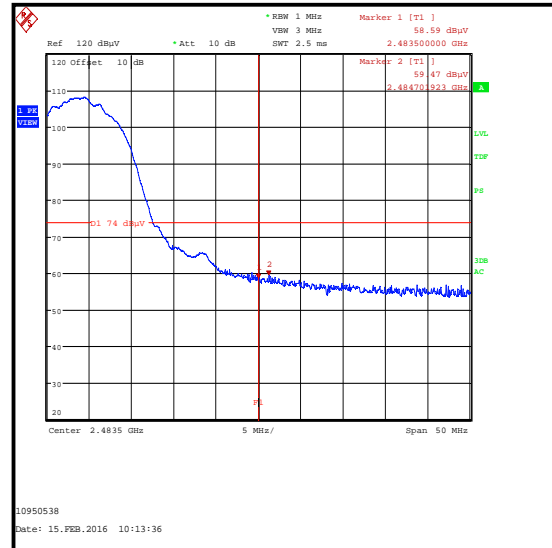
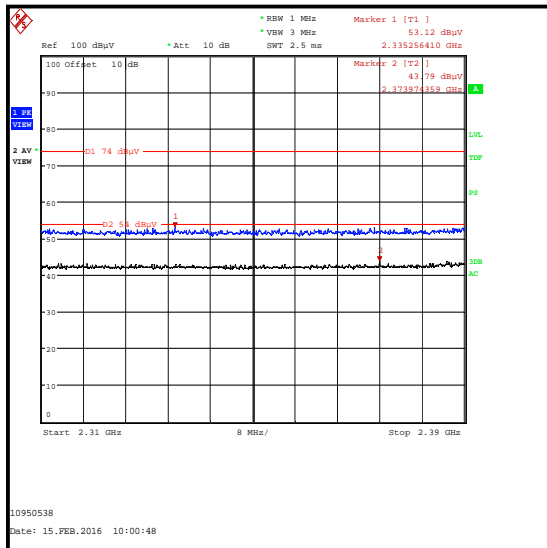
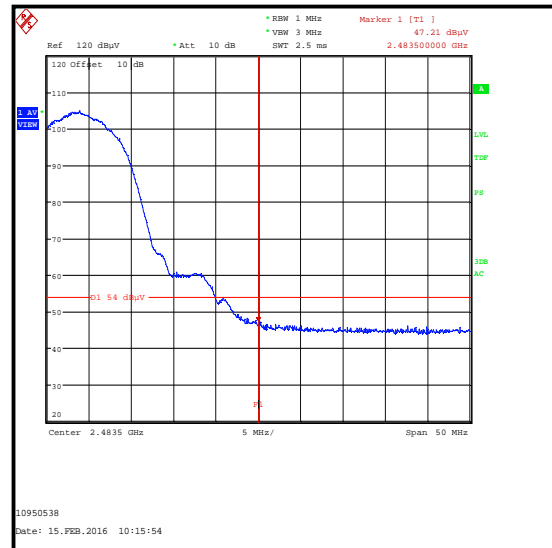
Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
2335.256	53.1	74.0	20.9	Complied
2483.5	58.6	74.0	15.4	Complied
2484.702	59.5	74.0	14.5	Complied

**Results: Upper Band Edge / Restricted Band / Average**

Frequency (MHz)	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
2373.974	43.8	54.0	10.2	Complied
2483.5	47.2	54.0	6.8	Complied

**Results: 2310 to 2390 MHz Restricted Band**

Frequency (MHz)	Peak Level (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)	Result
2335.256	53.1*	54.0	0.9	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: Peak / 802.11g / BPSK / 9 Mbps****Results: Lower Band Edge**

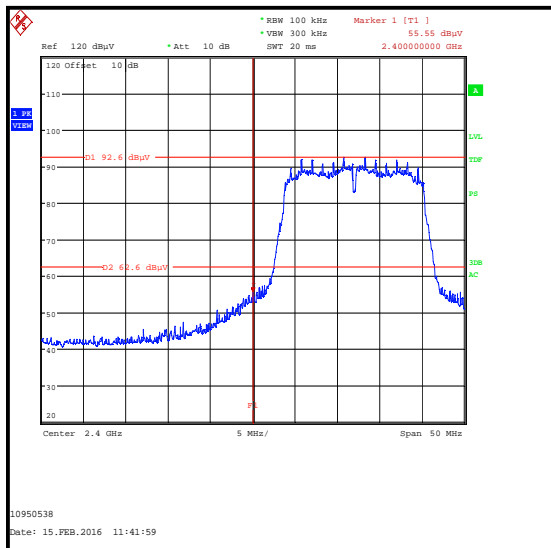
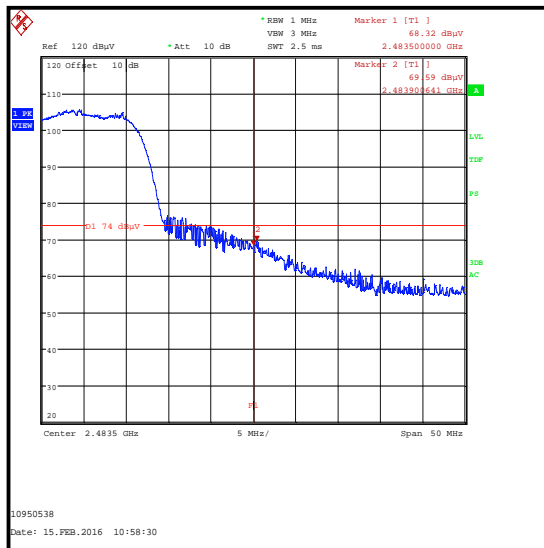
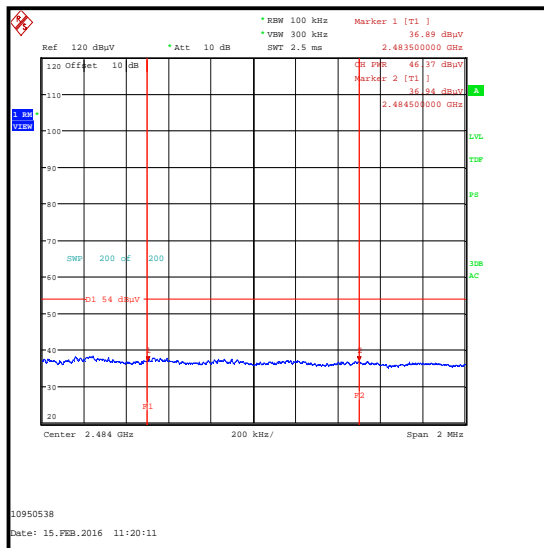
Frequency (MHz)	Level (dB $\mu$ V/m)	-30 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
2400	55.6	62.6	7.0	Complied

**Results: Upper Band Edge / Restricted Band / Peak**

Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	64.9	74.0	9.1	Complied
2483.901	69.6	74.0	4.4	Complied

**Results: Upper Band Edge / Restricted Band / Average**

Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	46.4	54.0	7.6	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: Peak / 802.11n HT20 / 16QAM / MCS3****Results: Lower Band Edge**

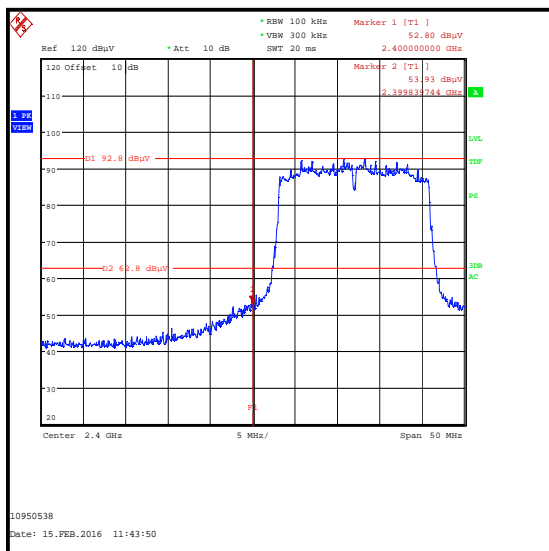
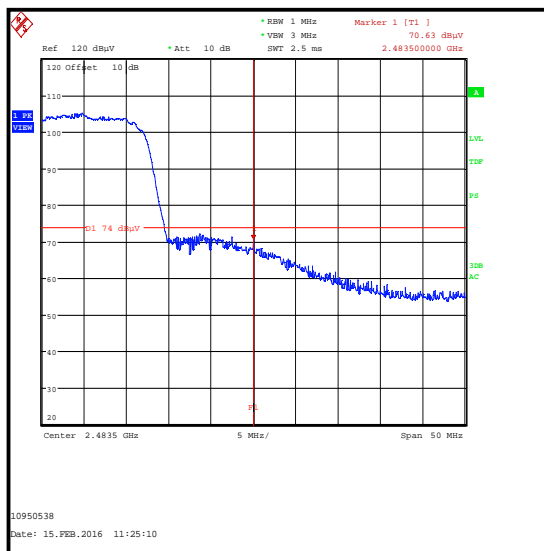
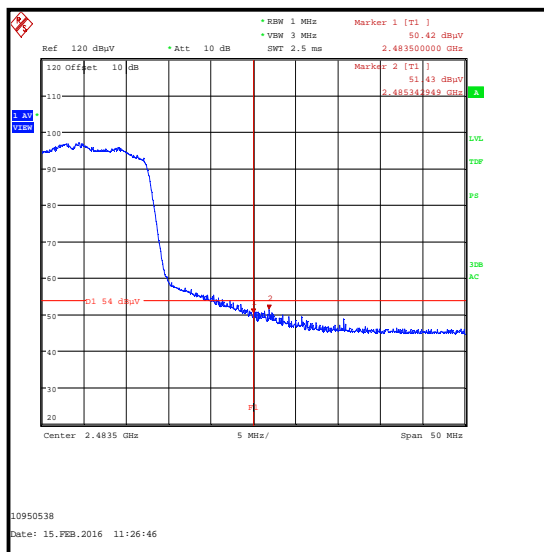
Frequency (MHz)	Level (dB $\mu$ V/m)	-30 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
2399.840	53.9	62.8	8.9	Complied
2400	52.8	62.8	10.0	Complied

**Results: Upper Band Edge / Restricted Band / Peak**

Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	70.6	74.0	3.4	Complied

**Results: Upper Band Edge / Restricted Band / Average**

Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.5	50.4	54.0	3.6	Complied
2485.343	51.4	54.0	2.6	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**

**Transmitter Band Edge 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	12 Jan 2017	12
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	21 May 2016	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	19 Dec 2016	12
A1818	Antenna	EMCO	3115	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	53	-	Corrected calibration due date for Asset No. A1534

--- END OF REPORT ---