



# TEST REPORT

**Test Report No. : UL-RPT-RP10895526JD04A V3.0**

**Manufacturer** : Bang & Olufsen a/s  
**Model No.** : WUS-AC08V  
**FCC ID** : TTUWUSAC08V  
**Technology** : WLAN  
**Test Standard(s)** : FCC Parts 15.209(a) & 15.247(d)

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 3.0 supersedes all previous versions.

**Date of Issue:** 19 December 2016

**Checked by:**

Sarah Williams  
Sarah Williams  
Engineer, Radio Laboratory

**Company Signatory:**

I. M. Watch  
Ian Watch  
Senior Engineer, 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.

---

## **UL VS LTD**

Pavilion A, Ashwood Park, Ashwood Way, Basingstoke, Hampshire, RG23 8BG, UK  
Telephone: +44 (0)1256 312000  
Facsimile: +44 (0)1256 312001

This page has been left intentionally blank.

**Table of Contents**

<b>01. 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	5
2.4. Deviations from the Test Specification	5
<b>3. Equipment Under Test (EUT) .....</b>	<b>6</b>
3.1. Identification of Equipment Under Test (EUT)	6
3.2. Description of EUT	6
3.3. Modifications Incorporated in the EUT	6
3.4. Additional Information Related to Testing	7
3.5. Support Equipment	8
<b>4. Operation and Monitoring of the EUT during Testing .....</b>	<b>11</b>
4.1. Operating Modes	11
4.2. Configuration and Peripherals	11
4.3. Power Settings	12
<b>5. Measurements, Examinations and Derived Results.....</b>	<b>13</b>
5.1. General Comments	13
5.2. Test Results	14
5.2.1. Transmitter Radiated Emissions	14
5.2.2. Transmitter Band Edge Radiated Emissions	22
<b>6. Measurement Uncertainty .....</b>	<b>42</b>
<b>7. Report Revision History .....</b>	<b>43</b>

## **1. Customer Information**

<b>Company Name:</b>	Bang & Olufsen A/S
<b>Address:</b>	Peter Bangs Vej 15 7600 Struer Denmark

## 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>	47CFR15.209
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Section 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>	16 March 2016 to 01 April 2016

### 2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
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		

### 2.3. Methods and Procedures

<b>Reference:</b>	ANSI C63.10-2013
<b>Title:</b>	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
<b>Reference:</b>	KDB 558074 D01 DTS Meas Guidance v03r05 April 8, 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>	WUS-AC08V
<b>Model Name or Number:</b>	WUS-AC08V
<b>Test Sample MAC address:</b>	542AA22F8F19 ( <i>Conducted sample</i> )
<b>Hardware Version:</b>	A1G
<b>Software Version:</b>	4.2.3.5
<b>FCC ID:</b>	TTUWUSAC08V

#### **3.1.1 Host Product Details**

<b>Brand Name:</b>	BeoVision 14-40
<b>Model Name or Number:</b>	BeoVision 14-40
<b>Test Sample Serial Number:</b>	92804 ( <i>Radiated sample</i> )
<b>Hardware Version:</b>	8009004
<b>Software Version:</b>	7.77

<b>Description:</b>	AC power 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

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

The equipment under test was a *Bluetooth Basic Rate + EDR*, *Bluetooth Low Energy*, IEEE 802.11a,b,g,n,ac WLAN module operating in the 2.4 GHz and 5 GHz bands, which was incorporated into a 40" Television. The EUT has two external antenna ports with two transmit chains and MIMO is supported. For 802.11a/g/n/ac operation the device uses two by two MIMO transmitters. Depending on the 802.11 data rate, the device transmits 1 or 2 spatial stream. The device uses spatial multiplexing and from an RF point of view the streams are correlated.

#### **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 (SISO)	1, 2, 5.5 & 11 Mbps
	802.11g	6, 9, 12, 18, 24, 36, 48 & 54 Mbps (SISO, or MIMO with CDD)
	802.11n HT20	MCS0 to MCS7 (1 spatial streams with either SISO, or 2-chain MIMO with CDD/STBC) MCS8 to MCS15 (2 spatial streams on 2 transmit chains)
	802.11n HT40	MCS0 to MCS7 (1 spatial streams with either SISO, or 2-chain MIMO with CDD/STBC) MCS8 to MCS15 (2 spatial streams on 2 transmit chains)
<b>Power Supply Requirement(s):</b>	Nominal	120 VAC 60 Hz
<b>Channel Spacing:</b>	20 MHz	
<b>Transmit Frequency Range:</b>	2412 MHz to 2462 MHz	
<b>Transmit Channels Tested:</b>	Channel Number	Channel Frequency (MHz)
	1	2412
	6	2437
	11	2462
<b>Channel Spacing:</b>	40 MHz	
<b>Transmit Frequency Range:</b>	2422 MHz to 2452 MHz	
<b>Transmit Channels Tested:</b>	Channel Number	Channel Frequency (MHz)
	3	2422
	9	2452

### **3.5. Support Equipment**

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

<b>Description:</b>	Remote control
<b>Brand Name:</b>	Bang & Olufsen a/s
<b>Model Name or Number:</b>	BeoRemote One T30
<b>Serial Number:</b>	25143484

<b>Description:</b>	External BTLE box
<b>Brand Name:</b>	Alpha Network
<b>Model Name or Number:</b>	WUS-AC08V
<b>Serial Number:</b>	H11145216

<b>Description:</b>	HDMI cable. Quantity 3. Length 2m
<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>	HDMI cable. Quantity 1. Length 3m
<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>	Now TV set top box
<b>Brand Name:</b>	Sky
<b>Model Name or Number:</b>	2400SK
<b>Serial Number:</b>	1MM4DE006281

<b>Description:</b>	Now TV set top box
<b>Brand Name:</b>	Sky
<b>Model Name or Number:</b>	2400SK
<b>Serial Number:</b>	1MM552038807

<b>Description:</b>	Now TV set top box
<b>Brand Name:</b>	Sky
<b>Model Name or Number:</b>	2400SK
<b>Serial Number:</b>	1MM4D8006255

**Support Equipment (continued)**

<b>Description:</b>	HDMI media player
<b>Brand Name:</b>	SUMVISION
<b>Model Name or Number:</b>	Cyclone Micro
<b>Serial Number:</b>	SUM091104017

<b>Description:</b>	Ethernet cable. Quantity 3. Length 2m
<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>	Ethernet cable. Quantity 3. Length 3m
<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>	Ethernet cable. Quantity 1. Length 5m
<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>	Ethernet cable. Quantity 1. Length 10m
<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>	ADSL2+ Modem Router
<b>Brand Name:</b>	Netgear
<b>Model Name or Number:</b>	DG834 v4
<b>Serial Number:</b>	1PL596BD001A4

<b>Description:</b>	ADSL Modem Router
<b>Brand Name:</b>	Linksys
<b>Model Name or Number:</b>	WAG54G
<b>Serial Number:</b>	CF610E100799

**Support Equipment (continued)**

<b>Description:</b>	USB cable type A male to type A male. Quantity 3. Length 3m
<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>	Audio cable 3.5mm male to 3.5mm male. Quantity 1. Length 3m
<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>	Aerial cable. Quantity 1. Length 2m length
<b>Brand Name:</b>	Belkin
<b>Model Name or Number:</b>	Not marked or stated
<b>Serial Number:</b>	Not marked or stated

<b>Description:</b>	Freeview Set Top Box
<b>Brand Name:</b>	Sagem
<b>Model Name or Number:</b>	251657024
<b>Serial Number:</b>	441901036882

<b>Description:</b>	USB cable type A male to type B male. Quantity 1. Length 3m with 3 FAIR-RITE V0 ferrites and 1 unmarked or stated ferrite
<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>	Laptop PC
<b>Brand Name:</b>	Lenovo
<b>Model Name or Number:</b>	T61
<b>Serial Number:</b>	L3E7586

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

## **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 *MT7662U\_QA\_tool\_V1.0.3.0* bespoke application supplied by the customer on a UL laptop PC. The application was used to enable a continuous transmission mode and to select the test channels, data rates and modulation schemes as required.
- 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
    - 802.11b – DQPSK / 2 Mbps
    - 802.11g SISO – BPSK / 6 Mbps
    - 802.11g CDD1 – BPSK / 6 Mbps
    - 802.11n HT20 SISO – 16QAM / 39 Mbps / MCS4
    - 802.11n HT20 CDD1 – BPSK / 6.5 Mbps / MCS0
    - 802.11n HT40 SISO – 16QAM / 81 Mbps / MCS4
    - 802.11n HT40 CDD1 – BPSK / 13.5 Mbps / MCS0
  - Widest bandwidth
    - 802.11b – DQPSK / 2 Mbps
    - 802.11g SISO – BPSK / 6 Mbps
    - 802.11g CDD1 – BPSK / 6 Mbps
    - 802.11n HT20 SISO – QPSK / 13 Mbps / MCS1
    - 802.11n HT20 CDD1 – BPSK / 6.5 Mbps / MCS0
    - 802.11n HT40 SISO – BPSK / 13.5 Mbps / MCS0
    - 802.11n HT40 CDD1 – BPSK / 13.5 Mbps / MCS0
- Transmitter spurious emissions were performed with the EUT transmitting with a data rate of 802.11g / 6 Mbps on Antenna 1. 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. Conducted output power results can be located UL-RPT- RP10895558JD02A test report and are available for inspection on the company server if required.
- Radiated measurements: In order to operate the EUT the TV needed to be enabled. This was done by turning on the TV and pairing it with T30 remote control with the external BTLE box which was connected to the TV. The external BTLE box has 0.83m cable with a USB type A male connector. Once the TV was enabled, the EUT could be controlled using the MT7662U application. This was connected between the TV and laptop by the means of a 2m USB cable (type A to type B) with four ferrites on it.

**Configuration and Peripherals (continued)**

- Once the EUT was in transmit mode, the T30 remote control and external BTLE box were removed from the chamber before testing commenced.
- For all radiated tests the support equipment was used to terminate all active ports.

**4.3. Power Settings**

The manufacturer's declared power settings stated in the table below were used for both SISO and MIMO measurements:

Mode	Power Setting		
	Bottom Channel	Middle Channel	Top Channel
802.11b SISO – 2 Mbps	12	14	14
802.11g SISO – 6 Mbps	14	16	16
802.11g CDD1 – 6 Mbps	0E	10	10
802.11n HT20 SISO – 13 Mbps / MCS1	14	N/A	16
802.11n HT20 SISO – 39 Mbps / MCS4	14	1A	16
802.11n HT20 CDD1 – 6.5 Mbps / MCS0	0E	10	10
802.11n HT40 SISO – 13.5 Mbps / MCS0	16	N/A	13
802.11n HT40 SISO – 81 Mbps / MCS4	1A	1A	18
802.11n HT40 CDD1 – 13.5 Mbps / MCS0	10	10	10

## **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 Radiated Emissions**

#### **Test Summary:**

Test Engineer:	Andrew Edwards	Test Date:	31 March 2016
Test Sample Serial Number:	92804		

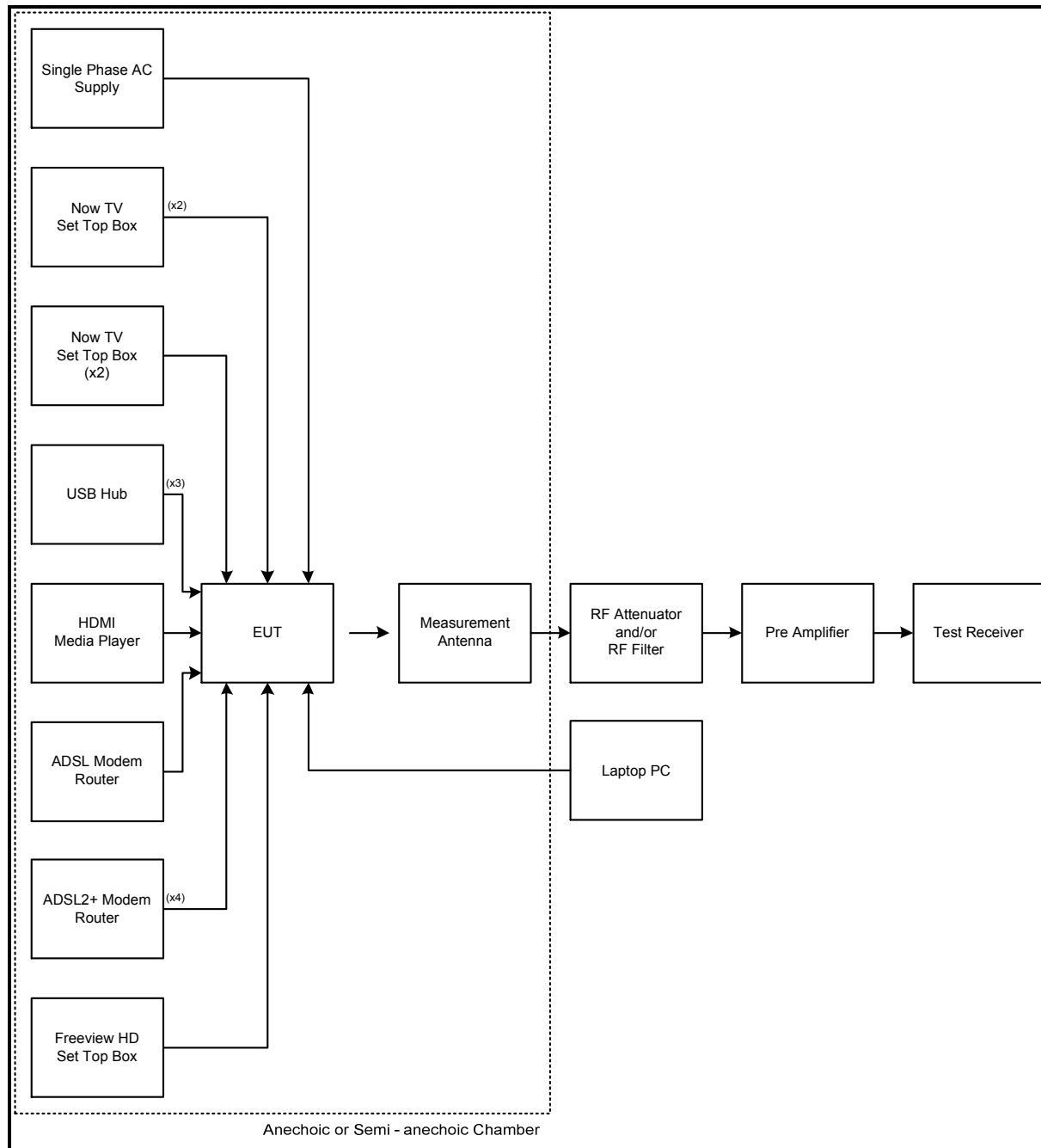
FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3 and 6.5
Frequency Range	30 MHz to 1000 MHz

#### **Environmental Conditions:**

Temperature (°C):	23
Relative Humidity (%):	32

#### **Note(s):**

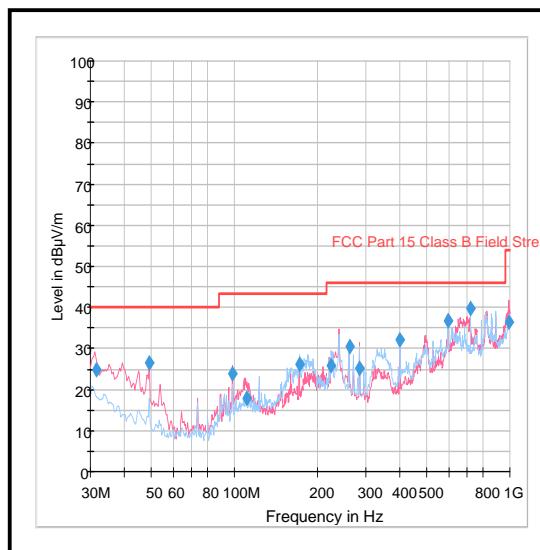
1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The preliminary scans showed similar emission levels below 1 GHz, for each channel of operation. Therefore final radiated emissions measurements were performed with the 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:**

*Note: The number in brackets relates to the quantity of cables which were connected between the TV and the support equipment.*

**Transmitter Radiated Emissions (continued)****Results: Middle Channel / 802.11g / SISO / 6 Mbps / Antenna 1**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
172.021	Horizontal	26.2	43.5	17.3	Complied
262.142	Horizontal	30.4	46.0	15.6	Complied
284.618	Vertical	25.3	46.0	20.7	Complied
399.988	Horizontal	32.0	46.0	14.0	Complied
991.048	Vertical	36.4	54.0	17.6	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)
M1627	Thermohygrometer	JM Handelpunkt	30.5015.10	None stated	11 Jan 2017	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	12 Jan 2017	12
G0543	Amplifier	Sonoma	310N	230801	29 May 2016	3
M1124	Test Receiver	Rohde & Schwarz	ESIB26	100046	18 Nov 2016	12
A259	Antenna	Chase	CBL6111	1513	19 Jul 2016	12
A1834	Attenuator	Hewlett Packard	8491B	10444	30 Mar 2017	12

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

<b>Test Engineer:</b>	Nick Steele	<b>Test Dates:</b>	16 March 2016 & 17 March 2016
<b>Test Sample Serial Number:</b>	92804		

<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>	23 to 24
<b>Relative Humidity (%):</b>	32

**Note(s):**

1. Transmitter radiated spurious emissions tests were performed with the EUT transmitting in 802.11g / 6 Mbps / SISO / Antenna 1, as this was found to transmit the highest power and therefore deemed worst case.
2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
3. All other 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.
4. The emission shown approximately at 2437 MHz on the 1 GHz to 4 GHz plot is the EUT fundamental.
5. 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. Final measurements above 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 1.5 m 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.
6. 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. Peak and average measurements were performed with their appropriate detectors during the pre-scan measurements.
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.
8. The reference level for the emission in the non-restricted band was established by following KDB 558074 Section 11.2 procedure.
9. \*\*-30 dBc limit applies in non-restricted band as the conducted output power measurements were performed using an average detector.
10. The six highest spurious emissions relative to the limit were recorded in table below, as stated in ANSI C63.10 Section 6.6.4.3.

**Transmitter Radiated Emissions (continued)****Results: Bottom Channel / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
1111.141	Vertical	53.2	54.0*	0.8	Complied
1289.902	Vertical	52.6	63.4**	10.8	Complied
1745.913	Horizontal	60.0	63.4**	3.4	Complied
2674.463	Vertical	54.5	63.4**	8.9	Complied
2867.272	Vertical	58.0	74.0	16.0	Complied
2978.926	Vertical	56.1	63.4**	7.3	Complied

**Results: Bottom Channel / Average**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2867.272	Vertical	49.0	54.0	5.0	Complied

**Results: Middle Channel / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
1111.141	Vertical	53.2	54.0*	0.8	Complied
1289.902	Vertical	52.6	68.3**	15.7	Complied
1745.913	Horizontal	60.0	68.3**	8.3	Complied
2674.463	Vertical	54.5	68.3**	13.8	Complied
2867.272	Vertical	58.0	74.0	16.0	Complied
2978.926	Vertical	56.1	68.3**	12.2	Complied

**Results: Middle Channel / Average**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2867.272	Vertical	49.0	54.0	5.0	Complied

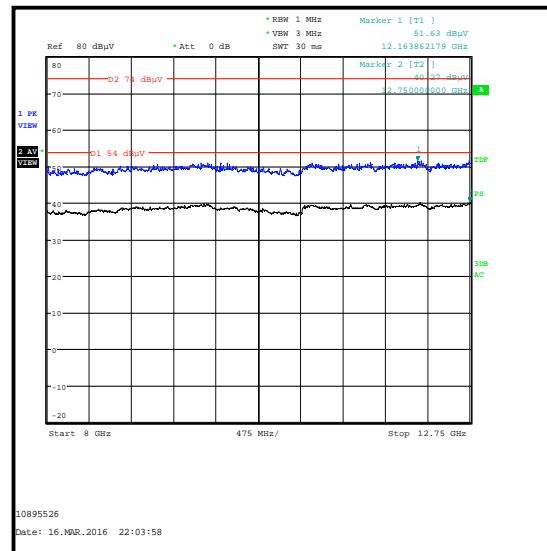
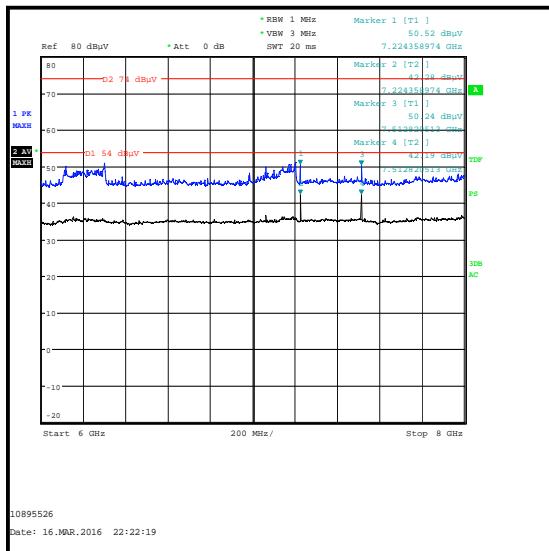
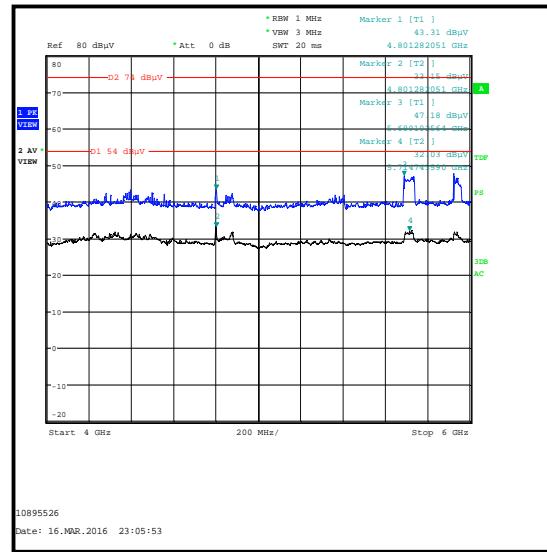
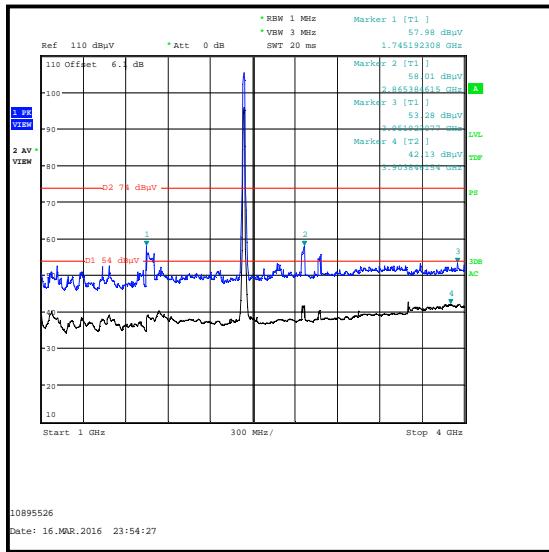
**Transmitter Radiated Emissions (continued)****Results: Top Channel / Peak**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
1111.141	Vertical	53.2	54.0*	0.8	Complied
1289.902	Vertical	52.6	68.8**	16.2	Complied
1745.913	Horizontal	60.0	68.8**	8.8	Complied
2674.463	Vertical	54.5	68.8**	14.3	Complied
2867.272	Vertical	58.0	74.0	16.0	Complied
2978.926	Vertical	56.1	68.8**	12.7	Complied

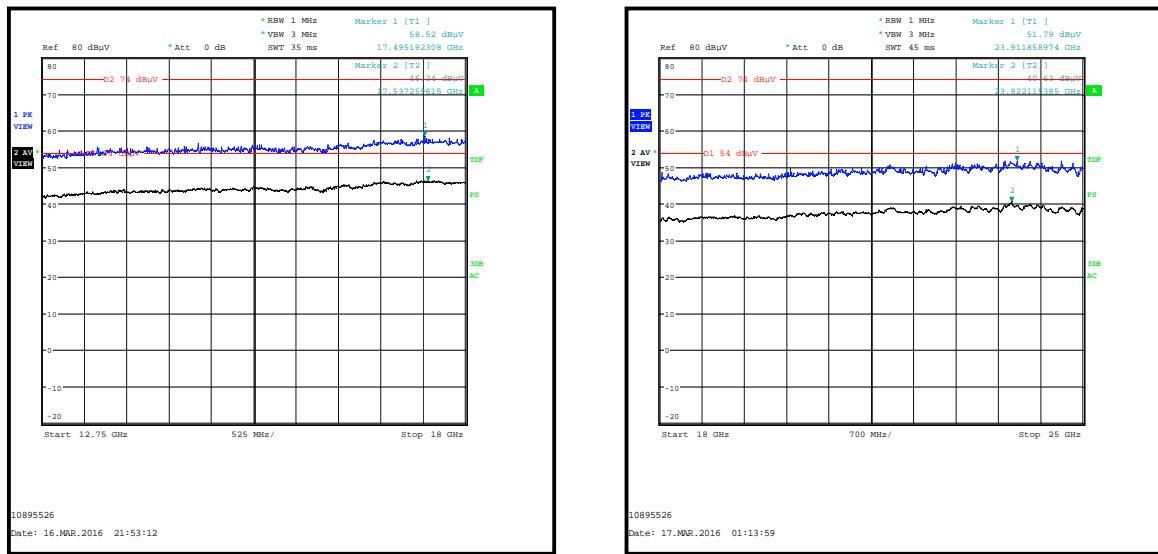
**Results: Top Channel / Average**

Frequency (MHz)	Antenna Polarity	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2867.272	Vertical	49.0	54.0	5.0	Complied

## Transmitter Radiated Emissions (continued)



## Transmitter Radiated Emissions (continued)



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)
M1656	Thermohygrometer	JM Handelpunkt	30.5015.13	Not 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 Mar 2017	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
A239	Attenuator	Huber & Suhner	6806.17.B	Not stated	05 May 2016	12
A1975	High Pass Filter	AtlanTecRF	AFH-03000	090424010	17 Apr 2016	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	12 Jan 2017	12
M1124	Test Receiver	Rohde & Schwarz	ESIB26	100046	18 Nov 2016	12
M1945	Thermohygrometer	JM Handelpunkt	30.5015.01	None stated	23 Apr 2016	12

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

<b>Test Engineer:</b>	Nick Steele	<b>Test Dates:</b>	17 March 2016 to 01 April 2016
<b>Test Sample Serial Number:</b>	92804		

<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

**Environmental Conditions:**

<b>Temperature (°C):</b>	22 to 25
<b>Relative Humidity (%):</b>	29 to 32

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

1. All supported modes and channel widths were initially investigated on one channel. The modes that produced the highest power and widest bandwidths were:

- o 802.11b – DQPSK / 2 Mbps / DAC0
- o 802.11g SISO – BPSK / 6 Mbps / DAC0
- o 802.11g CDD1 – BPSK / 6 Mbps
- o 802.11n HT20 SISO – QPSK / 13 Mbps / MCS1
- o 802.11n HT20 SISO – 16QAM / 39 Mbps / MCS4
- o 802.11n HT20 CDD1 – BPSK / 6.5 Mbps / MCS0
- o 802.11n HT40 SISO – BPSK / 13.5 Mbps / MCS0
- o 802.11n HT40 SISO – 16QAM / 81 Mbps / MCS4
- o 802.11n HT40 CDD1 – BPSK / 13.5 Mbps / MCS0

Final measurements were performed with the above configurations.

2. For SISO modes, the EUT was transmitting from Port 1 (DAC 0) only as this Port emits the highest output power level and was therefore deemed to be worst case. For CDD1 modes, the EUT was transmitting from both ports.
3. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
4. 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.
5. 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.
6. 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 detector was used, sweep time was set to auto and trace mode was Max Hold. For average measurements the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth 10 Hz. 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 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.
7. There is a restricted band 10 MHz below the lower band edge. The test receiver was set up as follows: the RBW set to 1 MHz, the VBW set to 3 MHz, with the sweep time set to auto couple. Peak and average measurements were performed with their respective detectors. Markers were placed on the highest point on each trace.

**Transmitter Band Edge Radiated Emissions (continued)****Results: 802.11b / 20 MHz / DQPSK / 2 Mbps / DAC 0****Results: Lower Band Edge**

Frequency (MHz)	Level (dB $\mu$ V/m)	-30 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
2400	48.9	63.9	15.0	Complied

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

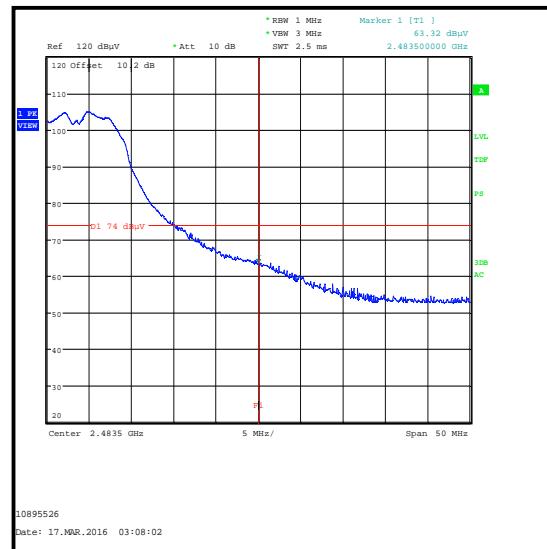
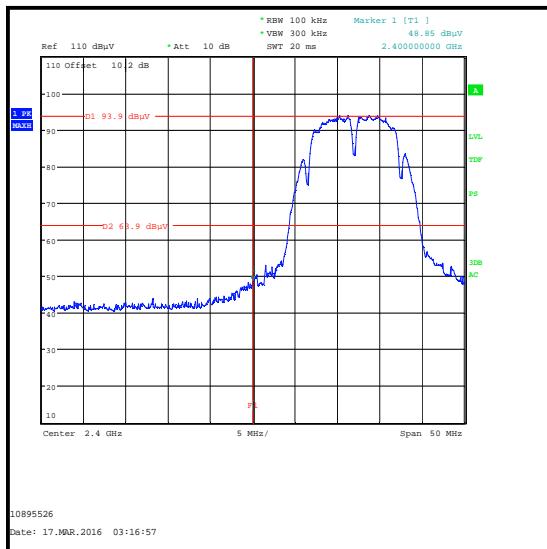
Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.615	54.9	74.0	19.1	Complied
2483.5	63.3	74.0	10.7	Complied

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

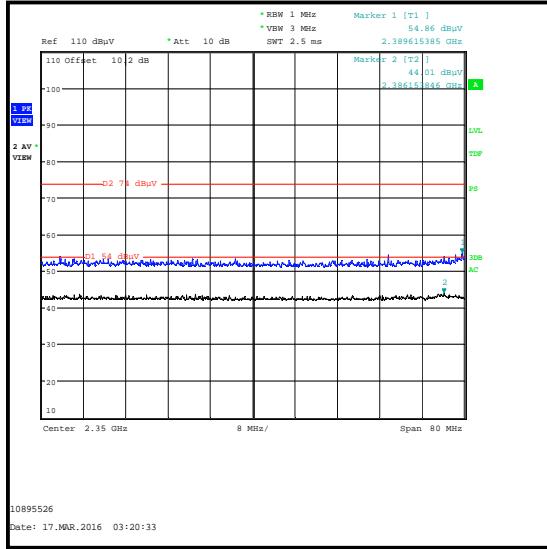
Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2386.154	44.0	54.0	10.0	Complied
2483.5	47.6	54.0	6.4	Complied
2486.625	48.5	54.0	5.5	Complied

## Transmitter Band Edge Radiated Emissions (continued)

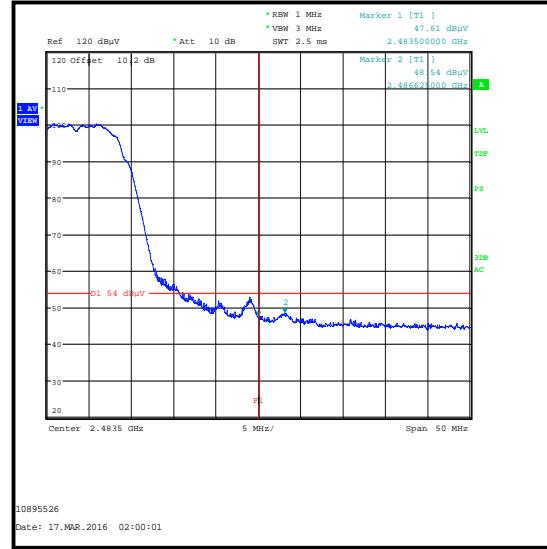
### Results: 802.11b / 20 MHz / DQPSK / 2 Mbps / DAC 0



### 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 / 20 MHz / SISO / BPSK / 6 Mbps / DAC 0****Results: Lower Band Edge**

Frequency (MHz)	Level (dB $\mu$ V/m)	-30 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
2399.439	54.1	63.4	9.3	Complied
2400	53.3	63.4	10.1	Complied

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

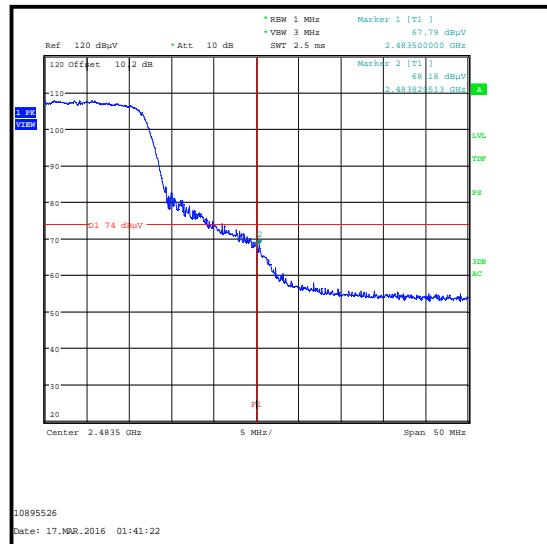
Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2390.000	57.0	74.0	17.0	Complied
2483.5	67.8	74.0	6.2	Complied
2483.821	68.2	74.0	5.8	Complied

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

Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.872	45.1	54.0	8.9	Complied
2483.5	52.9	54.0	1.1	Complied

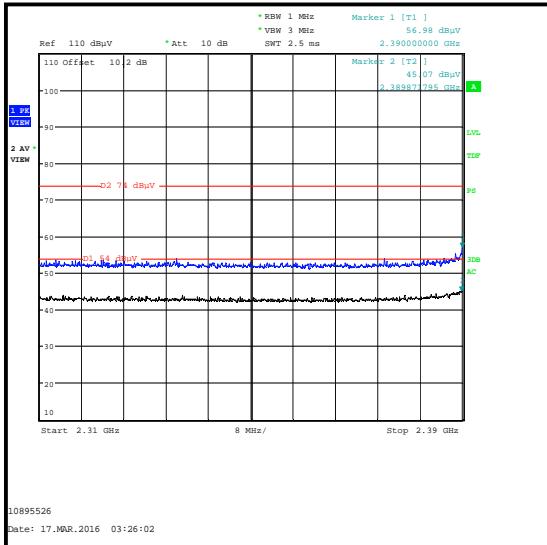
## Transmitter Band Edge Radiated Emissions (continued)

## Results: 802.11g / 20 MHz / SISO / BPSK / 6 Mbps / DAC 0



## 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 / 20 MHz / CDD1 / BPSK / 6 Mbps****Results: Lower Band Edge**

Frequency (MHz)	Level (dB $\mu$ V/m)	-30 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
2400	51.3	60.6	9.3	Complied

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

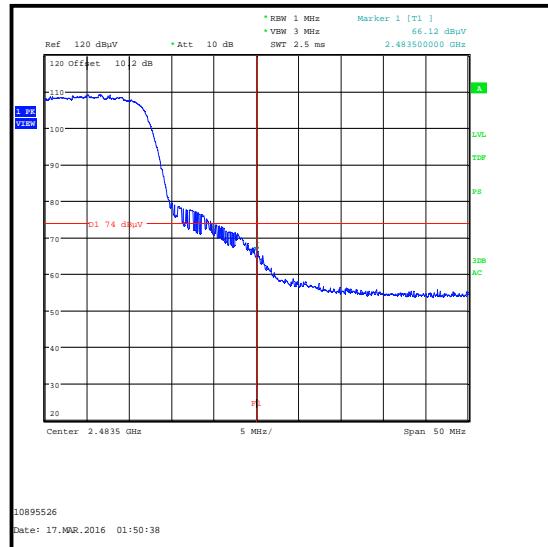
Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2390.000	57.8	74.0	16.2	Complied
2483.5	66.1	74.0	7.9	Complied

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

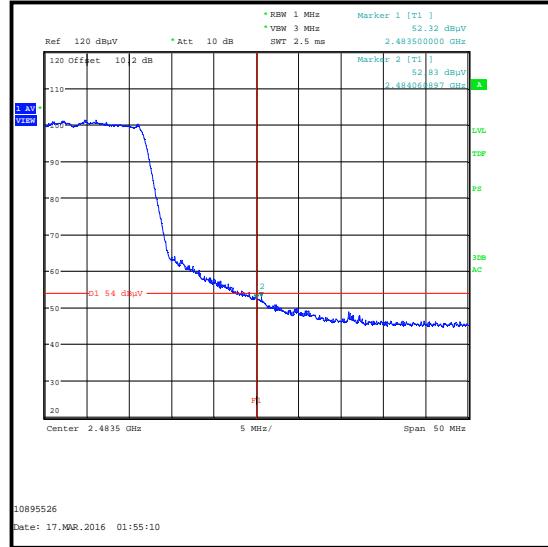
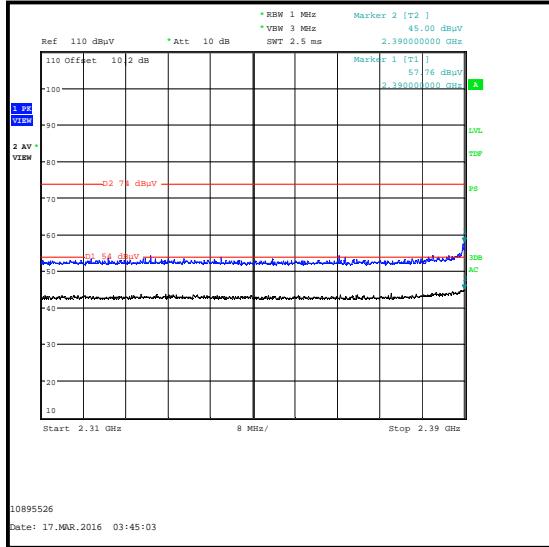
Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2390.000	45.0	54.0	9.0	Complied
2483.5	52.3	54.0	1.7	Complied
2484.061	52.8	54.0	1.2	Complied

## Transmitter Band Edge Radiated Emissions (continued)

## Results: 802.11g / 20 MHz / CDD1 / BPSK / 6 Mbps



## Lower Band Edge Peak Measurement



## 2310 MHz to 2390 MHz Restricted Band Plot

## Upper Band Edge Average Measurement

**Transmitter Band Edge Radiated Emissions (continued)****Results: 802.11n HT20 / SISO / QPSK / MCS1****Results: Lower Band Edge**

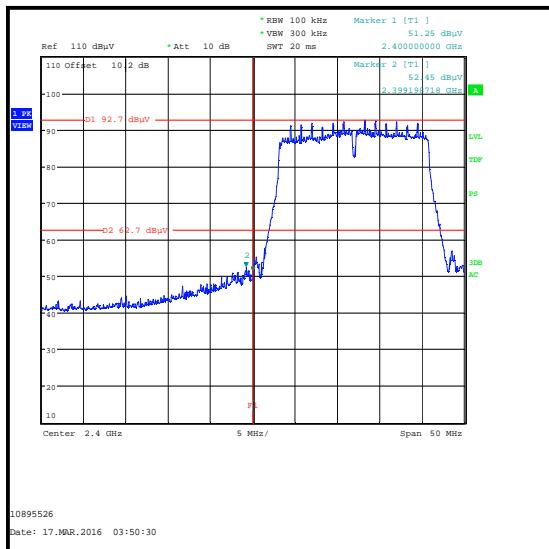
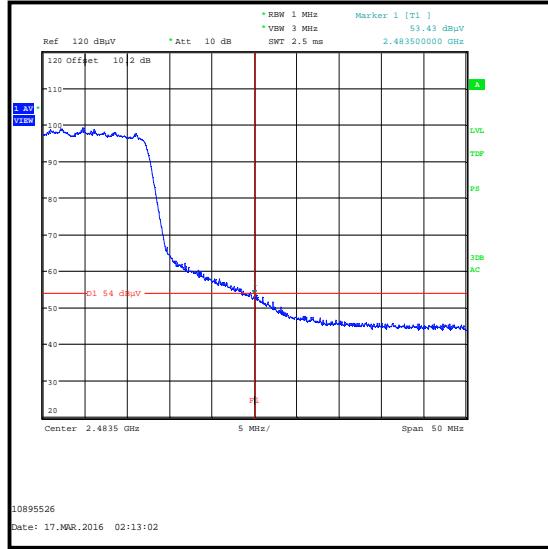
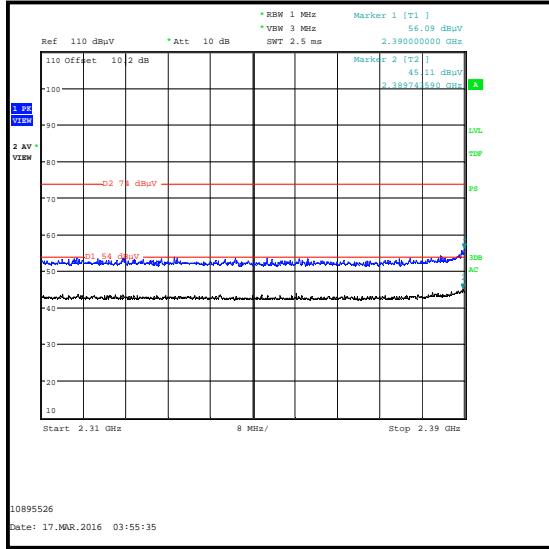
Frequency (MHz)	Level (dB $\mu$ V/m)	-30 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
2399.199	52.5	62.7	10.2	Complied
2400	51.3	62.7	11.4	Complied

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

Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2390.000	56.1	74.0	17.9	Complied
2483.5	66.6	74.0	7.4	Complied
2483.660	68.4	74.0	5.6	Complied

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

Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.744	45.1	54.0	8.9	Complied
2483.5	53.4	54.0	0.6	Complied

**Transmitter Band Edge Radiated Emissions (continued)****Results: 802.11n HT20 / SISO / QPSK / MCS1****Lower Band Edge Peak Measurement****2310 MHz to 2390 MHz Restricted Band Plot****Upper Band Edge Average Measurement**

**Transmitter Band Edge Radiated Emissions (continued)****Results: 802.11n HT20 / SISO / 16QAM / MCS4****Results: Lower Band Edge**

Frequency (MHz)	Level (dB $\mu$ V/m)	-30 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
2395.673	53.1	61.1	8.0	Complied
2400	51.7	61.1	9.4	Complied

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

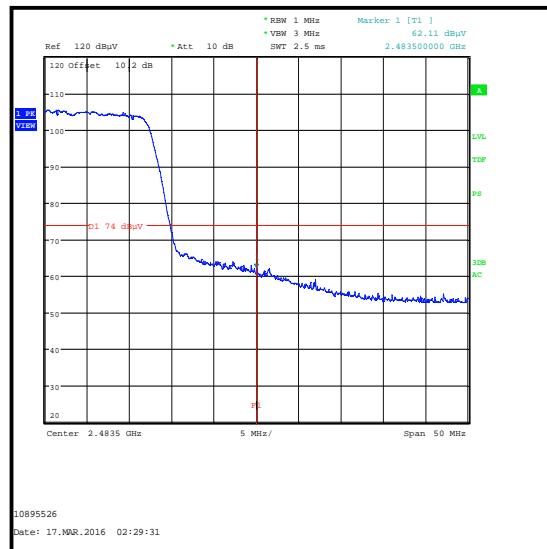
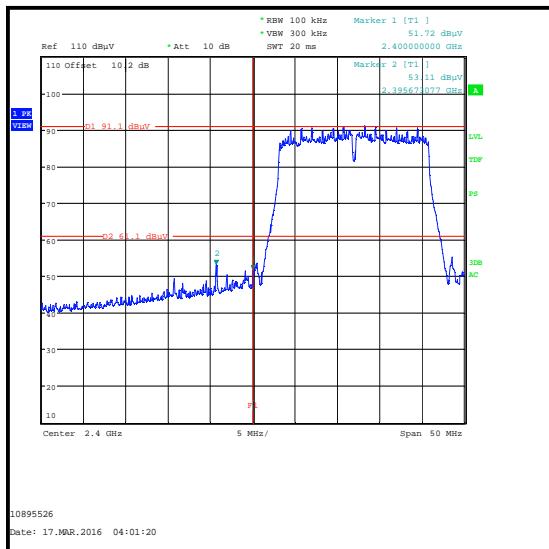
Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.359	56.8	74.0	17.2	Complied
2483.5	62.1	74.0	11.9	Complied

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

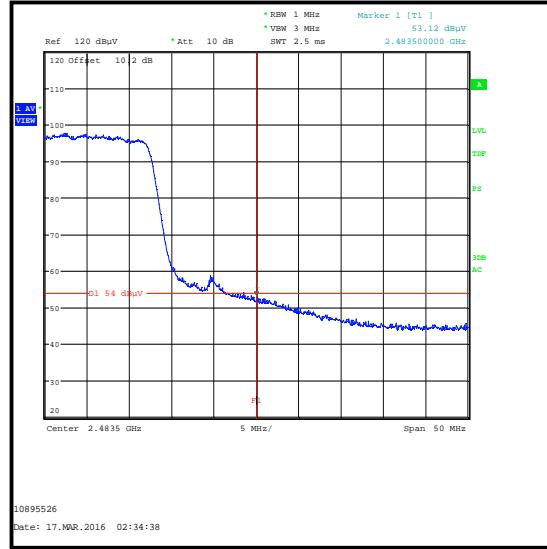
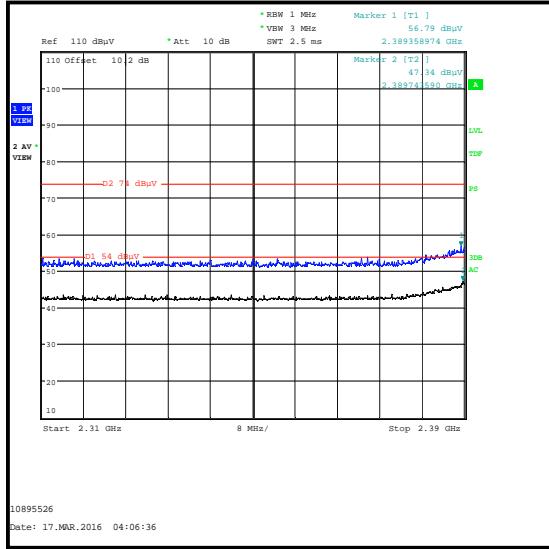
Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.744	47.3	54.0	6.7	Complied
2483.5	53.1	54.0	0.9	Complied

### Transmitter Band Edge Radiated Emissions (continued)

## Results: 802.11n HT20 / SISO / 16QAM / MCS4



## Lower Band Edge Peak Measurement



## 2310 MHz to 2390 MHz Restricted Band Plot

## Upper Band Edge Average Measurement

**Transmitter Band Edge Radiated Emissions (continued)****Results: 802.11n HT20 / CDD1 / BPSK / MCS0****Results: Lower Band Edge**

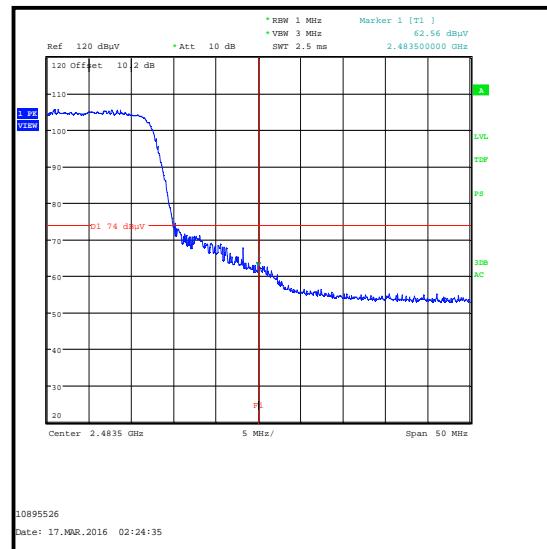
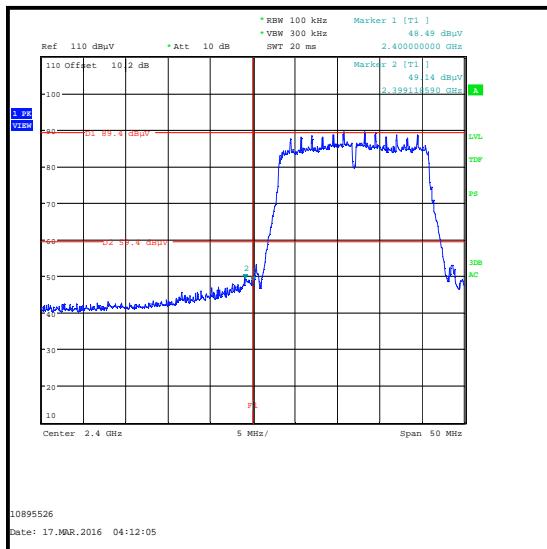
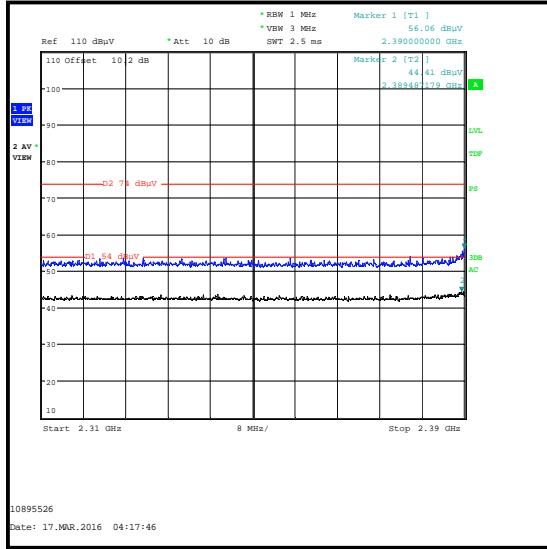
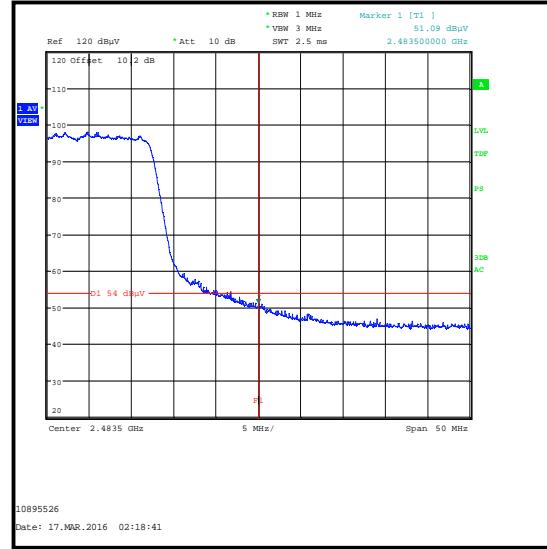
Frequency (MHz)	Level (dB $\mu$ V/m)	-30 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
2399.119	49.1	59.4	10.3	Complied
2400	48.5	59.4	10.9	Complied

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

Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2390.000	56.1	74.0	17.9	Complied
2483.5	62.6	74.0	11.4	Complied

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

Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.487	44.4	54.0	9.6	Complied
2483.5	51.1	54.0	2.9	Complied

**Transmitter Band Edge Radiated Emissions (continued)****Results: 802.11n HT20 / CDD1 / BPSK / MCS0****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: 802.11n / HT40 / SISO / BPSK / MCS0****Results: Lower Band Edge**

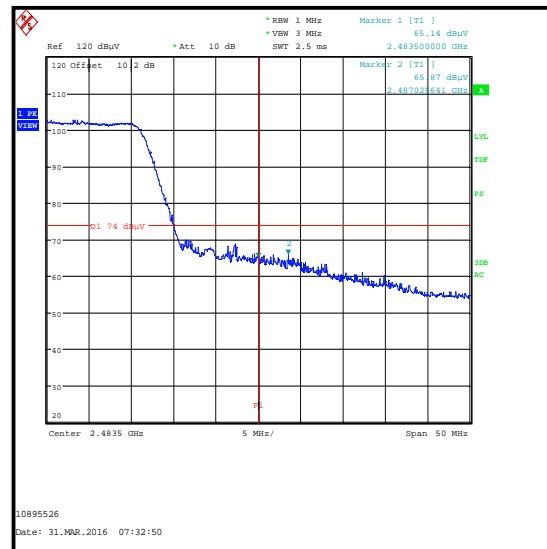
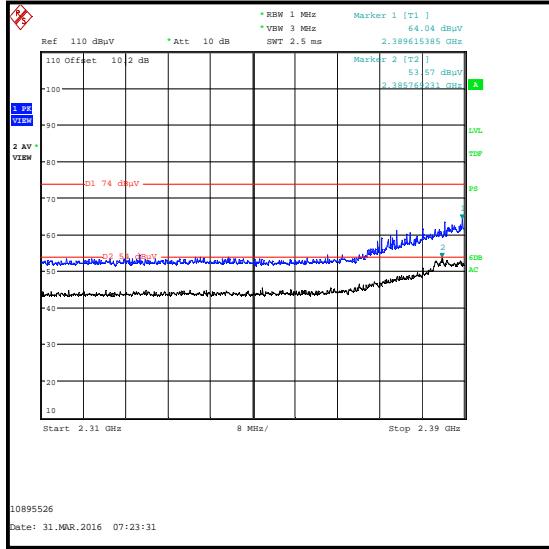
Frequency (MHz)	Level (dB $\mu$ V/m)	-30 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
2400	54.5	61.4	6.9	Complied

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

Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2389.615	64.0	74.0	10.0	Complied
2483.5	65.1	74.0	8.9	Complied
2487.026	65.9	74.0	8.1	Complied

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

Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2385.769	53.6	54.0	0.4	Complied
2483.5	53.0	54.0	1.0	Complied
2485.503	53.7	54.0	0.3	Complied

**Transmitter Band Edge Radiated Emissions (continued)****Results: 802.11n / HT40 / SISO / BPSK / MCS0****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: 802.11n / HT40 / SISO / 16QAM / MCS4****Results: Lower Band Edge**

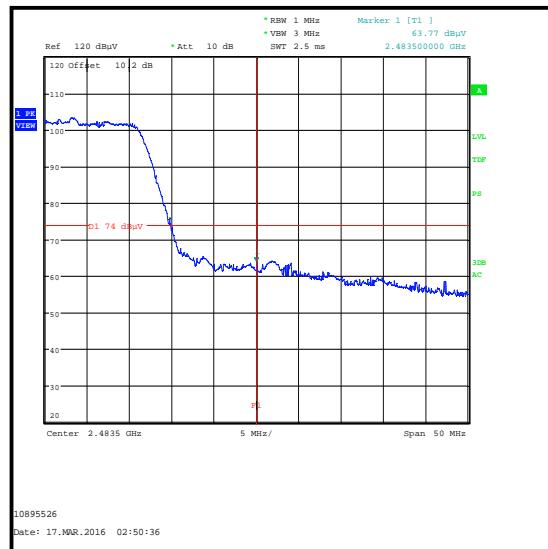
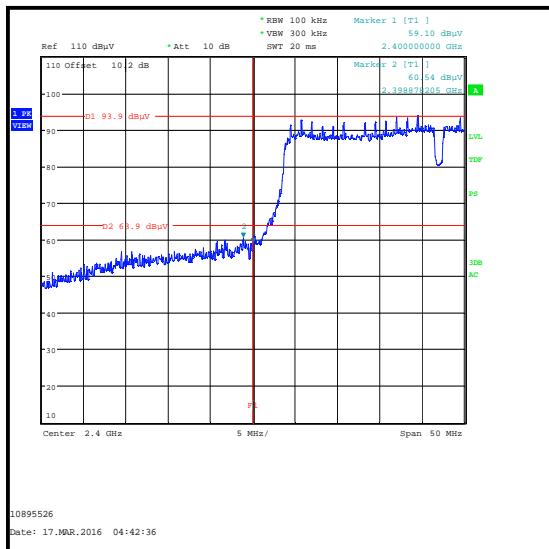
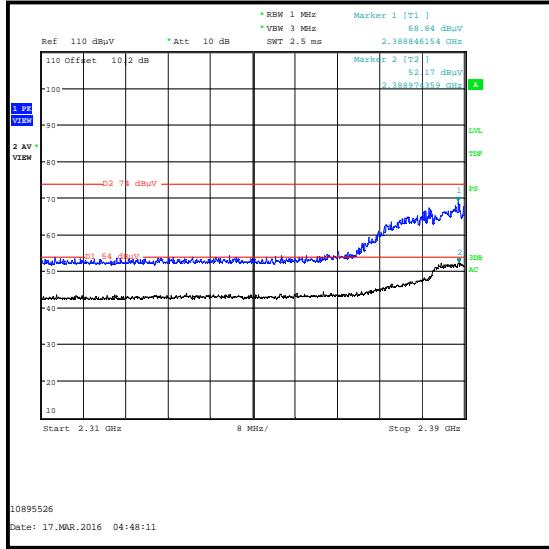
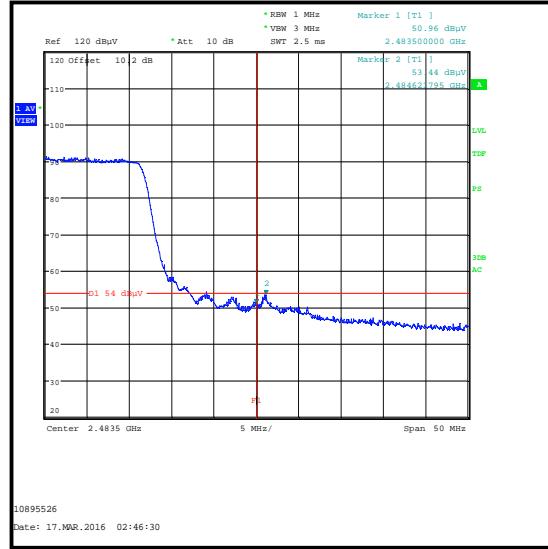
Frequency (MHz)	Level (dB $\mu$ V/m)	-30 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
2398.878	60.5	63.9	3.4	Complied
2400	59.1	63.9	4.8	Complied

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

Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2388.846	68.8	74.0	5.2	Complied
2483.5	63.8	74.0	10.2	Complied

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

Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2388.974	52.2	54.0	1.8	Complied
2483.5	51.0	54.0	3.0	Complied
2484.622	53.4	54.0	0.6	Complied

**Transmitter Band Edge Radiated Emissions (continued)****Results: 802.11n / HT40 / SISO / 16QAM / MCS4****Lower Band Edge Peak Measurement****2310 MHz to 2390 MHz Restricted Band Plot****Upper Band Edge Average Measurement**

**Transmitter Band Edge Radiated Emissions (continued)****Results: 802.11n / HT40 / CDD1 / BPSK / MCS0****Results: Lower Band Edge**

Frequency (MHz)	Level (dB $\mu$ V/m)	-30 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
2396.715	59.0	61.2	2.2	Complied
2400	57.6	61.2	3.6	Complied

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

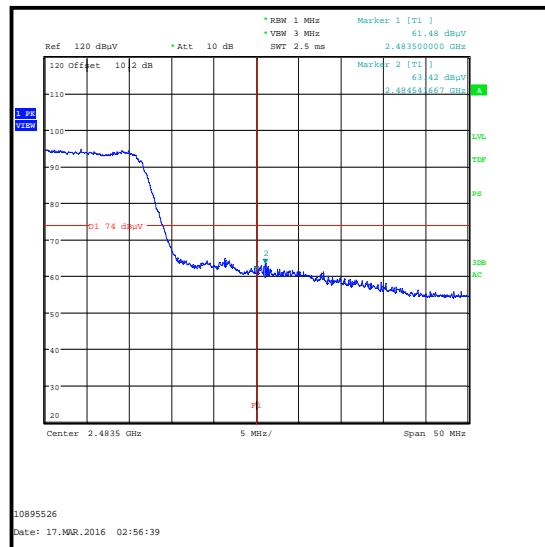
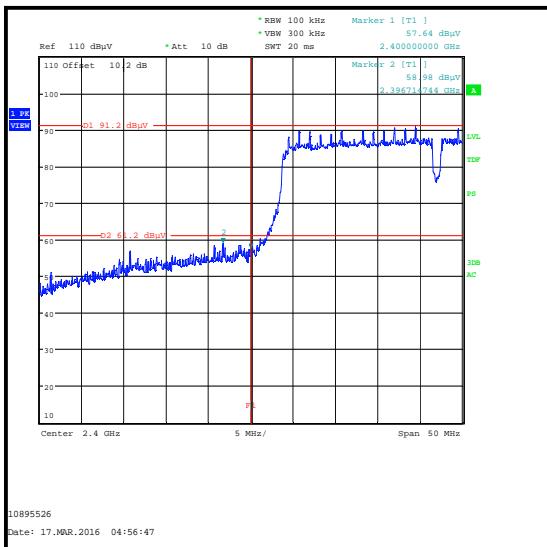
Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2388.205	68.8	74.0	5.2	Complied
2483.5	61.5	74.0	12.5	Complied
2484.542	63.4	74.0	10.6	Complied

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

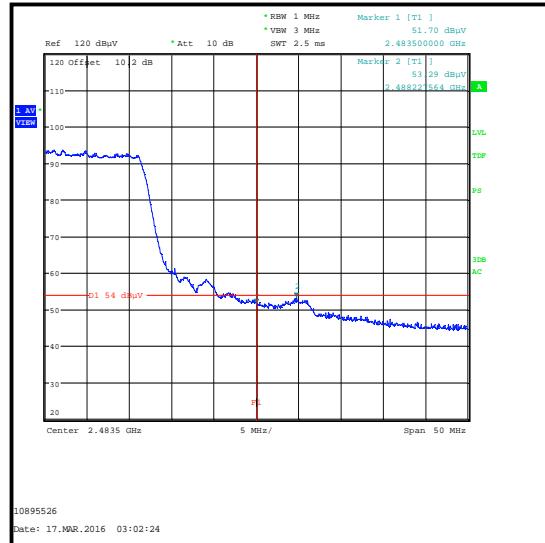
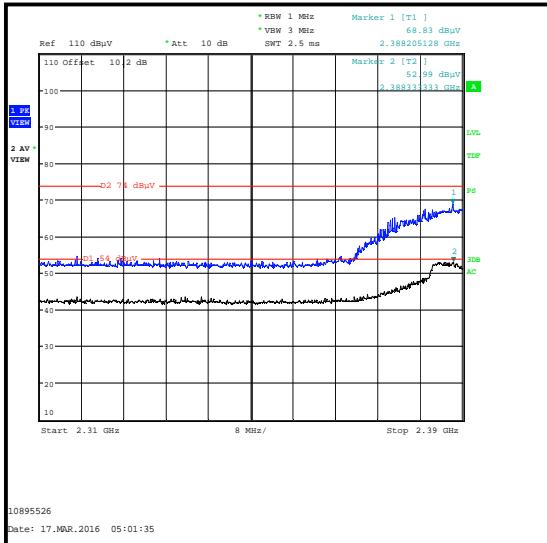
Frequency (MHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2388.333	53.0	54.0	1.0	Complied
2483.5	51.7	54.0	2.3	Complied
2488.228	53.3	54.0	0.7	Complied

### Transmitter Band Edge Radiated Emissions (continued)

## Results: 802.11n / HT40 / CDD1 / BPSK / MCS0



## Lower Band Edge Peak Measurement



#### 2310 MHz to 2390 MHz Restricted Band Plot

## 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	Not stated	23 Apr 2016	12
K0002	3m RSE Chamber	Rainford EMC	N/A	N/A	21 Dec 2016	12
A1534	Pre Amplifier	Hewlett Packard	8449B	3008A00405	19 Dec 2016	12
M1886	Test Receiver	Rohde & Schwarz	ESU26	100554	21 Mar 2017	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
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
3.0	-	-	Model Number updated, Sections 3.1 and 3.2 updated

**--- END OF REPORT ---**