



TEST REPORT

Test Report No. : UL-RPT-RP11624992JD05A V3.0

Customer : Apple Inc.
Model No. : A1842
FCC ID : BCGA1842
Technology : WLAN
Test Standard(s) : FCC Parts 15.209(a) & 15.247

Test Laboratory : UL VS LTD, Basingstoke, Hampshire, RG24 8AH, United Kingdom

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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: 22 August 2017

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Report Revision History

Version Number	Issue Date	Revision Details	Revised By
1.0	01/08/2017	Initial Version	Ian Watch
2.0	11/08/2017	Page 10. Changed maximum output power from 24.4 to 22.8 dBm. Page 11. Changed Goldeneye adaptor name from Foxlink to Apple. Page 13. Various changes to bullet points as requested by the customer. Page 58. Changed Test Dates from '04 July 2017 & 25 July 2017' to '04 July 2017, 05 July 2017 & 25 July 2017'.	Ian Watch
3.0	22/08/2017	Changed Model No. to A1842 Changed description of EUT in Section 1.1	Ian Watch

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1. Attestation of Test Results

1.1. Description of EUT

The device is an interactive digital media player which plays content onto a screen through an HDMI port. It incorporates Wi-Fi and Bluetooth radios.

1.2. General Information

Specification Reference:	47CFR15.247
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
Specification Reference:	47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.209
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	09 May 2017 to 29 July 2017

1.3. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.35(c)	Transmitter Duty Cycle	Note 1
Part 15.247(a)(2)	Transmitter Minimum 6 dB Bandwidth	Complied
Part 15.247(e)	Transmitter Power Spectral Density	Complied
Part 15.247(b)(3)	Transmitter Maximum (Average) Output Power	Complied
Part 15.247(d) & 15.209(a)	Transmitter Radiated Emissions	Complied
Part 15.247(d) & 15.209(a)	Transmitter Band Edge Radiated Emissions	Complied

Note(s):

- For the data rates declared as worst cases and reported in this test report, duty cycle was measured to be greater than 98%. Plots for these measurements are archived on the UL VS LTD IT server and available for inspection upon request.
- There are two vendors of the WiFi/Bluetooth radio modules, Vendor 1 and Vendor 2.
- The WiFi/Bluetooth radio modules have the same mechanical outline (i.e. the same packaging dimension and pin layout), use the same on-board antenna matching circuit, have an identical antenna structure and are built and tested to conform to the same specification and to operate within the same tolerances.

Baseline testing was performed on the two vendors to determine the worst case.

1.4. 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.

2. Summary of Testing

2.1. Facilities and Accreditation

The test site and measurement facilities used to collect data are located at Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom. The following table identifies which facilities were utilised for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

Site 1	
Site 2	X
Site 17	X

UL VS LTD is accredited by UKAS. The tests reported herein have been performed in accordance with its terms of accreditation.

2.2. Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	KDB 558074 D01 DTS Meas Guidance v04 April 5, 2017
Title:	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under Section 15.247
Reference:	KDB 662911 D01 Multiple Transmitter Output v02r01 October 31, 2013
Title:	Emissions Testing of Transmitters with Multiple Outputs in the Same Band

2.3. Calibration and Uncertainty

Measuring Instrument Calibration

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.

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 measured (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
Minimum 6 dB Bandwidth	2.4 GHz to 2.4835 GHz	95%	±4.59 %
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.

2.4. Test and Measurement Equipment

Test Equipment Used for 6 dB Bandwidth, Power Spectral Density and Maximum (Average) Output Power

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2005	Thermohygrometer	Testo	608-H1	45046700	22 Feb 2018	12
M1835	Signal Analyser	Rohde & Schwarz	FSV30	103050	06 Mar 2018	12
A2952	RF Switch	Pickering	64-102-002	XZ361012	Calibrated before use	-
A2930	Attenuator	AtlanTecRF	AB18W5-10	000907-18#1	Calibrated before use	-
A2846	Attenuator	Radiall	R411.810.12 1	23944722	Calibrated before use	-
M1804	Signal Generator	Rohde & Schwarz	SMP22	100026	03 Feb 2018	42

Test Equipment Used for Transmitter Radiated Emissions

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2003	Thermohygrometer	JM Handelspunkt	608-H1	45046641	22 Feb 2018	12
K0017	3m RSE Chamber	Rainford	N/A	N/A	14 Apr 2018	12
A2863	Amplifier	Hewlett Packard	8449B	3008A02100	11 Apr 2018	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	13 Apr 2018	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	03 Mar 2018	12
A2971	Low Pass Filter	AtlanTecRF	AFL-02000	15062902845	06 Mar 2018	12
A2914	High Pass Filter	AtlanTecRF	AFH-03000	2155	06 Mar 2018	12
A2903	Antenna	Schwarzbeck	VULB 9163	9163-944	22 Aug 2017	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	11 Apr 2018	12
A2890	Antenna	Schwarzbeck	HWRD 750	014	11 Apr 2018	12
A2892	Antenna	Schwarzbeck	BBHA 9170	9170-727	11 Apr 2018	12
A2893	Pre Amplifier	Schwarzbeck	BBV 9721	9721-021	11 Apr 2018	12

Test Equipment Used for Transmitter Band Edge Radiated Emissions

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1656	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	22 Feb 2018	12
K0002	3m RSE Chamber	Rainford	N/A	N/A	16 Nov 2017	12
A1534	Amplifier	Hewlett Packard	8449B	3008A00405	09 Nov 2017	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	28 Oct 2017	12
A1396	Attenuator	Huber & Suhner	6810.17.B	757987	28 Feb 2018	12
A1818	Antenna	EMCO	3115	00075692	08 Nov 2017	12

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	Apple Inc.
Model Name or Number:	A1842
Test Sample Serial Number:	C07TK026J4C7 (<i>Radiated sample #1</i>)
Hardware Version:	EVT
Software Version:	15J42500h
FCC ID:	BCGA1842

Brand Name:	Apple Inc.
Model Name or Number:	A1842
Test Sample Serial Number:	C07TK007J4C6 (<i>Radiated sample #2</i>)
Hardware Version:	EVT
Software Version:	15J42500h
FCC ID:	BCGA1842

Brand Name:	Apple Inc.
Model Name or Number:	A1842
Test Sample Serial Number:	C07TK02MJ4C7 (<i>Radiated sample #3</i>)
Hardware Version:	EVT
Software Version:	15J42500h
FCC ID:	BCGA1842

Brand Name:	Apple Inc.
Model Name or Number:	A1842
Test Sample Serial Number:	C07TK002J4C6 (<i>Radiated sample #4</i>)
Hardware Version:	EVT
Software Version:	15J42500h
FCC ID:	BCGA1842

Brand Name:	Apple Inc.
Model Name or Number:	A1842
Test Sample Serial Number:	C07TK02MJ4C7 (<i>Conducted sample</i>)
Hardware Version:	EVT
Software Version:	15J42500h
FCC ID:	BCGA1842

3.2. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.3. Additional Information Related to Testing

Technology Tested:	WLAN (IEEE 802.11b,g,n) / Digital Transmission System	
Type of Unit:	Transceiver	
Modulation Type:	DBPSK, DQPSK, BPSK, QPSK, 16QAM & 64QAM	
Data Rates:	802.11b (SISO)	1, 2, 5.5 & 11 Mbit/s
	802.11g (SISO)	6, 9, 12, 18, 24, 36, 48 & 54 Mbit/s
	802.11n HT20 (SISO)	MCS0 to MCS7
	802.11n HT20 (MIMO)	MCS0 to MCS15 (CDD MCS0 to MCS7)
Power Supply Requirement(s):	Nominal	120 VAC 60 Hz
Maximum Conducted Output Power:	22.8 dBm	
Channel Spacing:	20 MHz	
Transmit Frequency Range:	2412 MHz to 2472 MHz	
Transmit Channels Tested:	Channel Number	Channel Frequency (MHz)
	1	2412
	2	2417
	3	2422
	6	2437
	7	2442
	11	2462
	12	2467
	13	2472

3.4. Description of Available Antennas

The radio utilizes 2 integrated antennas, with the following declared maximum gains between 2400 – 2483.5 MHz:

Antenna Port	Antenna Gain (dBi)
1	0.9
2	-0.1

3.5. Description of Test Setup

Support Equipment

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

Description:	Goldeneye Adaptor
Brand Name:	Apple
Model Name or Number:	X892
Serial Number:	C4MB4360888X8921H

Description:	USB to lightning cable
Brand Name:	Apple
Model Name or Number:	Kanzi
Serial Number:	31BB61

Description:	Laptop PC
Brand Name:	Lenovo
Model Name or Number:	L440
Serial Number:	R9-019E9Z 14/04

Description:	Laptop PC
Brand Name:	Apple
Model Name or Number:	MacBook Pro
Serial Number:	C02Q81PFG3QD

Description:	USB Hub
Brand Name:	Hama
Model Name or Number:	00078498
Serial Number:	09825891600

Description:	2 Way HDMI Smart Splitter
Brand Name:	Neet
Model Name or Number:	NCSP0102
Serial Number:	X00037BP4D

Description:	Power Cable. Length 1.8 metres.
Brand Name:	Apple
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Support Equipment (continued)

Description:	Ethernet Cable. Length 2.0 metres.
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	HDMI Cable. Length 1.8 metres
Brand Name:	Apple
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	Ethernet Hub
Brand Name:	Netgear
Model Name or Number:	GS605
Serial Number:	1YG19430021A1

Operating Modes

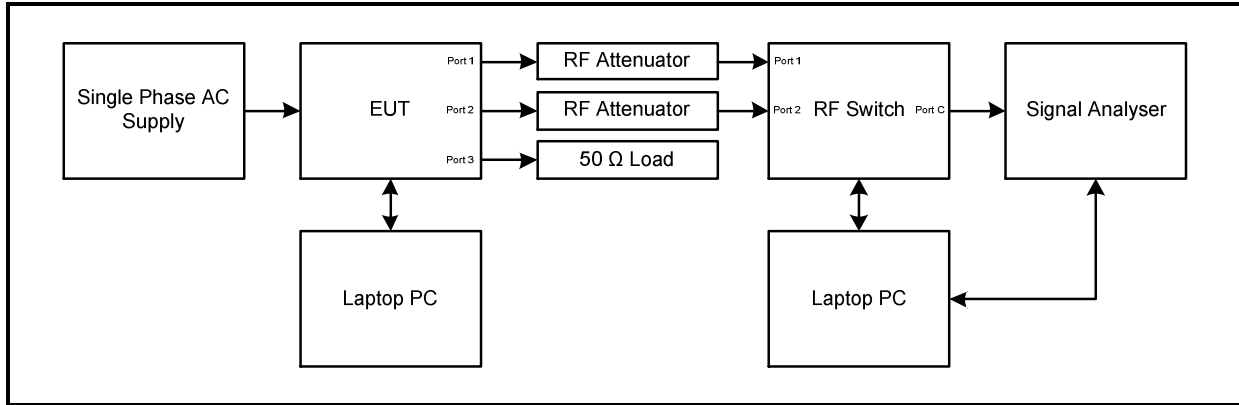
The EUT was tested in the following operating mode(s):

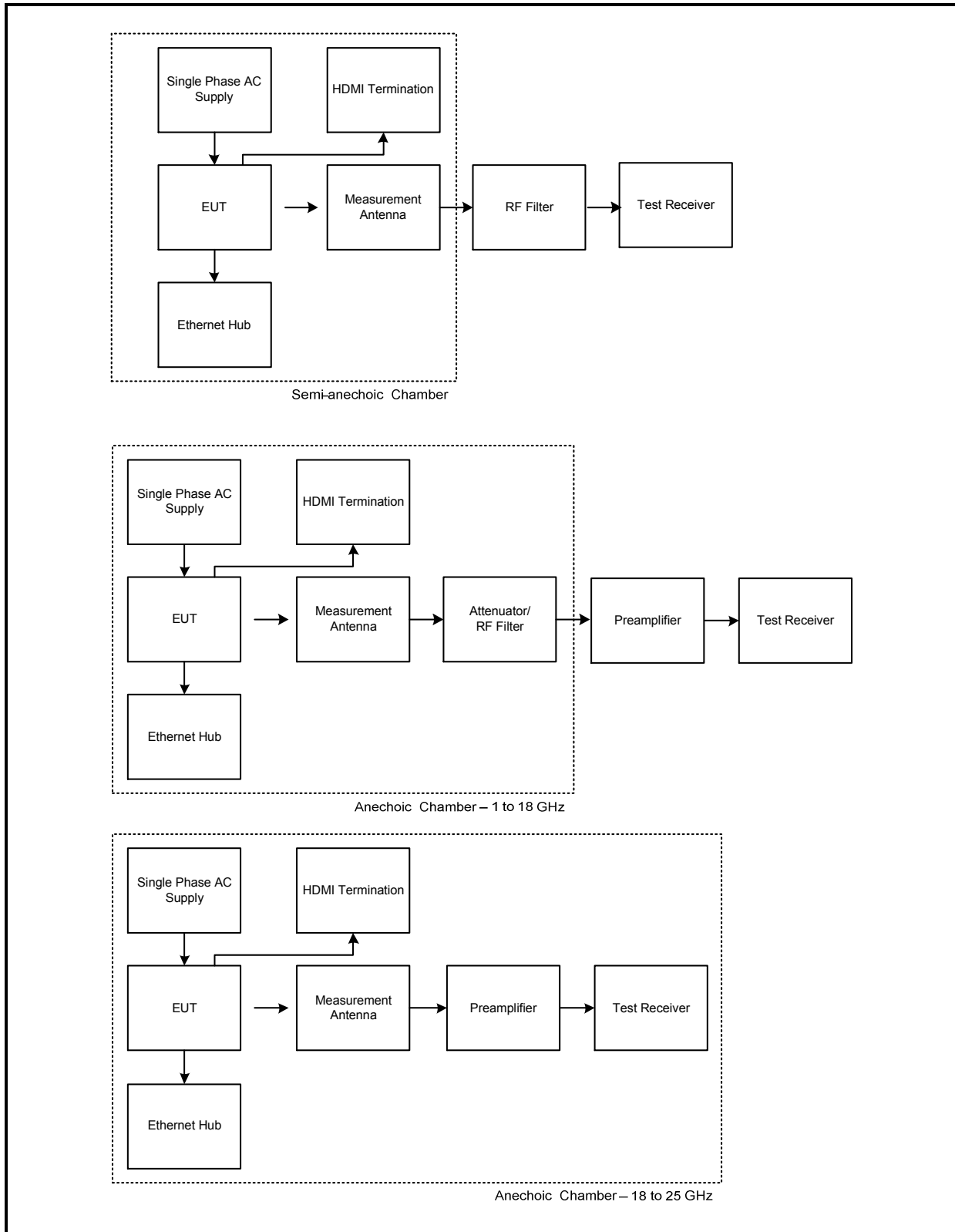
- Continuously transmitting with a modulated carrier at maximum power on the relevant channels as required using the supported data rates/modulation types.

Configuration and Peripherals

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

- The EUT was controlled in test mode using a software application on the laptop PC supplied by the customer. The application was used to enable a continuous transmission and to select the test channels as required. The customer supplied a document containing the setup instructions 'EUT_setup_v3.2.docx'. The laptop PC was connected to the EUT via a Goldeneye adaptor and Kanzi cable.
- The customer declared the worst case SISO and MIMO modes for testing which were:
 - o 802.11b: 1 Mbit/s / SISO on Port 1
 - o 802.11g: 6 Mbit/s / SISO on Port 1
 - o 802.11n HT20: MCS0 / SISO on Port 1
 - o 802.11n HT20: MCS0 / MIMO (2Tx CDD)
- The EUT has two separate antennas which correspond to two separate antenna ports. Port 1 and Port 2 correspond to antenna 1 and antenna 2 respectively.
- For the Transmitter Minimum 6 dB Bandwidth test, only SISO modes were tested since the bandwidth does not change depending on chains used.
- Transmitter spurious emissions tests were performed with the EUT transmitting 802.11b 1 Mbit/s Port 1 and 802.11n HT20 MCS0 MIMO 2 Tx CDD.
- During radiated emissions tests, the HDMI port was terminated into a Cyclone multimedia player adaptor. Once placed in test mode, the Goldeneye adaptor and USB to lightning cable were removed and replaced with an Ethernet cable terminated into an Ethernet hub.
- The conducted sample with serial number C07TK02MJ4C7 was used for minimum 6 dB bandwidth, maximum output power and power spectral density tests.
- The radiated samples with the serial numbers C07TK007J4C6 and C07TK026J4C7, were used radiated emissions tests.
- The radiated samples with the serial numbers C07TK02MJ4C7 and C07TK002J4C6, were used band edge radiated emissions tests.
- Additional testing on channels near the upper band edge was requested.

Test Setup Diagrams**Conducted Tests:****Test Setup for Transmitter Minimum 6 dB Bandwidth, Power Spectral Density & Maximum (Average) Output Power**

Radiated Tests:**Test Setup for Transmitter Radiated Emissions**

4. Antenna Port Test Results

4.1. Transmitter Minimum 6 dB Bandwidth

Test Summary:

Test Engineer:	Georgios Vrezas	Test Date:	29 July 2017
Test Sample Serial Number:	C07TK02MJ4C7		

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

Environmental Conditions:

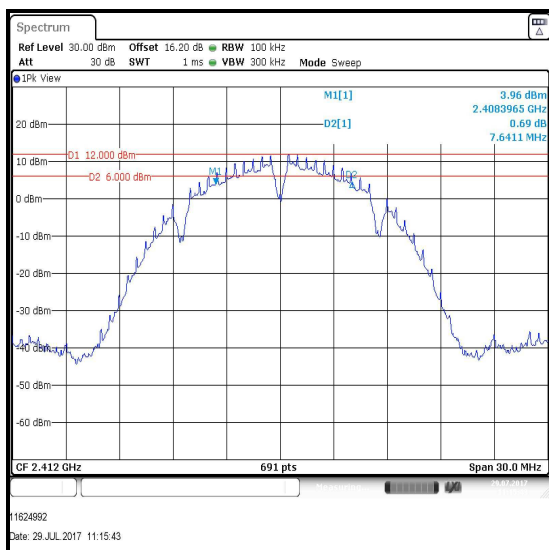
Temperature (°C):	25
Relative Humidity (%):	42

Note(s):

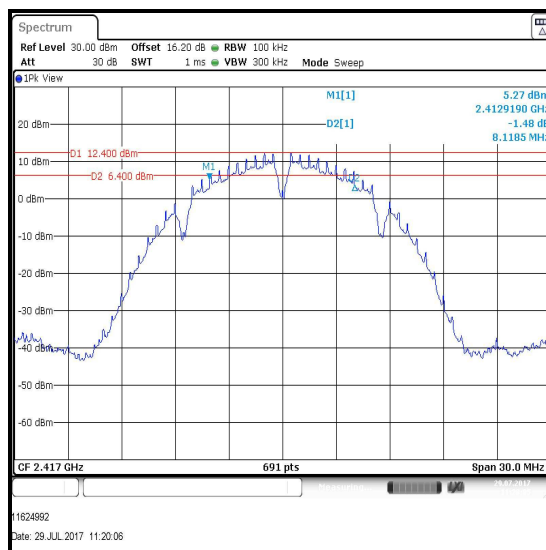
1. For the Transmitter Minimum 6 dB Bandwidth test, only the following SISO modes were tested since the bandwidth does not change depending on chains used:
 - o 802.11b – 1 Mbit/s / SISO on Port 1
 - o 802.11g – 6 Mbit/s / SISO on Port 1
 - o 802.11n HT20 – MCS0 / SISO on Port 1
2. Final measurements 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. Additional channels were tested as requested by the customer. 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 30 MHz. The DTS bandwidth was measured at 6 dB down from the peak of the signal.
3. The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cables. An RF level offset was entered on the signal analyser to compensate for the loss of the switch, attenuator and RF cables.

Transmitter Minimum 6 dB Bandwidth (continued)**Results: 802.11b / 20 MHz / DBPSK / 1 Mbit/s / Port 1**

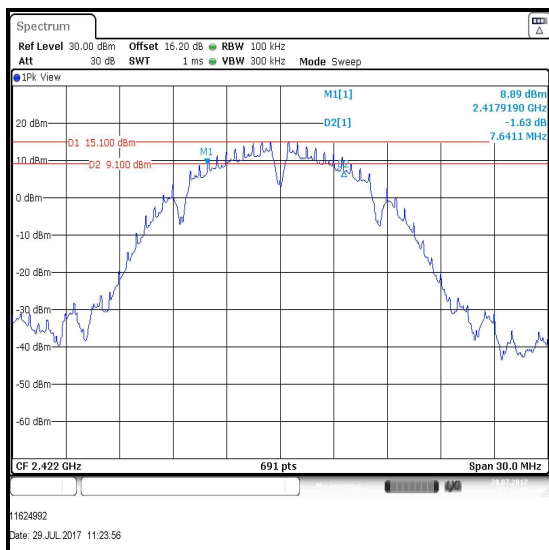
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
1	7641	≥500	7141	Complied
2	8119	≥500	7619	Complied
3	7641	≥500	7141	Complied
6	8162	≥500	7662	Complied
7	7641	≥500	7141	Complied
11	8162	≥500	7662	Complied
12	8119	≥500	7619	Complied
13	7641	≥500	7141	Complied

Transmitter Minimum 6 dB Bandwidth (continued)**Results: 802.11b / 20 MHz / DBPSK / 1 Mbit/s / Port 1**

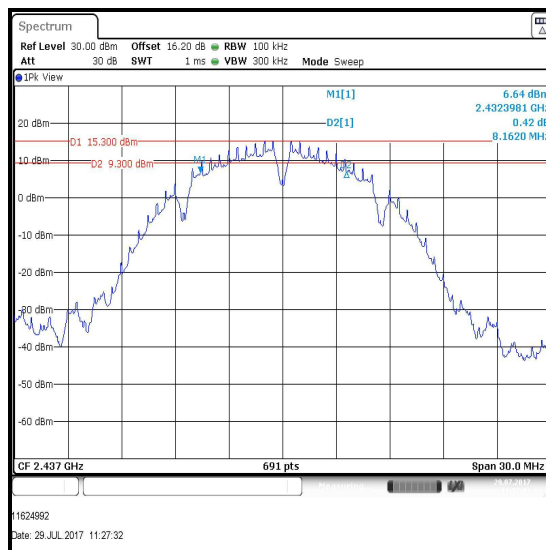
Channel 1



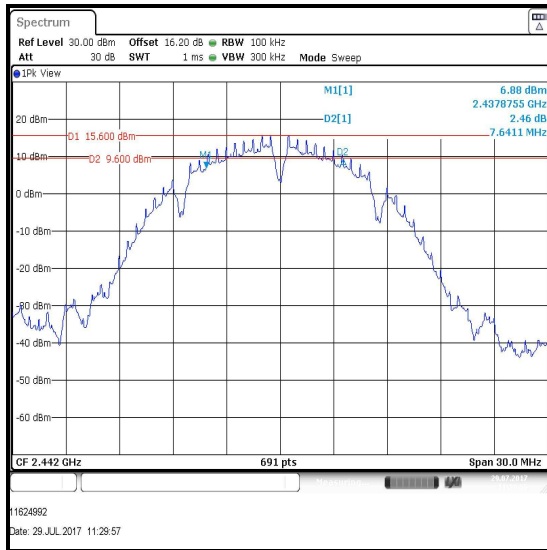
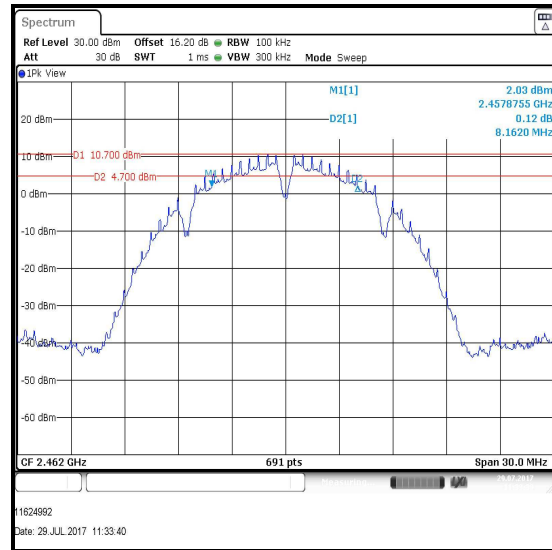
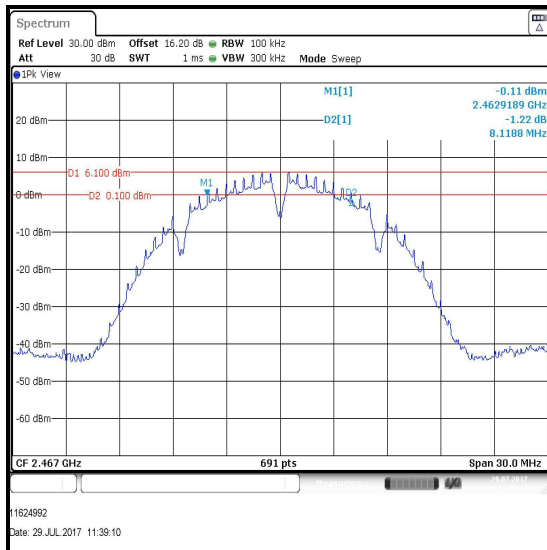
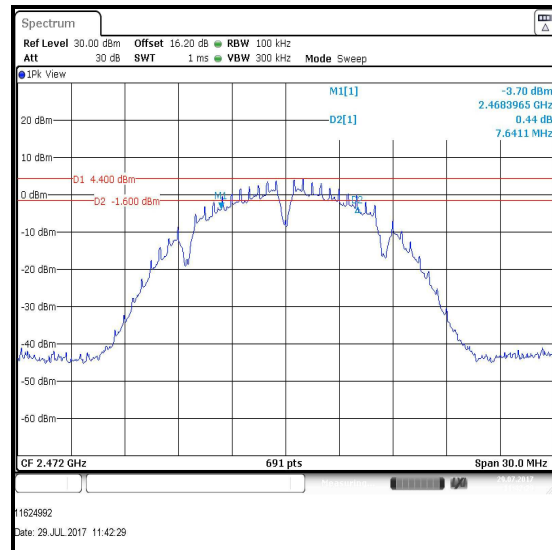
Channel 2



Channel 3

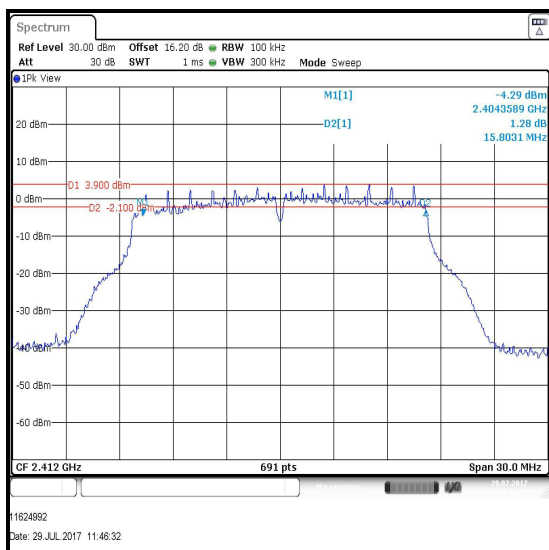
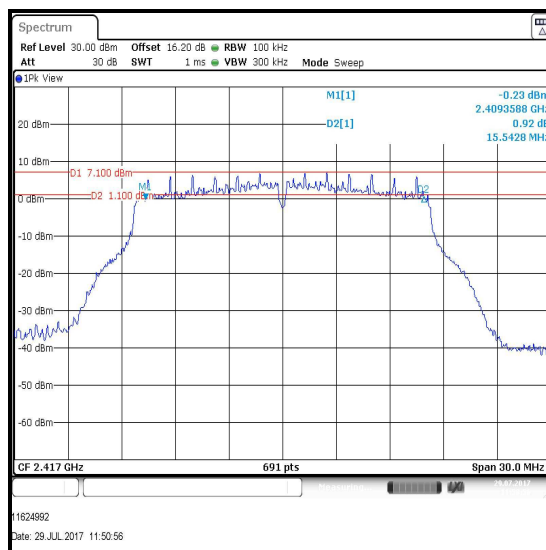
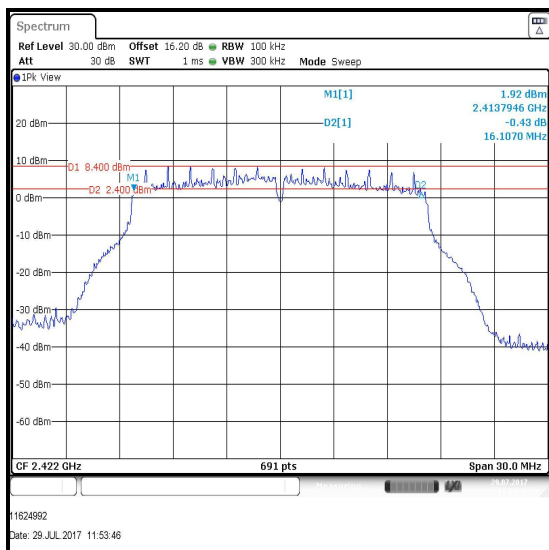
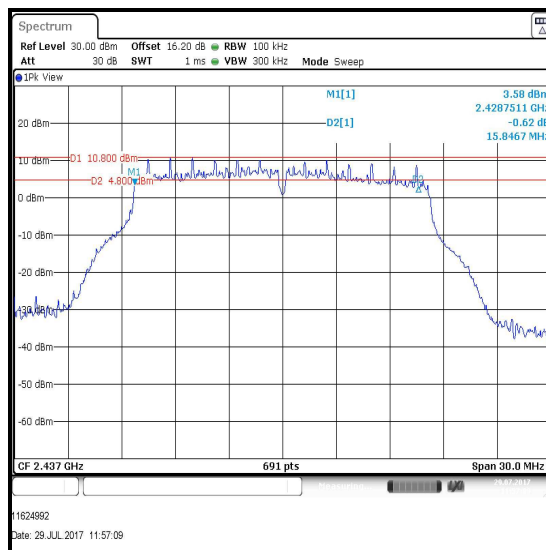


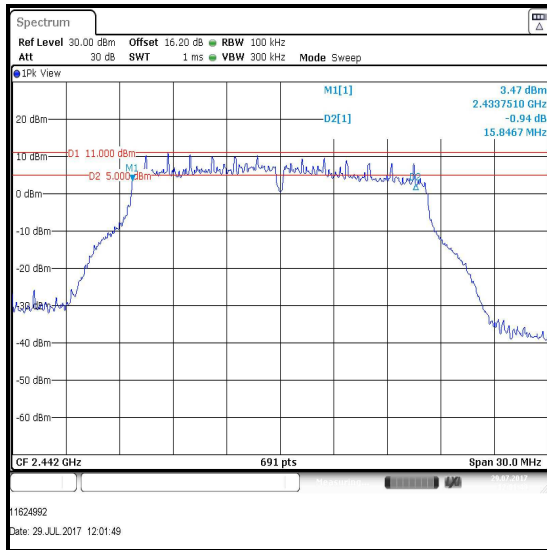
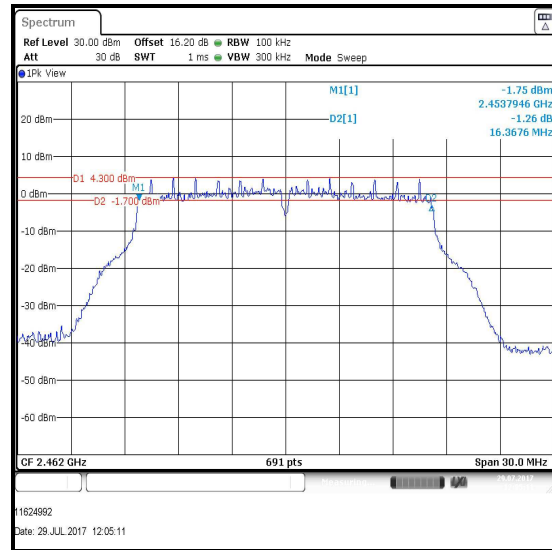
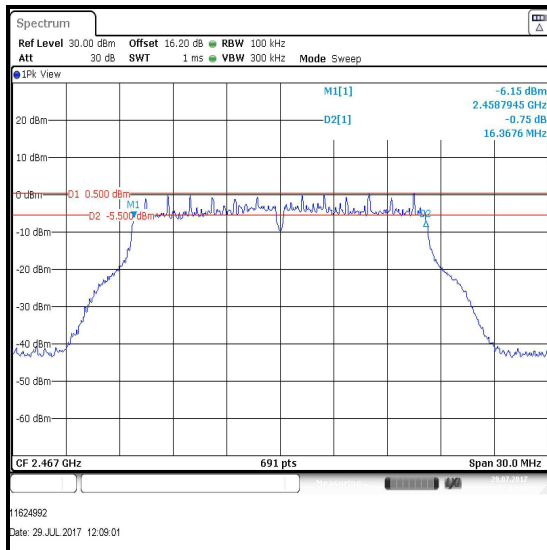
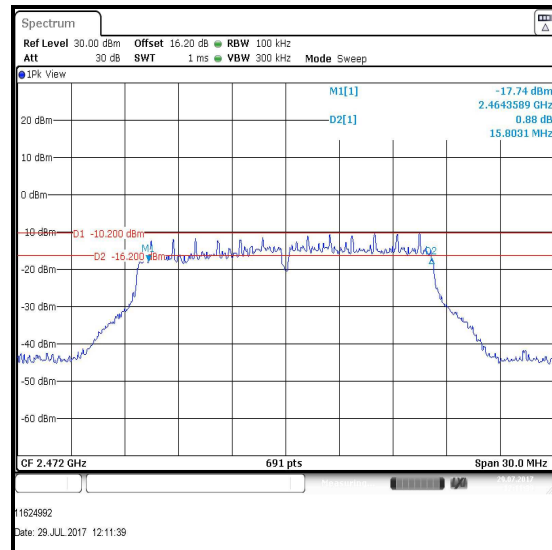
Channel 6

Transmitter Minimum 6 dB Bandwidth (continued)**Results: 802.11b / 20 MHz / DBPSK / 1 Mbit/s / Port 1****Channel 7****Channel 11****Channel 12****Channel 13**

Transmitter Minimum 6 dB Bandwidth (continued)**Results: 802.11g / 20 MHz / BPSK / 6 Mbit/s / Port 1**

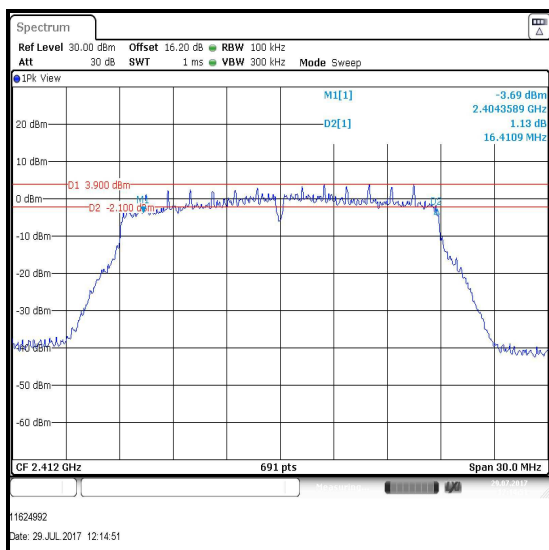
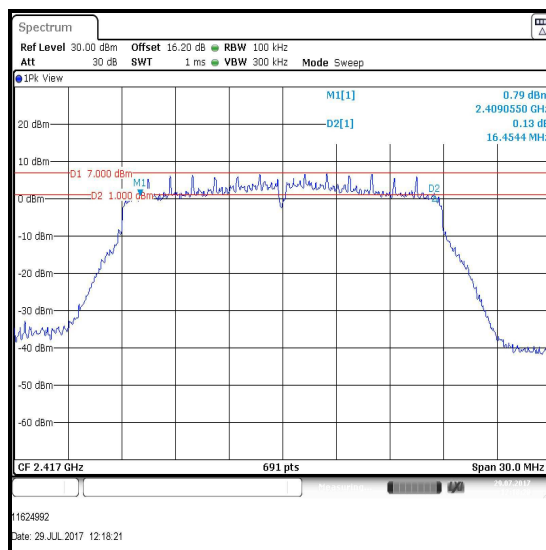
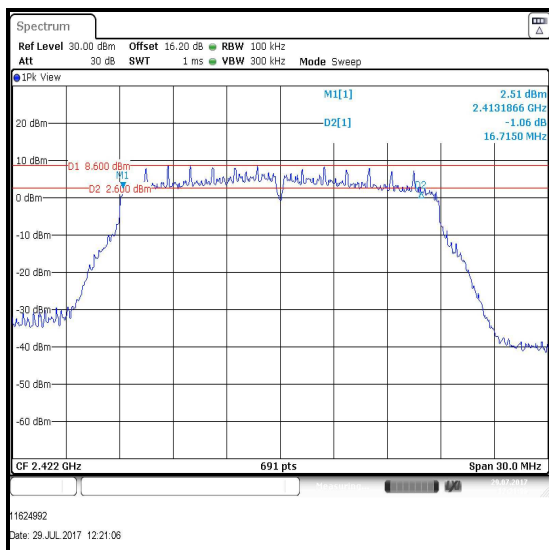
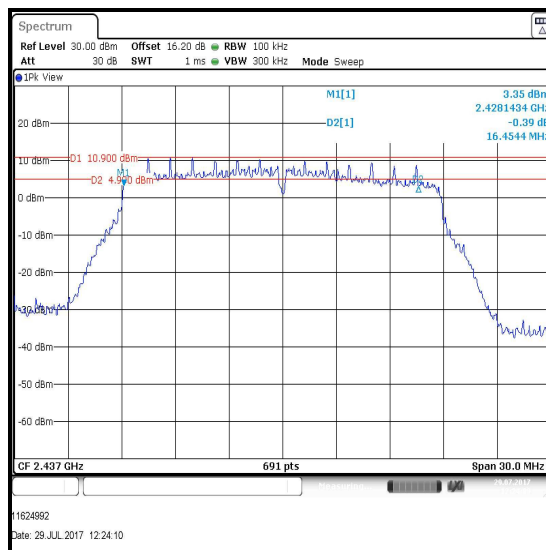
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
1	15803	≥500	15303	Complied
2	15543	≥500	15043	Complied
3	16107	≥500	15607	Complied
6	15847	≥500	15347	Complied
7	15847	≥500	15347	Complied
11	16368	≥500	15868	Complied
12	16368	≥500	15868	Complied
13	15803	≥500	15303	Complied

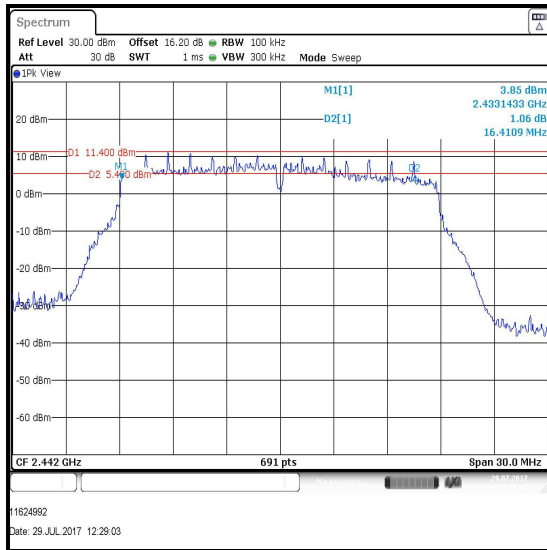
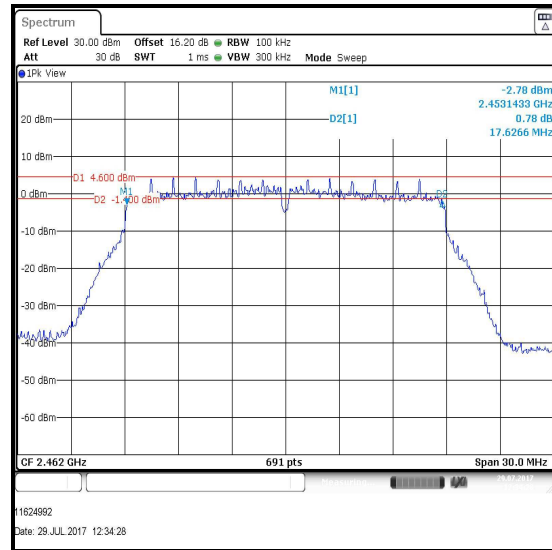
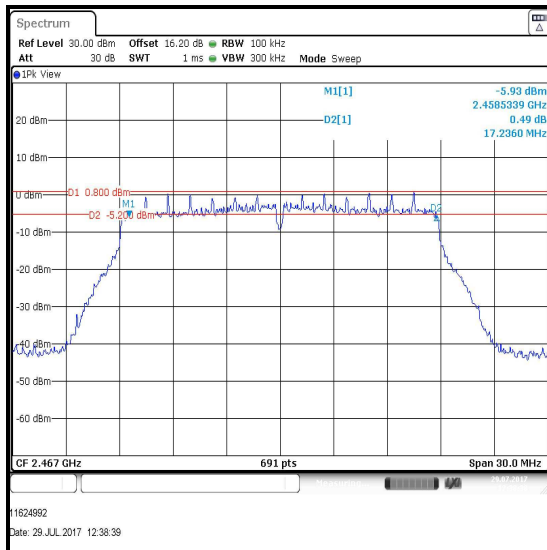
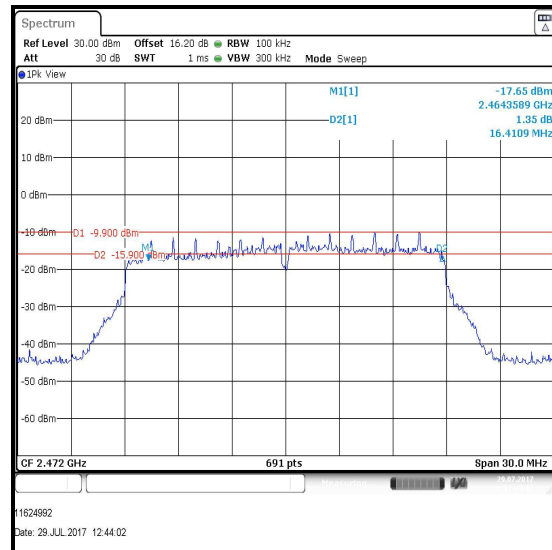
Transmitter Minimum 6 dB Bandwidth (continued)**Results: 802.11g / 20 MHz / BPSK / 6 Mbit/s / Port 1****Channel 1****Channel 2****Channel 3****Channel 6**

Transmitter Minimum 6 dB Bandwidth (continued)**Results: 802.11g / 20 MHz / BPSK / 6 Mbit/s / Port 1****Channel 7****Channel 11****Channel 12****Channel 13**

Transmitter Minimum 6 dB Bandwidth (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / Port 1**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
1	16411	≥500	15911	Complied
2	16454	≥500	15954	Complied
3	16715	≥500	16215	Complied
6	16454	≥500	15954	Complied
7	16411	≥500	15911	Complied
11	17627	≥500	17127	Complied
12	17236	≥500	16736	Complied
13	16411	≥500	15911	Complied

Transmitter Minimum 6 dB Bandwidth (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / Port 1****Channel 1****Channel 2****Channel 3****Channel 6**

Transmitter Minimum 6 dB Bandwidth (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / Port 1****Channel 7****Channel 11****Channel 12****Channel 13**

4.2. Transmitter Power Spectral Density

Test Summary:

Test Engineer:	Georgios Vrezas	Test Date:	29 July 2017
Test Sample Serial Number:	C07TK02MJ4C7		

FCC Reference:	Part 15.247(e)
Test Method Used:	FCC KDB 558074 Section 10.3 and Notes below

Environmental Conditions:

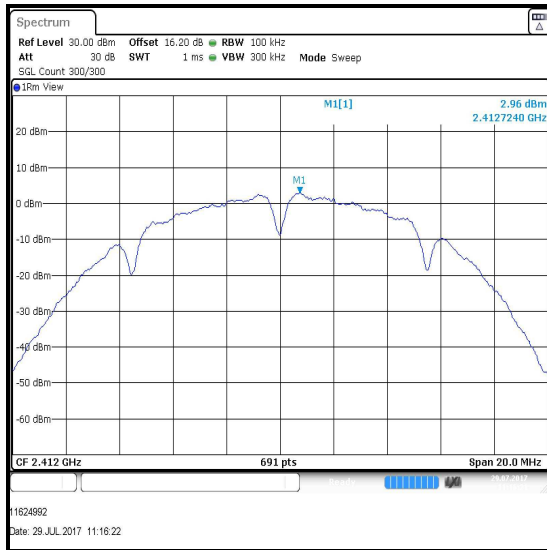
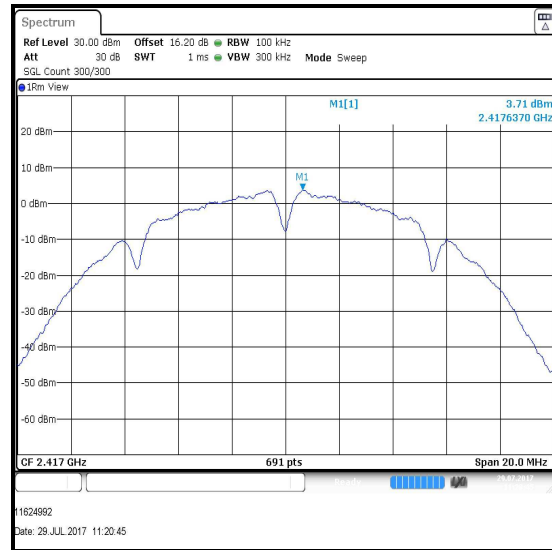
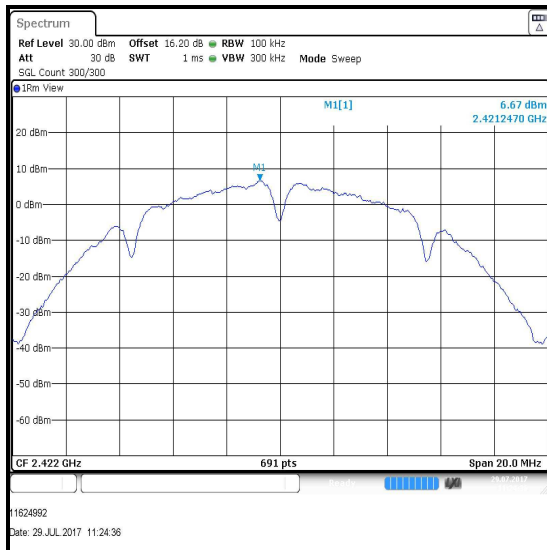
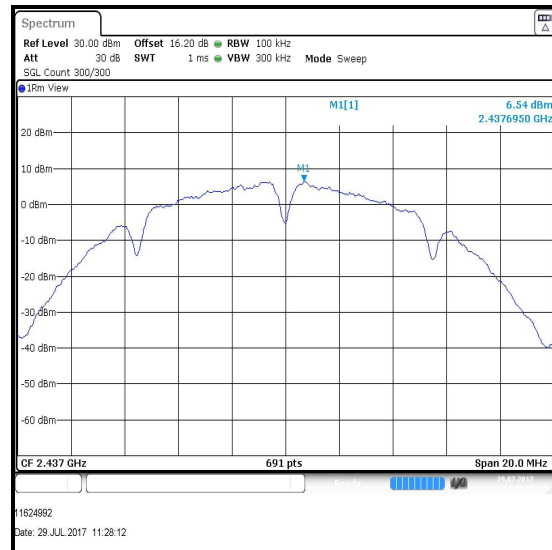
Temperature (°C):	25
Relative Humidity (%):	42

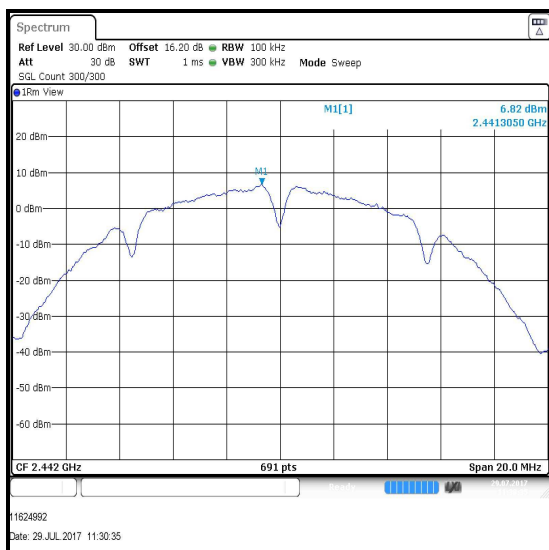
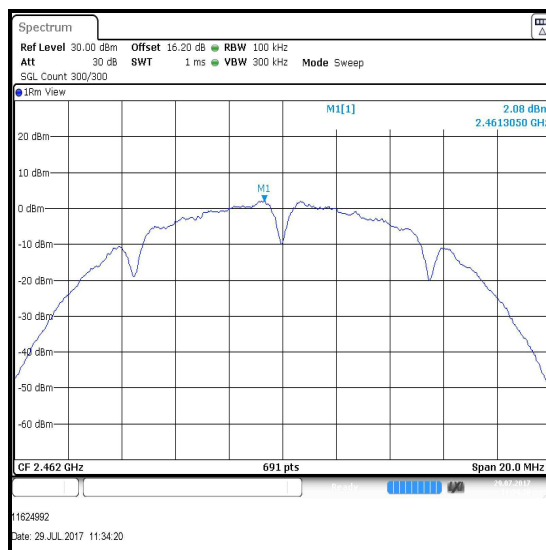
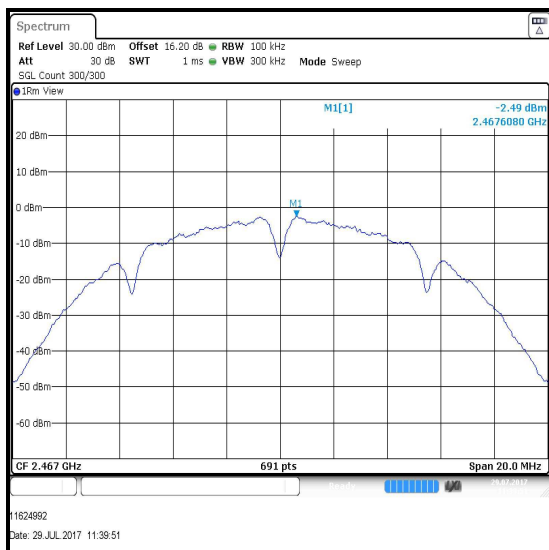
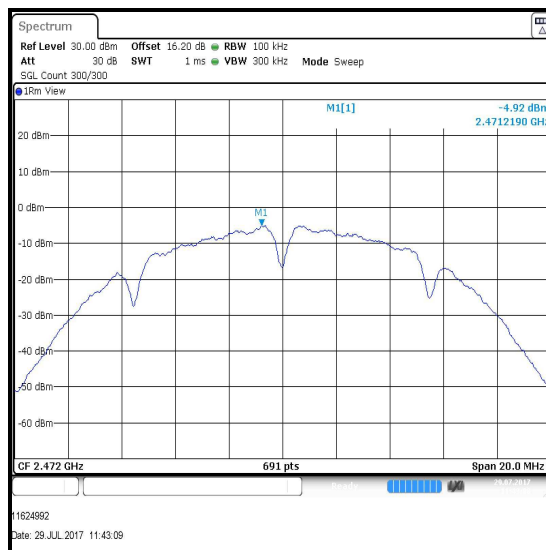
Note(s):

1. The customer requested the following data rates to be used for all measurements:
 - o 802.11b – 1 Mbit/s / SISO on Port 1
 - o 802.11g – 6 Mbit/s / SISO on Port 1
 - o 802.11n HT20 – MCS0 / SISO on Port 1
 - o 802.11n HT20 – MCS0 / MIMO (2Tx CDD)
2. Final measurements were performed using the above configurations on the bottom, middle and top channels. Additional channels were tested as requested by the customer.
3. Testing was performed in accordance with KDB 558074 Section 10.3 Method AVGPSSD-1. The signal analyser resolution bandwidth was set to 100 kHz and video bandwidth to 300 kHz. An RMS detector was used and sweep time set manually to perform trace averaging over 300 traces. The span was set to at least 1.5 times the 99% occupied emission bandwidth. The highest peak of the measured signal was recorded.
4. For 802.11n MIMO, PSD was measured on both ports and then combined using the *measure and sum spectral maxima across the outputs* technique, stated in FCC KDB 662911 D01 Section E)2)a).
5. The signal analyser was connected to the RF ports on the EUT using an RF switch, suitable attenuation and RF cables. An RF level offset was entered on the signal analyser to compensate for the loss of the switch, attenuators and RF cables.

Transmitter Power Spectral Density (continued)**Results: 802.11b / 20 MHz / DBPSK / 1 Mbit/s / Port 1**

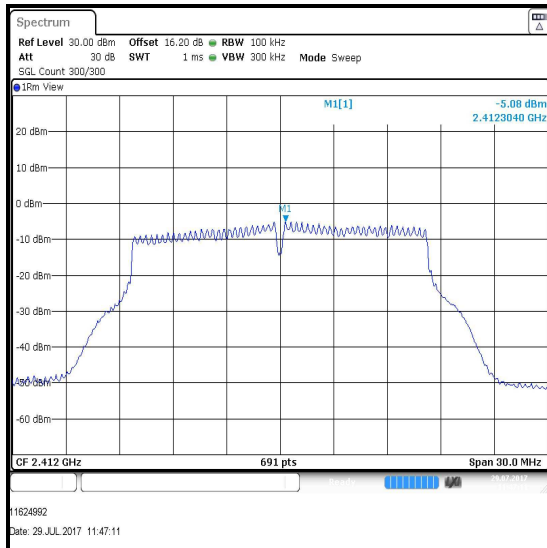
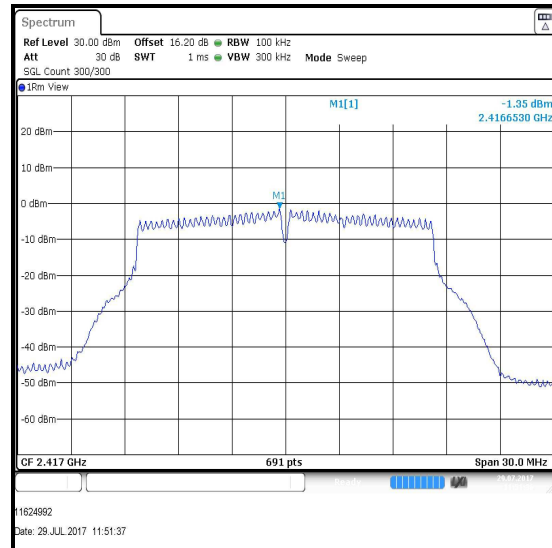
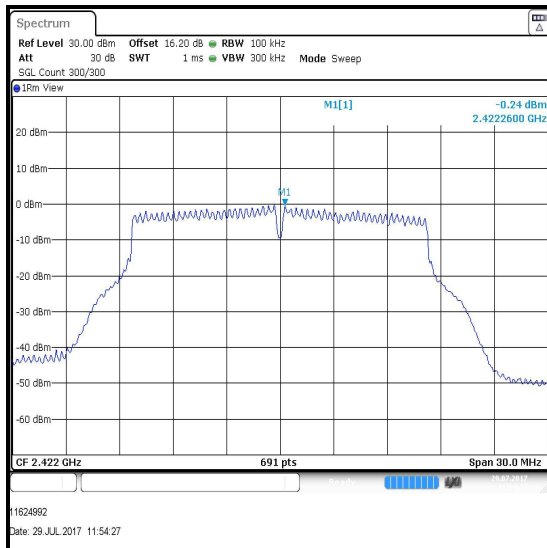
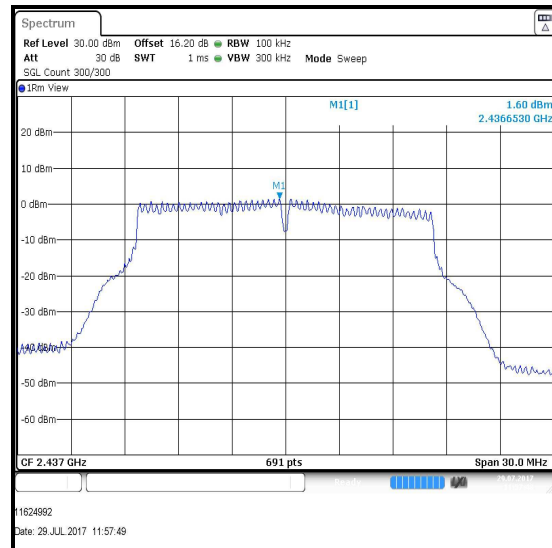
Channel	Output Power (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
1	3.0	8.0	5.0	Complied
2	3.7	8.0	4.3	Complied
3	6.7	8.0	1.3	Complied
6	6.5	8.0	1.5	Complied
7	6.8	8.0	1.2	Complied
11	2.1	8.0	5.9	Complied
12	-2.5	8.0	10.5	Complied
13	-4.9	8.0	12.9	Complied

Transmitter Power Spectral Density (continued)**Results: 802.11b / 20 MHz / DBPSK / 1 Mbit/s / Port 1****Channel 1****Channel 2****Channel 3****Channel 6**

Transmitter Power Spectral Density (continued)**Results: 802.11b / 20 MHz / DBPSK / 1 Mbit/s / Port 1****Channel 7****Channel 11****Channel 12****Channel 13**

Transmitter Power Spectral Density (continued)**Results: 802.11g / 20 MHz / BPSK / 6 Mbit/s / Port 1**

Channel	Output Power (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
1	-5.1	8.0	13.1	Complied
2	-1.3	8.0	9.3	Complied
3	-0.2	8.0	8.2	Complied
6	1.6	8.0	6.4	Complied
7	1.3	8.0	6.7	Complied
11	-4.7	8.0	12.7	Complied
12	-8.4	8.0	16.4	Complied
13	-19.8	8.0	27.8	Complied

Transmitter Power Spectral Density (continued)**Results: 802.11g / 20 MHz / BPSK / 6 Mbit/s / Port 1****Channel 1****Channel 2****Channel 3****Channel 6**