



TEST REPORT

Test Report No. : UL-RPT-RP11161473JD06A

Manufacturer : Apple Inc.
Model No. : A1706
FCC ID : BCGA1706
Technology : WLAN
Test Standard(s) : FCC Parts 15.209(a) & 15.247

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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 1.0

Date of Issue: 28 September 2016

Checked by:

Sarah Williams
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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.

UL VS LTD

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1. Customer Information

Company Name:	Apple
Address:	1 Infinite Loop Cupertino, CA 95014 U.S.A

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR15.247
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
Specification Reference:	47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.209
Site Registration:	209735
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	07 August 2016 to 23 September 2016

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.247(a)(2)	Transmitter Minimum 6 dB Bandwidth	Complied
Part 15.35(c)	Transmitter Duty Cycle	Note 1
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):

1. For the data rates declared as worst cases and tested in this test report, duty cycle was measured to be greater than 98%. Plots for these measurements are archived on the company server and available for inspection upon request

2.3. Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	KDB 558074 D01 DTS Meas Guidance v03r05 April 8, 2016
Title:	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §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

2.4. Deviations from the Test Specification

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

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	Apple
Model Name or Number:	A1706
Test Sample Serial Number:	C02S200CHH5Q (<i>Conducted sample with RF ports</i>)
Hardware Version:	EVT
Software Version:	OS: 16B2272a WLAN: 7.21.171.5
FCC ID:	BCGA1706

Brand Name:	Apple
Model Name or Number:	A1706
Test Sample Serial Number:	C02S2003HH5Y (<i>Radiated sample #1</i>)
Hardware Version:	EVT
Software Version:	OS: 16B2272a WLAN: 7.21.171.5
FCC ID:	BCGA1706

Brand Name:	Apple
Model Name or Number:	A1706
Test Sample Serial Number:	C02S200EHH5Q (<i>Radiated sample #2</i>)
Hardware Version:	EVT
Software Version:	OS: 16B2272a WLAN: 7.21.171.5
FCC ID:	BCGA1706

Brand Name:	Apple
Model Name or Number:	A1706
Test Sample Serial Number:	C02S200CHH5W (<i>Radiated sample #3</i>)
Hardware Version:	EVT
Software Version:	OS: 16B2272a WLAN: 7.21.171.5
FCC ID:	BCGA1706

3.2. Description of EUT

The equipment under test was a Notebook PC with 2.4 GHz and 5 GHz wireless LAN and Bluetooth capabilities.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Technology Tested:	WLAN (IEEE 802.11b,g,n) / Digital Transmission System	
Type of Unit:	Transceiver	
Modulation Type:	DBPSK, DQPSK, BPSK, QPSK, 16QAM & 64QAM	
Data Rates:	802.11b	1, 2, 5.5 & 11 Mbit/s
	802.11g	6, 9, 12, 18, 24, 36, 48 & 54 Mbit/s
	802.11n HT20	MCS0 to MCS7 (1 spatial stream with either SISO or 2/3-chain MIMO CDD/TxBF operation) MCS8 to MCS15 (2 spatial streams on 2 transmit chains w/ or w/o TxBF) MCS16 to MCS23 (3 spatial streams on 3 transmit chains w/ or w/o TxBF)
Power Supply Requirement(s):	Nominal	3.8 VDC via 120 VAC 60 Hz adaptor
Maximum Conducted Output Power:	16.7 dBm	
Declared Antenna Gain:	Port 1:	2.0 dBi
	Port 2:	3.3 dBi
	Port 3:	2.3 dBi
Directional Antenna Gain: (see Note 1)	Ports 2 & 3	5.8 dBi
	Ports 1, 2 & 3	7.3 dBi
Channel Spacing:	20 MHz	
Transmit Frequency Range:	2400 MHz to 2483.5 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

Note(s):

1. Detailed calculations can be found in Appendix 2.

3.5. Support Equipment

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

Description:	Test Laptop
Brand Name:	Apple
Model Name or Number:	MacBook Pro
Serial Number:	C2QLQ03XF9F2

Description:	AC to DC Power adaptor
Brand Name:	Apple
Model Name or Number:	A1718
Serial Number:	Not marked or stated

Description:	USB-C Charge Cable (2 m)
Brand Name:	Apple
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	Personal Hands Free (PHF)
Brand Name:	Apple
Model Name or Number:	Apple Ear Plugs
Serial Number:	Not marked or stated

Description:	USB-A to USB-C adaptor (x3)
Brand Name:	Apple
Model Name or Number:	A1632
Serial Number:	Not marked or stated

Description:	USB Hub
Brand Name:	Belkin
Model Name or Number:	Not marked or stated
Serial Number:	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):

- The customer declared the worst case SISO and MIMO modes for testing which were:
 - o 802.11b: 1 Mbit/s / SISO on Port 2
 - o 802.11g: 6 Mbit/s / SISO on Port 2
 - o 802.11n HT20: MCS0 / SISO on Port 2
 - o 802.11n HT20: MCS0 / MIMO (2Tx CDD) on Ports 2 & 3
 - o 802.11n HT20: MCS0 / MIMO (3Tx CDD) on Ports 1, 2 & 3
 - o 802.11n HT20: MCS0 / MIMO (2Tx CDD with TxBF) on Ports 2 & 3
 - o 802.11n HT20: MCS0 / MIMO (3Tx CDD with TxBF) on Ports 1, 2 & 3
- All the above listed modes were tested on the EUT. The beamforming (TxBF) modes were found to have the same power or lesser than the equivalent non-TxBF modes and have therefore been excluded from this report. All plots are archived securely on the UL VS IT server and are available for inspection upon request.
- Non-TxBF modes: Continuously transmitting (100% duty cycle) a modulated carrier at target power levels in the above modes and on channels given in section 3.4.
- TxBF modes: Transmitting a modulated carrier with maximum possible duty cycle at target power levels in the above modes and on channels given in section 3.4.
- For the Transmitter Minimum 6 dB Bandwidth test, only SISO modes were tested since the bandwidth does not change depending on chains used.

4.2. Configuration and Peripherals

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

- For continuous transmit tests, the EUT's WLAN radio was controlled directly by using the supplied chipset manufacturer's 'wl' commands. These were run from within a terminal window on the EUT. The commands used could enable continuous transmission and allowed the selection of test channels, antennas, modes, data rates and modulation schemes as required.
- For TxBF modes, the EUT was communicating via a conducted RF link with an identical device. The EUT ran iPerf bandwidth testing application in client mode to produce maximum throughput.
- The customer supplied U.FL RF cables with the EUT in order to perform conducted measurements. This measured additional path loss was measured and included in any path loss calculations.
- Radiated Emissions testing was performed with the EUT in normal position and whilst charging through its power supply. All ports on the EUT were populated with applicable cables and terminations during the test.

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 Minimum 6 dB Bandwidth

Test Summary:

Test Engineer:	Sandeep Bharat	Test Dates:	02 September 2016 & 05 September 2016
Test Sample Serial Number:	C02S200CHH5Q		

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

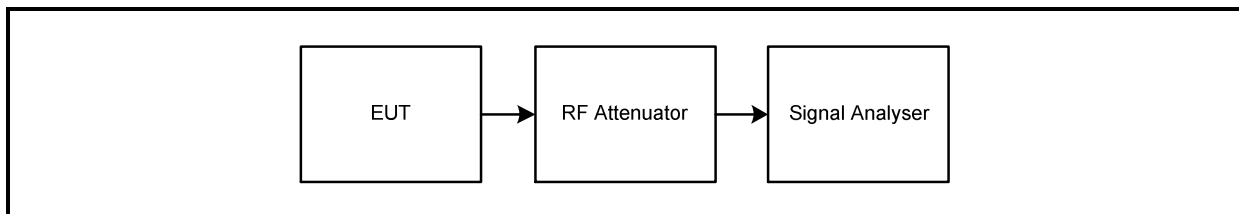
Environmental Conditions:

Temperature (°C):	23 to 24
Relative Humidity (%):	45 to 53

Note(s):

- 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:
 - 802.11b – 1 Mbit/s / SISO on Port 2
 - 802.11g – 6 Mbit/s / SISO on Port 2
 - 802.11n HT20 – MCS0 / SISO on Port 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.
- The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable.

Test setup:

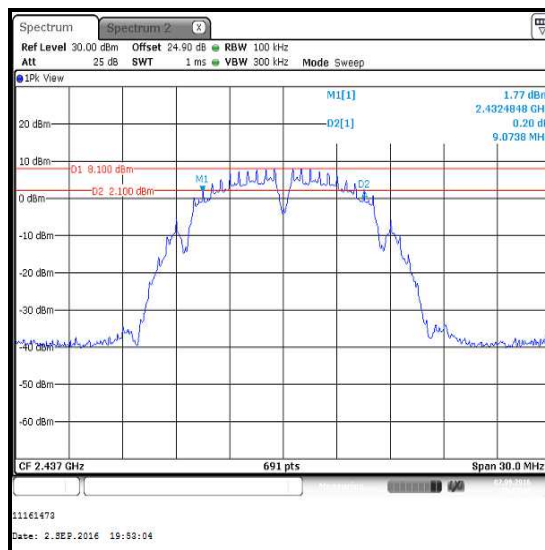


Transmitter Minimum 6 dB Bandwidth (continued)**Results: 802.11b / 20 MHz / DBPSK / 1 Mbit/s / Port 2**

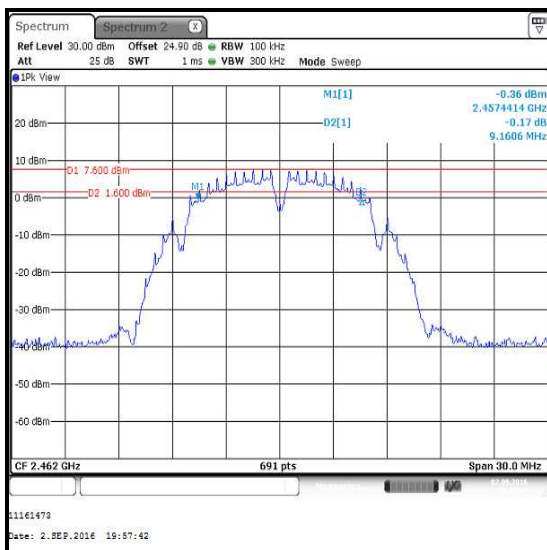
Channel	6dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
1	9117	≥500	8617	Complied
6	9074	≥500	8574	Complied
11	9161	≥500	8661	Complied



Channel 1



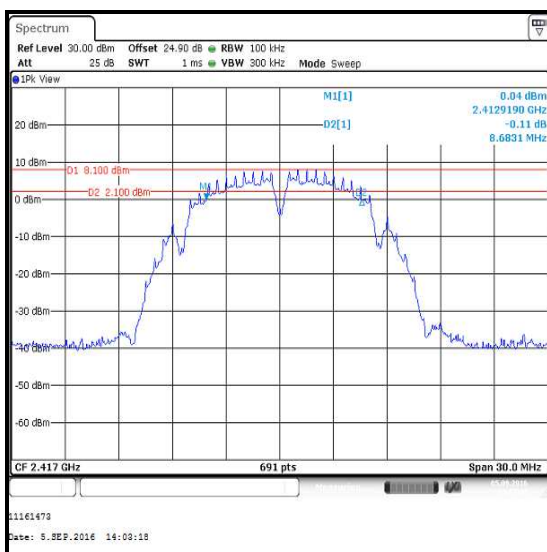
Channel 6



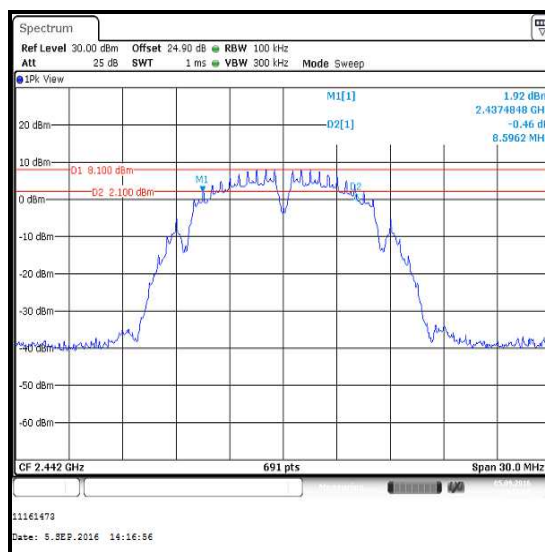
Channel 11

Transmitter Minimum 6 dB Bandwidth (continued)**Results: 802.11b / 20 MHz / DBPSK / 1 Mbit/s / Port 2**

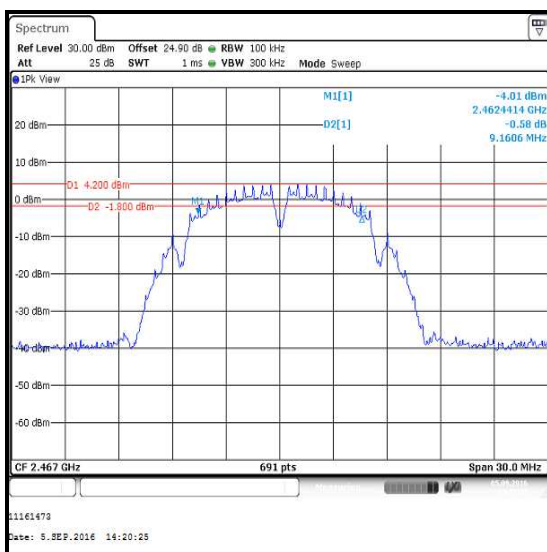
Channel	6dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
2	8683	≥500	8183	Complied
7	8596	≥500	8096	Complied
12	9161	≥500	8661	Complied
13	9074	≥500	8574	Complied



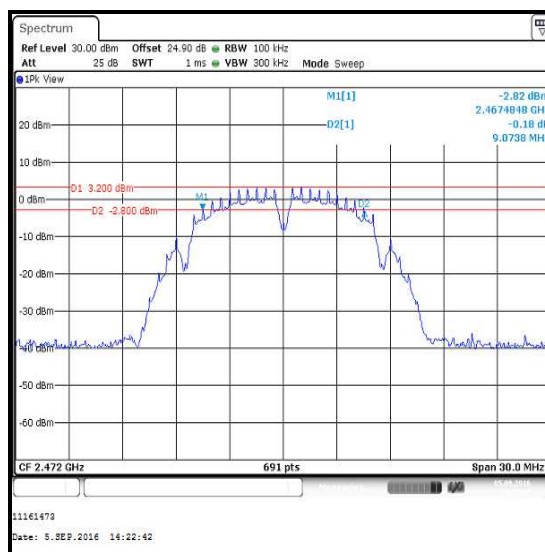
Channel 2



Channel 7



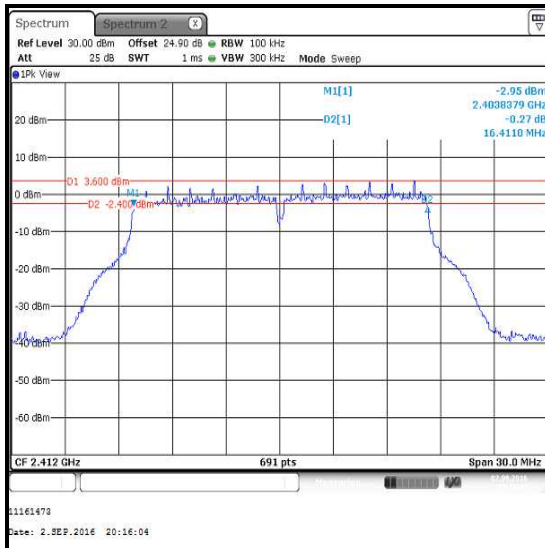
Channel 12



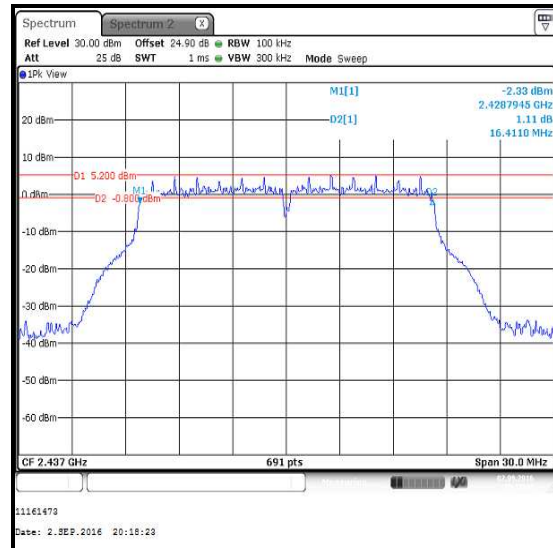
Channel 13

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

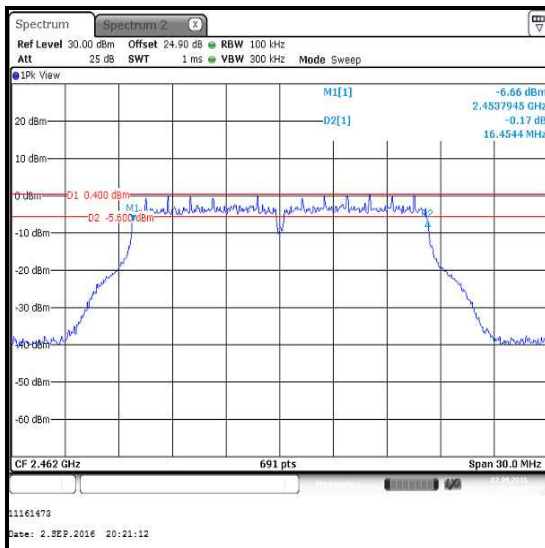
Channel	6dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
1	16411	≥500	15911	Complied
6	16411	≥500	15911	Complied
11	16454	≥500	15954	Complied



Channel 1



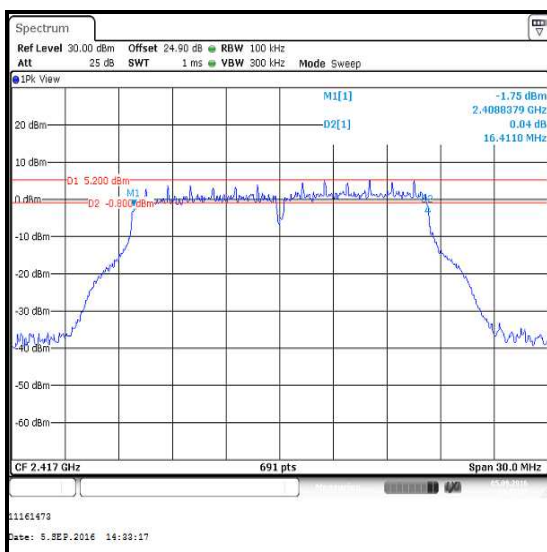
Channel 6



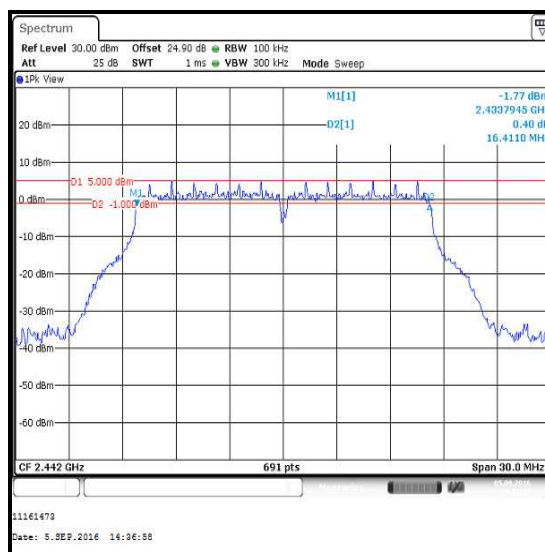
Channel 11

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

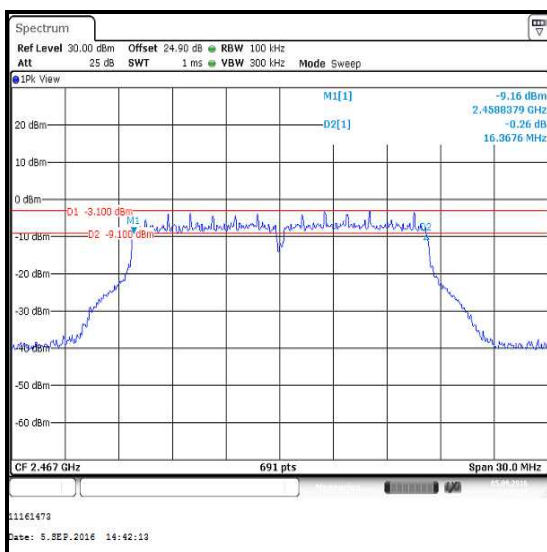
Channel	6dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
2	16411	≥500	15911	Complied
7	16411	≥500	15911	Complied
12	16368	≥500	15868	Complied
13	16411	≥500	15911	Complied



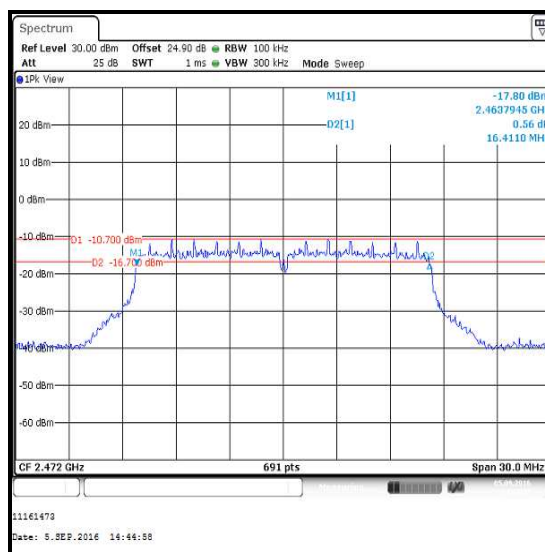
Channel 2



Channel 7



Channel 12

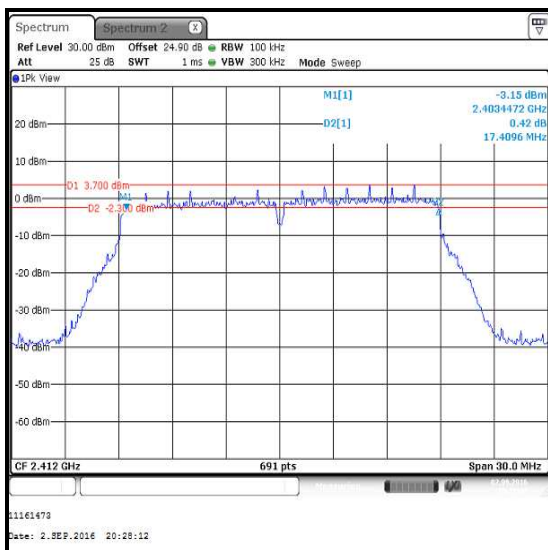


Channel 13

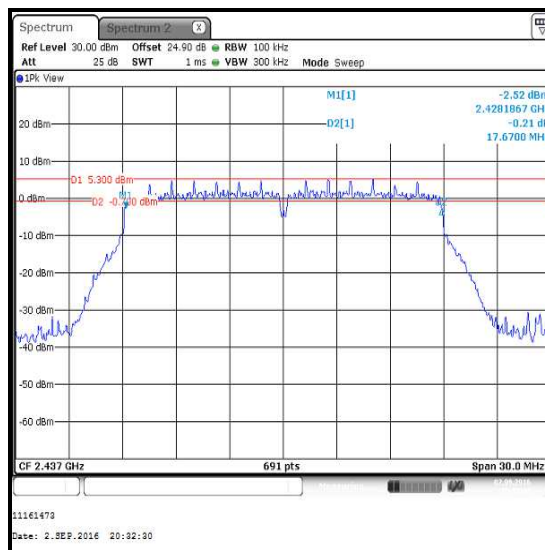
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11n / 20 MHz / BPSK / MCS0 / Port 2

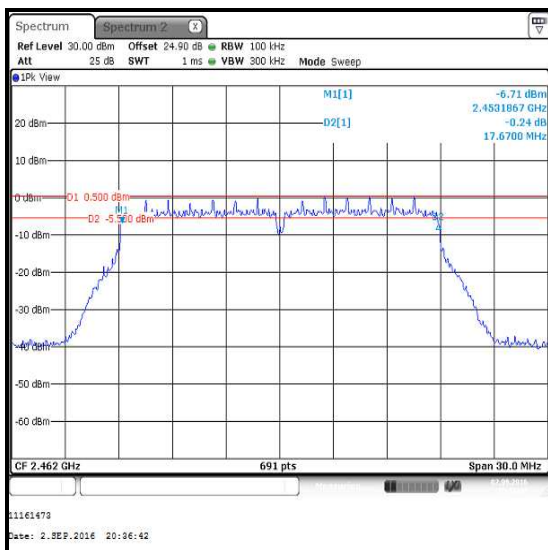
Channel	6dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
1	17410	≥500	16910	Complied
6	17670	≥500	17170	Complied
11	17670	≥500	17170	Complied



Channel 1



Channel 6



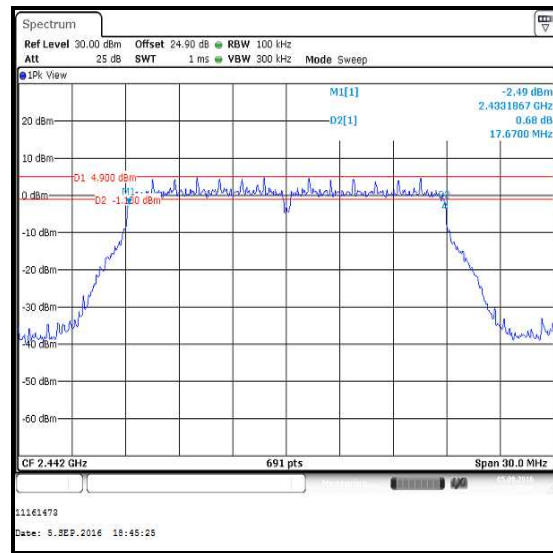
Channel 11

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

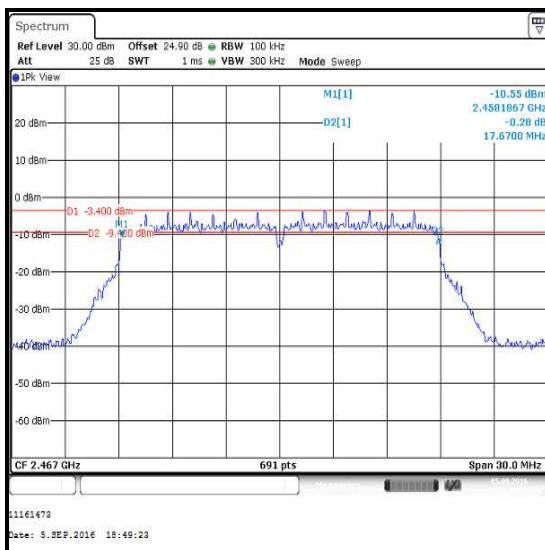
Channel	6dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
2	17279	≥500	16779	Complied
7	17670	≥500	17170	Complied
12	17670	≥500	17170	Complied
13	17670	≥500	17170	Complied



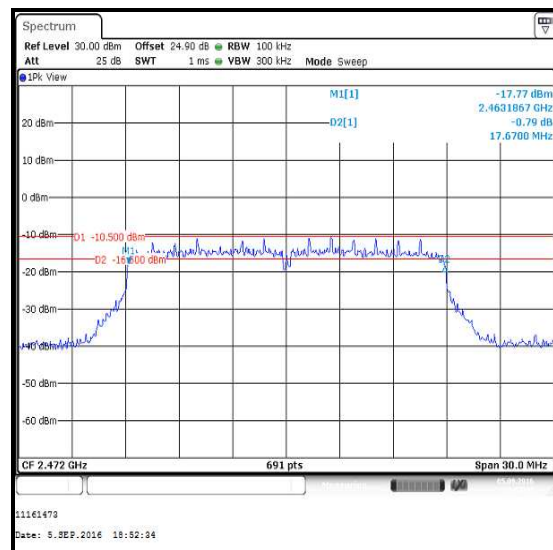
Channel 2



Channel 7



Channel 12



Channel 13

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
M1996	Signal Analyser	Rohde & Schwarz	FSV13	100975	02 Mar 2017	12
A2526	Attenuator	AtlanTecRF	AN18W5-20	832828#1	Calibrated before use	-
G0607	Signal Generator	Rohde & Schwarz	SMU200A	100943	10 May 2019	36

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

Test Engineer:	Sandeep Bharat	Test Dates:	02 September 2016 to 05 September 2016
Test Sample Serial Number:	C02S200CHH5Q		

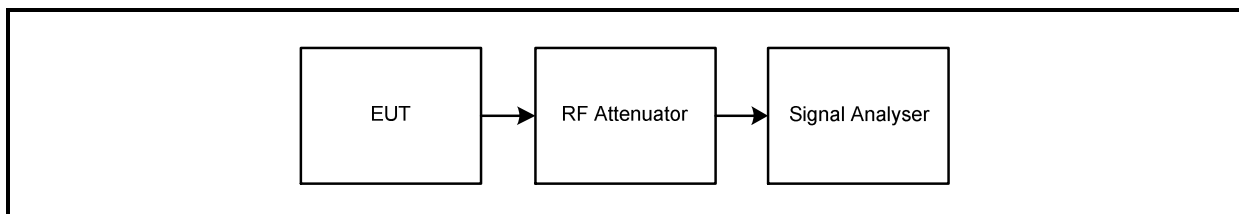
FCC Reference:	Part 15.247(e)
Test Method Used:	FCC KDB 558074 Section 10.3

Environmental Conditions:

Temperature (°C):	23 to 24
Relative Humidity (%):	45 to 53

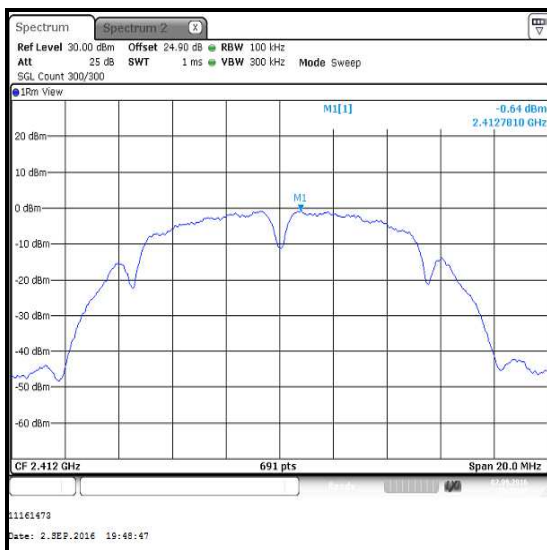
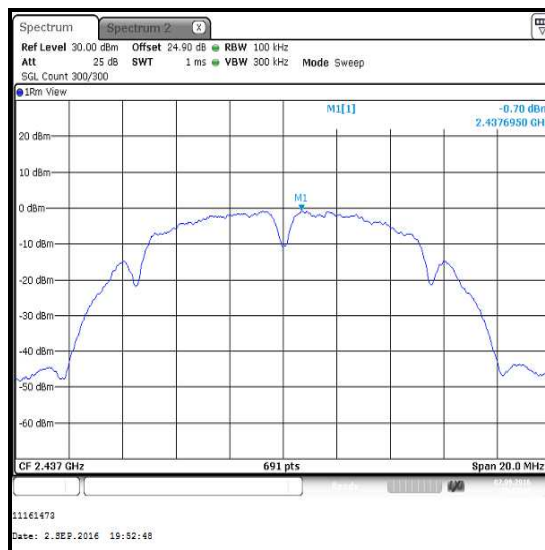
Note(s):

- The customer declared the following data rates to be used for all measurements:
 - o 802.11b – 1 Mbit/s / SISO on Port 2
 - o 802.11g – 6 Mbit/s / SISO on Port 2
 - o 802.11n HT20 – MCS0 / SISO on Port 2
 - o 802.11n HT20 – MCS0 / MIMO (2Tx CDD) on Ports 2 & 3
 - o 802.11n HT20 – MCS0 / MIMO (3Tx CDD) on Ports 1, 2 & 3
- Final measurements were performed using the above configurations on the bottom, middle and top channels. Additional channels were tested as requested by the customer.
- Testing was performed in accordance with KDB 558074 Section 10.3 Method AVGPDS-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 (see Appendix 1 for reference plots). The highest peak of the measured signal was recorded.
- 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).
- The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.

Test setup:

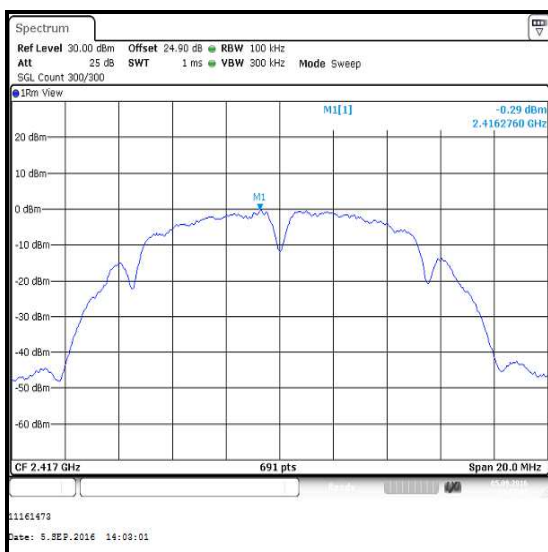
Transmitter Power Spectral Density (continued)**Results: 802.11b / 20 MHz / DBPSK / 1 Mbit/s / Port 2**

Channel	Frequency (MHz)	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
1	2412	-0.6	8.0	8.6	Complied
6	2437	-0.7	8.0	8.7	Complied
11	2462	-0.9	8.0	8.9	Complied

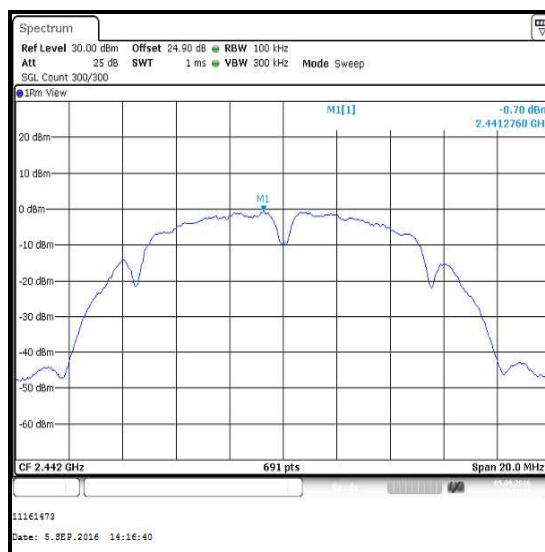
**Channel 1****Channel 6****Channel 11**

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

Channel	Frequency (MHz)	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
2	2417	-0.3	8.0	8.3	Complied
7	2442	-0.7	8.0	8.7	Complied
12	2467	-4.5	8.0	12.5	Complied
13	2472	-5.5	8.0	13.5	Complied



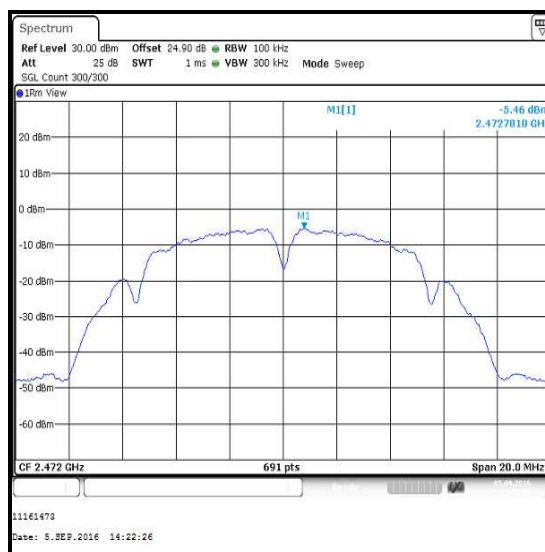
Channel 2



Channel 7



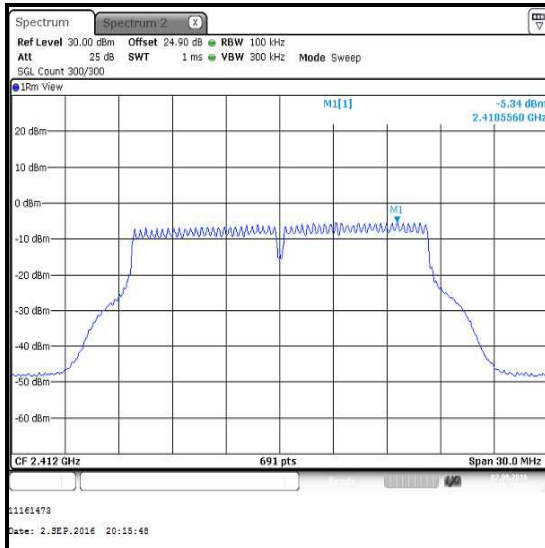
Channel 12



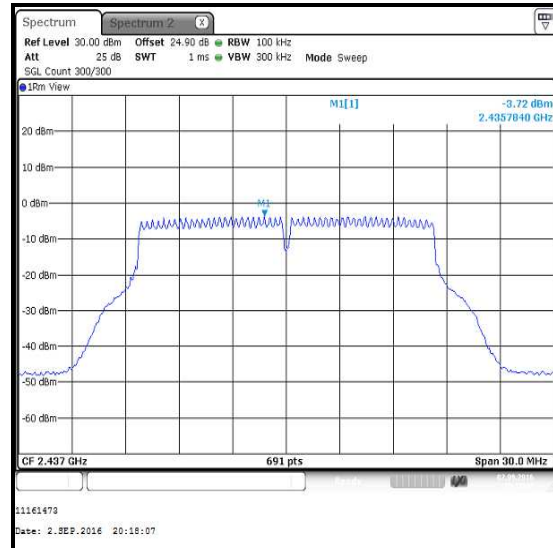
Channel 13

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

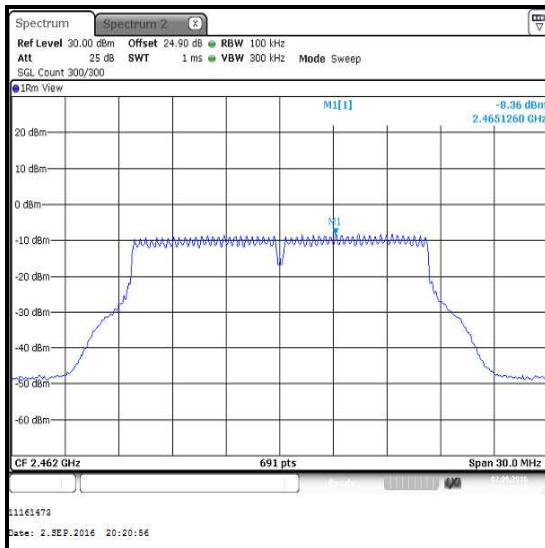
Channel	Frequency (MHz)	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
1	2412	-5.3	8.0	13.3	Complied
6	2437	-3.7	8.0	11.7	Complied
11	2462	-8.4	8.0	16.4	Complied



Channel 1



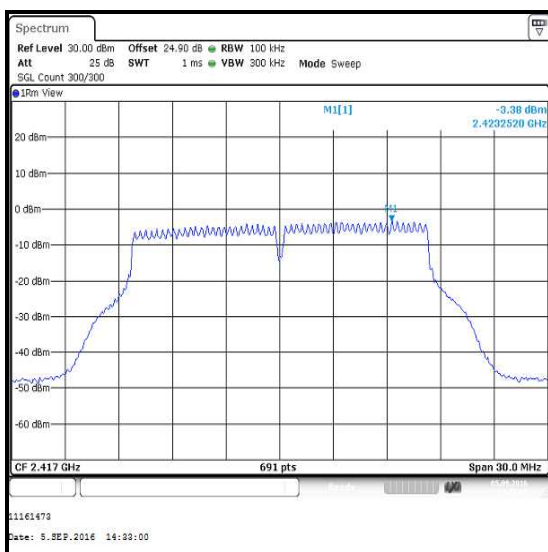
Channel 6



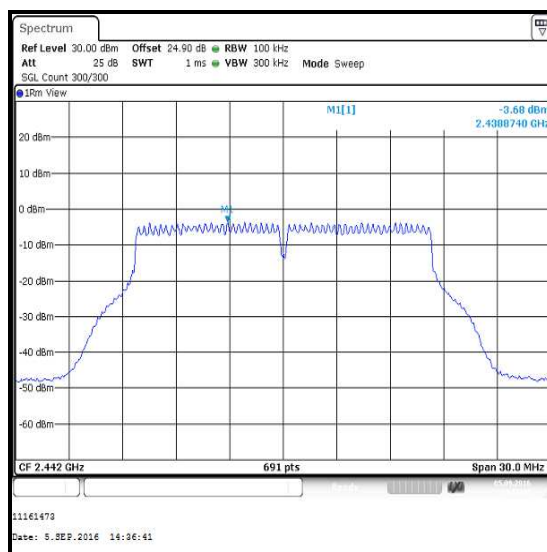
Channel 11

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

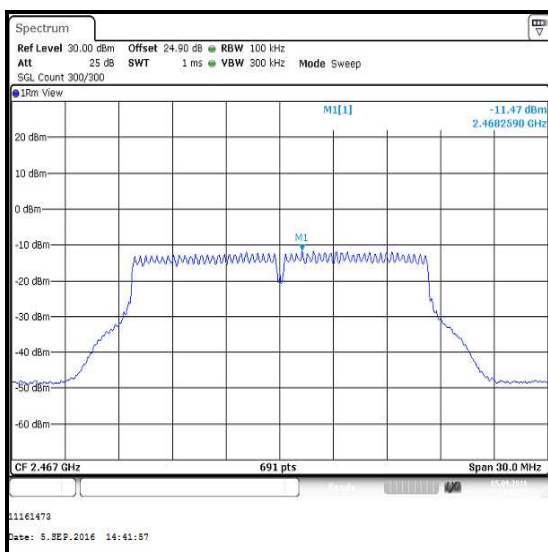
Channel	Frequency (MHz)	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
2	2417	-3.4	8.0	11.4	Complied
7	2442	-3.7	8.0	11.7	Complied
12	2467	-11.5	8.0	19.5	Complied
13	2472	-19.2	8.0	27.2	Complied



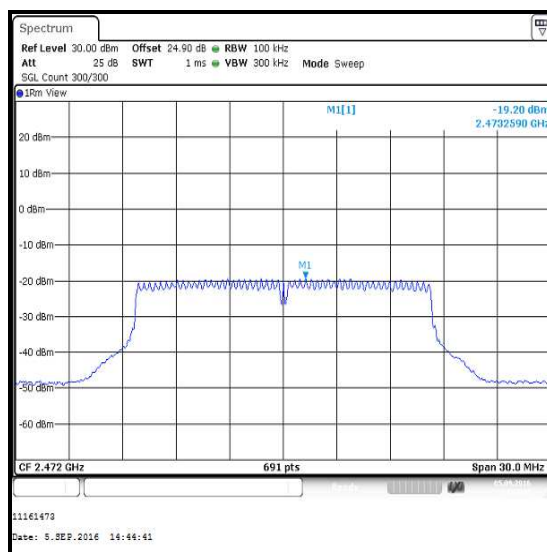
Channel 2



Channel 7



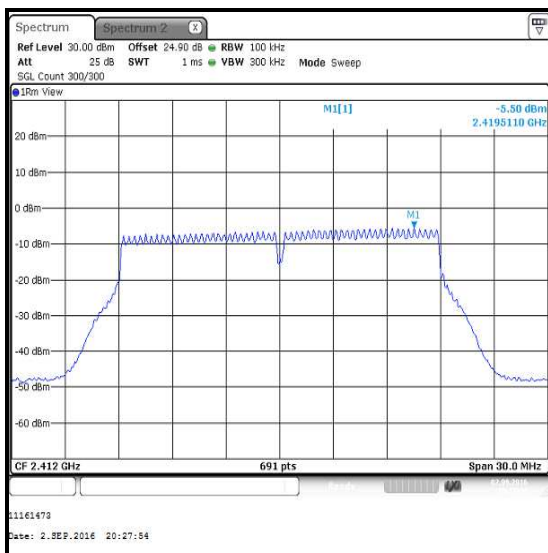
Channel 12



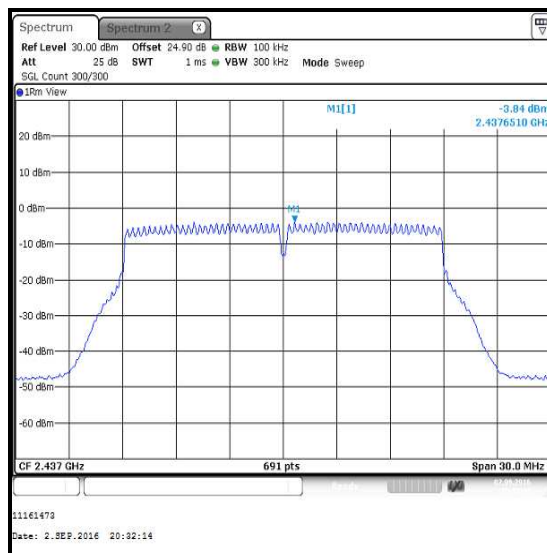
Channel 13

Transmitter Power Spectral Density (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / SISO / Port 2**

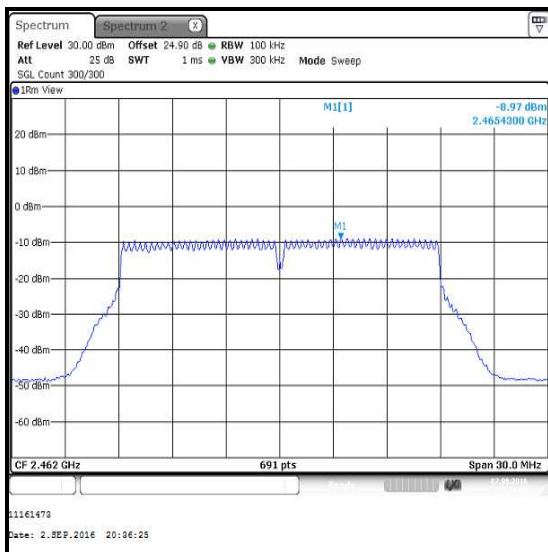
Channel	Frequency (MHz)	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
1	2412	-5.5	8.0	13.5	Complied
6	2437	-3.8	8.0	11.8	Complied
11	2462	-9.0	8.0	17.0	Complied



Channel 1



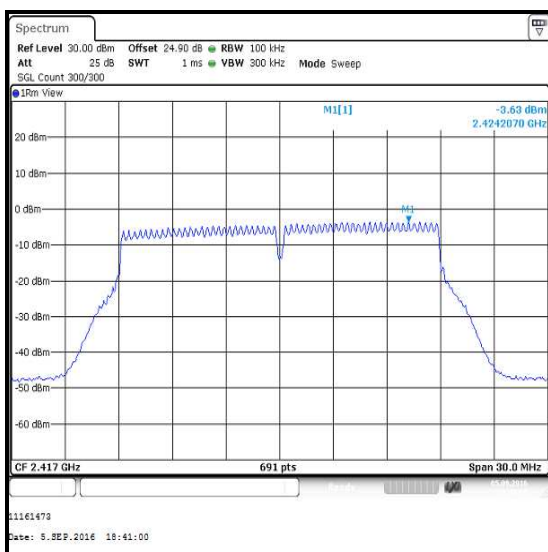
Channel 6



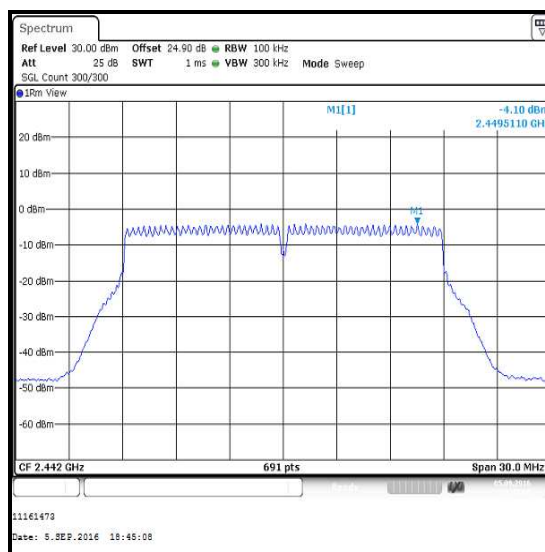
Channel 11

Transmitter Power Spectral Density (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / SISO / Port 2**

Channel	Frequency (MHz)	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
2	2417	-3.6	8.0	11.6	Complied
7	2442	-4.1	8.0	12.1	Complied
12	2467	-12.8	8.0	20.8	Complied
13	2472	-19.8	8.0	27.8	Complied



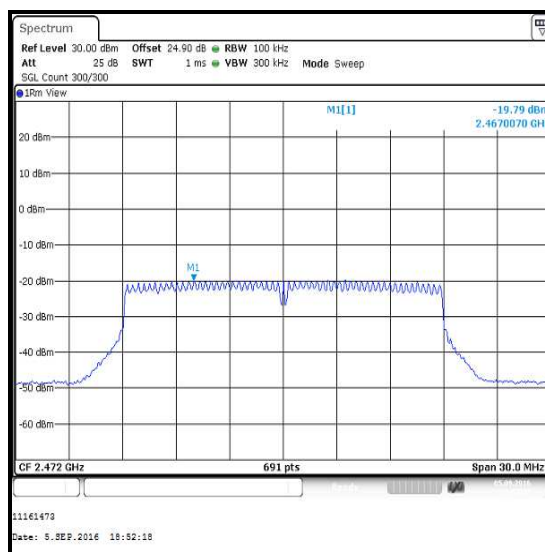
Channel 2



Channel 7



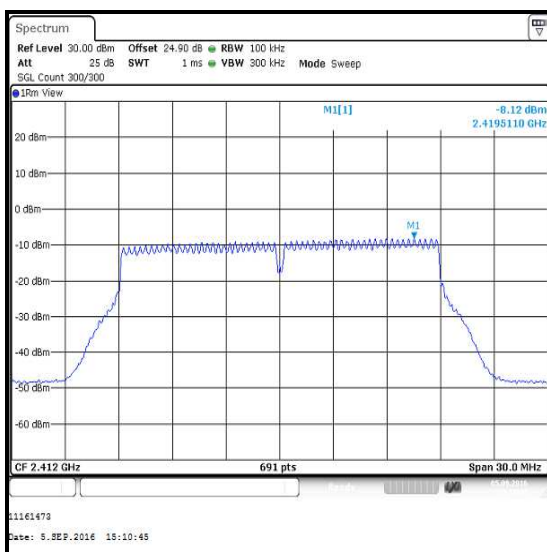
Channel 12



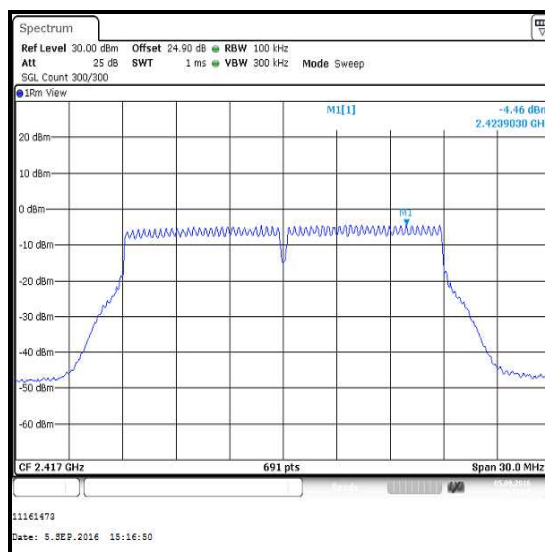
Channel 13

Transmitter Power Spectral Density (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (2Tx CDD) / Port 2**

Channel	Frequency (MHz)	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
1	2412	-8.1	8.0	16.1	Complied
2	2417	-4.5	8.0	12.5	Complied
6	2437	-3.9	8.0	11.9	Complied
7	2442	-3.8	8.0	11.8	Complied



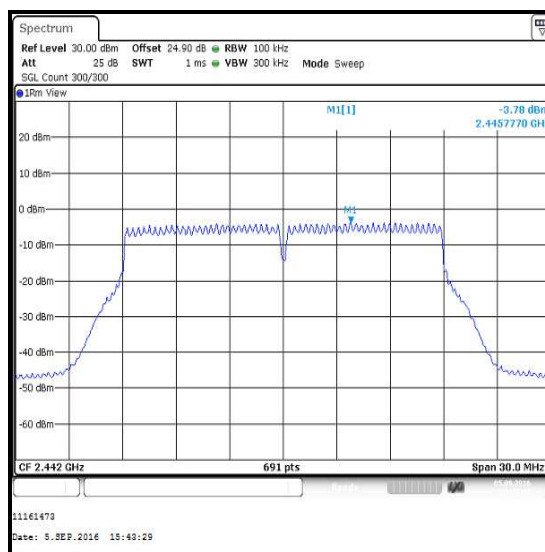
Channel 1



Channel 2



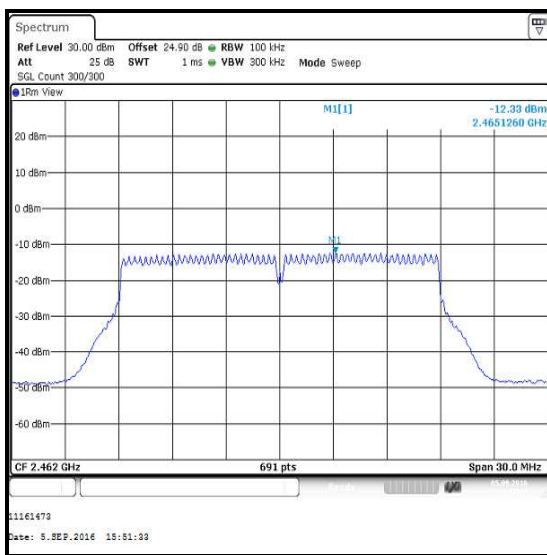
Channel 6



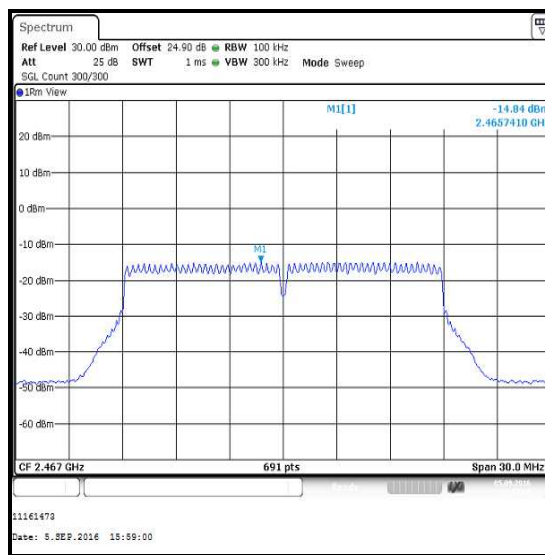
Channel 7

Transmitter Power Spectral Density (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (2Tx CDD) / Port 2 (continued)**

Channel	Frequency (MHz)	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
11	2462	-12.3	8.0	20.3	Complied
12	2467	-14.8	8.0	22.8	Complied



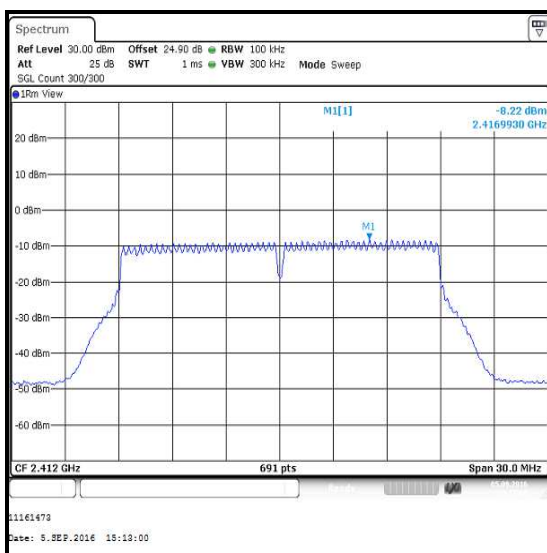
Channel 11



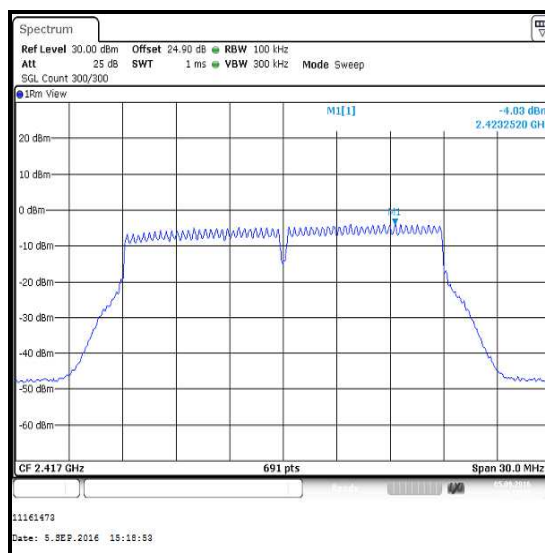
Channel 12

Transmitter Power Spectral Density (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (2Tx CDD) / Port 3**

Channel	Frequency (MHz)	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
1	2412	-8.2	8.0	16.2	Complied
2	2417	-4.0	8.0	12.0	Complied
6	2437	-3.7	8.0	11.7	Complied
7	2442	-3.9	8.0	11.9	Complied



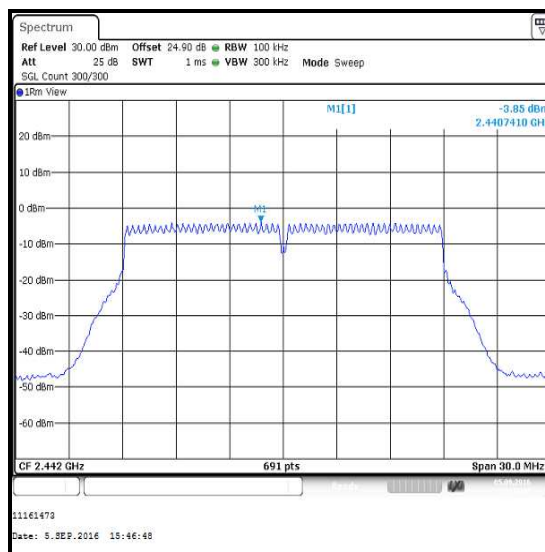
Channel 1



Channel 2



Channel 6



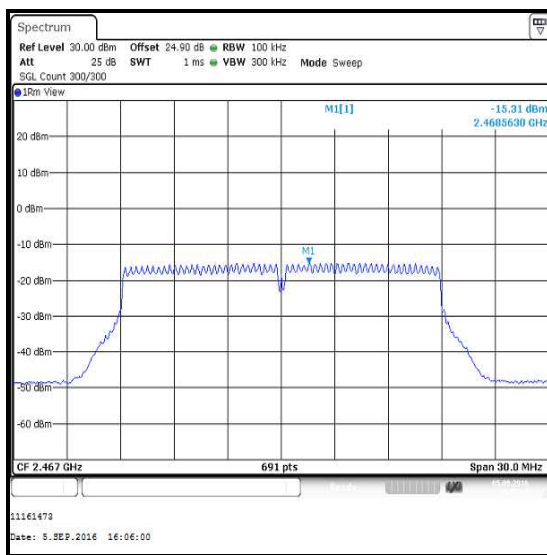
Channel 7

Transmitter Power Spectral Density (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (2Tx CDD) / Port 3 (continued)**

Channel	Frequency (MHz)	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
11	2462	-12.6	8.0	20.6	Complied
12	2467	-15.3	8.0	23.3	Complied



Channel 11



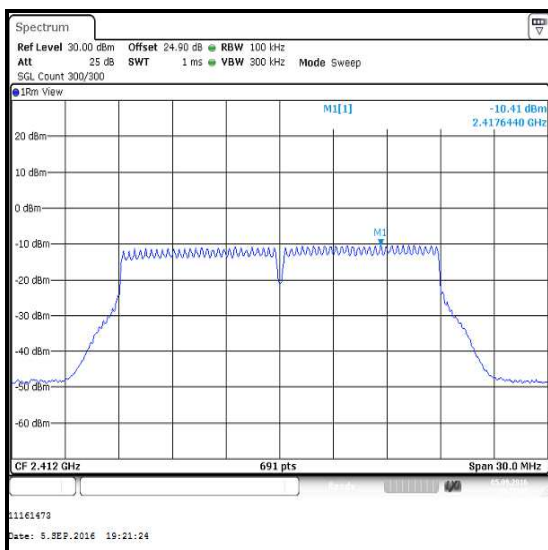
Channel 12

Transmitter Power Spectral Density (continued)**Combined PSD / MIMO (2Tx CDD) / Port 2 & Port 3****Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (2Tx CDD)**

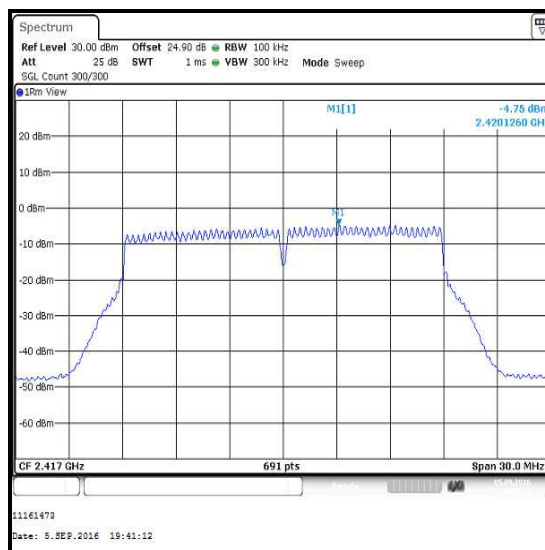
Channel	Frequency (MHz)	PSD on Port 2 (dBm/100 kHz)	PSD on Port 3 (dBm/100 kHz)	Combined PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
1	2412	-8.1	-8.2	-5.1	8.0	13.1	Complied
2	2417	-4.5	-4.0	-1.2	8.0	9.2	Complied
6	2437	-3.9	-3.7	-0.8	8.0	8.8	Complied
7	2442	-3.8	-3.9	-0.8	8.0	8.8	Complied
11	2462	-12.3	-12.6	-9.4	8.0	17.4	Complied
12	2467	-14.8	-15.3	-12.0	8.0	20.0	Complied

Transmitter Power Spectral Density (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (3Tx CDD) / Port 1**

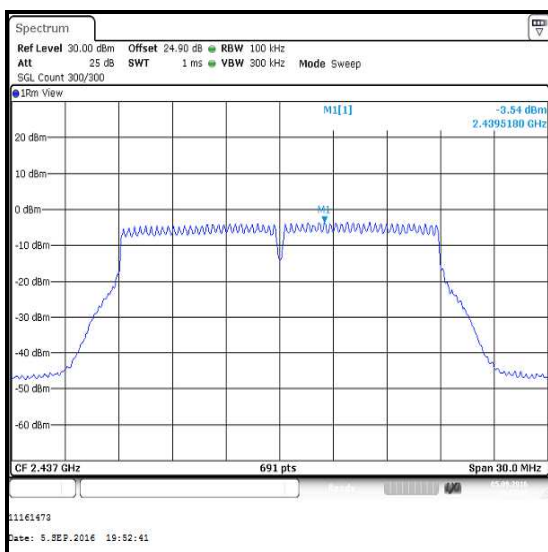
Channel	Frequency (MHz)	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
1	2412	-10.4	8.0	18.4	Complied
2	2417	-4.8	8.0	12.8	Complied
6	2437	-3.5	8.0	11.5	Complied
7	2442	-3.9	8.0	11.9	Complied



Channel 1



Channel 2



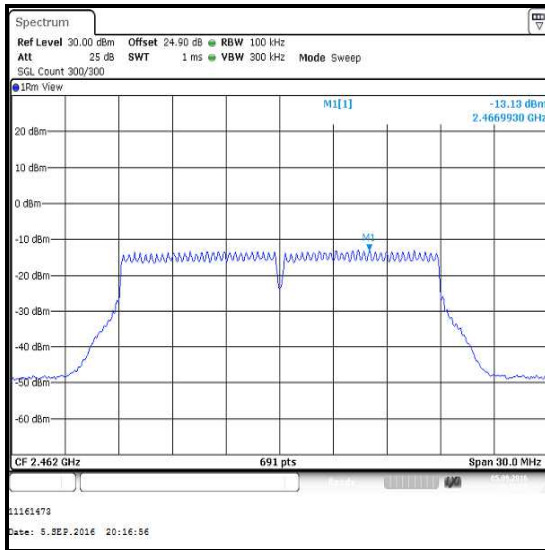
Channel 6



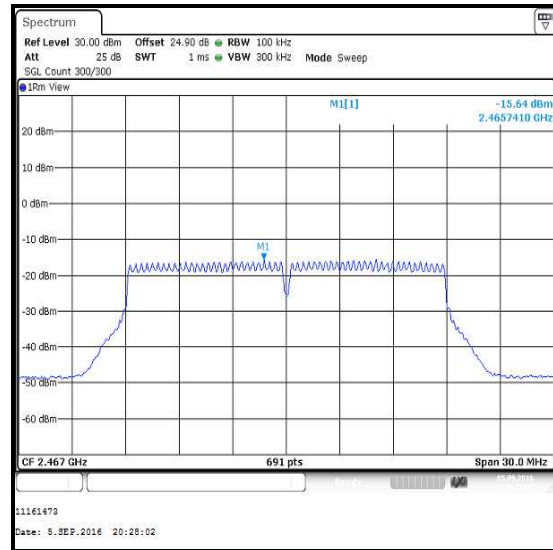
Channel 7

Transmitter Power Spectral Density (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (3Tx CDD) / Port 1 (continued)**

Channel	Frequency (MHz)	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
11	2462	-13.1	8.0	21.1	Complied
12	2467	-15.6	8.0	23.6	Complied



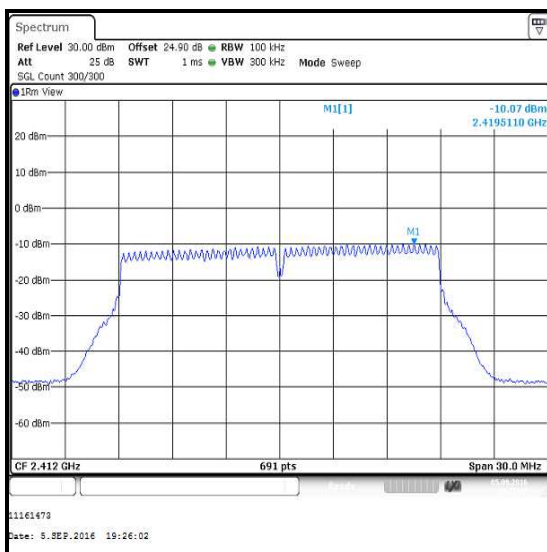
Channel 11



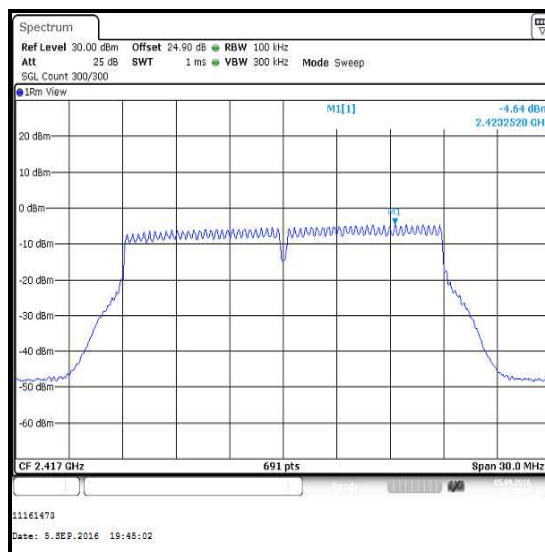
Channel 12

Transmitter Power Spectral Density (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (3Tx CDD) / Port 2**

Channel	Frequency (MHz)	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
1	2412	-10.1	8.0	18.1	Complied
2	2417	-4.6	8.0	12.6	Complied
6	2437	-4.0	8.0	12.0	Complied
7	2442	-4.1	8.0	12.1	Complied



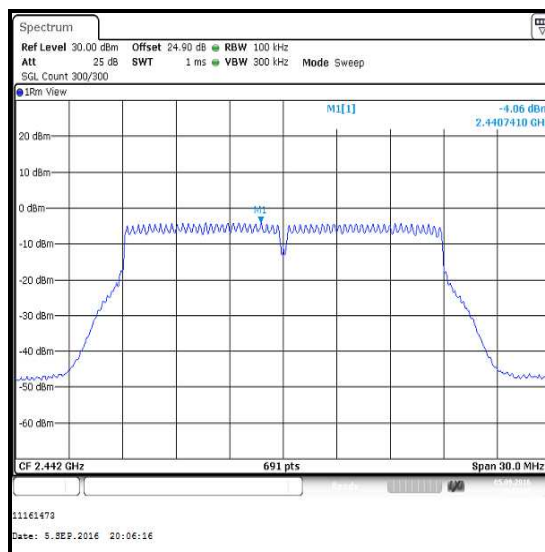
Channel 1



Channel 2



Channel 6



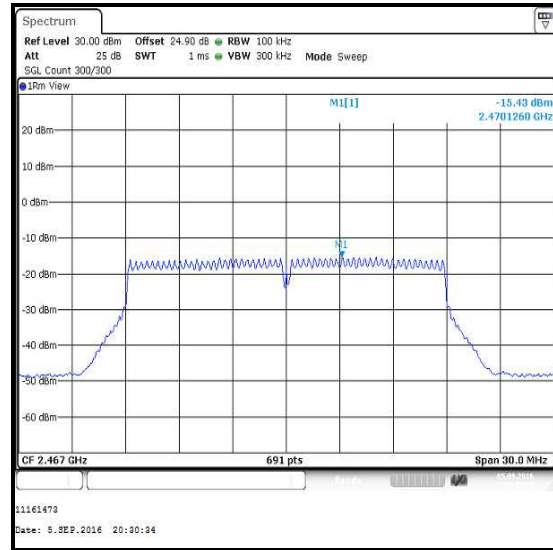
Channel 7

Transmitter Power Spectral Density (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (3Tx CDD) / Port 2 (continued)**

Channel	Frequency (MHz)	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
11	2462	-13.3	8.0	21.3	Complied
12	2467	-15.4	8.0	23.4	Complied



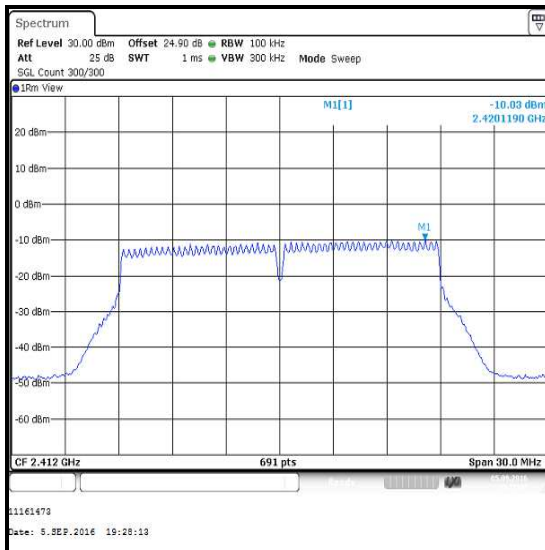
Channel 11



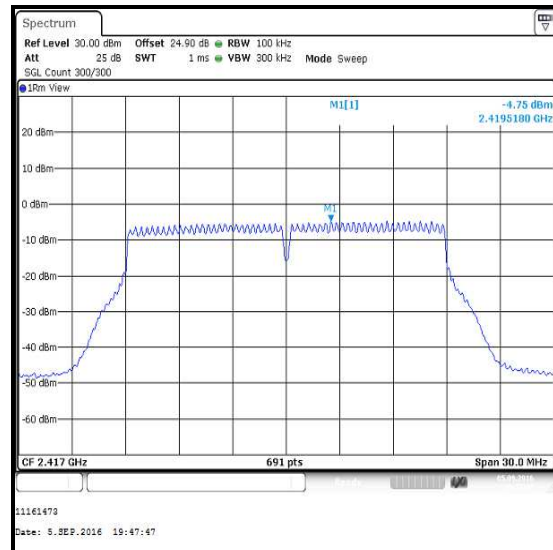
Channel 12

Transmitter Power Spectral Density (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (3Tx CDD) / Port 3**

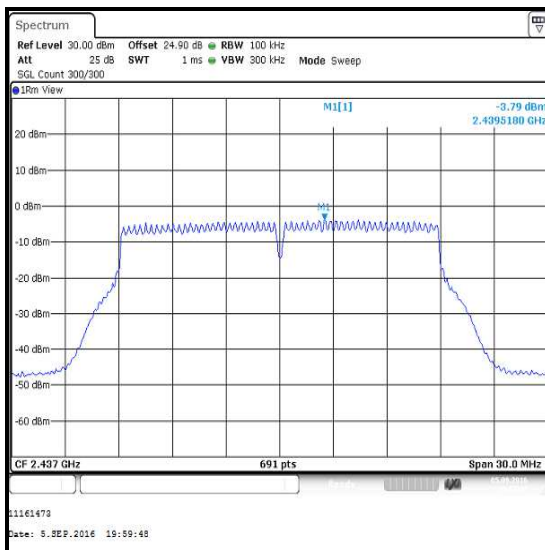
Channel	Frequency (MHz)	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
1	2412	-10.0	8.0	18.0	Complied
2	2417	-4.7	8.0	12.7	Complied
6	2437	-3.8	8.0	11.8	Complied
7	2442	-4.3	8.0	12.3	Complied



Channel 1



Channel 2



Channel 6



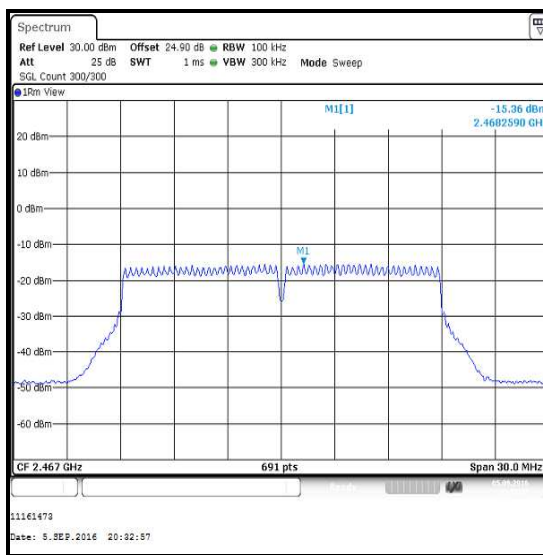
Channel 7

Transmitter Power Spectral Density (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (3Tx CDD) / Port 3 (continued)**

Channel	Frequency (MHz)	PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
11	2462	-13.6	8.0	21.6	Complied
12	2467	-15.4	8.0	23.4	Complied



Channel 11



Channel 12

Transmitter Power Spectral Density (continued)**Combined PSD / MIMO (3Tx CDD) / Port 1, Port 2 & Port 3****Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (3Tx CDD)**

Channel	Frequency (MHz)	PSD on Port 1 (dBm/100 kHz)	PSD on Port 2 (dBm/100 kHz)	PSD on Port 3 (dBm/100 kHz)	Combined PSD (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
1	2412	-10.4	-10.1	-10.0	-5.4	8.0	13.4	Complied
2	2417	-4.8	-4.6	-4.7	0.1	8.0	7.9	Complied
6	2437	-3.5	-4.0	-3.8	1.0	8.0	7.0	Complied
7	2442	-3.9	-4.1	-4.3	0.7	8.0	7.3	Complied
11	2462	-13.1	-13.3	-13.6	-8.6	8.0	16.6	Complied
12	2467	-15.6	-15.4	-15.4	-10.7	8.0	18.7	Complied

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
M1996	Signal Analyser	Rohde & Schwarz	FSV13	100975	02 Mar 2017	12
A2526	Attenuator	AtlanTecRF	AN18W5-20	832828#1	Calibrated before use	-
A030	Step Attenuator	Narda	745-69	01544	Calibrated before use	-
A2500	Directional Coupler	AtlanTecRF	CDC-003060-10	13122501835	Calibrated before use	-
A2501	Directional Coupler	AtlanTecRF	CDC-003060-10	13122501836	Calibrated before use	-
A2502	Directional Coupler	AtlanTecRF	CDC-003060-10	13122501837	Calibrated before use	-
M200	Power Divider	Narda	4313C-4	10019	Calibrated before use	-
M204	Power Divider	Narda	4313C-4	10021	Calibrated before use	-
G0607	Signal Generator	Rohde & Schwarz	SMU200A	100943	10 May 2019	36

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

Test Engineer:	Sandeep Bharat	Test Dates:	05 September 2016 to 23 September 2016
Test Sample Serial Number:	C02S200CHH5Q		

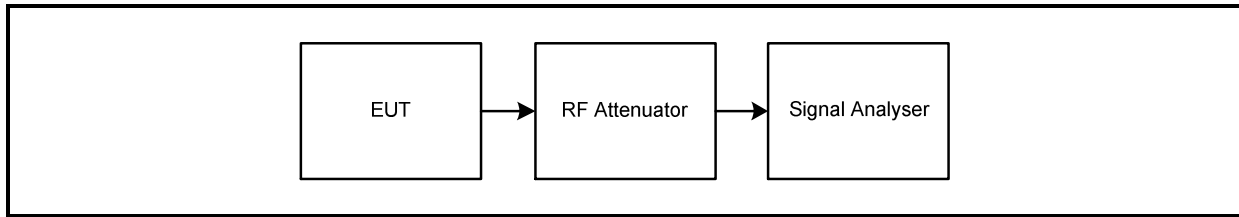
FCC Reference:	Part 15.247(b)(3)
Test Method Used:	FCC KDB 558074 Section 9.2.2.2

Environmental Conditions:

Temperature (°C):	23 to 25
Relative Humidity (%):	45 to 57

Note(s):

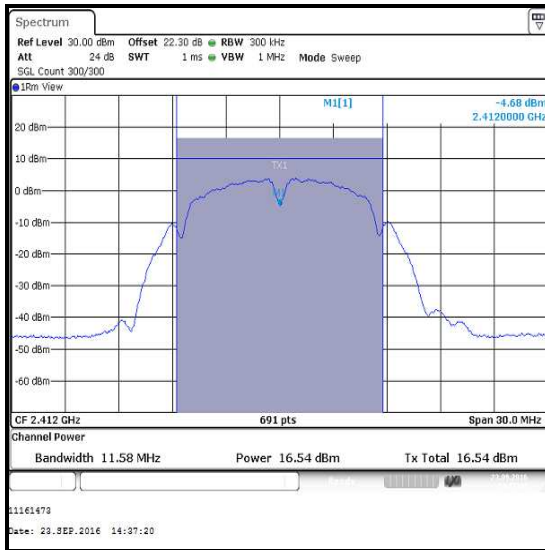
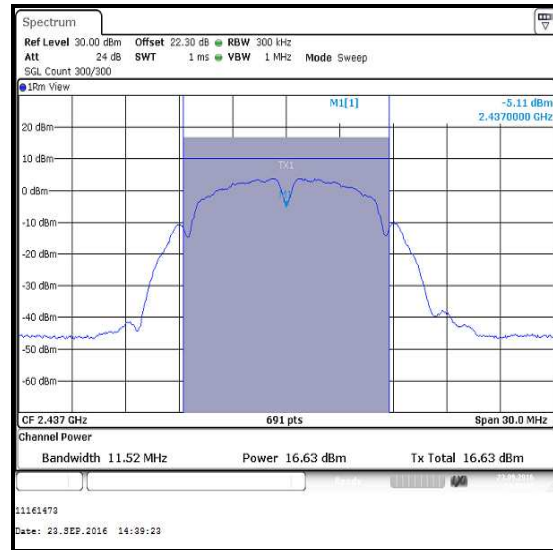
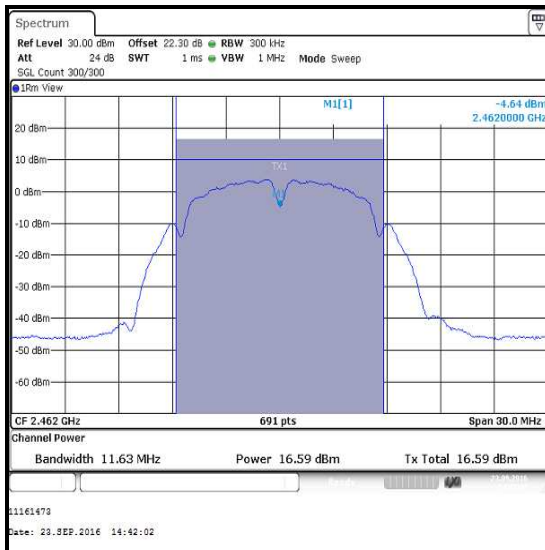
- The customer declared the following data rates to be used for all measurements:
 - o 802.11b – 1 Mbit/s / SISO on Port 2
 - o 802.11g – 6 Mbit/s / SISO on Port 2
 - o 802.11n HT20 – MCS0 / SISO on Port 2
 - o 802.11n HT20 – MCS0 / MIMO (2Tx CDD) on Ports 2 & 3
 - o 802.11n HT20 – MCS0 / MIMO (3Tx CDD) on Ports 1, 2 & 3
- Final measurements were performed using the above configurations on the bottom, middle and top channels. Additional channels were tested as requested by the customer.
- The power has been integrated over the 99% occupied bandwidth (OBW) see Appendix 1 for reference plots.
- The EUT was transmitting at 100% duty cycle and testing was performed in accordance with KDB 558074 Section 9.2.2.2 Method AVGSA-1. The signal analyser's integration function was used to integrate across the OBW. The signal analyser resolution bandwidth was set to 1-5% of the OBW and video bandwidth to at least 3 times the resolution bandwidth. 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.
- For 802.11n MIMO, conducted power was measured on all ports and then combined using the measure-and-sum technique stated in FCC KDB 662911 D01 Section E)1). For EIRP, the directional antenna gain as calculated in FCC KDB 662911 D01 Section 2)f)(ii) was added to the conducted output power. Detailed calculations can be found in Appendix 2 (Directional Antenna Gain Calculations).
- The signal analyser was connected to the RF ports on the EUT using suitable attenuation and RF cables. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cables.
- For MIMO (3Tx CDD) modes, the limit for conducted output power has been reduced by the same amount in dB that the directional gain of the antennas exceeds 6 dBi, in accordance with 15.247(b)(4).

Transmitter Maximum (Average) Output Power (continued)**Test setup:****Results: 802.11b / 20 MHz / DBPSK / 1 Mbit/s / Port 2****Conducted Peak Limit Comparison**

Channel	Frequency (MHz)	Conducted Power (dBm)	Power Limit (dBm)	Margin (dB)	Result
1	2412	16.5	30.0	13.5	Complied
6	2437	16.6	30.0	13.4	Complied
11	2462	16.6	30.0	13.4	Complied

De Facto EIRP Limit Comparison

Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
1	16.5	3.3	19.8	36.0	16.2	Complied
6	16.6	3.3	19.9	36.0	16.1	Complied
11	16.6	3.3	19.9	36.0	16.1	Complied

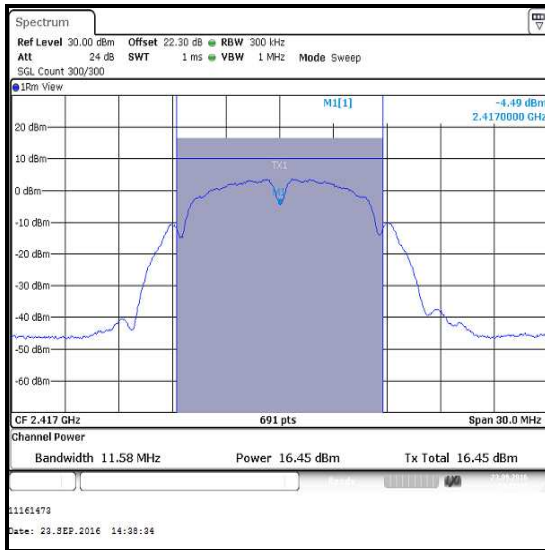
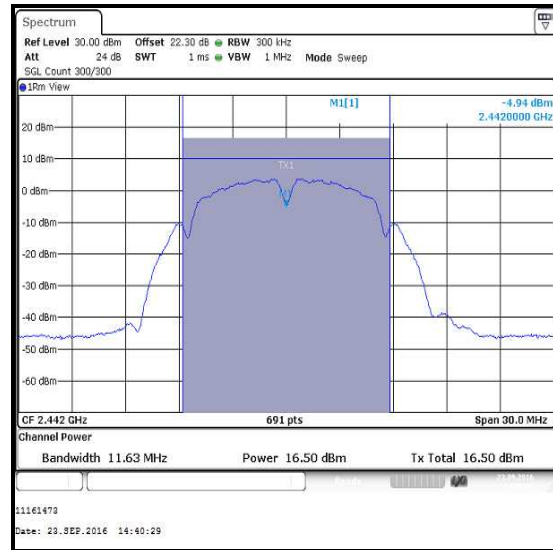
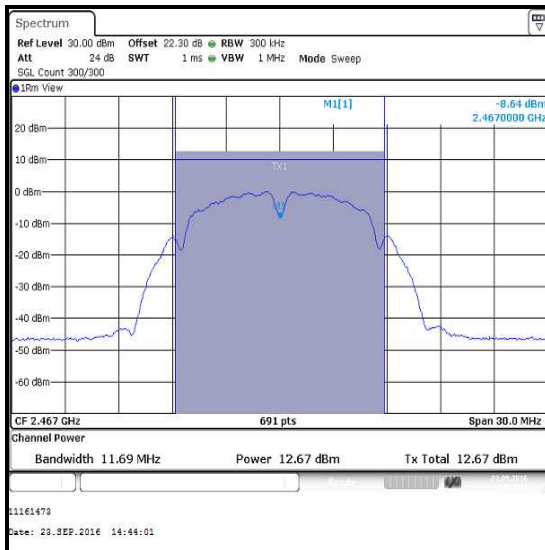
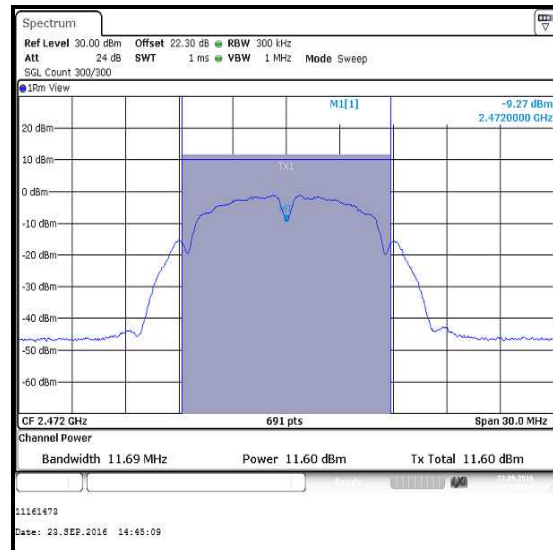
Transmitter Maximum (Average) Output Power (continued)**Results: 802.11b / 20 MHz / DBPSK / 1 Mbit/s / Port 2 (continued)****Channel 1****Channel 6****Channel 11**

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11b / 20 MHz / DBPSK / 1 Mbit/s / Port 2****Conducted Peak Limit Comparison**

Channel	Frequency (MHz)	Conducted Power (dBm)	Power Limit (dBm)	Margin (dB)	Result
2	2417	16.5	30.0	13.5	Complied
7	2442	16.5	30.0	13.5	Complied
12	2467	12.7	30.0	17.3	Complied
13	2472	11.6	30.0	18.4	Complied

De Facto EIRP Limit Comparison

Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
2	16.5	3.3	19.8	36.0	16.2	Complied
7	16.5	3.3	19.8	36.0	16.2	Complied
12	12.7	3.3	16.0	36.0	20.0	Complied
13	11.6	3.3	14.9	36.0	21.1	Complied

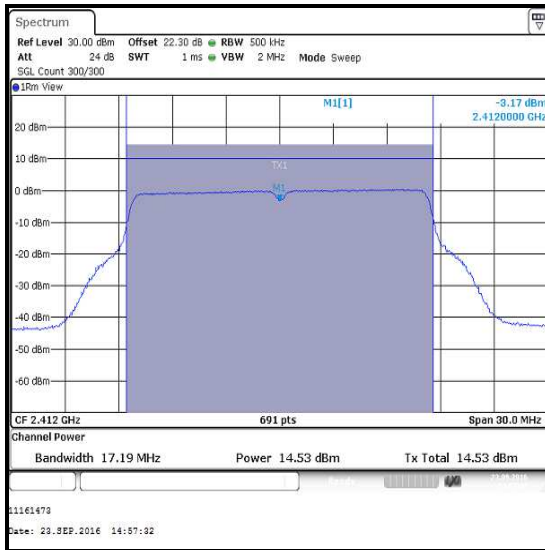
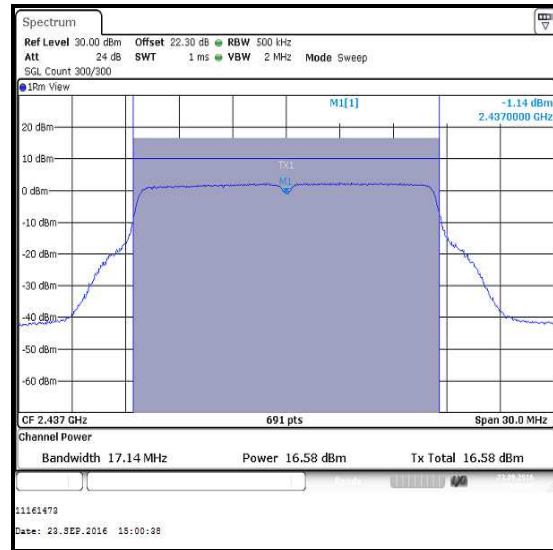
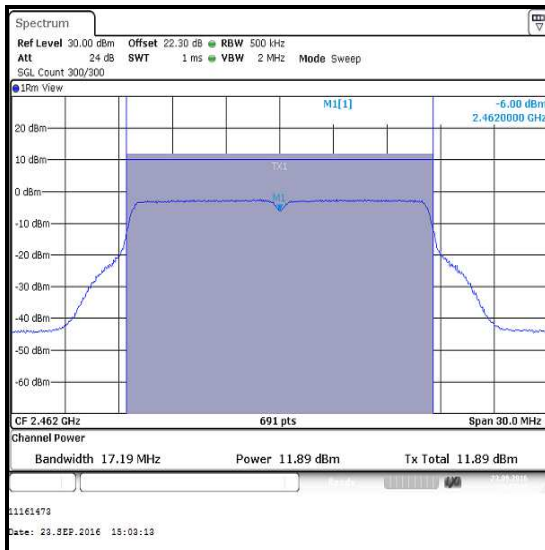
Transmitter Maximum (Average) Output Power (continued)**Results: 802.11b / 20 MHz / DBPSK / 1 Mbit/s / Port 2 (continued)****Channel 2****Channel 7****Channel 12****Channel 13**

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11g / 20 MHz / BPSK / 6 Mbit/s / Port 2****Conducted Peak Limit Comparison**

Channel	Frequency (MHz)	Conducted Power (dBm)	Power Limit (dBm)	Margin (dB)	Result
1	2412	14.5	30.0	15.5	Complied
6	2437	16.6	30.0	13.4	Complied
11	2462	11.9	30.0	18.1	Complied

De Facto EIRP Limit Comparison

Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
1	14.5	3.3	17.8	36.0	18.2	Complied
6	16.6	3.3	19.9	36.0	16.1	Complied
11	11.9	3.3	15.2	36.0	20.8	Complied

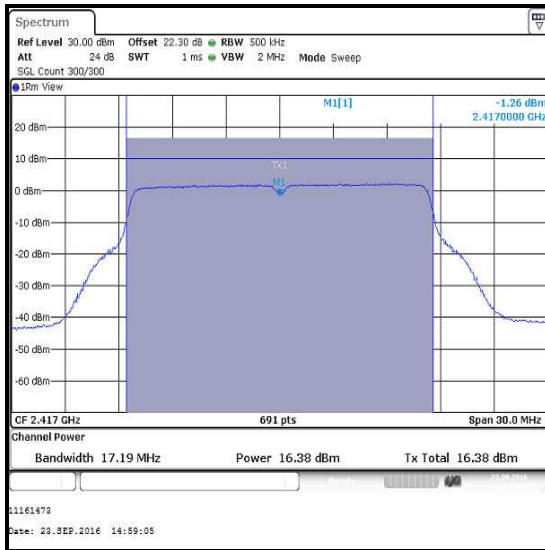
Transmitter Maximum (Average) Output Power (continued)**Results: 802.11g / 20 MHz / BPSK / 6 Mbit/s / Port 2 (continued)****Channel 1****Channel 6****Channel 11**

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11g / 20 MHz / BPSK / 6 Mbit/s / Port 2****Conducted Peak Limit Comparison**

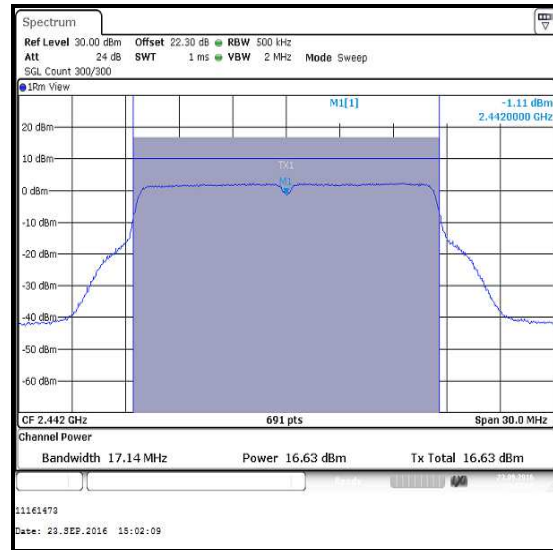
Channel	Frequency (MHz)	Conducted Power (dBm)	Power Limit (dBm)	Margin (dB)	Result
2	2417	16.4	30.0	13.6	Complied
7	2442	16.6	30.0	13.4	Complied
12	2467	8.0	30.0	22.0	Complied
13	2472	0.9	30.0	29.1	Complied

De Facto EIRP Limit Comparison

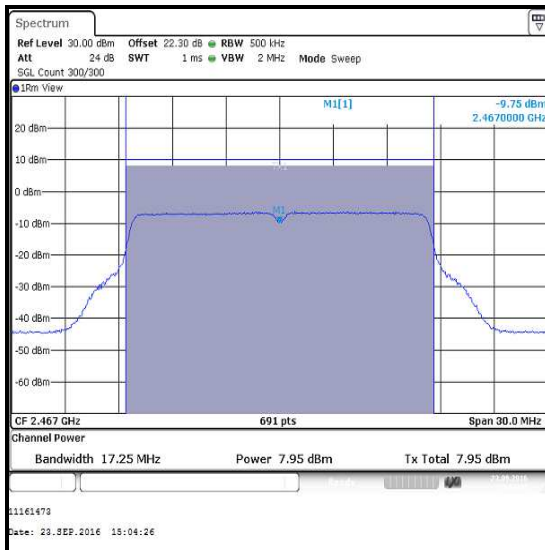
Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
2	16.4	3.3	19.7	36.0	16.3	Complied
7	16.6	3.3	19.9	36.0	16.1	Complied
12	8.0	3.3	11.3	36.0	24.7	Complied
13	0.9	3.3	4.2	36.0	31.8	Complied

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11g / 20 MHz / BPSK / 6 Mbit/s / Port 2 (continued)**

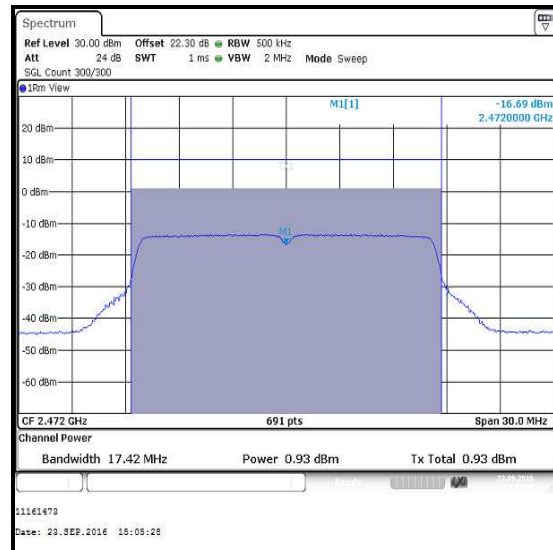
Channel 2



Channel 7



Channel 12



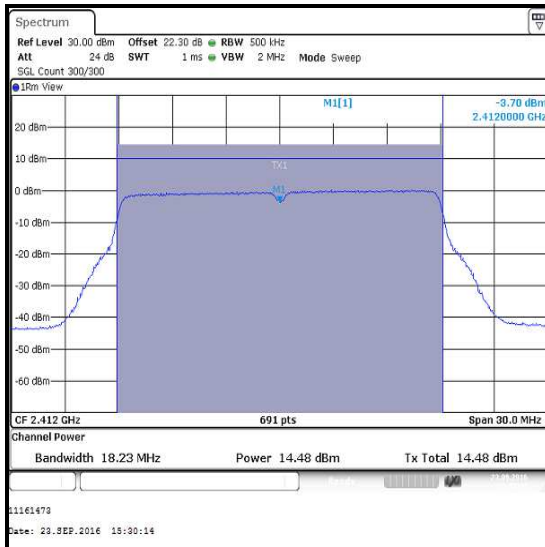
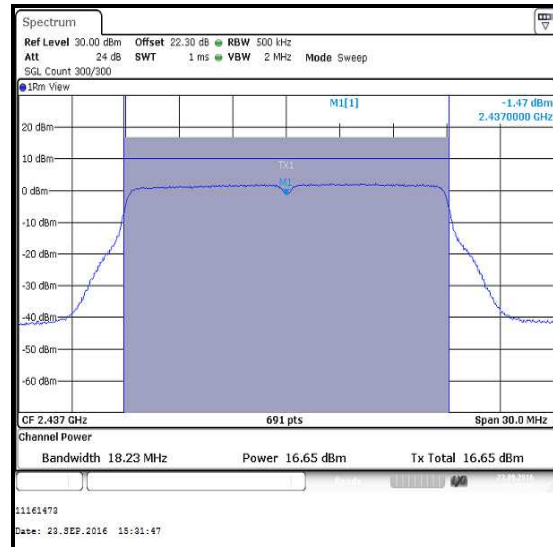
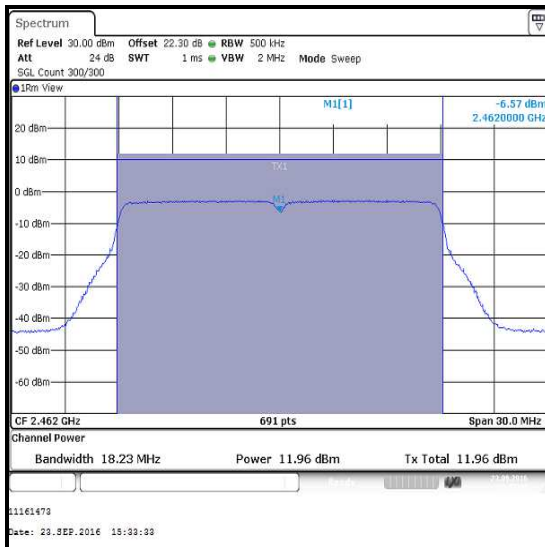
Channel 13

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / SISO / Port 2****Conducted Peak Limit Comparison**

Channel	Frequency (MHz)	Corrected Power (dBm)	Power Limit (dBm)	Margin (dB)	Result
1	2412	14.5	30.0	15.5	Complied
6	2437	16.7	30.0	13.3	Complied
11	2462	12.0	30.0	18.0	Complied

De Facto EIRP Limit Comparison

Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
1	14.5	3.3	17.8	36.0	18.2	Complied
6	16.7	3.3	20.0	36.0	16.0	Complied
11	12.0	3.3	15.3	36.0	20.7	Complied

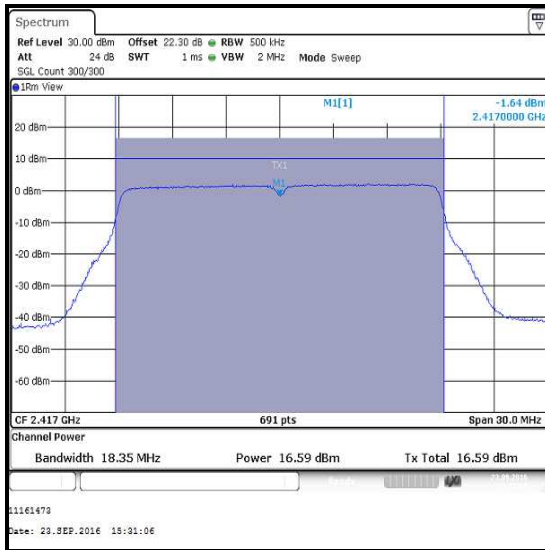
Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / SISO / Port 2 (continued)****Channel 1****Channel 6****Channel 11**

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / SISO / Port 2****Conducted Peak Limit Comparison**

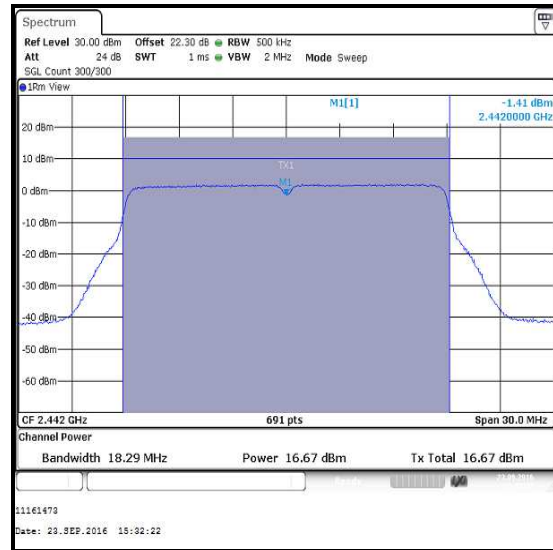
Channel	Frequency (MHz)	Conducted Power (dBm)	Power Limit (dBm)	Margin (dB)	Result
2	2417	16.6	30.0	13.4	Complied
7	2442	16.7	30.0	13.3	Complied
12	2467	8.0	30.0	22.0	Complied
13	2472	0.9	30.0	29.1	Complied

De Facto EIRP Limit Comparison

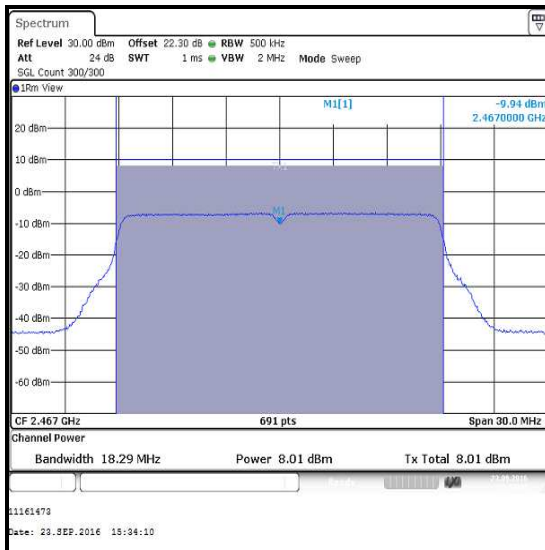
Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
2	16.6	3.3	19.9	36.0	16.1	Complied
7	16.7	3.3	20.0	36.0	16.0	Complied
12	8.0	3.3	11.3	36.0	24.7	Complied
13	0.9	3.3	4.2	36.0	31.8	Complied

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / SISO / Port 2 (continued)**

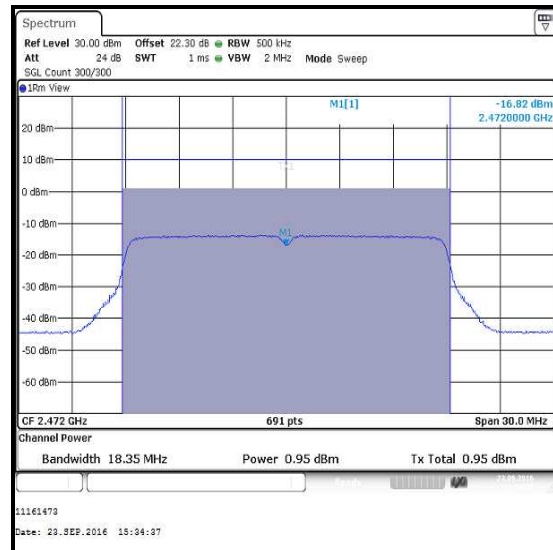
Channel 2



Channel 7



Channel 12



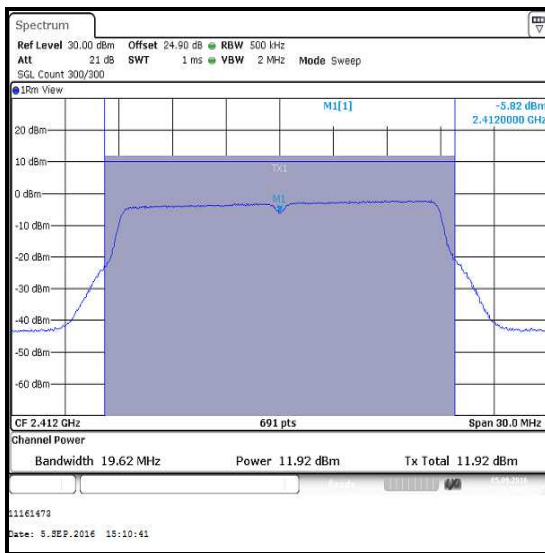
Channel 13

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (2Tx CDD) / Port 2****Conducted Peak Limit Comparison**

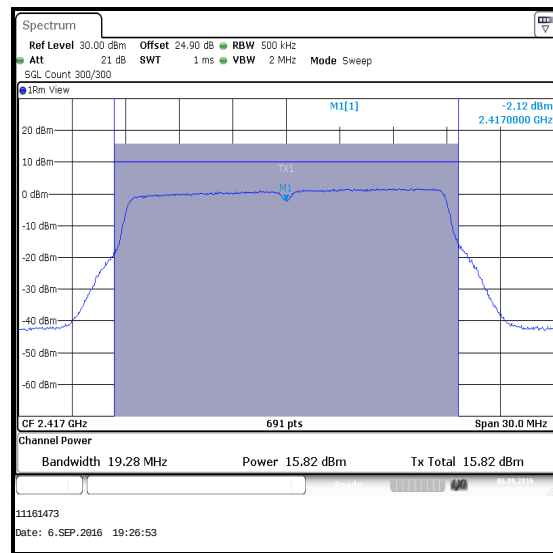
Channel	Frequency (MHz)	Conducted Power (dBm)	Power Limit (dBm)	Margin (dB)	Result
1	2412	11.9	30.0	18.1	Complied
2	2417	15.8	30.0	14.2	Complied
6	2437	16.6	30.0	13.4	Complied
7	2442	16.6	30.0	13.4	Complied
11	2462	8.3	30.0	21.7	Complied
12	2467	5.8	30.0	24.2	Complied

De Facto EIRP Limit Comparison

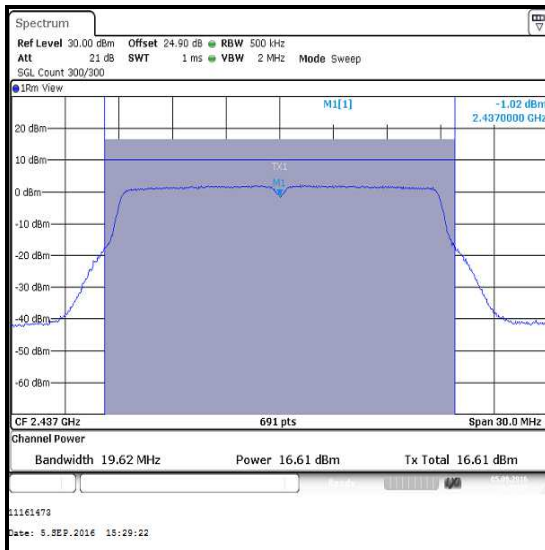
Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
1	11.9	3.3	15.2	36.0	20.8	Complied
2	15.8	3.3	19.1	36.0	16.9	Complied
6	16.6	3.3	19.9	36.0	16.1	Complied
7	16.6	3.3	19.9	36.0	16.1	Complied
11	8.3	3.3	11.6	36.0	24.4	Complied
12	5.8	3.3	9.1	36.0	26.9	Complied

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (2Tx CDD) / Port 2 (continued)**

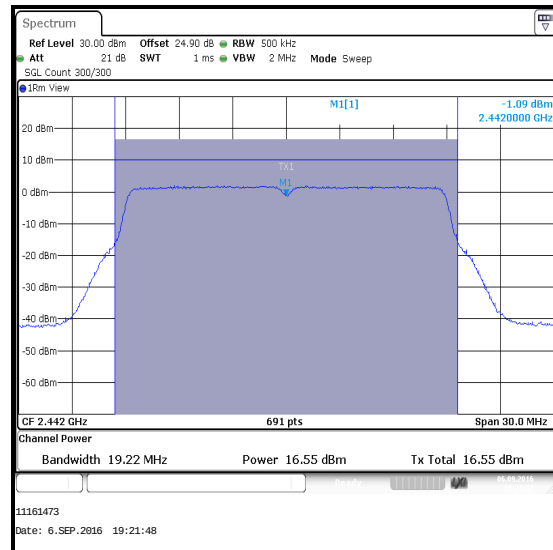
Channel 1



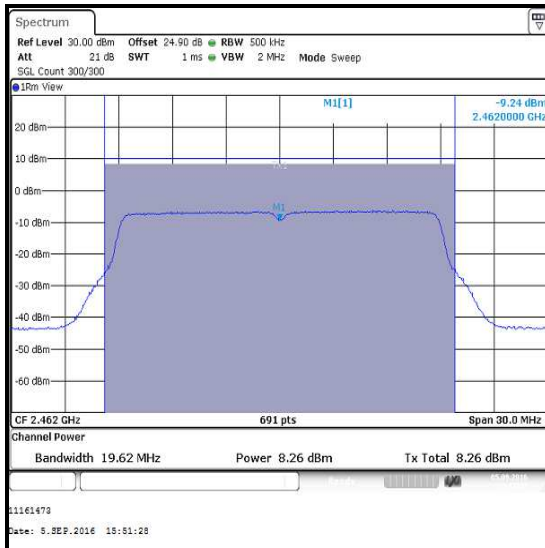
Channel 2



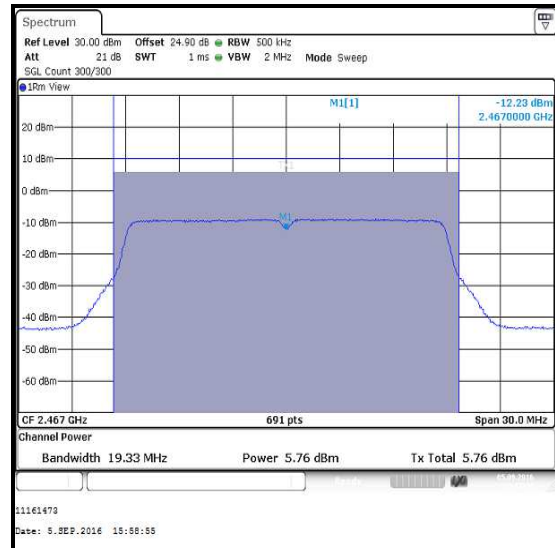
Channel 6



Channel 7

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (2Tx CDD) / Port 2 (continued)**

Channel 11



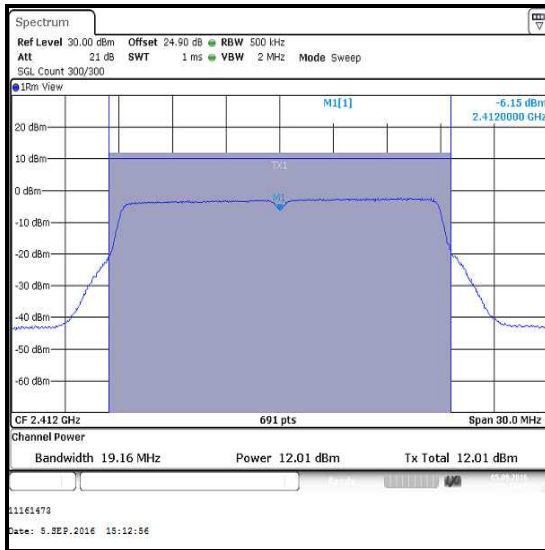
Channel 12

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (2Tx CDD) / Port 3****Conducted Peak Limit Comparison**

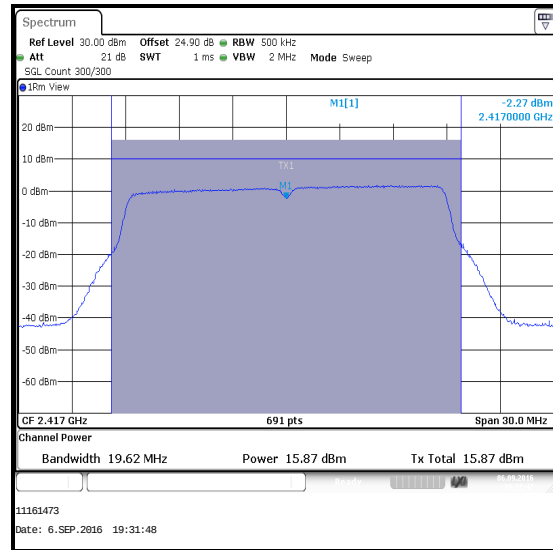
Channel	Frequency (MHz)	Conducted Power (dBm)	Power Limit (dBm)	Margin (dB)	Result
1	2412	12.0	30.0	18.0	Complied
2	2417	15.9	30.0	14.1	Complied
6	2437	16.6	30.0	13.4	Complied
7	2442	16.7	30.0	13.3	Complied
11	2462	8.2	30.0	21.8	Complied
12	2467	5.6	30.0	24.4	Complied

De Facto EIRP Limit Comparison

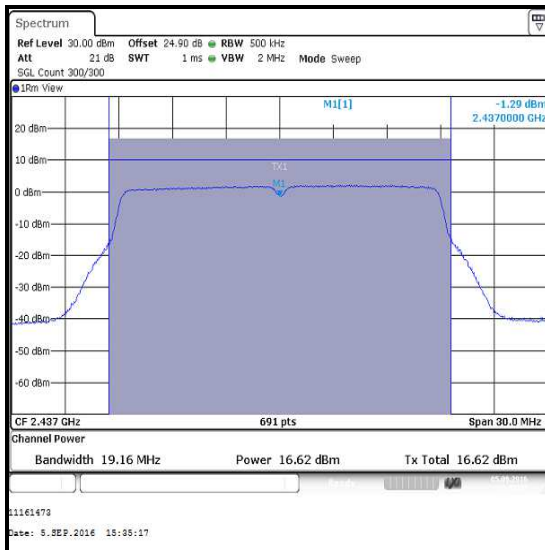
Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
1	12.0	2.3	14.3	36.0	21.7	Complied
2	15.9	2.3	18.2	36.0	17.8	Complied
6	16.6	2.3	18.9	36.0	17.1	Complied
7	16.7	2.3	19.0	36.0	17.0	Complied
11	8.2	2.3	10.5	36.0	25.5	Complied
12	5.6	2.3	7.9	36.0	28.1	Complied

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (2Tx CDD) / Port 3 (continued)**

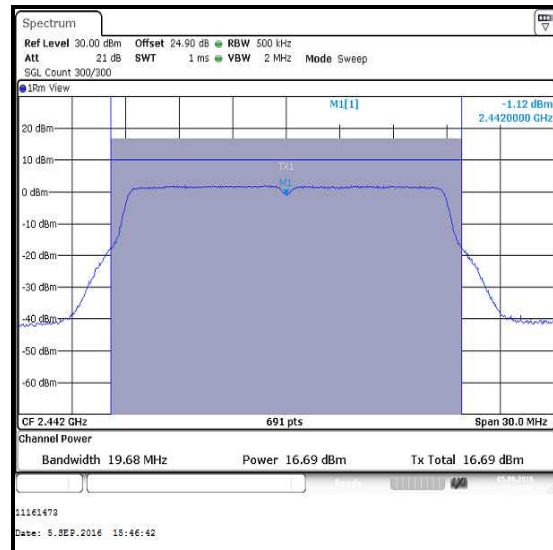
Channel 1



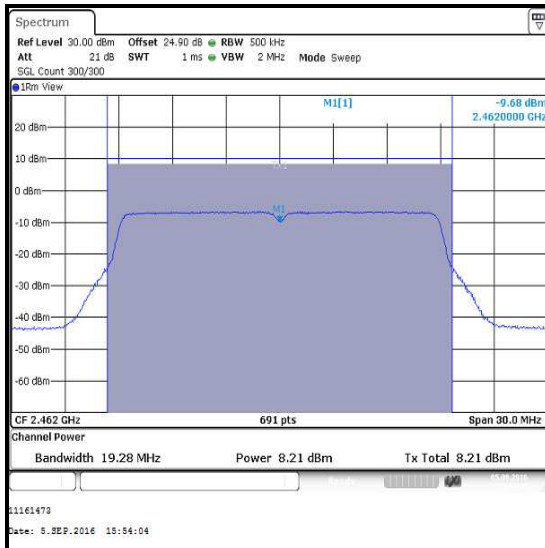
Channel 2



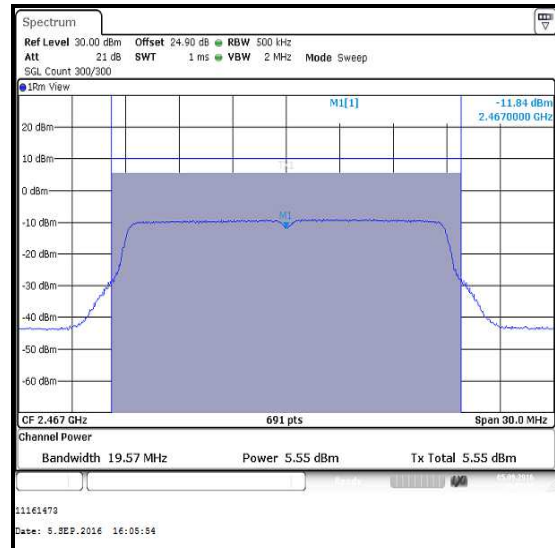
Channel 6



Channel 7

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (2Tx CDD) / Port 3 (continued)**

Channel 11



Channel 12

Transmitter Maximum (Average) Output Power (continued)**Combined Output Power / MIMO (2Tx CDD) / Port 2 & Port 3****Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (2Tx CDD)****Conducted Peak Limit Comparison**

Channel	Frequency (MHz)	Conducted Power on Port 2 (dBm)	Conducted Power on Port 3 (dBm)	Combined Conducted Power (dBm)	Power Limit (dBm)	Margin (dB)	Result
1	2412	11.9	12.0	15.0	30.0	15.0	Complied
2	2417	15.8	15.9	18.9	30.0	11.1	Complied
6	2437	16.6	16.6	19.6	30.0	10.4	Complied
7	2442	16.6	16.7	19.7	30.0	10.3	Complied
11	2462	8.3	8.2	11.3	30.0	18.7	Complied
12	2467	5.8	5.6	8.7	30.0	21.3	Complied

De Facto EIRP Limit Comparison

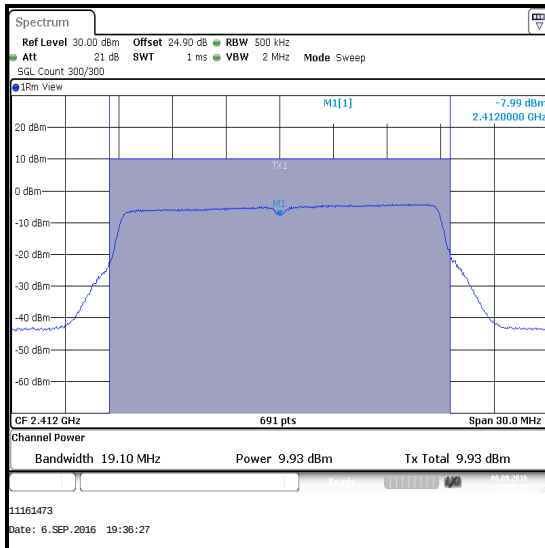
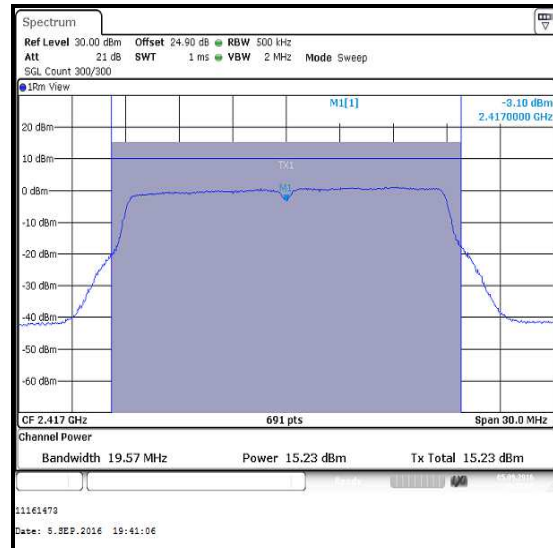
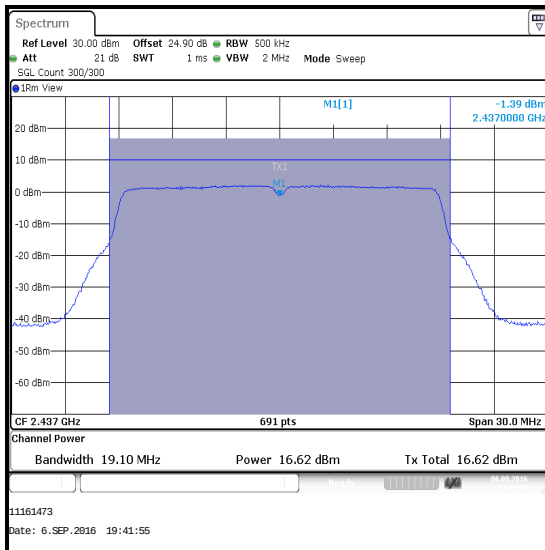
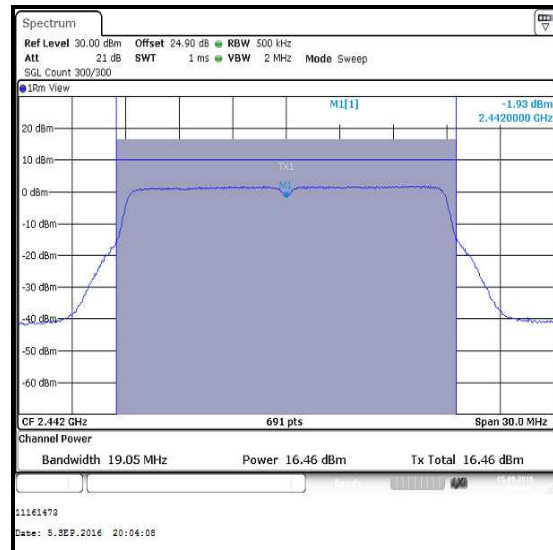
Channel	Combined Conducted Power (dBm)	Effective Antenna Gain (dBi)	Effective EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
1	15.0	5.8	20.8	36.0	15.2	Complied
2	18.9	5.8	24.7	36.0	11.3	Complied
6	19.6	5.8	25.4	36.0	10.6	Complied
7	19.7	5.8	25.5	36.0	10.5	Complied
11	11.3	5.8	17.1	36.0	18.9	Complied
12	8.7	5.8	14.5	36.0	21.5	Complied

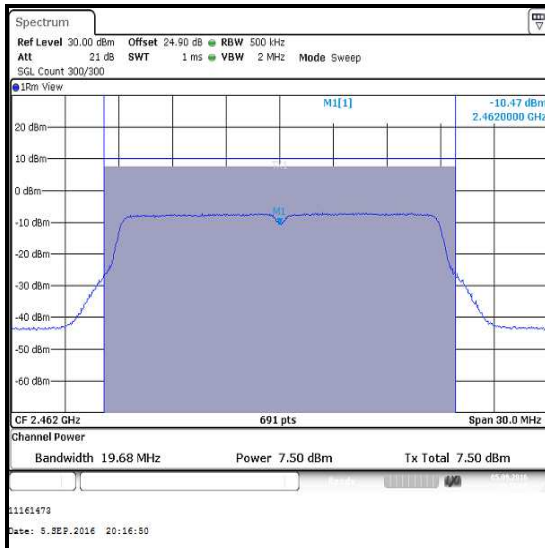
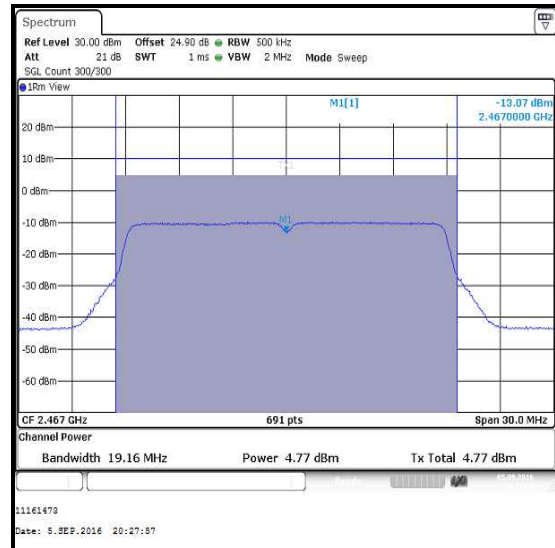
Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (3Tx CDD) / Port 1****Conducted Peak Limit Comparison**

Channel	Frequency (MHz)	Conducted Power (dBm)	Power Limit (dBm)	Margin (dB)	Result
1	2412	9.9	30.0	20.1	Complied
2	2417	15.2	30.0	14.8	Complied
6	2437	16.6	30.0	13.4	Complied
7	2442	16.5	30.0	13.5	Complied
11	2462	7.5	30.0	22.5	Complied
12	2467	4.8	30.0	25.2	Complied

De Facto EIRP Limit Comparison

Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
1	9.9	2.0	11.9	36.0	24.1	Complied
2	15.2	2.0	17.2	36.0	18.8	Complied
6	16.6	2.0	18.6	36.0	17.4	Complied
7	16.5	2.0	18.5	36.0	17.5	Complied
11	7.5	2.0	9.5	36.0	26.5	Complied
12	4.8	2.0	6.8	36.0	29.2	Complied

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (3Tx CDD) / Port 1 (continued)****Channel 1****Channel 2****Channel 6****Channel 7**

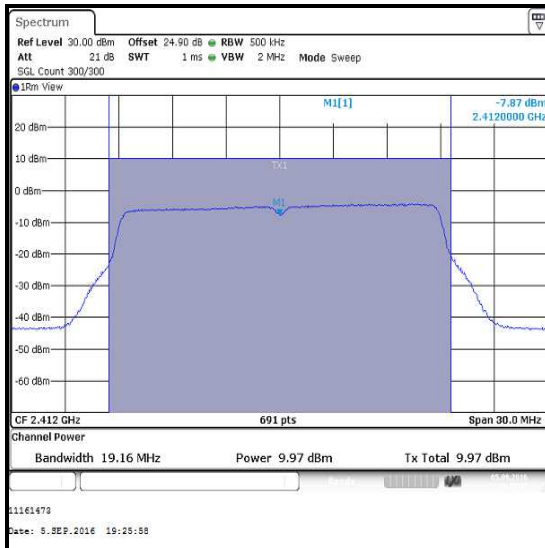
Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (3Tx CDD) / Port 1 (continued)****Channel 11****Channel 12**

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (3Tx CDD) / Port 2****Conducted Peak Limit Comparison**

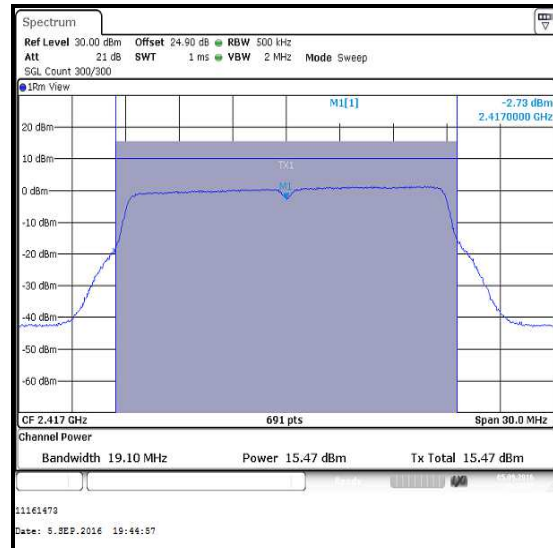
Channel	Frequency (MHz)	Conducted Power (dBm)	Power Limit (dBm)	Margin (dB)	Result
1	2412	10.0	30.0	20.0	Complied
2	2417	15.5	30.0	14.5	Complied
6	2437	16.6	30.0	13.4	Complied
7	2442	16.6	30.0	13.4	Complied
11	2462	7.3	30.0	22.7	Complied
12	2467	5.1	30.0	24.9	Complied

De Facto EIRP Limit Comparison

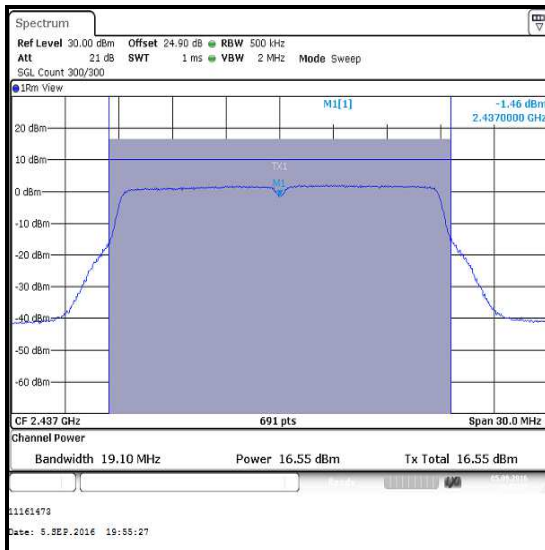
Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
1	10.0	3.3	13.3	36.0	22.7	Complied
2	15.5	3.3	18.8	36.0	17.2	Complied
6	16.6	3.3	19.9	36.0	16.1	Complied
7	16.6	3.3	19.9	36.0	16.1	Complied
11	7.3	3.3	10.6	36.0	25.4	Complied
12	5.1	3.3	8.4	36.0	27.6	Complied

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (3Tx CDD) / Port 2 (continued)**

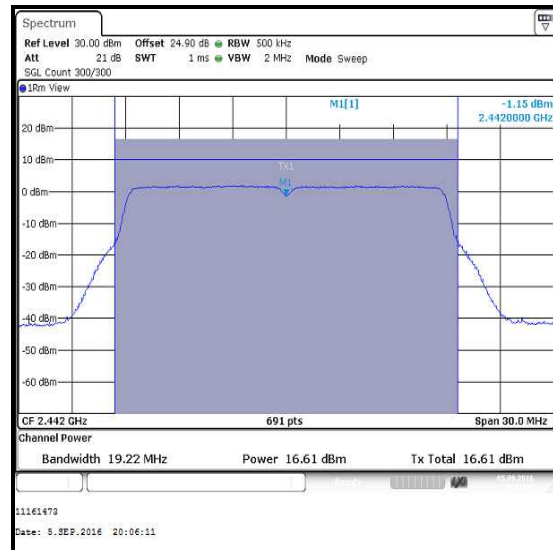
Channel 1



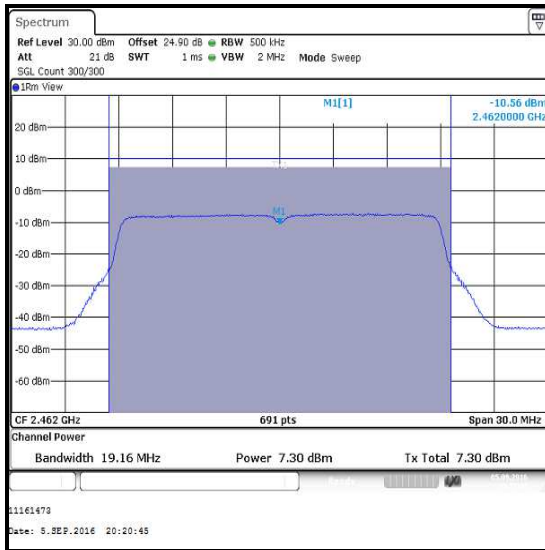
Channel 2



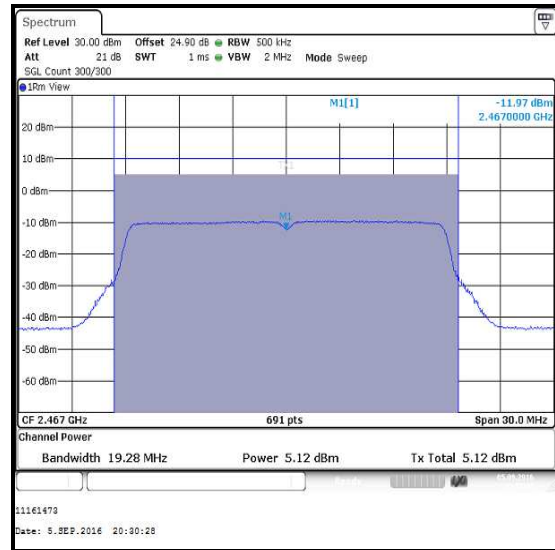
Channel 6



Channel 7

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (3Tx CDD) / Port 2 (continued)**

Channel 11



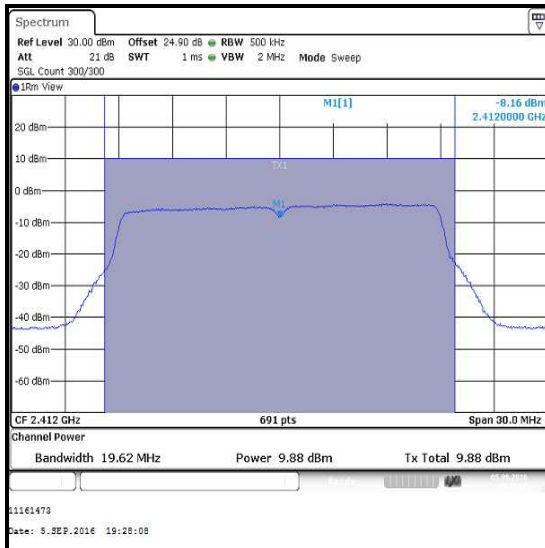
Channel 12

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (3Tx CDD) / Port 3****Conducted Peak Limit Comparison**

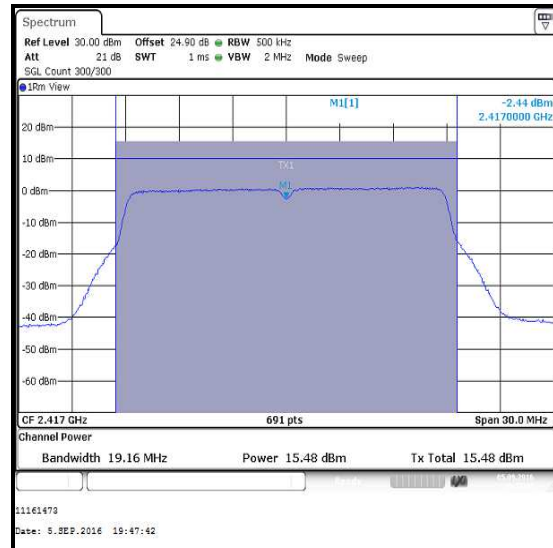
Channel	Frequency (MHz)	Conducted Power (dBm)	Power Limit (dBm)	Margin (dB)	Result
1	2412	9.9	30.0	20.1	Complied
2	2417	15.5	30.0	14.5	Complied
6	2437	16.5	30.0	13.5	Complied
7	2442	16.5	30.0	13.5	Complied
11	2462	7.1	30.0	22.9	Complied
12	2467	5.0	30.0	25.0	Complied

De Facto EIRP Limit Comparison

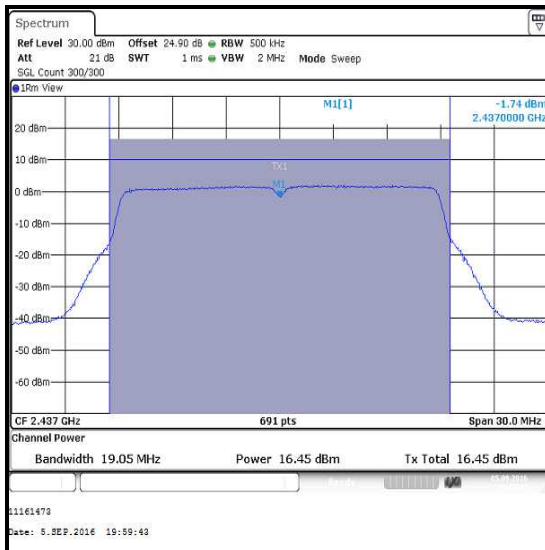
Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
1	9.9	2.3	12.2	36.0	23.8	Complied
2	15.5	2.3	17.8	36.0	18.2	Complied
6	16.5	2.3	18.8	36.0	17.2	Complied
7	16.5	2.3	18.8	36.0	17.2	Complied
11	7.1	2.3	9.4	36.0	26.6	Complied
12	5.0	2.3	7.3	36.0	28.7	Complied

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (3Tx CDD) / Port 3 (continued)**

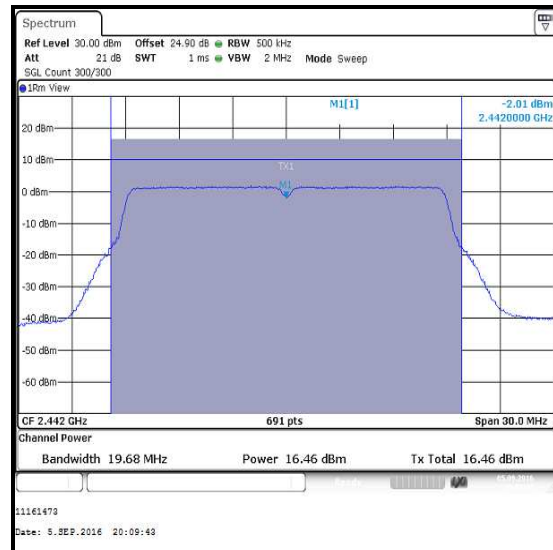
Channel 1



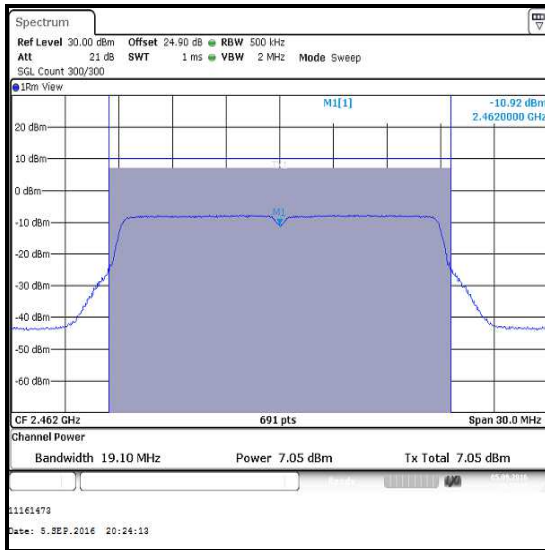
Channel 2



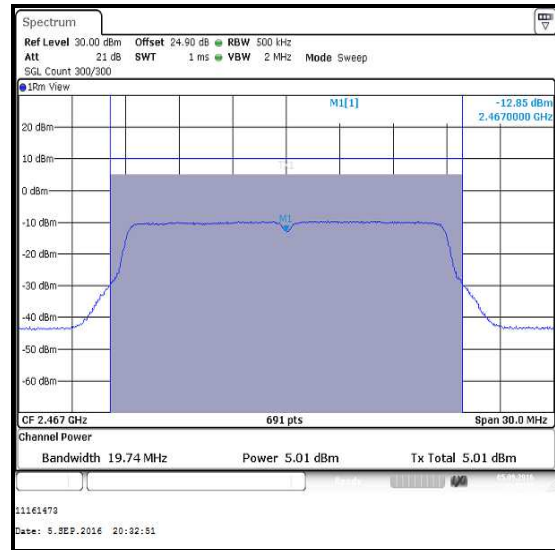
Channel 6



Channel 7

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (3Tx CDD) / Port 3 (continued)**

Channel 11



Channel 12

Transmitter Maximum (Average) Output Power (continued)**Combined Output Power / MIMO (3Tx CDD) / Port 1, Port 2 & Port 3****Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO (3Tx CDD)****Conducted Peak Limit Comparison**

Channel	Frequency (MHz)	Conducted Power on Port 1 (dBm)	Conducted Power on Port 2 (dBm)	Conducted Power on Port 3 (dBm)	Combined Conducted Power (dBm)	Power Limit (dBm)	Margin (dB)	Result
1	2412	9.9	10.0	9.9	14.7	28.7	14.0	Complied
2	2417	15.2	15.5	15.5	20.2	28.7	8.5	Complied
6	2437	16.6	16.6	16.5	21.3	28.7	7.4	Complied
7	2442	16.5	16.6	16.5	21.3	28.7	7.4	Complied
11	2462	7.5	7.3	7.1	12.1	28.7	16.6	Complied
12	2467	4.8	5.1	5.0	9.7	28.7	19.0	Complied

De Facto EIRP Limit Comparison

Channel	Combined Conducted Power (dBm)	Effective Antenna Gain (dBi)	Effective EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
1	14.7	7.3	22.0	36.0	14.0	Complied
2	20.2	7.3	27.5	36.0	8.5	Complied
6	21.3	7.3	28.6	36.0	7.4	Complied
7	21.3	7.3	28.6	36.0	7.4	Complied
11	12.1	7.3	19.4	36.0	16.6	Complied
12	9.7	7.3	17.0	36.0	19.0	Complied

Transmitter Maximum (Average) Output Power (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
M1996	Signal Analyser	Rohde & Schwarz	FSV13	100975	02 Mar 2017	12
A2526	Attenuator	AtlanTecRF	AN18W5-20	832828#1	Calibrated before use	-
A030	Step Attenuator	Narda	745-69	01544	Calibrated before use	-
A2500	Directional Coupler	AtlanTecRF	CDC-003060-10	13122501835	Calibrated before use	-
A2501	Directional Coupler	AtlanTecRF	CDC-003060-10	13122501836	Calibrated before use	-
A2502	Directional Coupler	AtlanTecRF	CDC-003060-10	13122501837	Calibrated before use	-
M200	Power Divider	Narda	4313C-4	10019	Calibrated before use	-
M204	Power Divider	Narda	4313C-4	10021	Calibrated before use	-
G0607	Signal Generator	Rohde & Schwarz	SMU200A	100943	10 May 2019	36

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

Test Engineers:	Stuart Martin, Nick Steele & Georgios Vrezas	Test Dates:	28 August 2016 to 04 September 2016
Test Sample Serial Number:	C02S2003HH5Y		

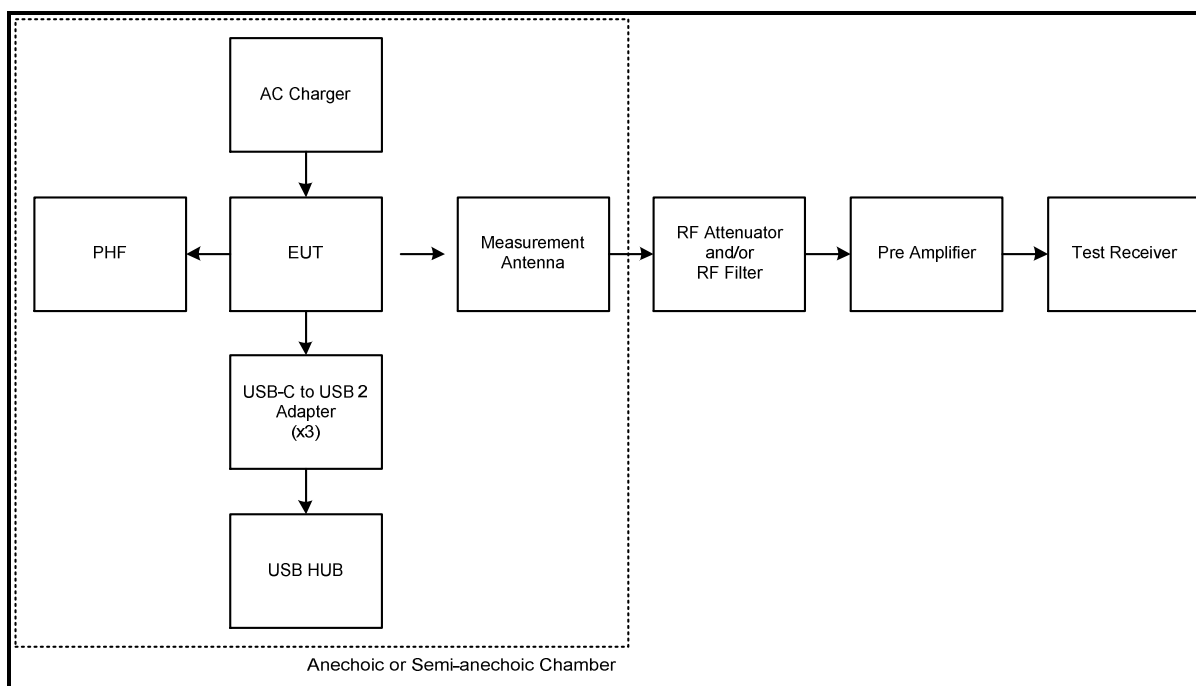
FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3 and 6.5
Frequency Range	30 MHz to 1000 MHz

Environmental Conditions:

Temperature (°C):	20 to 25
Relative Humidity (%):	35 to 55

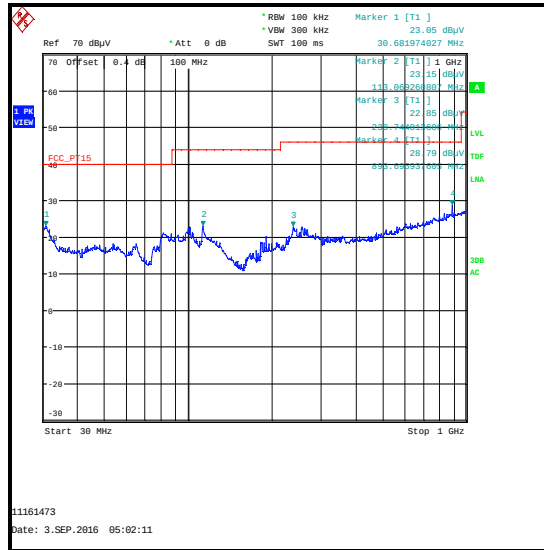
Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. Although all the modes listed in Section 4.1 of this report were tested, only the middle channel plots for the worst case mode with respect to power have been included in this section. Other channels and modes were seen to produce similar results and have therefore been excluded from this report. All plots are archived securely on the UL VS IT server and are available for inspection upon request.
3. All 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. Therefore the highest peak noise floor reading of the measuring receiver was recorded in the table below.
4. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0017) 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.

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

Transmitter Radiated Emissions (continued)**Results: Middle Channel / 802.11n / HT20 / MCS0 / MIMO (3Tx CDD) on Ports 1, 2 & 3**

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
893.696	Vertical	28.8	46.0	17.2	Complied

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2003	Thermohygrometer	Testo	608-H1	45046641	22 Apr 2017	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	19 May 2017	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	21 Mar 2017	12
A2888	Antenna	Schwarzbeck	VULB 9163	9163-941	07 Apr 2017	12
A2175	Low Pass Filter	AtlanTecRF	AFL-01000	800976	30 Apr 2017	12

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

Test Engineers:	Stuart Martin, Nick Steele & Georgios Vrezas	Test Dates:	28 August 2016 to 04 September 2016
Test Sample Serial Numbers:	C02S2003HH5Y, C02S200EHH5Q & C02S200CHH5W		

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

Environmental Conditions:

Temperature (°C):	20 to 25
Relative Humidity (%):	35 to 55

Note(s):

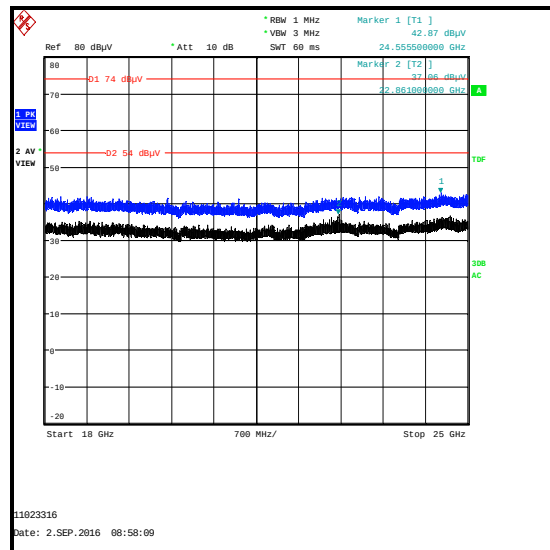
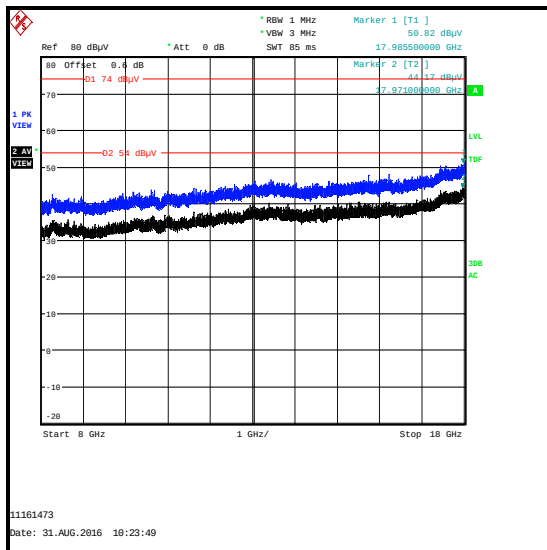
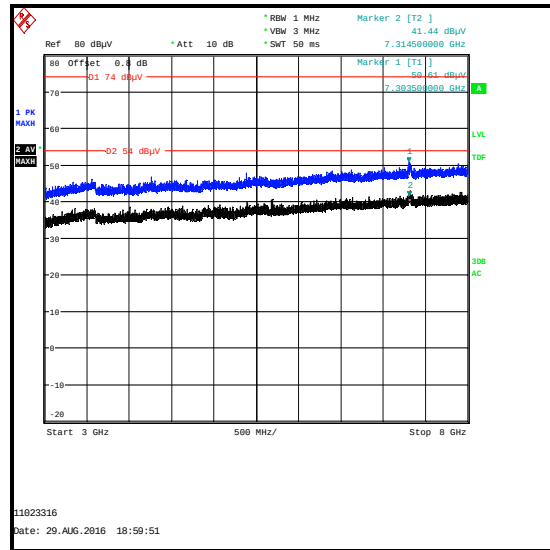
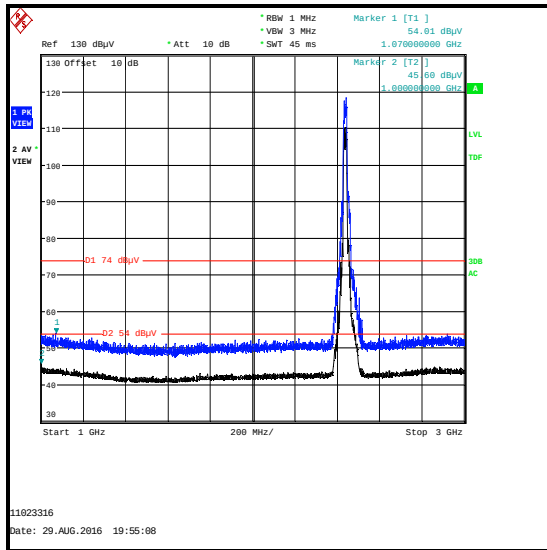
- Although all the modes listed in Section 4.1 of this report were tested, only the middle channel plots for the worst case mode with respect to power have been included in this section. Other channels and modes were seen to produce similar results and have therefore been excluded from this report. All plots are archived securely on the UL VS IT server and are available for inspection upon request.
- The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
- 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.
- The emission shown approximately at 2437 MHz on the 1 GHz to 4 GHz plot is the EUT fundamental.
- Measurements were performed in an anechoic chamber (Asset Number K0017) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres 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.
- Pre-scans were performed and a marker placed on the highest measured level of the appropriate plot. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. The sweep time was set to auto.

Results: Peak / Middle Channel / 802.11n / HT20 / MCS0 / MIMO (3Tx CDD) on Ports 1, 2 & 3

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Result
1070.000	Vertical	54.0	74.0	20.0	Complied

Results: Average / Middle Channel / 802.11n / HT20 / MCS0 / MIMO (3Tx CDD) on Ports 1, 2 & 3

Frequency (MHz)	Antenna Polarity	Average Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
1000.000	Vertical	45.6	54.0	8.4	Complied

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)
M2003	Thermohygrometer	Testo	608-H1	45046641	22 Apr 2017	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	19 May 2017	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	21 Mar 2017	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B	07 Apr 2017	12
A2890	Antenna	Schwarzbeck	HWRD 750	014	06 May 2017	12
A2892	Antenna	Schwarzbeck	BBHA 9170	9170-727	07 Apr 2017	12
A2863	Pre-Amplifier	Agilent	8449B	3008A02100	07 Jan 2017	12
A2891	Pre-Amplifier	Schwarzbeck	BBV 9718	9718-306	07 Apr 2017	12
A2893	Pre-Amplifier	Schwarzbeck	BBV 9721	9721-021	07 Apr 2017	12
A2914	High Pass Filter	AtlanTecRF	AFH-03000	2155	19 May 2017	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	1601900001	01 Jun 2017	12
A2916	Attenuator	AtlanTecRF	AN185W-10	832827#1	19 May 2017	12

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

Test Engineers:	Stuart Martin, Andrew Edwards, Nick Steele & Georgios Vrezas	Test Dates:	08 August 2016 to 27 September 2016
Test Sample Serial Numbers:	C02S2003HH5Y, C02S200EHH5Q & C02S200CHH5W		

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

Environmental Conditions:

Temperature (°C):	20 to 25
Relative Humidity (%):	35 to 55

Note(s):

- The customer declared the following data rates to be used for all measurements as:

- o 802.11b – 1 Mbit/s / SISO on Port 2
- o 802.11g – 6 Mbit/s / SISO on Port 2
- o 802.11n HT20 – MCS0 / SISO on Port 2
- o 802.11n HT20 – MCS0 / MIMO (2Tx CDD) on Ports 2 & 3
- o 802.11n HT20 – MCS0 / MIMO (3Tx CDD) on Ports 1, 2 & 3

Final measurements were performed with the above configurations.

- The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
- 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.
- 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 100 traces performed. For average measurements the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth 3 MHz. An RMS detector was used, sweep time was set to auto and 100 traces performed. 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.
- 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 / 1 Mbit/s / SISO on Port 2****Results: Lower Band Edge**

Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	-30 dBc Limit (dB μ V/m)	Margin (dB)	Result
1	2399.439	66.5	85.0	18.5	Complied
2	2400.000	48.5	80.2	31.7	Complied
3	2399.359	48.5	80.4	31.9	Complied

Results: Restricted Band / Lower Band Edge / Peak

Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
1	2389.359	54.8	74.0	19.2	Complied
2	2387.564	53.1	74.0	20.9	Complied
3	2386.795	53.1	74.0	20.9	Complied

Results: Restricted Band / Lower Band Edge / Average

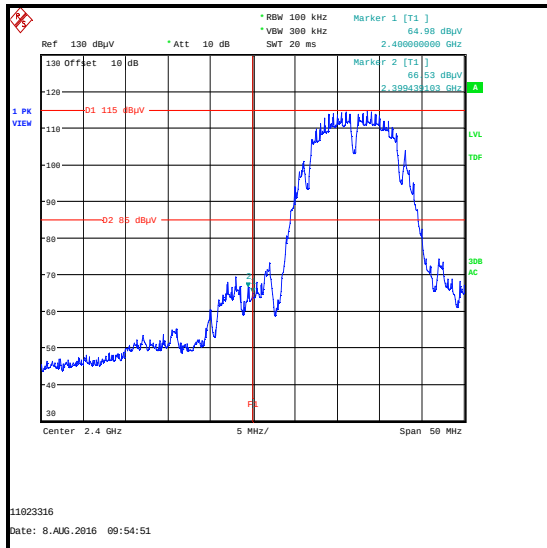
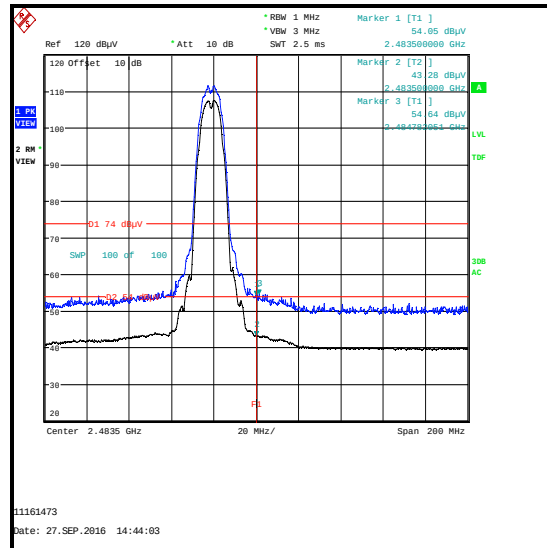
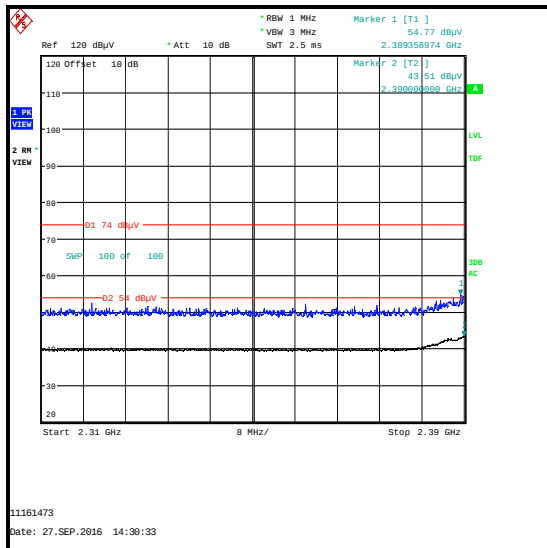
Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
1	2390.000	43.5	54.0	10.5	Complied
2	2389.872	42.2	54.0	11.8	Complied
3	2390.000	41.4	54.0	12.6	Complied

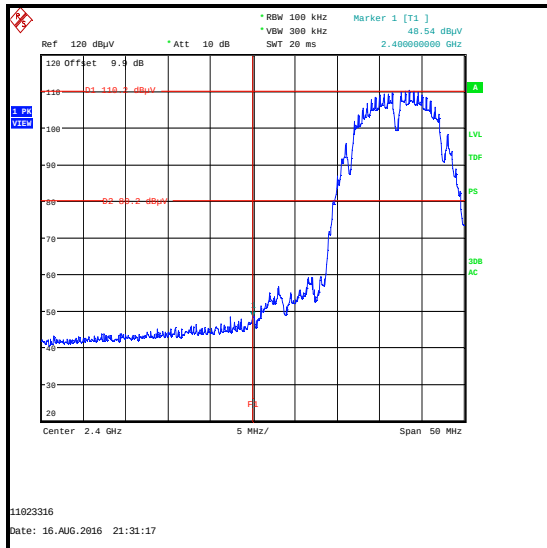
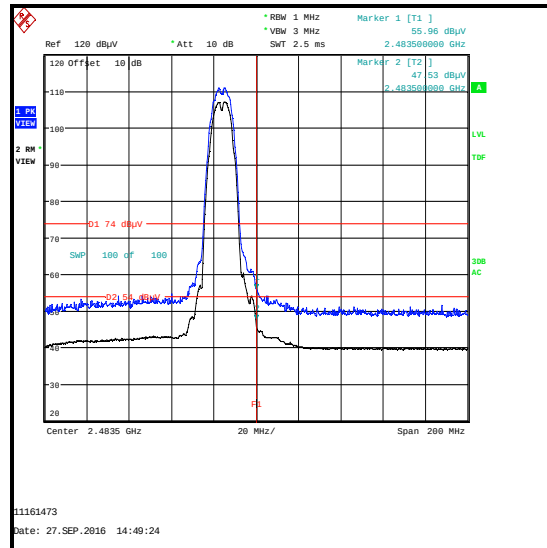
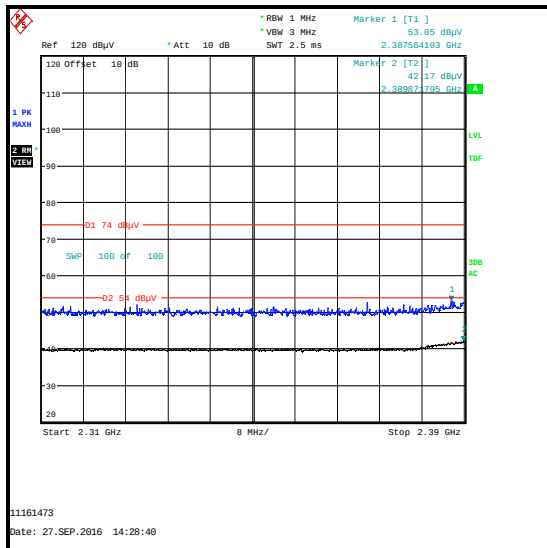
Results: Upper Band Edge / Restricted Band / Peak

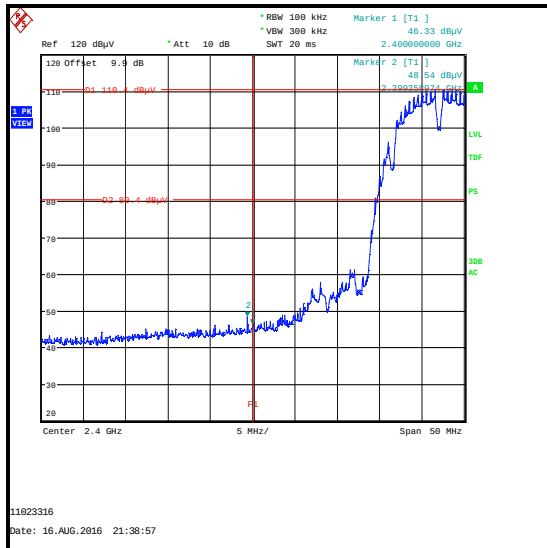
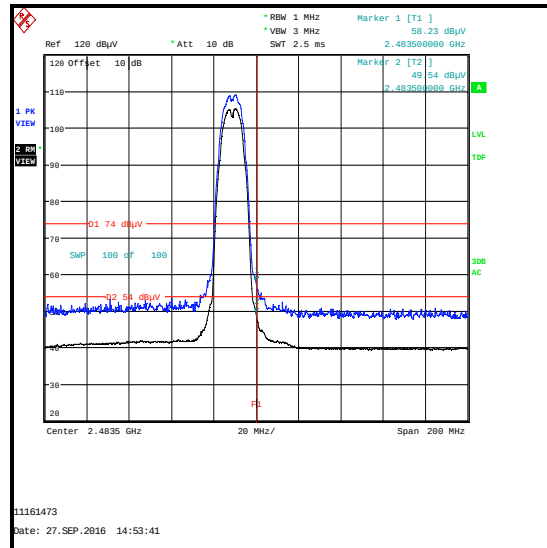
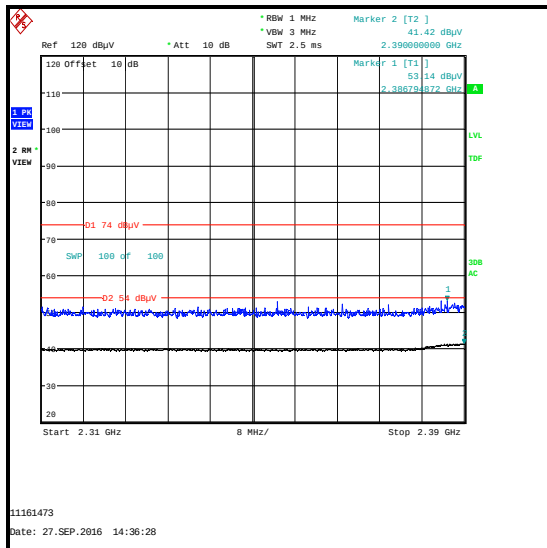
Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
11	2484.782	54.6	74.0	19.4	Complied
12	2483.500	56.0	74.0	18.0	Complied
13	2483.500	58.2	74.0	15.8	Complied

Results: Upper Band Edge / Restricted Band / Average

Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
11	2483.500	43.3	54.0	10.7	Complied
12	2483.500	47.5	54.0	6.5	Complied
13	2483.500	49.5	54.0	4.5	Complied

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11b / 1 Mbit/s / SISO on Port 2****Lower Band Edge Peak Measurement
Channel 1****Upper Band Edge Peak & Average Measurements
Channel 11****2310 MHz to 2390 MHz Restricted Band
Channel 1**

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11b / 1 Mbit/s / SISO on Port 2****Lower Band Edge Peak Measurement
Channel 2****Upper Band Edge Peak & Average Measurements
Channel 12****2310 MHz to 2390 MHz Restricted Band
Channel 2**

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11b / 1 Mbit/s / SISO on Port 2****Lower Band Edge Peak Measurement
Channel 3****Upper Band Edge Peak & Average Measurements
Channel 13****2310 MHz to 2390 MHz Restricted Band
Channel 3**

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11g / 6 Mbit/s / SISO on Port 2****Results: Lower Band Edge**

Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	-30 dBc Limit (dB μ V/m)	Margin (dB)	Result
1	2399.872	58.7	65.0	6.3	Complied
2	2399.519	60.8	70.1	9.3	Complied
3	2399.679	59.5	70.1	10.6	Complied

Results: Restricted Band / Lower Band Edge / Peak

Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
1	2387.179	68.1	74.0	5.9	Complied
2	2389.615	64.4	74.0	9.6	Complied
3	2388.590	68.1	74.0	5.9	Complied

Results: Restricted Band / Lower Band Edge / Average

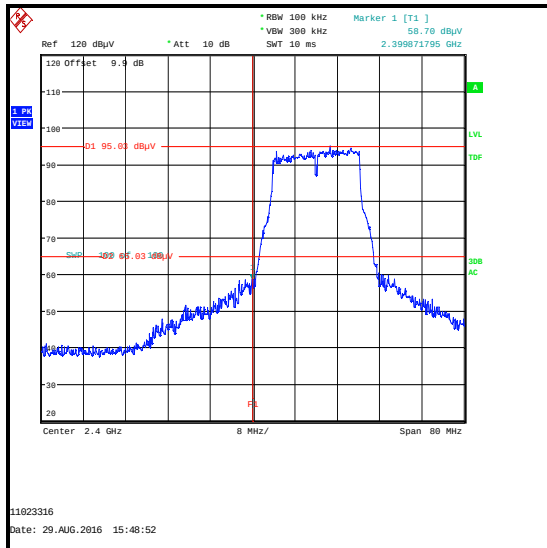
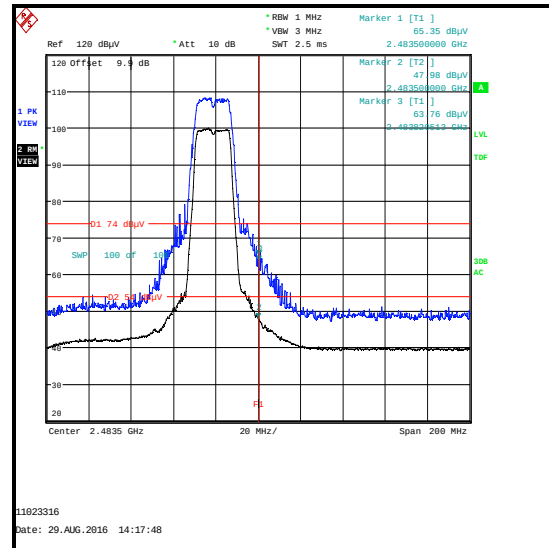
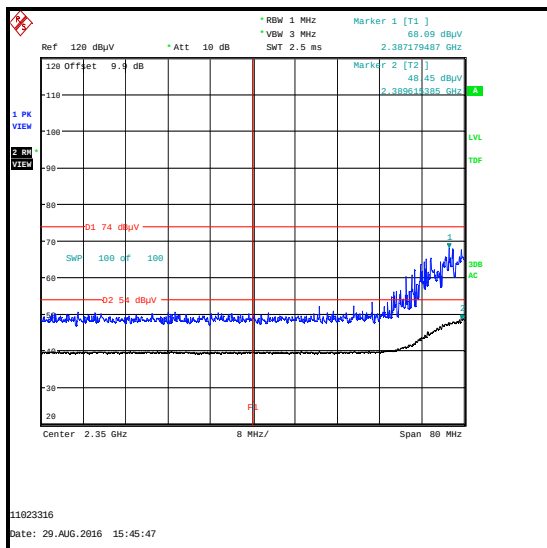
Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
1	2389.615	48.5	54.0	5.5	Complied
2	2389.744	47.3	54.0	6.7	Complied
3	2389.872	48.3	54.0	5.7	Complied

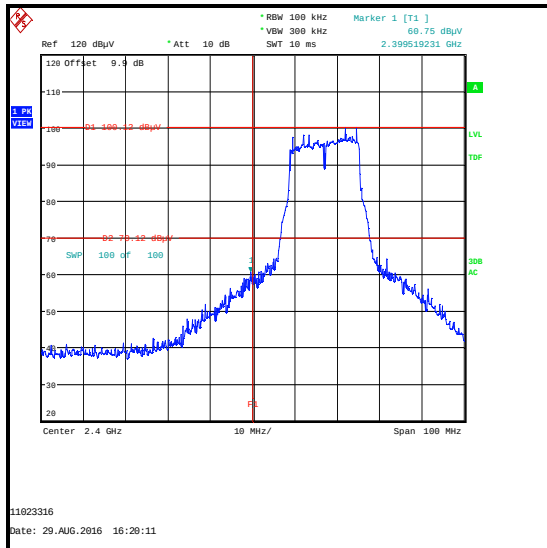
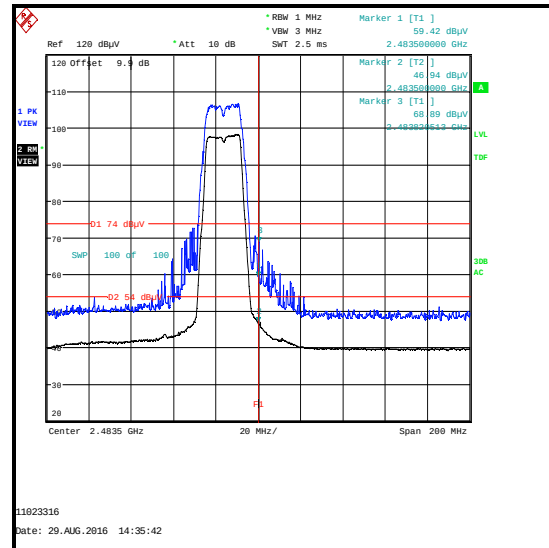
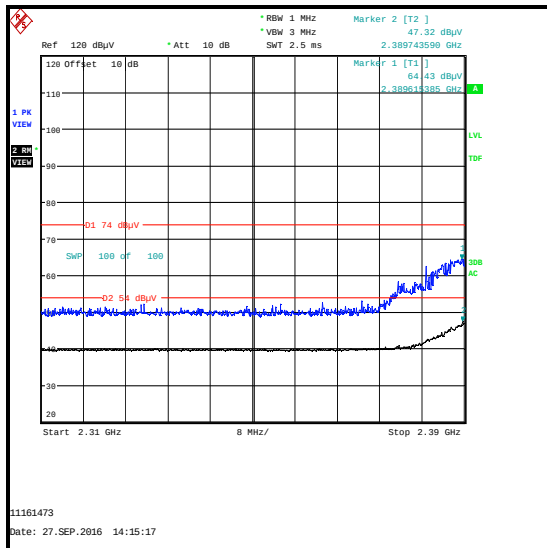
Results: Upper Band Edge / Restricted Band / Peak

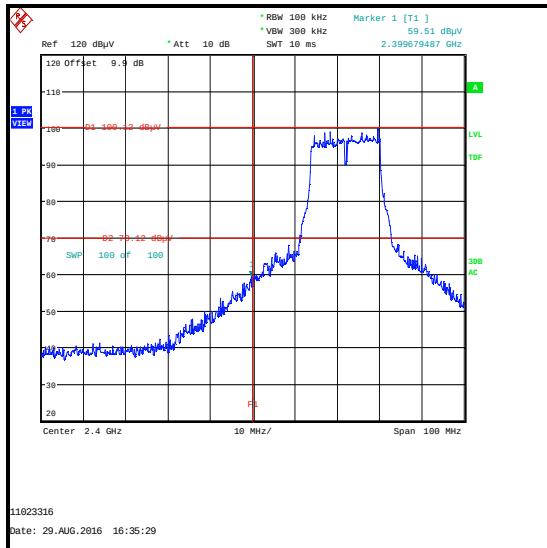
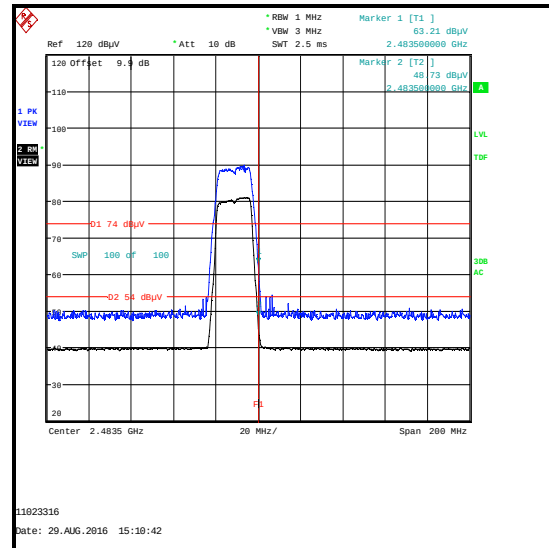
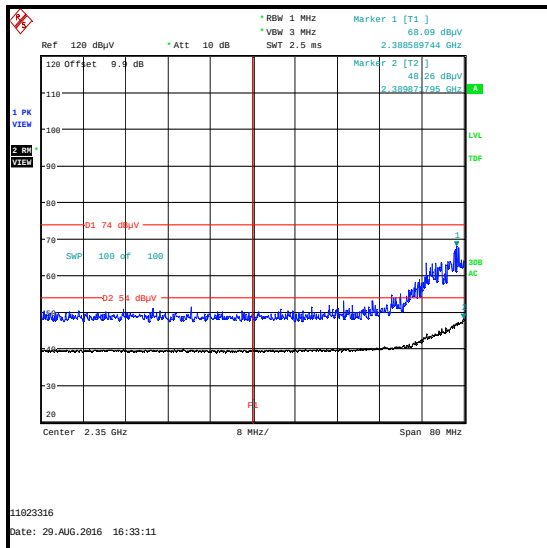
Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
11	2483.500	65.4	74.0	8.6	Complied
12	2483.827	68.9	74.0	5.1	Complied
13	2483.500	63.2	74.0	10.8	Complied

Results: Upper Band Edge / Restricted Band / Average

Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
11	2483.500	48.0	54.0	6.0	Complied
12	2483.500	46.9	54.0	7.1	Complied
13	2483.500	48.7	54.0	5.3	Complied

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11g / 6 Mbit/s / SISO on Port 2****Lower Band Edge Peak Measurement
Channel 1****Upper Band Edge Peak & Average Measurements
Channel 11****2310 MHz to 2390 MHz Restricted Band
Channel 1**

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11g / 6 Mbit/s / SISO on Port 2****Lower Band Edge Peak Measurement
Channel 2****Upper Band Edge Peak & Average Measurements
Channel 12****2310 MHz to 2390 MHz Restricted Band
Channel 2**

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11g / 6 Mbit/s / SISO on Port 2****Lower Band Edge Peak Measurement
Channel 3****Upper Band Edge Peak & Average Measurements
Channel 13****2310 MHz to 2390 MHz Restricted Band
Channel 3**

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11n HT20 / MCS0 / SISO on Port 2****Results: Lower Band Edge**

Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	-30 dBc Limit (dB μ V/m)	Margin (dB)	Result
1	2400.000	48.3	60.2	11.9	Complied
2	2399.920	61.4	72.3	10.9	Complied
3	2399.519	58.3	72.3	14.0	Complied

Results: Restricted Band / Lower Band Edge / Peak

Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
1	2389.359	68.5	74.0	5.5	Complied
2	2386.282	62.5	74.0	11.5	Complied
3	2386.410	61.4	74.0	12.6	Complied

Results: Restricted Band / Lower Band Edge / Average

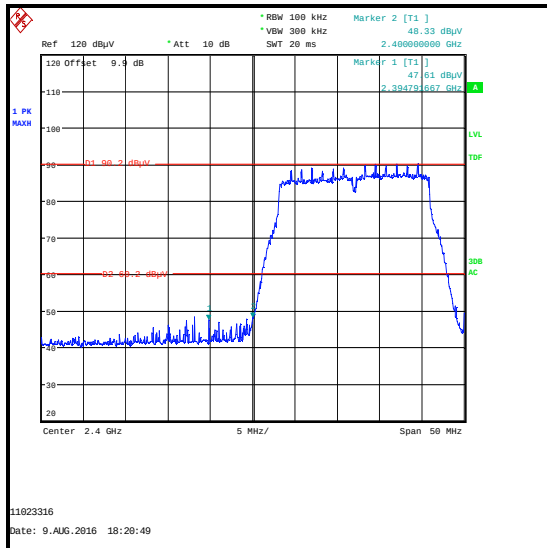
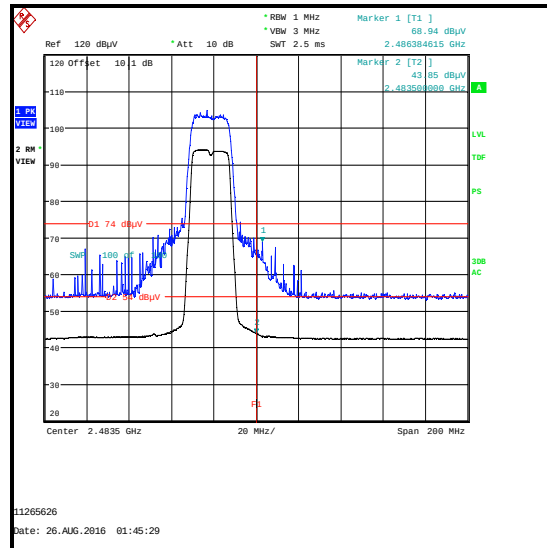
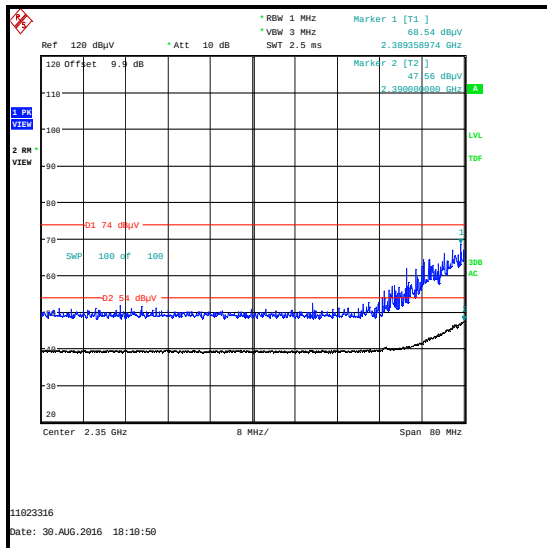
Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
1	2390.000	47.6	54.0	6.4	Complied
2	2390.000	42.4	54.0	11.6	Complied
3	2389.231	41.4	54.0	12.6	Complied

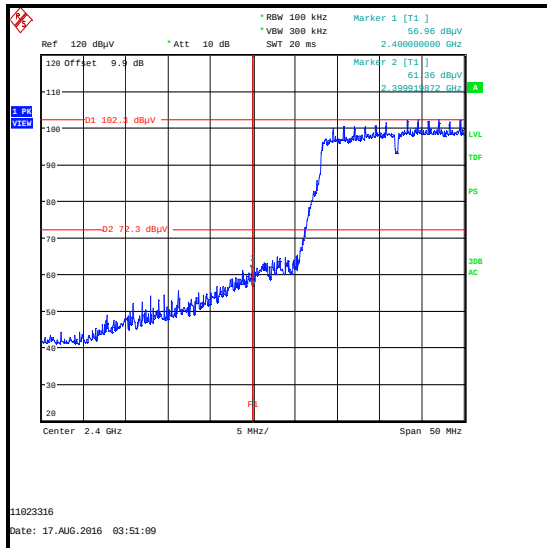
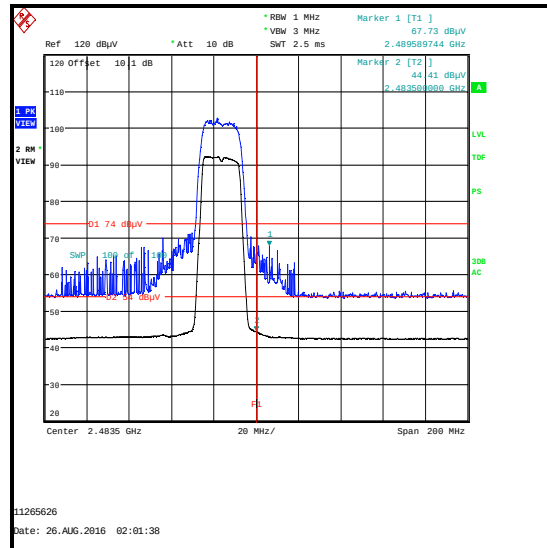
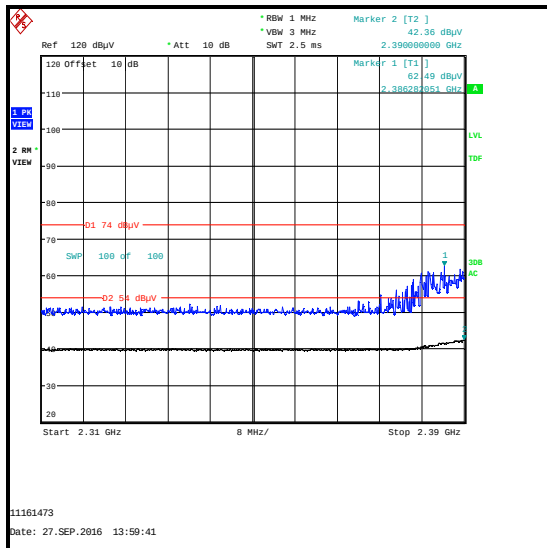
Results: Upper Band Edge / Restricted Band / Peak

Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
11	2486.385	68.9	74.0	5.1	Complied
12	2489.590	67.7	74.0	6.3	Complied
13	2483.500	60.1	74.0	13.9	Complied

Results: Upper Band Edge / Restricted Band / Average

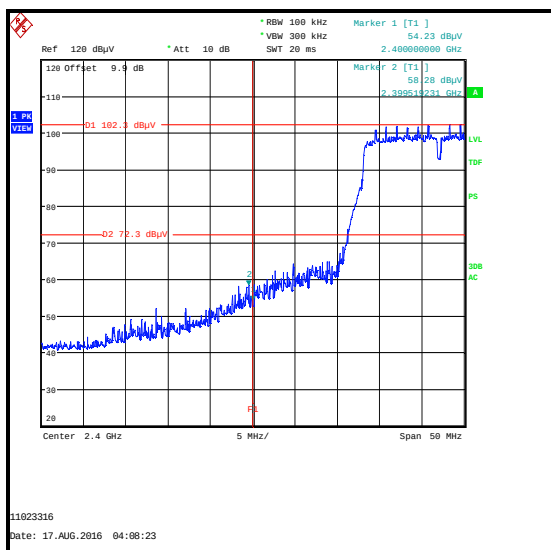
Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
11	2483.500	43.9	54.0	10.1	Complied
12	2483.500	44.4	54.0	9.6	Complied
13	2483.500	43.5	54.0	10.5	Complied

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11n HT20 / MCS0 / SISO on Port 2****Lower Band Edge Peak Measurement
Channel 1****Upper Band Edge Peak & Average Measurements
Channel 11****2310 MHz to 2390 MHz Restricted Band
Channel 1**

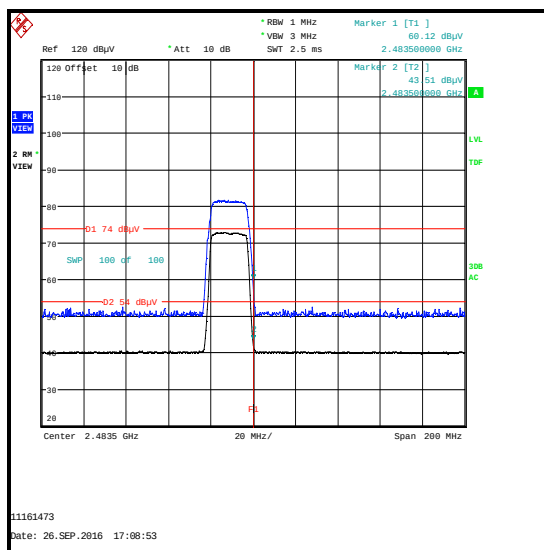
Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11n HT20 / MCS0 / SISO on Port 2****Lower Band Edge Peak Measurement
Channel 2****Upper Band Edge Peak & Average Measurements
Channel 12****2310 MHz to 2390 MHz Restricted Band
Channel 2**

Transmitter Band Edge Radiated Emissions (continued)

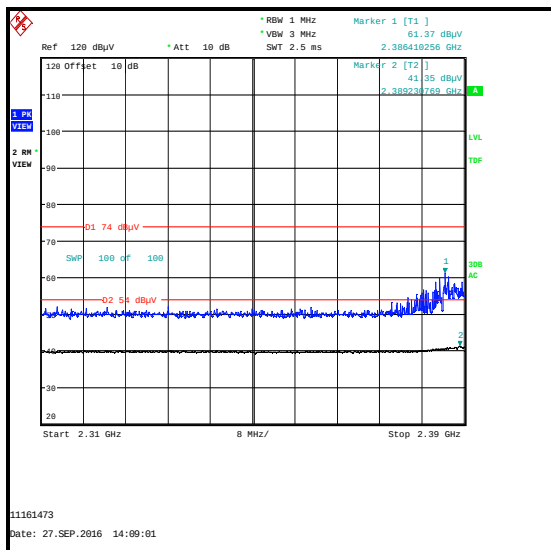
Results: 802.11n HT20 / MCS0 / SISO on Port 2



Lower Band Edge Peak Measurement Channel 3



Upper Band Edge Peak & Average Measurements Channel 13



2310 MHz to 2390 MHz Restricted Band Channel 3

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11n HT20 / MCS0 / MIMO (2Tx CDD) on Ports 2 & 3****Results: Lower Band Edge**

Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	-30 dBc Limit (dB μ V/m)	Margin (dB)	Result
1	2399.760	74.8	80.2	5.4	Complied
2	2399.808	75.0	80.6	5.6	Complied
3	2398.558	55.7	72.6	16.9	Complied

Results: Restricted Band / Lower Band Edge / Peak

Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
1	2388.974	68.4	74.0	5.6	Complied
2	2390.000	68.6	74.0	5.4	Complied
3	2388.077	68.6	74.0	5.4	Complied

Results: Restricted Band / Lower Band Edge / Average

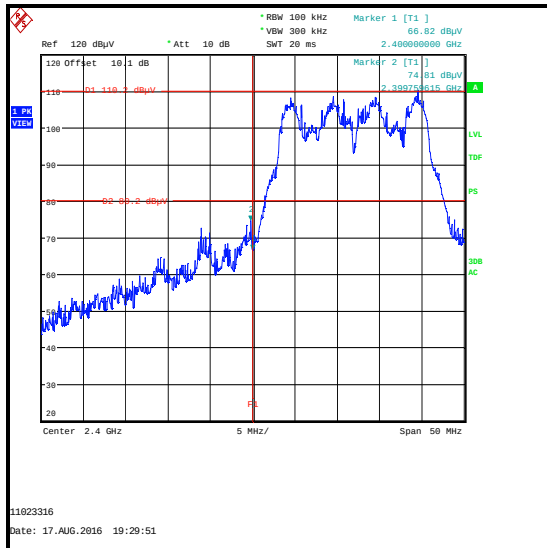
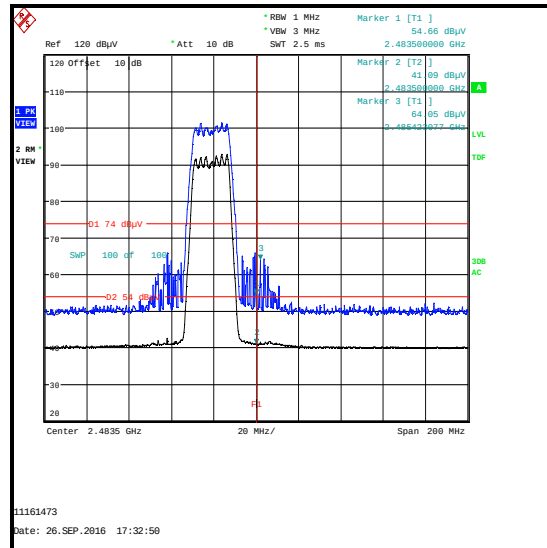
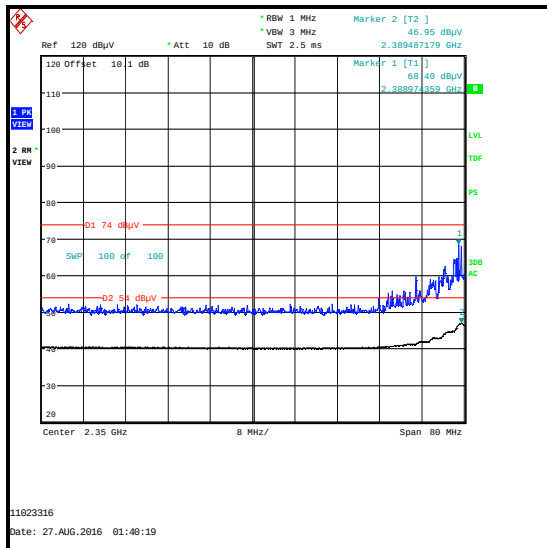
Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
1	2389.487	47.0	54.0	7.0	Complied
2	2388.718	48.1	54.0	5.9	Complied
3	2388.718	49.7	54.0	4.3	Complied

Results: Upper Band Edge / Restricted Band / Peak

Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
11	2485.432	64.1	74.0	9.9	Complied
12	2483.500	64.7	74.0	9.3	Complied

Results: Upper Band Edge / Restricted Band / Average

Transmit Channel	Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
11	2483.500	41.1	54.0	12.9	Complied
12	2483.500	41.4	54.0	12.6	Complied

Transmitter Band Edge Radiated Emissions (continued)**Results: 802.11n HT20 / MCS0 / MIMO (2Tx CDD) on Ports 2 & 3****Lower Band Edge Peak Measurement
Channel 1****Upper Band Edge Peak & Average Measurements
Channel 11****2310 MHz to 2390 MHz Restricted Band
Channel 1**