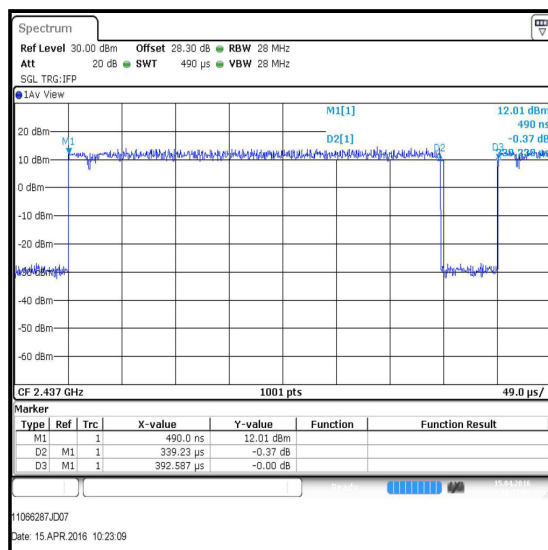
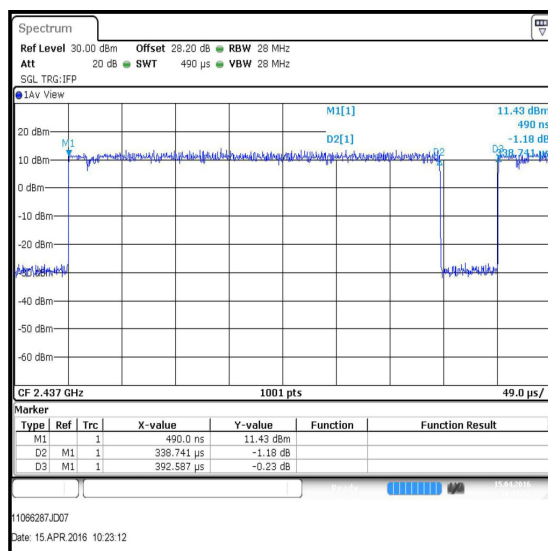


Transmitter Duty Cycle (continued)**Results: 802.11n / 40 MHz / MCS2 / Port 1**

Pulse Duration (µs)	Period (µs)	Duty Cycle (dB)
339.230	392.587	0.6

**Results: 802.11n / 40 MHz / MCS2 / Port 2**

Pulse Duration (µs)	Period (µs)	Duty Cycle (dB)
338.741	392.587	0.6



Transmitter Duty Cycle (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
M1873	Signal Analyser	Rohde & Schwarz	FSV30	103074	03 Jul 2016	12
M1867	Attenuator	Huber + Suhner AG	6820.17.B	07101	Calibrated before use	-
A2847	Attenuator	Radiall	R411.820.121	24671450	Calibrated before use	-
A2345	Attenuator	Macom	2082-6043-20	None stated	Calibrated before use	-
135878	RF Switch	Pickering Interfaces	64-102-002 & 40-881-001	XZ340281 & X311198	Calibrated before use	-
S0538	DC Power Supply	TTi	PL154	250135	Calibrated before use	-
M1251	Multimeter	Fluke	175	89170179	26 May 2016	12
M1252	Signal Generator	Hewlett Packard	83640A	3119A00489	26 Oct 2017	24

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

Test Engineer:	Georgios Vrezas	Test Date:	18 April 2016
Test Sample IMEI:	357232070003098		

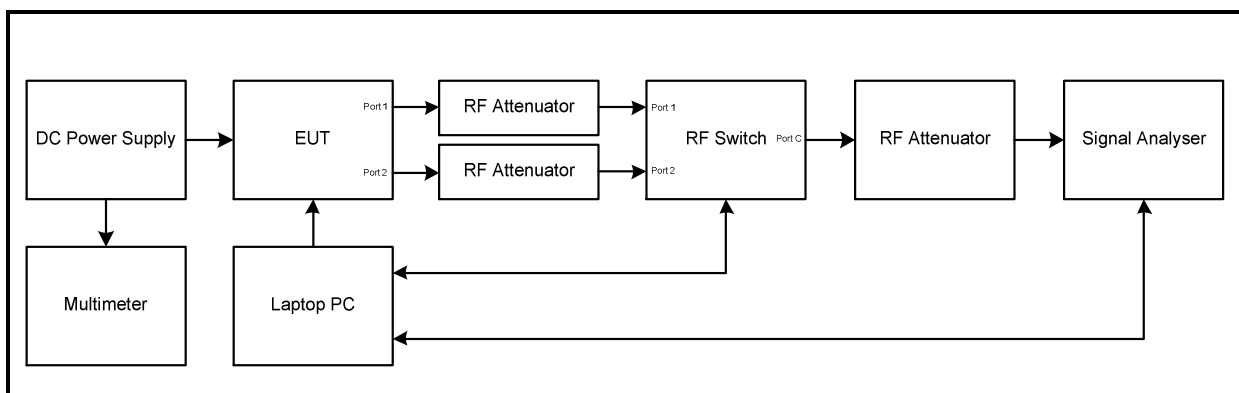
FCC Reference:	Part 15.247(e)
Test Method Used:	FCC KDB 558074 Section 10.5 and notes below

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	28

Note(s):

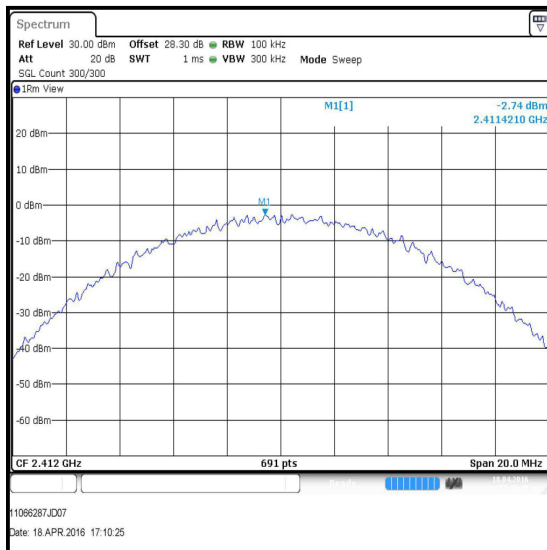
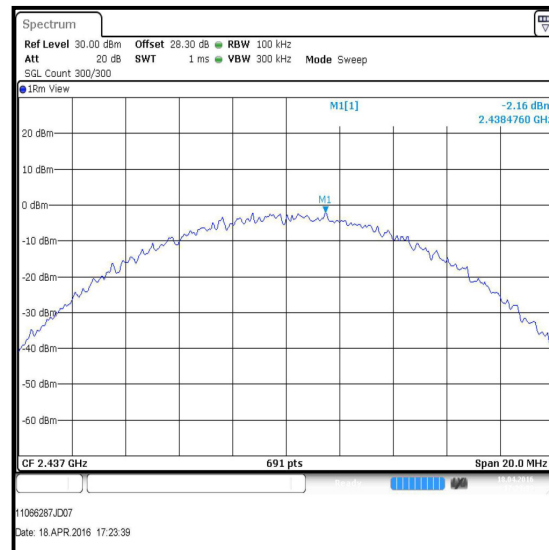
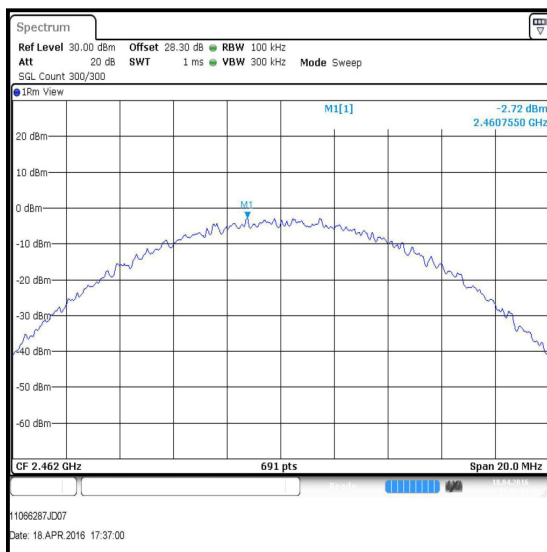
- All supported modes and channel widths were initially investigated on one channel. The modes that produced the highest power spectral density were:
 - 802.11b – DQPSK / 11 Mbit/s
 - 802.11g – 16QAM / 24 Mbit/s
 - 802.11n / HT20 – 64QAM / 58.5 Mbit/s / MCS6 (GI = 800 ns)
 - 802.11n / HT40 – QPSK / 40.5 Mbit/s / MCS2 (GI = 800 ns)
- Final measurements were performed using the above configurations on the bottom, middle and top channels.
- The EUT was transmitting at <98% duty cycle and testing was performed in accordance with KDB 558074 Section 10.5 Method AVGPSPD-2. The signal analyser resolution bandwidth was set to 100 kHz and video bandwidth 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. The calculated duty cycle shown in Section 5.2.3 of this test report was added to the measured average power spectral density in order to compute the average power spectral density during the actual transmission time.
- 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)b).
- The signal analyser was connected to the RF ports on the EUT via an RF switch, using suitable attenuation and RF cables. An RF level offset was entered on the signal analyser to compensate for the loss of the RF switch, attenuators and RF cables.

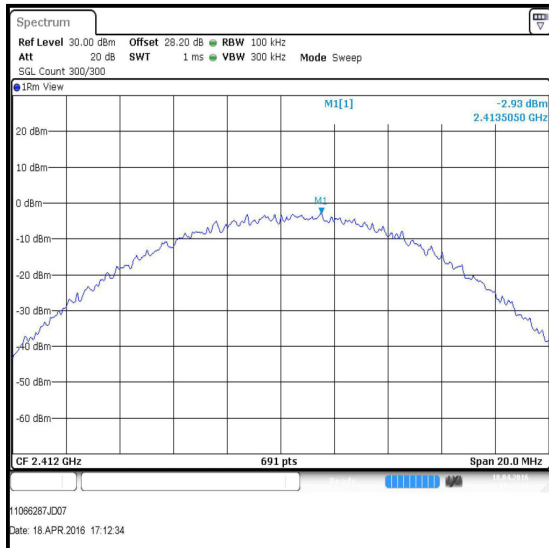
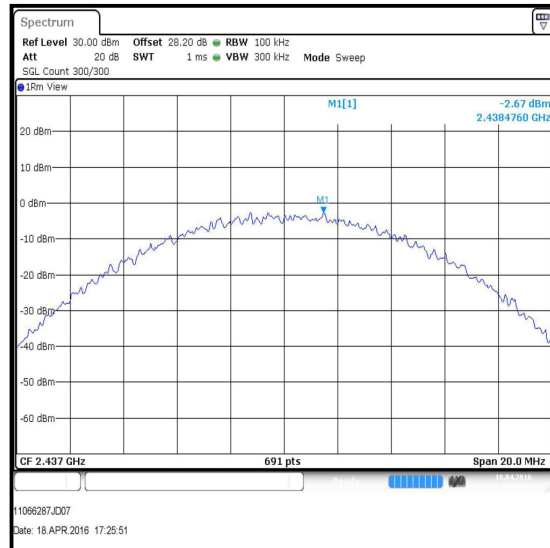
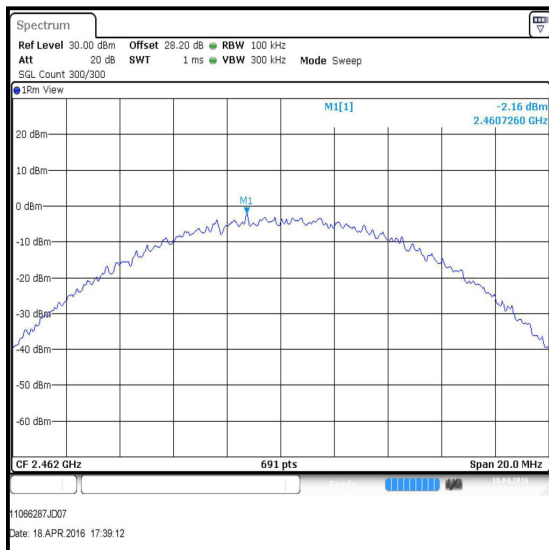
Test setup:

Transmitter Power Spectral Density (continued)**Results: 802.11b / 20 MHz / DQPSK / 11 Mbit/s**

Channel	Port 1			Port 2		
	PSD (dBm / 3 kHz)	Duty Cycle Correction (dB)	Corrected PSD (dBm / 3 kHz)	PSD (dBm / 3 kHz)	Duty Cycle Correction (dB)	Corrected PSD (dBm / 3 kHz)
Bottom	-2.7	0.2	-2.5	-2.9	0.2	-2.7
Middle	-2.2	0.2	-2.0	-2.7	0.2	-2.5
Top	-2.7	0.2	-2.5	-2.2	0.2	-2.0

Channel	Corrected PSD at Port 1 (dBm / 3 kHz)	Corrected PSD at Port 2 (dBm / 3 kHz)	Combined PSD (dBm / 3 kHz)	PSD Limit (dBm / 3 kHz)	Margin (dB)	Result
Bottom	-2.5	-2.7	0.4	8.0	7.6	Complied
Middle	-2.0	-2.5	0.8	8.0	7.2	Complied
Top	-2.5	-2.0	0.8	8.0	7.2	Complied

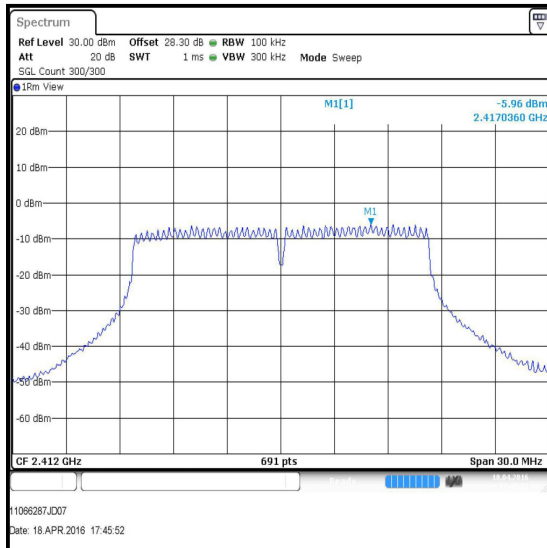
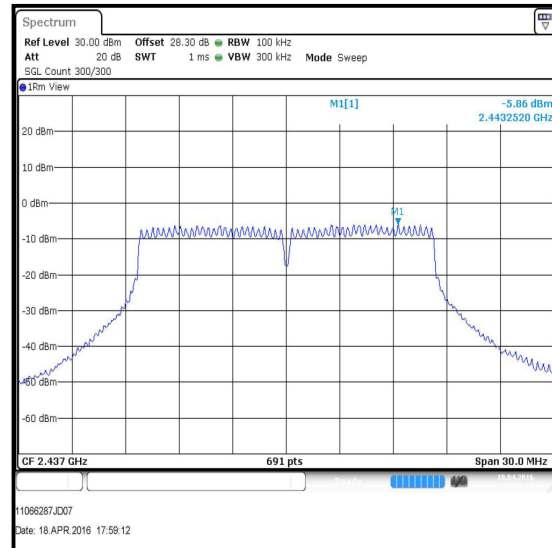
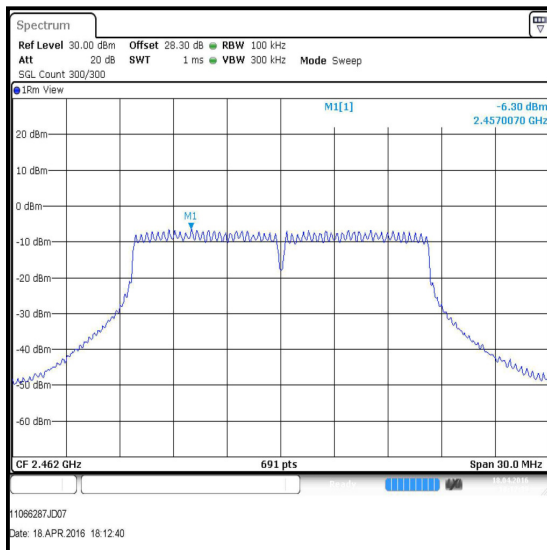
Transmitter Power Spectral Density (continued)**Results: 802.11b / 20 MHz / DQPSK / 11 Mbit/s / Port 1****Bottom Channel****Middle Channel****Top Channel**

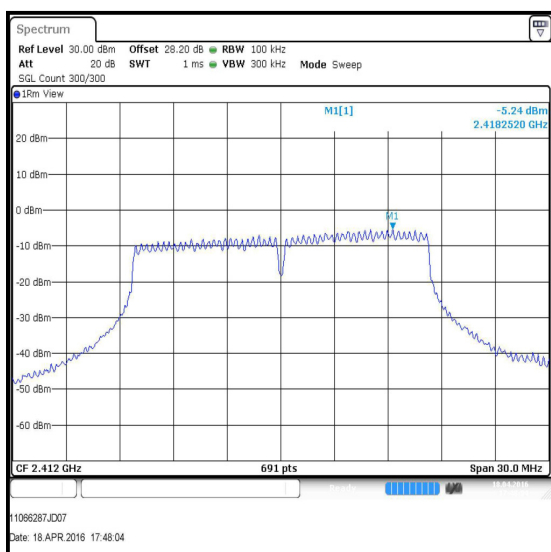
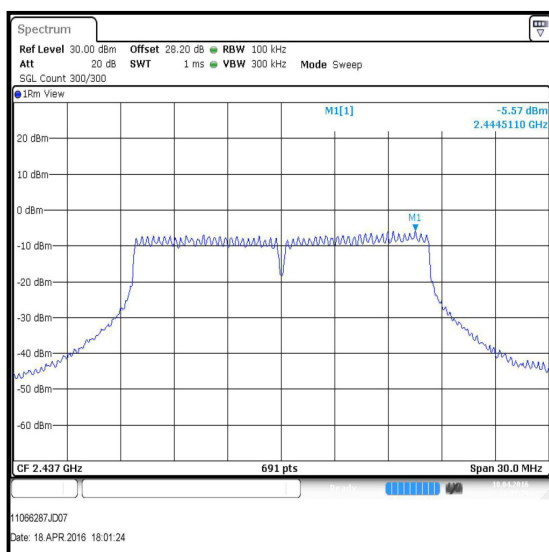
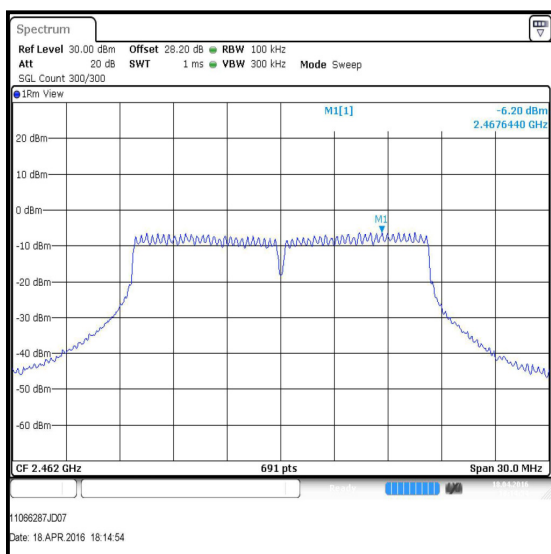
Transmitter Power Spectral Density (continued)**Results: 802.11b / 20 MHz / DQPSK / 11 Mbit/s / Port 2****Bottom Channel****Middle Channel****Top Channel**

Transmitter Power Spectral Density (continued)**Results: 802.11g / 20 MHz / 16QAM / 24 Mbit/s**

Channel	Port 1			Port 2		
	PSD (dBm / 3 kHz)	Duty Cycle Correction (dB)	Corrected PSD (dBm / 3 kHz)	PSD (dBm / 3 kHz)	Duty Cycle Correction (dB)	Corrected PSD (dBm / 3 kHz)
Bottom	-6.0	0.4	-5.6	-5.2	0.4	-4.8
Middle	-5.9	0.4	-5.5	-5.6	0.4	-5.2
Top	-6.3	0.4	-5.9	-6.2	0.4	-5.8

Channel	Corrected PSD at Port 1 (dBm / 3 kHz)	Corrected PSD at Port 2 (dBm / 3 kHz)	Combined PSD (dBm / 3 kHz)	PSD Limit (dBm / 3 kHz)	Margin (dB)	Result
Bottom	-5.6	-4.8	-2.2	8.0	10.2	Complied
Middle	-5.5	-5.2	-2.3	8.0	10.3	Complied
Top	-5.9	-5.8	-2.8	8.0	10.8	Complied

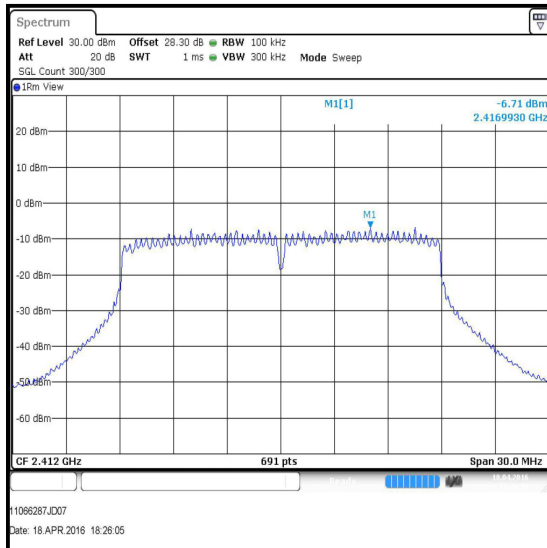
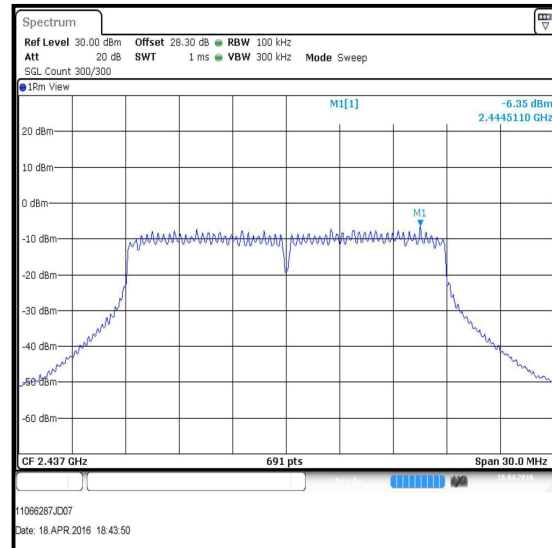
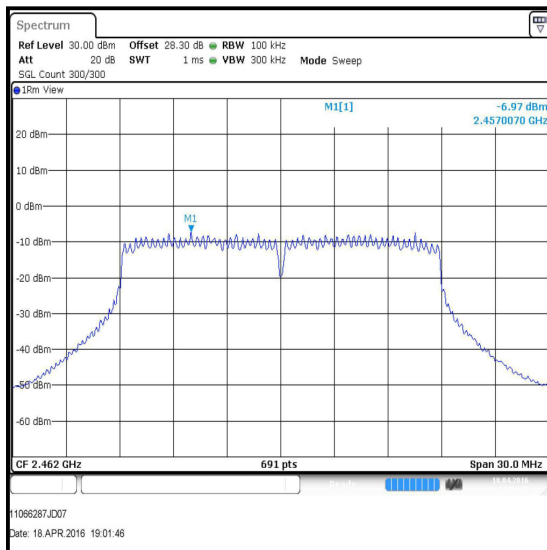
Transmitter Power Spectral Density (continued)**Results: 802.11g / 20 MHz / 16QAM / 24 Mbit/s / Port 1****Bottom Channel****Middle Channel****Top Channel**

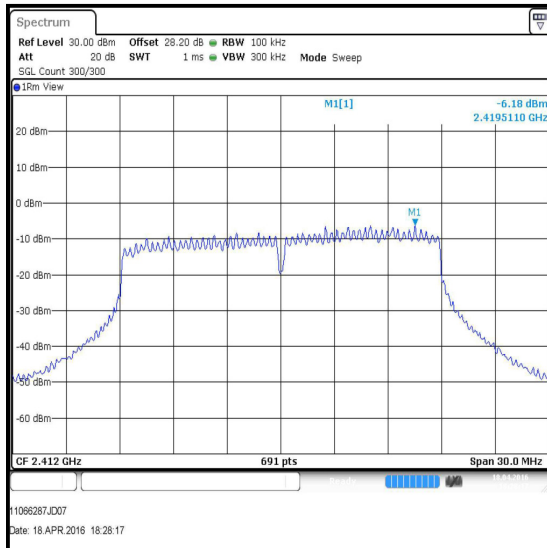
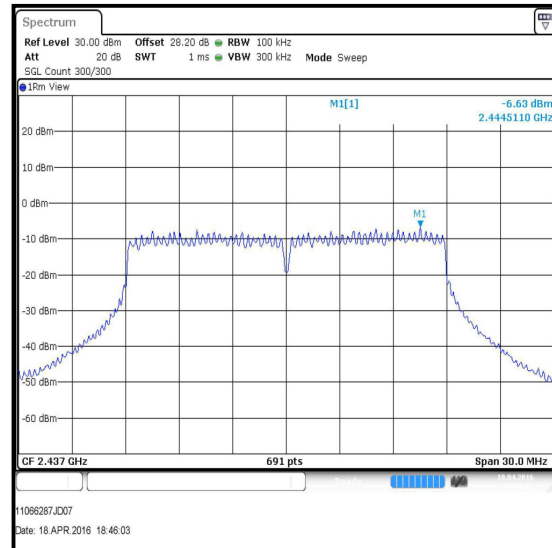
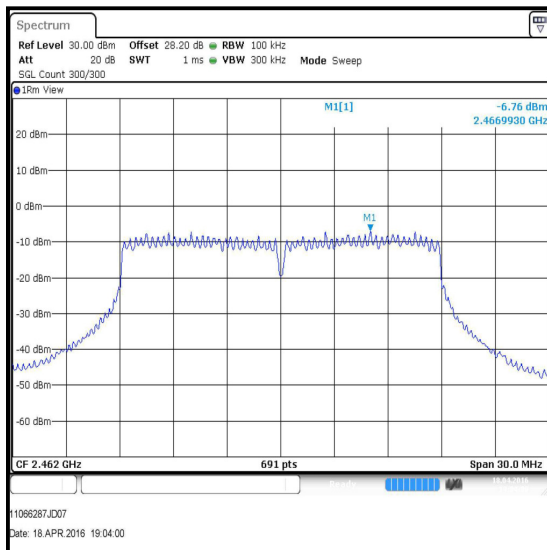
Transmitter Power Spectral Density (continued)**Results: 802.11g / 20 MHz / 16QAM / 24 Mbit/s / Port 2****Bottom Channel****Middle Channel****Top Channel**

Transmitter Power Spectral Density (continued)**Results: 802.11n / 20 MHz / 64QAM / MCS6**

Channel	Port 1			Port 2		
	PSD (dBm / 3 kHz)	Duty Cycle Correction (dB)	Corrected PSD (dBm / 3 kHz)	PSD (dBm / 3 kHz)	Duty Cycle Correction (dB)	Corrected PSD (dBm / 3 kHz)
Bottom	-6.7	0.8	-5.9	-6.2	0.9	-5.3
Middle	-6.3	0.8	-5.5	-6.6	0.9	-5.7
Top	-7.0	0.8	-6.2	-6.8	0.9	-5.9

Channel	Corrected PSD at Port 1 (dBm / 3 kHz)	Corrected PSD at Port 2 (dBm / 3 kHz)	Combined PSD (dBm / 3 kHz)	PSD Limit (dBm / 3 kHz)	Margin (dB)	Result
Bottom	-5.9	-5.3	-2.6	8.0	10.6	Complied
Middle	-5.5	-5.7	-2.6	8.0	10.6	Complied
Top	-6.2	-5.9	-3.0	8.0	11.0	Complied

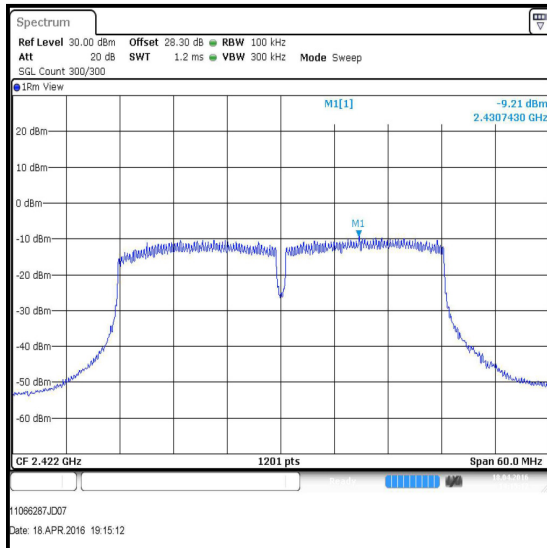
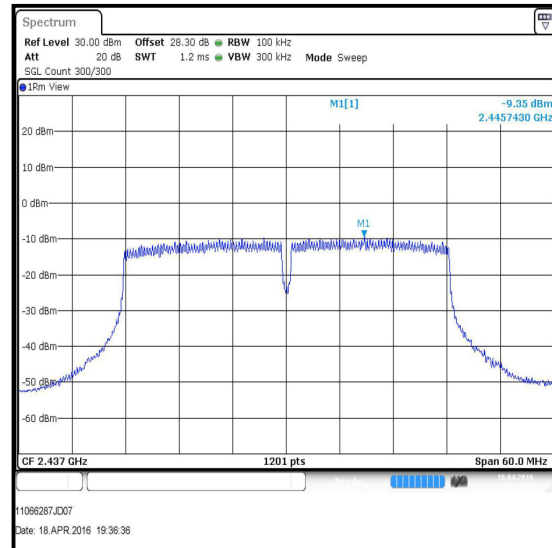
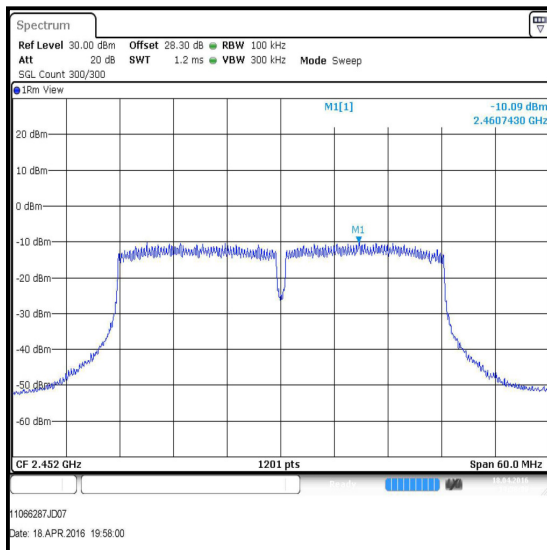
Transmitter Power Spectral Density (continued)**Results: 802.11n / 20 MHz / 64QAM / MCS6 / Port 1****Bottom Channel****Middle Channel****Top Channel**

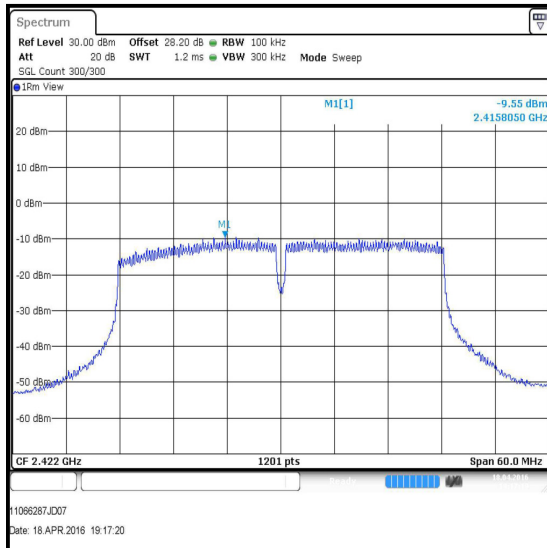
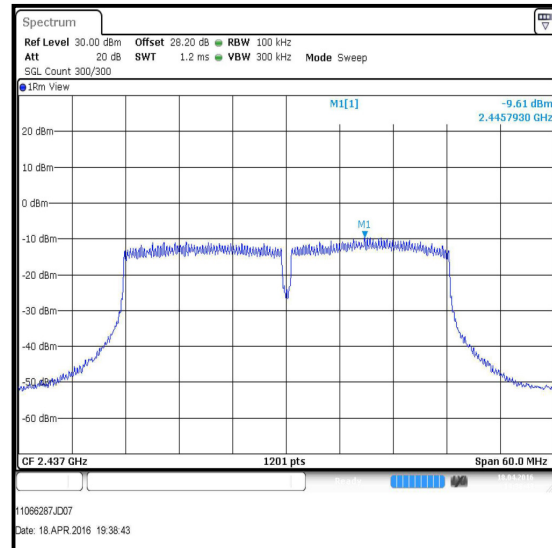
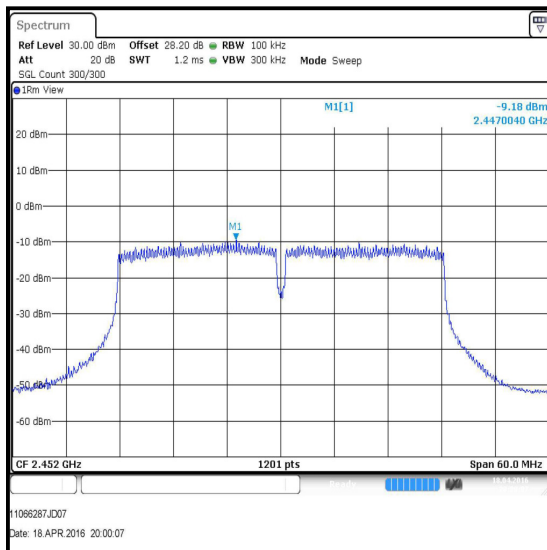
Transmitter Power Spectral Density (continued)**Results: 802.11n / 20 MHz / 64QAM / MCS6 / Port 2****Bottom Channel****Middle Channel****Top Channel**

Transmitter Power Spectral Density (continued)**Results: 802.11n / 40 MHz / QPSK / MCS2**

Channel	Port 1			Port 2		
	PSD (dBm / 3 kHz)	Duty Cycle Correction (dB)	Corrected PSD (dBm / 3 kHz)	PSD (dBm / 3 kHz)	Duty Cycle Correction (dB)	Corrected PSD (dBm / 3 kHz)
Bottom	-9.2	0.6	-8.6	-9.5	0.6	-8.9
Middle	-9.3	0.6	-8.7	-9.6	0.6	-9.0
Top	-10.1	0.6	-9.5	-9.2	0.6	-8.6

Channel	Corrected PSD at Port 1 (dBm / 3 kHz)	Corrected PSD at Port 2 (dBm / 3 kHz)	Combined PSD (dBm / 3 kHz)	PSD Limit (dBm / 3 kHz)	Margin (dB)	Result
Bottom	-8.6	-8.9	-5.7	8.0	13.7	Complied
Middle	-8.7	-9.0	-5.8	8.0	13.8	Complied
Top	-9.5	-8.6	-6.0	8.0	14.0	Complied

Transmitter Power Spectral Density (continued)**Results: 802.11n / 40 MHz / QPSK / MCS2 / Port 1****Bottom Channel****Middle Channel****Top Channel**

Transmitter Power Spectral Density (continued)**Results: 802.11n / 40 MHz / QPSK / MCS2 / Port 2****Bottom Channel****Middle Channel****Top Channel**

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

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2002	Thermohygrometer	Testo	608-H1	45041825	02 Apr 2017	12
M1873	Signal Analyser	Rohde & Schwarz	FSV30	103074	03 Jul 2016	12
M1867	Attenuator	Huber + Suhner AG	6820.17.B	07101	Calibrated before use	-
A2847	Attenuator	Radiall	R411.820.121	24671450	Calibrated before use	-
A2345	Attenuator	Macom	2082-6043-20	None stated	Calibrated before use	-
135878	RF Switch	Pickering Interfaces	64-102-002 & 40-881-001	XZ340281 & X311198	Calibrated before use	-
S0538	DC Power Supply	TTi	PL154	250135	Calibrated before use	-
M1251	Multimeter	Fluke	175	89170179	26 May 2016	12
M1252	Signal Generator	Hewlett Packard	83640A	3119A00489	26 Oct 2017	24

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

Test Engineer:	Georgios Vrezas	Test Dates:	18 April 2016 to 22 April 2016
Test Sample IMEI:	357232070003098		

FCC Reference:	Part 15.247(b)(3)
Test Method Used:	FCC KDB 558074 Section 9.2.2.4 and notes below

Environmental Conditions:

Temperature (°C):	23 to 24
Relative Humidity (%):	28 to 30

Note(s):

- All supported modes and channel widths were initially investigated on one channel. The modes that produced the highest power were:
 - 802.11b – DQPSK / 11 Mbit/s
 - 802.11g – 16QAM / 24 Mbit/s
 - 802.11n / HT20 – 64QAM / 58.5 Mbit/s / MCS6 (GI = 800 ns)
 - 802.11n / HT40 – QPSK / 40.5 Mbit/s / MCS2 (GI = 800 ns)
- Final measurements were performed using the above configurations on the bottom, middle and top channels. Power measurements were integrated over the 99% emission bandwidth. Plots for the occupied bandwidth are archived on the UL VS LTD IT server and available for inspection upon request.
- Testing was performed in accordance with KDB 558074 Section 9.2.2.4 Method AVGSA-2. The signal analyser's integration function was used to integrate across the 99% occupied bandwidth. For the 20 MHz channel bandwidth, the signal analyser resolution bandwidth was set to 300 kHz and video bandwidth 1 MHz. For the 40 MHz channel bandwidth, the signal analyser resolution bandwidth was set to 500 kHz and video bandwidth 2 MHz. 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 duty cycle calculated in Section 5.2.3 of this test report was added to the measured power in order to compute the average power during the actual transmission time.
- Power was measured on both ports and then combined using the measure-and-sum technique stated in FCC KDB 662911 D01 Section E)1).
- As the data streams are correlated for 802.11b, 802.11g, 802.11n HT20 MCS0 to MCS7 and 802.11n HT40 MCS0 to MCS7, the directional antenna gain has been calculated in accordance with FCC KDB 662911 D01 Section F)2)f)(ii):

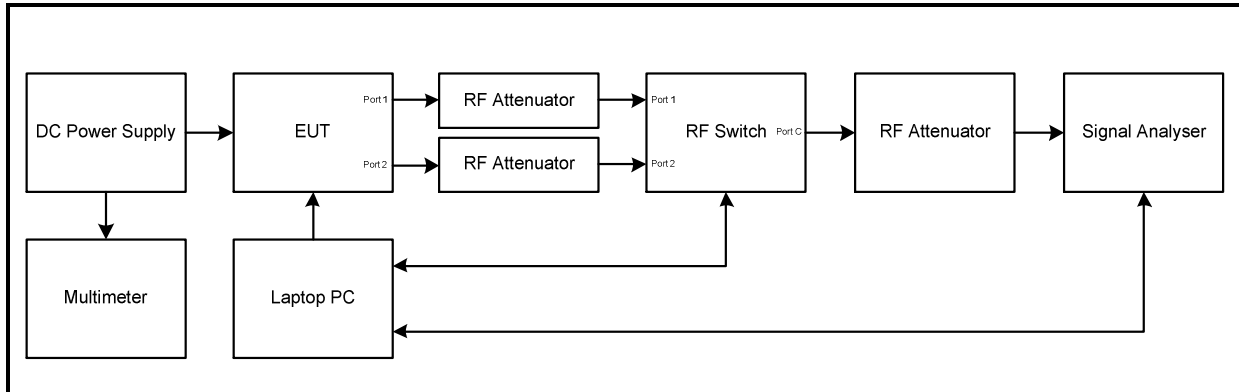
$$\begin{aligned}
 \text{Directional Gain} &= 10 \log \left[\frac{\sum_{j=1}^{N_{SS}} \left(\sum_{k=1}^{N_{ANT}} g_{j,k} \right)^2}{N_{ANT}} \right] = 10 \log \left[\frac{\sum_{j=1}^1 \left(\sum_{k=1}^2 g_{j,k} \right)^2}{2} \right] = \\
 &= 10 \log \left[\frac{(g_{1,1} + g_{1,2})^2}{2} \right] = 10 \log \left[\frac{\left(10^{\frac{G_1}{20}} + 10^{\frac{G_2}{20}} \right)^2}{2} \right] = 10 \log \left[\frac{\left(10^{\frac{-1.66}{20}} + 10^{\frac{-4.37}{20}} \right)^2}{2} \right] = 0.1 \text{ dBi}
 \end{aligned}$$

Transmitter Maximum (Average) Output Power (continued)**Note(s):**

6. For 802.11n HT20 MCS8 to MCS15 and 802.11n HT40 MCS8 to MCS15, the EUT uses spatial multiplexing, with unequal antenna gains and each transmit antenna driven by only one spatial stream. The directional antenna gain has been calculated in accordance with FCC KDB 662911 D01 Section F)2)e)(ii):

$$\begin{aligned}
 \text{Directional Gain} &= 10 \log \left[\frac{\sum_{j=1}^{N_{SS}} \left(\sum_{k=1}^{N_{ANT}} g_{j,k} \right)^2}{N_{ANT}} \right] = 10 \log \left[\frac{\sum_{j=1}^2 \left(\sum_{k=1}^2 g_{j,k} \right)^2}{2} \right] = \\
 &= 10 \log \left[\frac{(g_{1,1} + g_{1,2})^2 + (g_{2,1} + g_{2,2})^2}{2} \right] = 10 \log \left[\frac{(g_{1,1})^2 + (g_{2,2})^2}{2} \right] = \\
 &= 10 \log \left[\frac{\left(10^{\frac{G_1}{20}} \right)^2 + \left(10^{\frac{G_2}{20}} \right)^2}{2} \right] = 10 \log \left[\frac{\left(10^{\frac{-1.66}{20}} \right)^2 + \left(10^{\frac{-4.37}{20}} \right)^2}{2} \right] = -2.8 \text{ dBi}
 \end{aligned}$$

7. The signal analyser was connected to the RF ports on the EUT via an RF switch, using suitable attenuation and RF cables. An RF level offset was entered on the signal analyser to compensate for the loss of the RF switch, attenuators and RF cables.

Test setup:

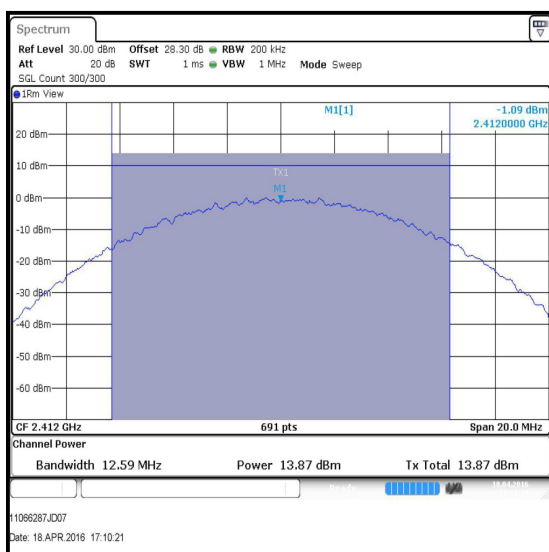
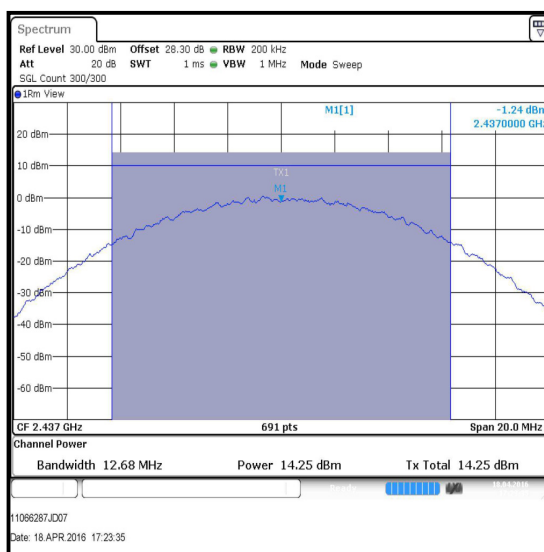
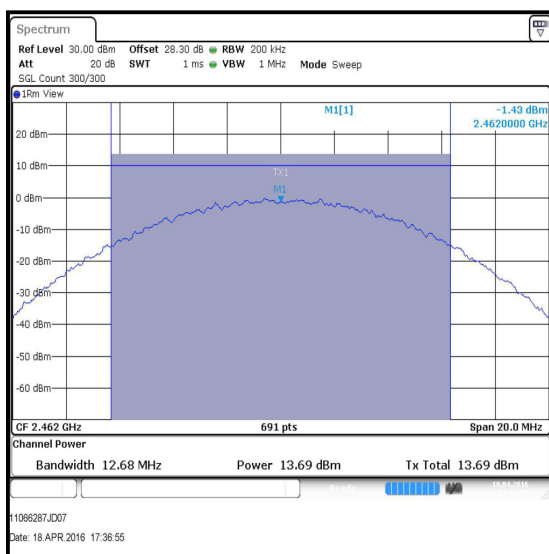
Transmitter Maximum (Average) Output Power (continued)**Results: 802.11b / 20 MHz / DQPSK / 11 Mbit/s****Conducted Peak Limit Comparison**

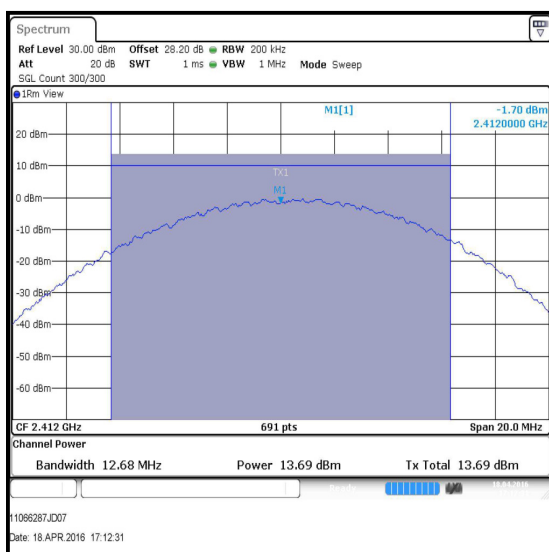
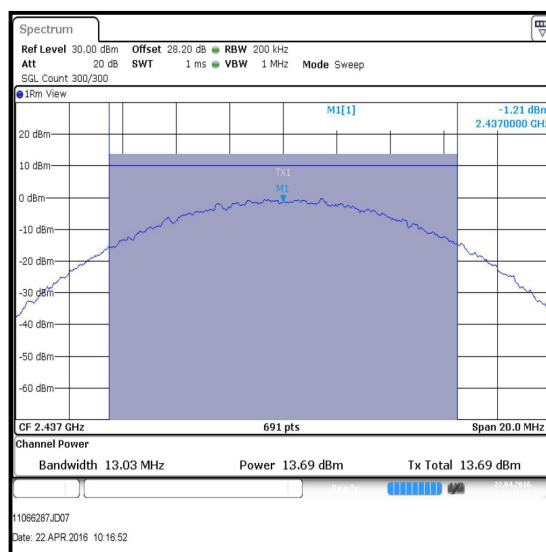
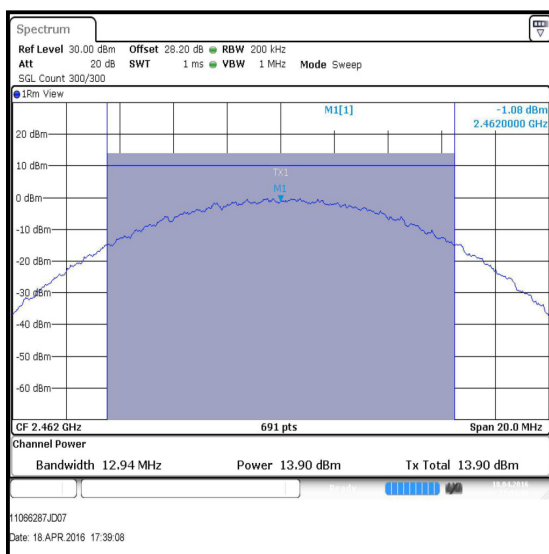
Channel	Port 1			Port 2		
	Conducted Peak Power (dBm)	Duty Cycle Correction (dB)	Corrected Conducted Peak Power (dBm)	Conducted Peak Power (dBm)	Duty Cycle Correction (dB)	Corrected Conducted Peak Power (dBm)
Bottom	13.9	0.2	14.1	13.7	0.2	13.9
Middle	14.3	0.2	14.5	13.7	0.2	13.9
Top	13.7	0.2	13.9	13.9	0.2	14.1

Channel	Corrected Conducted Peak Power Port 1 (dBm)	Corrected Conducted Peak Power Port 2 (dBm)	Combined Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	14.1	13.9	17.0	30.0	13.0	Complied
Middle	14.5	13.9	17.2	30.0	12.8	Complied
Top	13.9	14.1	17.0	30.0	13.0	Complied

De Facto EIRP Limit Comparison

Channel	Combined Conducted Peak Power (dBm)	Directional Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	17.0	0.1	17.1	36.0	18.9	Complied
Middle	17.2	0.1	17.3	36.0	18.7	Complied
Top	17.0	0.1	17.1	36.0	18.9	Complied

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11b / 20 MHz / DQPSK / 11 Mbit/s / Port 1****Bottom Channel****Middle Channel****Top Channel**

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11b / 20 MHz / DQPSK / 11 Mbit/s / Port 2****Bottom Channel****Middle Channel****Top Channel**

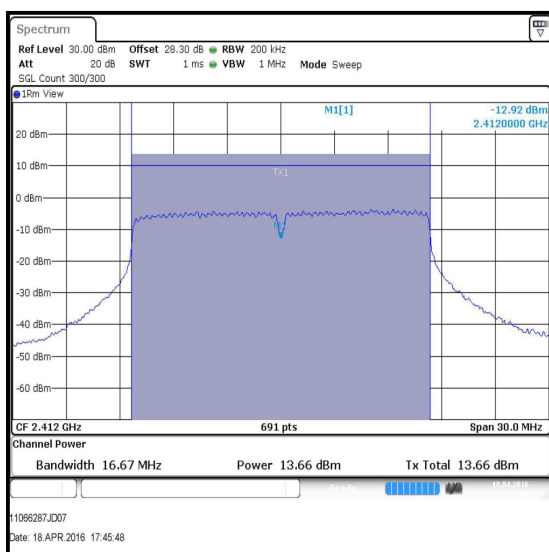
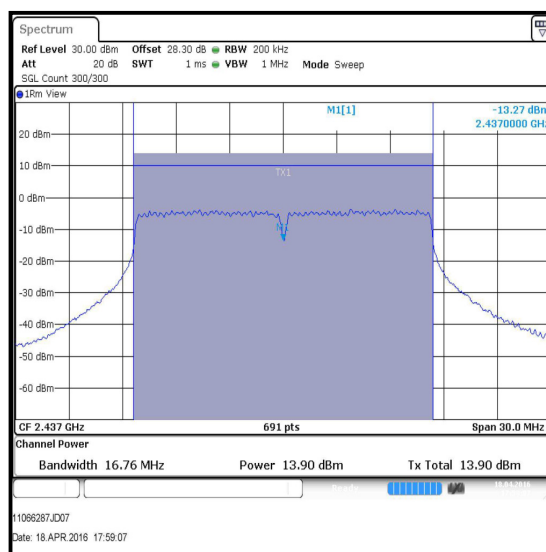
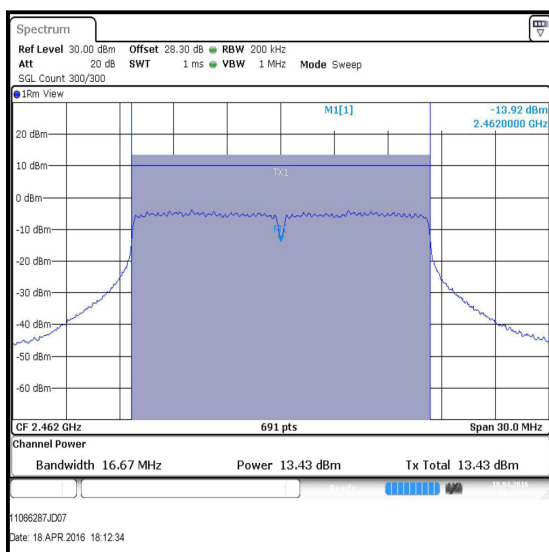
Transmitter Maximum (Average) Output Power (continued)**Results: 802.11g / 20 MHz / 16QAM / 24 Mbit/s****Conducted Peak Limit Comparison**

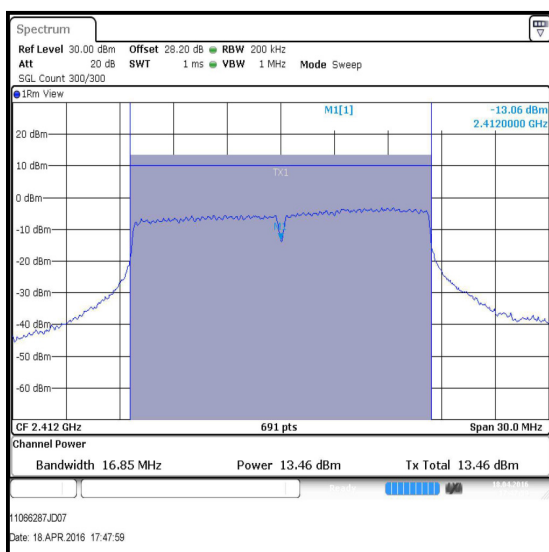
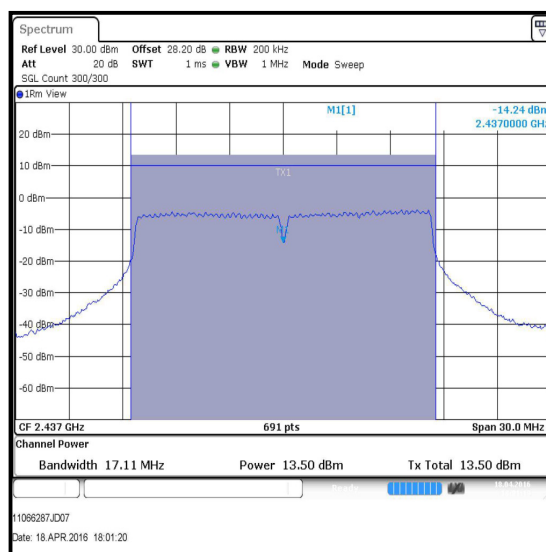
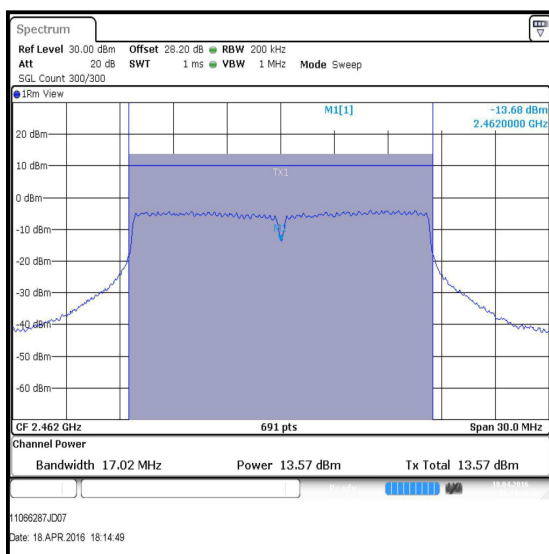
Channel	Port 1			Port 2		
	Conducted Peak Power (dBm)	Duty Cycle Correction (dB)	Corrected Conducted Peak Power (dBm)	Conducted Peak Power (dBm)	Duty Cycle Correction (dB)	Corrected Conducted Peak Power (dBm)
Bottom	13.7	0.4	14.1	13.5	0.4	13.9
Middle	13.9	0.4	14.3	13.5	0.4	13.9
Top	13.4	0.4	13.8	13.6	0.4	14.0

Channel	Corrected Conducted Peak Power Port 1 (dBm)	Corrected Conducted Peak Power Port 2 (dBm)	Combined Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	14.1	13.9	17.0	30.0	13.0	Complied
Middle	14.3	13.9	17.1	30.0	12.9	Complied
Top	13.8	14.0	16.9	30.0	13.1	Complied

De Facto EIRP Limit Comparison

Channel	Combined Conducted Peak Power (dBm)	Directional Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	17.0	0.1	17.1	36.0	18.9	Complied
Middle	17.1	0.1	17.2	36.0	18.8	Complied
Top	16.9	0.1	17.0	36.0	19.0	Complied

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11g / 20 MHz / 16QAM / 24 Mbit/s / Port 1****Bottom Channel****Middle Channel****Top Channel**

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11g / 20 MHz / 16QAM / 24 Mbit/s / Port 2****Bottom Channel****Middle Channel****Top Channel**

Transmitter Maximum (Average) Output Power (continued)**Results: 802.11n / 20 MHz / 64QAM / MCS6****Conducted Peak Limit Comparison**

Channel	Port 1			Port 2		
	Conducted Peak Power (dBm)	Duty Cycle Correction (dB)	Corrected Conducted Peak Power (dBm)	Conducted Peak Power (dBm)	Duty Cycle Correction (dB)	Corrected Conducted Peak Power (dBm)
Bottom	12.2	0.8	13.0	12.1	0.9	13.0
Middle	12.4	0.8	13.2	12.2	0.9	13.1
Top	12.1	0.8	12.9	12.2	0.9	13.1

Channel	Corrected Conducted Peak Power Port 1 (dBm)	Corrected Conducted Peak Power Port 2 (dBm)	Combined Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	13.0	13.0	16.0	30.0	14.0	Complied
Middle	13.2	13.1	16.2	30.0	13.8	Complied
Top	12.9	13.1	16.0	30.0	14.0	Complied

De Facto EIRP Limit Comparison

Channel	Combined Conducted Peak Power (dBm)	Directional Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	16.0	0.1	16.1	36.0	19.9	Complied
Middle	16.2	0.1	16.3	36.0	19.7	Complied
Top	16.0	0.1	16.1	36.0	19.9	Complied