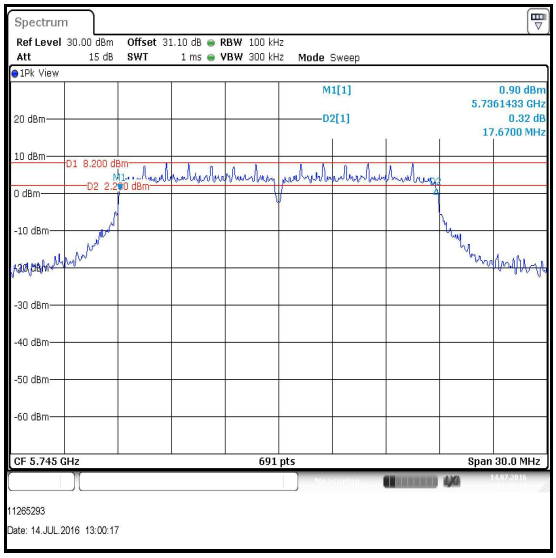
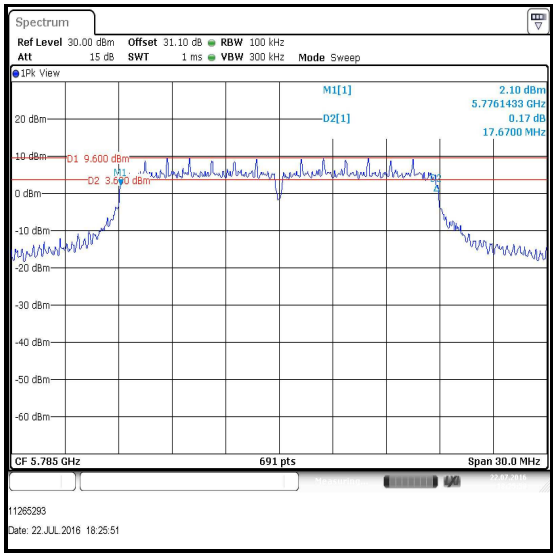
Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band) (continued)

Results: 802.11n / 20 MHz / SISO / BPSK / MCS0

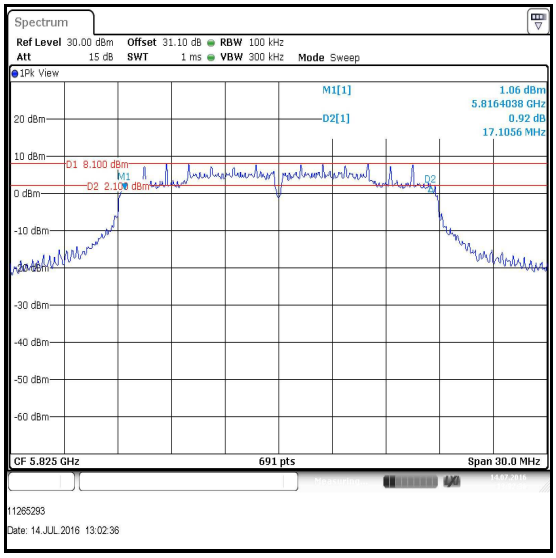
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	17670	≥500	17170	Complied
Middle	17670	≥500	17170	Complied
Top	17106	≥500	16606	Complied



Bottom Channel



Middle Channel

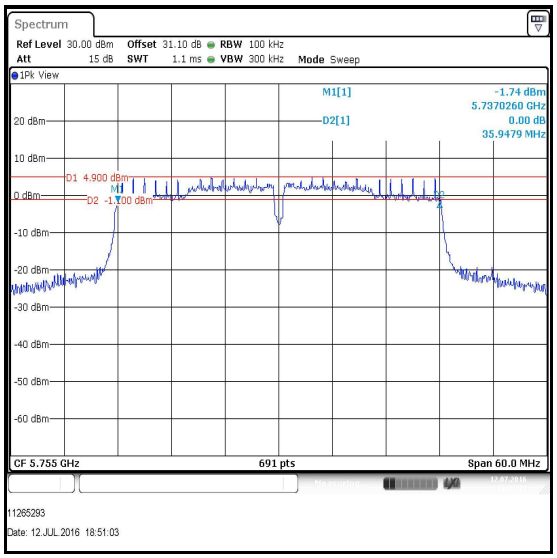


Top Channel

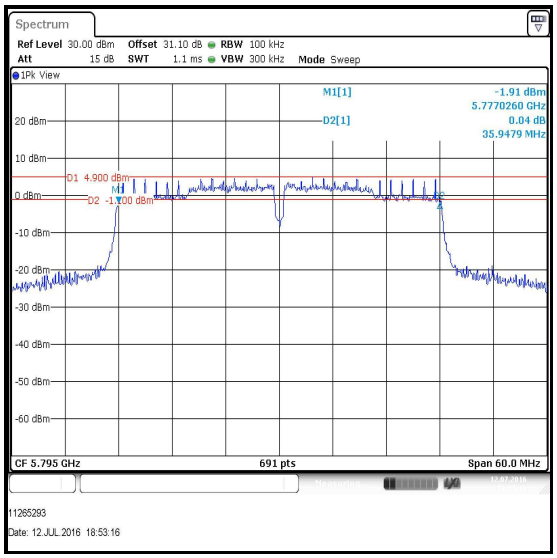
Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band) (continued)

Results: 802.11n / 40 MHz / SISO / BPSK / MCS0

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	35948	≥500	35448	Complied
Top	35948	≥500	35448	Complied



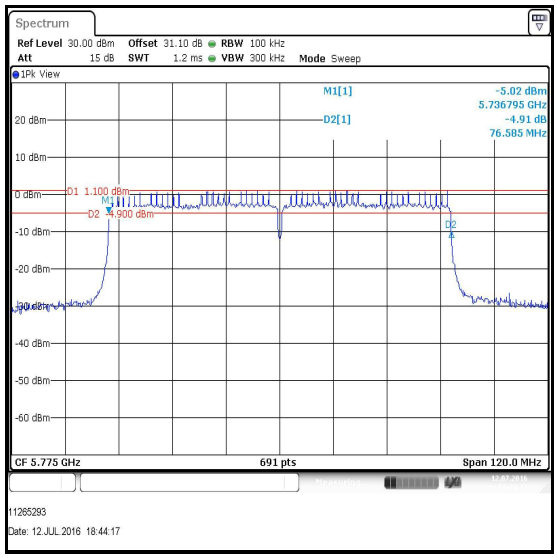
Bottom Channel



Top Channel

Results: 802.11n / 80 MHz / SISO / BPSK / MCS0

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Single	76585	≥500	76085	Complied

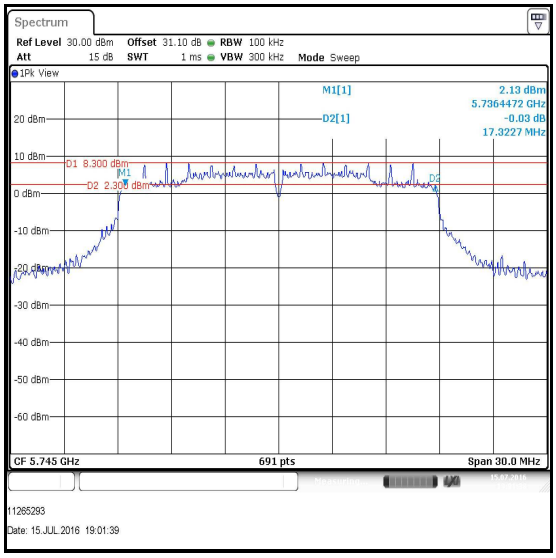


Single Channel

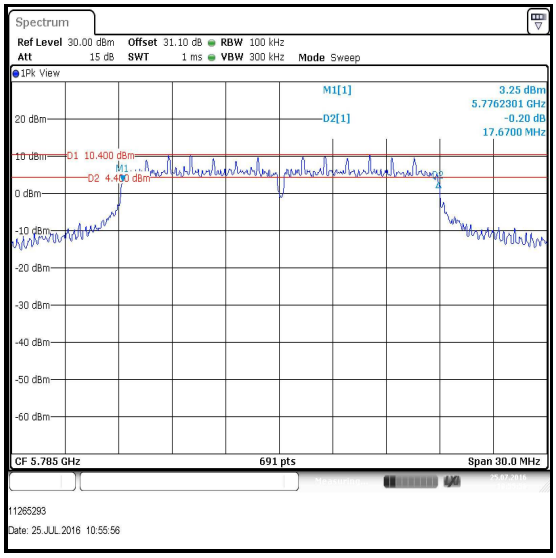
Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band) (continued)

Results: 802.11n / 20 MHz / MIMO / BPSK / MCS0 / Port 1

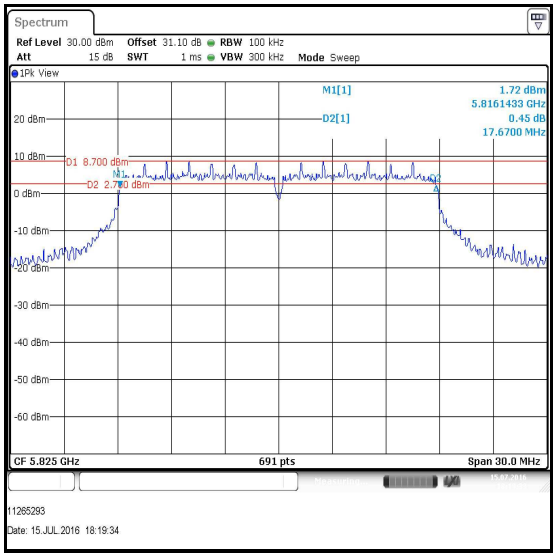
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	17323	≥500	16823	Complied
Middle	17670	≥500	17170	Complied
Top	17670	≥500	17170	Complied



Bottom Channel



Middle Channel

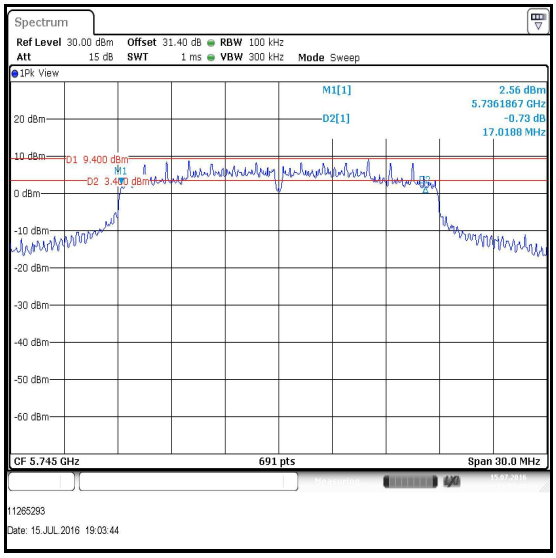


Top Channel

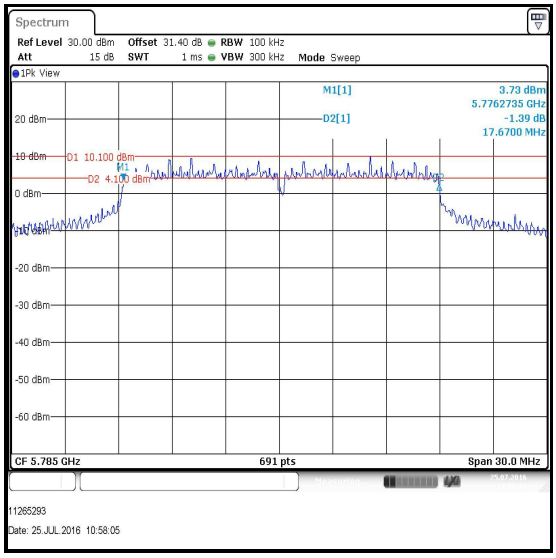
Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band) (continued)

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

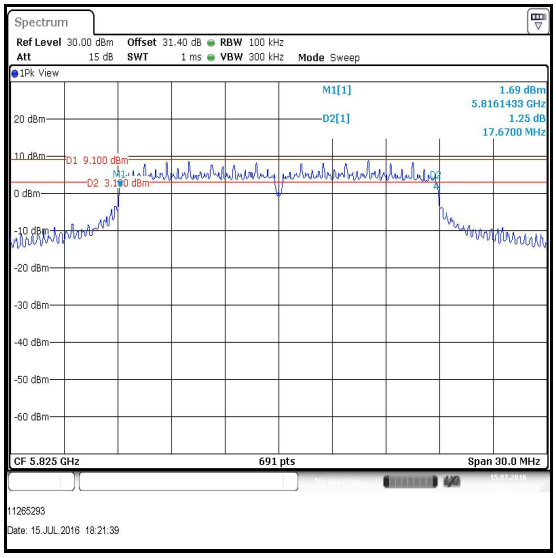
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	17019	≥500	16519	Complied
Middle	17670	≥500	17170	Complied
Top	17670	≥500	17170	Complied



Bottom Channel



Middle Channel

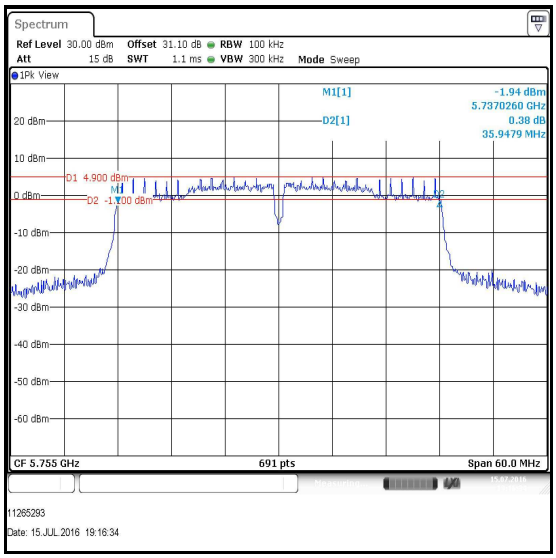


Top Channel

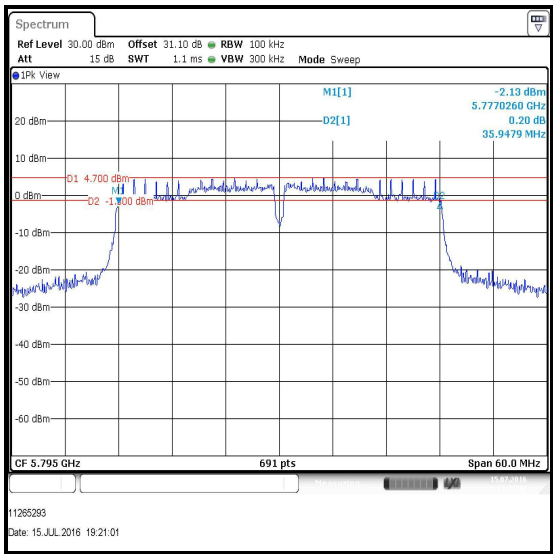
Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band) (continued)

Results: 802.11n / 40 MHz / MIMO / BPSK / MCS0 / Port 1

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	35948	≥500	35448	Complied
Top	35948	≥500	35448	Complied



Bottom Channel

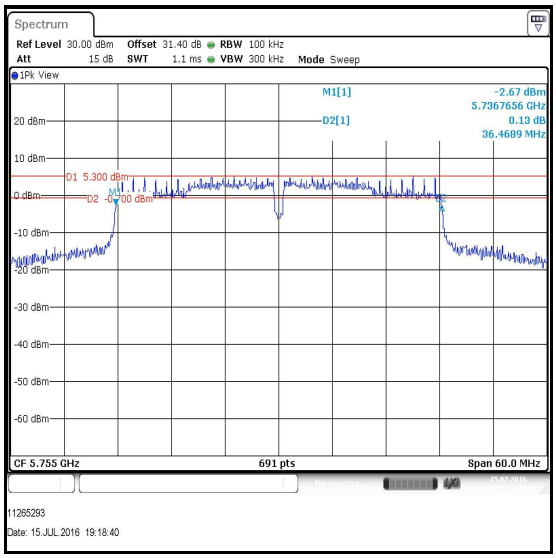


Top Channel

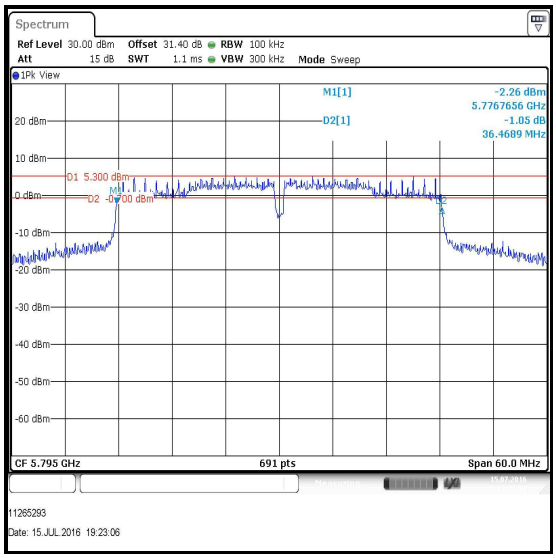
Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band) (continued)

Results: 802.11n / 40 MHz / MIMO / BPSK / MCS0 / Port 2

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	36469	≥500	35969	Complied
Top	36469	≥500	35969	Complied



Bottom Channel

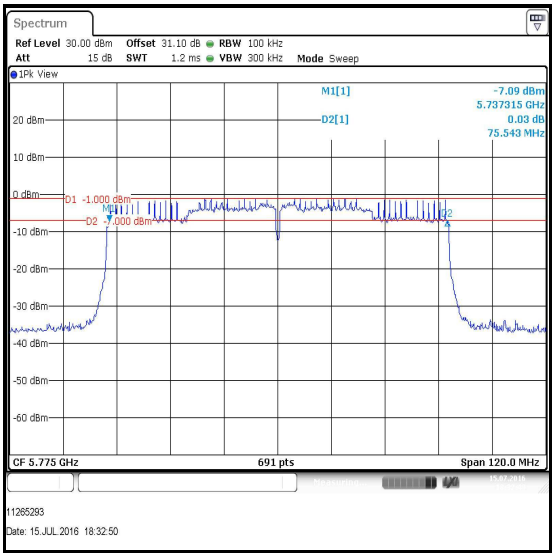


Top Channel

Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band) (continued)

Results: 802.11ac / 80 MHz / MIMO / BPSK / MCS0x1 / Port 1

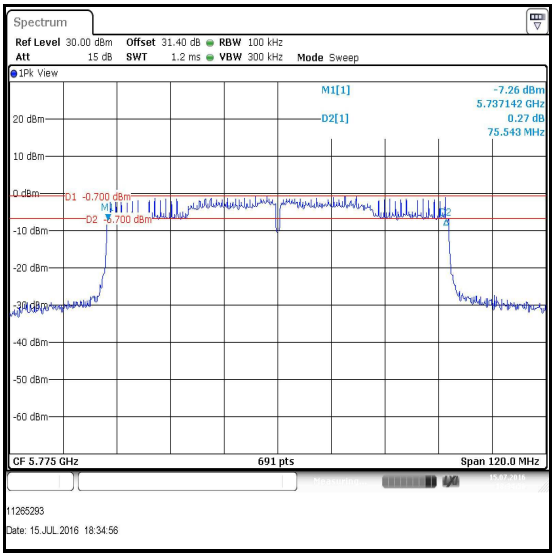
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Single	75543	≥500	75043	Complied



Single Channel

Results: 802.11ac / 80 MHz / MIMO / BPSK / MCS0x1 / Port 2

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Single	75543	≥500	75043	Complied



Single Channel

Transmitter Minimum 6 dB Bandwidth (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	02 Apr 2017	12
M1835	Signal Analyser	Rohde & Schwarz	FSV30	103050	27 Feb 2017	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	-
A2952	RF Switch	Pickering Interfaces	64-102-002 & 40-881-001	XZ361012 & X361507	Calibrated before use	-
M1252	Signal Generator	Hewlett Packard	83640A	3119A00489	26 Oct 2017	24

5.2.3. Transmitter Duty Cycle

Test Summary:

Test Engineer:	Georgios Vrezas	**Test Date:**	25 July 2016
Test Sample Serial Number:	C39RW006HFML		

FCC Reference:	Part 15.35(c)
Test Method Used:	KDB 789033 D02 Section II.B.2.b)

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	43

Note(s):

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

10 log 1 / (On Time / [Period or 100ms whichever is the lesser]).

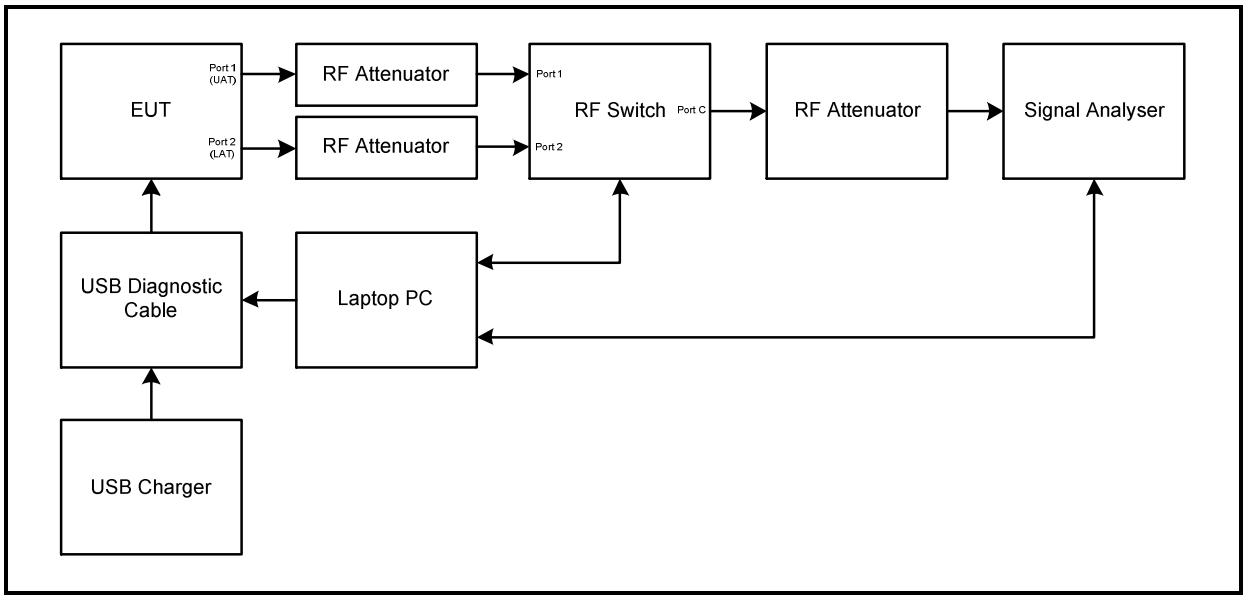
802.11n HT40 / SISO / MCS0 / Port 1 duty cycle: 10 log (1 / (942.500/967.560)) = 0.1
802.11ac VHT80 / SISO / MCS0 / Port 1 duty cycle: 10 log (1 / (458.880/481.862)) = 0.2
802802.11n HT40 / MIMO / MCS0 / Port 1 duty cycle: 10 log (1 / (942.500/966.540)) = 0.1
802.11n HT40 / MIMO / MCS0 / Port 2 duty cycle: 10 log (1 / (942.500/966.250)) = 0.1
802.11ac VHT80 / MIMO / MCS0x1 / Port 1 duty cycle: 10 log (1 / (458.414/481.896)) = 0.2
802.11ac VHT80 / MIMO / MCS0x1 / Port 2 duty cycle: 10 log (1 / (459.054/481.651)) = 0.2

2. Plots below are for data rates with a duty cycle less than 98%. Results for all other modes are archived on the Company server and available for inspection if required.

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

Transmitter Duty Cycle (continued)

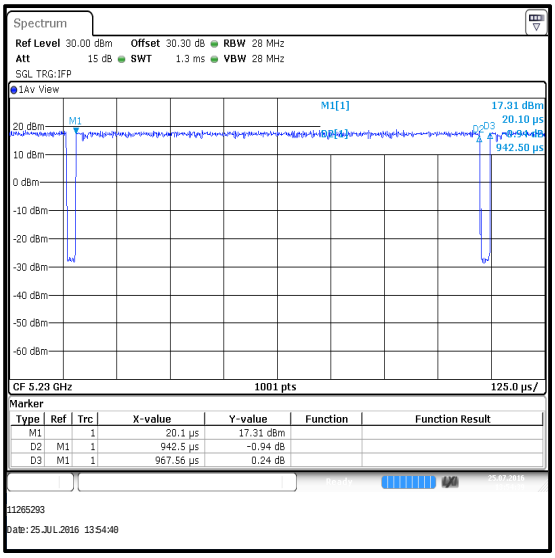
Test setup:



Transmitter Duty Cycle (continued)

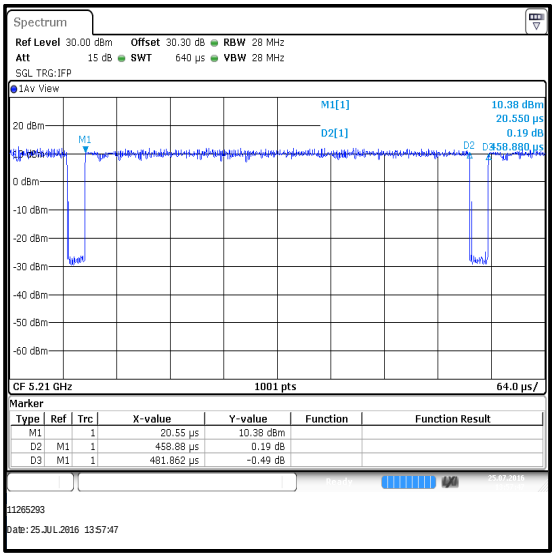
Results: 802.11n / 40 MHz / SISO / MCS0 / Port 1

Pulse Duration (µs)	Period (µs)	Duty Cycle (dB)
942.500	967.560	0.1



Results: 802.11ac / 80 MHz / SISO / MCS0 / Port 1

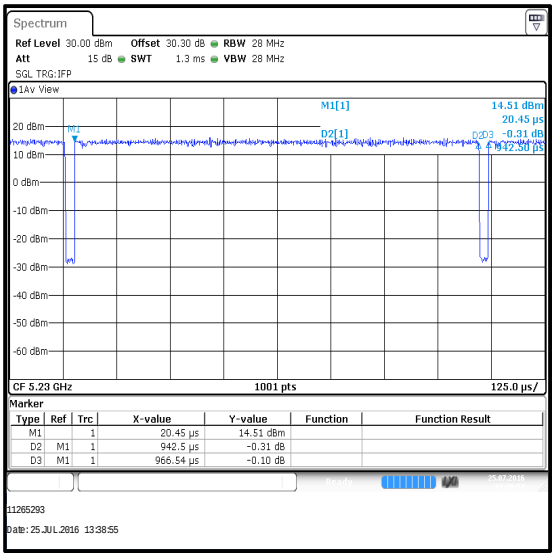
Pulse Duration (µs)	Period (µs)	Duty Cycle (dB)
458.880	481.862	0.2



Transmitter Duty Cycle (continued)

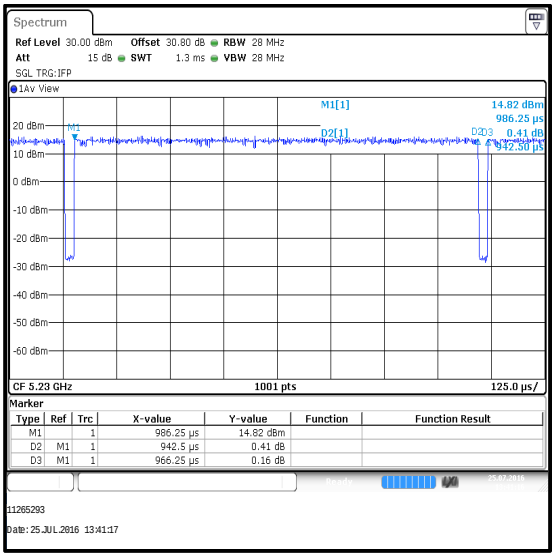
Results: 802.11n / 40 MHz / MIMO / MCS0 / Port 1

Pulse Duration (µs)	Period (µs)	Duty Cycle (dB)
942.500	966.540	0.1



Results: 802.11n / 40 MHz / MIMO / MCS0 / Port 2

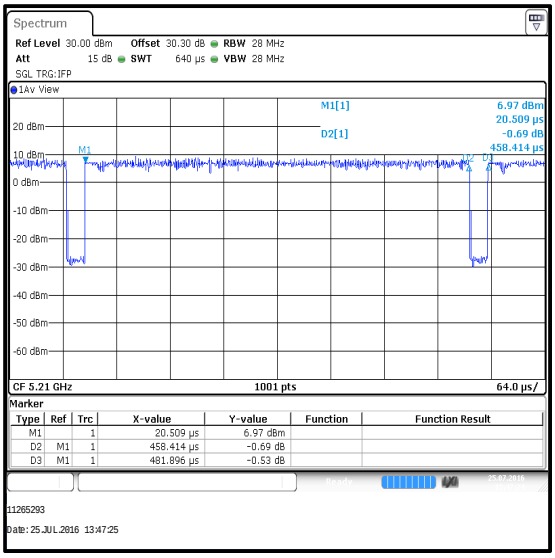
Pulse Duration (µs)	Period (µs)	Duty Cycle (dB)
942.500	966.250	0.1



Transmitter Duty Cycle (continued)

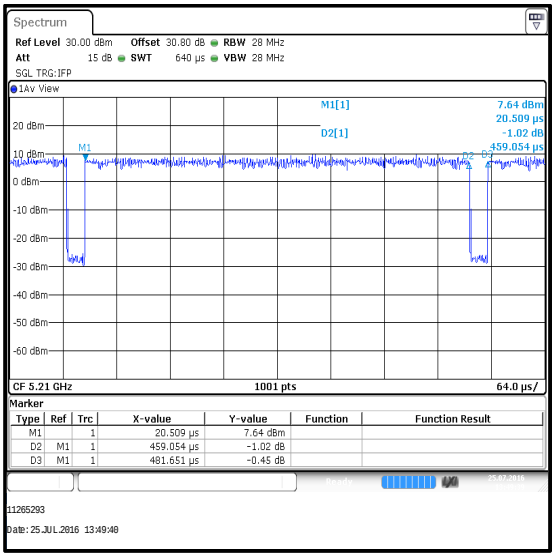
Results: 802.11ac / 80 MHz / MIMO / MCS0x1 / Port 1

Pulse Duration (µs)	Period (µs)	Duty Cycle (dB)
458.414	481.896	0.2



Results: 802.11ac / 80 MHz / MIMO / MCS0x1 / Port 2

Pulse Duration (µs)	Period (µs)	Duty Cycle (dB)
459.054	481.651	0.2



Transmitter Duty Cycle (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	02 Apr 2017	12
M1835	Signal Analyser	Rohde & Schwarz	FSV30	103050	27 Feb 2017	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	-
A2952	RF Switch	Pickering Interfaces	64-102-002 & 40-881-001	XZ361012 & X361507	Calibrated before use	-
M1252	Signal Generator	Hewlett Packard	83640A	3119A00489	26 Oct 2017	24

5.2.4. Transmitter Maximum Conducted Output Power

Test Summary:

Test Engineer:	Georgios Vrezas	**Test Dates:**	12 July 2016 to 22 July 2016
Test Sample Serial Number:	C39RW006HFML		

FCC Reference:	Part 15.407(a)(1)(iv)
Test Method Used:	KDB 789033 D02 Section II.E.2.b) and II.E.2.d)

Environmental Conditions:

Temperature (°C):	24 to 25
Relative Humidity (%):	40 to 43

Note(s):

1. For conducted power tests where the duty cycle is >98%, the measurements were performed using a signal analyser in accordance with FCC KDB 789033 D02 II.E.2.b) Method SA-1. Where the duty cycle is <98%, the measurements were performed in accordance with FCC KDB 789033 D02 II.E.2.d) Method SA-2.
2. The customer declared the following data rates to be used for all measurements as:

   On U-NII bands 1 and 2A:

   - 802.11a – BPSK / 6 Mbps / Port 2
   - 802.11n HT20 SISO – BPSK / 6.5 Mbps / MCS0 / Port 2
   - 802.11n HT40 SISO – BPSK / 13.5 Mbps / MCS0 / Port 2
   - 802.11ac VHT80 SISO – BPSK / 29.3 Mbps / MCS0 / Port 2
   - 802.11n HT20 MIMO – BPSK / 6.5 Mbps / MCS0
   - 802.11n HT40 MIMO – BPSK / 13.5 Mbps / MCS0
   - 802.11ac VHT80 MIMO – BPSK / 29.3 Mbps / MCS0x1

   On U-NII bands 2C and 3:

   - 802.11a – BPSK / 6 Mbps / Port 1
   - 802.11n HT20 SISO – BPSK / 6.5 Mbps / MCS0 / Port 1
   - 802.11n HT40 SISO – BPSK / 13.5 Mbps / MCS0 / Port 1
   - 802.11ac VHT80 SISO – BPSK / 29.3 Mbps / MCS0 / Port 1
   - 802.11n HT20 MIMO – BPSK / 6.5 Mbps / MCS0
   - 802.11n HT40 MIMO – BPSK / 13.5 Mbps / MCS0
   - 802.11ac VHT80 MIMO – BPSK / 29.3 Mbps / MCS0x1

   Measurements were then performed in these modes on all relevant channels in all operating bands.
3. For data rates where the EUT was transmitting at <98% duty cycle, the calculated duty cycle in section 5.2.3 was added to the measured power in order to compute the average power during the actual transmission time.
4. Power was measured on both ports and then combined using the measure-and-sum technique stated in FCC KDB 662911 D01 Section E)1).
5. For SISO modes, the antenna gain is < 6 dBi.

Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) (continued)

Note(s):

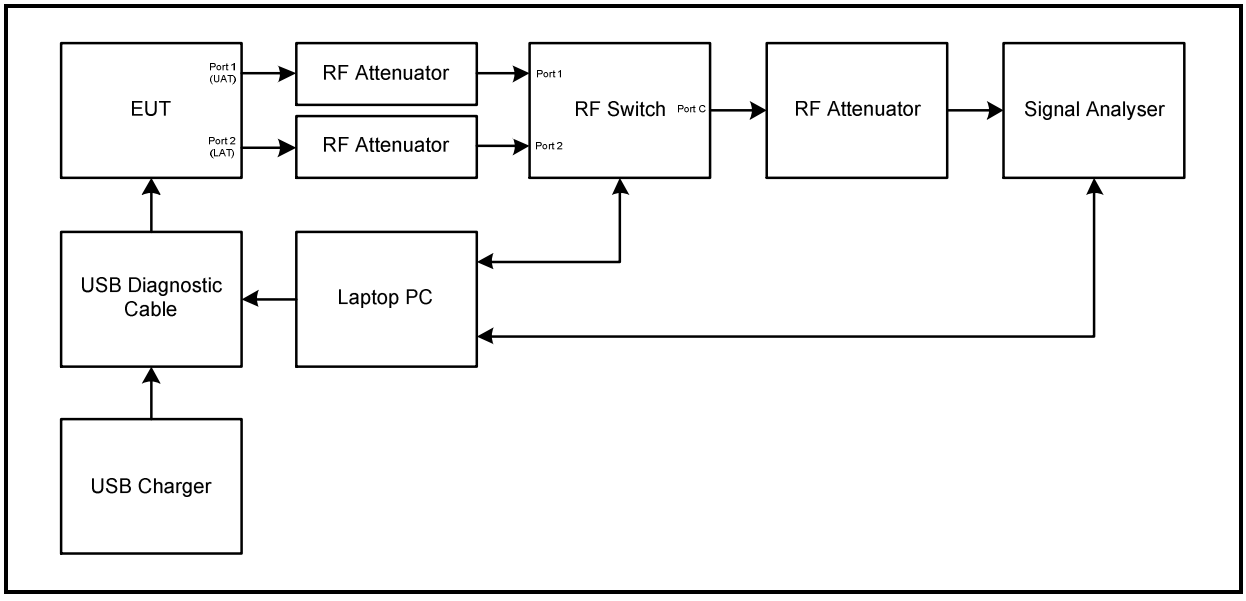
6. For MIMO modes presented in this section of the test report, the data stream is correlated as it is single stream with CDD on. The directional antenna gain has been calculated in accordance with KDB 662911 D01 Section F)2)f)(ii). The EUT antenna has a gain of -3.1 dBi for port 1 and -0.9 dBi for port 2, in the frequency range 5.15 GHz to 5.25 GHz:

$$\text{Directional Gain} = 10\log\left[\frac{\sum_{j=1}^{N_{SS}}\left(\sum_{k=1}^{N_{ANT}} g_{j,k}\right)^2}{N_{ANT}}\right] = 10\log\left[\frac{\sum_{j=1}^{1}\left(\sum_{k=1}^{2} g_{j,k}\right)^2}{2}\right]$$

$$= \mathbf{10\log\left[\frac{\left(g_{1,1}+g_{1,2}\right)^2}{2}\right] = 10\log\left[\frac{\left(10^{\frac{G_1}{20}}+10^{\frac{G_2}{20}}\right)^2}{2}\right] = 10\log\left[\frac{\left(10^{\frac{-3.1}{20}}+10^{\frac{-0.9}{20}}\right)^2}{2}\right] = 1.1\ \text{dBi}}$$

7. The signal analyser was connected to the RF port on the EUT using an RF switch, suitable attenuation and RF cables. An RF level offset was entered on the signal analyser to compensate for the loss of the switch, attenuators and RF cables.
8. The Part 15.407(a)(1)(iv) limit shall not exceed 250 mW (24.0 dBm).
9. Testing was performed with the EUT transmitting with power levels equal to or greater than those stated in the respective SAR test report. WLAN modes which provided higher output powers than those given within the SAR report, are the result of the device being configured with higher power settings for testing purposes.

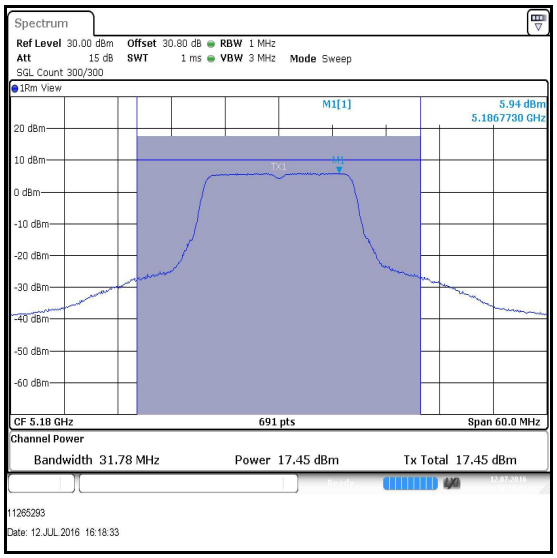
Test setup:



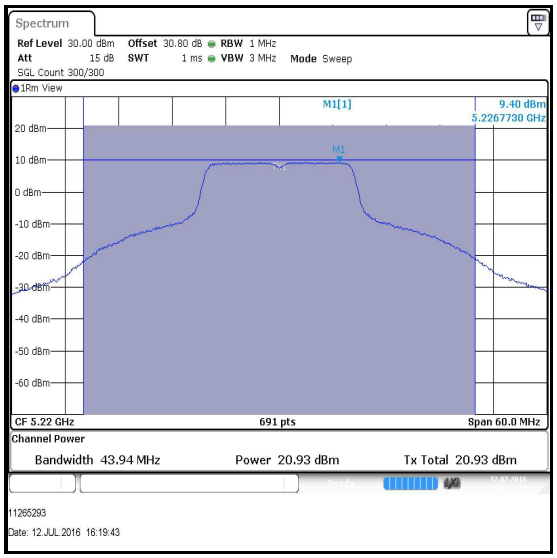
Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) (continued)

Results: 802.11a / 20 MHz / BPSK / 6 Mbps

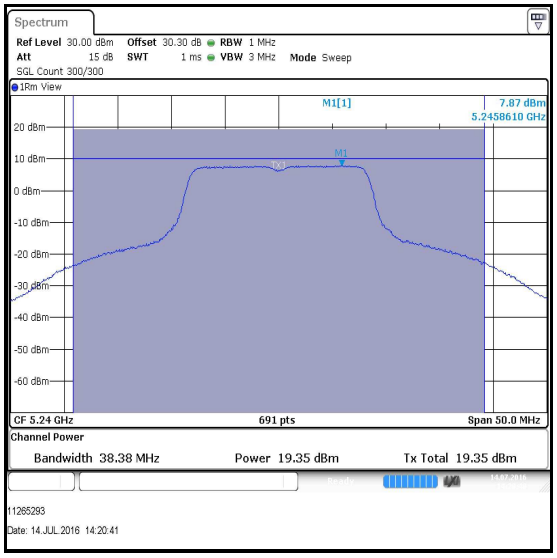
Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5180	17.5	24.0	6.5	Complied
Middle	5220	20.9	24.0	3.1	Complied
Top	5240	19.4	24.0	4.6	Complied



Bottom Channel



Middle Channel

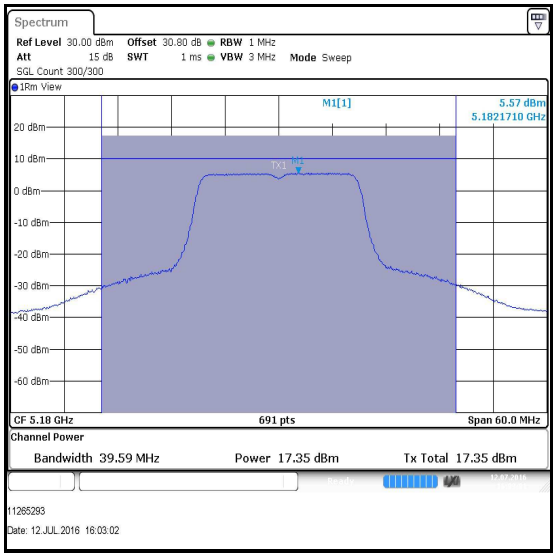


Top Channel

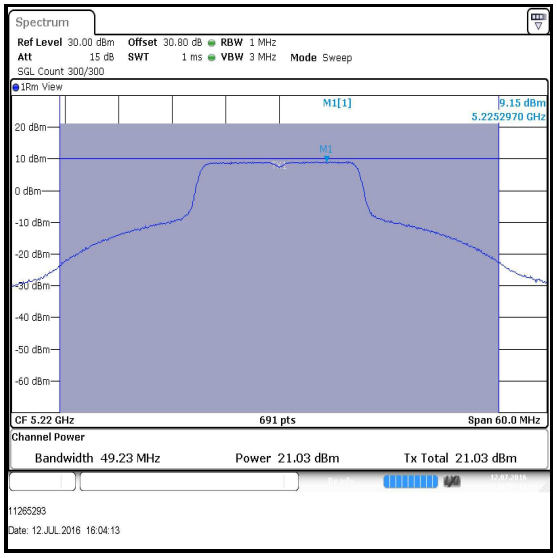
Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) (continued)

Results: 802.11n / 20 MHz / BPSK / MCS0 / SISO

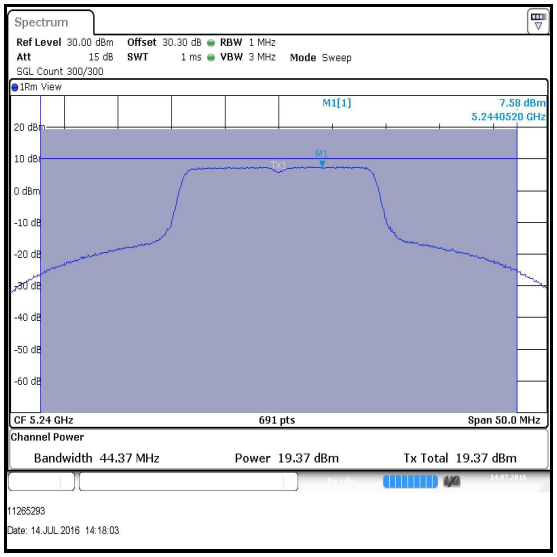
Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5180	17.4	24.0	6.6	Complied
Middle	5220	21.0	24.0	3.0	Complied
Top	5240	19.4	24.0	4.6	Complied



Bottom Channel



Middle Channel

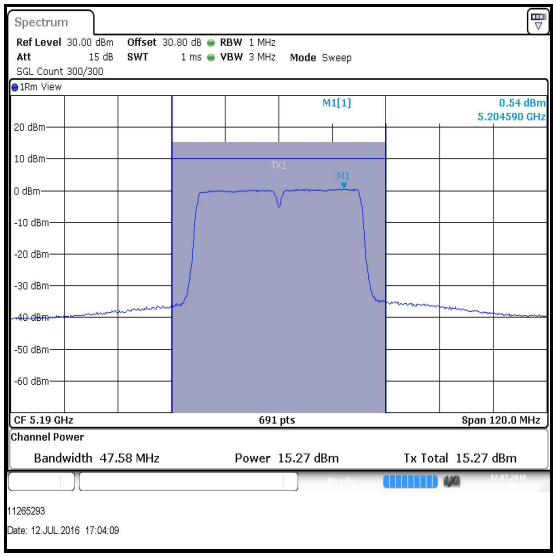


Top Channel

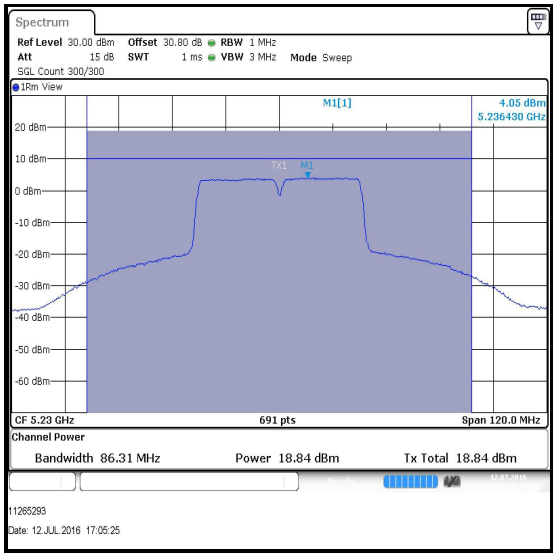
Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) (continued)

Results: 802.11n / 40 MHz / BPSK / MCS0 / SISO

Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5190	15.3	0.1	15.4	24.0	8.6	Complied
Top	5230	18.8	0.1	18.9	24.0	5.1	Complied



Bottom Channel

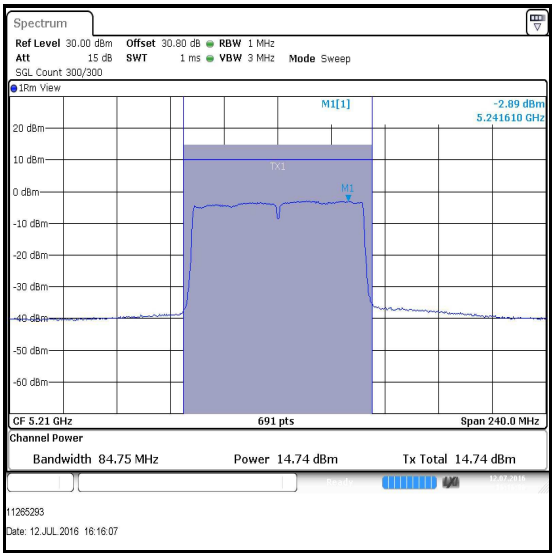


Top Channel

Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) (continued)

Results: 802.11ac / 80 MHz / BPSK / MCS0 / SISO

Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Single	5210	14.7	0.2	14.9	24.0	9.1	Complied



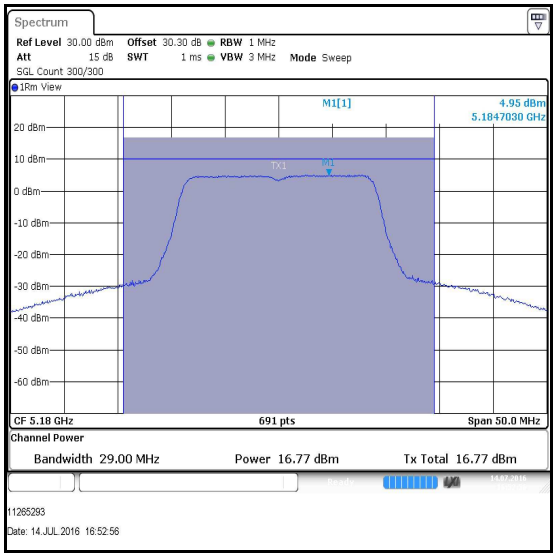
Single Channel

Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) (continued)

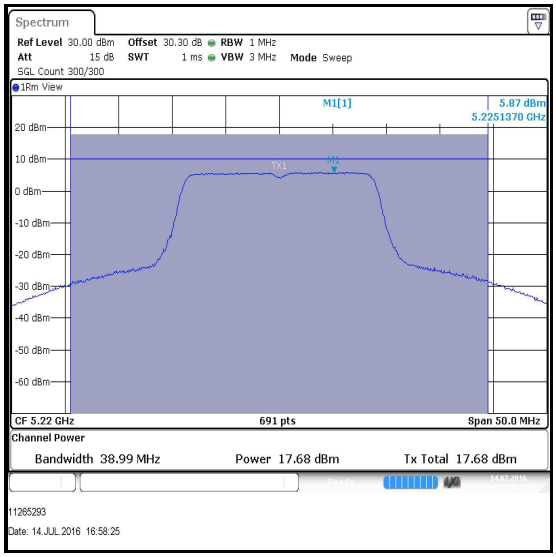
Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO

Channel	Frequency (MHz)	Conducted Power Port 1 (dBm)	Conducted Power Port 2 (dBm)	Combined Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5180	16.8	16.7	19.8	24.0	4.2	Complied
Middle	5220	17.7	17.7	20.7	24.0	3.3	Complied
Top	5240	17.9	17.9	20.9	24.0	3.1	Complied

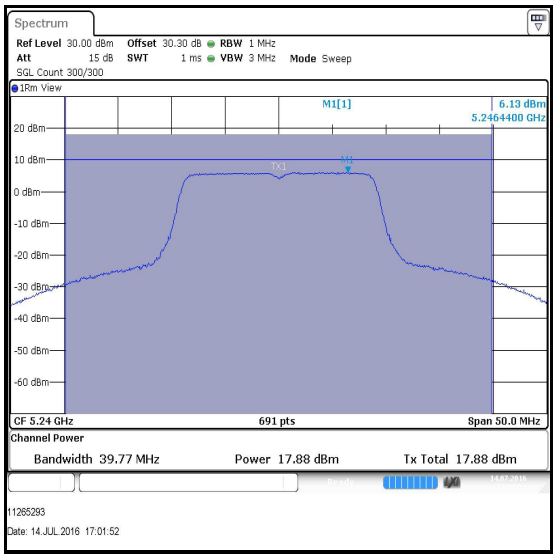
Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO / Port 1



Bottom Channel



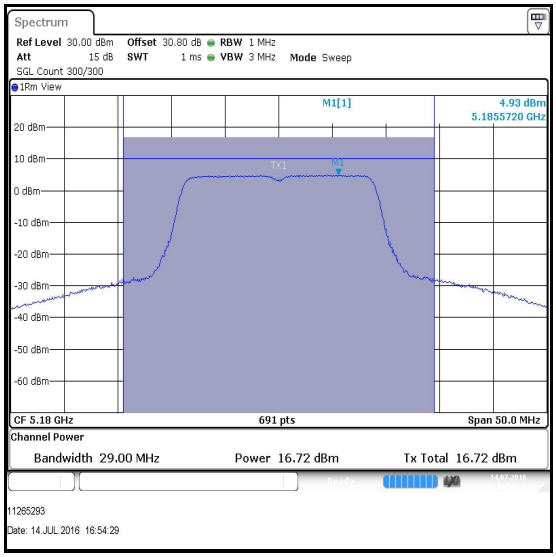
Middle Channel



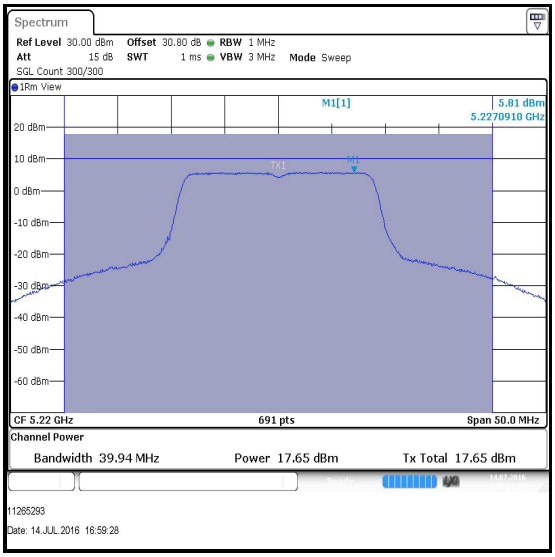
Top Channel

Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) (continued)

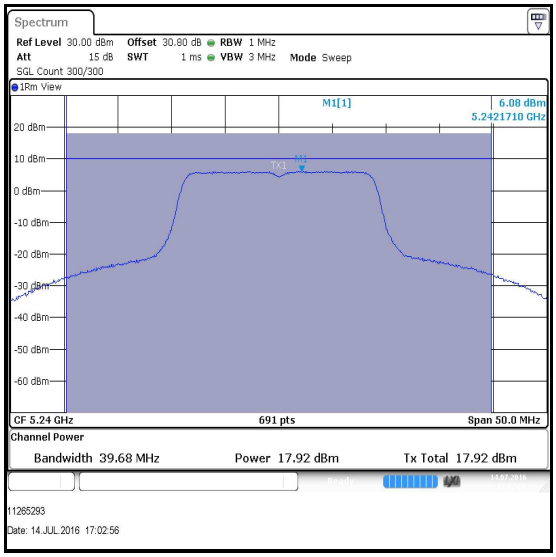
Results: 802.11n / 20 MHz / BPSK / MCS0 / MIMO / Port 2



Bottom Channel



Middle Channel



Top Channel

Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) (continued)

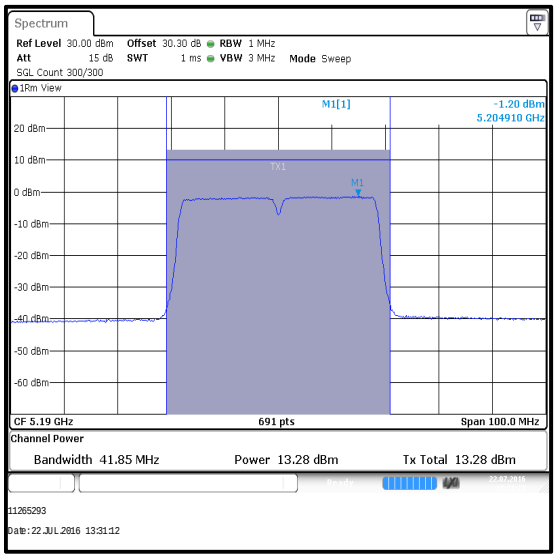
Results: 802.11n / 40 MHz / BPSK / MCS0 / MIMO

Channel	Frequency (MHz)	Port 1			Port 2		
		Conducted Power (dBm)	Duty Cycle Correction (dB)	Corrected Conducted Power (dBm)	Conducted Power (dBm)	Duty Cycle Correction (dB)	Corrected Conducted Power (dBm)
Bottom	5190	13.3	0.1	13.4	13.2	0.1	13.3
Top	5230	17.7	0.1	17.8	17.8	0.1	17.9

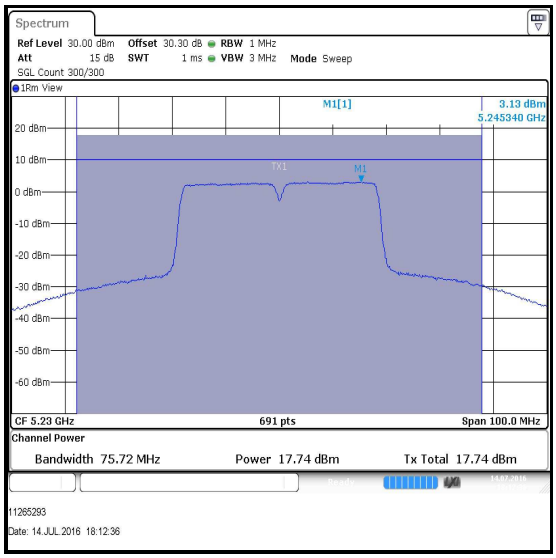
Channel	Corrected Conducted Power Port 1 (dBm)	Corrected Conducted Power Port 2 (dBm)	Combined Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	13.4	13.3	16.4	24.0	7.6	Complied
Top	17.8	17.9	20.9	24.0	3.1	Complied

Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) (continued)

Results: 802.11n / 40 MHz / BPSK / MCS0 / MIMO / Port 1

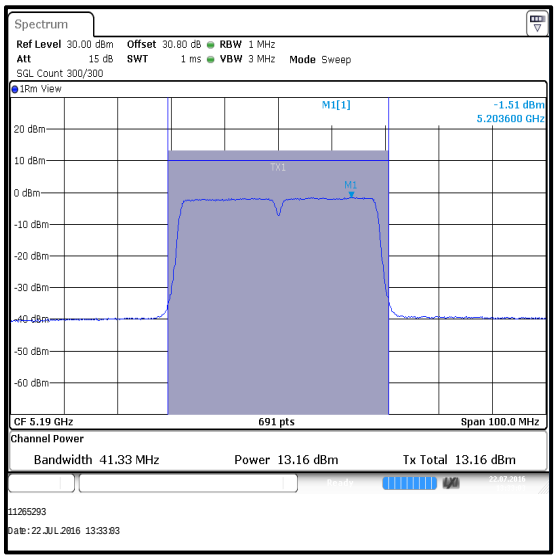


Bottom Channel

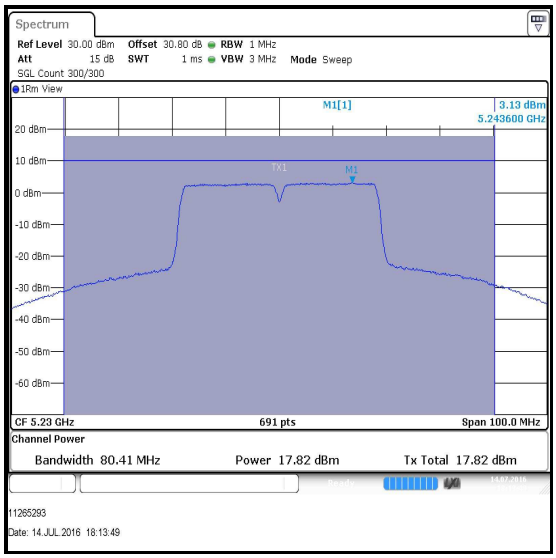


Top Channel

Results: 802.11n / 40 MHz / BPSK / MCS0 / MIMO / Port 2



Bottom Channel



Top Channel

Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) (continued)

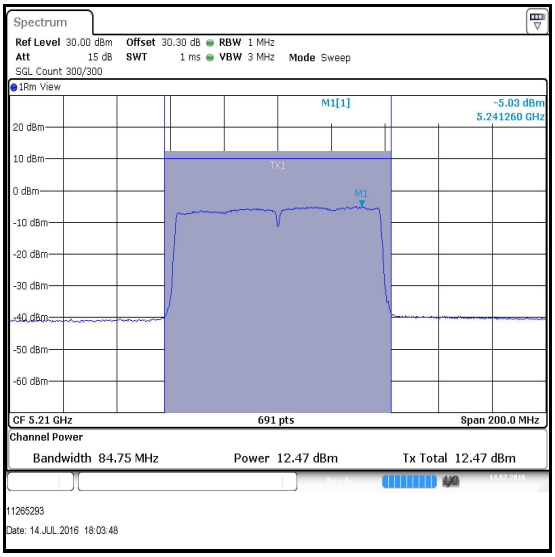
Results: 802.11ac / 80 MHz / BPSK / MCS0x1 / MIMO

Channel	Frequency (MHz)	Port 1			Port 2		
		Conducted Power (dBm)	Duty Cycle Correction (dB)	Corrected Conducted Power (dBm)	Conducted Power (dBm)	Duty Cycle Correction (dB)	Corrected Conducted Power (dBm)
Single	5210	12.5	0.2	12.7	12.5	0.2	12.7

Channel	Corrected Conducted Power Port 1 (dBm)	Corrected Conducted Power Port 2 (dBm)	Combined Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Single	12.7	12.7	15.7	24.0	8.3	Complied

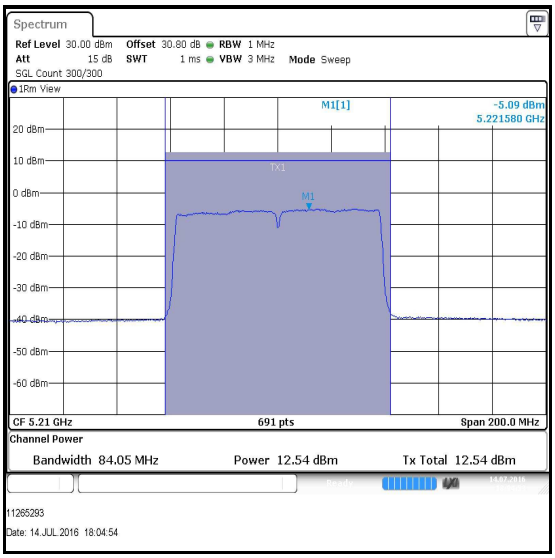
Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) (continued)

Results: 802.11ac / 80 MHz / BPSK / MCS0x1 / MIMO / Port 1



Single Channel

Results: 802.11ac / 80 MHz / BPSK / MCS0x1 / MIMO / Port 2



Single Channel

Transmitter Maximum Conducted Output Power (5.25-5.35 GHz & 5.47-5.725 GHz bands)

Test Summary:

Test Engineer:	Georgios Vrezas	**Test Dates:**	12 July 2016 to 22 July 2016
Test Sample Serial Number:	C39RW006HFML		

FCC Reference:	Part 15.407(a)(2)
Test Method Used:	KDB 789033 D02 Section II.E.2.b) and II.E.2.d)

Environmental Conditions:

Temperature (°C):	24 to 25
Relative Humidity (%):	40 to 43

Note(s):

1. The FCC Part 15.407(a)(2) limit is the lesser of 250 mW (24.0 dBm) or 11 dBm + 10 $\log_{10}$ B, where B is the previously measured 26 dB emission bandwidth in MHz. For both U-NII-2A and U-NII-2C bands, the 26 dB EBW is greater than 20 MHz.

$$\begin{gathered}\text{For B} > 20\text{ MHz} \rightarrow \\ \rightarrow \log_{10}\text{B} > \log_{10} 20 \rightarrow \\ \rightarrow 10\log_{10}\text{B} > 10\log_{10} 20 \rightarrow \\ \rightarrow 11 + 10\log_{10}\text{B} > 11 + 10\log_{10} 20 \rightarrow \\ \rightarrow 11 + 10\log_{10}\text{B} > 24.0\text{ dBm}\end{gathered}$$

   Therefore for measured emission bandwidths greater than 20 MHz, the lesser of the two limits is the fixed limit of 250 mW (24.0 dBm). This was applied to the results.

2. For SISO modes, the antenna gain is < 6 dBi.

3. For MIMO modes presented in this section of the test report, the data stream is correlated as it is single stream with CDD on. The directional antenna gain has been calculated in accordance with KDB 662911 D01 Section F)2)f)(ii). The EUT antenna has a gain of -2.1 dBi for port 1 and -0.5 dBi for port 2, in the frequency range 5.25 GHz to 5.35 GHz:

$$\text{Directional Gain} = 10\log\left[\frac{\sum_{j=1}^{N_{SS}}\left(\sum_{k=1}^{N_{ANT}} g_{j,k}\right)^2}{N_{ANT}}\right] = 10\log\left[\frac{\sum_{j=1}^{1}\left(\sum_{k=1}^{2} g_{j,k}\right)^2}{2}\right]$$

$$= \mathbf{10\log\left[\frac{\left(g_{1,1}+g_{1,2}\right)^2}{2}\right] = 10\log\left[\frac{\left(10^{\frac{G_1}{20}}+10^{\frac{G_2}{20}}\right)^2}{2}\right] = 10\log\left[\frac{\left(10^{\frac{-2.1}{20}}+10^{\frac{-0.5}{20}}\right)^2}{2}\right] = 1.7\text{ dBi}}$$

Transmitter Maximum Conducted Output Power (5.25-5.35 GHz & 5.47-5.725 GHz bands) (continued)

Note(s):

4. For MIMO modes presented in this section of the test report, the data stream is correlated as it is single stream with CDD on. The directional antenna gain has been calculated in accordance with KDB 662911 D01 Section F)2)f)(ii). The EUT antenna has a gain of 0.7 dBi for port 1 and 0.1 dBi for port 2, in the frequency range 5.47 GHz to 5.725 GHz:

$$\text{Directional Gain} = 10\log\left[\frac{\sum_{j=1}^{N_{SS}}\left(\sum_{k=1}^{N_{ANT}} g_{j,k}\right)^2}{N_{ANT}}\right] = 10\log\left[\frac{\sum_{j=1}^{1}\left(\sum_{k=1}^{2} g_{j,k}\right)^2}{2}\right]$$

$$= \mathbf{10\log\left[\frac{\left(g_{1,1}+g_{1,2}\right)^2}{2}\right] = 10\log\left[\frac{\left(10^{\frac{G_1}{20}}+10^{\frac{G_2}{20}}\right)^2}{2}\right] = 10\log\left[\frac{\left(10^{\frac{0.7}{20}}+10^{\frac{0.1}{20}}\right)^2}{2}\right] = 3.4\ \text{dBi}}$$