TEST REPORT

Test Report No. : UL-RPT-RP11906202-1216E

Manufacturer	:	Dyson Technology Limited
Model No.	:	DBWIFIBLE01
FCC ID	:	QVHDBWIFIBLE01
Technology	:	WLAN
Test Standard(s)	:	FCC Parts 15.209(a), 15.403 & 15.407

1. This test report shall not be reproduced in full or partial, without the written approval of UL VS LTD.
2. The results in this report apply only to the sample(s) tested.
3. The sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 1.0.

Date of Issue: 20 December 2017

Checked by:

Ian Watch
Senior Engineer, Radio Laboratory

Company Signatory:

Sarah Williams
Senior Engineer, Radio Laboratory
UL VS LTD

This laboratory is accredited by UKAS. The tests reported herein have been performed in accordance with its terms of accreditation.

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Table of Contents

1. Customer Information **4**

2. Summary of Testing **5**
2.1. General Information 5
2.2. Summary of Test Results 6
2.3. Methods and Procedures 7
2.4. Deviations from the Test Specification 7

3. Equipment Under Test (EUT) **8**
3.1. Identification of Equipment Under Test (EUT) 8
3.2. Description of EUT 8
3.3. Modifications Incorporated in the EUT 8
3.4. Additional Information Related to Testing 9
3.5. Support Equipment 11

4. Operation and Monitoring of the EUT during Testing **12**
4.1. Operating Modes 12
4.2. Configuration and Peripherals 12

5. Measurements, Examinations and Derived Results **14**
5.1. General Comments 14
5.2. Test Results 15
5.2.1. Transmitter 26 dB Emission Bandwidth 15
5.2.2. Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band) 34
5.2.3. Transmitter Duty Cycle 39
5.2.4. Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) 48
5.2.5. Transmitter Maximum Conducted Output Power (5.25-5.35 GHz & 5.47-5.725 GHz bands) 52
5.2.6. Transmitter Maximum Conducted Output Power (5.725-5.85 GHz band) 57
5.2.7. Transmitter Maximum Power Spectral Density (5.15-5.25 GHz band) 61
5.2.8. Transmitter Maximum Power Spectral Density (5.25-5.35 GHz & 5.47-5.725 GHz bands) 64
5.2.9. Transmitter Maximum Power Spectral Density (5.725-5.85 GHz band) 67
5.2.10. Transmitter Out of Band Radiated Emissions 70
5.2.11. Transmitter Band Edge Radiated Emissions 85

6. Measurement Uncertainty **114**

7. Report Revision History **115**

1. Customer Information

Company Name:	Dyson Technology Limited
Address:	Tetbury Hill Malmesbury Swindon SN16 0RP United Kingdom

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR15.407 and 47CFR15.403
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart E (Unlicensed National Information Infrastructure Devices) – Sections 15.403 and 15.407
Specification Reference:	47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 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:	09 November 2017 to 17 November 2017

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.403(i)	Transmitter 26 dB Emission Bandwidth	✓
Part 15.407(e)	Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band)	✓
Part 15.35(c)	Transmitter Duty Cycle	Note 1
Part 15.407(a)(1)(iv)	Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band)	✓
Part 15.407(a)(2)	Transmitter Maximum Conducted Output Power (5.25-5.35 GHz & 5.47-5.725 GHz bands)	✓
Part 15.407(a)(3)	Transmitter Maximum Conducted Output Power (5.725-5.85 GHz band)	✓
Part 15.407(a)(1)(iv)	Transmitter Peak Power Spectral Density (5.15-5.25 GHz band)	✓
Part 15.407(a)(2)	Transmitter Peak Power Spectral Density (5.25-5.35 GHz & 5.47-5.725 GHz bands)	✓
Part 15.407(a)(3)	Transmitter Peak Power Spectral Density (5.725-5.85 GHz band)	✓
Part 15.407(b)/15.209(a)	Transmitter Out of Band Radiated Emissions	✓
Part 15.407(b)/15.209(a)	Transmitter Band Edge Radiated Emissions	✓

Key to Results

✓ = Complied ✗ = Did not comply

Note(s):

1. The measurement was performed to assist in the calculation of the level of average output power, power spectral density, peak excursion and emissions as the EUT employs pulsed operation.

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 789033 D02 General UNII Test Procedures New Rules v01r04 May 2, 2017
Title:	Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices – Part 15, Subpart E

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 specifications identified above.

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	Dyson
Model Name or Number:	DBWIFIBLE01
Test Sample Serial Number:	43 *(Radiated sample)*
Hardware Version	259866-01/05 (EB2.2)
Software Version:	MFG SDK 442.1
FCC ID:	QVHDBWIFIBLE01

Brand Name:	Dyson
Model Name or Number:	DBWIFIBLE01
Test Sample Serial Number:	26 *(Conducted sample)*
Hardware Version:	259866-01/05 (EB2.2)
Software Version:	MFG SDK 442.1
FCC ID:	QVHDBWIFIBLE01

3.2. Description of EUT

The Equipment Under Test was a *Bluetooth* Low Energy and WLAN module operating in the 2.4 & 5 GHz bands.

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 802.11a,n) / U-NII		
Type of Unit:	Transceiver		
Modulation:	BPSK, QPSK, 16QAM & 64QAM		
Data rates:	802.11a	6, 9, 12, 18, 24, 36 ,48 & 54	
	802.11n HT20	MCS0 to MCS7 (1 spatial stream) GI = 800 ns	
Power Supply Requirement(s):	Nominal	3.3 VDC	
Antenna Gains:	5.15 to 5.25 GHz	2.6 dBi	
	5.25 to 5.35 GHz	2.3 dBi	
	5.47 to 5.725 GHz	3.7 dBi	
	5.725 to 5.85 GHz	4.1 dBi	
Channel Spacing:	20 MHz		
Transmit Frequency Band:	5150 MHz to 5250 MHz		
Transmit Channels Tested:	**Channel ID**	**Channel Number**	**Channel Frequency (MHz)**
	Bottom	36	5180
	Middle	40	5200
	Top	48	5240
Transmit Frequency Band:	5250 MHz to 5350 MHz		
Transmit Channels Tested:	**Channel ID**	**Channel Number**	**Channel Frequency (MHz)**
	Bottom	52	5260
	Middle	56	5280
	Top	64	5320

Additional Information Related to Testing (continued)

Transmit Frequency Band:	5470 MHz to 5725 MHz		
Transmit Channels Tested:	**Channel ID**	**Channel Number**	**Channel Frequency (MHz)**
	Bottom	100	5500
	Middle	116	5580
	Top	140	5700
Transmit Frequency Band:	5725 MHz to 5850 MHz		
Transmit Channels Tested:	**Channel ID**	**Channel Number**	**Channel Frequency (MHz)**
	Bottom	149	5745
	Middle	157	5785
	Top	165	5825

3.5. Support Equipment

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

Description:	Laptop PC
Brand Name:	Lenovo
Model Name or Number:	T420
Serial Number:	R8-VM66D

Description:	USB Micro-B Cable. Length 1.5 metres
Brand Name:	Not stated or marked
Model Name or Number:	Not stated or marked
Serial Number:	Not stated or marked

Description:	Test Jig
Brand Name:	Not stated or marked
Model Name or Number:	Not stated or marked
Serial Number:	Not stated or marked

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

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

- Continuously transmitting with a modulated carrier at maximum power on the bottom, middle and top channels as required using the supported data rates/modulation types.

4.2. Configuration and Peripherals

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

- Controlled using a bespoke application on the laptop PC supplied by the customer. The application was used to enable continuous transmission and receive modes and to select the test channels, data rates and modulation schemes as required.
- All supported modes and channel widths were initially investigated on one channel. The modes that produced the highest power and widest bandwidth for all bands were:
    - Highest power
        - 802.11a - BPSK / 6 Mbit/s
        - 802.11n HT20 / BPSK / MCS0 (GI = 800 ns)
    - Highest power spectral density
        - 802.11a – BPSK / 6 Mbit/s
        - 802.11n HT20 – BPSK / MCS0
    - Widest bandwidth
        - 802.11a / 16QAM / 24 Mbit/s
        - 802.11n HT20 / 64QAM / MCS5 (GI = 800 ns)

  Pre-scan results for all modes are archived on the UL VS LTD IT server and available for inspection if required.
- All supported modes and channel widths were initially investigated on one channel. The modes that produced the narrowest bandwidth for the 5725 to 5850 MHz band were:
    - Narrowest bandwidth
        - 802.11a – BPSK / 9 Mbit/s
        - 802.11n HT20 – QPSK / MCS2 (GI = 800 ns)
- RF cables and attenuators connecting the test equipment to the EUT were calibrated before use and the calibration data incorporated into the conducted measurement results.

Configuration and Peripherals (continued)

- Transmitter spurious emissions were performed with the EUT transmitting with a data rate of 6 Mbit/s (802.11a). This was found to be the worst case modulation scheme with regards to emissions after preliminary investigations and, as this mode emits the highest transmit output power level, it was deemed to be the worst case.
- Pre-scans for radiated emissions below and above 1 GHz were initially checked in X,Y& Z orientations. The worst case orientations were:
    - Below 1 GHz: Z Axis with the EUT back against the table
    - Above 1 GHz: Z Axis with the EUT back against the table
- The conducted sample with serial number 26 was used for 26 dB bandwidth, minimum 6 dB bandwidth, duty cycle, maximum output power and peak power spectral density tests.
- The radiated sample with serial number 43 was used for all other tests.
- The test setup instructions were supplied in a file *"Radio Test Mode Instructions.pdf" -08/18/2017*. This is archived on the UL VS LTD IT network and is available for inspection if required.

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 26 dB Emission Bandwidth

Test Summary:

Test Engineer:	Max Passell	**Test Dates:**	09 November 2017
Test Sample Serial Number:	26		

FCC Reference:	Part 15.403(i)
Test Method Used:	KDB 789033 D02 Section II.C.1.

Environmental Conditions:

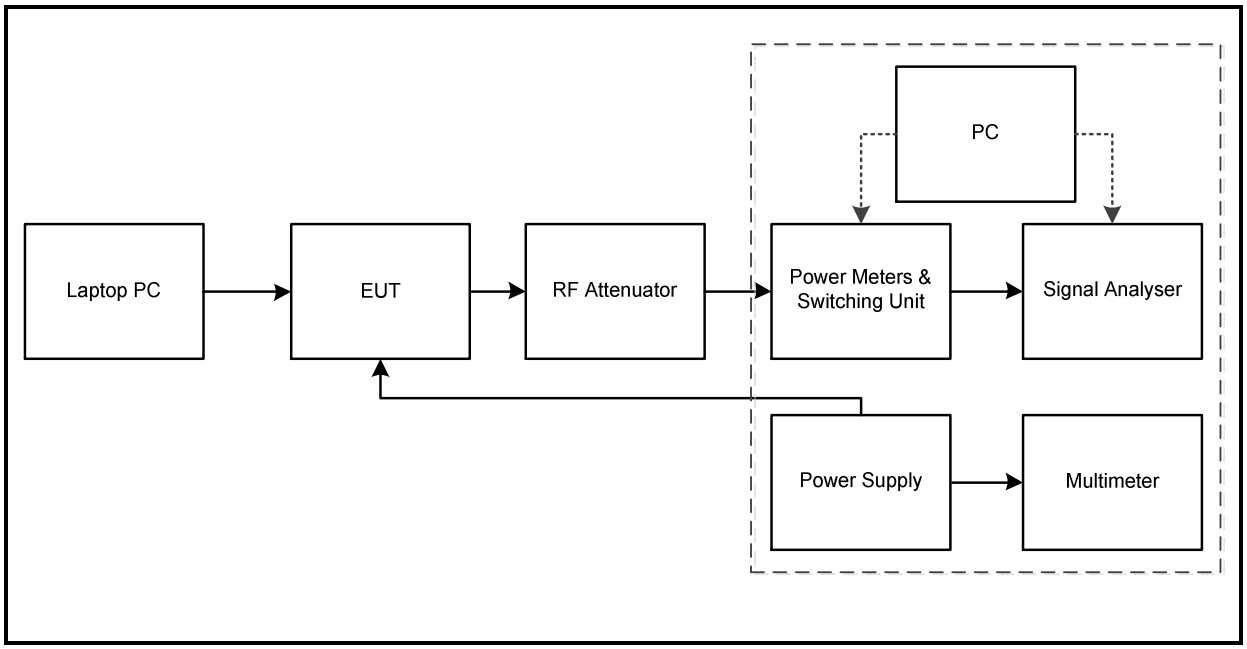
Temperature (°C):	20 to 23
Relative Humidity (%):	33 to 36

Note(s):

1. All configurations supported by the EUT were investigated on the one channel in accordance with KDB 789033 Section II.C.1. Emission Bandwidth (EBW) test procedure. The data rates that produced the widest bandwidth and therefore deemed worst case were:
    - 802.11a – 16QAM / 24 Mbit/s
    - 802.11n HT20 – 64QAM / MCS5 (GI = 800 ns)
2. Final measurements were performed in each supported operating band using the above configurations on the bottom, middle and top or single channels.
3. Plots for all data rates are archived on the UL VS LTD IT server and available for inspection upon request.
4. The signal analyser was connected to the RF port on the EUT using a RF switch, suitable attenuation and RF cables. A RF level offset was entered in to the signal analyser to compensate for the loss of the switch, attenuators and RF cables.
5. For the power measurements in this report, the highest power output level was recorded when the EUT was configured as:
    - 802.11a – BPSK / 6 Mbit/s
    - 802.11n HT20 – BPSK / MCS0 (GI = 800 ns)
6. Emission bandwidth plots for these configurations have been included as ‘Reference plots’ at the end of this section and the results used for calculations in Section 5.3.4.

Transmitter 26 dB Emission Bandwidth (continued)

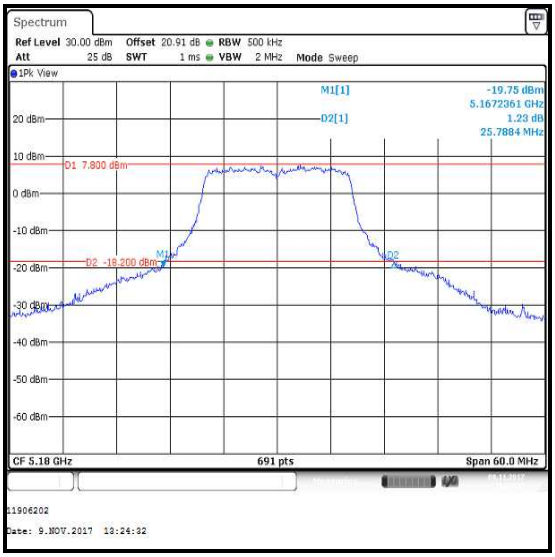
Test setup:



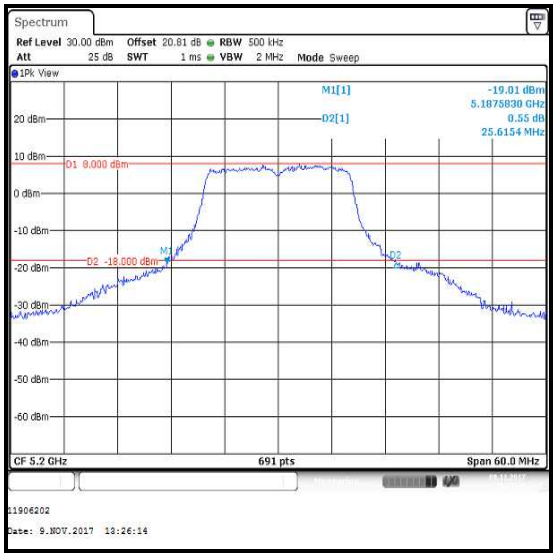
Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band)(continued)

Results: 802.11a / 20 MHz / 16QAM / 24 Mbit/s

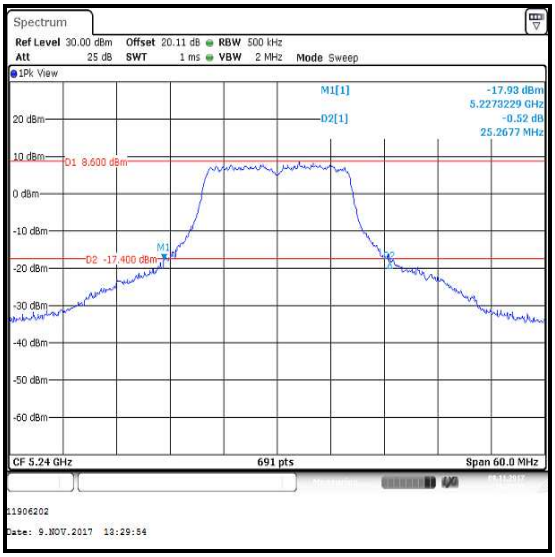
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	25.788
Middle	5200	25.615
Top	5240	25.268



Bottom Channel



Middle Channel

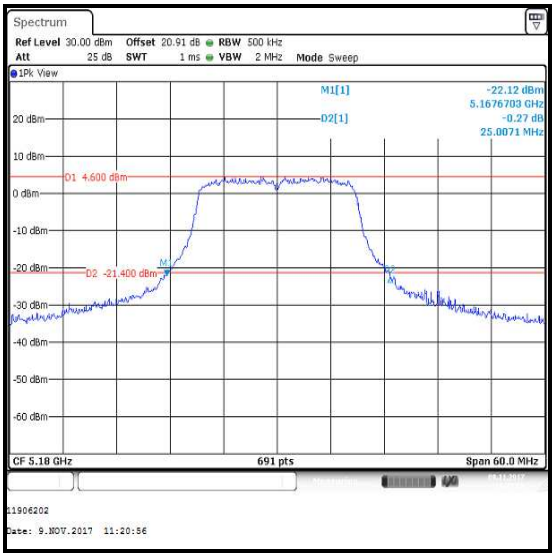


Top Channel

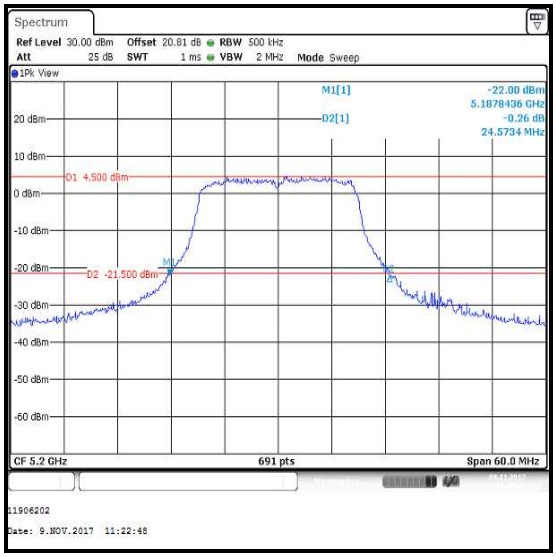
Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band)(continued)

Results: 802.11n / 20 MHz / 64QAM / MCS5

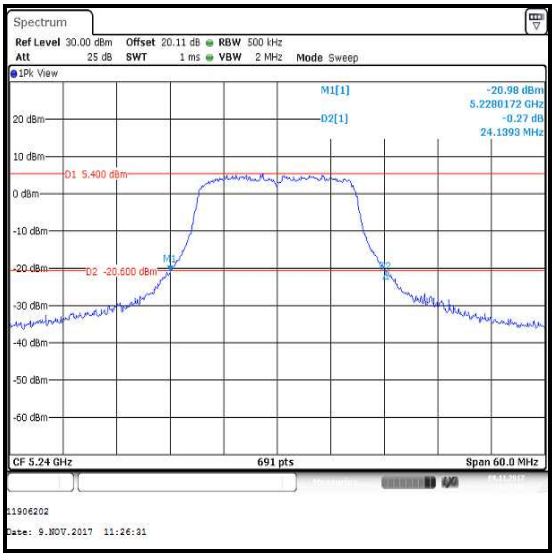
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	25.007
Middle	5200	24.573
Top	5240	24.139



Bottom Channel



Middle Channel

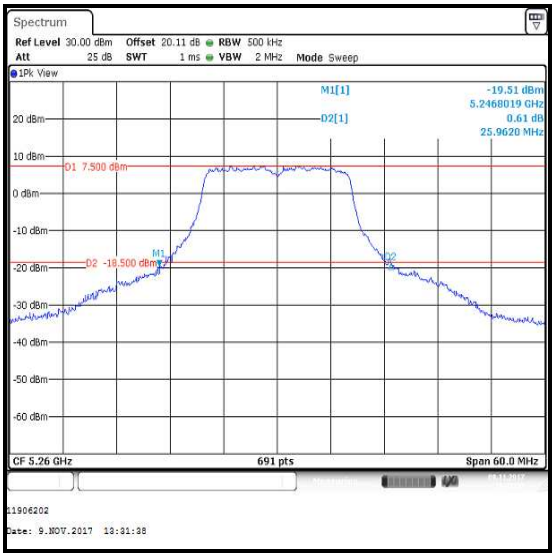


Top Channel

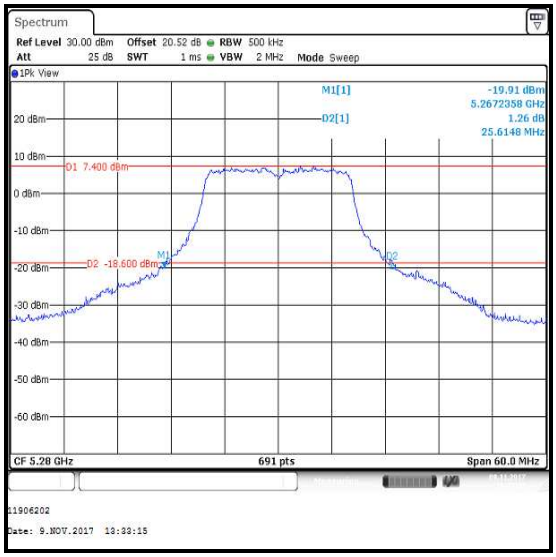
Transmitter 26 dB Emission Bandwidth (5.25-5.35 GHz band)(continued)

Results: 802.11a / 20 MHz / 16QAM / 24 Mbit/s

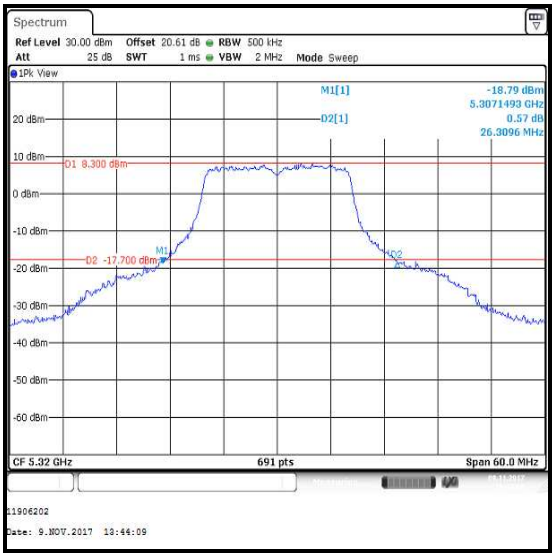
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5260	25.962
Middle	5280	25.615
Top	5320	26.310



Bottom Channel



Middle Channel

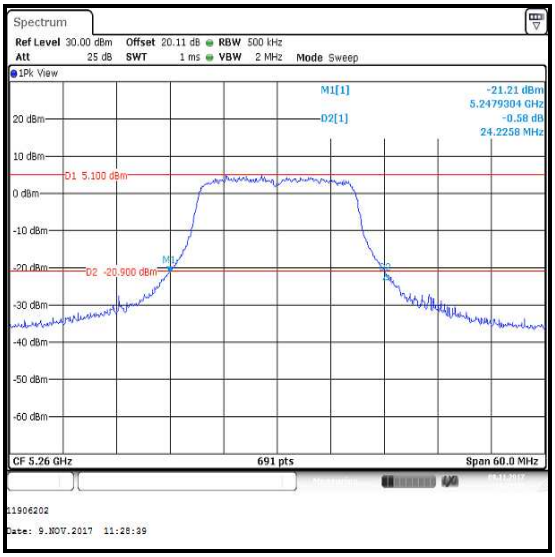


Top Channel

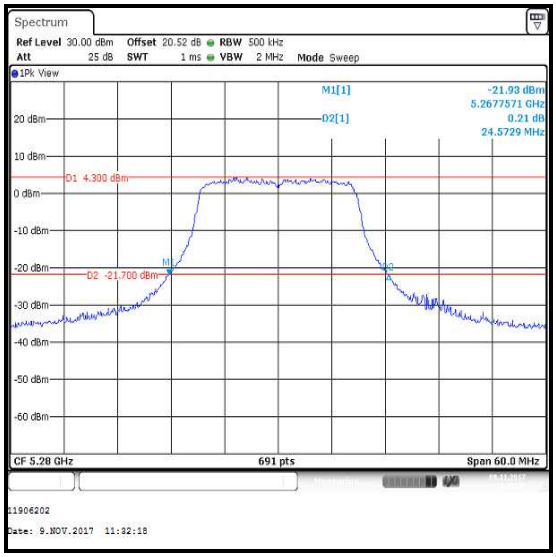
Transmitter 26 dB Emission Bandwidth (5.25-5.35 GHz band)(continued)

Results: 802.11n / 20 MHz / 64QAM / MCS5

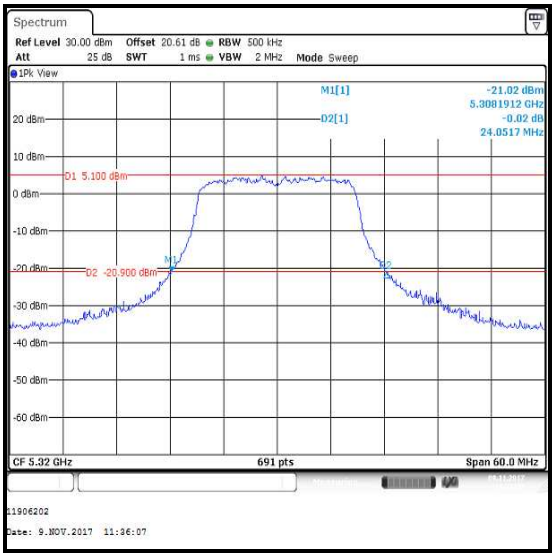
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5260	24.226
Middle	5280	24.573
Top	5320	24.052



Bottom Channel



Middle Channel

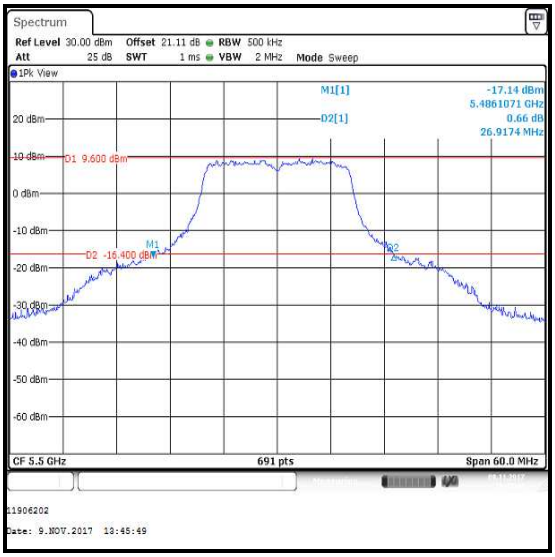


Top Channel

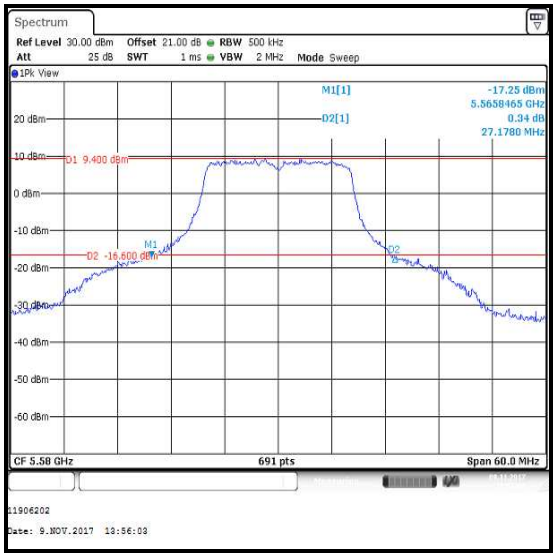
Transmitter 26 dB Emission Bandwidth (5.47-5.725 GHz band)(continued)

Results: 802.11a / 20 MHz / 16QAM / 24 Mbit/s

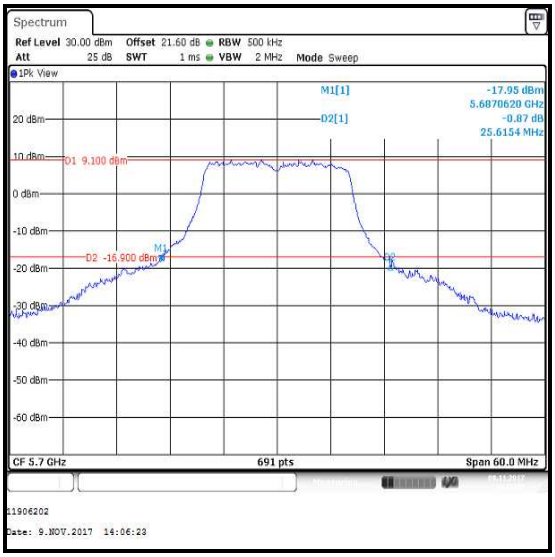
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5500	26.917
Middle	5580	27.178
Top	5700	25.615



Bottom Channel



Middle Channel

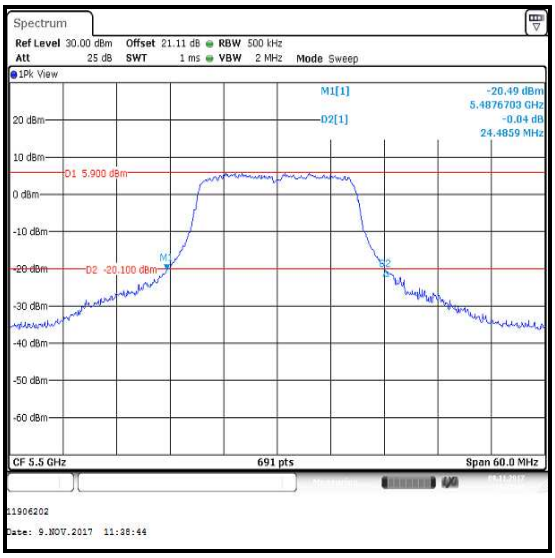


Top Channel

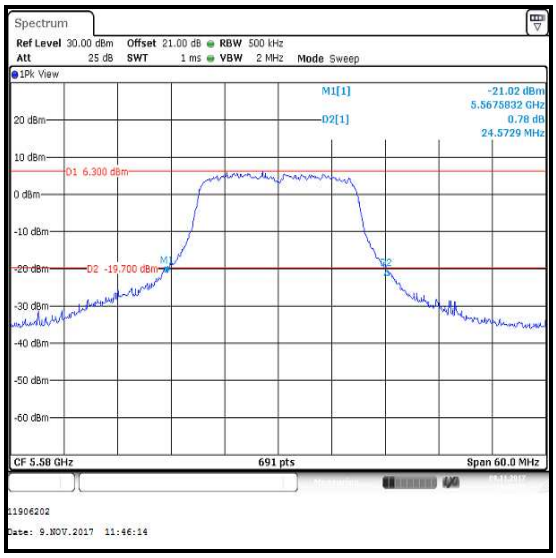
Transmitter 26 dB Emission Bandwidth (5.47-5.725 GHz band)(continued)

Results: 802.11n / 20 MHz / 64QAM / MCS5

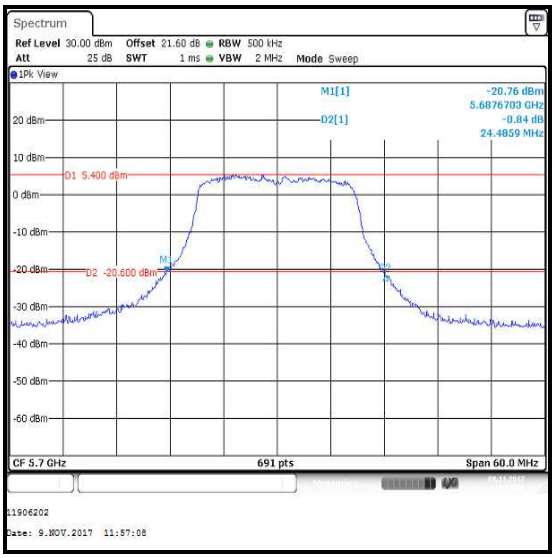
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5500	24.486
Middle	5580	24.573
Top	5700	24.486



Bottom Channel



Middle Channel

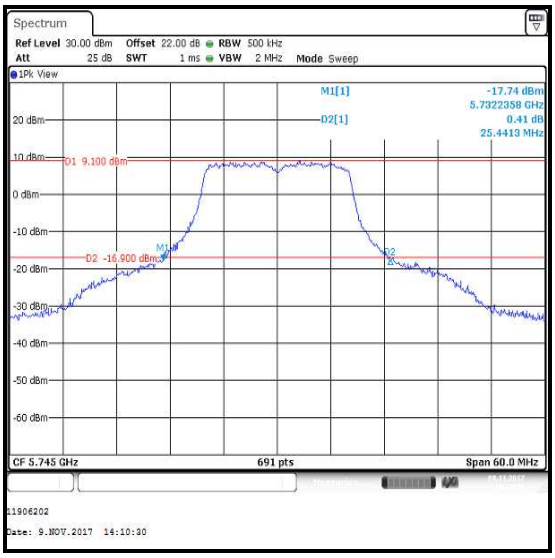


Top Channel

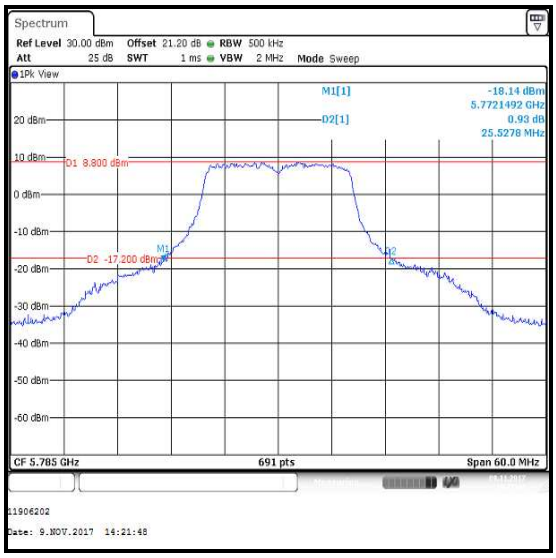
Transmitter 26 dB Emission Bandwidth (5.725-5.785 GHz band)(continued)

Results: 802.11a / 20 MHz / 16QAM / 24 Mbit/s

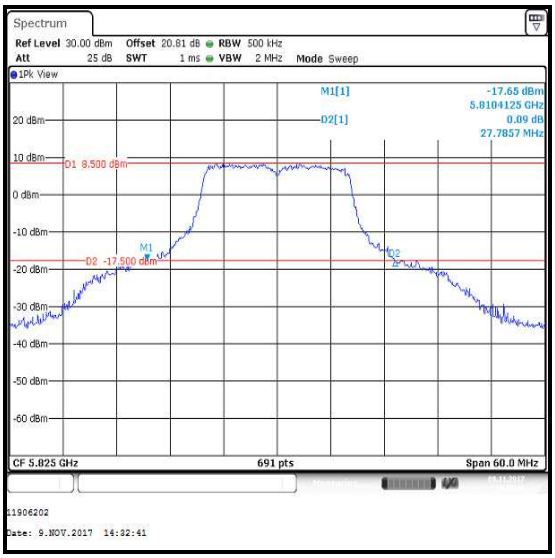
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5745	25.441
Middle	5785	25.528
Top	5825	27.786



Bottom Channel



Middle Channel

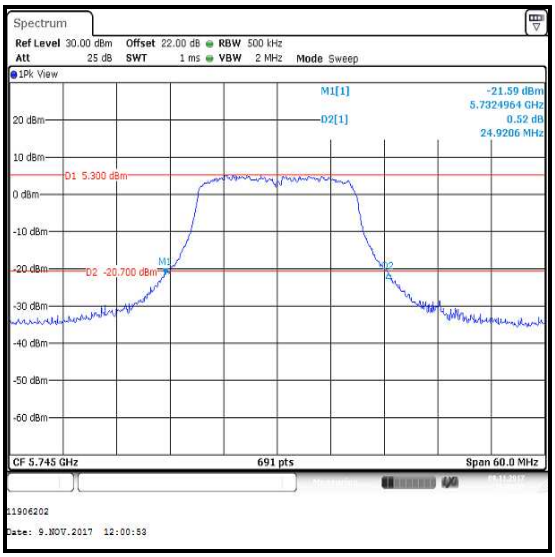


Top Channel

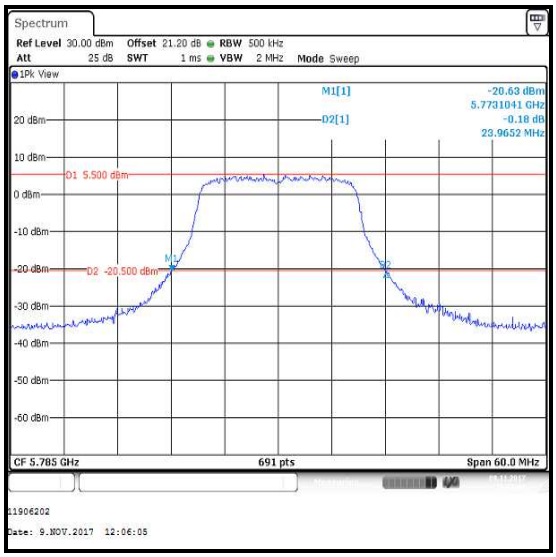
Transmitter 26 dB Emission Bandwidth (5.725-5.785 GHz band)(continued)

Results: 802.11n / 20 MHz / 64QAM / MCS5

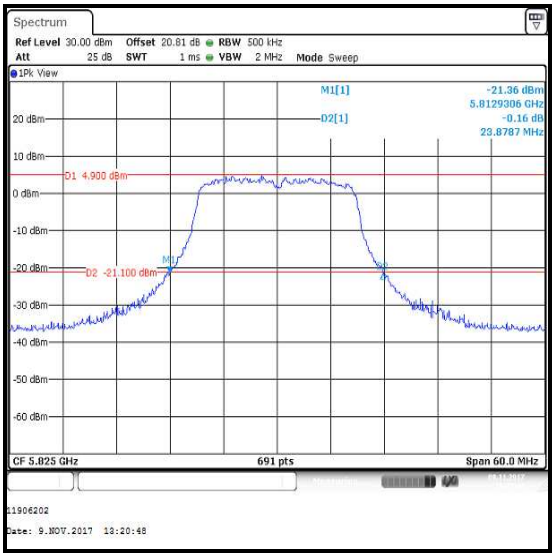
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5745	24.921
Middle	5785	23.965
Top	5825	23.879



Bottom Channel



Middle Channel

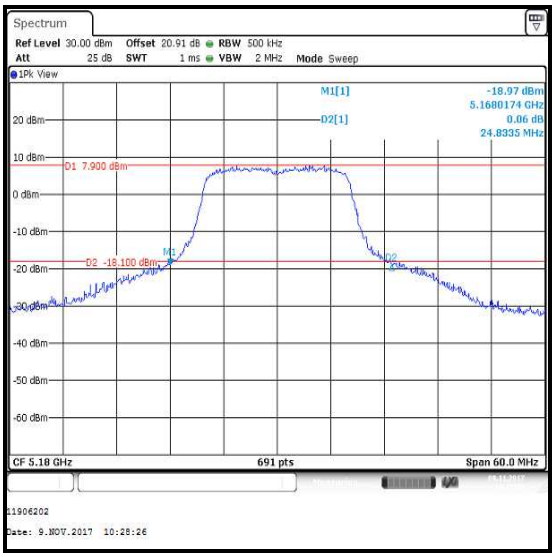


Top Channel

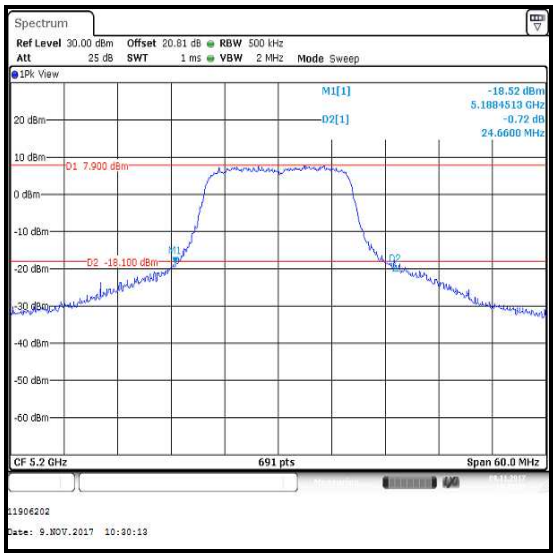
Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band)(continued)

Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s (Reference Plots)

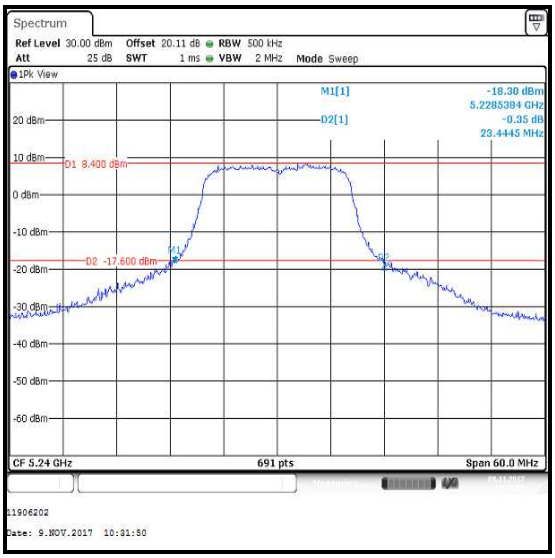
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	24.834
Middle	5200	24.660
Top	5240	23.444



Bottom Channel



Middle Channel

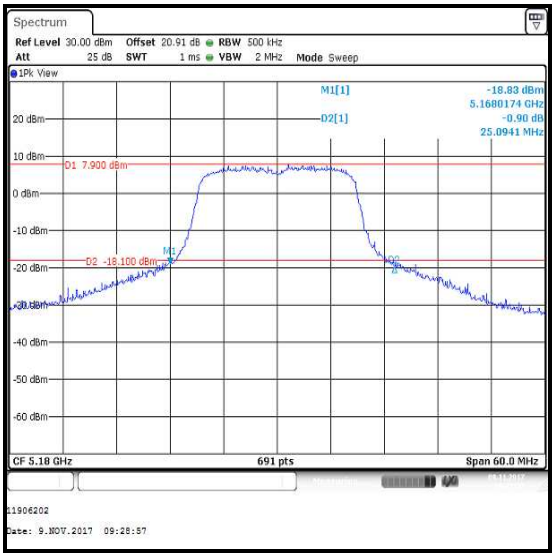


Top Channel

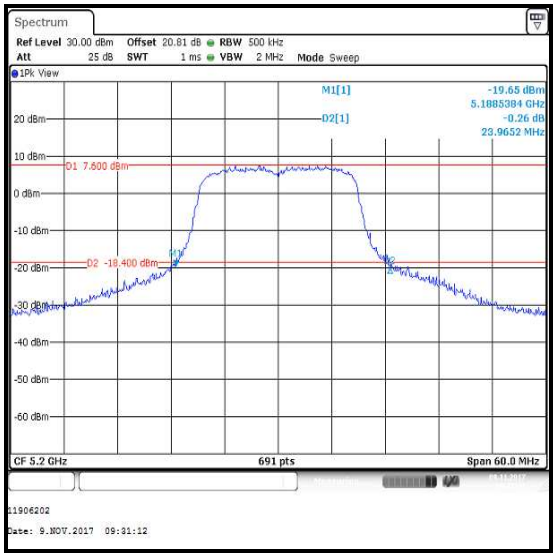
Transmitter 26 dB Emission Bandwidth (5.15-5.25 GHz band)(continued)

Results: 802.11n / 20 MHz / BPSK / MCS0 (Reference Plots)

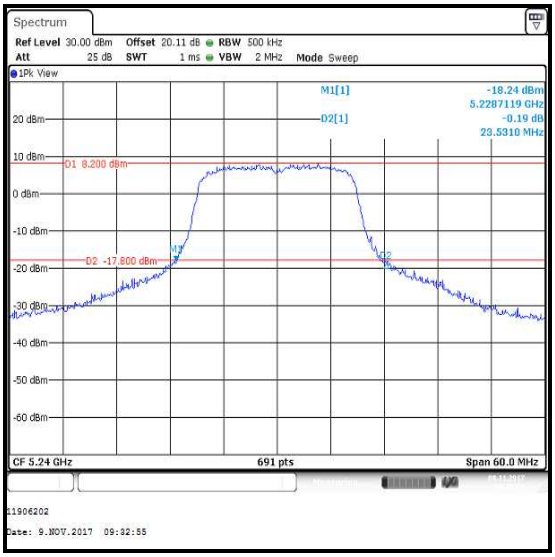
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5180	25.094
Middle	5200	23.965
Top	5240	23.531



Bottom Channel



Middle Channel

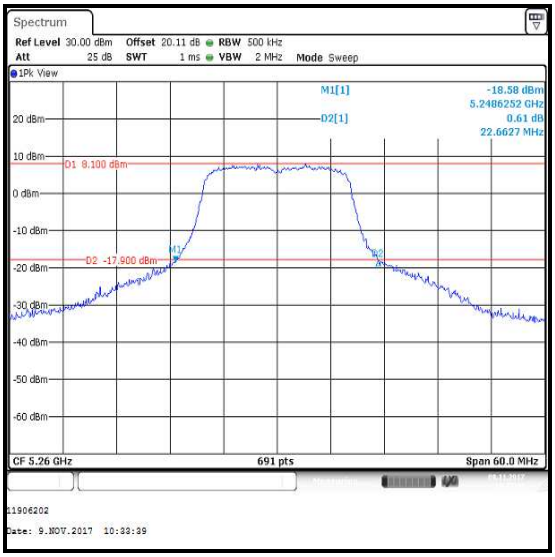


Top Channel

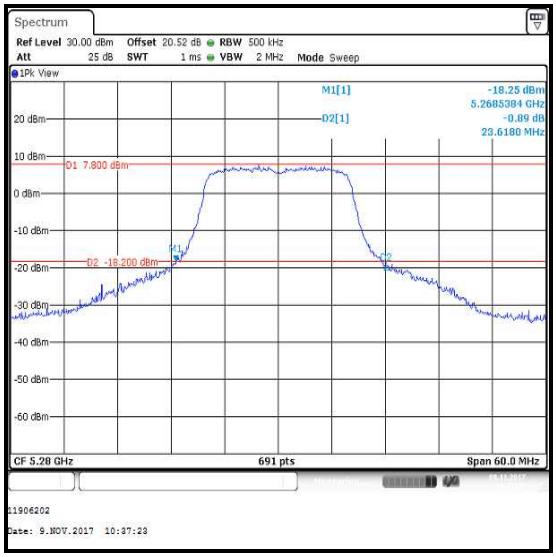
Transmitter 26 dB Emission Bandwidth (5.25-5.35 GHz band)(continued)

Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s (Reference plots)

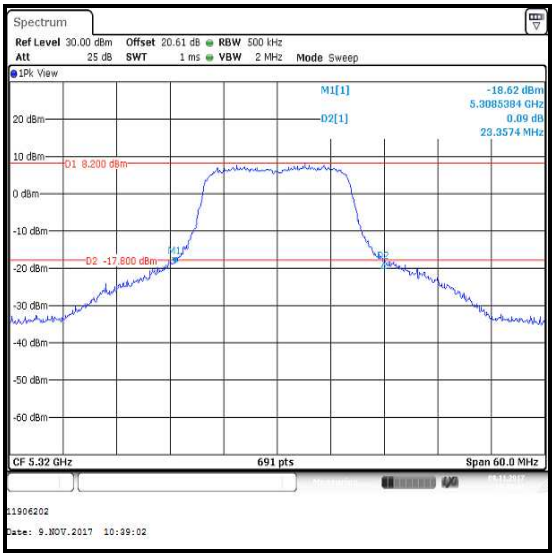
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5260	22.663
Middle	5280	23.618
Top	5320	23.357



Bottom Channel



Middle Channel

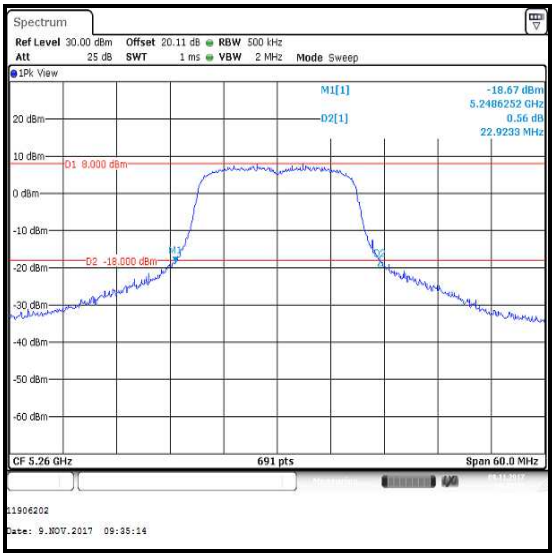


Top Channel

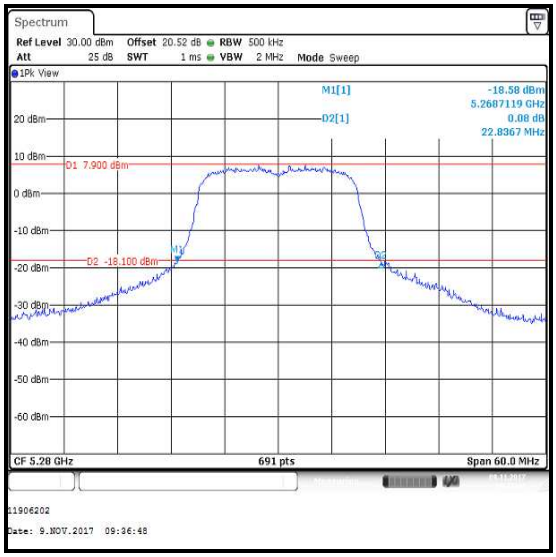
Transmitter 26 dB Emission Bandwidth (5.25-5.35 GHz band)(continued)

Results: 802.11n / 20 MHz / BPSK / MCS0 (Reference plots)

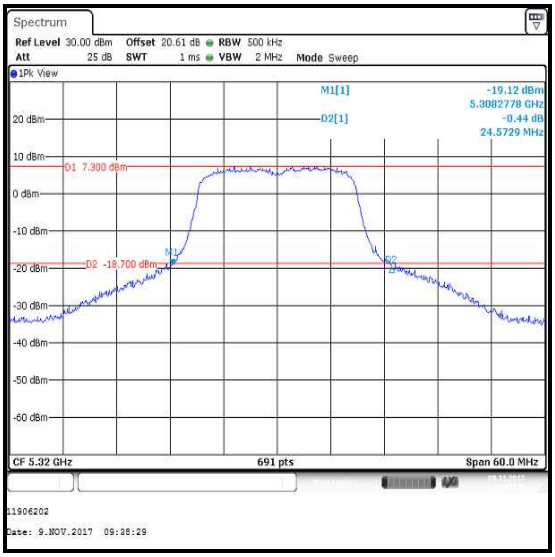
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5260	22.923
Middle	5280	22.837
Top	5320	24.573



Bottom Channel



Middle Channel

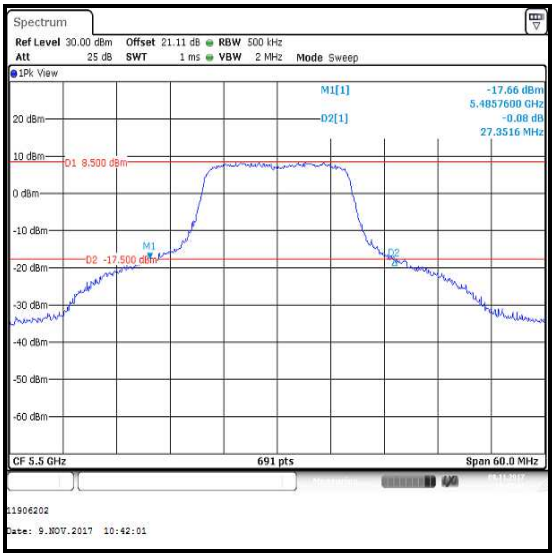


Top Channel

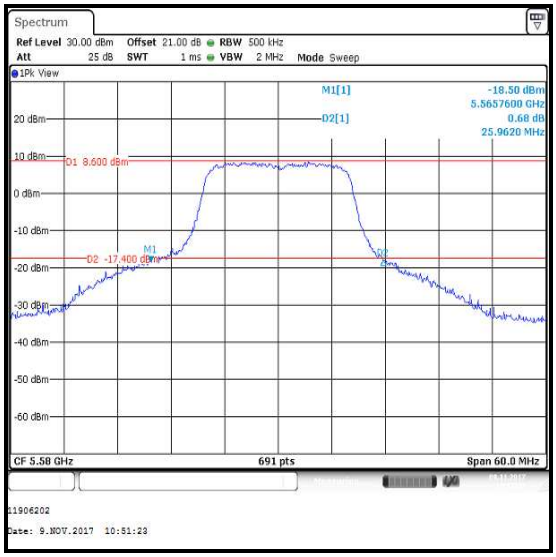
Transmitter 26 dB Emission Bandwidth (5.47-5.725 GHz band)(continued)

Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s (Reference plots)

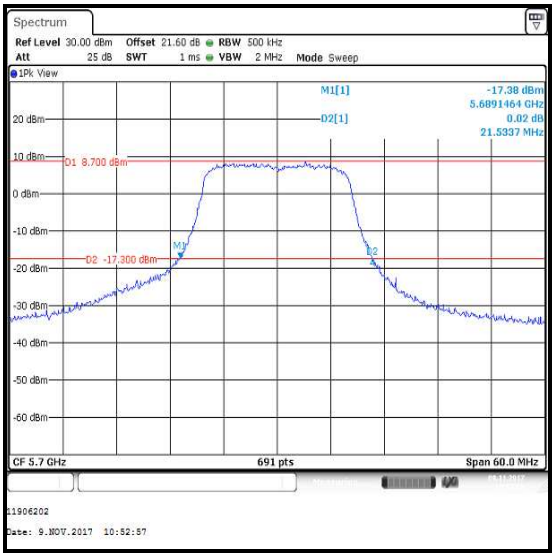
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5500	27.352
Middle	5580	25.962
Top	5700	21.534



Bottom Channel



Middle Channel

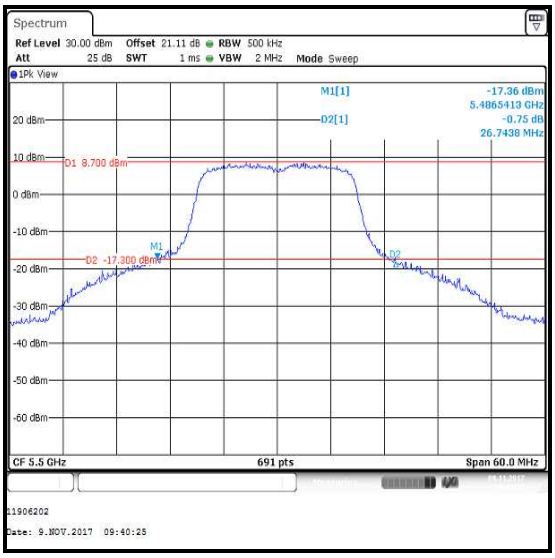


Top Channel

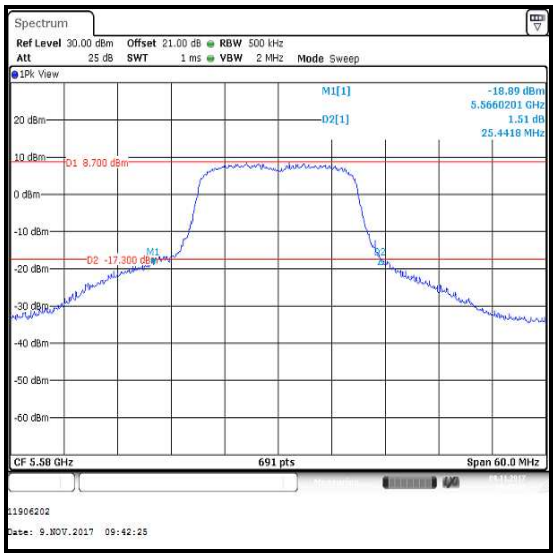
Transmitter 26 dB Emission Bandwidth (5.47-5.725 GHz band)(continued)

Results: 802.11n / 20 MHz / BPSK / MCS0 (Reference plots)

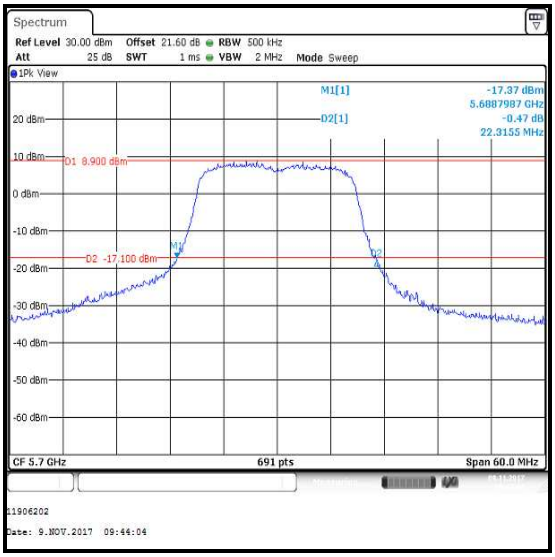
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5500	26.744
Middle	5580	25.442
Top	5700	22.316



Bottom Channel



Middle Channel

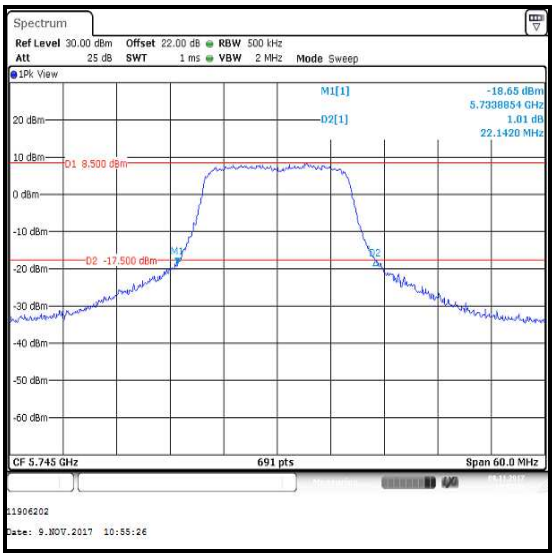


Top Channel

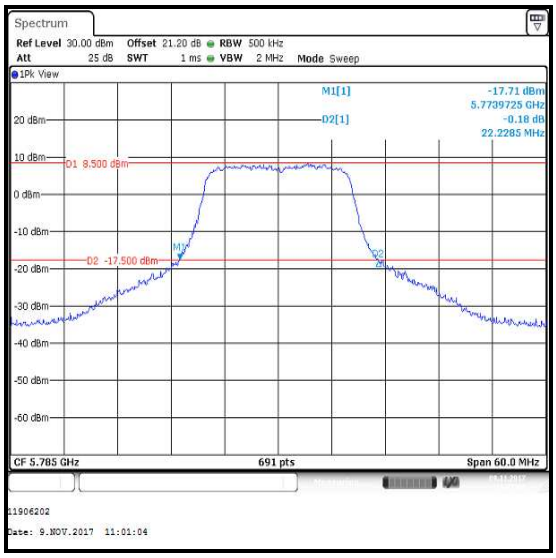
Transmitter 26 dB Emission Bandwidth (5.725-5.85 GHz band)(continued)

Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s (Reference plots)

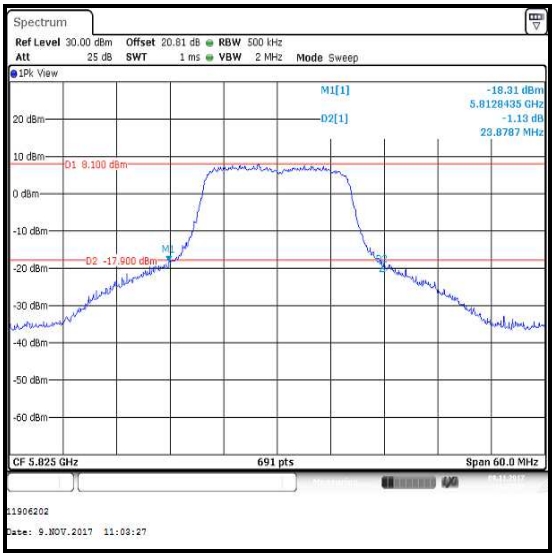
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5745	22.142
Middle	5785	22.228
Top	5825	23.879



Bottom Channel



Middle Channel

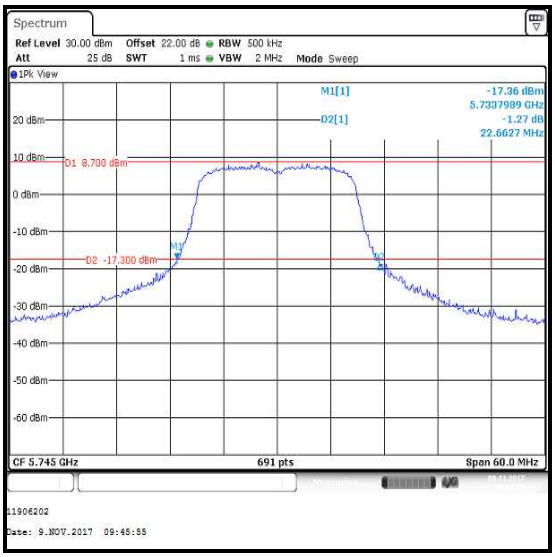


Top Channel

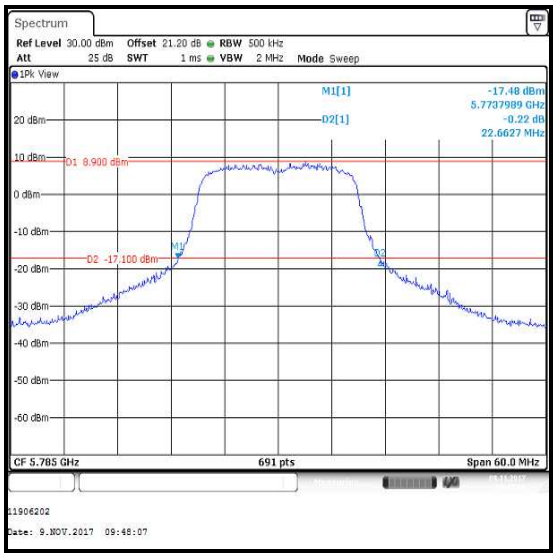
Transmitter 26 dB Emission Bandwidth (5.725-5.85 GHz band)(continued)

Results: 802.11n / 20 MHz / BPSK / MCS0 (Reference plots)

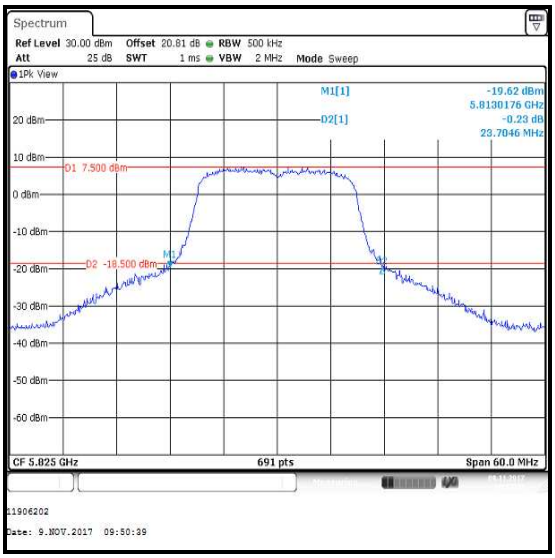
Channel	Frequency (MHz)	26 dB Emission Bandwidth (MHz)
Bottom	5745	22.663
Middle	5785	22.663
Top	5825	23.705



Bottom Channel



Middle Channel



Top Channel

Transmitter 26 dB Emission 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	22 Feb 2018	12
A3028	6 dB Attenuator	Broadwave Technologies	351-311-006	#2	Calibrated before use	12
A3004	RF Switch	Pickering Interfaces	64-102-002	XZ363230	Calibrated before use	-
M2018	Signal Analyser	Rohde & Schwarz	FSV7	102699	23 Mar 2018	12
M1818	Multimeter	Fluke	79 Series III	71811580	12 Apr 2018	12
M2020	Power Sensor	Boonton	55006	9970	22 Mar 2018	12
S0586	Power Supply Unit	Keithley	2303	4310413	23 Mar 2018	12

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

Test Summary:

Test Engineer:	Max Passell	**Test Dates:**	09 November 2017
Test Sample Serial Number:	26		

FCC Reference:	Part 15.407(e)
Test Method Used:	KDB 789033 D02 Section II.C.2.

Environmental Conditions:

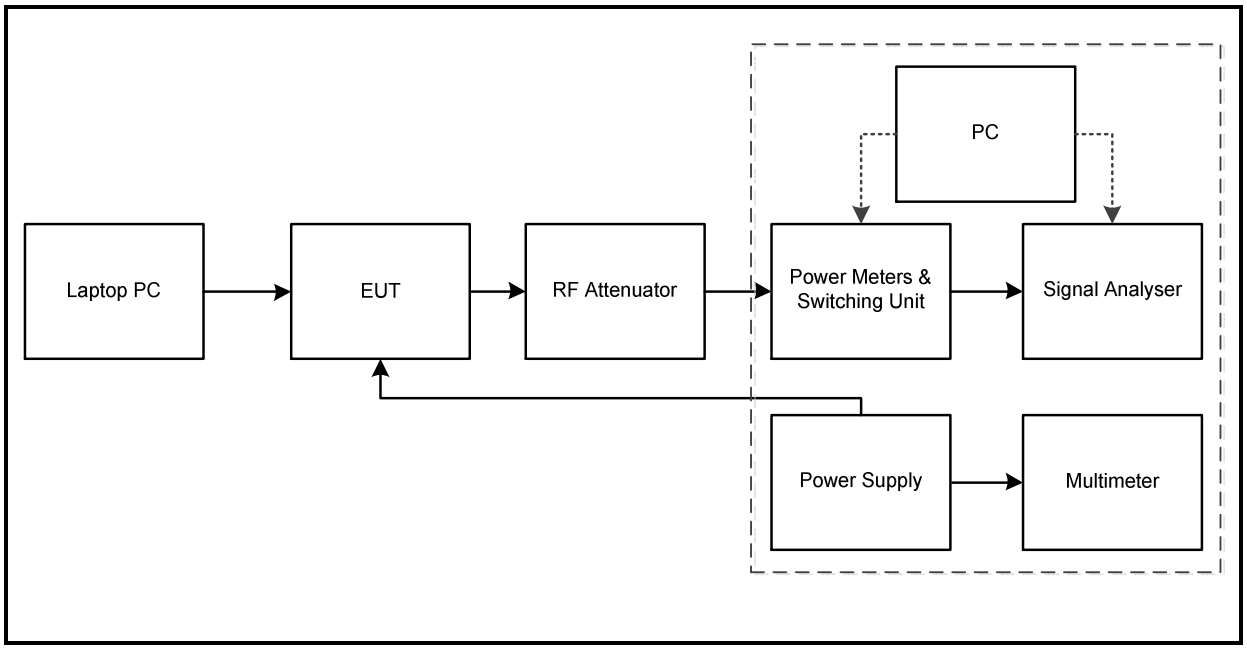
Temperature (°C):	20 to 23
Relative Humidity (%):	33 to 36

Note(s):

1. All configurations supported by the EUT were investigated on one channel in accordance with KDB 789033 Section II.C.2. Minimum Emission Bandwidth for the band 5.725-5.85 GHz measurement procedure. 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 for 20 MHz channels and 60 MHz for 40 MHz channels. The bandwidth was measured at 6 dB down from the peak of the signal.The data rates that produced the narrowest bandwidth and therefore deemed worst case were:
    - 802.11a – BPSK / 9 Mbit/s
    - 802.11n HT20 – QPSK / MCS2 (GI = 800 ns)
2. Final measurements were performed using the above configurations on the bottom, middle and top channels.
3. Plots for all data rates are archived on the UL VS LTD IT server and available for inspection upon request.
4. The signal analyser was connected to the RF port on the EUT using a RF switch, suitable attenuation and RF cables. A RF level offset was entered in to the signal analyser to compensate for the loss of the switch, attenuators and RF cables..

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

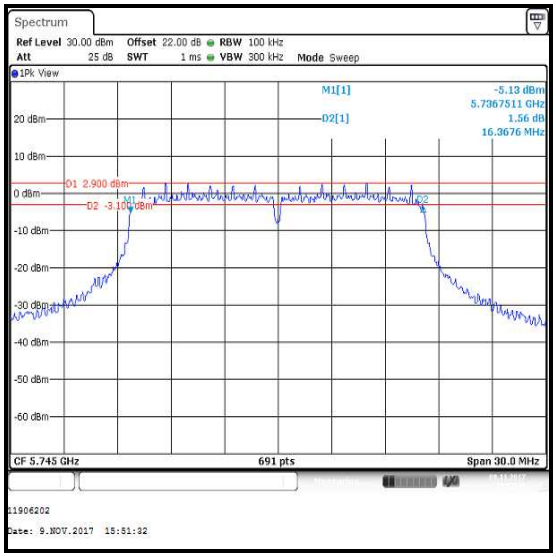
Test setup:



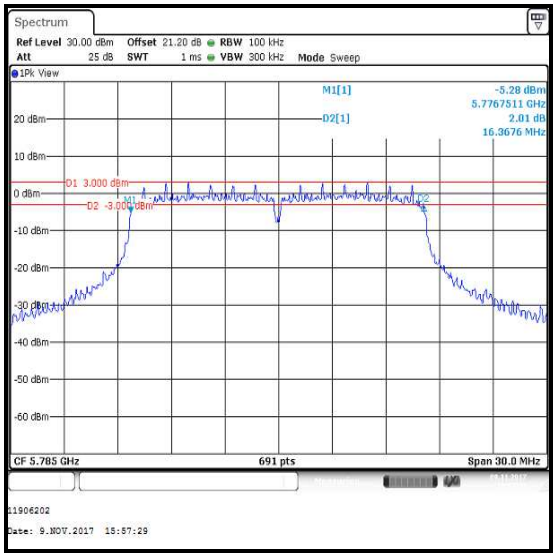
Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band) (continued)

Results: 802.11a / 20 MHz / QPSK / 9 Mbit/s

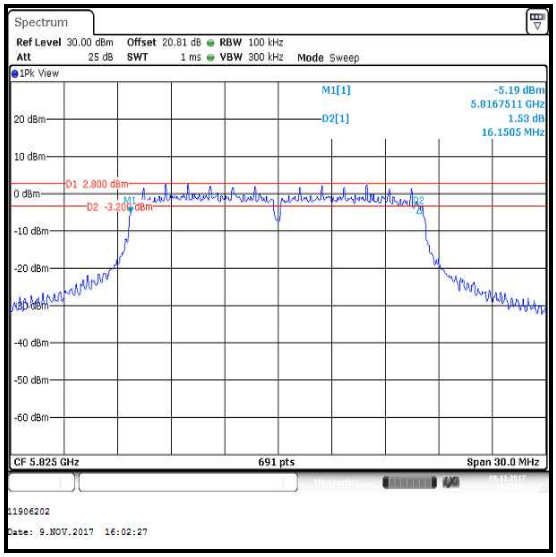
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	16368	≥500	15868	Complied
Middle	16368	≥500	15868	Complied
Top	16151	≥500	15651	Complied



Bottom Channel



Middle Channel

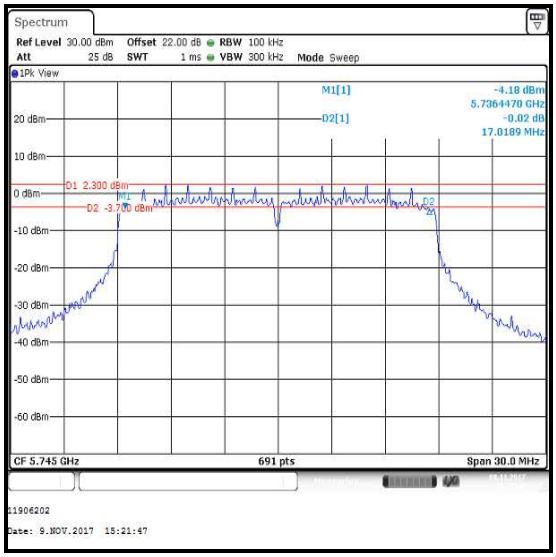


Top Channel

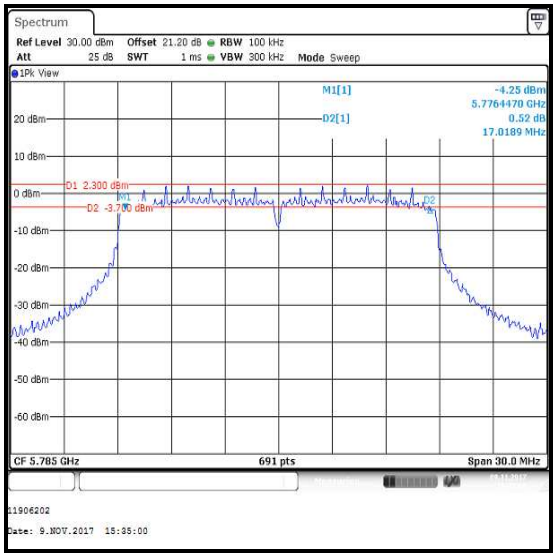
Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band) (continued)

Results: 802.11n / 20 MHz / QPSK / MCS2

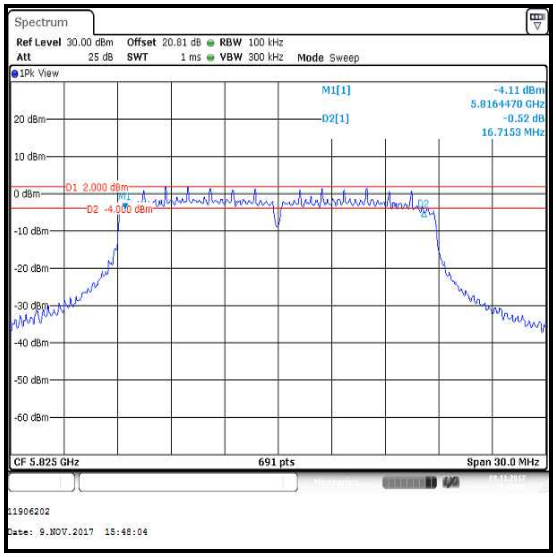
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	17019	≥500	16519	Complied
Middle	17019	≥500	16519	Complied
Top	16715	≥500	16215	Complied



Bottom Channel



Middle Channel



Top Channel

Transmitter Minimum 6 dB Bandwidth (5.725-5.85 GHz band) (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	22 Feb 2018	12
A3028	6 dB Attenuator	Broadwave Technologies	351-311-006	#2	Calibrated before use	12
A3004	RF Switch	Pickering Interfaces	64-102-002	XZ363230	Calibrated before use	-
M2018	Signal Analyser	Rohde & Schwarz	FSV7	102699	23 Mar 2018	12
M1818	Multimeter	Fluke	79 Series III	71811580	12 Apr 2018	12
M2020	Power Sensor	Boonton	55006	9970	22 Mar 2018	12
S0586	Power Supply Unit	Keithley	2303	4310413	23 Mar 2018	12

5.2.3. Transmitter Duty Cycle

Test Summary:

Test Engineer:	Max Passell	**Test Dates:**	09 November 2017
Test Sample Serial Number:	26		

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

Environmental Conditions:

Temperature (°C):	20 to 23
Relative Humidity (%):	33 to 36

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 signal analyser in the time domain and calculated as shown below:

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

802.11a / 6 Mbit/s duty cycle: 10 log (1 / (2.0176 / 2.0612)) = 0.1

802.11a / 9 Mbit/s duty cycle: 10 log (1 / (1.3526 / 1.3925)) = 0.1

802.11a / 24 Mbit/s duty cycle: 10 log (1 / (0.5223 / 0.5593)) = 0.3

802.11n HT20 / MCS0 duty cycle: 10 log (1 / (1.8821 / 1.9253)) = 0.1

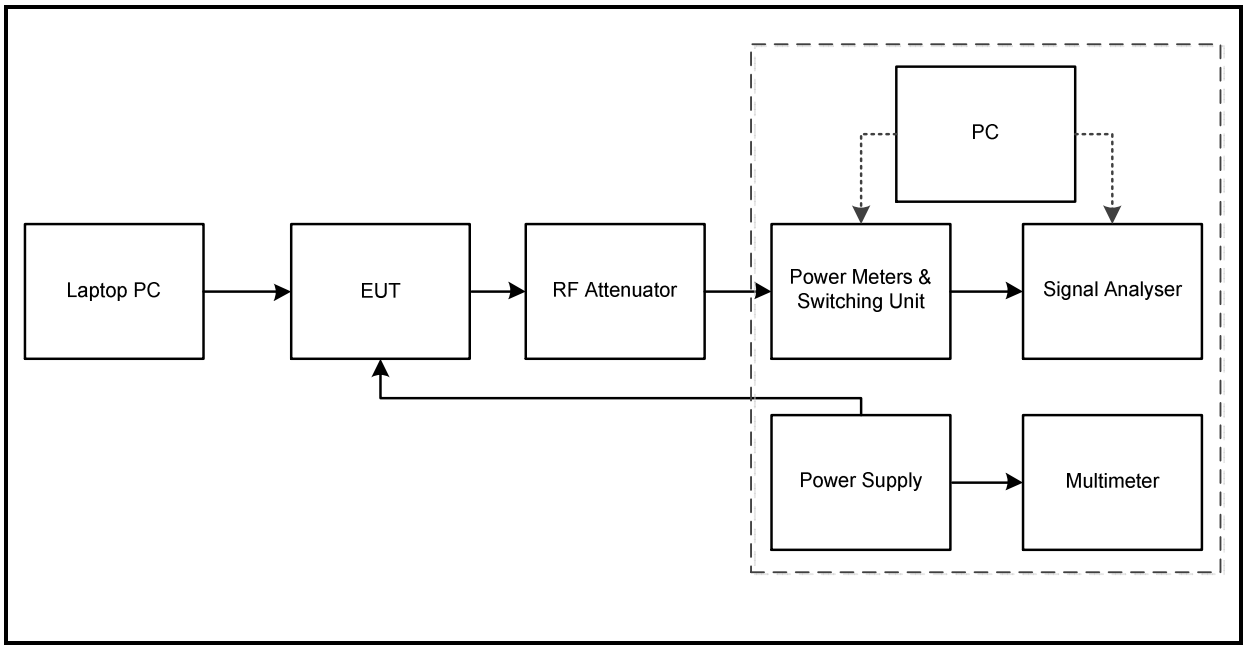
802.11n HT20 / MCS2 duty cycle: 10 log (1 / (0.6543 / 0.6914)) = 0.2

802.11n HT20 / MCS5 duty cycle: 10 log (1 / (0.6543 / 0.6914)) = 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 UL VS LTD IT server and available for inspection if required.

Transmitter Duty Cycle (continued)

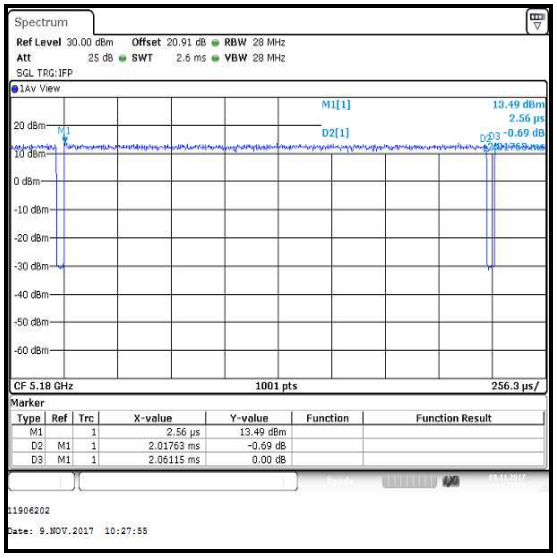
Test setup:



Transmitter Duty Cycle (continued)

Results: 802.11a / 20 MHz / 6 Mbit/s

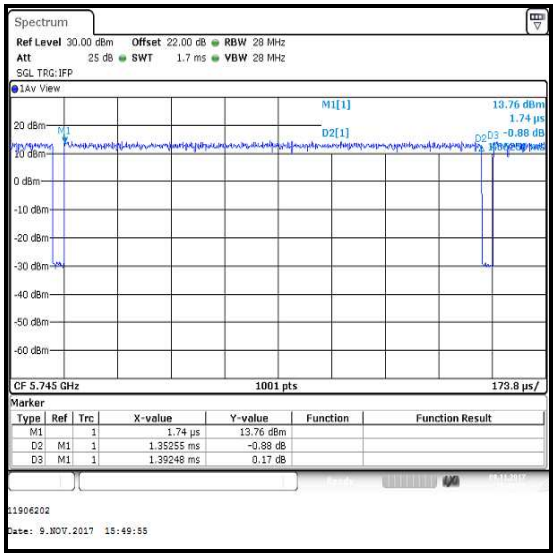
Pulse Duration (ms)	Period (ms)	Duty Cycle (%)
2.0176	2.0612	97.9



Transmitter Duty Cycle (continued)

Results: 802.11a / 20 MHz / BPSK / 9 Mbit/s

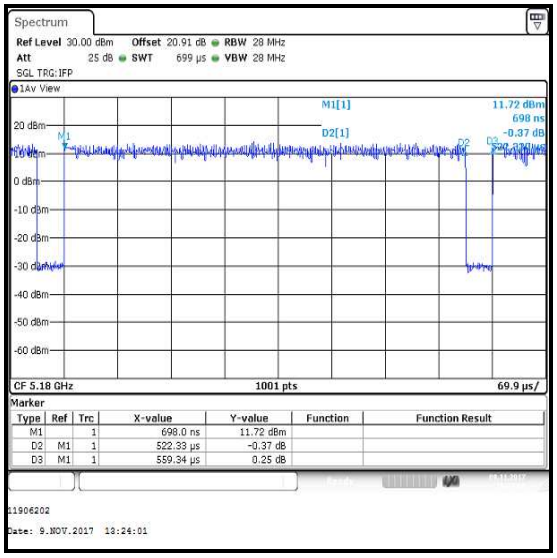
Pulse Duration (ms)	Period (ms)	Duty Cycle (%)
1.3526	1.3925	97.1



Transmitter Duty Cycle (continued)

Results: 802.11a / 20 MHz / 16QAM / 24 Mbit/s

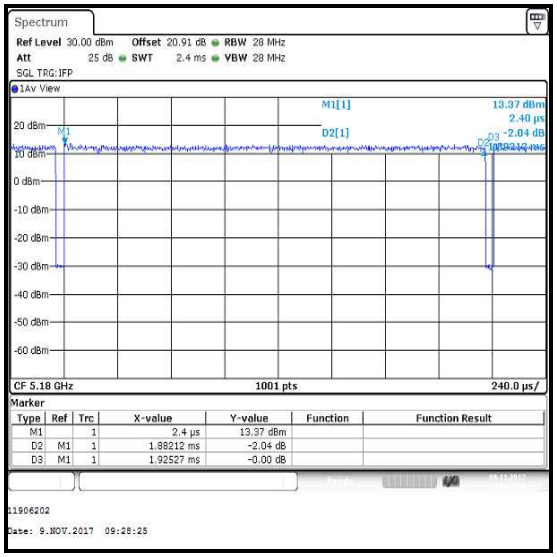
Pulse Duration (ms)	Period (ms)	Duty Cycle (%)
0.5223	0.5593	93.4



Transmitter Duty Cycle (continued)

Results: 802.11n / 20 MHz / BPSK / MCS0

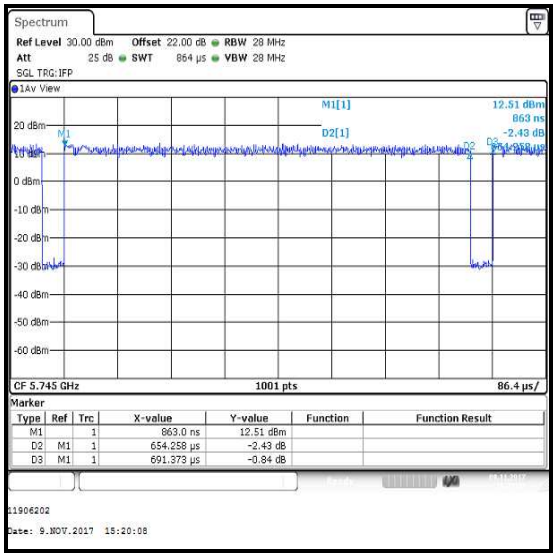
Pulse Duration (ms)	Period (ms)	Duty Cycle (%)
1.8821	1.9253	97.8



Transmitter Duty Cycle (continued)

Results: 802.11n / 20 MHz / QPSK/ MCS2

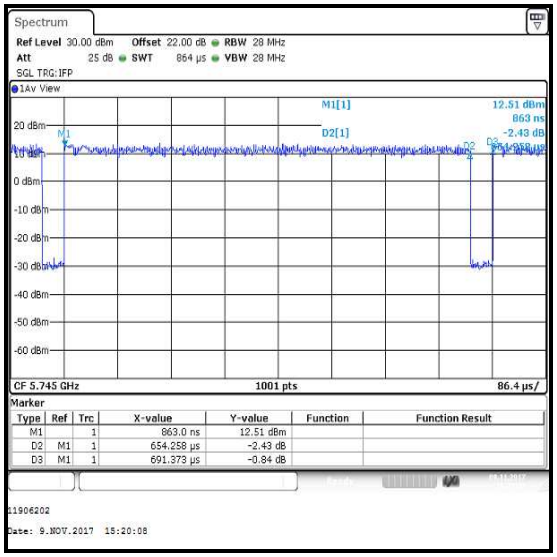
Pulse Duration (ms)	Period (ms)	Duty Cycle (%)
0.6543	0.6914	94.6



Transmitter Duty Cycle (continued)

Results: 802.11n / 20 MHz / 64QAM / MCS5

Pulse Duration (ms)	Period (ms)	Duty Cycle (%)
0.6543	0.6914	94.6



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	22 Feb 2018	12
A3028	6 dB Attenuator	Broadwave Technologies	351-311-006	#2	Calibrated before use	12
A3004	RF Switch	Pickering Interfaces	64-102-002	XZ363230	Calibrated before use	-
M2018	Signal Analyser	Rohde & Schwarz	FSV7	102699	23 Mar 2018	12
M1818	Multimeter	Fluke	79 Series III	71811580	12 Apr 2018	12
M2020	Power Sensor	Boonton	55006	9970	22 Mar 2018	12
S0586	Power Supply Unit	Keithley	2303	4310413	23 Mar 2018	12

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

Test Summary:

Test Engineer:	Max Passell	**Test Date:**	09 November 2017
Test Sample Serial Number:	26		

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

Environmental Conditions:

Temperature (°C):	20 to 23
Relative Humidity (%):	33 to 36

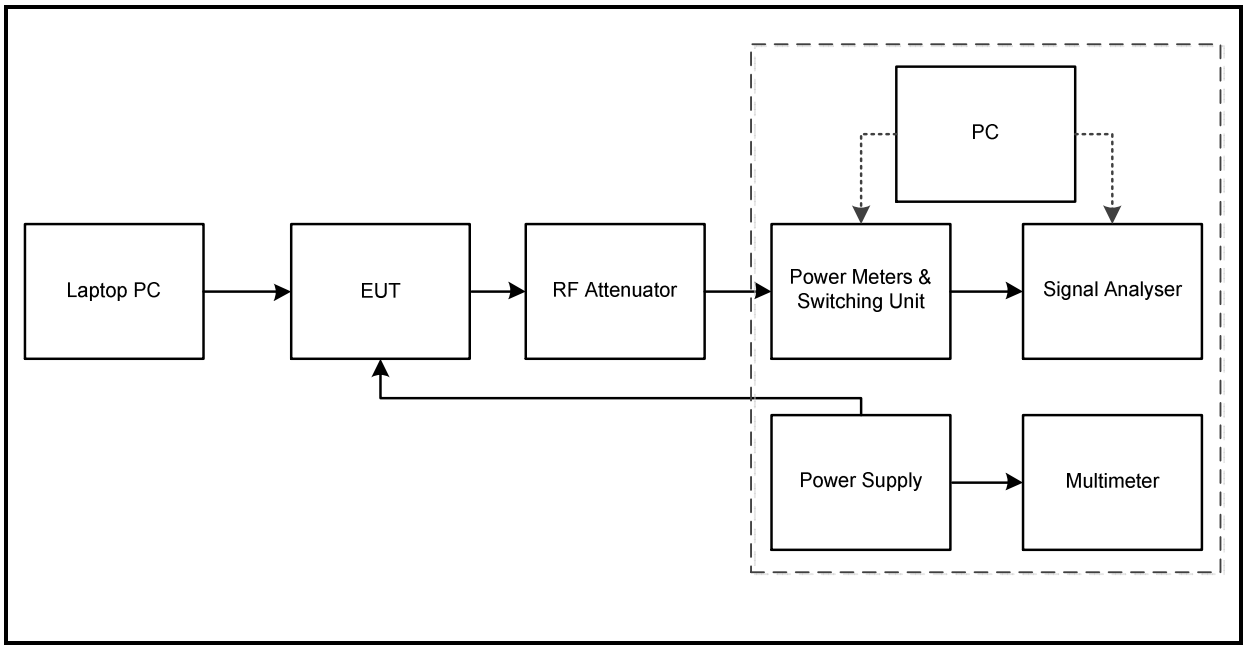
Note(s):

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 II.E.2.b) Method SA-1.Where the duty cycle is <98%, the measurements were performed in accordance with FCC KDB 798033 II.E.2.d) Method SA-2.
2. All supported modes and channel widths were initially investigated on one channel. The modes that produced the highest power and therefore deemed worst case were:
   - 802.11a – BPSK / 6 Mbit/s
   - 802.11n HT20 – BPSK / MCS0 (GI = 800 ns)

   Measurements were then performed in these modes on bottom, middle and top channels in all operating bands.
3. For all operating modes the EUT antenna has a gain of < 6 dBi.
4. For data rates where the EUT was transmitting at <98% duty cycle, the calculated duty cycle 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.
5. The signal analyser was connected to the RF port on the EUT using a RF switch, suitable attenuation and RF cables. A RF level offset was entered in to the signal analyser to compensate for the loss of the switch, attenuators and RF cables.
6. The Part 15.407(a)(1)(iv) limit shall not exceed 250 mW (24.0 dBm).

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

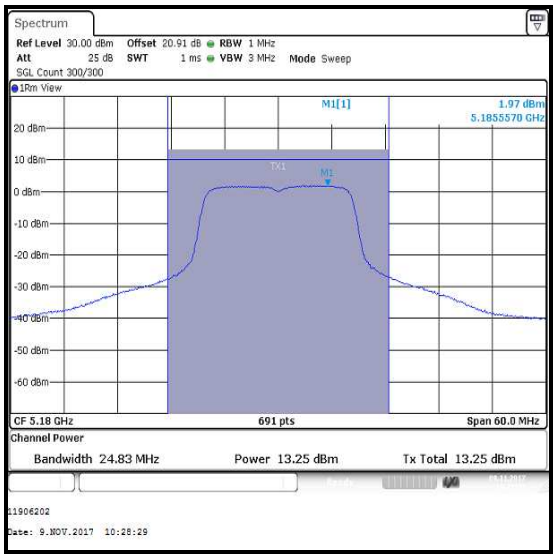
Test setup:



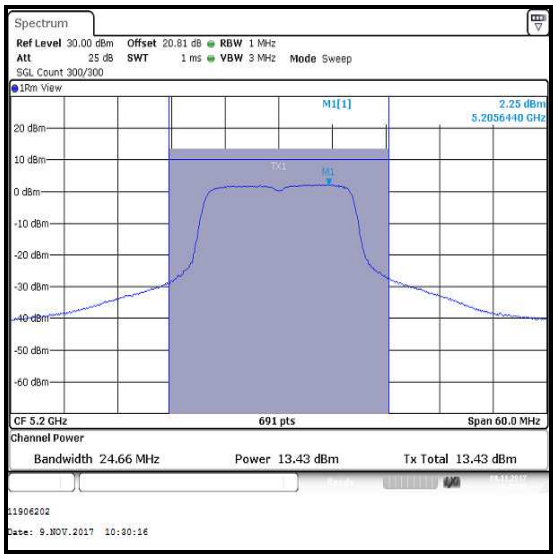
Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) (continued)

Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s

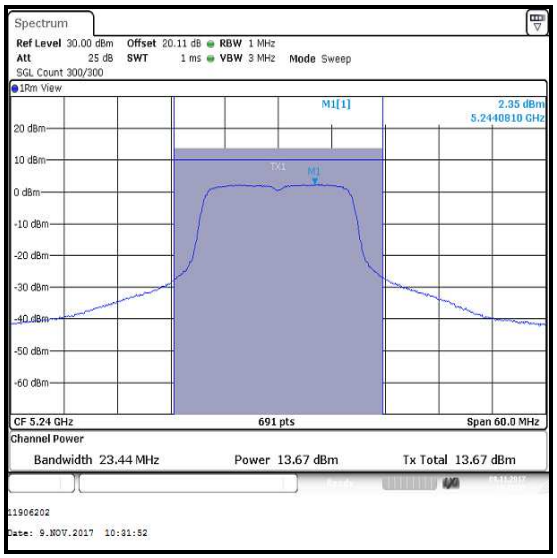
Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5180	13.3	0.1	13.4	24.0	10.6	Complied
Middle	5200	13.4	0.1	13.5	24.0	10.5	Complied
Top	5240	13.7	0.1	13.8	24.0	10.2	Complied



Bottom Channel



Middle Channel

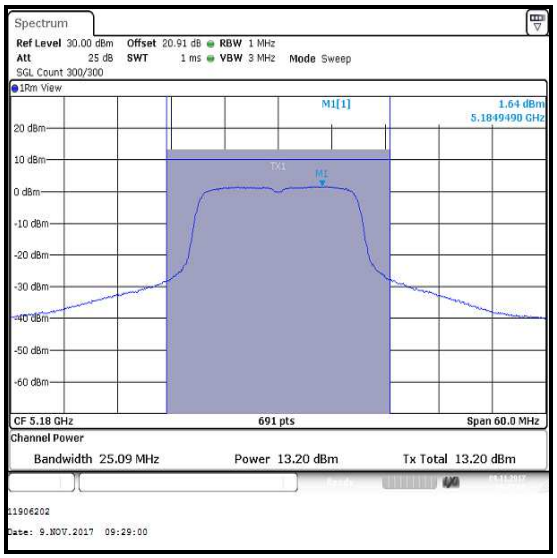


Top Channel

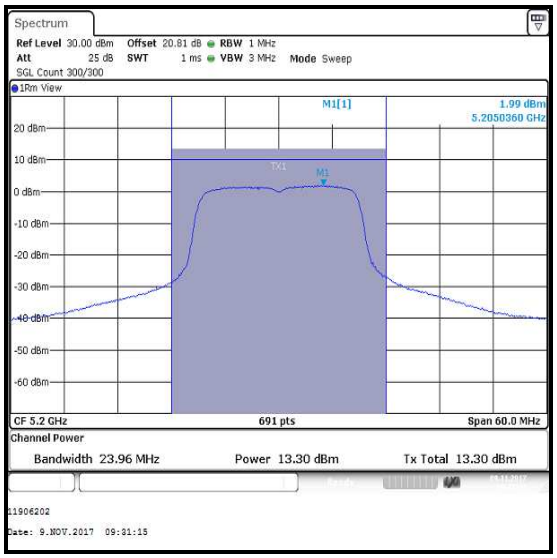
Transmitter Maximum Conducted Output Power (5.15-5.25 GHz band) (continued)

Results: 802.11n / 20 MHz / BPSK / MCS0

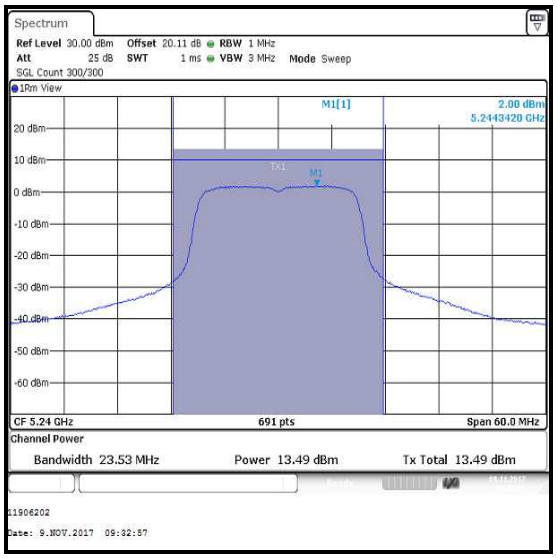
Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5180	13.2	0.1	13.3	24.0	10.7	Complied
Middle	5200	13.3	0.1	13.4	24.0	10.6	Complied
Top	5240	13.5	0.1	13.6	24.0	10.4	Complied



Bottom Channel



Middle Channel



Top Channel

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

Test Summary:

Test Engineer:	Max Passell	**Test Date:**	09 November 2017
Test Sample Serial Number:	26		

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

Environmental Conditions:

Temperature (°C):	20 to 23
Relative Humidity (%):	33 to 36

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. The limit for each channel was calculated as below:

5.25-5.35 GHz band

802.11a 20 MHz channel width / Bottom channel = *11 dBm + 10 $\log_{10}$ 22.663 = 24.6 dBm*
802.11a 20 MHz channel width / Middle channel = *11 dBm + 10 $\log_{10}$ 23.618 = 24.7 dBm*
802.11a 20 MHz channel width / Top channel = *11 dBm + 10 $\log_{10}$ 23.357 = 24.7 dBm*

802.11n 20 MHz channel width / Bottom channel = *11 dBm + 10 $\log_{10}$ 22.923 = 24.6 dBm*
802.11n 20 MHz channel width / Middle channel = *11 dBm + 10 $\log_{10}$ 22.837 = 24.6 dBm*
802.11n 20 MHz channel width / Top channel = *11 dBm + 10 $\log_{10}$ 24.573 = 24.9 dBm*

5.47-5.725 GHz band

802.11a 20 MHz channel width / Bottom channel = *11 dBm + 10 $\log_{10}$ 27.352 = 25.4 dBm*
802.11a 20 MHz channel width / Middle channel = *11 dBm + 10 $\log_{10}$ 25.962 = 25.1 dBm*
802.11a 20 MHz channel width / Top channel = *11 dBm + 10 $\log_{10}$ 21.534 = 24.3 dBm*

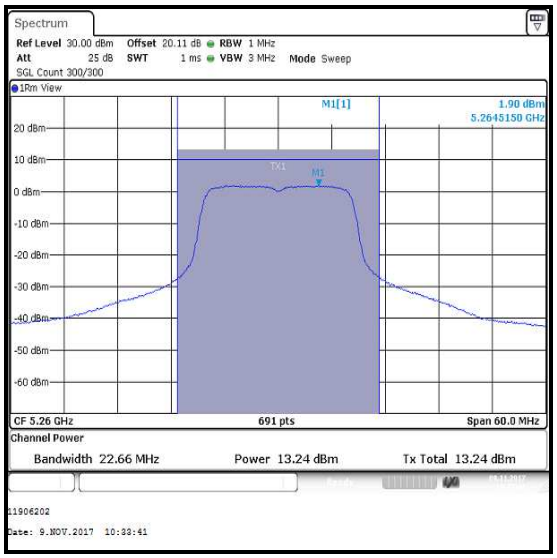
802.11n 20 MHz channel width / Bottom channel = *11 dBm + 10 $\log_{10}$ 26.744 = 25.3 dBm*
802.11n 20 MHz channel width / Middle channel = *11 dBm + 10 $\log_{10}$ 25.442 = 25.1 dBm*
802.11n 20 MHz channel width / Top channel = *11 dBm + 10 $\log_{10}$ 22.316 = 24.5 dBm*

2. The lesser of the two limits is the fixed limit of 250 mW (24.0 dBm). This was applied to the results.

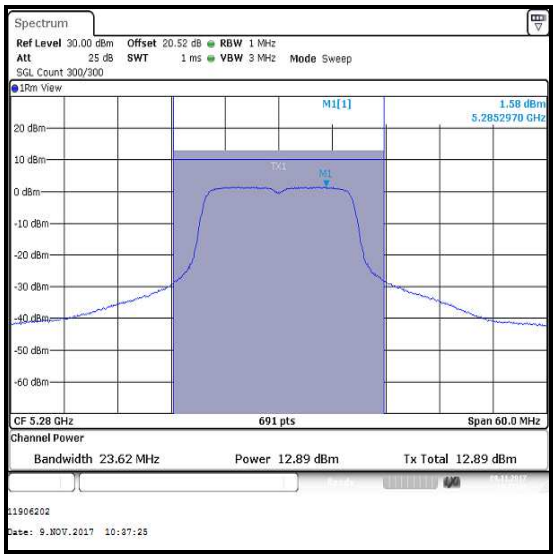
Transmitter Maximum Conducted Output Power (5.25-5.35 GHz band) (continued)

Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s

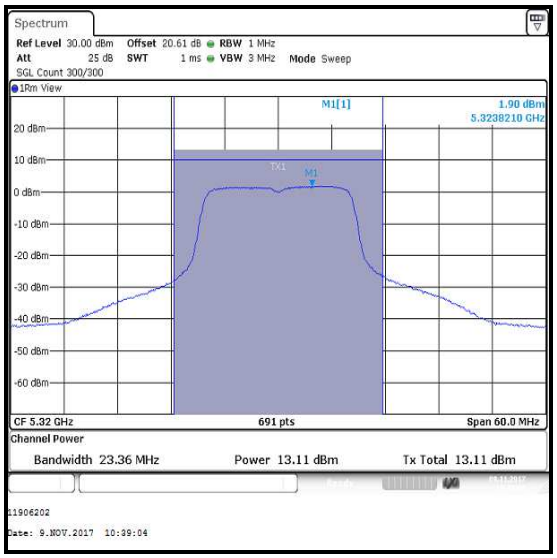
Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5260	13.2	0.1	13.3	24.0	10.7	Complied
Middle	5280	12.9	0.1	13.0	24.0	11.0	Complied
Top	5320	13.1	0.1	13.2	24.0	10.8	Complied



Bottom Channel



Middle Channel

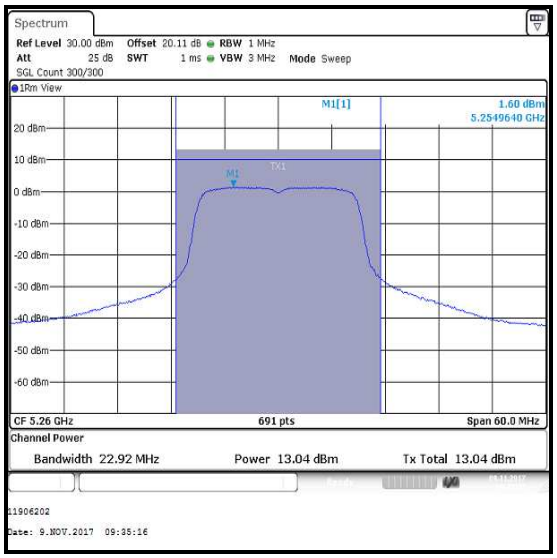


Top Channel

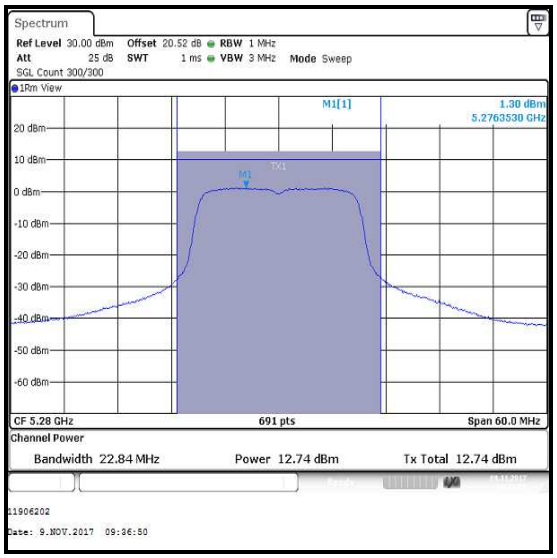
Transmitter Maximum Conducted Output Power (5.25-5.35 GHz band) (continued)

Results: 802.11n / 20 MHz / BPSK / MCS0

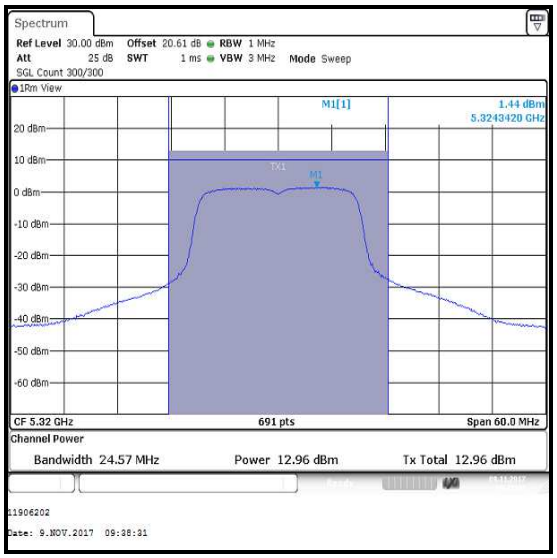
Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5260	13.0	0.1	13.1	24.0	10.9	Complied
Middle	5280	12.7	0.1	12.8	24.0	11.2	Complied
Top	5320	13.0	0.1	13.1	24.0	10.9	Complied



Bottom Channel



Middle Channel

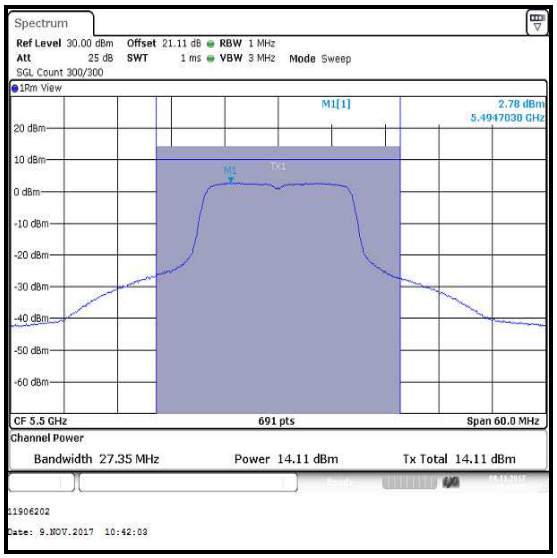


Top Channel

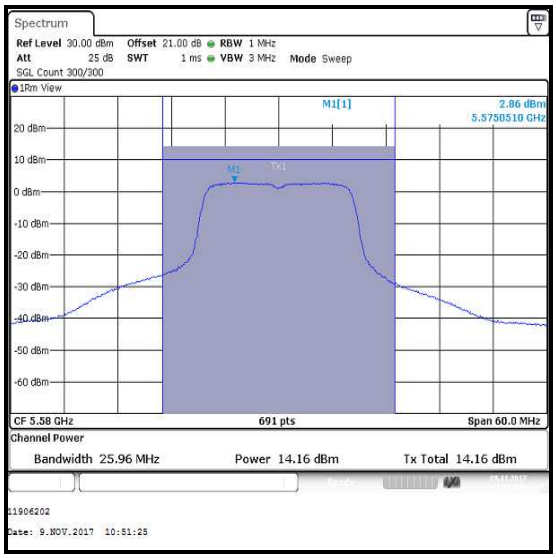
Transmitter Maximum Conducted Output Power (5.47-5.725 GHz band) (continued)

Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s

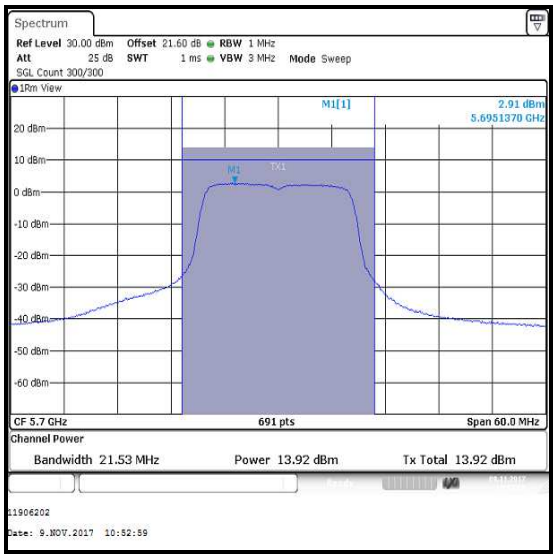
Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5500	14.1	0.1	14.2	24.0	9.8	Complied
Middle	5580	14.2	0.1	14.3	24.0	9.7	Complied
Top	5700	13.9	0.1	14.0	24.0	10.0	Complied



Bottom Channel



Middle Channel

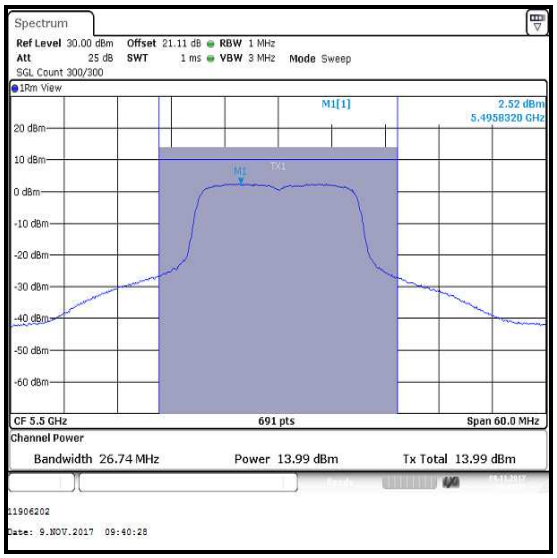


Top Channel

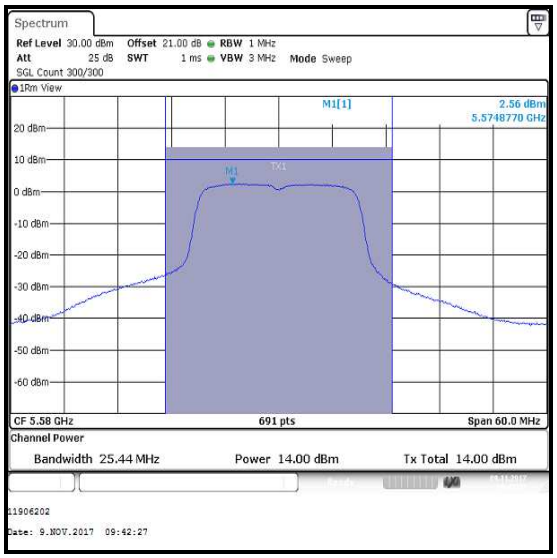
Transmitter Maximum Conducted Output Power (5.47-5.725 GHz band) (continued)

Results: 802.11n / 20 MHz / BPSK / MCS0

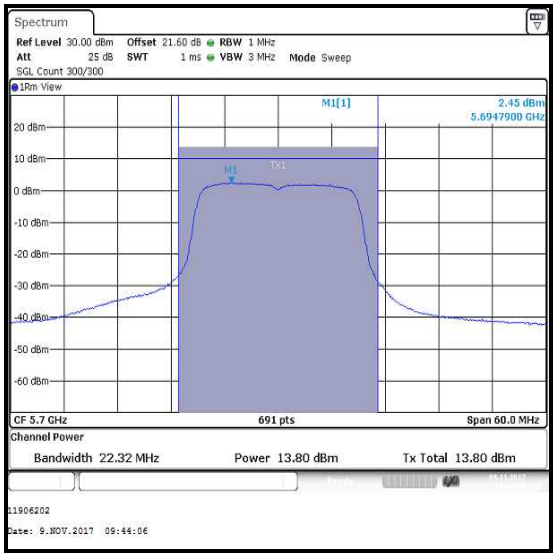
Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5500	14.0	0.1	14.1	24.0	9.9	Complied
Middle	5580	14.0	0.1	14.1	24.0	9.9	Complied
Top	5700	13.8	0.1	13.9	24.0	10.1	Complied



Bottom Channel



Middle Channel



Top Channel

5.2.6. Transmitter Maximum Conducted Output Power (5.725-5.85 GHz band)

Test Summary:

Test Engineer:	Max Passell	**Test Date:**	09 November 2017
Test Sample Serial Number:	26		

FCC Reference:	Part 15.407(a)(3)
Test Method Used:	KDB 789033 D02 Section II.E.2.d)

Environmental Conditions:

Temperature (°C):	20 to 23
Relative Humidity (%):	33 to 36

Note(s):

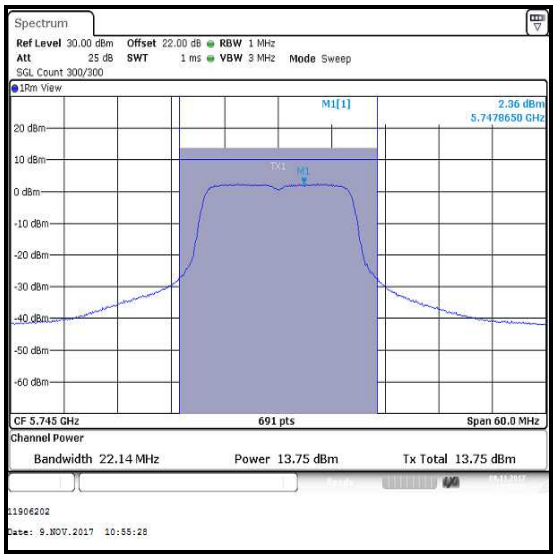
1. For conducted power tests where the duty cycle is >98%, the measurements were performed using a signal analyser in accordance with FCC KDB 789033 II.E.2.b) Method SA-1. Where the duty cucle is <98%, the measurements were performed in accordance with FCC KDB 789033 II.E.2.b) Method SA-2.
2. All supported modes and channel widths were initially investigated on one channel. The modes that produced the highest power and therefore deemed worst case were:
   - 802.11a – BPSK / 6 Mbit/s
   - 802.11n HT20 – BPSK / MCS0 (GI = 800 ns)

   Measurements were then performed in these modes on bottom, middle and top channels in all operating bands.
3. For data rates where the EUT was transmitting <98% duty cycle, the calculated duty cycle 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.
4. The signal analyser was connected to the RF port on the EUT using a RF switch, suitable attenuation and RF cables. A RF level offset was entered in to the signal analyser to compensate for the loss of the switch, attenuators and RF cables.
5. For all modes of operation the antenna gain is < 6 dBi
6. The FCC Part 15.407(a)(3) limit shall not exceed 1 W (30.0 dBm)..

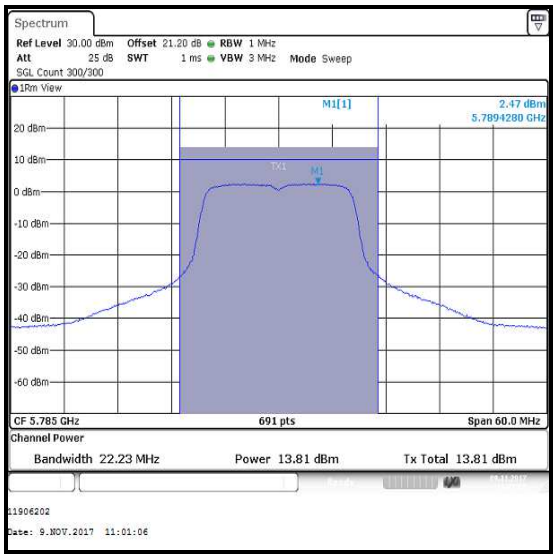
Transmitter Maximum Conducted Output Power (5.725-5.85 GHz band) (continued)

Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s

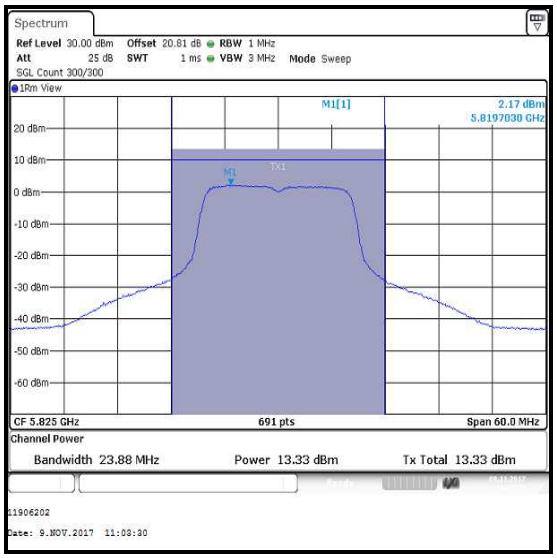
Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5745	13.8	0.1	13.9	30.0	16.1	Complied
Middle	5785	13.8	0.1	13.9	30.0	16.1	Complied
Top	5825	13.3	0.1	13.4	30.0	16.6	Complied



Bottom Channel



Middle Channel

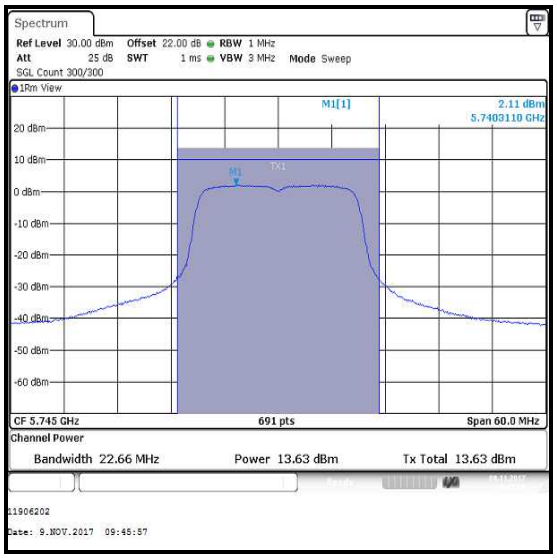


Top Channel

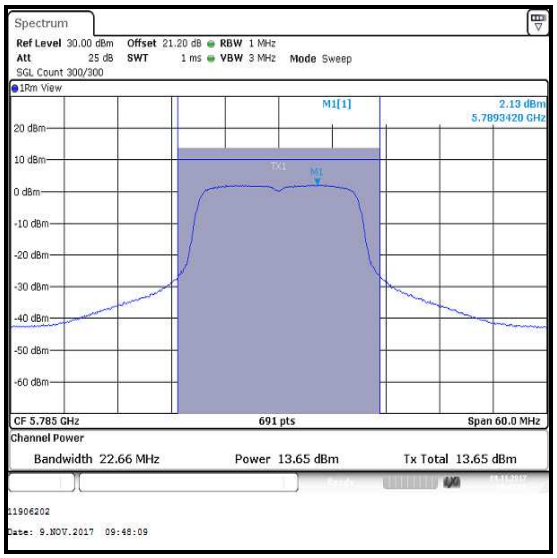
Transmitter Maximum Conducted Output Power (5.725-5.85 GHz band) (continued)

Results: 802.11n / 20 MHz / BPSK / MCS0

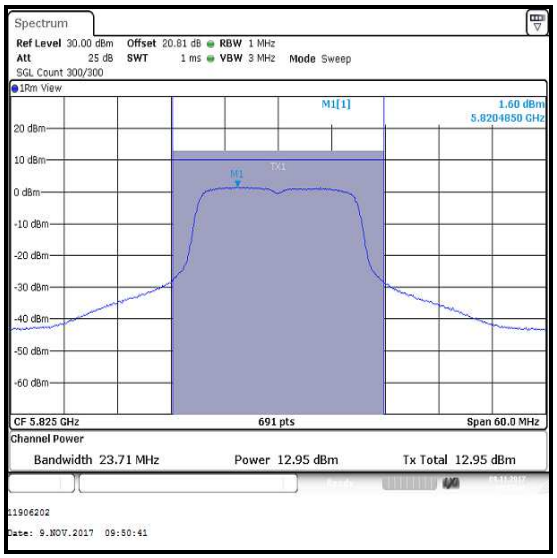
Channel	Frequency (MHz)	Conducted Power (dBm)	Duty cycle correction factor (dB)	Corrected Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	5745	13.6	0.1	13.7	30.0	16.3	Complied
Middle	5785	13.7	0.1	13.8	30.0	16.2	Complied
Top	5825	13.0	0.1	13.1	30.0	16.9	Complied



Bottom Channel



Middle Channel



Top Channel

Transmitter Maximum Conducted Output Power (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	22 Feb 2018	12
A3028	6 dB Attenuator	Broadwave Technologies	351-311-006	#2	Calibrated before use	12
A3004	RF Switch	Pickering Interfaces	64-102-002	XZ363230	Calibrated before use	-
M2018	Signal Analyser	Rohde & Schwarz	FSV7	102699	23 Mar 2018	12
M1818	Multimeter	Fluke	79 Series III	71811580	12 Apr 2018	12
M2020	Power Sensor	Boonton	55006	9970	22 Mar 2018	12
S0586	Power Supply Unit	Keithley	2303	4310413	23 Mar 2018	12

5.2.7. Transmitter Maximum Power Spectral Density (5.15-5.25 GHz band)

Test Summary:

Test Engineer:	Max Passell	**Test Date:**	09 November 2017
Test Sample Serial Number:	26		

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

Environmental Conditions:

Temperature (°C):	20 to 23
Relative Humidity (%):	33 to 36

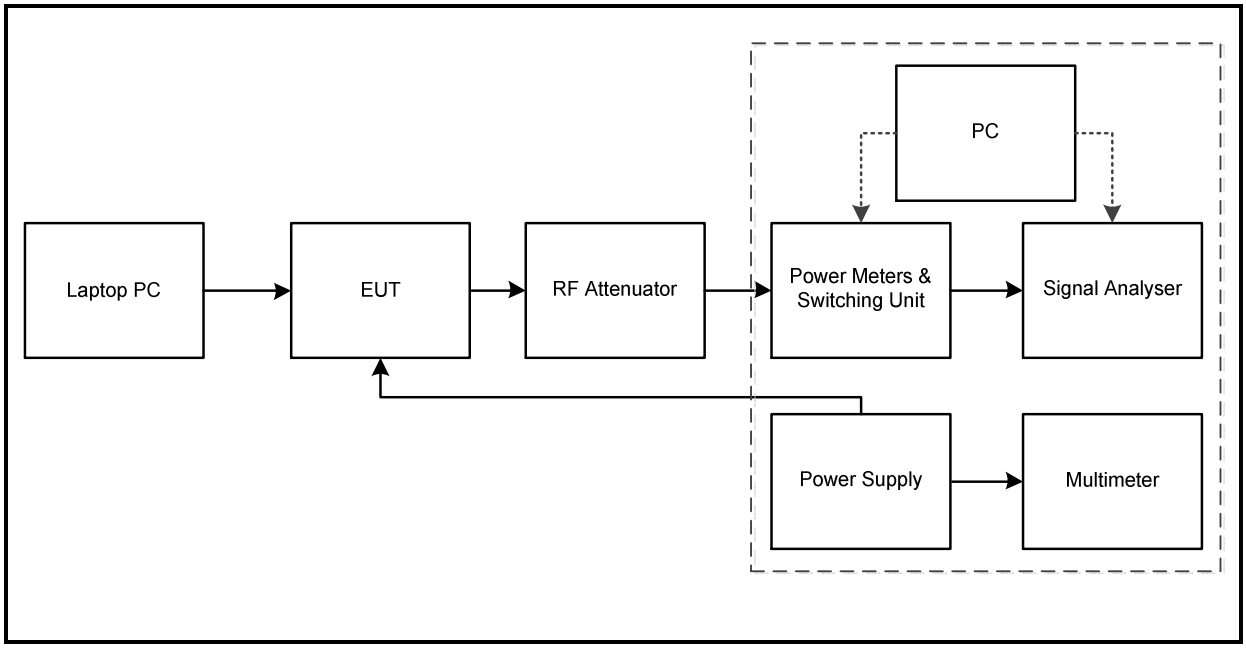
Note(s):

1. Transmitter Maximum Power Spectral Density tests in all bands were performed using a signal analyser in accordance with KDB 789033 II. F referencing II.E.2.b) Method SA-1 and II.E.2.d) Method SA-2.
2. All supported modes and channel widths were initially investigated on one channel. The modes that produced the highest power and therefore deemed worst case were:
   - 802.11a - BPSK / 6 Mbit/s
   - 802.11n HT20 - BPSK / MCS0 (GI = 800 ns)

   Measurements were then performed in these modes on bottom, middle and top channels in all operating bands.
3. For data rates where the EUT was transmitting at <98% duty cycle, the calculated duty cycle in Section 5.2.4 of this report was added to the measured maximum power spectral density in order to compute the average maximum power spectral density during the actual transmission time.
4. FCC Part 15.407(a)(1)(iv) limit for PPSD is <11 dBm/MHz.
5. For all modes of operation, the antenna gain is < 6 dBi
6. The signal analyser was connected to the RF port on the EUT using a RF switch, suitable attenuation and RF cables. A RF level offset was entered in to the signal analyser to compensate for the loss of the switch, attenuators and RF cables.
7. As the power spectral density test uses the same test method as the output power test, before the power is integrated across the 26 dB bandwidth, the conducted power spectral density plots are located in the conducted output power Section 5.2.3 of this test report. The peak spectral density was measured by placing a marker on the peak of the signal and the results entered in the tables below.

Transmitter Maximum Power Spectral Density (5.15-5.25 GHz band) (continued)

Test setup:



Transmitter Maximum Power Spectral Density (5.15-5.25 GHz band) (continued)

Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s

Channel	Frequency (MHz)	PPSD (dBm /MHz)	Duty cycle correction factor (dB)	Corrected PPSD (dBm /MHz)	Limit (dBm /MHz)	Margin (dB)	Result
Bottom	5180	2.0	0.1	2.1	11.0	8.9	Complied
Middle	5200	2.2	0.1	2.3	11.0	8.7	Complied
Top	5240	2.3	0.1	2.4	11.0	8.6	Complied

Results: 802.11n / 20 MHz / BPSK / MCS0

Channel	Frequency (MHz)	PPSD (dBm /MHz)	Duty cycle correction factor (dB)	Corrected PPSD (dBm /MHz)	Limit (dBm /MHz)	Margin (dB)	Result
Bottom	5180	1.6	0.1	1.7	11.0	9.3	Complied
Middle	5200	2.0	0.1	2.1	11.0	8.9	Complied
Top	5240	2.0	0.1	2.1	11.0	8.9	Complied

5.2.8. Transmitter Maximum Power Spectral Density (5.25-5.35 GHz & 5.47-5.725 GHz bands)

Test Summary:

Test Engineer:	Max Passell	**Test Date:**	09 November 2017
Test Sample Serial Number:	26		

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

Environmental Conditions:

Temperature (°C):	20 to 23
Relative Humidity (%):	33 to 36

Note(s):

1. Transmitter Maximum Power Spectral Density tests in all bands were performed using a signal analyser in accordance with KDB 789033 II. F referencing II.E.2.b) Method SA-1 and II.E.2.d) Method SA-2.
2. All supported modes and channel widths were initially investigated on one channel. The modes that produced the highest power and therefore deemed worst case were:
   - 802.11a - BPSK / 6 Mbit/s
   - 802.11n HT20 - BPSK / MCS0 (GI = 800 ns)
3. Measurements were then performed in these modes on bottom, middle and top channels in all operating bands.
4. For data rates where the EUT was transmitting at <98% duty cycle, the calculated duty cycle in Section 5.2.3 of this report was added to the measured maximum power spectral density in order to compute the average maximum power spectral density during the actual transmission time.
5. FCC Part 15.407(a)(2) limit for PPSD in the 5.25-5.35 GHz and the 5.47-5.725 operating bands is <11 dBm/MHz.
6. For all modes of operation, the antenna gain is < 6 dBi
7. The signal analyser was connected to the RF port on the EUT using a RF switch, suitable attenuation and RF cables. A RF level offset was entered in to the signal analyser to compensate for the loss of the switch, attenuators and RF cables.
8. As the power spectral density test uses the same test method as the output power test, before the power is integrated across the 26 dB bandwidth, the conducted power spectral density plots are located in the conducted output power section 5.2.4 of this test report. The peak spectral density was measured by placing a marker on the peak of the signal and the results entered in the tables below.

Transmitter Maximum Power Spectral Density (5.25-5.35 GHz band) (continued)

Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s

Channel	Frequency (MHz)	PPSD (dBm /MHz)	Duty cycle correction factor (dB)	Corrected PPSD (dBm /MHz)	Limit (dBm /MHz)	Margin (dB)	Result
Bottom	5260	1.9	0.1	2.0	11.0	9.0	Complied
Middle	5280	1.6	0.1	1.7	11.0	9.3	Complied
Top	5320	1.9	0.1	2.0	11.0	9.0	Complied

Results: 802.11n / 20 MHz / BPSK / MCS0

Channel	Frequency (MHz)	PPSD (dBm /MHz)	Duty cycle correction factor (dB)	Corrected PPSD (dBm /MHz)	Limit (dBm /MHz)	Margin (dB)	Result
Bottom	5260	1.6	0.1	1.7	11.0	9.3	Complied
Middle	5280	1.3	0.1	1.4	11.0	9.6	Complied
Top	5320	1.4	0.1	1.5	11.0	9.5	Complied

Transmitter Maximum Power Spectral Density (5.47-5.725 GHz band) (continued)

Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s

Channel	Frequency (MHz)	PPSD (dBm /MHz)	Duty cycle correction factor (dB)	Corrected PPSD (dBm /MHz)	Limit (dBm /MHz)	Margin (dB)	Result
Bottom	5500	2.8	0.1	2.9	11.0	8.1	Complied
Middle	5580	2.9	0.1	3.0	11.0	8.0	Complied
Top	5700	2.9	0.1	3.0	11.0	8.0	Complied

Results: 802.11n / 20 MHz / BPSK / MCS0

Channel	Frequency (MHz)	PPSD (dBm /MHz)	Duty cycle correction factor (dB)	Corrected PPSD (dBm /MHz)	Limit (dBm /MHz)	Margin (dB)	Result
Bottom	5500	2.5	0.1	2.6	11.0	8.4	Complied
Middle	5580	2.6	0.1	2.7	11.0	8.3	Complied
Top	5700	2.5	0.1	2.6	11.0	8.4	Complied

5.2.9. Transmitter Maximum Power Spectral Density (5.725-5.85 GHz band)

Test Summary:

Test Engineer:	Max Passell	**Test Date:**	09 November 2017
Test Sample Serial Number:	26		

FCC Reference:	Part 15.407(a)(3)
Test Method Used:	KDB 789033 D02 Section II.F. referencing II.E.2.d)

Environmental Conditions:

Temperature (°C):	20 to 23
Relative Humidity (%):	33 to 36

Note(s):

1. Transmitter Maximum Power Spectral Density tests in all bands were performed using a signal analyser in accordance with KDB 789033 II. F referencing II.E.2.b) Method SA-1 and II.E.2.d) Method SA-2.
2. All supported modes and channel widths were initially investigated on one channel. The modes that produced the highest power and therefore deemed worst case were:
    - 802.11a - BPSK / 6 Mbit/s
    - 802.11n HT20 - BPSK / MCS0 (GI = 800 ns)

Measurements were then performed in these modes on bottom, middle and top channels in all operating bands.

3. For data rates where the EUT was transmitting at <98% duty cycle, the calculated duty cycle in Section 5.2.4 of this report was added to the measured maximum power spectral density in order to compute the average maximum power spectral density during the actual transmission time.
4. FCC Part 15.407(a)(1)(iv) limit for PPSD is <11 dBm/MHz.
5. For all modes of operation, the antenna gain is < 6 dBi
6. The signal analyser was connected to the RF port on the EUT using a RF switch, suitable attenuation and RF cables. A RF level offset was entered in to the signal analyser to compensate for the loss of the switch, attenuators and RF cables.
7. As the power spectral density test uses the same test method as the output power test, before the power is integrated across the 26 dB bandwidth, the conducted power spectral density plots are located in the conducted output power Section 5.2.4 of this test report. The peak spectral density was measured by placing a marker on the peak of the signal and the results entered in the tables below.
8. FCC Part 15.407(a)(3) limit for PPSD in the 5.725-5.85 GHz operating band is <30 dBm/500 kHz.

Transmitter Maximum Power Spectral Density (5.725-5.85 GHz band) (continued)

Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s

Channel	Frequency (MHz)	PPSD (dBm / MHz)	Duty cycle correction factor (dB)	Corrected PPSD (dBm / MHz)	Limit (dBm / 500 kHz)	Margin (dB)	Result
Bottom	5745	2.4	0.1	2.5	30.0	27.5	Complied
Middle	5785	2.5	0.1	2.6	30.0	27.4	Complied
Top	5825	2.2	0.1	2.3	30.0	27.7	Complied

Results: 802.11n / 20 MHz / BPSK / MCS0

Channel	Frequency (MHz)	PPSD (dBm / MHz)	Duty cycle correction factor (dB)	Corrected PPSD (dBm / MHz)	Limit (dBm / 500 kHz)	Margin (dB)	Result
Bottom	5745	2.1	0.1	2.2	30.0	27.8	Complied
Middle	5785	2.1	0.1	2.2	30.0	27.8	Complied
Top	5825	1.6	0.1	1.7	30.0	28.3	Complied

Transmitter Maximum Power Spectral Density (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	22 Feb 2018	12
A3028	6 dB Attenuator	Broadwave Technologies	351-311-006	#2	Calibrated before use	12
A3004	RF Switch	Pickering Interfaces	64-102-002	XZ363230	Calibrated before use	-
M2018	Signal Analyser	Rohde & Schwarz	FSV7	102699	23 Mar 2018	12
M1818	Multimeter	Fluke	79 Series III	71811580	12 Apr 2018	12
M2020	Power Sensor	Boonton	55006	9970	22 Mar 2018	12
S0586	Power Supply Unit	Keithley	2303	4310413	23 Mar 2018	12

5.2.10. Transmitter Out of Band Radiated Emissions

Test Summary:

Test Engineer:	John Ferdinand	**Test Date:**	16 November 2017
Test Sample Serial Number:	43		

FCC Reference:	Parts 15.407(b)(3),(6),(7) & 15.209(a)
Test Method Used:	KDB 789033 II.G. & ANSI C63.10 Sections 6.3 and 6.5
Frequency Range:	30MHz to 1000 MHz

Environmental Conditions:

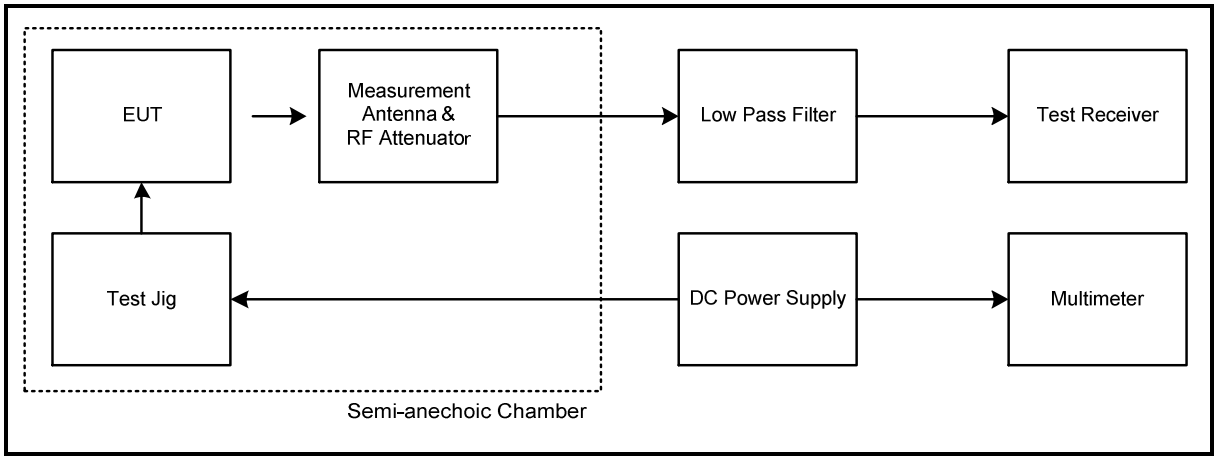
Temperature (°C):	22
Relative Humidity (%):	44

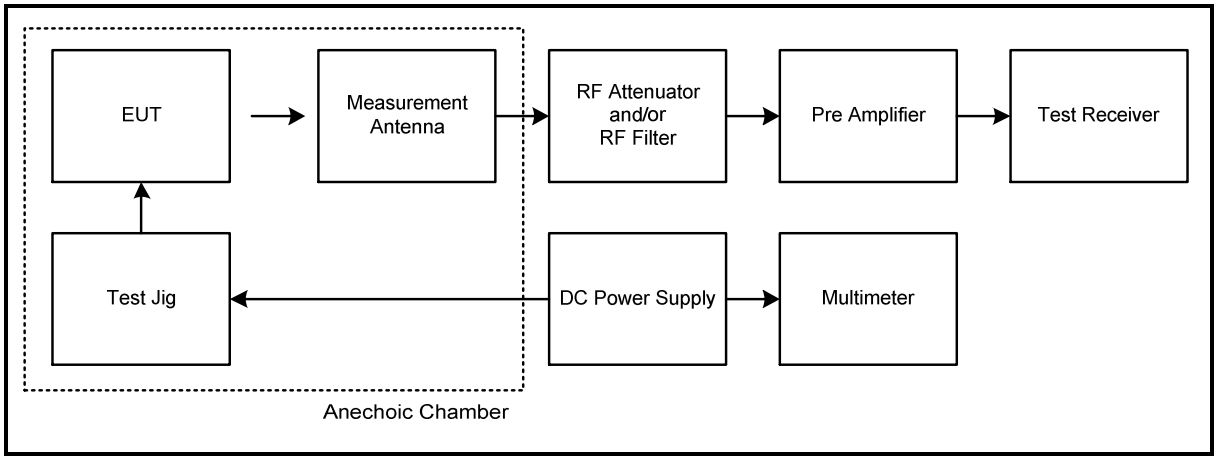
Note(s):

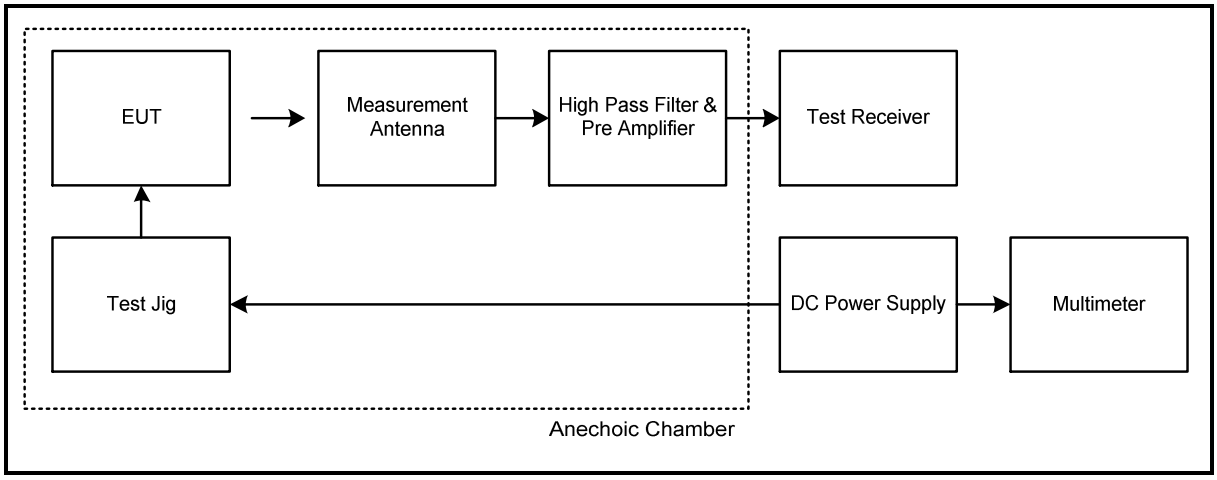
1. Measurements below 1 GHz were limited to the 5.47-5.725 GHz band, the EUT was transmitting with a data rate of 6 Mbit/s (802.11a) as it produced the highest conducted output power and was therefore deemed worst case.
2. Pre-scans with the EUT transmitting on the middle channel were measured according to FCC Part 15.407(b)(3) which states for transmitters operating in the band 5.47 to 5.725 GHz: all emissions outside of the band 5.47-5.725 GHz band shall not exceed -27 dBm/MHz. Part(b)(6) states unwanted emissions below 1 GHz must comply with the general field strength limits set forth in 15.209. Part(b)(7) states the provisions of 15.205 apply, i.e. restricted bands of operation.
3. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
4. The preliminary scans showed similar emission levels below 1 GHz, for each channel of operation. Therefore final radiated emissions measurements were performed with the EUT set to the middle channel only.
5. All other emissions shown on the pre-scan plots were investigated and found to be ambient, or >20 dB below the applicable limit or below the measurement system noise floor.
6. 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.
7. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 120 kHz and video bandwidth 500 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
8. Final measurements were performed on the marker frequencies and the results entered into the table below. The test receiver resolution bandwidth was set to 120 kHz, using a CISPR quasi-peak detector and span wide enough to see the whole emission.

Transmitter Out of Band Radiated Emissions (continued)

Test setup for radiated measurements:







Transmitter Out of Band Radiated Emissions (5.47 to 5.725 GHz band operation) (continued)

Results: Middle Channel / Field Strength

Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
280.029	Horizontal	26.9	46.0	19.1	Complied

Note: This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying table.

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2003	Thermohygrometer	Testo	608-H1	45046641	22 Feb 2018	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	14 Apr 2018	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	13 Apr 2018	12
A2888	Antenna	Schwarzbeck	VULB 9163	9163-941	25 Apr 2018	12
A2147	Attenuator	AtlanTecRF	AN18-06	09020206-06	25 Apr 2018	12
A2131	Low Pass Filter	AtlanTecRF	AFL-02000	JFB1004-002	27 Feb 2018	12
M1269	Multimeter	Fluke	179	90250210	02 May 2018	12
S0538	Bench Power Supply	TTI	PL154	250135	Calibrated before use	-

Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)

Test Summary:

Test Engineer:	John Ferdinand	**Test Date:**	16 November 2017
Test Sample Serial Number:	43		

FCC Reference:	Part 15.407(b)(1),(7) & 15.209(a)
Test Method Used:	KDB 789033 II.G. & ANSI C63.10 Sections 6.3 and 6.6
Frequency Range:	1 GHz to 40 GHz

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	40

Note(s):

1. FCC Part 15.407(b)(1) states for transmitters operating in the band 5.15 to 5.25 GHz: all emissions outside of the 5.15 to 5.35 GHz band will not exceed -27 dBm/MHz. Part(b)(7) states the provisions of 15.205 apply i.e. restricted bands of operation.
2. Pre-scans were performed with the EUT transmitting on top channel in the 5.475 to 5.725 GHz band. An inquiry was made to the FCC and the response was pre-scans could be performed in the band with the highest conducted output power and all final measurements should be performed on any emissions seen in each band.
3. The final measured value, for the given emission in the field strength result tables, incorporates the calibrated antenna factor and cable loss.
4. Appropriate RF filters and attenuators were used during pre-scans and final measurements. Insertion losses were entered on the test receiver as RF levels offsets.
5. All other emissions shown on the pre-scan plots were investigated and found to be ambient or >20 dB below the applicable limit or below the measurement system noise floor.
6. Measurements above 1 GHz were performed in a fully anechoic chamber (Asset Number K0017) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the test chamber floor in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.

Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)

Results: Bottom Channel / EIRP

Frequency (MHz)	Antenna Polarity	Level (dBm)	Limit (dBm)	Margin (dB)	Result
10359.730	Horizontal	-36.6	-27.0	9.6	Complied

Results: Middle Channel / EIRP

Frequency (MHz)	Antenna Polarity	Level (dBm)	Limit (dBm)	Margin (dB)	Result
10399.960	Horizontal	-37.7	-27.0	10.7	Complied

Results: Top Channel / EIRP

Frequency (MHz)	Antenna Polarity	Level (dBm)	Limit (dBm)	Margin (dB)	Result
10479.760	Horizontal	-40.8	-27.0	13.8	Complied

Transmitter Out of Band Radiated Emissions (5.25-5.35 GHz band operation) (continued)

Test Summary:

Test Engineer:	John Ferdinand	**Test Date:**	16 November 2017
Test Sample Serial Number:	43		

FCC Reference:	Part 15.407(b)(2),(7) & 15.209(a)
Test Method Used:	KDB 789033 II.G. & ANSI C63.10 Sections 6.3 and 6.6
Frequency Range:	1 GHz to 40 GHz

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	44

Note(s):

1. FCC Part 15.407(b)(2) states for transmitters operating in the band 5.25 to 5.35 GHz: all emissions outside of the 5.15-5.35 GHz band will not exceed -27 dBm/MHz. Part(b)(7) states the provisions of 15.205 apply i.e. restricted bands of operation.
2. Pre-scans were performed with the EUT transmitting on top channel in the 5.475 to 5.725 GHz band. An inquiry was made to the FCC and the response was pre-scans could be performed in the band with the highest conducted output power and all final measurements should be performed on any emissions seen in each band.
3. The final measured value, for the given emission in the field strength result tables, incorporates the calibrated antenna factor and cable loss.
4. Appropriate RF filters and attenuators were used during pre-scans and final measurements. Insertion losses were entered on the test receiver as RF levels offsets.
5. All other emissions shown on the pre-scan plot were investigated and found to be ambient or >20 dB below the applicable limit or below the measurement system noise floor.
6. Measurements above 1 GHz were performed in a fully anechoic chamber (Asset Number K0017) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the test chamber floor in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.

Transmitter Out of Band Radiated Emissions (5.25-5.35 GHz band operation) (continued)

Results: Bottom Channel / EIRP

Frequency (MHz)	Antenna Polarity	Level (dBm)	Limit (dBm)	Margin (dB)	Result
10520.520	Horizontal	-41.6	-27.0	14.6	Complied

Results: Middle Channel / EIRP

Frequency (MHz)	Antenna Polarity	Level (dBm)	Limit (dBm)	Margin (dB)	Result
10562.640	Horizontal	-43.8	-27.0	16.8	Complied

Results: Top Channel / EIRP

Frequency (MHz)	Antenna Polarity	Level (dBm)	Limit (dBm)	Margin (dB)	Result
10640.360	Horizontal	-45.3	-27.0	18.3	Complied

Results: Top Channel / Field Strength

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
10640.360	Horizontal	49.9	54.0	4.1	Complied

Transmitter Out of Band Radiated Emissions (5.47-5.725 GHz band operation) (continued)

Test Summary:

Test Engineer:	John Ferdinand	**Test Dates:**	15 November 2017 to 17 November 2017
Test Sample Serial Number:	43		

FCC Reference:	Part 15.407(b)(3),(7) & 15.209(a)
Test Method Used:	KDB 789033 II.G. & ANSI C63.10 Sections 6.3 and 6.6
Frequency Range:	1 GHz to 40 GHz

Environmental Conditions:

Temperature (°C):	23 to 24
Relative Humidity (%):	39 to 44

Note(s):

1. FCC Part 15.407(b)(3) states for transmitters operating in the band 5.47 to 5.725 GHz: all emissions outside of the band will not exceed -27 dBm/MHz. Part(b)(7) states the provisions of 15.205 apply i.e. restricted bands of operation.
2. Pre-scans were performed with the EUT transmitting on the middle channel in this band. An inquiry was made to the FCC and the response was pre-scans could be performed in the band with the highest conducted output power (802.11a / 6 Mbit/s) and all final measurements should be performed on any emission seen for each band.
3. The final measured value, for the given emission in the field strength result tables, incorporates the calibrated antenna factor and cable loss.
4. The emission shown on the 1 GHz to 8 GHz plot is the EUT fundamental.
5. Appropriate RF filters and attenuators were used during pre-scans and final measurements. Insertion losses were entered on the test receiver as RF levels offsets.
6. In accordance with KDB 789033 Section II.G.1.c) if the peak measurement is below the average limit, it is not necessary to perform a separate average measurement.
7. In accordance with KDB 789033 Section II.G.6.c) Method AD (vii), for average measurements, data rates where the EUT was transmitting <98% duty cycle, the duty cycle correction factor calculated in Section 5.2.3 of this report was added to the measured result.
8. Measurements were performed across the two restricted bands closest to the bands of operation with the EUT transmitting on the bottom channel in the 5.15 to 5.25 GHz band and bottom channel 5.47 to 5.725 GHz range. Plots are included in this section of the test report. Peak and average measurements were made.
9. All other emissions shown on the pre-scan plot were investigated and found to be ambient or >20 dB below the applicable limit or below the measurement system noise floor.
10. Measurements above 1 GHz were performed in a fully anechoic chamber (Asset Number K0017) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the test chamber floor in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.

Transmitter Out of Band Radiated Emissions (5.47-5.725 GHz band operation) (continued)

Results: Bottom Channel / EIRP

Frequency (MHz)	Antenna Polarity	Level (dBm)	Limit (dBm)	Margin (dB)	Result
10998.240	Horizontal	-38.0	-27.0	11.0	Complied

Results: Bottom Channel / Field Strength / Peak

Frequency (MHz)	Antenna Polarity	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
10998.240	Horizontal	57.2	74.0	16.8	Complied

Results: Bottom Channel / Field Strength / Average

Frequency (MHz)	Antenna Polarity	Measured Level (dBμV/m)	Duty cycle correction (dB)	Corrected Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
10999.760	Horizontal	43.1	0.1	43.2	54.0	10.8	Complied

Results: Middle Channel / EIRP

Frequency (MHz)	Antenna Polarity	Level (dBm)	Limit (dBm)	Margin (dB)	Result
11160.960	Horizontal	-36.0	-27.0	9.0	Complied

Results: Middle Channel / Field Strength / Peak

Frequency (MHz)	Antenna Polarity	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
11160.960	Horizontal	59.2	74.0	14.8	Complied

Results: Middle Channel / Field Strength / Average

Frequency (MHz)	Antenna Polarity	Measured Level (dBμV/m)	Duty cycle correction (dB)	Corrected Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
11160.480	Horizontal	46.3	0.1	46.4	54.0	7.6	Complied

Results: Top Channel / EIRP

Frequency (MHz)	Antenna Polarity	Level (dBm)	Limit (dBm)	Margin (dB)	Result
11400.088	Horizontal	-36.9	-27.0	9.9	Complied

Results: Top Channel / Field Strength / Peak

Frequency (MHz)	Antenna Polarity	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
11400.088	Horizontal	58.3	74.0	15.7	Complied

Transmitter Out of Band Radiated Emissions (5.47-5.725 GHz band operation) (continued)

Results: Top Channel / Field Strength / Average

Frequency (MHz)	Antenna Polarity	Measured Level (dBµV/m)	Duty cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
11401.120	Horizontal	41.2	0.1	41.3	54.0	12.7	Complied

Results: Restricted Band 4.5-5.15 GHz / Field Strength / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5148.500	63.5	74.0	10.5	Complied

Results: Restricted Band 4.5-5.15 GHz / Field Strength / Average

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5150	50.5	54.0	3.5	Complied

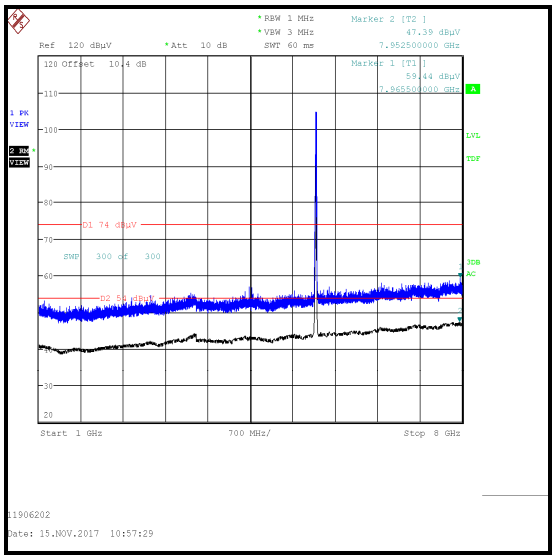
Results: Restricted Band 5.35-5.46 GHz / Field Strength / Peak

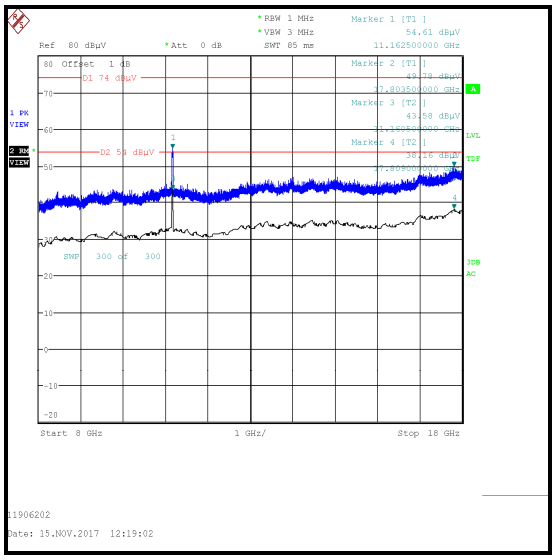
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5458.646	56.4	74.0	17.6	Complied

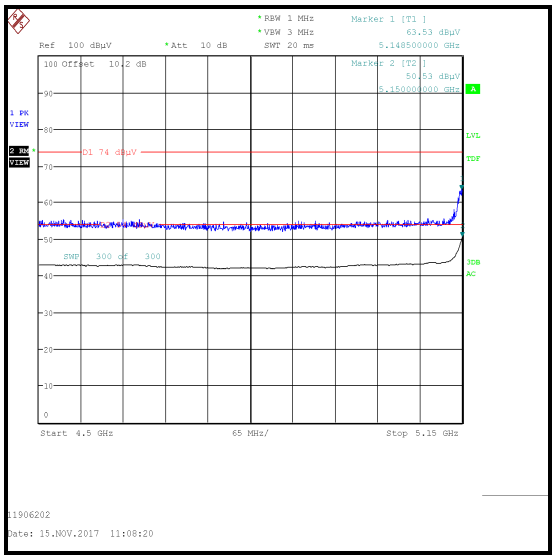
Results: Restricted Band 5.35-5.46 GHz / Field Strength / Average

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5459.238	43.7	54.0	10.3	Complied

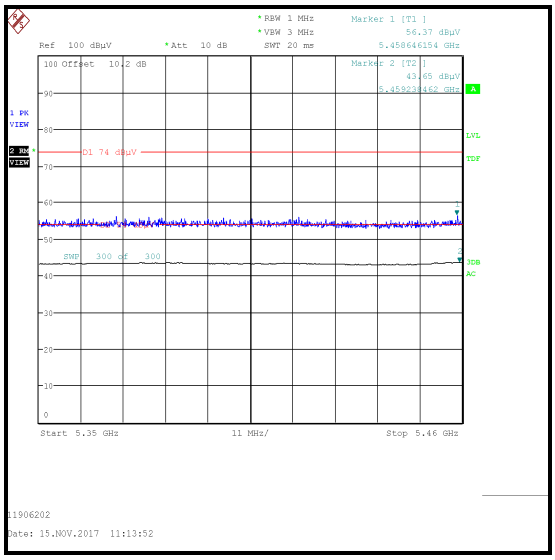
Transmitter Out of Band Radiated Emissions (5.47-5.725 GHz band operation) (continued)





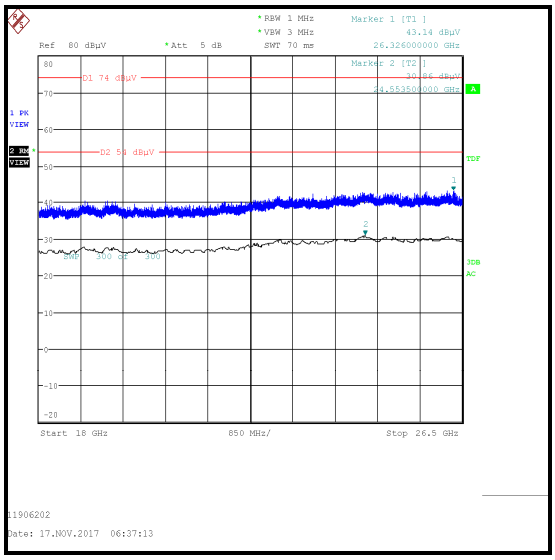


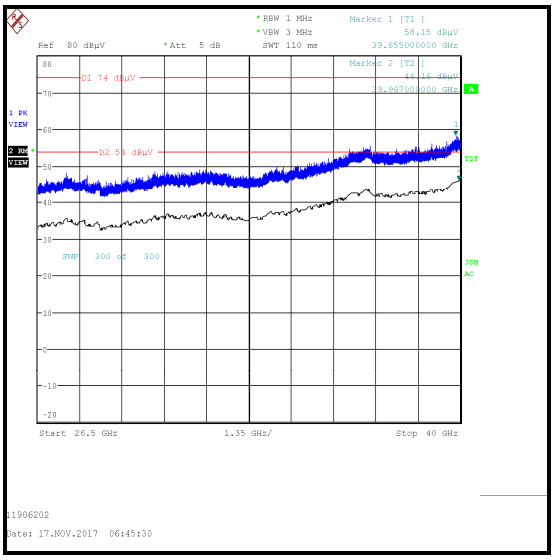
Restricted Band 4.5 GHz to 5.15 GHz



Restricted Band 5.35 GHz to 5.46 GHz

Transmitter Out of Band Radiated Emissions (5.47-5.725 GHz band operation) (continued)





Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Out of Band Radiated Emissions (5.725-5.85 GHz band operation) (continued)

Test Summary:

Test Engineer:	John Ferdinand	**Test Date:**	16 November 2017
Test Sample Serial Number:	43		

FCC Reference:	Part 15.407(b)(4)(i),(7) & 15.209(a)
Test Method Used:	KDB 789033 II.G. & ANSI C63.10 Sections 6.3 and 6.6
Frequency Range:	1 GHz to 40 GHz

Environmental Conditions:

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

Note(s):

1. FCC Part 15.407(b)(4)(i) states for transmitters operating in the band 5.725 to 5.85 GHz: all emissions shall be limited to a level of -27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge. Part(b)(7) states the provisions of 15.205 apply i.e. restricted bands of operation.
2. Pre-scans were performed with the EUT transmitting on the top channel in the 5.47 to 5.725 GHz band. An inquiry was made to the FCC and the response was pre-scans could be performed in the band with the highest conducted output power and all final measurements should be performed on any emissions seen in each band.
3. The final measured value, for the given emission in the field strength result tables, incorporates the calibrated antenna factor and cable loss.
4. Appropriate RF filters and attenuators were used during pre-scans and final measurements. Insertion losses were entered on the test receiver as RF levels offsets.
5. In accordance with KDB 789033 Section II.G.1.c) if the peak measurement is below the average limit, it is not necessary to perform a separate average measurement.
6. In accordance with KDB 789033 Section II.G.6.c) Method AD (vii), for average measurements, data rates where the EUT was transmitting <98% duty cycle, the duty cycle correction factor calculated in Section 5.2.3 of this report was added to the measured result.
7. All other emissions shown on the pre-scan plot were investigated and found to be ambient or >20 dB below the applicable limit or below the measurement system noise floor.
8. Measurements above 1 GHz were performed in a fully anechoic chamber (Asset Number K0017) at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the test chamber floor in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.

Transmitter Out of Band Radiated Emissions (5.725-5.85 GHz band operation) (continued)

Results: Bottom Channel / EIRP

Frequency (MHz)	Antenna Polarity	Level (dBm)	Limit (dBm)	Margin (dB)	Result
11490.720	Horizontal	-35.1	-27.0	8.1	Complied

Results: Bottom Channel / Field Strength / Peak

Frequency (MHz)	Antenna Polarity	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
11490.720	Horizontal	60.1	74.0	13.9	Complied

Results: Bottom Channel / Field Strength / Average

Frequency (MHz)	Antenna Polarity	Measured Level (dBμV/m)	Duty cycle correction (dB)	Corrected Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
11491.360	Horizontal	43.4	0.1	43.5	54.0	10.5	Complied

Results: Middle Channel / EIRP

Frequency (MHz)	Antenna Polarity	Level (dBm)	Limit (dBm)	Margin (dB)	Result
11529.766	Horizontal	-38.9	-27.0	11.9	Complied

Results: Middle Channel / Field Strength / Peak

Frequency (MHz)	Antenna Polarity	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
11529.766	Horizontal	56.3	74.0	17.7	Complied

Results: Middle Channel / Field Strength / Average

Frequency (MHz)	Antenna Polarity	Measured Level (dBμV/m)	Duty cycle correction (dB)	Corrected Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
11528.861	Horizontal	42.4	0.1	42.5	54.0	11.5	Complied

Results: Top Channel / EIRP

Frequency (MHz)	Antenna Polarity	Level (dBm)	Limit (dBm)	Margin (dB)	Result
11567.092	Horizontal	-39.8	-27.0	12.8	Complied

Results: Top Channel / Field Strength / Peak

Frequency (MHz)	Antenna Polarity	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
11567.092	Horizontal	55.4	74.0	18.6	Complied

Transmitter Out of Band Radiated Emissions (5.725-5.85 GHz band operation) (continued)

Results: Top Channel / Field Strength / Average

Frequency (MHz)	Antenna Polarity	Measured Level (dBµV/m)	Duty cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
11568.102	Horizontal	41.2	0.1	41.3	54.0	12.7	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 Feb 2018	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	14 Feb 2018	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	13 Apr 2018	12
A2863	Pre Amplifier	Agilent	8449B	3008A02100	11 Apr 2018	12
A2891	Pre Amplifier	Schwarzbeck	BBV 9718	9718-306	11 Apr 2018	12
A2893	Pre Amplifier	Schwarzbeck	BBV 9721	9721-021	11 Apr 2018	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	11 Apr 2018	12
A2890	Antenna	Schwarzbeck	HWRD 750	014	11 Apr 2018	12
A2892	Antenna	Schwarzbeck	BBHA 9170	9170-727	11 Apr 2018	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	03 Mar 2018	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	1601900001	18 May 2018	12
M1269	Multimeter	Fluke	179	90250210	02 May 2018	12
S0538	Bench Power Supply	TTI	PL154	250135	Calibrated before use	-

5.2.11. Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	John Ferdinand	**Test Dates:**	09 November 2017 to 14 November 2017
Test Sample Serial Number:	43		

FCC Reference:	Parts 15.407(b)(1),(7), 15.205 & 15.209(a)
Test Method Used:	ANSI C63.10 Section 6.10 & KDB 789033 II.G.

Environmental Conditions:

Temperature (°C):	20 to 23
Relative Humidity (%):	34 to 43

Note(s):

1. An inquiry was made to the FCC and the response confirmed band edge measurements need only be performed in the EUT modes that produce the highest power and the widest bandwidths. The modes that produced the highest power and widest bandwidth were:
    - 802.11a / BPSK / 6 Mbit/s
    - 802.11a / 16QAM / 24 Mbit/s
    - 802.11n HT20 / BPSK / MCS0 (GI = 800 ns)
    - 802.11n HT20 / 64QAM / MCS5 (GI = 800 ns)
2. Lower band edge measurements were performed with the EUT transmitting on the bottom channel. Upper band edge measurements were performed with the EUT transmitting on the top channel.
3. Field strength measurements using peak and average detectors were performed in the restricted bands below 5.15 GHz and above 5.35 GHz. Field strength and EIRP results were found to be compliant with the restricted band limits and Part 15.407 out-of-band limits.
4. In accordance with KDB 789033 Section II.G.6.c) Method AD (vii), for average measurements, data rates where the EUT was transmitting <98% duty cycle, the duty cycle correction factor calculated in Section 5.2.3 of this report was added to the measured result.

Transmitter Band Edge Radiated Emissions (5.15-5.25 GHz band operation) (continued)

Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5149.615	64.2	74.0	9.8	Complied
5150	63.6	74.0	10.4	Complied

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5350	53.2	74.0	20.8	Complied
5416.154	55.8	74.0	18.2	Complied

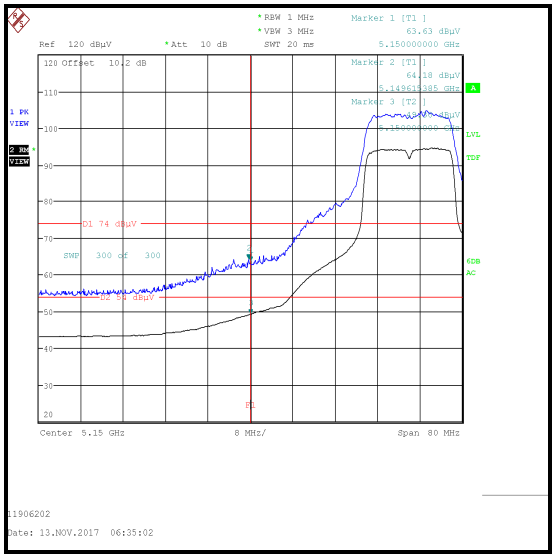
Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s / Average

Frequency (MHz)	Level (dBµV/m)	Duty Cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5150	49.3	0.1	49.4	54.0	4.6	Complied

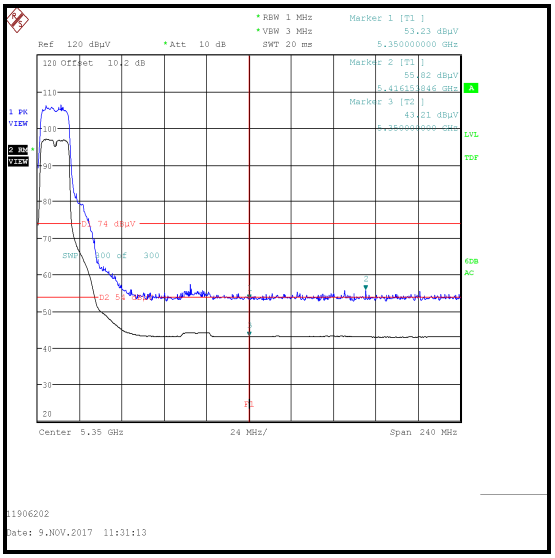
Frequency (MHz)	Level (dBµV/m)	Duty Cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5350	43.2	0.1	43.3	54.0	10.7	Complied

Transmitter Band Edge Radiated Emissions (5.15-5.25 GHz band operation) (continued)

Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s



Lower Band Edge



Upper Band Edge

Transmitter Band Edge Radiated Emissions (5.15-5.25 GHz band operation) (continued)

Results: 802.11a / 20 MHz / 16QAM / 24 Mbit/s / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5150	62.0	74.0	12.0	Complied

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5350	54.2	74.0	19.8	Complied
5419.615	54.9	74.0	19.1	Complied

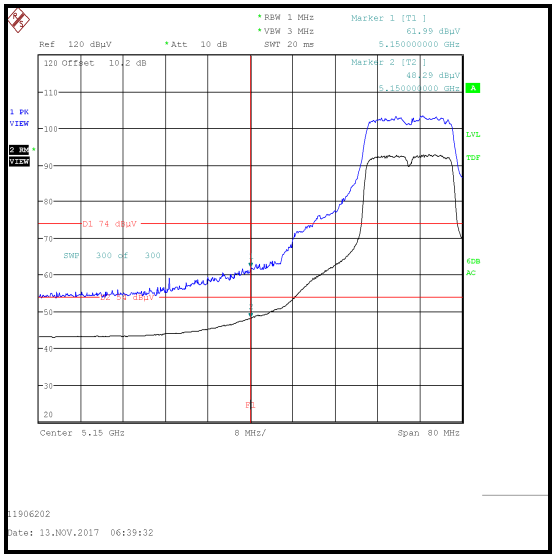
Results: 802.11a / 20 MHz / 16QAM / 24 Mbit/s / Average

Frequency (MHz)	Level (dBµV/m)	Duty Cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5150	48.3	0.3	48.6	54.0	5.4	Complied

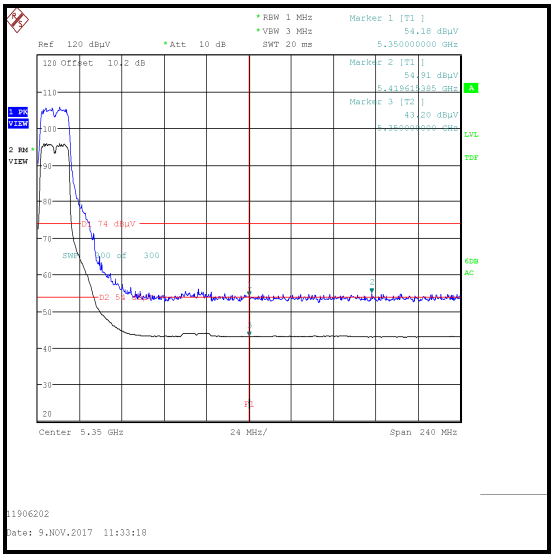
Frequency (MHz)	Level (dBµV/m)	Duty Cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5350	43.2	0.3	43.5	54.0	10.5	Complied

Transmitter Band Edge Radiated Emissions (5.15-5.25 GHz band operation) (continued)

Results: 802.11a / 20 MHz / 16QAM / 24 Mbit/s



Lower Band Edge



Upper Band Edge

Transmitter Band Edge Radiated Emissions (5.15-5.25 GHz band operation) (continued)

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

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5149.615	65.7	74.0	8.3	Complied
5150	65.6	74.0	8.4	Complied

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5350	54.7	74.0	19.3	Complied
5358.462	56.0	74.0	18.0	Complied

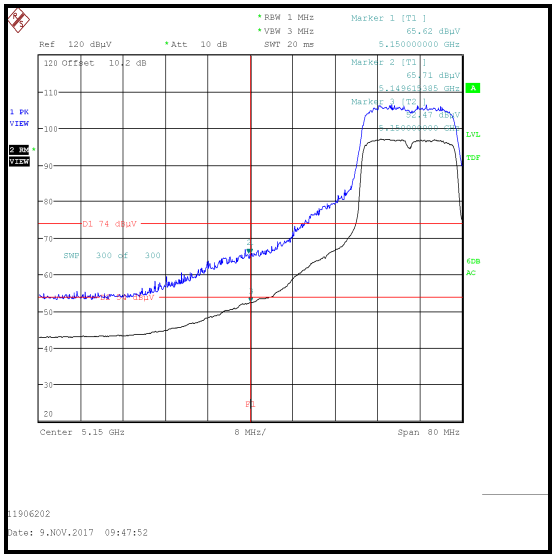
Results: 802.11n / 20 MHz / BPSK / MCS0 / Average

Frequency (MHz)	Level (dBµV/m)	Duty Cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5150	52.5	0.1	52.6	54.0	1.4	Complied

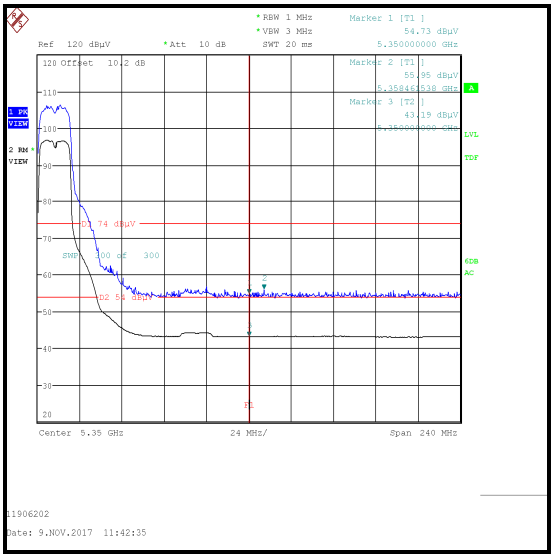
Frequency (MHz)	Level (dBµV/m)	Duty Cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5350	43.2	0.1	43.3	54.0	10.7	Complied

Transmitter Band Edge Radiated Emissions (5.15-5.25 GHz band operation) (continued)

Results: 802.11n / 20 MHz / BPSK / MCS0



Lower Band Edge



Upper Band Edge

Transmitter Band Edge Radiated Emissions (5.15-5.25 GHz band operation) (continued)

Results: 802.11n / 20 MHz / 64QAM / MCS5 / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5146.923	62.2	74.0	11.8	Complied
5150	60.8	74.0	13.2	Complied

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5350	54.0	74.0	20.0	Complied
5453.077	55.4	74.0	18.6	Complied

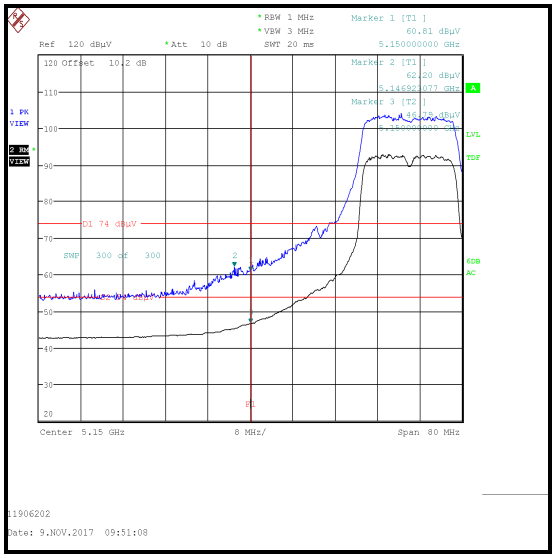
Results: 802.11n / 20 MHz / 64QAM / MCS5 / Average

Frequency (MHz)	Level (dBµV/m)	Duty Cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5150	46.8	0.5	47.3	54.0	6.7	Complied

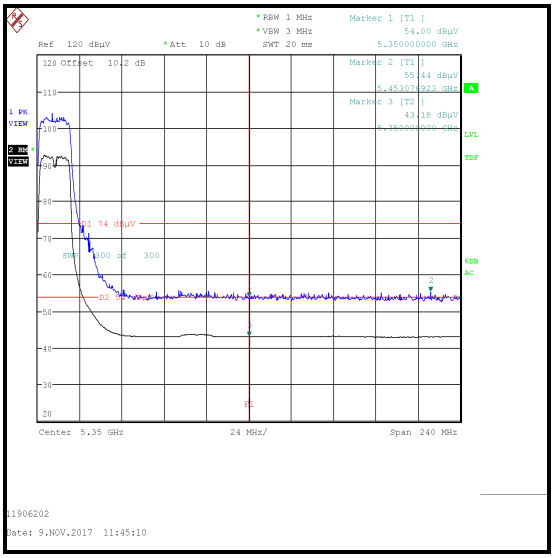
Frequency (MHz)	Level (dBµV/m)	Duty Cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5350	43.2	0.5	43.7	54.0	10.3	Complied

Transmitter Band Edge Radiated Emissions (5.15-5.25 GHz band operation) (continued)

Results: 802.11n / 20 MHz / 64QAM / MCS5



Lower Band Edge



Upper Band Edge

Transmitter Band Edge Radiated Emissions (5.25-5.35 GHz band)

Test Summary:

Test Engineer:	John Ferdinand	**Test Dates:**	09 November 2017 to 14 November 2017
Test Sample Serial Number:	43		

FCC Reference:	Parts 15.407(b)(2),(7), 15.205 & 15.209(a)
Test Method Used:	ANSI C63.10 Section 6.10 & KDB 789033 II.G.

Environmental Conditions:

Temperature (°C):	20 to 23
Relative Humidity (%):	34 to 43

Note(s):

1. An inquiry was made to the FCC and the response confirmed band edge measurements need only be performed in the EUT modes that produce the highest power and the widest bandwidths. The modes that produced the highest power and widest bandwidth were:
    - 802.11a / BPSK / 6 Mbit/s
    - 802.11a / 16QAM / 24 Mbit/s
    - 802.11n HT20 / BPSK / MCS0 (GI = 800 ns)
    - 802.11n HT20 / 64QAM / MCS5 (GI = 800 ns)
2. Lower band edge measurements were performed with the EUT transmitting on the bottom channel. Upper band edge measurements were performed with the EUT transmitting on the top channel.
3. Field strength measurements using peak and average detectors were performed in the restricted bands below 5.15 GHz and above 5.35 GHz. Field strength and EIRP results were found to be compliant with the restricted band limits and Part 15.407 out-of-band limits.
4. In accordance with KDB 789033 Section II.G.6.c) Method AD (vii), for average measurements, data rates where the EUT was transmitting <98% duty cycle, the duty cycle correction factor calculated in section 5.2.3 was added to the measured result.

Transmitter Band Edge Radiated Emissions (5.25-5.35 GHz band operation) (continued)

Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s / Peak

Frequency (MHz)	Peak Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5058.077	55.8	74.0	18.2	Complied
5150	53.0	74.0	21.0	Complied

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5350	56.8	74.0	17.2	Complied
5352.180	58.5	74.0	15.5	Complied

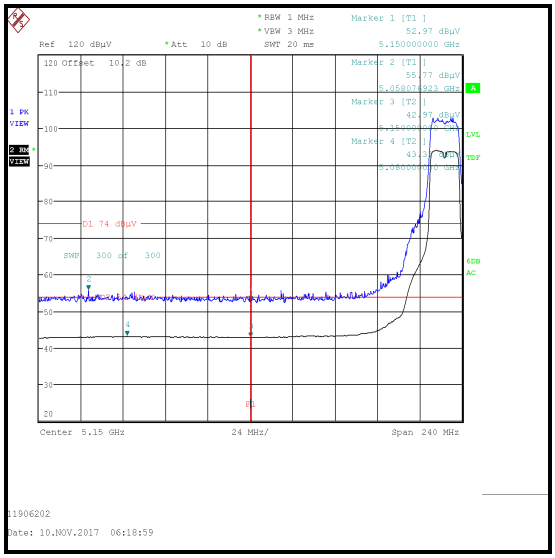
Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s / Average

Frequency (MHz)	Level (dBµV/m)	Duty Cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5080	43.3	0.1	43.4	54.0	10.6	Complied
5150	43.0	0.1	43.1	54.0	10.9	Complied

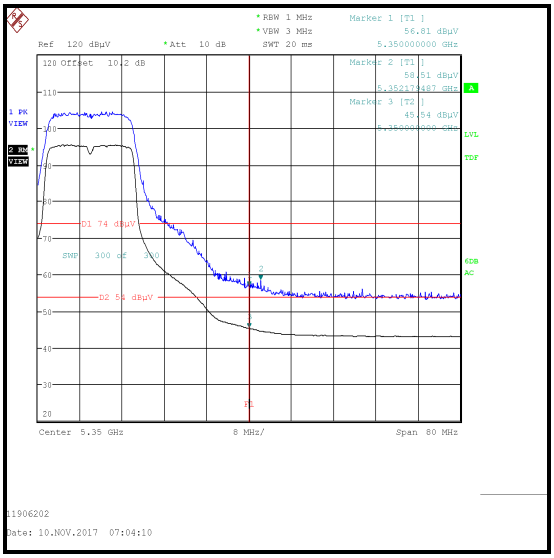
Frequency (MHz)	Level (dBµV/m)	Duty Cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5350	45.5	0.1	45.6	54.0	8.4	Complied

Transmitter Band Edge Radiated Emissions (5.25-5.35 GHz band operation) (continued)

Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s



Lower Band Edge



Upper Band Edge

Transmitter Band Edge Radiated Emissions (5.25-5.35 GHz band operation) (continued)

Results: 802.11a / 20 MHz / 16QAM / 24 Mbit/s / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5076.923	55.4	74.0	18.6	Complied
5150	53.6	74.0	20.4	Complied

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5350	57.3	74.0	16.7	Complied
5350.769	58.3	74.0	15.7	Complied

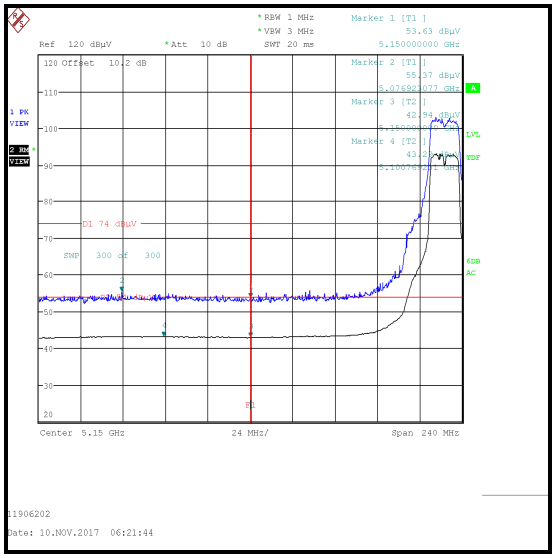
Results: 802.11a / 20 MHz / 16QAM / 24 Mbit/s / Average

Frequency (MHz)	Level (dBµV/m)	Duty Cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5100.769	43.3	0.3	43.6	54.0	10.4	Complied
5150	42.9	0.3	43.2	54.0	10.8	Complied

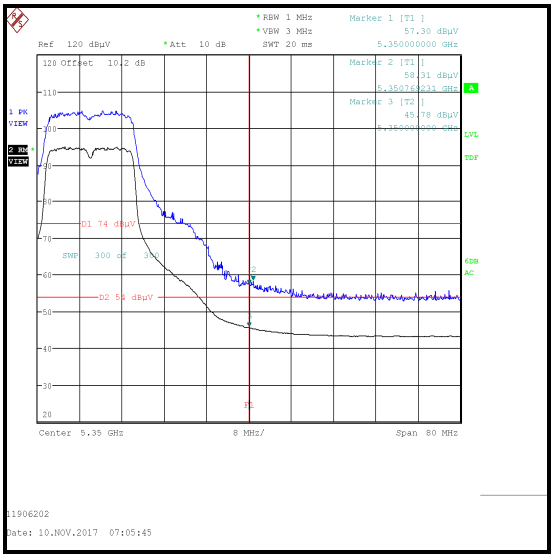
Frequency (MHz)	Level (dBµV/m)	Duty Cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5350	45.8	0.3	46.1	54.0	7.9	Complied

Transmitter Band Edge Radiated Emissions (5.25-5.35 GHz band operation) (continued)

Results: 802.11a / 20 MHz / 16QAM / 24 Mbit/s



Lower Band Edge



Upper Band Edge

Transmitter Band Edge Radiated Emissions (5.25-5.35 GHz band operation) (continued)

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

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5138.077	55.5	74.0	18.5	Complied
5150	53.2	74.0	20.8	Complied

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5350	57.3	74.0	16.7	Complied
5350.256	58.4	74.0	15.6	Complied

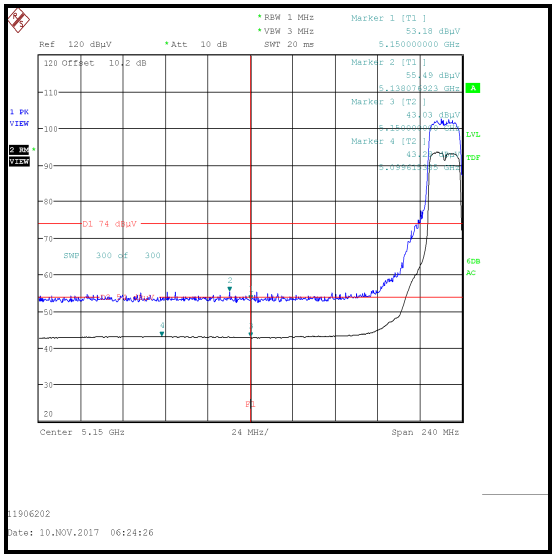
Results: 802.11n / 20 MHz / BPSK / MCS0 / Average

Frequency (MHz)	Level (dBµV/m)	Duty Cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5099.615	43.2	0.1	43.3	54.0	10.7	Complied
5150	43.0	0.1	43.1	54.0	10.9	Complied

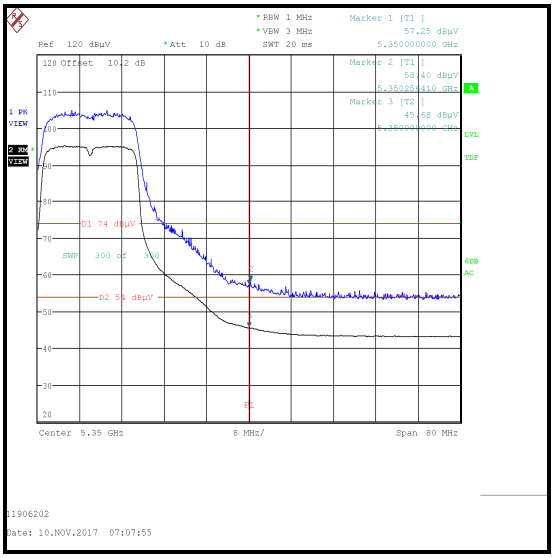
Frequency (MHz)	Level (dBµV/m)	Duty Cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5350	45.7	0.1	45.8	54.0	8.2	Complied

Transmitter Band Edge Radiated Emissions (5.25-5.35 GHz band operation) (continued)

Results: 802.11n / 20 MHz / BPSK / MCS0



Lower Band Edge



Upper Band Edge

Transmitter Band Edge Radiated Emissions (5.25-5.35 GHz band operation) (continued)

Results: 802.11n / 20 MHz / 64QAM / MCS5 / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5095.769	55.3	74.0	18.7	Complied
5150	53.8	74.0	20.2	Complied

Frequency (MHz)	Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
5350	54.2	74.0	19.8	Complied
5351.538	55.9	74.0	18.1	Complied

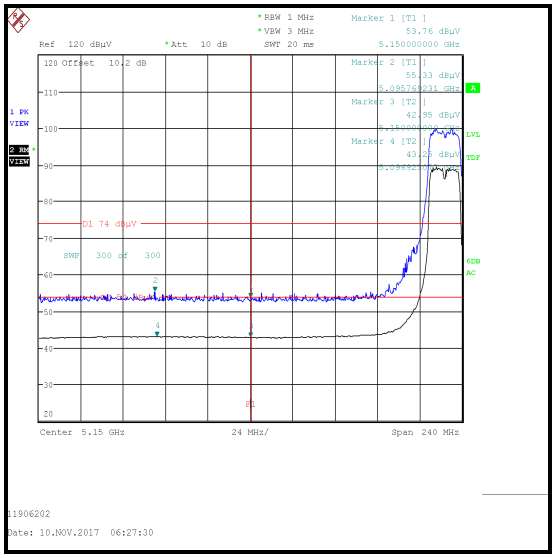
Results 802.11n / 20 MHz / 64QAM / MCS5 / Average

Frequency (MHz)	Level (dBµV/m)	Duty Cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5096.923	43.3	0.5	43.8	54.0	10.2	Complied
5150	43.0	0.5	43.5	54.0	10.5	Complied

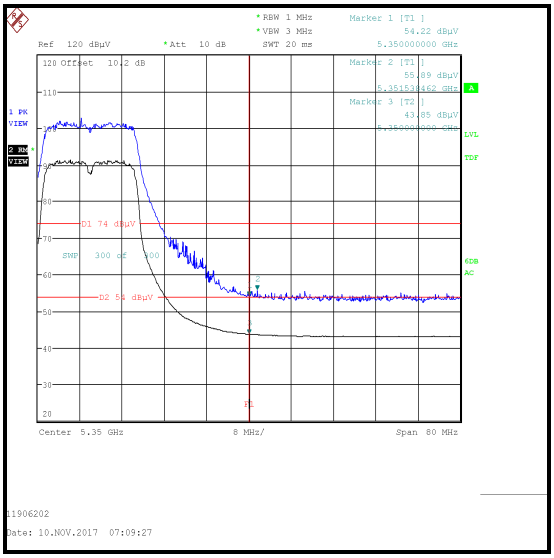
Frequency (MHz)	Level (dBµV/m)	Duty Cycle correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5350	43.9	0.5	44.4	54.0	9.6	Complied

Transmitter Band Edge Radiated Emissions (5.25-5.35 GHz band operation) (continued)

Results: 802.11n / 20 MHz / 64QAM / MCS5



Lower Band Edge



Upper Band Edge

Transmitter Band Edge Radiated Emissions (5.47-5.725 GHz band)

Test Summary:

Test Engineer:	John Ferdinand	**Test Dates:**	10 November 2017 to 15 November 2017
Test Sample Serial Number:	43		

FCC Reference:	Parts 15.407(b)(3),(7), 15.205 & 15.209(a)
Test Method Used:	ANSI C63.10 Section 6.10 & KDB 789033 II.G.

Environmental Conditions:

Temperature (°C):	20 to 23
Relative Humidity (%):	34 to 43

Note(s):

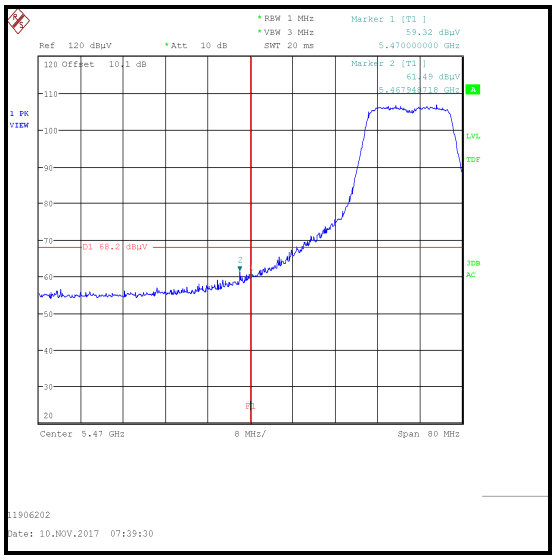
1. An inquiry was made to the FCC and the response confirmed band edge measurements need only be performed in the EUT modes that produce the highest power and the widest bandwidths. The modes that produced the highest power and widest bandwidth were:
    - 802.11a / BPSK / 6 Mbit/s
    - 802.11a / 16QAM / 24 Mbit/s
    - 802.11n HT20 / BPSK / MCS0 (GI = 800 ns)
    - 802.11n HT20 / 64QAM / MCS5 (GI = 800 ns)
2. Lower band edge measurements were performed with the EUT transmitting on the bottom channel. Upper band edge measurements were performed with the EUT transmitting on the top channel.
3. For transmitters operating in the 5.47-5.725 GHz band: all emissions outside of the 5.47-5.725 GHz band shall not exceed an EIRP of -27 dBm/MHz. However, there are restricted bands of operation below the lower band edge at 4.5-5.15 GHz and also at 5.35-5.46 GHz therefore the provisions of FCC Part 15.205 apply. Tests were performed in these restricted bands of operation with the EUT transmitting on the bottom and top channels within 5.47-5.725 GHz band, the results are included in the transmitter 5.25-5.35 GHz band radiated spurious emissions section of this test report.
4. For completeness, results are also shown as EIRP in dBm and also as field strength in dBµV/m. Measured field strength was converted to EIRP in accordance with KDB 789033 II.G.2.d.(iii) using a conversion factor of 95.2.

Transmitter Band Edge Radiated Emissions (5.47-5.725 GHz band operation) (continued)

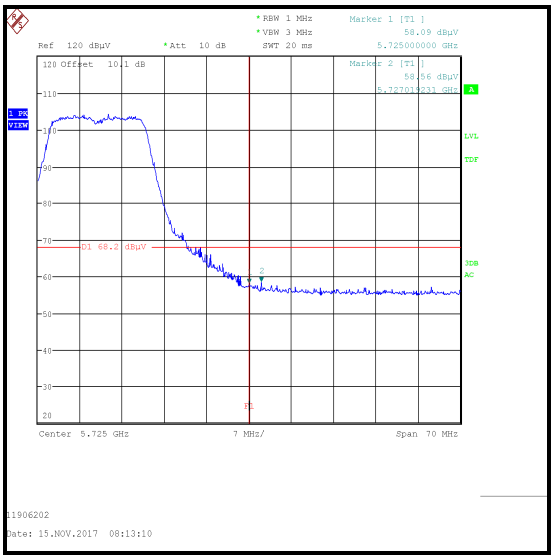
Results 802.11a / 20 MHz / BPSK / 6 Mbit/s / Peak

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)	Result
5467.949	-33.7	-27.0	6.7	Complied
5470	-35.9	-27.0	8.9	Complied
5725	-37.1	-27.0	10.1	Complied
5741.715	-36.6	-27.0	9.6	Complied

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5467.949	61.5	68.2	6.7	Complied
5470	59.3	68.2	8.9	Complied
5725	58.1	68.2	10.1	Complied
5727.019	58.6	68.2	9.6	Complied



Lower Band Edge



Upper Band Edge

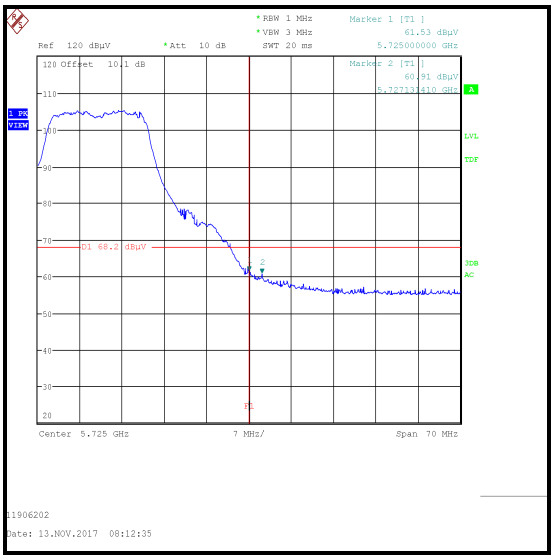
Transmitter Band Edge Radiated Emissions (5.47-5.725 GHz band operation) (continued)

Results 802.11a / 20 MHz / 16QAM / 24 Mbit/s / Peak

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)	Result
5467.692	-32.9	-27.0	5.9	Complied
5470	-33.5	-27.0	6.5	Complied
5725	-33.7	-27.0	6.7	Complied
5727.131	-34.3	-27.0	7.3	Complied

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5467.692	62.3	68.2	5.9	Complied
5470	61.7	68.2	6.5	Complied
5725	61.5	68.2	6.7	Complied
5727.131	60.9	68.2	7.3	Complied

Lower Band Edge



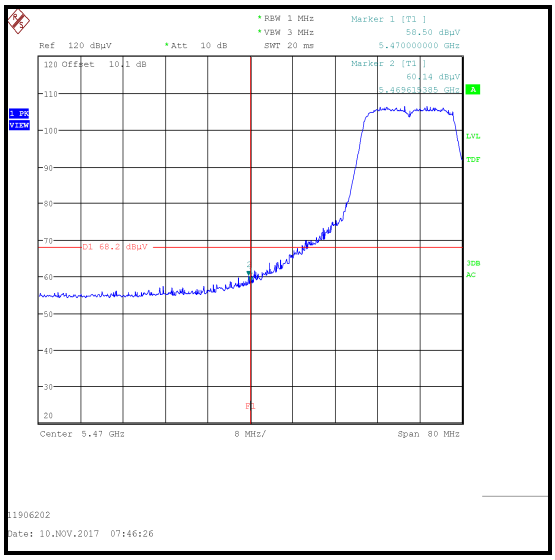
Upper Band Edge

Transmitter Band Edge Radiated Emissions (5.47-5.725 GHz band operation) (continued)

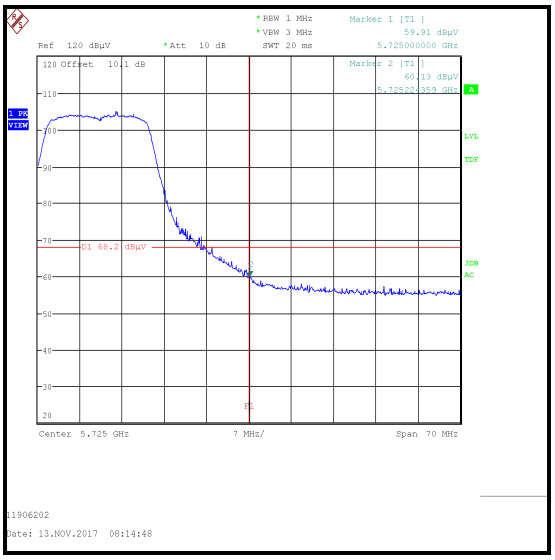
Results: 802.11n / 20 MHz / BPSK / MCS0 / Peak

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)	Result
5469.615	-35.1	-27.0	8.1	Complied
5470	-36.7	-27.0	9.7	Complied
5725	-35.3	-27.0	8.3	Complied
5725.224	-35.1	-27.0	8.1	Complied

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5469.615	60.1	68.2	8.1	Complied
5470	58.5	68.2	9.7	Complied
5725	59.9	68.2	8.3	Complied
5725.224	60.1	68.2	8.1	Complied



Lower Band Edge



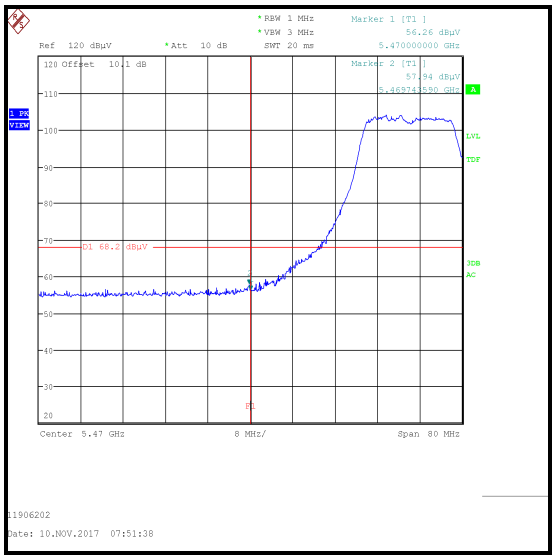
Upper Band Edge

Transmitter Band Edge Radiated Emissions (5.47-5.725 GHz band operation) (continued)

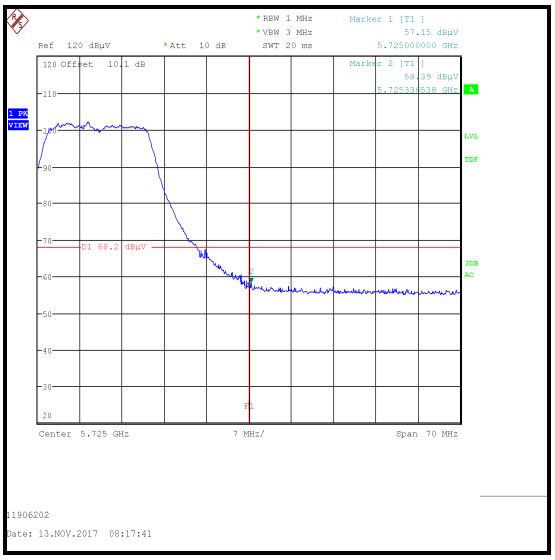
Results: 802.11n / 20 MHz / 64QAM / MCS5 / Peak

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)	Result
5469.744	-37.3	-27.0	10.3	Complied
5470	-38.9	-27.0	11.9	Complied
5725	-38.0	-27.0	11.0	Complied
5725.337	-36.8	-27.0	9.8	Complied

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5469.744	57.9	68.2	10.3	Complied
5470	56.3	68.2	11.9	Complied
5725	57.2	68.2	11.0	Complied
5725.337	58.4	68.2	9.8	Complied



Lower Band Edge



Upper Band Edge

Transmitter Band Edge Radiated Emissions (5.725-5.85 GHz band)

Test Summary:

Test Engineer:	John Ferdinand	**Test Dates:**	09 November 2017 to 14 November 2017
Test Sample Serial Number:	43		

FCC Reference:	Parts 15.407(b)(4)(i),(7), 15.205 & 15.209(a)
Test Method Used:	ANSI C63.10 Section 6.10 & KDB 789033 II.G

Environmental Conditions:

Temperature (°C):	20 to 23
Relative Humidity (%):	34 to 43

Note(s):

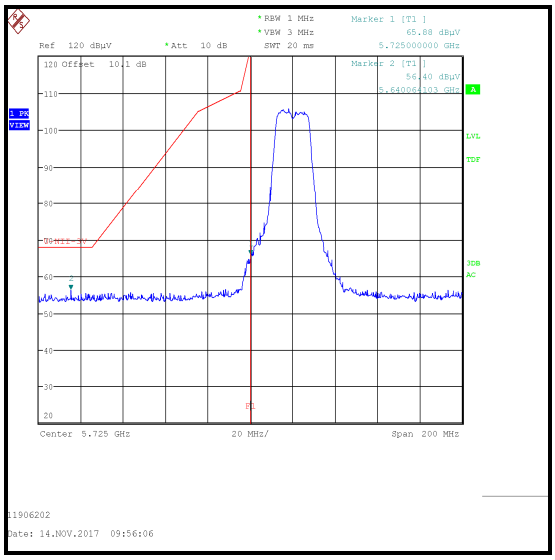
1. An inquiry was made to the FCC and the response confirmed band edge measurements need only be performed in the EUT modes that produce the highest power and the widest bandwidths. The modes that produced the highest power and widest bandwidth were:
    - 802.11a / BPSK / 6 Mbit/s
    - 802.11a / 16QAM / 24 Mbit/s
    - 802.11n HT20 / BPSK / MCS0 (GI = 800 ns)
    - 802.11n HT20 / 64QAM / MCS5 (GI = 800 ns)
2. Lower band edge measurements were performed with the EUT transmitting on the bottom channel. Upper band edge measurements were performed with the EUT transmitting on the top channel.
3. For completeness, results are also shown as EIRP in dBm and also as field strength in dBµV/m. Measured field strength was converted to EIRP in accordance with KDB 789033 G.2.d)(iii) using a conversion factor of 95.2.

Transmitter Band Edge Radiated Emissions (5.725-5.85 GHz band operation) (continued)

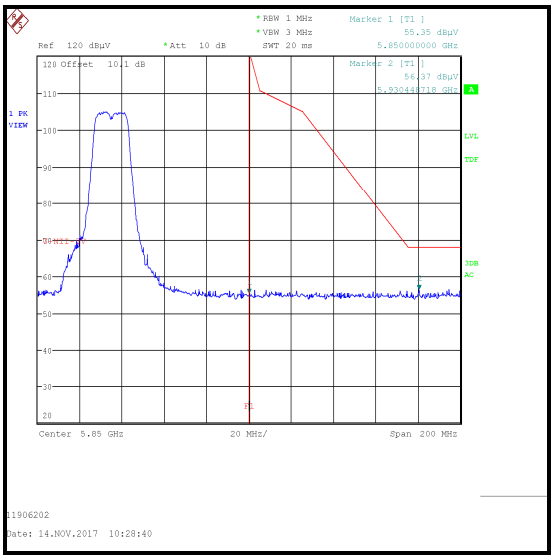
Results: 802.11a / 20 MHz / BPSK / 6 Mbit/s / Peak

Frequency (MHz)	Level (dBm)	Limit (dBm/MHz)	Margin (dB)	Result
5640.064	-38.8	-27.0	11.8	Complied
5725	-29.3	27.0	56.3	Complied
5850	-39.8	27.0	66.8	Complied
5930.449	-38.8	-27.0	11.8	Complied

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5640.064	56.4	68.2	11.8	Complied
5725	65.9	122.2	56.3	Complied
5850	55.4	122.2	66.8	Complied
5930.449	56.4	68.2	11.8	Complied



Lower Band Edge Measurement



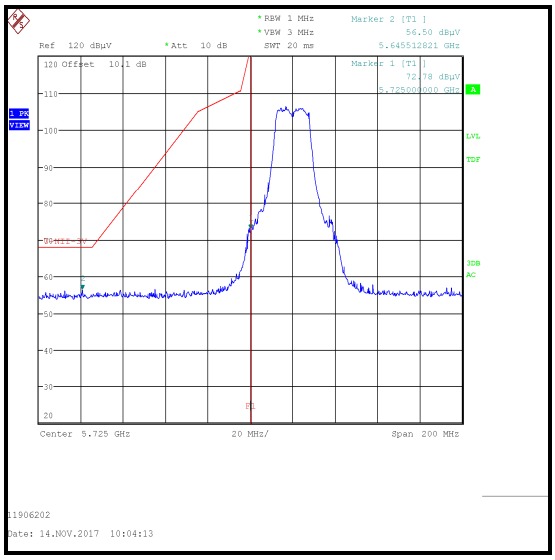
Upper Band Edge Measurement

Transmitter Band Edge Radiated Emissions (5.725-5.85 GHz band operation) (continued)

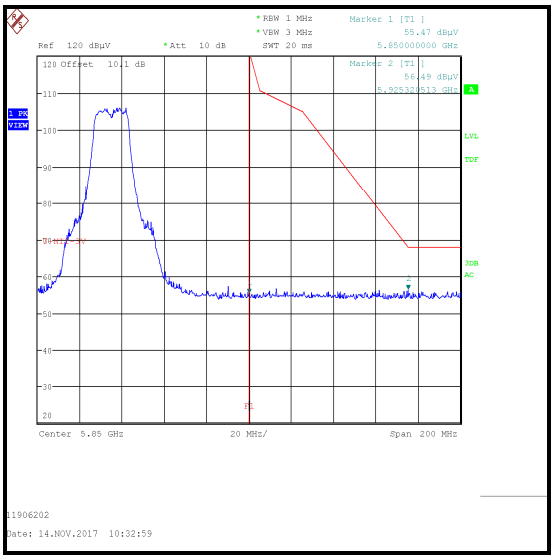
Results: 802.11a / 20 MHz / 16QAM / 24 Mbit/s / Peak

Frequency (MHz)	Level (dBm)	Limit (dBm/MHz)	Margin (dB)	Result
5645.513	-38.7	-27.0	11.7	Complied
5725	-22.4	27.0	49.4	Complied
5850	-39.7	27.0	66.7	Complied
5925.321	-38.7	-27.0	11.7	Complied

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5645.513	56.5	68.2	11.7	Complied
5725	72.8	122.2	49.4	Complied
5850	55.5	122.2	66.7	Complied
5925.321	56.5	68.2	11.7	Complied



Lower Band Edge Measurement



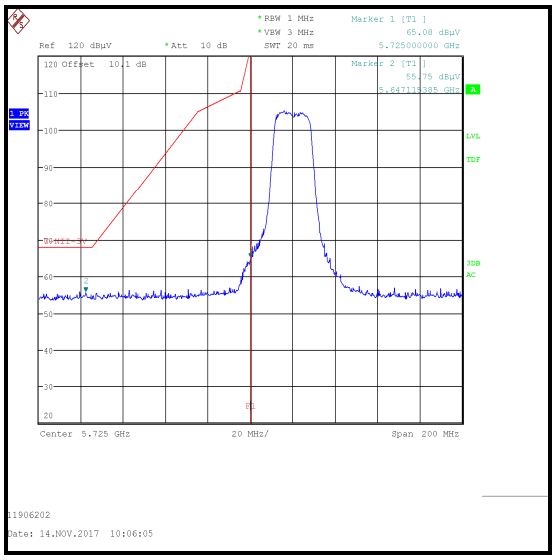
Upper Band Edge Measurement

Transmitter Band Edge Radiated Emissions (5.725-5.85 GHz band operation) (continued)

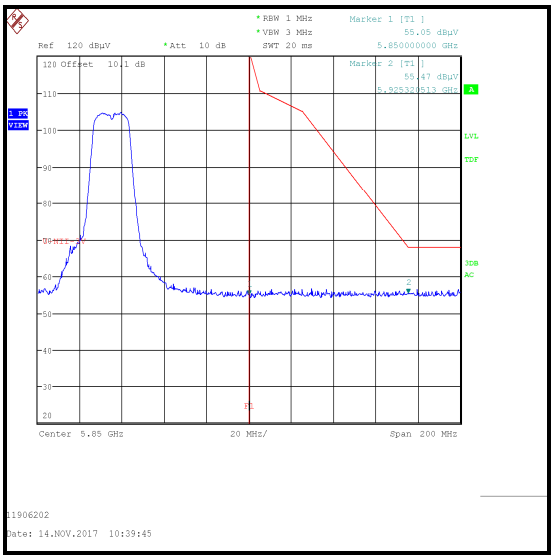
Results: 802.11n / 20 MHz / BPSK / MCS0 / Peak

Frequency (MHz)	Level (dBm)	Limit (dBm/MHz)	Margin (dB)	Result
5647.115	-39.4	-27.0	12.4	Complied
5725	-30.1	27.0	57.1	Complied
5850	-40.1	27.0	67.1	Complied
5925.321	-39.7	-27.0	12.7	Complied

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5647.115	55.8	68.2	12.4	Complied
5725	65.1	122.2	57.1	Complied
5850	55.1	122.2	67.1	Complied
5925.321	55.5	68.2	12.7	Complied



Lower Band Edge



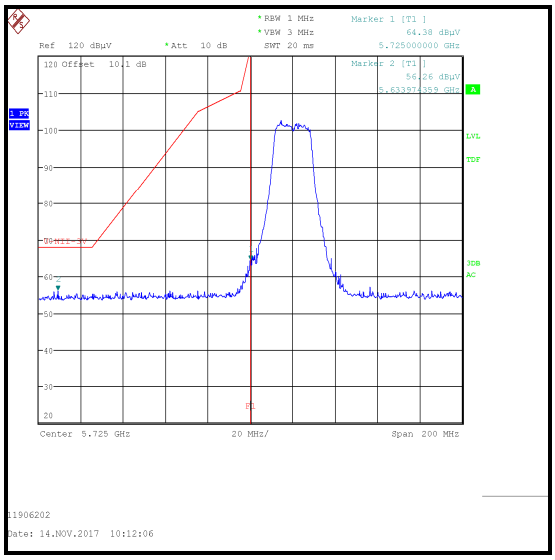
Upper Band Edge

Transmitter Band Edge Radiated Emissions (5.725-5.85 GHz band operation) (continued)

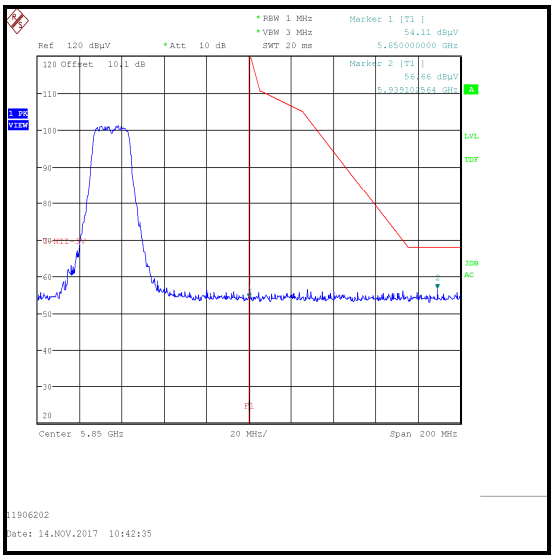
Results:802.11n / 20 MHz / 64QAM / MCS5 / Peak

Frequency (MHz)	Level (dBm)	Limit (dBm/MHz)	Margin (dB)	Result
5633.974	-38.9	-27.0	11.9	Complied
5725	-30.8	27.0	57.8	Complied
5850	-41.1	27.0	68.1	Complied
5939.103	-38.5	-27.0	11.5	Complied

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
5633.974	56.3	68.2	11.9	Complied
5725	64.4	122.2	57.8	Complied
5850	54.1	122.2	68.1	Complied
5939.103	56.7	68.2	11.5	Complied



Lower Band Edge



Upper Band Edge

Transmitter Band Edge 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 Feb 2018	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	14 Feb 2018	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	13 Apr 2018	12
A2863	Pre Amplifier	Agilent	8449B	3008A02100	11 Apr 2018	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	11 Apr 2018	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	03 Mar 2018	12
M1269	Multimeter	Fluke	179	90250210	02 May 2018	12
S0538	Bench Power Supply	TTI	PL154	250135	Calibrated before use	-

6. Measurement Uncertainty

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
Maximum Conducted Output Power	5.15 GHz to 5.850 GHz	95%	±1.13 dB
Maximum Power Spectral Density	5.15 GHz to 5.850 GHz	95%	±1.13 dB
Minimum 6 dB Emission Bandwidth	5.15 GHz to 5.850 GHz	95%	±4.59 %
26 dB Emission Bandwidth	5.15 GHz to 5.850 GHz	95%	±4.59 %
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±5.65 dB
Radiated Spurious Emissions	1 GHz to 40 GHz	95%	±2.94 dB

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

7. Report Revision History

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0	-	-	Initial Version

--- END OF REPORT ---