TEST REPORT

Test Report No. : UL-RPT-RP12007095-116A V2.0

Manufacturer	:	Cabletime Limited
Model No.	:	601
FCC ID	:	2APSA6011000
Technology	:	WLAN
Test Standard(s)	:	FCC Parts 15.207, 15.209(a) & 15.247

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 2.0 supersedes all previous versions.

Date of Issue: 10 August 2018

Checked by:

Ben Mercer
Senior Test Engineer, Radio Laboratory

Company Signatory:

Sarah Williams
Senior Test 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.

UL VS LTD

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1. Customer Information

Company Name:	Cabletime Limited
Address:	64 Greenham Road Newbury Berkshire RG14 7HX United Kingdom

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR15.247
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
Specification Reference:	47CFR15.207 and 47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.207 and 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:	23 January 2018 to 31 May 2018

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.207	Transmitter AC Conducted Emissions	✓
Part 15.247(a)(2)	Transmitter Minimum 6 dB Bandwidth	✓
Part 15.35(c)	Transmitter Duty Cycle	Note 1
Part 15.247(e)	Transmitter Power Spectral Density	✓
Part 15.247(b)(3)	Transmitter Maximum (Average) Output Power	✓
Part 15.247(d) & 15.209(a)	Transmitter Radiated Emissions	✓
Part 15.247(d) & 15.209(a)	Transmitter Band Edge Radiated Emissions	✓

Key to Results

✓ = Complied ✗ = Did not comply

Note(s):

1. This measurement was performed to assist in the calculation of the level of emissions. The EUT cannot transmit continuously and sweep triggering/signal gating cannot be implemented.

2.3. Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	KDB 558074 D01 DTS Meas Guidance v04 April 5, 2017
Title:	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
Reference:	KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015
Title:	AC Power-Line Conducted Emissions Frequently Asked Questions
Reference:	KDB 662911 D01 Multiple Transmitter Output v02r01 October 31, 2013
Title:	Emissions Testing of Transmitters with Multiple Outputs in the Same Band

2.4. Deviations from the Test Specification

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

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	RoomStar
Model Name or Number:	601
Test Sample Serial Number:	Not marked or stated *(Radiated sample)*
Mac Address:	00226D476F14
Hardware Version:	1
Software Version:	6.01
FCC ID:	2APSA6011000

Brand Name:	RoomStar
Model Name or Number:	601
Test Sample Serial Number:	Not marked or stated *(Conducted sample)*
Mac Address:	00226D476F28
Hardware Version:	1
Software Version:	6.01
FCC ID:	2APSA6011000

3.2. Description of EUT

The equipment under test was an OTT/IP Settop unit with WIFI and wired network connectivity.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Technology Tested:	WLAN (IEEE 802.11b,g,n) / Digital Transmission System	
Type of Unit:	Transceiver	
Modulation Type:	DBPSK, DQPSK, BPSK, QPSK, 16QAM & 64QAM	
Data Rates:	802.11b (SISO)	1, 2, 5.5 & 11 Mbps
	802.11b (MIMO)	1, 2, 5.5 & 11 Mbps (CDD)
	802.11g (SISO)	6, 9, 12, 18, 24, 36, 48 & 54 Mbps
	802.11g (MIMO)	6, 9, 12, 18, 24, 36, 48 & 54 Mbps (CDD)
	802.11n HT20 (SISO)	MCS0 to MCS7
	802.11n HT20 (MIMO)	MCS0 to MCS15 (CDD MCS0 to MCS7)
	802.11n HT40 (SISO)	MCS0 to MCS7
	802.11n HT40 (MIMO)	MCS0 to MCS15 (CDD MCS0 to MCS7)
Power Supply Requirement(s):	Nominal	5.0 VDC via 120 VAC 60 Hz adaptor
Maximum Conducted Output Power:	17.1 dBm	
Declared Antenna Gains:	Antenna 1	4.8 dBi
	Antenna 2	2.5 dBi
Channel Spacing:	20 MHz & 40 MHz	
Transmit Frequency Range:	2412 MHz to 2462 MHz	
Transmit Channels Tested (20 MHz channel spacing):	**Channel Number**	**Channel Frequency (MHz)**
	1	2412
	6	2437
	11	2462
Transmit Channels Tested (40 MHz channel spacing):	**Channel Number**	**Channel Frequency (MHz)**
	3	2422
	9	2452

3.5. Support Equipment

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

Brand Name:	iP IDEAL power
Description:	Switch mode power supply
Model Name or Number:	DYS612-050240W-1
Serial Number:	Not marked or stated

Brand Name:	Dell
Description:	Laptop PC
Model Name or Number:	Vostro
Serial Number:	DBD8ZM1

Brand Name:	DT Mini Slim
Description:	USB Dongle
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Brand Name:	Cabletime Limited
Description:	MTI Interface
Model Name or Number:	Issue 2
Serial Number:	Not marked or stated

Brand Name:	Not marked or stated
Description:	Resistor terminator
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Brand Name:	Not marked or stated
Description:	AV termination
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Brand Name:	Netgear
Description:	WiFi Router
Model Name or Number:	WNR2000v5
Serial Number:	4D015C5P00425

Support Equipment (continued)

Brand Name:	HDMI Cable Quantity 1. Length 3m.
Description:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Brand Name:	Ethernt Cable Cable Quantity 1. Length 1.5m.
Description:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

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

- 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, following “Instructions for RoomStar 601.docx”. The application was used to enable a continuous transmission mode 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
        - 802.11b / SISO & MIMO - DBPSK / 1 Mbps
        - 802.11g / SISO & MIMO - BPSK / 6 Mbps
        - 802.11n HT20 / SISO & MIMO - BPSK / MCS0
        - 802.11n HT40 / SISO & MIMO - BPSK / MCS0
    - Highest power spectral density
        - 802.11b / SISO & MIMO - DBPSK / 1 Mbps
        - 802.11g / SISO & MIMO - BPSK / 6 Mbps
        - 802.11n HT20 / SISO & MIMO - BPSK / MCS0
        - 802.11n HT40 / SISO & MIMO - BPSK / MCS0
    - Widest bandwidth
        - 802.11b / SISO & MIMO - DBPSK / 1 Mbps
        - 802.11g / SISO & MIMO - 16QAM / 24 Mbps
        - 802.11n HT20 / SISO - 16QAM / MCS4
        - 802.11n HT20 / MIMO - 16QAM / MCS3
        - 802.11n HT40 / SISO & MIMO - 16QAM / MCS4
- The EUT has two separate antennas which correspond to two separate antenna ports. Tx Chain 0 and Tx Chain 1 correspond to antenna 1 and antenna 2 respectively.
- AC conducted emission were performed with the EUT transmitting with a data rate of 802.11n HT20 / MIMO / BPSK / MCS0. 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.
- Transmitter spurious emissions were performed with the EUT transmitting with a data rate of 802.11n HT20 / MIMO / BPSK / MCS0. This was found to be the worst case modulation scheme with regards to emissions after preliminary investigations and, as this mode emits the highest output power level, it was deemed to be the worst case.

Configuration and Peripherals (continued)

- Transmitter radiated spurious emissions tests were performed with the EUT in orientation stated below as they were found to be the worst case during pre-scans. All the accessories were individually connected and measurements made during the pre-scans to determine the worst case combination.
    - Below 1 GHz
        - Z-Axis The EUT was positioned vertically on its front face.
    - Above 1 GHz
        - Y Axis. The EUT was positioned on its back in its normal mode of operation.
- Radiated band edge emissions were performed with the EUT in the following orentionation as this procedurd the worst case position for band edge:
    - SISO & MIMO – Y Axis. The EUT was positioned on its back in its normal mode of operation.
- All active ports were terminated, employing all available accessories.
- The conducted sample with MAC address of 00226D476F28 was used for minimum 6 dB bandwidth, duty cycle, maximum output power and power spectral density tests.
- The radiated sample with MAC address of 00226D476F14 was used for all other tests.

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 AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	Andrew Edwards	**Test Date:**	07 April 2018
Test Sample MAC Address:	00226D476F14		

FCC Reference:	Part 15.207
Test Method Used:	ANSI C63.10 Section 6.2 / FCC KDB 174176 and notes below

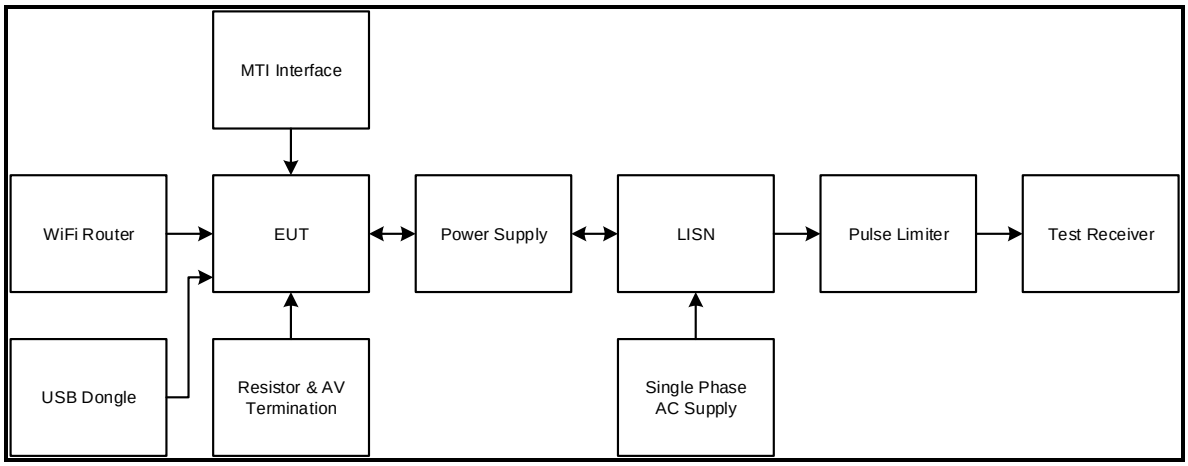
Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	31

Note(s):

1. The EUT was connected to the switch mode power supply, which was in turn connected to a 120 VAC 60 Hz single phase supply via a LISN.
2. In accordance with FCC KDB 174176 Q4, tests were performed with a 240 VAC 60 Hz single phase supply as this was within the voltage range marked on the 100-240 VAC~50/60 Hz power supply.
3. A pulse limiter was fitted between the LISN and the test receiver.
4. Pre-scans were performed and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered into the tables below.
5. Only the highest 6 emissions have been reported in the tables below in accordance with ANSI C63.10 section 6.2.5.

Test setup:



Transmitter AC Conducted Spurious Emissions (continued)

Results: Live / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.168	Live	61.2	65.1	3.9	Complied
0.204	Live	52.9	63.4	10.5	Complied
0.218	Live	58.0	62.9	4.9	Complied
0.267	Live	58.1	61.2	3.1	Complied
0.299	Live	55.8	60.3	4.5	Complied
0.470	Live	48.4	56.5	8.1	Complied

Results: Live / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.173	Live	44.7	54.8	10.1	Complied
0.173	Live	45.1	54.8	9.7	Complied
0.218	Live	41.4	52.9	11.5	Complied
0.267	Live	39.3	51.2	11.9	Complied
0.308	Live	36.3	50.0	13.7	Complied
0.393	Live	33.7	48.0	14.3	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

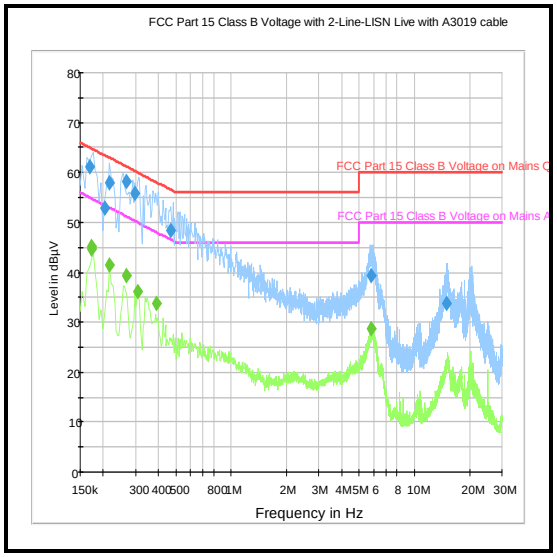
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.191	Neutral	54.9	64.0	9.1	Complied
0.263	Neutral	58.0	61.4	3.4	Complied
0.272	Neutral	58.5	61.1	2.6	Complied
0.308	Neutral	56.2	60.0	3.8	Complied
0.402	Neutral	52.2	57.8	5.6	Complied
0.645	Neutral	46.5	56.0	9.5	Complied

Results: Neutral / Average / 120 VAC 60 Hz

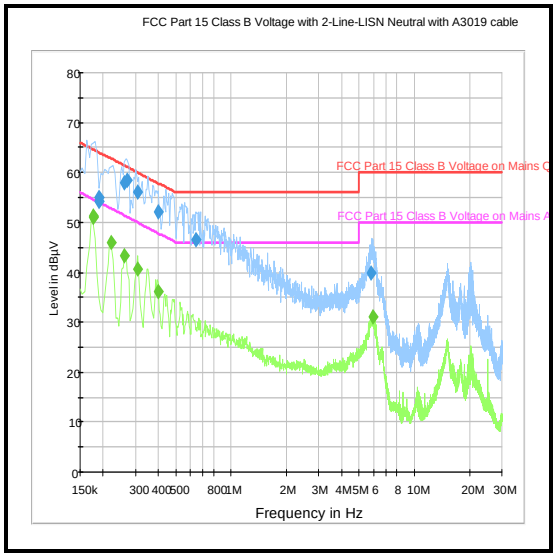
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.177	Neutral	51.0	54.6	3.6	Complied
0.177	Neutral	51.4	54.6	3.2	Complied
0.222	Neutral	46.1	52.7	6.6	Complied
0.263	Neutral	43.3	51.4	8.1	Complied
0.308	Neutral	40.6	50.0	9.4	Complied
0.402	Neutral	36.2	47.8	11.6	Complied

Transmitter AC Conducted Spurious Emissions (continued)

Results: 120 VAC 60 Hz



Live



Neutral

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

Transmitter AC Conducted Spurious Emissions (continued)

Results: Live / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.177	Live	63.7	64.6	0.9	Complied
0.222	Live	59.1	62.7	3.6	Complied
0.267	Live	59.1	61.2	2.1	Complied
0.321	Live	52.3	59.7	7.4	Complied
0.357	Live	54.7	58.8	4.1	Complied
0.465	Live	50.9	56.6	5.7	Complied

Results: Live / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.173	Live	51.3	54.8	3.5	Complied
0.177	Live	51.4	54.6	3.2	Complied
0.222	Live	47.4	52.7	5.3	Complied
0.267	Live	44.3	51.2	6.9	Complied
0.312	Live	42.9	49.9	7.0	Complied
0.492	Live	36.7	46.1	9.4	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

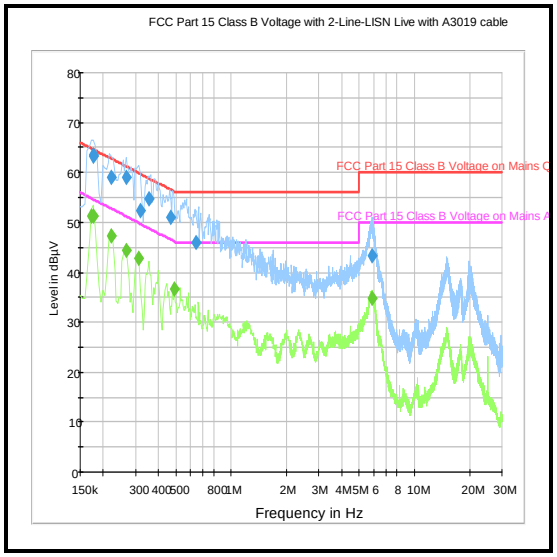
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.173	Neutral	63.3	64.8	1.5	Complied
0.182	Neutral	63.0	64.4	1.4	Complied
0.213	Neutral	58.3	63.1	4.8	Complied
0.254	Neutral	57.9	61.6	3.7	Complied
0.299	Neutral	56.3	60.3	4.0	Complied
0.303	Neutral	55.7	60.2	4.5	Complied

Results: Neutral / Average / 240 VAC 60 Hz

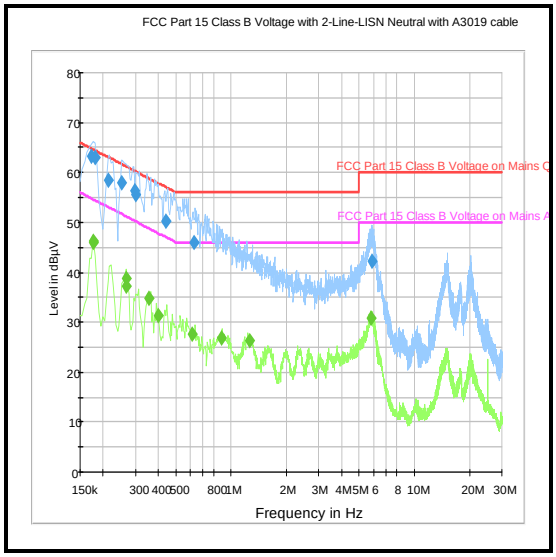
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.177	Neutral	46.2	54.6	8.4	Complied
0.177	Neutral	46.0	54.6	8.6	Complied
0.267	Neutral	38.7	51.2	12.5	Complied
0.267	Neutral	37.3	51.2	13.9	Complied
0.357	Neutral	34.8	48.8	14.0	Complied
0.402	Neutral	31.5	47.8	16.3	Complied

Transmitter AC Conducted Spurious Emissions (continued)

Results: 240 VAC 60 Hz



Live



Neutral

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

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2013	Thermohygrometer	Testo	608-H1	45046419	20 Jun 2018	12
M1263	Test Receiver	Rohde & Schwarz	ESIB7	100265	13 Nov 2018	12
A649	LISN	Rohde & Schwarz	ESH3-Z5	825562/008	31 May 2018	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	06 Apr 2019	12
M1229	Multimeter	Fluke	179	87640015	12 Apr 2018	12
A2953	Variable AC Power Supply	Tacima	SC 5467	Not stated	Calibrated before use	-

5.2.2. Transmitter Minimum 6 dB Bandwidth

Test Summary:

Test Engineers:	Philip Harrison, Stefan Ho & Patrick Jones	**Test Dates:**	23 January 2018 to 18 May 2018
Test Sample MAC Address:	00226D476F28		

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

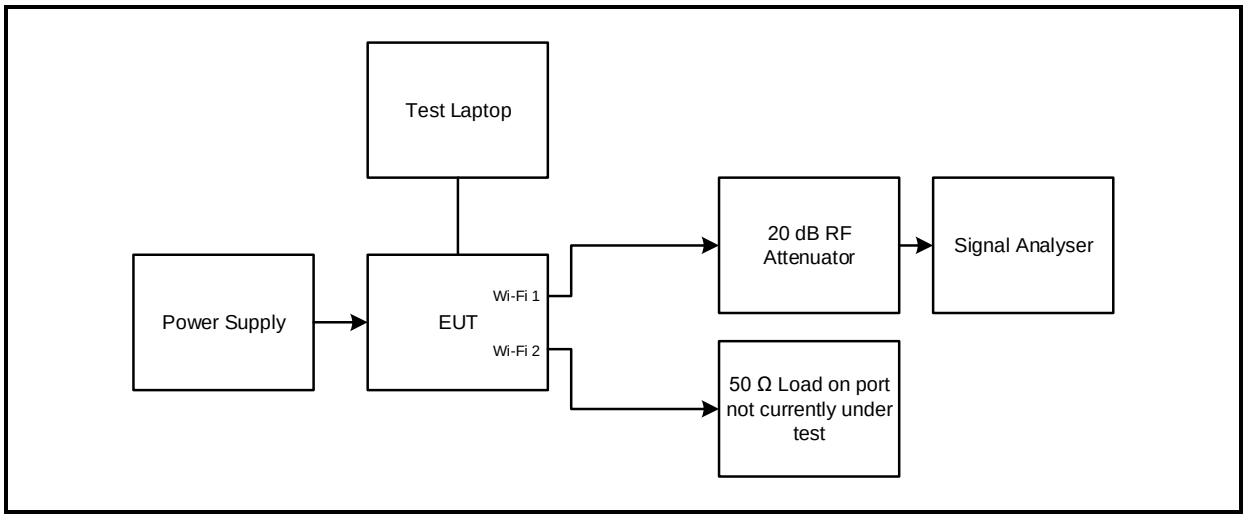
Environmental Conditions:

Temperature (°C):	23 to 24
Relative Humidity (%):	38 to 53

Note(s):

1. All configurations supported by the EUT were investigated on one channel in accordance with KDB 558074 Section 8.1 Option 1 measurement procedure. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and the trace mode was set to max hold. The span was set to 60 MHz for 20 MHz channel bandwidth and 120 MHz for 40 MHz channel bandwidth. The DTS 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:
    - 802.11b / SISO – DQPSK / 5.5 Mbps
    - 802.11b / MIMO – DBPSK / 2 Mbps
    - 802.11g / SISO & MIMO – BPSK / 6 Mbps
    - 802.11n HT20 / SISO & MIMO – BPSK / MCS0
    - 802.11n HT40 / SISO & MIMO – BPSK / MCS0
2. Final measurements were performed using the above configurations on the bottom, middle and top channels in accordance with KDB 558074 Section 8.1 Option 1 measurement procedure.
3. Plots for all data rates are archived on the company server and available for inspection upon request.
4. The signal analyser was connected to the EUT RF port using a coaxial cable and suitable attenuation.

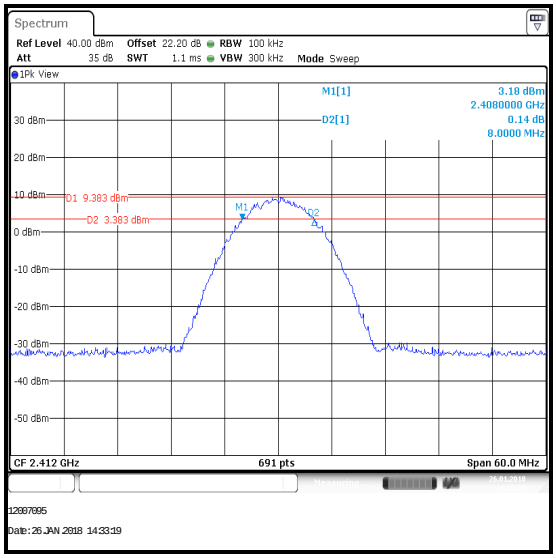
Test setup:


Test Laptop
Power Supply
EUT
Wi-Fi 1
Wi-Fi 2
20 dB RF Attenuator
Signal Analyser
50 Ω Load on port not currently under test

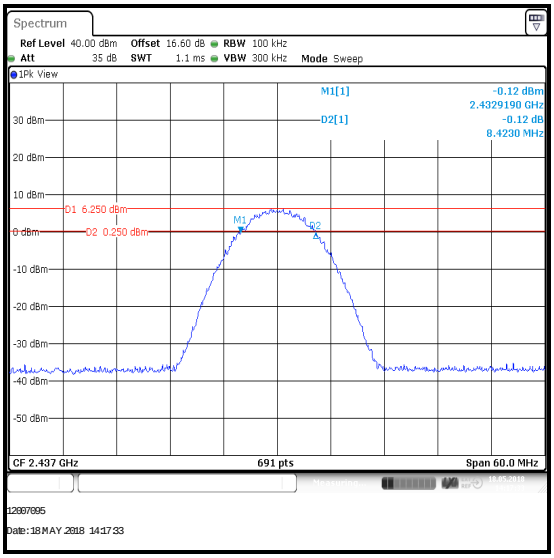
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11b / 20 MHz / DQPSK / 5.5 Mbps / SISO

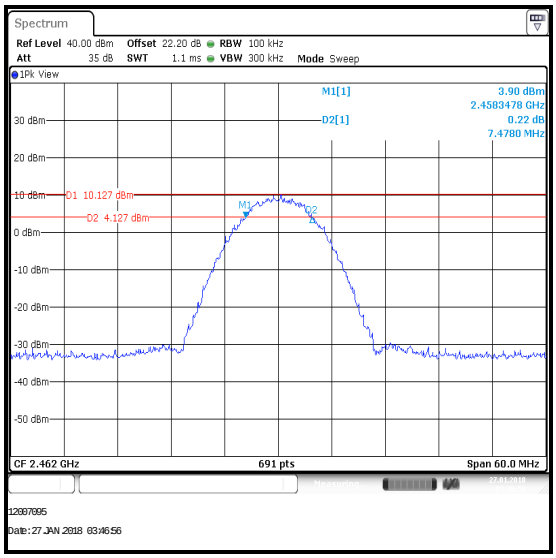
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	8000	≥500	7500	Complied
Middle	8423	≥500	7923	Complied
Top	7478	≥500	6978	Complied



Bottom Channel



Middle Channel

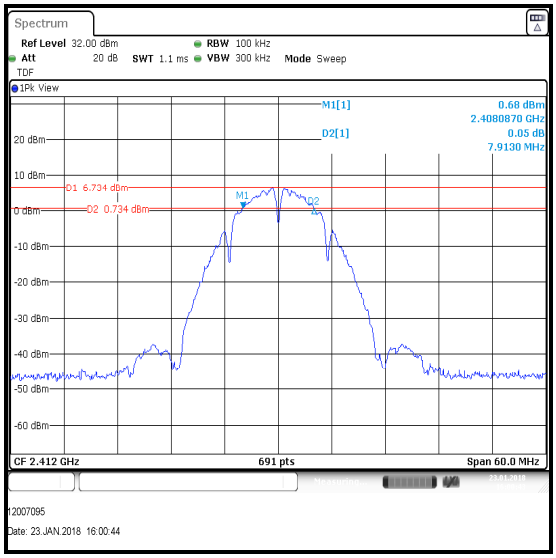


Top Channel

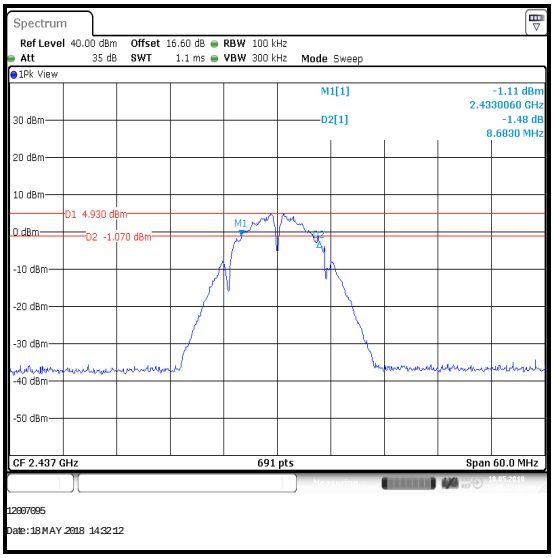
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11b / 20 MHz / DBPSK / 2 Mbps / MIMO Port 0

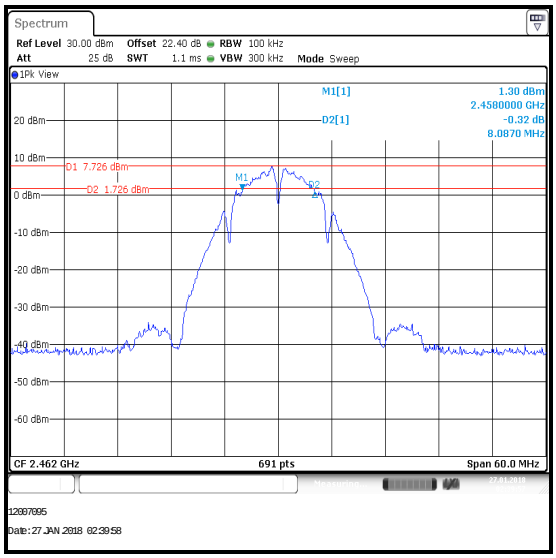
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	7913	≥500	7413	Complied
Middle	8683	≥500	8183	Complied
Top	8087	≥500	7587	Complied



Bottom Channel



Middle Channel

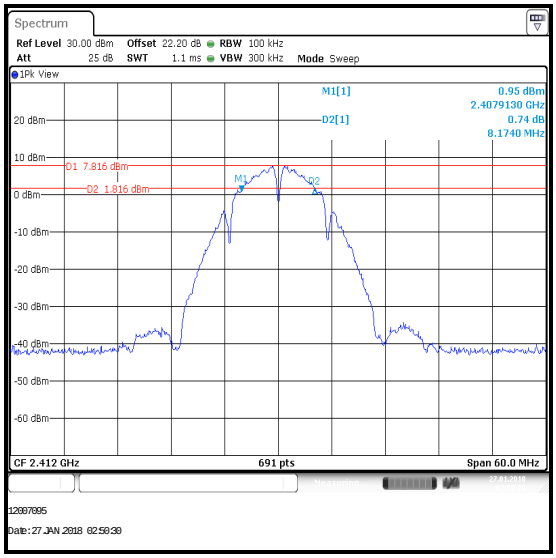


Top Channel

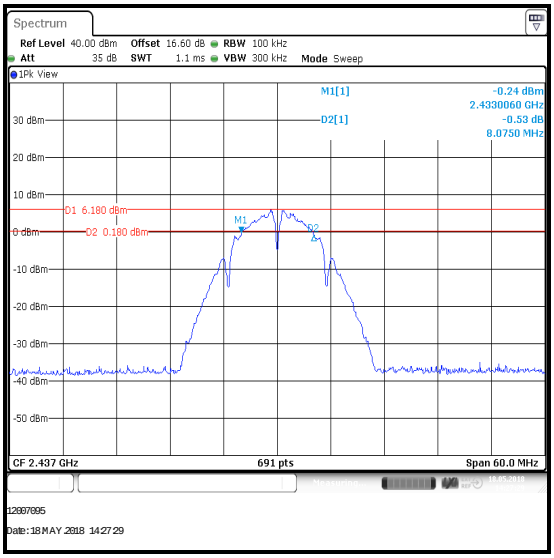
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11b / 20 MHz / DBPSK / 2 Mbps / MIMO Port 1

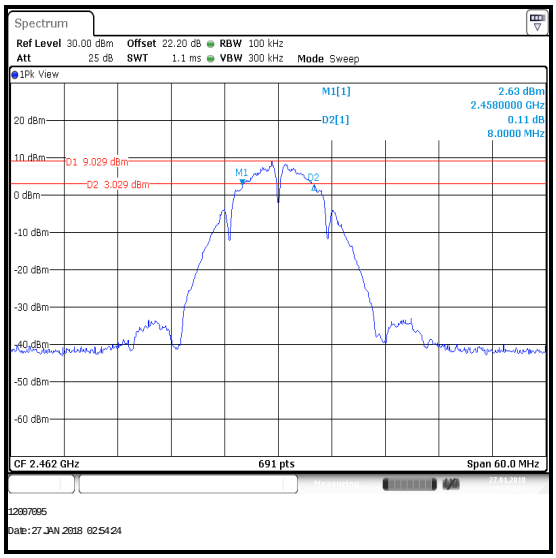
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	8174	≥500	7674	Complied
Middle	8075	≥500	7575	Complied
Top	8000	≥500	7500	Complied



Bottom Channel



Middle Channel

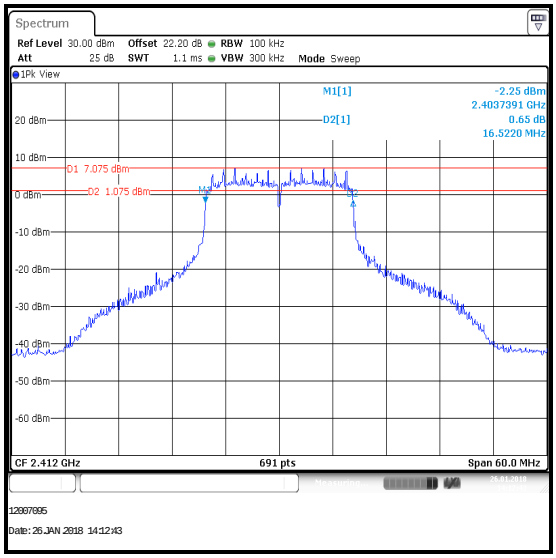


Top Channel

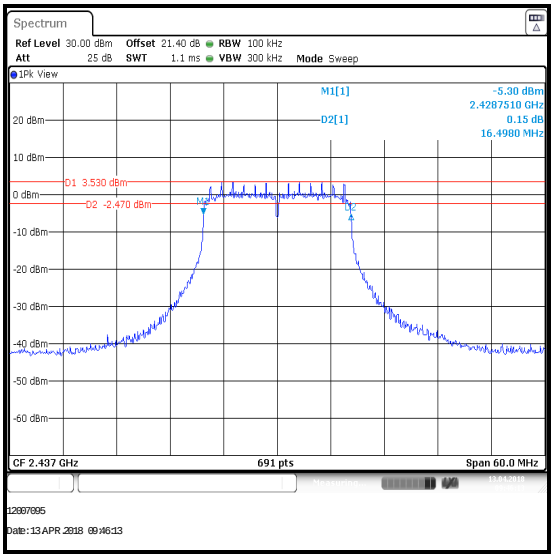
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11g / 20 MHz / BPSK / 6 Mbps / SISO

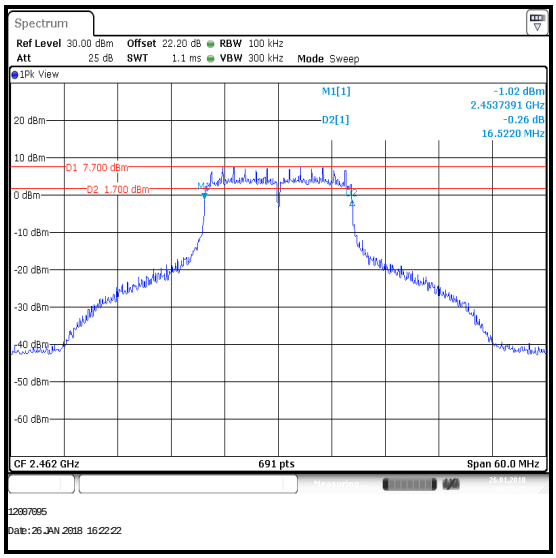
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	16522	≥500	16022	Complied
Middle	16498	≥500	15998	Complied
Top	16522	≥500	16022	Complied



Bottom Channel



Middle Channel

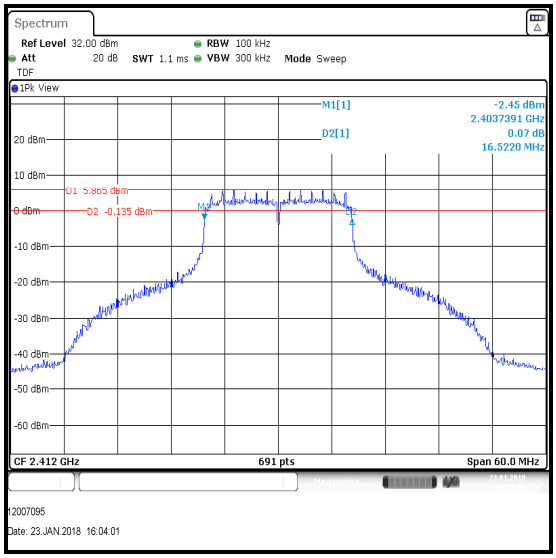


Top Channel

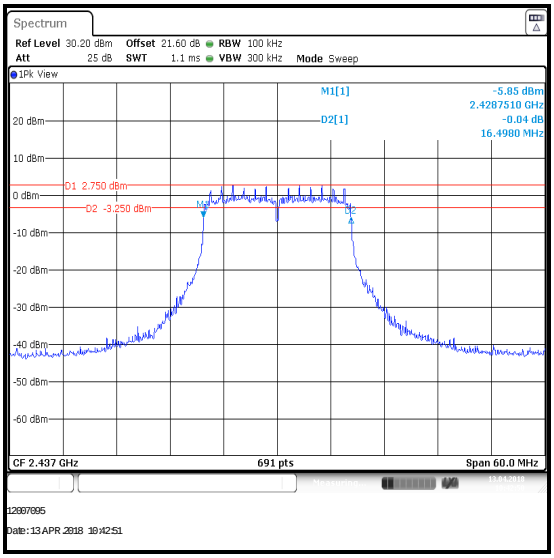
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11g / 20 MHz / BPSK / 6 Mbps / MIMO / Port 0

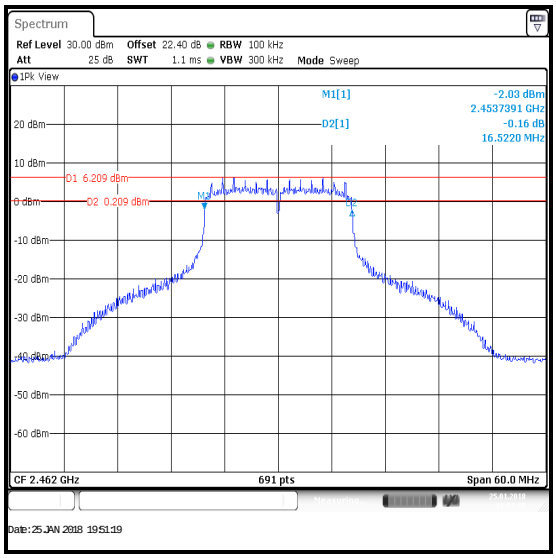
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	16522	≥500	16022	Complied
Middle	16498	≥500	15998	Complied
Top	16522	≥500	16022	Complied



Bottom Channel



Middle Channel

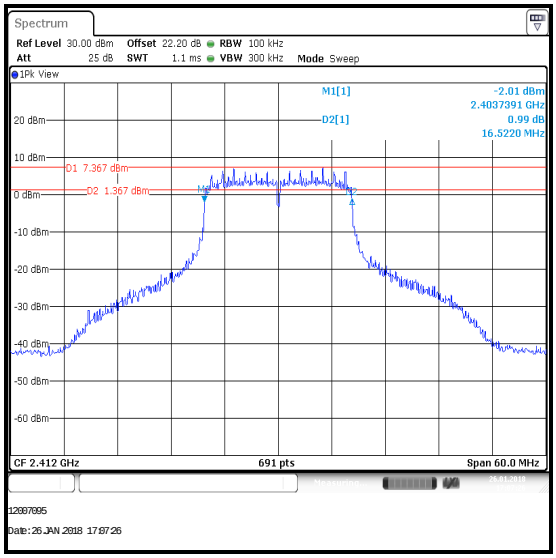


Top Channel

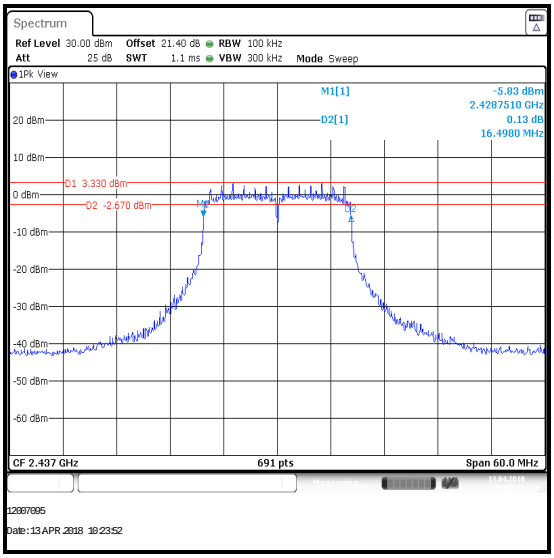
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11g / 20 MHz / BPSK / 6 Mbps / MIMO / Port 1

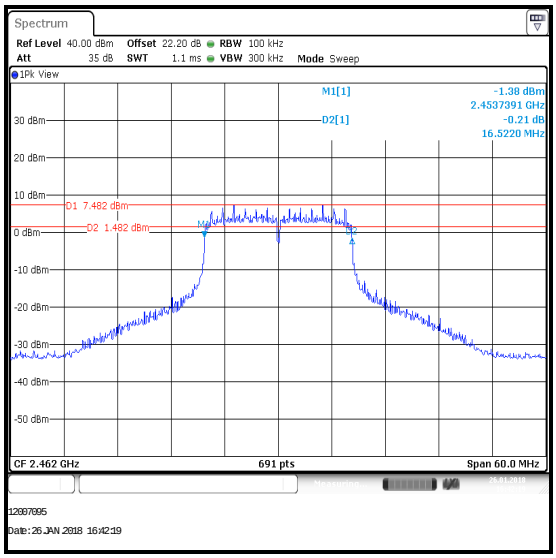
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	16522	≥500	16022	Complied
Middle	16498	≥500	15998	Complied
Top	16522	≥500	16022	Complied



Bottom Channel



Middle Channel

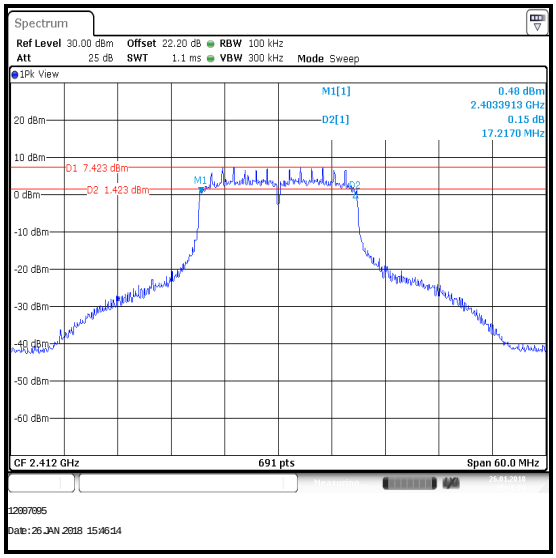


Top Channel

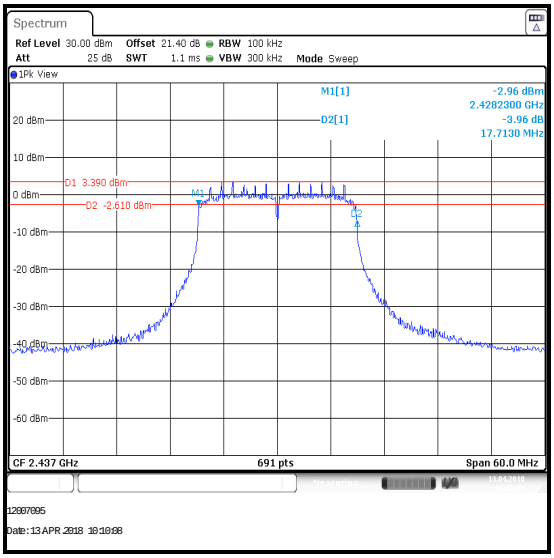
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11n / HT20 / BPSK / MCS0 / SISO

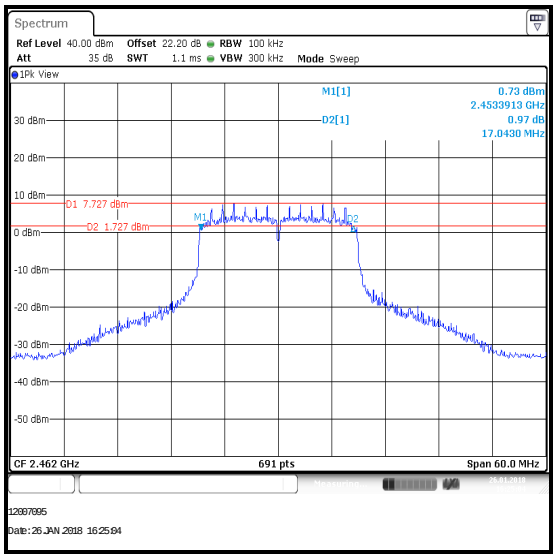
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	17217	≥500	16717	Complied
Middle	17713	≥500	17213	Complied
Top	17043	≥500	16543	Complied



Bottom Channel



Middle Channel

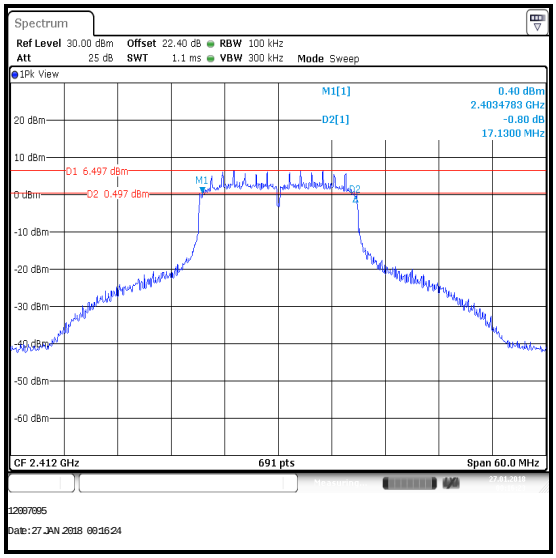


Top Channel

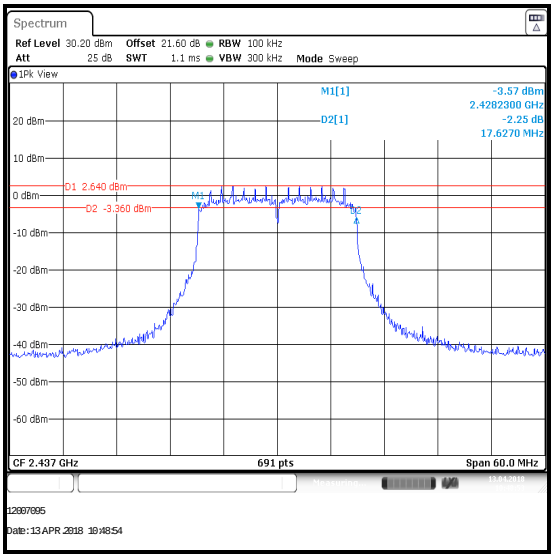
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11n / HT20 / BPSK / MCS0 / MIMO / Port 0

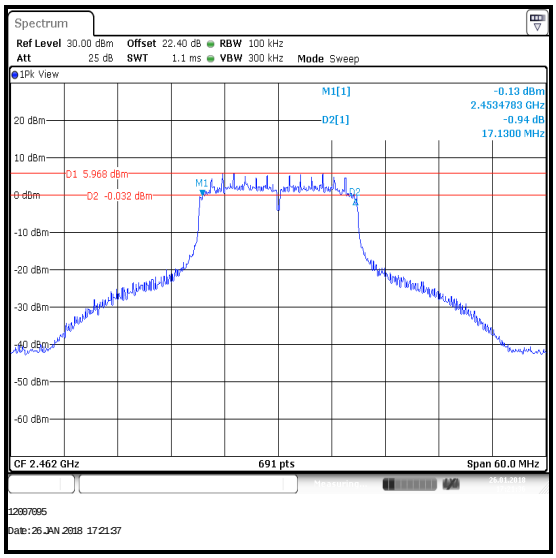
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	17130	≥500	16630	Complied
Middle	17627	≥500	17127	Complied
Top	17130	≥500	16630	Complied



Bottom Channel



Middle Channel

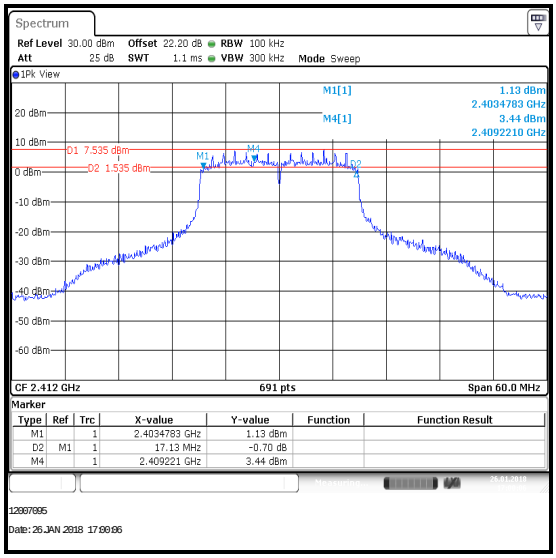


Top Channel

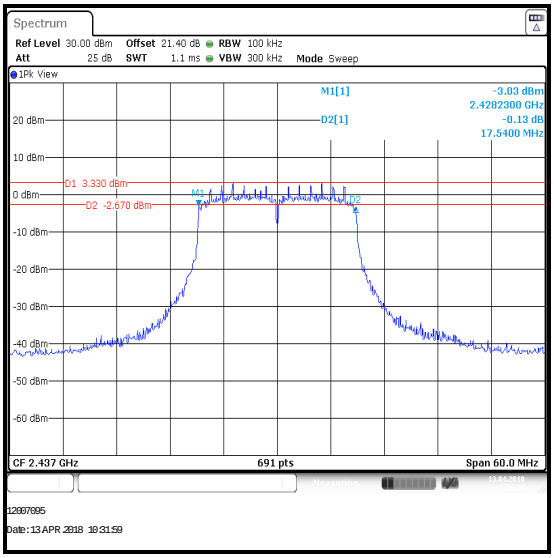
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11n / HT20 / BPSK / MCS0 / MIMO / Port 1

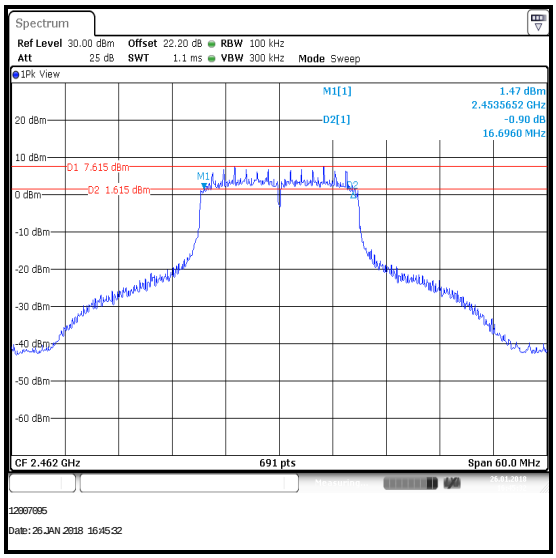
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	17130	≥500	16630	Complied
Middle	17540	≥500	17040	Complied
Top	16696	≥500	16196	Complied



Bottom Channel



Middle Channel

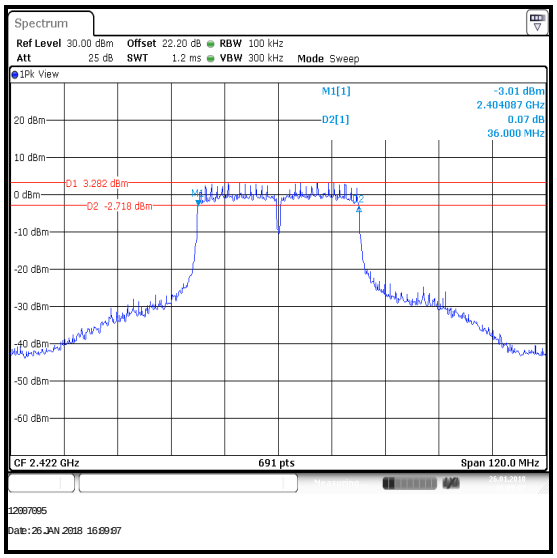


Top Channel

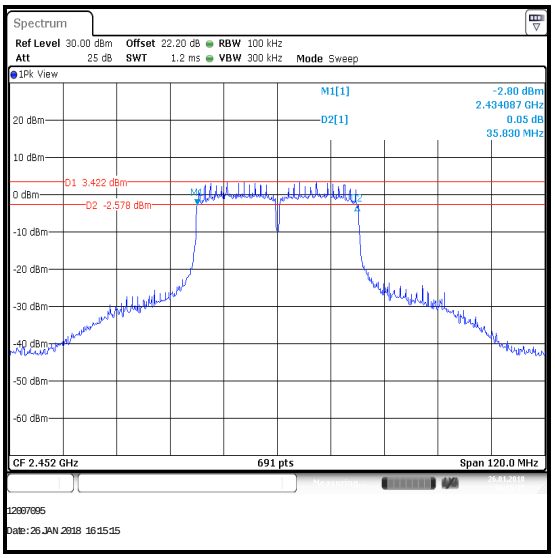
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11n / HT40 / BPSK / MCS0 / SISO

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	36000	≥500	35500	Complied
Top	35830	≥500	35330	Complied



Bottom Channel

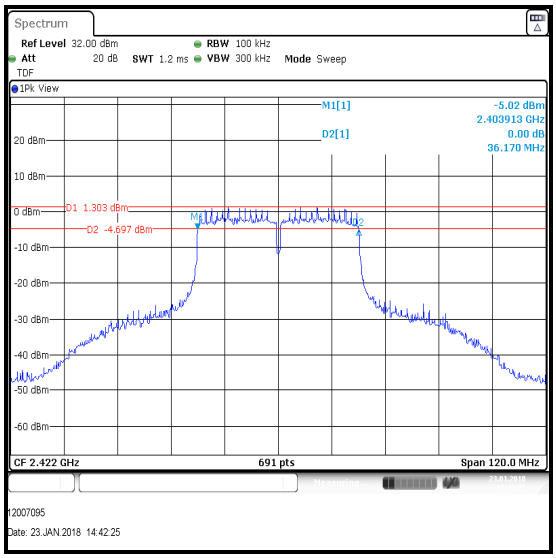


Top Channel

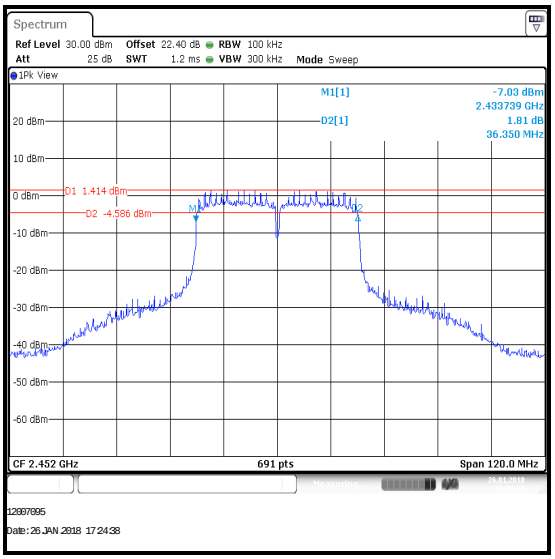
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11n / HT40 / BPSK / MCS0 / MIMO / Port 0

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	36170	≥500	35670	Complied
Top	36350	≥500	35850	Complied



Bottom Channel

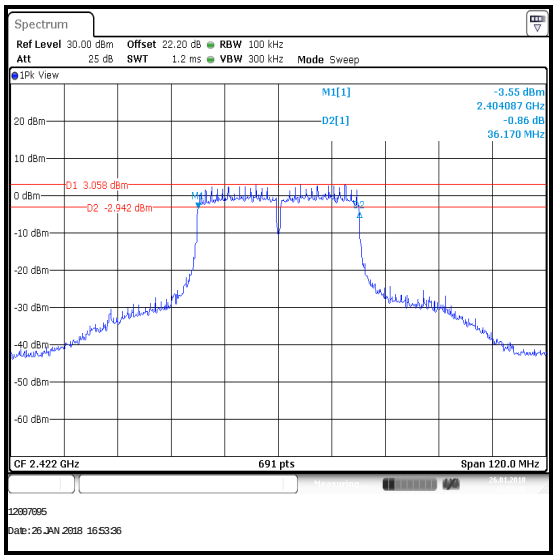


Top Channel

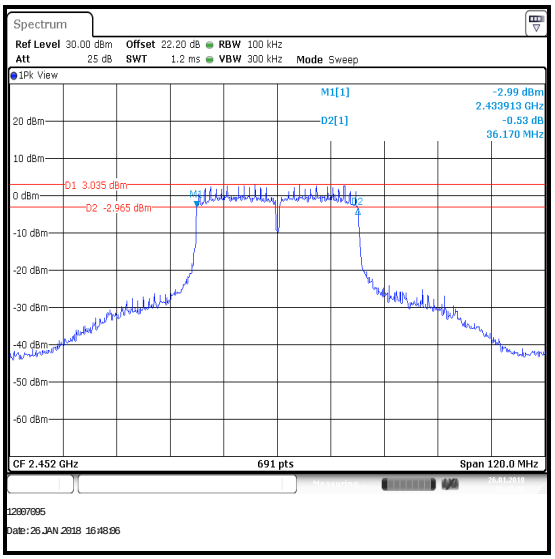
Transmitter Minimum 6 dB Bandwidth (continued)

Results: 802.11n / HT40 / BPSK / MCS0 / MIMO / Port 1

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	36170	≥500	35670	Complied
Top	36170	≥500	35670	Complied



Bottom Channel



Top Channel

Transmitter Minimum 6 dB Bandwidth (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2005	Thermohygrometer	Testo	608-H1	45046700	28 Feb 2019	12
M1873	Signal Analyser	Rohde & Schwarz	FSV30	103074	06 Jun 2018	12
M1835	Signal Analyser	Rohde & Schwarz	FSV30	103050	19 Mar 2019	12
G0628	Vector Signal Generator	Rohde & Schwarz	SMBV100A	261847	28 Sep 2020	36
A2631	Attenuator	Weinschel Associates	WA75-6-12	A300	Calibrated before use	-
A2633	Attenuator	Weinschel Associates	WA75-10-12	A302	Calibrated before use	-
A2922	Attenuator	AtlanTecRF	AN18W5-20	832828#5	Calibrated before use	-
A2923	Attenuator	AtlanTecRF	AN18W5-20	832828#6	Calibrated before use	-

5.2.3. Transmitter Duty Cycle

Test Summary:

Test Engineer:	Philip Harrison	**Test Dates:**	24 January 2018, 25 January 2018 & 26 January 2018
Test Sample MAC Address:	00226D476F28		

FCC Reference:	Part 15.35(c)
Test Method Used:	FCC KDB 558074 Section 6.0

Environmental Conditions:

Temperature (°C):	22 to 25
Relative Humidity (%):	45 to 53

Note(s):

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

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

802.11g / 20 MHz / 6 Mbps duty cycle 10 log (1 / (1.432/1.521)) = 0.3 dB

802.11g / 20 MHz / 24 Mbps duty cycle 10 log (1 / (0.376/0.482)) = 1.1 dB

802.11n / HT20 / MCS0 duty cycle: 10 log (1 / (1.340/1.447)) = 0.3 dB

802.11n / HT20 / MCS3 duty cycle: 10 log (1 / (0.364/0.470)) = 1.1 dB

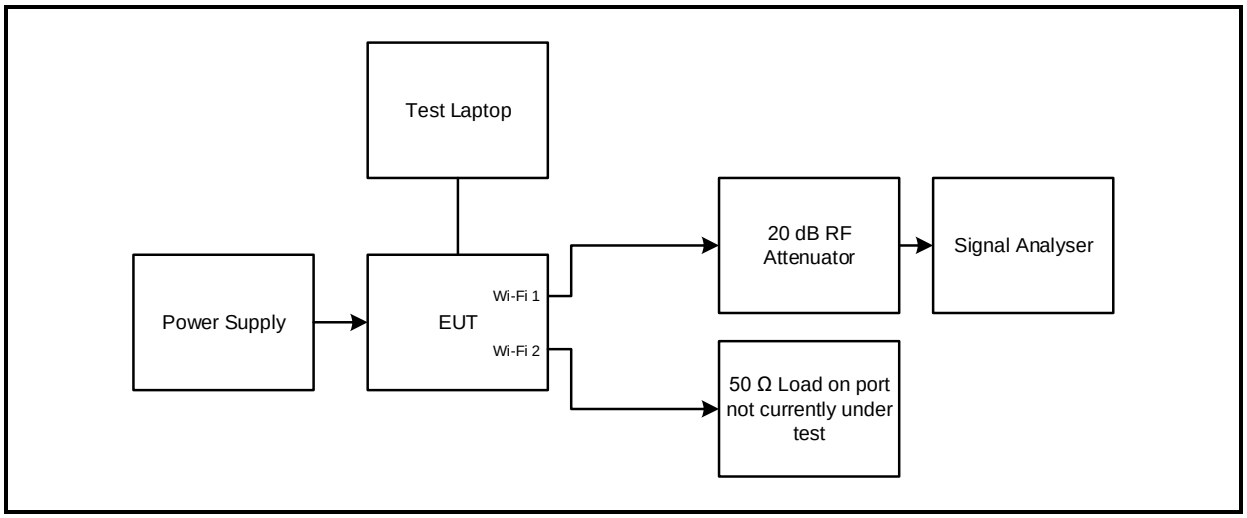
802.11n / HT20 / MCS4 duty cycle: 10 log (1 / (0.256/0.344)) = 1.3 dB

802.11n / HT40 / MCS0 duty cycle: 10 log (1 / (0.664/0.779)) = 0.7 dB

802.11n / HT40 / MCS4 duty cycle: 10 log (1 / (0.144/0.241)) = 2.2dB

2. For 802.11b, the duty cycle was measured to be greater than 98%.

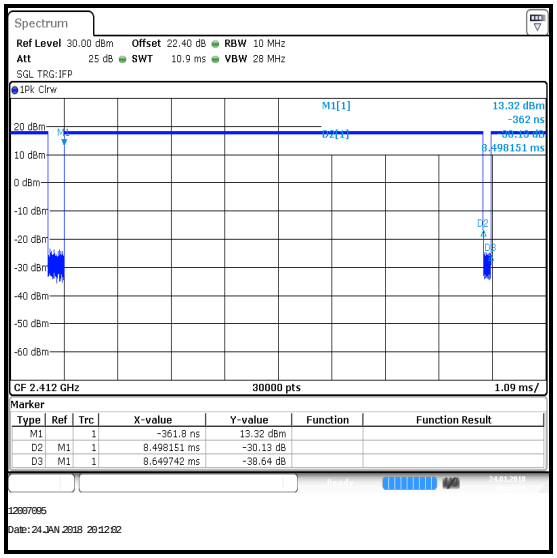
Test setup:



Transmitter Duty Cycle (continued)

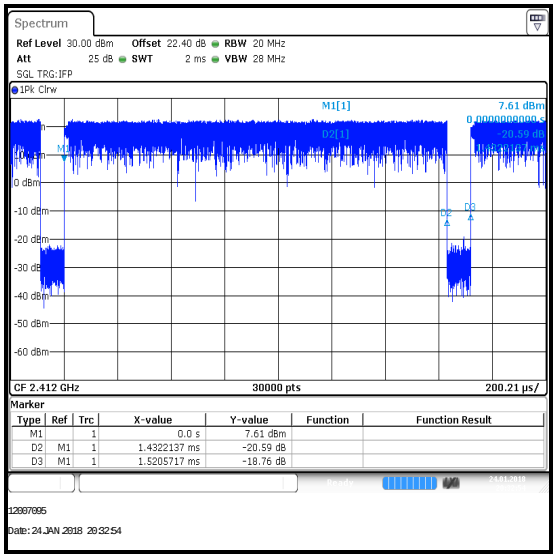
Results: 802.11b / 20 MHz / 1 Mbps

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
8.498	8.650	0.0



Results: 802.11g / 20 MHz / 6 Mbps

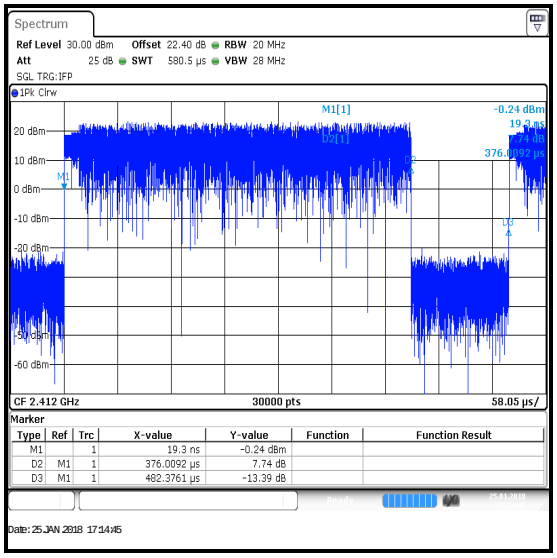
Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
1.432	1.521	0.3



Transmitter Duty Cycle (continued)

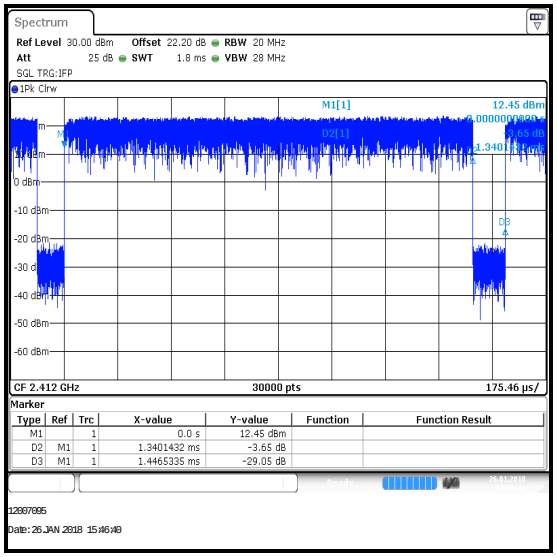
Results: 802.11g / 20 MHz / 24 Mbps

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.376	0.482	1.1



Results: 802.11n / HT20 / MCS0

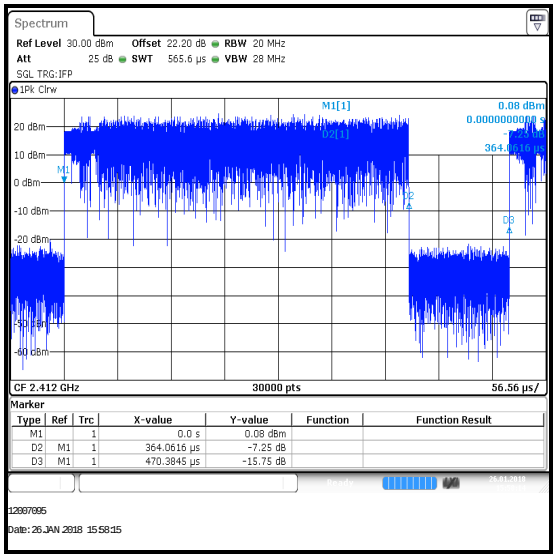
Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
1.340	1.447	0.3



Transmitter Duty Cycle (continued)

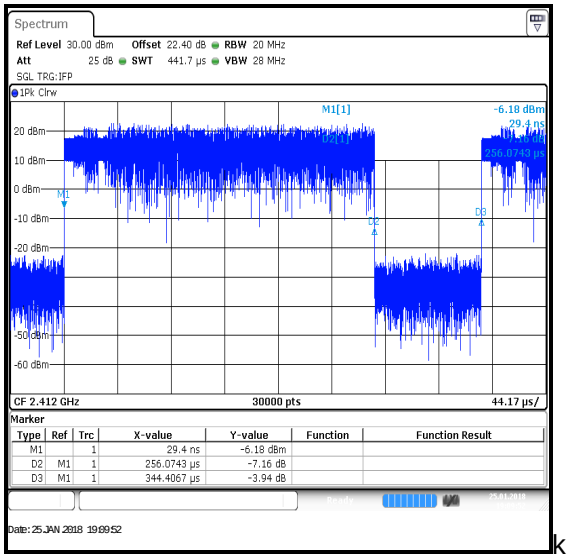
Results: 802.11n / HT20 / MCS3

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.364	0.470	1.1



Results: 802.11n / HT20 / MCS4

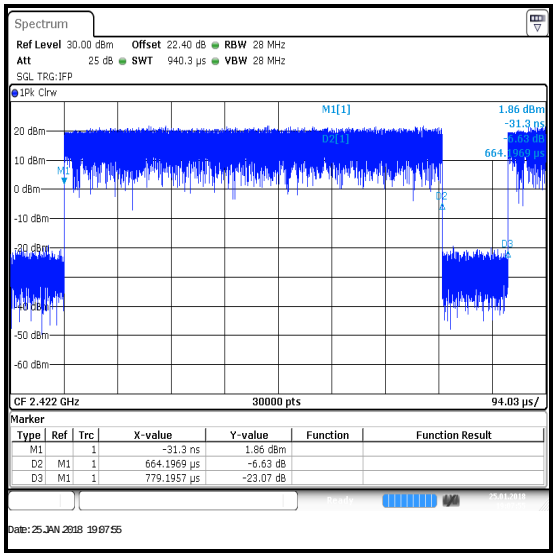
Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.256	0.344	1.3



Transmitter Duty Cycle (continued)

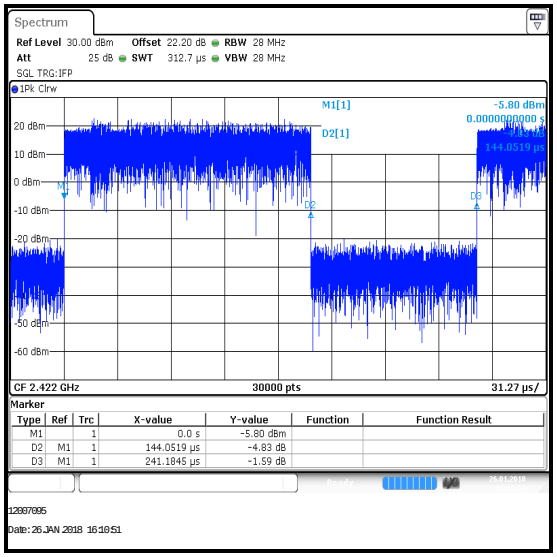
Results: 802.11n / HT40 / MCS0

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.664	0.779	0.7



Results: 802.11n / HT40 / MCS4

Pulse Duration (ms)	Period (ms)	Duty Cycle (dB)
0.144	0.241	2.2



Transmitter Duty Cycle (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2005	Thermohygrometer	Testo	608-H1	45046700	28 Feb 2019	12
M1873	Signal Analyser	Rohde & Schwarz	FSV30	103074	06 Jun 2018	12
G0628	Vector Signal Generator	Rohde & Schwarz	SMBV100A	261847	28 Sep 2020	36
A2922	Attenuator	AtlanTecRF	AN18W5-20	832828#5	Calibrated before use	-
A2923	Attenuator	AtlanTecRF	AN18W5-20	832828#6	Calibrated before use	-

5.2.4. Transmitter Power Spectral Density

Test Summary:

Test Engineers:	Stefan Ho & Patrick Jones	**Test Dates:**	13 April 2018 to 16 May 2018
Test Sample MAC Address:	00226D476F28		

FCC Reference:	Part 15.247(e)
Test Method Used:	FCC KDB 558074 Sections 10.3, 10.5 & 10.7

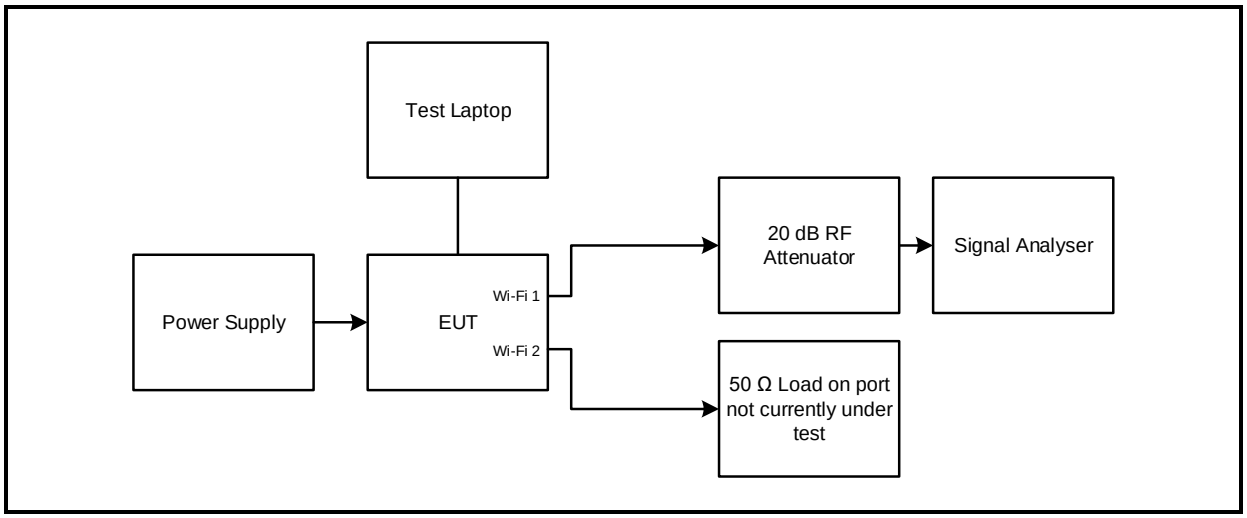
Environmental Conditions:

Temperature (°C):	23 to 24
Relative Humidity (%):	37 to 48

Note(s):

1. All supported modes and channel widths were initially investigated on one channel. The modes that produced the highest power were:
    - 802.11b / SISO & MIMO - DBPSK / 1 Mbps
    - 802.11g / SISO & MIMO - BPSK / 6 Mbps
    - 802.11n HT20 / SISO & MIMO- BPSK / MCS0
    - 802.11n HT40 / SISO & MIMO - BPSK / MCS0
2. Final measurements were performed using the above configurations on the bottom, middle and top channels.
3. For 802.11b the EUT was transmitting at ≥98% duty cycle. Testing was therefore performed in accordance with KDB 558074 Section 10.3 Method AVGPSD-1. The signal analyser resolution bandwidth was set to 50 kHz and video bandwidth 200 kHz. An RMS detector was used and sweep time set to auto coupled to perform trace averaging over at least 100 traces. The span was set to at least 1.5 times the 99% occupied emission bandwidth. The highest peak of the measured signal was recorded.
4. For 802.11g SISO and 802.11n HTXX SISO, the EUT was transmitting at <98% duty cycle with < 2% variation. Testing was therefore performed in accordance with KDB 558074 Section 10.5 Method AVGPSD-2. The signal analyser resolution bandwidth was set to 50 kHz and video bandwidth 200 kHz. An RMS detector was used and sweep time set to auto coupled. The span was set to at least 1.5 times the 99% occupied emission bandwidth. The calculated duty cycle in section 5.2.3 was added to the measured average power spectral density in order to compute the average power spectral density during the actual transmission time.
5. For 802.11g MIMO and 802.11n HTXX MIMO, the EUT was transmitting at <98% duty cycle with >2% variation. Testing was therefore performed in accordance with KDB 558074 Section 10.7 Method AVGPSD-3. The signal analyser resolution bandwidth was set to 50 kHz and video bandwidth 200 kHz. An RMS detector was used and sweep time set to 100 ms or 1 second as appropriate. The trace type was set to max hold and left to stabilise for at least 60 seconds. The span was set to at least 1.5 times the 99% occupied emission bandwidth. The highest peak of the measured signal was recorded.
6. For MIMO measurements, PSD was measured on both ports and then combined using the *measure and sum spectral maxima across the outputs* technique, stated in FCC KDB 662911 D01 Section E)2)b).
7. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.

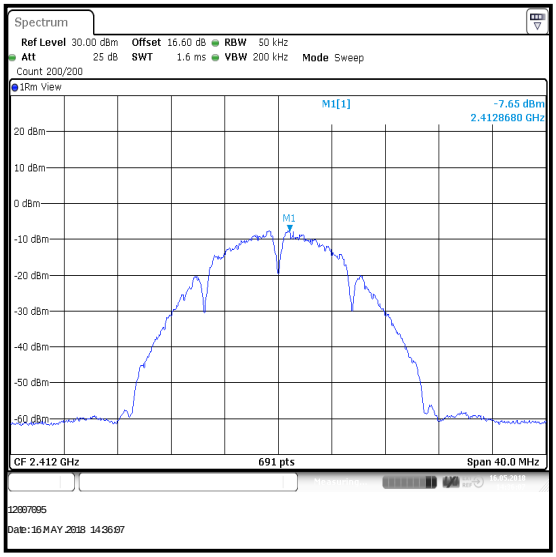
Test setup:


Test Laptop
Power Supply
EUT
Wi-Fi 1
Wi-Fi 2
20 dB RF Attenuator
Signal Analyser
50 Ω Load on port not currently under test

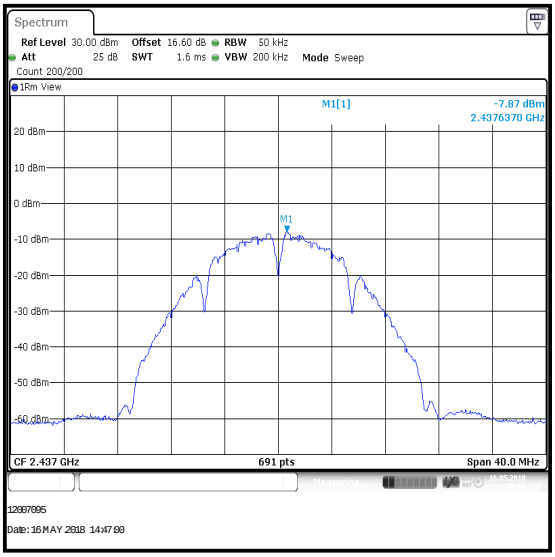
Transmitter Power Spectral Density (continued)

Results: 802.11b / 20 MHz / DBPSK / 1 Mbps / SISO / Port 1

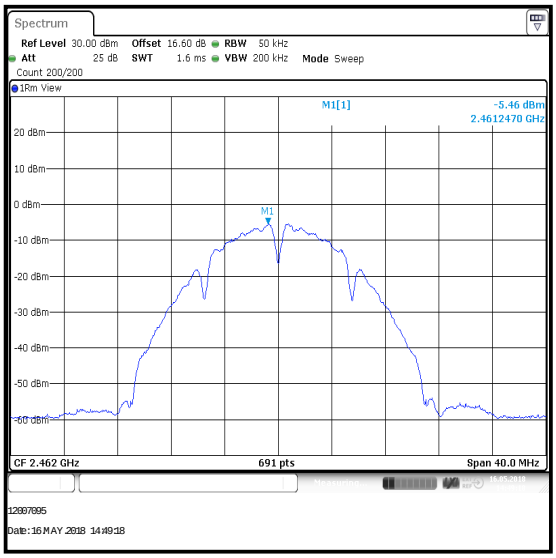
Channel	Output Power (dBm/3 kHz)	Limit (dBm/3kHz)	Margin (dB)	Result
Bottom	-7.7	8.0	15.7	Complied
Middle	-7.9	8.0	15.9	Complied
Top	-5.5	8.0	13.5	Complied



Bottom Channel



Middle Channel

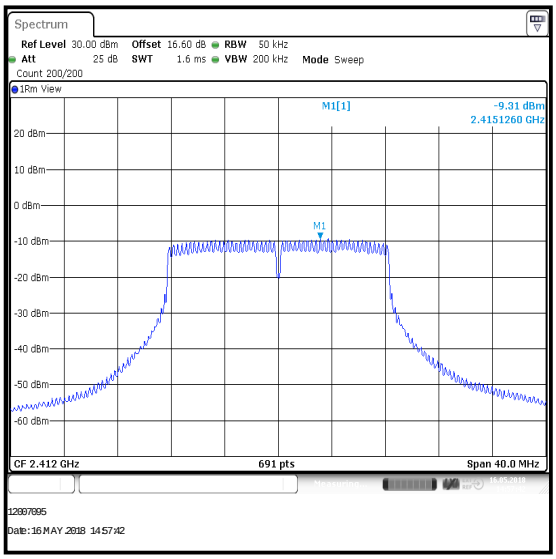


Top Channel

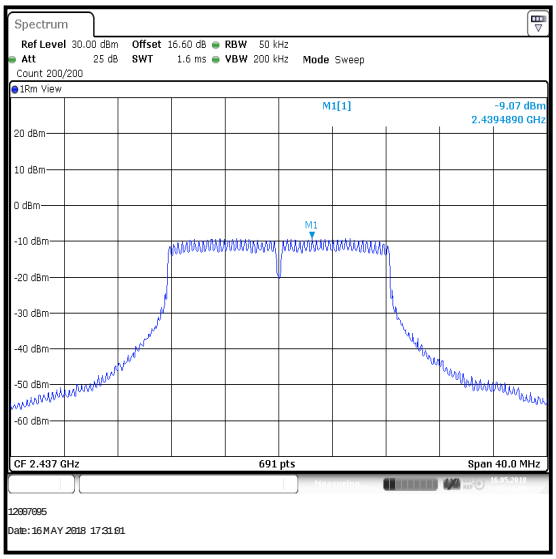
Transmitter Power Spectral Density (continued)

Results: 802.11g / 20 MHz / BPSK / 6 Mbps / Port 1

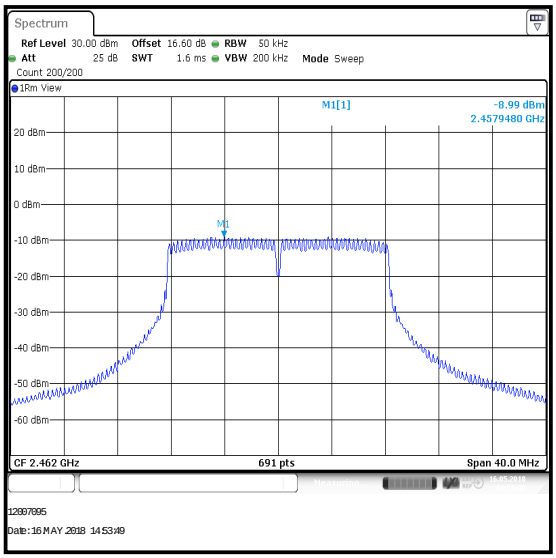
Channel	Output Power (dBm/3 kHz)	Duty Cycle Correction (dB)	Corrected PSD (dBm/3 kHz)	Limit (dBm/3kHz)	Margin (dB)	Result
Bottom	-9.3	0.3	-9.0	8.0	17.0	Complied
Middle	-9.1	0.3	-8.8	8.0	16.8	Complied
Top	-9.0	0.3	-8.7	8.0	16.7	Complied



Bottom Channel



Middle Channel

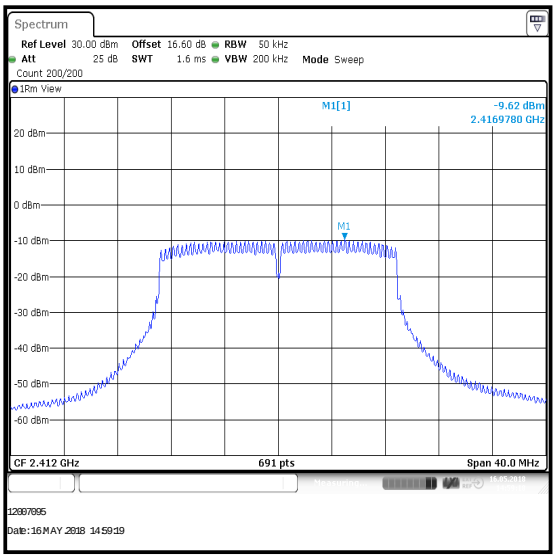


Top Channel

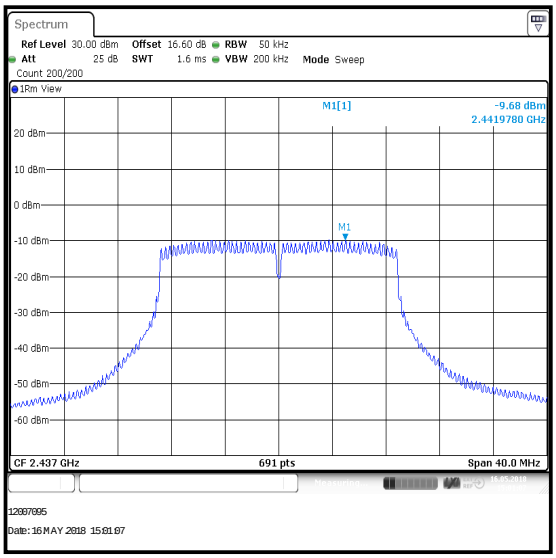
Transmitter Power Spectral Density (continued)

Results: 802.11n / HT20 / BPSK / MCS0 / SISO / Port 1

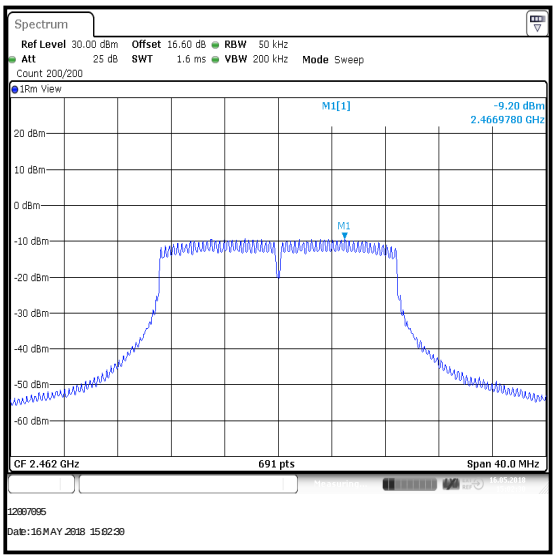
Channel	Output Power (dBm/3 kHz)	Duty Cycle Correction (dB)	Corrected PSD (dBm/3 kHz)	Limit (dBm/3kHz)	Margin (dB)	Result
Bottom	-9.6	0.3	-9.3	8.0	17.3	Complied
Middle	-9.7	0.3	-9.4	8.0	17.4	Complied
Top	-9.2	0.3	-8.9	8.0	16.9	Complied



Bottom Channel



Middle Channel

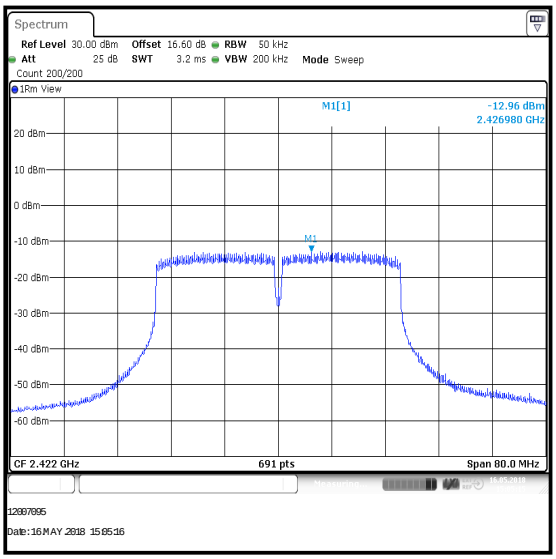


Top Channel

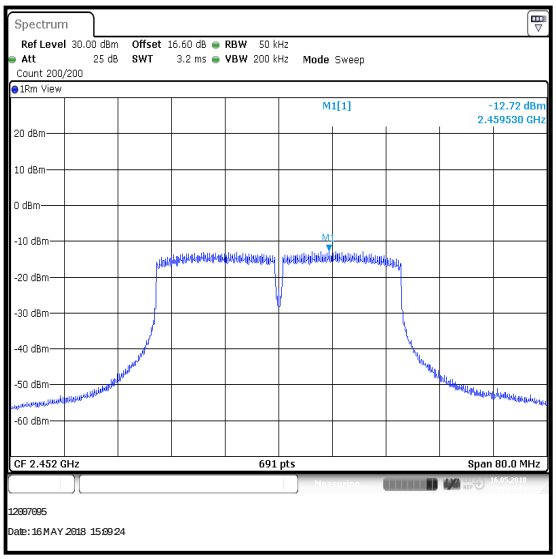
Transmitter Power Spectral Density (continued)

Results: 802.11n / HT40 / BPSK / MCS0 / SISO / Port 1

Channel	Output Power (dBm/3 kHz)	Duty Cycle Correction (dB)	Corrected PSD (dBm/3 kHz)	Limit (dBm/3kHz)	Margin (dB)	Result
Bottom	-13.0	0.7	-12.3	8.0	20.3	Complied
Top	-12.7	0.7	-12.0	8.0	20.0	Complied



Bottom Channel



Top Channel

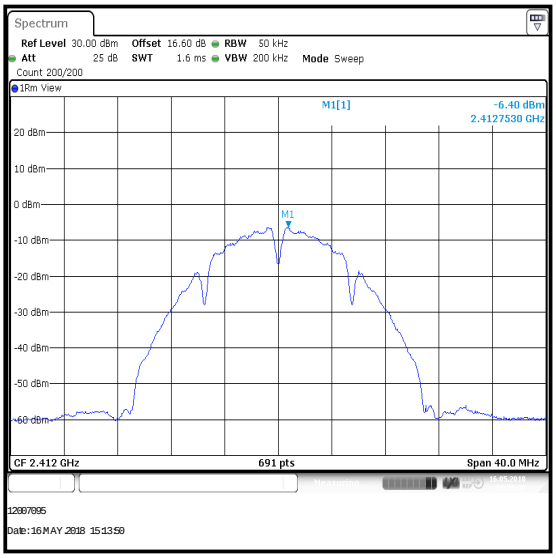
Transmitter Power Spectral Density (continued)

Results: 802.11b / 20 MHz / DBPSK / 1 Mbps / MIMO

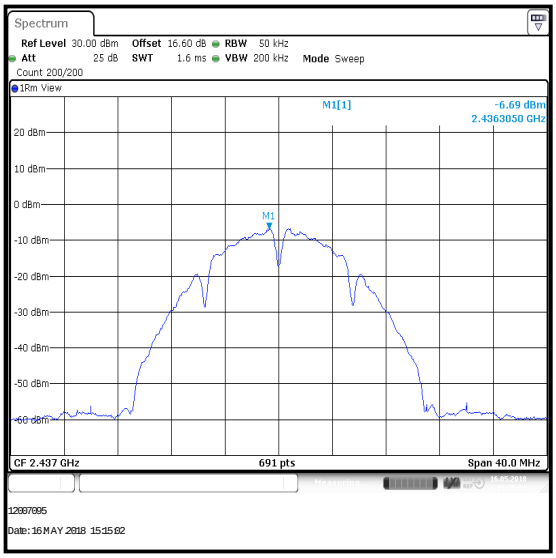
Channel	PSD at Port 0 (dBm / 3 kHz)	PSD at Port 1 (dBm / 3 kHz)	Combined PSD (dBm / 3 kHz)	PSD Limit (dBm / 3 kHz)	Margin (dB)	Result
Bottom	-6.4	-6.2	-3.3	8.0	11.3	Complied
Middle	-6.7	-5.6	-3.1	8.0	11.1	Complied
Top	-6.8	-5.8	-3.3	8.0	11.3	Complied

Transmitter Power Spectral Density (continued)

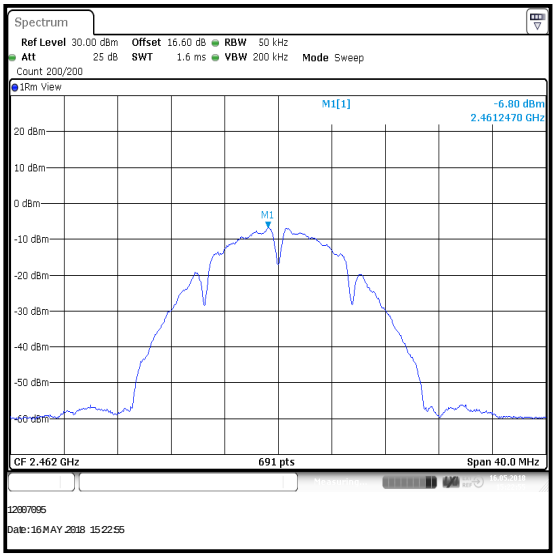
Results: 802.11b / 20 MHz / DBPSK / 1 Mbps / MIMO / Port 0



Bottom Channel



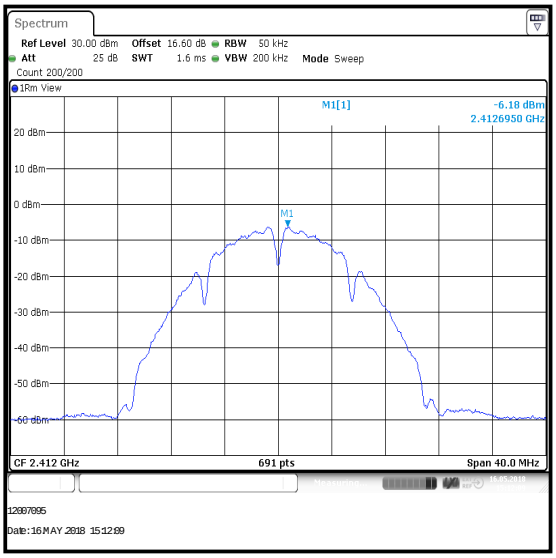
Middle Channel



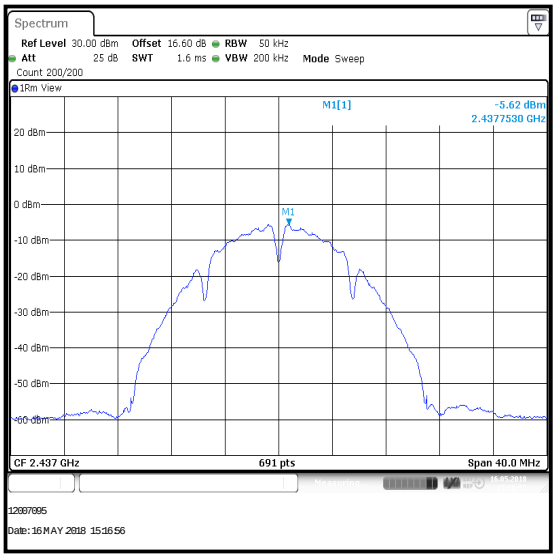
Top Channel

Transmitter Power Spectral Density (continued)

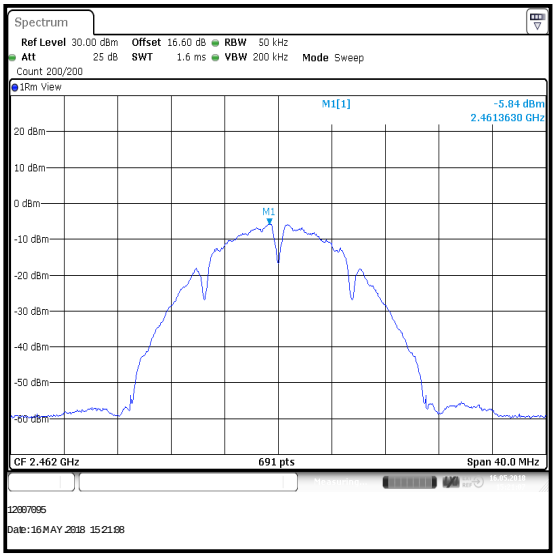
Results: 802.11b / 20 MHz / DBPSK / 1 Mbps / MIMO / Port 1



Bottom Channel



Middle Channel



Top Channel

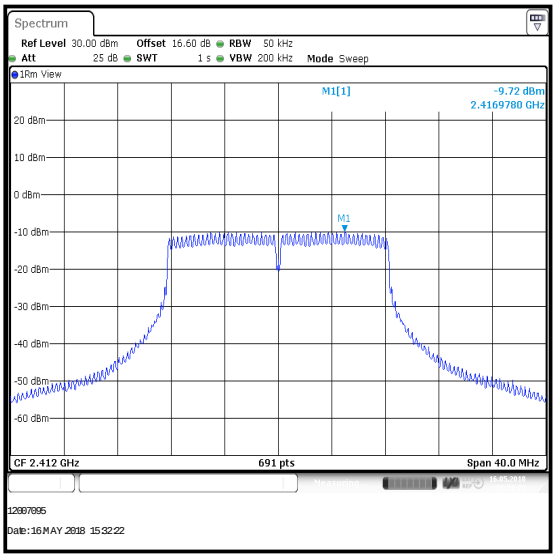
Transmitter Power Spectral Density (continued)

Results: 802.11g / 20 MHz / BPSK / 6 Mbps / MIMO

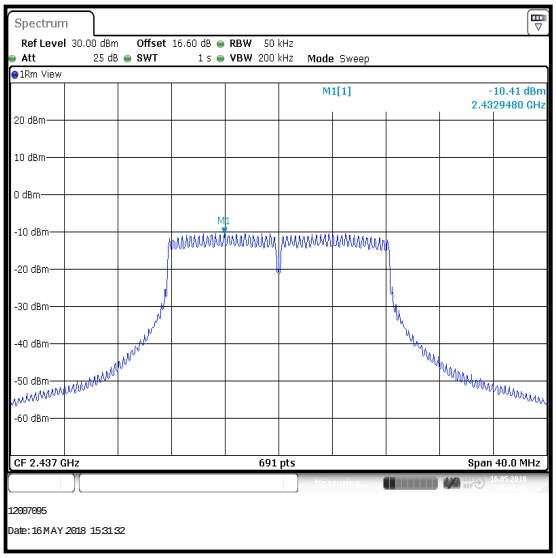
Channel	PSD at Port 0 (dBm / 3 kHz)	PSD at Port 1 (dBm / 3 kHz)	Combined PSD (dBm / 3 kHz)	PSD Limit (dBm / 3 kHz)	Margin (dB)	Result
Bottom	-9.7	-9.5	-6.6	8.0	14.6	Complied
Middle	-10.4	-9.1	-6.7	8.0	14.7	Complied
Top	-10.2	-9.0	-6.6	8.0	14.6	Complied

Transmitter Power Spectral Density (continued)

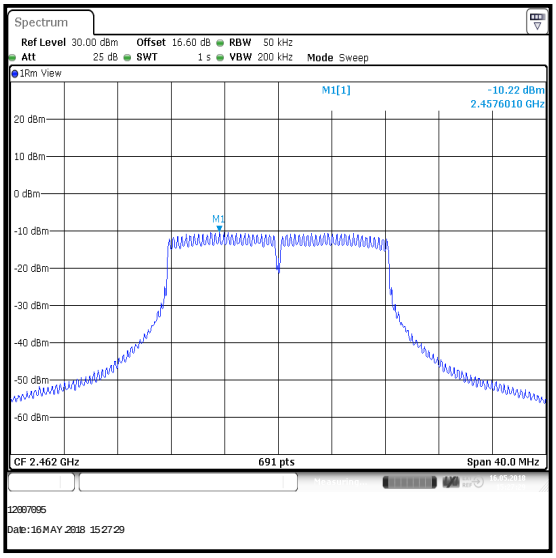
Results: 802.11g / 20 MHz / BPSK / 6 Mbps / MIMO / Port 0



Bottom Channel



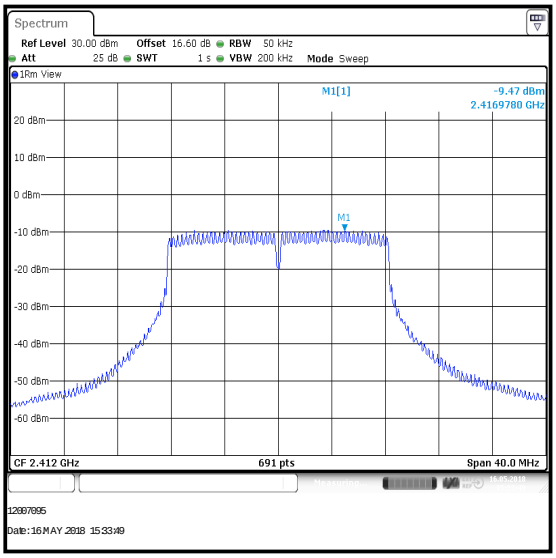
Middle Channel



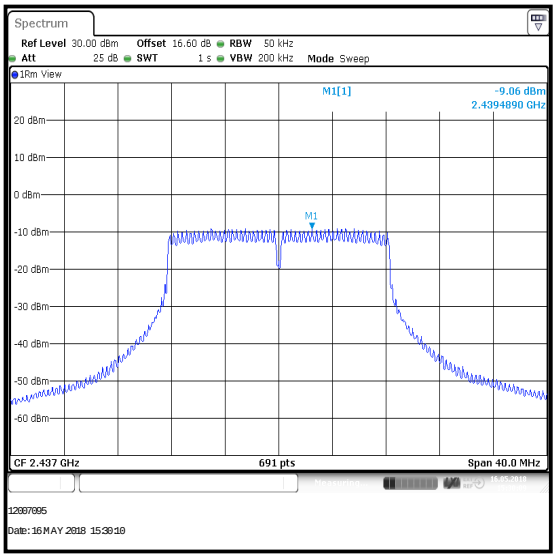
Top Channel

Transmitter Power Spectral Density (continued)

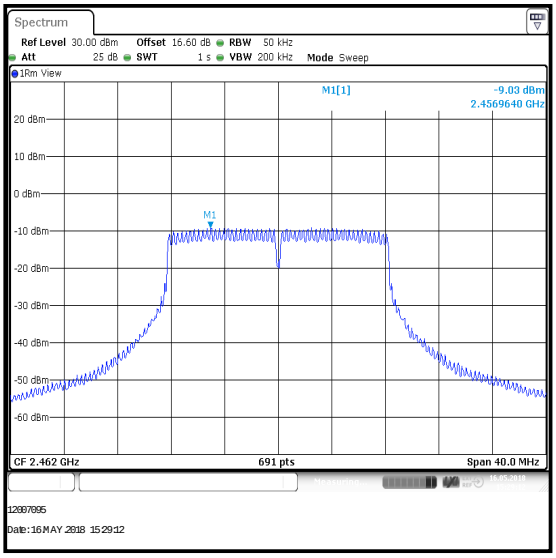
Results: 802.11g / 20 MHz / BPSK / 6 Mbps / MIMO / Port 1



Bottom Channel



Middle Channel



Top Channel

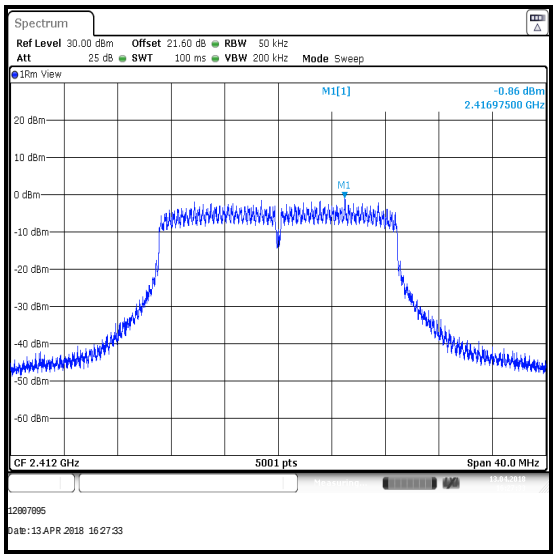
Transmitter Power Spectral Density (continued)

Results: 802.11n / HT20 / BPSK / MCS0 / MIMO

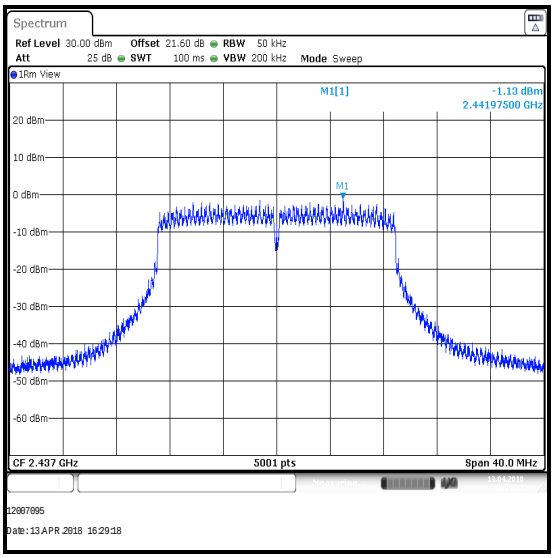
Channel	PSD at Port 0 (dBm / 3 kHz)	PSD at Port 1 (dBm / 3 kHz)	Combined PSD (dBm / 3 kHz)	PSD Limit (dBm / 3 kHz)	Margin (dB)	Result
Bottom	-0.9	-1.3	1.9	8.0	6.1	Complied
Middle	-1.1	-1.0	2.0	8.0	6.0	Complied
Top	-1.3	-0.9	1.9	8.0	6.1	Complied

Transmitter Power Spectral Density (continued)

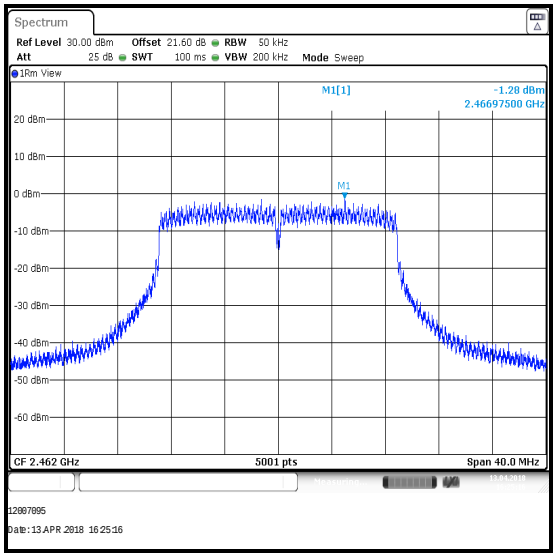
Results: 802.11n / HT20 / BPSK / MCS0 / MIMO / Port 0



Bottom Channel



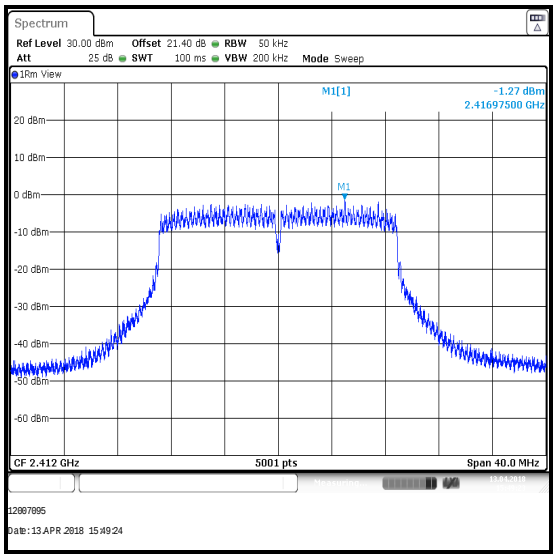
Middle Channel



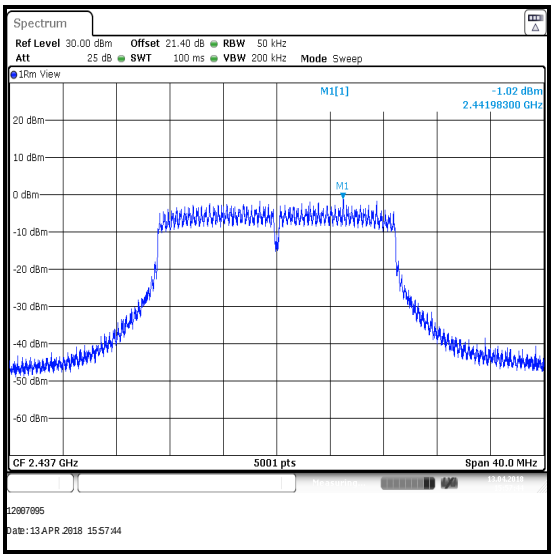
Top Channel

Transmitter Power Spectral Density (continued)

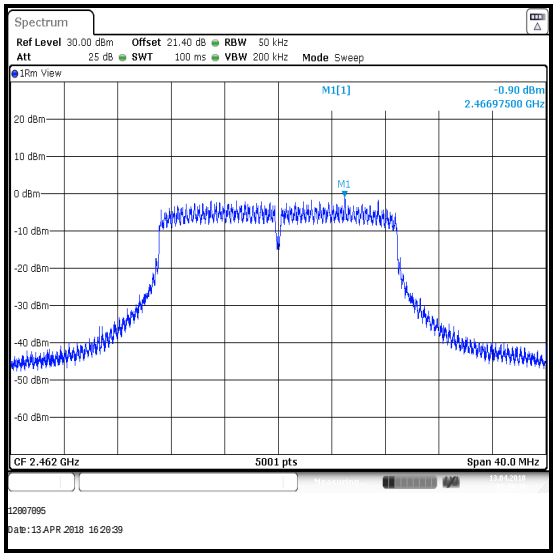
Results: 802.11n / HT20 / BPSK / MCS0 / MIMO / Port 1



Bottom Channel



Middle Channel



Top Channel

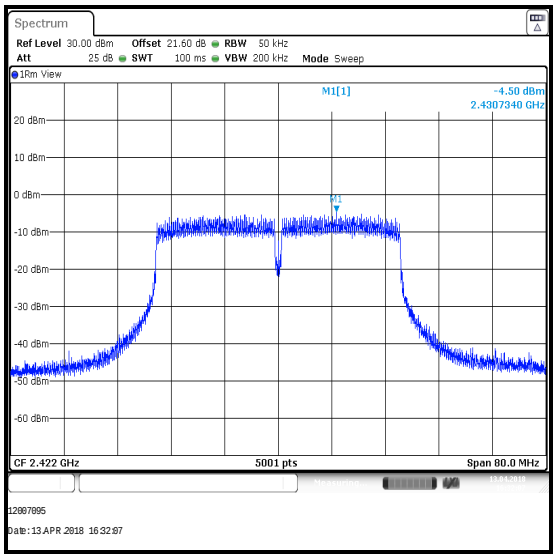
Transmitter Power Spectral Density (continued)

Results: 802.11n / HT40 / BPSK / MCS0 / MIMO

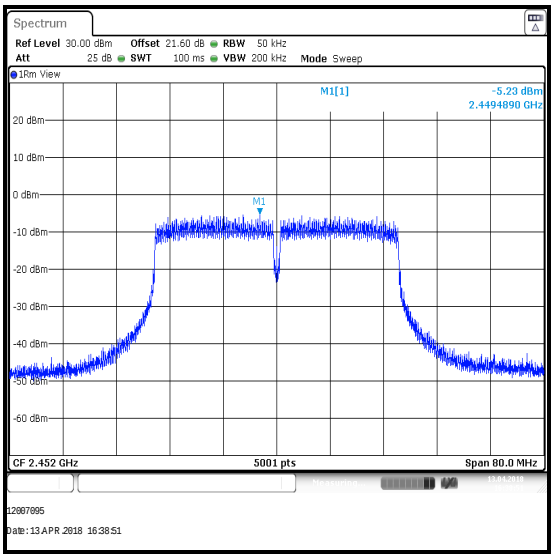
Channel	PSD at Port 0 (dBm / 3 kHz)	PSD at Port 1 (dBm / 3 kHz)	Combined PSD (dBm / 3 kHz)	PSD Limit (dBm / 3 kHz)	Margin (dB)	Result
Bottom	-4.5	-4.7	-1.6	8.0	9.6	Complied
Top	-5.2	-4.2	-1.7	8.0	9.7	Complied

Transmitter Power Spectral Density (continued)

Results: 802.11n / HT40 / BPSK / MCS0 / MIMO / Port 0

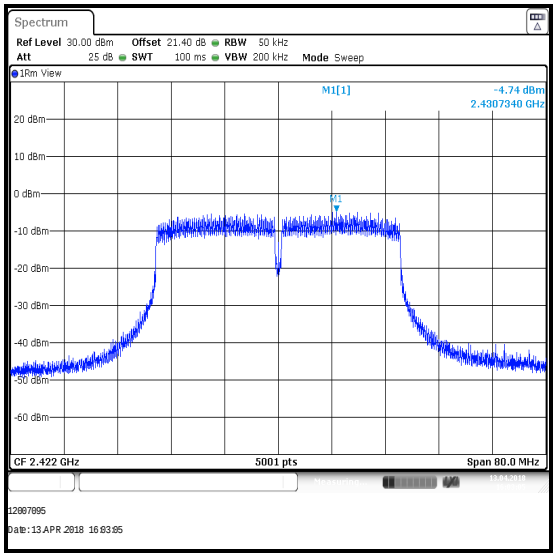


Bottom Channel

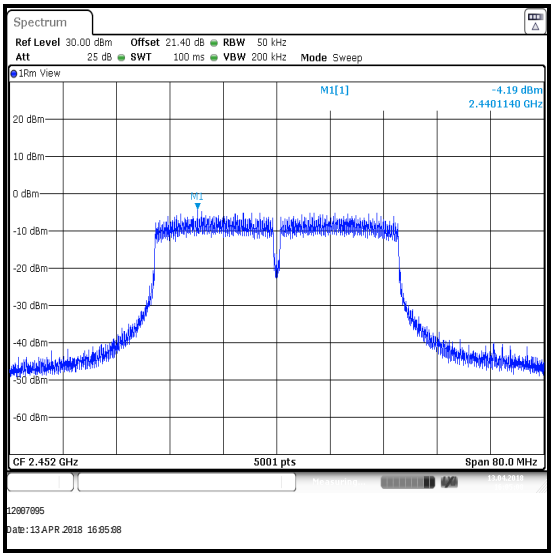


Top Channel

Results: 802.11n / HT40 / BPSK / MCS0 / MIMO / Port 1



Bottom Channel



Top Channel

Transmitter Power Spectral Density (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2005	Thermohygrometer	Testo	608-H1	45046700	28 Feb 2019	12
M1835	Signal Analyser	Rohde & Schwarz	FSV30	103050	19 Mar 2019	12
M1873	Signal Analyser	Rohde & Schwarz	FSV30	103074	06 Jun 2018	12
G0628	Vector Signal Generator	Rohde & Schwarz	SMBV100A	261847	28 Sep 2020	36
A2631	Attenuator	Weinschel Associates	WA75-6-12	A300	Calibrated before use	-
A2633	Attenuator	Weinschel Associates	WA75-10-12	A302	Calibrated before use	-
A2922	Attenuator	AtlanTecRF	AN18W5-20	832828#5	Calibrated before use	-
A2923	Attenuator	AtlanTecRF	AN18W5-20	832828#6	Calibrated before use	-

5.2.5. Transmitter Maximum (Average) Output Power

Test Summary:

Test Engineers:	Stefan Ho & Patrick Jones	**Test Dates:**	13 April 2018 to 31 May 2018
Test Sample MAC Address:	00226D476F28		

FCC Reference:	Part 15.247(b)(3)
Test Method Used:	FCC KDB 558074 Sections 9.2.2.2, 9.2.2.4 & 9.2.2.6

Environmental Conditions:

Temperature (°C):	23 to 24
Relative Humidity (%):	37 to 58

Note(s):

1. All supported modes and channel widths were initially investigated on one channel. The modes that produced the highest power were:
    - 802.11b / SISO & MIMO – DBPSK / 1 Mbps
    - 802.11g / SISO & MIMO – BPSK / 6 Mbps
    - 802.11n HT20 / SISO & MIMO – BPSK / MCS0
    - 802.11n HT40 / SISO & MIMO – BPSK / MCS0
2. Final measurements were performed using the above configurations on the bottom, middle and top channels. The power has been integrated over the 99% emission bandwidth. Plots for the occupied bandwidth are archived on the company server and available for inspection upon request.
3. For 802.11b the EUT was transmitting at ≥98% duty cycle. Testing was therefore performed in accordance with KDB 558074 Section 9.2.2.2, Method AVGSA-1. The signal analyser's integration function was used to integrate across the 99% occupied bandwidth.The signal analyser resolution bandwidth was set to 200 kHz and video bandwidth 1 MHz. An RMS detector was used and sweep time set to auto couple to perform trace averaging over at least 100 traces. The span was set to at least 1.5 times the 99% occupied emission bandwidth.
4. For 802.11g SISO and 802.11n HTXX SISO, the EUT was transmitting at <98% duty cycle with <2% variation. Testing was therefore performed in accordance with KDB 558074 Section 9.2.2.4 Method AVGSA-2. The signal analyser's integration function was used to integrate across the 99% occupied bandwidth. The signal analyser resolution bandwidth was set to 200 kHz and video bandwidth 1 MHz. An RMS detector was used and sweep time set to auto couple. The span was set to at least 1.5 times the 99% occupied emission bandwidth. The calculated duty cycle in section 5.2.3 was added to the measured average power spectral density in order to compute the average power spectral density during the actual transmission time.
5. For 802.11g MIMO and 802.11n HTXX MIMO, the EUT was transmitting at <98% duty cycle with >2% variation. Testing was therefore performed in accordance with KDB 558074 Section 9.2.2.6 Method AVGSA-3. The signal analyser's integration function was used to integrate across the 99% occupied bandwidth. The signal analyser resolution bandwidth was set to 200 kHz and video bandwidth 1 MHz. An RMS detector was used and sweep time set to 1 ms or 1 second as appropriate. The trace type was set to max hold and left to stabilise for at least 60 seconds. The span was set to at least 1.5 times the 99% occupied emission bandwidth.
6. For MIMO measurements, power was measured on both ports and then combined using the measure-and-sum technique stated in FCC KDB 662911 D01 Section E)1).

Transmitter Maximum (Average) Output Power (continued)

Note(s):

7. As the data streams are correlated for CDD MIMO, the directional antenna gain has been calculated in accordance with Section F)2)f) (ii).

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

$$\text{For } N_{SS} = 1, N_{ANT} = 2, g_{1,1} = 10^{\frac{G_{ANTENNA\,1}}{20}} = 10^{\frac{2.5}{20}}$$

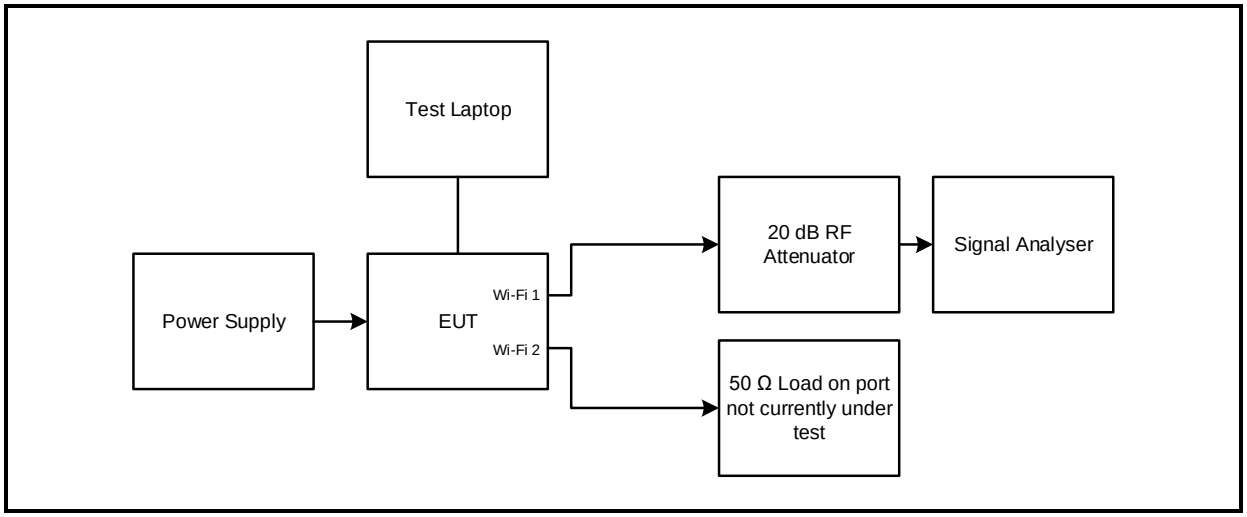
$$\text{and } g_{1,2} = 10^{\frac{G_{ANTENNA\,2}}{20}} = 10^{\frac{4.8}{20}},$$

the equation above gives the following result:

$$\text{Directional Gain} = 10\log\left[\frac{(1.33 + 1.74)^2}{2}\right] = 6.7\ dBi$$

8. In accordance with Part 15.247(b)(4), the conducted output power limit for MIMO measurements below has been reduced to account for the directional antenna gain exceeding 6 dBi.
9. The signal analyser was connected to the RF port on the EUT using suitable attenuation and RF cable. An RF level offset was entered on the signal analyser to compensate for the loss of the attenuator and RF cable.

Test setup:



Transmitter Maximum (Average) Output Power (continued)

Results: 802.11b / 20 MHz / DBPSK / 1 Mbps / SISO / Port 1

Conducted Peak Limit Comparison

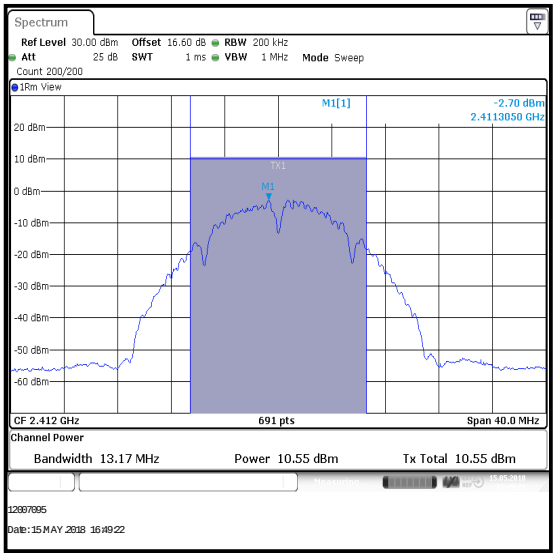
Channel	Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	10.6	30.0	19.4	Complied
Middle	11.4	30.0	18.6	Complied
Top	11.3	30.0	18.7	Complied

De Facto EIRP Limit Comparison

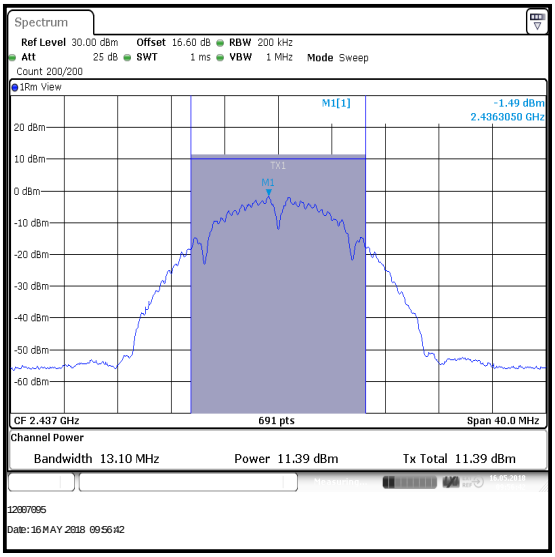
Channel	Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	10.6	4.8	15.4	36.0	20.6	Complied
Middle	11.4	4.8	16.2	36.0	19.8	Complied
Top	11.3	4.8	16.1	36.0	19.9	Complied

Transmitter Maximum (Average) Output Power (continued)

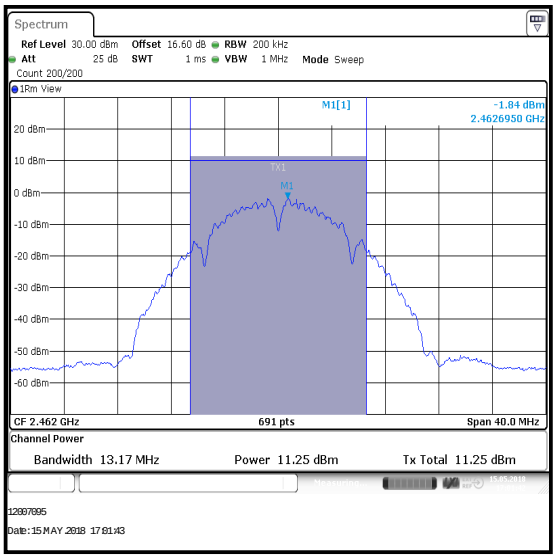
Results: 802.11b / 20 MHz / DBPSK / 1 Mbps / SISO / Port 1



Bottom Channel



Middle Channel



Top Channel

Transmitter Maximum (Average) Output Power (continued)

Results: 802.11g / 20 MHz / BPSK / 6 Mbps / SISO / Port 1

Conducted Peak Limit Comparison

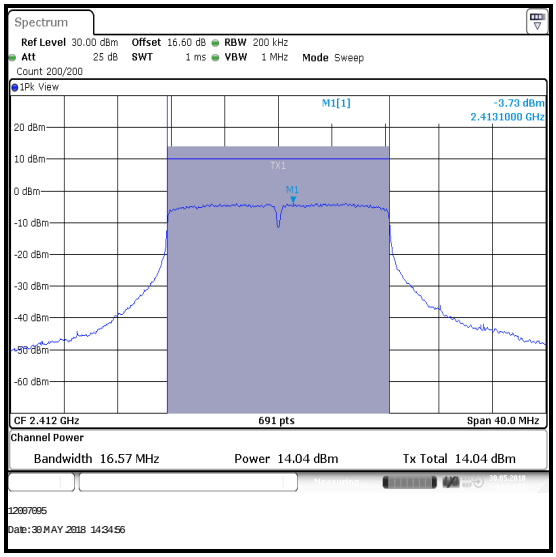
Channel	Conducted Power (dBm)	Duty Cycle Correction (dB)	Corrected Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	14.0	0.3	14.3	30.0	15.7	Complied
Middle	14.4	0.3	14.7	30.0	15.3	Complied
Top	14.3	0.3	14.6	30.0	15.4	Complied

De Facto EIRP Limit Comparison

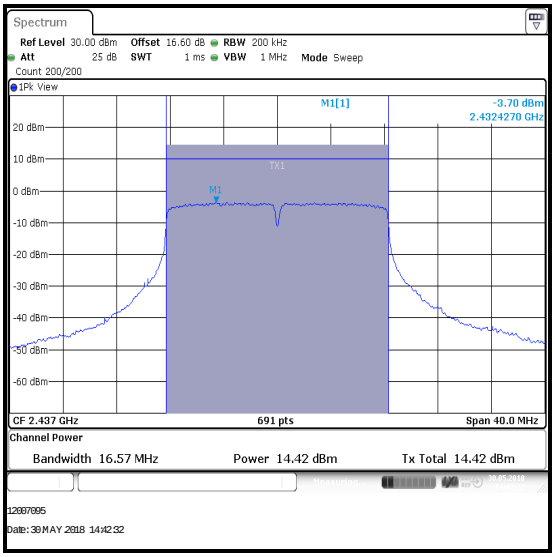
Channel	Corrected Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	14.3	4.8	19.1	36.0	16.9	Complied
Middle	14.7	4.8	19.5	36.0	16.5	Complied
Top	14.6	4.8	19.4	36.0	16.6	Complied

Transmitter Maximum (Average) Output Power (continued)

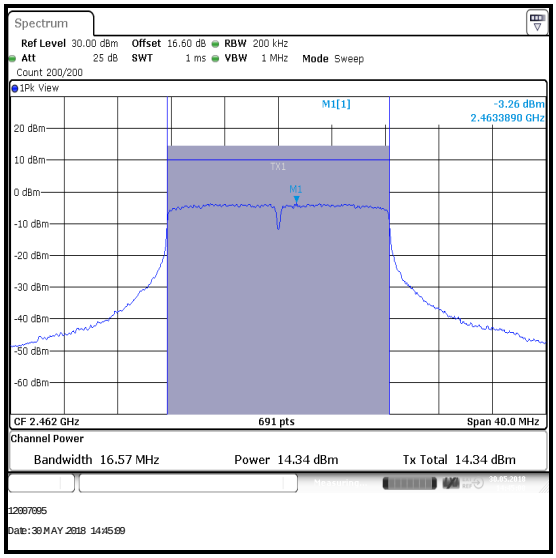
Results: 802.11g / 20 MHz / BPSK / 6 Mbps / SISO / Port 1



Bottom Channel



Middle Channel



Top Channel

Transmitter Maximum (Average) Output Power (continued)

Results: 802.11n / HT20 / BPSK / MCS0 / SISO / Port 1

Conducted Peak Limit Comparison

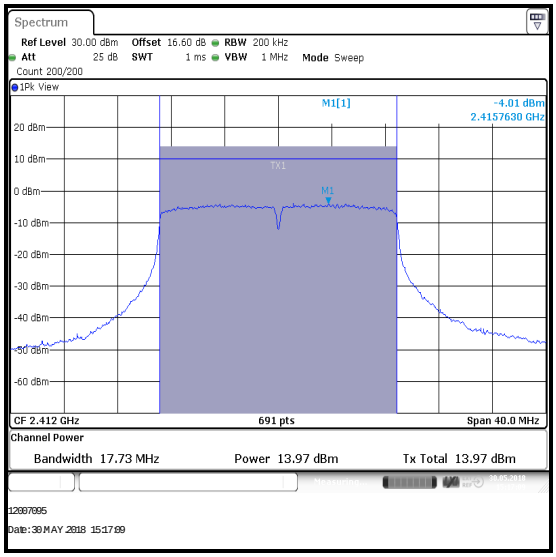
Channel	Conducted Power (dBm)	Duty Cycle Correction (dB)	Corrected Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	14.0	0.3	14.3	30.0	15.7	Complied
Middle	14.3	0.3	14.6	30.0	15.4	Complied
Top	14.2	0.3	14.5	30.0	15.5	Complied

De Facto EIRP Limit Comparison

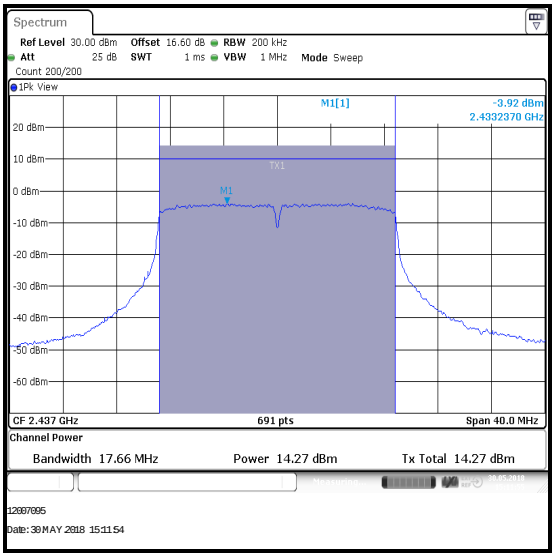
Channel	Corrected Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	14.3	4.8	19.1	36.0	16.9	Complied
Middle	14.6	4.8	19.4	36.0	16.6	Complied
Top	14.5	4.8	19.3	36.0	16.7	Complied

Transmitter Maximum (Average) Output Power (continued)

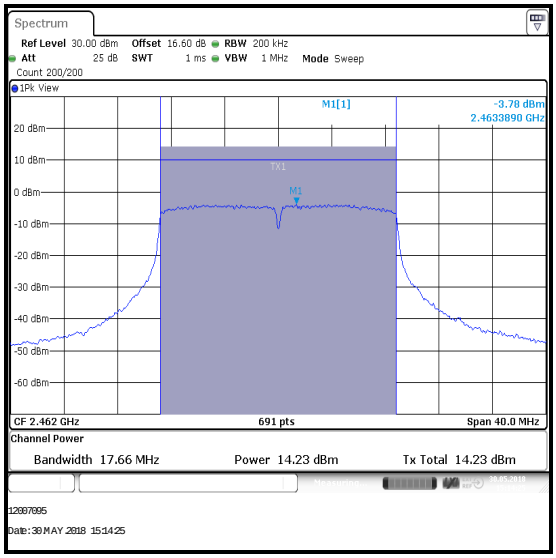
Results: 802.11n / HT20 / BPSK / MCS0 / SISO / Port 1



Bottom Channel



Middle Channel



Top Channel

Transmitter Maximum (Average) Output Power (continued)

Results: 802.11n / HT40 / BPSK / MCS0 / SISO / Port 1

Conducted Peak Limit Comparison

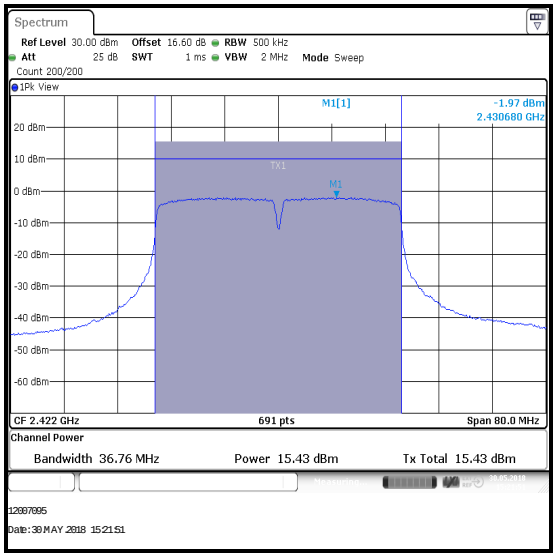
Channel	Conducted Power (dBm)	Duty Cycle Correction (dB)	Corrected Conducted Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	15.4	0.7	16.1	30.0	13.9	Complied
Top	15.4	0.7	16.1	30.0	13.9	Complied

De Facto EIRP Limit Comparison

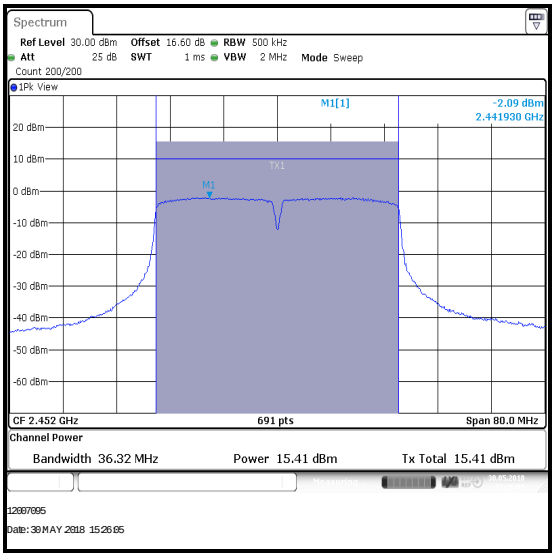
Channel	Corrected Conducted Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	16.1	4.8	20.9	36.0	15.1	Complied
Top	16.1	4.8	20.9	36.0	15.1	Complied

Transmitter Maximum (Average) Output Power (continued)

Results: 802.11n / HT40 / BPSK / MCS0 / SISO / Port 1



Bottom Channel



Top Channel

Transmitter Maximum (Average) Output Power (continued)

Results: 802.11b / 20 MHz / DBPSK / MIMO

Conducted Peak Limit Comparison

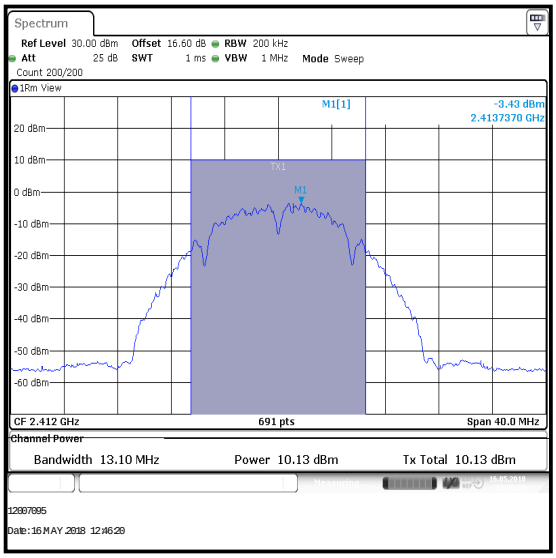
Channel	Conducted Peak Power Port 0 (dBm)	Conducted Peak Power Port 1 (dBm)	Combined Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	10.1	9.6	12.9	29.3	16.4	Complied
Middle	10.0	10.1	13.1	29.3	16.2	Complied
Top	10.0	10.4	13.2	29.3	16.1	Complied

De Facto EIRP Limit Comparison

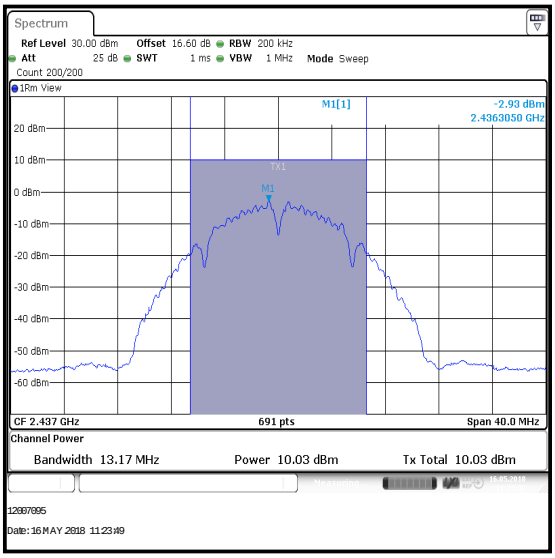
Channel	Combined Conducted Peak Power (dBm)	Directional Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	12.9	6.7	19.6	36.0	16.4	Complied
Middle	13.1	6.7	19.8	36.0	16.2	Complied
Top	13.2	6.7	19.9	36.0	16.1	Complied

Transmitter Maximum (Average) Output Power (continued)

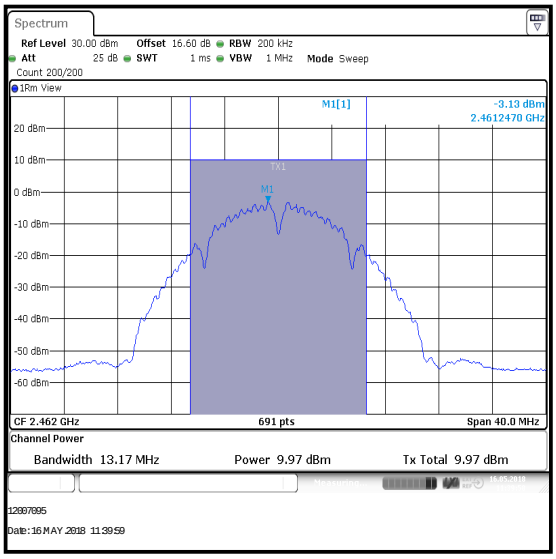
Results: 802.11b / 20 MHz / DBPSK / MIMO / Port 0



Bottom Channel



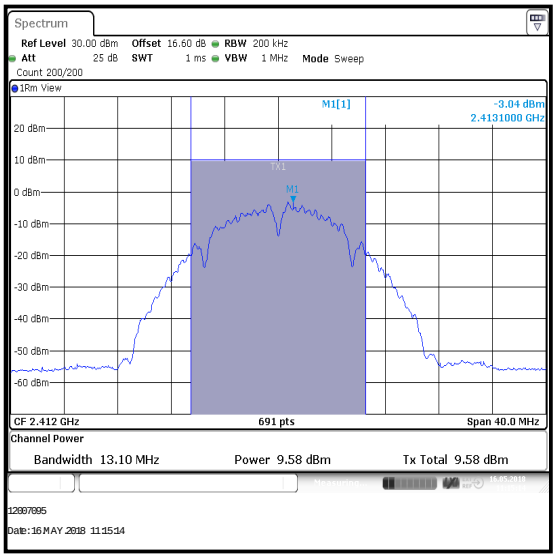
Middle Channel



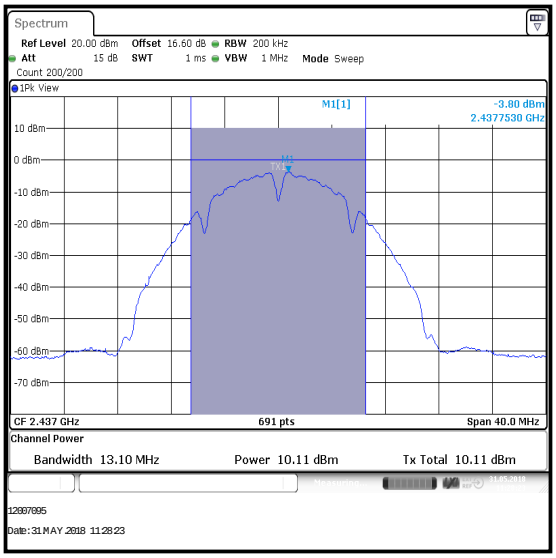
Top Channel

Transmitter Maximum (Average) Output Power (continued)

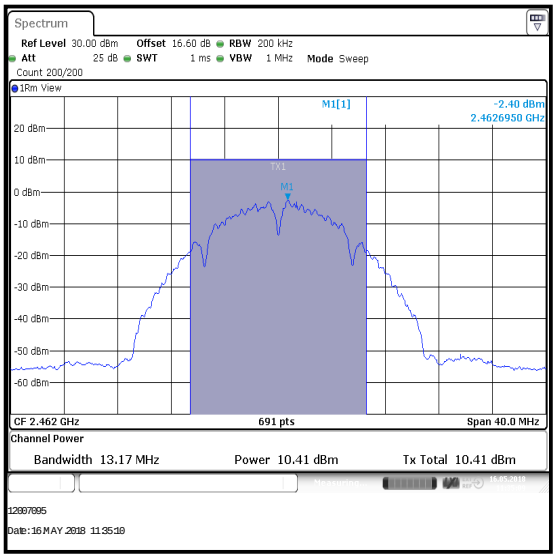
Results: 802.11b / 20 MHz / DBPSK / MIMO / Port 1



Bottom Channel



Middle Channel



Top Channel

Transmitter Maximum (Average) Output Power (continued)

Results: 802.11g / 20 MHz / BPSK / MIMO

Conducted Peak Limit Comparison

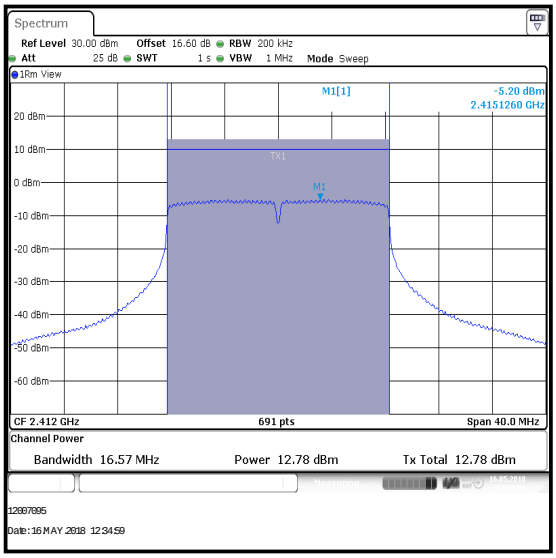
Channel	Conducted Peak Power Port 0 (dBm)	Conducted Peak Power Port 1 (dBm)	Combined Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	12.8	13.1	16.0	29.3	13.3	Complied
Middle	12.5	13.7	16.2	29.3	13.1	Complied
Top	12.2	13.6	16.0	29.3	13.3	Complied

De Facto EIRP Limit Comparison

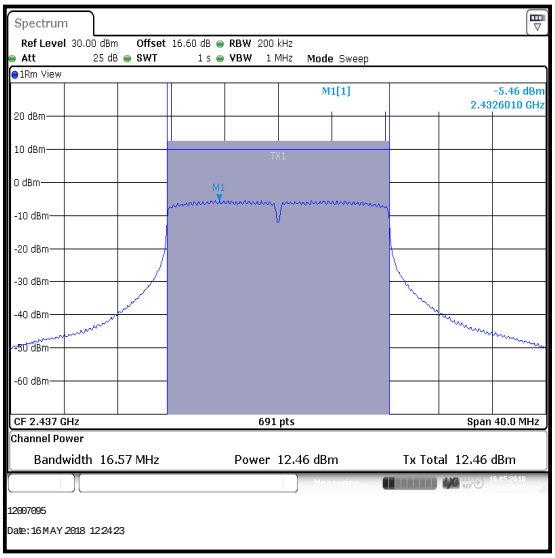
Channel	Combined Conducted Peak Power (dBm)	Directional Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	16.0	6.7	22.7	36.0	13.3	Complied
Middle	16.2	6.7	22.9	36.0	13.1	Complied
Top	16.0	6.7	22.7	36.0	13.3	Complied

Transmitter Maximum (Average) Output Power (continued)

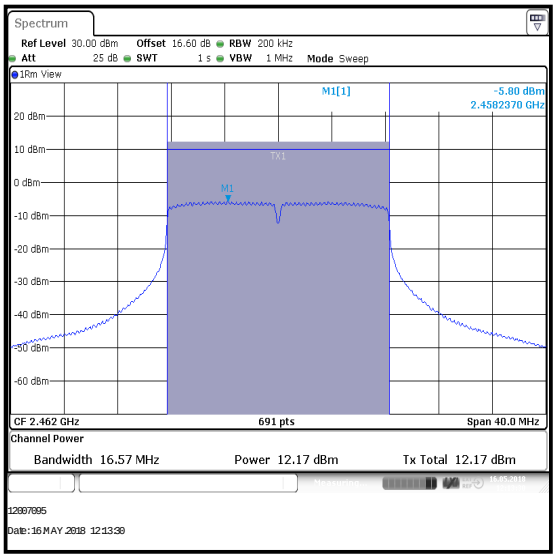
Results: 802.11g / 20 MHz / BPSK / MIMO / Port 0



Bottom Channel



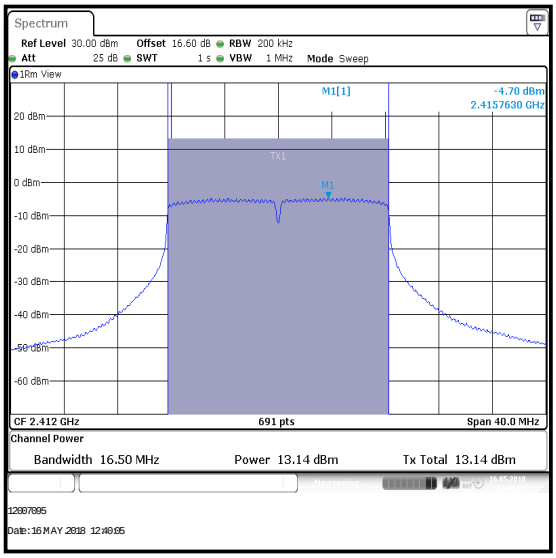
Middle Channel



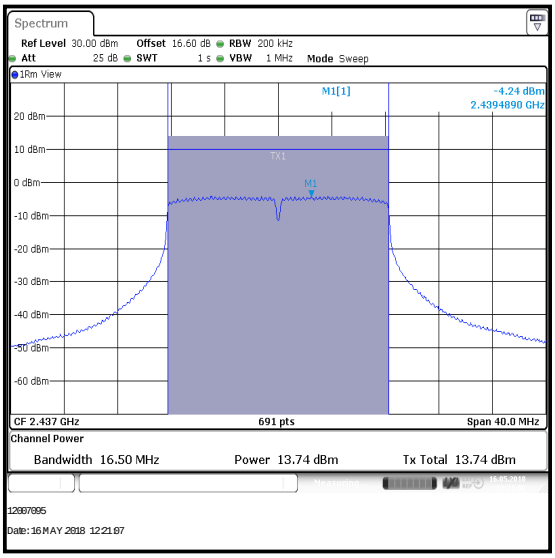
Top Channel

Transmitter Maximum (Average) Output Power (continued)

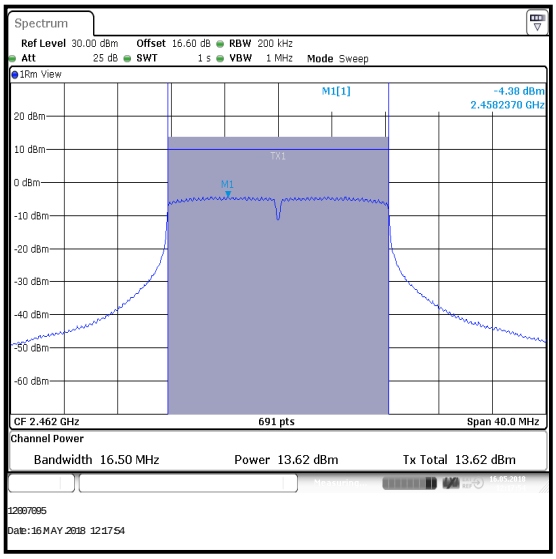
Results: 802.11g / 20 MHz / BPSK / MIMO / Port 1



Bottom Channel



Middle Channel



Top Channel

Transmitter Maximum (Average) Output Power (continued)

Results: 802.11n / HT20 / BPSK / MCS0 / MIMO

Conducted Peak Limit Comparison

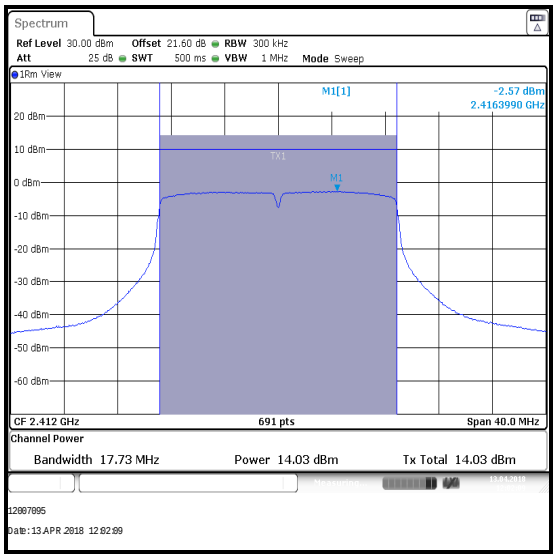
Channel	Corrected Conducted Peak Power Port 0 (dBm)	Corrected Conducted Peak Power Port 1 (dBm)	Combined Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	14.0	13.4	16.7	29.3	12.6	Complied
Middle	13.9	14.0	17.0	29.3	12.3	Complied
Top	13.9	14.0	17.0	29.3	12.3	Complied

De Facto EIRP Limit Comparison

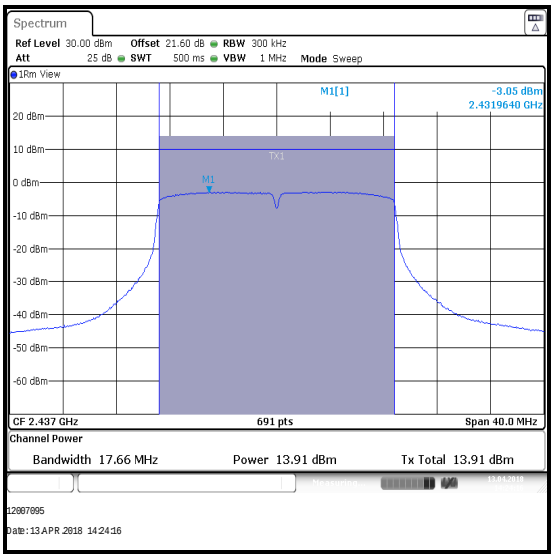
Channel	Combined Conducted Peak Power (dBm)	Directional Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	16.7	6.7	23.4	36.0	12.6	Complied
Middle	17.0	6.7	23.7	36.0	12.3	Complied
Top	17.0	6.7	23.7	36.0	12.3	Complied

Transmitter Maximum (Average) Output Power (continued)

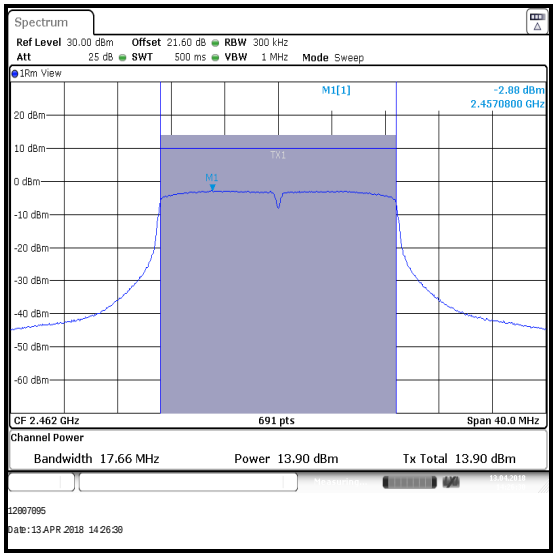
Results: 802.11n / HT20 / BPSK / MCS0 / MIMO / Port 0



Bottom Channel



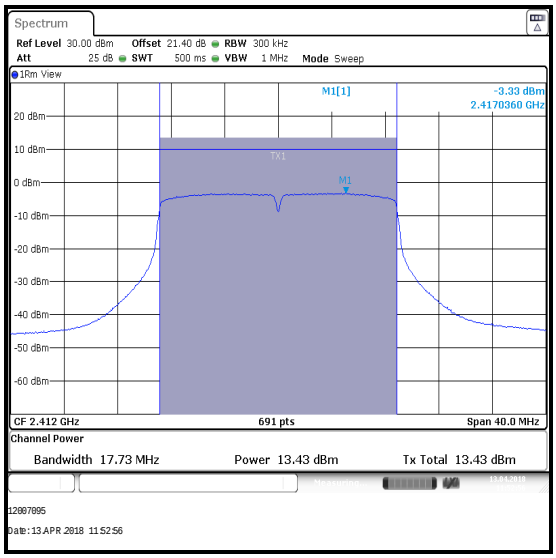
Middle Channel



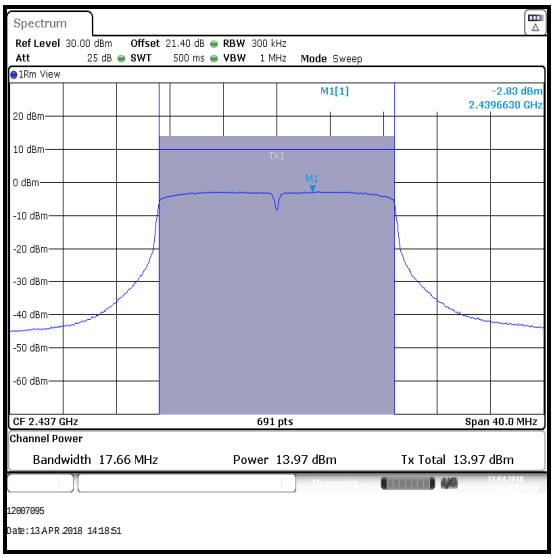
Top Channel

Transmitter Maximum (Average) Output Power (continued)

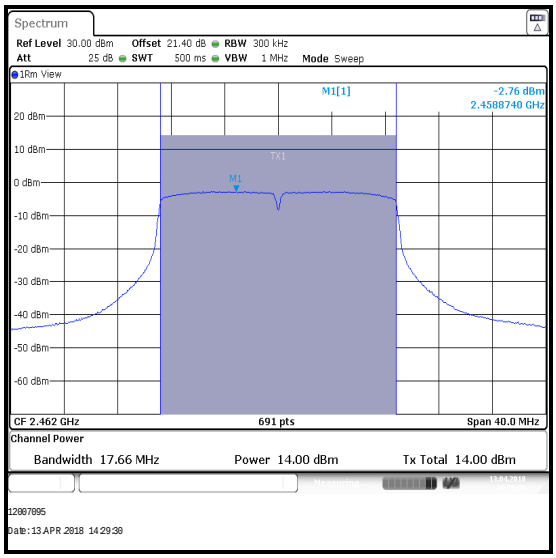
Results: 802.11n / HT20 / BPSK / MCS0 / MIMO / Port 1



Bottom Channel



Middle Channel



Top Channel

Transmitter Maximum (Average) Output Power (continued)

Results: 802.11n / HT40 / BPSK / MCS0 / MIMO

Conducted Peak Limit Comparison

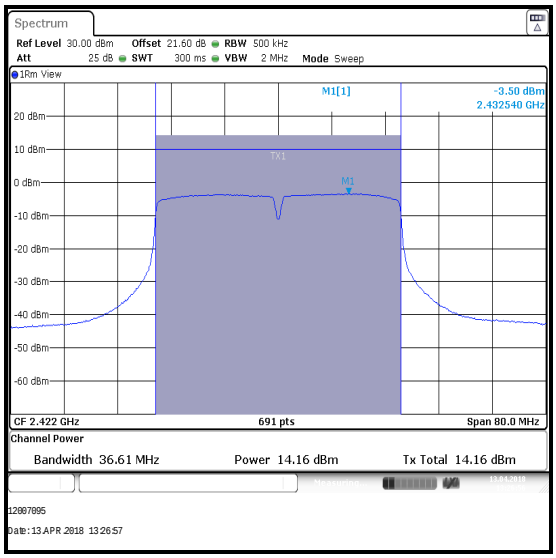
Channel	Corrected Conducted Peak Power Port 0 (dBm)	Corrected Conducted Peak Power Port 1 (dBm)	Combined Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	14.2	13.9	17.1	29.3	12.2	Complied
Top	13.7	14.1	16.9	29.3	12.4	Complied

De Facto EIRP Limit Comparison

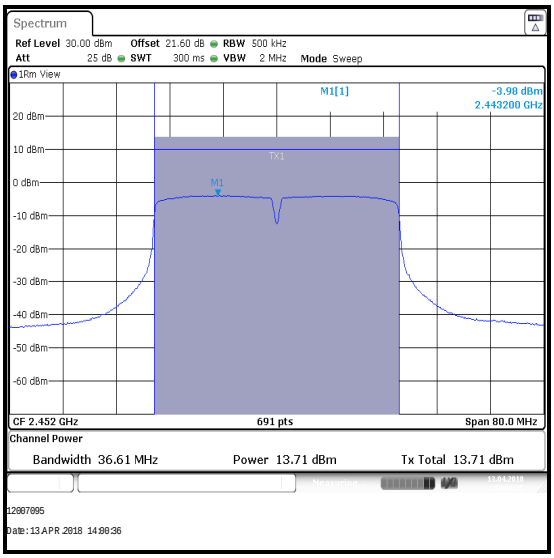
Channel	Combined Conducted Peak Power (dBm)	Directional Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	17.1	6.7	23.8	36.0	12.2	Complied
Top	16.9	6.7	23.6	36.0	12.4	Complied

Transmitter Maximum (Average) Output Power (continued)

Results: 802.11n / HT40 / BPSK / MCS0 / MIMO / Port 0

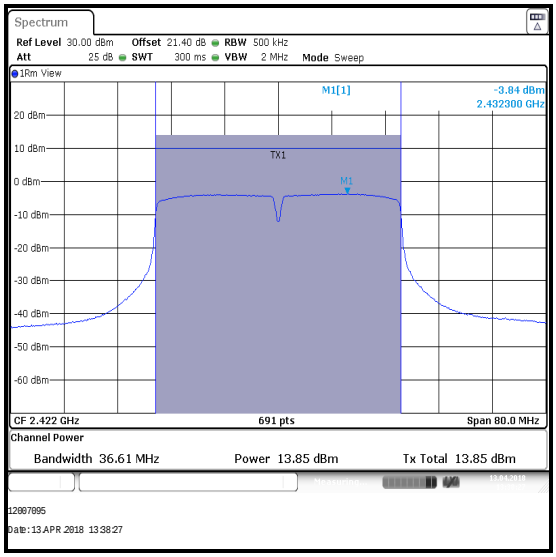


Bottom Channel

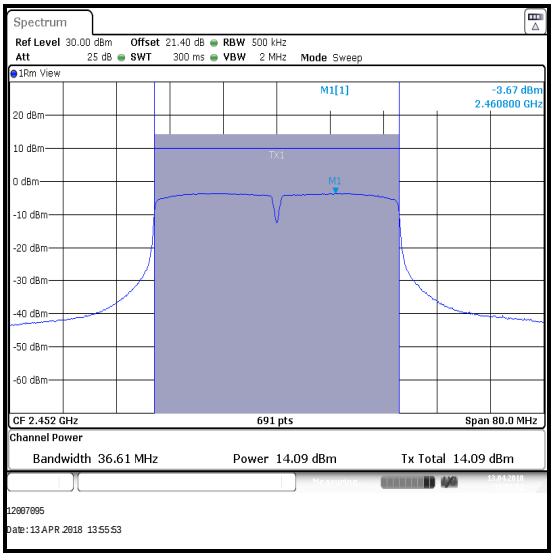


Top Channel

Results: 802.11n / HT40 / BPSK / MCS0 / MIMO / Port 1



Bottom Channel



Top Channel

Transmitter Maximum (Average) Output Power (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2005	Thermohygrometer	Testo	608-H1	45046700	28 Feb 2019	12
M1873	Signal Analyser	Rohde & Schwarz	FSV30	103074	06 Jun 2018	12
M1835	Signal Analyser	Rohde & Schwarz	FSV30	103050	19 Mar 2019	12
A2631	Attenuator	Weinschel Associates	WA75-6-12	A300	Calibrated before use	-
A2633	Attenuator	Weinschel Associates	WA75-10-12	A302	Calibrated before use	-
G0628	Vector Signal Generator	Rohde & Schwarz	SMBV100A	261847	28 Sep 2020	36
A2922	Attenuator	AtlanTecRF	AN18W5-20	832828#5	Calibrated before use	-
A2923	Attenuator	AtlanTecRF	AN18W5-20	832828#6	Calibrated before use	-

5.2.6. Transmitter Radiated Emissions

Test Summary:

Test Engineer:	Andrew Edwards	**Test Date:**	11 April 2018
Test Sample MAC Address:	00226D476F14		

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

Environmental Conditions:

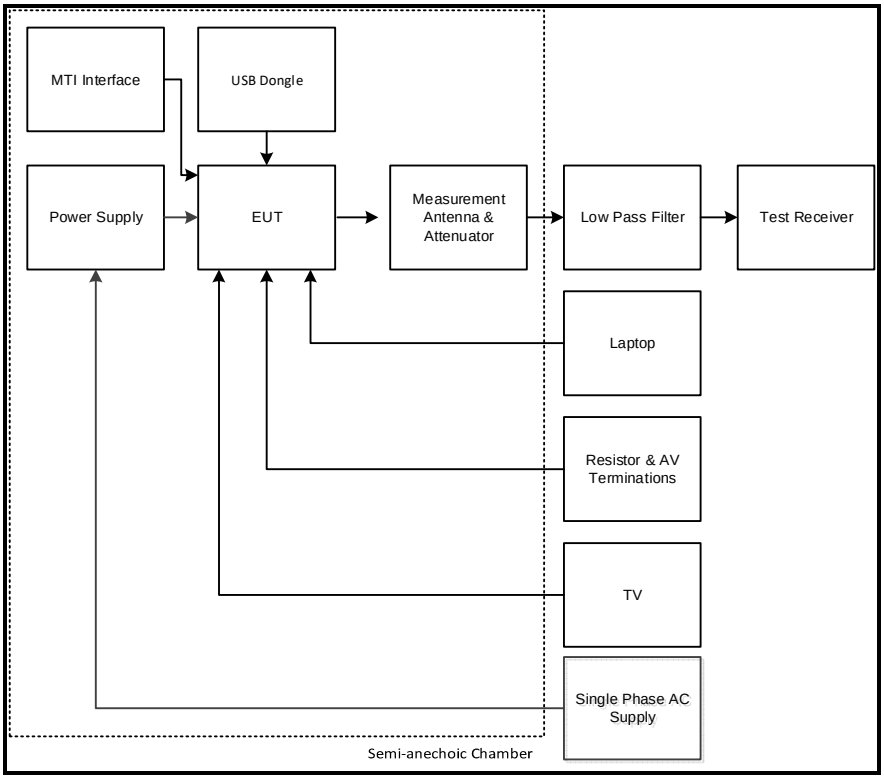
Temperature (°C):	22
Relative Humidity (%):	48

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. 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.
3. All other emissions shown on the pre-scan plots were investigated and found to be ambient, >20 dB below the applicable limit or below the measurement system noise floor and were therefore not recorded.
4. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0017) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
5. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 120 kHz and video bandwidth 500 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
6. 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 a wide enough span to capture the entire emission.

Transmitter Radiated Emissions (continued)

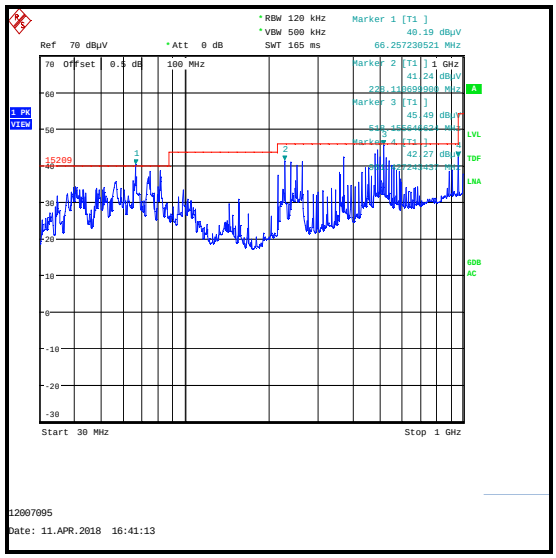
Test setup for radiated measurements:



Transmitter Radiated Emissions (continued)

Results: Middle Channel / 802.11n / HT20 / 6.5 Mbps / MCS0 / MIMO

Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
73.925	Vertical	34.5	40.0	5.5	Complied
168.005	Horizontal	24.5	43.5	19.0	Complied
240.075	Horizontal	33.9	46.0	12.1	Complied
252.044	Horizontal	39.7	46.0	6.3	Complied
264.016	Horizontal	41.8	46.0	4.2	Complied
276.010	Horizontal	31.2	46.0	14.8	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	27 Feb 2019	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	21 Feb 2019	12
M1630	Test Receiver	Rohde & Schwarz	ESU40	100233	03 Aug 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	22 Feb 2019	12

Transmitter Radiated Emissions (continued)

Test Summary:

Test Engineer:	Andrew Edwards	**Test Dates:**	10 April 2018 & 11 April 2018
Test Sample MAC Address:	00226D476F14		

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

Environmental Conditions:

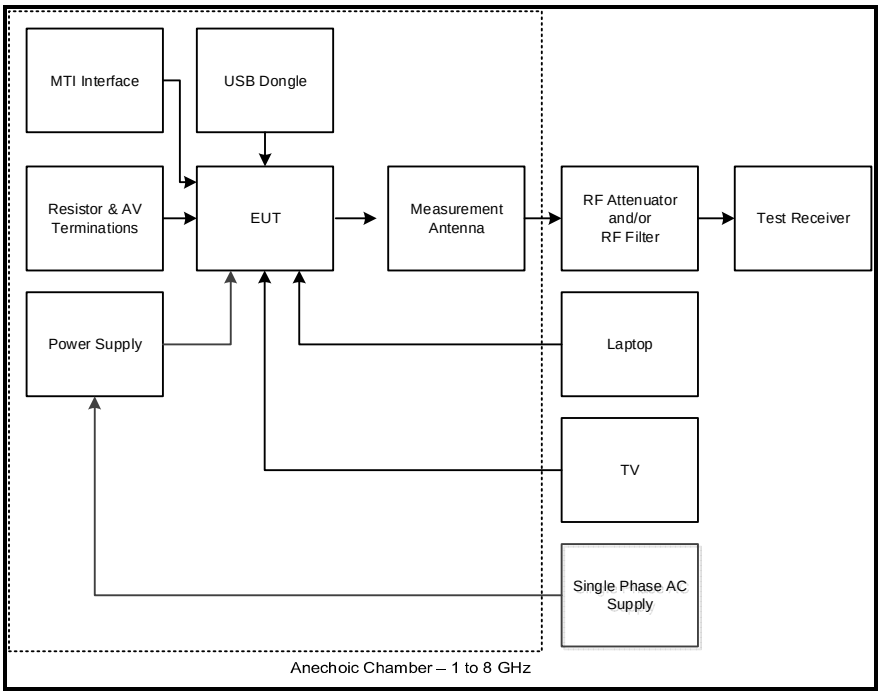
Temperature (°C):	22 to 23
Relative Humidity (%):	41 to 50

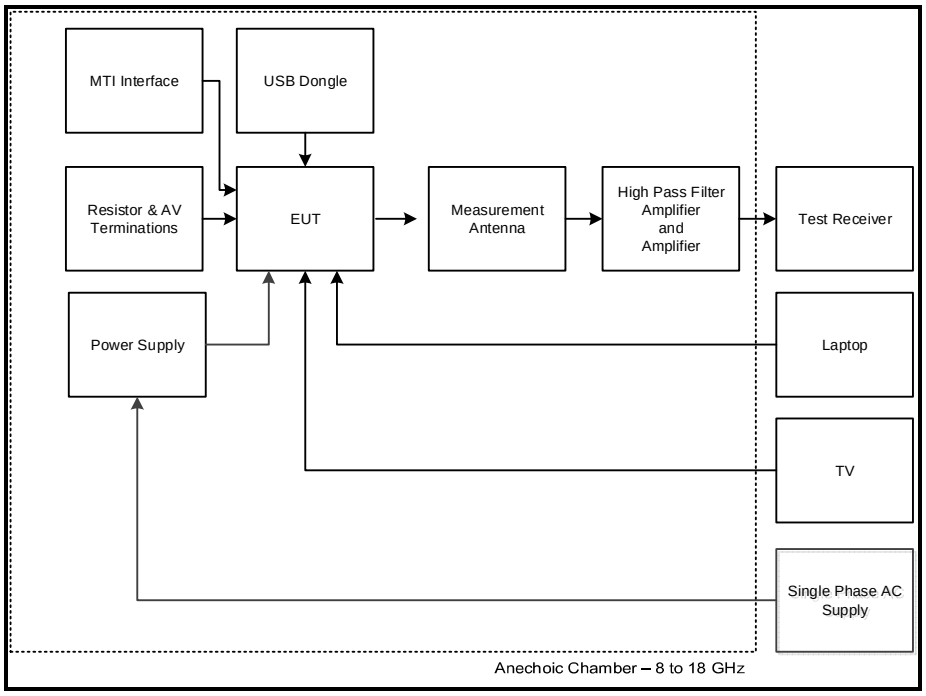
Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. All other emissions shown on the pre-scan plot were investigated and found to be ambient, >20 dB below the appropriate limit or below the measurement system noise floor.
3. The emission shown at approximately 2437 MHz on the 1 GHz to 3 GHz plot is the EUT fundamental.
4. In accordance with ANSI C63.10 Section 6.6.4.3 (Note 1), if the peak measured value complies with the average limit, it is not necessary to perform an average measurement.
5. Pre-scans 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. All measurement antennas were placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT. Final measurements above 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 1.5 m 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.
6. Pre-scans were performed and a marker placed on the highest measured level of the appropriate plot. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. The sweep time was set to auto.

Transmitter Radiated Emissions (continued)

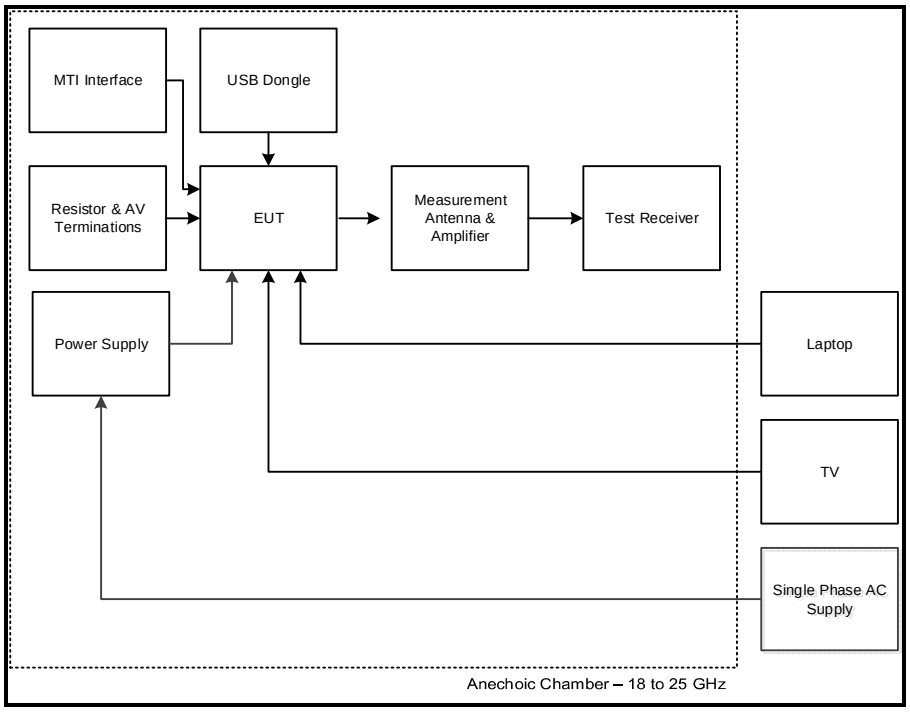
Test setup for radiated measurements:





Transmitter Radiated Emissions (continued)

Test setup for radiated measurements:



Transmitter Radiated Emissions (continued)

Results: Bottom Channel

Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
3861.263	Vertical	44.0	54.0	10.0	Complied
4158.130	Vertical	48.2	54.0	5.8	Complied
4454.928	Horizontal	47.3	54.0	6.7	Complied
4560.140	Vertical	45.9	54.0	8.1	Complied
4752.302	Vertical	46.2	54.0	7.8	Complied
4820.820	Vertical	50.7	54.0	3.3	Complied

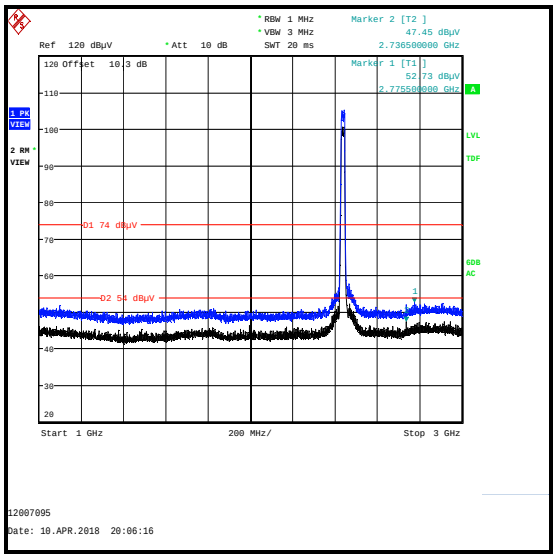
Results: Middle Channel

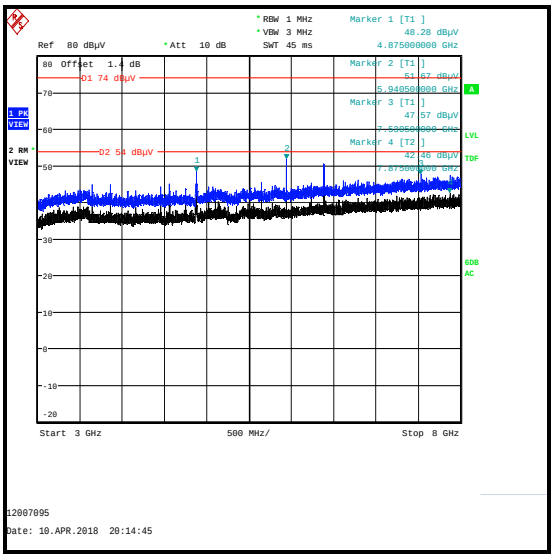
Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
3861.263	Vertical	44.0	54.0	10.0	Complied
4158.130	Vertical	48.2	54.0	5.8	Complied
4454.928	Horizontail	47.3	54.0	6.7	Complied
4560.140	Vertical	45.9	54.0	8.1	Complied
4752.302	Vertical	46.2	54.0	7.8	Complied
4872.400	Vertical	50.6	54.0	3.4	Complied

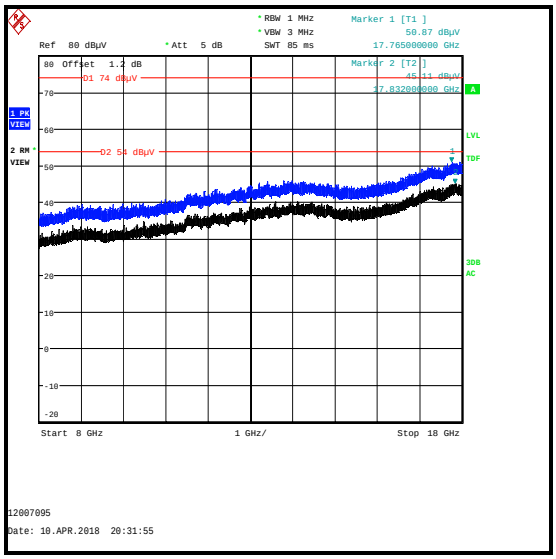
Results: Top Channel

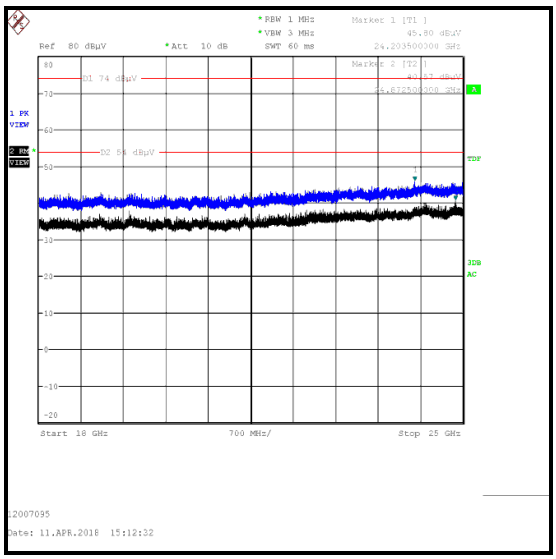
Frequency (MHz)	Antenna Polarity	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
3861.263	Vertical	44.0	54.0	10.0	Complied
4158.130	Vertical	48.2	54.0	5.8	Complied
4454.928	Horizontail	47.3	54.0	6.7	Complied
4560.140	Vertical	45.9	54.0	8.1	Complied
4752.302	Vertical	46.2	54.0	7.8	Complied
4923.940	Vertical	50.7	54.0	3.3	Complied

Transmitter Radiated Emissions (continued)









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

Transmitter Radiated Emissions (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2003	Thermohygrometer	Testo	608-H1	45046641	27 Feb 2019	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	21 Feb 2019	12
M1630	Test Receiver	Rohde & Schwarz	ESU40	100233	03 Aug 2018	12
A2863	Pre Amplifier	Agilent	8449B	3008A02100	19 Feb 2019	12
A2891	Pre Amplifier	Schwarzbeck	BBV 9718	9718-306	20 Feb 2019	12
A2896	Pre Amplifier	Schwarzbeck	BBV 9721	9721 - 023	20 Feb 2019	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	19 Feb 2019	12
A2890	Antenna	Schwarzbeck	HWRD 750	014	19 Feb 2019	12
A2895	Antenna	Schwarzbeck	BBHA 9170	9170-728	20 Feb 2019	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	21 Feb 2019	12
A2914	High Pass Filter	AtlanTecRF	AFH-03000	2155	22 Feb 2019	12
A2947	High Pass Filter	AtlanTecRF	AFH-73000	1601900001	22 Feb 2019	12

5.2.7. Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	Andrew Edwards	**Test Dates:**	09 April 2018 & 10 April 2018
Test Sample MAC Address:	00226D476F14		

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

Environmental Conditions:

Temperature (°C):	22 to 23
Relative Humidity (%):	45 to 46

Note(s):

1. 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:
   - 802.11g – BPSK / 6 Mbps / SISO
   - 802.11g – 16QAM / 24 Mbps / SISO
   - 802.11n HT20 – BPSK / 6.5 Mbps / MCS0 / SISO
   - 802.11n HT20 – 16QAM / 39 Mbps / MCS4 / SISO
   - 802.11n HT40 – BPSK / 13.5 Mbps / MCS0 / SISO
   - 802.11n HT40 –16QAM / 81 Mbps / MCS4 / SISO
   - 802.11b – DBPSK / 1 Mbps / MIMO
   - 802.11g – BPSK / 6 Mbps / MIMO
   - 802.11g – 16QAM / 24 Mbps / MIMO
   - 802.11n HT20 – BPSK / 6.5 Mbps / MCS0 / MIMO
   - 802.11n HT20 – 16QAM / 26 Mbps / MCS3 / MIMO
   - 802.11n HT40 – BPSK / 13.5 Mbps / MCS0 / MIMO
   - 802.11n HT40 –16QAM / 81 Mbps / MCS4 / MIMO

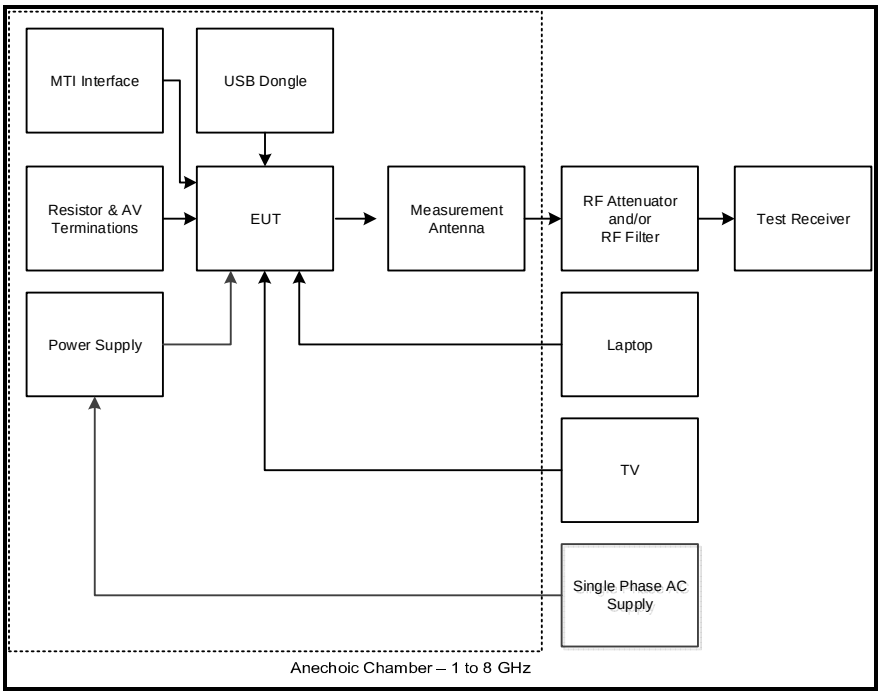
   Final measurements were performed with the above configurations.
2. For all SISO modes, the EUT was transmitting from Port 1 only as this port emits the highest output power level and was therefore deemed to be worst case. For MIMO modes, the EUT was transmitting from both ports.
3. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
4. The maximum conducted (average) output power was previously measured. In accordance with FCC KDB 558074 Section 11.1(b), the lower band edge measurement should be performed with a peak detector and the -30 dBc limit applied.
5. For 802.11b mode the EUT was transmitting at ≥98% duty cycle. Restricted band measurements were therefore performed in accordance with KDB 558074 Section 12.2.5.1.
6. For 802.11g 24 Mbps SISO, 802.11g MIMO and 802.11n HTXX MIMO modes the EUT was transmitting at <98% duty cycle with >2% variation. Restricted band measurements were therefore performed in accordance with KDB 558074 Section 12.2.5.3.

Transmitter Band Edge Radiated Emissions (continued)

Note(s):

7. For all other modes the EUT was transmitting at <98% duty cycle with <2% variation. Restricted band measurements were therefore performed in accordance with KDB 558074 Section 12.2.5.2
8. As the lower band edge falls within a non-restricted band, only peak measurements are required. In accordance with FCC KDB 558074 Section 11.1, the test method in Section 11.3 was followed: the test receiver resolution bandwidth was set to 100 kHz and video bandwidth to 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The test receiver was left to sweep for a sufficient length of time in order to maximise the carrier level and out-of-band emissions. A marker and corresponding reference level line were placed on the peak of the carrier. As the maximum conducted (average) output power was measured using an RMS detector, an out-of-band limit line was placed 30 dB below the peak level in accordance with FCC KDB 558074 Section 11.1(b). A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent non-restricted band of operation (where a higher level emission was present). Marker frequencies and levels were recorded.
9. As the upper band edge is adjacent to a restricted band both peak and average measurements were recorded by placing a marker at the edge of the band. For peak measurements the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth 3 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. For average measurements when the duty cycle varied <2%, the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth to 3 MHz. An RMS detector was used, sweep time was set to auto and trace mode was set to trace averaging over 300 sweeps. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent restricted band of operation (where a higher level emission was present). Marker frequencies and levels were recorded.
10. For average measurements when the duty cycle varied >2%, the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth to 1/T, where T is the smallest transmission period. A Peak detector was used, sweep time was set to auto and trace mode was Max Hold. The test receiver was left to sweep for a sufficient length of time in order to maximise the carrier level and out-of-band emissions. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent restricted band of operation (where a higher level emission was present). Marker frequencies and levels were recorded.

Test setup for radiated measurements:



Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11b / 20 MHz / DBPSK / 1 Mbps / SISO

Results: Lower Band Edge

Frequency (MHz)	Level (dBµV/m)	-30 dBc Limit (dBµV/m)	Margin (dB)	Result
2397.997	45.9	69.0	23.1	Complied
2400.000	43.6	69.0	25.4	Complied

Results: Upper Band Edge / Restricted Band / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	54.4	74.0	19.6	Complied
2484.510	55.7	74.0	18.3	Complied

Results: Upper Band Edge / Restricted Band / Average

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	43.8	54.0	10.2	Complied

Results: 2310 to 2390 MHz / Restricted Band / Peak

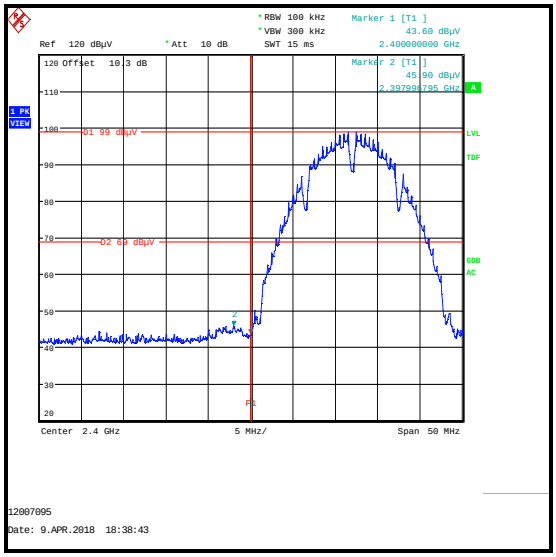
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2388.846	53.6	74.0	20.4	Complied

Results: 2310 to 2390 MHz / Restricted Band / Average

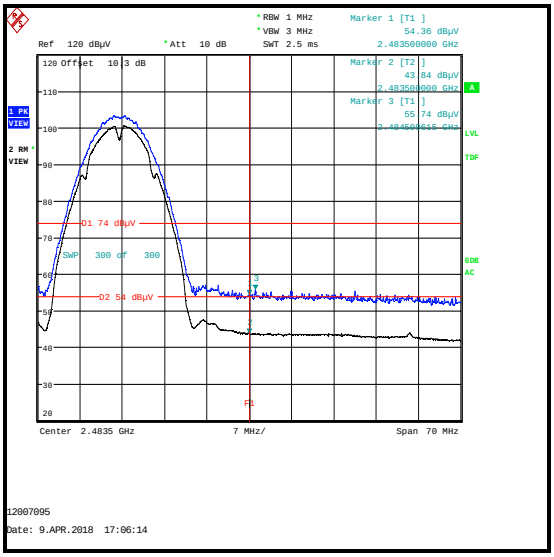
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2363.974	42.5	54.0	11.5	Complied

Transmitter Band Edge Radiated Emissions (continued)

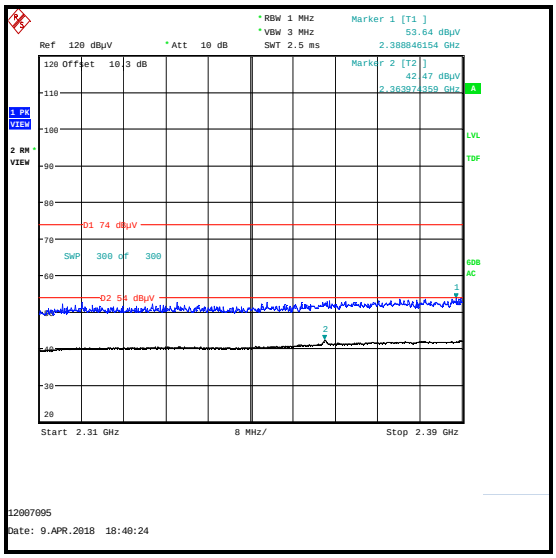
Results: 802.11b / 20 MHz / DBPSK / 1 Mbps / SISO Tx chain 1



Lower Band Edge Peak Measurement



Upper Band Edge Measurement



2310 MHz to 2390 MHz Restricted Band

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11g / 20 MHz / BPSK / 6 Mbps / SISO

Results: Lower Band Edge

Frequency (MHz)	Level (dBµV/m)	-30 dBc Limit (dBµV/m)	Margin (dB)	Result
2399.519	59.1	65.1	6.0	Complied
2400.000	58.1	65.1	7.0	Complied

Results: Upper Band Edge / Restricted Band / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	59.7	74.0	14.3	Complied
2483.612	60.3	74.0	13.7	Complied

Results: Upper Band Edge / Restricted Band / Average

Frequency (MHz)	Level (dBµV/m)	Duty cycle Correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	47.8	0.3	48.1	54.0	5.9	Complied

Results: 2310 to 2390 MHz / Restricted Band / Peak

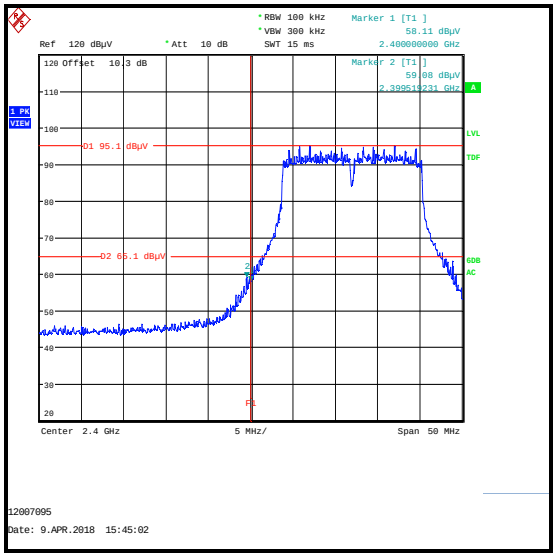
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2389.615	56.9	74.0	17.1	Complied

Results: 2310 to 2390 MHz / Restricted Band / Average

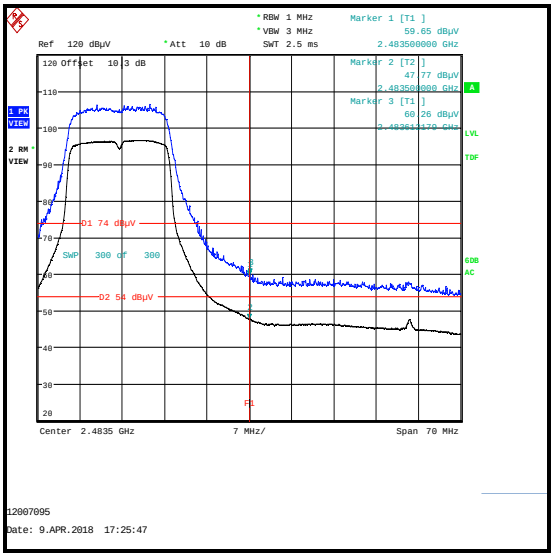
Frequency (MHz)	Level (dBµV/m)	Duty cycle Correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2389.872	45.2	0.3	45.5	54.0	8.5	Complied

Transmitter Band Edge Radiated Emissions (continued)

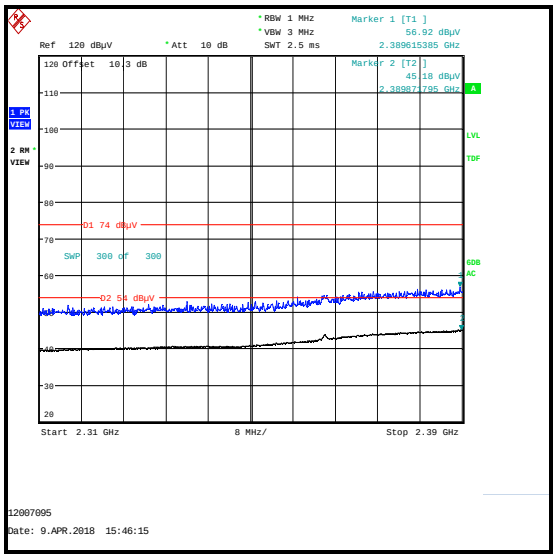
Results: 802.11g / 20 MHz / BPSK / 6 Mbps / SISO



Lower Band Edge Peak Measurement



Upper Band Edge Measurement



2310 MHz to 2390 MHz Restricted Band

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11g / 20 MHz / 16QAM / 24 Mbps / SISO

Results: Lower Band Edge

Frequency (MHz)	Level (dBµV/m)	-30 dBc Limit (dBµV/m)	Margin (dB)	Result
2400.000	60.1	65.4	5.3	Complied

Results: Upper Band Edge / Restricted Band / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	62.3	74.0	11.7	Complied
2483.612	63.8	74.0	10.2	Complied

Results: Upper Band Edge / Restricted Band / Average

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	50.5	54.0	3.5	Complied
2483.724	50.6	54.0	3.4	Complied

Results: 2310 to 2390 MHz / Restricted Band / Peak

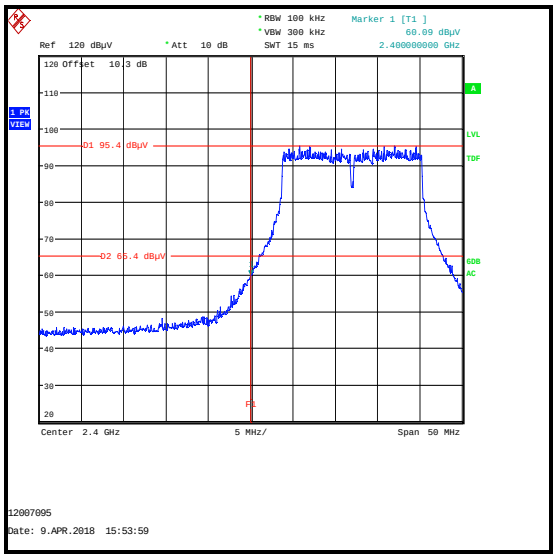
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2389.872	57.2	74.0	16.8	Complied

Results: 2310 to 2390 MHz / Restricted Band / Average

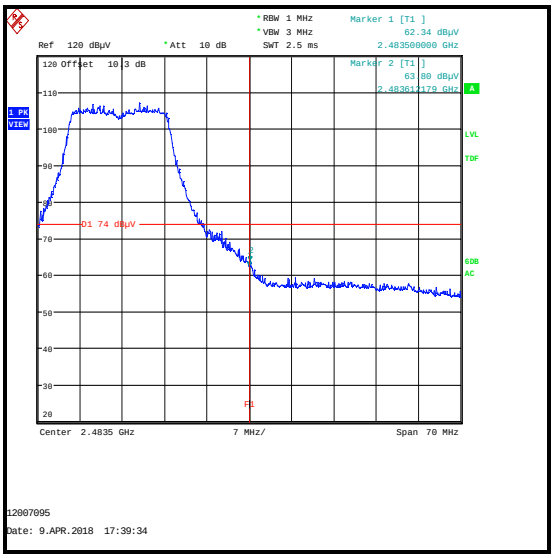
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2389.487	47.8	54.0	6.2	Complied

Transmitter Band Edge Radiated Emissions (continued)

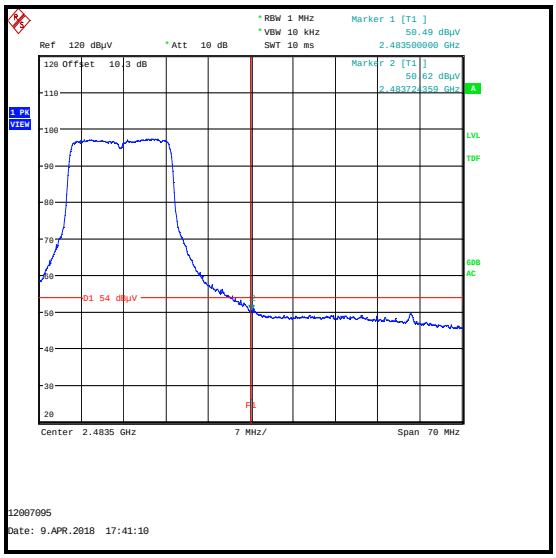
Results: 802.11g / 20 MHz / 16QAM / 24 Mbps / SISO



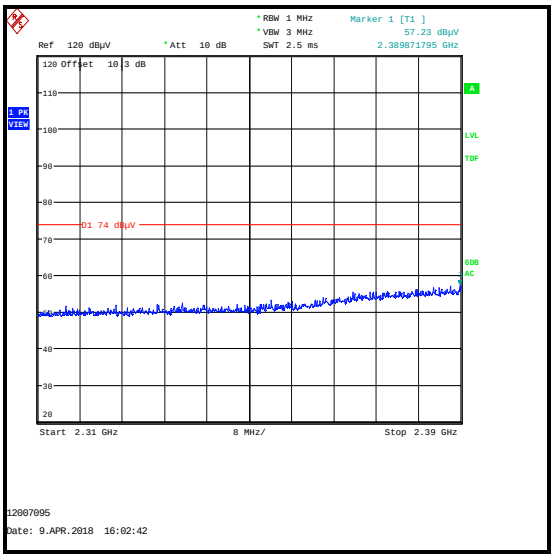
Lower Band Edge Peak Measurement



Upper Band Edge Peak Measurement



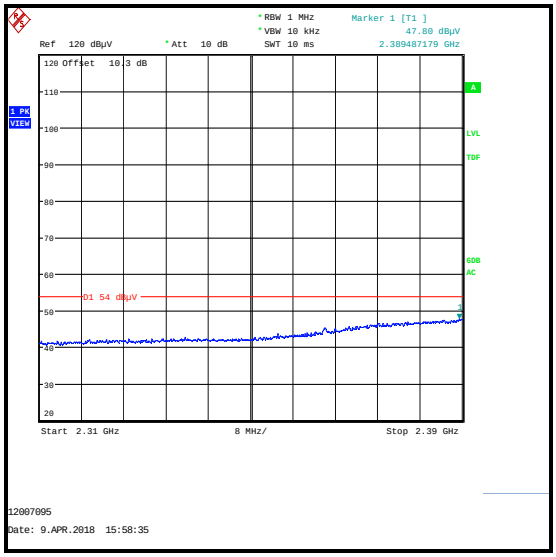
Upper Band Edge Average Measurement



2310 MHz to 2390 MHz Restricted Band Peak

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11g / 20 MHz / 16QAM / 24 Mbps / SISO



2310 MHz to 2390 MHz Restricted Band Average

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11n HT20 / BPSK / 6.5 Mbps / MCS0 / SISO

Results: Lower Band Edge

Frequency (MHz)	Level (dBµV/m)	-30 dBc Limit (dBµV/m)	Margin (dB)	Result
2399.840	59.0	65.1	6.1	Complied
2400.000	58.4	65.1	6.7	Complied

Results: Upper Band Edge / Restricted Band / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	60.8	74.0	13.2	Complied

Results: Upper Band Edge / Restricted Band / Average

Frequency (MHz)	Level (dBµV/m)	Duty cycle Correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	48.2	0.3	48.5	54.0	5.5	Complied

Results: 2310 to 2390 MHz / Restricted Band / Peak

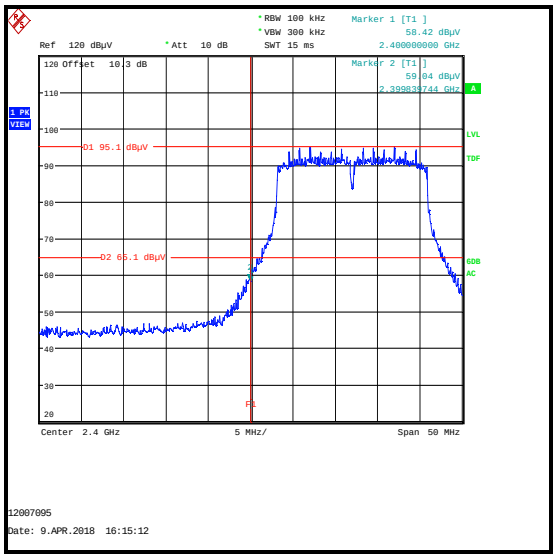
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2386.538	55.4	74.0	18.6	Complied

Results: 2310 to 2390 MHz / Restricted Band / Average

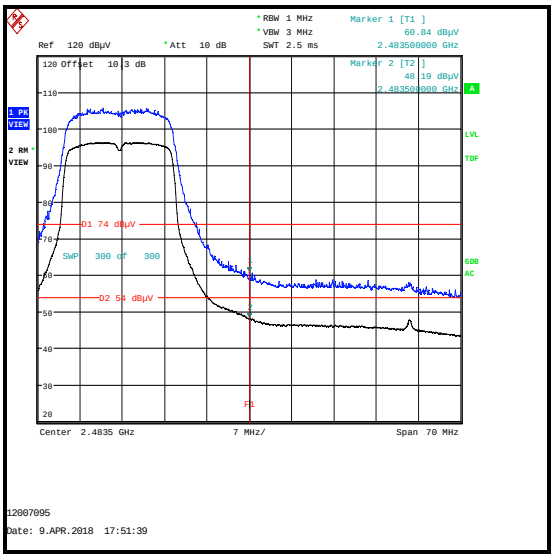
Frequency (MHz)	Level (dBµV/m)	Duty cycle Correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2389.743	43.9	0.3	44.2	54.0	9.8	Complied

Transmitter Band Edge Radiated Emissions (continued)

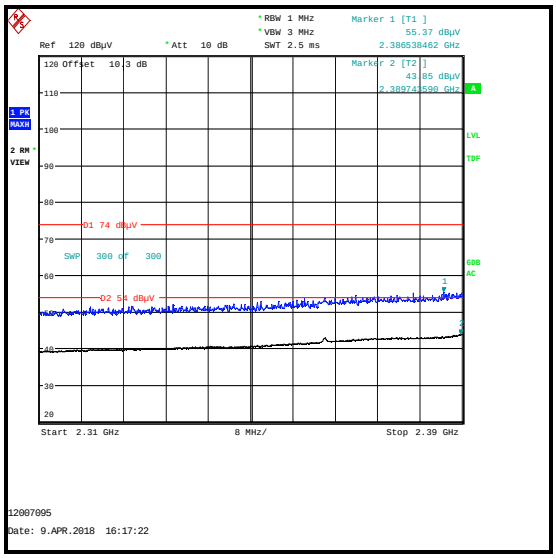
Results: 802.11n HT20 / BPSK / 6.5 Mbps / MCS0 / SISO



Lower Band Edge Peak Measurement



Upper Band Edge Measurement



2310 MHz to 2390 MHz Restricted Band

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11n HT20 / 16QAM / 39 Mbps / MCS4 / SISO

Results: Lower Band Edge

Frequency (MHz)	Level (dBµV/m)	-30 dBc Limit (dBµV/m)	Margin (dB)	Result
2399.840	60.7	64.7	4.0	Complied
2400.000	60.2	64.7	4.5	Complied

Results: Upper Band Edge / Restricted Band / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	61.6	74.0	12.4	Complied
2483.612	62.2	74.0	11.8	Complied

Results: Upper Band Edge / Restricted Band / Average

Frequency (MHz)	Level (dBµV/m)	Duty cycle Correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	47.0	1.3	48.3	54.0	5.7	Complied

Results: 2310 to 2390 MHz / Restricted Band / Peak

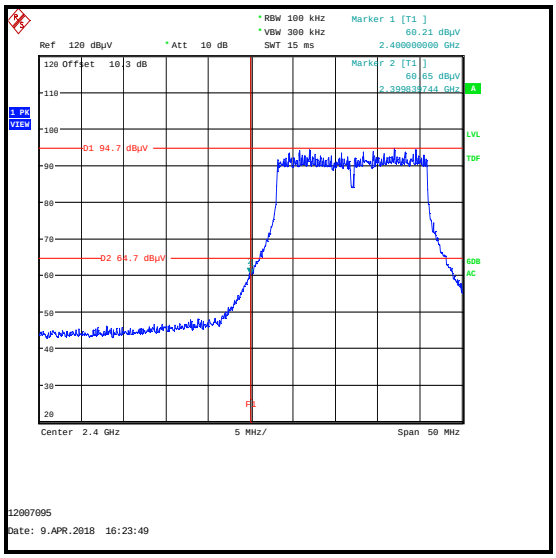
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2389.231	56.6	74.0	17.4	Complied

Results: 2310 to 2390 MHz / Restricted Band / Average

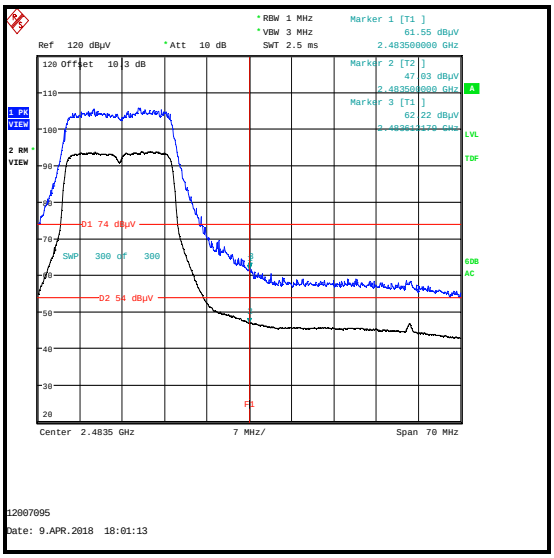
Frequency (MHz)	Level (dBµV/m)	Duty cycle Correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2389.615	43.8	1.3	45.1	54.0	8.9	Complied

Transmitter Band Edge Radiated Emissions (continued)

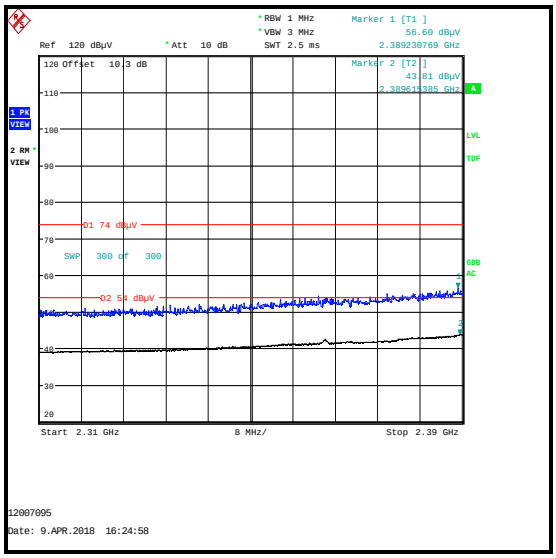
Results: 802.11n HT20 / 16QAM / 39 Mbps / MCS4 / SISO



Lower Band Edge Peak Measurement



Upper Band Edge Measurement



2310 MHz to 2390 MHz Restricted Band

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11n HT40 / BPSK / 13.5 Mbps / MCS0 / SISO

Results: Lower Band Edge

Frequency (MHz)	Level (dBµV/m)	-30 dBc Limit (dBµV/m)	Margin (dB)	Result
2399.856	60.7	62.7	2.0	Complied
2400.000	59.5	62.7	3.2	Complied

Results: Upper Band Edge / Restricted Band / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	65.4	74.0	8.6	Complied
2485.792	67.8	74.0	6.2	Complied

Results: Upper Band Edge / Restricted Band / Average

Frequency (MHz)	Level (dBµV/m)	Duty cycle Correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	49.1	0.7	49.8	54.0	4.2	Complied
2500.000	49.7	0.7	50.4	54.0	3.6	Complied

Results: 2310 to 2390 MHz / Restricted Band / Peak

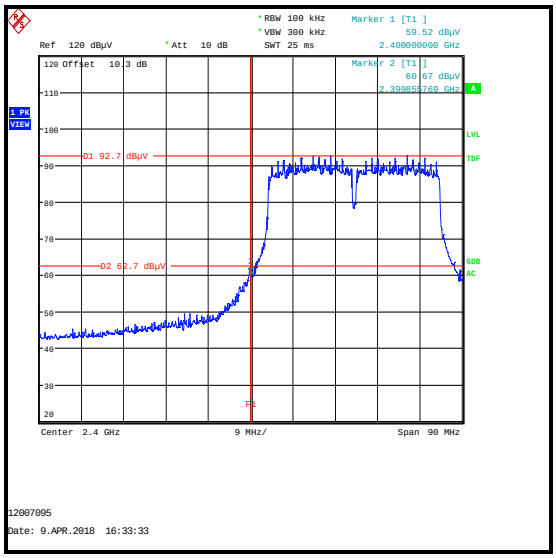
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2388.974	64.7	74.0	9.3	Complied

Results: 2310 to 2390 MHz / Restricted Band / Average

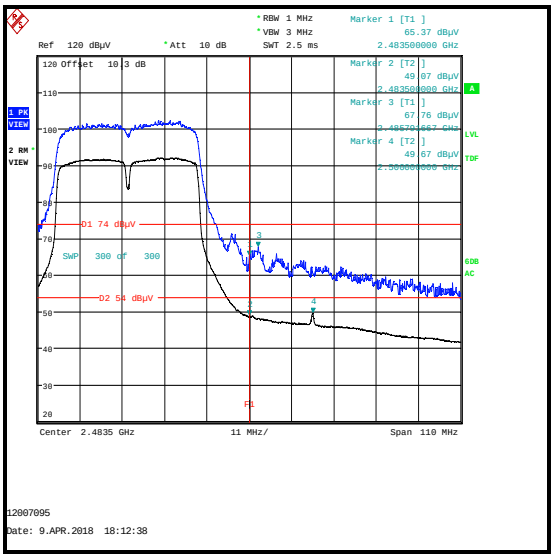
Frequency (MHz)	Level (dBµV/m)	Duty cycle Correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2389.872	44.7	0.7	45.4	54.0	8.6	Complied

Transmitter Band Edge Radiated Emissions (continued)

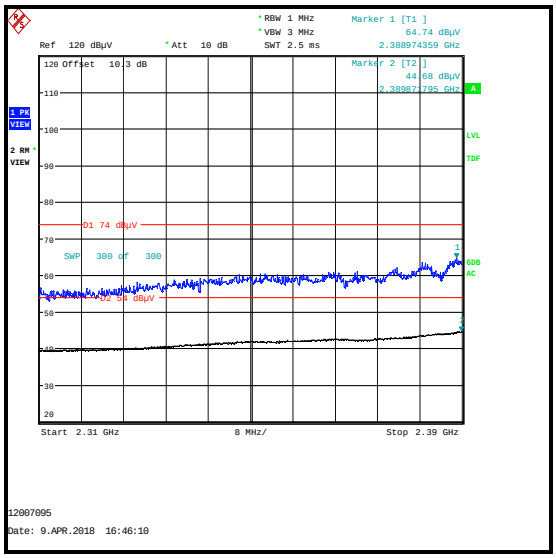
Results: 802.11n HT40 / BPSK / 13.5 Mbps / MCS0 / SISO



Lower Band Edge Peak Measurement



Upper Band Edge Measurement



2310 MHz to 2390 MHz Restricted Band

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11n HT40 / 16QAM / 81 Mbps / MCS4 / SISO

Results: Lower Band Edge

Frequency (MHz)	Level (dBµV/m)	-30 dBc Limit (dBµV/m)	Margin (dB)	Result
2400.000	60.4	62.6	2.2	Complied

Results: Upper Band Edge / Restricted Band / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	64.8	74.0	9.2	Complied
2484.916	67.8	74.0	6.2	Complied

Results: Upper Band Edge / Restricted Band / Average

Frequency (MHz)	Level (dBµV/m)	Duty cycle Correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	47.2	2.2	49.4	54.0	4.6	Complied
2499.894	48.4	2.2	50.6	54.0	3.4	Complied

Results: 2310 to 2390 MHz / Restricted Band / Peak

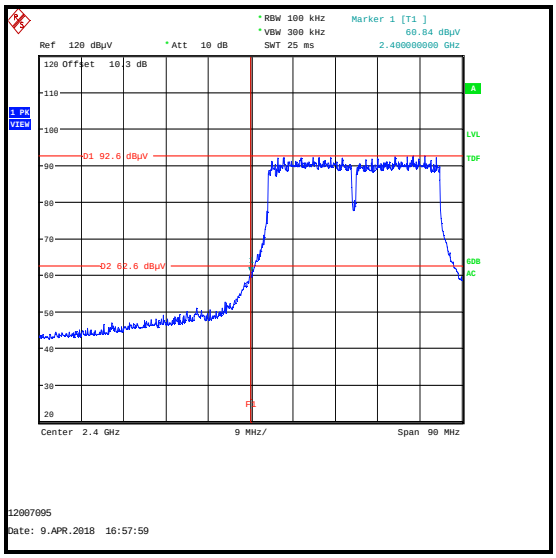
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2388.590	62.1	74.0	11.9	Complied

Results: 2310 to 2390 MHz / Restricted Band / Average

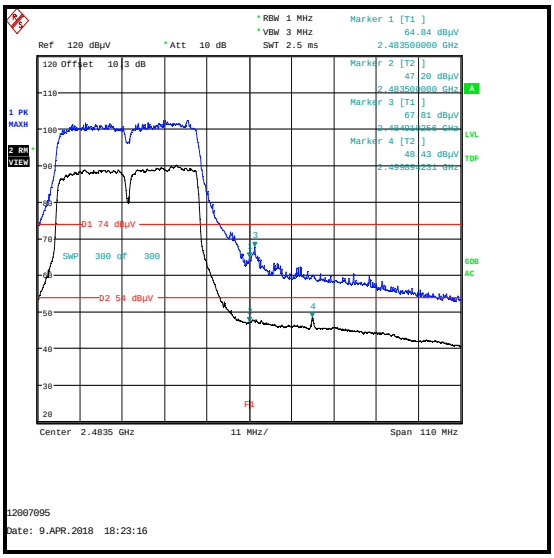
Frequency (MHz)	Level (dBµV/m)	Duty cycle Correction (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2387.051	43.9	2.2	46.1	54.0	7.9	Complied

Transmitter Band Edge Radiated Emissions (continued)

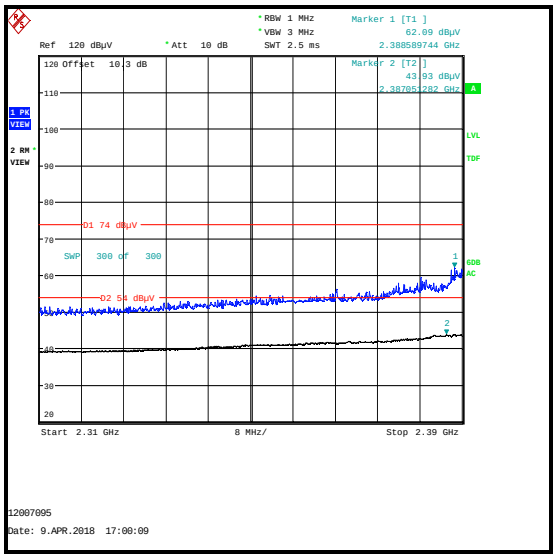
Results: 802.11n HT40 / 16QAM / 81 Mbps / MCS4 / SISO



Lower Band Edge Peak Measurement



Upper Band Edge Peak Measurement



2310 MHz to 2390 MHz Restricted Band

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11b / 20 MHz / DBPSK / 1 Mbps / MIMO

Results: Lower Band Edge

Frequency (MHz)	Level (dBµV/m)	-30 dBc Limit (dBµV/m)	Margin (dB)	Result
2395.994	50.5	73.8	23.3	Complied
2400.000	47.8	73.8	26.0	Complied

Results: Upper Band Edge / Restricted Band / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	58.4	74.0	15.6	Complied
2484.173	59.7	74.0	14.3	Complied

Results: Upper Band Edge / Restricted Band / Average

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	47.4	54.0	6.6	Complied

Results: 2310 to 2390 MHz / Restricted Band / Peak

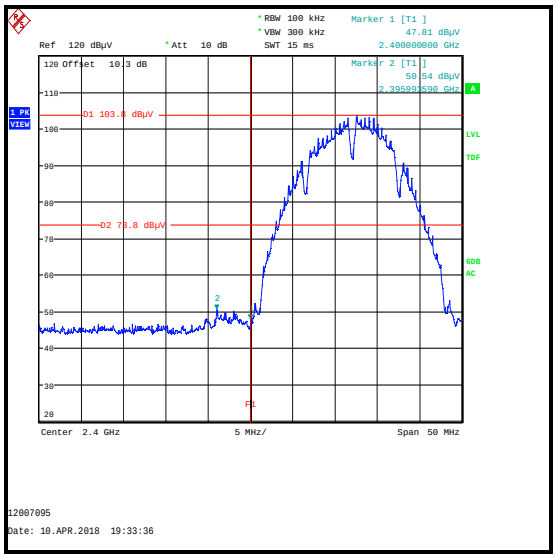
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2368.974	56.7	74.0	17.3	Complied

Results: 2310 to 2390 MHz / Restricted Band / Average

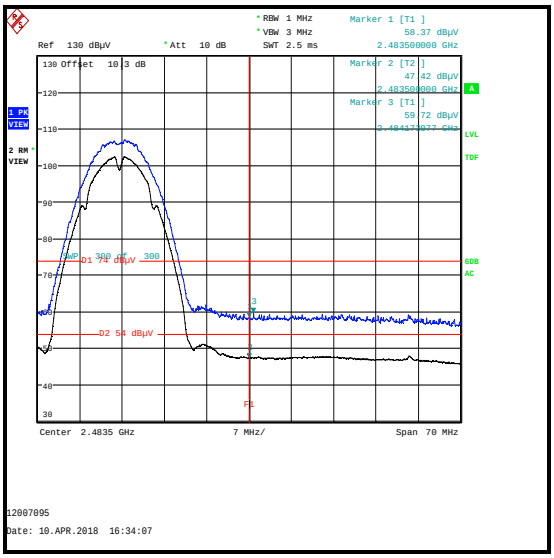
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2382.435	45.4	54.0	8.6	Complied

Transmitter Band Edge Radiated Emissions (continued)

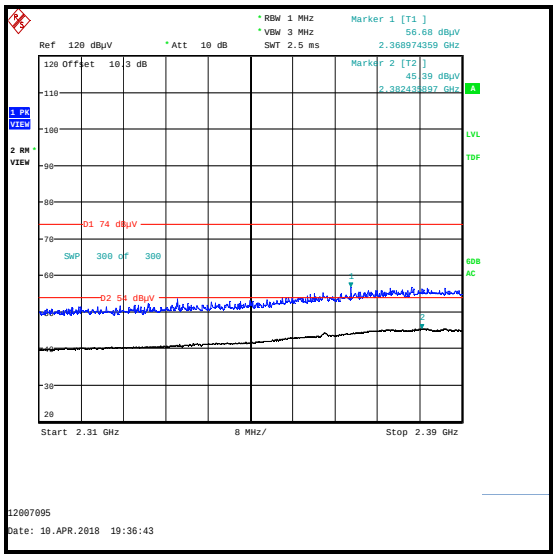
Results: 802.11b / 20 MHz / DBPSK / 1 Mbps / MIMO



Lower Band Edge Peak Measurement



Upper Band Edge Peak Measurement



2310 MHz to 2390 MHz Restricted Band

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11g / 20 MHz / BPSK / 6 Mbps / MIMO

Results: Lower Band Edge

Frequency (MHz)	Level (dBµV/m)	-30 dBc Limit (dBµV/m)	Margin (dB)	Result
2399.920	62.3	69.1	6.8	Complied
2400.000	59.0	69.1	10.1	Complied

Results: Upper Band Edge / Restricted Band / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	62.0	74.0	12.0	Complied

Results: Upper Band Edge / Restricted Band / Average

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	53.0	54.0	1.0	Complied

Results: 2310 to 2390 MHz / Restricted Band / Peak

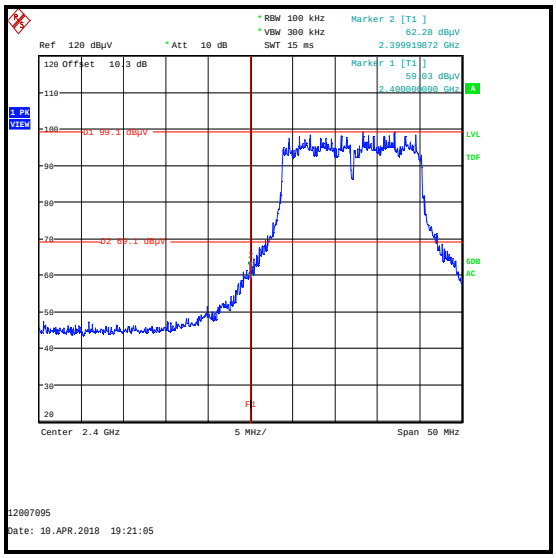
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2387.436	57.8	74.0	16.2	Complied

Results: 2310 to 2390 MHz / Restricted Band / Average

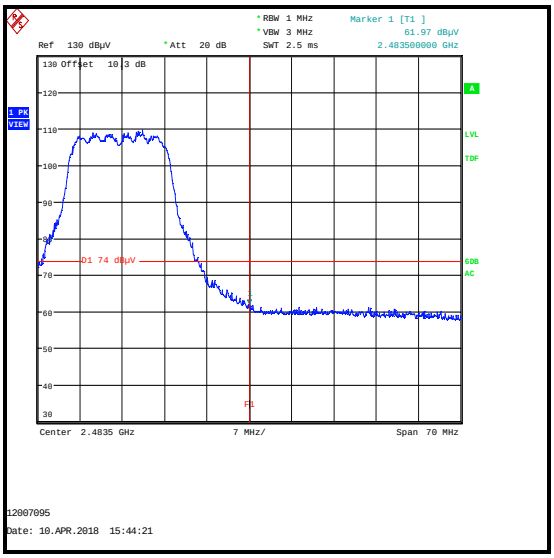
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2389.743	48.0	54.0	6.0	Complied

Transmitter Band Edge Radiated Emissions (continued)

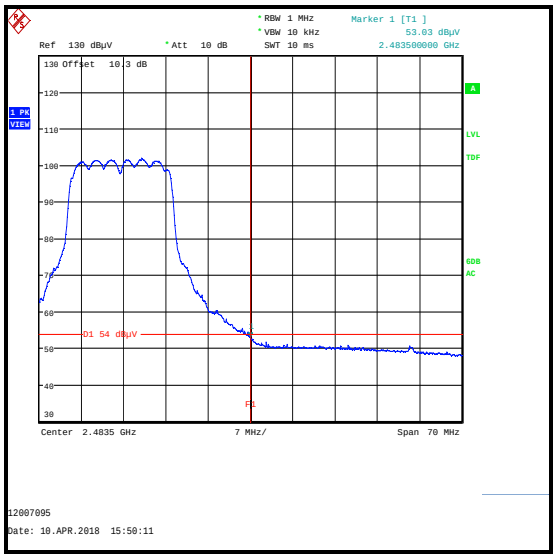
Results: 802.11g / 20 MHz / BPSK / 6 Mbps / MIMO



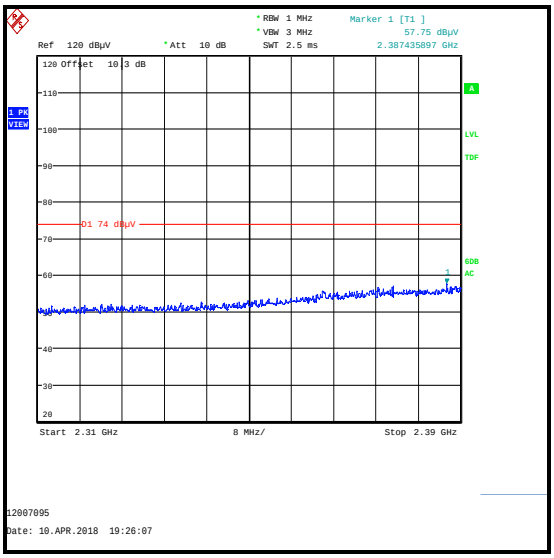
Lower Band Edge Peak Measurement



Upper Band Edge Peak Measurement



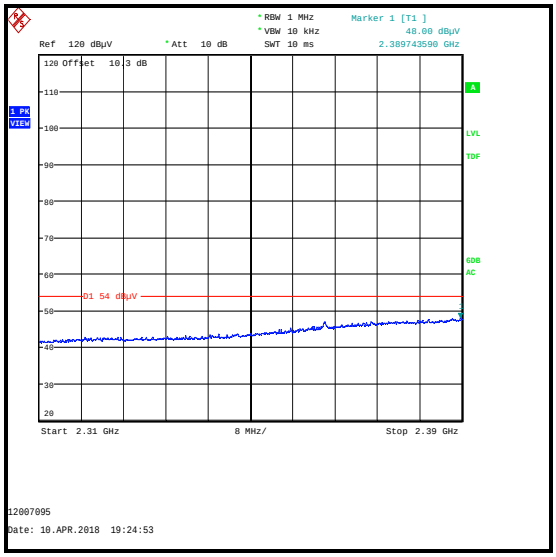
Upper Band Edge Average Measurement



2310 MHz to 2390 MHz Restricted Band Peak

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11g / 20 MHz / BPSK / 6 Mbps / MIMO



2310 MHz to 2390 MHz Restricted Band Average

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11g / 20 MHz / 16QAM / 24 Mbps / MIMO

Results: Lower Band Edge

Frequency (MHz)	Level (dBµV/m)	-30 dBc Limit (dBµV/m)	Margin (dB)	Result
2399.840	62.3	68.7	6.4	Complied
2400.000	61.6	68.7	7.1	Complied

Results: Upper Band Edge / Restricted Band / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	64.2	74.0	9.8	Complied
2483.724	64.5	74.0	9.5	Complied

Results: Upper Band Edge / Restricted Band / Average

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	53.5	54.0	0.5	Complied

Results: 2310 to 2390 MHz / Restricted Band / Peak

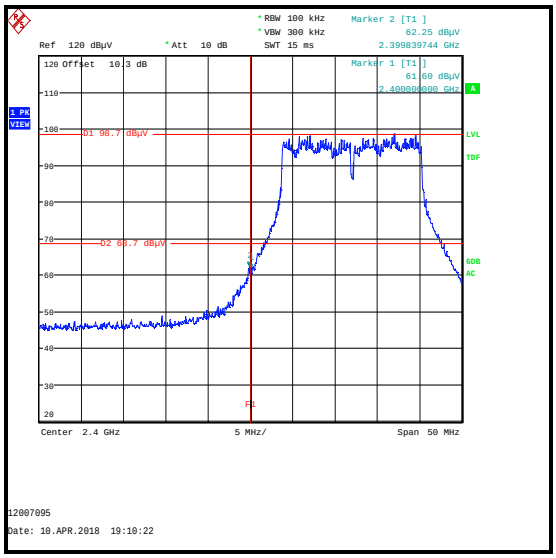
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2389.744	58.9	74.0	15.1	Complied

Results: 2310 to 2390 MHz / Restricted Band / Average

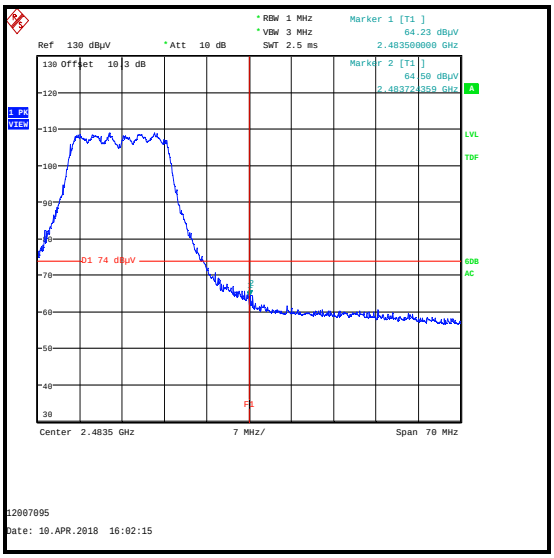
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2390.000	48.9	54.0	5.1	Complied

Transmitter Band Edge Radiated Emissions (continued)

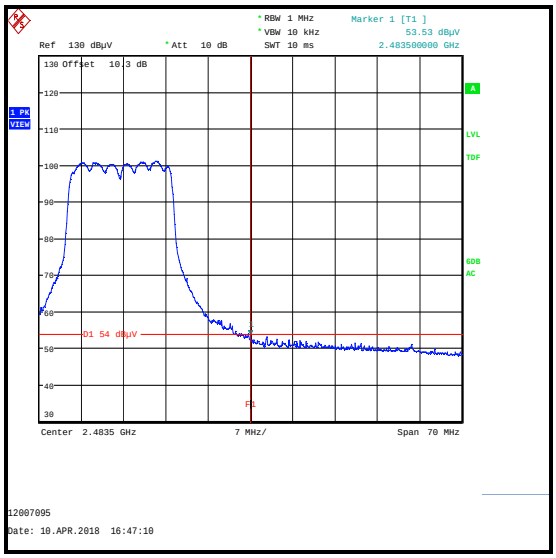
Results: 802.11g / 20 MHz / 16QAM / 24 Mbps / MIMO



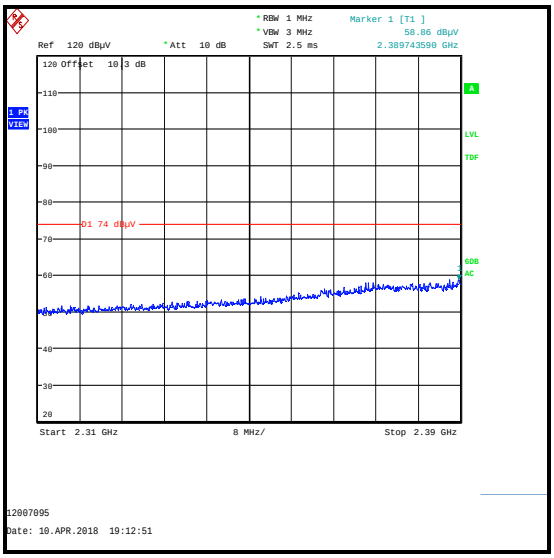
Lower Band Edge Peak Measurement



Upper Band Edge Peak Measurement



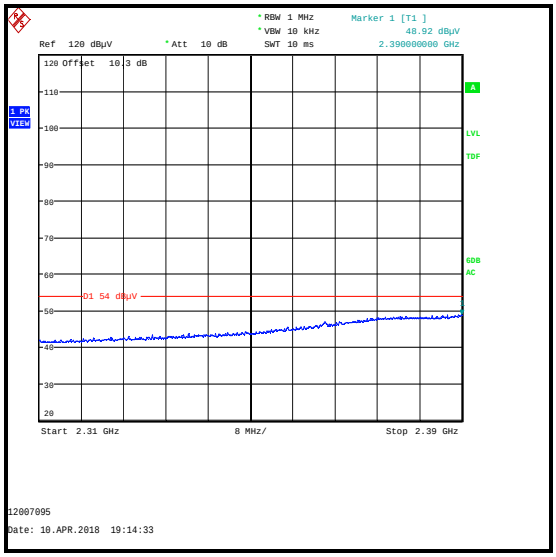
Upper Band Edge Average Measurement



2310 MHz to 2390 MHz Restricted Band Peak

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11g / 20 MHz / 16QAM / 24 Mbps / MIMO



2310 MHz to 2390 MHz Restricted Band Average

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11n HT20 / BPSK / 6.5 Mbps / MCS0 / MIMO

Results: Lower Band Edge

Frequency (MHz)	Level (dBµV/m)	-30 dBc Limit (dBµV/m)	Margin (dB)	Result
2399.840	62.8	68.8	6.0	Complied
2400.000	61.7	68.8	7.1	Complied

Results: Upper Band Edge / Restricted Band / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	62.0	74.0	12.0	Complied
2483.837	62.5	74.0	11.5	Complied

Results: Upper Band Edge / Restricted Band / Average

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	51.5	54.0	2.5	Complied
2483.612	51.8	54.0	2.2	Complied

Results: 2310 to 2390 MHz / Restricted Band / Peak

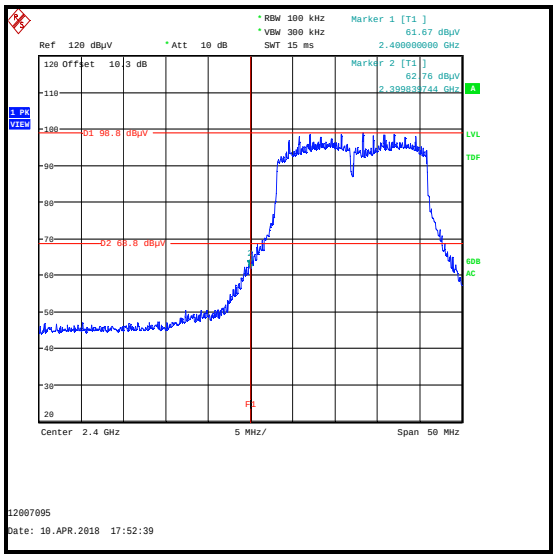
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2379.871	57.6	74.0	16.4	Complied

Results: 2310 to 2390 MHz / Restricted Band / Average

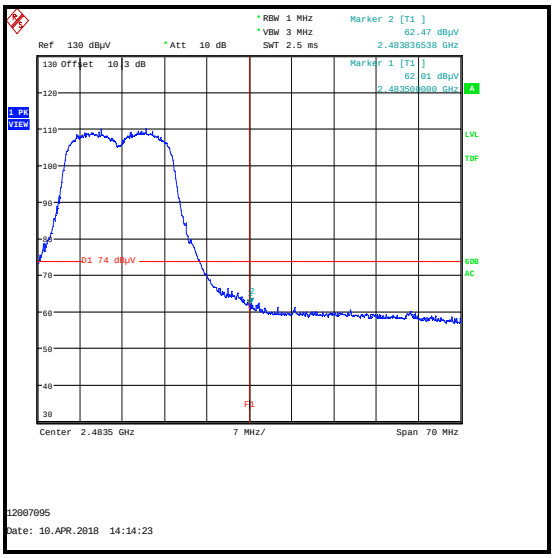
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2389.872	48.2	54.0	5.8	Complied

Transmitter Band Edge Radiated Emissions (continued)

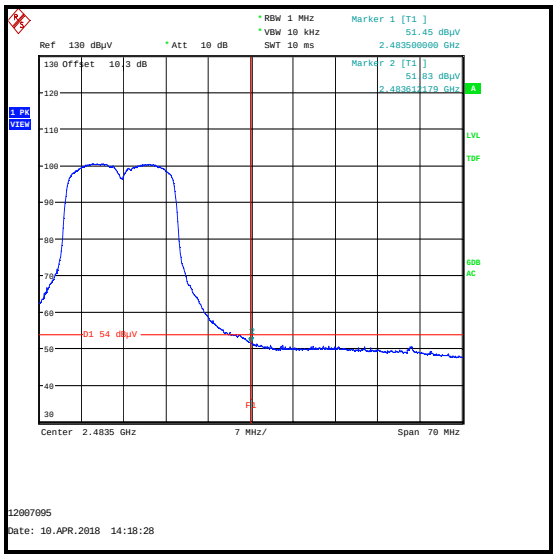
Results: 802.11n HT20 / BPSK / 6.5 Mbps / MCS0 / MIMO



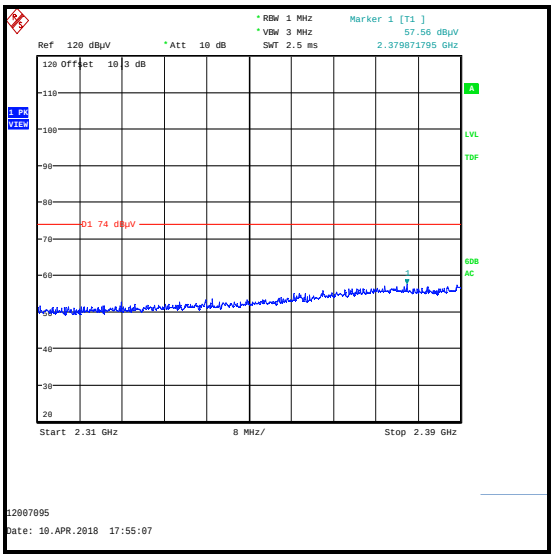
Lower Band Edge Peak Measurement



Upper Band Edge Peak Measurement



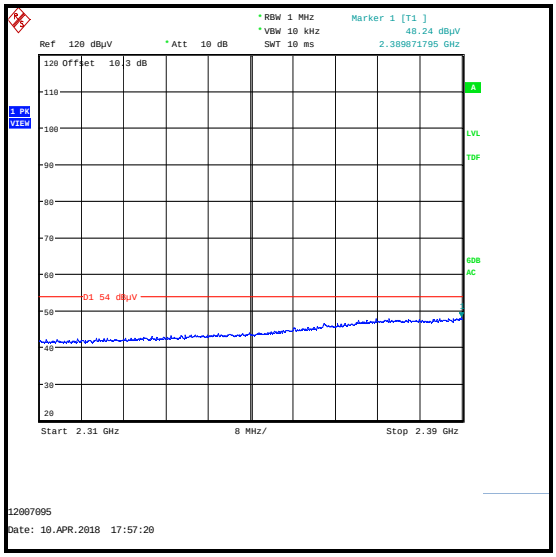
Upper Band Edge Average Measurement



2310 MHz to 2390 MHz Restricted Band Peak

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11n HT20 / BPSK / 6.5 Mbps / MCS0 / MIMO



2310 MHz to 2390 MHz Restricted Band Average

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11n HT20 / 16QAM / 26 Mbps / MCS3 / MIMO

Results: Lower Band Edge

Frequency (MHz)	Level (dBµV/m)	-30 dBc Limit (dBµV/m)	Margin (dB)	Result
2400.000	61.8	67.0	5.2	Complied

Results: Upper Band Edge / Restricted Band / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	63.4	74.0	10.6	Complied

Results: Upper Band Edge / Restricted Band / Average

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	52.7	54.0	1.3	Complied

Results: 2310 to 2390 MHz / Restricted Band / Peak

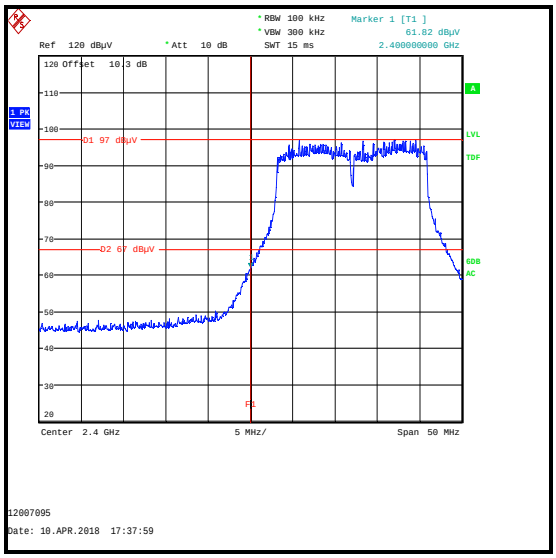
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2389.744	57.8	74.0	16.2	Complied

Results: 2310 to 2390 MHz / Restricted Band / Average

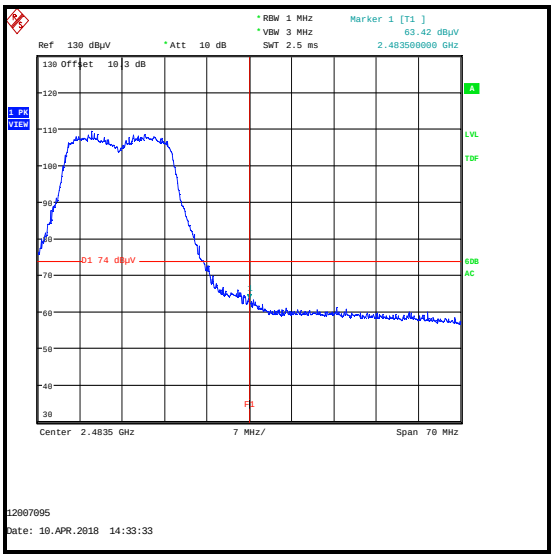
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2389.872	49.1	54.0	4.9	Complied

Transmitter Band Edge Radiated Emissions (continued)

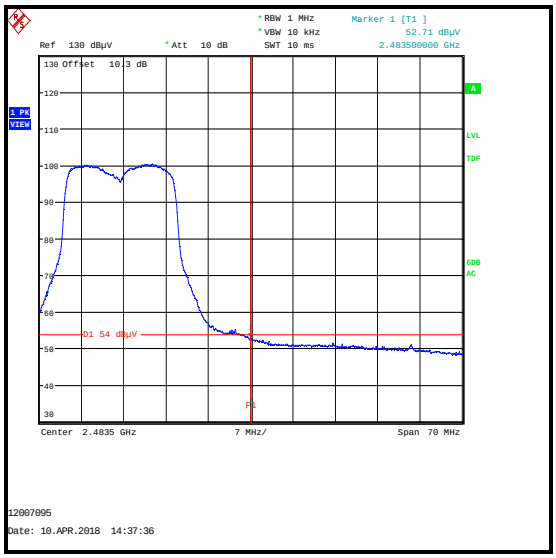
Results: 802.11n HT20 / 16QAM / 26 Mbps / MCS3 / MIMO



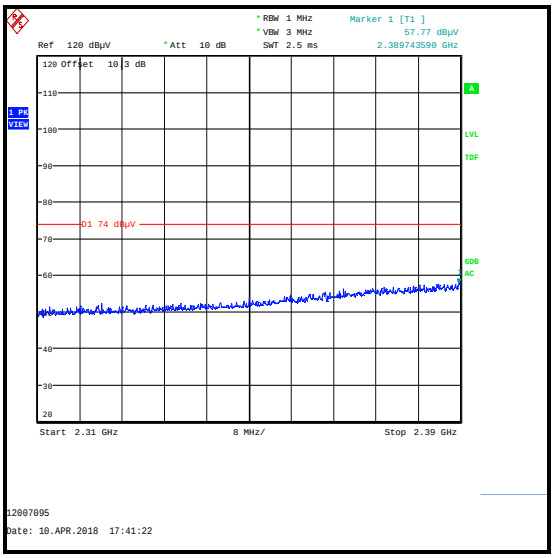
Lower Band Edge Peak Measurement



Upper Band Edge Peak Measurement



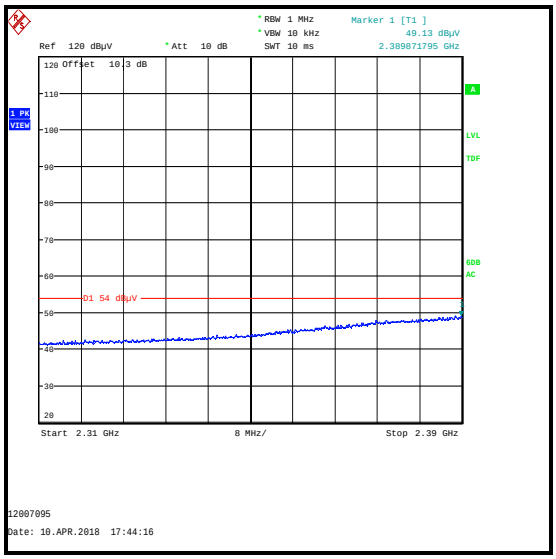
Upper Band Edge Average Measurement



2310 MHz to 2390 MHz Restricted Band Peak

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11n HT20 / 16QAM / 26 Mbps / MCS3 / MIMO



2310 MHz to 2390 MHz Restricted Band Average

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11n HT40 / BPSK / 13.5 Mbps / MCS0 / MIMO

Results: Lower Band Edge

Frequency (MHz)	Level (dBµV/m)	-30 dBc Limit (dBµV/m)	Margin (dB)	Result
2399.567	64.5	66.9	2.4	Complied
2400.000	62.9	66.9	4.0	Complied

Results: Upper Band Edge / Restricted Band / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	66.6	74.0	7.4	Complied
2484.910	70.7	74.0	3.3	Complied

Results: Upper Band Edge / Restricted Band / Average

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	51.9	54.0	2.1	Complied
2499.894	51.6	54.0	2.4	Complied

Results: 2310 to 2390 MHz / Restricted Band / Peak

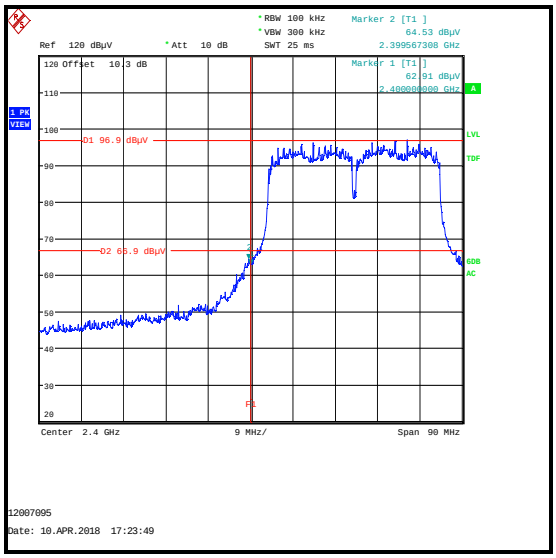
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2388.461	71.0	74.0	3.0	Complied

Results: 2310 to 2390 MHz / Restricted Band / Average

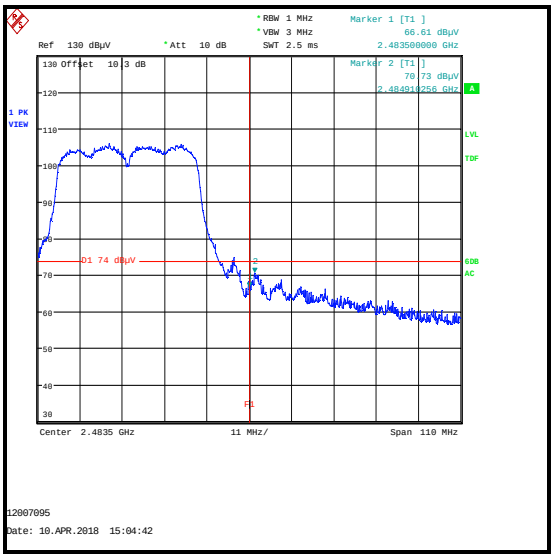
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2390.000	49.9	54.0	4.1	Complied

Transmitter Band Edge Radiated Emissions (continued)

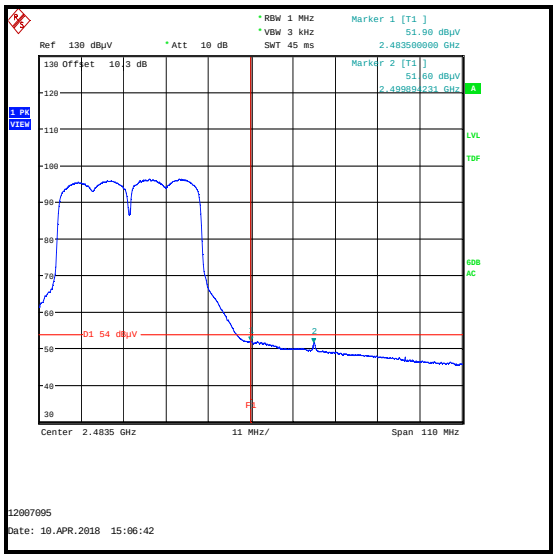
Results: 802.11n HT40 / BPSK / 13.5 Mbps / MCS0 / MIMO



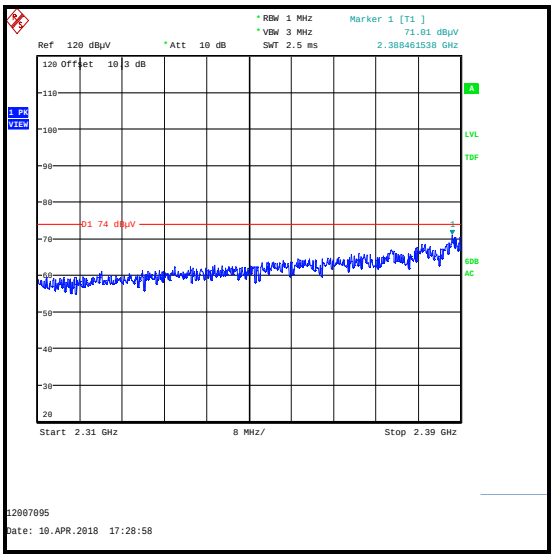
Lower Band Edge Peak Measurement



Upper Band Edge Peak Measurement



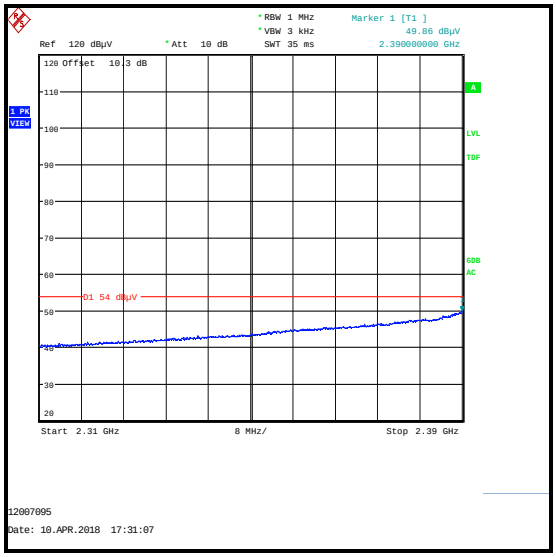
Upper Band Edge Average Measurement



2310 MHz to 2390 MHz Restricted Band Peak

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11n HT40 / BPSK / 13.5 Mbps / MCS0 / MIMO



2310 MHz to 2390 MHz Restricted Band Average

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11n HT40 / 16QAM / 81 Mbps / MCS4 / MIMO

Results: Lower Band Edge

Frequency (MHz)	Level (dBµV/m)	-30 dBc Limit (dBµV/m)	Margin (dB)	Result
2400.000	62.0	65.5	3.5	Complied

Results: Upper Band Edge / Restricted Band / Peak

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	65.7	74.0	8.3	Complied
2485.615	68.9	74.0	5.1	Complied

Results: Upper Band Edge / Restricted Band / Average

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2483.500	53.5	54.0	0.5	Complied
2500.000	52.9	54.0	1.1	Complied

Results: 2310 to 2390 MHz / Restricted Band / Peak

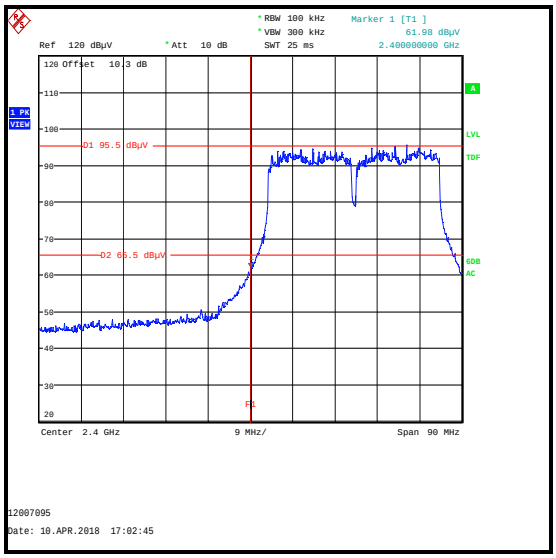
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2389.231	67.6	74.0	6.4	Complied

Results: 2310 to 2390 MHz / Restricted Band / Average

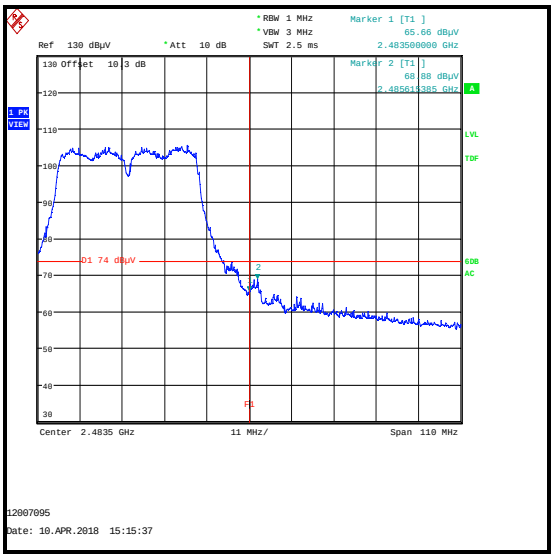
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
2389.487	50.8	54.0	3.2	Complied

Transmitter Band Edge Radiated Emissions (continued)

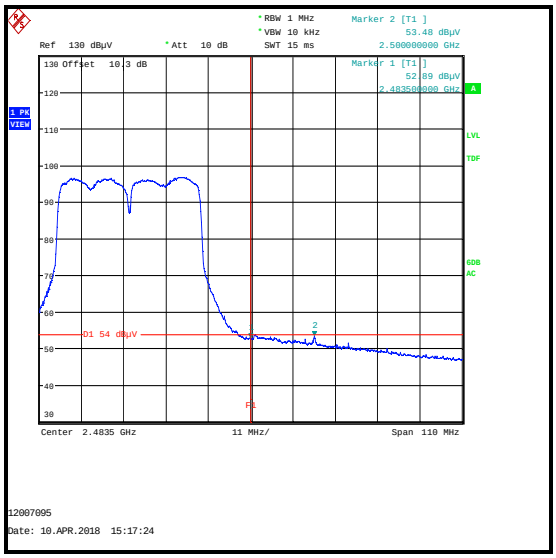
Results: 802.11n HT40 / 16QAM / 81 Mbps / MCS4 / MIMO



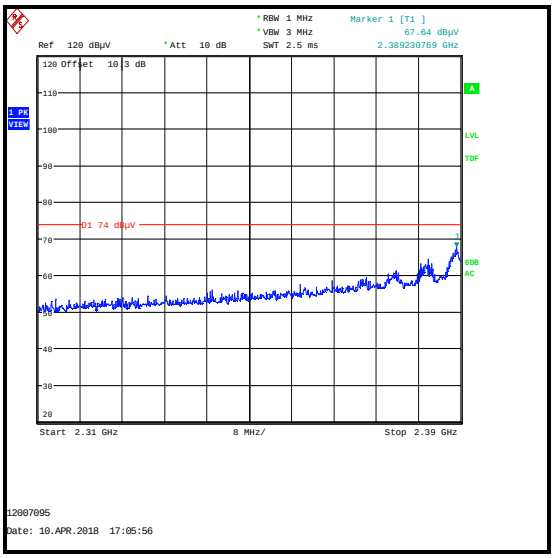
Lower Band Edge Peak Measurement



Upper Band Edge Peak Measurement



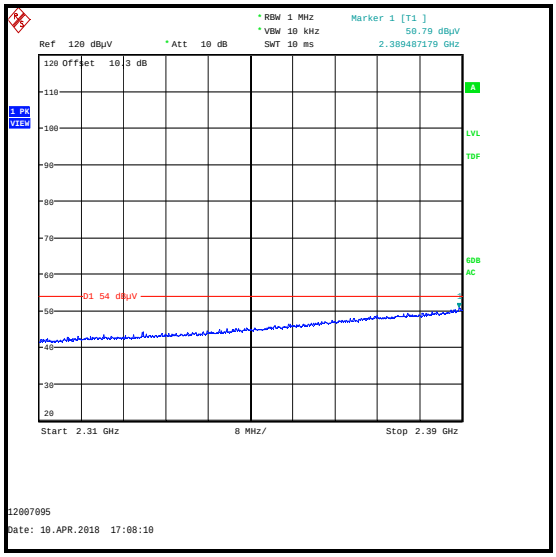
Upper Band Edge Average Measurement



2310 MHz to 2390 MHz Restricted Band Peak

Transmitter Band Edge Radiated Emissions (continued)

Results: 802.11n HT40 / 16QAM / 81 Mbps / MCS4 / MIMO



2310 MHz to 2390 MHz Restricted Band Average

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2003	Thermohygrometer	Testo	608-H1	45046641	27 Feb 2019	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	21 Feb 2019	12
M1630	Test Receiver	Rohde & Schwarz	ESU40	100233	03 Aug 2018	12
A2863	Pre Amplifier	Agilent	8449B	3008A02100	19 Feb 2019	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	19 Feb 2019	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	21 Feb 2019	12

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
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±2.40 dB
Minimum 6 dB Bandwidth	2.4 GHz to 2.4835 GHz	95%	±4.59 %
Duty Cycle	2.4 GHz to 2.4835 GHz	95%	±1.14 %
Spectral Power Density	2.4 GHz to 2.4835 GHz	95%	±1.13 dB
Conducted Maximum Output Power	2.4 GHz to 2.4835 GHz	95%	±1.13 dB
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±4.65 dB
Radiated Spurious Emissions	1 GHz to 25 GHz	95%	±2.94 dB

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

7. Report Revision History

Version Number	Revision Details		
	Page No(s)	**Clause**	**Details**
1.0	-	-	Initial Version
2.0	8	3.4	Corrected maximum conducted output power.

--- END OF REPORT ---