



# TEST REPORT

**Test Report No. : UL-RPT-RP-13697467-216-FCC**

**Applicant** : Boxine GmbH  
**Model No.** : 03-xxxx (colour coding)  
**FCC ID** : 2AU47-00002  
**Technology** : WLAN 5 GHz (802.11 a, n)  
**Test Standard(s)** : FCC Parts 15.207, 15.209(a) & 15.407

For details of applied tests refer to test result summary

1. This test report shall not be reproduced in full or partial, without the written approval of UL International Germany GmbH.
2. The results in this report apply only to the sample tested.
3. The test results in this report are traceable to the national or international standards.
4. Test Report Version 1.0
5. Result of the tested sample: **PASS**

*Krume, Ivanov*

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Prepared by: Krume, Ivanov  
Title: Laboratory Engineer  
Date: 13 July 2021

*Ajit Phadtare*

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Approved by: Ajit, Phadtare  
Title: Lead Test Engineer  
Date: 13 July 2021



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

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## **1. Customer Information**

### **1.1.Applicant Information**

<b>Company Name:</b>	Boxine GmbH
<b>Company Address:</b>	Grafenberger Allee 120, 40237 Düsseldorf, GERMANY
<b>Contact Person:</b>	Andrej Henkel
<b>Contact E-Mail Address:</b>	andrej.henkel@boxine.de
<b>Contact Phone No.:</b>	+49 211 542540-49

### **1.2.Manufacturer Information**

<b>Company Name:</b>	Boxine GmbH
<b>Company Address:</b>	Grafenberger Allee 120, 40237 Düsseldorf, GERMANY
<b>Contact Person:</b>	Andrej Henkel
<b>Contact E-Mail Address:</b>	andrej.henkel@boxine.de
<b>Contact Phone No.:</b>	+49 211 542540-49

## **2. Summary of Testing**

### **2.1. General Information**

#### **Applied Standards**

<b>Specification Reference:</b>	47CFR15.407 and 47CFR15.403
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart E (Unlicensed National Information Infrastructure Devices) – Sections 15.403 and 15.407
<b>Specification Reference:</b>	47CFR15.207 and 47CFR15.209
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.207 and 15.209

#### **Location**

<b>Location of Testing:</b>	UL International Germany GmbH Hedelfinger Str. 61 70327 Stuttgart Germany
<b>Test Firm Registration:</b>	399704

#### **Date information**

<b>Order Date:</b>	29 January 2021
<b>EUT arrived:</b>	06 April 2021
<b>Test Dates:</b>	19 April 2021 to 30 June 2021
<b>EUT returned:</b>	-/-

## 2.2. Summary of Test Results

Clause	Measurement (5.15-5.25 GHz band)	Complied	Did not comply	Not performed	Not applicable
Part 15.207	Transmitter AC Conducted Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Part 15.403(i)	Transmitter 26 dB Emission Bandwidth	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Part 15.35(c)	Transmitter Duty Cycle <sup>(1)</sup>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Part 15.407(a)(1)(iv)	Transmitter Maximum Conducted Output Power	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Part 15.407(a)(1)(iv)	Transmitter Peak Power Spectral Density	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Part 15.407(b)/15.209(a)	Transmitter Out of Band Radiated Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Part 15.407(b)/15.209(a)	Transmitter Band Edge Radiated Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Part 15.407(g)	Transmitter Frequency Stability <sup>(2)</sup> (Temperature & Voltage Variation)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Part 15.407(h)(1)	Transmitter Power Control <sup>(3)</sup>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

### Note(s):

1. The measurement was performed to assist in the calculation of the level of emissions.
2. As per applicant's user manual Frequency stability is better than  $\pm 20$  ppm which ensures that the signal remains in the allocated bands under all operational conditions stated in the user manual.
3. Not applicable as EUT does not support operations in 5.25-5.35 GHz band and the 5.47-5.725 GHz band.

## 2.3. Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	FCC KDB 789033 D02 General U-NII Test Procedures New Rules v02r01 December 14, 2017
Title:	Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices – Part 15, Subpart E
Reference:	FCC KDB 174176 D01 Line Conducted FAQ v01r01June 3, 2015
Title:	AC Power-Line Conducted Emissions Frequently Asked Questions

## 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)**

<b>Brand Name:</b>	Toniebox Starterset
<b>Model Name or Number:</b>	03-xxxx (colour coding)
<b>Serial Number:</b>	TB1.5 ( <i>Radiated RF Sample</i> )
<b>MAC ID:</b>	90-E2-02-20-AC-6C (TB 1.5 Radio 1)
<b>Hardware Version Number:</b>	1.5
<b>Software Version Number:</b>	Radio Tool Firmware für CC3235
<b>FCC ID:</b>	2AU47-00002

<b>Brand Name:</b>	Toniebox Starterset
<b>Model Name or Number:</b>	03-xxxx (colour coding)
<b>Serial Number:</b>	TB1.5 ( <i>Conducted RF Sample</i> )
<b>MAC ID:</b>	90:E2:02:23:C5:B7 (TB 1.5 Radio 2)
<b>Hardware Version Number:</b>	1.5
<b>Software Version Number:</b>	Radio Tool Firmware für CC3235
<b>FCC ID:</b>	2AU47-00002

<b>Brand Name:</b>	Tonies
<b>Model Name or Number:</b>	DYS619-090150W-2
<b>Serial Number:</b>	DYS619-090150-16917A
<b>Hardware Version Number:</b>	1.0
<b>Additional Details:</b>	AC-DC Adapter- Switching Mode Power Supply 100-240 V AC / 0.5 A / 50Hz to 9 V DC / 1.5 A

#### **3.2. Description of EUT**

The equipment under test was a Toniebox Starterset consists of the Toniebox itself, a power supply including docking station DYS 619 and Tonie Lauscher (headset). Toniebox Starterset is an Audio system for children. Tonie figures to be purchased separately are placed on the Toniebox (TB).

An RFID receiver in the Toniebox reads the product ID from the figure (passive RFID chip in the Tonie figure). Via the WLAN module in the TB, the audio content is downloaded from the Boxine-Tonie cloud to the TB's internal memory (flash drive) via the Internet and played back via the TB speaker or Headphone.

This device supports WLAN 2.4 GHz 802.11 b-, g-, n-modes, operations in 2.4 – 2.4835 GHz ISM & WLAN 5GHz a-, n-modes, operations in U-NII-1 5 GHz bands.

#### **3.3. Modifications Incorporated in the EUT**

No modifications were applied to the EUT during testing.

### **3.4. Additional Information Related to Testing**

<b>Technology Tested:</b>	WLAN (IEEE 802.11a,n) / Digital Transmission System				
<b>Type of Unit:</b>	Transceiver				
<b>Supported Modulation Types:</b>	OFDM				
<b>Supported Data rates:</b>	802.11a	54 Mbit/s (SISO)			
	802.11n HT20	MCS7 (SISO)			
<b>Power Supply Type 1:</b>	AC-DC Adapter- Switching Mode Power Supply				
<b>Power Supply Requirement(s):</b>	100-240 V AC / 0.5 A / 50Hz to 9 V DC / 1.5 A				
<b>Power Supply Type 2:</b>	Internal Rechargeable Battery via AC /DC Adapter				
<b>Power Supply Requirement(s):</b>	3.6 V DC / 0.1 A				
<b>Antenna Type:</b>	PCB Antenna				
<b>Antenna Description:</b>	Integral				
<b>Declared Antenna Gain:</b>	4.0 dBi				
<b>Measured Maximum Conducted Output Power:</b>	6.50 dBm				
<b>Transceiver Frequency Band:</b>	5150 MHz to 5250 MHz [U-NII-1 Band]				
<b>Nominal Channel Bandwidth</b>	20 MHz				
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>Channel Number</b>	<b>Channel Frequency (MHz)</b>		
	Bottom	36	5180		
	Middle	40	5200		
	Top	48	5240		

### **3.5. Support Equipment**

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

#### **A. Support Equipment (In-house)**

Item	Description	Brand Name	Model Name or Number	Serial Number
1	-/-	-/-	-/-	-/-

#### **B. Support Equipment (Manufacturer supplied)**

Item	Description	Brand Name	Model Name or Number	Serial Number
1	Programming PCB	Boxine	Debug Board 1.0	N/A
2	Laptop with (Radio Tool Firmware für CC3235)	Lenovo	DE01244	PF-2CVWY5
3	USB Cable	N/A	N/A	N/A

## **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 modulated carrier with maximum power setting and a combination of:

- a-Mode | 54 Mbps | Packetsize 1400 Bytes | Power Level 0 / SISO Mode \*
- n-Mode HT20 | MCS7 | Packetsize 1400 Bytes | Power Level 0\* / SISO Mode \*

\*As per applicant's declaration the EUT implements 802.11a mode 54 Mbps and 802.11n mode MCS7(65Mbps).

## **4.2. Configuration and Peripherals**

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

### **EUT Power Supply:**

- The EUT can be powered via either AC/DC power adapter or charged internal battery.
- The critical tests (RF output power, power spectral density, occupied bandwidth) were performed once with AC/DC power adapter and also with fully charged internal battery.
- All radiated spurious emissions have been performed only with EUT powered via AC/DC power adapter.
- For AC conducted line emissions measurement the EUT was powered via AC/DC power adapter. The measurements were carried out with 120 VAC /60 Hz & 240 VAC/60 Hz.

### **Test Mode Activation:**

- The EUT was programmed via a programming PCB which was supplied by the customer.
- The EUT was controlled using a software application named CC3235 Radio Tool supplied by the customer. The application was used to enable continuous transmission and to select the test channels as required.
- The transmitter test modes were configured to maximum supported power settings (PWR 0).
- As the EUT continuous transmission of the EUT ( $D \geq 98\%$ ) cannot be achieved and EUT was transmitting continuously with a constant Duty Cycle of
  - 802.11a | 54 Mbps : 39.38 % (duty cycle variations are less than  $\pm 2\%$ ). Therefore, a Duty Cycle Correction Factor of 4.05 dB was added to all average measurements
  - 802.11n(HT20) | MCS7: 33.50 % (duty cycle variations are less than  $\pm 2\%$ ). Therefore, a Duty Cycle Correction Factor of 4.75 dB was added to all average measurements

to compute the corrected average values of the emissions that would have been measured had the test been performed at 100% Duty Cycle.

### **Conducted Measurements:**

- All conducted measurements were carried out by using conducted samples U.F.L to SMA (Female) RF Cable soldered on PCB by the customer. The maximum attenuation of 0.40 dB at the tested frequencies was added to a reference level offset to each of the conducted plots.

### **Radiated Measurements:**

- In accordance with ANSI C63.10 section 5.10.7, the EUT allows for the connection of external accessories, including external electrical control signals. Hence emission tests shall be performed with the EUT and accessories configured in a manner that tends to produce maximum emissions; therefore all radiated tests were performed with EUT powered via AC/DC power adapter 120 VAC / 60 Hz.
- Before starting final radiated spurious emission measurements "worst case verification" with the EUT in Standing-position & Laying-position was performed by Lab.
- The EUT in Laying-position was found to be the worst case, with the orientation of the Toniebox-Ears in upper case, therefore this report includes relevant results.
- The radiated measurements below 30 MHz were performed with the EUT positioned on the turn table and rotating 360 degrees while the loop antenna height was set to 80 cm.
- The radiated measurements above 30 MHz were performed with the EUT positioned on the turn table and rotating 360 degrees while the antenna height varies from 1 to 4 m over the measurement frequency range.
- R&S® EMC32 V10.60.10 Software was used for the Radiated spurious emission measurements.

## **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 DAkkS 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:**

<b>Test Engineers:</b>	Krume Ivanov	<b>Test Dates:</b>	20 April 2021 to 22 April 2021
<b>Test Sample Serial Number:</b>	TB1.5 ( <i>Radiated RF Sample</i> )		
<b>Test Site Identification</b>	SR 7/8		

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

#### **Environmental Conditions:**

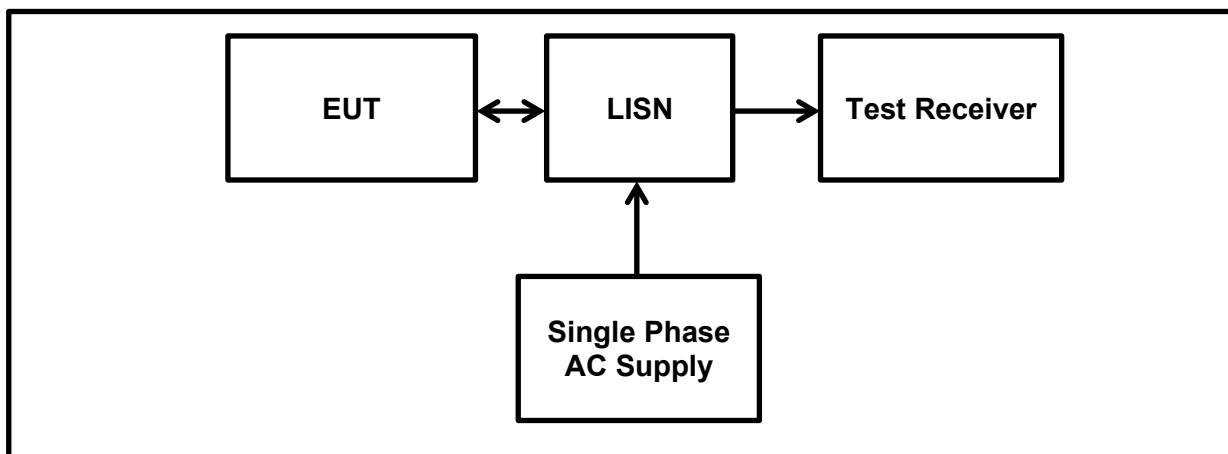
<b>Temperature (°C):</b>	23.3 to 25.6
<b>Relative Humidity (%):</b>	35.2 to 43.8

#### **Settings of the Instrument**

<b>Detector</b>	Quasi Peak/ Average Peak
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#### **Note(s):**

1. The EUT was plugged into a AC/DC Power Supply. The Power Supply was connected to 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. The EUT was configured with the following modes:  
a-Mode | 54 Mbps | Power Level 0 | Channel 36: 5180 MHz
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. The final measured value, for the given emission, in the table below incorporates the cable loss.
6. All other emissions shown on the pre-scan plot were investigated and found to be ambient or >20 dB below the applicable limit or below the measurement system noise floor.
7. Measurements were performed in shielded room (SR7/ 8 Asset Number 1603671). The EUT was placed at a height of 80 cm above the reference ground plane and in a distance of 40 cm from the vertical ground plane at the edge of the table.
8. Measurement software used: Toyo EMI Software; CE measurement software EP5/CE Ver 4.0.1.

**Transmitter AC Conducted Spurious Emissions (continued)****Test Setup:**

**Transmitter AC Conducted Spurious Emissions (continued)****Results: 802.11a / 20 MHz / 54Mbps / PWR 0****Results: Live / Quasi Peak / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.1521	Live	45.40	65.80	20.40	Complied
0.1677	Live	44.70	65.50	20.80	Complied
0.1889	Live	44.20	64.80	20.60	Complied
0.2017	Live	40.00	63.60	23.60	Complied
0.2136	Live	39.30	61.40	22.10	Complied
0.2790	Live	28.80	56.00	27.20	Complied

**Results: Live / Average / 120 VAC 60 Hz**

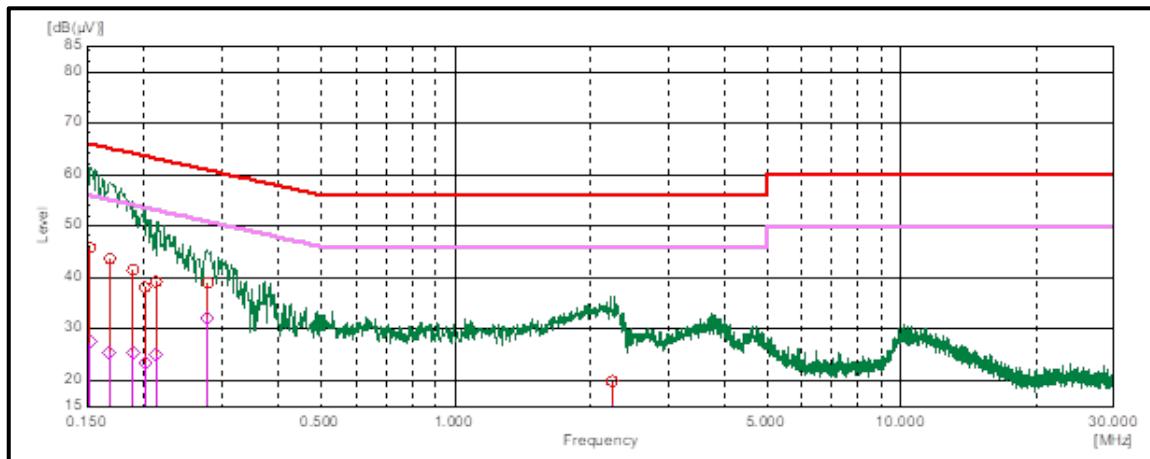
Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.1521	Live	45.80	65.90	20.10	Complied
0.1677	Live	43.60	65.10	21.50	Complied
0.1889	Live	41.50	64.10	22.60	Complied
0.2017	Live	38.10	63.50	25.40	Complied
0.2136	Live	39.30	63.10	23.80	Complied
0.2790	Live	39.00	60.80	21.80	Complied

**Results: Neutral / Quasi Peak / 120 VAC 60 Hz**

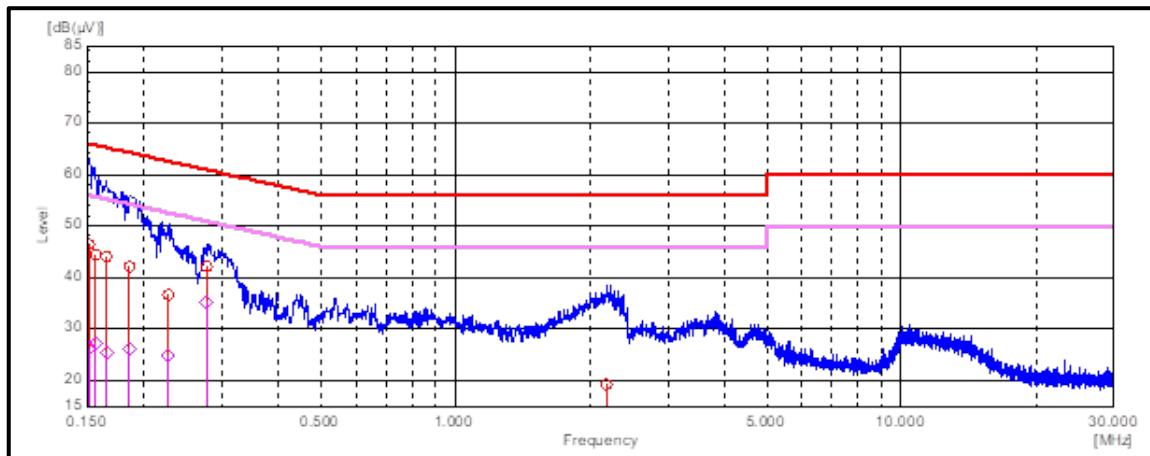
Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.1504	Neutral	46.40	66.00	19.60	Complied
0.1560	Neutral	44.50	65.70	21.20	Complied
0.1655	Neutral	44.10	65.20	21.10	Complied
0.1865	Neutral	42.10	64.20	22.10	Complied
0.2271	Neutral	36.70	62.60	25.90	Complied
0.2775	Neutral	42.10	60.90	18.80	Complied

**Results: Neutral / Average / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.1504	Neutral	26.30	56.00	29.70	Complied
0.1560	Neutral	27.30	55.70	28.40	Complied
0.1655	Neutral	25.30	55.20	29.90	Complied
0.1865	Neutral	26.30	54.20	27.90	Complied
0.2271	Neutral	24.80	52.60	27.80	Complied
0.2775	Neutral	35.20	50.90	15.70	Complied

**Transmitter AC Conducted Spurious Emissions (continued)****Results: 802.11a / 20 MHz / 54Mbps / PWR 0****Plot: Live and Neutral Line / 120 VAC 60 Hz**

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

**Plot: Neutral Line / 120 VAC 60 Hz**

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

**Result: Pass**

**Transmitter AC Conducted Spurious Emissions (continued)****Results: 802.11a / 20 MHz / 54 Mbps / PWR 0****Results: Live / Quasi Peak / 240 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.1521	Live	45.80	65.90	20.10	Complied
0.1677	Live	43.60	65.10	21.50	Complied
0.1889	Live	41.50	64.10	22.60	Complied
0.2017	Live	38.10	63.50	25.40	Complied
0.2136	Live	39.30	63.10	23.80	Complied
0.2790	Live	39.00	60.80	21.80	Complied

**Results: Live / Average / 240 VAC 60 Hz**

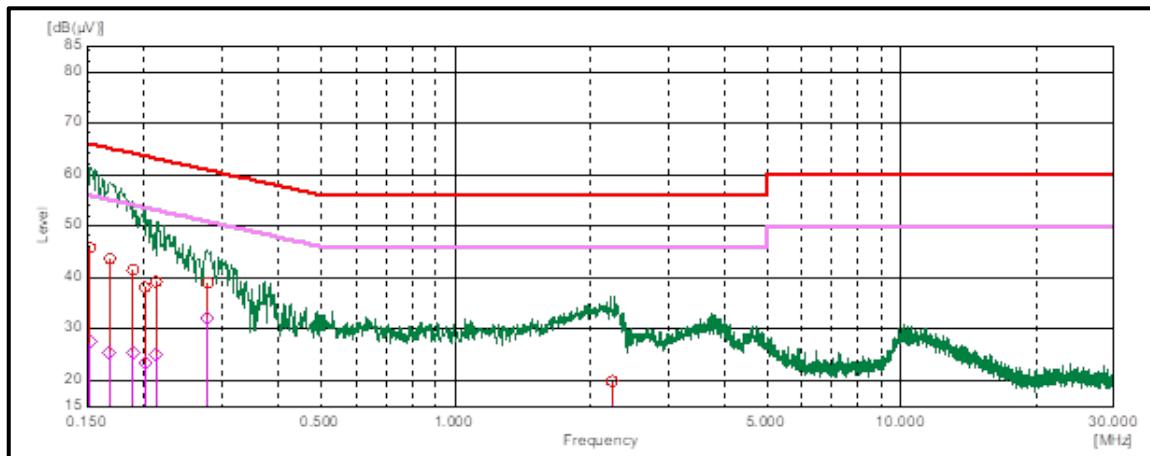
Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.1521	Live	27.60	55.90	28.30	Complied
0.1677	Live	25.40	55.10	29.70	Complied
0.1889	Live	25.50	54.10	28.60	Complied
0.2017	Live	23.50	53.50	30.00	Complied
0.2136	Live	25.00	53.10	28.10	Complied
0.2790	Live	32.20	50.80	18.60	Complied

**Results: Neutral / Quasi Peak / 240 VAC 60 Hz**

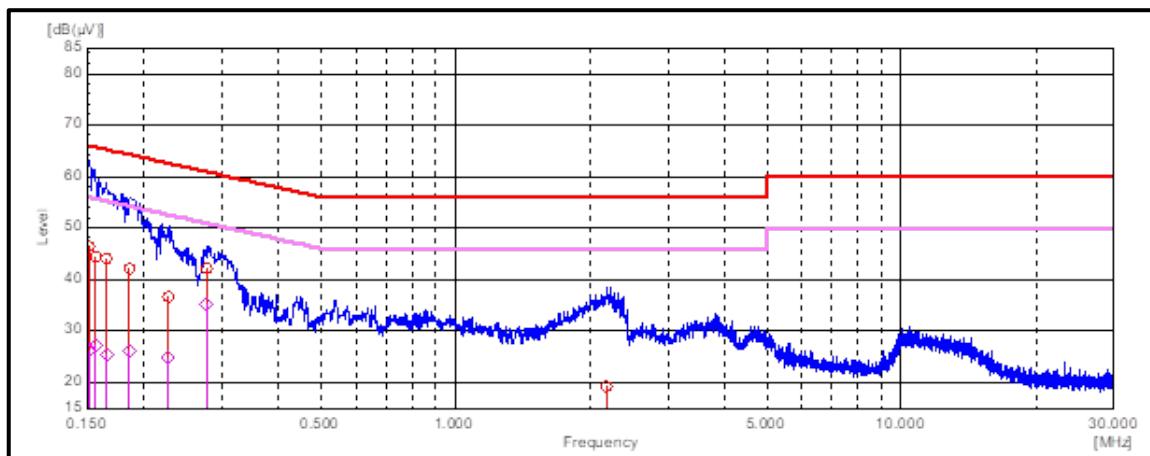
Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.1504	Neutral	46.40	66.00	19.60	Complied
0.1560	Neutral	44.50	65.70	21.20	Complied
0.1655	Neutral	44.10	65.20	21.10	Complied
0.1865	Neutral	42.10	64.20	22.10	Complied
0.2271	Neutral	36.70	62.60	25.90	Complied
0.2775	Neutral	42.10	60.90	18.80	Complied

**Results: Neutral / Average / 240 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.1504	Neutral	26.30	56.00	29.70	Complied
0.1560	Neutral	27.30	55.70	28.40	Complied
0.1655	Neutral	25.30	55.20	29.90	Complied
0.1865	Neutral	26.30	54.20	27.90	Complied
0.2271	Neutral	24.80	52.60	27.80	Complied
0.2775	Neutral	35.20	50.90	15.70	Complied

**Transmitter AC Conducted Spurious Emissions (continued)****Results: 802.11a / 20 MHz / 54 Mbps / PWR 0****Plot: Live Line / 240VAC 60 Hz**

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

**Plot: Neutral Line / 240 VAC 60 Hz**

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

**Result: Pass**

## **5.2.2. Transmitter 26 dB Emission Bandwidth**

### **Test Summary:**

<b>Test Engineer:</b>	Krume Ivanov	<b>Test Date:</b>	30 April 2021
<b>Test Sample Serial Number:</b>	TB1.5 ( <i>Conducted RF Sample</i> )		
<b>Test Site Identification</b>	SR 9		

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

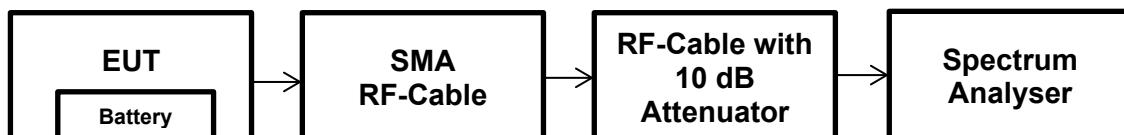
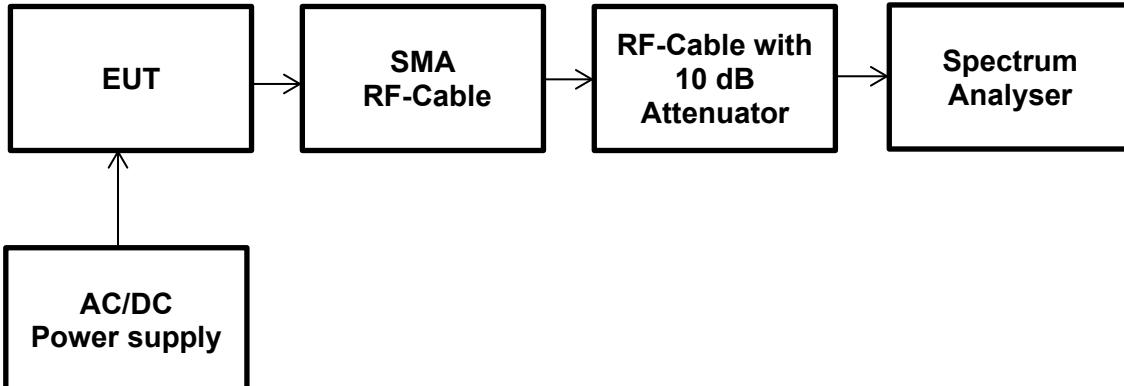
### **Environmental Conditions:**

<b>Temperatures (°C):</b>	24.3
<b>Relative Humidity (%):</b>	31.6

### **Notes:**

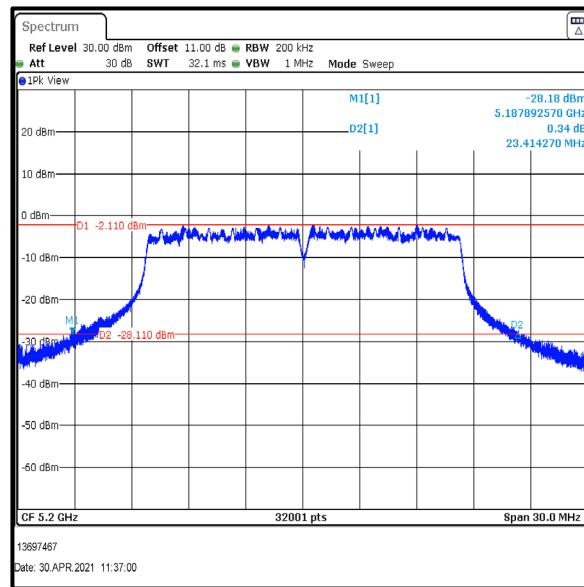
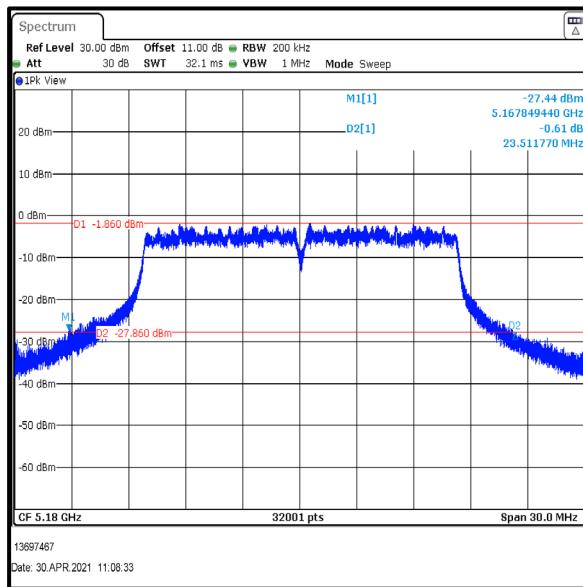
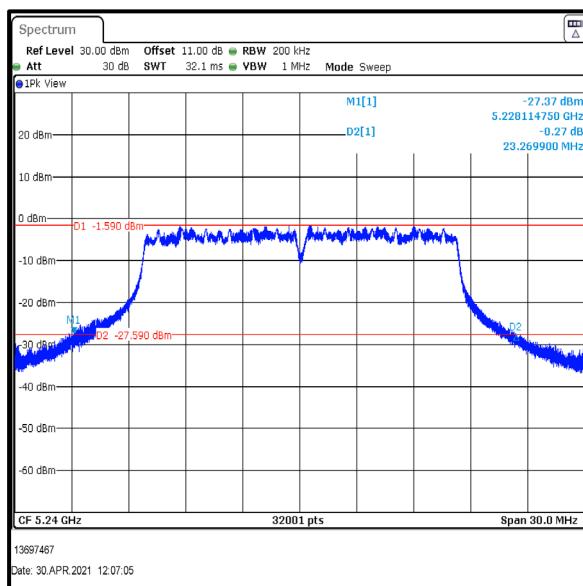
1. All configurations supported by the EUT were investigated on the one channel in accordance with KDB 789033 Section II.C.1. Emission Bandwidth (EBW) test procedure.
2. The spectrum analyser resolution bandwidth was set to 200 kHz (approximately 1% of the emission bandwidth) and video bandwidth 1 MHz (> RBW). A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The Emission Bandwidth was measured at 26 dB down from the peak of the signal.
3. Final measurements were performed using the below configurations on the bottom, middle and top channels.
4. The RF port on the EUT was connected to the spectrum analyser using suitable attenuation and RF cable. The measured values takes into consideration the external attenuation correction factors.
  - The SMA (Female) RF Cable soldered on PCB with maximum attenuation of 0.4 dB at the tested frequencies.
  - The RF cable attenuation maximum 0.6 dB@2.4GHz from the EUT to Analyzer including the 10 dB attenuation at the input of Spectrum Analyzer

Therefore, total a reference level offset 11.0 dB was added to each of the at the tested frequencies conducted plots.

**Transmitter 26 dB Emission Bandwidth (continued)****Test Setup (Internal Battery Powered):****Test Setup (AC-DC Power Supply):**

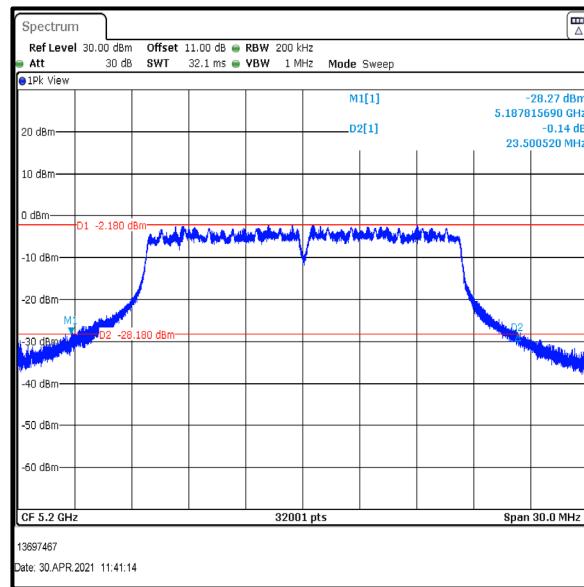
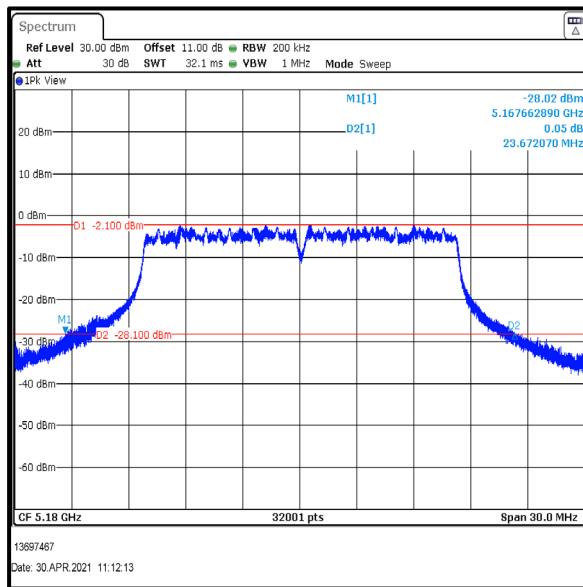
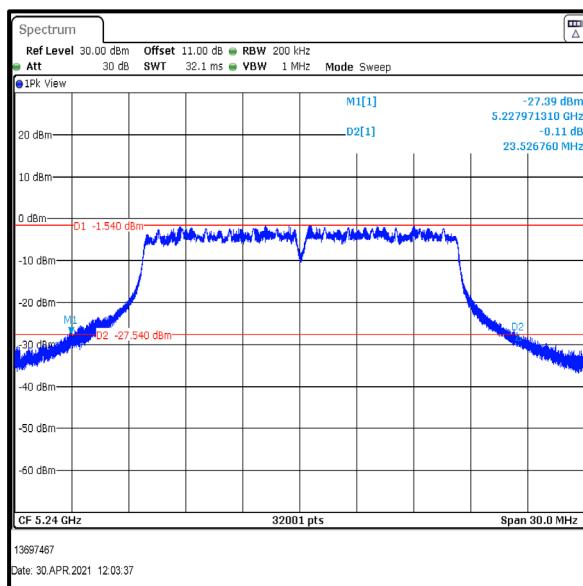
**Transmitter 26 dB Emission Bandwidth (continued)****Results: AC-DC Power Supply / 802.11a / 20 MHz / 54 Mbps / PWR 0**

Channel	26 dB Emission Bandwidth (MHz)
Bottom	23.512
Middle	23.414
Top	23.270

**Bottom****Middle****Top****Result: Pass**

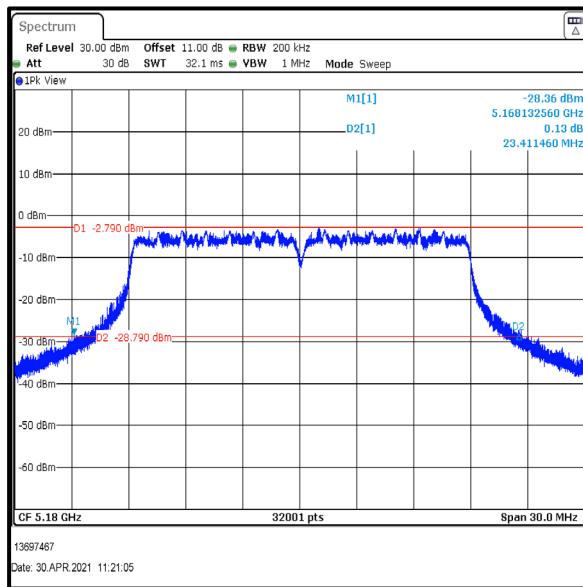
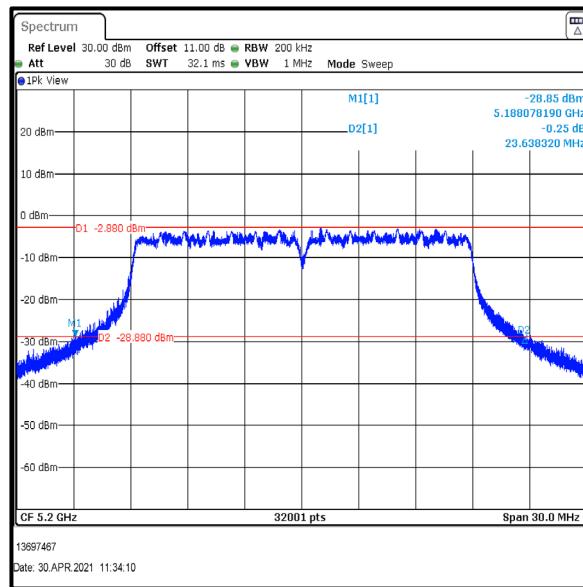
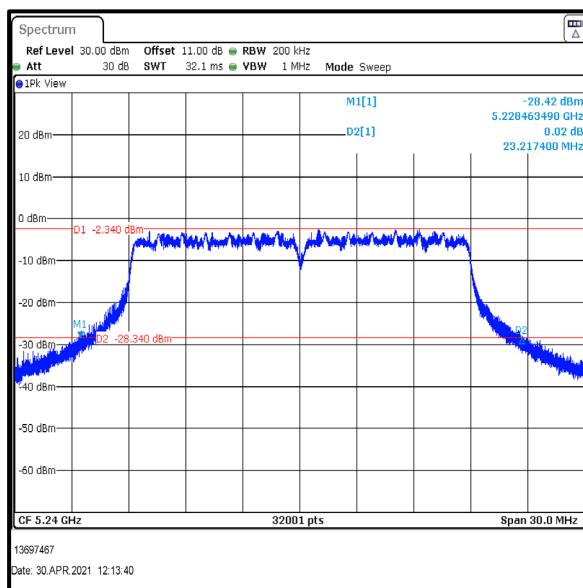
**Transmitter 26 dB Emission Bandwidth (continued)****Results: Fully Charged Internal Battery / 802.11a / 20 MHz / 54 Mbps / PWR 0**

Channel	26 dB Emission Bandwidth (MHz)
Bottom	23.672
Middle	23.501
Top	23.527

**Bottom****Middle****Top****Result: Pass**

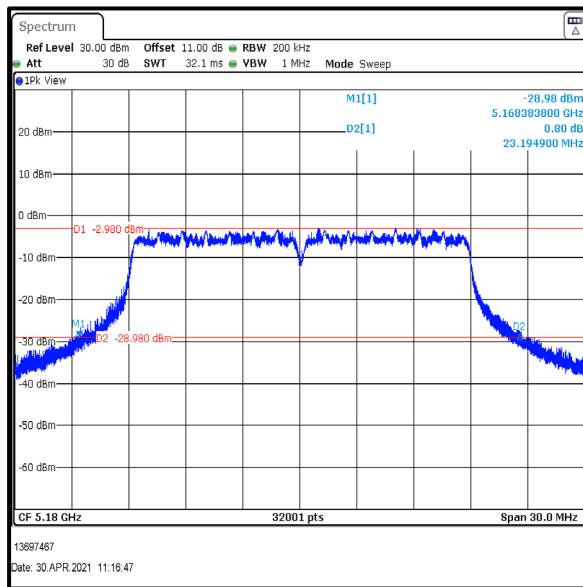
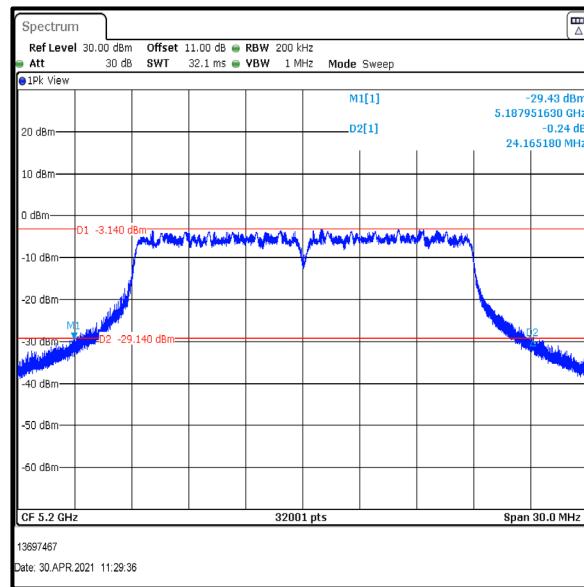
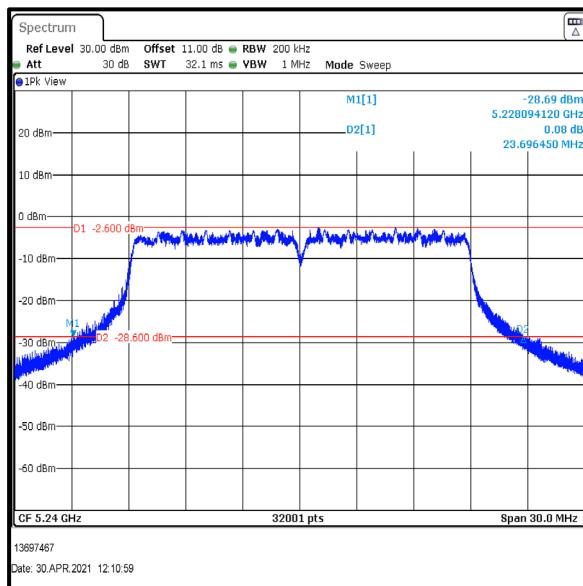
**Transmitter 26 dB Emission Bandwidth (continued)****Results: AC-DC Power Supply / 802.11n / 20 MHz / MCS7 / PWR 0**

Channel	26 dB Emission Bandwidth (MHz)
Bottom	23.411
Middle	23.638
Top	23.217

**Bottom****Middle****Top****Result: Pass**

**Transmitter 26 dB Emission Bandwidth (continued)****Results: Fully Charged Internal Battery / 802.11n / 20 MHz / MCS7 / PWR 0**

Channel	26 dB Emission Bandwidth (MHz)
Bottom	23.195
Middle	24.165
Top	23.696

**Bottom****Middle****Top****Result: Pass**

### **5.2.3. Transmitter Duty Cycle**

#### **Test Summary:**

<b>Test Engineer:</b>	Krume Ivanov	<b>Test Date:</b>	19 April 2021 to 29 April 2021
<b>Test Sample Serial Number:</b>	TB1.5 ( <i>Conducted RF Sample</i> )		
<b>Test Site Identification</b>	SR 9		

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

#### **Environmental Conditions:**

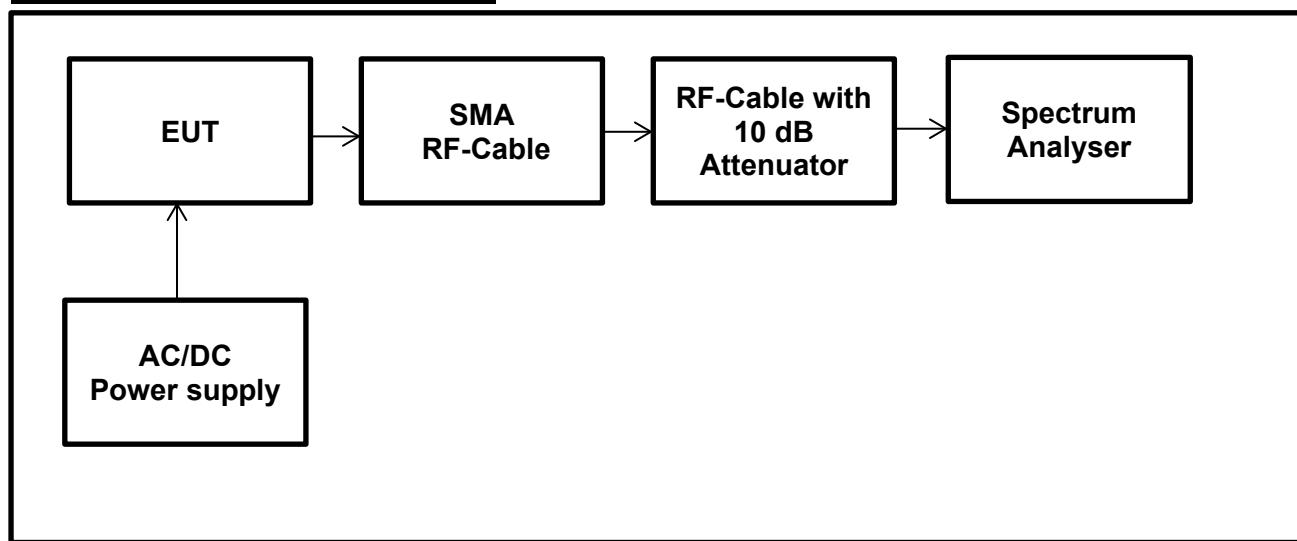
<b>Temperature (°C):</b>	23.3 to 25.8
<b>Relative Humidity (%):</b>	30.6 to 39.7

#### **Notes:**

1. The transmitter duty cycle was measured using a spectrum analyser in the time domain and calculated by using the following calculation:
 
$$\text{Duty Cycle (\%)} = 100 \times [\text{On Time (T}_{\text{ON}}\text{)}] / [\text{Period}(\text{T}_{\text{ON}} + \text{T}_{\text{OFF}}) \text{ or } 100\text{ms whichever is the lesser}]$$

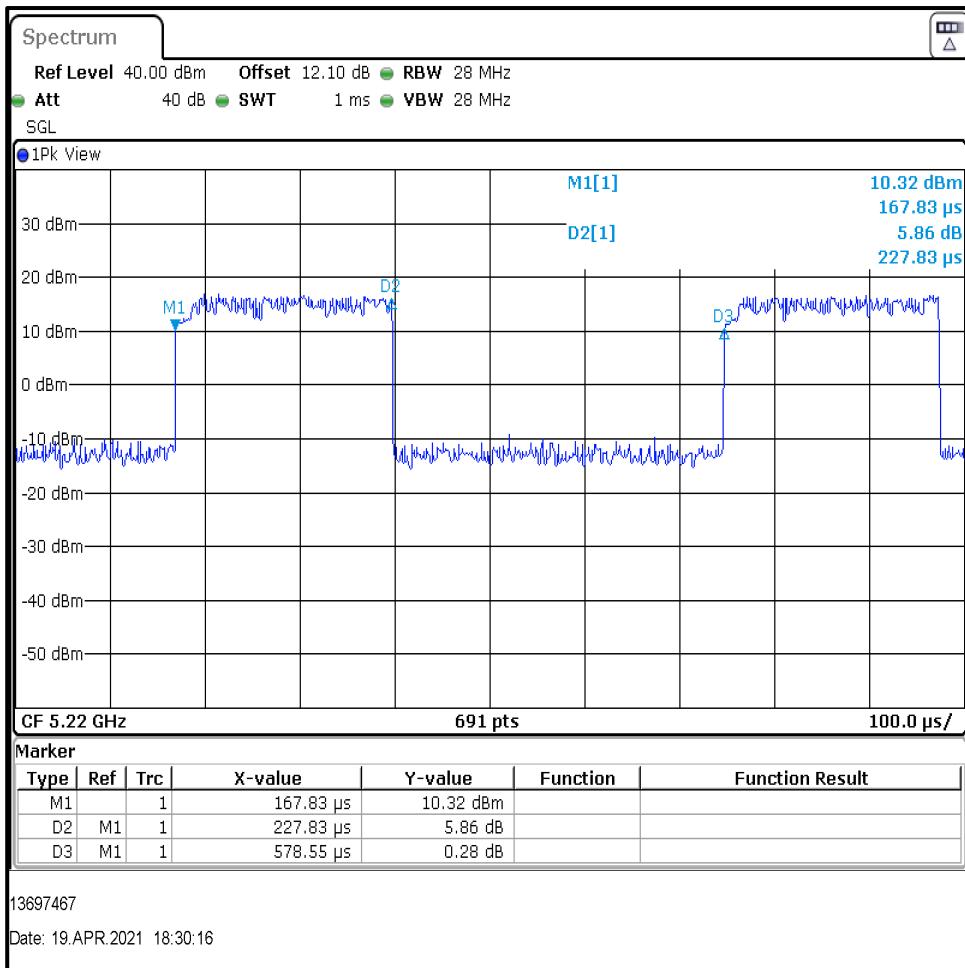
$$\text{Duty Cycle Correction Factor} = 10 \log 1 / [\text{On Time (T}_{\text{ON}}\text{)}] / [\text{Period}(\text{T}_{\text{ON}} + \text{T}_{\text{OFF}}) \text{ or } 100\text{ms whichever is the lesser}]$$
  - Duty Cycle Correction Factor for a-mode 54 Mbps: 4.05 dB
  - Duty Cycle Correction Factor for n-mode HT20 MCS7: 4.75 dB
2. The RF port on the EUT was connected to the spectrum analyser using suitable attenuation and RF cable. The measured values takes into consideration the external attenuation correction factors.
  - The SMA (Female) RF Cable soldered on PCB with maximum attenuation of 0.4 dB at the tested frequencies.
  - The RF cable attenuation maximum 0.6 dB@2.4GHz from the EUT to Analyzer including the 10 dB attenuation at the input of Spectrum Analyzer

Therefore, total a reference level offset 11.0 dB was added to each of the at the tested frequencies conducted plots.

**Transmitter Duty Cycle (continued)****Test Setup (AC-DC Power Supply):**

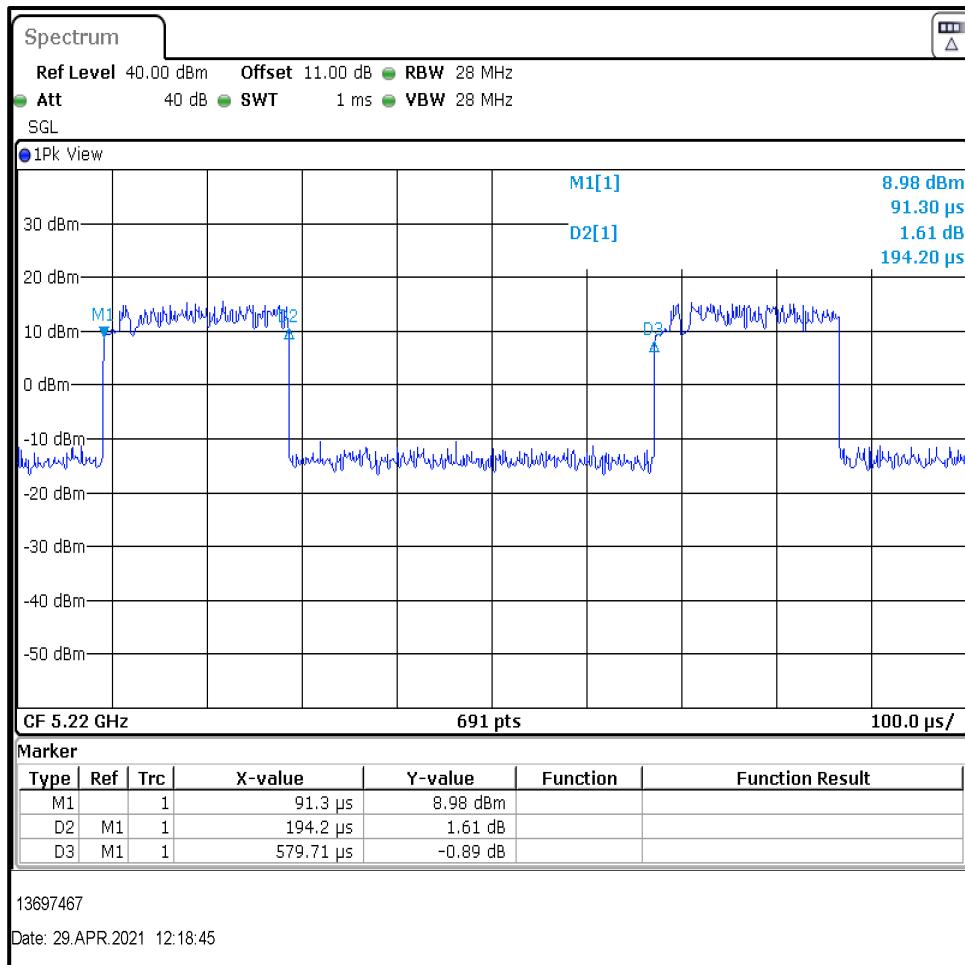
**Transmitter Duty Cycle (continued)****Results: AC-DC Power Supply 802.11a / 20 MHz / 54 Mbps / PWR 0**

Pulse On Time (T <sub>ON</sub> ) (ms)	Pulse Period (T <sub>ON</sub> + T <sub>OFF</sub> ) (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
0.22783	0.57855	39.38	4.05

**Result: Pass**

**Transmitter Duty Cycle (continued)****Results: AC-DC Power Supply / 802.11n / 20 MHz / MCS7 / PWR 0**

Pulse On Time (T <sub>ON</sub> ) (ms)	Pulse Period (T <sub>ON</sub> + T <sub>OFF</sub> ) (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
0.19420	0.57971	33.50	4.75

**Result: Pass**

### **5.2.4. Transmitter Maximum Conducted Output Power**

#### **Test Summary:**

<b>Test Engineer:</b>	Krume Ivanov	<b>Test Date:</b>	04 May 2021
<b>Test Sample Serial Number:</b>	TB1.5 ( <i>Conducted RF Sample</i> )		
<b>Test Site Identification</b>	SR 9		

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

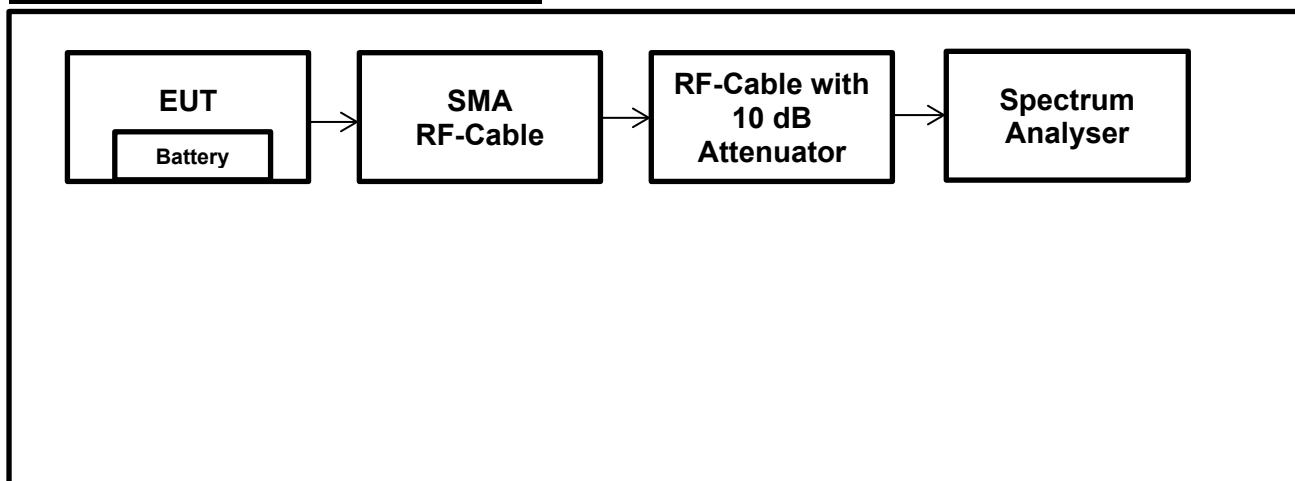
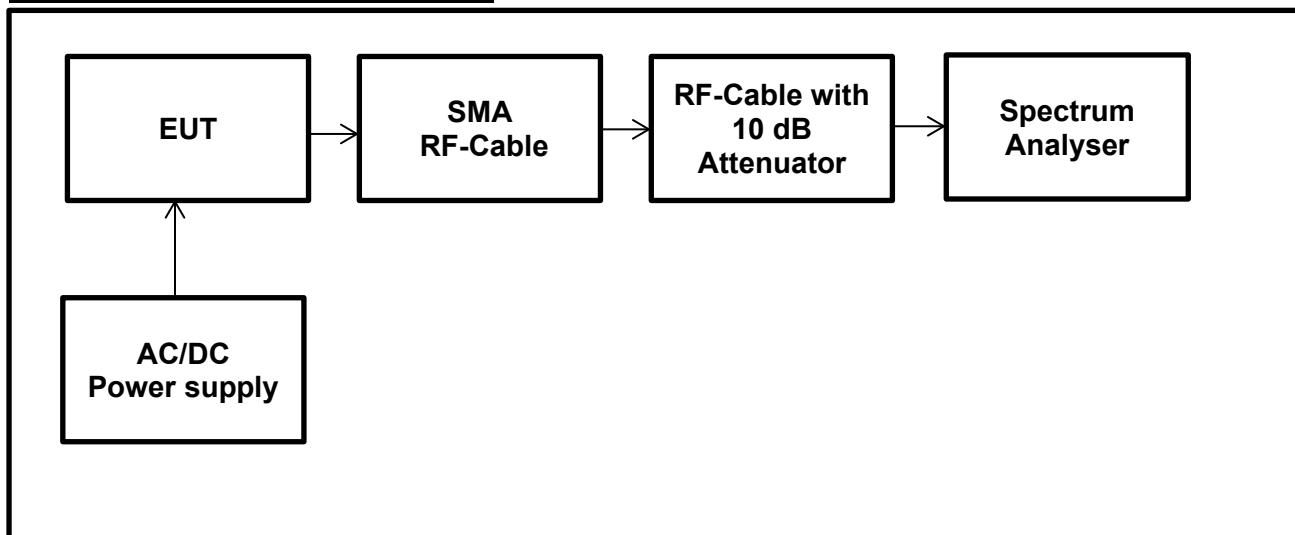
#### **Environmental Conditions:**

<b>Temperature (°C):</b>	27.2
<b>Relative Humidity (%):</b>	32.6

#### **Notes:**

1. For conducted power tests where the duty cycle is <98%, the measurements were performed in accordance with FCC KDB 789033 II. E. 2. D) Method SA-2. The spectrum analyser's integration function was used to integrate across the 99% emission bandwidth. The resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. An RMS detector was used and sweep time was set to auto and 200 traces performed. The span was set to 30 MHz so as to encompass the entire 99% occupied bandwidth. The channel power results are recorded in the tables below.
2. As the EUT was transmitting at <98% duty cycle, the calculated duty cycle in section 5.2.3 was added to the measured power values in order to compute the average power during the actual transmission time.
3. The RF port on the EUT was connected to the spectrum analyser using suitable attenuation and RF cable. The measured values takes into consideration the external attenuation correction factors.
  - The SMA (Female) RF Cable soldered on PCB with maximum attenuation of 0.4 dB at the tested frequencies.
  - The RF cable attenuation maximum 0.6 dB@2.4GHz from the EUT to Analyzer including the 10 dB attenuation at the input of Spectrum Analyzer

Therefore, total a reference level offset 11.0 dB was added to each of the at the tested frequencies conducted plots.

**Transmitter Maximum Conducted Output Power (continued)****Test Setup (Internal Battery Powered):****Test Setup (AC-DC Power Supply):**

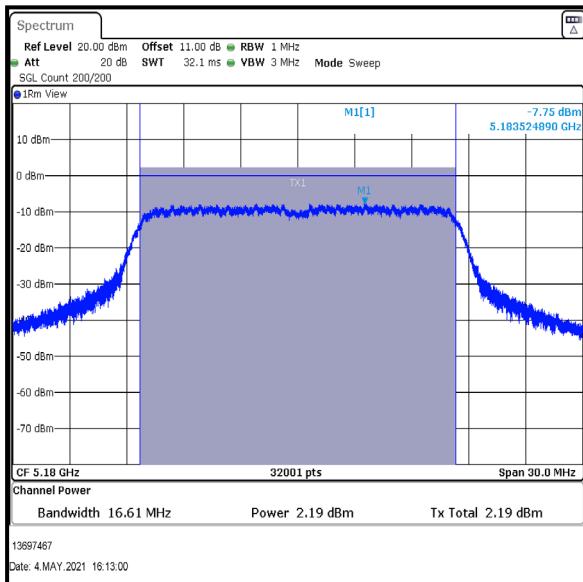
**Transmitter Maximum Conducted Output Power (continued)****Results: AC-DC Power Supply / 802.11a / 20 MHz / 54 Mbps / PWR 0****Conducted Power Limit Comparision:**

Channel	Conducted Average Power (dBm)	Duty Cycle Correction Factor (dB)	Corrected Conducted Average Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	2.19	4.05	6.24	24.00	17.76	Complied
Middle	2.13	4.05	6.18	24.00	17.82	Complied
Top	2.42	4.05	6.47	24.00	17.53	Complied

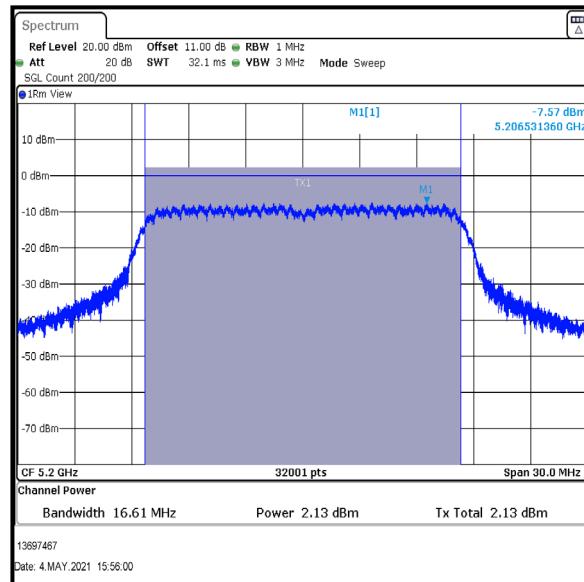
**De Facto EIRP Limit Comparision:**

Channel	Corrected Conducted Average Power (dBm)	Directional Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)	Result
Bottom	6.24	4.0	10.24	30.00	19.76	Complied
Middle	6.18	4.0	10.18	30.00	19.82	Complied
Top	6.47	4.0	10.47	30.00	19.53	Complied

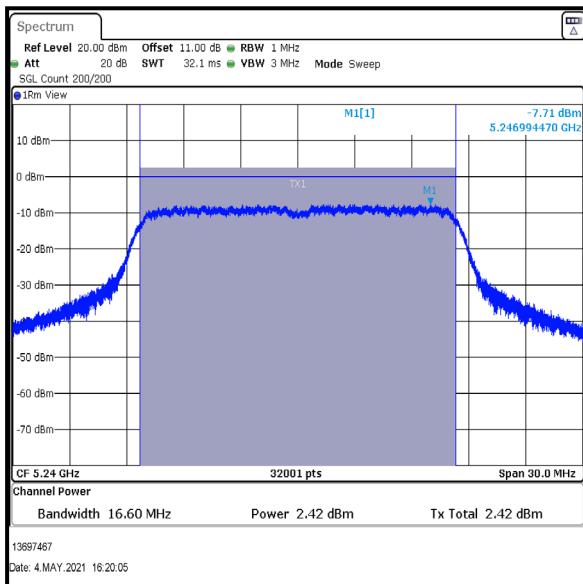
**Result: Pass**

**Transmitter Maximum Conducted Output Power (continued)****Results: AC-DC Power Supply / 802.11a / 20 MHz / 54 Mbps / PWR 0**

Bottom



Middle



Top

**Result: Pass**

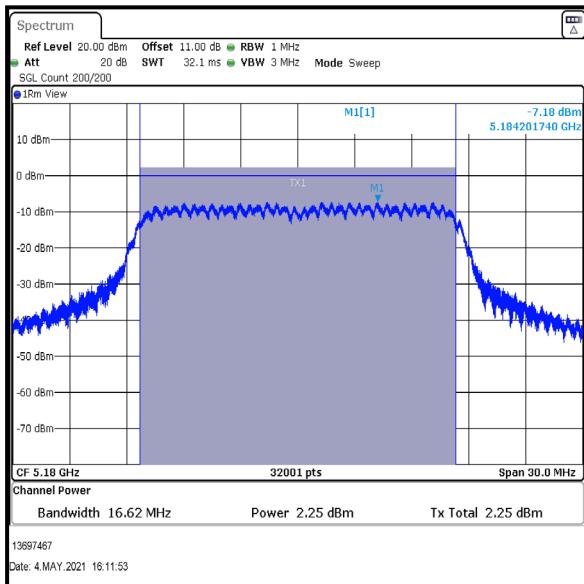
**Transmitter Maximum Conducted Output Power (continued)****Results: Fully Charged Internal Battery / 802.11a / 20 MHz / 54 Mbps / PWR 0****Conducted Power Limit Comparision:**

Channel	Conducted Average Power (dBm)	Duty Cycle Correction Factor (dB)	Corrected Conducted Average Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	2.25	4.05	6.30	24.00	17.70	Complied
Middle	2.25	4.05	6.30	24.00	17.70	Complied
Top	2.45	4.05	6.50	24.00	17.50	Complied

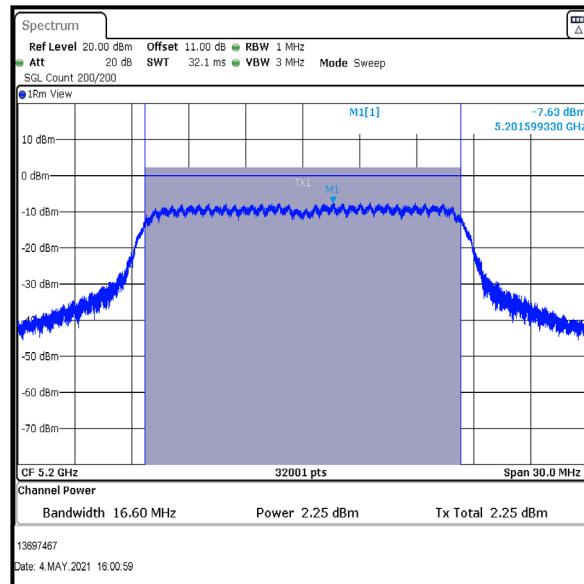
**De Facto EIRP Limit Comparision:**

Channel	Corrected Conducted Average Power (dBm)	Directional Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)	Result
Bottom	6.30	4.0	10.30	30.00	19.70	Complied
Middle	6.30	4.0	10.30	30.00	19.70	Complied
Top	6.50	4.0	10.50	30.00	19.50	Complied

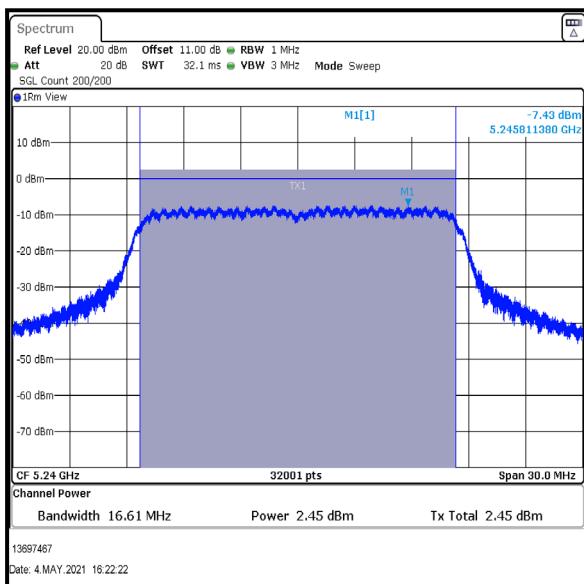
**Result: Pass**

**Transmitter Maximum Conducted Output Power (continued)****Results: Fully Charged Internal Battery / 802.11a / 20 MHz / 54 Mbps / PWR 0**

Bottom



Middle



Top

**Result: Pass**

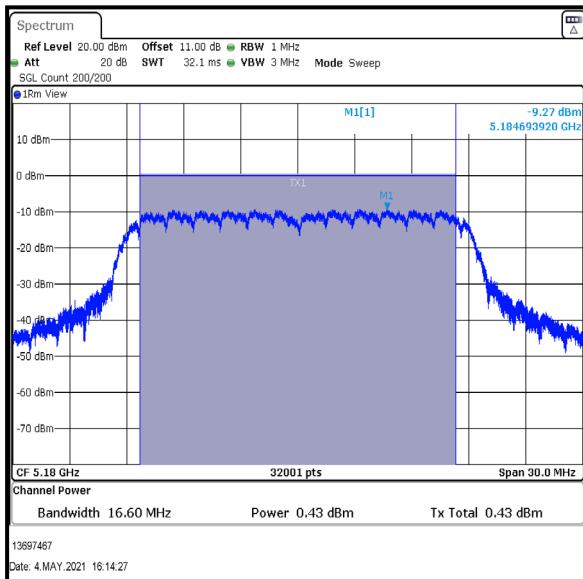
**Transmitter Maximum Conducted Output Power (continued)****Results: AC-DC Power Supply / 802.11n / 20 MHz / MCS7 PWR 0****Conducted Power Limit Comparision:**

Channel	Conducted Average Power (dBm)	Duty Cycle Correction Factor (dB)	Corrected Conducted Average Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	0.43	4.75	5.18	24.00	18.82	Complied
Middle	0.72	4.75	5.47	24.00	18.53	Complied
Top	0.95	4.75	5.70	24.00	18.30	Complied

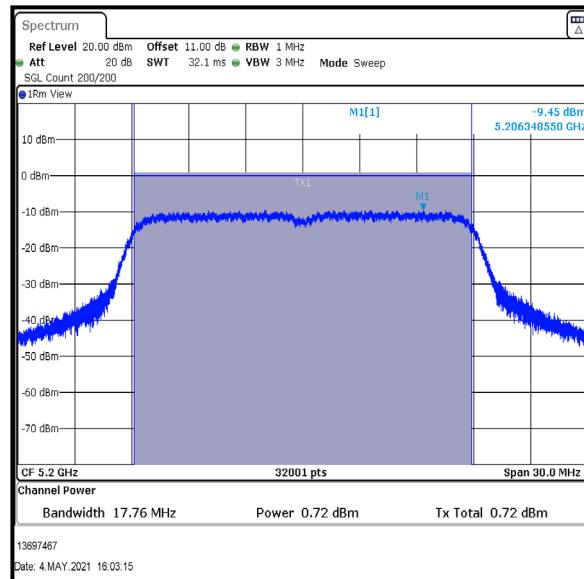
**De Facto EIRP Limit Comparision:**

Channel	Corrected Conducted Average Power (dBm)	Directional Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)	Result
Bottom	5.18	4.0	9.18	30.00	20.82	Complied
Middle	5.47	4.0	9.47	30.00	20.53	Complied
Top	5.70	4.0	9.70	30.00	20.30	Complied

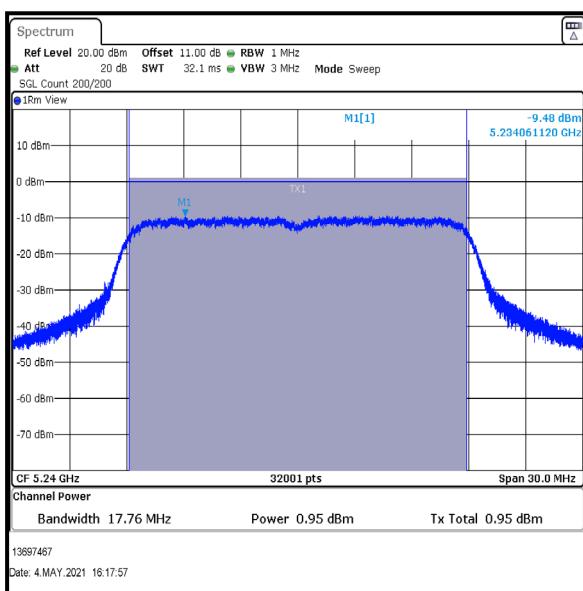
**Result: Pass**

**Transmitter Maximum Conducted Output Power (continued)****Results: AC-DC Power Supply / 802.11n / 20 MHz / MCS7 / PWR 0**

Bottom



Middle



Top

**Result: Pass**

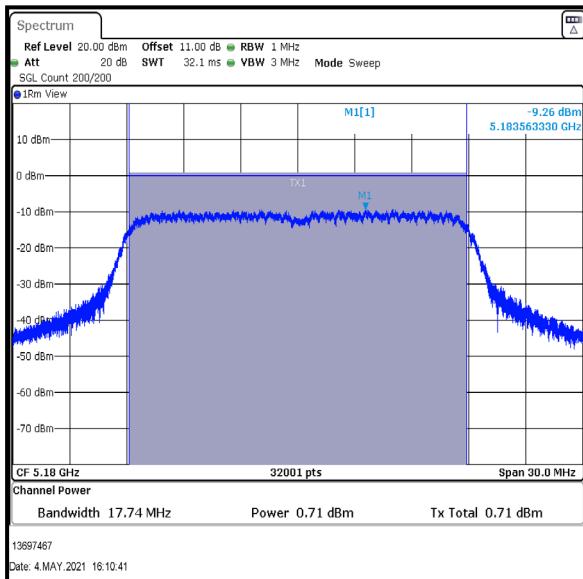
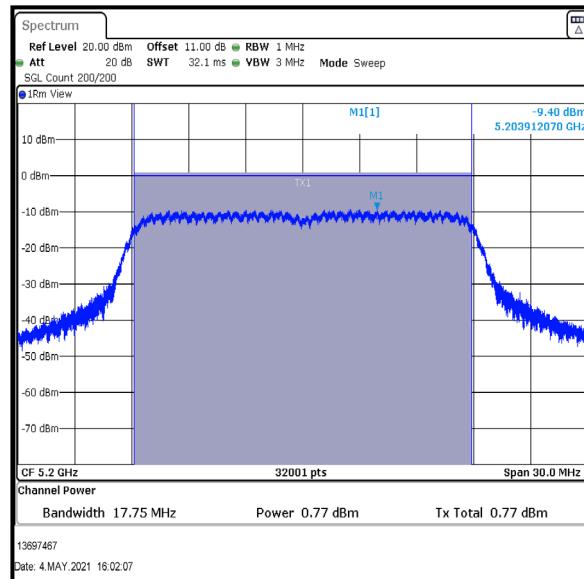
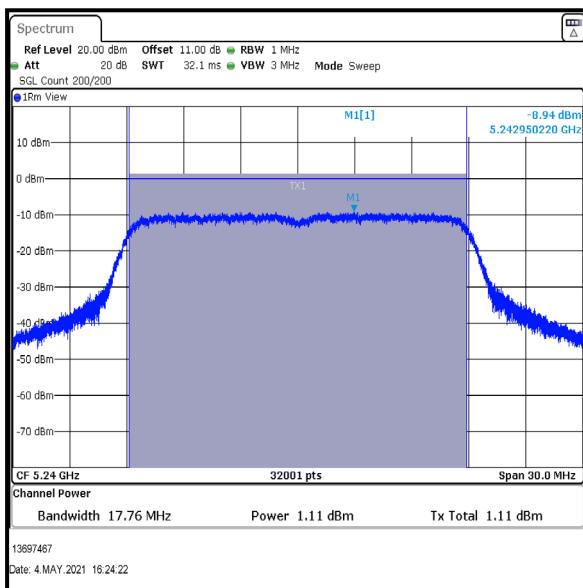
**Transmitter Maximum Conducted Output Power (continued)****Results: Fully Charged Internal Battery / 802.11n / 20 MHz / MCS7 / PWR 0****Conducted Power Limit Comparision:**

Channel	Conducted Average Power (dBm)	Duty Cycle Correction Factor (dB)	Corrected Conducted Average Power (dBm)	Conducted Power Limit (dBm)	Margin (dB)	Result
Bottom	0.71	4.75	5.46	24.00	18.54	Complied
Middle	0.77	4.75	5.52	24.00	18.48	Complied
Top	1.11	4.75	5.86	24.00	18.14	Complied

**De Facto EIRP Limit Comparision:**

Channel	Corrected Conducted Average Power (dBm)	Directional Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)	Result
Bottom	5.46	4.0	9.46	30.00	20.54	Complied
Middle	5.52	4.0	9.52	30.00	20.48	Complied
Top	5.86	4.0	9.86	30.00	20.14	Complied

**Result: Pass**

**Transmitter Maximum Conducted Output Power (continued)****Results: Fully Charged Internal Battery / 802.11n / 20 MHz / MCS7 / PWR 0****Bottom****Middle****Top****Result: Pass**

**5.2.5. Transmitter Maximum Power Spectral Density****Test Summary:**

<b>Test Engineer:</b>	Krume Ivanov	<b>Test Date:</b>	04 May 2021
<b>Test Sample Serial Number:</b>	TB1.5 ( <i>Conducted RF Sample</i> )		
<b>Test Site Identification</b>	SR 9		

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

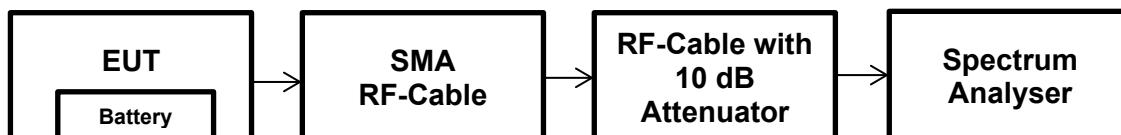
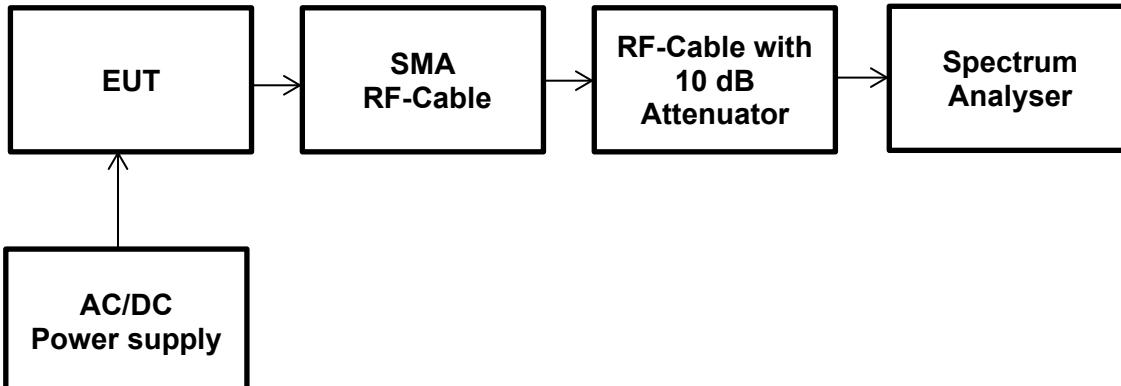
**Environmental Conditions:**

<b>Temperature (°C):</b>	27.2
<b>Relative Humidity (%):</b>	32.6

**Notes:**

1. Transmitter Maximum Power Spectral Density tests were performed using a spectrum analyser in accordance with KDB 789033 II. F referencing Section II. E.2.d).
2. Method SA-2: The resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. An RMS detector was used and sweep time set to auto and 300 traces performed. The span was set to 30 MHz so as to encompass the entire 99% occupied bandwidth. A marker was placed at the peak of the measured level. The peak level is recorded in the tables below.
4. As the EUT was transmitting at <98% duty cycle, the calculated duty cycle in section 5.2.3 was added to the measured power values in order to compute the average power during the actual transmission time.
5. The RF port on the EUT was connected to the spectrum analyser using suitable attenuation and RF cable. The measured values takes into consideration the external attenuation correction factors.
  - The SMA (Female) RF Cable soldered on PCB with maximum attenuation of 0.4 dB at the tested frequencies.
  - The RF cable attenuation maximum 0.6 dB@2.4GHz from the EUT to Analyzer including the 10 dB attenuation at the input of Spectrum Analyzer

Therefore, total a reference level offset 11.0 dB was added to each of the at the tested frequencies conducted plots.

**Transmitter Maximum Power Spectral Density (continued)****Test Setup (Internal Battery Powered):****Test Setup (AC-DC Power Supply):**

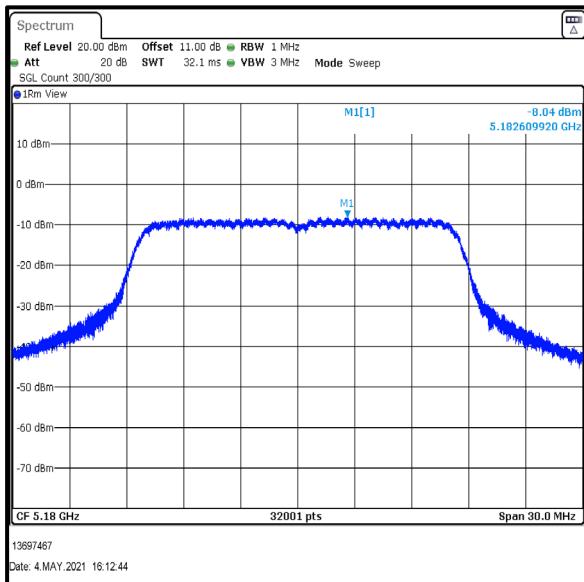
**Transmitter Maximum Power Spectral Density (continued)****Results: AC-DC Power Supply / 802.11a / 20 MHz / 54 Mbps / PWR 0****Conducted Power Limit Comparision:**

Channel	Conducted Average PSD (dBm /MHz)	Duty Cycle Correction Factor (dB)	Corrected Conducted Average PSD (dBm /MHz)	Conducted PSD Limit (dBm/ MHz)	Margin (dB)	Result
Bottom	-8.04	4.05	-3.99	11.00	14.99	Complied
Middle	-7.98	4.05	-3.93	11.00	14.93	Complied
Top	-7.77	4.05	-3.72	11.00	14.72	Complied

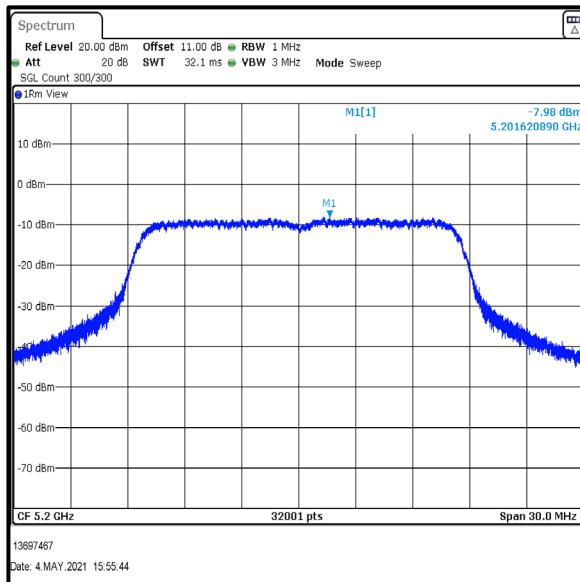
**De Facto EIRP Limit Comparision:**

Channel	Corrected Conducted Average PSD (dBm /MHz)	Directional Antenna Gain (dBi)	EIRP PSD (dBm)	EIRP PSD Limit (dBm/ MHz)	Margin (dB)	Result
Bottom	-3.99	4.0	0.01	17.00	16.99	Complied
Middle	-3.93	4.0	0.07	17.00	16.93	Complied
Top	-3.72	4.0	0.28	17.00	16.72	Complied

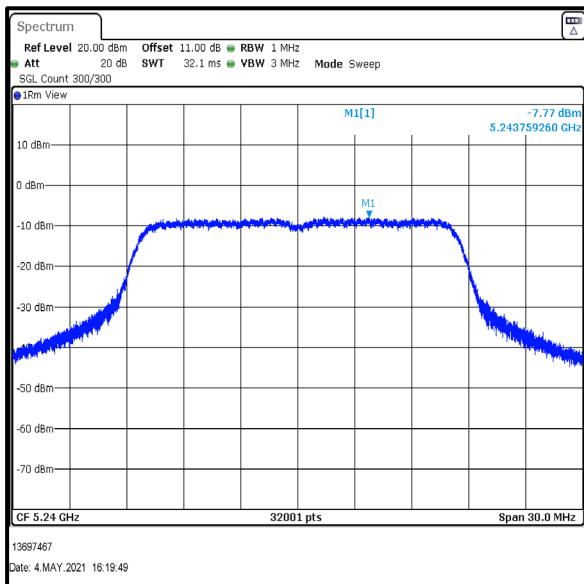
**Result: Pass**

**Transmitter Maximum Power Spectral Density (continued)****Results: AC-DC Power Supply / 802.11a / 20 MHz / 54 Mbps / PWR 0**

Bottom



Middle



Top

**Result: Pass**

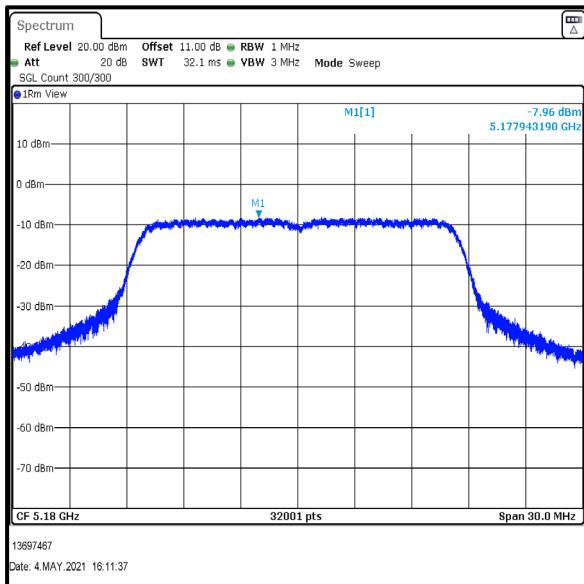
**Transmitter Maximum Power Spectral Density (continued)****Results: Fully Charged Internal Battery / 802.11a / 20 MHz / 54 Mbps / PWR 0****Conducted Power Limit Comparision:**

Channel	Conducted Average PSD (dBm /MHz)	Duty Cycle Correction Factor (dB)	Corrected Conducted Average PSD (dBm /MHz)	Conducted PSD Limit (dBm/ MHz)	Margin (dB)	Result
Bottom	-7.96	4.05	-3.91	11.00	14.91	Complied
Middle	-8.05	4.05	-4.00	11.00	15.00	Complied
Top	-7.74	4.05	-3.69	11.00	14.69	Complied

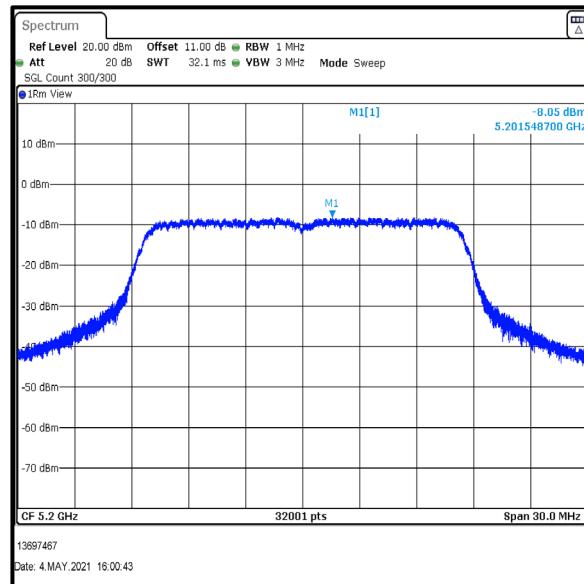
**De Facto EIRP Limit Comparision:**

Channel	Corrected Conducted Average PSD (dBm /MHz)	Directional Antenna Gain (dBi)	EIRP PSD (dBm)	EIRP PSD Limit (dBm/ MHz)	Margin (dB)	Result
Bottom	-3.91	4.0	0.09	17.00	16.91	Complied
Middle	-4.00	4.0	0.00	17.00	17.00	Complied
Top	-3.69	4.0	0.31	17.00	16.69	Complied

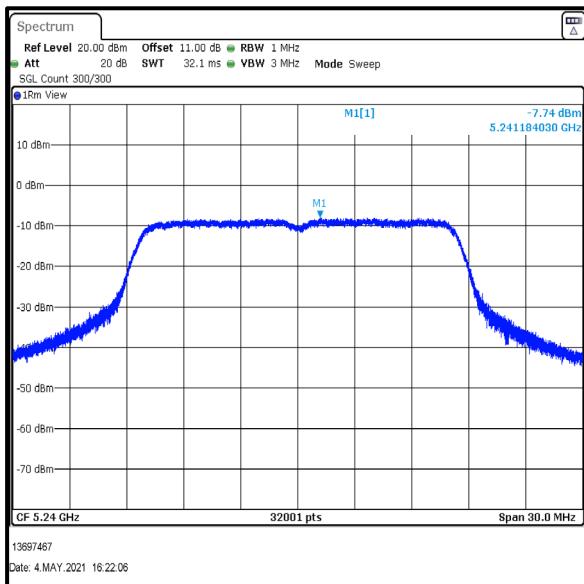
**Result: Pass**

**Transmitter Maximum Power Spectral Density (continued)****Results: Fully Charged Internal Battery / 802.11a / 20 MHz / 54 Mbps / PWR 0**

Bottom



Middle



Top

**Result: Pass**

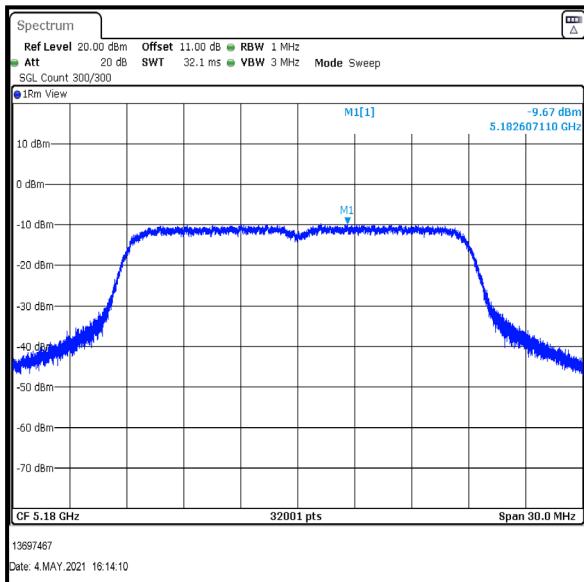
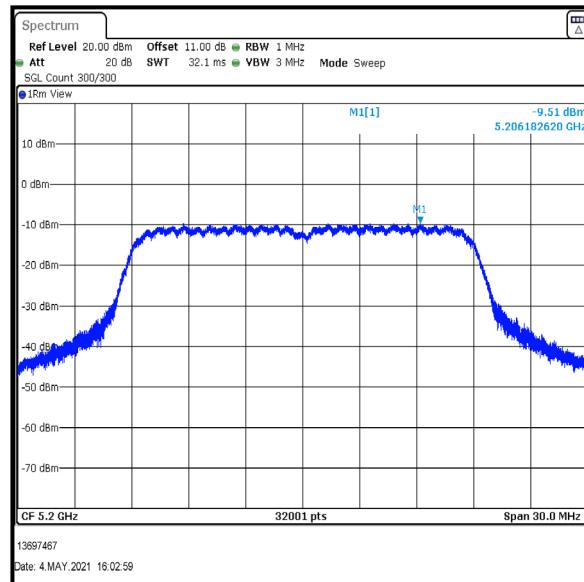
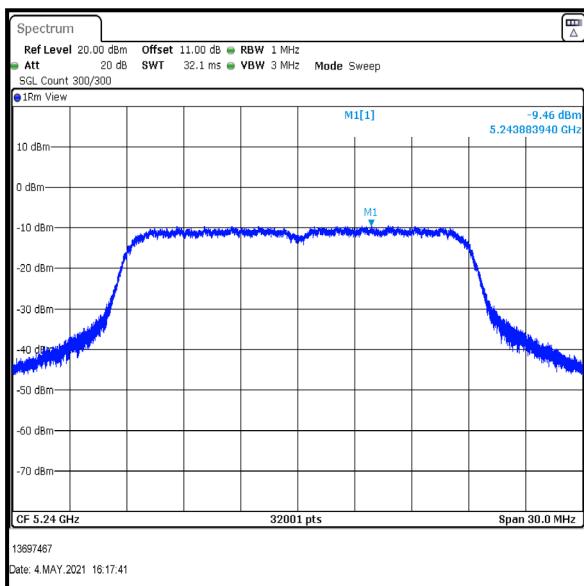
**Transmitter Maximum Power Spectral Density (continued)****Results: AC-DC Power Supply / 802.11n / 20 MHz / MCS7 / PWR 0****Conducted Power Limit Comparision:**

Channel	Conducted Average PSD (dBm /MHz)	Duty Cycle Correction Factor (dB)	Corrected Conducted Average PSD (dBm /MHz)	Conducted PSD Limit (dBm/ MHz)	Margin (dB)	Result
Bottom	-9.67	4.75	-4.92	11.00	15.92	Complied
Middle	-9.51	4.75	-4.76	11.00	15.76	Complied
Top	-9.46	4.75	-4.71	11.00	15.71	Complied

**De Facto EIRP Limit Comparision:**

Channel	Corrected Conducted Average PSD (dBm /MHz)	Directional Antenna Gain (dBi)	EIRP PSD (dBm)	EIRP PSD Limit (dBm/ MHz)	Margin (dB)	Result
Bottom	-4.92	4.0	-0.92	17.00	17.92	Complied
Middle	-4.76	4.0	-0.76	17.00	17.76	Complied
Top	-4.71	4.0	-0.71	17.00	17.71	Complied

**Result: Pass**

**Transmitter Maximum Power Spectral Density (continued)****Results: AC-DC Power Supply / 802.11n / 20 MHz / MCS7 / PWR 0****Bottom****Middle****Top****Result: Pass**

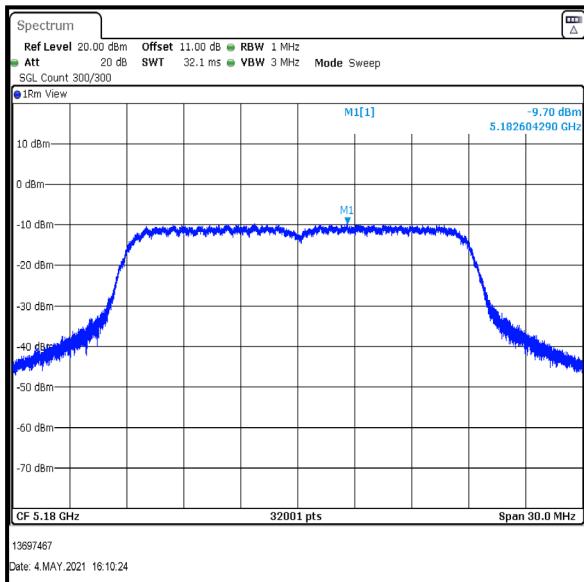
**Transmitter Maximum Power Spectral Density (continued)****Results: Fully Charged Internal Battery / 802.11n / 20 MHz / MCS7 / PWR 0****Conducted Power Limit Comparision:**

Channel	Conducted Average PSD (dBm /MHz)	Duty Cycle Correction Factor (dB)	Corrected Conducted Average PSD (dBm /MHz)	Conducted PSD Limit (dBm/ MHz)	Margin (dB)	Result
Bottom	-9.70	4.75	-4.95	11.00	15.95	Complied
Middle	-9.64	4.75	-4.89	11.00	15.89	Complied
Top	-9.18	4.75	-4.43	11.00	15.43	Complied

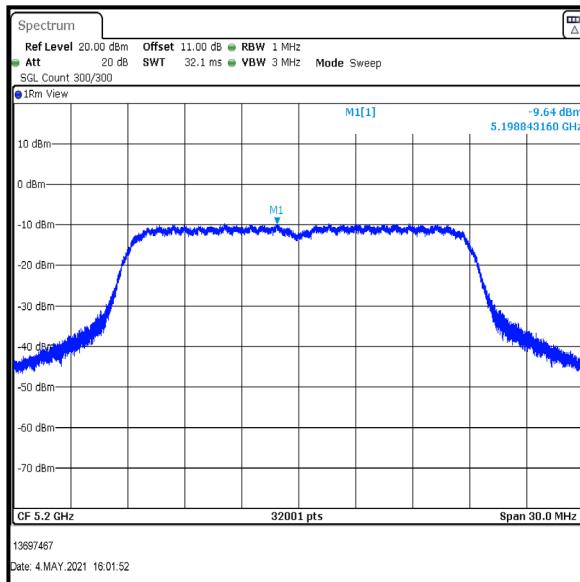
**De Facto EIRP Limit Comparision:**

Channel	Corrected Conducted Average PSD (dBm /MHz)	Directional Antenna Gain (dBi)	EIRP PSD (dBm)	EIRP PSD Limit (dBm/ MHz)	Margin (dB)	Result
Bottom	-4.95	4.0	-0.95	17.00	17.95	Complied
Middle	-4.89	4.0	-0.89	17.00	17.89	Complied
Top	-4.43	4.0	-0.43	17.00	17.43	Complied

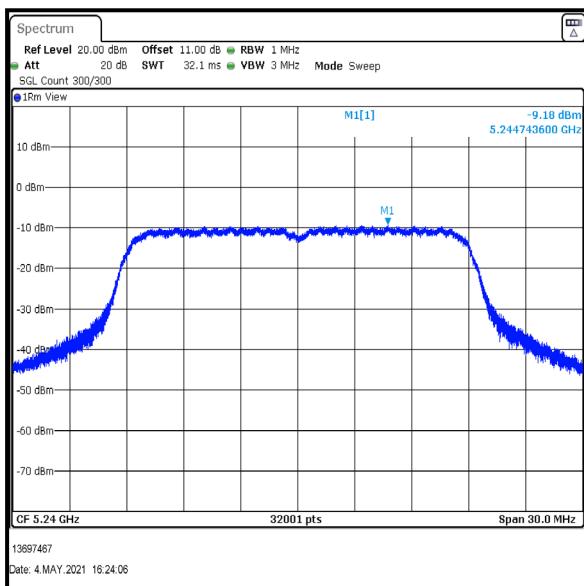
**Result: Pass**

**Transmitter Maximum Power Spectral Density (continued)****Results: Fully Charged Internal Battery / 802.11n / 20 MHz / MCS7 / PWR 0**

Bottom



Middle



Top

**Result: Pass**

**5.2.6. Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation)****Test Summary:**

<b>Test Engineer:</b>	Krume Ivanov	<b>Test Date:</b>	20 April 2021
<b>Test Sample Serial Number:</b>	TB1.5 ( <i>Radiated RF Sample</i> )		
<b>Test Site Identification</b>	SR 1/2		

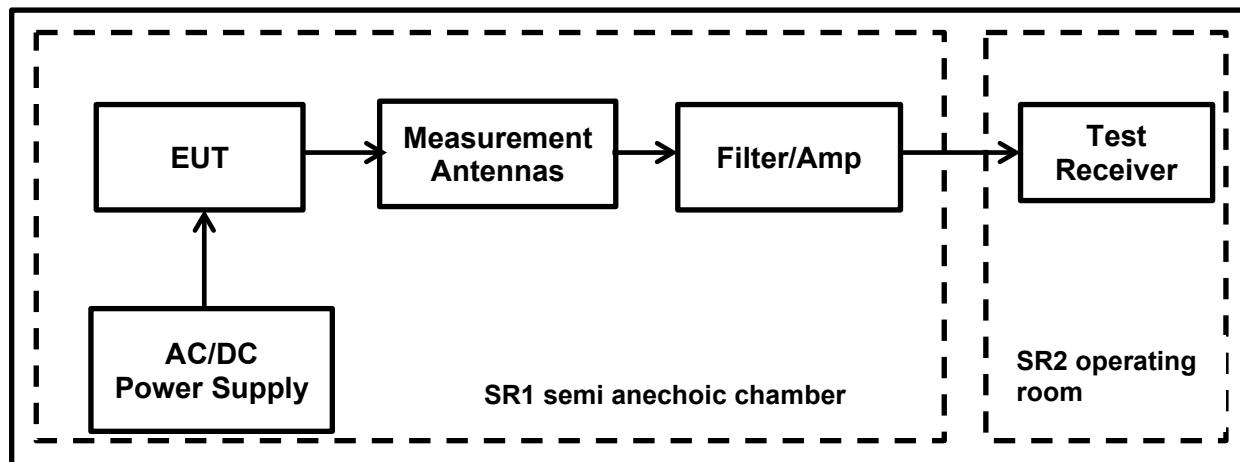
<b>FCC Reference:</b>	Parts 15.407(b)(1),(9) & 15.209(a)
<b>Test Method Used:</b>	FCC KDB 789033 II .G.1, II .G.2, II .G.3 & II .G.4. & ANSI C63.10 Sections 6.3 and 6.4
<b>Frequency Range:</b>	9 kHz to 30 MHz

**Environmental Conditions:**

<b>Temperature (°C):</b>	21.7
<b>Relative Humidity (%):</b>	47.2

**Note(s):**

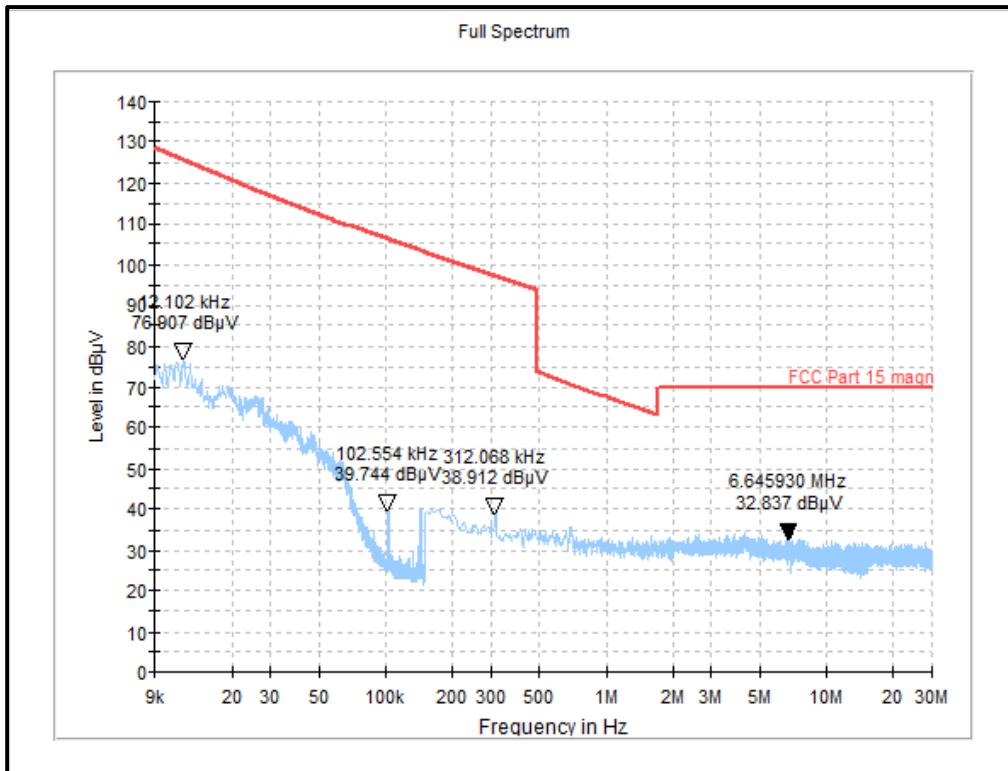
1. In accordance with FCC KDB 414788 D01 Radiated Test Site & ANSI C63.10 clause 5.2 an alternative test site that can demonstrate equivalence to a open area test site may be used. Therefore, the measurement was performed in a Semi Anechoic Chamber. (The OATS / SAC comparison data is available upon request).
2. The limits are specified at a test distances of 30 and 300 metres. However, as specified in FCC Section 15.31 (f)(2) & ANSI C63.10 clause 6.4.3, measurements may be performed at a closer distance and the measured level extrapolated to the specified measurement distance using the method described in clauses 6.4.4, specifically sub-clause 6.4.4.1 which specifies that the measured level shall be extrapolated to the specified distance by conservatively presuming that the field strength decays at 40 dB/decade.
3. Therefore the limit values are extrapolated to a measurement distance of 3 m.
  - 9 kHz- 490 kHz: limits extrapolated from 300 m to 3 m by adding 80 dB at 40 dB/decade.
  - 490kHz-1705 kHz: limits extrapolated from 30 m to 3 m by adding 40 dB /decade.
4. The preliminary scans showed similar emission levels below 30 MHz, for each channel & modes(a,n) of operation. Therefore final radiated emissions measurements were performed with the EUT set to the top channel only.
5. All emissions shown on the pre-scan plots were investigated and found to be below system noise floor.
6. Measurements below 30 MHz were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) at a distance of 3 m. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. The measurement loop antenna height was 80 cm.
7. Pre-scans were performed and markers placed on the highest measured levels. The test receiver was set to:
  - Frequency range: 9 kHz-150kHz : RBW: 300 Hz /VBW: 1 kHz
  - Frequency range: 150 kHz – 30 MHz: RBW: 10 kHz /VBW: 30 kHz
  - Detector: Max-Peak detector
  - Trace Mode: Max Hold

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Test Setup:**

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Results: AC-DC Power Supply / 802.11a / 20 MHz / 54 Mbps / PWR 0 / Top Channel**

Frequency (MHz)	Loop Antenna Orientation	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
No critical spurious emissions were found					

Plot: Radiated Transmitter spurious emission from 9 kHz – 30 MHz



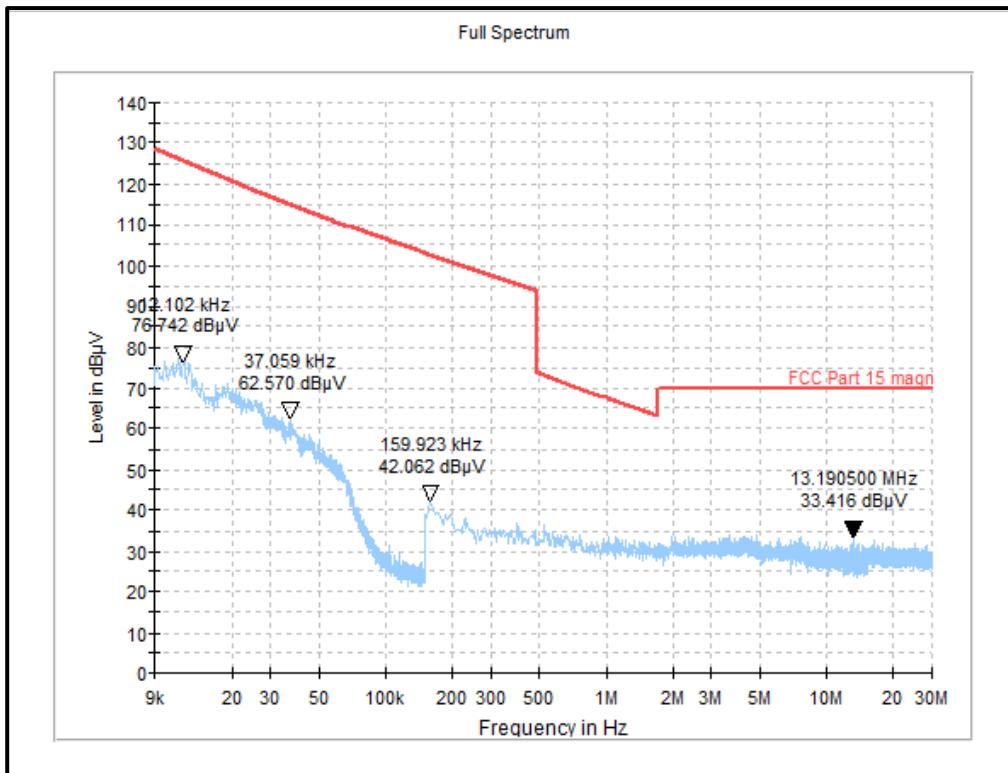
*Note: This plot is a pre-scan and for indication purposes only.  
For final measurements, see accompanying table.*

**Result: Pass**

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Results: AC-DC Power Supply / 802.11n / 20 MHz / MCS7 / PWR 0 / Top Channel**

Frequency (MHz)	Loop Antenna Oriantation	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
No critical spurious emissions were found					

Plot: Radiated Transmitter spurious emission from 9 kHz – 30 MHz



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

**Result: Pass**

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Test Summary:**

<b>Test Engineer:</b>	Krume Ivanov	<b>Test Date:</b>	27 April 2021
<b>Test Sample Serial Number:</b>	TB1.5 ( <i>Radiated RF Sample</i> )		
<b>Test Site Identification</b>	SR 1/2		

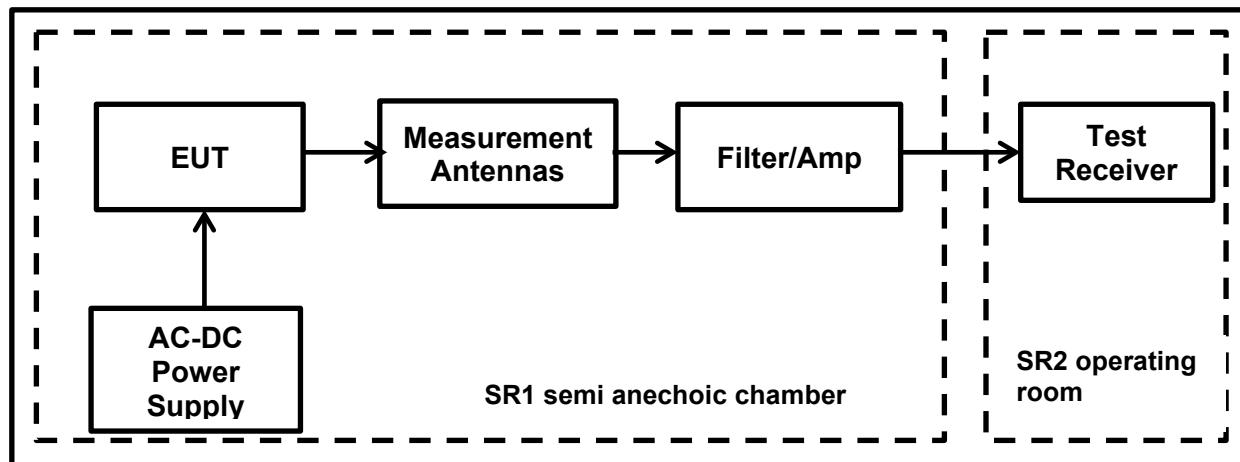
<b>FCC Reference:</b>	Parts 15.407(b)(1),(9) & 15.209(a)
<b>Test Method Used:</b>	FCC KDB 789033 II .G.1, II .G.2, II .G.3 & II .G.4 & ANSI C63.10 Sections 6.3 and 6.5
<b>Frequency Range:</b>	30 MHz to 1000 MHz

**Environmental Conditions:**

<b>Temperature (°C):</b>	23.0
<b>Relative Humidity (%):</b>	32.0

**Note(s):**

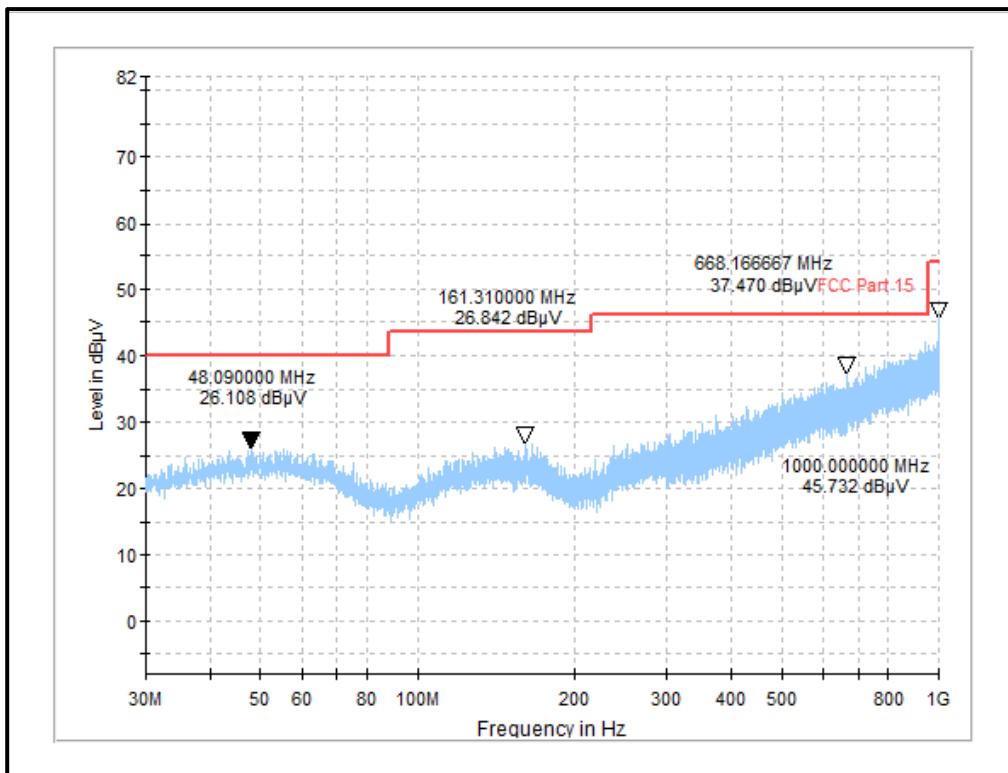
1. Measurements below 1 GHz were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) at a distance of 3 m. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 m to 4 m.
2. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
3. The preliminary scans showed similar emission levels below 1000 MHz, for each channel & modes(a,n) of operation. Therefore final radiated emissions measurements were performed with the EUT set to the top channel only.
4. All emissions shown on the pre-scan plots were investigated and found to be below system noise floor.

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Test Setup:**

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Results: AC-DC Power Supply / UNII-1 / 802.11a / 20 MHz / 54 Mbps / PWR 0 / Top Channel**

Frequency (MHz)	Antenna Polarization	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
No critical spurious emissions were found					

Plot: Radiated Transmitter spurious emission from 30 MHz – 1 GHz



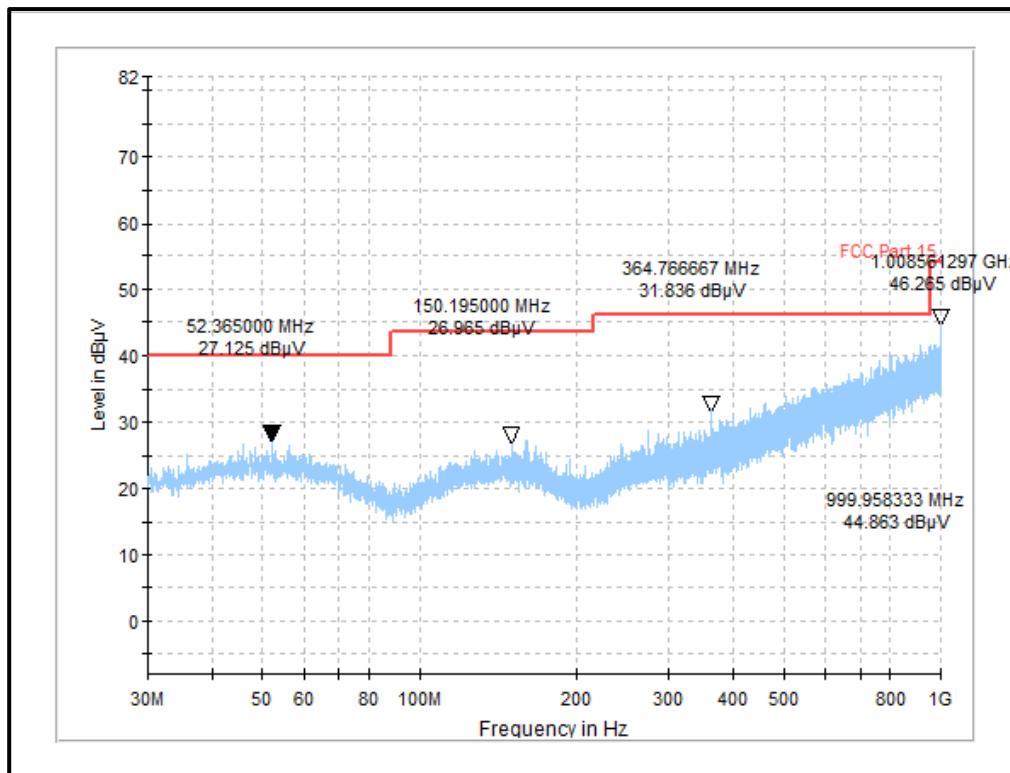
*Note: This plot is a pre-scan and for indication purposes only.  
For final measurements, see accompanying table.*

**Result: Pass**

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Results: AC-DC Power Supply / UNII-1 / 802.11n / 20 MHz / MCS7 / PWR 0 / Top Channel**

Frequency (MHz)	Antenna Polarization	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
No critical spurious emissions were found					

Plot: Radiated Transmitter spurious emission from 30 MHz – 1 GHz

**Result: Pass**

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Test Summary:**

<b>Test Engineer:</b>	Krume Ivanov	<b>Test Date:</b>	23 April 2021 to 14 May 2021
<b>Test Sample Serial Number:</b>	TB1.5 ( <i>Radiated RF Sample</i> )		
<b>Test Site Identification</b>	SR 1/2		

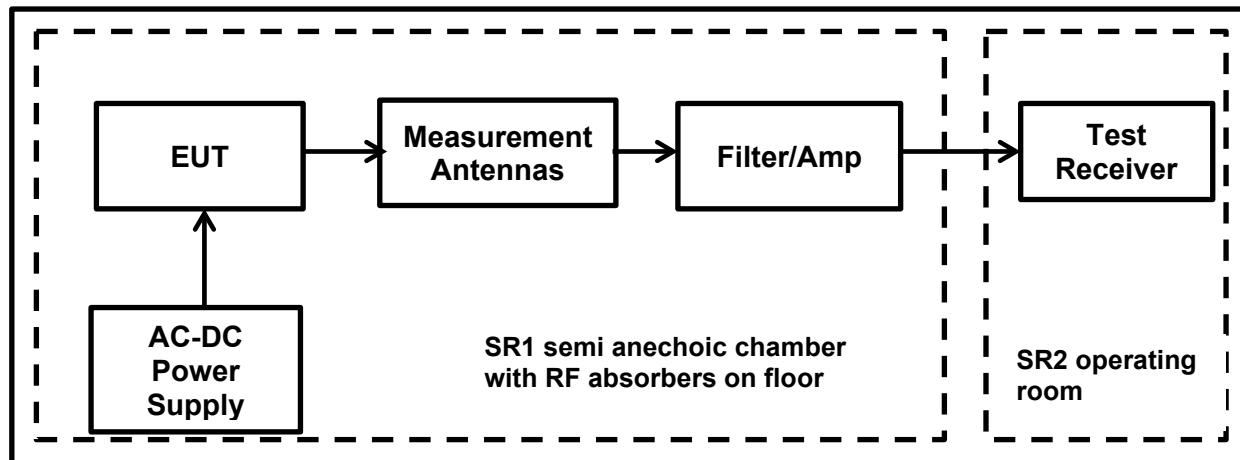
<b>FCC Reference:</b>	Parts 15.407(b)(1),(8) & 15.209(a)
<b>Test Method Used:</b>	FCC KDB 789033 II .G.1, II .G.2, II .G.3, II .G.5 &, II .G.6 ANSI C63.10:2013 Sections 6.3 and 6.6
<b>Frequency Range</b>	1 GHz to 40 GHz

**Environmental Conditions:**

<b>Temperature (°C):</b>	23.2 to 26.8
<b>Relative Humidity (%):</b>	27.8 to 33.5

**Note(s):**

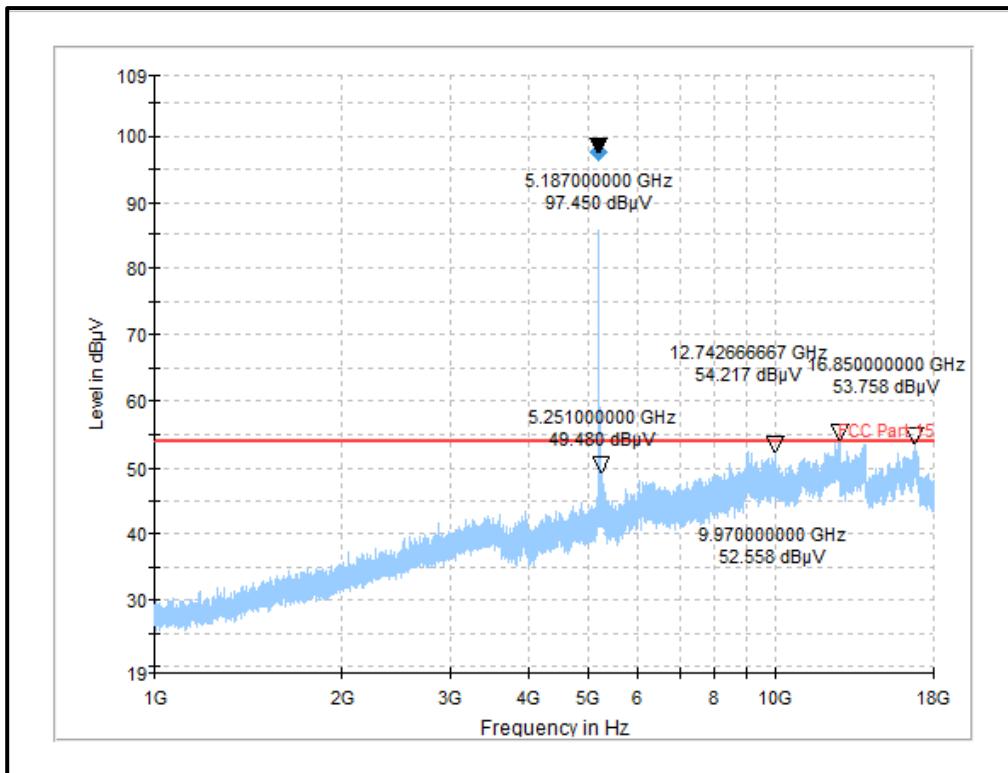
1. The emissions shown at frequencies approximately 5.15-5.25 GHz on the 1 GHz to 18 GHz plots are the EUT fundamental for the tested channel.
2. Pre-scans above 1 GHz were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) with absorber on the floor at a distance of 3 m. The EUT was placed at a height of 1.5 m above the test chamber floor in the centre of the chamber turntable. All measurement antennas were placed at a fixed height of 1.5 m above the test chamber floor, in line with the EUT. Final measurements above 1 GHz were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) with absorber on the floor at a distance of 3 m. 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 m to 4 m.
3. 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.
4. For frequency range between 1 GHz to 18 GHz, no critical emissions were found. All emissions shown on the pre-scans were investigated and found to be below the noise floor of the measurement system.
5. The preliminary scans showed similar emission levels above 18 GHz, for each channel & modes of operation. Therefore, final radiated emissions measurements were performed with the EUT set to the top channel only.
6. For frequency range between 18 GHz and 40 GHz, no critical emissions were found. All emissions shown on the pre-scans were investigated and found to be below the noise floor of the measurement system.

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Test Setup:**

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Results: AC-DC Power Supply / UNII-1 / 802.11a / 20 MHz / 54 Mbps / PWR 0 / Bottom Channel**

Frequency (MHz)	Antenna Polarization	MaxPeak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
No critical spurious emissions were found					

Plot: Radiated Transmitter spurious emission from 1 GHz – 18 GHz



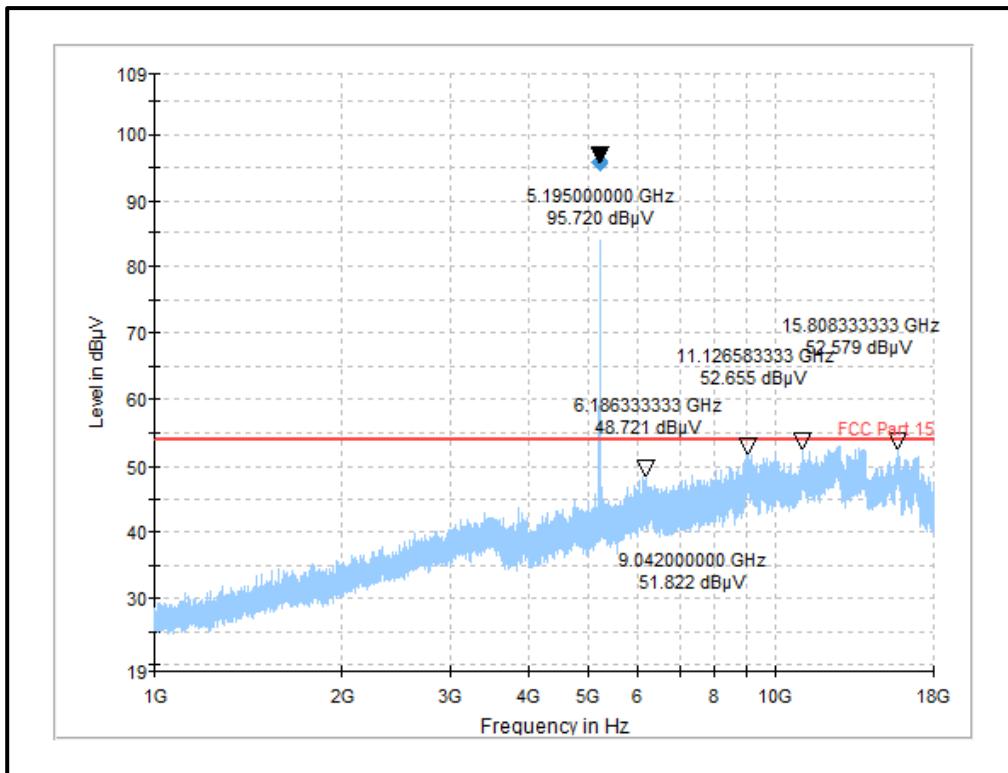
*Note: This plot is a pre-scan and for indication purposes only.  
For final measurements, see accompanying table.*

**Result: Pass**

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Results: AC-DC Power Supply / UNII-1 / 802.11a / 20 MHz / 54 Mbps / PWR 0 / Middle Channel**

Frequency (MHz)	Antenna Polarization	MaxPeak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
No critical spurious emissions were found					

Plot: Radiated Transmitter spurious emission from 1 GHz – 18 GHz



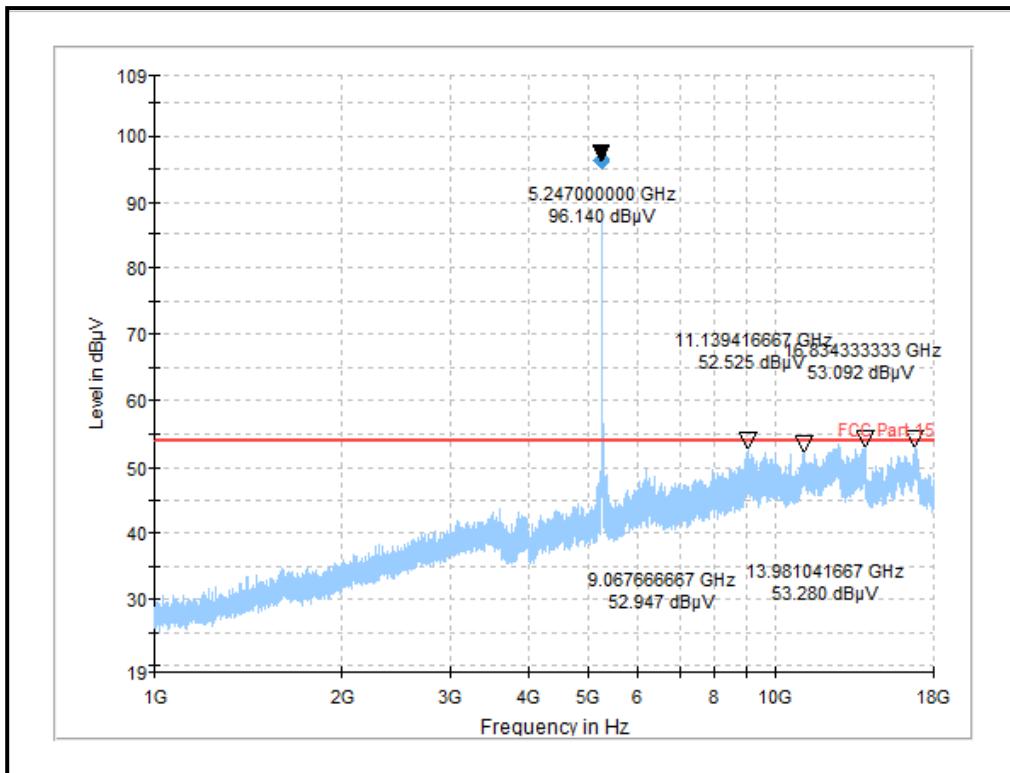
*Note: This plot is a pre-scan and for indication purposes only.  
For final measurements, see accompanying table.*

**Result: Pass**

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Results: AC-DC Power Supply / UNII-1 / 802.11a / 20 MHz / 54 Mbps / PWR 0 / Top Channel**

Frequency (MHz)	Antenna Polarization	MaxPeak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
No critical spurious emissions were found					

Plot: Radiated Transmitter spurious emission from 1 GHz – 18 GHz



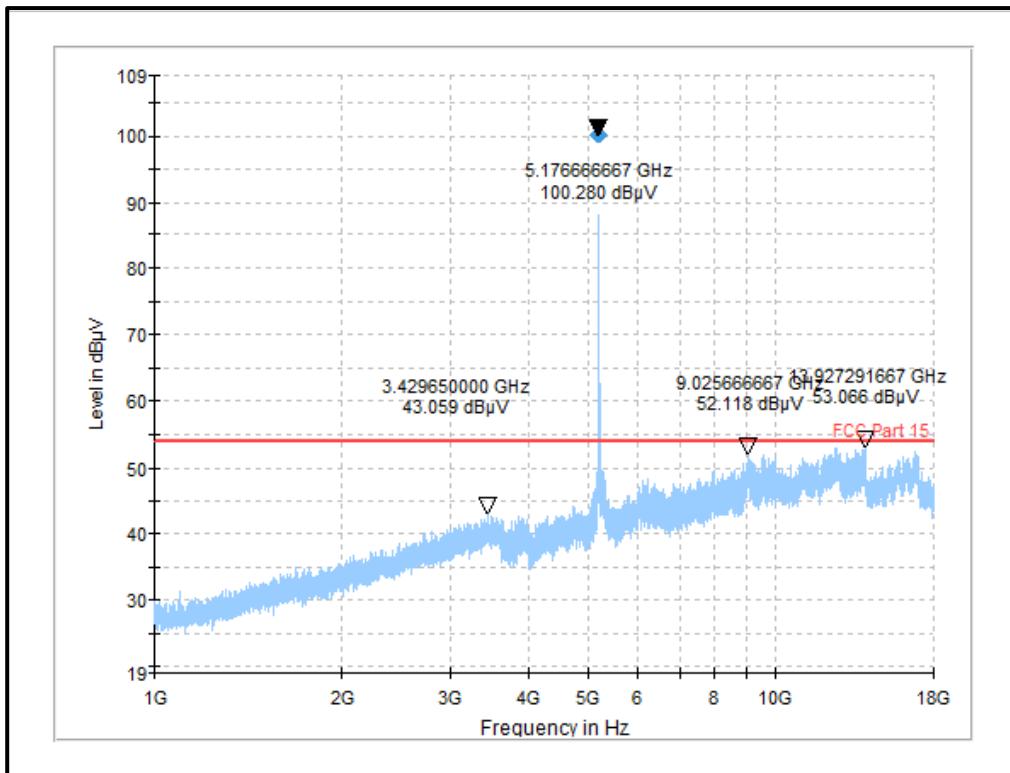
*Note: This plot is a pre-scan and for indication purposes only.  
For final measurements, see accompanying table.*

**Result: Pass**

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Results: AC-DC Power Supply / UNII-1 / 802.11n / 20 MHz / MCS7 / PWR 0 / Bottom Channel**

Frequency (MHz)	Antenna Polarization	MaxPeak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
No critical spurious emissions were found					

Plot: Radiated Transmitter spurious emission from 1 GHz – 18 GHz



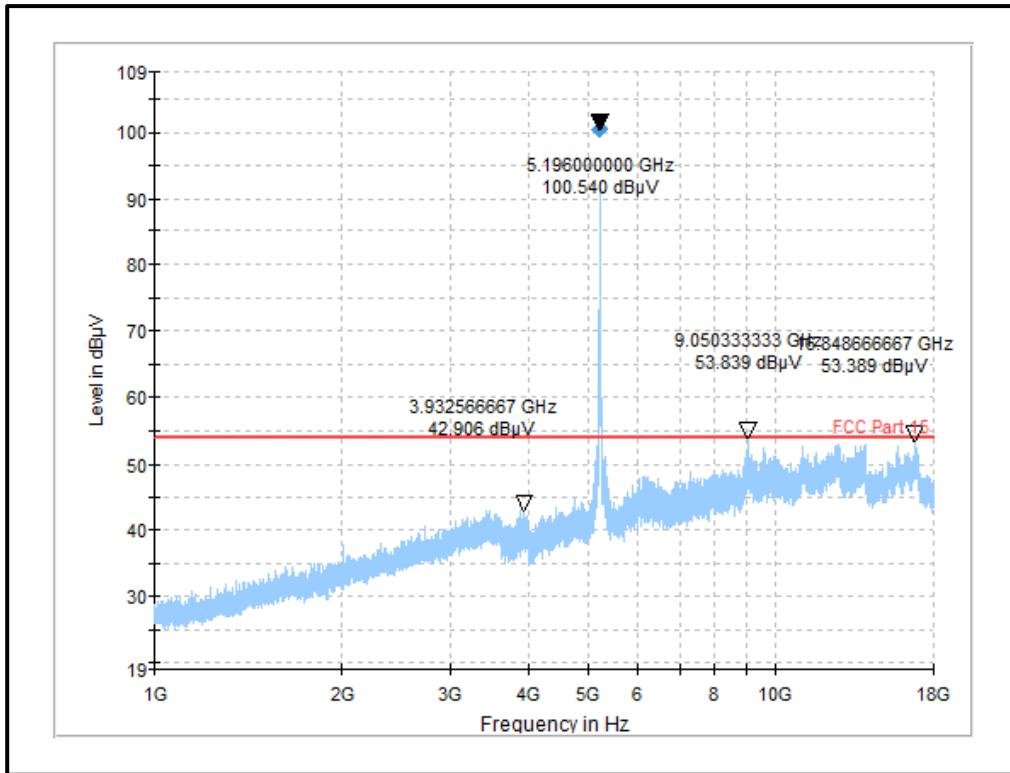
*Note: This plot is a pre-scan and for indication purposes only.  
For final measurements, see accompanying table.*

**Result: Pass**

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Results: AC-DC Power Supply / UNII-1 / 802.11n / 20 MHz / MCS7 / PWR 0 / Middle Channel**

Frequency (MHz)	Antenna Polarization	MaxPeak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
No critical spurious emissions were found					

Plot: Radiated Transmitter spurious emission from 1 GHz – 18 GHz



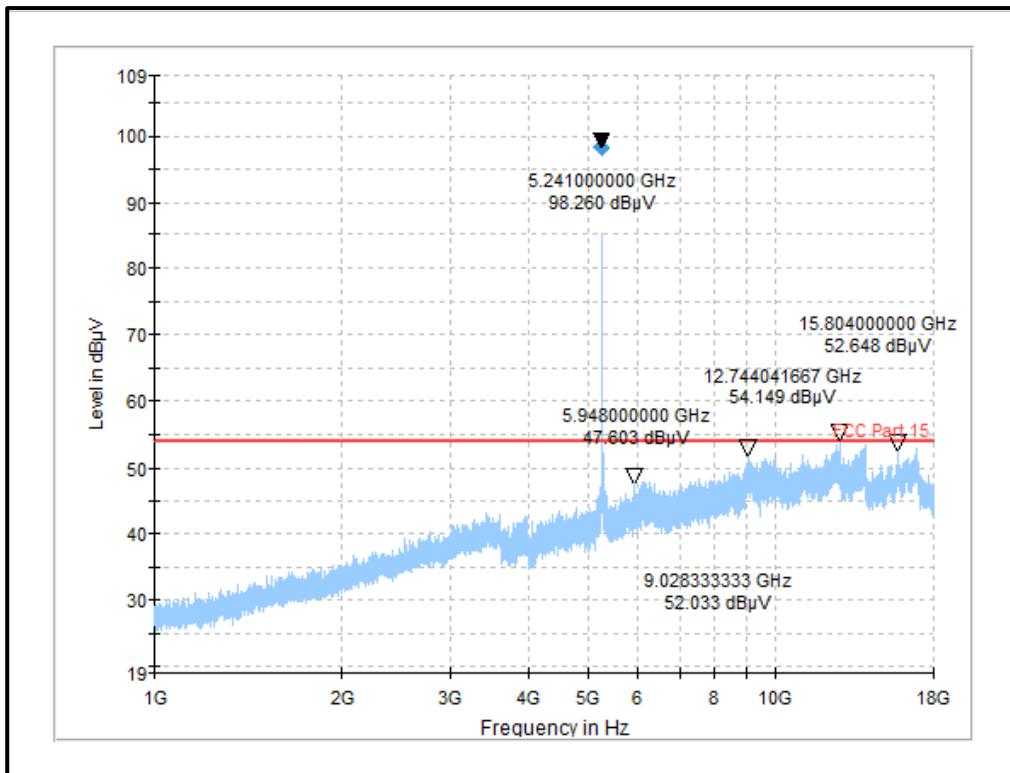
*Note: This plot is a pre-scan and for indication purposes only.  
For final measurements, see accompanying table.*

**Result: Pass**

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Results: AC-DC Power Supply / UNII-1 / 802.11n / 20 MHz / MCS7 / PWR 0 / Top Channel**

Frequency (MHz)	Antenna Polarization	MaxPeak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
No critical spurious emissions were found					

Plot: Radiated Transmitter spurious emission from 1 GHz – 18 GHz



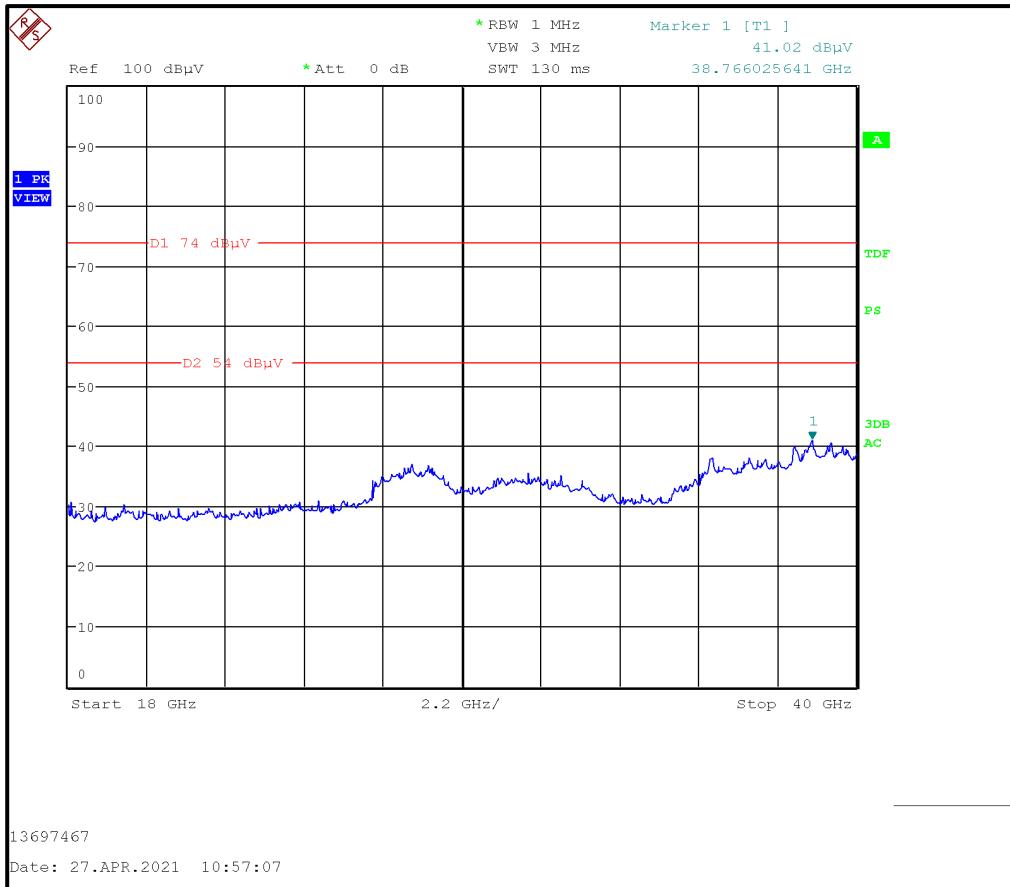
*Note: This plot is a pre-scan and for indication purposes only.  
For final measurements, see accompanying table.*

**Result: Pass**

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Results: AC-DC Power Supply / UNII-1 / 802.11a / 20 MHz / 54 Mbps / PWR 0 / Top Channel**

Frequency (MHz)	Antenna Polarization	MaxPeak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
No critical spurious emissions were found					

Plot: Radiated Transmitter spurious emission from 18 GHz – 40 GHz



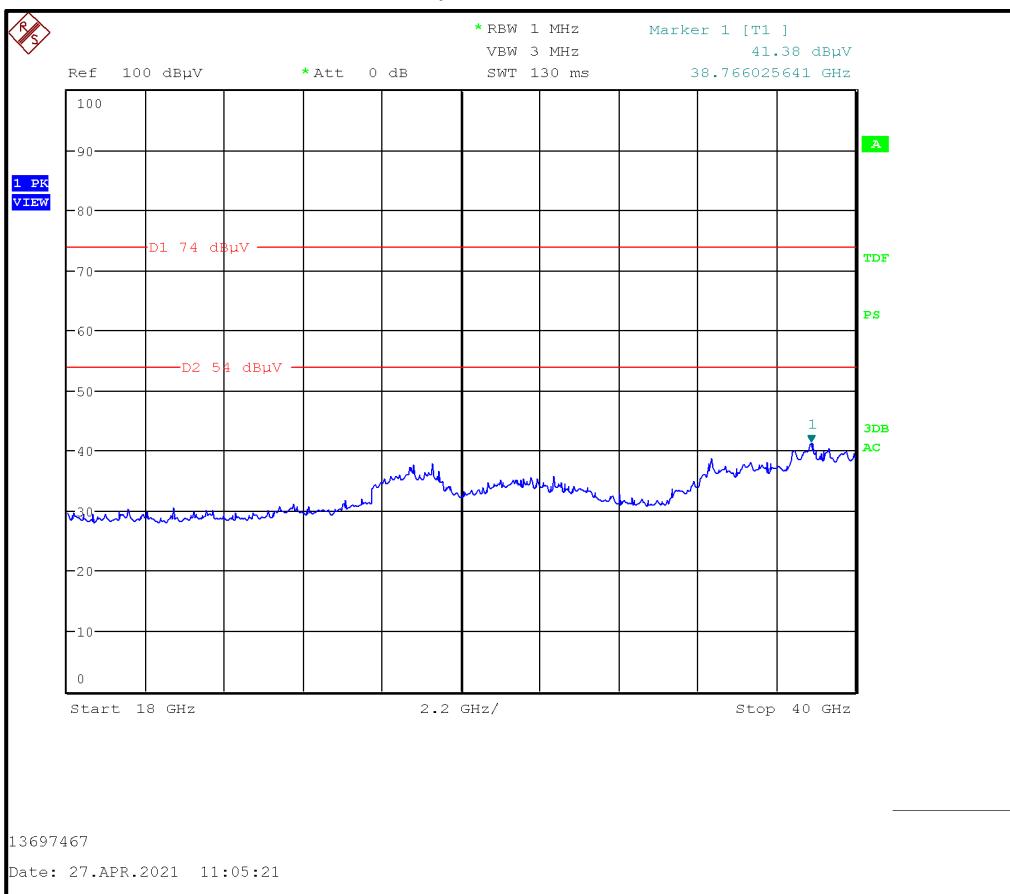
*Note: This plot is a pre-scan and for indication purposes only.  
 For final measurements, see accompanying table.*

**Result: Pass**

**Transmitter Out of Band Radiated Emissions (5.15-5.25 GHz band operation) (continued)****Results: AC-DC Power Supply / UNII-1 / 802.11n / 20 MHz / MCS7 / PWR 0 / Top Channel**

Frequency (MHz)	Antenna Polarization	MaxPeak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
No critical spurious emissions were found					

Plot: Radiated Transmitter spurious emission from 18 GHz – 40 GHz



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

**Result: Pass**

## **5.2.7. Transmitter Band Edge Radiated Emissions**

### **Test Summary:**

<b>Test Engineers:</b>	Krume Ivanov	<b>Test Dates:</b>	19 April 2021 to 30 June 2021
<b>Test Sample Serial Number:</b>	TB1.5 ( <i>Radiated RF Sample</i> )		
<b>Test Site Identification</b>	SR 1/2		

<b>FCC Reference:</b>	Parts 15.407(b)(1),(8), 15.205 & 15.209(a)
<b>Test Method Used:</b>	FCC KDB 789033 D02 Section II.G.1, II.G.2, II.G.3, II.G.5 & II.G.6 ANSI C63.10 Sections 6.3 and 6.6

### **Environmental Conditions:**

<b>Temperature (°C):</b>	22.6 to 24.5
<b>Relative Humidity (%):</b>	29.3 to 33.8

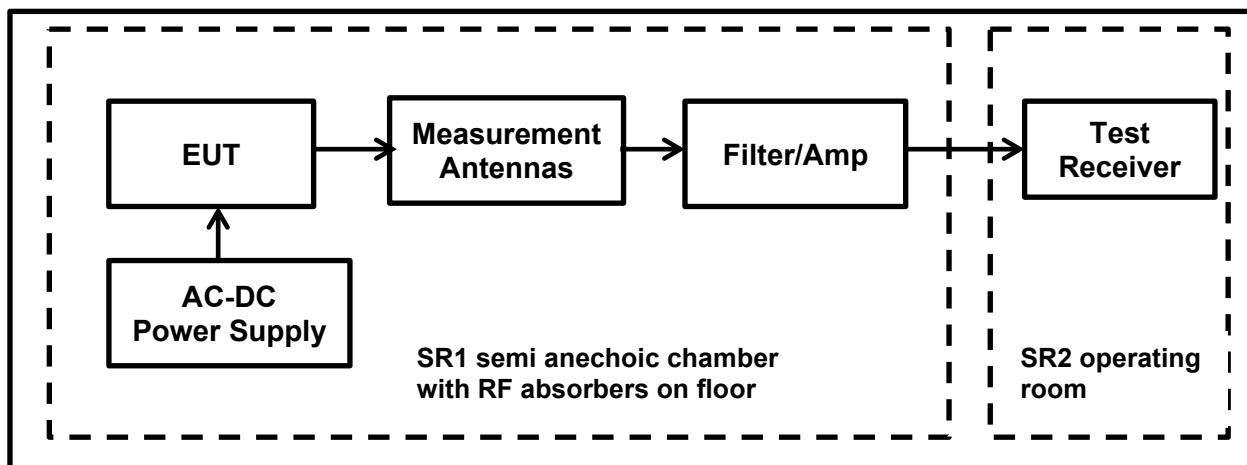
### **Notes:**

1. According to FCC KDB 789033 D02 Section II.G.5 & II.G.6 Transmitter Band Edge Radiated Emissions were performed.)
2. The test receiver was set to RBW: 1 MHz | VBW: 3 MHz | Sweep time: Auto | Trace mode: max hold | Span: large enough to capture unwanted band edge emissions with trace stabilizations.
3. In accordance with KDB 789033 Section II.D.v), Method AD (vi), the average measurements were performed using an increased number of sweeps A value of 300 was used for all measurements as this number ensured that the requirement Sweep  $\geq 2 \times$  Span / RBW is met.
4. Transmitter Band Edge Radiated Emissions were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) with absorbers on the ground at a distance of 3 meters. The EUT was placed at a height of 1.5 meters above the test chamber floor in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna with tilting function enabled over the range 1 meter to 4 meters above the test chamber floor, in line with the EUT.
5. The maximum emissions around band edges were searched & are indicated with a marker placed on them.
6. For transmitters operating in the 5.15-5.25 GHz band: all emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27 dBm/MHz. However, there are restricted bands of operation below the lower band edge at 4.5-5.15 GHz and also above the upper band edge at 5.35-5.46 GHz therefore the provisions of FCC Part 15.205 apply.
7. As all radiated band edge measurements have been performed with R.B.W. 1 MHz; the limits in dBm / MHz can be converted to dB $\mu$ V/m by adding a conversion factor of 95.2 (in accordance with KDB 789033 G.2.d)(iii)).
8. Field strength measurements using peak and average detectors were performed in the restricted bands below 5.15 GHz and above 5.35 GHz.
9. In accordance with KDB 789033 Section II.G.1.c) If all peak measurements satisfy the average limit, then average measurements are not required.
10. For unwanted emissions measured with Peak detector there are two limit possibilities:
  - According to FCC 15.209 peak limit (above 1 GHz) is 74 dB $\mu$ V/m (restricted band limit)
  - According to FCC 15.407(b)(4)(i) peak limit is 68.2 dB $\mu$ V/m (non-restricted band limit)
11. \*Therefore unwanted emissions in restricted as well non restricted bands, measured with Peak detector lowest limit 68.2 dB $\mu$ V/m has been applied.

**Transmitter Band Edge Radiated Emissions (continued)****Notes:**

12. In accordance with ANSI C63.10 Section 12.7.7.2 Method AD g), for average measurements, data rates where the EUT was transmitting < 98% duty cycle, the duty cycle correction factor calculated in section 5.2.3 was added to the measured result.
13. \*\*As the EUT continuous transmission of the EUT ( $D \geq 98\%$ ) cannot be achieved and EUT was transmitting continuously with a constant Duty Cycle of
  - 802.11a I 54 Mbps : 39.38 % (duty cycle variations are less than  $\pm 2\%$ ). Therefore, a Duty Cycle Correction Factor of 4.05 dB was added to all average measurements
  - 802.11n(HT20) I MCS7: 33.50 % (duty cycle variations are less than  $\pm 2\%$ ). Therefore, a Duty Cycle Correction Factor of 4.75 dB was added to all average measurements

to compute the corrected average values of the emissions that would have been measured had the test been performed at 100% Duty Cycle.

**Test Setup:**

**Transmitter Band Edge Radiated Emissions (continued)****Results: AC-DC Power Supply / UNII-1 / 802.11a / 20 MHz / 54 Mbps / PWR 0****Results: CH36 / Lower Band Edge / Peak**

Frequency (MHz)	Peak Level (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
5110.00	61.55	68.20*	6.65	Complied
5150.00	60.37	68.20*	7.83	Complied

**Results: CH36 / Lower Band Edge / Average**

Frequency (MHz)	Average Level (dB $\mu$ V/m)	Duty Cycle Correction Factor (dB)	Corrected Average Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
5149.85	49.00	4.05	53.05**	54.00	0.95	Complied
5150.00	49.02	4.05	53.07**	54.00	0.93	Complied

**Results: CH48 / Upper Band Edge / Peak**

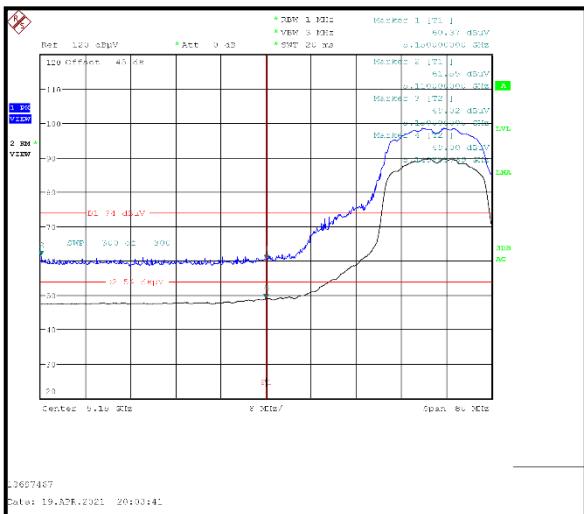
Frequency (MHz)	Peak Level (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
5350.00	60.36	68.20*	7.84	Complied
5359.23	62.23	68.20*	5.97	Complied

**Results: CH48 / Upper Band Edge / Average**

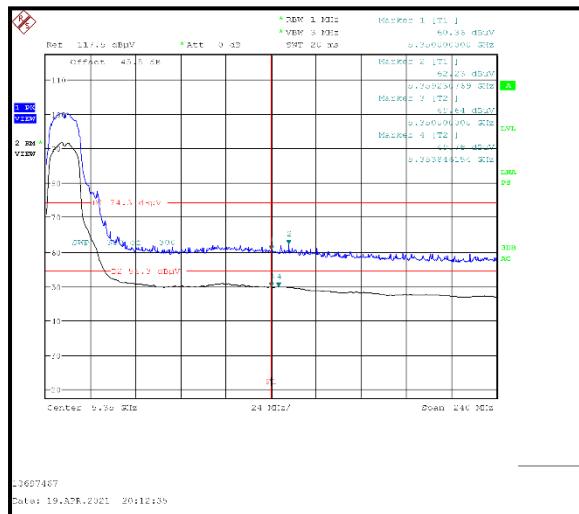
Frequency (MHz)	Average Level (dB $\mu$ V/m)	Duty Cycle Correction Factor (dB)	Corrected Average Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
5350.00	49.64	4.05	53.69**	54.00	0.31	Complied
5353.84	49.78	4.05	53.83**	54.00	0.17	Complied

## Transmitter Band Edge Radiated Emissions (continued)

## Results: AC-DC Power Supply / UNII-1 / 802.11a / 20 MHz / 54 Mbps / PWR 0



## Lower Band Edge Measurement



## Upper Band Edge Measurement

## Result: Pass within Measurement Uncertainty

**Transmitter Band Edge Radiated Emissions (continued)****Results: AC-DC Power Supply / UNII-1 / 802.11n / 20 MHz / MCS7 / PWR 0****Results: CH36 / Lower Band Edge / Peak**

Frequency (MHz)	Peak Level (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
5110.00	61.46	68.20*	6.74	Complied
5148.38	61.33	68.20*	6.87	Complied

**Results: CH36 / Lower Band Edge / Average**

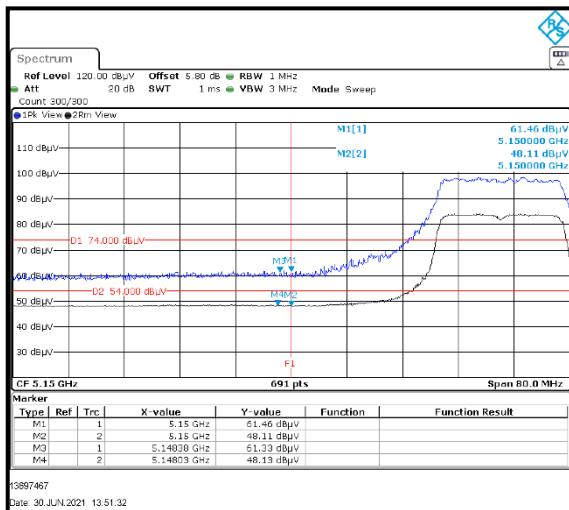
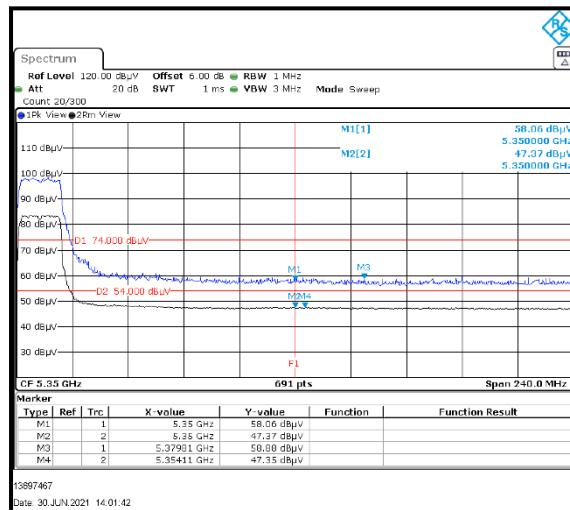
Frequency (MHz)	Average Level (dB $\mu$ V/m)	Duty Cycle Correction Factor (dB)	Corrected Average Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
5148.03	48.13	4.75	52.88**	54.00	1.12	Complied
5150.00	48.11	4.75	52.86**	54.00	1.14	Complied

**Results: CH48 / Upper Band Edge / Peak**

Frequency (MHz)	Peak Level (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
5350.00	58.06	68.20*	10.14	Complied
5379.81	58.88	68.20*	9.32	Complied

**Results: CH48 / Upper Band Edge / Average**

Frequency (MHz)	Average Level (dB $\mu$ V/m)	Duty Cycle Correction Factor (dB)	Corrected Average Level (dB $\mu$ V/m)	Average Limit (dB $\mu$ V/m)	Margin (dB)	Result
5350.00	47.37	4.75	52.12**	54.00	1.88	Complied
5354.11	47.35	4.75	52.10**	54.00	1.90	Complied

**Transmitter Band Edge Radiated Emissions (continued)****Results: AC-DC Power Supply / UNII-1 / 802.11n / 20 MHz / MCS7 / PWR 0****Lower Band Edge Measurement****Upper Band Edge Measurement****Result: Pass within Measurement Uncertainty**

## **6. Measurement Uncertainty**

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	Confidence Level (%)	Calculated Uncertainty
AC Conducted Spurious Emissions	95%	±2.49 dB
Conducted Maximum Peak Output Power	95%	±0.59 dB
Conducted Maximum Power Spectral Density	95%	±0.59 dB
Radiated Spurious Emissions	95%	±3.10 dB
Band Edge Radiated Emissions	95%	±3.10 dB
Transmitter Duty Cycle	95%	±3.4%
26 dB Bandwidth	95%	±0.87 %

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. Used equipment

### Test site: SR 1/2

ID	Manufacturer	Type	Model	Serial	Calibration Date	Cal. Cycle (months)
1	Rohde & Schwarz	Antenna, Loop	HFH2-Z2	831247/012	10/07/2020	36
377	BONN Elektronik	Amplifier, Low Noise Pre	BLMA 0118-1A	025294B	08/07/2020	12
423	Bonn Elektronik	Amplifier, Low Noise Pre	BLMA 1840-1A	55929	09/07/2020	12
460	Deisel	Turntable	DT 4250 S	n/a	n/a	n/a
452	Schwarzbeck	Antenna, Trilog Broadband	VULB 9168	9168-240	02/09/2020	24
496	Rohde & Schwarz	Antenna, log. - periodical	HL050	100297	05/08/2020	36
607	Schwarzbeck	Antenna broadband horn antenna	BBHA 9170	9170-561	15/10/2019	36
587	Maturo	antenna mast, tilting	TAM 4.0-E	011/7180311	n/a	n/a
588	Maturo	Controller	NCD	029/7180311	n/a	n/a
591	Rohde & Schwarz	Receiver	ESU 40	100244/040	07/07/2020	12
608	Rohde & Schwarz	Switch Matrix	OSP 120	101227	lab verification	n/a
628	Maturo	Antenna mast	CAM 4.0-P	224/19590716	n/a	n/a
629	Maturo	Kippeinrichtung	KE 2.5-R-M	MAT002	n/a	n/a
-/-	Testo	Thermo-Hygrometer	608-H1	01	lab verification	n/a
328	SPS	AC/DC power distribution system	PAS 5000	A2464 00/2 0200	lab verification	n/a
1603665	Siemens Matsushita Components	semi-anechoic chamber SR1/ 2	-/-	B83117-A1421-T161	n/a	n/a

### Test site: SR 7/8

ID	Manufacturer	Type	Model	Serial	Calibration Date	Cal. Cycle (months)
23	Rohde & Schwarz	Artificial Mains Network	ESH3-Z5	831767/013	07/07/2020	12
349	Rohde & Schwarz	Receiver, EMI Test	ESIB7	836697/009	09/07/2020	12
-/-	Testo	Thermo-Hygrometer	608-H1	08	lab verification	n/a
327	SPS	AC/DC power distribution system	PAS 5000	A2464 00/1 0200	lab verification	n/a

### Test site: SR 9

ID	Manufacturer	Type	Model	Serial	Calibration Date	Cal. Cycle (months)
445	Huber & Suhner	RF Attenuator (10dB)	6810.17.AC	--	lab verification	12
637	Rohde & Schwarz	Spectrum Analyzer	FSV40	101587	08/07/2020	12
636	Rohde & Schwarz	Switching Unit Power Meter	OSP-B157W8	101698	07/07/2020	12
-/-	Testo	Thermo-Hygrometer	608-H1	07	lab verification	n/a
-/-	Huber & Suhner	RF Cable (upto 18GHz)	-/-	-/-	lab verification	n/a
327	SPS	AC/DC power distribution system	PAS 5000	A2464 00/1 0200	lab verification	n/a
1603668	Siemens Matsushita Components	shielded room		B83117-B1422-T161	n/a	n/a

## 8. Report Revision History

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0	74	-	Initial Version