



# TEST REPORT

**Test Report No. : UL-RPT-RP-13847161-116-FCC**

**Applicant** : Playbrush GmbH  
**Model No.** : A122  
**FCC ID** : 2AF47A122  
**Technology** : Bluetooth – Low Energy  
**Test Standard(s)** : FCC Parts 15.207, 15.209(a) & 15.247

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**

Prepared by: M. Asim, Shahzad  
Title: Laboratory Engineer  
Date: 12 October 2021

Approved by: Ajit, Phadtare  
Title: Lead Test Engineer  
Date: 12 October 2021



Deutsche  
Akkreditierungsstelle  
D-PL-19381-02-00

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>	Playbrush GmbH
<b>Company Address:</b>	Alserbachstrasse 2/9, 1090 Wien, Austria
<b>Company Phone No.:</b>	-/-
<b>Company E-Mail:</b>	support@playbrush.com
<b>Contact Person:</b>	Paul Varga
<b>Contact E-Mail Address:</b>	Paul@playbrush.com
<b>Contact Phone No.:</b>	+4369919088835

### **1.2.Manufacturer Information**

<b>Company Name:</b>	Trisa AG
<b>Company Address:</b>	Kantonsstrasse 31, CH-6234 Triengen, Switzerland
<b>Company Phone No.:</b>	info@trisa.ch
<b>Company E-Mail:</b>	+41 41 935 35 35
<b>Contact Person:</b>	Martin Neubauer
<b>Contact E-Mail Address:</b>	Martin.neubauer@trisa.ch
<b>Contact Phone No.:</b>	+41 41 935 3475

## **2. Summary of Testing**

### **2.1. General Information**

#### **Applied Standards**

<b>Specification Reference:</b>	47CFR15.247
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
<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>	26 May 2021
<b>EUT arrived:</b>	20 August 2021
<b>Test Dates:</b>	02 September 2021 to 09 September 2021
<b>EUT returned:</b>	-/-

## 2.2. Summary of Test Results

Clause	Measurement	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 15.247(a)(2)	Transmitter Minimum 6 dB 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 15.247(e)	Transmitter Power Spectral Density <sup>(2)</sup>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Part 15.247(b)(3)	Transmitter Maximum Peak Output Power	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Part 15.247(d)/15.209(a)	Transmitter Radiated Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Part 15.247(d)/15.209(a)	Transmitter Band Edge Radiated Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

### Note(s):

1. The measurement was performed to assist in the calculation of the average measurements.
2. In accordance with ANSI C63.10-2013 Section 11.10.1, PSD is not required if the maximum conducted output power is less than the PSD limit of 8 dBm / 3 kHz. The PSD level is therefore deemed to be equal to the measured total output power.

## 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 558074 D01 DTS Meas Guidance v05r02 April 2, 2019
Title:	Guidance for compliance measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section 15.247 of the FCC rules
Reference:	FCC KDB 174176 D01 Line Conducted FAQ v01r01 June 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>	Playbrush
<b>Model Name or Number:</b>	A122
<b>Test Sample Serial Number:</b>	Not Stated (Conducted Test Sample)
<b>Hardware Version Number:</b>	v 3.4
<b>Software Version Number:</b>	v 1.1.30
<b>FCC ID:</b>	2AF47A122

<b>Brand Name:</b>	Playbrush
<b>Model Name or Number:</b>	A122
<b>Test Sample Serial Number:</b>	Not Stated (Radiated Test Sample)
<b>Hardware Version Number:</b>	v 3.4
<b>Software Version Number:</b>	v 1.1.30
<b>FCC ID:</b>	2AF47A122

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

The equipment under test was a Powered Toothbrush, supporting Bluetooth Low Energy operations in 2.4 - 2.4835 GHz ISM band and inductive charger.

#### **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:	Bluetooth Low Energy / Digital Transmission System		
Type of Unit:	Transceiver		
Power Supply Requirement(s):	Nominal	3.7 V DC (Internal Rechargeable Battery)	
Charger Power Supply Requirement(s):	Nominal	100-240V AC	
Channel Spacing:	2 MHz		
Modulation:	GFSK		
Data Rate:	1 Mbps		
Maximum Conducted Output Power:	3.99 dBm		
Declared Antenna Gain:	0 dBi		
Antenna Type:	Integral PCB Antenna		
Antenna Details:	Custom Design		
Transmit Frequency Range:	2402 MHz to 2480 MHz		
Transmit Channels Tested:	Channel ID	RF Channel	Channel Frequency (MHz)
	Bottom	37	2402
	Middle	19	2444
	Top	39	2480

**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
	-/-	-/-	-/-	-/-

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

Item	Description	Brand Name	Model Name or Number	Serial Number
1	Wireless (WPT) Power Supply Adapter	TRT	Type: 4680 100-240 V/ 50-60Hz 0.9W	Not Stated
2	Wireless (WPT) Power Supply Adapter	TRT	Type: 4656 100-240 V/ 50-60Hz 0.9W	Not 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 modulated carrier with combination of  
BT-LE Test Mode :1 Mbps | PRBS9 | Maximum Power Settings (PWR 0)

### **4.2. Configuration and Peripherals**

#### **EUT Power Supply:**

- The EUT can be powered via internal rechargeable battery charged via Wireless (WPT) Power Supply Adapter. The Wireless (WPT) Power Supply Adapter was connected to either 120 VAC /60 Hz or 240 VAC/60 Hz single phase supply via a LISN.

#### **Test Mode Activation:**

- The customer supplied a document containing the setup instructions "Playbrush Smart One v3.4 radio testing-UL.pdf".
- The EUTs were configured into required Bluetooth LE TX test modes using the Playbrush G3-DTM control which was supplied by the customer.
- The transmitter power was configured to maximum value (Power 0) & was not accessible during the tests.
- 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 62.1 % (duty cycle variations are less than  $\pm 2\%$ ).
- Therefore, a Duty Cycle Correction Factor of 2.06 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.

#### **AC Conducted Line Measurements:**

- In accordance with ANSI C63.10 section 5.10.7, emission tests shall be performed with the EUT and accessories configured in a manner that tends to produce maximum emissions; therefore the EUT radiated samples with fully discharged internal battery in continuous charging mode placed on Wireless (WPT) Power Supply Adapter; were used for AC conducted emissions measurements.
- The Wireless (WPT) Power Supply Adapter was connected to either 120 VAC /60 Hz or 240 VAC/60 Hz single phase supply via a LISN.

#### **Conducted Measurements:**

- All conducted measurements were carried out by using conducted samples with SMA (Female) RF Cable soldered on PCB by the customer.
- The SMA (Female) RF cable's attenuation (maximum 0.5 dB@2.4GHz) 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, emission tests shall be performed with the EUT and accessories configured in a manner that tends to produce maximum emissions; therefore the EUT radiated samples with fully charged internal battery in continuous charging mode placed on Wireless (WPT) Power Supply Adapter; were used for radiated spurious emission & radiated band edge measurements.
- 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 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:

Test Engineer:	M.Asim,Shahzad	Test Date:	09 September 2021
Test Sample Serial Number:	Not Stated (Radiated Test Sample)		
Test Site Identification	SR 7/8		

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

#### Environmental Conditions:

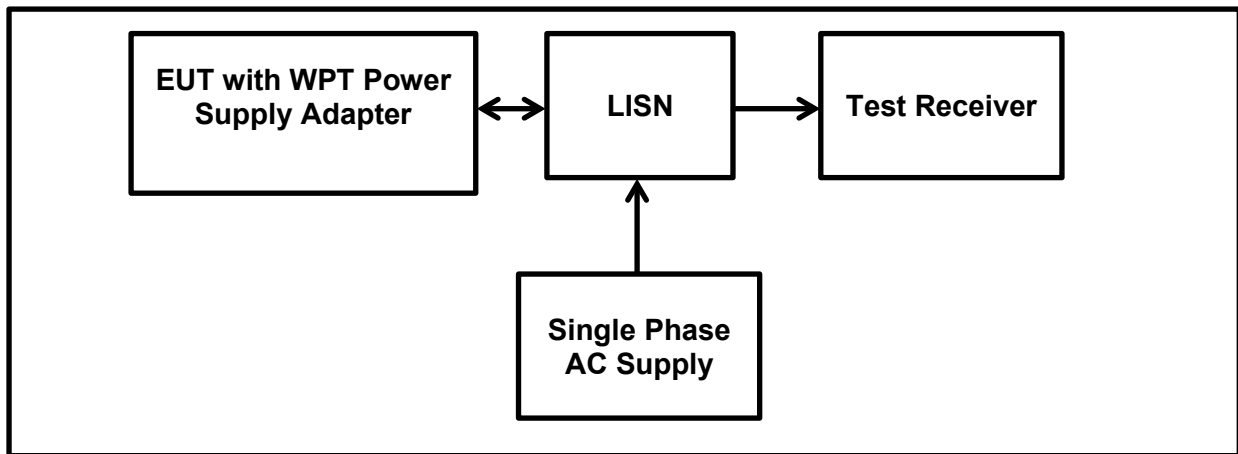
Temperature (°C):	26.0
Relative Humidity (%):	36.0

#### Settings of the Instrument

Detector	Quasi Peak/ Average Peak
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#### Note(s):

1. In accordance with ANSI C63.10 section 5.10.7, emission tests shall be performed with the EUT and accessories configured in a manner that tends to produce maximum emissions; therefore the EUT radiated samples with fully discharged internal battery in continuous charging mode placed on Wireless (WPT) Power Supply Adapter; were used for AC conducted emissions measurements.
2. The Power Supply Adapter was connected to 120 VAC /60 Hz single phase supply via a LISN.
3. 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.
4. The EUT was configured as following, BT-LE Test Mode :1 Mbps | PRBS9 | Maximum Power Settings (PWR 0).
5. 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.
6. The final measured value, for the given emission, in the table below incorporates the cable loss.
7. All other emissions shown on the pre-scan plot were investigated. Only the highest 6 emissions have been reported in the tables below in accordance with ANSI C63.10 section 6.2.5.
8. 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.
9. 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: Live / Quasi Peak / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.1811	Live	53.1	64.4	11.3	Complied
0.2702	Live	45.9	61.1	15.2	Complied
0.3589	Live	44.4	58.8	14.4	Complied
0.4241	Live	43.3	57.4	14.1	Complied
0.5383	Live	42.8	56.0	13.2	Complied
0.7186	Live	40.2	56.0	15.8	Complied

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

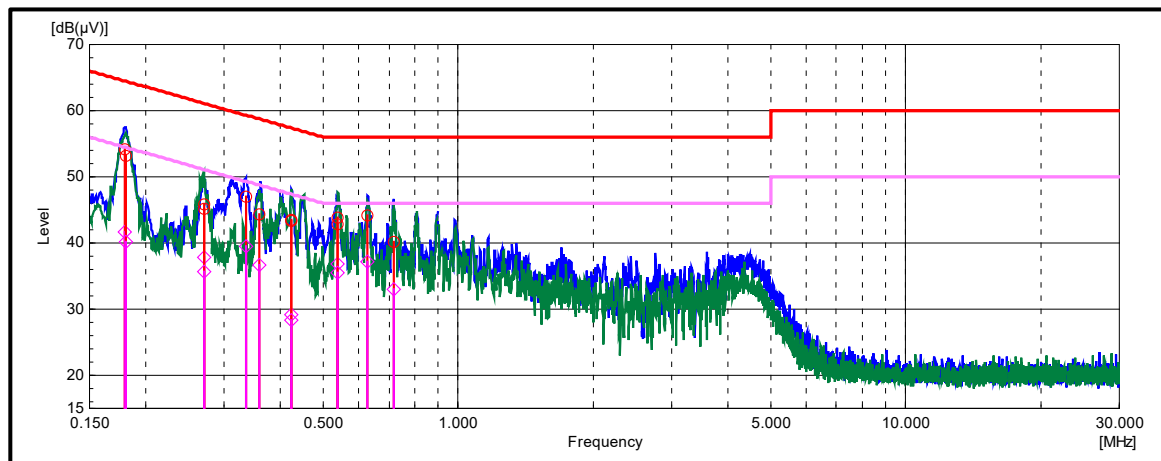
Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.1811	Live	41.7	54.5	12.8	Complied
0.2702	Live	37.8	51.1	13.3	Complied
0.3589	Live	39.6	49.3	9.7	Complied
0.4241	Live	29.1	47.4	18.3	Complied
0.5383	Live	36.9	46.0	9.1	Complied
0.7186	Live	37.2	46.0	8.8	Complied

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

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.1801	Neutral	54.2	64.5	10.3	Complied
0.2707	Neutral	45.2	61.1	15.9	Complied
0.3349	Neutral	47.0	59.3	12.3	Complied
0.4241	Neutral	43.4	57.4	14.0	Complied
0.5383	Neutral	43.8	56.0	12.2	Complied
0.6265	Neutral	44.1	56.0	11.9	Complied

**Transmitter AC Conducted Spurious Emissions (continued)****Results: Neutral / Average / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.1801	Neutral	41.7	54.5	12.8	Complied
0.2707	Neutral	37.8	51.1	13.3	Complied
0.3349	Neutral	39.6	49.3	9.7	Complied
0.4241	Neutral	29.1	47.4	18.3	Complied
0.5383	Neutral	36.9	46.0	9.1	Complied
0.6265	Neutral	37.2	46.0	8.8	Complied

**Result: Pass****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.*

**Transmitter AC Conducted Spurious Emissions (continued)****Results: Live / Quasi Peak / 240 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.1791	Live	53.6	64.5	10.9	Complied
0.2687	Live	45.8	61.2	15.4	Complied
0.3564	Live	43.5	58.8	15.3	Complied
0.5373	Live	42.4	56.0	13.6	Complied
0.6275	Live	42.0	56.0	14.0	Complied
0.9860	Live	37.1	56.0	18.9	Complied

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

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.1791	Live	41.5	54.5	13.0	Complied
0.2687	Live	39.1	51.2	12.1	Complied
0.3564	Live	39.8	49.6	9.8	Complied
0.5373	Live	34.5	48.7	14.2	Complied
0.6275	Live	36.2	46.0	9.8	Complied
0.9860	Live	30.2	46.0	15.8	Complied

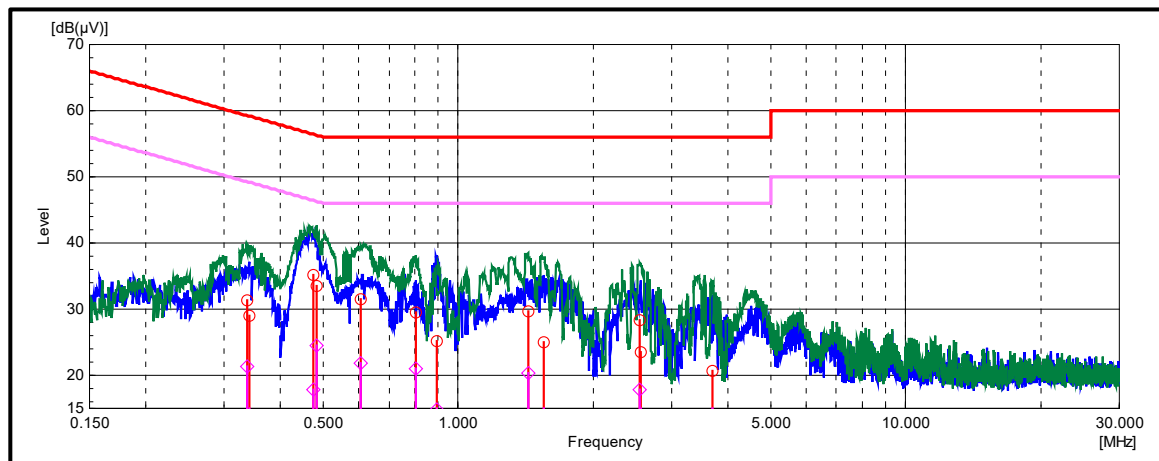
**Results: Neutral / Quasi Peak / 240 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.1796	Neutral	53.7	64.5	10.8	Complied
0.2687	Neutral	48.1	61.2	13.1	Complied
0.3234	Neutral	47.6	59.6	12.0	Complied
0.3614	Neutral	42.8	58.7	15.9	Complied
0.5343	Neutral	43.5	56.0	12.5	Complied
0.9882	Neutral	38.0	56.0	18.0	Complied



**Transmitter AC Conducted Spurious Emissions (continued)****Results: Neutral / Average / 240 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.1796	Neutral	41.5	54.5	13.0	Complied
0.2687	Neutral	39.1	51.2	12.1	Complied
0.3234	Neutral	39.8	49.6	9.8	Complied
0.3614	Neutral	34.5	48.7	14.2	Complied
0.5343	Neutral	36.2	46.0	9.8	Complied
0.9882	Neutral	30.2	46.0	15.8	Complied

**Result: Pass****Plot: Live and Neutral Line / 240 VAC 60 Hz**

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

**5.2.2. Transmitter 6 dB Bandwidth****Test Summary:**

<b>Test Engineer:</b>	M.Asim,Shahzad	<b>Test Date:</b>	09 September 2021
<b>Test Sample Serial Number:</b>	Not Stated (Conducted Test Sample)		
<b>Test Site Identification</b>	SR 9		

<b>FCC Reference:</b>	Part 15.247(a)(2)
<b>Test Method Used:</b>	FCC KDB 558074 Section 8.2 referencing ANSI C63.10:2013 Section 11.8.1 Option 1

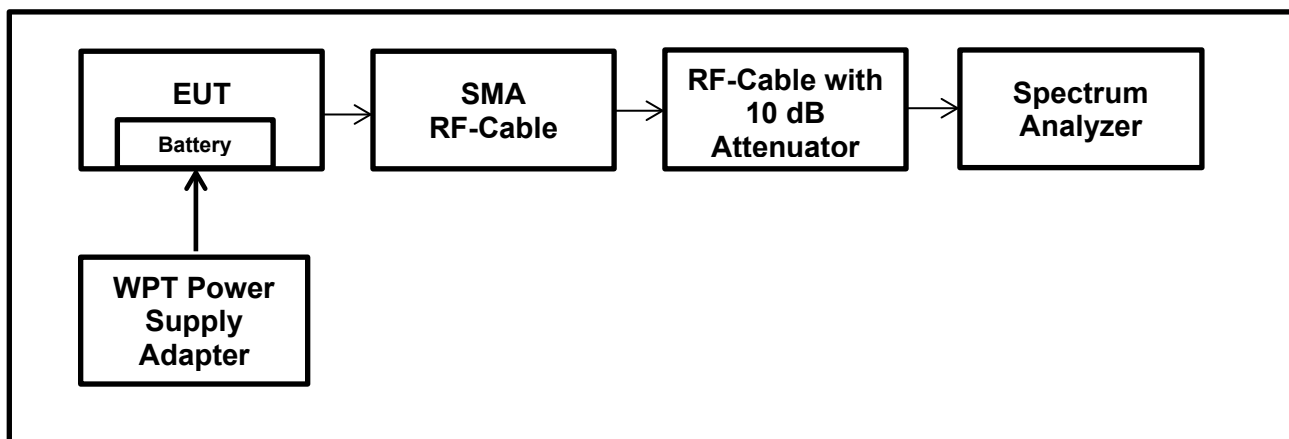
**Environmental Conditions:**

<b>Temperature (°C):</b>	26.0
<b>Relative Humidity (%):</b>	51.0

**Note(s):**

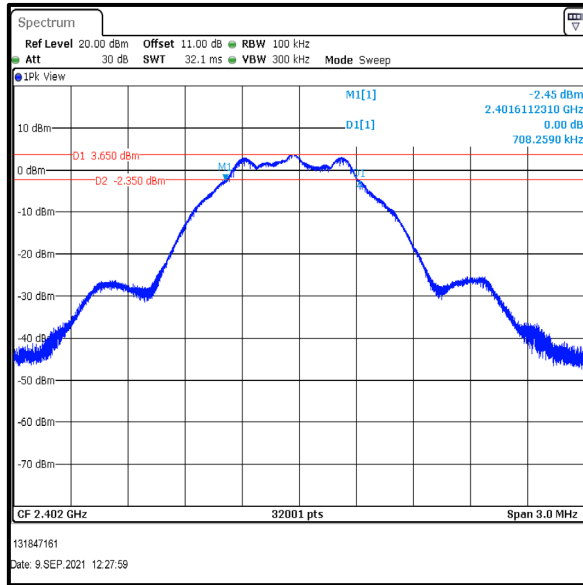
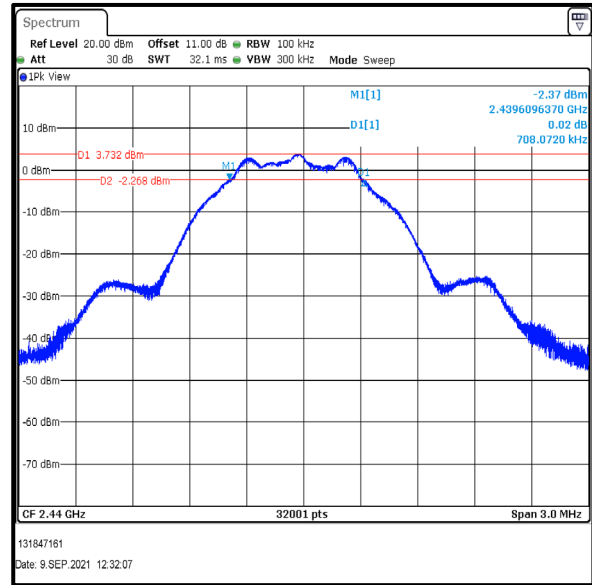
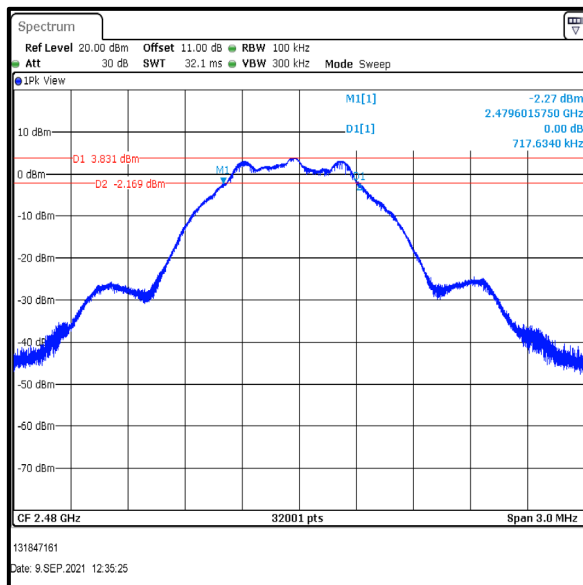
1. The measurements were performed using the above configurations on the bottom, middle and top channels in accordance FCC KDB 558074 Section 8.2 referencing ANSI C63.10 Section 11.8 (11.8.1 Option 1 measurement procedure).
2. The spectrum analyser resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The DTS bandwidth was measured at 6 dB down from the peak of the signal.
3. The RF port on the EUT was connected to the spectrum analyser using suitable attenuation and RF cable. The measured values take into consideration the external attenuation correction factors.
  - The SMA (Female) RF Cable soldered on PCB with maximum attenuation of 0.5 dB at the tested frequencies.
  - The RF cable from the EUT to Analyzer with maximum attenuation of 0.5 dB at the tested frequencies including the 10 dB attenuator 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.

**Test Setup:**

**Transmitter Minimum 6 dB Bandwidth (continued)****Results: BT-LE Mode / TX / PRBS9 / PWR 0**

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	708.259	≥ 500	208.259	Complied
Middle	708.072	≥ 500	208.072	Complied
Top	717.634	≥ 500	217.634	Complied

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

**5.2.3. Transmitter Duty Cycle****Test Summary:**

<b>Test Engineer:</b>	M.Asim,Shahzad	<b>Test Date:</b>	02 September 2021
<b>Test Sample Serial Number:</b>	Not Stated (Radiated Test Sample)		
<b>Test Site Identification</b>	SR 1/2		

<b>FCC Reference:</b>	Part 15.35(c)
<b>Test Method Used:</b>	FCC KDB 558074 Section 6.0 referencing ANSI C63.10 Section 11.6

**Environmental Conditions:**

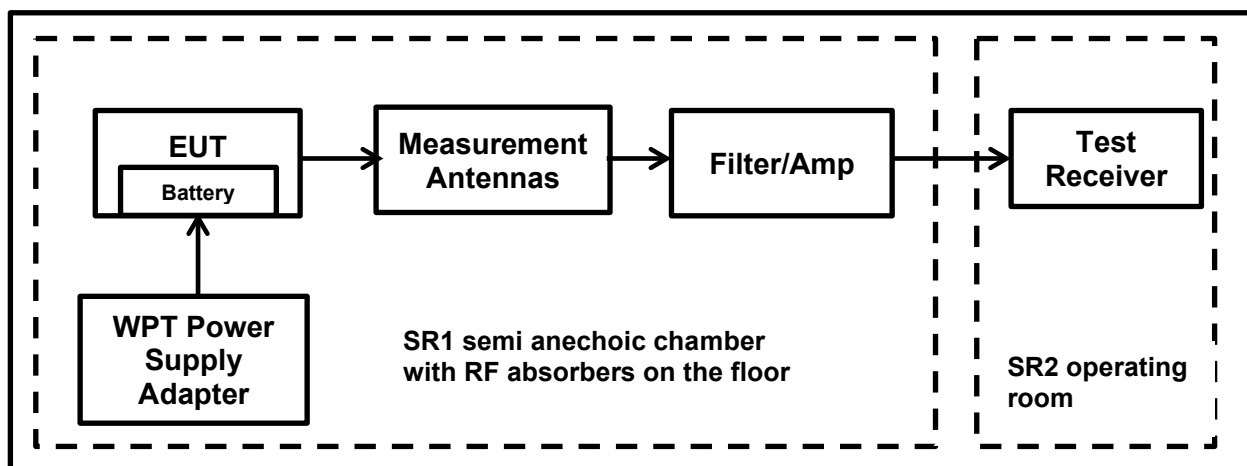
<b>Temperature (°C):</b>	24.0
<b>Relative Humidity (%):</b>	50.0

**Note:**

- The transmitter duty cycle was measured using a spectrum analyser in the time domain and calculated by using the following calculation:

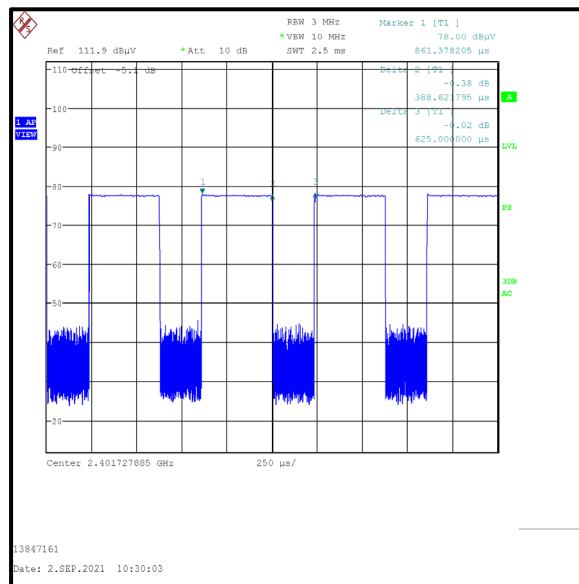
$$\text{Duty Cycle (\%)} = 100 \times [\text{On Time } (T_{ON})] / [\text{Period}(T_{ON} + T_{OFF}) \text{ or } 100\text{ms whichever is the lesser}]$$

$$\text{Duty Cycle Correction Factor} = 10 \log 1 / [\text{On Time } (T_{ON})] / [\text{Period}(T_{ON} + T_{OFF}) \text{ or } 100\text{ms whichever is the lesser}]$$

**Test Setup:**

**Transmitter Duty Cycle (continued)****Results: BT-LE Mode / TX / PRBS9 / 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)
0.3886	0.6250	62.1	2.06



**5.2.4. Transmitter Maximum Peak Output Power****Test Summary:**

<b>Test Engineer:</b>	M.Asim,Shahzad	<b>Test Date:</b>	09 September 2021
<b>Test Sample Serial Number:</b>	Not Stated (Conducted Test Sample)		
<b>Test Site Identification</b>	SR 9		

<b>FCC Reference:</b>	Part 15.247(b)(3)
<b>Test Method Used:</b>	FCC KDB 558074 Section 8.3.1.1 referencing ANSI C63.10 Section 11.9.1.1

**Environmental Conditions:**

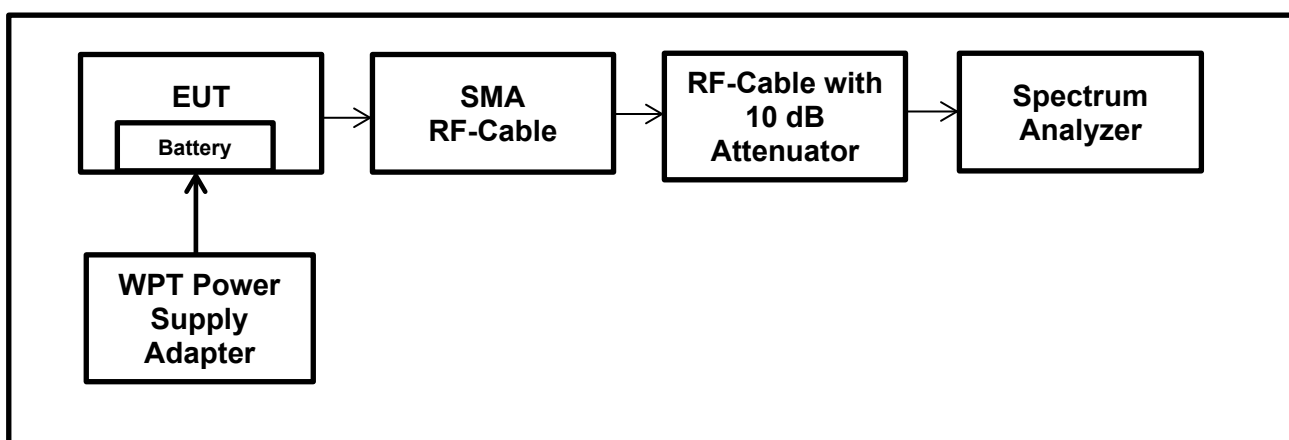
<b>Temperature (°C):</b>	26.0
<b>Relative Humidity (%):</b>	51.0

**Notes:**

1. Conducted power tests were performed using a spectrum analyser in accordance with FCC KDB 558074 Section 8.3.1.1 with the RBW  $\geq$  DTS bandwidth referencing ANSI C63.10 Section 11.9.1.1.
2. The signal analyser resolution bandwidth was set to 3 MHz and video bandwidth of 10 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 10 MHz. A marker was placed at the peak of the signal and the results recorded in the table below.
3. The RF port on the EUT was connected to the spectrum analyser using suitable attenuation and RF cable. The measured values take into consideration the external attenuation correction factors.
  - The SMA (Female) RF Cable soldered on PCB with maximum attenuation of 0.5 dB at the tested frequencies.
  - The RF cable from the EUT to Analyzer with maximum attenuation of 0.5 dB at the tested frequencies including the 10 dB attenuator 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.

4. The declared antenna gain was added to conducted power to obtain the EIRP.

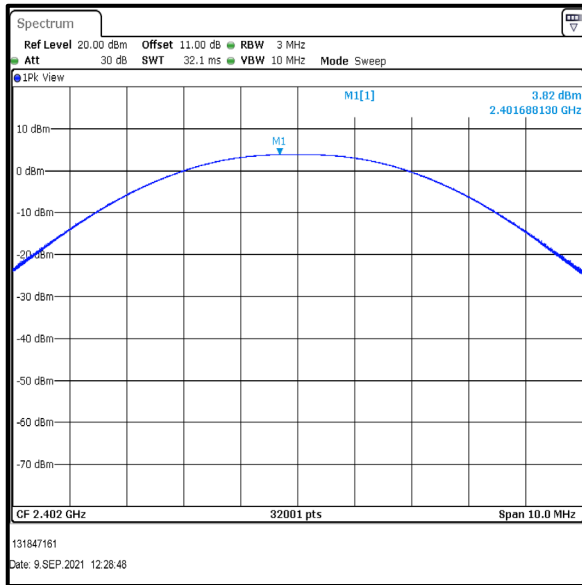
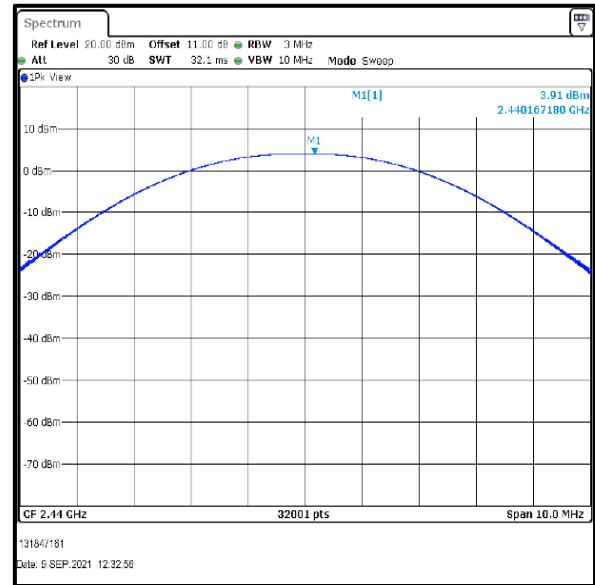
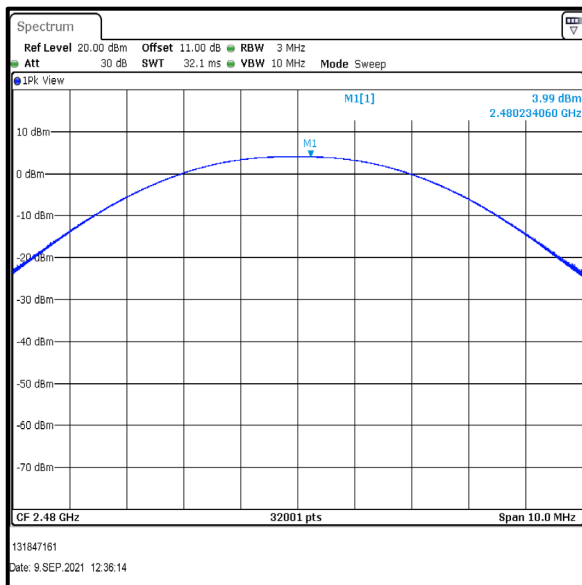
**Test Setup:**

**Transmitter Maximum Peak Output Power (continued)****Results: BT-LE Mode / TX / PRBS9 / PWR 0**

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	3.82	30.00	26.18	Complied
Middle	3.91	30.00	26.09	Complied
Top	3.99	30.00	26.01	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	3.82	0.0	3.82	36.00	32.18	Complied
Middle	3.91	0.0	3.91	36.00	32.09	Complied
Top	3.99	0.0	3.99	36.00	32.01	Complied

**Result: Pass**

**Transmitter Maximum Peak Output Power (continued)****Results: BT-LE Mode / TX / PRBS9 / PWR 0****Bottom Channel****Middle Channel****Top Channel**



**5.2.5. Transmitter Radiated Emissions****Test Summary:**

<b>Test Engineer:</b>	M.Asim,Shahzad	<b>Test Date:</b>	03 September 2021
<b>Test Sample Serial Number:</b>	Not Stated (Radiated Test Sample)		
<b>Test Site Identification</b>	SR 1/2		

<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	FCC KDB 558074 Sections 8.5 & 8.6 referencing ANSI C63.10 Sections 11.11 and 11.12 ANSI C63.10:2013 Sections 6.3 and 6.4
<b>Frequency Range</b>	9 kHz to 30 MHz

**Environmental Conditions:**

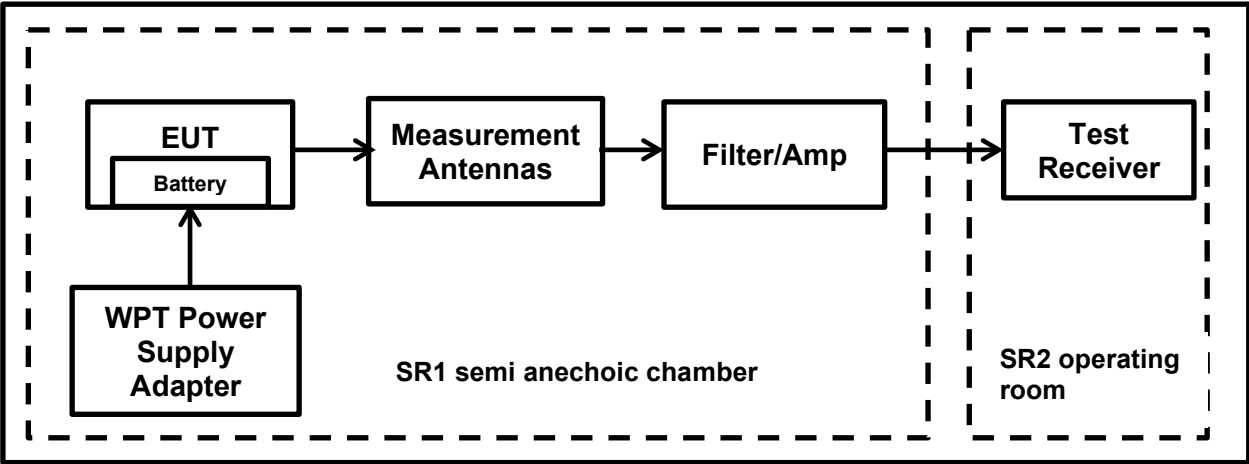
<b>Temperature (°C):</b>	24.4
<b>Relative Humidity (%):</b>	46.4

**Notes:**

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.  
Therefore, measurements were performed at a measurement distance of 3 m.
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.
  - 490 kHz-1705 kHz: limits extrapolated from 30 m to 3 m by adding 40 dB at 40 dB /decade.
4. 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.
5. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
6. All other emissions shown on the pre-scans were investigated and found to be > 20 dB below the applicable limits.
7. Pre-scans were performed and markers placed on the highest measured levels. The test receiver was set to:
  - Frequency range: 9 kHz-150 kHz : RBW: 1 kHz /VBW: 3 kHz
  - Frequency range: 150 kHz – 30 MHz: RBW: 10 kHz /VBW: 30 kHz
  - Detector: Max-Peak detector
  - Trace Mode: Max Hold

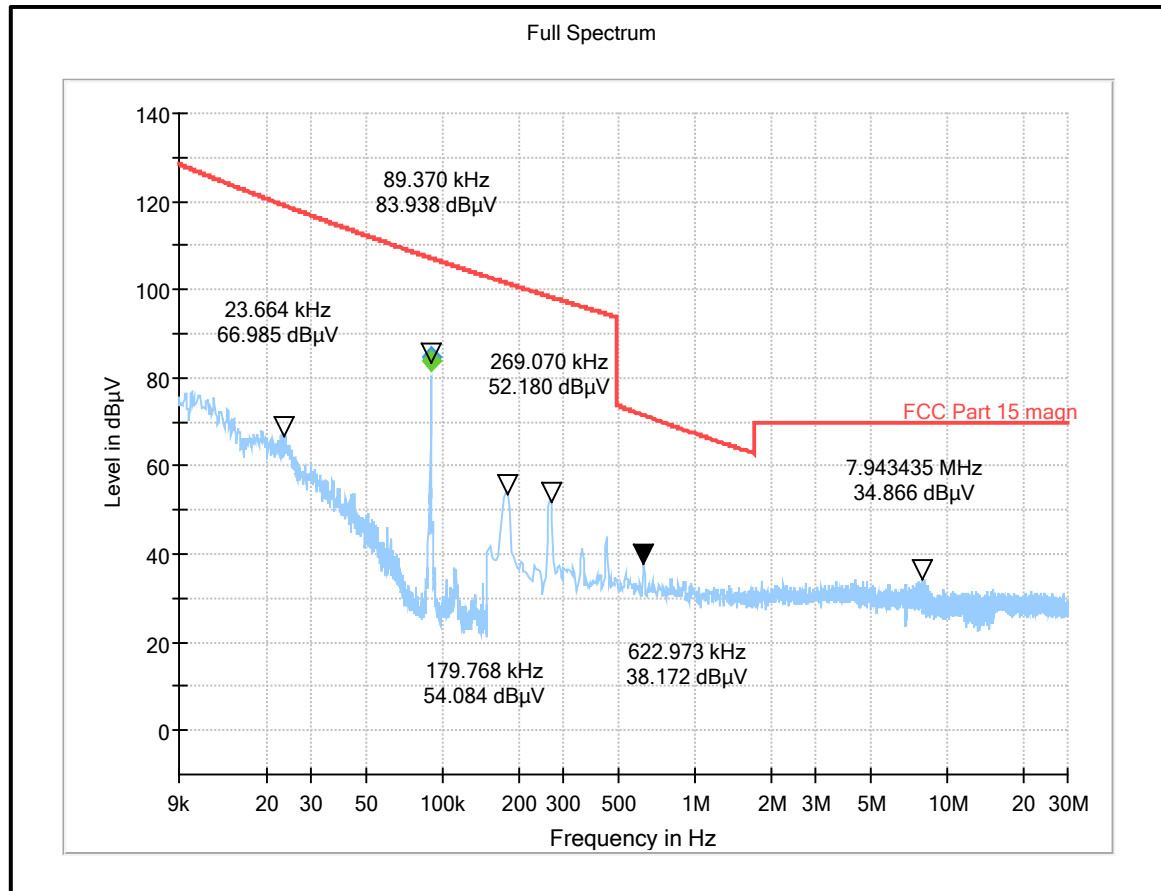
**Transmitter Radiated Emissions (continued)**

**Test Setup:**



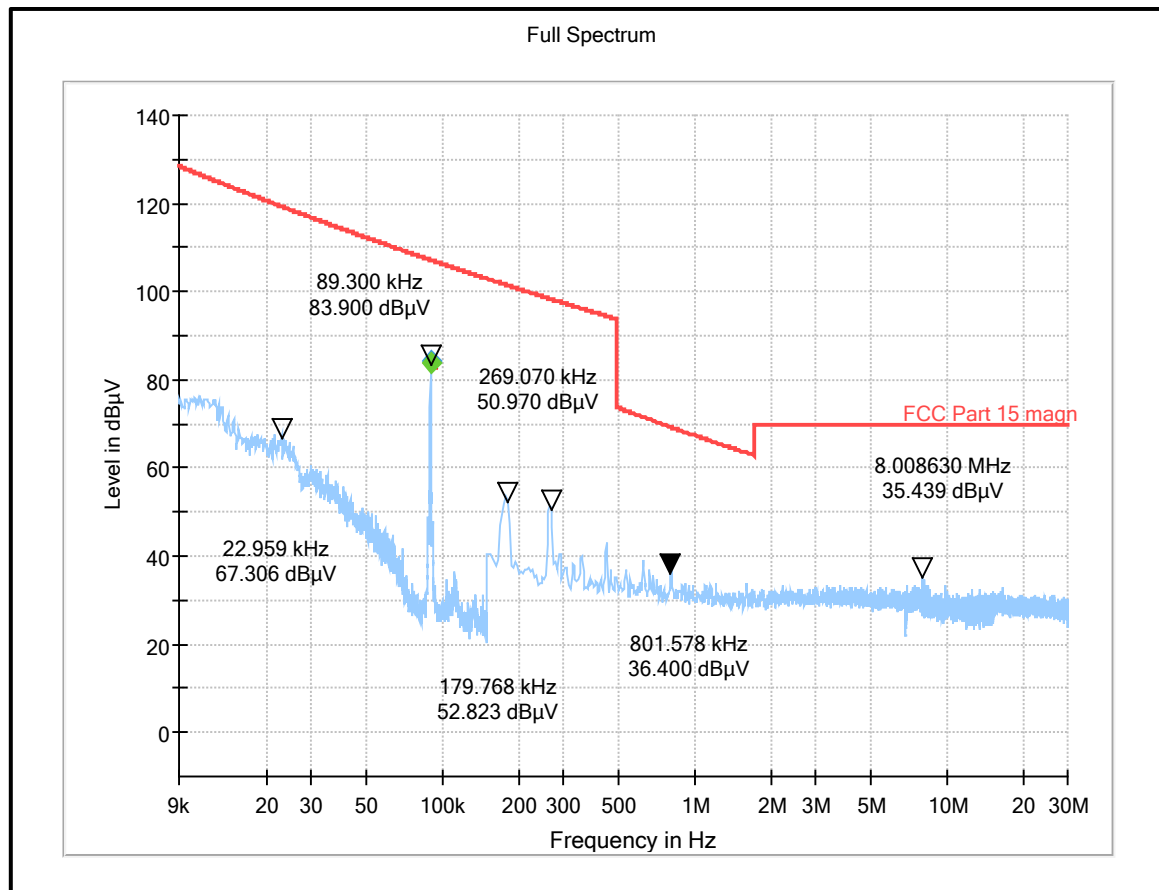
**Transmitter Radiated Emissions (continued)****Results: BT-LE Mode / TX / PRBS9 / PWR 0 / Bottom Channel**

Frequency (MHz)	Loop Antenna Orientation	MaxPeak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
0.089441	0° to EUT	84.53	107.24	22.71	Complied

**Plot: 9 kHz – 30 MHz: BT-LE Mode / TX / PRBS9 / PWR 0 / Bottom Channel****Result: Pass**

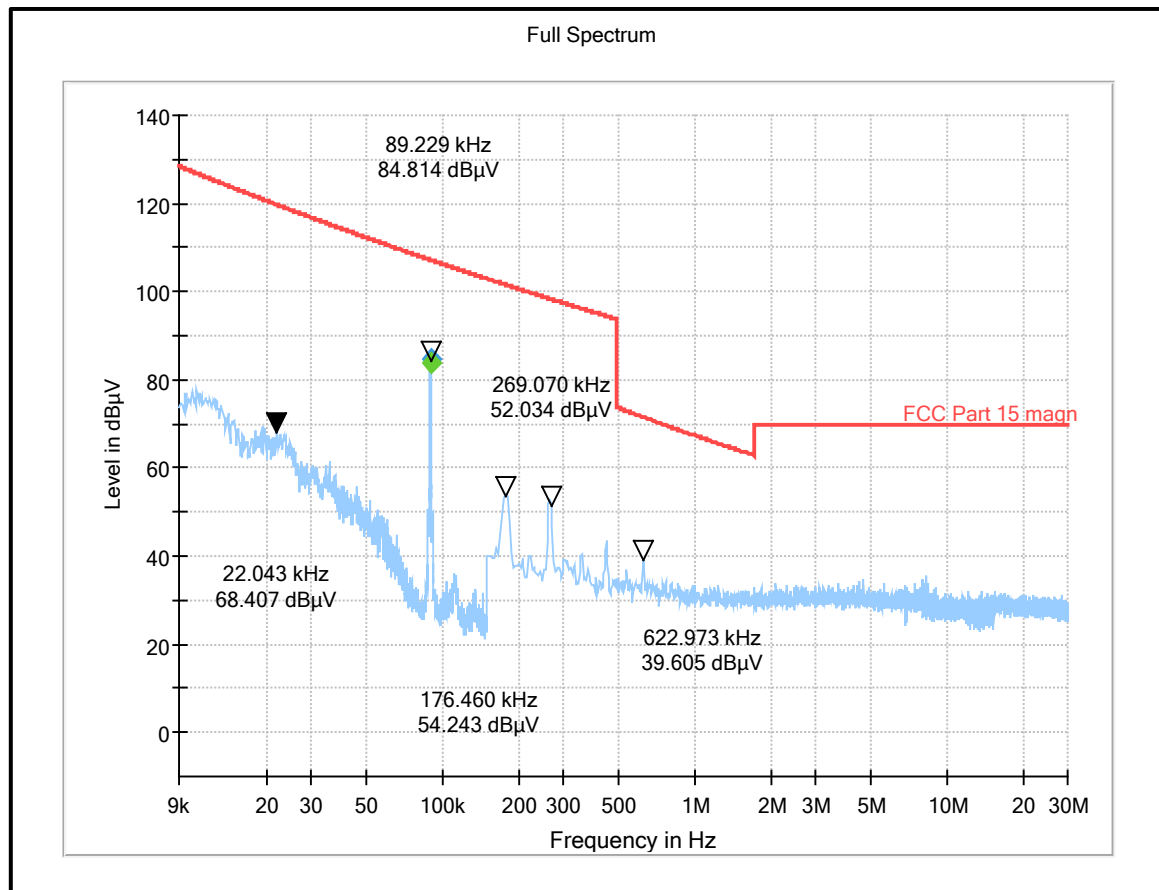
**Transmitter Radiated Emissions (continued)****Results: BT-LE Mode / TX / PRBS9 / PWR 0 / Middle Channel**

Frequency (MHz)	Loop Antenna Orientation	MaxPeak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
0.089300	0° to EUT	84.49	107.26	22.77	Complied

**Plot: 9 kHz – 30 MHz: BT-LE Mode / TX / PRBS9 / PWR 0 / Middle Channel****Result: Pass**

**Transmitter Radiated Emissions (continued)****Results: BT-LE Mode / TX / PRBS9 / PWR 0 / Top Channel**

Frequency (MHz)	Loop Antenna Orientation	MaxPeak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
0.089229	0° to EUT	84.63	107.26	22.63	Complied

**Plot: 9 kHz – 30 MHz: BT-LE Mode / TX / PRBS9 / PWR 0 / Top Channel****Result: Pass**

**Transmitter Radiated Emissions (continued)****Test Summary:**

<b>Test Engineer:</b>	M.Asim,Shahzad	<b>Test Date:</b>	03 September 2021
<b>Test Sample Serial Number:</b>	Not Stated (Radiated Test Sample)		
<b>Test Site Identification</b>	SR 1/2		

<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	FCC KDB 558074 Sections 8.5 & 8.6 referencing ANSI C63.10 Sections 11.11 and 11.12 ANSI C63.10:2013 Sections 6.3 and 6.5
<b>Frequency Range</b>	30 MHz to 1000 MHz

**Environmental Conditions:**

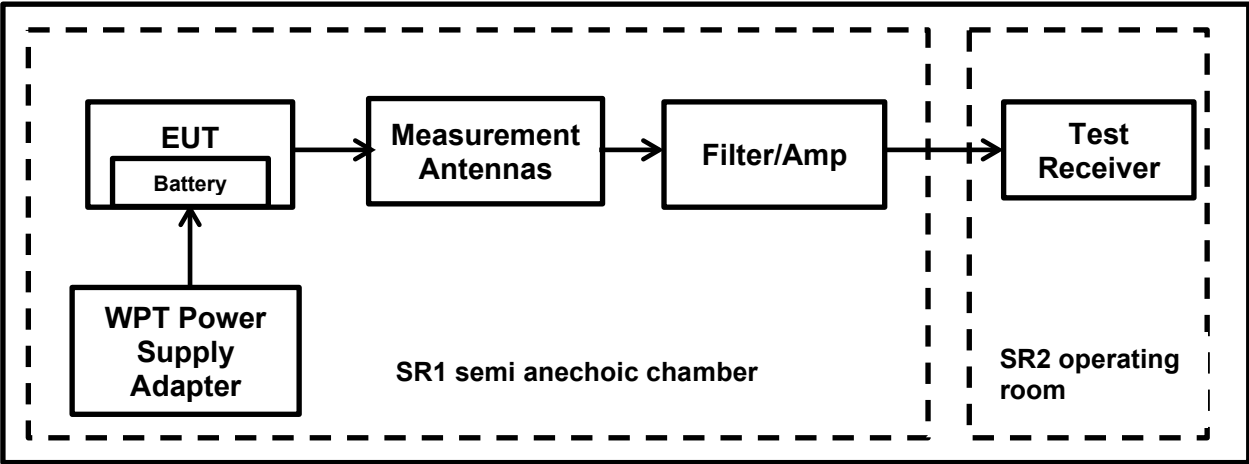
<b>Temperature (°C):</b>	24.4
<b>Relative Humidity (%):</b>	46.4

**Notes:**

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. All emissions shown on the pre-scan plots were investigated and found to be below system noise floor.

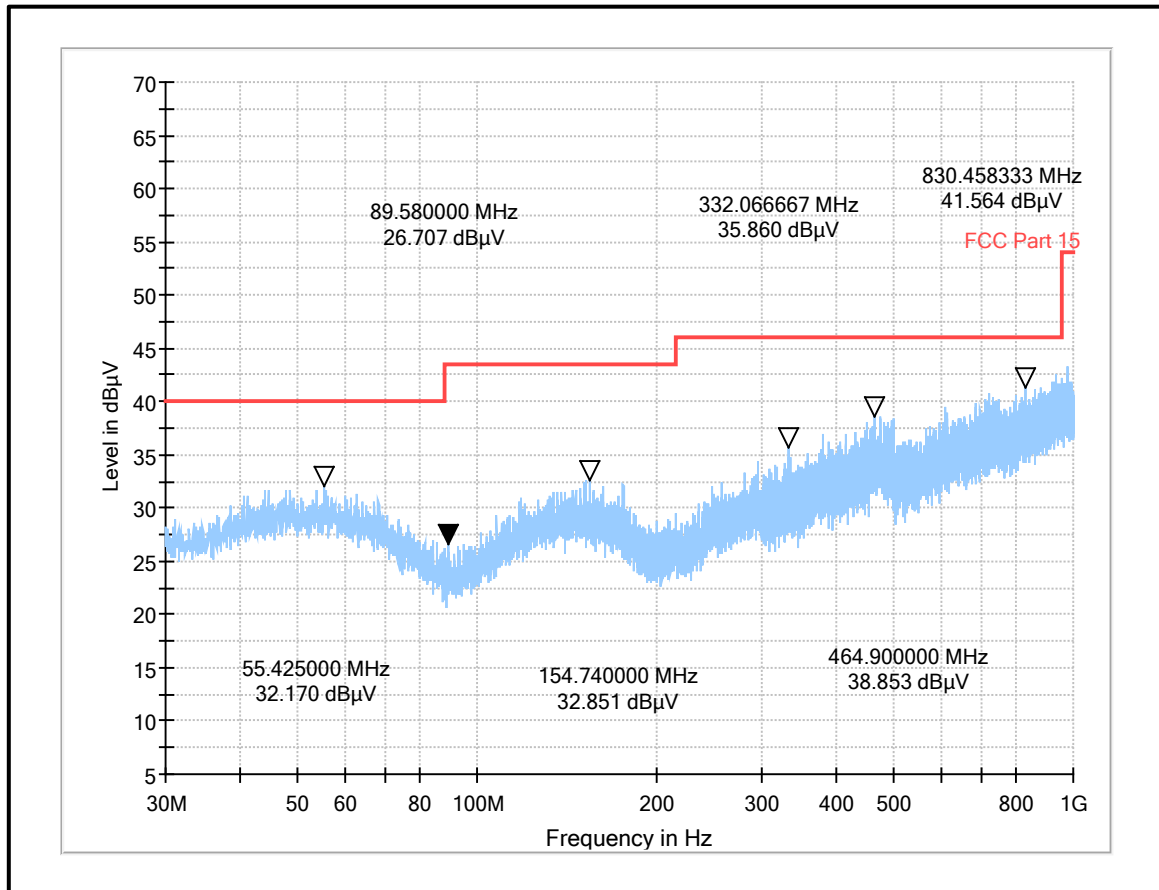
**Transmitter Radiated Emissions (continued)**

**Test Setup:**



**Transmitter Radiated Emissions (continued)****Results: BT-LE Mode / TX / PRBS9 / PWR 0 / Bottom Channel**

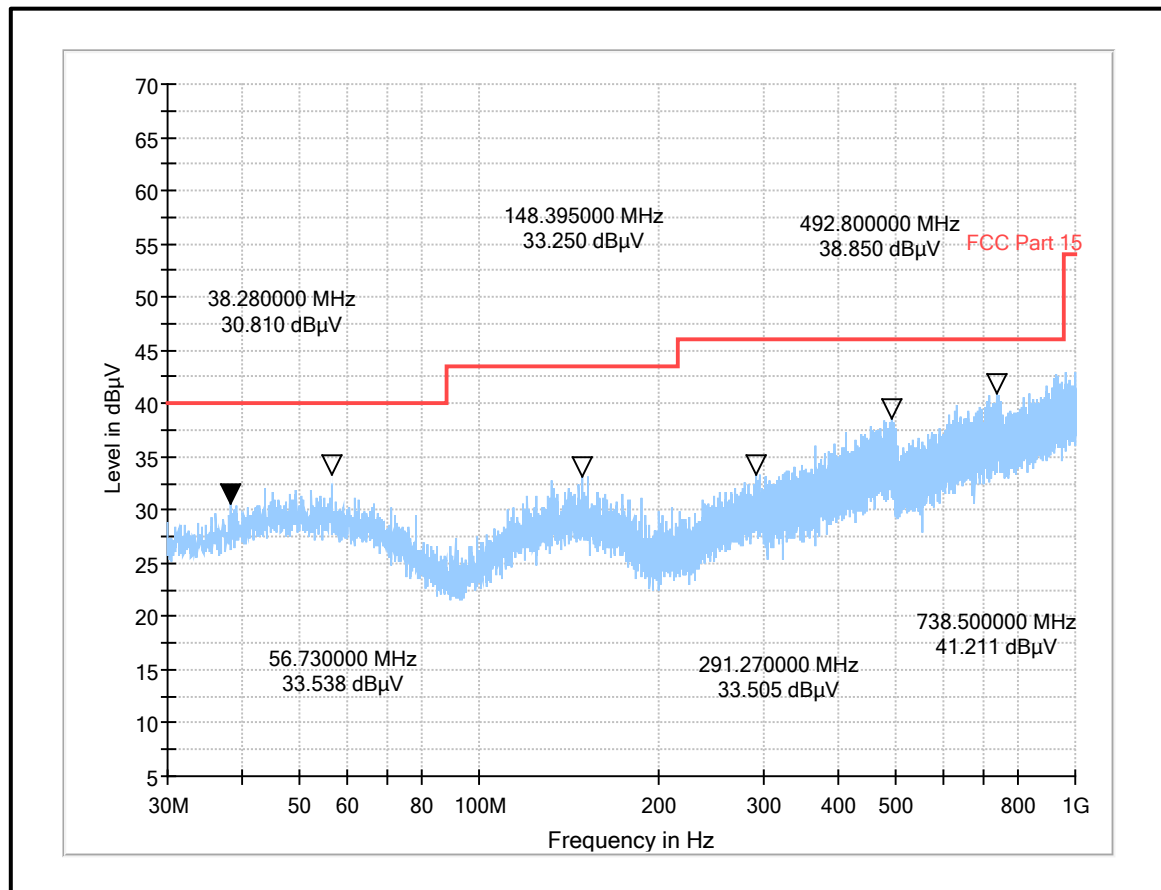
Frequency (MHz)	Antenna Polarization	MaxPeak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
No critical spurious emissions were detected					

**Plot: 30 MHz-1 GHz: BT-LE Mode / TX / PRBS9 / PWR 0 / Bottom Channel****Result: Pass**



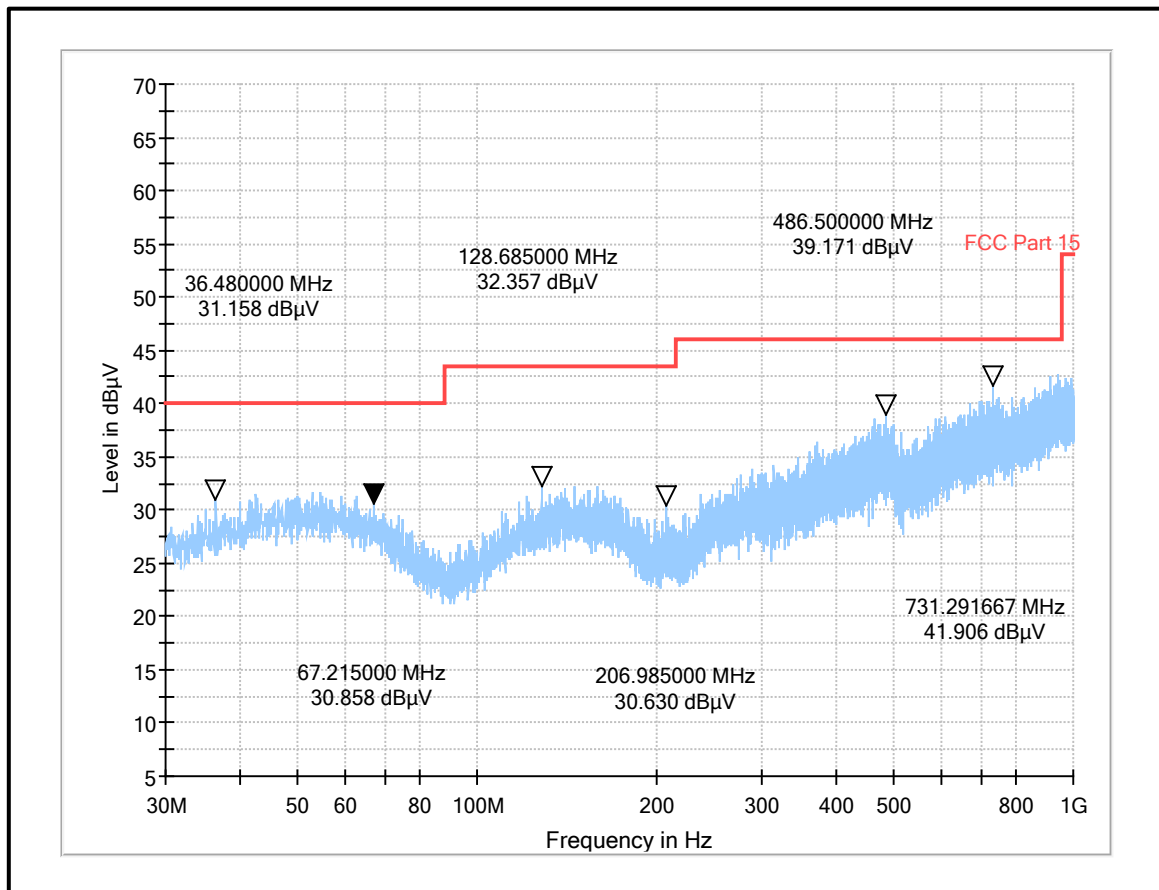
**Transmitter Radiated Emissions (continued)****Results: BT-LE Mode / TX / PRBS9 / PWR 0 / Middle Channel**

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

**Plot: 30 MHz-1 GHz: BT-LE Mode / TX / PRBS9 / PWR 0 / Middle Channel****Result: Pass**

**Transmitter Radiated Emissions (continued)****Results: BT-LE Mode / TX / PRBS9 / 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 detected					

**Plot: 30 MHz-1 GHz: BT-LE Mode / TX / PRBS9 / PWR 0 / Top Channel****Result: Pass**

**Transmitter Radiated Emissions (continued)****Test Summary:**

<b>Test Engineer:</b>	M.Asim,Shahzad	<b>Test Date:</b>	02 & 06 September 2021
<b>Test Sample Serial Number:</b>	Not Stated (Radiated Test Sample)		
<b>Test Site Identification</b>	SR 1/2		

<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	FCC KDB 558074 Sections 8.5 & 8.6 referencing ANSI C63.10 Sections 11.11 and 11.12 ANSI C63.10:2013 Sections 6.3 and 6.6
<b>Frequency Range</b>	1 GHz to 25 GHz

**Environmental Conditions:**

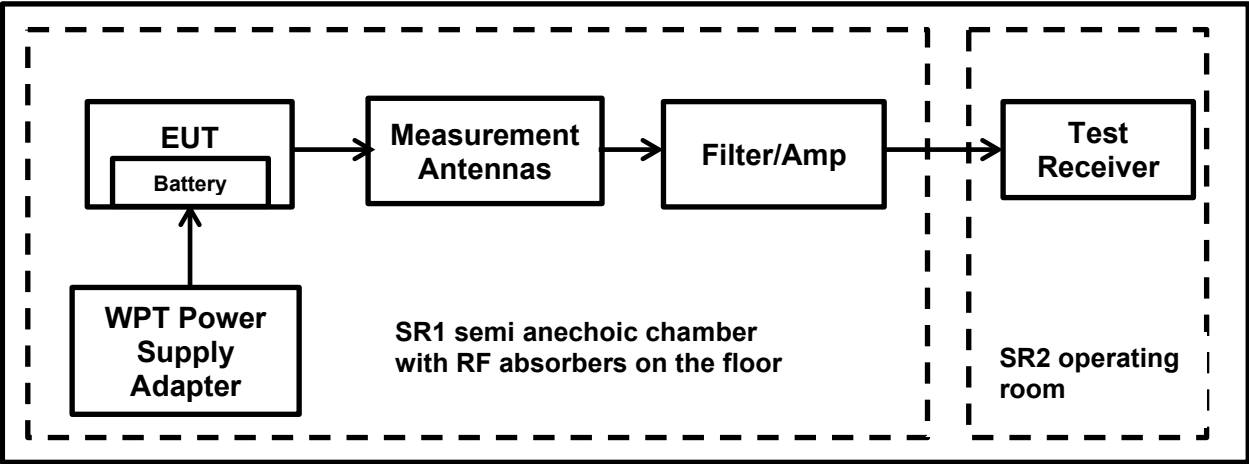
<b>Temperature (°C):</b>	24.0 & 24.4
<b>Relative Humidity (%):</b>	50.0 & 44.5

**Note(s):**

1. Pre-scans above 1 GHz were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) with RF absorbers 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.
2. 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.
3. The emissions shown at frequencies approximately 2.4 GHz to 2.4835 GHz on the 1 GHz to 18 GHz plots are the EUT fundamental for the tested channel.
4. For frequency range between 1 GHz and 18 GHz, no critical spurious emissions were detected.
5. For frequency range between 18 GHz and 25 GHz, no critical emissions were found.

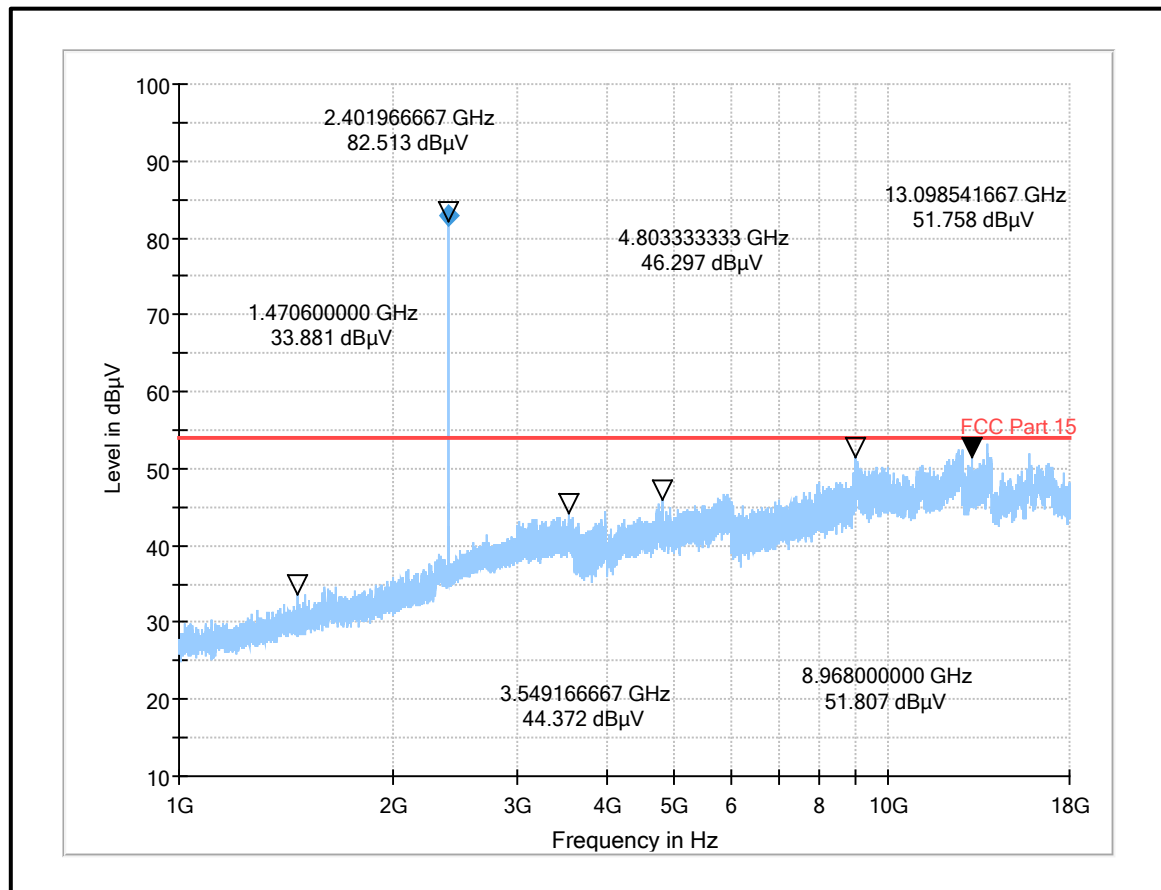
**Transmitter Radiated Emissions (continued)**

**Test Setup:**



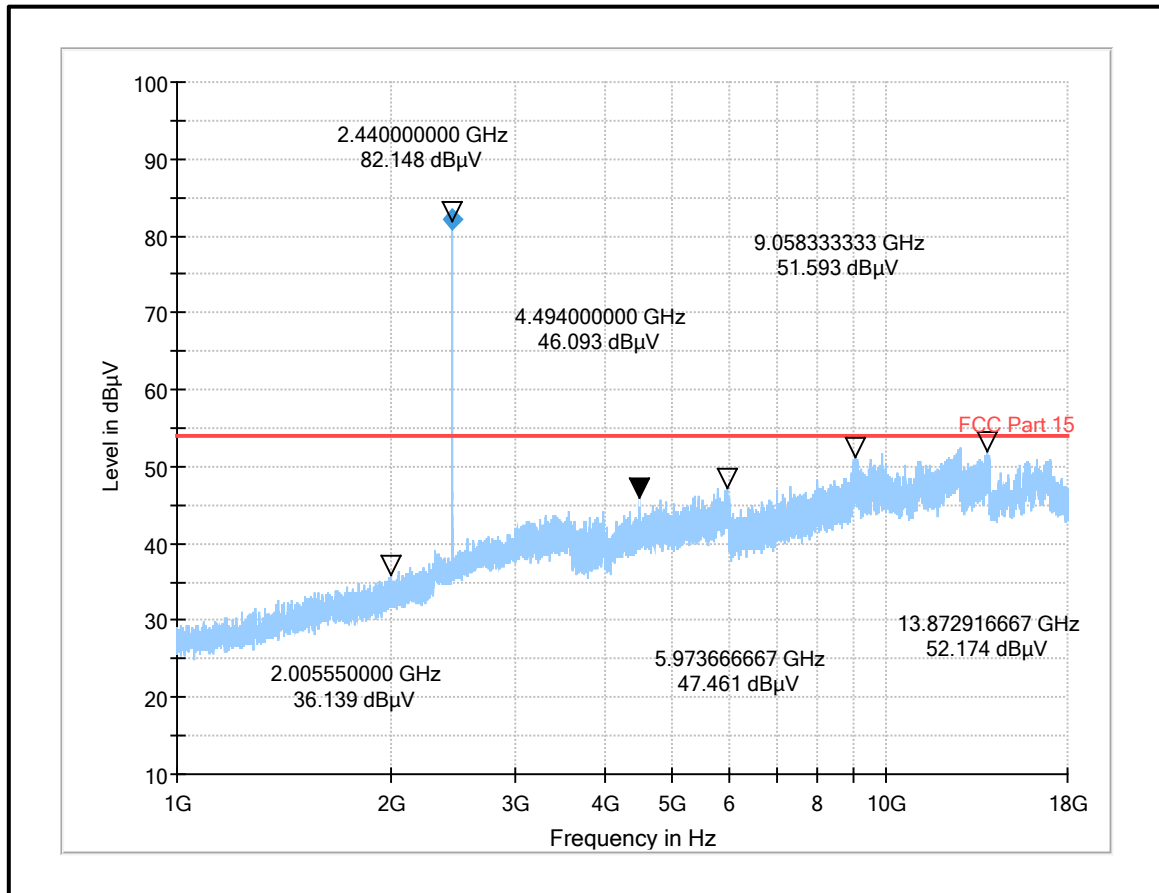
**Transmitter Radiated Emissions (continued)****Results: BT-LE Mode / TX / PRBS9 / PWR 0 / Bottom Channel**

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

**Plot: 1 GHz – 18 GHz: BT-LE Mode / TX / PRBS9 / PWR 0 / Bottom Channel****Result: Pass**

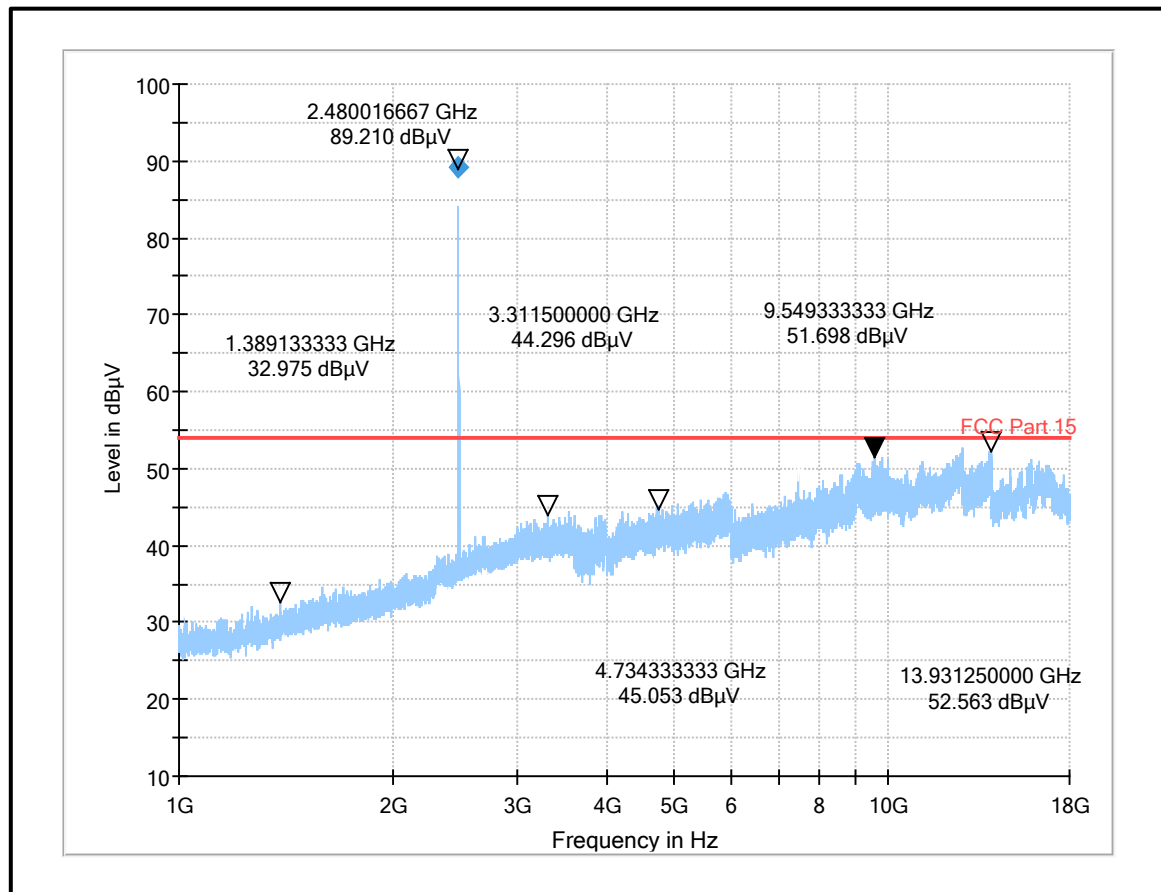
**Transmitter Radiated Emissions (continued)****Results: BT-LE Mode / TX/ PRBS9 / PWR 0 / Middle Channel**

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

**Plot: 1 GHz – 18 GHz: BT-LE Mode / TX / PRBS9 / PWR 0 / Middle Channel****Result: Pass**

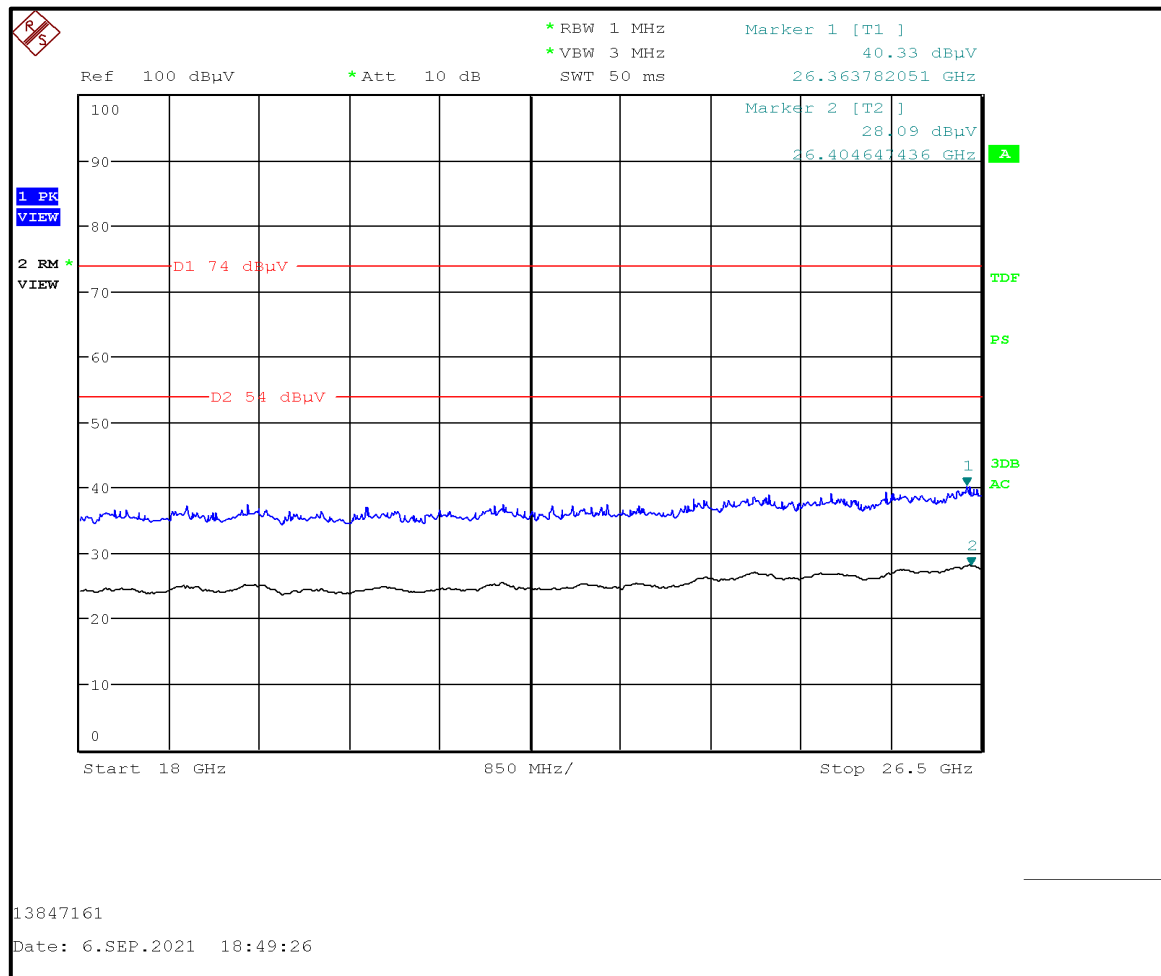
**Transmitter Radiated Emissions (continued)****Results: BT-LE Mode / TX / PRBS9 / PWR 0 / Top Channel**

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

**Plot: 1 GHz – 18 GHz: BT-LE Mode / TX / PRBS9 / PWR 0 / Top Channel****Result: Pass**

**Transmitter Radiated Emissions (continued)****Results: BT-LE Mode / TX / PRBS9 / PWR 0 / Bottom Channel**

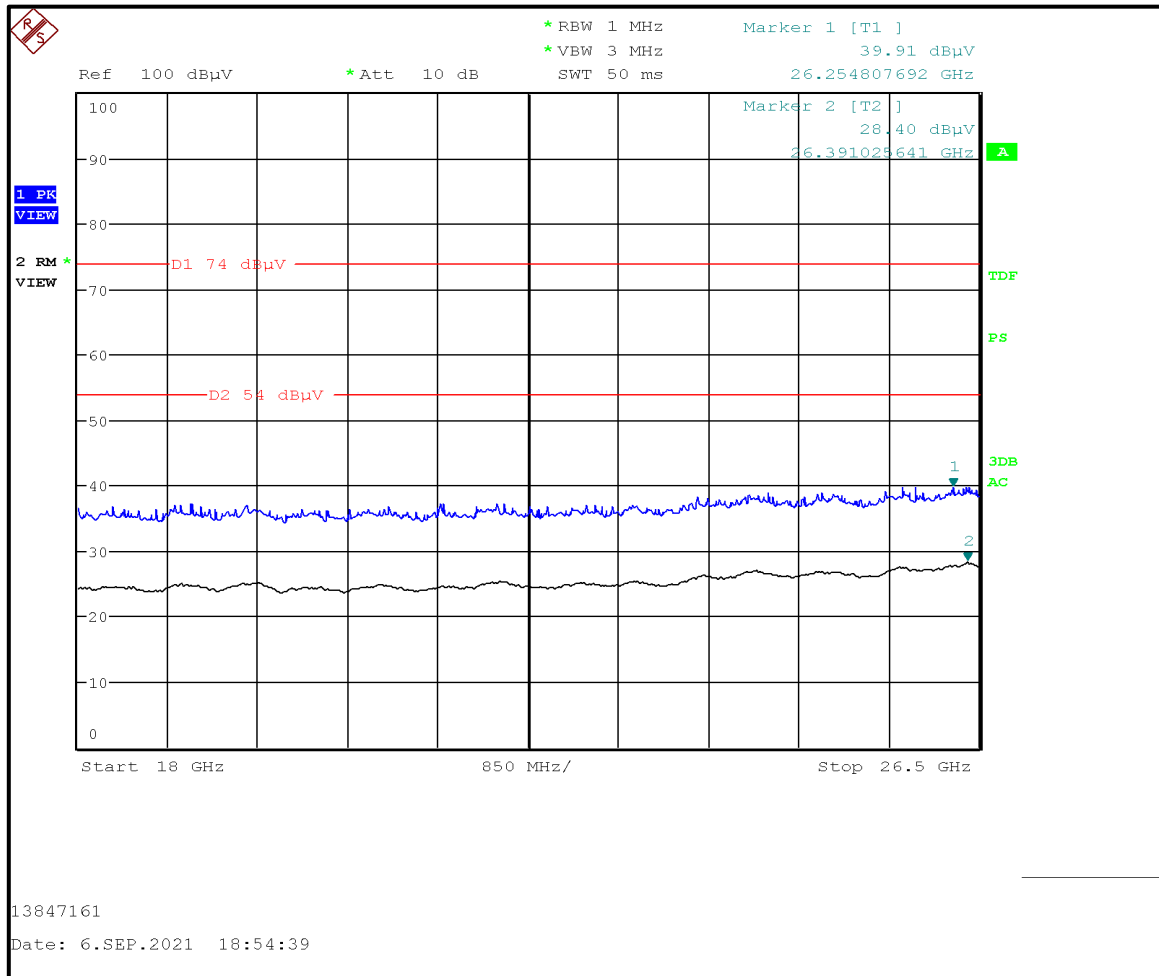
Frequency (MHz)	Antenna Polarization	MaxPeak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
No critical spurious emissions were detected					

**Plot: 1 GHz – 18 GHz: BT-LE Mode / TX / PRBS9 / PWR 0 / Bottom Channel****Result: Pass**



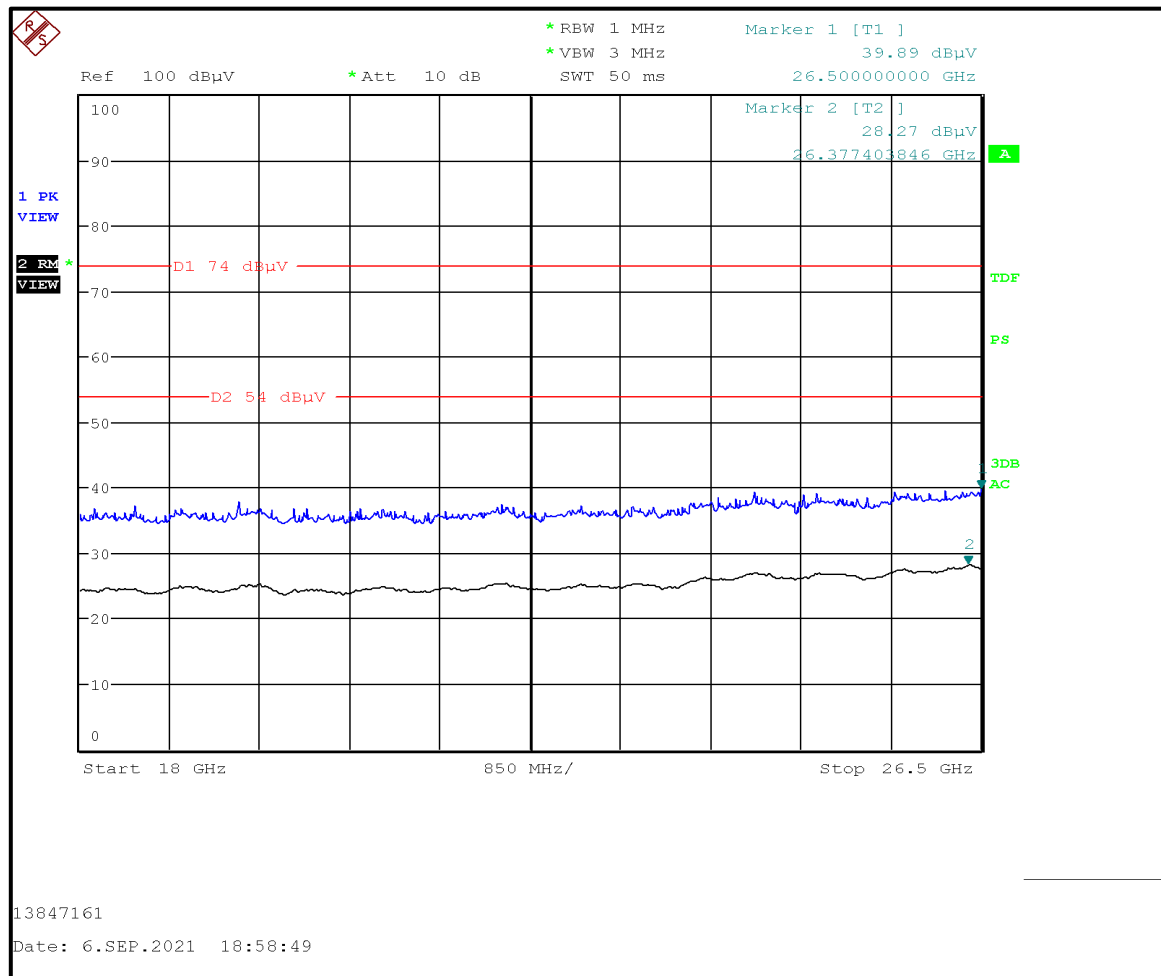
**Transmitter Radiated Emissions (continued)****Results: BT-LE Mode / TX/ PRBS9 / PWR 0/ Middle Channel**

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

**Plot: 1 GHz – 18 GHz: BT-LE Mode / TX / PRBS9 / PWR 0 / Middle Channel****Result: Pass**

**Transmitter Radiated Emissions (continued)****Results: BT-LE Mode / TX/ PRBS9 / 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 detected					

**Plot: 1 GHz – 18 GHz: BT-LE Mode / TX/ PRBS9 / PWR 0/ Top Channel****Result: Pass**

**5.2.6. Transmitter Band Edge Radiated Emissions****Test Summary:**

<b>Test Engineer:</b>	M.Asim,Shahzad	<b>Test Date:</b>	02 September 2021
<b>Test Sample Serial Number:</b>	Not Stated (Radiated Test Sample)		
<b>Test Site Identification</b>	SR 1/2		

<b>FCC Reference:</b>	Parts 15.247(d) & 15.209(a)
<b>Test Method Used:</b>	DTS emissions in non-restricted frequency bands: FCC KDB 558074 Section 8.5 referencing ANSI C63.10:2013 Sections 11.11
	DTS emissions in restricted frequency bands: FCC KDB 558074 Section 8.6 referencing ANSI C63.10:2013 Sections 11.12
	ANSI C63.10:2013 Sections 6.10.4, 6.10.5

**Environmental Conditions:**

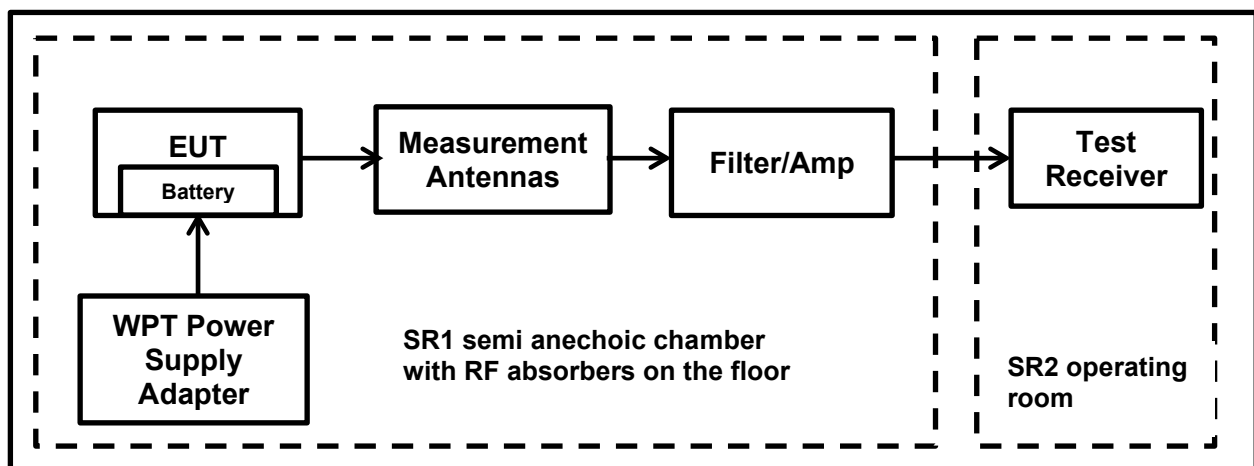
<b>Temperature (°C):</b>	24.4
<b>Relative Humidity (%):</b>	44.5

**Note(s):**

1. The measurements were in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) with RF absorbers 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. Maximum emission levels were determined by height searching the measurement antenna over the range 1 m to 4 m
2. As the lower band edge falls within a non-restricted band, measurements were performed in accordance with FCC KDB 558074 Section 8.5 referencing ANSI C63.10 Section 11.11.  
As the maximum peak conducted output power was previously measured, in accordance with ANSI C63.10 Section 11.11.1(a) lower band edge measurement was performed with a peak detector and the -20 dBc limit applied.
3. As the lower band edge falls within a non-restricted band, only peak measurements are required. 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. 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. Marker frequencies and levels were recorded.
4. The restricted band peak measurements were performed in accordance with ANSI C63.10 Section 11.12.2.4.
5. As the EUT continuous transmission of the EUT ( $D \geq 98\%$ ) cannot be achieved and the duty cycle is constant (duty cycle variations are less than  $\pm 2\%$ ), the restricted band average measurements were performed in accordance with ANSI C63.10 Section 11.12.2.5.2.

**Transmitter Band Edge Radiated Emissions (continued)****Note(s):**

6. As the upper band edge falls within 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 the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth 3 MHz. A RMS detector in linear power averaging mode was used. 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.
7. There is a restricted band 10 MHz below the lower band edge. The test receiver was set up as follows: the RBW set to 1 MHz, the VBW set to 3 MHz, with the sweep time set to auto couple. Peak and average measurements were performed with their respective detectors. Markers were placed on the highest point on each trace.
8. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
9. \*\* 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 62.1% (duty cycle variations are less than  $\pm 2\%$ ). Therefore, a Duty Cycle Correction Factor of 2.06 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: BT-LE Mode / TX/ PRBS9 / PWR 0****Results: Lower Band Edge / Peak**

Frequency (MHz)	Peak Level (dB $\mu$ V/m)	-20 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
2399.90	37.78	65.38	27.60	Complied
2400.00	38.06	65.38	27.32	Complied

**Results: 2310 to 2390 MHz Restricted Band / Peak**

Frequency (MHz)	Peak Level (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
2375.00	47.80	74.0	26.20	Complied

**Results: 2310 to 2390 MHz Restricted Band / 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
2337.94	36.23	2.06	38.29**	54.0	15.71	Complied

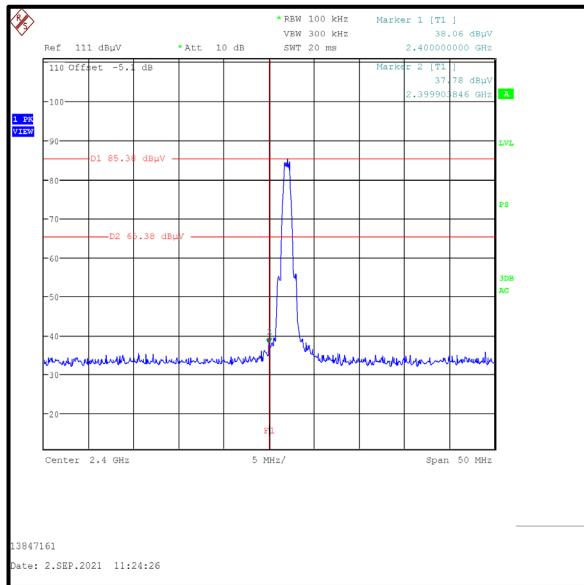
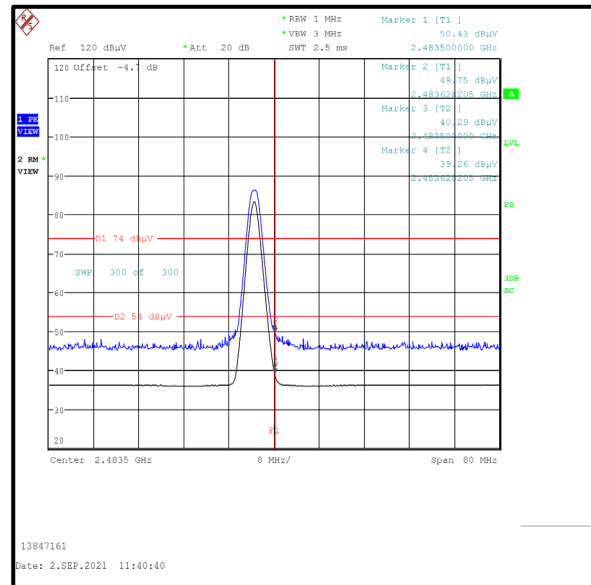
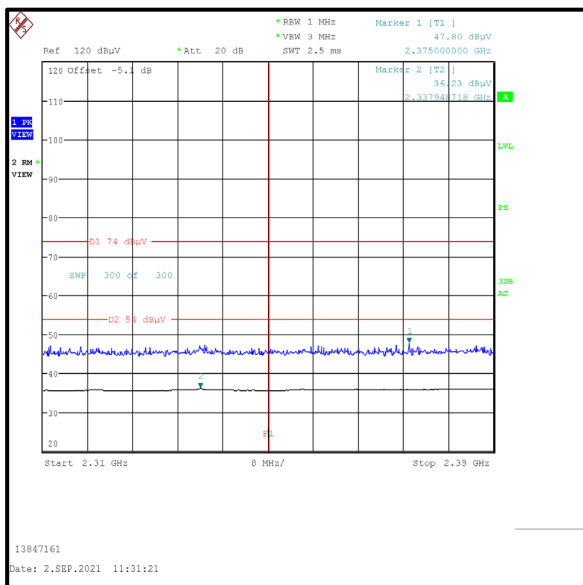
**Results: Upper Band Edge / Peak**

Frequency (MHz)	Peak Level (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Margin (dB)	Result
2483.50	50.43	74.0	23.57	Complied
2483.62	49.75	74.0	24.25	Complied

**Results: 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
2483.50	40.29	2.06	42.35**	54.0	11.65	Complied
2483.62	39.26	2.06	41.32**	54.0	12.68	Complied

**Result: Pass**

**Transmitter Band Edge Radiated Emissions (continued)****Results: BT-LE Mode / TX/ PRBS9 / PWR 0****Lower Band Edge Peak Measurement****Upper Band Edge Peak & Average Measurement****2310 MHz to 2390 MHz Restricted Band****Result: Pass**

## 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
Transmitter Duty Cycle	95%	±3.4%
Radiated Spurious Emissions	95%	±3.10 dB
Band Edge Radiated Emissions	95%	±3.10 dB
Minimum 6 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	14/07/2021	12
423	Bonn Elektronik	Amplifier, Low Noise Pre	BLMA 1840-1A	55929	16/07/2021	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	28/06/2021	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	ESH3-Z5	831767/013	14/07/2021	12
28	Rohde & Schwarz	Passive Probe	ESH2-Z3	none	11/07/2019	36
349	Rohde & Schwarz	Receiver, EMI Test	ESIB7	836697/009	13/07/2021	12
351	Rohde & Schwarz	network, Artificial Mains	ESH3-Z5	862770/018	14/07/2021	12
564	Teseq	Impedance stabilisation network (ISN)	ISN T800	26076	14/07/2021	24
616	Rohde & Schwarz	ISN	ENY81-CA6	101656	07/07/2020	36
-/-	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	13/07/2021	12
-/-	Testo	Thermo-Hygrometer	608-H1	07	lab verification	n/a
-/-	Huber & Suhner	RF Cable ( upto 18GHz)	-/-	-/-	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	49	-	Initial Version

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