



Solutions

# TEST REPORT

**Test Report No.: UL-RPT-RP-15081798-216-FCC**

**Applicant \*** : Pirelli Tire LLC  
**Model No. \*** : PSN2-09S  
**FCC ID \*** : 2ANX7CPSN2  
**Technology \*** : Bluetooth – Low Energy  
**Test Standard(s)** : **FCC Parts 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 1.2 supersede Version 1.1 with immediate effect**  
Test Report No. UL-RPT-RP-15081798-216-FCC Version 1.2, Issue Date 11 JULY 2024 replaces  
Test Report No. UL-RPT-RP-15081798-216-FCC Version 1.1, Issue Date 11 JUNE 2024, which is no longer valid.
5. Result of the tested sample: **Pass**
6. All information marked with a (\*) were provided by customer / applicant or authorized representative

Prepared by: Muhammad Faiq Khan  
Title: Project Engineer  
Date: 11 July 2024

Approved by: Rachid Acharkaoui  
Title: Operations Manager  
Date: 11 July 2024



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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>	Pirelli Tire LLC
<b>Company Address:</b>	10 East 40th Street 25th Floor 10016 New York, NY, USA
<b>Company Phone No.:</b>	N/A
<b>Company E-Mail:</b>	N/A
<b>Contact Person:</b>	Camila Amaral Surcan
<b>Contact E-Mail Address:</b>	camila.surcan@pirelli.com
<b>Contact Phone No.:</b>	+1-706-936-2502

### **1.2.Manufacturer Information**

<b>Company Name:</b>	Pirelli Tyre S.p.A.
<b>Company Address:</b>	Via Piero e Alberto Pirelli 25 – 20126 Milano, Italy
<b>Company Phone No.:</b>	N/A
<b>Company E-Mail:</b>	N/A
<b>Contact Person:</b>	Simona Scotti
<b>Contact E-Mail Address:</b>	simona.scotti@pirelli.com
<b>Contact Phone No.:</b>	+39 026442

## **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>	47CFR15.209
<b>Specification Title:</b>	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.209

#### **Location**

<b>Location of Testing:</b>	UL International Germany GmbH Hedelfinger Strasse. 61, 70327 Stuttgart, GERMANY
<b>Registration Number:</b>	399704

#### **Date Information**

<b>Order Date:</b>	30 November 2023
<b>EUT Arrived:</b>	20 February 2024
<b>Test Dates:</b>	21 February 2024 to 27 March 2024
<b>EUT Returned:</b>	-/-

**2.2. Summary of Test Results**

DIGITAL TRANSMISSION SYSTEMS (DTS): 2400-2483.5 MHz					
FCC Part 15 Clause	Compliance Test Description	Test Result			
		C	N.C.	N.P.	N.A.
15.207	Transmitter AC Power Line Conducted Emissions <sup>(1)</sup>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" 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>(2)</sup>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Part 15.247(e)	Transmitter Power Spectral Density <sup>(3)</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"/>
15.247(d) & 15.209(a)	Transmitter Radiated Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15.247(d) & 15.209(a)	Transmitter Band Edge Radiated Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>C: COMPLIED   N.C.: NOT COMPLIED   N.P.: NOT PERFORMED   N.A.: NOT APPLICABLE</b>					
<b>Decision rule:</b> Where not otherwise specified or communicated in writing, statements of conformity (e.g. Pass/Fail) are established according to the following decision rule: considering the ILAC G8:2019 chapter 4.2.1 (simple acceptance rule). This leads to a maximum 50% of false accept or false reject when the measured value equals the tolerance limit. See ILAC-G8:09/2019 for further details.					

**Note(s):**

1. The EUT is battery powered device therefore AC conducted emissions were not performed.
2. The measurement was performed to assist the average measurements.
3. 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**

<b>Reference:</b>	ANSI C63.10-2013
<b>Title:</b>	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
<b>Reference:</b>	FCC KDB 558074 D01 DTS Meas. Guidance v05r02 April 2, 2019
<b>Title:</b>	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

**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>	Pirelli
<b>Model Name or Number:</b>	PSN2-09S
<b>Test Sample Serial Number:</b>	MAC: AA2402150022 (Radiated Test sample)
<b>Hardware Version:</b>	V1.0
<b>Software Version:</b>	V1.0
<b>FCC ID:</b>	2ANX7CPSN2

<b>Brand Name:</b>	Pirelli
<b>Model Name or Number:</b>	PSN2-09S
<b>Test Sample Serial Number:</b>	MAC: AA2402070000 (Conducted Test sample with w.FL connector)
<b>Hardware Version Number:</b>	V1.0
<b>Firmware Version Number:</b>	V1.0
<b>FCC ID:</b>	2ANX7CPSN2

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

The equipment under test was a Tyre mounted sensor with BT LE interface, supporting Bluetooth Low Energy operations in 2400-2483.5MHz ISM band.

#### **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>	Bluetooth – Low Energy		
<b>FCC Equipment Classification:</b>	Digital Transmission System (DTS)		
<b>Type of Unit:</b>	Transceiver		
<b>Operating Frequency Range:</b>	2402 MHz to 2480 MHz		
<b>Channel Spacing:</b>	2 MHz		
<b>Tested Data Rate(s) &amp; Modulation(s):</b>	1 Mbps	GFSK	
<b>Maximum Conducted Output Power:</b>	6.41 dBm		
<b>Peak Antenna Gain of the system:</b>	-6 dBi		
<b>Antenna Type:</b>	SMD Antenna		
<b>Antenna Details:</b>	Johanson Technology 2450AT18D0100E-AEC		
<b>Transmit Channels Tested:</b>	<b>Channel ID</b>	<b>RF Channel</b>	<b>Frequency (MHz)</b>
	Bottom	0	2402
	Middle	19	2440
	Top	39	2480
<b>Power Supply Requirement(s):</b>	3V DC via non-rechargeable battery		

**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	Test Laptop With Test Software Ncp commander v4.3.3	Lenovo	20NYS1GL1U	PC1D101H
2	Android Smartphone With mobile app EFR connect	Samsung	S10	-/-
3	AC/DC power supply	Aim TTi	CPX400S	-/-

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

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



## **4. Operation and Monitoring of the EUT during Testing**

### **4.1. Operating Modes**

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

- BT-LE Test Mode: Continuously transmitting modulated carrier with combination of
  - Bluetooth Low Energy (BLE) | PRBS9 | 1 Mbps | Bottom / Middle / Top Channel | PWR 6 dBm

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

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

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

- The EUT used for conducted measurements was powered with 3 V DC via external power supply.
- The EUT used for radiated measurements was powered with 3 V DC internal battery.

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

- The EUT can be connected with the Test laptop via UART-USB cable. The laptop was removed from the measuring area during the measurement.
- The test modes for the conducted measurements were activated using the test software / Radio Tool "Ncp commander v4.3.3". This test software / Radio Tool was installed on the test laptop to enable continuous transmission and to select the required test channels.
- The test modes for the Radiated measurements were activated by using a mobile application "EFR connect". After configuration the mobile was removed from measuring area.

#### **Conducted Measurements:**

- All conducted measurements were carried out by using the EUT RF sample with w.FL to SMA cable connected on the PCB antenna port. The combined attenuation of the w.FL-SMA RF cable between the EUT antenna connector and spectrum analyser was 1.52 dB @2.402GHz, 1.57 @2.442GHz and 1.62 @2.480GHz, the value were added as a reference level offset to each of the conducted plots.

#### **Radiated Measurements:**

- The EUT radiated sample was used for radiated spurious emission and band edge measurements.
- Before starting the measurement, the EUT was evaluated for the worst-case position w.r.t to maximum radiated power measured in standing, laying and 45° tilting positions. The EUT integrated antenna in standing position was found out to be the worst-case. Therefore, this report includes relevant results.
- 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 at 100 cm.
- 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 V11.30.00 Software was used for the Radiated spurious emission measurements.

#### **Duty Cycle Correction Details:**

- As the continuous transmission of the EUT (D ≥ 98%) cannot be achieved and EUT was transmitting continuously with 85.50% duty cycle (+/- 2% tolerance). Duty Cycle Correction Factor of 0.68 dB was added to all average 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 Duty Cycle**

**Test Summary:**

<b>Test Engineer:</b>	Muhammad Faiq Khan	<b>Test Date:</b>	21 February 2024
<b>Test Sample Serial Number:</b>	MAC: AA2402070000 (Conducted Test sample with w.FL connector)		
<b>Test Site Identification</b>	SR 9		

<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>	20.9
<b>Relative Humidity (%):</b>	46.3

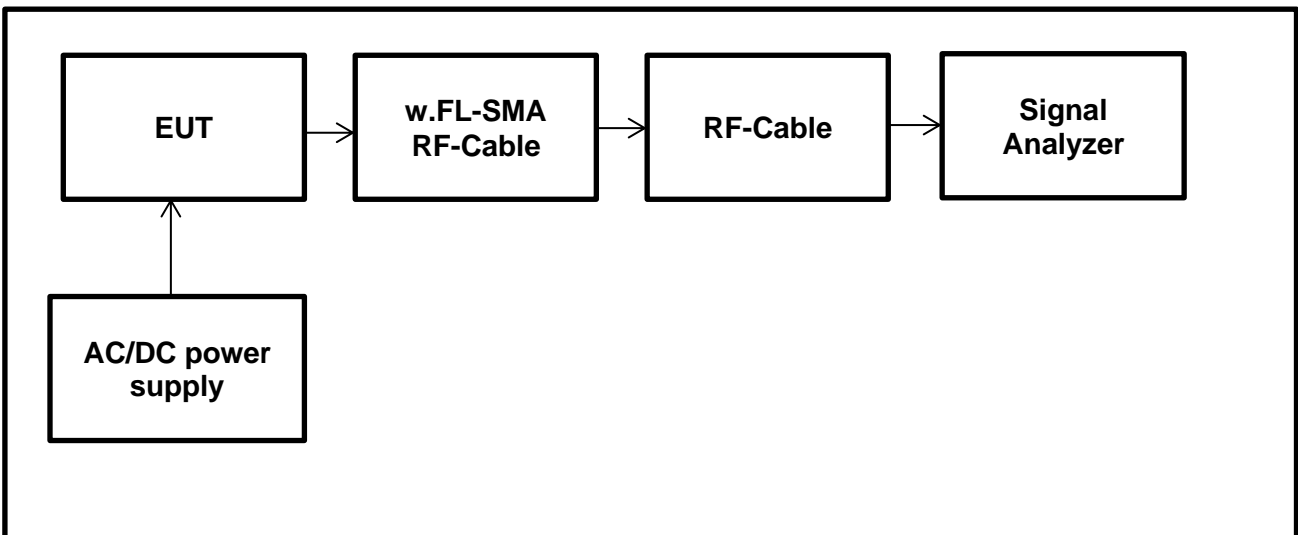
**Note:**

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

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

$$Duty\ Cycle\ Correction\ Factor = 10\ log\ 1 / [On\ Time\ (T_{ON})] / [Period(T_{ON}+ T_{OFF})\ or\ 100ms\ whichever\ is\ the\ lesser]$$
- All conducted measurements were carried out by using the EUT RF sample with w.FL to SMA cable connected on the PCB antenna port. The combined attenuation of the w.FL-SMA RF cable between the EUT antenna connector and spectrum analyser was 1.52 dB @2.402GHz, the value was added to as a reference level offset to the plot.

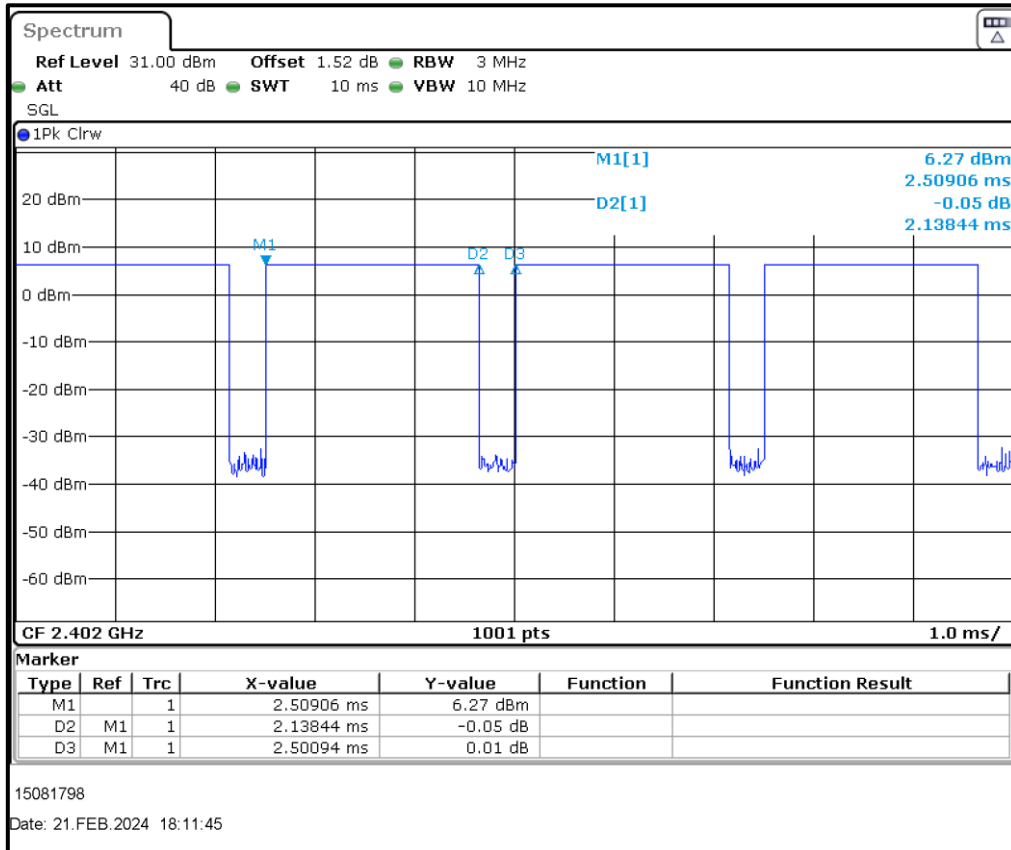
**Test Setup:**



**Transmitter Duty Cycle (continued)**

**Results: BT-LE / 1 Mbps / PRBS9 / PWR 6 / Bottom Channel**

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)
2.13844	2.50094	85.50	0.68



**Result: Pass**

**5.2.2. Transmitter Minimum 6 dB Bandwidth**

**Test Summary:**

<b>Test Engineer:</b>	Muhammad Faiq Khan	<b>Test Date:</b>	21 February 2024
<b>Test Sample Serial Number:</b>	MAC: AA2402070000 (Conducted Test sample with w.FL connector)		
<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

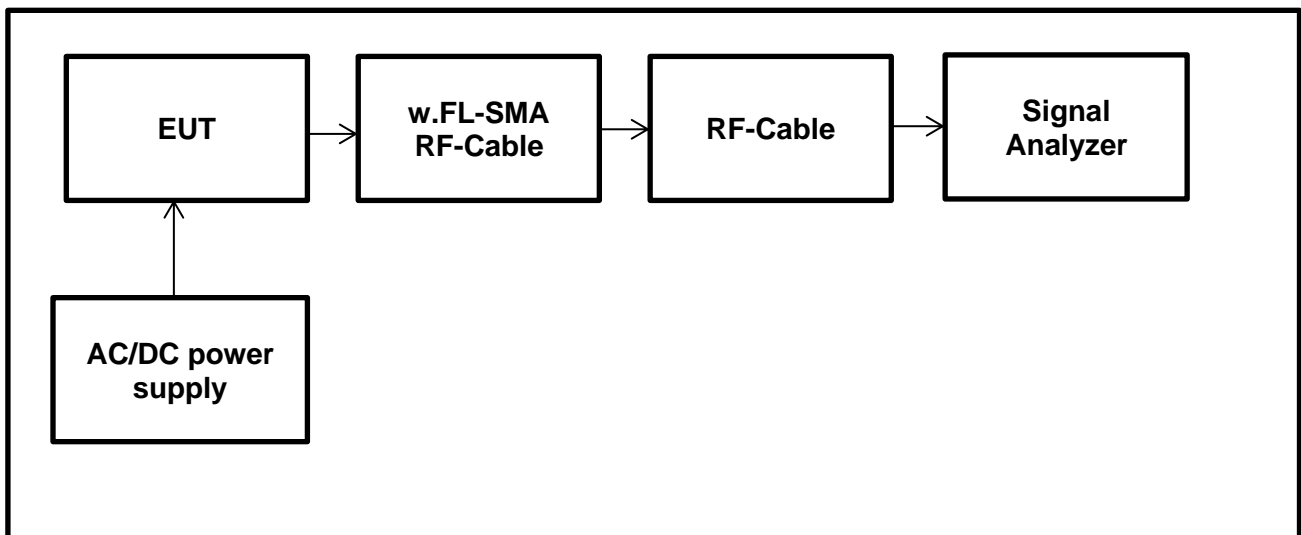
**Environmental Conditions:**

<b>Temperature (°C):</b>	20.9
<b>Relative Humidity (%):</b>	46.3

**Notes:**

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. All conducted measurements were carried out by using the EUT RF sample with w.FL to SMA cable connected on the PCB antenna port. The combined attenuation of the w.FL-SMA RF cable between the EUT antenna connector and spectrum analyser was 1.52 dB @2.402GHz, 1.57 @2.442GHz and 1.62 @2.480GHz, the value were added as a reference level offset to each of the conducted plots.

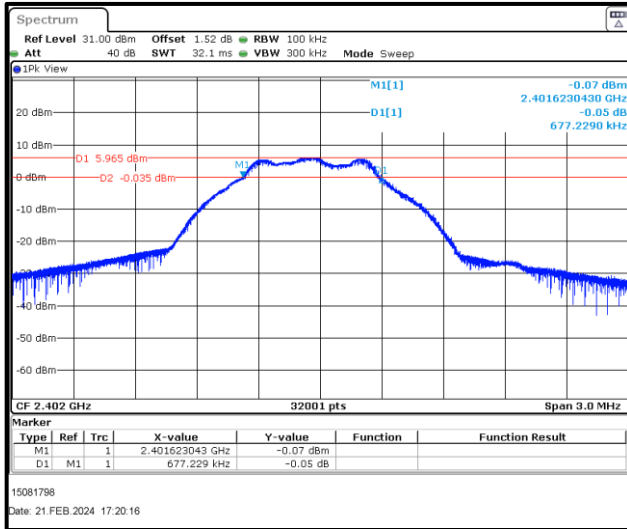
**Test Setup:**



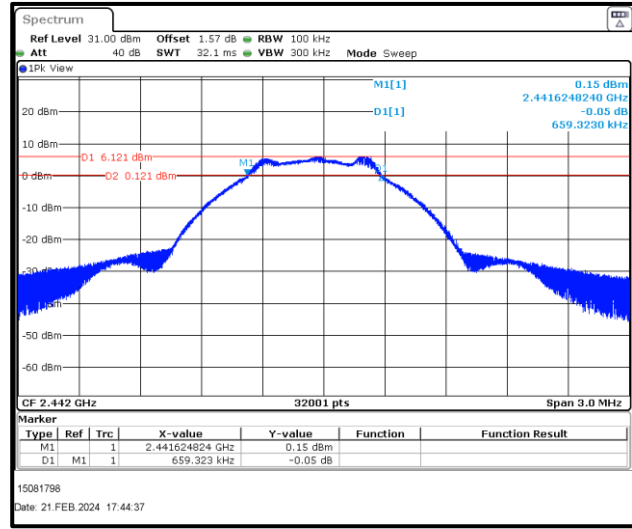
**Transmitter Minimum 6 dB Bandwidth (continued)**

**Results: BT-LE / 1 Mbps / PRBS9 / PWR 6**

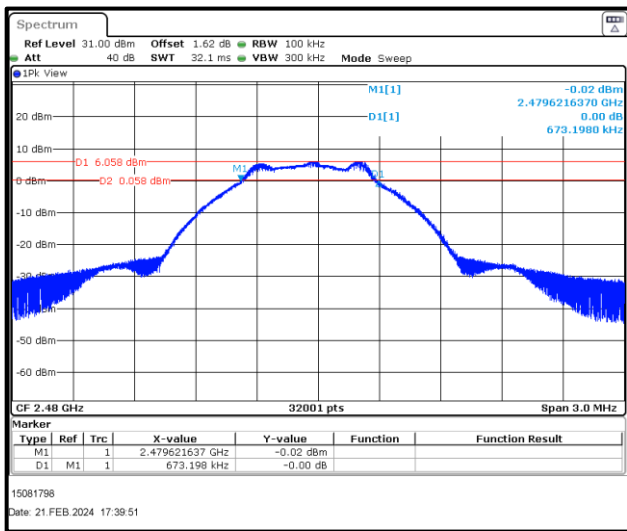
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	677.229	≥ 500	177.229	Complied
Middle	659.323	≥ 500	159.323	Complied
Top	673.198	≥ 500	173.198	Complied



Bottom Channel



Middle Channel



Top Channel

Result: **Pass**

**5.2.3. Transmitter Maximum (Peak) Output Power**

**Test Summary:**

<b>Test Engineer:</b>	Muhammad Faiq Khan	<b>Test Date:</b>	21 February 2024
<b>Test Sample Serial Number:</b>	MAC: AA2402070000 (Conducted Test sample with w.FL connector)		
<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 8.3.1.3 referencing ANSI C63.10 Sections 11.9.1.1

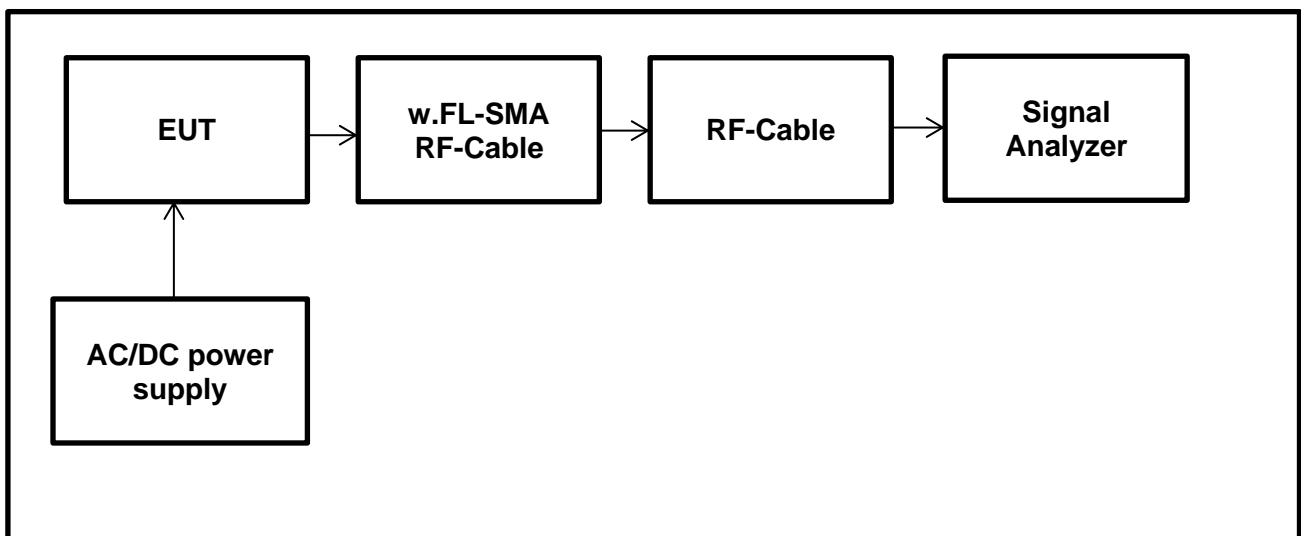
**Environmental Conditions:**

<b>Temperature (°C):</b>	20.9
<b>Relative Humidity (%):</b>	46.3

**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 ≥ 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. All conducted measurements were carried out by using the EUT RF sample with w.FL to SMA cable connected on the PCB antenna port. The combined attenuation of the w.FL-SMA RF cable between the EUT antenna connector and spectrum analyser was 1.52 dB @2.402GHz, 1.57 @2.442GHz and 1.62 @2.480GHz, the value were added as a reference level offset to each of the conducted plots.
4. The declared antenna gain was added to conducted power to obtain the relevant EIRP values.

**Test Setup:**



**Transmitter Maximum Peak Output Power (continued)****Results: BT-LE / 1 Mbps / PRBS9 / PWR 6**

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	6.41	30.00	23.59	Complied
Middle	6.29	30.00	23.71	Complied
Top	6.22	30.00	23.88	Complied

**Results EIRP: BT-LE / 1 Mbps / PRBS9 / PWR 6**

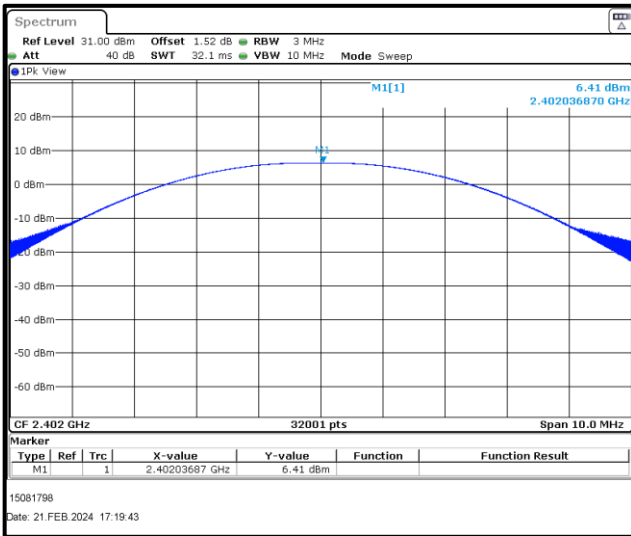
Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	6.41	-6.0	0.41	36.00	35.59	Complied
Middle	6.29	-6.0	0.29	36.00	35.71	Complied
Top	6.22	-6.0	0.22	36.00	35.88	Complied

**Result: Pass**

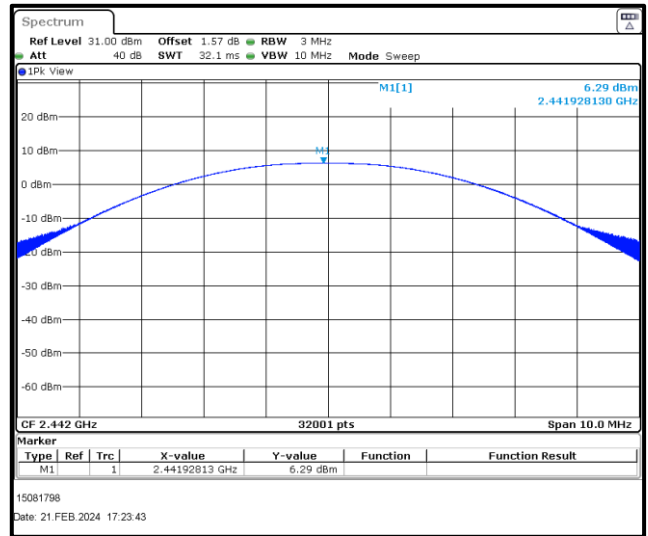


**Transmitter Maximum Peak Output Power (continued)**

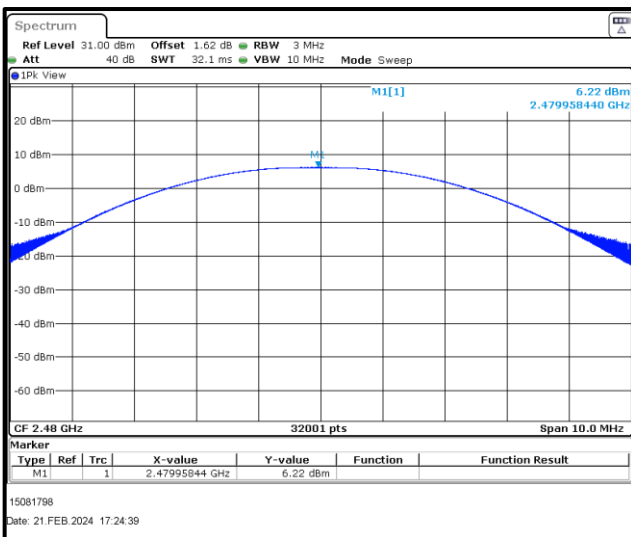
**Plots: BT-LE / 1 Mbps / PRBS9 / PWR 6**



**Bottom Channel**



**Middle Channel**



**Top Channel**

## 5.2.4. Transmitter Radiated Emissions

### Test Summary:

<b>Test Engineer:</b>	Muhammad Faiq Khan	<b>Test Date:</b>	27 March 2024
<b>Test Sample Serial Number:</b>	MAC: AA2402150022 (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>	22.3
<b>Relative Humidity (%):</b>	43.7

### Notes:

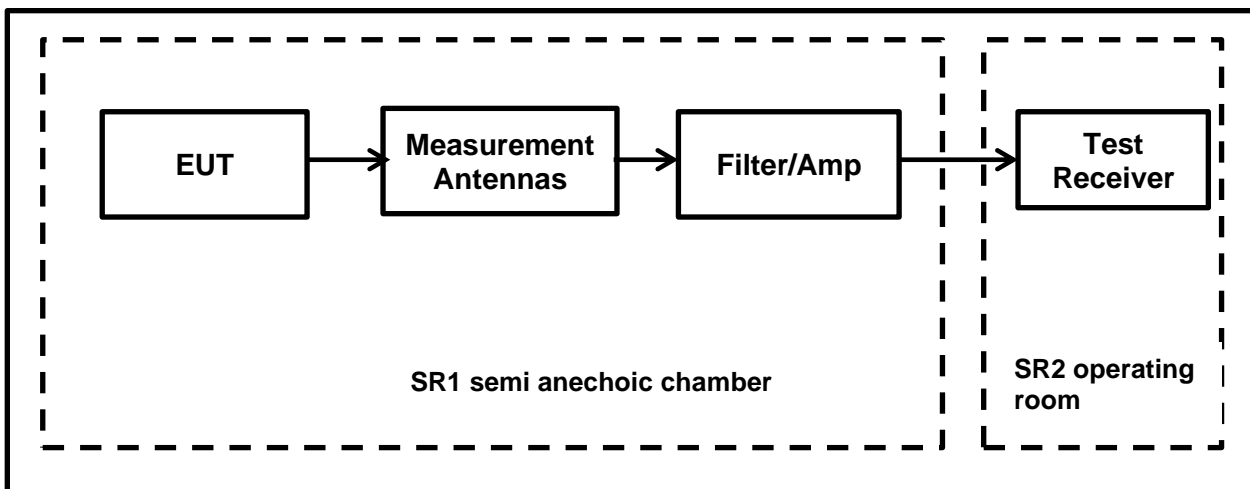
- In accordance with FCC KDB 414788 D01 Radiated Test Site & ANSI C63.10 clause 5.2 an alternative test site that can demonstrate equivalence to an open area test site may be used. Therefore, the measurement was performed in a Semi Anechoic Chamber. (The OATS / SAC comparison data is available upon request).
- 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.
- The measured values at 3 m were extrapolated to the required measurement distances of 300 m and 30 m and compared the specified limits at those distances as follows:
  - 9 kHz- 490 kHz: measured value extrapolated from 3 m to 300 m by subtracting 80 dB at 40 dB /decade.
  - 490 kHz-30 MHz: measured value extrapolated from 3 m to 30 m by subtracting 40 dB at 40 dB /decade.

The results table shows both the measured levels at 3 m and the same measurement values extrapolated to the actual measurement distance for the limits specified at 30 and 300 metres.

Conversely, the limit line shown on the spectrum plot was extrapolated to 3 m from 300 m and 30 m using the 40 dB /decade rule.
- 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 100 cm.
- The EUT was configured with the following worst-case mode w.r.t output power:
  - BT-LE | 1 Mbps | PRBS9 | PWR 6 | Bottom Channel
- The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.

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

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: 300 Hz / VBW: 1 kHz
  - Frequency range: 150 kHz – 30 MHz: RBW: 10 kHz / VBW: 30 kHz
  - Detector: Peak detector
  - Trace Mode: Max Hold

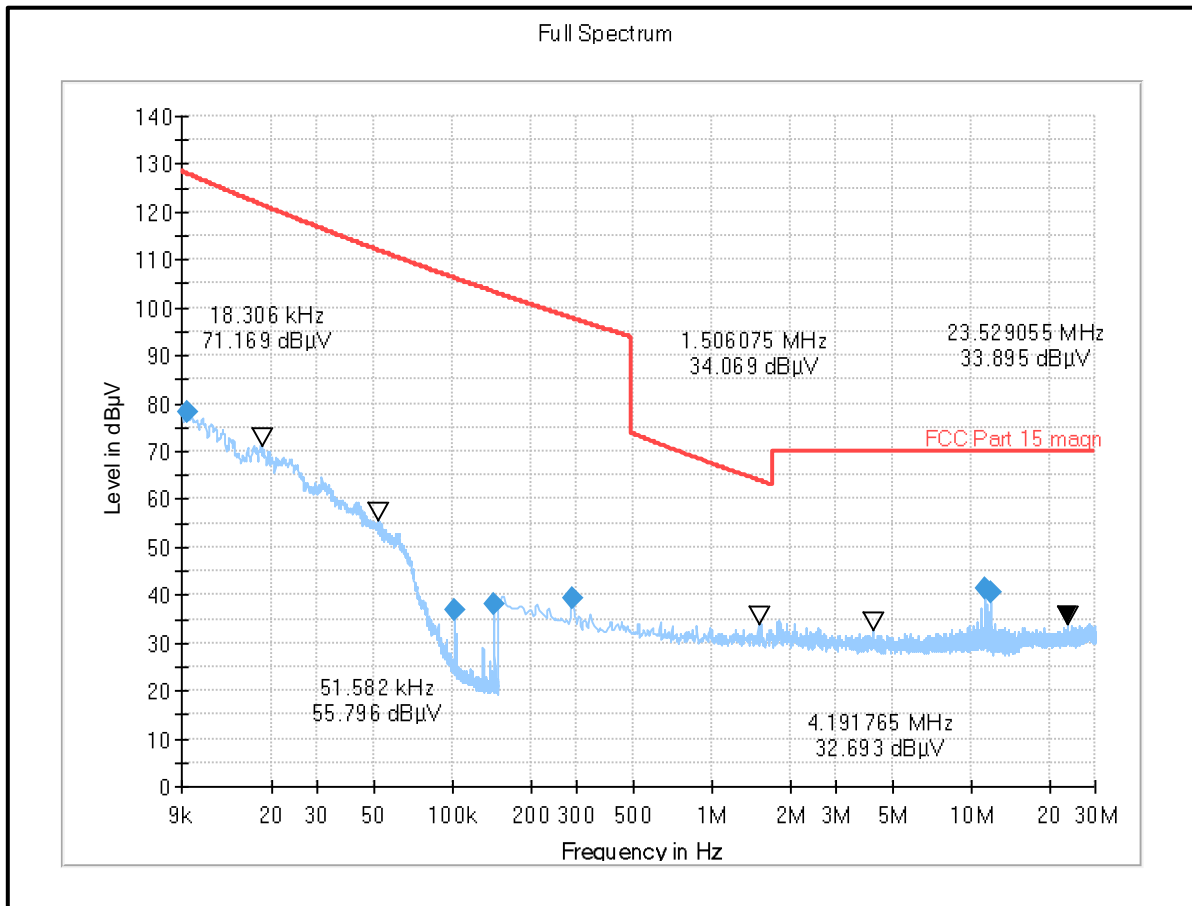
**Test Setup:**

**Transmitter Radiated Emissions (continued)**

**Results: BT-LE / 1 Mbps / PRBS9 / Bottom Channel / PWR 6**

Frequency (MHz)	Loop Antenna Orientation	MaxPeak Level at 3 m(dBµV/m) Note 2	MaxPeak Emission Level extrapolated (dBmV/m) Note 3	Limit (dBµV/m)	Margin (dB)	Result
0.009564	90°	78.17	-1.83	47.89	49.72	Complied
0.101708	90°	36.88	-43.12	26.16	69.28	Complied
0.144783	0°	37.88	-42.12	23.25	65.37	Complied
0.288915	0°	39.40	-40.6	17.78	58.38	Complied
11.263365	90°	41.23	1.23	30.00	28.77	Complied
11.865335	90°	40.44	0.44	30.00	29.56	Complied

**Plot: 9 kHz – 30 MHz: BT-LE / 1 Mbps / PRBS9 / PWR 6 / Bottom Channel**



**Result: Pass**

**Transmitter Radiated Emissions (continued)**

**Test Summary:**

<b>Test Engineer:</b>	Muhammad Faiq Khan	<b>Test Date:</b>	27 March 2024
<b>Test Sample Serial Number:</b>	MAC: AA2402150022 (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

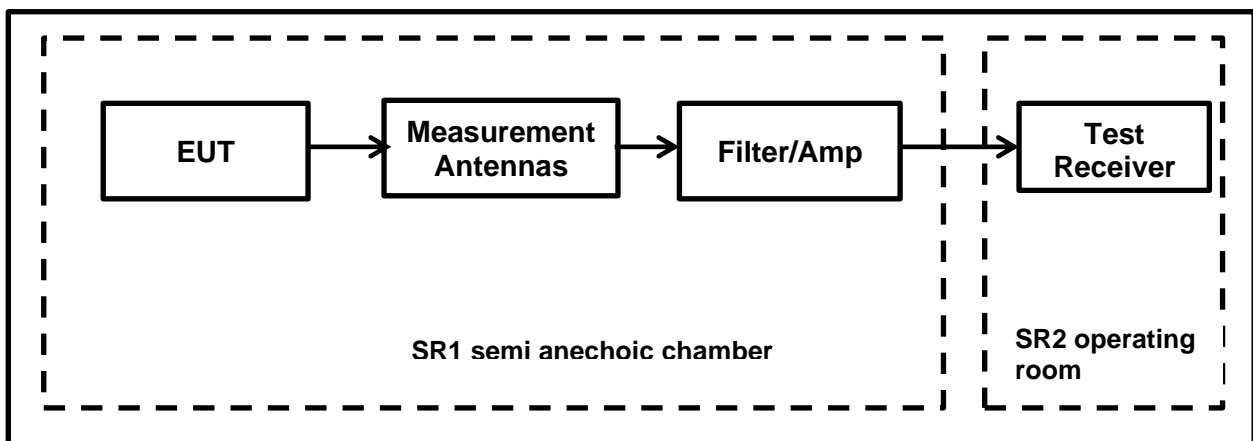
**Environmental Conditions:**

<b>Temperature (°C):</b>	22.3
<b>Relative Humidity (%):</b>	43.7

**Note(s):**

1. Measurements below 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
2. The EUT was configured with the following worst-case mode w.r.t Output power:
  - BT-LE | 1 Mbps | PRBS9 | PWR 6 | Bottom Channel
3. 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.
4. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
5. All other emissions shown on the pre-scan plot were investigated and found to be below the measurement system noise floor.

**Test Setup:**

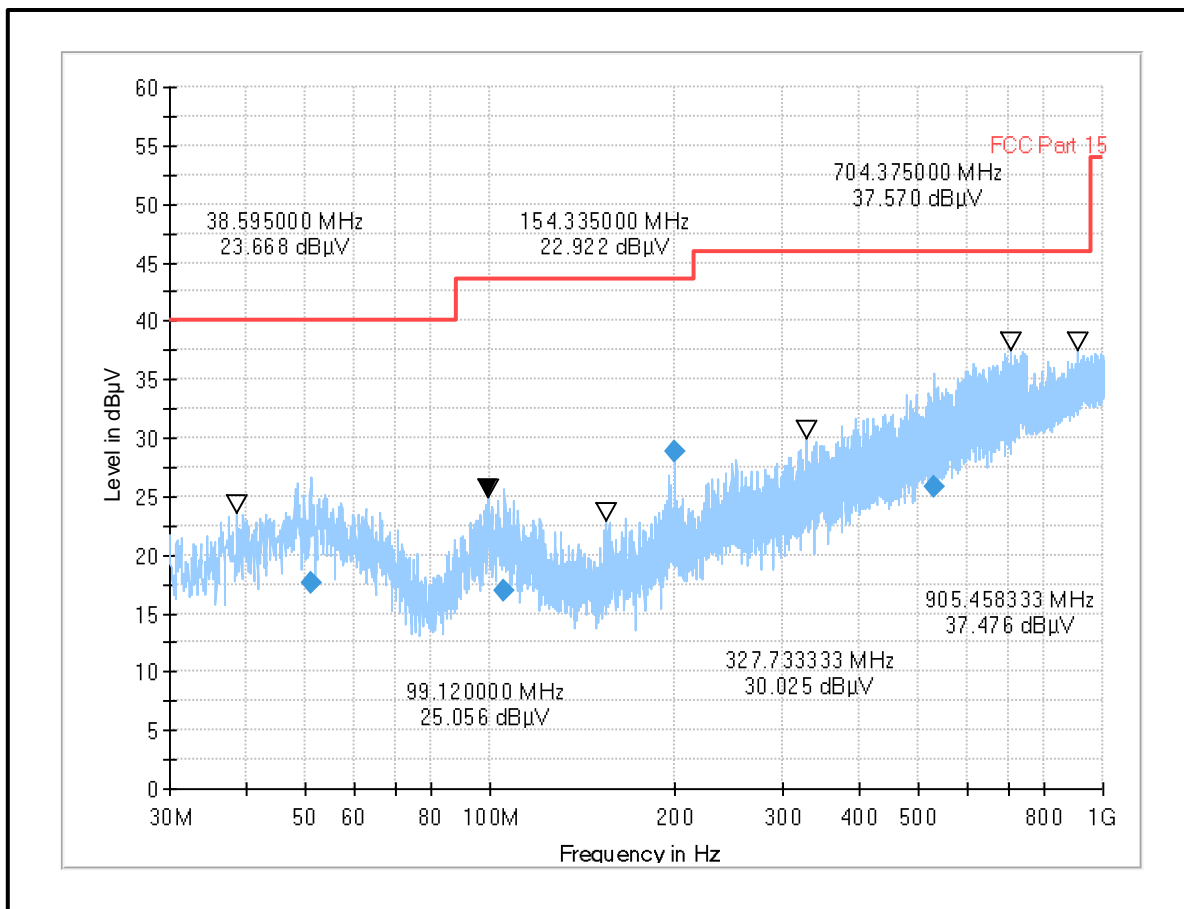


**Transmitter Radiated Emissions (continued)**

**Results: BT-LE / 1 Mbps / PRBS9 / Bottom Channel / PWR 6**

Frequency (MHz)	Antenna Polarization	MaxPeak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
51.015000	Vertical	17.68	40.00	22.32	Complied
105.600000	Horizontal	16.90	43.50	26.60	Complied
199.965000	Vertical	28.75	43.50	14.75	Complied
531.791667	Vertical	25.74	46.00	20.26	Complied

**Plot: 30 MHz – 1GHz: BT-LE / 1 Mbps / PRBS9 / PWR 6 / Bottom Channel**



**Result: Pass**

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

<b>Test Engineer:</b>	Muhammad Faiq Khan	<b>Test Date:</b>	04 March 2024
<b>Test Sample Serial Number:</b>	MAC: AA2402150022 (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 26.5 GHz

**Environmental Conditions:**

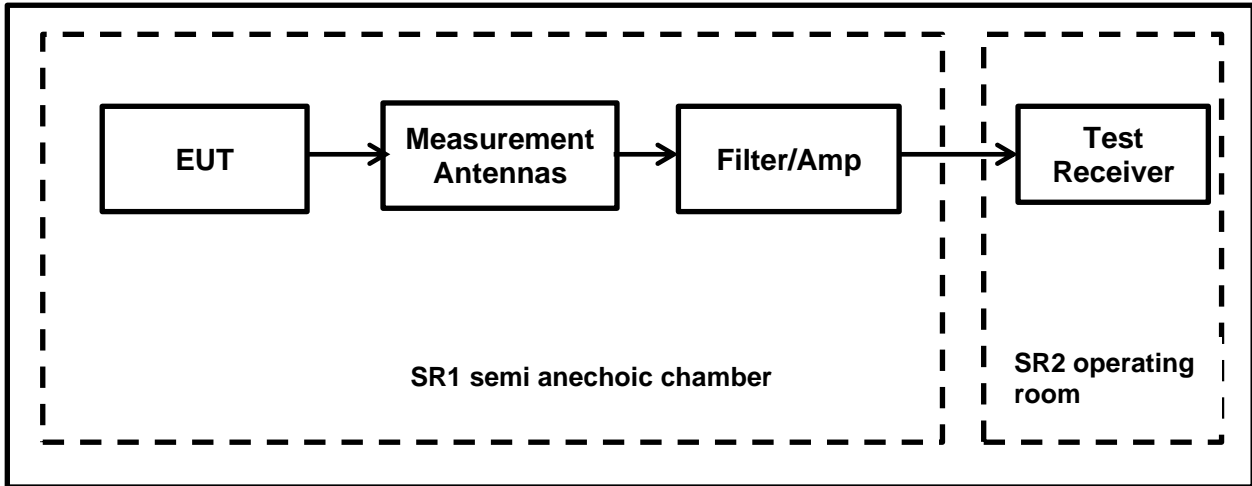
<b>Temperature (°C):</b>	22.3
<b>Relative Humidity (%):</b>	46.4

**Notes:**

- 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.
- EUT was configured with the following parameters.
  - BT-LE | 1 Mbps | PRBS9 | PWR 6 | Bottom/Middle/Top Channel
- 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.
- 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.
- In accordance with ANSI C63.10-2013 Section 5.3.3 & 6.5.3 measurements above 18 GHz were performed at closer distance (1 m); because at specified measurement distance (3m) for compliance the instrumentation noise floor was typically close to the radiated emission limit.
- As the continuous transmission of the EUT (D ≥ 98%) cannot be achieved and EUT was transmitting continuously with 85.50% duty cycle (+/- 2% tolerance). Duty Cycle Correction Factor of 0.68 dB was added to all average measurements.
- The final measured value in the table below incorporates the calibrated antenna factor and cable loss.

**Transmitter Radiated Emissions (continued)**

**Test Setup:**



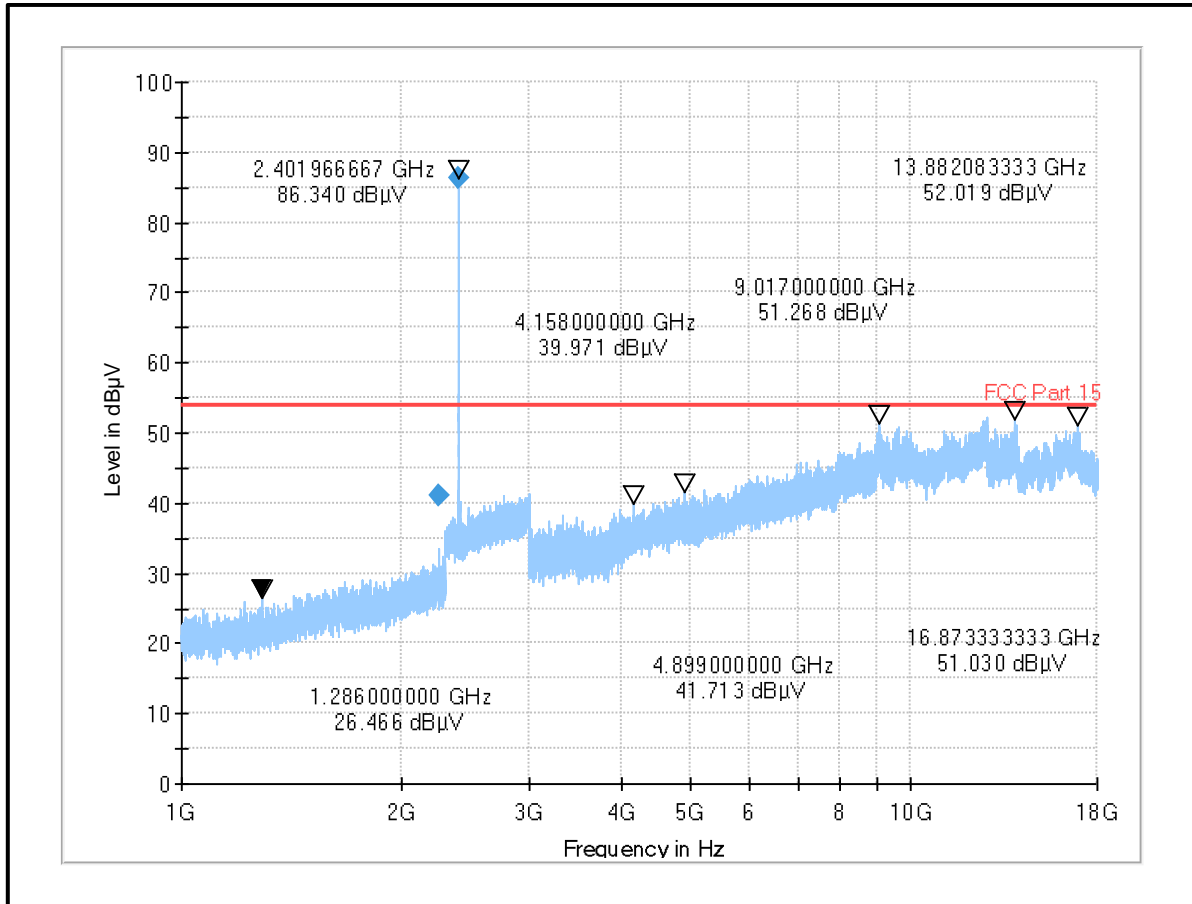


**Transmitter Radiated Emissions (continued)**

**Results: BT-LE / 1 Mbps / PRBS9 / Bottom Channel / PWR 6 / 1-18 GHz**

Frequency (MHz)	Antenna Polarization	MaxPeak Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
2252.766667	Horizontal	41.05	54.00	12.95	Complied

**Plot: 1 GHz – 18 GHz: BT-LE / 1 Mbps / PRBS9 / PWR 6 / Bottom Channel**



**Result: Pass**

**Transmitter Radiated Emissions (continued)**

**Results: BT-LE / 1 Mbps / PRBS9 / Middle Channel / PWR 6 / 1-18 GHz**

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

Result: **Pass**

**Results: BT-LE / 1 Mbps / PRBS9 / Top Channel / PWR 6 / 1-18 GHz**

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

Result: **Pass**

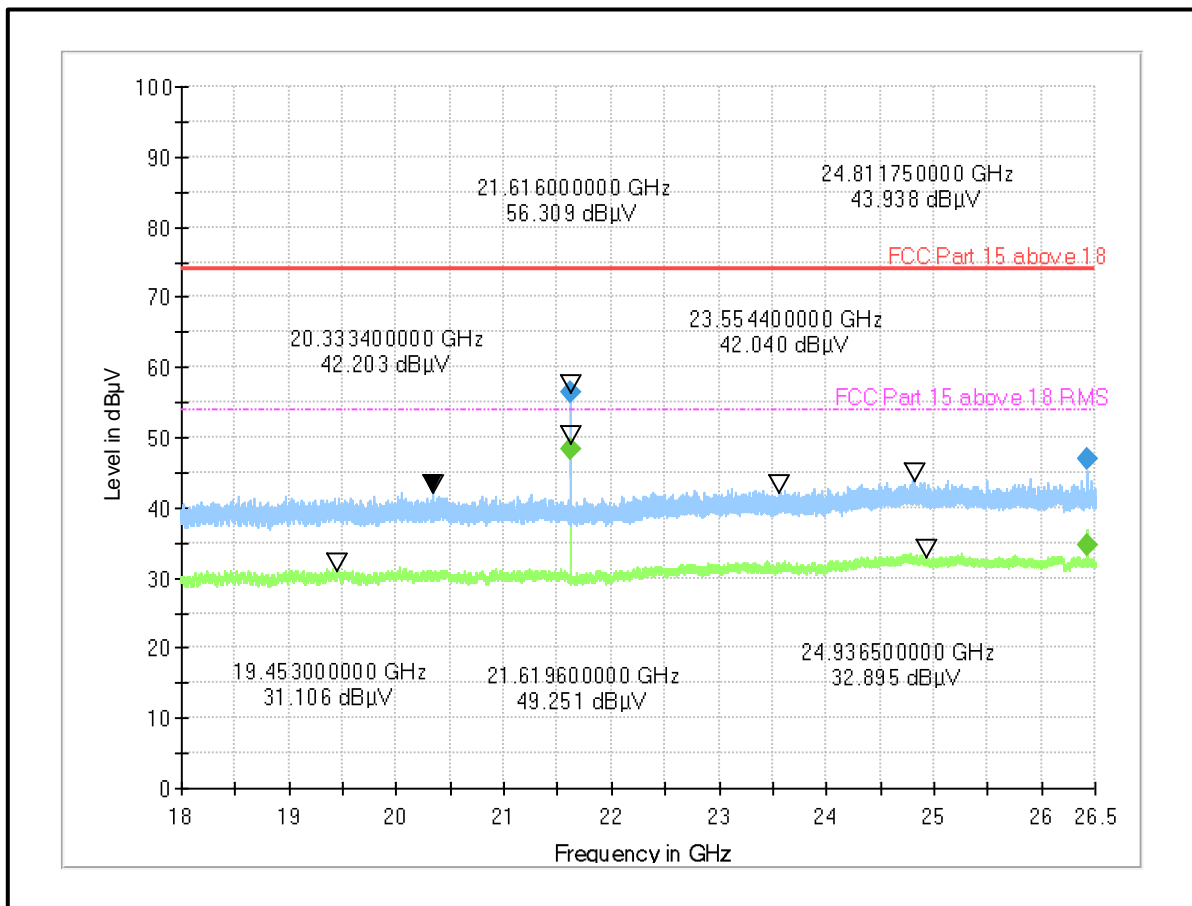
**Transmitter Radiated Emissions (continued)**

**Results: BT-LE / 1 Mbps / PRBS9 / Bottom Channel / PWR 6 / 18-26.5 GHz**

Frequency (MHz)	Antenna Polarization	MaxPeak Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
21616.000000	Vertical	56.32	74.00	17.68	Complied
26419.500000	Vertical	46.91	74.00	27.09	Complied

Frequency (MHz)	Antenna Polarization	Average Level (dBμV/m)	Corrected Average Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
21616.000000	Horizontal	48.37	49.05	54.00	4.95	Complied
26419.500000	Vertical	34.54	35.22	54.00	18.78	Complied

**Plot: 18 GHz – 26.5 GHz: BT-LE / 1 Mbps / PRBS9 / PWR 6 / Bottom Channel**



**Result: Pass**

**Transmitter Radiated Emissions (continued)**

**Results: BT-LE / 1 Mbps / PRBS9 / Middle Channel / PWR 6 / 18-26.5 GHz**

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

Result: **Pass**

**Results: BT-LE / 1 Mbps / PRBS9 / Top Channel / PWR 6 / 18-26.5 GHz**

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

Result: **Pass**

**5.2.5. Transmitter Band Edge Radiated Emissions**

**Test Summary:**

<b>Test Engineer:</b>	Muhammad Faiq Khan	<b>Test Date:</b>	04 March 2024
<b>Test Sample Serial Number:</b>	MAC: AA2402150022 (Radiated Test sample)		
<b>Test Site Identification</b>	SR 1/2		

<b>FCC Reference:</b>	Parts 15.247(d), 15.209(a) & 15.205(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:**

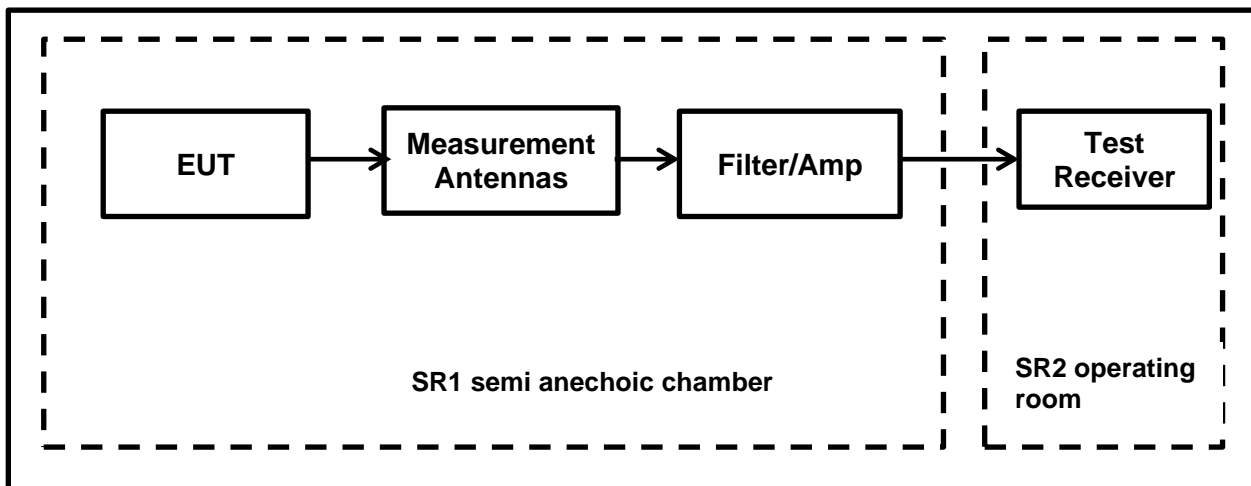
<b>Temperature (°C):</b>	22.3
<b>Relative Humidity (%):</b>	46.4

**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. Since maximum conducted (Peak) 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 300 sweeps 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 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 and RMS detector in linear power averaging mode was used. The test receiver was left to sweep for 300 sweeps 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.
6. 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.

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

7. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
8. As the continuous transmission of the EUT ( $D \geq 98\%$ ) cannot be achieved and EUT was transmitting continuously with 85.50% duty cycle (+/- 2% tolerance). Duty Cycle Correction Factor of 0.68 dB was added to all average measurements.

**Test Setup:**

**Transmitter Band Edge Radiated Emissions (continued)****Results: BT-LE / 1 Mbps / PRBS9 / PWR 6****Results: Lower Band Edge / Peak**

Frequency (MHz)	Peak Level (dB $\mu$ V/m)	-20 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
2399.95	50.38	70.39	20.01	Complied
2400.00	51.40	70.39	18.99	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
2364.54	47.25	74.00	26.75	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
2382.68	32.61	0.68	33.29	54.00	20.71	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	63.42	74.00	10.58	Complied
2483.58	62.70	74.00	11.30	Complied

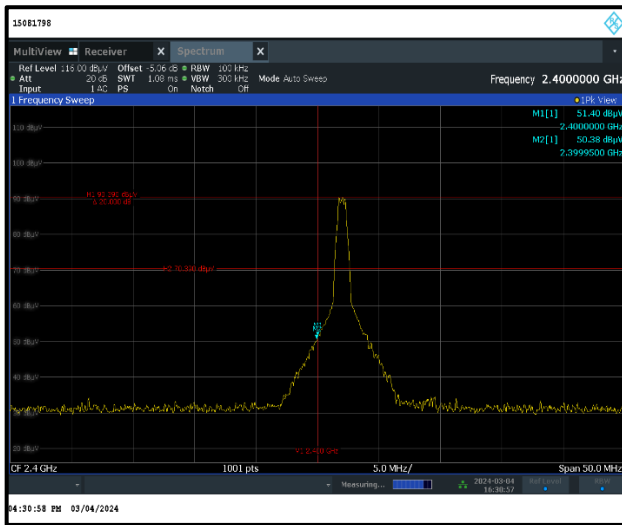
**Results: Upper Band Edge / Average**

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	37.23	0.68	37.91	54.00	16.09	Complied
2483.58	36.63	0.68	37.31	54.00	16.69	Complied

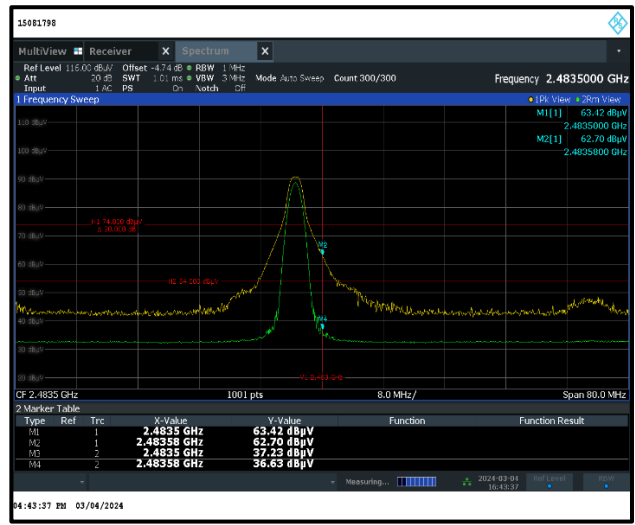
**Result: Pass**

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

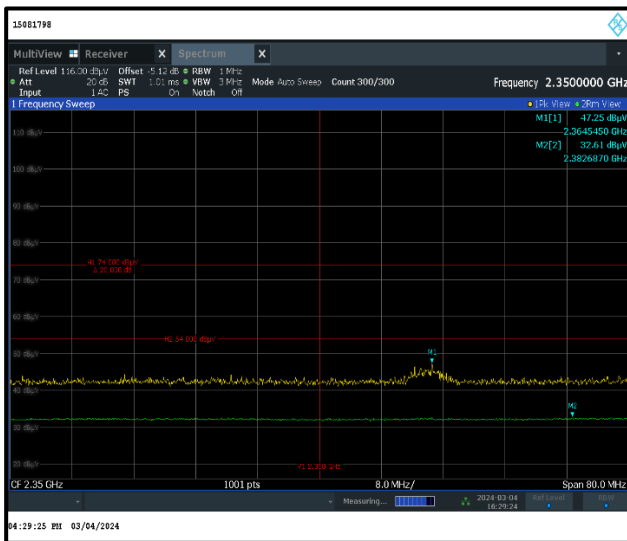
**Results: BT-LE / 1 Mbps / PRBS9 / PWR 6**



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
Minimum 6 dB Bandwidth	95%	±0.87 %
Transmitter Duty Cycle	95%	±3.4%
Conducted Maximum Peak Output Power	95%	±0.59 dB
Radiated Spurious Emissions	95%	±3.10 dB
Band Edge Radiated Emissions	95%	±3.10 dB

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

## 7. 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	18/07/2023	36
377	BONN Elektronik	Amplifier, Low Noise Pre	BLMA 0118-1A	025294B	18/07/2023	12
460	Deisel	Turntable	DT 4250 S	n/a	n/a	n/a
465	Schwarzbeck	Antenna, Trilog Broadband	VULB 9163	01691	30/11/2023	36
496	Rohde & Schwarz	Antenna, log. - periodical	HL050	100297	22/08/2022	24
588	Maturo	Controller	NCD	029/7180311	n/a	n/a
591	Rohde & Schwarz	Receiver	ESU 40	100244/040	13/07/2023	12
607	Schwarzbeck	Antenna broadband horn antenna	BBHA 9170	9170-561	12/01/2024	48
669	Rohde & Schwarz	EMI Test Receiver	ESW 44	103087	13/07/2023	18
694	Rohde & Schwarz	Signal Analyzer	FSW 50	101847	09/05/2023	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
681	Maturo	Antenna mast, tilting	BAM4.5-P	402/0718.1	n/a	n/a

### Test site: SR 9

ID	Manufacturer	Type	Model	Serial	Calibration Date	Cal. Cycle (months)
625	Schwarzbeck	Antenna, H-field	HFSL 7101	109	lab verification only relative measurements	n/a
637	Rohde & Schwarz	Spectrum Analyser	FSV40	101587	12/07/2023	12
-/-	Testo	Thermo-Hygrometer	608-H1	07	lab verification	n/a
645	Weiss Umwelttechnik	Climatic Chamber	LabEvent T/110/70/3	5822619794 0010	lab verification	n/a
327	SPS	AC/DC power distribution system	PAS 5000	A2464 00/1 0200	lab verification	n/a

### 8. Report Revision History

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0	-	-	Initial Version
1.1	18	5.2.4	Notes updated
	21	5.2.4	Notes updated
	23	5.2.4	Notes updated
	25	5.2.4	Result table format updated
	26	5.2.4	Plot title corrected
<b>Test Report Version 1.2 supersede Version 1.1 with immediate effect</b> Test Report No. UL-RPT-RP-15081798-216-FCC Version 1.2, Issue Date 11 JULY 2024 replaces Test Report No. UL-RPT-RP-15081798-216-FCC Version 1.1, Issue Date 11 JUNE 2024, which is no longer valid.			
1.2	Page No(s)	Clause	Details
	18-19	5.2.4	Notes arrangement updated
	23	5.2.4	Notes updated
	25-28	5.2.4	Results updated

--- END OF REPORT ---