



Solutions

TEST REPORT

Test Report No.: UL-RPT-RP-15089026-116-FCC

Applicant * : Workaround GmbH
Model No. * : Mark Display
FCC ID * : 2AOJL-MARK-Display
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-15089026-116-FCC Version 1.2, Issue Date 16 JANUARY 2024 replaces
Test Report No. UL-RPT-RP-15089026-116-FCC Version 1.1, Issue Date 15 JANUARY 2024, which is no longer valid.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: 16 January 2024

Approved by: Rachid, Acharkaoui
Title: Operations Manager
Date: 16 January 2024



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.

UL INTERNATIONAL GERMANY GMBH

Hedelfinger Str. 61
70327 Stuttgart, Germany
STU.CTECHLab@ul.com

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1. Customer Information *

1.A. Applicant Information

Company Name:	Workaround GmbH
Company Address:	Rupert-Mayer-Str. 44, 81379 Munich,Germany
Company Phone No.:	+49 89 26203500
Company E-Mail:	support@proglove.com
Contact Person:	Arif Şamil Çılgın
Contact E-Mail Address:	arif.cilgin@proglove.de
Contact Phone No.:	+4917677379345

1.2. Manufacturer Information

Company Name:	Workaround GmbH
Company Address:	Rupert-Mayer-Str. 44, 81379 Munich,Germany
Company Phone No.:	+49 89 26203500
Company E-Mail:	support@proglove.com
Contact Person:	Arif Şamil Çılgın
Contact E-Mail Address:	arif.cilgin@proglove.de
Contact Phone No.:	+4917677379345

2. Summary of Testing

2.1. General Information

Applied FCC Rule Part(s)

Specification Reference:	47CFR15.247
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Section 15.247
Specification Reference:	47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Section 15.209

Location

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

Date Information

Order Date:	06 December 2023
EUT Arrived:	21 March 2023
Test Dates:	23 December 2023 to 29 December 2023
EUT Returned:	-/-

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 ⁽³⁾	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
15.35(c)	Transmitter Duty Cycle ⁽¹⁾	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15.247(a)(2)	Transmitter Minimum 6 dB Bandwidth	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15.247(b)(3)	Transmitter Maximum Peak Output Power	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15.247(e)	Transmitter Power Spectral Density ⁽²⁾	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" 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"/>
C: COMPLIED N.C.: NOT COMPLIED N.P.: NOT PERFORMED N.A.: NOT APPLICABLE					
Decision rule: 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 measurement was performed to assist the average measurement.
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.
3. Not applicable as according to customer EUT does not support transmit or receive modes while charging.

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

2.4. Deviations from the Test Specification

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

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT) *

Brand Name:	ProGlove
Model Name or Number:	Mark Display
Test Sample Serial Number:	MD MR C28 014313 (Radiated Test Sample)
Hardware Version Number:	C
Firmware Version Number:	2.3
FCC ID:	2AOJL-MARK-Display

Brand Name:	ProGlove
Model Name or Number:	Mark Display
Test Sample Serial Number:	MD MR C28 014312 (Radiated Test Sample)
Hardware Version Number:	C
Firmware Version Number:	2.3
FCC ID:	2AOJL-MARK-Display

Brand Name:	ProGlove
Model Name or Number:	Mark Display
Test Sample Serial Number:	MD MR C28 014299 (Conducted Test Sample with SMA connector)
Hardware Version Number:	C
Firmware Version Number:	2.3
FCC ID:	2AOJL-MARK-Display

3.2. Description of EUT *

The equipment under test was a Wireless wearable bar-code reader, supporting Bluetooth Low Energy operations in 2.4 – 2.4835 GHz 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 *

Technology Tested:	Bluetooth – Low Energy		
Equipment Classification:	Digital Transmission System (DTS)		
Type of Unit:	Transceiver		
Operating Frequency Range:	2402 MHz to 2480 MHz		
Channel Spacing:	2 MHz		
Tested Data Rate(s) & Modulation(s):	1 Mbps	GFSK	
Antenna Type:	Custom Flex PCB Antenna		
Antenna Details:	Golden Shine BLE Antenna, MARK 2 (Custom Design)		
Declared Antenna Gain:	-1.78 dBi		
Max Conducted Output power:	6.47 dBm		
Transmit Channels Tested:	Channel ID	RF Channel	Frequency (MHz)
	Bottom	37	2402
	Middle	17	2440
	Top	39	2480
Power Supply Requirement(s):	Nominal	3.7 V DC (Internal 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	-/-	-/-	-/-	-/-

B. Support Equipment (Manufacturer supplied)

Item	Description	Brand Name	Model Name or Number	Serial Number
1	Glove with button to trigger Mark	PROGLOVE	Not marked or stated	Not marked or stated
2	Charging Station S (5 V DC 1.2 A LPS)	PROGLOVE	PGCS 3020 24367	Not marked or stated
3	AC/DC Adapter (5 V DC 1.2 A)	Sunny Electronics	SYS1561-1105	Not marked or stated
4	Type A to USB Type C USB Charging Cable Length 1.5 m	Not marked or stated	Not marked or stated	Not marked or stated

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

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

- Continuously transmitting modulated carrier with combination of
 - BT-LE | 1 Mbps | PWR MAX | Channel Bottom / Middle / Top | PRBS9 |

4.2. Configuration and Peripherals

The customer supplied document containing the setup instructions "MARK Display& MARK Basic Certification Helper (rev-E) (2).pdf", 11.11.2021 was used to configure the EUT.

EUT Power Supply:

- The EUT was powered via 3.7V Internal battery for radiated measurements.

Test Mode Activation:

- The EUTs were configured into required Bluetooth LE TX test modes using the QR codes which were supplied by the customer.
- For the modulated test mode activation TXRAND and PRBS9 options were selected.
- The transmitter power was configured to maximum value & was not accessible during the tests.

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:

- The EUT radiated samples with fully charged internal battery 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.
- EUT in Standing position was found 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 EUT continuous transmission of the EUT ($D \geq 98\%$) can be achieved and EUT was transmitting continuously with a constant Duty Cycle of 48% duty cycle (duty cycle variations are less than $\pm 2\%$). Therefore, Duty Cycle Correction Factors of 3.19 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.

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 6 dB Bandwidth

Test Summary:

Test Engineer:	Muhammad Faiq Khan	Test Date:	23 December 2023
Test Sample Serial Number:	MD MR C28 014299 (Conducted Test Sample with SMA connector)		
Test Site Identification	SR 9		

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

Environmental Conditions:

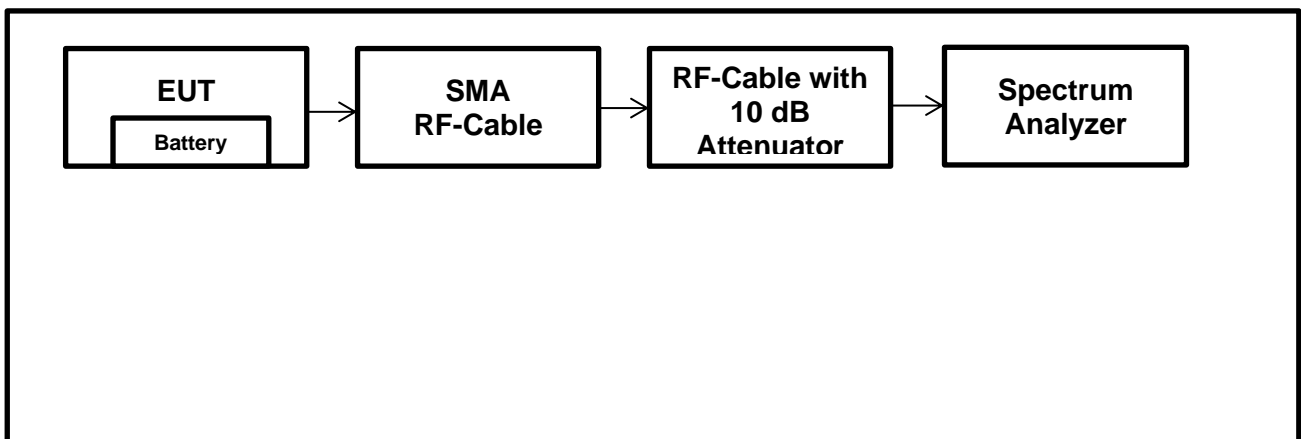
Temperature (°C):	23.1
Relative Humidity (%):	37.6

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.
 - o The SMA (Female) RF Cable soldered on PCB with maximum attenuation of 0.5 dB at the tested frequencies.
 - o 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.

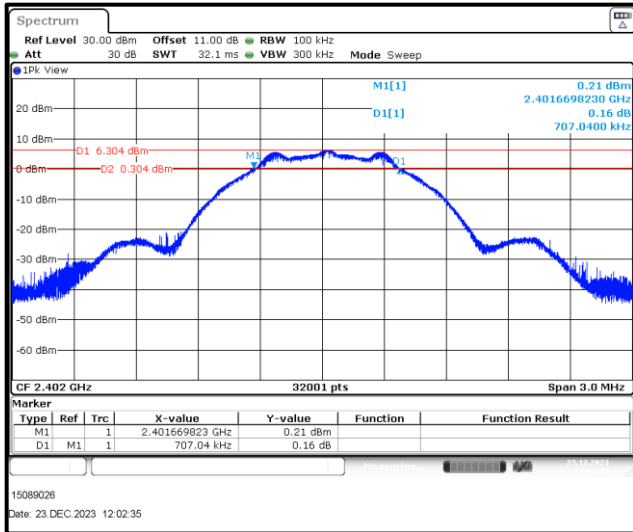
Test Setup:



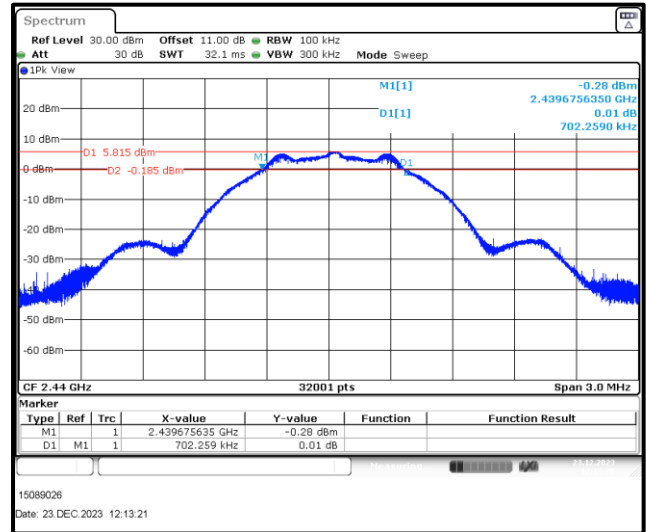
Transmitter Minimum 6 dB Bandwidth (continued)

Results: BT-LE Mode / TXRAND / PRBS9 / PWR MAX

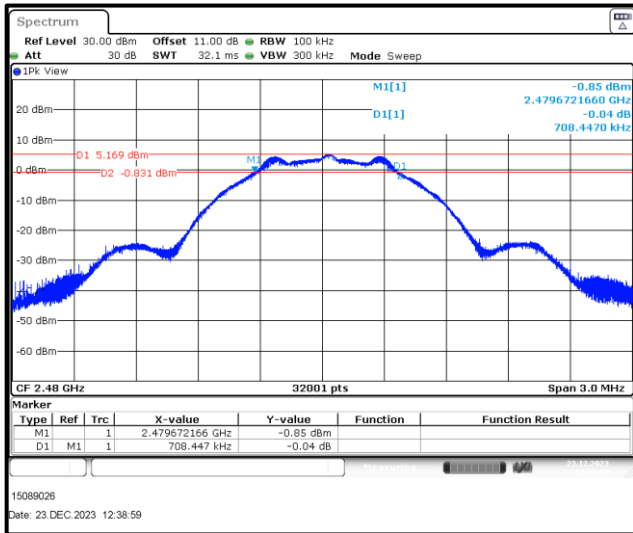
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	707.04	≥ 500	207.04	Complied
Middle	702.25	≥ 500	202.25	Complied
Top	708.44	≥ 500	208.44	Complied



Bottom Channel



Middle Channel



Top Channel

Result: **Pass**

5.2.2. Transmitter Duty Cycle

Test Summary:

Test Engineer:	Muhammad Faiq Khan	Test Date:	23 December 2023
Test Sample Serial Number:	MD MR C28 014313 (Radiated Test Sample)		
Test Site Identification	SR 1/2		

FCC Reference:	Part 15.35(c)
Test Method Used:	FCC KDB 558074 Section 6 referencing ANSI C63.10 Section 11.6

Environmental Conditions:

Temperature (°C):	20.9
Relative Humidity (%):	39.6

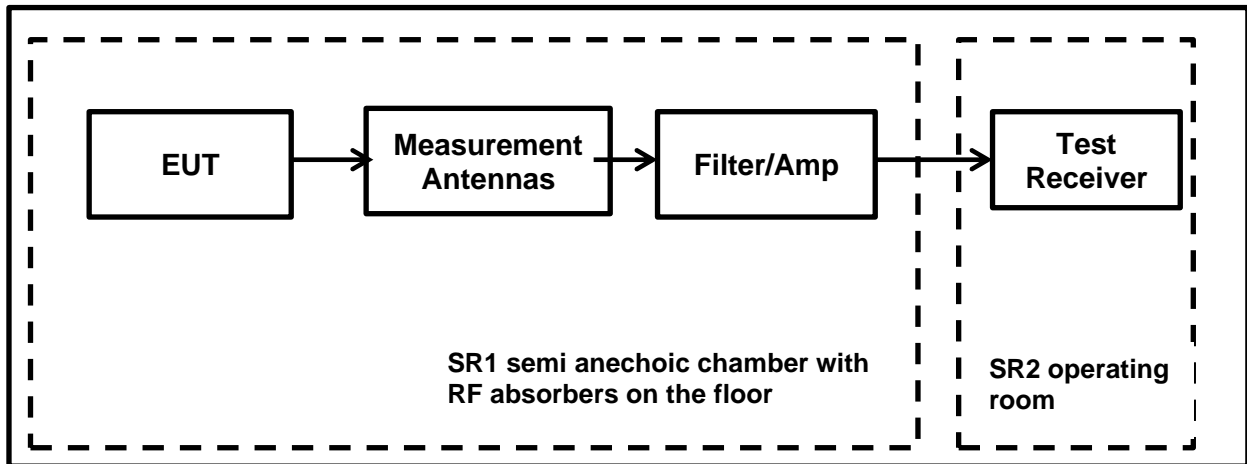
Note:

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

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

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

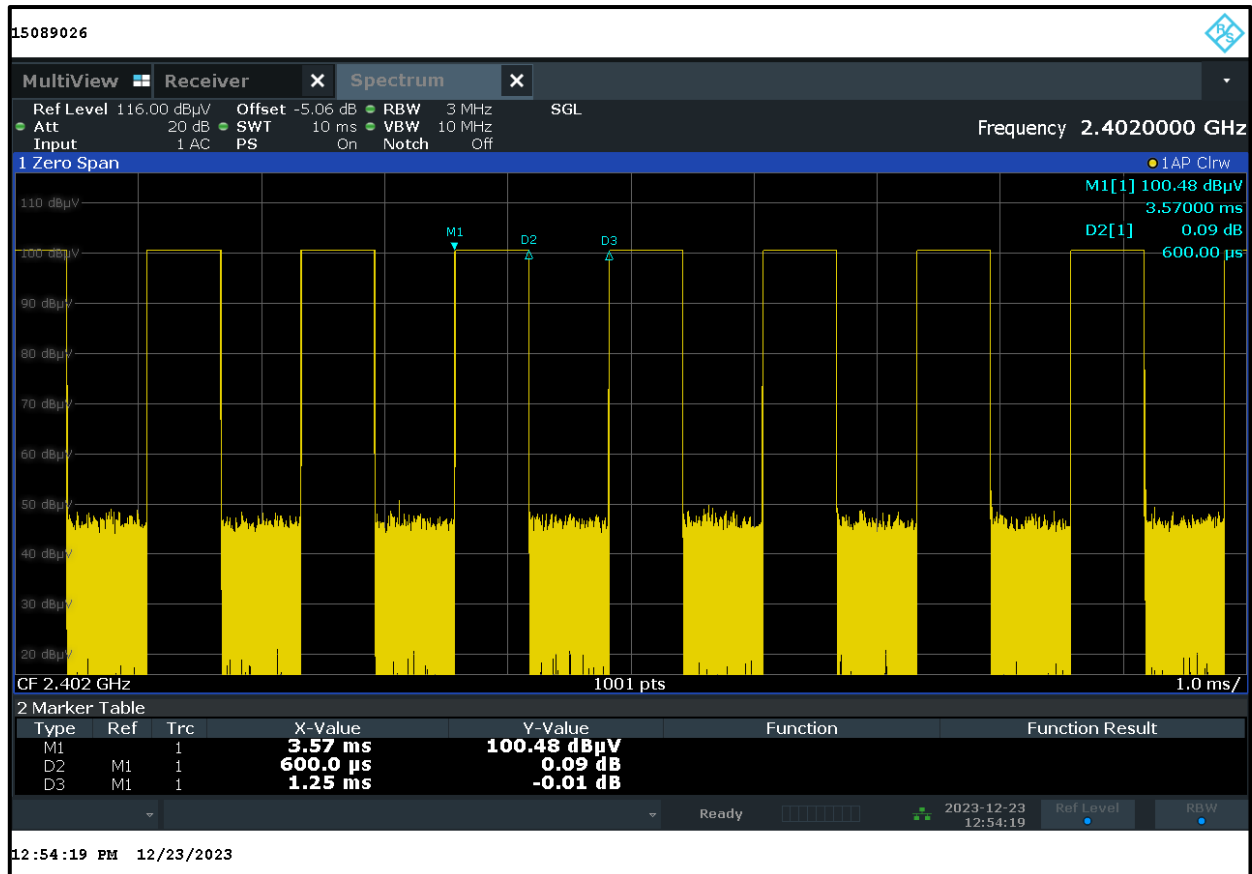
Test Setup:



Transmitter Duty Cycle (continued)

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

Pulse On Time (T _{ON}) (ms)	Pulse Period (T _{ON} +T _{OFF}) (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
0.6	1.25	48	3.19



5.2.3. Transmitter Maximum Peak Output Power

Test Summary:

Test Engineer:	Muhammad Faiq Khan	Test Date:	23 December 2023
Test Sample Serial Number:	MD MR C28 014299 (Conducted Test Sample with SMA connector)		
Test Site Identification	SR 9		

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

Environmental Conditions:

Temperature (°C):	23.1
Relative Humidity (%):	37.6

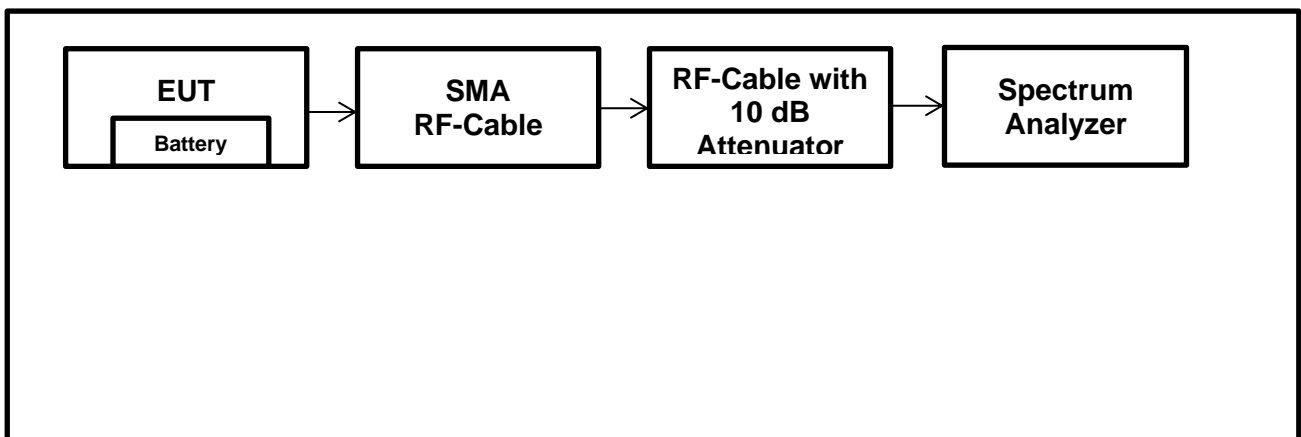
Notes:

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. 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.
 - o The SMA (Female) RF Cable soldered on PCB with maximum attenuation of 0.5 dB at the tested frequencies.
 - o 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 / TXRAND / PRBS9 / PWR MAX

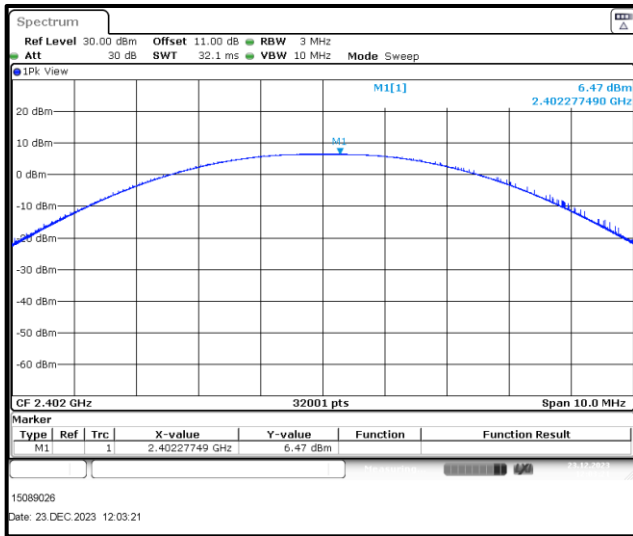
Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	6.47	30.00	23.53	Complied
Middle	5.97	30.00	24.03	Complied
Top	5.33	30.00	24.67	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	6.47	-1.78	4.69	36.00	31.31	Complied
Middle	5.97	-1.78	4.19	36.00	31.81	Complied
Top	5.33	-1.78	3.55	36.00	32.45	Complied

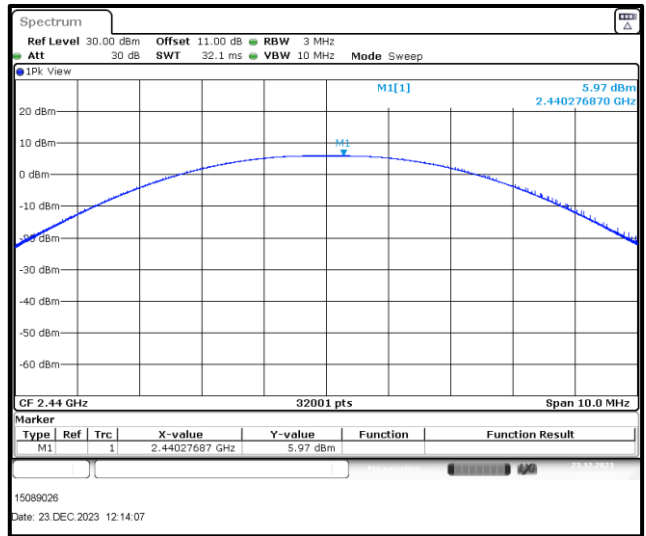
Result: Pass

Transmitter Maximum Peak Output Power (continued)

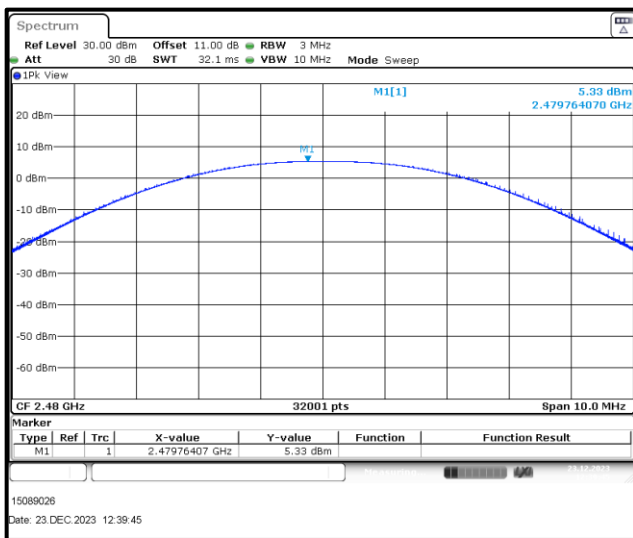
Results: BT-LE Mode / TXRAND / PRBS9 / PWR MAX



Bottom Channel



Middle Channel



Top Channel

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

Test Engineer:	Muhammad Faiq Khan	Test Date:	23 December 2023
Test Sample Serial Number:	MD MR C28 014313 (Radiated Test Sample)		
Test Site Identification	SR 1/2		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	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
Frequency Range	9 kHz to 30 MHz

Environmental Conditions:

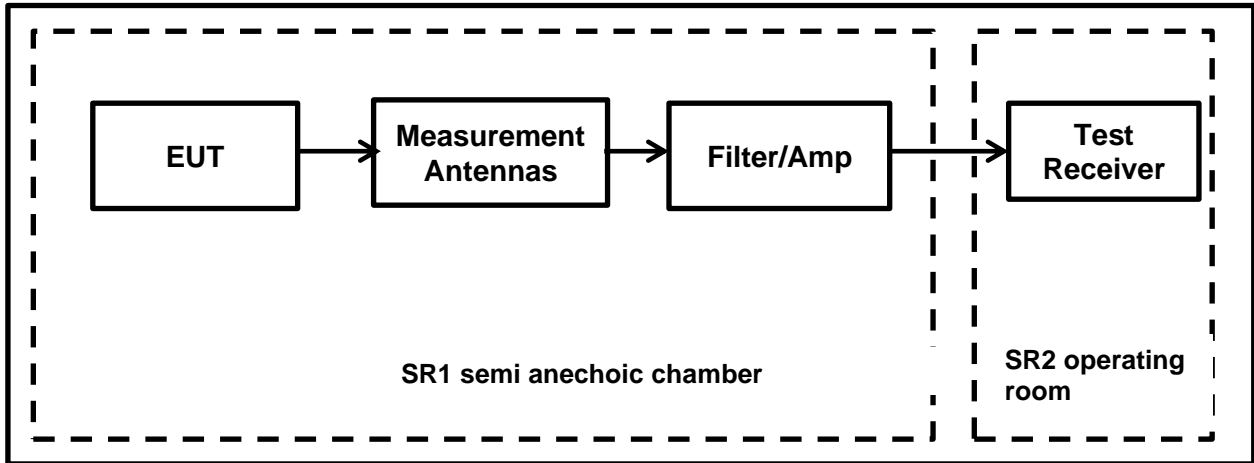
Temperature (°C):	20.9
Relative Humidity (%):	39.6

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 distance 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 measurement distance of 3m.
- 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.
- 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 in the centre of the chamber turntable at 80 cm height. The measurement loop antenna height was 100 cm.
- The radiated emissions measurements were performed with EUT set to following worst-case mode.
 - BT-LE | 1 Mbps | PRBS9 | PWR MAX | Bottom Channel |
- The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
- All other emissions shown on the pre-scan plots were investigated and found to be below system noise floor.
- 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

Transmitter Radiated Emissions (continued)

Test Setup:

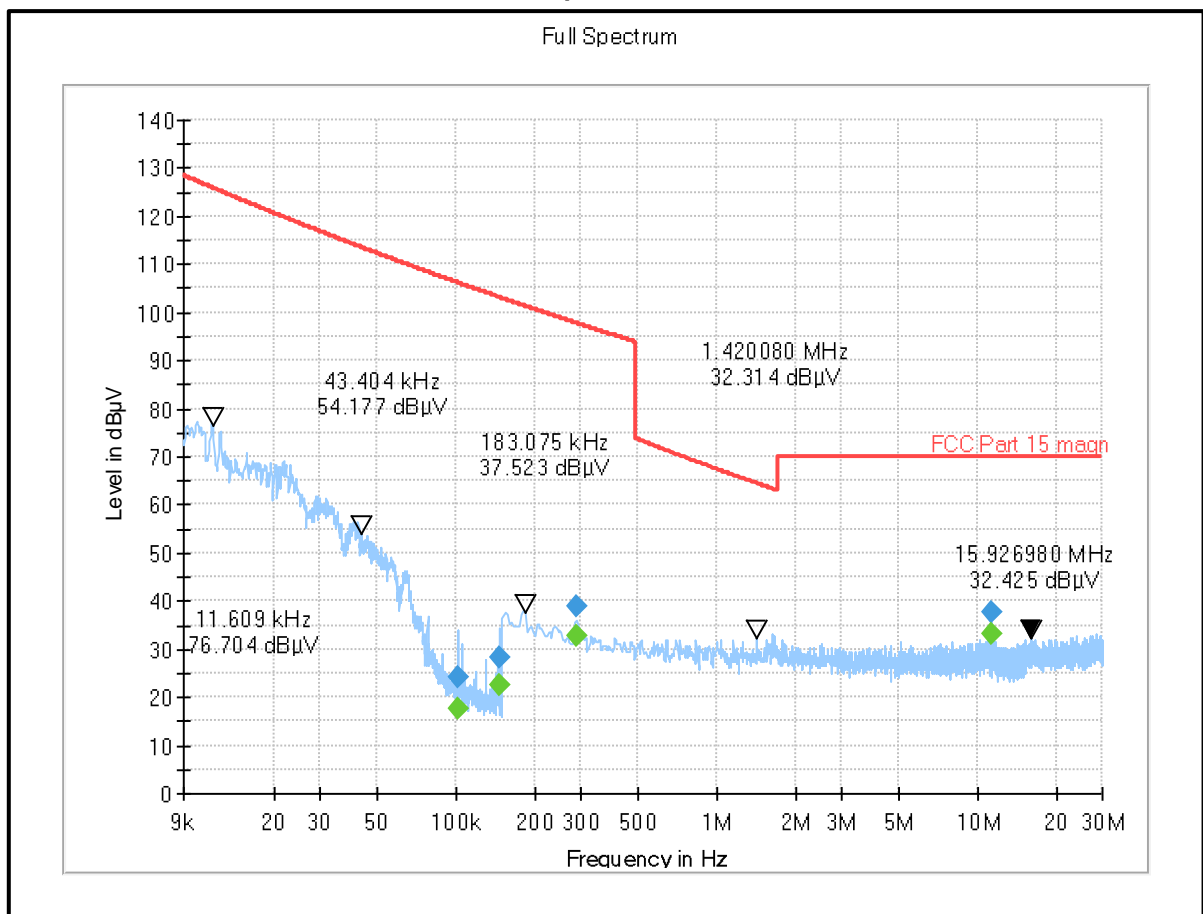


Transmitter Radiated Emissions (continued)

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

Frequency (MHz)	MaxPeak Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Loop Antenna Orientation	Result
0.101778	24.21	106.16	81.95	90° to EUT	Complied
0.145982	28.16	103.19	75.02	90° to EUT	Complied
0.288915	38.90	97.78	58.88	0° to EUT	Complied
11.238.290	37.73	70.00	32.27	0° to EUT	Complied

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



Result: Pass

Transmitter Radiated Emissions (continued)

Test Summary:

Test Engineer:	Muhammad Faiq Khan	Test Date:	23 December 2023
Test Sample Serial Number:	MD MR C28 014313 (Radiated Test Sample)		
Test Site Identification	SR 1/2		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	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
Frequency Range	30 MHz to 1000 MHz

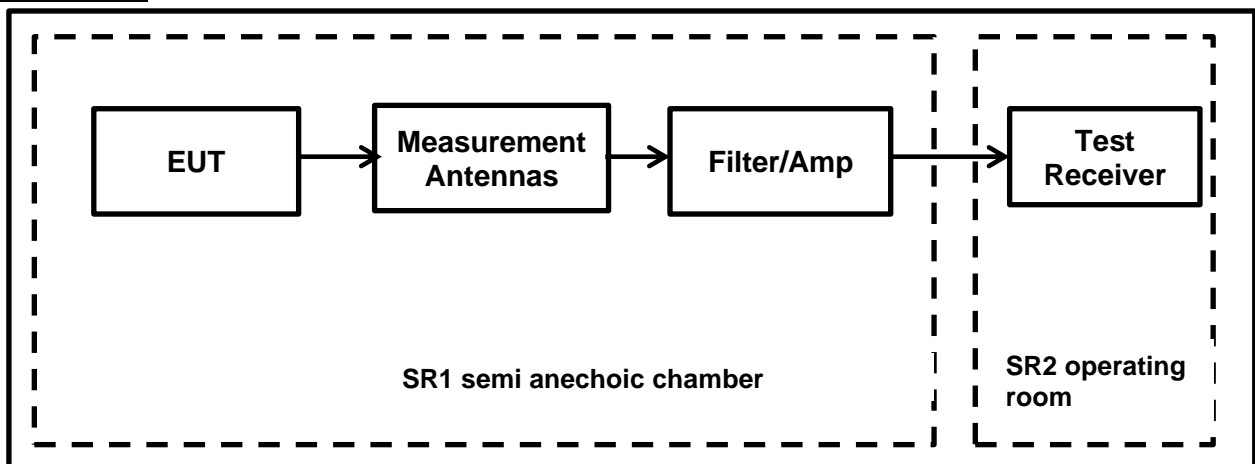
Environmental Conditions:

Temperature (°C):	20.9
Relative Humidity (%):	39.6

Note(s):

- 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.
- 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.
- The radiated emissions measurements were performed with EUT set to following worst-case mode.
 - BT-LE | 1 Mbps | PRBS9 | PWR MAX | Bottom Channel |
- The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
- All other emissions shown on the pre-scan plots were investigated and found to be below system noise floor.

Test Setup:

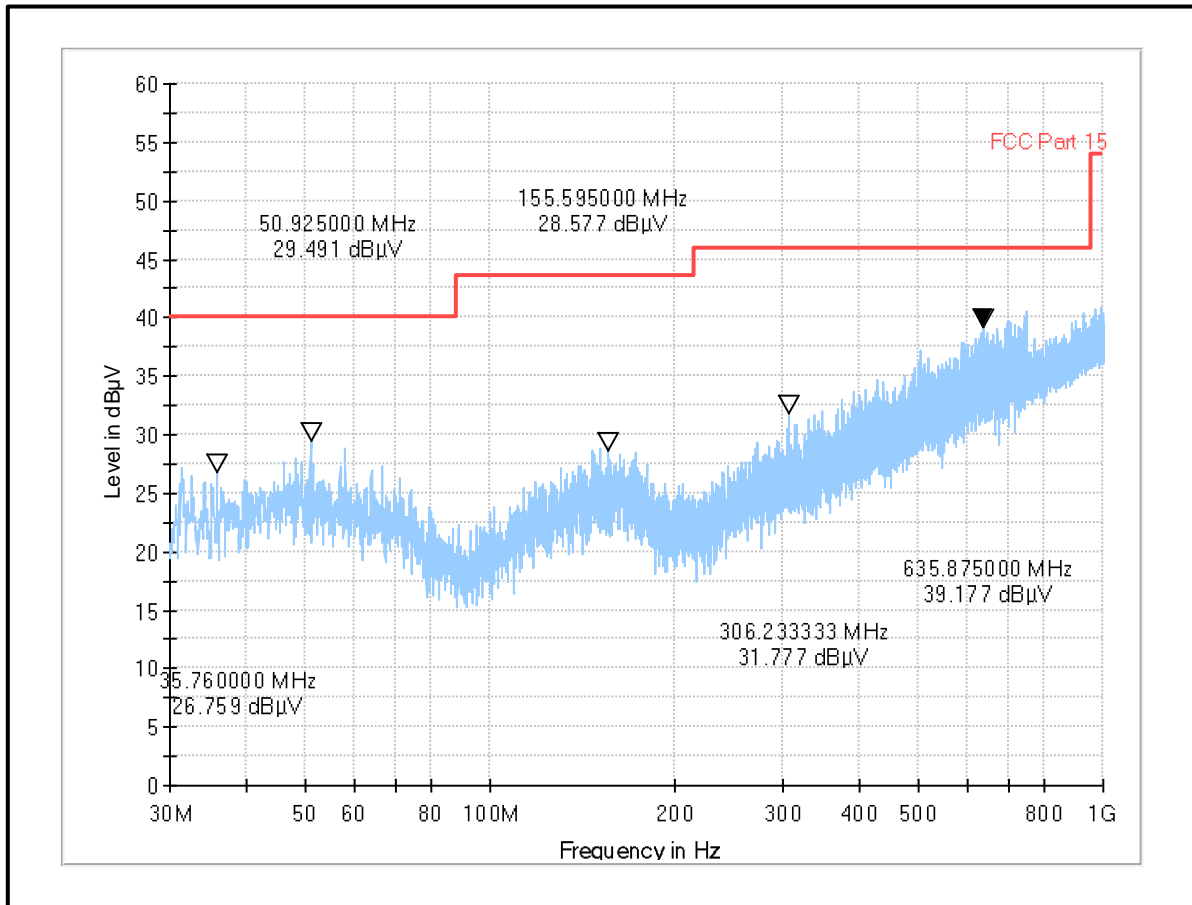


Transmitter Radiated Emissions (continued)

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

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

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



Result: Pass

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

Test Engineer:	Abbas Al-Hussainy	Test Date:	28 & 29 December 2023
Test Sample Serial Number:	MD MR C28 014313 (Radiated Test Sample)		
Test Site Identification	SR 1/2		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	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
Frequency Range	1 GHz to 26.5 GHz

Environmental Conditions:

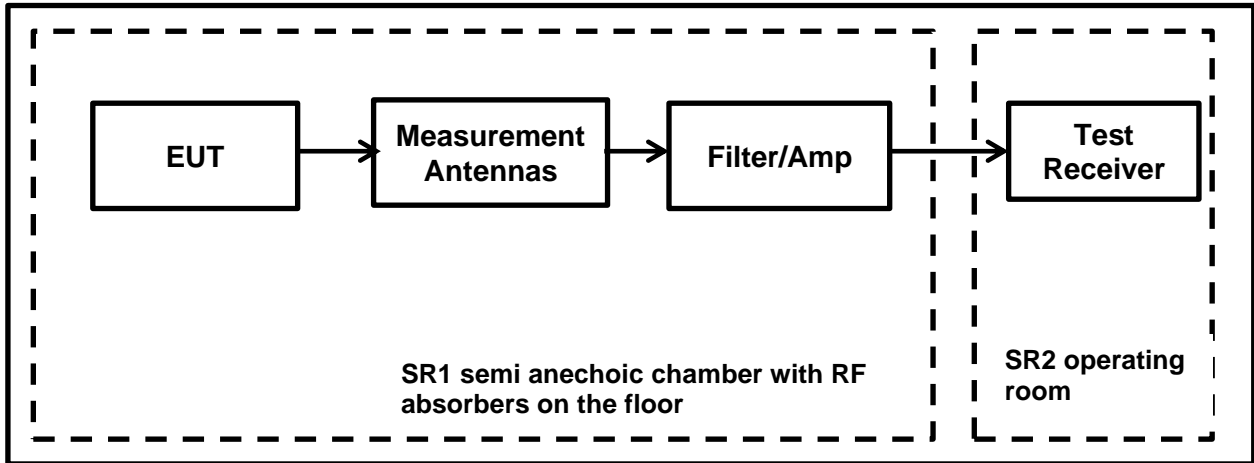
Temperature (°C):	20.4 to 21.1
Relative Humidity (%):	38.5 to 41.0

Note(s):

- 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.
- 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.
- The radiated emissions measurements were performed with EUT set to following worst-case mode.
 - BT-LE | 1 Mbps | PRBS9 | PWR MAX | Bottom Channel |
- Pre-scans were performed, and marker placed on the highest measured level of the plot. The test receiver RBW was set to 1 MHz and VBW 3 MHz. The sweep time was set to auto.
- The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
- All other emissions shown on the pre-scan plots were investigated and found to be below system noise floor.
- In accordance with ANSI C63.10 Section 6.6.4.3 (Note 1), if the peak measured value complies with the average limit, it is unnecessary to perform an average measurement.
- 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.
- For frequency range between 18 GHz and 26.5 GHz, on the pre-scan plots were investigated and found to be below system noise floor.

Transmitter Radiated Emissions (continued)

Test Setup:

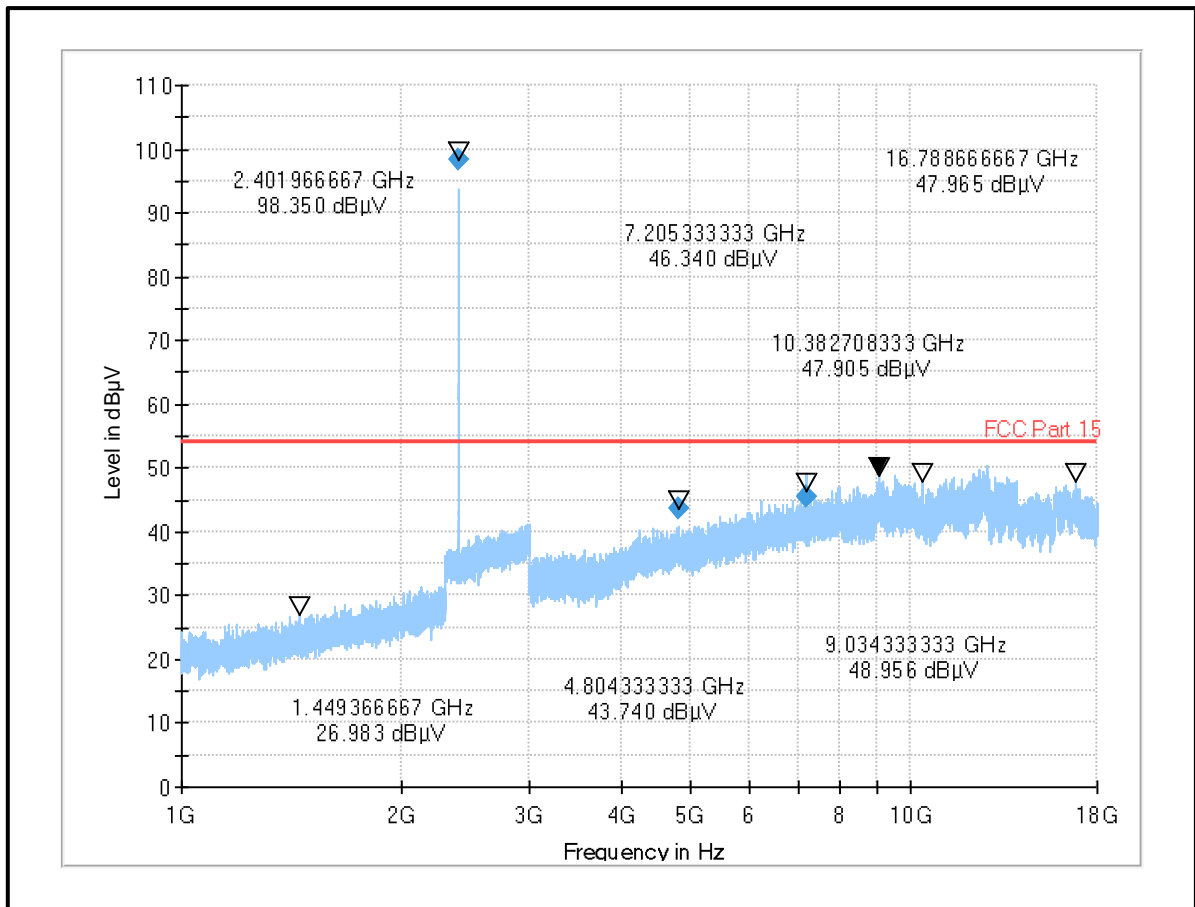


Transmitter Radiated Emissions (continued)

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

Frequency (MHz)	Antenna Polarization	MaxPeak Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
4804.333333	Vertical	43.74	54.00	10.26	Complied
7206.666667	Horizontal	45.40	54.00	8.60	Complied

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



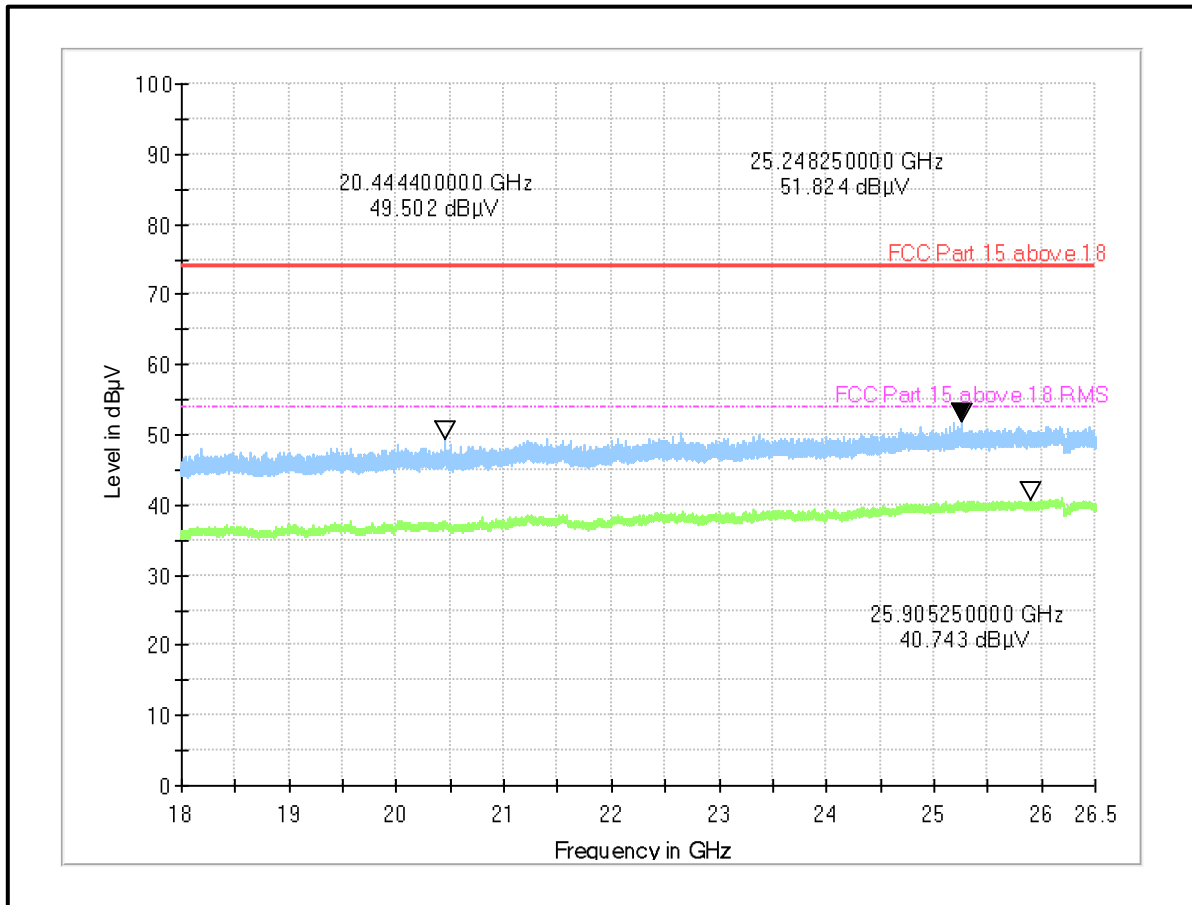
Result: Pass

Transmitter Radiated Emissions (continued)

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

Frequency (MHz)	Antenna Polarization	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
No critical spurious emissions were detected					

Plot: 18 GHz – 25 GHz: BT-LE / 1 Mbps / PRBS9 / PWR MAX / Bottom Channel



Result: Pass

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

Test Engineer:	Muhammad Faiq Khan	Test Date:	23 December 2023
Test Sample Serial Number:	MD MR C28 014313 (Radiated Test Sample)		
Test Site Identification	SR 1/2		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	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
	FCC KDB 558074 Section 8.7 referencing ANSI C63.10:2013 Sections 6.10.4, 6.10.5, 11.13

Environmental Conditions:

Temperature (°C):	20.4
Relative Humidity (%):	38.5

Note(s):

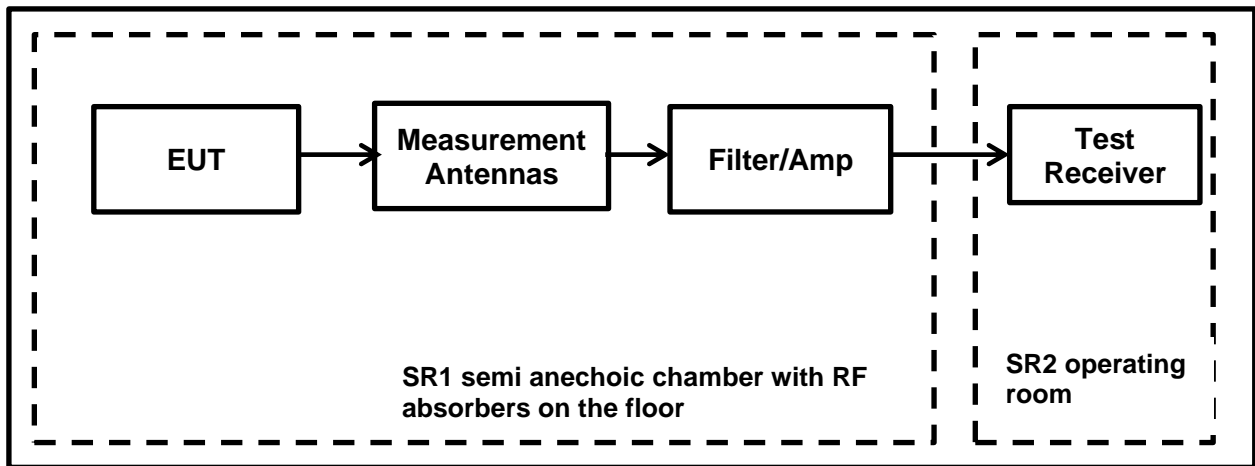
- The measurements were in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) with RF absorbers on the floor at a distance of 3 m. The EUT was placed at a height of 1.5 m above the test chamber floor in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 m to 4 m.
- 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.
- 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.
- The restricted band peak measurements were performed in accordance with ANSI C63.10 Section 11.12.2.4.
- 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.
- 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):

7. The EUT was configured with the following modes:
 - BT-LE | 1 Mbps | PRBS9 | PWR MAX |
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 48 % (duty cycle variations are less than $\pm 2\%$) in 1 Mbps data rates. Therefore, a Duty Cycle Correction Factor of 3.19 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 / 1 Mbps / PRBS9 / PWR MAX

Results: Lower Band Edge / Peak

Frequency (MHz)	Peak Level (dBµV/m)	-20 dBc Limit (dBµV/m)	Margin (dB)	Result
2399.95	45.40	78.03	32.63	Complied
2400.00	47.66	78.03	30.37	Complied

Results: 2310 to 2390 MHz Restricted Band / Peak

Frequency (MHz)	Peak Level (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Result
2388.60	49.39	74.00	24.61	Complied

Results: 2310 to 2390 MHz Restricted Band / Average

Frequency (MHz)	Average Level (dBµV/m)	Duty Cycle Correction Factor (dB)	Corrected Average Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2370.06	35.80	3.19	38.99**	54.0	15.01	Complied

Results: Upper Band Edge / Peak

Frequency (MHz)	Peak Level (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Result
2483.50	60.32	74.00	13.68	Complied
2483.90	55.10	74.00	18.90	Complied

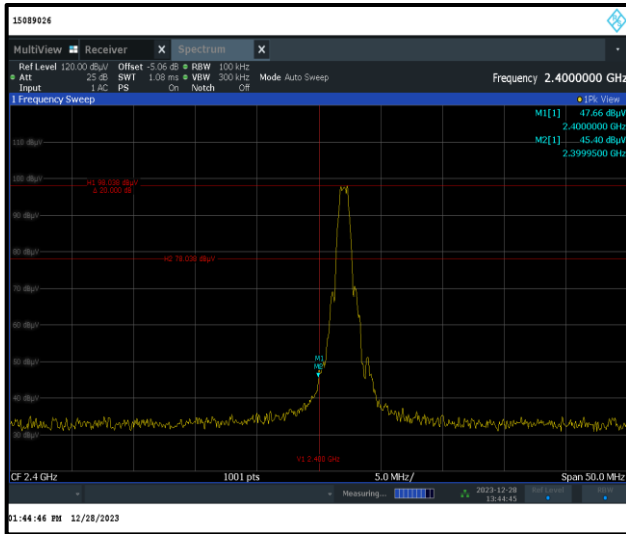
Results: Upper Band Edge / Average

Frequency (MHz)	Average Level (dBµV/m)	Duty Cycle Correction Factor (dB)	Corrected Average Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2483.50	36.85	3.19	40.04**	54.0	13.96	Complied
2483.58	36.76	3.19	39.95**	54.0	14.05	Complied

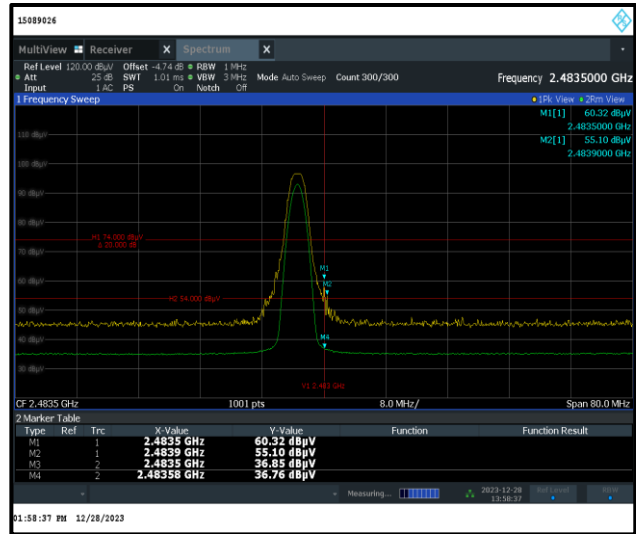
Result: **Pass**

Transmitter Band Edge Radiated Emissions (continued)

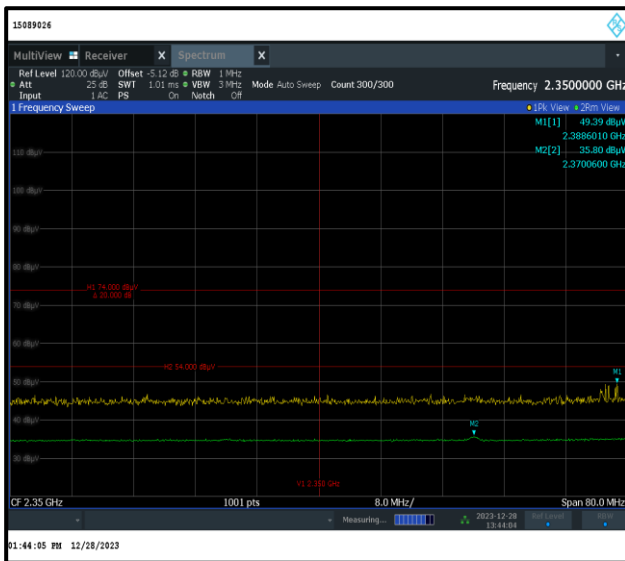
Results : BT-LE / 1 Mbps / PRBS9 / PWR MAX



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
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	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 9168	9168-240	02/09/2020	42
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	15/10/2019	54
669	Rohde & Schwarz	EMI Test Receiver	ESW 44	103087	13/07/2023	18
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
327	SPS	AC/DC power distribution system	PAS 5000	A2464 00/1 0200	lab verification	n/a
-/	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

Test site: SR 7/8

ID	Manufacturer	Type	Model	Serial No.	Calibration Date	Cal. Cycle
22	Rohde & Schwarz	Artificial Mains	ESH3-Z5	831767/014	18.07.2023	12
23	Rohde & Schwarz	Artificial Mains	ESH3-Z5	831767/013	18.07.2023	12
28	Rohde & Schwarz	Passive Probe	ESH2-Z3	none	13.07.2022	36
215	Rohde & Schwarz	Artificial Mains Network	ESH2-Z5	879675/002	18.07.2023	24
349	Rohde & Schwarz	Receiver, EMI Test	ESIB7	836697/009	18.07.2023	12
351	Rohde & Schwarz	network, Artificial Mains	ESH3-Z5	862770/018	18.07.2023	12
505	Rohde & Schwarz	Absorbing Clamp	MDS21	100005	21.07.2023	48

8. Report Revision History

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0	40	-	Initial Version
1.1	5	2.1	Applied FCC Rule part table updated
	6	2.2	Summary of Test Results table and notes updated
	6	2.3	Test method table updated
	8	3.4	Additional information table updated
	9	4.2	Configuration and peripherals notes updated
	11	5.2	Test results updated (deleted AC conducted emissions chapter)
	13	5.2.2	Test method updated
	14	5.2.2	Results table updated
	16	5.2.3	Results table updated with updated Antenna gain
	18, 21 & 23	5.2.4	Notes updated
	25	5.2.4	Results table updated
	28	5.2.5	Notes updated
	29	5.2.6	Results table updated with updated duty cycle
31	6	Table updated	
32	7	Used equipment table for SR1/2 updated	
<p>Test Report Version 1.2 supersedes Version 1.1 with immediate effect</p> <p>Test Report No. UL-RPT-RP-15089026-116-FCC Version 1.2, Issue Date 16 JANUARY 2024 replaces Test Report No. UL-RPT-RP-15089026-116-FCC Version 1.1, Issue Date 15 JANUARY 2024, which is no longer valid.</p>			
1.2	as below	as below	Current Version
	5.2.2	13	Test setup diagram updated
	5.2.4	23	Standard reference updated
	5.2.4	24	Test setup diagram updated
	5.2.5	28	Test setup diagram updated
32	7	Used equipment table for SR1/2 updated	

--- END OF REPORT ---