



Solutions

TEST REPORT

Test Report No.: UL-RPT-RP-14732015-116-FCC

Applicant * : Grundfos Holding A/S
Model No. * : 92563363
FCC ID * : FCC ID: OG3-UP001
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 1.2 supersede Version 1.1 with immediate effect**
Test Report No. UL-RPT-RP-14732015-116-FCC Version 1.2, Issue Date 30 AUGUST 2023 replaces
Test Report No. UL-RPT-RP-14732015-116-FCC Version 1.1, Issue Date 07 AUGUST 2023, which is no longer valid.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: 30 August 2023

Approved by: Rachid, Acharkaoui
Title: Operations Manager
Date: 30 August 2023



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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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Table of Contents

1. Customer Information *	4
1.1. Applicant Information	4
1.2. Manufacturer Information	4
2. Summary of Testing	5
2.1. General Information	5
Applied Standards	5
Location	5
Date Information	5
2.2. Summary of Test Results	6
2.3. Methods and Procedures	6
2.4. Deviations from the Test Specification	6
3. Equipment Under Test (EUT)	7
3.1. Identification of Equipment Under Test (EUT) *	7
3.2. Description of EUT *	7
3.3. Modifications Incorporated in the EUT	7
3.4. Additional Information Related to Testing *	8
3.5. Support Equipment	8
A. Support Equipment (In-house)	8
B. Support Equipment (Manufacturer supplied) *	8
4. Operation and Monitoring of the EUT during Testing	9
4.1. Operating Modes	9
4.2. Configuration and Peripherals	9
5. Measurements, Examinations and Derived Results	10
5.1. General Comments	10
5.2. Test Results	11
5.2.1. Transmitter AC Conducted Spurious Emissions	11
5.2.2. Transmitter Minimum 6 dB Bandwidth	14
5.2.3. Transmitter Maximum (Peak) Output Power	16
5.2.4. Transmitter Radiated Emissions	19
5.2.5. Transmitter Band Edge Radiated Emissions	28
6. Measurement Uncertainty	32
7. Used equipment	33
8. Report Revision History	34

1. Customer Information *

1.1. Applicant Information

Company Name:	Grundfos Holding A/S
Company Address:	Poul Due Jensens Vej 7, DK-8850 Bjerringbro, Denmark
Contact Person:	Kristian Baasch Thomsen
Contact E-Mail Address:	productcompliance@grundfos.com
Contact Phone No.:	+4587501400

1.2. Manufacturer Information

Company Name:	Grundfos Holding A/S
Company Address:	Poul Due Jensens Vej 7, DK-8850 Bjerringbro, Denmark
Contact Person:	Thomas Young Olesen
Contact E-Mail Address:	productcompliance@grundfos.com
Contact Phone No.:	+4587501400

2. Summary of Testing

2.1. General Information

Applied Standards

Specification Reference:	47CFR15.247
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
Specification Reference:	47CFR15.207 and 47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.207 and 15.209

Location

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

Date Information

Order Date:	20 March 2023
EUT Arrived:	27 March 2023
Test Dates:	03 April 2023 to 05 April 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	<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 ⁽²⁾	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Part 15.247(e)	Transmitter Power Spectral Density ⁽¹⁾	<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"/>
C: COMPLIED N.C.: NOT COMPLIED N.P.: NOT PERFORMED N.A.: NOT APPLICABLE					
<p>Decision rule: If the decision rule is not included in the applied customer specification or testing standard, the binary statement for simple acceptance, as defined in ILAC G8: 2019 Section 4.2.1, is applied as the decision rule for a pass/ fail statement. If the measured value is on the limit, the result is defined as a pass. In this case the risk of a false positive is 50%. For further information regarding risk assessment refer to ILAC G8: 2019.</p>					

Note(s):

1. 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. The measurement was performed to assist the average measurements.

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) *

Brand Name:	Grundfos
Model Name or Number:	92563363
Test Sample Serial Number:	Not Serialised (Radiated Test Sample)
Hardware Version Number:	R09
Firmware Version Number:	92811431V06.00.01.00001
FCC ID:	FCC ID: OG3-UP001

Brand Name:	Grundfos
Model Name or Number:	92563363
Test Sample Serial Number:	Not Serialised (Conducted Test Sample)
Hardware Version Number:	R09
Firmware Version Number:	92811431V06.00.01.00001
FCC ID:	FCC ID: OG3-UP001

3.2. Description of EUT *

The equipment under test was Radio module PCBA for Grundfos pumps providing smart device connectivity, with Model Nr. 92563363; 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 *

Technology Tested:	Bluetooth – Low Energy		
FCC 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):	2 Mbps	GFSK	
Maximum Conducted Output Power:	1.78 dBm		
Declared Antenna Gain:	Max -0.41 dBi		
Antenna Type:	IFA		
Antenna Details:	PIFA Coplanar Inverted F Antenna, Grundfos		
Transmit Channels Tested:	Channel ID	RF Channel	Frequency (MHz)
	Bottom	37	2402
	Middle	17	2440
	Top	39	2480
Power Supply Requirement(s):	5V DC with USB-UART cable via Laptop 115V AC / 60 Hz		
Highest internally generated clock and/ or oscillator frequency:	2480 MHz BLE upper TX frequency 48 MHz (Oscillator frequency for BLE radio) 32 MHz (oscillator frequency for internal CPU clock)		

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	Laptop PC with Test Software: BleServiceTool	HP	Elitebook	-/-

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
 - Data Rate: 2 Mbps | Packet Type: PRBS9 | Power Settings: Max | Channel: Bottom / Middle / Top

4.2. Configuration and Peripherals

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

EUT Power Supply:

- The EUT used for the conducted measurement was powered with 5 V DC through an USB-UART Cable via laptop.
- The EUT used for all other measurements was powered by AC mains 115V AC / 60 Hz.

Test Mode Activation:

- The EUT used for conducted measurement can be connected with the Test laptop via USB-UART cable supplied by the customer. The cable was also connected during the measurement.
- The EUT used for all other measurements can be connected with the Test Laptop vis USB-Serial control box. The cables were removed during the measurement.
- The test modes were activated using the test software / Radio Tool "BleServiceTool". This test software / Radio Tool was installed on the customer test laptop to enable continuous transmission and to select the required test channels.

AC Conducted Emissions Measurements:

- The EUT radiated sample was used for AC conducted emissions measurement.
- For AC conducted line emissions measurement the EUT was powered with 115 VAC / 60 Hz as defined by customer.
- The Toyo EMI Software EP5/CE Ver 4.0.1. was used for these measurements.

Conducted Measurements:

- All conducted measurements were carried out by using the EUT RF sample with SMA cable soldered on to the PCB. The SMA RF cable's attenuation (maximum 0.5 dB@2.4GHz) was added to 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 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 ($D \geq 98\%$) can be achieved and EUT was transmitting continuously with 100% duty cycle (+/- 2% tolerance). No Duty Cycle Correction Factors were 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 AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	Muhammad Faiq Khan	Test Date:	05 April 2023
Test Sample Serial Number:	Not Serialised (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):	23.5
Relative Humidity (%):	35.8

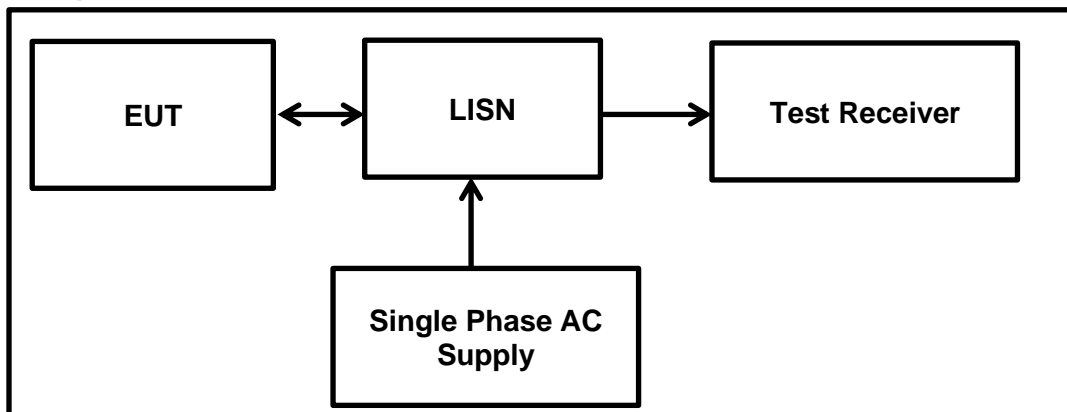
Settings of the Instrument

Detector	Quasi Peak/ Average
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Note(s):

1. The EUT was powered with 115 VAC / 60 Hz as defined by customer.
2. The EUT was configured with the following modes:
 - BT-LE | 2 Mbps | PRBS9 | PWR Max | Bottom Channel
3. 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.
4. The final measured value, for the given emission, in the table below incorporates the cable loss.
5. 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.
6. 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.
7. Measurement software used: Toyo EMI Software; CE measurement software EP5/CE Ver 4.0.1.

Test Setup:



Transmitter AC Conducted Spurious Emissions (continued)**Results: BT-LE | 2 Mbps | PRBS9 | PWR Max | Bottom Channel****Results: Live / Quasi Peak / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.160530	Live	35.10	65.40	30.30	Complied
0.885670	Live	22.50	56.00	33.50	Complied
2.526030	Live	23.70	56.00	32.30	Complied
13.899350	Live	26.10	60.00	33.90	Complied
18.331000	Live	28.00	60.00	32.00	Complied
22.012650	Live	27.40	60.00	32.60	Complied

Results: Live / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.160530	Live	24.40	55.40	31.00	Complied
0.885670	Live	16.40	46.00	29.60	Complied
2.526030	Live	15.00	46.00	31.00	Complied
13.899350	Live	19.80	50.00	30.20	Complied
18.331000	Live	21.30	50.00	28.70	Complied
22.012650	Live	20.80	50.00	29.20	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.183260	Neutral	33.10	64.30	31.20	Complied
0.434570	Neutral	24.50	57.20	32.70	Complied
0.911800	Neutral	27.10	56.00	28.90	Complied
1.967140	Neutral	26.30	56.00	29.70	Complied
14.698450	Neutral	27.30	60.00	32.70	Complied
18.883270	Neutral	29.60	60.00	30.40	Complied

Transmitter AC Conducted Spurious Emissions (continued)

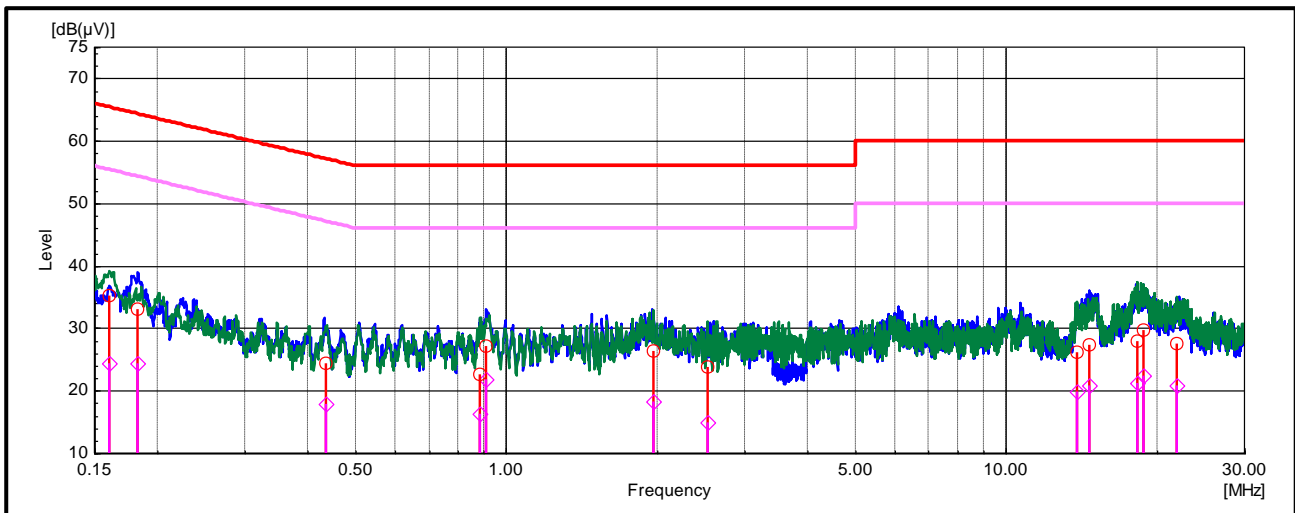
Results: BT-LE | 2 Mbps | PRBS9 | PWR Max | Bottom Channel

Results: Neutral / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.183260	Neutral	24.40	54.30	29.90	Complied
0.434570	Neutral	17.90	47.20	29.30	Complied
0.911800	Neutral	21.90	46.00	24.10	Complied
1.967140	Neutral	18.20	46.00	27.80	Complied
14.698450	Neutral	20.90	50.00	29.10	Complied
18.883270	Neutral	22.50	50.00	27.50	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.

5.2.2. Transmitter Minimum 6 dB Bandwidth

Test Summary:

Test Engineer:	Muhammad Faiq Khan	Test Date:	03 April 2023
Test Sample Serial Number:	Not Serialised (Conducted Test Sample)		
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:

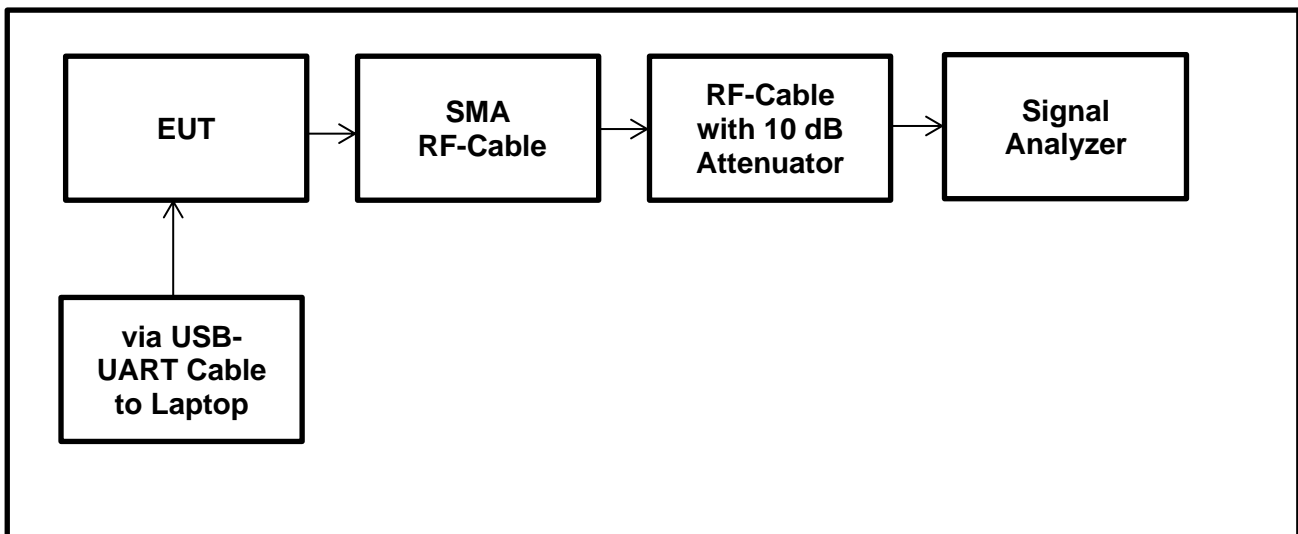
Temperature (°C):	22.2
Relative Humidity (%):	32.9

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. The RF port on the EUT was connected to the spectrum analyser using suitable attenuation and RF cable. The measured values takes into consideration the external attenuation correction factors.
 - The SMA (Female) RF Cable soldered on PCB with maximum attenuation of 0.4 dB at the tested frequencies.
 - The RF cable attenuation maximum 0.6 dB@2.4GHz from the EUT to Analyzer including the 10 dB attenuation at the input of Spectrum Analyzer

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

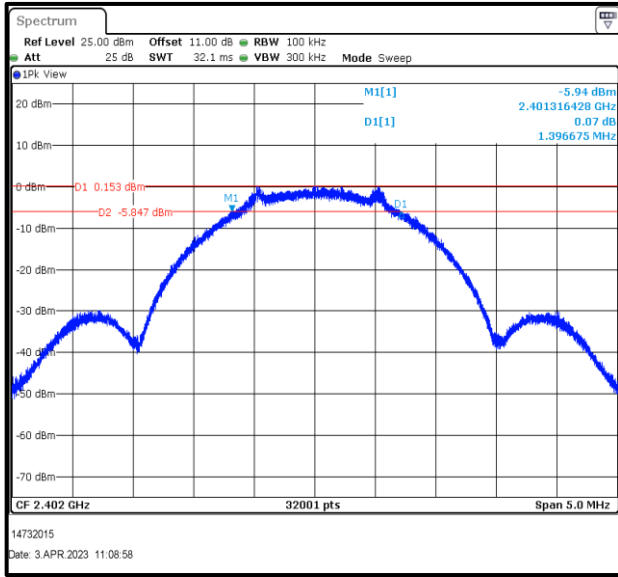
Test Setup:



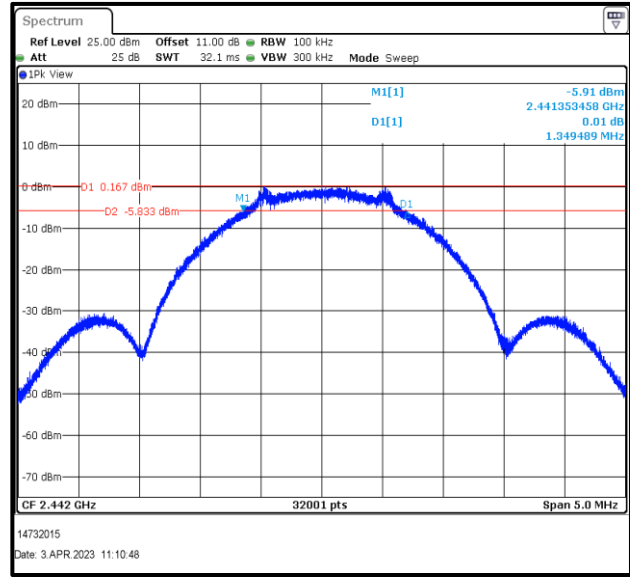
Transmitter Minimum 6 dB Bandwidth (continued)

Results: BT-LE / 2 Mbps / PRBS9 / PWR Max

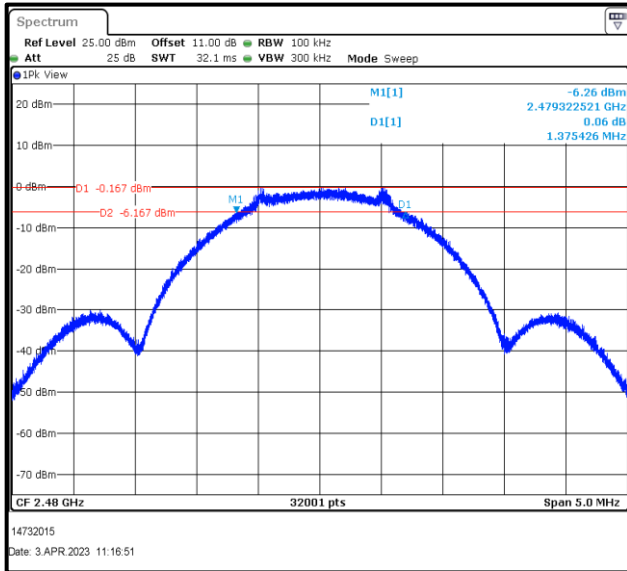
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	1396.675	≥ 500	896.675	Complied
Middle	1349.489	≥ 500	849.489	Complied
Top	1375.426	≥ 500	875.426	Complied



Bottom Channel



Middle Channel



Top Channel

Result: Pass

5.2.3. Transmitter Maximum (Peak) Output Power

Test Summary:

Test Engineer:	Muhammad Faiq Khan	Test Date:	03 April 2023
Test Sample Serial Number:	Not Serialised (Conducted Test Sample)		
Test Site Identification	SR 9		

FCC Reference:	Part 15.247(b)(3)
Test Method Used:	FCC KDB 558074 Section 8.3.1.3 referencing ANSI C63.10 Sections 11.9.1.1

Environmental Conditions:

Temperature (°C):	22.2
Relative Humidity (%):	32.9

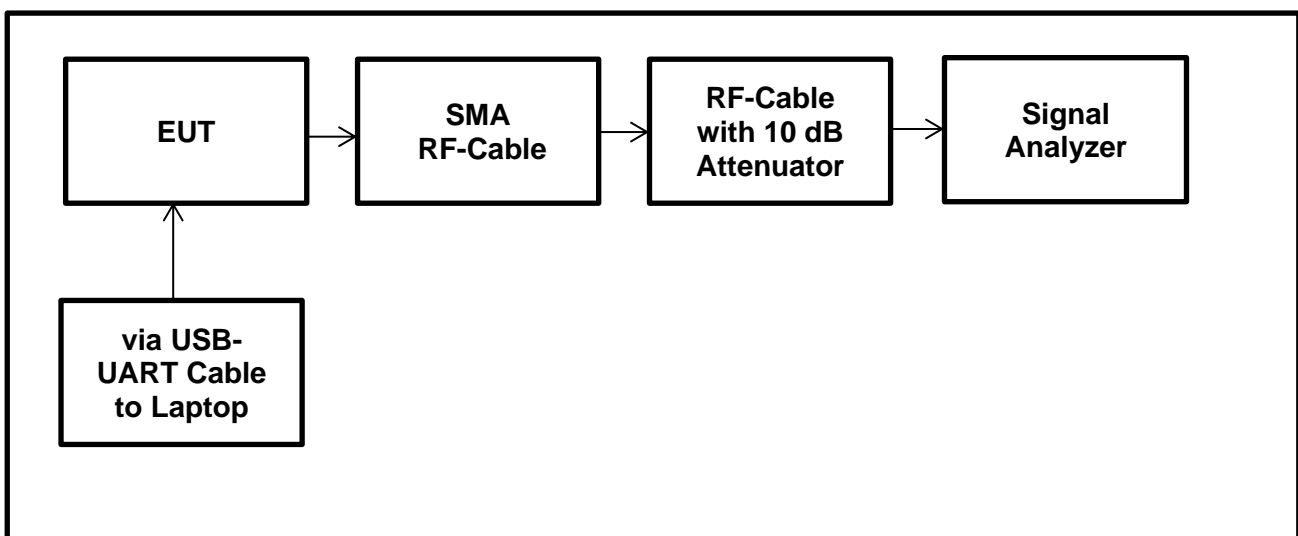
Notes:

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 takes into consideration the external attenuation correction factors.
 - The SMA (Female) RF Cable soldered on PCB with maximum attenuation of 0.4 dB at the tested frequencies.
 - The RF cable attenuation maximum 0.6 dB@2.4GHz from the EUT to RF power meter including the 10 dB attenuation at the input of RF power meter.

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

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 / 2 Mbps / PRBS9 / PWR Max**

Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	1.78	30.00	28.22	Complied
Middle	1.73	30.00	28.27	Complied
Top	1.41	30.00	28.59	Complied

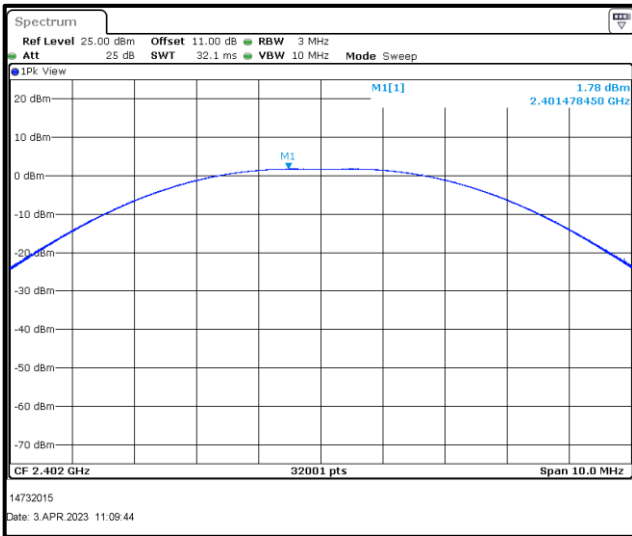
Results EIRP: BT-LE / 2 Mbps / PRBS9 / PWR Max

Channel	Conducted Peak Power (dBm)	Declared Stitched Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	1.78	-0.41	1.37	36.00	34.63	Complied
Middle	1.73	-0.41	1.32	36.00	34.68	Complied
Top	1.41	-0.41	1.00	36.00	35.00	Complied

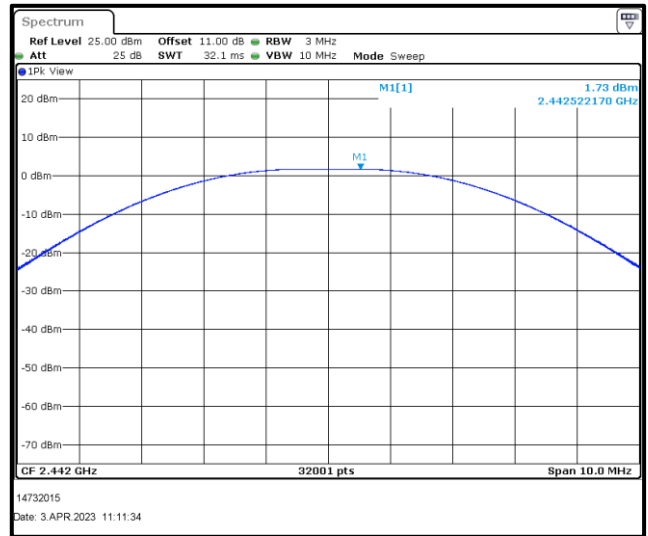
Result: Pass

Transmitter Maximum Peak Output Power (continued)

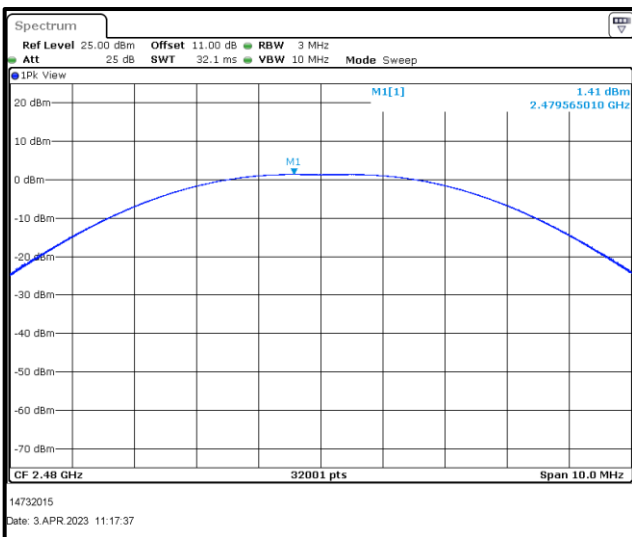
Plots: BT-LE / 1 Mbps / PRBS9 / PWR Max



Bottom Channel



Middle Channel



Top Channel

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

Test Engineer:	Muhammad Faiq Khan	Test Date:	03 April 2023
Test Sample Serial Number:	Not Serialised (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:

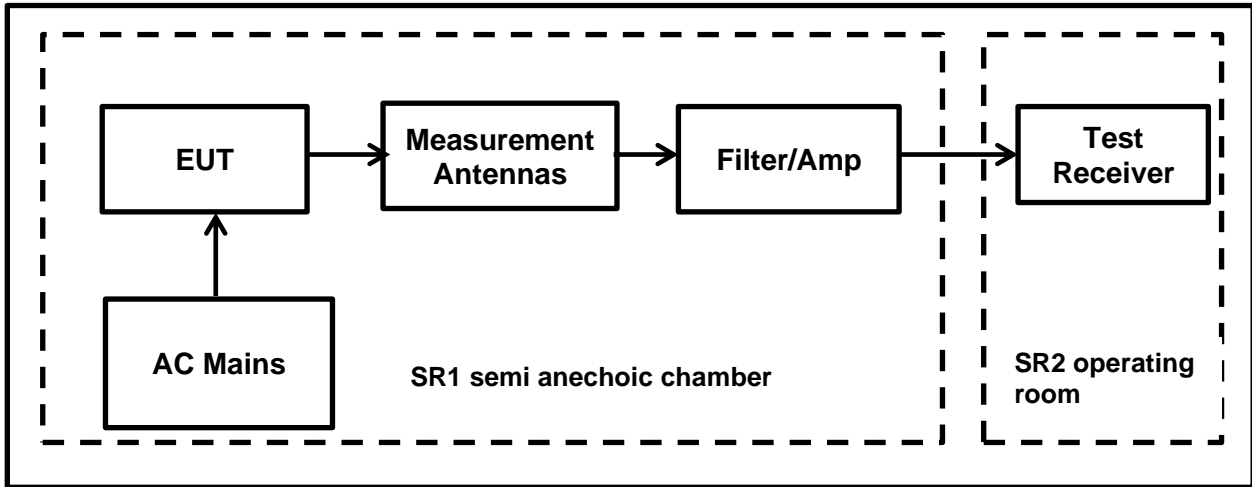
Temperature (°C):	21.4
Relative Humidity (%):	35.2

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.
- 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 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.
- In accordance with FCC KDB 996369 D04 Section 3.4 (b) the Host Product testing has been performed on unwanted (spurious) radiated emissions on the worst-case modulation and channel per frequency range as shown in original filing.
- The EUT was configured with the following modes:
 - BT-LE | 2 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.
- 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:

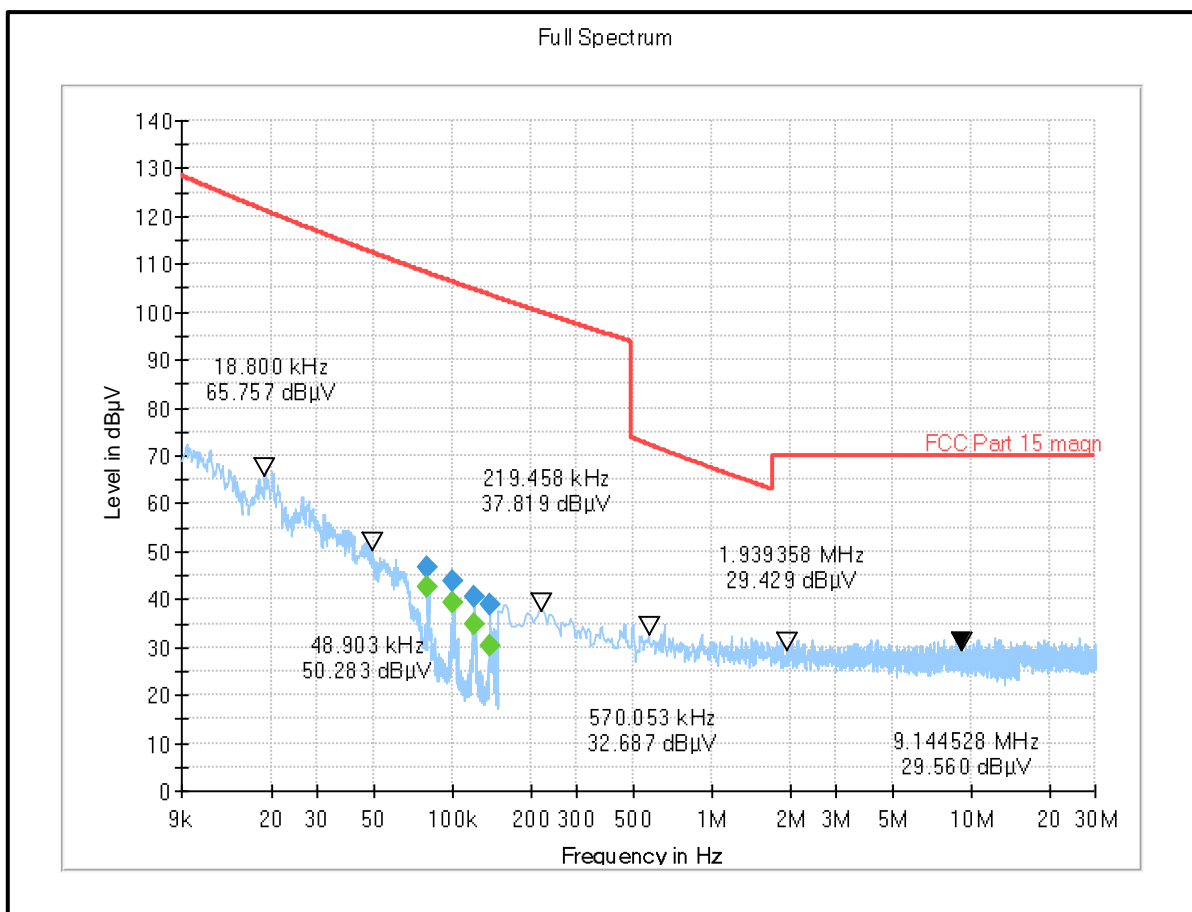


Transmitter Radiated Emissions (continued)

Results: BT-LE / 2 Mbps / PRBS9 / Bottom Channel / PWR Max

Frequency (MHz)	Loop Antenna Orientation	MaxPeak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
0.080064	0° to the EUT	46.70	108.18	61.48	Complied
0.100157	0° to the EUT	43.94	106.29	62.35	Complied
0.120179	0° to the EUT	40.36	104.78	64.42	Complied
0.140201	0° to the EUT	38.96	103.51	64.55	Complied

Plot: 9 kHz – 30 MHz: BT-LE / 2 Mbps / PRBS9 / PWR Max / Bottom Channel



Result: Pass

Transmitter Radiated Emissions (continued)

Test Summary:

Test Engineer:	Muhammad Faiq Khan	Test Date:	03 April 2023
Test Sample Serial Number:	Not Serialised (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

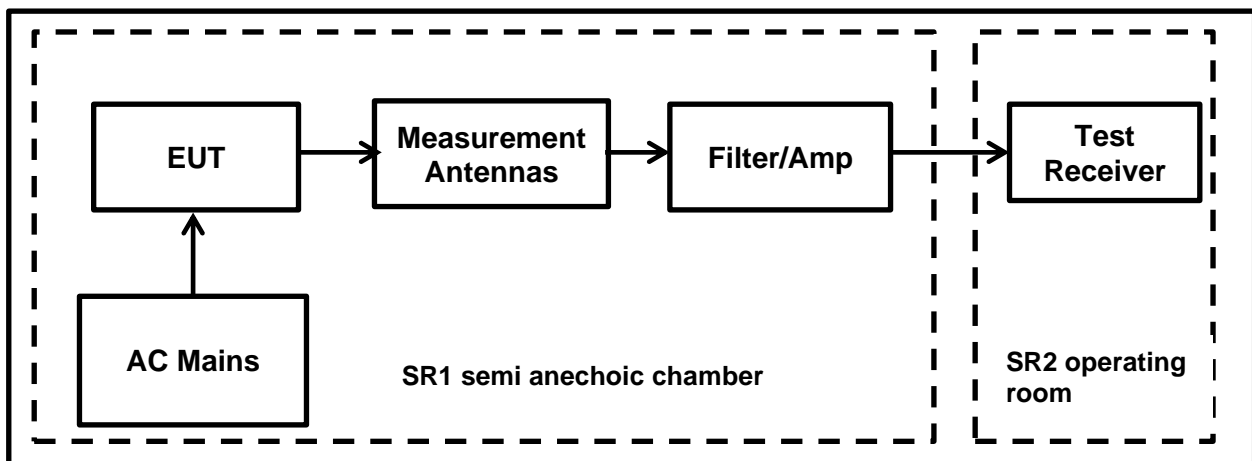
Environmental Conditions:

Temperature (°C):	21.4
Relative Humidity (%):	35.2

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.
- In accordance with FCC KDB 996369 D04 Section 3.4 (b) the Host Product testing has been performed on unwanted (spurious) radiated emissions on the worst-case modulation and channel per frequency range as shown in original filing.
- The EUT was configured with the following modes:
 - BT-LE | 2 Mbps | PRBS9 | PWR Max | Bottom Channel
- 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 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 plot were investigated and found to be below the measurement system noise floor.

Test Setup:

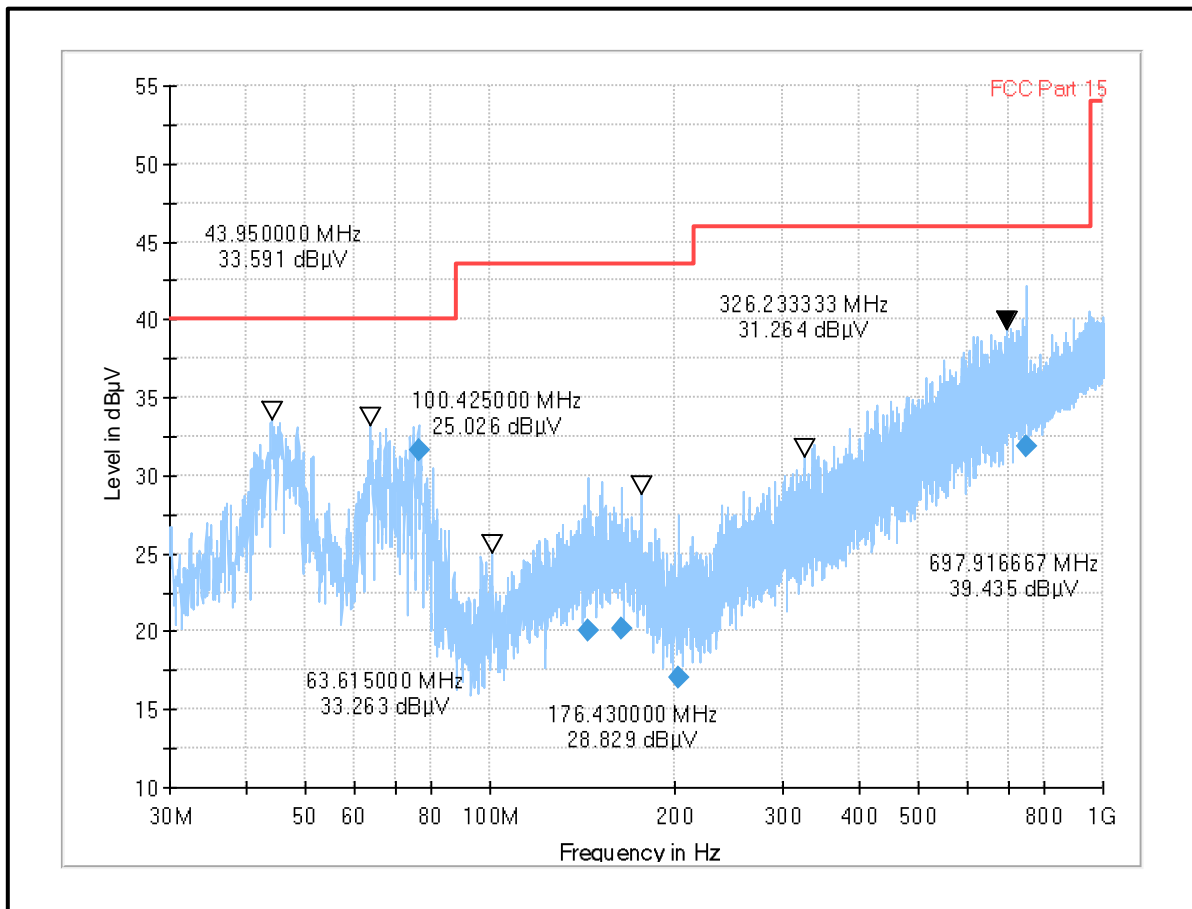


Transmitter Radiated Emissions (continued)

Results: BT-LE / 2 Mbps / PRBS9 / Bottom Channel / PWR Max

Frequency (MHz)	Antenna Polarization	MaxPeak Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
76.350000	Vertical	31.63	40.00	8.37	Complied
144.300000	Vertical	20.08	43.50	23.42	Complied
163.920000	Vertical	20.23	43.50	23.27	Complied
203.520000	Vertical	17.08	43.50	26.42	Complied
750.000000	Horizontal	31.86	46.00	14.14	Complied

Plot: 30 MHz – 1GHz: BT-LE / 2 Mbps / PRBS9 / PWR Max / Bottom Channel



Result: Pass

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

Test Engineer:	Muhammad Faiq Khan	Test Date:	03 April 2023
Test Sample Serial Number:	Not Serialised (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 6.6
Frequency Range:	1 GHz to 25 GHz

Environmental Conditions:

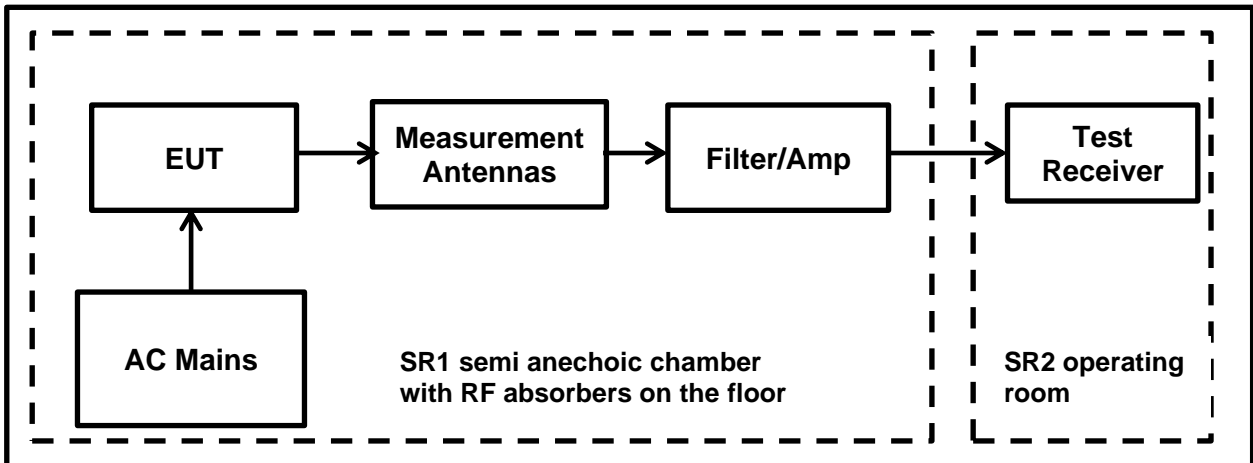
Temperature (°C):	23.9
Relative Humidity (%):	37.0

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.
- In accordance with FCC KDB 996369 D04 Section 3.4 (b) the Host Product testing has been performed on unwanted (spurious) radiated emissions on the worst-case modulation and channel per frequency range as shown in original filing.
- The EUT was configured with the following modes:
 - BT-LE | 2 Mbps | PRBS9 | PWR Max | Bottom 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.
- For frequency range between 18 GHz and 25 GHz, no critical emissions were found. All emissions shown on the pre-scans were investigated and found to be below the noise floor of the measurement system

Transmitter Radiated Emissions (continued)

Test Setup:

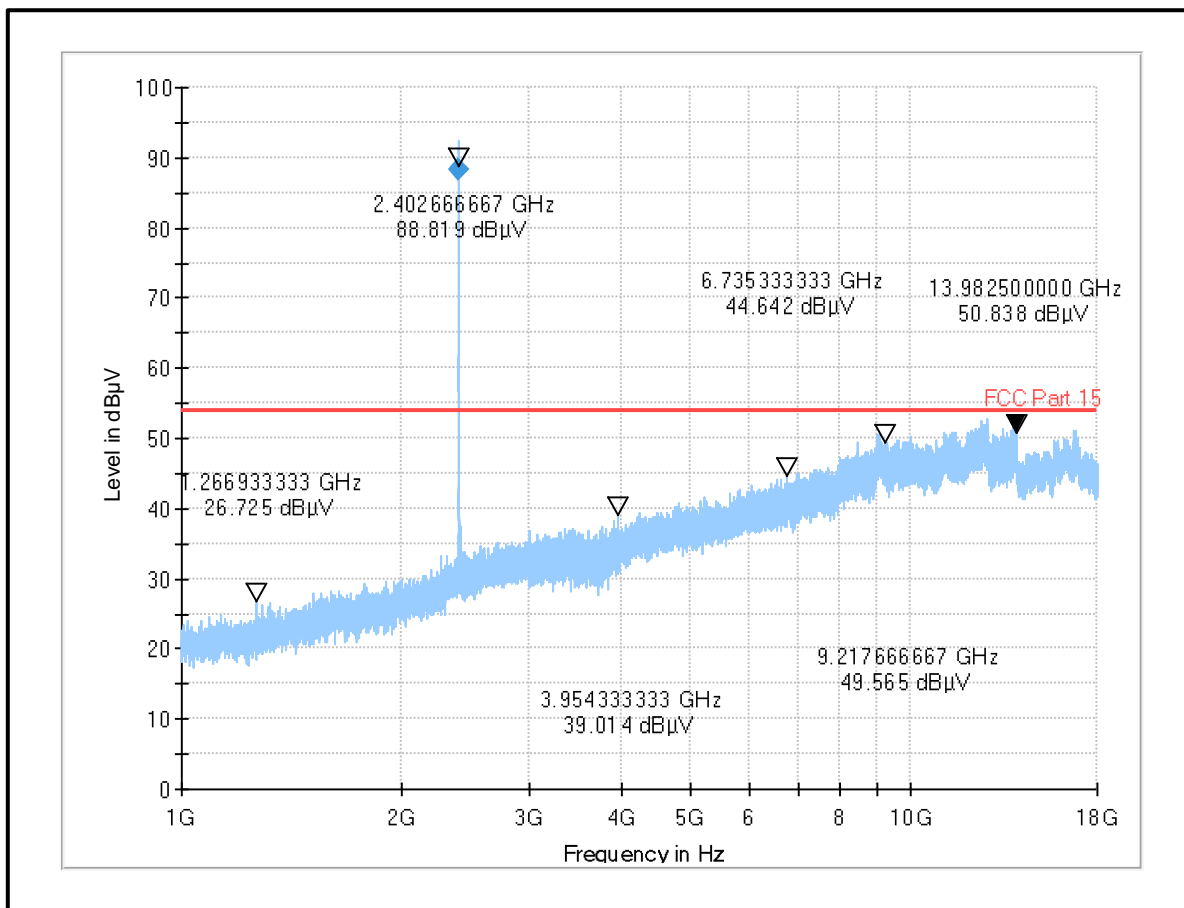


Transmitter Radiated Emissions (continued)

Results: BT-LE / 2 Mbps / PRBS9 / Bottom Channel / PWR Max

Frequency (MHz)	Antenna Polarization	Peak Level (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)	Result
No critical emissions detected					

Plot: 1 GHz – 18 GHz: BT-LE / 2 Mbps / PRBS9 / PWR Max / Bottom Channel



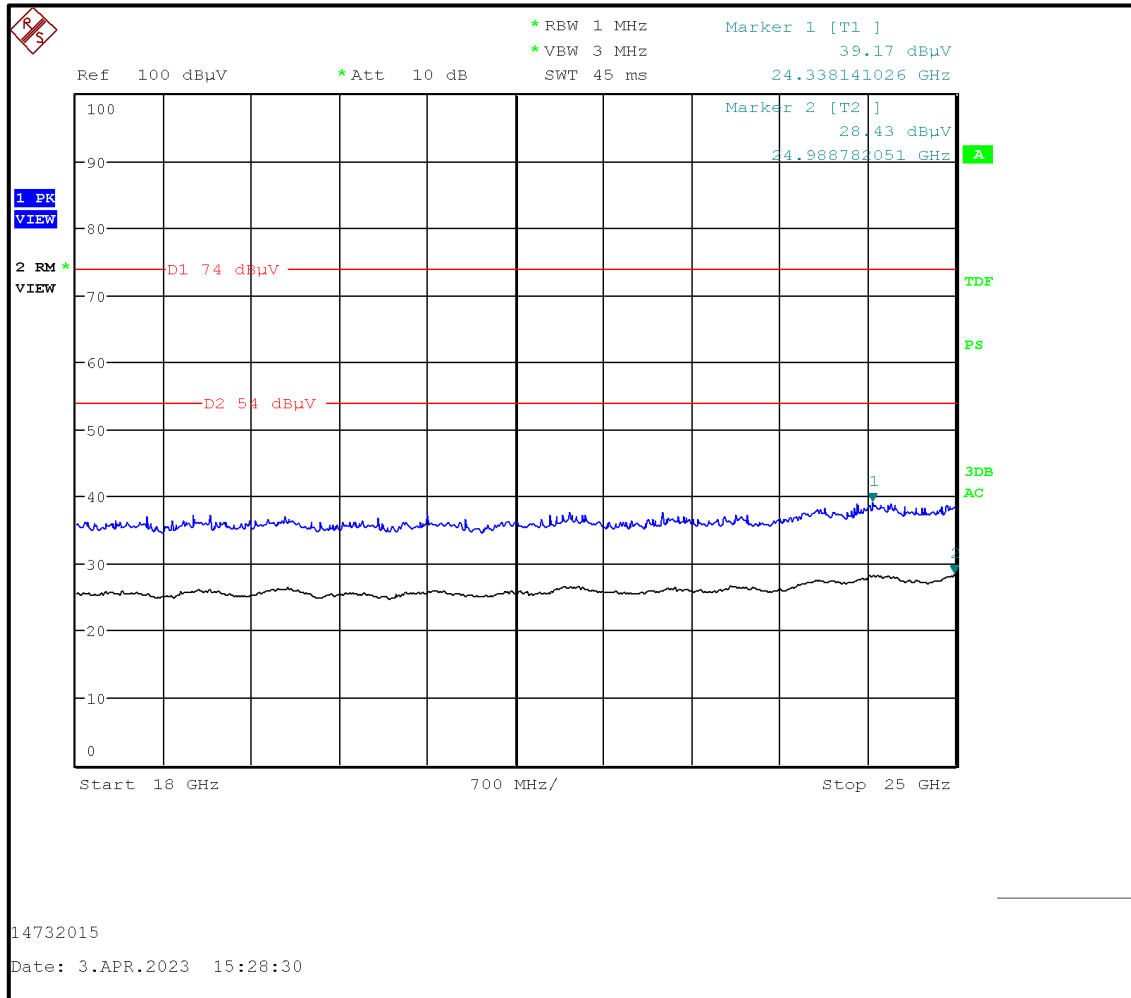
Result: Pass

Transmitter Radiated Emissions (continued)

Results: BT-LE / 2 Mbps / PRBS9 / Bottom Channel / PWR Max

Frequency (MHz)	Antenna Polarization	Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
All emissions were below the level of the measurement system noise floor.					

Plot: 18 GHz – 25 GHz: BT-LE / 2 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:	03 April 2023
Test Sample Serial Number:	Not Serialised (Radiated Test Sample)		
Test Site Identification	SR 1/2		

FCC Reference:	Parts 15.247(d), 15.209(a) & 15.205(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
	ANSI C63.10:2013 Sections 6.10.4, 6.10.5

Environmental Conditions:

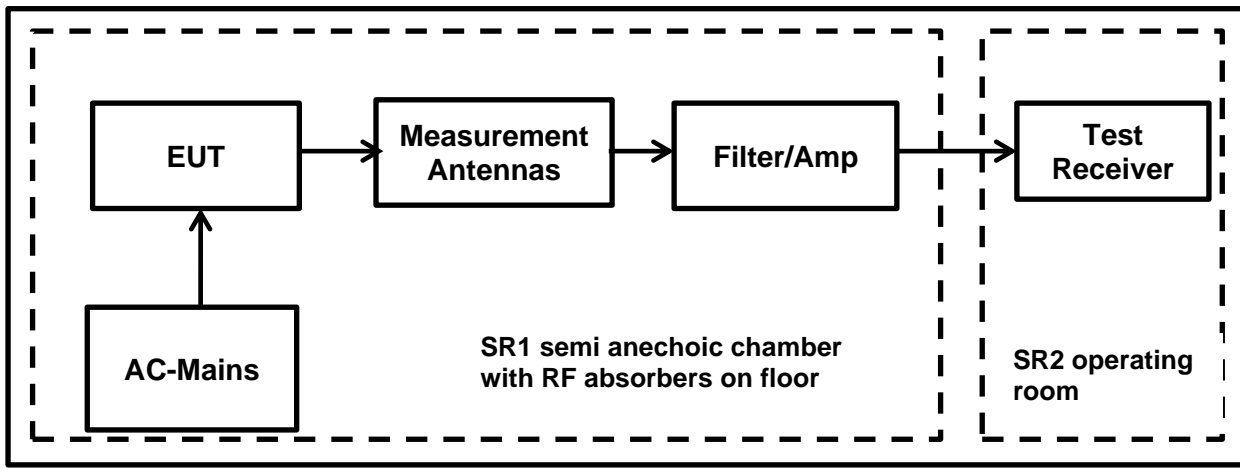
Temperature (°C):	23.9
Relative Humidity (%):	37.0

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. 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.
- 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): (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 EUT continuous transmission of the EUT ($D \geq 98\%$) can be achieved and EUT was transmitting continuously with a constant Duty Cycle of 100 % (duty cycle variations are less than $\pm 2\%$). Therefore, a Duty Cycle Correction Factor isn't applicable to the measured average values of the emissions.

Test Setup:

Transmitter Band Edge Radiated Emissions (continued)**Results: BT-LE / 2 Mbps / PRBS9 / PWR Max****Results: Lower Band Edge / Peak**

Frequency (MHz)	Peak Level (dB μ V/m)	-20 dBc Limit (dB μ V/m)	Margin (dB)	Result
2399.00	45.44	75.85	30.41	Complied
2400.00	62.00	75.85	13.85	Complied

Results: 2310 to 2390 MHz Restricted Band / Peak

Frequency (MHz)	Peak Level (dB μ V/m)	Peak Limit (dB μ V/m)	Margin (dB)	Result
2360.94	46.05	74.00	27.95	Complied

Results: 2310 to 2390 MHz Restricted Band / Average

Frequency (MHz)	Average Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2388.60	34.42	54.00	19.58	Complied

Results: Upper Band Edge / Peak

Frequency (MHz)	Peak Level (dB μ V/m)	Peak Limit (dB μ V/m)	Margin (dB)	Result
2483.50	55.33	74.00	18.67	Complied
2483.58	53.72	74.00	20.28	Complied

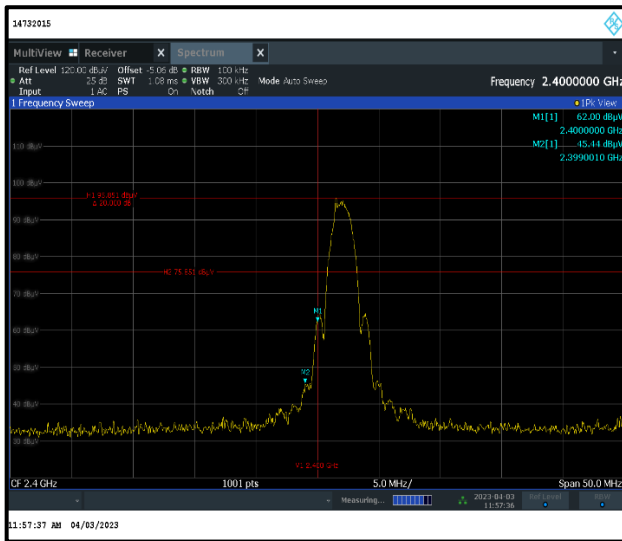
Results: Upper Band Edge / Average

Frequency (MHz)	Average Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2483.50	45.78	54.00	8.22	Complied
2483.58	44.85	54.00	9.15	Complied

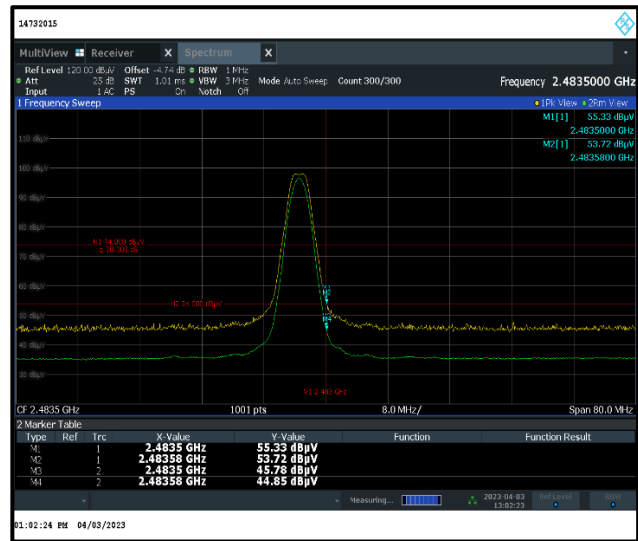
Result: Pass

Transmitter Band Edge Radiated Emissions (continued)

Results: BT-LE / 2 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
AC Conducted Spurious Emissions	95%	±2.49 dB
Minimum 6 dB Bandwidth	95%	±0.87 %
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	10/07/2020	36
377	BONN Elektronik	Amplifier, Low Noise Pre	BLMA 0118-1A	025294B	13/07/2022	12
423	Bonn Elektronik	Amplifier, Low Noise Pre	BLMA 1840-1A	55929	13/07/2022	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	36
495	Rohde & Schwarz	Antenna, log. - periodical	HL050	100296	06/08/2021	24
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	13/07/2022	12
669	Rohde & Schwarz	EMI Test Receiver	ESW 44	103087	03/02/2022	18
607	Schwarzbeck	Antenna broadband horn antenna	BBHA 9170	9170-561	2019-10-15	48
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)
445	Huber & Suhner	RF Attenuator (10 dB)	6810.17.AC	--	lab verification	12
637	Rohde & Schwarz	Spectrum Analyzer	FSV40	101587	13/07/2022	12
-/-	Testo	Thermo-Hygrometer	608-H1	07	lab verification	n/a
-/-	Huber & Suhner	RF Cable (up to 18 GHz)	-/-	-/-	lab verification	n/a
327	SPS	AC/DC power distribution system	PAS 5000	A2464 00/1 0200	lab verification	n/a
1603668	Siemens Matsushita Components	shielded room		B83117-B1422-T161	n/a	n/a

Test site: SR 7/8

ID	Manufacturer	Type	Model	Serial	Calibration Date	Cal. Cycle (months)
23	Rohde & Schwarz	Artificial Mains	ESH3-Z5	831767/013	11/07/2022	12
349	Rohde & Schwarz	Receiver, EMI Test	ESIB7	836697/009	12/07/2022	12
351	Rohde & Schwarz	network, Artificial Mains	ESH3-Z5	862770/018	11/07/2022	12
-/-	Testo	Thermo-Hygrometer	608-H1	08	lab verification	n/a
327	SPS	AC/DC power distribution system	PAS 5000	A2464 00/1 0200	lab verification	n/a

8. Report Revision History

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0	34	-	Initial Version
1.1	1 & 7	-	FCC ID identifier updated
Test Report Version 1.2 supersede Version 1.1 with immediate effect Test Report No. UL-RPT-RP-14732015-116-FCC Version 1.2, Issue Date 30 AUGUST 2023 replaces Test Report No. UL-RPT-RP-14732015-116-FCC Version 1.1, Issue Date 07 AUGUST 2023, which is no longer valid.			
1.2	as below	as below	Current Version
	16	5.2.3	Test Method and notes updated

--- END OF REPORT ---