

FCC and ISED Test Report

Dyson Technology Limited
Robot Vacuum Cleaner, Model: RB03

In accordance with FCC 47 CFR Part 15C, ISED
RSS-247 and ISED RSS-GEN
(2.4 GHz Bluetooth Low Energy)

Prepared for: Dyson Technology Limited
Tetbury Hill
Malmesbury
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United Kingdom



Add value.
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FCC ID: QVHRB03002

IC: 7986A-RB03002

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Document 75951525-01 Issue 01

SIGNATURE

NAME	JOB TITLE	RESPONSIBLE FOR	ISSUE DATE
Steve Marshall	Senior Engineer	Authorised Signatory	16 May 2023

Signatures in this approval box have checked this document in line with the requirements of TUV SUD document control rules.

ENGINEERING STATEMENT

The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 15C, ISED RSS-247 and ISED RSS-GEN. The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Graeme Lawler	16 May 2023	
Testing	George Porter	16 May 2023	

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

ISED Accreditation
12669A Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15C: 2020, ISED RSS-247: Issue 2 (02-2017) and ISED RSS-GEN: Issue 5 (04-2018) + A2 (02-2021) for the tests detailed in section 1.3.



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1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	16-May-2023

Table 1

1.2 Introduction

Applicant	Dyson Technology Limited
Manufacturer	Dyson Technology Limited
Model Number(s)	RB03
Serial Number(s)	H8U-JP-FJN0002X and H9C-UK-PCA0009A
Hardware Version(s)	OR1.5
HLP Version	2
PCBA Version	289439-01
Software Version(s)	RB03ED.01.00.002.0012
Number of Samples Tested	2
Test Specification/Issue/Date	FCC 47 CFR Part 15C: 2020 ISED RSS-247: Issue 2 (02-2017) ISED RSS-GEN: Issue 5 (04-2018) + A2 (02-2021)
Order Number	6000112313
Date	25-February-2021
Date of Receipt of EUT	15-April-2021 and 28-September-2021
Start of Test	07-May-2021
Finish of Test	19-October-2021
Name of Engineer(s)	Graeme Lawler and George Porter
Related Document(s)	ANSI C63.10 (2013)



1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15C, ISED RSS-247 and ISED RSS-GEN is shown below.

Section	Specification Clause			Test Description	Result	Comments/Base Standard
	Part 15C	RSS-247	RSS-GEN			
Configuration and Mode: Bluetooth Low Energy						
-	15.203	-	-	Antenna Requirement	N/T	The device complies with the provisions of this section, as it uses permanently attached integral antennas.
2.1	15.205	-	8.10	Restricted Band Edges	Pass	
2.2	15.247 (a)(2)	5.2	6.7	Emission Bandwidth	Pass	
2.3	15.247 (b)	5.4	6.12	Maximum Conducted Output Power	Pass	
2.4	15.247 (d)	5.5	-	Authorised Band Edges	Pass	
2.5	15.247 (d) and 15.205	3.3 and 5.5	6.13 and 8.9	Spurious Radiated Emissions	Pass	
2.6	15.247 (e)	5.2	6.12	Power Spectral Density	Pass	

Table 2



1.4 Application Form

Equipment Description

Technical Description: (Please provide a brief description of the intended use of the equipment including the technologies the product supports)	Robotic vacuum cleaner with 2.4GHz, 5GHz Wi-Fi and Bluetooth Low Energy wireless technologies	
Manufacturer:	Dyson Technology Ltd	
Model:	RB03	
Part Number:	RB03	
Hardware Version:	OR1.5	
Software Version:	RB03ED.01.00.002.0012	
FCC ID of the product under test – see guidance here	QVHRB03002	
IC ID of the product under test – see guidance here	7986A-RB03002	

Table 3

Intentional Radiators

Technology	BLE	2.4 GHz	5 GHz			
Frequency Range (MHz to MHz)	2400 MHz – 2483.5 MHz	2400 MHz – 2483.5 MHz	5150 MHz to 5850 MHz			
Conducted Declared Output Power (dBm)	Refer to Supplied RF Power Tables					
Antenna Gain (dBi)	4.08	4.08	6.3			
Supported Bandwidth(s) (MHz) (e.g 1 MHz, 20 MHz, 40 MHz)	1 MHz	20/40 MHz	20/40/80 MHz			
Modulation Scheme(s) (e.g GFSK, QPSK etc)	GFSK	DQPSK, DBPSK, DSSS, CCK and OFDM	OFDM			
ITU Emission Designator (see guidance here) (not mandatory for Part 15 devices)	N/A	N/A	N/A			
Bottom Frequency (MHz)	2402	2412	5180			
Middle Frequency (MHz)	2440	2437	5500			
Top Frequency (MHz)	2480	2462	5825			

Table 4



Un-intentional Radiators

Highest frequency generated or used in the device or on which the device operates or tunes	5850 MHz
Lowest frequency generated or used in the device or on which the device operates or tunes	30 MHz
Class A Digital Device (Use in commercial, industrial or business environment) ☐	
Class B Digital Device (Use in residential environment only) ☒	

Table 5

AC Power Source

AC supply frequency:	50/60	Hz
Voltage	100 - 240	V
Max current:	2.4	A
Single Phase ☒ Three Phase ☐		

Table 6

DC Power Source

Nominal voltage:		V
Extreme upper voltage:		V
Extreme lower voltage:		V
Max current:		A

Table 7

Battery Power Source

Voltage:	21.6	V
End-point voltage:	15.9	V (Point at which the battery will terminate)
Alkaline ☐ Leclanche ☐ Lithium ☒ Nickel Cadmium ☐ Lead Acid* ☐ *(Vehicle regulated)		
Other ☐	Please detail:	

Table 8

Charging

Can the EUT transmit whilst being charged	Yes ☒ No ☐
---	---

Table 9

Temperature

Minimum temperature:	0	°C
Maximum temperature:	60	°C

Table 10



Antenna Characteristics

Antenna connector ☐			State impedance		Ohm
Temporary antenna connector ☐			State impedance		Ohm
Integral antenna ☒	Type:	Patch Antenna	Gain	2.4GHz: 4.08 5GHz: 6.3	dBi
External antenna ☐	Type:		Gain		dBi
For external antenna only: Standard Antenna Jack ☐ If yes, describe how user is prohibited from changing antenna (if not professional installed): Equipment is only ever professionally installed ☐ Non-standard Antenna Jack ☐					

Table 11

Ancillaries (if applicable)

Manufacturer:		Part Number:	
Model:		Country of Origin:	

Table 12

The above information was provided by the applicant.



1.5 Product Information

1.5.1 Technical Description

The EUT is a Robotic vacuum cleaner with 2.4 GHz, 5 GHz Wi-Fi and Bluetooth Low Energy wireless technologies.

1.5.2 Antenna Gain

The manufacturer provided antenna gain values for each operating channel which have been used to calculate EIRP where required:

Band	Chan # (20MHz)	Max Gain (dBi)
2.4 GHz	1	3.77
	2	3.59
	3	3.46
	4	3.67
	5	3.89
	6	4.08
	7	4.08
	8	4.01
	9	3.92
	10	3.90
	11	3.99
	12	4.04
	13	4.05

Table 13 – Antenna Gain

For Bluetooth Low Energy, the antenna gain closest to those specified for 2.4 GHz WiFi channels as per the table above were used for all EIRP results recorded in this report.



1.6 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

1.7 EUT Modification Record

The table below details modifications made to the EUT during the test programme.

The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Model: RB03, Serial Number: H8U-JP-FJN0002X			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: RB03, Serial Number: H9C-UK-PCA0009A			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 14

1.8 Test Location

TÜV SÜD conducted the following tests at our Fareham Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: Bluetooth Low Energy		
Restricted Band Edges	Graeme Lawler	UKAS
Emission Bandwidth	George Porter	UKAS
Maximum Conducted Output Power	George Porter	UKAS
Authorised Band Edges	Graeme Lawler	UKAS
Spurious Radiated Emissions	Graeme Lawler	UKAS
Power Spectral Density	George Porter	UKAS

Table 15

Office Address:

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire
PO15 5RL
United Kingdom



2 Test Details

2.1 Restricted Band Edges

2.1.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.205
ISED RSS-GEN, Clause 8.10

2.1.2 Equipment Under Test and Modification State

RB03, S/N: H9C-UK-PCA0009A - Modification State 0

2.1.3 Date of Test

10-October-2021

2.1.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 6.10.5.

Plots for average measurements were taken in accordance with ANSI C63.10, clause 4.1.4.2.5. These are shown for information purposes and were used to determine the worst-case measurement point. Final average measurements were then taken in accordance with ANSI C63.10, clause 11.12.2.5.2 to obtain the measurement result recorded in the test results tables.

The following conversion can be applied to convert from dB μ V/m to μ V/m:
 $10^{(\text{Field Strength in dB}\mu\text{V/m}/20)}$.

2.1.5 Environmental Conditions

Ambient Temperature	20.1 °C
Relative Humidity	51.8 %

2.1.6 Test Results

Bluetooth Low Energy

Modulation/Packet Type	Tx Frequency (MHz)	Antenna Port	Band Edge Frequency (MHz)	Peak Level (dB μ V/m)	Average Level (dB μ V/m)
GFSK/DH1	2402	Main	2390.0	55.92	43.28
GFSK/DH1	2480	Main	2483.5	59.28	51.43

Table 16 - Restricted Band Edge Results

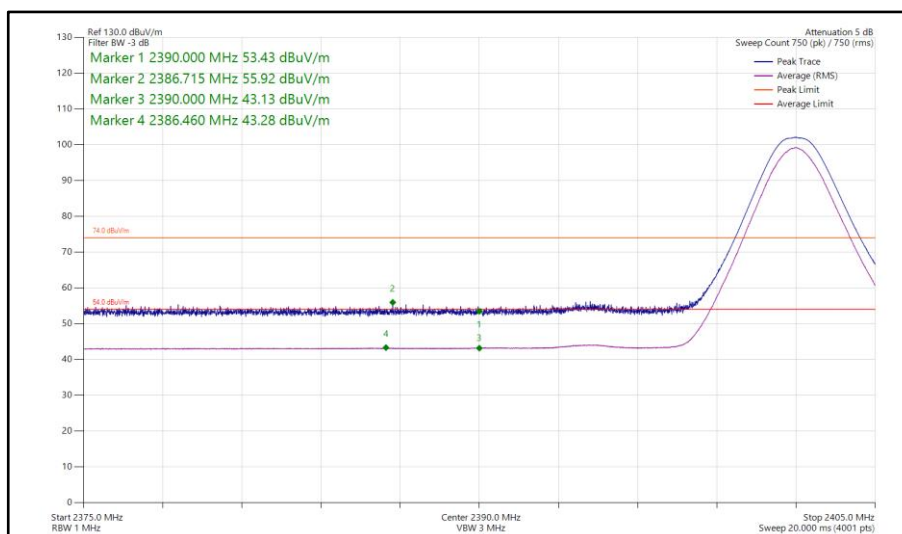


Figure 1 – GFSK/DH1, 2402 MHz, Band Edge Frequency 2390 MHz

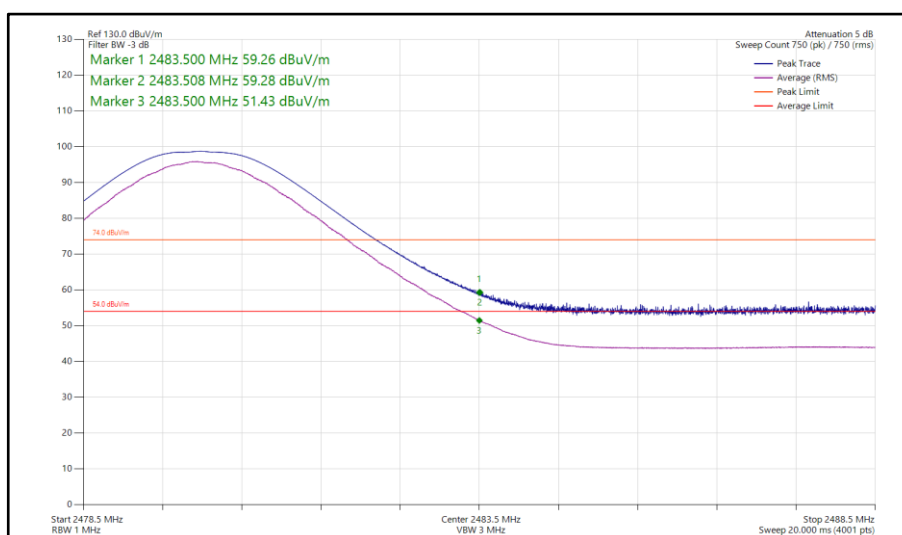


Figure 2 – GFSK/DH1, 2480 MHz, Band Edge Frequency 2483.5 MHz



FCC 47 CFR Part 15, Limit Clause 15.209

Frequency (MHz)	Field Strength ($\mu\text{V/m}$ at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

Table 17

ISED RSS-GEN, Limit Clause 8.9

Frequency (MHz)	Field Strength ($\mu\text{V/m}$ at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960*	500

Table 18

*Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.



2.1.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 12.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Test Receiver	Rohde & Schwarz	ESU40	3506	12	18-Mar-2022
EmX Emissions Software	TUV SUD	V2.1.11	5125	-	Software
Broadband Horn Antenna (1-10 GHz)	Schwarzbeck	BBHA 9120 B	5215	12	01-Apr-2022
Cable (NType-NType, 8 m)	Teledyne	PR90-088-8MTR	5450	6	08-Mar-2022
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB-40	5481	12	31-Mar-2022
Turntable & Mast Controller	Maturo Gmbh	NCD/498/2799.01	5612	-	TU
Tilt Antenna Mast TAM 4.0-P	Maturo Gmbh	TAM 4.0-P	5613	-	TU
Turntable	Maturo Gmbh	Turntable 1.5 SI-2t	5614	-	TU
Screened Room (12)	MVG	EMC-3	5621	36	11-Aug-2023
Cable Assembly - 18GHz 8m	Junkosha	MWX221-08000NMSNMS/B	5732	6	05-Feb-2022

Table 19

TU - Traceability Unscheduled



2.2 Emission Bandwidth

2.2.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(2)
ISED RSS-247, Clause 5.2
ISED RSS-GEN, Clause 6.7

2.2.2 Equipment Under Test and Modification State

RB03, S/N: H8U-JP-FJN0002X - Modification State 0

2.2.3 Date of Test

07-May-2021

2.2.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 11.1.8.1 for 6 dB bandwidth and 6.9.3 for 99% occupied bandwidth measurements.

2.2.5 Environmental Conditions

Ambient Temperature	23.8 °C
Relative Humidity	23.1 %



2.2.6 Test Results

Bluetooth Low Energy

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (a)(2) RSS-247 5.2 a)	Test Method(s):	C63.10 6.9.3 C63.10 11.8.1
Additional Reference(s):	-		

DUT Configuration			
Mode:	Main - GFSK (LE 1M)	Duty Cycle (%):	-
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (Main)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	6 dB Bandwidth (MHz)					Limit (kHz)
	A	B	C	D	Minimum	
2402	0.704	-	-	-	0.704	≥500.0
2440	0.704	-	-	-	0.704	≥500.0
2480	0.708	-	-	-	0.708	≥500.0

Table 20 - 6 dB Bandwidth Results

Test Frequency (MHz)	99% Bandwidth (MHz)					Limit (kHz)
	A	B	C	D	Minimum	
2402	1.028	-	-	-	1.028	-
2440	1.028	-	-	-	1.028	-
2480	1.024	-	-	-	1.024	-

Table 21 - 99% Bandwidth Results

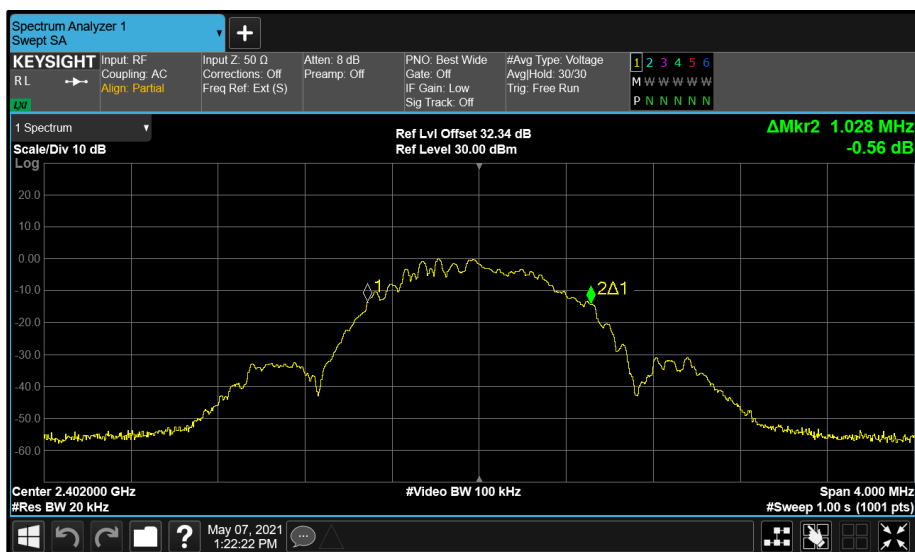


Figure 3 - Main (A) 2402 MHz (CH37) 99% Bandwidth

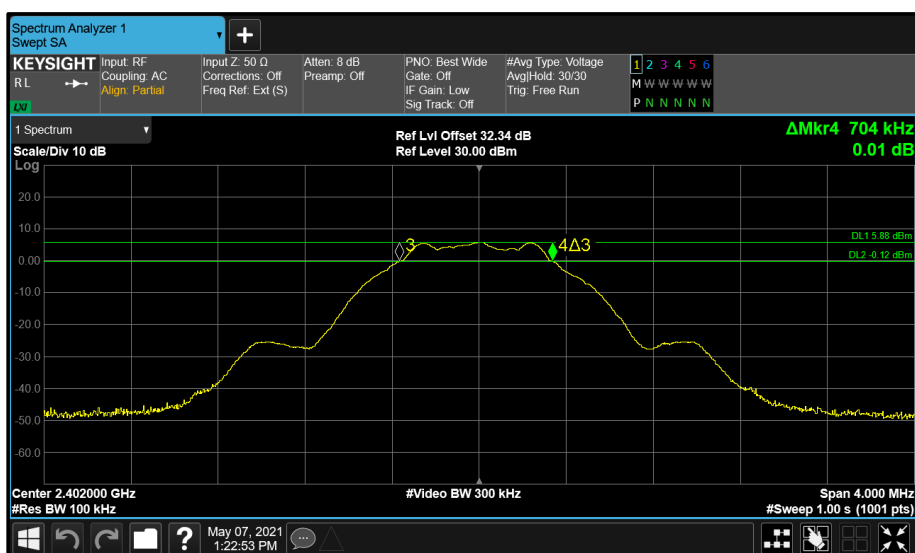


Figure 4 - Main (A) 2402 MHz (CH37) 6 dB Bandwidth

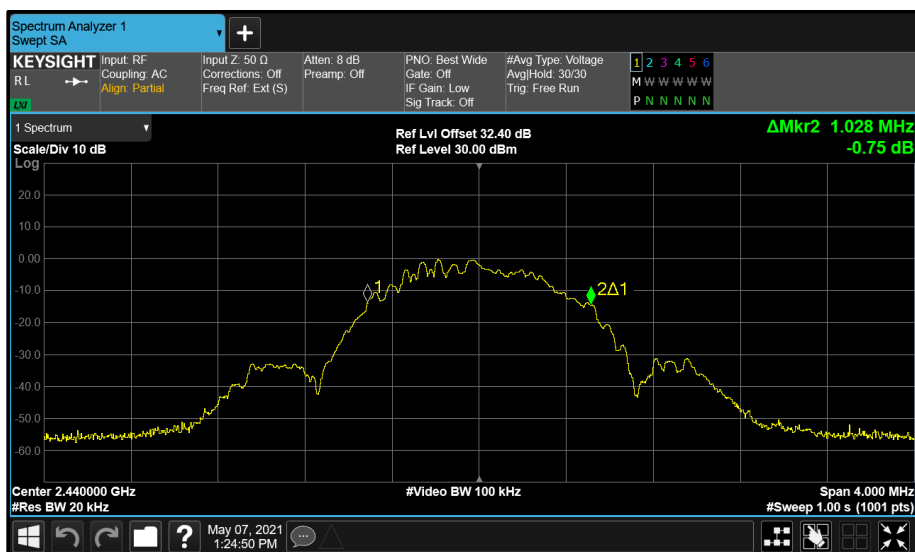


Figure 5 - Main (A) 2440 MHz (CH17) 99% Bandwidth

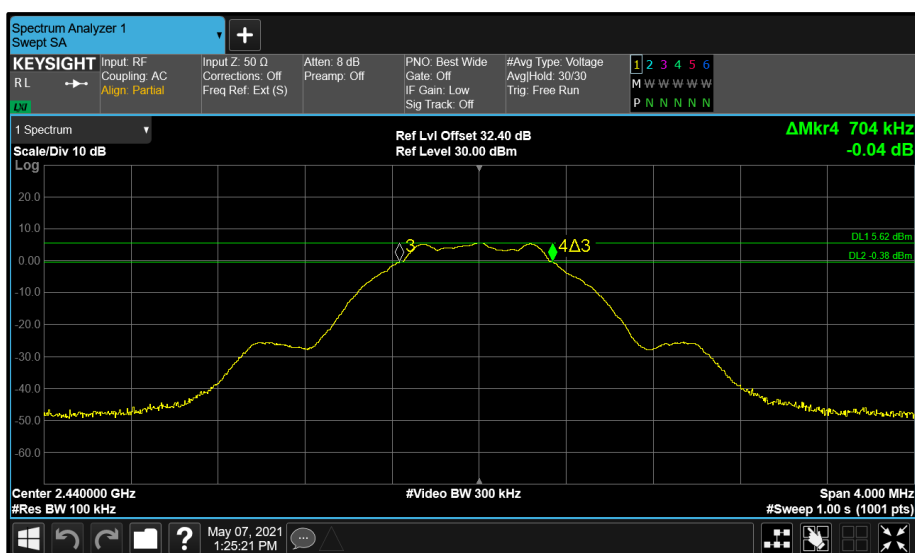


Figure 6 - Main (A) 2440 MHz (CH17) 6 dB Bandwidth

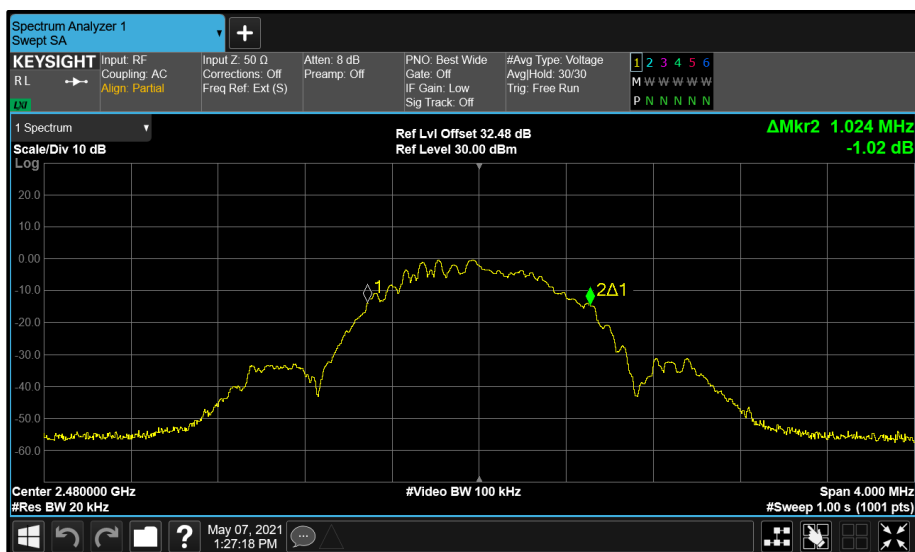


Figure 7 - Main (A) 2480 MHz (CH39) 99% Bandwidth

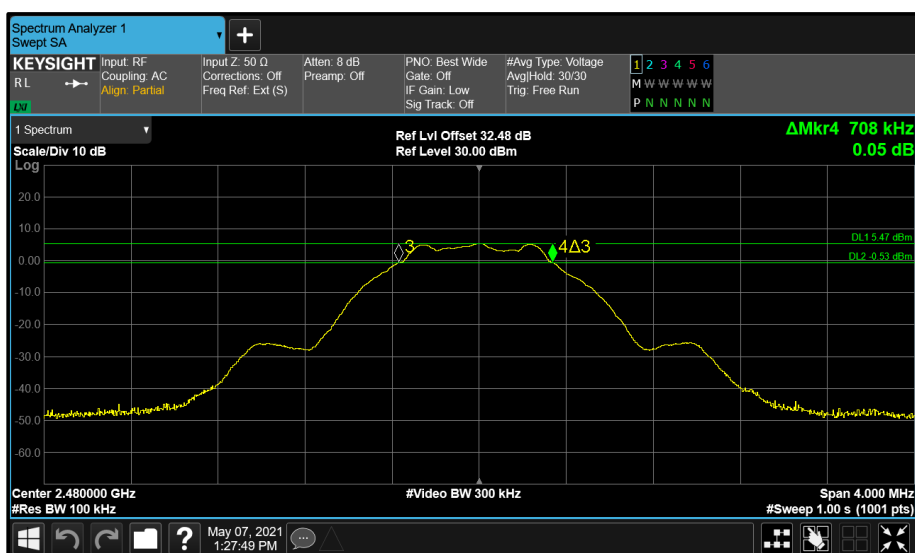


Figure 8 - Main (A) 2480 MHz (CH39) 6 dB Bandwidth

FCC 47 CFR Part 15, Limit Clause 15.247(a)(2) and ISED RSS-247, Clause 5.2(a)

The minimum 6 dB Bandwidth shall be at least 500 kHz.



2.2.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	17-May-2021
Multimeter	Iso-tech	IDM101	2421	12	30-Oct-2021
Hygrometer	Rotronic	I-1000	3220	12	16-Oct-2021
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	17-May-2021
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	04-Mar-2022
Signal Commissioning Unit	TUV SUD	SCU001	5546	12	16-Apr-2022

Table 22



2.3 Maximum Conducted Output Power

2.3.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (b)
ISED RSS-247, Clause 5.4
ISED RSS-GEN, Clause 6.12

2.3.2 Equipment Under Test and Modification State

RB03, S/N: H8U-JP-FJN0002X - Modification State 0

2.3.3 Date of Test

07-May-2021

2.3.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 11.9.1.3 method PKPM1.

2.3.5 Environmental Conditions

Ambient Temperature	23.8 °C
Relative Humidity	23.1 %



2.3.6 Test Results

Bluetooth Low Energy

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (b)(3) RSS-247 5.4 d)	Test Method(s):	C63.10 11.9.1.3
Additional Reference(s):	-		

DUT Configuration			
Mode:	Main - GFSK (LE 1M)	Duty Cycle (%):	62.4
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (Main)	Peak Antenna Gain (dBi):	4.08

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)
	A	B	C	D	Σ		
2402	5.67	-	-	-	-	30.00	-24.33
2440	5.43	-	-	-	-	30.00	-24.57
2480	5.20	-	-	-	-	30.00	-24.80

Table 23 - FCC Maximum Conducted (peak) Output Power Results

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
	A	B	C	D	Σ					
2402	5.67	-	-	-	-	30.00	-24.33	9.44	36.00	-26.56
2440	5.43	-	-	-	-	30.00	-24.57	9.51	36.00	-26.49
2480	5.20	-	-	-	-	30.00	-24.80	9.25	36.00	-26.75

Table 24 - ISED Maximum Conducted (peak) Output Power Results

FCC 47 CFR Part 15, Limit Clause 15.247 (b)(3)

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt.

ISED RSS-247, Limit Clause 5.4 (b)

For DTSSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e) of the specification.



2.3.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	17-May-2021
Multimeter	Iso-tech	IDM101	2421	12	30-Oct-2021
Hygrometer	Rotronic	I-1000	3220	12	16-Oct-2021
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	17-May-2021
USB Power Sensor	Boonton	RTP5006	5184	12	19-Apr-2022
Signal Commissioning Unit	TUV SUD	SCU001	5546	12	16-Apr-2022

Table 25



2.4 Authorised Band Edges

2.4.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (d)
ISED RSS-247, Clause 5.5

2.4.2 Equipment Under Test and Modification State

RB03, S/N: H9C-UK-PCA0009A - Modification State 0

2.4.3 Date of Test

10-October-2021

2.4.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 6.10.4.

2.4.5 Environmental Conditions

Ambient Temperature	20.1 °C
Relative Humidity	51.8 %

2.4.6 Test Results

Bluetooth Low Energy

Modulation/Packet Type	Antenna Port	Tx Frequency (MHz)	Band Edge Frequency (MHz)	Level (dBc)
GFSK/DH1	Main	2402	2400.0	-53.49
GFSK/DH1	Main	2480	2483.5	-52.07

Table 26 - Authorised Band Edge Results

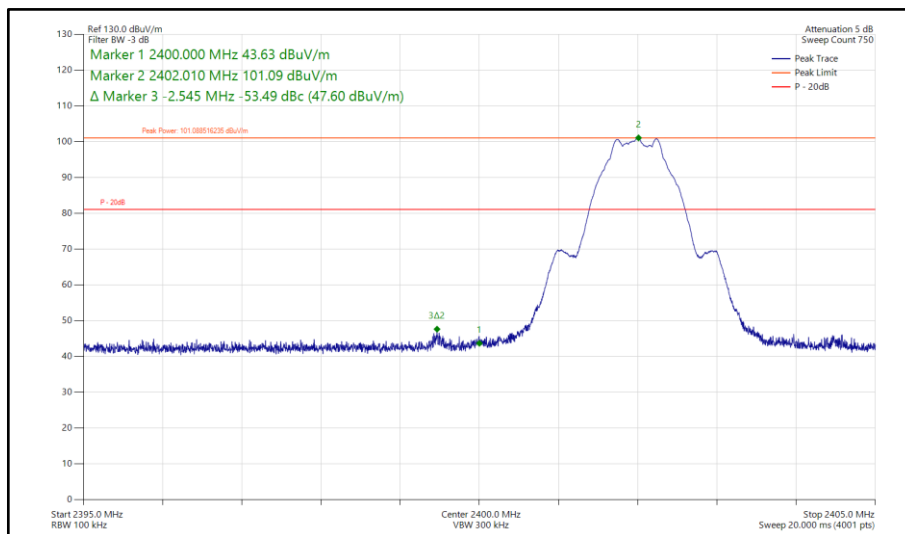


Figure 9 - GFSK/DH1 - 2402 MHz (CH37), Band Edge Frequency 2400 MHz

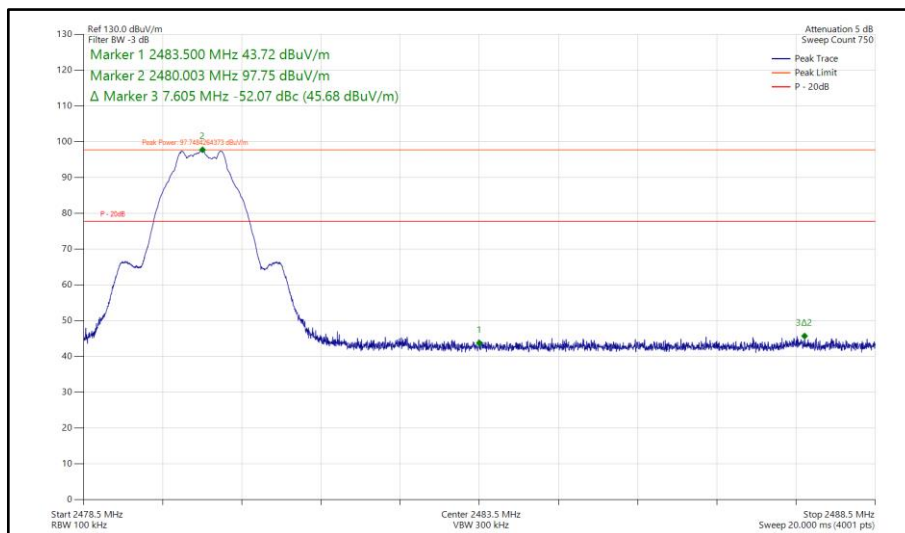


Figure 10 - GFSK/DH1 - 2480 MHz (CH39), Band Edge Frequency 2483.5 MHz



FCC 47 CFR Part 15, Limit Clause 15.247 (d)

20 dB below the fundamental measured in a 100 kHz bandwidth using a peak detector. If the transmitter complies with the conducted power limits, based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB below the fundamental instead of 20 dB.

ISED RSS-247, Limit Clause 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

2.4.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 12.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Test Receiver	Rohde & Schwarz	ESU40	3506	12	18-Mar-2022
EmX Emissions Software	TUV SUD	V2.1.11	5125	-	Software
Broadband Horn Antenna (1-10 GHz)	Schwarzbeck	BBHA 9120 B	5215	12	01-Apr-2022
Cable (NType-NType, 8 m)	Teledyne	PR90-088-8MTR	5450	6	08-Mar-2022
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB-40	5481	12	31-Mar-2022
Turntable & Mast Controller	Maturo Gmbh	NCD/498/2799.01	5612	-	TU
Tilt Antenna Mast TAM 4.0-P	Maturo Gmbh	TAM 4.0-P	5613	-	TU
Turntable	Maturo Gmbh	Turntable 1.5 SI-2t	5614	-	TU
Screened Room (12)	MVG	EMC-3	5621	36	11-Aug-2023
Cable Assembly - 18GHz 8m	Junkosha	MWX221-08000NMSNMS/B	5732	6	05-Feb-2022

Table 27

TU - Traceability Unscheduled



2.5 Spurious Radiated Emissions

2.5.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.205 and 15.247
ISED RSS-247, Clause 3.3 and 5.5
ISED RSS-GEN, Clause 6.13 and 8.9

2.5.2 Equipment Under Test and Modification State

RB03, S/N: H9C-UK-PCA0009A - Modification State 0

2.5.3 Date of Test

10-October-2021 to 19-October-2021

2.5.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 6.3, 6.5 and 6.6.

The EUT was placed on the non-conducting platform in a manner typical of a normal installation.

For frequencies > 1 GHz, plots for average measurements were taken in accordance with ANSI C63.10, clause 4.1.4.2.5 to characterize the EUT. Where emissions were detected, final average measurements were taken in accordance with ANSI C63.10, clause 11.12.2.5.2.

The plots shown are the characterisation of the EUT. The limits on the plots represent the most stringent case for restricted bands, (74/54 dBuV/m) when compared to 20 dBc outside restricted bands. The limits shown have been used as a threshold to determine where further measurements are necessary. Where results are within 10 dB of the limits shown on the plots, further investigation was carried out and reported in results tables.

The following conversion can be applied to convert from dBuV/m to $\mu\text{V/m}$:
 $10^{(\text{Field Strength in dBuV/m}/20)}$

At a measurement distance of 1 meter the limit line was increased by $20 \cdot \text{LOG}(3/1) = 9.54 \text{ dB}$.

Where formal measurements have been necessary, the results have been presented in the emissions table.

2.5.5 Test Setup Diagram – Radiated Emissions

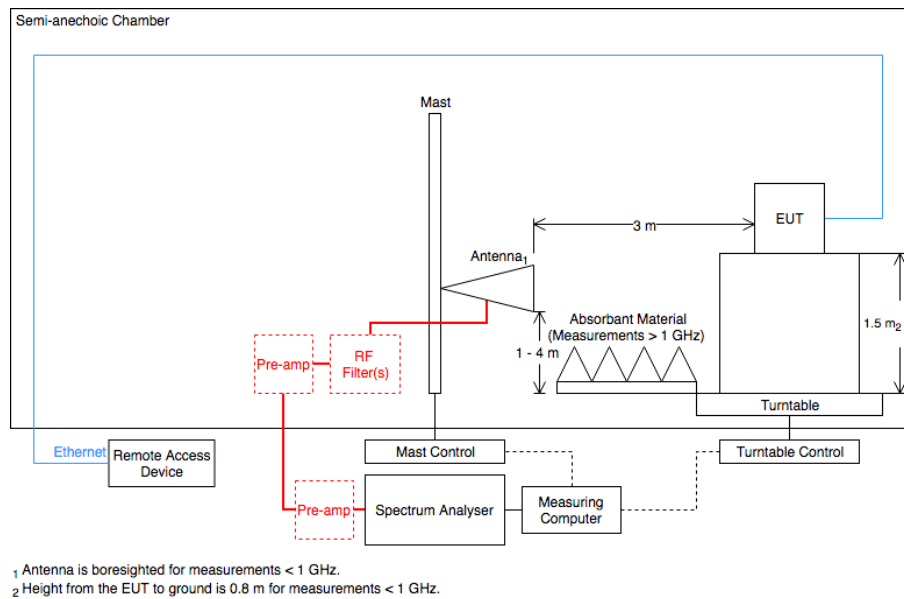


Figure 11 - Radiated Emissions Test Setup Diagram

2.5.6 Environmental Conditions

Ambient Temperature	20.1 - 26.3 °C
Relative Humidity	37.8 - 51.8 %



2.5.7 Test Results

Bluetooth Low Energy

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
*							

Table 28 - BLE, 2402 MHz, 30 MHz to 25 GHz

*No emissions found within 10 dB of the limit.

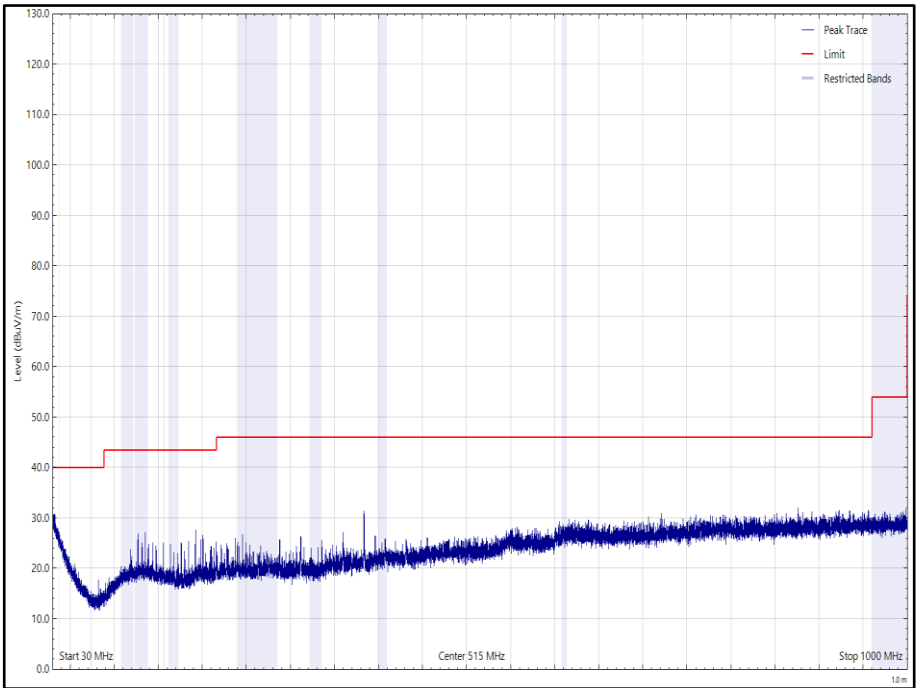


Figure 12 - BLE, 2402 MHz, 30 MHz to 1 GHz, Horizontal (Peak)

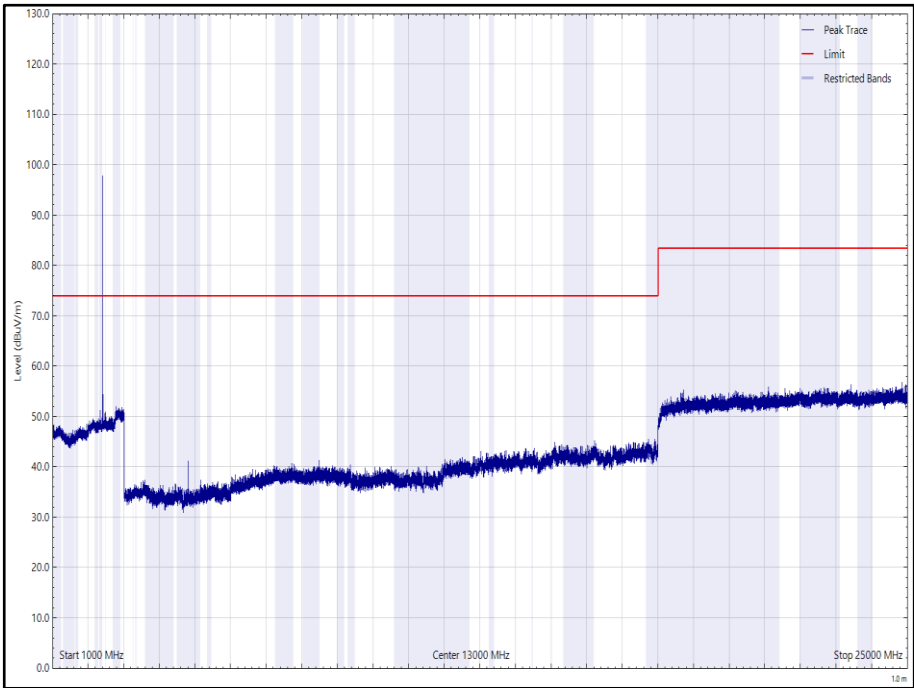


Figure 13 - BLE, 2402 MHz, 1 GHz to 25 GHz, Horizontal (Peak)

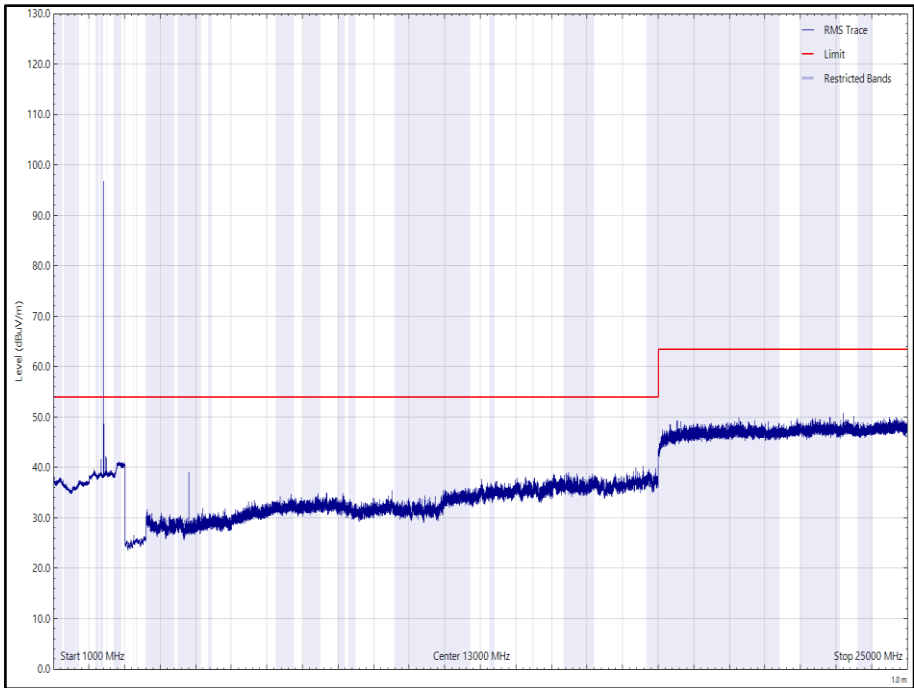


Figure 14 - BLE, 2402 MHz, 1 GHz to 25 GHz, Horizontal (rms)

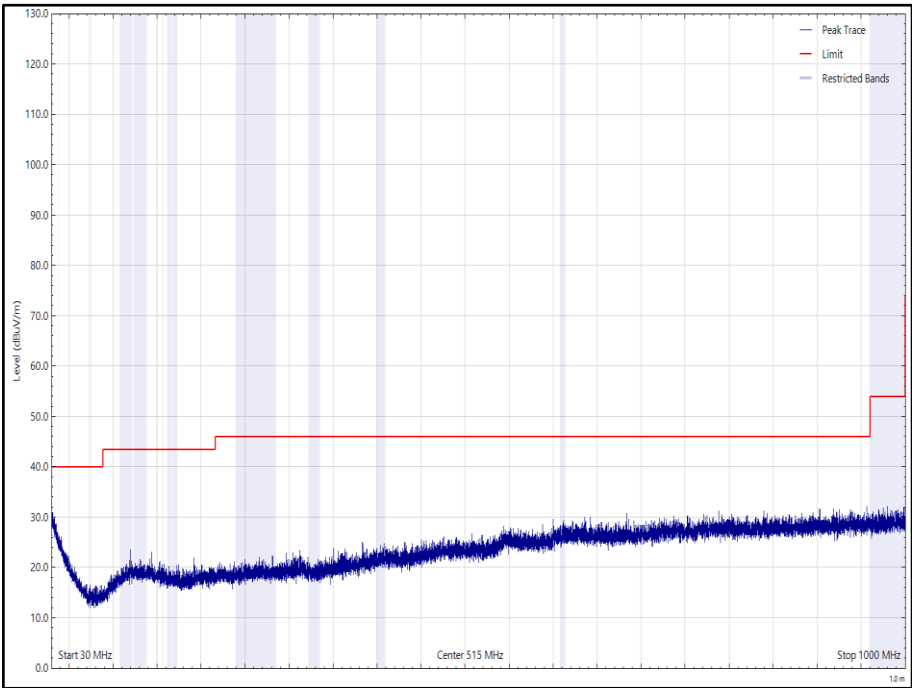


Figure 15 - BLE, 2402 MHz, 30 MHz to 1 GHz, Vertical (Peak)

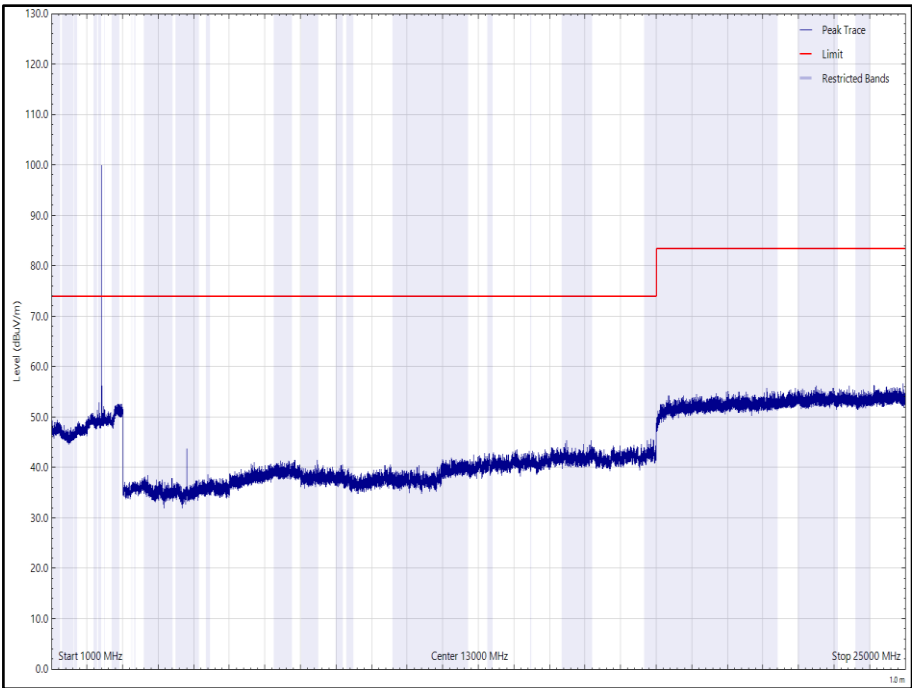


Figure 16 - BLE, 2402 MHz, 1 GHz to 25 GHz, Vertical (Peak)

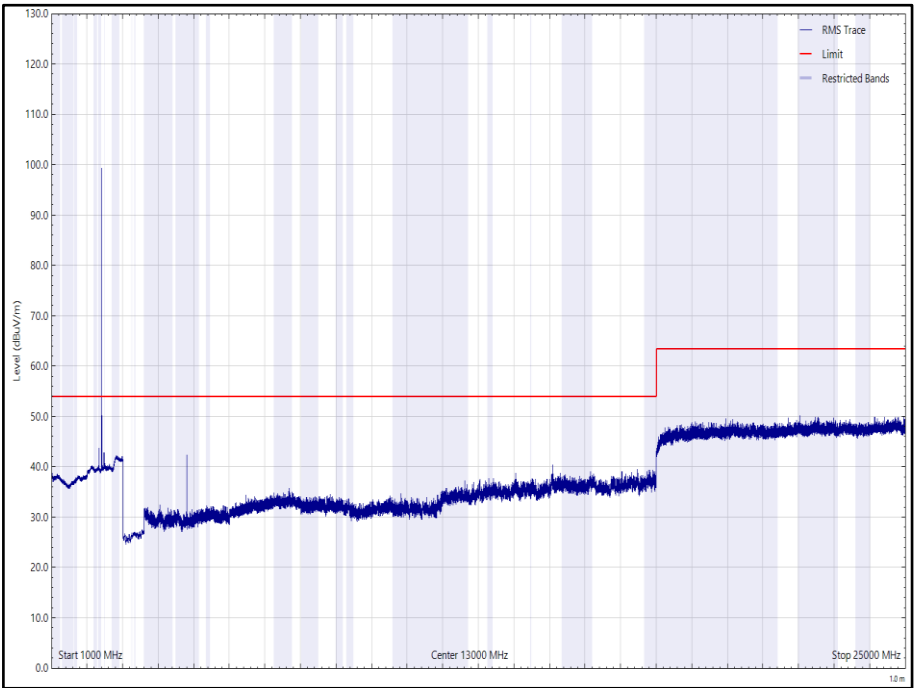


Figure 17 - BLE, 2402 MHz, 1 GHz to 25 GHz, Vertical (rms)

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
2369.487	43.6	54.0	-10.4	RMS	114	125	Vertical

Table 29 - BLE, 2440 MHz, 30 MHz to 25 GHz

No other emissions found within 10 dB of the limit.

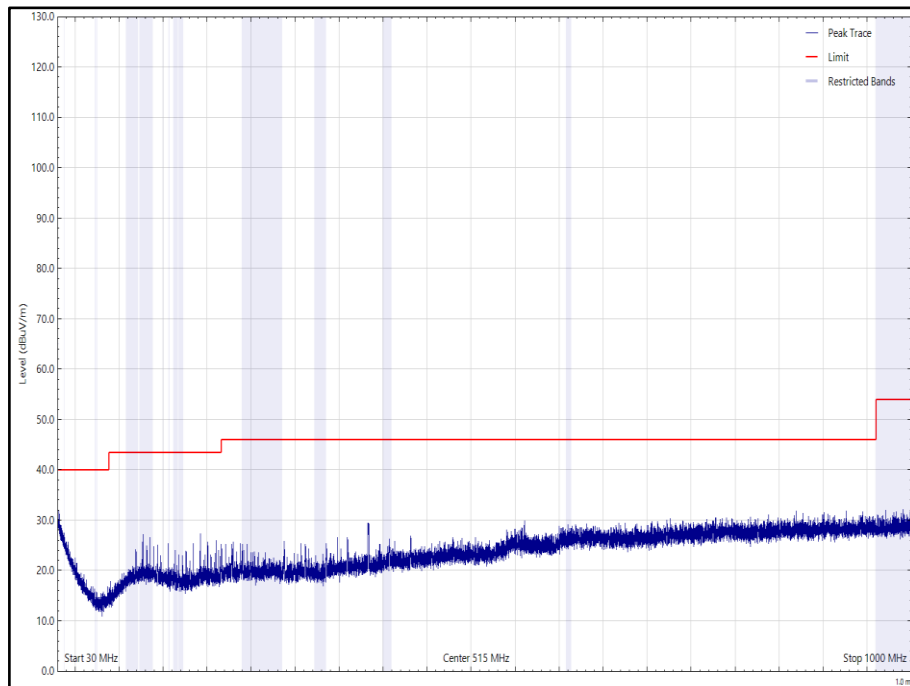


Figure 18 - BLE, 2440 MHz, 30 MHz to 1 GHz, Horizontal (Peak)

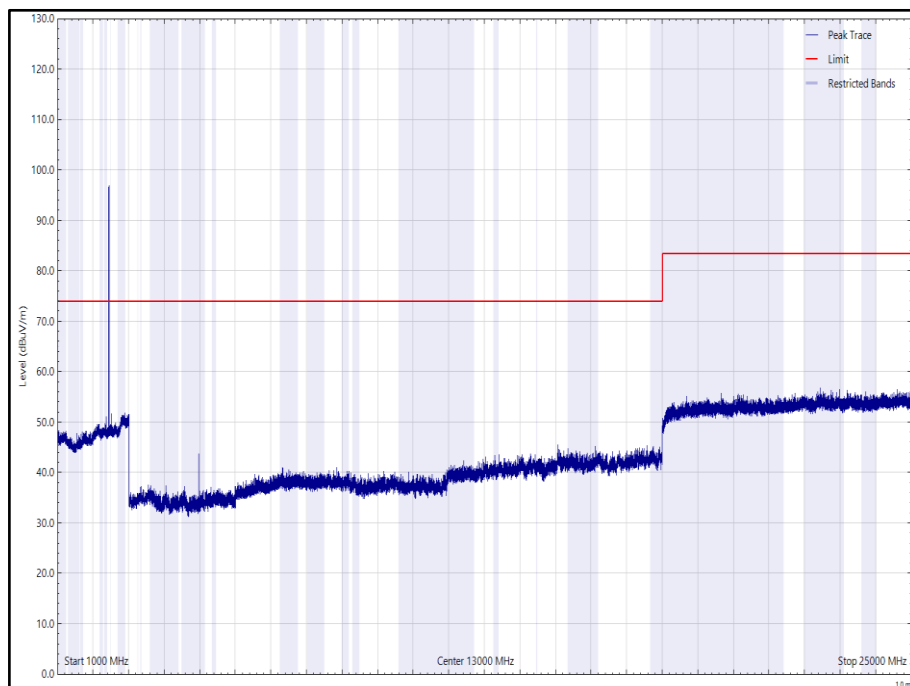


Figure 19 - BLE, 2440 MHz, 1 GHz to 25 GHz, Horizontal (Peak)

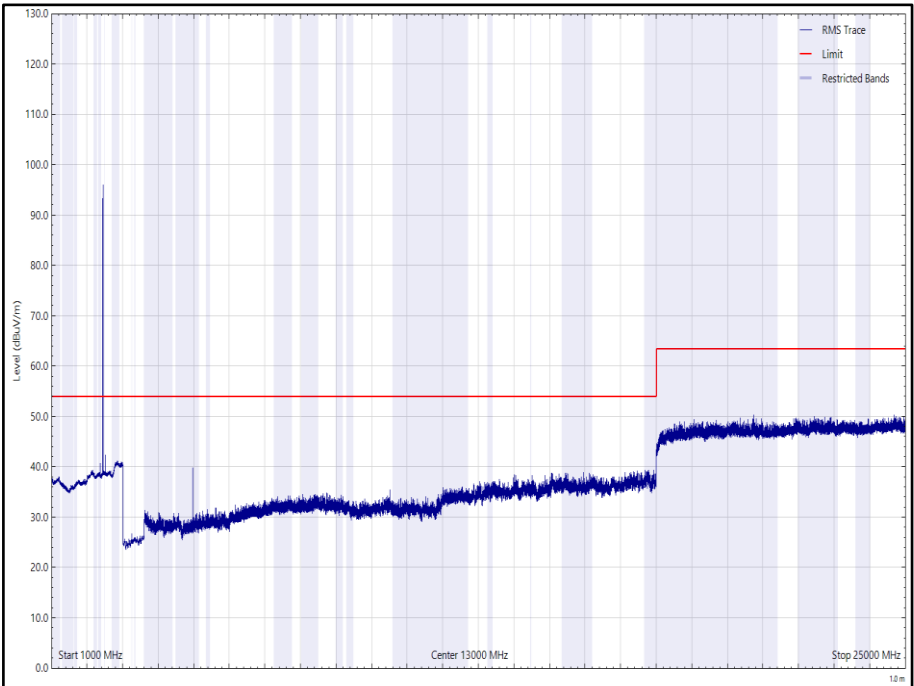


Figure 20 - BLE, 2440 MHz, 1 GHz to 25 GHz, Horizontal (rms)

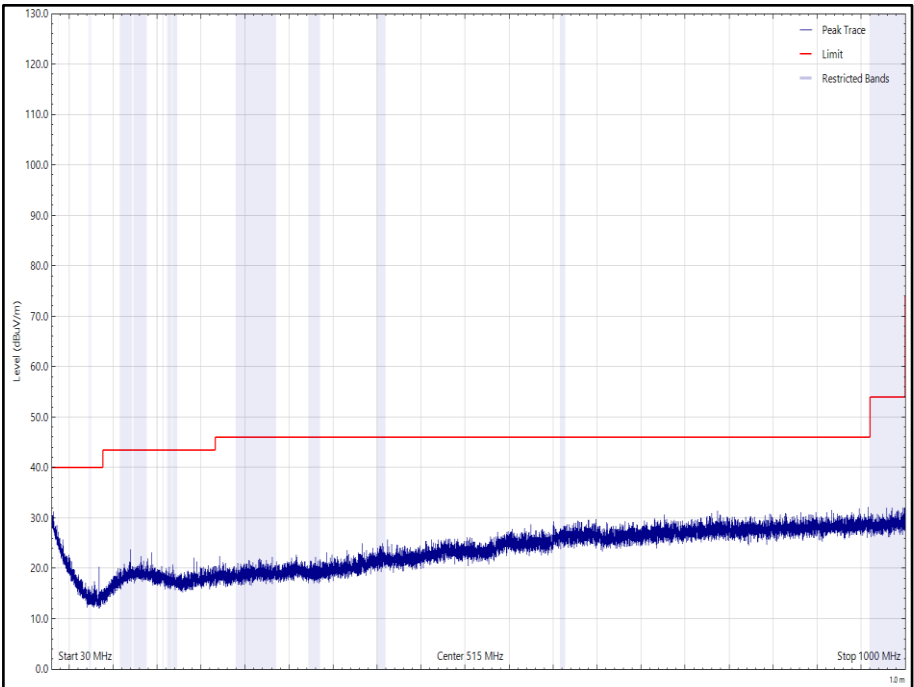


Figure 21 - BLE, 2440 MHz, 30 MHz to 1 GHz, Vertical (Peak)

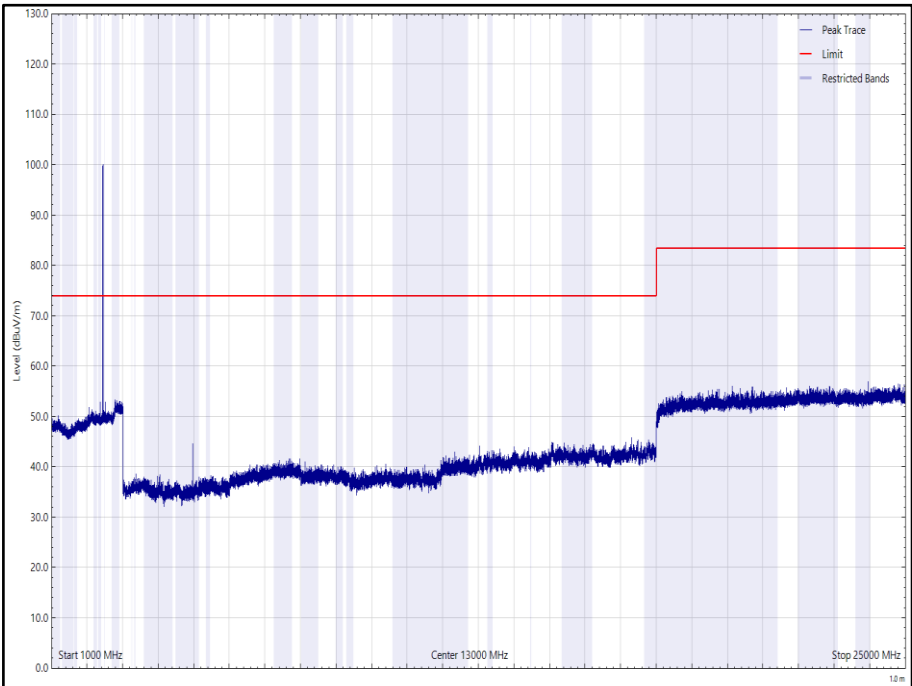


Figure 22 - BLE, 2440 MHz, 1 GHz to 25 GHz, Vertical (Peak)

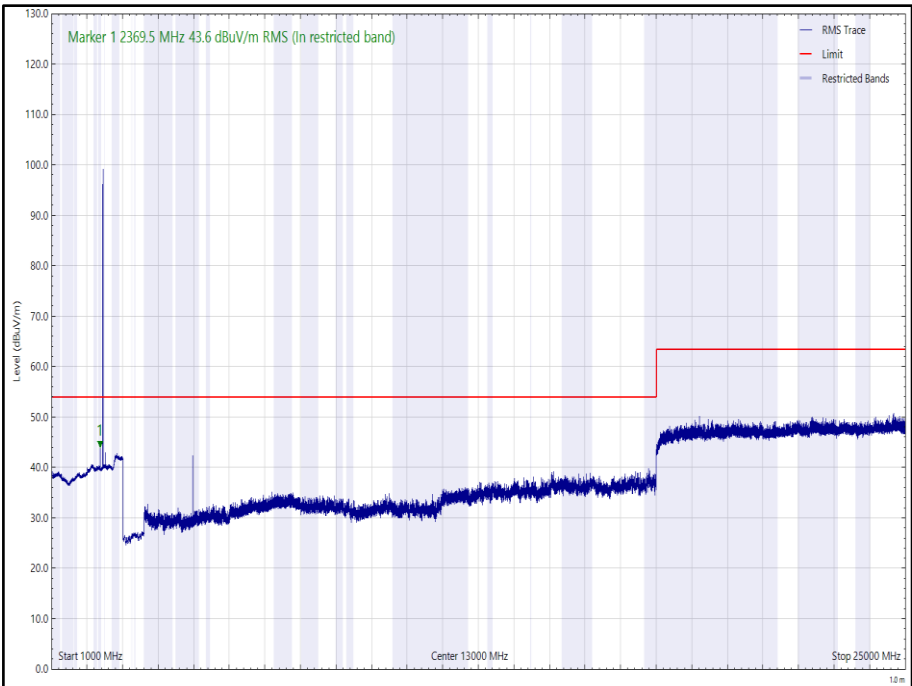


Figure 23 - BLE, 2440 MHz, 1 GHz to 25 GHz, Vertical (rms)

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
4959.785	38.6	54.0	-15.4	RMS	334	100	Vertical

Table 30 - BLE, 2480 MHz, 1 to 25 GHz

No other emissions found within 10 dB of the limit.

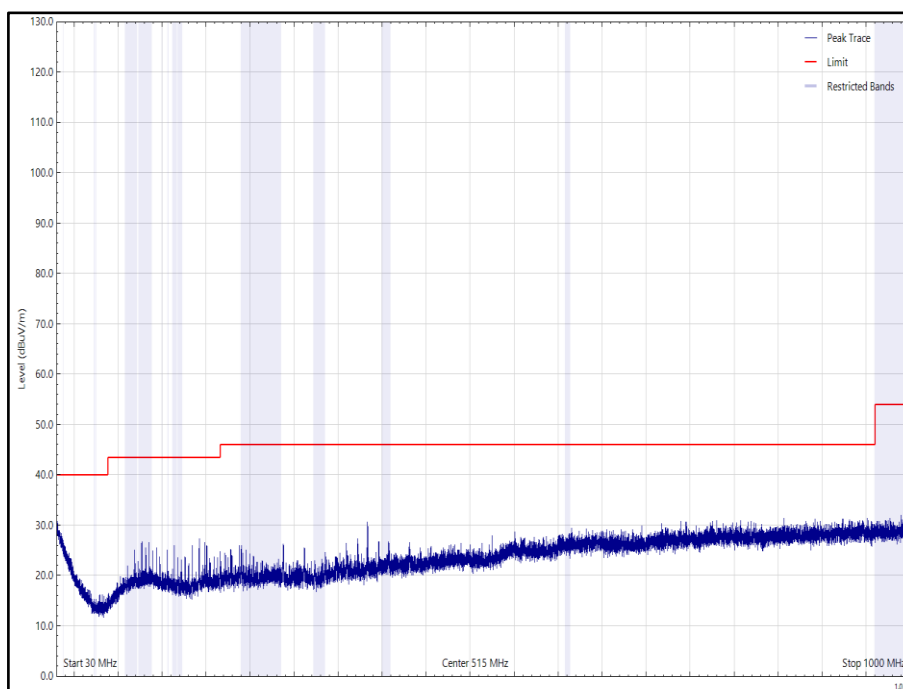


Figure 24 - BLE, 2480 MHz, 30 MHz to 1 GHz, Horizontal (Peak)

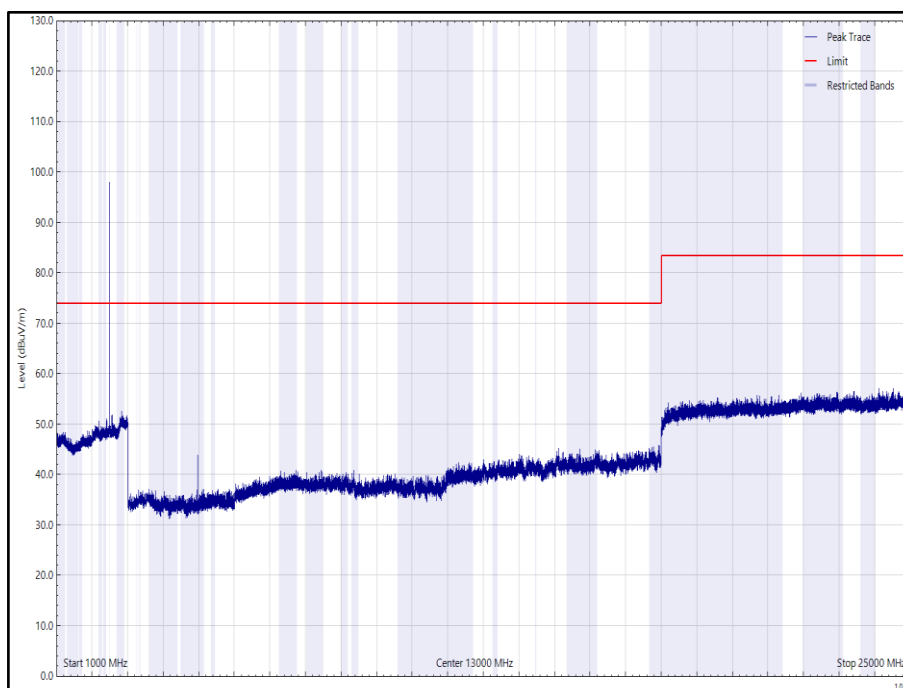


Figure 25 - BLE, 2480 MHz, 1 GHz to 25 GHz, Horizontal (Peak)

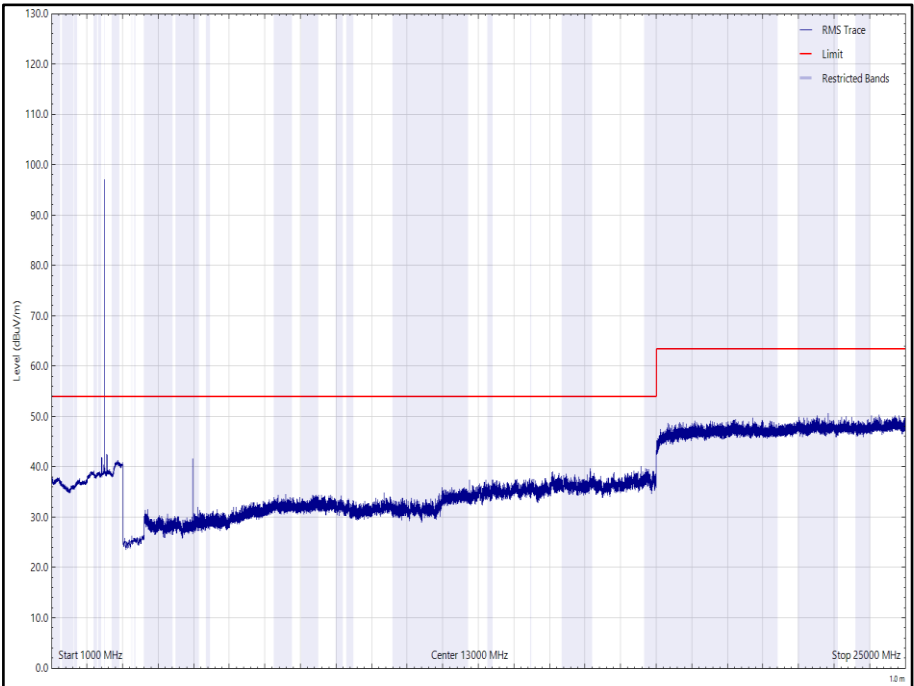


Figure 26 - BLE, 2480 MHz, 1 GHz to 25 GHz, Horizontal (rms)

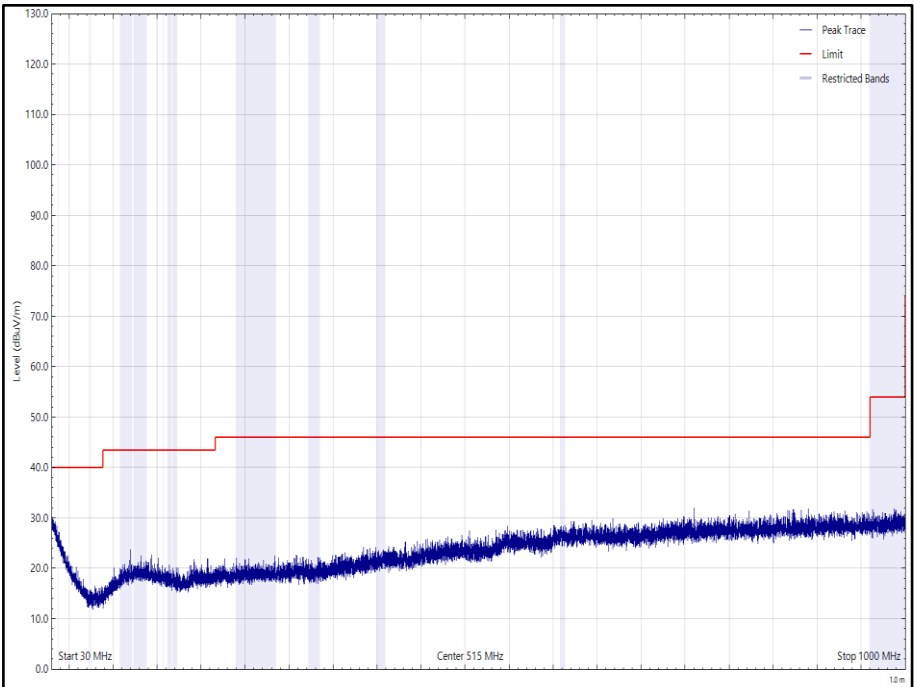


Figure 27 - BLE, 2480 MHz, 30 MHz to 1 GHz, Vertical (Peak)

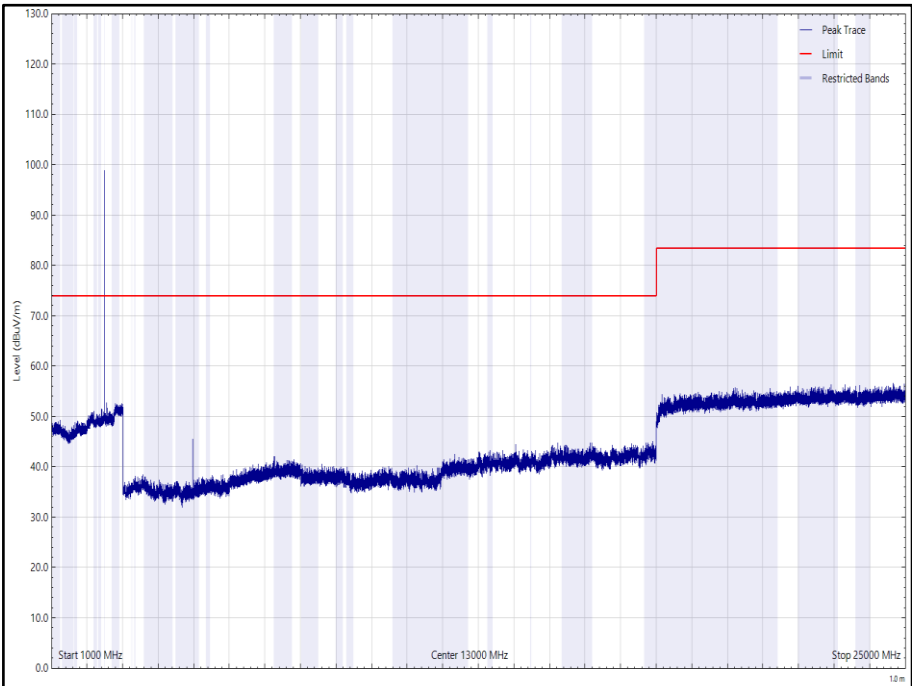


Figure 28 - BLE, 2480 MHz, 1 GHz to 25 GHz, Vertical (Peak)

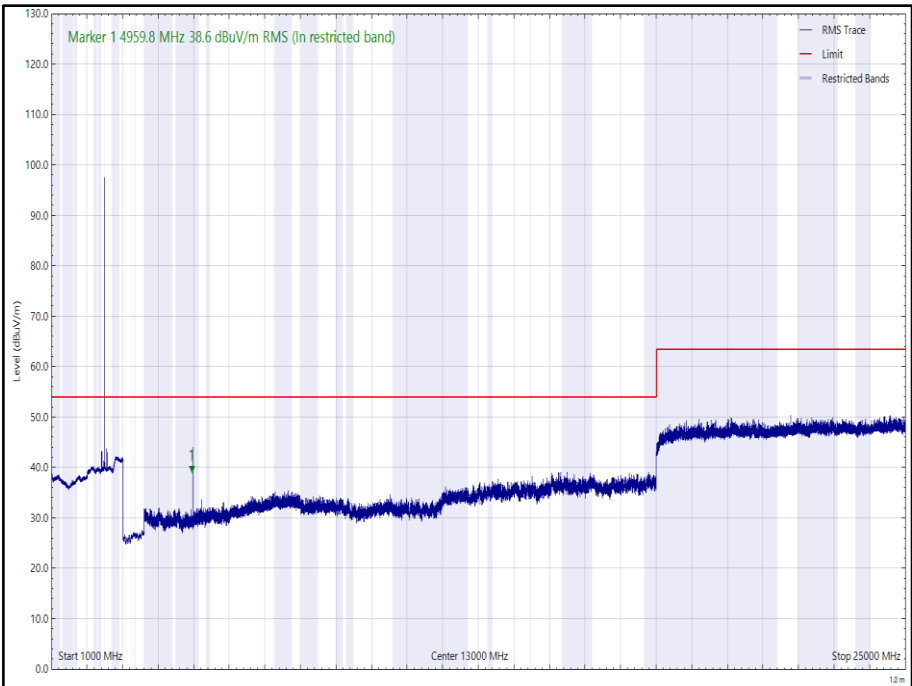


Figure 29 - BLE, 2480 MHz, 1 GHz to 25 GHz, Vertical (rms)



FCC 47 CFR Part 15, Limit Clause 15.247 (d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in 15.209(a)

ISED RSS-247, Limit Clause 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

In addition, radiated emissions which fall in the restricted bands, as defined in RSS-GEN, clause 8.10, must also comply with the radiated emission limits specified in RSS-GEN clause 8.9.

2.5.8 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 12.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Antenna 18-40GHz (Double Ridge Guide)	Link Microtek Ltd	AM180HA-K-TU2	230	24	27-Jul-2022
Antenna with attenuator (Bilog, 30 MHz to 3 GHz)	Schaffner	CBL6143	287	24	14-Oct-2022
Pre-Amplifier, (8 GHz to 18 GHz)	Phase One	PS04-0086	1533	12	5-Feb-2022
18GHz - 40GHz Pre-Amplifier	Phase One	PS04-0087	1534	12	2-Aug-2022
Multimeter	Fluke	79 Series II	3057	12	23-Aug-2022
Test Receiver	Rohde & Schwarz	ESU40	3506	12	18-Mar-2022
Cable (K-Type to K-Type, 2 m)	Scott Cables	KPS-1501-2000-KPS	4526	6	6-Mar-2022
Cable (N-Type to N-Type, 1 m)	Rosenberger	LU7-036-1000	5031	12	23-Jul-2022
EmX Emissions Software	TUV SUD	V2.1.11	5125	-	Software
3 GHz High pass filter	Wainwright	WHKX12-2580-3000-18000-80SS	5219	12	22-Feb-2022
Pre-Amplifier (30 dB, 1 GHz to 18 GHz)	Schwarzbeck	BBV 9718 C	5350	12	22-Sep-2022
Cable (sma-sma, 2 m)	Junkosha	MWX221-02000DMS	5428	12	20-Oct-2022
Cable (N-Type to N-Type, 8 m)	Teledyne	PR90-088-8MTR	5450	6	8-Mar-2022
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB-40	5481	12	31-Mar-2022
1m K-Type Cable	Junkosha	MWX241-01000KMSKMS/A	5512	12	9-Apr-2022
2m K Type Cable	Junkosha	MWX241-02000KMSKMS/A	5524	12	24-Mar-2022
Antenna (DRG, 7.5 GHz to 18 GHz)	Schwarzbeck	HWRD750	5610	12	15-Oct-2022
Antenna (DRG, 1 GHz to 10 GHz)	Schwarzbeck	BBHA 9120 B	5611	12	15-Oct-2022
Turntable & Mast Controller	Maturo Gmbh	NCD/498/2799.01	5612	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	5613	-	TU
Turntable	Maturo Gmbh	Turntable 1.5 SI-2t	5614	-	TU
Screened Room (12)	MVG	EMC-3	5621	36	11-Aug-2023

Table 31

TU - Traceability Unscheduled



2.6 Power Spectral Density

2.6.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (e)
ISED RSS-247, Clause 5.2
ISED RSS-GEN, Clause 6.12

2.6.2 Equipment Under Test and Modification State

RB03, S/N: H8U-JP-FJN0002X - Modification State 0

2.6.3 Date of Test

07-May-2021

2.6.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 11.10.2 method PKPSD.

2.6.5 Environmental Conditions

Ambient Temperature	23.8 °C
Relative Humidity	23.1 %



2.6.6 Test Results

Bluetooth Low Energy

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (e) RSS-247 5.2 b)	Test Method(s):	C63.10 11.10.2
Additional Reference(s):	-		

DUT Configuration			
Mode:	Main - GFSK (LE 1M)	Duty Cycle (%):	62.4
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (Main)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	RBW (kHz)	PSD (dBm/RBW)					Limit (dBm/3 kHz)	Margin (dB)
		A	B	C	D	Σ		
2402	3.0	-8.55	-	-	-	-	8.00	-16.55
2440	3.0	-8.73	-	-	-	-	8.00	-16.73
2480	3.0	-8.88	-	-	-	-	8.00	-16.88

Table 32 - Maximum Power Spectral Density Results

FCC 47 CFR Part 15, Limit Clause 15.247 (e)

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

ISED RSS-247, Limit Clause 5.2(b)

The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission



2.6.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	17-May-2021
Multimeter	Iso-tech	IDM101	2421	12	30-Oct-2021
Hygrometer	Rotronic	I-1000	3220	12	16-Oct-2021
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	17-May-2021
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	04-Mar-2022
Signal Commissioning Unit	TUV SUD	SCU001	5546	12	16-Apr-2022

Table 33

3 Photographs

3.1 Test Setup Photographs



Figure 30 - Test Setup - 30 MHz to 1 GHz

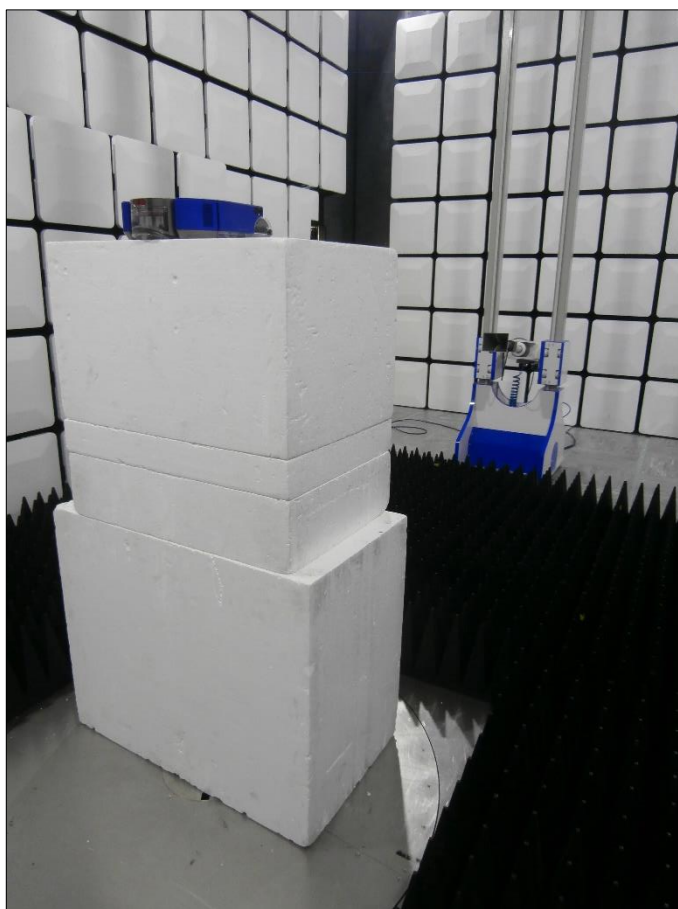


Figure 31 - Test Setup - 1 GHz to 18 GHz



Figure 32 - Test Setup - 18 GHz to 25 GHz



4 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Test Name	Measurement Uncertainty
Restricted Band Edges	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Emission Bandwidth	± 25.354 kHz
Maximum Conducted Output Power	± 3.2 dB
Authorised Band Edges	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Spurious Radiated Emissions	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Power Spectral Density	± 3.2 dB

Table 34

Measurement Uncertainty Decision Rule

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115: 2007, clause 4.4.3 and 4.5.1.