FCC Test Report

Omni-ID
Bluetooth Low Energy Tag, Model: Sense Asset

In accordance with FCC 47 CFR Part 15C (Bluetooth Low Energy)

Prepared for: Omni-ID
The Enterprise Centre
Coxbridge Business Park
Alton Road
Farnham
Surrey
GU10 5EH
UNITED KINGDOM

FCC ID: 2AYW9-SENSE

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Document 75949856-04 Issue 01

SIGNATURE			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Neil Rousell	Senior Engineer	Authorised Signatory	02 July 2021

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD 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. The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Daniel Cameron	02 July 2021	
Testing	Anthony Hubbard	02 July 2021	

FCC Accreditation
90987 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: 2019 for the tests detailed in section 1.3.

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Contents

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	02 July 2021

Table 1

1.2 Introduction

Applicant	Omni-ID
Manufacturer	Omni-ID
Model Number(s)	Sense Asset
Serial Number(s)	Jan21/1073R, Jan21/1065R, Jan21/1068R, Jan21/1075R, Not Serialised Storix ID0035, Not Serialised Storix ID0045, Not Serialised Storix ID0046 and Not Serialised Storix ID0047
Hardware Version(s)	E
Software Version(s)	1.7
Number of Samples Tested	8
Test Specification/Issue/Date	FCC 47 CFR Part 15C: 2019
Order Number Date	20200033 27-August-2020
Date of Receipt of EUT	11-February-2021
Start of Test	15-February-2021
Finish of Test	15-April-2021
Name of Engineer(s)	Daniel Cameron and Anthony Hubbard
Related Document(s)	ANSI C63.4 (2014) ANSI C63.10 (2013) KDB 662911 D01 v02r01

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15C is shown below.

Section	Specification Clause	Test Description	Result	Comments/Base Standard
Configuration and Mode: 2.4 GHz Bluetooth Low Energy				
2.1	15.205	Restricted Band Edges	Pass	
2.2	15.247 (a)(2)	Emission Bandwidth	Pass	
2.3	15.247 (b)	Maximum Conducted Output Power	Pass	
2.4	15.247 (d)	Authorised Band Edges	Pass	
2.5	15.247 (d) and 15.209	Spurious Radiated Emissions	Pass	
2.6	15.247 (e)	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)*	A BLE tag used to locate personnel and Assets Tag advertises only and does not pair.
Manufacturer:	Omni Id
Model:	Sense Asset
Part Number:	CP14885
Hardware Version:	E
Software Version:	1.7
FCC ID of the product under test – see guidance here	2AYW9-SENSE
IC ID of the product under test – see guidance here	Not Applicable

Intentional Radiators

Technology	Bluetooth Low Energy
Frequency Range (MHz to MHz)	2401-2481
Conducted Declared Output Power (dBm)	8
Antenna Gain (dBi)	0
Supported Bandwidth(s) (MHz) (e.g 1 MHz, 20 MHz, 40 MHz)	1 MHz
Modulation Scheme(s) (e.g GFSK, QPSK etc)	GFSK
ITU Emission Designator (see guidance here) (not mandatory for Part 15 devices)	2G45XD
Bottom Frequency (MHz)	2401
Middle Frequency (MHz)	2441
Top Frequency (MHz)	2481

Un-intentional Radiators

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

Battery Power Source

Voltage:	3	V
End-point voltage:	1.8	V *(Point at which the battery will terminate)*
Alkaline ☐ Leclanche ☒ Lithium ☐ Nickel Cadmium ☐ Lead Acid* ☐ **(Vehicle regulated)*		
Other ☐ Please detail:		

Charging

Can the EUT transmit whilst being charged	Yes ☐ No ☒

Temperature

Minimum temperature:	-20.0	°C
Maximum temperature:	+60.0	°C

Antenna Characteristics

Antenna connector ☐			State impedance		Ohm
Temporary antenna connector ☐			State impedance		Ohm
Integral antenna ☒	Type:	PCB Etch	Gain	0	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 ☐					

Ancillaries (if applicable)

Manufacturer:		Part Number:	
Model:		Country of Origin:	

Name: Charles Vilner
Position held: Omni-ID Engineering Director
Date: 10 February 2021

1.5 Product Information

1.5.1 Technical Description

BLE tag used for tagging both assets and personnel.

1.5.2 Additional Information

Each tag was pre-programmed to an individual frequency, therefore different samples were used for each channel. The table below is a summary of the operating frequency for each tag that was tested:

Sample Serial Number	Operating Frequency (MHz)
Jan21/1073R	2402
Jan21/1075R	2426
Not Serialised Storix ID0035	2480
Jan21/1065R	2401
Jan21/1068R	2402
Not Serialised Storix ID0045	2426
Not Serialised Storix ID0046	2480
Not Serialised Storix ID0047	2402

Table 3 – Test Sample Operating Frequencies

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: Sense Asset, Serial Number: Jan21/1073R			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: Sense Asset, Serial Number: Jan21/1075R			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: Sense Asset, Serial Number: Not Serialised Storix ID0035			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: Sense Asset, Serial Number: Jan21/1065R			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: Sense Asset, Serial Number: Jan21/1068R			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: Sense Asset, Serial Number: 2			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: Sense Asset, Serial Number: Not Serialised Storix ID0046			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: Sense Asset, Serial Number: 4			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 4

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: 2.4 GHz Bluetooth Low Energy		
Restricted Band Edges	Anthony Hubbard	UKAS
Emission Bandwidth	Daniel Cameron	UKAS
Maximum Conducted Output Power	Daniel Cameron	UKAS
Authorised Band Edges	Anthony Hubbard	UKAS
Spurious Radiated Emissions	Anthony Hubbard	UKAS
Power Spectral Density	Daniel Cameron	UKAS

Table 5

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

2.1.2 Equipment Under Test and Modification State

Sense Asset, S/N: Jan21/1065R - Modification State 0
Sense Asset, S/N: Jan21/1068R - Modification State 0
Sense Asset, S/N: Not Serialised Storix ID0046 - Modification State 0
Sense Asset, S/N: Not Serialised Storix ID0047 - Modification State 0

2.1.3 Date of Test

02-April-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 4.1.4.2.2. to obtain the measurement result recorded in the test results tables.

The following conversion can be applied to convert from dBµV/m to µV/m:
10^(Field Strength in dBµV/m/20)

2.1.5 Environmental Conditions

Ambient Temperature	19.4 °C
Relative Humidity	38.9 %

2.1.6 Test Results

2.4 GHz Bluetooth Low Energy

Modulation	Frequency (MHz)	Measured Frequency (MHz)	Peak Level (dBµV/m)	Average Level (dBµV/m)
GFSK	2401	2390.0	58.09	46.25
GFSK	2402	2390.0	58.22	46.19
GFSK	2480	2483.5	57.96	45.58
GFSK	2481	2483.5	57.72	46.23

Table 6 - Restricted Band Edge Results

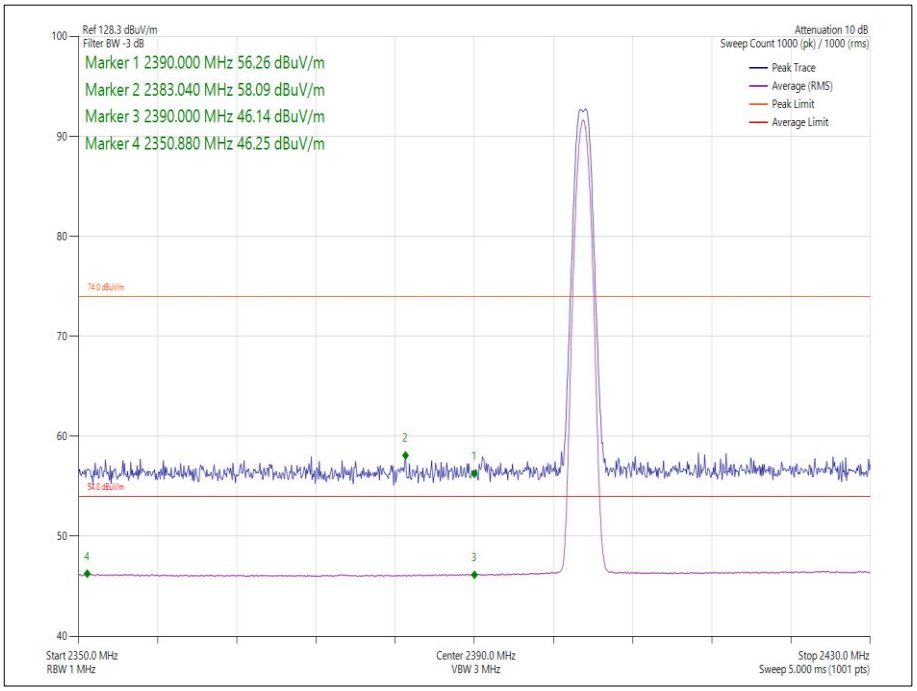

Figure 1 - GFSK - 2401 MHz - Measured Frequency 2390.0 MHz

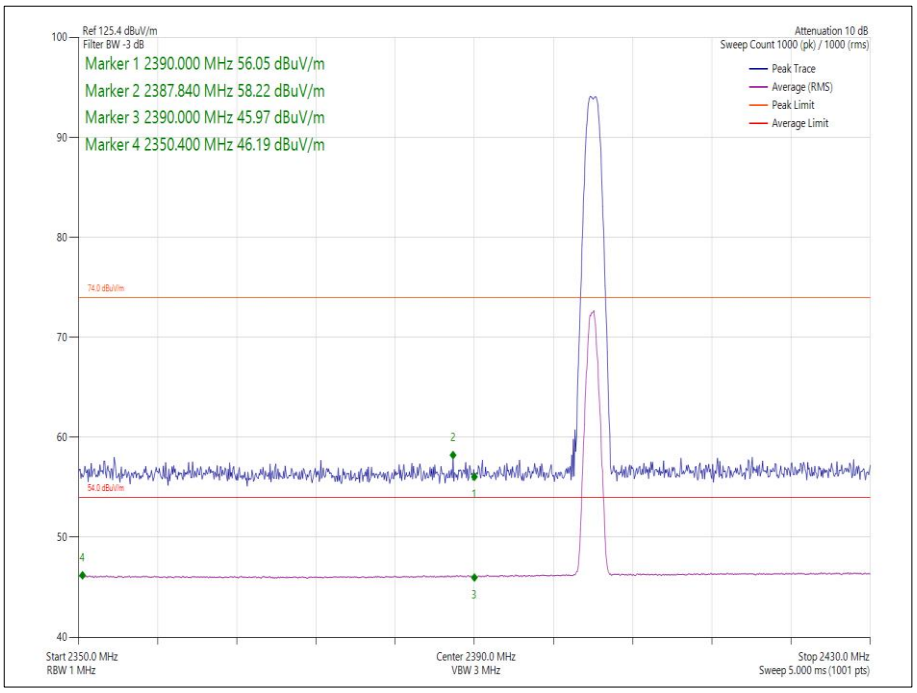

Figure 2 - GFSK - 2402 MHz - Measured Frequency 2390.0 MHz

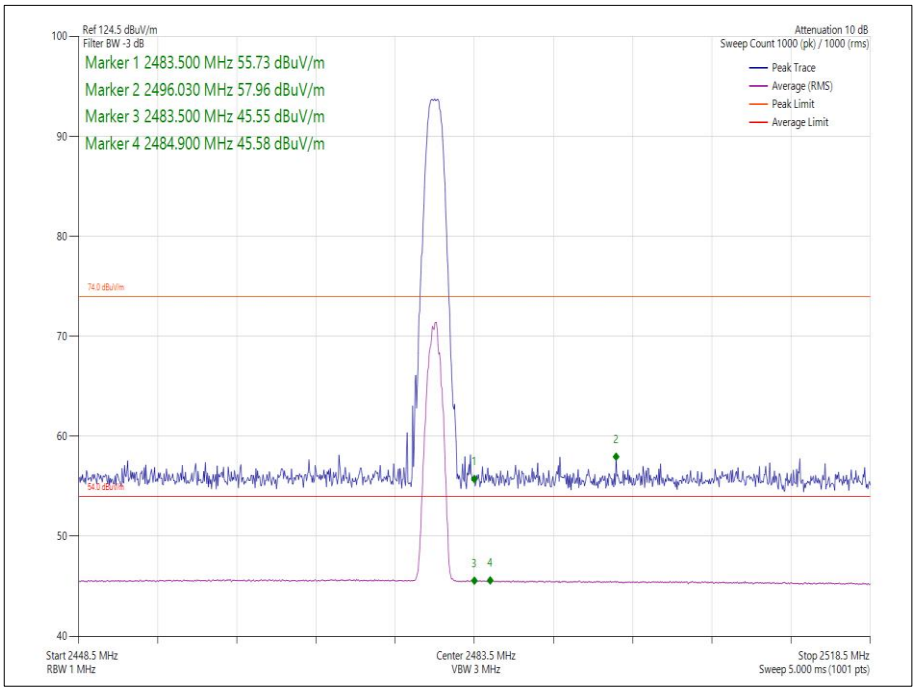

Figure 3 - GFSK - 2480 MHz - Measured Frequency 2483.5 MHz

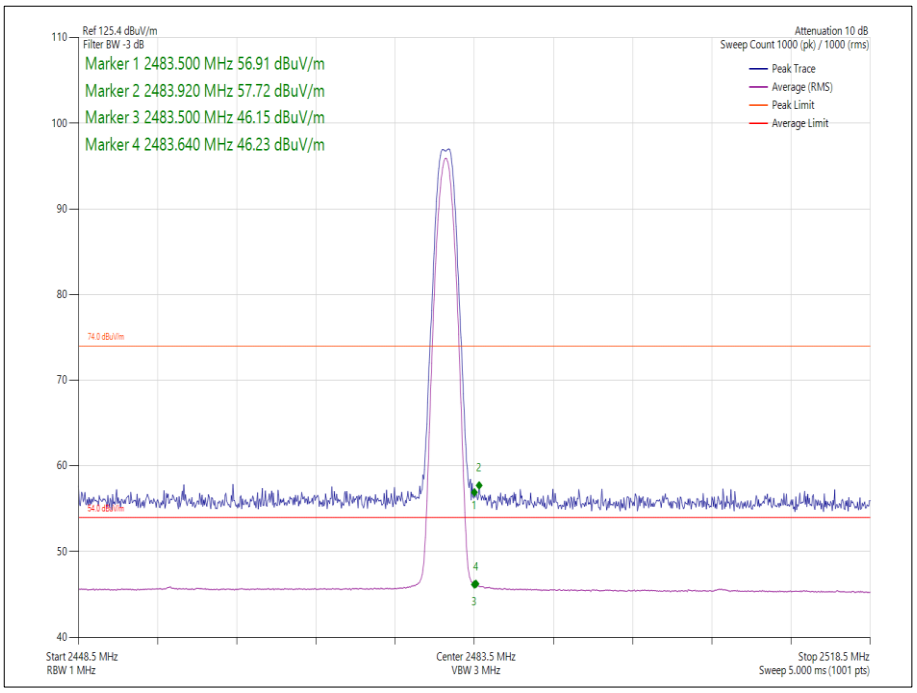

Figure 4 - GFSK - 2481 MHz - Measured Frequency 2483.5 MHz

FCC 47 CFR Part 15, Limit Clause 15.209

Frequency (MHz)	Field Strength (µV/m at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

Table 7

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 Due
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	18-Mar-2022
EmX Emissions Software	TUV SUD	V2.1.4 V.V2.1.4	5125	-	Software
3.5 mm 2m Cable	Junkosha	MWX221-02000DMS	5428	12	15-Oct-2021
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB 40	5604	12	08-Sep-2021
Broadband Horn Antenna (1-10 GHz)	Schwarzbeck	BBHA 9120 B	5611	12	22-Sep-2021
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
3m Semi Anechoic Chamber	MVG	EMC-3	5621	36	11-Aug-2023
Cable Assembly - 18GHz 8m	Junkosha	MWX221-08000NMSNMS/B	5732	6	05-Aug-2021

Table 8

TU - Traceability Unscheduled

2.2 Emission Bandwidth

2.2.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(2)

2.2.2 Equipment Under Test and Modification State

Sense Asset, S/N: Jan21/1073R - Modification State 0
Sense Asset, S/N: Jan21/1075R - Modification State 0
Sense Asset, S/N: Not Serialised Storix ID0035 - Modification State 0

2.2.3 Date of Test

15-February-2021 to 22-February-2021

2.2.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 11.8.1

2.2.5 Environmental Conditions

Ambient Temperature	22.0 - 22.6 °C
Relative Humidity	39.8 - 41.4 %

2.2.6 Test Results

2.4 GHz Bluetooth Low Energy

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

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

Test Frequency (MHz)	6 dB Bandwidth (MHz)					Limit (kHz)
	A	B	C	D	Minimum	
2402	0.752	-	-	-	0.752	≥500.0
2426	0.752	-	-	-	0.752	≥500.0
2480	0.756	-	-	-	0.756	≥500.0

Table 9 - 6 dB Bandwidth Results

Test Frequency (MHz)	99% Bandwidth (MHz)					Limit (kHz)
	A	B	C	D	Minimum	
2402	1.064	-	-	-	1.064	-
2426	1.068	-	-	-	1.068	-
2480	1.068	-	-	-	1.068	-

Table 10 - 99% Bandwidth Results

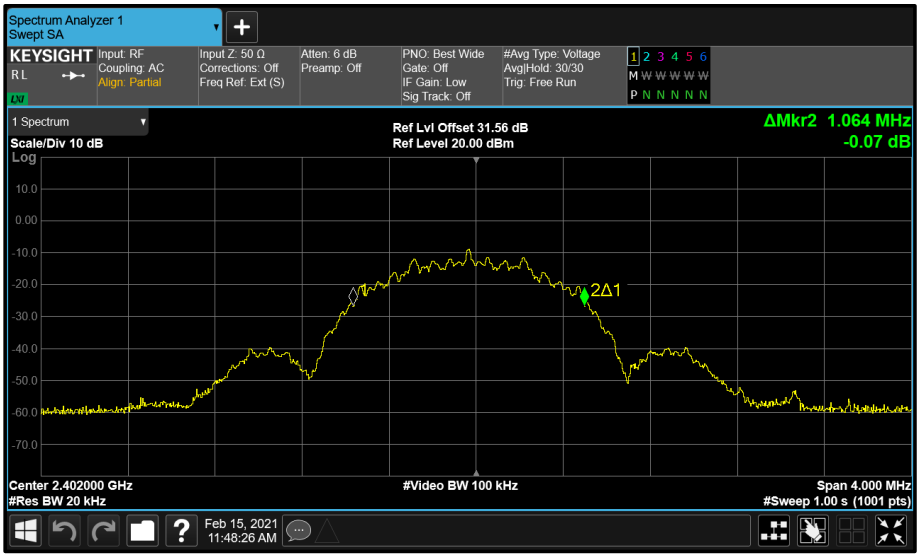

Figure 5 - COM (A) 2402 MHz (CH0) 99% Bandwidth

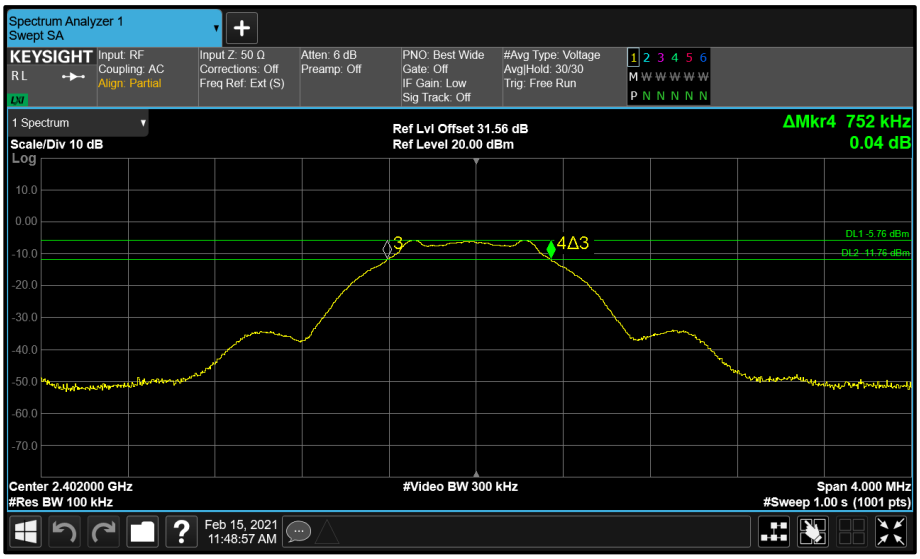

Figure 6 - COM (A) 2402 MHz (CH0) 6 dB Bandwidth

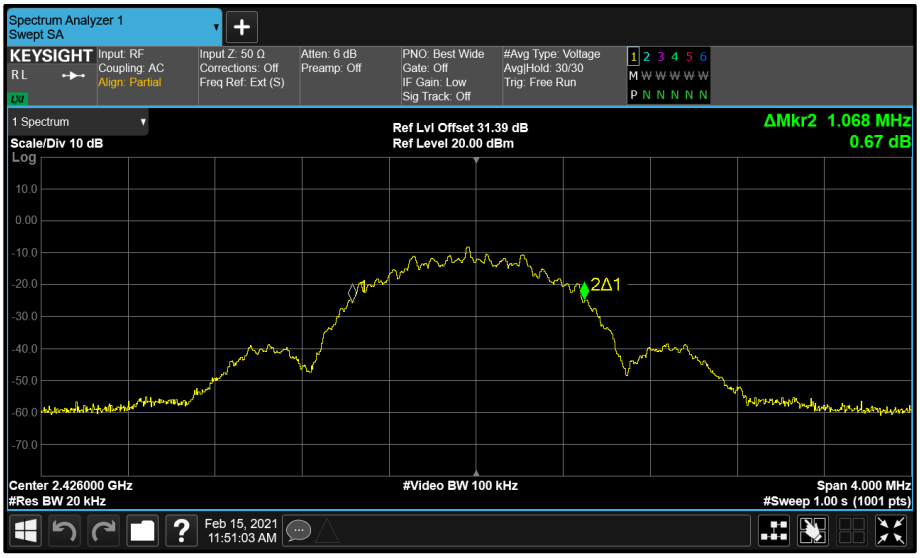

Figure 7 - COM (A) 2426 MHz (CH12) 99% Bandwidth

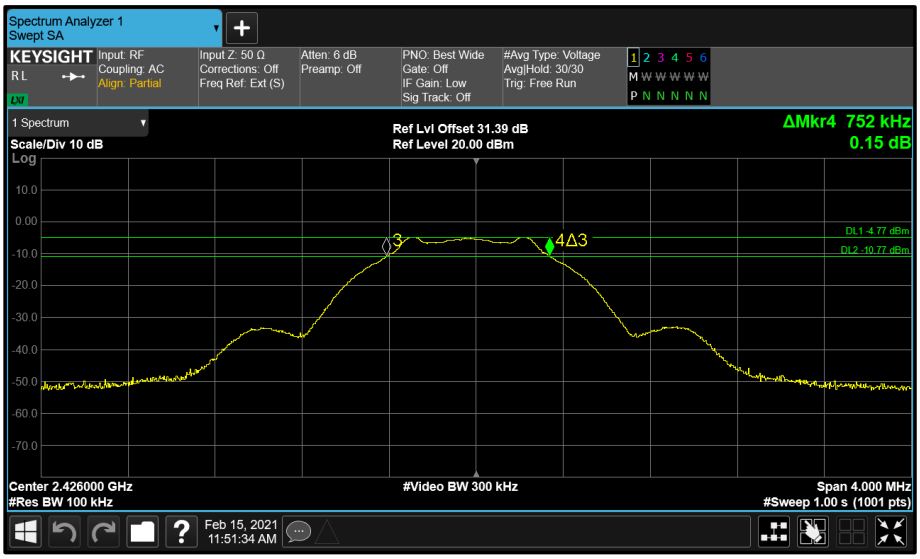

Figure 8 - COM (A) 2426 MHz (CH12) 6 dB Bandwidth

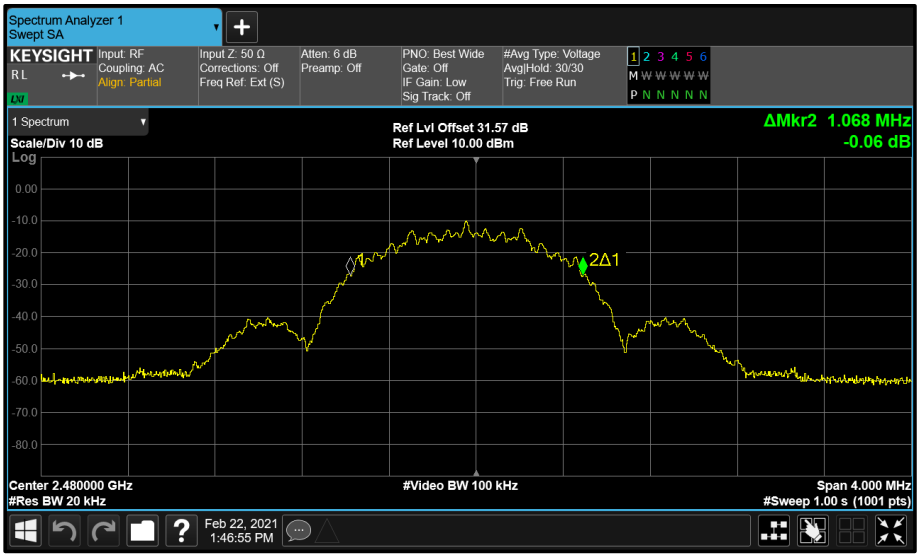

Figure 9 - COM (A) 2480 MHz (CH39) 99% Bandwidth

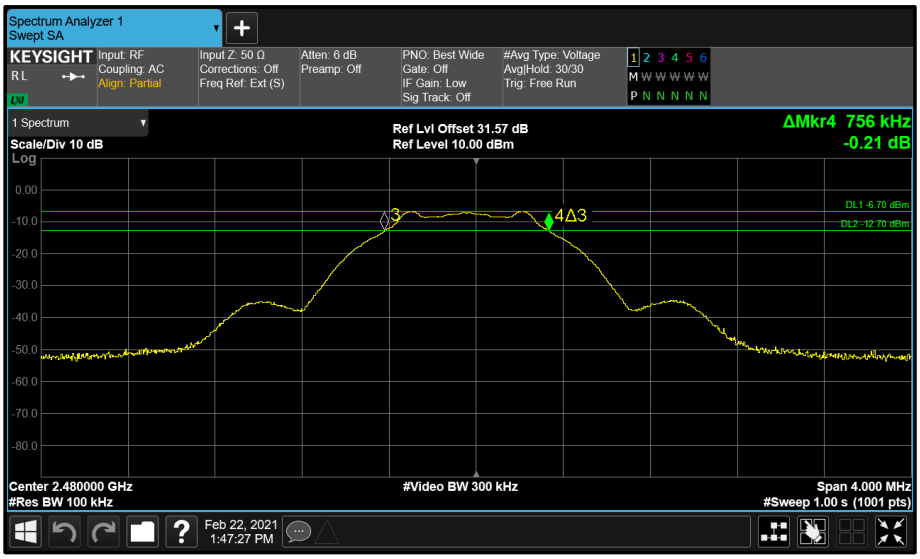

Figure 10 - COM (A) 2480 MHz (CH39) 6 dB Bandwidth

FCC 47 CFR Part 15, Limit Clause 15.247(a)(2)

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 Due
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
Climatic Chamber	Aralab	FitoTerm 300E45	4823	12	19-Mar-2021
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	04-Mar-2022
Signal Commissioning Unit	TUV SUD	SCU001	5546	12	15-Apr-2021

Table 11

2.3 Maximum Conducted Output Power

2.3.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (b)

2.3.2 Equipment Under Test and Modification State

Sense Asset, S/N: Jan21/1073R - Modification State 0
Sense Asset, S/N: Jan21/1075R - Modification State 0
Sense Asset, S/N: Not Serialised Storix ID0035 - Modification State 0

2.3.3 Date of Test

15-February-2021 to 22-February-2021

2.3.4 Test Method

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

2.3.5 Environmental Conditions

Ambient Temperature	22.0 - 22.6 °C
Relative Humidity	39.8 - 41.4 %

2.3.6 Test Results

2.4 GHz Bluetooth Low Energy

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

DUT Configuration			
Mode:	Asset GFSK (LE 1M)	Duty Cycle (%):	100.0
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (COM)	Antenna Gain (dBi):	0.00

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)
	A	B	C	D	∑		
2402	-4.49	-	-	-	-	30.00	-34.49
2426	-3.37	-	-	-	-	30.00	-33.37
2480	-5.35	-	-	-	-	30.00	-35.35

Table 12 - FCC 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.

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 Due
Multimeter	Iso-tech	IDM101	2421	12	30-Oct-2021
Hygrometer	Rotronic	I-1000	3220	12	16-Oct-2021
Climatic Chamber	Aralab	FitoTerm 300E45	4823	12	19-Mar-2021
USB Power Sensor	Boonton	RTP5006	5184	12	20-Apr-2021
Signal Commissioning Unit	TUV SUD	SCU001	5546	12	15-Apr-2021

Table 13

2.4 Authorised Band Edges

2.4.1 Specification Reference

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

2.4.2 Equipment Under Test and Modification State

Sense Asset, S/N: Jan21/1065R - Modification State 0
Sense Asset, S/N: Jan21/1068R - Modification State 0
Sense Asset, S/N: Not Serialised Storix ID0046 - Modification State 0
Sense Asset, S/N: Not Serialised Storix ID0047 - Modification State 0

2.4.3 Date of Test

02-April-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	19.4 °C
Relative Humidity	38.9 %

2.4.6 Test Results

2.4 GHz Bluetooth Low Energy

Modulation	Frequency (MHz)	Measured Frequency (MHz)	Level (dBc)
GFSK	2401	2400	-25.68
GFSK	2402	2400	-43.62
GFSK	2480	2483.5	-43.40
GFSK	2481	2483.5	-47.92

Table 14 - Authorised Band Edge Results

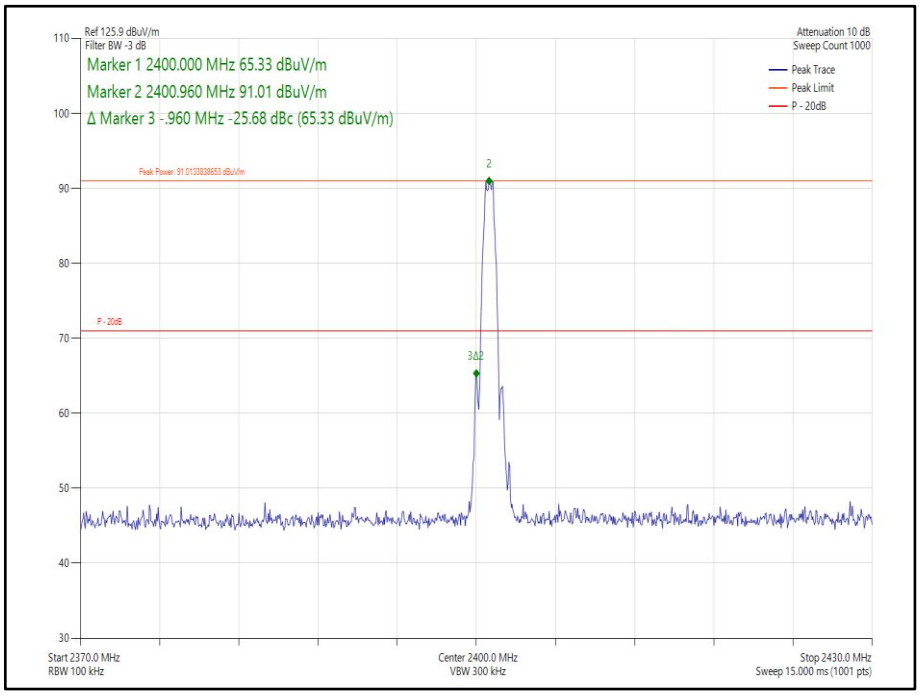

Figure 11 - GFSK - 2401 MHz - Measured Frequency - 2400 MHz

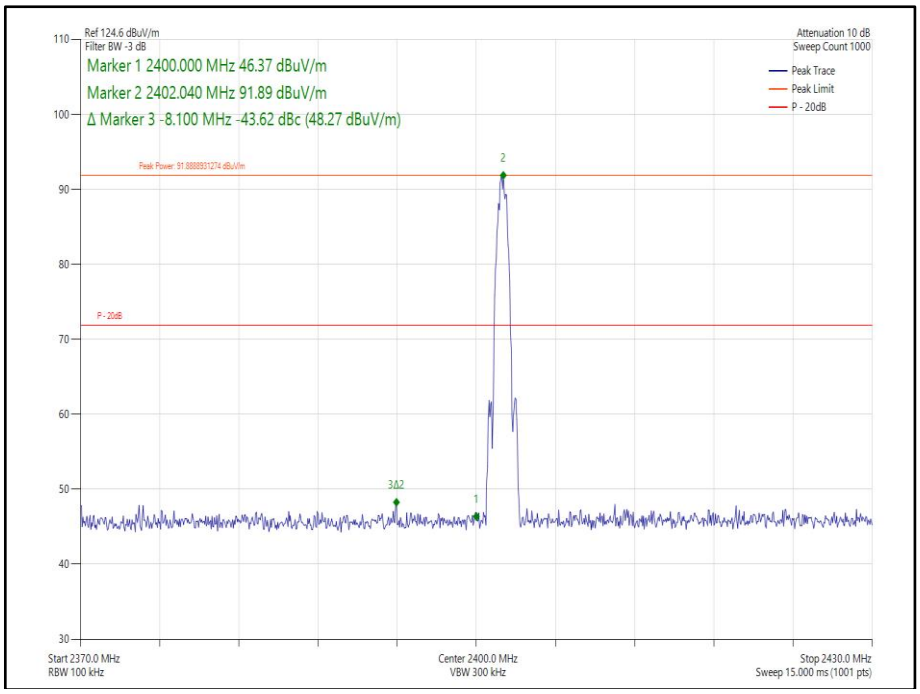

Figure 12 - GFSK - 2402 MHz - Measured Frequency 2400 MHz

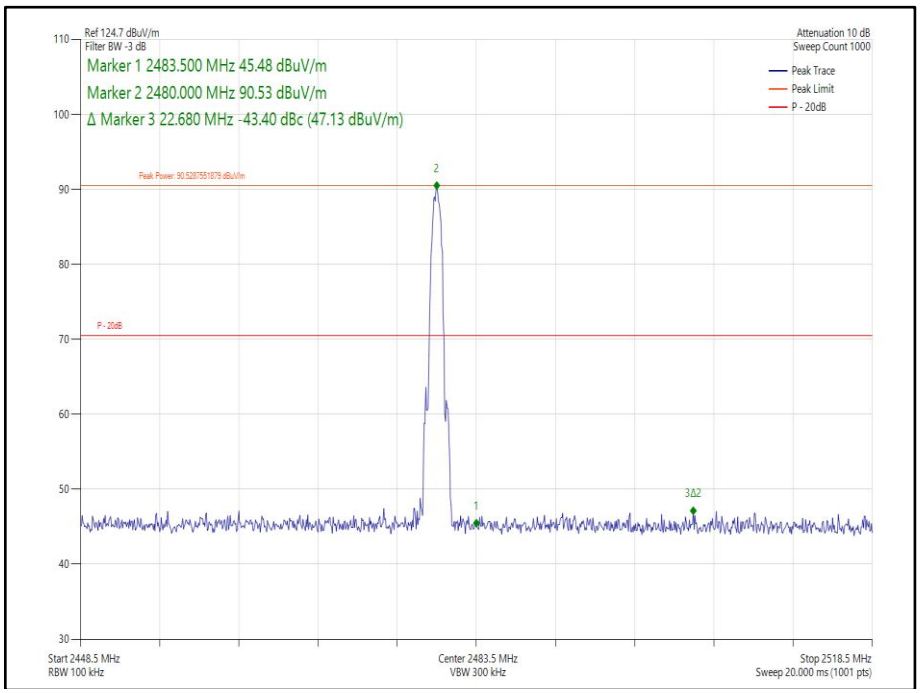

Figure 13 - GFSK - 2480 MHz - Measured Frequency 2485.5 MHz

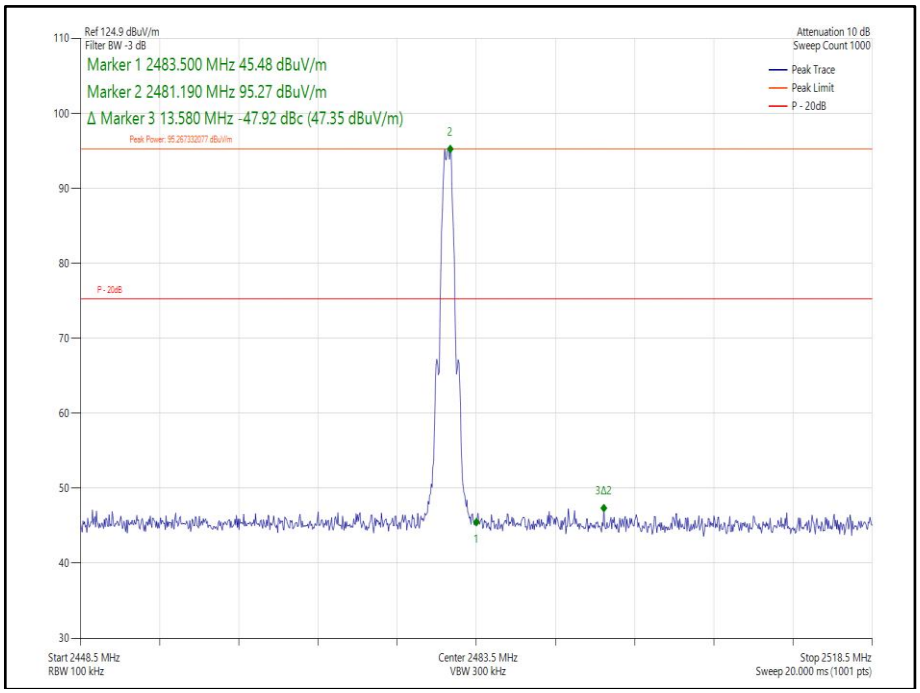

Figure 14 - GFSK - 2481 MHz - Measured Frequency 2483.5 MHz

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.

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 Due
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	18-Mar-2022
EmX Emissions Software	TUV SUD	V2.1.4 V.V2.1.4	5125	-	Software
3.5 mm 2m Cable	Junkosha	MWX221-02000DMS	5428	12	15-Oct-2021
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB 40	5604	12	08-Sep-2021
Broadband Horn Antenna (1-10 GHz)	Schwarzbeck	BBHA 9120 B	5611	12	22-Sep-2021
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
3m Semi Anechoic Chamber	MVG	EMC-3	5621	36	11-Aug-2023
Cable Assembly - 18GHz 8m	Junkosha	MWX221-08000NMSNMS/B	5732	6	05-Aug-2021

Table 15

TU - Traceability Unscheduled

2.5 Spurious Radiated Emissions

2.5.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (d) and 15.209

2.5.2 Equipment Under Test and Modification State

Sense Asset, S/N: Not Serialised Storix ID0045 - Modification State 0
Sense Asset, S/N: Not Serialised Storix ID0046 - Modification State 0
Sense Asset, S/N: Not Serialised Storix ID0047 - Modification State 0

2.5.3 Date of Test

13-April-2021 to 15-April-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. As the EUT could be used in multiple planes, pre-scans were performed with the EUT orientated in X, Y and Z planes with reference to the ground plane.

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 4.1.4.2.2.

The plots shown are the characterization 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 dBµV/m to µV/m:
10^(Field Strength in dBµV/m/20).

To determine the emission characteristic of the EUT above 18 GHz, the test antenna was swept over all faces of the EUT whilst observing a spectral display. The frequency of any emissions of interest was noted for formal measurement at the correct measurement distance of 1m. This procedure was repeated for all relevant transmit operating channels.

At a measurement distance of 1 meter the limit line was increased by 20*LOG(3/1) = 9.54 dB.

Representative noise floor plots are presented in the plot section of the report for one operating channel only.

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

2.5.5 Example Test Setup Diagram

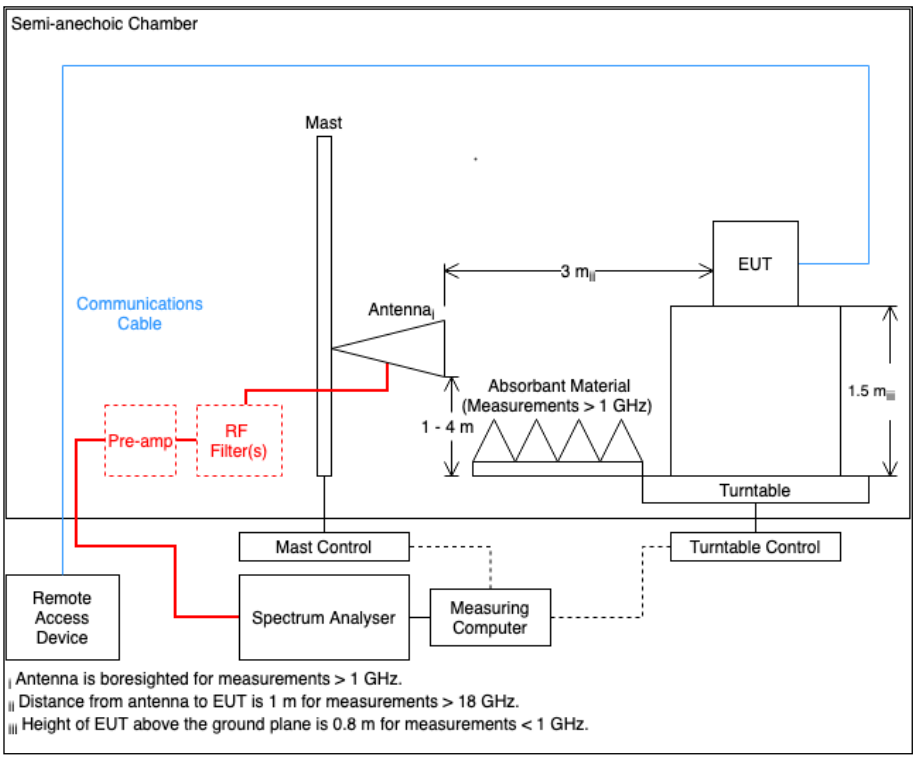

Figure 15

2.5.6 Environmental Conditions

Ambient Temperature	18.8 - 21.4 °C
Relative Humidity	22.8 - 30.9 %

2.5.7 Test Results

2.4 GHz Bluetooth Low Energy

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

Table 16 – 2402 MHz, 30 MHz to 25 GHz

*No emissions were detected within 10 dB of the limit.

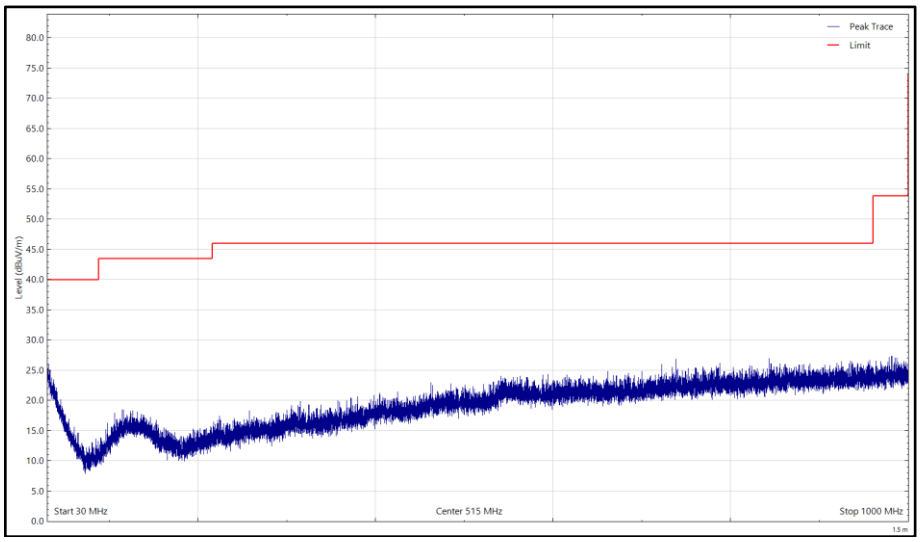

Figure 16 - 2402 MHz, 30 MHz to 1 GHz, Horizontal, Orientation X

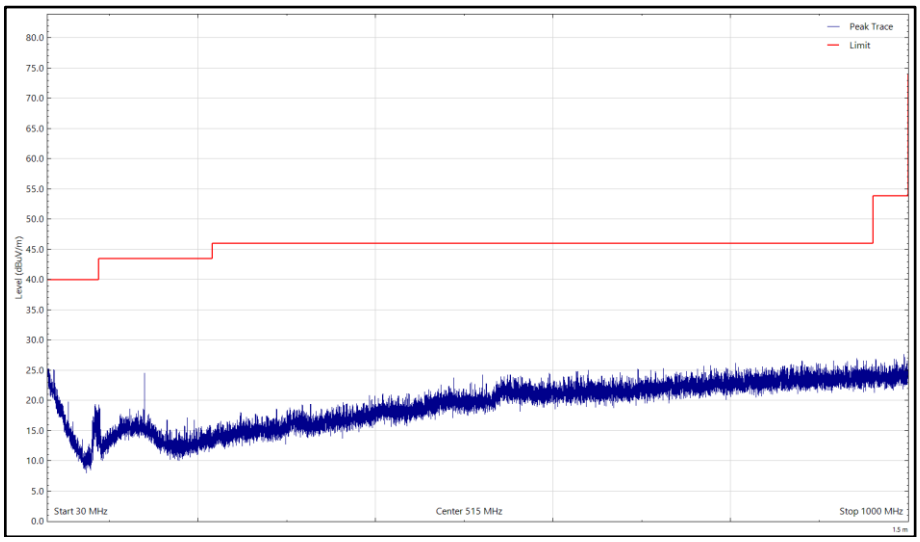

Figure 17 - 2402 MHz, 30 MHz to 1 GHz, Vertical, Orientation X

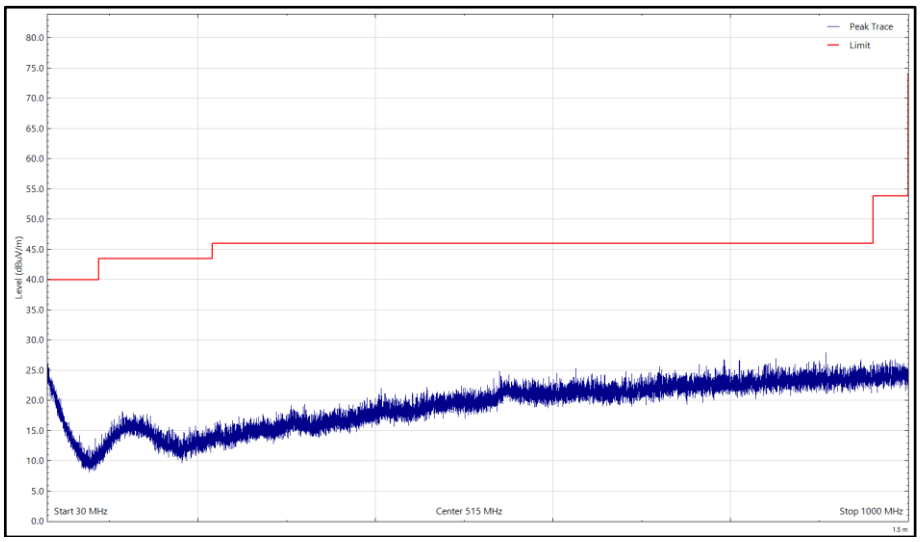

Figure 18 - 2402 MHz, 30 MHz to 1 GHz, Horizontal, Orientation Y

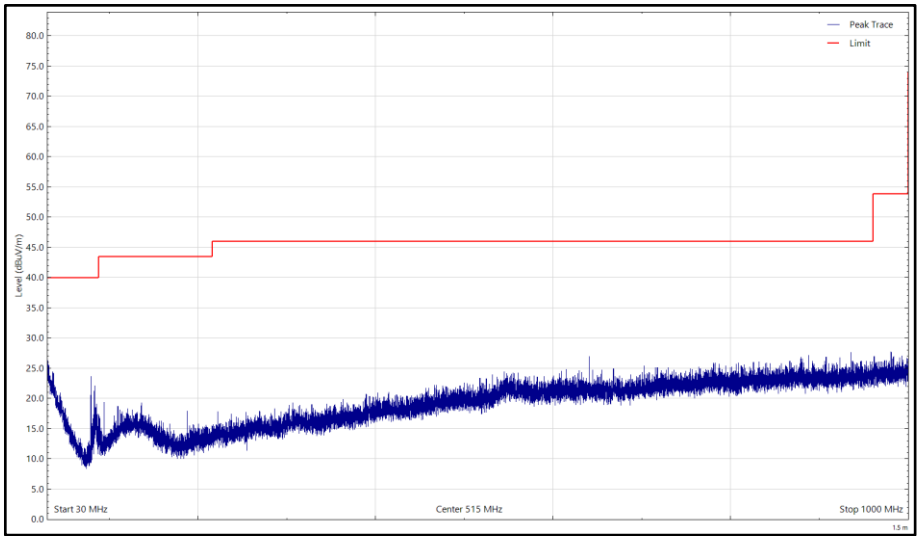

Figure 19 - 2402 MHz, 30 MHz to 1 GHz, Vertical, Orientation Y

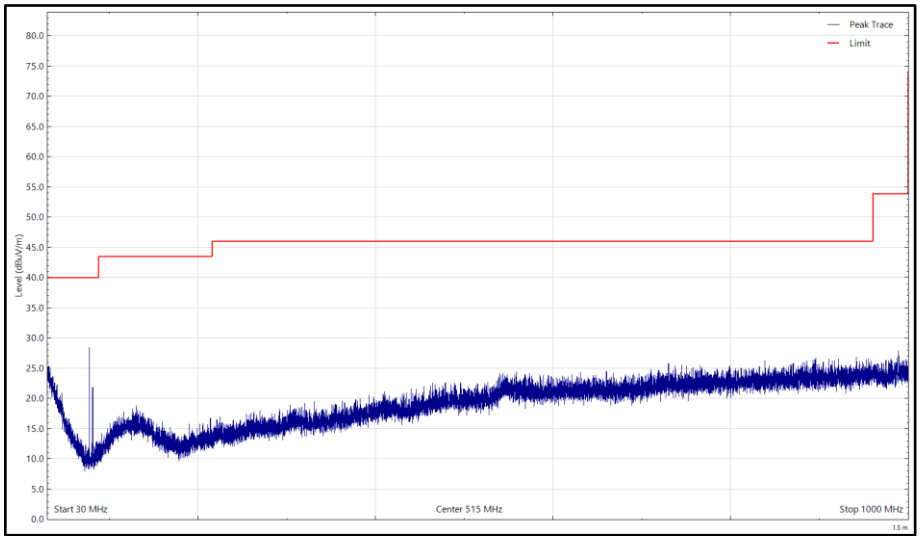

Figure 20 - 2402 MHz, 30 MHz to 1 GHz, Horizontal, Orientation Z

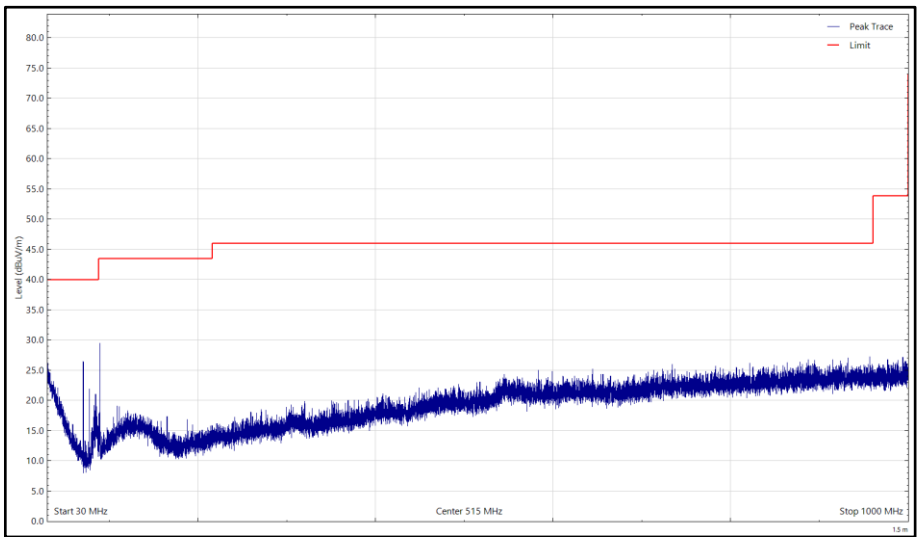

Figure 21 - 2402 MHz, 30 MHz to 1 GHz, Vertical, Orientation Z

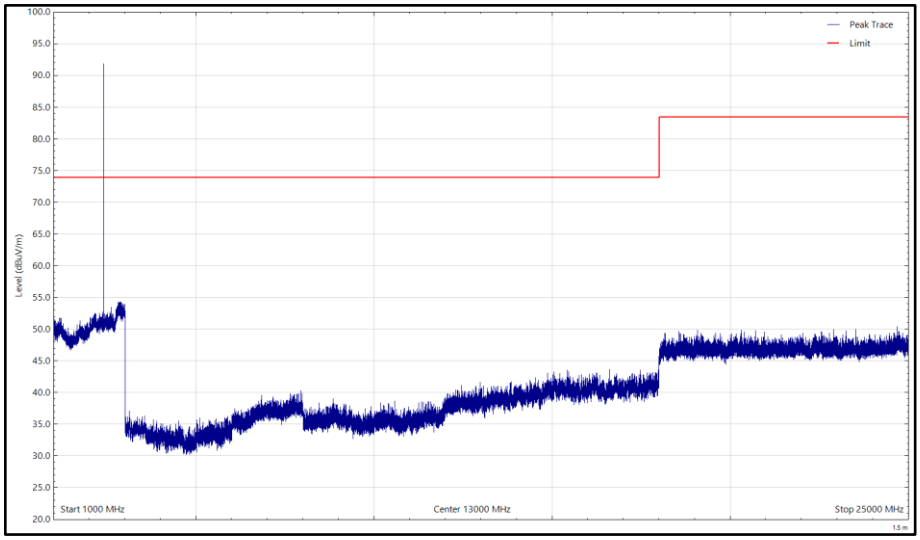

Figure 22 - 2402 MHz, 1 GHz to 25 GHz, Horizontal, Orientation X - Peak

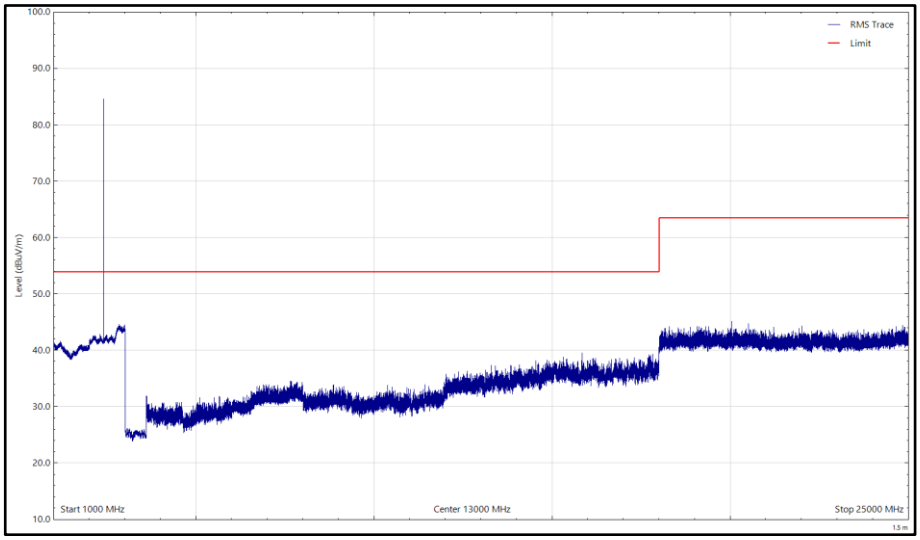

Figure 23 - 2402 MHz, 1 GHz to 25 GHz, Horizontal, Orientation X - Average

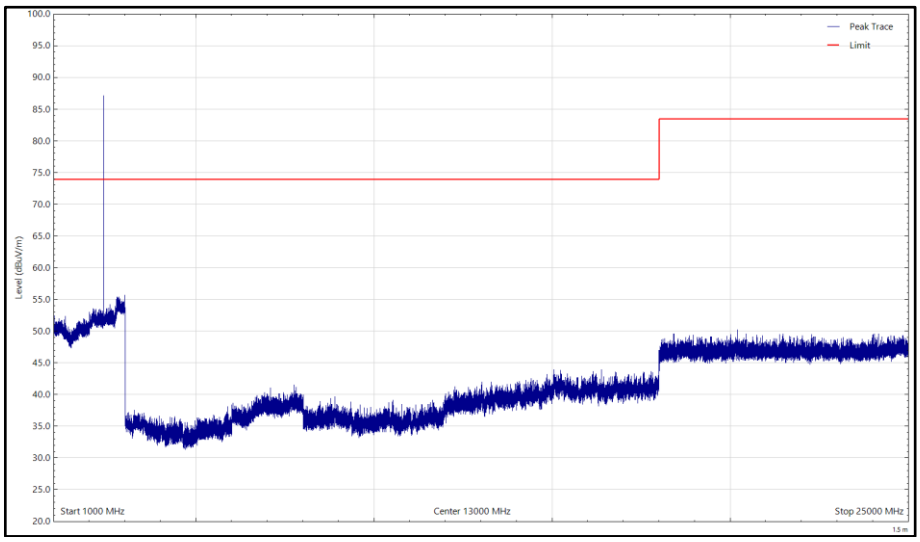

Figure 24 - 2402 MHz, 1 GHz to 25 GHz, Vertical, Orientation X - Peak

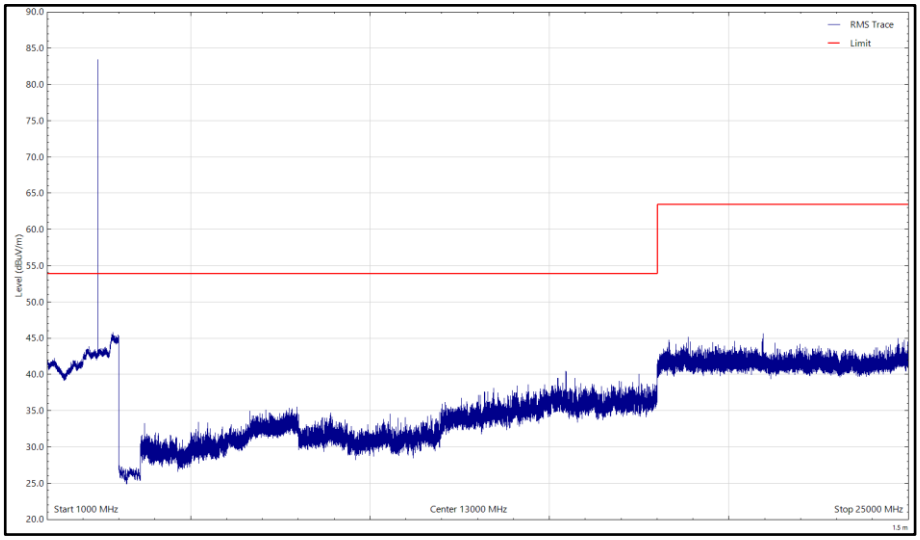

Figure 25 - 2402 MHz, 1 GHz to 25 GHz, Vertical, Orientation X - Average

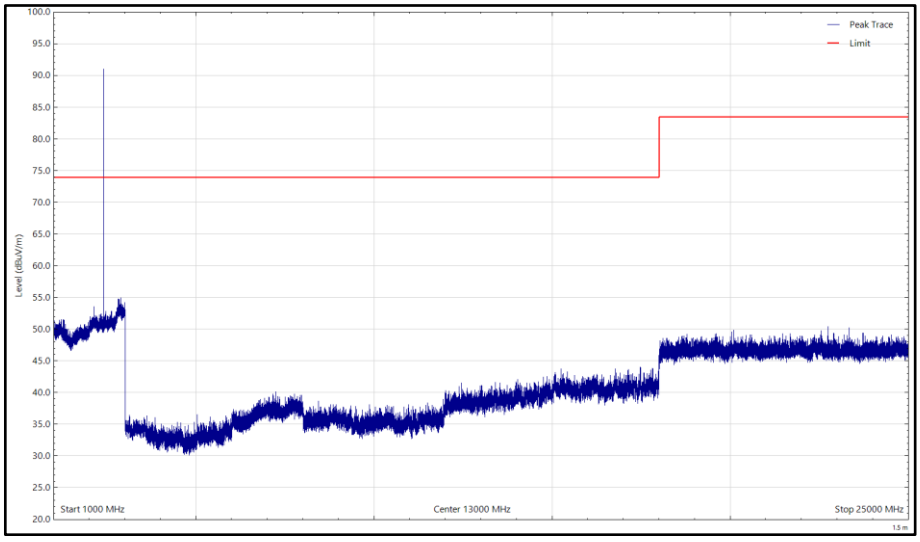

Figure 26 - 2402 MHz, 1 GHz to 25 GHz, Horizontal, Orientation Y - Peak

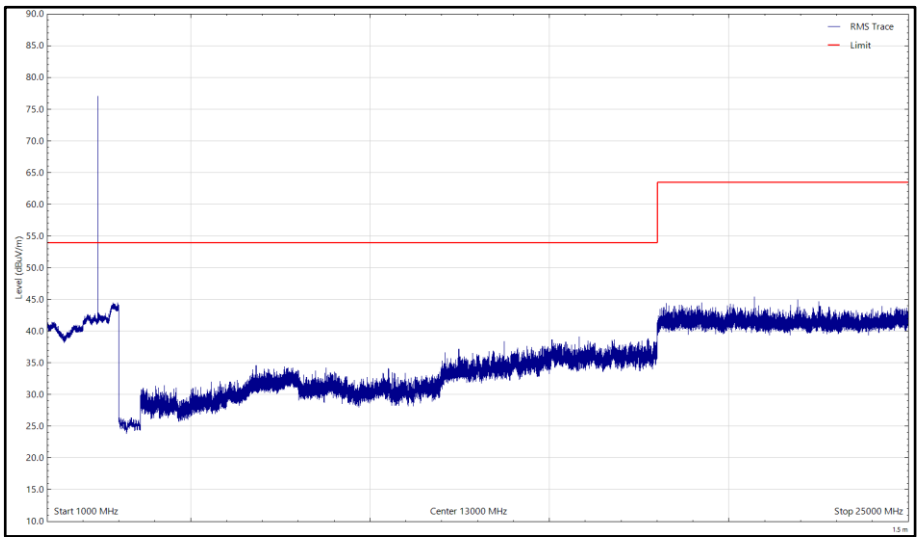

Figure 27 - 2402 MHz, 1 GHz to 25 GHz, Horizontal, Orientation Y - Average

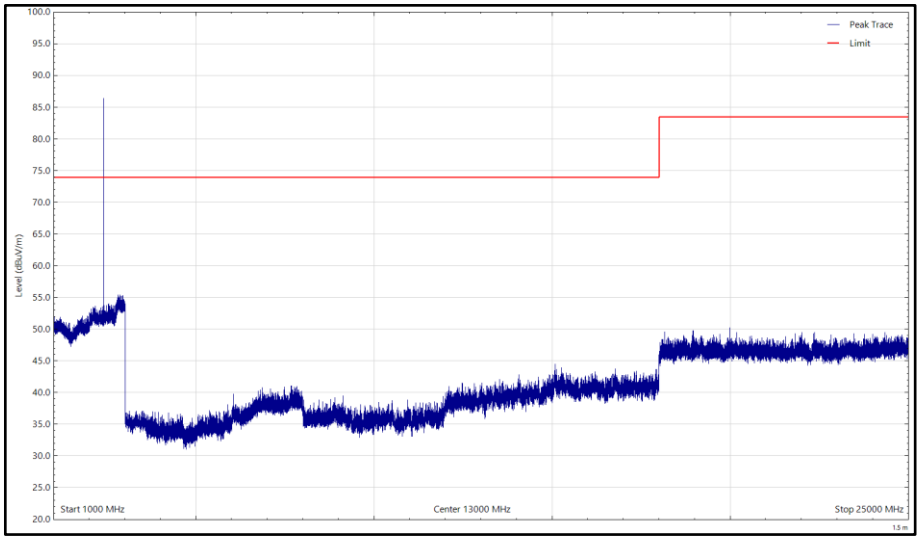

Figure 28 - 2402 MHz, 1 GHz to 25 GHz, Vertical, Orientation Y - Peak

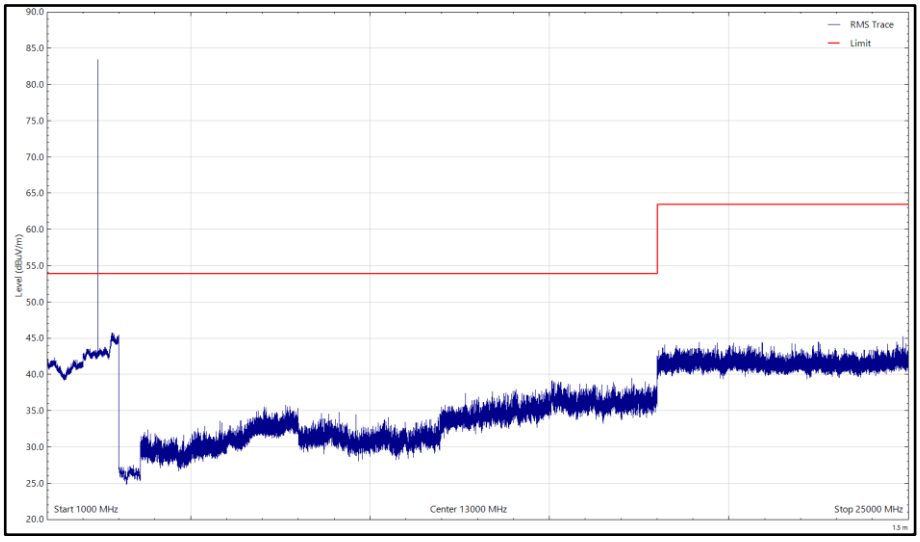

Figure 29 - 2402 MHz, 1 GHz to 25 GHz, Vertical, Orientation Y - Average

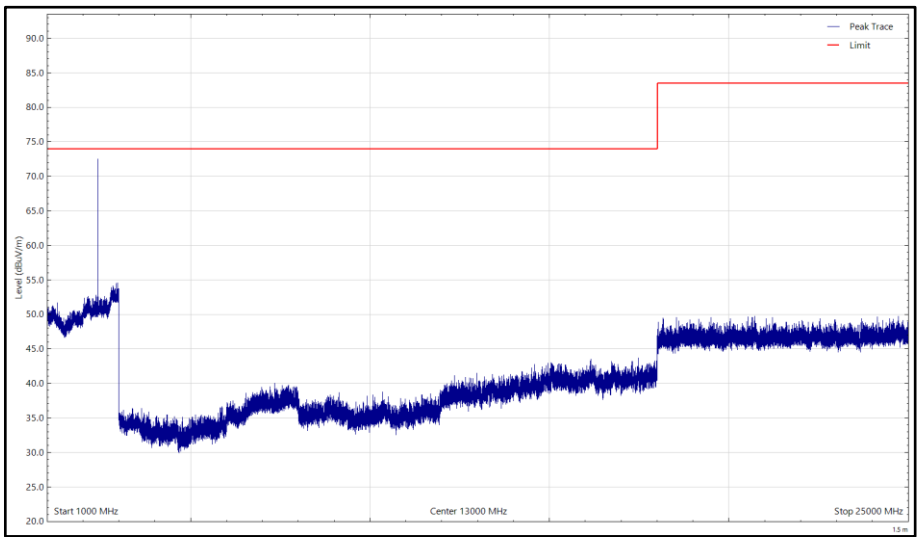

Figure 30 - 2402 MHz, 1 GHz to 25 GHz, Horizontal, Orientation Z - Peak

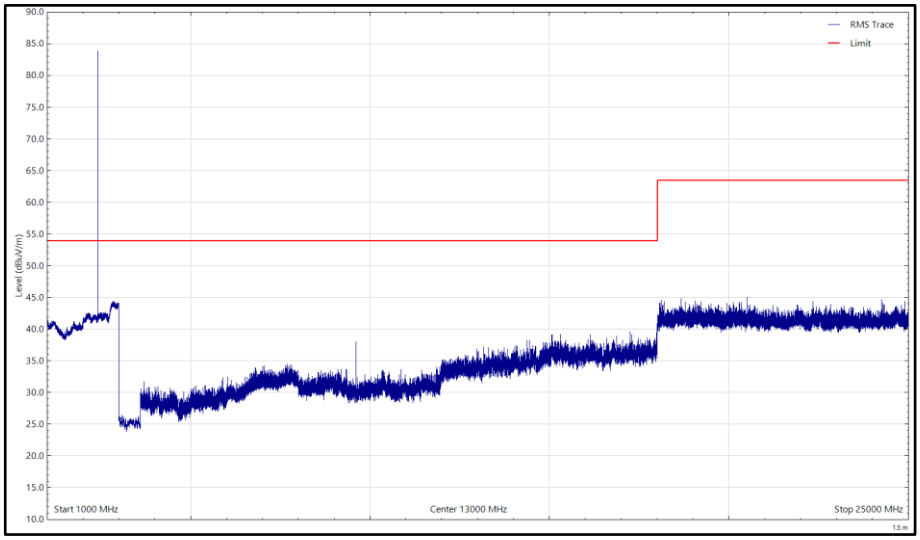

Figure 31 - 2402 MHz, 1 GHz to 25 GHz, Horizontal, Orientation Z - Average

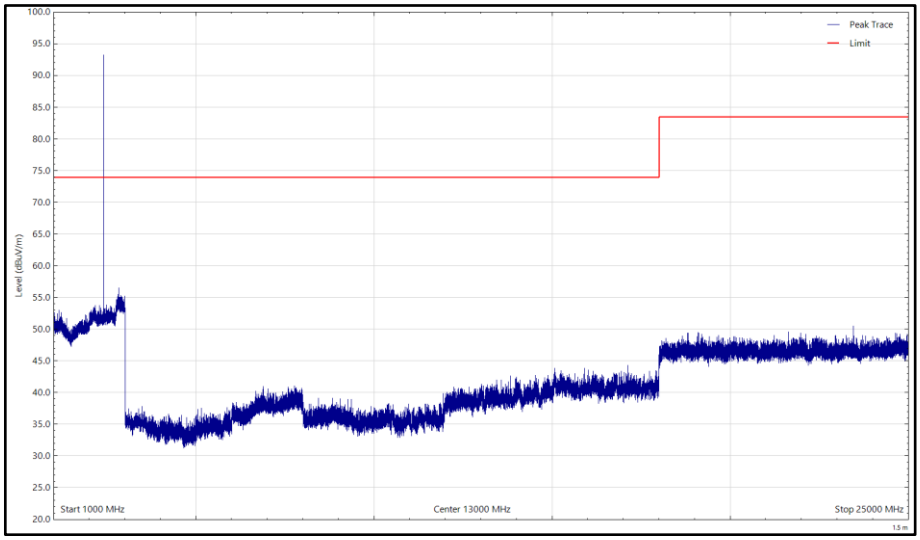

Figure 32 - 2402 MHz, 1 GHz to 25 GHz, Vertical, Orientation Z - Peak

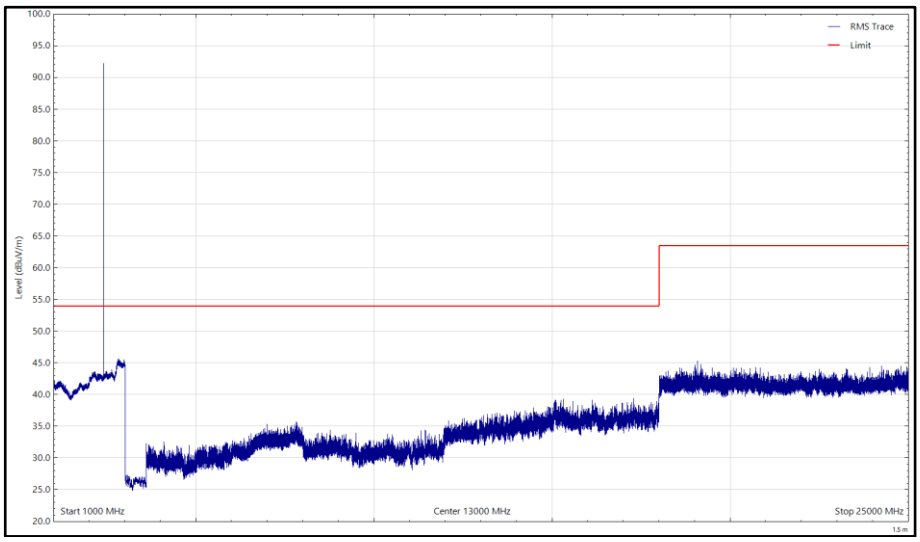

Figure 33 - 2402 MHz, 1 GHz to 25 GHz, Vertical, Orientation Z - Average

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

Table 17 – 2426 MHz, 30 MHz to 25 GHz

*No emissions were detected within 10 dB of the limit.

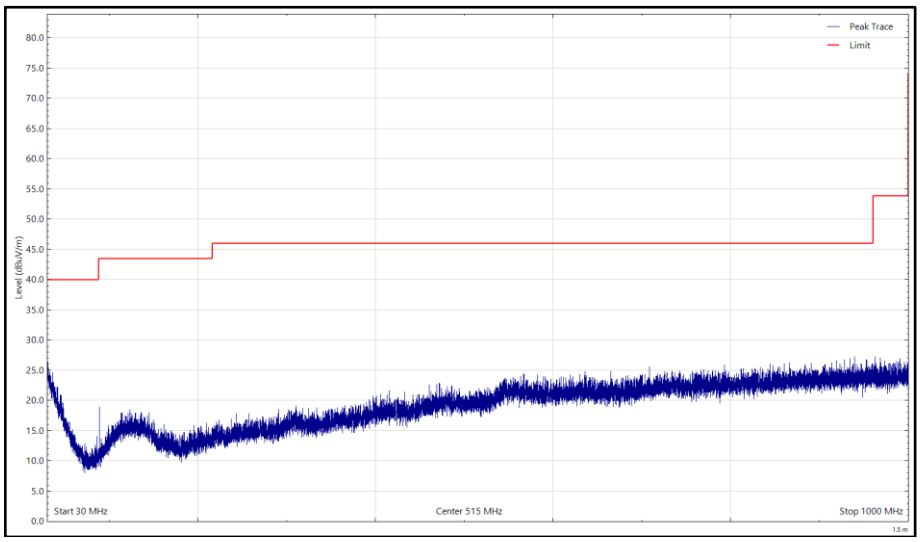

Figure 34 - 2426 MHz, 30 MHz to 1 GHz, Horizontal, Orientation X

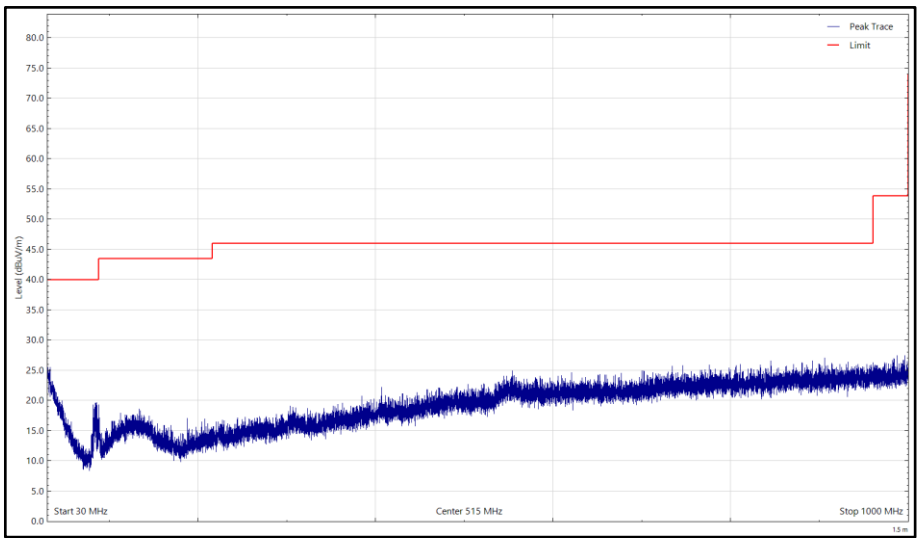

Figure 35 - 2426 MHz, 30 MHz to 1 GHz, Vertical, Orientation X

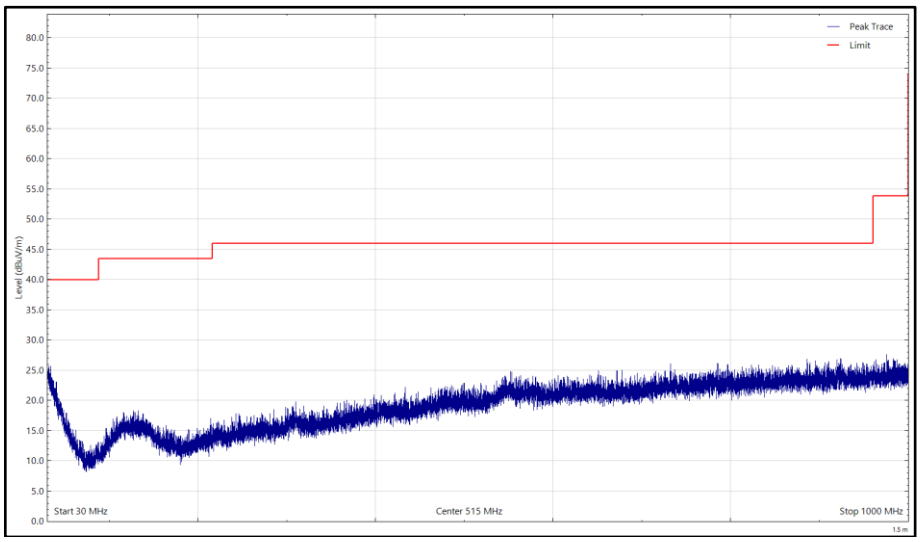

Figure 36 - 2426 MHz, 30 MHz to 1 GHz, Horizontal, Orientation Y

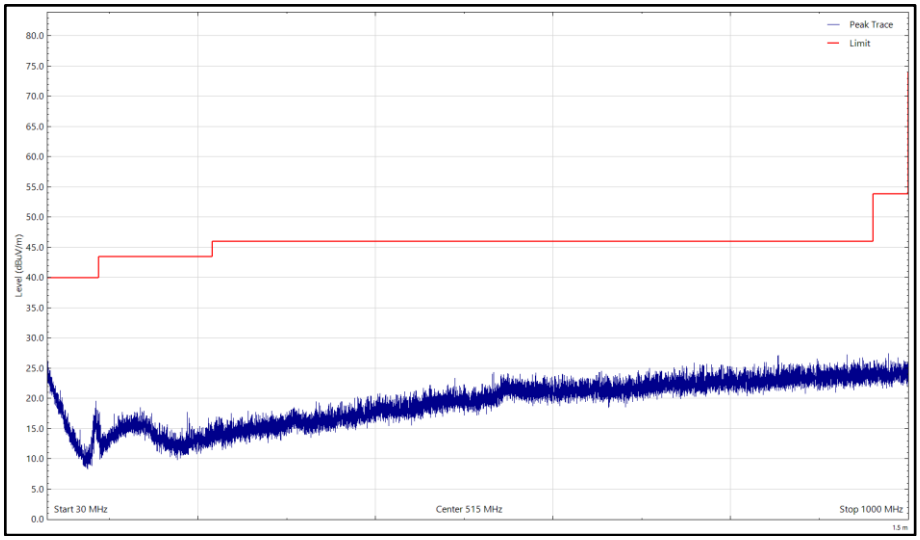

Figure 37 - 2426 MHz, 30 MHz to 1 GHz, Vertical, Orientation Y

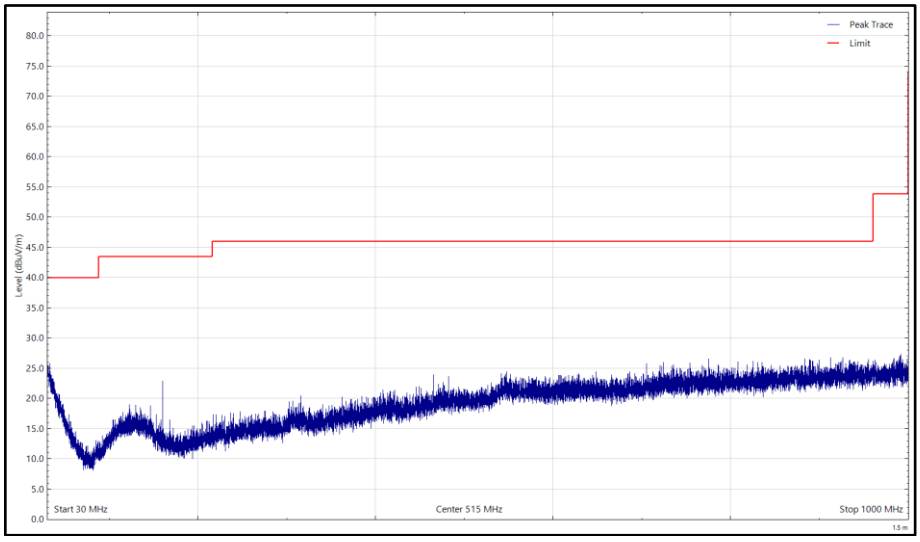

Figure 38 - 2426 MHz, 30 MHz to 1 GHz, Horizontal, Orientation Z

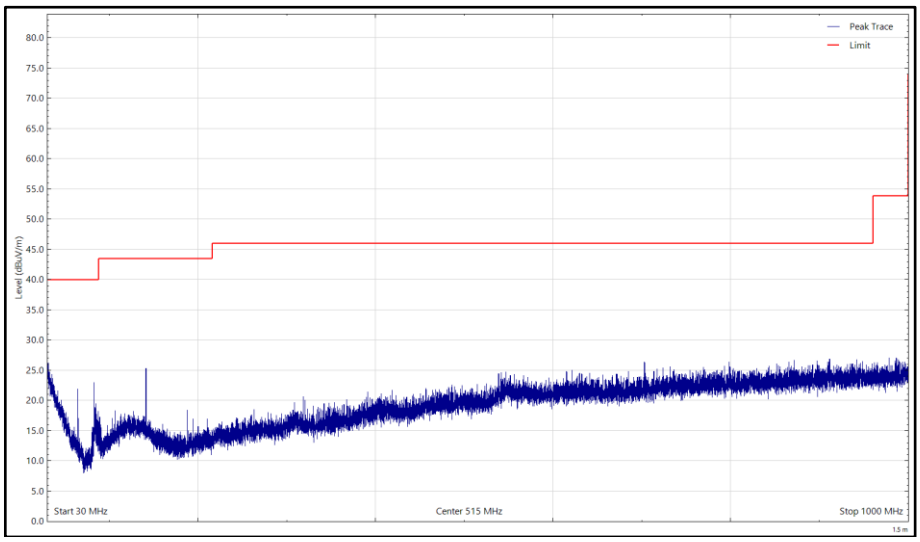

Figure 39 - 2426 MHz, 30 MHz to 1 GHz, Vertical, Orientation Z

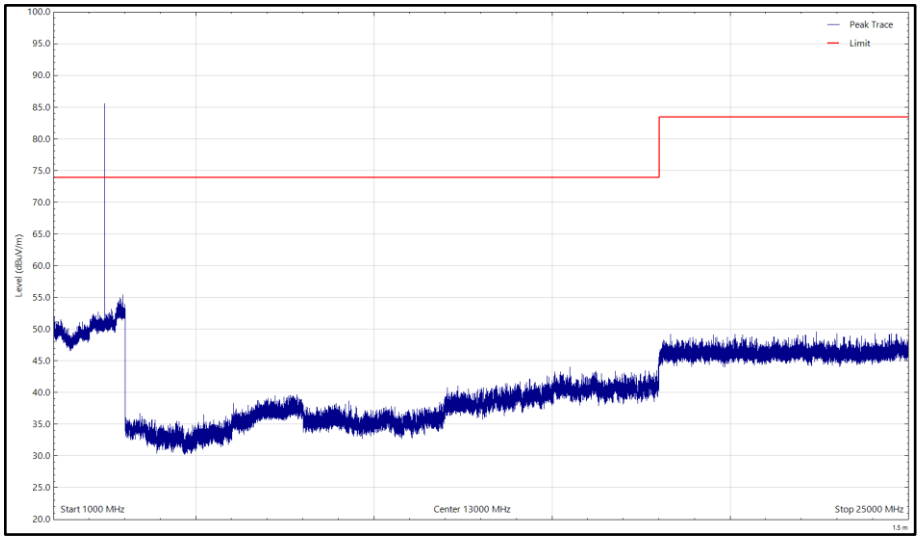

Figure 40 - 2426 MHz, 1 GHz to 25 GHz, Horizontal, Orientation X - Peak

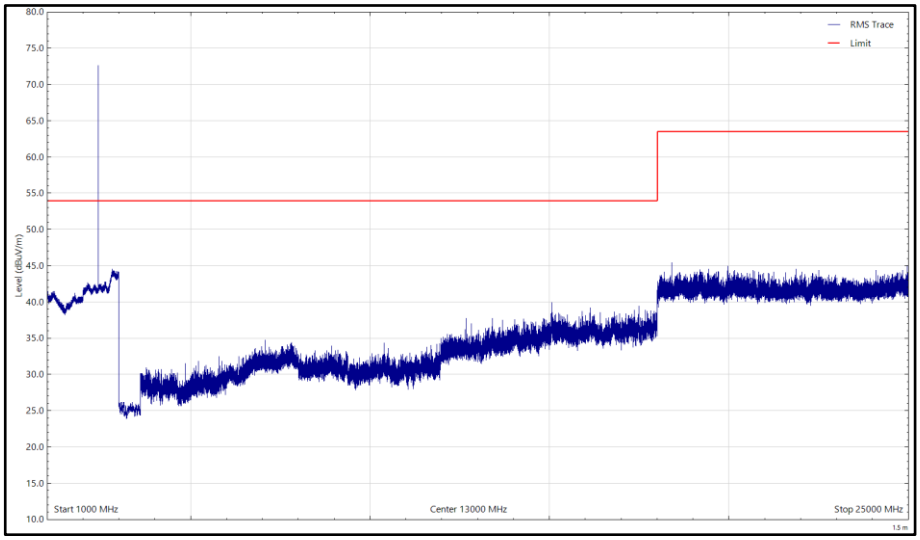

Figure 41 - 2426 MHz, 1 GHz to 25 GHz, Horizontal, Orientation X - Average

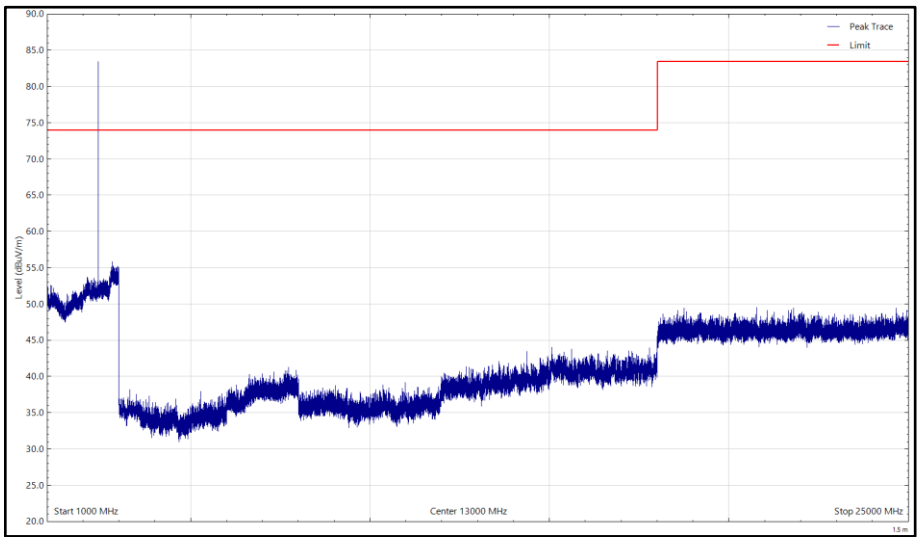

Figure 42 - 2426 MHz, 1 GHz to 25 GHz, Vertical, Orientation X - Peak

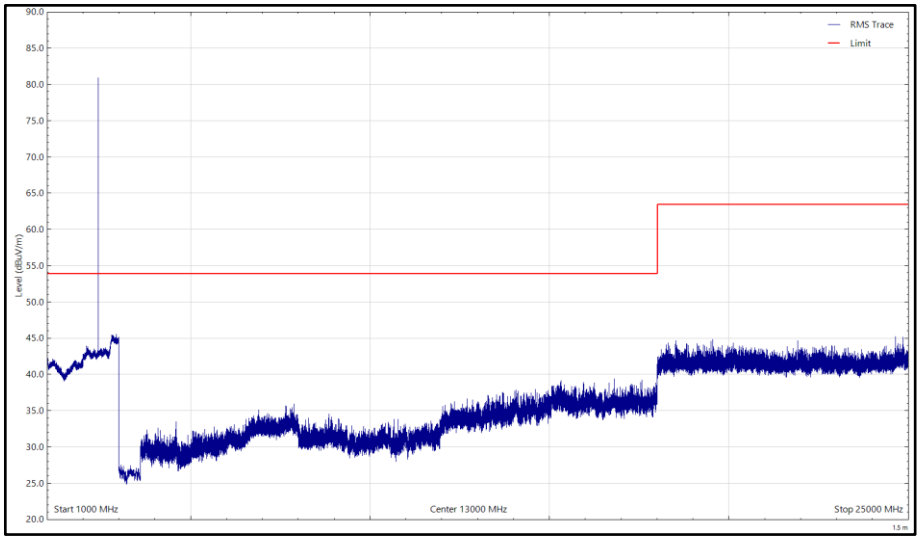

Figure 43 - 2426 MHz, 1 GHz to 25 GHz, Vertical, Orientation X - Average

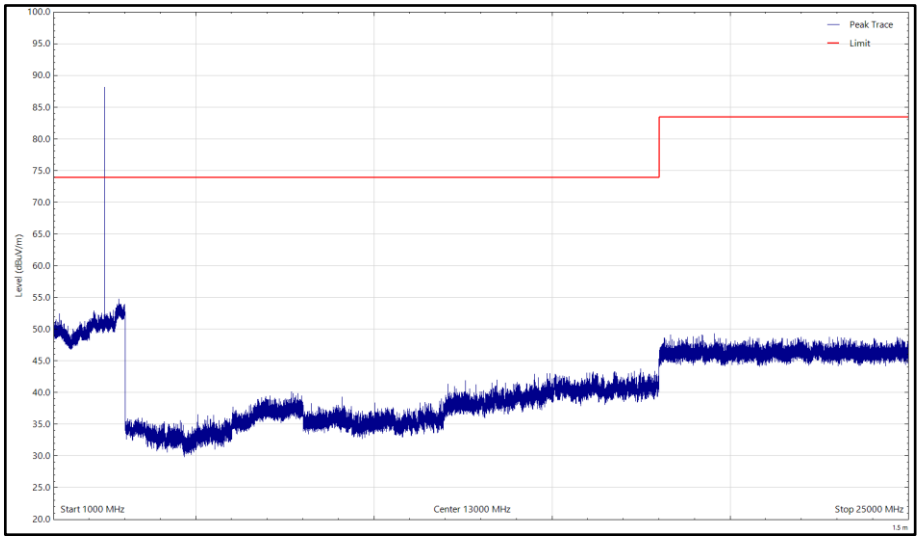

Figure 44 - 2426 MHz, 1 GHz to 25 GHz, Horizontal, Orientation Y - Peak

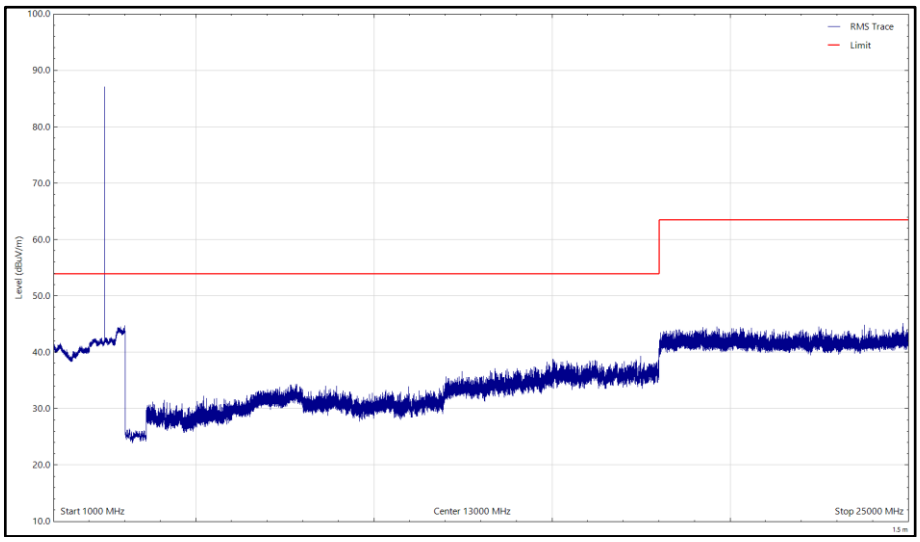

Figure 45 - 2426 MHz, 1 GHz to 25 GHz, Horizontal, Orientation Y - Average

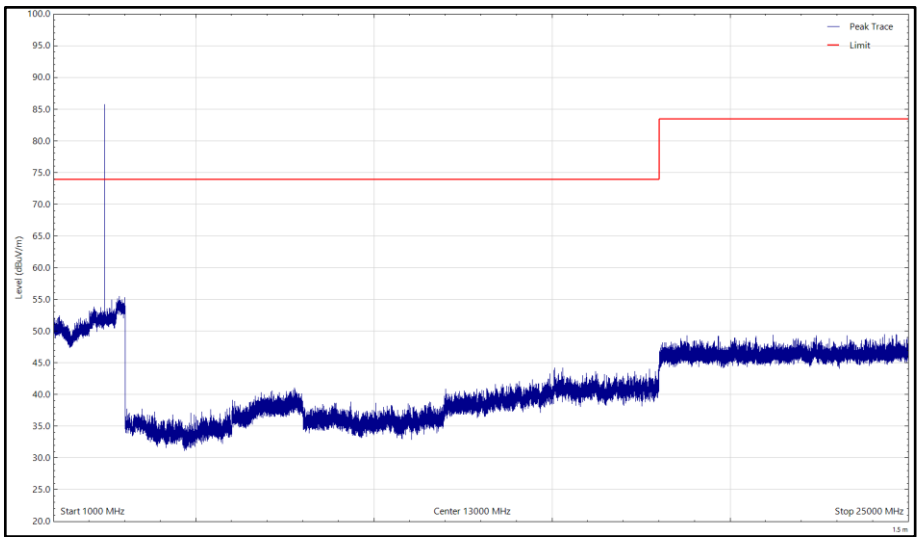

Figure 46 - 2426 MHz, 1 GHz to 25 GHz, Vertical, Orientation Y - Peak

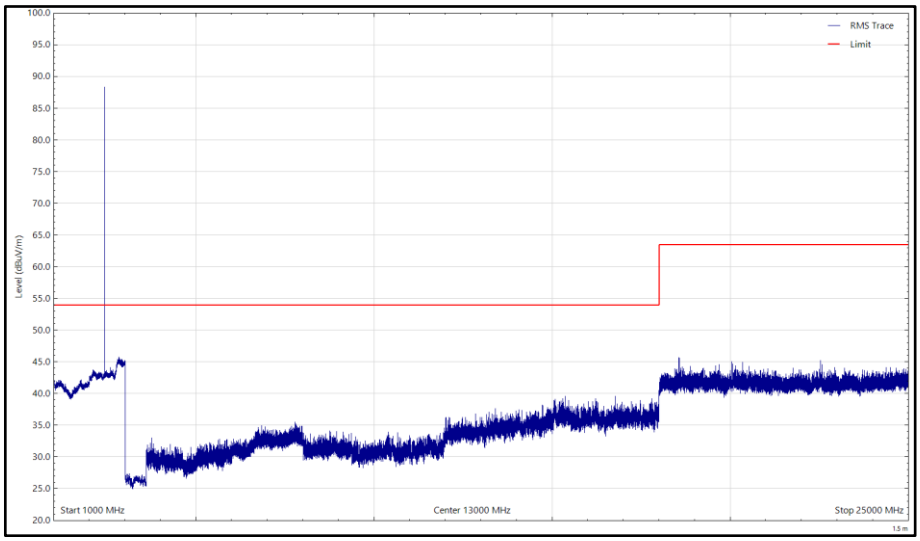

Figure 47 - 2426 MHz, 1 GHz to 25 GHz, Vertical, Orientation Y - Average

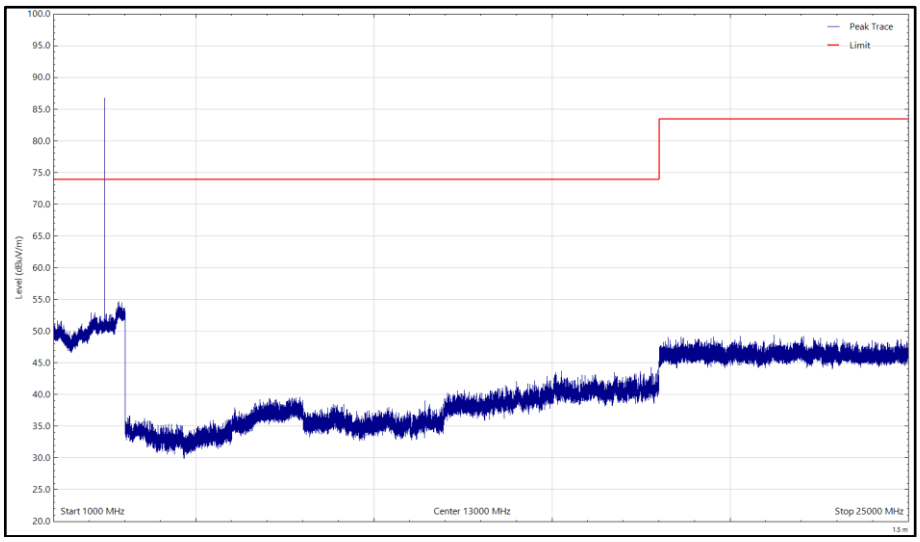

Figure 48 - 2426 MHz, 1 GHz to 25 GHz, Horizontal, Orientation Z - Peak

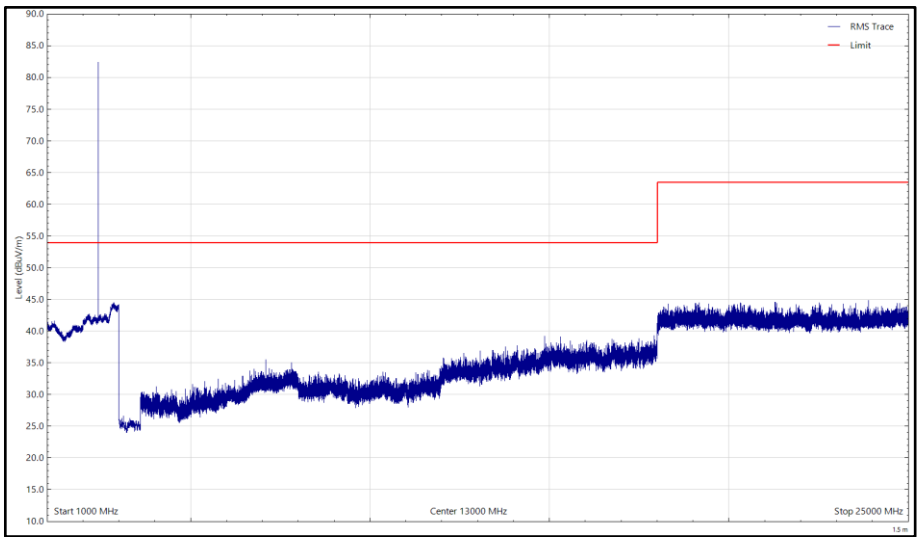

Figure 49 - 2426 MHz, 1 GHz to 25 GHz, Horizontal, Orientation Z - Average

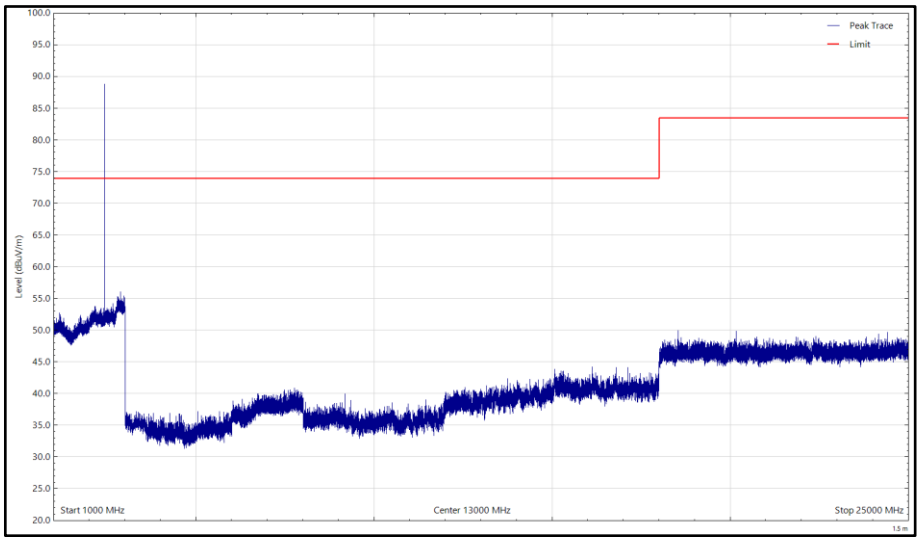

Figure 50 - 2426 MHz, 1 GHz to 25 GHz, Vertical, Orientation Z - Peak

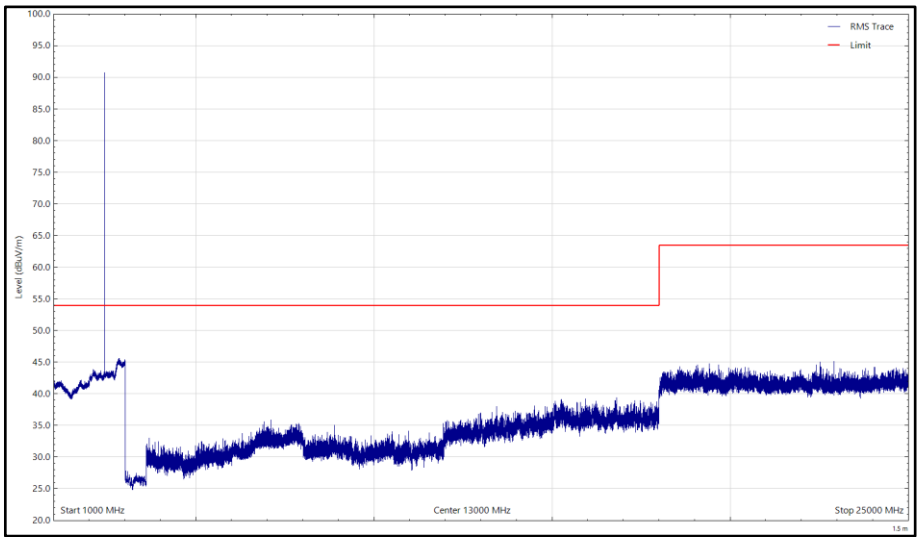

Figure 51 - 2426 MHz, 1 GHz to 25 GHz, Vertical, Orientation Z - Average

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

Table 18 – 2480 MHz, 30 MHz to 25 GHz

*No emissions were detected within 10 dB of the limit.

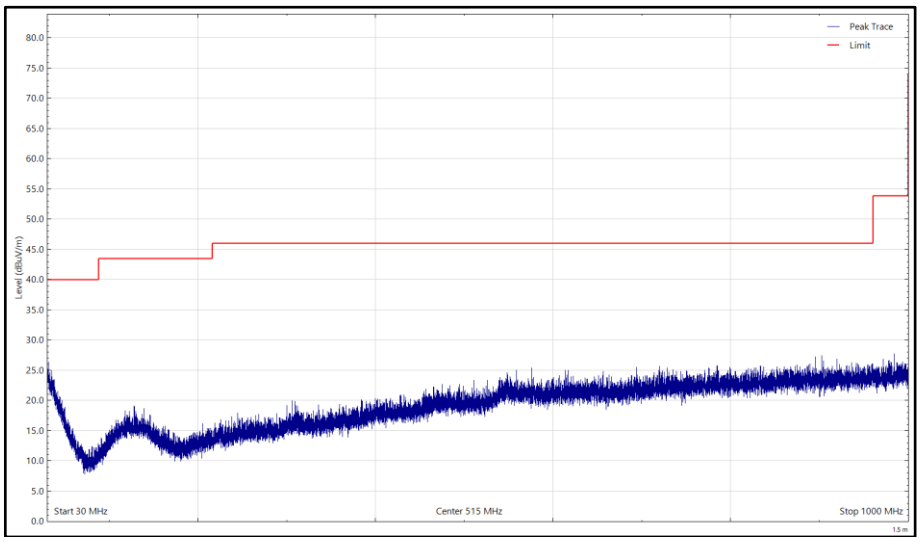

Figure 52 - 2480 MHz, 30 MHz to 1 GHz, Horizontal, Orientation X

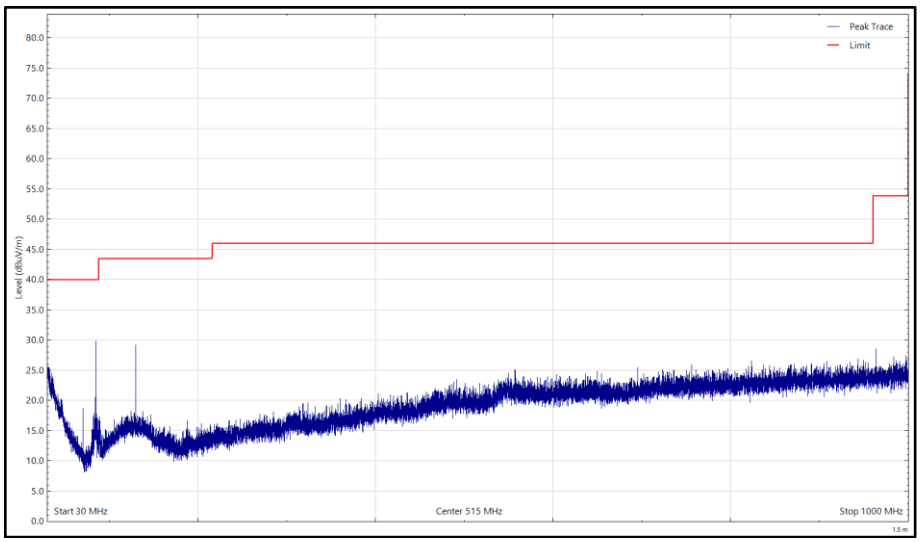

Figure 53 - 2480 MHz, 30 MHz to 1 GHz, Vertical, Orientation X

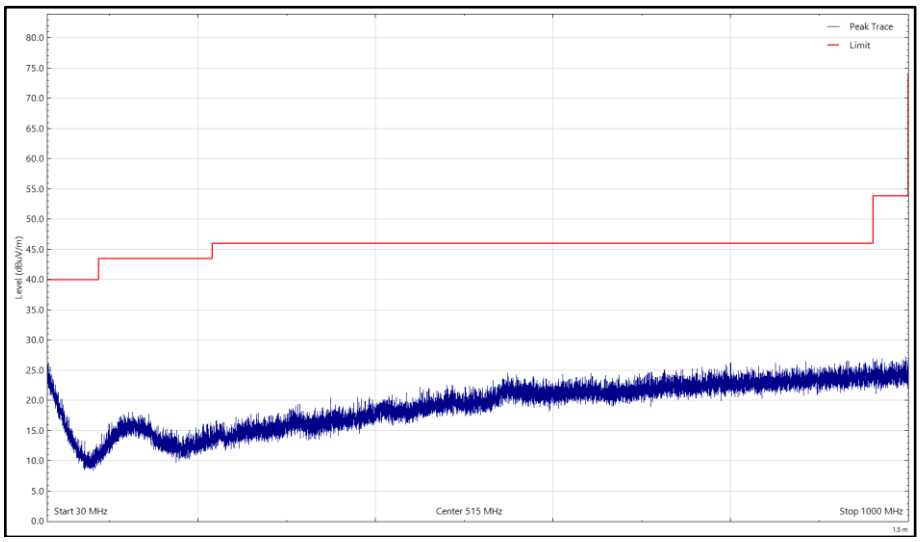

Figure 54 - 2480 MHz, 30 MHz to 1 GHz, Horizontal, Orientation Y

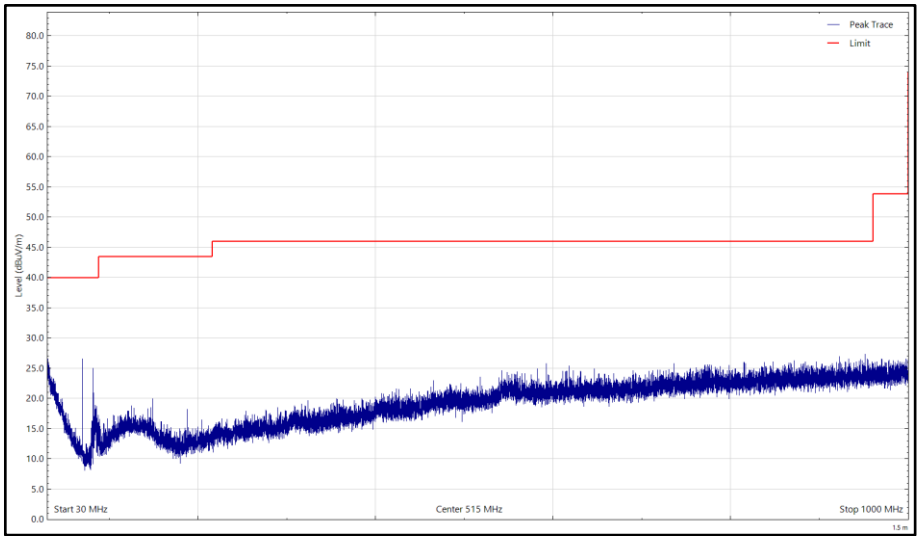

Figure 55 - 2480 MHz, 30 MHz to 1 GHz, Vertical, Orientation Y

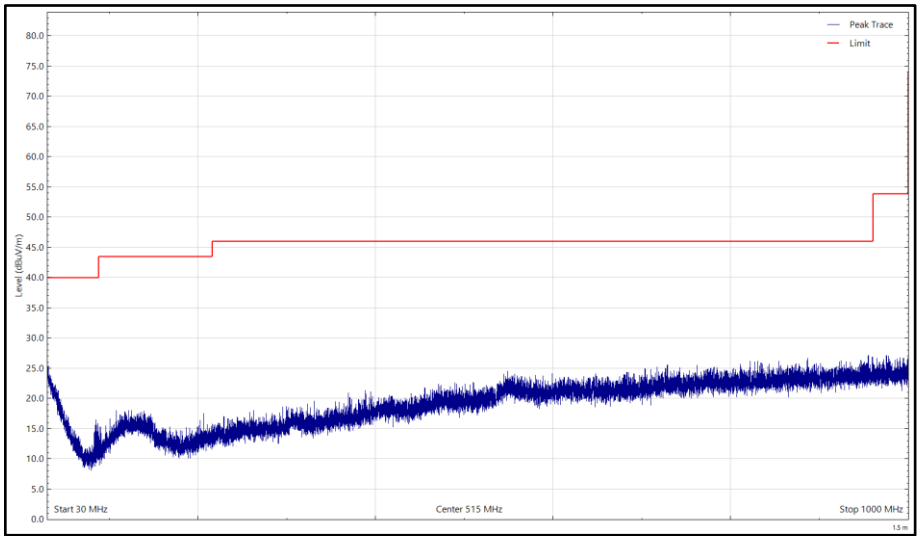

Figure 56 - 2480 MHz, 30 MHz to 1 GHz, Horizontal, Orientation Z

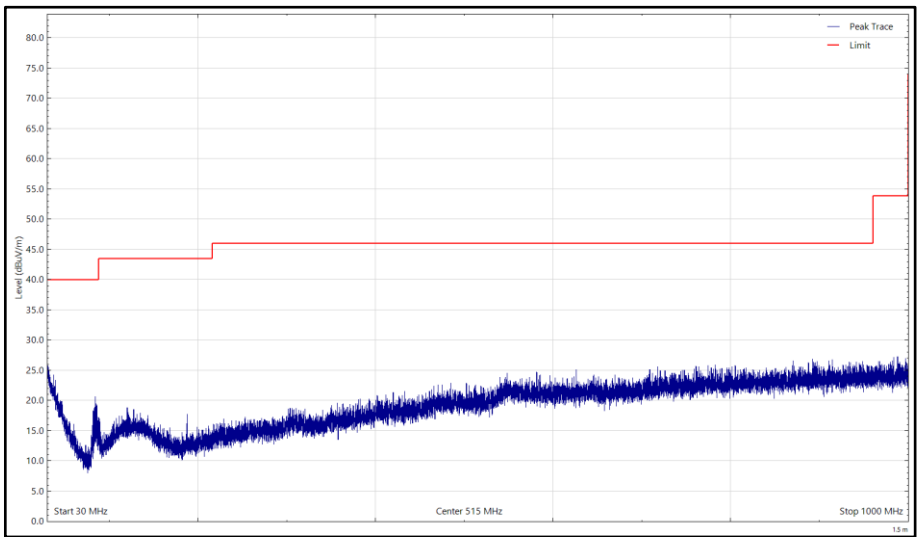

Figure 57 - 2480 MHz, 30 MHz to 1 GHz, Vertical, Orientation Z

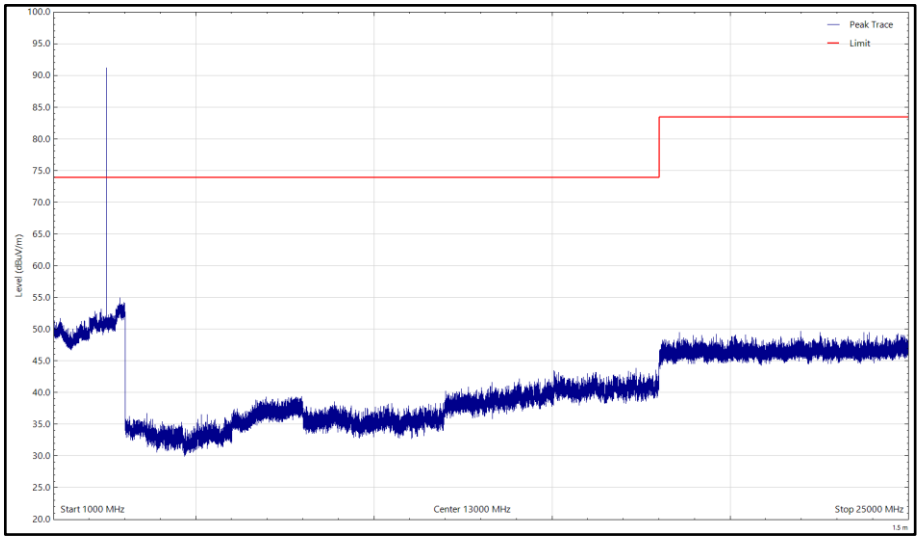

Figure 58 - 2480 MHz, 1 GHz to 25 GHz, Horizontal, Orientation X - Peak

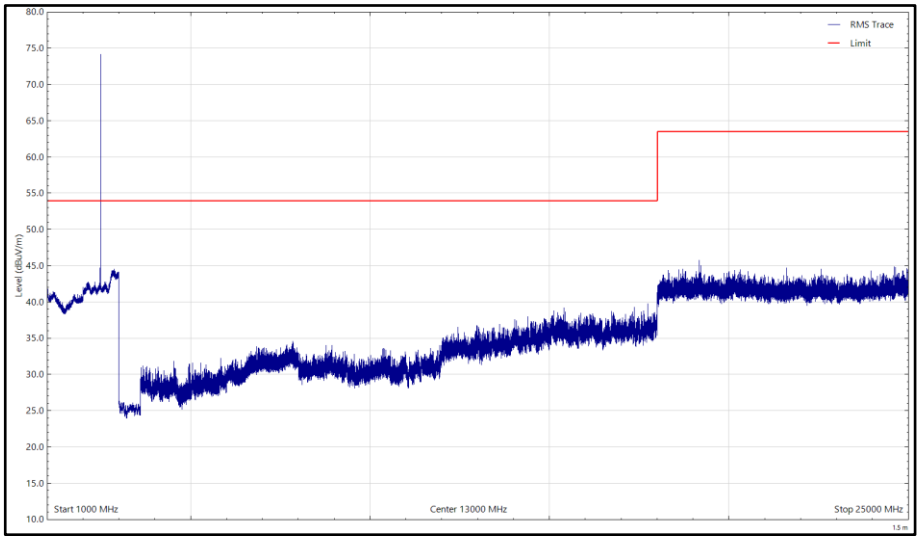

Figure 59 - 2480 MHz, 1 GHz to 25 GHz, Horizontal, Orientation X - Average

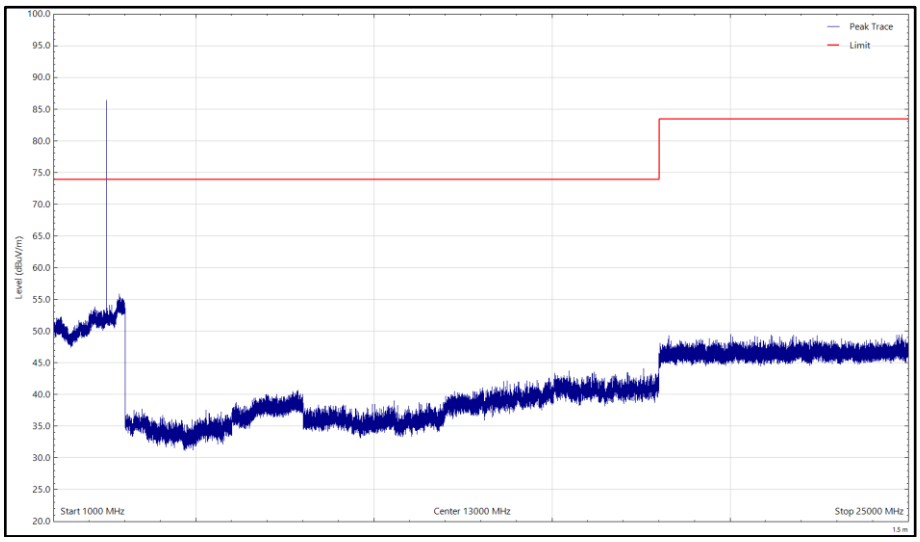

Figure 60 - 2480 MHz, 1 GHz to 25 GHz, Vertical, Orientation X - Peak

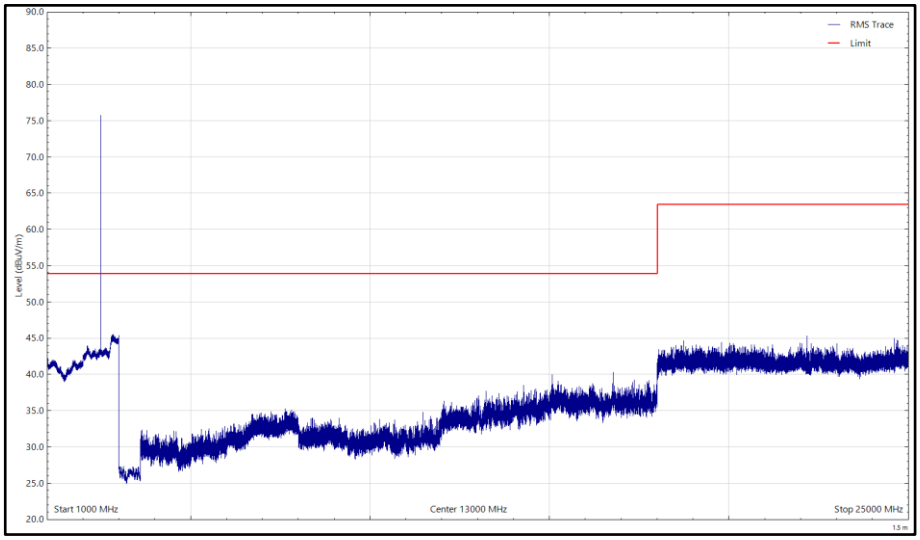

Figure 61 - 2480 MHz, 1 GHz to 25 GHz, Vertical, Orientation X - Average

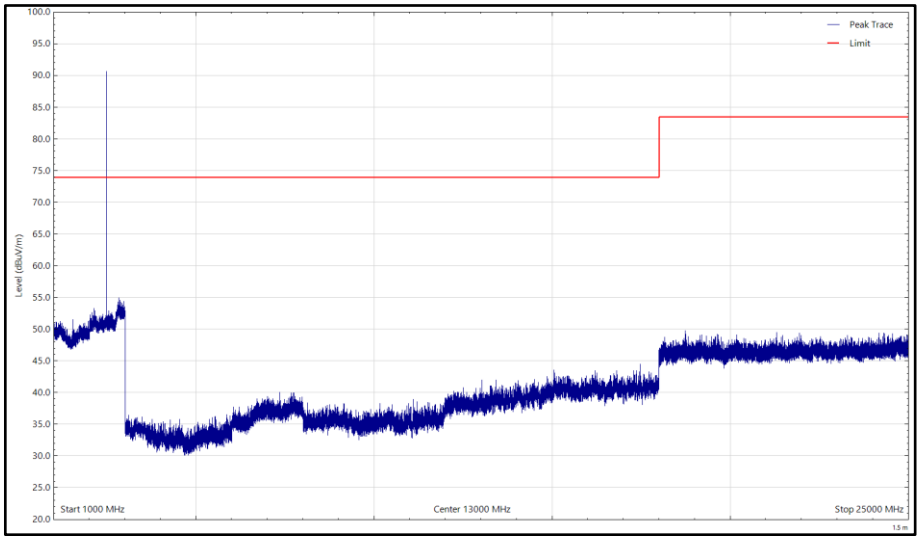

Figure 62 – 2480 MHz, 1 GHz to 25 GHz, Horizontal, Orientation Y - Peak

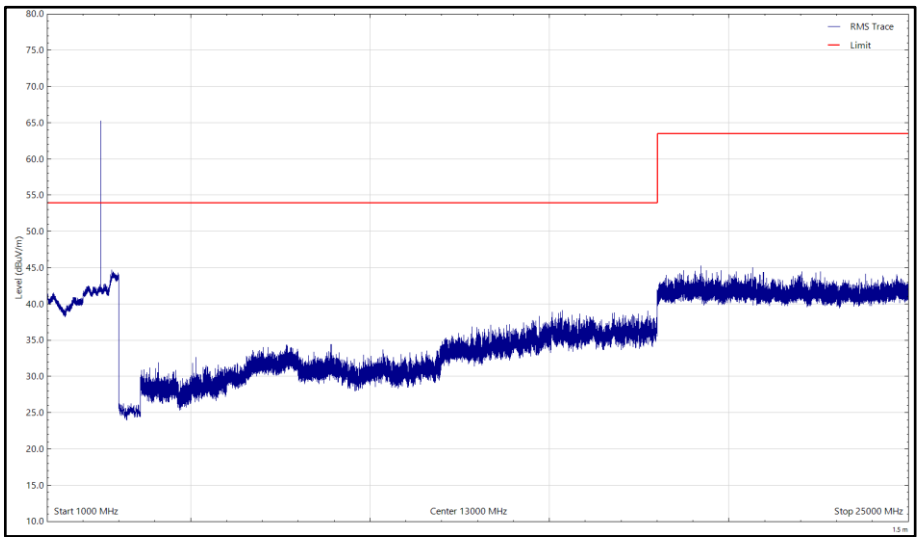

Figure 63 - 2480 MHz, 1 GHz to 25 GHz, Horizontal, Orientation Y - Average

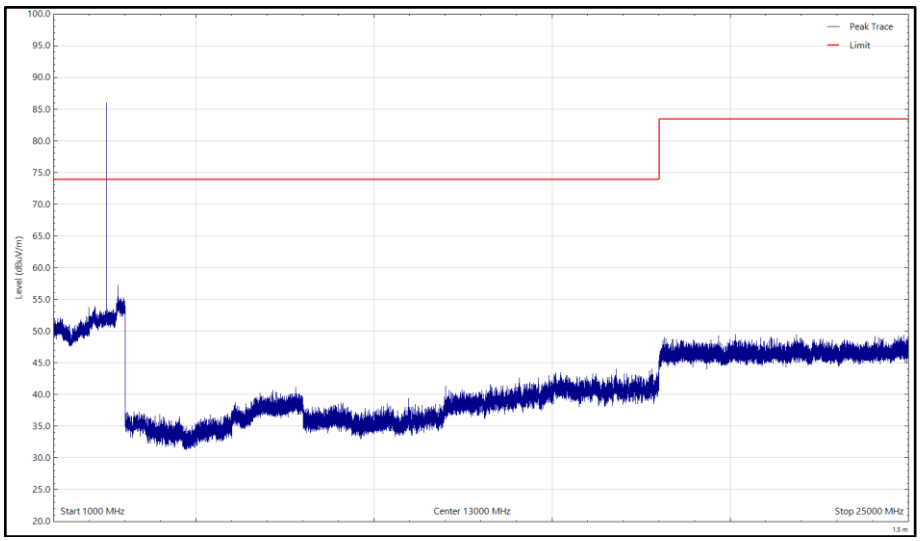

Figure 64 - 2480 MHz, 1 GHz to 25 GHz, Vertical, Orientation Y - Peak

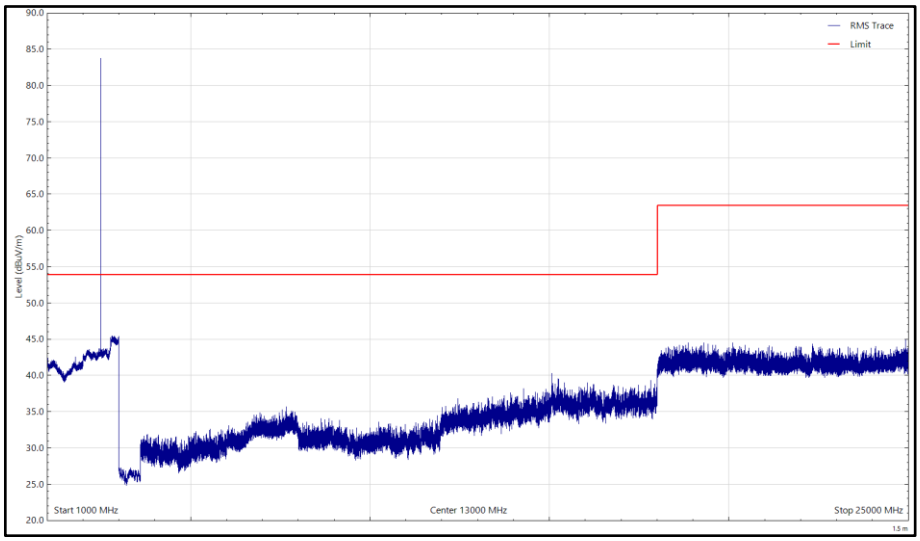

Figure 65 – 2480 MHz, 1 GHz to 25 GHz, Vertical, Orientation Y - Average

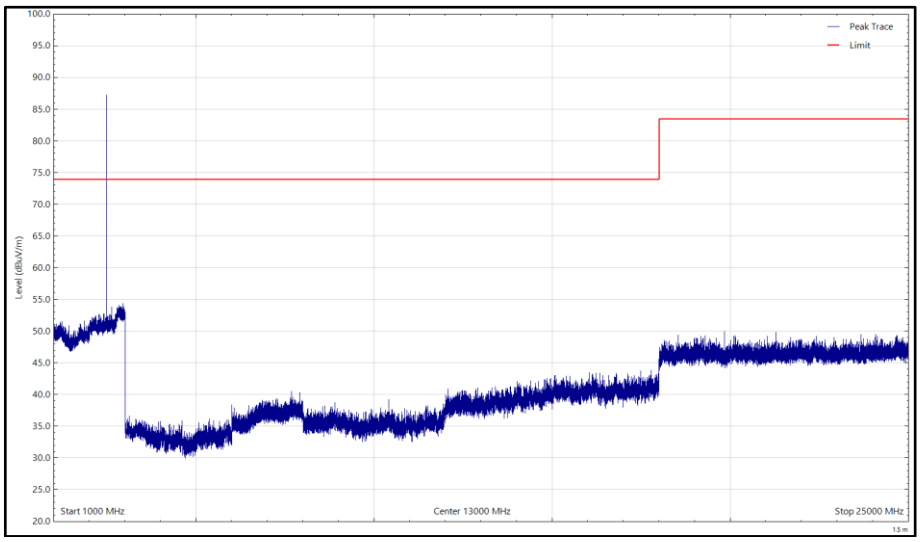

Figure 66 - 2480 MHz, 1 GHz to 25 GHz, Horizontal, Orientation Z - Peak

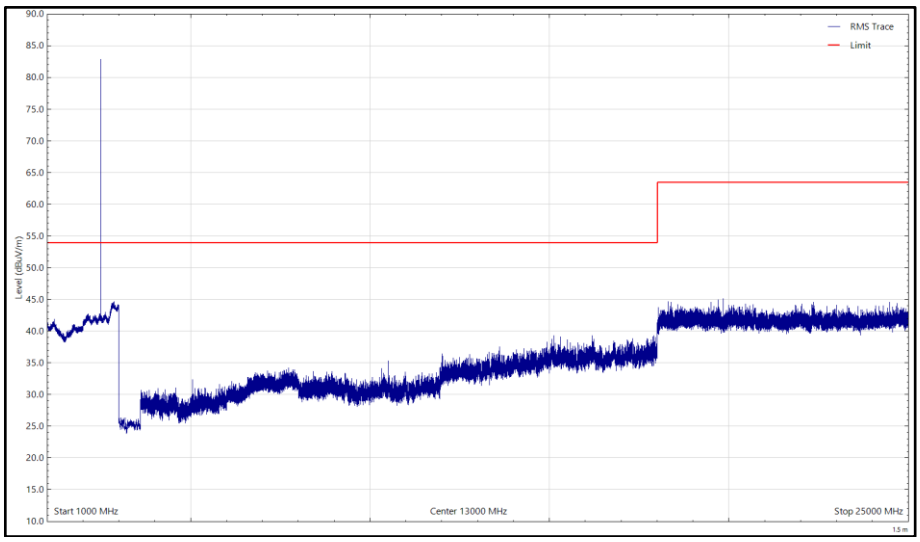

Figure 67 - 2480 MHz, 1 GHz to 25 GHz, Horizontal, Orientation Z - Average

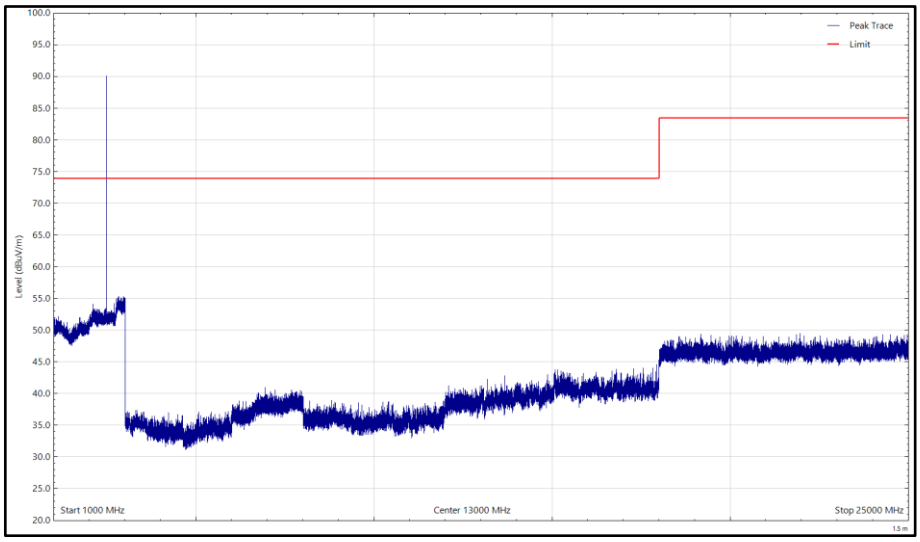

Figure 68 - 2480 MHz, 1 GHz to 25 GHz, Vertical, Orientation Z - Peak

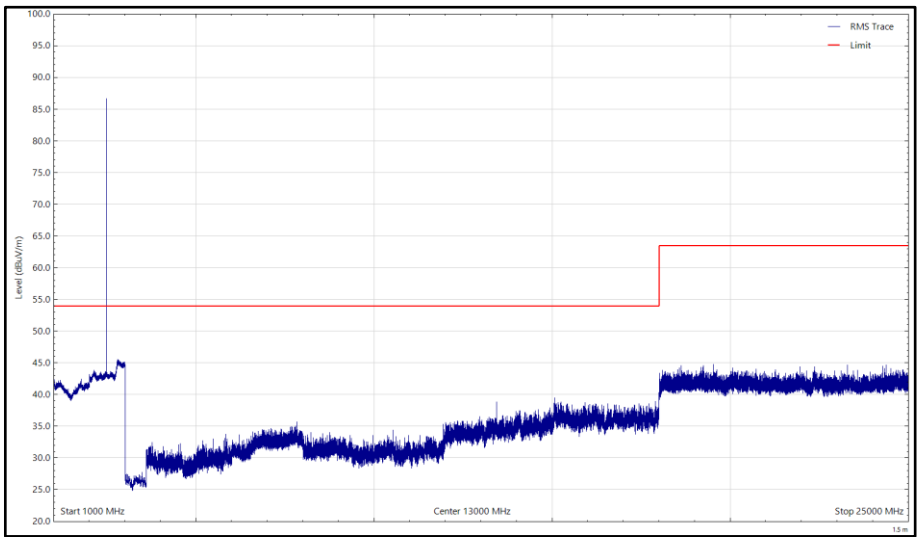

Figure 69 - 2480 MHz, 1 GHz to 25 GHz, Vertical, Orientation Z - Average

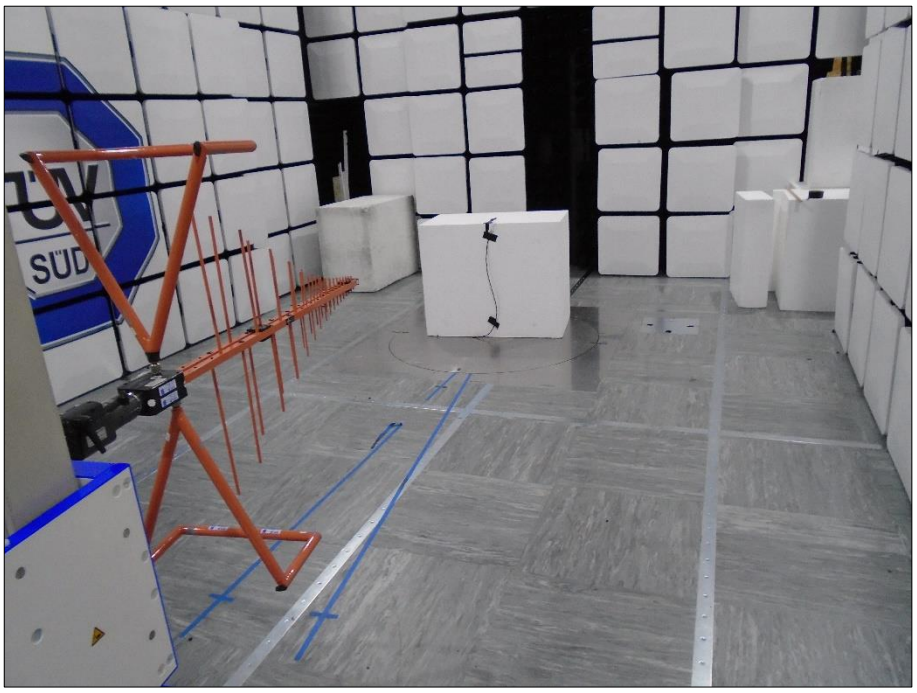

Figure 70 - 30 MHz to 1 GHz

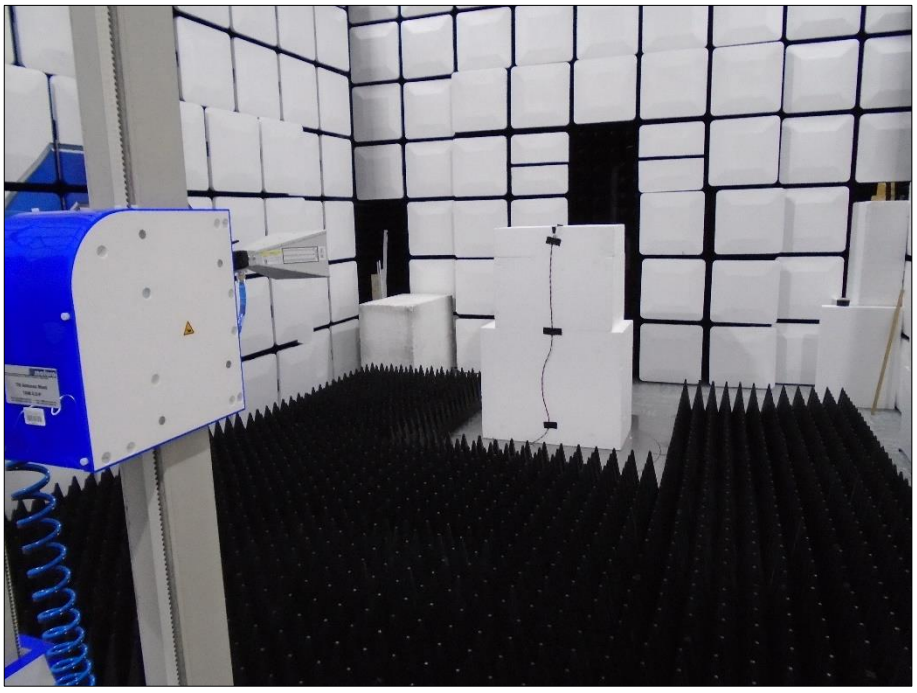

Figure 71 - 1 GHz to 8 GHz

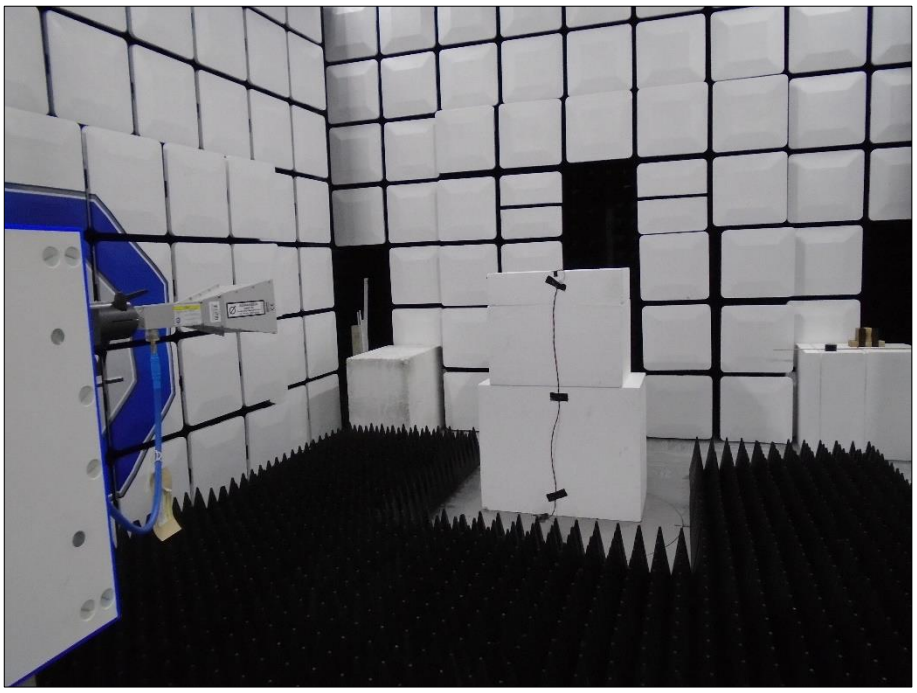

Figure 72 - 8 GHz to 18 GHz

Figure 73 - 18 GHz to 25 GHz

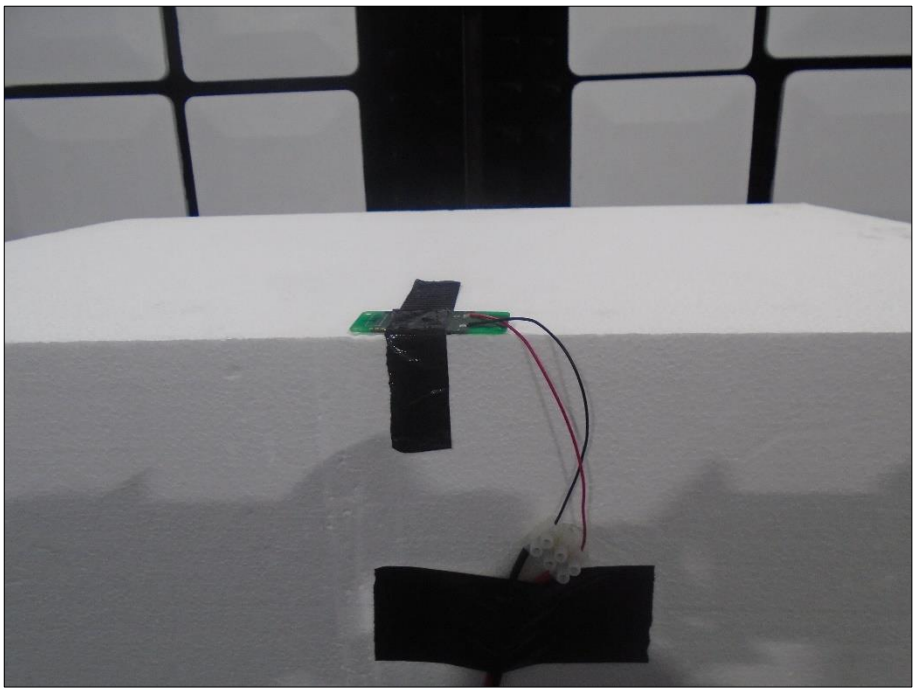

Figure 74 - Orientation X

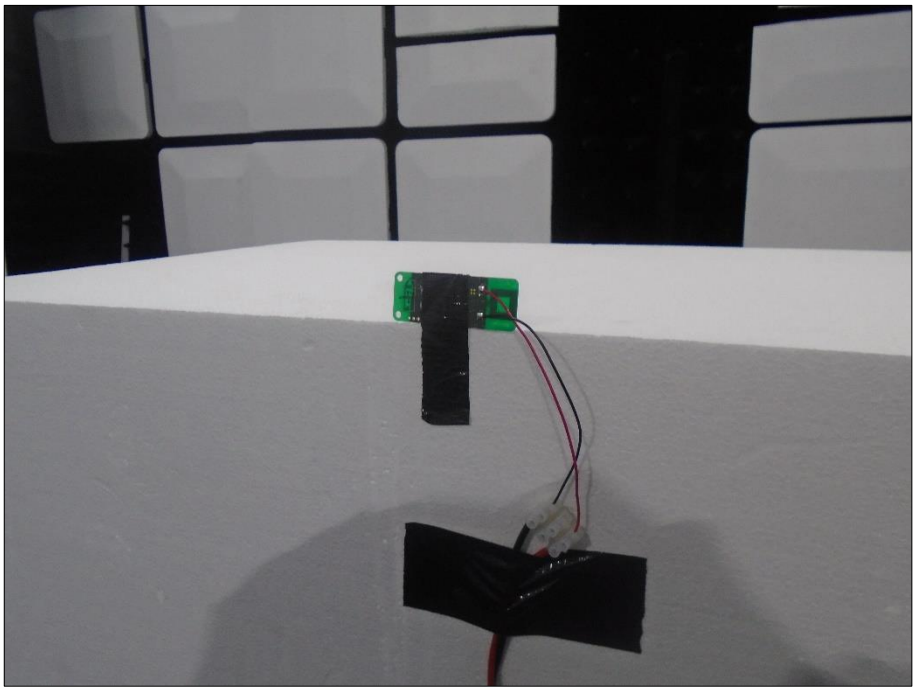

Figure 75 - Orientation Y

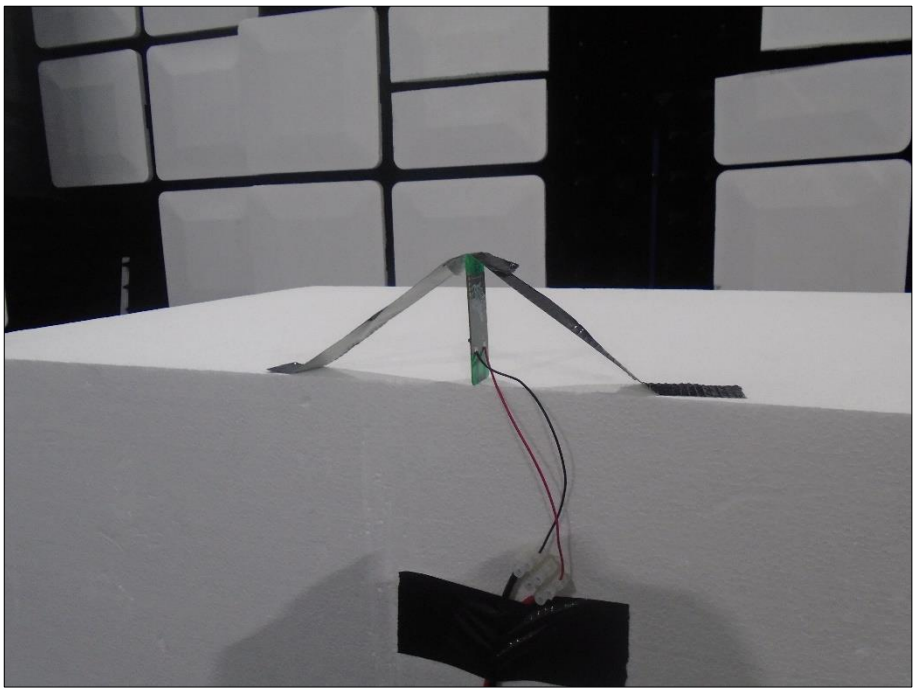

Figure 76 - Orientation Z

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)

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 Due
Antenna 18-40GHz (Double Ridge Guide)	Link Microtek Ltd	AM180HA-K-TU2	230	24	27-Jul-2022
Antenna with permanent attenuator (Bilog)	Schaffner	CBL6143	287	24	14-Oct-2022
Multimeter	Fluke	75 Mk3	455	12	30-Nov-2021
Pre-Amplifier, (8 GHz to 18 GHz)	Phase One	PS04-0086	1533	12	05-Feb-2022
18GHz - 40GHz Pre-Amplifier	Phase One	PSO4-0087	1534	12	18-Feb-2022

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	18-Mar-2022
Cable (Yellow, Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4527	6	24-Sep-2021
Cable (40 GHz)	Rosenberger	LU1-001-500	5021	12	22-Jun-2021
EmX Emissions Software	TUV SUD	V2.1.4 V.V2.1.4	5125	-	Software
Preamplifier (30dB 1GHz to 18GHz)	Schwarzbeck	BBV 9718 C	5350	12	21-Sep-2021
Test Receiver	Rohde & Schwarz	ESW44	5379	12	15-Dec-2021
Cable 2.92m	Junkosha	MWX241/B	5411	12	22-Jun-2021
3.5 mm 2m Cable	Junkosha	MWX221-02000DMS	5428	12	15-Oct-2021
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB-40	5481	12	18-Mar-2021
1m -SMA Cable	Junkosha	MWX221-01000AMSAMS/A	5515	12	01-Apr-2021
8m N Type Cable	Junkosha	MWX221-08000NMSNMS/B	5519	12	24-Mar-2021
3 GHz High pass Filter	Wainwright	WHKX12-2580-3000-18000-80SS	5548	12	05-May-2021
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB 40	5604	12	08-Sep-2021
DRG Horn Antenna (7.5-18GHz)	Schwarzbeck	HWRD750	5610	12	22-Sep-2021
Broadband Horn Antenna (1-10 GHz)	Schwarzbeck	BBHA 9120 B	5611	12	22-Sep-2021
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
3m Semi Anechoic Chamber	MVG	EMC-3	5621	36	11-Aug-2023
Cable Assembly - 18GHz 8m	Junkosha	MWX221-08000NMSNMS/B	5732	6	05-Aug-2021

Table 19

TU - Traceability Unscheduled

2.6 Power Spectral Density

2.6.1 Specification Reference

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

2.6.2 Equipment Under Test and Modification State

Sense Asset, S/N: Jan21/1073R - Modification State 0
Sense Asset, S/N: Jan21/1075R - Modification State 0
Sense Asset, S/N: Not Serialised Storix ID0035 - Modification State 0

2.6.3 Date of Test

15-February-2021 to 22-February-2021

2.6.4 Test Method

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

2.6.5 Environmental Conditions

Ambient Temperature	22.0 - 22.6 °C
Relative Humidity	39.8 - 41.4 %

2.6.6 Test Results

2.4 GHz Bluetooth Low Energy

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

DUT Configuration			
Mode:	Asset GFSK (LE 1M)	Duty Cycle (%):	100.0
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (COM)	Antenna Gain (dBi):	-

Test Frequency (MHz)	RBW (kHz)	PSD (dBm/RBW)					Limit (dBm/3 kHz)	Margin (dB)
		A	B	C	D	∑		
2402	3.0	-18.21	-	-	-	-	8.00	-26.21
2426	3.0	-17.39	-	-	-	-	8.00	-25.39
2480	3.0	-19.36	-	-	-	-	8.00	-27.36

Table 20 - 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.

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 Due
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
Climatic Chamber	Aralab	FitoTerm 300E45	4823	12	19-Mar-2021
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	04-Mar-2022
Signal Commissioning Unit	TUV SUD	SCU001	5546	12	15-Apr-2021

Table 21

3 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	± 50.10 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 22

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.