FCC and ISED Test Report

Naim Audio Ltd
Module, Model: BTM-1254

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

Add value.
Inspire trust.

Prepared for: Naim Audio Ltd
Southampton Road
Salisbury
SP1 2LN
United Kingdom

FCC ID: 2ACURBTM1254 IC: 12217A-BTM1254

COMMERCIAL-IN-CONFIDENCE

Document 75951962-01 Issue 01

SIGNATURE			
P Harrison			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Phil Harrison	Senior Engineer	Authorised Signatory	13 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, 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	13 July 2021	
Testing	George Porter	13 July 2021	

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: 2019, ISED RSS-247: Issue 2 (02-2017) and ISED RSS-GEN: Issue 5 (04-2018) + A1 (03-2019) for the tests detailed in section 1.3.

DISCLAIMER AND COPYRIGHT

This non-binding report has been prepared by TÜV SÜD with all reasonable skill and care. The document is confidential to the potential Client and TÜV SÜD. No part of this document may be reproduced without the prior written approval of TÜV SÜD. © 2021 TÜV SÜD. This report relates only to the actual item/items tested.

ACCREDITATION

Our UKAS Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our UKAS Accreditation. Results of tests not covered by our UKAS Accreditation Schedule are marked NUA (Not UKAS Accredited).

TÜV SÜD
is a trading name of TUV SUD Ltd
Registered in Scotland at East Kilbride,
Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TUV SUD Ltd is a
TÜV SÜD Group Company

Phone: +44 (0) 1489 558100
Fax: +44 (0) 1489 558101
www.tuvsud.com/en

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

Contents

1 Report Summary 2

1.1 Report Modification Record 2
1.2 Introduction 2
1.3 Brief Summary of Results 3
1.4 Application Form 4
1.5 Product Information 6
1.6 Deviations from the Standard 6
1.7 EUT Modification Record 6
1.8 Test Location 6

2 Test Details 7

2.1 Restricted Band Edges 7
2.2 Frequency Hopping Systems - Number of Hopping Channels 13
2.3 Frequency Hopping Systems - Average Time of Occupancy 15
2.4 Frequency Hopping Systems - Channel Separation 17
2.5 Frequency Hopping Systems - 20 dB Bandwidth 22
2.6 Maximum Conducted Output Power 30
2.7 Spurious Radiated Emissions 35
2.8 Authorised Band Edges 50

3 Measurement Uncertainty 58

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	13 July 2021

Table 1

1.2 Introduction

Applicant	Naim Audio Ltd
Manufacturer	Naim Audio Ltd
Model Number(s)	BTM-1254
Serial Number(s)	00FF07
Hardware Version(s)	BTM-1254
Software Version(s)	a63-AARM-ATC-SPDIF_AAC-1254_20201218_withoutLL; (ADK6.3)
Number of Samples Tested	1
Test Specification/Issue/Date	FCC 47 CFR Part 15C: 2019 ISED RSS-247: Issue 2 (02-2017) ISED RSS-GEN: Issue 5 (04-2018) + A1 (03-2019)
Order Number Date	P-104885 15-April-2021
Date of Receipt of EUT	24-February-2021
Start of Test	13-June-2021
Finish of Test	21-June-2021
Name of Engineer(s)	Graeme Lawler and George Porter
Related Document(s)	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, 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: 2.4 GHz Bluetooth						
2.1	15.205	-	8.10	Restricted Band Edges	Pass	
2.2	15.247 (a)(1)	5.1	-	Frequency Hopping Systems - Number of Hopping Channels	Pass	
2.3	15.247 (a)(1)	5.1	-	Frequency Hopping Systems - Average Time of Occupancy	Pass	It was observed by the test lab that the hopping sequence was not pseudo-random as required by the Bluetooth SIG.
2.4	15.247 (a)(1)	5.1	-	Frequency Hopping Systems - Channel Separation	Pass	
2.5	15.247 (a)(1)	5.1	6.7	Frequency Hopping Systems - 20 dB Bandwidth	Pass	
2.6	15.247 (b)	5.4	6.12	Maximum Conducted Output Power	Pass	
2.7	15.247 (d) and 15.205	3.3 and 5.5	6.13	Spurious Radiated Emissions	Pass	
2.8	15.247 (d)	5.5	-	Authorised Band Edges	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)*	The BTM1254 Stereo Audio Module contains a Qualcomm-QCC5125 chip with 64M Flash This module is to be approved as a standalone Bluetooth module for use in Naim Audio products. To be co-loacated with other radio modules but not to be functioning at the same time.
Manufacturer:	Rayson Technology Co., Ltd.
Model:	BTM1254
Part Number:	BTM1254
Hardware Version:	BTM-1254
Software Version:	a63-AARM-ATC-SPDIF_AAC-1254_20201218_withoutLL; (ADK6.3)
FCC ID of the product under test – see guidance here	2ACURBTM1254
IC ID of the product under test – see guidance here	12217A-BTM1254

Table 3

Intentional Radiators

Technology	Bluetooth
Frequency Range (MHz to MHz)	2402 ~ 2480
Conducted Declared Output Power (dBm)	8
Antenna Gain (dBi)	4
Supported Bandwidth(s) (MHz) (e.g 1 MHz, 20 MHz, 40 MHz)	1
Modulation Scheme(s) (e.g GFSK, QPSK etc)	GFSK, π/4 DQPSK, 8-DPSK
ITU Emission Designator (see guidance here) (not mandatory for Part 15 devices)	
Bottom Frequency (MHz)	2402
Middle Frequency (MHz)	2442
Top Frequency (MHz)	2480

Table 4

Un-intentional Radiators

Highest frequency generated or used in the device or on which the device operates or tunes	2483.5 MHz
Lowest frequency generated or used in the device or on which the device operates or tunes	2400 MHz
Class A Digital Device (Use in commercial, industrial or business environment) ☐ Class B Digital Device (Use in residential environment only) ☒	

Table 5

DC Power Source

Nominal voltage:	5.0	V
Extreme upper voltage:	5.25	V
Extreme lower voltage:	4.75	V
Max current:	0.4	A

Table 6

Charging

Can the EUT transmit whilst being charged	Yes ☐ No ☒

Table 7

Temperature

Minimum temperature:	-25	°C
Maximum temperature:	+75	°C

Table 8

Antenna Characteristics

Antenna connector ☒ U-FL			State impedance	50	Ohm
Temporary antenna connector ☐			State impedance		Ohm
Integral antenna ☒	Type:	Inverted-L PCB conductor	Gain	4	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 9

Ancillaries (if applicable)

Manufacturer:		Part Number:	
Model:		Country of Origin:	

Table 10

I hereby declare that the information supplied is correct and complete.

Name: Ashley Harper
Position held: Compliance Engineer
Date: 21 April 2021

1.5 Product Information

1.5.1 Technical Description

The BTM1254 Stereo Audio Module contains a Qualcomm-QCC5125 chip with 64M Flash.

This module is to be approved as a standalone Bluetooth module for use in Naim Audio products. To be co-located with other radio modules but not to be functioning at the same time.

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: BTM-1254, Serial Number: 00FF07			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 11

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		
Restricted Band Edges	Graeme Lawler	UKAS
Frequency Hopping Systems - Number of Hopping Channels	George Porter	UKAS
Frequency Hopping Systems - Average Time of Occupancy	George Porter	UKAS
Frequency Hopping Systems - Channel Separation	George Porter	UKAS
Frequency Hopping Systems - 20 dB Bandwidth	George Porter	UKAS
Maximum Conducted Output Power	George Porter	UKAS
Spurious Radiated Emissions	Graeme Lawler	UKAS
Authorised Band Edges	Graeme Lawler	UKAS

Table 12

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

BTM-1254, S/N: 00FF07 - Modification State 0

2.1.3 Date of Test

13-June-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 4.1.4.2.3. 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)

A red asterisk appears on the plots in the sections below due to a known issue whereby a second trace is used with different settings to the first. TUV SUD confirms that for each trace no settings were changed to those used to make the measurements in the plot below.

2.1.5 Environmental Conditions

Ambient Temperature	20.6 °C
Relative Humidity	59.7 %

2.1.6 Test Results

<u>2.4 GHz Bluetooth</u>

Modulation	Packet Type	Frequency (MHz)	Band Edge Frequency (MHz)	Peak Level (dBµV/m)	Average Level (dBµV/m)
GFSK	DH5	2402	2390.0	57.98	44.13
GFSK	DH5	2480	2483.5	58.84	44.83
8-DPSK	2DH5	2402	2390.0	57.75	44.14
8-DPSK	2DH5	2480	2483.5	59.04	44.91
π/4 DQPSK	3DH5	2402	2390.0	56.57	44.18
π/4 DQPSK	3DH5	2480	2483.5	59.77	44.90

Table 13

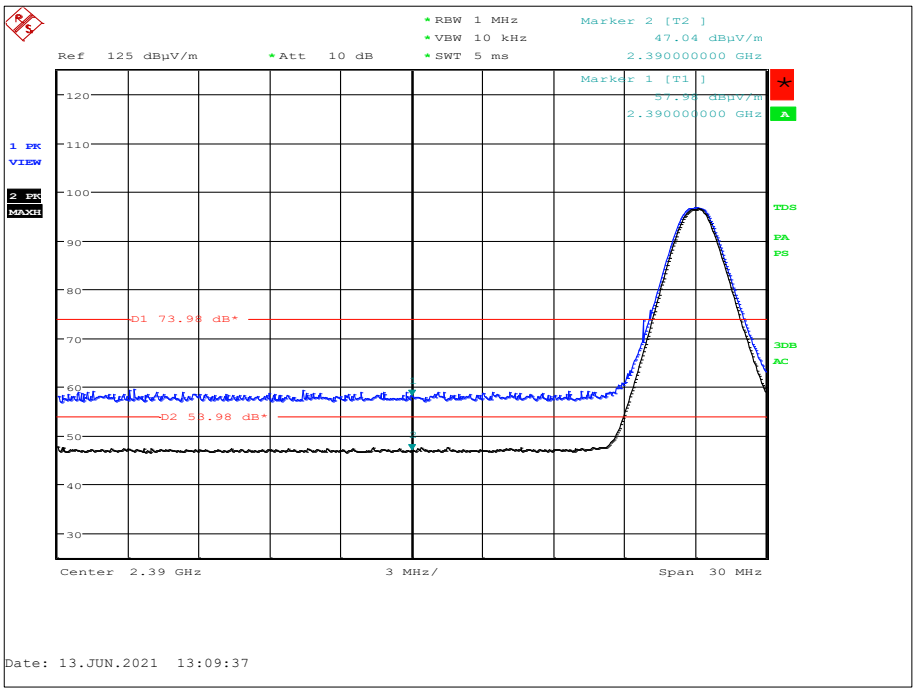

Figure 1 - GFSK/DH5 - 2402 MHz – Band Edge Frequency 2390.0 MHz

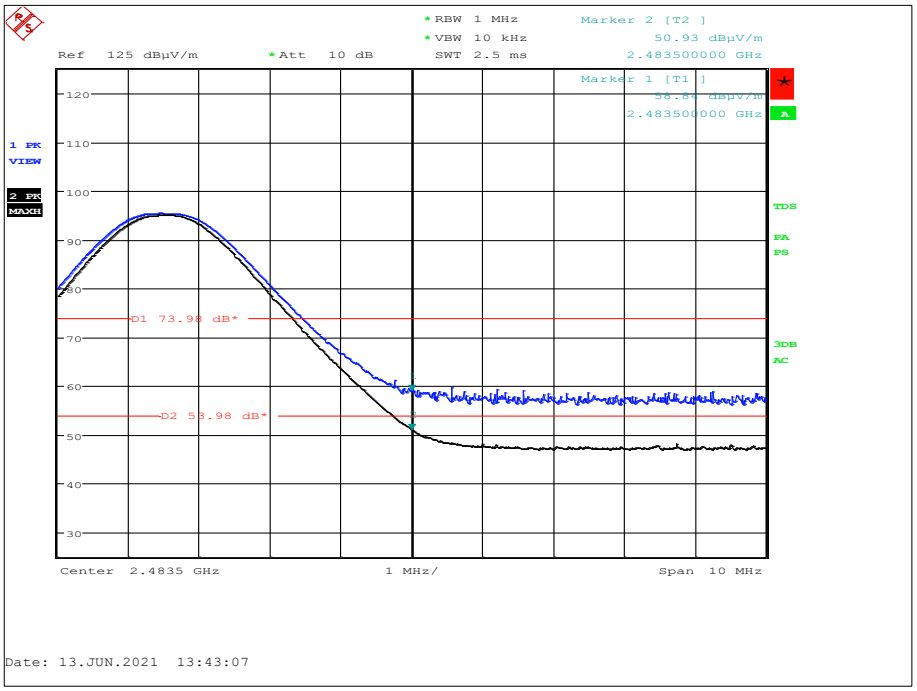

Figure 2 - GFSK/DH5 - 2480 MHz – Band Edge Frequency 2483.5 MHz

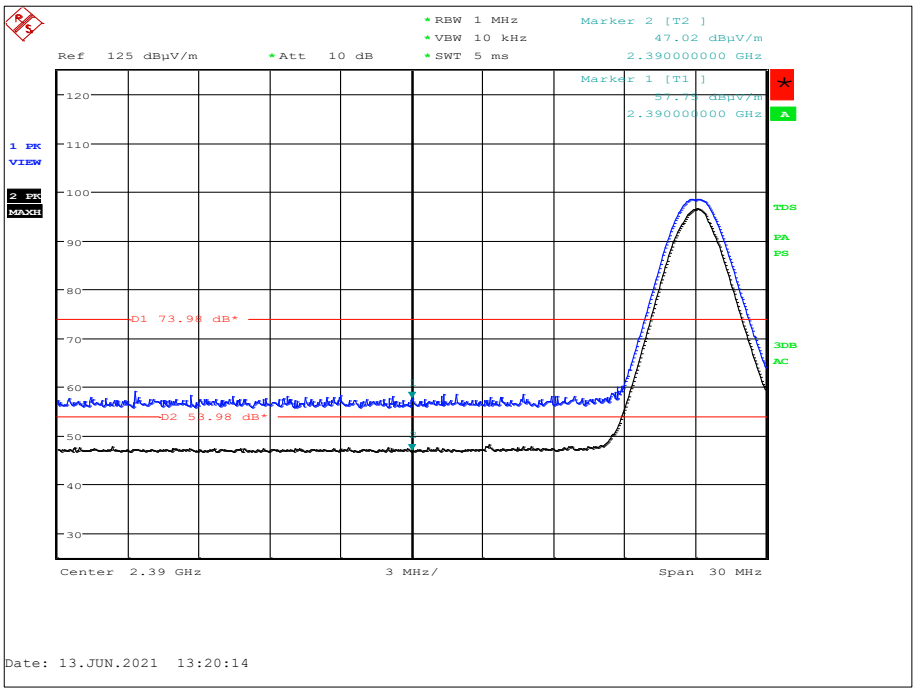

Figure 3 - 8-DPSK/2DH5 - 2402 MHz – Band Edge Frequency 2390.0 MHz

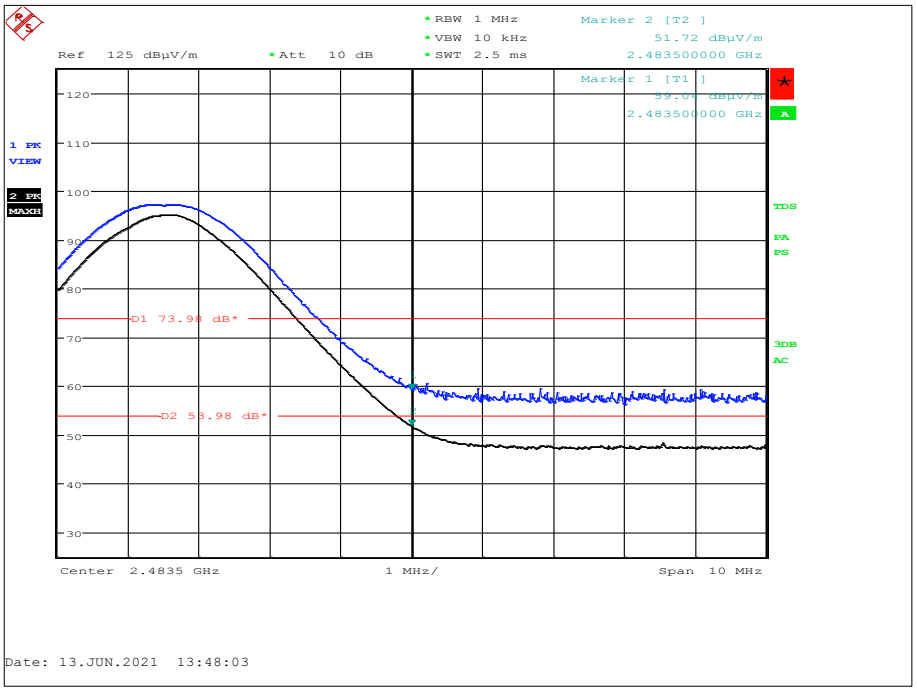

Figure 4 - 8-DPSK/2DH5 - 2480 MHz – Band Edge Frequency 2483.5 MHz

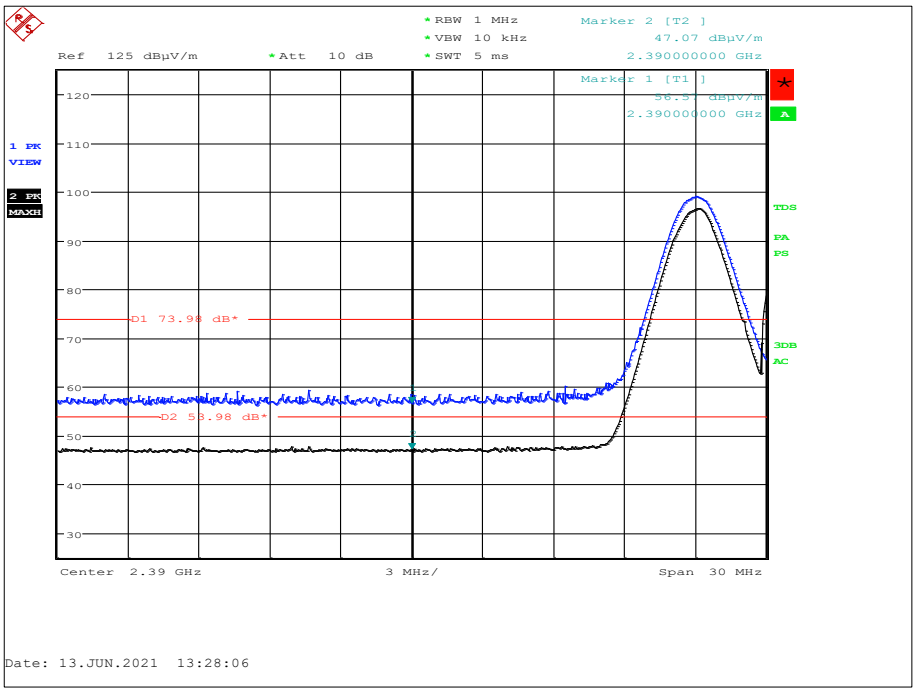

Figure 5 - π/4 DQPSK/3DH5 - 2402 MHz – Band Edge Frequency 2390.0 MHz

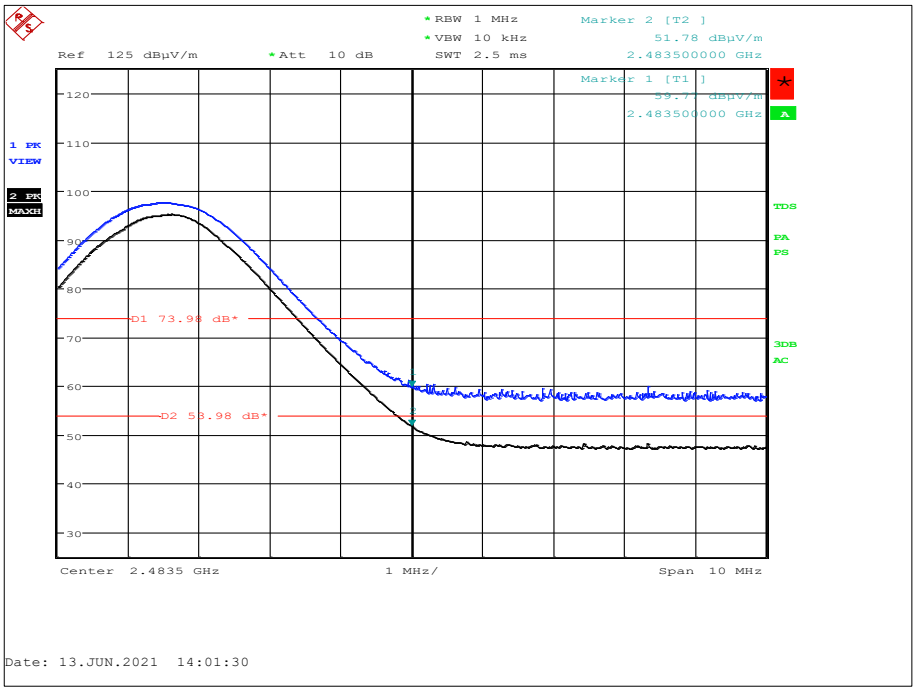

Figure 6 - π/4 DQPSK/3DH5 - 2480 MHz – Band Edge Frequency 2483.5 MHz

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 14

ISED RSS-GEN, Limit Clause 8.9

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 15

*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
Power Supply Unit	Farnell	LT30-2	2045	-	TU
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	18-Mar-2022
Multimeter	Fluke	177	3813	12	22-Dec-2021
EmX Emissions Software	TUV SUD	V2.1.9	5125	-	Software
3.5 mm 2m Cable	Junkosha	MWX221-02000DMS	5428	12	15-Oct-2021
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
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 16

TU - Traceability Unscheduled

2.2 Frequency Hopping Systems - Number of Hopping Channels

2.2.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)
ISED RSS-247, Clause 5.1

2.2.2 Equipment Under Test and Modification State

BTM-1254, S/N: 00FF07 - Modification State 0

2.2.3 Date of Test

18-June-2021

2.2.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 7.8.3

2.2.5 Environmental Conditions

Ambient Temperature	22.6 °C
Relative Humidity	59.1 %

2.2.6 Test Results

2.4 GHz Bluetooth

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247(a)(1)(iii) RSS-247 5.1 d)	Test Method(s):	C63.10 7.8.3
Additional Reference(s):	-		

DUT Configuration			
Mode:	GFSK (DH5)	Duty Cycle (%):	-
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (RF_IO)	Peak Antenna Gain (dBi):	-

Number of Hopping Frequencies	Limit
79	≥15

Table 17 - Number of Hopping Frequencies Results

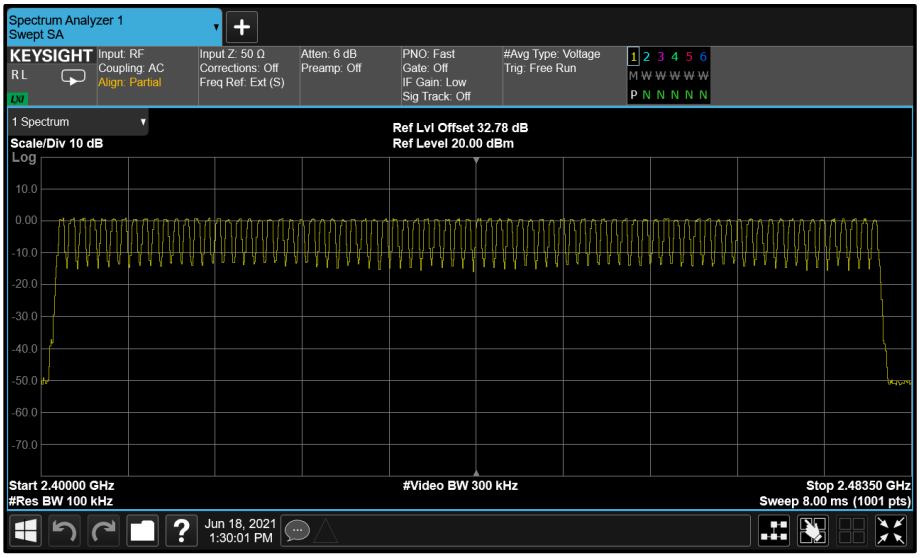

Figure 7 - GFSK (DH5) - Number of Hopping Channels

FCC 47 CFR Part 15, Limit Clause 15.247 (a)(1)(iii)

≥ 15 channels

ISED RSS-247, Limit Clause 5.1 (d)

FHSs operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels.

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
Power Supply Unit	Hewlett Packard	6282A	132	-	TU
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	03-Dec-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	03-Dec-2021
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	04-Mar-2022
Signal Commissioning Unit	TUV SUD	SCU001	5546	12	16-Apr-2022

Table 18

TU - Traceability Unscheduled

2.3 Frequency Hopping Systems - Average Time of Occupancy

2.3.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)
ISED RSS-247, Clause 5.1

2.3.2 Equipment Under Test and Modification State

BTM-1254, S/N: 00FF07 - Modification State 0

2.3.3 Date of Test

21-June-2021

2.3.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 7.8.4

Based on the results seen, it appeared the EUT was not using the proper fully-randomised hopping map in the test mode provided. The test result may therefore not be fully representative of real-world operation. The customer could not help find an alternative test mode which did not cycle through the same fixed hopping map. However, the module is based on a chip which has Bluetooth SIG approval and therefore compliance may also be based on the standard Bluetooth hopping map requirements for even use of hopping frequencies.

2.3.5 Environmental Conditions

Ambient Temperature 20.7 °C
Relative Humidity 56.0 %

2.3.6 Test Results

2.4 GHz Bluetooth

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247 (a)(1)(iii) RSS-247 5.1 d)	Test Method(s):	C63.10 7.8.4
Additional Reference(s):	-		

DUT Configuration			
Mode:	GFSK (DH5)	Duty Cycle (%):	77.0
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (RF_IO)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	Time of Occupancy			Limit (ms)
	Dwell Time (ms)	Number of Transmissions	Time of Occupancy (ms)	
2402	2.890	106	306.4	400.0

Table 19 - Time of Occupancy Results

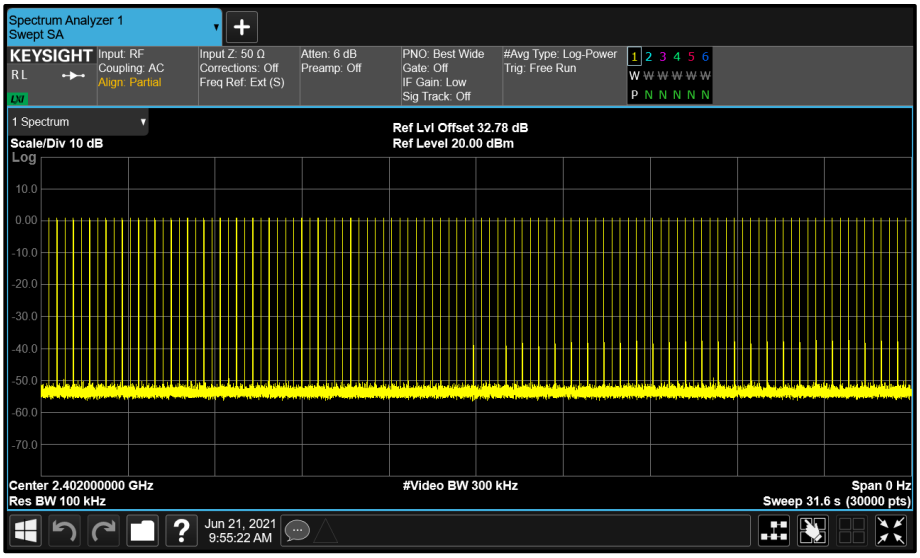

Figure 8 - GFSK - 2402 MHz Accumulated Transmit Time

FCC 47 CFR Part 15, Limit Clause 15.247 (a)(1)(iii)

Frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

Industry Canada RSS-247, Limit Clause 5.1 (d)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed.

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
Power Supply Unit	Hewlett Packard	6282A	132	-	TU
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	03-Dec-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	03-Dec-2021
USB Power Sensor	Boonton	RTP5006	5184	12	19-Apr-2022
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	04-Mar-2022
Signal Commissioning Unit	TUV SUD	SCU001	5546	12	16-Apr-2022

Table 20

TU - Traceability Unscheduled

2.4 Frequency Hopping Systems - Channel Separation

2.4.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)
ISED RSS-247, Clause 5.1

2.4.2 Equipment Under Test and Modification State

BTM-1254, S/N: 00FF07 - Modification State 0

2.4.3 Date of Test

18-June-2021

2.4.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 7.8.3

2.4.5 Environmental Conditions

Ambient Temperature	22.6 °C
Relative Humidity	59.1 %

2.4.6 Test Results

2.4 GHz Bluetooth

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247(a)(1) RSS-247 5.1 b)	Test Method(s):	C63.10 7.8.2
Additional Reference(s):	-		

DUT Configuration			
Mode:	GFSK (DH5)	Duty Cycle (%):	-
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (RF_IO)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	20 dB Bandwidth (MHz)	Carrier Frequency Separation (MHz)			Limit (kHz)
		F1C	F2C	FHS	
2442	0.942	2442.004	2443.004	1.000	≥639.0

Table 21 - Carrier Frequency Separation Results

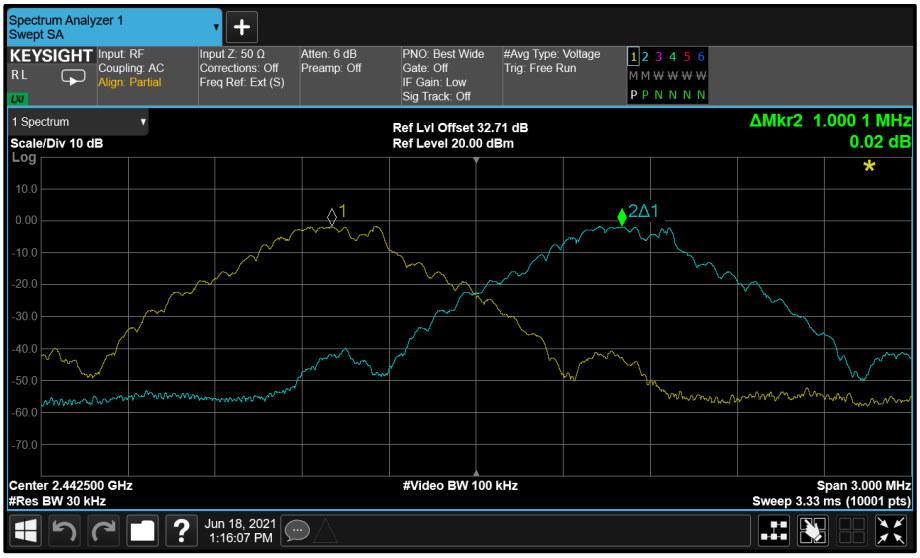

Figure 9 - GFSK - 2442 MHz (CH40)

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247(a)(1) RSS-247 5.1 b)	Test Method(s):	C63.10 7.8.2
Additional Reference(s):	-		

DUT Configuration			
Mode:	π/4 DQPSK (2-DH5)	Duty Cycle (%):	-
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (RF_IO)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	20 dB Bandwidth (MHz)	Carrier Frequency Separation (MHz)			Limit (kHz)
		F1C	F2C	FHS	
2442	1.335	2441.990	2442.990	1.000	≥894.7

Table 22 - Carrier Frequency Separation Results

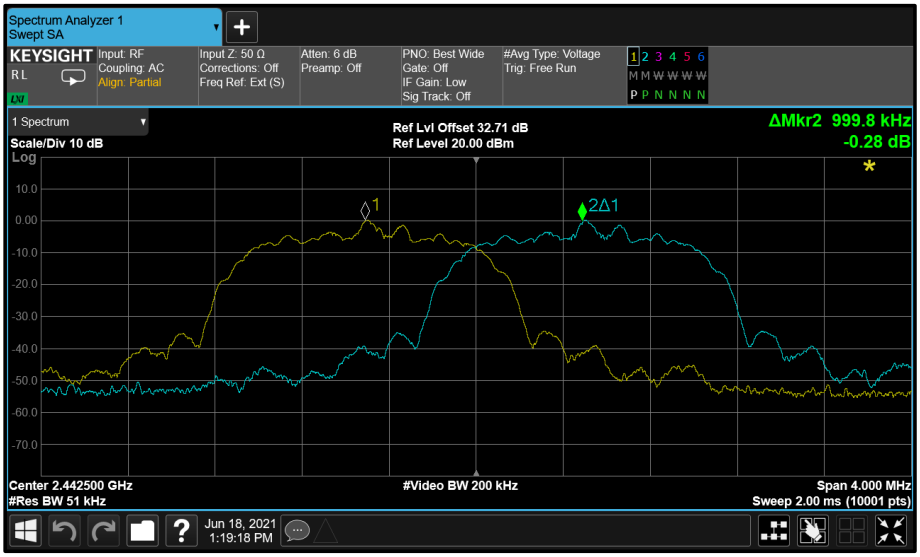

Figure 10 - π/4 DQPSK - 2442 MHz (CH40)

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247(a)(1) RSS-247 5.1 b)	Test Method(s):	C63.10 7.8.2
Additional Reference(s):	-		

DUT Configuration			
Mode:	8-DPSK (3-DH5)	Duty Cycle (%):	-
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (RF_IO)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	20 dB Bandwidth (MHz)	Carrier Frequency Separation (MHz)			Limit (kHz)
		F1C	F2C	FHS	
2442	1.320	2441.998	2442.997	0.999	≥879.7

Table 23 - Carrier Frequency Separation Results

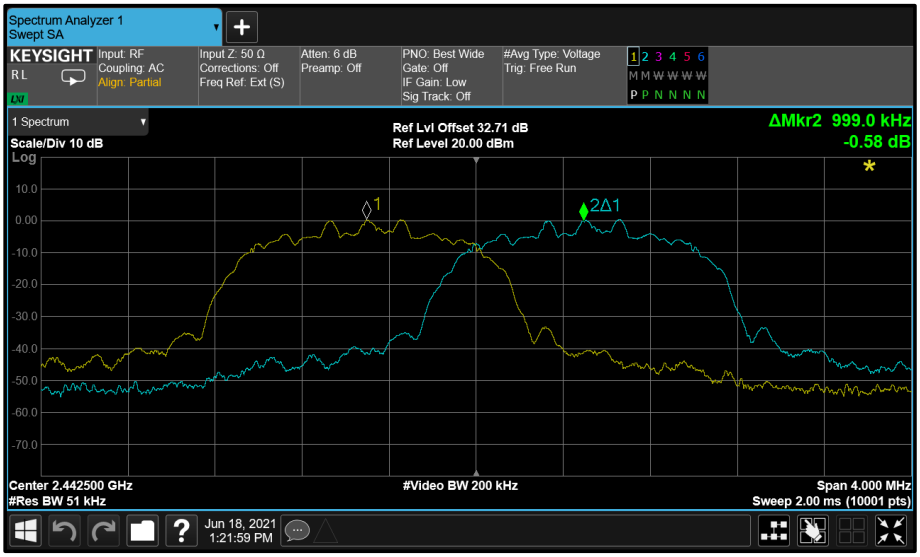

Figure 11 - 8-DPSK - 2442 MHz (CH40)

<u>FCC 47 CFR Part 15, Limit Clause 15.247 (a)(1)</u>

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Alternatively, frequency hopping systems operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 0.125 W.

<u>ISED RSS-247, Limit Clause 5.1 (b)</u>

FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSs operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

2.4.7 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
Power Supply Unit	Hewlett Packard	6282A	132	-	TU
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	03-Dec-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	03-Dec-2021
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	04-Mar-2022
Signal Commissioning Unit	TUV SUD	SCU001	5546	12	16-Apr-2022

Table 24

TU - Traceability Unscheduled

2.5 Frequency Hopping Systems - 20 dB Bandwidth

2.5.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)
ISED RSS-247, Clause 5.1
ISED RSS-GEN, Clause 6.7

2.5.2 Equipment Under Test and Modification State

BTM-1254, S/N: 00FF07 - Modification State 0

2.5.3 Date of Test

18-June-2021

2.5.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 6.9.2

2.5.5 Environmental Conditions

Ambient Temperature	22.6 °C
Relative Humidity	59.1 %

2.5.6 Test Results

2.4 GHz Bluetooth

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247 (a)(1) RSS-247 5.1	Test Method(s):	C63.10 6.9.2
Additional Reference(s):	-		

DUT Configuration			
Mode:	GFSK (DH5)	Duty Cycle (%):	-
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (RF_IO)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	20 dB Bandwidth (MHz)			
	A	B	C	D
2402	0.942	-	-	-
2442	0.942	-	-	-
2480	0.942	-	-	-

Table 25 - 20 dB Bandwidth Results

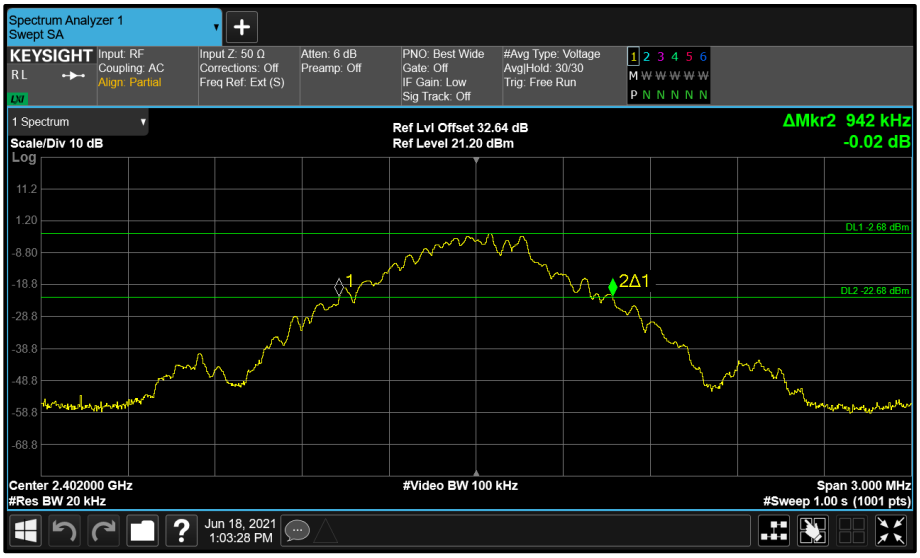

Figure 12 - RF_IO (A) 2402 MHz (CH0) 20 dB Bandwidth

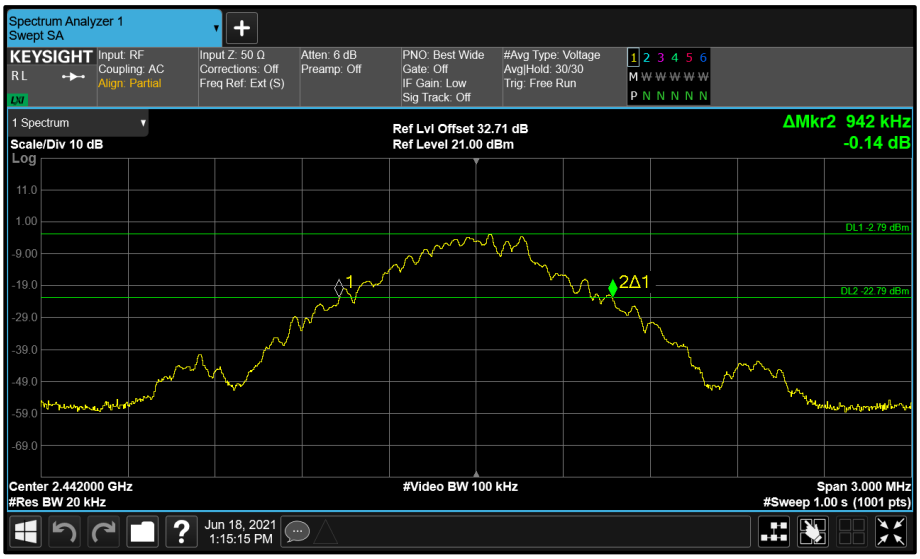

Figure 13 - RF_IO (A) 2442 MHz (CH40) 20 dB Bandwidth

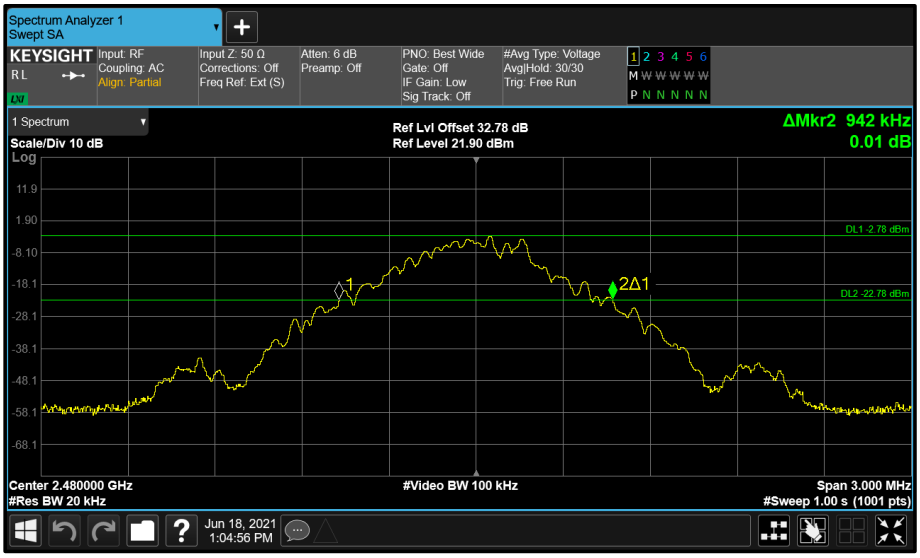

Figure 14 - RF_IO (A) 2480 MHz (CH78) 20 dB Bandwidth

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247 (a)(1) RSS-247 5.1	Test Method(s):	C63.10 6.9.2
Additional Reference(s):	-		

DUT Configuration			
Mode:	π/4 DQPSK (2-DH5)	Duty Cycle (%):	-
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (RF_IO)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	20 dB Bandwidth (MHz)			
	A	B	C	D
2402	1.335	-	-	-
2442	1.335	-	-	-
2480	1.340	-	-	-

Table 26 - 20 dB Bandwidth Results

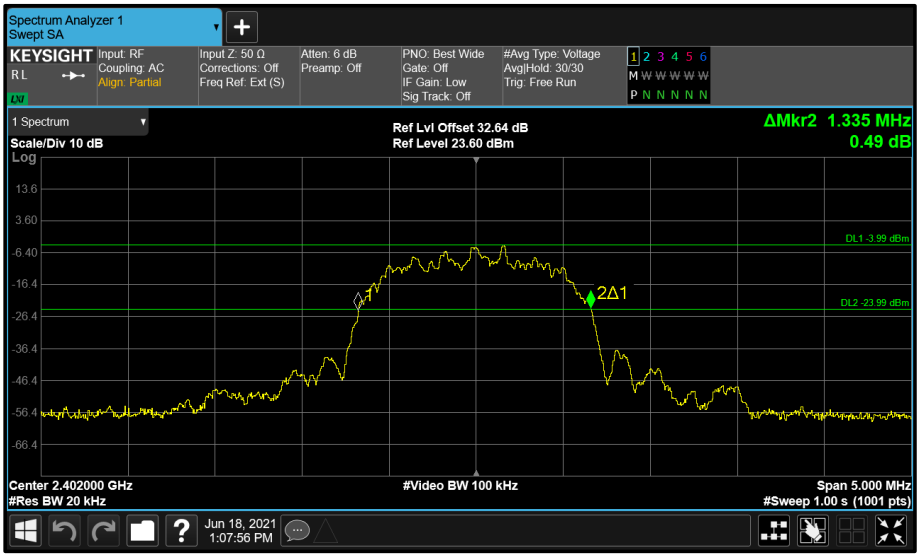

Figure 15 - RF_IO (A) 2402 MHz (CH0) 20 dB Bandwidth

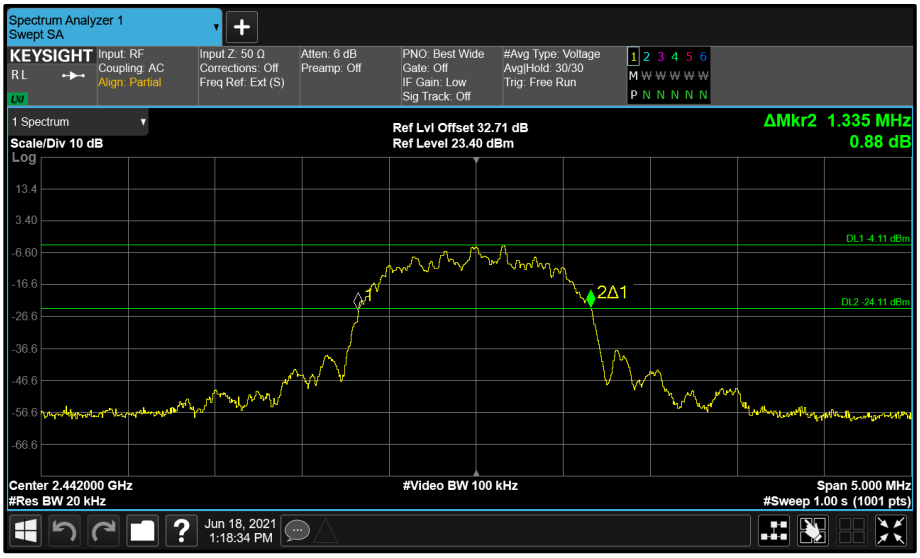

Figure 16 - RF_IO (A) 2442 MHz (CH40) 20 dB Bandwidth

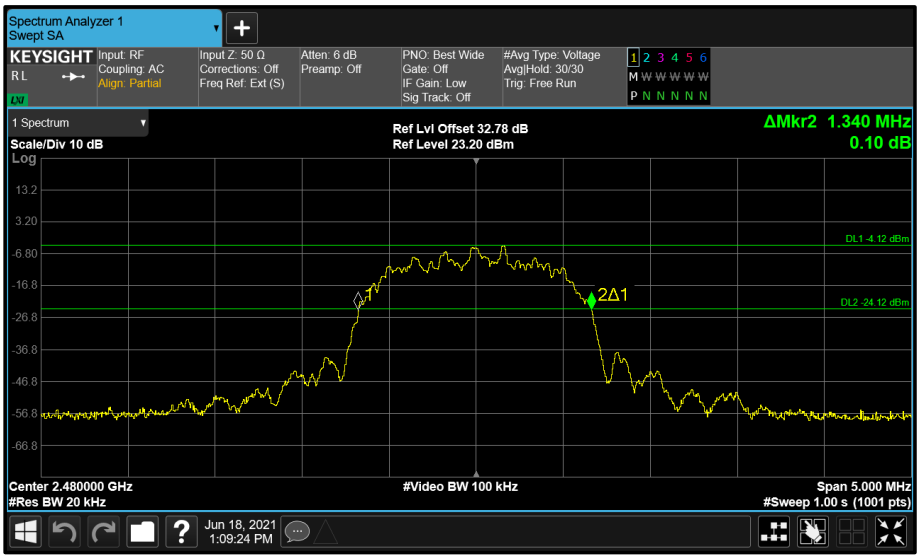

Figure 17 - RF_IO (A) 2480 MHz (CH78) 20 dB Bandwidth

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247 (a)(1) RSS-247 5.1	Test Method(s):	C63.10 6.9.2
Additional Reference(s):	-		

DUT Configuration			
Mode:	8-DPSK (3-DH5)	Duty Cycle (%):	-
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (RF_IO)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	20 dB Bandwidth (MHz)			
	A	B	C	D
2402	1.320	-	-	-
2442	1.320	-	-	-
2480	1.325	-	-	-

Table 27 - 20 dB Bandwidth Results

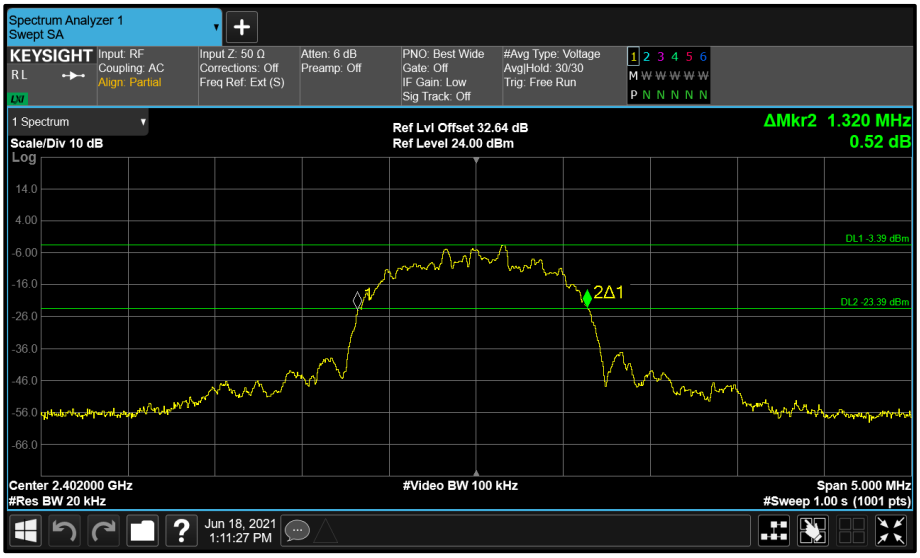

Figure 18 - RF_IO (A) 2402 MHz (CH0) 20 dB Bandwidth

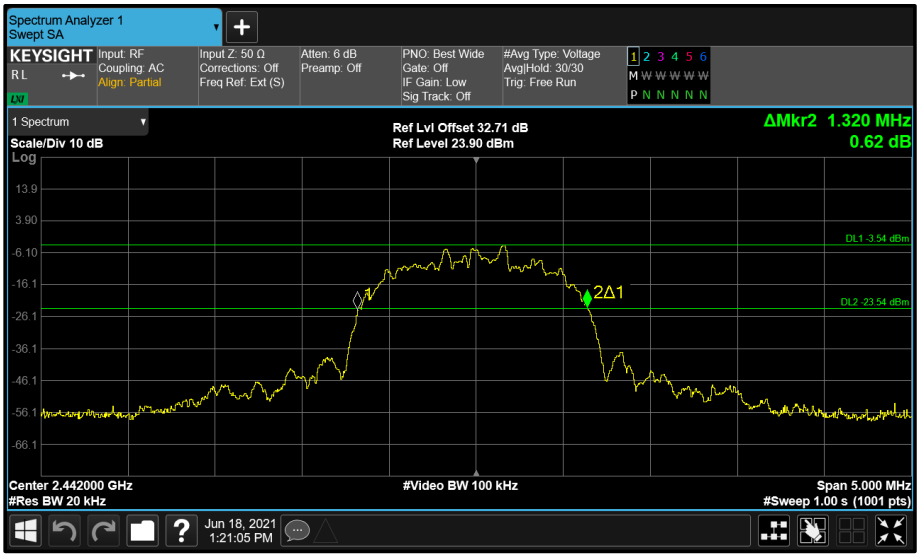

Figure 19 - RF_IO (A) 2442 MHz (CH40) 20 dB Bandwidth

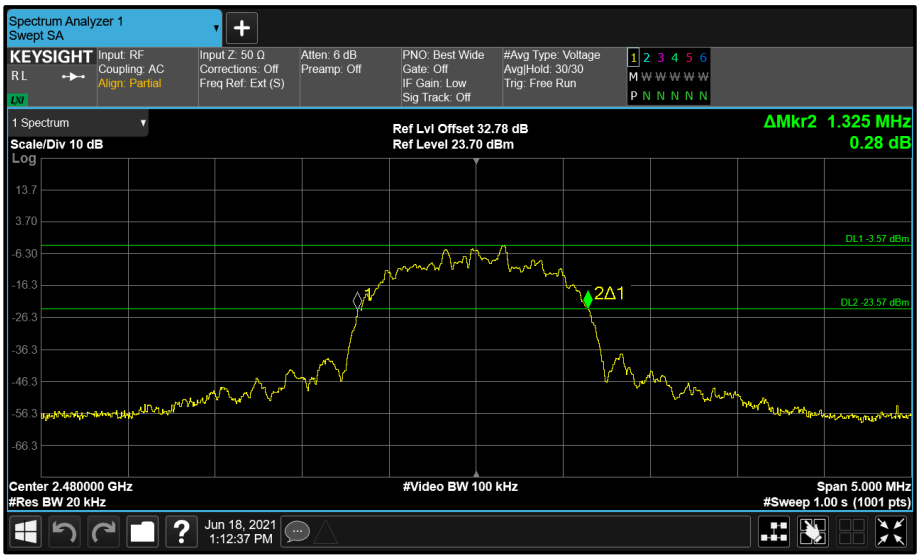

Figure 20 - RF_IO (A) 2480 MHz (CH78) 20 dB Bandwidth

FCC 47 CFR Part 15 and ISED RSS-247 Limit Clause

None specified.

2.5.7 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
Power Supply Unit	Hewlett Packard	6282A	132	-	TU
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	03-Dec-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	03-Dec-2021
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	04-Mar-2022
Signal Commissioning Unit	TUV SUD	SCU001	5546	12	16-Apr-2022

Table 28

TU - Traceability Unscheduled

2.6 Maximum Conducted Output Power

2.6.1 Specification Reference

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

2.6.2 Equipment Under Test and Modification State

BTM-1254, S/N: 00FF07 - Modification State 0

2.6.3 Date of Test

18-June-2021

2.6.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 7.8.5

2.6.5 Environmental Conditions

Ambient Temperature 22.6 °C
Relative Humidity 59.1 %

2.6.6 Test Results

2.4 GHz Bluetooth

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (b)(1) RSS-247 5.4 b)	Test Method(s):	C63.10 7.8.5
Additional Reference(s):	-		

DUT Configuration			
Mode:	GFSK (DH5)	Duty Cycle (%):	77.0
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (RF_IO)	Peak Antenna Gain (dBi):	4.00

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)
	A	B	C	D	∑		
2402	1.19	-	-	-	-	30.00	-28.81
2442	1.05	-	-	-	-	30.00	-28.95
2480	1.91	-	-	-	-	30.00	-28.09

Table 29 - 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	∑					
2402	1.19	-	-	-	-	30.00	-28.81	5.19	36.00	-30.81
2442	1.05	-	-	-	-	30.00	-28.95	5.05	36.00	-30.95
2480	1.91	-	-	-	-	30.00	-28.09	5.91	36.00	-30.09

Table 30 - ISED Maximum Conducted (peak) Output Power Results

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (b)(1) RSS-247 5.4 b)	Test Method(s):	C63.10 7.8.5
Additional Reference(s):	-		

DUT Configuration			
Mode:	π/4 DQPSK (2-DH5)	Duty Cycle (%):	77.2
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (RF_IO)	Peak Antenna Gain (dBi):	4.00

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)
	A	B	C	D	∑		
2402	3.56	-	-	-	-	30.00	-26.44
2442	3.40	-	-	-	-	30.00	-26.60
2480	3.22	-	-	-	-	30.00	-26.78

Table 31 - 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	∑					
2402	3.56	-	-	-	-	30.00	-26.44	7.56	36.00	-28.44
2442	3.40	-	-	-	-	30.00	-26.60	7.40	36.00	-28.60
2480	3.22	-	-	-	-	30.00	-26.78	7.22	36.00	-28.78

Table 32 - ISED Maximum Conducted (peak) Output Power Results

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (b)(1) RSS-247 5.4 b)	Test Method(s):	C63.10 7.8.5
Additional Reference(s):	-		

DUT Configuration			
Mode:	8-DPSK (3-DH5)	Duty Cycle (%):	77.2
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (RF_IO)	Peak Antenna Gain (dBi):	4.00

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)
	A	B	C	D	∑		
2402	4.04	-	-	-	-	30.00	-25.96
2442	3.89	-	-	-	-	30.00	-26.11
2480	3.67	-	-	-	-	30.00	-26.33

Table 33 - 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	∑					
2402	4.04	-	-	-	-	30.00	-25.96	8.04	36.00	-27.96
2442	3.89	-	-	-	-	30.00	-26.11	7.89	36.00	-28.11
2480	3.67	-	-	-	-	30.00	-26.33	7.67	36.00	-28.33

Table 34 - 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 DTSs 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.

2.6.7 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
Power Supply Unit	Hewlett Packard	6282A	132	-	TU
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	12-Apr-2022
USB Power Sensor	Boonton	RTP5006	5184	12	19-Apr-2022
Signal Commissioning Unit	TUV SUD	SCU001	5546	12	16-Apr-2022

Table 35

TU - Traceability Unscheduled

2.7 Spurious Radiated Emissions

2.7.1 Specification Reference

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

2.7.2 Equipment Under Test and Modification State

BTM-1254, S/N: 00FF07 - Modification State 0

2.7.3 Date of Test

13-June-2021 to 14-June-2021

2.7.4 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 an EUT which could reasonable 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.

Ports on the EUT were terminated with loads as described in ANSI C63.4, clause 6.2.4. For EUT's with multiple connectors of the same type, additional interconnecting cables were connected, and pre-scans performed to determine whether the level of the emissions were increased by >2 dB. 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 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 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.

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

2.7.5 Example Test Setup Diagram

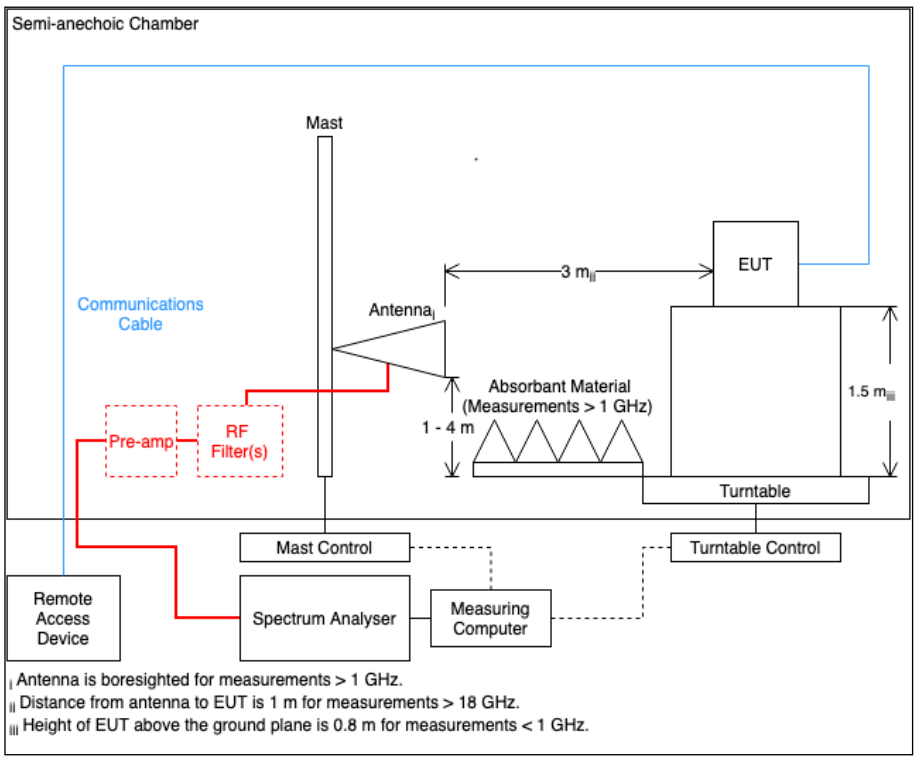

Figure 21

2.7.6 Environmental Conditions

Ambient Temperature	20.6 - 21.1 °C
Relative Humidity	59.7 - 61.4 %

2.7.7 Test Results

2.4 GHz Bluetooth

Testing was performed on the modulation and packet type which resulted in the highest conducted output power. The Modulation/Packet type was GFSK/DH5.

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation	Orientation
127.969	42.36	43.50	1.14	Q-Peak	290	100	Vertical	-

Table 36 - 2402 MHz, 30 MHz to 1 GHz

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

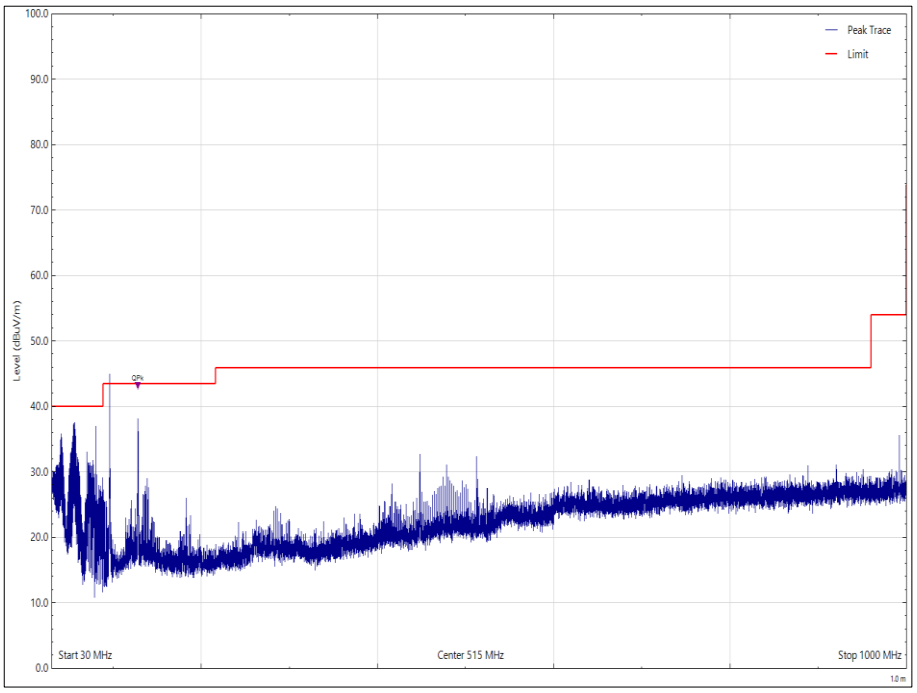

Figure 22 - 2402 MHz, 30 MHz to 1 GHz, Vertical

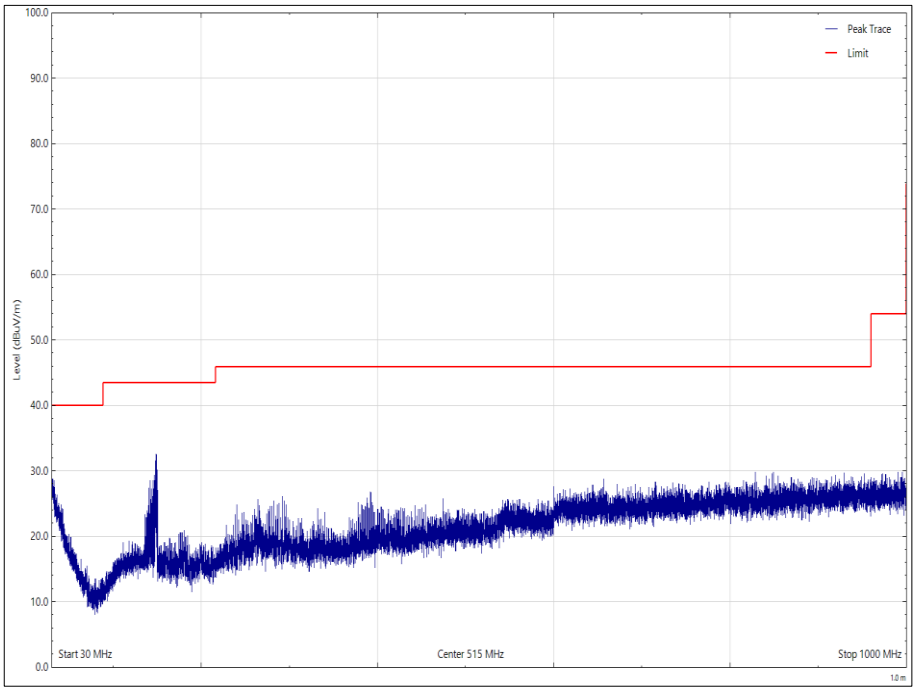

Figure 23 - 2402 MHz, 30 MHz to 1 GHz, Horizontal

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

Table 37 - 2402 MHz, 1 GHz to 25 GHz

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

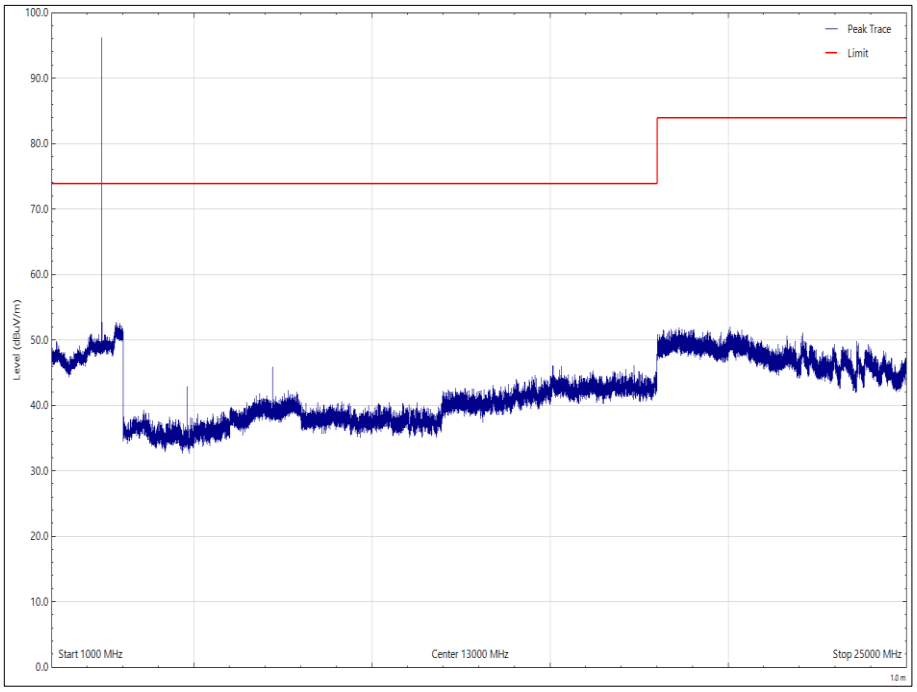

Figure 24 - 2402 MHz, 1 GHz to 25 GHz, Vertical - Peak

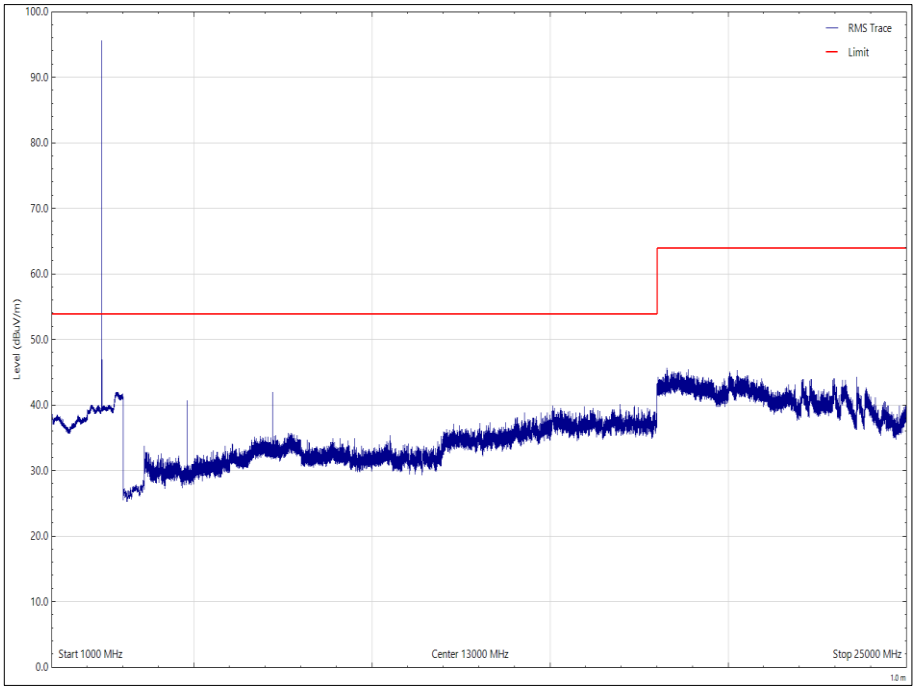

Figure 25 - 2402 MHz, 1 GHz to 25 GHz, Vertical- Average

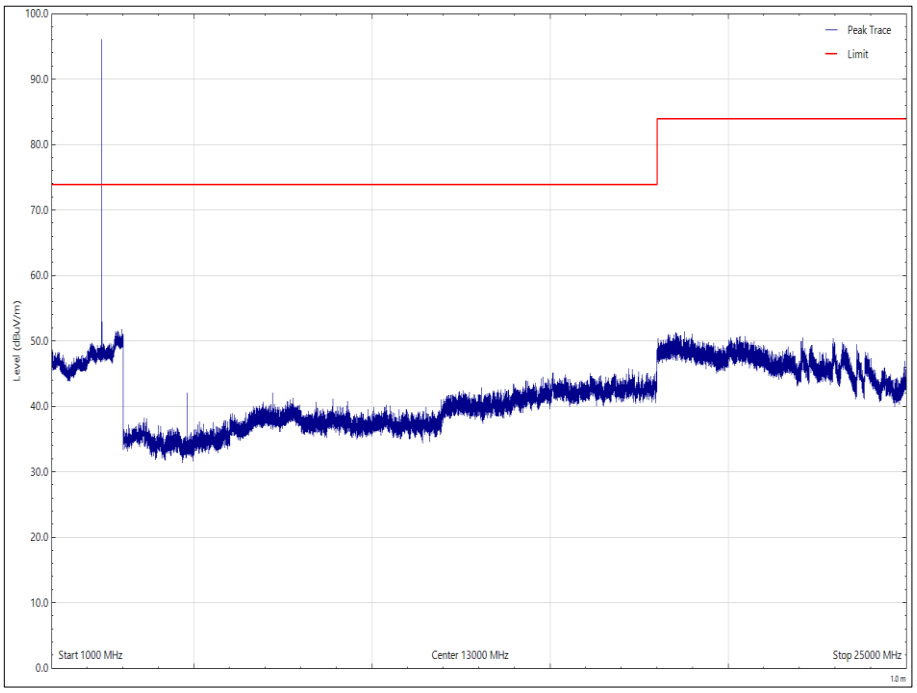

Figure 26 - 2402 MHz, 1 GHz to 25 GHz, Horizontal - Peak

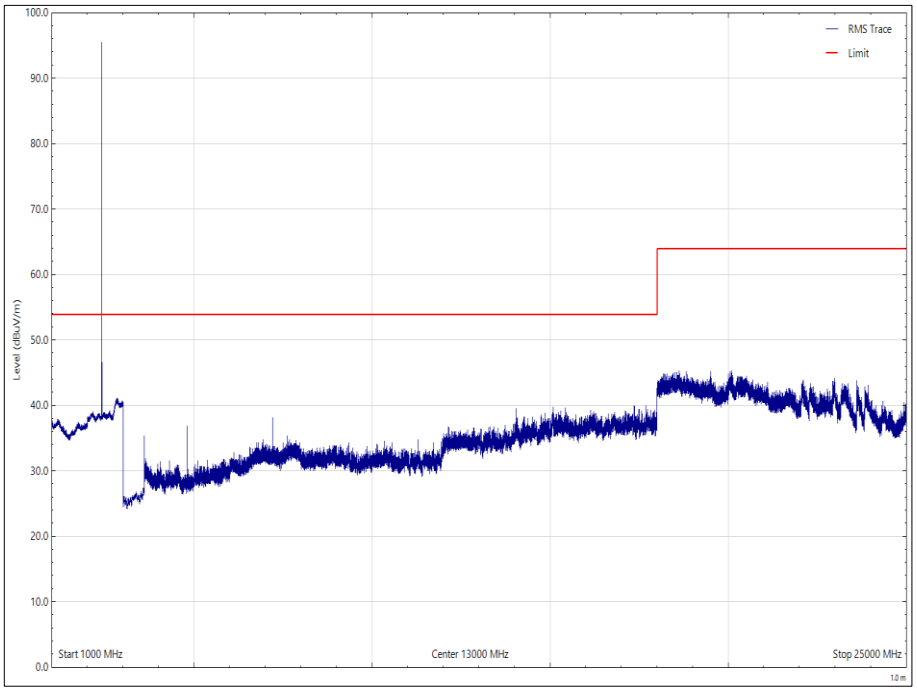

Figure 27 - 2402 MHz, 1 GHz to 25 GHz, Horizontal - Average

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation	Orientation
38.046	35.73	40.00	4.27	Q-Peak	0	110	Vertical	-
256.026	42.16	46.00	3.84	Q-Peak	113	100	Horizontal	-

Table 38 - 2441 MHz, 30 MHz to 1 GHz

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

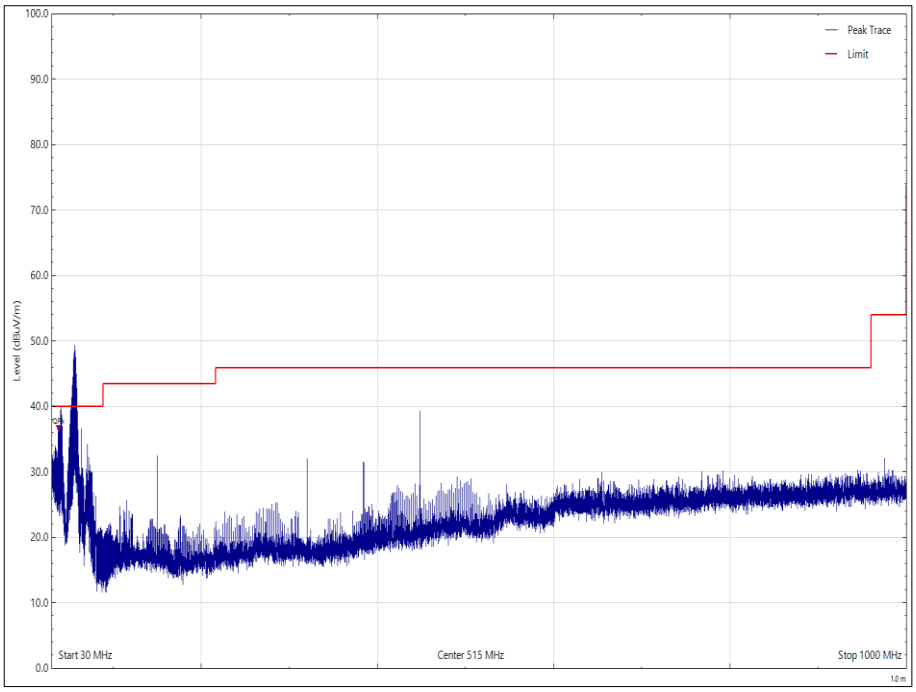

Figure 28 - 2441 MHz, 30 MHz to 1 GHz, Vertical

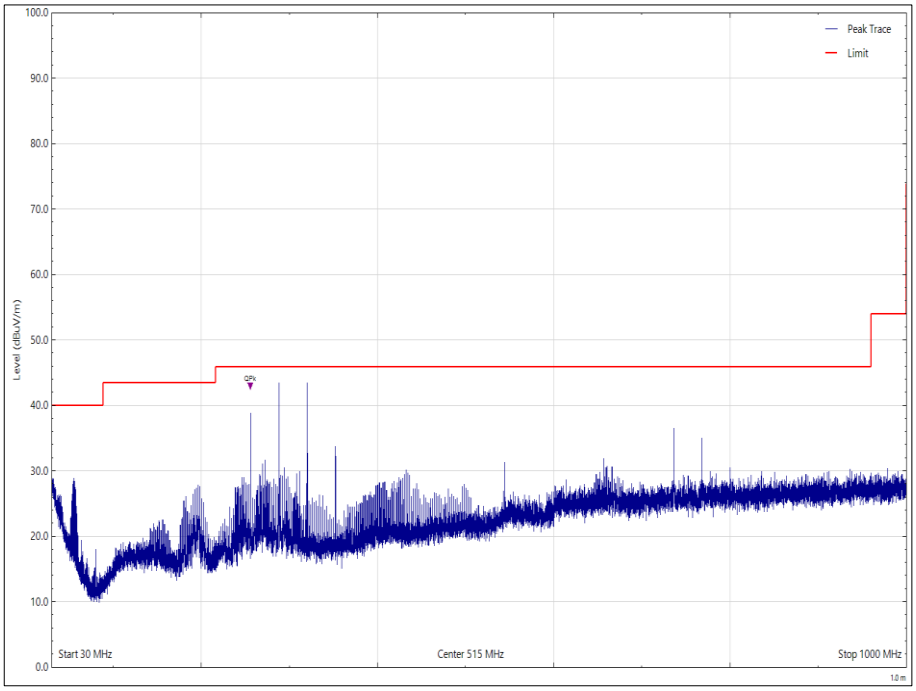

Figure 29 - 2441 MHz, 30 MHz to 1 GHz, Horizontal

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

Table 39 - 2441 MHz - 1 GHz to 25 GHz

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

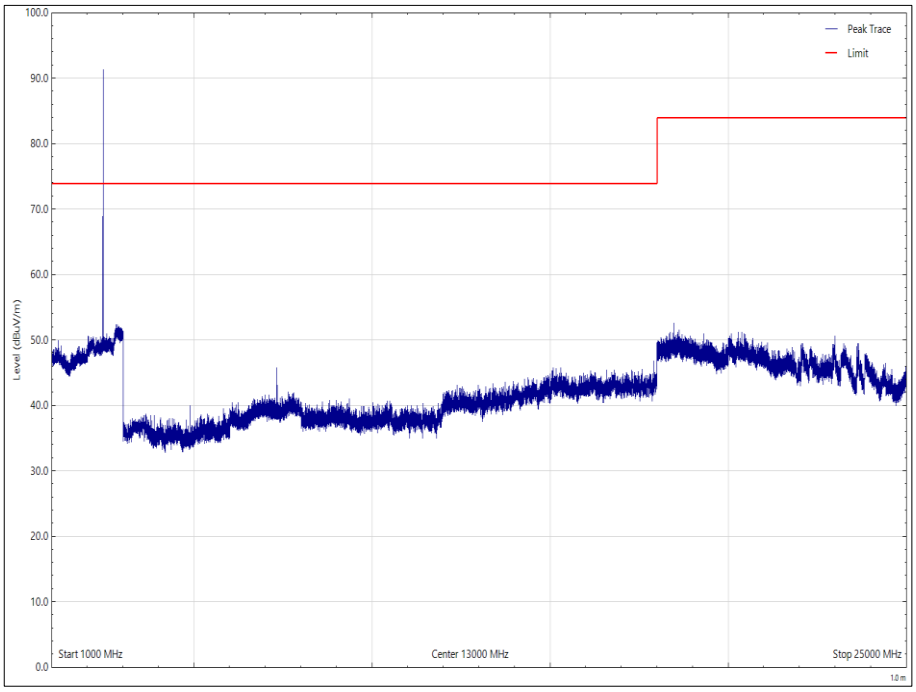

Figure 30 - 2441 MHz - 1 GHz to 25 GHz, Vertical - Peak

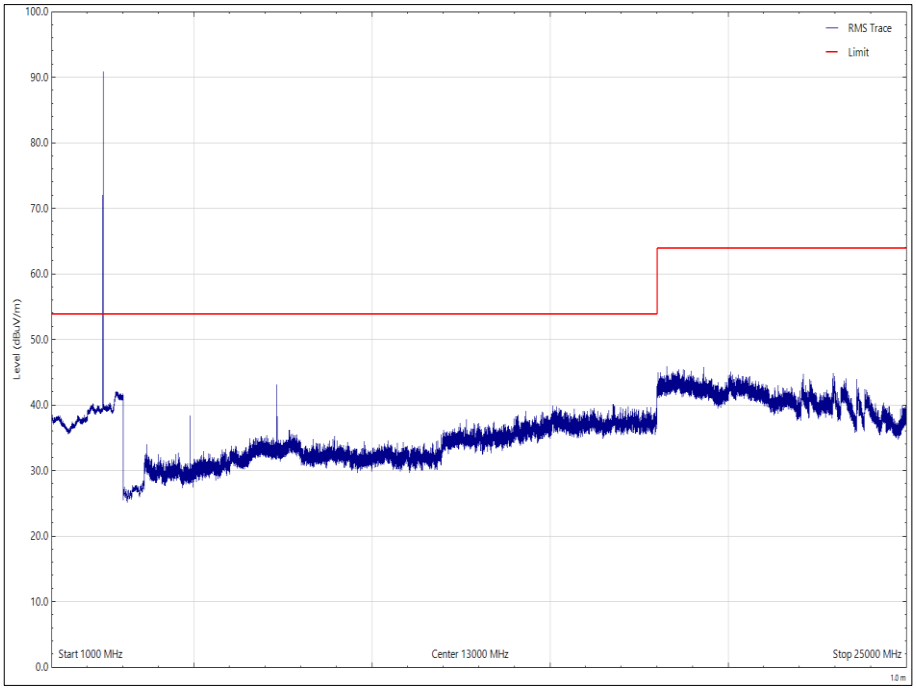

Figure 31 - 2441 MHz - 1 GHz to 25 GHz, Vertical - Average

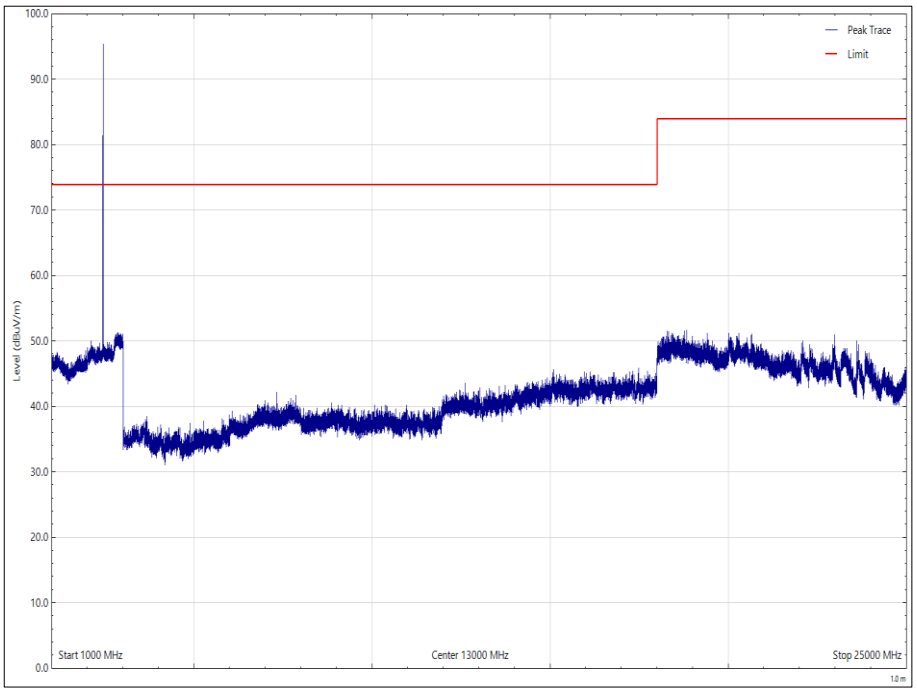

Figure 32 - 2441 MHz - 1 GHz to 25 GHz, Horizontal - Peak

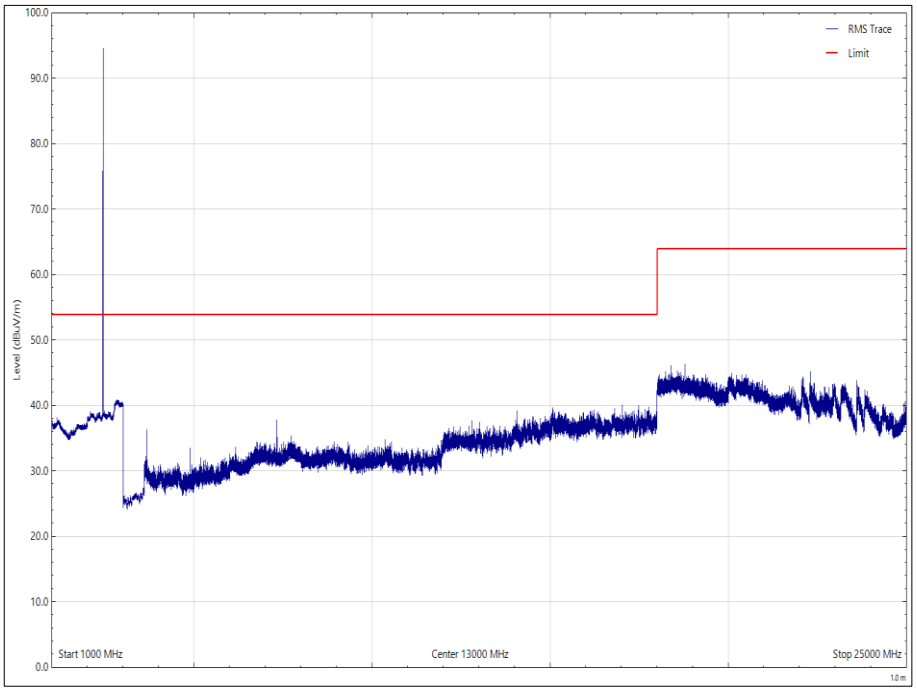

Figure 33 - 2441 MHz - 1 GHz to 25 GHz, Horizontal - Average

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation	Orientation
37.581	35.86	40.00	4.14	Q-Peak	298	100	Vertical	-

Table 40 - 2480 MHz, 30 MHz to 1 GHz

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

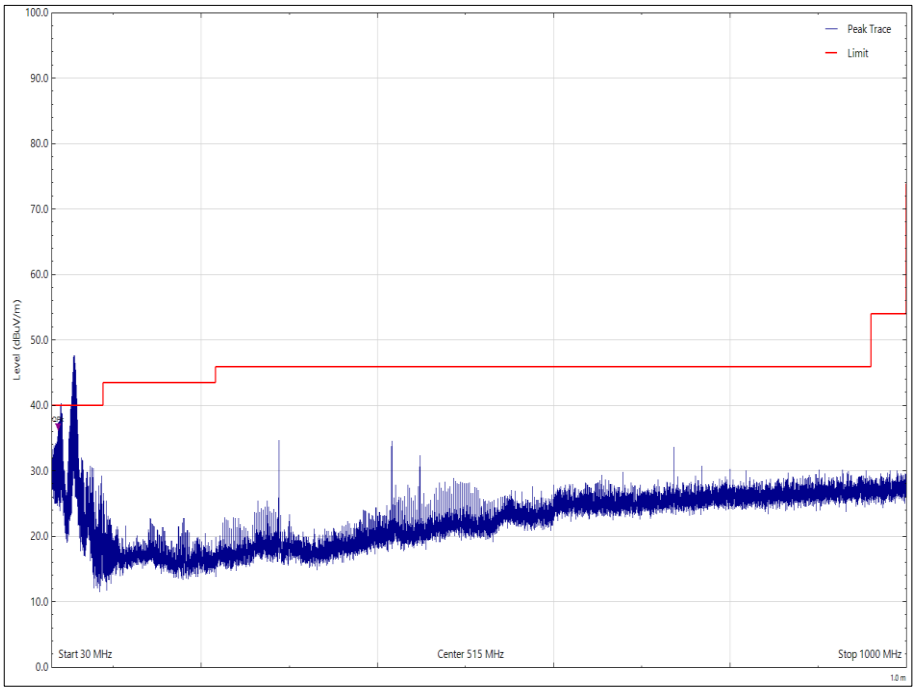

Figure 34 - 2480 MHz, 30 MHz to 1 GHz, Vertical

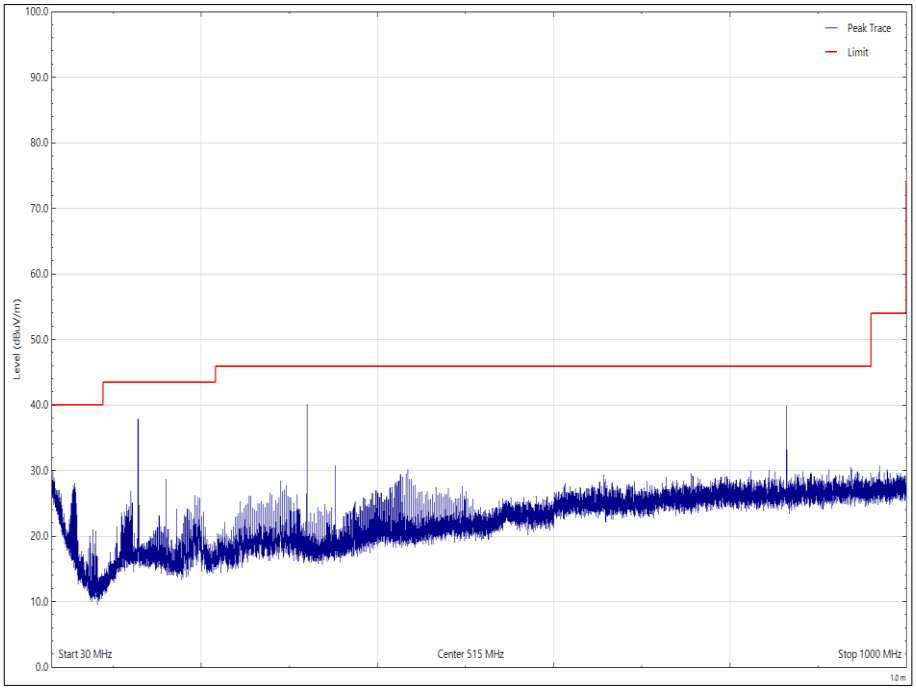

Figure 35 - 2480 MHz, 30 MHz to 1 GHz, Horizontal

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

Table 41 - 2480 MHz - 1 GHz to 25 GHz

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

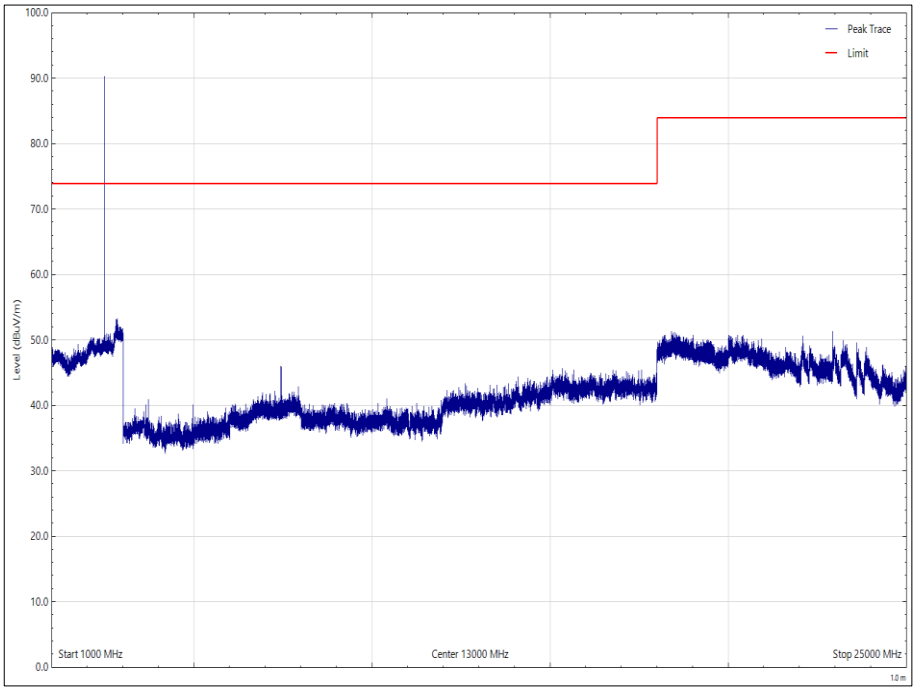

Figure 36 - 2480 MHz - 1 GHz to 25 GHz, Vertical - Peak

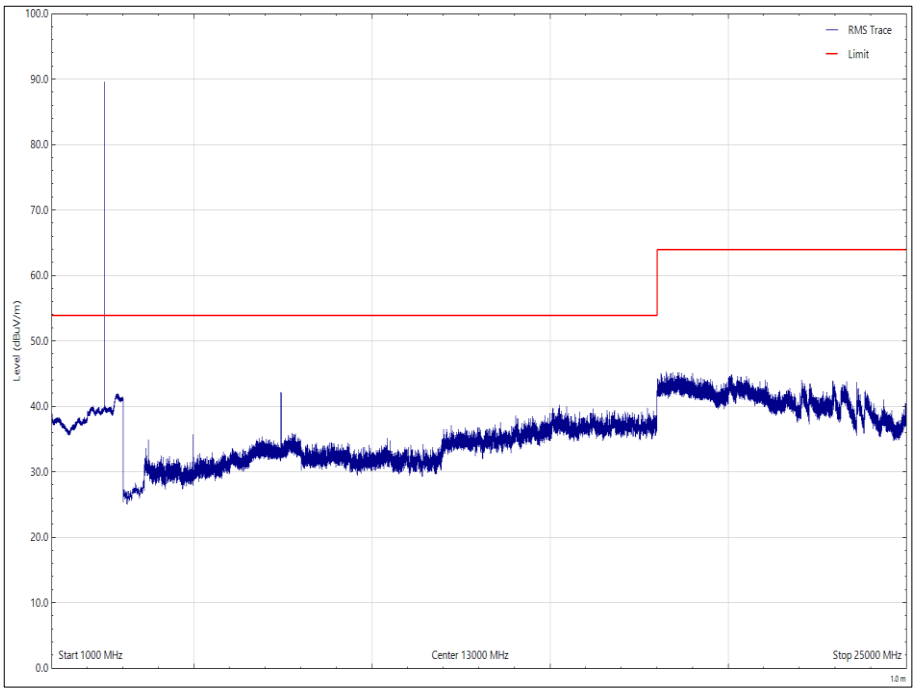

Figure 37 - 2480 MHz - 1 GHz to 25 GHz, Vertical - Average

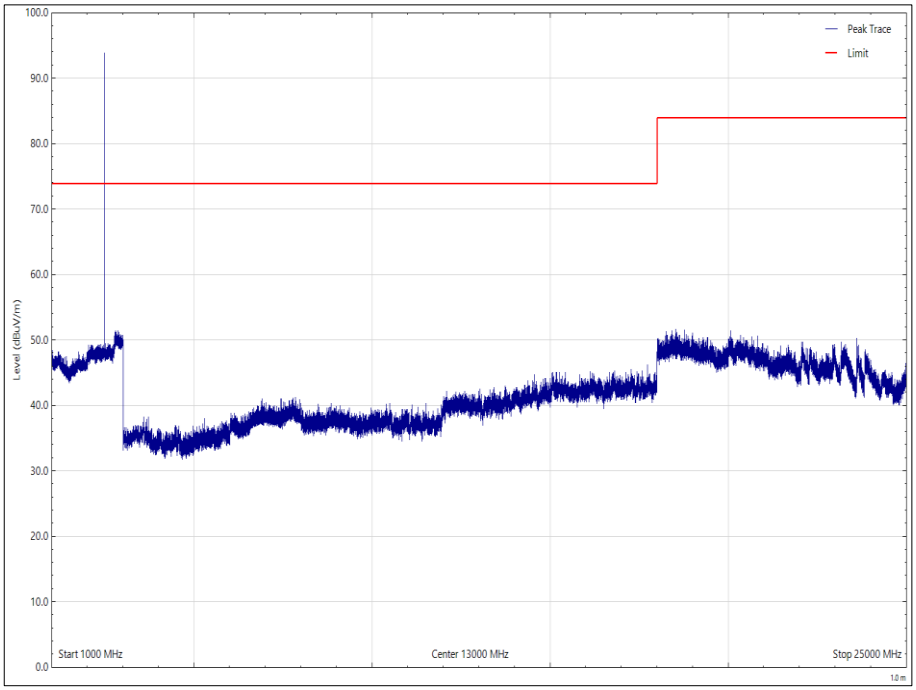

Figure 38 - 2480 MHz - 1 GHz to 25 GHz, Horizontal - Peak

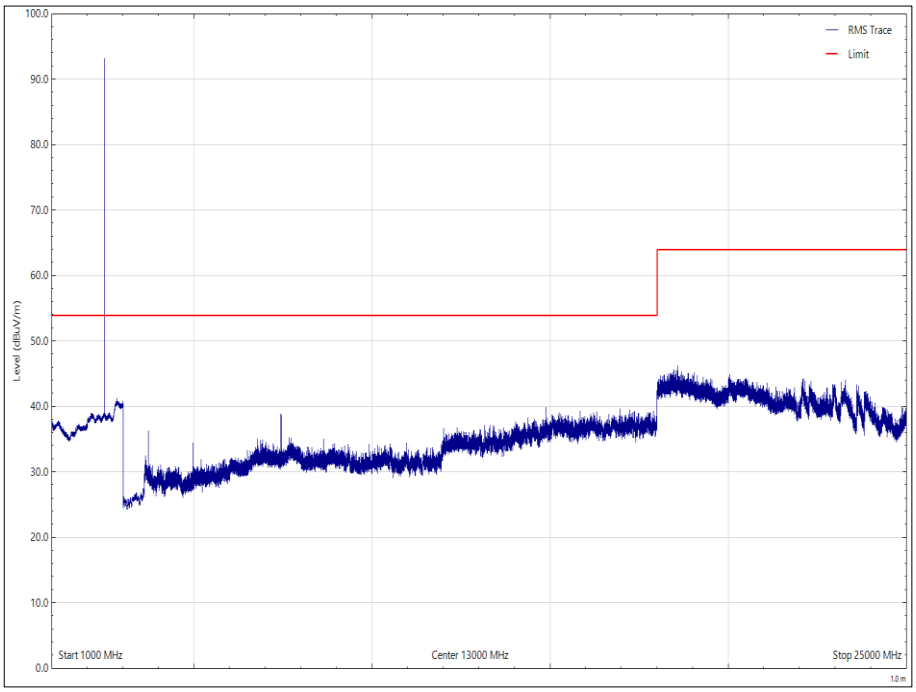

Figure 39 - 2480 MHz - 1 GHz to 25 GHz, Horizontal, - Average

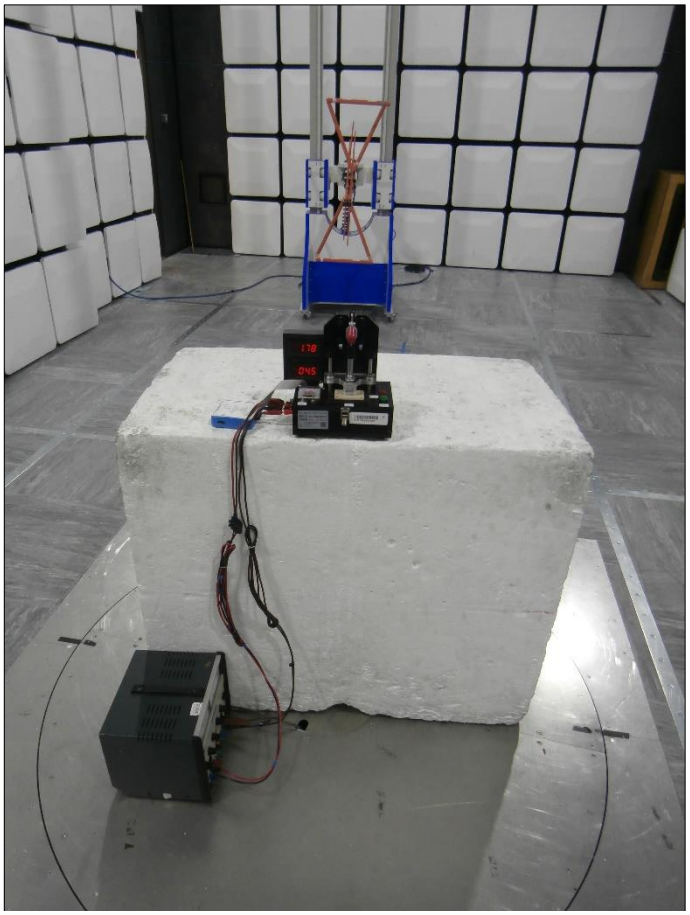

Figure 40 - Test Setup - 30 MHz to 1 GHz

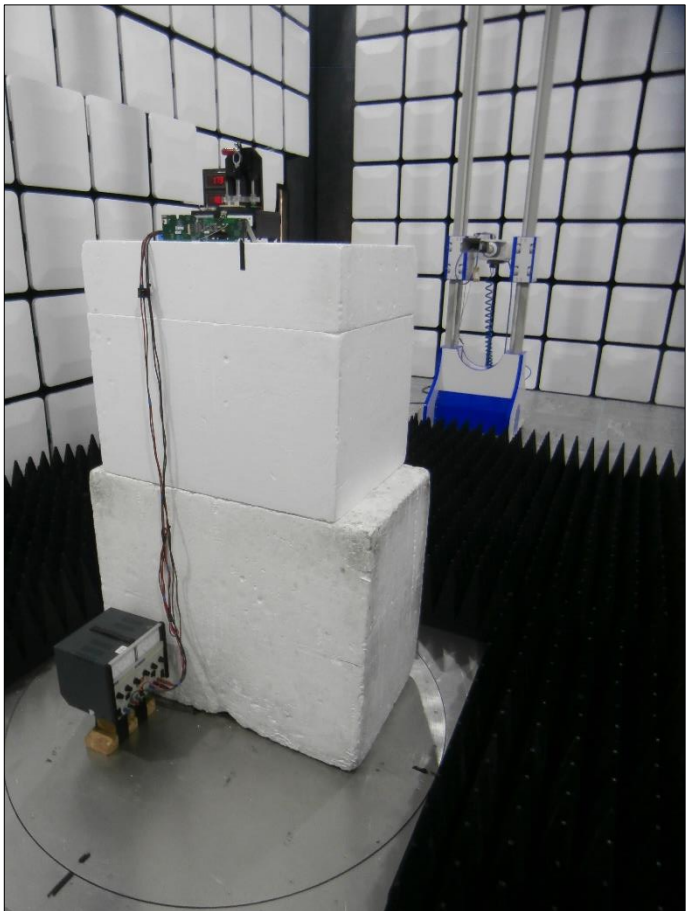

Figure 41 - Test Setup - 1 GHz to 18 GHz

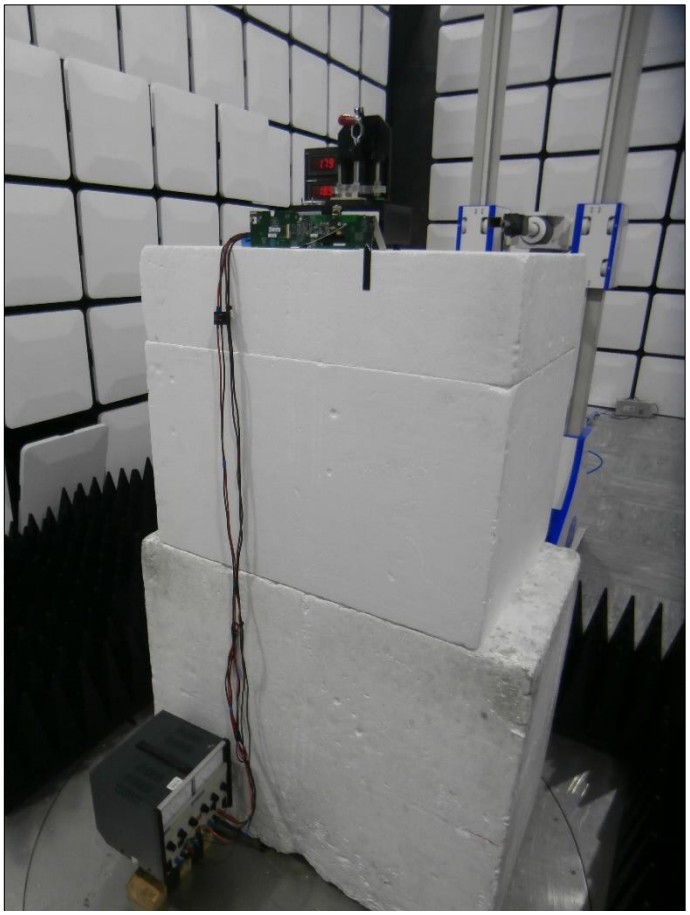

Figure 42 - Test Setup - 18 GHz to 25 GHz

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.

2.7.8 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 permanent attenuator (Bilog)	Schaffner	CBL6143	287	24	14-Oct-2022
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
Power Supply Unit	Farnell	LT30-2	2045	-	TU
Comb Generator	Schaffner	RSG1000	3034	-	TU
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	18-Mar-2022
Multimeter	Fluke	177	3813	12	22-Dec-2021
EmX Emissions Software	TUV SUD	V2.1.9	5125	-	Software
Preamplifier (30dB 1GHz to 18GHz)	Schwarzbeck	BBV 9718 C	5350	12	21-Sep-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	31-Mar-2022
1m K-Type Cable	Junkosha	MWX241-01000KMSKMS/A	5512	12	09-Apr-2022
8m N-Type Cable	Junkosha	MWX221-08000NMSNMS/B	5521	-	O/P Mon
3 GHz High pass Filter	Wainwright	WHKX12-2580-3000-18000-80SS	5548	12	07-May-2022
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 42

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

2.8 Authorised Band Edges

2.8.1 Specification Reference

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

2.8.2 Equipment Under Test and Modification State

BTM-1254, S/N: 00FF07 - Modification State 0

2.8.3 Date of Test

13-June-2021

2.8.4 Test Method

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

2.8.5 Environmental Conditions

Ambient Temperature 20.6 °C
Relative Humidity 60.1 %

2.8.6 Test Results

2.4 GHz Bluetooth

Mode	Modulation	Packet Type	Frequency (MHz)	Band Edge Frequency (MHz)	Level (dBc)
Hopping	GFSK	DH5	2402	2400.0	-46.85
Hopping	GFSK	DH5	2480	2483.5	-47.84
Hopping	8-DPSK	2DH5	2402	2400.0	-44.78
Hopping	8-DPSK	2DH5	2480	2483.5	-46.65
Hopping	π/4 DQPSK	3DH5	2402	2400.0	-46.76
Hopping	π/4 DQPSK	3DH5	2480	2483.5	-45.76
Static	GFSK	DH5	2402	2400.0	-47.64
Static	GFSK	DH5	2480	2483.5	-47.12
Static	8-DPSK	2DH5	2402	2400.0	-47.06
Static	8-DPSK	2DH5	2480	2483.5	-46.88
Static	π/4 DQPSK	3DH5	2402	2400.0	-46.53
Static	π/4 DQPSK	3DH5	2480	2483.5	-47.12

Table 43

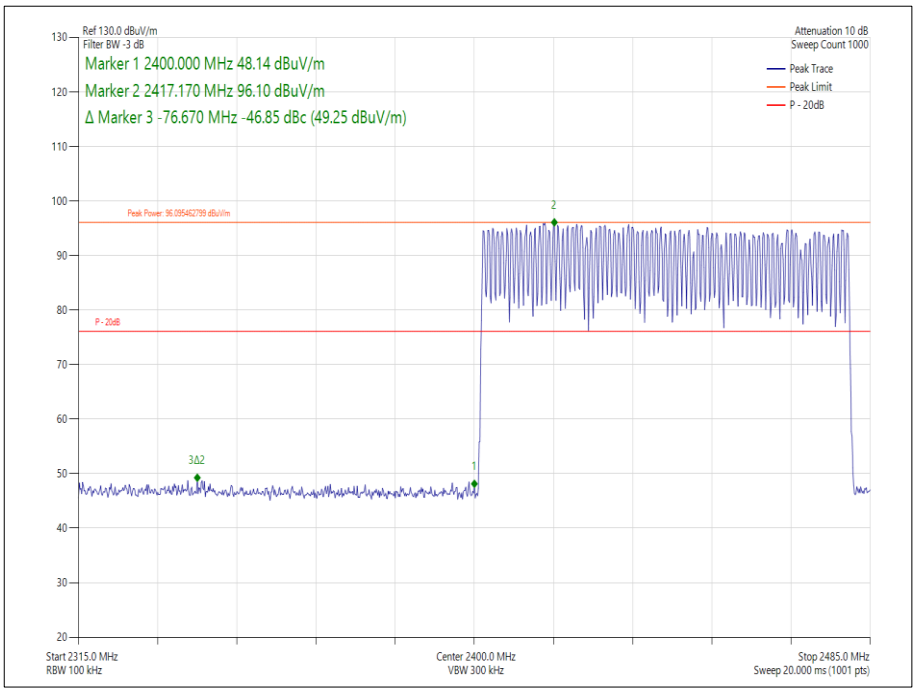

Figure 43 - Hopping - GFSK/DH5, 2402 MHz - Measured Frequency 2400.0 MHz

Figure 44 - Hopping - GFSK/DH5, 2480 MHz - Measured Frequency 2483.5 MHz

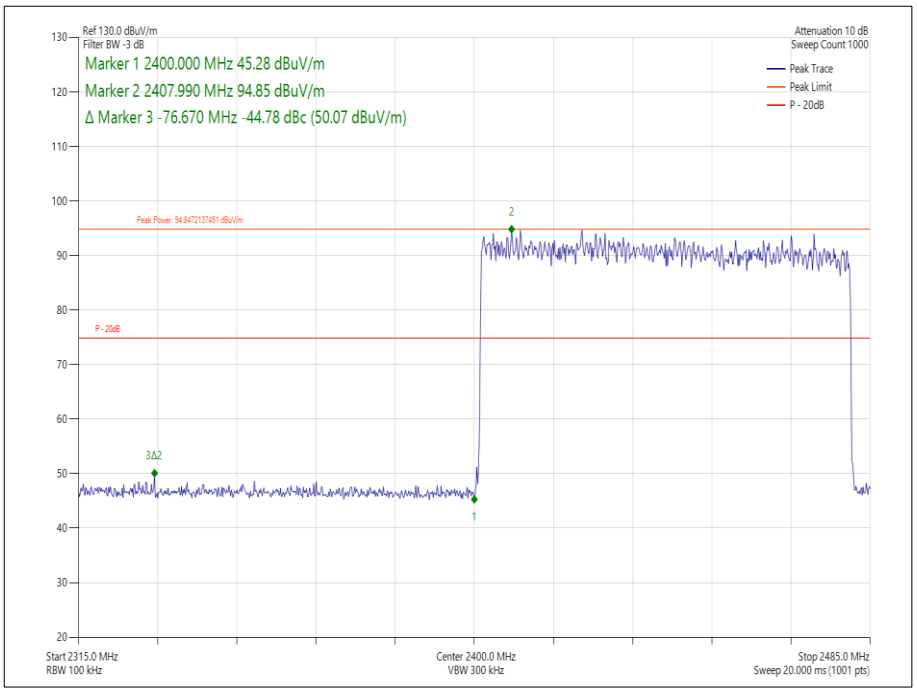

Figure 45 - Hopping - 8-DPSK/2DH5, 2402 MHz - Measured Frequency 2400.0 MHz

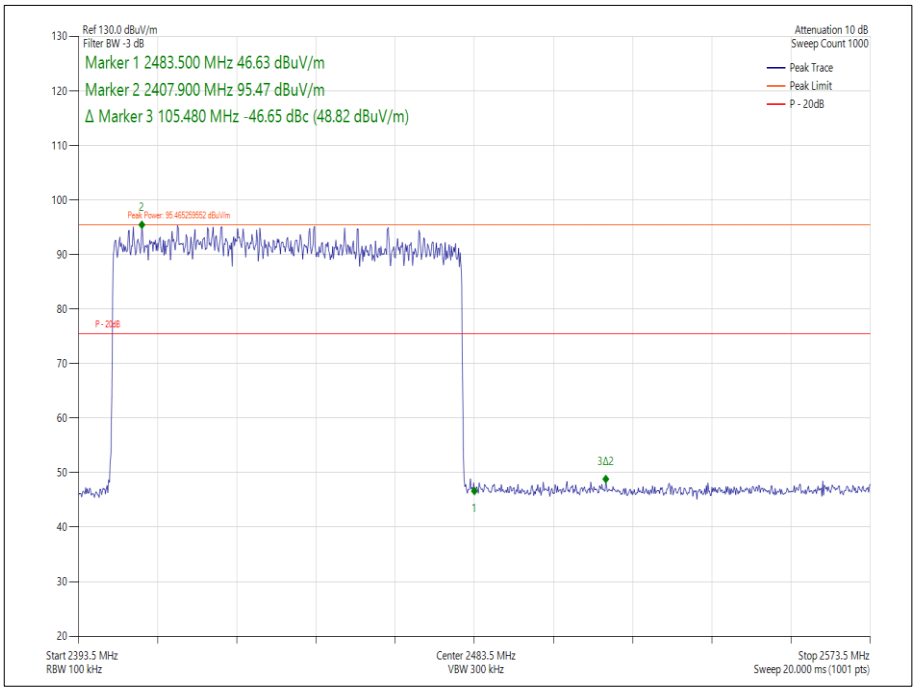

Figure 46 - Hopping - 8-DPSK/2DH5, 2480 MHz - Measured Frequency 2483.5 MHz

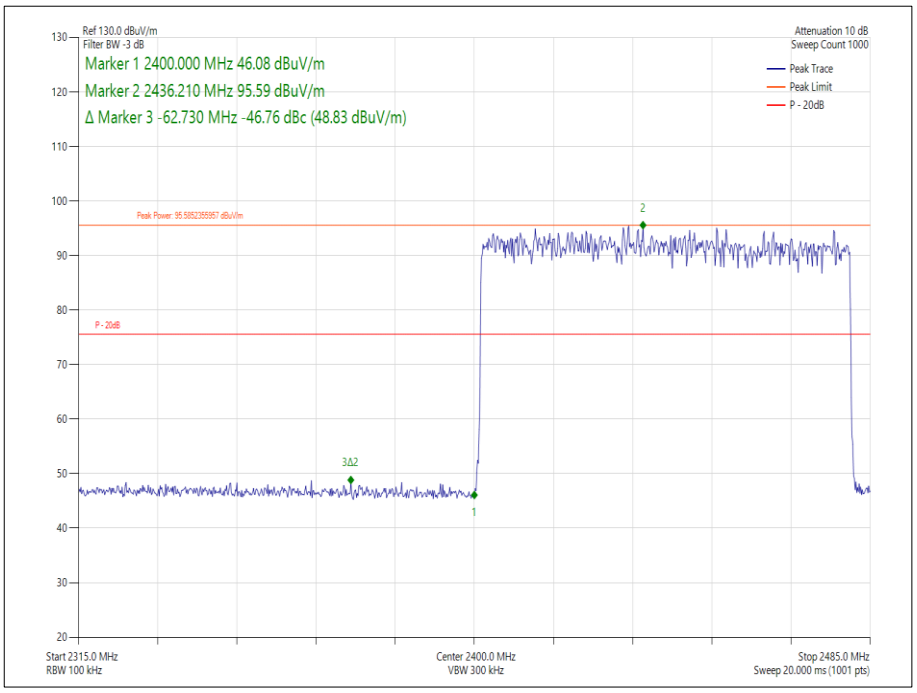

Figure 47 - Hopping - π/4 DQPSK/3DH5, 2402 MHz - Measured Frequency 2400.0 MHz

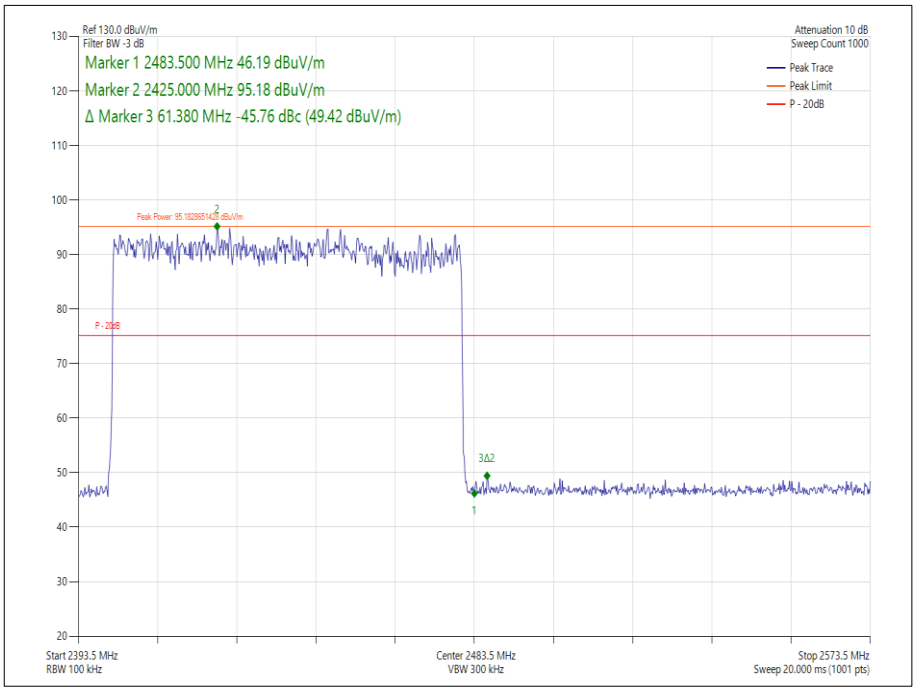

Figure 48 - Hopping - π/4 DQPSK/3DH5, 2480 MHz - Measured Frequency 2483.5 MHz

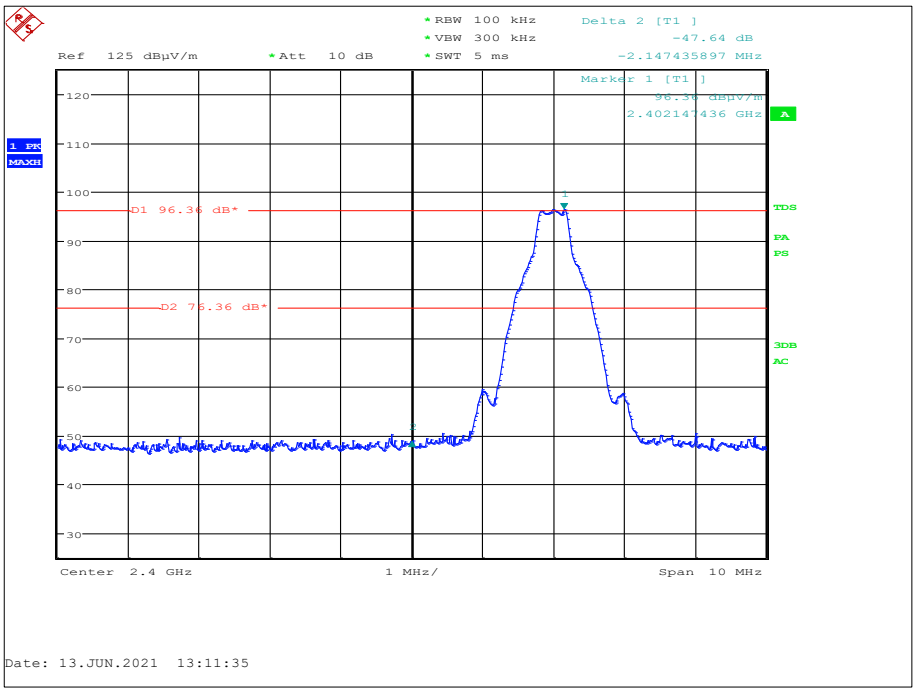

Figure 49 - Static - GFSK/DH5,2402 MHz - Measured Frequency 2400.0 MHz

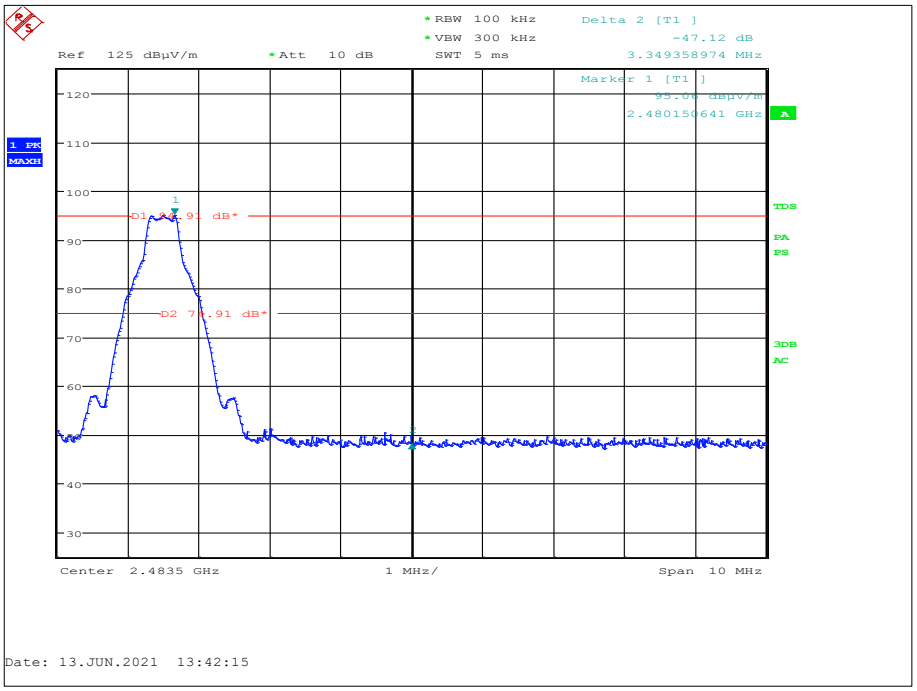

Figure 50 - Static - GFSK/DH5, 2480 MHz - Measured Frequency 2483.5 MHz

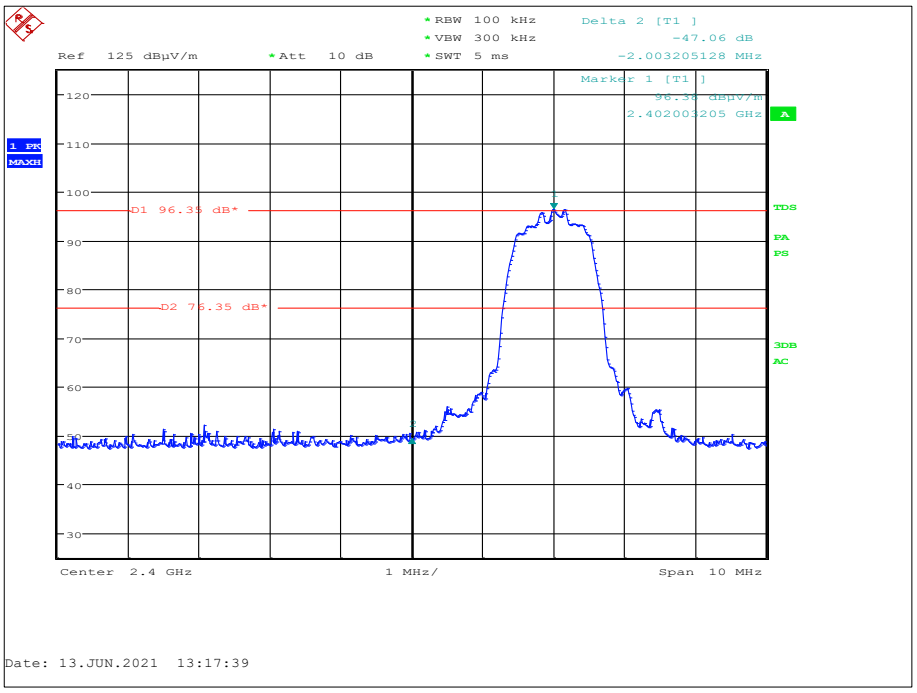

Figure 51 - Static - 8-DPSK/2DH5, 2402 MHz - Measured Frequency 2400.0 MHz

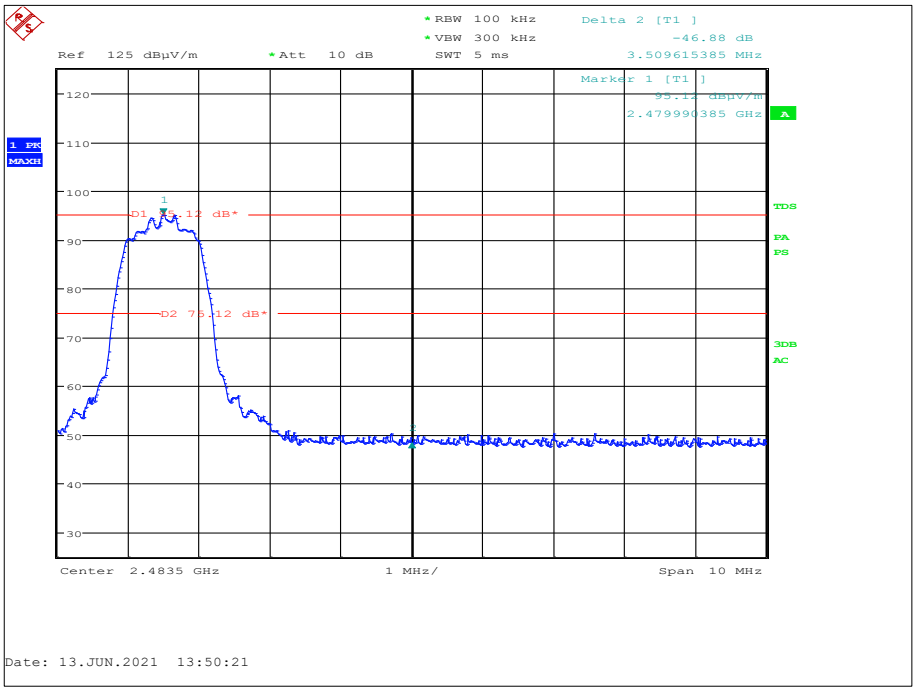

Figure 52 - Static - 8-DPSK/2DH5, 2480 MHz - Measured Frequency 2483.5 MHz

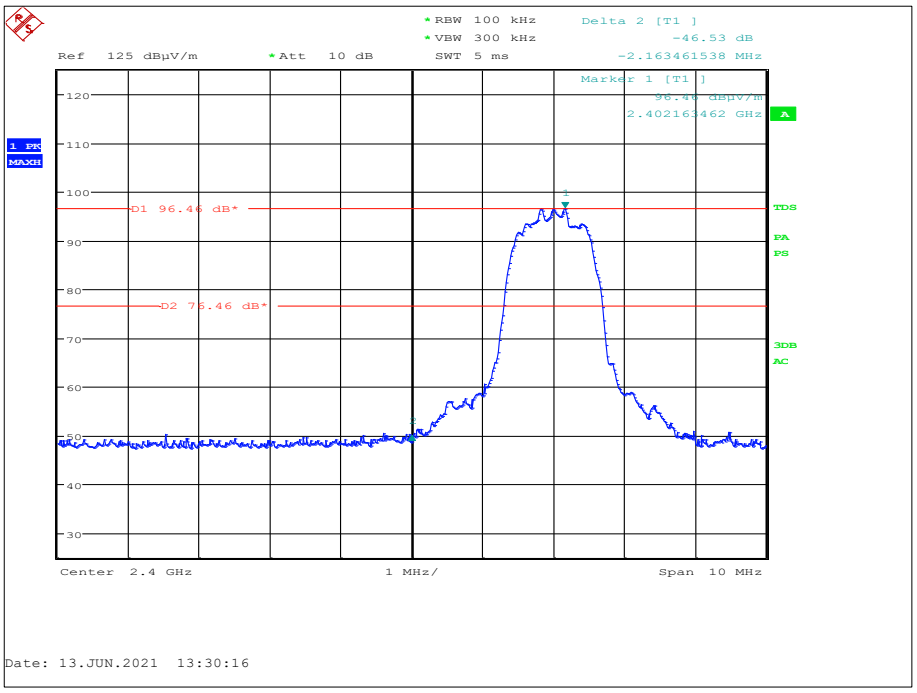

Figure 53 - Static - π/4 DQPSK/3DH5, 2402 MHz - Measured Frequency 2400.0 MHz

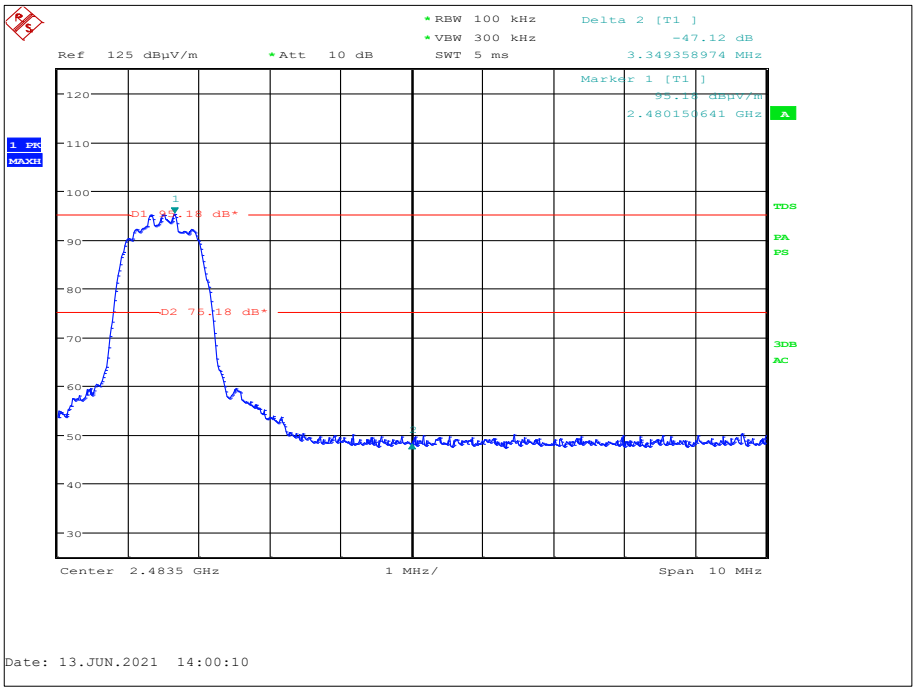

Figure 54 - Static - π/4 DQPSK/3DH5, 2480 MHz - Measured Frequency 2483.5 MHz

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.

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.

2.8.7 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
Power Supply Unit	Farnell	LT30-2	2045	-	TU
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	18-Mar-2022
Multimeter	Fluke	177	3813	12	22-Dec-2021
EmX Emissions Software	TUV SUD	V2.1.9	5125	-	Software
3.5 mm 2m Cable	Junkosha	MWX221-02000DMS	5428	12	15-Oct-2021
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
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 44

TU - Traceability Unscheduled

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
Frequency Hopping Systems - Number of Hopping Channels	-
Frequency Hopping Systems - Average Time of Occupancy	-
Frequency Hopping Systems - Channel Separation	± 23.512 kHz
Frequency Hopping Systems - 20 dB Bandwidth	± 23.512 kHz
Maximum Conducted Output Power	± 3.2 dB
Spurious Radiated Emissions	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Authorised Band Edges	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB

Table 45

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.