

FCC and ISED Test Report

MiX Telematics International (Pty) Ltd
Telematics Unit, Model: MiX 3400-B

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

Prepared for: MiX Telematics International (Pty) Ltd
Blaauwklip Office Park 2
Cnr Strand & Webersvalley Roads
Stellenbosch
South Africa



Add value.
Inspire trust.

FCC ID: 2AFMS-3400XG

IC: Not applicable

COMMERCIAL-IN-CONFIDENCE

Document 75952029-07 Issue 01

SIGNATURE

NAME	JOB TITLE	RESPONSIBLE FOR	ISSUE DATE
Steve Marshall	Senior Engineer	Authorised Signatory	11 August 2022

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	Paul Dickson	11 August 2022	
Testing	Neil Rousell	11 August 2022	

FCC Accreditation

90987 Octagon House, Fareham Test Laboratory

ISED Accreditation

12669A Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY

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



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Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TÜV SÜD 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



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1 Report Summary

1.1 Report Modification Record

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

Issue	Description of Change	Date of Issue
1	First Issue	11-August 2022

Table 1

1.2 Introduction

Applicant	MiX Telematics International (Pty) Ltd
Manufacturer	MiX Telematics International (Pty) Ltd
Model Number(s)	MiX 3400-B
Manufacturer's Declared Variant(s)	MiX 3400-B (TLA) U0140MT MiX 3400-B (VZN) U0142MT
Serial Number(s)	33000051, 33000052 and 33000054
Hardware Version(s)	1
Software Version(s)	5.2.x
Number of Samples Tested	3
Test Specification/Issue/Date	FCC 47 CFR Part 15C: 2020 ISED RSS-247: Issue 2 (02-2017) ISED RSS-GEN: Issue 5 (04-2018) + A2 (02-2021)
Order Number	P0094972
Date	20-April-2021
Date of Receipt of EUT	26-May-2022
Start of Test	23-June-2022
Finish of Test	28-July-2022
Name of Engineer(s)	Paul Dickson and Neil Rousell
Related Document(s)	ANSI C63.10 (2020) ANSI C63.4 (2014)



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
	FCC Part 15C	RSS-247	RSS-GEN			
Configuration and Mode: 2.4 GHz Bluetooth Low Energy						
-	15.203	-	-	Antenna Requirement	N/T	The device complies with the provisions of this section, as it uses permanently attached integral antennas.
2.1	15.205	3.3	8.10	Restricted Band Edges	Pass	
2.2	15.247 (a)(2)	5.2	6.7	Emission Bandwidth	Pass	
2.3	15.247 (b)	5.4	6.12	Maximum Conducted Output Power	Pass	
2.4	15.247 (d) and 15.209	3.3 and 5.5	6.13 and 8.9	Spurious Radiated Emissions	Pass	
2.5	15.247 (d)	5.5	-	Authorised Band Edges	Pass	
2.6	15.247 (e)	5.2	6.12	Power Spectral Density	Pass	

Table 2



1.4 Manufacturer's Declared Variant(s)

The following information was provided by the customer:

Modem	Technology	P/N	Model	Model	Region/	Network operator
BG96	LTE Cat M1/2G	U0051MT	MiX 3400-B	MiX 3400 Electronic Unit (EU) with Backup Battery and Quectel BG96 modem	1 & 2	Various and AT&T
BG96	LTE Cat M1/2G	U0140MT	MiX 3400-B (TLA)	MiX 3400 Electronic Unit (EU) with Backup Battery and Quectel BG96 Cat M1 modem (with Telstra modem FW)	3 Australia	Telstra
BG96	LTE Cat M1/2G	U0142MT	MiX 3400-B (VZN)	MiX 3400 Electronic Unit (EU) with Backup Battery and Quectel BG96 Cat M1 modem (with Telstra modem FW)	2 North America	Verizon

The models listed in the table above present the same electrical, physical and electro mechanics characteristics e.g., the same layout, PCB, components, and enclosure.
The MiX 3400-B, MiX 3400-B (VZN) and MiX 3400-B (TLA) use the same modem hardware, but the modem firmware is specific to the regions and network operators listed above.



1.5 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 MiX3000 series product, that is aimed on the easy-install and light fleet market. It consists mainly of an on-board-computer, modem, GNSS, accelerometer, Low Energy Bluetooth, 2 x analogue inputs, serial communication ports (3 x CAN, L & K-Line, LIN, J1850/J1708 and RS232), 3 x LED's, switchable positive-drive and an audible buzzer. The range includes variants with LTE CAT1/2G and CAT M1/2G modems. All variants make use of the same PCB with the integrated modem, as the only discernible difference with the variant modems populated at the same location on a compatible PCB land pattern. MiX 3400-B Electronic Unit (EU) with Backup Battery and Quectel BG96 modem. MiX 3410 Electronic Unit (EU) with Backup Battery and Quectel EG912Y-EU modem.	
Manufacturer:	MiX Telematics International (Pty) Ltd.	
Model:	MiX 3400-B	
Part Number:	U0051MT	
Hardware Version:	1	
Software Version:	5.2.x	
FCC ID of the product under test – see guidance here	2AFMS-3400XG	
IC ID of the product under test – see guidance here	-	

Table 3

Intentional Radiators

Technology	LTE Band 2	LTE Band 3	LTE Band 4	LTE Band 5	LTE Band 12	LTE Band 13
Frequency Range (MHz to MHz)	1850-1910	1710-1785	1710-1755	824-849	699-716	777-787
Conducted Declared Output Power (dBm)	23	23	23	23	23	23
Antenna Gain (dBi)	2.07	1.46	1.46	0.21	0.76	1.39
Supported Bandwidth(s) (MHz) (e.g. 1 MHz, 20 MHz, 40 MHz)	1.4	1.4	1.4	1.4	1.4	1.4
Modulation Scheme(s) (e.g. GFSK, QPSK etc)	QPSK/ 16-QAM	QPSK/ 16-QAM	QPSK/ 16-QAM	QPSK/ 16-QAM	QPSK/ 16-QAM	QPSK/ 16-QAM
ITU Emission Designator (see guidance here) (not mandatory for Part 15 devices)	1M40W7D	1M40W7D	1M40W7D	1M40W7D	1M40W7D	1M40W7D
Bottom Frequency (MHz)	1850	1710	1710	824	699	777
Middle Frequency (MHz)	1880	1747.5	1747.5	836.5	707.5	782
Top Frequency (MHz)	1910	1785	1755	849	716	787

Table 4



Technology	SRD2400
Frequency Band (MHz)	2400-2480
Conducted Declared Output Power (dBm)	4
Antenna Gain (dBi)	2.1
Supported Bandwidth(s) (MHz)	1
Modulation Scheme(s)	GFSK
ITU Emission Designator	1M00F1D
Bottom Frequency (MHz)	2402
Middle Frequency (MHz)	2440
Top Frequency (MHz)	2480

Table 5

Un-intentional Radiators

Highest frequency generated or used in the device or on which the device operates or tunes	2690 MHz
Lowest frequency generated or used in the device or on which the device operates or tunes	699MHz
Class A Digital Device (Use in commercial, industrial or business environment) ☐	
Class B Digital Device (Use in residential environment only) ☒	

Table 6

AC Power Source

AC supply frequency:	N/A	Hz
Voltage	N/A	V
Max current:	N/A	A
Single Phase ☐ Three Phase ☐		

Table 7

DC Power Source

Nominal voltage:	13.8/27.6	V
Extreme upper voltage:	32	V
Extreme lower voltage:	10.5	V
Max current:	0.5A typical ; 2.5A absolute max (7.5A Fused)	A

Table 8



Battery Power Source

Voltage:	3.2	V
End-point voltage:	2.7	V (Point at which the battery will terminate)
Alkaline ☐ Leclanche ☐ Lithium ☒ Nickel Cadmium ☐ Lead Acid* ☐ *(Vehicle regulated)		
Other ☐	Please detail:	

Table 9

Charging

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

Table 10

Temperature

Minimum temperature:	-20	°C
Maximum temperature:	60	°C

Table 11

Cable Loss

Adapter Cable Loss (Conducted sample)		dB
--	--	----

Table 12

Antenna Characteristics

Antenna connector ☐			State impedance		Ohm
Temporary antenna connector ☒			State impedance	50	Ohm
Integral antenna ☒	Type:	LTE BLE GNSS	Gain	3 2.1 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 13



Ancillaries (if applicable)

Manufacturer:	MiX Telematics	Part Number:	A0061MT
Model:	MiX 3000 Universal OBDII Plugin Harness for light vehicles	Country of Origin:	South Africa
Manufacturer:	MiX Telematics	Part Number:	A0062MT
Model:	MiX 3000 Universal J1939 Plugin Harness for heavy vehicles	Country of Origin:	South Africa
Manufacturer:	MiX Telematics	Part Number:	440FT0931
Model:	Serial Harness SR1	Country of Origin:	South Africa

Table 14

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

Name: Ben van der Merwe
Position held: Senior Engineer
Date: 27 May 2022



1.6 Product Information

1.6.1 Technical Description

The MiX3000 series product, that is aimed on the easy-install and light fleet market. It consists mainly of an on-board-computer, modem, GNSS, accelerometer, Low Energy Bluetooth, 2 x analogue inputs, serial communication ports (3 x CAN, L & K-Line, LIN, J1850/J1708 and RS232), 3 x LED's, switchable positive-drive and an audible buzzer.

The range includes variants with LTE CAT1/2G and CAT M1/2G modems. All variants make use of the same PCB with the integrated modem, as the only discernible difference with the variant modems populated at the same location on a compatible PCB land pattern.

MiX 3400-B Electronic Unit (EU) with Backup Battery and Quectel BG96 modem. MiX 3410 Electronic Unit (EU) with Backup Battery and Quectel EG912Y-EU modem.

1.7 Deviations from the Standard

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

1.8 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: MiX 3400-B, Serial Number: 33000054			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: MiX 3400-B, Serial Number: 33000052			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: MiX 3400-B, Serial Number: 33000051			
1	Power Setting changed in software to 0 dBm.	Paul Dickson	28-July-2022

Table 15



1.9 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	Paul Dickson	UKAS
Emission Bandwidth	Neil Rousell	UKAS
Maximum Conducted Output Power	Neil Rousell	UKAS
Spurious Radiated Emissions	Paul Dickson	UKAS
Authorised Band Edges	Paul Dickson	UKAS
Power Spectral Density	Neil Rousell	UKAS

Table 16

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-247, Clause 3.3
ISED RSS-GEN, Clause 8.10

2.1.2 Equipment Under Test and Modification State

MiX 3400-B, S/N: 33000054 - Modification State 0

2.1.3 Date of Test

05-July-2022 to 09-July-2022

2.1.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 6.10.5 and 11.12.1.

Plots for average measurements were taken in accordance with ANSI C63.10, clause 11.12.2.5.2.

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

2.1.5 Environmental Conditions

Ambient Temperature	19.3 - 23.4 °C
Relative Humidity	42.0 - 60.4 %

2.1.6 Test Results

2.4 GHz Bluetooth Low Energy

Modulation	Frequency (MHz)	Band Edge Frequency (MHz)	Peak Level (dBμV/m)	Average Level (dBμV/m)
GFSK	2402	2390	51.50	39.81
GFSK	2480	2483.5	50.69	39.17

Table 17

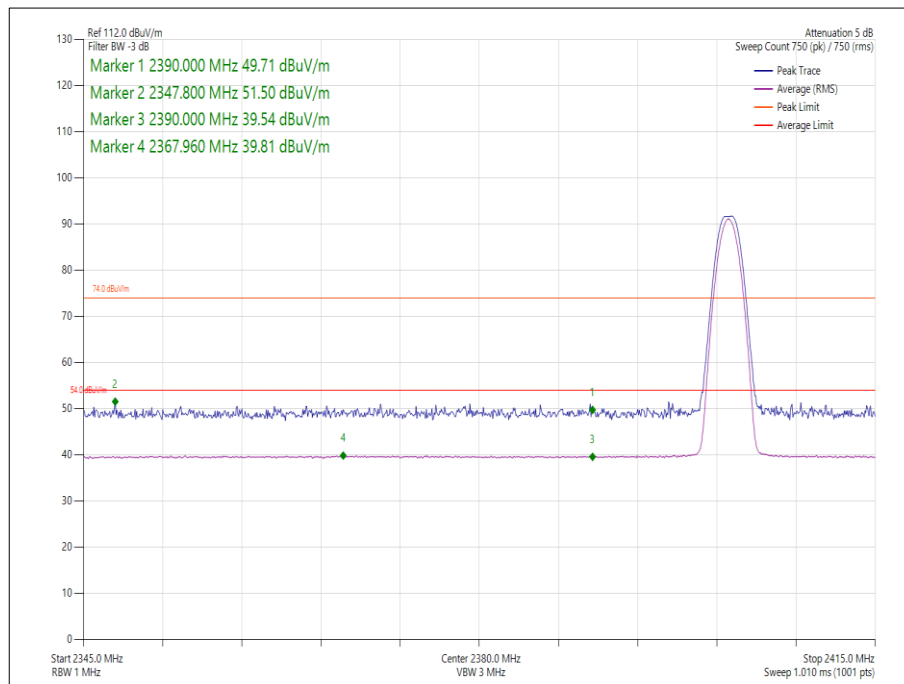


Figure 1 - GFSK - 2402 MHz - Band Edge Frequency 2390 MHz

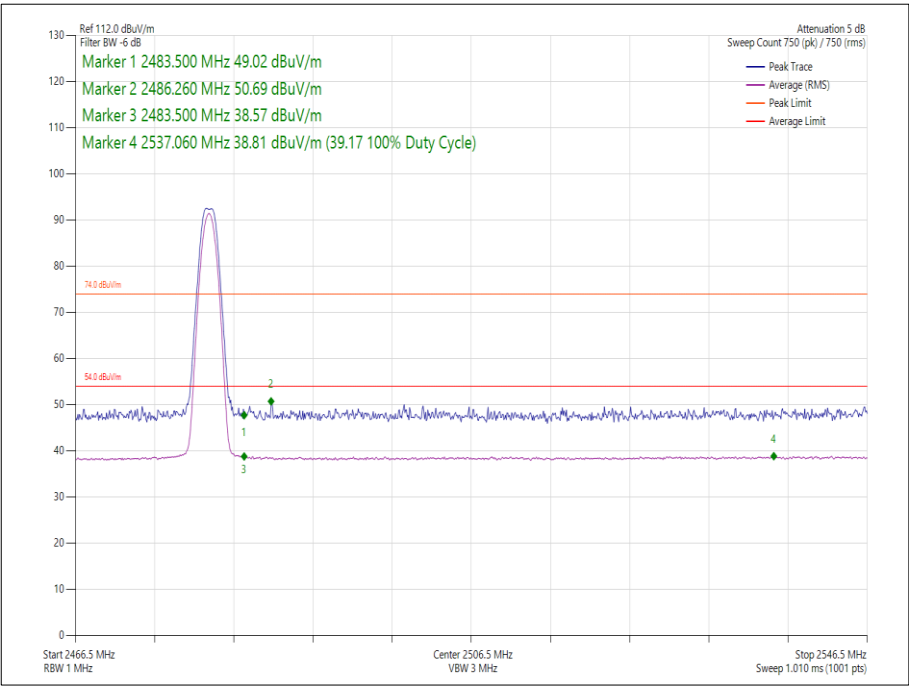


Figure 2 - GFSK - 2480 MHz - Band Edge Frequency 2483.5 MHz

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 18

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 19

*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
DC Power Supply	Hewlett Packard	6269B	1909	-	O/P Mon
True RMS Multimeter	Fluke	179	4006	12	29-Mar-2023
Cable (SMA to SMA, 2 m)	Rhophase	3PS-1801A-2000-3PS	4113	12	27-Jan-2023
Emissions Software	TUV SUD	EmX V3.1.2	5125	-	Software
Cable (N-Type to N-Type, 8 m)	Teledyne	PR90-088-8MTR	5212	12	06-Sep-2022
Cable (N-Type to N-Type, 8 m)	Teledyne	PR90-088-8MTR	5450	6	06-Oct-2022
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB 40	5605	12	23-Sep-2022
Antenna (DRG 1-10.5GHz)	Schwarzbeck	BBHA9120B	5611	12	15-Oct-2022
Turntable & Mast Controller	Maturo Gmbh	NCD/498/2799.01	5612	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	5613	-	TU
Turntable	Maturo Gmbh	Turntable 1.5 SI-2t	5614	-	TU
Screened Room (12)	MVG	EMC-3	5621	36	11-Aug-2023
EMI Test Receiver	Rohde & Schwarz	ESW44	5912	12	17-Feb-2023

Table 20

TU - Traceability Unscheduled



2.2 Emission Bandwidth

2.2.1 Specification Reference

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

2.2.2 Equipment Under Test and Modification State

MiX 3400-B, S/N: 33000052 - Modification State 0

2.2.3 Date of Test

23-June-2022

2.2.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 11.8.1 for 6 dB BW and 6.9.3 for 99% occupied bandwidth measurements.

2.2.5 Environmental Conditions

Ambient Temperature	23.1 °C
Relative Humidity	43.6 %



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) RSS-247 5.2 a)	Test Method(s):	C63.10 6.9.3 C63.10 11.8.1
Additional Reference(s):	-		

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

Test Frequency (MHz)	6 dB Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2402	0.752	-	-	-	≥500.0
2440	0.752	-	-	-	≥500.0
2480	0.732	-	-	-	≥500.0

Table 21 - 6 dB Bandwidth Results

Test Frequency (MHz)	99% Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2402	1.080	-	-	-	-
2440	1.080	-	-	-	-
2480	1.080	-	-	-	-

Table 22 - 99% Bandwidth Results

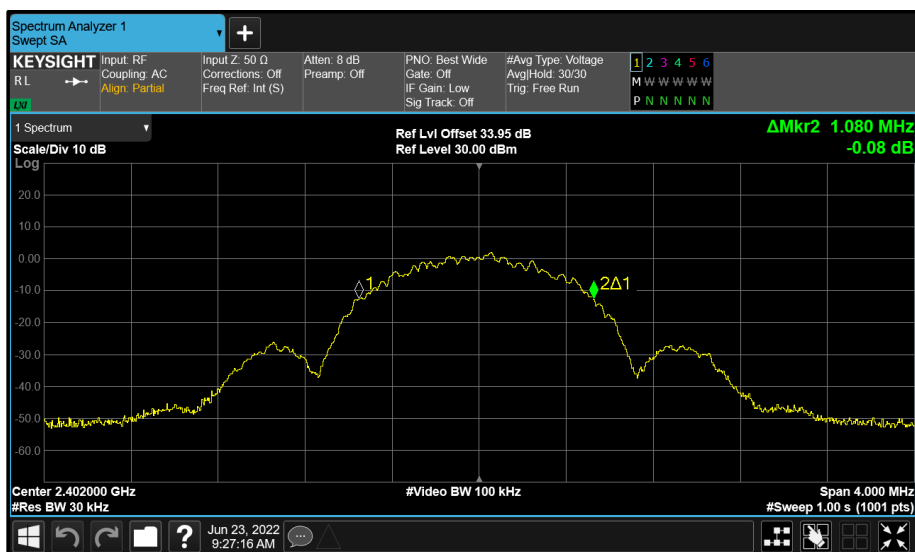


Figure 3 - A (A) 2402 MHz (CH37) 99% Bandwidth

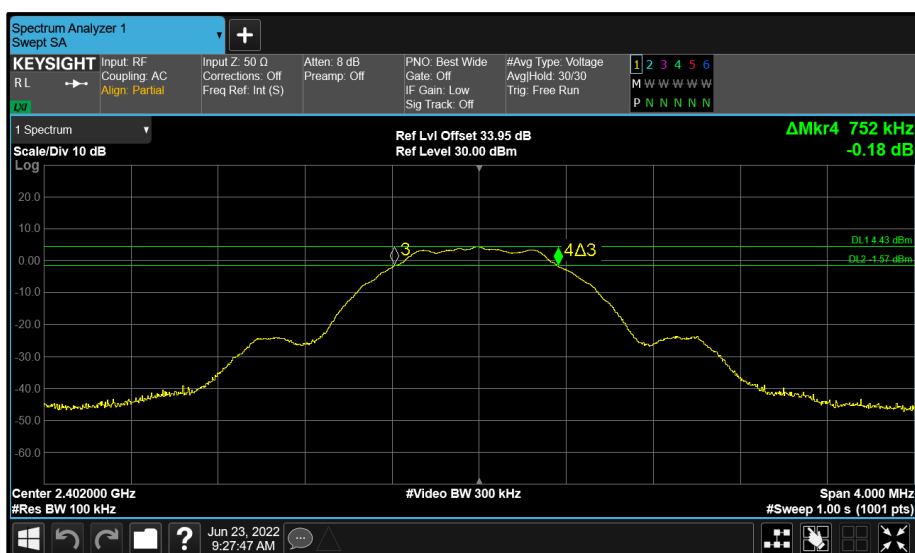


Figure 4 - A (A) 2402 MHz (CH37) 6 dB Bandwidth

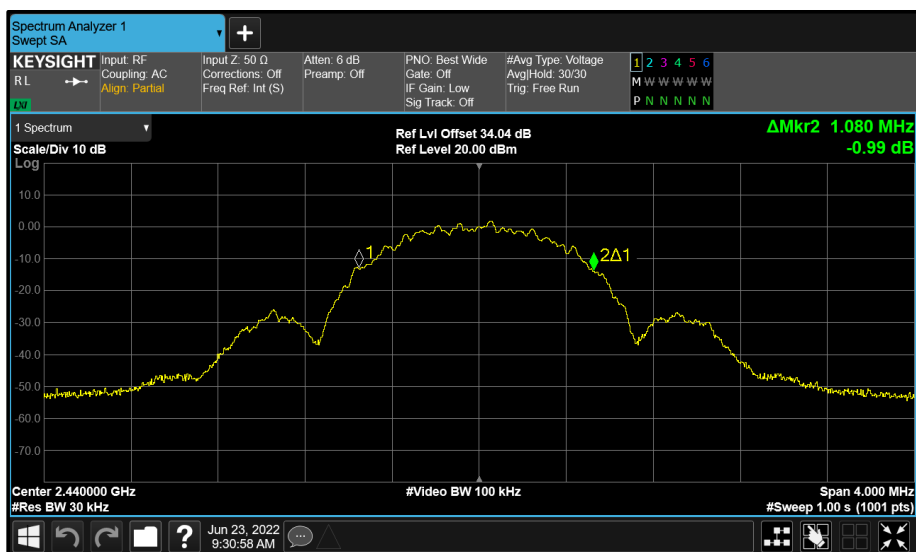


Figure 5 - A (A) 2440 MHz (CH17) 99% Bandwidth

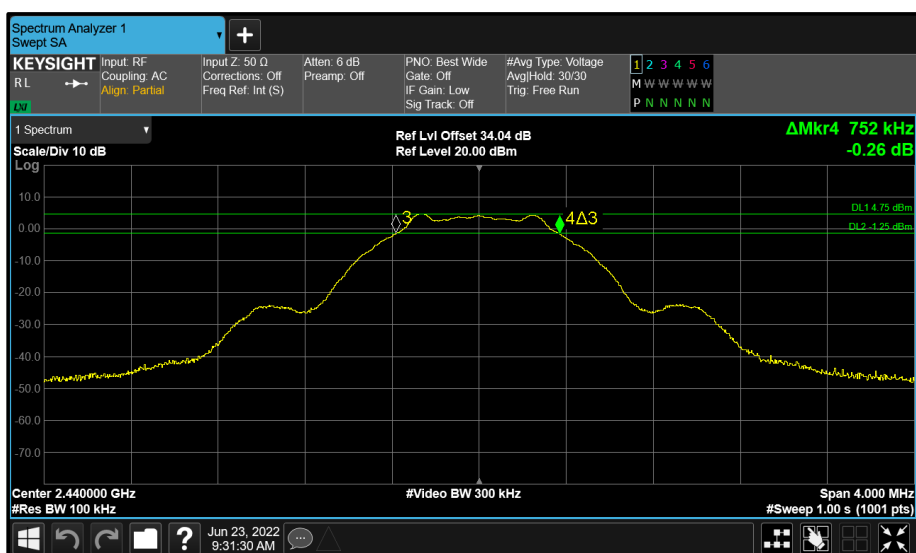


Figure 6 - A (A) 2440 MHz (CH17) 6 dB Bandwidth

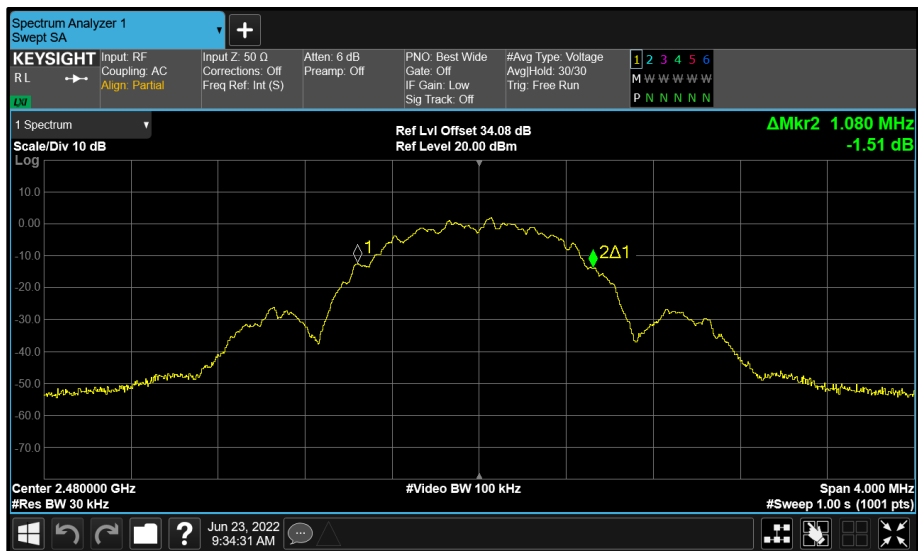


Figure 7 - A (A) 2480 MHz (CH39) 99% Bandwidth

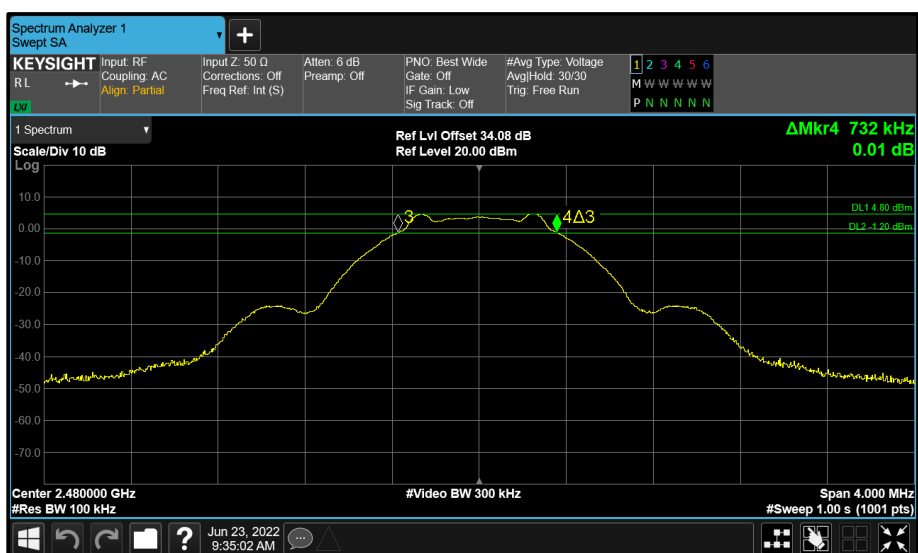


Figure 8 - A (A) 2480 MHz (CH39) 6 dB Bandwidth

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

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



2.2.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
True RMS Multimeter	Fluke	179	4006	12	29-Mar-2023
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB-40	5475	12	25-Apr-2023
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	21-Mar-2024
Signal Conditioning Unit	TUV SUD	SCU001	5546	12	06-Apr-2023
USB Power Sensor	Boonton	RTP5008	5820	12	06-Apr-2023
Climatic Chamber	Weiss Technik	TempEvent T/180/40/3	5894	12	27-May-2023
DC Power Module 60V 20A 300W	Keysight Technologies	N6754A	5970	-	O/P Mon

Table 23

O/P Mon – Output Monitored using calibrated equipment



2.3 Maximum Conducted Output Power

2.3.1 Specification Reference

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

2.3.2 Equipment Under Test and Modification State

MiX 3400-B, S/N: 33000052 - Modification State 0

2.3.3 Date of Test

23-June-2022

2.3.4 Test Method

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

2.3.5 Environmental Conditions

Ambient Temperature	23.1 °C
Relative Humidity	43.6 %



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) RSS-247 5.4 d)	Test Method(s):	C63.10 11.9.1.2
Additional Reference(s):	-		

DUT Configuration			
Mode:	BLE GFSK (LE 1M)	Duty Cycle (%):	100.0
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (A)	Peak Antenna Gain (dBi):	2.10

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)
	A	B	C	D	Σ		
2402	5.10	-	-	-	-	30.00	-24.90
2440	5.00	-	-	-	-	30.00	-25.00
2480	4.88	-	-	-	-	30.00	-25.12

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

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
	A	B	C	D	Σ					
2402	5.10	-	-	-	-	30.00	-24.90	7.20	36.00	-28.80
2440	5.00	-	-	-	-	30.00	-25.00	7.10	36.00	-28.90
2480	4.88	-	-	-	-	30.00	-25.12	6.98	36.00	-29.02

Table 25 - 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 (d)

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.



2.3.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
True RMS Multimeter	Fluke	179	4006	12	29-Mar-2023
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB-40	5475	12	25-Apr-2023
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	21-Mar-2024
Signal Conditioning Unit	TUV SUD	SCU001	5546	12	06-Apr-2023
USB Power Sensor	Boonton	RTP5008	5820	12	06-Apr-2023
Climatic Chamber	Weiss Technik	TempEvent T/180/40/3	5894	12	27-May-2023
DC Power Module 60V 20A 300W	Keysight Technologies	N6754A	5970	-	O/P Mon

Table 26

O/P Mon – Output Monitored using calibrated equipment



2.4 Spurious Radiated Emissions

2.4.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (d) and 15.209
ISED RSS-247, Clause 3.3 and 5.5
ISED RSS-GEN, Clause 6.13 and 8.9

2.4.2 Equipment Under Test and Modification State

MiX 3400-B, S/N: 33000054 - Modification State 0
MiX 3400-B, S/N: 33000051 - Modification State 1

2.4.3 Date of Test

05-July-2022 to 28-July-2022

2.4.4 Test Method

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

For frequencies > 1 GHz, plots for average measurements were taken in accordance with ANSI C63.10, clause 11.12.2.5.2.

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

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.

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:

$10^{(\text{Field Strength in dB}\mu\text{V/m}/20)}$.

Above 18 GHz, the measurement distance was reduced to 1 m. The limit line was increased by $20 \cdot \text{LOG}(3/1) = 9.54$ dB.

2.4.5 Example Test Setup Diagram

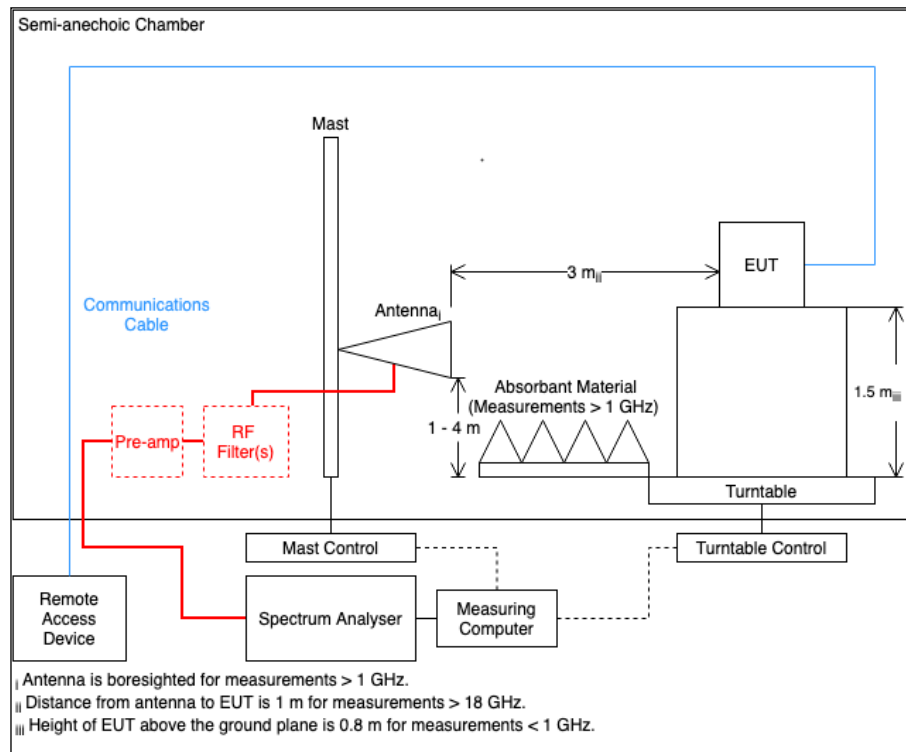


Figure 9

2.4.6 Environmental Conditions

Ambient Temperature	19.3 - 23.4 °C
Relative Humidity	42.0 - 60.4 %

2.4.7 Test Results

2.4 GHz Bluetooth Low Energy

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
4803.891	45.0	54.0	-8.9	RMS	140	121	Vertical
4804.106	49.0	54.0	-4.9	RMS	36	286	Horizontal

Table 27 - 2402 MHz (CH37), LE1M, 30 MHz to 25 GHz

No other emissions found within 10 dB of the limit.

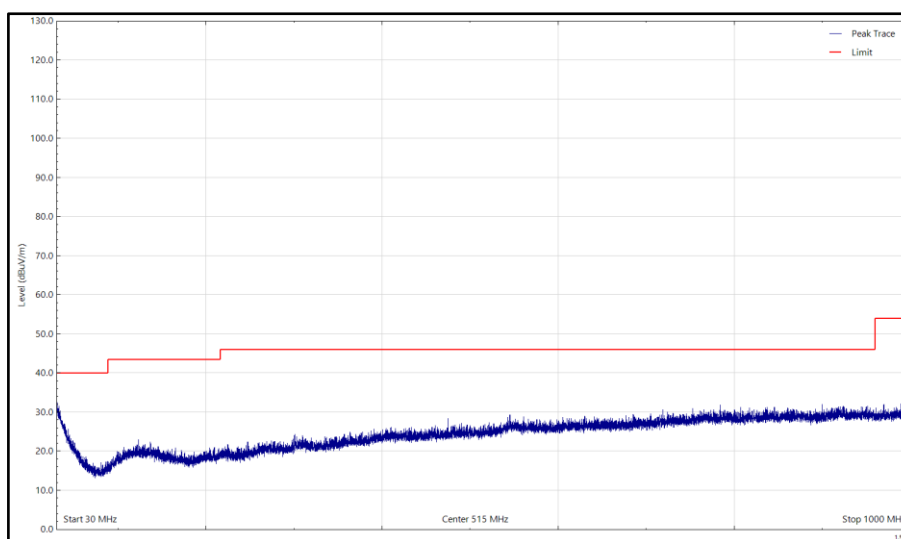


Figure 10 - 2402 MHz (CH37), LE1M, 30 MHz to 1 GHz, Horizontal (Peak)

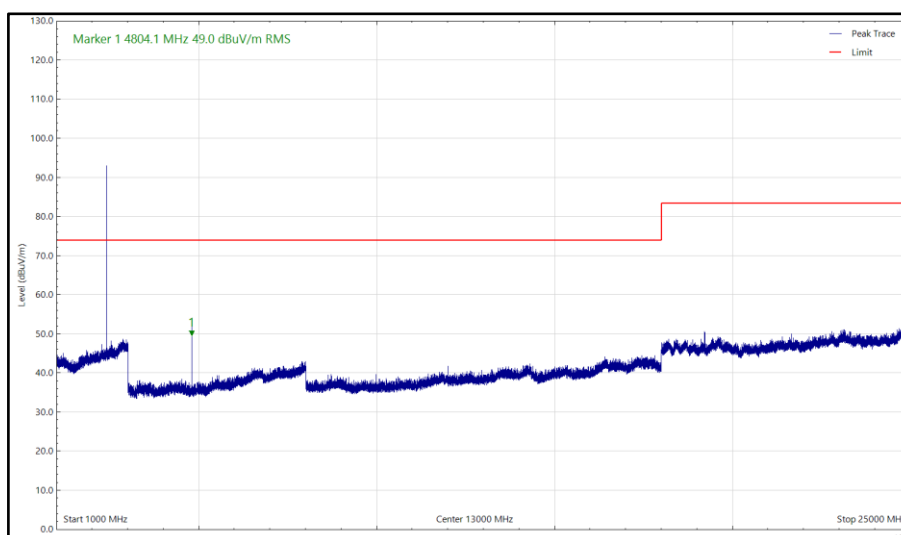


Figure 11 - 2402 MHz (CH37), LE1M, 1 GHz to 25 GHz, Horizontal (Peak)

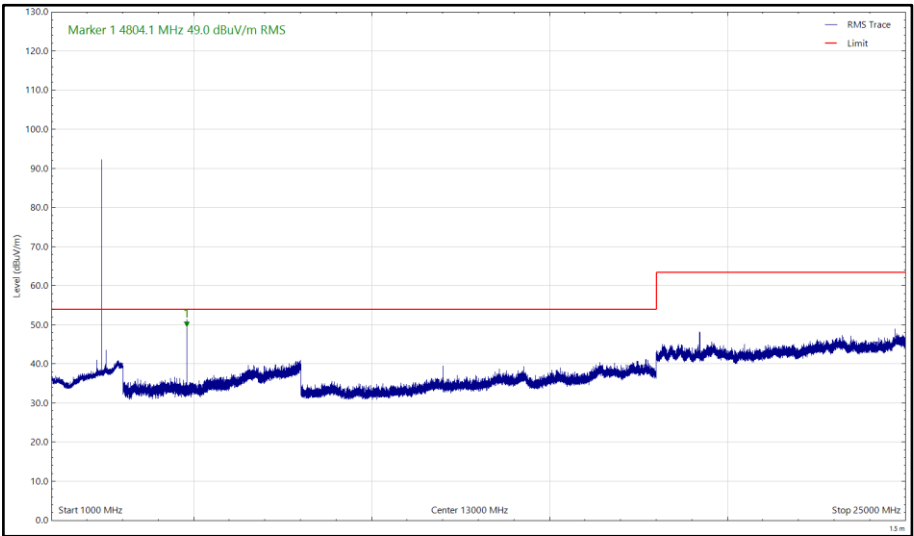


Figure 12 - 2402 MHz (CH37), LE1M, 1 GHz to 25 GHz, Horizontal (rms)

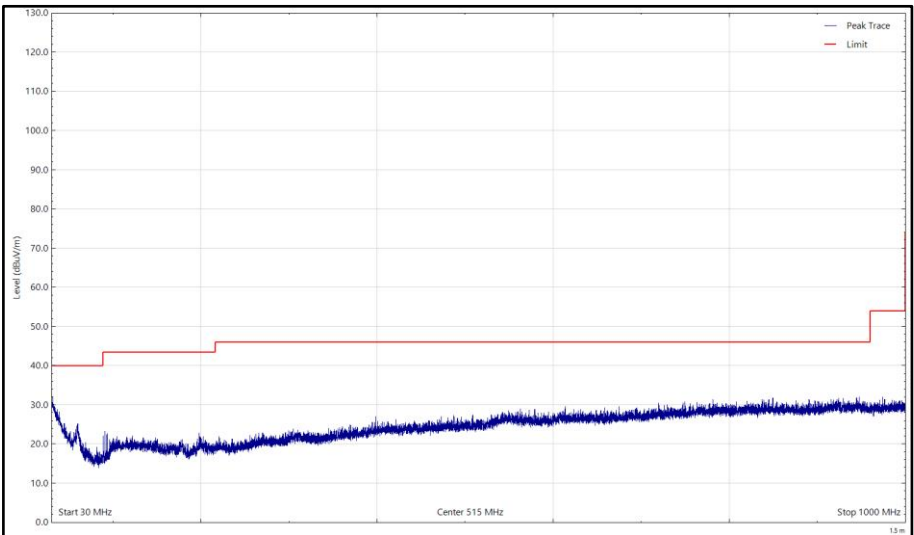


Figure 13 - 2402 MHz (CH37), LE1M, 30 MHz to 1 GHz, Vertical (Peak)

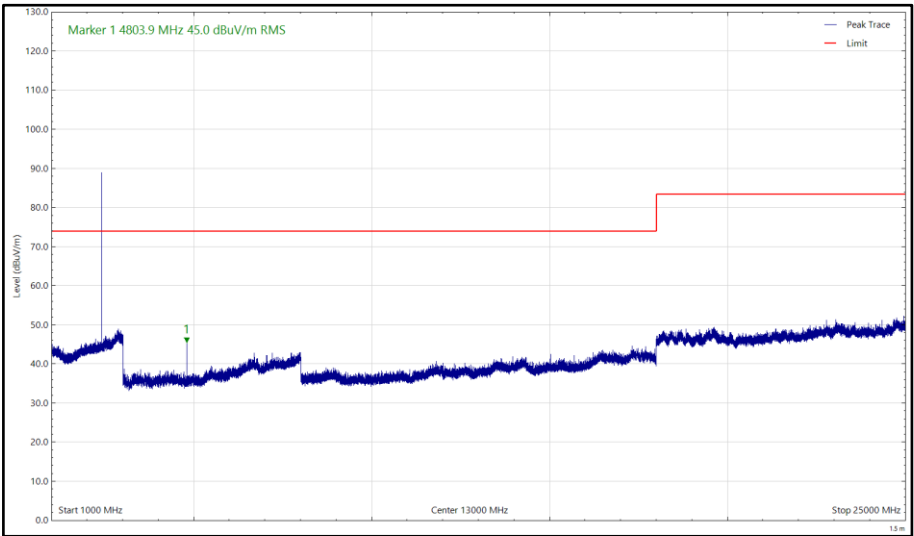


Figure 14 - 2402 MHz (CH37), LE1M, 1 GHz to 25 GHz, Vertical (Peak)

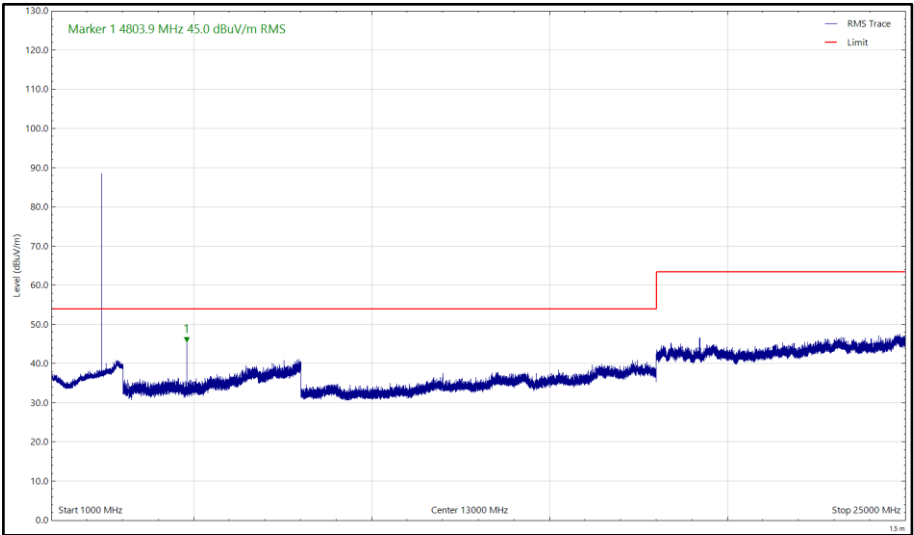


Figure 15 - 2402 MHz (CH37), LE1M, 1 GHz to 25 GHz, Vertical (rms)

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
4879.908	49.1	54.0	-4.9	RMS	140	110	Horizontal

Table 28 - 2440 MHz (CH17), LE1M, 30 MHz to 25 GHz

No other emissions found within 6 dB of the limit.

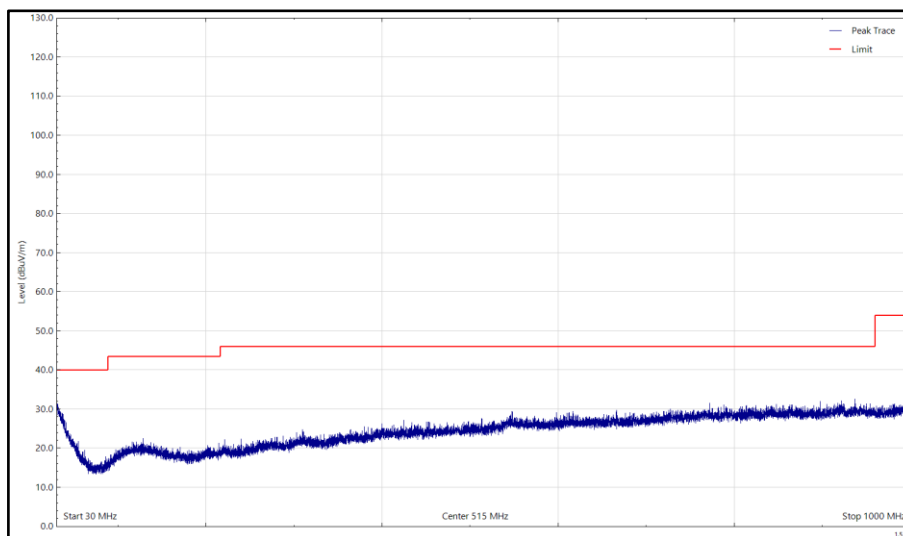


Figure 16 - 2440 MHz (CH17), LE1M, 30 MHz to 1 GHz, Horizontal (Peak)

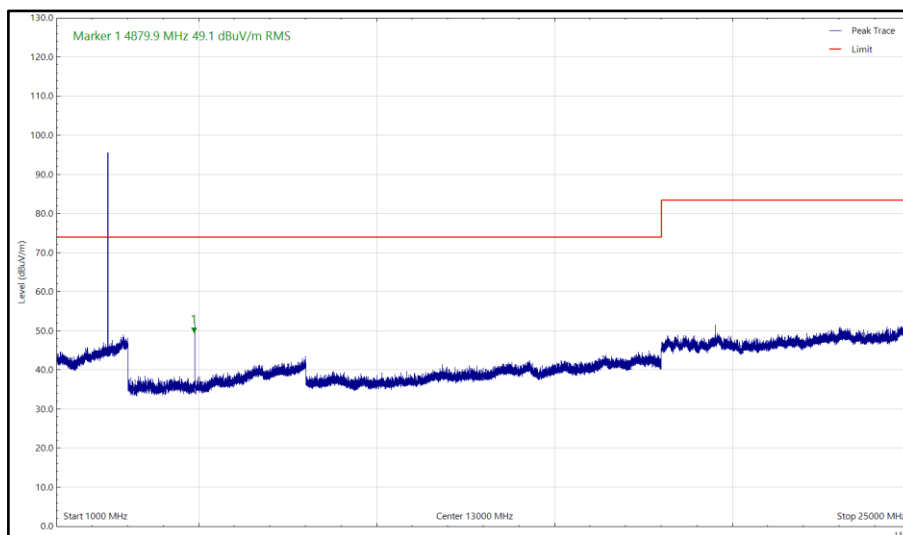


Figure 17 - 2440 MHz (CH17), LE1M, 1 GHz to 25 GHz, Horizontal (Peak)

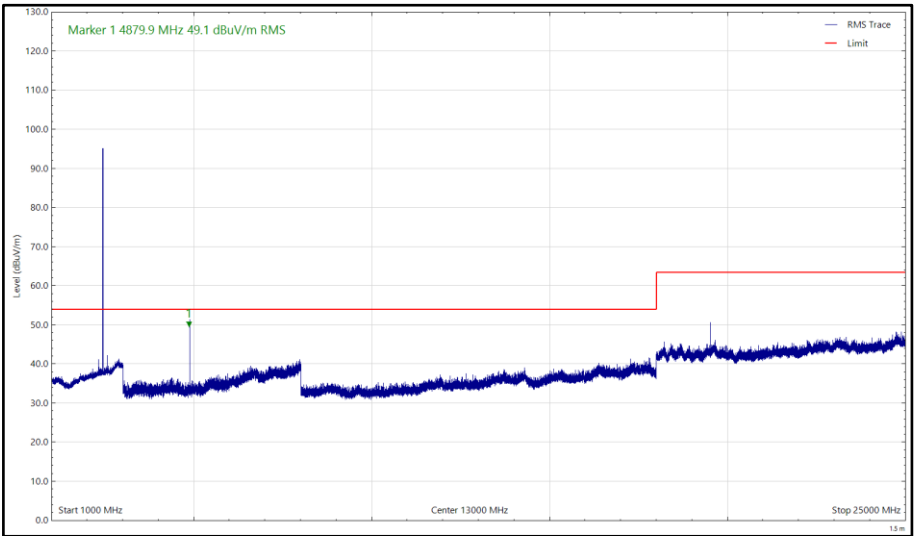


Figure 18 - 2440 MHz (CH17), LE1M, 1 GHz to 25 GHz, Horizontal (rms)

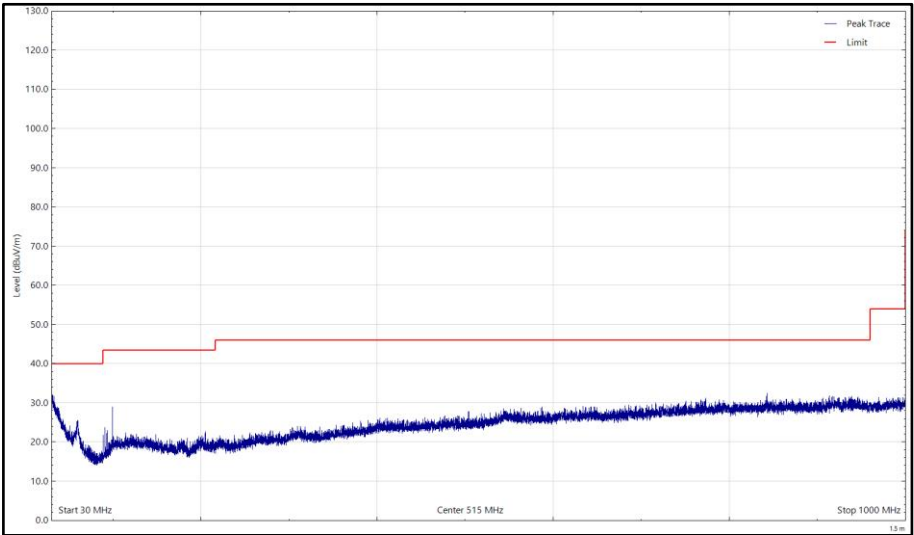


Figure 19 - 2440 MHz (CH17), LE1M, 30 MHz to 1 GHz, Vertical (Peak)

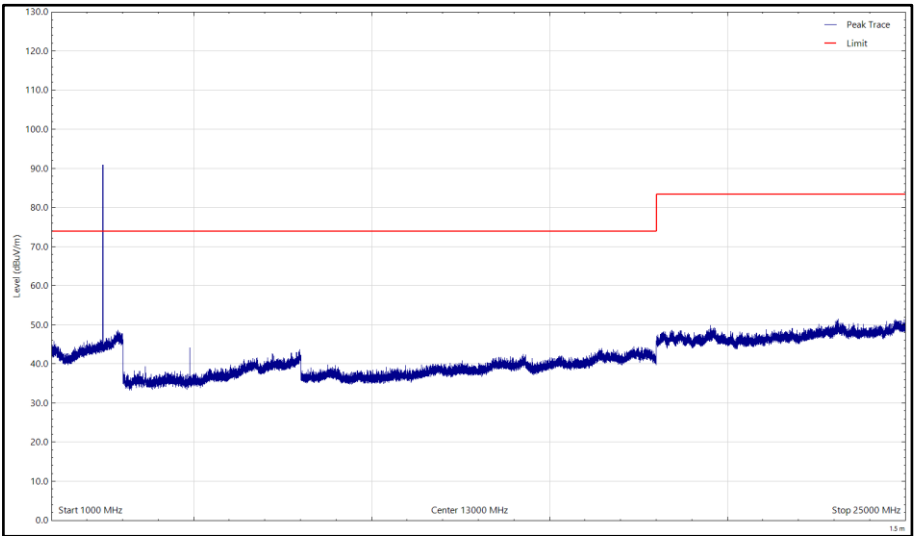


Figure 20 - 2440 MHz (CH17), LE1M, 1 GHz to 25 GHz, Vertical (Peak)

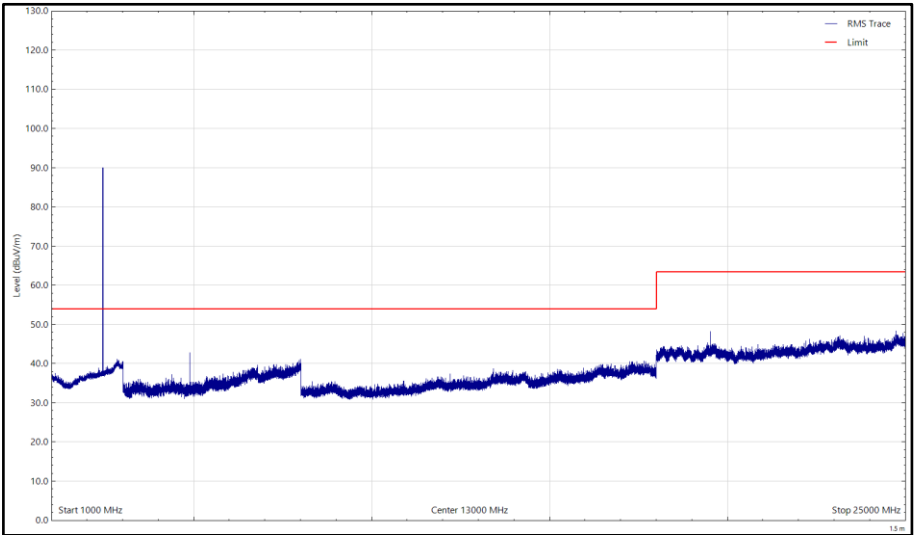


Figure 21 - 2440 MHz (CH17), LE1M, 1 GHz to 25 GHz, Vertical (rms)



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

Table 29 - 2480 MHz (CH39), LE1M, 30 MHz to 25 GH

*No emissions found within 6 dB of the limit.

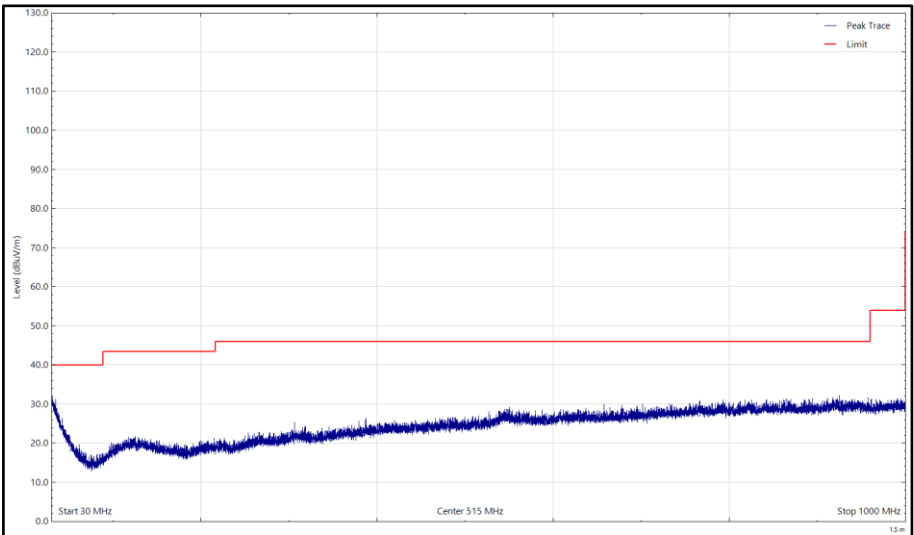


Figure 22 - 2480 MHz (CH39), LE1M, 30 MHz to 1 GHz, Horizontal (Peak)

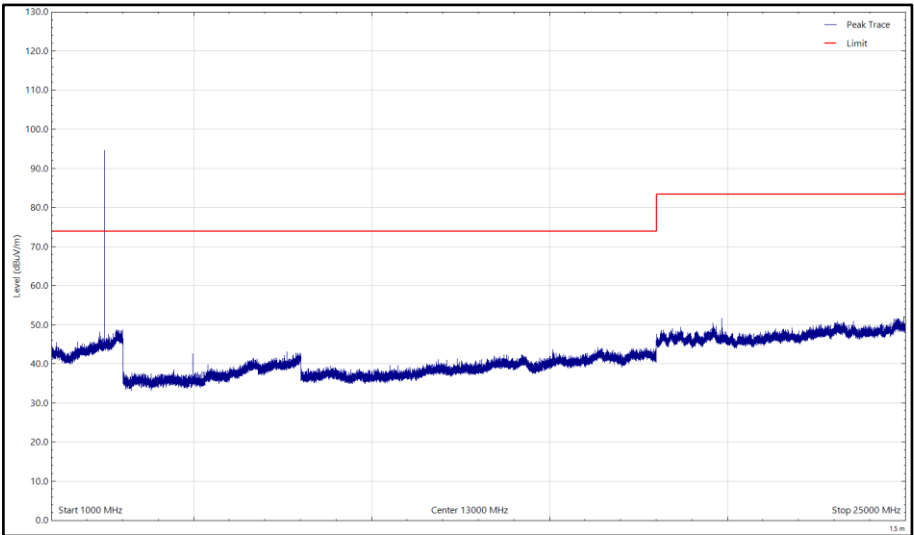


Figure 23 - 2480 MHz (CH39), LE1M, 1 GHz to 25 GHz, Horizontal (Peak)

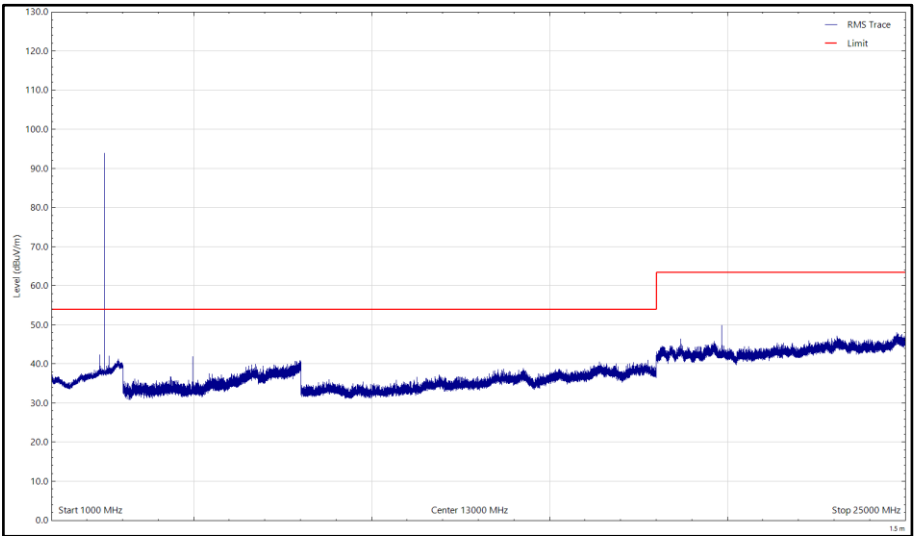


Figure 24 - 2480 MHz (CH39), LE1M, 1 GHz to 25 GHz, Horizontal (rms)

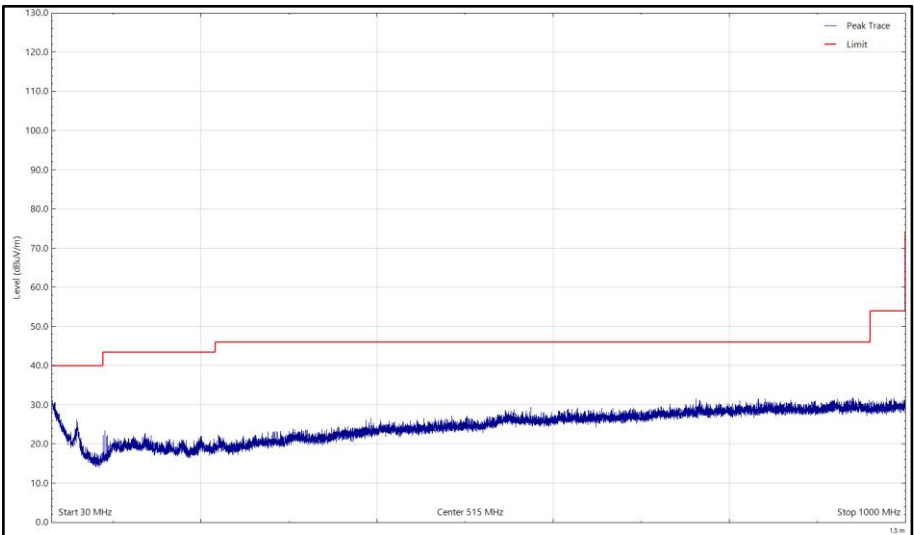


Figure 25 - 2480 MHz (CH39), LE1M, 30 MHz to 1 GHz, Vertical (Peak)

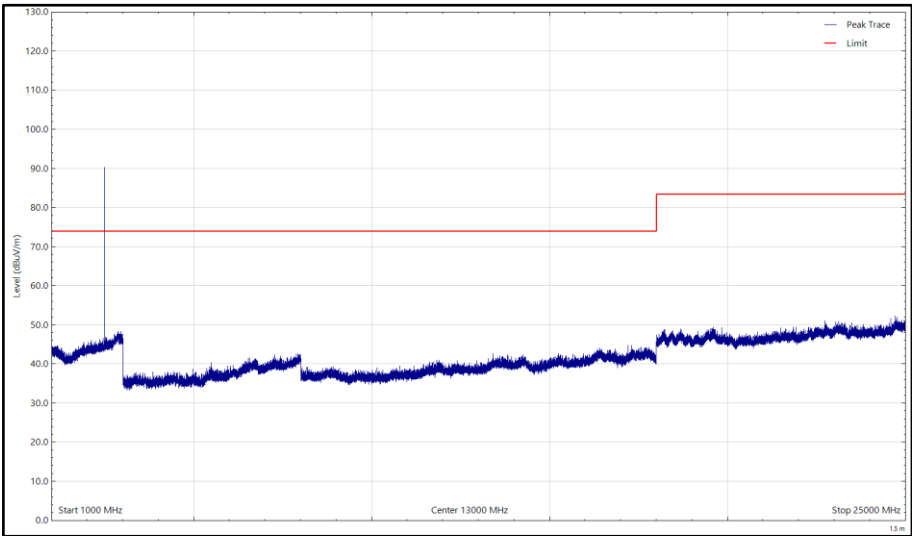


Figure 26 - 2480 MHz (CH39), LE1M, 1 GHz to 25 GHz, Vertical (Peak)

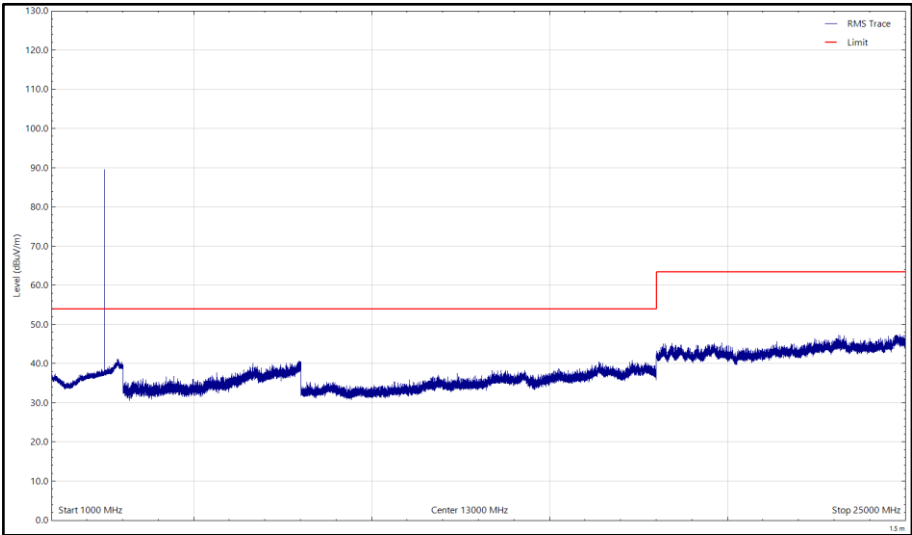


Figure 27 - 2480 MHz (CH39), LE1M, 1 GHz to 25 GHz, Vertical (rms)



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

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

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

ISED RSS-247, Limit Clause 5.5

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

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



2.4.8 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 with attenuator (Bilog, 30 MHz to 3 GHz)	Schaffner	CBL6143	287	24	14-Oct-2022
DC Power Supply	Hewlett Packard	6269B	1909	-	O/P Mon
Comb Generator	Schaffner	RSG1000	3034	-	TU
True RMS Multimeter	Fluke	179	4006	12	29-Mar-2023
Cable (SMA to SMA, 2 m)	Rhophase	3PS-1801A-2000-3PS	4113	12	27-Jan-2023
Cable (N-Type to N-Type, 1 m)	Rosenberger	LU7-036-1000	5031	12	09-Aug-2022
Emissions Software	TUV SUD	EmX V3.1.2	5125	-	Software
Cable (N-Type to N-Type, 8 m)	Teledyne	PR90-088-8MTR	5212	12	06-Sep-2022
Antenna (DRG, 15 GHz to 40 GHz)	Schwarzbeck	BBHA 9170	5217	12	25-Jan-2023
Pre-Amplifier (18 GHz to 40 GHz)	Schwarzbeck	BBV 9721	5218	12	25-Jan-2023
Pre-Amplifier (1 GHz to 18 GHz)	Schwarzbeck	BBV 9718 C	5350	12	22-Sep-2022
Thermo-hygro-Barometer	PCE Instruments	PCE-THB-40	5472	12	25-Mar-2023
3 GHz High pass Filter	Wainwright	WHKX12-2580-3000-18000-80SS	5547	12	11-May-2023
Antenna (DRG, 7.5 GHz to 18 GHz)	Schwarzbeck	HWRD750	5610	12	15-Oct-2022
Antenna (DRG 1-10.5GHz)	Schwarzbeck	BBHA9120B	5611	12	15-Oct-2022
Turntable & Mast Controller	Maturo Gmbh	NCD/498/2799.01	5612	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	5613	-	TU
Turntable	Maturo Gmbh	Turntable 1.5 SI-2t	5614	-	TU
Screened Room (12)	MVG	EMC-3	5621	36	11-Aug-2023
Test Receiver	Rohde & Schwarz	ESW44	5914	12	21-Feb-2023

Table 30

TU - Traceability Unscheduled



2.5 Authorised Band Edges

2.5.1 Specification Reference

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

2.5.2 Equipment Under Test and Modification State

MiX 3400-B, S/N: 33000054 - Modification State 0

2.5.3 Date of Test

05-July-2022 to 09-July-2022

2.5.4 Test Method

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

2.5.5 Environmental Conditions

Ambient Temperature	19.3 - 23.4 °C
Relative Humidity	42.0 - 60.4 %

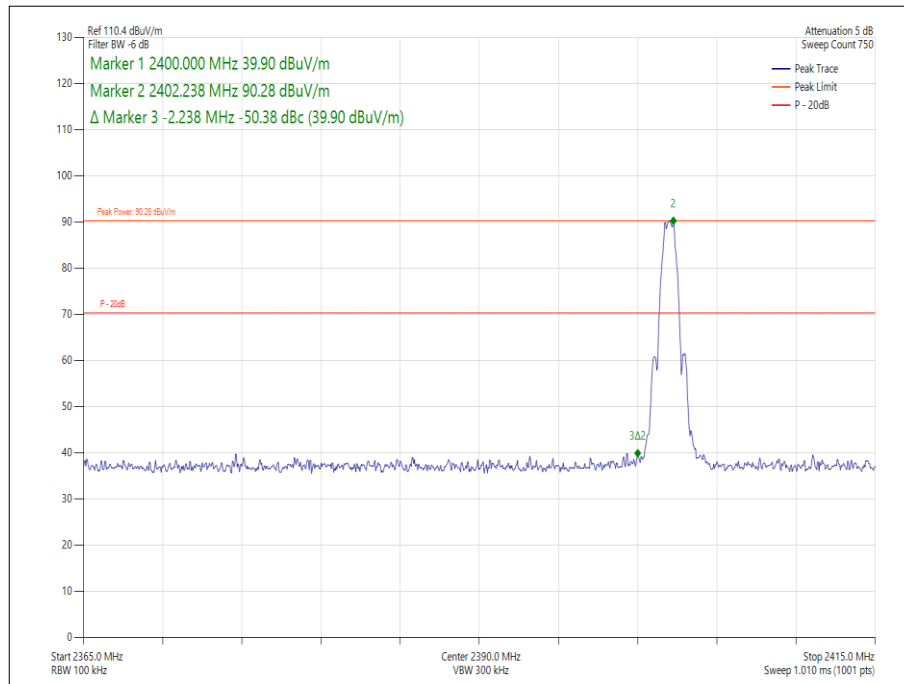


Figure 29 - GFSK, 2402 MHz - Band Edge Frequency 2400 MHz

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.



2.5.7 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
DC Power Supply	Hewlett Packard	6269B	1909	-	O/P Mon
True RMS Multimeter	Fluke	179	4006	12	29-Mar-2023
Cable (SMA to SMA, 2 m)	Rhophase	3PS-1801A-2000-3PS	4113	12	27-Jan-2023
Emissions Software	TUV SUD	EmX V3.1.2	5125	-	Software
Cable (N-Type to N-Type, 8 m)	Teledyne	PR90-088-8MTR	5212	12	06-Sep-2022
Cable (N-Type to N-Type, 8 m)	Teledyne	PR90-088-8MTR	5450	6	06-Oct-2022
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB 40	5605	12	23-Sep-2022
Antenna (DRG 1-10.5GHz)	Schwarzbeck	BBHA9120B	5611	12	15-Oct-2022
Turntable & Mast Controller	Maturo Gmbh	NCD/498/2799.01	5612	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	5613	-	TU
Turntable	Maturo Gmbh	Turntable 1.5 SI-2t	5614	-	TU
Screened Room (12)	MVG	EMC-3	5621	36	11-Aug-2023
EMI Test Receiver	Rohde & Schwarz	ESW44	5912	12	17-Feb-2023

Table 32

TU - Traceability Unscheduled



2.6 Power Spectral Density

2.6.1 Specification Reference

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

2.6.2 Equipment Under Test and Modification State

MiX 3400-B, S/N: 33000052 - Modification State 0

2.6.3 Date of Test

23-June-2022

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	23.1 °C
Relative Humidity	43.6 %



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) RSS-247 5.2 b)	Test Method(s):	C63.10 11.10.2
Additional Reference(s):	-		

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

Test Frequency (MHz)	RBW (kHz)	PSD (dBm/RBW)					Limit (dBm/3 kHz)	Margin (dB)
		A	B	C	D	Σ		
2402	3.0	-7.48	-	-	-	-	8.00	-15.48
2440	3.0	-6.70	-	-	-	-	8.00	-14.70
2480	3.0	-6.80	-	-	-	-	8.00	-14.80

Table 33 - Maximum Power Spectral Density Results

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

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

ISED RSS-247, Limit Clause 5.2(b)

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



2.6.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
True RMS Multimeter	Fluke	179	4006	12	29-Mar-2023
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB-40	5475	12	25-Apr-2023
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	21-Mar-2024
Signal Conditioning Unit	TUV SUD	SCU001	5546	12	06-Apr-2023
USB Power Sensor	Boonton	RTP5008	5820	12	06-Apr-2023
Climatic Chamber	Weiss Technik	TempEvent T/180/40/3	5894	12	27-May-2023
DC Power Module 60V 20A 300W	Keysight Technologies	N6754A	5970	-	O/P Mon

Table 34

O/P Mon – Output Monitored using calibrated equipment

3 Photographs

3.1 Test Setup Photographs

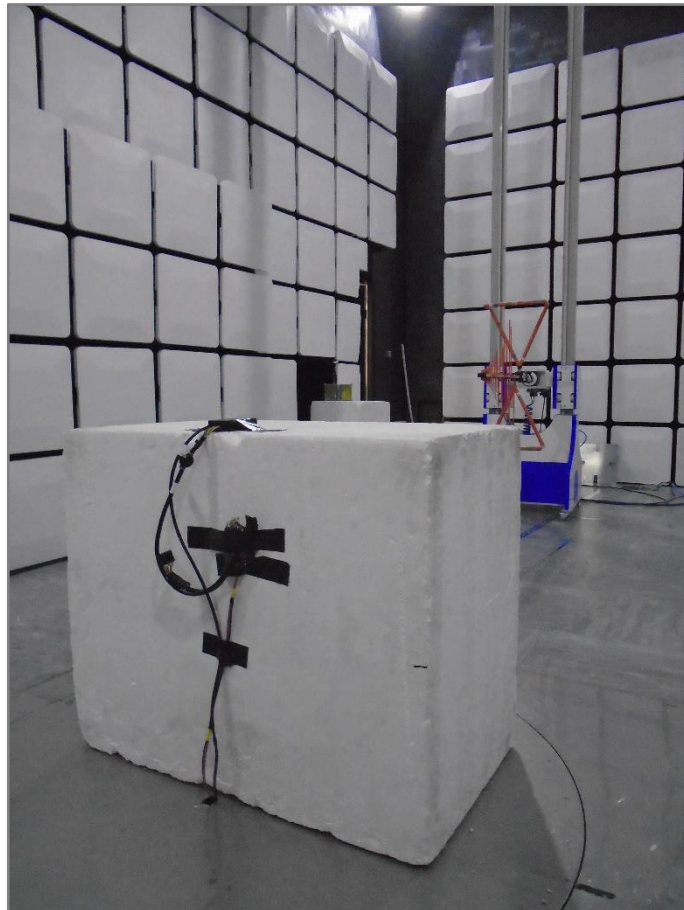


Figure 30 - Test Setup - 30 MHz to 1 GHz

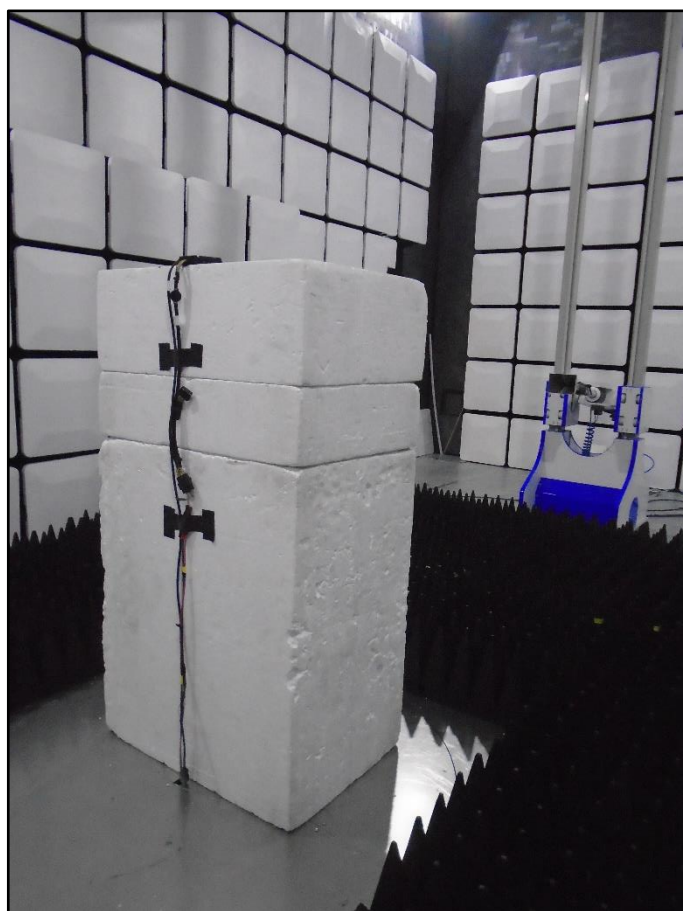


Figure 31 - Test Setup - 1 GHz to 18 GHz

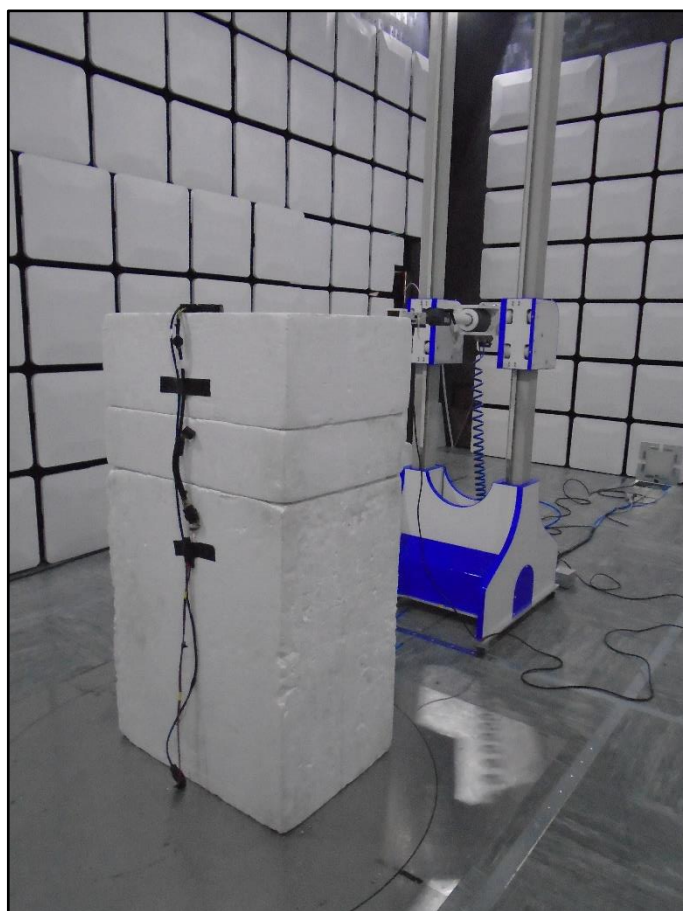


Figure 32 - Test Setup - 18 GHz to 25 GHz



4 Measurement Uncertainty

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

Test Name	Measurement Uncertainty
Restricted Band Edges	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Emission Bandwidth	± 50.1 kHz
Maximum Conducted Output Power	± 1.38 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
Power Spectral Density	± 1.49 dB

Table 35

Measurement Uncertainty Decision Rule – Accuracy Method

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. (Procedure 2). The measurement results are directly compared with the test limit to determine conformance with the requirements of the standard.

Risk: The uncertainty of measurement about the measured result is negligible with regard to the final pass/fail decision. The measurement result can be directly compared with the test limit to determine conformance with the requirement (compare IEC Guide 115). The level of risk to falsely accept and falsely reject items is further described in ILAC-G8.