

FCC and ISED Test Report

Ruxbury ApS
Model: EM1

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

Prepared for: Ruxbury ApS
C/O Zenegy
Slotsmarken 16, 2970 Hørsholm
Denmark

FCC ID: 2A38W-RX0101

IC: 28175-RX0101



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Document 75954061-05 Issue 01

SIGNATURE

NAME	JOB TITLE	RESPONSIBLE FOR	ISSUE DATE
Steve Marshall	Senior Engineer	Authorised Signatory	24 May 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	24 May 2022	
Testing	Graeme Lawler	24 May 2022	
Testing	Daniel Cameron	24 May 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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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	24 May 2022

Table 1

1.2 Introduction

Applicant	Ruxbury ApS
Manufacturer	Ruxbury ApS
Model Number(s)	EM1
Serial Number(s)	00003P, 00002P and 00001P
Hardware Version(s)	V1.0
Software Version(s)	V1.0
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	PO-DK-10
Date	09-December-2021
Date of Receipt of EUT	17-January-2022 and 14-January-2022
Start of Test	17-February-2022
Finish of Test	14-May-2022
Name of Engineer(s)	Paul Dickson, Graeme Lawler and Daniel Cameron
Related Document(s)	ANSI C63.10 (2020)



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: Internal Antenna - BLE - Single Antenna						
2.1	15.205	3.3	8.10	Restricted Band Edges	Pass	
2.2	15.207	3.1	8.8	AC Power Line Conducted Emissions	Pass	
2.3	15.247 (a)(2)	5.2	6.7	Emission Bandwidth	Pass	
2.4	15.247 (b)	5.4	6.12	Maximum Conducted Output Power	Pass	
2.5	15.247 (d) and 15.209	3.3 and 5.5	6.13 and 8.9	Spurious Radiated Emissions	Pass	
2.6	15.247 (d)	5.5	-	Authorised Band Edges	Pass	
2.7	15.247 (e)	5.2	6.12	Power Spectral Density	Pass	

Table 2



1.4 Application Form

Equipment Description

Technical Description: (Please provide a brief description of the intended use of the equipment including the technologies the product supports)	Heart Rate Monitor for horses sending data via BLE to a smart phone	
Manufacturer:	Ruxbury ApS	
Model:	EM1	
Part Number:	RX-0101	
Hardware Version:	V1.0	
Software Version:	V1.0	
FCC ID of the product under test – see guidance here	2A38W-RX0101	
IC ID of the product under test – see guidance here	28175-RX0101	

Table 3

Intentional Radiators

Technology	BLE					
Frequency Range (MHz to MHz)	2400 to 2483.5					
Conducted Declared Output Power (dBm)	5 dBm					
Antenna Gain (dBi)	2					
Supported Bandwidth(s) (MHz) (e.g. 1 MHz, 20 MHz, 40 MHz)						
Modulation Scheme(s) (e.g. GFSK, QPSK etc)						
ITU Emission Designator (see guidance here) (not mandatory for Part 15 devices)						
Bottom Frequency (MHz)	2402					
Middle Frequency (MHz)	2440					
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	2480 MHz
Lowest frequency generated or used in the device or on which the device operates or tunes	48MHz
Class A Digital Device (Use in commercial, industrial or business environment) ☐	
Class B Digital Device (Use in residential environment only) ☐	

Table 5



AC Power Source

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

Table 6

DC Power Source

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

Table 7

Battery Power Source

Voltage:	3,7	V
End-point voltage:	4,2 down to 2,7	V (Point at which the battery will terminate)
Alkaline ☐ Leclanche ☐ Lithium ☒ Nickel Cadmium ☐ Lead Acid* ☐ *(Vehicle regulated)		
Other ☐	Please detail:	

Table 8

Charging

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

Table 9

Temperature

Minimum temperature:	-10	°C
Maximum temperature:	40	°C

Table 10

Cable Loss

Adapter Cable Loss (Conducted sample)	Estimated 2	dB
--	-------------	----

Table 11



Antenna Characteristics

Antenna connector ☐			State impedance		Ohm
Temporary antenna connector ☒			State impedance	Estimated 50	Ohm
Integral antenna ☒	Type:		Gain		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 12

Ancillaries (if applicable)

Manufacturer:		Part Number:	
Model:		Country of Origin:	

Table 13

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

Name: Tomasz Goldman

Position held: CTO

Date: 11 January 2022



1.5 Product Information

1.5.1 Technical Description

Heart Rate and Motion Monitor for horses sending data via BLE to a smart phone.

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: EM1, Serial Number: 00001P			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: EM1, Serial Number: 00002P			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: EM1, Serial Number: 00003P			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 14



1.8 Test Location

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

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: Internal Antenna - BLE - Single Antenna		
Restricted Band Edges	Paul Dickson	UKAS
AC Power Line Conducted Emissions	Graeme Lawler	UKAS
Emission Bandwidth	Daniel Cameron	UKAS
Maximum Conducted Output Power	Daniel Cameron	UKAS
Spurious Radiated Emissions	Paul Dickson	UKAS
Authorised Band Edges	Paul Dickson	UKAS
Power Spectral Density	Daniel Cameron	UKAS

Table 15

Office Address:

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



2 Test Details

2.1 Restricted Band Edges

2.1.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.205
ISED RSS-247, Clause 3.3
ISED RSS-GEN, Clause, 8.10

2.1.2 Equipment Under Test and Modification State

EM1, S/N: 00003P - Modification State 0

2.1.3 Date of Test

17-February-2022 to 14-May-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.
They were not duty cycle corrected because the EUT has a protocol-limited duty cycle.

The following conversion can be applied to convert from dB μ V/m to μ V/m:

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

2.1.5 Environmental Conditions

Ambient Temperature	20.0 - 27.7 °C
Relative Humidity	23.3 - 41.1 %

2.1.6 Test Results

Internal Antenna - BLE - Single Antenna

Modulation	Frequency (MHz)	Band Edge Frequency (MHz)	Peak Level (dB μ V/m)	Average Level (dB μ V/m)
GFSK	2402	2390	50.04	38.49
GFSK	2480	2483.5	56.97	49.02

Table 16

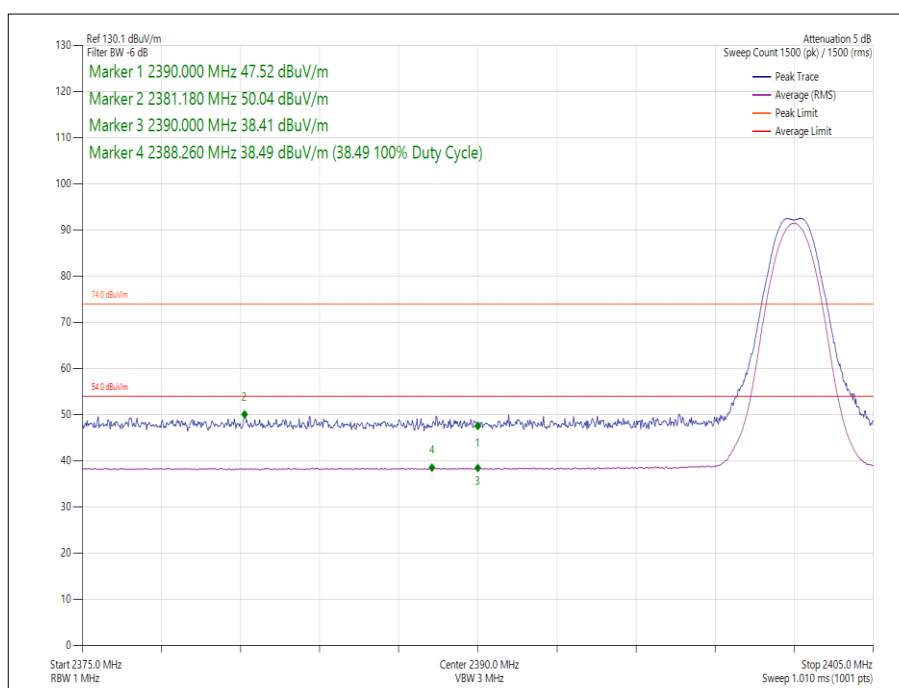


Figure 1 - GFSK - 2402 MHz - Band Edge Frequency 2390 MHz

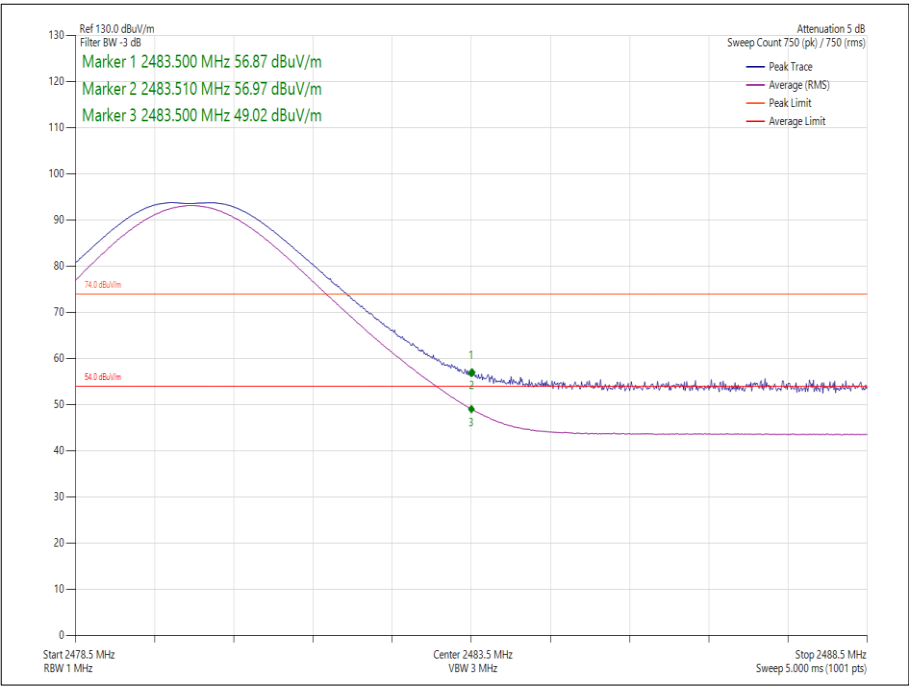


Figure 2 - GFSK - 2480 MHz - Band Edge Frequency 2483.5 MHz

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 17

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 18

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



2.1.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 12.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Test Receiver	Rohde & Schwarz	ESU40	3506	12	18-Mar-2022
Cable (SMA to SMA, 2 m)	Rhophase	3PS-1801A-2000-3PS	4113	12	27-Jan-2023
Emissions Software	TUV SUD	EmX V3.0.1	5125	-	Software
Cable (N to N 8m)	Teledyne	PR90-088-8MTR	5212	12	06-Sep-2022
Cable (N-Type to N-Type, 8 m)	Teledyne	PR90-088-8MTR	5450	6	01-Apr-2022
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB-40	5471	12	06-Apr-2023
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB-40	5481	12	31-Mar-2022
Antenna (DRG, 1 GHz to 10 GHz)	Schwarzbeck	BBHA 9120 B	5611	12	15-Oct-2022
Turntable & Mast Controller	Maturo Gmbh	NCD/498/2799.01	5612	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	5613	-	TU
Turntable	Maturo Gmbh	Turntable 1.5 SI-2t	5614	-	TU
Screened Room (12)	MVG	EMC-3	5621	36	11-Aug-2023
EMI Test Receiver	Rohde & Schwarz	ESW44	5914	12	21-Feb-2023

Table 19

TU - Traceability Unscheduled



2.2 AC Power Line Conducted Emissions

2.2.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.207
ISED RSS-247, Clause 3.1
ISED RSS-GEN, Clause 8.8

2.2.2 Equipment Under Test and Modification State

EM1, S/N: 00001P - Modification State 0

2.2.3 Date of Test

23-March-2022

2.2.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 6.2.

The EUT was placed on a non-conductive table 0.8m above a reference ground plane and 0.4m away from a vertical coupling plane

All power was connected to the EUT through an Artificial Mains Network (AMN).

Conducted disturbance voltage measurements on mains lines were made at the output of the AMN.

2.2.5 Environmental Conditions

Ambient Temperature	19.9 °C
Relative Humidity	33.2 %



2.2.6 Test Results

Internal Antenna - BLE - Single Antenna

Applied supply voltage: 119.6 V AC

Applied supply frequency: 60 Hz

Frequency (MHz)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector
0.500	46.3	56.0	-9.7	Q-Peak
0.500	37.0	46.0	-9.0	CISPR Avg
0.502	46.2	56.0	-9.8	Q-Peak
0.502	36.5	46.0	-9.5	CISPR Avg

Table 20 - Neutral Line Emissions Results

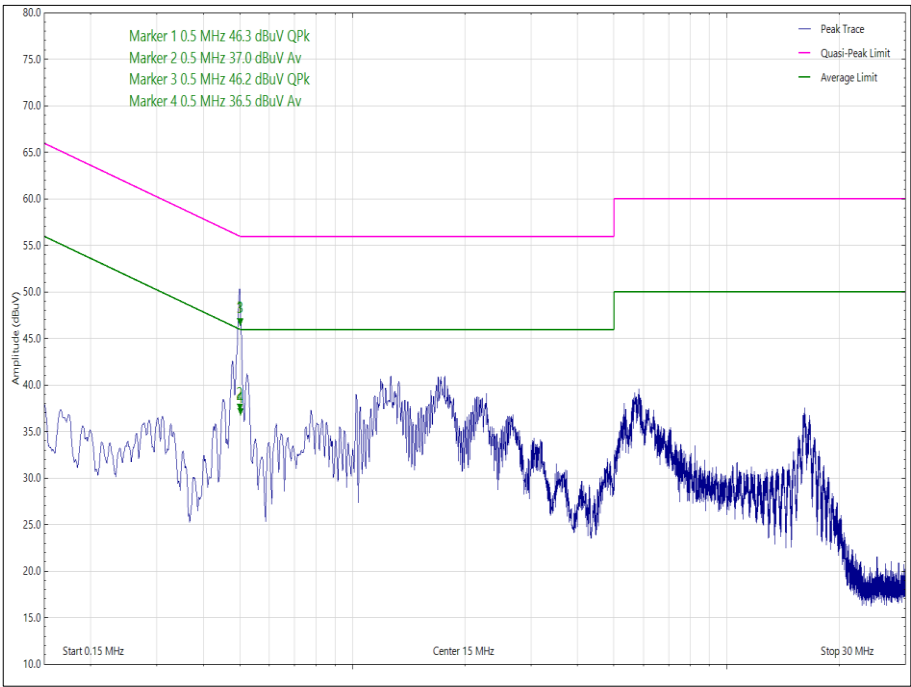


Figure 3 - Neutral Line - 150 kHz to 30 MHz

Frequency (MHz)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector
0.498	44.3	56.0	-11.8	Q-Peak
0.498	38.4	46.0	-7.6	CISPR Avg
0.501	44.7	56.0	-11.3	Q-Peak
0.501	39.0	46.0	-7.0	CISPR Avg

Table 21 - Live Line Emissions Results

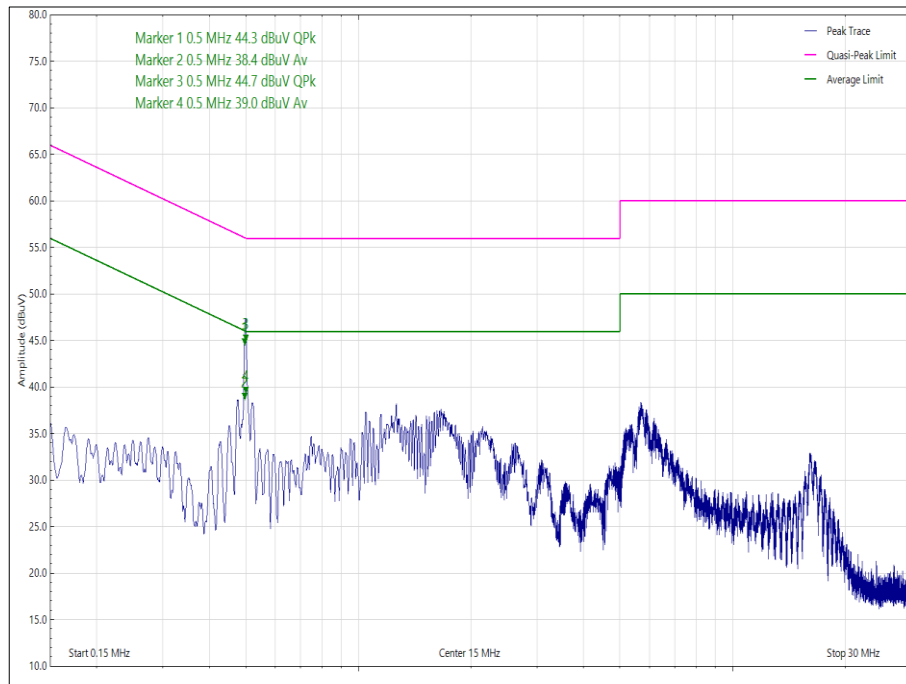


Figure 4 - Live Line - 150 kHz to 30 MHz

FCC 47 CFR Part 15, Limit Clause 15.207 and ISED RSS-GEN, Limit Clause 8.8

Frequency of Emission (MHz)	Conducted Limit (dBμV)	
	Quasi-Peak	CISPR Average
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50

Table 22

*Decreases with the logarithm of the frequency.



2.2.7 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
LISN	Rohde & Schwarz	ESH3-Z5	1390	12	31-Jan-2023
Transient Limiter	Hewlett Packard	11947A	2378	12	13-Oct-2022
Multimeter	Fluke	177	3832	12	08-Jul-2022
Cable (SMA to SMA, 2 m)	Rhophase	3PS-1801A-2000-3PS	4113	12	27-Jan-2023
Emissions Software	TUV SUD	EmX V3.0.1	5125	-	Software
Cable (N-Type to N-Type, 8 m)	Teledyne	PR90-088-8MTR	5450	6	01-Apr-2022
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB-40	5481	12	31-Mar-2022
EMI Test Receiver	Rohde & Schwarz	ESW44	5912	12	Class 1 (Ext)

Table 23



2.3 Emission Bandwidth

2.3.1 Specification Reference

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

2.3.2 Equipment Under Test and Modification State

EM1, S/N: 00002P - Modification State 0

2.3.3 Date of Test

27-April-2022

2.3.4 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.

2.3.5 Environmental Conditions

Ambient Temperature	24.3 °C
Relative Humidity	27.3 %



2.3.6 Test Results

Internal Antenna - BLE - Single Antenna

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 (Main)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	6 dB Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2402	0.688	-	-	-	≥500.0
2440	0.716	-	-	-	≥500.0
2480	0.700	-	-	-	≥500.0

Table 24 - 6 dB Bandwidth Results

Test Frequency (MHz)	99% Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2402	1.080	-	-	-	-
2440	1.092	-	-	-	-
2480	1.088	-	-	-	-

Table 25 - 99% Bandwidth Results

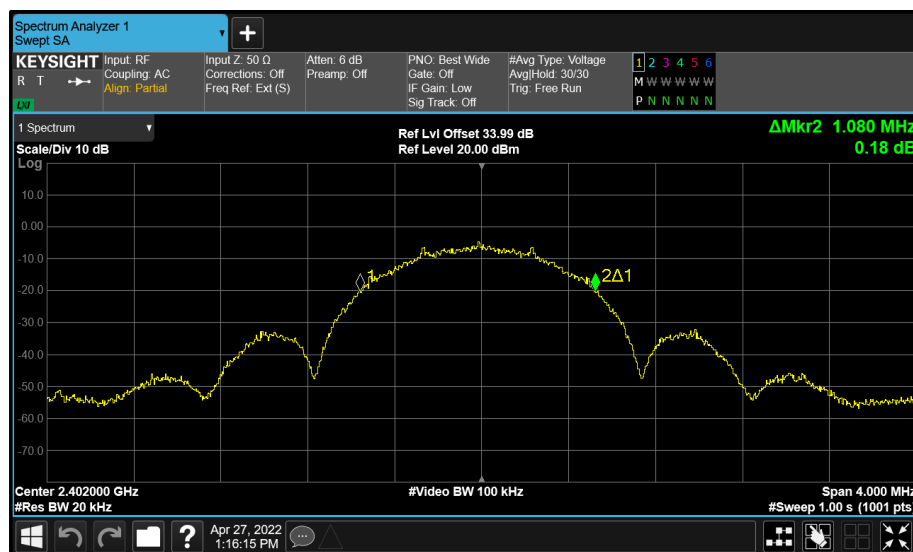


Figure 5 - Main (A) 2402 MHz (CH37) 99% Bandwidth

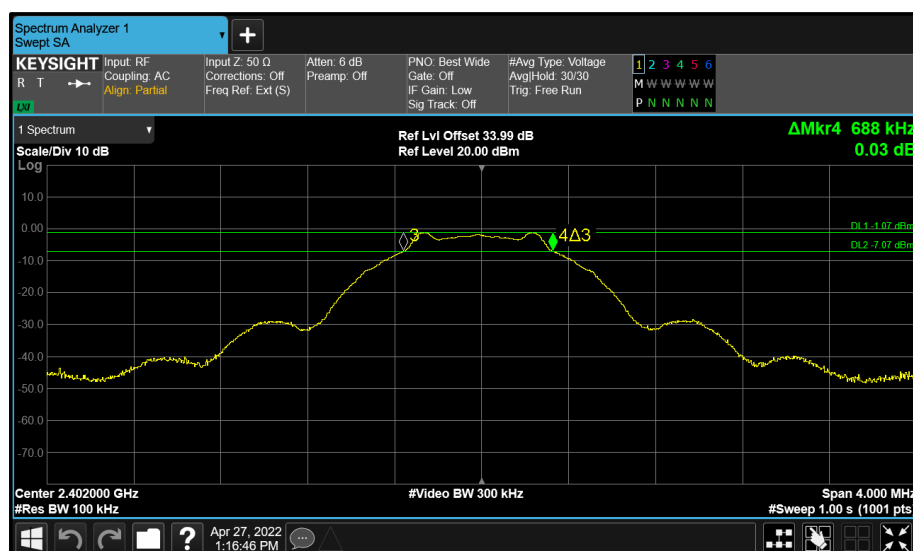


Figure 6 - Main (A) 2402 MHz (CH37) 6 dB Bandwidth

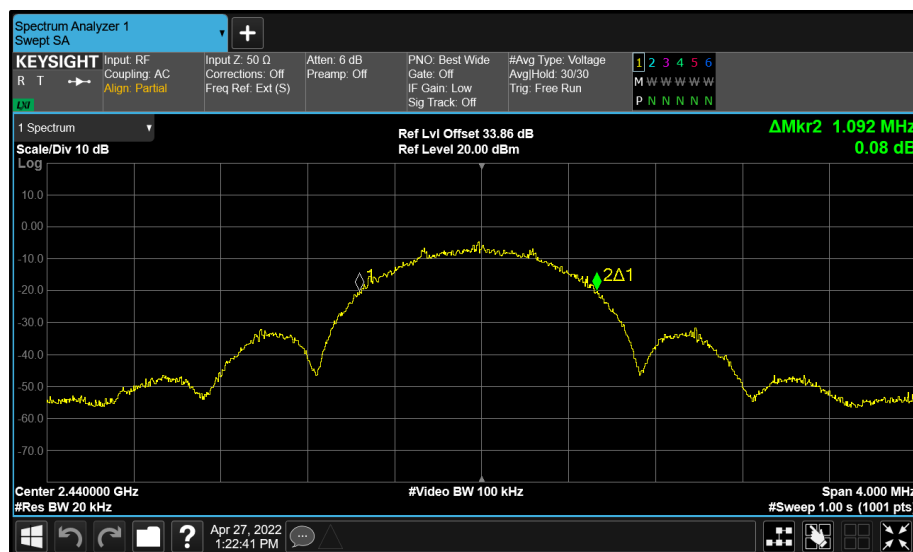


Figure 7 - Main (A) 2440 MHz (CH17) 99% Bandwidth

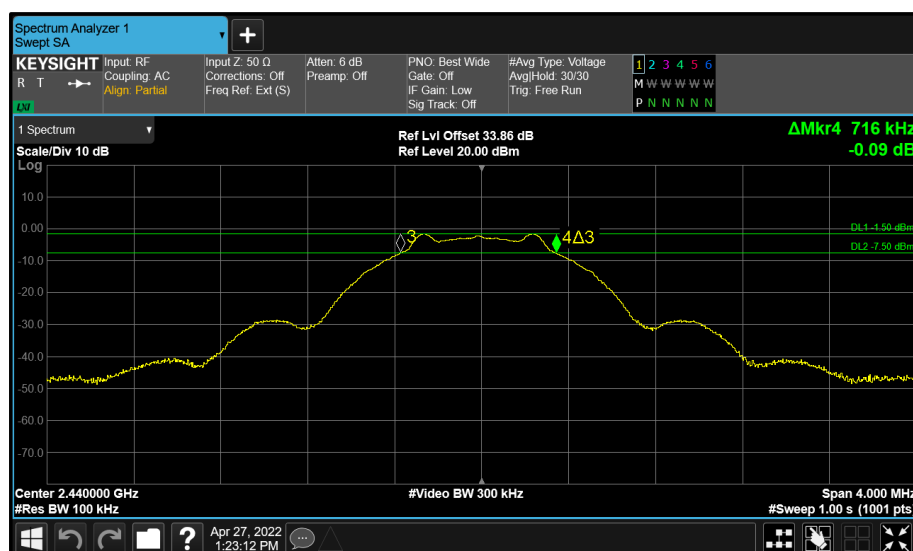


Figure 8 - Main (A) 2440 MHz (CH17) 6 dB Bandwidth

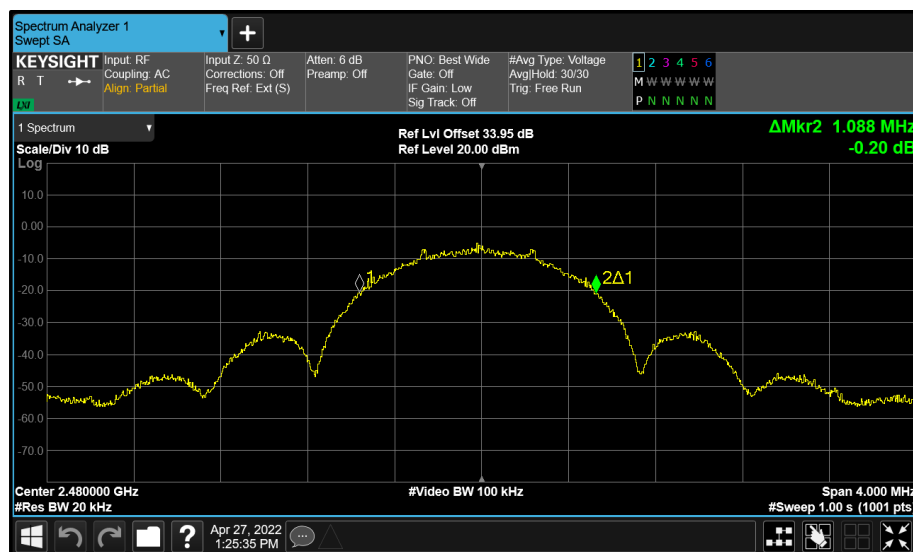


Figure 9 - Main (A) 2480 MHz (CH39) 99% Bandwidth

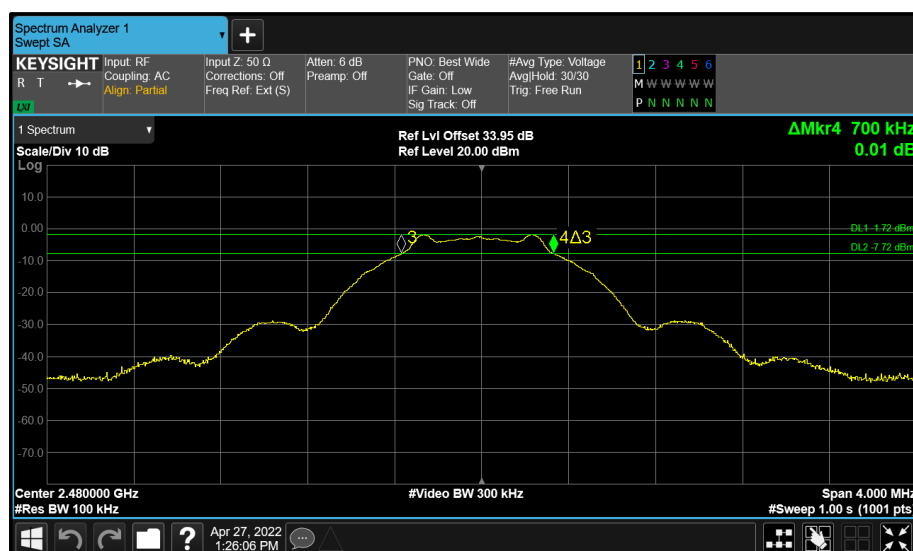


Figure 10 - Main (A) 2480 MHz (CH39) 6 dB Bandwidth

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

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



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
Hygrometer	Rotronic	I-1000	3220	12	05-Nov-2022
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	30-Jun-2022
MXA Signal Analyser	Keysight Technologies	N9020B	5529	24	06-Jun-2022
Signal Conditioning Unit	TUV SUD	SCU002	5759	12	30-Jun-2022

Table 26



2.4 Maximum Conducted Output Power

2.4.1 Specification Reference

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

2.4.2 Equipment Under Test and Modification State

EM1, S/N: 00002P - Modification State 0

2.4.3 Date of Test

27-April-2022

2.4.4 Test Method

The test was performed in accordance with ANSI C63.10 clause 11.9.1.2.(PKPM1)

2.4.5 Environmental Conditions

Ambient Temperature	24.3 °C
Relative Humidity	27.3 %



2.4.6 Test Results

Internal Antenna - BLE - Single Antenna

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 (Main)	Peak Antenna Gain (dBi):	2.00

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)
	A	B	C	D	Σ		
2402	-0.70	-	-	-	-	30.00	-30.70
2440	-1.00	-	-	-	-	30.00	-31.00
2480	-1.48	-	-	-	-	30.00	-31.48

Table 27 - 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	-0.70	-	-	-	-	30.00	-30.70	1.30	36.00	-34.70
2440	-1.00	-	-	-	-	30.00	-31.00	1.00	36.00	-35.00
2480	-1.48	-	-	-	-	30.00	-31.48	0.52	36.00	-35.48

Table 28 - 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.



2.4.7 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
Hygrometer	Rotronic	I-1000	3220	12	05-Nov-2022
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	30-Jun-2022
Signal Conditioning Unit	TUV SUD	SCU002	5759	12	30-Jun-2022
USB Power Sensor	Boonton	RTP5008	5832	12	10-May-2022

Table 29



2.5 Spurious Radiated Emissions

2.5.1 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

2.5.2 Equipment Under Test and Modification State

EM1, S/N: 00002P - Modification State 0

2.5.3 Date of Test

15-March-2022 to 19-March-2022

2.5.4 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.

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

The following conversion can be applied to convert from dBuV/m to $\mu\text{V/m}$:

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

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

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

Note: ANSI C63.10 table 11 requires three channels to be tested for transmitters with an operating frequency range near the top, middle and bottom. The bottom channel used for this test was considered 'near' the bottom and therefore deemed acceptable to demonstrate compliance.

2.5.7 Test Results

Internal Antenna - BLE - Single Antenna

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
4807.825	44.0	54.0	-10.0	RMS	247	100	Vertical
4807.887	45.9	54.0	-8.1	RMS	42	100	Horizontal
4807.915	44.5	54.0	-9.5	RMS	323	100	Vertical

Table 30 - CH0 (2404 MHz), LE1M, Orientation: X, 30 MHz to 25 GHz

No other emissions found within 6 dB of the limit.

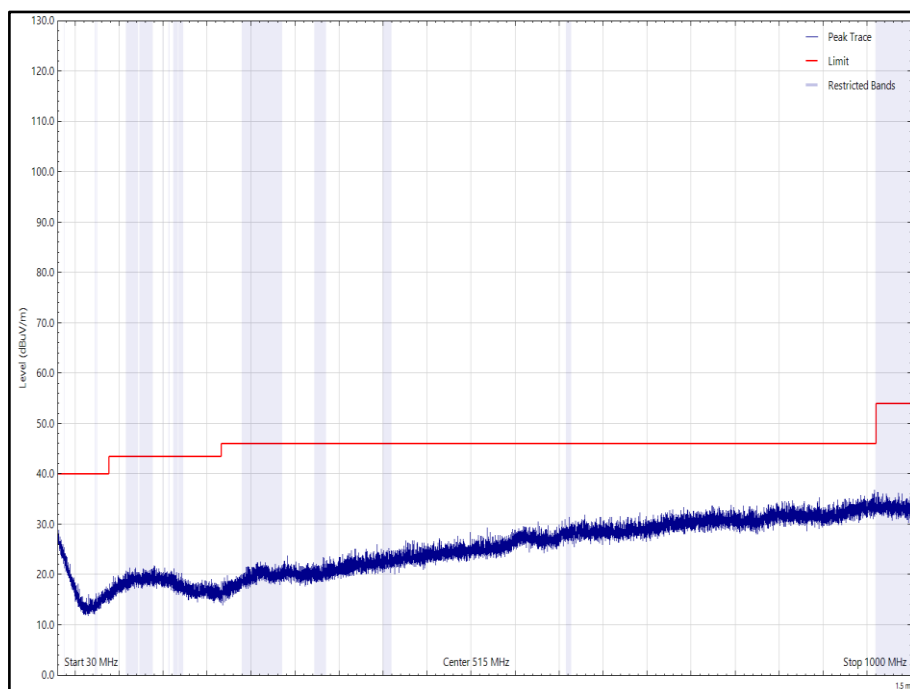


Figure 12 - CH0 (2404 MHz), LE1M, Orientation: X, 30 MHz to 1 GHz, Horizontal (Peak)

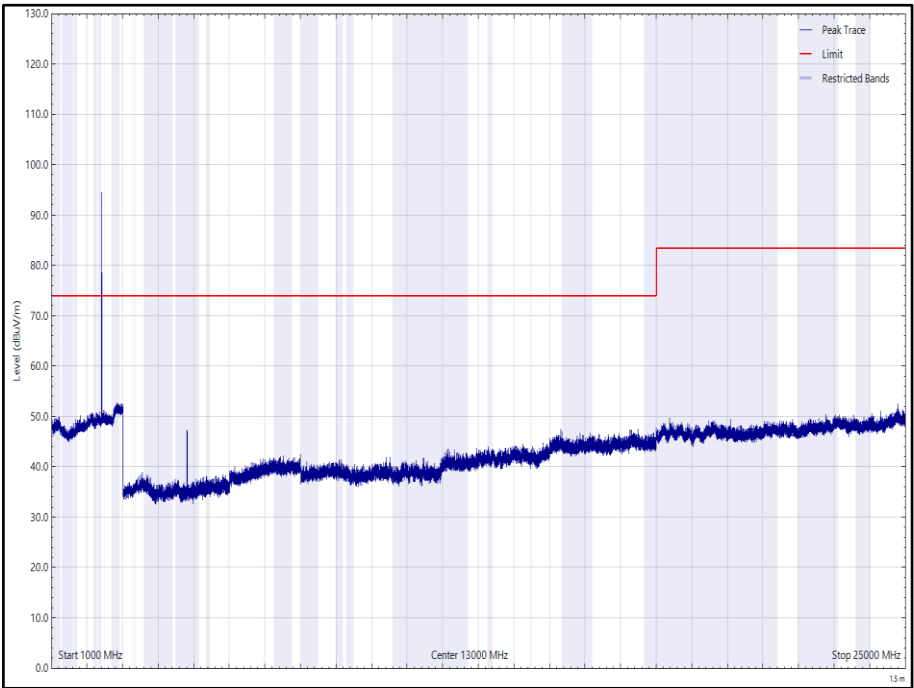


Figure 13 - CH0 (2404 MHz), LE1M, Orientation: X, 1 GHz to 25 GHz, Horizontal (Peak)

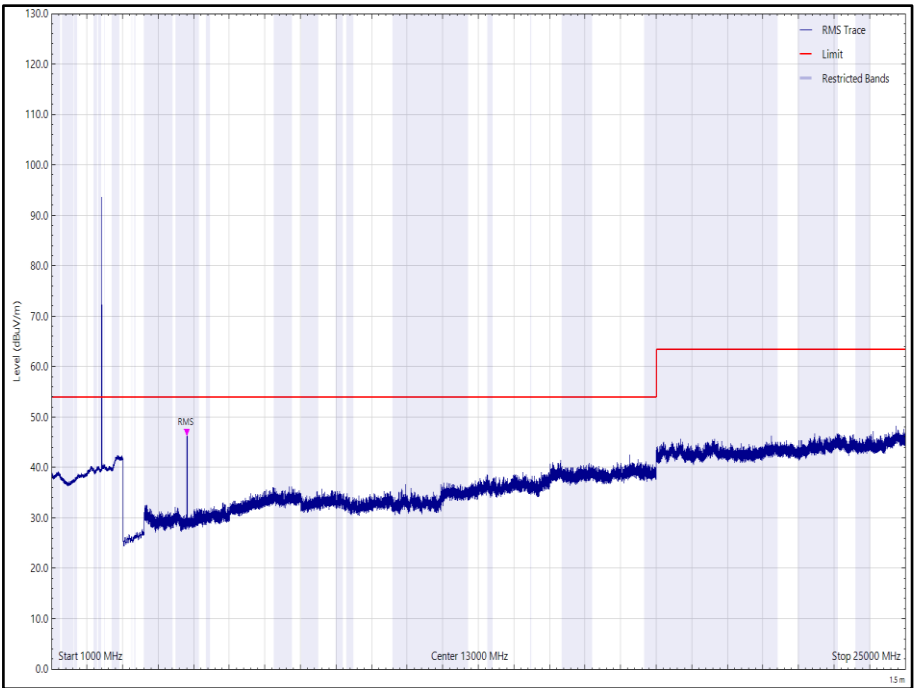


Figure 14 - CH0 (2404 MHz), LE1M, Orientation: X, 1 GHz to 25 GHz, Horizontal (rms)

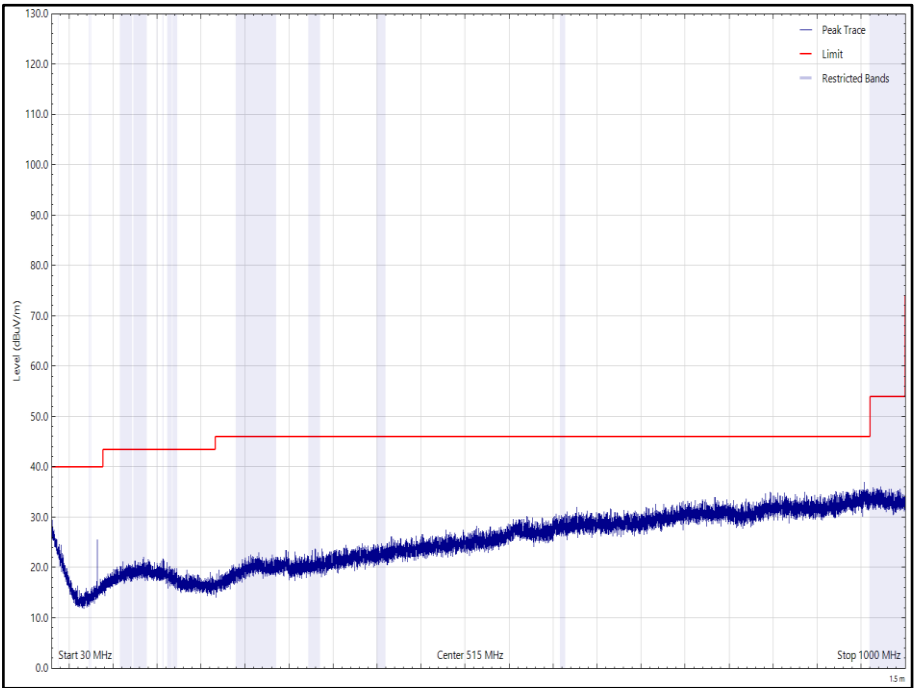


Figure 15 - CH0 (2404 MHz), LE1M, Orientation: X, 30 MHz to 1 GHz, Vertical (Peak)

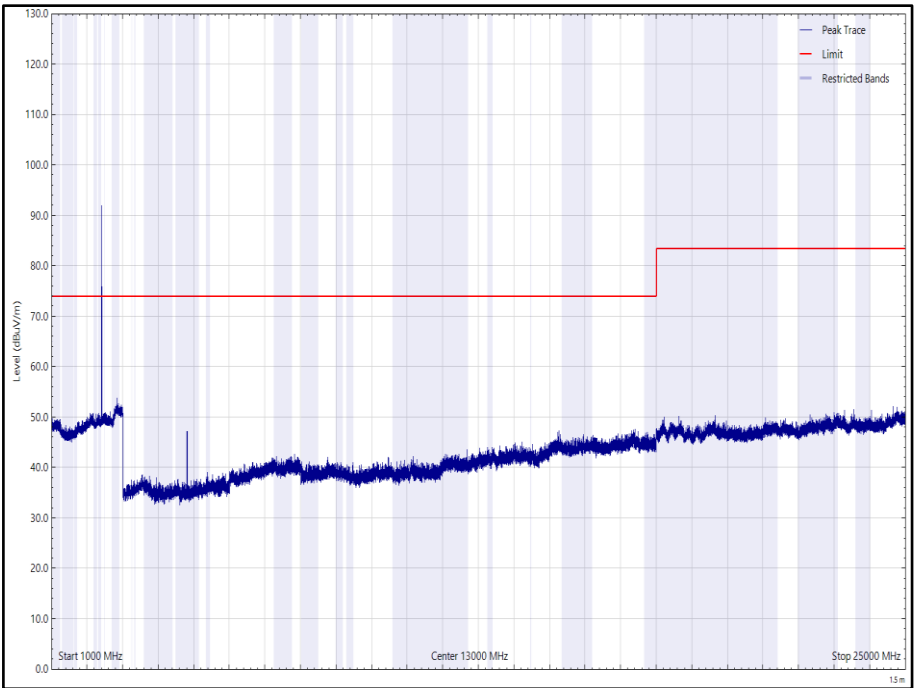


Figure 16 - CH0 (2404 MHz), LE1M, Orientation: X, 1 GHz to 25 GHz, Vertical (Peak)

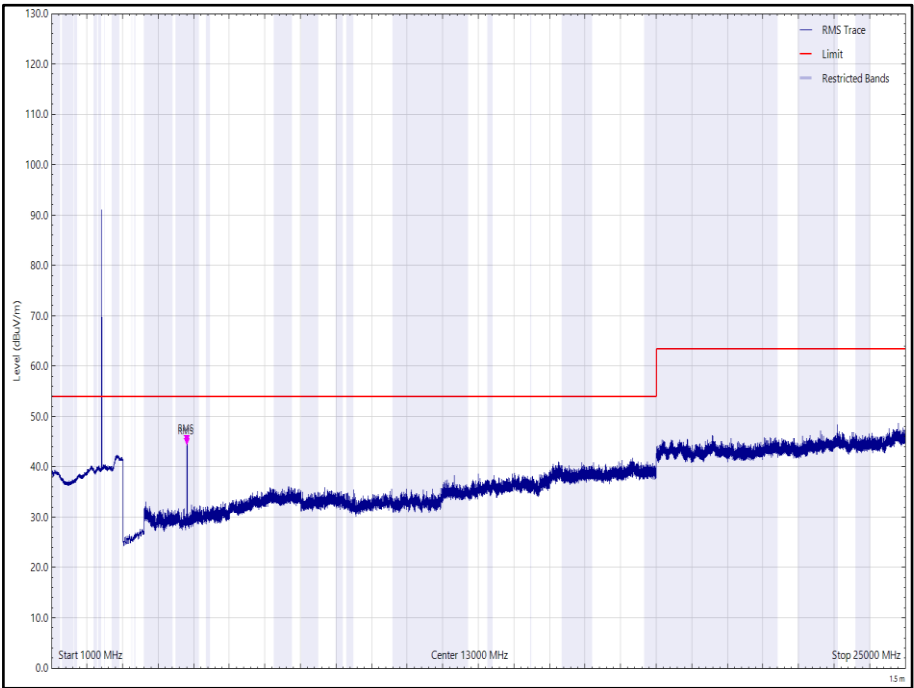


Figure 17 - CH0 (2404 MHz), LE1M, Orientation: X, 1 GHz to 25 GHz, Vertical (rms)

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

Table 31 - CH17 (2440 MHz), LE1M, Orientation: X, 30 MHz to 25 GHz

*No emissions found within 6 dB of the limit.

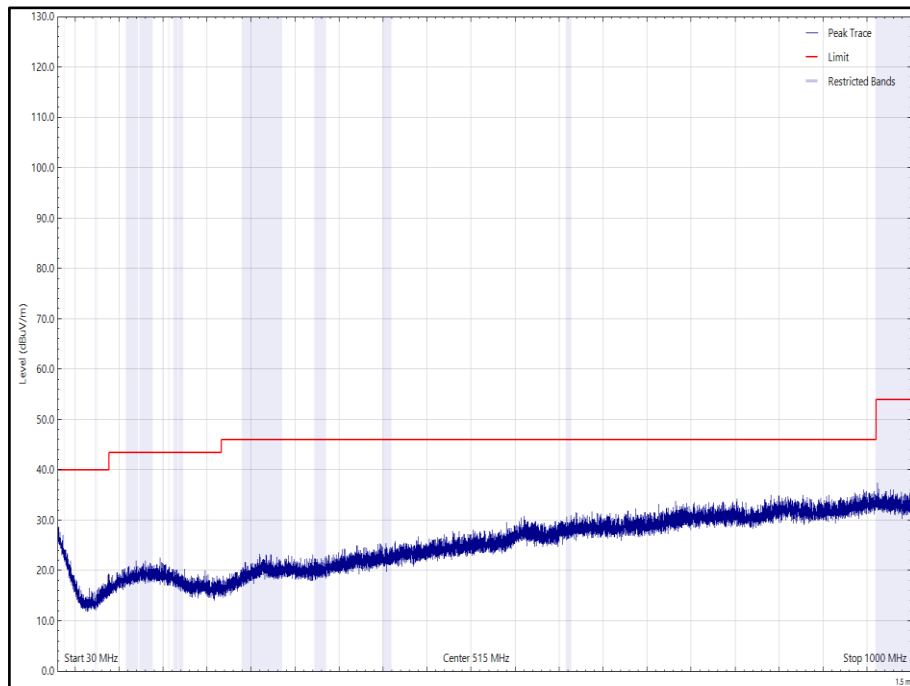


Figure 18 - CH17 (2440 MHz), LE1M, Orientation: X, 30 MHz to 1 GHz, Horizontal (Peak)

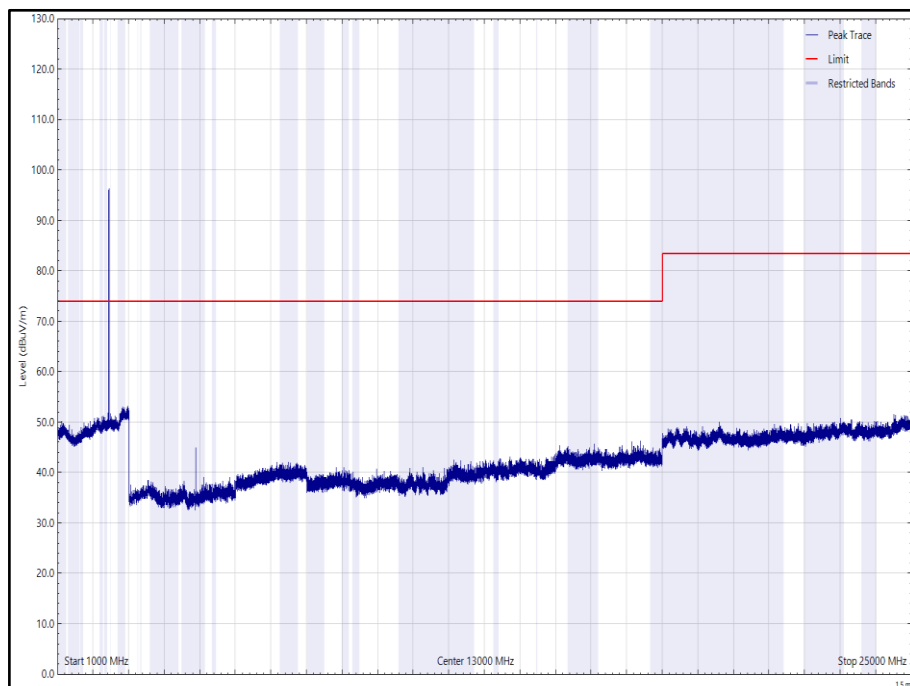


Figure 19 - CH17 (2440 MHz), LE1M, Orientation: X, 1 GHz to 25 GHz, Horizontal (Peak)

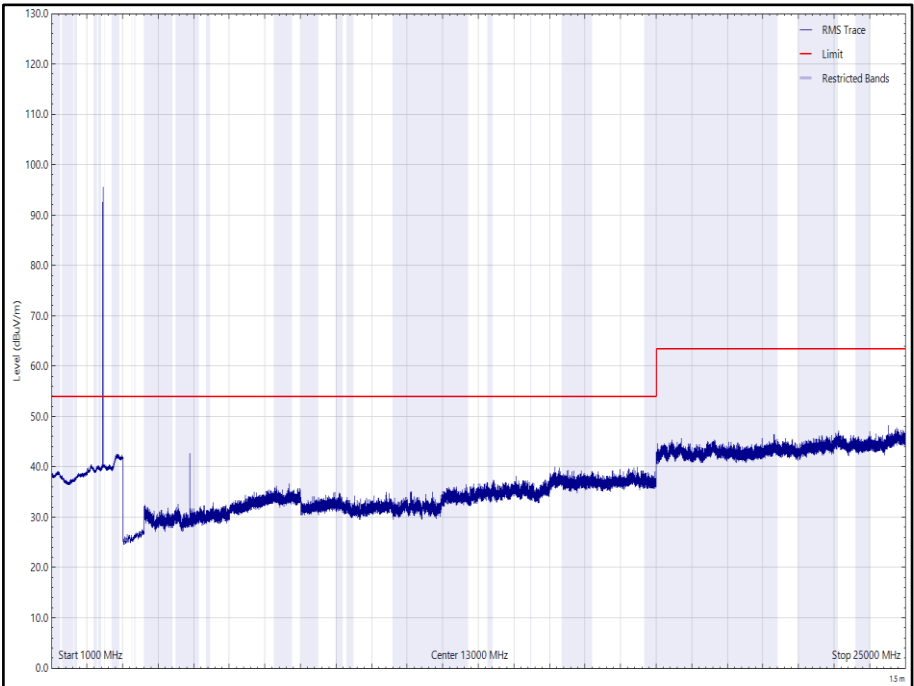


Figure 20 - CH17 (2440 MHz), LE1M, Orientation: X, 1 GHz to 25 GHz, Horizontal (rms)

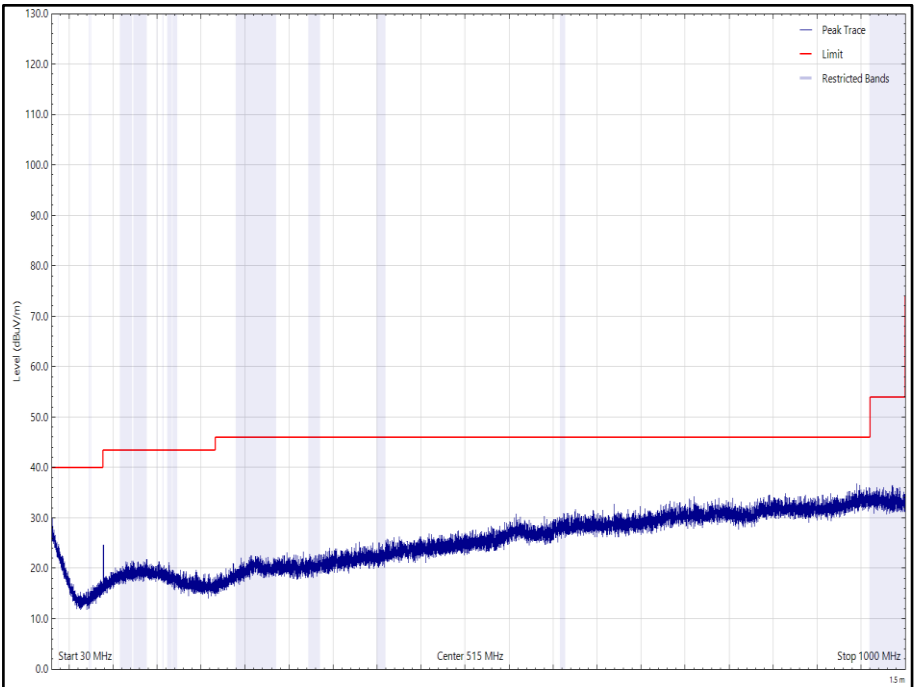


Figure 21 - CH17 (2440 MHz), LE1M, Orientation: X, 30 MHz to 1 GHz, Vertical (Peak)

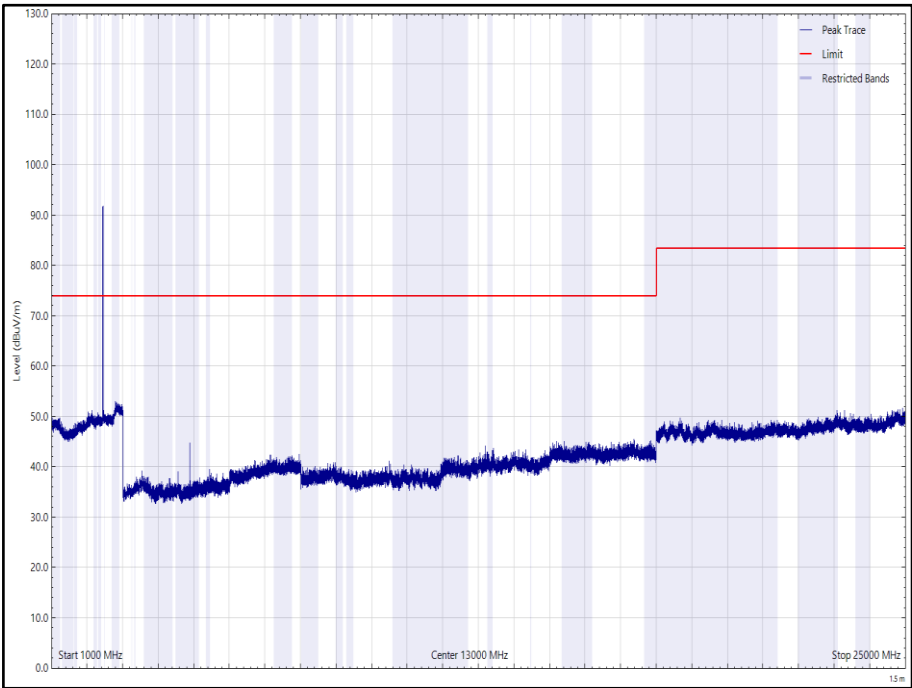


Figure 22 - CH17 (2440 MHz), LE1M, Orientation: X, 1 GHz to 25 GHz, Vertical (Peak)

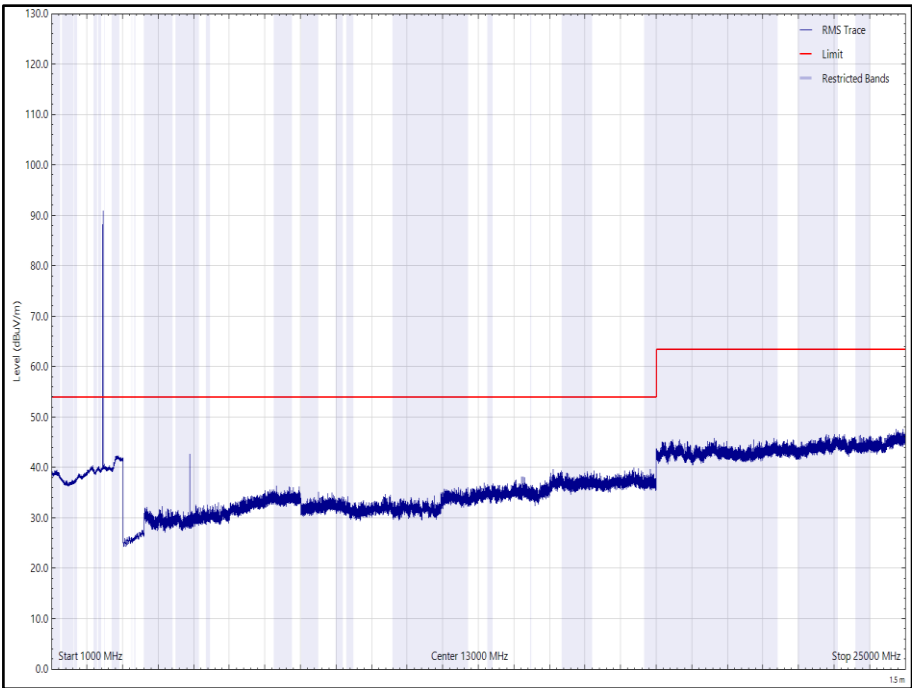


Figure 23 - CH17 (2440 MHz), LE1M, Orientation: X, 1 GHz to 25 GHz, Vertical (rms)

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

Table 32 - CH39 (2480 MHz), LE1M, Orientation: X, 30 MHz to 25 GHz

*No emissions found within 6 dB of the limit.

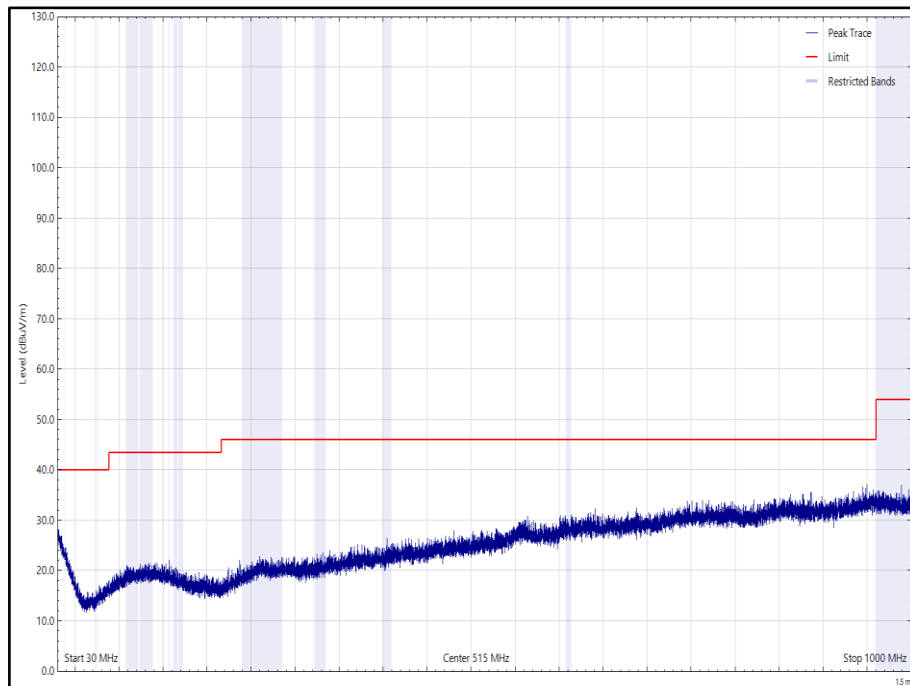


Figure 24 - CH39 (2480 MHz), LE1M, Orientation: X, 30 MHz to 1 GHz, Horizontal (Peak)

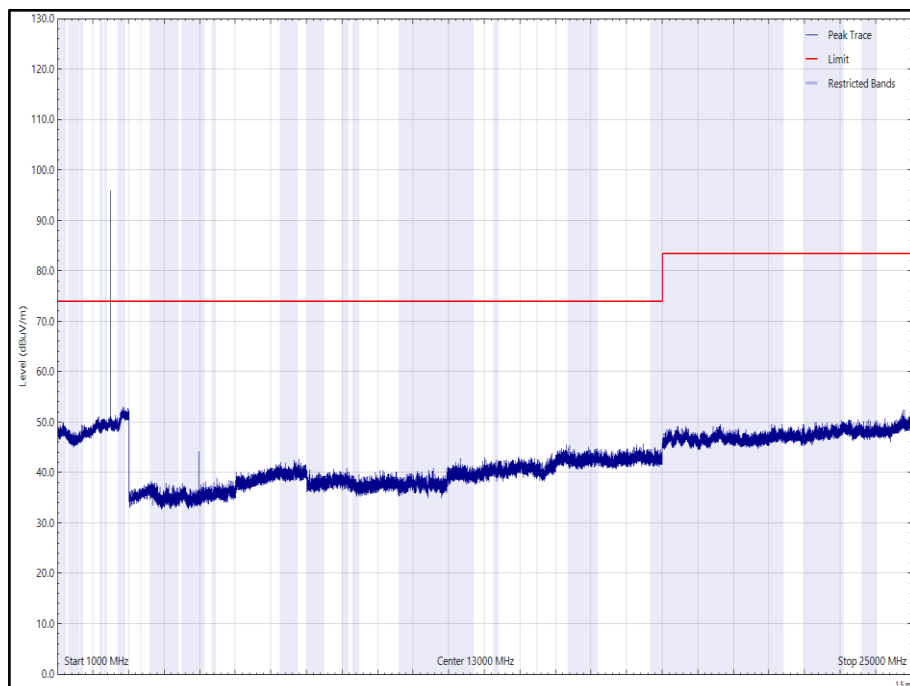


Figure 25 - CH39 (2480 MHz), LE1M, Orientation: X, 1 GHz to 25 GHz, Horizontal (Peak)

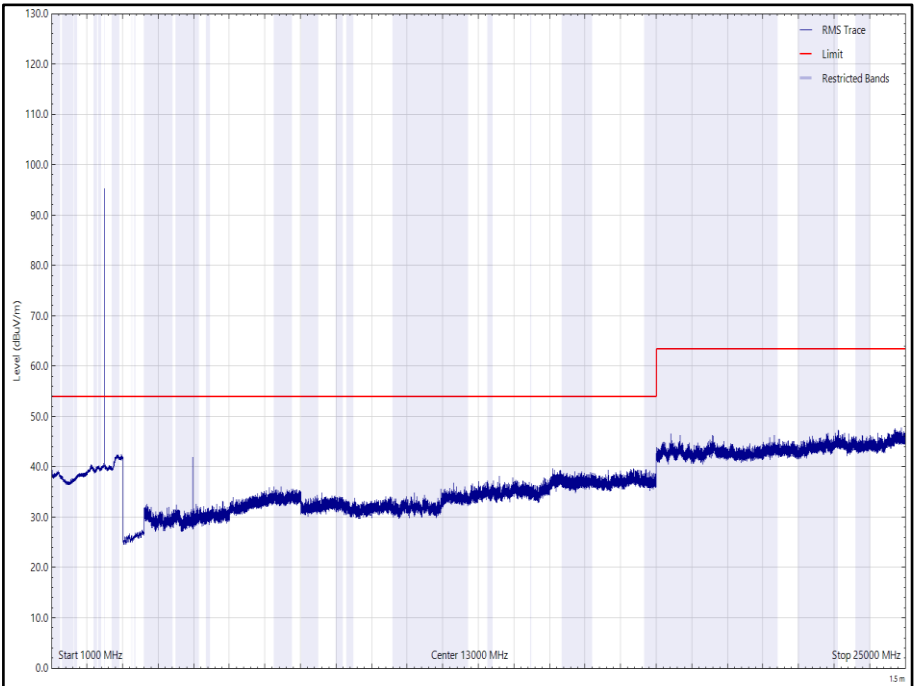


Figure 26 - CH39 (2480 MHz), LE1M, Orientation: X, 1 GHz to 25 GHz, Horizontal (rms)

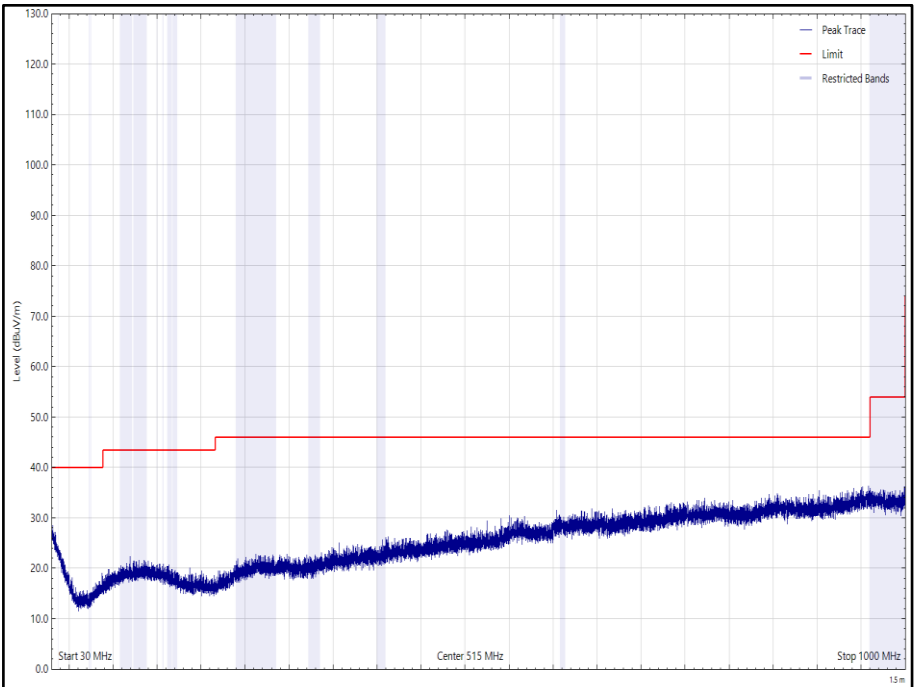


Figure 27 - CH39 (2480 MHz), LE1M, Orientation: X, 30 MHz to 1 GHz, Vertical (Peak)

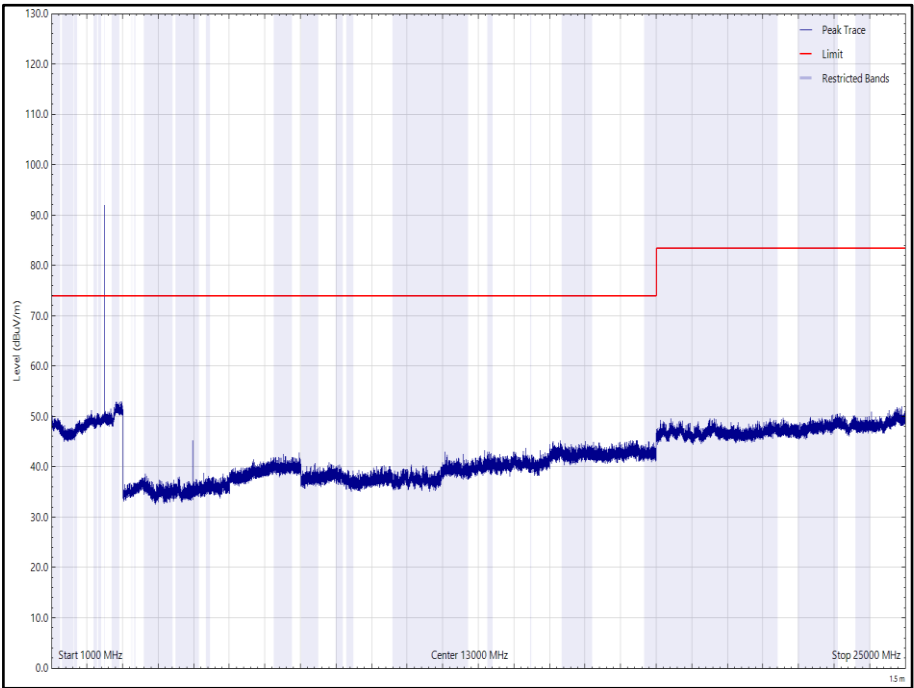


Figure 28 - CH39 (2480 MHz), LE1M, Orientation: X, 1 GHz to 25 GHz, Vertical (Peak)

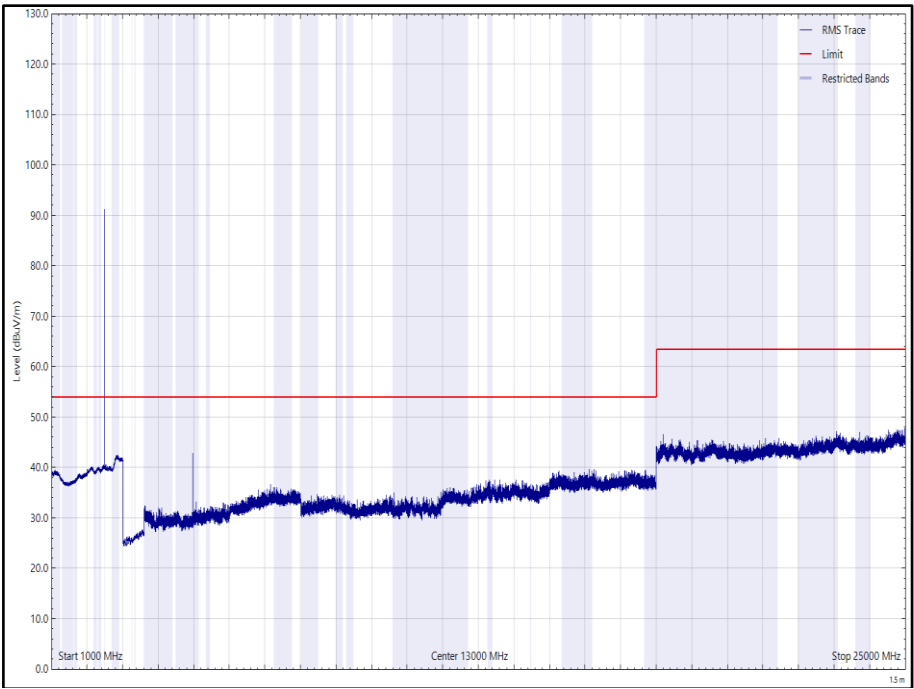


Figure 29 - CH39 (2480 MHz), LE1M, Orientation: X, 1 GHz to 25 GHz, Vertical (rms)

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
4808.104	46.4	54.0	-7.6	RMS	168	132	Horizontal

Table 33 - CH0 (2404 MHz), LE1M, Orientation: Y, 30 MHz to 25 GHz

No other emissions found within 6 dB of the limit.

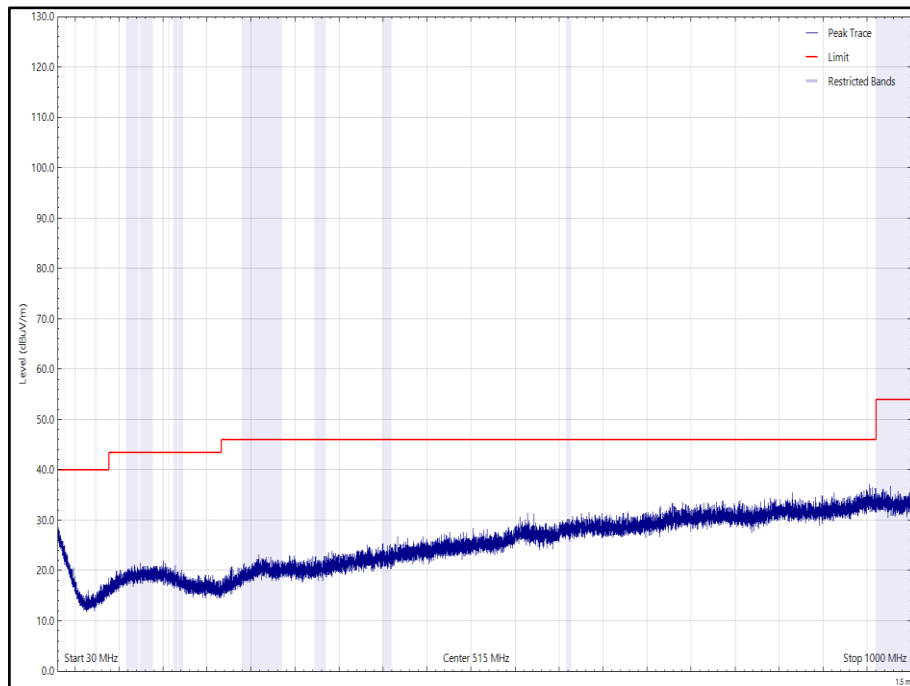


Figure 30 - CH0 (2404 MHz), LE1M, Orientation: Y, 30 MHz to 1 GHz, Horizontal (Peak)

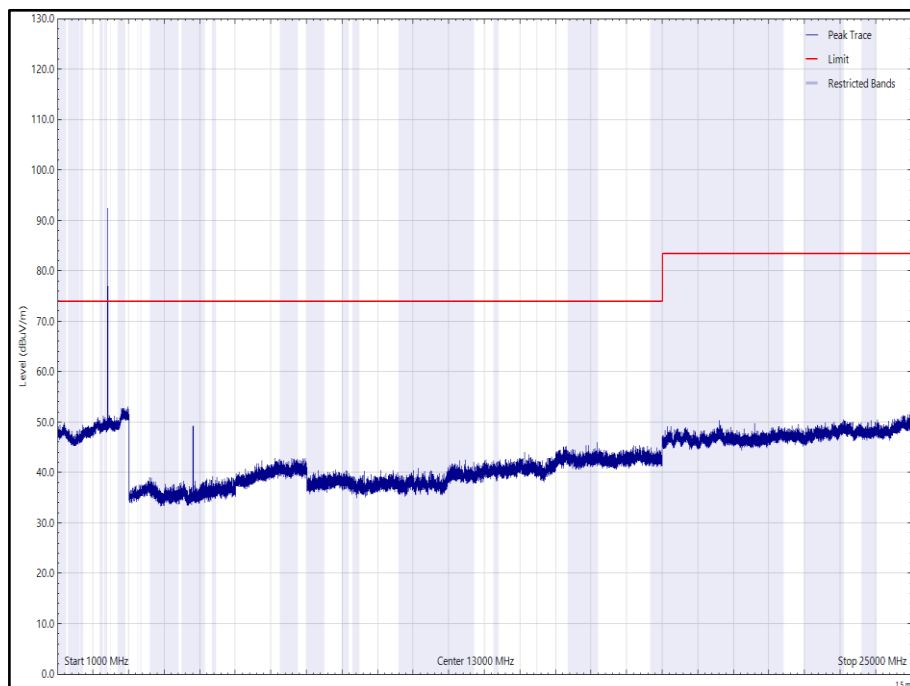


Figure 31 - CH0 (2404 MHz), LE1M, Orientation: Y, 1 GHz to 25 GHz, Horizontal (Peak)

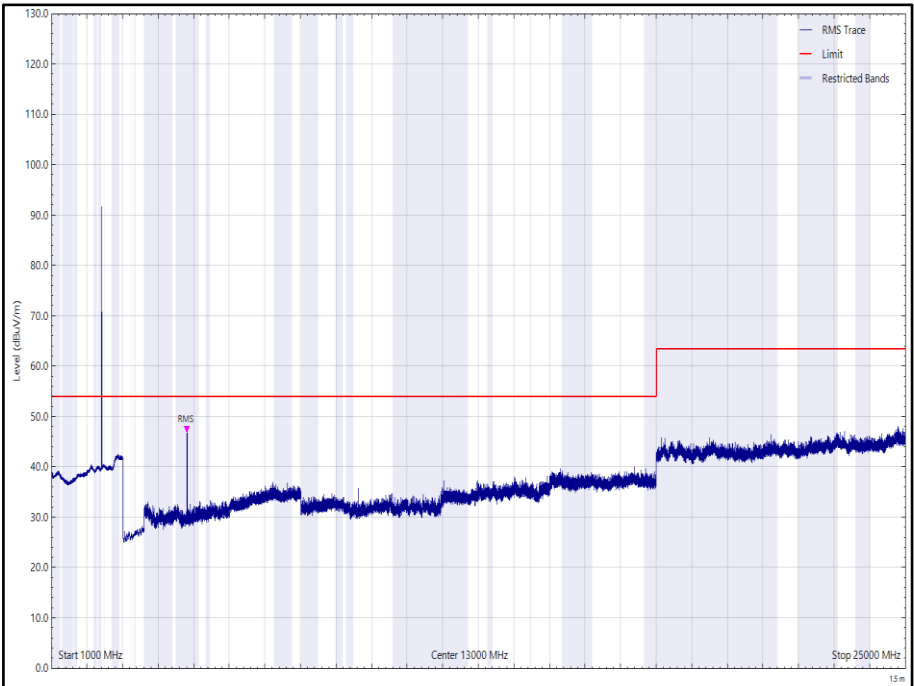


Figure 32 - CH0 (2404 MHz), LE1M, Orientation: Y, 1 GHz to 25 GHz, Horizontal (rms)

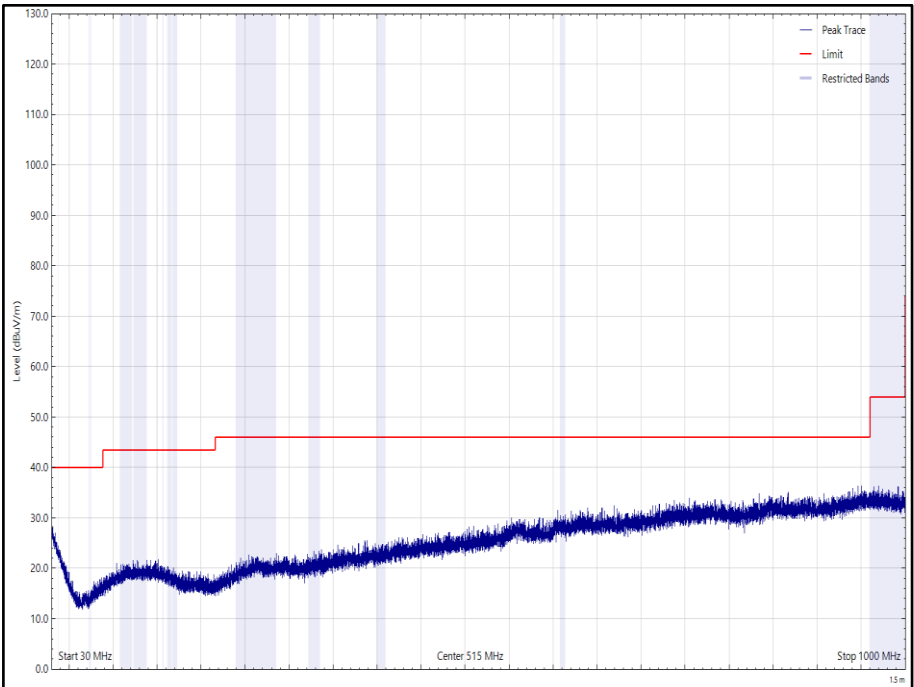


Figure 33 - CH0 (2404 MHz), LE1M, Orientation: Y, 30 MHz to 1 GHz, Vertical (Peak)

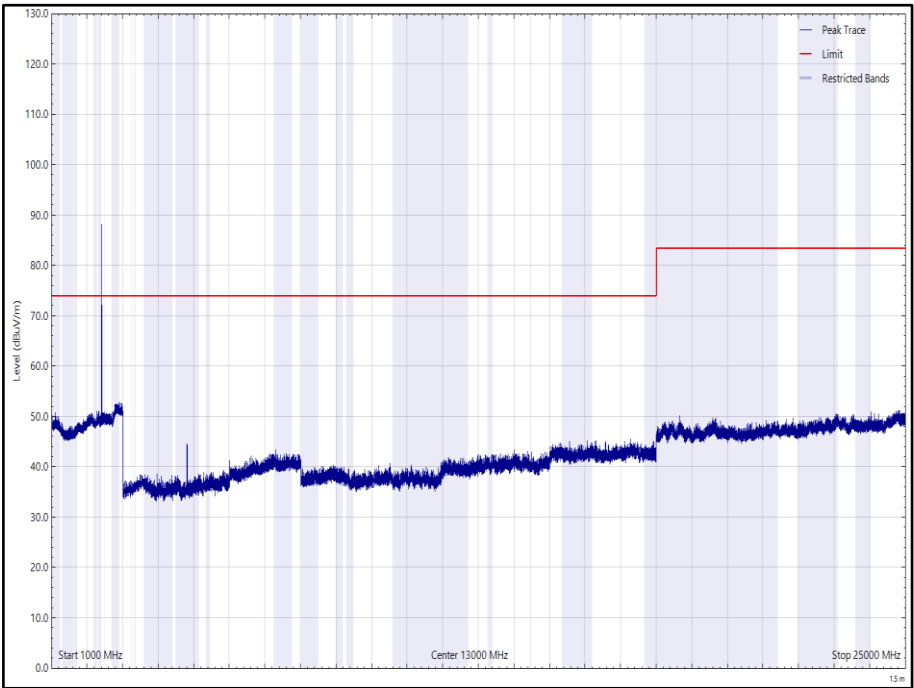


Figure 34 - CH0 (2404 MHz), LE1M, Orientation: Y, 1 GHz to 25 GHz, Vertical (Peak)

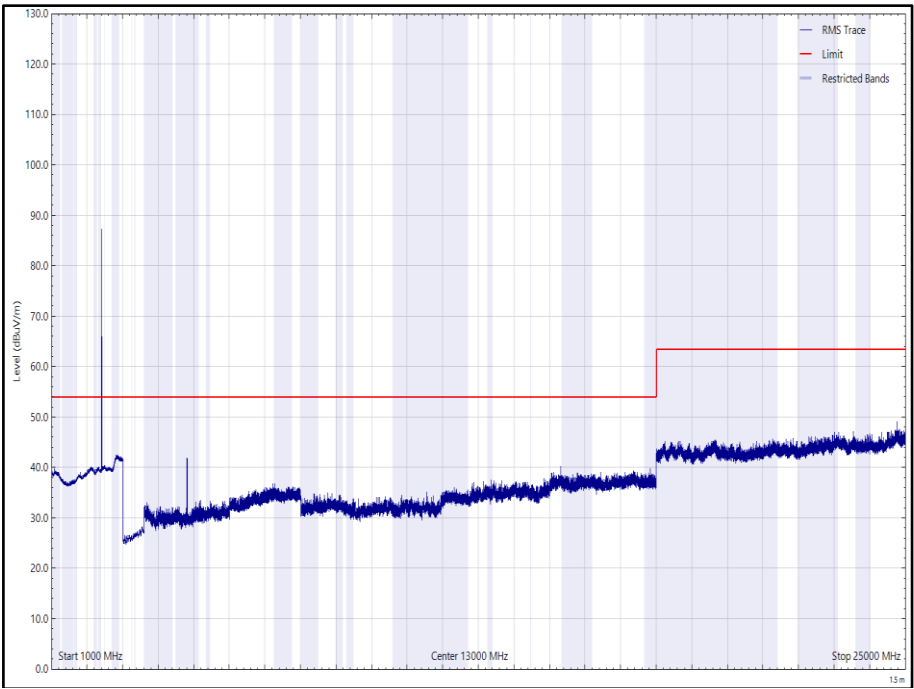


Figure 35 - CH0 (2404 MHz), LE1M, Orientation: Y, 1 GHz to 25 GHz, Vertical (rms)



Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
4880.072	47.6	54.0	-6.4	RMS	170	157	Horizontal
4880.077	45.0	54.0	-9.0	RMS	200	181	Vertical

Table 34 - CH17 (2440 MHz), LE1M, Orientation: Y, 30 MHz to 25 GHz

No other emissions found within 6 dB of the limit.

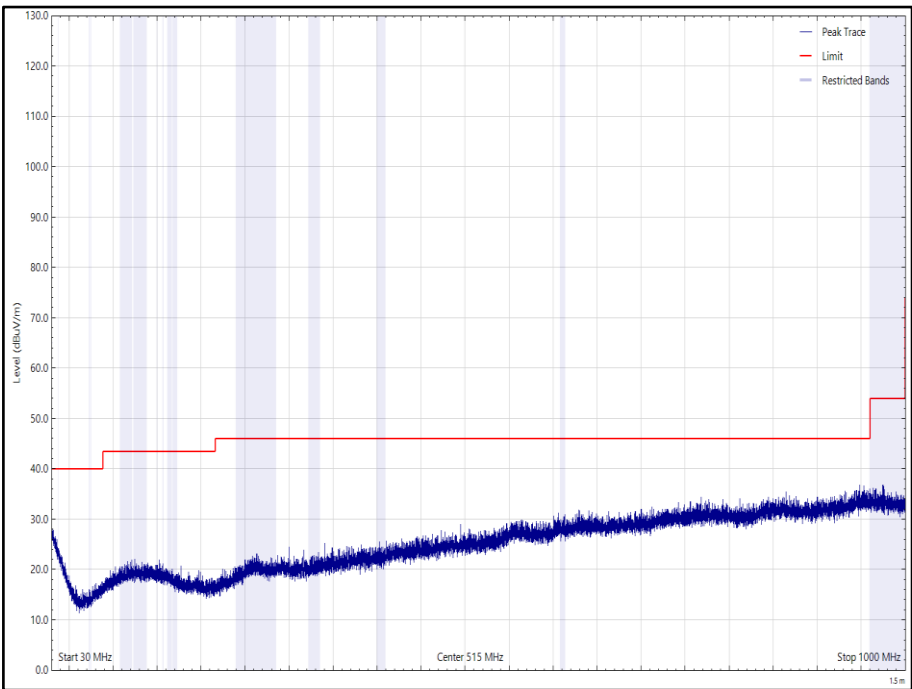


Figure 36 - CH17 (2440 MHz), LE1M, Orientation: Y, 30 MHz to 1 GHz, Horizontal (Peak)

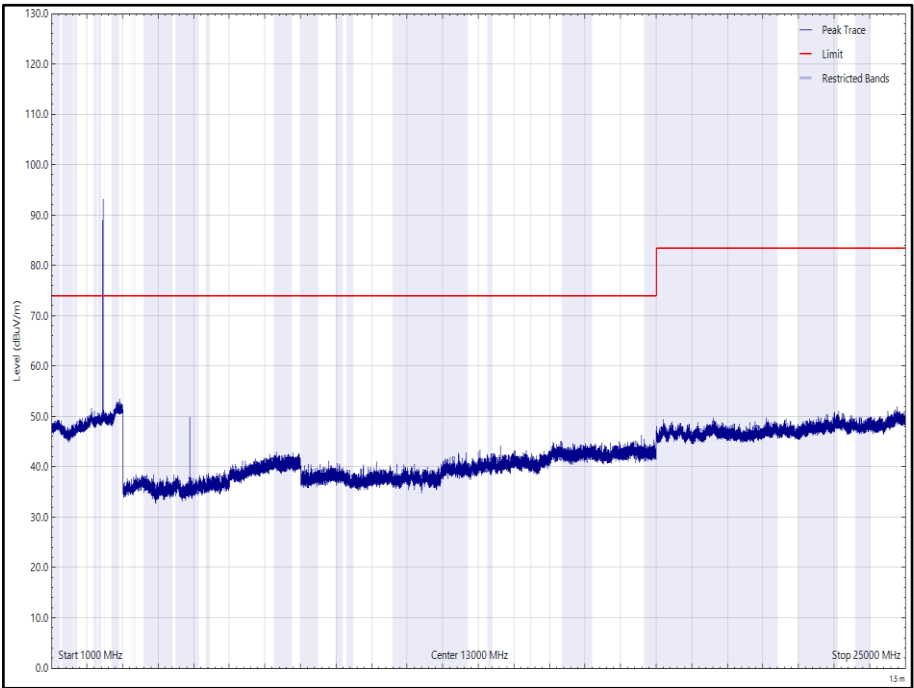


Figure 37 - CH17 (2440 MHz), LE1M, Orientation: Y, 1 GHz to 25 GHz, Horizontal (Peak)

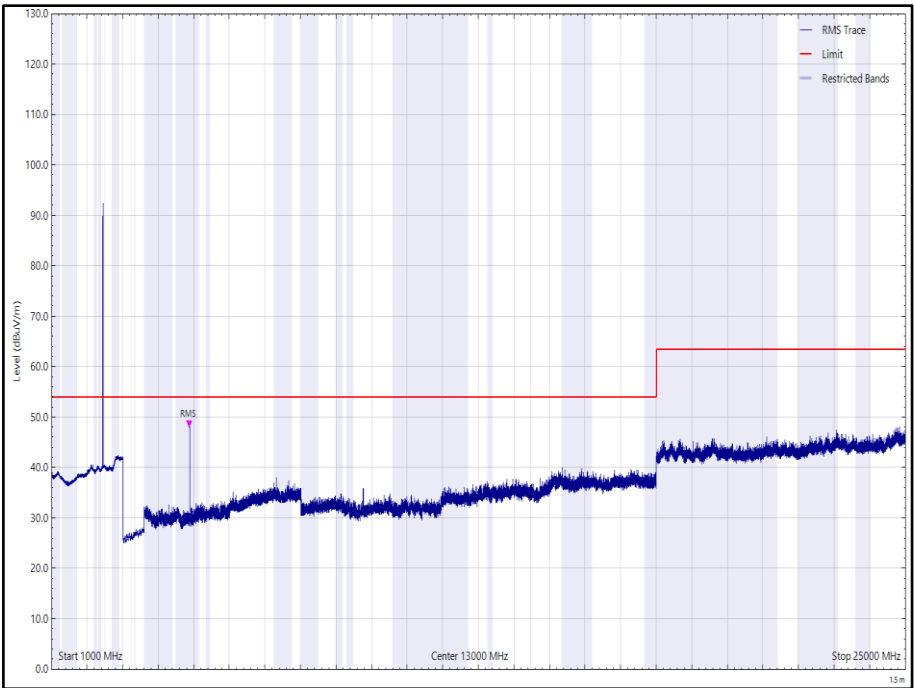


Figure 38 - CH17 (2440 MHz), LE1M, Orientation: Y, 1 GHz to 25 GHz, Horizontal (rms)

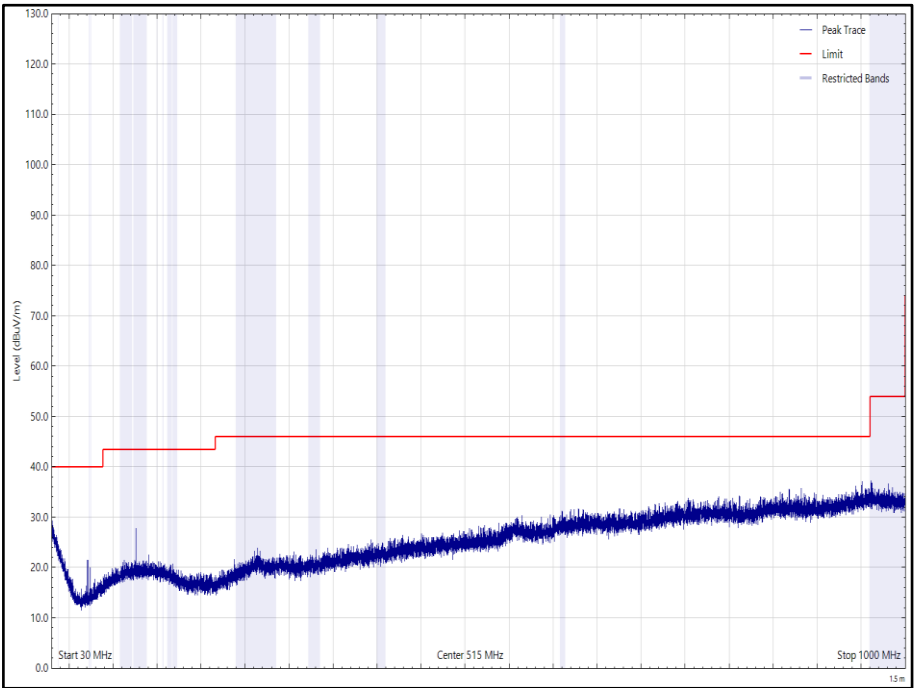


Figure 39 - CH17 (2440 MHz), LE1M, Orientation: Y, 30 MHz to 1 GHz, Vertical (Peak)

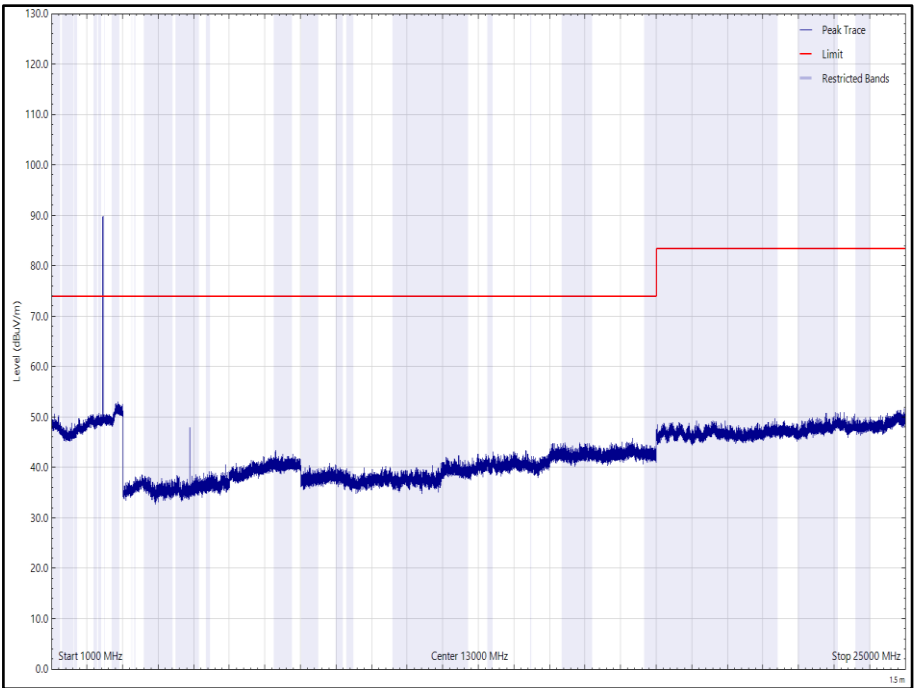


Figure 40 - CH17 (2440 MHz), LE1M, Orientation: Y, 1 GHz to 25 GHz, Vertical (Peak)

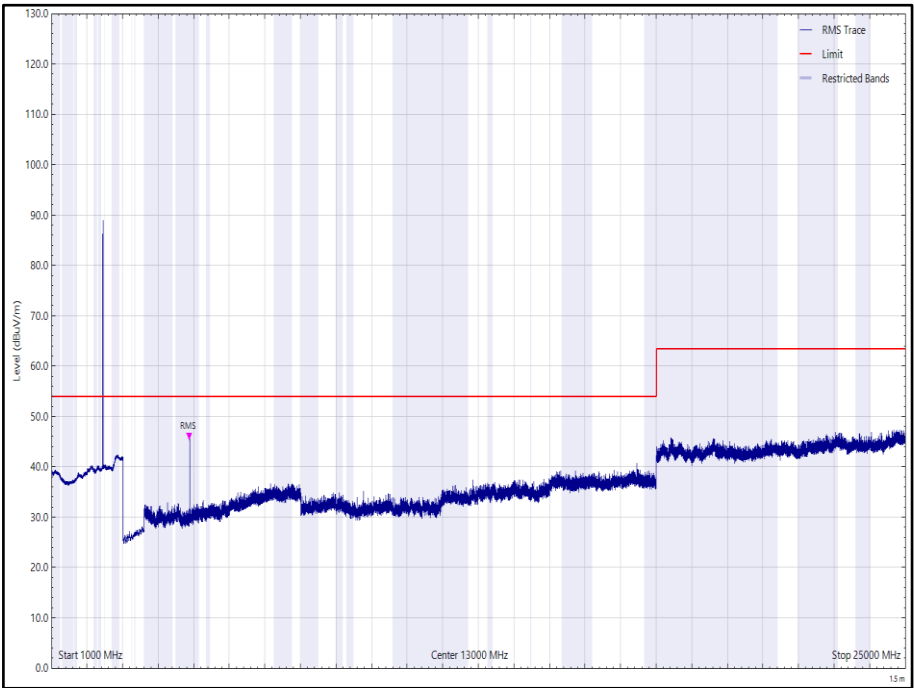


Figure 41 - CH17 (2440 MHz), LE1M, Orientation: Y, 1 GHz to 25 GHz, Vertical (rms)

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
4959.825	48.2	54.0	-5.8	RMS	167	118	Horizontal

Table 35 - CH39 (2480 MHz), LE1M, Orientation: Y, 30 MHz to 25 GHz

No other emissions found within 6 dB of the limit.

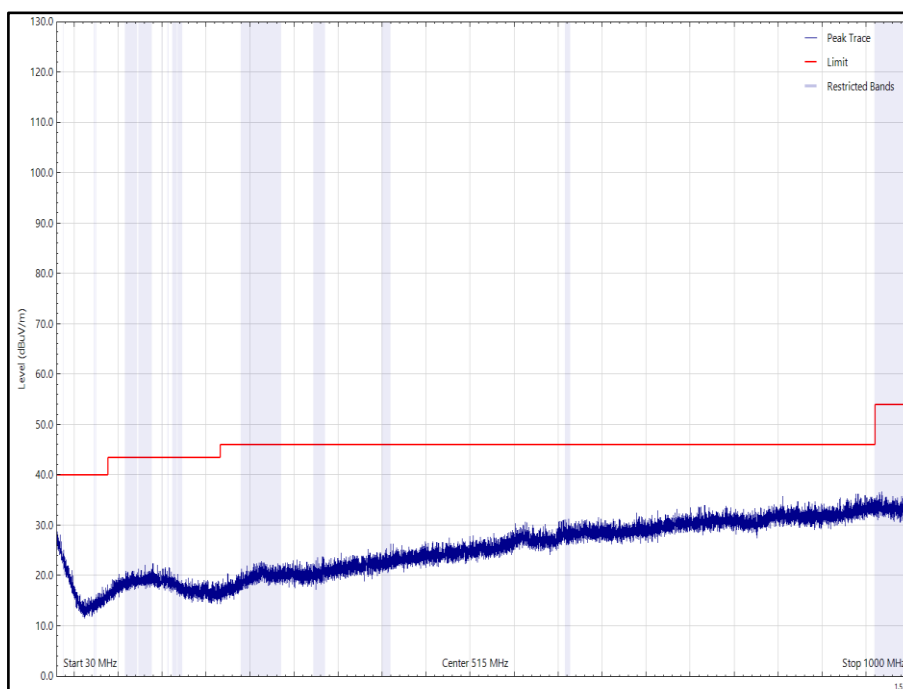


Figure 42 - CH39 (2480 MHz), LE1M, Orientation: Y, 30 MHz to 1 GHz, Horizontal (Peak)

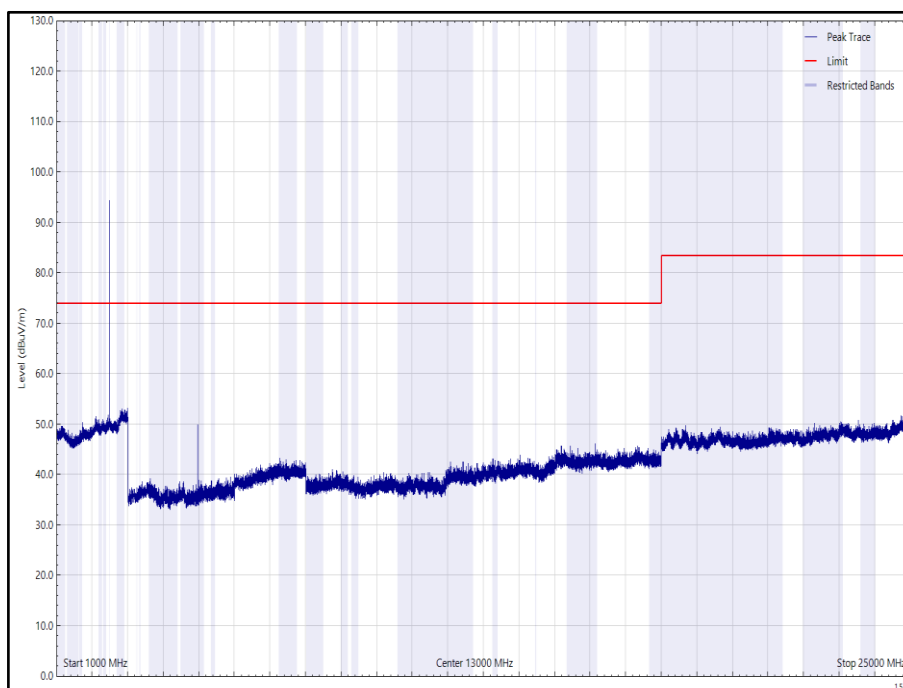


Figure 43 - CH39 (2480 MHz), LE1M, Orientation: Y, 1 GHz to 25 GHz, Horizontal (Peak)

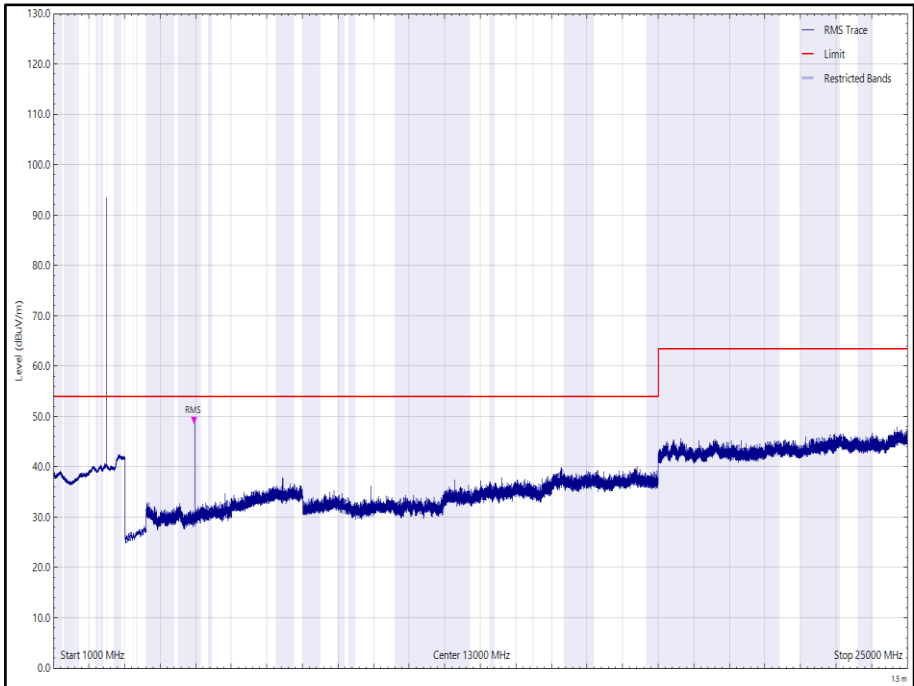


Figure 44 - CH39 (2480 MHz), LE1M, Orientation: Y, 1 GHz to 25 GHz, Horizontal (rms)

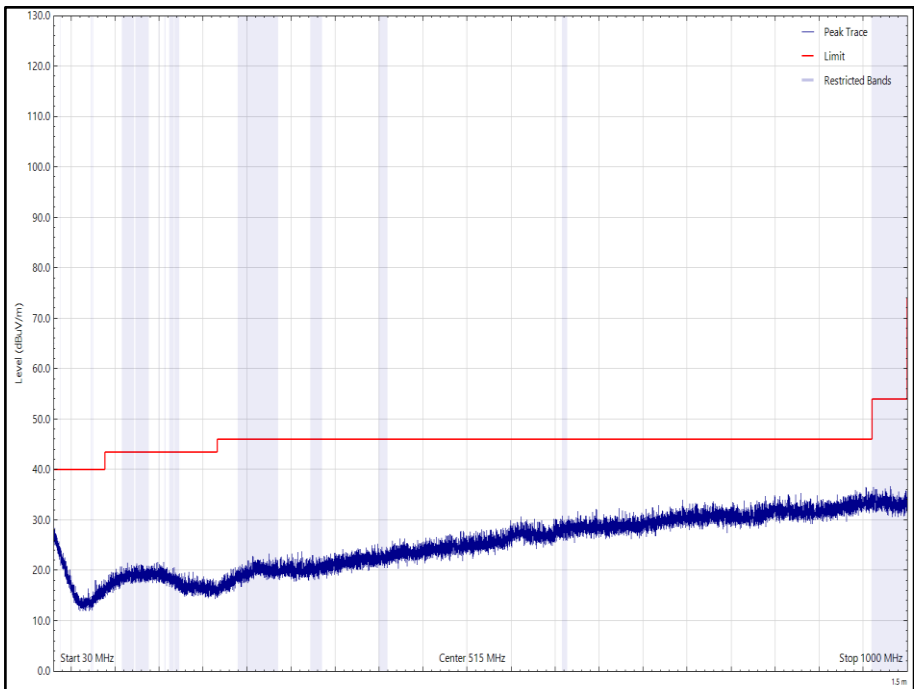


Figure 45 - CH39 (2480 MHz), LE1M, Orientation: Y, 30 MHz to 1 GHz, Vertical (Peak)

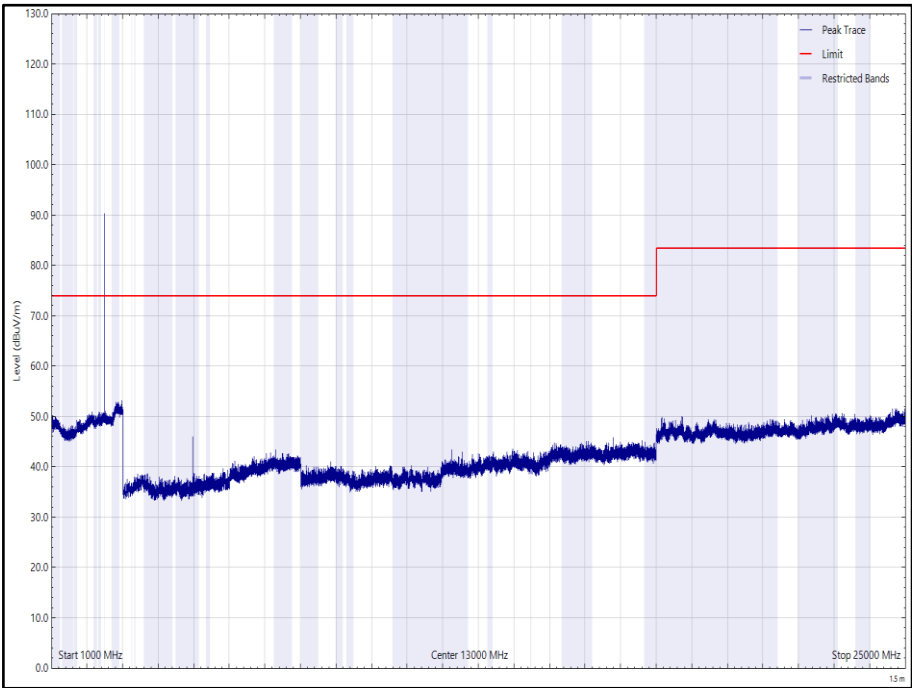


Figure 46 - CH39 (2480 MHz), LE1M, Orientation: Y, 1 GHz to 25 GHz, Vertical (Peak)

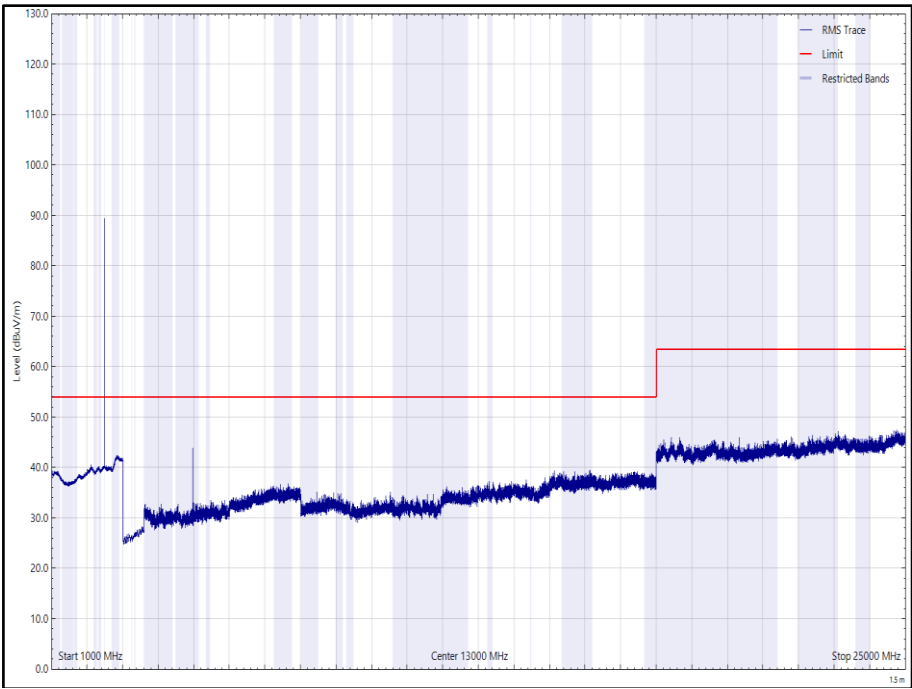


Figure 47 - CH39 (2480 MHz), LE1M, Orientation: Y, 1 GHz to 25 GHz, Vertical (rms)



Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
4807.882	44.4	54.0	-9.6	RMS	173	110	Horizontal
4807.914	45.6	54.0	-8.4	RMS	171	147	Vertical

Table 36 - CH0 (2404 MHz), LE1M, Orientation: Z, 30 MHz to 25 GHz

No other emissions found within 6 dB of the limit.

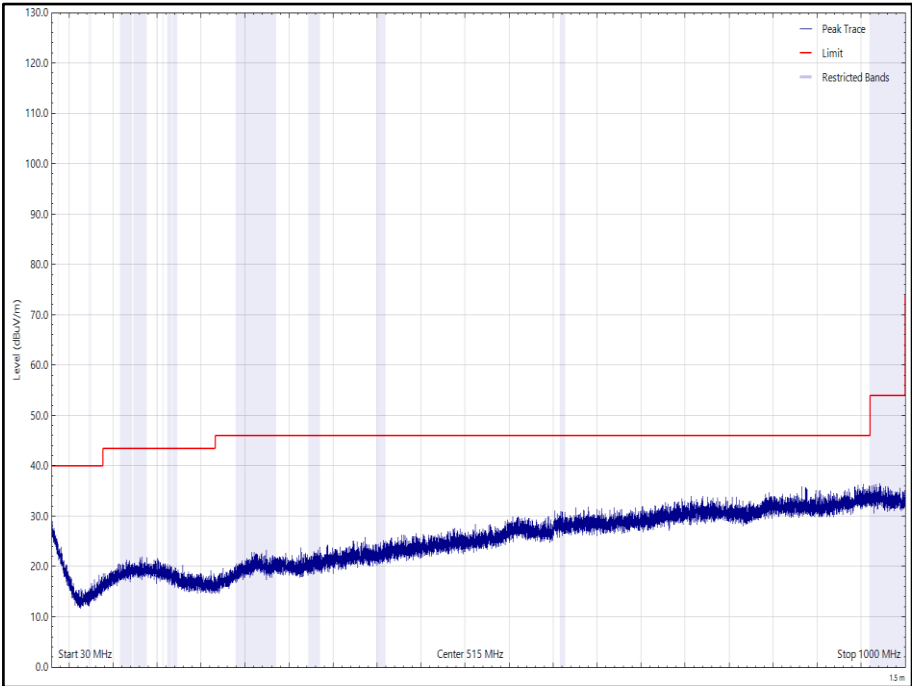


Figure 48 - CH0 (2404 MHz), LE1M, Orientation: Z, 30 MHz to 1 GHz, Horizontal (Peak)

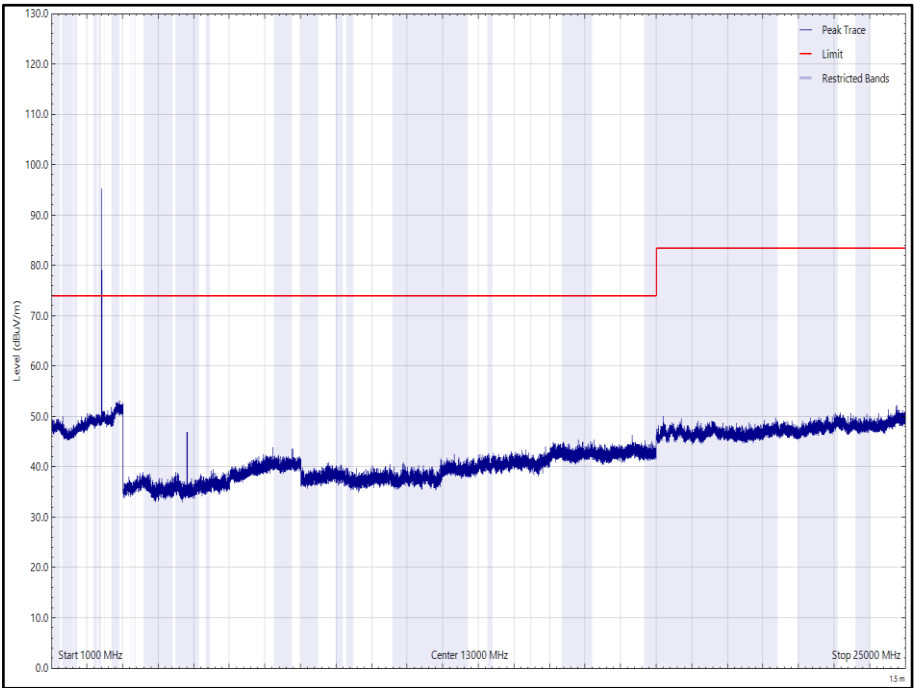


Figure 49 - CH0 (2404 MHz), LE1M, Orientation: Z, 1 GHz to 25 GHz, Horizontal (Peak)

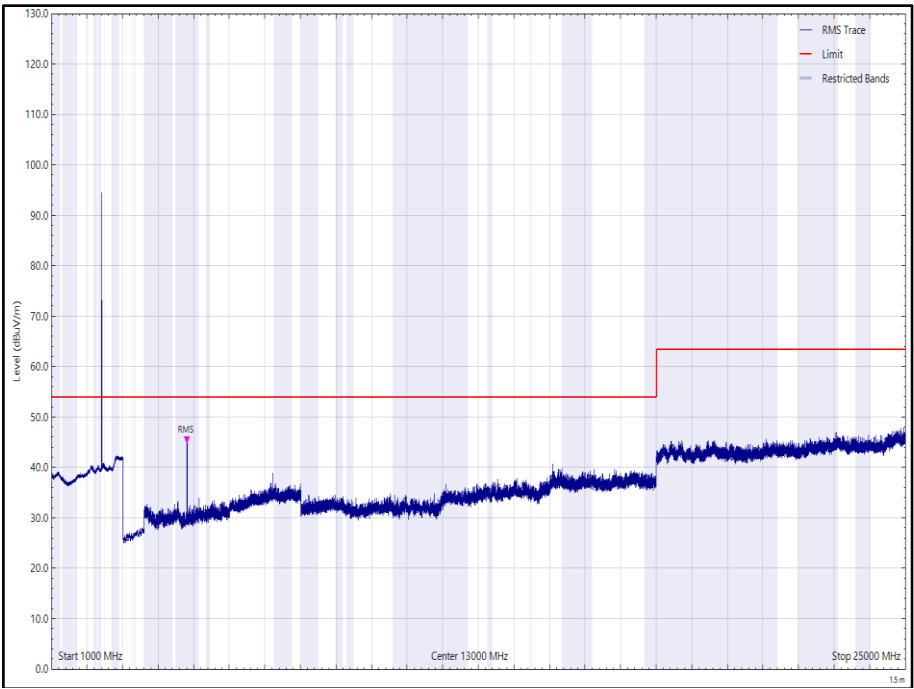


Figure 50 - CH0 (2404 MHz), LE1M, Orientation: Z, 1 GHz to 25 GHz, Horizontal (rms)

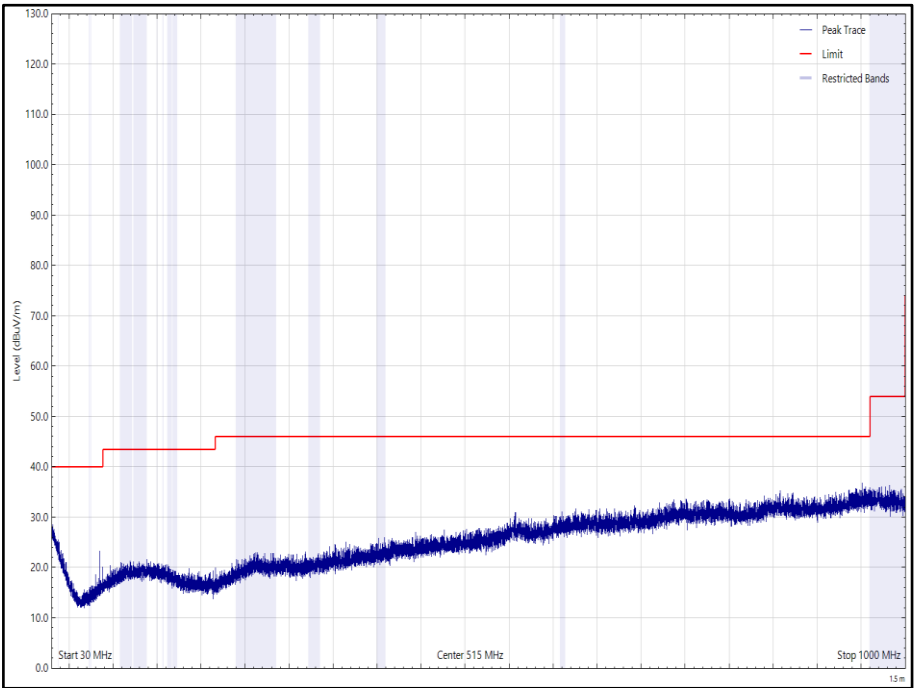


Figure 51 - CH0 (2404 MHz), LE1M, Orientation: Z, 30 MHz to 1 GHz, Vertical (Peak)

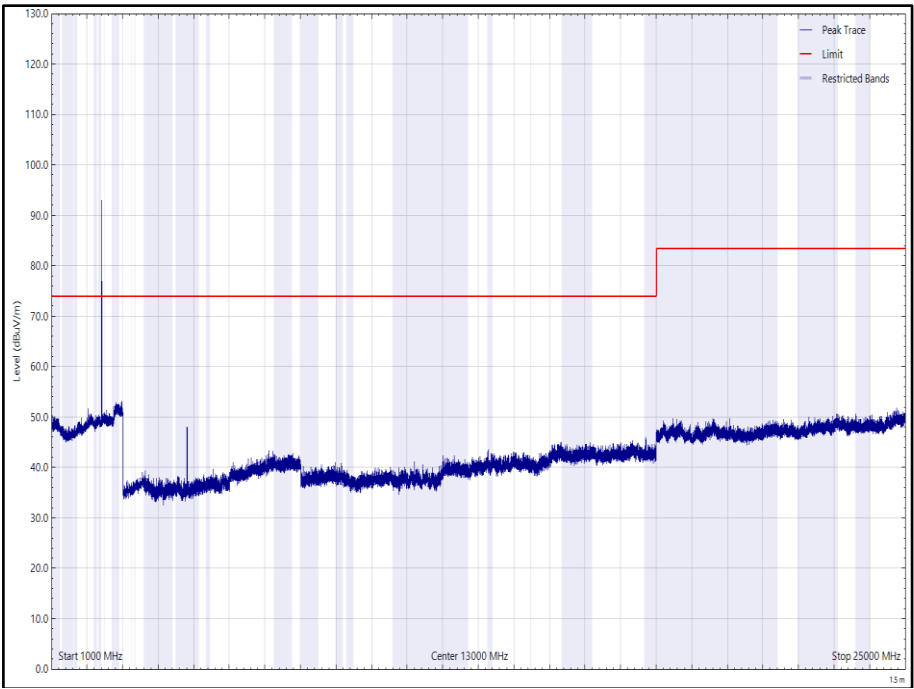


Figure 52 - CH0 (2404 MHz), LE1M, Orientation: Z, 1 GHz to 25 GHz, Vertical (Peak)

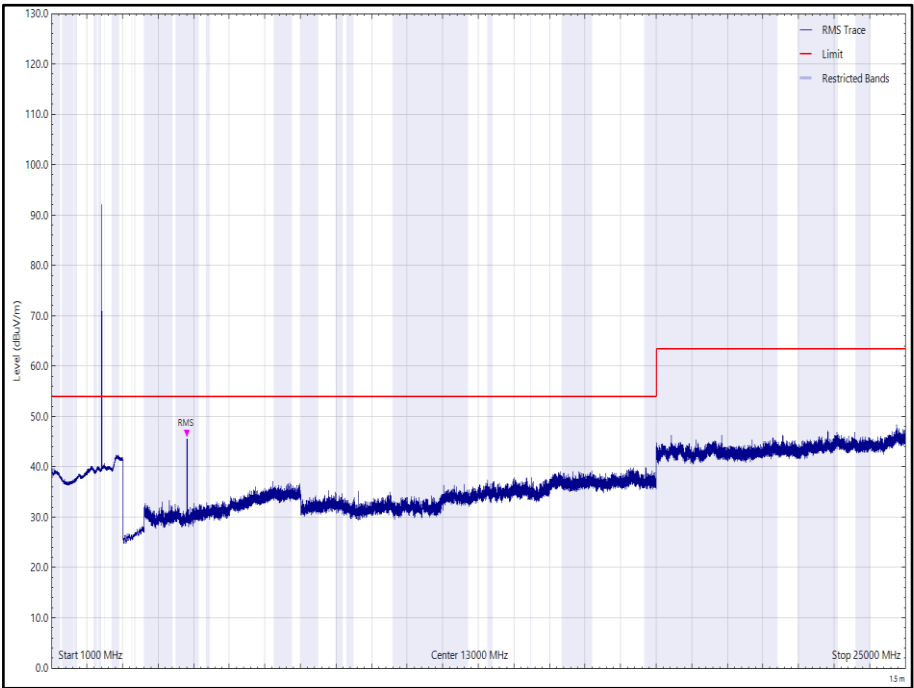


Figure 53 - CH0 (2404 MHz), LE1M, Orientation: Z, 1 GHz to 25 GHz, Vertical (rms)



Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
4880.020	47.6	54.0	-6.4	RMS	187	193	Vertical
4880.090	45.6	54.0	-8.4	RMS	322	100	Horizontal

Table 37 - CH17 (2440 MHz), LE1M, Orientation: Z, 30 MHz to 25 GHz

No other emissions found within 6 dB of the limit.

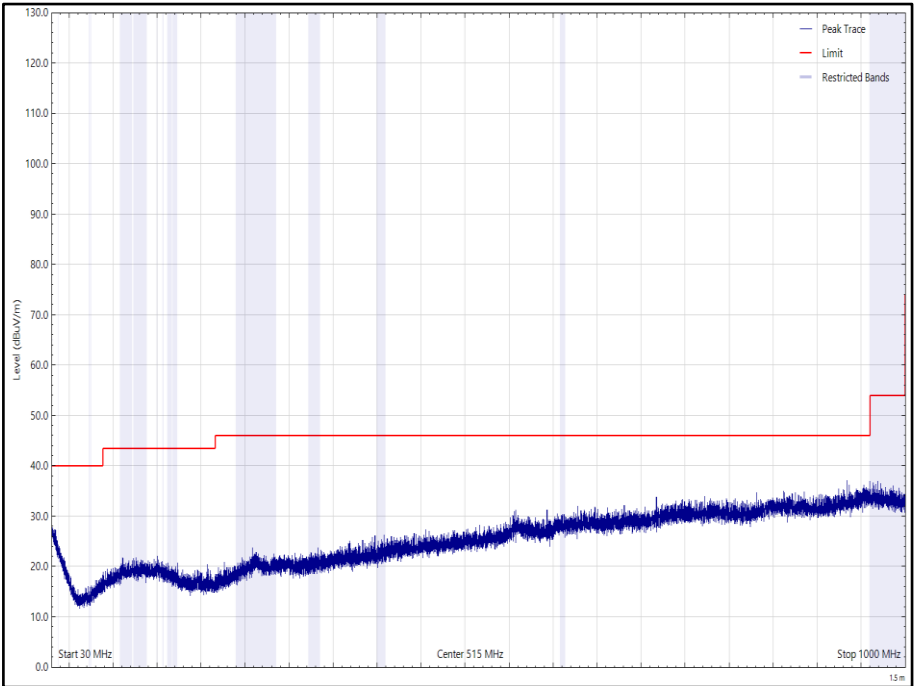


Figure 54 - CH17 (2440 MHz), LE1M, Orientation: Z, 30 MHz to 1 GHz, Horizontal (Peak)

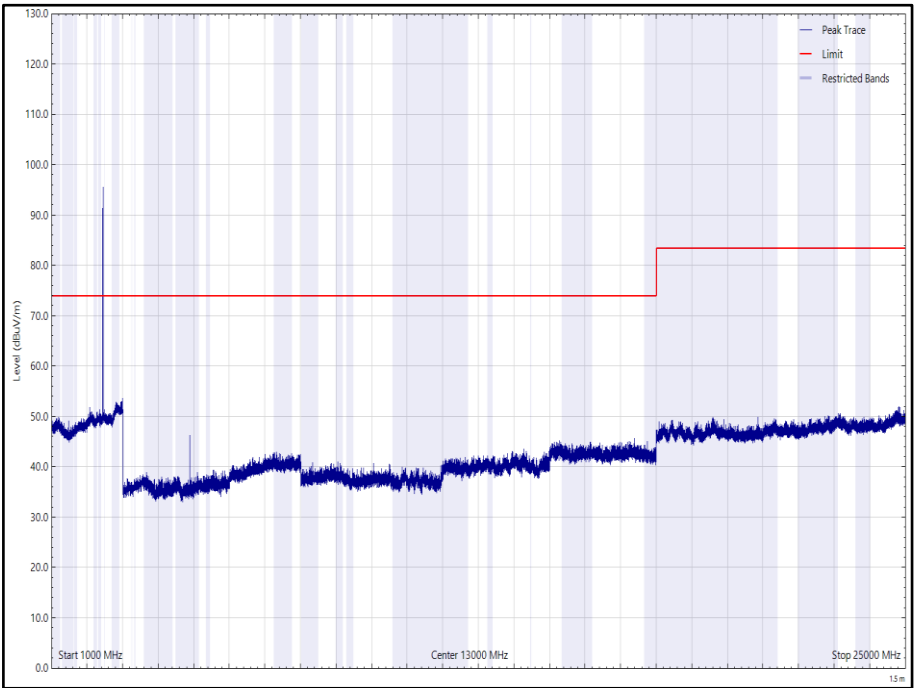


Figure 55 - CH17 (2440 MHz), LE1M, Orientation: Z, 1 GHz to 25 GHz, Horizontal (Peak)

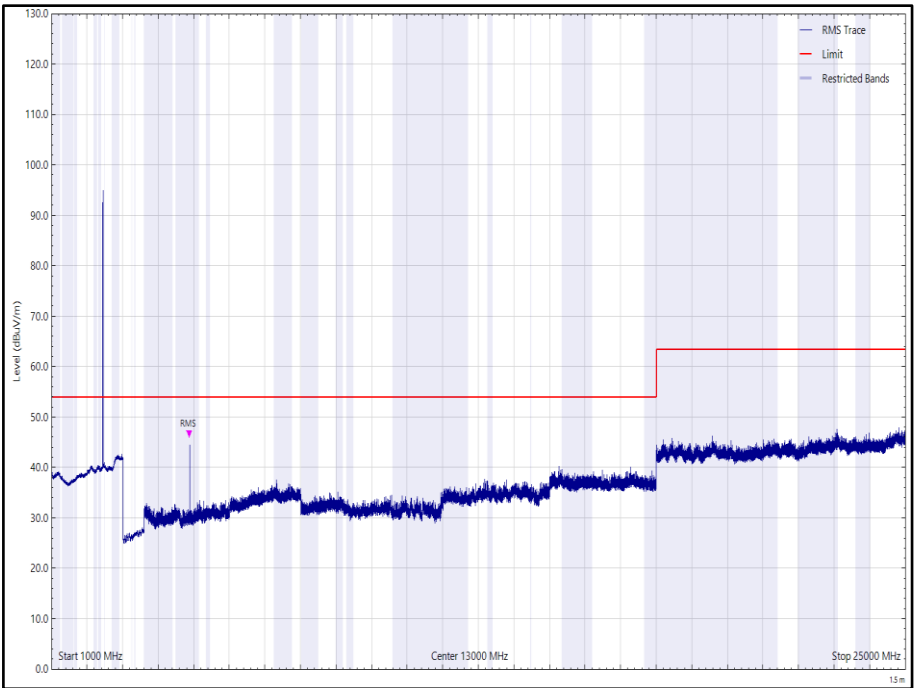


Figure 56 - CH17 (2440 MHz), LE1M, Orientation: Z, 1 GHz to 25 GHz, Horizontal (rms)

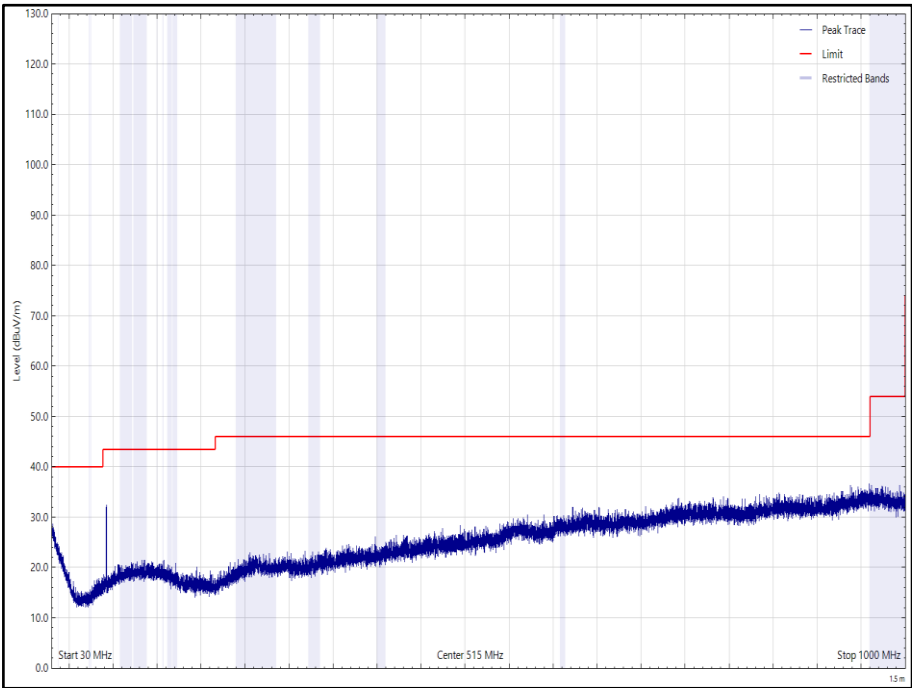


Figure 57 - CH17 (2440 MHz), LE1M, Orientation: Z, 30 MHz to 1 GHz, Vertical (Peak)

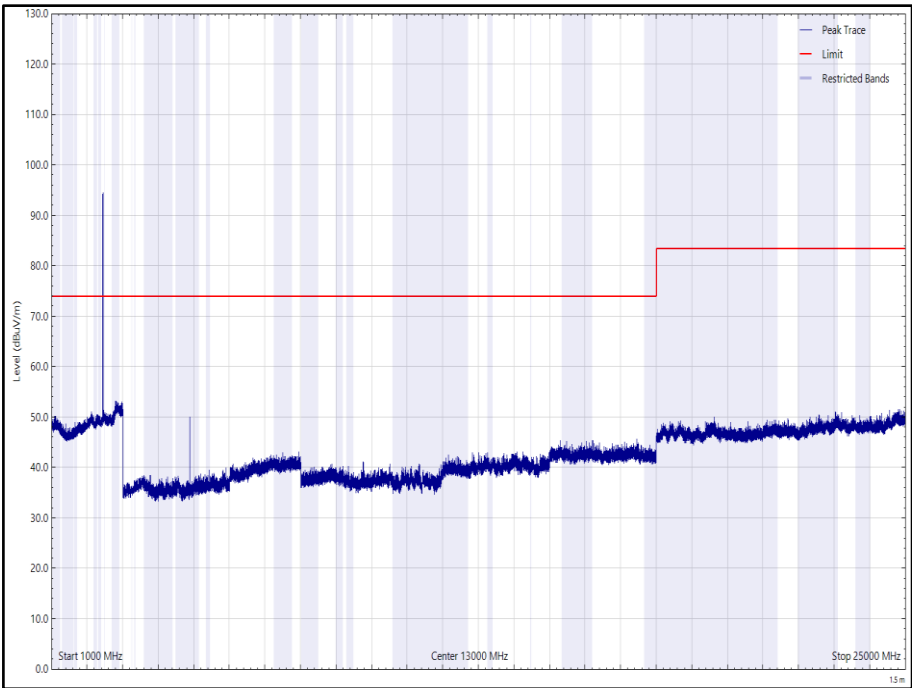


Figure 58 - CH17 (2440 MHz), LE1M, Orientation: Z, 1 GHz to 25 GHz, Vertical (Peak)

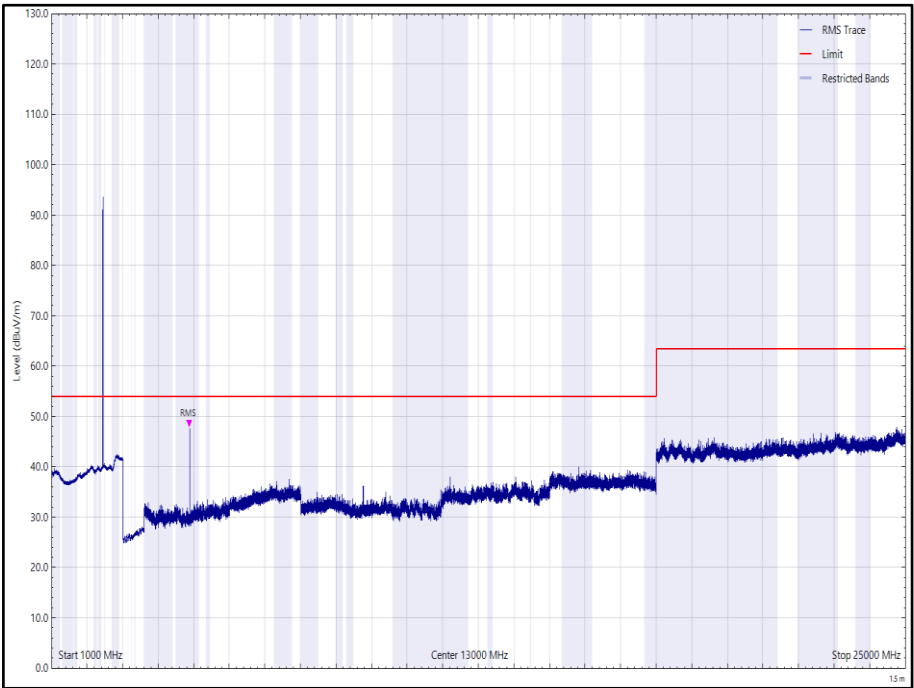


Figure 59 - CH17 (2440 MHz), LE1M, Orientation: Z, 1 GHz to 25 GHz, Vertical (rms)



Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
4959.836	48.1	54.0	-5.9	RMS	193	207	Vertical
4959.857	45.4	54.0	-8.6	RMS	329	100	Horizontal

Table 38 - CH39 (2480 MHz), LE1M, Orientation: Z, 30 MHz to 25 GHz

No other emissions found within 6 dB of the limit.

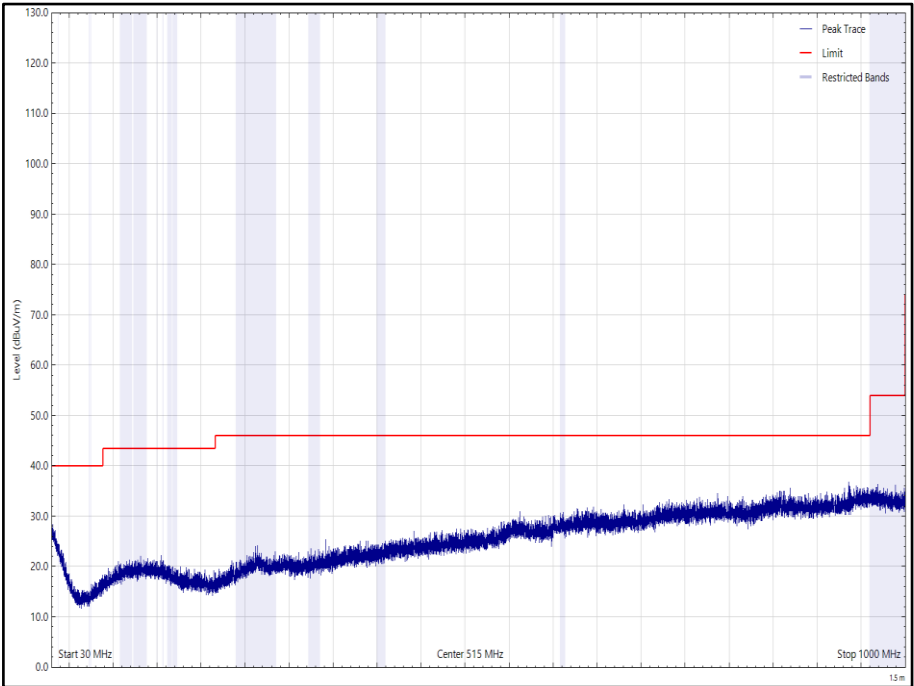


Figure 60 - CH39 (2480 MHz), LE1M, Orientation: Z, 30 MHz to 1 GHz, Horizontal (Peak)

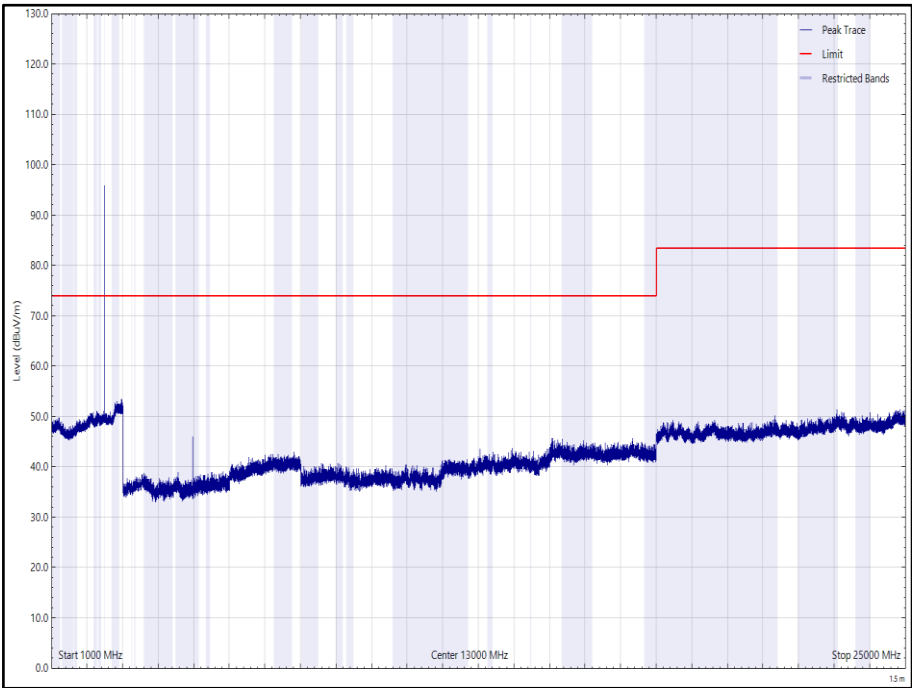


Figure 61 - CH39 (2480 MHz), LE1M, Orientation: Z, 1 GHz to 25 GHz, Horizontal (Peak)

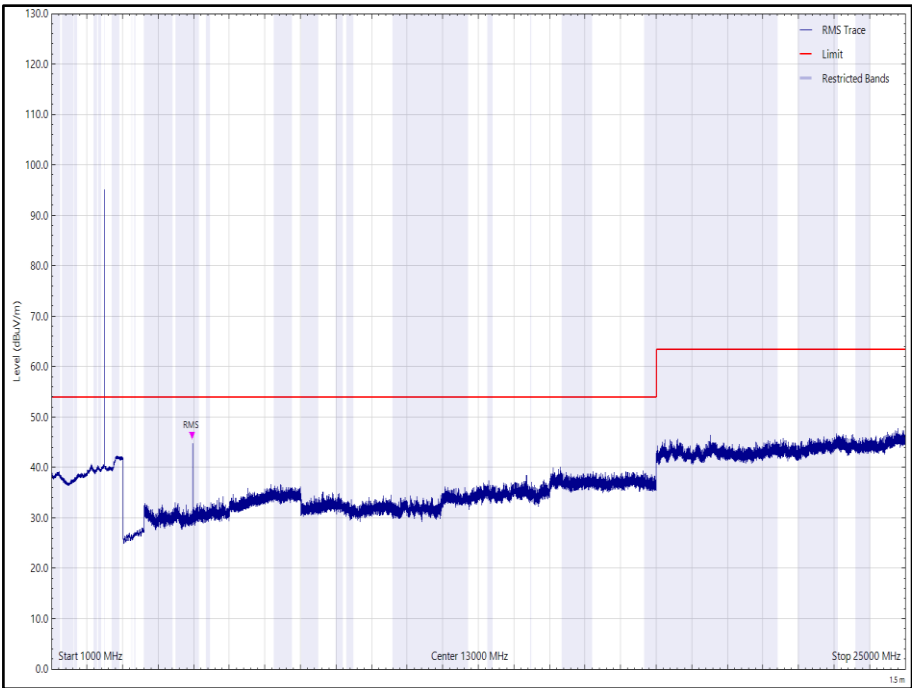


Figure 62 - CH39 (2480 MHz), LE1M, Orientation: Z, 1 GHz to 25 GHz, Horizontal (rms)

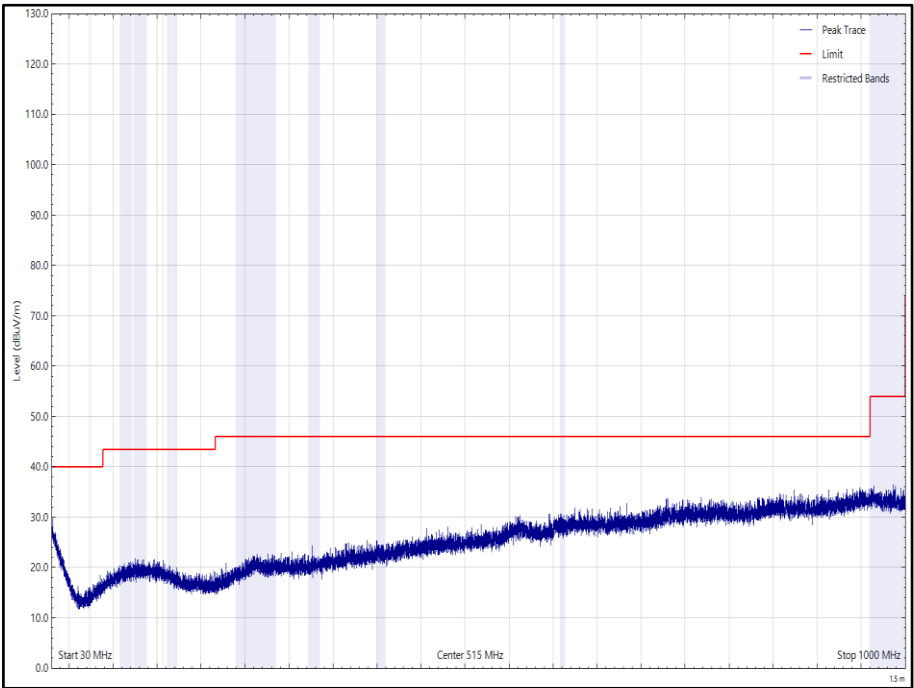


Figure 63 - CH39 (2480 MHz), LE1M, Orientation: Z, 30 MHz to 1 GHz, Vertical (Peak)

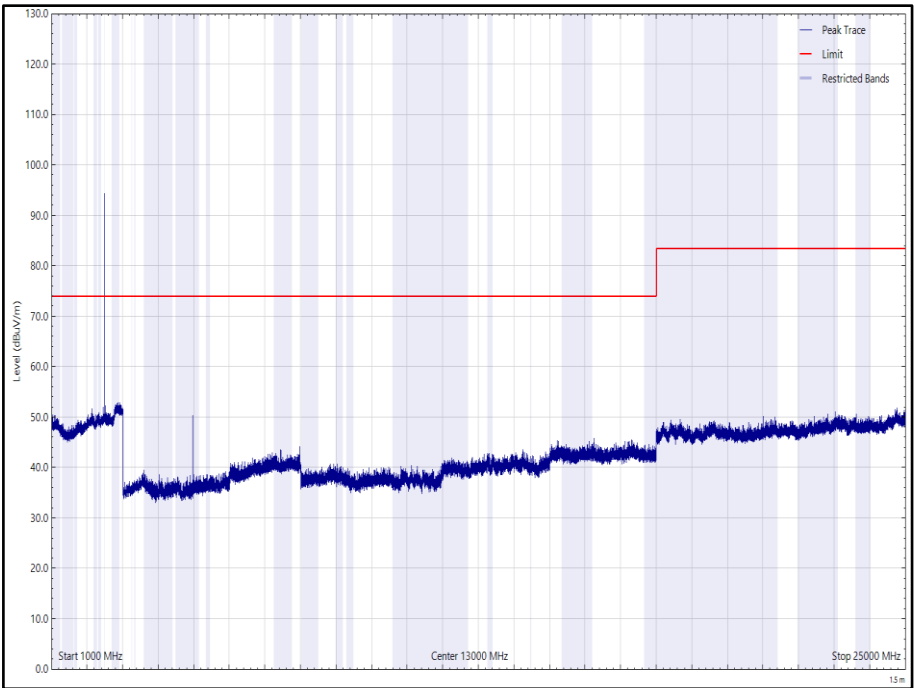


Figure 64 - CH39 (2480 MHz), LE1M, Orientation: Z, 1 GHz to 25 GHz, Vertical (Peak)

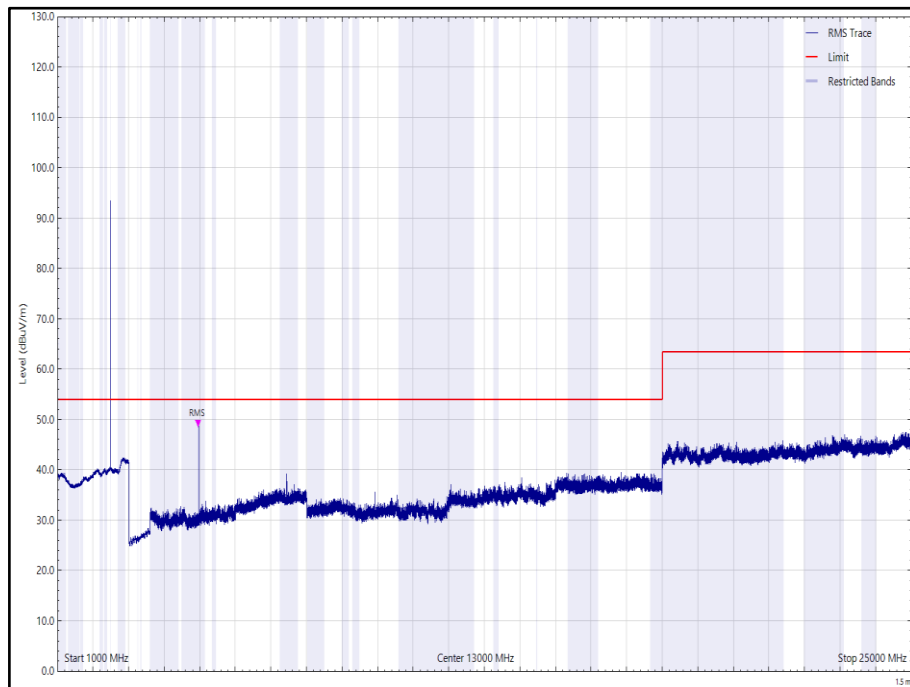


Figure 65 - CH39 (2480 MHz), LE1M, Orientation: Z, 1 GHz to 25 GHz, Vertical (rms)

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

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

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

ISED RSS-247, Limit Clause 5.5

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

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



2.5.8 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 12.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Comb Generator	Schaffner	RSG1000	3034	-	TU
Multimeter	Fluke	79 Series II	3057	12	23-Aug-2022
Test Receiver	Rohde & Schwarz	ESU40	3506	12	18-Mar-2022
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	23-Jul-2022
Emissions Software	TUV SUD	EmX V3.0.1	5125	-	Software
Horn Antenna (15-40GHz)	Schwarzbeck	BBHA 9170	5217	12	25-Jan-2023
Preamplifier (30dB 18-40GHz)	Schwarzbeck	BBV 9721	5218	12	25-Jan-2023
Pre-Amplifier (1 GHz to 18 GHz)	Schwarzbeck	BBV 9718 C	5350	12	22-Sep-2022
Cable (N-Type to N-Type, 8 m)	Teledyne	PR90-088-8MTR	5450	6	01-Apr-2022
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB-40	5481	12	31-Mar-2022
3 GHz High pass Filter	Wainwright	WHKX12-2580-3000-18000-80SS	5548	12	07-May-2022
Antenna (DRG, 7.5 GHz to 18 GHz)	Schwarzbeck	HWRD750	5610	12	15-Oct-2022
Antenna (DRG, 1 GHz to 10 GHz)	Schwarzbeck	BBHA 9120 B	5611	12	15-Oct-2022
Turntable & Mast Controller	Maturo Gmbh	NCD/498/2799.01	5612	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	5613	-	TU
Turntable	Maturo Gmbh	Turntable 1.5 SI-2t	5614	-	TU
Antenna (Bi-Log, 30 MHz to 1 GHz)	Teseq	CBL6111D	5615	24	16-Oct-2022
Screened Room (12)	MVG	EMC-3	5621	36	11-Aug-2023
EMI Test Receiver	Rohde & Schwarz	ESW44	5914	12	21-Feb-2023

Table 39

TU - Traceability Unscheduled



2.6 Authorised Band Edges

2.6.1 Specification Reference

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

2.6.2 Equipment Under Test and Modification State

EM1, S/N: 00003P - Modification State 0

2.6.3 Date of Test

17-February-2022 to 14-May-2022

2.6.4 Test Method

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

2.6.5 Environmental Conditions

Ambient Temperature	20.0 - 27.7 °C
Relative Humidity	23.3 - 41.1 %



2.6.6 Test Results

Internal Antenna - BLE - Single Antenna

Modulation	Frequency (MHz)	Band Edge Frequency (MHz)	Level (dBc)
GFSK	2402	2400	-44.89
GFSK	2480	2483.5	-47.71

Table 40

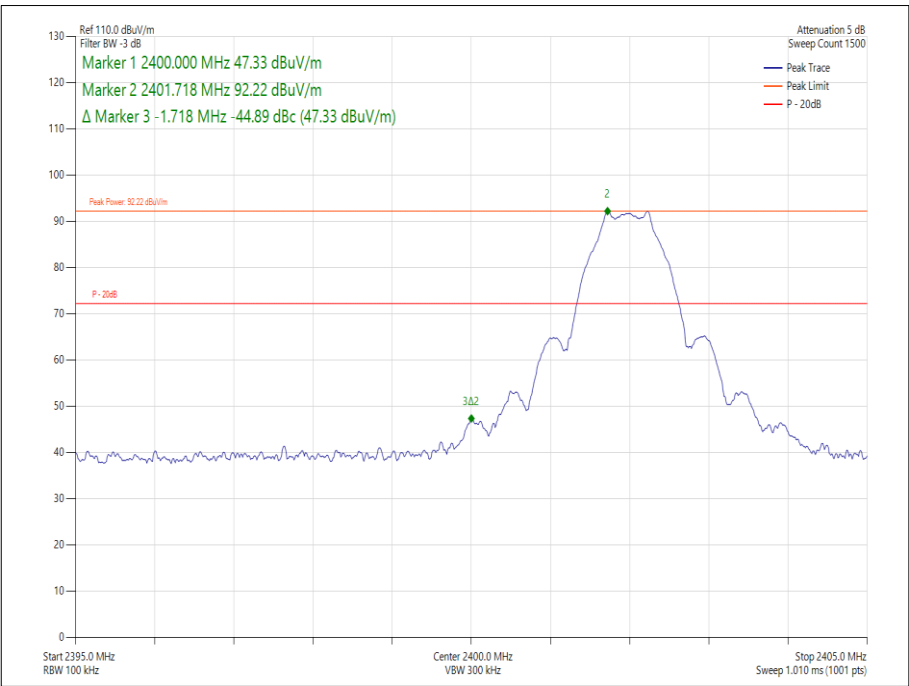


Figure 66 - GFSK, 2402 MHz - Band Edge Frequency 2400 MHz

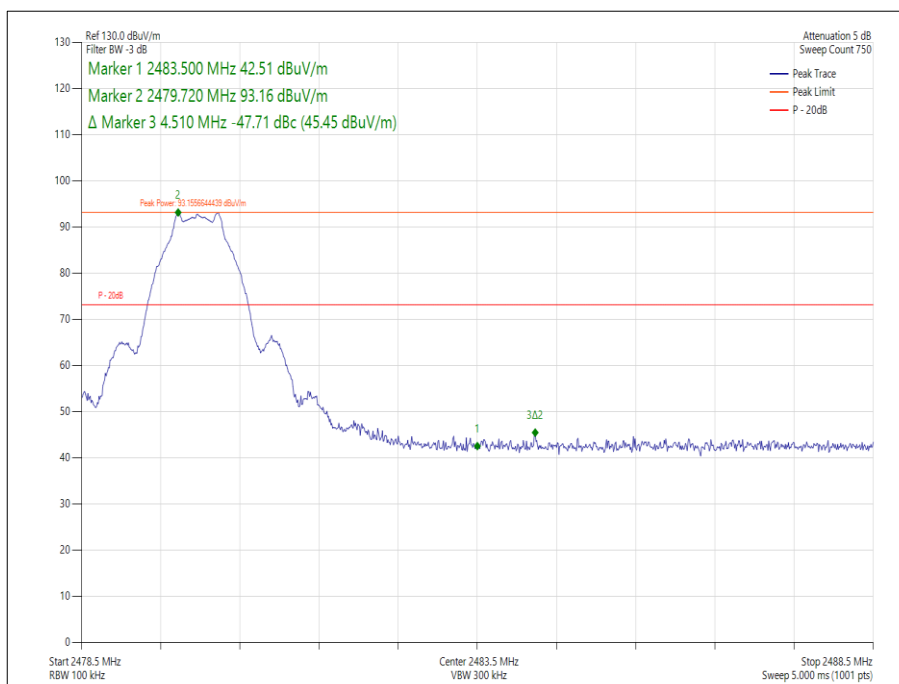


Figure 67 - GFSK, 2480 MHz - Band Edge Frequency 2483.5 MHz

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

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

ISED RSS-247, Limit Clause 5.5

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



2.6.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 12.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Test Receiver	Rohde & Schwarz	ESU40	3506	12	18-Mar-2022
Cable (SMA to SMA, 2 m)	Rhophase	3PS-1801A-2000-3PS	4113	12	27-Jan-2023
Emissions Software	TUV SUD	EmX V3.0.1	5125	-	Software
Cable (N to N 8m)	Teledyne	PR90-088-8MTR	5212	12	06-Sep-2022
Cable (N-Type to N-Type, 8 m)	Teledyne	PR90-088-8MTR	5450	6	01-Apr-2022
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB-40	5471	12	06-Apr-2023
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB-40	5481	12	31-Mar-2022
Antenna (DRG, 1 GHz to 10 GHz)	Schwarzbeck	BBHA 9120 B	5611	12	15-Oct-2022
Turntable & Mast Controller	Maturo Gmbh	NCD/498/2799.01	5612	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	5613	-	TU
Turntable	Maturo Gmbh	Turntable 1.5 SI-2t	5614	-	TU
Screened Room (12)	MVG	EMC-3	5621	36	11-Aug-2023
EMI Test Receiver	Rohde & Schwarz	ESW44	5914	12	21-Feb-2023

Table 41

TU - Traceability Unscheduled



2.7 Power Spectral Density

2.7.1 Specification Reference

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

2.7.2 Equipment Under Test and Modification State

EM1, S/N: 00002P - Modification State 0

2.7.3 Date of Test

27-April-2022

2.7.4 Test Method

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

2.7.5 Environmental Conditions

Ambient Temperature	24.3 °C
Relative Humidity	27.3 %



2.7.6 Test Results

Internal Antenna - BLE - Single Antenna

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 (Main)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	RBW (kHz)	PSD (dBm/RBW)					Limit (dBm/3 kHz)	Margin (dB)
		A	B	C	D	Σ		
2402	3.0	-9.55	-	-	-	-	8.00	-17.55
2440	3.0	-12.29	-	-	-	-	8.00	-20.29
2480	3.0	-13.27	-	-	-	-	8.00	-21.27

Table 42 - 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



2.7.7 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
Hygrometer	Rotronic	I-1000	3220	12	05-Nov-2022
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	30-Jun-2022
MXA Signal Analyser	Keysight Technologies	N9020B	5529	24	06-Jun-2022
Signal Conditioning Unit	TUV SUD	SCU002	5759	12	30-Jun-2022

Table 43

3 Photographs

3.1 Test Setup Photographs



Figure 68 - AC Line Conducted Emissions



Figure 69 - AC Line Conducted Emissions

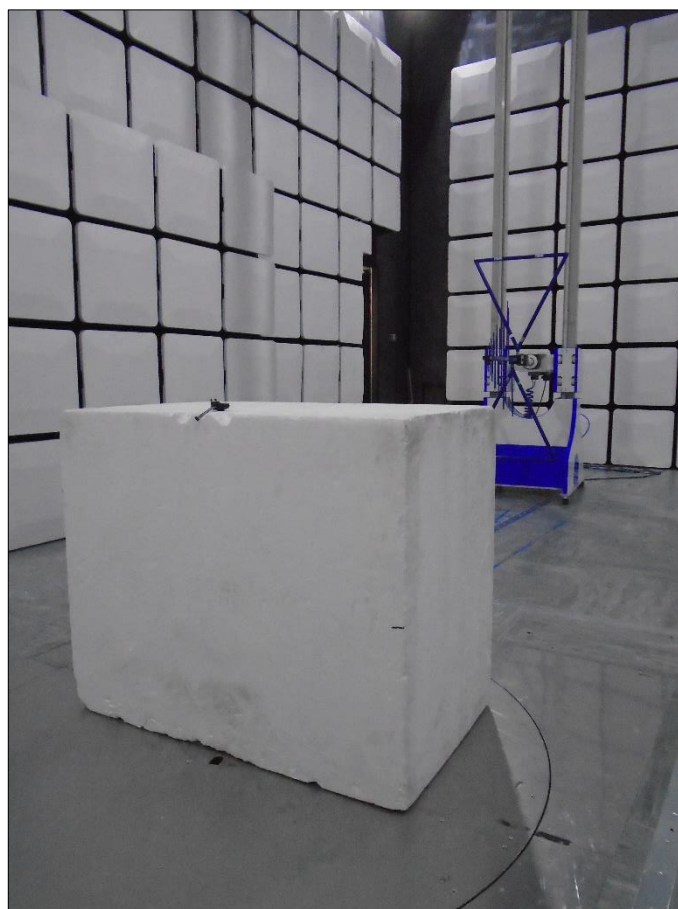


Figure 70 - Test Setup - 30 MHz to 1 GHz Orientation X



Figure 71 - Test Setup - 30 MHz to 1 GHz Orientation Y



Figure 72 - Test Setup - 30 MHz to 1 GHz Orientation Z

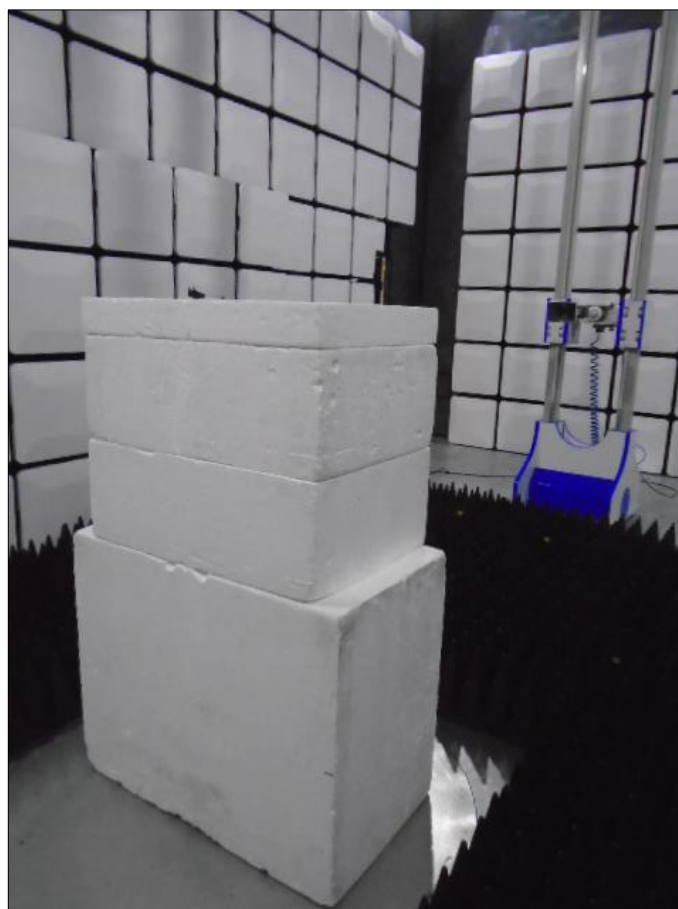


Figure 73 - Test Setup - 1 GHz to 18 GHz Orientation X

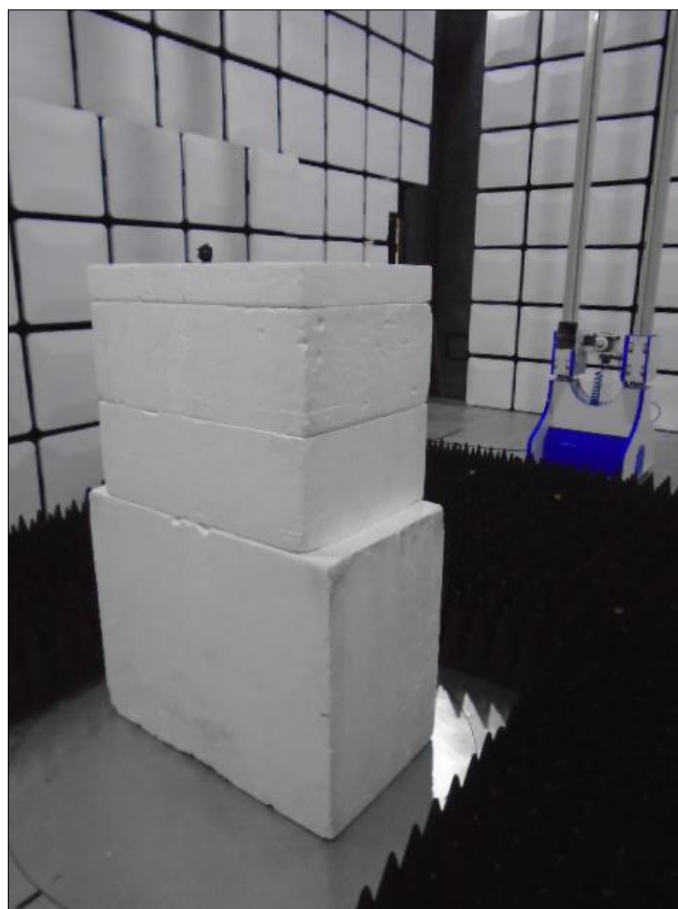


Figure 74 - Test Setup - 1 GHz to 18 GHz Orientation Y



Figure 75 - Test Setup - 1 GHz to 18 GHz Orientation Z



Figure 76 - Test Setup - 18 GHz to 25 GHz Orientation X

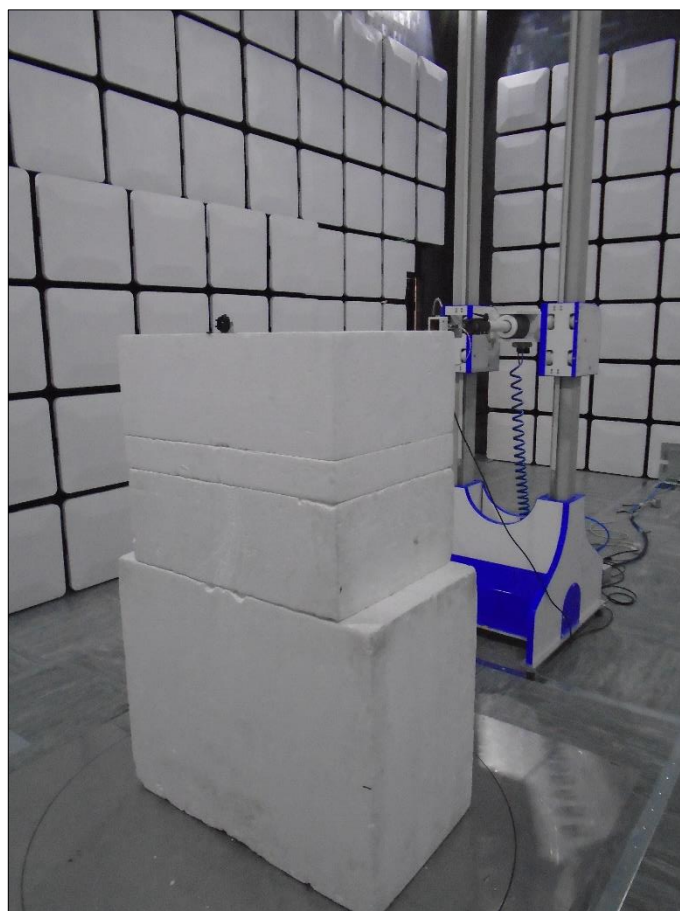


Figure 77 - Test Setup - 18 GHz to 25 GHz Orientation Y

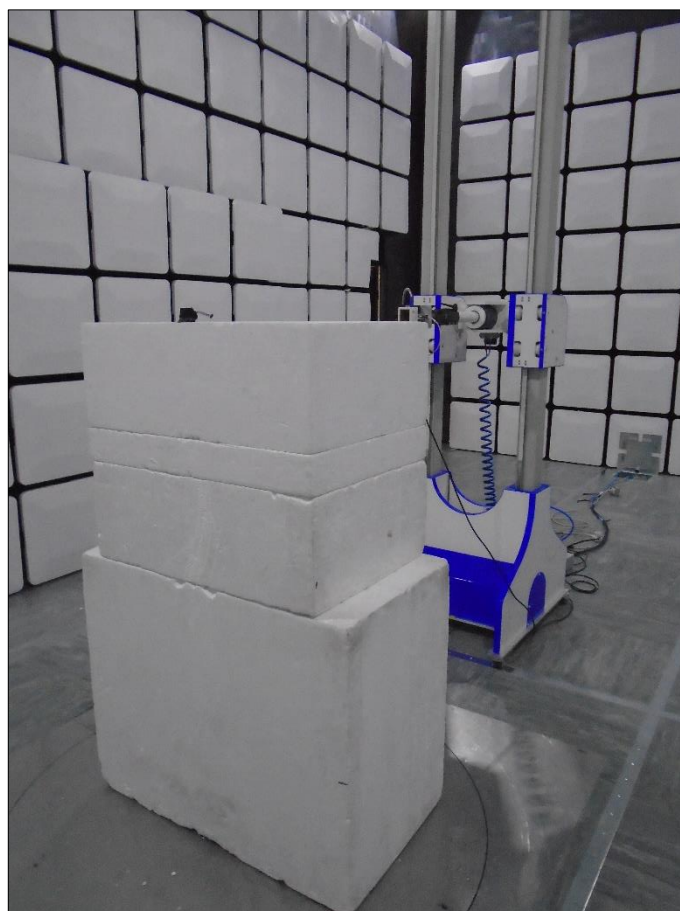


Figure 78 - Test Setup - 18 GHz to 25 GHz Orientation Z



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
AC Power Line Conducted Emissions	150 kHz to 30 MHz, LISN, ± 3.7 dB
Emission Bandwidth	± 50.10 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
Power Spectral Density	± 3.2 dB

Table 44

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.