

FCC and ISED Test Report

Reelables, Inc
Model: N-Label



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

Prepared for: Reelables, Inc.
113 Cherry St. 76660,
Seattle,
Washington
United States 98104

FCC ID: 2A7TQRN0001

IC: 33042-RN0001

COMMERCIAL-IN-CONFIDENCE

Document 75961990-02 Issue 02

SIGNATURE

NAME	JOB TITLE	RESPONSIBLE FOR	ISSUE DATE
Steve Marshall	Senior Engineer	Authorised Signatory	21 January 2025

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	Ahmad Javid	21 January 2025	
	Thomas Biddlecombe	21 January 2025	

FCC Accreditation

492497/UK2010 Octagon House, Fareham Test Laboratory

ISED Accreditation

12669A/UK0003 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: 2023, ISED RSS-247: Issue 3 (2023-08) and ISED RSS-GEN: Issue 5 (2018-04) + A2 (2021-02) 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	06 January 2025
2	Update to FCC ID, Antenna Gain, Device Category and Output Power	21 January 2025

Table 1

1.2 Introduction

Applicant	Reelables, Inc.
Manufacturer	Reelables Europe, Ltd.
Model Number(s)	N-Label
Serial Number(s)	RAD 1 CON 1
Hardware Version(s)	5.61
Software Version(s)	1.11
Number of Samples Tested	2
Test Specification/Issue/Date	FCC 47 CFR Part 15C: 2023 ISED RSS-247: Issue 3 (2023-08) ISED RSS-GEN: Issue 5 (2018-04) + A2 (2021-02)
Order Number	15018
Date	11-July-2024
Date of Receipt of EUT	10-September-2024
Start of Test	10-September-2024
Finish of Test	11-September-2024
Name of Engineer(s)	Ahmad Javid Thomas Biddlecombe
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, ISSED RSS-247 and ISSED RSS-GEN is shown below.

Section	Specification Clause			Test Description	Result	Comments/Base Standard
	Part 15C	RSS-247	RSS-GEN			
Configuration and Mode: Bluetooth Low Energy						
-	15.203	-	-	Antenna Requirement	N/T	The EUT meets the requirements of 15.203 as it uses permanently attached integral antennas
2.1	15.205	3.3	8.10	Restricted Band Edges	Pass	ANSI C63.10 (2020)
2.2	15.247 (a)(2)	5.2	6.7	Emission Bandwidth	Pass	ANSI C63.10 (2020)
2.3	15.247 (b)	5.4	6.12	Maximum Conducted Output Power	Pass	ANSI C63.10 (2020)
2.4	15.247 (d)	5.5	-	Authorised Band Edges	Pass	ANSI C63.10 (2020)
2.5	15.247 (d) and 15.209	3.3 & 5.5	6.13 & 8.9	Spurious Radiated Emissions	Pass	ANSI C63.10 (2020)
2.6	15.247 (e)	5.2	6.12	Power Spectral Density	Pass	ANSI C63.10 (2020)

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 N-Label from Reelables is an NB-IoT cellular device in the form factor of a thin 4x8" shipping label. It tracks the location of parcels and cargo using cell tower positioning and WiFi SSID scanning only. The intended use is a stickable label to corrugated paper cartons or other shippable containers. The N-Label comprises the following wireless technologies: NB-IoT, Bluetooth, WiFi (RX scan only) and NFC (passive).	
Manufacturer:		Reelables Europe, Ltd.	
Model:		N-Label	
Part Number:		N0001	
Hardware Version:		5.61	
Software Version:		1.11	
FCC ID of the product under test – see guidance here		2A7TQRN0001	
IC ID of the product under test – see guidance here		33042-RN0001	
Device Category	Mobile ☐	Portable ☒	Fixed ☐
Equipment is fitted with an Audio Low Pass Filter		Yes ☐	No ☒

Table 3

Intentional Radiators

Technology	NB-IoT Band 13	NB-IoT Band 12	NB-IoT Band 5	Bluetooth Low Energy		
Frequency Range (MHz to MHz)	777MHz- 787MHz	698MHz- 716MHz	824MHz- 849MHz	2400MHz- 2483.5MHz		
Conducted Declared Output Power (dBm)	10dBm	20dBm	18dBm	2.5dBm		
Antenna Gain (dBi)	-0.4	-0.43	-2.07	2.14		
Supported Bandwidth(s) (MHz) (e.g. 1 MHz, 20 MHz, 40 MHz)	200KHz	200KHz	200KHz	1, 2		
Modulation Scheme(s) (e.g. GFSK, QPSK etc)	QPSK BPSK	QPSK BPSK	QPSK BPSK	GFSK		
ITU Emission Designator (see guidance here) (not mandatory for Part 15 devices)				1M00GXW, 2M00GXW		
Bottom Frequency (MHz)	777.0	701.5	826.5	2402		
Middle Frequency (MHz)	782.0	707.5	836.5	2440		
Top Frequency (MHz)	787.0	713.5	846.5	2480		

Table 4



Un-intentional Radiators

Highest frequency generated or used in the device or on which the device operates or tunes	2483.5MHz
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 5

AC Power Source

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

Table 6

DC Power Source

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

Table 7

Battery Power Source

Voltage:	4.5	V
End-point voltage:	2.2	V (Point at which the battery will terminate)
Alkaline ☐ Leclanche ☐ Lithium ☐ Nickel Cadmium ☐ Lead Acid* ☐ *(Vehicle regulated)		
Other ☒ Zinc-carbon	Please detail:	Zn-MnO2 coated battery

Table 8

Charging

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

Table 9

Temperature

Minimum temperature:	-20	°C
Maximum temperature:	50	°C

Table 10



Cable Loss

Adapter Cable Loss (Conducted sample)	0.9	dB
--	-----	----

Table 11

Antenna Characteristics

Antenna connector ☐			State impedance		Ohm
Temporary antenna connector ☐			State impedance		Ohm
Integral antenna ☒	Type:	PIFA	Gain	See above	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 ☐
 All part 15 applications will need to show how the antenna gain was derived either from a manufacturer data sheet or a measurement. Where the gain of the antenna is inherently accounted for as a result of the measurement, such as field strength measurements on a part 15.249 or 15.231 device, so the gain does not necessarily need to be verified. However, enough information regarding the construction of the antenna shall be provided. Such information maybe photographs, length of wire antenna etc.

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: Brian Krejcarek
 Position held: CEO
 Date: January 16, 2025



1.5 Product Information

1.5.1 Technical Description

The N-Label from Reelables is an NB-IoT cellular device in the form factor of a thin 4x8" shipping label. It tracks the location of parcels and cargo using cell tower positioning and WiFi SSID scanning only. The intended use is a stickable label to corrugated paper cartons or other shippable containers. The N-Label comprises the following wireless technologies: NB-IoT, Bluetooth, WiFi (RX scan only) and NFC (passive).

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: N-Label, Serial Number: CON 1			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: N-Label, Serial Number: RAD 1			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 14



1.8 Test Location

TÜV SÜD conducted the following tests at our Octagon House Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: Bluetooth Low Energy		
Restricted Band Edges	Ahmad Javid	UKAS
Emission Bandwidth	Thomas Biddlecombe	UKAS
Maximum Conducted Output Power	Thomas Biddlecombe	UKAS
Authorised Band Edges	Ahmad Javid	UKAS
Spurious Radiated Emissions	Ahmad Javid	UKAS
Power Spectral Density	Thomas Biddlecombe	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

N-Label, S/N RAD 1: - Modification State 0

2.1.3 Date of Test

11-September-2024

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	21.4 °C
Relative Humidity	55.6 %

2.1.6 Test Results

Bluetooth Low Energy

Modulation	Frequency (MHz)	Band Edge Frequency (MHz)	Peak Level (dBμV/m)	Average Level (dBμV/m)
GFSK	2402	2390	56.01	44.95
GFSK	2480	2483.5	61.39	48.94

Table 16

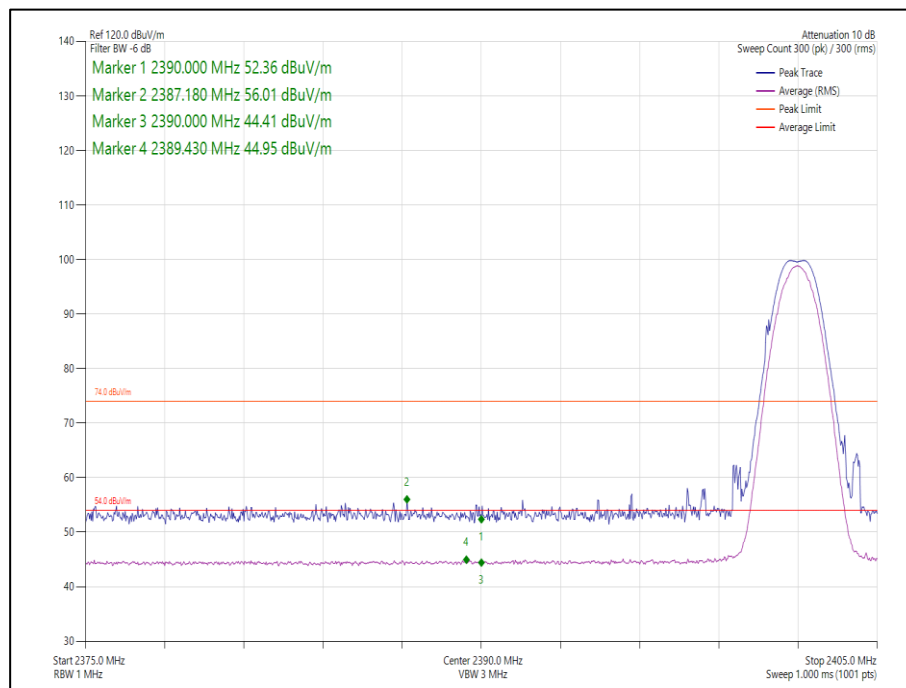


Figure 1 - GFSK - 2402 MHz - Band Edge Frequency 2390 MHz

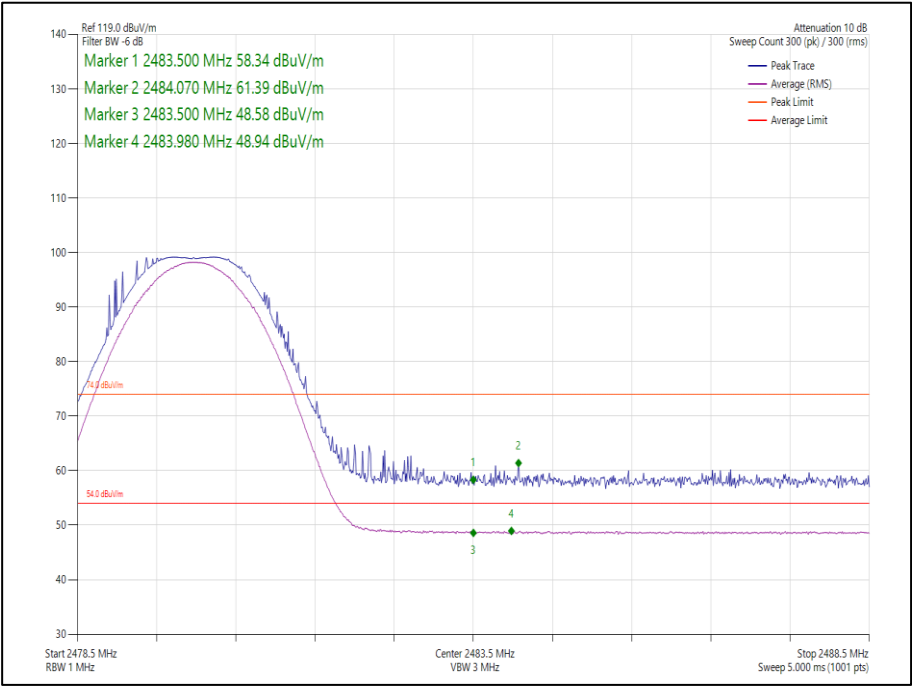


Figure 2 - GFSK - 2480 MHz - Band Edge Frequency 2483.5 MHz

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 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
3m Semi-Anechoic Chamber	Rainford	RF Chamber 5	1545	36	23-Apr-2027
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	18-Apr-2025
Mast Controller	Maturo GmbH	NCD	4810	-	TU
Tilt Antenna Mast	Maturo GmbH	TAM 4.0-P	4811	-	TU
Antenna (DRG 1-10.5GHz)	Schwarzbeck	BBHA9120B	4848	12	14-Jul-2025
Emissions Software	TUV SUD	EmX V3.4.2	5125	-	Software
Cable (SMA to SMA, 2 m)	Junkosha	MWX221-02000AMSAMS/A	5517	12	23-May-2025
Humidity & Temperature meter	R.S Components	1364	6149	12	12-Aug-2025
Cable (N to N 8m)	Junkosha	MWX221-08000NMSNMS/B	6331	12	17-Feb-2025

Table 19

TU - Traceability Unscheduled



2.2 Emission Bandwidth

2.2.1 Specification Reference

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

2.2.2 Equipment Under Test and Modification State

N-Label, S/N CON 1 - Modification State 0

2.2.3 Date of Test

11-September-2024

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	19.4 °C
Relative Humidity	45.8 %



2.2.6 Test Results

Bluetooth Low Energy

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

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

Test Frequency (MHz)	6 dB Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2402	0.908	-	-	-	≥500.0
2426	0.880	-	-	-	≥500.0
2480	0.924	-	-	-	≥500.0

Table 20 - 6 dB Bandwidth Results

Test Frequency (MHz)	99% Bandwidth (MHz)				Limit (kHz)
	A	B	C	D	
2402	1.116	-	-	-	-
2426	1.104	-	-	-	-
2480	1.100	-	-	-	-

Table 21 - 99% Bandwidth Results

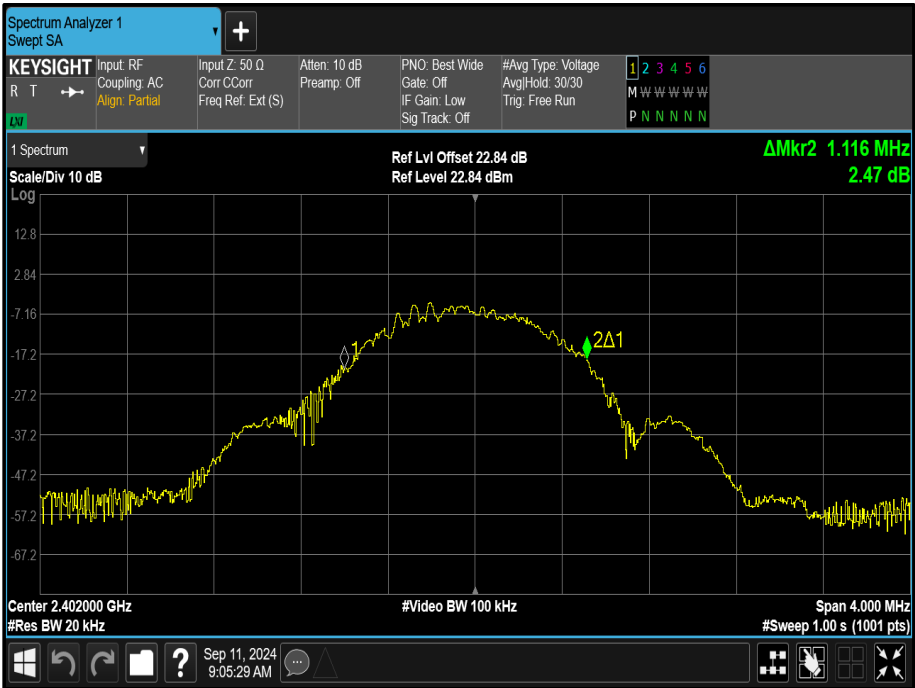


Figure 3 - 2402 MHz (CH37) 99% Bandwidth

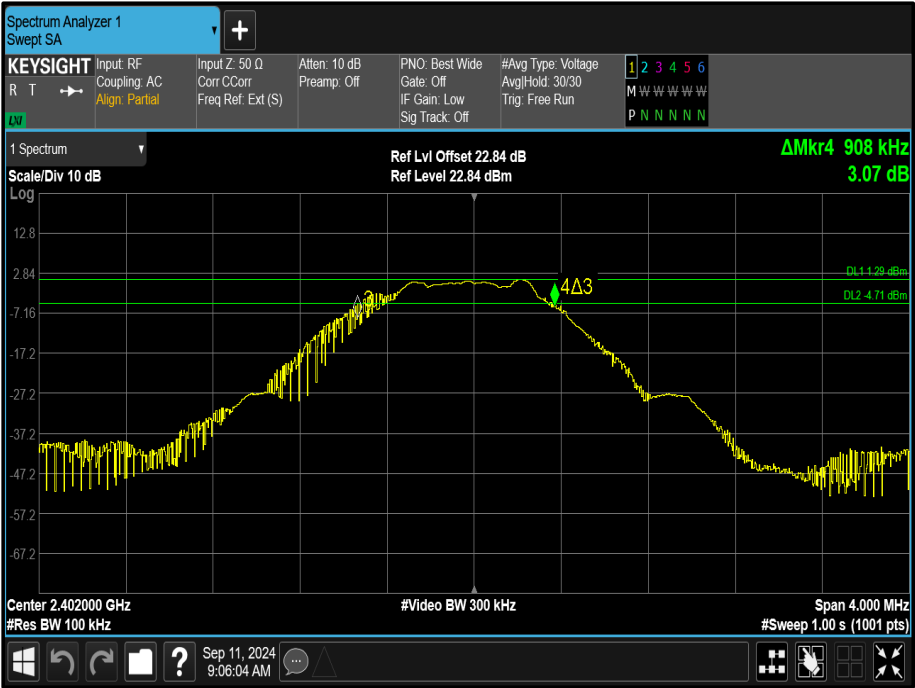


Figure 4 - 2402 MHz (CH37) 6 dB Bandwidth

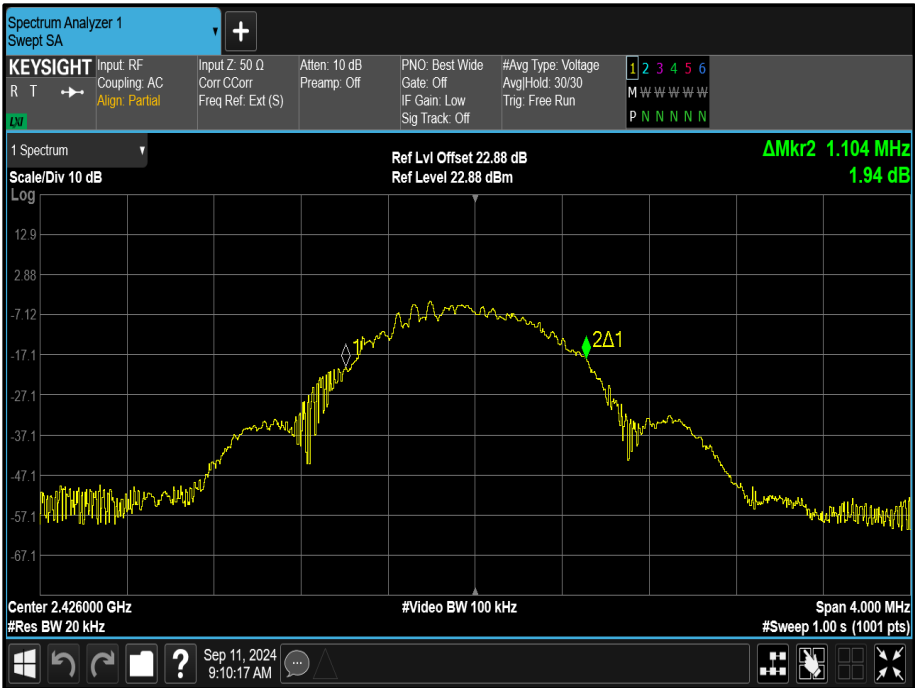


Figure 5 - 2426 MHz (CH38) 99% Bandwidth

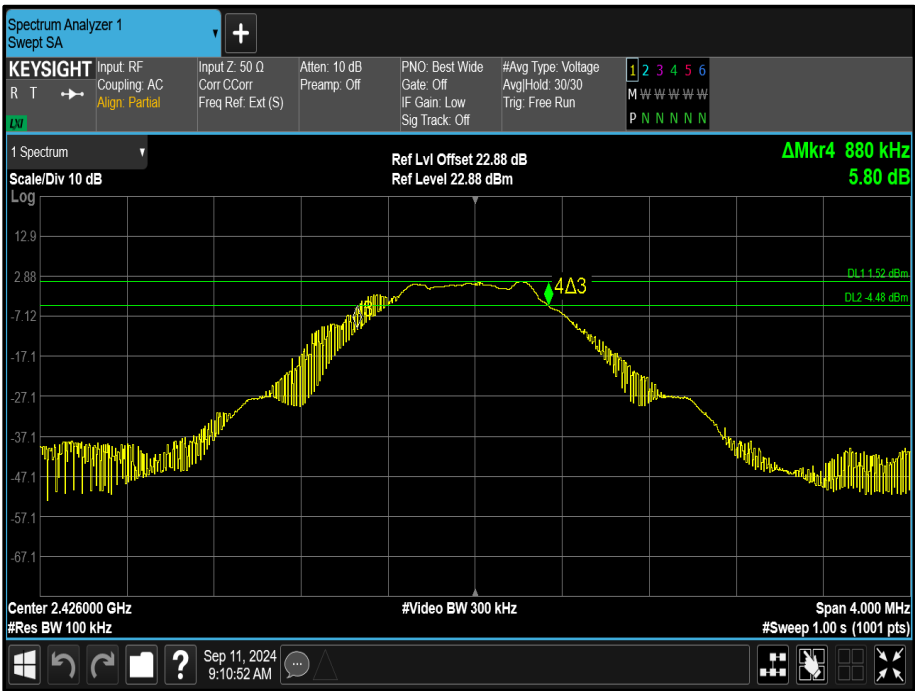


Figure 6 - 2426 MHz (CH38) 6 dB Bandwidth

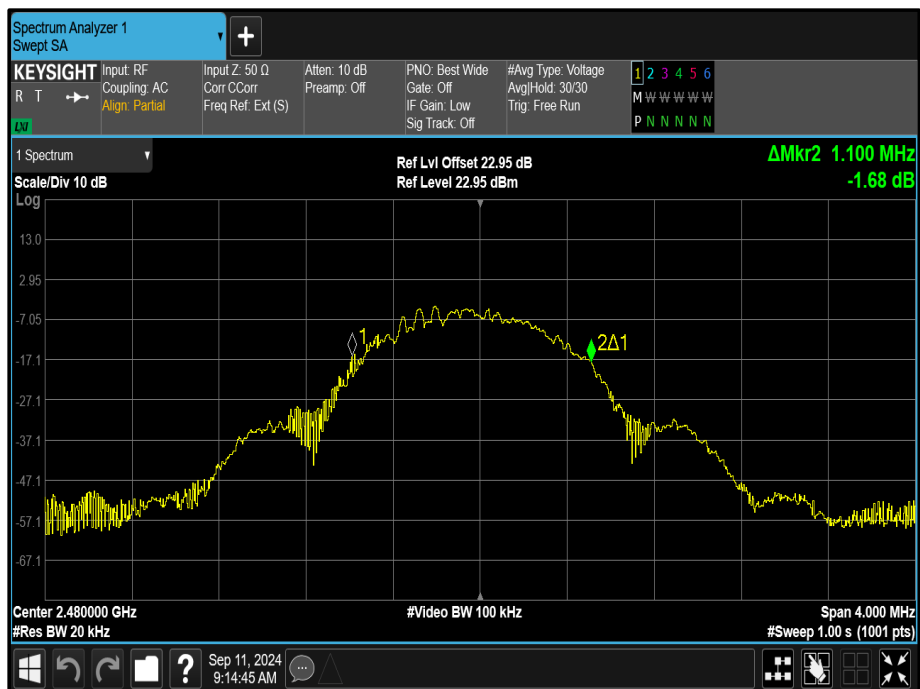


Figure 7 - 2480 MHz (CH39) 99% Bandwidth

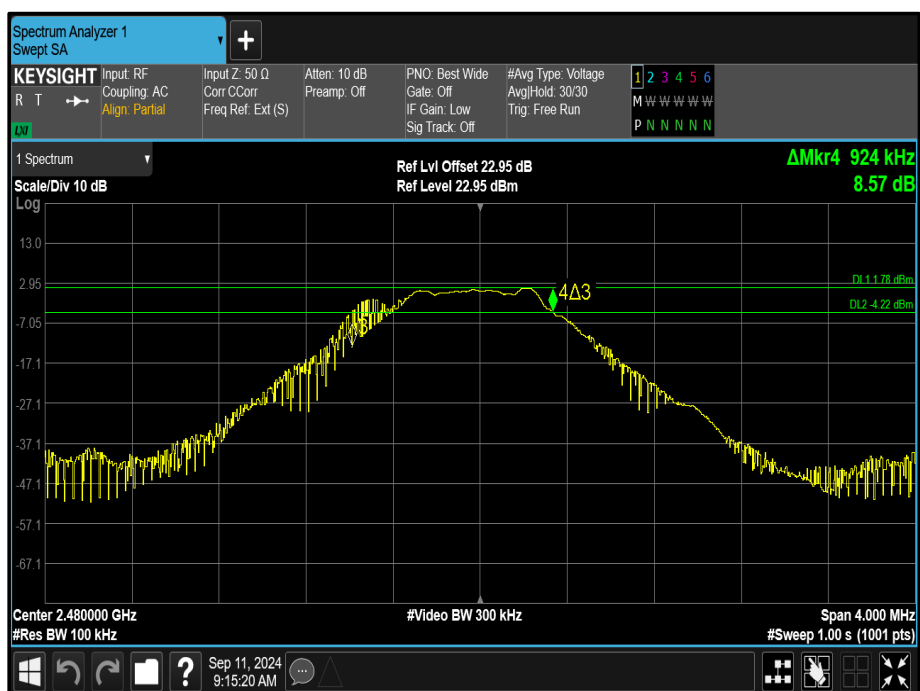


Figure 8 - 2480 MHz (CH39) 6 dB Bandwidth

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

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



2.2.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Hygrometer	Rotronic	I-1000	3220	12	28-Nov-2024
GPSDR Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	09-Mar-2025
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	18-Sep-2025
Signal Conditioning Unit	TUV SUD	SPECTRUM_SCU001	6350	12	02-Aug-2025
SCU Cable Assembly SCU	TUV SUD	SPECTRUM_SCU_CA	6638	12	02-Aug-2025

Table 22



2.3 Maximum Conducted Output Power

2.3.1 Specification Reference

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

2.3.2 Equipment Under Test and Modification State

N-Label, S/N CON 1 - Modification State 0

2.3.3 Date of Test

11-September-2024

2.3.4 Test Method

Bluetooth Low Energy

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

2.3.5 Environmental Conditions

Ambient Temperature 19.4 °C
Relative Humidity 45.8 %

2.3.6 Test Results

Bluetooth Low Energy

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	15.247 (b)(3) RSS-247 5.4 d)	Test Method(s):	C63.10 11.9.1.2
Additional Reference(s):	-		

DUT Configuration			
Mode:	BLE GFSK (LE 1M)	Duty Cycle (%):	98.6
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	Soldered SMA	Peak Antenna Gain (dBi):	2.14

Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)
	A	B	C	D	Σ		
2402	2.75	-	-	-	-	30.00	-27.25
2426	2.97	-	-	-	-	30.00	-27.03
2480	3.19	-	-	-	-	30.00	-26.81

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



Test Frequency (MHz)	Maximum Conducted Output Power (dBm)					Limit (dBm)	Margin (dB)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
	A	B	C	D	Σ					
2402	2.75	-	-	-	-	30.00	-27.25	4.89	36.00	-31.11
2426	2.97	-	-	-	-	30.00	-27.03	5.11	36.00	-30.89
2480	3.19	-	-	-	-	30.00	-26.81	5.33	36.00	-30.67

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

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

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

ISED RSS-247, Limit Clause 5.4 (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 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Hygrometer	Rotronic	I-1000	3220	12	28-Nov-2024
GPSDR Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	09-Mar-2025
USB Power Sensor	Boonton	RTP5008	5833	12	26-Jul-2025
Signal Conditioning Unit	TUV SUD	SPECTRUM_SCU001	6350	12	02-Aug-2025
SCU Cable Assembly SCU	TUV SUD	SPECTRUM_SCU_CA	6638	12	02-Aug-2025

Table 25

TU - Traceability Unscheduled

O/P Mon – Output Monitored using calibrated equipment



2.4 Authorised Band Edges

2.4.1 Specification Reference

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

2.4.2 Equipment Under Test and Modification State

N-Label, S/N RAD 1 - Modification State 0

2.4.3 Date of Test

11-September-2024

2.4.4 Test Method

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

2.4.5 Environmental Conditions

Ambient Temperature 21.4 °C
Relative Humidity 55.6 %

2.4.6 Test Results

Bluetooth Low Energy

Modulation	Frequency (MHz)	Band Edge Frequency (MHz)	Level (dBc)
GFSK	2402	2400	-45.72
GFSK	2480	2483.5	-48.16

Table 26

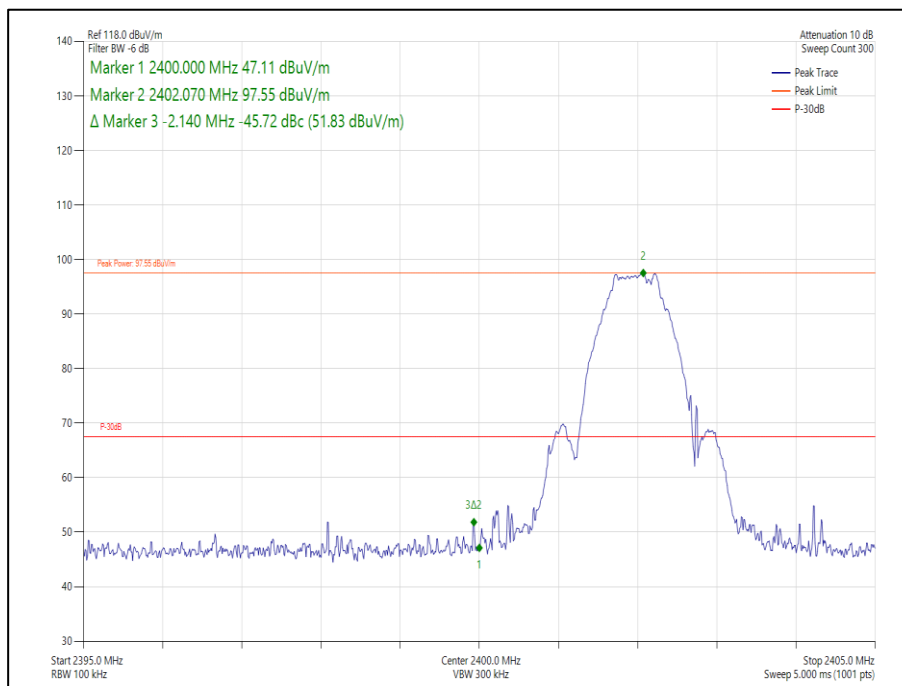


Figure 9 - GFSK, 2402 MHz - Band Edge Frequency 2400 MHz

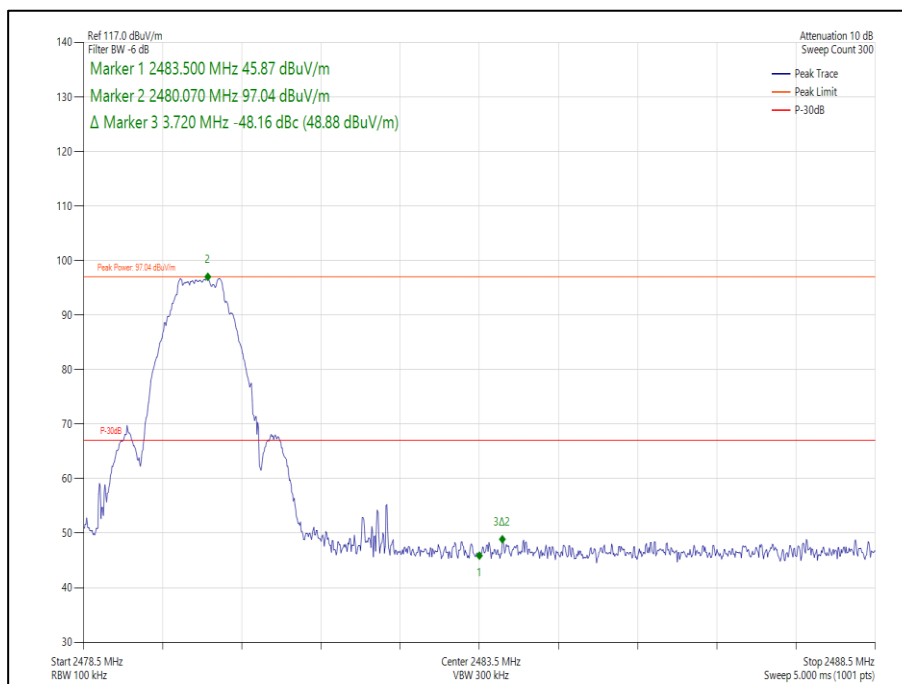


Figure 10 - GFSK, 2480 MHz - Band Edge Frequency 2483.5 MHz



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.

2.4.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
3m Semi-Anechoic Chamber	Rainford	RF Chamber 5	1545	36	23-Apr-2027
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	18-Apr-2025
Mast Controller	Maturo GmbH	NCD	4810	-	TU
Tilt Antenna Mast	Maturo GmbH	TAM 4.0-P	4811	-	TU
Antenna (DRG 1-10.5GHz)	Schwarzbeck	BBHA9120B	4848	12	14-Jul-2025
Emissions Software	TUV SUD	EmX V3.4.2	5125	-	Software
Cable (SMA to SMA, 2 m)	Junkosha	MWX221-02000AMSAMS/A	5517	12	23-May-2025
Humidity & Temperature meter	R.S Components	1364	6149	12	12-Aug-2025
Cable (N to N 8m)	Junkosha	MWX221-08000NMSNMS/B	6331	12	17-Feb-2025

Table 27

TU - Traceability Unscheduled



2.5 Spurious Radiated Emissions

2.5.1 Specification Reference

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

2.5.2 Equipment Under Test and Modification State

N-Label, S/N RAD 1 - Modification State 0

2.5.3 Date of Test

10-September-2024 to 11-September-2024

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. As the EUT was considered mobile/portable and therefore reasonable to 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

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 uV/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 $20 \cdot \text{LOG}(3/1) = 9.54$ dB.

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

2.5.5 Example Test Setup Diagram

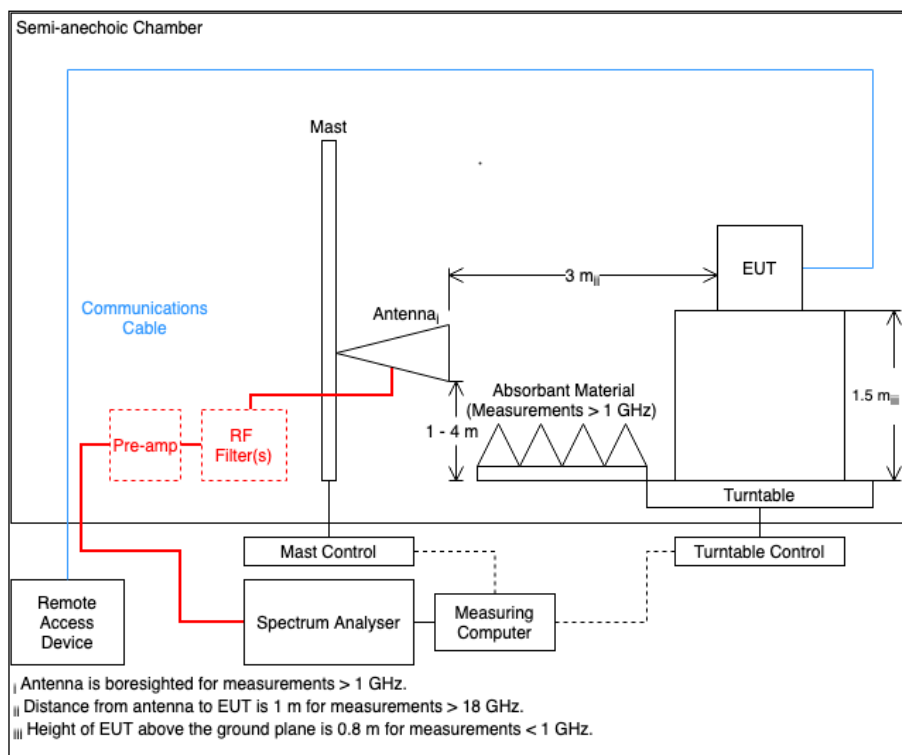


Figure 11

2.5.6 Environmental Conditions

Ambient Temperature 20.3 - 21.4 °C
Relative Humidity 53.4 - 55.6 %

2.5.7 Test Results

Bluetooth Low Energy

Frequency (MHz)	Level	Limit	Margin (dB)	Detector	Unit	Angle (°)	Height (cm)	Polarisation
*								

Table 28 - Ch39_BLE_LE1M - X, 2480 MHz, 30 MHz to 25 GHz

*No emissions found within 10 dB of the limit.

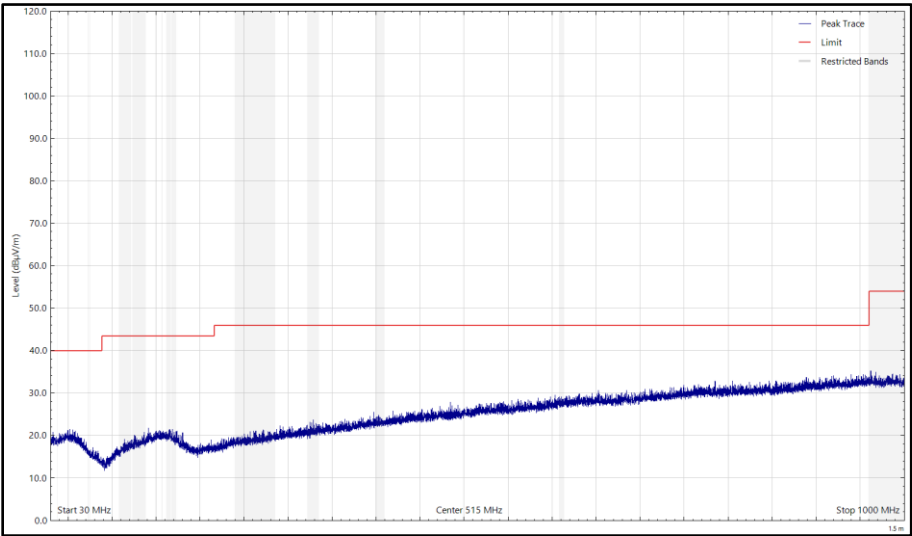


Figure 12 - Ch39_BLE_LE1M - X, 2480 MHz, 30 MHz to 1 GHz, Horizontal (Peak)

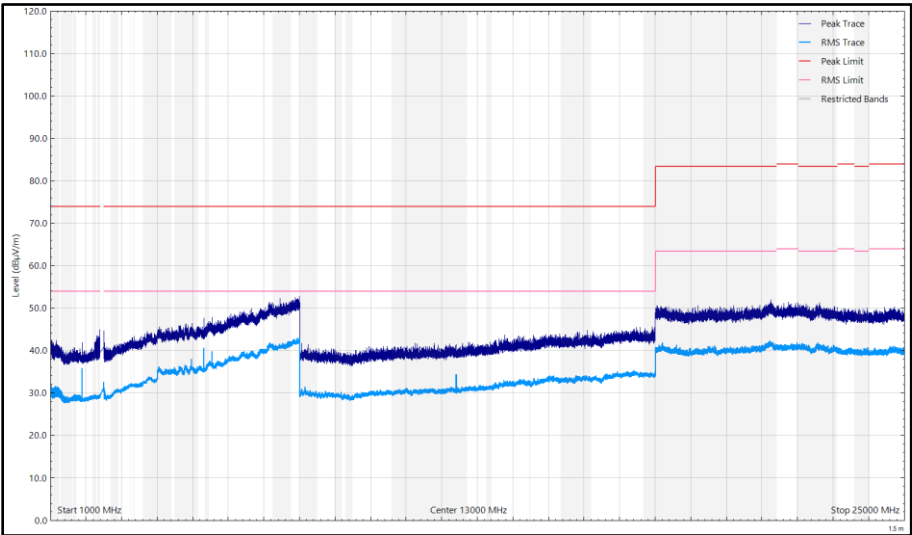


Figure 13 - Ch39_BLE_LE1M - X, 2480 MHz, 1 GHz to 25 GHz, Horizontal

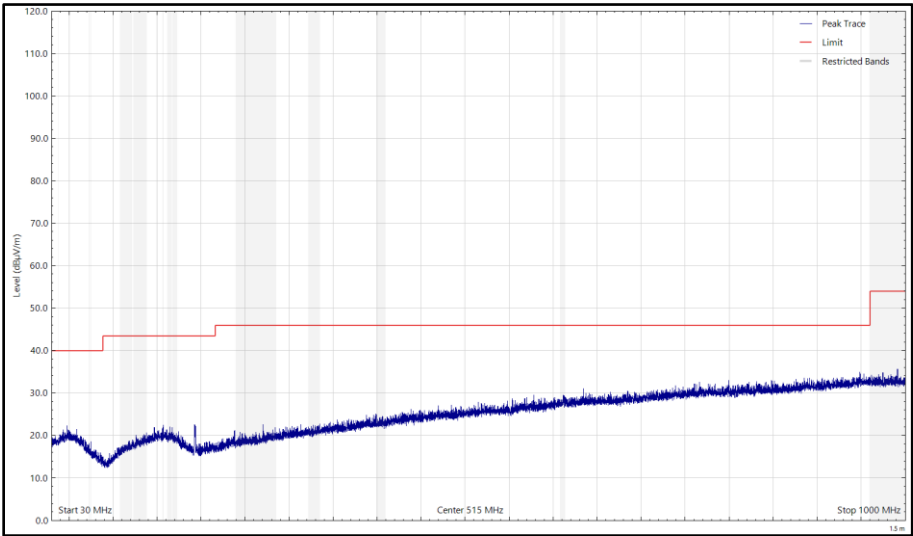


Figure 14 - Ch39_BLE_LE1M - X, 2480 MHz, 30 MHz to 1 GHz, Vertical (Peak)

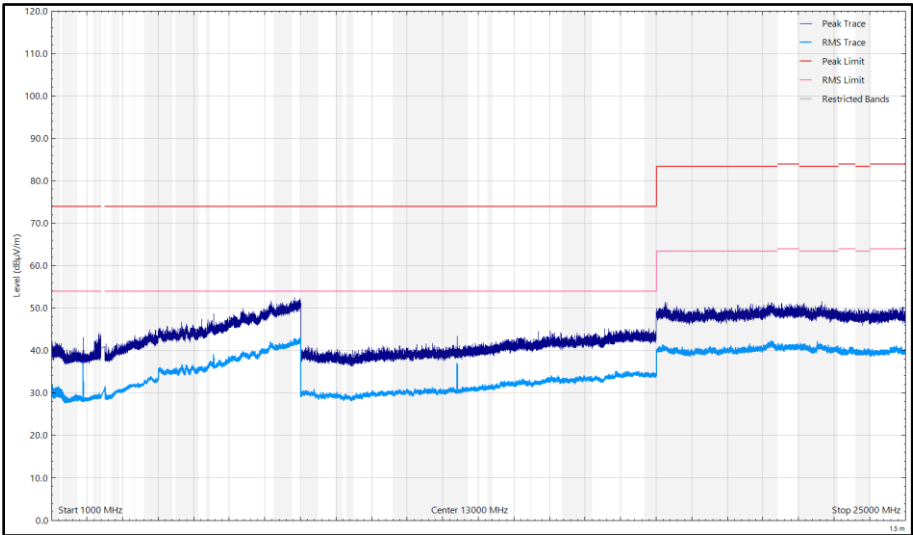


Figure 15 - Ch39_BLE_LE1M - X, 2480 MHz, 1 GHz to 25 GHz, Vertical

Frequency (MHz)	Level	Limit	Margin (dB)	Detector	Unit	Angle (°)	Height (cm)	Polarisation
952.760	34.36	46.00	-11.64	Q-Peak	dBuV/m	308	100	Vertical

Table 29 - Ch39_BLE_LE1M - Y, 2480 MHz, 30 MHz to 25 GHz

No other emissions found within 10 dB of the limit.

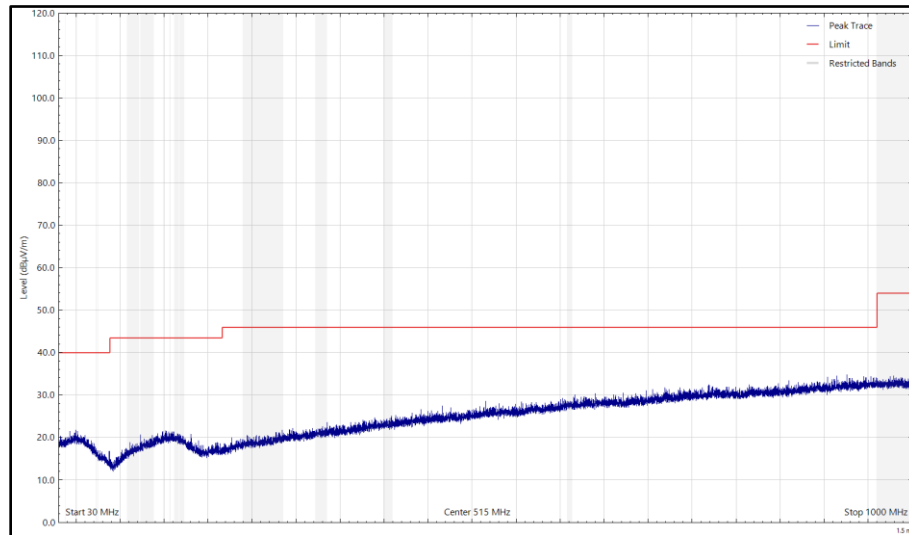


Figure 16 - Ch39_BLE_LE1M - Y, 2480 MHz, 30 MHz to 1 GHz, Horizontal (Peak)

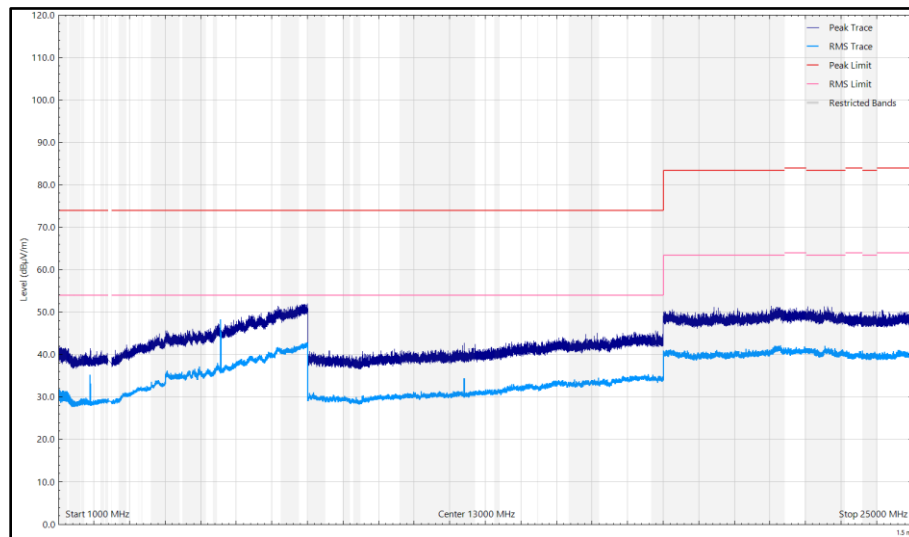


Figure 17 - Ch39_BLE_LE1M - Y, 2480 MHz, 1 GHz to 25 GHz, Horizontal

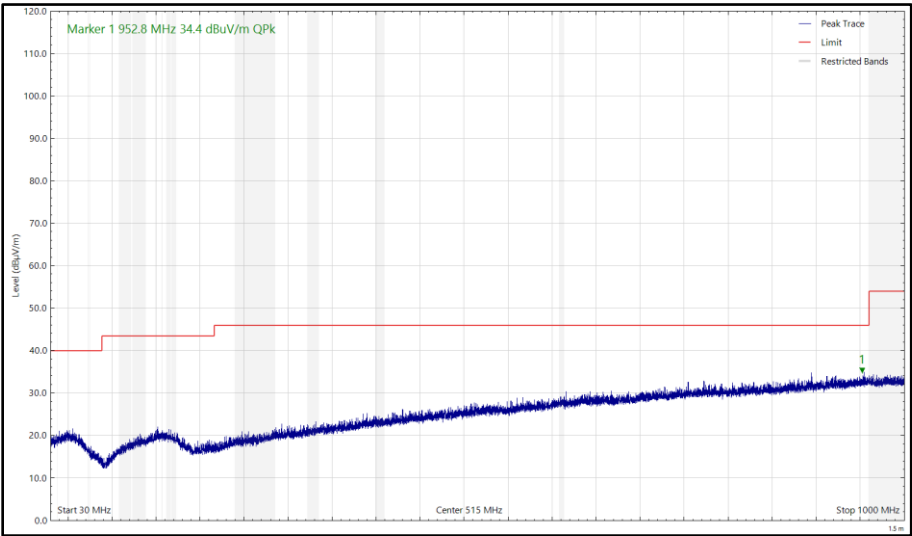


Figure 18 - Ch39_BLE_LE1M - Y, 2480 MHz, 30 MHz to 1 GHz, Vertical (Peak)

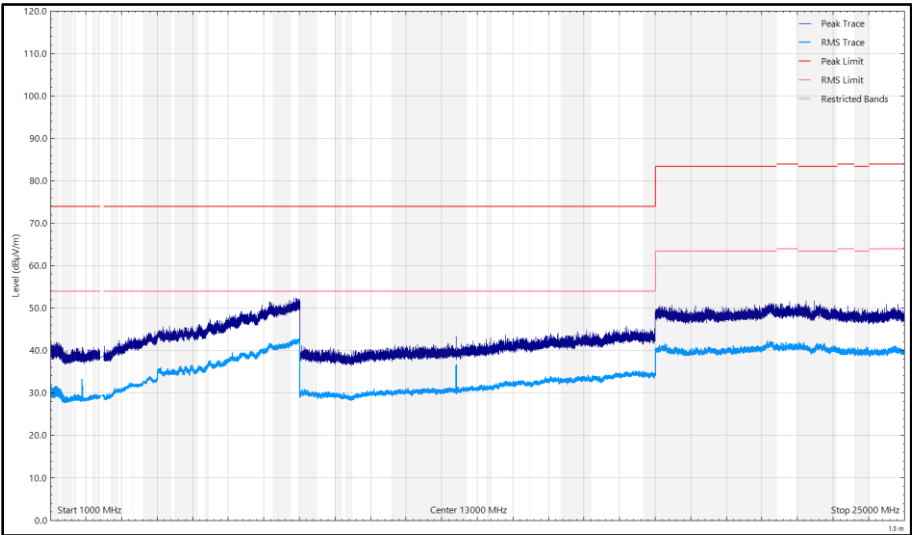


Figure 19 - Ch39_BLE_LE1M - Y, 2480 MHz, 1 GHz to 25 GHz, Vertical



Frequency (MHz)	Level	Limit	Margin (dB)	Detector	Unit	Angle (°)	Height (cm)	Polarisation
*								

Table 30 - Ch39_BLE_LE1M - Z, 2480 MHz, 30 MHz to 25 GHz

*No emissions found within 10 dB of the limit.

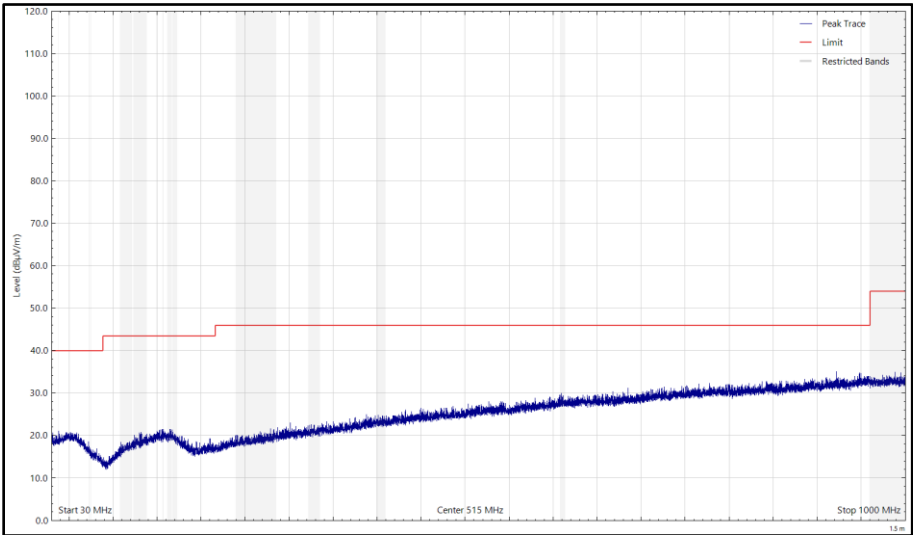


Figure 20 - Ch39_BLE_LE1M - Z, 2480 MHz, 30 MHz to 1 GHz, Horizontal (Peak)

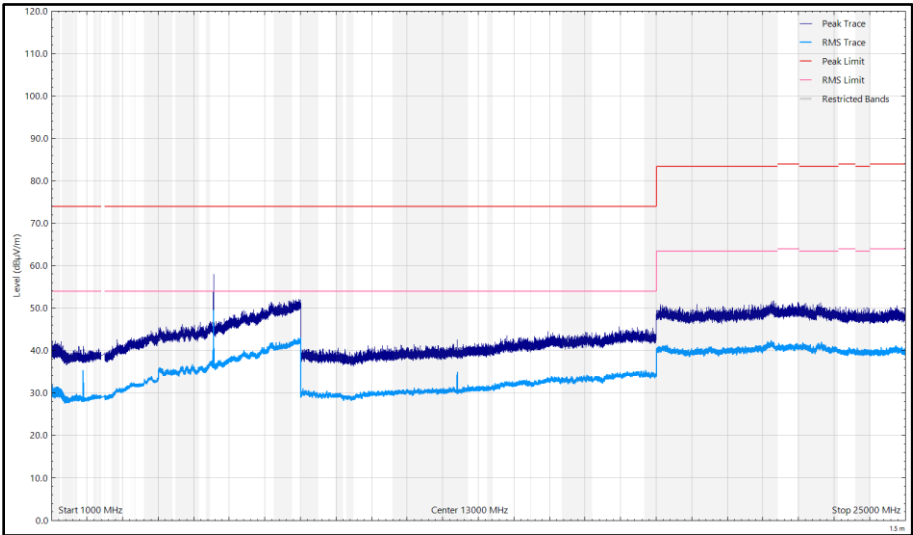


Figure 21 - Ch39_BLE_LE1M - Z, 2480 MHz, 1 GHz to 25 GHz, Horizontal

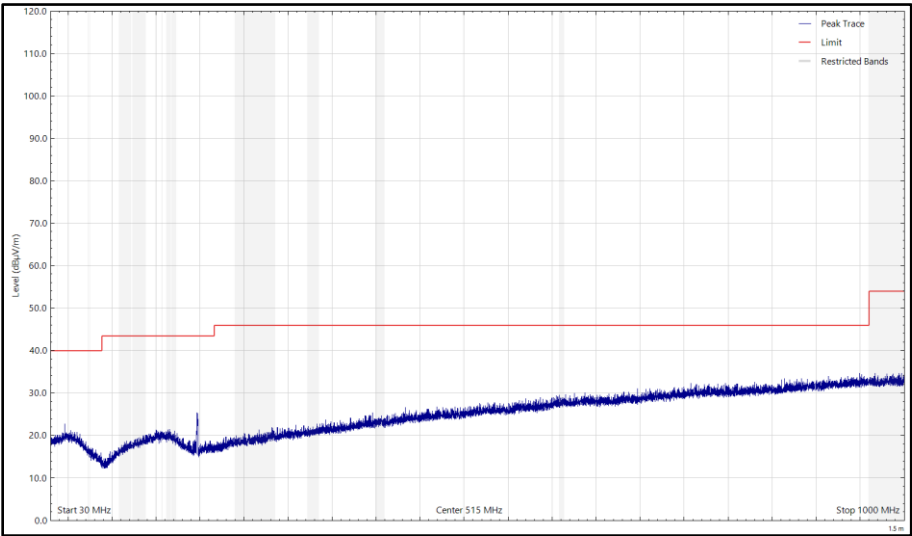


Figure 22 - Ch39_BLE_LE1M - Z, 2480 MHz, 30 MHz to 1 GHz, Vertical (Peak)

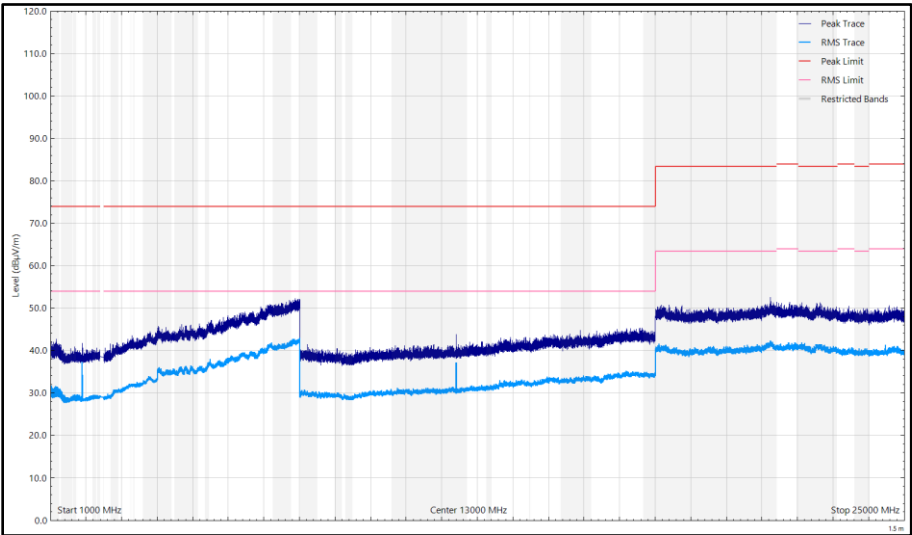


Figure 23 - Ch39_BLE_LE1M - Z, 2480 MHz, 1 GHz to 25 GHz, Vertical

Frequency (MHz)	Level	Limit	Margin (dB)	Detector	Unit	Angle (°)	Height (cm)	Polarisation
5532.220	35.46	54.00	-18.54	RMS	dBuV/m	245	271	Horizontal

Table 31 - Ch17_BLE_LE1M - Z, 2440 MHz, 30 MHz to 25 GHz

No other emissions found within 10 dB of the limit.

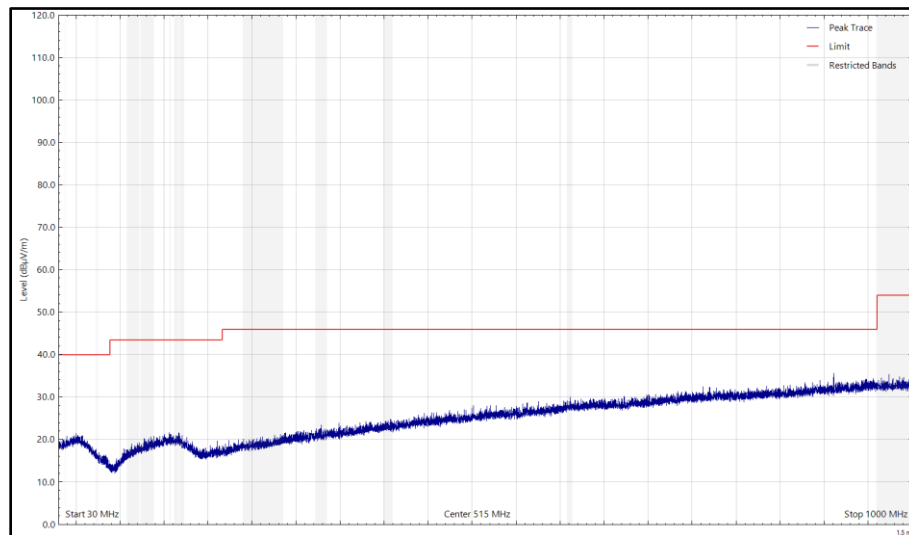


Figure 24 - Ch17_BLE_LE1M - Z, 2440 MHz, 30 MHz to 1 GHz, Horizontal (Peak)

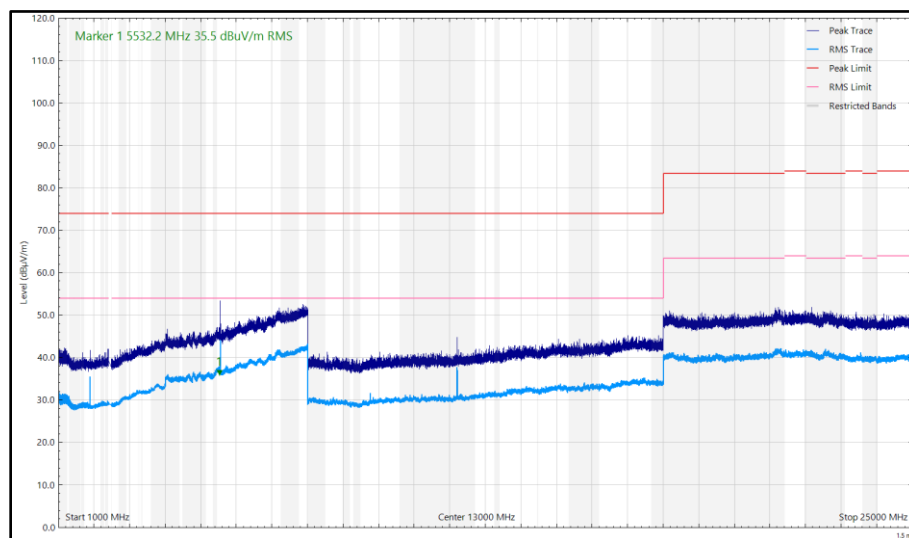


Figure 25 - Ch17_BLE_LE1M - Z, 2440 MHz, 1 GHz to 25 GHz, Horizontal

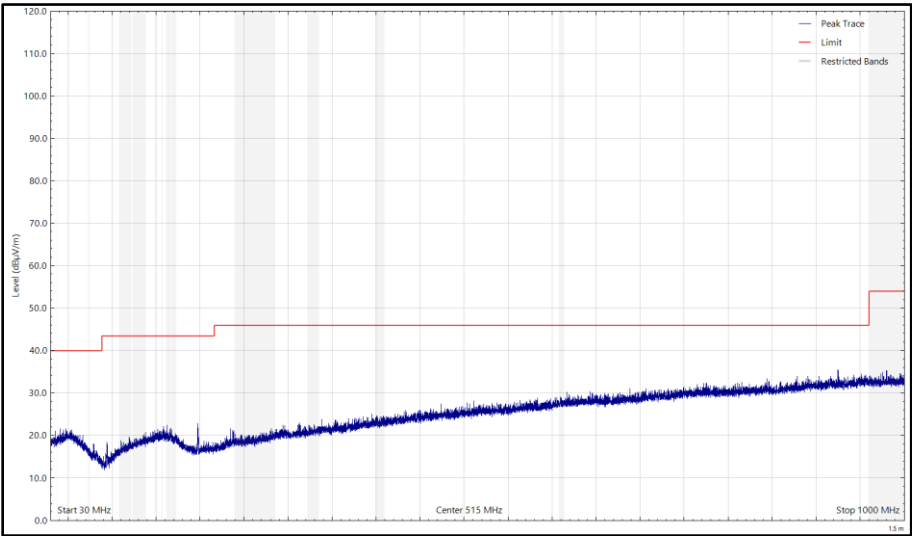


Figure 26 - Ch17_BLE_LE1M - Z, 2440 MHz, 30 MHz to 1 GHz, Vertical (Peak)

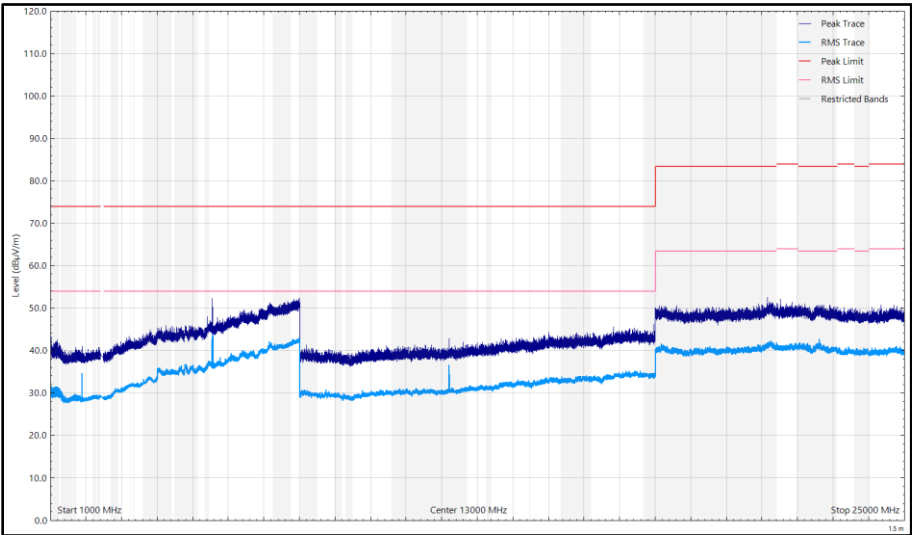


Figure 27 - Ch17_BLE_LE1M - Z, 2440 MHz, 1 GHz to 25 GHz, Vertical



Frequency (MHz)	Level	Limit	Margin (dB)	Detector	Unit	Angle (°)	Height (cm)	Polarisation
*								

Table 32 - Ch17_BLE_LE1M - Y, 2440 MHz, 30 MHz to 25 GHz

*No emissions found within 10 dB of the limit.

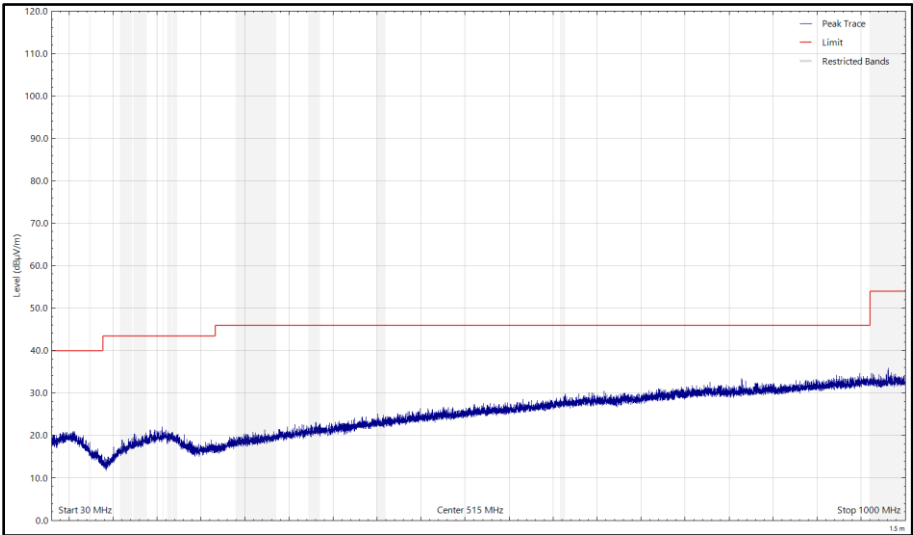


Figure 28 - Ch17_BLE_LE1M - Y, 2440 MHz, 30 MHz to 1 GHz, Horizontal (Peak)

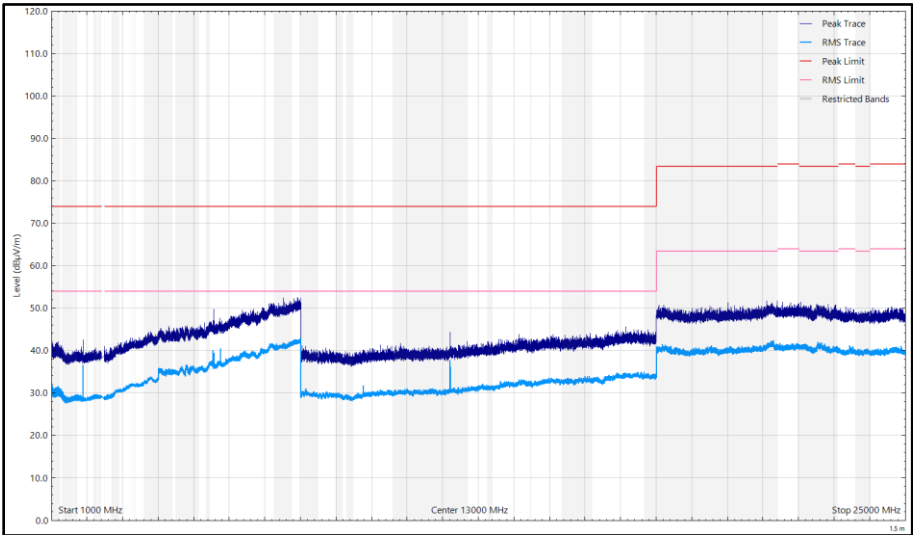


Figure 29 - Ch17_BLE_LE1M - Y, 2440 MHz, 1 GHz to 25 GHz, Horizontal

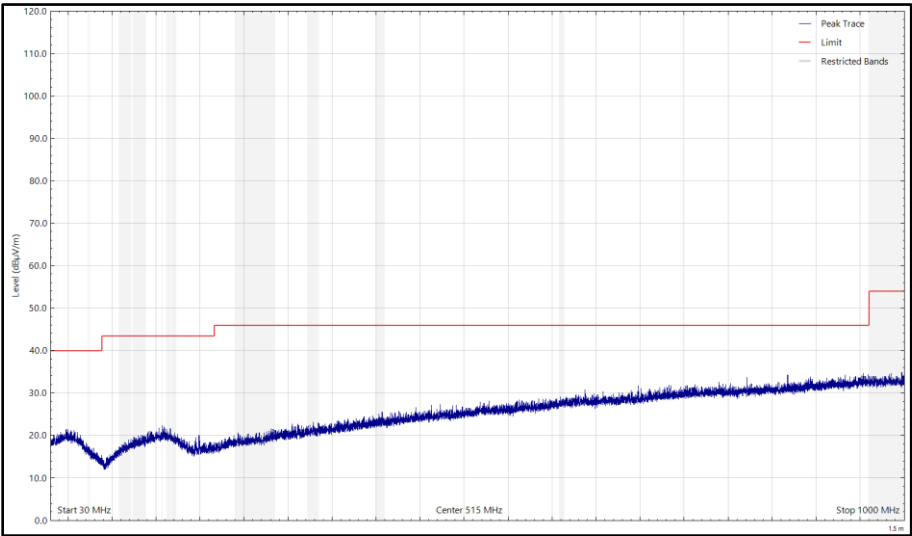


Figure 30 - Ch17_BLE_LE1M - Y, 2440 MHz, 30 MHz to 1 GHz, Vertical (Peak)

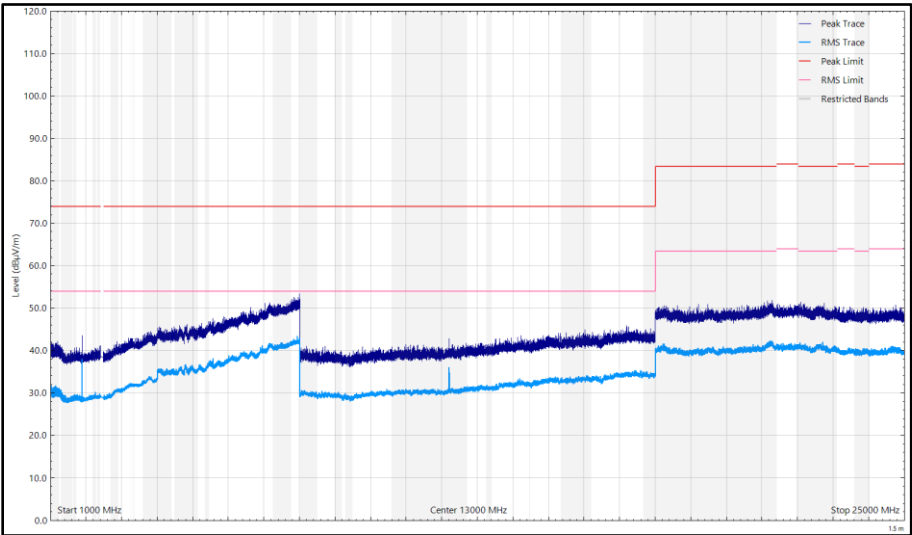


Figure 31 - Ch17_BLE_LE1M - Y, 2440 MHz, 1 GHz to 25 GHz, Vertical

Frequency (MHz)	Level	Limit	Margin (dB)	Detector	Unit	Angle (°)	Height (cm)	Polarisation
*								

Table 33 - Ch17_BLE_LE1M - X, 2440 MHz, 30 MHz to 25 GHz

*No emissions found within 10 dB of the limit.

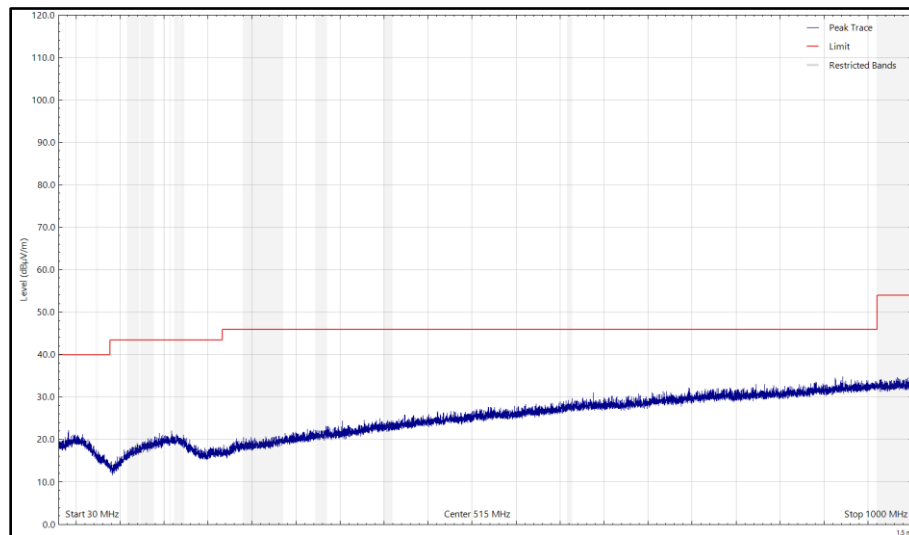


Figure 32 - Ch17_BLE_LE1M - X, 2440 MHz, 30 MHz to 1 GHz, Horizontal (Peak)

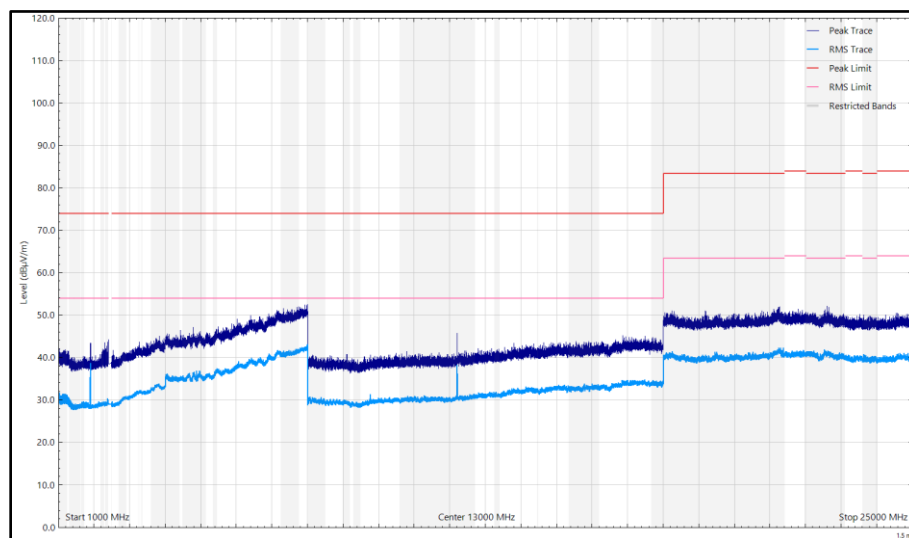


Figure 33 - Ch17_BLE_LE1M - X, 2440 MHz, 1 GHz to 25 GHz, Horizontal

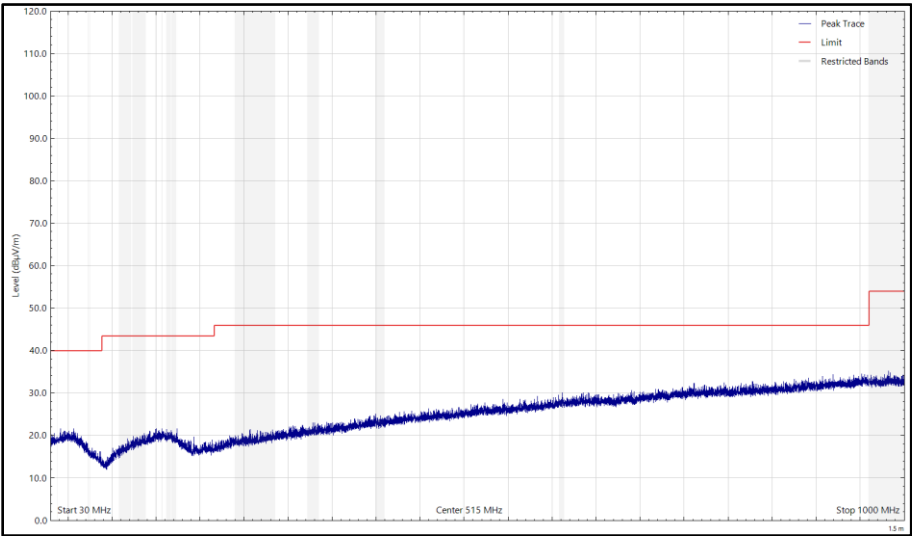


Figure 34 - Ch17_BLE_LE1M - X, 2440 MHz, 30 MHz to 1 GHz, Vertical (Peak)

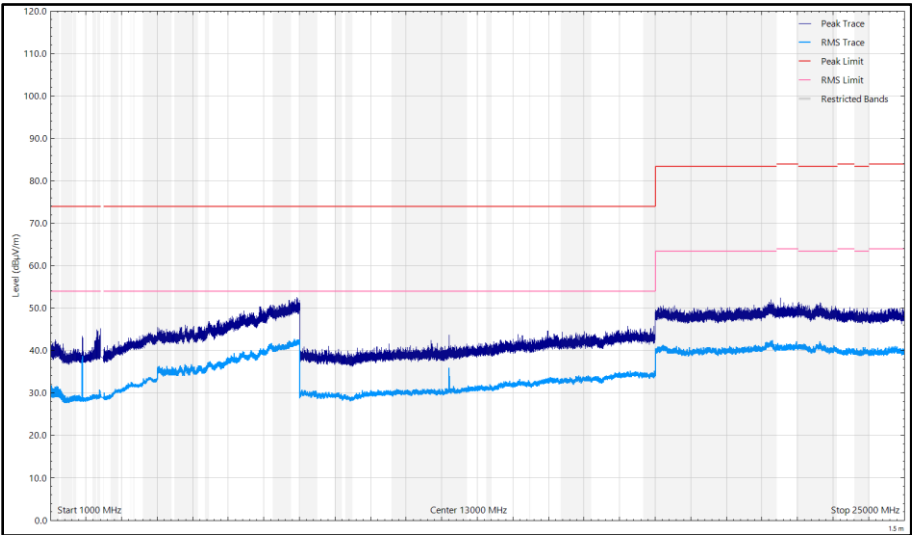


Figure 35 - Ch17_BLE_LE1M - X, 2440 MHz, 1 GHz to 25 GHz, Vertical



Frequency (MHz)	Level	Limit	Margin (dB)	Detector	Unit	Angle (°)	Height (cm)	Polarisation
*								

Table 34 - Ch37_BLE_LE1M - X, 2402 MHz, 30 MHz to 25 GHz

*No emissions found within 10 dB of the limit.

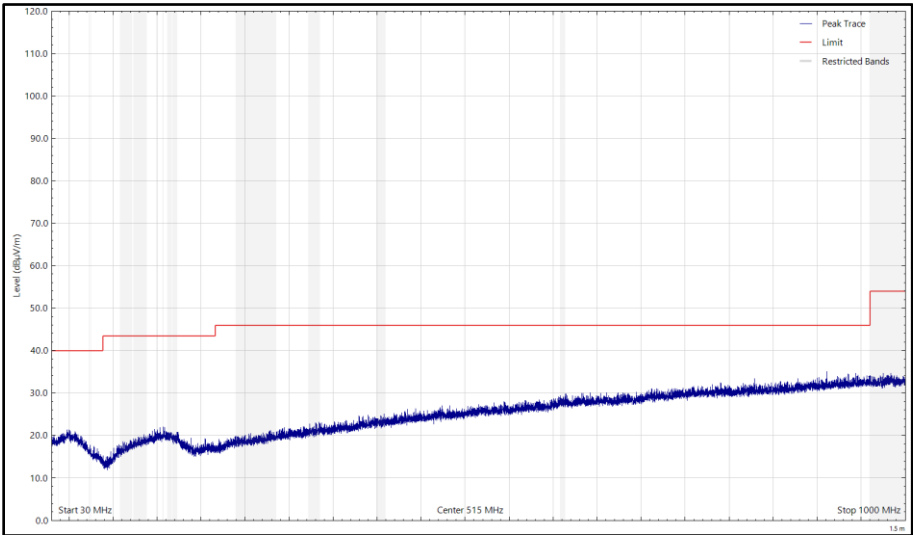


Figure 36 - Ch37_BLE_LE1M - X, 2402 MHz, 30 MHz to 1 GHz, Horizontal (Peak)

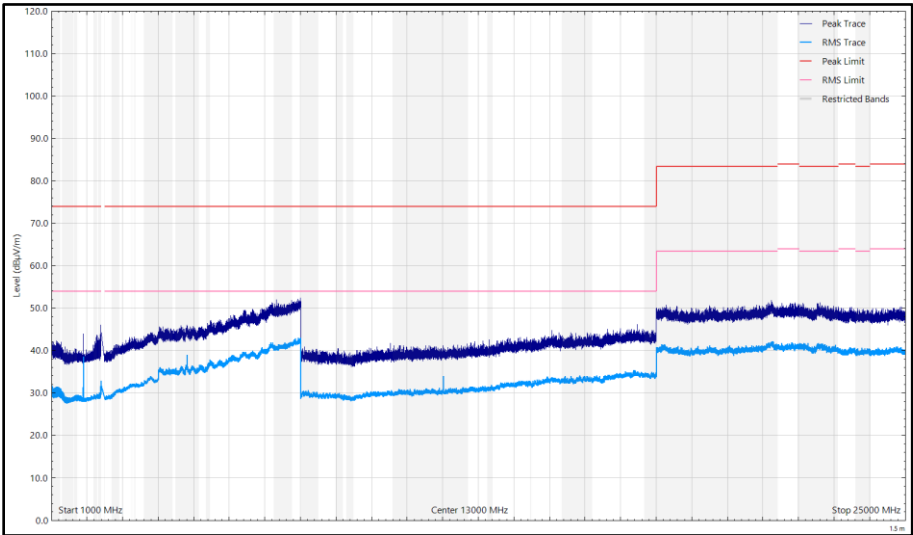


Figure 37 - Ch37_BLE_LE1M - X, 2402 MHz, 1 GHz to 25 GHz, Horizontal

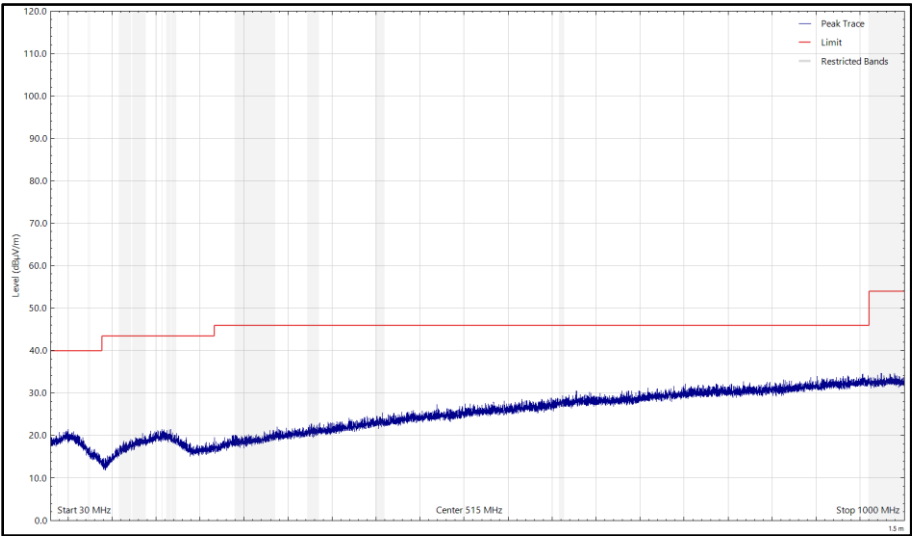


Figure 38 - Ch37_BLE_LE1M - X, 2402 MHz, 30 MHz to 1 GHz, Vertical (Peak)

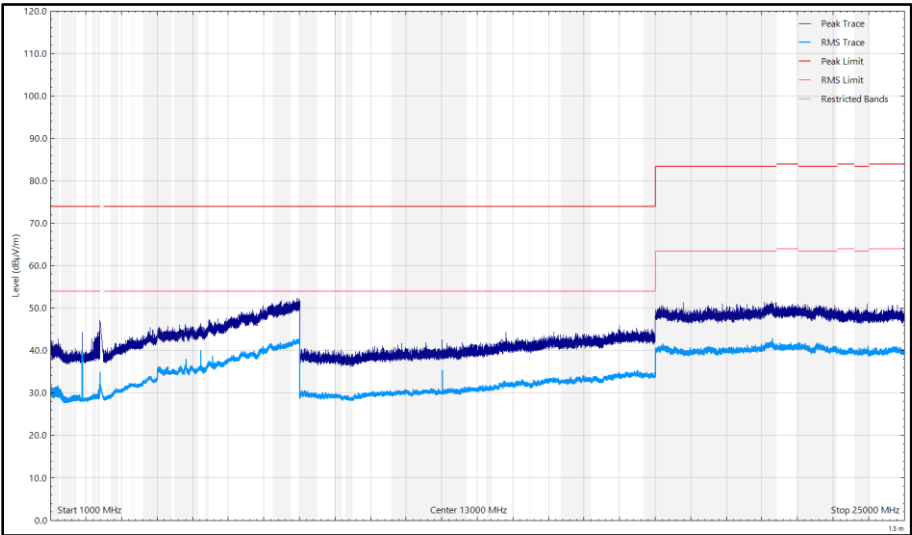


Figure 39 - Ch37_BLE_LE1M - X, 2402 MHz, 1 GHz to 25 GHz, Vertical



Frequency (MHz)	Level	Limit	Margin (dB)	Detector	Unit	Angle (°)	Height (cm)	Polarisation
*								

Table 35 - Ch37_BLE_LE1M - Y, 2402 MHz, 30 MHz to 25 GHz

*No emissions found within 10 dB of the limit.

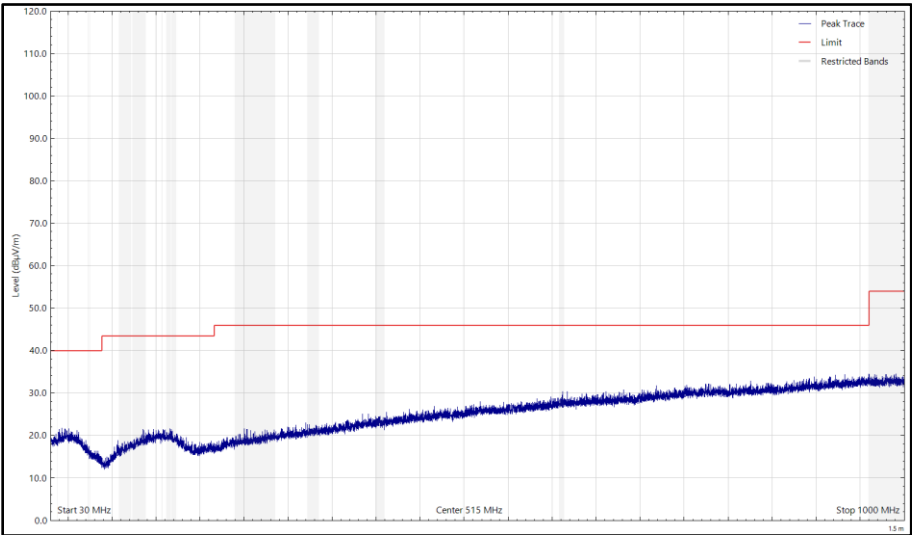


Figure 40 - Ch37_BLE_LE1M - Y, 2402 MHz, 30 MHz to 1 GHz, Horizontal (Peak)

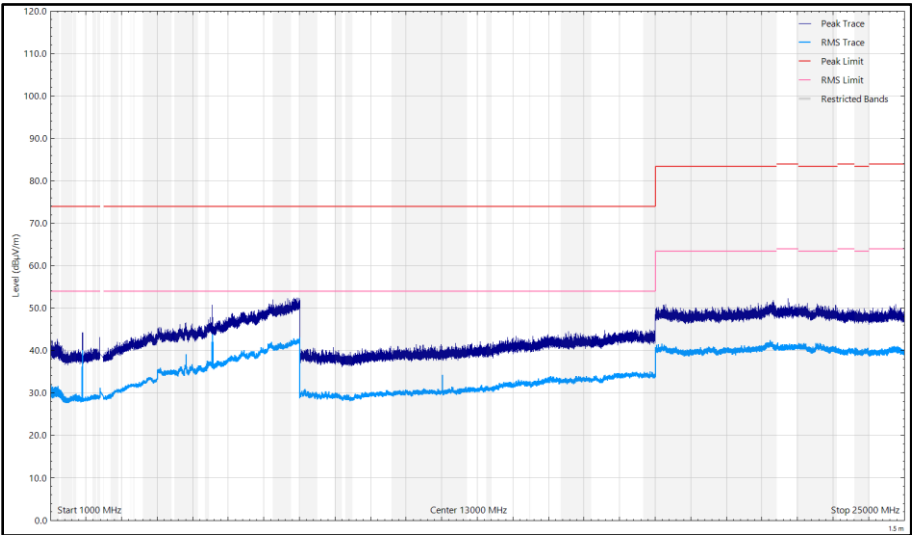


Figure 41 - Ch37_BLE_LE1M - Y, 2402 MHz, 1 GHz to 25 GHz, Horizontal

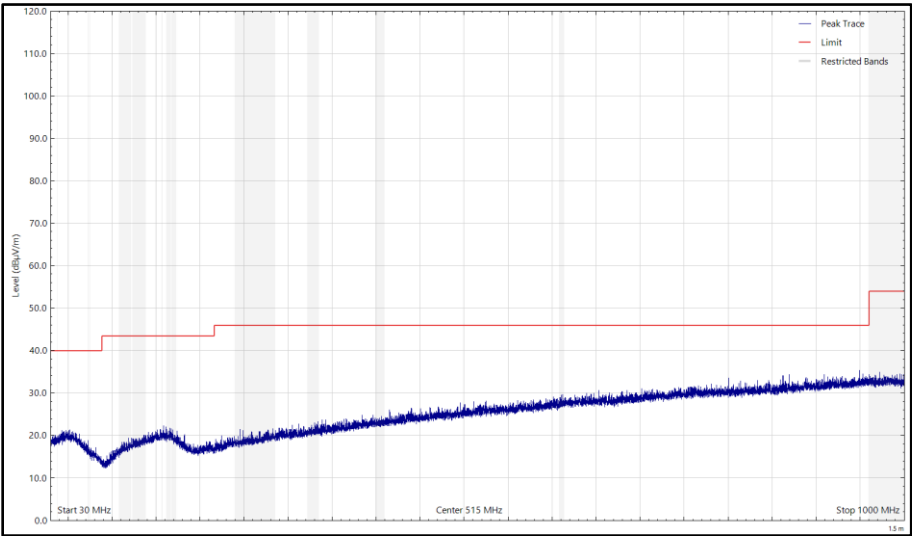


Figure 42 - Ch37_BLE_LE1M - Y, 2402 MHz, 30 MHz to 1 GHz, Vertical (Peak)

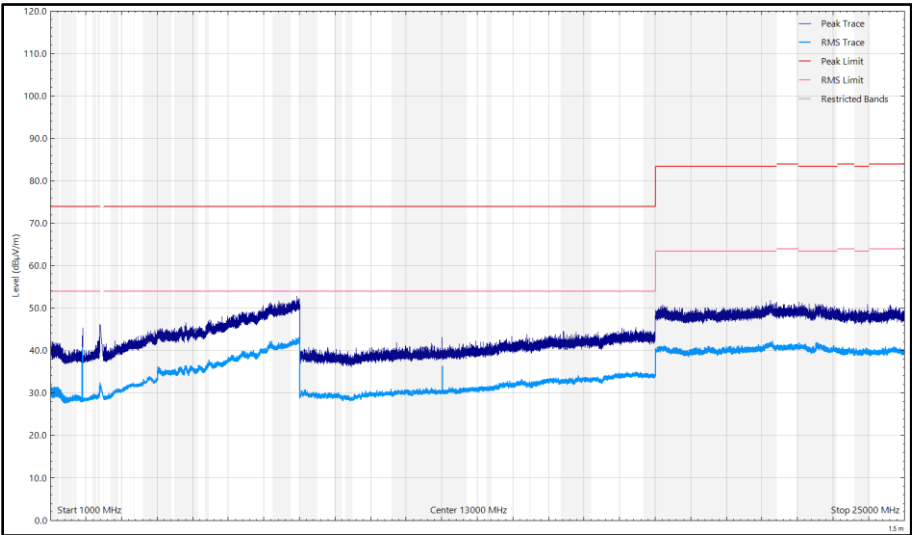


Figure 43 - Ch37_BLE_LE1M - Y, 2402 MHz, 1 GHz to 25 GHz, Vertical



Frequency (MHz)	Level	Limit	Margin (dB)	Detector	Unit	Angle (°)	Height (cm)	Polarisation
*								

Table 36 - Ch37_BLE_LE1M - Z, 2402 MHz, 30 MHz to 25 GHz

*No emissions found within 10 dB of the limit.

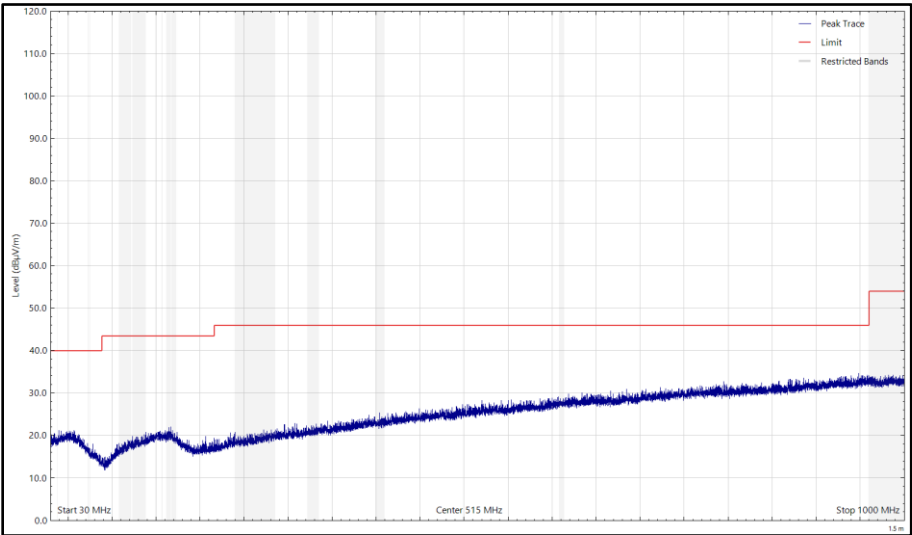


Figure 44 - Ch37_BLE_LE1M - Z, 2402 MHz, 30 MHz to 1 GHz, Horizontal (Peak)

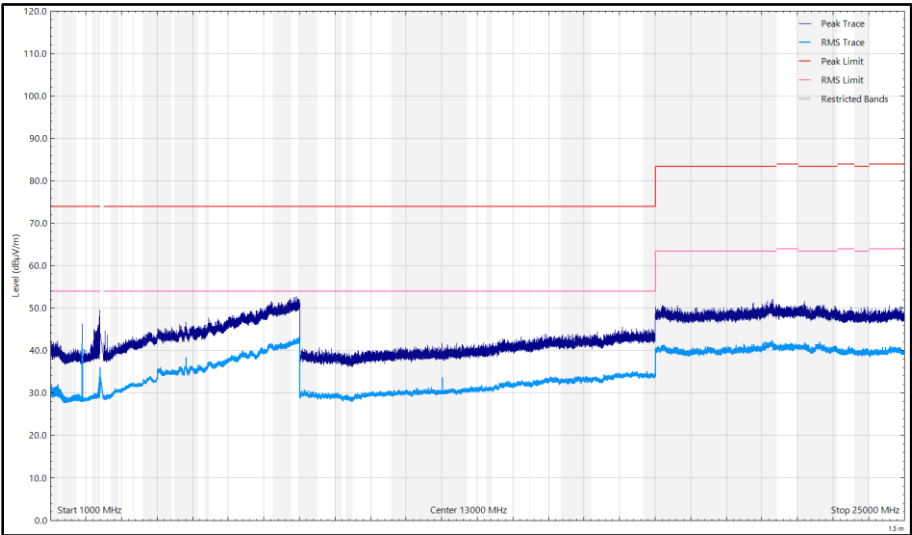


Figure 45 - Ch37_BLE_LE1M - Z, 2402 MHz, 1 GHz to 25 GHz, Horizontal

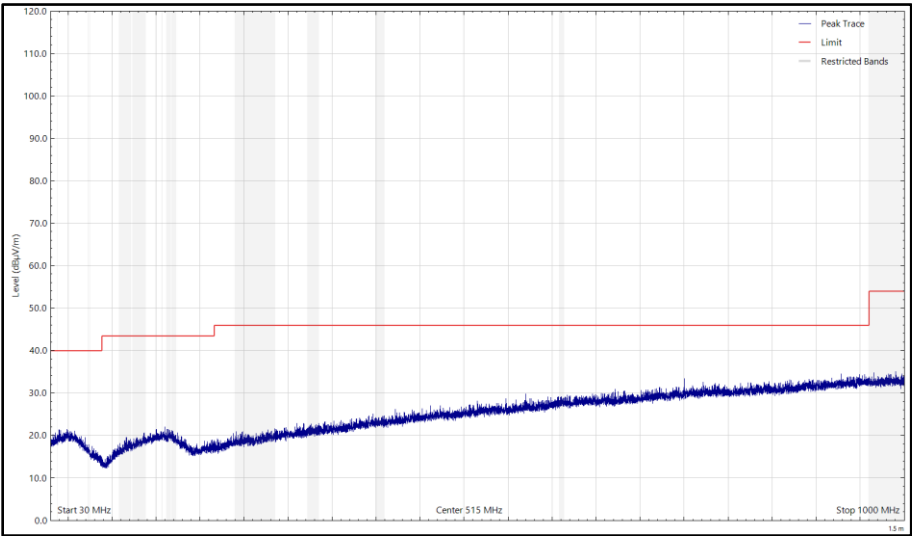


Figure 46 - Ch37_BLE_LE1M - Z, 2402 MHz, 30 MHz to 1 GHz, Vertical (Peak)

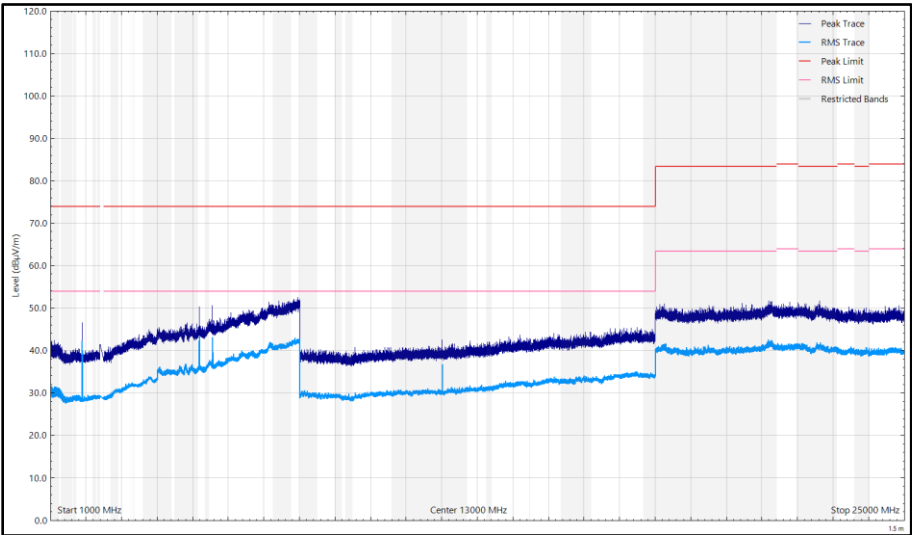


Figure 47 - Ch37_BLE_LE1M - Z, 2402 MHz, 1 GHz to 25 GHz, Vertical



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 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Antenna (DRG, 18 GHz to 40 GHz)	Link Microtek Ltd	AM180HA-K-TU2	230	24	23-Sep-2024
3m Semi-Anechoic Chamber	Rainford	RF Chamber 5	1545	36	23-Apr-2027
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	18-Apr-2025
Mast Controller	Maturo GmbH	NCD	4810	-	TU
Tilt Antenna Mast	Maturo GmbH	TAM 4.0-P	4811	-	TU
Antenna (DRG 1-10.5GHz)	Schwarzbeck	BBHA9120B	4848	12	14-Jul-2025
4dB Attenuator	Pasternack	PE7047-4	4935	12	31-Jul-2025
Emissions Software	TUV SUD	EmX V3.4.2	5125	-	Software
Pre-amplifier (30 dB, 1GHz to 18GHz)	Schwarzbeck	BBV 9718 C	5261	12	09-Apr-2025
3.5 mm 1m Cable	Junkosha	MWX221-01000DMS	5417	12	06-Jun-2025
Cable (SMA to SMA 1m)	Junkosha	MWX221-01000AMSAMS/A	5514	12	23-May-2025
Cable (SMA to SMA, 2 m)	Junkosha	MWX221-02000AMSAMS/A	5517	12	23-May-2025
3 GHz High pass Filter	Wainwright	WHKX12-2580-3000-18000-80SS	5548	12	15-Aug-2025
7 GHz High pass Filter	Wainwright	WHKX12-5850-6800-18000-80SS	5551	12	29-May-2025
Pre-Amplifier (8 GHz to 18 GHz)	Wright Technologies	APS06-0061	5596	12	27-Oct-2024
Antenna (DRG, 7.5 GHz to 18 GHz)	Schwarzbeck	HWRD750	5610	12	15-Oct-2024
Cable (K-Type to K-Type, 2 m)	Junkosha	MWX241/B	5909	12	18-Feb-2025
Humidity & Temperature meter	R.S Components	1364	6149	12	12-Aug-2025
Cable (N to N 8m)	Junkosha	MWX221-08000NMSNMS/B	6331	12	17-Feb-2025
Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9168	6635	24	13-Jun-2025

Table 37

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

N-Label, S/N CON 1 - Modification State 0

2.6.3 Date of Test

11-September-2024

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 19.4 °C
Relative Humidity 45.8 %

2.6.6 Test Results

Bluetooth Low Energy

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

DUT Configuration			
Mode:	BLE GFSK (LE 1M)	Duty Cycle (%):	98.6
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	Soldered SMA	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	-14.46	-	-	-	-	8.00	-22.46
2426	3.0	-13.70	-	-	-	-	8.00	-21.70
2480	3.0	-13.42	-	-	-	-	8.00	-21.42

Table 38 - Maximum Power Spectral Density Results



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

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

ISED RSS-247, Limit Clause 5.2(b)

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

2.6.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Hygrometer	Rotronic	I-1000	3220	12	28-Nov-2024
GPSDR Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	09-Mar-2025
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	18-Sep-2025
Signal Conditioning Unit	TUV SUD	SPECTRUM_SCU001	6350	12	02-Aug-2025
SCU Cable Assembly SCU	TUV SUD	SPECTRUM_SCU_CA	6638	12	02-Aug-2025

Table 39

3 Photographs

3.1 Test Setup Photographs



Figure 48 – Test Setup 30 MHz to 1 GHz

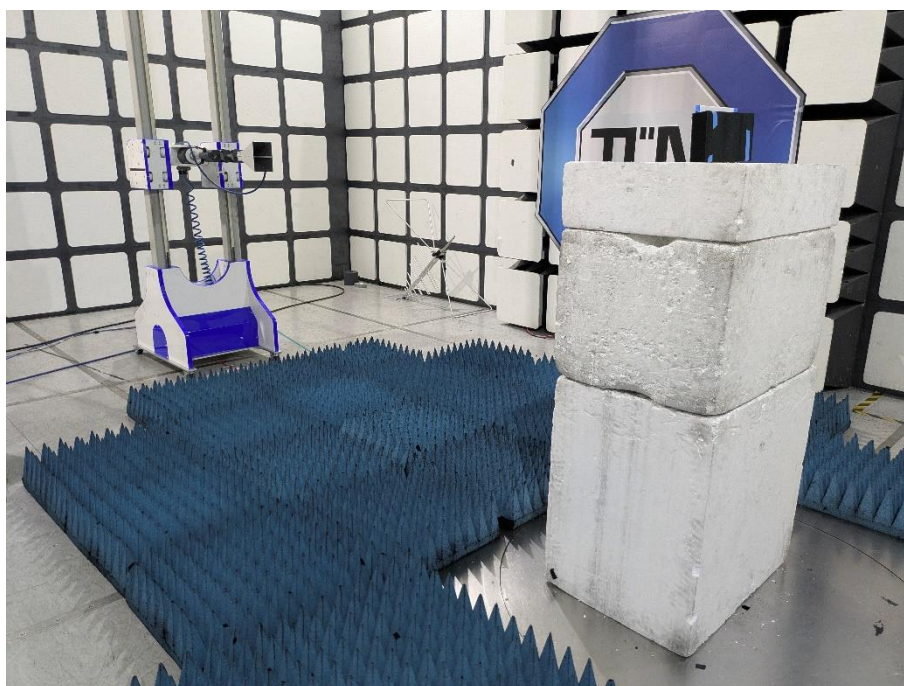


Figure 49 – Test Setup 1 GHz to 18 GHz

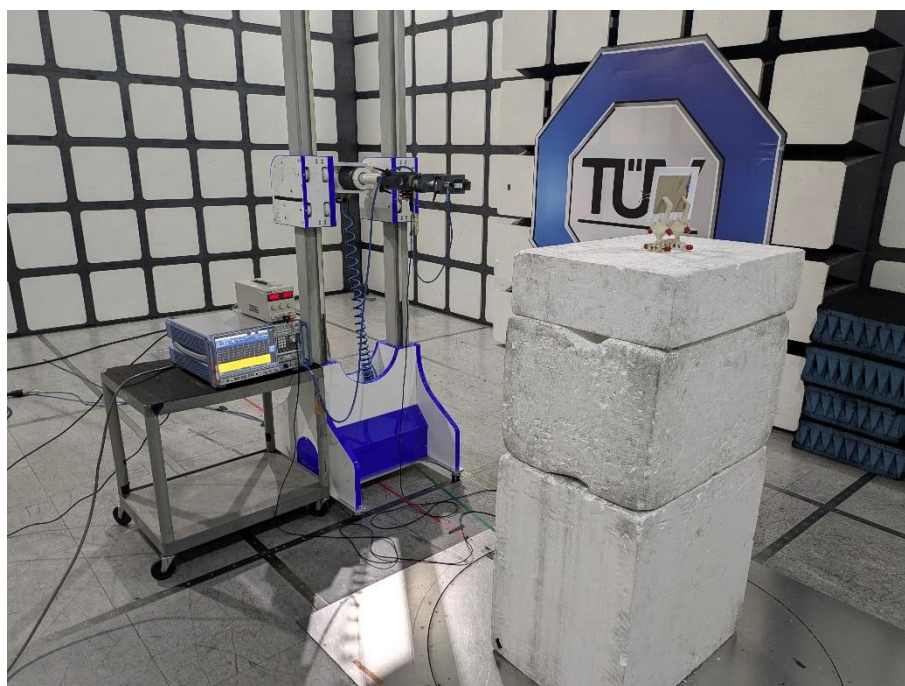


Figure 50 – Test Setup 18 GHz to 25 GHz



4 Measurement Uncertainty

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

Test Name	Measurement Uncertainty
Restricted Band Edges	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Emission Bandwidth	± 25.34 kHz Lab
Maximum Conducted Output Power	± 1.38 dB
Authorised Band Edges	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Spurious Radiated Emissions	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Power Spectral Density	± 1.49 dB

Table 40

Measurement Uncertainty Decision Rule – Accuracy Method

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115:2021, Clause 4.4.3 (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.