

# FCC and ISED Test Report

XYZ Reality Ltd

Model: Atom Hard Hat

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

Prepared for: XYZ Reality Ltd  
Unit G0, G02, 338-346  
Goswell Road  
Angel  
Clerkenwell  
EC1V 7LQ  
United Kingdom



Add value.  
Inspire trust.

FCC ID: 2A3C5-XYZ1201 (contains FCC ID PD992260NG)  
IC: 28181XYZ1201 (Contains IC 1000M-9260NG)

## COMMERCIAL-IN-CONFIDENCE

Document 75952587-15 Issue 01

### SIGNATURE

| NAME           | JOB TITLE       | RESPONSIBLE FOR      | ISSUE DATE       |
|----------------|-----------------|----------------------|------------------|
| Steve Marshall | Senior Engineer | Authorised Signatory | 11 February 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         | Graeme Lawler  | 11 February 2022 |           |
| Testing         | Daniel Cameron | 11 February 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.



#### DISCLAIMER AND COPYRIGHT

This non-binding report has been prepared by TÜV SÜD with all reasonable skill and care. The document is confidential to the potential Client and TÜV SÜD. No part of this document may be reproduced without the prior written approval of TÜV SÜD. © 2022 TÜV SÜD. This report relates only to the actual item/items tested.

#### ACCREDITATION

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

TÜV SÜD  
is a trading name of TÜV SÜD Ltd  
Registered in Scotland at East Kilbride,  
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](http://www.tuvsud.com/en)

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



## Contents

|          |                                      |           |
|----------|--------------------------------------|-----------|
| <b>1</b> | <b>Report Summary .....</b>          | <b>2</b>  |
| 1.1      | Report Modification Record.....      | 2         |
| 1.2      | Introduction.....                    | 2         |
| 1.3      | Brief Summary of Results .....       | 3         |
| 1.4      | Application Form .....               | 4         |
| 1.5      | Product Information .....            | 7         |
| 1.6      | Deviations from the Standard.....    | 7         |
| 1.7      | EUT Modification Record .....        | 7         |
| 1.8      | Test Location .....                  | 7         |
| <b>2</b> | <b>Test Details .....</b>            | <b>8</b>  |
| 2.1      | Restricted Band Edges.....           | 8         |
| 2.2      | Emission Bandwidth .....             | 14        |
| 2.3      | Maximum Conducted Output Power ..... | 20        |
| 2.4      | Spurious Radiated Emissions .....    | 23        |
| 2.5      | Authorised Band Edges .....          | 60        |
| 2.6      | Power Spectral Density .....         | 64        |
| <b>3</b> | <b>Photographs .....</b>             | <b>67</b> |
| 3.1      | Test Setup Photographs .....         | 67        |
| <b>4</b> | <b>Measurement Uncertainty .....</b> | <b>76</b> |



# 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-February-2022 |

**Table 1**

## 1.2 Introduction

|                               |                                                                                                                |
|-------------------------------|----------------------------------------------------------------------------------------------------------------|
| Applicant                     | XYZ Reality Ltd                                                                                                |
| Manufacturer                  | XYZ Reality Ltd                                                                                                |
| Model Number(s)               | Atom Hard Hat                                                                                                  |
| Serial Number(s)              | Not serialised (Storix-ID 599374-117) and XYZR0047_02                                                          |
| Hardware Version(s)           | Not Applicable                                                                                                 |
| Software Version(s)           | Windows Certification Build                                                                                    |
| Number of Samples Tested      | 2                                                                                                              |
| Test Specification/Issue/Date | FCC 47 CFR Part 15C: 2020<br>ISED RSS-247: Issue 2 (02-2017)<br>ISED RSS-GEN: Issue 5 (04-2018) + A2 (02-2021) |
| Order Number                  | XYZ0179                                                                                                        |
| Date                          | 21-June-2021                                                                                                   |
| Date of Receipt of EUT        | 06-September-2021                                                                                              |
| Start of Test                 | 07-November-2021                                                                                               |
| Finish of Test                | 16-November-2021                                                                                               |
| Name of Engineer(s)           | Graeme Lawler and Daniel Cameron                                                                               |
| Related Document(s)           | ANSI C63.10 (2013)                                                                                             |



### 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                                                                                      |
|---------------------------------------------------------------|-----------------------|-------------|--------------|--------------------------------|--------|-------------------------------------------------------------------------------------------------------------|
|                                                               | FCC Part 15C          | RSS-247     | RSS-GEN      |                                |        |                                                                                                             |
| Configuration and Mode: Hard Hat - 2.4 GHz proprietary device |                       |             |              |                                |        |                                                                                                             |
| -                                                             | 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                | -           | 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 Application Form

### Equipment Description

|                                                                                                                                                     |                                                                          |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|--|
| Technical Description:<br>(Please provide a brief description of the intended use of the equipment including the technologies the product supports) | Protective hard Hat with integrated eye protection and augmented reality |  |
| Manufacturer:                                                                                                                                       | XYZ Reality Ltd                                                          |  |
| Model:                                                                                                                                              | Atom Hard Hat                                                            |  |
| Part Number:                                                                                                                                        | XYZ-12-01                                                                |  |
| Hardware Version:                                                                                                                                   | Not Applicable                                                           |  |
| Software Version:                                                                                                                                   | Windows Certification Build                                              |  |
| FCC ID of the product under test – <a href="#">see guidance here</a>                                                                                | 2A3C5-XYZ1201 (contains FCC ID PD992260NG)                               |  |
| IC ID of the product under test – <a href="#">see guidance here</a>                                                                                 | 28181XYZ1201 (Contains IC 1000M-9260NG)                                  |  |

Table 3

### Intentional Radiators

| Technology                                                                                        | Bluetooth LE | WLAN 2.4 GHz         | Proprietary ISM 2.4GHz |  |  |  |
|---------------------------------------------------------------------------------------------------|--------------|----------------------|------------------------|--|--|--|
| Frequency Range (MHz to MHz)                                                                      | 2402-2480    | 2412-2462            | 2402-2480              |  |  |  |
| Conducted Declared Output Power (dBm)                                                             | 5.5 ± 2 dB   | 20 ± 1 dB            | 0                      |  |  |  |
| Antenna Gain (dBi)                                                                                | 2.8          | 2.8                  | 2.8                    |  |  |  |
| Supported Bandwidth(s) (MHz) (e.g 1 MHz, 20 MHz, 40 MHz)                                          | 1            | 20 / 40              | 1                      |  |  |  |
| Modulation Scheme(s) (e.g GFSK, QPSK etc)                                                         | GFSK / DQPSK | OFDM / OFDM-HT / CCK | GFSK / DQPSK           |  |  |  |
| ITU Emission Designator ( <a href="#">see guidance here</a> ) (not mandatory for Part 15 devices) | 1M00F1D      | 20M3D1W / 40M3D1W    | 1M00F1D                |  |  |  |
| Bottom Frequency (MHz)                                                                            | 2402         | 2412                 | 2402                   |  |  |  |
| Middle Frequency (MHz)                                                                            | 2440         | 2437                 | 2440                   |  |  |  |
| Top Frequency (MHz)                                                                               | 2480         | 2472                 | 2480                   |  |  |  |

Table 4

### Un-intentional Radiators

|                                                                                                         |  |
|---------------------------------------------------------------------------------------------------------|--|
| Highest frequency generated or used in the device or on which the device operates or tunes              |  |
| Lowest frequency generated or used in the device or on which the device operates or tunes               |  |
| Class A Digital Device (Use in commercial, industrial or business environment) <input type="checkbox"/> |  |
| Class B Digital Device (Use in residential environment only) <input checked="" type="checkbox"/>        |  |

Table 5



#### AC Power Source

|                                                                            |  |    |
|----------------------------------------------------------------------------|--|----|
| AC supply frequency:                                                       |  | Hz |
| Voltage                                                                    |  | V  |
| Max current:                                                               |  | A  |
| Single Phase <input type="checkbox"/> Three Phase <input type="checkbox"/> |  |    |

**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:                                                                                                                                                                                               | 7.4            | V                                             |
| End-point voltage:                                                                                                                                                                                     |                | V (Point at which the battery will terminate) |
| Alkaline <input type="checkbox"/> Leclanche <input type="checkbox"/> Lithium <input type="checkbox"/> Nickel Cadmium <input type="checkbox"/> Lead Acid* <input type="checkbox"/> *(Vehicle regulated) |                |                                               |
| Other <input checked="" type="checkbox"/>                                                                                                                                                              | Please detail: | Li Ion                                        |

**Table 8**

#### Charging

|                                           |                                                                     |
|-------------------------------------------|---------------------------------------------------------------------|
| Can the EUT transmit whilst being charged | Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> |
|-------------------------------------------|---------------------------------------------------------------------|

**Table 9**

#### Temperature

|                      |    |    |
|----------------------|----|----|
| Minimum temperature: | 0  | °C |
| Maximum temperature: | 40 | °C |

**Table 10**

#### Cable Loss

|                                       |     |    |
|---------------------------------------|-----|----|
| Adapter Cable Loss (Conducted sample) | 1.3 | dB |
|---------------------------------------|-----|----|

**Table 11**



### Antenna Characteristics

|                                                                                                                                                                                                                                                                                                                                  |       |          |                 |     |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----------|-----------------|-----|-----|
| Antenna connector <input checked="" type="checkbox"/>                                                                                                                                                                                                                                                                            |       |          | State impedance | 50  | Ohm |
| Temporary antenna connector <input type="checkbox"/>                                                                                                                                                                                                                                                                             |       |          | State impedance |     | Ohm |
| Integral antenna <input checked="" type="checkbox"/>                                                                                                                                                                                                                                                                             | Type: | Flexible | Gain            | 2.8 | dBi |
| External antenna <input type="checkbox"/>                                                                                                                                                                                                                                                                                        | Type: |          | Gain            |     | dBi |
| <p>For external antenna only:</p> <p>Standard Antenna Jack <input type="checkbox"/> If yes, describe how user is prohibited from changing antenna (if not professional installed):</p> <p>Equipment is only ever professionally installed <input type="checkbox"/></p> <p>Non-standard Antenna Jack <input type="checkbox"/></p> |       |          |                 |     |     |

**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: Dave Williams

Position held: Director of Engineering, DitroniX Ltd

Date: 04 November 2021



## 1.5 Product Information

### 1.5.1 Technical Description

Protective hard Hat with integrated eye protection and augmented reality.

### 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: Atom Hard Hat, Serial Number: Not serialised (Storix-ID 599374-117) |                                                 |                        |                          |
| 0                                                                          | As supplied by the customer                     | Not Applicable         | Not Applicable           |
| Model: Not Applicable, Serial Number: XYZR0047_02                          |                                                 |                        |                          |
| 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: Hard Hat - 2.4 GHz proprietary device |                     |               |
| Restricted Band Edges                                         | Graeme Lawler       | UKAS          |
| Emission Bandwidth                                            | Daniel Cameron      | UKAS          |
| Maximum Conducted Output Power                                | Daniel Cameron      | UKAS          |
| Spurious Radiated Emissions                                   | Graeme Lawler       | UKAS          |
| Authorised Band Edges                                         | Graeme Lawler       | 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-GEN, Clause 8.10

#### 2.1.2 Equipment Under Test and Modification State

Atom Hard Hat, S/N: Not serialised (Storix-ID 599374-117) - Modification State 0

#### 2.1.3 Date of Test

16-November-2021

#### 2.1.4 Test Method

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

Plots for average measurements were taken in accordance with ANSI C63.10, clause 4.1.4.2.3. These are shown for information purposes and were used to determine the worst-case measurement point. Final average measurements were then taken in accordance with ANSI C63.10, clause 4.1.4.2.3 to obtain the measurement result recorded in the test results tables.

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

#### 2.1.5 Environmental Conditions

|                     |         |
|---------------------|---------|
| Ambient Temperature | 20.9 °C |
| Relative Humidity   | 43.4 %  |

## 2.1.6 Test Results

### Hard Hat - 2.4 GHz proprietary device

| Mode   | Frequency (MHz)   | Band Edge Frequency (MHz) | Peak Level (dBμV/m) | Average Level (dBμV/m) |
|--------|-------------------|---------------------------|---------------------|------------------------|
| Static | 2402 - 250 kbps   | 2390                      | 58.64               | 42.92                  |
| Static | 2402 - 1 Mbps     | 2390                      | 60.05               | 42.54                  |
| Static | 2402 - 2 Mbps     | 2390                      | 59.62               | 42.66                  |
| Static | 2483.5 - 250 kbps | 2483.5                    | 68.31               | 47.61                  |
| Static | 2483.5 - 1 Mbps   | 2483.5                    | 68.38               | 46.91                  |
| Static | 2483.5 - 2 Mbps   | 2483.5                    | 68.46               | 47.96                  |

Table 16

### Remarks

The red asterisks on the following plots are a nature of using two traces with different settings. TUV SUD confirms no settings were changed on the peak trace once the trace was set to VIEW.

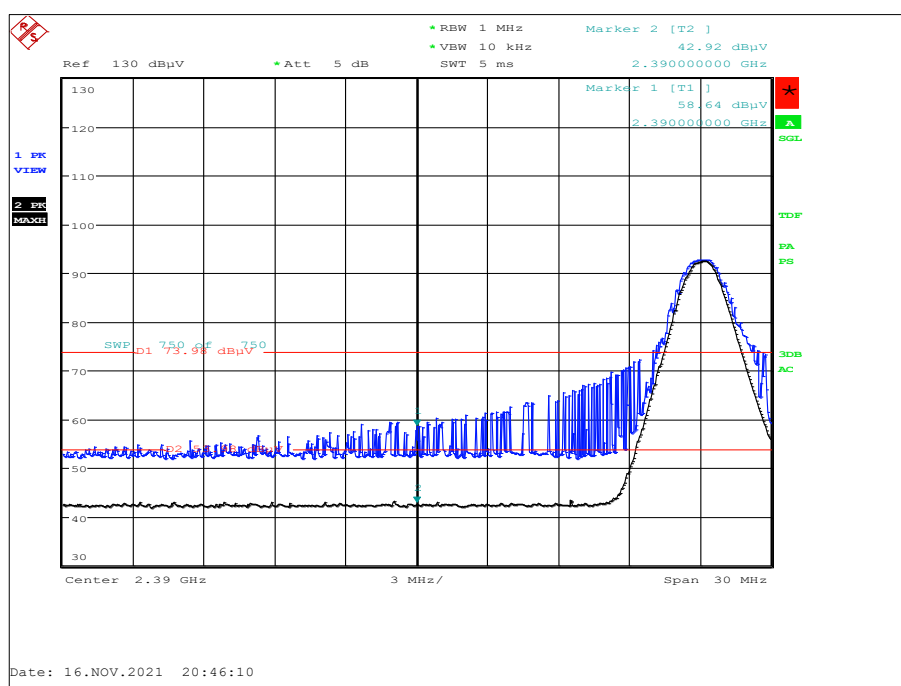


Figure 1 - 2402 MHz - 250 kbps - Band Edge Frequency 2390 MHz

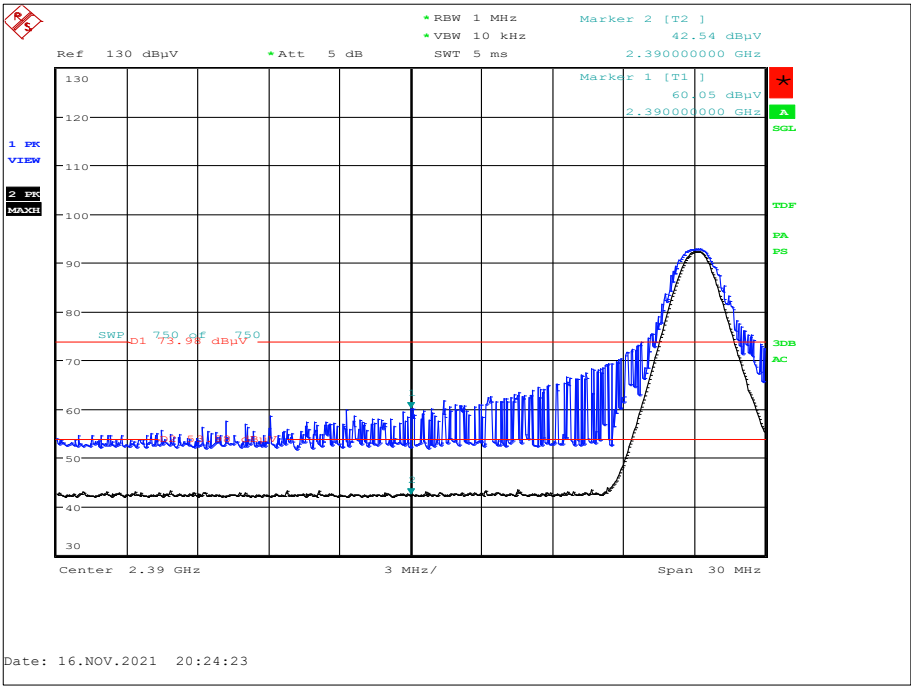


Figure 2 - 2402 MHz - 1 Mbps - Band Edge Frequency 2390 MHz

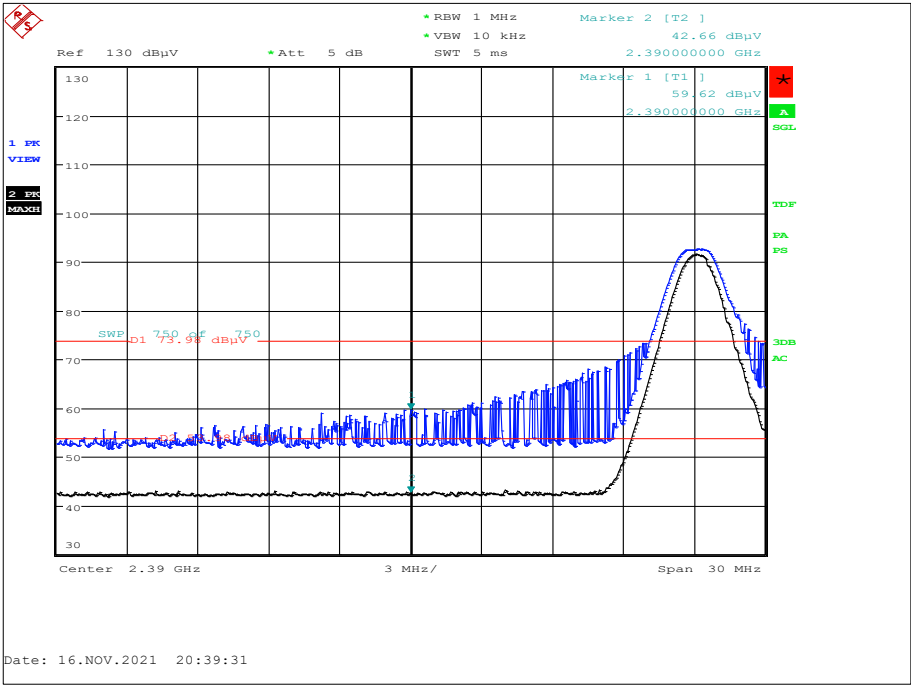


Figure 3 - 2402 MHz - 2 Mbps - Band Edge Frequency 2390 MHz

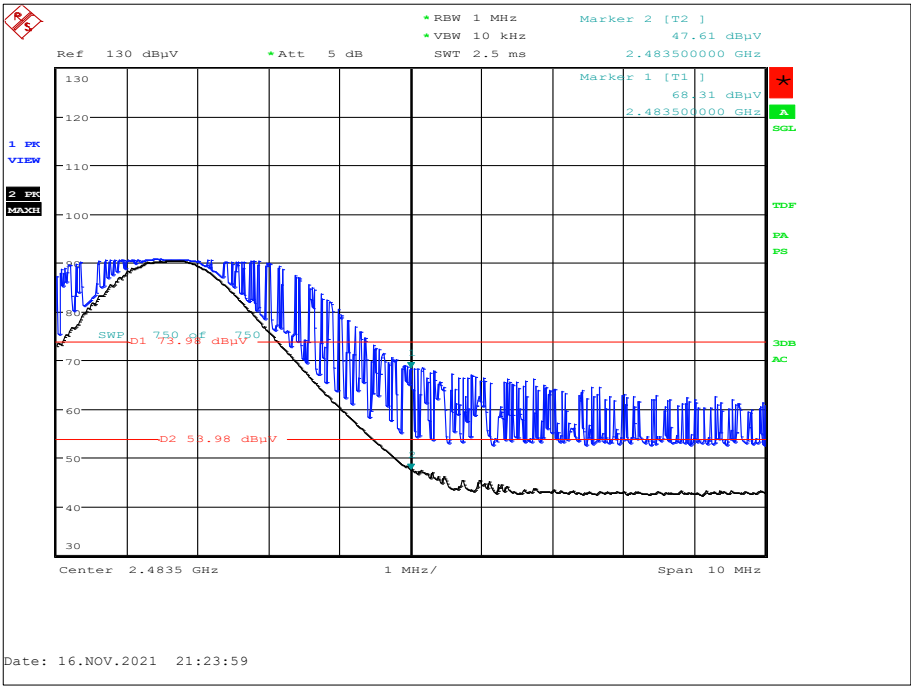


Figure 4 - 2480 MHz - 250 kbps - Band Edge Frequency 2483.5 MHz

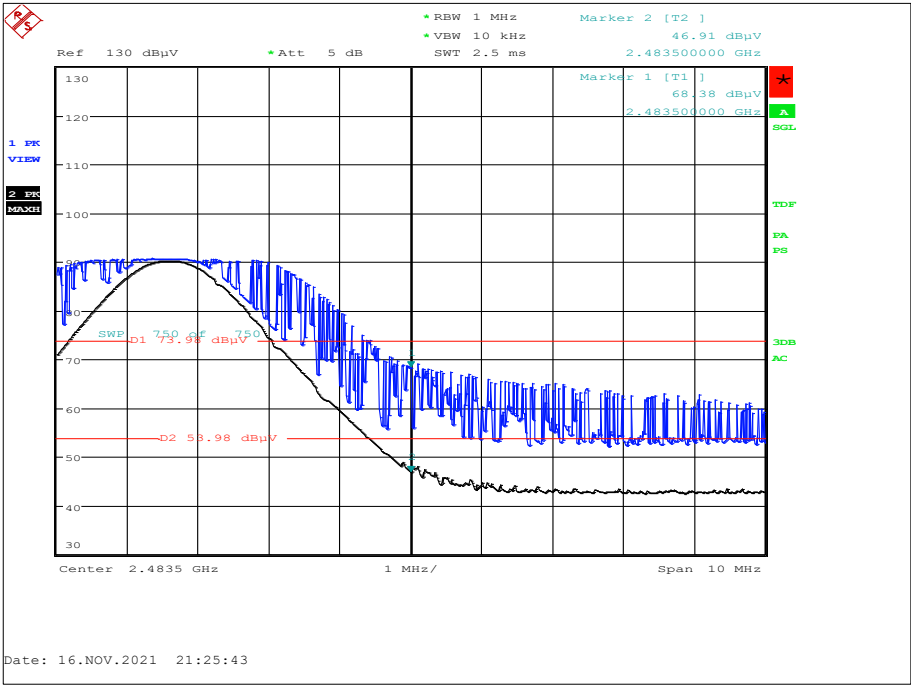
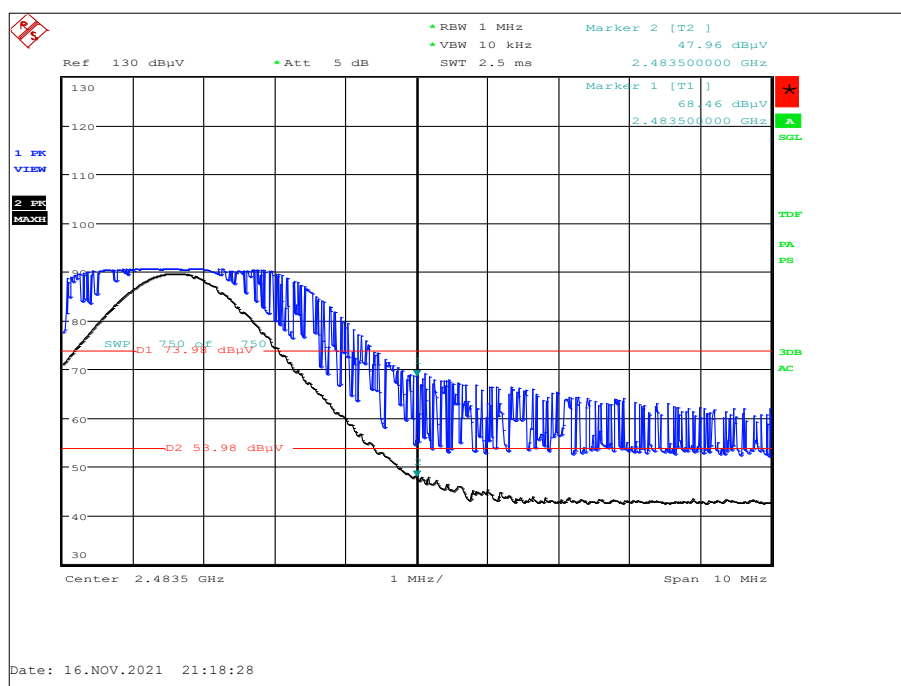


Figure 5 - 2480 MHz - 1 Mbps - Band Edge Frequency 2483.5 MHz



**Figure 6 - 2480 MHz - 2 Mbps - 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 (K-Type to K-Type, 2 m)  | Scott Cables    | KPS-1501-2000-KPS   | 4526  | 6                           | 06-Mar-2022         |
| EmX Emissions Software         | TUV SUD         | V2.1.11             | 5125  | -                           | Software            |
| Cable (N-Type to N-Type, 8 m)  | Teledyne        | PR90-088-8MTR       | 5450  | 6                           | 08-Mar-2022         |
| 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         |

**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**

Atom Hard Hat, S/N: XYZR0047\_02 - Modification State 0

### **2.2.3 Date of Test**

10-November-2021

### **2.2.4 Test Method**

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

### **2.2.5 Environmental Conditions**

|                     |         |
|---------------------|---------|
| Ambient Temperature | 22.9 °C |
| Relative Humidity   | 48.6 %  |



## 2.2.6 Test Results

### Hard Hat - 2.4 GHz proprietary device

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

| DUT Configuration      |                 |                          |   |
|------------------------|-----------------|--------------------------|---|
| Mode:                  | Proprietary ISM | Duty Cycle (%):          | - |
| Data Rate:             | 250 kbps        | DCCF (dB):               | - |
| Antenna Configuration: | SISO            | Peak Antenna Gain (dBi): | - |
| Active Port(s):        | A (A)           | Active Chain(s):         | 0 |

| Test Frequency (MHz) | 6 dB Bandwidth (MHz) |   |   |   |         | Limit (kHz) |
|----------------------|----------------------|---|---|---|---------|-------------|
|                      | A                    | B | C | D | Minimum |             |
| 2402                 | 0.944                | - | - | - | 0.944   | ≥500.0      |
| 2442                 | 0.572                | - | - | - | 0.572   | ≥500.0      |
| 2480                 | 0.796                | - | - | - | 0.796   | ≥500.0      |

**Table 20 - 6 dB Bandwidth Results**

| Test Frequency (MHz) | 99% Bandwidth (MHz) |   |   |   |         | Limit (kHz) |
|----------------------|---------------------|---|---|---|---------|-------------|
|                      | A                   | B | C | D | Minimum |             |
| 2402                 | 0.928               | - | - | - | 0.928   | -           |
| 2442                 | 0.560               | - | - | - | 0.560   | -           |
| 2480                 | 1.768               | - | - | - | 1.768   | -           |

**Table 21 - 99% Bandwidth Results**

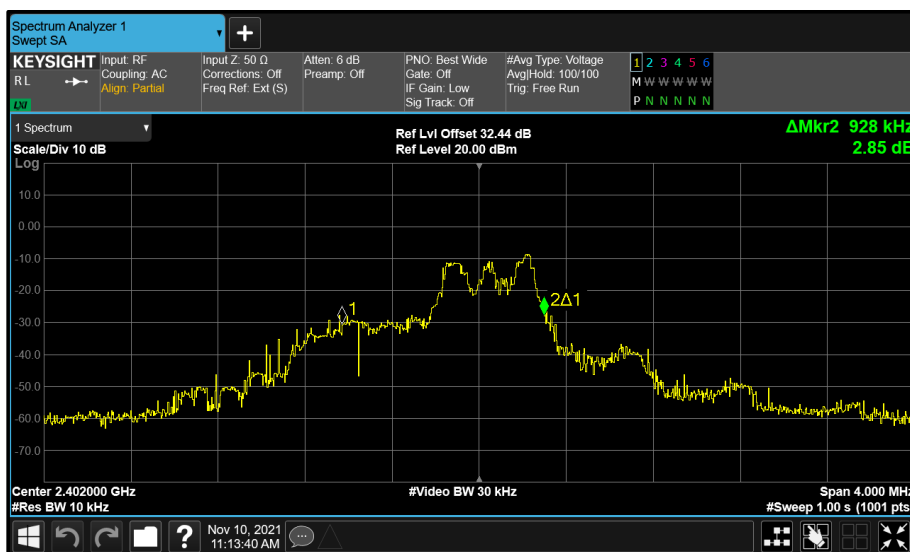


Figure 7 - A (A) 2402 MHz 99% Bandwidth

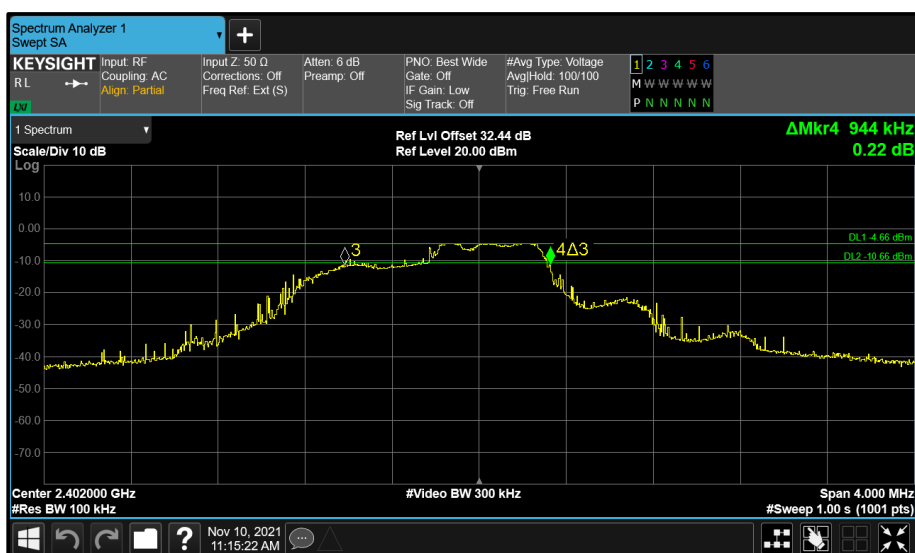


Figure 8 - A (A) 2402 MHz 6 dB Bandwidth

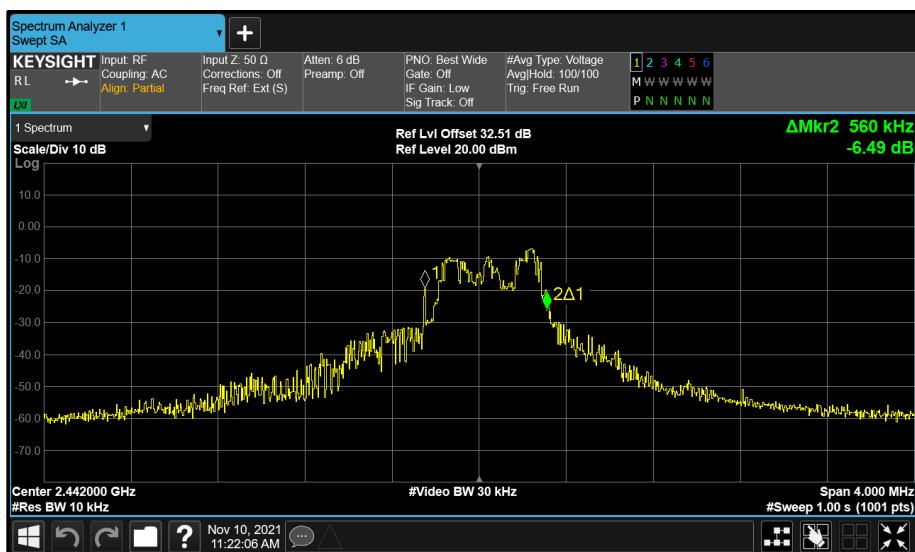


Figure 9 - A (A) 2442 MHz 99% Bandwidth

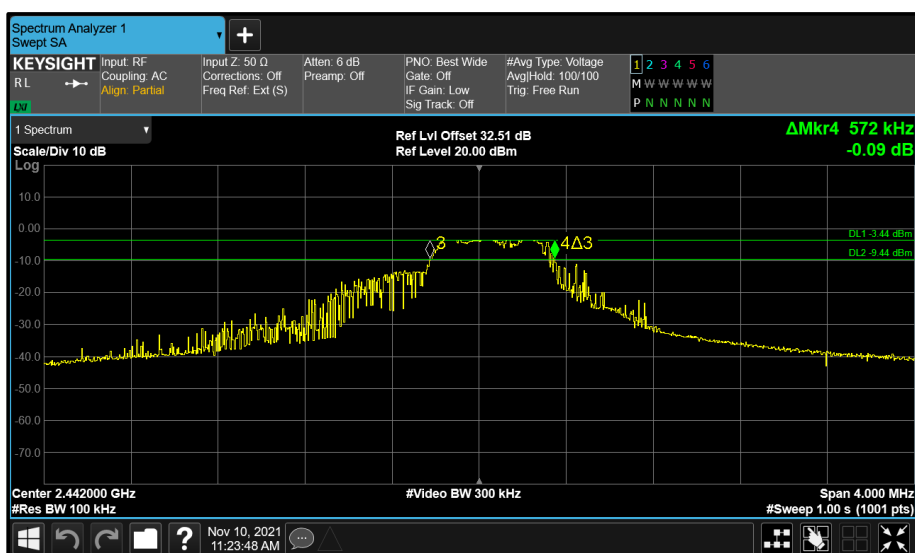


Figure 10 - A (A) 2442 MHz 6 dB Bandwidth

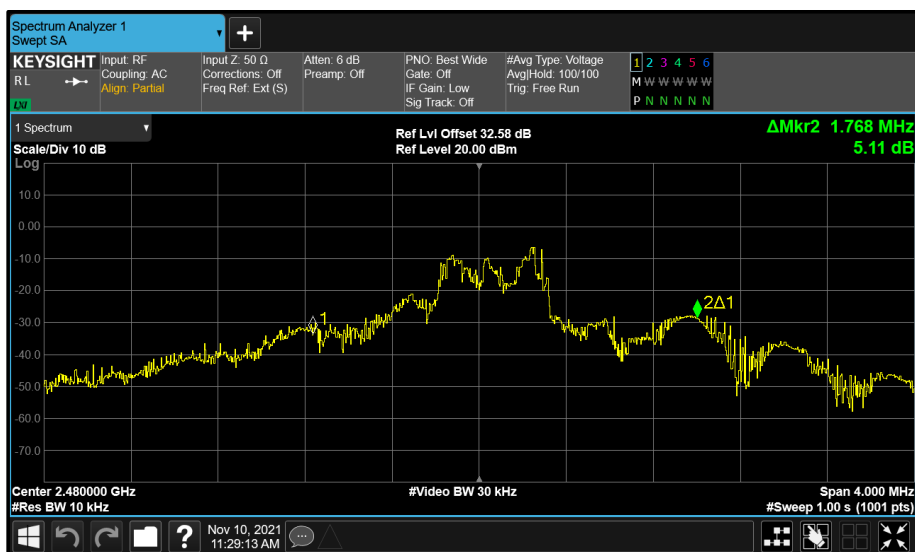


Figure 11 - A (A) 2480 MHz 99% Bandwidth

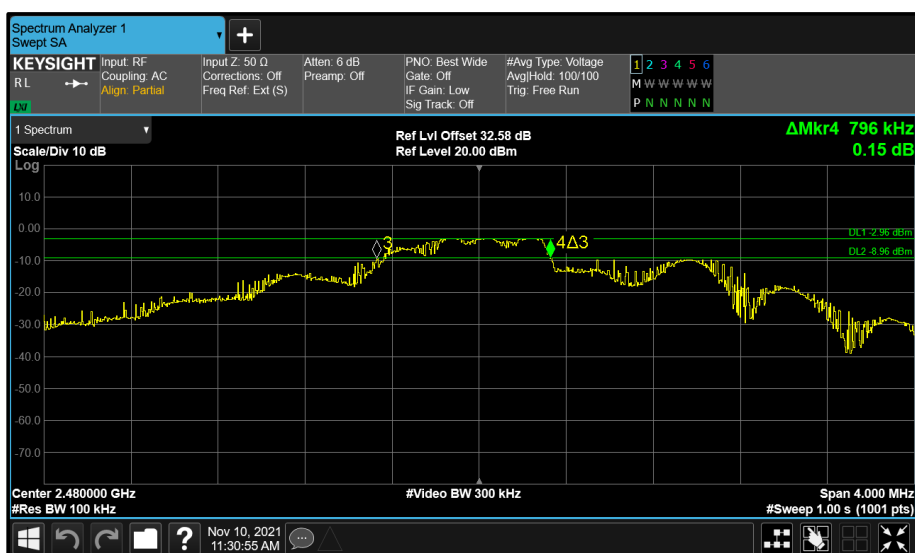


Figure 12 - A (A) 2480 MHz 6 dB Bandwidth

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 1.

| Instrument                | Manufacturer          | Type No                   | TE No | Calibration Period (months) | Calibration Expires |
|---------------------------|-----------------------|---------------------------|-------|-----------------------------|---------------------|
| Rubidium Standard         | Rohde & Schwarz       | XSRM                      | 1316  | 6                           | 03-Dec-2021         |
| Frequency Standard        | Spectracom            | SecureSync 1200-0408-0601 | 4393  | 6                           | 03-Dec-2021         |
| Climatic Chamber          | Aralab                | FitoTerm 300E45           | 4823  | 12                          | 12-Apr-2022         |
| Hygropalm Hygrometer      | Rotronic              | HP21                      | 5264  | 12                          | 12-Jul-2022         |
| MXA Signal Analyser       | Keysight Technologies | N9020B                    | 5528  | 24                          | 04-Mar-2022         |
| Signal Commissioning Unit | TUV SUD               | SCU001                    | 5546  | 12                          | 16-Apr-2022         |

**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**

Atom Hard Hat, S/N: XYZR0047\_02 - Modification State 0

### **2.3.3 Date of Test**

10-November-2021

### **2.3.4 Test Method**

The test was performed in accordance with ANSI C63.10, clause 11.9.2.3.2.

### **2.3.5 Environmental Conditions**

|                     |         |
|---------------------|---------|
| Ambient Temperature | 22.9 °C |
| Relative Humidity   | 48.6 %  |



## 2.3.6 Test Results

### Hard Hat - 2.4 GHz proprietary device

| Test Configuration       |                                 |                 |                   |
|--------------------------|---------------------------------|-----------------|-------------------|
| Frequency Range:         | 2400-2483.5 MHz                 | Band:           | 2.4 GHz           |
| Limit Clause(s):         | 15.247 (b)(3)<br>RSS-247 5.4 d) | Test Method(s): | C63.10 11.9.2.3.2 |
| Additional Reference(s): | -                               |                 |                   |

| DUT Configuration      |                 |                          |      |
|------------------------|-----------------|--------------------------|------|
| Mode:                  | Proprietary ISM | Duty Cycle (%):          | 8.6  |
| Data Rate:             | 250 kbps        | DCCF (dB):               | -    |
| Antenna Configuration: | SISO            | Peak Antenna Gain (dBi): | 2.80 |
| Active Port(s):        | A (A)           | Active Chain(s):         | 0    |

| Test Frequency (MHz) | Maximum Conducted Output Power (dBm) |   |   |   |   | Limit (dBm) | Margin (dB) |
|----------------------|--------------------------------------|---|---|---|---|-------------|-------------|
|                      | A                                    | B | C | D | Σ |             |             |
| 2402                 | -4.86                                | - | - | - | - | 30.00       | -34.86      |
| 2442                 | -3.71                                | - | - | - | - | 30.00       | -33.71      |
| 2480                 | -3.33                                | - | - | - | - | 30.00       | -33.33      |

**Table 23 - FCC Maximum Conducted (average) 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                 | -4.86                                | - | - | - | - | 30.00       | -34.86      | -2.06      | 36.00            | -38.06           |
| 2442                 | -3.71                                | - | - | - | - | 30.00       | -33.71      | -0.91      | 36.00            | -36.91           |
| 2480                 | -3.33                                | - | - | - | - | 30.00       | -33.33      | -0.53      | 36.00            | -36.53           |

**Table 24 - ISED Maximum Conducted (average) Output Power Results**

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

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

#### ISED RSS-247, Limit Clause 5.4 (b)

For DTSS employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e) of the specification.



### 2.3.7 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 |
|---------------------------|-----------------|---------------------------|-------|-----------------------------|---------------------|
| Rubidium Standard         | Rohde & Schwarz | XSRM                      | 1316  | 6                           | 03-Dec-2021         |
| Frequency Standard        | Spectracom      | SecureSync 1200-0408-0601 | 4393  | 6                           | 03-Dec-2021         |
| Climatic Chamber          | Aralab          | FitoTerm 300E45           | 4823  | 12                          | 12-Apr-2022         |
| USB Power Sensor          | Boonton         | RTP5006                   | 5184  | 12                          | 19-Apr-2022         |
| Hygropalm Hygrometer      | Rotronic        | HP21                      | 5264  | 12                          | 12-Jul-2022         |
| Signal Commissioning Unit | TUV SUD         | SCU001                    | 5546  | 12                          | 16-Apr-2022         |

**Table 25**



## **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**

Atom Hard Hat, S/N: Not serialised (Storix-ID 599374-117) - Modification State 0

### **2.4.3 Date of Test**

07-November-2021 to 08-November-2021

### **2.4.4 Test Method**

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

The EUT was placed on the non-conducting platform in a manner typical of a normal installation. For an EUT which could reasonably be used in multiple planes, pre-scans were performed with the EUT orientated in X, Y and Z planes with reference to the ground plane.

For frequencies > 1 GHz, plots for average measurements were taken in accordance with ANSI C63.10, clause 4.1.4.2.5 to characterize the EUT. Where emissions were detected, final average measurements were taken in accordance with ANSI C63.10, clause 4.1.4.2.2.

The plots shown are the 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:  
 $10^{(\text{Field Strength in dBuV/m}/20)}$

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

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

#### 2.4.5 Example Test Setup Diagram

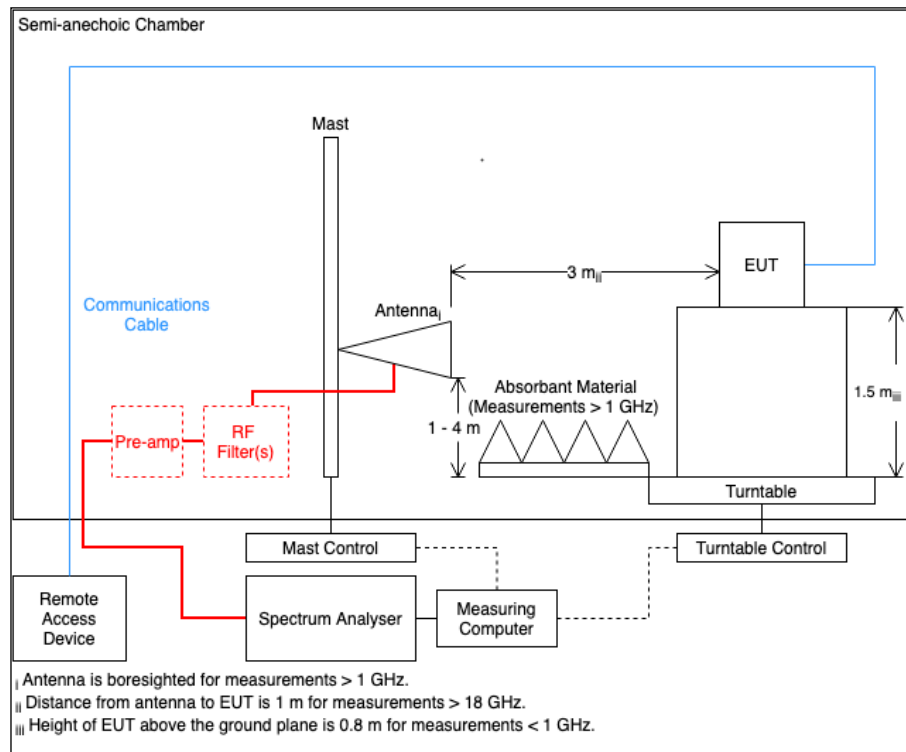


Figure 13

#### 2.4.6 Environmental Conditions

|                     |                |
|---------------------|----------------|
| Ambient Temperature | 19.2 - 20.3 °C |
| Relative Humidity   | 44.9 - 46.8 %  |

## 2.4.7 Test Results

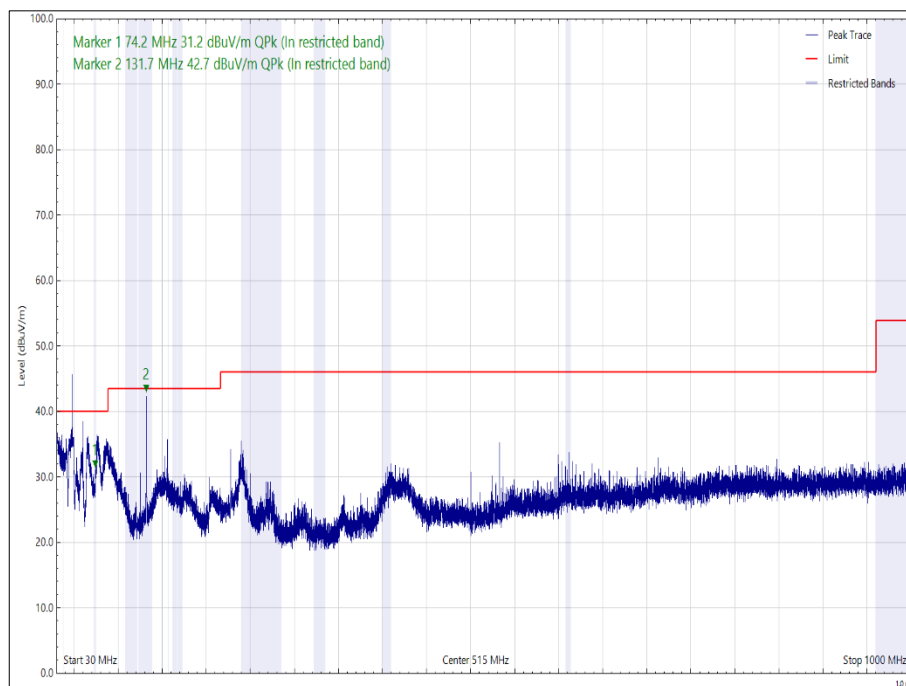
### Hard Hat - 2.4 GHz proprietary device

Testing was performed with the device configured to transmit a CW tone, this was considered worst-case.

| Frequency (MHz) | Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Detector | Angle (°) | Height (cm) | Polarisation | Orientation |
|-----------------|----------------|----------------|-------------|----------|-----------|-------------|--------------|-------------|
| 74.175          | 31.16          | 40.00          | -8.84       | Q-Peak   | 124       | 100         | Vertical     | X           |
| 74.349          | 30.12          | 40.00          | -9.88       | Q-Peak   | 106       | 101         | Vertical     | Z           |
| 131.603         | 37.03          | 43.52          | -6.49       | Q-Peak   | 218       | 108         | Vertical     | Z           |
| 131.674         | 43.09          | 43.52          | -0.43       | Q-Peak   | 184       | 100         | Vertical     | Y           |
| 131.743         | 42.67          | 43.52          | -0.85       | Q-Peak   | 243       | 100         | Vertical     | X           |
| 131.775         | 36.52          | 43.52          | -7.00       | Q-Peak   | 360       | 159         | Horizontal   | Y           |

**Table 26 - 2402 MHz, 30 MHz to 1 GHz**

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



**Figure 14 - 2402 MHz, 30 MHz to 1 GHz, Vertical, X Orientation**

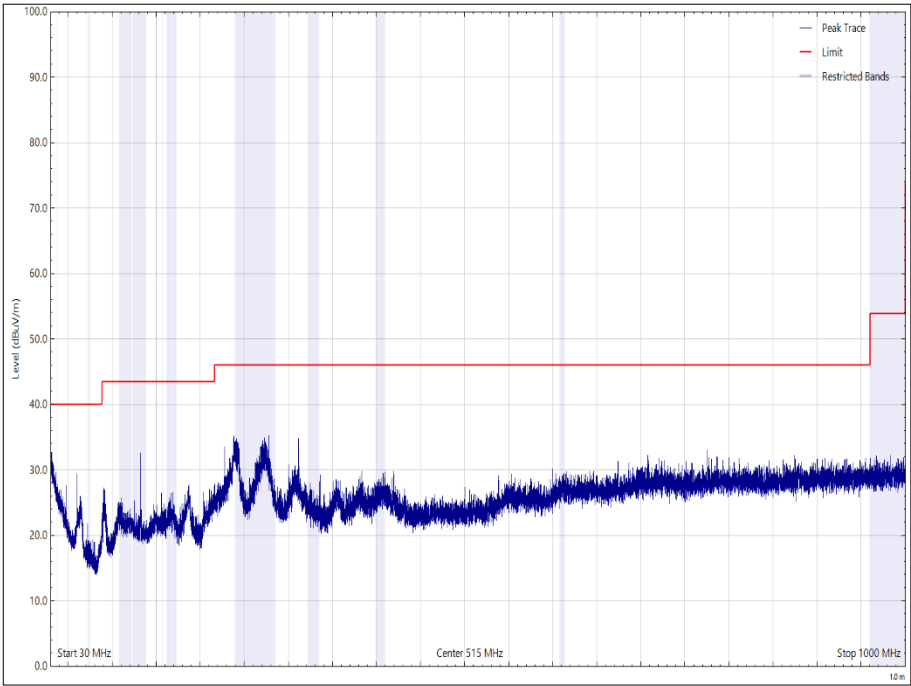


Figure 15 - 2402 MHz, 30 MHz to 1 GHz, Horizontal, X Orientation

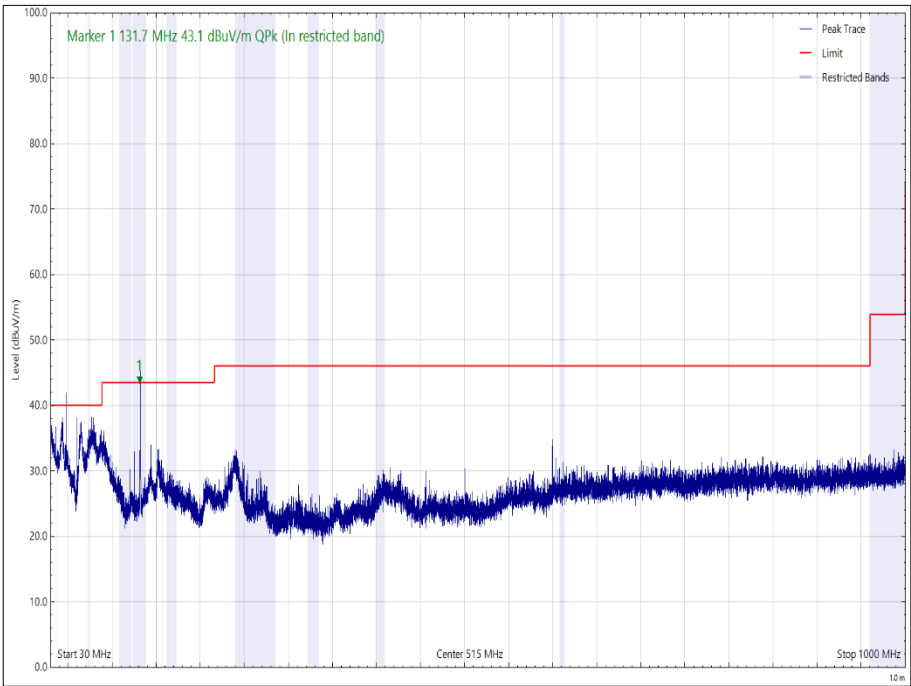


Figure 16 - 2402 MHz, 30 MHz to 1 GHz, Vertical, Y Orientation

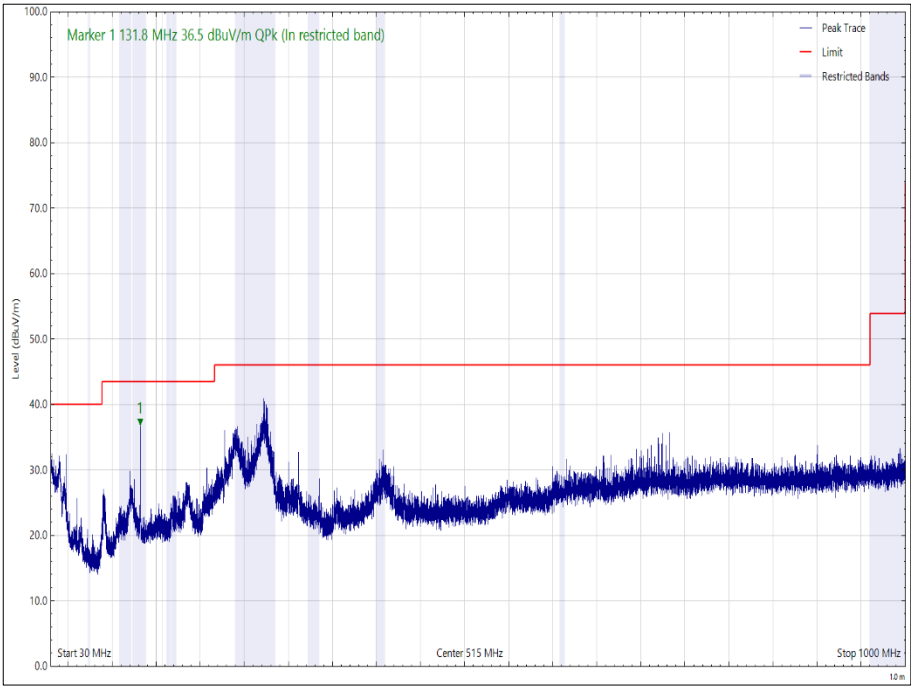


Figure 17 - 2402 MHz, 30 MHz to 1 GHz, Horizontal, Y Orientation

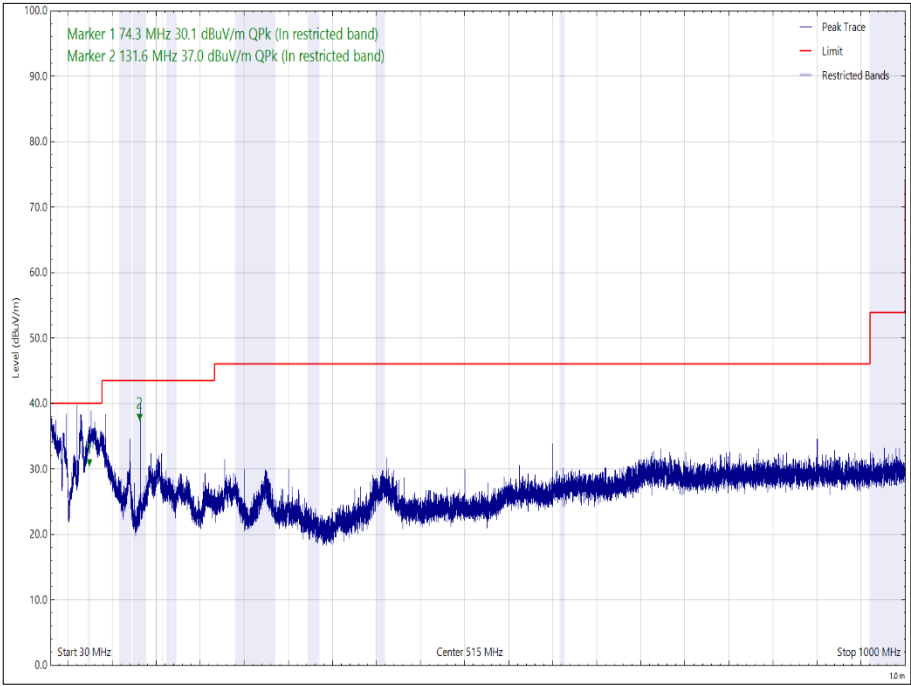


Figure 18 - 2402 MHz, 30 MHz to 1 GHz, Vertical, Z Orientation

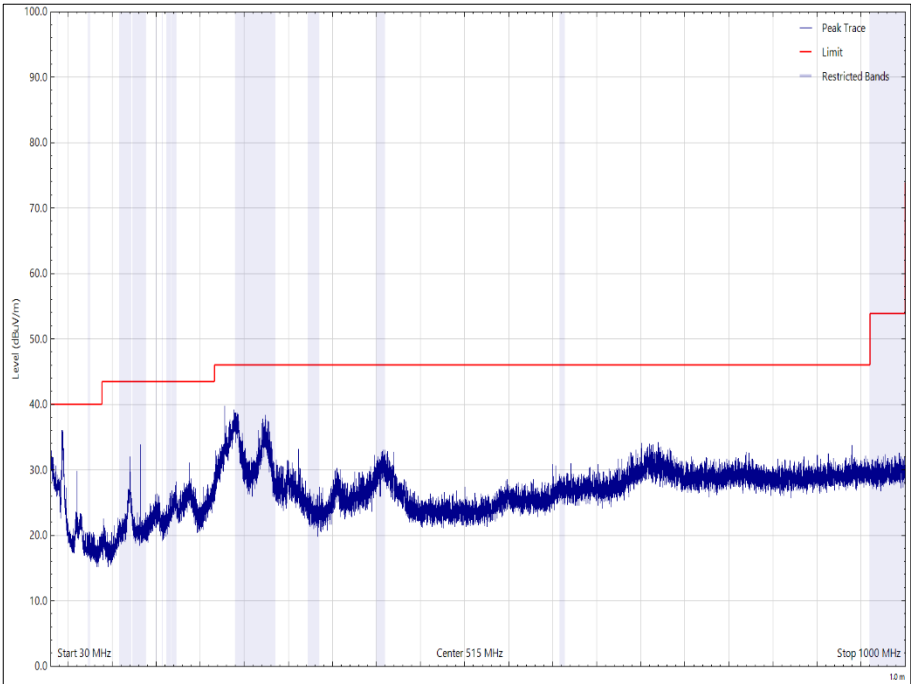
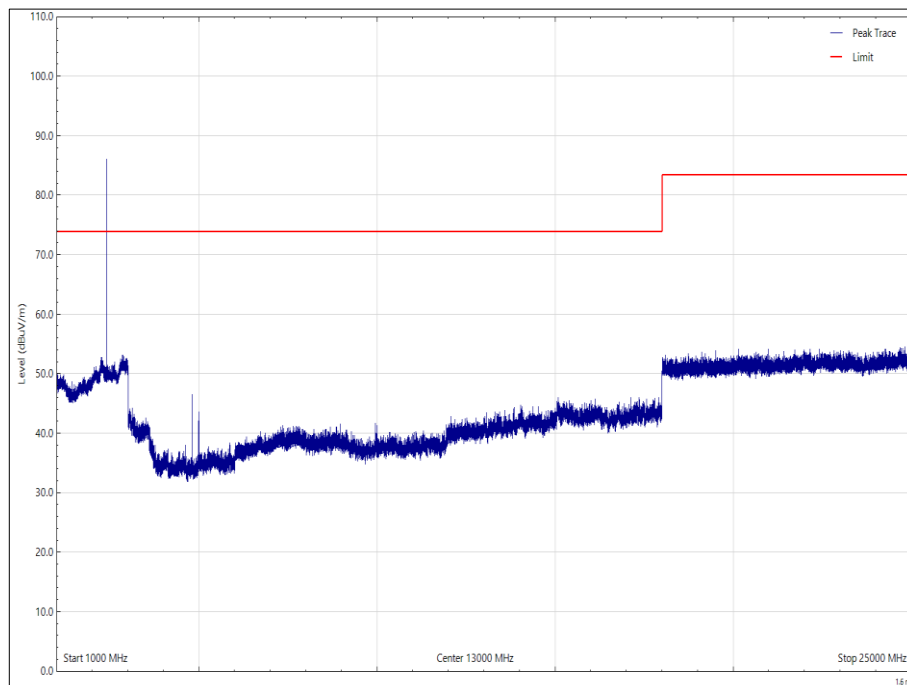


Figure 19 - 2402 MHz, 30 MHz to 1 GHz, Horizontal, Z Orientation

| Frequency (MHz) | Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Detector | Angle (°) | Height (cm) | Polarisation | Orientation |
|-----------------|----------------|----------------|-------------|----------|-----------|-------------|--------------|-------------|
| 4804.046        | 46.60          | 53.98          | -7.38       | Average  | 181       | 155         | Vertical     | X           |
| 4804.050`       | 46.54          | 53.98          | -7.44       | Average  | 127       | 155         | Horizontal   | X           |
| 4804.083        | 48.26          | 53.98          | -5.72       | Average  | 340       | 171         | Vertical     | Z           |
| 4804.091        | 47.55          | 53.98          | -6.43       | Average  | 350       | 169         | Horizontal   | Z           |
| 4804.116        | 47.00          | 53.98          | -6.98       | Average  | 350       | 155         | Vertical     | Y           |
| 4804.132        | 47.10          | 53.98          | -6.88       | Average  | 5         | 213         | Horizontal   | Y           |

**Table 27 - 2402 MHz, 1 GHz to 25 GHz**

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



**Figure 20 - 2402 MHz, 1 GHz to 25 GHz, Vertical, X Orientation - Peak**

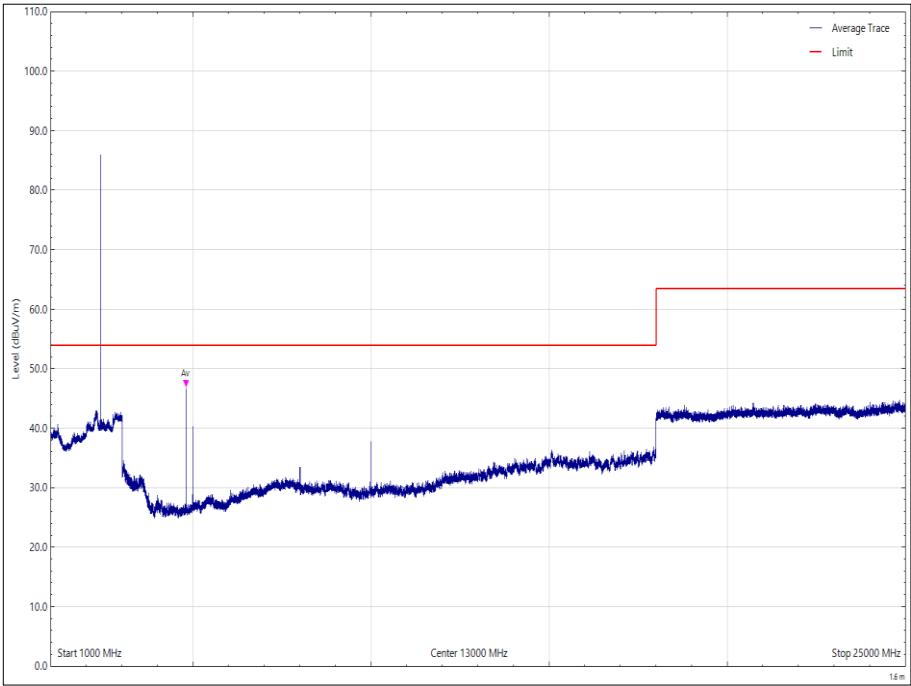


Figure 21 - 2402 MHz, 1 GHz to 25 GHz, Vertical, X Orientation - Average

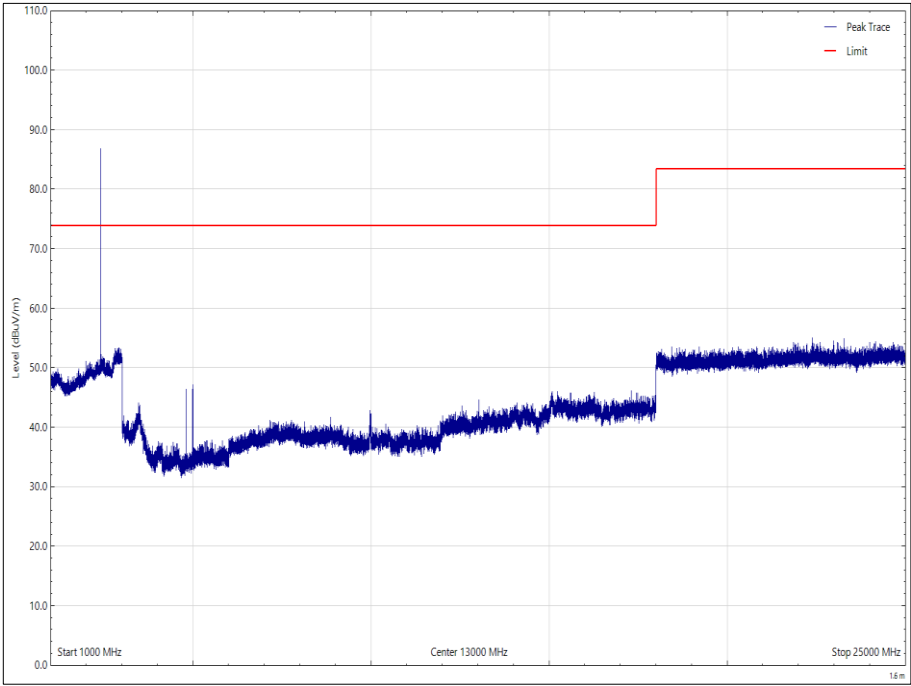


Figure 22 - 2402 MHz, 1 GHz to 25 GHz, Horizontal, X Orientation - Peak

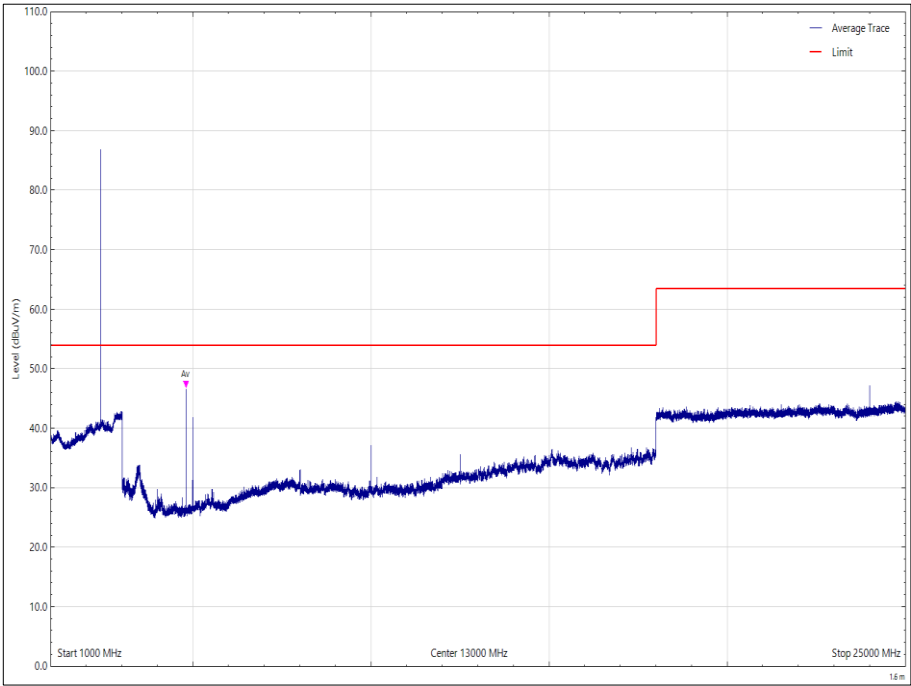


Figure 23 - 2402 MHz, 1 GHz to 25 GHz, Horizontal, X Orientation - Average

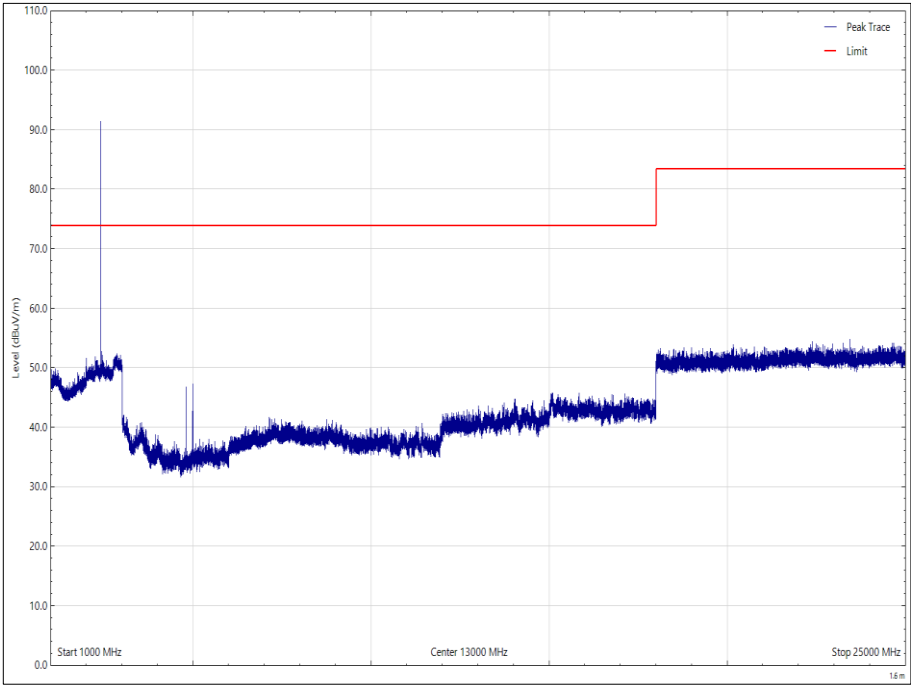


Figure 24 - 2402 MHz, 1 GHz to 25 GHz, Vertical, Y Orientation - Peak

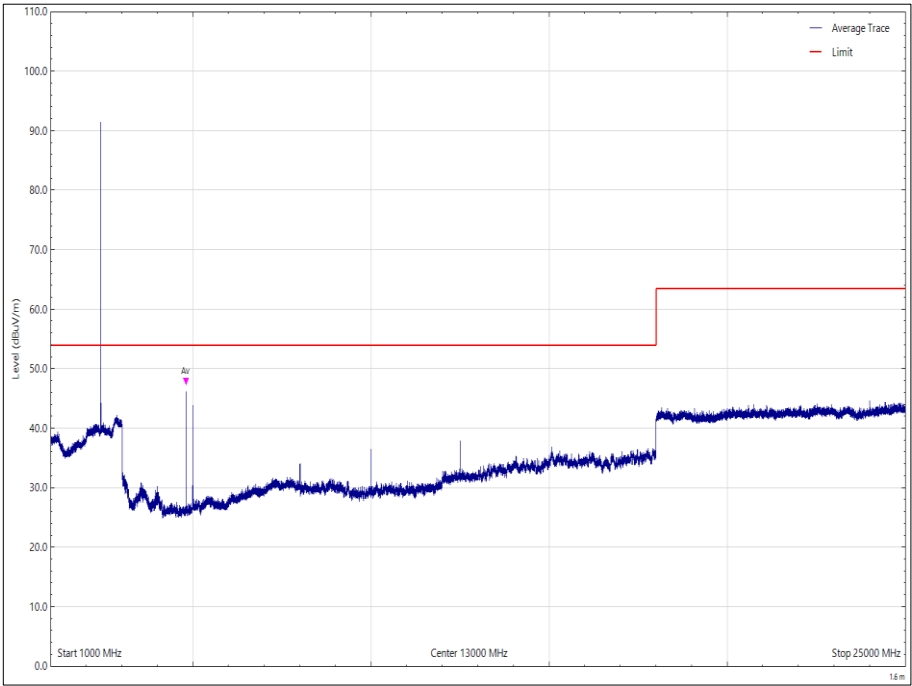


Figure 25 - 2402 MHz, 1 GHz to 25 GHz, Vertical, Y Orientation - Average

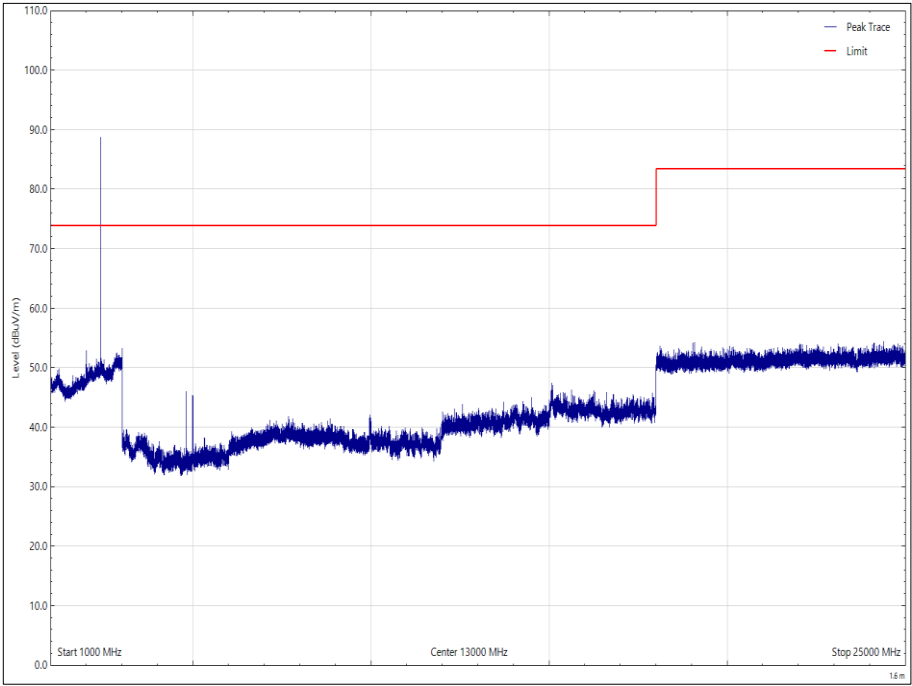


Figure 26 - 2402 MHz, 1 GHz to 25 GHz, Horizontal, Y Orientation - Peak

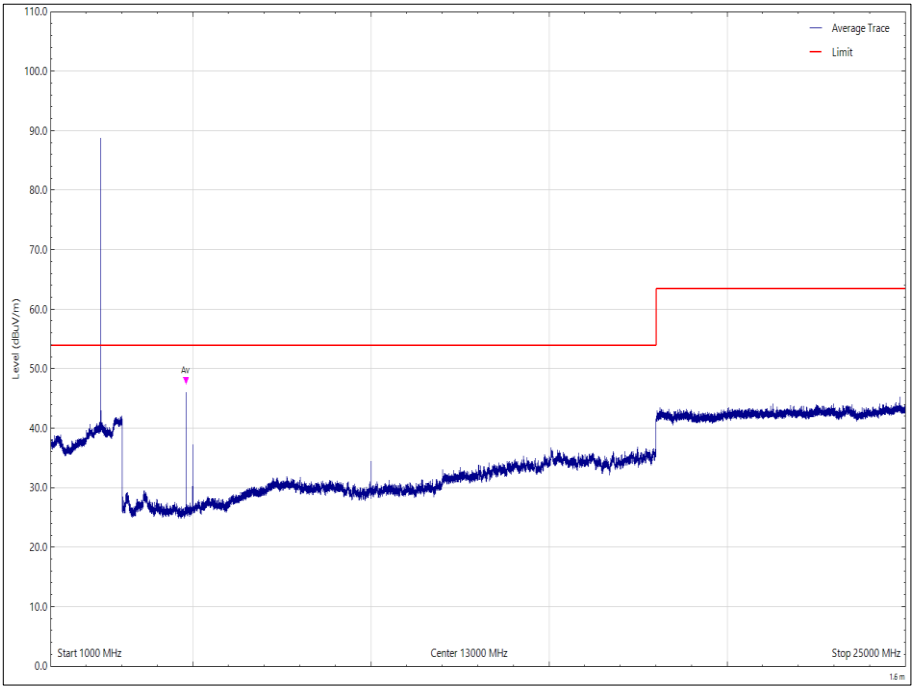


Figure 27 - 2402 MHz, 1 GHz to 25 GHz, Horizontal, Y Orientation - Average

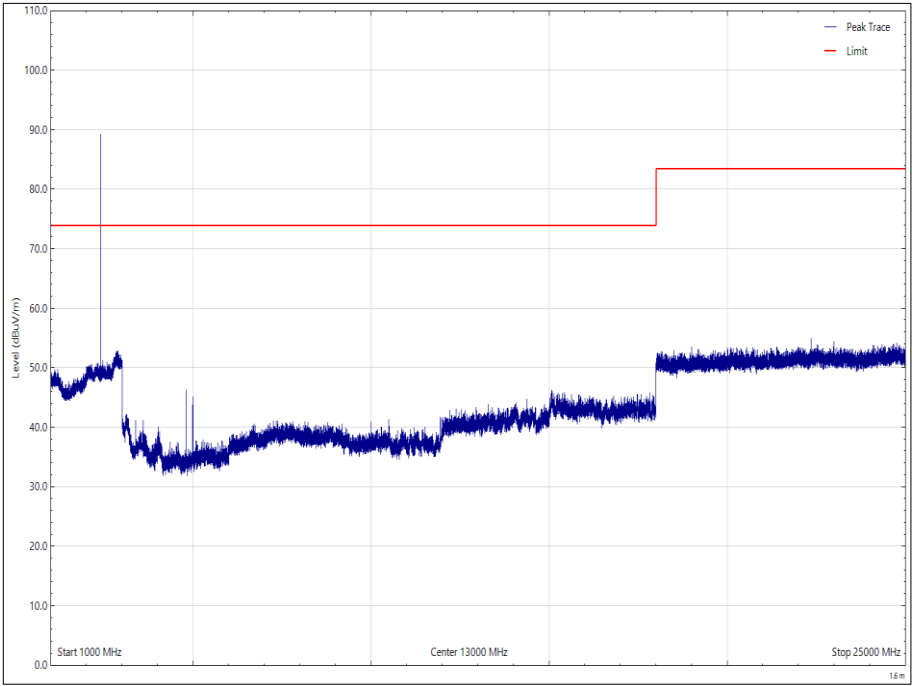


Figure 28 - 2402 MHz, 1 GHz to 25 GHz, Vertical, Z Orientation - Peak

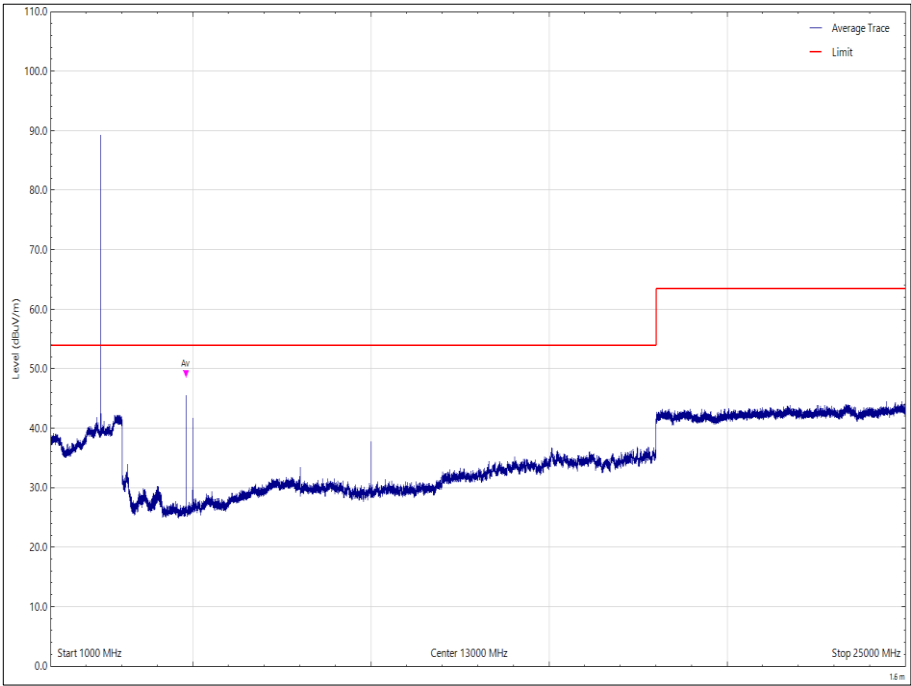


Figure 29 - 2402 MHz, 1 GHz to 25 GHz, Vertical, Z Orientation - Average

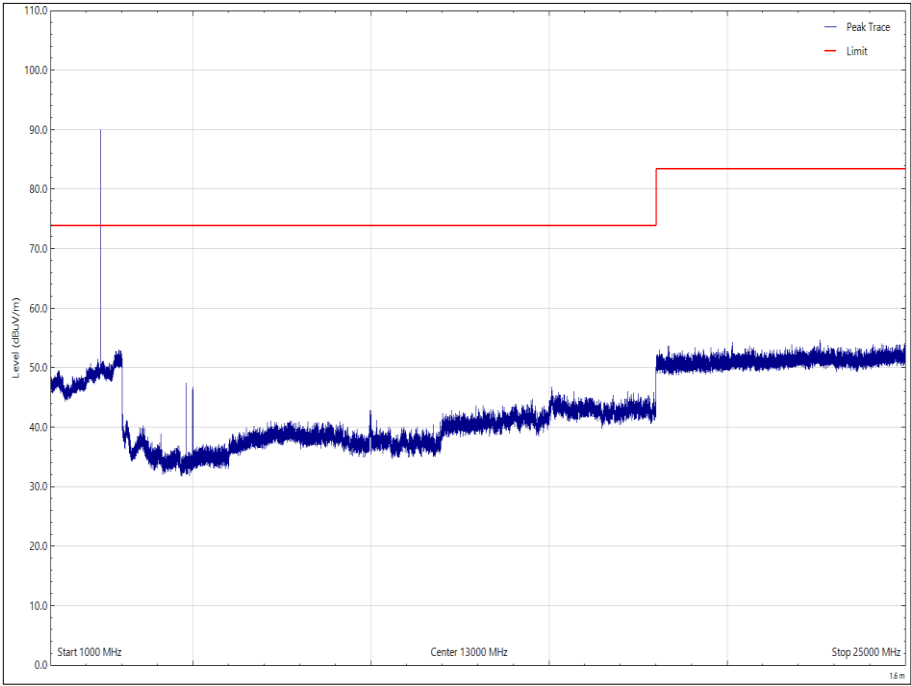


Figure 30 - 2402 MHz, 1 GHz to 25 GHz, Horizontal, Z Orientation - Peak

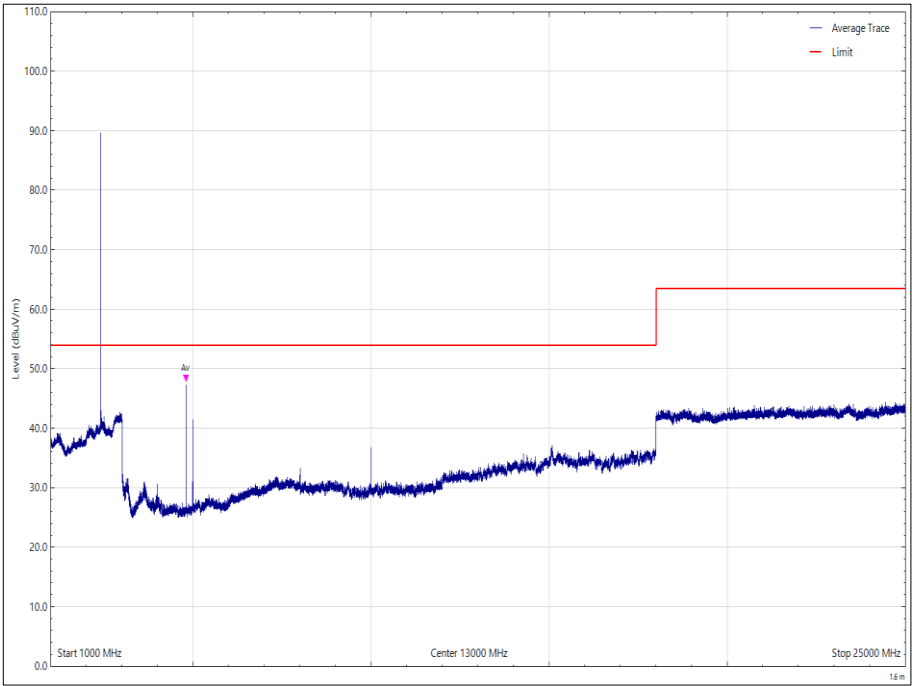
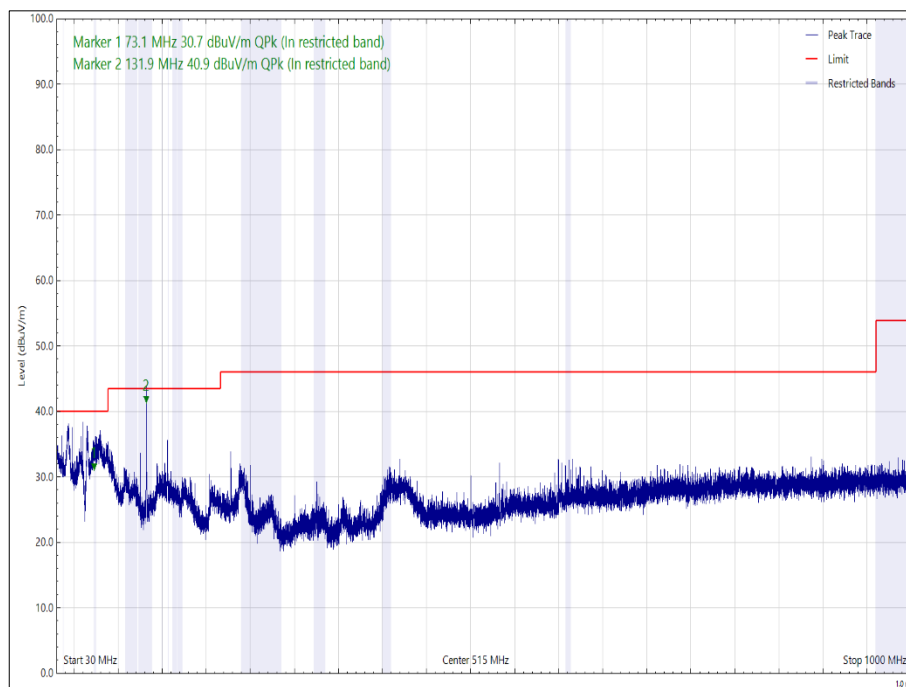


Figure 31 - 2402 MHz, 1 GHz to 25 GHz, Horizontal, Z Orientation - Average

| Frequency (MHz) | Level (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) | Detector | Angle (°) | Height (cm) | Polarisation | Orientation |
|-----------------|----------------------|----------------------|-------------|----------|-----------|-------------|--------------|-------------|
| 73.100          | 30.68                | 40.00                | -9.32       | Q-Peak   | 104       | 149         | Vertical     | X           |
| 74.178          | 30.91                | 40.00                | -9.09       | Q-Peak   | 123       | 100         | Vertical     | Z           |
| 131.674         | 35.24                | 43.52                | -8.28       | Q-Peak   | 0         | 196         | Horizontal   | Y           |
| 131.737         | 34.96                | 43.52                | -8.56       | Q-Peak   | 255       | 187         | Horizontal   | Z           |
| 131.775         | 41.08                | 43.52                | -2.44       | Q-Peak   | 168       | 100         | Vertical     | Y           |
| 131.794         | 38.67                | 43.52                | -4.85       | Q-Peak   | 216       | 100         | Vertical     | Z           |
| 131.871         | 40.93                | 43.52                | -2.59       | Q-Peak   | 247       | 102         | Vertical     | X           |
| 240.026         | 36.02                | 46.02                | -10.00      | Q-Peak   | 287       | 105         | Horizontal   | Z           |
| 272.701         | 36.19                | 46.02                | -9.83       | Q-Peak   | 177       | 100         | Horizontal   | X           |
| 272.801         | 36.45                | 46.02                | -9.57       | Q-Peak   | 36        | 104         | Horizontal   | Y           |
| 273.121         | 36.13                | 46.02                | -9.89       | Q-Peak   | 270       | 108         | Horizontal   | Z           |

**Table 28 - 2440 MHz, 30 MHz to 1 GHz**

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



**Figure 32 - 2440 MHz, 30 MHz to 1 GHz, Vertical, X Orientation**

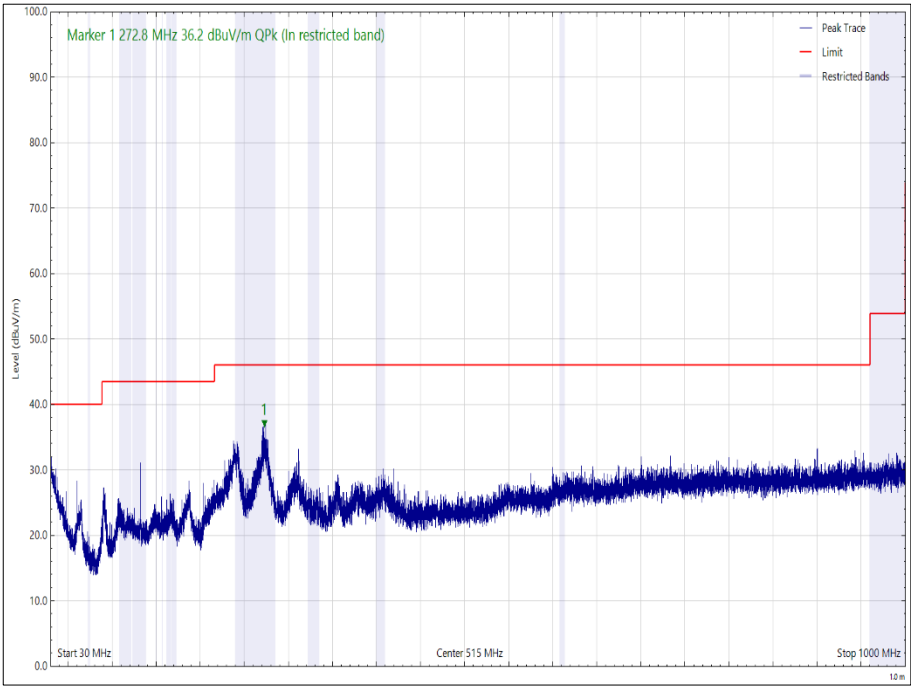


Figure 33 - 2440 MHz, 30 MHz to 1 GHz, Horizontal, X Orientation

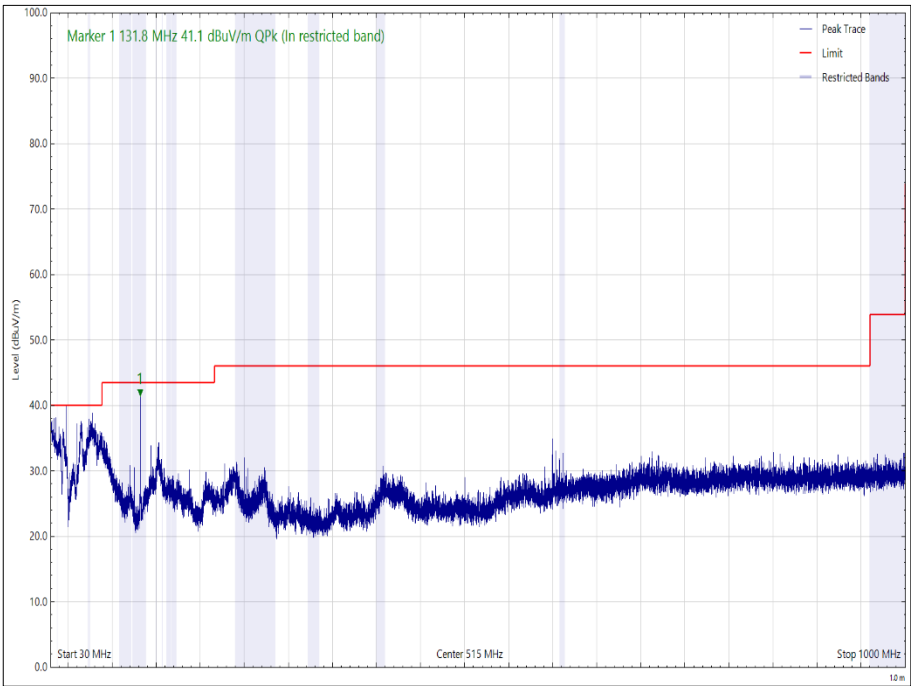


Figure 34 - 2440 MHz, 30 MHz to 1 GHz, Vertical, Y Orientation

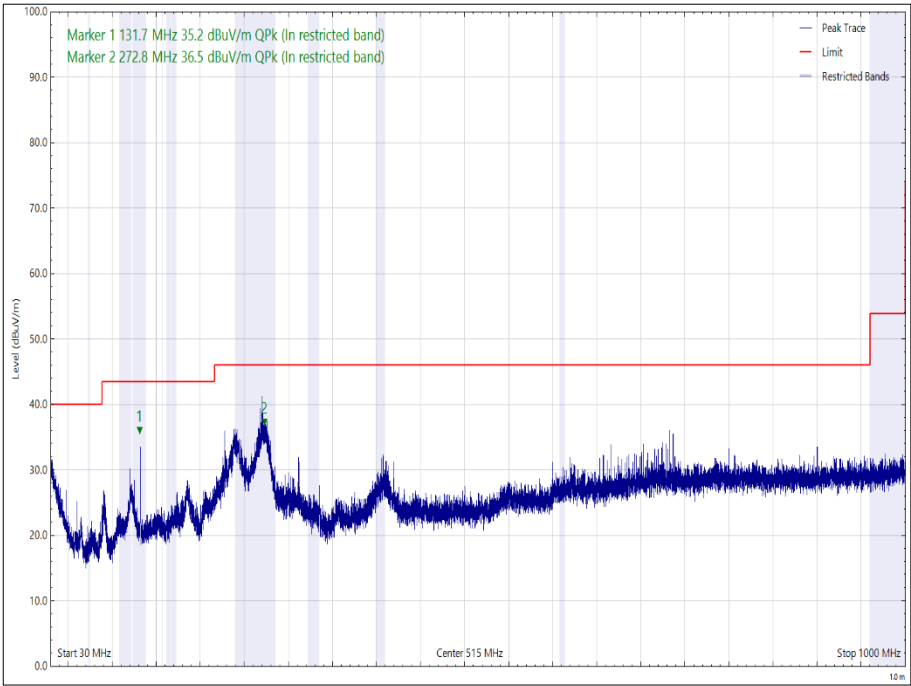


Figure 35 - 2440 MHz, 30 MHz to 1 GHz, Horizontal, Y Orientation

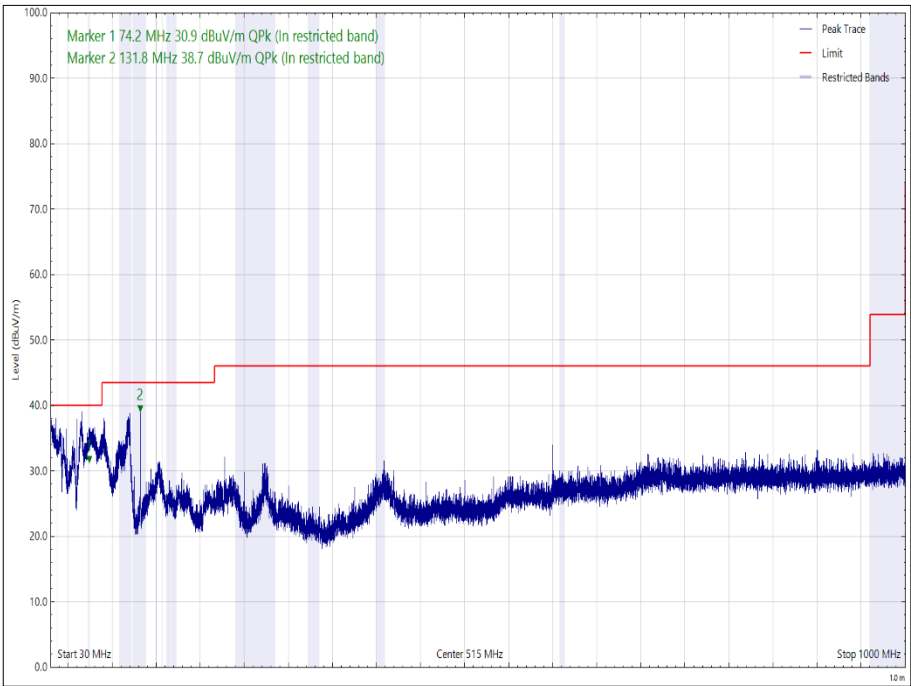


Figure 36 - 2440 MHz, 30 MHz to 1 GHz, Vertical, Z Orientation

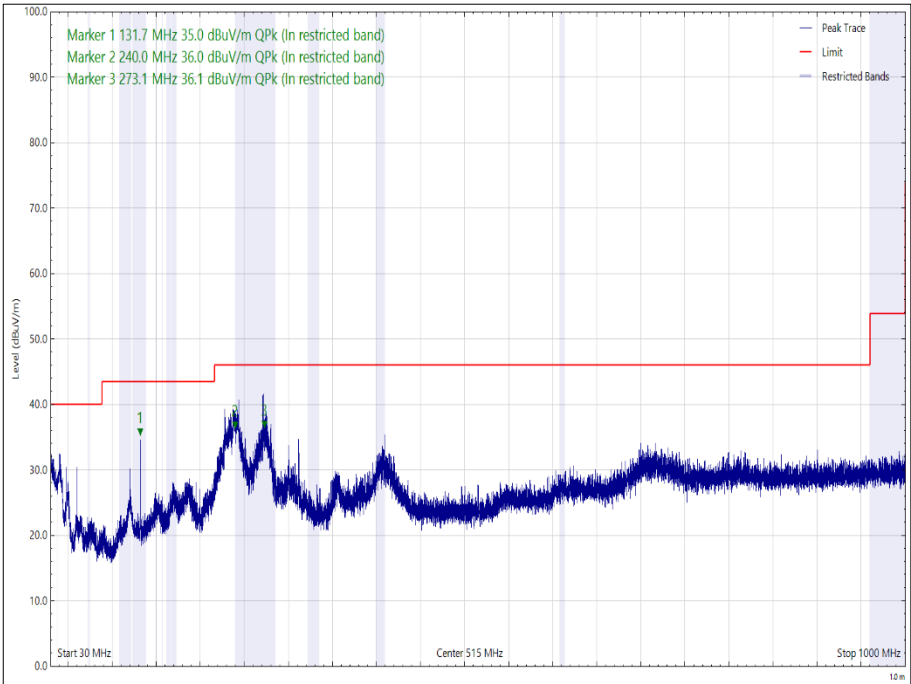
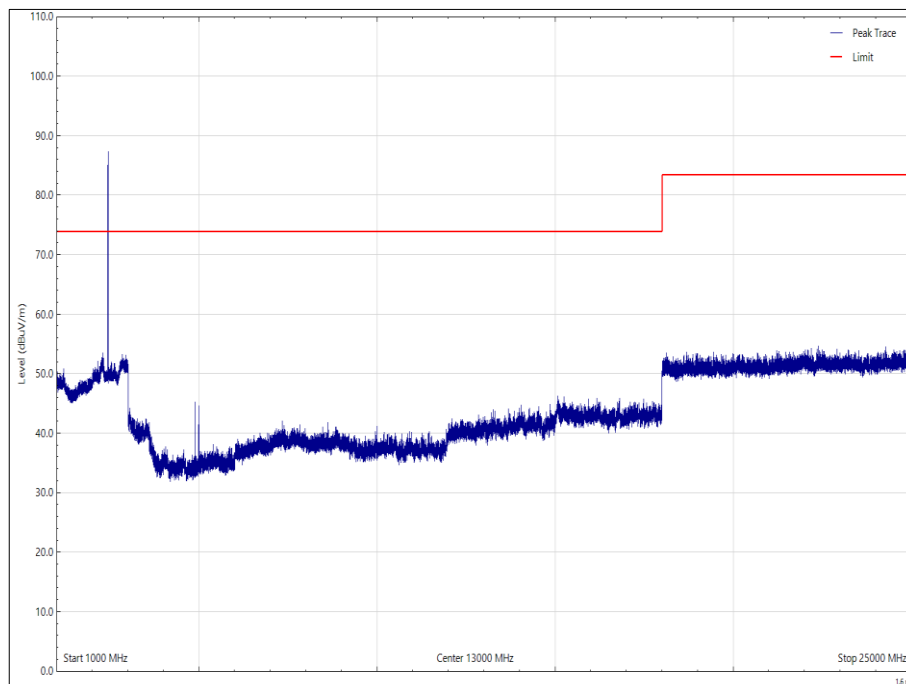


Figure 37 - 2440 MHz, 30 MHz to 1 GHz, Horizontal, Z Orientation

| Frequency (MHz) | Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Detector | Angle (°) | Height (cm) | Polarisation | Orientation |
|-----------------|----------------|----------------|-------------|----------|-----------|-------------|--------------|-------------|
| 4880.106        | 45.37          | 53.98          | -8.61       | Average  | 179       | 174         | Vertical     | X           |
| 4880.114        | 44.69          | 53.98          | -9.29       | Average  | 341       | 175         | Vertical     | Z           |
| 4880.122        | 45.88          | 53.98          | -8.10       | Average  | 354       | 155         | Vertical     | Y           |
| 4880.129        | 47.65          | 53.98          | -6.33       | Average  | 355       | 179         | Horizontal   | Z           |

**Table 29 - 2440 MHz - 1 GHz to 25 GHz**

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



**Figure 38 - 2440 MHz - 1 GHz to 25 GHz, Vertical, X Orientation - Peak**

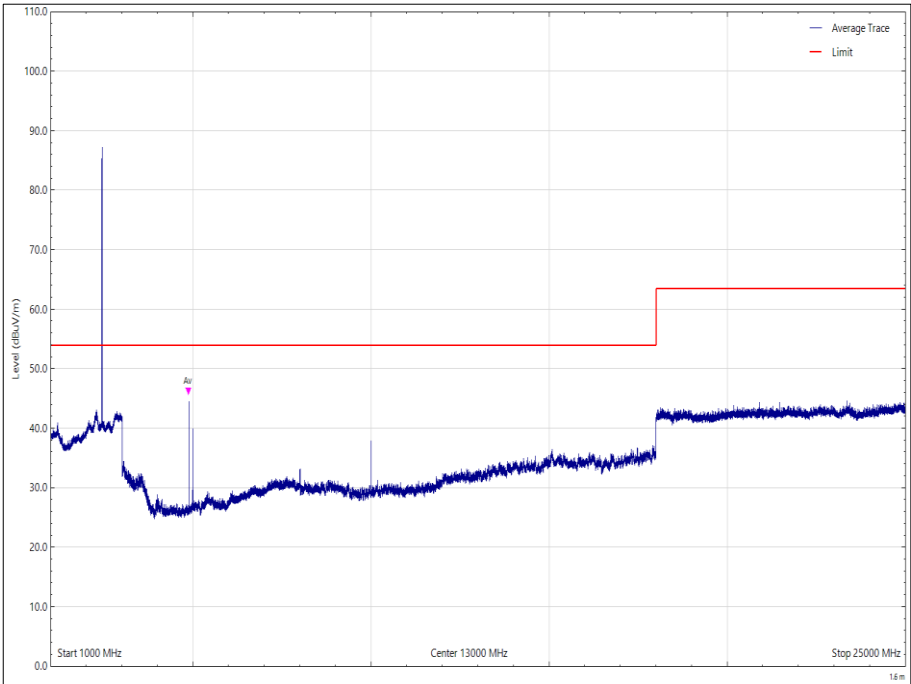


Figure 39 - 2440 MHz - 1 GHz to 25 GHz, Vertical, X Orientation - Average

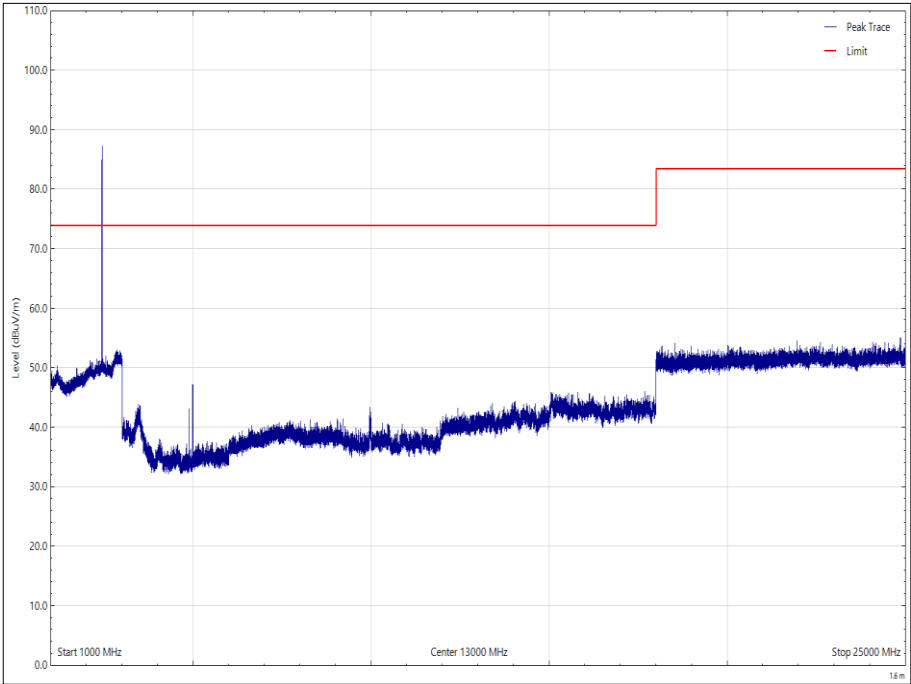


Figure 40 - 2440 MHz - 1 GHz to 25 GHz, Horizontal, X Orientation - Peak

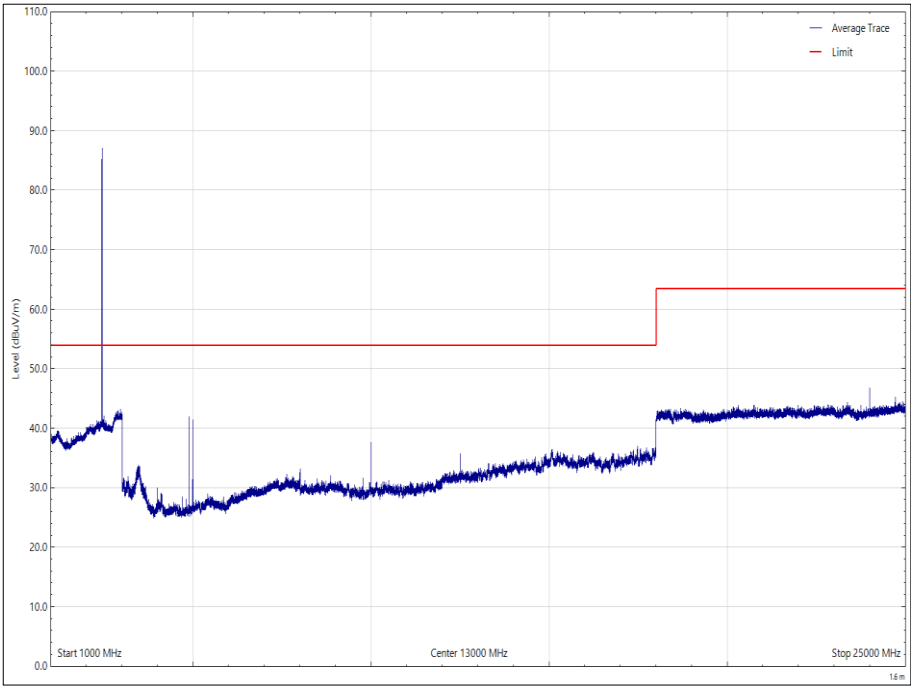


Figure 41 - 2440 MHz - 1 GHz to 25 GHz, Horizontal, X Orientation - Average

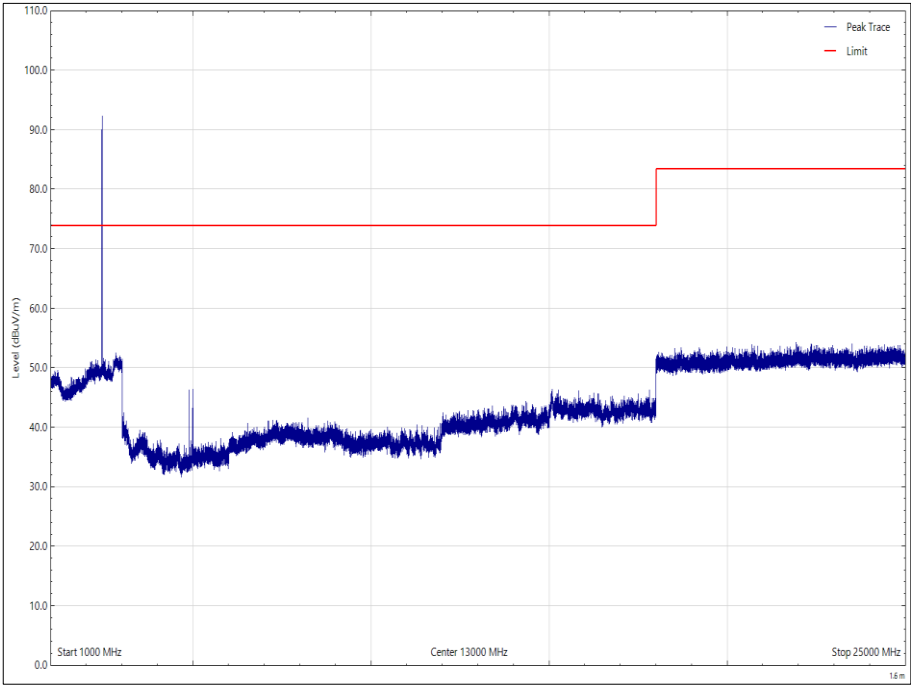


Figure 42 - 2440 MHz - 1 GHz to 25 GHz, Vertical, Y Orientation - Peak

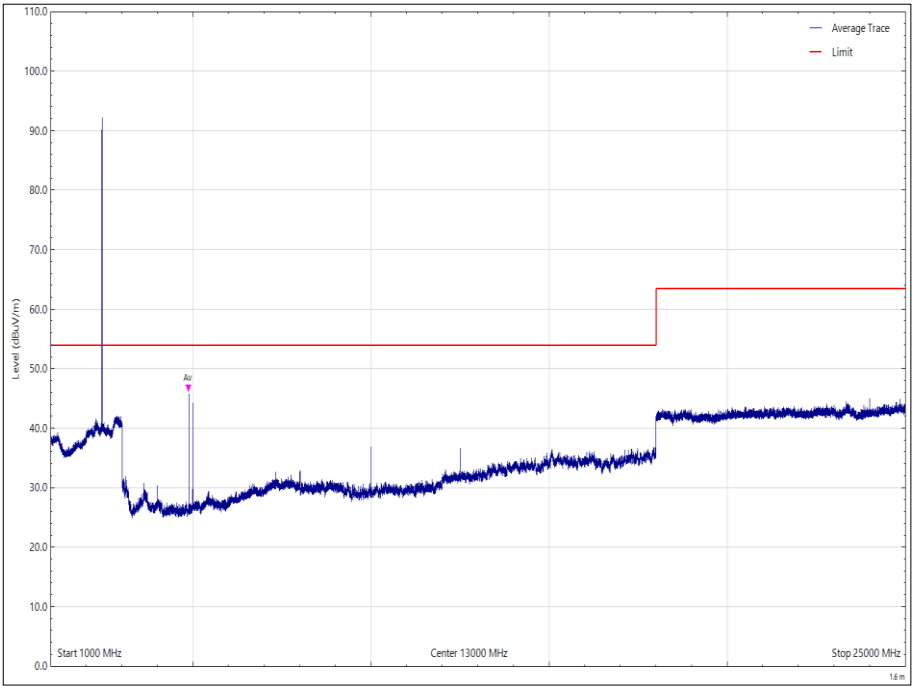


Figure 43 - 2440 MHz - 1 GHz to 25 GHz, Vertical, Y Orientation - Average

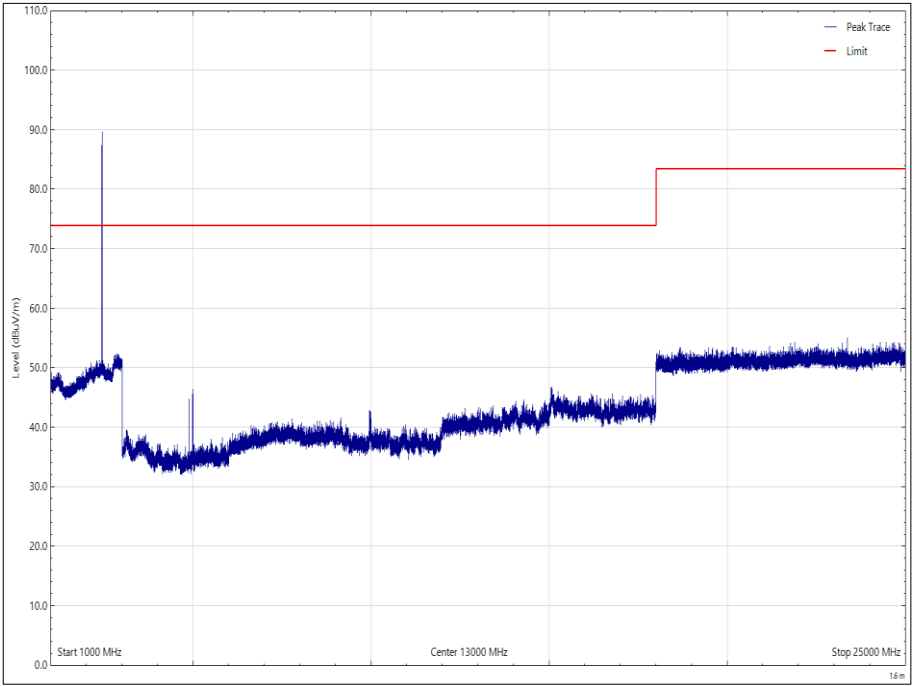


Figure 44 - 2440 MHz - 1 GHz to 25 GHz, Horizontal, Y Orientation - Peak

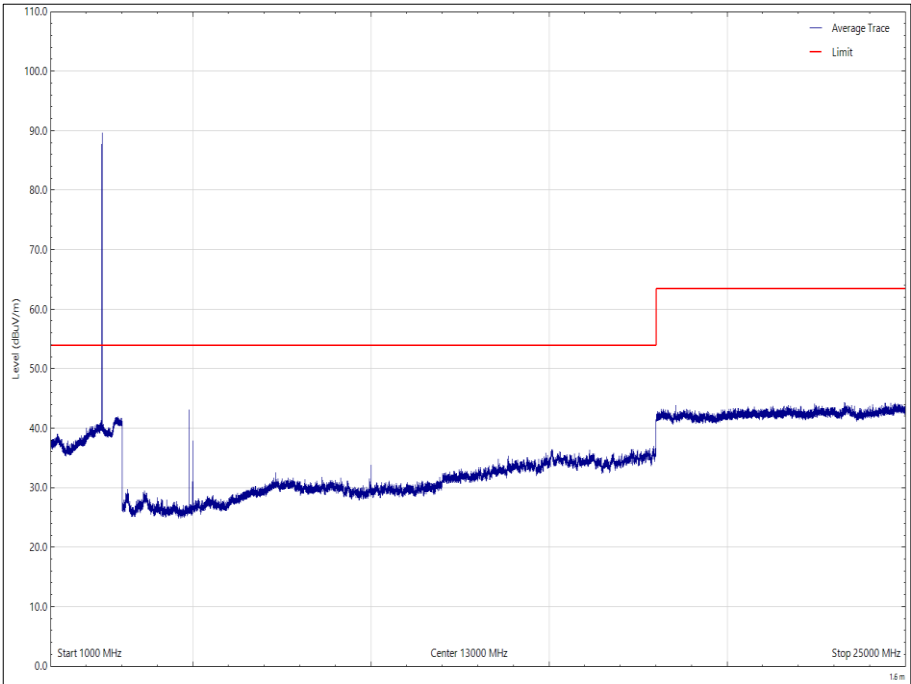


Figure 45 - 2440 MHz - 1 GHz to 25 GHz, Horizontal, Y Orientation - Average

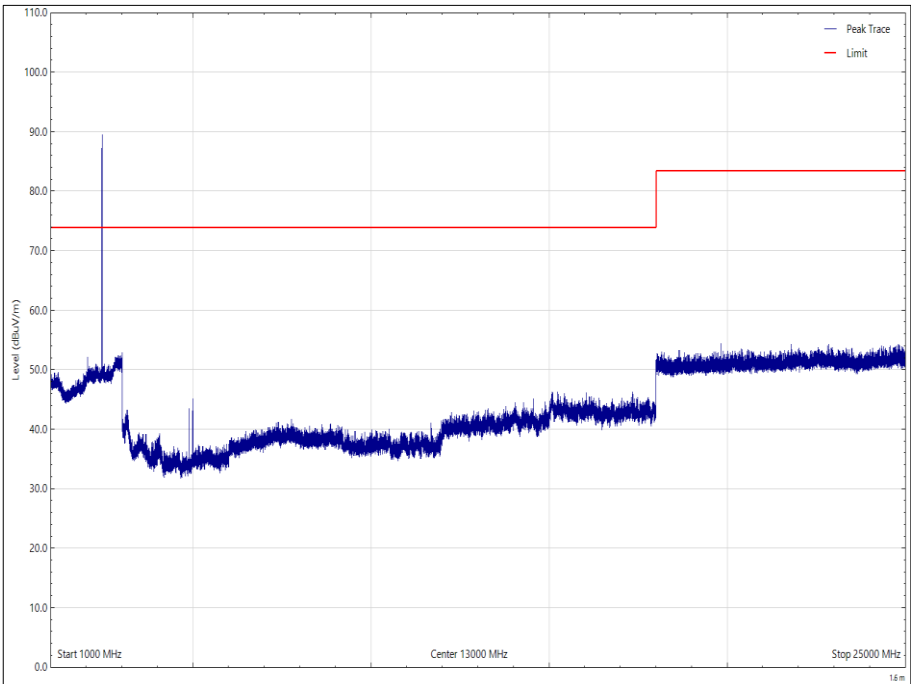


Figure 46 - 2440 MHz - 1 GHz to 25 GHz, Vertical, Z Orientation - Peak

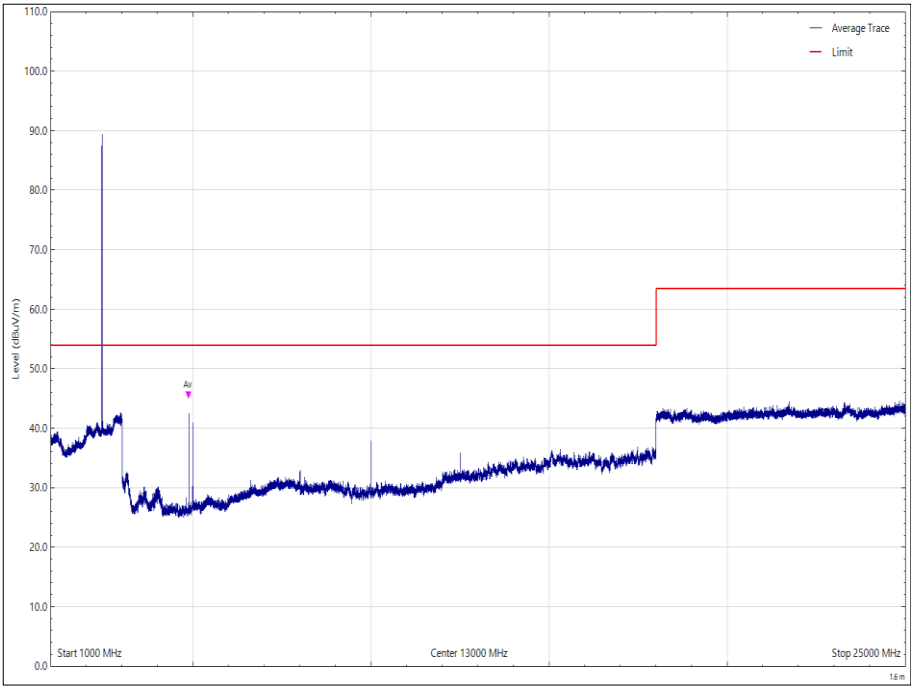


Figure 47 - 2440 MHz - 1 GHz to 25 GHz, Vertical, Z Orientation - Average

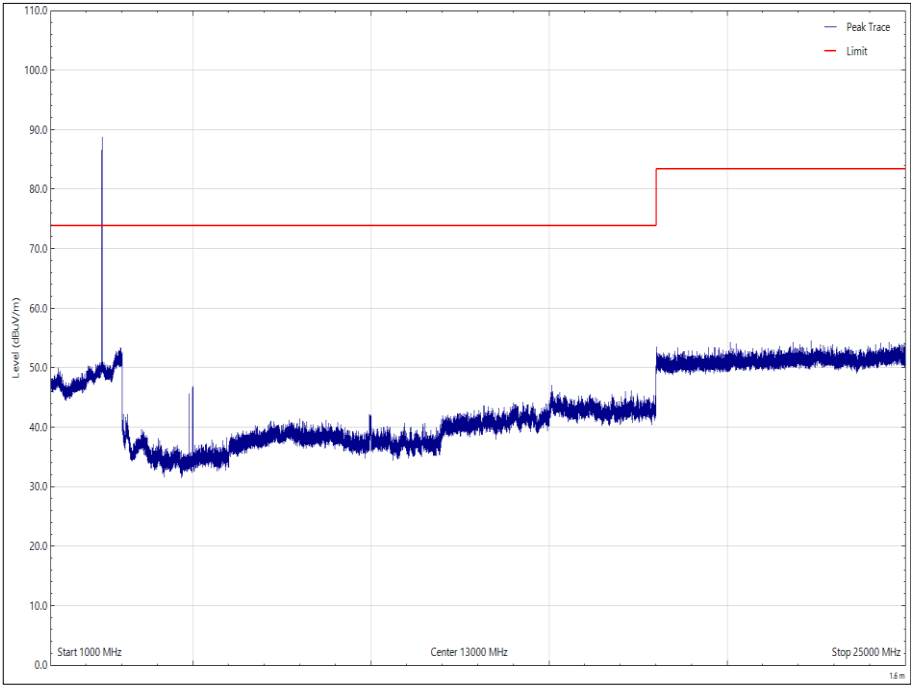


Figure 48 - 2440 MHz - 1 GHz to 25 GHz, Horizontal, Z Orientation - Peak

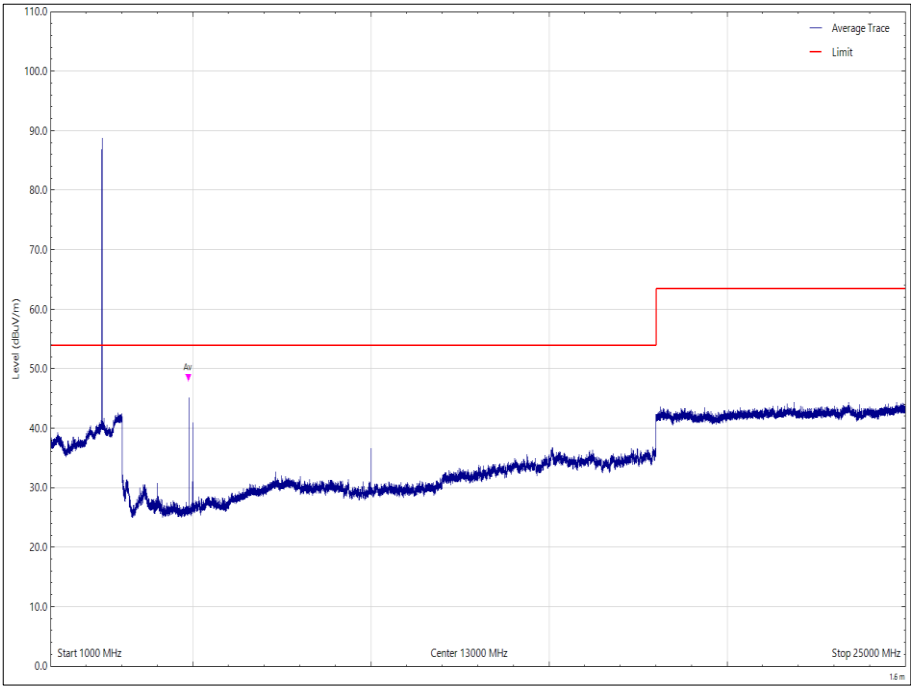
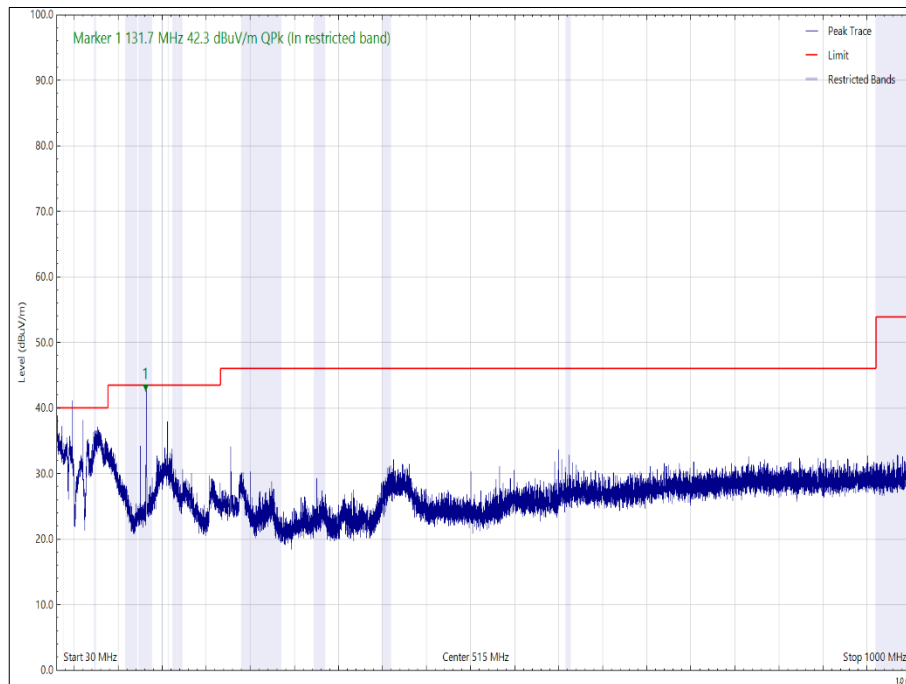


Figure 49 - 2440 MHz - 1 GHz to 25 GHz, Horizontal, Z Orientation - Average

| Frequency (MHz) | Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Detector | Angle (°) | Height (cm) | Polarisation | Orientation |
|-----------------|----------------|----------------|-------------|----------|-----------|-------------|--------------|-------------|
| 75.005          | 31.03          | 40.00          | -8.97       | Q-Peak   | 222       | 100         | Vertical     | Z           |
| 75.113          | 31.89          | 40.00          | -8.11       | Q-Peak   | 61        | 100         | Vertical     | Y           |
| 131.651         | 42.30          | 43.52          | -1.22       | Q-Peak   | 227       | 102         | Vertical     | X           |
| 131.702         | 35.09          | 43.52          | -8.43       | Q-Peak   | 278       | 279         | Horizontal   | Z           |
| 131.715         | 38.57          | 43.52          | -4.95       | Q-Peak   | 223       | 100         | Vertical     | Z           |
| 131.768         | 34.33          | 43.52          | -9.19       | Q-Peak   | 127       | 155         | Horizontal   | Y           |
| 131.806         | 41.49          | 43.52          | -2.03       | Q-Peak   | 174       | 100         | Vertical     | Y           |
| 240.962         | 37.73          | 46.02          | -8.29       | Q-Peak   | 266       | 100         | Horizontal   | Z           |
| 273.123         | 38.93          | 46.02          | -7.09       | Q-Peak   | 20        | 100         | Horizontal   | Y           |
| 273.227         | 36.48          | 46.02          | -9.54       | Q-Peak   | 257       | 110         | Horizontal   | Z           |

**Table 30 - 2480 MHz, 30 MHz to 1 GHz**

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



**Figure 50 - 2480 MHz, 30 MHz to 1 GHz, Vertical, X Orientation**

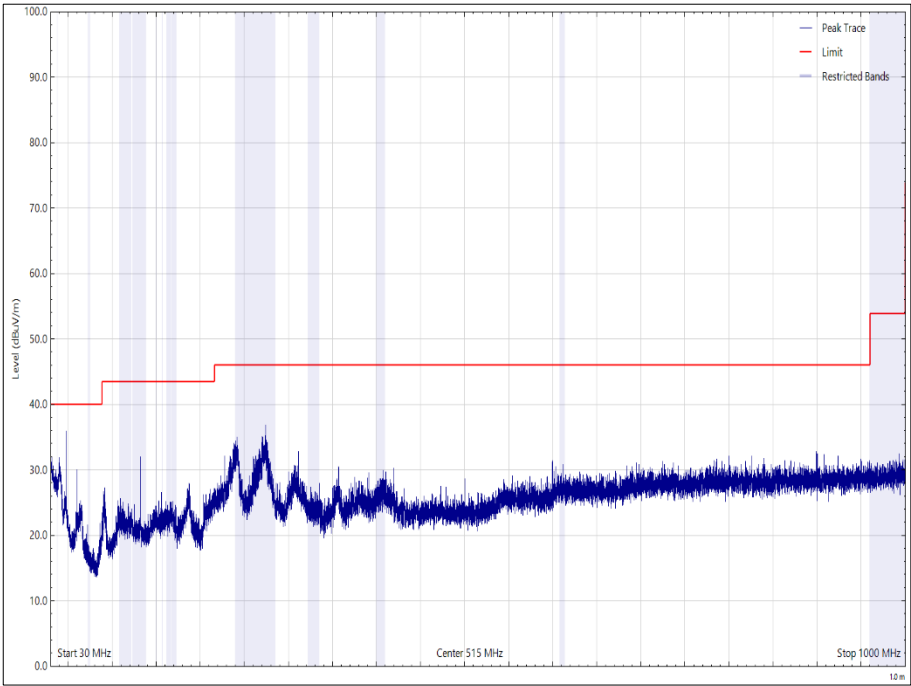


Figure 51 - 2480 MHz, 30 MHz to 1 GHz, Horizontal, X Orientation

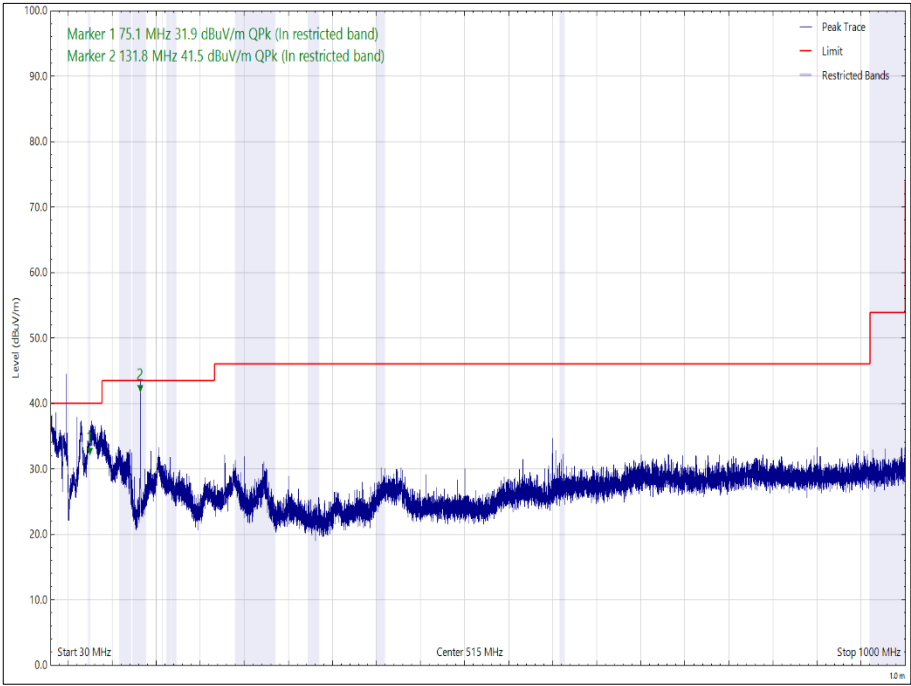


Figure 52 - 2480 MHz, 30 MHz to 1 GHz, Vertical, Y Orientation

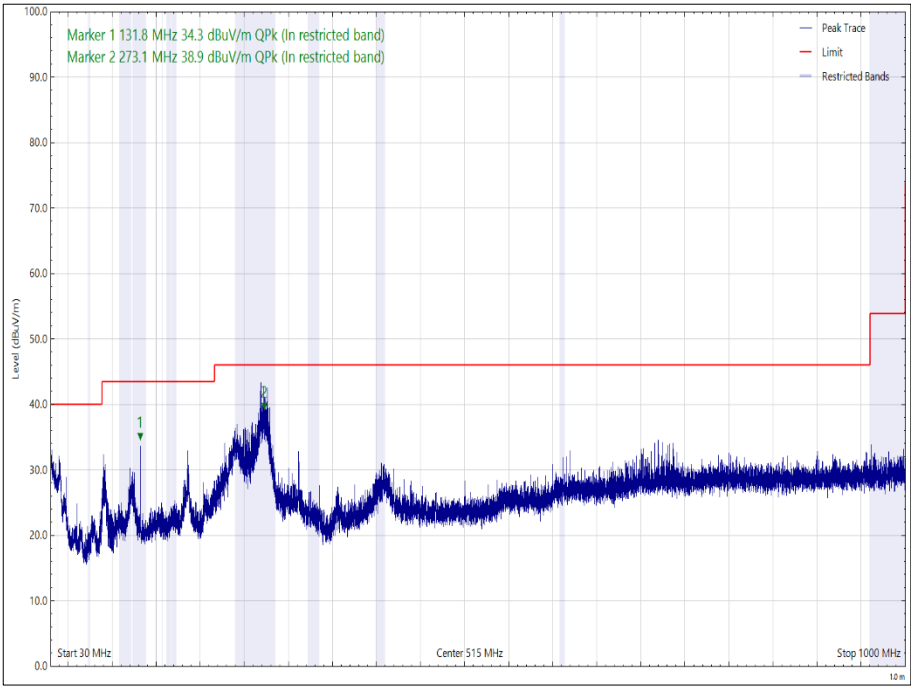


Figure 53 - 2480 MHz, 30 MHz to 1 GHz, Horizontal, Y Orientation

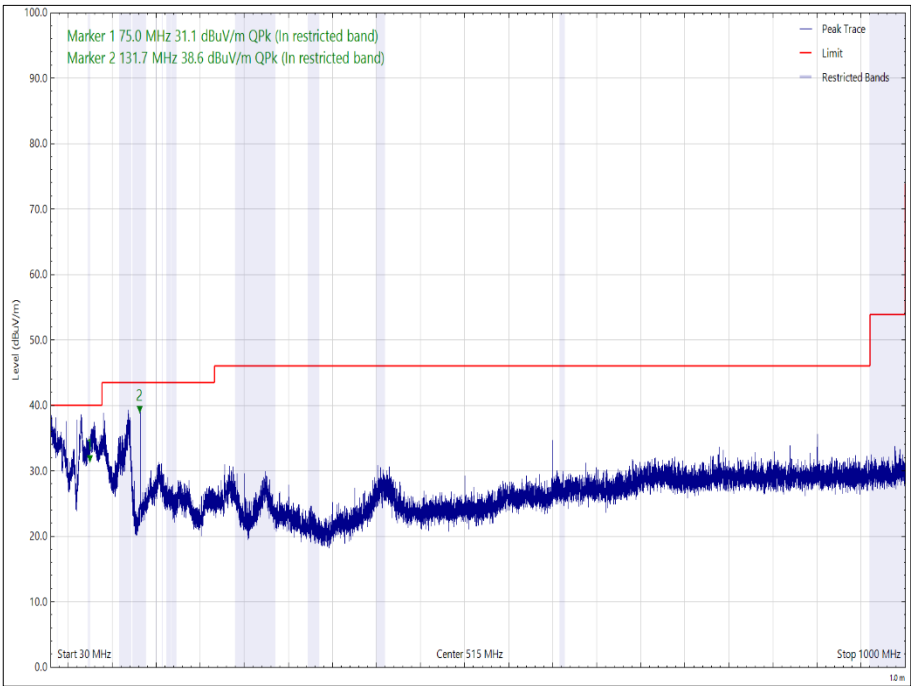


Figure 54 - 2480 MHz, 30 MHz to 1 GHz, Vertical, Z Orientation

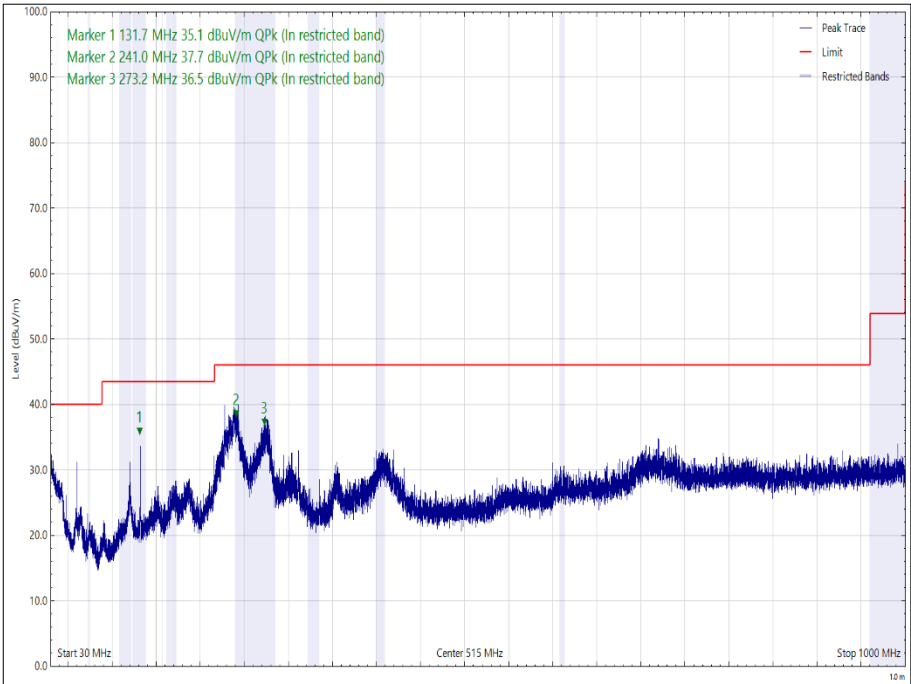
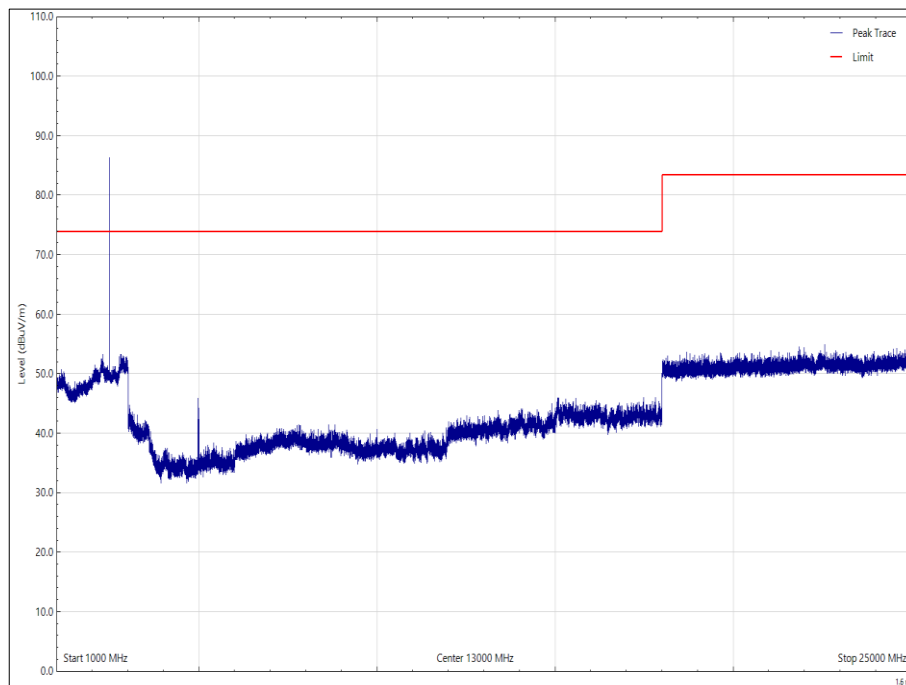


Figure 55 - 2480 MHz, 30 MHz to 1 GHz, Horizontal, Z Orientation

| Frequency (MHz) | Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Detector | Angle (°) | Height (cm) | Polarisation | Orientation |
|-----------------|----------------|----------------|-------------|----------|-----------|-------------|--------------|-------------|
| 4960.079        | 46.33          | 53.98          | -7.65       | Average  | 179       | 164         | Vertical     | X           |
| 4960.087        | 44.21          | 53.98          | -9.77       | Average  | 76        | 179         | Horizontal   | X           |
| 4960.067        | 47.88          | 53.98          | -6.10       | Average  | 0         | 155         | Vertical     | Y           |
| 4960.082        | 48.88          | 53.98          | -5.10       | Average  | 359       | 176         | Horizontal   | Z           |
| 4960.107        | 46.78          | 53.98          | -7.20       | Average  | 316       | 171         | Horizontal   | Y           |
| 4960.114        | 45.35          | 53.98          | -8.63       | Average  | 339       | 201         | Vertical     | Z           |

**Table 31 - 2480 MHz - 1 GHz to 25 GHz**

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



**Figure 56 - 2480 MHz - 1 GHz to 25 GHz, Vertical, X Orientation - Peak**

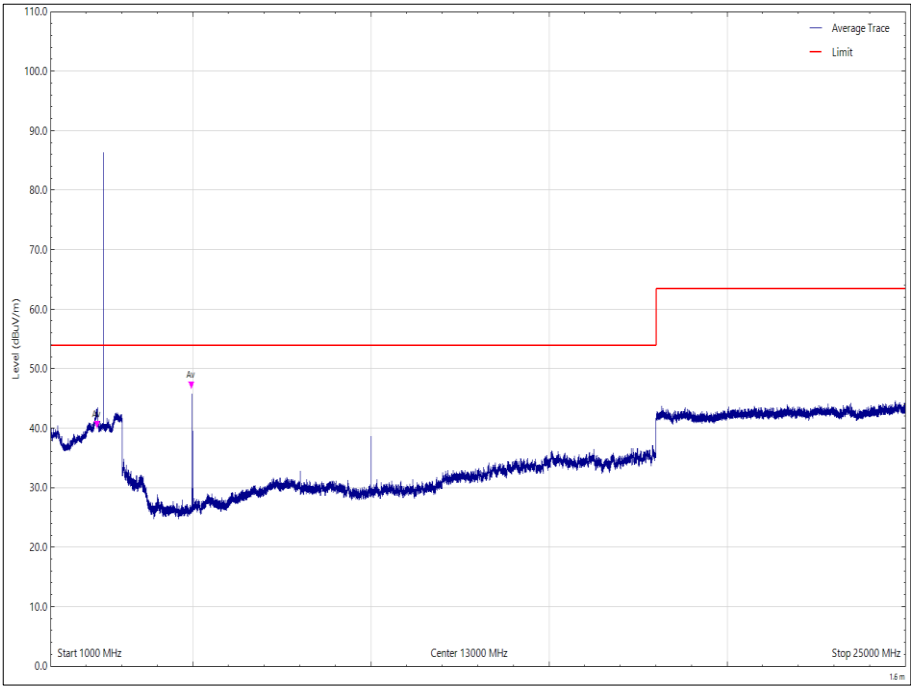


Figure 57 - 2480 MHz - 1 GHz to 25 GHz, Vertical, X Orientation - Average

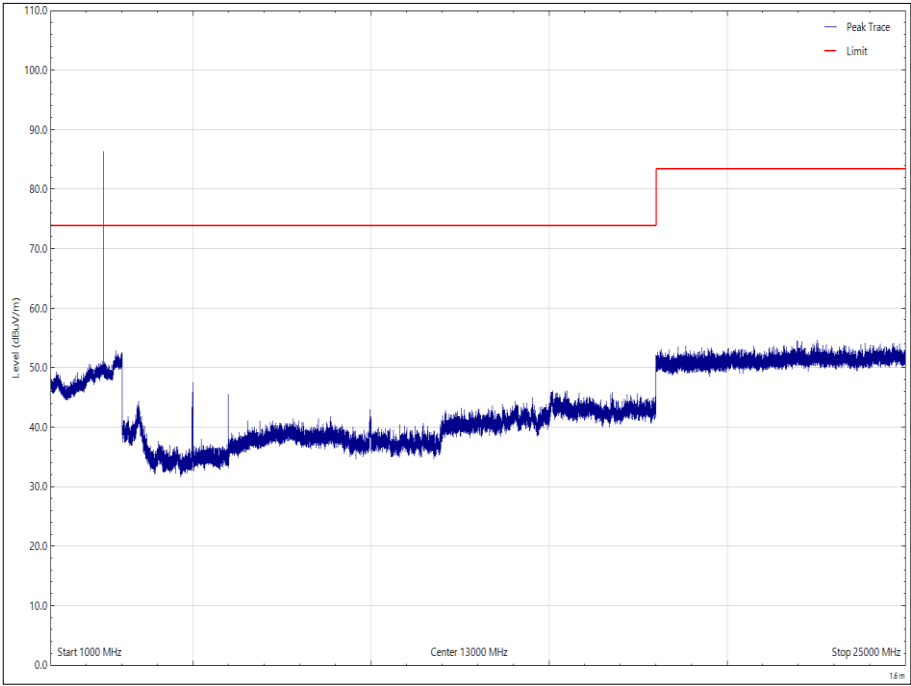


Figure 58 - 2480 MHz - 1 GHz to 25 GHz, Horizontal, X Orientation - Peak

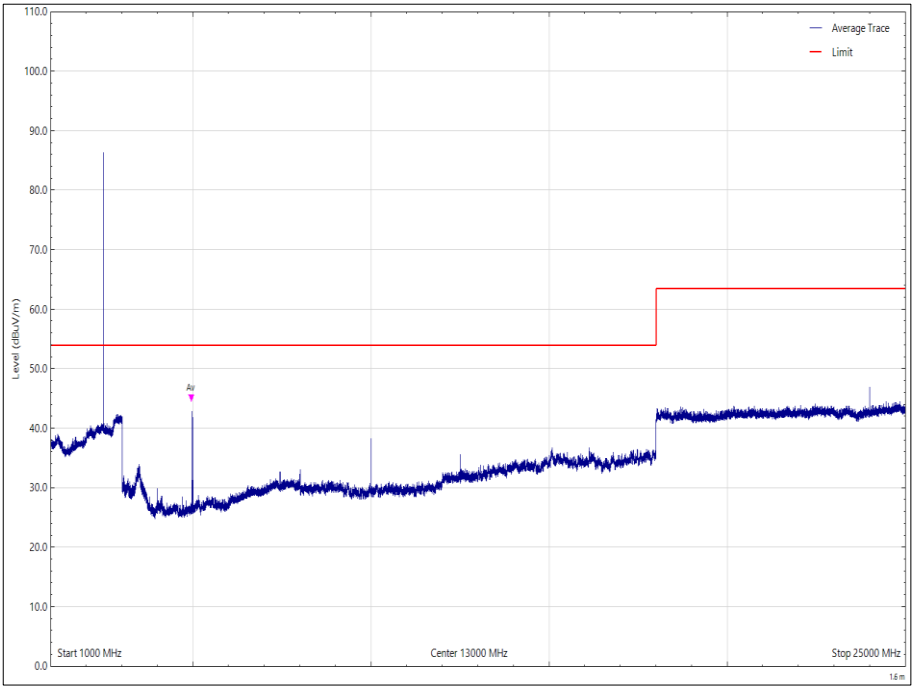


Figure 59 - 2480 MHz - 1 GHz to 25 GHz, Horizontal, X Orientation - Average

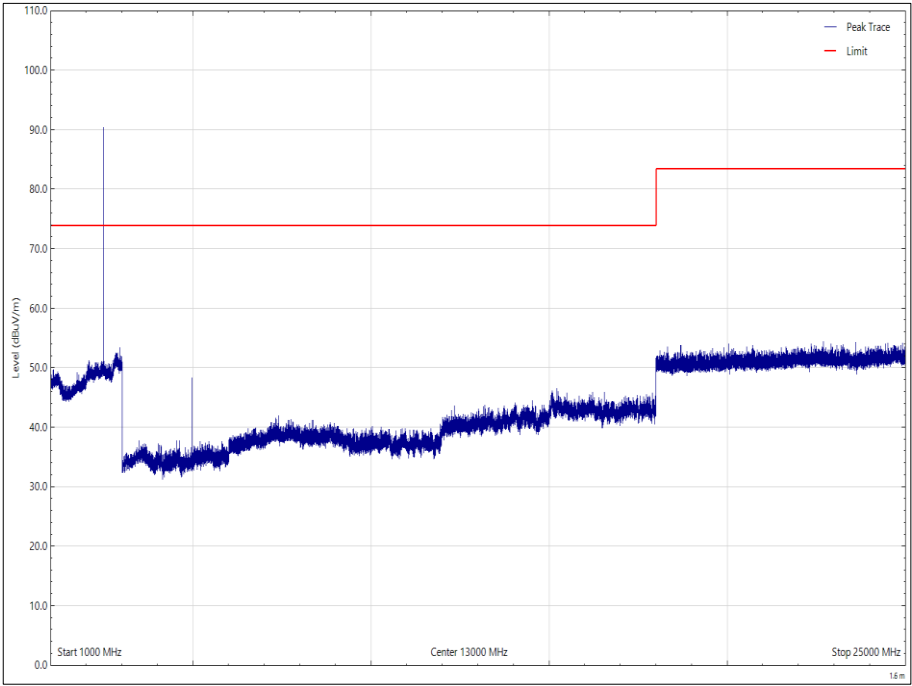


Figure 60 - 2480 MHz - 1 GHz to 25 GHz, Vertical, Y Orientation - Peak

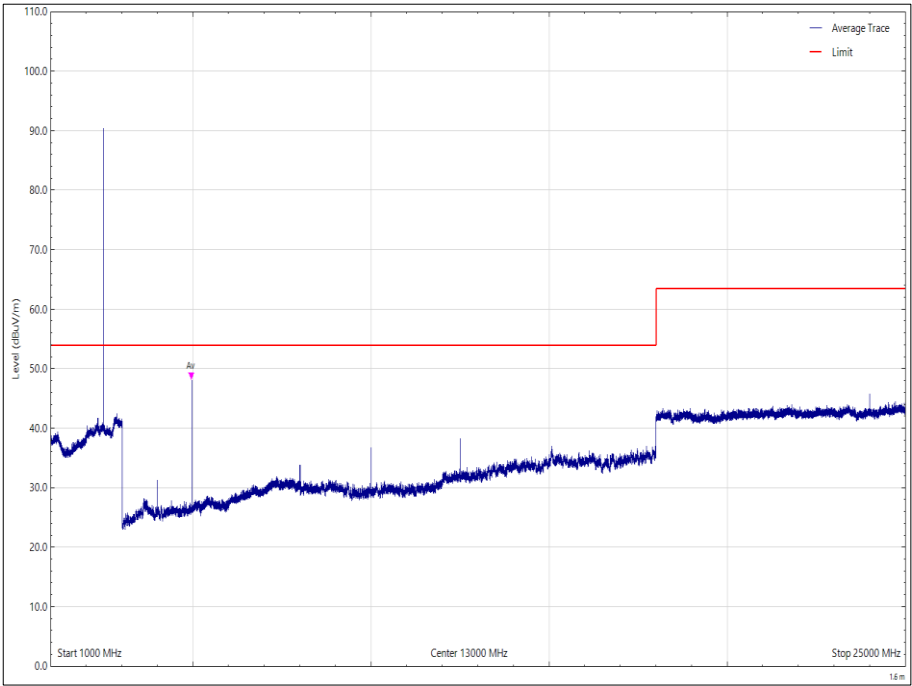


Figure 61 - 2480 MHz - 1 GHz to 25 GHz, Vertical, Y Orientation - Average

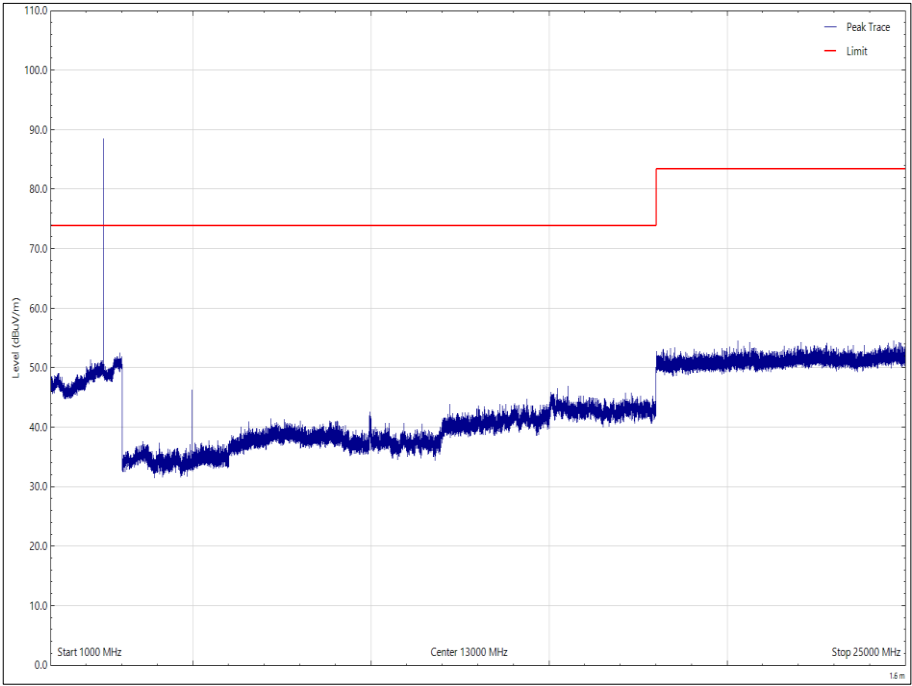


Figure 62 - 2480 MHz - 1 GHz to 25 GHz, Horizontal, Y Orientation - Peak

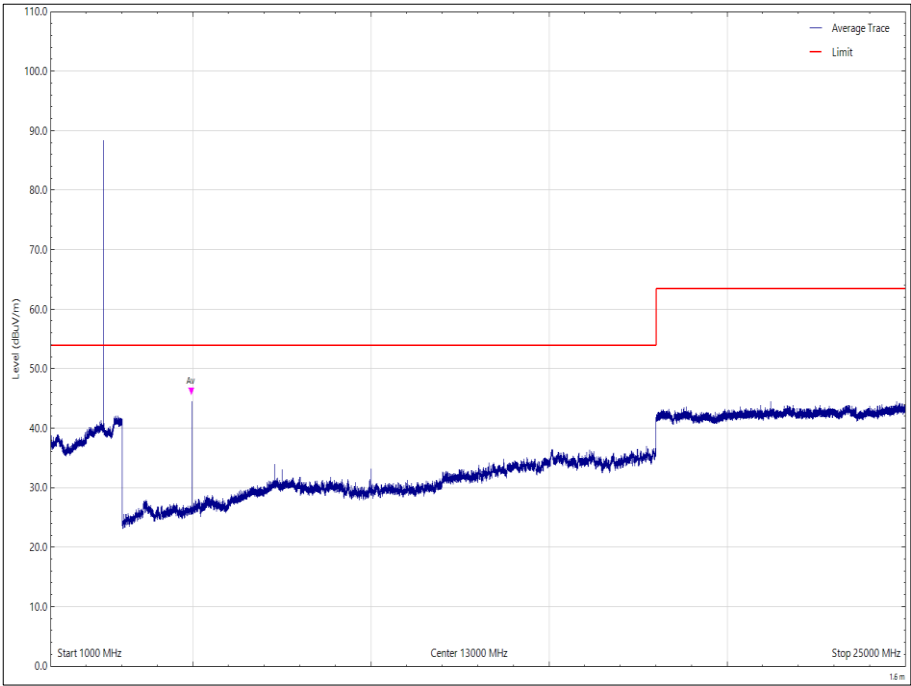


Figure 63 - 2480 MHz - 1 GHz to 25 GHz, Horizontal, Y Orientation - Average

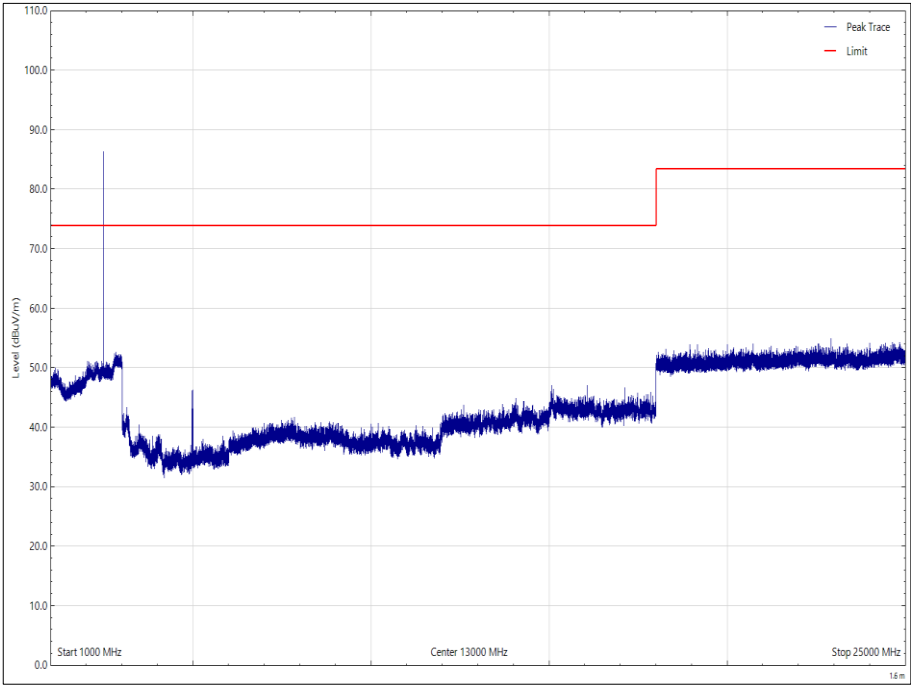


Figure 64 - 2480 MHz - 1 GHz to 25 GHz, Vertical, Z Orientation - Peak

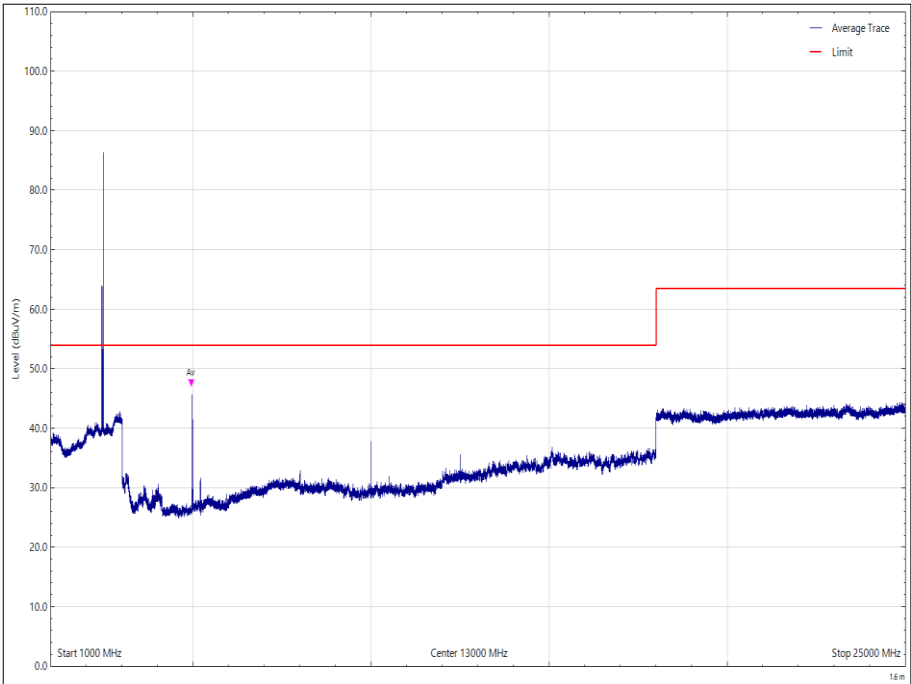


Figure 65 - 2480 MHz - 1 GHz to 25 GHz, Vertical, Z Orientation - Average

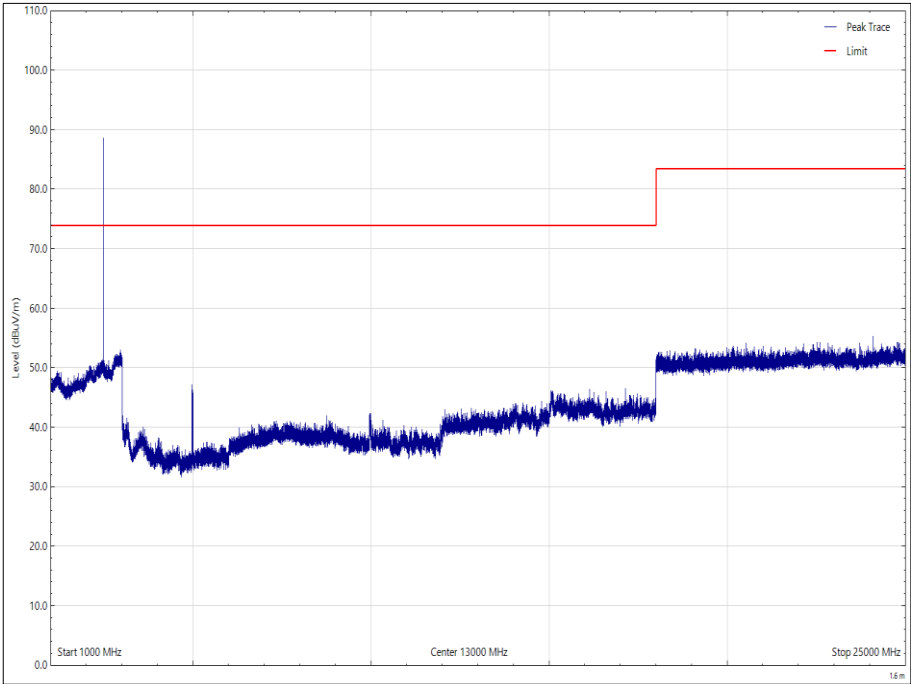
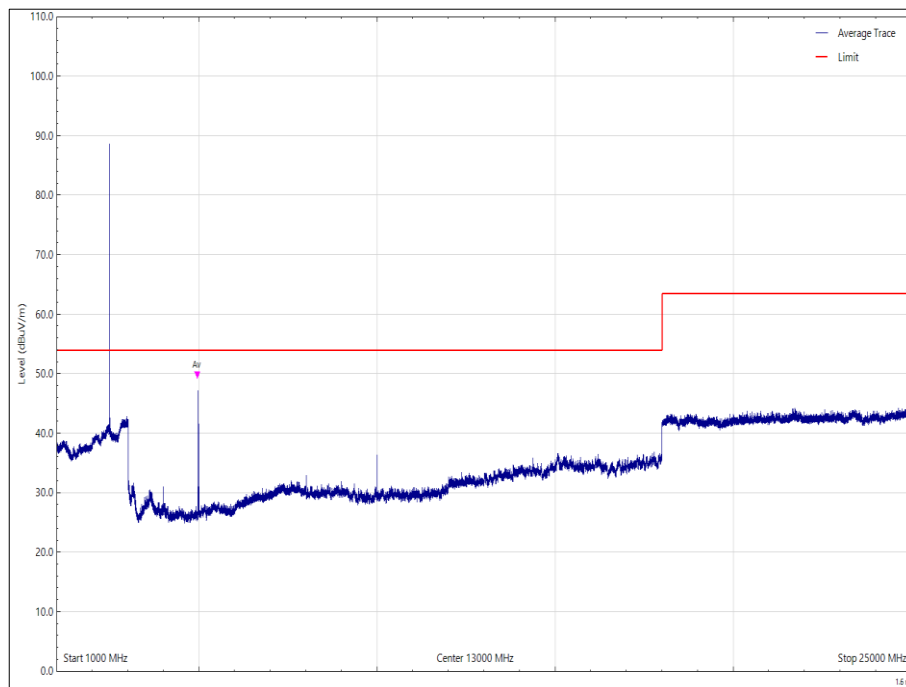


Figure 66 - 2480 MHz - 1 GHz to 25 GHz, Horizontal, Z Orientation - Peak



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

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 18-40GHz (Double Ridge Guide)            | Link Microtek Ltd | AM180HA-K-TU2               | 230   | 24                          | 27-Jul-2022         |
| Antenna with attenuator (Bilog, 30 MHz to 3 GHz) | Schaffner         | CBL6143                     | 287   | 24                          | 14-Oct-2022         |
| Pre-Amplifier, (8 GHz to 18 GHz)                 | Phase One         | PS04-0086                   | 1533  | 12                          | 05-Feb-2022         |
| 18GHz - 40GHz Pre-Amplifier                      | Phase One         | PS04-0087                   | 1534  | 12                          | 02-Aug-2022         |
| 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 1503 2M 2.92(P)m 2.92(P)m                  | Rhophase          | KPS-1503A-2000-KPS          | 4293  | 12                          | 16-Nov-2021         |
| Cable (K-Type to K-Type, 2 m)                    | Scott Cables      | KPS-1501-2000-KPS           | 4526  | 6                           | 06-Mar-2022         |
| Cable (N-Type to N-Type, 1 m)                    | Rosenberger       | LU7-036-1000                | 5031  | 12                          | 23-Jul-2022         |
| EmX Emissions Software                           | TUV SUD           | V2.1.11                     | 5125  | -                           | Software            |
| DRG Horn Antenna (7.5-18GHz)                     | Schwarzbeck       | HWRD750                     | 5216  | 12                          | 01-Apr-2022         |
| Pre-Amplifier (30 dB, 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                           | 08-Mar-2022         |
| Thermo-Hygro-Barometer                           | PCE Instruments   | PCE-THB-40                  | 5481  | 12                          | 31-Mar-2022         |
| Cable (K-Type to K-Type, 1 m)                    | Junkosha          | MWX241-01000KMSKMS/A        | 5511  | 12                          | 09-Apr-2022         |
| 1m K-Type Cable                                  | Junkosha          | MWX241-01000KMSKMS/A        | 5512  | 12                          | 09-Apr-2022         |
| 2m K Type Cable                                  | Junkosha          | MWX241-02000KMSKMS/A        | 5524  | 12                          | 24-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                  |



| Instrument                          | Manufacturer | Type No  | TE No | Calibration Period (months) | Calibration Expires |
|-------------------------------------|--------------|----------|-------|-----------------------------|---------------------|
| CBL 6111D 30-1000MHz Bi-Log Antenna | Teseq        | CBL6111D | 5615  | 24                          | 16-Oct-2022         |
| Screened Room (12)                  | MVG          | EMC-3    | 5621  | 36                          | 11-Aug-2023         |

**Table 32**

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**

Atom Hard Hat, S/N: Not serialised (Storix-ID 599374-117) - Modification State 0

### **2.5.3 Date of Test**

16-November-2021

### **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 | 20.9 °C |
| Relative Humidity   | 43.4 %  |



2.5.6 Test Results

Hard Hat - 2.4 GHz proprietary device

| Mode   | Frequency (MHz) | Band Edge Frequency (MHz) | Level (dBc) |
|--------|-----------------|---------------------------|-------------|
| Static | 2402 - 250 kbps | 2400                      | -38.71      |
| Static | 2402 - 1 Mbps   | 2400                      | -41.24      |
| Static | 2402 - 2 Mbps   | 2400                      | -37.63      |

Table 33

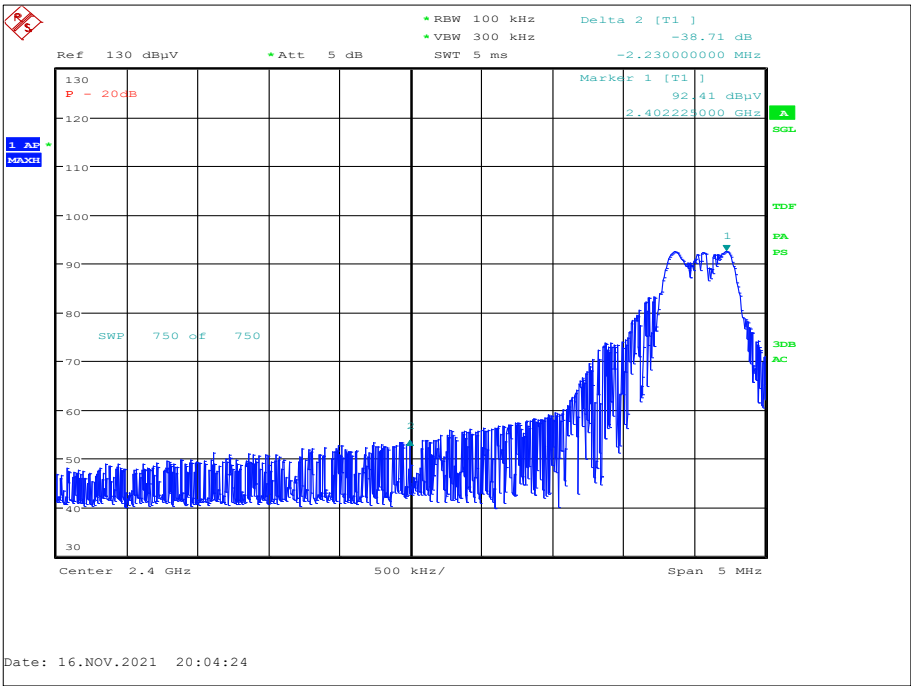


Figure 68 - Static, 2402 MHz - 250 kbps - Measured Frequency 2400 MHz

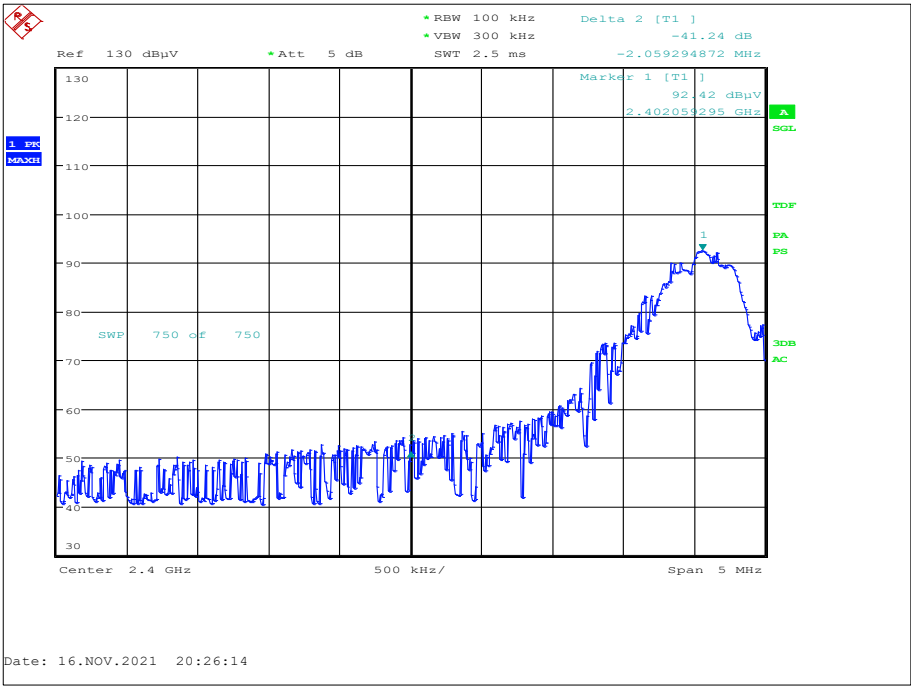


Figure 69 - Static, 2402 MHz - 1 Mbps - Measured Frequency 2400 MHz

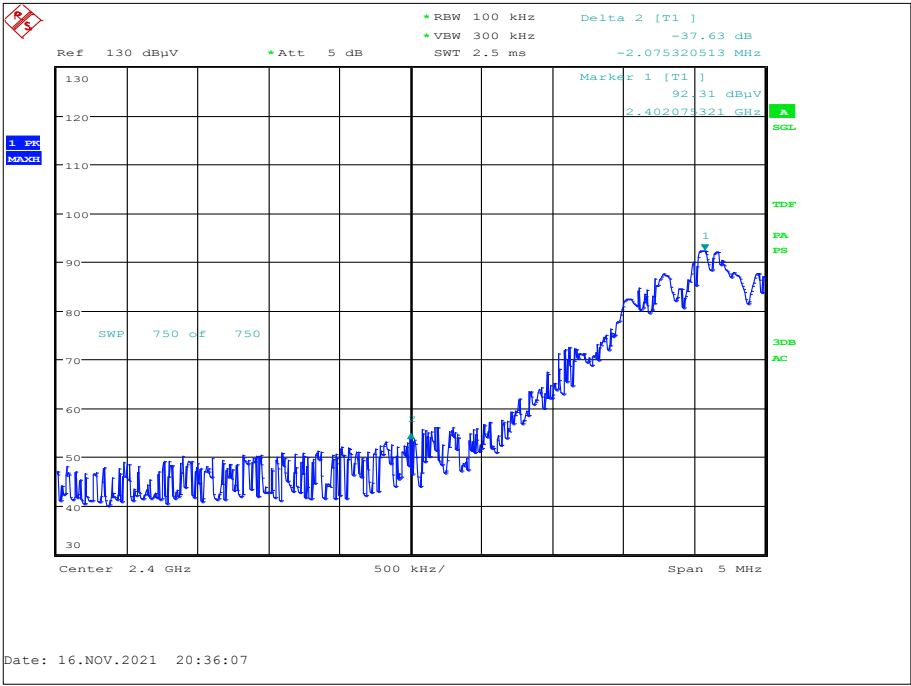


Figure 70 - Static, 2402 MHz - 2 Mbps - Measured Frequency 2400 MHz



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 |
|--------------------------------|-----------------|---------------------|-------|-----------------------------|---------------------|
| Test Receiver                  | Rohde & Schwarz | ESU40               | 3506  | 12                          | 18-Mar-2022         |
| Cable (K-Type to K-Type, 2 m)  | Scott Cables    | KPS-1501-2000-KPS   | 4526  | 6                           | 06-Mar-2022         |
| EmX Emissions Software         | TUV SUD         | V2.1.11             | 5125  | -                           | Software            |
| Cable (N-Type to N-Type, 8 m)  | Teledyne        | PR90-088-8MTR       | 5450  | 6                           | 08-Mar-2022         |
| 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         |

**Table 34**

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**

Atom Hard Hat, S/N: XYZR0047\_02 - Modification State 0

### **2.6.3 Date of Test**

10-November-2021

### **2.6.4 Test Method**

This test was performed in accordance with ANSI C63.10, clause 11.10.5.

### **2.6.5 Environmental Conditions**

|                     |         |
|---------------------|---------|
| Ambient Temperature | 22.9 °C |
| Relative Humidity   | 48.6 %  |



## 2.6.6 Test Results

### Hard Hat - 2.4 GHz proprietary device

| Test Configuration       |                                                                 |                 |                |
|--------------------------|-----------------------------------------------------------------|-----------------|----------------|
| Frequency Range:         | 2400-2483.5 MHz                                                 | Band:           | 2.4 GHz        |
| Limit Clause(s):         | 15.247 (e)<br>RSS-247 5.2 b)                                    | Test Method(s): | C63.10 11.10.5 |
| Additional Reference(s): | -                                                               |                 |                |
| Note(s):                 | DCCF was added to the spectrum analyser reference level offset. |                 |                |

| DUT Configuration      |                 |                          |       |
|------------------------|-----------------|--------------------------|-------|
| Mode:                  | Proprietary ISM | Duty Cycle (%):          | 8.6   |
| Data Rate:             | 250 kbps        | DCCF (dB):               | 10.66 |
| Antenna Configuration: | SISO            | Peak Antenna Gain (dBi): | -     |
| Active Port(s):        | A (A)           | Active Chain(s):         | 0     |

| Test Frequency (MHz) | RBW (kHz) | PSD (dBm/RBW) |   |   |   |   | Limit (dBm/3 kHz) | Margin (dB) |
|----------------------|-----------|---------------|---|---|---|---|-------------------|-------------|
|                      |           | A             | B | C | D | Σ |                   |             |
| 2402                 | 10.0      | -14.47        | - | - | - | - | 8.00              | -22.47      |
| 2442                 | 10.0      | -13.15        | - | - | - | - | 8.00              | -21.15      |
| 2480                 | 10.0      | -13.54        | - | - | - | - | 8.00              | -21.54      |

**Table 35 - 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 |
|---------------------------|-----------------------|---------------------------|-------|-----------------------------|---------------------|
| Rubidium Standard         | Rohde & Schwarz       | XSRM                      | 1316  | 6                           | 03-Dec-2021         |
| Frequency Standard        | Spectracom            | SecureSync 1200-0408-0601 | 4393  | 6                           | 03-Dec-2021         |
| Climatic Chamber          | Aralab                | FitoTerm 300E45           | 4823  | 12                          | 12-Apr-2022         |
| Hygropalm Hygrometer      | Rotronic              | HP21                      | 5264  | 12                          | 12-Jul-2022         |
| MXA Signal Analyser       | Keysight Technologies | N9020B                    | 5528  | 24                          | 04-Mar-2022         |
| Signal Commissioning Unit | TUV SUD               | SCU001                    | 5546  | 12                          | 16-Apr-2022         |

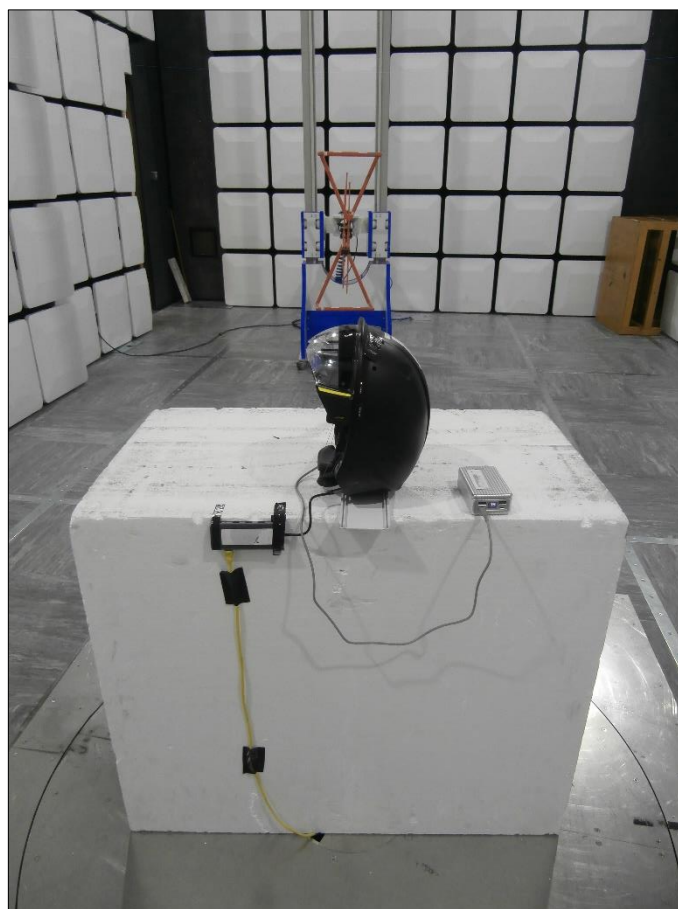
**Table 36**

### 3 Photographs

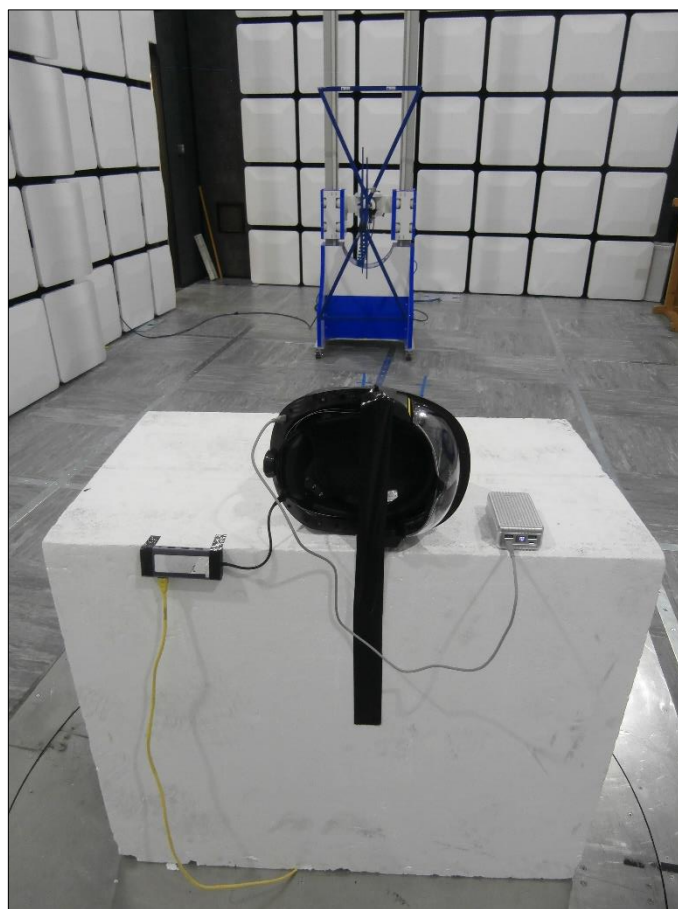
#### 3.1 Test Setup Photographs



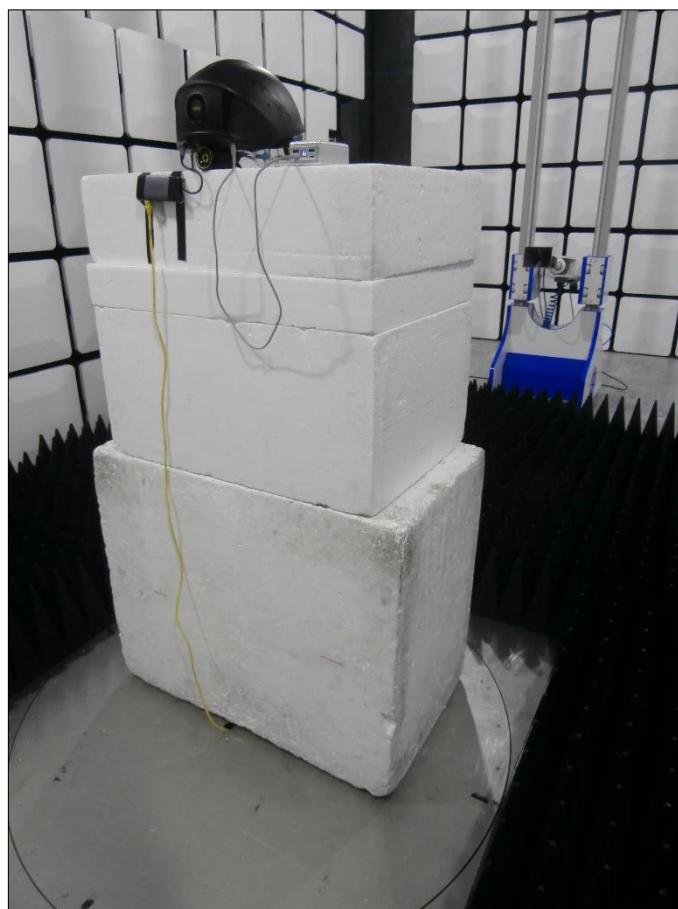
**Figure 71 - Test Setup - 30 MHz to 1 GHz - X Orientation**



**Figure 72 - Test Setup - 30 MHz to 1 GHz - Y Orientation**



**Figure 73 - Test Setup - 30 MHz to 1 GHz - Z Orientation**



**Figure 74 - Test Setup - 1 GHz to 18 GHz - X Orientation**



**Figure 75 - Test Setup - 1 GHz to 18 GHz - Y Orientation**



**Figure 76 - Test Setup - 1 GHz to 18 GHz - Z Orientation**



**Figure 77 - Test Setup - 18 GHz to 25 GHz - X Orientation**



**Figure 78 - Test Setup - 18 GHz to 25 GHz - Y Orientation**



**Figure 79 - Test Setup - 18 GHz to 25 GHz - Z Orientation**



## 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: $\pm 5.2$ dB<br>1 GHz to 40 GHz: $\pm 6.3$ dB |
| Emission Bandwidth             | $\pm 25.354$ kHz                                               |
| Maximum Conducted Output Power | $\pm 3.2$ dB                                                   |
| Spurious Radiated Emissions    | 30 MHz to 1 GHz: $\pm 5.2$ dB<br>1 GHz to 40 GHz: $\pm 6.3$ dB |
| Authorised Band Edges          | 30 MHz to 1 GHz: $\pm 5.2$ dB<br>1 GHz to 40 GHz: $\pm 6.3$ dB |
| Power Spectral Density         | $\pm 3.2$ dB                                                   |

**Table 37**

### 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.