

FCC and ISED Test Report

Apple Inc
Model: A2169

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

Prepared for: Apple Inc
One Apple Park Way, Cupertino, California,
95014, USA

FCC ID: BCGA2169

IC: 579C-A2169

COMMERCIAL-IN-CONFIDENCE

Document 75946858-16 Issue 02



SIGNATURE

| NAME | JOB TITLE | RESPONSIBLE FOR | ISSUE DATE |
|---------------|-----------------|----------------------|------------------|
| Phil Harrison | Senior Engineer | Authorised Signatory | 18 February 2021 |

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

ENGINEERING STATEMENT

The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 15C, ISED RSS-247 and ISED RSS-GEN. The sample tested was found to comply with the requirements defined in the applied rules.

| RESPONSIBLE FOR | NAME | DATE | SIGNATURE |
|-----------------|-----------------|------------------|-----------|
| Testing | George Porter | 18 February 2021 | |
| Testing | Mohammad Malik | 18 February 2021 | |
| Testing | Ainsley Jenkins | 18 February 2021 | |
| Testing | Liang Tian | 18 February 2021 | |
| Testing | Connor Lee | 18 February 2021 | |
| Testing | Aasim Butt | 18 February 2021 | |

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

ISED Accreditation
12669A Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15C: 2019, ISED RSS-247: Issue 2 (02-2017) and ISED RSS-GEN: Issue 5 (04-2018) + A1 (03-2019) for the tests detailed in section 1.3.



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ACCREDITATION

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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 | 17 February 2021 |
| 2 | Updated test Equipment Lists | 18 February 2021 |

Table 1

1.2 Introduction

| | |
|-------------------------------|--|
| Applicant | Apple Inc |
| Manufacturer | Apple Inc |
| Model Number(s) | A2169 |
| Serial Number(s) | C07CM0EKQ4TG and C07CL0AMQ4TG |
| Hardware Version(s) | REV1.0 |
| Software Version(s) | 18J42710o |
| Number of Samples Tested | 2 |
| Test Specification/Issue/Date | FCC 47 CFR Part 15C: 2019 ISED RSS-247: Issue 2 (02-2017) ISED RSS-GEN: Issue 5 (04-2018) + A1 (03-2019) |
| Order Number | 0540188556 |
| Date | 07-April-2020 |
| Date of Receipt of EUT | 01-June-2020 and 08-July-2020 |
| Start of Test | 20-June-2020 |
| Finish of Test | 10-February-2021 |
| Name of Engineer(s) | George Porter, Mohammad Malik, Ainsley Jenkins, Liang Tian, Connor Lee & Aasim Butt |
| Related Document(s) | ANSI C63.10 (2013) KDB 662911 D01 v02r01 |



1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15C, ISED RSS-247 and ISED RSS-GEN is shown below.

| Section | Specification Clause | | | Test Description | Result | Comments/Base Standard |
|--|-----------------------|---------|---------|--------------------------------|--------|------------------------|
| | Part 15C | RSS-247 | RSS-GEN | | | |
| Configuration and Mode: 2.4 GHz Thread - DTS | | | | | | |
| 2.1 | 15.247 (b) | 5.4 | 6.12 | Maximum Conducted Output Power | Pass | |
| 2.2 | 15.247 (e) | 5.2 | 6.12 | Power Spectral Density | Pass | |
| 2.3 | 15.247 (a)(2) | 5.2 | 6.7 | Emission Bandwidth | Pass | |
| 2.4 | 15.205 | - | 8.10 | Restricted Band Edges | Pass | |
| 2.5 | 15.247 (d) | 5.5 | - | Authorised Band Edges | Pass | |
| 2.6 | 15.247 (d) and 15.205 | 5.5 | 6.13 | Spurious Radiated Emissions | Pass | |

Table 2



1.4 Product Information

1.4.1 Technical Description

The Equipment under test (EUT) was an Apple TV Set Top Box with Bluetooth, Bluetooth Low Energy, Thread and 802.11 a/b/g/n/ac/ax capabilities in the 2.4 GHz and 5 GHz bands.

1.4.2 Test Setup

For conducted tests, a conducted test point was provided by the manufacturer via a UFL connector and cable. The loss of these test cables was known and compensated for in any conducted measurements.

Thread employs SISO operation from a dedicated core.

For all tests, the EUT was put into a continuous transmit test mode with the manufacturer’s test commands via a script running in the EUTs terminal application. The EUT then transmitted the required type of modulation/packet type on a static channel.

All testing was performed with the EUT powered via a 120 V AC, 60 Hz source.

1.4.3 Antenna Gain Table (2.4 GHz Thread)

| Antenna Port | Frequency Range (MHz) | Peak Gain (dBi) | Conducted Cable Loss (dB) |
|--------------|-----------------------|-----------------|---------------------------|
| Thread | 2400 to 2480 | 2.87 | 0.50 |

Table 3

1.5 Deviations from the Standard

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

1.6 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: A2169, Serial Number: C07CL0AMQ4TG | | | |
| 0 | As supplied by the customer | Not Applicable | Not Applicable |
| Model: A2169, Serial Number: C07CM0EKQ4TG | | | |
| 0 | As supplied by the customer | Not Applicable | Not Applicable |

Table 4



1.7 Test Location

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

| Test Name | Name of Engineer(s) | Accreditation |
|--|--|---------------|
| Configuration and Mode: 2.4 GHz Thread - DTS | | |
| Maximum Conducted Output Power | George Porter | UKAS |
| Power Spectral Density | George Porter | UKAS |
| Emission Bandwidth | George Porter | UKAS |
| Restricted Band Edges | Ainsley Jenkins, Liang Tian, Connor Lee and Aasim Butt | UKAS |
| Authorised Band Edges | Ainsley Jenkins, Liang Tian, Connor Lee and Aasim Butt | UKAS |
| Spurious Radiated Emissions | Mohammad Malik | UKAS |

Table 5

Office Address:

Octagon House
Concorde Way
Segensworth North
Fareham
Hampshire
PO15 5RL
United Kingdom



2 Test Details

2.1 Maximum Conducted Output Power

2.1.1 Specification Reference

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

2.1.2 Equipment Under Test and Modification State

A2169, S/N: C07CM0EKQ4TG - Modification State 0

2.1.3 Date of Test

10-February-2021

2.1.4 Test Method

The test was performed in accordance with ANSI C63.10 clause 11.9.1.3 Method PKPM1 and clause 11.9.2.3.2 Method AVGPM-G.

2.1.5 Environmental Conditions

| | |
|---------------------|---------|
| Ambient Temperature | 21.2 °C |
| Relative Humidity | 18.6 % |



2.1.6 Test Results

2.4 GHz Thread - DTS

| 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 11.9.1.3 |
| Additional Reference(s): | - | | |

| DUT Configuration | | | |
|------------------------|-----------------|---------------------|------|
| Mode: | Thread (Thread) | Duty Cycle (%): | 85.3 |
| Antenna Configuration: | SISO | DCCF (dB): | - |
| Active Ports(s): | D (Thread) | Antenna Gain (dBi): | 2.87 |

| Test Frequency (MHz) | Maximum Conducted Output Power (dBm) | | | | | Limit (dBm) | Margin (dB) |
|----------------------|--------------------------------------|---|---|-------|---|-------------|-------------|
| | A | B | C | D | Σ | | |
| 2405 | - | - | - | 15.96 | - | 30.00 | -14.04 |
| 2440 | - | - | - | 17.12 | - | 30.00 | -12.88 |
| 2475 | - | - | - | 17.27 | - | 30.00 | -12.73 |

Table 6 - 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 | | | | | |
| 2405 | - | - | - | 15.96 | - | 30.00 | -14.04 | 18.83 | 36.00 | -17.17 |
| 2440 | - | - | - | 17.12 | - | 30.00 | -12.88 | 19.99 | 36.00 | -16.01 |
| 2475 | - | - | - | 17.27 | - | 30.00 | -12.73 | 20.14 | 36.00 | -15.86 |

Table 7 - ISED Maximum Conducted (peak) Output Power Results

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

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

ISED RSS-247, Limit Clause 5.4 (b)

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



2.1.7 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 Due |
|------------------------------|--------------|---------|-------|-----------------------------|-----------------|
| Multimeter | Iso-tech | IDM101 | 2421 | 12 | 30-Oct-2021 |
| Hygrometer | Rotronic | I-1000 | 3220 | 12 | 16-Oct-2021 |
| AC Programmable Power Supply | iTech | IT7324 | 5225 | - | O/P Mon |
| USB Power Sensor | BOONTON | RTP5006 | 5279 | 12 | 27-Apr-2021 |
| Signal Commissioning Unit | TUV SUD | SCU001 | 5546 | 12 | 15-Apr-2021 |

Table 8

O/P Mon – Output Monitored using calibrated equipment



2.2 Power Spectral Density

2.2.1 Specification Reference

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

2.2.2 Equipment Under Test and Modification State

A2169, S/N: C07CM0EKQ4TG - Modification State 0

2.2.3 Date of Test

10-February-2021

2.2.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 11.10.5 (AVGPSD-2).

Where the EUT duty cycle was < 98 % and repeatable within 2%, the spectrum analyser was set to trace (power) averaging and a duty cycle correction was added as calculated in the result tables below.

2.2.5 Environmental Conditions

| | |
|---------------------|---------|
| Ambient Temperature | 21.2 °C |
| Relative Humidity | 18.6 % |



2.2.6 Test Results

2.4 GHz Thread - DTS

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

| DUT Configuration | | | |
|------------------------|-----------------|---------------------|------|
| Mode: | Thread (Thread) | Duty Cycle (%): | 85.3 |
| Antenna Configuration: | SISO | DCCF (dB): | 0.69 |
| Active Ports(s): | D (Thread) | Antenna Gain (dBi): | - |

| Test Frequency (MHz) | RBW (kHz) | PSD (dBm/RBW) | | | | | Limit (dBm/3 kHz) | Margin (dB) |
|----------------------|-----------|---------------|---|---|------|---|-------------------|-------------|
| | | A | B | C | D | Σ | | |
| 2405 | 3.0 | - | - | - | 3.71 | - | 8.00 | -4.29 |
| 2440 | 3.0 | - | - | - | 4.62 | - | 8.00 | -3.38 |
| 2475 | 3.0 | - | - | - | 5.13 | - | 8.00 | -2.87 |

Table 9 - 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



2.2.7 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 Due |
|------------------------------|-----------------------|---------------------------|-------|-----------------------------|-----------------|
| Rubidium Standard | Rohde & Schwarz | XSRM | 1316 | 6 | 07-May-2021 |
| Multimeter | Iso-tech | IDM101 | 2421 | 12 | 30-Oct-2021 |
| Hygrometer | Rotronic | I-1000 | 3220 | 12 | 16-Oct-2021 |
| Frequency Standard | Spectracom | SecureSync 1200-0408-0601 | 4393 | 6 | 07-May-2021 |
| AC Programmable Power Supply | iTech | IT7324 | 5225 | - | O/P Mon |
| MXA Signal Analyser | Keysight Technologies | N9020B | 5528 | 24 | 04-Mar-2022 |
| Signal Commissioning Unit | TUV SUD | SCU001 | 5546 | 12 | 15-Apr-2021 |

Table 10

O/P Mon – Output Monitored using calibrated equipment



2.3 Emission Bandwidth

2.3.1 Specification Reference

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

2.3.2 Equipment Under Test and Modification State

A2169, S/N: C07CM0EKQ4TG - Modification State 0

2.3.3 Date of Test

10-February-2021

2.3.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 11.8.2.

2.3.5 Environmental Conditions

Ambient Temperature 21.2 °C
 Relative Humidity 18.6 %

2.3.6 Test Results

2.4 GHz Thread - DTS

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

| DUT Configuration | | | |
|------------------------|-----------------|---------------------|---|
| Mode: | Thread (Thread) | Duty Cycle (%): | - |
| Antenna Configuration: | SISO | DCCF (dB): | - |
| Active Ports(s): | D (Thread) | Antenna Gain (dBi): | - |

| Test Frequency (MHz) | 6 dB Bandwidth (MHz) | | | | | Limit (kHz) |
|----------------------|----------------------|---|---|-------|---------|-------------|
| | A | B | C | D | Minimum | |
| 2405 | - | - | - | 1.220 | 1.220 | ≥500.0 |
| 2440 | - | - | - | 1.220 | 1.220 | ≥500.0 |
| 2475 | - | - | - | 1.240 | 1.240 | ≥500.0 |

Table 11 - 6 dB Bandwidth Results

| Test Frequency (MHz) | 99% Bandwidth (MHz) | | | | | Limit (kHz) |
|----------------------|---------------------|---|---|-------|---------|-------------|
| | A | B | C | D | Minimum | |
| 2405 | - | - | - | 2.250 | 2.250 | - |
| 2440 | - | - | - | 2.250 | 2.250 | - |
| 2475 | - | - | - | 2.250 | 2.250 | - |



Table 12 - 99% Bandwidth Results



Figure 1 - 99% Bandwidth



Figure 2 - 6 dB Bandwidth



Figure 3 - 99% Bandwidth



Figure 4 - 6 dB Bandwidth



Figure 5 - 99% Bandwidth



Figure 6 - 6 dB Bandwidth

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

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



2.3.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

| Instrument | Manufacturer | Type No | TE No | Calibration Period (months) | Calibration Due |
|------------------------------|-----------------------|---------------------------|-------|-----------------------------|-----------------|
| Rubidium Standard | Rohde & Schwarz | XSRM | 1316 | 6 | 17-May-2021 |
| Multimeter | Iso-tech | IDM101 | 2421 | 12 | 30-Oct-2021 |
| Hygrometer | Rotronic | I-1000 | 3220 | 12 | 16-Oct-2021 |
| Frequency Standard | Spectracom | SecureSync 1200-0408-0601 | 4393 | 6 | 07-May-2021 |
| AC Programmable Power Supply | iTech | IT7324 | 5225 | - | O/P Mon |
| MXA Signal Analyser | Keysight Technologies | N9020B | 5528 | 24 | 04-Mar-2022 |
| Signal Commissioning Unit | TUV SUD | SCU001 | 5546 | 12 | 15-Apr-2021 |

Table 13

O/P Mon – Output Monitored using calibrated equipment



2.4 Restricted Band Edges

2.4.1 Specification Reference

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

2.4.2 Equipment Under Test and Modification State

A2169, S/N: C07CL0AMQ4TG - Modification State 0

2.4.3 Date of Test

20-June-2020 to 27-October-2020

2.4.4 Test Method

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

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

2.4.5 Environmental Conditions

Ambient Temperature 20.7 - 23.8 °C
Relative Humidity 44.8 - 53.7 °C

2.4.6 Test Results

2.4 GHz Thread - DTS

| Mode | Modulation | Packet Type | Tx Frequency (MHz) | Band Edge Frequency (MHz) | Peak Level (dB μ V/m) | Average Level (dB μ V/m) |
|--------|------------|-------------|--------------------|---------------------------|---------------------------|------------------------------|
| Static | OQPSK | Thread | 2405 | 2390.0 | 58.83 | 41.68 |
| Static | OQPSK | Thread | 2475 | 2483.5 | 58.12 | 45.49 |

Table 14 - Restricted Band Edge Results

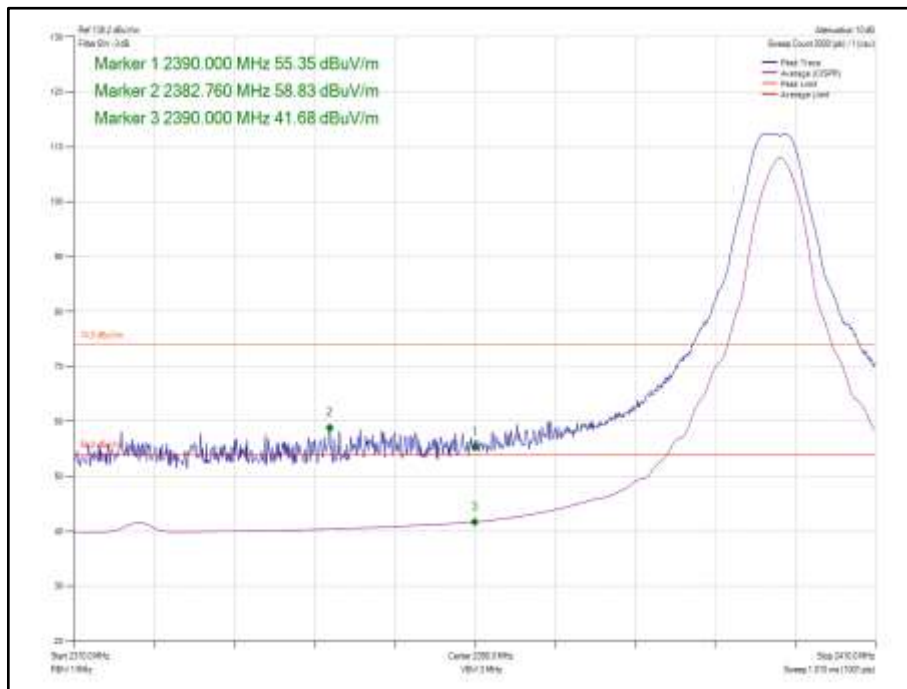


Figure 7 - Static – Thread - 2405 MHz - Band Edge Frequency 2390.0 MHz

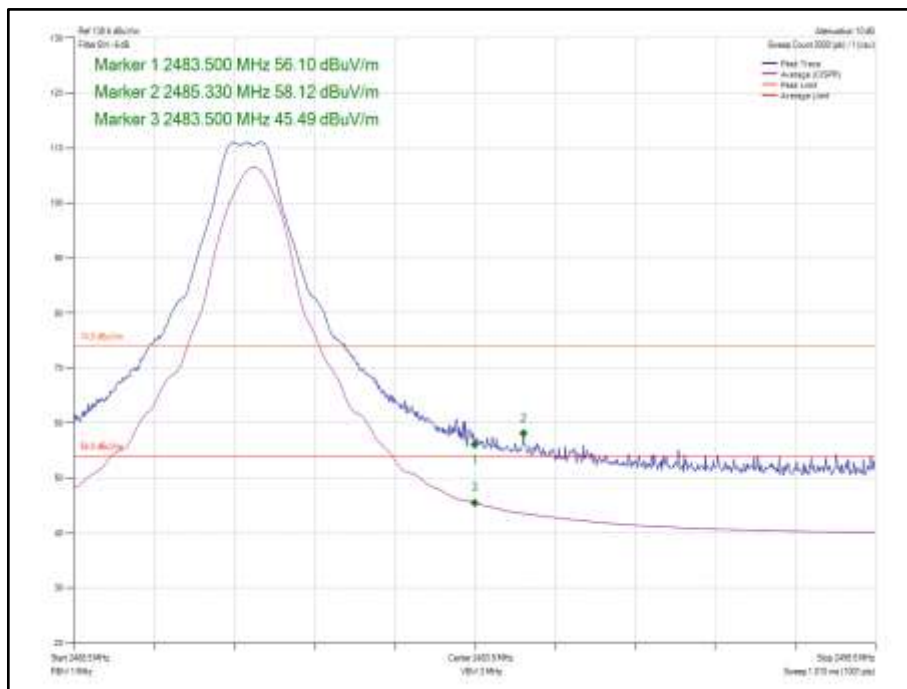


Figure 8 - Static – Thread- 2475 MHz - Band Edge Frequency 2483.5 MHz



FCC 47 CFR Part 15, Limit Clause 15.209

| Frequency (MHz) | Field Strength ($\mu\text{V}/\text{m}$ at 3 m) |
|-----------------|---|
| 30 to 88 | 100 |
| 88 to 216 | 150 |
| 216 to 960 | 200 |
| Above 960 | 500 |

Table 15

ISED RSS-GEN, Limit Clause 8.9

| Frequency (MHz) | Field Strength ($\mu\text{V}/\text{m}$ at 3 m) |
|-----------------|---|
| 30 to 88 | 100 |
| 88 to 216 | 150 |
| 216 to 960 | 200 |
| Above 960* | 500 |

Table 16

*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.



2.4.7 Test Location and Test Equipment Used

This test was carried out in RF Chamber 11.

| Instrument | Manufacturer | Type No | TE No | Calibration Period (months) | Calibration Due |
|-------------------------------|-----------------|----------------------|-------|-----------------------------|-----------------|
| Multimeter | Iso-tech | IDM101 | 2424 | 12 | 12-Dec-2020 |
| EMI Test Receiver | Rohde & Schwarz | ESW44 | 5084 | 12 | 28-Nov-2020 |
| EmX Emissions Software | TUV SUD | V2.0.1 | 5125 | - | Software |
| Screened Room (11) | Rainford | Rainford | 5136 | 36 | 01-Nov-2021 |
| Mast | Maturo | TAM 4.0-P | 5158 | - | TU |
| Mast and Turntable Controller | Maturo | Maturo NCD | 5159 | - | TU |
| Turntable | Maturo | TT 15WF | 5160 | - | TU |
| Horn Antenna (1-10GHz) | Schwarzbeck | BBHA 9120 B | 5215 | 12 | 10-Mar-2021 |
| Thermo-Hygro-Barometer | PCE Instruments | PCE-THB-40 | 5475 | 12 | 17-Mar-2021 |
| 2m SMA Cable | Junkosha | MWX221-02000AMSAMS/A | 5518 | 12 | 01-Apr-2021 |
| 8m N Type Cable | Junkosha | MWX221-08000NMSNMS/B | 5522 | 12 | 24-Mar-2021 |

Table 17

TU - Traceability Unscheduled



2.5 Authorised Band Edges

2.5.1 Specification Reference

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

2.5.2 Equipment Under Test and Modification State

A2169, S/N: C07CL0AMQ4TG - Modification State 0

2.5.3 Date of Test

20-June-2020 to 27-October-2020

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 20.7 - 23.8 °C
 Relative Humidity 44.8 - 53.7 °C

2.5.6 Test Results

2.4 GHz Thread - DTS

| Mode | Modulation | Packet Type | Tx Frequency (MHz) | Band Edge Frequency (MHz) | Level (dBc) |
|--------|------------|-------------|--------------------|---------------------------|-------------|
| Static | OQPSK | Thread | 2405 | 2400.0 | -49.81 |

Table 18 - Authorised Band Edge Results

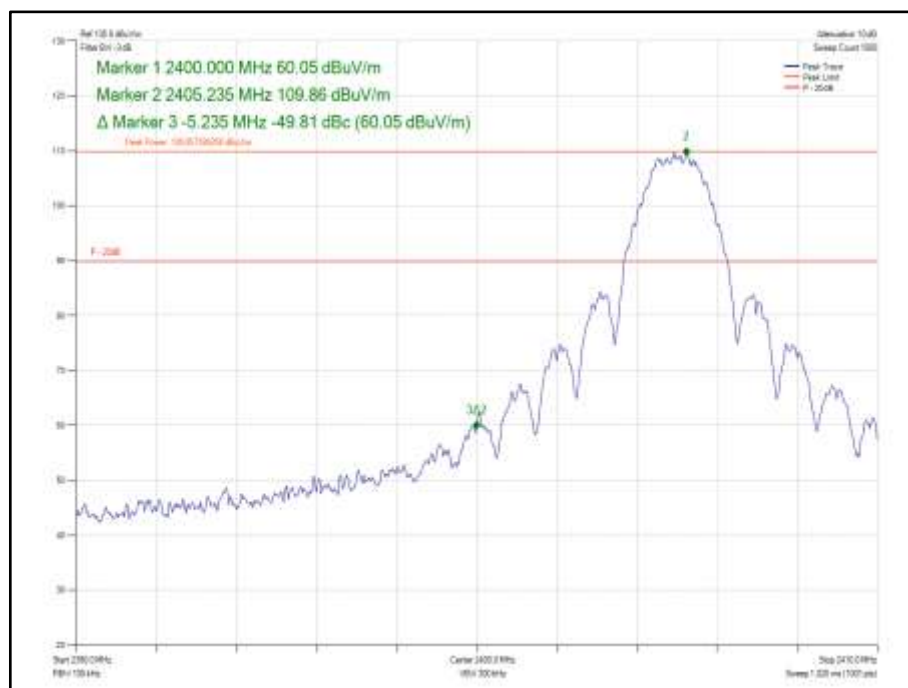


Figure 9 - Static – Thread - 2405 MHz - Band Edge Frequency 2400.0 MHz



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 RF Chamber 11.

| Instrument | Manufacturer | Type No | TE No | Calibration Period (months) | Calibration Due |
|-------------------------------|-----------------|----------------------|-------|-----------------------------|-----------------|
| Multimeter | Iso-tech | IDM101 | 2424 | 12 | 12-Dec-2020 |
| EMI Test Receiver | Rohde & Schwarz | ESW44 | 5084 | 12 | 28-Nov-2020 |
| EmX Emissions Software | TUV SUD | V2.0.1 | 5125 | - | Software |
| Screened Room (11) | Rainford | Rainford | 5136 | 36 | 01-Nov-2021 |
| Mast | Maturo | TAM 4.0-P | 5158 | - | TU |
| Mast and Turntable Controller | Maturo | Maturo NCD | 5159 | - | TU |
| Turntable | Maturo | TT 15WF | 5160 | - | TU |
| Horn Antenna (1-10GHz) | Schwarzbeck | BBHA 9120 B | 5215 | 12 | 10-Mar-2021 |
| Thermo-Hygro-Barometer | PCE Instruments | PCE-THB-40 | 5475 | 12 | 17-Mar-2021 |
| 2m SMA Cable | Junkosha | MWX221-02000AMSAMS/A | 5518 | 12 | 01-Apr-2021 |
| 8m N Type Cable | Junkosha | MWX221-08000NMSNMS/B | 5522 | 12 | 24-Mar-2021 |

Table 19

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

2.6 Spurious Radiated Emissions

2.6.1 Specification Reference

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

2.6.2 Equipment Under Test and Modification State

A2169, S/N: C07CL0AMQ4TG - Modification State 0

2.6.3 Date of Test

02-November-2020 to 03-November-2020

2.6.4 Test Method

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

The plots shown are the characterization of the EUT. The limits on the plots represent the most stringent case for restricted bands, (54/74 dBuV/m @ 3m and 64/84 dBuV/m @ 1m) when compared to 20 dBc (Peak) and 30 dBc (Average) outside restricted bands. The limits shown have been used as a threshold to determine where further measurements are necessary. Where results are within 10 dB of the limits shown on the plots, further investigation was carried out and reported in results tables.

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

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

2.6.5 Example Test Setup Diagram

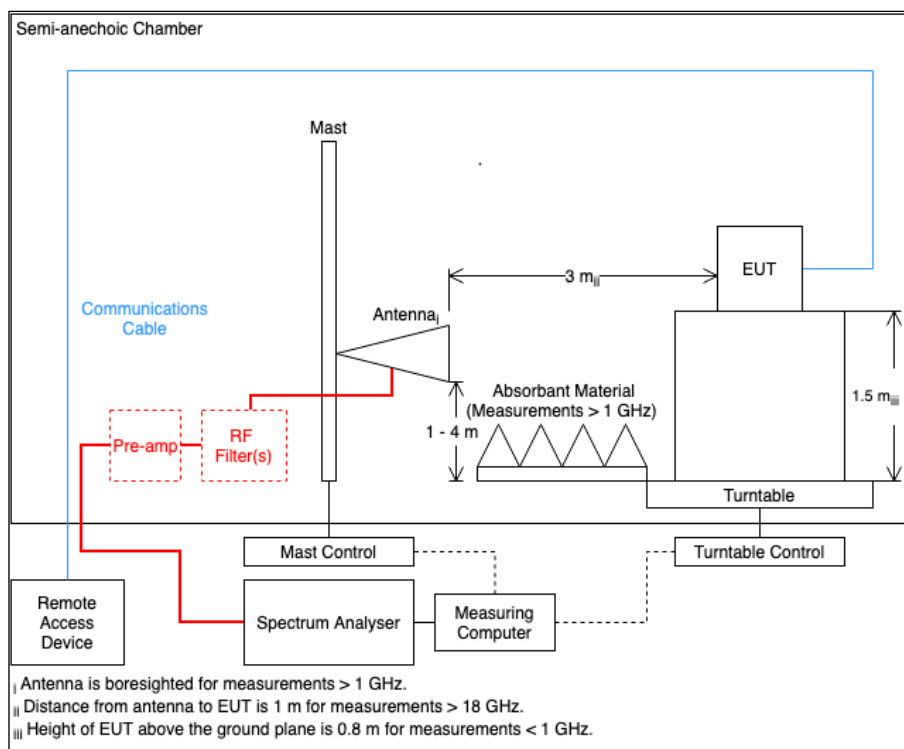


Figure 10



2.6.6 Environmental Conditions

Ambient Temperature 22.1 °C
 Relative Humidity 55.8 %

2.6.7 Test Results

2.4 GHz Thread - DTS

| Frequency (MHz) | Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector | Angle (°) | Height (cm) | Polarisation |
|-----------------|----------------|----------------|-------------|----------|-----------|-------------|--------------|
| 135.936 | 24.1 | 43.5 | -19.4 | Q-Peak | 151 | 100 | Vertical |
| 2372.969 | 38.3 | 54.0 | -15.7 | RMS | 340 | 359 | Vertical |
| 2373.135 | 37.3 | 54.0 | -16.7 | RMS | 56 | 148 | Horizontal |
| 19243.845 | 45.0 | 54.0 | -9.1 | RMS | 162 | 100 | Horizontal |
| 19243.940 | 47.6 | 54.0 | -6.4 | RMS | 161 | 100 | Vertical |

Table 20 - 2405 MHz (CH11), Thread, 30 MHz to 26 GHz

No other emissions found within 6 dB of the limit.

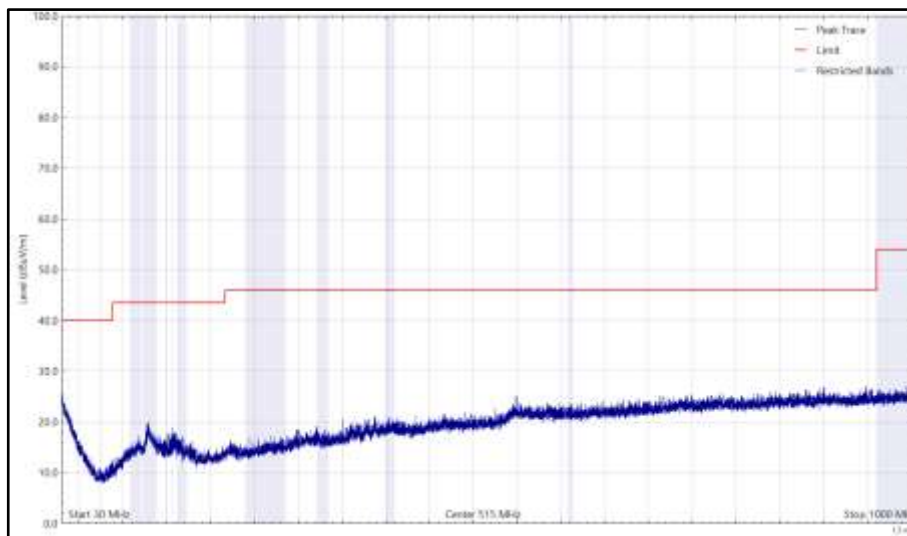


Figure 11- 2405 MHz (CH11), Thread, 30 MHz to 1 GHz, Horizontal (Peak)

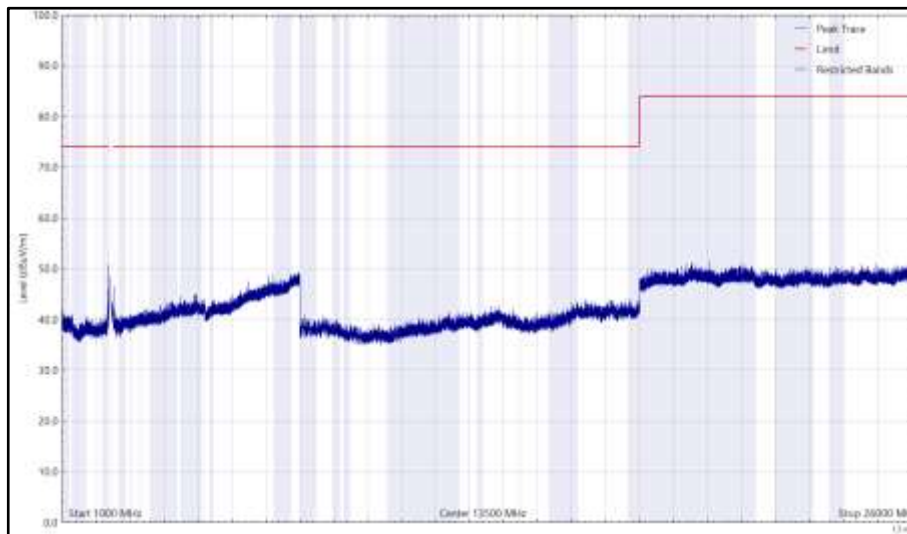


Figure 12- 2405 MHz (CH11), Thread, 1 GHz to 26 GHz, Horizontal (Peak)

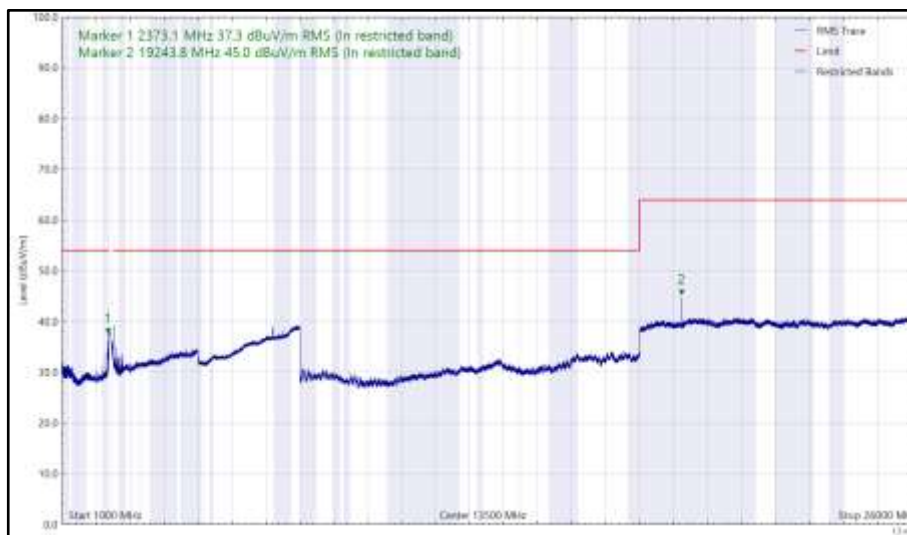


Figure 13- 2405 MHz (CH11), Thread, 1 GHz to 26 GHz, Horizontal (rms)



Figure 14- 2405 MHz (CH11), Thread, 30 MHz to 1 GHz, Vertical (Peak)

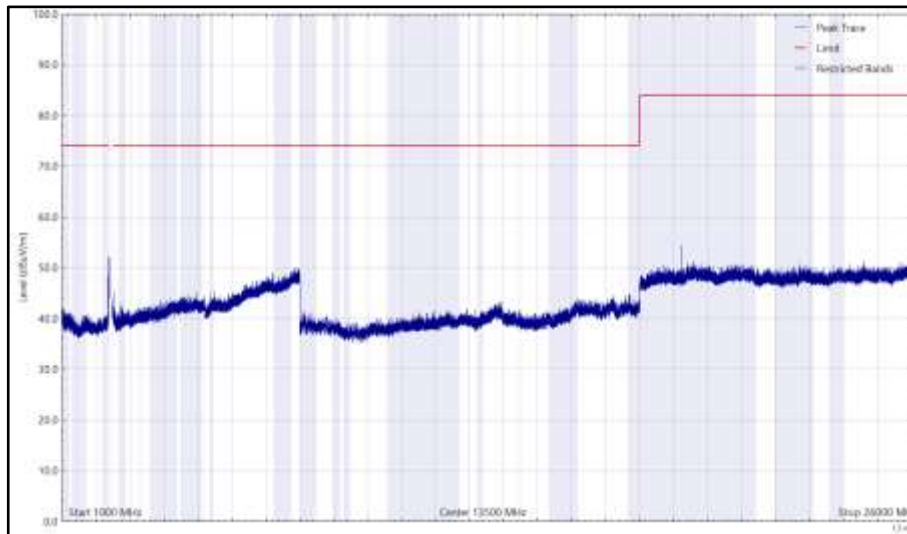


Figure 15- 2405 MHz (CH11), Thread, 1 GHz to 26 GHz, Vertical (Peak)

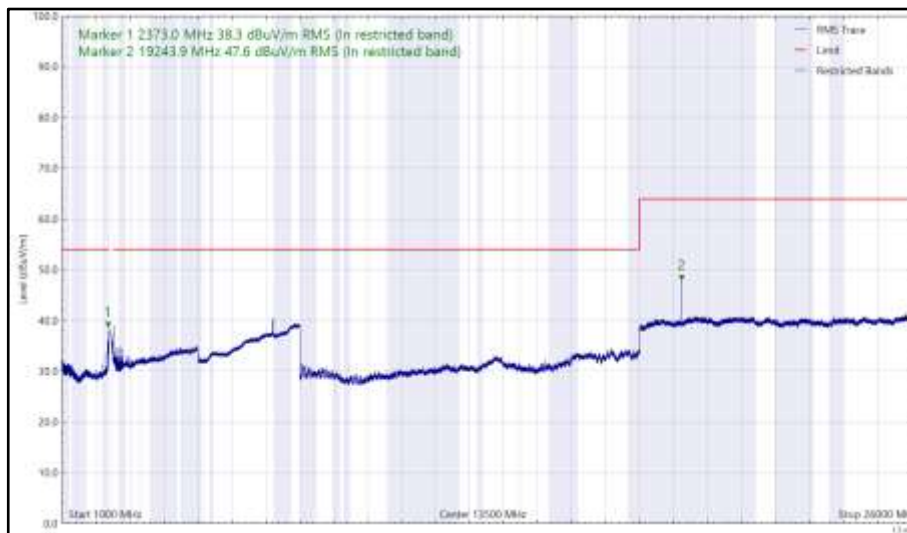


Figure 16 - 2405 MHz (CH11), Thread, 1 GHz to 26 GHz, Vertical (rms)



| Frequency (MHz) | Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector | Angle (°) | Height (cm) | Polarisation |
|-----------------|----------------|----------------|-------------|----------|-----------|-------------|--------------|
| 136.415 | 23.8 | 43.5 | -19.7 | Q-Peak | 150 | 100 | Vertical |
| 2376.007 | 36.5 | 54.0 | -17.5 | RMS | 341 | 364 | Vertical |
| 2376.052 | 35.2 | 54.0 | -18.8 | RMS | 59 | 100 | Horizontal |
| 2696.178 | 34.6 | 54.0 | -19.4 | RMS | 326 | 169 | Vertical |
| 7321.306 | 41.3 | 54.0 | -12.7 | RMS | 349 | 388 | Horizontal |
| 7321.356 | 41.6 | 54.0 | -12.4 | RMS | 271 | 110 | Vertical |
| 19523.865 | 41.9 | 54.0 | -12.1 | RMS | 213 | 100 | Horizontal |
| 19523.950 | 44.1 | 54.0 | -9.9 | RMS | 159 | 100 | Vertical |

Table 21 - 2440 MHz (CH18), Thread, 30 MHz to 26 GHz

No other emissions found within 6 dB of the limit.

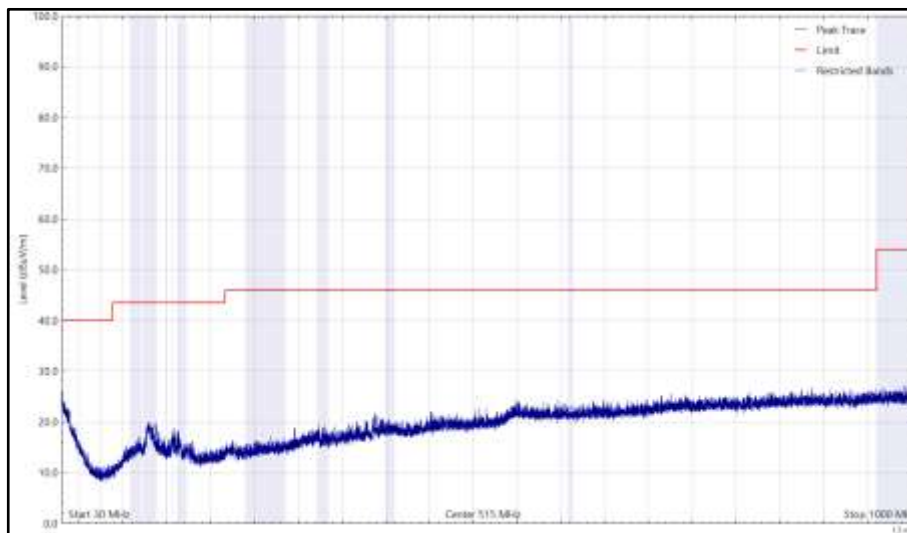


Figure 17- 2440 MHz (CH18), Thread, 30 MHz to 1 GHz, Horizontal (Peak)

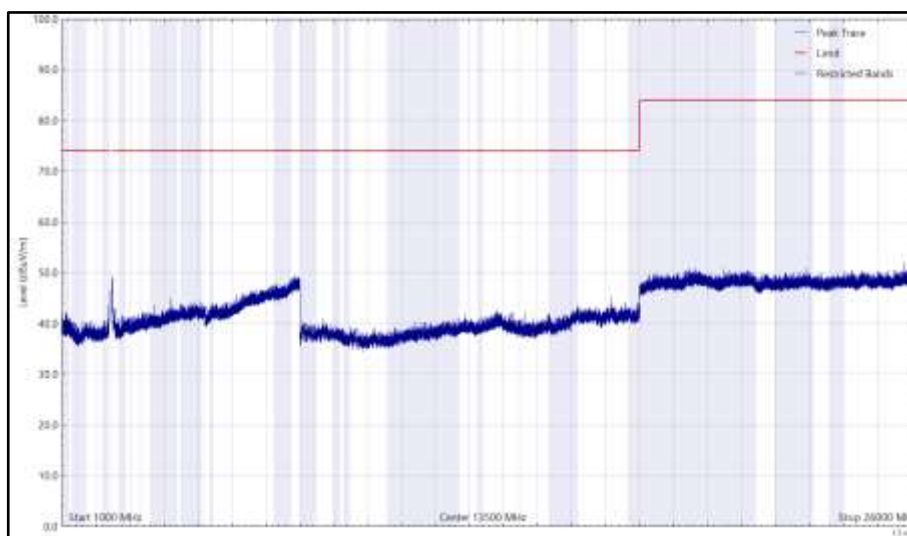


Figure 18- 2440 MHz (CH18), Thread, 1 GHz to 26 GHz, Horizontal (Peak)

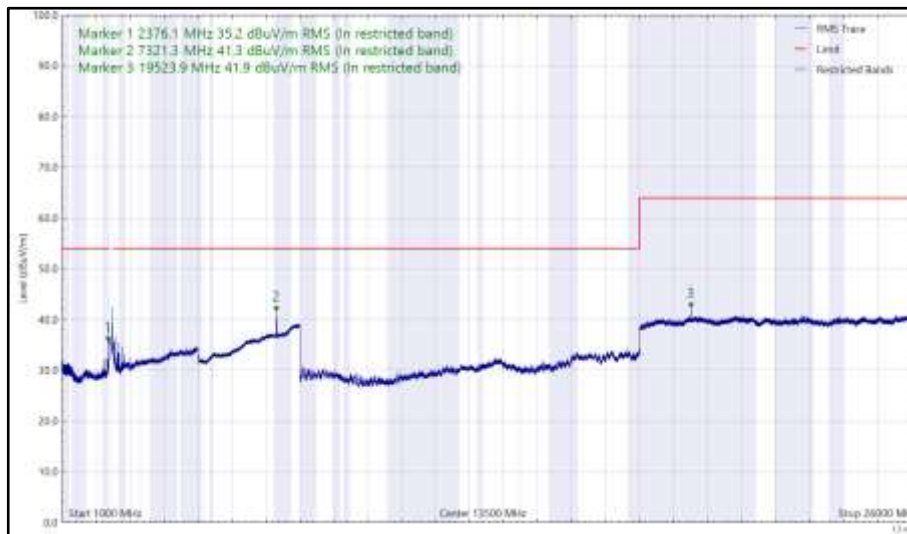


Figure 19- 2440 MHz (CH18), Thread, 1 GHz to 26 GHz, Horizontal (rms)

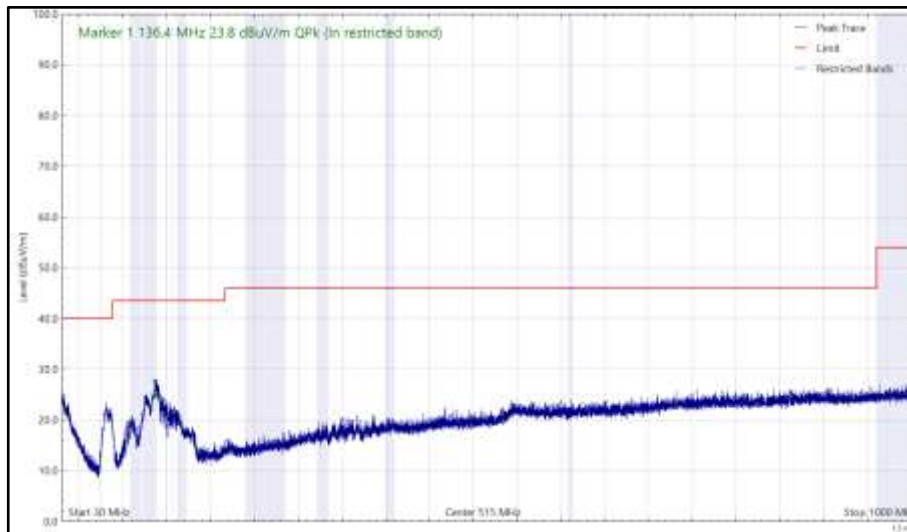


Figure 20- 2440 MHz (CH18), Thread, 30 MHz to 1 GHz, Vertical (Peak)

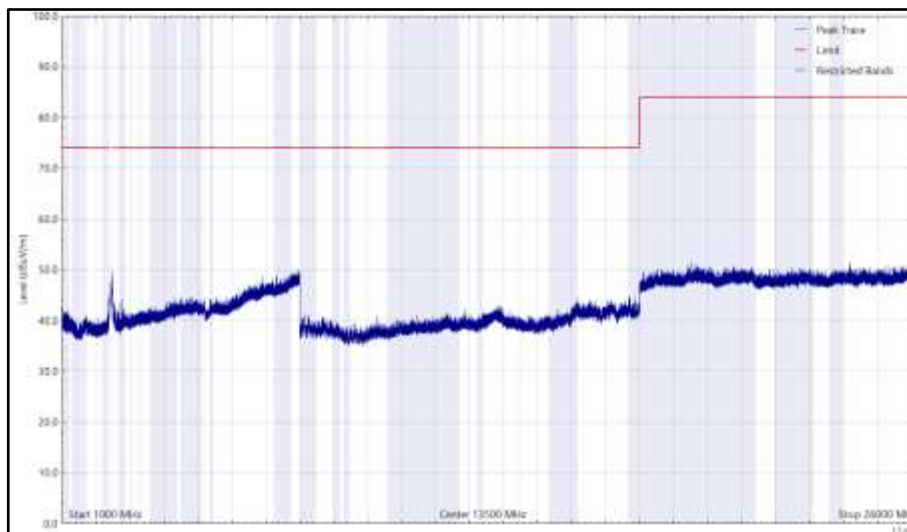


Figure 21- 2440 MHz (CH18), Thread, 1 GHz to 26 GHz, Vertical (Peak)

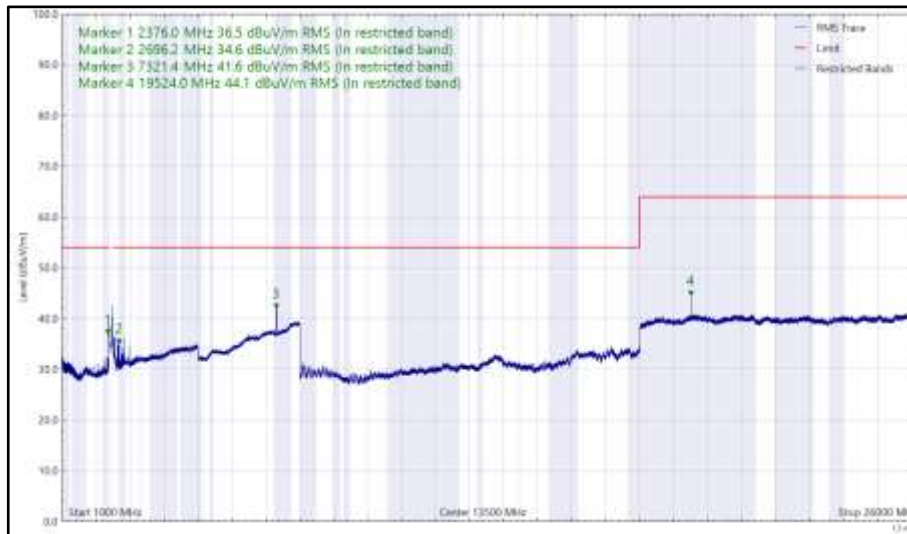


Figure 22- 2440 MHz (CH18), Thread, 1 GHz to 26 GHz, Vertical (rms)



| Frequency (MHz) | Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector | Angle (°) | Height (cm) | Polarisation |
|-----------------|----------------|----------------|-------------|----------|-----------|-------------|--------------|
| 134.672 | 23.6 | 43.5 | -19.9 | Q-Peak | 151 | 107 | Vertical |
| 2347.206 | 34.2 | 54.0 | -19.8 | RMS | 142 | 104 | Vertical |
| 7426.286 | 39.6 | 54.0 | -14.5 | RMS | 280 | 321 | Horizontal |
| 7426.444 | 38.9 | 54.0 | -15.1 | RMS | 0 | 219 | Vertical |
| 19803.790 | 42.5 | 54.0 | -11.5 | RMS | 212 | 100 | Horizontal |
| 19803.805 | 42.7 | 54.0 | -11.3 | RMS | 162 | 100 | Vertical |

Table 22 - 2475 MHz (CH25), Thread, 30 MHz to 26 GHz

No other emissions found within 6 dB of the limit.

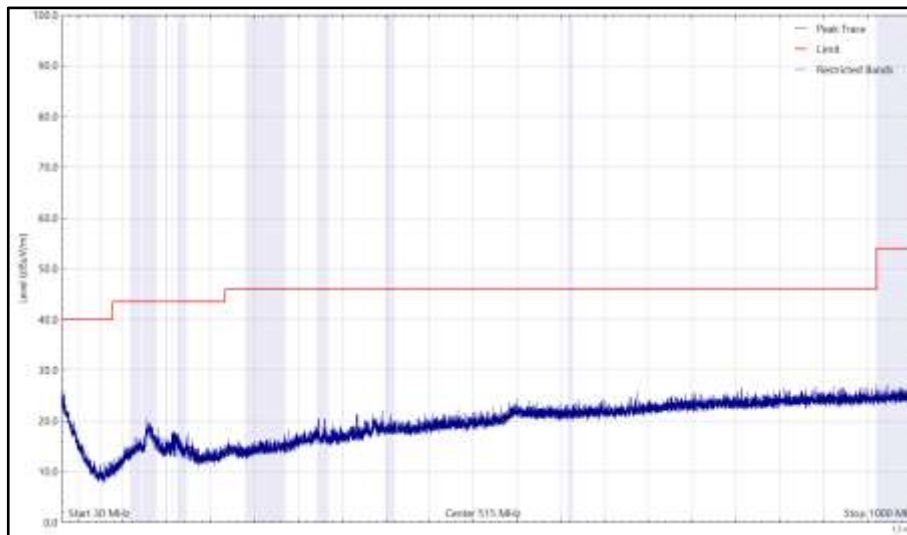


Figure 23- 2475 MHz (CH25), Thread, 30 MHz to 1 GHz, Horizontal (Peak)

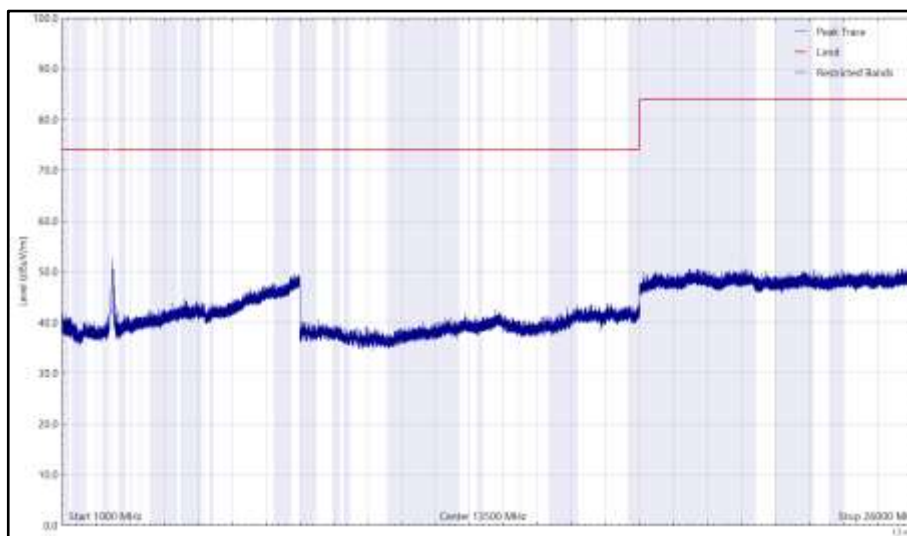


Figure 24- 2475 MHz (CH25), Thread, 1 GHz to 26 GHz, Horizontal (Peak)

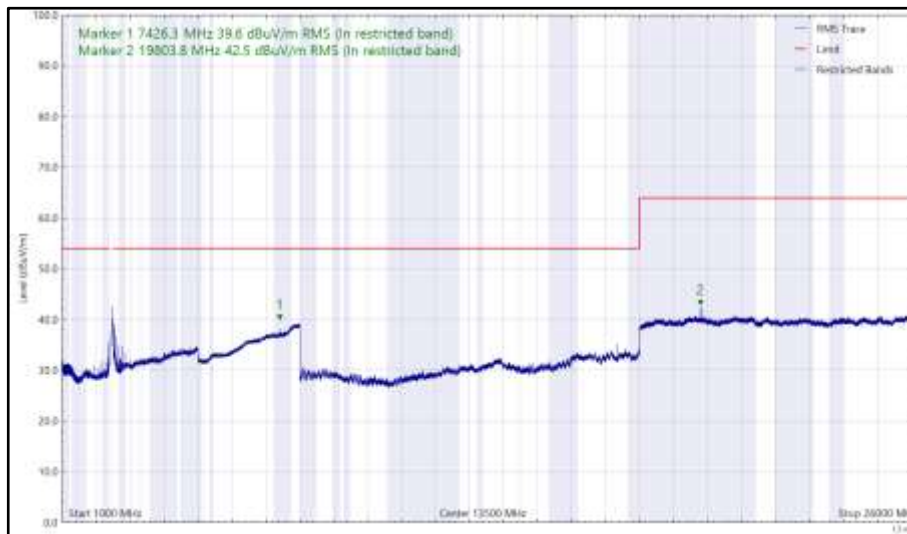


Figure 25- 2475 MHz (CH25), Thread, 1 GHz to 26 GHz, Horizontal (rms)

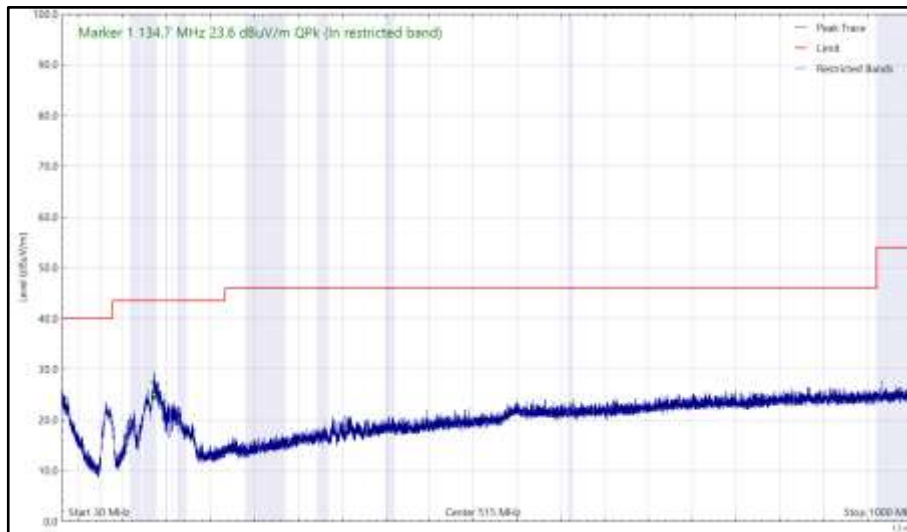


Figure 26- 2475 MHz (CH25), Thread, 30 MHz to 1 GHz, Vertical (Peak)

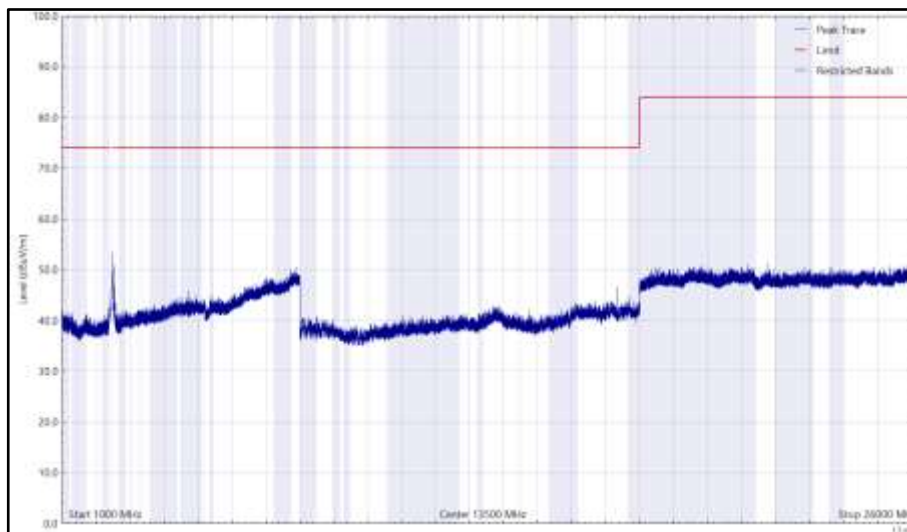


Figure 27 - 2475 MHz (CH25), Thread, 1 GHz to 26 GHz, Vertical (Peak)

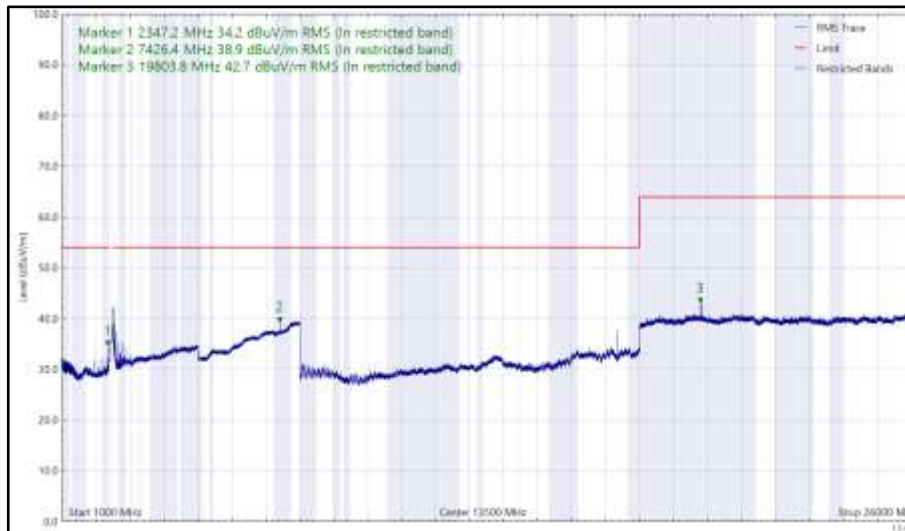


Figure 28 - 2475 MHz (CH25), Thread, 1 GHz to 26 GHz, Vertical (rms)

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

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

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

ISED RSS-247, Limit Clause 5.5

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



2.6.8 Test Location and Test Equipment Used

This test was carried out in RF Chamber 5.

| Instrument | Manufacturer | Type No | TE No | Calibration Period (months) | Calibration Due |
|---|---------------------|--|-------|-----------------------------|-----------------|
| Antenna 18-40GHz (Double Ridge Guide) | Link Microtek Ltd | AM180HA-K-TU2 | 230 | 24 | 27-Jul-2022 |
| 18GHz - 40GHz Pre-Amplifier | Phase One | PSO4-0087 | 1534 | 12 | 18-Feb-2021 |
| Screened Room (5) | Rainford | Rainford | 1545 | 36 | 23-Jan-2021 |
| Turntable Controller | Inn-Co GmbH | CO 1000 | 1606 | - | TU |
| Antenna with permanent attenuator (Bilog) | Chase | CBL6143 | 2904 | 24 | 30-Sep-2021 |
| Mast Controller | Maturo GmbH | NCD | 4810 | - | TU |
| Double Ridge Broadband Horn Antenna | Schwarzbeck | BBHA 9120 B | 4848 | 12 | 10-Mar-2021 |
| Band Reject Filter - 2.425 GHz | Wainwright | WRCGV14-2390-2400-2450-2460-50SS | 5067 | 12 | 02-Oct-2021 |
| Band Reject Filter - 2.4585 GHz | Wainwright | WRCGV14-2423.5-2433.5-2483.5-2493.5-50SS | 5069 | 12 | 12-Oct-2021 |
| Cable (18 GHz) | Rosenberger | LU7-071-1000 | 5103 | 12 | 12-Oct-2021 |
| DRG Horn Antenna (7.5-18GHz) | Schwarzbeck | HWRD750 | 5216 | 12 | 10-Mar-2021 |
| Horn Antenna (15-40GHz) | Schwarzbeck | BBHA 9170 | 5217 | 12 | 14-Oct-2021 |
| Preamplifier (30dB 1GHz to 18GHz) | Schwarzbeck | BBV 9718 C | 5261 | 12 | 07-Apr-2021 |
| Hygropalm Hygrometer | Rotronic | HP21 | 5264 | 12 | 15-Jul-2021 |
| 1m -K-Type Cable | Junkosha | MWX241-01000KMSKMS/A | 5511 | 12 | 03-Apr-2021 |
| 1m -SMA Cable | Junkosha | MWX221-01000AMSAMS/A | 5513 | 12 | 01-Apr-2021 |
| 1m -SMA Cable | Junkosha | MWX221-01000AMSAMS/A | 5514 | 12 | 01-Apr-2021 |
| 2m SMA Cable | Junkosha | MWX221-02000AMSAMS/A | 5517 | 12 | 01-Apr-2021 |
| 8m N-Type Cable | Junkosha | MWX221-08000NMSNMS/B | 5520 | 12 | 24-Mar-2021 |
| 2 m K Type Cable | Junkosha | MWX241-02000KMSKMS/A | 5523 | 12 | 03-Apr-2021 |
| EMI Test Receiver | Rohde & Schwarz | ESW44 | 5527 | 12 | 06-Feb-2021 |
| 3 GHz High pass Filter | Wainwright | WHKX12-2580-3000-18000-80SS | 5549 | 12 | 05-May-2021 |
| 1200 MHz Low Pass Filter (01) | Mini-Circuits | VLF-1200+ | 5559 | 12 | 23-May-2021 |
| 8 - 18 GHz Amplifier | Wright Technologies | APS06-0061 | 5596 | 12 | 25-Aug-2021 |

Table 23

TU - Traceability Unscheduled



3 Measurement Uncertainty

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

| Test Name | Measurement Uncertainty |
|--------------------------------|--|
| Maximum Conducted Output Power | ± 3.2 dB |
| Power Spectral Density | ± 3.2 dB |
| Emission Bandwidth | ± 42.867 kHz |
| Restricted Band Edges | 30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB |
| Authorised Band Edges | 30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB |
| Spurious Radiated Emissions | 30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB |

Table 24

Measurement Uncertainty Decision Rule

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115: 2007, clause 4.4.3 and 4.5.1.