

Report on the FCC and IC Testing of the: Apple Inc. Model: A1993

In accordance with FCC 47 CFR Part 15C and
Industry Canada RSS-247 / RSS-GEN

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

FCC ID: BCGA1993 IC: 579C-A1993



Product Service

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Document Number: 75942779-11 | Issue: 02

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|---------------|----------------|----------------------|-----------------|
| Simon Bennett | Chief Engineer | Authorised Signatory | 09 October 2018 |

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service 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 and Industry Canada RSS-247 and Industry Canada RSS-GEN. The sample tested was found to comply with the requirements defined in the applied rules.

SIGNATURE

| NAME | JOB TITLE | RESPONSIBLE FOR | ISSUE DATE |
|------------------|---------------|-----------------|-----------------|
| Mehadi Choudhury | Test Engineer | Testing | 09 October 2018 |

FCC Accreditation

90987 Octagon House, Fareham Test Laboratory

Industry Canada Accreditation

IC2932B-1 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: 2017, Industry Canada RSS-247: Issue 2 (2017-02) and Industry Canada RSS-GEN: Issue 5 (2018-04) for the tests detailed in section 1.3.



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TÜV SÜD Product Service
is a trading name of TUV SUD Ltd
Registered in Scotland at East Kilbride,
Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TUV SUD Ltd is a
TÜV SÜD Group Company

Phone: +44 (0) 1489 558100
Fax: +44 (0) 1489 558101
www.tuv-sud.co.uk

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

Contents

| | | |
|----------|--------------------------------------|-----------|
| 1 | Report Summary | 2 |
| 1.1 | Report Modification Record..... | 2 |
| 1.2 | Introduction..... | 2 |
| 1.3 | Brief Summary of Results | 3 |
| 1.4 | Product Information | 4 |
| 1.5 | Deviations from the Standard..... | 4 |
| 1.6 | EUT Modification Record | 4 |
| 1.7 | Test Location..... | 5 |
| 2 | Test Details | 6 |
| 2.1 | Maximum Conducted Output Power | 6 |
| 2.2 | Power Spectral Density | 13 |
| 2.3 | Emission Bandwidth | 19 |
| 2.4 | Authorised Band Edges | 25 |
| 2.5 | Restricted Band Edges | 28 |
| 2.6 | Spurious Radiated Emissions | 34 |
| 3 | Measurement Uncertainty | 47 |

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 | 26 September 2018 |
| 2 | Second Issue - FCCID and ICID updated | 09 October 2018 |

Table 1

1.2 Introduction

| | |
|-------------------------------|---|
| Applicant | Apple Inc. |
| Manufacturer | Apple Inc. |
| Model Number(s) | A1993 |
| Serial Number(s) | C07WR00KK2T5 and C07WT00HK2V0 |
| Hardware Version(s) | EVT |
| Software Version(s) | 18B2034 |
| Number of Samples Tested | 2 |
| Test Specification/Issue/Date | FCC 47 CFR Part 15C (2017) Industry Canada RSS-247 Issue 2 (2017-02) Industry Canada RSS-GEN: Issue 5 (2018-04) |
| Order Number | 0540058293 |
| Date | 18-May-2018 |
| Date of Receipt of EUT | 12-July-2018 and 20-June-2018 |
| Start of Test | 30-June-2018 |
| Finish of Test | 18-July-2018 |
| Name of Engineer(s) | Mehadi Choudhury, Graeme Lawler, Tony Hubbard Malik Mohammed and Sharif Sendagire |
| 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 and Industry Canada RSS-247 and Industry Canada RSS-GEN is shown below.

| Section | Specification Clause | | | Test Description | Result | Comments/Base Standard |
|---|----------------------|---------|---------|--------------------------------|--------|------------------------|
| | Part 15C | RSS-247 | RSS-GEN | | | |
| Configuration and Mode: Bluetooth Low Energy (1M) | | | | | | |
| 2.1 | 15.247 (b) | 5.4 | 6.12 | Maximum Conducted Output Power | Pass | ANSI C63.10 |
| 2.2 | 15.247 (e) | 5.2 | 6.12 | Power Spectral Density | Pass | ANSI C63.10 |
| 2.3 | 15.247 (a)(2) | 5.2 | 6.7 | Emission Bandwidth | Pass | ANSI C63.10 |
| 2.4 | 15.247 (d) | 5.5 | - | Authorised Band Edges | Pass | ANSI C63.10 |
| 2.5 | 15.205 | - | 8.10 | Restricted Band Edges | Pass | ANSI C63.10 |
| 2.6 | 15.247 (d) | 5.5 | 6.13 | Spurious Radiated Emissions | Pass | ANSI C63.10 |
| Configuration and Mode: Bluetooth Low Energy (2M) | | | | | | |
| 2.1 | 15.247 (b) | 5.4 | 6.12 | Maximum Conducted Output Power | Pass | ANSI C63.10 |
| 2.2 | 15.247 (e) | 5.2 | 6.12 | Power Spectral Density | Pass | ANSI C63.10 |
| 2.3 | 15.247 (a)(2) | 5.2 | 6.7 | Emission Bandwidth | Pass | ANSI C63.10 |
| 2.4 | 15.247 (d) | 5.5 | - | Authorised Band Edges | Pass | ANSI C63.10 |
| 2.5 | 15.205 | - | 8.10 | Restricted Band Edges | Pass | ANSI C63.10 |

Table 2

1.4 Product Information

1.4.1 Technical Description

The Equipment Under Test (EUT) was a desktop computer, with Bluetooth, Bluetooth Low Energy and 802.11 b/g/n/ac capabilities in the 2.4GHz and 5GHz bands.

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 |
|-----------------------------|---|------------------------|--------------------------|
| Serial Number: C07WT00HK2V0 | | | |
| 0 | As supplied by the customer | Not Applicable | Not Applicable |
| Serial Number: C07WR00KK2T5 | | | |
| 0 | As supplied by the customer | Not Applicable | Not Applicable |

Table 3

1.7 Test Location

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

| Test Name | Name of Engineer(s) | Accreditation |
|---|--|---------------|
| Configuration and Mode: Bluetooth Low Energy (1M) | | |
| Maximum Conducted Output Power | Mehadi Choudhury | UKAS |
| Power Spectral Density | Mehadi Choudhury | UKAS |
| Emission Bandwidth | Mehadi Choudhury | UKAS |
| Authorised Band Edges | Graeme Lawler, Tony Hubbard, Malik Mohammed & Sharif Sendagire | UKAS |
| Restricted Band Edges | | UKAS |
| Spurious Radiated Emissions | | |
| Configuration and Mode: Bluetooth Low Energy (2M) | | |
| Maximum Conducted Output Power | Mehadi Choudhury | UKAS |
| Power Spectral Density | Mehadi Choudhury | UKAS |
| Emission Bandwidth | Mehadi Choudhury | UKAS |
| Authorised Band Edges | Graeme Lawler, Tony Hubbard, Malik Mohammed & Sharif Sendagire | UKAS |
| Restricted Band Edges | | UKAS |

Table 4

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)(3)
Industry Canada RSS-247, Clause 5.4

2.1.2 Equipment Under Test and Modification State

A1993, S/N: C07WR00KK2T5 - Modification State 0

2.1.3 Date of Test

18-July-2018

2.1.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 11.9.1

2.1.5 Environmental Conditions

Ambient Temperature 23.8 °C
Relative Humidity 46.6 %

2.1.6 Test Results

Bluetooth Low Energy (1M)

Testing was performed on the modulation/packet type with the highest conducted output power.

Modulation/Packet Type: GFSK/DH1

| Frequency (MHz) | Maximum Output Power | |
|-----------------|----------------------|------|
| | dBm | mW |
| 2402 | 8.30 | 6.76 |
| 2440 | 8.38 | 6.89 |
| 2480 | 8.22 | 6.64 |

Table 5



Figure 1 - 2402 MHz - Maximum Output Power (1M)



Figure 2 - 2440 MHz - Maximum Output Power (1M)



Figure 3 - 2480 MHz - Maximum Output Power (1M)

Bluetooth Low Energy (2M)

| Frequency (MHz) | Maximum Output Power | |
|-----------------|----------------------|------|
| | dBm | mW |
| 2402 | 8.17 | 6.56 |
| 2440 | 8.47 | 7.03 |
| 2480 | 8.56 | 7.18 |

Table 6



Figure 8 - 2402 MHz - Maximum Output Power (2M)

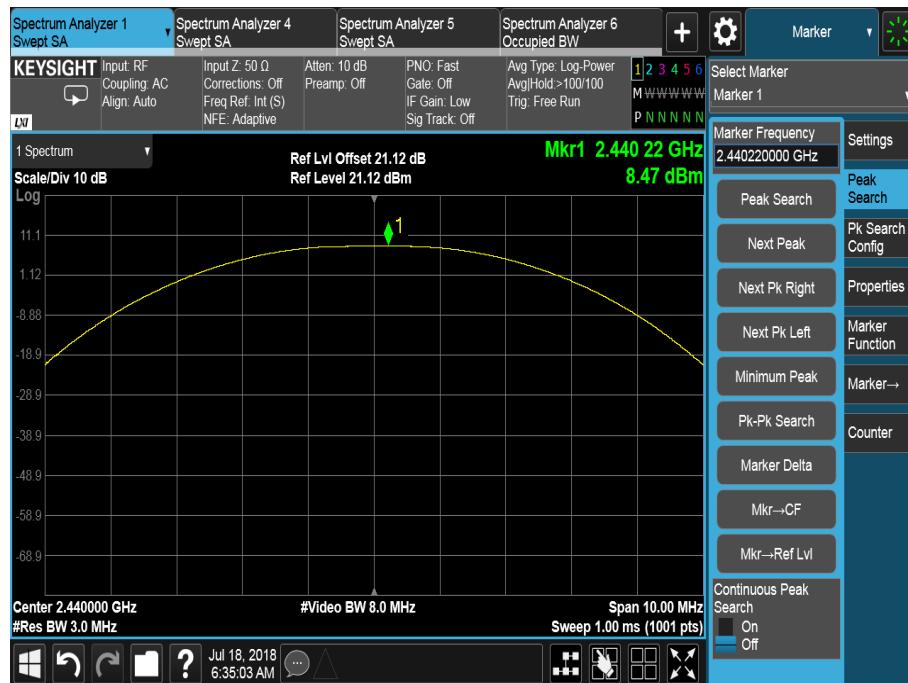


Figure 9 - 2440 MHz - Maximum Output Power (2M)



Figure 10 - 2480 MHz - Maximum Output Power (2M)



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.

Industry Canada RSS-247, Limit Clause 5.4 (d)

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

2.1.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 3.

| Instrument | Manufacturer | Type No | TE No | Calibration Period (months) | Calibration Due |
|-----------------------------|-------------------------|---------------------------|-------|-----------------------------|-----------------|
| 20dB/2W Attenuator | Narda | 4772-20 | 462 | - | TU |
| Mains Voltage Monitor | TUV SUD Product Service | MVM1 | 1378 | 12 | 17-Apr-2019 |
| Cable (3m, SMA(m) - SMA(m)) | Reynolds | 262-0248-3000 | 2402 | 12 | 19-Sep-2018 |
| Hygrometer | Rotronic | I-1000 | 2891 | 12 | 30-Aug-2018 |
| Network Analyser | Rohde & Schwarz | ZVA 40 | 3548 | 12 | 02-Oct-2018 |
| Calibration Unit | Rohde & Schwarz | ZV-Z54 | 4368 | 12 | 06-Mar-2019 |
| Frequency Standard | Spectracom | SecureSync 1200-0408-0601 | 4393 | 6 | 20-Oct-2018 |
| EXA | Keysight Technologies | N9010B | 4969 | 12 | 21-Dec-2018 |

Table 7

TU - Traceability Unscheduled



2.2 Power Spectral Density

2.2.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (e) and Industry Canada RSS-247 5.2

2.2.2 Equipment Under Test and Modification State

A1993, S/N: C07WR00KK2T5 - Modification State 0

2.2.3 Date of Test

18-July-2018

2.2.4 Test Method

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

2.2.5 Environmental Conditions

Ambient Temperature 23.8 °C

Relative Humidity 46.6 %

2.2.6 Test Results

Bluetooth Low Energy (1M)

Modulation/Packet Type: GFSK/DH1

| Frequency (MHz) | Power Spectral Density (dBm) |
|-----------------|------------------------------|
| 2402 | 4.89 |
| 2440 | 5.15 |
| 2480 | 5.05 |

Table 8 - Power Spectral Density



Figure 4 - 2402 MHz, Power Spectral Density (1M)



Figure 5 - 2440 MHz, Power Spectral Density (1M)



Figure 6 - 2480 MHz, Power Spectral Density (1M)

Bluetooth Low Energy (2M)

Modulation/Packet Type: GFSK/DH1

| Frequency (MHz) | Power Spectral Density (dBm) |
|-----------------|------------------------------|
| 2402 | 6.63 |
| 2440 | 6.66 |
| 2480 | 6.86 |

Table 9 - Power Spectral Density



Figure 7 - 2402 MHz, Power Spectral Density (2M)



Figure 8 - 2440 MHz, Power Spectral Density (2M)



Figure 9 - 2480 MHz, Power Spectral Density (2M)

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.

Industry Canada 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 3.

| Instrument | Manufacturer | Type No | TE No | Calibration Period (months) | Calibration Due |
|-----------------------------|-------------------------|---------------------------|-------|-----------------------------|-----------------|
| 20dB/2W Attenuator | Narda | 4772-20 | 462 | - | TU |
| Mains Voltage Monitor | TUV SUD Product Service | MVM1 | 1378 | 12 | 17-Apr-2019 |
| Cable(3m, SMA(m) - SMA(m)) | Reynolds | 262-0248-3000 | 2402 | 12 | 19-Sep-2018 |
| Hygrometer | Rotronic | I-1000 | 2891 | 12 | 30-Aug-2018 |
| Network Analyser | Rohde & Schwarz | ZVA 40 | 3548 | 12 | 02-Oct-2018 |
| Calibration Unit | Rohde & Schwarz | ZV-Z54 | 4368 | 12 | 06-Mar-2019 |
| Frequency Standard | Spectracom | SecureSync 1200-0408-0601 | 4393 | 6 | 20-Oct-2018 |
| EXA | Keysight Technologies | N9010B | 4969 | 12 | 21-Dec-2018 |

Table 10

TU - Traceability Unscheduled



2.3 Emission Bandwidth

2.3.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(2) and Industry Canada RSS-247 5.2

2.3.2 Equipment Under Test and Modification State

A1993, S/N: C07WR00KK2T5 - Modification State 0

2.3.3 Date of Test

18-July-2018

2.3.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 11.8 option 2

2.3.5 Environmental Conditions

Ambient Temperature 23.8 °C

Relative Humidity 46.6 %

2.3.6 Test Results

Bluetooth Low Energy (1M)

Modulation/Packet Type: GFSK/DH1

| Frequency (MHz) | 6 dB Bandwidth (MHz) | 99% Occupied Bandwidth (MHz) |
|-----------------|----------------------|------------------------------|
| 2402 | 734.400 | 1.066 |
| 2440 | 725.300 | 1.067 |
| 2480 | 728.000 | 1.065 |

Table 11

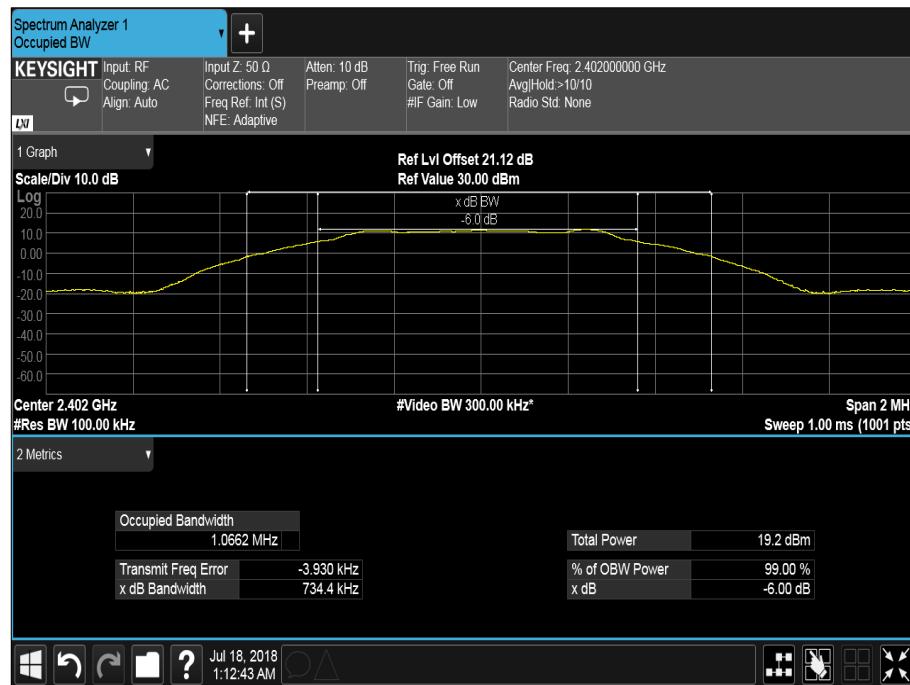


Figure 10 - 2402 MHz – 6 dB Bandwidth (1M)

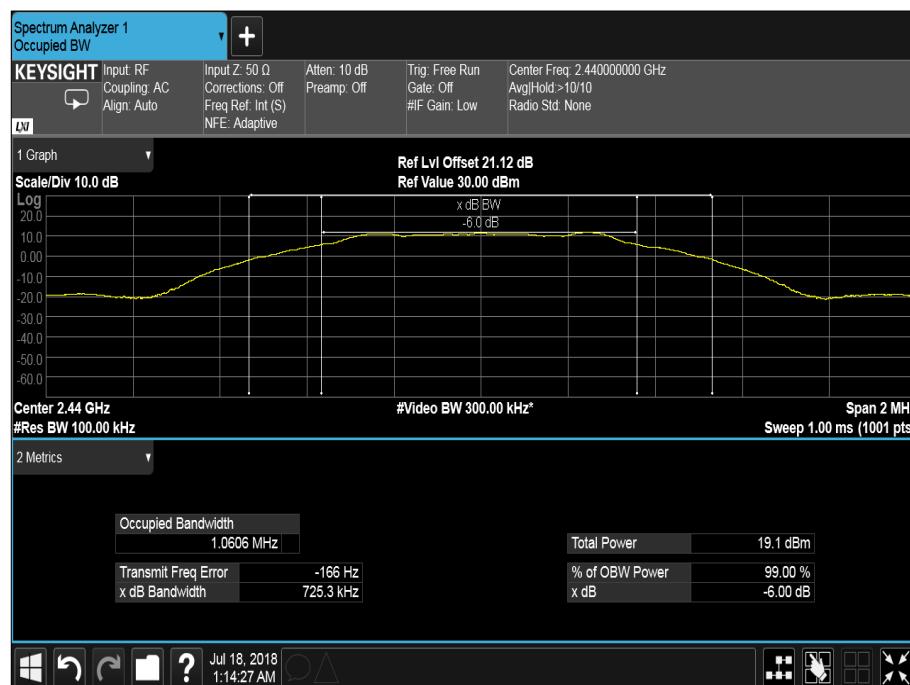


Figure 11 - 2440 MHz – 6 dB Bandwidth (1M)

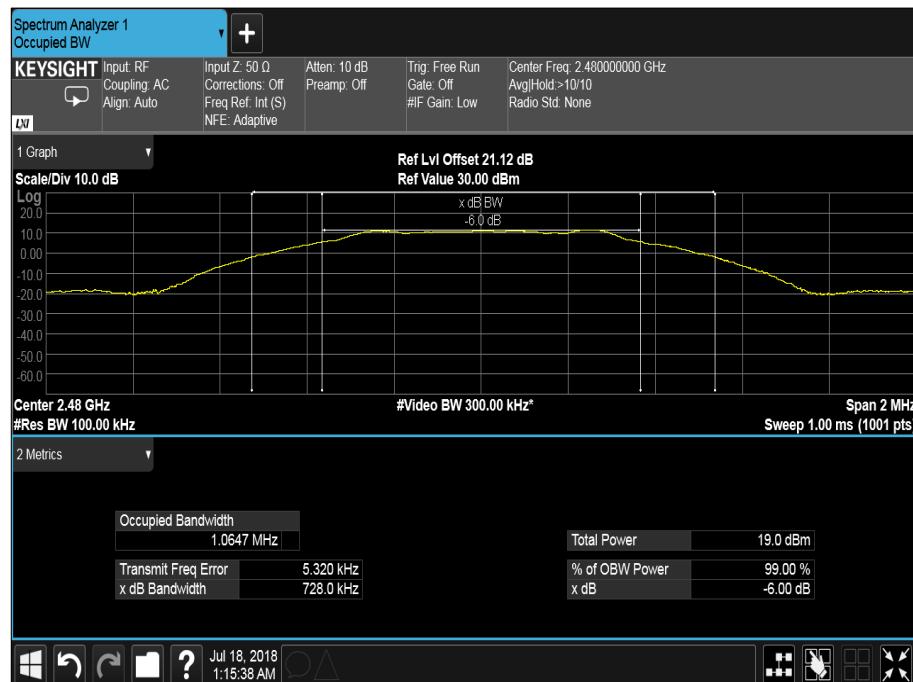


Figure 12 - 2480 MHz – 6 dB Bandwidth (1M)

Bluetooth Low Energy (2M)

Modulation/Packet Type: GFSK/DH1

| Frequency (MHz) | 6 dB Bandwidth (MHz) | 99% Occupied Bandwidth (MHz) |
|-----------------|----------------------|------------------------------|
| 2402 | 1.104 | 2.069 |
| 2440 | 1.095 | 2.065 |
| 2480 | 1.097 | 2.065 |

Table 12

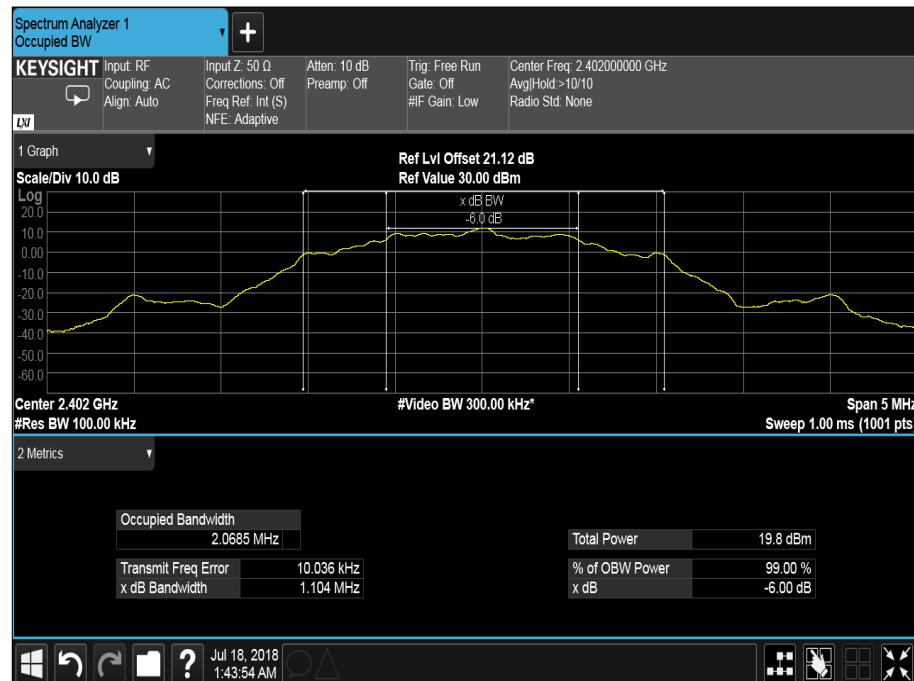


Figure 13 - 2402 MHz – 6 dB Bandwidth (2M)

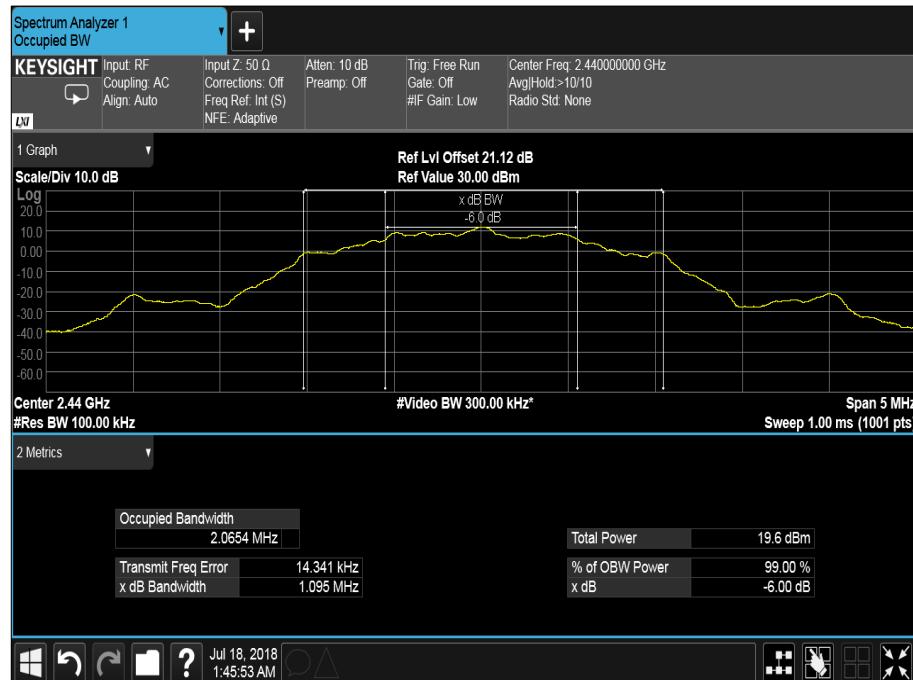


Figure 14 - 2440 MHz – 6 dB Bandwidth (2M)

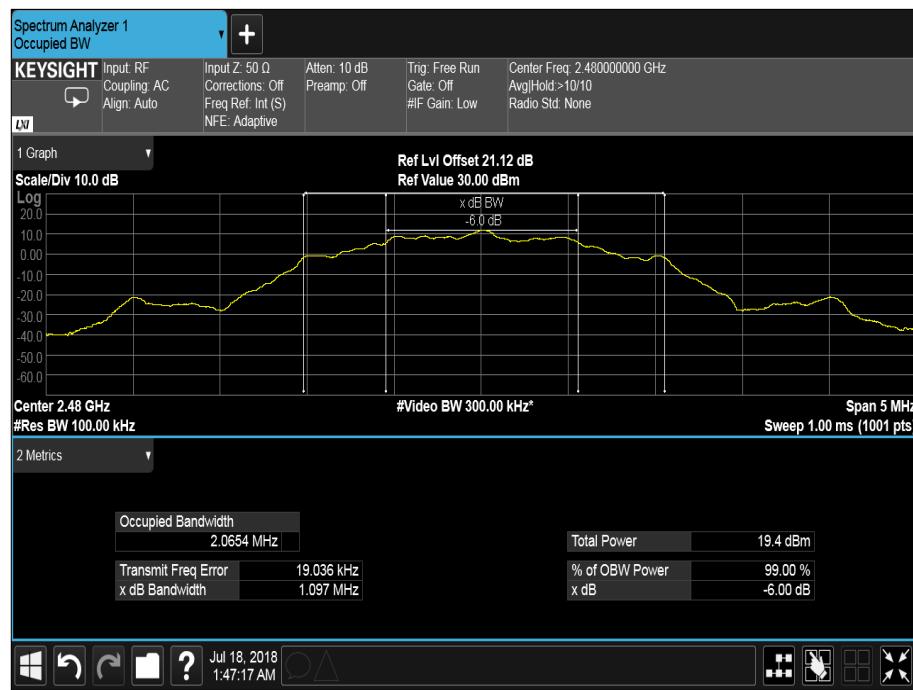


Figure 15 - 2480 MHz – 6 dB Bandwidth (2M)



FCC 47 CFR Part 15, Limit Clause 15.247(a)(2) and Industry Canada 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 3.

| Instrument | Manufacturer | Type No | TE No | Calibration Period (months) | Calibration Due |
|------------------------------|-------------------------|---------------------------|-------|-----------------------------|-----------------|
| 20dB/2W Attenuator | Narda | 4772-20 | 462 | - | TU |
| Mains Voltage Monitor | TUV SUD Product Service | MVM1 | 1378 | 12 | 17-Apr-2019 |
| Cable(3m, SMA(m) - SMA(m)) | Reynolds | 262-0248-3000 | 2402 | 12 | 19-Sep-2018 |
| Hygrometer | Rotronic | I-1000 | 2891 | 12 | 30-Aug-2018 |
| Network Analyser | Rohde & Schwarz | ZVA 40 | 3548 | 12 | 02-Oct-2018 |
| Calibration Unit | Rohde & Schwarz | ZV-Z54 | 4368 | 12 | 06-Mar-2019 |
| Frequency Standard | Spectracom | SecureSync 1200-0408-0601 | 4393 | 6 | 20-Oct-2018 |
| EXA | Keysight Technologies | N9010B | 4969 | 12 | 21-Dec-2018 |

Table 13

TU - Traceability Unscheduled



2.4 Authorised Band Edges

2.4.1 Specification Reference

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

2.4.2 Equipment Under Test and Modification State

A1993, S/N: C07WT00HK2V0 - Modification State 0

2.4.3 Date of Test

30-June-2018 to 03-July-2018

2.4.4 Test Method

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

Note: 2483.5 MHz is both an Authorised Bandwidth and a Restricted Band Edge. Of the two limits, the Restricted Band Edge is the most stringent and therefore demonstrates compliance with the 20 dBc Authorised Bandwidth requirement."

2.4.5 Environmental Conditions

Ambient Temperature 19.3 - 23.6 °C

Relative Humidity 50.8 - 51.6 %

2.4.6 Test Results

Bluetooth Low Energy (1M)

| Modulation | Packet Type | Frequency (MHz) | Measured Frequency (MHz) | Level (dBc) |
|------------|-------------|-----------------|--------------------------|-------------|
| GFSK | DH1 | 2402 | 2400.0 | -58.70 |

Table 14

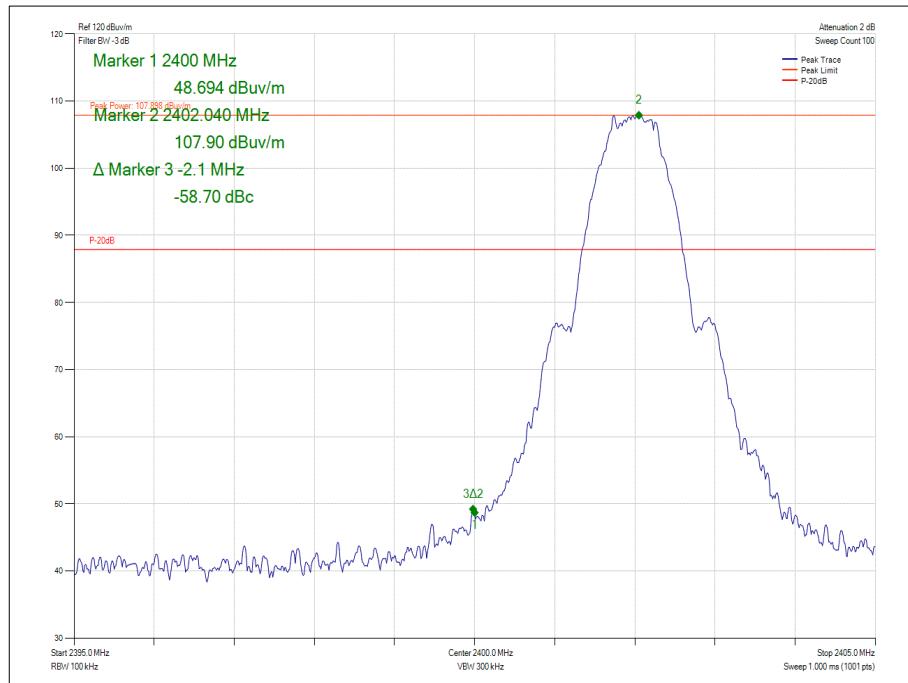


Figure 16 - GFSK/DH1 (1M) - 2402 MHz - Measured Frequency 2400.0 MHz

Bluetooth Low Energy (2M)

| Modulation | Packet Type | Frequency (MHz) | Measured Frequency (MHz) | Level (dBc) |
|------------|-------------|-----------------|--------------------------|-------------|
| GFSK | DH1 | 2402 | 2400.0 | -34.76 |

Table 15

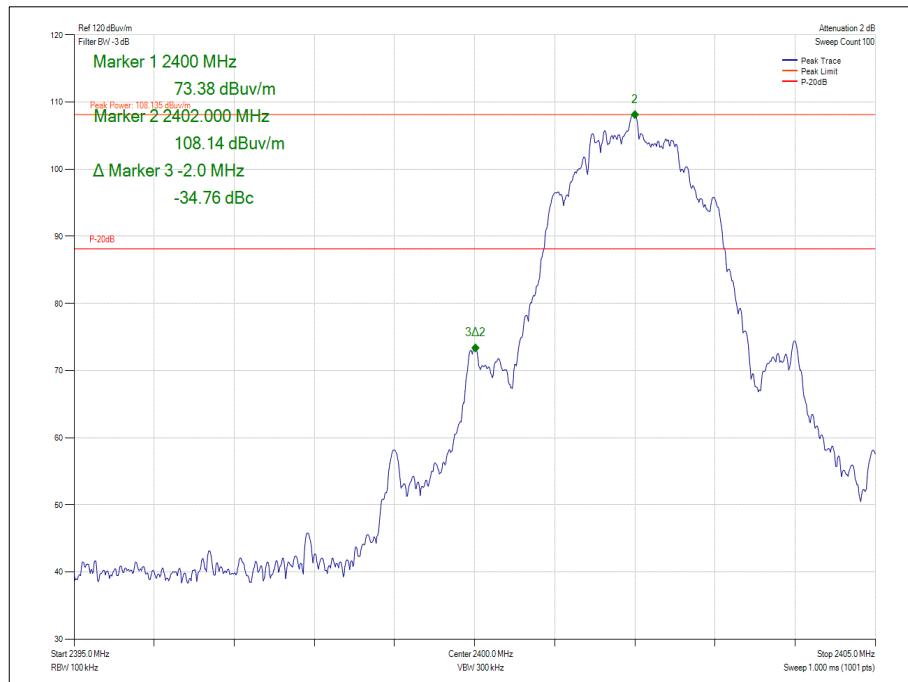


Figure 17 - GFSK/DH1 (2M) - 2402 MHz - Measured Frequency 2400.0 MHz

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.

Industry Canada RSS-247, Limit Clause 5.5

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

2.4.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

| Instrument | Manufacturer | Type No | TE No | Calibration Period (months) | Calibration Due |
|-------------------------------------|-----------------------|---------------------|-------|-----------------------------|-----------------|
| 10dB/1W SMA Attenuator dc - 18GHz | Sealectro | 60-674-1010-89 | 3 | 12 | 31-Aug-2018 |
| Screened Room (5) | Rainford | Rainford | 1545 | 36 | 23-Jan-2021 |
| Turntable Controller | Inn-Co GmbH | CO 1000 | 1606 | - | TU |
| EMI Test Receiver | Rohde & Schwarz | ESU40 | 3506 | 12 | 22-Nov-2018 |
| 1 Metre SMA Cable | Rhophase | 3PS-1801A-1000-3PS | 4099 | 12 | 19-Sep-2018 |
| Cable (Rx, Nm-Nm, 7m) | Scott Cables | SLU18-NMNM-07.00M | 4498 | - | O/P Mon |
| Cable (Rx, Km-Km 2m) | Scott Cables | KPS-1501-2000-KPS | 4526 | 6 | 31-Aug-2018 |
| EMI Receiver | Keysight Technologies | N9038A MXE | 4628 | 12 | 4-Jul-2019 |
| EMI Receiver | Keysight Technologies | N9038A MXE | 4629 | 12 | 13-Sep-2018 |
| Mast Controller | Maturo GmbH | NCD | 4810 | - | TU |
| Tilt Antenna Mast | Maturo GmbH | TAM 4.0-P | 4811 | - | TU |
| 9m N type RF cable | Rosenberger | 2303-0 9.0m PNm PNm | 4827 | 6 | 4-Jan-2019 |
| Double Ridge Broadband Horn Antenna | Schwarzbeck | BBHA 9120 B | 4848 | 12 | 12-Feb-2019 |
| Hygrometer | Rotronic | HP21 | 4989 | 12 | 26-Apr-2019 |

Table 16

TU - Traceability Unscheduled

O/P Mon – Output Monitored using calibrated equipment

2.5 Restricted Band Edges

2.5.1 Specification Reference

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

2.5.2 Equipment Under Test and Modification State

A1993, S/N: C07WT00HK2V0 - Modification State 0

2.5.3 Date of Test

30-June-2018 to 03-July-2018

2.5.4 Test Method

Testing was performed in accordance with ANSI C63.10, clause 11.11, 11.12.1 and 11.12.2.7.

Plots for average measurements were taken in accordance with ANSI C63.10, clause 4.1.4.2.3.

Final average measurements were taken in accordance with ANSI C63.10, clause 4.1.4.2.2.

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

2.5.5 Environmental Conditions

Ambient Temperature 19.3 - 23.6 °C

Relative Humidity 50.8 - 51.6 %

2.5.6 Test Results

Bluetooth Low Energy (1M)

| Modulation | Packet Type | Frequency (MHz) | Measured Frequency (MHz) | Peak Level (dB μ V/m) | Average Level (dB μ V/m) |
|------------|-------------|-----------------|--------------------------|---------------------------|------------------------------|
| GFSK | DH1 | 2402 | 2390.0 | 52.80 | 41.70 |
| GFSK | DH1 | 2480 | 2483.63 | 54.29 | 45.04 |

Table 17

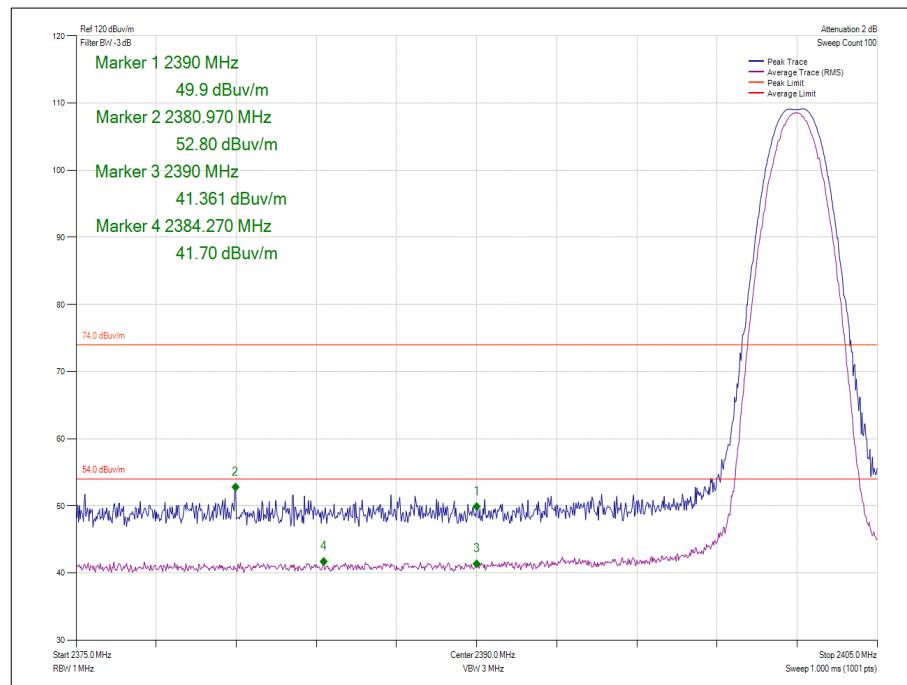


Figure 18 - GFSK/DH1 (1M) - 2402 MHz - Measured Frequency 2390.0 MHz

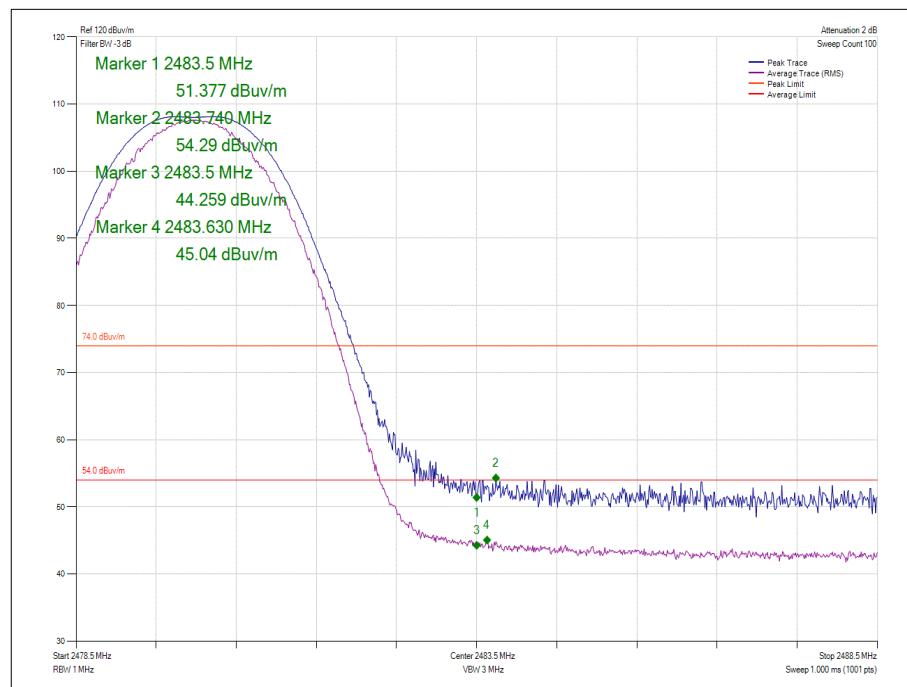


Figure 19 - GFSK/DH1 (1M) - 2480 MHz - Measured Frequency 2483.5 MHz

Bluetooth Low Energy (2M)

| Modulation | Packet Type | Frequency (MHz) | Measured Frequency (MHz) | Peak Level (dB μ V/m) | Average Level (dB μ V/m) |
|------------|-------------|-----------------|--------------------------|---------------------------|------------------------------|
| GFSK | DH1 | 2402 | 2390.0 | 53.42 | 43.38 |
| GFSK | DH1 | 2480 | 2483.53 | 61.18 | 47.82 |

Table 18

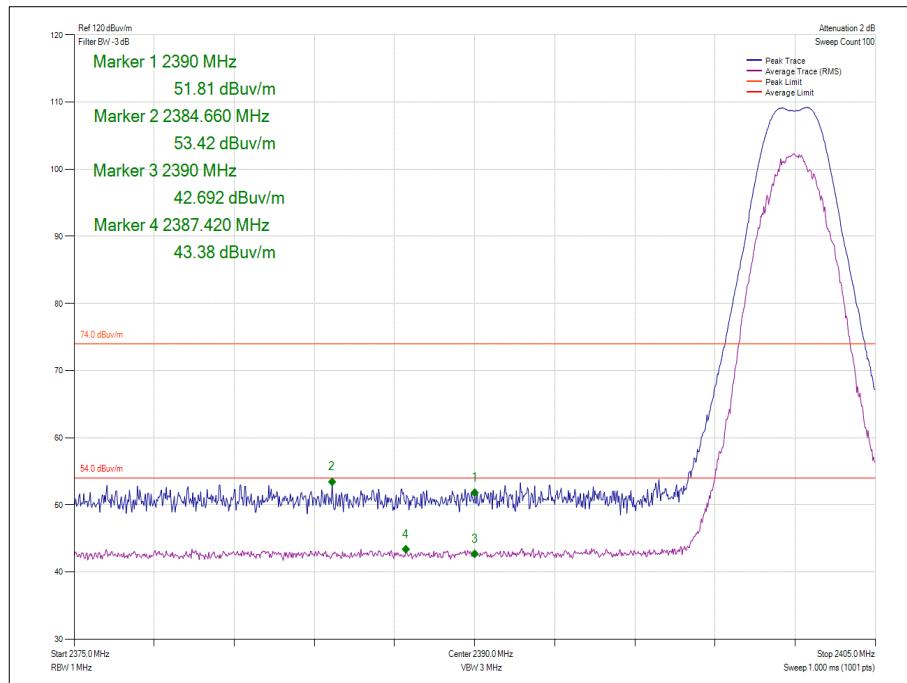


Figure 20 - GFSK/DH1 (2M) - 2402 MHz - Measured Frequency 2390.0 MHz

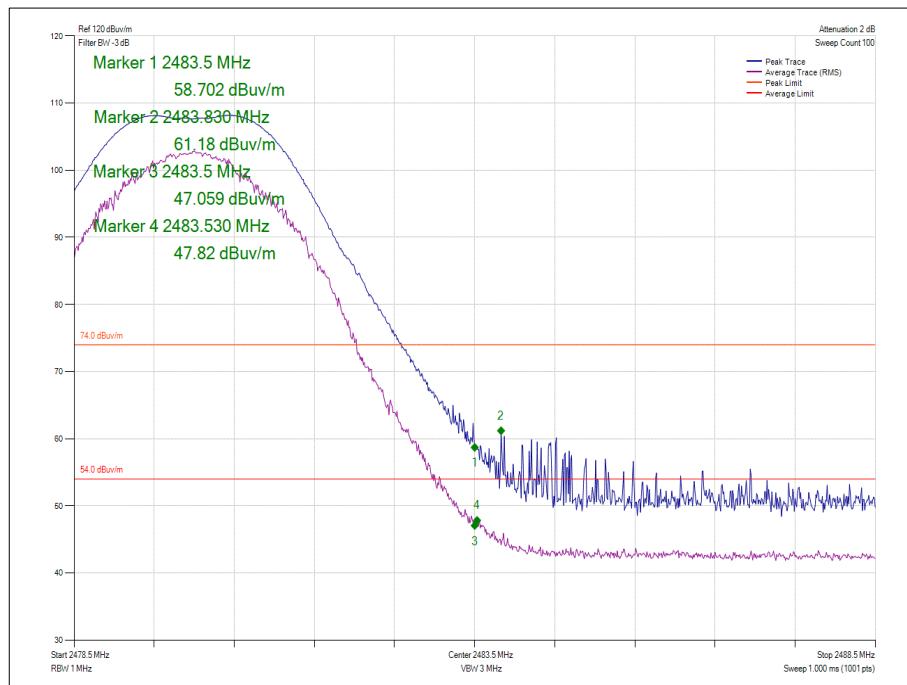


Figure 21 - GFSK/DH1 (2M) - 2480 MHz - Measured Frequency 2483.5 MHz

FCC 47 CFR Part 15, Limit Clause 15.209

| Frequency (MHz) | Field Strength (μ V/m at 3 m) |
|-----------------|------------------------------------|
| 30 to 88 | 100 |
| 88 to 216 | 150 |
| 216 to 960 | 200 |
| Above 960 | 500 |

Table 19

Industry Canada RSS-GEN, Limit Clause 8.9

| Frequency (MHz) | Field Strength (μ V/m at 3 metres) |
|-----------------|---|
| 30-88 | 100 |
| 88-216 | 150 |
| 216-960 | 200 |
| Above 960* | 500 |

Table 20

*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.

2.5.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

| Instrument | Manufacturer | Type No | TE No | Calibration Period (months) | Calibration Due |
|-------------------------------------|-------------------------|---------------------|-------|-----------------------------|-----------------|
| 10dB/1W SMA Attenuator dc - 18GHz | Sealectro | 60-674-1010-89 | 3 | 12 | 31-Aug-2018 |
| Mains Voltage Monitor | TUV SUD Product Service | MVM1 | 1378 | 12 | 17-Apr-2019 |
| Turntable Controller | Inn-Co GmbH | CO 1000 | 1606 | - | TU |
| EMI Test Receiver | Rohde & Schwarz | ESU40 | 3506 | 12 | 22-Nov-2018 |
| 1 Metre SMA Cable | Rhophase | 3PS-1801A-1000-3PS | 4099 | 12 | 19-Sep-2018 |
| Cable (Rx, Nm-Nm, 7m) | Scott Cables | SLU18-NMNM-07.00M | 4498 | - | O/P Mon |
| Cable (Rx, Km-Km 2m) | Scott Cables | KPS-1501-2000-KPS | 4526 | 6 | 31-Aug-2018 |
| EMI Receiver | Keysight Technologies | N9038A MXE | 4628 | 12 | 4-Jul-2019 |
| EMI Receiver | Keysight Technologies | N9038A MXE | 4629 | 12 | 13-Sep-2018 |
| Mast Controller | Maturo GmbH | NCD | 4810 | - | TU |
| Tilt Antenna Mast | Maturo GmbH | TAM 4.0-P | 4811 | - | TU |
| 9m N type RF cable | Rosenberger | 2303-0 9.0m PNm PNm | 4827 | 6 | 4-Jan-2019 |
| Double Ridge Broadband Horn Antenna | Schwarzbeck | BBHA 9120 B | 4848 | 12 | 12-Feb-2019 |
| Hygrometer | Rotronic | HP21 | 4989 | 12 | 26-Apr-2019 |

Table 21

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
Industry Canada RSS-247, Clause 5.5
Industry Canada RSS-GEN, Clause 6.13

2.6.2 Equipment Under Test and Modification State

A1993, S/N: C07WT00HK2V0 - Modification State 0

2.6.3 Date of Test

10-July-2018 to 17-July-2018

2.6.4 Test Method

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

In the 30MHz to 1GHz range pre-scans were only performed on mid channel (2441 MHz) and any emissions identified then measured on bottom (2402 MHz) and top (2480 MHz).

Plots for average measurements were taken in accordance with ANSI C63.10-2013 clause 4.1.4.2.3 to characterize the EUT. Where emissions were detected, final average measurements were taken in accordance with ANSI C63.10-2013 clause 4.1.4.2.2.

The plots shown are the characterization of the EUT. The limits on the plots represent the most stringent case for restricted bands, (54/74 dB_µV/m @ 3m and 64/84 dB_µV/m @ 1m) 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 dB_µV/m to µV/m:
10[^] (Field Strength in dB_µV/m/20).

2.6.5 Environmental Conditions

Ambient Temperature 20.4 °C
Relative Humidity 60.8 %

2.6.6 Test Results

Bluetooth Low Energy (1M)

Testing was performed on the modulation and packet type which resulted in the highest conducted output power. Modulation/Packet Type: GFSK/DH1

| Frequency (GHz) | Result (dB _µ V/m) | | Limit (dB _µ V/m) | | Margin (dB _µ V/m) | |
|-----------------|------------------------------|---------|-----------------------------|---------|------------------------------|---------|
| | Peak | Average | Peak | Average | Peak | Average |
| * | | | | | | |

Table 22 – 2441 MHz - 30 MHz to 1 GHz – Radiated

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

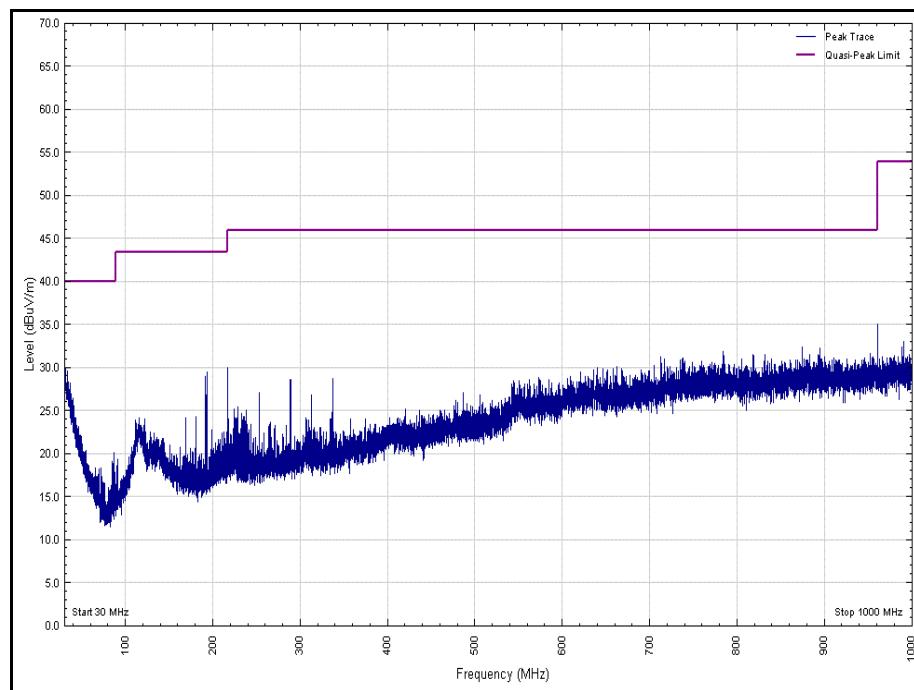


Figure 22 - 2441 MHz - 30 MHz to 1 GHz - Horizontal

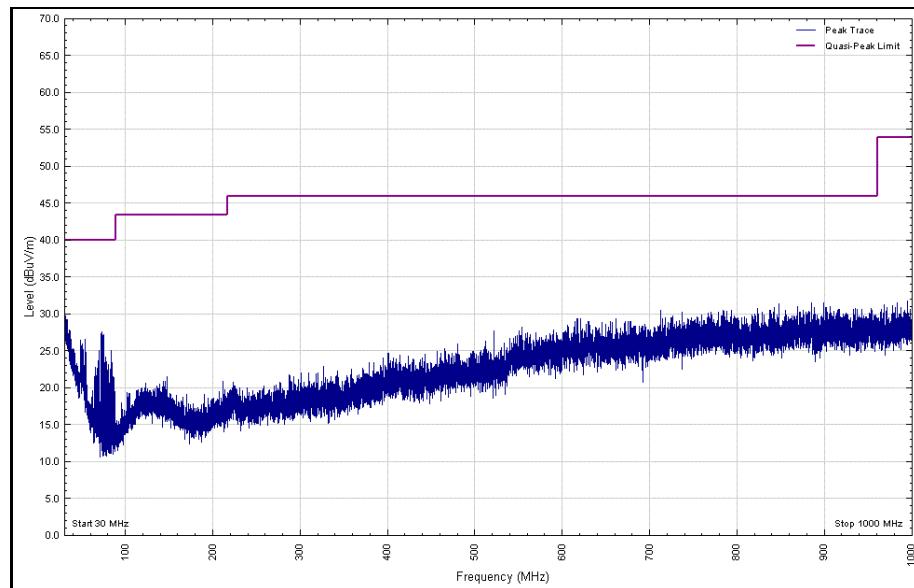


Figure 23 - 2441 MHz - 30 MHz to 1 GHz - Vertical

2402 MHz

| Frequency (GHz) | Result (μ V/m) | | Limit (μ V/m) | | Margin (μ V/m) | |
|-----------------|---------------------|---------|--------------------|---------|---------------------|---------|
| | Peak | Average | Peak | Average | Peak | Average |
| * | | | | | | |

Table 23 - 1 GHz to 26 GHz - Radiated

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

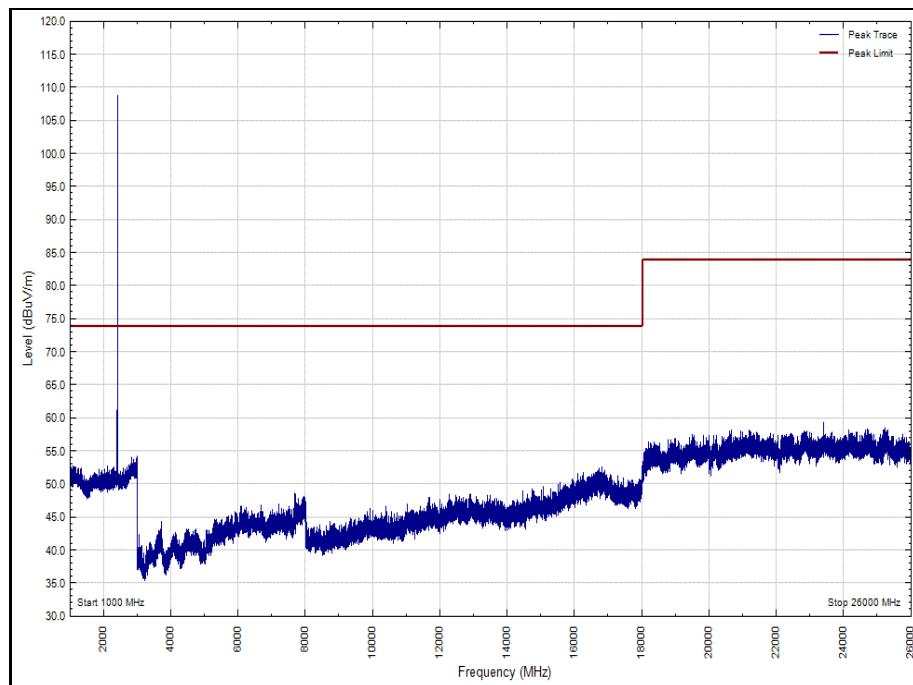


Figure 24 - 1 GHz to 26 GHz – Horizontal (Peak)

Note - The emissions seen at 2402 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.

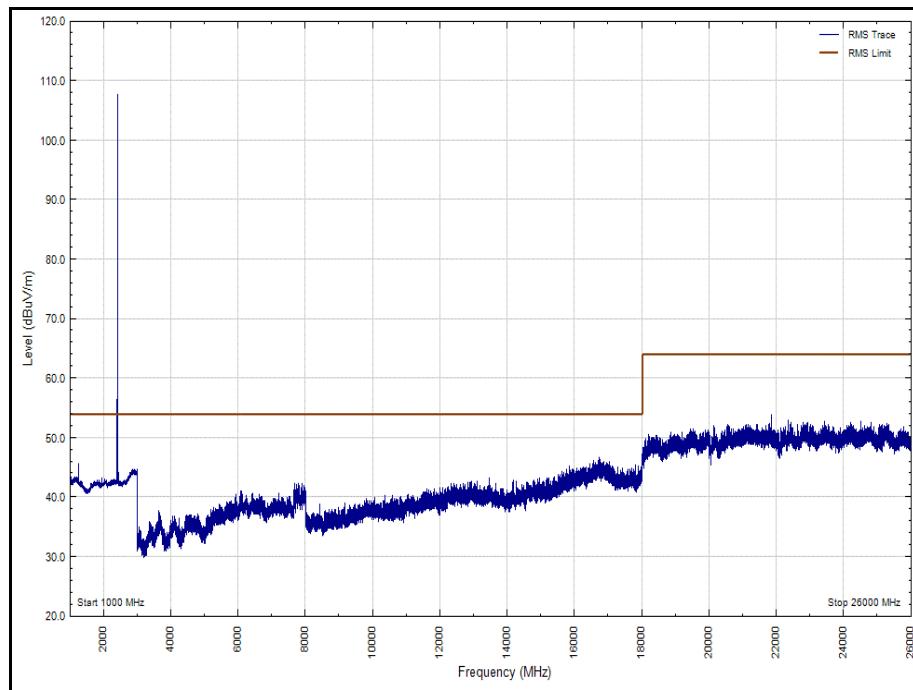


Figure 25 - 1 GHz to 26 GHz – Horizontal (Average)

Note - The emissions seen at 2402 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.

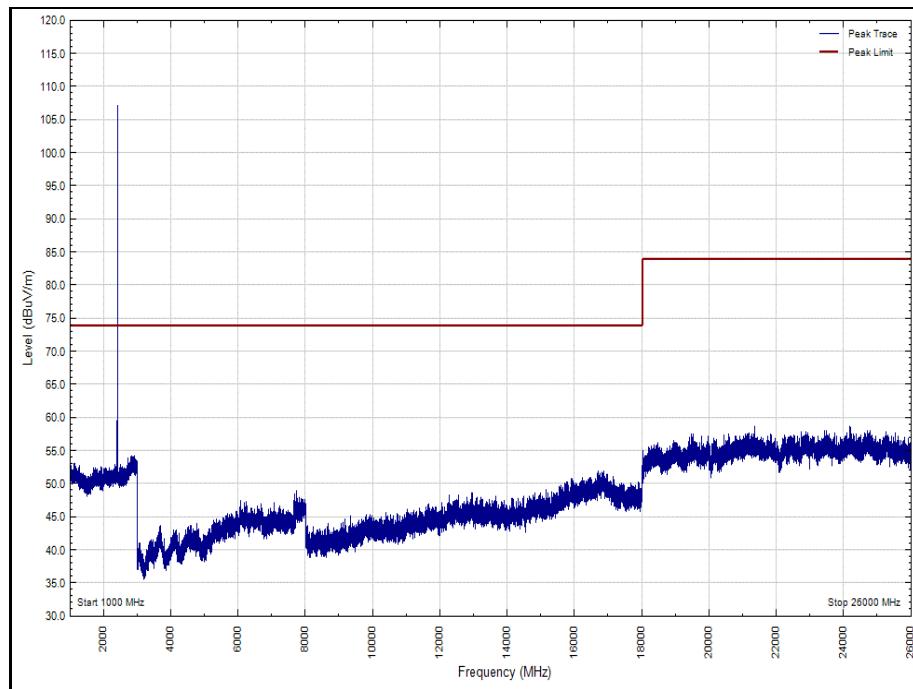


Figure 26 - 1 GHz to 26 GHz - Vertical (Peak)

Note - The emissions seen at 2402 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.

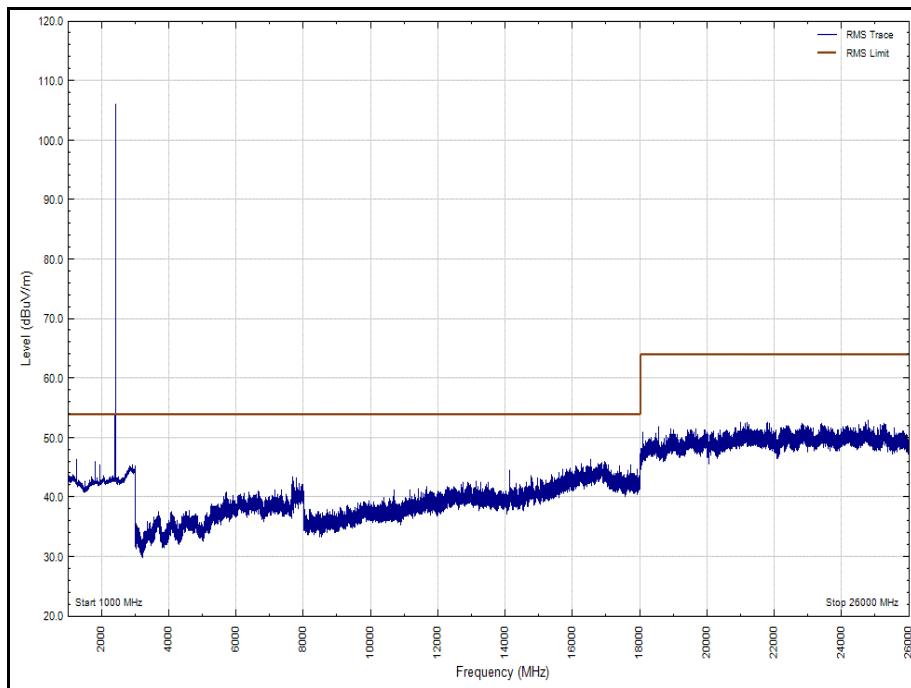


Figure 27 - 1 GHz to 26 GHz – Vertical (Average)

Note - The emissions seen at 2402 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.

2441 MHz

| Frequency (GHz) | Result (μ V/m) | | Limit (μ V/m) | | Margin (μ V/m) | |
|-----------------|---------------------|---------|--------------------|---------|---------------------|---------|
| | Peak | Average | Peak | Average | Peak | Average |
| * | | | | | | |

Table 24 - 1 GHz to 26 GHz - Radiated

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

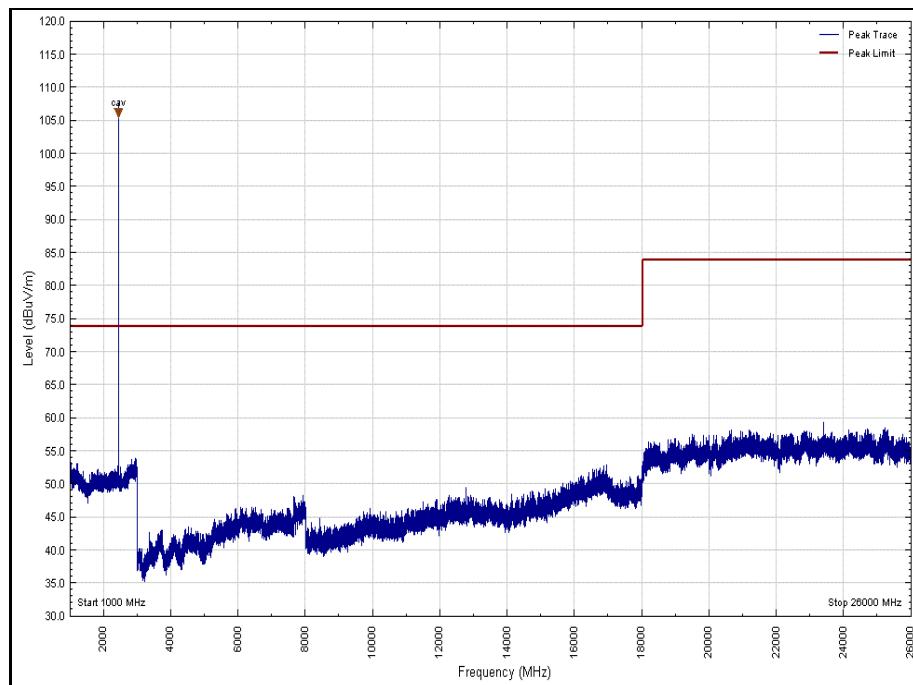


Figure 28 - 1 GHz to 26 GHz Horizontal (Peak)

Note - The emissions seen at 2441 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.

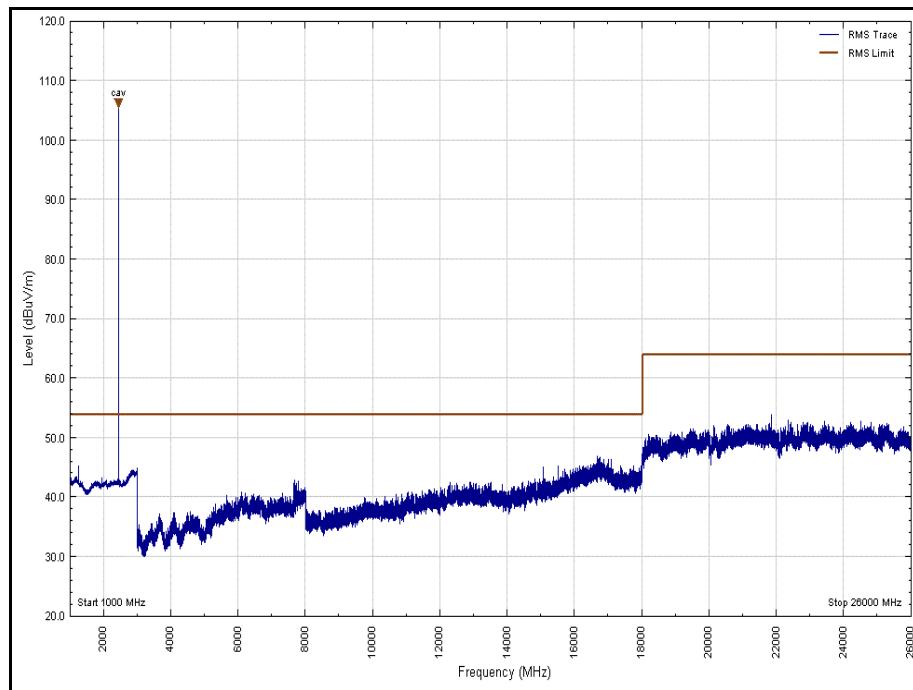


Figure 29 - 1 GHz to 26 GHz Horizontal (Average)

Note - The emissions seen at 2441 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.

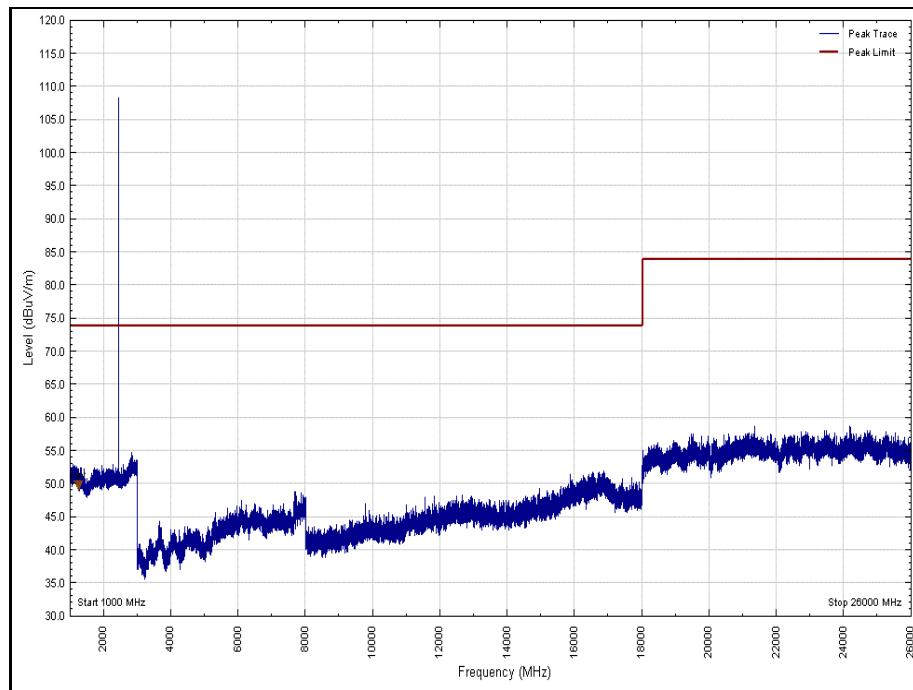


Figure 30 - 1 GHz to 26 GHz Vertical (Peak)

Note - The emissions seen at 2441 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.

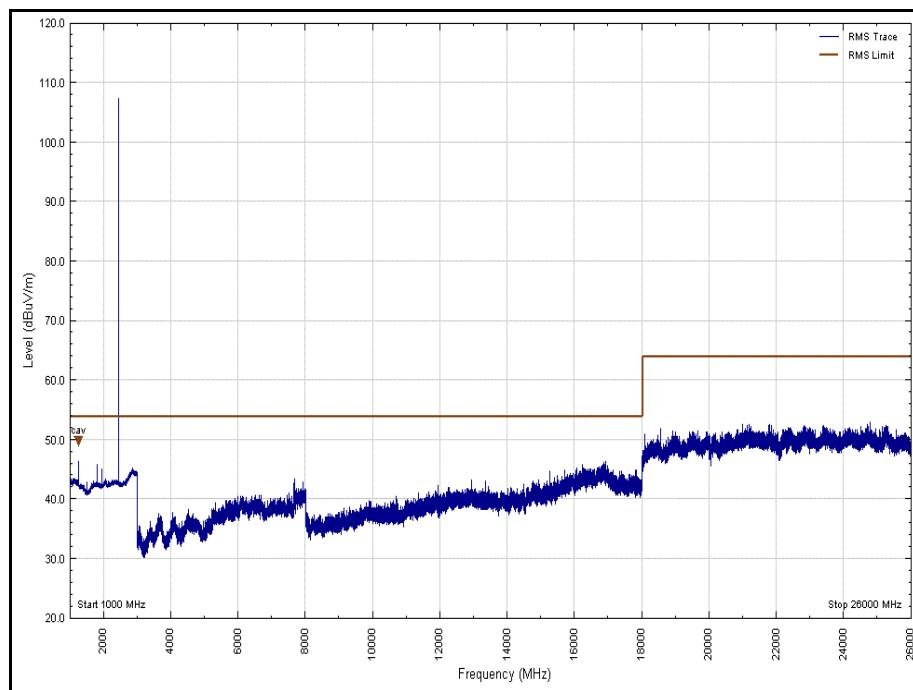


Figure 31 - 1 GHz to 26 GHz Vertical (Average)

Note - The emissions seen at 2441 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.

2480 MHz

| Frequency (GHz) | Result (μ V/m) | | Limit (μ V/m) | | Margin (μ V/m) | |
|-----------------|---------------------|---------|--------------------|---------|---------------------|---------|
| | Peak | Average | Peak | Average | Peak | Average |
| * | | | | | | |

Table 25 - 1 GHz to 26 GHz - Radiated

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

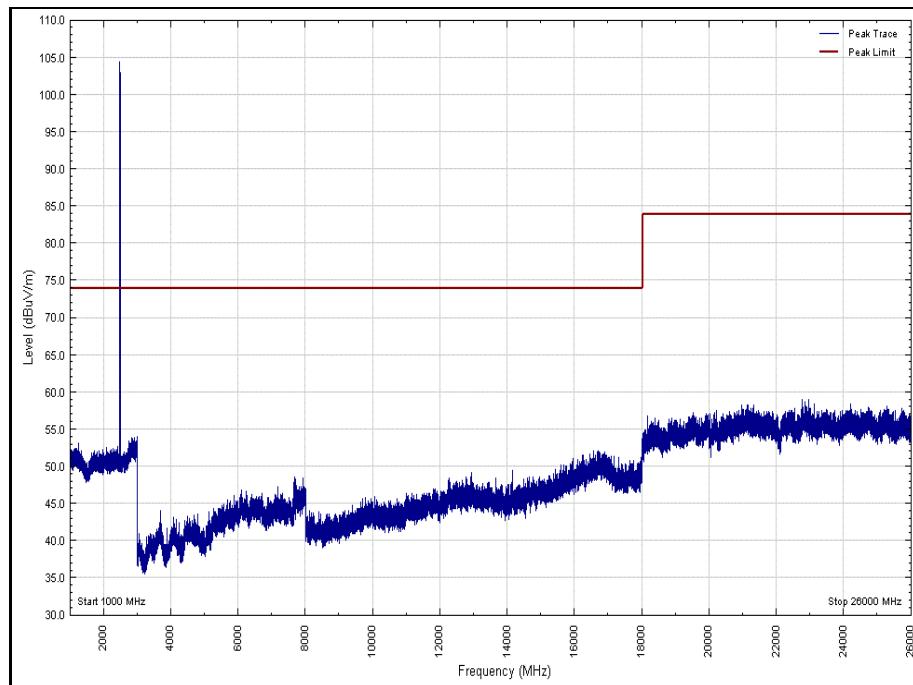


Figure 32 - 1 GHz to 26 GHz Horizontal (Peak)

Note - The emissions seen at 2480 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.

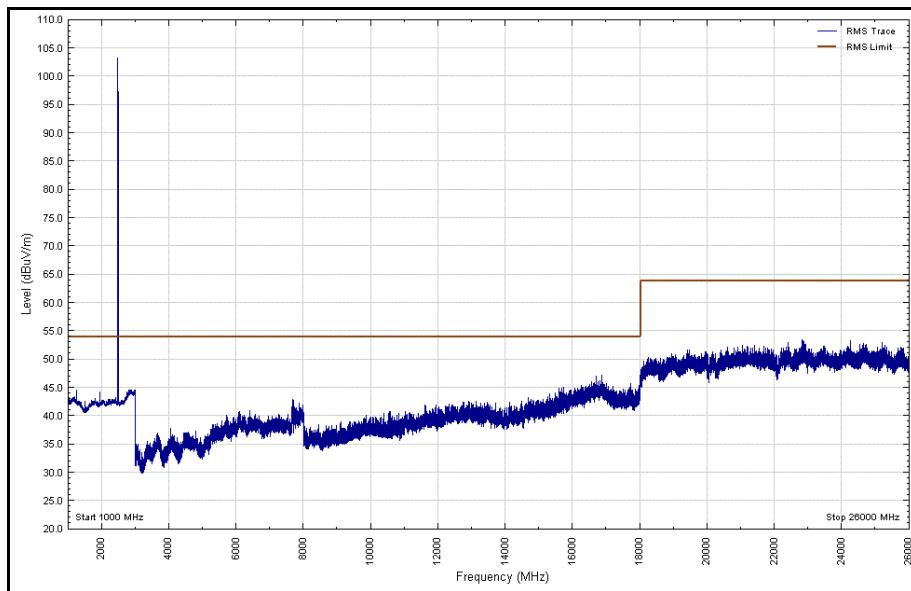


Figure 33 - 1 GHz to 26 GHz Horizontal (Average)

Note - The emissions seen at 2480 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.

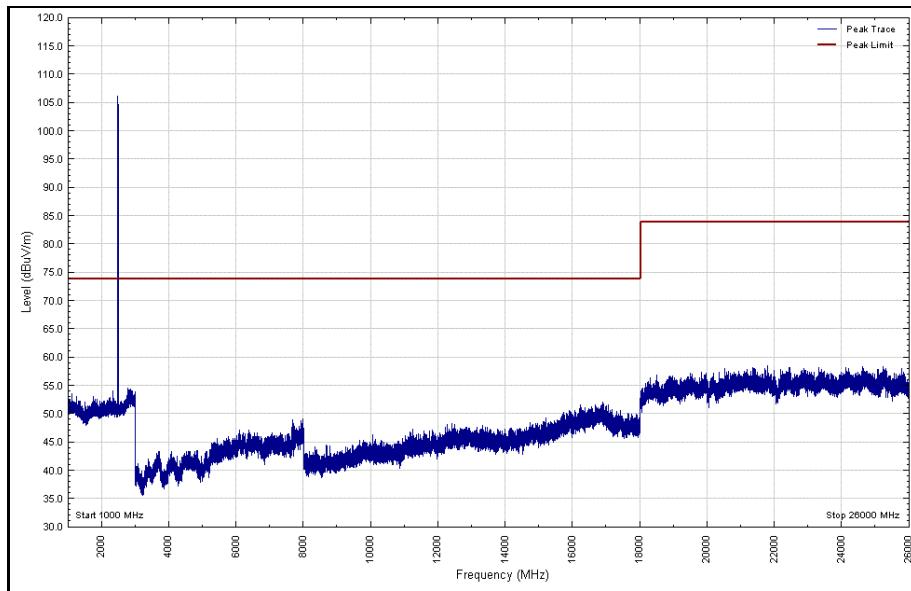


Figure 34 - 1 GHz to 26 GHz Vertical (Peak)

Note - The emissions seen at 2480 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.

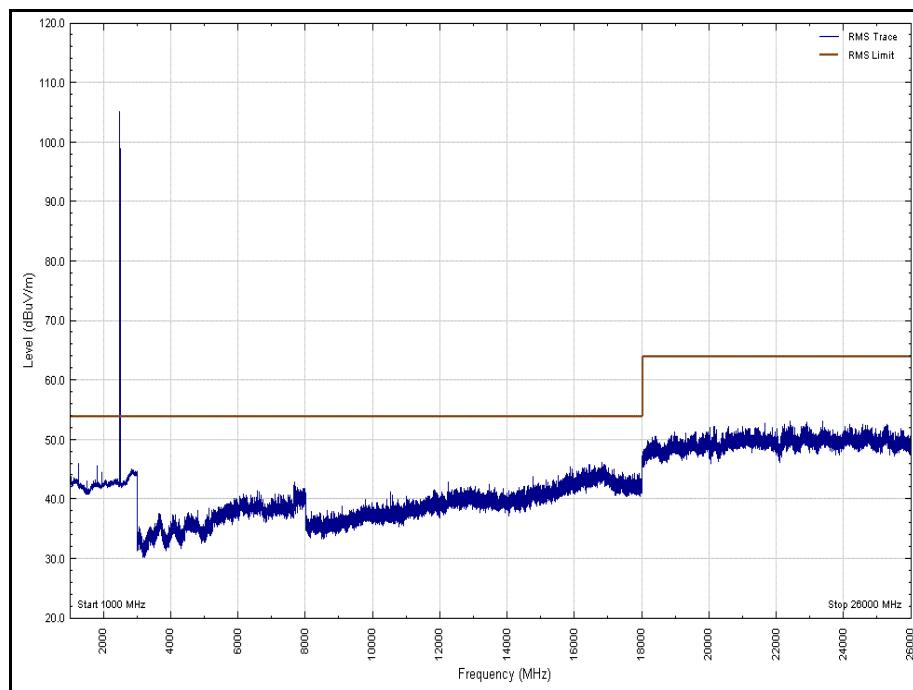


Figure 35 - 1 GHz to 26 GHz Vertical (Average)

Note - The emissions seen at 2480 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.



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)

Industry Canada RSS-247, Limit Clause 5.5

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

2.6.7 Test Location and Test Equipment Used

| Instrument | Manufacturer | Type No | TE No | Calibration Period (months) | Calibration Due |
|---------------------------------------|-----------------------|---------------------|-------|-----------------------------|-----------------|
| 10dB/1W SMA Attenuator dc -18GHz | Sealectro | 60-674-1010-89 | 3 | 12 | 31-Aug-2018 |
| Multimeter | White Gold | WG022 | 190 | 12 | 24-Nov-2018 |
| Antenna 18-40GHz (Double Ridge Guide) | Link Microtek Ltd | AM180HA-K-TU2 | 230 | 24 | 2-May-2020 |
| Antenna (Bilog) | Schaffner | CBL6143 | 287 | 24 | 15-May-2020 |
| Dual Power Supply Unit | Thurlby | PL320 | 288 | - | TU |
| Filter (High Pass) | Lorch | SHP7-7000-SR | 566 | 12 | 10-May-2019 |
| Pre-Amplifier | Phase One | PS04-0086 | 1533 | 12 | 12-Jan-2019 |
| 18GHz - 40GHz Pre-Amplifier | Phase One | PS04-0087 | 1534 | 12 | 2-Feb-2019 |
| Screened Room (5) | Rainford | Rainford | 1545 | 36 | 23-Jan-2021 |
| Turntable Controller | Inn-Co GmbH | CO 1000 | 1606 | - | TU |
| Antenna (Bilog) | Chase | CBL6143 | 2904 | 24 | 8-Aug-2019 |
| Cable (N-N, 8m) | Rhophase | NPS-2302-8000-NPS | 3248 | - | O/P Mon |
| EMI Test Receiver | Rohde & Schwarz | ESU40 | 3506 | 12 | 22-Nov-2018 |
| Network Analyser | Rohde & Schwarz | ZVA 40 | 3548 | 12 | 2-Oct-2018 |
| 1 Metre SMA Cable | Rhophase | 3PS-1801A-1000-3PS | 4099 | 12 | 19-Sep-2018 |
| 1501A 4.0M Km Km Cable | Rhophase | KPS-1501A-4000-KPS | 4301 | 12 | 19-Feb-2019 |
| 1GHz to 8GHz Low Noise Amplifier | Wright Technologies | APS04-0085 | 4365 | 12 | 18-Oct-2018 |
| Cable (Rx, Nm-Nm, 7m) | Scott Cables | SLU18-NMNM-07.00M | 4498 | - | O/P Mon |
| Cable (Rx, Km-Km 2m) | Scott Cables | KPS-1501-2000-KPS | 4526 | 6 | 31-Aug-2018 |
| Cable (Rx, SAMA-SAMA 0.5m) | Scott Cables | SLSLL18-SMSM-00.50M | 4528 | 6 | 15-Aug-2018 |
| EMI Receiver | Keysight Technologies | N9038A MXE | 4628 | 12 | 04-July-2019 |
| Double Ridged Waveguide Horn Antenna | ETS-Lindgren | 3117 | 4722 | 12 | 1-Mar-2019 |
| Mast Controller | Maturo GmbH | NCD | 4810 | - | TU |
| Tilt Antenna Mast | Maturo GmbH | TAM 4.0-P | 4811 | - | TU |
| 9m N type RF cable | Rosenberger | 2303-0 9.0m PNm PNm | 4827 | 6 | 4-Jan-2019 |
| Double Ridge Broadband Horn Antenna | Schwarzbeck | BBHA 9120 B | 4848 | 12 | 12-Feb-2019 |
| 4dB Attenuator | Pasternack | PE7047-4 | 4935 | 12 | 28-Nov-2018 |
| Hygrometer | Rotronic | HP21 | 4989 | 12 | 26-Apr-2019 |
| Cable (26.5GHz) | Rosenberger | LU7-133-5000 | 5019 | - | O/P Mon |
| Cable (40GHz) | Rosenberger | LU1-001-2000 | 5020 | - | O/P Mon |

Table 26

TU - Traceability Unscheduled

O/P Mon – Output Monitored using calibrated equipment

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 | ± 33.079 kHz |
| Authorised Band Edges | 30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB |
| Restricted 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 27