

# Partial Report on the Radio Testing of the: Apple Inc. Model: A1993

In accordance with FCC 47 CFR Part 15, Industry  
Canada RSS 247 & Industry Canada RSS-GEN,  
(Simultaneous Transmissions)

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

FCC ID: BCGA1993

IC: 579C-A1993



Product Service

**Choose certainty.  
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## COMMERCIAL-IN-CONFIDENCE

Document Number: 75942779-14 | Issue: 02

### SIGNATURE

| NAME            | JOB TITLE      | RESPONSIBLE FOR      | ISSUE DATE      |
|-----------------|----------------|----------------------|-----------------|
| Matthew Russell | RF Team Leader | Authorised Signatory | 08 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 15, 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      |
|---------------|---------------|-----------------|-----------------|
| Graeme Lawler | Test Engineer | Testing         | 08 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 and Industry Canada RSS-247: Issue 2 (2017-02) and Industry Canada RSS-GEN: Issue 05 (2017-02) for the tests detailed in section 1.3.



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## 1 Report Summary

### 1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

| Issue | Description of Change                 | Date of Issue     |
|-------|---------------------------------------|-------------------|
| 1     | First Issue                           | 26 September 2018 |
| 2     | Second Issue - FCCID and ICID updated | 08 October 2018   |

**Table 1**

### 1.2 Introduction

|                               |                                                                                                                         |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Applicant                     | Apple Inc.                                                                                                              |
| Manufacturer                  | Apple Inc.                                                                                                              |
| Model Number(s)               | A1993                                                                                                                   |
| Serial Number(s)              | C07WT00HK2V0                                                                                                            |
| Hardware Version(s)           | EVT                                                                                                                     |
| Software Version(s)           | 18B2034                                                                                                                 |
| Number of Samples Tested      | 1                                                                                                                       |
| Test Specification/Issue/Date | FCC 47 CFR Part 15: (2017)<br>Industry Canada RSS-247: Issue 2 (2017-02)<br>Industry Canada RSS-GEN: Issue 05 (2017-02) |
| Order Number                  | 0540058293                                                                                                              |
| Date                          | 18-May-2018                                                                                                             |
| Date of Receipt of EUT        | 20-June-2018                                                                                                            |
| Start of Test                 | 20-August-2018                                                                                                          |
| Finish of Test                | 20-August-2018                                                                                                          |
| Name of Engineer(s)           | Graeme Lawler                                                                                                           |
| Related Document(s)           | ANSI C63.10 (2013)                                                                                                      |



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### 1.3 Brief Summary of Results

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

| Section                                                                          | Specification Clause            |             |              | Test Description                                        | Result | Comments/Base Standard |
|----------------------------------------------------------------------------------|---------------------------------|-------------|--------------|---------------------------------------------------------|--------|------------------------|
|                                                                                  | FCC Part 15                     | RSS-247     | RSS-GEN      |                                                         |        |                        |
| Configuration and Mode: CoTX - 2.4 GHz WLAN Main, 5 GHz WLAN Aux & Bluetooth BDR |                                 |             |              |                                                         |        |                        |
| 2.1                                                                              | 15.247 (d),<br>15.407 (b)       | 5.5, 6.2    | 8.9, 8.10    | Radiated Spurious Emissions (Simultaneous Transmission) | Pass   | ANSI C63.10            |
| Configuration and Mode: CoTX – 5 GHz WLAN Main, 2.4 GHz WLAN Aux & Bluetooth BDR |                                 |             |              |                                                         |        |                        |
| 2.1                                                                              | 15.247 (d)<br>and<br>15.407 (b) | 5.5 and 6.2 | 8.9 and 8.10 | Radiated Spurious Emissions (Simultaneous Transmission) | 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           |

**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: CoTX - 2.4 GHz WLAN Main, 5 GHz WLAN Aux & Bluetooth BDR |                     |               |
| Radiated Spurious Emissions<br>(Simultaneous Transmission)                       | Graeme Lawler       | UKAS          |
| Configuration and Mode: CoTX – 5 GHz WLAN Main, 2.4 GHz WLAN Aux & Bluetooth BDR |                     |               |
| Radiated Spurious Emissions<br>(Simultaneous Transmission)                       | Graeme Lawler       | UKAS          |

**Table 4**

Office Address:

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



## 2 Test Details

### 2.1 Radiated Spurious Emissions (Simultaneous Transmission)

#### 2.1.1 Specification Reference

FCC 47 CFR Parts 15, Clause 15.247 (d) and 15.407 (b)  
Industry Canada RSS 247, Clause 5.5 and 6.2  
Industry Canada RSS GEN, Clause 8.9 and 8.10

#### 2.1.2 Equipment Under Test and Modification State

A1993, S/N: C07WT00HK2V0 - Modification State 0

#### 2.1.3 Date of Test

20-August-2018

#### 2.1.4 Test Method

The test was performed in accordance with ANSI C63.10, clauses 6.3, 6.5 and 6.6.

For frequencies > 1 GHz, plots for average measurements were taken in accordance with ANSI C63.10 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 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, (74/54 dBuV/m) when compared to the relevant limits 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.

For frequencies > 18 GHz, the measurement distance was reduced to 1 meter and the limit line was increased by  $20 \cdot \log(3/1) = 9.54$  dB.

#### 2.1.5 Environmental Conditions

Ambient Temperature 20.4 - 20.8 °C  
Relative Humidity 60.8 - 61.0 %

#### 2.1.6 Test Results

CoTX - 2.4 GHz WLAN Main, 5 GHz WLAN Aux & Bluetooth BDR

The EUT was configured for simultaneous transmission in the following mode of operation:

| Technology                      | Frequency Band (MHz)   | Channel Frequency (MHz) |
|---------------------------------|------------------------|-------------------------|
| Main: 802.11b                   | 2400 MHz to 2483.5 MHz | 2441                    |
| Aux: 802.11n - 20 MHz Bandwidth | U-NII 2c               | 5500                    |
| Bluetooth (BDR)                 | 2400 MHz to 2483.5 MHz | 2402                    |

**Table 5 - Modes of Operation**



| Frequency (MHz) | QP Level (dBuV/m) | QP Limit (dBuV/m) | QP Margin (dBuV/m) | Angle(Deg) | Height(m) | Polarity |
|-----------------|-------------------|-------------------|--------------------|------------|-----------|----------|
| *               |                   |                   |                    |            |           |          |

Table 6 - 30 MHz to 1 GHz Emissions Results

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

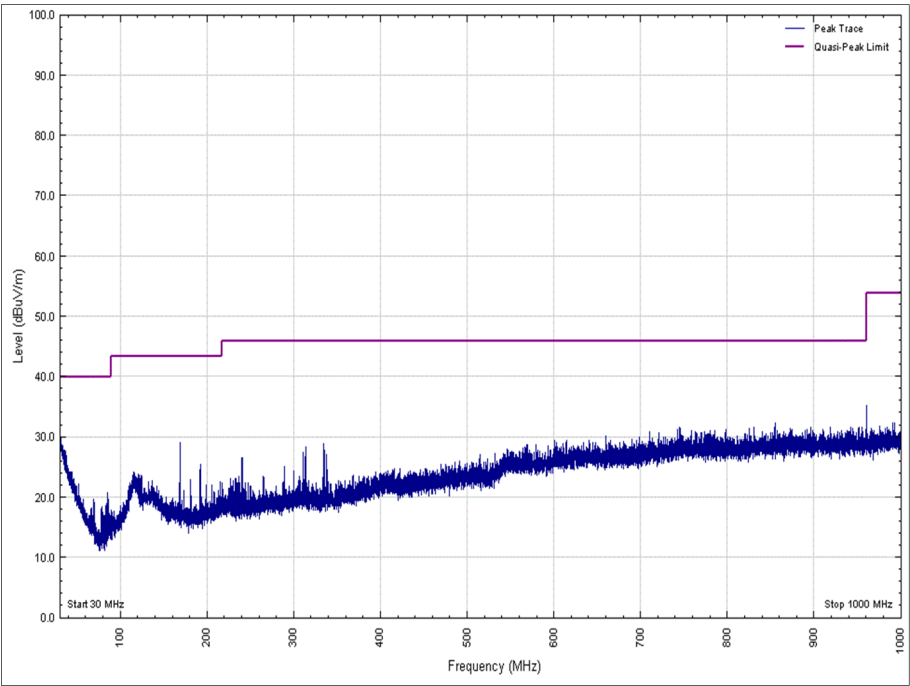


Figure 1 - 30 MHz to 1 GHz - Horizontal

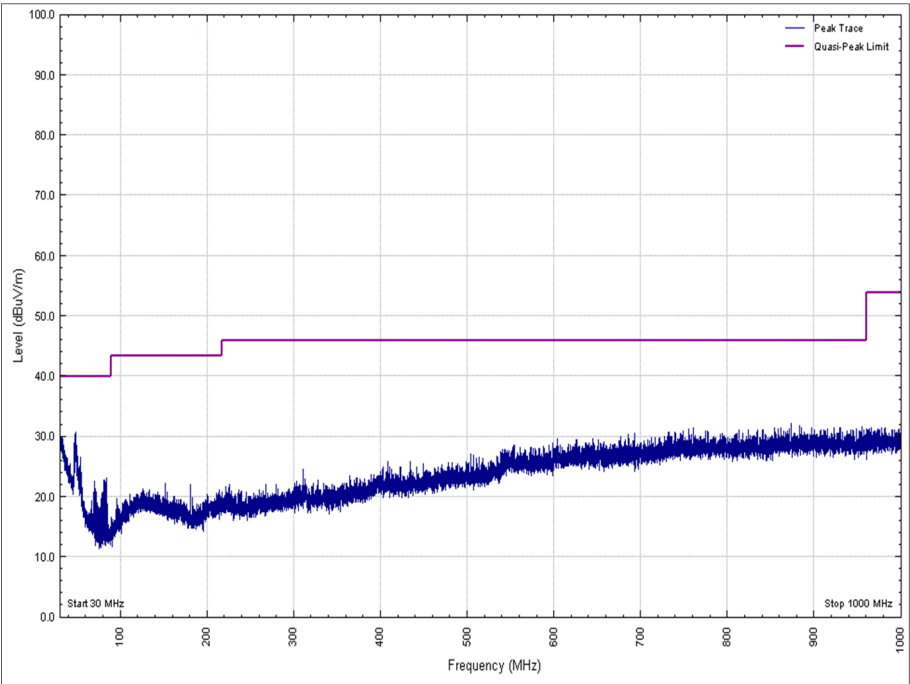


Figure 2 - 30 MHz to 1 GHz - Vertical



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

Table 7 - 1 GHz to 40 GHz Emissions Results

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

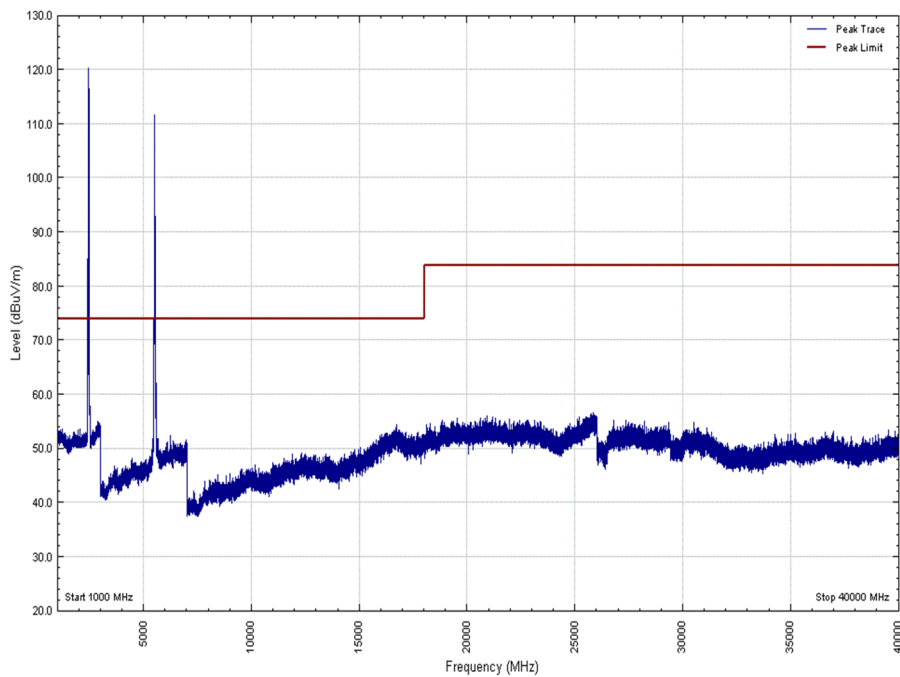


Figure 3 - 1 GHz to 40 GHz – Horizontal (Peak)

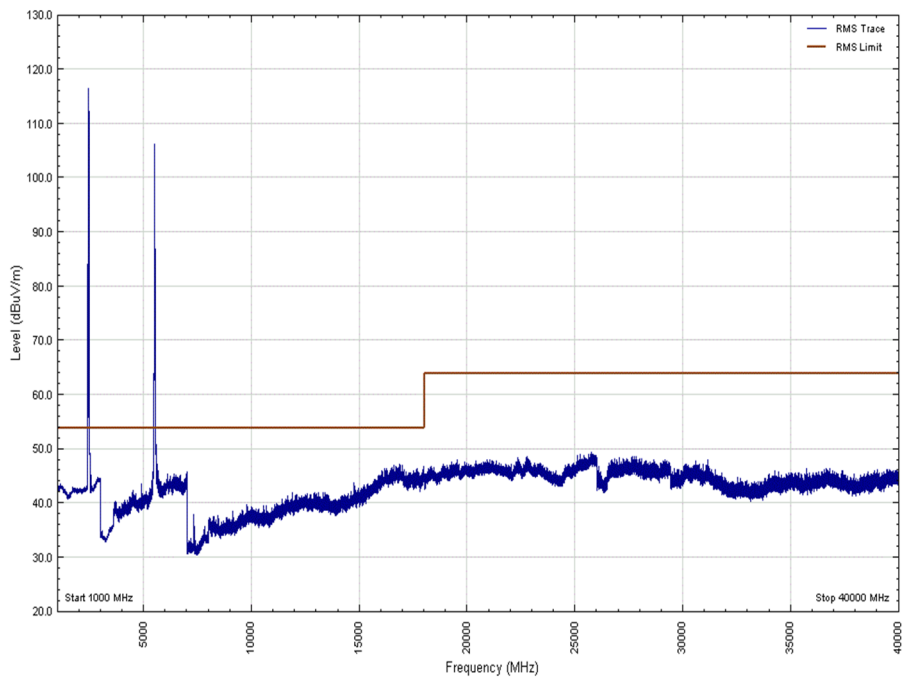


Figure 4 - 1 GHz to 40 GHz – Horizontal (Average)

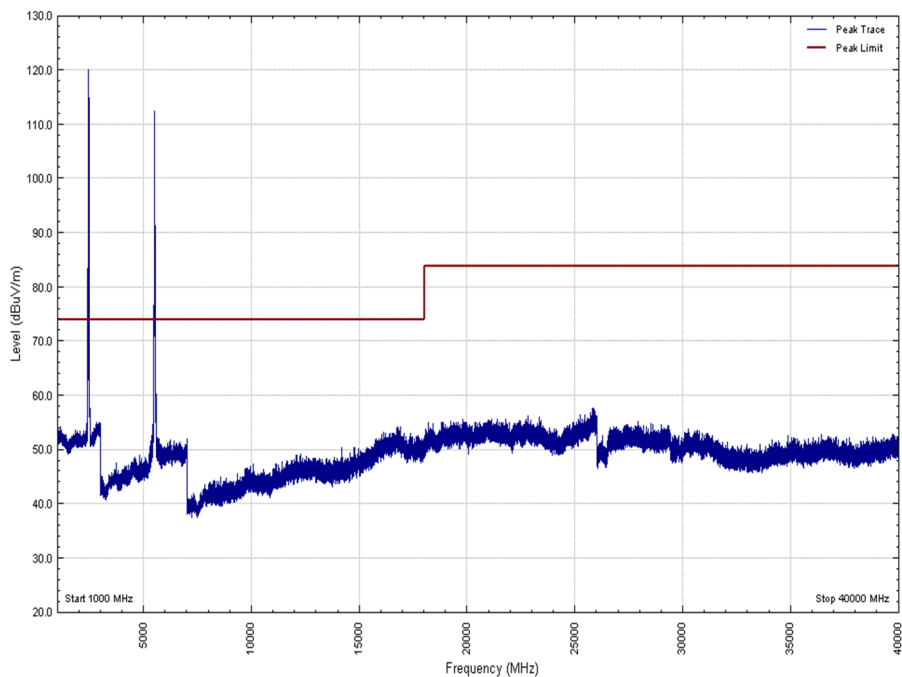


Figure 5 - 1 GHz to 40 GHz – Vertical (Peak)

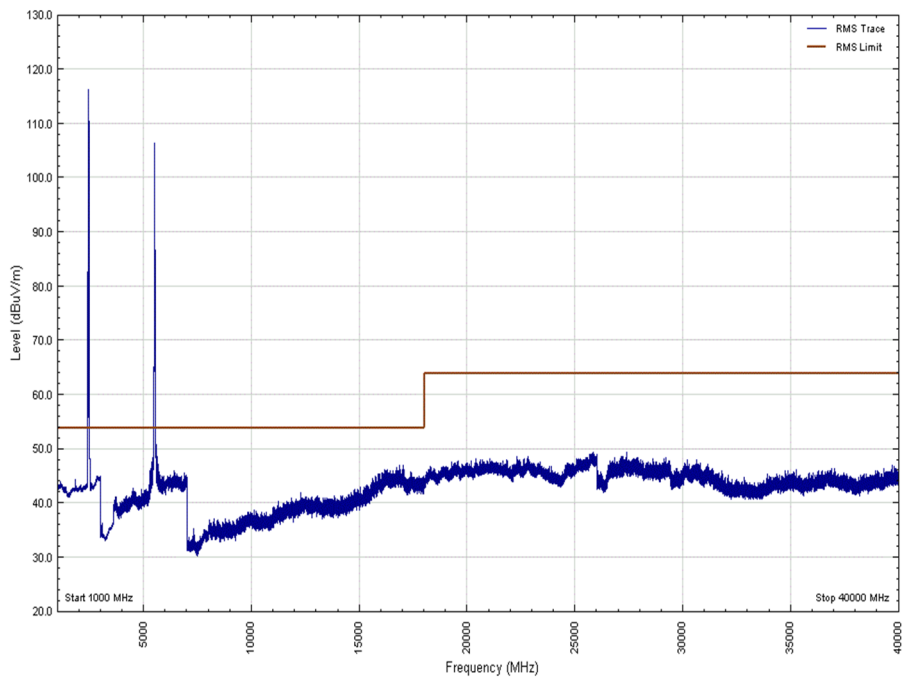


Figure 6 - 1 GHz to 40 GHz – Vertical (Average)

FCC 47 CFR Parts Limit Clause15.247(d), 15.407(b), 15.205, Industry Canada RSS 247 Limit Clause 5.5, 6.2 and Industry Canada RSS-GEN Limit Clause 8.10

The least stringent limit from the applicable rule parts was used to determine compliance for Radiated Emissions testing of multiple transmission sources.

| Rule Part                                 | Limit                                          |
|-------------------------------------------|------------------------------------------------|
| Part 15.247 (d) / RSS 247, clause 5.5     | -20 dBc                                        |
| Part 15.407 (b) / RSS 247, clause 6.2.3.2 | -27 dBm (EIRP) / 68 dBμV/m at 3m.              |
| Part 15.205 / RSS GEN clause 8.10         | Peak: 74 dBμV/m at 3m, Average 54 dBμV/m at 3m |

Table 8 - Limit Table

CoTX – 5 GHz WLAN Main, 2.4 GHz WLAN Aux & Bluetooth BDR

The EUT was configured for simultaneous transmission in the following mode of operation:

| Technology                       | Frequency Band (MHz)   | Channel Frequency (MHz) |
|----------------------------------|------------------------|-------------------------|
| Main: 802.11n - 20 MHz Bandwidth | U-NII 2c               | 5500                    |
| Aux: 802.11b                     | 2400 MHz to 2483.5 MHz | 2441                    |
| Bluetooth                        | 2400 MHz to 2483.5 MHz | 2480                    |

Table 9 - Modes of Operation

| Frequency (MHz) | QP Level (dBuV/m) | QP Limit (dBuV/m) | QP Margin (dBuV/m) | Angle(Deg) | Height(m) | Polarity |
|-----------------|-------------------|-------------------|--------------------|------------|-----------|----------|
| *               |                   |                   |                    |            |           |          |

Table 10 - 30 MHz to 1 GHz Emissions Results

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

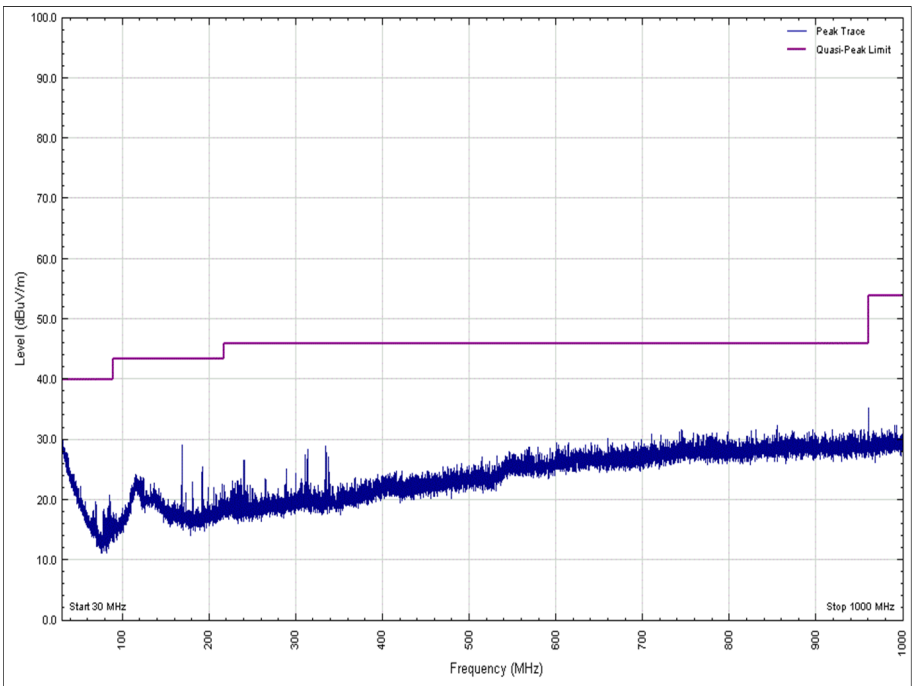


Figure 7 - 30 MHz to 1 GHz - Horizontal

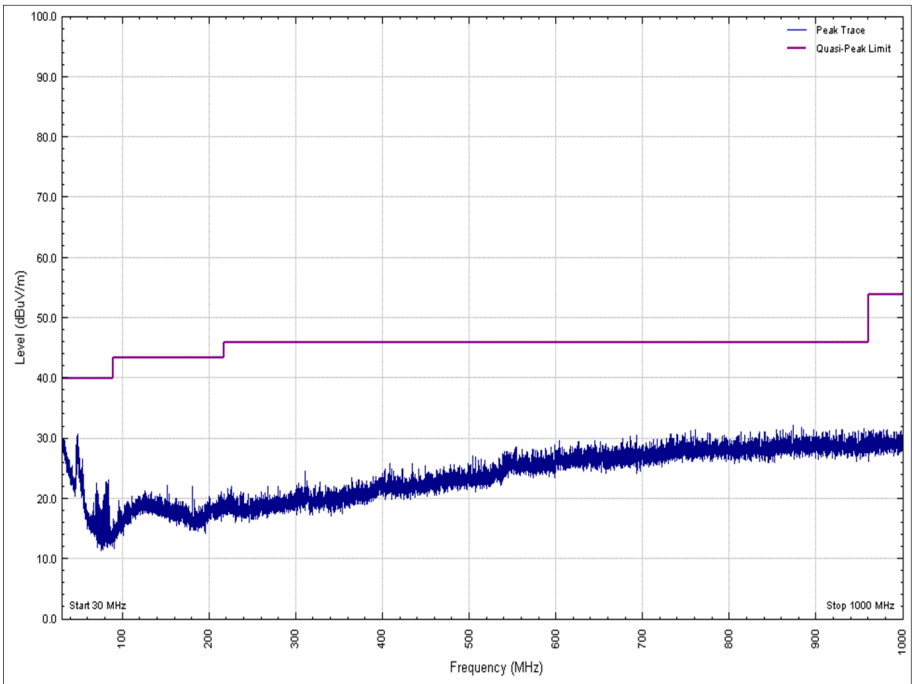


Figure 8 - 30 MHz to 1 GHz - Vertical



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

Table 11 - 1 GHz to 40 GHz Emissions Results

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

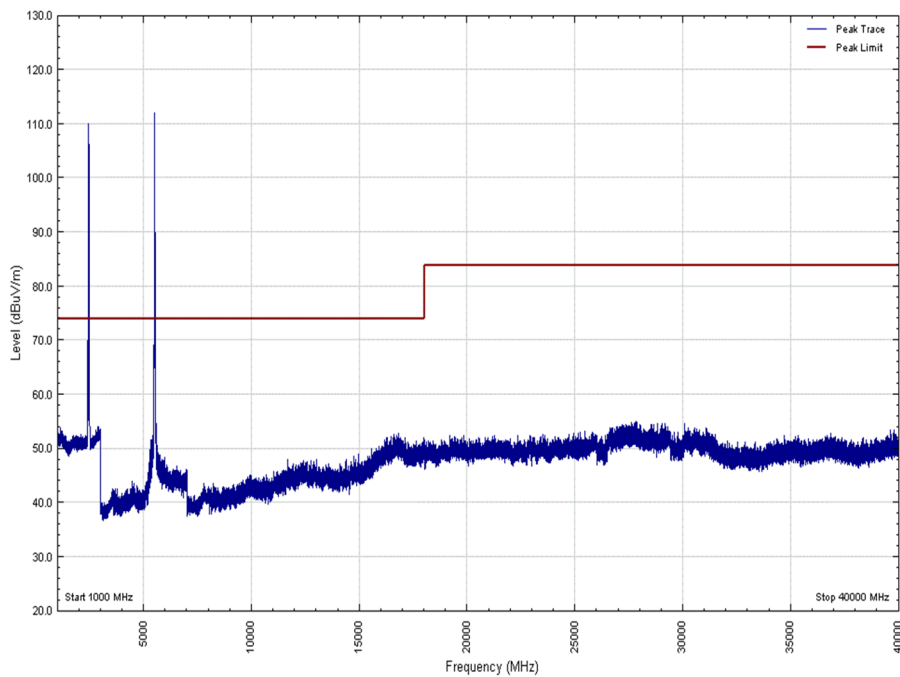


Figure 9 - 1 GHz to 40 GHz – Horizontal (Peak)

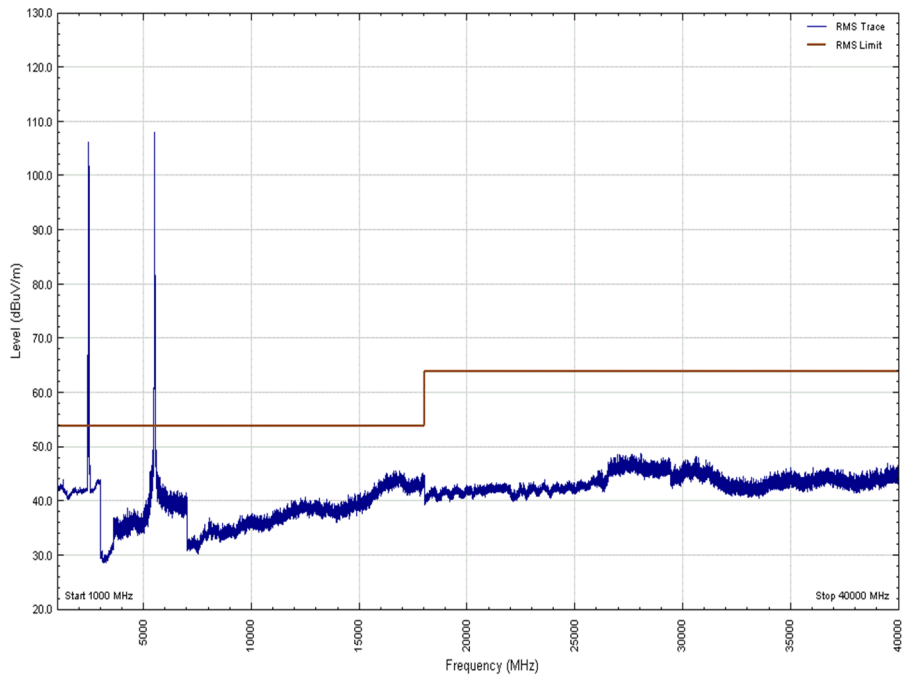


Figure 10 - 1 GHz to 40 GHz – Horizontal (Average)

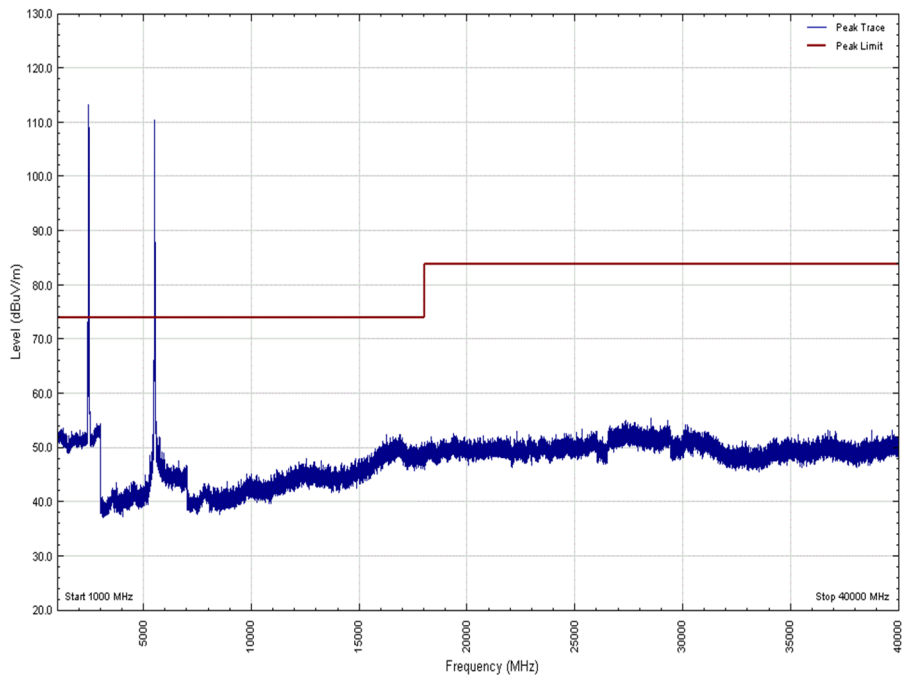


Figure 11 - 1 GHz to 40 GHz – Vertical (Peak)

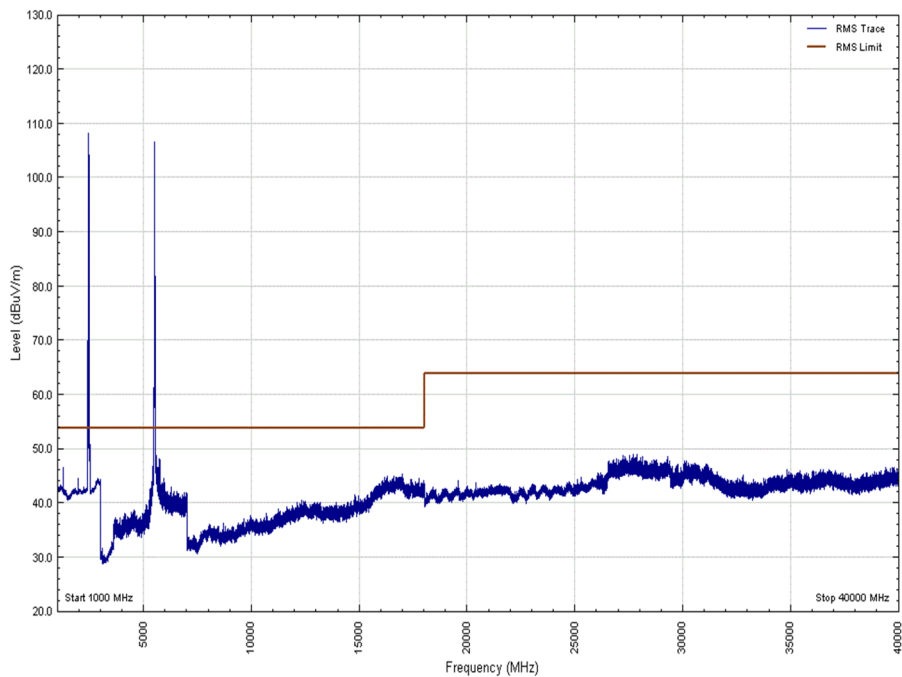


Figure 12 - 1 GHz to 40 GHz – Vertical (Average)

FCC 47 CFR Parts Limit Clause15.247(d), 15.407(b), 15.205, Industry Canada RSS 247 Limit Clause 5.5, 6.2 and Industry Canada RSS-GEN Limit Clause 8.10

The least stringent limit from the applicable rule parts was used to determine compliance for Radiated Emissions testing of multiple transmission sources.

| Rule Part                                 | Limit                                          |
|-------------------------------------------|------------------------------------------------|
| Part 15.247 (d) / RSS 247, clause 5.5     | -20 dBc                                        |
| Part 15.407 (b) / RSS 247, clause 6.2.3.2 | -27 dBm (EIRP) / 68 dBμV/m at 3m.              |
| Part 15.205 / RSS GEN clause 8.10         | Peak: 74 dBμV/m at 3m, Average 54 dBμV/m at 3m |

Table 12 - Limit Table



## 2.1.7 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     |
| 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     |
| 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     |
| 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 13**

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                                        |
|-----------------------------|----------------------------------------------------------------|
| Spurious Radiated Emissions | 30 MHz to 1 GHz: $\pm 5.2$ dB<br>1 GHz to 40 GHz: $\pm 6.3$ dB |

Table 14