Partial Report on the Radio Testing of the: Apple Inc. Model: A2159 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: BCGA2159 IC: 579C-A2159

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Document Number: 75945152-15 | Issue: 01

SIGNATURE			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Matthew Russell	RF Team Leader	Authorised Signatory	07 May 2019

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 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**
Malik Mohammed	Shift Technician	Testing	07 May 2019
George Porter	Assistant Engineer	Testing	07 May 2019
Cristian Onaca	Shift Technician	Testing	07 May 2019
Jay Balendrarajah	Shift Technician	Testing	07 May 2019

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 (2018-04) for the tests detailed in section 1.3.

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Contents

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	March 2019

Table 1

1.2 Introduction

Applicant	Apple Inc.
Manufacturer	Apple Inc.
Model Number(s)	A2159
Serial Number(s)	C02Y4006L59F
Hardware Version(s)	REV 1.0
Software Version(s)	18F65
Number of Samples Tested	1
Test Specification/Issue/Date	FCC 47 CFR Part 15: (2017) Industry Canada RSS-247: Issue 2 (2017-02) Industry Canada RSS-GEN: Issue 05 (2018-04)
Order Number	0540175066
Date	21-February-2019
First Date of Receipt of EUT	06-February-2019
Start of Test	06-February-2019
Finish of Test	12-March-2019
Name of Engineer(s)	Malik Mohammed, George Porter, Cristian Onaca, Jay Balendrarajah
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 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 – 5 GHz WLAN & Bluetooth BDR						
2.1	15.247 (d), 15.407 (b) & 15.209	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 Laptop computer, with Bluetooth, Bluetooth Low Energy and 802.11 a/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: C02Y4006L59F			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 3

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: CoTX – 5 GHz WLAN & Bluetooth BDR		
Radiated Spurious Emissions (Simultaneous Transmission)	Malik Mohammed, George Porter, Cristian Onaca, Jay Balendrarajah	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), 15.407 (b) & 15.209
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

A2159, S/N: C02Y4006L59F - Modification State 0

2.1.3 Date of Test

06-February-2019 to 12-March 2019

2.1.4 Test Method

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

Plots for average measurements were taken in accordance with ANSI C63.10 using an average detector and max hold trace 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*LOG (3/1) = 9.54 dB.

2.1.5 Environmental Conditions

Ambient Temperature	21.7 - 29.4 °C
Relative Humidity	22.5 – 45.0 %

2.1.6 Test Results

CoTX – 5 GHz WLAN & Bluetooth BDR

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

Technology	Frequency Band (MHz)	Channel Number:
802.11n HT20 CDD	5470 MHz to 5725MHz	36, 64, 100, 140, 165
Bluetooth DH5	2400 MHz to 2483.5 MHz	39

Table 5 - Modes of Operation

Note: Emissions measurements on WLAN Channels 36 and 165, when tested in combination with Bluetooth Channel 39, were performed from 30MHz to 40GHz. Tests on all other channels (64, 100, 140) were limited to 1GHz to 40GHz

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

Table 6 - 30 MHz to 1 GHz Emissions Results

*No emissions were detected within 10 dB of the applicable test limit, those emissions that are shown on the plots fall into unrestricted bands.

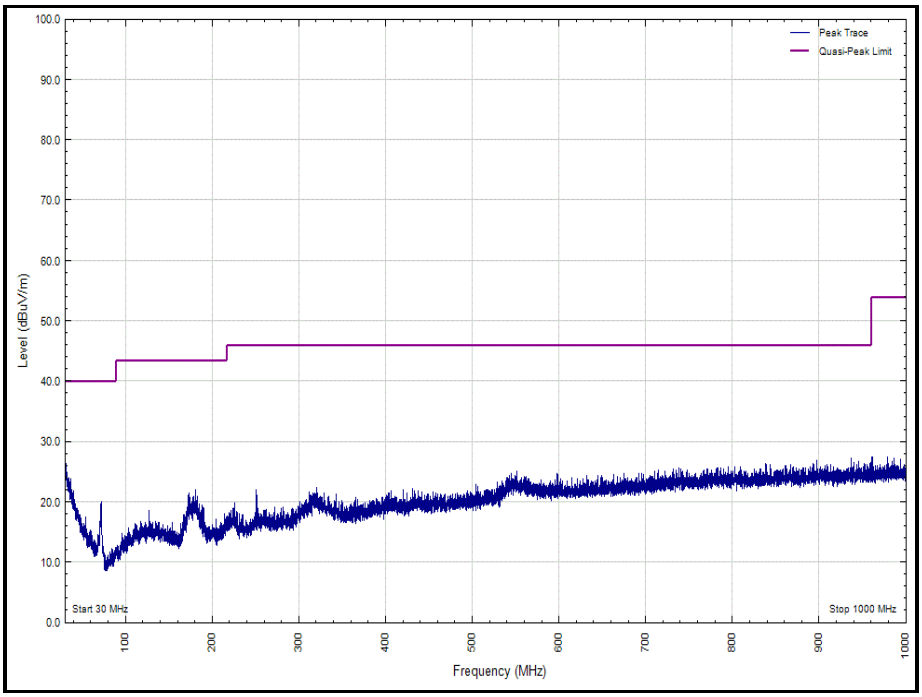

Figure 1 - 30 MHz to 1 GHz – Horizontal (UNII-1 Channel 36, Bluetooth DH5 Channel 39)

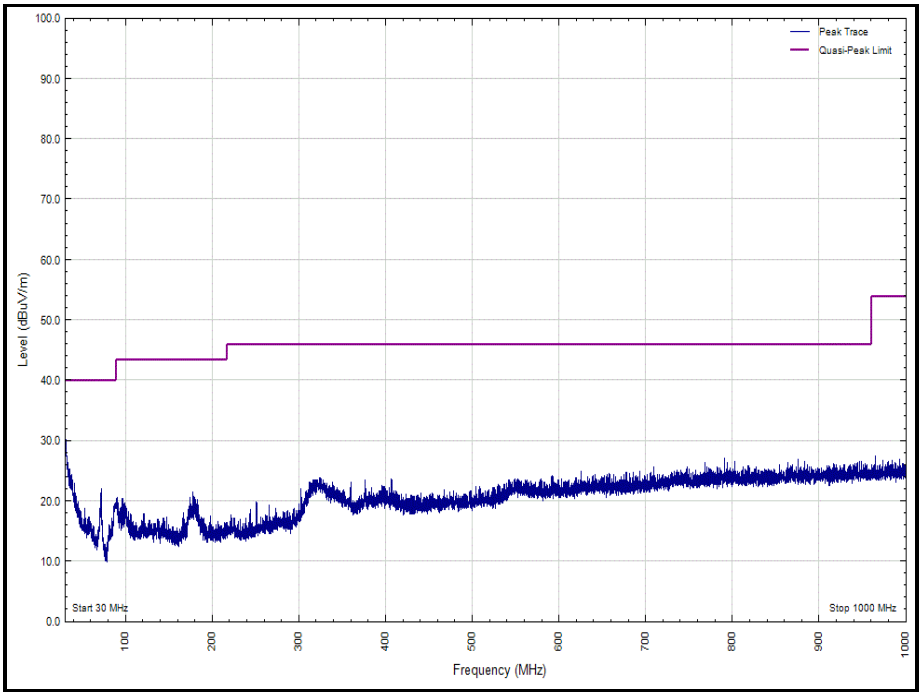

Figure 2 - 30 MHz to 1 GHz – Vertical (UNII-1 Channel 36, Bluetooth DH5 Channel 39)

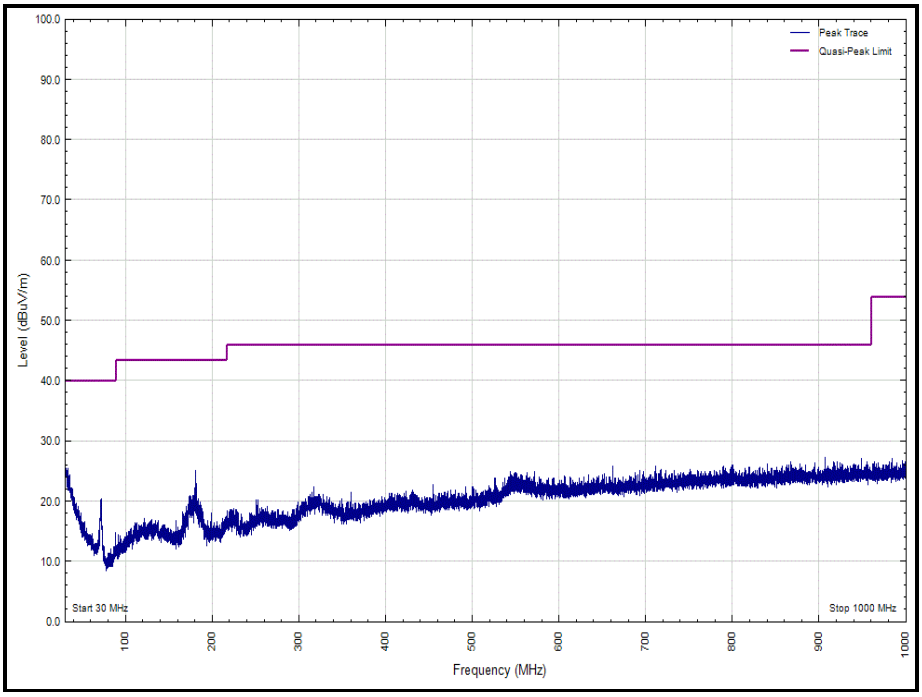

Figure 3 - 30 MHz to 1 GHz – Horizontal (UNII-3 Channel 165, Bluetooth DH5 Channel 39)

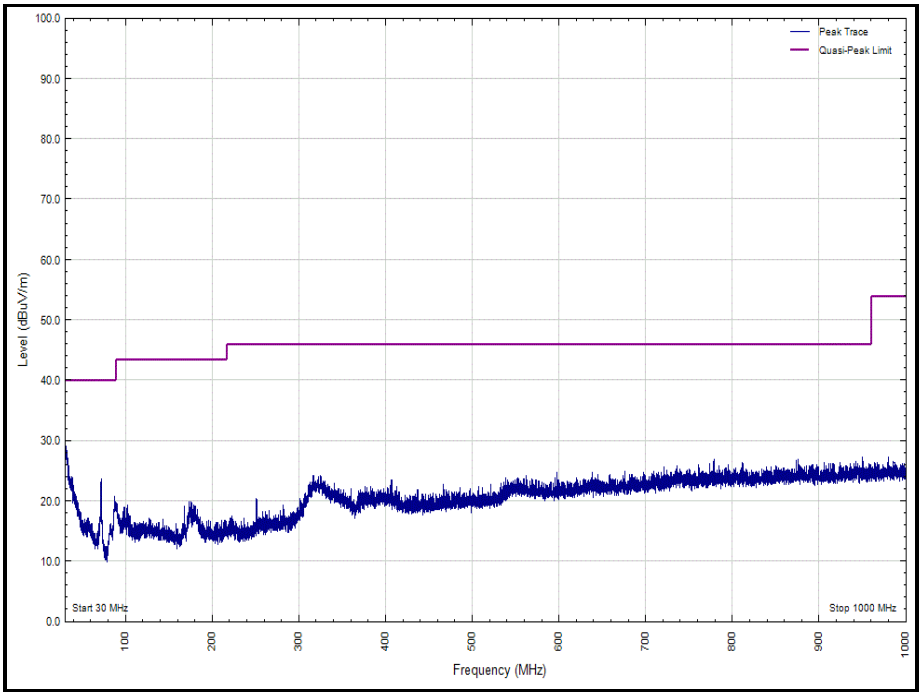

Figure 4 - 30 MHz to 1 GHz – Vertical (UNII-3 Channel 165, Bluetooth DH5 Channel 39)

Frequency (MHz)	Result (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
	Peak	Average	Peak	Average	Peak	Average
2141.339	*	38.3	74.0	54.0	n/a	-15.70
2146.298	*	36.16	74.0	54.0	n/a	-17.84
7323.412	*	41.34	74.0	54.0	n/a	-12.66

Table 7 - 1 GHz to 40 GHz Emissions Results UNII-1 Channel 36, Bluetooth DH5 Channel 39

Notes:

1. *No Emissions were detected within 10 dB of the applicable Limit
1. The Fundamental Emission of the WLAN is 5180 MHz
2. The Fundamental Emission of the Bluetooth is 2441 MHz

Frequency (MHz)	Result (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
	Peak	Average	Peak	Average	Peak	Average
2007.722	*	35.42	74.0	54.0	n/a	-18.58
2877.426	*	37.44	74.0	54.0	n/a	-16.56
4882.000	*	40.7	74.0	54.0	n/a	-13.30
7322.861	*	42.3	74.0	54.0	n/a	-11.70
10641.242	56.28	46.11	74.0	54.0	-17.72	-7.89

Table 8 - 1 GHz to 40 GHz Emissions Results UNII-2a Channel 64, Bluetooth DH5 Channel 39

Notes:

1. *No Emissions were detected within 10 dB of the applicable Limit
2. The Fundamental Emission of the WLAN is 5320 MHz
3. The Fundamental Emission of the Bluetooth is 2441 MHz

Frequency (MHz)	Result (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
	Peak	Average	Peak	Average	Peak	Average
4882.157	*	41.29	74.0	54.0	n/a	-12.71
7323.263	*	43.85	74.0	54.0	n/a	-10.15
11000.806	*	40.91	74.0	54.0	n/a	-13.09

Table 9 - 1 GHz to 40 GHz Emissions Results UNII-2c Channel 100, Bluetooth DH5 Channel 39

Notes:

1. *No Emissions were detected within 10dB of the applicable Limit
2. The Fundamental Emission of the WLAN is 5500MHz
3. The Fundamental Emission of the Bluetooth is 2441MHz

Frequency (MHz)	Result (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
	Peak	Average	Peak	Average	Peak	Average
4881.862	*	40.65	74.0	54.0	n/a	-13.35
7323.134	*	48.24	74.0	54.0	n/a	-5.76
11397.481	*	38.09	74.0	54.0	n/a	-15.91

Table 10 - 1 GHz to 40 GHz Emissions Results UNII-2c Channel 140, Bluetooth DH5 Channel 39

Notes:

1. *No Emissions were detected within 10dB of the applicable Limit
2. The Fundamental Emission of the WLAN is 5700MHz
3. The Fundamental Emission of the Bluetooth is 2441MHz

Frequency (MHz)	Result (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
	Peak	Average	Peak	Average	Peak	Average
4881.998	*	40.92	74.0	54.0	n/a	-13.08
7323.027	*	44.36	74.0	54.0	n/a	-9.64

Table 11 - 1 GHz to 40 GHz Emissions Results UNII-3 Channel 165, Bluetooth DH5 Channel 39

Notes:

1. *No Emissions were detected within 10dB of the applicable Limit
2. The Fundamental Emission of the WLAN is 5825MHz
3. The Fundamental Emission of the Bluetooth is 2441MHz

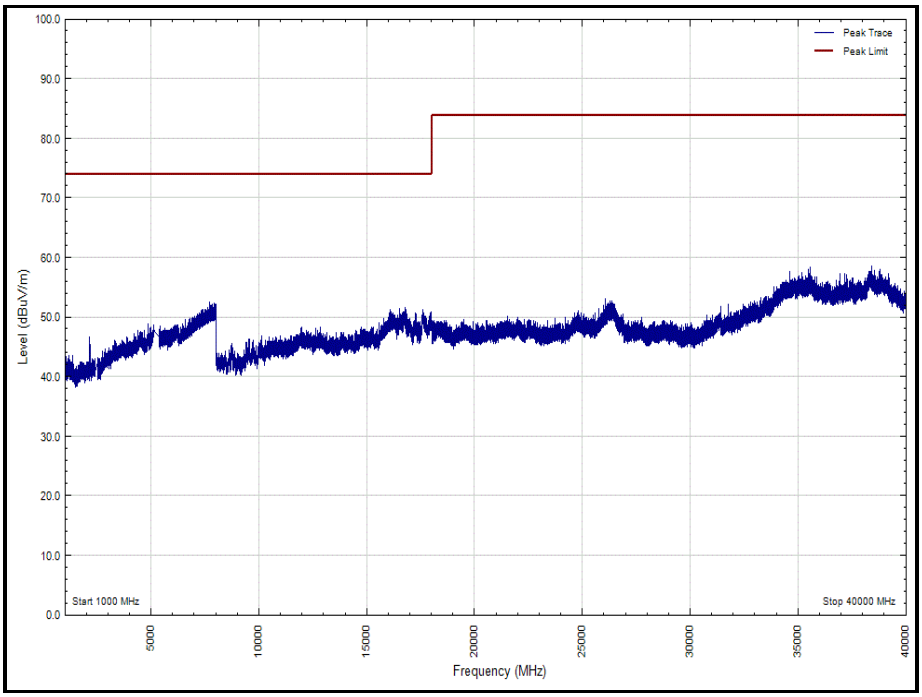

Figure 5 - 1 GHz to 40 GHz – Horizontal Peak (UNII-1 Channel 36, Bluetooth DH5 Channel 39)

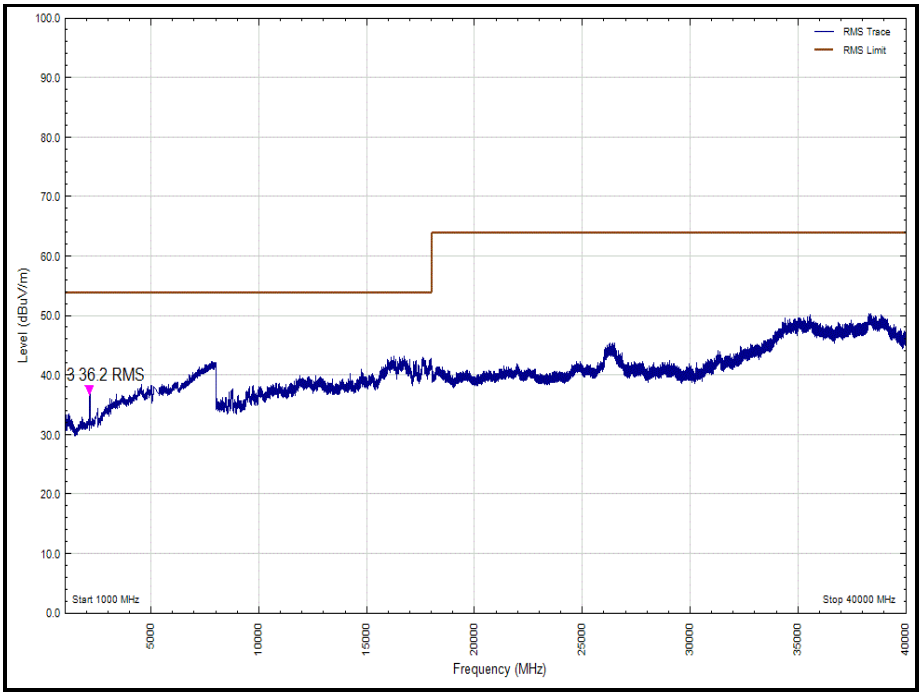

Figure 6 - 1 GHz to 40 GHz – Horizontal Average (UNII-1 Channel 36, Bluetooth DH5 Channel 39)

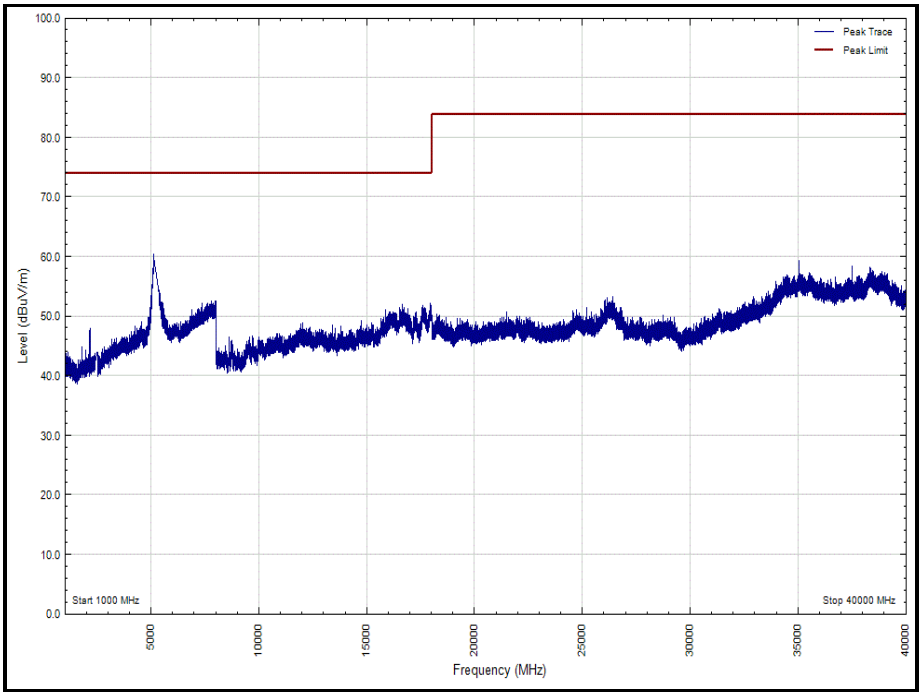

Figure 7 - 1 GHz to 40 GHz – Vertical Peak (UNII-1 Channel 36, Bluetooth DH5 Channel 39)

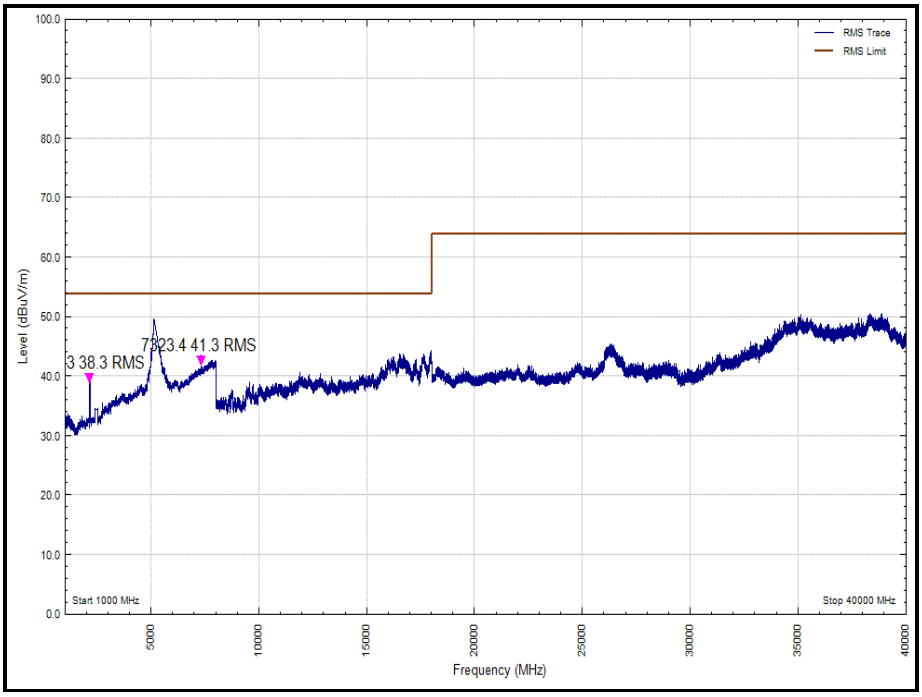

Figure 8 - 1 GHz to 40 GHz – Vertical Average (UNII-1 Channel 36, Bluetooth DH5 Channel 39)

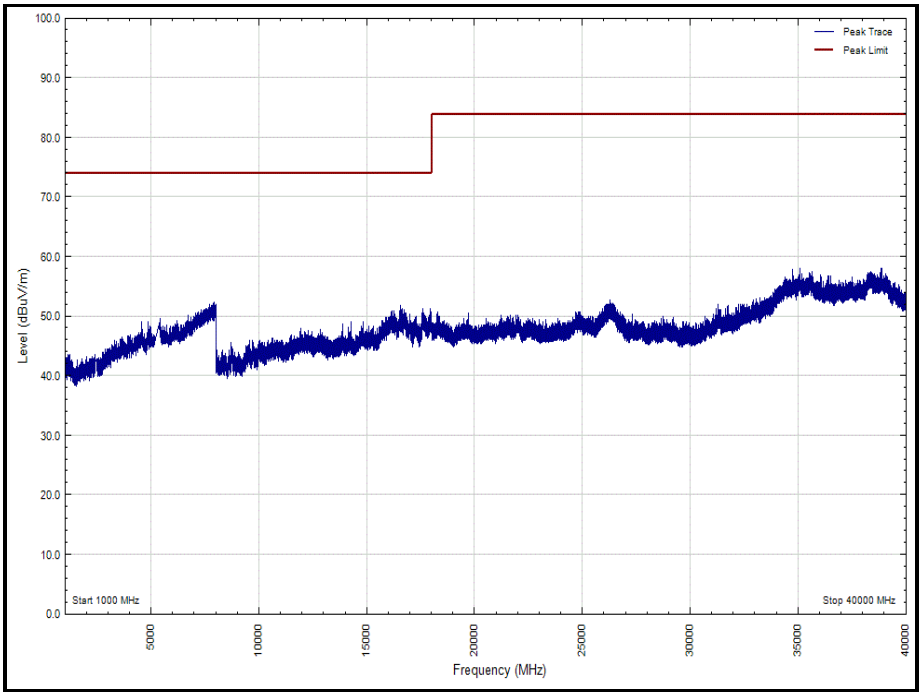

Figure 9 - 1 GHz to 40 GHz – Horizontal Peak (UNII-2a Channel 64, Bluetooth DH5 Channel 39)

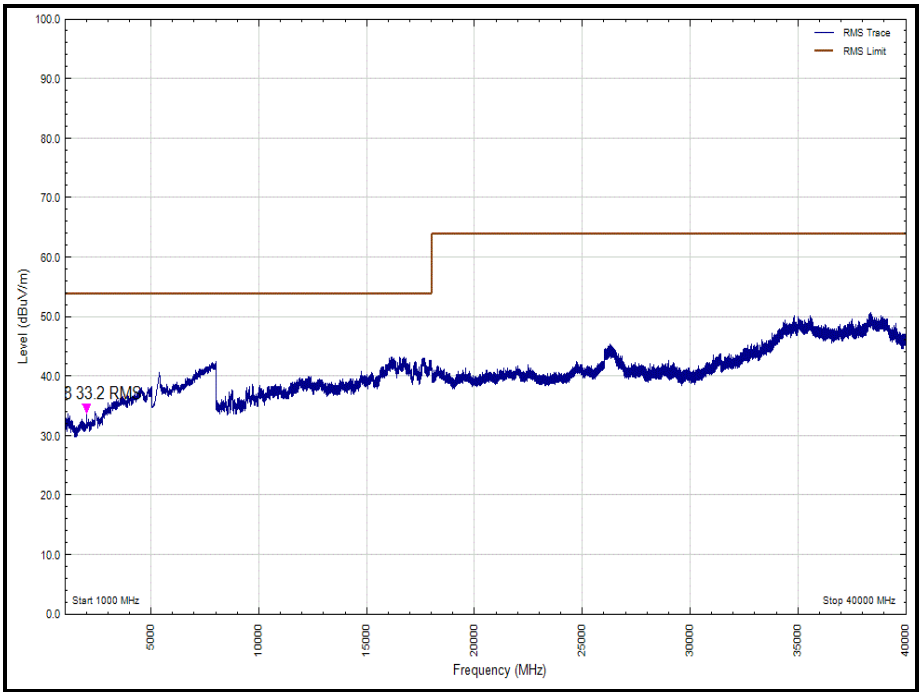

Figure 10 - 1 GHz to 40 GHz – Horizontal Average (UNII-2a Channel 64, Bluetooth DH5 Channel 39)

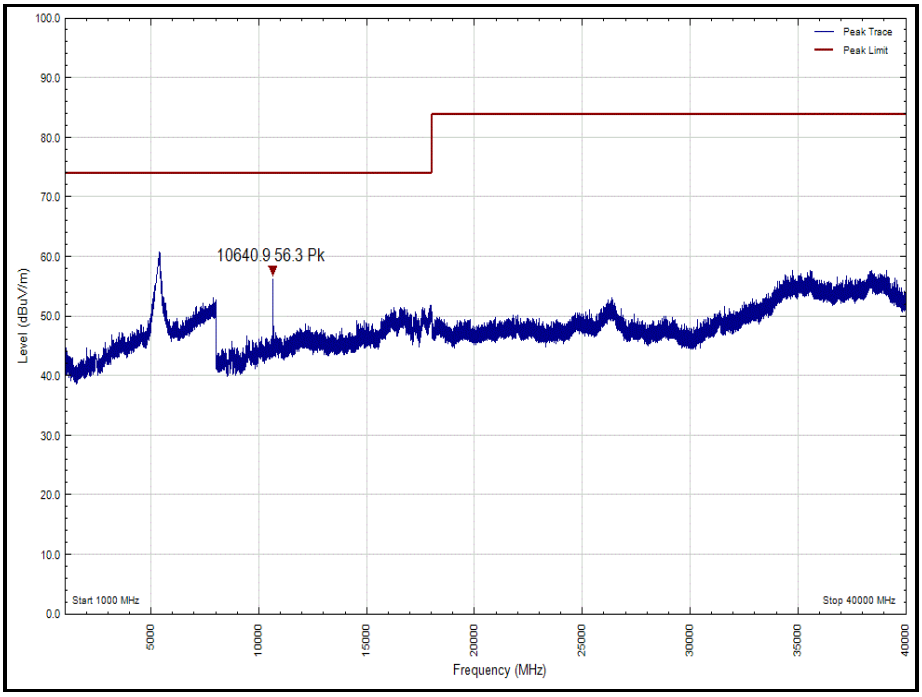

Figure 11 - 1 GHz to 40 GHz – Vertical Peak (UNII-2a Channel 64, Bluetooth DH5 Channel 39)

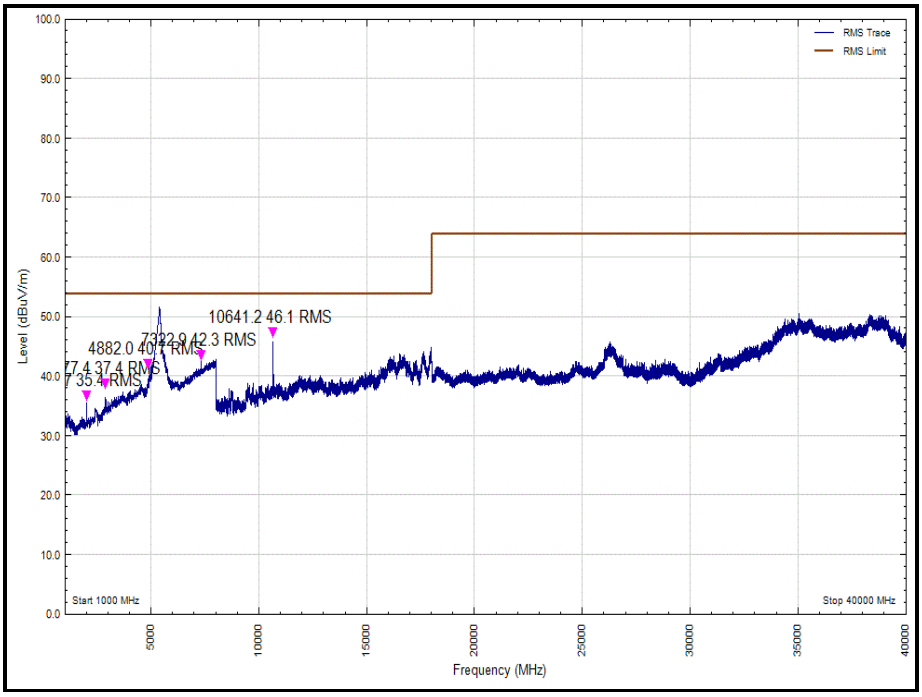

Figure 12 - 1 GHz to 40 GHz – Vertical Average (UNII-2a Channel 64, Bluetooth DH5 Channel 39)

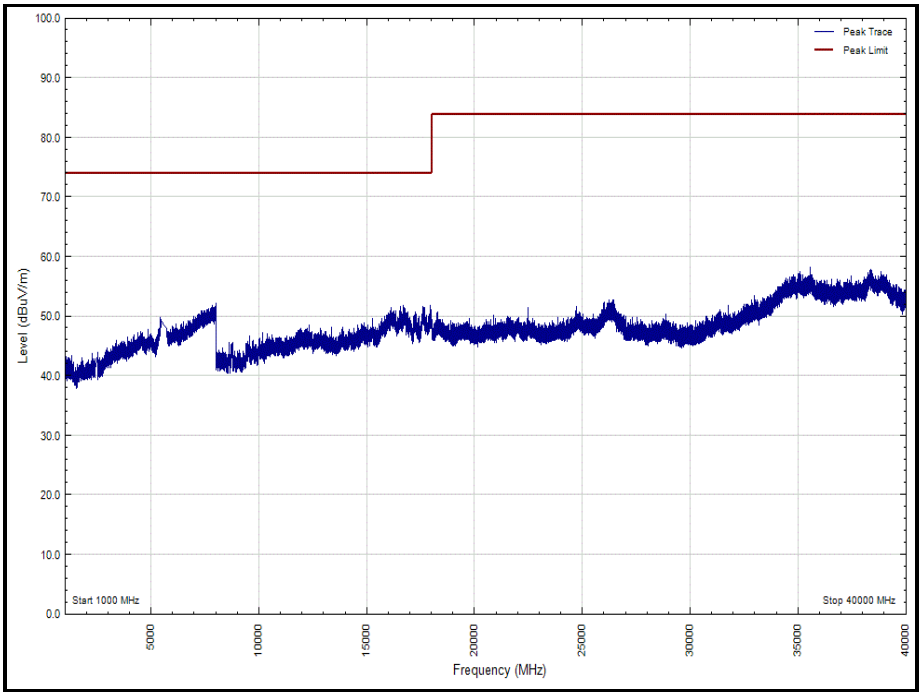

Figure 13 - 1 GHz to 40 GHz – Horizontal Peak (UNII-2c Channel 100, Bluetooth DH5 Channel 39)

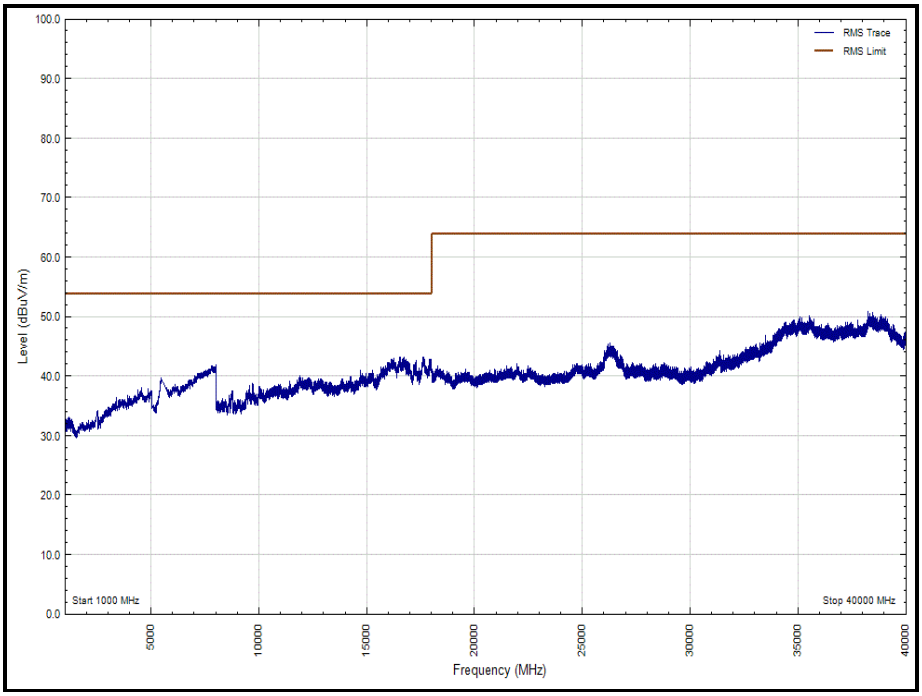

Figure 14 - 1 GHz to 40 GHz – Horizontal Average (UNII-2c Channel 100, Bluetooth DH5 Channel 39)

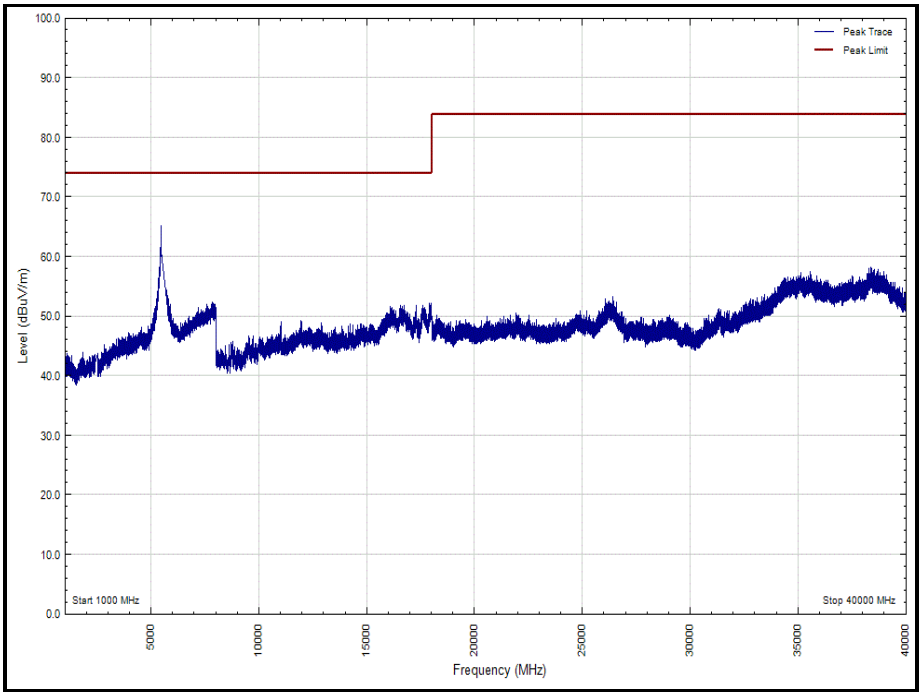

Figure 15 - 1 GHz to 40 GHz – Vertical Peak (UNII-2c Channel 100, Bluetooth DH5 Channel 39)

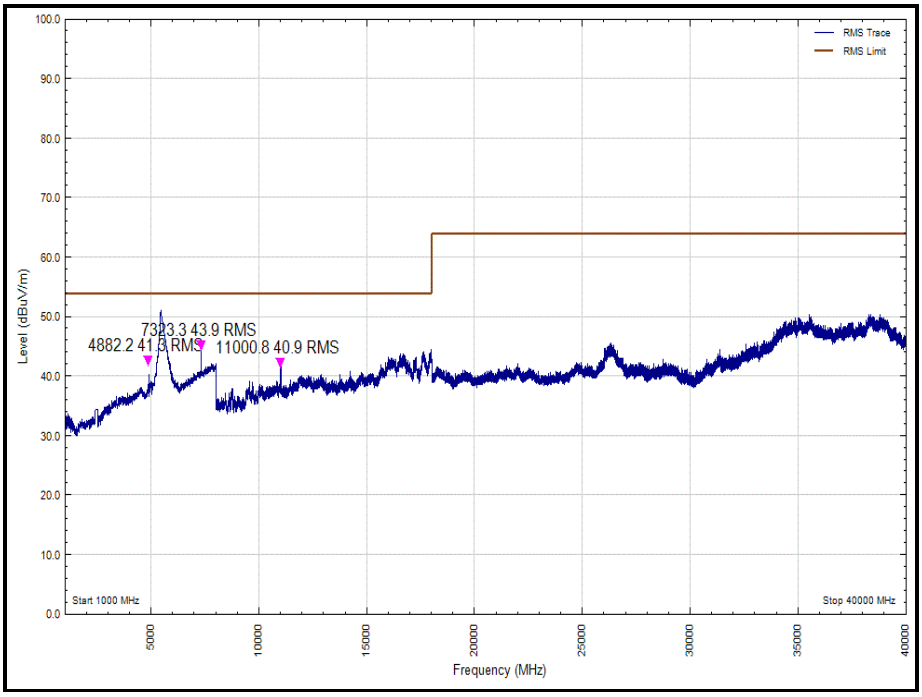

Figure 16 - 1 GHz to 40 GHz – Vertical Average (UNII-2c Channel 100, Bluetooth DH5 Channel 39)

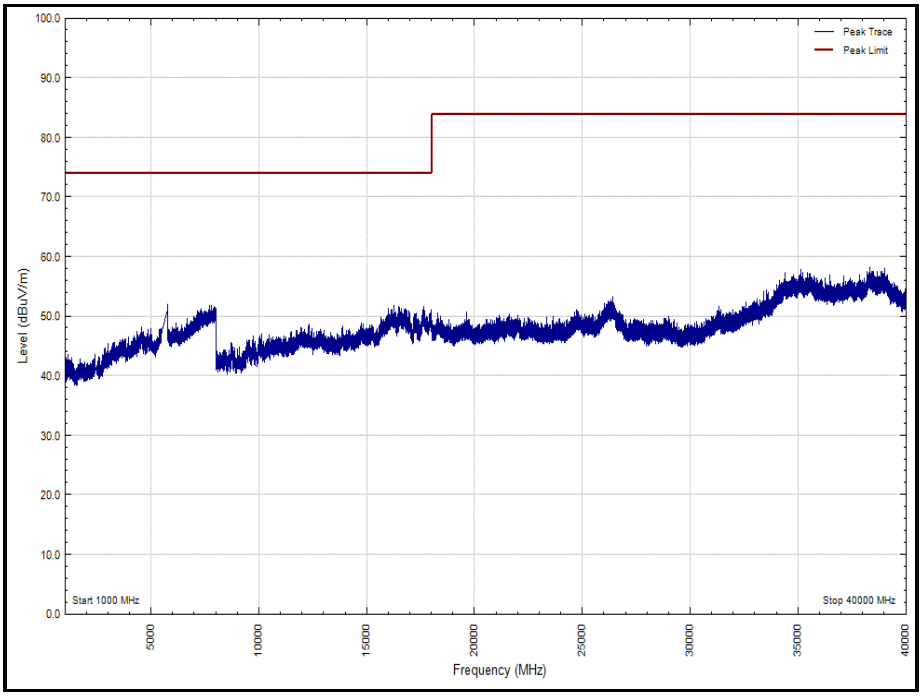

Figure 17 - 1 GHz to 40 GHz – Horizontal Peak (UNII-2c Channel 140, Bluetooth DH5 Channel 39

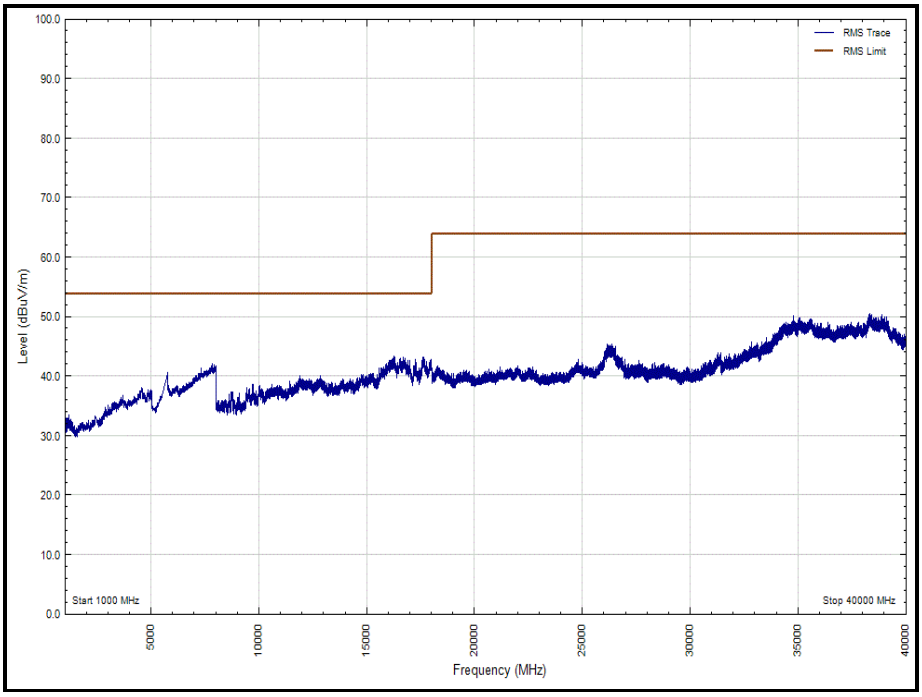

Figure 18 - 1 GHz to 40 GHz – Horizontal Average (UNII-2c Channel 140, Bluetooth DH5 Channel 39)

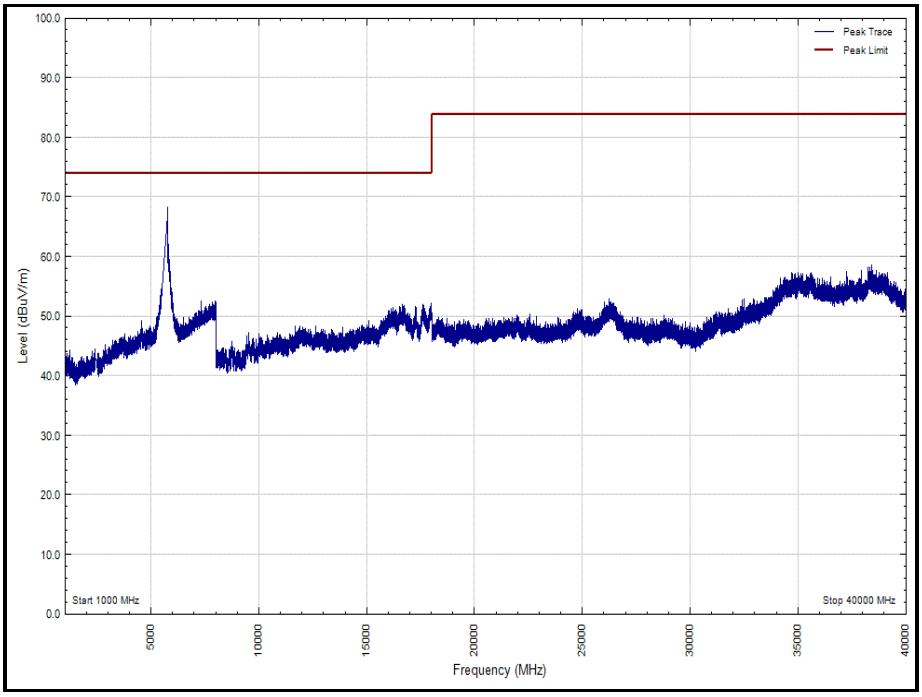

Figure 19 - 1 GHz to 40 GHz – Vertical Peak (UNII-2c Channel 140, Bluetooth DH5 Channel 39)

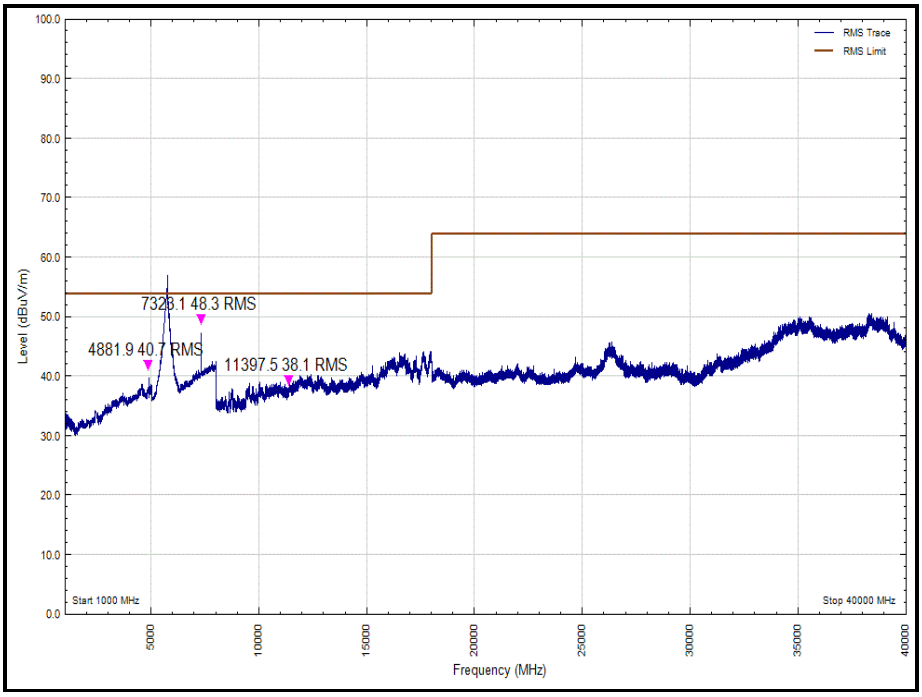

Figure 20 - 1 GHz to 40 GHz – Vertical Average (UNII-3 Channel 140, Bluetooth DH5 Channel 39)

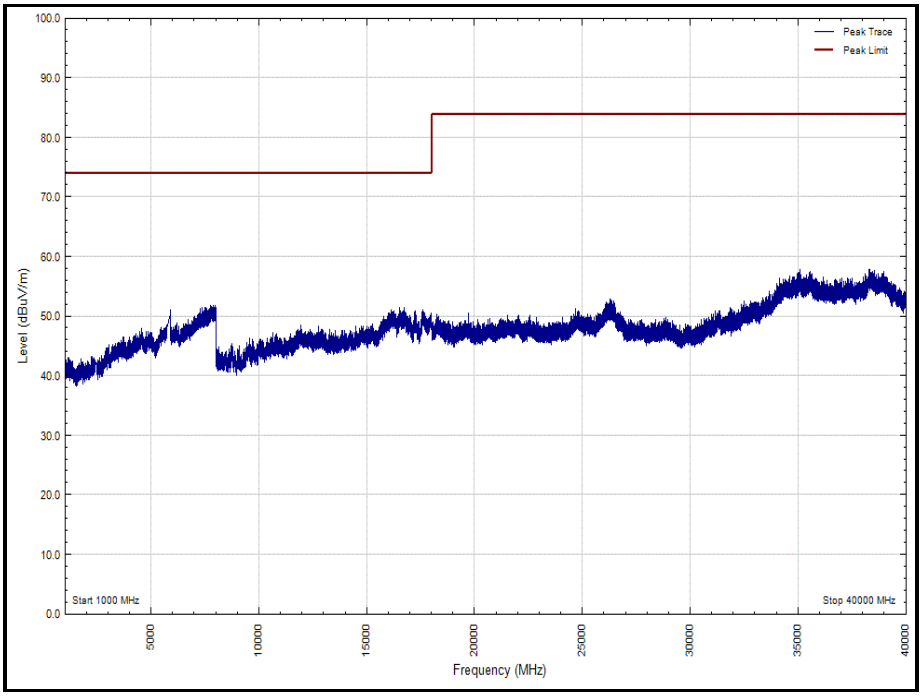

Figure 21 - 1 GHz to 40 GHz – Horizontal Peak (UNII-3 Channel 165, Bluetooth DH5 Channel 39)

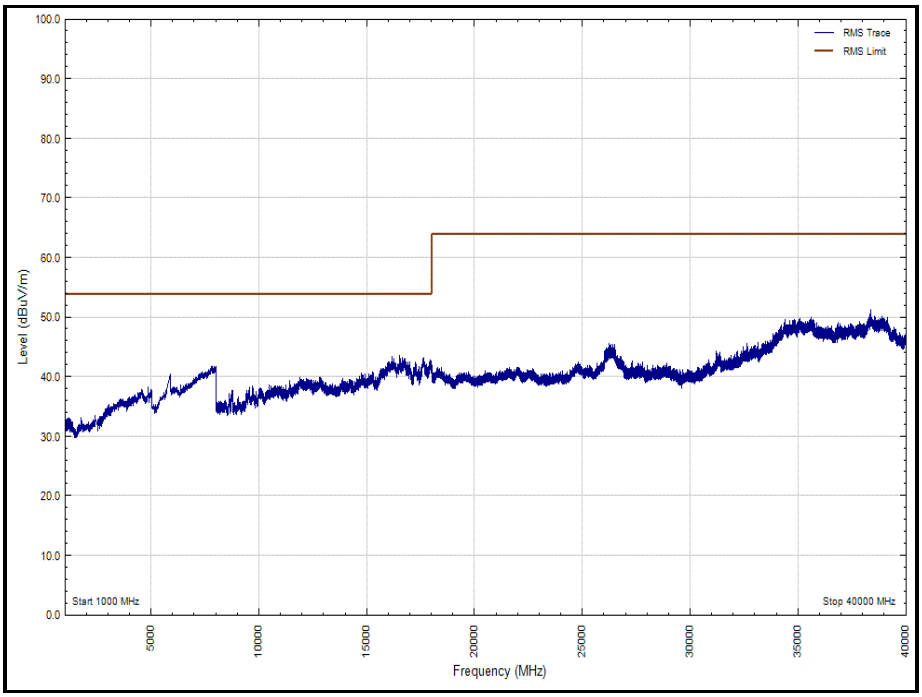

Figure 22 - 1 GHz to 40 GHz – Horizontal Average (UNII-3 Channel 165, Bluetooth DH5 Channel 39)

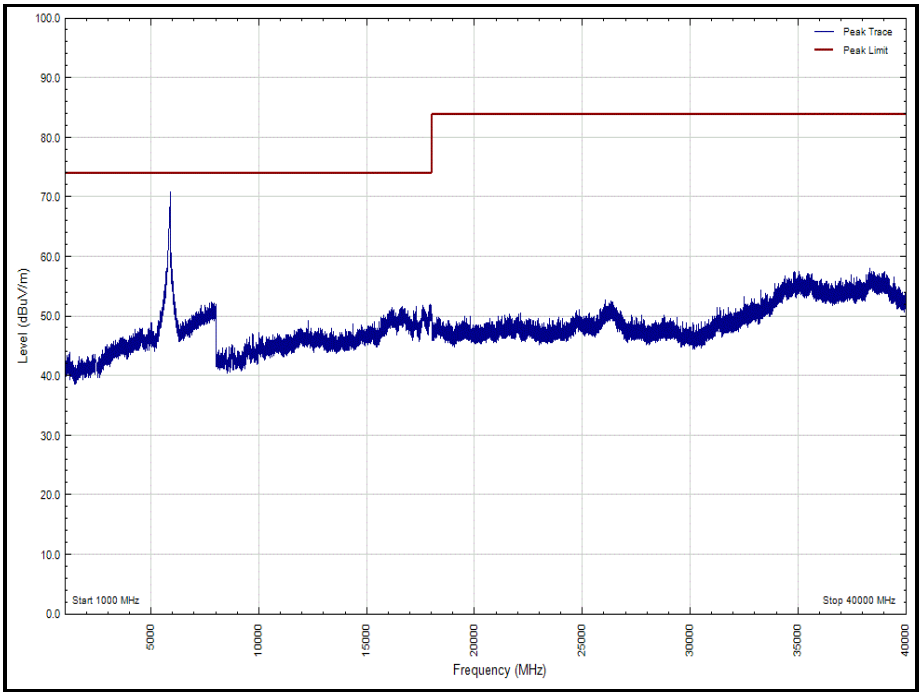

Figure 23 - 1 GHz to 40 GHz – Vertical Peak (UNII-3 Channel 165, Bluetooth DH5 Channel 39)

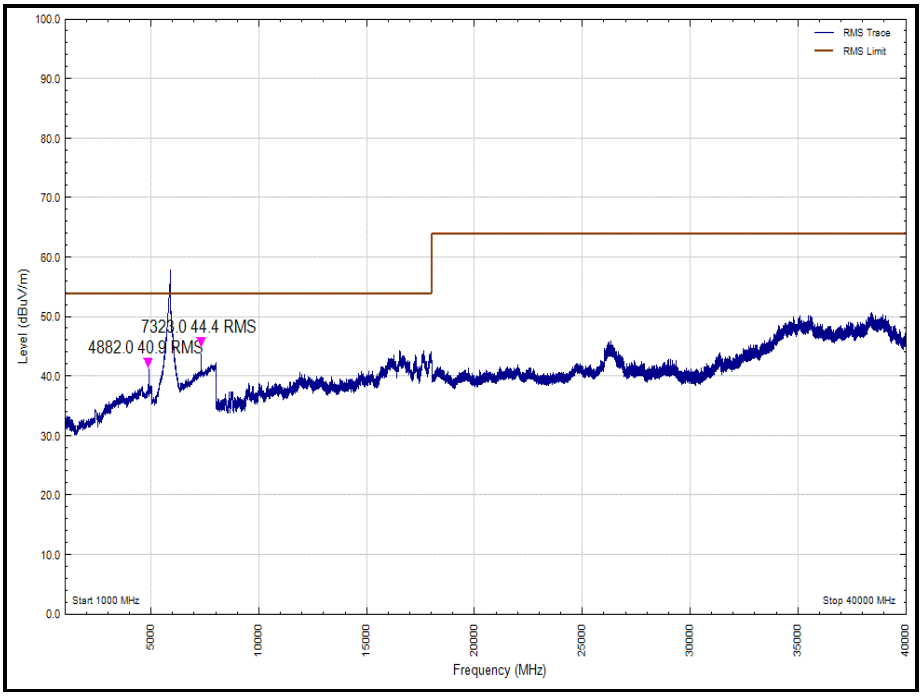

Figure 24 - 1 GHz to 40 GHz – Vertical Average (UNII-3 Channel 165, Bluetooth DH5 Channel 39)

FCC 47 CFR Parts Limit Clause 15.247(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 15.209 / RSS GEN clause 8.9	<960 MHz: FCC 15.205 and RSS-GEN clause 8.9 (Table 5) >960 MHz: 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
Antenna 18-40GHz (Double Ridge Guide)	Link Microtek Ltd	AM180HA-K-TU2	230	24	2-May-2020
Antenna with permanent attenuator (Bilog)	Schaffner	CBL6143	287	24	15-May-2020
Filter (High Pass)	Lorch	SHP7-7000-SR	566	12	10-May-2019
Pre-Amplifier	Phase One	PS04-0086	1533	12	8-Feb-2020
Hygromer	Rotronic	Hygropalm	2404	12	26-Apr-2019
Cable 1503 2M 2.92(P)m 2.92(P)m	Rhophase	KPS-1503A-2000-KPS	4293	12	26-Oct-2019
Cable (Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4526	6	26-Apr-2019
High Pass Filter (4GHz)	K&L Microwave	11SH10-4000/X18000-0/0	4599	12	4-Sep-2019
Horn Antenna	ETS-Lindgren	3117	4722	12	5-Mar-2020
4dB Attenuator	Pasternack	PE7047-4	4935	24	28-Nov-2019
Band Reject Filter - 2.425 GHz	Wainwright	WRCGV14-2390-2400-2450-2460-50SS	5066	12	2-Oct-2019
Band Reject Filter - 2.4585 GHz	Wainwright	WRCGV14-2423.5-2433.5-2483.5-2493.5-50SS	5068	12	2-Oct-2019
Band Reject Filter - 5.795GHz	Wainwright	WRCJV10-5725-5755-5835-5865-50SS	5070	12	1-Oct-2019
Band Reject Filter - 5.22 GHz	Wainwright	WRCJV12-5120-5150-5290-5320-50SS	5072	12	28-Sep-2019
Band Reject Filter - 5.28 GHz	Wainwright	WRCJV12-5180-5210-5350-5380-50SS	5074	12	27-Sep-2019
Band Reject Filter - 5.775 GHz	Wainwright	WRCJV10-5700-5735-5815-5850-50SS	5076	12	1-Oct-2019
Band Reject Filter - 5.570 GHz	Wainwright	WRCJV10-5440-5490-5650-5700-50SS	5078	12	28-Sep-2019
Band Reject Filter - 5.690 GHz	Wainwright	WRCJV8-5635-5670-5710-5745-50SS	5080	12	27-Sep-2019
EMI Test Receiver	Rohde & Schwarz	ESW44	5084	12	12-Sep-2019
8m N-Type RF Cable	Teledyne	PR90-088-8MTR	5095	12	4-Oct-2019
Cable (18GHz)	Rosenberger	LU7-071-1000	5101	12	4-Oct-2019
Cable (18GHz)	Rosenberger	LU7-071-1000	5102	12	4-Oct-2019
Cable (18GHz)	Rosenberger	LU7-071-1000	5104	12	5-Oct-2019
Cable (18GHz)	Rosenberger	LU7-071-2000	5107	12	5-Oct-2019

Table 13

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: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB

Table 14