

Report on the FCC and IC Testing of:
Apple Inc. Model: A2141
In accordance with FCC 47 CFR Part 15,
ISED RSS 247 & ISED RSS-GEN
(Simultaneous Transmissions)

Prepared for: Apple Inc.
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California 95014 USA

FCC ID: BCGA2141

IC: 579C-A2141

COMMERCIAL-IN-CONFIDENCE

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SIGNATURE

NAME	JOB TITLE	RESPONSIBLE FOR	ISSUE DATE
Ryan Henley	Sales Manager – RF and Telecom	Authorised Signatory	24 October 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, ISED RSS-247 and ISED RSS-GEN (Simultaneous Transmission). The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Malik Mohammad	24 October 2019	
Testing	Cristian Onaca	24 October 2019	
Testing	Faisal Malyar	24 October 2019	
Testing	Ahmad Javid	24 October 2019	
Testing	Jay Balendrarajah	24 October 2019	
Testing	George Porter	24 October 2019	

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

Industry Canada Accreditation
IC12669A Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15: 2018, ISED RSS-247: Issue 2 (2017-02) and ISED RSS-GEN: Issue 5 A1 (2019-03) 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	24 October 2019

Table 1

1.2 Introduction

Applicant	Apple Inc
Manufacturer	Apple Inc
Model Number(s)	A2141
Serial Number(s)	C02YT00GL51N
Hardware Version(s)	REV1.0
Software Version(s)	19A497
Number of Samples Tested	1
Test Specification/Issue/Date	FCC 47 CFR Part 15: (2018) ISED RSS-247: Issue 2 (2017-02) ISED RSS-GEN Issue 5 A1 (2019-03)
Start of Test	03-August-2019
Finish of Test	02-October-2019
Name of Engineer(s)	Malik Mohammad, Cristian Onaca, Jay Balendrarajah, Ahmad Javid, Faisal Malyar and George Porter
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 Parts 15, ISED RSS-247 and ISED RSS-GEN (Simultaneous Transmission) is shown below.

Section	Specification Clause			Test Description	Result	Comments/Base Standard
	FCC Part 15	RSS-247	RSS-GEN			
Configuration and Mode: 5 GHz WLAN (Main) & Bluetooth						
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
Configuration and Mode: 2.4 GHz WLAN (Main) & 5 GHz WLAN (Aux)						
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
Configuration and Mode: 5 GHz WLAN (Main) & 2.4 GHz WLAN (Aux)						
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 2.4 GHz and 5 GHz 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
Model: A2141: Serial Number: C02YT00GL51N			
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: 5 GHz WLAN (Main) & Bluetooth		
Radiated Spurious Emissions (Simultaneous Transmission)	Malik Mohammad, Cristian Onaca, Jay Balendrarajah, Ahmad Javid, Faisal Malyar, George Porter	UKAS
Configuration and Mode: 2.4 GHz WLAN (Main) & 5 GHz WLAN (Aux)		
Radiated Spurious Emissions (Simultaneous Transmission)	Malik Mohammad, Cristian Onaca, Jay Balendrarajah, Ahmad Javid, Faisal Malyar, George Porter	UKAS
Configuration and Mode: 5 GHz WLAN (Main) & 2.4 GHz WLAN (Aux)		
Radiated Spurious Emissions (Simultaneous Transmission)	Malik Mohammad, Cristian Onaca, Jay Balendrarajah, Ahmad Javid, Faisal Malyar, George Porter	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) and 15.209
ISED RSS 247, Clause 5.5 and 6.2
ISED RSS GEN, Clause 8.9 and 8.10

2.1.2 Equipment Under Test and Modification State

A2141, S/N: C02YT00GL51N - Modification State 0

2.1.3 Date of Test

03-August-2019 to 02-October-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 (RMS) 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 4.1.4.2.5.

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 19.9 - 23.0 °C
Relative Humidity 56.2 - 67.0 %

2.1.6 Test Results

5 GHz WLAN (Main) & Bluetooth

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

Technology	Frequency Band (MHz)	Channel Frequency (MHz)
802.11n - 20 MHz Bandwidth	5470 MHz to 5725 MHz (U-NII 2c)	5500 MHz
Bluetooth – GFSK/DH5	2400 MHz to 2483.5 MHz	2479 MHz

Table 5 - Modes of Operation

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dB)	Angle (°)	Height (m)	Polarisation
288.4	33.1	46.0	12.9	223	1.06	Horizontal
427.9	26.0	46.0	20.0	10	1.03	Vertical

Table 6 – 30 MHz to 1 GHz – Emission Results

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

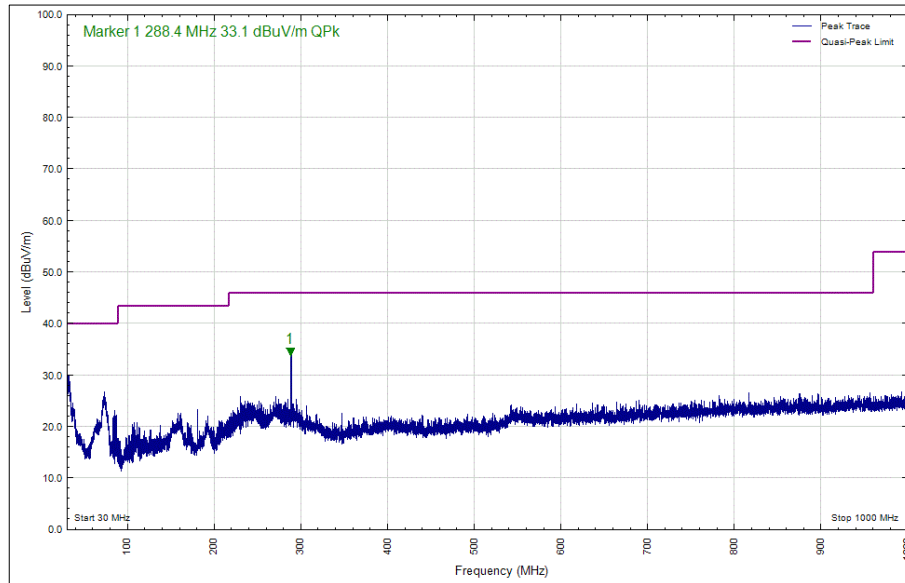


Figure 1 - 30 MHz to 1 GHz – Horizontal

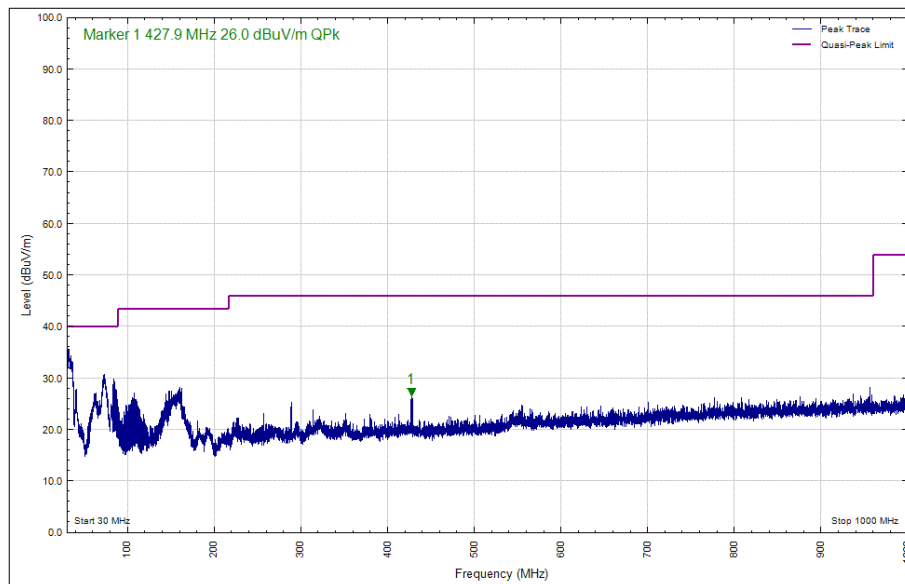


Figure 2 - 30 MHz to 1 GHz - Vertical



Frequency (GHz)	Result (dB μ V/m)		Limit (dB μ V/m)		Margin (dB)		Angle (°)	Height (m)	Polarisation
	Peak	Average	Peak	Average	Peak	Average			
5041.8	-	42.0		54	-	-12.0	6	3.32	Vertical
5424.4	-	46.2		54	-	-7.8	359	2.65	Vertical
5270.9	56.1	-	74	-	-17.9	-	10	2.49	Vertical
5279.1	55.7	-	-74	-	-18.3	-	3	2.84	Vertical

Table 7 – 1 GHz to 40 GHz Emissions Results

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

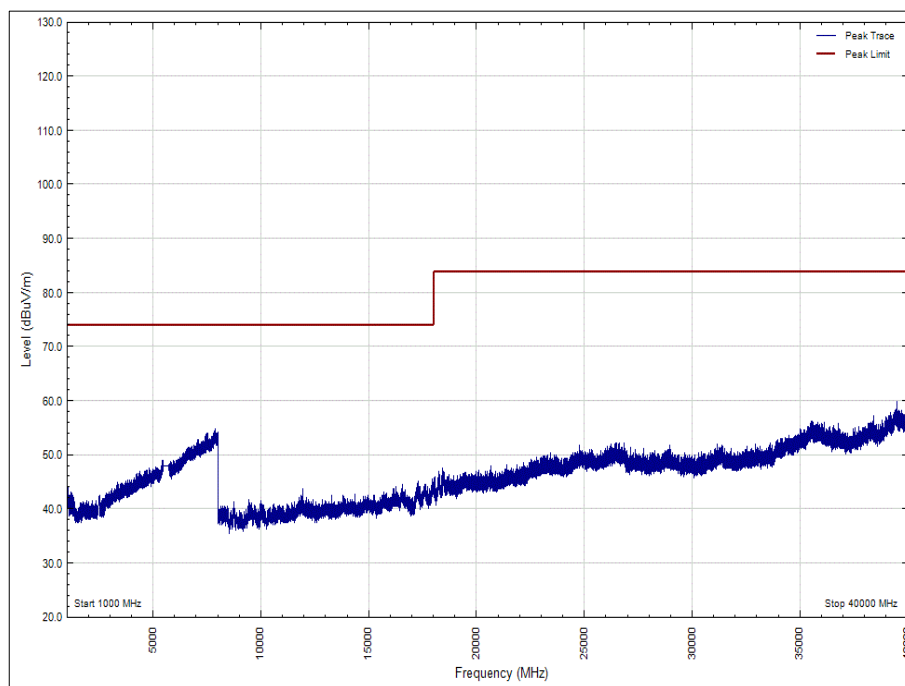


Figure 3 – 1 GHz to 40 GHz – Horizontal (Peak)

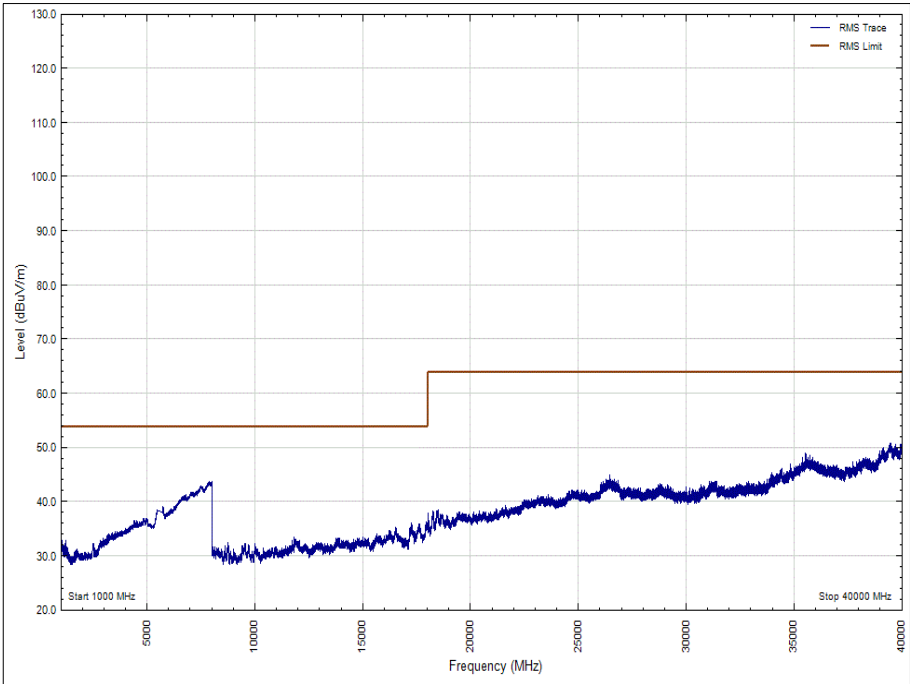


Figure 4 – 1 GHz to 40 GHz – Horizontal (Average)

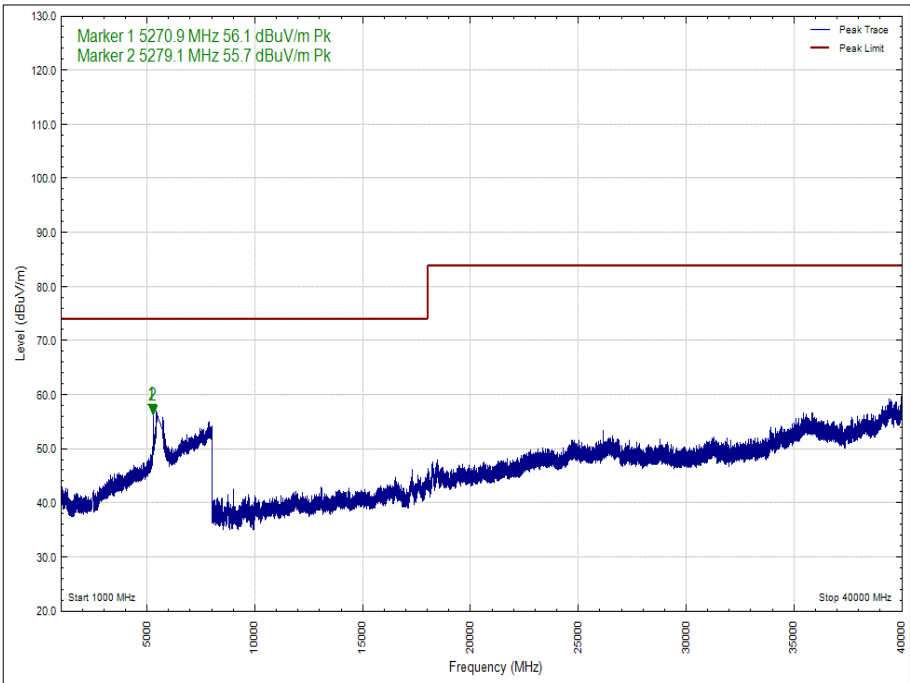


Figure 5 – 1 GHz to 40 GHz – Vertical (Peak)

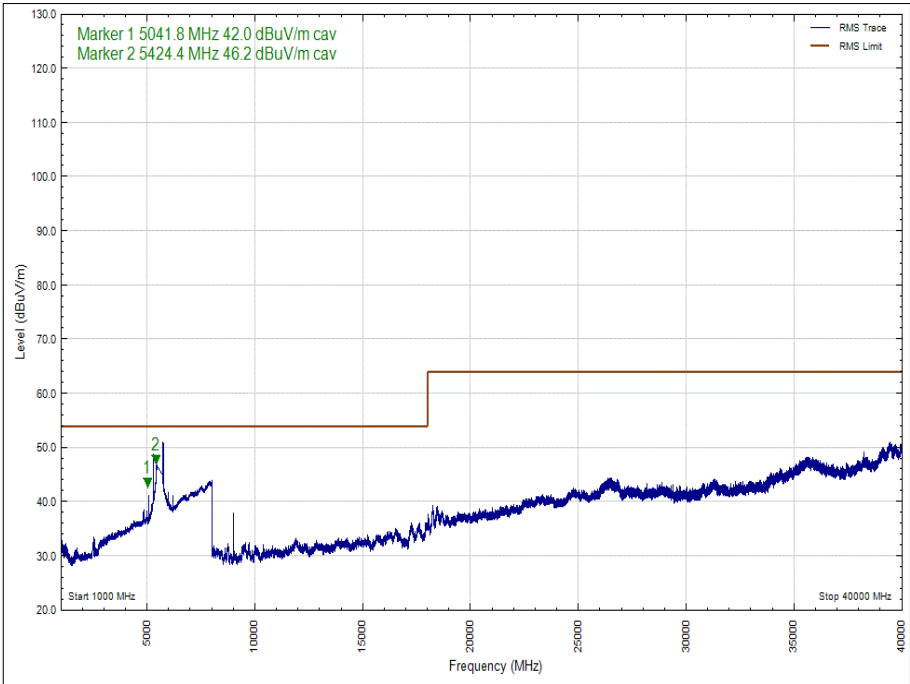


Figure 6 – 1 GHz to 40 GHz – Vertical (Average)



2.4 GHz WLAN (Main) & 5 GHz WLAN (Aux)

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

Technology	Frequency Band (MHz)	Channel Frequency (MHz)
802.11b - 1 Mbps (Core 0-1-2)	2400 MHz to 2483.5 MHz	2442
802.11n - 20 MHz Bandwidth MCS0 (Aux)	5470 MHz to 5725 MHz (U-NII 2c)	5500

Table 8 - Modes of Operation

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dBuV/m)	Angle (°)	Height (m)	Polarisation
288.4	31.9	46.0	14.1	223	1.07	Horizontal

Table 9 – 30 MHz to 1 GHz – Radiated

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

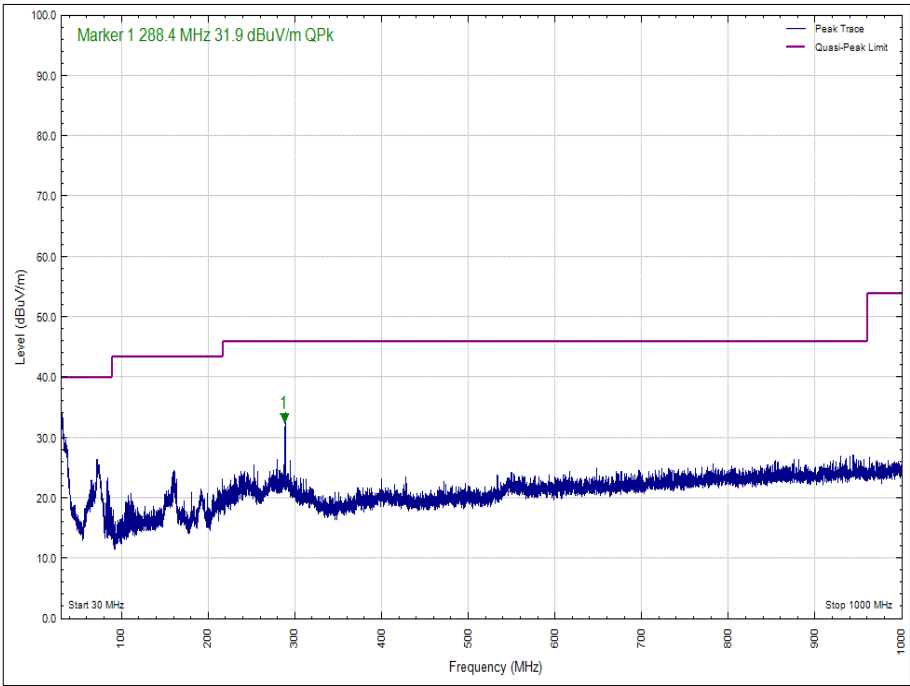


Figure 7 - 30 MHz to 1 GHz – Horizontal

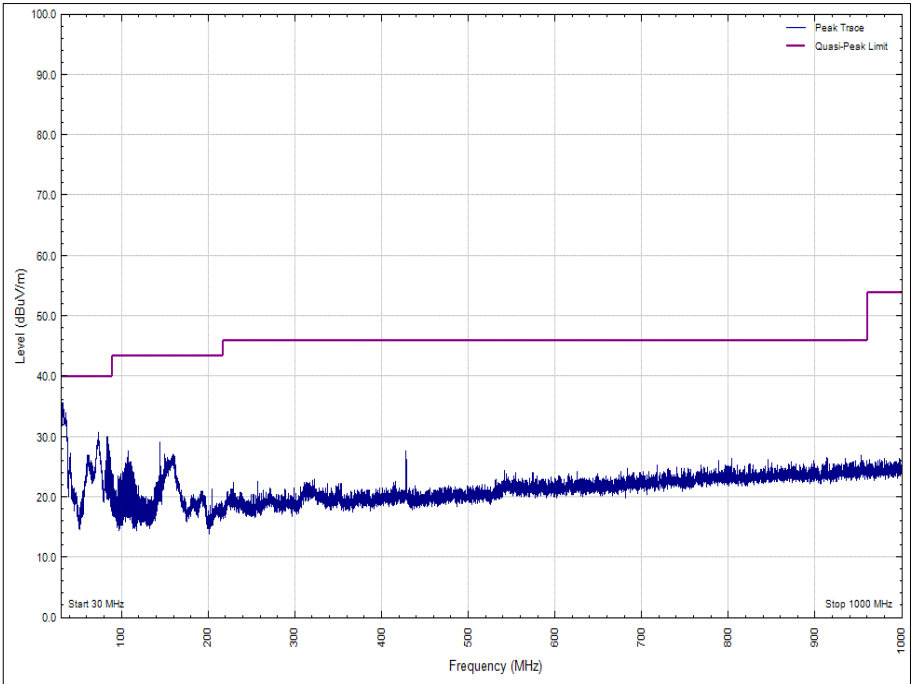


Figure 8 - 30 MHz to 1 GHz - Vertical



Frequency (GHz)	Result (dBµV/m)		Limit (dBµV/m)		Margin (dBµV/m)		Angle (°)	Height (m)	Polarisation
	Peak	Average	Peak	Average	Peak	Average			
4883.8	-	46.1	-	54	-	7.9	8	3.45	Vertical

Table 10 - 1 GHz to 40 GHz Emissions Results

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

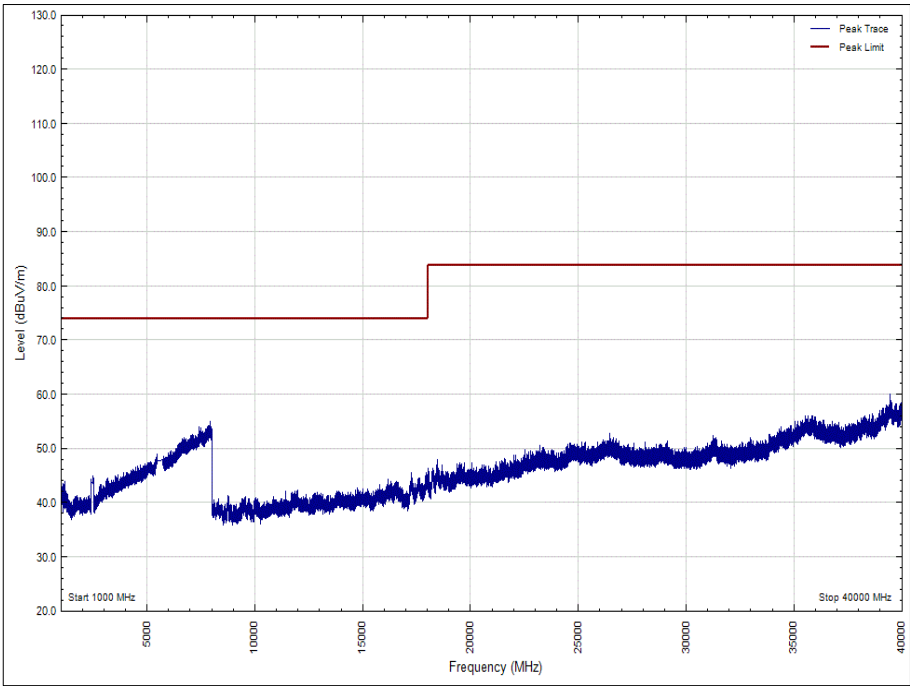


Figure 9 - 1 GHz to 40 GHz – Horizontal (Peak)

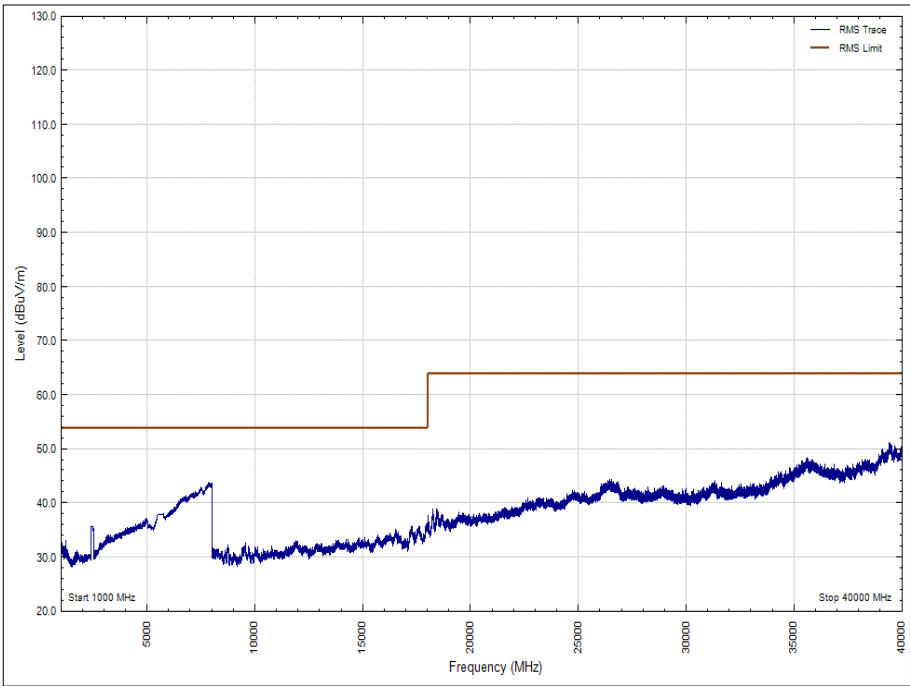


Figure 10 - 1 GHz to 40 GHz – Horizontal (Average)

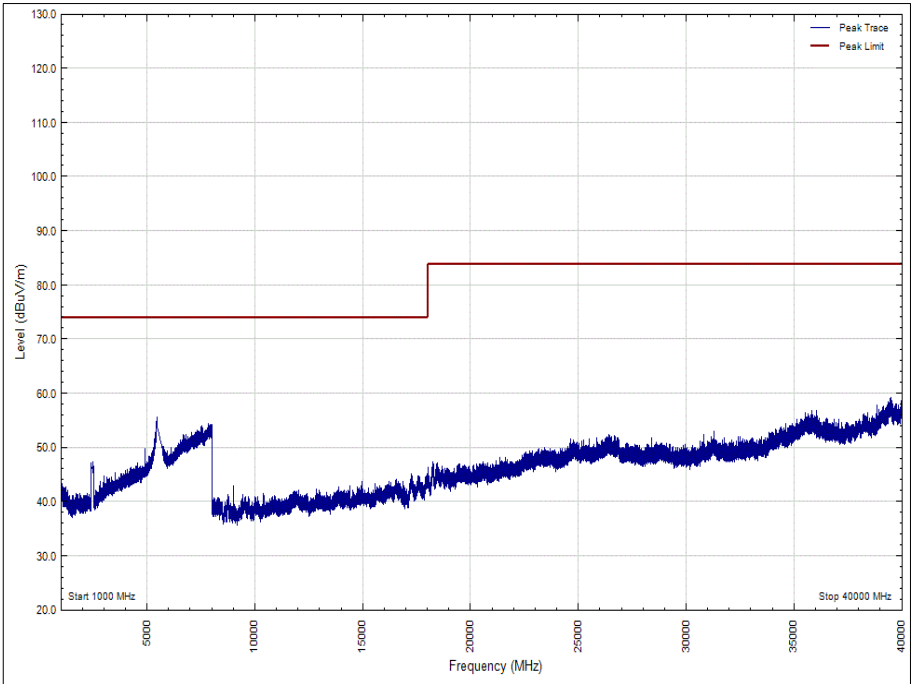


Figure 11 - 1 GHz to 40 GHz – Vertical (Peak)

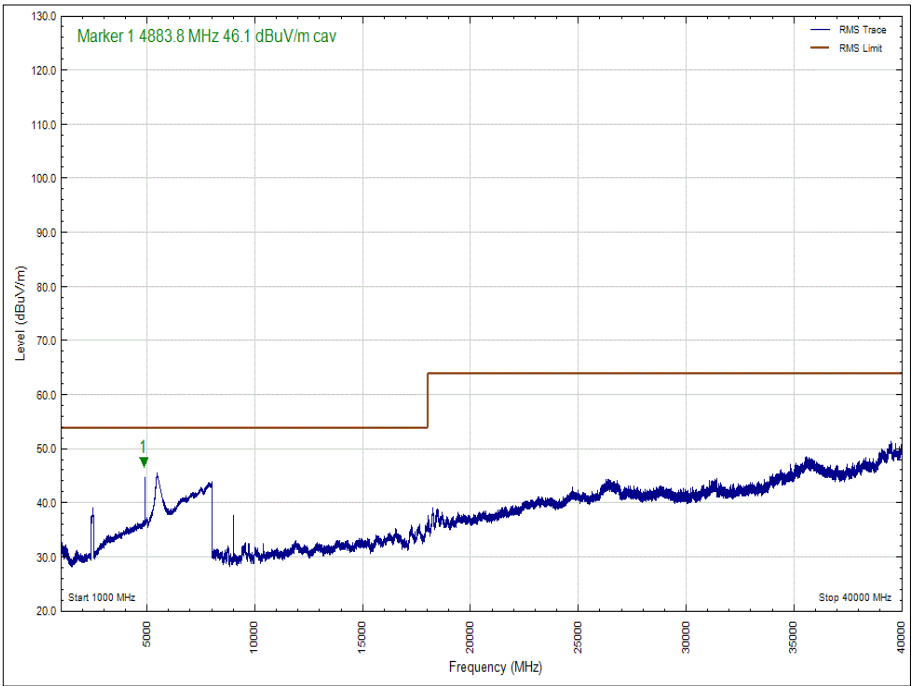


Figure 12 - 1 GHz to 40 GHz – Vertical (Average)



5 GHz WLAN (Main) & 2.4 GHz WLAN (Aux)

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

Technology	Frequency Band (MHz)	Channel Frequency (MHz)
802.11b - 1 Mbps (Aux)	2400 MHz to 2483.5 MHz	2442
802.11n - 20 MHz Bandwidth MCS0 (Core 0-1-2)	5470 MHz to 5725 MHz (U-NII 2c)	5500

Table 11 - Modes of Operation

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dB)	Angle (°)	Height (m)	Polarisation
*						

Table 12 – 30 MHz to 1 GHz – Radiated

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

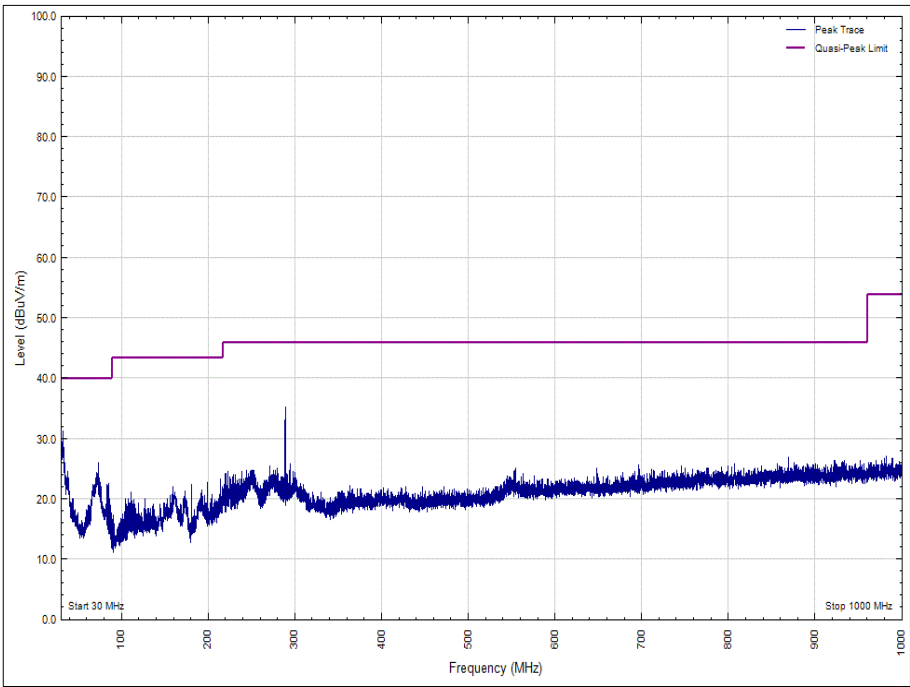


Figure 13 - 30 MHz to 1 GHz – Horizontal

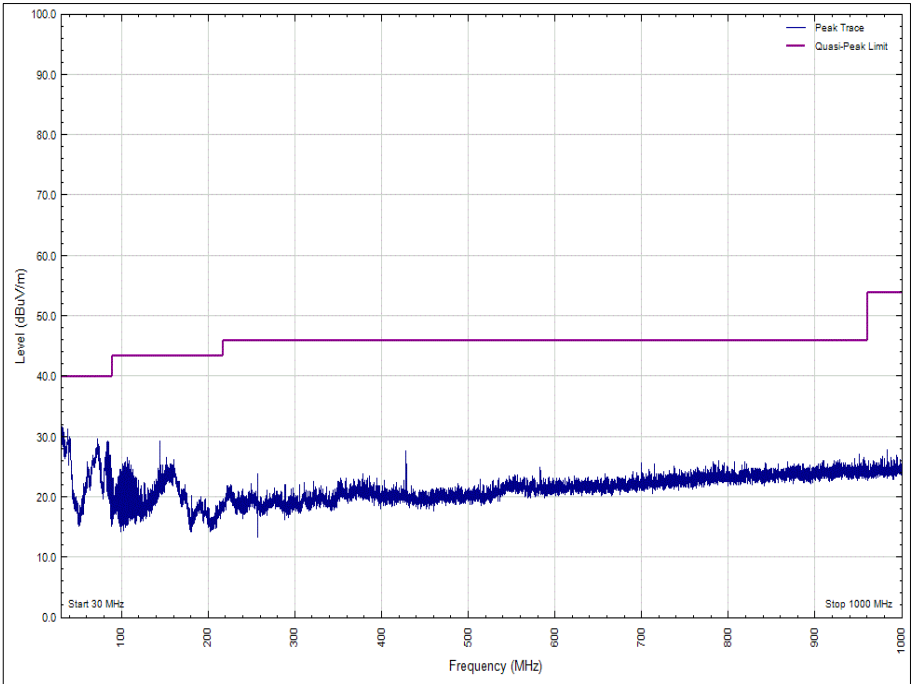


Figure 14 - 30 MHz to 1 GHz - Vertical



Frequency (GHz)	Result (dB μ V/m)		Limit (dB μ V/m)		Margin (dB μ V/m)		Angle (°)	Height (m)	Polarisation
	Peak	Average	Peak	Average	Peak	Average			
4884.027	-	50.88	-	54	-	3.12	3	2.48	Vertical
5041.726	-	40.71		54		13.29	1	2.54	Vertical

Table 13 - 1 GHz to 40 GHz Emissions Results

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

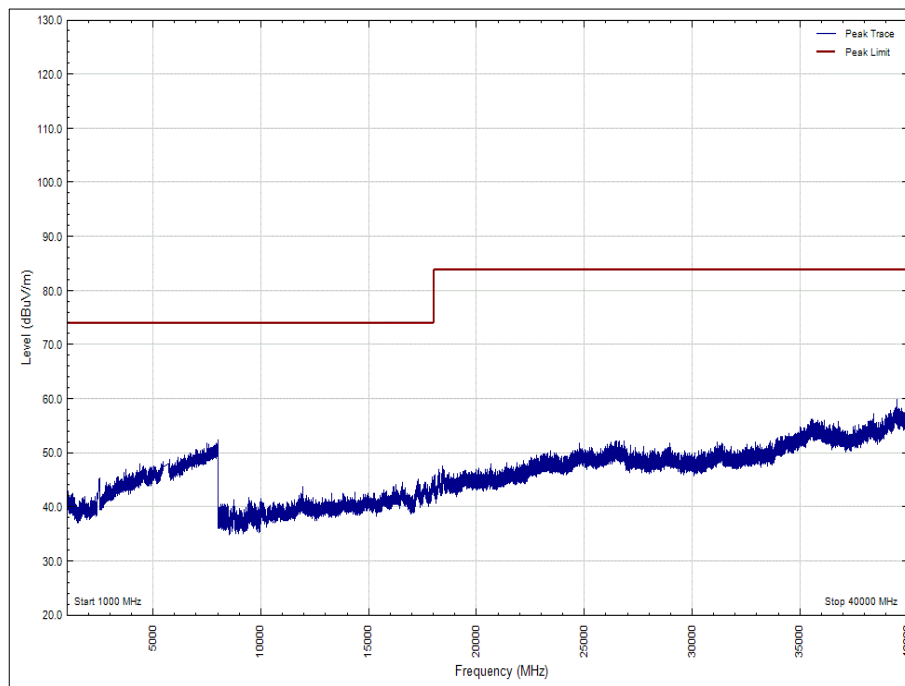


Figure 15 - 1 GHz to 40 GHz – Horizontal (Peak)

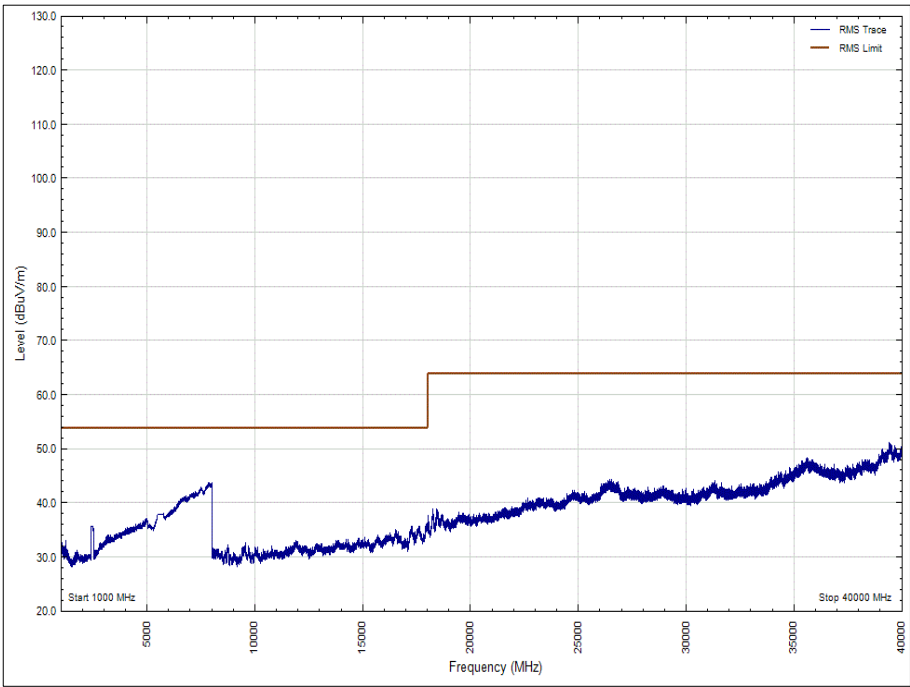


Figure 16 - 1 GHz to 40 GHz – Horizontal (Average)

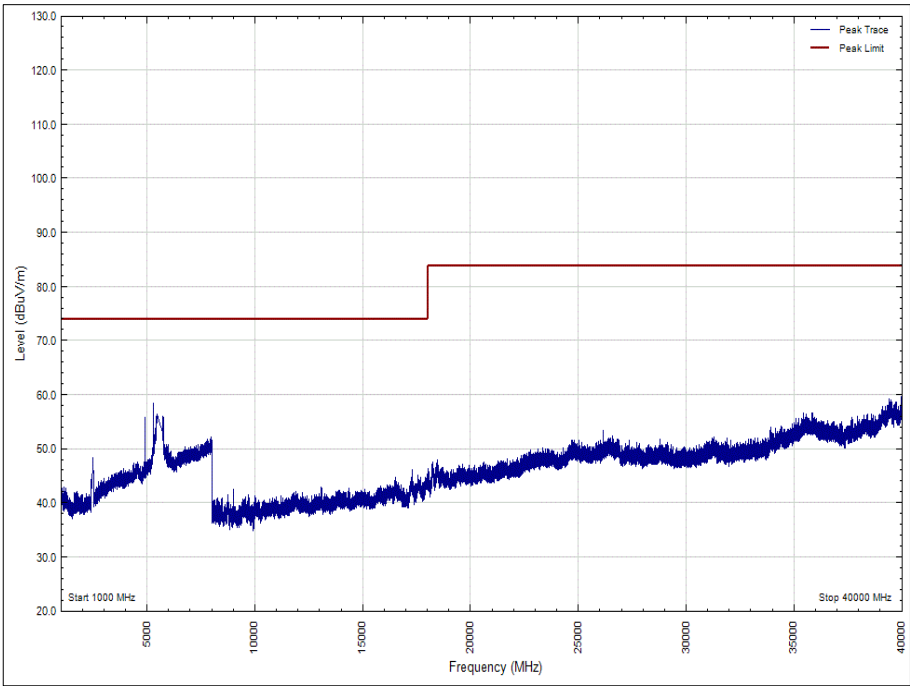


Figure 17 - 1 GHz to 40 GHz – Vertical (Peak)

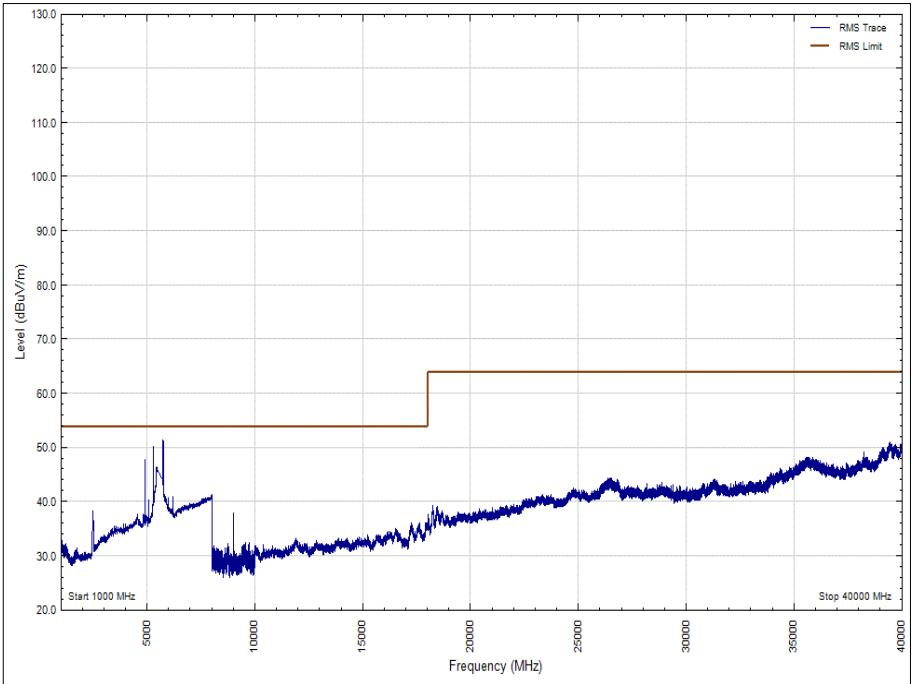


Figure 18 - 1 GHz to 40 GHz – Vertical (Average)



Limit Clause

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

Specification and Clause	Limit
FCC Part 15.247 (d)	-20 dBc
FCC Part 15.407 (b)	-27 dBm (EIRP) / 68.2 dBµV/m at 3 m
FCC Part 15.209 (Within restricted bands listed in 15.205)	Peak: 74 dBµV/m at 3 m Average 54 dBµV/m at 3 m
ISED RSS-247, Clause 5.5	-20 dBc
ISED RSS-247, Clause 6.2	-27 dBm (EIRP) / 68.2 dBµV/m at 3 m
ISED RSS-GEN, Clause 8.9 (Within restricted bands listed in clause 8.8)	Peak: 74 dBµV/m at 3 m Average 54 dBµV/m at 3 m

Table 14 - Limit Table



2.1.7 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
Filter (High Pass)	Lorch	SHP7-7000-SR	566	12	06-Jun-2020
Pre-Amplifier	Phase One	PS04-0086	1533	12	08-Feb-2020
Hygrometer	Rotronic	HYGROPALM 1	2338	12	15-Nov-2019
1GHz to 8GHz Low Noise Amplifier	Wright Technologies	APS04-0085	4365	12	25-Oct-2019
Cable (Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4526	6	11-Dec-2019
Double Ridged Waveguide Horn Antenna	ETS-Lindgren	3117	4722	12	05-Mar-2020
Double Ridge Broadband Horn Antenna	Schwarzbeck	BBHA 9120 B	4848	12	11-Mar-2020
8 - 18 GHz pre amp	Wright Technologies	PS06-0061	4971	12	07-Dec-2019
Band Reject Filter - 5.795GHz	Wainwright	WRCJV10-5440-5490-5650-5700-50SS	5078	12	01-Oct-2019
EMI Test Receiver	Rohde & Schwarz	ESW44	5084	12	12-Sep-2019
8m N-Type RF Cable	Teledyne	PR90-088-8MTR	5093	12	04-Oct-2019
8m N-Type RF Cable	Teledyne	PR90-088-8MTR	5095	12	04-Oct-2019
Cable (18 GHz)	Rosenberger	LU7-071-1000	5102	12	04-Oct-2019
Cable (18 GHz)	Rosenberger	LU7-071-1000	5104	12	05-Oct-2019
Cable (18 GHz)	Rosenberger	LU7-071-1000	5105	12	05-Oct-2019
Cable (18 GHz)	Rosenberger	LU7-071-2000	5107	12	05-Oct-2019
Cable (18 GHz)	Rosenberger	LU7-071-2000	5109	12	05-Oct-2019
Band Reject Filter - 2.4585 GHz	Wainwright	WRCGV14-2423.5-2433.5-2483.5-2493.5-50SS	5068	12	02-Oct-2019
EmX Software	TUV SUD	EmX V.1.4.8.3	5125	-	Software
1.5m 40GHz RF Cable	Scott Cables	KPS-1501-2000-KPS	5127	6	11-Dec-2019
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	11-Mar-2020
DRG Horn Antenna (7.5-18GHz)	Schwarzbeck	HWRD750	5216	12	11-Mar-2020

Table 15

TU – Traceability Unscheduled



3 Measurement Uncertainty

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

Test Name	Measurement Uncertainty
Radiated Spurious Emissions (Simultaneous Transmission)	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB

Table 16