

FCC and ISCED Test Report

Apple Inc
Model: A2439

In accordance with FCC 47 CFR Part 15,
ISED RSS-247 and ISCED RSS-GEN (2.4 GHz
WLAN, 5 GHz WLAN and 2.4 GHz Bluetooth)

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

FCC ID: BCGA2439

IC: 579C-A2439



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Document 75949506-14 Issue 01

SIGNATURE

NAME	JOB TITLE	RESPONSIBLE FOR	ISSUE DATE
Steve Marshall	Senior Engineer	Authorised Signatory	10 February 2021

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

ENGINEERING STATEMENT

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

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Connor Lee	10 February 2021	
Testing	Aasim Butt	10 February 2021	
Testing	Colin Brain	10 February 2021	
Testing	Liang Tian	10 February 2021	

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

ISED Accreditation
12669A Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Parts 15: 2019, ISCED RSS-247: Issue 2 (2017-02) and ISCED RSS-GEN: Issue 5 (04-2018) + A1 (03-2019) 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	10 February 2021

Table 1

1.2 Introduction

Applicant	Apple Inc
Manufacturer	Apple Inc
Model Number(s)	A2439
Serial Number(s)	C02DM00M0FTN
Hardware Version(s)	REV1.0
Software Version(s)	20W430340t
Number of Samples Tested	1
Test Specification/Issue/Date	FCC 47 CFR Part 15: 2019 ISED RSS-247: Issue 2 (2017-02) ISED RSS-GEN: Issue 5 (04-2018) + A1 (03-2019)
Order Number	0540205414
Date	13-July-2020
Date of Receipt of EUT	11-December-2020
Start of Test	14-December-2020
Finish of Test	15-January-2021
Name of Engineer(s)	Connor Lee, Aasim Butt, Colin Brain and Liang Tian
Related Document(s)	ANSI C63.4: 2009 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 is shown below.

Section	Specification Clause			Test Description	Result	Comments/Base Standard
	FCC Part 15	RSS-247	RSS-GEN			
Configuration and Mode: SDB - 2.4 GHz WLAN and 5 GHz WLAN						
2.1	15.247 (d), 15.407 (b) and 15.209	5.5 and 6.2	8.9 and 8.10	Radiated Spurious Emissions (Simultaneous Transmission)	Pass	ANSI C63.10: 2013
Configuration and Mode: CoTX - 2.4 GHz WLAN, 5 GHz WLAN and 2.4 GHz Bluetooth						
2.1	15.247 (d), 15.407 (b) and 15.209	5.5 and 6.2	8.9 and 8.10	Radiated Spurious Emissions (Simultaneous Transmission)	Pass	ANSI C63.10: 2013

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 a/b/g/n/ac/ax 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: A2439, Serial Number: C02DM00M0FTN			
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: SDB - 2.4 GHz WLAN and 5 GHz WLAN		
Radiated Spurious Emissions (Simultaneous Transmission)	Connor Lee, Aasim Butt, Colin Brain and Liang Tian	UKAS
Configuration and Mode: CoTX - 2.4 GHz WLAN, 5 GHz WLAN and 2.4 GHz Bluetooth		
Radiated Spurious Emissions (Simultaneous Transmission)	Connor Lee, Aasim Butt, Colin Brain and Liang Tian	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

A2439, S/N: C02DM00M0FTN - Modification State 0

2.1.3 Date of Test

14-December-2020 to 15-January-2021

2.1.4 Test Method

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

The EUT was placed on the non-conducting platform in a manner typical of a normal installation.

Ports on the EUT were terminated with loads as described in ANSI C63.4 clause 6.2.4 for each type of port on the EUT.

For frequencies > 1 GHz, plots for average measurements were taken in accordance with ANSI C63.10, clause 4.1.4.2.5 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, 11.11, 11.12, 12.7.2 or 12.7.3 depending on the nature of the emission measured.

The plots shown are the characterisation of the EUT. The limits on the plots represent the most stringent case for restricted bands, (74/54 dBuV/m) when compared to non-restricted band limits. 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 dBμV/m to μV/m:
 $10^{(\text{Field Strength in dB}\mu\text{V/m}/20)}$

To determine the emission characteristic of the EUT above 18 GHz, the test antenna was swept over all faces of the EUT whilst observing a spectral display. The frequency of any emissions of interest was noted for formal measurement at the correct measurement distance of 1m. This procedure was repeated for all relevant transmit operating channels.

At a measurement distance of 1 meter the limit line was increased by $20 \cdot \text{LOG}(3/1) = 9.54$ dB.

2.1.5 Example Test Setup Diagram

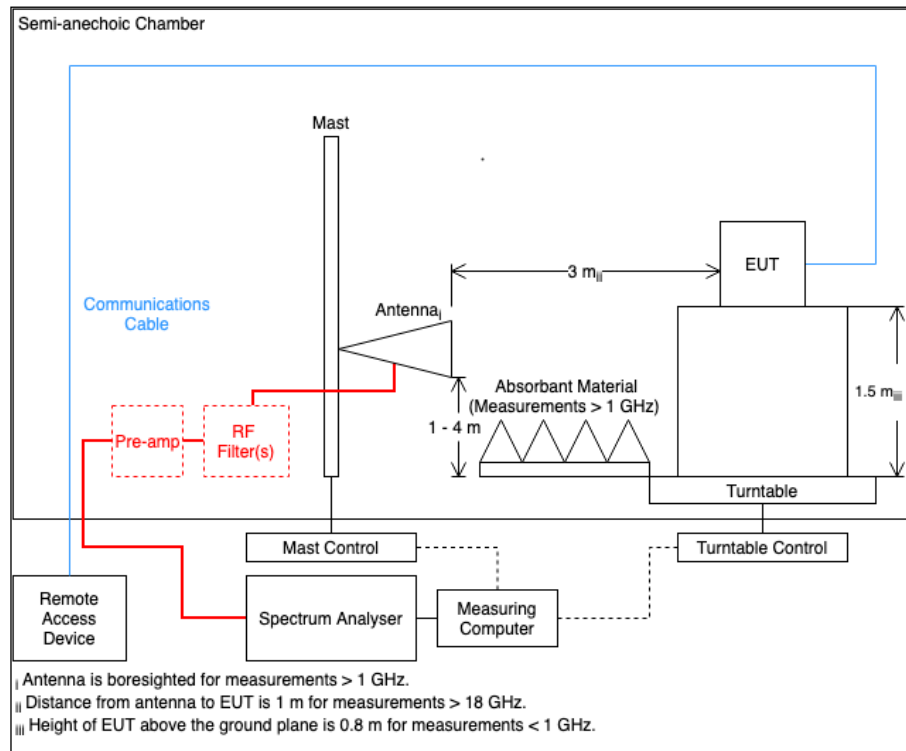


Figure 1

2.1.6 Environmental Conditions

Ambient Temperature	18.1 - 25.6 °C
Relative Humidity	22.0 - 50.4 %

2.1.7 Test Results

SDB - 2.4 GHz WLAN and 5 GHz WLAN

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
4905.080	36.5	54.0	-17.2	RMS	155	110	Horizontal
4905.201	43.3	54.0	-10.4	RMS	19	104	Vertical
11360.967	45.3	54.0	-8.6	RMS	164	100	Vertical
11361.017	44.8	54.0	-9.1	RMS	249	153	Horizontal
11362.770	56.6	74.0	-17.4	Peak	251	156	Horizontal
11362.836	57.2	74.0	-16.9	Peak	158	104	Vertical

Table 5 - 2452 MHz (CH9), HT20, CDD, Core 0 + Core 1 and U-NII-2C - 5680 MHz (CH136), HT20, CDD, Core 0 + Core 1

No other emissions found within 6 dB of the limit.

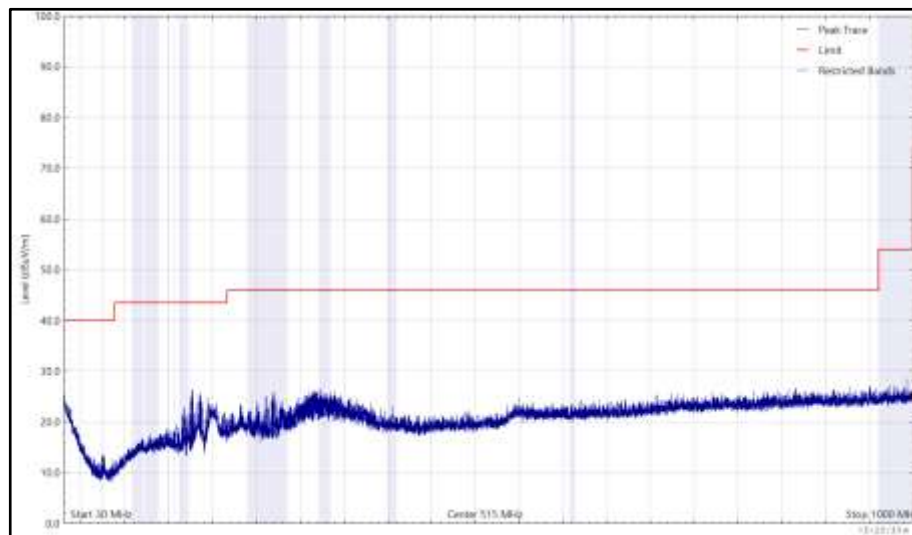


Figure 2 - 2452 MHz (CH9), HT20, CDD, Core 0 + Core 1 and U-NII-2C - 5680 MHz (CH136), HT20, CDD, Core 0 + Core 1, 30 MHz to 1 GHz, Horizontal (Peak)

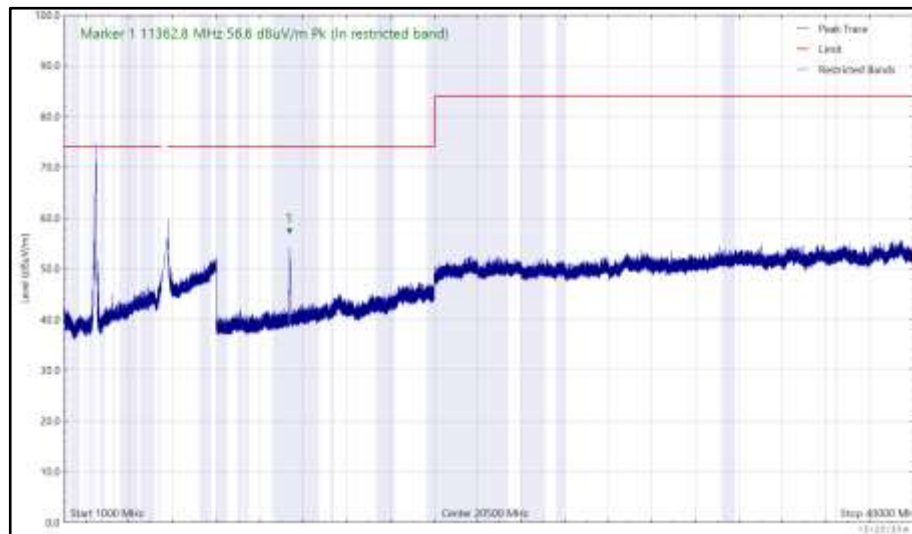


Figure 3 - 2452 MHz (CH9), HT20, CDD, Core 0 + Core 1 and U-NII-2C - 5680 MHz (CH136), HT20, CDD, Core 0 + Core 1, 1 GHz to 40 GHz, Horizontal (Peak)

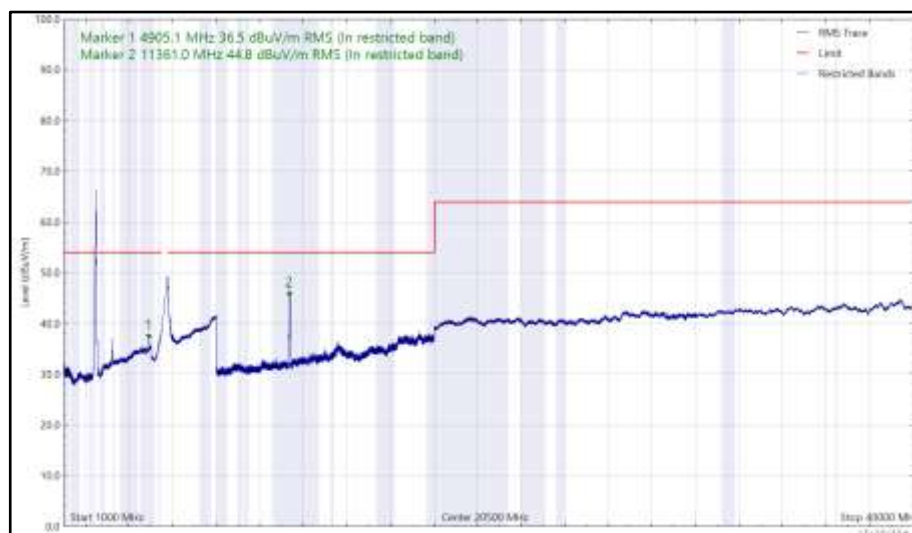


Figure 4 - 2452 MHz (CH9), HT20, CDD, Core 0 + Core 1 and U-NII-2C - 5680 MHz (CH136), HT20, CDD, Core 0 + Core 1, 1 GHz to 40 GHz, Horizontal (rms)

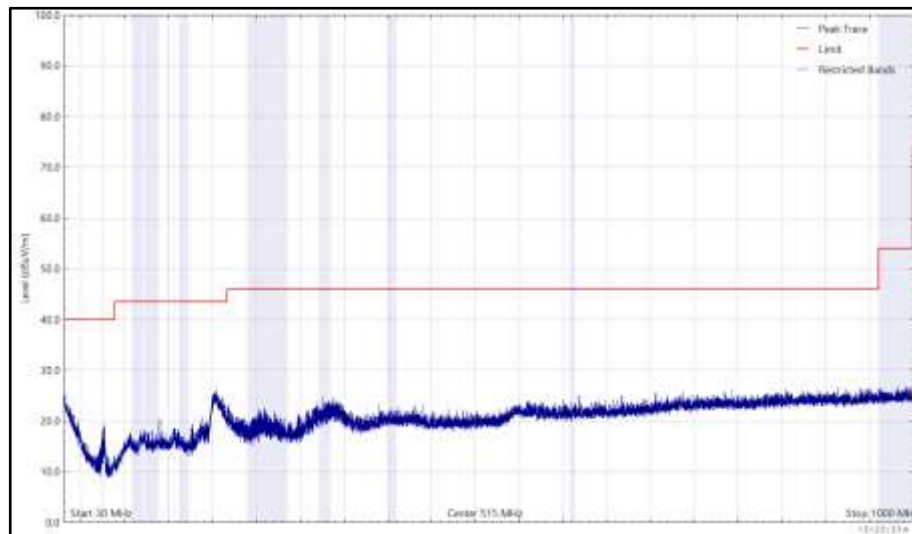


Figure 5 - 2452 MHz (CH9), HT20, CDD, Core 0 + Core 1 and U-NII-2C - 5680 MHz (CH136), HT20, CDD, Core 0 + Core 1, 30 MHz to 1 GHz, Vertical (Peak)

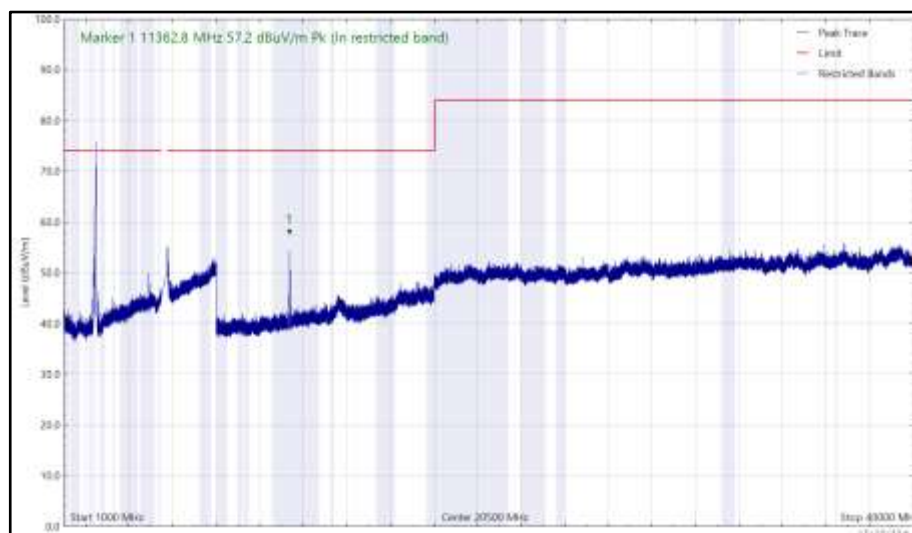


Figure 6 - 2452 MHz (CH9), HT20, CDD, Core 0 + Core 1 and U-NII-2C - 5680 MHz (CH136), HT20, CDD, Core 0 + Core 1, 1 GHz to 40 GHz, Vertical (Peak)

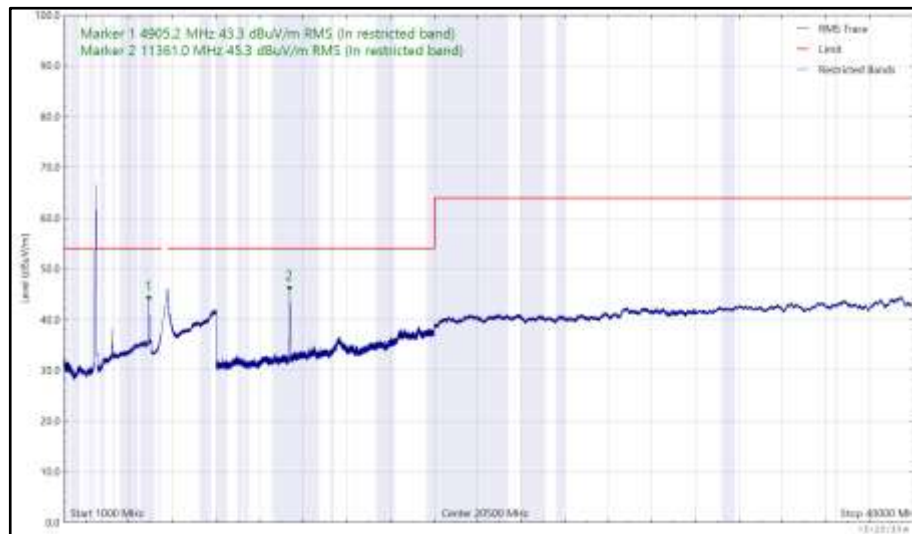


Figure 7 - 2452 MHz (CH9), HT20, CDD, Core 0 + Core 1 and U-NII-2C - 5680 MHz (CH136), HT20, CDD, Core 0 + Core 1, 1 GHz to 40 GHz, Vertical (rms)

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
2782.276	34.1	54.0	-19.7	RMS	182	277	Vertical
4835.345	42.1	54.0	-11.7	RMS	15	175	Vertical

Table 6 - 2417 MHz (CH2), HT20, CDD, Core 0 + Core 1 and U-NII-1 - 5200 MHz (CH40), HT20, CDD, Core 0 + Core 1

No other emissions found within 6 dB of the limit.

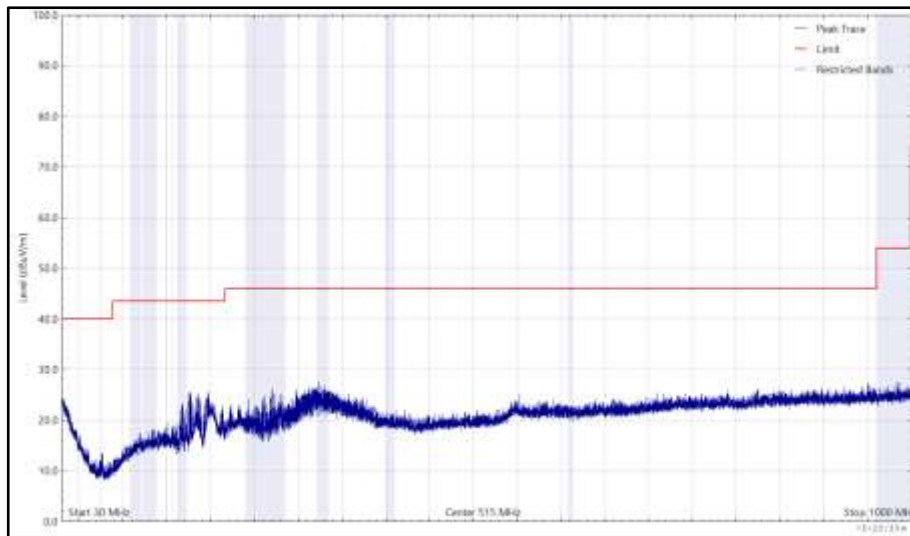


Figure 8 - 2417 MHz (CH2), HT20, CDD, Core 0 + Core 1 and U-NII-1 - 5200 MHz (CH40), HT20, CDD, Core 0 + Core 1, 30 MHz to 1 GHz, Horizontal (Peak)

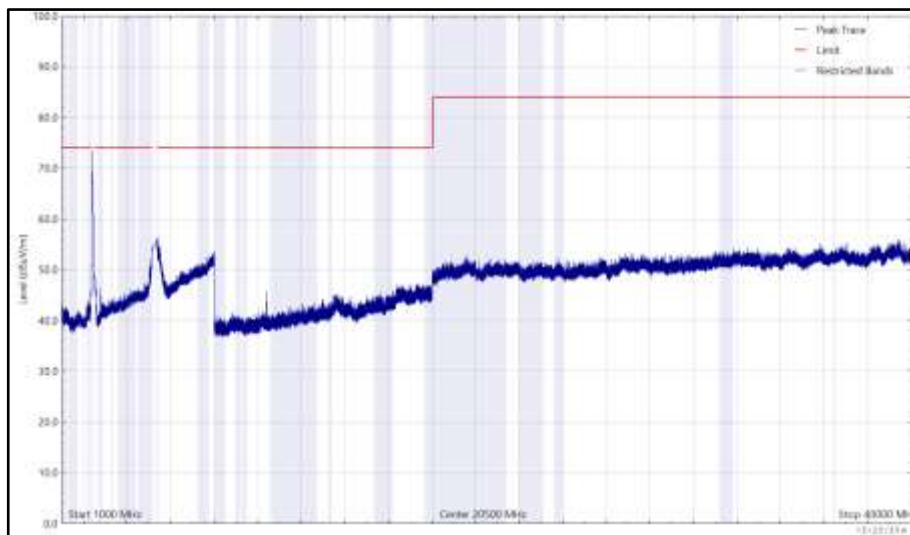


Figure 9 - 2417 MHz (CH2), HT20, CDD, Core 0 + Core 1 and U-NII-1 - 5200 MHz (CH40), HT20, CDD, Core 0 + Core 1, 1 GHz to 40 GHz, Horizontal (Peak)

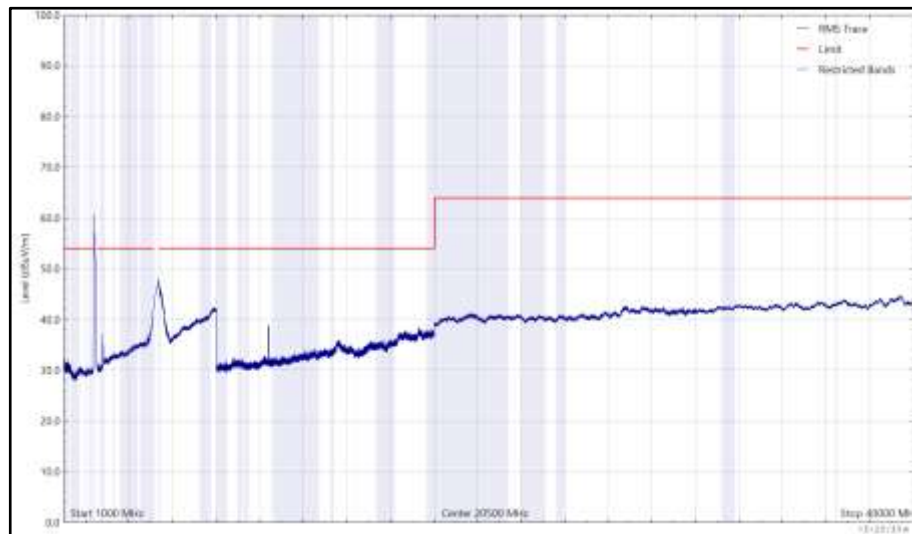


Figure 10 - 2417 MHz (CH2), HT20, CDD, Core 0 + Core 1 and U-NII-1 - 5200 MHz (CH40), HT20, CDD, Core 0 + Core 1, 1 GHz to 40 GHz, Horizontal (rms)

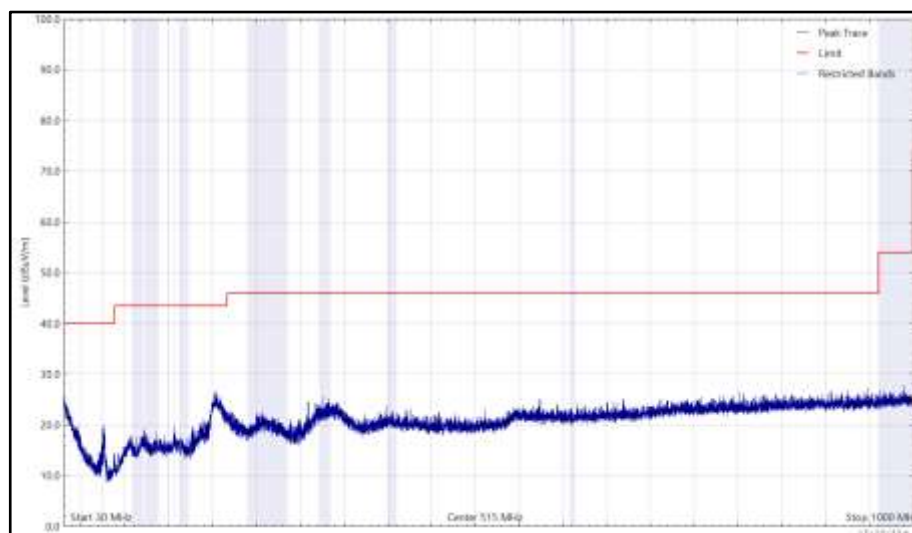


Figure 11 - 2417 MHz (CH2), HT20, CDD, Core 0 + Core 1 and U-NII-1 - 5200 MHz (CH40), HT20, CDD, Core 0 + Core 1, 30 MHz to 1 GHz, Vertical (Peak)

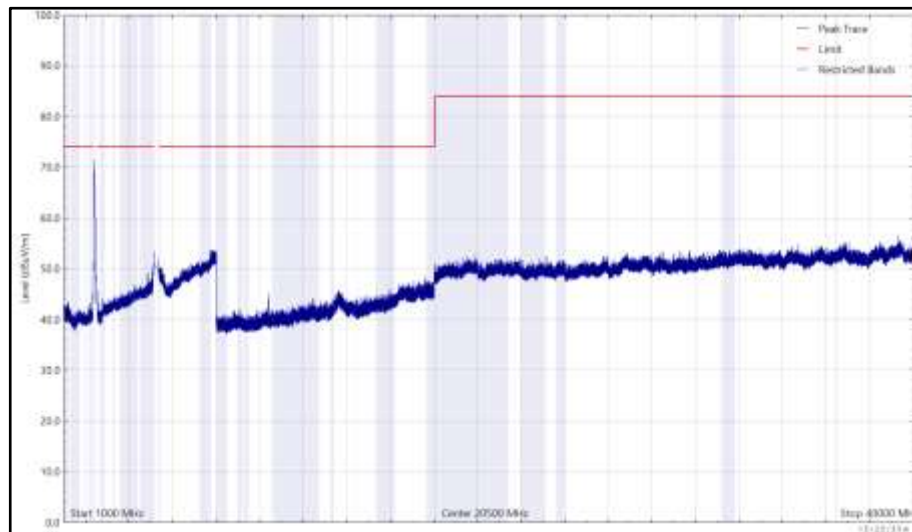


Figure 12 - 2417 MHz (CH2), HT20, CDD, Core 0 + Core 1 and U-NII-1 - 5200 MHz (CH40), HT20, CDD, Core 0 + Core 1, 1 GHz to 40 GHz, Vertical (Peak)

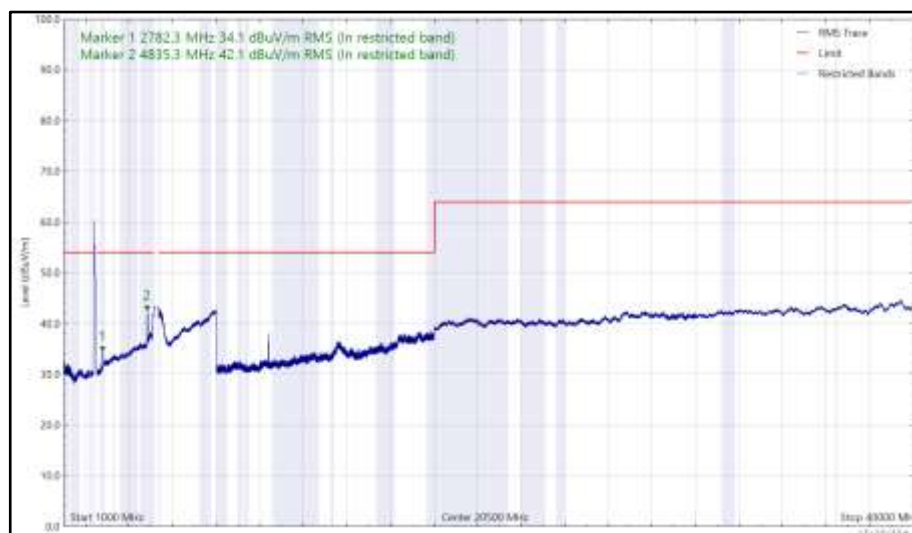


Figure 13 - 2417 MHz (CH2), HT20, CDD, Core 0 + Core 1 and U-NII-1 - 5200 MHz (CH40), HT20, CDD, Core 0 + Core 1, 1 GHz to 40 GHz, Vertical (rms)

CoTX - 2.4 GHz WLAN and 5 GHz WLAN and 2.4 GHz Bluetooth

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
2783.285	35.6	54.0	-18.4	RMS	312	372	Horizontal
12082.993	31.3	54.0	-22.3	RMS	200	107	Horizontal

Table 7 - 2417 MHz (CH2), HT20, Core 0 + Core 1 and U-NII-1 - 5200 MHz (CH40), HT20, Core 0 + Core 1 and 2480 MHz (CH78), DH5, iPA, Core 2

No other emissions found within 6 dB of the limit.

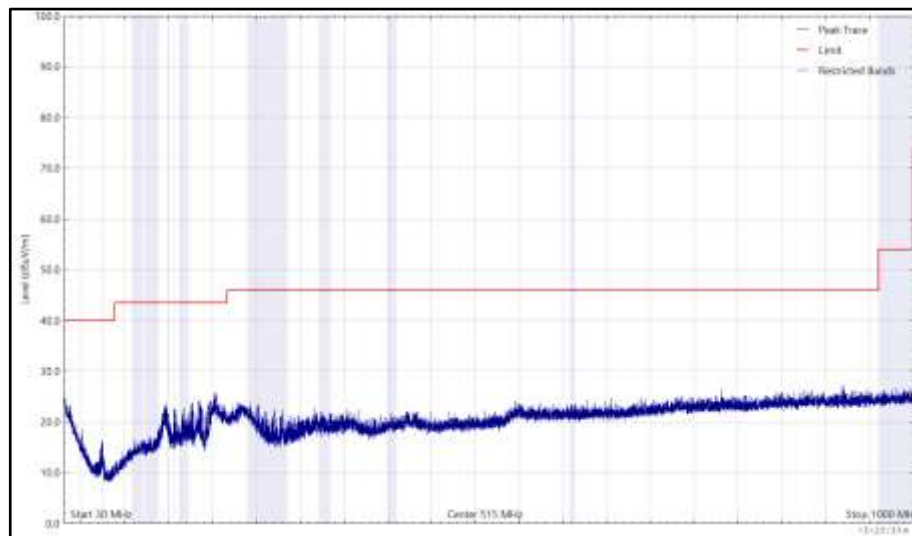


Figure 14 - 2417 MHz (CH2), HT20, Core 0 + Core 1 and U-NII-1 - 5200 MHz (CH40), HT20, Core 0 + Core 1 and 2480 MHz (CH78), DH5, iPA, Core 2, 30 MHz to 1 GHz, Horizontal (Peak)

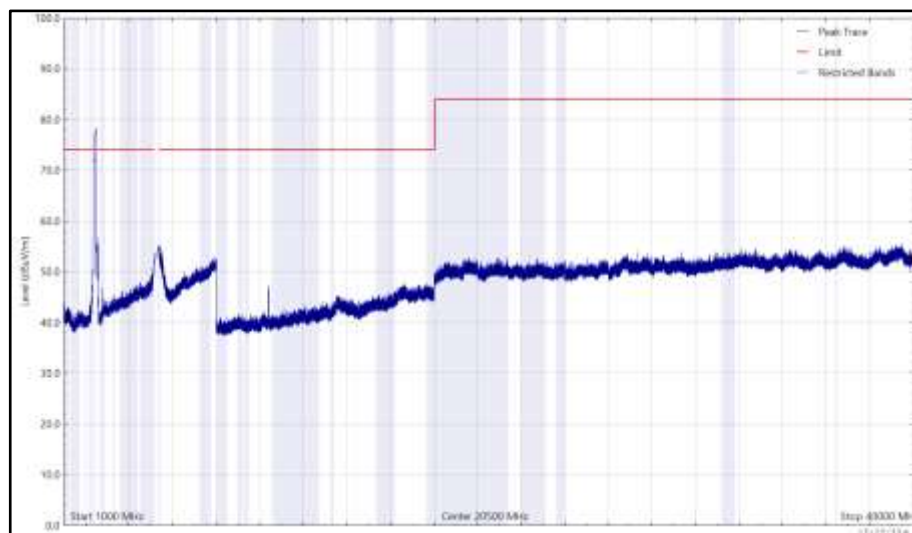


Figure 15 - 2417 MHz (CH2), HT20, Core 0 + Core 1 and U-NII-1 - 5200 MHz (CH40), HT20, Core 0 + Core 1 and 2480 MHz (CH78), DH5, iPA, Core 2, 1 GHz to 40 GHz, Horizontal (Peak)

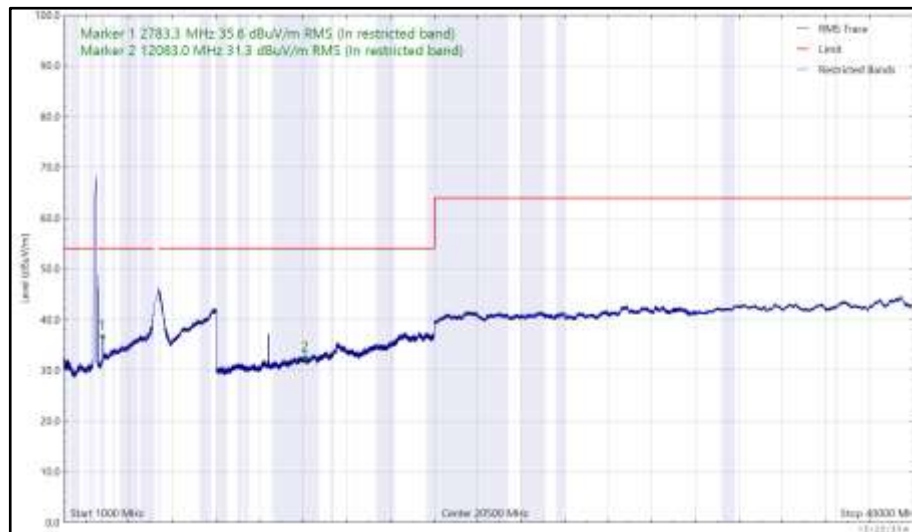


Figure 16 - 2417 MHz (CH2), HT20, Core 0 + Core 1 and U-NII-1 - 5200 MHz (CH40), HT20, Core 0 + Core 1 and 2480 MHz (CH78), DH5, iPA, Core 2, 1 GHz to 40 GHz, Horizontal (rms)

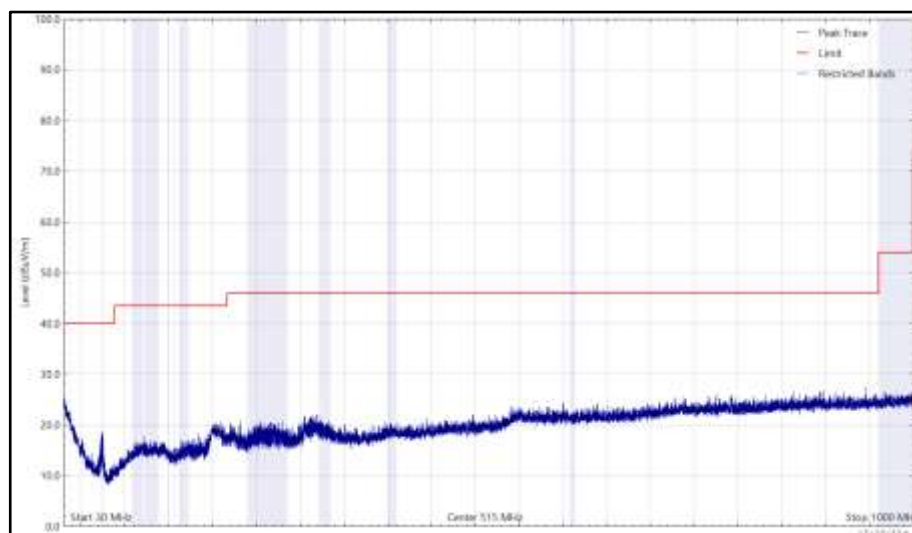


Figure 17 - 2417 MHz (CH2), HT20, Core 0 + Core 1 and U-NII-1 - 5200 MHz (CH40), HT20, Core 0 + Core 1 and 2480 MHz (CH78), DH5, iPA, Core 2, 30 MHz to 1 GHz, Vertical (Peak)

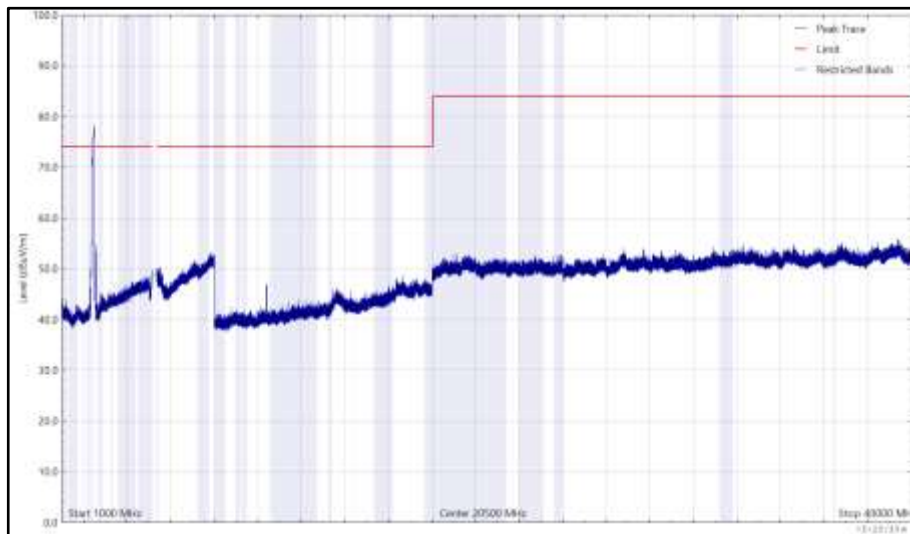


Figure 18 - 2417 MHz (CH2), HT20, Core 0 + Core 1 and U-NII-1 - 5200 MHz (CH40), HT20, Core 0 + Core 1 and 2480 MHz (CH78), DH5, iPA, Core 2, 1 GHz to 40 GHz, Vertical (Peak)

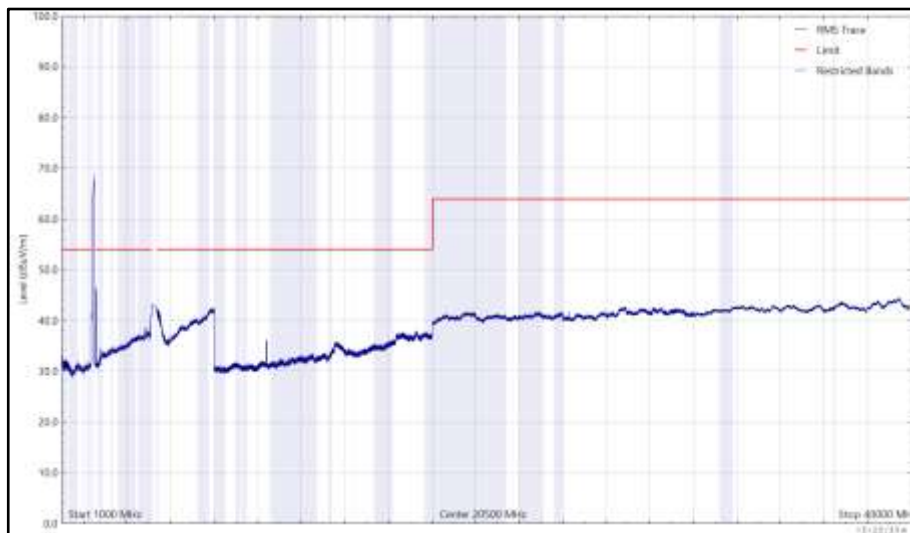


Figure 19 - 2417 MHz (CH2), HT20, Core 0 + Core 1 and U-NII-1 - 5200 MHz (CH40), HT20, Core 0 + Core 1 and 2480 MHz (CH78), DH5, iPA, Core 2, 1 GHz to 40 GHz, Vertical (rms)



Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
73.207	20.7	40.0	-19.3	Q-Peak	270	239	Vertical
2351.231	44.1	54.0	-9.9	RMS	37	214	Horizontal
2356.449	35.6	54.0	-18.4	RMS	156	145	Vertical
2802.303	37.5	54.0	-16.5	RMS	281	260	Horizontal
4905.121	43.8	54.0	-9.8	RMS	2	229	Vertical
4905.156	38.8	54.0	-14.8	RMS	0	158	Horizontal
11360.860	43.8	54.0	-10.1	RMS	358	246	Vertical
11360.882	47.0	54.0	-6.9	RMS	257	107	Horizontal
11362.641	56.8	74.0	-17.2	Peak	360	243	Vertical
11362.916	56.9	74.0	-17.0	Peak	244	100	Horizontal

Table 8 - 2452 MHz (CH9), HT20, Core 0 + Core 1 and U-NII-2C - 5680 MHz (CH136), HT20, Core 0 + Core 1 and 2402 MHz (CH0), DH5, iPA, Core 2

No other emissions found within 6 dB of the limit.

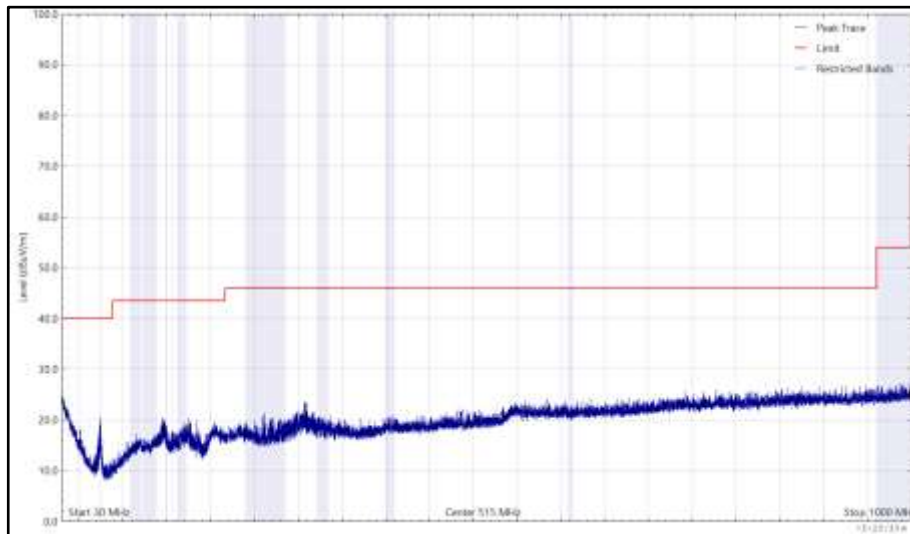


Figure 20 - 2452 MHz (CH9), HT20, Core 0 + Core 1 and U-NII-2C - 5680 MHz (CH136), HT20, Core 0 + Core 1 and 2402 MHz (CH0), DH5, iPA, Core 2, 30 MHz to 1 GHz, Horizontal (Peak)

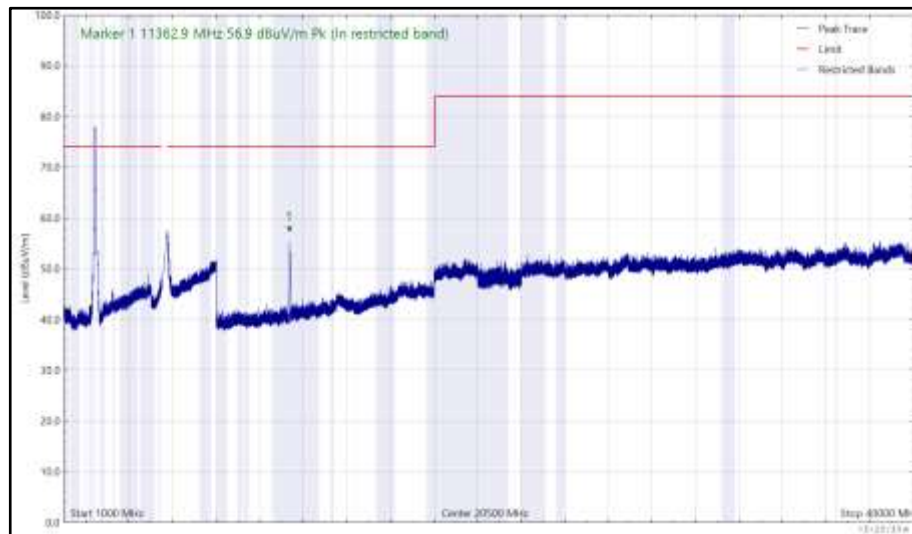


Figure 21 - 2452 MHz (CH9), HT20, Core 0 + Core 1 and U-NII-2C - 5680 MHz (CH136), HT20, Core 0 + Core 1 and 2402 MHz (CH0), DH5, iPA, Core 2, 1 GHz to 40 GHz, Horizontal (Peak)

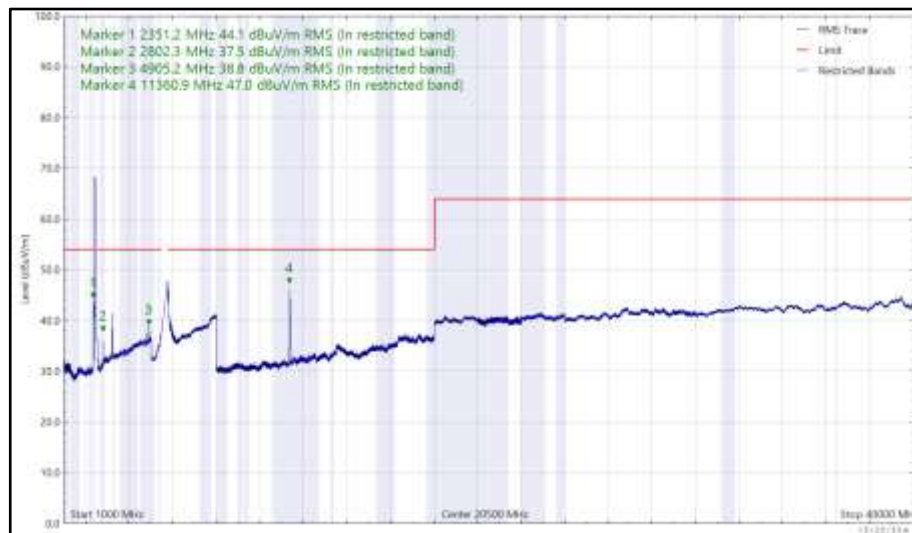


Figure 22 - 2452 MHz (CH9), HT20, Core 0 + Core 1 and U-NII-2C - 5680 MHz (CH136), HT20, Core 0 + Core 1 and 2402 MHz (CH0), DH5, iPA, Core 2, 1 GHz to 40 GHz, Horizontal (rms)

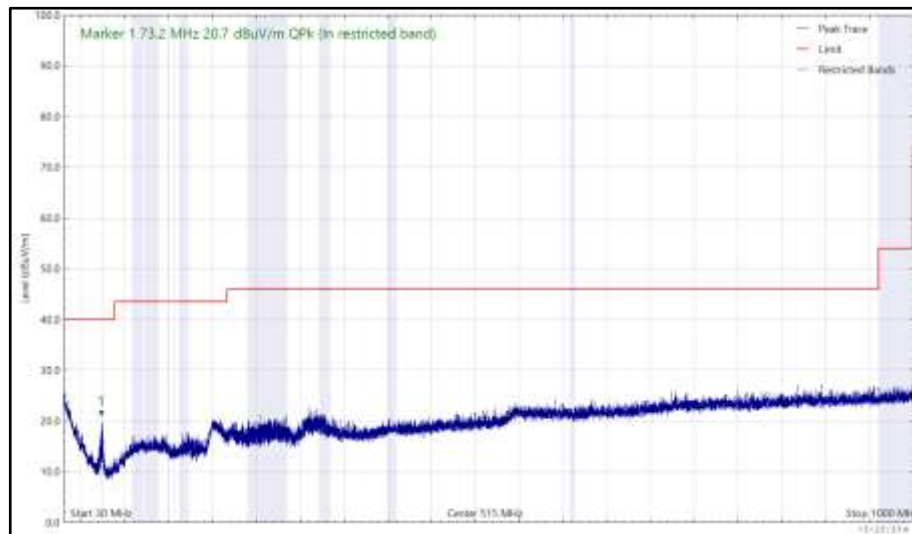


Figure 23 - 2452 MHz (CH9), HT20, Core 0 + Core 1 and U-NII-2C - 5680 MHz (CH136), HT20, Core 0 + Core 1 and 2402 MHz (CH0), DH5, iPA, Core 2, 30 MHz to 1 GHz, Vertical (Peak)

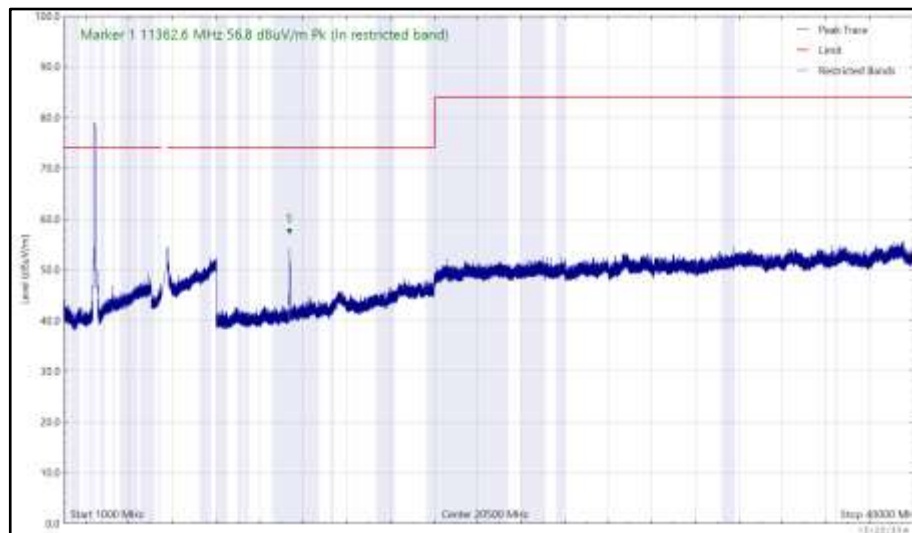


Figure 24 - 2452 MHz (CH9), HT20, Core 0 + Core 1 and U-NII-2C - 5680 MHz (CH136), HT20, Core 0 + Core 1 and 2402 MHz (CH0), DH5, iPA, Core 2, 1 GHz to 40 GHz, Vertical (Peak)

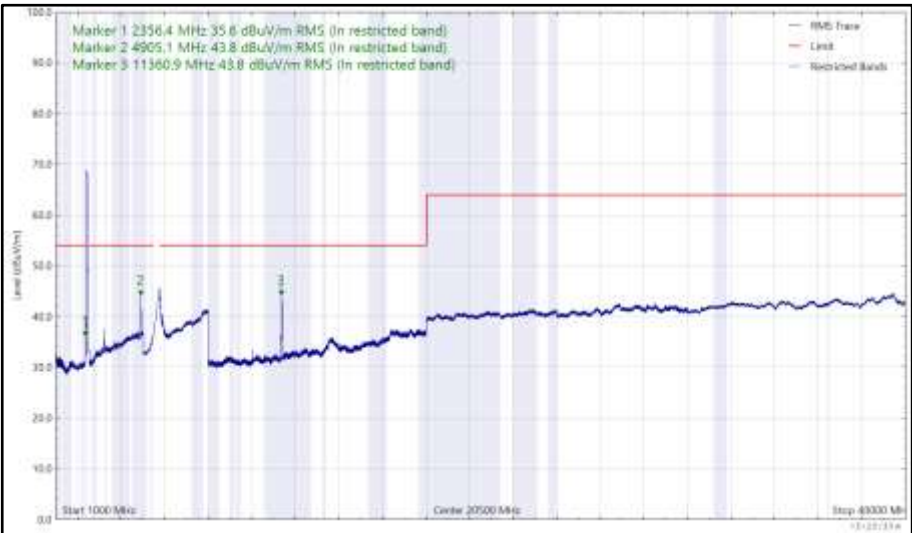


Figure 25 - 2452 MHz (CH9), HT20, Core 0 + Core 1 and U-NII-2C - 5680 MHz (CH136), HT20, Core 0 + Core 1 and 2402 MHz (CH0), DH5, iPA, Core 2, 1 GHz to 40 GHz, Vertical (rms)

Limit Clauses

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 9



2.1.8 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
Antenna 18-40GHz (Double Ridge Guide)	Link Microtek Ltd	AM180HA-K-TU2	230	24	27-Jul-2022
18GHz - 40GHz Pre-Amplifier	Phase One	PSO4-0087	1534	12	18-Feb-2021
Screened room (5)	Rainford	Rainford	1545	36	23-Jan-2021
Antenna with permanent attenuator (Bilog)	Chase	CBL6143	2904	24	30-Sep-2021
Double Ridge Broadband Horn Antenna	Schwarzbeck	BBHA 9120 B	4848	12	10-Mar-2021
8 - 18 GHz pre amp	Wright Technologies	PS06-0061/PS06-0060	4971	6	04-May-2021
EmX Emissions Software	TUV SUD	V2.1.0	5125	-	Software
Band Reject Filter - 2.425 GHz	Wainwright	WRCGV14-2390-2400-2450-2460-50SS	5067	12	02-Oct-2021
Band Reject Filter - 2.4585 GHz	Wainwright	WRCGV14-2423.5-2433.5-2483.5-2493.5-50SS	5069	12	12-Oct-2021
Band Reject Filter - 5.22 GHz	Wainwright	WRCJV12-5120-5150-5290-5320-50SS	5073	12	02-Oct-2021
Band Reject Filter - 5.690 GHz	Wainwright	WRCJV8-5635-5670-5710-5745-50SS	5081	12	02-Oct-2021
3 GHz High pass filter	Wainwright	WHKX12-2580-3000-18000-80SS	5220	12	25-Mar-2021
Preamplifier (30dB 1GHz to 18GHz)	Schwarzbeck	BBV 9718 C	5261	12	07-Apr-2021
Antenna (DRG Horn 7.5-18GHz)	Schwarzbeck	HWRD750	5348	12	22-Sep-2021
1m K-Type Cable	Junkosha	MWX241-01000KMSKMS/A	5511	12	03-Apr-2021
1m -SMA Cable	Junkosha	MWX221-01000AMSAMS/A	5513	12	01-Apr-2021
1m -SMA Cable	Junkosha	MWX221-01000AMSAMS/A	5514	12	01-Apr-2021
1m -SMA Cable	Junkosha	MWX221-01000AMSAMS/A	5515	12	01-Apr-2021
2m SMA Cable	Junkosha	MWX221-02000AMSAMS/A	5517	12	01-Apr-2021
8m N Type Cable	Junkosha	MWX221-08000NMSNMS/B	5519	12	24-Mar-2021
8m N-Type Cable	Junkosha	MWX221-08000NMSNMS/B	5520	12	24-Mar-2021
2 m K Type Cable	Junkosha	MWX241-02000KMSKMS/A	5523	12	03-Apr-2021
7 GHz High pass Filter	Wainwright	WHKX12-5850-6800-18000-80SS	5549	12	23-May-2021



Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
1200 MHz Low Pass Filter (01)	Mini-Circuits	VLF-1200+	5559	12	23-May-2021
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB 40	5604	12	08-Sep-2021

Table 10



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 11

Measurement Uncertainty Decision Rule

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