

FCC and ISED Test Report

Apple Inc
Model: A2681

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

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

FCC ID: BCGA2681

IC: 579C-A2681

COMMERCIAL-IN-CONFIDENCE

Document 75954421-14 Issue 01



Add value.
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NAME	JOB TITLE	RESPONSIBLE FOR	ISSUE DATE
Steve Marshall	Senior Engineer	Authorised Signatory	03 May 2022

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, ISED RSS-247 and ISED RSS-GEN. The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Report Generation	Hollie Marshall	03 May 2022	

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 Part 15: 2020, ISED RSS-247: Issue 2 (2017-02) and ISED RSS-GEN: Issue 5 (04-2018) + A2 (02-2021 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	03 May 2022

Table 1

1.2 Introduction

Applicant	Apple Inc
Manufacturer	Apple Inc
Model Number(s)	A2681
Serial Number(s)	MW4P32N6T0 and DQH576VJ7N
Hardware Version(s)	REV 1.0
Software Version(s)	21E71860f and 21E61410w
Number of Samples Tested	2
Test Specification/Issue/Date	FCC 47 CFR Part 15: 2020 ISED RSS-247: Issue 2 (2017-02) ISED RSS-GEN: Issue 5 (04-2018) + A2 (02-2021)
Order Number	0540246998
Date of Receipt of EUT	16-February-2022
Start of Test	03-March-2022
Finish of Test	29-March-2022
Name of Engineer(s)	Ian Hart, Mohammad Malik, Danial Shafique, Ahmad Javid and Thomas Randall
Related Document(s)	ANSI C63.4: 2014 ANSI C63.10: 2013



1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC and ISED (Simultaneous Transmission) 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 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	
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	

Table 2



1.4 Product Information

1.4.1 Technical Description

The equipment under test was an Apple laptop computer with Bluetooth® and IEEE 802.11 a/b/g/n/ac/ax Wi-Fi 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: A2681, Serial Number: MW4P32N6T0			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: A2681, Serial Number: DQH576VJ7N			
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 - 2.4 GHz WLAN, 5 GHz WLAN and Bluetooth		
Radiated Spurious Emissions (Simultaneous Transmission)	Ian Hart, Thomas Randall and Mohammad Malik	UKAS
Configuration and Mode: SDB - 2.4 GHz WLAN and 5 GHz WLAN		
Radiated Spurious Emissions (Simultaneous Transmission)	Ian Hart, Mohammad Malik, Danial Shafique, Ahmad Javid and Thomas Randall	UKAS

Table 4

Office Address:

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



2 Test Details

2.1 Radiated Spurious Emissions (Simultaneous Transmission)

2.1.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.209, 15.247 (d) and 15.407 (b)
ISED RSS-247, Clause 5.5 and 6.2
ISED RSS-GEN, Clause 8.9

2.1.2 Equipment Under Test and Modification State

A2681, S/N: MW4P32N6T0 - Modification State 0
A2681, S/N: DQH576VJ7N - Modification State 0

2.1.3 Date of Test

03-March-2022 to 29-March-2022

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:
 $10^{(\text{Field Strength in dB}\mu\text{V/m}/20)}$

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 Test Setup Diagram

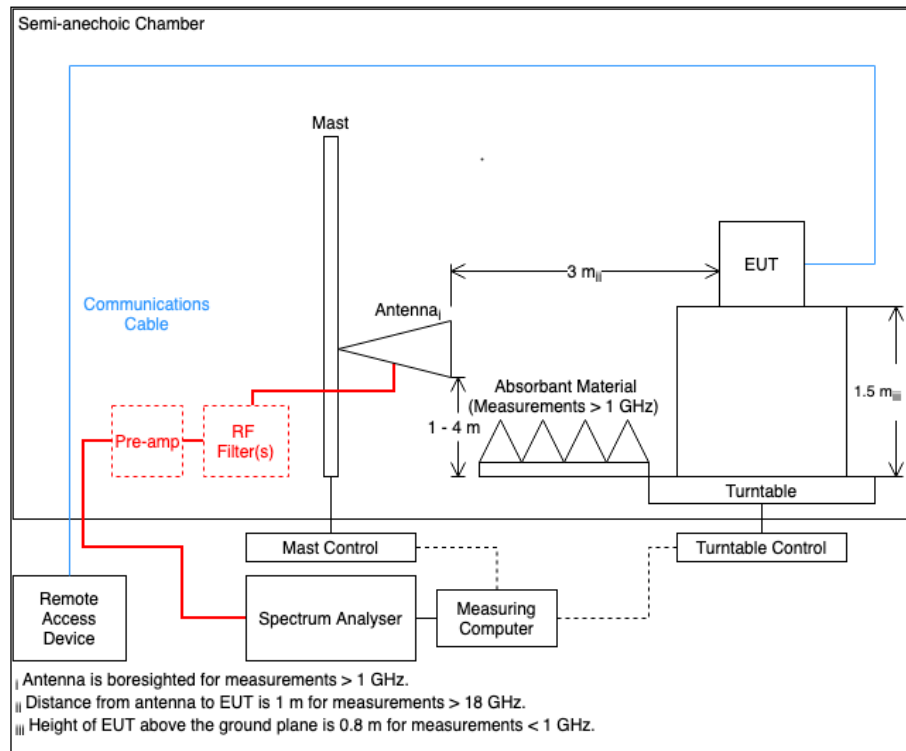


Figure 1

2.1.6 Environmental Conditions

Ambient Temperature	19.6 - 30.7 °C
Relative Humidity	24.8 - 41.3 %

2.1.7 Test Results

CoTx - 5 GHz WLAN and Bluetooth

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
37.816	26.5	40.0	-13.5	Q-Peak	91	100	Vertical
73.800	35.3	40.0	-4.7	Q-Peak	274	236	Vertical
73.804	32.8	40.0	-7.2	Q-Peak	0	368	Horizontal
110.637	25.7	43.5	-17.8	Q-Peak	217	105	Vertical
113.405	33.7	43.5	-9.8	Q-Peak	172	262	Horizontal
115.565	28.5	43.5	-15.1	Q-Peak	77	100	Vertical
125.485	20.8	43.5	-22.7	Q-Peak	331	261	Horizontal
125.519	21.0	43.5	-22.5	Q-Peak	131	102	Vertical
4804.231	37.7	54.0	-16.3	CISPR Avg	4	328	Vertical

Table 5 - U-NII-1 – 5200 MHz (CH40), VHT20, CDD, Core 0 + Core 1 and 2402 MHz (CH0), DH5, ePA, Core 0 + Core 1, 30 MHz to 40 GHz

No other emissions found within 6 dB of the limit.

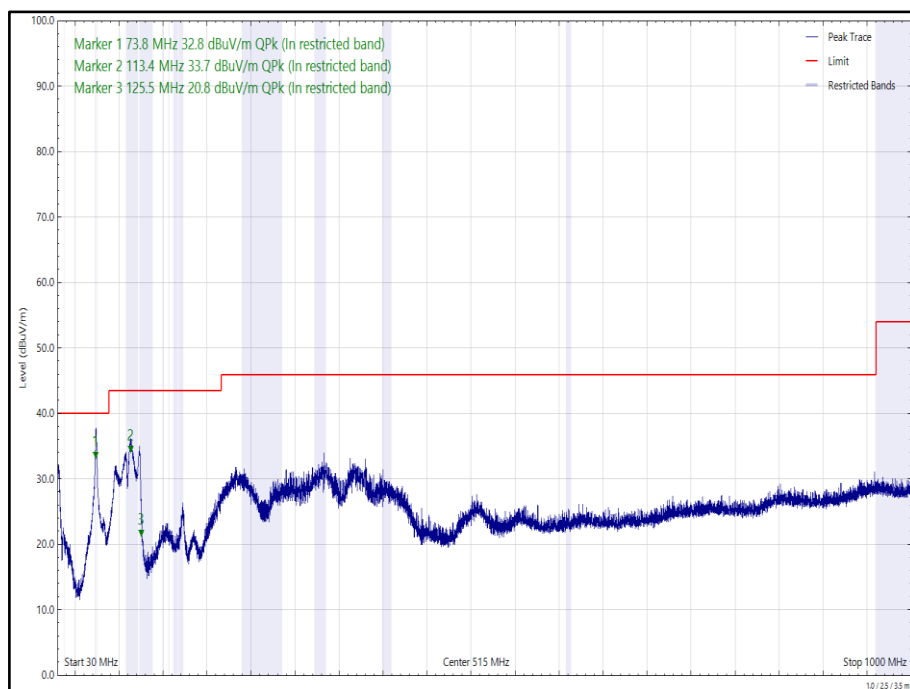


Figure 2 - U-NII-1 – 5200 MHz (CH40), VHT20, CDD, Core 0 + Core 1 and 2402 MHz (CH0), DH5, ePA, 30 MHz to 1 GHz, Horizontal (Peak)

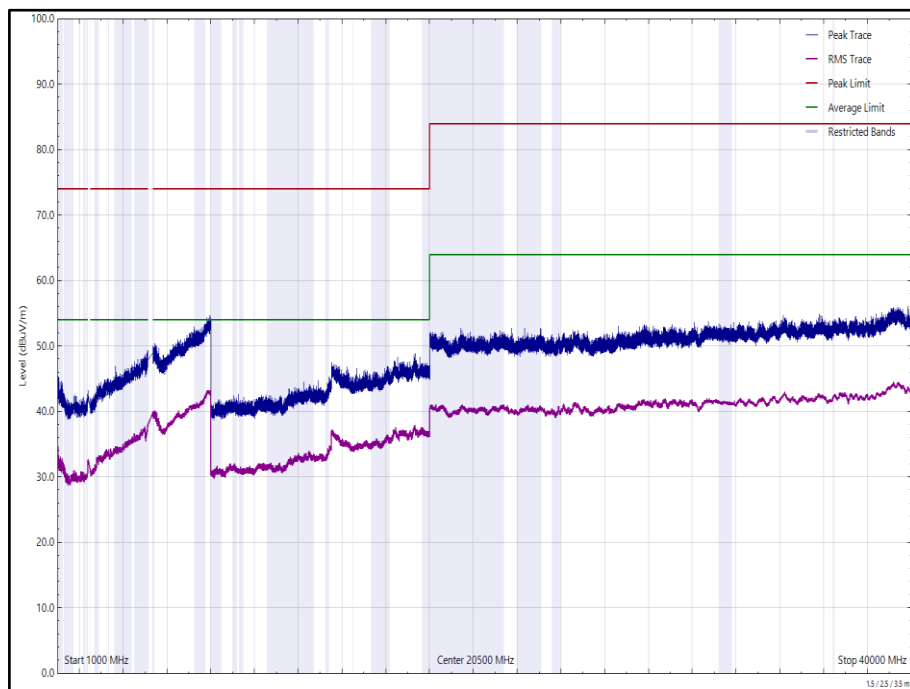


Figure 3 - U-NII-1 – 5200 MHz (CH40), VHT20, CDD, Core 0 + Core 1 and 2402 MHz (CH0), DH5, ePA, Core 0 + Core 1, 1 GHz to 40 GHz, Horizontal

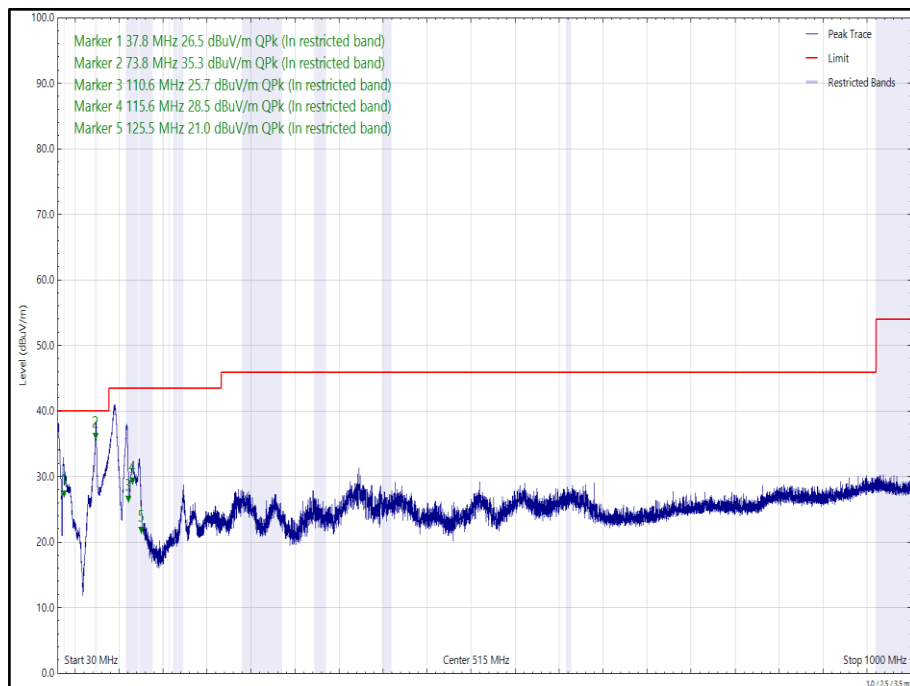


Figure 4 - U-NII-1 – 5200 MHz (CH40), VHT20, CDD, Core 0 + Core 1 and 2402 MHz (CH0), DH5, ePA, 30 MHz to 1 GHz, Vertical (Peak)

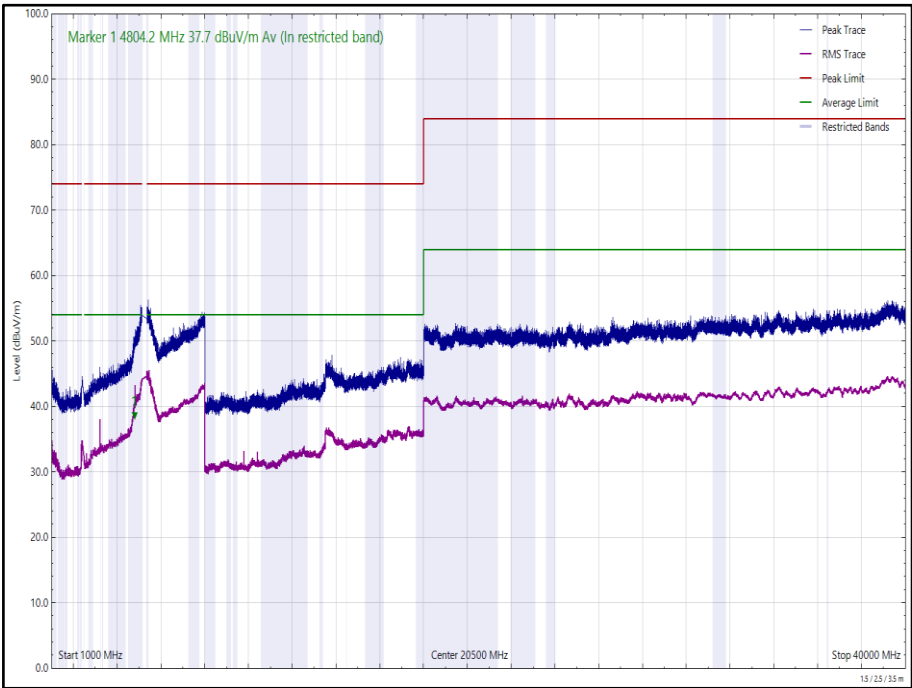


Figure 5 - U-NII-1 – 5200 MHz (CH40), VHT20, CDD, Core 0 + Core 1 and 2402 MHz (CH0), DH5, ePA, Core 0 + Core 1, 1 GHz to 40 GHz, Vertical

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
37.962	26.2	40.0	-13.8	Q-Peak	0	100	Vertical
73.795	35.7	40.0	-4.3	Q-Peak	271	218	Vertical
73.802	33.9	40.0	-6.1	Q-Peak	350	349	Horizontal
110.633	25.6	43.5	-17.9	Q-Peak	207	108	Vertical
112.927	33.8	43.5	-9.7	Q-Peak	172	255	Horizontal
125.428	20.5	43.5	-23.1	Q-Peak	320	260	Horizontal
125.513	21.0	43.5	-22.5	Q-Peak	139	104	Vertical
4960.042	41.3	54.0	-12.7	CISPR Avg	340	288	Vertical

Table 6 - U-NII-2C – 5680 MHz (CH136), VHT20, CDD, Core 0 + Core 1 and 2480 MHz (CH78), DH5, ePA, 30 MHz to 40 GHz

No other emissions found within 6 dB of the limit.

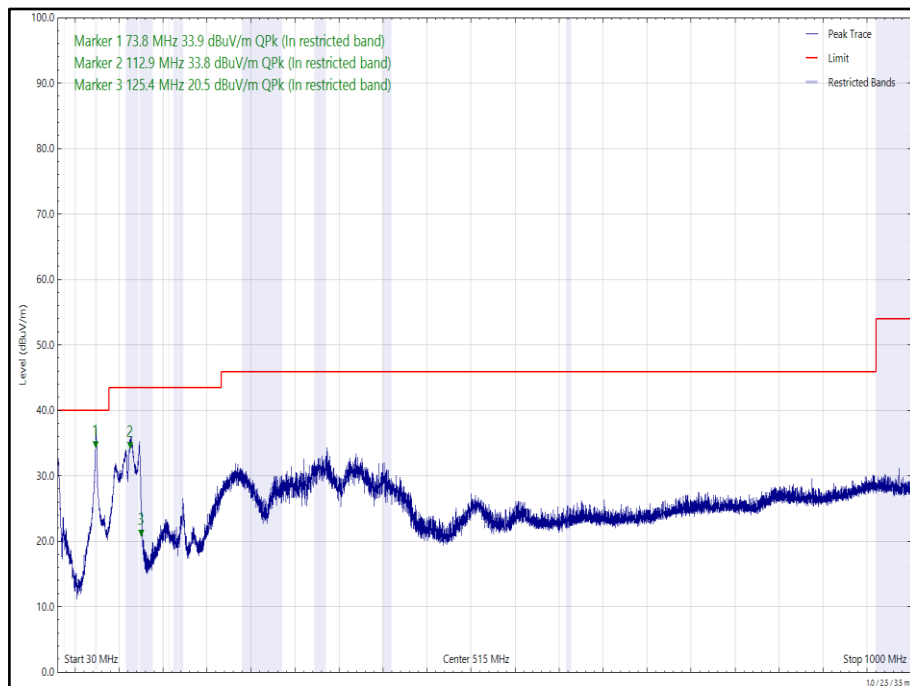


Figure 6 - U-NII-2C – 5680 MHz (CH136), VHT20, CDD, Core 0 + Core 1 and 2480 MHz (CH78), DH5, ePA, 30 MHz to 1 GHz, Horizontal (Peak)

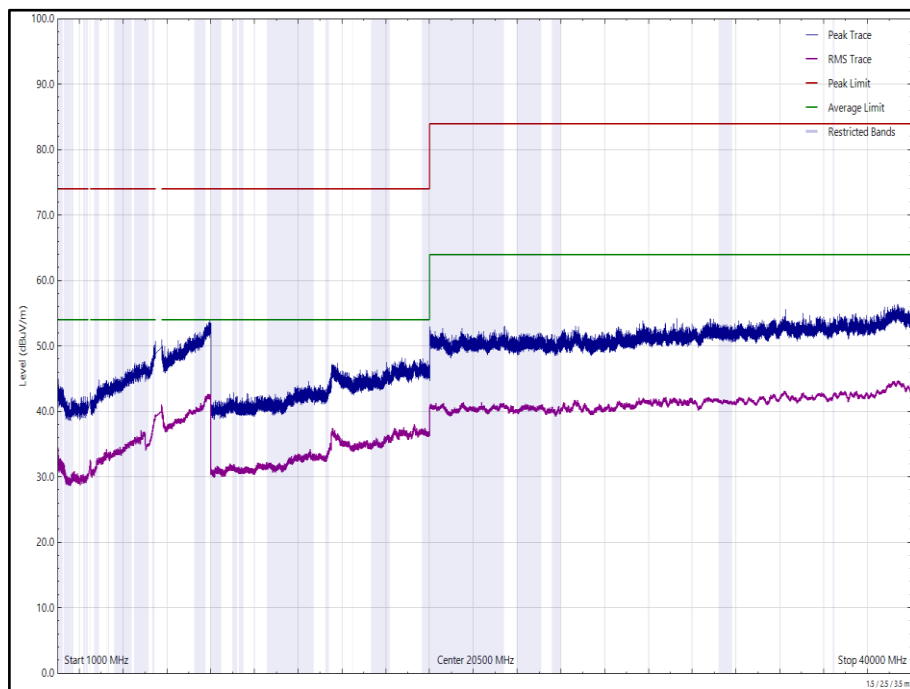


Figure 7 - U-NII-2C – 5680 MHz (CH136), VHT20, CDD, Core 0 + Core 1 and 2480 MHz (CH78), DH5, ePA, Core 0 + Core 1, 1 GHz to 40 GHz, Horizontal

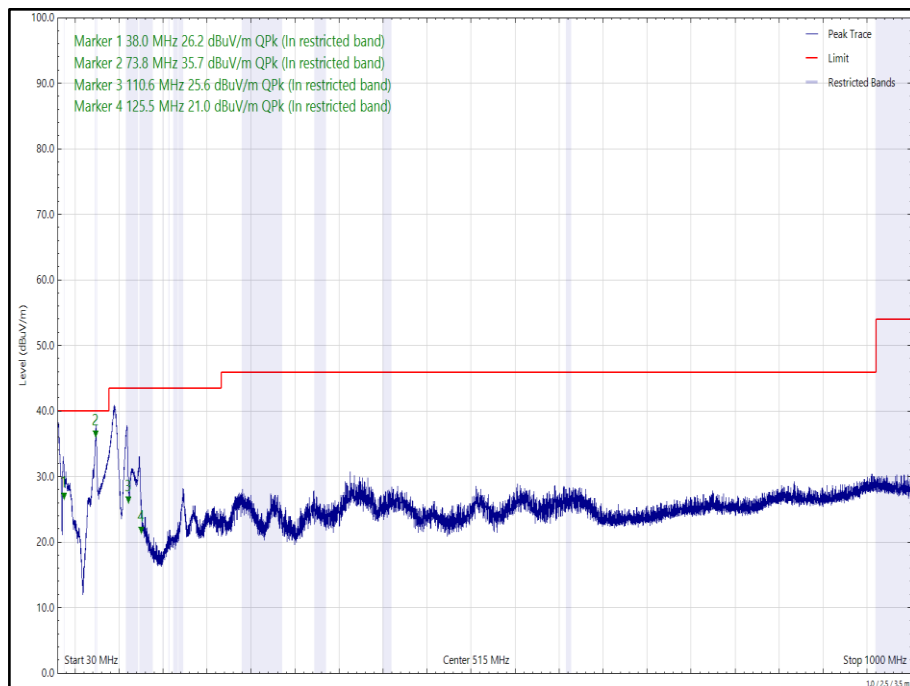


Figure 8 - U-NII-2C – 5680 MHz (CH136), VHT20, CDD, Core 0 + Core 1 and 2480 MHz (CH78), DH5, ePA, 30 MHz to 1 GHz, Vertical (Peak)

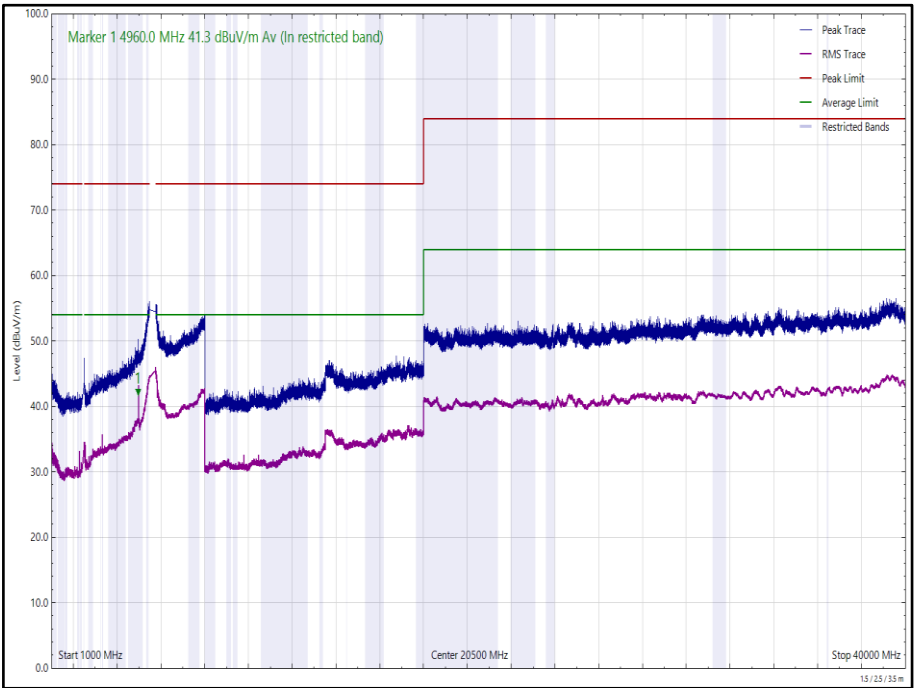


Figure 9 - U-NII-2C – 5680 MHz (CH136), VHT20, CDD, Core 0 + Core 1 and 2480 MHz (CH78), DH5, ePA, Core 0 + Core 1, 1 GHz to 40 GHz, Vertical

SDB - 2.4 GHz WLAN and 5 GHz WLAN

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
37.768	29.3	40.0	-10.7	Q-Peak	353	101	Vertical
37.908	15.1	40.0	-25.0	Q-Peak	163	229	Horizontal
73.839	17.0	40.0	-23.0	Q-Peak	112	260	Horizontal
73.981	22.5	40.0	-17.5	Q-Peak	257	171	Vertical
109.255	34.6	43.5	-8.9	Q-Peak	121	100	Vertical
114.668	34.8	43.5	-8.7	Q-Peak	350	261	Horizontal
117.751	38.2	43.5	-5.3	Q-Peak	179	100	Vertical
119.630	32.9	43.5	-10.6	Q-Peak	206	250	Horizontal
2789.922	33.2	54.0	-20.8	RMS	9	327	Vertical
4824.412	42.1	54.0	-11.9	RMS	0	304	Vertical
4824.909	55.8	74.0	-18.2	Peak	0	304	Vertical

Table 7 - 2412 MHz (CH1), HT20, Core 0 + Core 1 and U-NII-1 – 5200 MHz (CH40), VHT20, CDD, Core 0 + Core 1, 30 MHz to 40 GHz

No other emissions found within 6 dB of the limit.

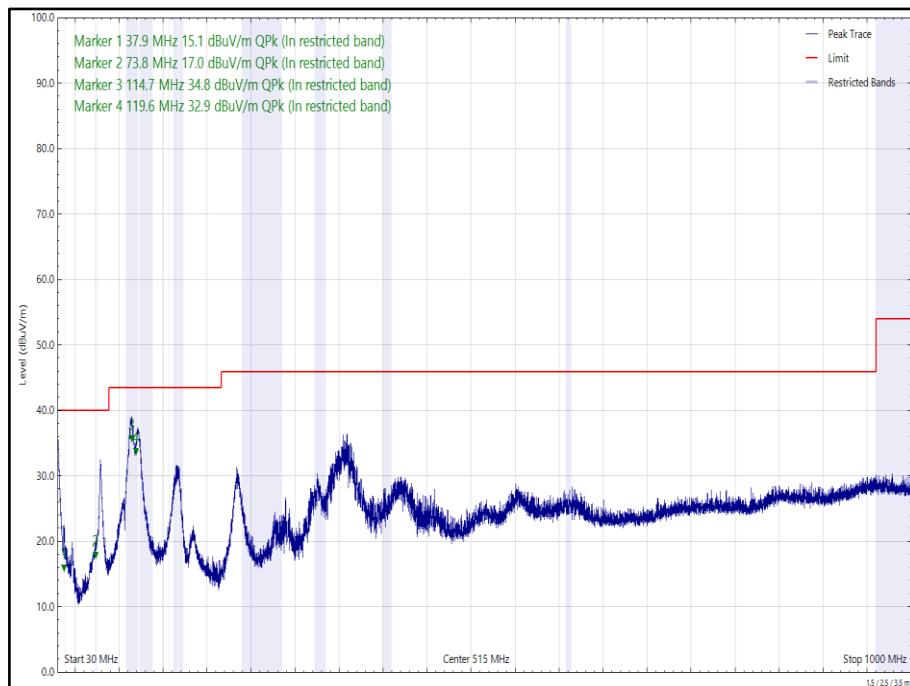


Figure 10 - 2412 MHz (CH1), HT20, Core 0 + Core 1 and U-NII-1 – 5200 MHz (CH40), VHT20, CDD, Core 0 + Core 1, 30 MHz to 1 GHz, Horizontal (Peak)

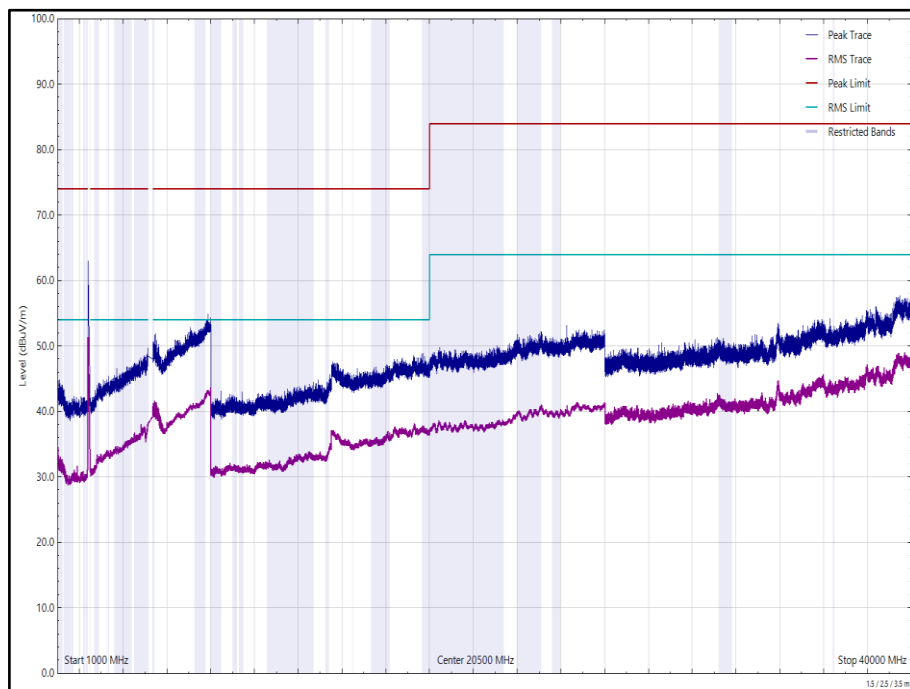


Figure 11 - 2412 MHz (CH1), HT20, Core 0 + Core 1 and U-NII-1 – 5200 MHz (CH40), VHT20, CDD, Core 0 + Core 1, 1 GHz to 40 GHz, Horizontal

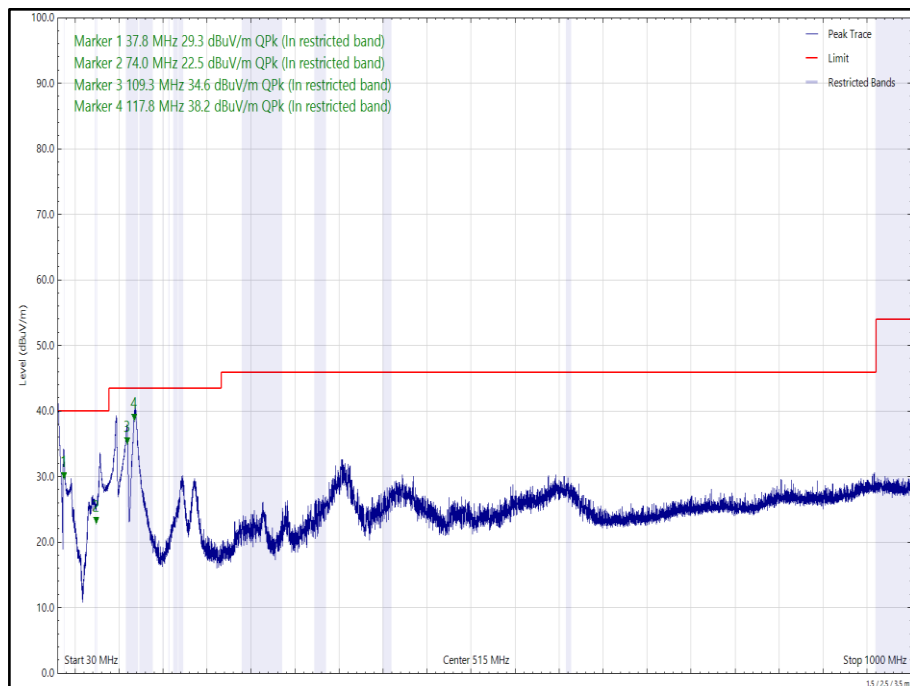


Figure 12 - 2412 MHz (CH1), HT20, Core 0 + Core 1 and U-NII-1 – 5200 MHz (CH40), VHT20, CDD, Core 0 + Core 1, 30 MHz to 1 GHz, Vertical (Peak)

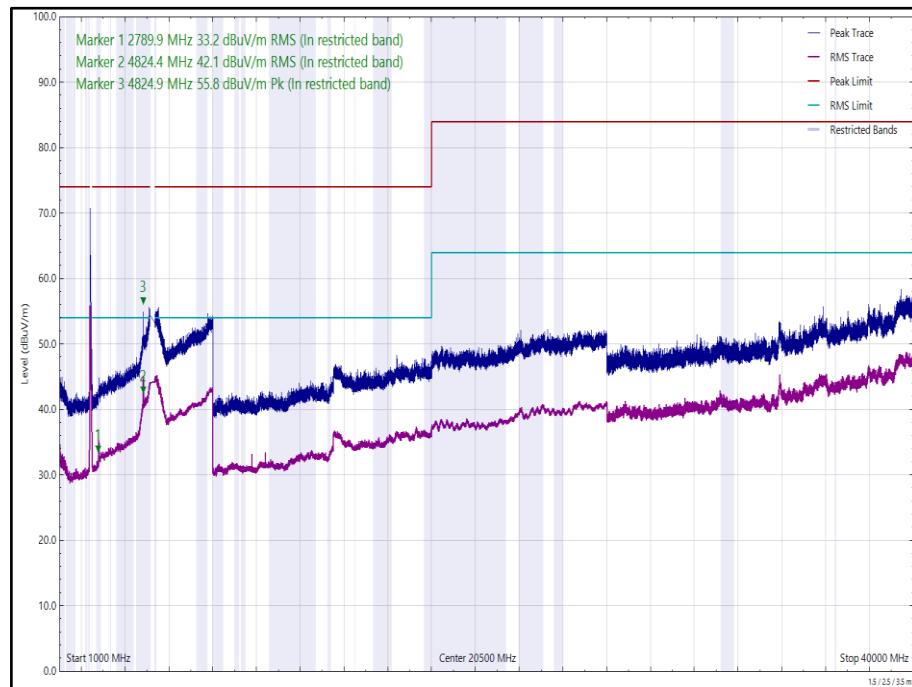


Figure 13 - 2412 MHz (CH1), HT20, Core 0 + Core 1 and U-NII-1 - 5200 MHz (CH40), VHT20, CDD, Core 0 + Core 1, 1 GHz to 40 GHz, Vertical

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
37.716	27.6	40.0	-12.4	Q-Peak	331	100	Vertical
37.797	16.1	40.0	-23.9	Q-Peak	95	221	Horizontal
73.961	21.2	40.0	-18.8	Q-Peak	260	296	Vertical
74.085	21.8	40.0	-18.2	Q-Peak	123	256	Horizontal
114.954	21.7	43.5	-21.8	Q-Peak	297	107	Vertical
119.319	34.6	43.5	-8.9	Q-Peak	0	253	Horizontal
124.989	30.1	43.5	-13.4	Q-Peak	131	103	Vertical

Table 8 - 2472 MHz (CH13), HT20, Core 0 + Core 1 and U-NII-2C – 5680 MHz (CH136), VHT20, CDD, Core 0 + Core 1, 30 MHz to 40 GHz

No other emissions found within 6 dB of the limit.

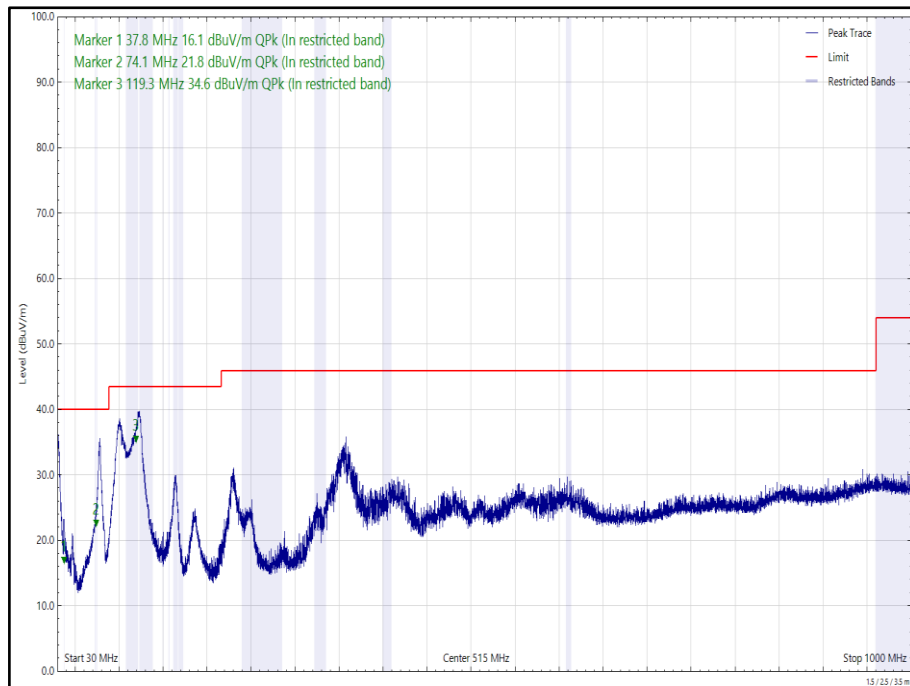


Figure 14 - 2472 MHz (CH13), HT20, Core 0 + Core 1 and U-NII-2C – 5680 MHz (CH136), VHT20, CDD, Core 0 + Core 1, 30 MHz to 1 GHz, Horizontal (Peak)

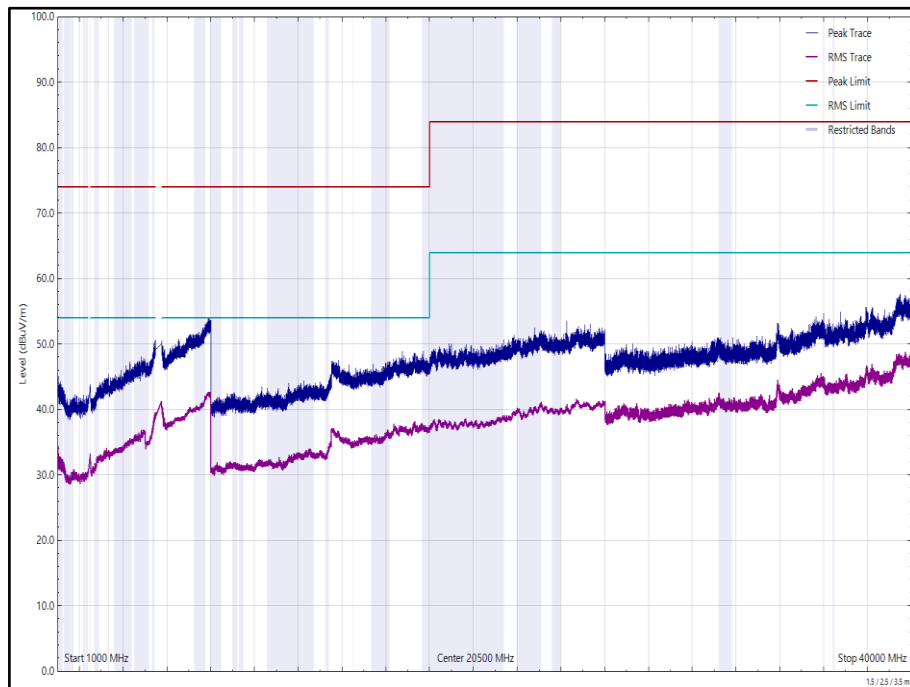


Figure 15 - 2472 MHz (CH13), HT20, Core 0 + Core 1 and U-NII-2C – 5680 MHz (CH136), VHT20, CDD, Core 0 + Core 1, 1 GHz to 40 GHz, Horizontal

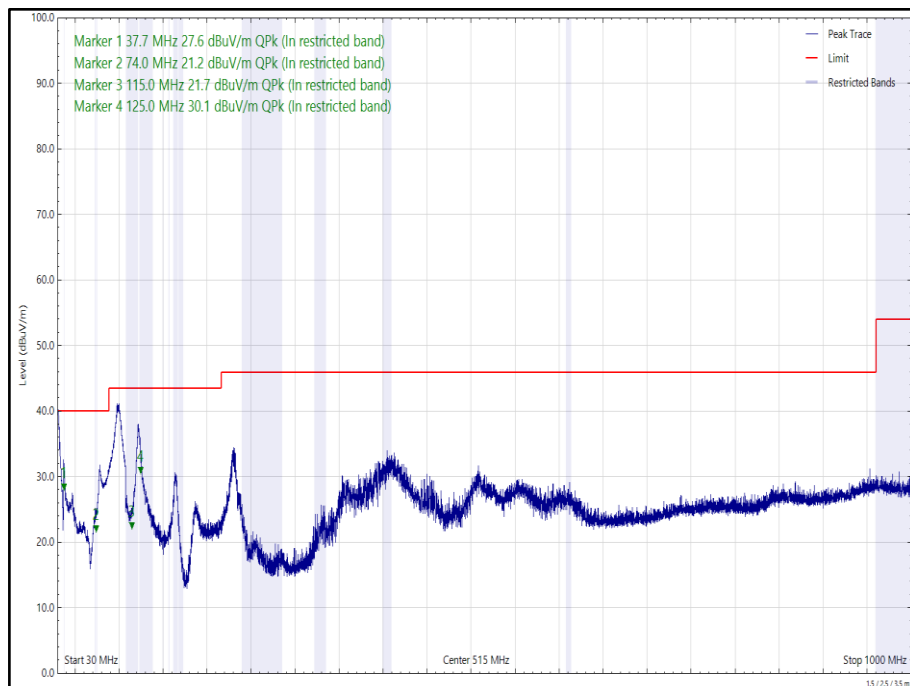


Figure 16 - 2472 MHz (CH13), HT20, Core 0 + Core 1 and U-NII-2C – 5680 MHz (CH136), VHT20, CDD, Core 0 + Core 1, 30 MHz to 1 GHz, Vertical (Peak)

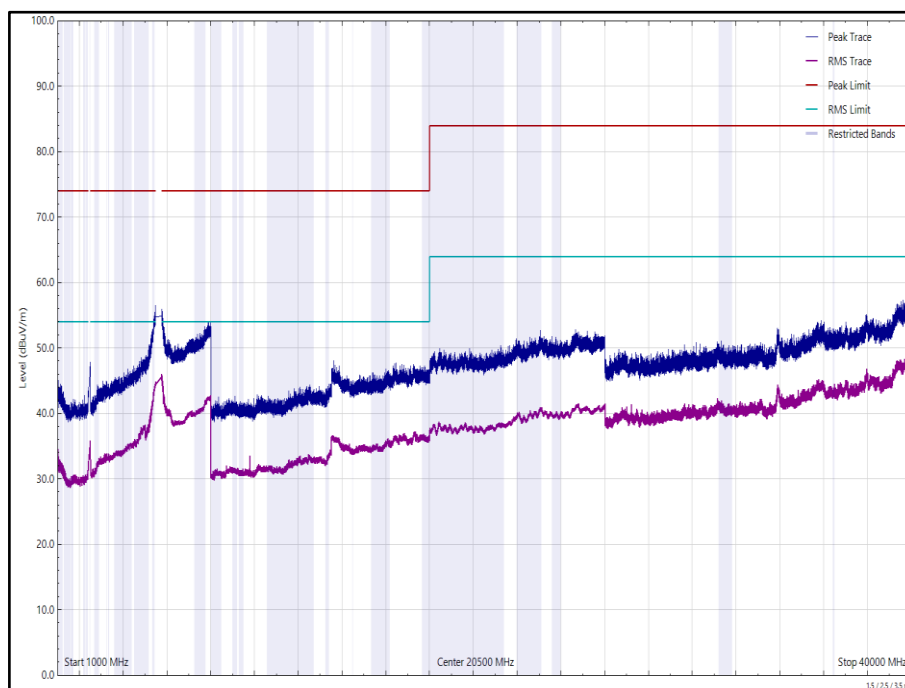


Figure 17 - 2472 MHz (CH13), HT20, Core 0 + Core 1 and U-NII-2C – 5680 MHz (CH136), VHT20, CDD, Core 0 + Core 1, 1 GHz to 40 GHz, Vertical

FCC 47 CFR Part 15 and ISSED RSS-247

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

The least stringent applicable limit was:

Clause	Limit
Part 15.247 (d) / RSS-247 Clause 5.5	-30 dBc
Part 15.407 (b) / RSS-247 Clause 6.2	-27 dBm (EIRP) / 68 dBμV/m at 3m.
Part 15.205 / RSS-GEN Clause 6.13	Peak: 74 dBμV/m at 3m, Average 54 dBμV/m at 3m

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 Expires
Antenna (DRG, 18 GHz to 40 GHz)	Link Microtek Ltd	AM180HA-K-TU2	230	24	27-Jul-2022
LISN	Rohde & Schwarz	ESH3-Z5	1390	12	31-Jan-2023
Pre-Amplifier (18 GHz to 40 GHz)	Phase One	PSO4-0087	1534	12	02-Aug-2022
Screened Room (5)	Rainford	Rainford	1545	36	15-Apr-2024
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Programmable Power Supply	Iso-tech	IPS 2010	2437	-	O/P Mon
Multimeter	Fluke	79 Series II	3057	12	23-Aug-2022
Mast Controller	Maturo GmbH	NCD	4810	-	TU
Tilt Antenna Mast	Maturo GmbH	TAM 4.0-P	4811	-	TU
Double Ridge Broadband Horn Antenna	Schwarzbeck	BBHA 9120 B	4848	12	01-Apr-2022
8 - 18 GHz pre amp	Wright Technologies	PS06-0061/PS06-0060	4971	6	09-Nov-2022
Band Reject Filter - 2.425 GHz	Wainwright	WRCGV14-2390-2400-2450-2460-50SS	5067	12	29-Sep-2022
Band Reject Filter - 2.4585 GHz	Wainwright	WRCGV14-2423.5-2433.5-2483.5-2493.5-50SS	5069	12	11-Oct-2022
Band Reject Filter - 5.22 GHz	Wainwright	WRCJV12-5120-5150-5290-5320-50SS	5073	12	29-Sep-2022
Band Reject Filter - 5.690 GHz	Wainwright	WRCJV8-5635-5670-5710-5745-50SS	5081	12	29-Sep-2022
Cable (18 GHz)	Rosenberger	LU7-071-1000	5103	12	17-Nov-2022
Emissions Software	TUV SUD	EmX V2.1.12	5125	-	Software
Horn Antenna (15-40GHz)	Schwarzbeck	BBHA 9170	5217	12	25-Jan-2023
Preamplifier (30dB 18-40GHz)	Schwarzbeck	BBV 9721	5218	12	25-Jan-2023
Preamplifier (30dB 1GHz to 18GHz)	Schwarzbeck	BBV 9718 C	5261	12	08-Apr-2022
Antenna (DRG Horn 7.5-18GHz)	Schwarzbeck	HWRD750	5348	12	15-Oct-2022
Cable (K-Type to K-Type, 1 m)	Junkosha	MWX241-01000KMSKMS/A	5511	12	09-Apr-2022
1m -SMA Cable	Junkosha	MWX221-01000AMSAMS/A	5513	12	09-Apr-2022
1m -SMA Cable	Junkosha	MWX221-01000AMSAMS/A	5514	12	09-Apr-2022



Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
2m SMA Cable	Junkosha	MWX221-02000AMSAMS/A	5517	12	09-Apr-2022
8m N Type Cable	Junkosha	MWX221-08000NMSNMS/B	5519	12	07-Mar-2023
8m N-Type Cable	Junkosha	MWX221-08000NMSNMS/B	5520	12	24-Mar-2023
Cable (K-Type to K-Type, 2 m)	Junkosha	MWX241-02000KMSKMS/A	5524	12	21-Apr-2022
EMI Test Receiver	Rohde & Schwarz	ESW44	5527	12	15-Apr-2022
7 GHz High pass Filter	Wainwright	WHKX12-5850-6800-18000-80SS	5549	12	20-May-2022
1200 MHz Low Pass Filter (01)	Mini-Circuits	VLF-1200+	5559	12	24-May-2022
Antenna (Bi-Log, 30 MHz to 1 GHz)	Teseq	CBL6111D	5615	24	16-Oct-2022

Table 10

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
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 – Accuracy Method

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. (Procedure 2). The measurement results are directly compared with the test limit to determine conformance with the requirements of the standard.

Risk: The uncertainty of measurement about the measured result is negligible with regard to the final pass/fail decision. The measurement result can be directly compared with the test limit to determine conformance with the requirement (compare IEC Guide 115). The level of risk to falsely accept and falsely reject items is further described in ILAC-G8.