

FCC and ISED Test Report

Apple Inc
Model: A2348

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

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

FCC ID: BCGA2348

IC: 579C-A2348

COMMERCIAL-IN-CONFIDENCE

Document 75949235-11 Issue 01



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SIGNATURE

NAME	JOB TITLE	RESPONSIBLE FOR	ISSUE DATE
Simon Bennett	Director Of Test Operations	Authorised Signatory	09 October 2020

Signatures in this approval box have checked this document in line with the requirements of TUV SUD 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 15C, 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
Testing	George Porter	09 October 2020	
Testing	Philip Harrison	09 October 2020	
Testing	Malik Mohammad	09 October 2020	
Testing	Faisal Malyar	09 October 2020	
Testing	Ahmad Javid	09 October 2020	
Testing	Jaiyanth Balendrarajah	09 October 2020	
Testing	Liang Tian	09 October 2020	

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 15C: 2019, ISED RSS-247: Issue 2 (02-2017) and ISED RSS-GEN: Issue 5 (04-2018) + A1 (03-2019) 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	09-October-2020

Table 1

1.2 Introduction

Applicant	Apple Inc
Manufacturer	Apple Inc
Model Number(s)	A2348
Serial Number(s)	C07D100W02H7 and C07D100D02DH
Hardware Version(s)	REV1.0
Software Version(s)	20W102770t
Number of Samples Tested	2
Test Specification/Issue/Date	FCC 47 CFR Part 15C: 2019 ISED RSS-247: Issue 2 (02-2017) ISED RSS-GEN: Issue 5 (04-2018) + A1 (03-2019)
Order Number	0540205400
Date	07-April-2020
Date of Receipt of EUT	18-August-2020
Start of Test	10-July-2020
Finish of Test	09-September-2020
Name of Engineer(s)	George Porter, Philip Harrison, Malik Mohammad, Faisal Malyar, Ahmad Javid, Jaiyanth Balendrarajah and Liang Tian
Related Document(s)	ANSI C63.10 (2013) KDB 662911 D01 v02r01



1.3 Brief Summary of Results

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

Section	Specification Clause			Test Description	Result	Comments/Base Standard
	Part 15C	RSS-247	RSS-GEN			
Configuration and Mode: 2.4 GHz WLAN						
2.1	15.247 (a)(2)	5.2	6.7	Emission Bandwidth	Pass	
2.2	15.247 (b)	5.4	6.12	Maximum Conducted Output Power	Pass	
2.3	15.247 (d) and 15.205	5.5	6.13	Spurious Radiated Emissions	Pass	
2.4	15.247 (d)	5.5	-	Authorised Band Edges	Pass	
2.5	15.205	-	8.10	Restricted Band Edges	Pass	
2.6	15.247 (e)	5.2	6.12	Power Spectral Density	Pass	

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.

1.4.2 Test Modes

The 2.4 GHz 802.11 radio supports SISO and 2x2 MIMO. 802.11b and 802.11g only supports SISO operation. 802.11n and 802.11ax are supported for both SISO and 2x2 MIMO at 20 MHz channel bandwidths only. 802.11ax supports Single User (SU) and Multi-User MIMO (MU-MIMO) modes. MU-MIMO modes support Resource Unit (RU) sizes of 26/52/106/242 subcarriers.

The EUT uses different output powers per core dependent on how many cores are used. It uses the same conducted power across all cores in any given mode, but due to the different antenna gains the radiated power per core differs.

After preliminary investigations were performed, the EUT was therefore tested in the following worst-case modes:

- SISO Modes (Core 1):
 - 802.11b 1 Mbps
 - 802.11g 6 Mbps
 - 802.11n HT20 MCS7
 - 802.11ax HE20 MCS7 SU & MU
- 2x2 MIMO Modes (Core 0 + Core 1):
 - 802.11n HT20 MCS7 – CDD
 - 802.11ax HE20 MCS7 CDD SU & MU

For 802.11ax modes, only SU modes (highest power) are reported for Output Power. For Bandwidth tests, only SU modes (widest BW) and MU-MIMO with 26 subcarriers (narrowest) are reported. For Power Spectral Density (PSD), RU sizes of 26 to 106 subcarriers are reported.



1.4.3 Test Set-up

For conducted tests the EUT antennas were disconnected and replaced with U.FL to SMA test cables to enable conducted testing on each core. The loss of these test cables were known and compensated for in any conducted measurements.

For all tests, the EUT was put into a continuous transmit test mode with the chipset manufacturer's test commands via a script running in the EUTs terminal application. The EUT then transmitted the required type of packeted 802.11 data frames of fixed length, containing the standard headers and with pseudo-random data content, ensuring the measured signals were representative and contained all the symbols at the highest power control level.

All testing was performed with the EUT powered via a 120 V AC, 60 Hz source.

1.4.4 Antenna Gain Table (2.4GHz WLAN)

Antenna Port	Frequency Range (MHz)	Peak Gain (dBi)	Conducted Cable Loss (dB)
Core 0	2400 to 2480	0.25	0.7
Core 1	2400 to 2480	5.00	0.7

Table 3

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: A2348, Serial Number: C07D100D02DH			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: A2348, Serial Number: C07D100W02H7			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 4



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: 2.4 GHz WLAN		
Maximum Conducted Output Power	George Porter	UKAS
Power Spectral Density	George Porter and Philip Harrison	UKAS
Emission Bandwidth	George Porter	UKAS
Spurious Radiated Emissions	Malik Mohammad, Faisal Malyar, Ahmad Javid, Jaiyanth Balendrarajah and Liang Tian	UKAS
Authorised Band Edges	Malik Mohammad, Faisal Malyar, Ahmad Javid, Jaiyanth Balendrarajah and Liang Tian	UKAS
Restricted Band Edges	Malik Mohammad, Faisal Malyar, Ahmad Javid, Jaiyanth Balendrarajah and Liang Tian	UKAS

Table 5

Office Address:

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



2 Test Details

2.1 Emission Bandwidth

2.1.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(2)
ISED RSS-247, Clause 5.2
ISED RSS-GEN, Clause 6.7

2.1.2 Equipment Under Test and Modification State

A2348, S/N: C07D100D02DH - Modification State 0

2.1.3 Date of Test

19-August-2020 to 09-September-2020

2.1.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 11.8.1 for 6 dB bandwidth and clause 6.9.3 for 99% occupied bandwidth.

For modes of operation using multiple cores, measurements were made on each core but only the worst case results are reported. Worst case was considered as the narrowest results for 6 dB bandwidth and the widest result for 26 dB bandwidth and 99% occupied bandwidth.

2.1.5 Environmental Conditions

Ambient Temperature 21.2 - 23.8 °C
Relative Humidity 43.3 - 70.8 %

2.1.6 Test Results

2.4 GHz WLAN

Channel	Bottom	Middle	Top
Frequency (MHz)	2412	2442	2472
6 dB Bandwidth (MHz)	8.160	8.160	8.640
99% Bandwidth (MHz)	12.947	12.974	13.034

Table 6 - 802.11b / 1 Mbps / SISO / Core 1

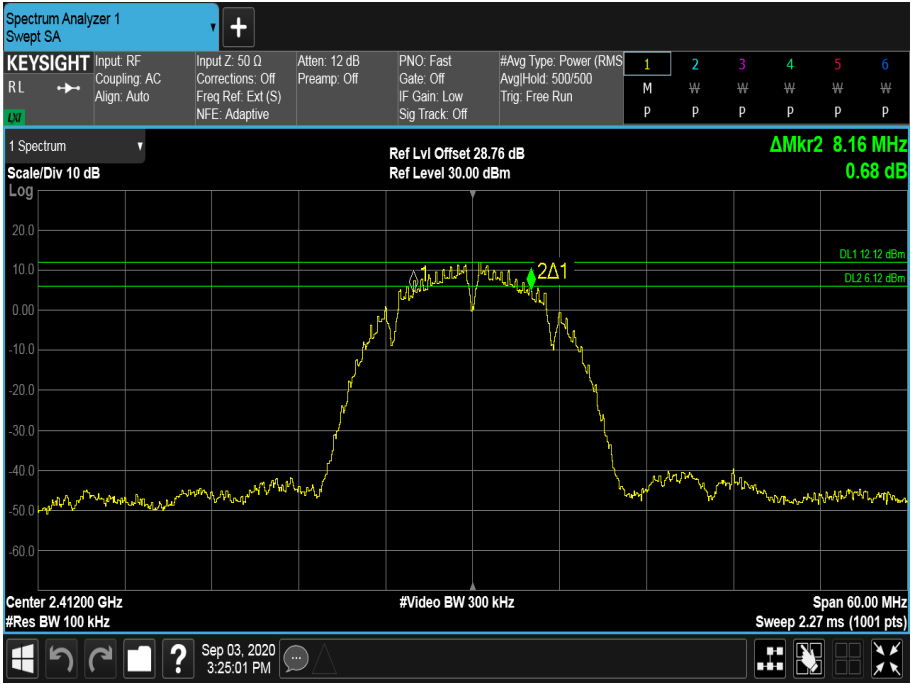


Figure 1 - 2412 MHz - 6 dB DTS Bandwidth



Figure 2 - 2412 MHz - 99% Occupied Bandwidth

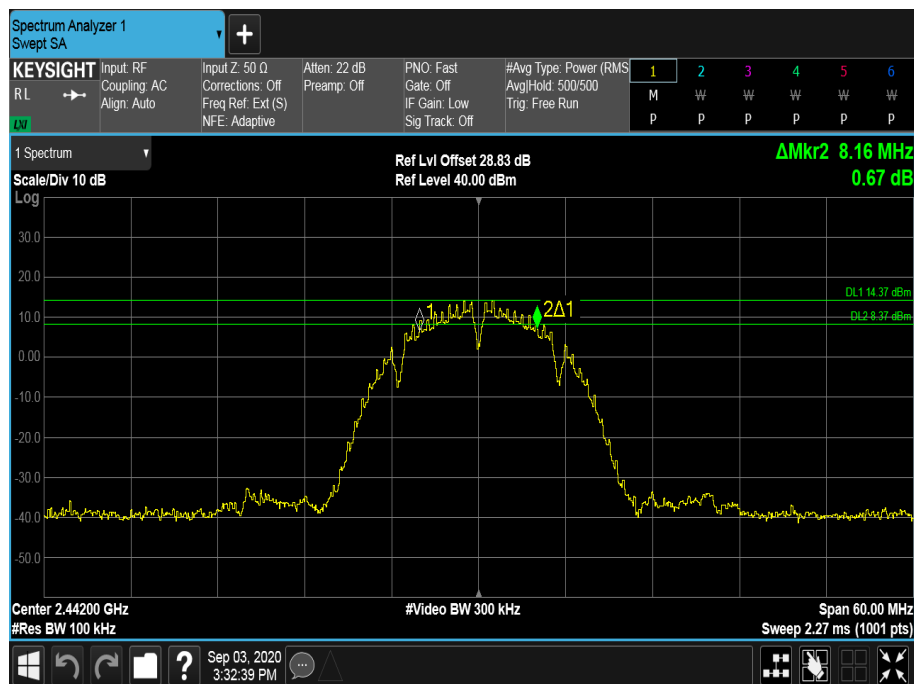


Figure 3 - 2442 MHz - 6 dB DTS Bandwidth

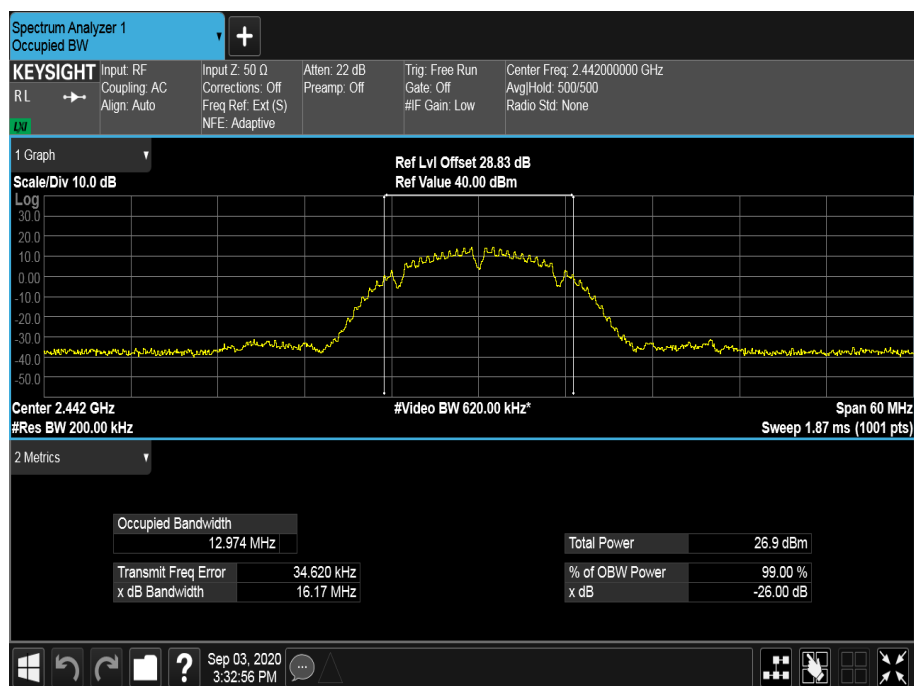


Figure 4 - 2442 MHz - 99% Occupied Bandwidth

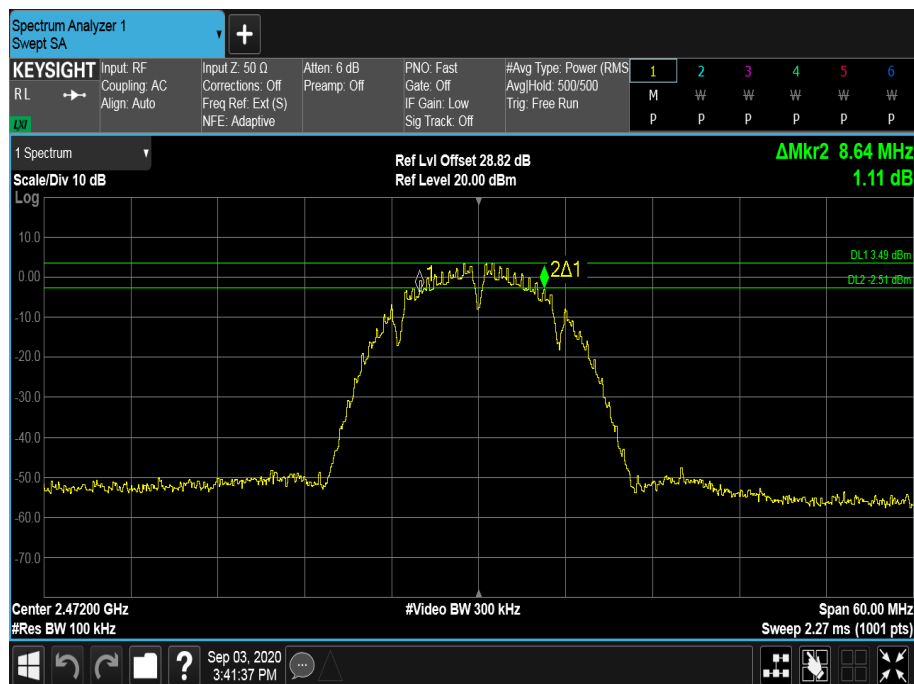


Figure 5 - 2472 MHz - 6 dB DTS Bandwidth

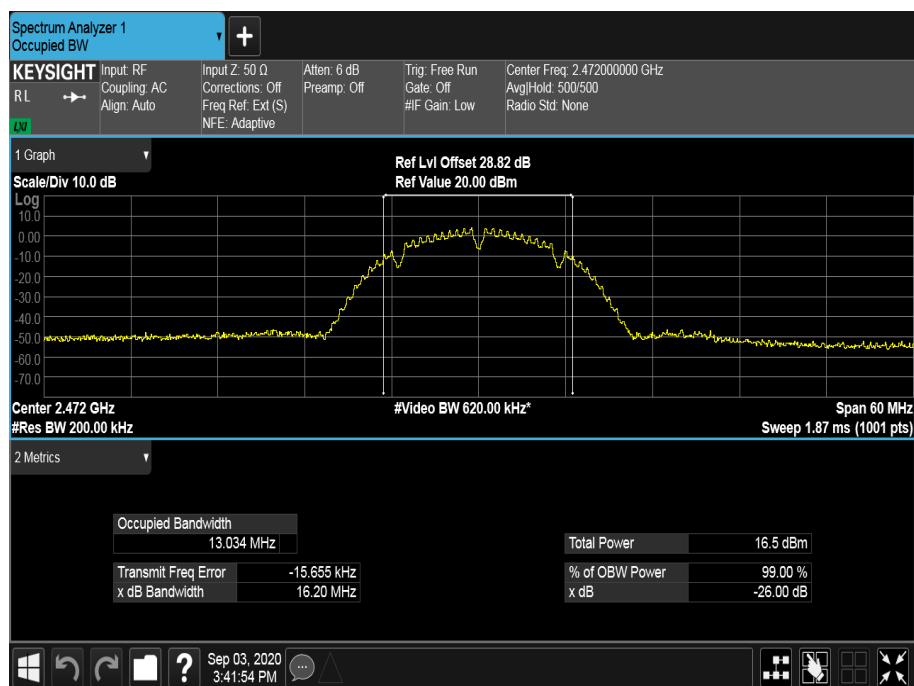


Figure 6 - 2472 MHz - 99% Occupied Bandwidth



Channel	Bottom	Middle	Top
Frequency (MHz)	2412	2442	2472
6 dB Bandwidth (MHz)	15.240	15.240	15.240
99% Bandwidth (MHz)	16.309	16.411	16.295

Table 7 - 802.11g / 6 Mbps / SISO / Core 1

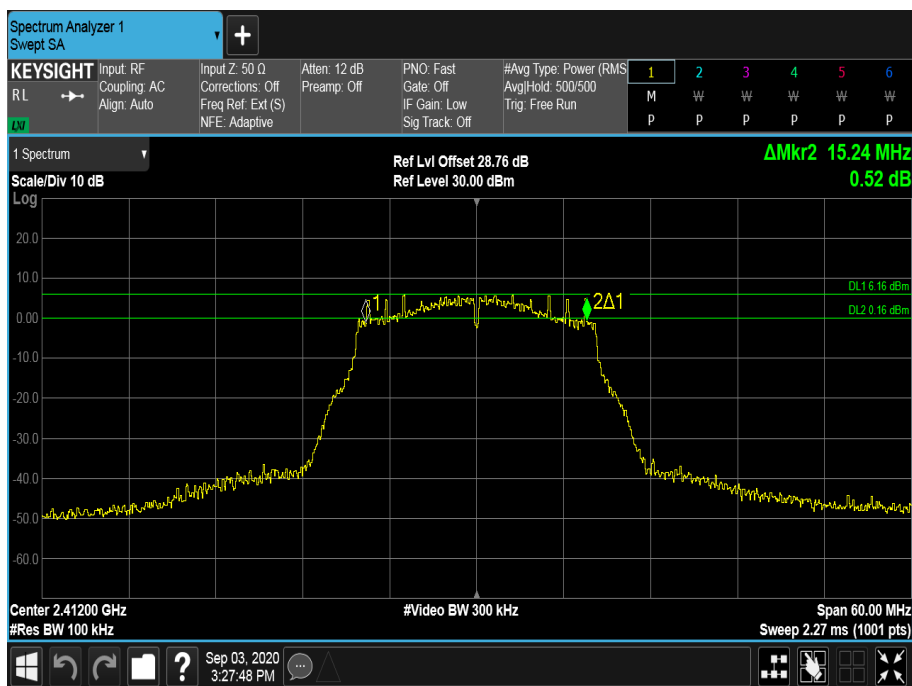


Figure 7 - 2412 MHz - 6 dB DTS Bandwidth

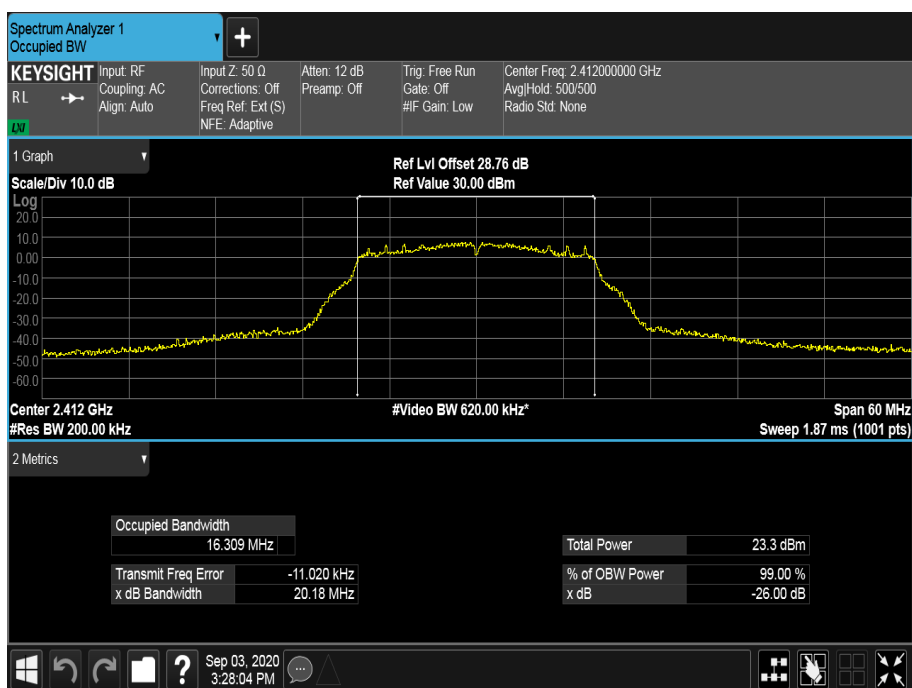


Figure 8 - 2412 MHz - 99% Occupied Bandwidth

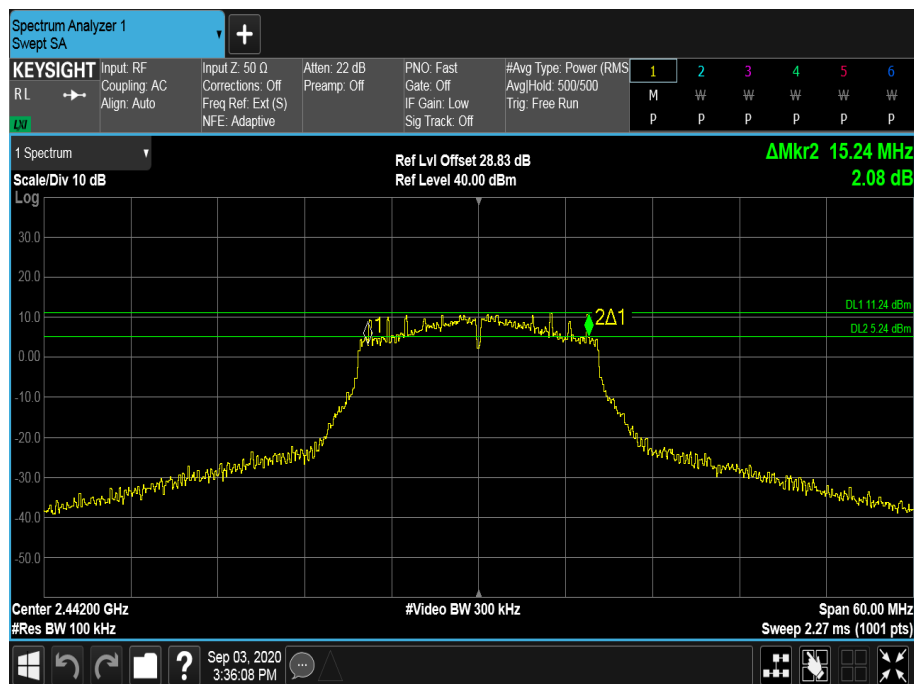


Figure 9 - 2442 MHz - 6 dB DTS Bandwidth

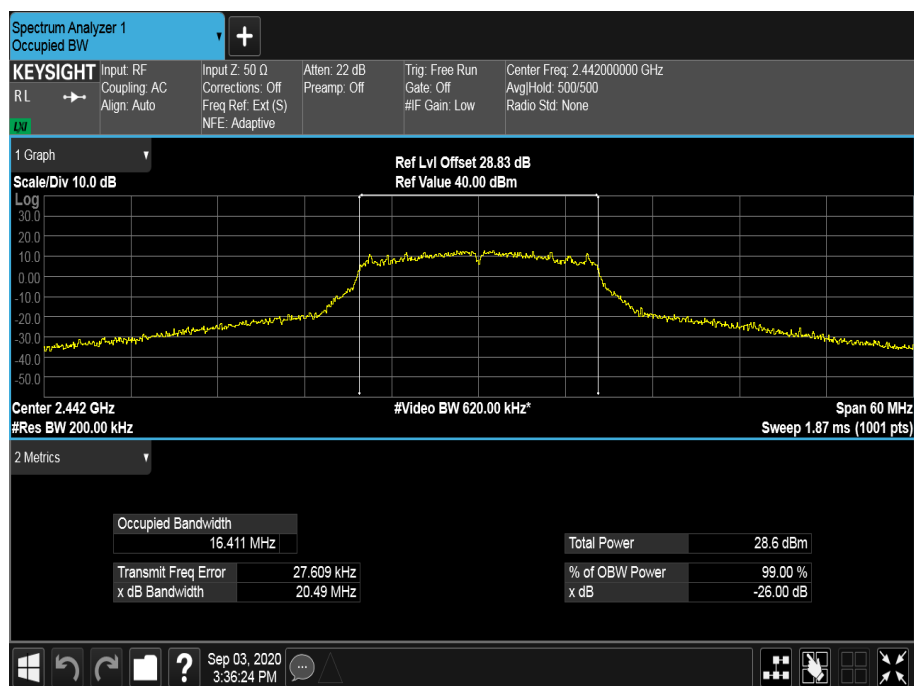


Figure 10 - 2442 MHz - 99% Occupied Bandwidth

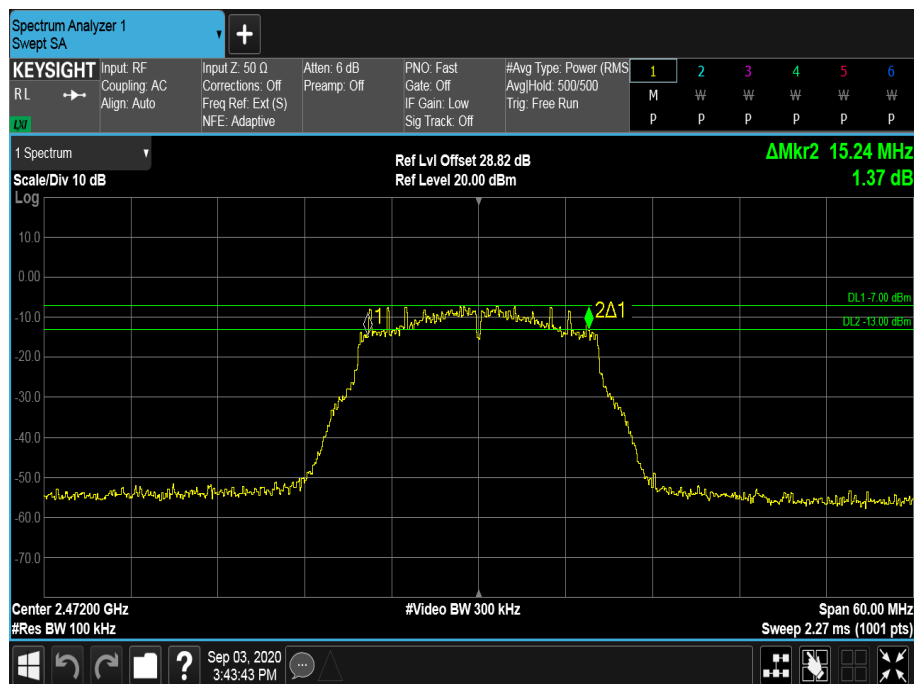


Figure 11 - 2472 MHz - 6 dB DTS Bandwidth

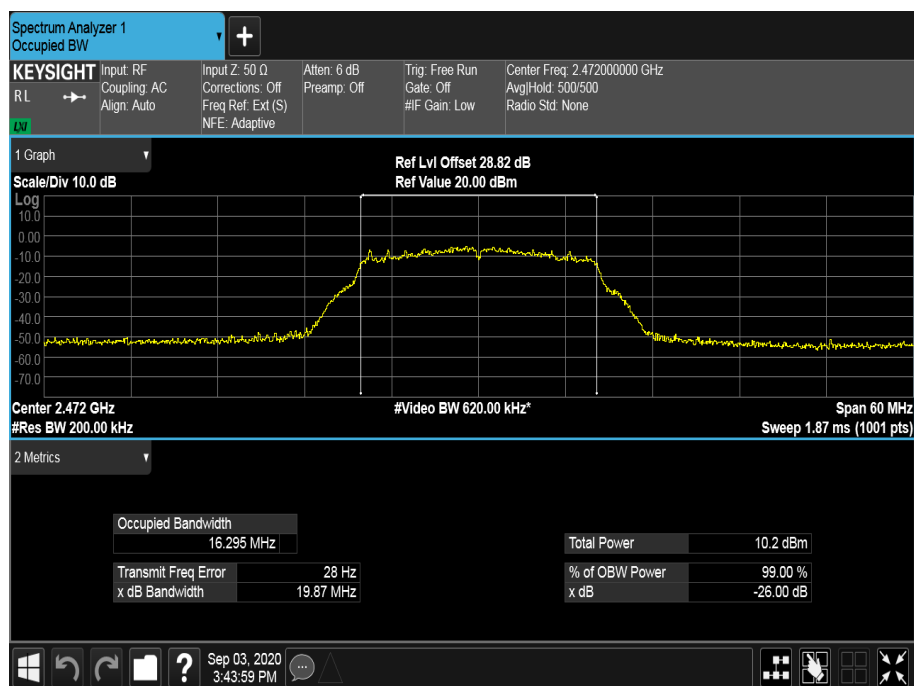


Figure 12 - 2472 MHz - 99% Occupied Bandwidth

Channel	Bottom	Middle	Top
Frequency (MHz)	2412	2442	2472
6 dB Bandwidth (MHz)	17.760	17.700	17.760
99% Bandwidth (MHz)	17.682	17.772	17.703

Table 8 - 802.11n / HT20 MCS7 / SISO / Core 1

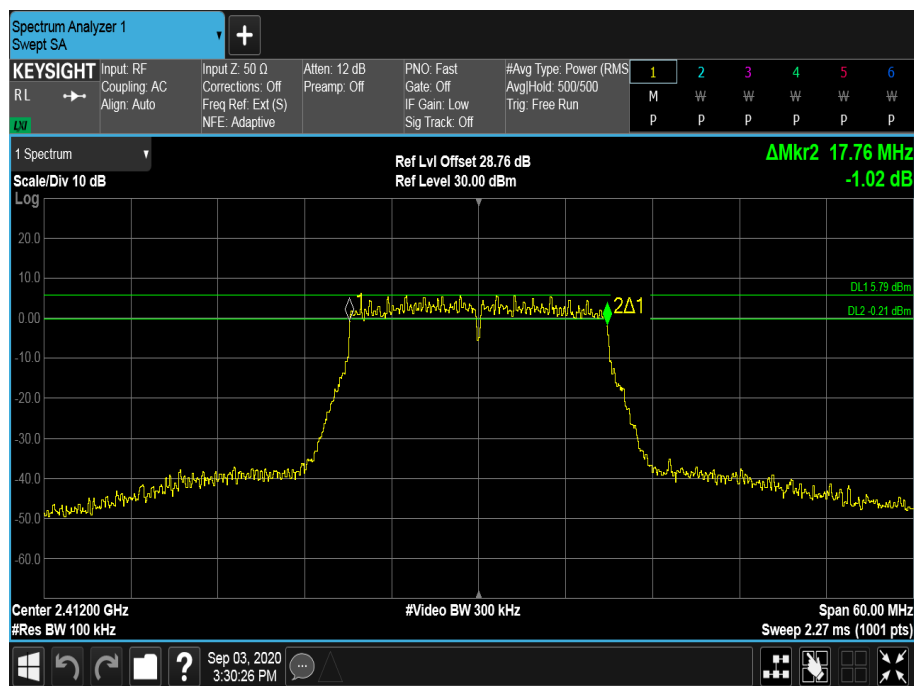


Figure 13 - 2412 MHz - 6 dB DTS Bandwidth

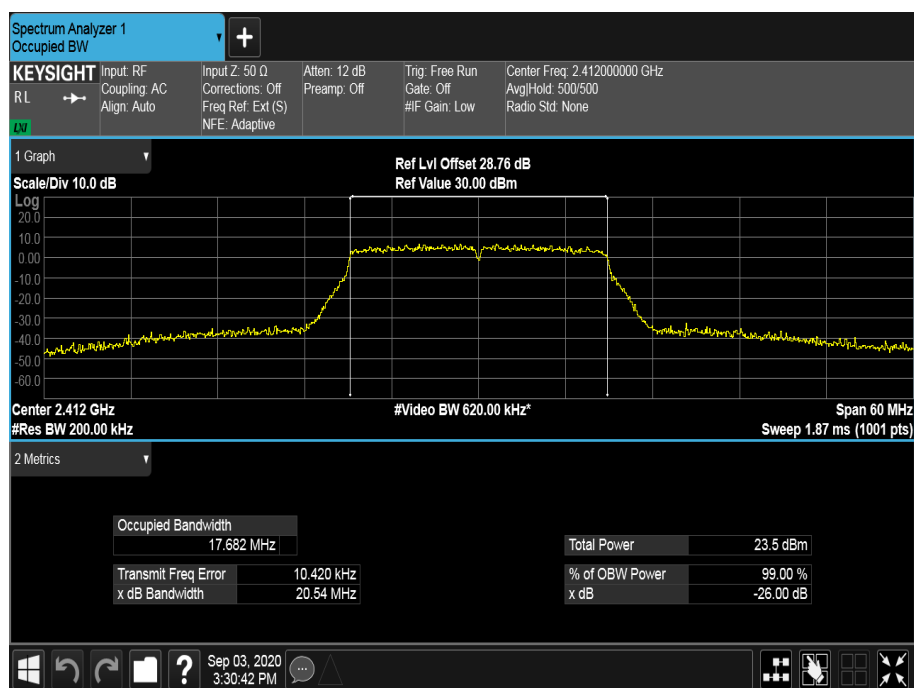


Figure 14 - 2412 MHz - 99% Occupied Bandwidth

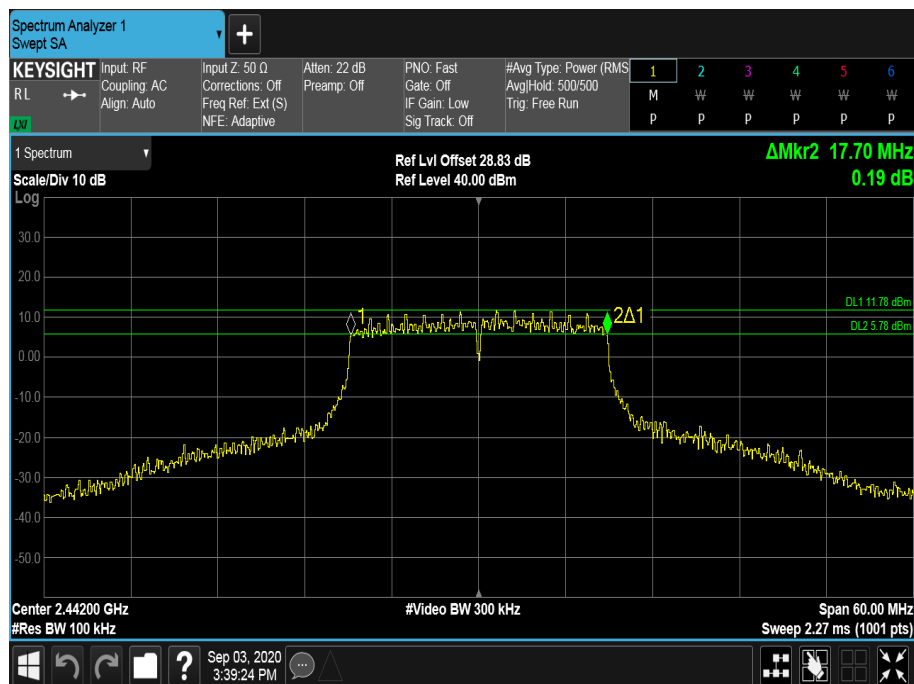


Figure 15 - 2442 MHz - 6 dB DTS Bandwidth

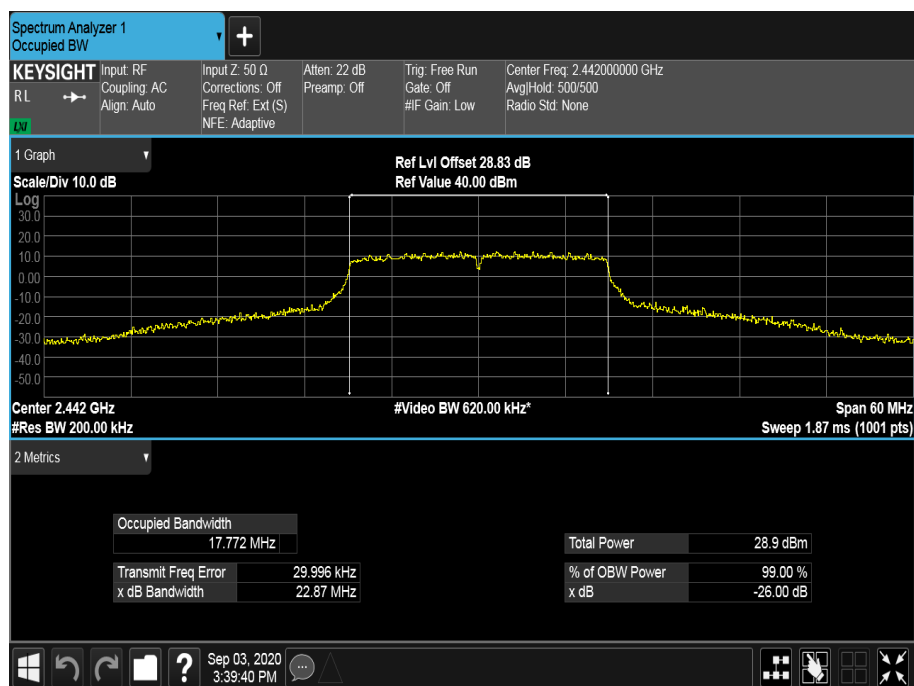


Figure 16 - 2442 MHz - 99% Occupied Bandwidth

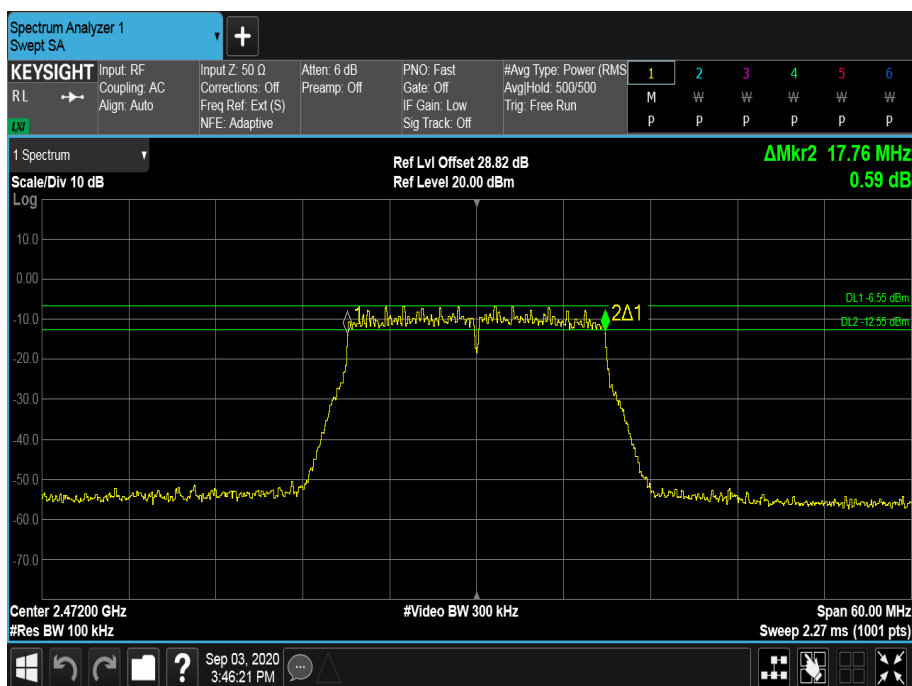


Figure 17 - 2472 MHz - 6 dB DTS Bandwidth

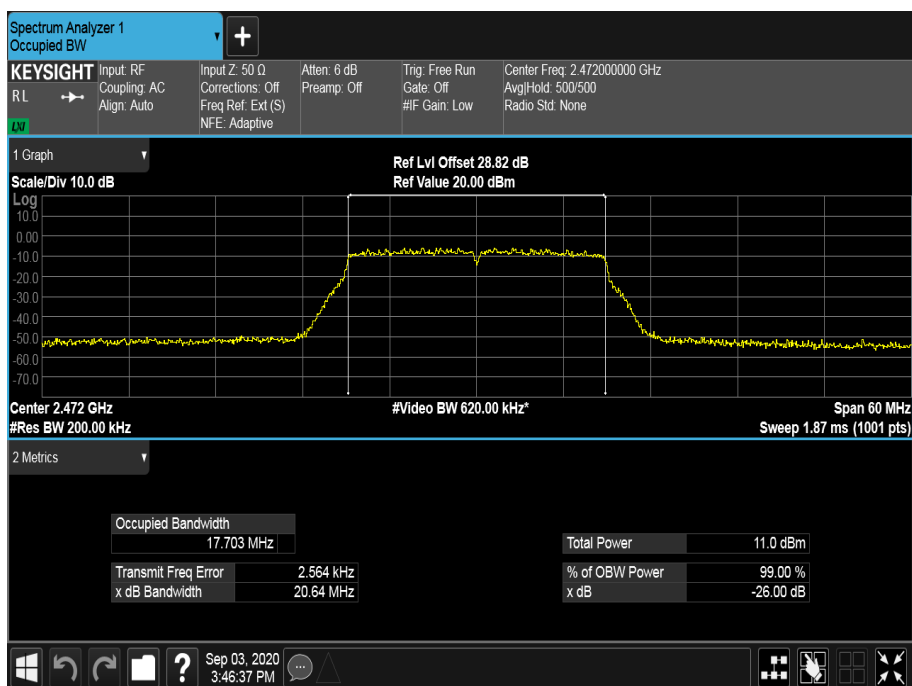


Figure 18 - 2472 MHz - 99% Occupied Bandwidth



Channel	Bottom	Middle	Top
Frequency (MHz)	2412	2442	2472
6 dB Bandwidth (MHz)	17.760	17.700	17.820
99% Bandwidth (MHz)	17.715	17.781	17.683

Table 9 - 802.11n / HT20 MCS7 / MIMO CDD / Cores 0+1

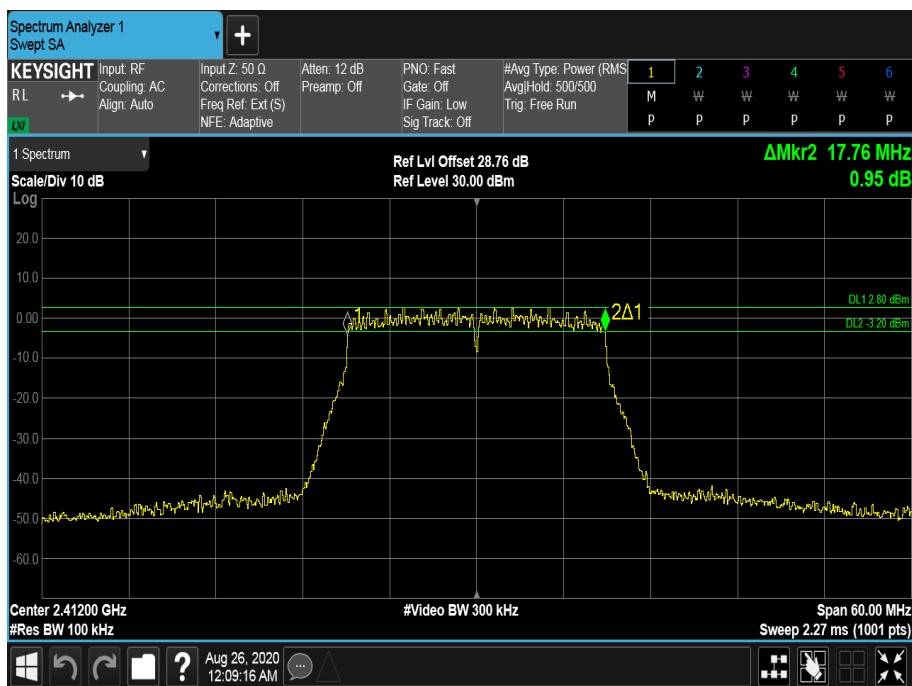


Figure 19 - 2412 MHz - 6 dB DTS Bandwidth

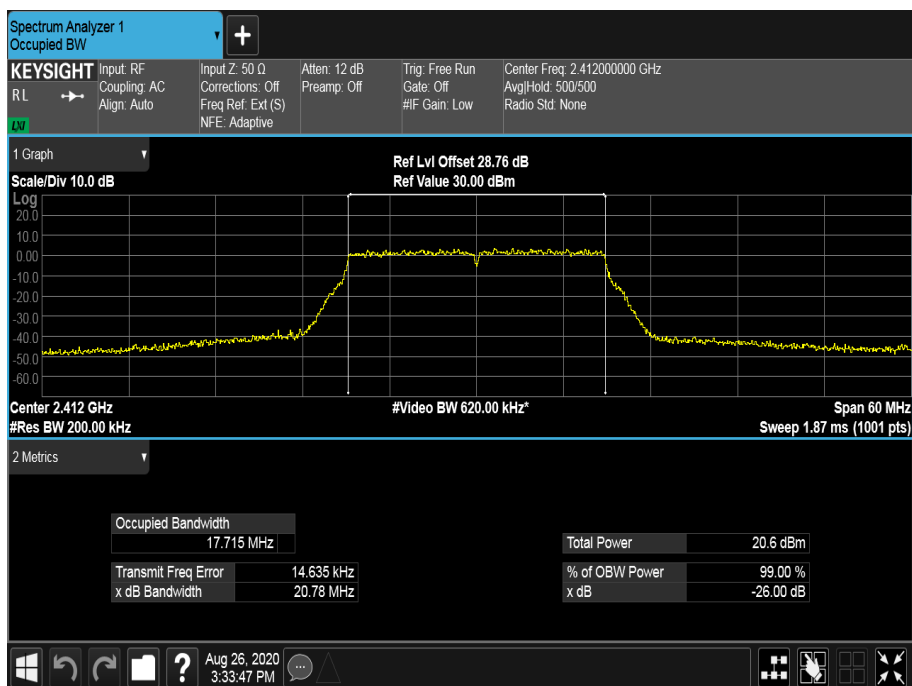


Figure 20 - 2412 MHz - 99% Occupied Bandwidth

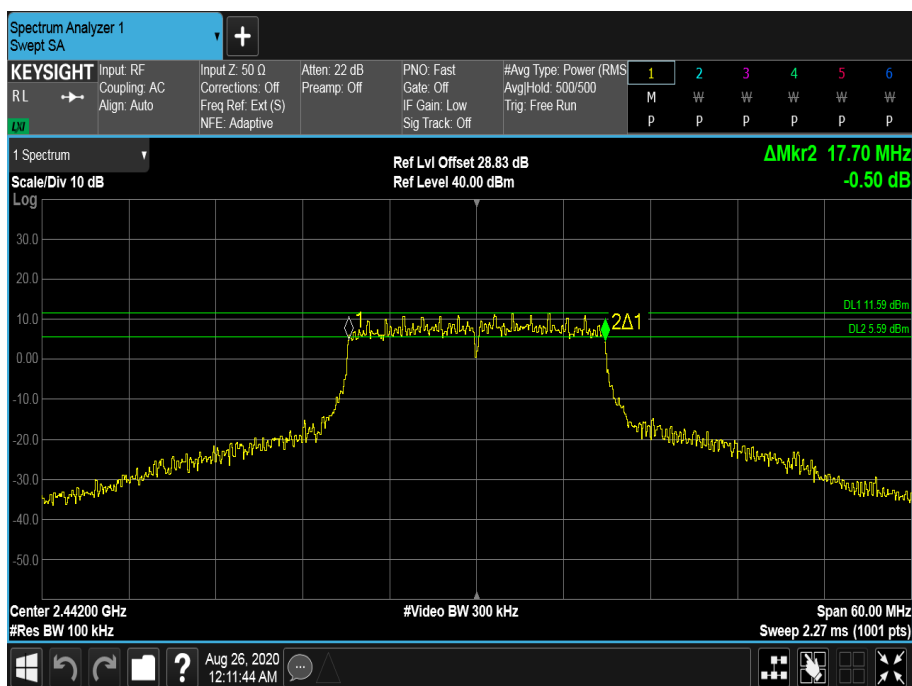


Figure 21 - 2442 MHz - 6 dB DTS Bandwidth

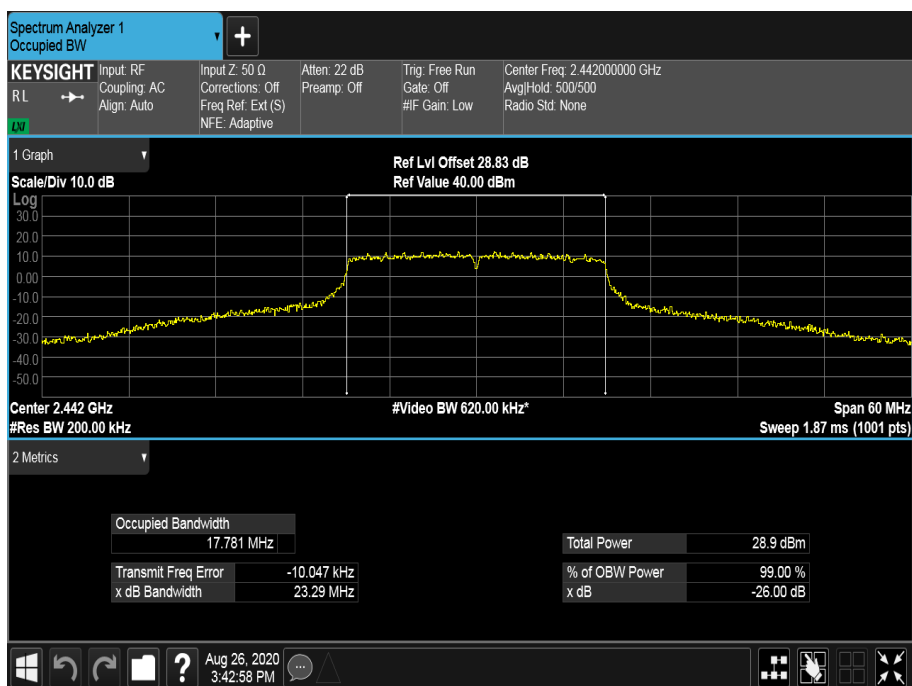


Figure 22 - 2442 MHz - 99% Occupied Bandwidth

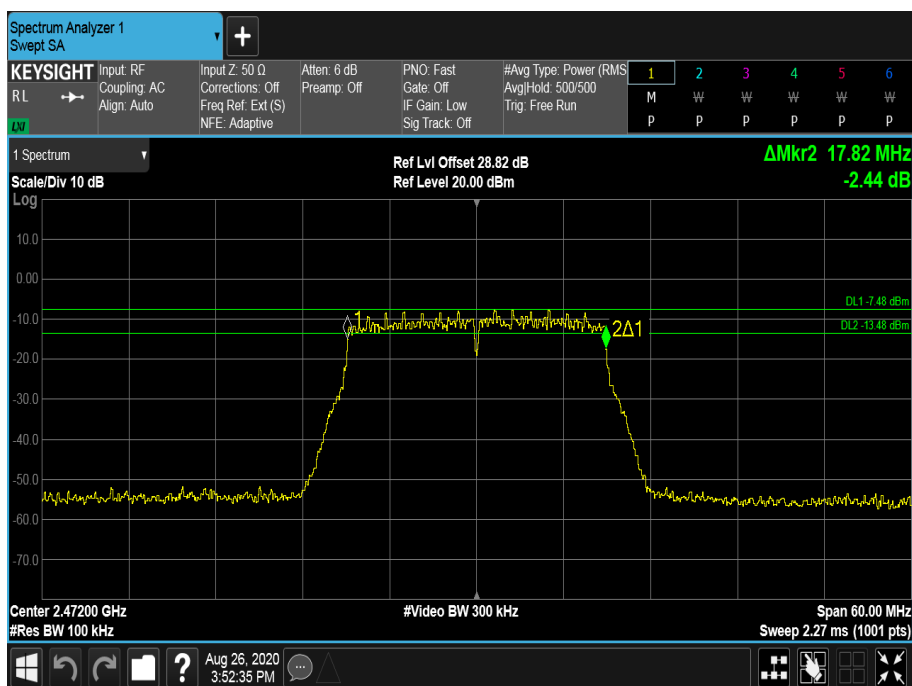


Figure 23 - 2472 MHz - 6 dB DTS Bandwidth

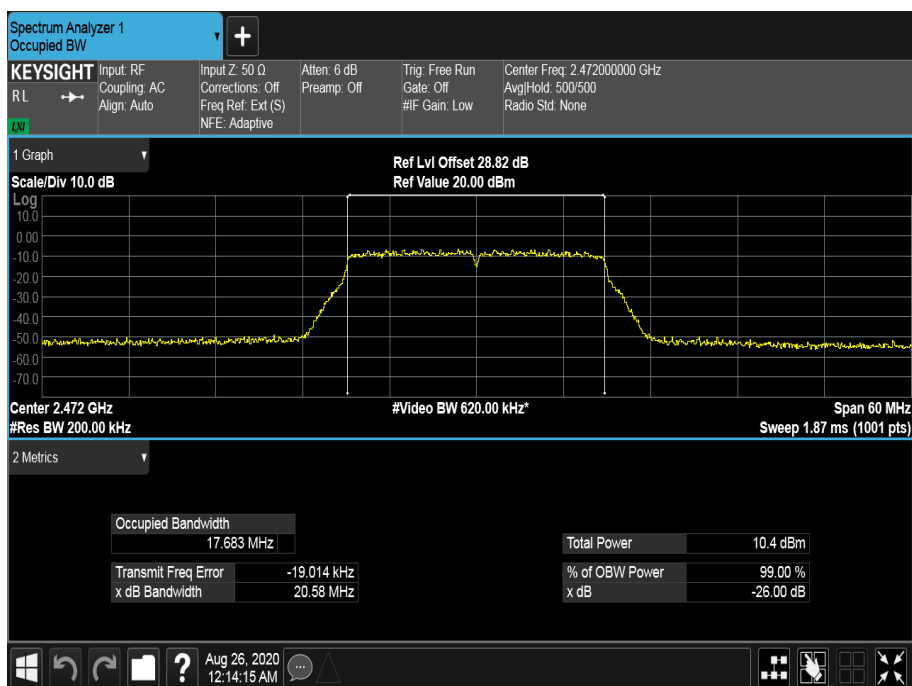


Figure 24 - 2472 MHz - 99% Occupied Bandwidth

Channel	Bottom	Middle	Top
Frequency (MHz)	2412	2442	2472
6 dB Bandwidth (MHz)	19.020	19.020	19.080
99% Bandwidth (MHz)	18.878	18.934	18.935

Table 10 - 802.11ax / HE20 MCS7x1 / SU / SISO / Core 1

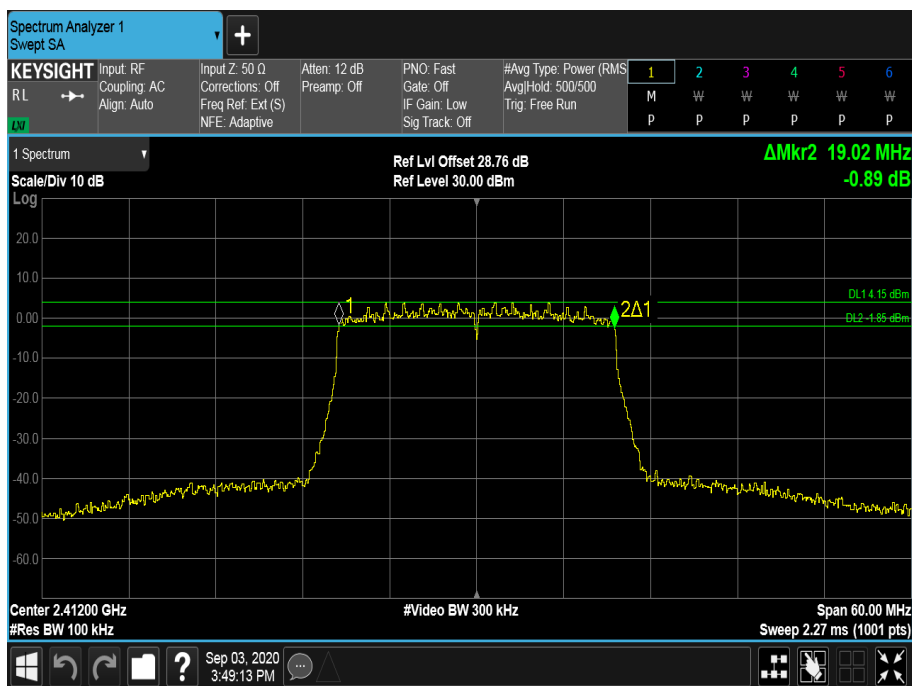


Figure 25 - 2412 MHz - 6 dB DTS Bandwidth

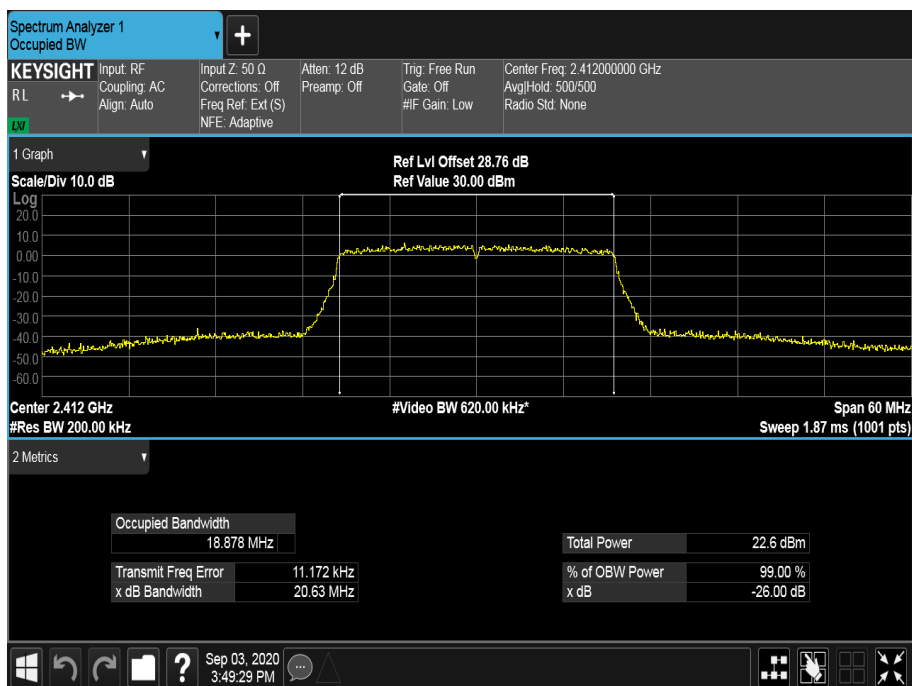


Figure 26 - 2412 MHz - 99% Occupied Bandwidth

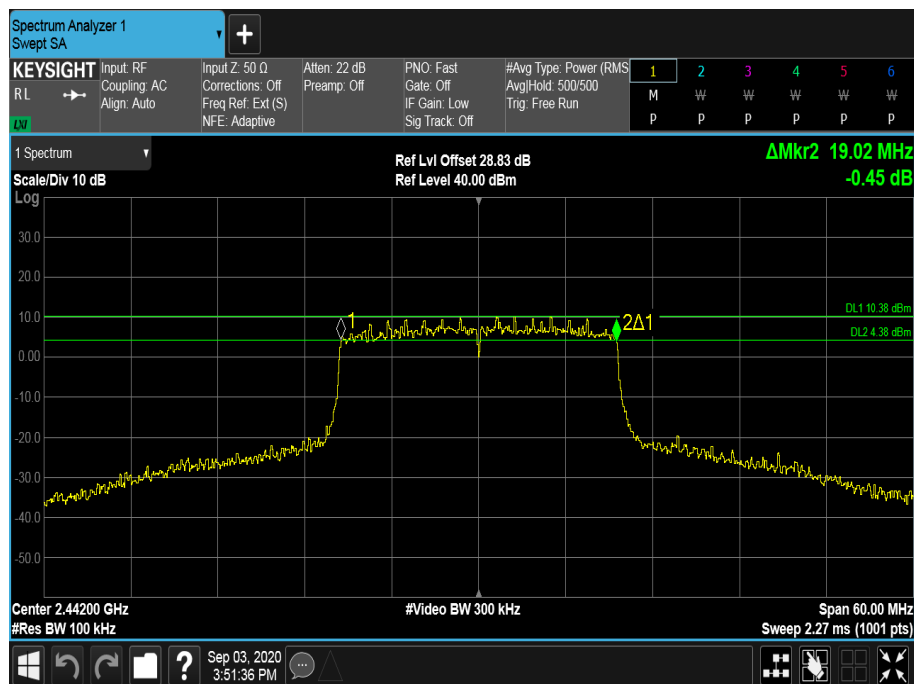


Figure 27 - 2442 MHz - 6 dB DTS Bandwidth

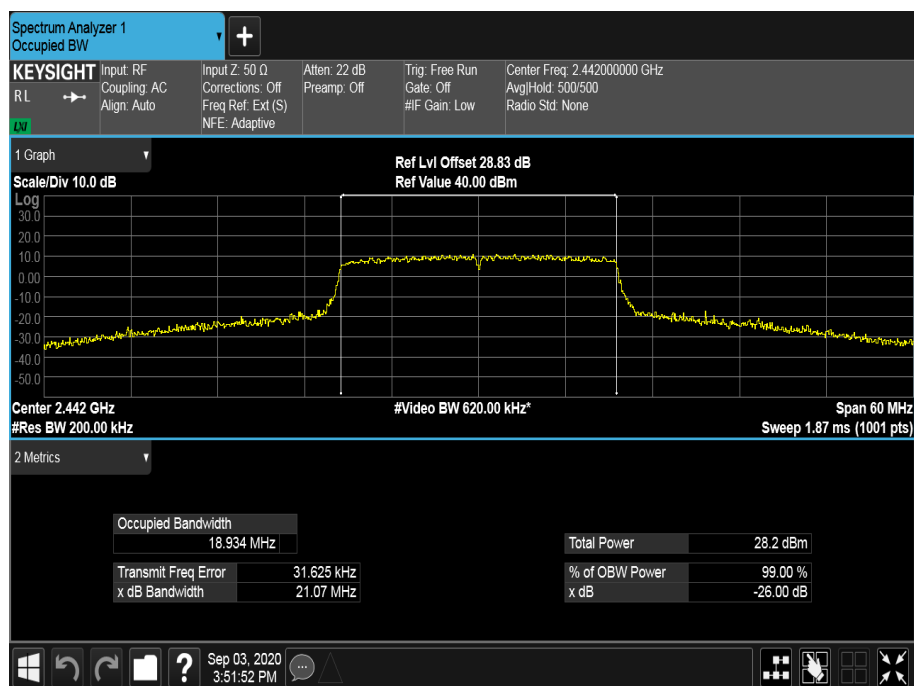


Figure 28 - 2442 MHz - 99% Occupied Bandwidth

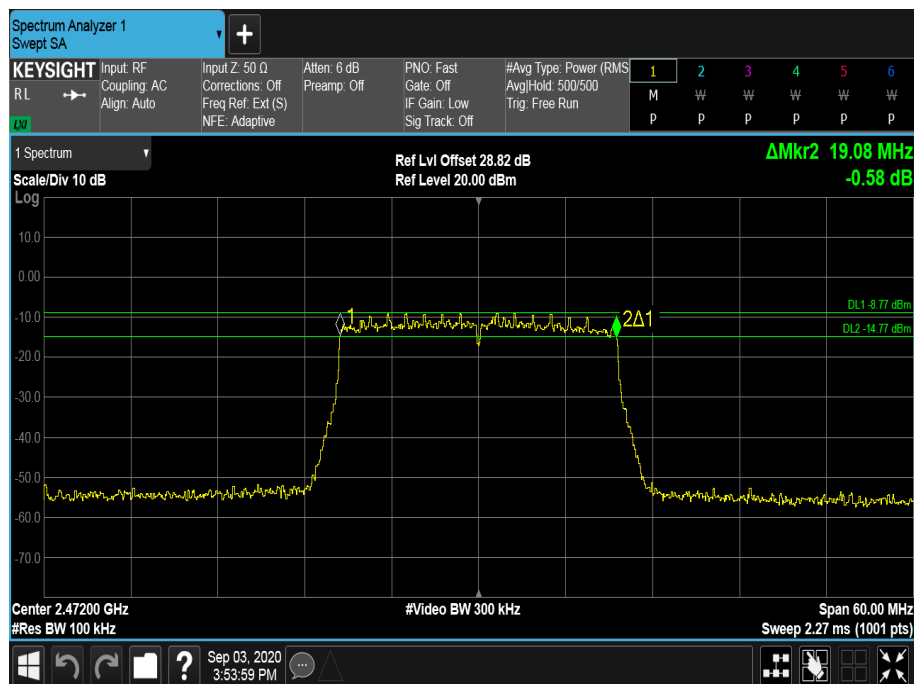


Figure 29 - 2472 MHz - 6 dB DTS Bandwidth

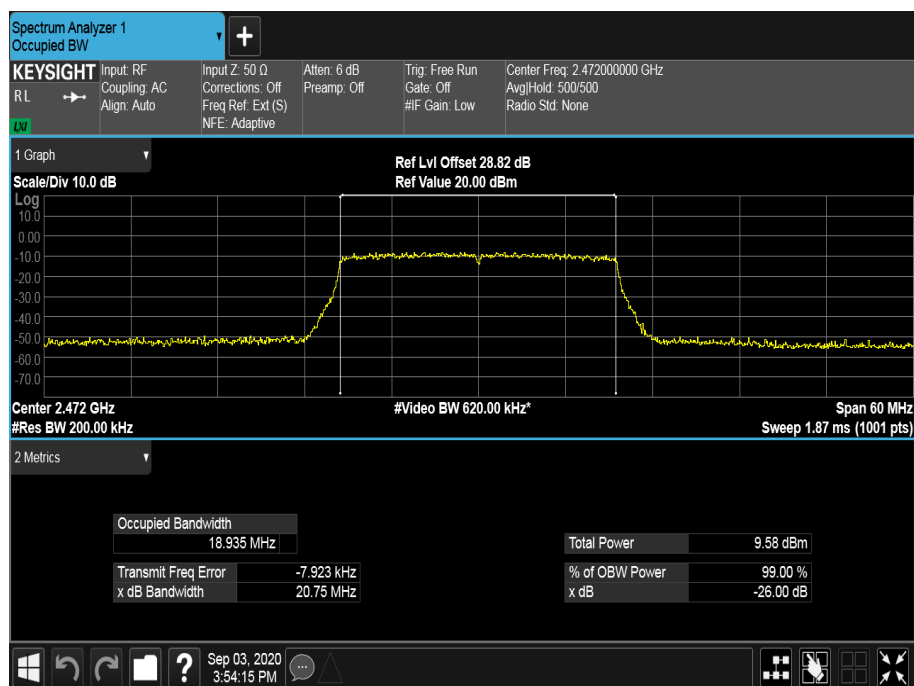


Figure 30 - 2472 MHz - 99% Occupied Bandwidth



Channel	Bottom	Middle	Top
Frequency (MHz)	2412	2442	2472
6 dB Bandwidth (MHz)	2.160	2.160	2.160
99% Bandwidth (MHz)	18.224	18.269	18.176

Table 11 - 802.11ax / HE20 MCS7x1 / RU 26-0 / SISO / Core 1

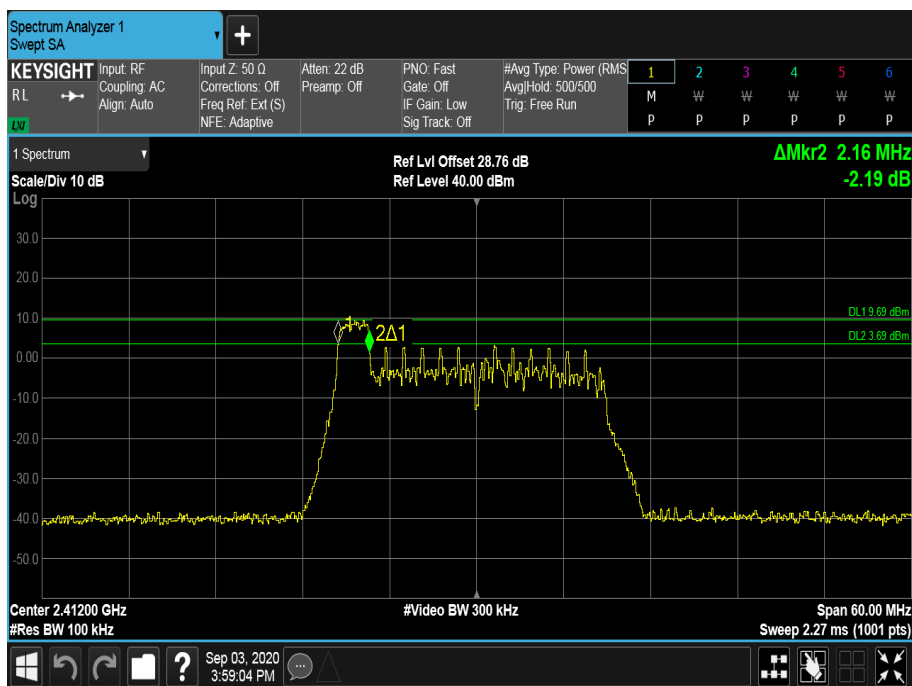


Figure 31 - 2412 MHz - 6 dB DTS Bandwidth

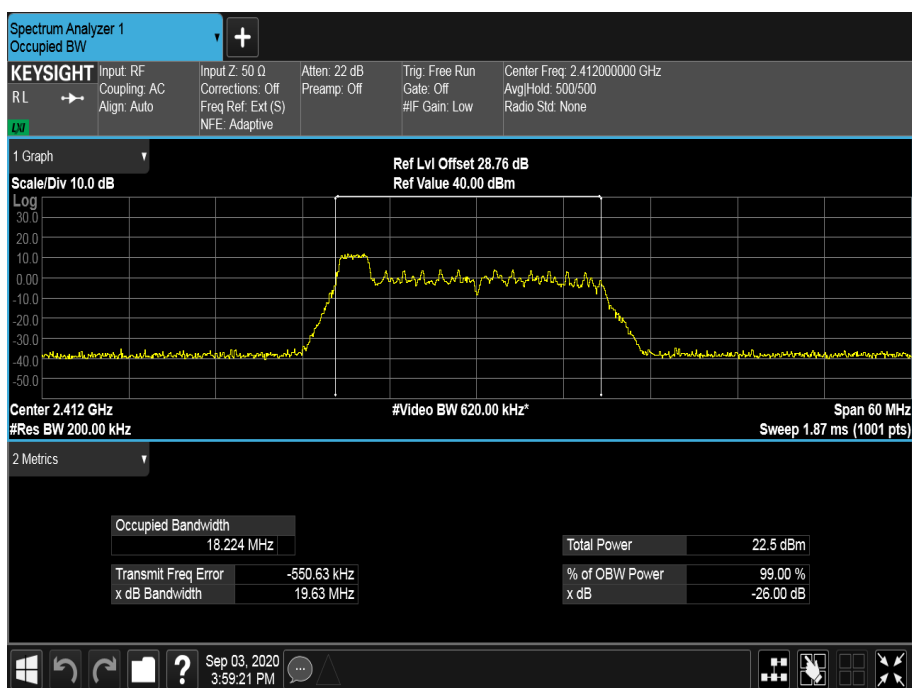


Figure 32 - 2412 MHz - 99% Occupied Bandwidth

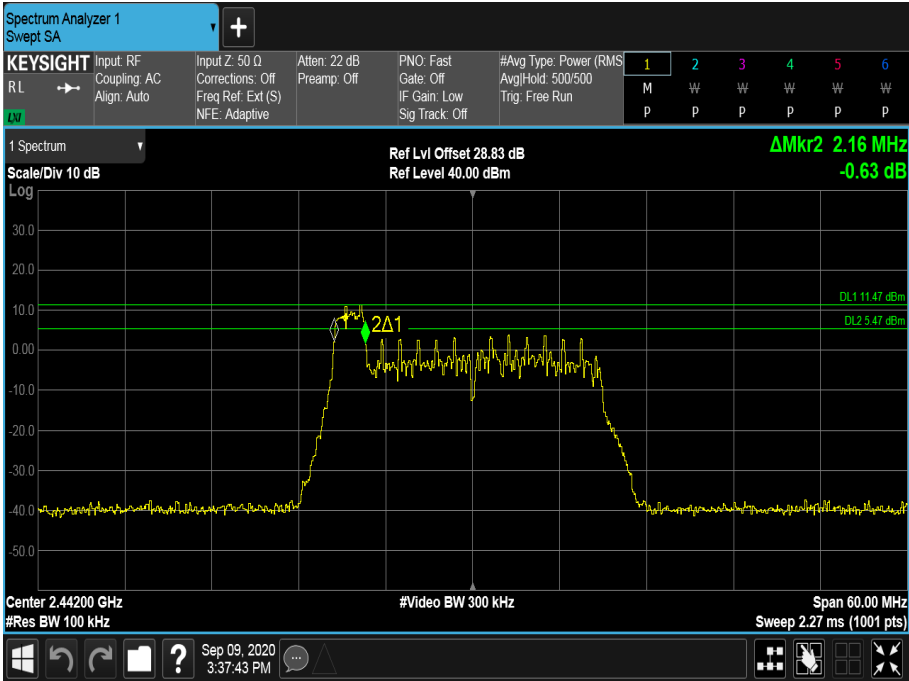


Figure 33 - 2442 MHz - 6 dB DTS Bandwidth

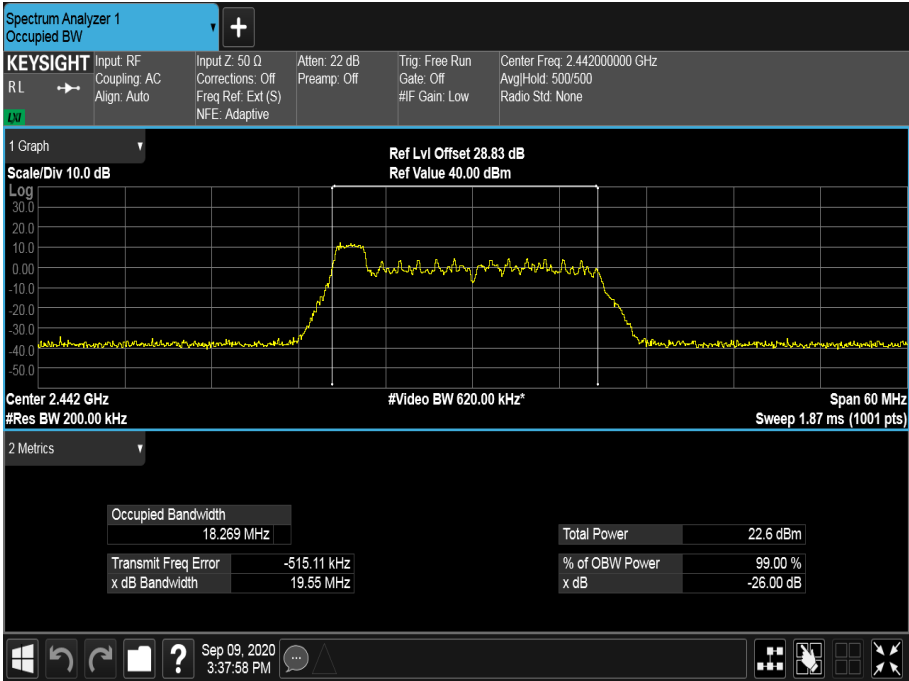


Figure 34 - 2442 MHz - 99% Occupied Bandwidth

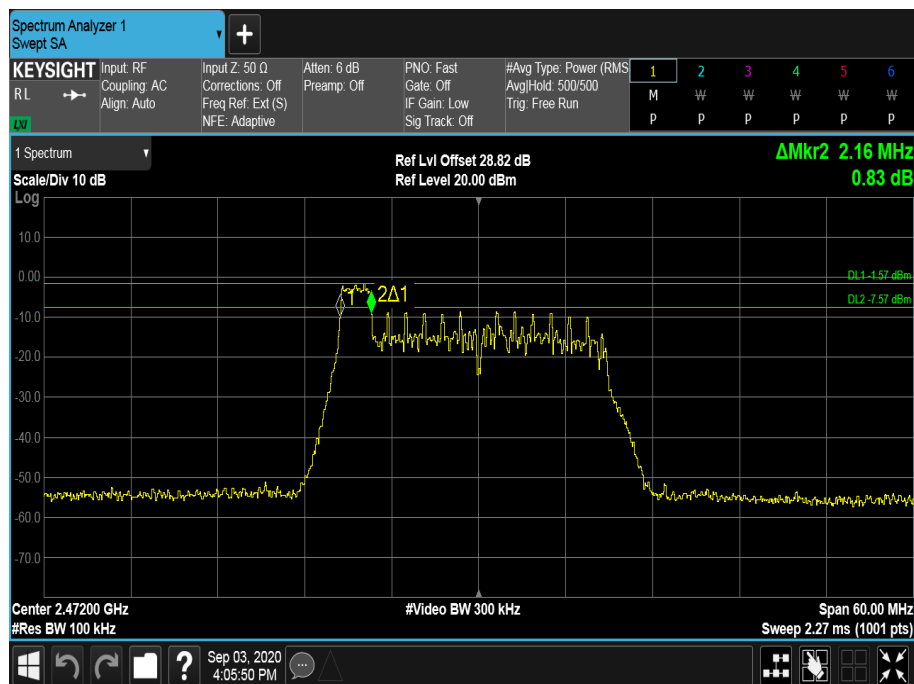


Figure 35 - 2472 MHz - 6 dB DTS Bandwidth

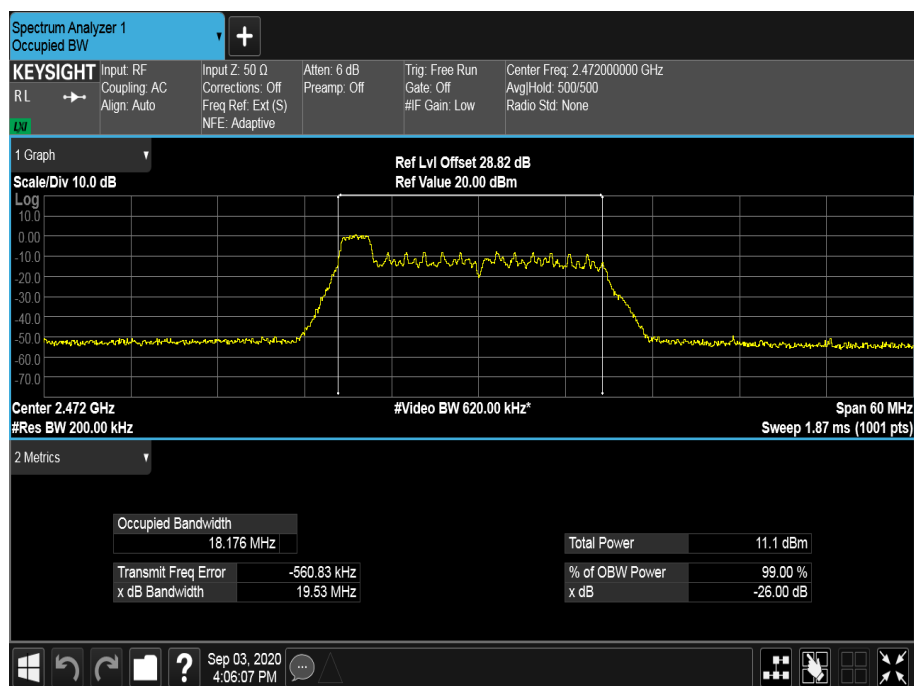


Figure 36 - 2472 MHz - 99% Occupied Bandwidth



Channel	Bottom	Middle	Top
Frequency (MHz)	2412	2442	2472
6 dB Bandwidth (MHz)	2.220	2.160	2.160
99% Bandwidth (MHz)	18.237	18.139	18.273

Table 12 - 802.11ax / HE20 MCS7x1 / RU 26-8 / SISO / Core 1



Figure 37 - 2412 MHz - 6 dB DTS Bandwidth

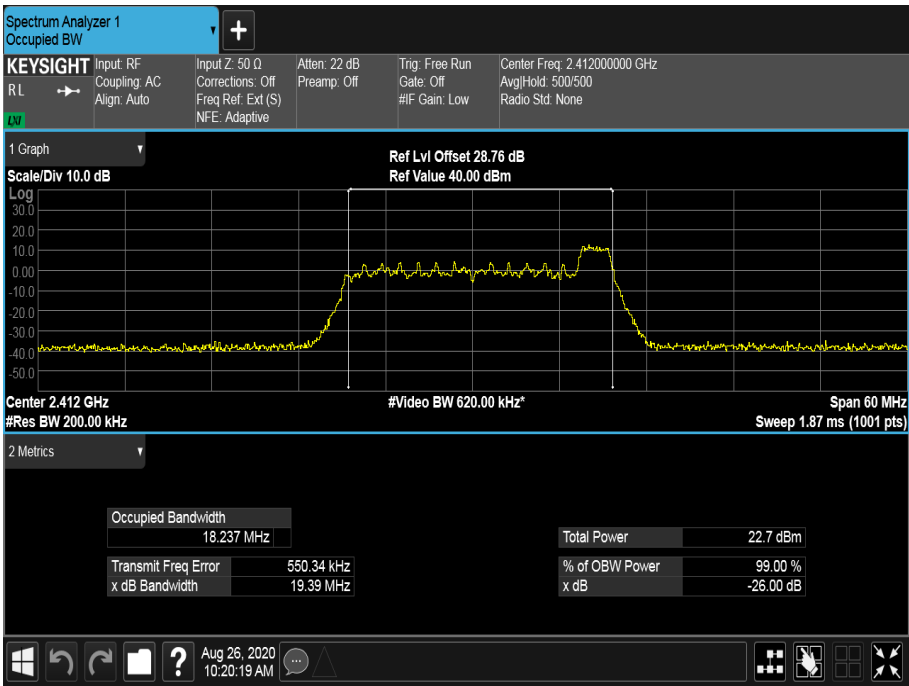


Figure 38 - 2412 MHz - 99% Occupied Bandwidth

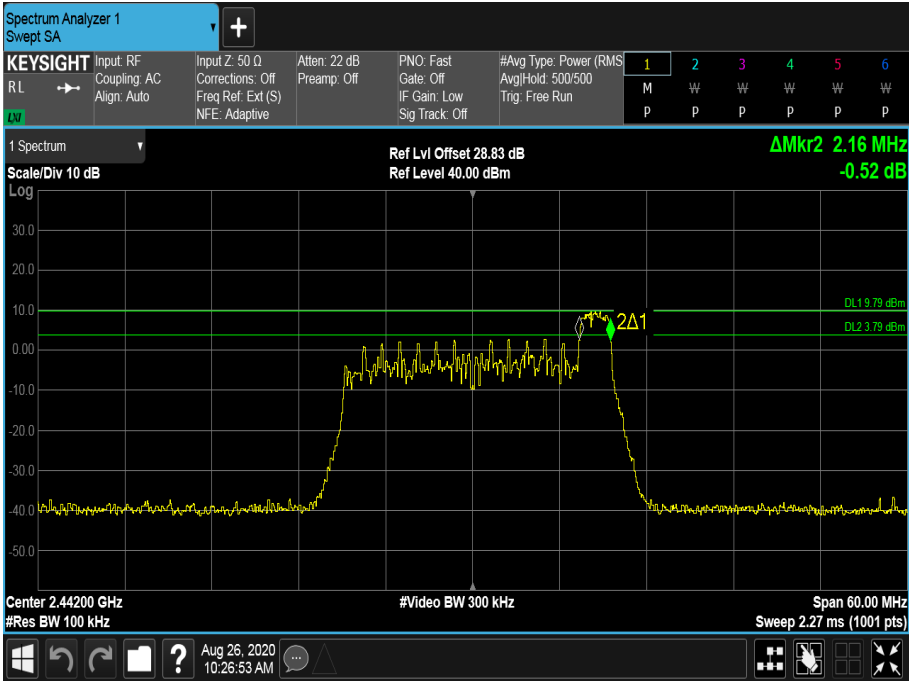


Figure 39 - 2442 MHz - 6 dB DTS Bandwidth

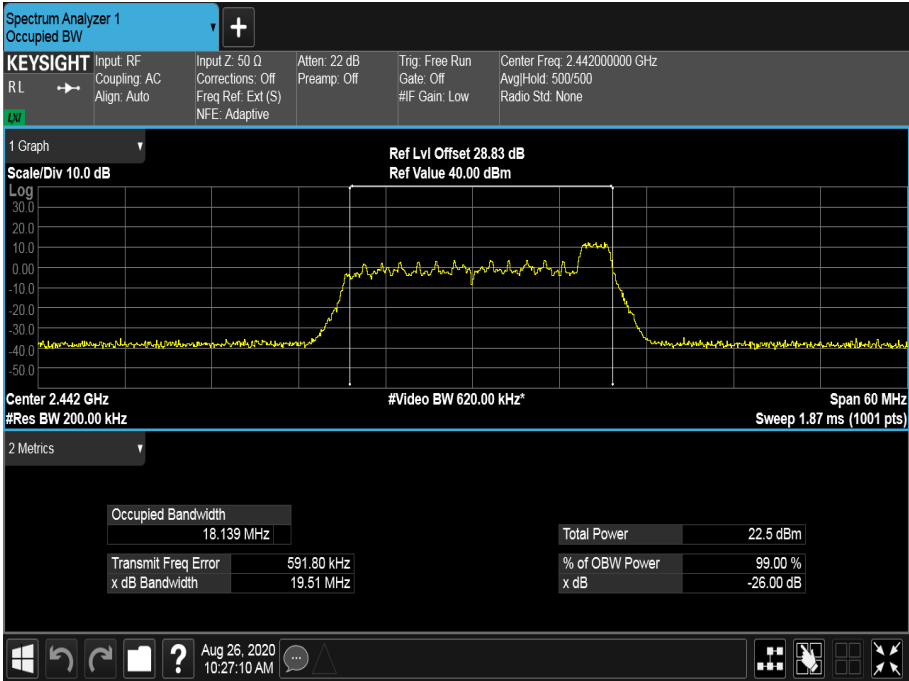


Figure 40 - 2442 MHz - 99% Occupied Bandwidth

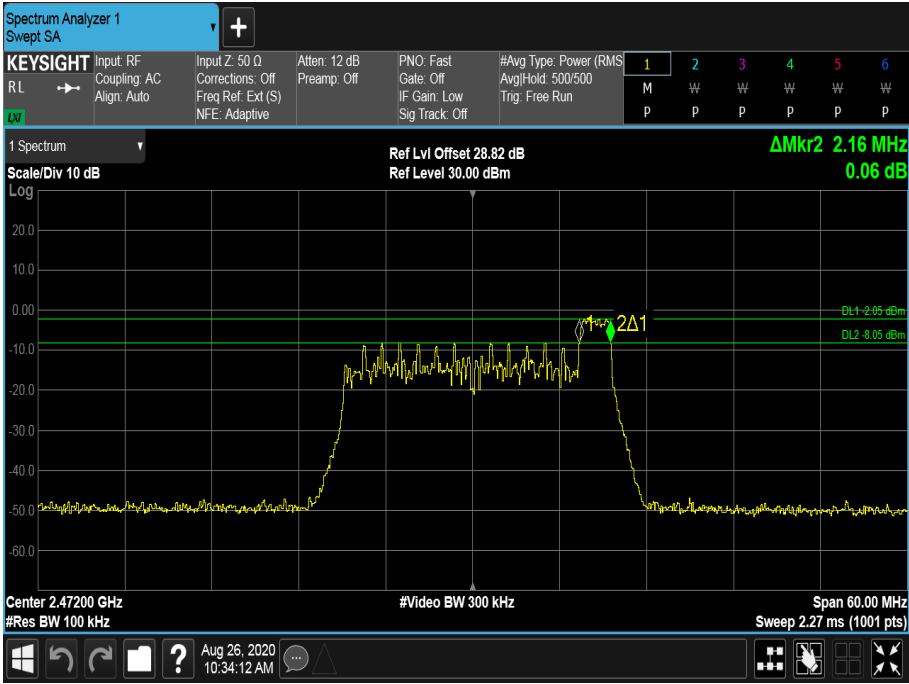


Figure 41 - 2472 MHz - 6 dB DTS Bandwidth

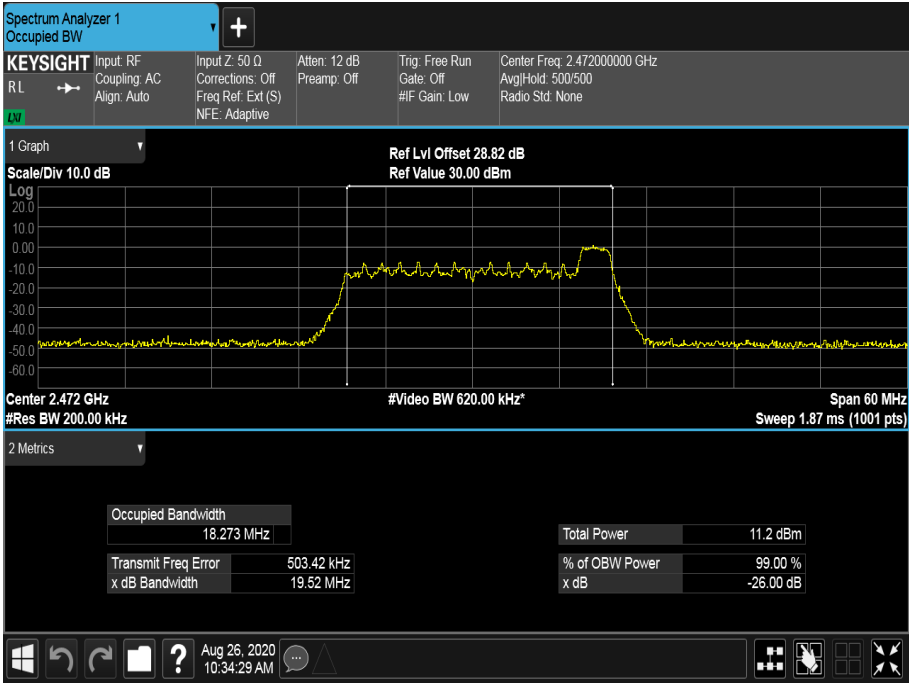


Figure 42 - 2472 MHz - 99% Occupied Bandwidth

Channel	Bottom	Middle	Top
Frequency (MHz)	2412	2442	2472
6 dB Bandwidth (MHz)	19.020	18.900	18.780
99% Bandwidth (MHz)	18.962	18.997	18.925

Table 13 - 802.11ax / HE20 MCS7x1 / SU / MIMO CDD / Cores 0+1

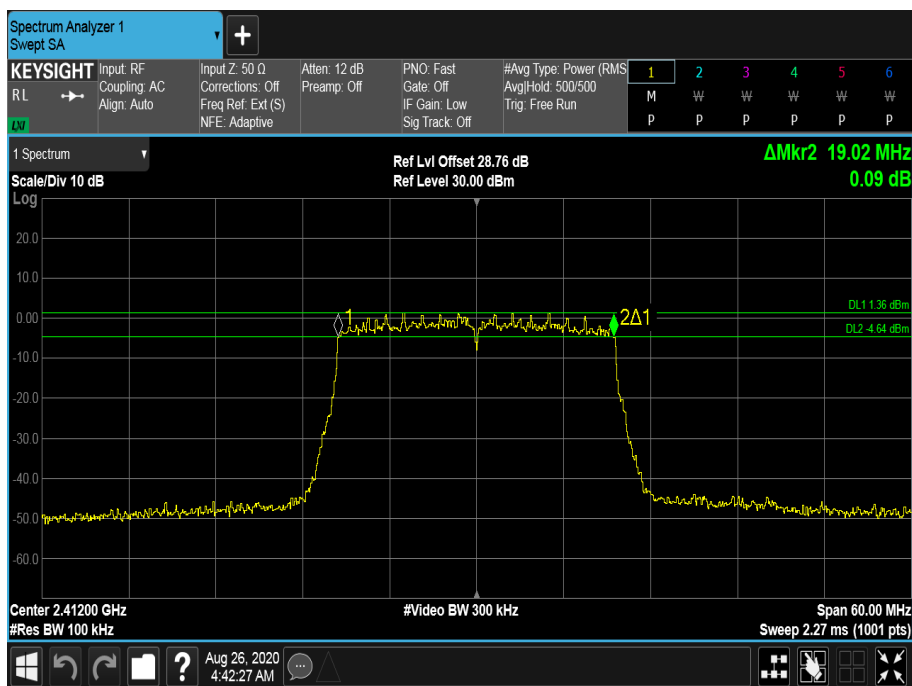


Figure 43 - 2412 MHz - 6 dB DTS Bandwidth

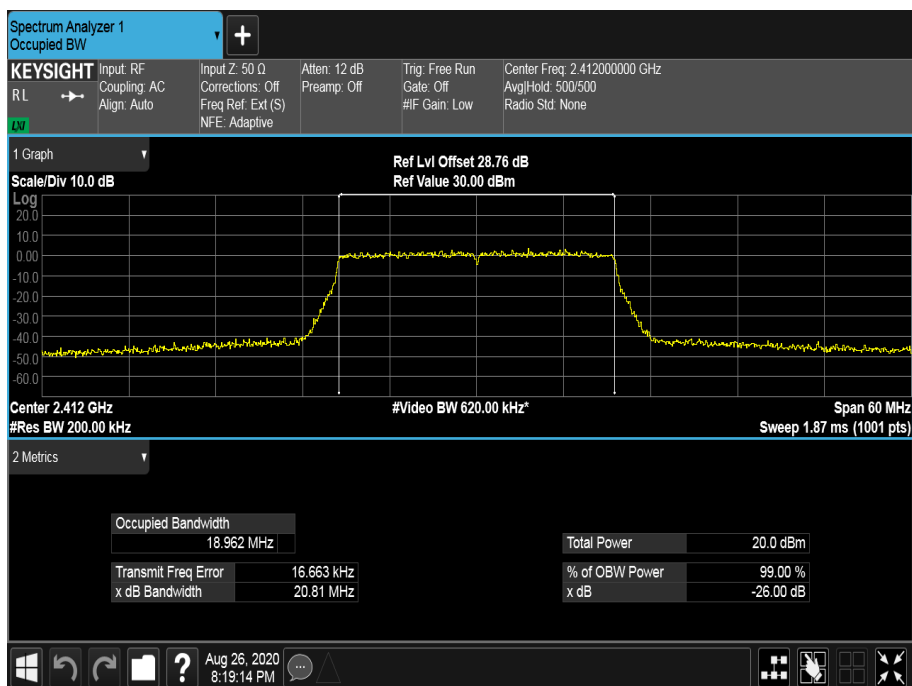


Figure 44 - 2412 MHz - 99% Occupied Bandwidth

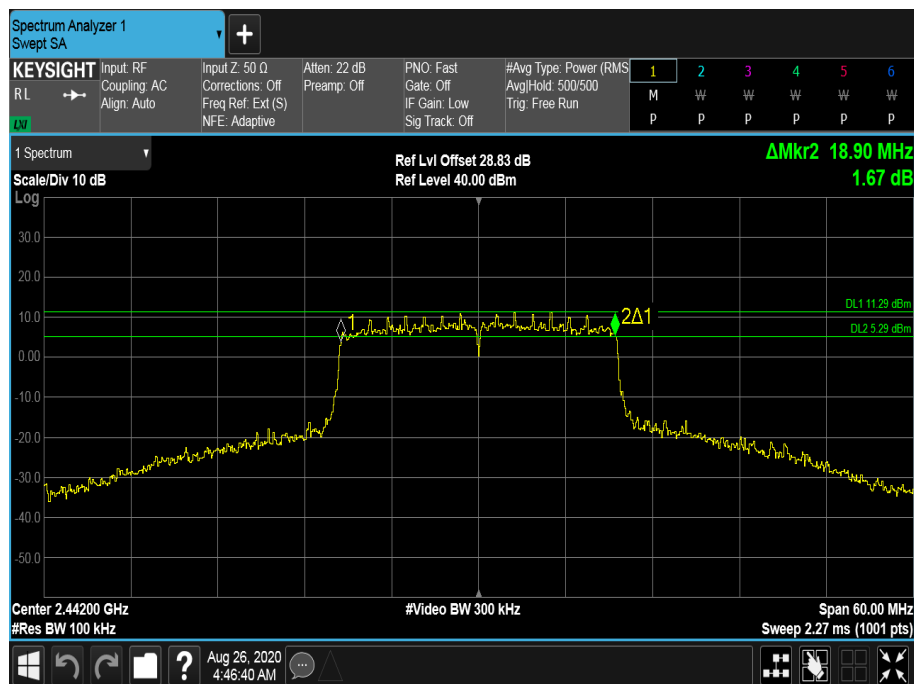


Figure 45 - 2442 MHz - 6 dB DTS Bandwidth

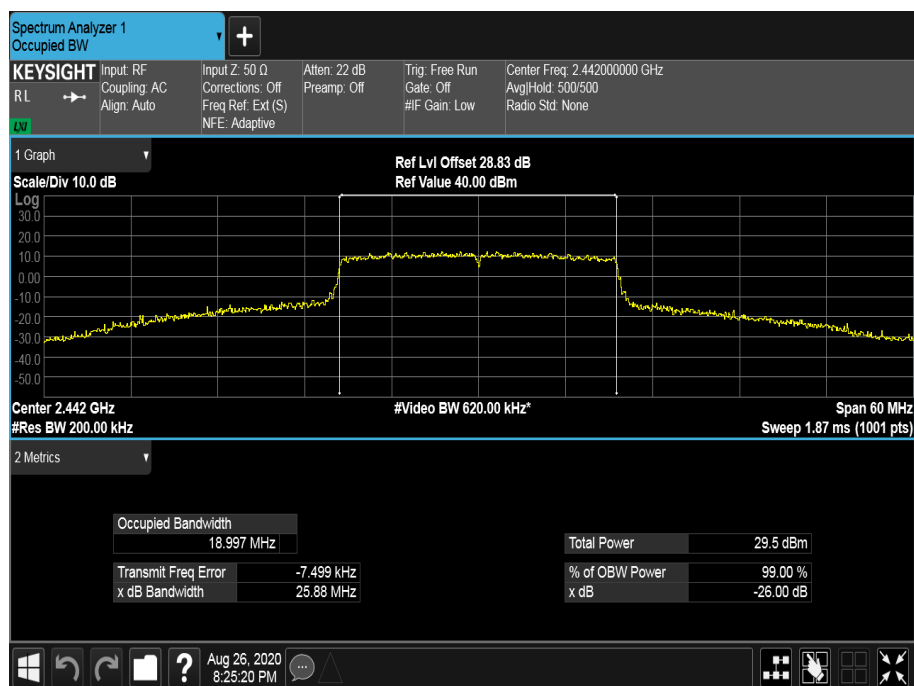


Figure 46 - 2442 MHz - 99% Occupied Bandwidth

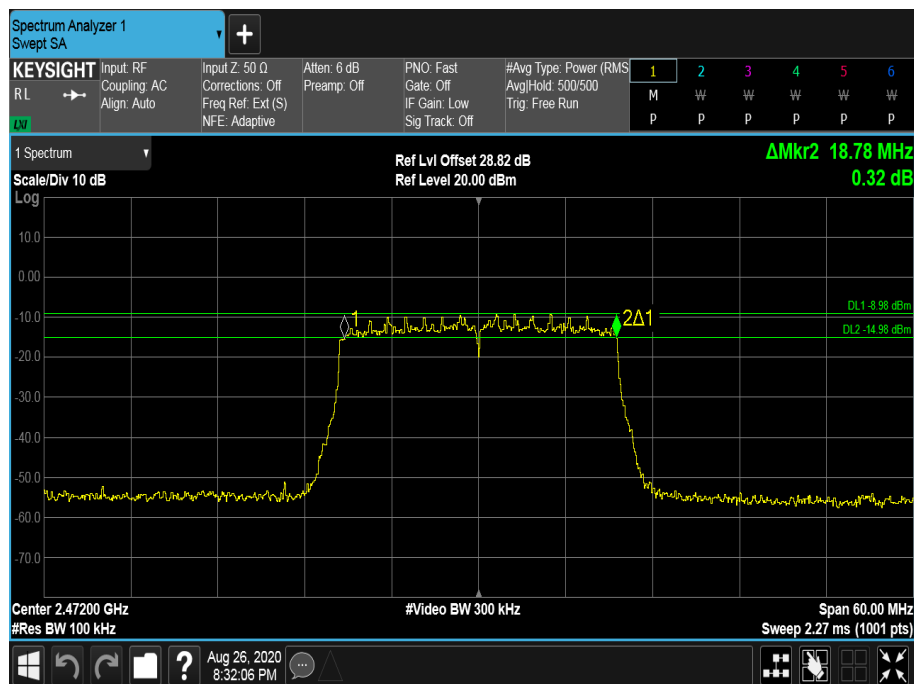


Figure 47 - 2472 MHz - 6 dB DTS Bandwidth

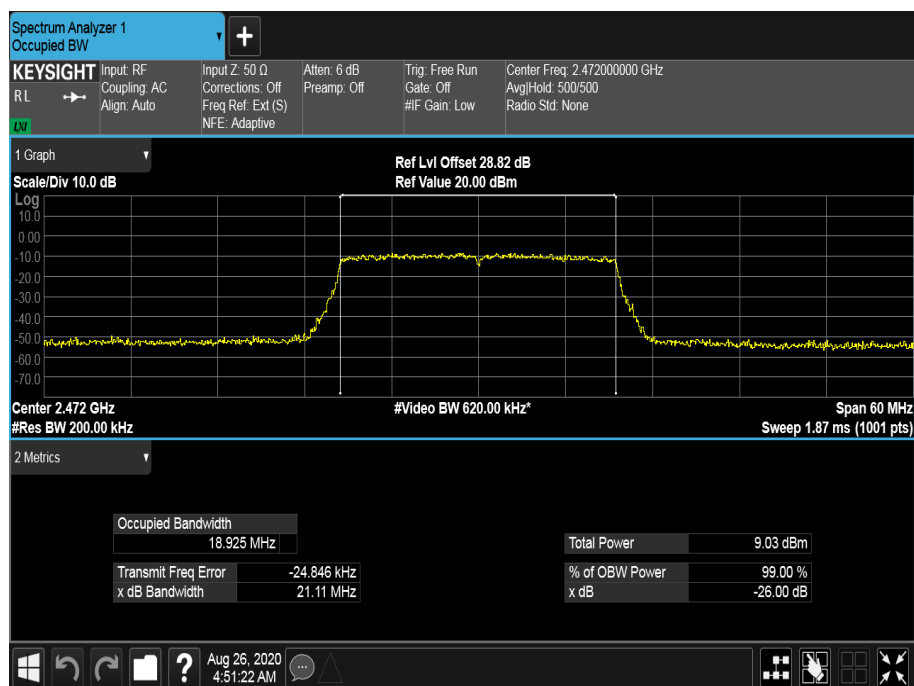


Figure 48 - 2472 MHz - 99% Occupied Bandwidth



Channel	Bottom	Middle	Top
Frequency (MHz)	2412	2442	2472
6 dB Bandwidth (MHz)	2.220	2.160	2.160
99% Bandwidth (MHz)	18.315	18.204	18.243

Table 14 - 802.11ax / HE20 MCS7x1 / RU 26-0 / MIMO CDD / Cores 0+1

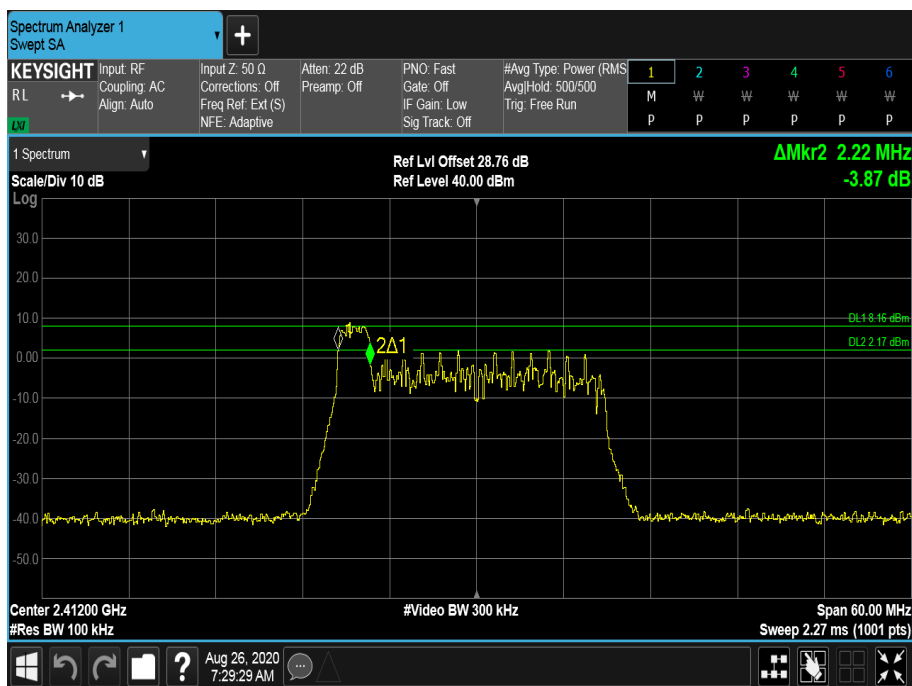


Figure 49 - 2412 MHz - 6 dB DTS Bandwidth

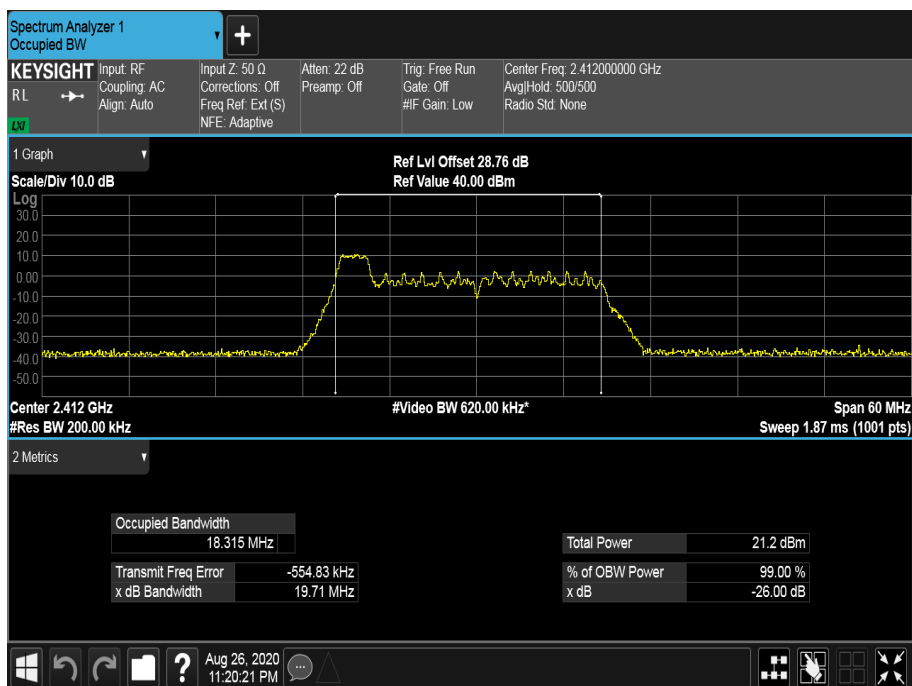


Figure 50 - 2412 MHz - 99% Occupied Bandwidth

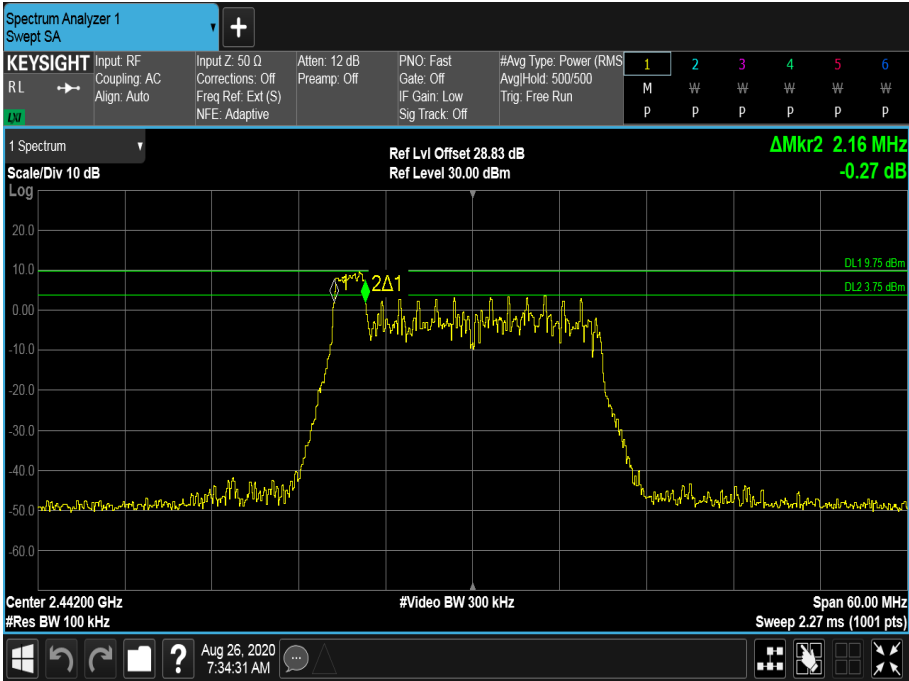


Figure 51 - 2442 MHz - 6 dB DTS Bandwidth

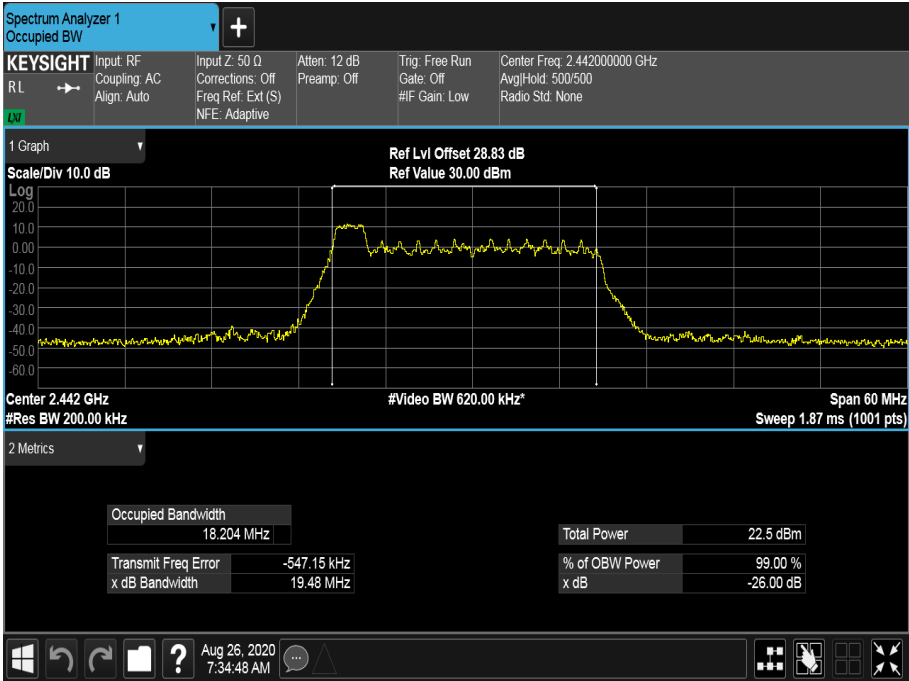


Figure 52 - 2442 MHz - 99% Occupied Bandwidth

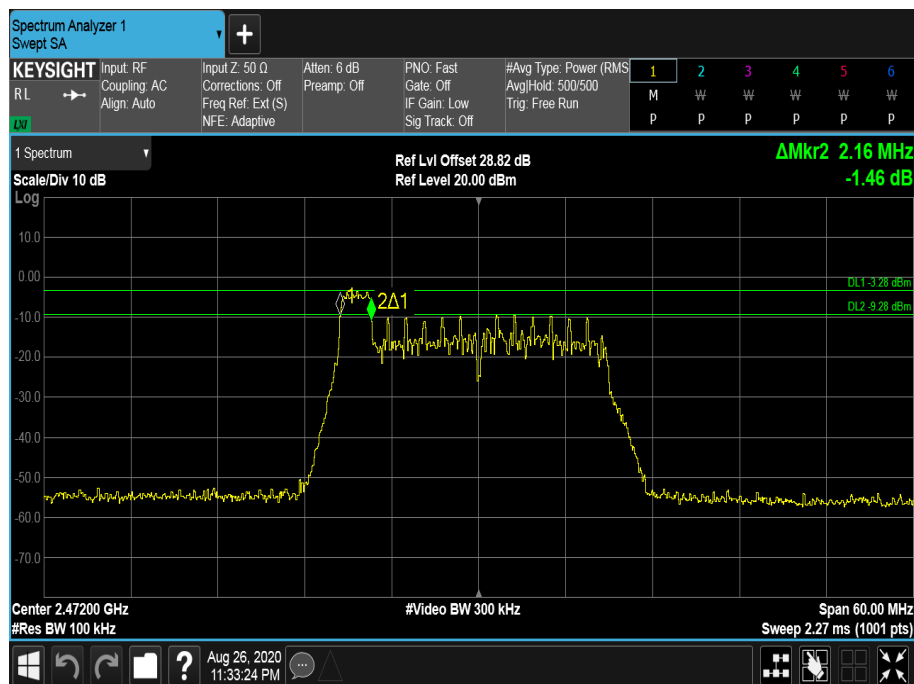


Figure 53 - 2472 MHz - 6 dB DTS Bandwidth

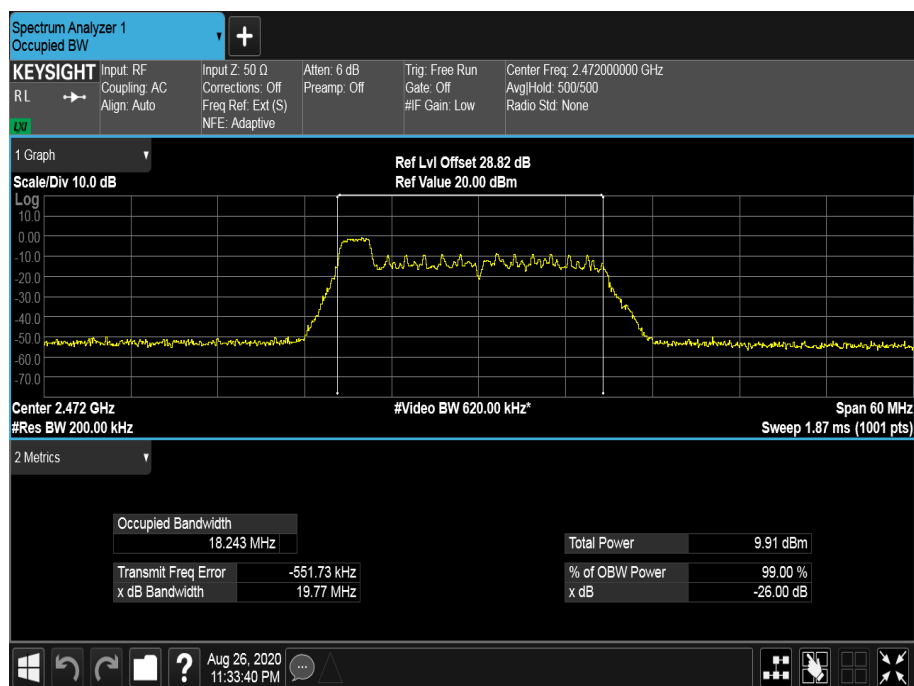
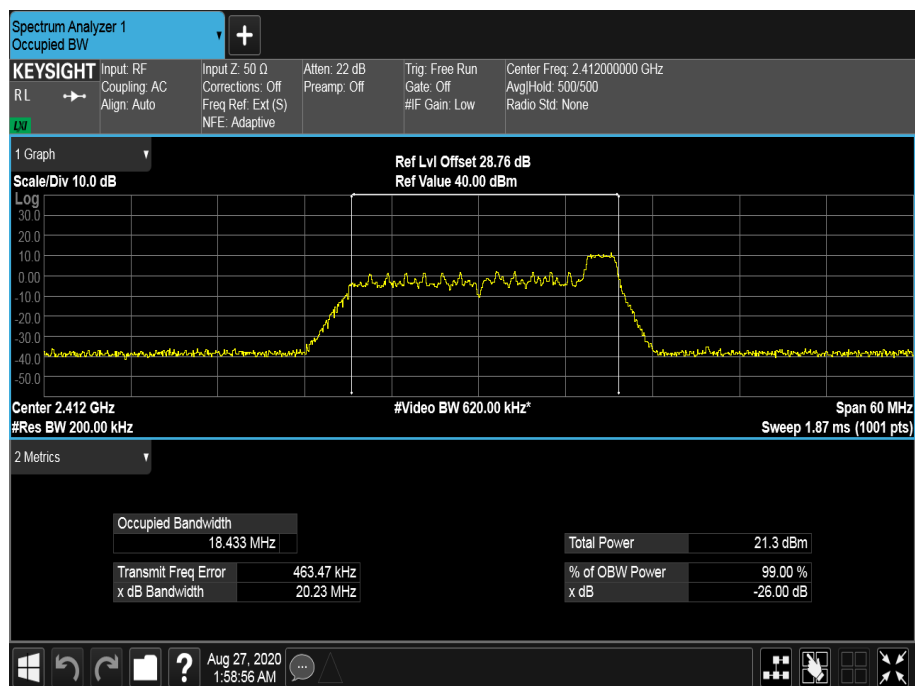
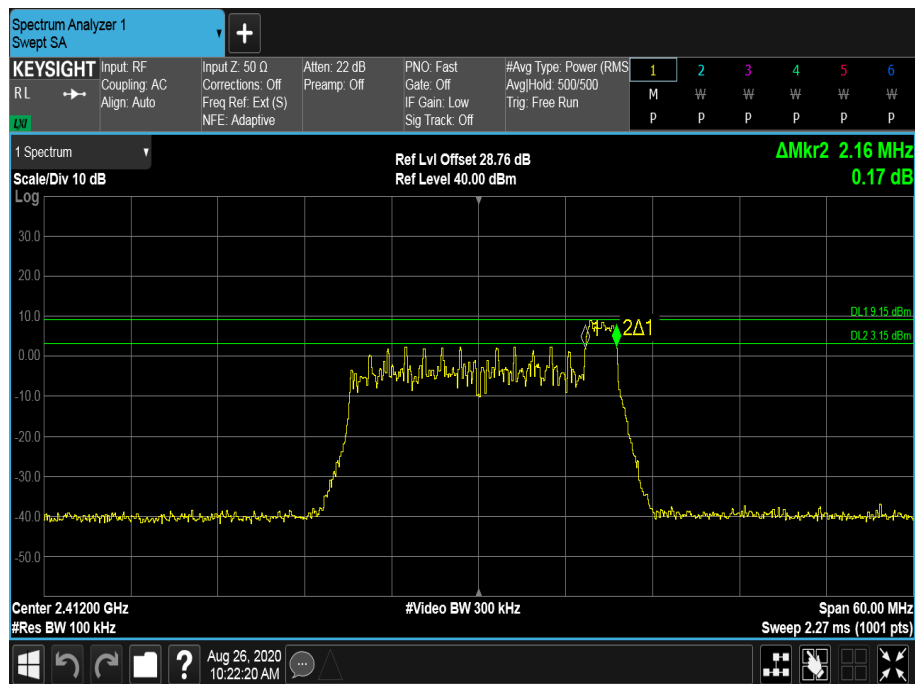


Figure 54 - 2472 MHz - 99% Occupied Bandwidth

Channel	Bottom	Middle	Top
Frequency (MHz)	2412	2442	2472
6 dB Bandwidth (MHz)	2.160	2.160	2.160
99% Bandwidth (MHz)	18.433	18.467	18.405



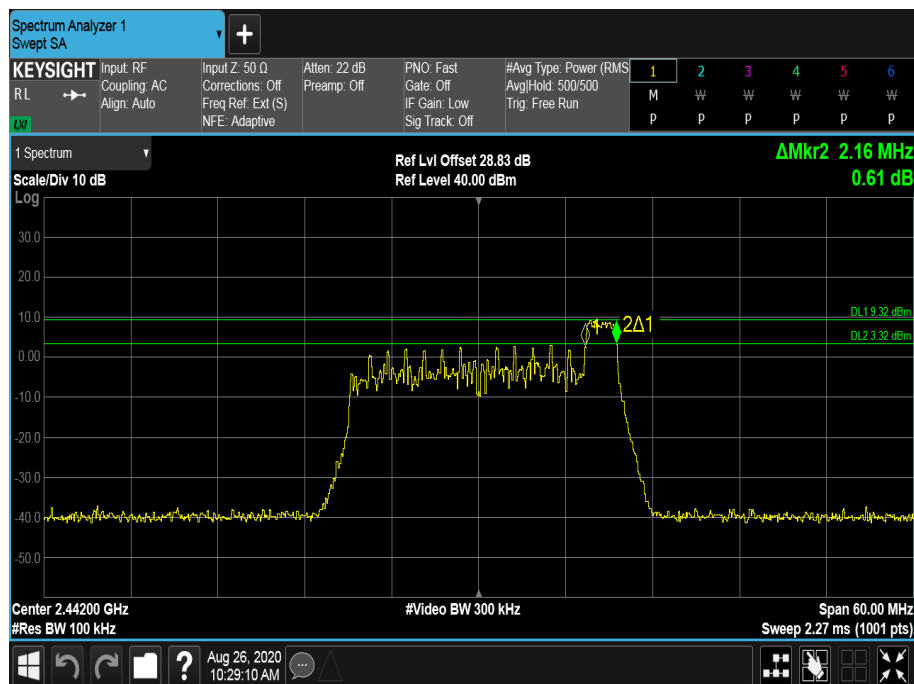


Figure 57 - 2442 MHz - 6 dB DTS Bandwidth

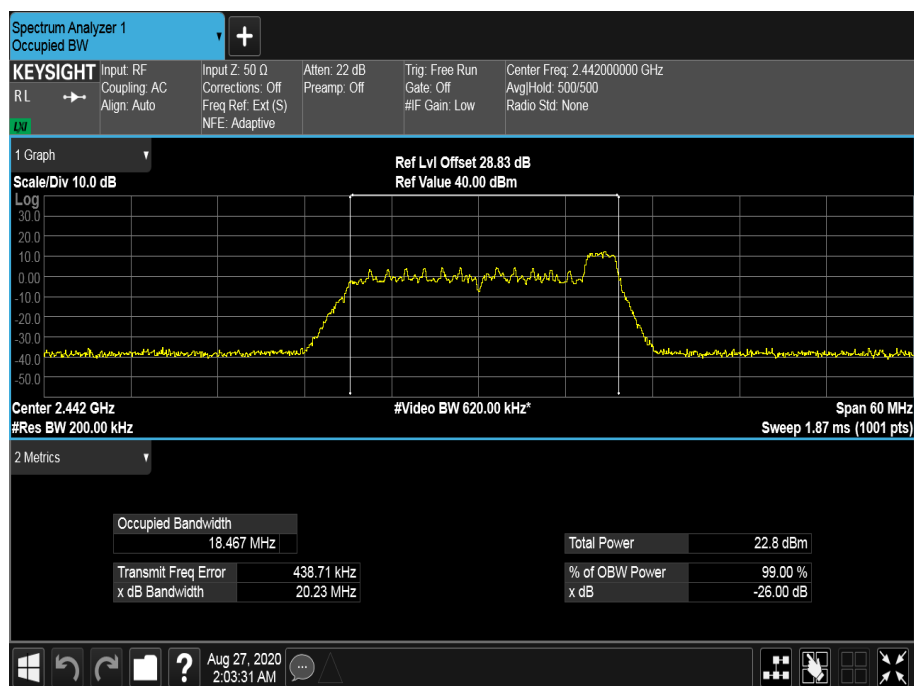


Figure 58 - 2442 MHz - 99% Occupied Bandwidth

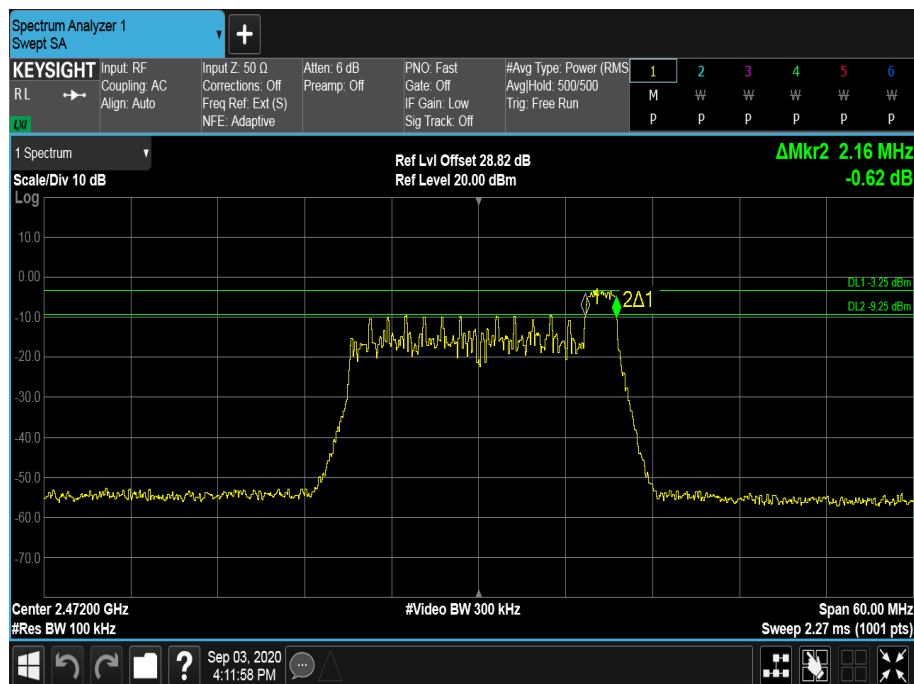


Figure 59 - 2472 MHz - 6 dB DTS Bandwidth

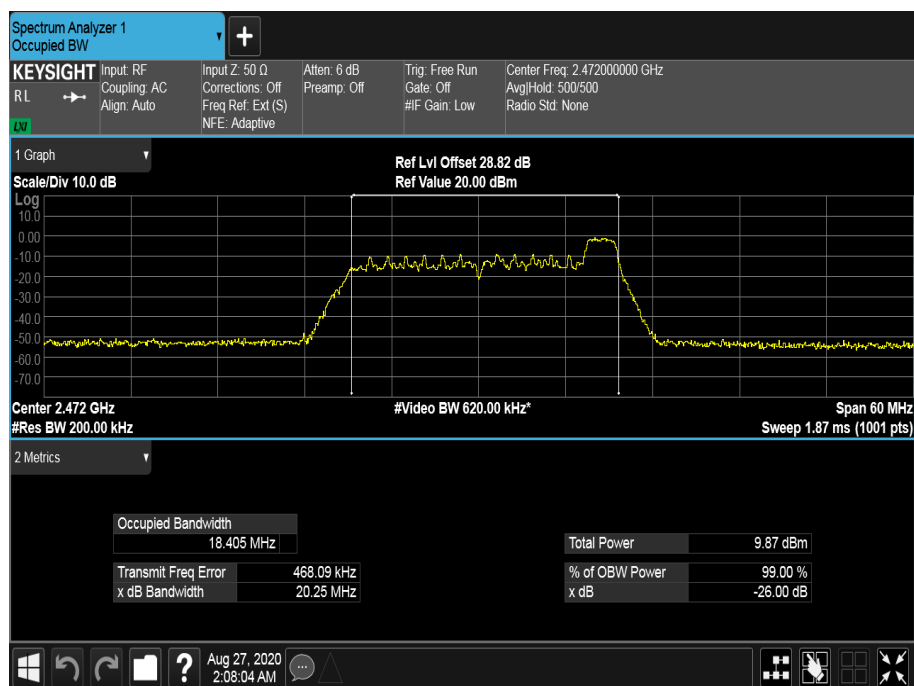


Figure 60 - 2472 MHz - 99% Occupied Bandwidth

FCC 47 CFR Part 15, Limit Clause 15.247(a)(2) and ISED RSS-247, Clause 5.2(a)

The minimum 6 dB Bandwidth shall be at least 500 kHz.



2.1.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Attenuator (10dB, 1W)	Sealectro	60-674-1010-89	1224	-	O/P Mon
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	08-Nov-2020
Hygrometer	Rotronic	I-1000	3220	12	25-Sep-2020
1800-6000 MHz Power Splitter	Mini-Circuits	ZN2PD-63-S+	4055	-	O/P Mon
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	08-Nov-2020
2 metre SMA Cable	Florida Labs	SMS-235SP-78.8-SMS	4517	12	22-Jun-2021
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4743	12	23-Sep-2020
EXA	Keysight Technologies	N9010B	4968	24	23-Dec-2021
Power Splitter, 4 way	Mini-Circuits	ZN4PD1-63-S+	5236	-	O/P Mon
3.5 mm 1m Cable	Junkosha	MWX221-01000DMS	5418	12	22-Jun-2021
3.5 mm 2m Cable	Junkosha	MWX221-02000DMS	5425	12	22-Jun-2021
Attenuator 2W 10dB DC-10GHz	Telegartner	J01156A0031	5579	-	O/P Mon
Attenuator 2W 10dB DC-10GHz	Telegartner	J01156A0031	5580	-	O/P Mon

Table 16

O/P Mon – Output Monitored using calibrated equipment



2.2 Maximum Conducted Output Power

2.2.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (b)
ISED RSS-247, Clause 5.4
ISED RSS-GEN, Clause 6.12

2.2.2 Equipment Under Test and Modification State

A2348, S/N: C07D100D02DH - Modification State 0

2.2.3 Date of Test

19-August-2020 to 09-September-2020

2.2.4 Test Method

The test was performed in accordance with ANSI C63.10 clause 11.9.2.3.2 Method AVGPM-G

The output power was verified as being the same from each transmit core, but the antenna gains were not identical, therefore the modes reported for SISO or 2x2 MIMO operation are those giving the highest EIRP and/or lowest conducted limit based on the combination of antennas giving highest total directional gain.

MIMO output port summing was performed in accordance with KDB 662911 D01. For the CDD results the Directional Gain was calculated in accordance with clause F)2)f)(ii) using the calculations from F)2)f)(i) with worst-case individual gain and an array gain of zero.

2.2.5 Environmental Conditions

Ambient Temperature	21.2 - 23.8 °C
Relative Humidity	43.3 - 70.8 %



2.2.6 Test Results

2.4 GHz WLAN

Channel	Bottom	Middle	Top
Frequency (MHz)	2412	2442	2472
Antenna Directional Gain (dBi)	5.00	5.00	5.00
15.247 Conducted Power Limit (dBm)	30.00	30.00	30.00
RSS-247 Conducted Power Limit (dBm)	30.00	30.00	30.00
Conducted Power (dBm)	19.98	22.16	11.66
RSS-247 EIRP Limit (dBm)	36.00	36.00	36.00
EIRP Power (dBm)	24.98	27.16	16.66

Table 17 - 802.11b / 1 Mbps / SISO / Core 1

Channel	Bottom	Middle	Top
Frequency (MHz)	2412	2442	2472
Antenna Directional Gain (dBi)	5.00	5.00	5.00
15.247 Conducted Power Limit (dBm)	30.00	30.00	30.00
RSS-247 Conducted Power Limit (dBm)	30.00	30.00	30.00
Conducted Power (dBm)	17.37	22.24	4.30
RSS-247 EIRP Limit (dBm)	36.00	36.00	36.00
EIRP Power (dBm)	22.37	27.24	9.30

Table 18 - 802.11g / 6 Mbps / SISO / Core 1

Channel	Bottom	Middle	Top
Frequency (MHz)	2412	2442	2472
Antenna Directional Gain (dBi)	5.00	5.00	5.00
15.247 Conducted Power Limit (dBm)	30.00	30.00	30.00
RSS-247 Conducted Power Limit (dBm)	30.00	30.00	30.00
Conducted Power (dBm)	16.85	22.42	4.44
RSS-247 EIRP Limit (dBm)	36.00	36.00	36.00
EIRP Power (dBm)	21.85	27.42	9.44

Table 19 - 802.11n / HT20 MCS7 / SISO / Core 1



Channel	Bottom	Middle	Top
Frequency (MHz)	2412	2442	2472
Conducted Power Core 0 (dBm)	14.29	22.38	3.76
Conducted Power Core 1 (dBm)	14.39	22.20	4.00
Antenna Directional Gain (dBi)	5.00	5.00	5.00
15.247 Conducted Power Limit (dBm)	30.00	30.00	30.00
RSS-247 Conducted Power Limit (dBm)	30.00	30.00	30.00
Total Conducted Power (dBm)	17.35	25.30	6.89
RSS-247 EIRP Limit (dBm)	36.00	36.00	36.00
EIRP Power (dBm)	22.35	30.30	11.89

Table 20 - 802.11n / HT20 MCS7 / MIMO CDD / Cores 0+1

Channel	Bottom	Middle	Top
Frequency (MHz)	2412	2442	2472
Antenna Directional Gain (dBi)	5.00	5.00	5.00
15.247 Conducted Power Limit (dBm)	30.00	30.00	30.00
RSS-247 Conducted Power Limit (dBm)	30.00	30.00	30.00
Conducted Power (dBm)	15.88	21.35	2.99
RSS-247 EIRP Limit (dBm)	36.00	36.00	36.00
EIRP Power (dBm)	20.88	26.35	7.99

Table 21 - 802.11ax / HE20 MCS7x1 / SU / SISO / Core 1

Channel	Bottom	Middle	Top
Frequency (MHz)	2412	2442	2472
Conducted Power Core 0 (dBm)	12.91	22.42	2.38
Conducted Power Core 1 (dBm)	12.91	22.16	2.35
Antenna Directional Gain (dBi)	5.00	5.00	5.00
15.247 Conducted Power Limit (dBm)	30.00	30.00	30.00
RSS-247 Conducted Power Limit (dBm)	30.00	30.00	30.00
Total Conducted Power (dBm)	15.92	25.31	5.37
RSS-247 EIRP Limit (dBm)	36.00	36.00	36.00
EIRP Power (dBm)	20.92	30.31	10.37

Table 22 - 802.11ax / HE20 MCS7x1 / SU / MIMO CDD / Cores 0+1



FCC 47 CFR Part 15, Limit Clause 15.247 (b)(3)

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt.

ISED RSS-247, Limit Clause 5.4 (b)

For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e) of the specification.

2.2.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Attenuator (10dB, 1W)	Sealectro	60-674-1010-89	1224	-	O/P Mon
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	08-Nov-2020
Multimeter	Iso-tech	IDM101	2424	12	12-Dec-2020
Hygrometer	Rotronic	I-1000	3220	12	25-Sep-2020
1800-6000 MHz Power Splitter	Mini-Circuits	ZN2PD-63-S+	4055	-	O/P Mon
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	08-Nov-2020
2 metre SMA Cable	Florida Labs	SMS-235SP-78.8-SMS	4517	12	22-Jun-2021
Power splitter - 2 port	Mini-Circuits	ZN2PD-63-S+	4743	12	23-Sep-2020
USB Power Sensor	Boonton	RTP5006	5187	12	09-Jan-2021
AC Programmable Power Supply	iTech	IT7324	5225	-	O/P Mon
Power Splitter, 4 way	Mini-Circuits	ZN4PD1-63-S+	5236	-	O/P Mon
3.5 mm 1m Cable	Junkosha	MWX221-01000DMS	5417	12	22-Jun-2021
3.5 mm 1m Cable	Junkosha	MWX221-01000DMS	5418	12	22-Jun-2021
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	04-Mar-2022
Attenuator 2W 10dB DC-10GHz	Telegartner	J01156A0031	5579	-	O/P Mon
Attenuator 2W 10dB DC-10GHz	Telegartner	J01156A0031	5580	-	O/P Mon

Table 23

O/P Mon – Output Monitored using calibrated equipment



2.3 Spurious Radiated Emissions

2.3.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (d) and 15.205
ISED RSS-247, Clause 5.5
ISED RSS-GEN, Clause 6.13

2.3.2 Equipment Under Test and Modification State

A2348, S/N: C07D100W02H7 - Modification State 0

2.3.3 Date of Test

17-August-2020 to 22-August-2020

2.3.4 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. One port of each type was loaded.

For frequencies > 1 GHz, plots for average measurements were taken in accordance with ANSI C63.10, clause 11.12.2.5.2.

Where duty cycle corrections were required for average results, these are included in the result tables but are not shown on the plots.

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 20 dBc 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.

Note the edges of the fundamental may be visible and in some cases appear to exceed the limit in these pre-scans. These band edge emissions were not measured in this section and are investigated fully in sections 2.4 and 2.5.

The following conversion can be applied to convert from dBuV/m to uV/m:
 $10^{(Field\ Strength\ in\ dBuV/m/20)}$.

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 $20 \cdot \log(3/1) = 9.54$ dB.

Where formal measurements have been necessary, the results have been presented in the emissions table.

In the 30 MHz to 1 GHz range pre-scans were only performed on the main radio mid channel (2437 MHz).

The worst case test mode was determined in accordance with ANSI C63.10 clause 5.6.2.2 b). 802.11b 1 Mbps was selected as the worst case from DSSS. For OFDM, HT20 MCS7 was selected as the operating mode with the highest output power. HE20 RU26 was chosen as the mode likely to result in the highest PSD. The EUT was configured to transmit with both chains at maximum output power only for OFDM.

2.3.5 Example Test Setup Diagram

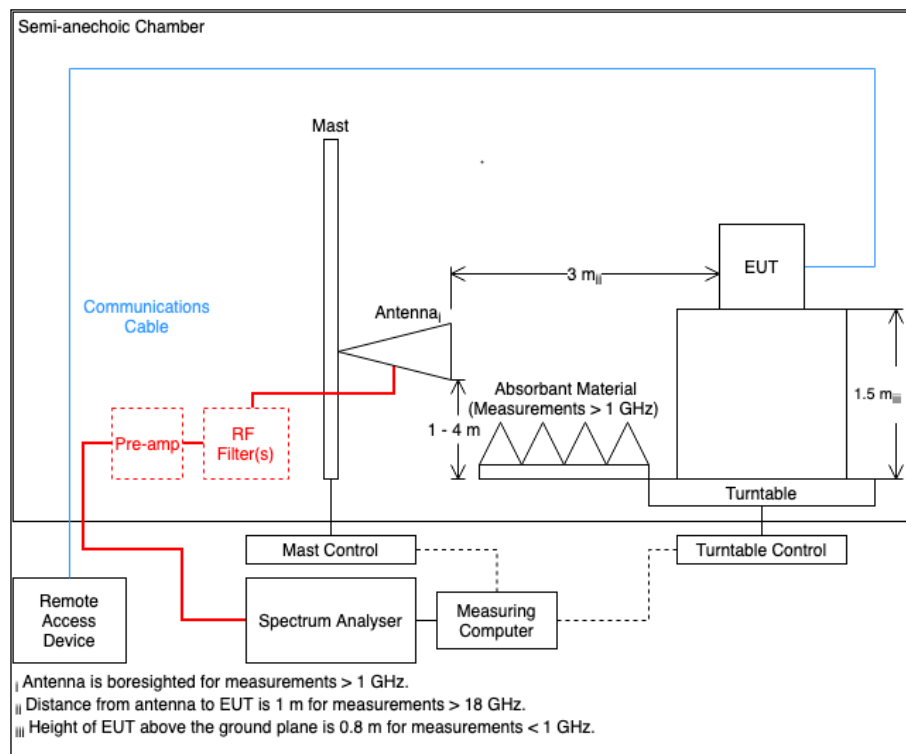


Figure 61

2.3.6 Environmental Conditions

Ambient Temperature	20.4 - 21.9 °C
Relative Humidity	40.5 - 55.6 %



2.3.7 Test Results

2.4 GHz WLAN

802.11b 20 MHz Bandwidth

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
4823.707	47.5	54.0	-6.5	RMS	145	127	Horizontal

Table 24 - 2412 MHz (CH1), 802.11b, Core 0, 1 GHz to 26 GHz

No other emissions found within 6 dB of the limit.

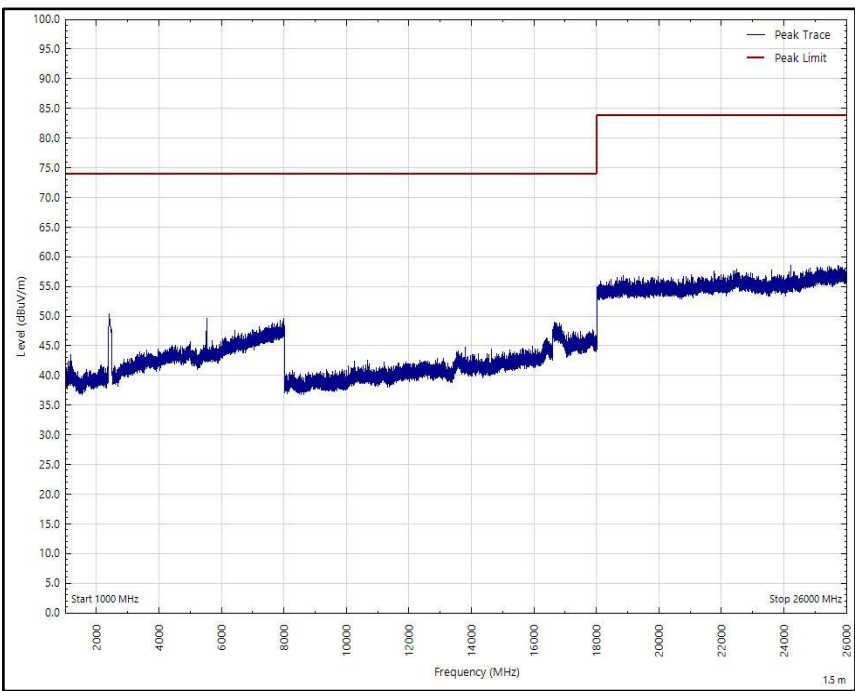


Figure 62 - 2412 MHz (CH1), 802.11b, Core 0, 1 GHz to 26 GHz, Horizontal (Peak)

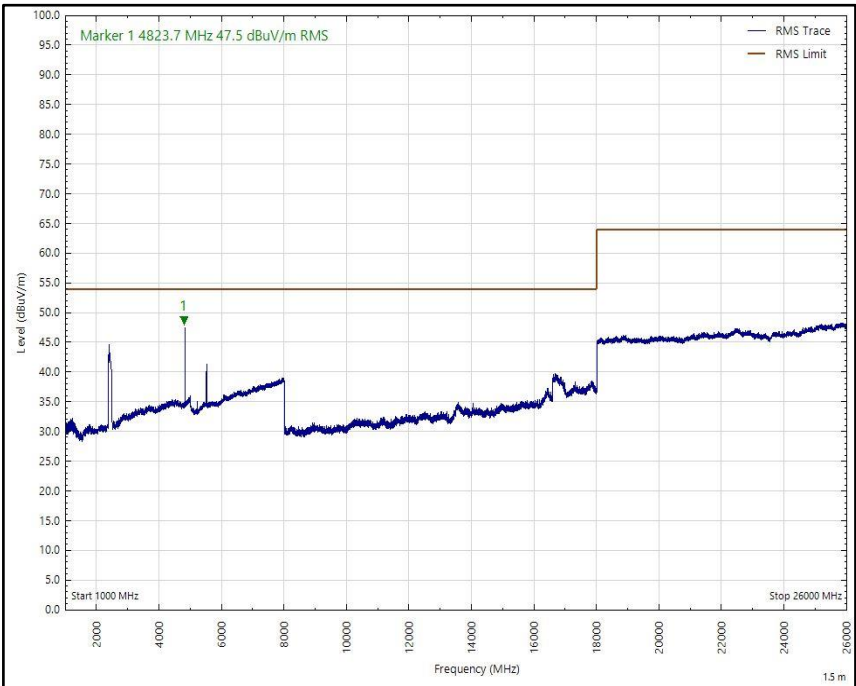


Figure 63 - 2412 MHz (CH1), 802.11b, Core 0, 1 GHz to 26 GHz, Horizontal (rms)

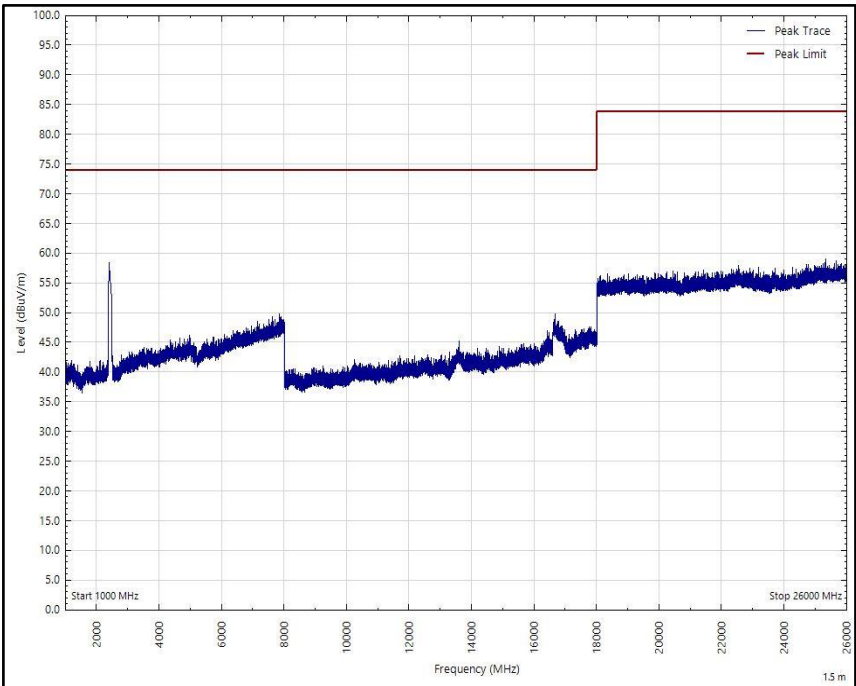


Figure 64 - 2412 MHz (CH1), 802.11b, Core 0, 1 GHz to 26 GHz, Vertical (Peak)

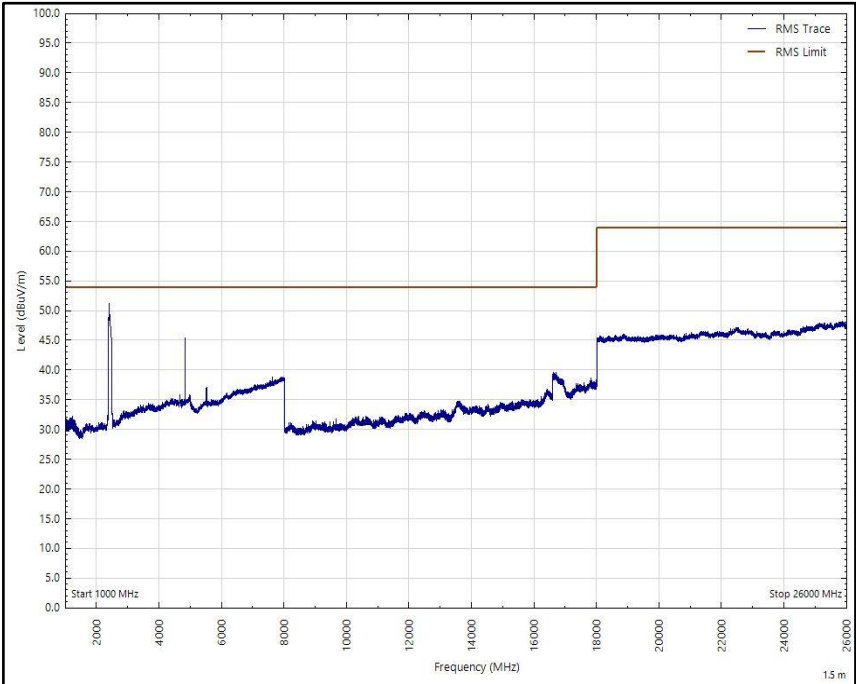


Figure 65 - 2412 MHz (CH1), 802.11b, Core 0, 1 GHz to 26 GHz, Vertical (rms)

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
4867.973	45.8	54.0	-8.2	RMS	175	267	Vertical
4874.115	46.7	54.0	-7.3	RMS	150	105	Horizontal

Table 25 - 2437 MHz (CH6), Core 0, 30 MHz to 26 GHz

No other emissions found within 6 dB of the limit.

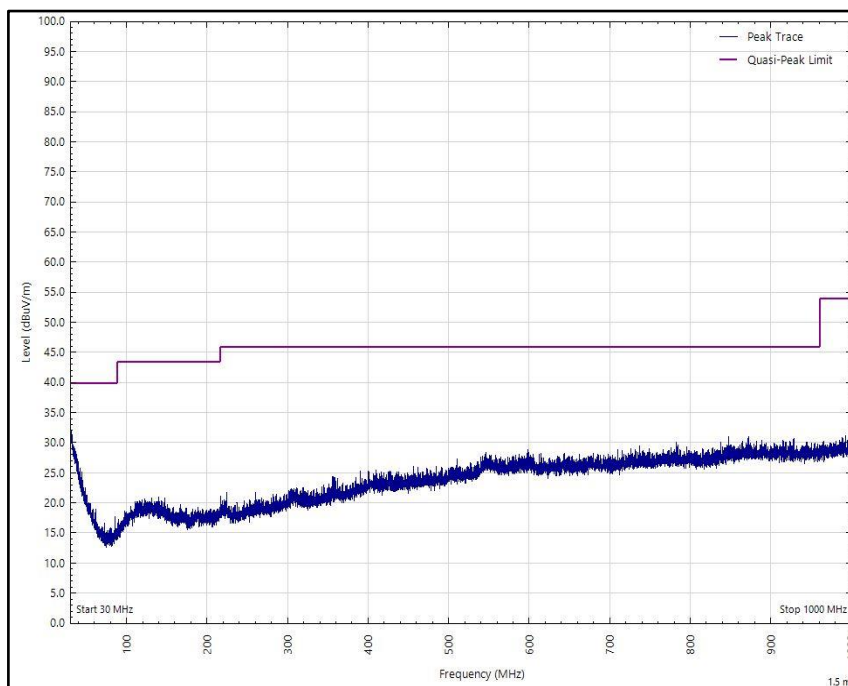


Figure 66 - 2437 MHz (CH6), 802.11b, Core 0, 30 MHz to 1 GHz, Horizontal (Peak)

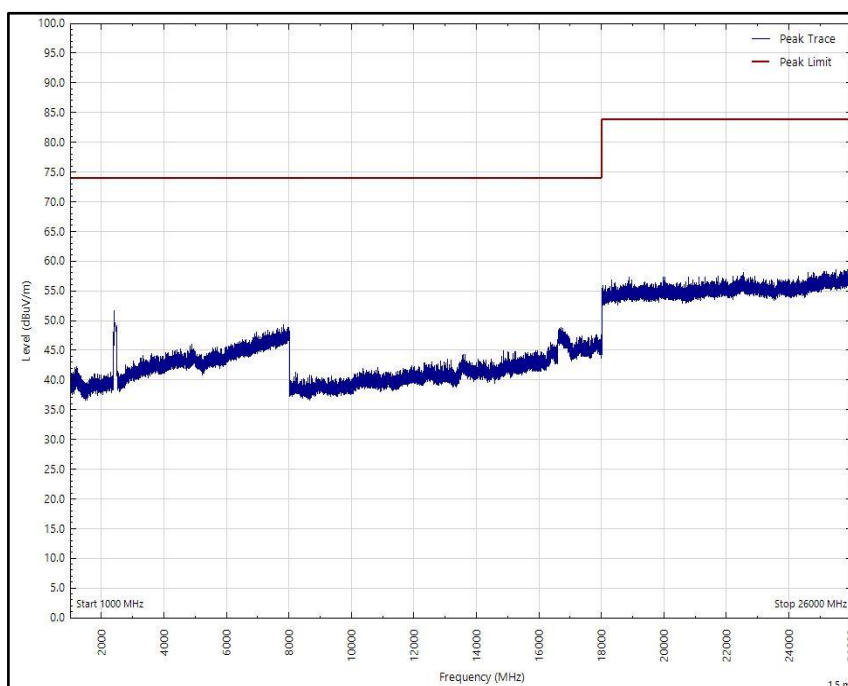


Figure 67 - 2437 MHz (CH6), 802.11b, Core 0, 1 GHz to 26 GHz, Horizontal (Peak)

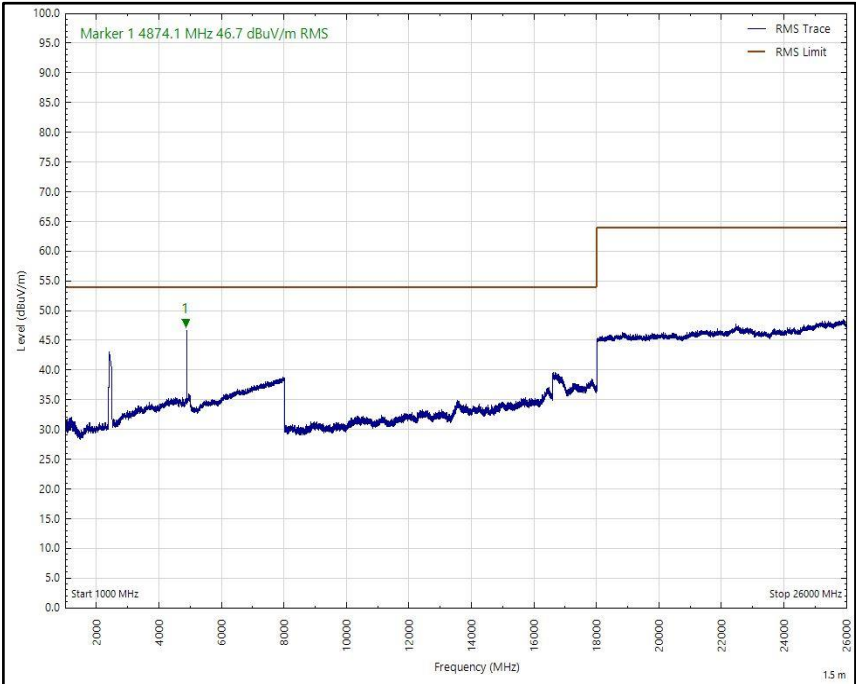


Figure 68 - 2437 MHz (CH6), 802.11b, Core 0, 1 GHz to 26 GHz, Horizontal (rms)

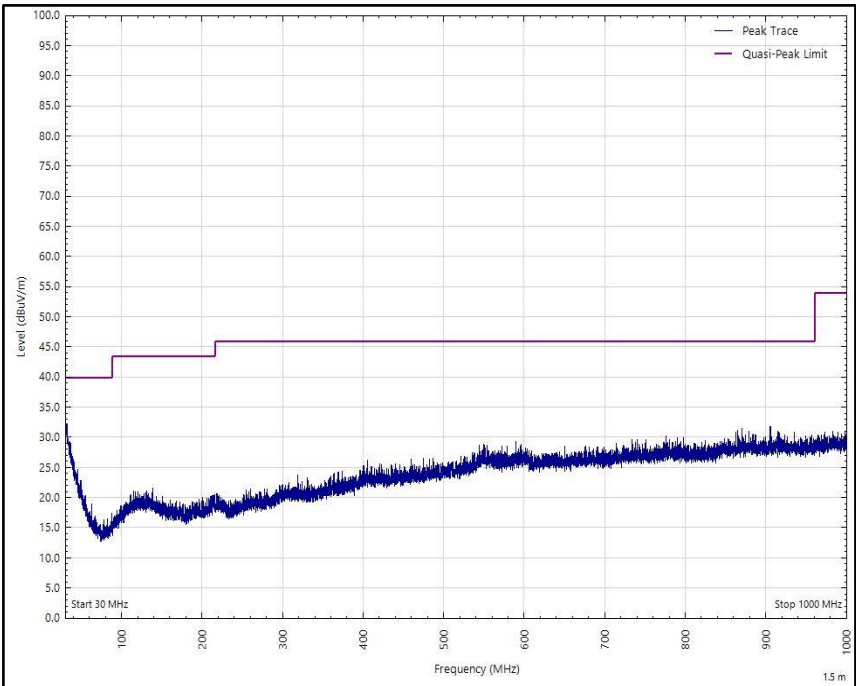


Figure 69 - 2437 MHz (CH6), 802.11b, Core 0, 30 MHz to 1 GHz, Vertical (Peak)

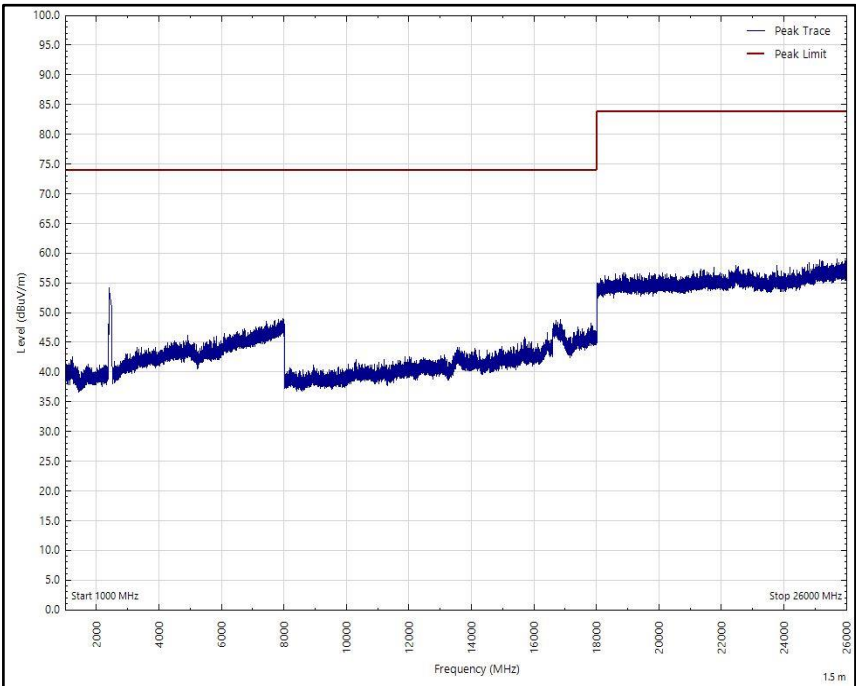


Figure 70 - 2437 MHz (CH6), 802.11b, Core 0, 1 GHz to 26 GHz, Vertical (Peak)

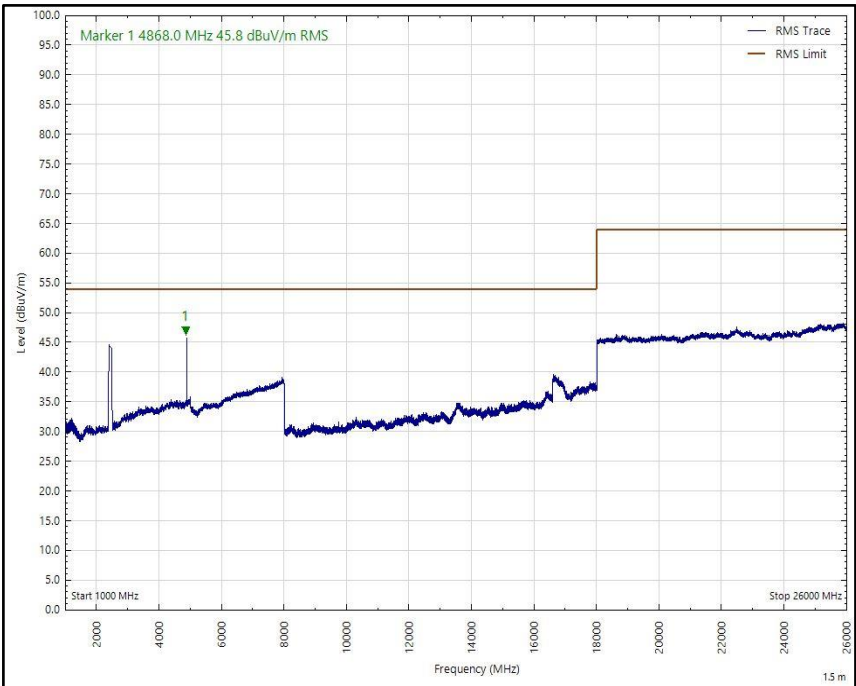


Figure 71 - 2437 MHz (CH6), 802.11b, Core 0, 1 GHz to 26 GHz, Vertical (rms)

Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Angle (°)	Height (cm)	Polarisation
4943.942	37.2	54.0	-16.8	RMS	212	110	Vertical
4944.008	37.7	54.0	-16.3	RMS	149	103	Horizontal

Table 26 - 2472 MHz (CH13), 802.11b, Core 0, 1 GHz to 26 GHz

No other emissions found within 6 dB of the limit.

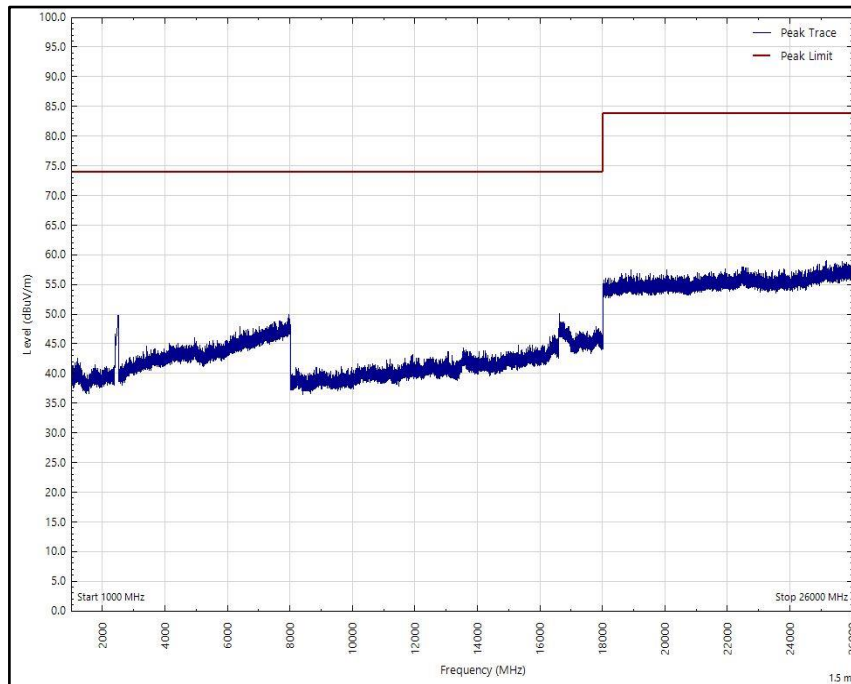


Figure 72 - 2472 MHz (CH13), 802.11b, Core 0, 1 GHz to 26 GHz, Horizontal (Peak)

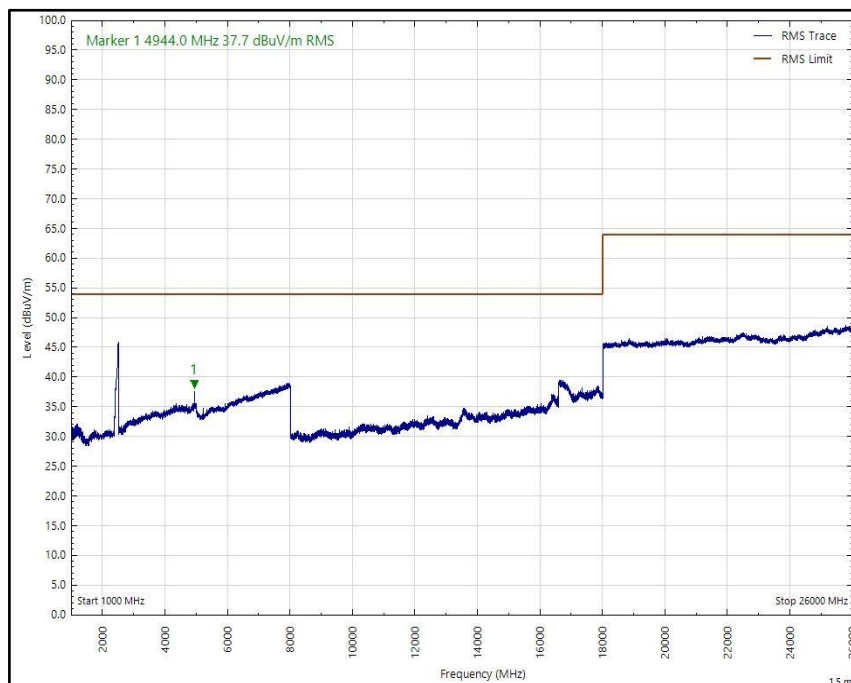


Figure 73 - 2472 MHz (CH13), 802.11b, Core 0, 1 GHz to 26 GHz, Horizontal (rms)

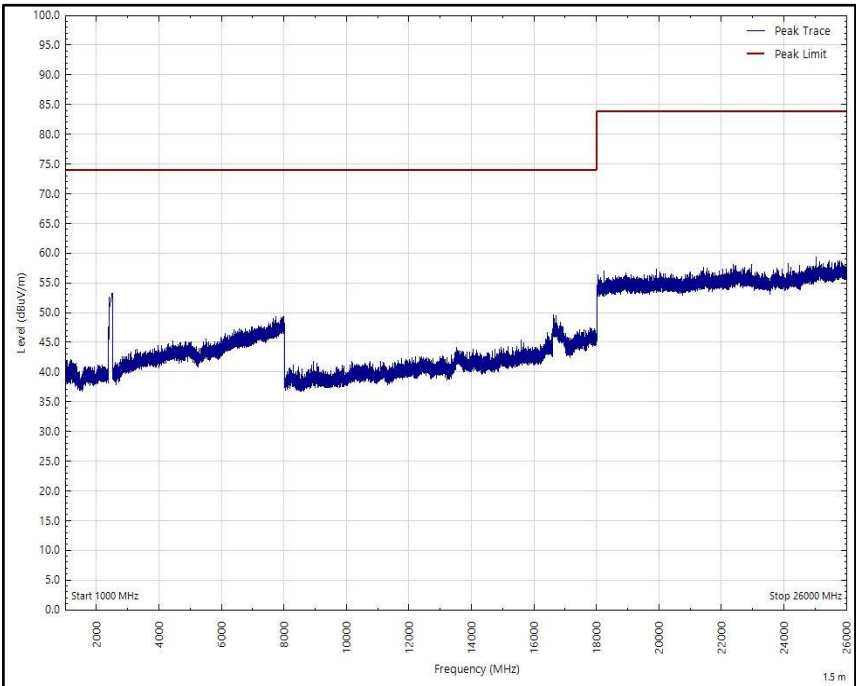


Figure 74 - 2472 MHz (CH13), 802.11b, Core 0, 1 GHz to 26 GHz, Vertical (Peak)

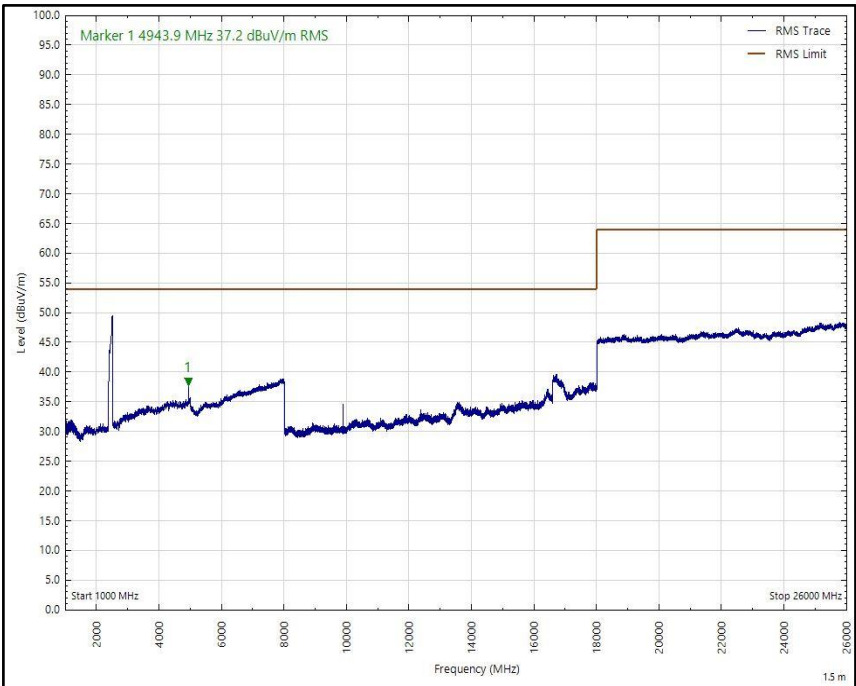


Figure 75 - 2472 MHz (CH13), 802.11b, Core 0, 1 GHz to 26 GHz, Vertical (rms)



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

Table 27 - 2412 MHz (CH1), 802.11b, Core 1, 1 GHz to 26 GHz

*No emissions found within 6 dB of the limit.

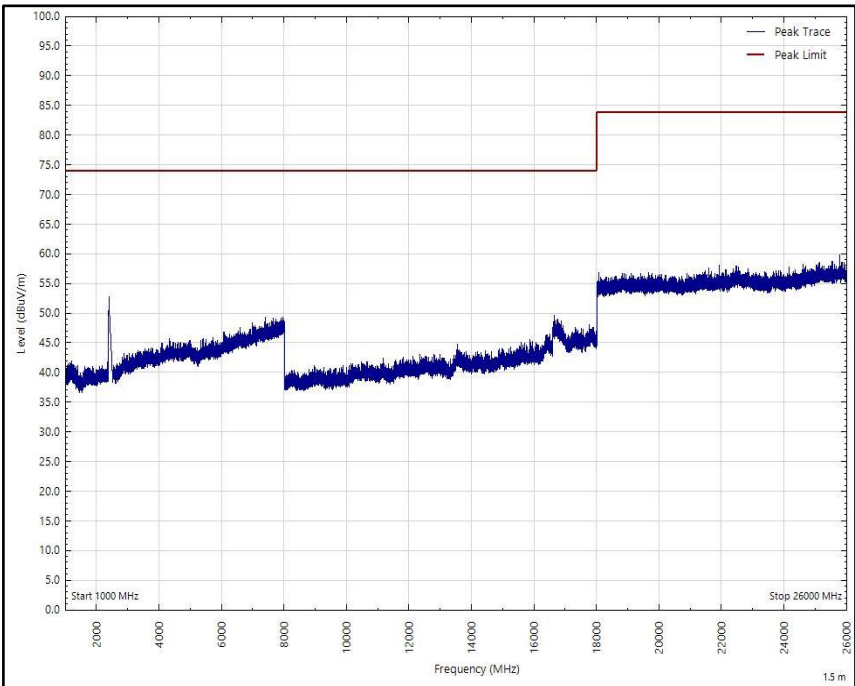


Figure 76 - 2412 MHz (CH1), 802.11b, Core 1, 1 GHz to 26 GHz, Horizontal (Peak)

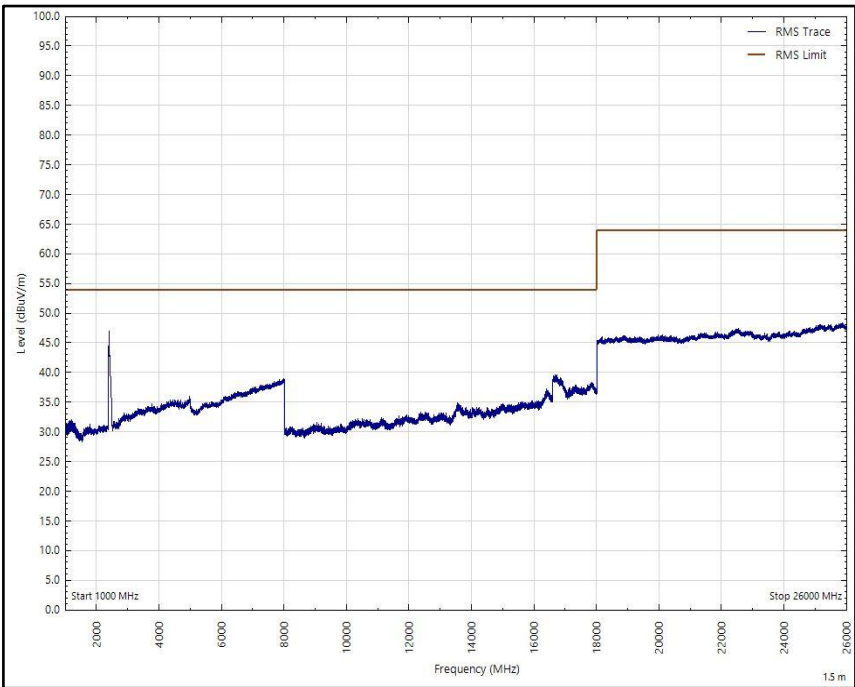


Figure 77 - 2412 MHz (CH1), 802.11b, Core 1, 1 GHz to 26 GHz, Horizontal (rms)

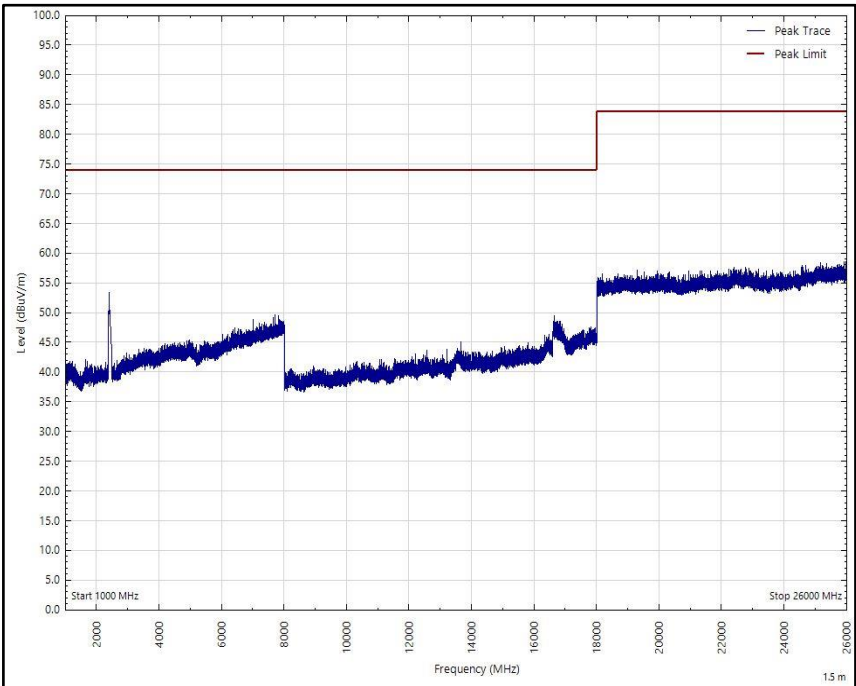


Figure 78 - 2412 MHz (CH1), 802.11b, Core 1, 1 GHz to 26 GHz, Vertical (Peak)

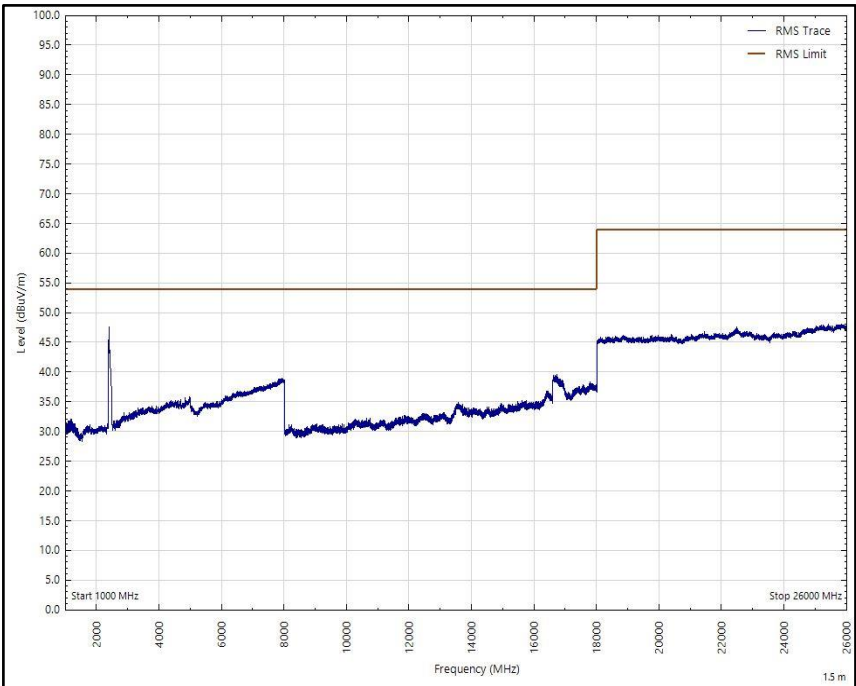


Figure 79 - 2412 MHz (CH1), 802.11b, Core 1, 1 GHz to 26 GHz, Vertical (rms)



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

Table 28 - 2437 MHz (CH6), 802.11b, Core 1, 30 MHz to 26 GHz

*No emissions found within 6 dB of the limit.

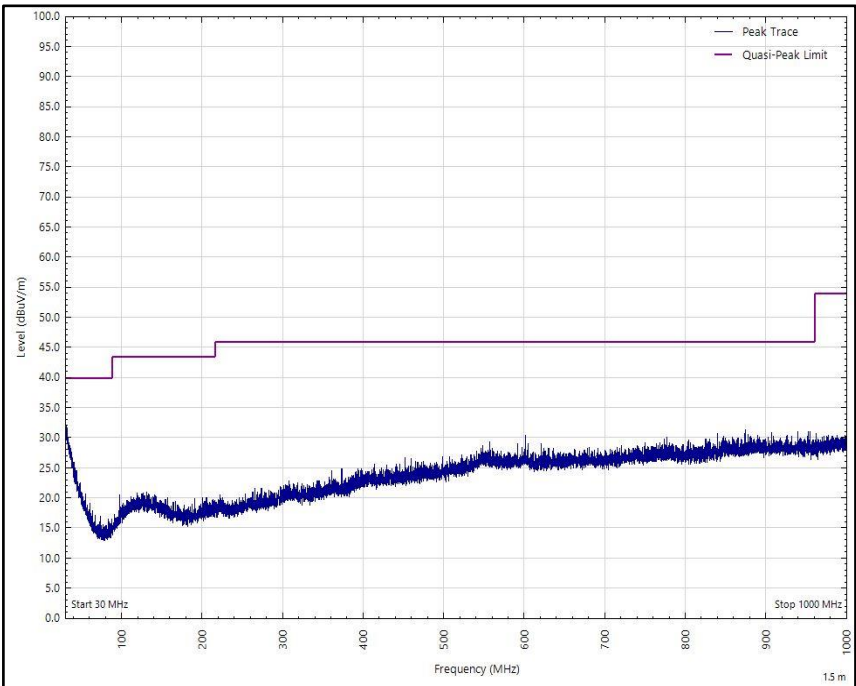


Figure 80 - 2437 MHz (CH6), 802.11b, Core 1, 30 MHz to 1 GHz, Horizontal (Peak)

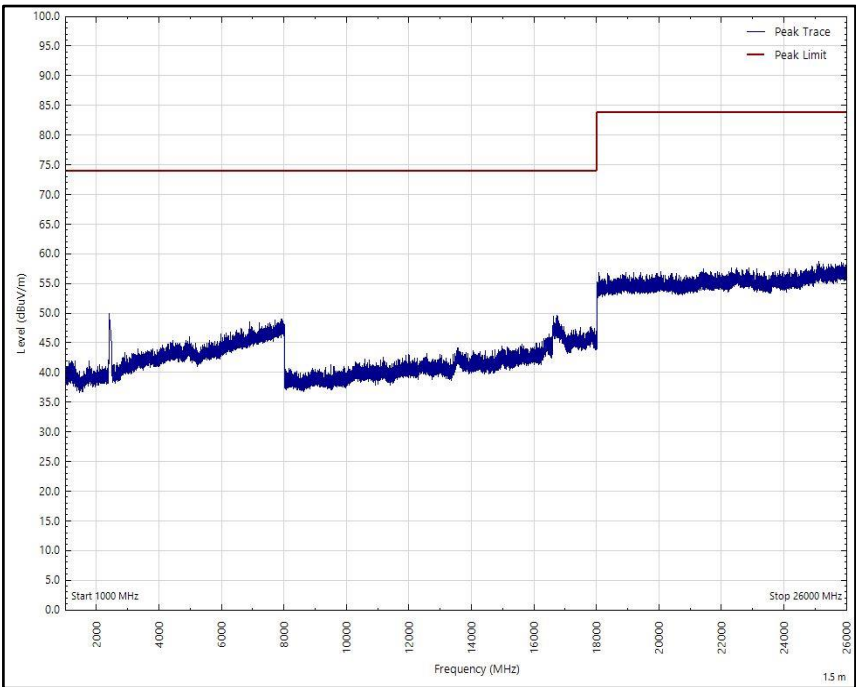


Figure 81 - 2437 MHz (CH6), 802.11b, Core 1, 1 GHz to 26 GHz, Horizontal (Peak)