RF Test Report

FCC 15 Subpart E (15.407)
RSS 247

SecureMesh WAN 2000 Series (GATE-2000-x; GWBR-2040-x; XTEN-2000-x; XBRG-2040-x, x=nil or F)

Product Service

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Prepared to:

Trilliant Networks Inc.

401 Harrison Oaks Blvd, suite 300
Cary, NC, 27513

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Author	Steve McFarlane	Feb 13, 2023	
Authorised Signatory	Scott Drysdale	Feb 13, 2023	

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

EXECUTIVE SUMMARY
A sample of this product was tested and found to be in compliance with:
FCC Part 15, Subpart E (UNII Devices) : March 18:2022
RS247: Issue 2, February, 2017

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ACCREDITATION
Our A2LA Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our A2LA Accreditation.

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SECTION 1

1 REPORT SUMMARY

Radio Testing

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
000	First Issue	Feb 13, 2023
001	Second issue – Split the file into 6 MB segments as per TCB request	June 13, 2023

Table 1 – Modification Records

1.2 Acronyms & Definitions

The following definitions and acronyms are applicable in this report. See also ANSI C63.10.

Acronyms

PER	Package Error Rate
DTS	Digital Transmission System
EIRP	Equivalent Isotropical Radiated Power
ETSI	European Telecommunications Standards Institute
EUT	Equipment Under Test
FVIN	Firmware Version Identification Number
HVIN	Hardware Version Identification Number(s)
OOB	Out of Band
PSD	Peak Power Spectrum Density
RBW	Resolution Bandwidth
RMS	Root mean square, i.e., $V_p/\sqrt{2}$
Rx	Referred as antennae for receiving RF signals
SD	Spurious Domain
TR	Technical Report
Tx	Referred as antenna for transmitting RF signals
VBW	Video Bandwidth
Vp	Peak Voltage
f_C	Carrier Center Frequency

1.3 Introduction

Applicant:	Trilliant Networks Inc.
Manufacturer:	Trilliant Networks Inc.
Number of Samples Tested:	3
Test Specification/Issue/Date:	Part 15 Subpart E §15.407: 7/08/2022 RSS-247, Issue 2:2017 789033 D02 General UNII Test Procedures New Rules v02r01 905462 D02 UNII DFS Compliance Procedure New Rules v02
Test Plan/Issue/Date:	WAN-2000 Radio & EMC Test Plan.pdf (Rev 1:2021-12-30)
Project Number:	7169008820
Date:	2022-02-04
Date of Receipt of EUT:	2021-12-05
Start of Test:	2022-02-03
Finish of Test:	2022-10-31
Name of Tester(s):	Jose Martinez / Scott Drysdale
Related Documents:	ANSI C63.10: American Standard Procedure for Compliance Testing of Unlicensed Wireless Devices. Supporting documents for EUT certification are separate exhibits

1.4 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 15.407 and RSS-247 is summarized in Table 2.

Section	§15.407	RSS-247 & -GEN	Test Description	Result
2.1	§15.207(a)	RSS-GEN 8.8	Conducted Emission	Pass
2.2	§15.407(a)(3)(i)	RSS-247 5.4 (c)	Peak Output Power	Pass
2.3	-	RSS-Gen 6.6	99% Emission Bandwidth	Pass
2.4	§15.215(c)	RSS-GEN	Minimum 6 dB RF Bandwidth	Pass
2.5	§15.407(e)		26dB Bandwidth	Pass
2.6	§15.407(b)(4)(1)	RSS-247 5.5	Out-of-Band Emissions - Conducted	Pass
2.7			Band-edge Compliance of RF Conducted Emissions	Pass
2.8	§15.407)	RSS-GEN	Spurious Radiated Emissions	Pass
2.9	§15.407(g)	RSS-GEN 8.11	Frequency Stability	Pass
2.10	§15.407(h)	RSS-247	Transmit Power Control	Pass
2.11	§15.407(h)	RSS-247	Dynamic Frequency Selection	Pass
2.8	-	RSS-Gen 7.1	Receiver Spurious Emissions	Pass
2.12	15.407	RSS-247	DFS Threshold	Pass
2.13	15.407	RSS-247	Detection Bandwidth	Pass

Table 2 – Test Summary Table

1.5 Product Information

1.6 Technical description

- Each SecureMesh Extender Bridge has a 5 GHz SecureMesh WAN radio with an array of 8 directional antennas. They interoperate as an element of the SecureMesh WAN and a 2.4 GHz SecureMesh NAN radio with an omnidirectional dipole antenna, acting as an access point for SecureMesh NAN devices. Also, a WIFI radio module is serves as a local connection to the unit.

- Each SecureMesh Gateway Bridge acts as a root node of the WAN, with a 10/100/1000 Base-T Ethernet port that connects back to the wired network. The SecureMesh WAN enables bidirectional communications between client devices and the Head End System (HES). It supports optional peer-to-peer communications by routing traffic through infrastructure devices, without routing traffic through the HES. High Reliability and low latency make it the right solution for Internet of Things (IoT) applications, video surveillance, or workforce management.

1.7 EUT General Description

MANUFACTURER	Trilliant Networks Inc.
TYPE	• GWBR-2040: Access point to WAN network and bridge to NAN network • XBGR-2040: Relay node of the WAN network and bridge to NAN network
Part No	• XBRG-2040 • GWBR-2040-F
SERIAL NUMBER	• XBGR-2040: NFQD0000052 • GWBR-2040-F: NFQD0000044
HARDWARE VERSION	• UCC WAN: CL-R0366A-5.0 • UCC Mesh: CL-R0366D-4.2 • Switch Board: CL-R0398A-5.1 • LED Board: CL-0408B-2.1
SOFTWARE VERSION	2.6.0 dev13
TRANSMITTER OPERATING BANDS	• UNII-2a: 5250MHz – 5350MHz • UNII-2c: 5470MHz – 5725MHz • UNII-3 5725-5850MHz
Transfer Rate:	• 802.11a up to 54 Mbit/s • 802.11n HT20 up to 135 Mbit/s • 802.11n HT40 up to 270 Mbit/s
MODULATION TYPES: (i.e. GMSK, QPSK)	OFDM; OQPSK; 802.11a;802.11n HT20; 802.11n HT40
Antenna Gain	16.5dBi

Rated Voltage	- PoE - +48Vdc
HIGHEST INTERNALLY GENERATED FREQUENCY	5850 MHz
Max Conducted (dBm) 5.25–5.35 GHz and 5.47–5.725 GHz **Based on 16.5 dBi antenna gain and the 26 dB bandwidth exceeding 20 MHz.**	13.5 dBm (30 dBm EIRP max)
Max Conducted (dBm) 5.725–5.85 GHz **Based on 16.5 dBi antenna gain**	13.5 dBm (30 dBm EIRP max)

More details in section 2.2 in WAN-2000 Radio & EMC Test Plan.pdf and the manufacturer documentation:

- DS100032TN_SecureMesh_WAN_Gateway_2_GATE-2000_Datasheet_v1.0_06.23.2020.pdf
- DS100033TN_SecureMesh_WAN_Extender_2_XTEN-2000_Datasheet_v1.0_06.23.2020.pdf
- DS100034TN_SecureMesh_WAN_Extender_Bridge_2_XBRG-2040_Datasheet_v1.0_08.12.2020.pdf
- DS100035TN_SecureMesh_WAN_Gateway_Bridge_2_GWBR-2040_Datasheet_v1.0_08.12.2020.pdf

1.8 Support Equipment and I/O cables

Manufacturer	Equipment/Cable	Description
Corning Optical Inc.	Fiber Optic Cable	
-	PoE Cable	PoE Cable Type 802.3at up to 30W
-	Ethernet Data Communication Cable	Cat 5 Ethernet Cable
Dell	Support Laptop	RWCL-HWLab3052; Windows 10 Enterprise; version 21H2; LAN: 192.1.2.111

1.9 Test Configuration Description

Test Configurations	Description
A	Antenna port conducted measurement. Manufacturer provided a test plan RF conducted measurements. Power setting set to according to the test cases

B	Radiated emissions test configuration. Identical programming procedure as Test Configuration A. EUT transmitting through the integral antenna.

1.10 EUT Exercise Software

The client provided a programming VanDyke software (version 8.5.4). The software allows to parse commands to control the EUT and activate UNII-2a, UNII-2c, and UNII-3 bands. More details disclosed in section 2.2 in WAN-2000 Radio & EMC Test Plan.pdf.

1.11 Mode of Operations

The PoE model works by connecting the using the PoE to the power outlet, which connect to the Ethernet data communication port of the laptop. And the other ethernet connection power up the EUT. To control the unit, the scrips (PowerAndFreq.vbs, ChanFreq.vbs, ShowLink.vbs and NoteTest.vbs) running on the VanDyke software (version 8.5.4) allows to setup the power, the frequency, and other parameters of the EUT.

- **Mode 1**. Transmission Mode (Tx) Mode – PowerAndFreq.vbs and set the power output of the EUT depending on the applicable band
- **Mode 2**. Reception (Rx) Mode – Use the XBGR-2040

The Fiber Optic model works in the same manner but powered by +48Vdc and using the TP-Link to control and communicate with the EUT.

1.12 List of Frequencies

Band (MHz)	Modulation	Channel (MHz)	Maximum Data Rates (Mbps)
UNII-2a (5250-5350)	802.11a	B:5260	54
		M:5290	
		T:5320	
	802.11n HT20	B:5260	135
		M:5290	
		T:5320	
	802.11n HT40	B:5270	270
		M:5290	
		T:5310	
UNII-2c (5470-5725)	802.11a	B:5500	54
		M:5590	
		T:5690	
	802.11n HT20	B:5500	135
		M:5590	
		T:5690	
	802.11n HT40	B:5510	270
		M:5580	
		T:5680	
UNII-3 (5725-5850)	802.11a	B:5735	54
		M:5785	
		T:5835	
	802.11n HT20	B:5735	135
		M:5785	
		T:5835	
	802.11n HT40	B:5755	270
		M:5795	
		T:5825	

Table 3 – Frequency Table – Test Frequencies

1.13 Worst Case of Conducted Output Power

Band	Modulation	Frequency Range (MHz)	Output Power (dBm)	Limit (dBm)[1]	Pass/Fail
UNII-2a:	802.11a	5250-5350	12.87	13.5	Pass
	802.11n HT20		12.95	13.5	Pass
	802.11n HT40		12.99	13.5	Pass
UNII-2c	802.11a	5470-5725	12.82	13.5	Pass
	802.11n HT20		12.85	13.5	Pass
	802.11n HT40		12.94	13.5	Pass
UNII-3	802.11a	5725-5850	25.79	30.0	Pass
	802.11n HT20		26.95	30.0	Pass
	802.11n HT40		22.98	30.0	Pass

Table 4 – Output Power – Worst-Case

Note 1: Based on 16.5 dBi antenna gain, and a 26 dB occupied bandwidth of more than 20 MHz where applicable. For UNII-3 band, the device operates as fixed point-to-point, so the limit does not take into account antenna gain.

1.14 Simplified Test Configuration Diagrams

1.14.1 RF Conducted

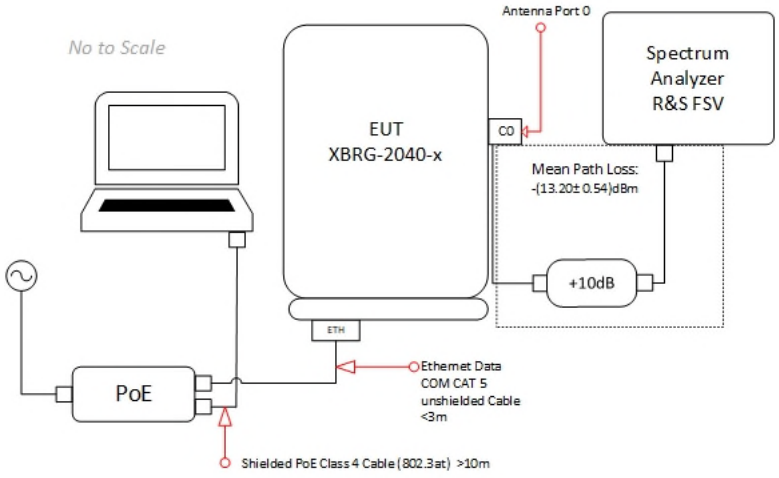


Figure 1: RE Setup – RF Conducted Measurements

1.14.2 Radiated Emissions

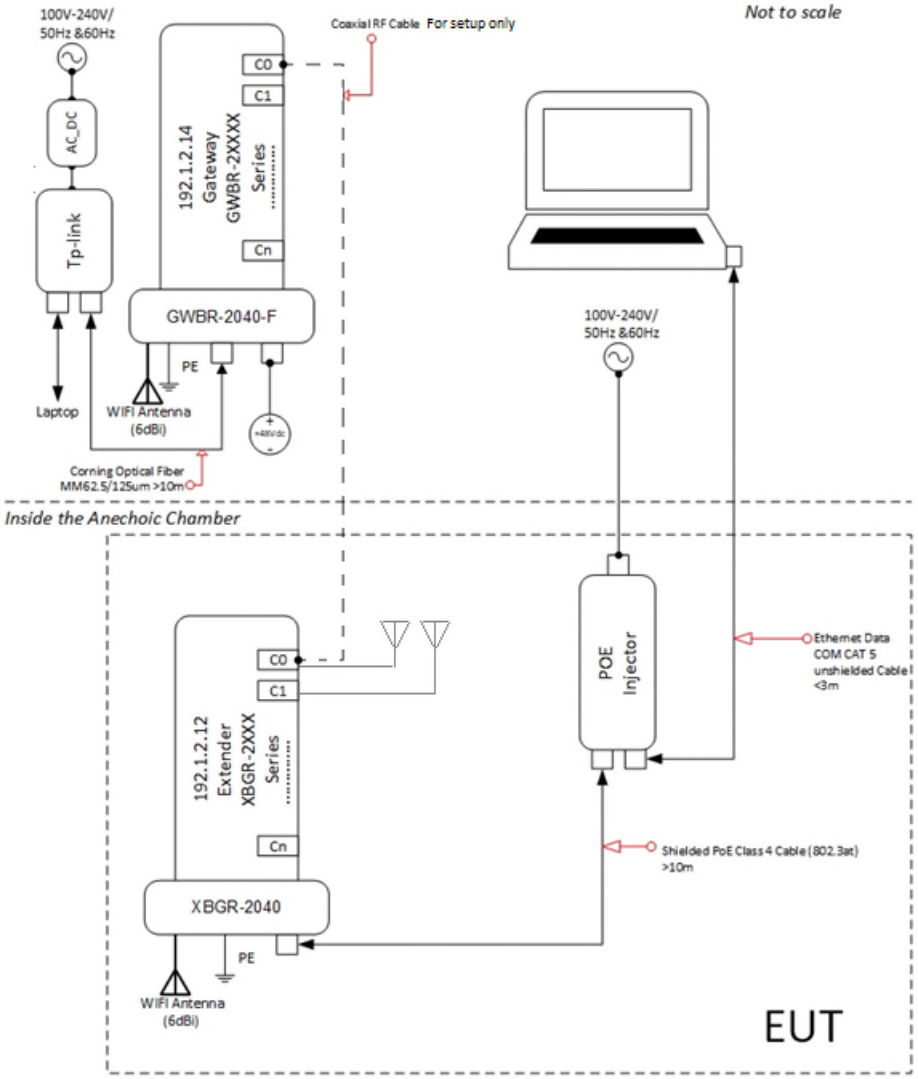


Figure 2: RE Setup – Extender (XBGR-2040) inside Anechoic Chamber

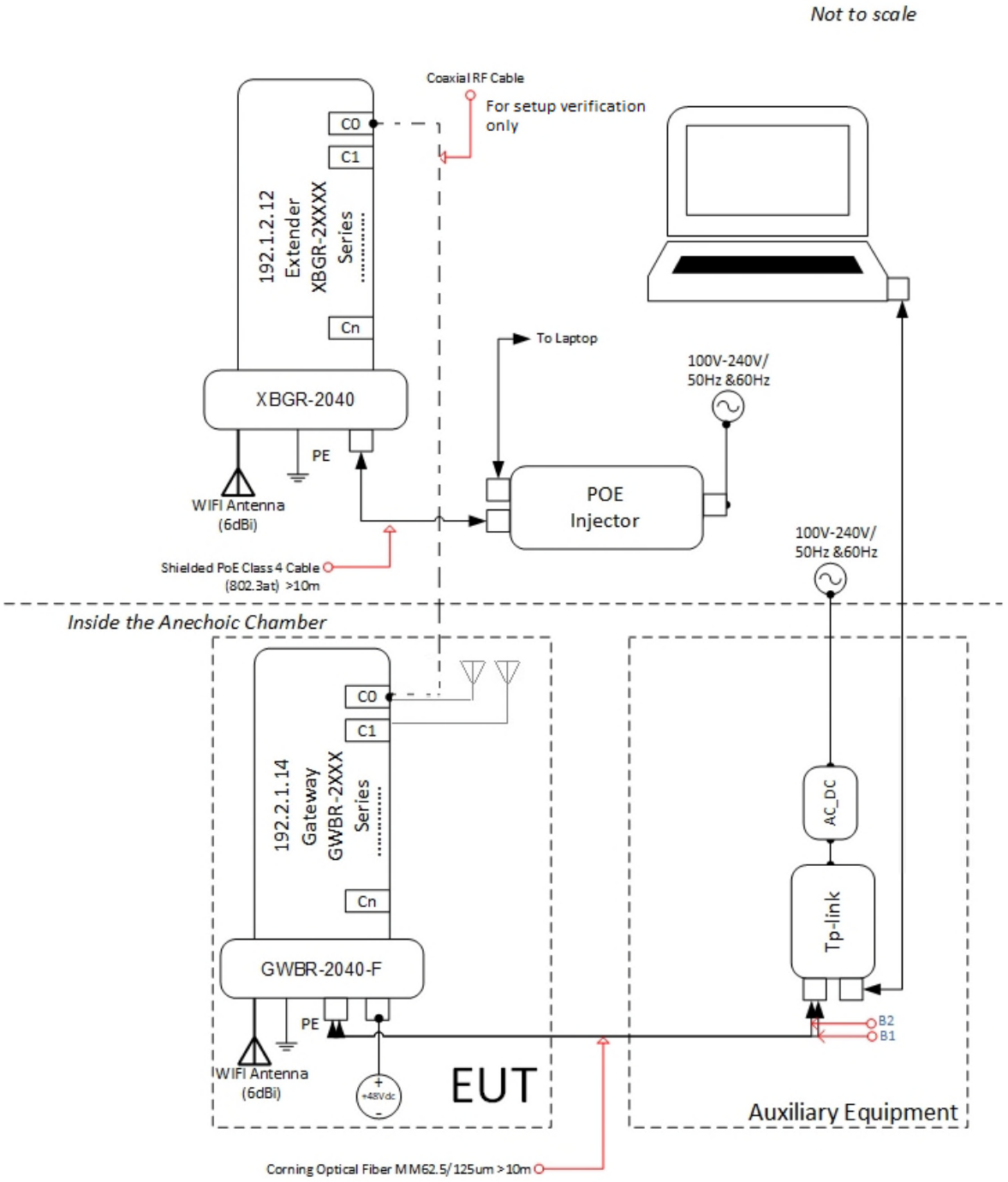


Figure 3: RE Setup – Gateway (GWBR-2040-F) inside Anechoic Chamber

1.15 Deviation from the Standard

No deviations from the applicable test standards or test plan were made during testing.

1.16 Test Methodology

All measurements contained in this report were conducted with IEE/ANSI C63.4-2014 American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

For conducted and radiated emissions, the equipment under test (EUT) was configured to measure its highest possible emission level. This level was based on the maximized cable configuration from exploratory testing per IEEE/ANSI C63.4-2014. The test modes were adapted according to the Operating Instructions provided by the manufacturer/client

1.17 Test Location

TÜV SÜD conducted the following tests at our Kanata, Ottawa. test laboratory.

Test Name	Test Specialist(s)
Peak Output Power	Jose Martinez
Conducted Emissions	Jose Martinez
99% Emission Bandwidth	Jose Martinez
Minimum 6 dB RF Bandwidth	Jose Martinez
Out-of-Band Emissions - Conducted	Jose Martinez
Band-edge Compliance of RF Conducted Emissions	Jose Martinez
Spurious Radiated Emissions	Jose Martinez
Receiver Spurious Emissions	Jose Martinez
Radiated Band Edge Measurements	Jose Martinez
DFS	Jose Martinez

Table 5 – EMC Test performed – Location

Office address: 1280 Teron Road, Kanata, Ottawa, K2C 1X2, Canada

2 TEST DETAILS

Radio Testing

2.1 Conducted Emissions

2.1.1 Specification Reference

Part 15 Subpart C §15.207(a)

2.1.2 Standard Applicable

An intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN).

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15–0.5	66 to 56 <Note 1>	56 to 46 <Note 1>
0.5–5	56	46
5–30	60	50
Note 1. *Decreases with the logarithm of the frequency*		

Table 6 – CE Limits

2.1.3 Equipment Under Test and Modification State

- PoE Model XBGR-2040: Modification state 0 (No modification)

2.1.4 Date of Test

03-03-2022

2.1.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.1.6 Environmental Conditions

Test performed at TÜV SÜD Canada, Kanata Location.

Ambient Temperature	23.5
Relative Humidity **(info only**)	25%
ATM Pressure	102kPa

2.1.7 Additional Observations

- Measurements were carried out in the worst-case scenario of modulation: 802.11n HT40 up to 270 Mbit/s
- The EUT was verified using the supplied AC Adapter.
- Verification performed while the EUT is on WLAN operating mode. No significant difference observed on the emissions when the EUT is on BTLE TX mode. Only WLAN test results presented.
- Measurement was done using BAT EMC software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.1.1.8 for sample computation.

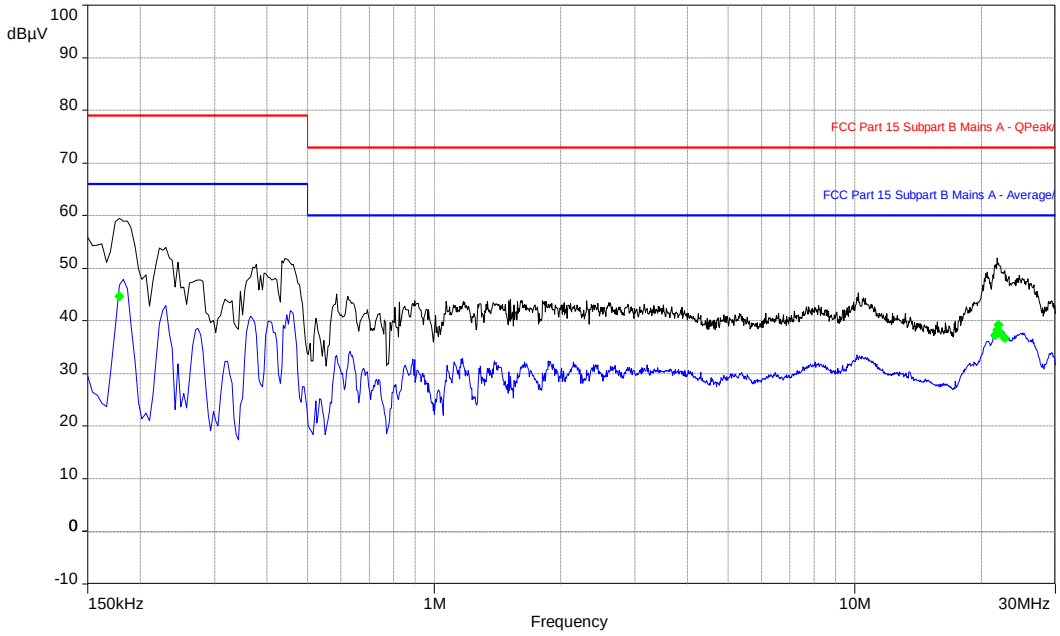
2.1.8 Sample Computation (Conducted Emission – Quasi Peak)

Measuring equipment raw measurement (dbµV) @ 150kHz			5.5
Correction Factor (dB)	Asset# SSG012403 (20 dB limiter)	19.9	20.7
	Asset# SSG01245 (cable)	0.15	
	Asset# SSG012711 (cable)	0.35	
	Asset# SSG013319 (LISN)	0.30	
Reported QuasiPeak Final Measurement (dBµV) @ 150kHz			**26.2**

2.1.9 Test Results

Compliant. See attached plots and tables below.

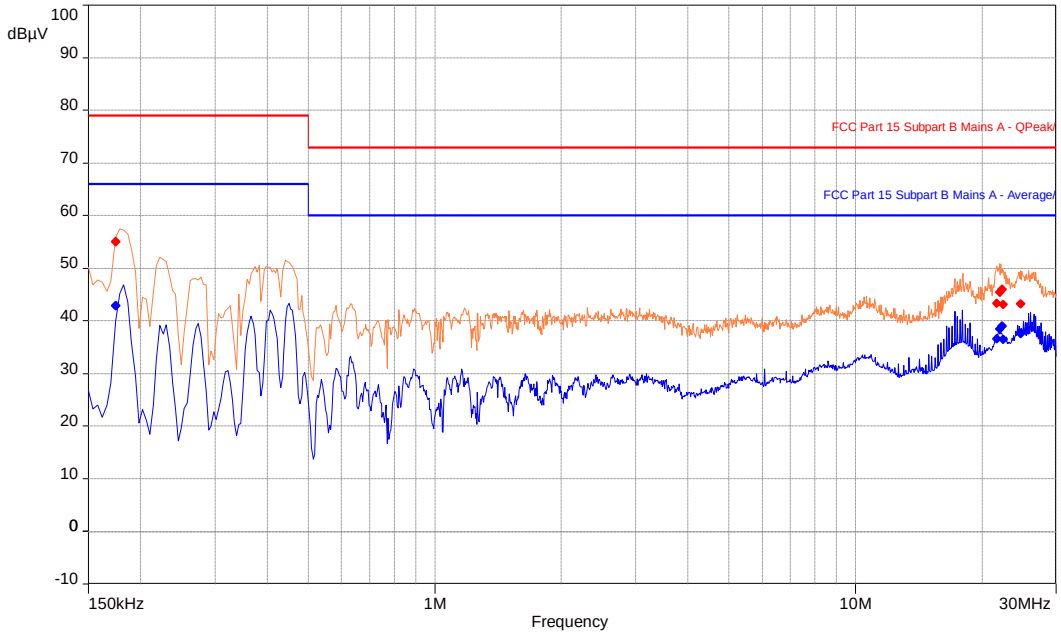
2.1.9.1 FCC Conducted Emissions Line 1 - Hot



Capture 1 : Conducted Emission Line 1 <Worst Case Scenario:802.11n HT40 up to 270 Mbit/s>

Frequency (MHz)	S R	Level Average (dBµV)	Level QP (dBµV)	Level Peak (dBµV)	Margin AVG (dB) (dBµV)	Margin QP (dB) (dBµV)	Margin - Peak to AVG (dBµV)	Limit AVG (dBµV)	Limit QP (dBµV)	Correction (dB)
0.177244	1	44.66	56.85	59.65	-21.34	-22.15	-6.35	66.00	79.00	19.53
21.519548	1	37.24	44.06	51.32	-22.76	-28.94	-8.68	60.00	73.00	19.35
21.813024	1	38.33	45.21	53.30	-21.67	-27.79	-6.70	60.00	73.00	19.36
21.986864	1	39.30	46.45	52.88	-20.70	-26.55	-7.12	60.00	73.00	19.36
22.146432	1	37.69	44.48	51.85	-22.31	-28.52	-8.15	60.00	73.00	19.36
22.774828	1	36.78	42.88	49.99	-23.22	-30.12	-10.01	60.00	73.00	19.37

2.1.9.2 FCC Conducted Emissions Line 2 – Neutral



Capture 2 : Conducted Emission Line 2 <Worst Case Scenario:802.11n HT40 up to 270 Mbit/s>

Frequency (MHz)	S R	Level Averag e (dBµV)	Level QP (dBµV)	Level Peak (dBµV)	Margin AVG (dB) (dBµV)	Margin QP (dB) (dBµV)	Margin - Peak to AVG (dBµV)	Limit AVG (dBµV)	Limit QP (dBµV)	Correcti on (dB)
0.17584	1	42.90	55.00	57.91	-23.10	-24.00	-8.09	66.00	79.00	19.53
21.687264	1	36.64	43.39	51.50	-23.36	-29.61	-8.50	60.00	73.00	19.35
22.02249	1	38.47	45.48	53.31	-21.53	-27.52	-6.69	60.00	73.00	19.36
22.27944	1	38.99	45.98	52.50	-21.01	-27.02	-7.50	60.00	73.00	19.36
22.463786	1	36.47	43.12	51.43	-23.53	-29.88	-8.57	60.00	73.00	19.36
24.706882	1	37.62	43.24	49.79	-22.38	-29.76	-10.21	60.00	73.00	19.44

2.2 Peak Output Power and Power Spectral Density

2.2.1 Specification Reference

§ 15.407 (a)(2)
§ 15.407 (a)(3)
RSS 247 Clause § 6.2.2.1
412172 D01 Determining ERP and EIRP v01r01
789033 D02 General UNII Test Procedures New Rules v02r01

2.2.2 Standard Applicable

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

2.2.3 Equipment Under Test and Modification State

- Fiber Model GWBR-2040-F: Modification State 0 (No modification)

2.2.4 Day of Test

05-04-2022
11-04-2022

2.2.5 Test equipment used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.2.6 Environmental Conditions

Ambient Temperature	23.5
Relative Humidity **(info only**)	30%
ATM Pressure	101kPa

2.2.7 Additional Observations

- This is a conducted test (Maximum conducted [average] output power) using direct connection to a spectrum analyser.
- An offset of 13.2dB was added to compensate for the external attenuator and cable used from the antenna port to the power sensor.
- Test methodology is per). All conditions under this Clause were satisfied.
- Test Program Power Settings as recommended by the manufacturer were: 30dBm for 802.11a, 802.11n HT20 and 802.11n HT40, respectively.
- Both Peak and Average measurements were recorded.
- Readings of the average power AP (dBm) considers both the attenuator and cable losses of 13.2dB.

2.2.8 Test Results

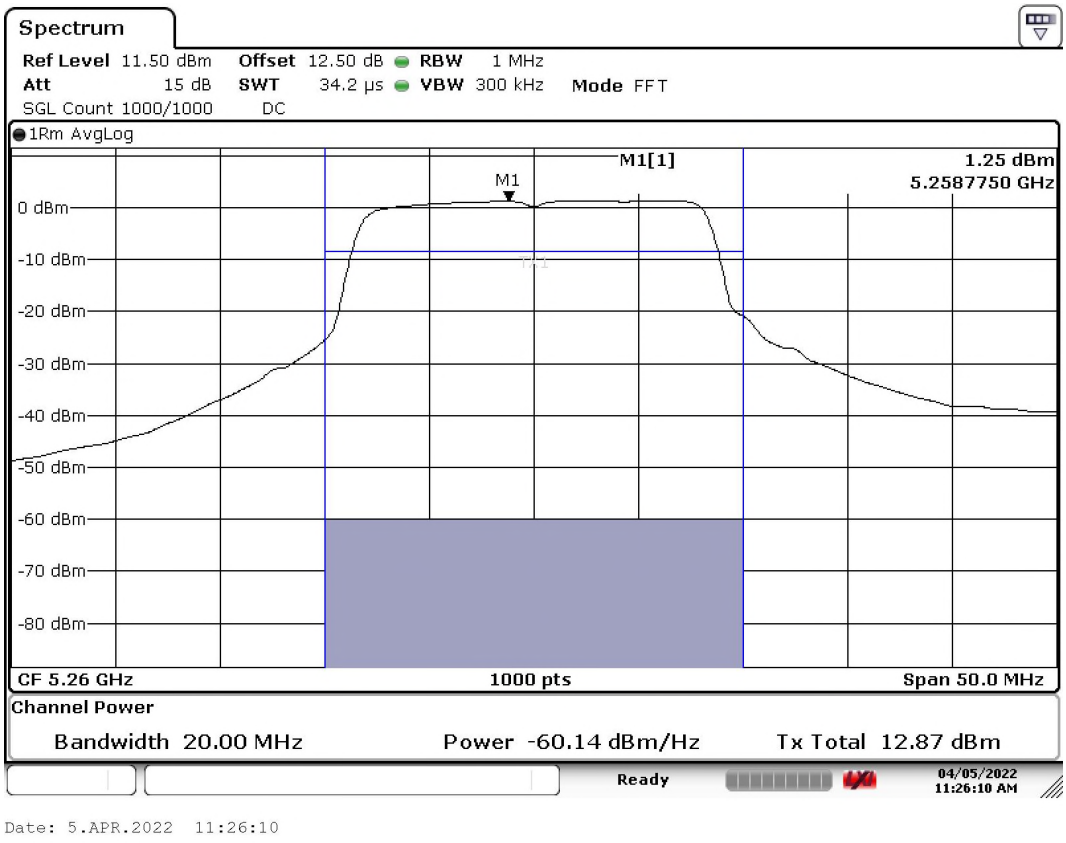
Target Power: 13.5 dBm UNII-2a and UNII-2b.
Target Power: Max of device, UNII-3

Band (MHz)	Modulation	Channel (MHz)	Data Rates (Mbps)	Measured Average Power AP (dBm) <Note 1>	Conducted Limit (dBm)	E.I.R.P (dBm) <Note 2>	EIRP Limit (dBm) <Note 3>	Result
UNII-2a (5250-5350)	802.11a	B:5260	54	12.87	13.5	29.37	30.0	Pass
		M:5290		12.55	13.5	29.05	30.0	Pass
		T:5320		12.62	13.5	29.12	30.0	Pass
	802.11n HT20	B:5260	135	12.58	13.5	29.08	30.0	Pass
		M:5290		12.82	13.5	29.32	30.0	Pass
		T:5320		12.95	13.5	29.45	30.0	Pass
	802.11n HT40	B:5270	270	12.98	13.5	29.48	30.0	Pass
		M:5290		12.95	13.5	29.45	30.0	Pass
		T:5310		12.99	13.5	29.49	30.0	Pass
UNII-2c (5470-5725)	802.11a	B:5500	54	12.37	13.5	28.87	30.0	Pass
		M:5590		12.82	13.5	29.32	30.0	Pass
		T:5690		12.79	13.5	29.29	30.0	Pass
	802.11n HT20	B:5500	135	12.78	13.5	29.28	30.0	Pass
		M:5590		12.73	13.5	29.23	30.0	Pass
		T:5690		12.85	13.5	29.35	30.0	Pass
	802.11n HT40	B:5510	270	12.81	13.5	29.31	30.0	Pass
		M:5580		12.94	13.5	29.44	30.0	Pass
		T:5680		12.62	13.5	29.12	30.0	Pass
UNII-3 (5725-5850)	802.11a	B:5735	54	22.32	30	38.82	N/A	Pass
		M:5785		25.79	30	42.29	N/A	Pass
		T:5835		21.14	30	37.64	N/A	Pass
	802.11n HT20	B:5735	135	26.95	30	43.45	N/A	Pass
		M:5785		25.78	30	42.28	N/A	Pass
		T:5835		24.14	30	40.64	N/A	Pass
	802.11n HT40	B:5755	270	22.22	30	38.72	N/A	Pass
		M:5795		22.98	30	39.48	N/A	Pass
		T:5825		19.69	30	36.19	N/A	Pass

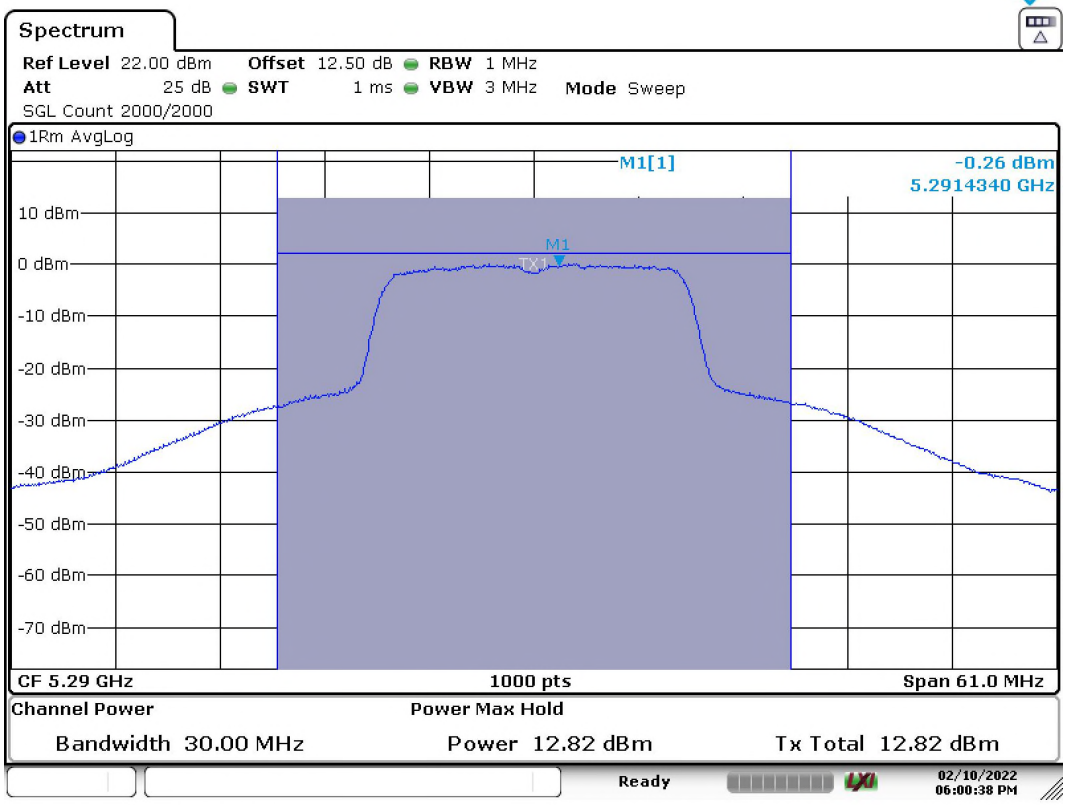
Note: As the system is direction point to point, no EIRP limit applies as per 15.407(a)(3).

2.2.9 Sample of Test Data

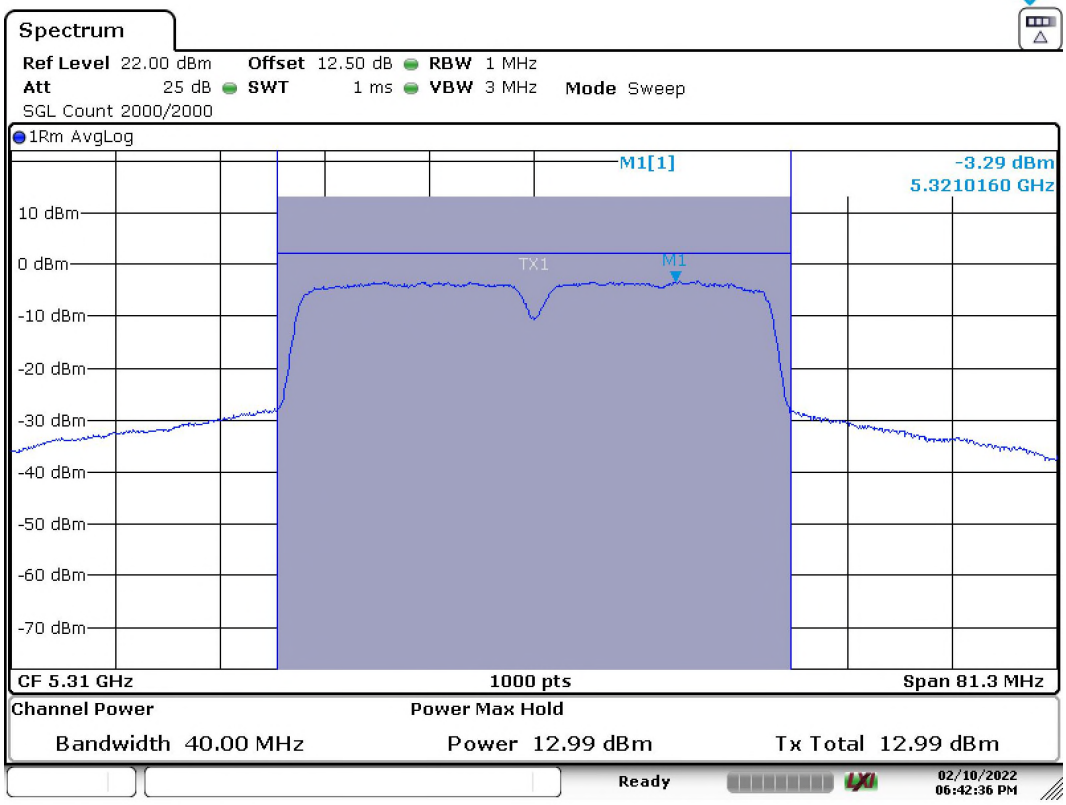
2.2.9.1 UNII-2a



Capture 3 : UNII 2a – Modulation 802.11a – Bottom: 5260 MHz

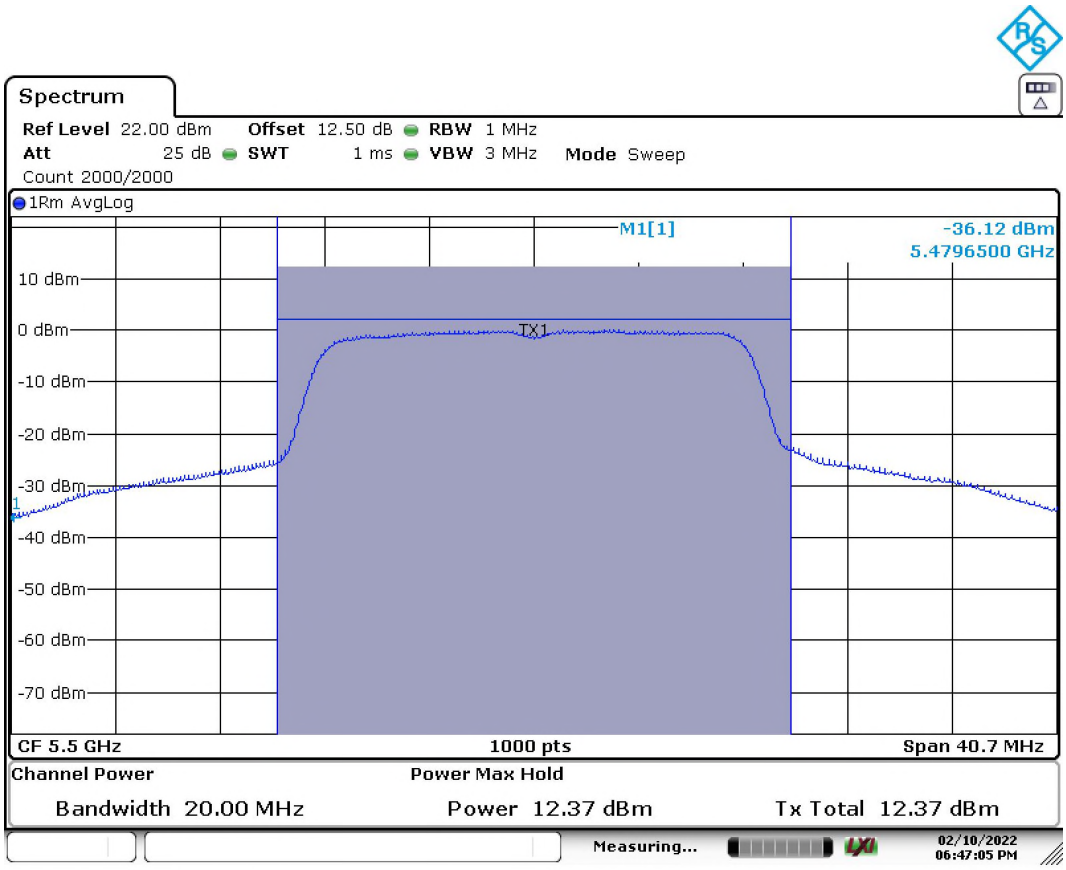


Capture 4 : UNII 2a – Modulation 802.11nHT20 – Middle: 5290 MHz

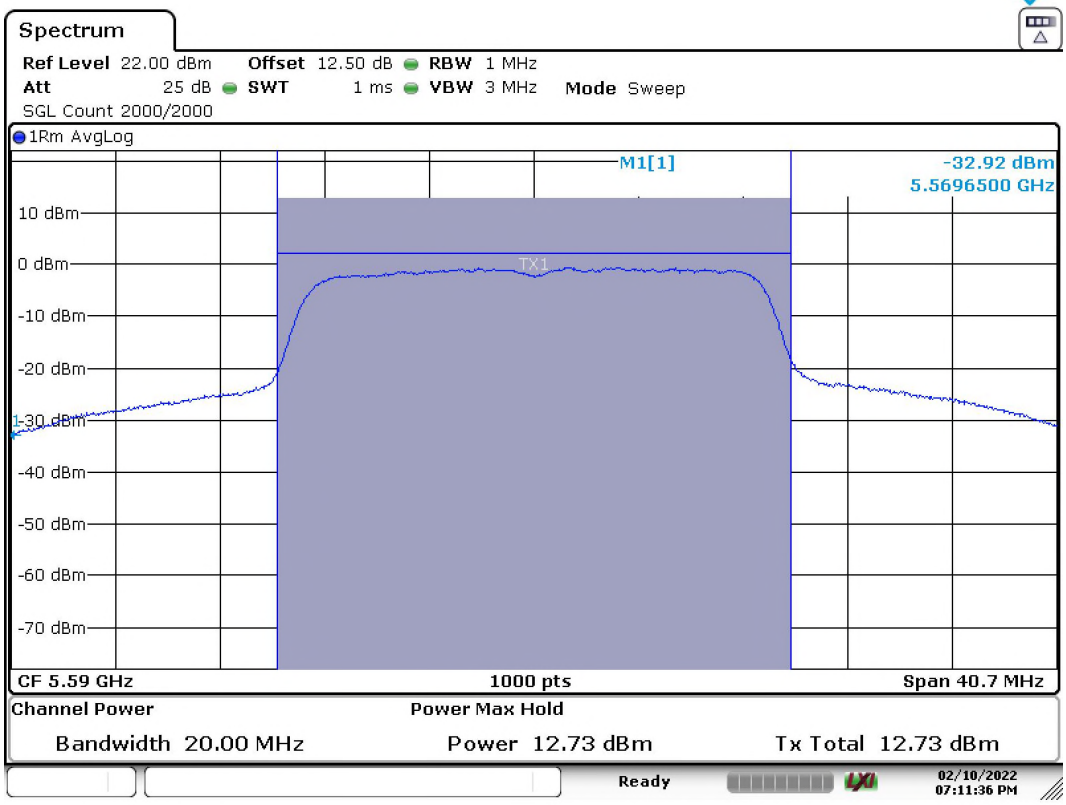


Capture 5 : UNII 2a – Modulation 802.11nHT40 – Top: 5310 MHz

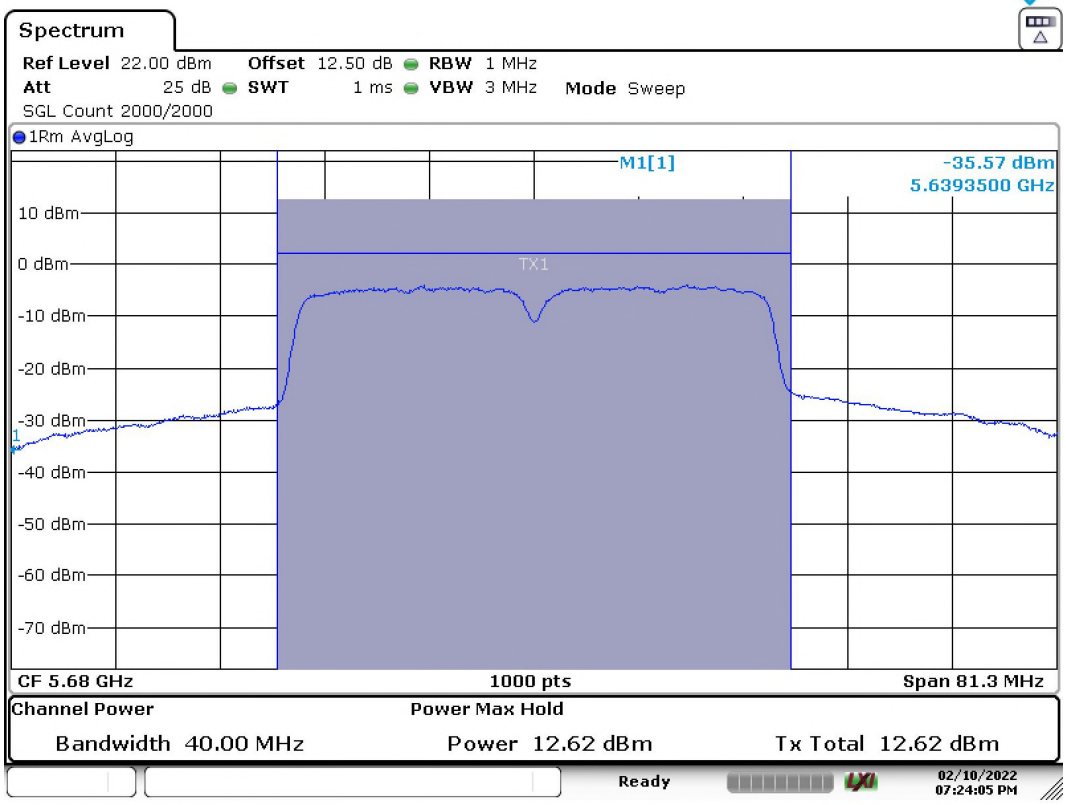
2.2.9.2 UNII-2c



Capture 6 : UNII 2c – Modulation 802.11a – Bottom: 5500 MHz

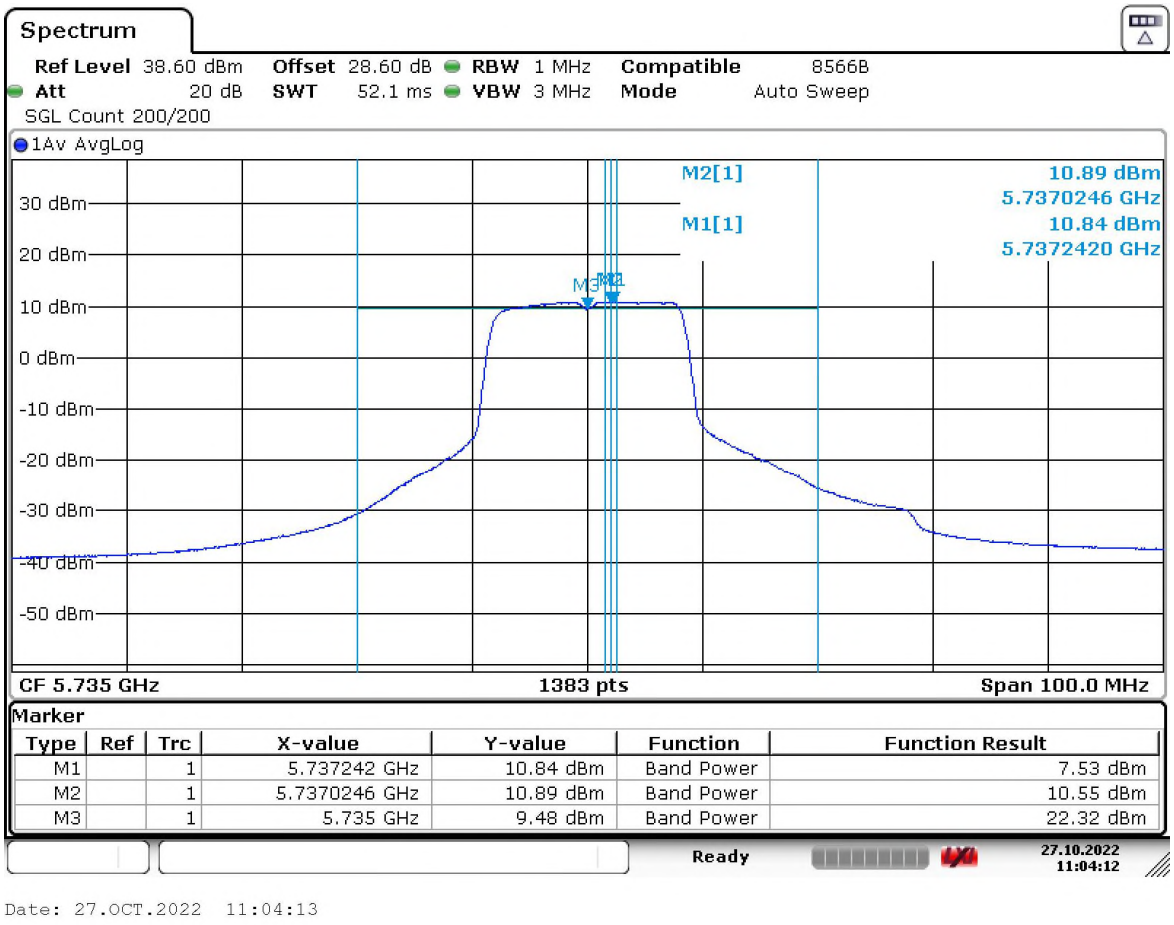


Capture 7 : UNII 2c – Modulation 802.11nHT20 – Middle: 5590 MHz

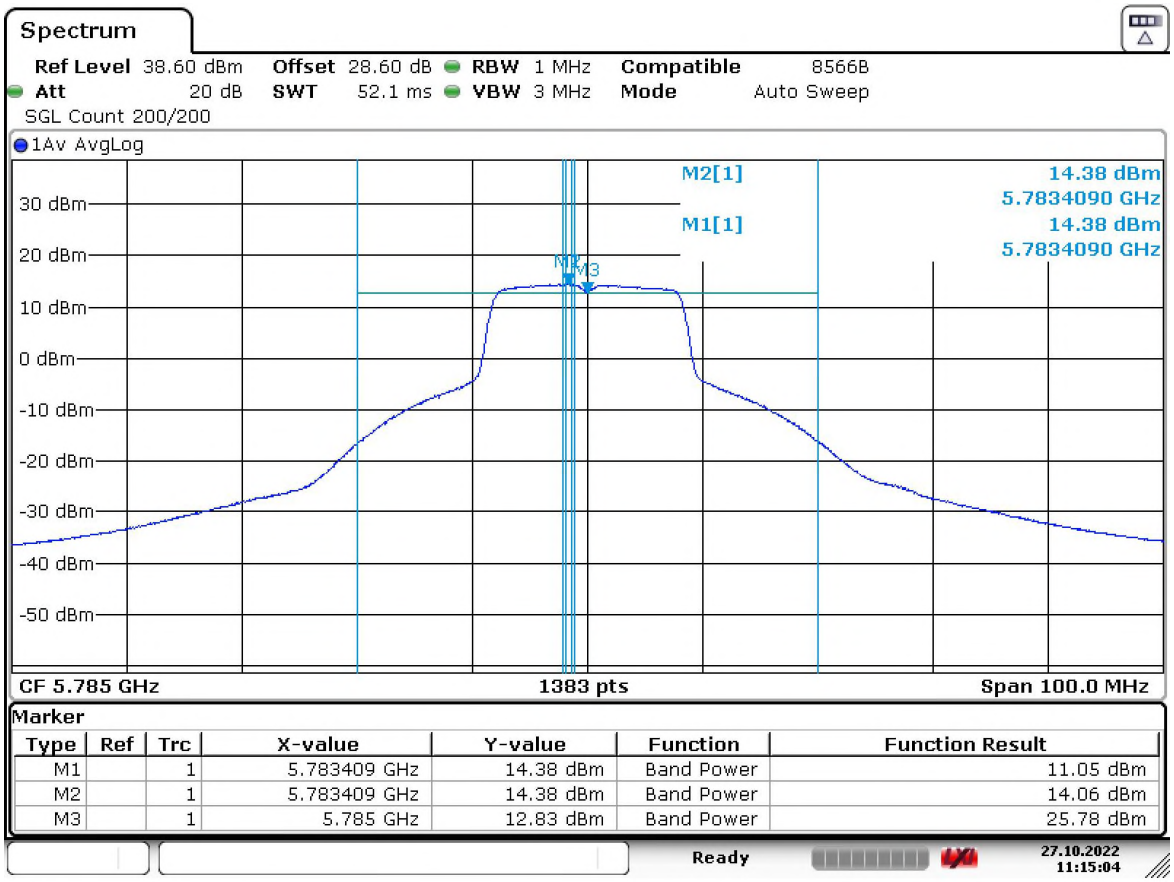


Capture 8 : UNII 2c – Modulation 802.11nHT40 – Top: 5680 MHz

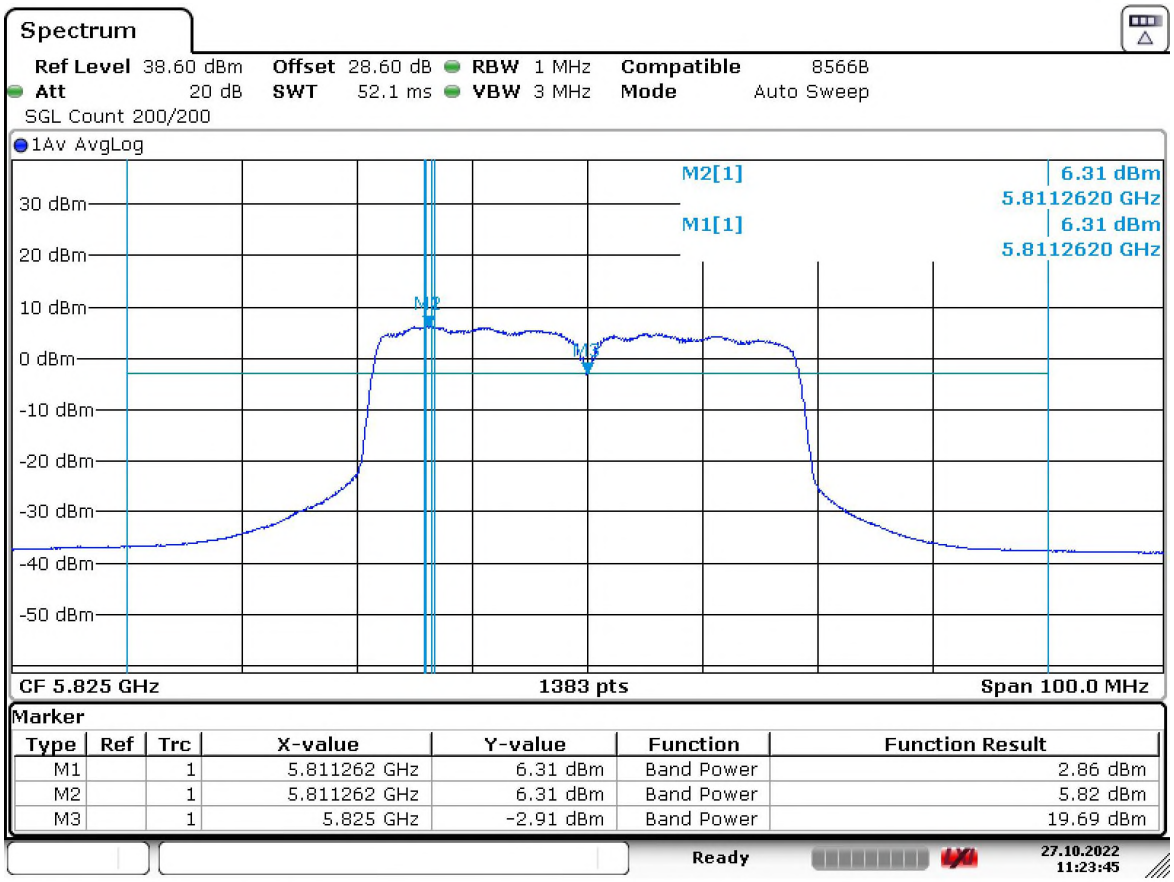
2.2.9.3 UNII-3



Capture 9 : UNII_3 – Modulation 802.11a – Bottom: 5735 MHz



Capture 10 : UNII_3 – Modulation 802.11nHT20 – Middle: 5835 MHz



Capture 11 : UNII_3 – Modulation 802.11nHT40 – Top: 5825 MHz

2.3 99% (Occupied) Emission Bandwidth

2.3.1 Specification Reference

RSS-Gen Clause 6.7
FCC Part 2, 2.202

Standard Applicable
The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth.
When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- • The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
- • The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

Note: Video averaging is not permitted.
A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.
The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.
The difference between the two recorded frequencies is the 99% occupied bandwidth.

2.3.2 Equipment Under Test and Modification State

- PoE Model XBGR-2040: Modification state 0 (No modification)

2.3.3 Day of Test

09-02-2022
07-04-2022

2.3.4 Test equipment used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.3.5 Environmental Conditions

Test performed at TÜV SÜD Canada, Kanata Location.

Ambient Temperature	21.3
Relative Humidity **(info only**)	30%
ATM Pressure	101kPa

2.3.6 Additional Observations

- This is a conducted test.
- A correction factor of 13.2dB was used to compensate for the external attenuator and cable used.
- Span is wide enough to capture the channel transmission.
- RBW is 1% of the span.
- VBW is 3X RBW.
- Sweep is auto.
- Detector is peak.
- The % Power Bandwidth setting in the spectrum analyzer was set to 99% (default).
- The Channel Bandwidth measurement function of the spectrum analyzer was used for this test.

2.3.7 Test Results

2.3.7.1 UNII_2a Band

Channel	Frequency (MHz)	99% Bandwidth (MHz)	Limits (MHz)	Results
Low channel	5260	19.1	≤20	Pass
Middle Channel	5290	19.1	≤20	Pass
Highest Channel	5320	19.1	≤20	Pass

Table 7 – 99% Bandwidth Results – UNII_2a Modulation 802.11a

Channel	Frequency (MHz)	99% Bandwidth (MHz)	Limits (MHz)	Results
Low channel	5260	19.3	≤20	Pass
Middle Channel	5290	19.8	≤20	Pass
Highest Channel	5320	19.3	≤20	Pass

Table 8 – 99% Bandwidth Results – UNII_2a Modulation 802.11nHT20

Channel	Frequency (MHz)	99% Bandwidth (MHz)	Limits (MHz)	Results
Low channel	5270	38.2	≤40	Pass
Middle Channel	5290	38.2	≤40	Pass
Highest Channel	5310	38.2	≤40	Pass

Table 9 – 99% Bandwidth Results – UNII_2a Modulation 802.11nHT40

2.3.7.2 UNII_2c Band

Channel	Frequency (MHz)	99% Bandwidth (MHz)	Limits (MHz)	Results
Low channel	5500	18.8	≤20	Pass
Middle Channel	5590	18.7	≤20	Pass
Highest Channel	5690	18.7	≤20	Pass

Table 10 – 99% Bandwidth Results – UNII_2c Modulation 802.11a

Channel	Frequency (MHz)	99% Bandwidth (MHz)	Limits (MHz)	Results
Low channel	5500	18.1	≤20	Pass
Middle Channel	5590	18.1	≤20	Pass
Highest Channel	5690	18.1	≤20	Pass

Table 11 – 99% Bandwidth Results – UNII_2c Modulation 802.11n HT20

Channel	Frequency (MHz)	99% Bandwidth (MHz)	Limits (MHz)	Results
Low channel	5510	38.4	≤20	Pass
Middle Channel	5580	38.4	≤20	Pass
Highest Channel	5680	38.2	≤20	Pass

Table 12 – 99% Bandwidth Results – UNII_2c Modulation 802.11nHT40

2.3.7.3 UNII_3 Band

Channel	Frequency (MHz)	99% Bandwidth (MHz)	Limits (MHz)	Results
Low channel	5735	18.89	≤20	Pass
Middle Channel	5785	19.68	≤20	Pass
Highest Channel	5835	18.89	≤20	Pass

Table 13 – 99% Bandwidth Results – UNII_3 Modulation 802.11n HT20

Channel	Frequency (MHz)	99% Bandwidth (MHz)	Limits (MHz)	Results
Low channel	5755	37.48	≤40	Pass
Middle Channel	5795	36.9	≤40	Pass
Highest Channel	5825	36.9	≤40	Pass

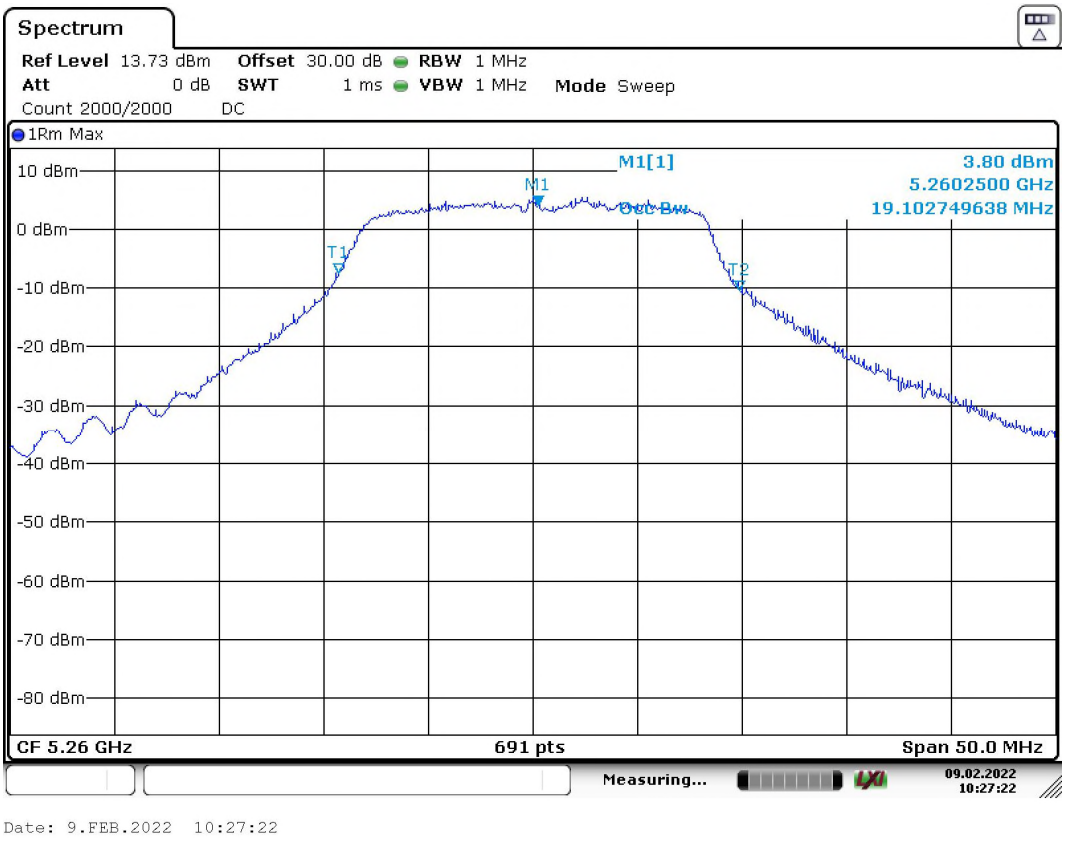
Table 14 – 99% Bandwidth Results – UNII_3 Modulation 802.11nHT40

Note: The tables shown above are representative or worst case of 802.11n and 802.11a.

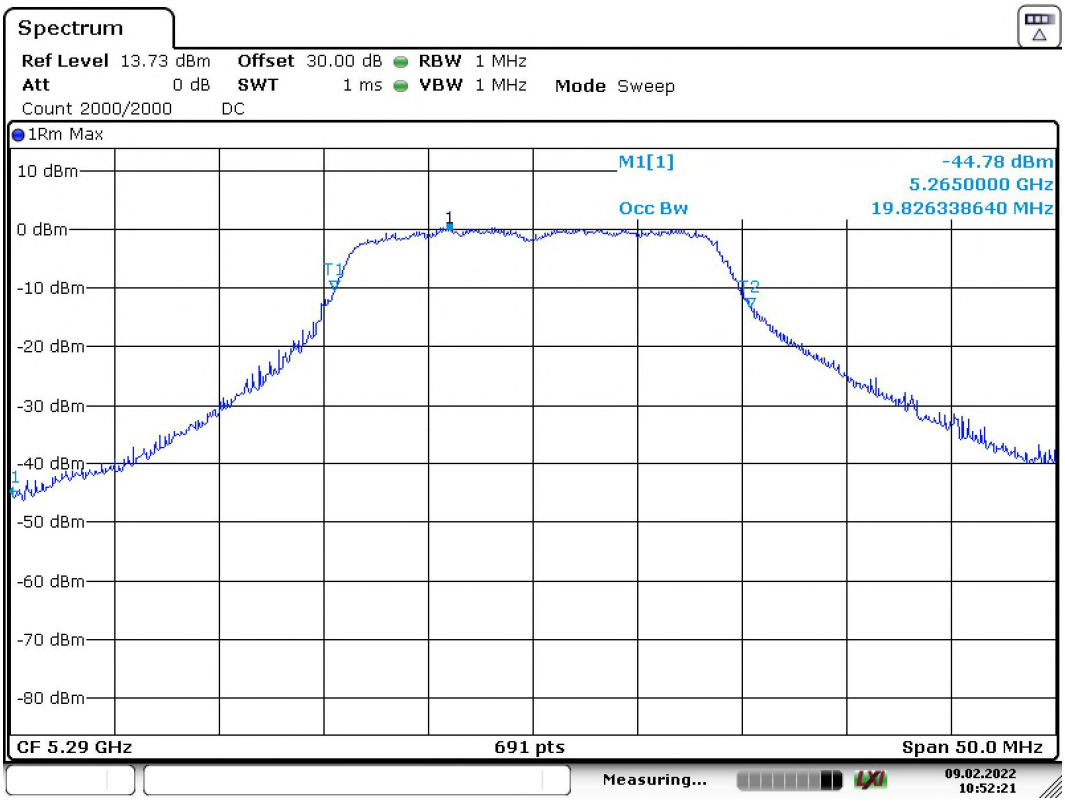
2.3.8 Sample of Test Plots

The graphs showed below show the OBW during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the 99% bandwidth of a channel during operation of the EUT. Max hold is performed for a duration of not less than 1 minute.

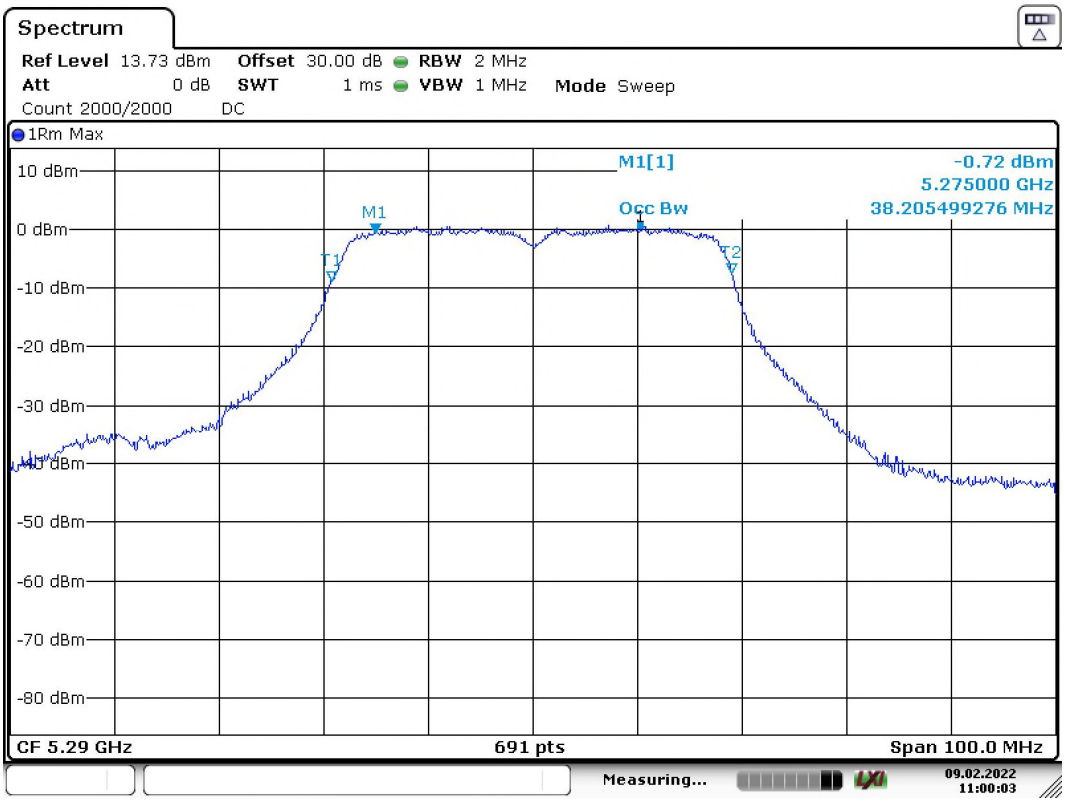
2.3.8.1 UNII_2a Band



Capture 12 : Test Results: 99% Bandwidth – 5260 MHz – 802.11a Modulation

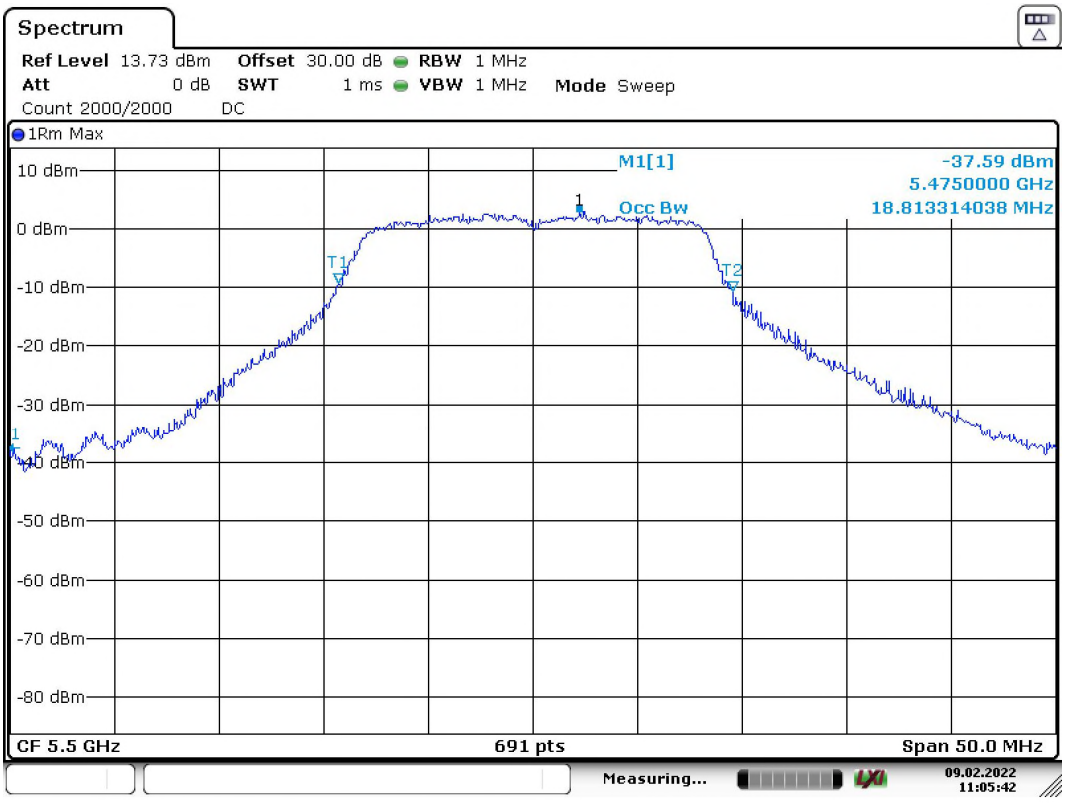


Capture 13 : Test Results: 99% Bandwidth – 5290 MHz – 802.11H20 Modulation

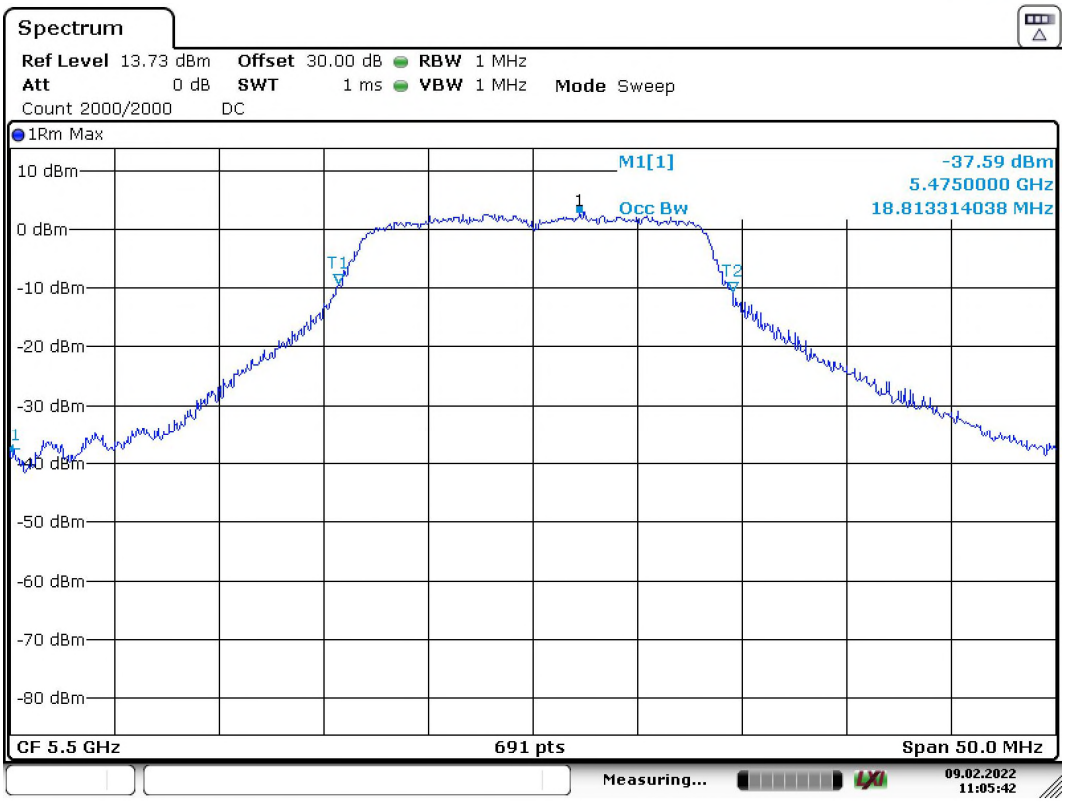


Capture 14 : Test Results: 99% Bandwidth – 5290 MHz – 802.11H40 Modulation

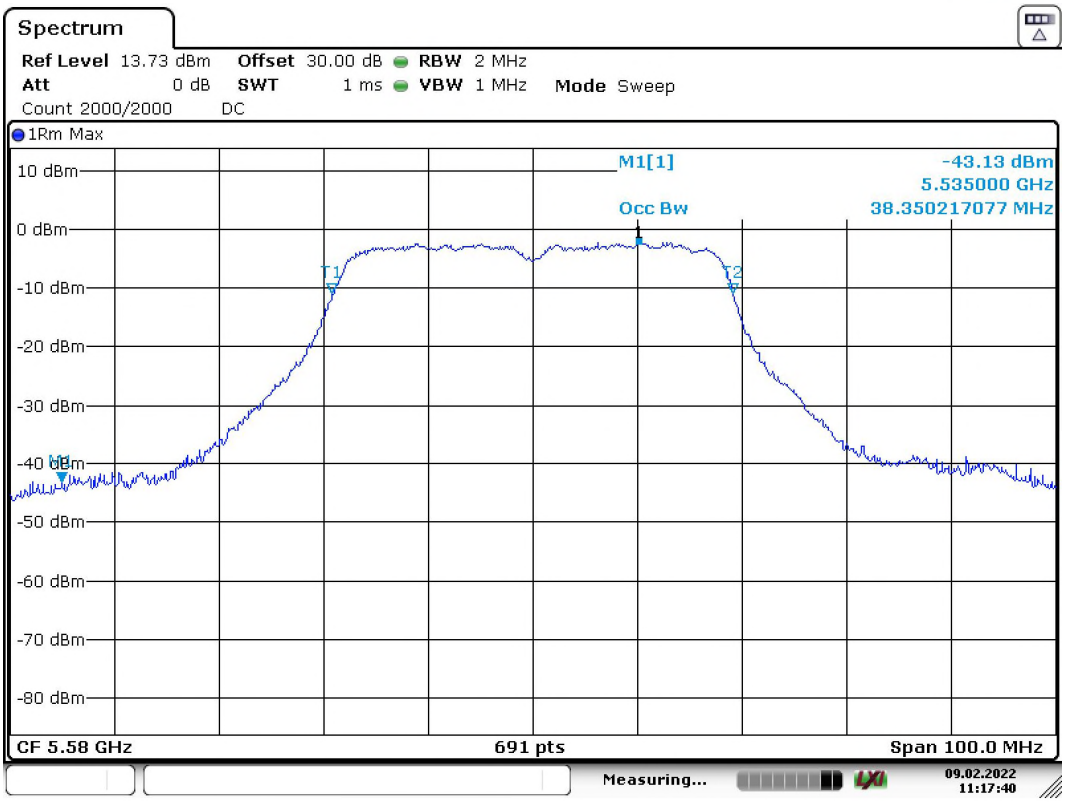
2.3.8.2 UNII_2c Band



Capture 15 : Test Results: 99% Bandwidth – 5500 MHz – 802.11a Modulation



Capture 16 : Test Results: 99% Bandwidth – 5590 MHz – 802.11H20 Modulation



Capture 17 : Test Results: 99% Bandwidth – 5580 MHz – 802.11H40 Modulation

2.4 6 dB RF Bandwidth

2.4.1 Specification Reference

Part 15 Subpart C §15.407(e)

2.4.2 Standard Applicable

Within the 5.725–5.85 GHz band, the minimum 6 dB bandwidth of U–NII devices shall be at least 500 kHz.

2.4.3 Equipment Under Test and Modification State

- PoE Model XBGR-2040: Modification state 0 (No modification)

2.4.4 Day of Test

11-02-2022

2.4.5 Test equipment used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.4.6 Environmental Conditions

Test performed at TÜV SÜD Canada, Kanata Location.

Ambient Temperature	24.3
Relative Humidity	30%
ATM Pressure	101kPa

2.4.7 Additional Observations

- This is a conducted test.
- An offset of 13.2dB was added to compensate for the external attenuator and cable used.
- Span is wide enough to capture the channel transmission.
- RBW is 1% of the span (802.11a, n HT20 and nHT40) while VBW is ≥ RBW.
- Sweep is auto.
- Detector is peak.
- Max hold function activated.
- "n dB down" marker function (6dB) of the spectrum analyzer was used for this test

2.4.8 Test Results

2.4.8.1 UNII_3 Band

Channel	Frequency (MHz)	Measured 6dB Bandwidth (MHz)	Limit	Results
Low channel	5735	18.1	≥500kHz	Pass
Middle Channel	5785	17.1	≥500kHz	Pass
Highest Channel	5835	16.8	≥500kHz	Pass

Table 15 – 20dB Bandwidth Results – UNII_2a Modulation 802.11a

Channel	Frequency (MHz)	Measured 6dB Bandwidth (MHz)	Limit	Results
Low channel	5735	17.9	≥500kHz	Pass
Middle Channel	5785	17.9	≥500kHz	Pass
Highest Channel	5835	18.0	≥500kHz	Pass

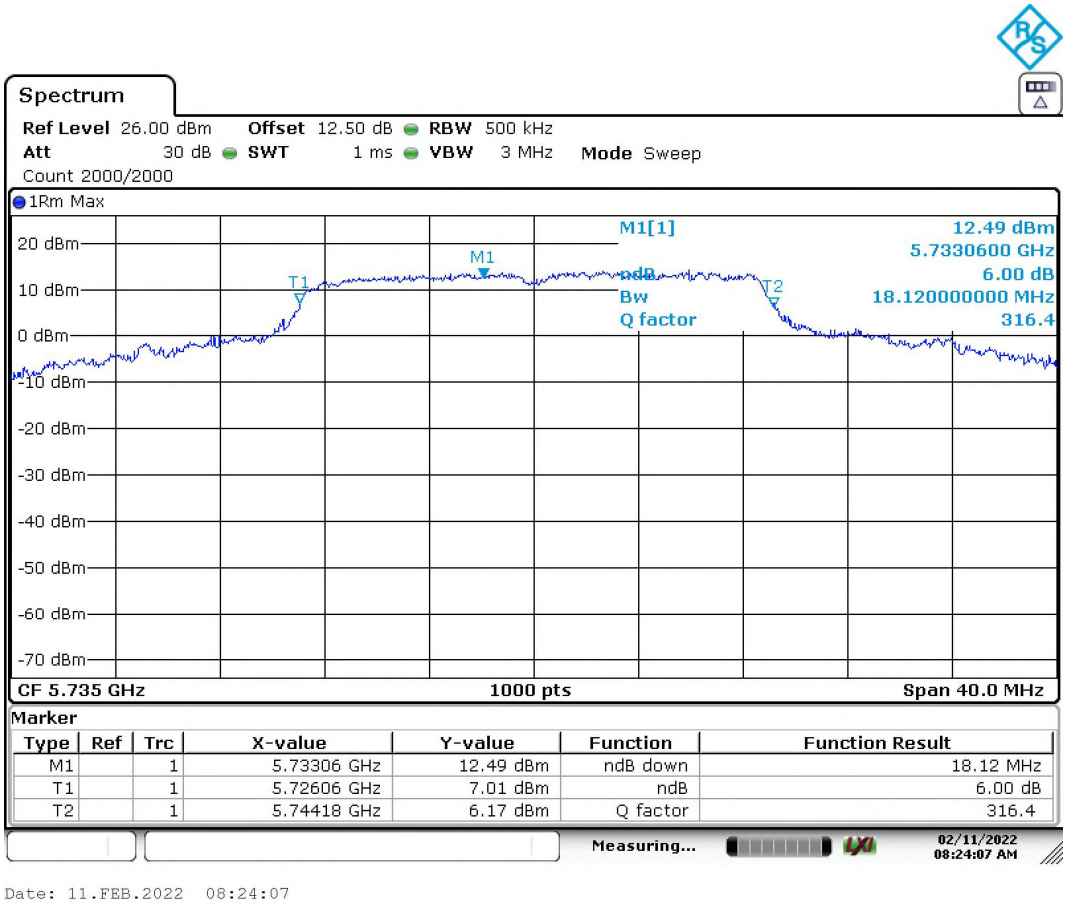
Table 16 – 20dB Bandwidth Results – UNII_2a Modulation 802.11nHT20

Channel	Frequency (MHz)	Measured 6dB Bandwidth (MHz)	Limit	Results
Low channel	5755	18.1	≥500kHz	Pass
Middle Channel	5795	18.2	≥500kHz	Pass
Highest Channel	5825	18.4	≥500kHz	Pass

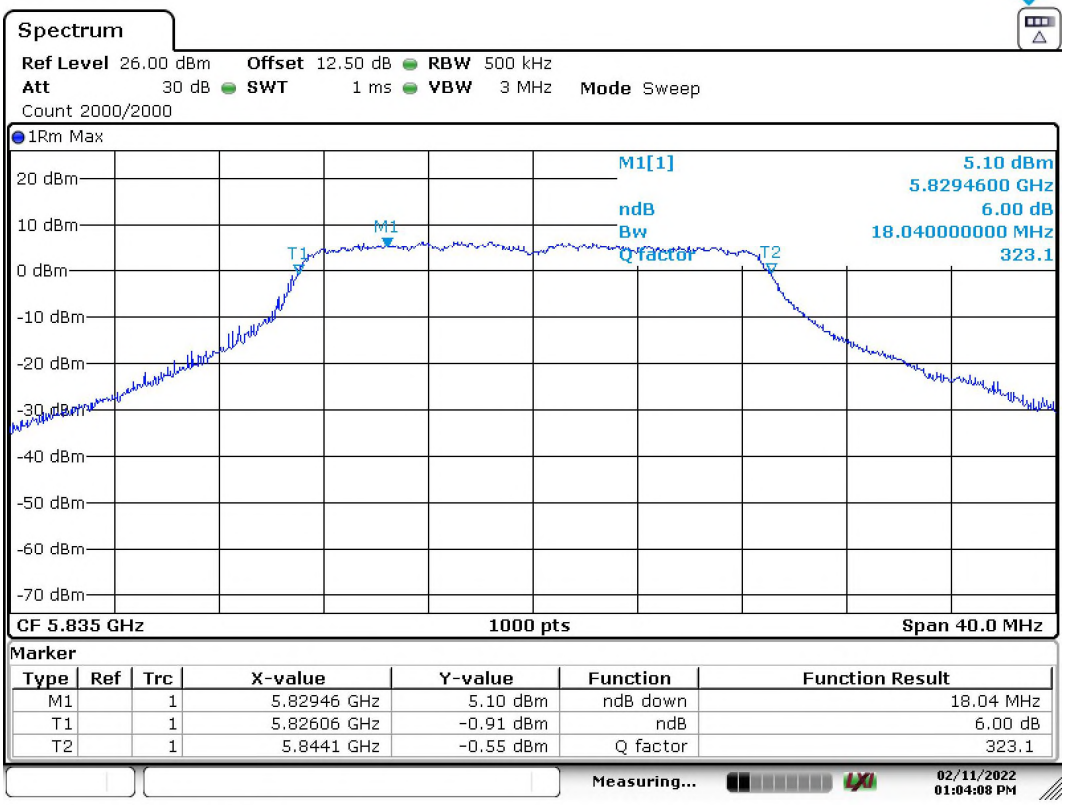
Table 17 – 20dB Bandwidth Results – UNII_2a Modulation 802.11nHT40

2.4.9 Sample of Test Plots

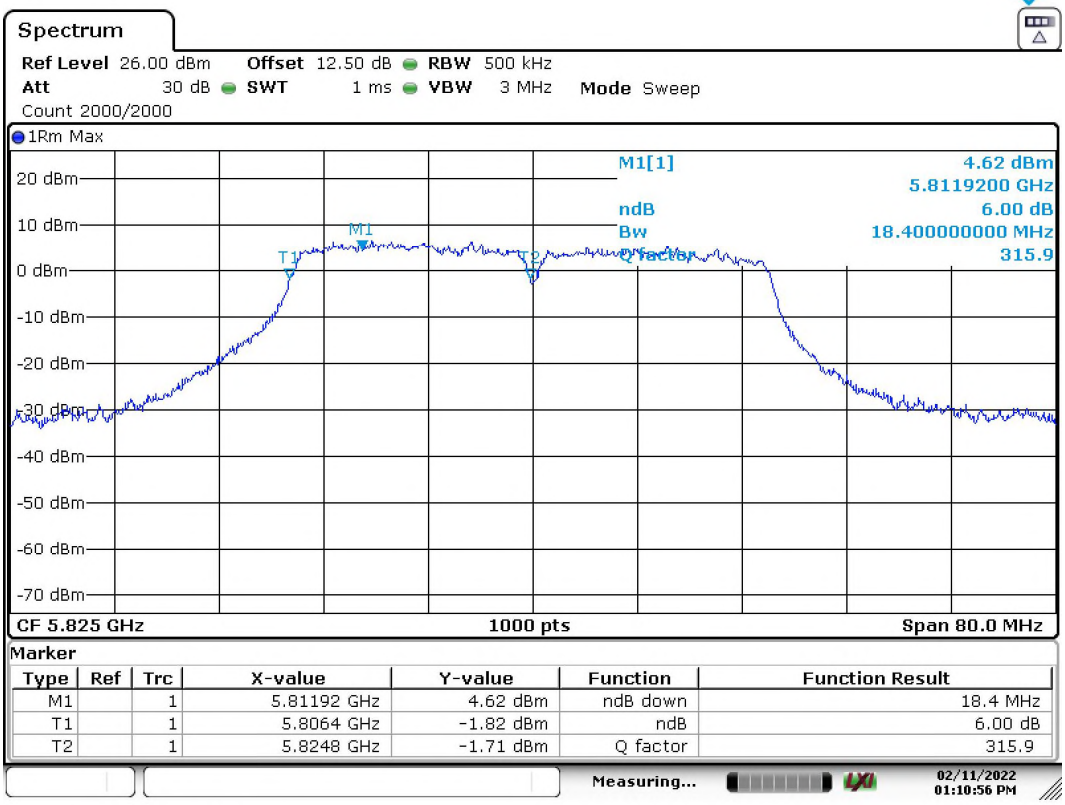
2.4.9.1 UNII_3 Band



Capture 18 : Test Results: 6dB Bandwidth – 5735 MHz – 802.11a Modulation



Capture 19 : Test Results: 6dB Bandwidth – 5835 MHz – 802.11nHT20 Modulation



Capture 20 : Test Results: 6dB Bandwidth – 5825 MHz – 802.11nHT40 Modulation

2.5 26 dB RF Bandwidth

2.5.1 Specification Reference

Part 15 Subpart C §15.407 general
RSS 247

2.5.2 Standard Applicable

15.407(a)(2) For the 5.25–5.35 GHz and 5.47–5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the **26 dB emission bandwidth** in megahertz.

15.407(a)(12) Power spectral density measurement: The maximum power spectral density is measured as a conducted emission by direct connection of a calibrated test instrument to the equipment under test. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used. Measurements in the 5.725–5.895 GHz band are made over a reference bandwidth of 500 kHz or the **26 dB emission bandwidth** of the device, whichever is less. Measurements in all other bands are made over a bandwidth of 1 MHz or the 26 dB emission bandwidth of the device, whichever is less.

15.407(h)(2) (2) Radar Detection Function of Dynamic Frequency Selection (DFS). UNII devices operating with any part of its **26 dB emission bandwidth** in the 5.25–5.35 GHz and 5.47–5.725 GHz bands shall employ a DFS radar detection mechanism to detect the presence of radar systems and to avoid co-channel operation with radar systems.

2.5.3 Equipment Under Test and Modification State

- PoE Model XBGR-2040: Modification state 0 (No modification)

2.5.4 Day of Test

11-02-2022

2.5.5 Test equipment used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.5.6 Environmental Conditions

Test performed at TÜV SÜD Canada, Kanata Location.

Ambient Temperature	24.3
Relative Humidity	30%
ATM Pressure	101kPa

2.5.7 Additional Observations

- This is a conducted test.
- An offset of 13.2dB was added to compensate for the external attenuator and cable used.
- Span is wide enough to capture the channel transmission.
- RBW is 1% of the span (802.11a, n HT20 and nHT40) while VBW is ≥ RBW.
- Sweep is auto.
- Detector is peak.
- Max hold function activated.
- "n dB down" marker function (26dB) of the spectrum analyzer was used for this test

2.5.8 Test Results

2.5.8.1 UNII_2a Band

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low channel	5260	25.924
Middle Channel	5290	25.524
Highest Channel	5320	25.275

Table 18 – 26 dB Bandwidth Results – UNII_2a Modulation 802.11a

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low channel	5260	23.826
Middle Channel	5290	24.376
Highest Channel	5320	24.625

Table 19 – 26 dB Bandwidth Results – UNII_2a Modulation 802.11nHT20

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low channel	5270	43.36
Middle Channel	5290	47.75
Highest Channel	5310	47.15

Table 20 – 26 dB Bandwidth Results – UNII_2a Modulation 802.11nHT40

2.5.8.2 UNII_2c Band

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low channel	5500	25.924
Middle Channel	5590	26.124
Highest Channel	5690	25.325

Table 21 – 26 dB Bandwidth Results – UNII_2c Modulation 802.11a

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low channel	5500	25.225
Middle Channel	5590	25.574
Highest Channel	5690	24.326

Table 22 – 26 dB Bandwidth Results – UNII_2c Modulation 802.11n HT20

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low channel	5510	47.85
Middle Channel	5580	48.45
Highest Channel	5680	47.95

Table 23 – 26 dB Bandwidth Results – UNII_2c Modulation 802.11nHT40

2.5.8.3 UNII_3 Band

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low channel	5735	28.322
Middle Channel	5785	41.908
Highest Channel	5835	25.175

Table 24 – 26 dB Bandwidth Results – UNII_3 Modulation 802.11a

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low channel	5735	26.474
Middle Channel	5785	37.712
Highest Channel	5835	24.525

Table 25 – 26 dB Bandwidth Results – UNII_3 Modulation 802.11n HT20

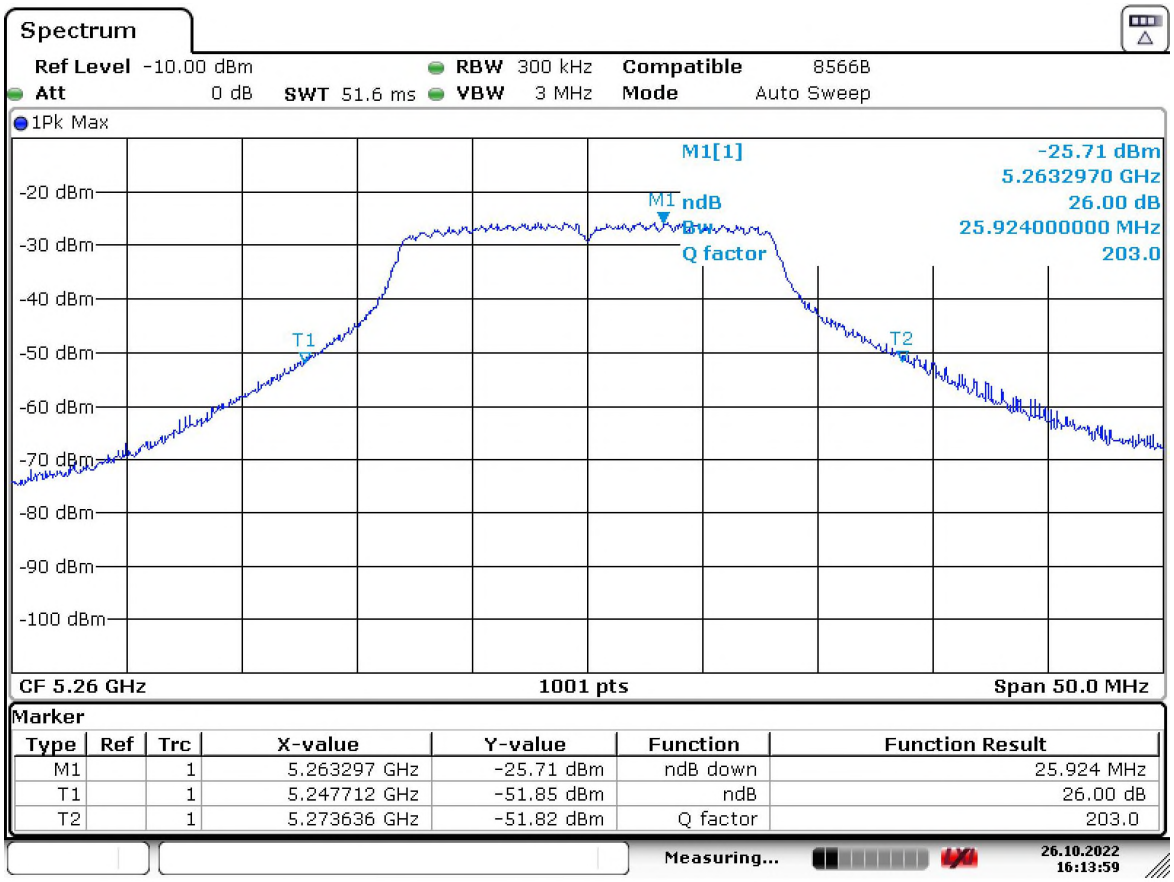
Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low channel	5755	46.65
Middle Channel	5795	48.05
Highest Channel	5825	46.95

Table 26 – 26 dB Bandwidth Results – UNII_3 Modulation 802.11nHT40

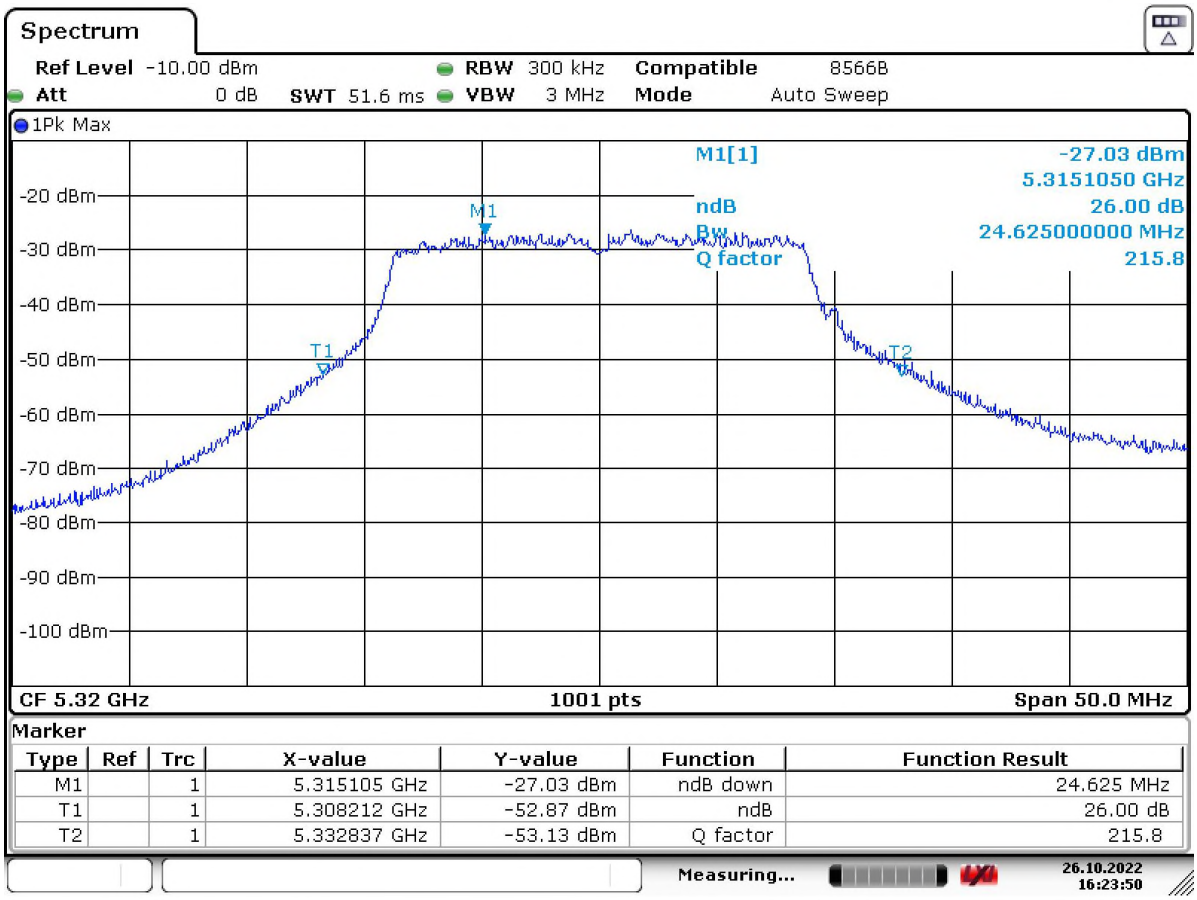
Note: The tables shown above are representative or worst case of 802.11n and 802.11a.

2.5.9 Sample of Test Plots

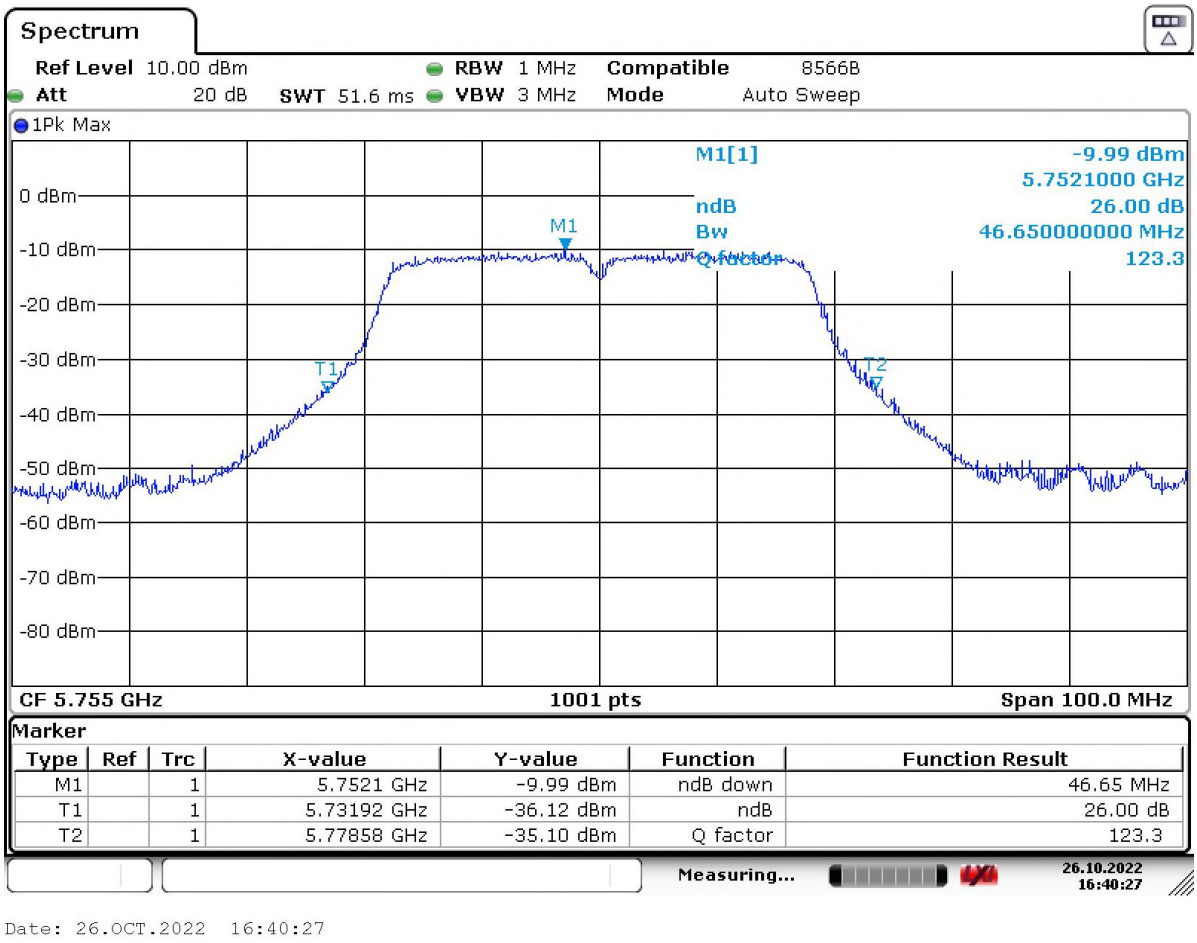
2.5.9.1 UNII_2a Band



Capture 21 : Test Results: 26dB Bandwidth –5260 MHz 802.11a

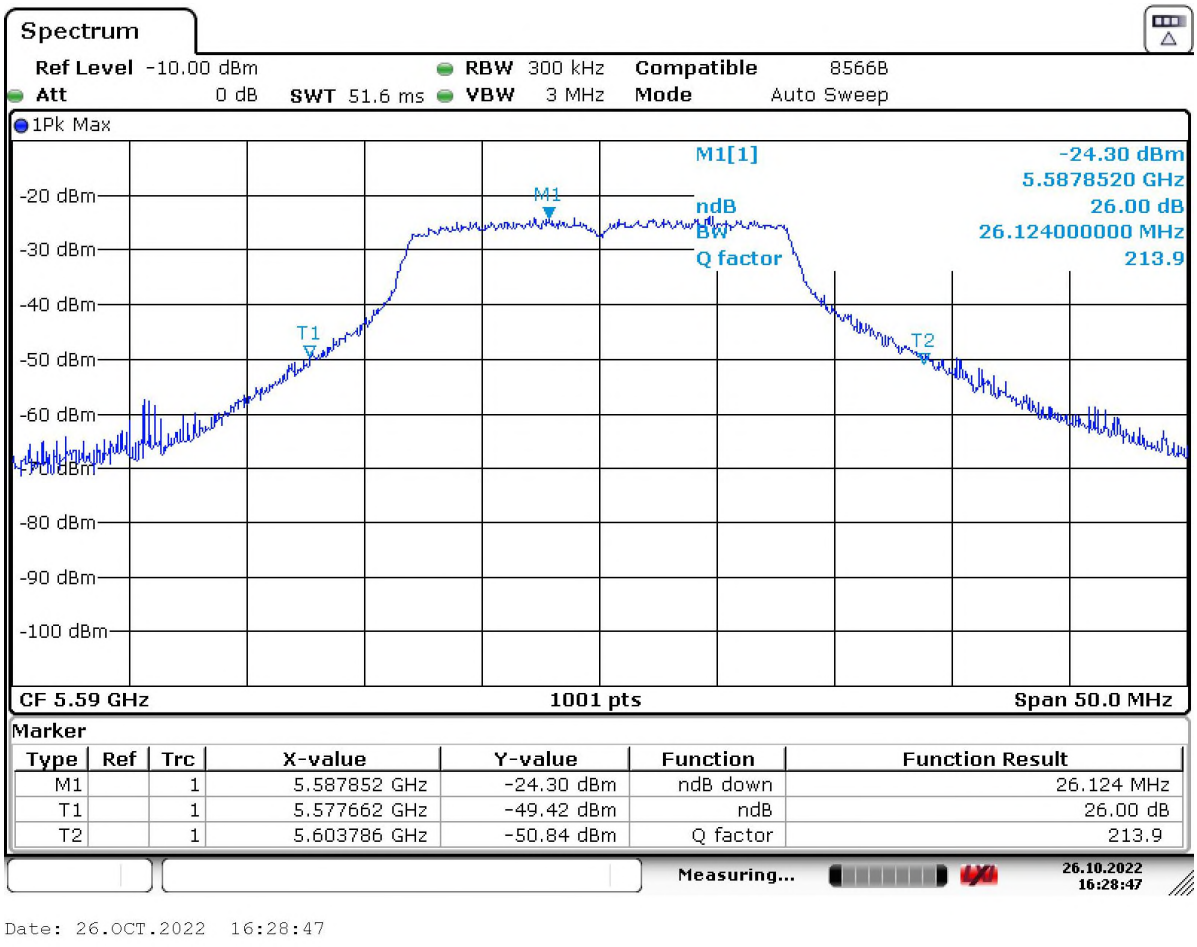


Capture 22 : Test Results: 26dB Bandwidth – 5320 MHz – 802.11nHT20

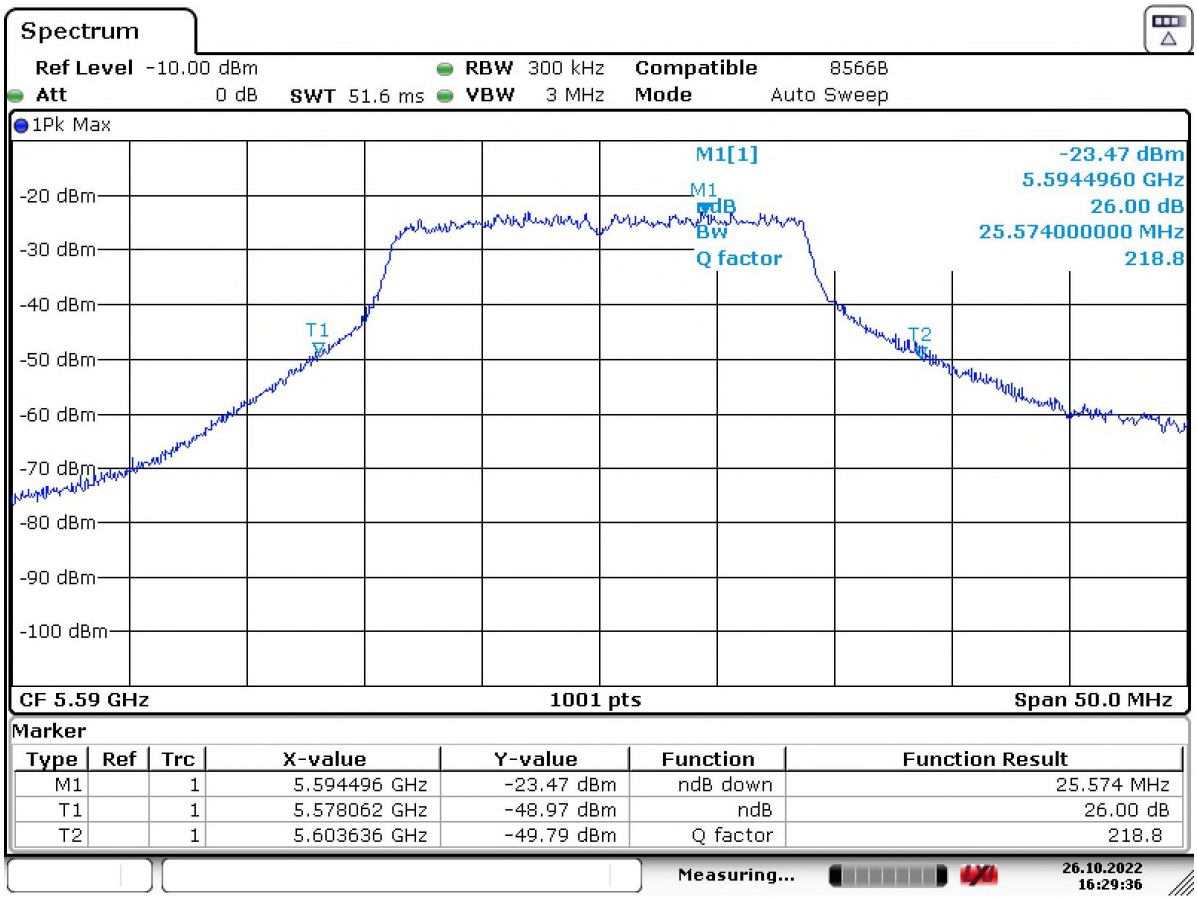


Capture 23 : Test Results: 26dB Bandwidth – 5755 MHz – 802.11nHT40 Modulation

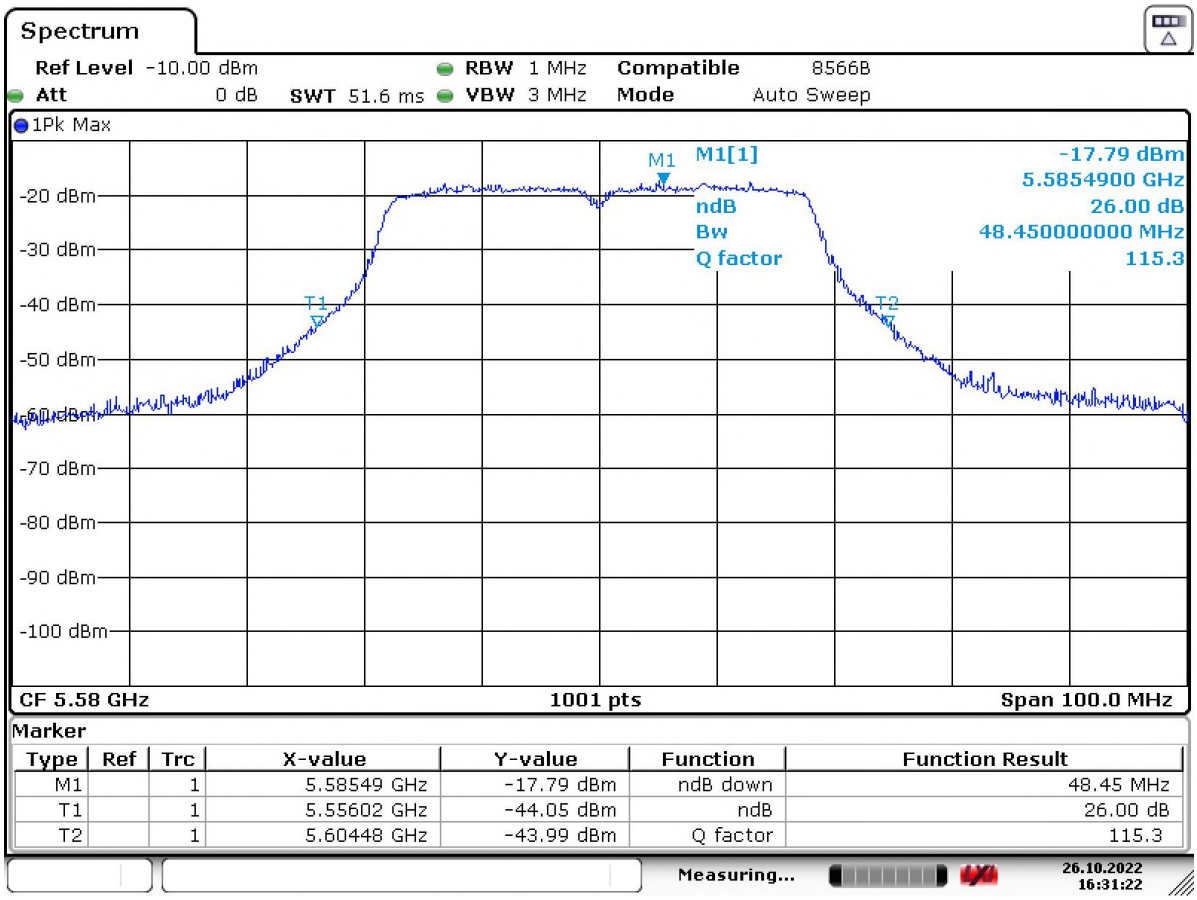
2.5.9.2 UNII_2c Band



Capture 24 : Test Results: 26dB Bandwidth –5590 MHz 802.11a

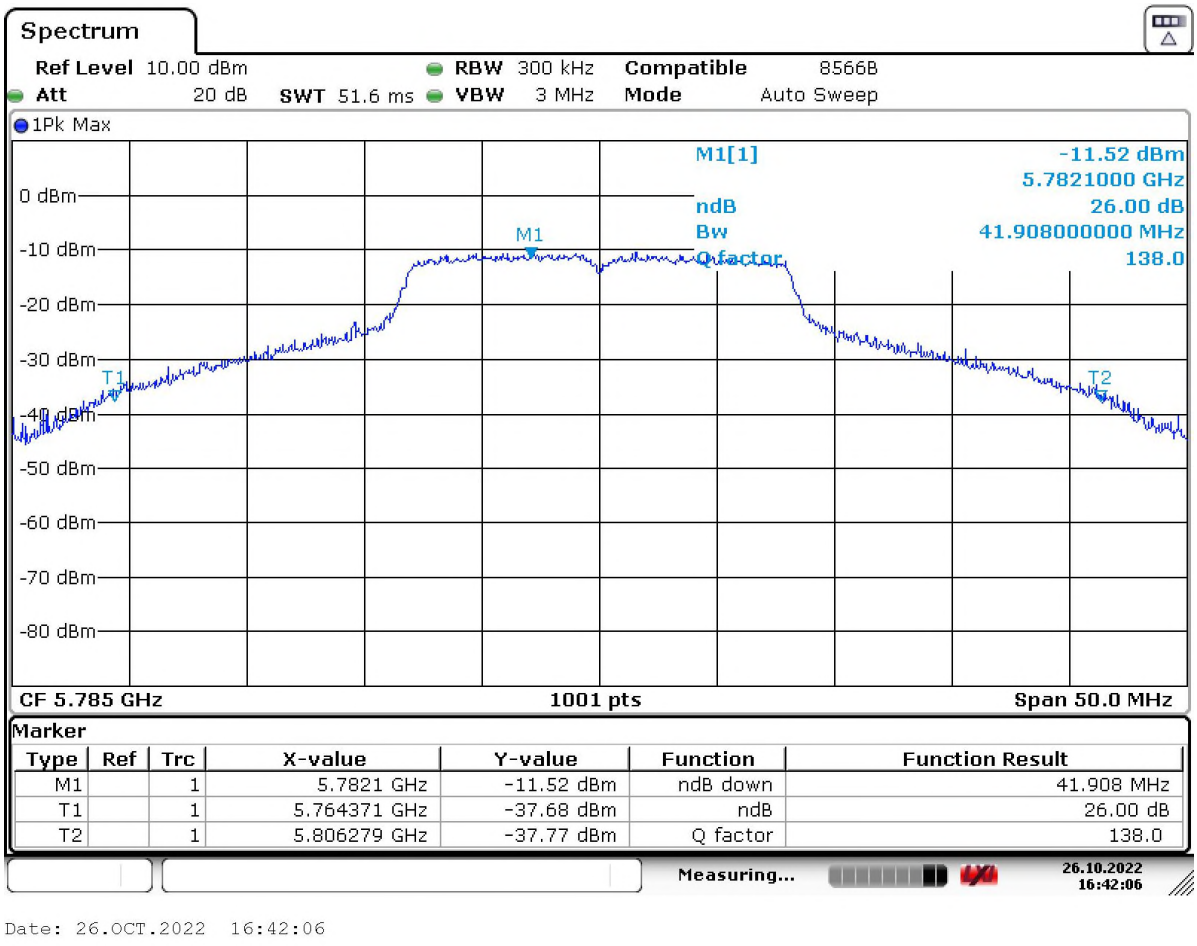


Capture 25 : Test Results: 26dB Bandwidth – 5590 MHz – 802.11nHT20

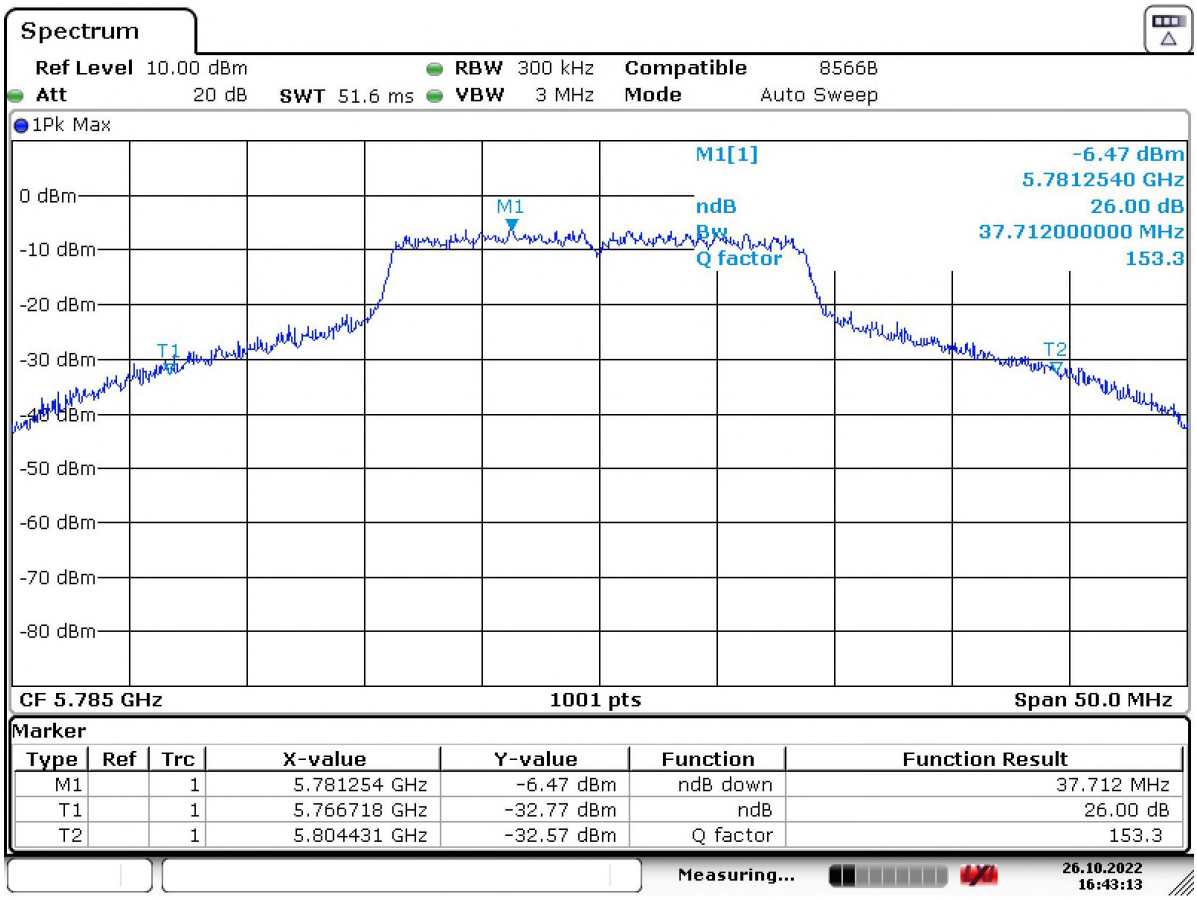


Capture 26 : Test Results: 26dB Bandwidth – 5580 MHz – 802.11nHT40 Modulation

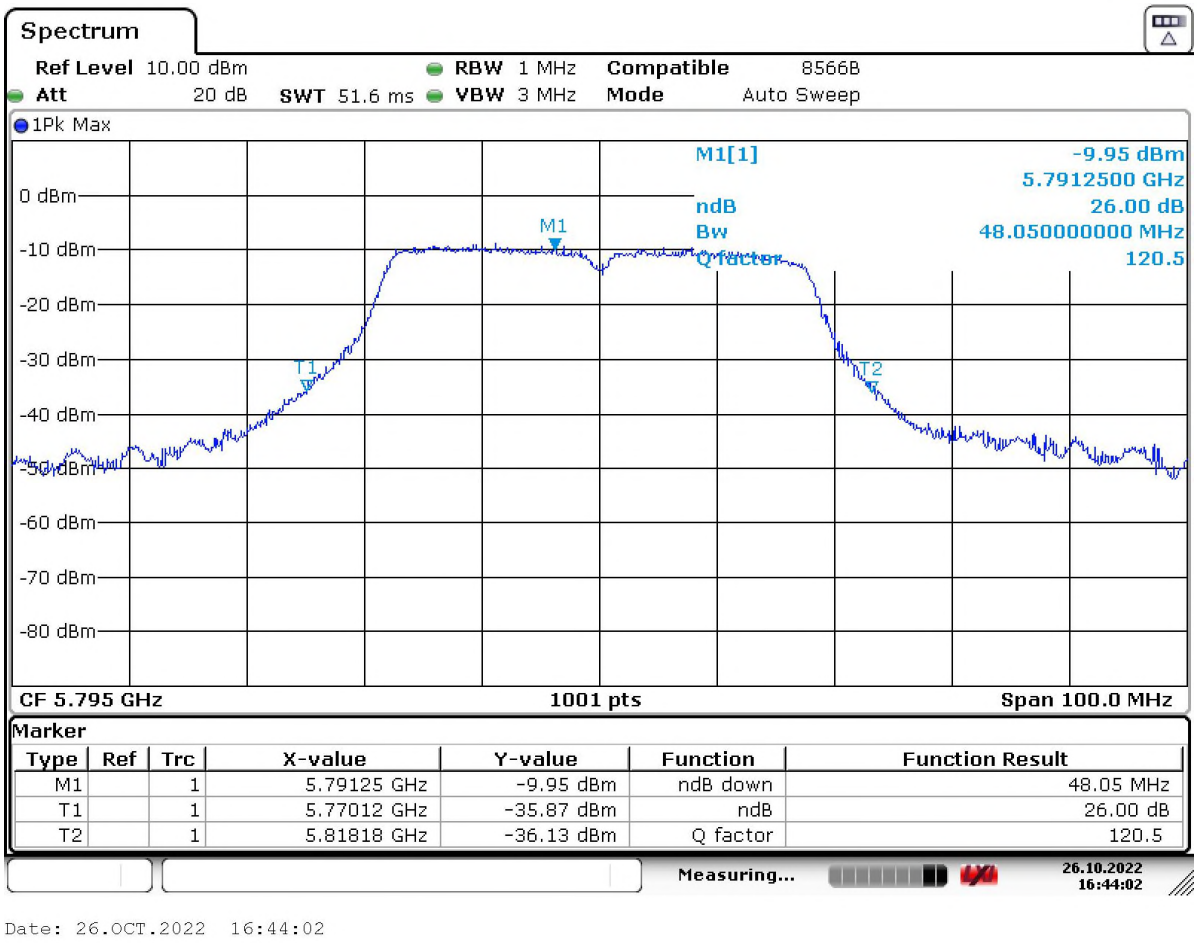
2.5.9.3 UNII_3 Band



Capture 27 : Test Results: 26dB Bandwidth –5785 MHz 802.11a



Capture 28 : Test Results: 26dB Bandwidth – 5785 MHz – 802.11nHT20



Capture 29 : Test Results: 26dB Bandwidth – 5795 MHz – 802.11nHT40 Modulation

2.6 Out-of-Band (OOB) Emissions – Radiated & Conducted

2.6.1 Specification Reference

FCC Part 15, 15.407 (b) 2 through 4 and
RSS-247 section 6
Below 1 GHz the general limits of 15.209 apply.
Note: For band 2a and 2c, OOB Emissions exclude emissions which occur within 2 MHz (2 x RBW) of the band edge. For band 3, OOB emissions exclude emissions which occur within 75 MHz above or below the band edge. These emissions are reported in the 'Band Edge' emissions section of this report.

2.6.2 Standard Applicable

For transmitters operating in the 5.25–5.35 GHz band: All emissions outside of the 5.15–5.35 GHz band shall not exceed an e.i.r.p. of -27 dBm/MHz. For transmitters operating in the 5.47–5.725 GHz band: All emissions outside of the 5.47–5.725 GHz band shall not exceed an e.i.r.p. of -27 dBm/MHz. For transmitters operating in the 5.725–5.85 GHz band:
(i) All emissions shall be limited to a level of -27 dBm/MHz at 75 MHz or more above or below the band edge.

2.6.3 Equipment Under Test and Modification State

- PoE Model XBGR-2040: Modification state 0 (No modification)

2.6.4 Day of Test/Initial of test personnel who performed the test

JM - 11-04-2022

2.6.5 Test equipment used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.6.6 Environmental Conditions

Test performed at TÜV SÜD Canada, Kanata Location.

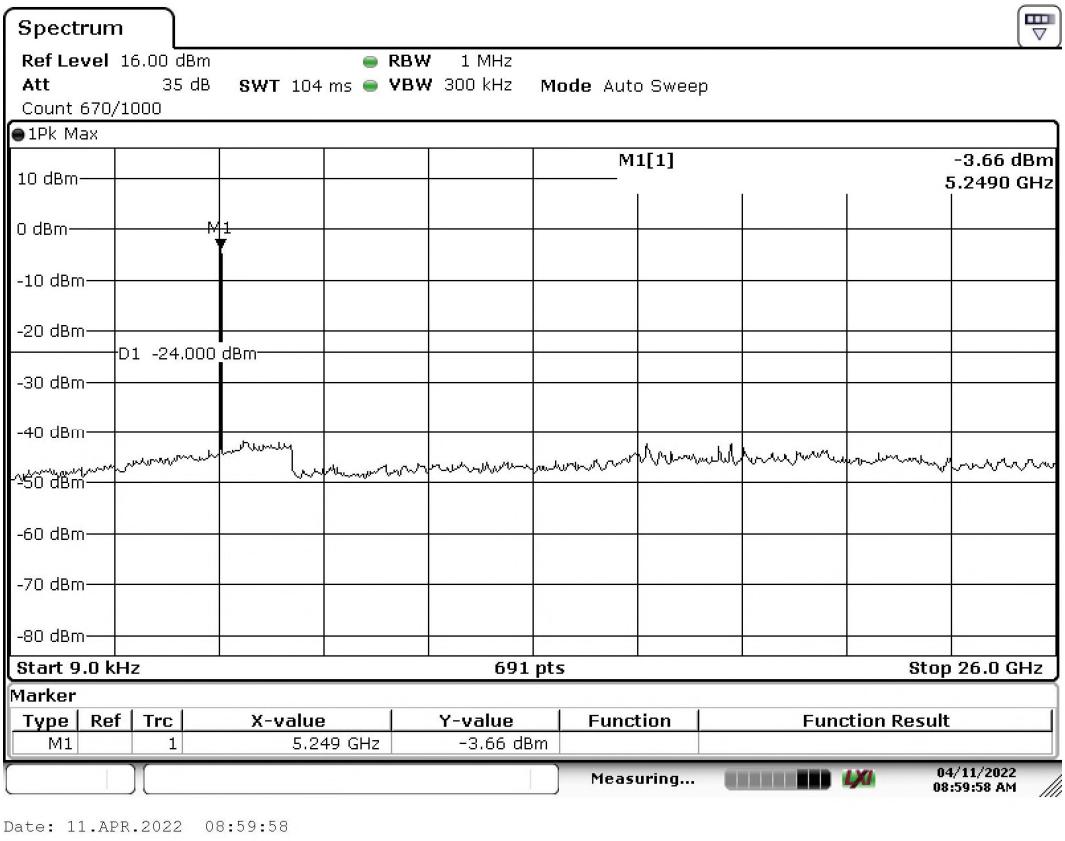
Ambient Temperature	20.8
Relative Humidity	25.4%
ATM Pressure	101kPa

2.6.7 Additional Observations

- Below 1 GHz this was performed as a radiated test.
- Above 1 GHz this was performed as an antenna port conducted test

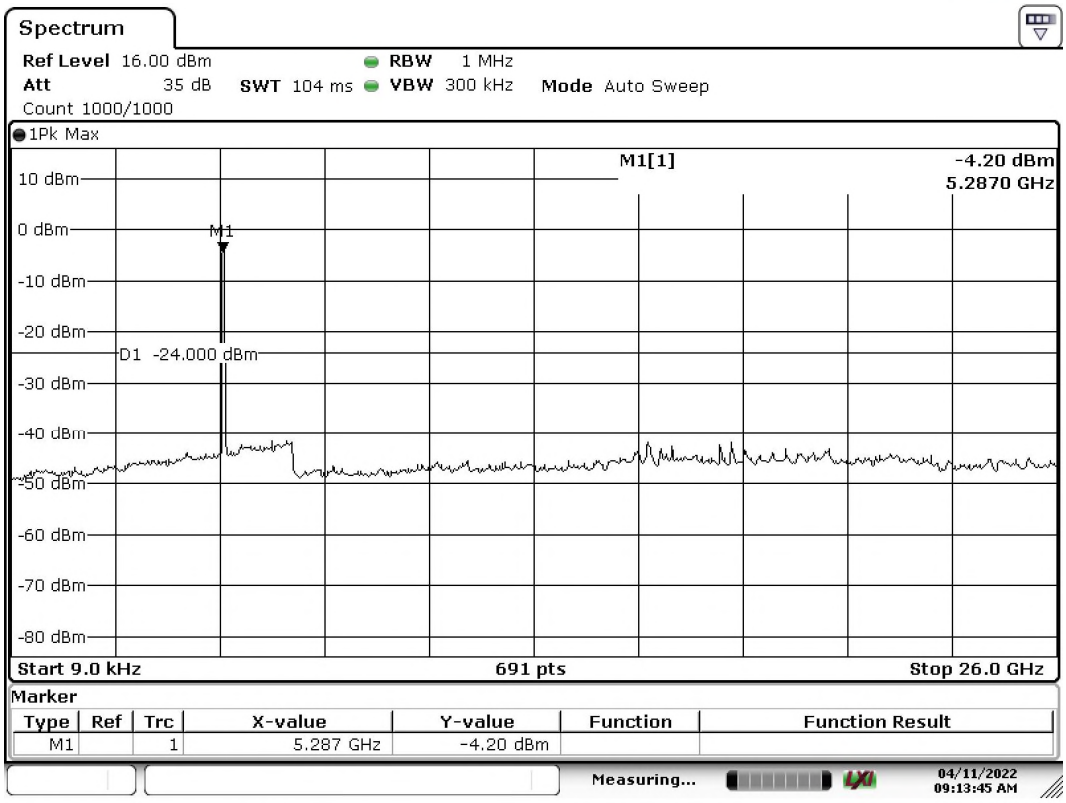
2.6.8 Sample of Test Plots

2.6.8.1 UNII_2a Band



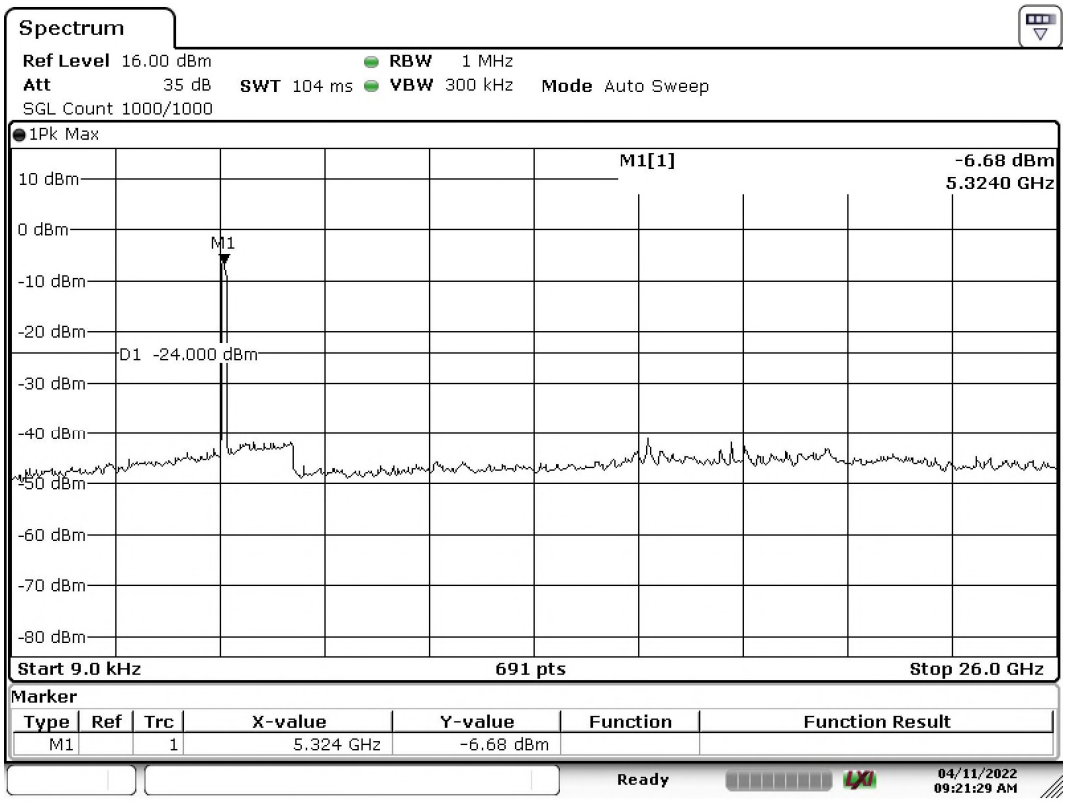
Capture 30 : Test Results: OOB Emissions – 9kHz to 26GHz – 5260 MHz – 802.11a Modulation

Note: No spurious emissions exceeded the worst-case limit of -43.5 dBm/MHz, which is the applicable limit of -27 dBm/MHz applying a worst case antenna factor of 16.5 dBi.



Capture 31 : Test Results: : OOB Emissions – 9kHz to 26GHz – 5290 MHz – 802.11HT20 Modulation

Note: No spurious emissions exceeded the worst-case limit of -43.5 dBm/MHz, which is the applicable limit of -27 dBm/MHz applying a worst case antenna factor of 16.5 dBi.



Capture 32 : Test Results: : OOB Emissions – 9kHz to 26GHz – 5310 MHz – 802.11HT40 Modulation

Note: No spurious emissions exceeded the worst-case limit of -43.5 dBm/MHz, which is the applicable limit of -27 dBm/MHz applying a worst case antenna factor of 16.5 dBi.