



**FCC PART 15, SUBPART C
ISED C RSS-247, ISSUE 2, FEBRUARY 2017**

TEST REPORT

For

Roku, Inc.

1155 Coleman Avenue, San Jose, CA 95110, USA

**FCC ID: TC2-R1044
IC: 5959A-R1041**

Report Type: Original Report	Model: 3940X2
Prepared By: Christian Schwartz Test Engineer	
Report Number: R2206134-247	
Report Date: 2022-09-06	
Reviewed By: Christian McCaig RF Lead Engineer	
Bay Area Compliance Laboratories Corp. 1274 Anvilwood Avenue, Sunnyvale, CA 94089, USA Tel: +1 (408) 732-9162, Fax: +1 (408) 732-9164	



Note: This test report is prepared for the customer shown above and for the device described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. This report **must not** be used by the customer to claim product certification, approval, or endorsement by A2LA*, NIST, or any agency of the Federal Government.

* This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "*" (Rev.2)

TABLE OF CONTENTS

1	General Description.....	5
1.1	Product Description for Equipment Under Test (EUT)	5
1.2	Objective.....	5
1.3	Related Submittal(s)/Grant(s)	5
1.4	Test Methodology	5
1.5	Measurement Uncertainty.....	6
1.6	Test Facility Registrations	6
1.7	Test Facility Accreditations	6
2	System Test Configuration.....	9
2.1	Justification.....	9
2.2	EUT Exercise Software.....	9
2.3	Duty Cycle Correction Factor	10
2.4	Equipment Modifications.....	13
2.5	Local Support Equipment	13
2.6	Support Equipment	13
2.7	Interface Ports and Cabling.....	13
3	Summary of Test Results	14
4	FCC §15.203 & ISEDC RSS-Gen §6.8 - Antenna Requirements	15
4.1	Applicable Standards	15
4.2	Antenna Description	16
5	FCC §2.1091, §15.407(f) & ISEDC RSS-102 - RF Exposure	17
5.1	Applicable Standards	17
5.2	FCC RF Exposure Exemption Evaluation Procedures.....	19
5.3	RF exposure evaluation exemption for FCC.....	22
5.4	RF exposure evaluation exemption for IC	22
6	FCC §15.207 & ISEDC RSS-Gen §8.8 - AC Power Line Conducted Emissions	23
6.1	Applicable Standards	23
6.2	Test Setup	23
6.3	Test Procedure	23
6.4	Test Setup Block Diagram.....	24
6.5	Corrected Amplitude and Margin Calculation.....	25
6.6	Test Equipment List and Details.....	25
6.7	Test Environmental Conditions	26
6.8	Summary of Test Results	26
6.9	Conducted Emissions Test Plots and Data.....	27
7	FCC §15.209, §15.247(d) & ISEDC RSS-247 §5.5, RSS-Gen §8.9, §8.10 - Spurious Radiated Emissions.....	29
7.1	Applicable Standards	29
7.2	Test Setup	30
7.3	Test Procedure	31
7.4	Corrected Amplitude & Margin Calculation.....	31
7.5	Test Setup Block Diagram.....	32
7.6	Test Equipment List and Details.....	34
7.7	Test Environmental Conditions	35
7.8	Summary of Test Results	35
7.9	Radiated Emissions Test Results	36
8	FCC §15.247(a) (2) & ISEDC RSS-247 §5.2, RSS-Gen §6.7 - Emission Bandwidth.....	43
8.1	Applicable Standards	43
8.2	Measurement Procedure.....	43
8.3	Test Setup Block Diagram.....	43
8.4	Test Equipment List and Details.....	43
8.5	Test Environmental Conditions	44
8.6	Test Results.....	44

9	FCC §15.247(b) (3) & ISEDC RSS-247 §5.4 - Maximum Output Power	57
9.1	Applicable Standards	57
9.2	Measurement Procedure.....	57
9.3	Test Setup Block Diagram	57
9.4	Test Equipment List and Details.....	57
9.5	Test Environmental Conditions	58
9.6	Test Results.....	58
10	FCC §15.247(d) & ISEDC RSS-247 §5.5 - 100 kHz Bandwidth of Band Edges.....	59
10.1	Applicable Standards	59
10.2	Measurement Procedure.....	59
10.3	Test Setup Block Diagram	59
10.4	Test Equipment List and Details.....	60
10.5	Test Environmental Conditions	60
10.6	Test Results.....	60
11	FCC §15.247(e) & ISEDC RSS-247 §5.2(2) – Peak Power Spectral Density	65
11.1	Applicable Standards	65
11.2	Measurement Procedure.....	65
11.3	Test Setup Block Diagram	65
11.4	Test Equipment List and Details.....	65
11.5	Test Environmental Conditions	66
11.6	Test Results.....	66
12	FCC §15.247(d) & ISEDC RSS-247 §5.5 - Spurious Emissions at Antenna Terminals	74
12.1	Applicable Standards	74
12.2	Test Procedure	74
12.3	Test Setup Block Diagram	74
12.4	Test Equipment List and Details.....	75
12.5	Test Environmental Conditions	75
12.6	Test Results.....	75
13	Annex A (Normative) – EUT Test Setup Photographs.....	88
14	Annex B (Normative) – EUT External Photographs	89
15	Annex C (Normative) – EUT Internal Photographs.....	90
16	Annex D (Normative) - A2LA Electrical Testing Certificate.....	91

DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R2206134-247	Original Report	2022-09-06

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test report was prepared on behalf of *Roku, Inc.*, and their product model: 3940X2, FCC ID: TC2-R1044, IC: 5959A-R1041 or the “EUT” as referred to in this report. It is a Set-Top-Box with 2.4GHz and 5GHz Wi-Fi capability.

1.2 Objective

This report was prepared on behalf of *Roku, Inc.* in accordance with Part 2, Subpart J, and Part 15, Subpart C of the Federal Communication Commission’s rules and ISED RSS-247 Issue 2, February 2017.

The objective was to determine compliance with FCC Part 15.247 and ISED RSS-247 for Antenna Requirement, RF Exposure, AC Line Conducted Emissions, Emission Bandwidth, Radiated & Conducted Spurious Emissions, 100 kHz Band Edges, Maximum Output Power, and Peak Power Spectrum Density

1.3 Related Submittal(s)/Grant(s)

Equipment Class: NII, FCC ID: TC2-R1044, IC: 5959A-R1041

1.4 Test Methodology

All measurements contained in this report were conducted in accordance with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and FCC KDB 558074 D01 DTS Meas Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.

1.5 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in the field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Parameter	Measurement uncertainty
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±0.86 dB
Power Spectral Density, conducted	±0.86 dB
Unwanted Emissions, conducted	±2.76 dB
All emissions, radiated	±4.94 dB
AC power line Conducted Emission	±2.0 dB
Temperature	±2 ° C
Humidity	±5 %
DC and low frequency voltages	±1.0 %
Time	±2 %
Duty Cycle	±3 %

1.6 Test Facility Registrations

BACLs test facilities that are used to perform Radiated and Conducted Emissions tests are currently recognized by the Federal Communications Commission as Accredited with NIST Designation Number US1129.

BACL's test facilities that are used to perform Radiated and Conducted Emissions tests are currently registered with Industry Canada under Registration Numbers: 3062A-1, 3062A-2, and 3062A-3.

BACL is a Chinese Taipei Bureau of Standards Metrology and Inspection (BSMI) validated Conformity Assessment Body (CAB), under Appendix B, Phase I Procedures of the APEC Mutual Recognition Arrangement (MRA). BACL's BSMI Lab Code Number is: SL2-IN-E-1002R

BACL's test facilities that are used to perform AC Line Conducted Emissions, Telecommunications Line Conducted Emissions, Radiated Emissions from 30 MHz to 1 GHz, and Radiated Emissions from 1 GHz to 6 GHz are currently recognized as Accredited in accordance with the Voluntary Control Council for Interference [VCCI] Article 15 procedures under Registration Number A-0027.

1.7 Test Facility Accreditations

Bay Area Compliance Laboratories Corp. (BACL) is:

A- An independent, 3rd-Party, Commercial Test Laboratory accredited to ISO/IEC 17025:2017 by A2LA (Test Laboratory Accreditation Certificate Number 3297.02), in the fields of: Electromagnetic Compatibility and Telecommunications. Unless noted by an Asterisk (*) in the Compliance Matrix (See Section 3 of this Test Report), BACL's ISO/IEC 17025:2017 Scope of Accreditation includes all of the Test Method Standards and/or the Product Family Standards detailed in this Test Report..

BACL's ISO/IEC 17025:2017 Scope of Accreditation includes a comprehensive suite of EMC Emissions, EMC Immunity, Radio, RF Exposure, Safety and wireline Telecommunications test methods applicable to a wide range of product categories. These product categories include Central Office Telecommunications Equipment [including NEBS - Network Equipment Building Systems], Unlicensed and Licensed Wireless and RF devices, Information Technology Equipment (ITE); Telecommunications Terminal Equipment (TTE); Medical Electrical Equipment; Industrial, Scientific and Medical Test Equipment; Professional Audio and Video Equipment; Industrial and Scientific Instruments and Laboratory Apparatus; Cable Distribution Systems, and Energy Efficient Lighting.

B- A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3297.03) to certify

- For the USA (Federal Communications Commission):
 - 1- All Unlicensed radio frequency devices within FCC Scopes A1, A2, A3, and A4;
 - 2- All Licensed radio frequency devices within FCC Scopes B1, B2, B3, and B4;
 - 3- All Telephone Terminal Equipment within FCC Scope C.
- For the Canada (Industry Canada):
 - 1 All Scope 1-Licence-Exempt Radio Frequency Devices;
 - 2 All Scope 2-Licensed Personal Mobile Radio Services;
 - 3 All Scope 3-Licensed General Mobile & Fixed Radio Services;
 - 4 All Scope 4-Licensed Maritime & Aviation Radio Services;
 - 5 All Scope 5-Licensed Fixed Microwave Radio Services
 - 6 All Broadcasting Technical Standards (BETS) in the Category I Equipment Standards List.
- For Singapore (Info-Communications Development Authority (IDA)):
 - 1 All Line Terminal Equipment: All Technical Specifications for Line Terminal Equipment – Table 1 of IDA MRA Recognition Scheme: 2011, Annex 2
 - 2. All Radio-Communication Equipment: All Technical Specifications for Radio-Communication Equipment – Table 2 of IDA MRA Recognition Scheme: 2011, Annex 2
- For the Hong Kong Special Administrative Region:
 - 1 All Radio Equipment, per KHCA 10XX-series Specifications;
 - 2 All GMDSS Marine Radio Equipment, per HKCA 12XX-series Specifications;
 - 3 All Fixed Network Equipment, per HKCA 20XX-series Specifications.
- For Japan:
 - 1 MIC Telecommunication Business Law (Terminal Equipment):
 - All Scope A1 - Terminal Equipment for the Purpose of Calls;
 - All Scope A2 - Other Terminal Equipment
 - 2 Radio Law (Radio Equipment):
 - All Scope B1 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 1 of the Radio Law
 - All Scope B2 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 2 of the Radio Law
 - All Scope B3 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 3 of the Radio Law

C- A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3297.01) to certify Products to USA's Environmental Protection Agency (EPA) ENERGY STAR Product Specifications for:

- 1 Electronics and Office Equipment:
 - for Telephony (ver. 3.0)
 - for Audio/Video (ver. 3.0)
 - for Battery Charging Systems (ver. 1.1)

- for Set-top Boxes & Cable Boxes (ver. 4.1)
- for Televisions (ver. 6.1)
- for Computers (ver. 6.0)
- for Displays (ver. 6.0)
- for Imaging Equipment (ver. 2.0)
- for Computer Servers (ver. 2.0)
- 2 Commercial Food Service Equipment
 - for Commercial Dishwashers (ver. 2.0)
 - for Commercial Ice Machines (ver. 2.0)
 - for Commercial Ovens (ver. 2.1)
 - for Commercial Refrigerators and Freezers
- 3 Lighting Products
 - For Decorative Light Strings (ver. 1.5)
 - For Luminaires (including sub-components) and Lamps (ver. 1.2)
 - For Compact Fluorescent Lamps (CFLs) (ver. 4.3)
 - For Integral LED Lamps (ver. 1.4)
- 4 Heating, Ventilation, and AC Products
 - for Residential Ceiling Fans (ver. 3.0)
 - for Residential Ventilating Fans (ver. 3.2)
- 5 Other
 - For Water Coolers (ver. 3.0)

D- A NIST Designated Phase-I and Phase-II Conformity Assessment Body (CAB) for the following economies and regulatory authorities under the terms of the stated MRAs/Treaties:

- Australia: ACMA (Australian Communication and Media Authority) – APEC Tel MRA -Phase I;
- Canada: (Innovation, Science and Economic development Canada - ISED) Foreign Certification Body – FCB – APEC Tel MRA -Phase I & Phase II;
- Chinese Taipei (Republic of China – Taiwan):
 - o BSMI (Bureau of Standards, Metrology and Inspection) APEC Tel MRA -Phase I;
 - o NCC (National Communications Commission) APEC Tel MRA -Phase I;
- European Union:
 - o EMC Directive 2014/30/EU US-EU EMC & Telecom MRA CAB (NB)
 - o Radio Equipment (RE) Directive 2014/53/EU US-EU EMC & Telecom MRA CAB (NB)
 - o Low Voltage Directive (LVD) 2014/35/EU
- Hong Kong Special Administrative Region: (Office of the Telecommunications Authority – OFTA) APEC Tel MRA -Phase I & Phase II
- Israel – US-Israel MRA Phase I
- Republic of Korea (Ministry of Communications - Radio Research Laboratory) APEC Tel MRA -Phase I
- Singapore: (Infocomm Media Development Authority - IMDA) APEC Tel MRA -Phase I & Phase II;
- Japan: VCCI - Voluntary Control Council for Interference US-Japan Telecom Treaty VCCI Side Letter-
- USA:
 - o ENERGY STAR Recognized Test Laboratory – US EPA
 - o Telecommunications Certification Body (TCB) – US FCC;
 - o Nationally Recognized Test Laboratory (NRTL) – US OSHA
- Vietnam: APEC Tel MRA -Phase I;

2 System Test Configuration

2.1 Justification

The EUT was configured for testing according to ANSI C63.10-2013 and FCC KDB 558074 D01 DTS Meas Guidance v05r02.

The EUT was tested in a testing mode to represent worst-case results during the final qualification test.

The worst-case data rates are determined to be as follows for each mode based upon investigation by measuring the average power, peak power and PPSD across all data rates bandwidths, and modulations.

2.2 EUT Exercise Software

The test software used was TeraTerm. The software is compliant with the standard requirements being tested against.

FCC/IC power settings:

Modulation	Frequency (MHz)	Power Setting
802.11b	2412	47
	2437	68
	2462	57
802.11g	2412	50
	2437	68
	2462	58
802.11n20	2412	49
	2437	68
	2462	54
802.11n40	2422	48
	2437	68
	2452	50

Data Rates Tested:

802.11b mode: 1Mbps

802.11g mode: 6Mbps

802.11n HT20 mode: MCS0

802.11n HT40 mode: MCS0

2.3 Duty Cycle Correction Factor

According to KDB 558074 D01 DTS Meas Guidance v05r02 section 6.0:

Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (i.e., with a duty cycle of greater than or equal to 98%). When continuous operation cannot be realized, then the use of sweep triggering/signal gating techniques can be utilized to ensure that measurements are made only during transmissions at the maximum power control level. Such sweep triggering/signal gating techniques will require knowledge of the minimum transmission duration (T) over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation. Sweep triggering/signal gating techniques can then be used if the measurement/sweep time of the analyzer can be set such that it does not exceed T at any time that data is being acquired (i.e., no transmitter off-time is to be considered).

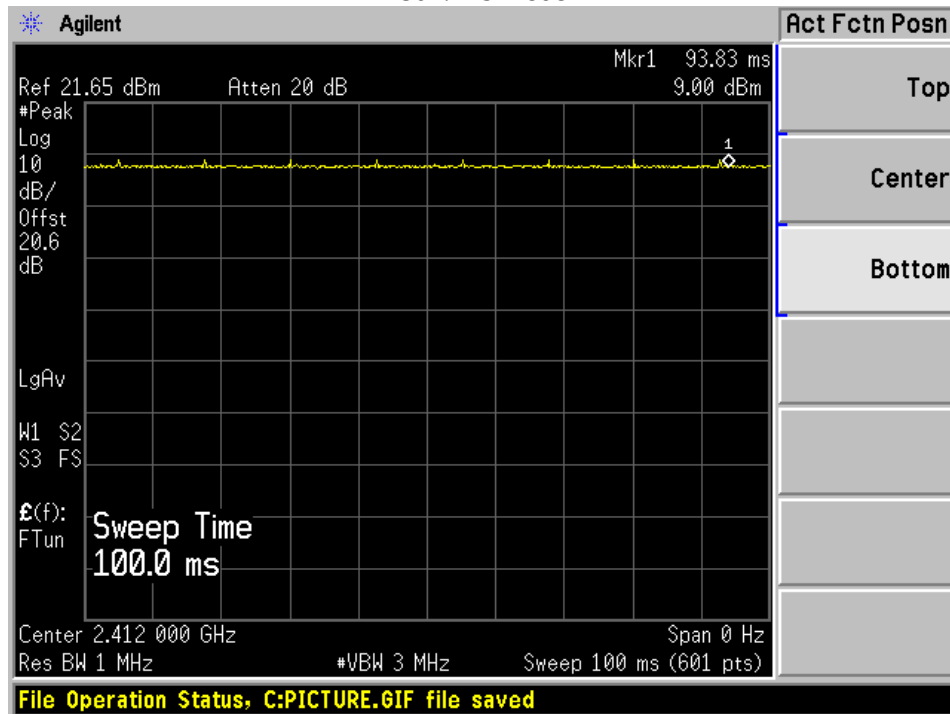
Radio Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
802.11b	-	-	100	0
802.11g	2.033	2.183	93.12	0.30
802.11n20	1.90	2.05	92.6	0.33
802.11n40	0.875	1.092	80.01	0.96

Duty Cycle = On Time (ms)/ Period (ms)

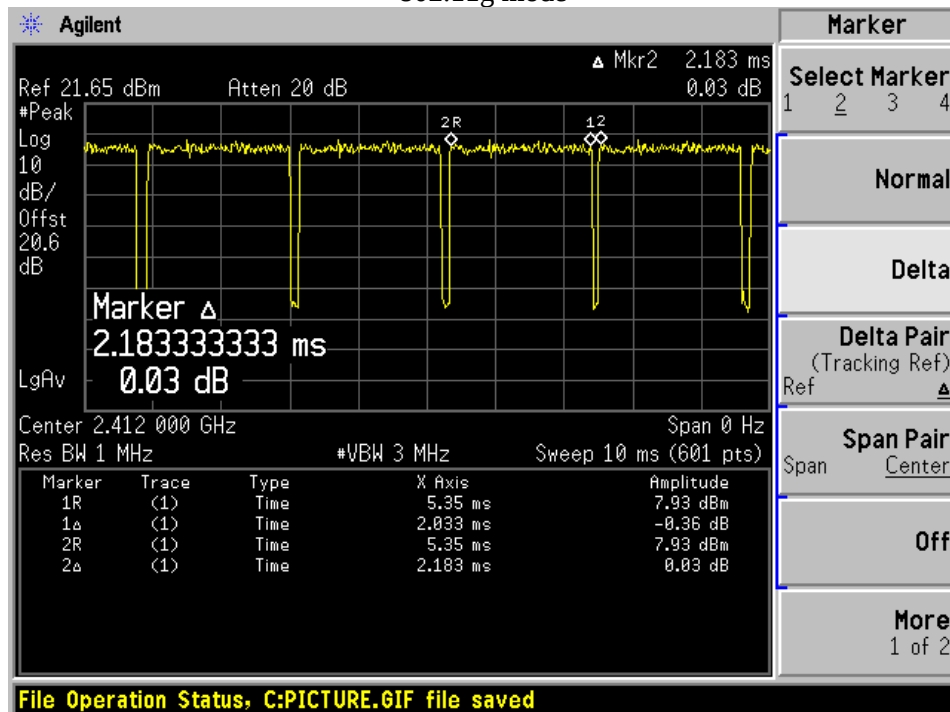
Duty Cycle Correction Factor (dB) = $10 \cdot \log(1/\text{Duty Cycle})$

Please refer to the following plots.

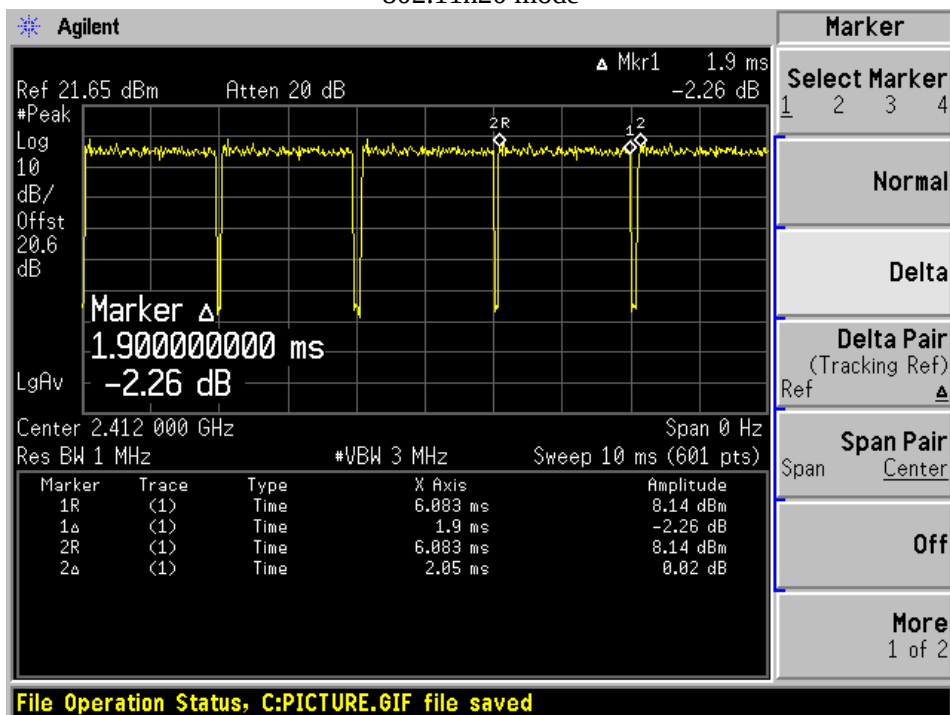
802.11b mode



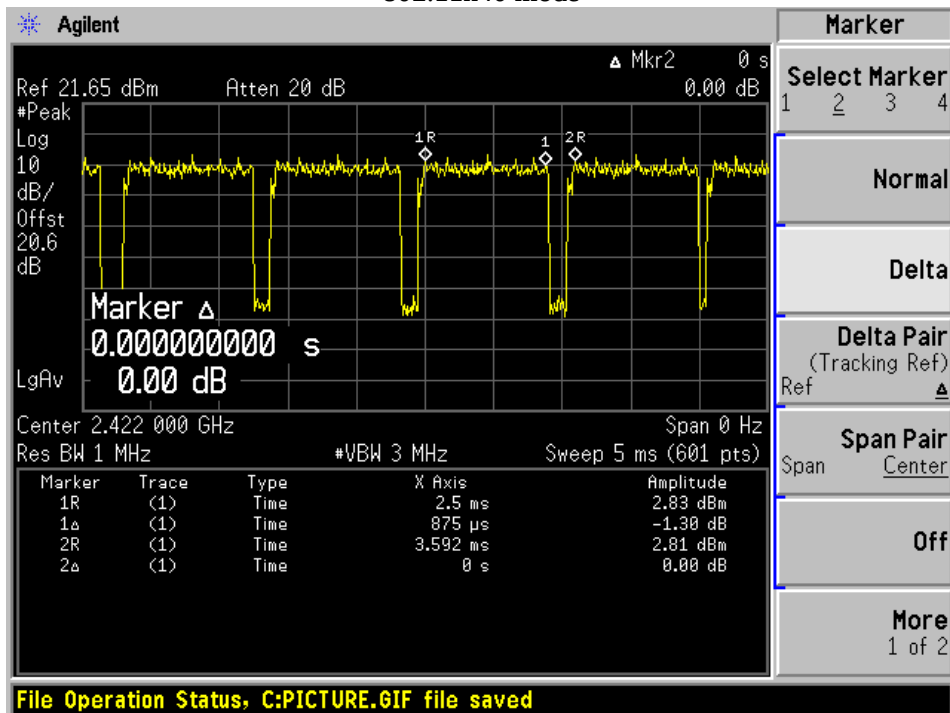
802.11g mode



802.11n20 mode



802.11n40 mode



2.4 Equipment Modifications

N/A

2.5 Local Support Equipment

Manufacturer	Description	Model
Dell	Laptop	Latitude E6410
Dell	TV Monitor	S3221QS

2.6 Support Equipment

Manufacturer	Description	Model
Roku, Inc.	Debug Board	-

2.7 Interface Ports and Cabling

Cable Description	Length (m)	To	From
USB Cable	< 1 m	Laptop	EUT
HDMI Cable	0.5	EUT	Monitor
RF Cable	< 1 m	EUT	PSA

3 Summary of Test Results

Results reported relate only to the product tested.

FCC/ISED Rules	Description of Test	Results
FCC §15.203 ISED RSS-Gen §6.8	Antenna Requirements	Compliant
FCC §2.1093, §15.247(i) ISED RSS-102	RF Exposure	Compliant
FCC §15.207 ISED RSS-Gen §8.8	AC Line Conducted Emissions	Compliant
FCC §15.209, §15.247(d) ISED RSS-247 §5.5 RSS-Gen §8.9, §8.10	Radiated Spurious Emissions	Compliant
FCC §15.247(a)(2) ISED RSS-247 §5.2 RSS-Gen §6.7	6 dB & 99% Emission Bandwidth	Compliant
FCC §15.247(b)(3) ISED RSS-247 §5.4	Maximum Output Power	Compliant
FCC §15.247(e) ISED RSS-247 §5.2(2)	Peak Power Spectral Density	Compliant
FCC §15.247(d) ISED RSS-247 §5.5	100 kHz Bandwidth of Frequency Band Edge	Compliant
FCC §2.1051, §15.247 (d) ISED RSS-247 §5.5	Spurious Emissions at Antenna Port	Compliant

BACL is responsible for all the information provided in this report, except when information is provided by the customer as identified in this report. Information provided by the customer, e.g., antenna gain, can affect the validity of results.

4 FCC §15.203 & ISEDC RSS-Gen §6.8 - Antenna Requirements

4.1 Applicable Standards

According to FCC §15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

And according to FCC §15.247 (b) (4), if transmitting antennas of directional gain greater than 6 dBi are used the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

According to ISEDC RSS-Gen §6.8: Transmitter Antenna

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

For license-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

This radio transmitter has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

4.2 Antenna Description

Radio	Frequency Range (MHz)	Maximum Antenna Gain (dBi)
2.4 GHz Wi-Fi	2400-2483.5	2.27

Note: The antennas used by the EUT are permanent attached antennas.

Note: Antenna used is a Chip Antenna.

Note: Antenna info is information provided by customer.

5 FCC §2.1091, §15.407(f) & ISED RSS-102 - RF Exposure

5.1 Applicable Standards

According to FCC KDB 447498 D04 Interim General RF Exposure Guidance v01, Section 2.1 RF Exposure Test Exemptions for Single Source,

2.1.1 General RF Exposure Test Exemption Considerations

RF exposure test exemptions provide means to obtain certification without the need of showing data (measurements, or analytical/numerical modeling) to demonstrate compliance. Hereafter, in this context, an RF source is referred to as “*exempt RF device*” in the sense that it is not required to show data demonstrating compliance to RF exposure limits.

Test exemptions apply for devices used in general population/uncontrolled exposure environments, according to the SAR-based, or MPE-based exemption thresholds.⁸ However, it is always possible, especially when the potential for exposure cannot be easily determined, that an RF exposure evaluation may become required according §§ 1.1307(c) and (d).

As detailed in Section 2.1.2, the 1 mW and SAR-based test exemption conditions are in terms of source-based available maximum time-averaged (matched conducted) output power for all operating configurations, adjusted for tune-up tolerance, and at the minimum *test separation distance* required for the particular RF exposure scenario under consideration. This minimum *test separation distance* is determined by the smallest distance from the antenna and radiating structures or outer surface of the device, according to the host form factor, exposure conditions and platform requirements, to any part of the body or extremity of a user or bystander. To qualify for SAR test exemption, the *test separation distances* applied must be fully explained and justified (typically in the SAR measurement, or SAR analysis report, according to KDB Pub. 865664) by showing the actual operating configurations and exposure conditions of the transmitter, and applicable host platform requirements (e.g., KDB Pubs. 648474, 616217, 941225)

When no other RF exposure testing or reporting is required, a statement of justification and compliance must be included in the equipment approval, in lieu of the SAR report, to qualify for SAR test exemption.

If RF exposure testing requirements for a specific device are covered in a KDB Publication, those requirements must be satisfied before applying any SAR test exemption provisions. For example, this is the case for handheld PTT two-way radios, handsets, laptops, and tablets, etc.⁹

Finally, when 10-g extremity SAR applies, SAR test exemption may be considered by applying a factor of 2.5 to the SAR-based exemption thresholds.

2.1.2 1-mW Test Exemption

Per §1.1307(b)(3)(i)(A), a single RF source is *exempt RF device* (from the requirement to show data demonstrating compliance to RF exposure limits, as previously mentioned) if the available maximum time-averaged power is no more than 1 mW, regardless of separation distance.

This exemption applies to all operating configurations and exposure conditions, for the frequency range 100 kHz to 100 GHz, regardless of fixed, mobile, or portable device exposure conditions. This is a standalone exemption, and it cannot be applied in conjunction with any other test exemption.

2.1.3 SAR-Based Exemption

A more comprehensive exemption, considering a variable power threshold that depends on both the *separation distance* and power, is provided in §1.1307(b)(3)(ii)(B). This exemption is applicable to the frequency range between 300 MHz and 6 GHz, with *test separation distances* between 0.5 cm and 40 cm, and for all RF sources in fixed, mobile, and portable device exposure conditions.

Accordingly, a RF source is considered an *RF exempt device* if it's available maximum time-averaged (matched conducted) power or its effective radiated power (ERP), whichever is greater, are below a specified threshold. This exemption threshold was derived based on general population 1-g SAR requirements and is detailed in Appendix C.

2.1.4 MPE-Based Exemption

An alternative to the SAR-based exemption is provided in §1.1307(b)(3)(ii)(C), for a much wider frequency range, from 300 kHz to 100 GHz, applicable for separation distances greater or equal to $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. The MPE-based test exemption condition is in terms of ERP, defined as the

⁸ Specific test exemption thresholds for operations under occupational/controlled limits are not established.

⁹ When SAR evaluation is required by the hotspot mode or UMPC mini-tablet procedures, that is, where an antenna is ≤ 2.5 cm from a surface or edge, the *test separation distance* from the phantom to the antenna or device enclosure, as appropriate, should be applied to determine SAR test exemption for such configurations, according to the criteria in this document. For that case, the *test separation distance* cannot be determined from the distance of the antenna to the device surface or edge.

According to ISED RSS-102 Issue 5 Section 2.5.1 Exemption Limits for Routine Evaluation-SAR Evaluation:

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in table below,

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤ 5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤ 300	71	101	132	162	193
450	52	70	88	106	123
835	17	30	42	55	67
1900	7	10	18	34	60
2450	4	7	15	30	52
3500	2	6	16	32	55
5800	1	6	15	27	41

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥ 50 mm
≤ 300	223	254	284	315	345
450	141	159	177	195	213
835	80	92	105	117	130
1900	99	153	225	316	431
2450	83	123	173	235	309
3500	86	124	170	225	290
5800	56	71	85	97	106

5.2 FCC RF Exposure Exemption Evaluation Procedures

According to FCC KDB 447498 D04 Interim General RF Exposure Guidance v01, Annex B Exemptions for Single Source,

B.1 General

This appendix provides the exemption criteria and summarizes relevant parameters and usage considerations based on descriptions in FCC 19-126.

B.2 Blanket 1 mW Blanket Exemption

The 1 mW Blanket Exemption of § 1.1307(b)(3)(i)(A) applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power of no more than 1 mW, regardless of separation distance. The 1 mW blanket exemption applies at separation distances less than 0.5 cm, including where there is no separation. This exemption shall not be used in conjunction with other exemption criteria other than those for multiple RF sources in paragraph § 1.1307(b)(3)(ii)(A). The 1 mW exemption is independent of service type and covers the full range of 100 kHz to 100 GHz, but it shall not be used in conjunction with other exemption criteria or in devices with higher-power transmitters operating in the same time-averaging period. Exposure from such higher-power transmitters would invalidate the underlying assumption that exposure from the lower-power transmitter is the only contributor to SAR in the relevant volume of tissue.

B.3 MPE-based Exemption

General frequency and separation-distance dependent MPE-based effective radiated power (ERP) thresholds are in Table B.1 [Table 1 of § 1.1307(b)(1)(i)(C)] to support an exemption from further evaluation from 300 kHz through 100 GHz.

Table B.1 – THRESHOLD FOR SINGLE RF SOURCE SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION

RF Source			Minimum Distance			Threshold ERP
f_L MHz		f_H MHz	$\lambda_L/2\pi$		$\lambda_H/2\pi$	W
0.3	-	1.34	159 m	-	35.6 m	1,920 R ²
1.34	-	30	35.6 m	-	1.6 m	3,450 R ² /f ²
30	-	300	1.6 m	-	159 mm	3.83 R ²
300	-	1,500	159 mm	-	31.8 mm	0.0128 R ² f
1,500	-	100,000	31.8 mm	-	0.5 mm	19.2 R ²
Subscripts L and H are low and high; λ is wavelength. From § 1.1307(b)(3)(i)(C), modified by adding Minimum Distance columns.						

The table applies to any RF source (i.e., single fixed, mobile, and portable transmitters) and specifies power and distance criteria for each of the five frequency ranges used for the MPE limits. These criteria apply at separation distances from any part of the radiating structure of at least $\lambda/2\pi$. The thresholds are based on the general population MPE limits with a single perfect reflection, outside of the reactive near-field, and in the main beam of the radiator.

For mobile devices that are not exempt per Table B.1 [Table 1 of § 1.1307(b)(1)(i)(C)] at distances from 20 cm to 40 cm and in 0.3 GHz to 6 GHz, evaluation of compliance with the exposure limits in § 1.1310 is necessary if the ERP of the device is greater than ERP_{20cm} in Formula (B.1) [repeated from § 2.1091(c)(1) and § 1.1307(b)(1)(i)(B)].

$$P_{th} \text{ (mW)} = ERP_{20 \text{ cm}} \text{ (mW)} = 2040f \quad 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz}$$

$$P_{th} \text{ (mW)} = ERP_{20 \text{ cm}} \text{ (mW)} = 3060 \quad 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz}$$
(B.1)

If the ERP is not easily obtained, then the available maximum time-averaged power may be used (i.e., without consideration of ERP only if the physical dimensions of the radiating structure(s) do not exceed the electrical length of $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole.

SAR-based exemptions are constant at separation distances between 20 cm and 40 cm to avoid discontinuities in the threshold when transitioning between SAR-based and MPE-based exemption criteria at 40 cm, considering the importance of reflections.

B.4 SAR-based Exemption

SAR-based thresholds are derived based on frequency, power, and separation distance of the RF source. The formula defines the thresholds in general for either available maximum time-averaged power or maximum time-averaged ERP, whichever is greater.

If the ERP of a device is not easily determined, such as for a portable device with a small form factor, the applicant may use the available maximum time-averaged power exclusively if the device antenna or radiating structure does not exceed an electrical length of $\lambda/4$.

As for devices with antennas of length greater than $\lambda/4$ where the gain is not well defined, but always less than that of a half-wave dipole (length $\lambda/2$), the available maximum time-averaged power generated by the device may be used in place of the maximum time-averaged ERP, where that value is not known.

The separation distance is the smallest distance from any part of the antenna or radiating structure for all persons, during operation at the applicable ERP. In the case of mobile or portable devices, the separation distance is from the outer housing of the device where it is closest to the antenna.

The SAR-based exemption formula of § 1.1307(b)(3)(i)(B), repeated here as Formula (B.2), applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power or effective radiated power (ERP), whichever is greater, of less than or equal to the threshold P_{th} (mW).

This method shall only be used at separation distances from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz (inclusive). P_{th} is given by Formula (B.2).

$$P_{th} \text{ (mW)} = ERP_{20 \text{ cm}} (d/20 \text{ cm})^x \quad d \leq 20 \text{ cm}$$

$$P_{th} \text{ (mW)} = ERP_{20 \text{ cm}} \quad 20 \text{ cm} < d \leq 40 \text{ cm} \quad (\text{B.2})$$

Where

$$x = -\log_{10} (60/(ERP_{20 \text{ cm}} \sqrt{f}))$$

and f is in GHz, d is the separation distance (cm), and $EPR_{20\text{cm}}$ is per Formula (B.1).

The example values shown in Table B.2 are for illustration only.

Table B.2 – Example Power Thresholds (mW)

Frequency (MHz)	Distance (mm)										
		5	10	15	20	25	30	35	40	45	50
300	39	65	88	110	129	148	166	184	201	217	
450	22	44	67	89	112	135	158	180	203	226	
835	9	25	44	66	90	116	145	175	207	240	
1900	3	12	26	44	66	92	122	157	195	236	
2450	3	10	22	38	59	83	111	143	179	219	
3600	2	8	18	32	49	71	96	125	158	195	
5800	1	6	14	25	40	58	80	106	136	169	

5.3 RF exposure evaluation exemption for FCC

Prediction frequency (GHz)			2.437	
Maximum output power (dBm)			21.49	
Maximum ERP (dBm)			21.61	
Maximum ERP (mW)			144.88	
Prediction distance (cm)			20	
Maximum antenna gain (dBi)			2.27	
$0.3 \text{ GHz} \leq f < 1.5 \text{ GHz}$	$ERP_{20 \text{ cm}}$ (mW)	x	SAR-based Exemption Threshold	
	-	-	$d \leq 20 \text{ cm}$	P_{th} (mW)
				-
			$20 \text{ cm} < d \leq 40 \text{ cm}$	P_{th} (mW)
				-
$1.5 \text{ GHz} \leq f \leq 6 \text{ GHz}$	$ERP_{20 \text{ cm}}$ (mW)	x	SAR-based Exemption Threshold	
	3060	-	$d \leq 20 \text{ cm}$	P_{th} (mW)
				-
			$20 \text{ cm} < d \leq 40 \text{ cm}$	P_{th} (mW)
				3060

As shown in the table above, the EUT's Max ERP is lower than the SAR-based Exemption Threshold. SAR testing for this device is exempted.

5.4 RF exposure evaluation exemption for IC

Maximum EIRP = 21.49 dBm + 2.27dBi = 23.76 dBm (0.238 W), which is less $1.31 \times 10^{-2} f^{0.6834} = 2.70 \text{ W} = 34.3 \text{ dBm}$. Therefore, ISED SAR testing is not required.

6 FCC §15.207 & ISEDC RSS-Gen §8.8 - AC Power Line Conducted Emissions

6.1 Applicable Standards

As per FCC §15.207 and ISEDC RSS GEN §8.8

For 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 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 ^{Note1}	56 to 46 ^{Note2}
0.5-5	56	46
5-30	60	50

Note1: Decreases with the logarithm of the frequency.

Note2: A linear average detector is required

6.2 Test Setup

The measurement was performed at shield room, using the setup per ANSI C63.10-2013 measurement procedure. The specification used was FCC §15.207 limits and and ISEDC RSS GEN §8.8.

External I/O cables were draped along the edge of the test table and bundle when necessary.

The AC/DC power adapter of the EUT was connected with LISN-1 which provided 120 V / 60 Hz AC power.

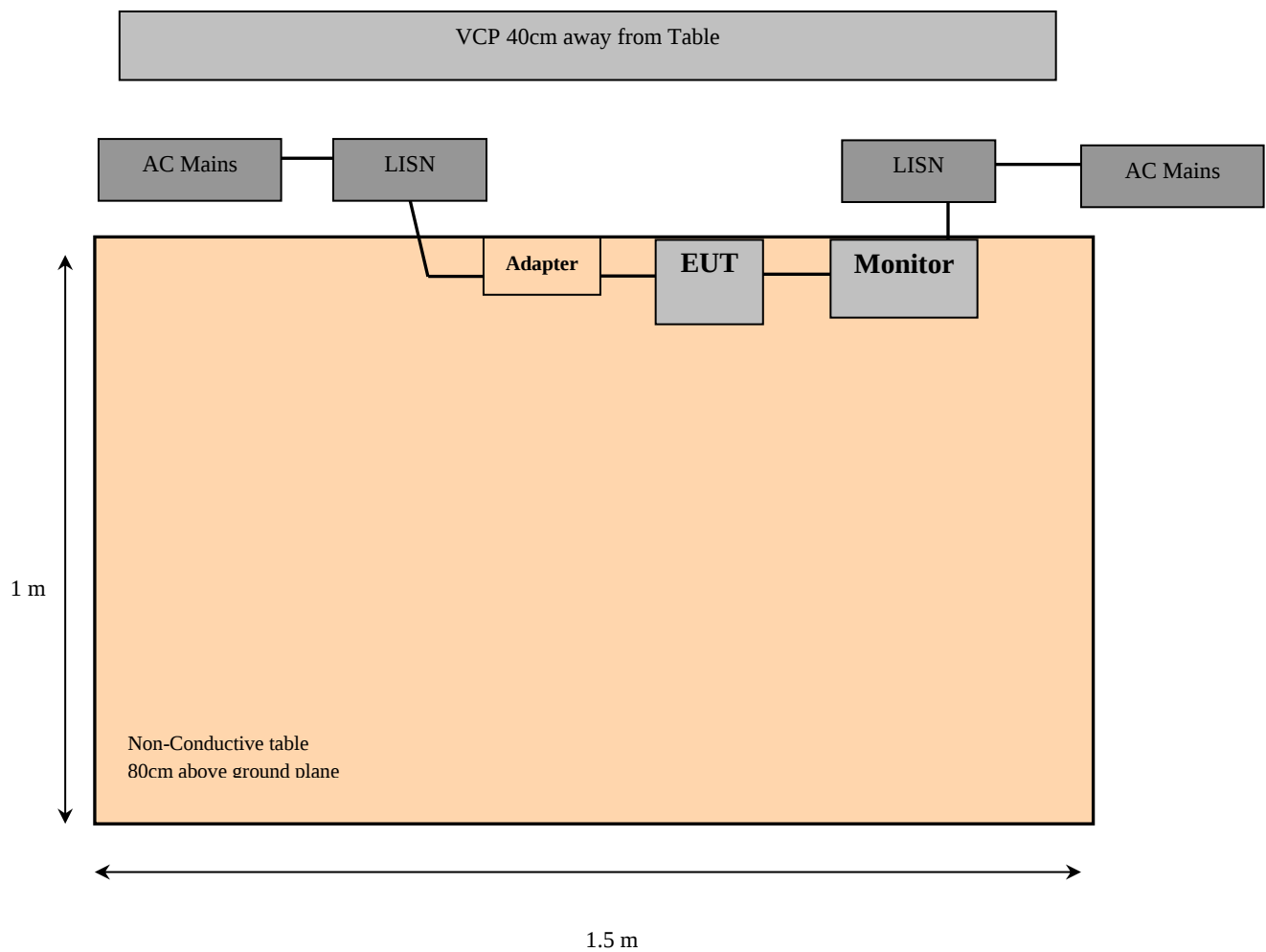
6.3 Test Procedure

During the conducted emissions test, the power cord of the EUT host system was connected to the mains outlet of the LISN-1 and the power cords of support equipment were connected to LISN-2.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All data was recorded in the peak, quasi-peak, and average detection mode. Quasi-Peak readings are distinguished with a "QP." Average readings are distinguished with an "Ave".

6.4 Test Setup Block Diagram



6.5 Corrected Amplitude and Margin Calculation

The Corrected Amplitude (CA) is calculated by adding the Correction Factor (CF) to indicated Amplitude (Ai) reading. The basic equation is as follows:

$$CA = A_i + CF$$

For example, a corrected amplitude of 46.2 dBuV = Indicated Reading (32.5 dBuV) + Correction Factor (13.7 dB)

The Correction Factor is calculated by adding Cable loss (CL), LISN calibration factor, and attenuation of the impulse limiter and the high pass filter. The basic equation is as follows:

$$CF = CL + \text{LISN calibration factor} + \text{Attenuation}$$

For example, a corrected amplitude of 46.2 dBuV = Indicated Reading (32.5 dBuV) + Cable Loss (3.5 dB) + LISN calibration factor (0.2 dB) + Attenuator (10 dB)

The “**Margin**” column of the following data tables indicates the degree of compliance within the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the maximum limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Corrected Amplitude} - \text{Limit}$$

6.6 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
124	Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100044	2021-05-14	2 years
681	Rohde & Schwarz	Impulse Limiter	ESH3-Z2	101962	2021-11-30	1 year
725	Solar Electronics Company	High Pass Filter	Type 7930-100	7930150203	2022-03-18	1 year
732	FCC	LISN	FCC-LISN-50-25-2-10-CISPR16	160129	2021-11-24	1 year
1187	Fairview Microwave	Coaxial Cable	PE3C2220-1250CM	1	2021-09-08	1 year
-	Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

Statement of Traceability: *BACL Corp.* attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 “A2LA Policy on Metrological Traceability”.

6.7 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	101.31 kPa

The testing was performed by Weishan Zhang on 2022-08-04 in the Ground Plane test site.

6.8 Summary of Test Results

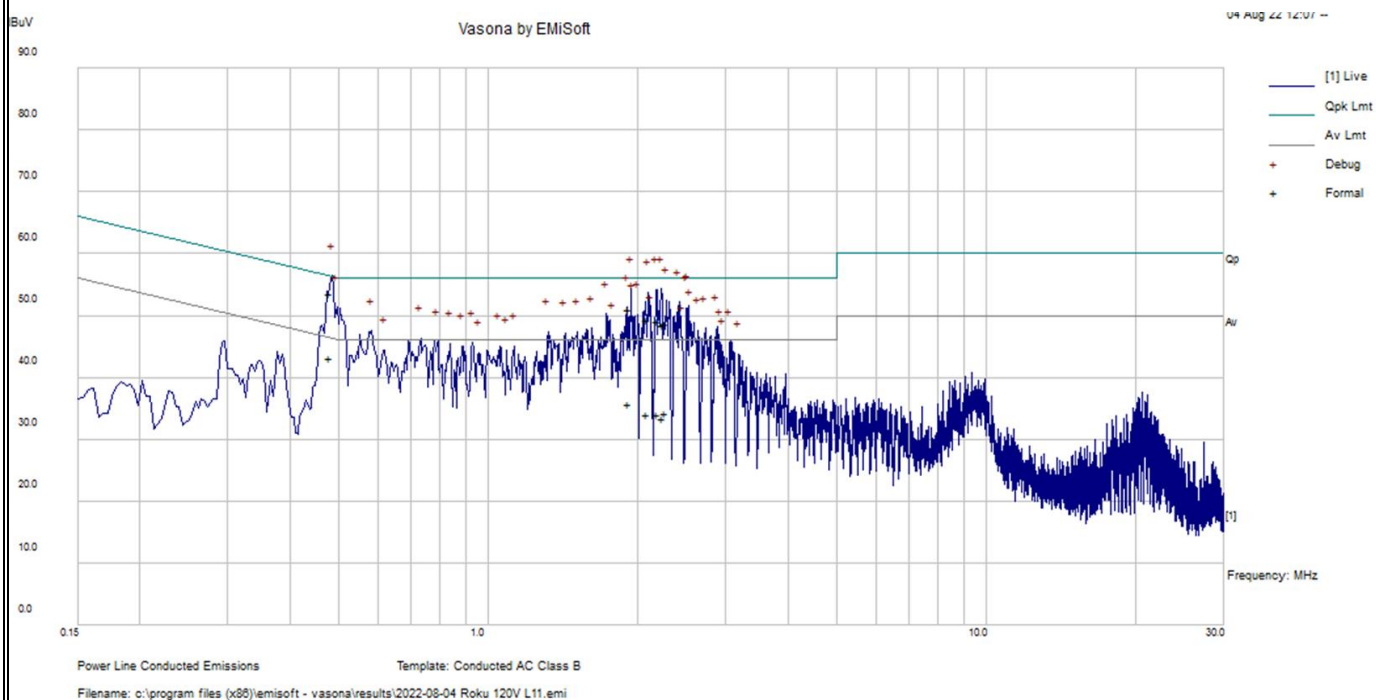
According to the recorded data in following table, the EUT complied with the FCC 15C & ISEDC standard's conducted emissions limits, with the margin reading of:

Connection: AC/DC adapter connected to 120 V/60 Hz, AC			
Margin (dB)	Frequency (MHz)	Conductor Mode (Line/Neutral)	Range (MHz)
-2.73	0.481983	Line	0.15-30

6.9 Conducted Emissions Test Plots and Data

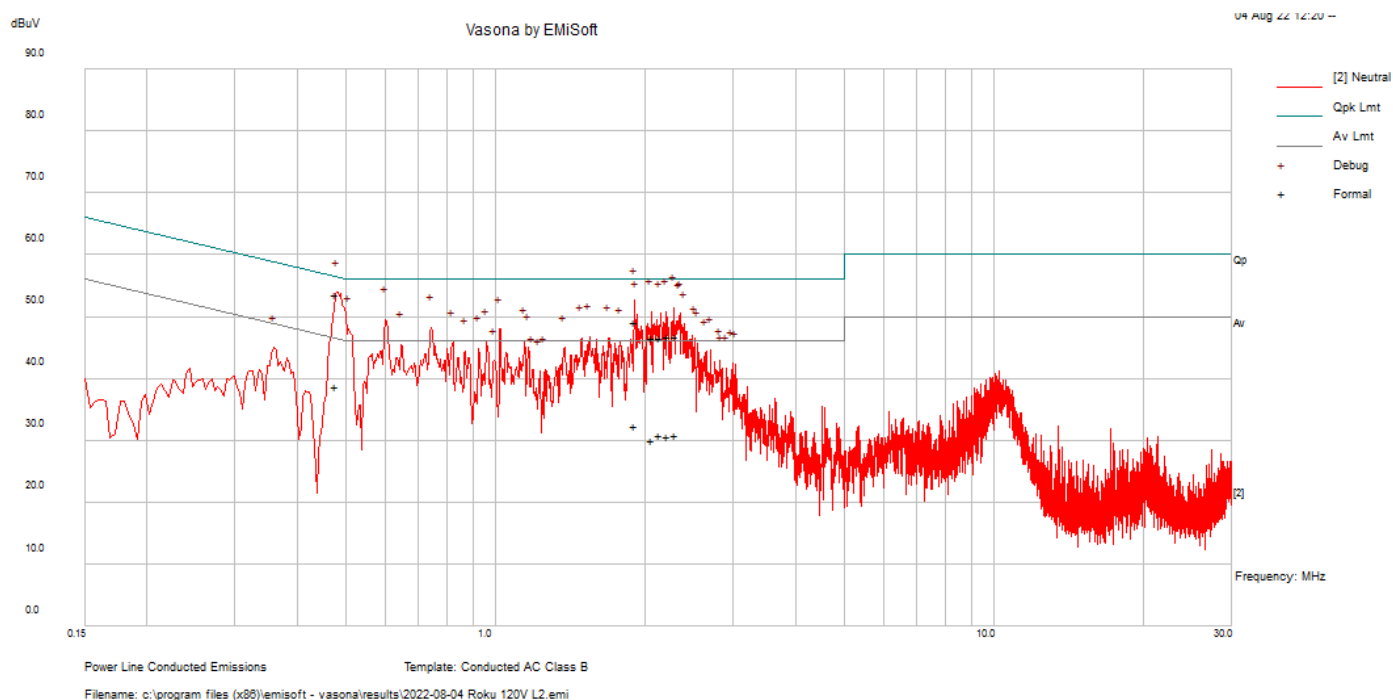
Worst Case: 802.11b mode – 2437 MHz

120 V, 60 Hz – Line



Frequency (MHz)	Ai. Reading (dBμV)	Correction Factor (dB)	Corrected Amplitude (dBμV)	Limit (dBμV)	Margin (dB)	Detector
0.481983	43.15	10.42	53.57	56.3	-2.73	QP
1.916935	40.84	10.13	50.97	56	-5.03	QP
2.244286	38.33	10.12	48.45	56	-7.55	QP
2.195128	39.07	10.12	49.19	56	-6.81	QP
2.091286	39.1	10.14	49.24	56	-6.76	QP
2.262867	38.49	10.12	48.61	56	-7.39	QP
0.481983	32.72	10.42	43.14	46.3	-3.17	Ave
1.916935	25.62	10.13	35.75	46	-10.25	Ave
2.244286	23.19	10.12	33.31	46	-12.69	Ave
2.195128	23.82	10.13	33.95	46	-12.05	Ave
2.091286	23.97	10.14	34.11	46	-11.89	Ave
2.262867	24.05	10.12	34.17	46	-11.83	Ave

120 V, 60 Hz – Neutral



Frequency (MHz)	Ai. Reading (dBuV)	Correction Factor (dB)	Corrected Amplitude (dBμV)	Limit (dBμV)	Margin (dB)	Detector
0.479368	43.11	10.42	53.53	56.35	-2.82	QP
1.900146	38.95	10.12	49.07	56	-6.93	QP
2.291379	36.71	10.11	46.82	56	-9.18	QP
2.060625	36.36	10.13	46.49	56	-9.51	QP
2.208872	36.7	10.12	46.82	56	-9.18	QP
2.136807	36.49	10.12	46.61	56	-9.39	QP
0.479368	28.26	10.43	38.69	46.35	-7.66	Ave
1.900146	22.31	10.12	32.43	46	-13.57	Ave
2.291379	20.65	10.12	30.77	46	-15.23	Ave
2.060625	19.8	10.13	29.93	46	-16.07	Ave
2.208872	20.53	10.11	30.64	46	-15.36	Ave
2.136807	20.66	10.12	30.78	46	-15.22	Ave

7 FCC §15.209, §15.247(d) & ISEDC RSS-247 §5.5, RSS-Gen §8.9, §8.10 - Spurious Radiated Emissions

7.1 Applicable Standards

As per FCC §15.35(d): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz.

As Per FCC §15.205(a) and RSS-Gen except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	960 – 1240	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	1300 – 1427	5.35 – 5.46
2.1735 – 2.1905	25.5 – 25.67	1435 – 1626.5	7.25 – 7.75
4.125 – 4.128	37.5 – 38.25	1645.5 – 1646.5	8.025 – 8.5
4.17725 – 4.17775	73 – 74.6	1660 – 1710	9.0 – 9.2
4.20725 – 4.20775	74.8 – 75.2	1718.8 – 1722.2	9.3 – 9.5
6.215 – 6.218	108 – 121.94	2200 – 2300	10.6 – 12.7
6.26775 – 6.26825	123 – 138	2310 – 2390	13.25 – 13.4
6.31175 – 6.31225	149.9 – 150.05	2483.5 – 2500	14.47 – 14.5
8.291 – 8.294	156.52475 – 156.52525	2690 – 2900	15.35 – 16.2
8.362 – 8.366	156.7 – 156.9	3260 – 3267	17.7 – 21.4
8.37625 – 8.38675	162.0125 – 167.17	3.332 – 3.339	22.01 – 23.12
8.41425 – 8.41475	167.72 – 173.2	3.3458 – 3.358	23.6 – 24.0
12.29 – 12.293	240 – 285	3.600 – 4.400	31.2 – 31.8
12.51975 – 12.52025	322 – 335.4		36.43 – 36.5
12.57675 – 12.57725	399.9 – 410		Above 38.6
13.36 – 13.41	608 – 614		

As per FCC §15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

As per FCC §15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c).

As per ISED RSS-Gen 8.9,

Except when the requirements applicable to a given device state otherwise, emission from licence-exempt transmitters shall comply with the field strength limits shown in the table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

General Field Strength Limits for Licence-Exemption Transmitters at Frequencies above 30 MHz

Frequency (MHz)	Field Strength (µV/m at 3 meters)
30-88	100
88-216	150
216-960	200
Above 960*	500

* Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.

Note: Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the specific RSS.

As per ISED RSS-247 §5.5, in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

7.2 Test Setup

The radiated emissions tests were performed in the 5-meter Chamber, using the setup in accordance with ANSI C63.10-2013. The specification used was the FCC 15 Subpart C and ISED RSS-247 limits.

The spacing between the peripherals was 10 centimeters.

External I/O cables were draped along the edge of the test table and bundle when necessary.

7.3 Test Procedure

For the radiated emissions test, the EUT host, and all support equipment power cords was connected to the AC floor outlet.

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

The EUT was set 3 meter away from the testing antenna, which was varied from 1-4 meter, and the EUT was placed on a turntable, which was 0.8 meter and 1.5 meter above the ground plane for below and above 1000 MHz measurements, the table shall be rotated for 360 degrees to find out the highest emission. The receiving antenna should be changed the polarization both of horizontal and vertical.

The spectrum analyzer or receiver is set as:

Below 1000 MHz:

$$\text{RBW} = 100 \text{ kHz} / \text{VBW} = 300 \text{ kHz} / \text{Sweep} = \text{Auto}$$

Above 1000 MHz:

- (1) Peak: $\text{RBW} = 1\text{MHz} / \text{VBW} = 1\text{MHz} / \text{Sweep} = \text{Auto}$
- (2) Average: $\text{RBW} = 1\text{MHz} / \text{VBW} = 10\text{Hz} / \text{Sweep} = \text{Auto}$

7.4 Corrected Amplitude & Margin Calculation

For emissions below 1 GHz,

The Corrected Amplitude (CA) is calculated by adding the Correction Factor to the S.A. Reading. The basic equation is as follows:

$$\text{CA} = \text{S.A. Reading} + \text{Correction Factor}$$

For example, a corrected amplitude of 40.3 dBuV/m = S.A. Reading (32.5 dBuV) + Correction Factor (7.8 dB/m)

The Correction Factor is calculated by adding the Antenna Factor (AF), the Cable Loss (CL), the Attenuator Factor (Atten) and subtracting the Amplifier Gain (Ga) together. This calculation is done in the measurement software, and reported in the test result section. The basic equation is as follows:

$$\text{Correction Factor} = \text{AF} + \text{CL} + \text{Atten} - \text{Ga}$$

The “**Margin**” column of the following data tables indicates the degree of compliance within the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the maximum limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Corrected Amplitude} - \text{Limit}$$

For emission above 1 GHz,

The Corrected Amplitude (CA) is calculated by adding the Antenna Factor (AF), the Cable Loss (CL), the Attenuator Factor (Atten) and subtracting the Amplifier Gain (Ga) to indicated Amplitude (Ai) reading. The basic equation is as follows:

$$\text{CA} = \text{Ai} + \text{AF} + \text{CL} + \text{Atten} - \text{Ga}$$

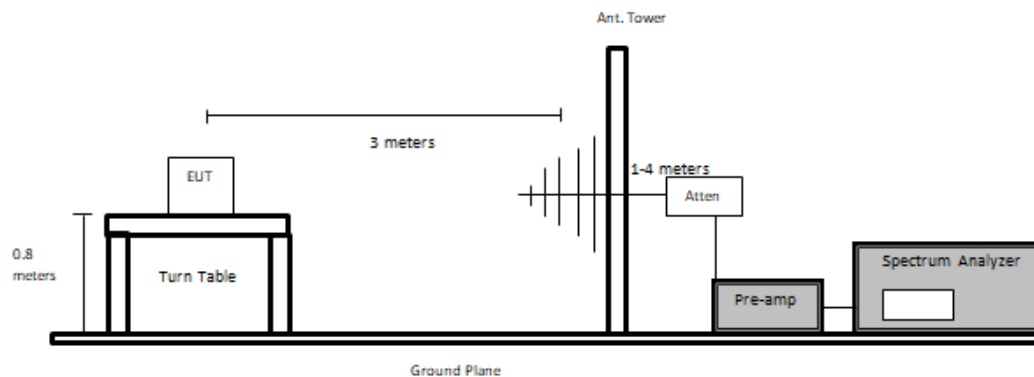
For example, a corrected amplitude of 40.3 dBuV/m = Indicated Reading (32.5 dBuV) + Antenna Factor (+23.5dB) + Cable Loss (3.7 dB) + Attenuator (10 dB) - Amplifier Gain (29.4 dB)

The “**Margin**” column of the following data tables indicates the degree of compliance within the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the maximum limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Corrected Amplitude} - \text{Limit}$$

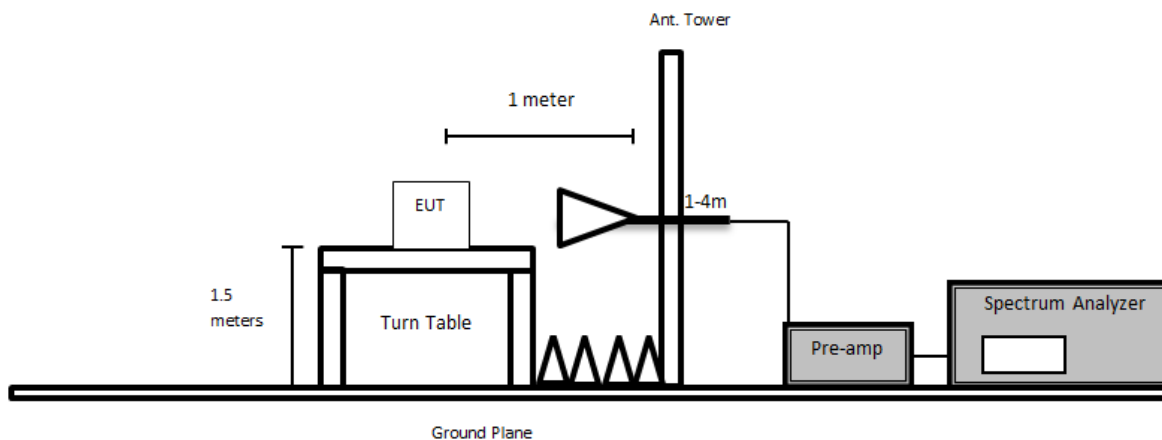
7.5 Test Setup Block Diagram

Below 1GHz:

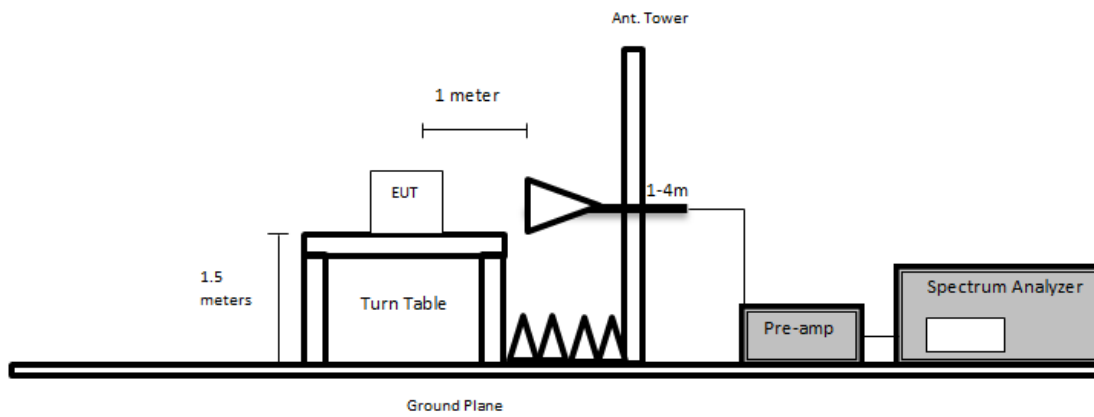


Above 1GHz:

Using Asset #1192



Using Asset #91



7.6 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
655	Rohde & Schwarz	Signal Analyzer	FSQ26	200749	2022-02-07	2 years
-	Sunol Science Corp	System Controller	SC110V	122303-1	N/R	N/A
310	Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950.03	G132150C M5351119	2021-04-05	2 years
658	HP	Pre-Amplifier	8449B	3008A01103	2022-07-22	1 year
459	HP	Pre Amplifier	8447D	2443A04374	2021-11-02	1 year
827	AH Systems	Preamplifier	PAM 1840 VH	170	2021-09-03	1 year
1192	ETS Lindgren	Horn Antenna	3117	00218973	2021-09-14	2 years
321	Sunol Sciences	Biconilog Antenna	JB3	A020106-2	2021-11-22	2 years
91	Wisewave	Antenna, Horn	ARH-4223-02	10555-02	2022-03-08	2 years
-	-	RF cable	-	-	Each time ¹	N/A
-	-	Notch Filter	-	-	Each time ¹	N/A
1077	Insulated Wire Corp.	157 Series 2.92 SM (x2) Armored 33 ft. Cable	KPS-1571AN-3960-KPS	DC 1917	2022-03-03	1 year
1228	Pasternack	Coaxial Cable, RG213	PE3496-800CM	2111301	2021-11-30	1 year
	Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

Note¹: equipment included in the test set-up will be checked each time before testing.

Statement of Traceability: BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".

7.7 Test Environmental Conditions

Temperature:	20-22 °C
Relative Humidity:	42-50 %
ATM Pressure:	102.7 kPa

The testing was performed by Deepak Mishra from 2022-07-06 to 2022-08-03 in 5m chamber 3.

7.8 Summary of Test Results

According to the data hereinafter, the EUT complied with FCC Part 15C and ISED RSS-247 standard's radiated emissions limits, and had the worst margin of:

2.4 GHz Wi-Fi

Mode: Transmitting			
Margin (dB)	Frequency (MHz)	Polarization (Horizontal/Vertical)	Configuration
-0.388	2483.5	H	G mode, 2462 MHz

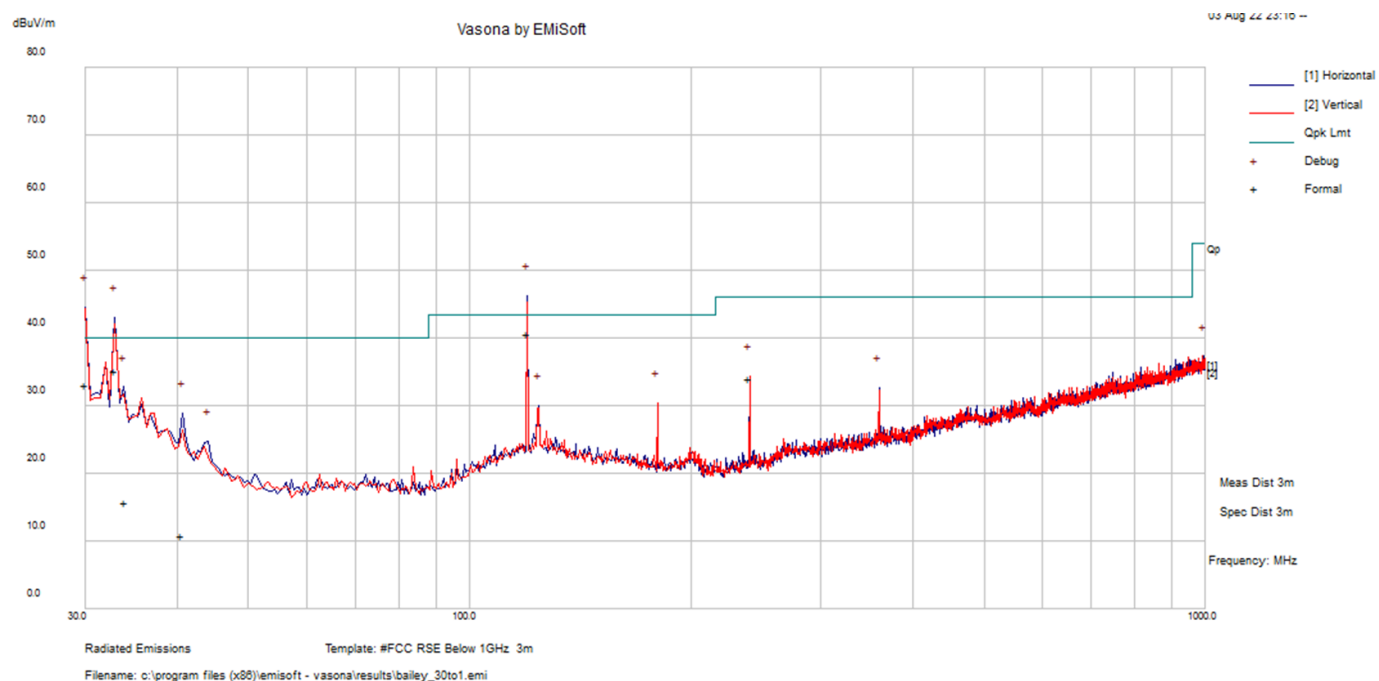
Please refer to the following table and plots for specific test result details

7.9 Radiated Emissions Test Results

Note: Pre-scan was performed in order to determine worst-case orientation of device with respect to measurement antenna. Plots/data shown represent measurements made in worst-case orientation.

1) 30 MHz – 1 GHz Worst Case, Measured at 3 meters

Worst Case: 2437 MHz, b mode



Frequency (MHz)	S.A. Reading (dBμV)	Correction Factor (dB/m)	Corrected Amplitude (dBμV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Comment
30	43.52	-10.36	33.16	139	H	298	40	-6.84	QP
32.976	47.86	-12.68	35.19	104	H	24	40	-4.81	QP
119.9748	58.64	-17.93	40.7	244	H	297	43.5	-2.8	QP
33.975	29.37	-13.58	15.79	280	H	295	40	-24.21	QP
40.544	29.45	-18.61	10.85	297	H	160	40	-29.15	QP
240.0385	54.09	-20.05	34.04	133	H	267	46	-11.96	QP

FCC/IC Limits for 1 GHz to 26.5 GHz				
Applicability	(dBm)	(uV/m at 3meters)	(dBuV/m at 3meters)	(dBuV/m at 1meter) ²
Restricted Band Average Limit	-	500	54	64
Restricted Band Peak Limit ¹	-	-	74	84

Note¹: Restricted Band Peak Limit is defined to be 20dB higher than Average Limit.

Note²: Limits at 1 meter are determined by applying a Distance correction factor accounts for extrapolation from 1 meters to 3 meters. Formula used is as follows: $20 \cdot \log(3\text{meters}/1\text{meter}) = 9.54$ (According to ANSI C63.10-2013 Section 9.4)

2) 1–18 GHz Measured at 1 meter

802.11b mode

Frequency (MHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre- Amp. (dB)	Cord. Reading (dBμV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBμV/m)	Margin (dB)	
Low Channel 2412 MHz											
2390	71.760	42	150	H	32.228	6.011	38.154	71.845	84	-12.155	Peak
2390	63.305	42	150	H	32.228	6.011	38.154	63.390	64	-0.610	Ave
4824	47.350	360	150	H	34.709	8.542	37.125	53.476	84	-30.524	Peak
4824	36.944	360	150	H	34.709	8.542	37.125	43.070	64	-20.930	Ave
7236	52.830	307	112	H	35.618	10.391	36.461	62.378	84	-21.622	Peak
7236	44.771	307	112	H	35.618	10.391	36.461	54.319	64	-9.681	Ave
Middle Channel 2437 MHz											
4874	48.460	76	117	H	34.709	8.562	37.027	54.704	84	-29.296	Peak
4874	40.318	76	117	H	34.709	8.562	37.027	46.562	64	-17.438	Ave
7311	51.330	321	116	H	35.618	10.565	36.454	61.059	84	-22.941	Peak
7311	44.750	321	116	H	35.618	10.565	36.454	54.479	64	-9.521	Ave
High Channel 2462 MHz											
2483.5	65.830	79	150	H	32.665	6.099	38.075	66.519	84	-17.481	Peak
2483.5	62.004	79	150	H	32.665	6.099	38.075	62.693	64	-1.307	Ave
4924	49.100	360	150	H	34.709	8.720	37.027	55.502	84	-28.498	Peak
4924	49.170	360	150	H	34.709	8.720	37.027	55.572	64	-8.428	Ave
7386	47.940	0	146	H	35.618	10.750	36.496	57.812	84	-26.188	Peak
7386	37.464	0	146	H	35.618	10.750	36.496	47.336	64	-16.664	Ave

802.11g mode

Frequency (MHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre- Amp. (dB)	Cord. Reading (dBμV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBμV/m)	Margin (dB)	
Low Channel 2412 MHz											
2390	78.970	68	150	H	32.228	6.011	38.154	79.055	84	-4.945	Peak
2390	62.924	68	150	H	32.228	6.011	38.154	63.009	64	-0.991	Ave
4824	48.490	27	150	H	34.709	8.542	37.125	54.616	84	-29.384	Peak
4824	36.561	27	150	H	34.709	8.542	37.125	42.687	64	-21.313	Ave
7236	51.740	340	124	H	35.618	10.391	36.461	61.288	84	-22.712	Peak
7236	39.586	340	124	H	35.618	10.391	36.461	49.134	64	-14.866	Ave
Middle Channel 2437 MHz											
4874	47.590	255	286	H	34.709	8.562	37.027	53.834	84	-30.166	Peak
4874	37.568	255	286	H	34.709	8.562	37.027	43.812	64	-20.188	Ave
7311	49.110	349	184	H	35.618	10.565	36.454	58.839	84	-25.161	Peak
7311	38.293	349	184	H	35.618	10.565	36.454	48.022	64	-15.978	Ave
High Channel 2462 MHz											
2483.5	78.120	39	150	H	32.665	6.099	38.075	78.809	84	-5.191	Peak
2483.5	62.923	39	150	H	32.665	6.099	38.075	63.612	64	-0.388	Ave
4924	46.880	318	225	H	34.709	8.720	37.027	53.282	84	-30.718	Peak
4924	37.265	318	225	H	34.709	8.720	37.027	43.667	64	-20.333	Ave
7386	47.250	317	163	H	35.618	10.750	36.496	57.122	84	-26.878	Peak
7386	36.622	317	163	H	35.618	10.750	36.496	46.494	64	-17.506	Ave

802.11n20 mode

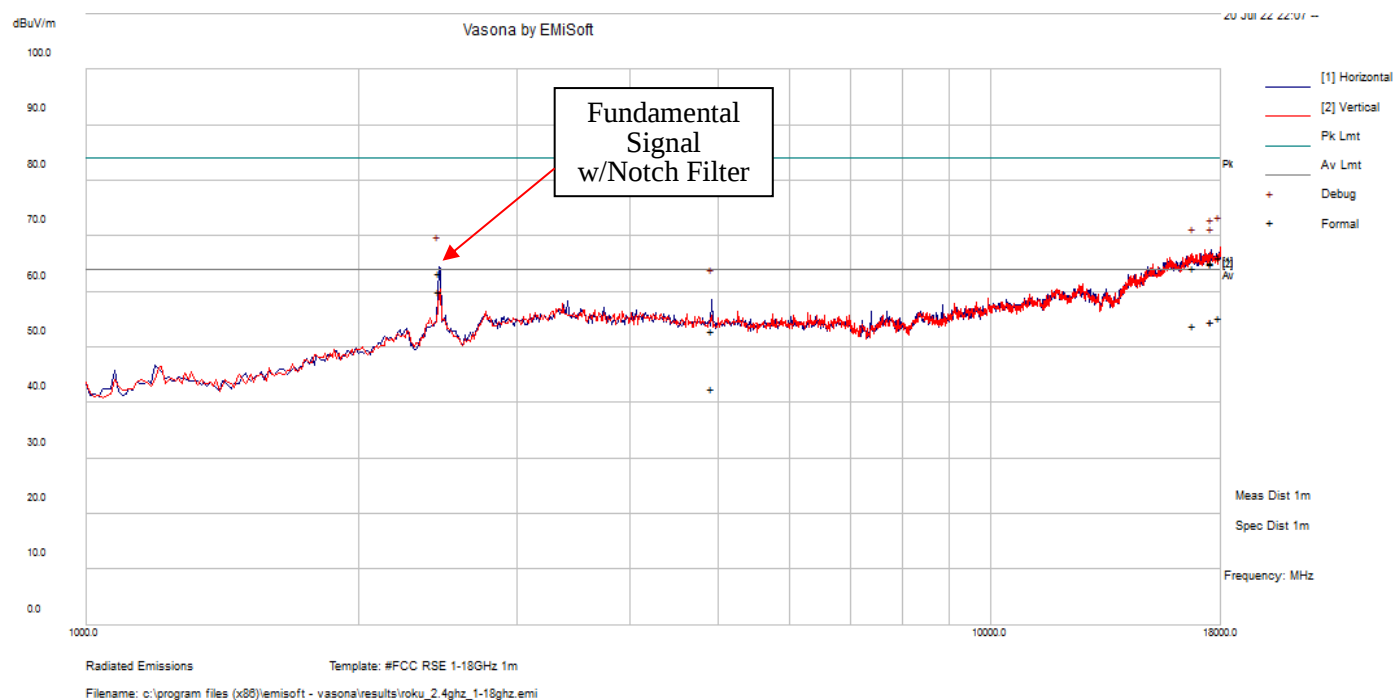
Frequency (MHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre- Amp. (dB)	Cord. Reading (dBμV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBμV/m)	Margin (dB)	
Low Channel 2412 MHz											
2390	75.440	62	150	H	32.228	6.011	38.154	75.525	84	-8.475	Peak
2390	62.951	62	150	H	32.228	6.011	38.154	63.036	64	-0.964	Ave
4824	47.880	214	149	H	34.709	8.542	37.125	54.006	84	-29.994	Peak
4824	37.106	214	149	H	34.709	8.542	37.125	43.232	64	-20.768	Ave
7236	48.240	350	199	H	35.618	10.391	36.461	57.788	84	-26.212	Peak
7236	37.848	350	199	H	35.618	10.391	36.461	47.396	64	-16.604	Ave
Middle Channel 2437 MHz											
4874	54.360	47	162	H	34.709	8.562	37.027	60.604	84	-23.396	Peak
4874	43.159	47	162	H	34.709	8.562	37.027	49.403	64	-14.597	Ave
7311	48.300	321	143	H	35.618	10.565	36.454	58.029	84	-25.971	Peak
7311	37.585	321	143	H	35.618	10.565	36.454	47.314	64	-16.686	Ave
High Channel 2462 MHz											
2483.5	76.780	61	145	H	32.665	6.099	38.075	77.469	84	-6.531	Peak
2483.5	61.433	61	145	H	32.665	6.099	38.075	62.122	64	-1.878	Ave
4924	59.240	296	210	H	34.709	8.720	37.027	65.642	84	-18.358	Peak
4924	47.371	296	210	H	34.709	8.720	37.027	53.773	64	-10.227	Ave
7386	59.930	317	172	H	35.618	10.750	36.496	69.802	84	-14.198	Peak
7386	47.911	317	172	H	35.618	10.750	36.496	57.783	64	-6.217	Ave

802.11n40 mode

Frequency (MHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre- Amp. (dB)	Cord. Reading (dBμV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBμV/m)	Margin (dB)	
Low Channel 2422 MHz											
2390	75.450	43	150	H	32.228	6.011	38.066	75.623	84	-8.377	Peak
2390	62.706	43	150	H	32.228	6.011	38.066	62.879	64	-1.121	Ave
4844	49.090	309	150	H	34.709	8.536	37.125	55.210	84	-28.790	Peak
4844	38.695	309	150	H	34.709	8.536	37.125	44.815	64	-19.185	Ave
7266	49.050	353	150	H	35.618	10.444	36.454	58.658	84	-25.342	Peak
7266	37.993	353	150	H	35.618	10.444	36.454	47.601	64	-16.399	Ave
Middle Channel 2437 MHz											
4874	60.460	139	293	H	34.709	8.562	37.027	66.704	84	-17.296	Peak
4874	48.112	139	293	H	34.709	8.562	37.027	54.356	64	-9.644	Ave
7311	49.410	328	146	H	35.618	10.565	36.454	59.139	84	-24.861	Peak
7311	37.302	328	146	H	35.618	10.565	36.454	47.031	64	-16.969	Ave
High Channel 2452 MHz											
2483.5	72.430	43	145	H	32.665	6.099	38.075	73.119	84	-10.881	Peak
2483.5	61.351	43	145	H	32.665	6.099	38.075	62.040	64	-1.960	Ave
4924	59.670	96	265	H	34.709	8.671	37.027	66.023	84	-17.977	Peak
4924	47.972	96	265	H	34.709	8.671	37.027	54.325	64	-9.675	Ave
7386	60.380	130	287	H	35.618	10.619	36.496	70.121	84	-13.879	Peak
7386	48.202	130	287	H	35.618	10.619	36.496	57.943	64	-6.057	Ave

3)1 GHz – 18 GHz Worst Case Scan at 1 Meter

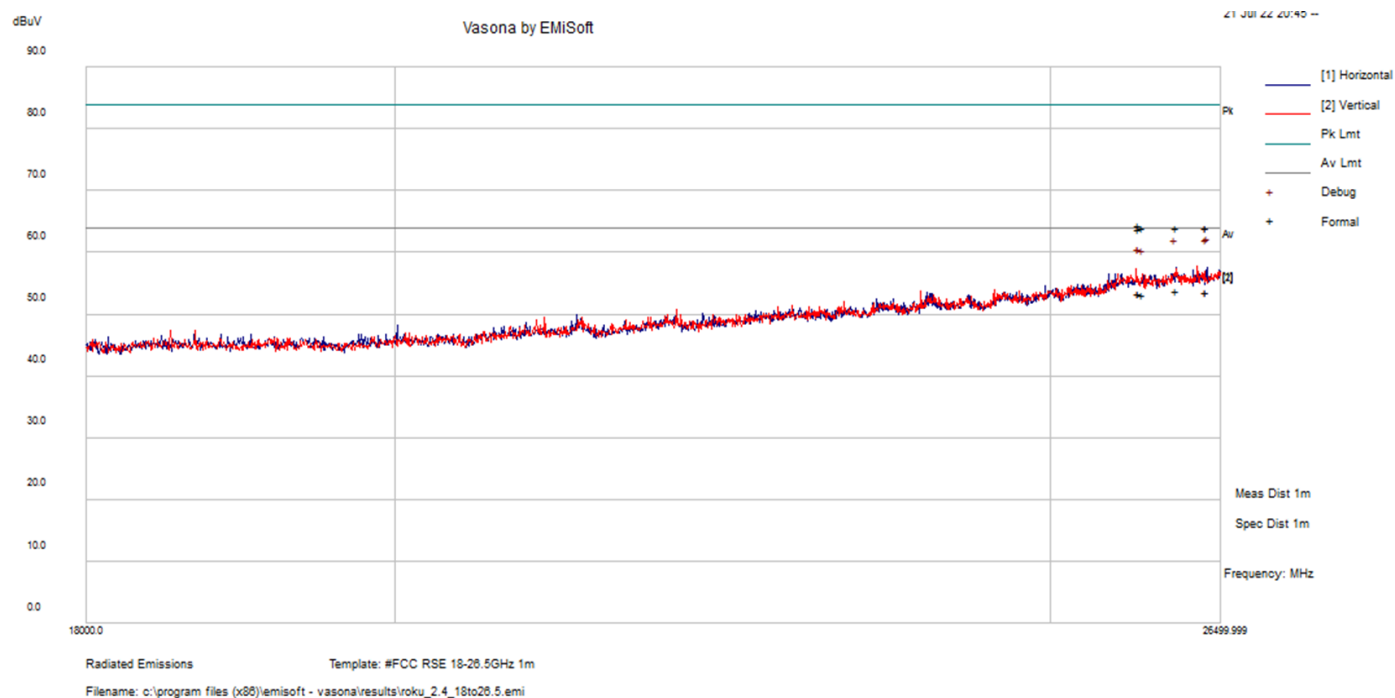
Worst Case: 2437 MHz, b mode



Frequency (MHz)	S.A. Reading (dBμV)	Correction Factor (dB/m)	Corrected Amplitude (dBμV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Comment
17956.93	47.02	19.16	66.18	232	V	132	84	-17.82	Peak
17956.93	36.22	19.16	55.38	232	V	132	64	-8.62	Avg

4) 18 GHz – 26.5 GHz Worst Case Scan at 1 Meter

Worst Case: 2437 MHz, b mode



Frequency (MHz)	S.A. Reading (dBμV)	Correction Factor (dB/m)	Corrected Amplitude (dBμV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Comment
26375.855	41.11	23	64.11	187	V	240	84	-19.89	Peak
26375.855	30.67	23	53.67	187	V	240	64	-10.33	Avg

8 FCC §15.247(a) (2) & ISEDC RSS-247 §5.2, RSS-Gen §6.7 - Emission Bandwidth

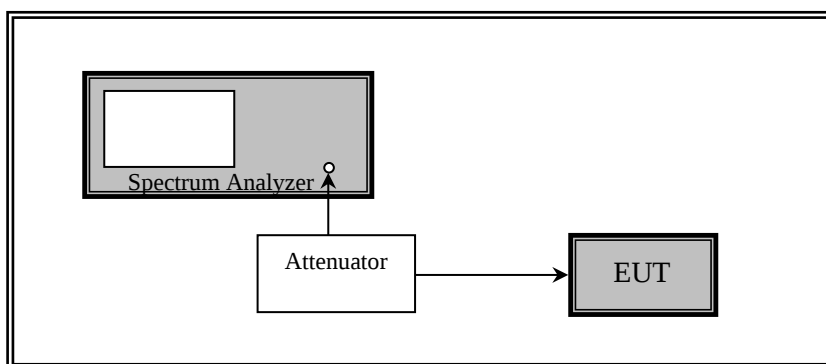
8.1 Applicable Standards

According to FCC §15.247(a) (2) and ISEDC RSS-247 §5.2: the minimum 6 dB bandwidth shall be 500 kHz.

8.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 8: DTS bandwidth.

8.3 Test Setup Block Diagram



8.4 Test Equipment List and Details

BACL Number	Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
287	Agilent	Signal Analyzer	E4446A	US44300386	2022-05-05	1 year
655	Rohde & Schwarz	Signal Analyzer	FSQ26	200749	2022-02-07	2 years
-	-	20dB attenuator	-	-	Each time ¹	N/A
-	-	RF cable	-	-	Each time ¹	N/A

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: **BACL Corp.** attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 “A2LA Policy on Metrological Traceability”.

8.5 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

Testing was performed by Christian Schwartz from 2022-07-08 to 2022-07-28 at the RF site.

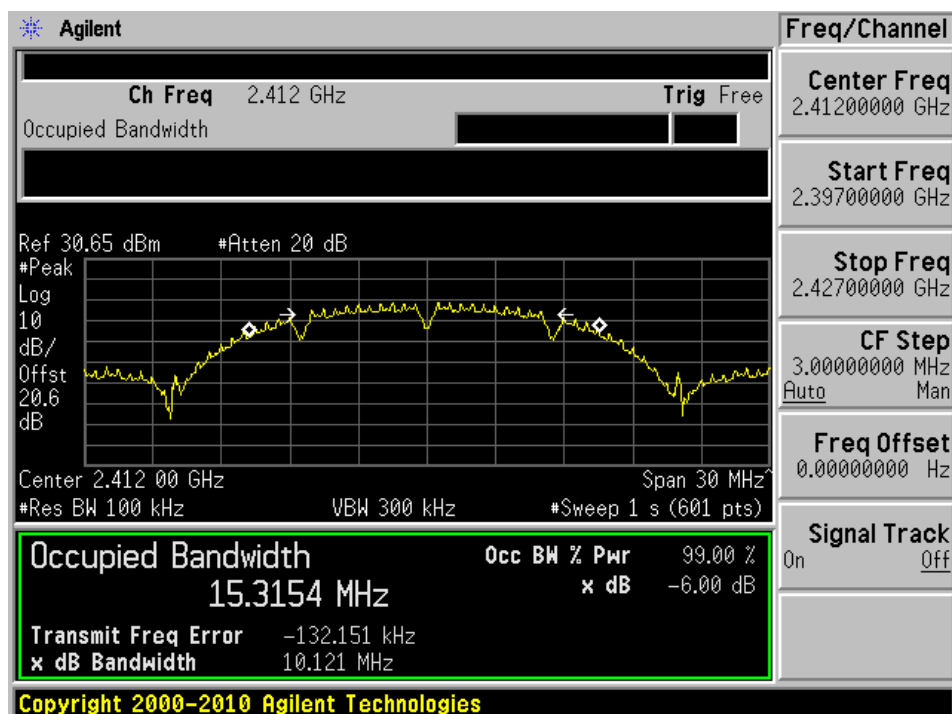
8.6 Test Results

Channel	Frequency (MHz)	6 dB OBW (MHz)	99% OBW (MHz)	6 dB OBW Limit (kHz)	Result
802.11b					
Low	2412	10.121	15.3631	≥500	Pass
Middle	2437	10.143	17.6787	≥500	Pass
High	2462	10.110	16.3989	≥500	Pass
802.11g					
Low	2412	16.366	16.6730	≥500	Pass
Middle	2437	16.336	21.8872	≥500	Pass
High	2462	16.345	17.6731	≥500	Pass
802.11n20					
Low	2412	17.272	17.6786	≥500	Pass
Middle	2437	16.316	21.6085	≥500	Pass
High	2462	16.958	17.7512	≥500	Pass
802.11n40					
Low	2422	35.490	36.3026	≥500	Pass
Middle	2437	35.649	43.6538	≥500	Pass
High	2452	35.391	36.1493	≥500	Pass

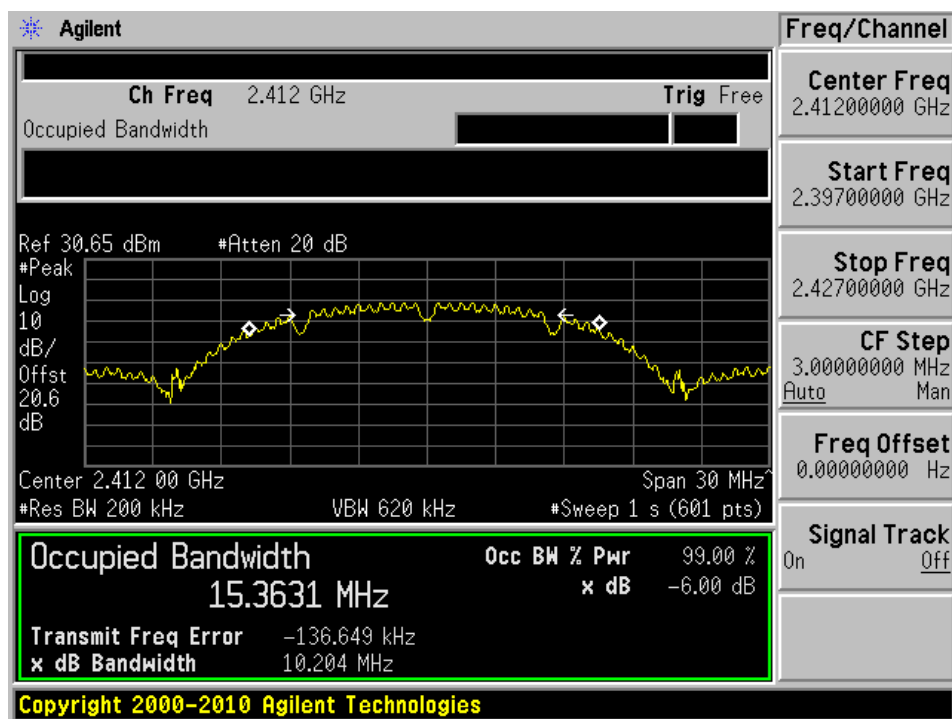
Please refer to the following plots for detailed test results:

802.11b mode

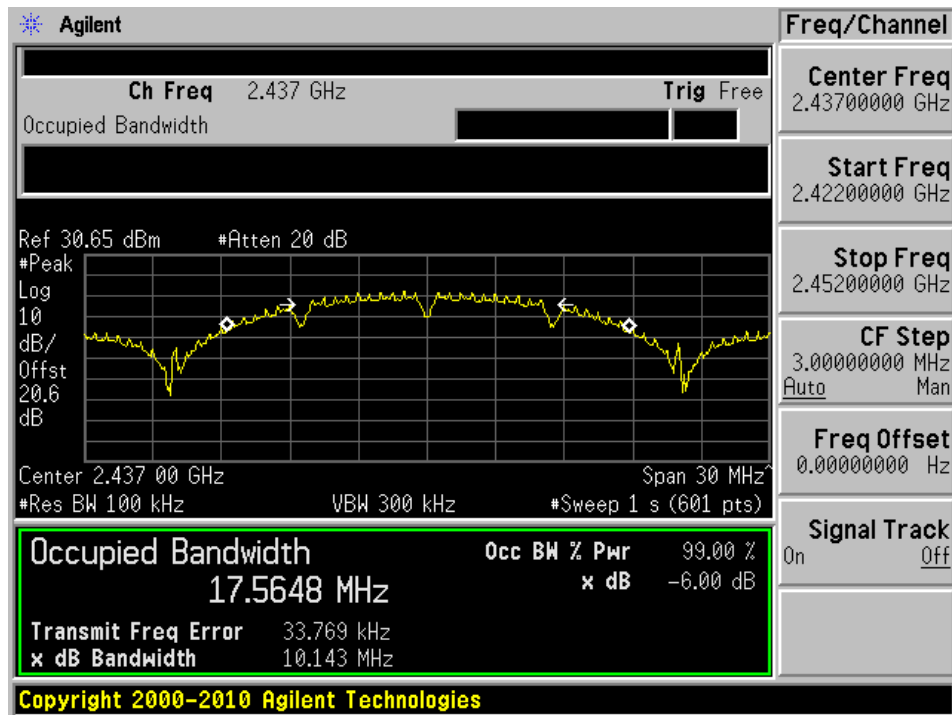
Low Channel 6 dB OBW



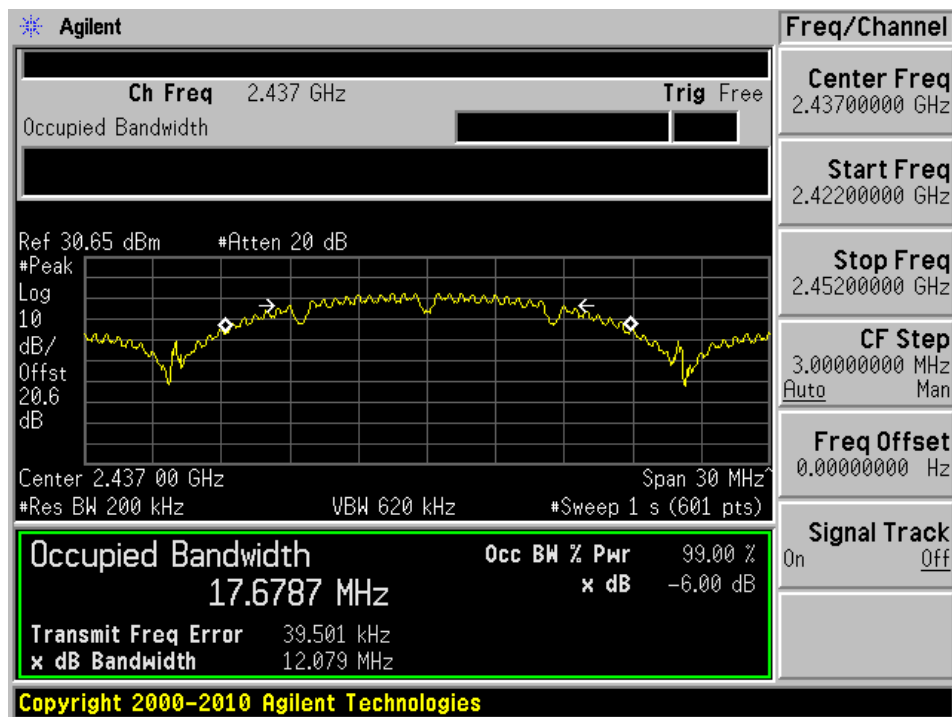
Low Channel 99% OBW



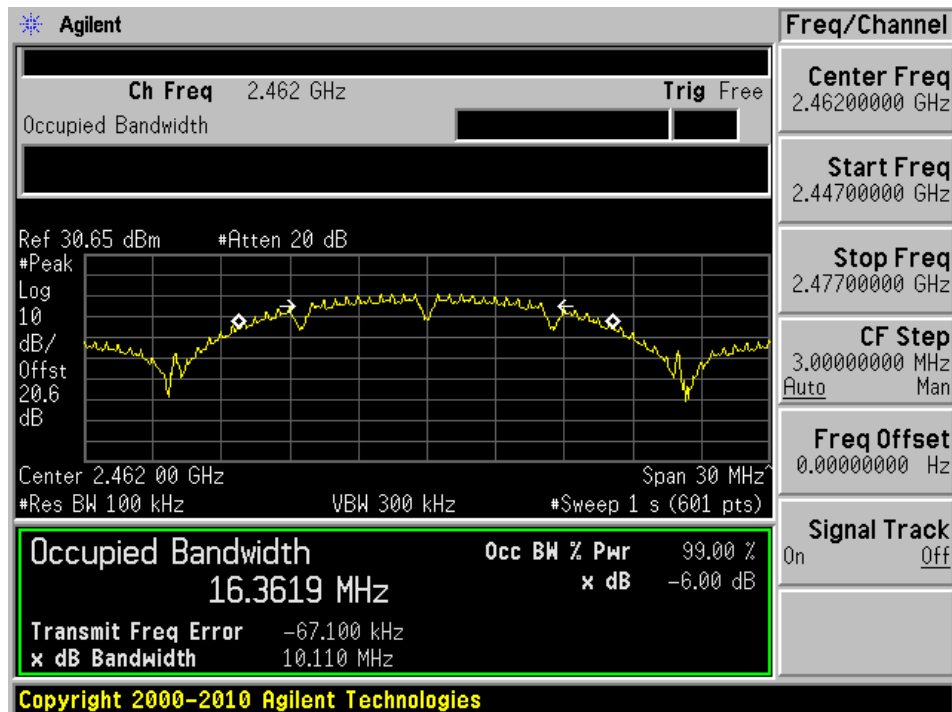
Mid Channel 6 dB OBW



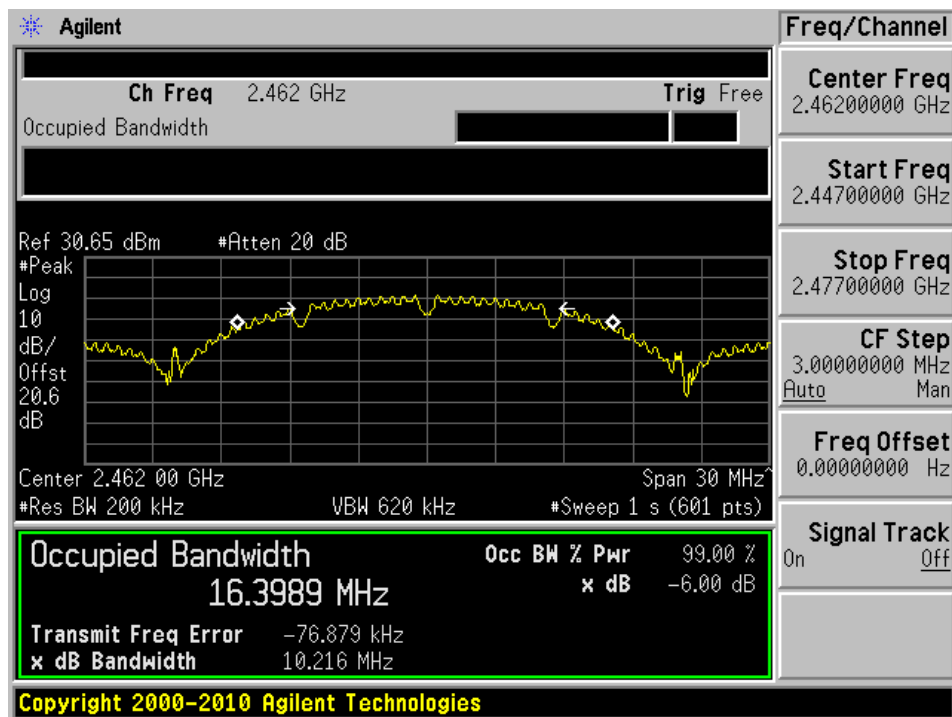
Mid Channel 99% OBW



High Channel 6 dB OBW

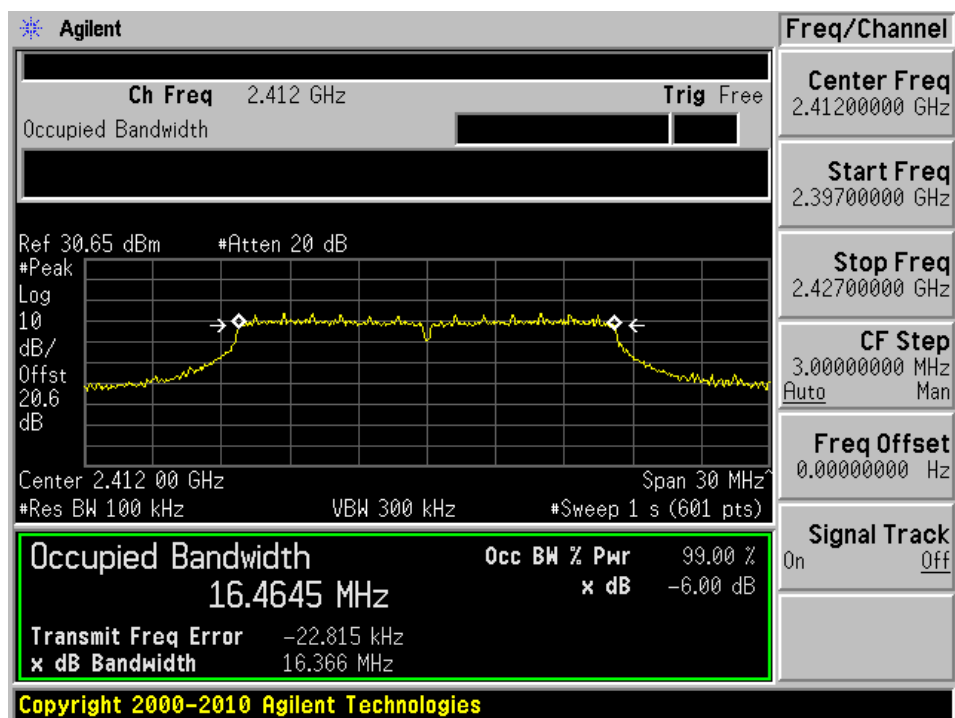


High Channel 99% OBW

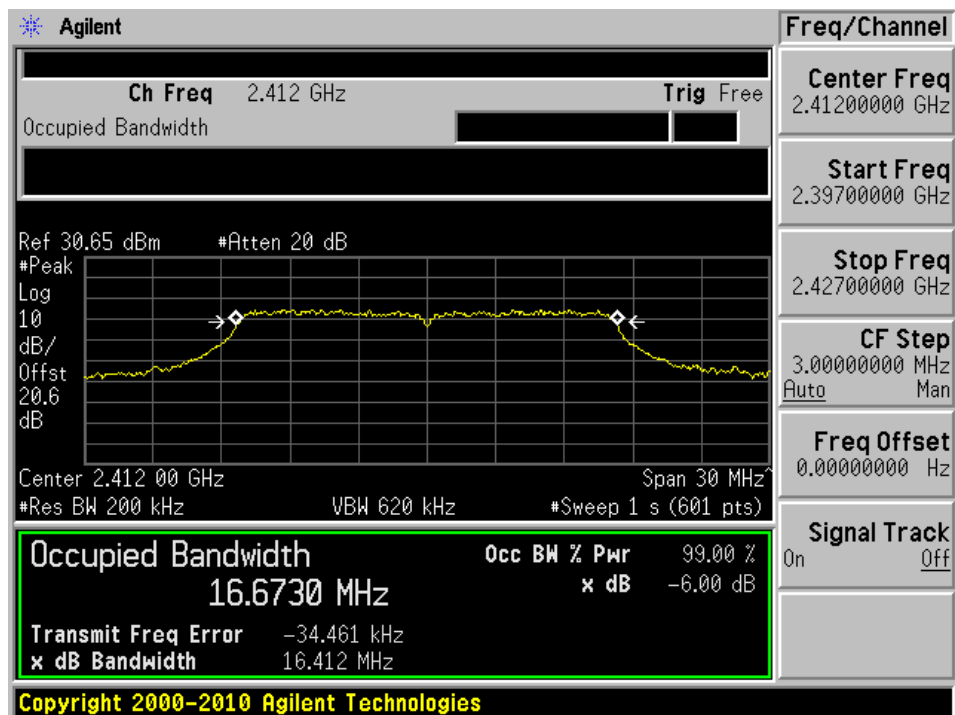


802.11g mode

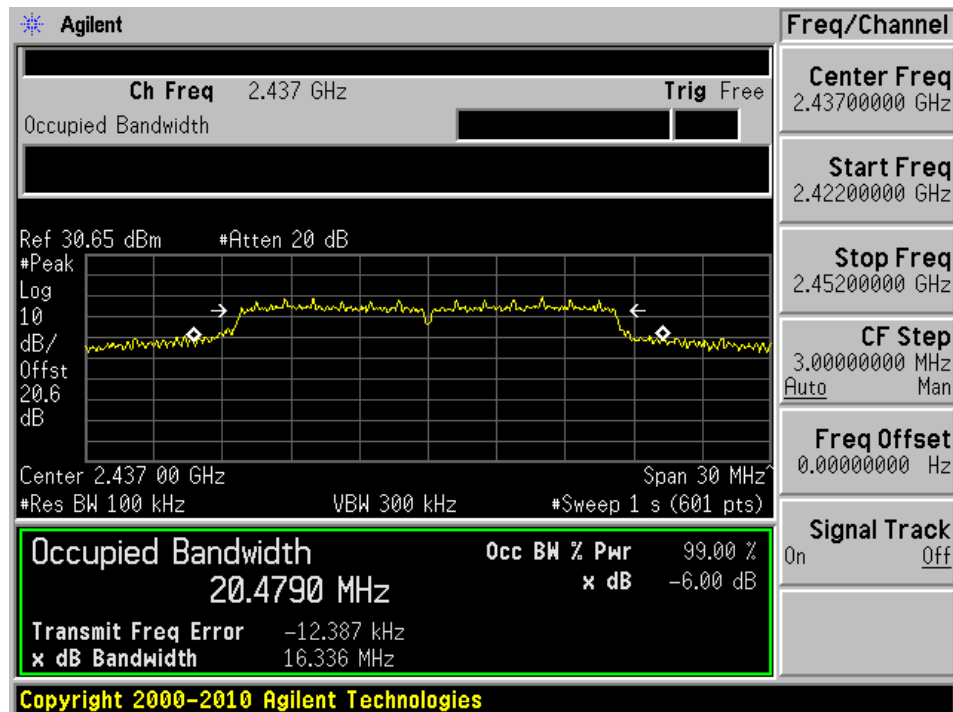
Low Channel 6 dB OBW



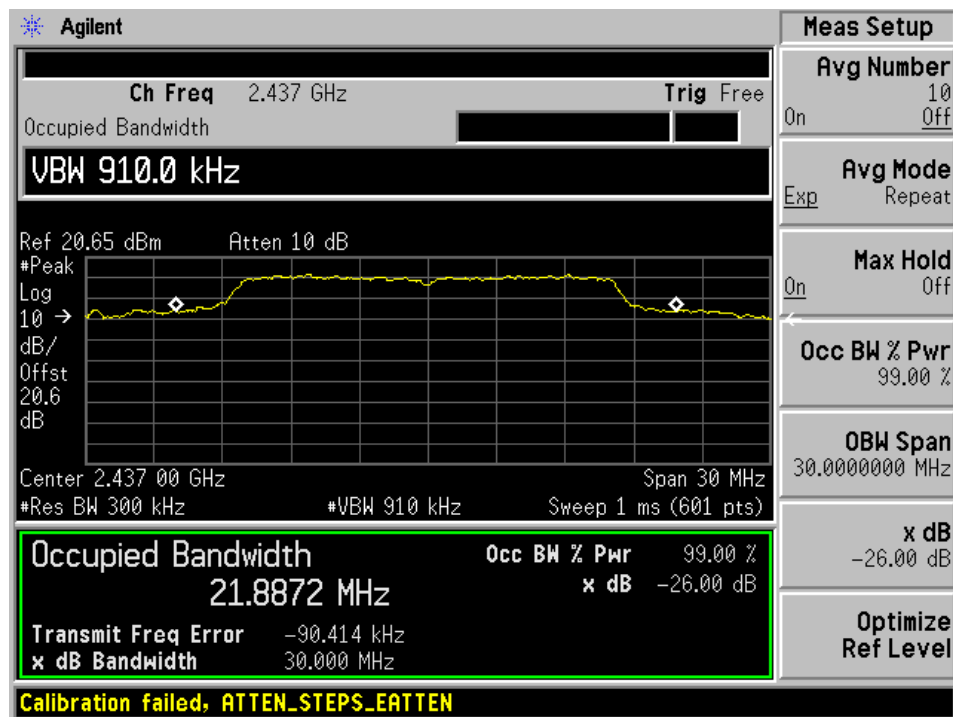
Low Channel 99% OBW



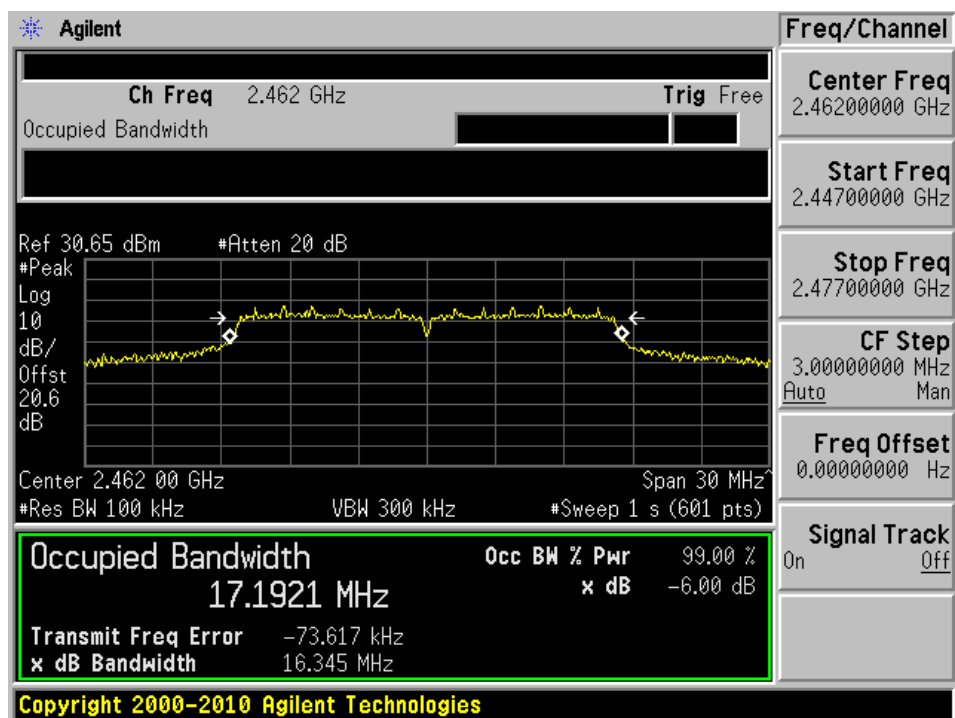
Mid Channel 6 dB OBW



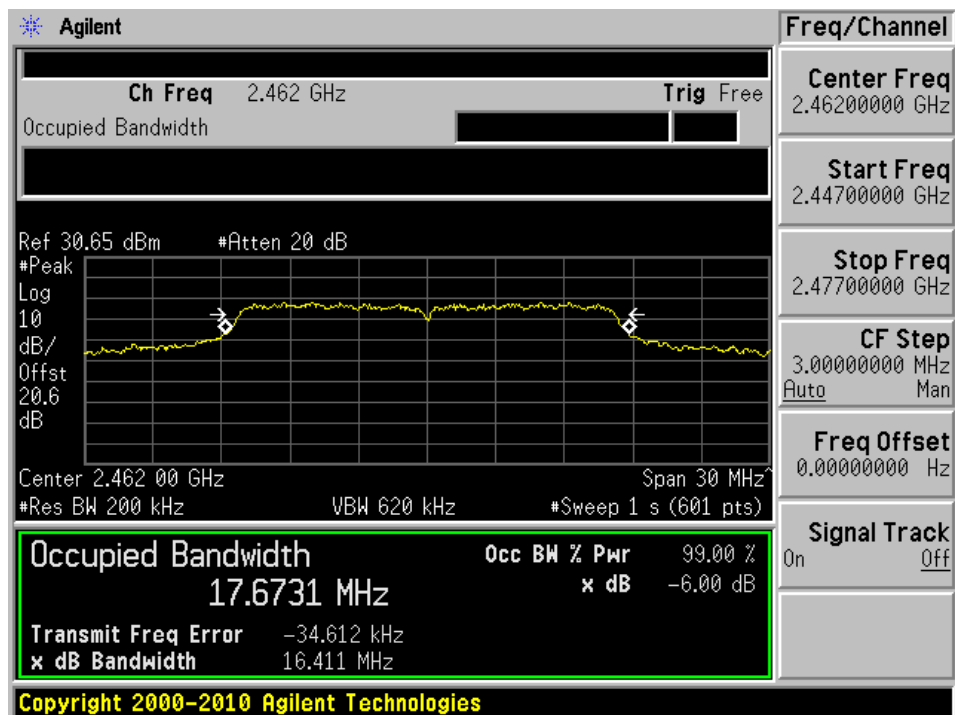
Mid Channel 99% OBW



High Channel 6 dB OBW

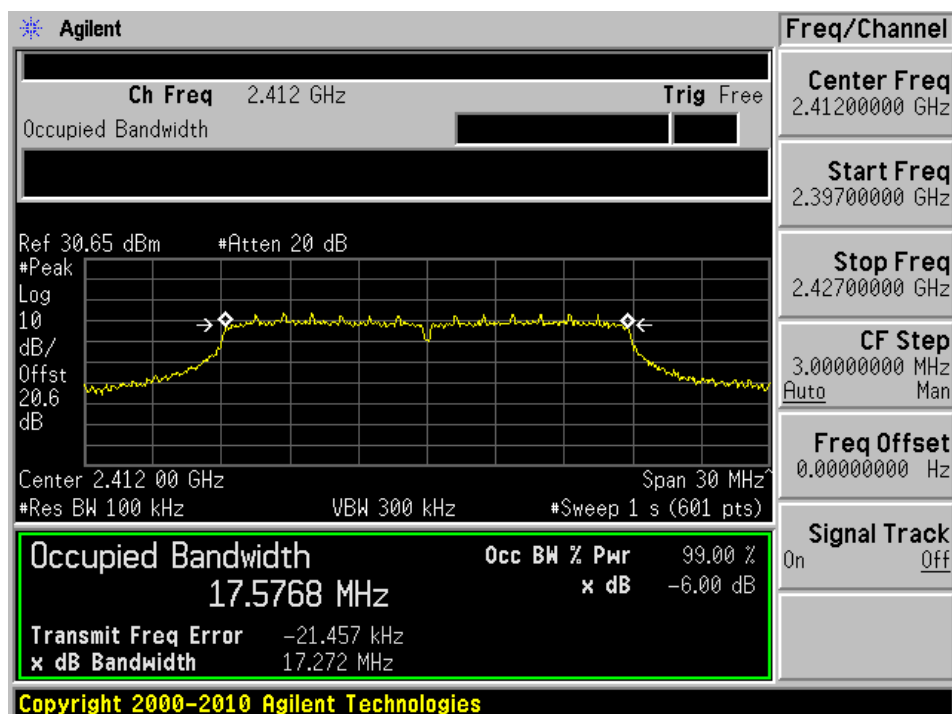


High Channel 99% OBW

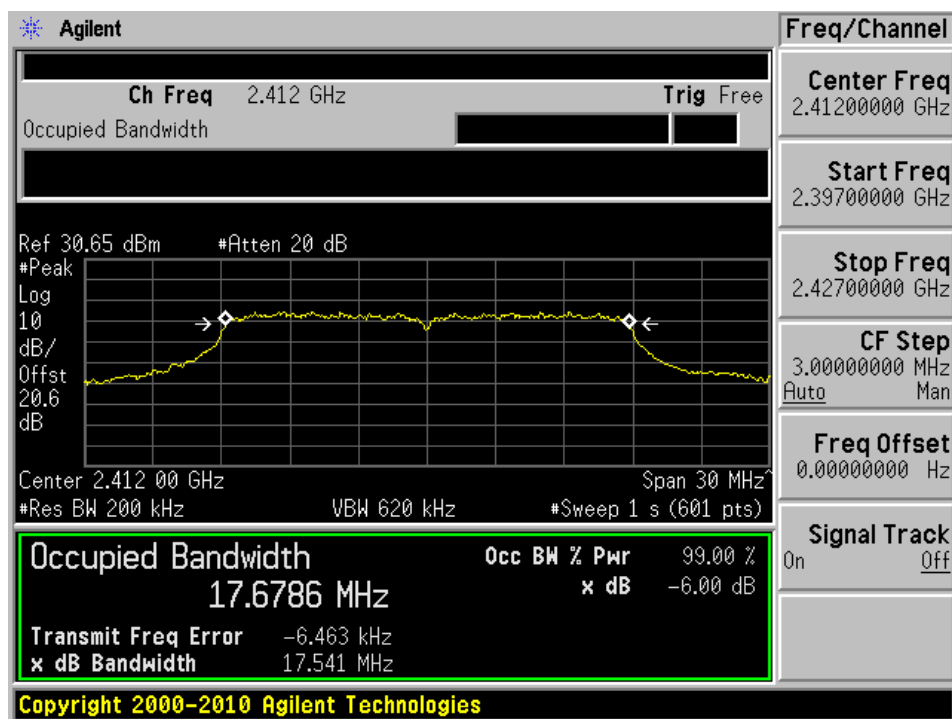


802.11n20 mode

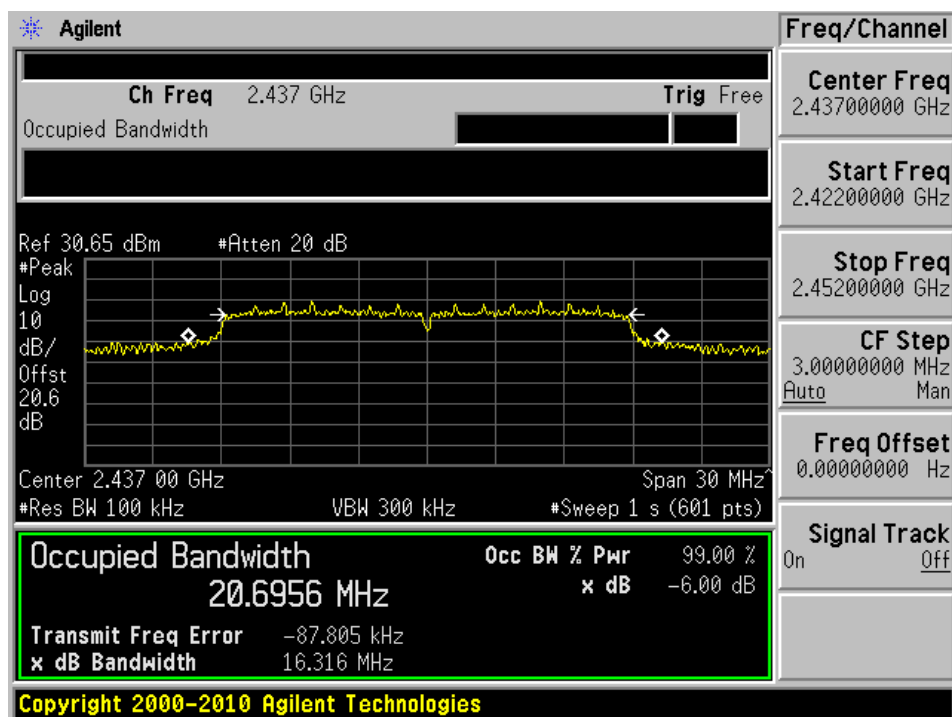
Low Channel 6 dB OBW



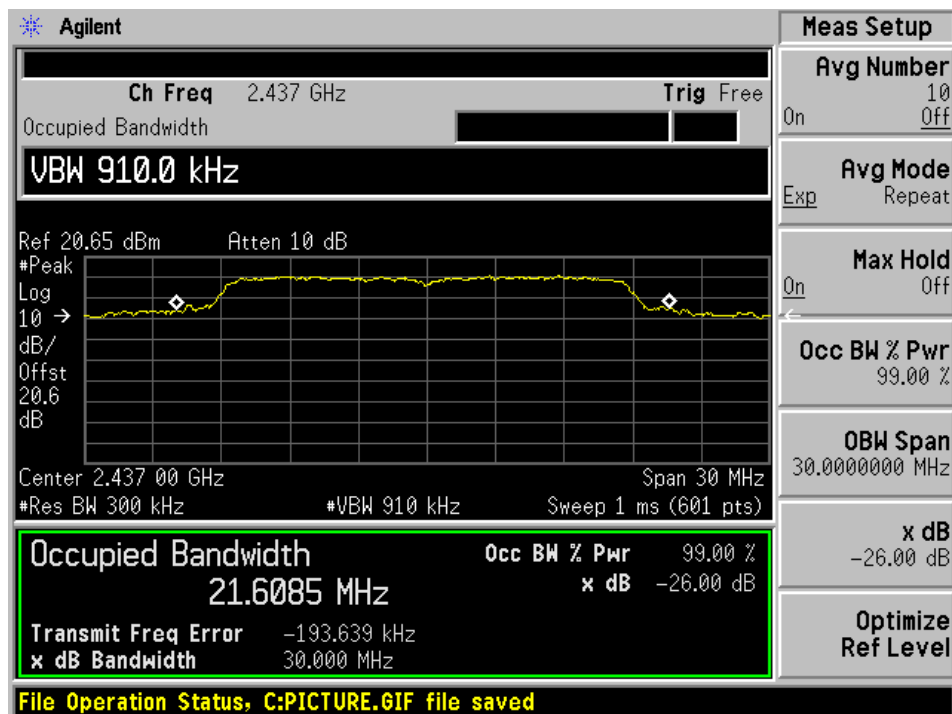
Low Channel 99% OBW



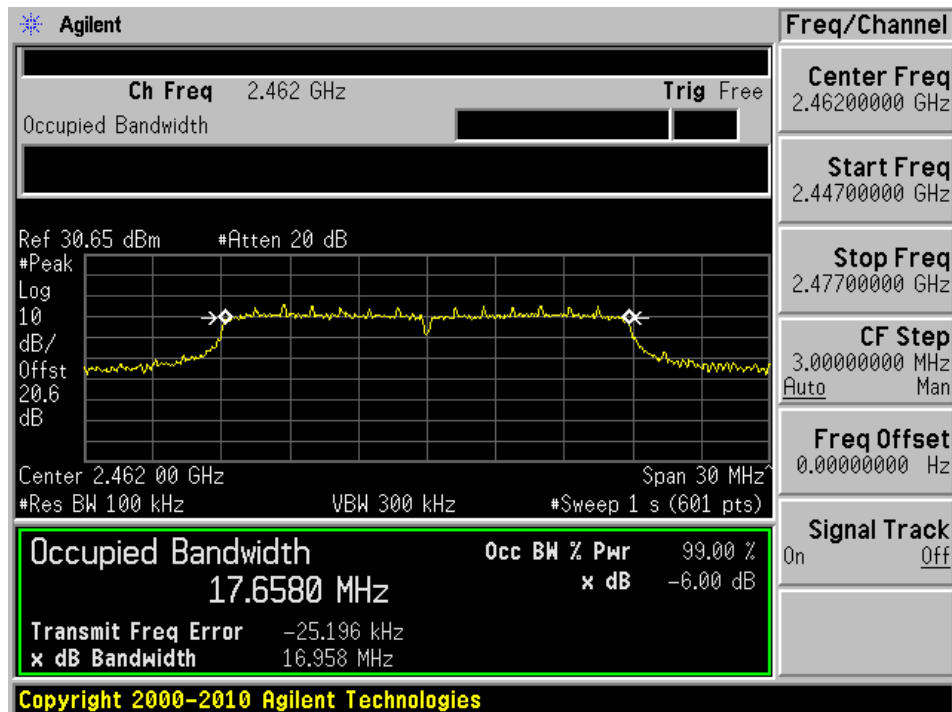
Mid Channel 6 dB OBW



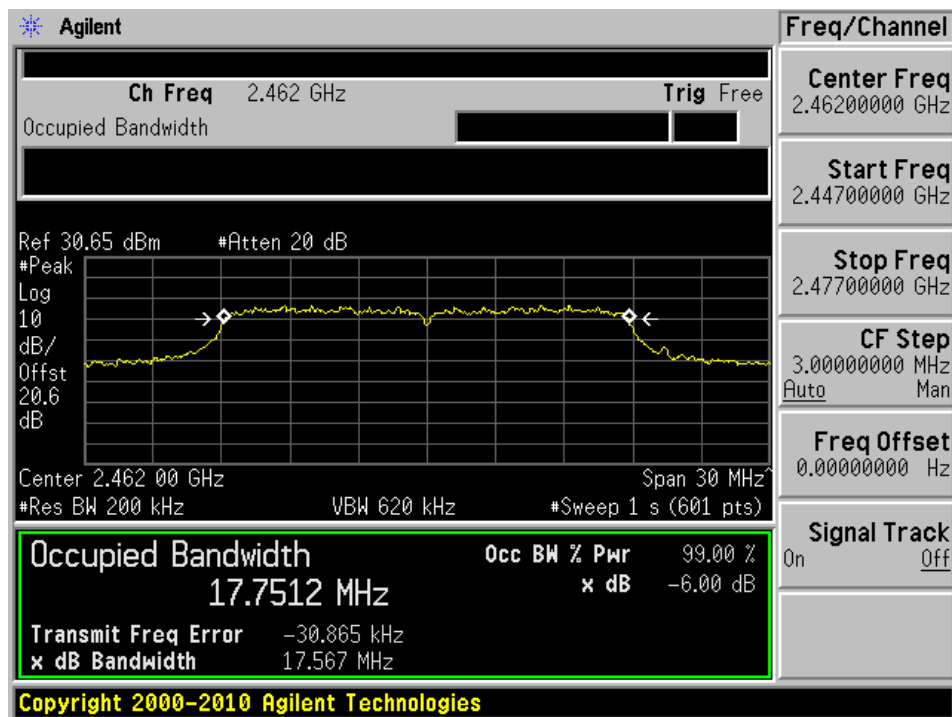
Mid Channel 99% OBW



High Channel 6 dB OBW

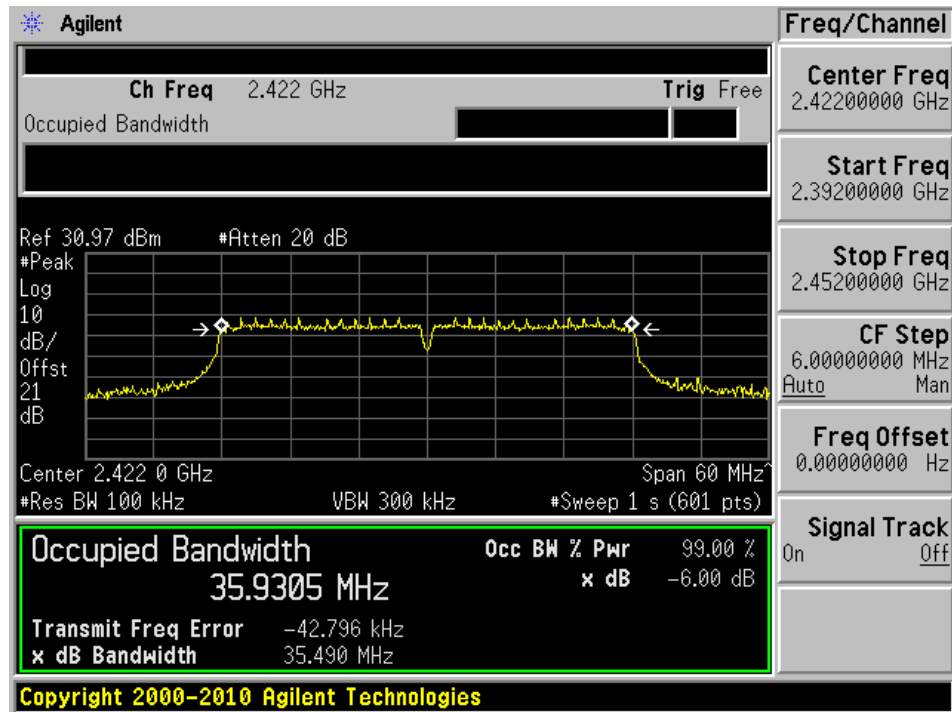


High Channel 99% OBW

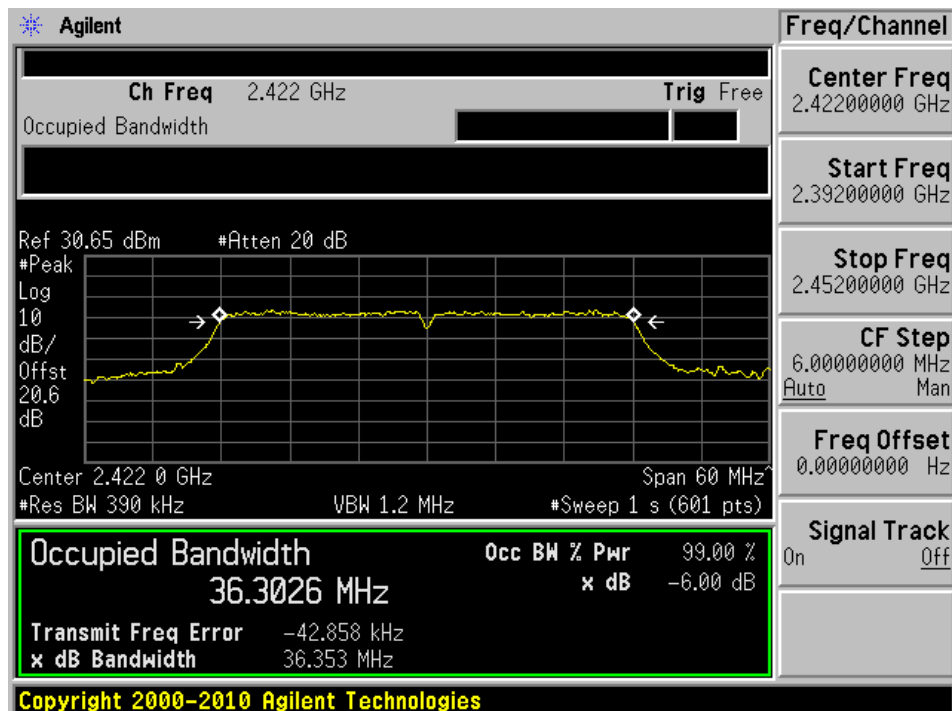


802.11n40 mode

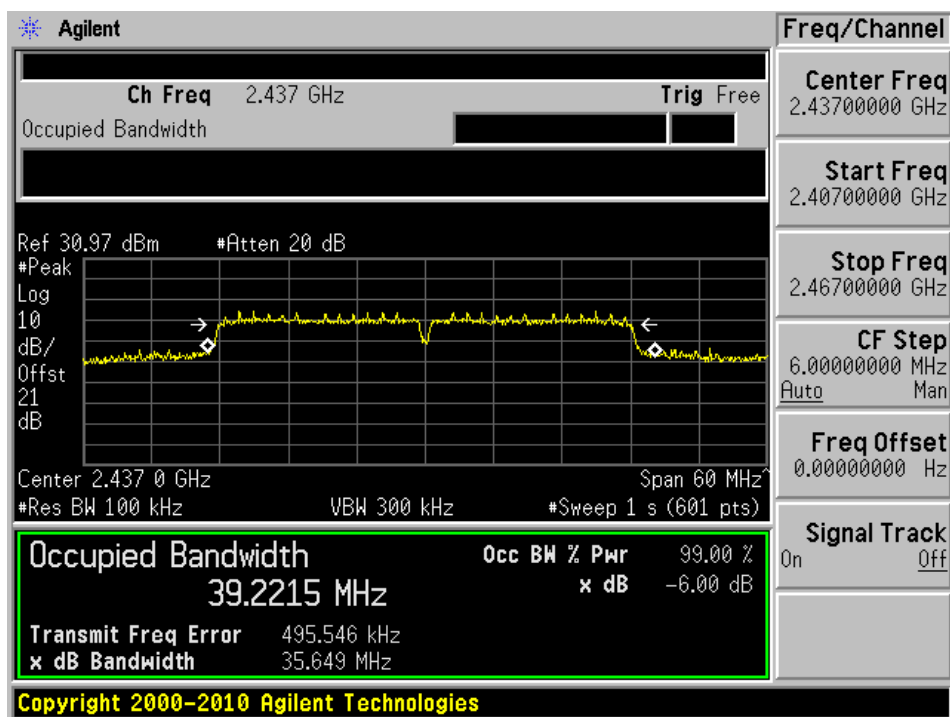
Low Channel 6 dB OBW



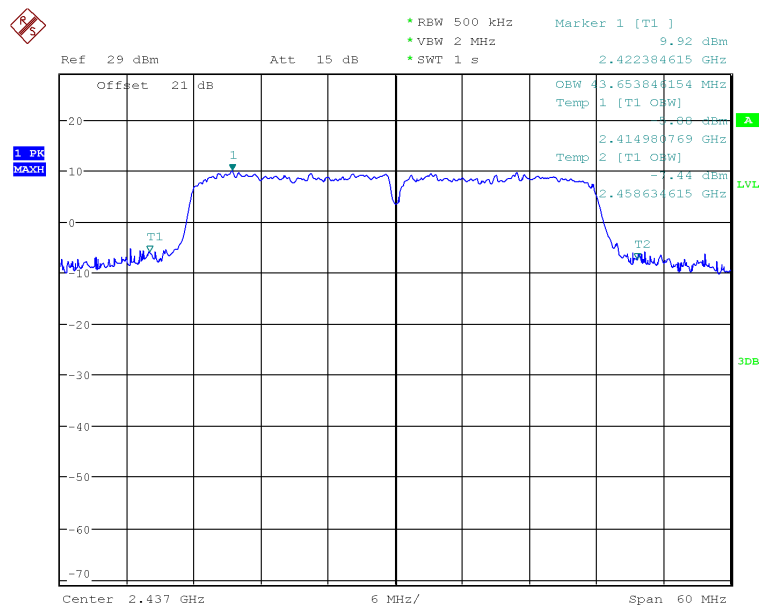
Low Channel 99% OBW



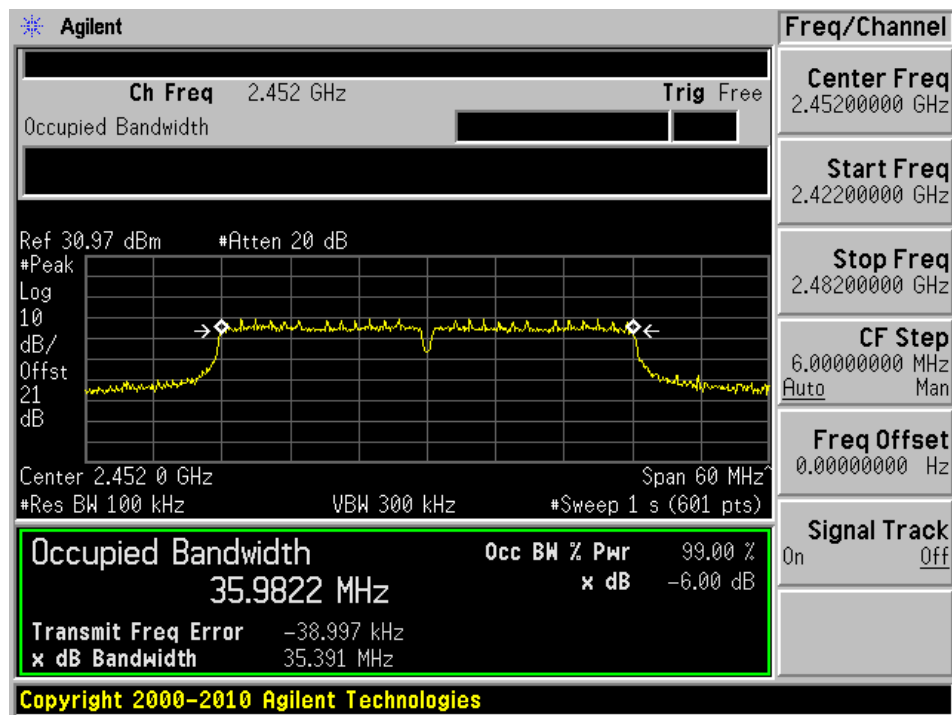
Mid Channel 6 dB OBW



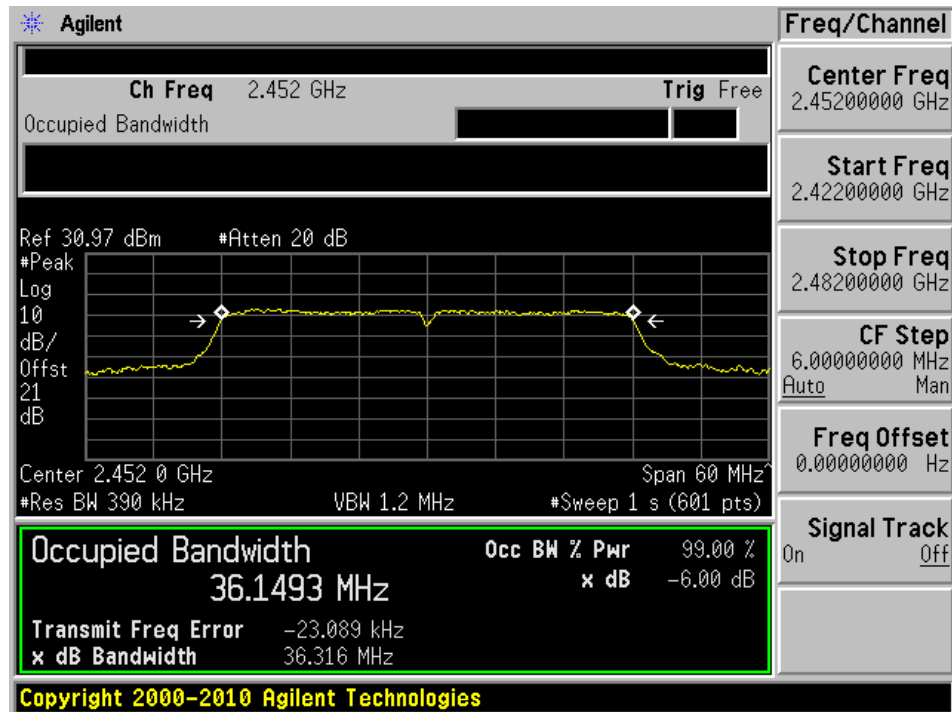
Mid Channel 99% OBW



High Channel 6 dB OBW



High Channel 99% OBW



9 FCC §15.247(b) (3) & ISEDC RSS-247 §5.4 - Maximum Output Power

9.1 Applicable Standards

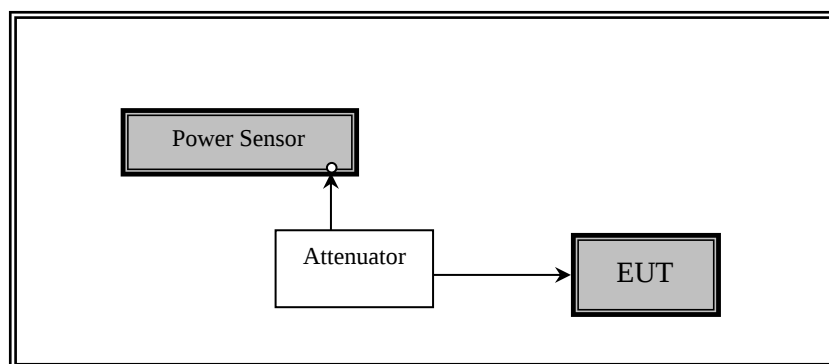
According to FCC §15.247(b) (3): For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted 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.

According to RSS-247 §5.4: 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).

9.2 Measurement Procedure

The measurements are based on ANSI C63.10-2013, Section 11.9.2.2.2.

9.3 Test Setup Block Diagram



9.4 Test Equipment List and Details

BACL Number	Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
-	-	20dB attenuator	-	-	Each time ¹	N/A
-	-	RF cable	-	-	Each time ¹	N/A
697	ETS- Lindgren	Power Sensor	7002-006	160097	2021-02-12	2 years

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: **BACL Corp.** attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".

9.5 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

Testing was performed by Christian Schwartz from 2022-07-08 to 2022-07-28 at the RF site.

9.6 Test Results

Channel	Frequency (MHz)	Conducted Output Power (dBm)	Output Power Limit (dBm)	Result
802.11b				
Low	2412	17.74	30	Pass
Middle	2437	21.49	30	Pass
High	2462	20.35	30	Pass
802.11g				
Low	2412	14.81	30	Pass
Middle	2437	19.22	30	Pass
High	2462	17.5	30	Pass
802.11n20				
Low	2412	14.31	30	Pass
Middle	2437	19.21	30	Pass
High	2462	16.11	30	Pass
802.11n40				
Low	2422	13.92	30	Pass
Middle	2437	19.08	30	Pass
High	2462	14.56	30	Pass

Note: Duty Cycle correction factor has already been added to the measurement.

10 FCC §15.247(d) & ISEDC RSS-247 §5.5 - 100 kHz Bandwidth of Band Edges

10.1 Applicable Standards

According to FCC §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emissions limits specified in §15.209(a) see §15.205(c).

According to ISEDC RSS-247 §5.5. In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

10.2 Measurement Procedure

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation

RBW = 100 kHz

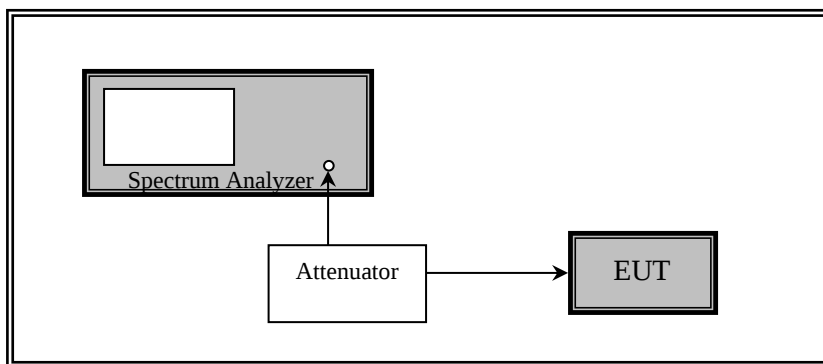
VBW = 300 kHz

Sweep = coupled

Detector function = peak

Trace = max hold

10.3 Test Setup Block Diagram



10.4 Test Equipment List and Details

BACL Number	Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
287	Agilent	Signal Analyzer	E4446A	US44300386	2022-05-05	1 year
-	-	20dB attenuator	-	-	Each time ¹	N/A
-	-	RF cable	-	-	Each time ¹	N/A

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: **BACL Corp.** attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".

10.5 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

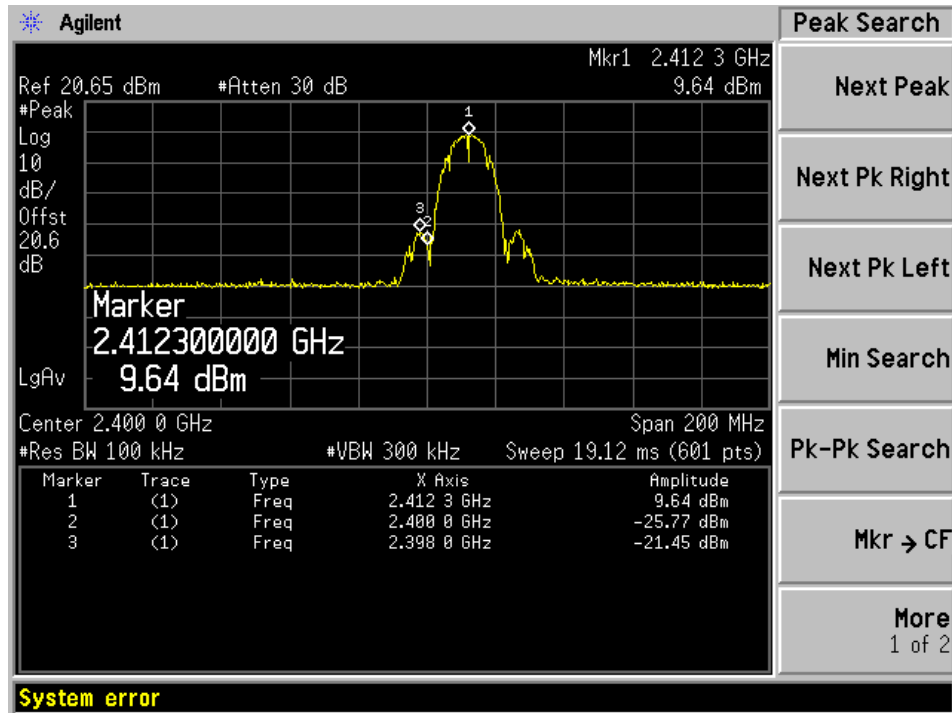
Testing was performed by Christian Schwartz from 2022-07-08 to 2022-07-28 at the RF site.

10.6 Test Results

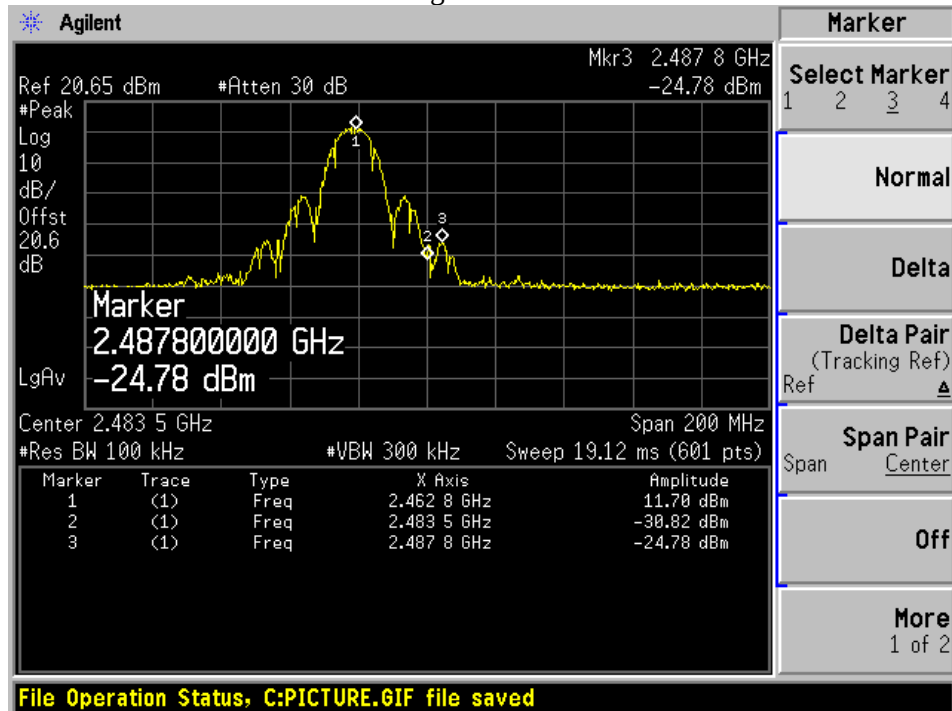
Please refer to the following plots for detailed test results

802.11 b mode

Low Channel

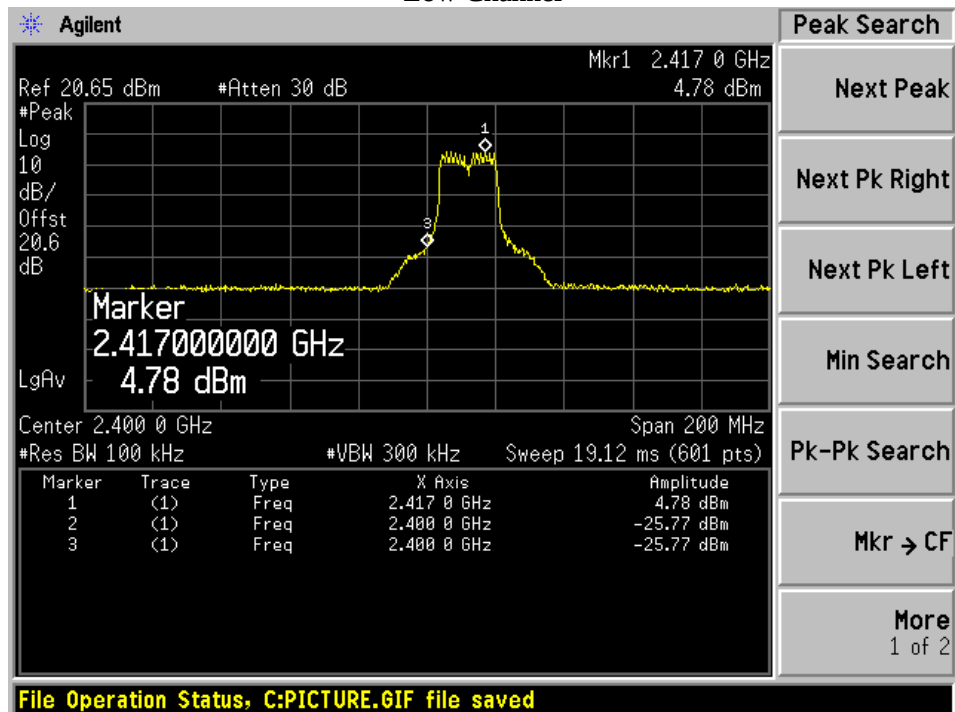


High Channel

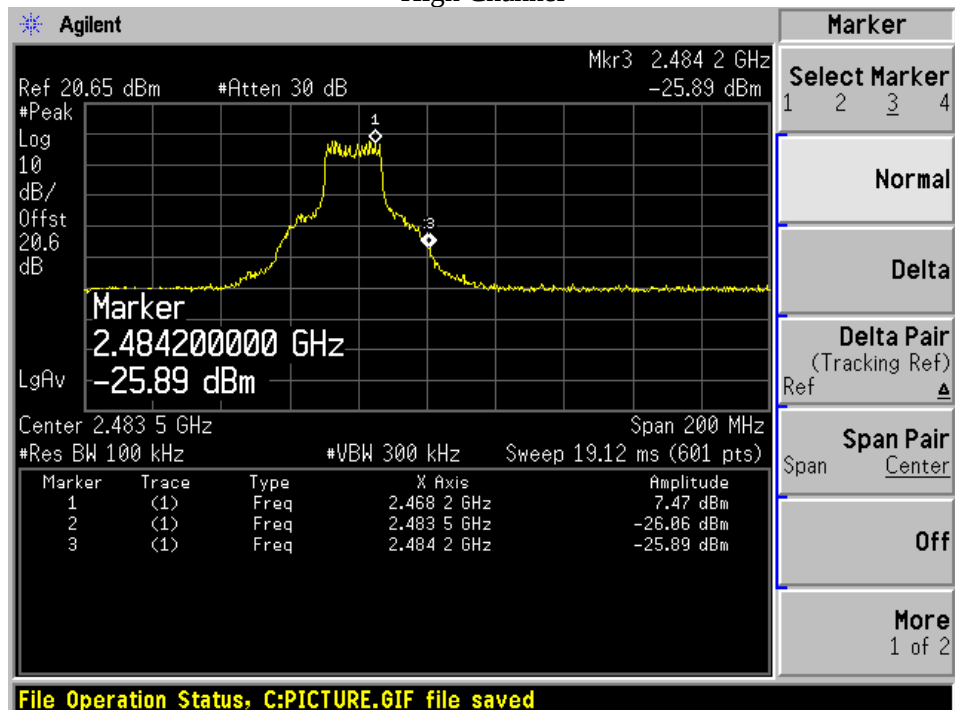


802.11g mode

Low Channel

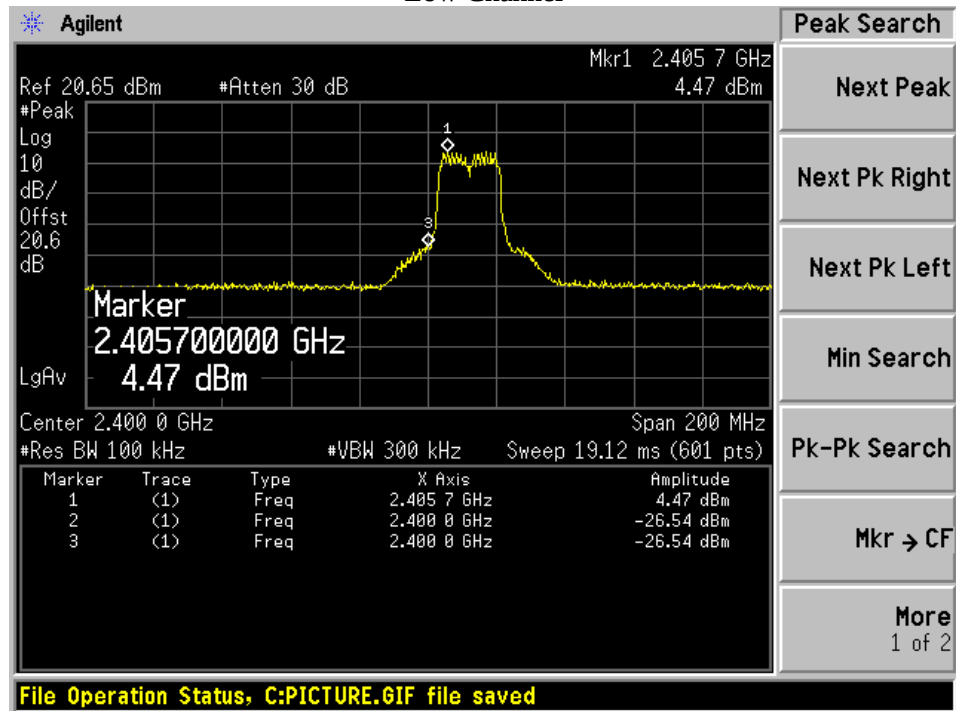


High Channel

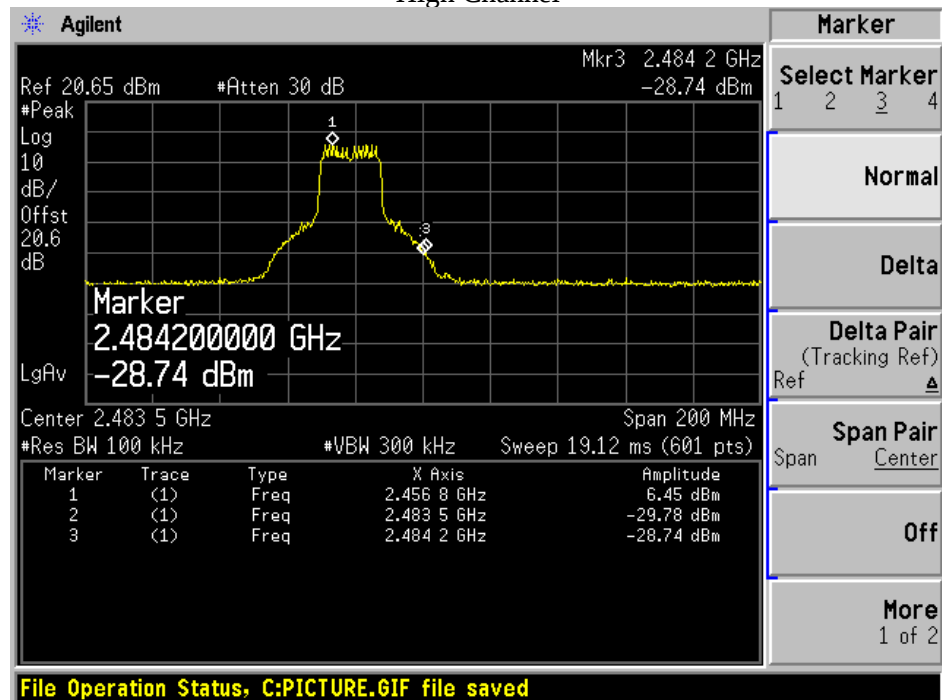


802.11n20 mode

Low Channel

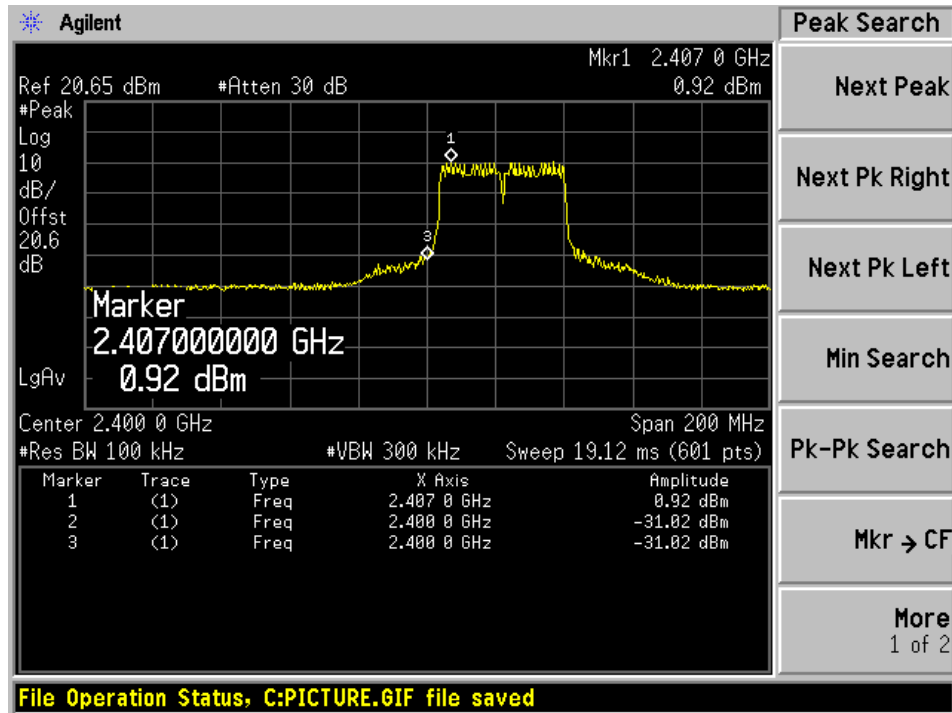


High Channel

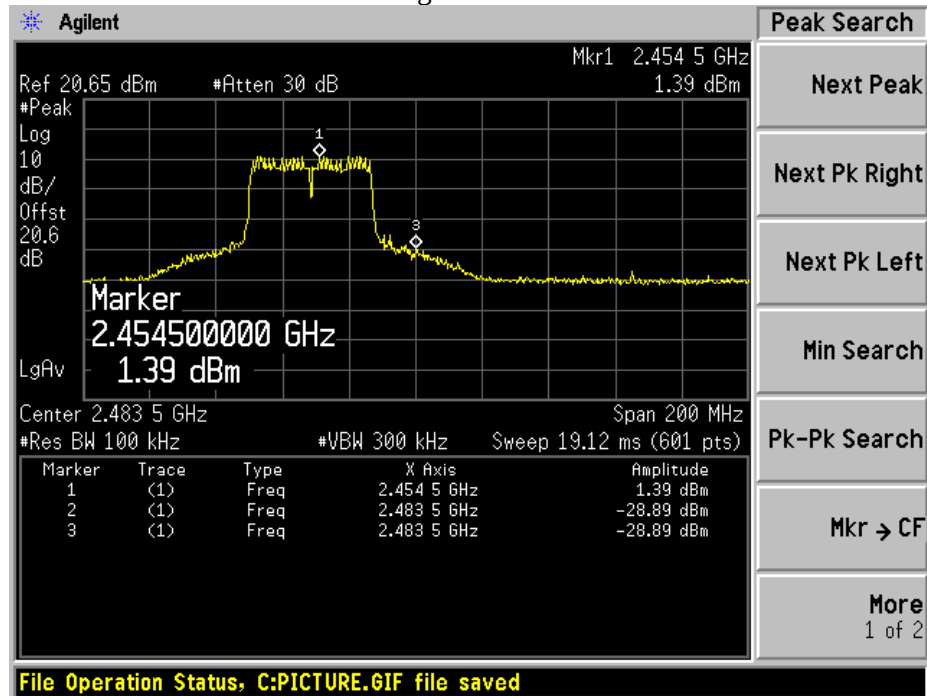


802.11n40 mode

Low Channel



High Channel



11 FCC §15.247(e) & ISEDC RSS-247 §5.2(2) – Peak Power Spectral Density

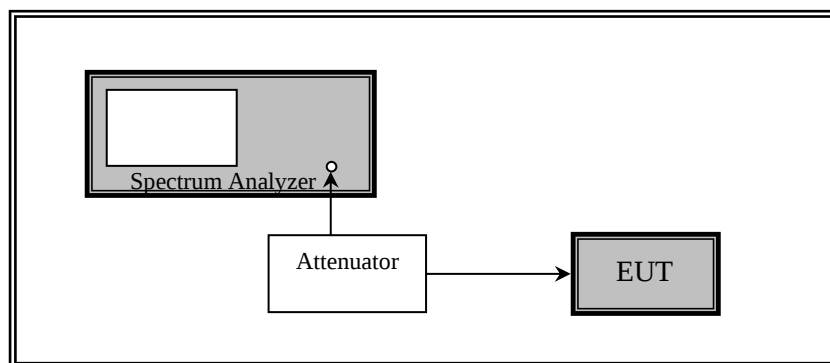
11.1 Applicable Standards

According to ECFR §15.247(e) and RSS-247 §5.2 (2) , for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

11.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 10: Maximum power spectral density level in the fundamental emission.

11.3 Test Setup Block Diagram



11.4 Test Equipment List and Details

BACL Number	Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
287	Agilent	Signal Analyzer	E4446A	US44300386	2022-05-05	1 year
-	-	20dB attenuator	-	-	Each time ¹	N/A
-	-	RF cable	-	-	Each time ¹	N/A

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: **BACL Corp.** attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".

11.5 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

Testing was performed by Christian Schwartz from 2022-07-08 to 2022-07-28 at the RF site.

11.6 Test Results

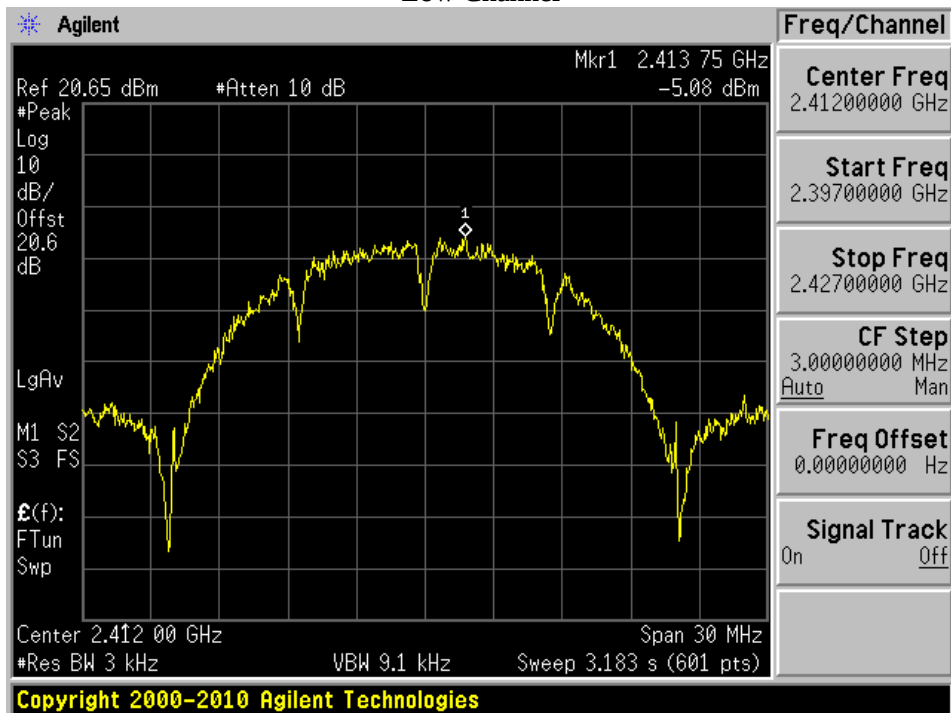
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Corrected PSD(dBm/3kHz)	Limit (dBm/3kHz)
802.11b mode				
Low	2412	-5.08	-5.08	8
Middle	2437	-1.8	-1.8	8
High	2462	-2.69	-2.69	8
802.11g mode				
Low	2412	-8.83	-8.53	8
Middle	2437	-6.01	-5.71	8
High	2462	-7.36	-7.06	8
802.11n20 mode				
Low	2412	-9.98	-9.65	8
Middle	2437	-6.17	-5.84	8
High	2462	-9.57	-9.24	8
802.11n40 mode				
Low	2422	-14.66	-13.7	8
Middle	2437	-8.49	-7.53	8
High	2452	-13.26	-12.3	8

*Note: Corrected PSD (dBm/3kHz) = PSD(dBm/3kHz) +10*log(1/x), where x is duty cycle

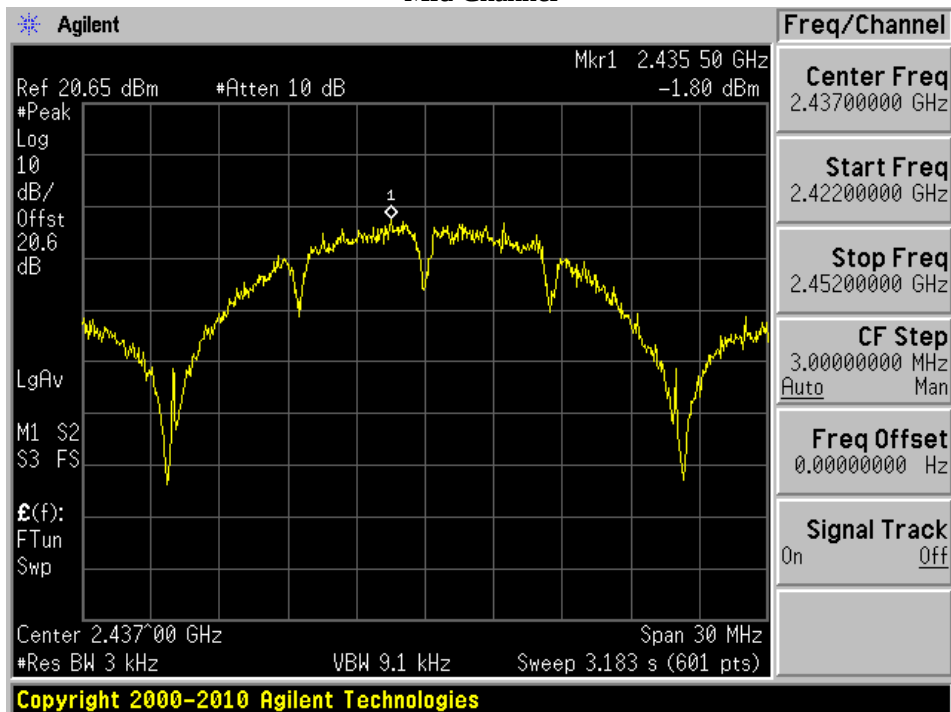
Please refer to the following plots for detailed test results

802.11b mode

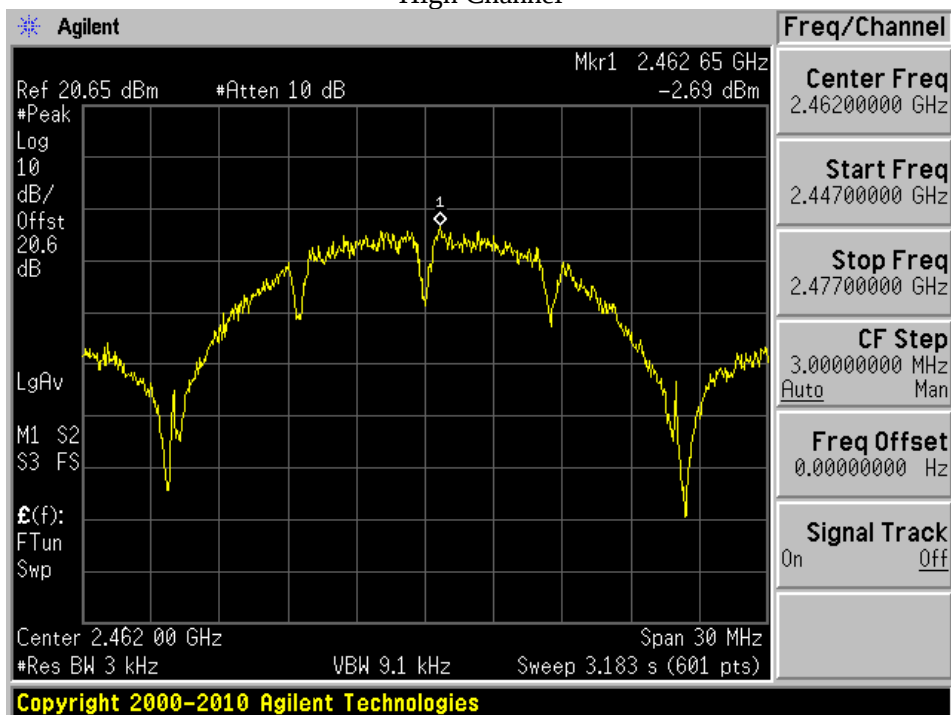
Low Channel



Mid Channel

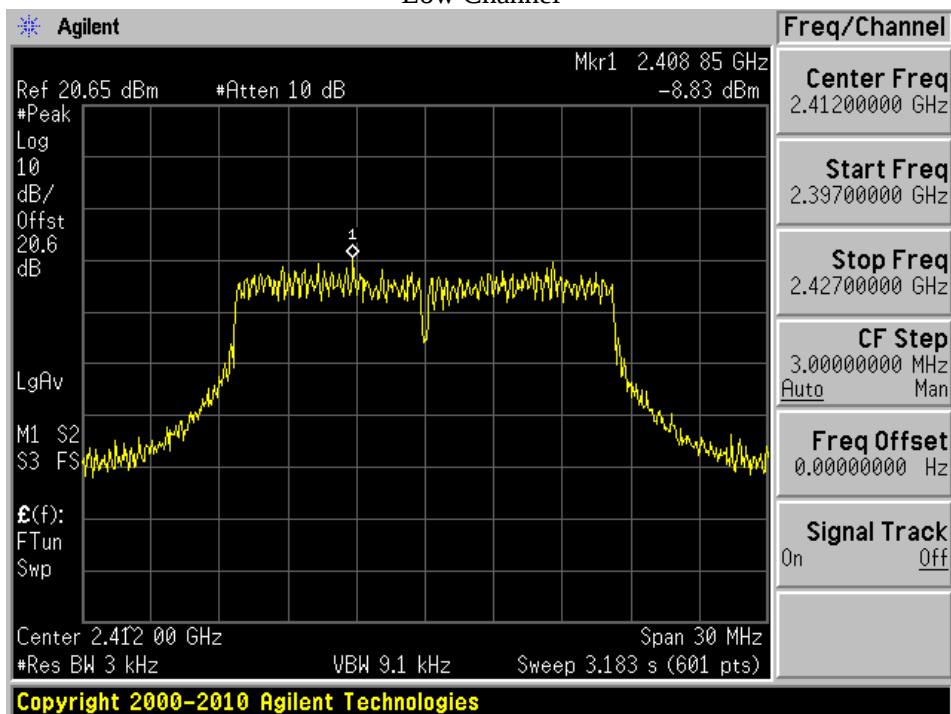


High Channel

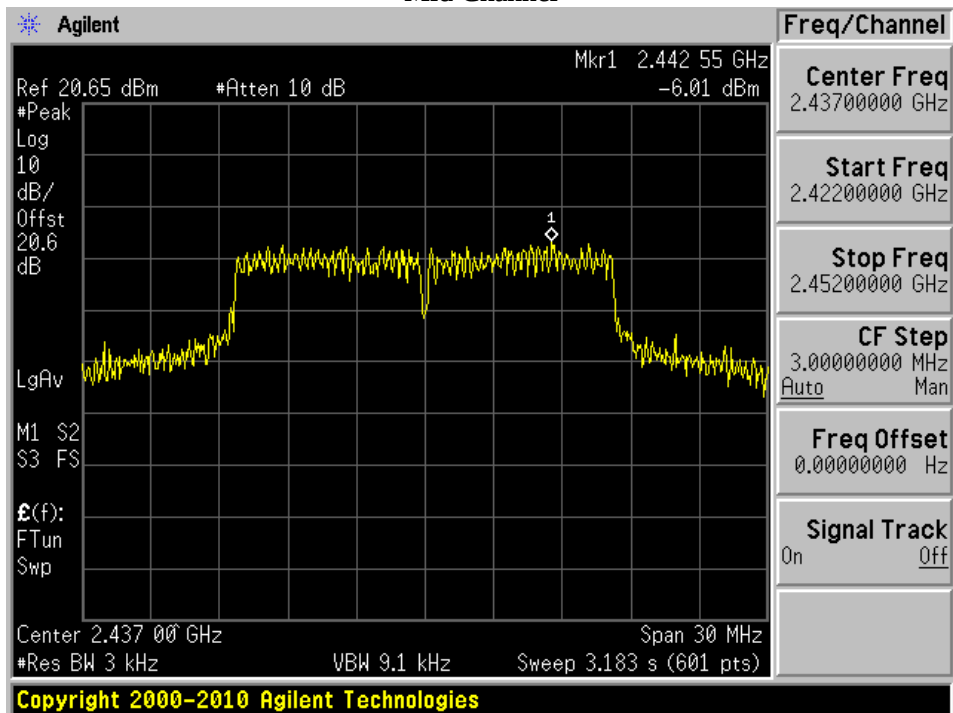


802.11g mode

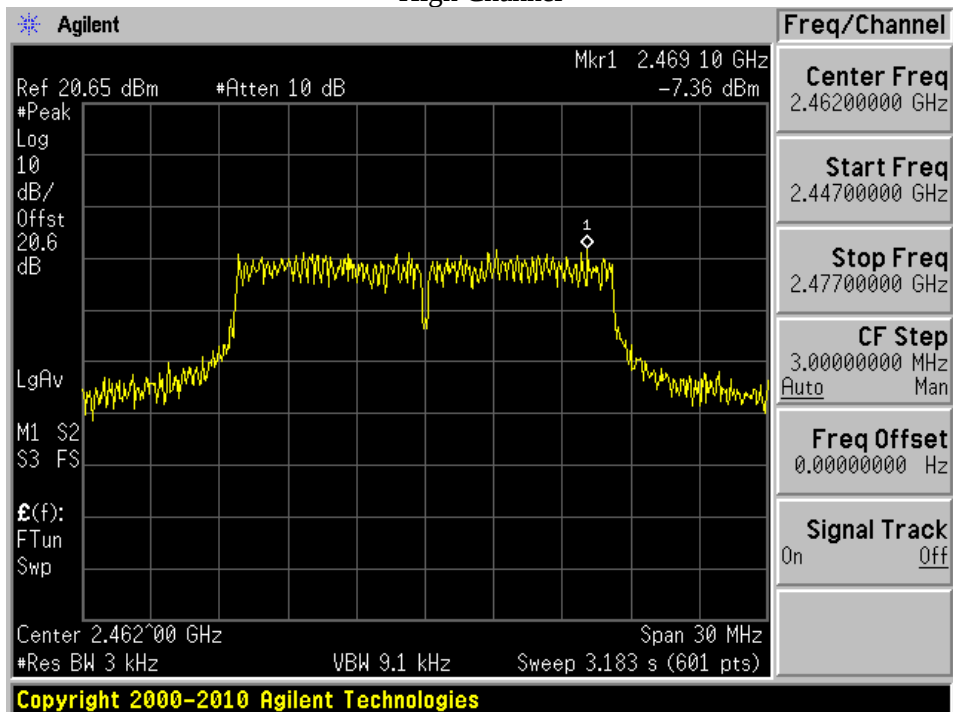
Low Channel



Mid Channel

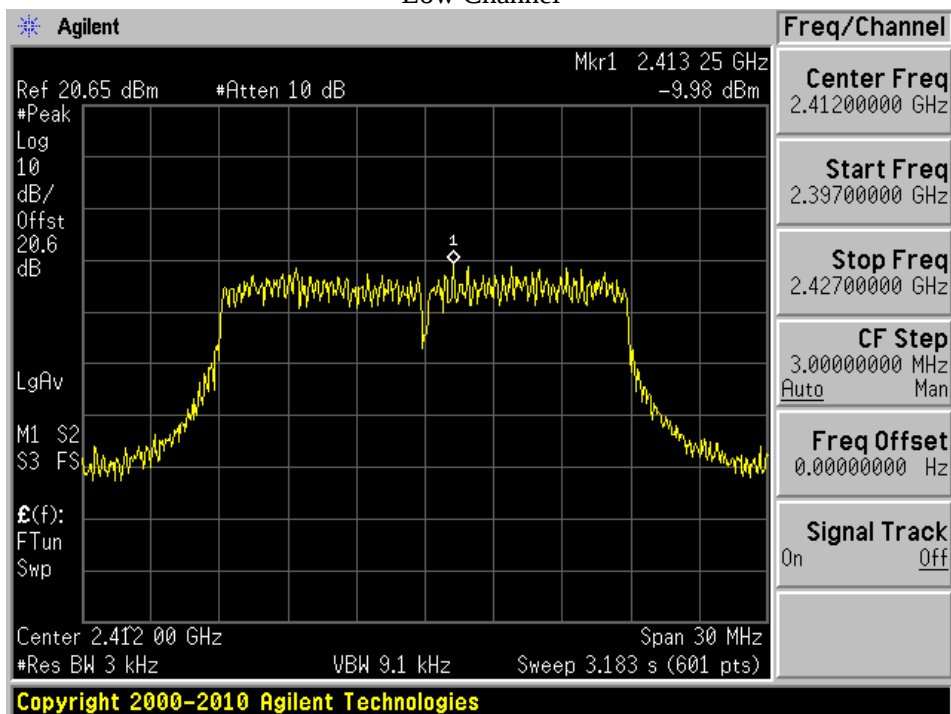


High Channel

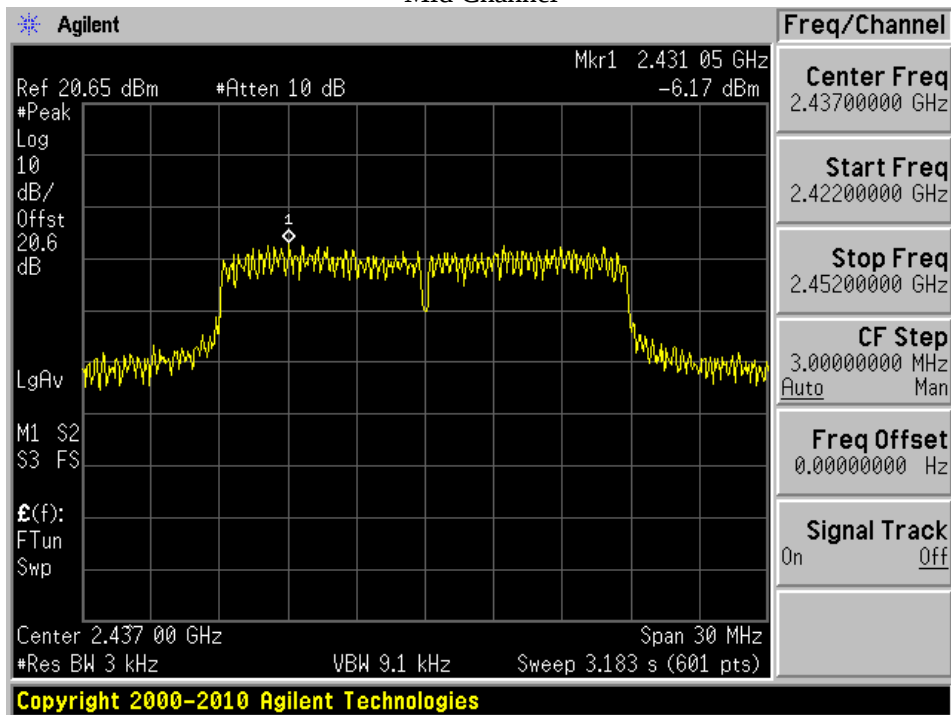


802.11n20 mode

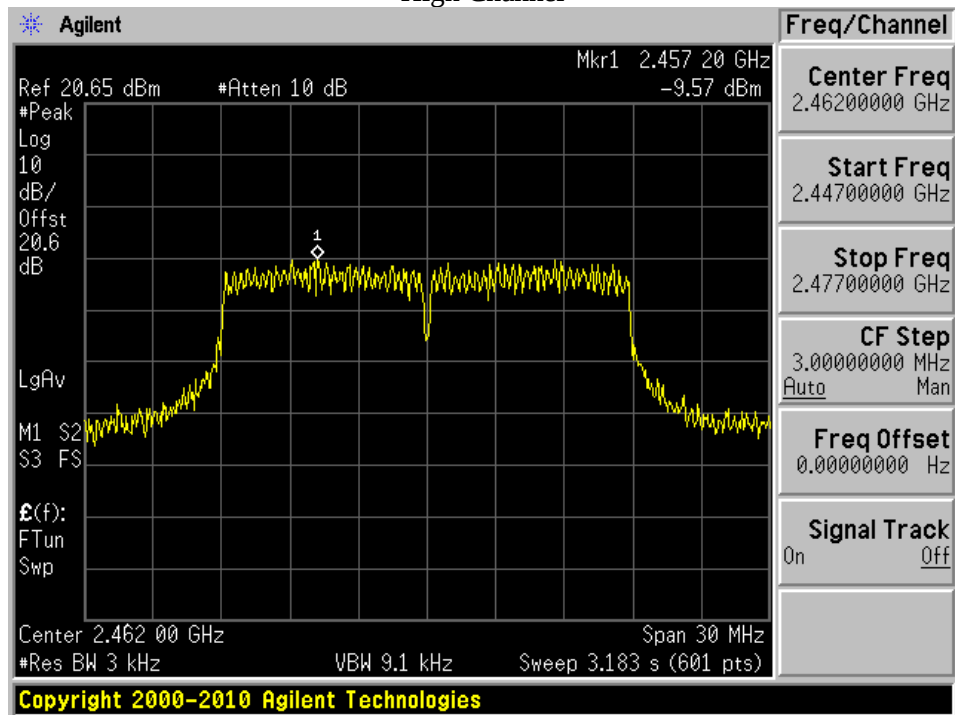
Low Channel



Mid Channel

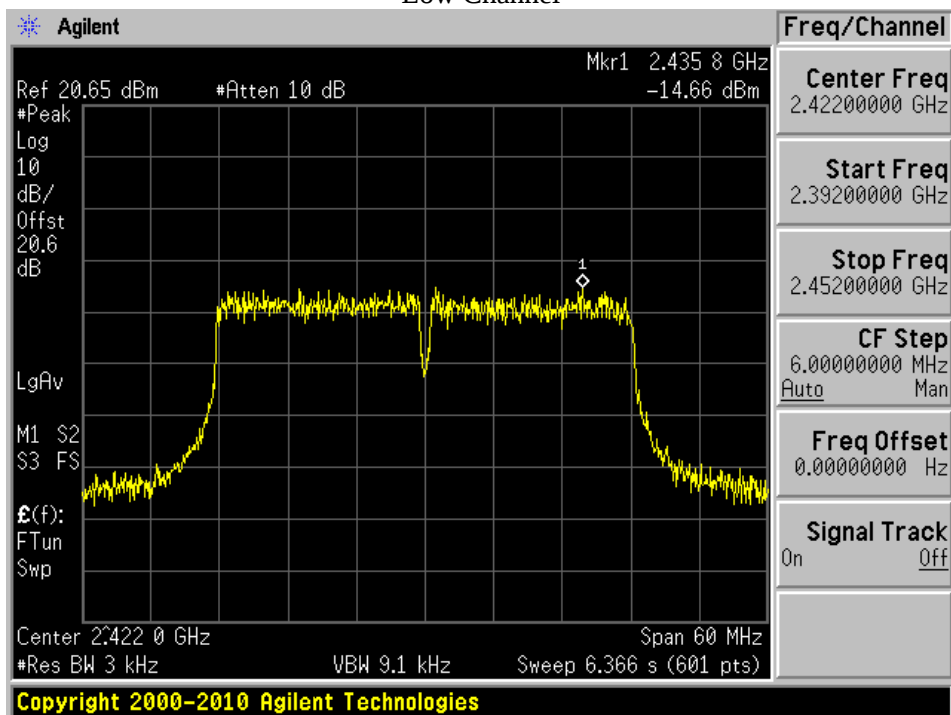


High Channel

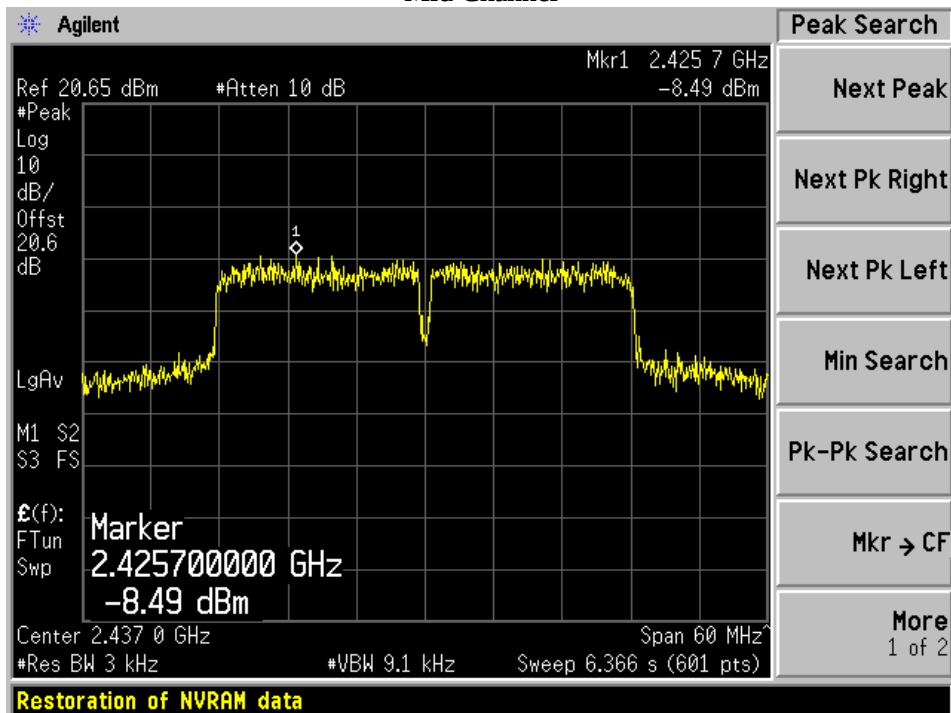


802.11n40 mode

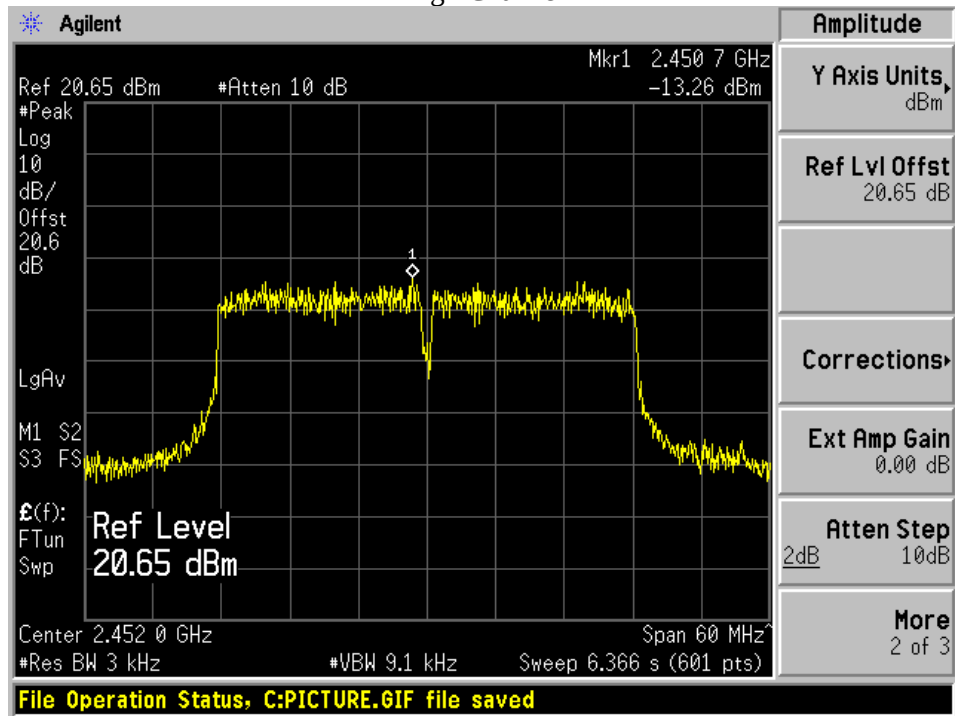
Low Channel



Mid Channel



High Channel



12 FCC §15.247(d) & ISEDC RSS-247 §5.5 - Spurious Emissions at Antenna Terminals

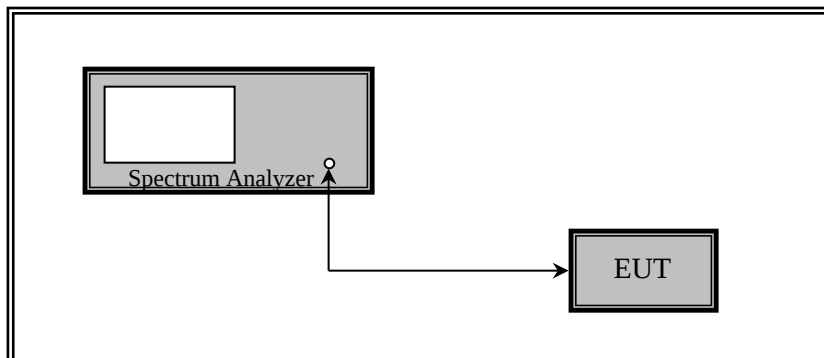
12.1 Applicable Standards

For FCC §15.247(d) and ISEDC RSS-247 §5.5, in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

12.2 Test Procedure

The RF output of the EUT was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz. Sufficient scans were taken to show any out of band emissions up to 10th harmonic.

12.3 Test Setup Block Diagram



12.4 Test Equipment List and Details

BACL Number	Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
287	Agilent	Signal Analyzer	E4446A	US44300386	2022-05-05	1 year
-	-	20dB attenuator	-	-	Each time ¹	N/A
-	-	RF cable	-	-	Each time ¹	N/A

Note¹: cable and attenuator included in the test set-up will be checked each time before testing.

Statement of Traceability: *BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

12.5 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

Testing was performed by Christian Schwartz from 2022-07-08 to 2022-07-28 at the RF site.

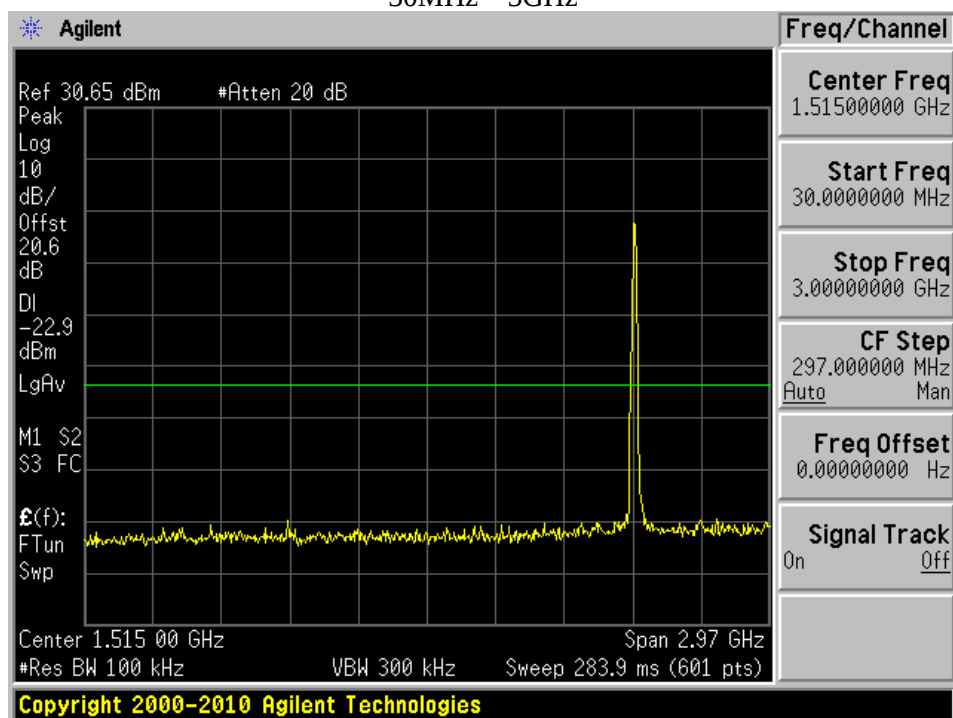
12.6 Test Results

Please refer to following plots.

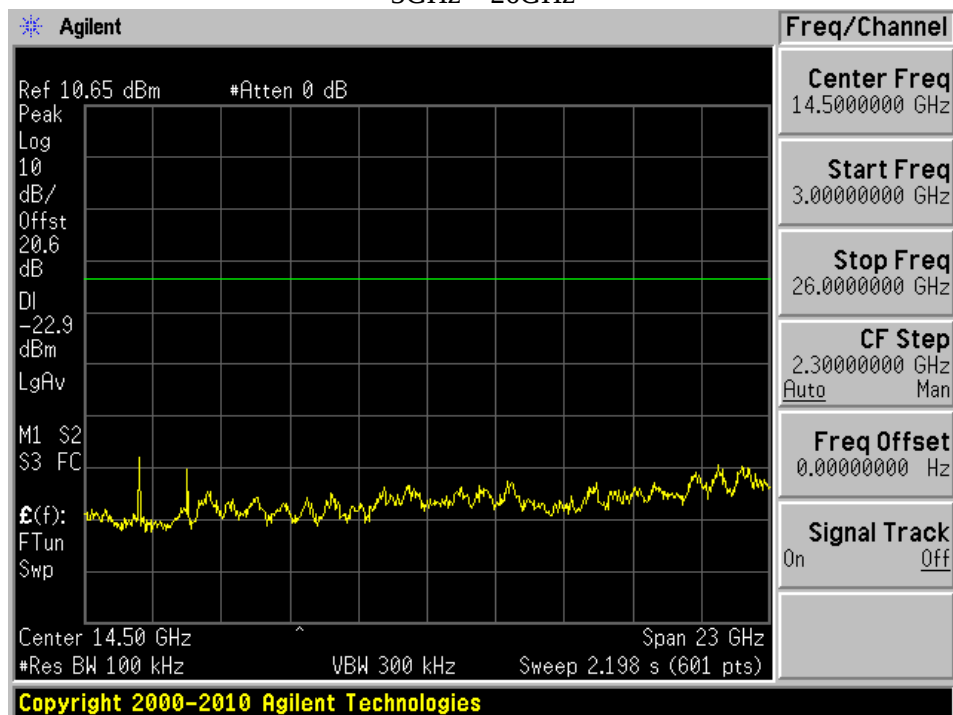
802.11b mode

Low Channel 2412MHz

30MHz – 3GHz

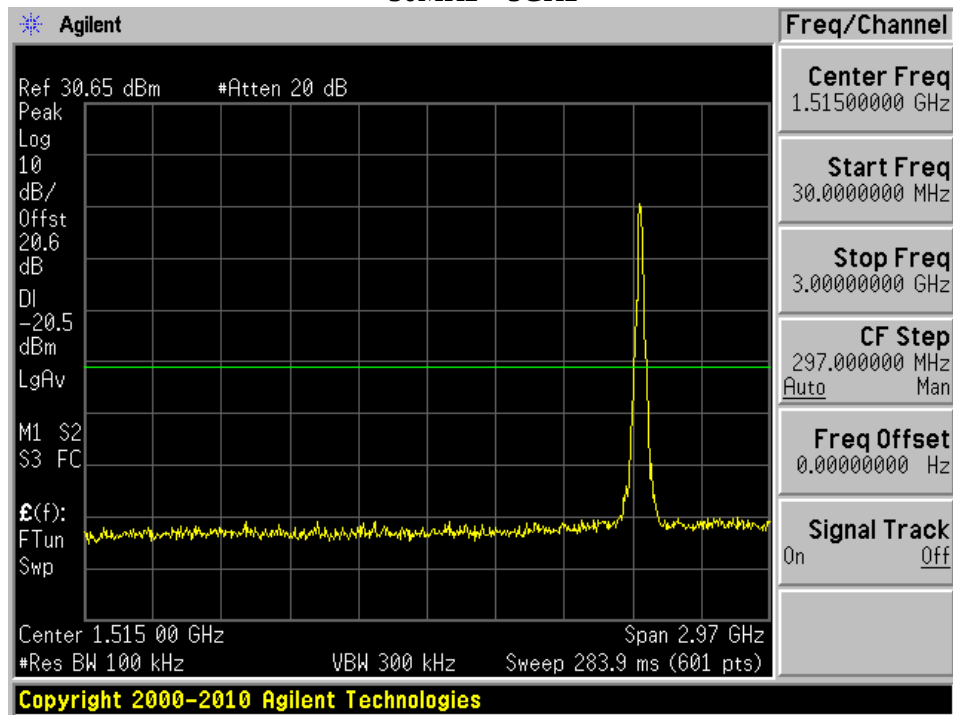


3GHz – 26GHz

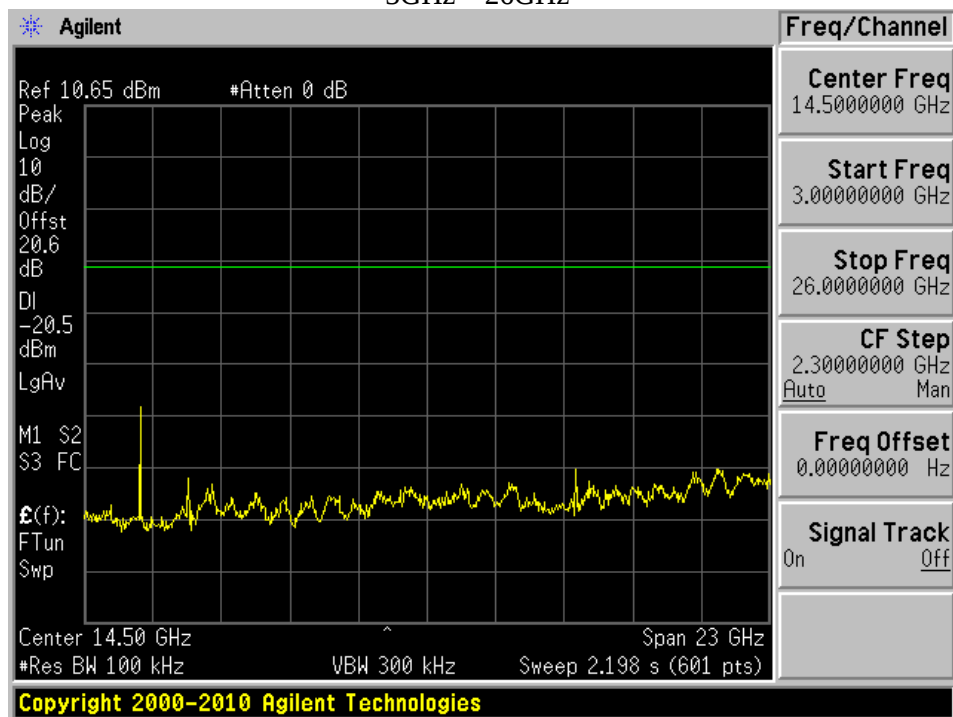


Mid Channel 2437MHz

30MHz – 3GHz

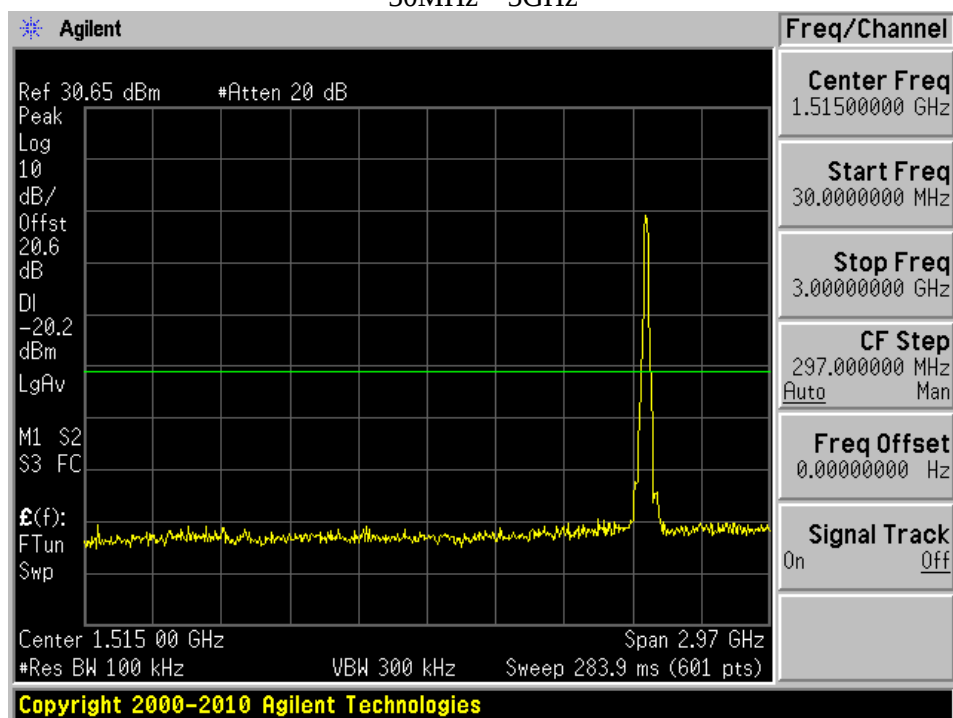


3GHz – 26GHz

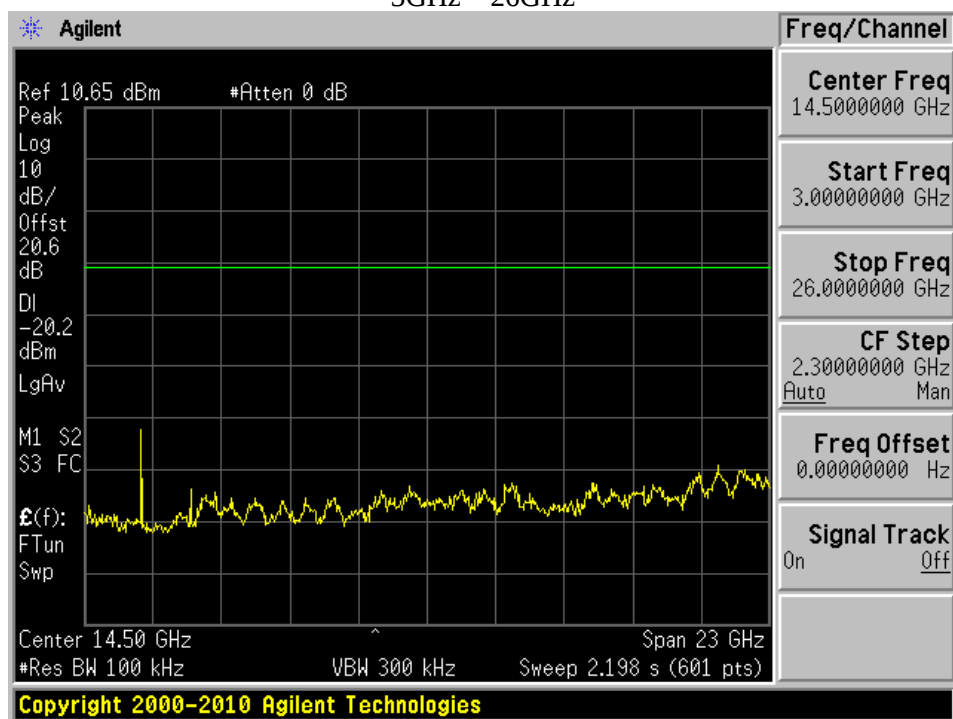


High Channel 2462MHz

30MHz – 3GHz



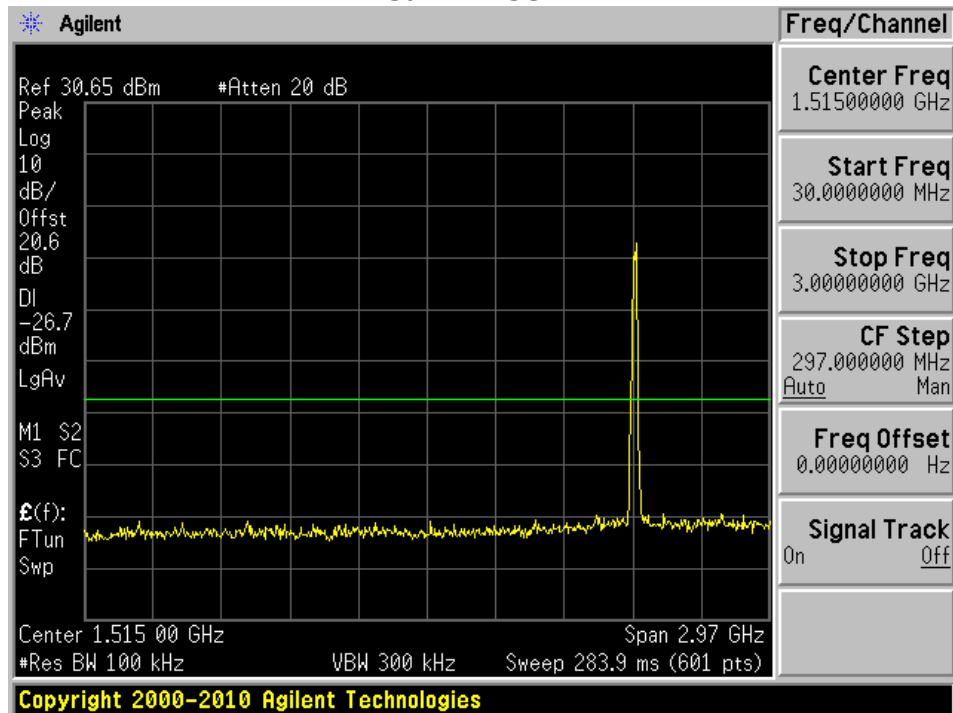
3GHz – 26GHz



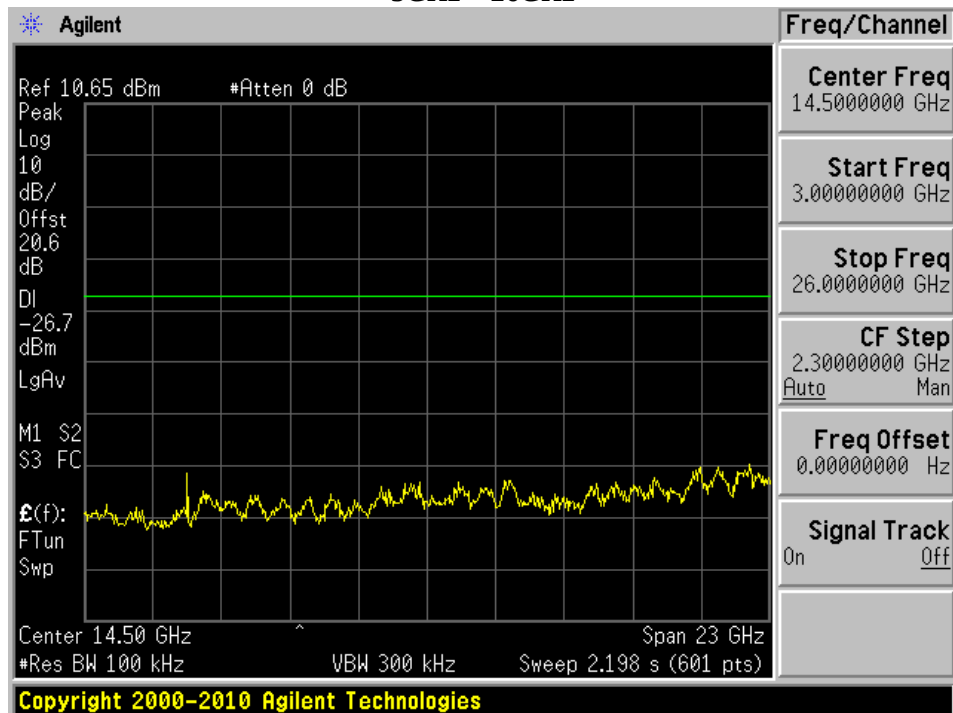
802.11g mode

Low Channel 2412MHz

30MHz – 3GHz

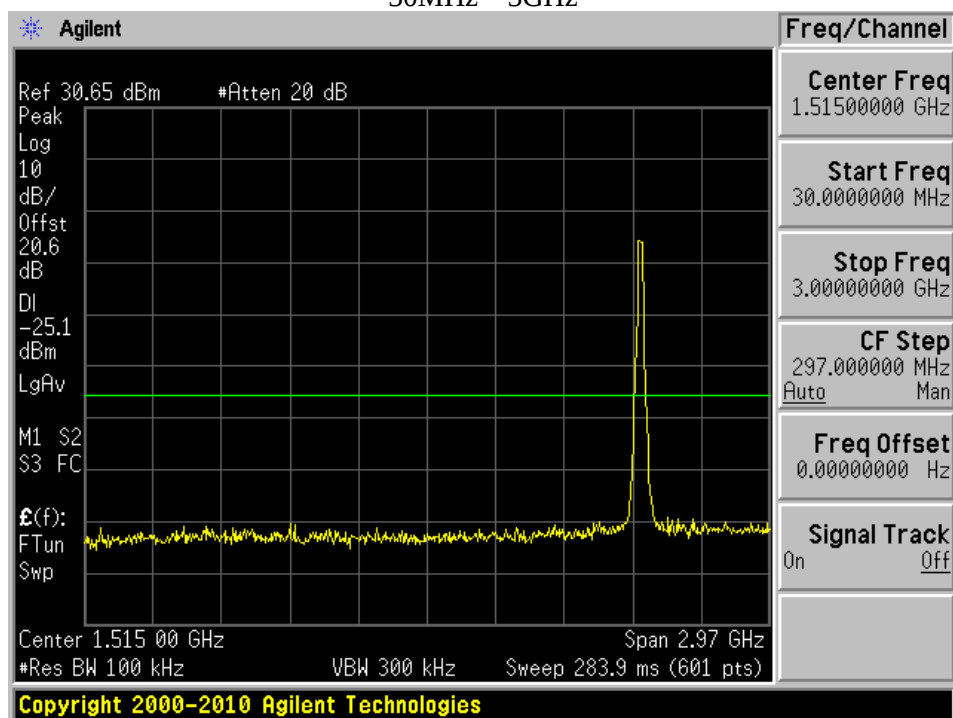


3GHz – 26GHz

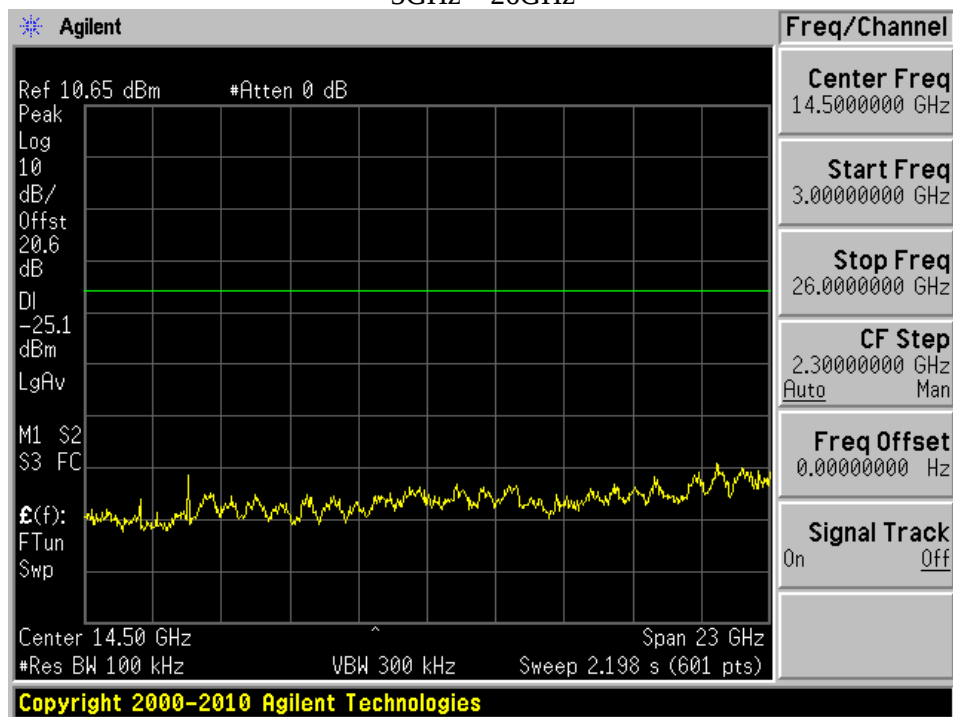


Mid Channel 2437MHz

30MHz – 3GHz

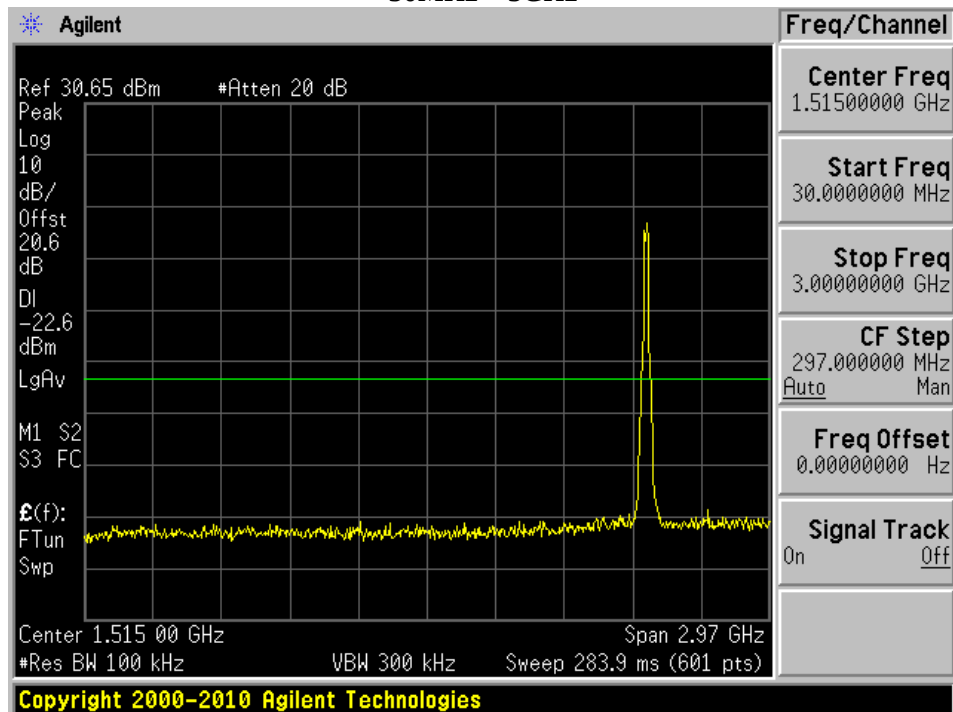


3GHz – 26GHz

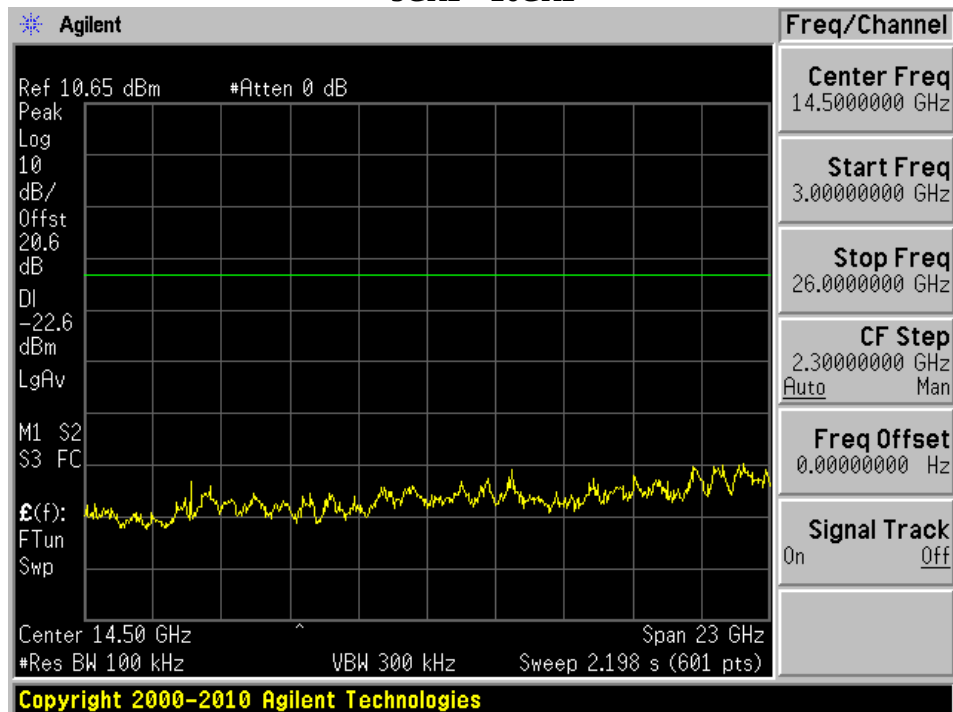


High Channel 2462MHz

30MHz – 3GHz



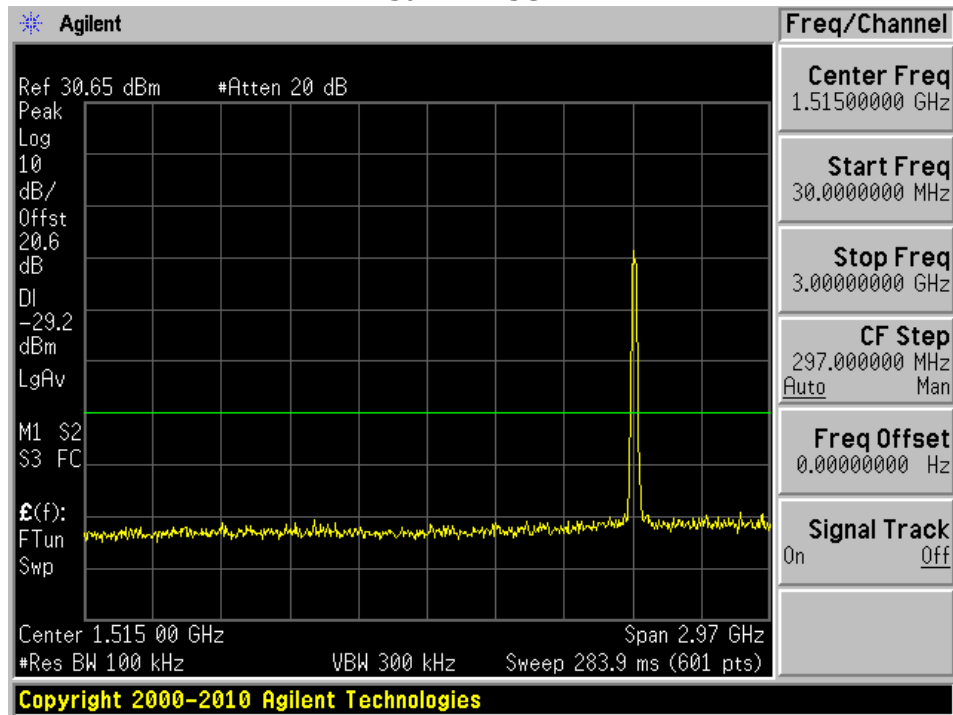
3GHz – 26GHz



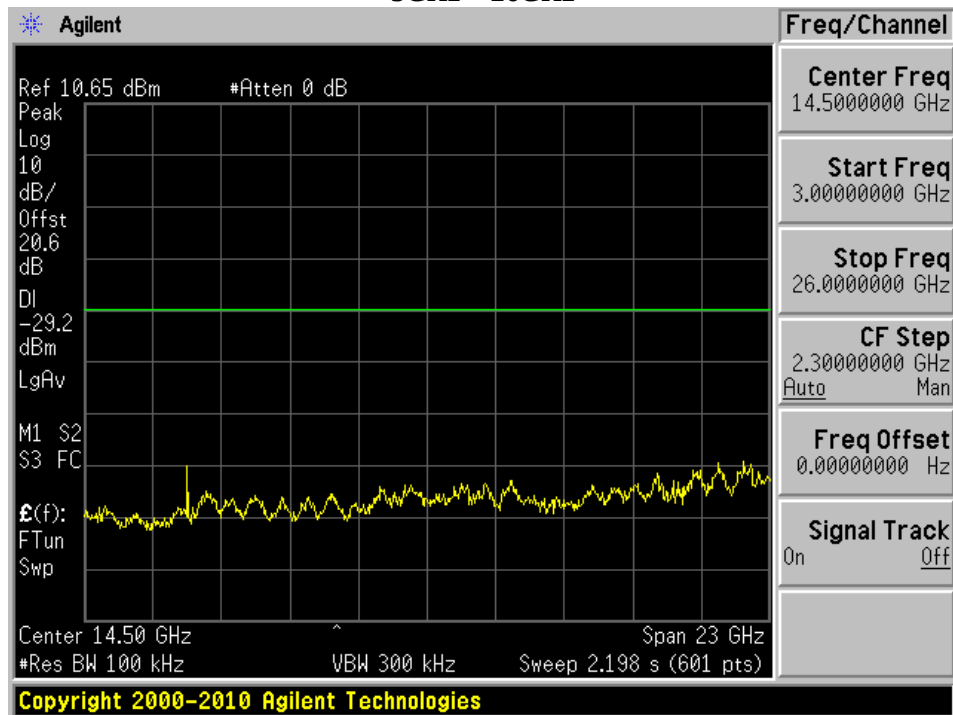
802.11n20 mode

Low Channel 2412MHz

30MHz – 3GHz

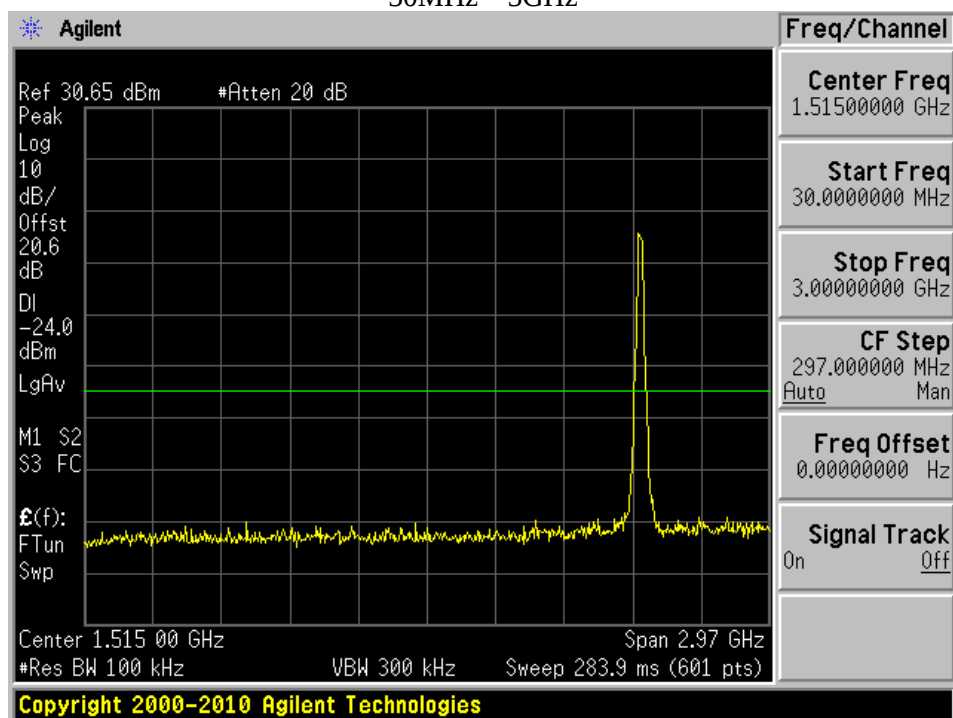


3GHz – 26GHz

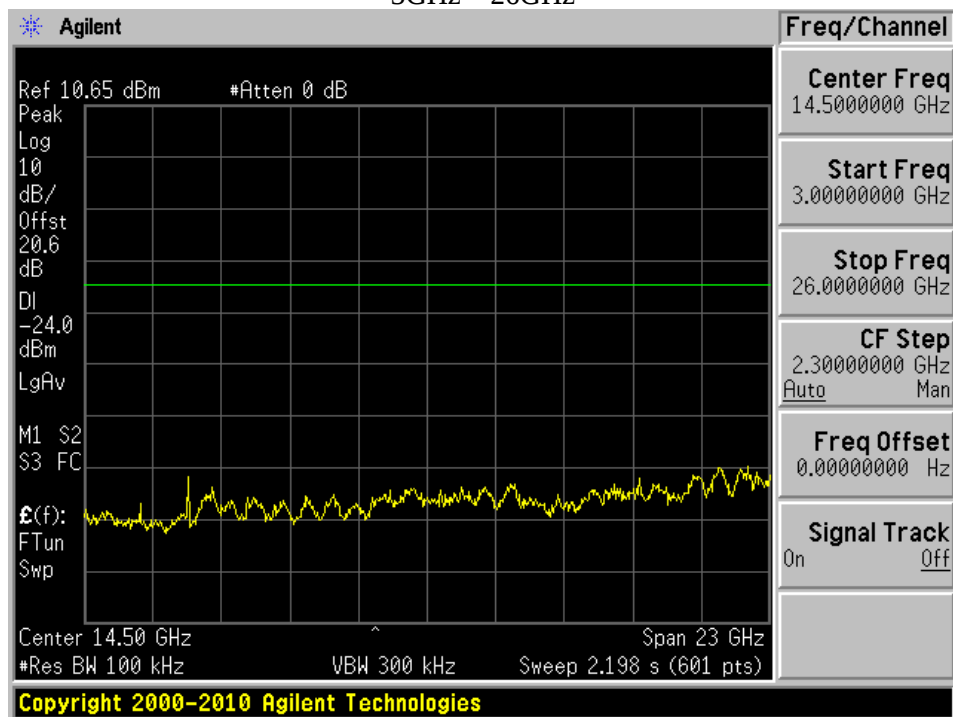


Mid Channel 2437MHz

30MHz – 3GHz

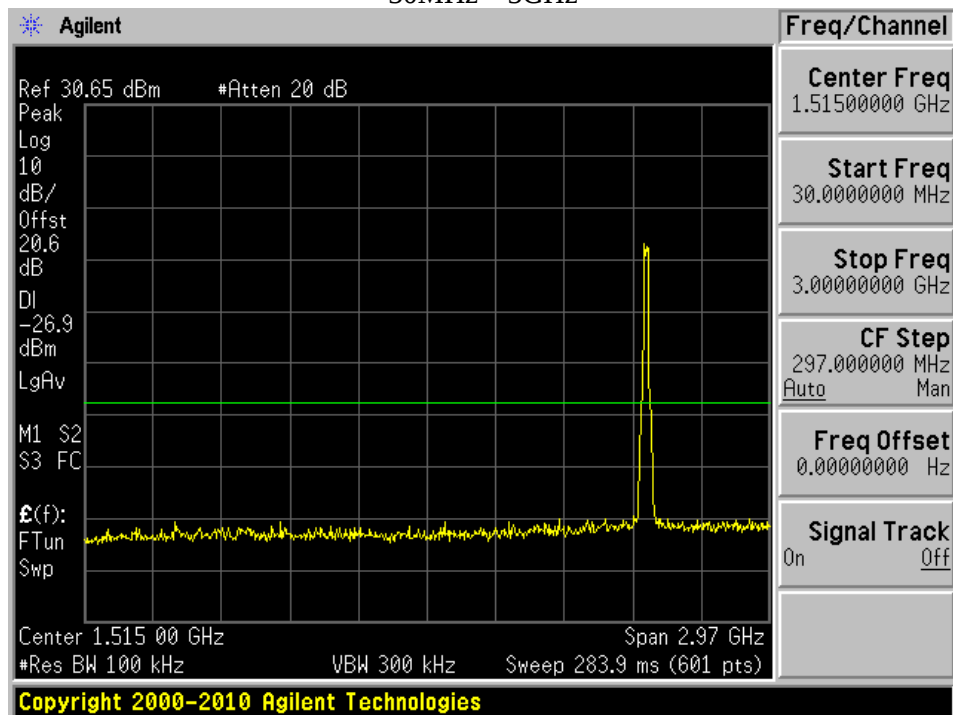


3GHz – 26GHz

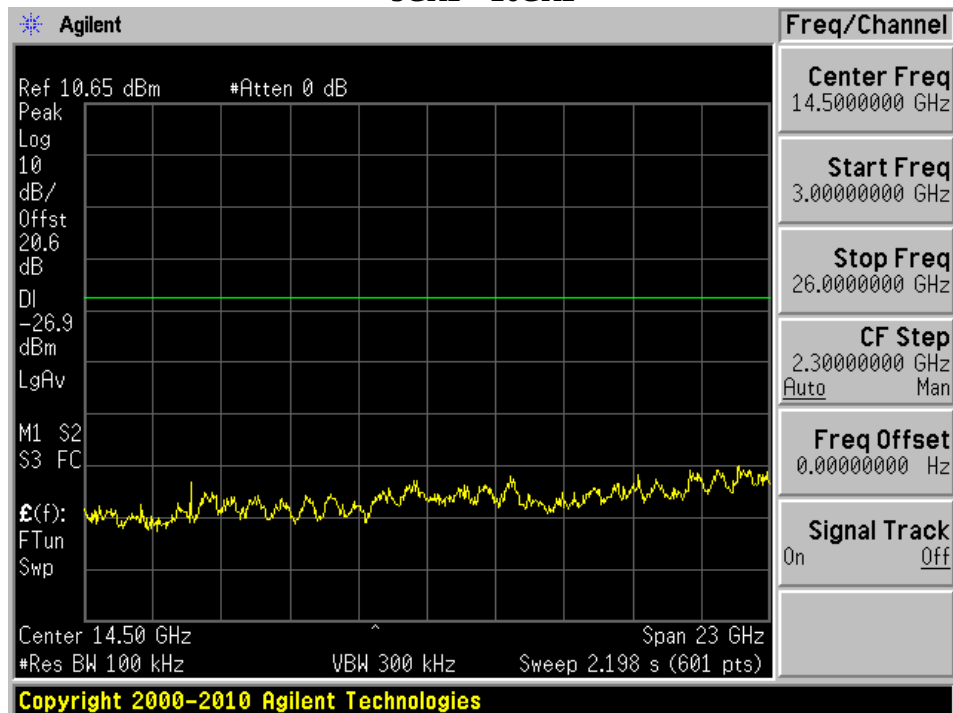


High Channel 2462MHz

30MHz – 3GHz



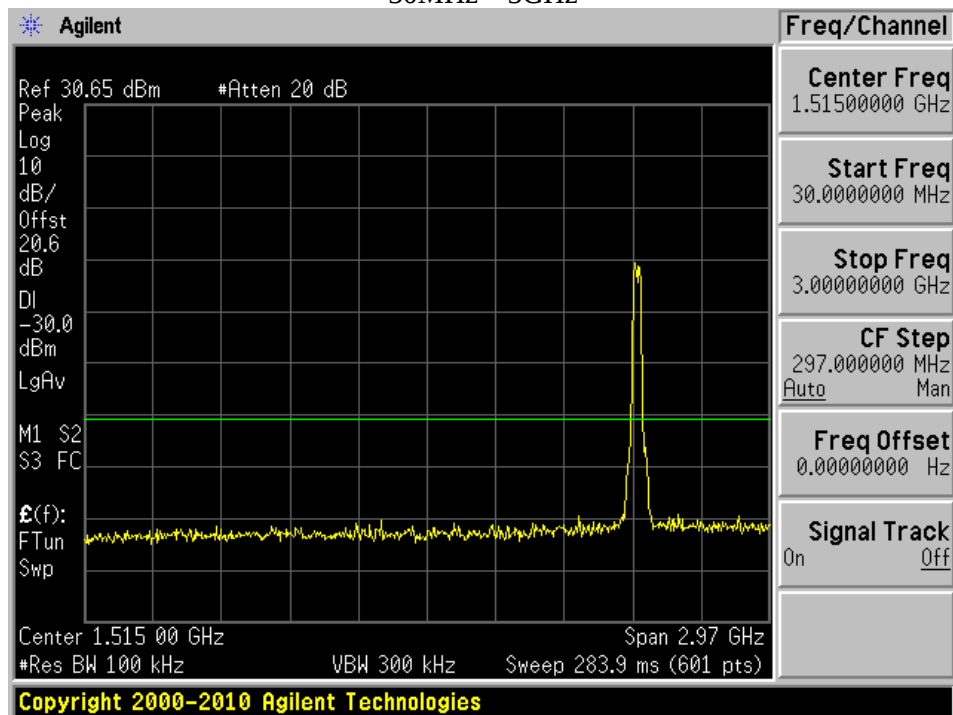
3GHz – 26GHz



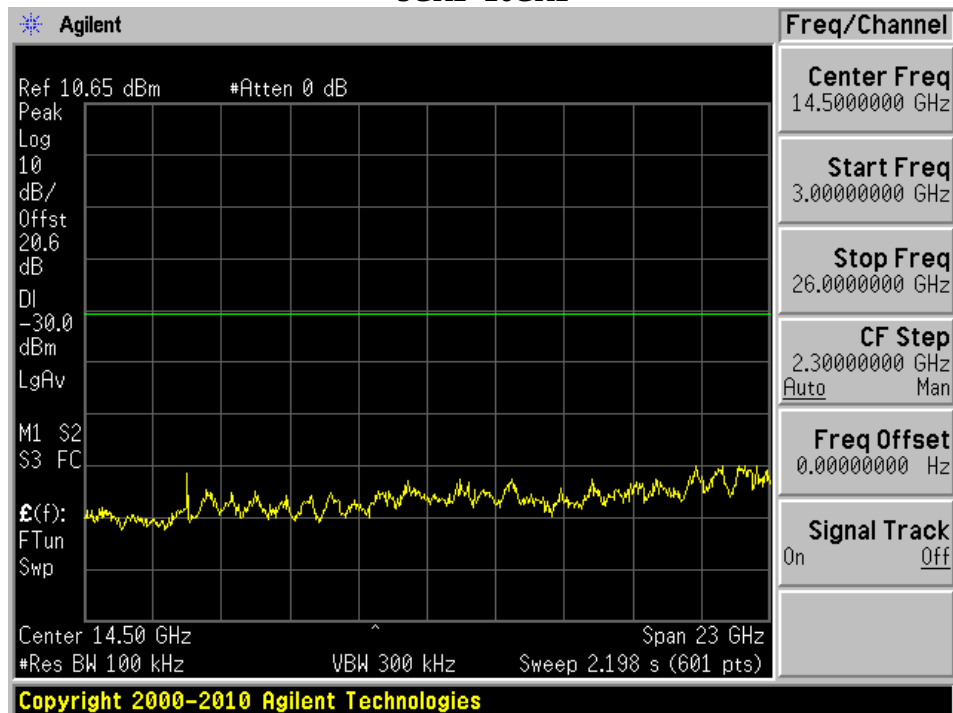
802.11n40 mode

Low Channel 2422MHz

30MHz – 3GHz

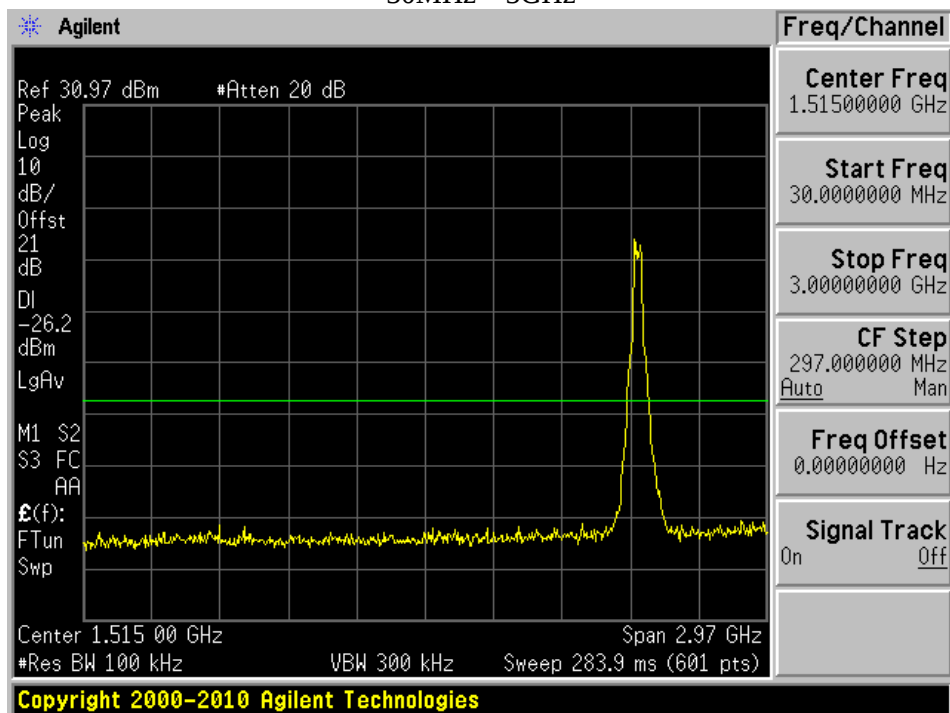


3GHz -26GHz

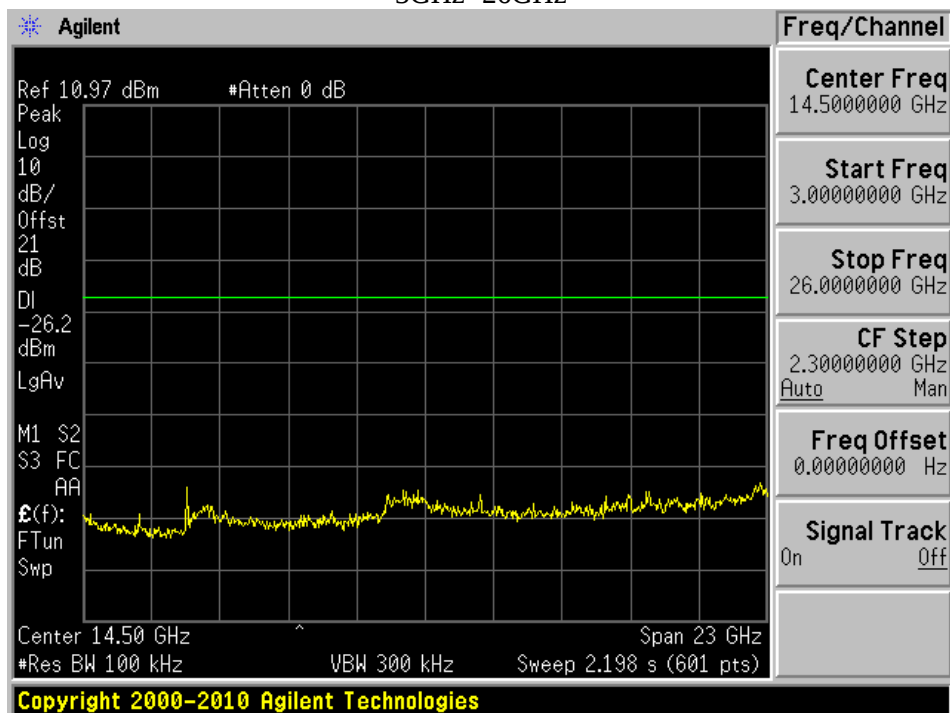


Mid Channel 2437MHz

30MHz – 3GHz

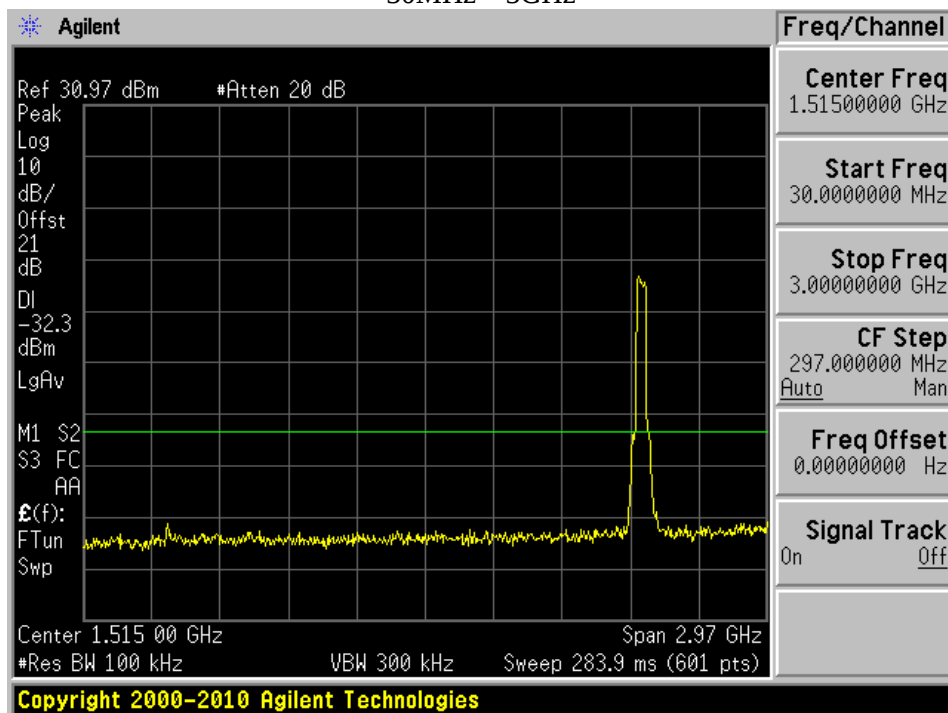


3GHz -26GHz

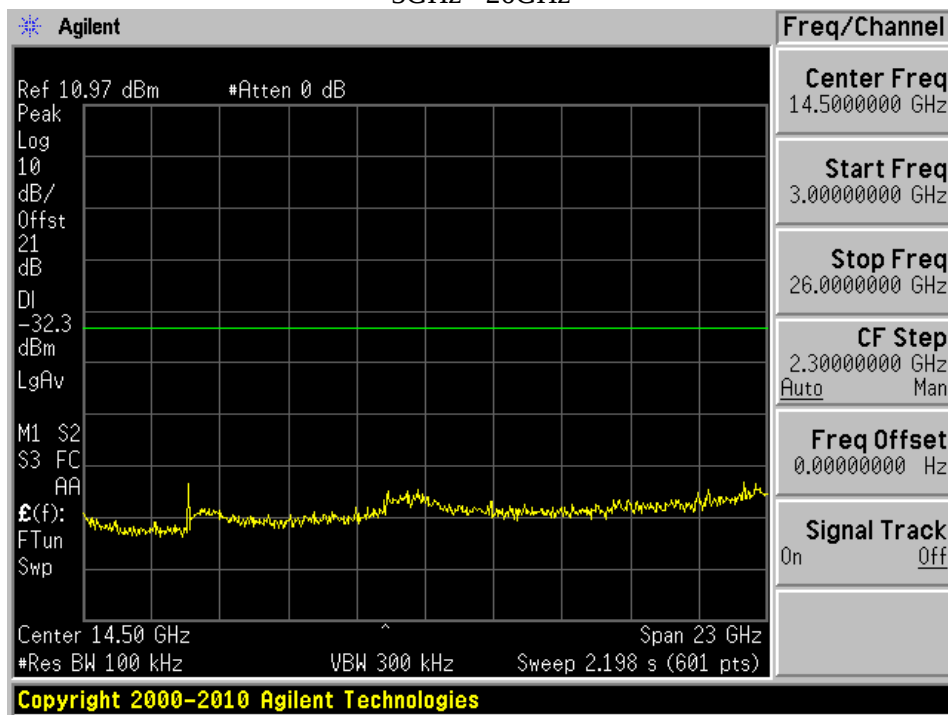


High Channel 2452MHz

30MHz – 3GHz



3GHz - 26GHz



13 Annex A (Normative) – EUT Test Setup Photographs

Please refer to the attachment.

14 Annex B (Normative) – EUT External Photographs

Please refer to the attachment.

15 Annex C (Normative) – EUT Internal Photographs

Please refer to the attachment.

16 Annex D (Normative) - A2LA Electrical Testing Certificate**Accredited Laboratory**

A2LA has accredited

BAY AREA COMPLIANCE LABORATORIES CORP.

Sunnyvale, CA

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 General requirements for the competence of testing and calibration laboratories. This laboratory also meets A2LA R222 - Specific Requirements EPA ENERGY STAR Accreditation Program. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

Presented this 10th day of March 2021.

A blue ink signature of Trace McInturff.

Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3297.02
Valid to September 30, 2022

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

Please follow the web link below for a full ISO 17025 scope

<https://www.a2la.org/scopepdf/3297-02.pdf>

--- END OF REPORT ---