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

TEST REPORT

For

Roku, Inc.

1155 Coleman Ave., San Jose, CA 95110, USA

FCC ID: TC2-R1038
IC: 5959A-R1035

Report Type:	**Model:**
Original Report	9102X

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Report Date:	2020-09-17
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CERTIFICATE #3297.02

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 "*"

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R2005041-DTS	Original Report	2020-07-20
1	R2005041-DTS	Updated 17065 reviewer comments	2020-09-17

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: *9402X*, FCC ID: TC2-R1038, IC: 5959A-R1035 or the "EUT" as referred to in this report. It is a Speaker Built-in Set-up-box.

1.2 Objective

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

The objective was to determine compliance with FCC Part 15.247 and ISEDC RSS-247 rules for Output Power, Antenna Requirements, 6 dB Bandwidth, Power Spectral Density, 100 kHz Bandwidth of Band Edges Measurement, Conducted and Radiated Spurious Emissions.

1.3 Related Submittal(s)/Grant(s)

FCC Part 15, Subpart C, Equipment DSS with FCC ID: TC2-R1038, IC: 5959A-R1035
FCC Part 15, Subpart E, Equipment NII with FCC ID: TC2-R1038, IC: 5959A-R1035

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	±0.57 dB
Power Spectral Density, conducted	±1.48dB
Unwanted Emissions, conducted	±1.57dB
All emissions, radiated	±4.0 dB
AC power line Conducted Emission	±2.0 dB
Temperature	±2 º 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 17025:2005 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 17025:2005 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 17025:2005 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 - ISEDC) Foreign Certification Body – FCB – APEC Tel MRA -Phase I & Phase II;

- Chinese Taipei (Republic of China – Taiwan):
  - BSMI (Bureau of Standards, Metrology and Inspection) APEC Tel MRA -Phase I;
  - NCC (National Communications Commission) APEC Tel MRA -Phase I;
- European Union:
  - EMC Directive 2014/30/EU US-EU EMC & Telecom MRA CAB (NB)
  - Radio Equipment (RE) Directive 2014/53/EU US-EU EMC & Telecom MRA CAB (NB)
  - 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:
  - ENERGY STAR Recognized Test Laboratory – US EPA
  - Telecommunications Certification Body (TCB) – US FCC;
  - 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 PuTTy. The software is compliant with the standard requirements being tested against.

Modulation	Frequency (MHz)	Power Setting RADIO 2		Power Setting RADIO 1
		Ant A	Ant B	
802.11b	2412	93	108	39
	2437	127	127	63
	2462	97	109	44
8002.11g	2412	67	74	42
	2437	127	127	63
	2462	67	75	46
802.11n20	2412	68	68	41
	2437	127	127	63
	2462	66	66	44

Data Rates Tested:
802.11b mode: 1Mbps
802.11g mode: 6Mbps
802.11n HT20 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 2

Radio Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
802.11b	12.39	12.83	96.57	0.15
802.11g	2.06	2.28	90.35	0.44
802.11n20	1.91	2.10	90.95	0.41

Radio 1

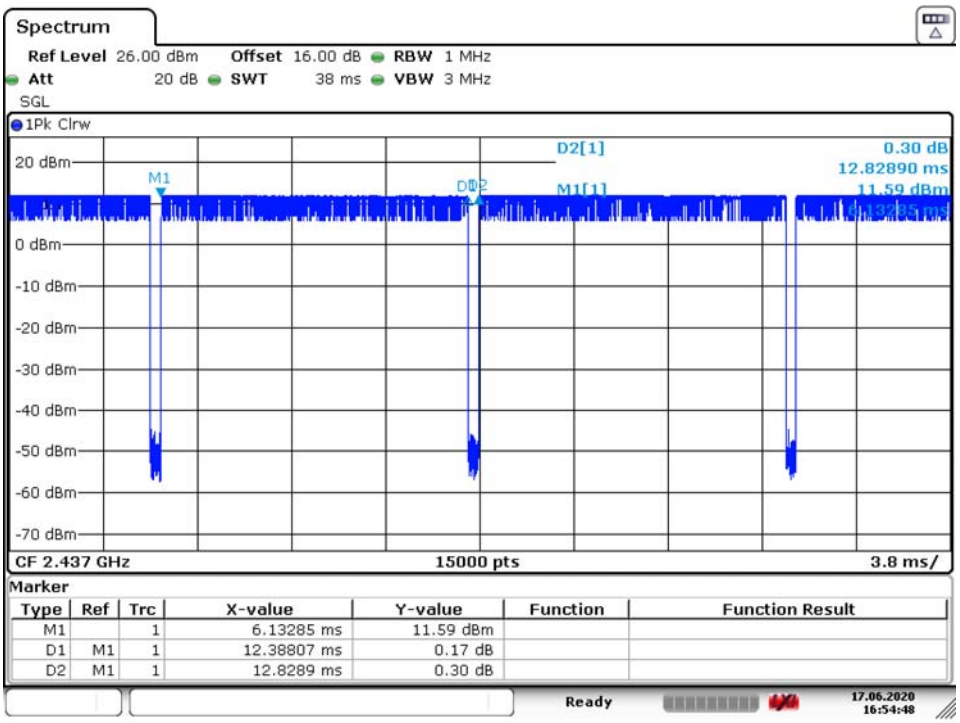
Radio Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
802.11b	12.45	12.52	99.44	0.02
802.11g	2.059	2.132	96.58	0.15
802.11n20	1.919	1.96	97.91	0.09

Duty Cycle = On Time (ms)/ Period (ms)
Duty Cycle Correction Factor (dB) = 10*log(1/Duty Cycle)

Please refer to the following plots.

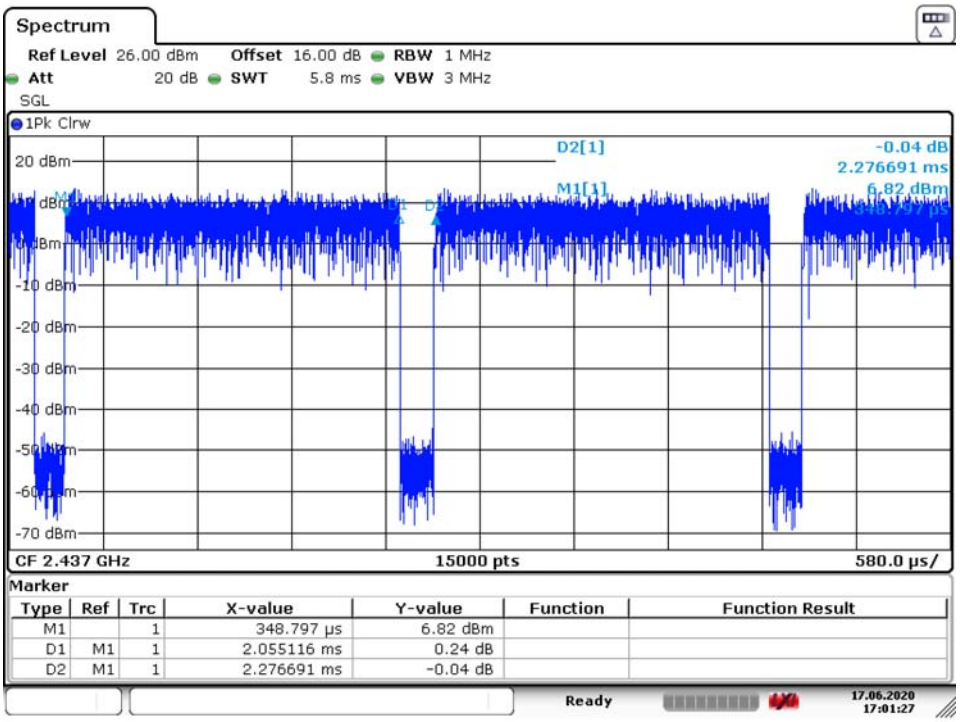
Radio 2

802.11b mode



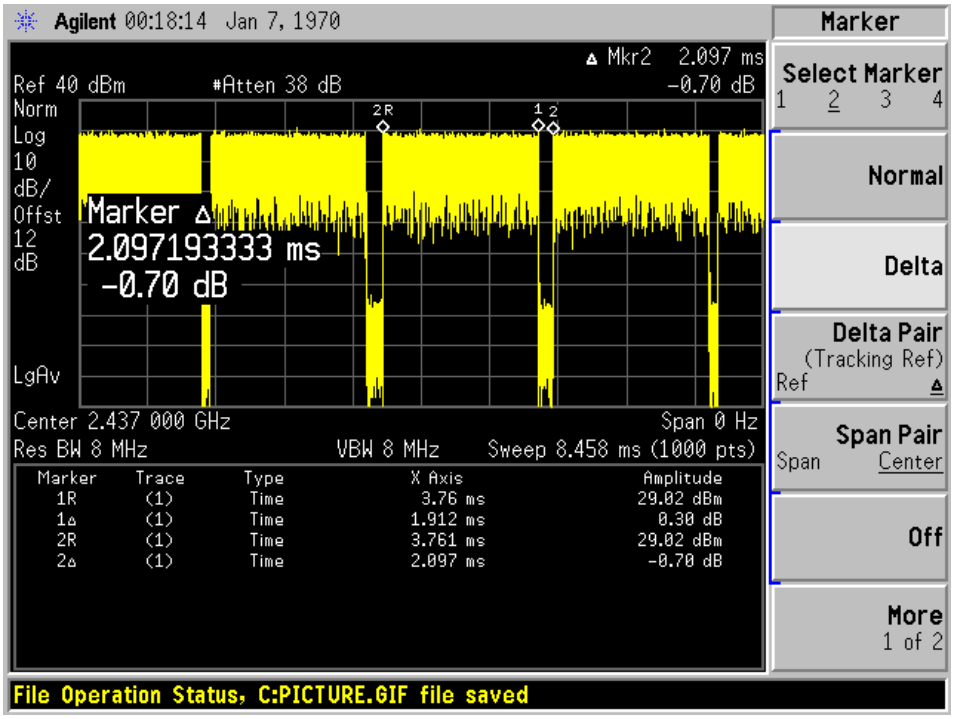
Date: 17.JUN.2020 16:54:48

802.11g mode



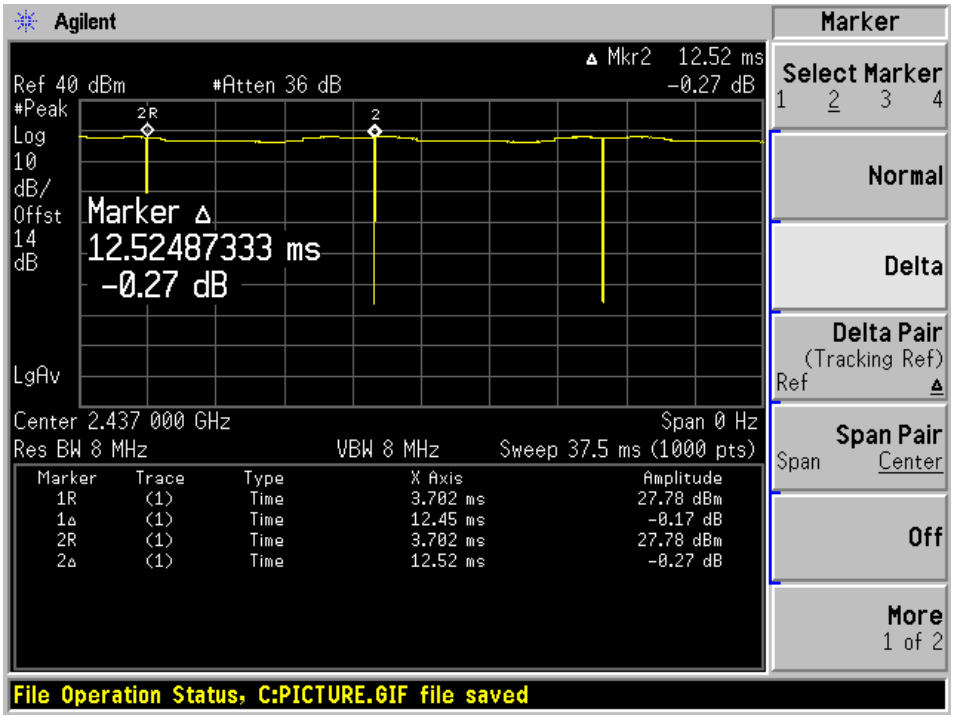
Date: 17.JUN.2020 17:01:28

802.11n20 mode

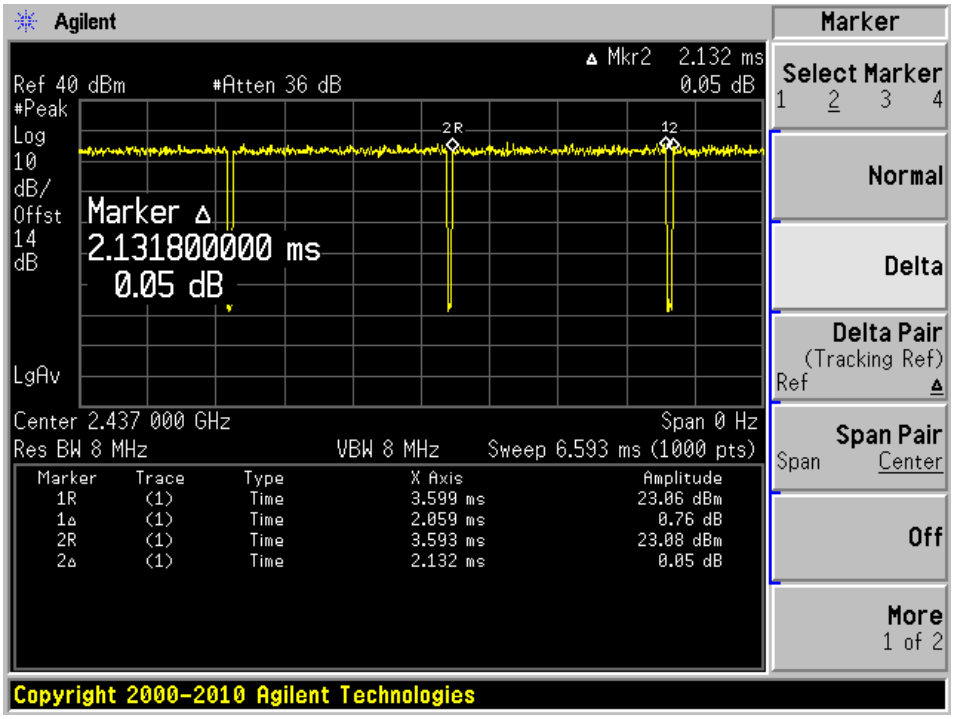


Radio 1

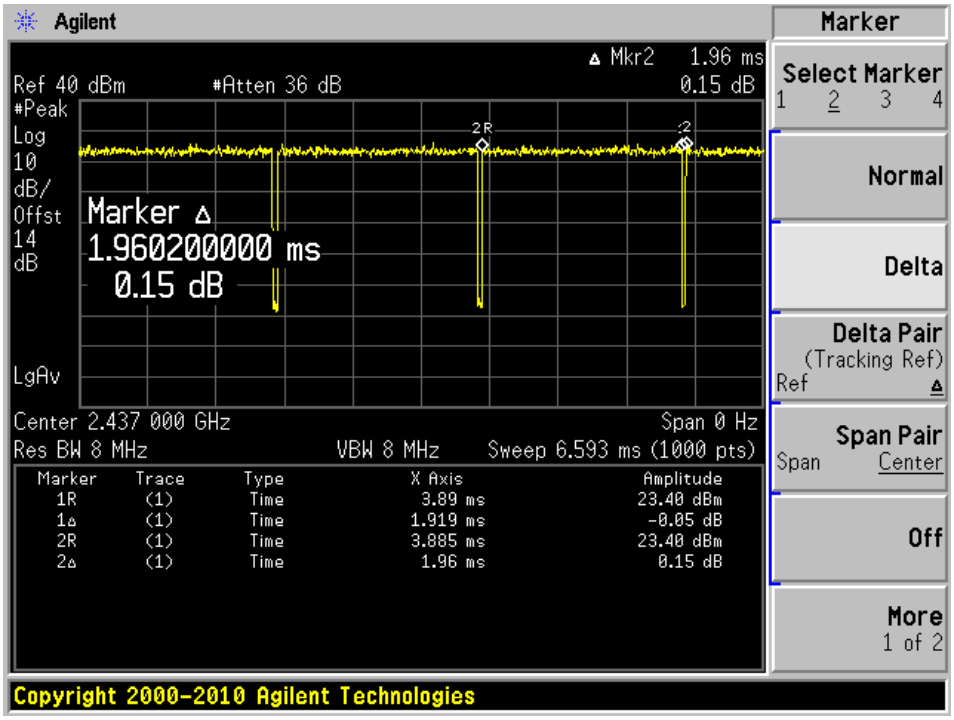
802.11b mode



802.11g mode



802.11n20 mode



2.4 Equipment Modifications

N/A

2.5 Local Support Equipment

Manufacturer	Description	Model
Dell	Laptop	Latitude E6410

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
RF Cable	< 1 m	EUT	PSA

3 Summary of Test Results

Results reported relate only to the product tested.

FCC and ISEDC Rules	Description of Test	Results
FCC §15.203 ISEDC RSS-Gen §6.8	Antenna Requirement	Compliant
FCC §15.207 ISEDC RSS-Gen §8.8	AC Line Conducted Emissions	Compliant
FCC §2.1091, §15.247(i) ISEDC RSS-102	RF Exposure	Compliant
FCC §2.1051, §15.247 (d) ISEDC RSS-247 §5.5	Spurious Emissions at Antenna Port	Compliant
FCC §2.1053, §15.205, §15.209, §15.247 (d) ISEDC RSS-247 §5.5 ISEDC RSS-Gen §8.9 and §8.10	Radiated Spurious Emissions	Compliant
FCC §15.247(a)(2) ISEDC RSS-247 §5.2 (1)	6 dB and 99% Emission Bandwidth	Compliant
FCC §15.247(b)(3) ISEDC RSS-247 §5.4 (4)	Maximum Peak Output Power	Compliant
FCC §15.247(d) ISEDC RSS-247 §5.5	100 kHz Bandwidth of Frequency Band Edge	Compliant
FCC §15.247(e) ISEDC RSS-247 §5.2 (2)	Power Spectral Density	Compliant

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 isotopically 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 [enter the device's ISED certification number] 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

The antennas used by the EUT are permanent attached antennas.

Radio	Antenna	Manufacturer/PN	Frequency Range (MHz)	Antenna Type	Maximum Antenna Gain (dBi)
Bluetooth	Single Antenna	N/A	2400-2500	PCB	2.3
Wi-Fi 2 2.4 GHz	Ant A	WC0D-15/GSD	2400-2500	PIFA	4
	Ant B	WC0D-15/GSD	2400-2500	PIFA	4
Wi-Fi 2 5 GHz	Ant A	WC0D-15/GSD	5150-5850	PIFA	4.5
	Ant B	WC0D-15/GSD	5150-5850	PIFA	4.5
Wi-Fi 1 2.4 GHz	Single Antenna	WC0D-15/GSD	2400-2500	PIFA	4
Wi-Fi 1 5 GHz	Single Antenna	WC0D-15/GSD	5150-5850	PIFA	4.5

5 FCC §2.1091, §15.247(i) & ISEDC RSS-102 – RF Exposure

5.1 Applicable Standards

According to FCC §15.247(i) and §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

According to KDB 447 498 Section (7.2), "simultaneous transmission of MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on calculated or measured field strengths or power density, is ≤ 1.0. The MPE ratio of each antenna is determined at the minimum *test separation distance* required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to MPE limit, at the test frequency.

Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	* (100)	30
1.34-30	824/f	2.19/f	* ($180/f^2$)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

Where: f = frequency in MHz
* = Plane-wave equivalent power density

Before equipment certification is granted, the procedure of IC RSS-102 must be followed concerning the exposure of humans to RF field.

According to ISED RSS-102 Issue 5:

2.5.2 Exemption Limits for Routine Evaluation – RF Exposure Evaluation

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz[6] and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2}\ f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

5.2 MPE Prediction

Predication of MPE limit at a given distance, Equation from OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: S = power density
P = power input to antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

5.3 MPE Results

2.4 Wi-Fi Radio 2

Worst Case: 802.11n20, Mid Channel 2437 MHz

Maximum peak output power at antenna input terminal (dBm):	26.23
Maximum peak output power at antenna input terminal (mW):	419.7590
Prediction distance (cm):	20
Prediction frequency (MHz):	2437
Maximum Antenna Gain, typical (dBi):	7
Maximum Antenna Gain (numeric):	5.0119
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.4185
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0
MPE Ratio (numeric):	0.4185

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.4185 mW/cm^2. Limit is 1.0 mW/cm^2.

2.4 Wi-Fi Radio 1

Worst Case: 802.11b, Mid Channel 2437 MHz

Maximum peak output power at antenna input terminal (dBm):	23.14
Maximum peak output power at antenna input terminal (mW):	206.06
Prediction distance (cm):	20
Prediction frequency (MHz):	2437
Maximum Antenna Gain, typical (dBi):	4
Maximum Antenna Gain (numeric):	2.51
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.10
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0
MPE Ratio (numeric):	0.10

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.10 mW/cm^2. Limit is 1.0 mW/cm^2.

Radio Co-location

The device supports the following radio co-location configurations.

	Wi-Fi Radio 2 2.4G	Wi-Fi Radio 2 UNII-1	Wi-Fi Radio 2 UNII-3
BT	X	X	X
Wi-Fi Radio 1 2.4G		X	X
Wi-Fi Radio 1 UNII-1	X		X
Wi-Fi Radio 1 UNII-3	X	X	

Worst Case Colocation 2.4 GHz Classic Bluetooth and 2.4 GHz Wi-Fi Radio 2 (MIMO):

Frequency Band	Max Conducted Power(dBm)	Evaluated Distance (cm)	Worst-Case MPE (mW/cm^2)	MPE Limit (mW/cm^2)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
Worst Case							
2.4 GHz Classic Bluetooth	11.81	20	0.0051	1.0	0.51%	42.36%	100%
2.4 Wi-Fi2 Radio 2	26.23	20	0.4185	1.0	41.85%		

Worst Case Colocation 2.4 GHz Wi-Fi Radio 1 (SISO) and 5.8 GHz Wi-Fi Radio 2 (MIMO):

Frequency Band	Max Conducted Power(dBm)	Evaluated Distance (cm)	Worst-Case MPE (mW/cm^2)	MPE Limit (mW/cm^2)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
Worst Case							
2.4 GHz Wi-Fi Radio 1	23.14	20	0.10	1.0	10%	32.44%	100%
5.8 GHz Wi-Fi Radio 2	23.02	20	0.2244	1.0	22.44%		

Worst Case Colocation 5.8 GHz Wi-Fi Radio 1 (SISO) and 2.4 GHz Wi-Fi Radio 2 (MIMO):

Frequency Band	Max Conducted Power(dBm)	Evaluated Distance (cm)	Worst-Case MPE (mW/cm^2)	MPE Limit (mW/cm^2)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
Worst Case							
5.8 GHz Wi-Fi Radio 1	21.77	20	0.0843	1.0	8.43%	50.28%	100%
2.4 GHz Wi-Fi Radio 2	26.23	20	0.4185	1.0	41.85%		

5.4 RF exposure evaluation exemption for IC

2.4 Wi-Fi Radio 2

Worst Case: 802.11n20, Mid Channel 2437 MHz

Maximum EIRP power = 26.23 dBm + 7 dBi = 33.23 dBm which is less than $1.31\times10^{-2}f^{0.6834}$ = 2.70 W = 34.31 dBm

2.4 Wi-Fi Radio 1

Worst Case: 802.11b, Mid Channel 2437 MHz

Maximum EIRP power = 23.14 dBm + 4 dBi = 27.14 dBm which is less than $1.31\times10^{-2}f^{0.6834}$ = 2.70 W = 34.31 dBm

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

6.1 Applicable Standards

As per FCC §15.207 and ISEDC RSS-Gen §8.8 Conducted limits:

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 μH/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 were FCC §15.207 and ISEDC RSS-Gen §8.8 limits.

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 were 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 Corrected Amplitude and Margin Calculation

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

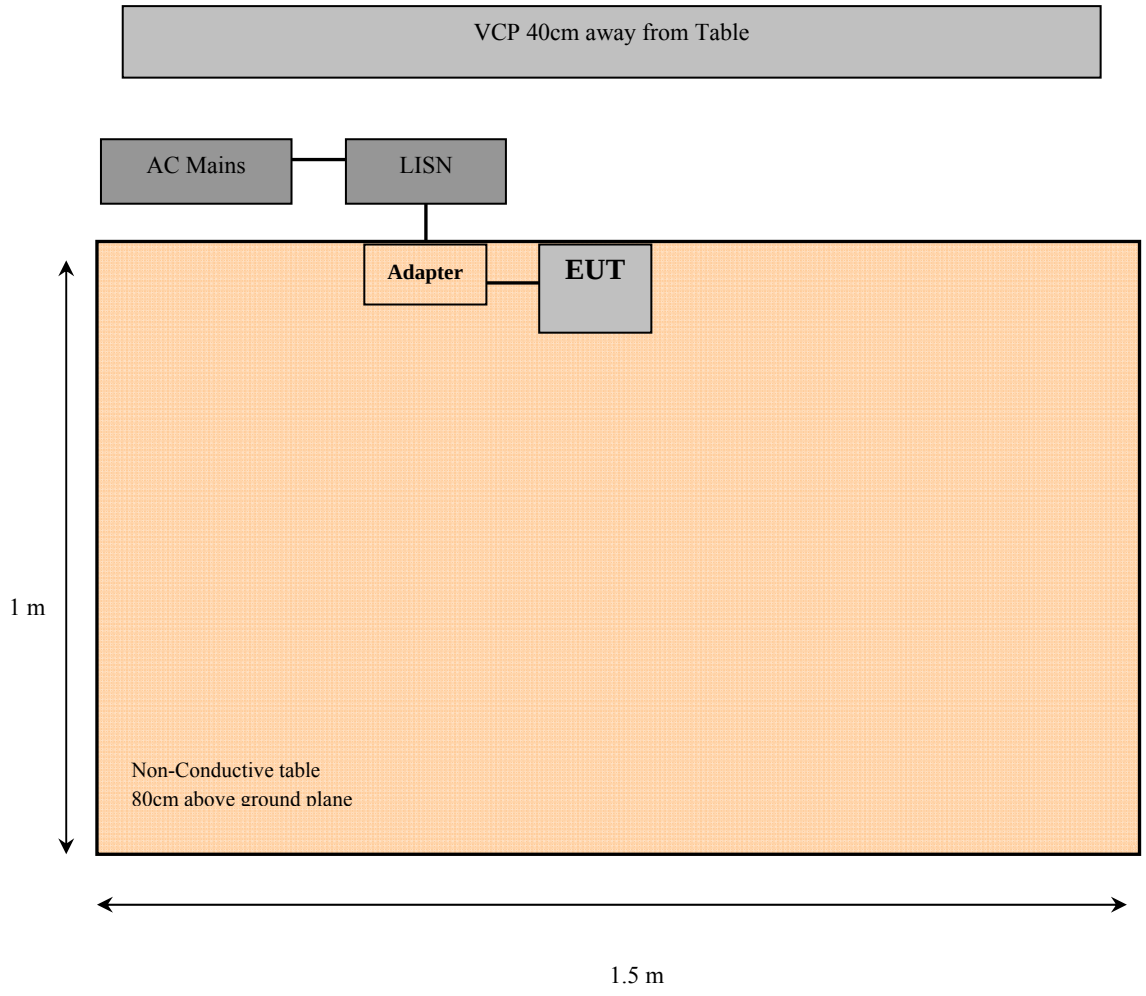
CA = Ai + CL + Atten

For example, a corrected amplitude of 46.2 dBuV = Indicated Reading (32.5 dBuV) + Cable Loss (3.7 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:

Margin = Corrected Amplitude – Limit

6.5 Test Setup Block Diagram



6.6 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde and Schwarz	Receiver, EMI Test	ESCI 1166.5950.03	100338	2018-07-05	2 years
Rohde and Schwarz	Impulse Limiter	ESH3-Z2	101964	2019-07-31	1 year
Solar Electronics Company	High Pass Filter	Type 7930-100	7930150202	2020-02-27	1 year
Suirong	30 ft conductive emission cable	LMR 400	-	N/R	N/A
FCC	LISN	FCC-LISN-50-25-2-10-CISPR16	160129	2019-07-11	14 months
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

6.7 Test Environmental Conditions

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

The testing was performed by Matthew Riego de Dios on 2020-06-23 in the Ground Plane test site.

6.8 Summary of Test Results

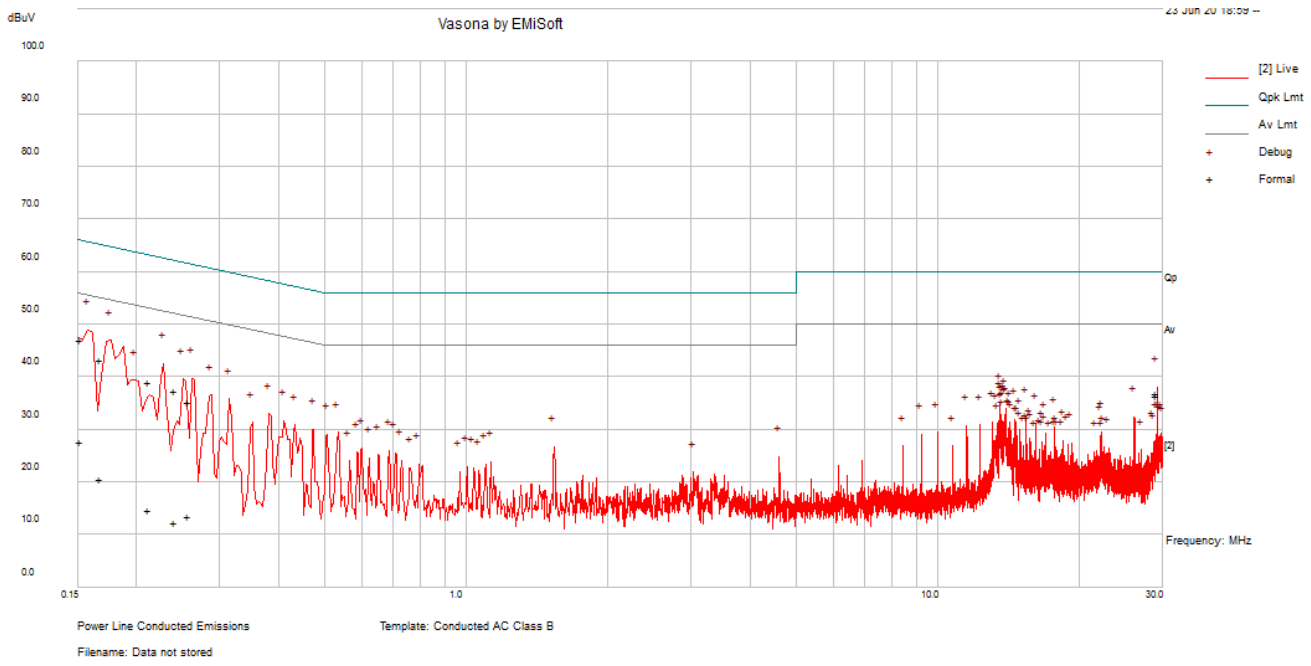
According to the recorded data in following table, the EUT complied with the FCC 15C and ISEDC RSS-Gen standard's conducted emissions limits, with the margin reading of:

Connection: AC/DC adapter connected to 120 V/60 Hz, AC			
Margin (dB)	**Frequency (MHz)**	**Conductor Mode (Line/Neutral)**	**Range (MHz)**
-13.65	29.184644	Line	0.15-30

6.9 Conducted Emissions Test Plots and Data

Worst Case: Radio 2 802.11n20 mode Low Channel

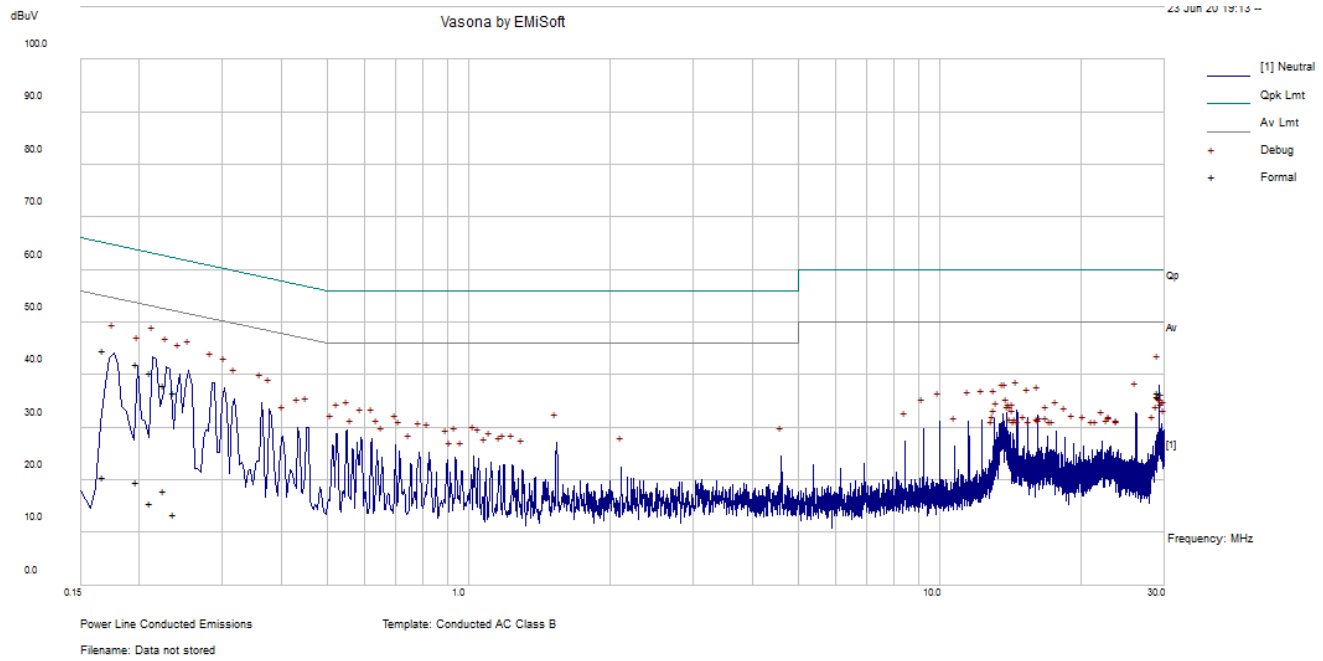
120 V, 60 Hz – Line



Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.151919	47	Line	65.89	-18.9	QP
0.167139	43.2	Line	65.1	-21.9	QP
0.211874	38.91	Line	63.13	-24.22	QP
0.257319	35.32	Line	61.52	-26.2	QP
29.184644	36.88	Line	60	-23.12	QP
0.240797	37.46	Line	62.07	-24.61	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.151919	27.59	Line	55.89	-28.3	Ave.
0.167139	20.64	Line	55.1	-34.47	Ave.
0.211874	14.59	Line	53.13	-38.54	Ave.
0.257319	13.59	Line	51.52	-37.93	Ave.
29.184644	36.35	Line	50	-13.65	Ave.
0.240797	12.23	Line	52.07	-39.84	Ave.

120 V, 60 Hz – Neutral



Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.197362	41.97	Neutral	63.72	-21.76	QP
0.167175	44.6	Neutral	65.1	-20.49	QP
0.23668	36.54	Neutral	62.21	-25.68	QP
0.211226	40.49	Neutral	63.16	-22.67	QP
0.226206	38.04	Neutral	62.59	-24.54	QP
29.182898	36.63	Neutral	60	-23.37	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
0.197362	19.6	Neutral	53.72	-34.12	Ave.
0.167175	20.59	Neutral	55.1	-34.51	Ave.
0.23668	13.51	Neutral	52.21	-38.71	Ave.
0.211226	15.63	Neutral	53.16	-37.52	Ave.
0.226206	18.09	Neutral	52.59	-34.49	Ave.
29.182898	35.92	Neutral	50	-14.08	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 0.495 – 0.505 2.1735 – 2.1905 4.125 – 4.128 4.17725 – 4.17775 4.20725 – 4.20775 6.215 – 6.218 6.26775 – 6.26825 6.31175 – 6.31225 8.291 – 8.294 8.362 – 8.366 8.37625 – 8.38675 8.41425 – 8.41475 12.29 – 12.293 12.51975 – 12.52025 12.57675 – 12.57725 13.36 – 13.41	16.42 – 16.423 16.69475 – 16.69525 25.5 – 25.67 37.5 – 38.25 73 – 74.6 74.8 – 75.2 108 – 121.94 123 – 138 149.9 – 150.05 156.52475 – 156.52525 156.7 – 156.9 162.0125 –167.17 167.72 – 173.2 240 – 285 322 – 335.4 399.9 – 410 608 – 614	960 – 1240 1300 – 1427 1435 – 1626.5 1645.5 – 1646.5 1660 – 1710 1718.8 – 1722.2 2200 – 2300 2310 – 2390 2483.5 – 2500 2690 – 2900 3260 – 3267 3.332 – 3.339 3 3458 – 3 358 3.600 – 4.400	4. 5 – 5. 15 5. 35 – 5. 46 7.25 – 7.75 8.025 – 8.5 9.0 – 9.2 9.3 – 9.5 10.6 – 12.7 13.25 – 13.4 14.47 – 14.5 15.35 – 16.2 17.7 – 21.4 22.01 – 23.12 23.6 – 24.0 31.2 – 31.8 36.43 – 36.5 Above 38.6

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 ISEDC RSS-Gen 8.9,

> Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 4 or Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Table 4 – General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Above 30 MHz

Frequency (MHz)	Field Strength (µv/m at 3 metres)
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 license-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 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.

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 ISEDC 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 were 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's polarity should be changed between horizontal and vertical.

The spectrum analyzer or receiver was set as:

Below 1000 MHz:

RBW = 100 kHz / VBW = 300 kHz / Sweep = Auto

Above 1000 MHz:

(1) Peak: RBW = 1MHz / VBW = 1MHz / Sweep = Auto
(2) Average: RBW = 1MHz / VBW = 10Hz or 1/T / Sweep = Auto

7.4 Corrected Amplitude and Margin Calculation

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:

CA = Ai + AF + CL + Atten – 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:

Margin = Corrected Amplitude - Limit

7.5 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	MY48250238	2019-07-26	1 year
Rhode & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100044	2018-10-26	2 years
BACL	5m3 Sensitivity Box	1	2	2019-10-02	1 year
Sunol Sciences	System Controller	SC99V	011003-1	N/R	N/A
Sunol Sciences	Biconilog Antenna	JB3	A020106-2	2019-11-20	2 years
ETS Lindgren	Horn Antenna	3117	00218973	2019-02-13	2 years
Wisewave	Antenna, Horn	ARH-4223-02	10555-02	2020-02-05	2 years
Wisewave	Antenna, Horn	ARH-2823-02	10555-01	2020-02-05	2 years
-	SMA cable	-	-	Each time[1]	N/A
IW Microwave	150 Series 2.92mm Cable	KPS1501AN-3780-KPS	DC 1925	2019-09-11	1 year
IW Microwave	157 Series Cable Armored with 2.92mm Male Plugs on Both Sides	KPS-1571AN-2400	DC 1922	2019-07-07	1 year
MDP DIgital	Times Microwave LMR 400 UltraFex Coaxial Cable 35\'	LMR400UF	BACL1904161	2020-05-20	1 year
AH Systems	Preamplifier	PAM 1840 VH	170	2019-09-24	1 year
Agilent	Preamplifier	8449B	3147A00400	2020-02-27	1 year
HP	Pre Amplifier	8447D	2443A04374	2019-08-13	1 year
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL *attests that all calibrations have been performed per the A2LA requirements, traceable to NIST.*

7.6 Test Environmental Conditions

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

The testing was performed by Matthew Riego de Dios from 2020-06-08 to 2020-06-29 in 5m chamber 3.

7.7 Summary of Test Results

According to the data hereinafter, the EUT complied with FCC Title 47, Part 15C and ISEDC RSS-247 standard's radiated emissions limits, and had the worst margin of:

2.4 GHz Wi-Fi

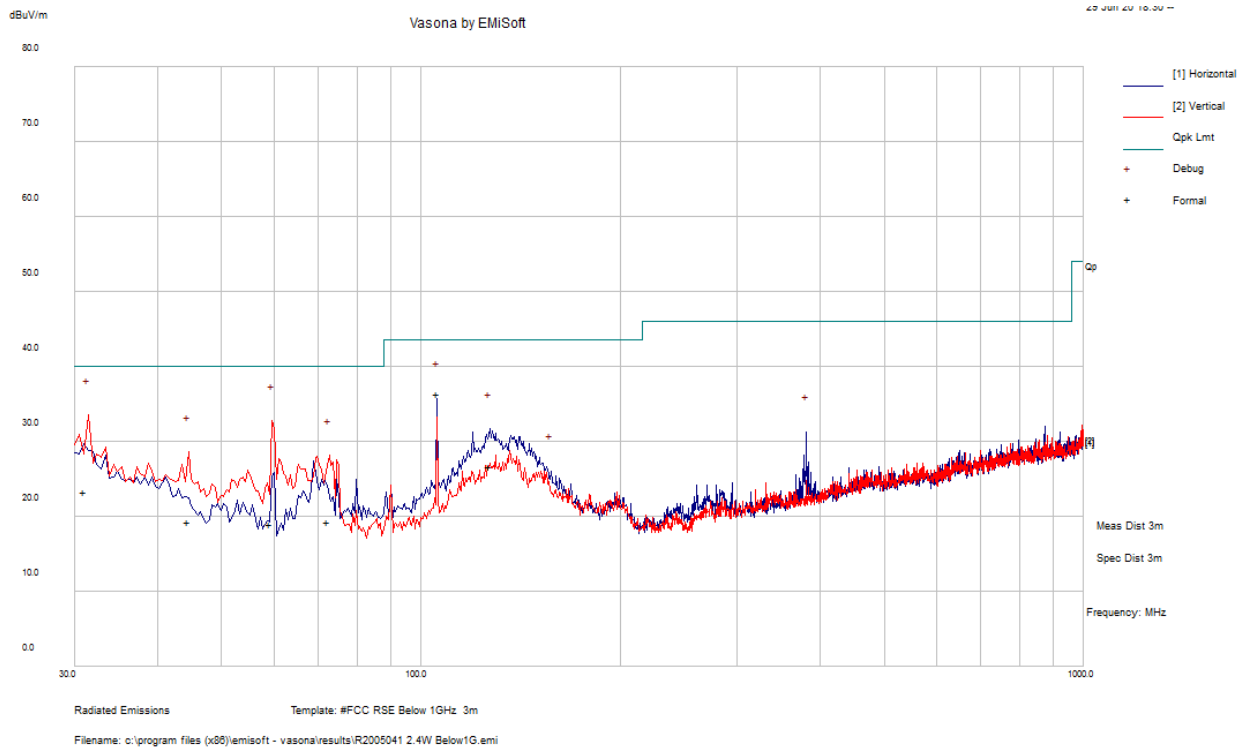
Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Radio, Mode, channel**
-0.58	2390	Horizontal	Radio 2, n20 mode, low channel

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

7.8 Radiated Emissions Test Results

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

Worst Case: Radio 2, n20 mode, Low Channel



Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
31.08075	23.36	102	V	251	40	-16.64	QP
59.27875	18.97	110	V	238	40	-21.03	QP
105.77475	36.34	101	H	7	43.5	-7.16	QP
44.453	19.4	136	V	202	40	-20.6	QP
126.838	26.66	219	H	304	43.5	-16.84	QP
72.2205	19.36	121	V	267	40	-20.64	QP

2) 1–25 GHz Measured at 3 meters

RADIO 2

802.11b mode Antenna A

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/ISEDC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2390	56.87	115	275	V	32.6	6.33	36.34	59.46	74	-14.54	Peak
2390	58.11	65	155	H	32.6	6.33	36.34	60.7	74	-13.3	Peak
2390	49.35	115	275	V	32.6	6.33	36.34	51.94	54	-2.06	Ave
2390	50.33	65	155	H	32.6	6.33	36.34	52.92	54	-1.08	Ave
4824	46.88	0	100	V	35	9.89	35.43	55.64	74	-18.36	Peak
4824	46.54	0	100	H	35	9.89	35.43	56.05	74	-17.95	Peak
4824	34.33	0	100	V	35	9.89	35.43	44.16	54	-9.84	Ave
4824	34.65	0	100	H	35	9.89	35.43	44.18	54	-9.82	Ave
7236	46.26	0	100	V	36.1	9.83	35.82	56.2	74	-17.8	Peak
7236	46.24	0	100	H	36.1	9.83	35.82	55.82	74	-18.18	Peak
7236	33.85	0	100	V	36.1	9.83	35.82	43.45	54	-10.55	Ave
7236	33.87	0	100	H	36.1	9.83	35.82	42.89	54	-11.11	Ave
Middle Channel 2437 MHz											
4874	49.63	127	188	V	35.2	10.96	35.43	60.36	74	-13.64	Peak
4874	50.12	195	115	H	35.2	10.96	35.43	60.85	74	-13.15	Peak
4874	41.98	127	188	V	35.2	10.96	35.43	52.71	54	-1.29	Ave
4874	42.48	195	115	H	35.2	10.96	35.43	53.21	54	-0.79	Ave
7311	46.61	0	100	V	36.1	10.95	35.82	57.84	74	-16.16	Peak
7311	46.39	0	100	H	36.1	10.95	35.82	57.62	74	-16.38	Peak
7311	34.27	0	100	V	36.1	10.95	35.82	45.5	54	-8.5	Ave
7311	33.74	0	100	H	36.1	10.95	35.82	44.97	54	-9.03	Ave
High Channel 2462 MHz											
2483.5	57.6	165	270	V	33	5.65	36.34	59.91	74	-14.09	Peak
2483.5	58.81	5	270	H	33	5.65	36.34	61.12	74	-12.88	Peak
2483.5	50.01	165	270	V	33	5.65	36.34	52.32	54	-1.68	Ave
2483.5	**50.94**	**5**	**270**	**H**	**33**	**5.65**	**36.34**	**53.25**	**54**	**-0.75**	**Ave**
4924	46.43	0	100	V	35.4	11.07	35.43	57.47	74	-16.53	Peak
4924	46.57	0	100	H	35.4	11.07	35.43	57.61	74	-16.39	Peak
4924	34.16	0	100	V	35.4	11.07	35.43	45.2	54	-8.8	Ave
4924	34.26	0	100	H	35.4	11.07	35.43	45.3	54	-8.7	Ave
7386	46.1	0	100	V	36.1	12.73	35.9	59.03	74	-14.97	Peak
7386	45.55	0	100	H	36.1	12.73	35.9	58.48	74	-15.52	Peak
7386	33.35	0	100	V	36.1	12.73	35.9	46.28	54	-7.72	Ave
7386	33.36	0	100	H	36.1	12.73	35.9	46.29	54	-7.71	Ave

802.11b mode Antenna B

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/ISEDC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2390	56.88	340	215	V	32.6	6.33	36.34	59.47	74	-14.53	Peak
2390	57.7	85	290	H	32.6	6.33	36.34	60.29	74	-13.71	Peak
2390	49.12	340	215	V	32.6	6.33	36.34	51.71	54	-2.28	Ave
2390	**50.65**	**85**	**290**	**H**	**32.6**	**6.33**	**36.34**	**53.24**	**54**	**-0.75**	**Ave**
4824	45.94	0	100	V	35	9.89	35.43	55.4	74	-18.6	Peak
4824	46.59	0	100	H	35	9.89	35.43	56.05	74	-17.95	Peak
4824	34.73	0	100	V	35	9.89	35.43	44.19	54	-9.81	Ave
4824	34.56	0	100	H	35	9.89	35.43	44.02	54	-9.98	Ave
7236	45.76	0	100	V	36.1	9.83	35.82	55.87	74	-18.13	Peak
7236	45.82	0	100	H	36.1	9.83	35.82	55.93	74	-18.07	Peak
7236	34.29	0	100	V	36.1	9.83	35.82	44.4	54	-9.6	Ave
7236	34.46	0	100	H	36.1	9.83	35.82	44.57	54	-9.43	Ave
Middle Channel 2437 MHz											
4874	46.57	0	100	V	35.2	10.96	35.43	57.3	74	-16.7	Peak
4874	46.3	0	100	H	35.2	10.96	35.43	57.03	74	-16.97	Peak
4874	34.17	0	100	V	35.2	10.96	35.43	44.9	54	-9.1	Ave
4874	33.56	0	100	H	35.2	10.96	35.43	44.29	54	-9.71	Ave
7311	44.99	0	100	V	36.1	10.95	35.82	56.22	74	-17.78	Peak
7311	45.1	0	100	H	36.1	10.95	35.82	56.33	74	-17.67	Peak
7311	33.05	0	100	V	36.1	10.95	35.82	44.28	54	-9.72	Ave
7311	33.56	0	100	H	36.1	10.95	35.82	44.79	54	-9.21	Ave
High Channel 2462 MHz											
2483.5	56.11	305	280	V	33	5.65	36.34	58.42	74	-15.58	Peak
2483.5	57.88	50	280	H	33	5.65	36.34	60.19	74	-13.81	Peak
2483.5	48.75	305	280	V	33	5.65	36.34	51.06	54	-2.93	Ave
2483.5	50.54	50	280	H	33	5.65	36.34	52.85	54	-1.14	Ave
4924	46.33	0	100	V	35.4	11.07	35.43	57.37	74	-16.63	Peak
4924	46.28	0	100	H	35.4	11.07	35.43	57.32	74	-16.68	Peak
4924	34.97	0	100	V	35.4	11.07	35.43	46.01	54	-7.99	Ave
4924	34.89	0	100	H	35.4	11.07	35.43	45.93	54	-8.07	Ave
7386	46.2	0	100	V	36.1	12.73	35.9	59.13	74	-14.87	Peak
7386	45.24	0	100	H	36.1	12.73	35.9	58.17	74	-15.83	Peak
7386	33.62	0	100	V	36.1	12.73	35.9	46.55	54	-7.45	Ave
7386	33.61	0	100	H	36.1	12.73	35.9	46.54	54	-7.46	Ave

802.11g mode Antenna A

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/ISEDC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2390	63.25	145	240	V	32.6	6.33	36.34	65.84	74	-8.16	Peak
2390	63.47	64	235	H	32.6	6.33	36.34	66.06	74	-7.94	Peak
2390	**49.72**	**145**	**240**	**V**	**32.6**	**6.33**	**36.34**	**52.31**	**54**	**-1.68**	**Ave**
2390	49.57	64	235	H	32.6	6.33	36.34	52.16	54	-1.83	Ave
4824	45.37	0	100	V	35	9.89	35.43	54.83	74	-19.17	Peak
4824	45.44	0	100	H	35	9.89	35.43	54.9	74	-19.1	Peak
4824	33.71	0	100	V	35	9.89	35.43	43.17	54	-10.83	Ave
4824	34.01	0	100	H	35	9.89	35.43	43.47	54	-10.53	Ave
7236	46.14	0	100	V	36.1	9.83	35.82	56.25	74	-17.75	Peak
7236	46.45	0	100	H	36.1	9.83	35.82	56.56	74	-17.44	Peak
7236	33.51	0	100	V	36.1	9.83	35.82	43.62	54	-10.38	Ave
7236	33.77	0	100	H	36.1	9.83	35.82	43.88	54	-10.12	Ave
Middle Channel 2437 MHz											
4874	47.02	0	100	V	35.2	10.96	35.43	57.75	74	-16.25	Peak
4874	46.69	0	100	H	35.2	10.96	35.43	57.42	74	-16.58	Peak
4874	35.4	0	100	V	35.2	10.96	35.43	46.13	54	-7.87	Ave
4874	35.18	0	100	H	35.2	10.96	35.43	45.91	54	-8.09	Ave
7311	46.71	0	100	V	36.1	10.95	35.82	57.94	74	-16.06	Peak
7311	46.36	0	100	H	36.1	10.95	35.82	57.59	74	-16.41	Peak
7311	35.74	0	100	V	36.1	10.95	35.82	46.97	54	-7.03	Ave
7311	35.91	0	100	H	36.1	10.95	35.82	47.14	54	-6.86	Ave
High Channel 2462 MHz											
2483.5	61.62	110	290	V	33	5.65	36.34	63.93	74	-10.07	Peak
2483.5	63.51	65	285	H	33	5.65	36.34	65.82	74	-8.18	Peak
2483.5	46.61	110	290	V	33	5.65	36.34	48l.92	54	-5.08	Ave
2483.5	49.88	65	285	H	33	5.65	36.34	52.19	54	-1.80	Ave
4924	46.54	0	100	V	35.4	11.07	35.43	57.58	74	-16.42	Peak
4924	46.56	0	100	H	35.4	11.07	35.43	57.6	74	-16.4	Peak
4924	34.59	0	100	V	35.4	11.07	35.43	45.63	54	-8.37	Ave
4924	34.22	0	100	H	35.4	11.07	35.43	45.26	54	-8.74	Ave
7386	45.39	0	100	V	36.1	12.73	35.9	58.32	74	-15.68	Peak
7386	45.54	0	100	H	36.1	12.73	35.9	58.47	74	-15.53	Peak
7386	34.08	0	100	V	36.1	12.73	35.9	47.01	54	-6.99	Ave
7386	34.02	0	100	H	36.1	12.73	35.9	46.95	54	-7.05	Ave

802.11g mode Antenna B

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/ISEDC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2390	63.88	328	300	V	32.6	6.33	36.34	66.47	74	-7.53	Peak
2390	63.45	95	300	H	32.6	6.33	36.34	66.04	74	-7.96	Peak
2390	**50.65**	**328**	**300**	**V**	**32.6**	**6.33**	**36.34**	**53.24**	**54**	**-0.75**	**Ave**
2390	50.45	95	300	H	32.6	6.33	36.34	53.04	54	-0.95	Ave
4824	45.2	0	100	V	35	9.89	35.43	54.66	74	-19.34	Peak
4824	45.69	0	100	H	35	9.89	35.43	55.15	74	-18.85	Peak
4824	33.55	0	100	V	35	9.89	35.43	43.01	54	-10.99	Ave
4824	33.64	0	100	H	35	9.89	35.43	43.1	54	-10.9	Ave
7236	45.49	0	100	V	36.1	9.83	35.82	55.6	74	-18.4	Peak
7236	45.63	0	100	H	36.1	9.83	35.82	55.74	74	-18.26	Peak
7236	33.7	0	100	V	36.1	9.83	35.82	43.81	54	-10.19	Ave
7236	33.59	0	100	H	36.1	9.83	35.82	43.7	54	-10.3	Ave
Middle Channel 2437 MHz											
4874	45.86	0	100	V	35.2	10.96	35.43	56.59	74	-17.41	Peak
4874	46.36	0	100	H	35.2	10.96	35.43	57.09	74	-16.91	Peak
4874	34.47	0	100	V	35.2	10.96	35.43	45.2	54	-8.8	Ave
4874	34.58	0	100	H	35.2	10.96	35.43	45.31	54	-8.69	Ave
7311	44.58	0	100	V	36.1	10.95	35.82	55.81	74	-18.19	Peak
7311	44.26	0	100	H	36.1	10.95	35.82	55.49	74	-18.51	Peak
7311	33.18	0	100	V	36.1	10.95	35.82	44.41	54	-9.59	Ave
7311	33.34	0	100	H	36.1	10.95	35.82	44.57	54	-9.43	Ave
High Channel 2462 MHz											
2483.5	65.12	330	275	V	33	5.65	36.34	67.43	74	-6.57	Peak
2483.5	66.89	55	275	H	33	5.65	36.34	69.2	74	-4.8	Peak
2483.5	49.08	330	275	V	33	5.65	36.34	51.39	54	-2.61	Ave
2483.5	50.67	55	275	H	33	5.65	36.34	52.98	54	-1.01	Ave
4924	46.41	0	100	V	35.4	11.07	35.43	57.45	74	-16.55	Peak
4924	46.04	0	100	H	35.4	11.07	35.43	57.08	74	-16.92	Peak
4924	34.73	0	100	V	35.4	11.07	35.43	45.77	54	-8.23	Ave
4924	34.72	0	100	H	35.4	11.07	35.43	45.76	54	-8.24	Ave
7386	44.71	0	100	V	36.1	12.73	35.9	57.64	74	-16.36	Peak
7386	44.99	0	100	H	36.1	12.73	35.9	57.92	74	-16.08	Peak
7386	33.94	0	100	V	36.1	12.73	35.9	46.87	54	-7.13	Ave
7386	33.79	0	100	H	36.1	12.73	35.9	46.72	54	-7.28	Ave

802.11n20 mode MIMO

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/ISEDC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2390	64.93	145	290	V	32.6	6.33	36.34	67.52	74	-6.48	Peak
2390	67.63	65	290	H	32.6	6.33	36.34	70.22	74	-3.78	Peak
2390	50.65	145	290	V	32.6	6.33	36.34	53.24	54	-0.75	Ave
2390	**50.82**	**65**	**290**	**H**	**32.6**	**6.33**	**36.34**	**53.41**	**54**	**-0.58**	**Ave**
4824	45.35	0	100	V	35	9.89	35.43	54.81	74	-19.19	Peak
4824	44.98	0	100	H	35	9.89	35.43	54.44	74	-19.56	Peak
4824	34.23	0	100	V	35	9.89	35.43	43.69	54	-10.31	Ave
4824	34.11	0	100	H	35	9.89	35.43	43.57	54	-10.43	Ave
7236	45.93	0	100	V	36.1	9.83	35.82	56.04	74	-17.96	Peak
7236	45.47	0	100	H	36.1	9.83	35.82	55.58	74	-18.42	Peak
7236	34.15	0	100	V	36.1	9.83	35.82	44.26	54	-9.74	Ave
7236	33.95	0	100	H	36.1	9.83	35.82	44.06	54	-9.94	Ave
Middle Channel 2437 MHz											
4874	48.77	346	136	V	35.2	10.96	35.43	59.5	74	-14.5	Peak
4874	48.08	146	150	H	35.2	10.96	35.43	58.81	74	-15.19	Peak
4874	35.51	346	136	V	35.2	10.96	35.43	46.24	54	-7.76	Ave
4874	35.98	146	150	H	35.2	10.96	35.43	46.71	54	-7.29	Ave
7311	45.1	0	100	V	36.1	10.95	35.82	56.33	74	-17.67	Peak
7311	45.45	0	100	H	36.1	10.95	35.82	56.68	74	-17.32	Peak
7311	33.54	0	100	V	36.1	10.95	35.82	44.77	54	-9.23	Ave
7311	33.44	0	100	H	36.1	10.95	35.82	44.67	54	-9.33	Ave
High Channel 2462 MHz											
2483.5	66.43	140	290	V	33	5.65	36.34	68.74	74	-5.26	Peak
2483.5	68.95	50	260	H	33	5.65	36.34	71.26	74	-2.74	Peak
2483.5	46.84	140	290	V	33	5.65	36.34	49.15	54	-4.85	Ave
2483.5	50.79	50	260	H	33	5.65	36.34	53.10	54	-0.90	Ave
4924	46.49	0	100	V	35.4	11.07	35.43	57.53	74	-16.47	Peak
4924	46.75	0	100	H	35.4	11.07	35.43	57.79	74	-16.21	Peak
4924	34.75	0	100	V	35.4	11.07	35.43	45.79	54	-8.21	Ave
4924	33.96	0	100	H	35.4	11.07	35.43	45.00	54	-9.00	Ave
7386	45.77	0	100	V	36.1	12.73	35.9	58.70	74	-15.30	Peak
7386	45.70	0	100	H	36.1	12.73	35.9	58.63	74	-15.37	Peak
7386	34.02	0	100	V	36.1	12.73	35.9	46.95	54	-7.05	Ave
7386	33.99	0	100	H	36.1	12.73	35.9	46.92	54	-7.08	Ave

RADIO 1

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/ISEDC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2390	55.91	345	112	V	32.6	6.33	36.34	58.50	74	-15.50	Peak
2390	56.96	218	240	H	32.6	6.33	36.34	59.55	74	-14.45	Peak
2390	47.98	345	112	V	32.6	6.33	36.34	50.57	54	-3.43	Ave
2390	49.37	218	240	H	32.6	6.33	36.34	51.96	54	-2.04	Ave
4824	46.18	0	100	V	35	9.89	35.43	55.64	74	-18.36	Peak
4824	46.59	0	100	H	35	9.89	35.43	56.05	74	-17.95	Peak
4824	34.70	0	100	V	35	9.89	35.43	44.16	54	-9.84	Ave
4824	34.72	0	100	H	35	9.89	35.43	44.18	54	-9.82	Ave
7236	46.09	0	100	V	36.1	9.83	35.82	56.20	74	-17.80	Peak
7236	45.71	0	100	H	36.1	9.83	35.82	55.82	74	-18.18	Peak
7236	33.34	0	100	V	36.1	9.83	35.82	43.45	54	-10.55	Ave
7236	32.78	0	100	H	36.1	9.83	35.82	42.89	54	-11.11	Ave
Middle Channel 2437 MHz											
4874	48.75	0	297	V	35.2	10.96	35.43	59.48	74	-14.52	Peak
4874	48.89	278	168	H	35.2	10.96	35.43	59.62	74	-14.38	Peak
4874	38.65	0	297	V	35.2	10.96	35.43	49.38	54	-4.62	Ave
4874	40.71	278	168	H	35.2	10.96	35.43	51.44	54	-2.56	Ave
7311	45.18	0	100	V	36.1	10.95	35.82	56.41	74	-17.59	Peak
7311	45.05	0	100	H	36.1	10.95	35.82	56.28	74	-17.72	Peak
7311	33.38	0	100	V	36.1	10.95	35.82	44.61	54	-9.39	Ave
7311	33.60	0	100	H	36.1	10.95	35.82	44.83	54	-9.17	Ave
High Channel 2462 MHz											
2483.5	56.36	325	115	V	33	5.65	36.34	58.67	74	-15.33	Peak
2483.5	58.06	230	115	H	33	5.65	36.34	60.37	74	-13.63	Peak
2483.5	48.71	325	115	V	33	5.65	36.34	51.02	54	-2.98	Ave
2483.5	**50.33**	**230**	**115**	**H**	**33**	**5.65**	**36.34**	**52.64**	**54**	**-1.36**	**Ave**
4924	46.64	0	100	V	35.4	11.07	35.43	57.68	74	-16.32	Peak
4924	46.75	0	100	H	35.4	11.07	35.43	57.79	74	-16.21	Peak
4924	34.95	0	100	V	35.4	11.07	35.43	45.99	54	-8.01	Ave
4924	34.77	0	100	H	35.4	11.07	35.43	45.81	54	-8.19	Ave
7386	45.12	0	100	V	36.1	12.73	35.9	58.05	74	-15.95	Peak
7386	45.54	0	100	H	36.1	12.73	35.9	58.47	74	-15.53	Peak
7386	33.76	0	100	V	36.1	12.73	35.9	46.69	54	-7.31	Ave
7386	33.75	0	100	H	36.1	12.73	35.9	46.68	54	-7.32	Ave

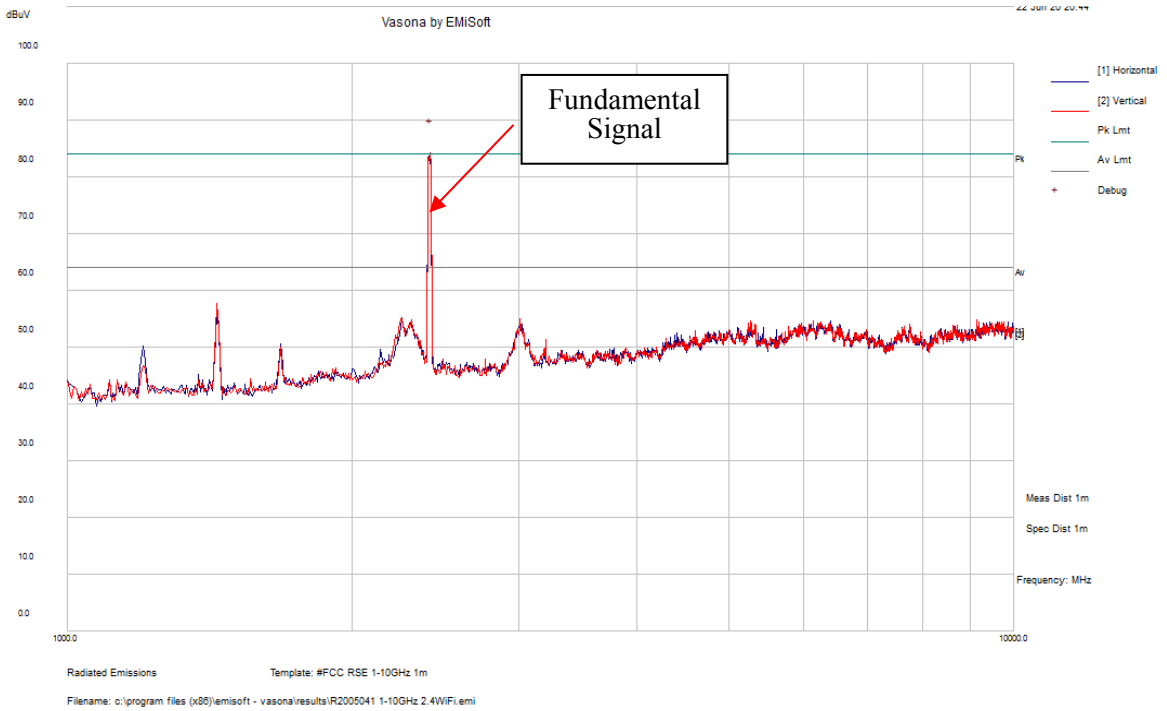
802.11g mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/ISEDC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2390	62.3	340	112	V	32.6	6.33	36.34	64.89	74	-9.11	Peak
2390	63.5	40	280	H	32.6	6.33	36.34	66.09	74	-7.91	Peak
2390	49.6	340	112	V	32.6	6.33	36.34	52.19	54	-1.81	Ave
2390	50.02	40	280	H	32.6	6.33	36.34	52.61	54	-1.39	Ave
4824	45.6	0	100	V	35	9.89	35.43	55.06	74	-18.94	Peak
4824	45.86	0	100	H	35	9.89	35.43	55.32	74	-18.68	Peak
4824	33.95	0	100	V	35	9.89	35.43	43.41	54	-10.59	Ave
4824	33.9	0	100	H	35	9.89	35.43	43.36	54	-10.64	Ave
7236	45.29	0	100	V	36.1	9.83	35.82	55.4	74	-18.6	Peak
7236	45.68	0	100	H	36.1	9.83	35.82	55.79	74	-18.21	Peak
7236	33.82	0	100	V	36.1	9.83	35.82	43.93	54	-10.07	Ave
7236	33.72	0	100	H	36.1	9.83	35.82	43.83	54	-10.17	Ave
Middle Channel 2437 MHz											
4874	46.29	0	100	V	35.2	10.96	35.43	57.02	74	-16.98	Peak
4874	46.39	0	100	H	35.2	10.96	35.43	57.12	74	-16.88	Peak
4874	34.62	0	100	V	35.2	10.96	35.43	45.35	54	-8.65	Ave
4874	34.6	0	100	H	35.2	10.96	35.43	45.33	54	-8.67	Ave
7311	48.92	355	106	V	36.1	10.95	35.82	60.15	74	-13.85	Peak
7311	48.68	91	100	H	36.1	10.95	35.82	59.91	74	-14.09	Peak
7311	36.37	355	106	V	36.1	10.95	35.82	47.6	54	-6.4	Ave
7311	35.98	91	100	H	36.1	10.95	35.82	47.21	54	-6.79	Ave
High Channel 2462 MHz											
2483.5	61.90	325	115	V	33	5.65	36.34	64.21	74	-9.79	Peak
2483.5	62.93	230	115	H	33	5.65	36.34	65.24	74	-8.76	Peak
2483.5	49.09	325	115	V	33	5.65	36.34	51.40	54	-2.60	Ave
2483.5	**50.74**	**230**	**115**	**H**	**33**	**5.65**	**36.34**	**53.05**	**54**	**-0.95**	**Ave**
4924	46.42	0	100	V	35.4	11.07	35.43	57.46	74	-16.54	Peak
4924	46.01	0	100	H	35.4	11.07	35.43	57.05	74	-16.95	Peak
4924	34.75	0	100	V	35.4	11.07	35.43	45.79	54	-8.21	Ave
4924	34.83	0	100	H	35.4	11.07	35.43	45.87	54	-8.13	Ave
7386	45.41	0	100	V	36.1	12.73	35.9	58.34	74	-15.66	Peak
7386	45.27	0	100	H	36.1	12.73	35.9	58.20	74	-15.80	Peak
7386	33.69	0	100	V	36.1	12.73	35.9	46.62	54	-7.38	Ave
7386	33.84	0	100	H	36.1	12.73	35.9	46.77	54	-7.23	Ave

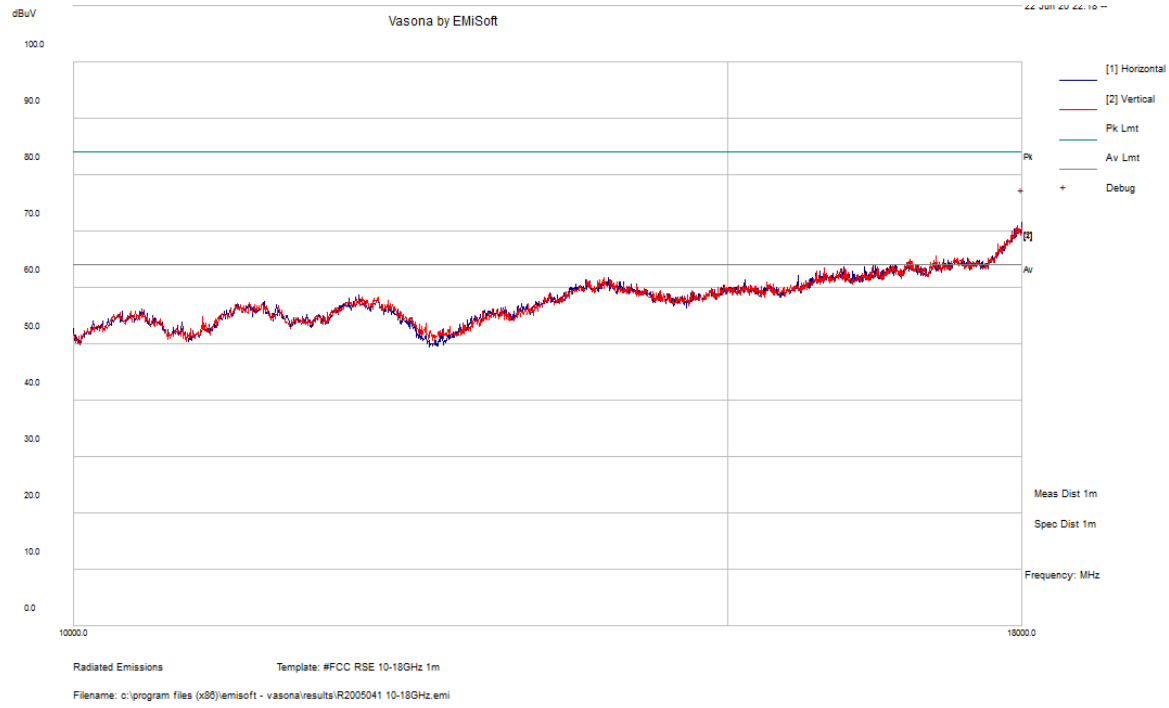
802.11n20 mode

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/ISEDC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2412 MHz											
2390	66.13	320	115	V	32.6	6.33	36.34	68.72	74	-5.28	Peak
2390	67.64	40	280	H	32.6	6.33	36.34	70.23	74	-3.77	Peak
2390	48.31	320	115	V	32.6	6.33	36.34	50.90	54	-3.10	Ave
2390	49.67	40	280	H	32.6	6.33	36.34	52.26	54	-1.74	Ave
4824	45.93	0	100	V	35	9.89	35.43	55.39	74	-18.61	Peak
4824	45.49	0	100	H	35	9.89	35.43	54.95	74	-19.05	Peak
4824	33.92	0	100	V	35	9.89	35.43	43.38	54	-10.62	Ave
4824	33.77	0	100	H	35	9.89	35.43	43.23	54	-10.77	Ave
7236	45.37	0	100	V	36.1	9.83	35.82	55.48	74	-18.52	Peak
7236	46.01	0	100	H	36.1	9.83	35.82	56.12	74	-17.88	Peak
7236	33.78	0	100	V	36.1	9.83	35.82	43.89	54	-10.11	Ave
7236	33.72	0	100	H	36.1	9.83	35.82	43.83	54	-10.17	Ave
Middle Channel 2437 MHz											
4874	46.2	0	100	V	35.2	10.96	35.43	56.93	74	-17.07	Peak
4874	46.03	0	100	H	35.2	10.96	35.43	56.76	74	-17.24	Peak
4874	34.61	0	100	V	35.2	10.96	35.43	45.34	54	-8.66	Ave
4874	34.63	0	100	H	35.2	10.96	35.43	45.36	54	-8.64	Ave
7311	48.8	353	132	V	36.1	10.95	35.82	60.03	74	-13.97	Peak
7311	48.1	87	117	H	36.1	10.95	35.82	59.33	74	-14.67	Peak
7311	36.02	353	132	V	36.1	10.95	35.82	47.25	54	-6.75	Ave
7311	35.97	87	117	H	36.1	10.95	35.82	47.2	54	-6.8	Ave
High Channel 2462 MHz											
2483.5	64.45	320	115	V	33	5.65	36.34	66.76	74	-7.24	Peak
2483.5	66.16	230	115	H	33	5.65	36.34	68.47	74	-5.53	Peak
2483.5	48.65	320	115	V	33	5.65	36.34	50.96	54	-3.04	Ave
2483.5	**50.70**	**230**	**115**	**H**	**33**	**5.65**	**36.34**	**53.01**	**54**	**-0.99**	**Ave**
4924	46.41	0	100	V	35.4	11.07	35.43	57.45	74	-16.55	Peak
4924	46.28	0	100	H	35.4	11.07	35.43	57.32	74	-16.68	Peak
4924	34.57	0	100	V	35.4	11.07	35.43	45.61	54	-8.39	Ave
4924	34.81	0	100	H	35.4	11.07	35.43	45.85	54	-8.15	Ave
7386	45.12	0	100	V	36.1	12.73	35.9	58.05	74	-15.95	Peak
7386	45.94	0	100	H	36.1	12.73	35.9	58.87	74	-15.13	Peak
7386	33.65	0	100	V	36.1	12.73	35.9	46.58	54	-7.42	Ave
7386	33.71	0	100	H	36.1	12.73	35.9	46.64	54	-7.36	Ave

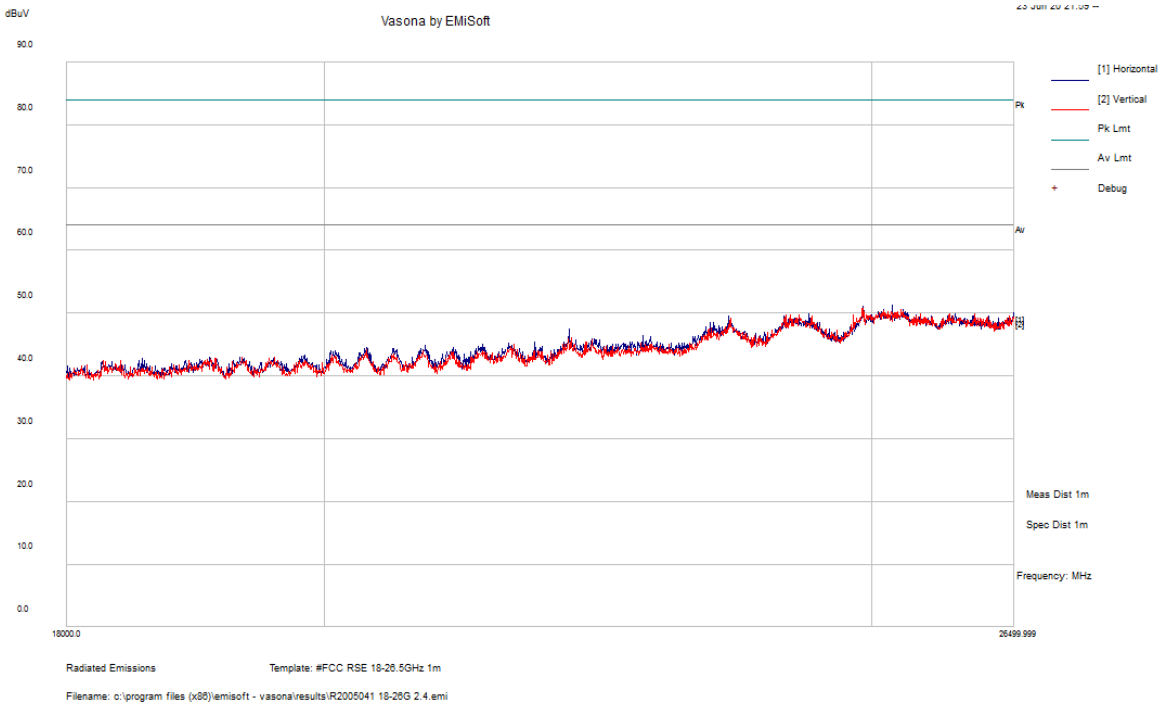
1 GHz – 10 GHz Worst Case Scan at 1 Meter



10 GHz – 18 GHz Worst Case Scan at 1 Meter



18 GHz – 26.5 GHz Worst Case Scan at 1 Meter



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

8.1 Applicable Standards

According to ECFR §15.247(a) (2) and ISEDC RSS-247 §5.2, systems using digital modulation techniques may operate in the 902~928 MHz, 2400~2483.5 MHz, and 5725~5850 MHz bands. The minimum 6 dB bandwidth shall be at least 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 Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	MY48250238	2019-06-26	1 year
-	RF cable	-	-	Each time[1]	N/A
-	20 dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

8.4 Test Environmental Conditions

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

The testing was performed by Tri Pham & Christian McCaig from 2020-05-13 to 2020-05-22 in RF site.

8.5 Test Results

Radio 2:

Channel	Frequency (MHz)	6 dB OBW (MHz)		99% OBW (MHz)		6 dB OBW Limit (kHz)	Result
		Antenna A	Antenna B	Antenna A	Antenna B		
802.11b							
Low	2412	10.16	10.16	14.65	14.83	≥ 500	Pass
Middle	2437	10.17	10.15	15.88	15.23	≥ 500	Pass
High	2462	10.15	10.16	14.68	14.77	≥ 500	Pass
802.11g							
Low	2412	15.54	15.74	16.63	16.47	≥ 500	Pass
Middle	2437	16.32	16.05	24.92	23.24	≥ 500	Pass
High	2462	16.29	16.09	16.54	16.46	≥ 500	Pass
802.11n20							
Low	2412	16.80	16.06	17.71	17.68	≥ 500	Pass
Middle	2437	16.31	16.96	25.16	23.98	≥ 500	Pass
High	2462	16.06	16.29	17.69	17.66	≥ 500	Pass

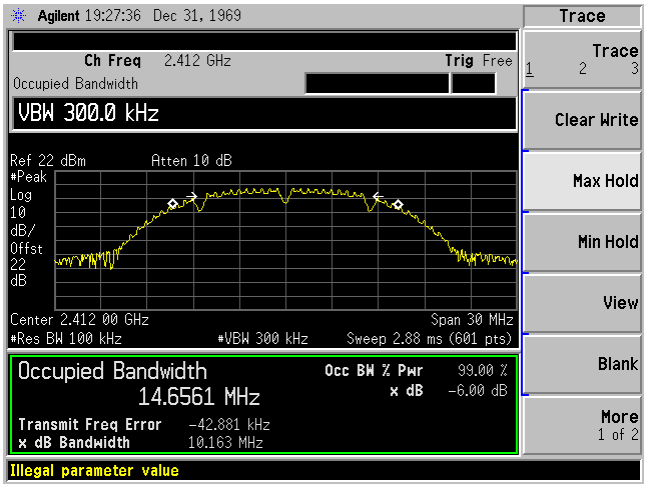
Radio 1:

Channel	Frequency (MHz)	6 dB OBW (MHz)	99% OBW (MHz)	6 dB OBW Limit (kHz)	Result
802.11b					
Low	2412	10.16	14.67	≥ 500	Pass
Middle	2437	10.15	14.54	≥ 500	Pass
High	2462	10.16	14.65	≥ 500	Pass
802.11g					
Low	2412	15.79	16.59	≥ 500	Pass
Middle	2437	16.03	16.58	≥ 500	Pass
High	2462	15.75	16.61	≥ 500	Pass
802.11n20					
Low	2412	17.02	17.74	≥ 500	Pass
Middle	2437	16.47	17.64	≥ 500	Pass
High	2462	16.58	17.68	≥ 500	Pass

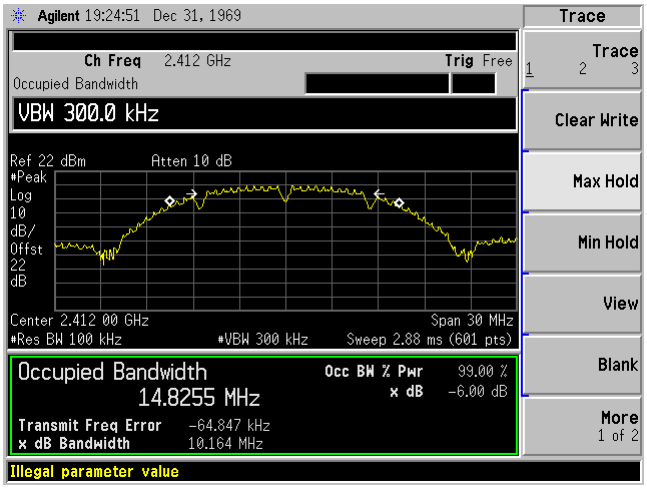
Please refer to the following plots for detailed test results:

RADIO 2 802.11b mode

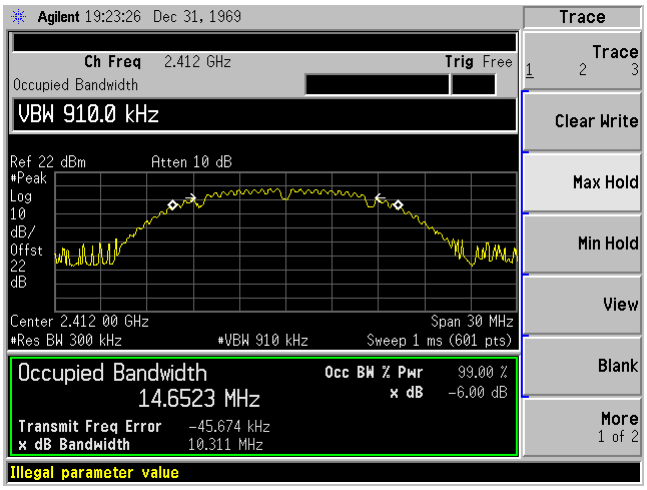
Low Channel 6 dB OBW Antenna A



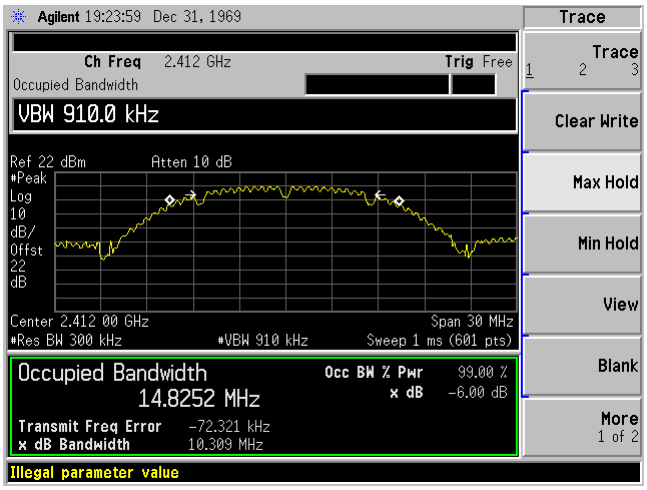
Low Channel 6 dB OBW Antenna B



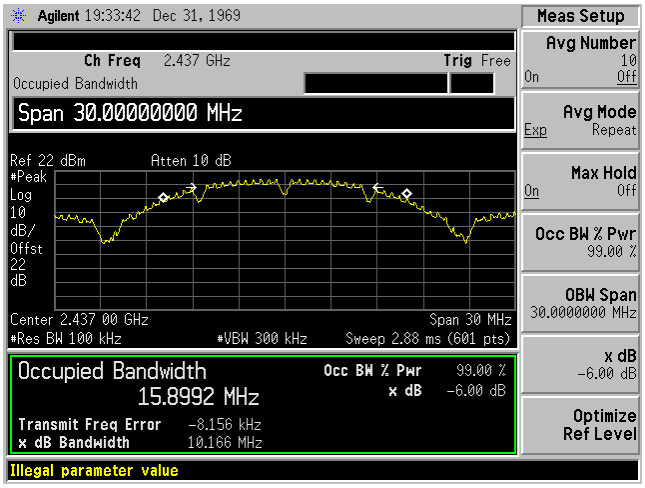
Low Channel 99% dB OBW Antenna A



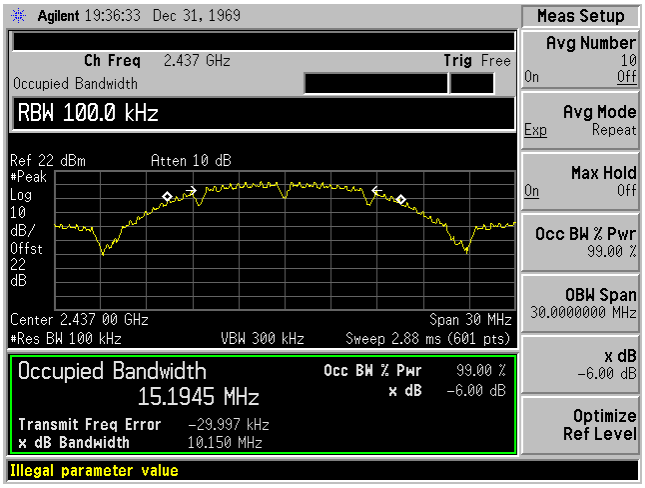
Low Channel 99% dB OBW Antenna B



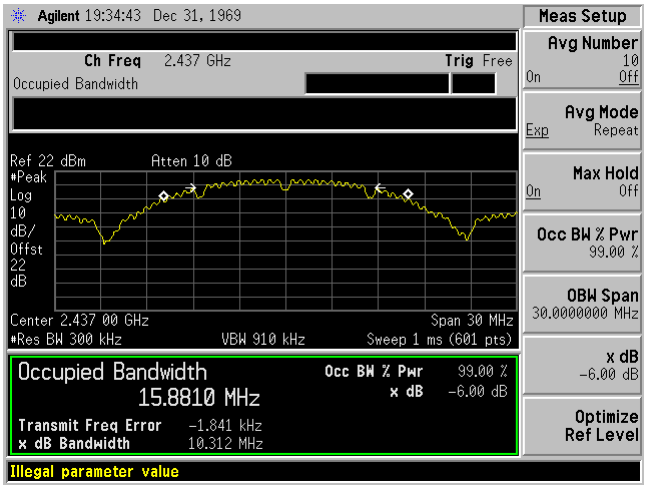
Mid Channel 6 dB OBW Antenna A



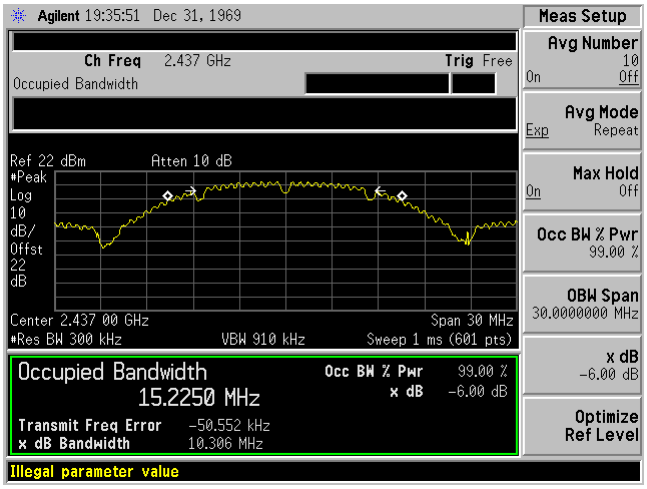
Mid Channel 6 dB OBW Antenna B



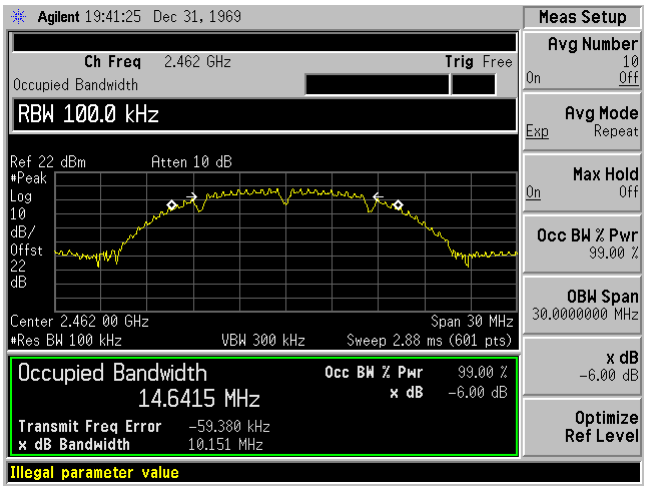
Mid Channel 99% dB OBW Antenna A



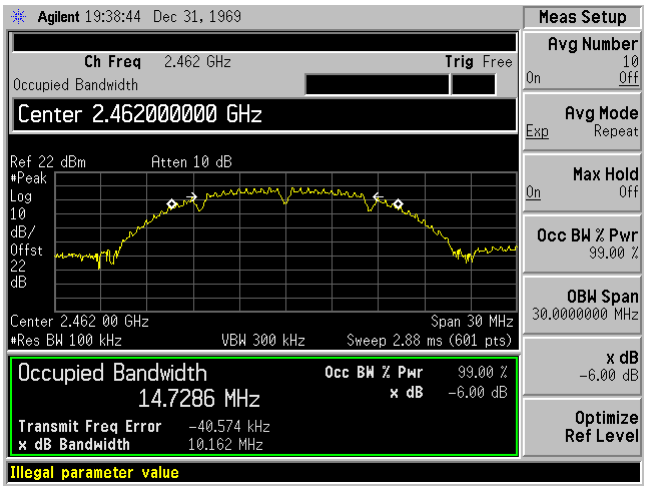
Mid Channel 99% dB OBW Antenna B



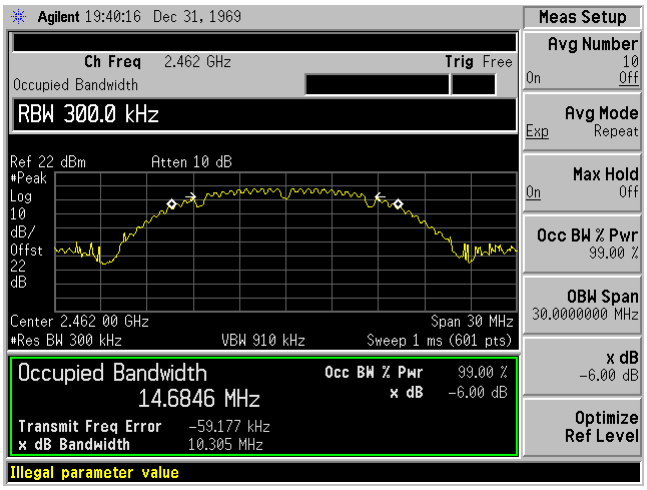
High Channel 6 dB OBW Antenna A



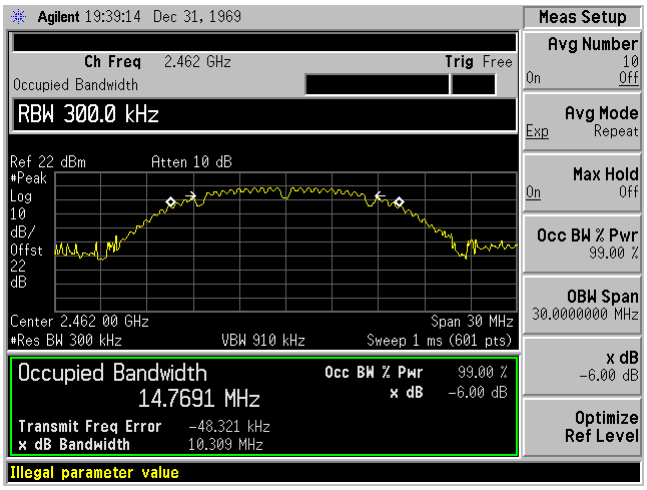
High Channel 6 dB OBW Antenna B



High Channel 99% dB OBW Antenna A

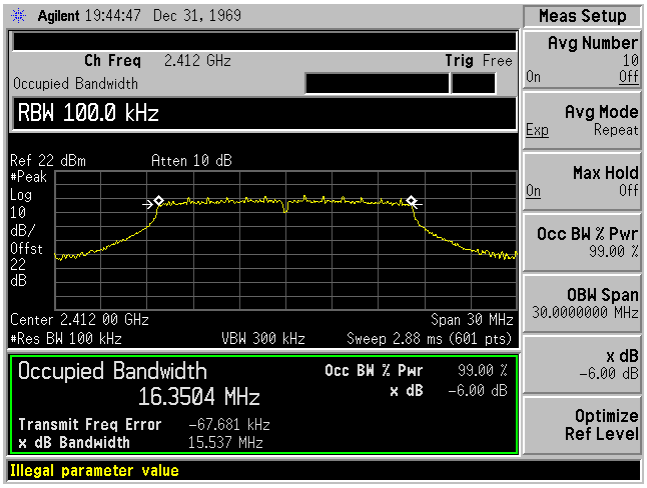


High Channel 99% dB OBW Antenna B

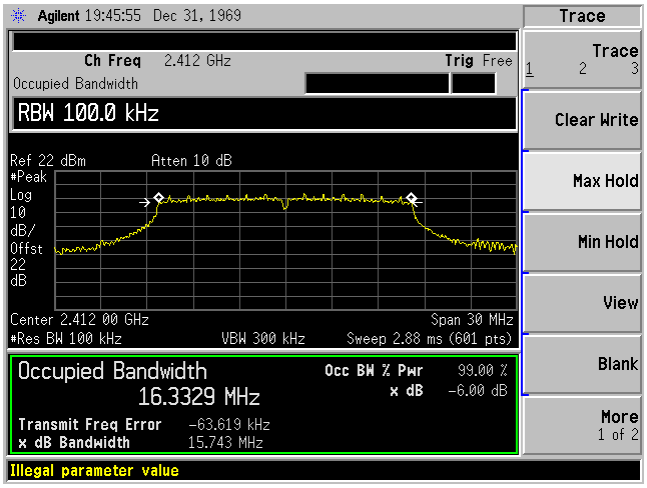


RADIO 2 802.11g mode

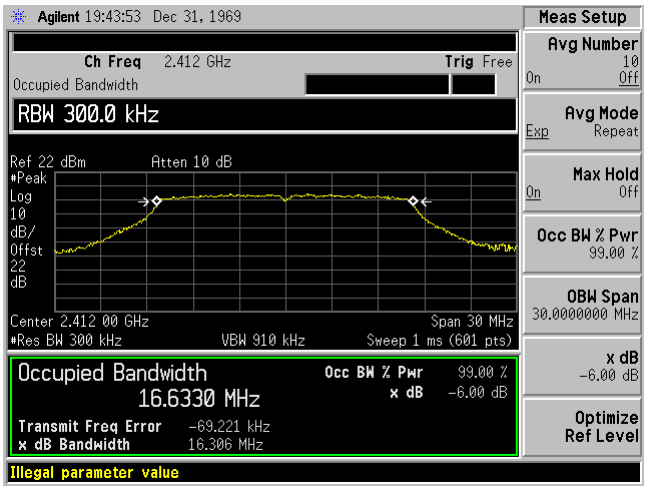
Low Channel 6 dB OBW Antenna A



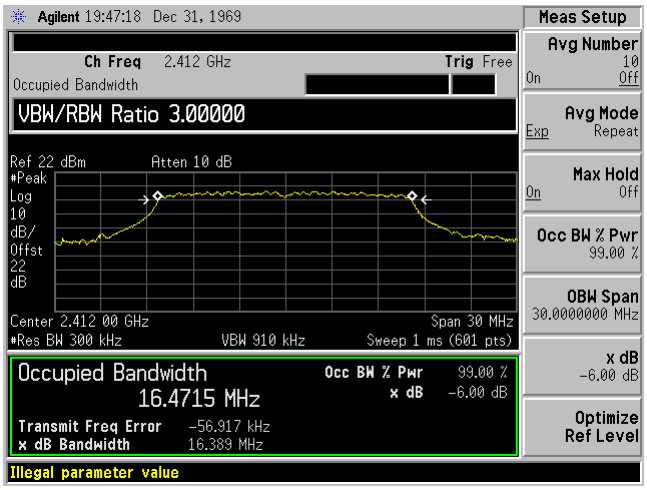
Low Channel 6 dB OBW Antenna B



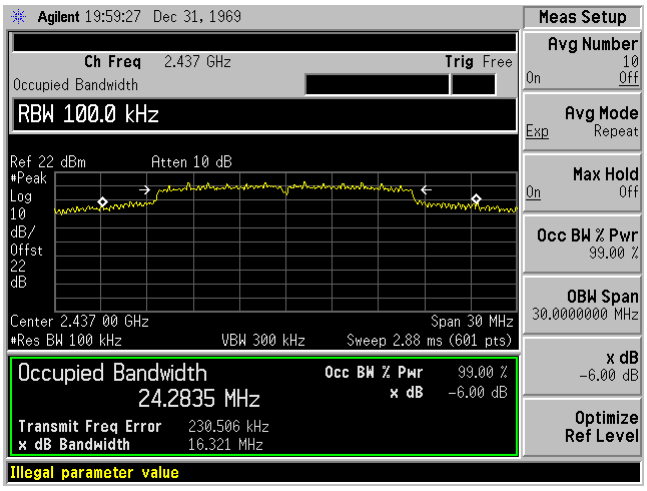
Low Channel 99% dB OBW Antenna A



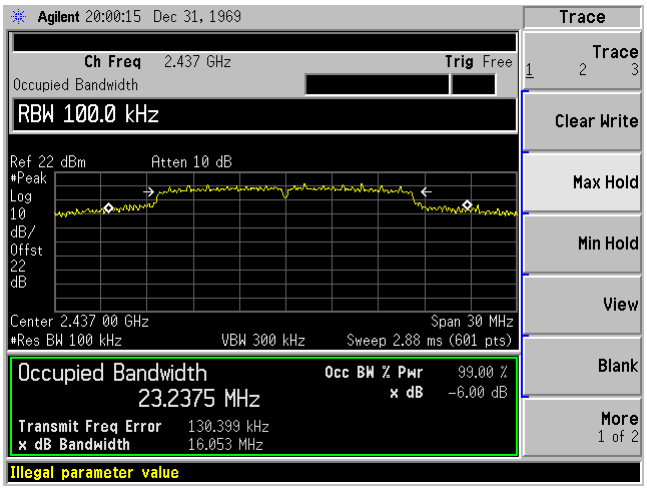
Low Channel 99% dB OBW Antenna B



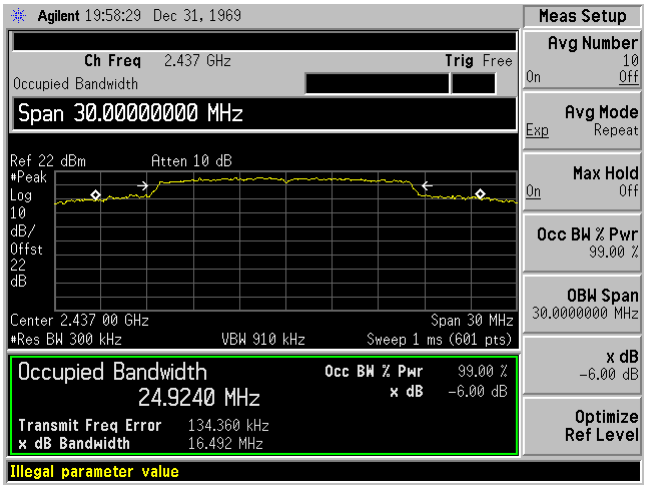
Mid Channel 6 dB OBW Antenna A



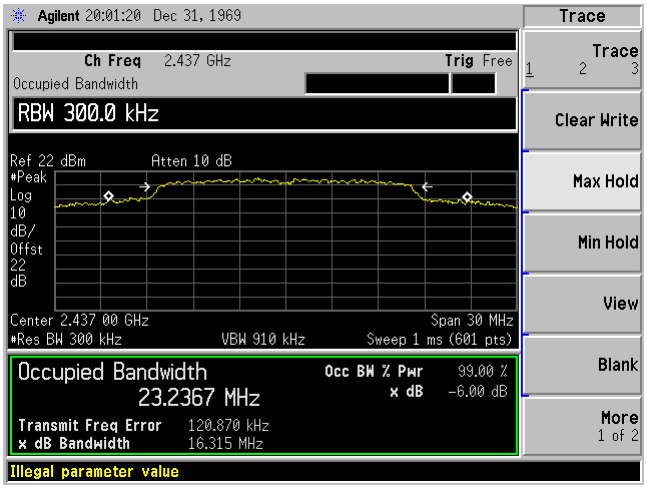
Mid Channel 6 dB OBW Antenna B



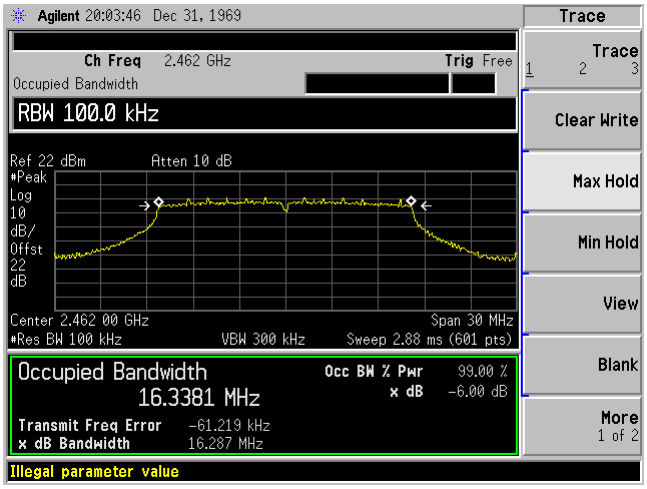
Mid Channel 99% dB OBW Antenna A



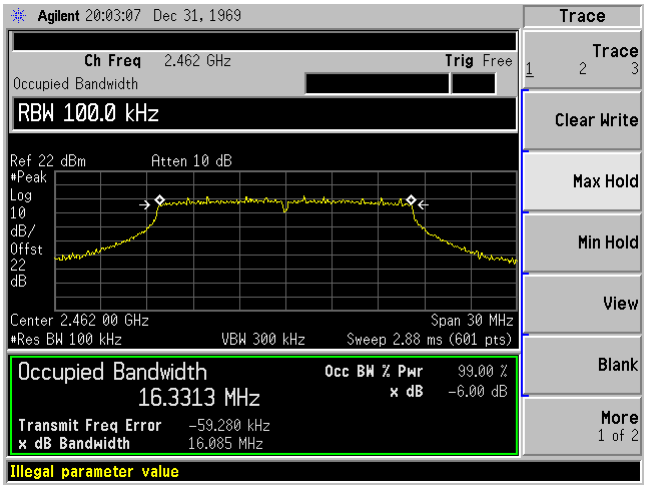
Mid Channel 99% dB OBW Antenna B



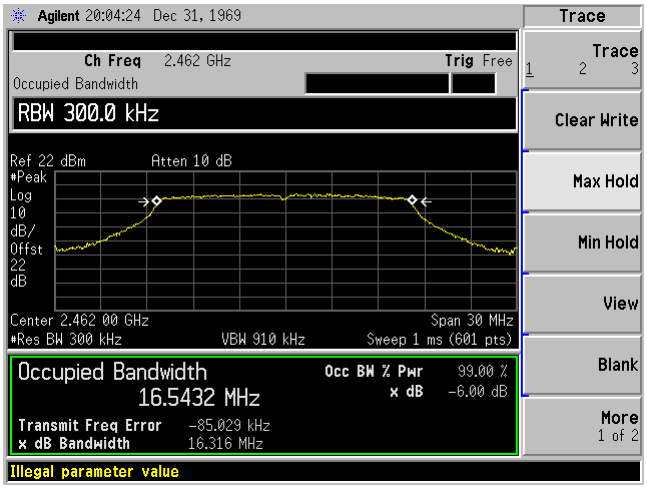
High Channel 6 dB OBW Antenna A



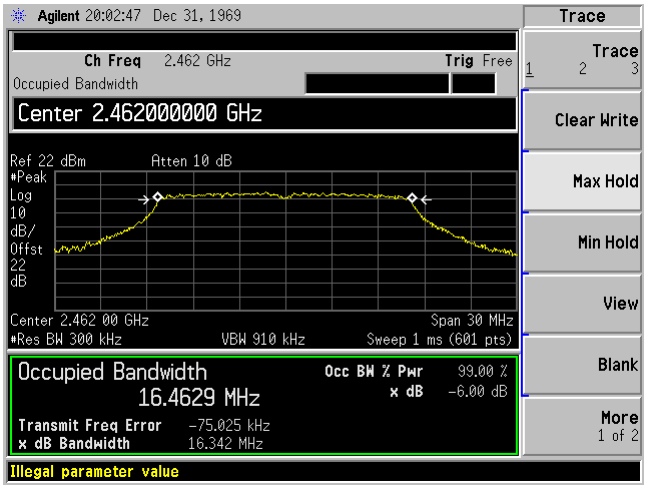
High Channel 6 dB OBW Antenna B



High Channel 99% dB OBW Antenna A

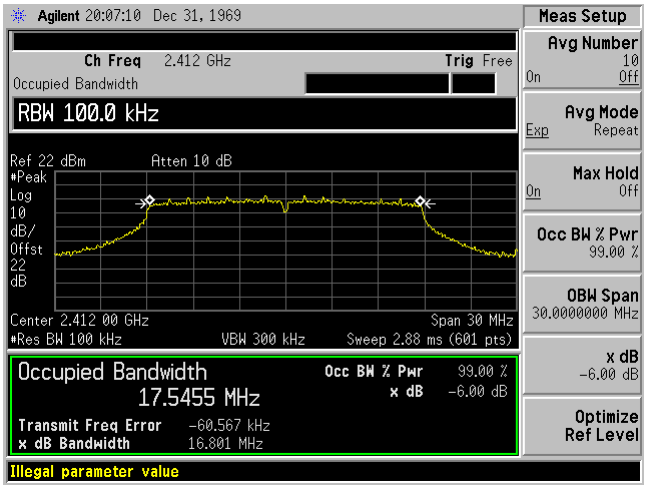


High Channel 99% dB OBW Antenna B

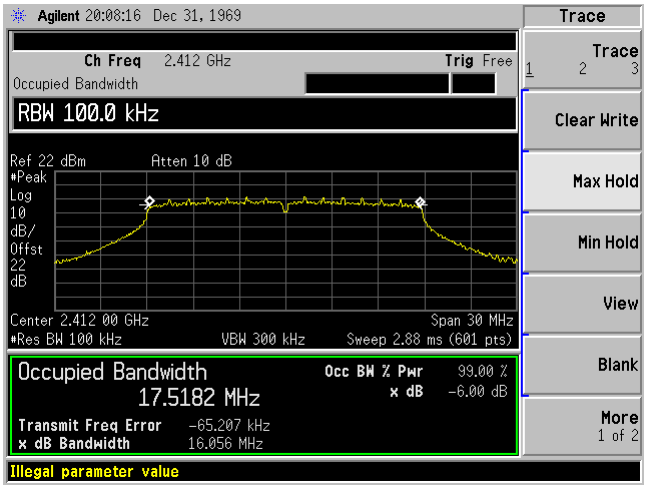


RADIO 2 802.11n20 mode

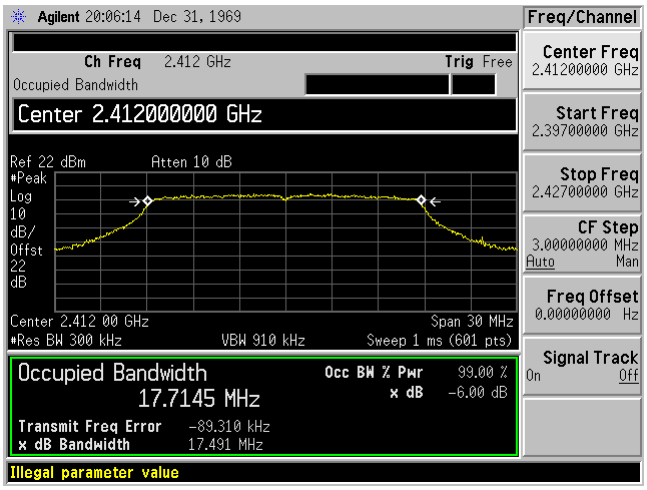
Low Channel 6 dB OBW Antenna A



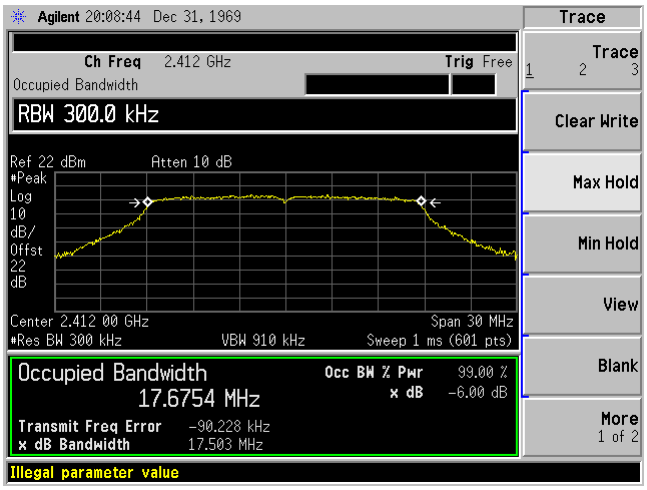
Low Channel 6 dB OBW Antenna B



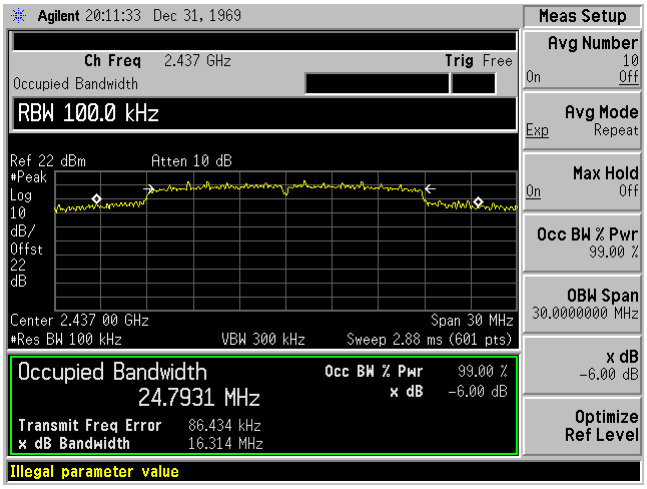
Low Channel 99% dB OBW Antenna A



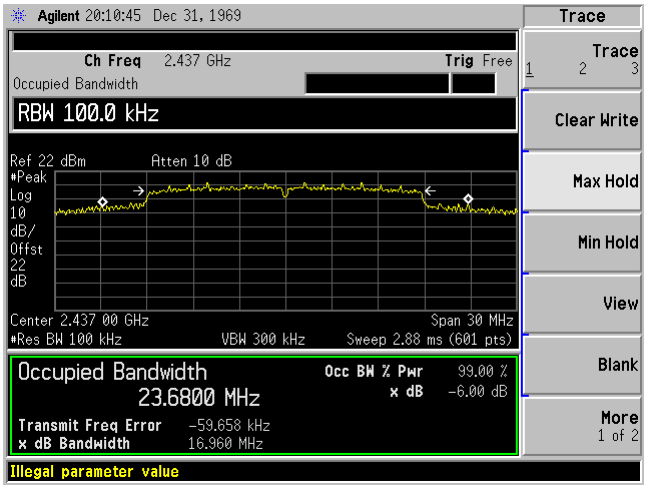
Low Channel 99% dB OBW Antenna B



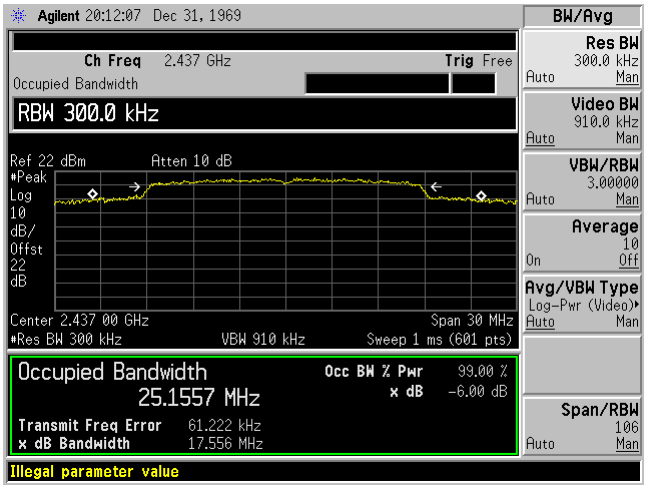
Mid Channel 6 dB OBW Antenna A



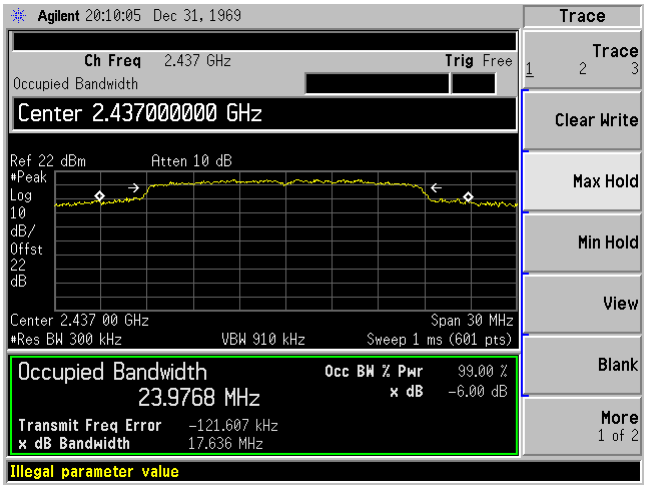
Mid Channel 6 dB OBW Antenna B



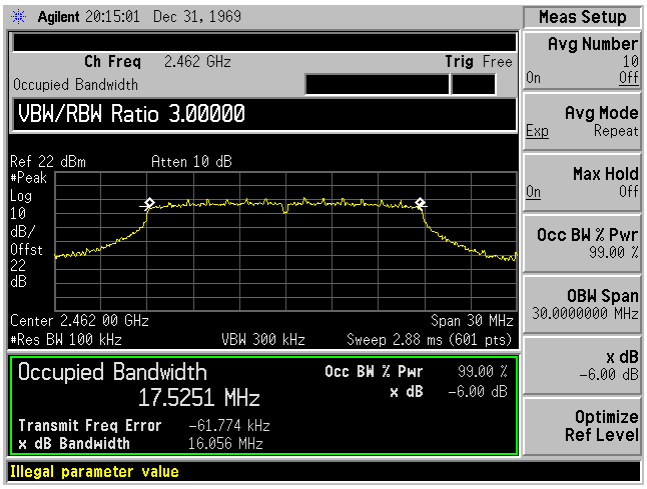
Mid Channel 99% dB OBW Antenna A



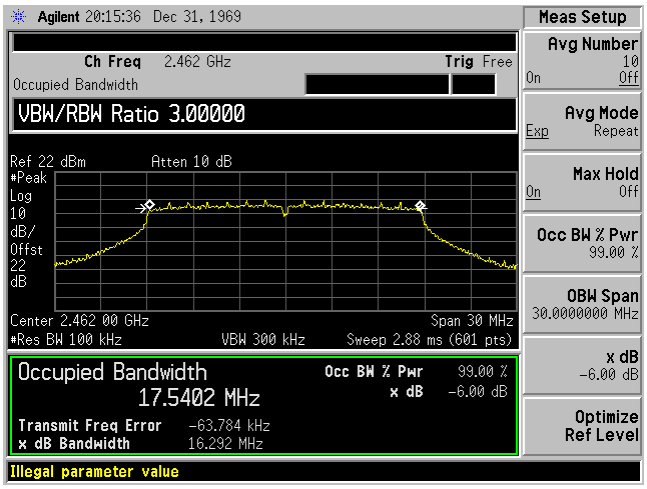
Mid Channel 99% dB OBW Antenna B



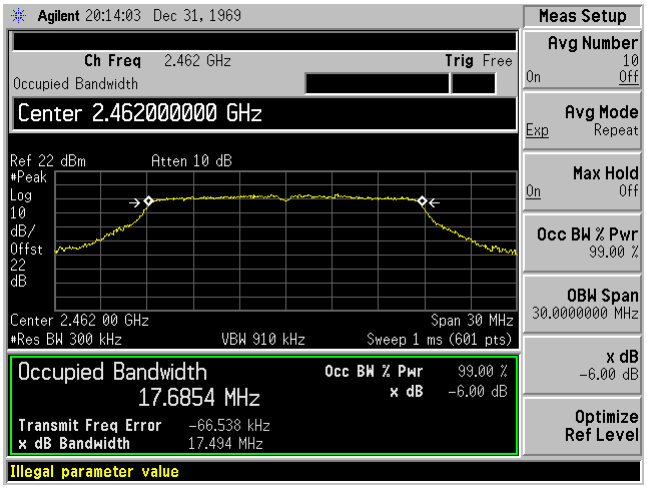
High Channel 6 dB OBW Antenna A



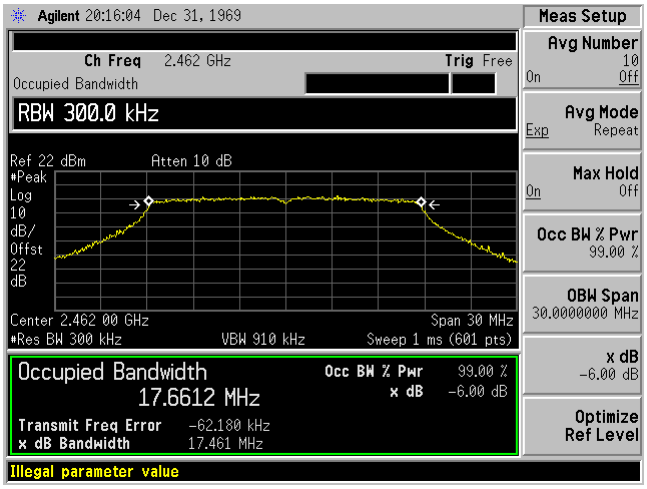
High Channel 6 dB OBW Antenna B



High Channel 99% dB OBW Antenna A

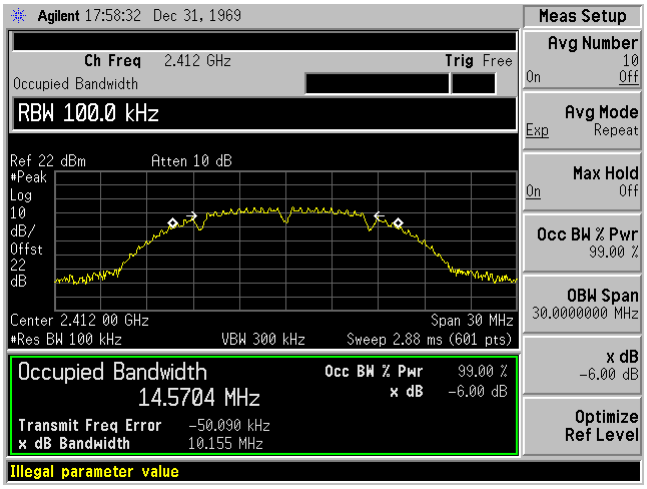


High Channel 99% dB OBW Antenna B

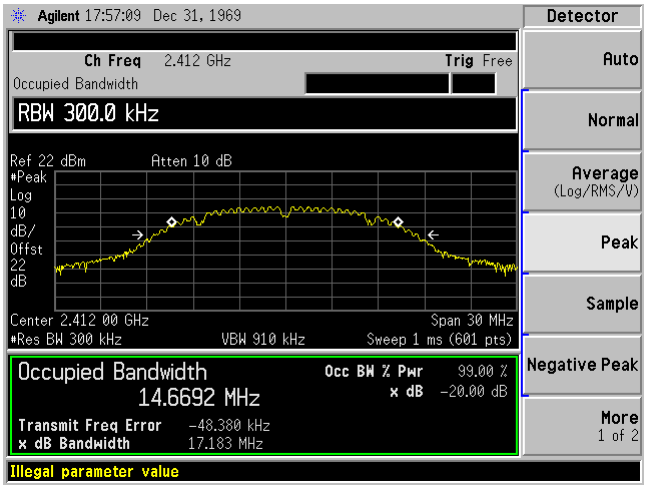


RADIO 1 802.11b mode

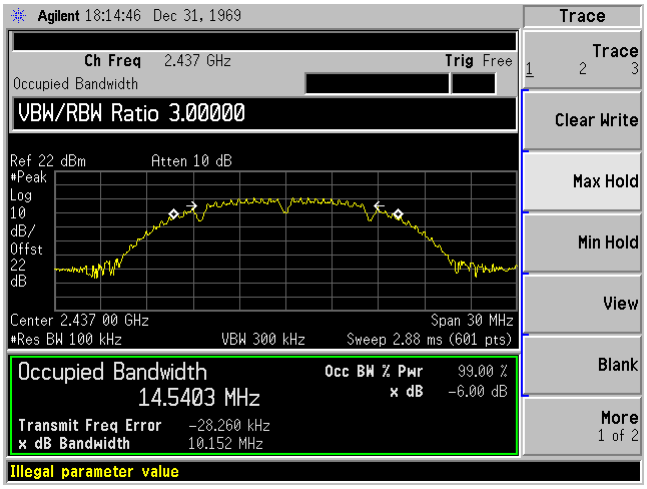
Low Channel 6 dB OBW



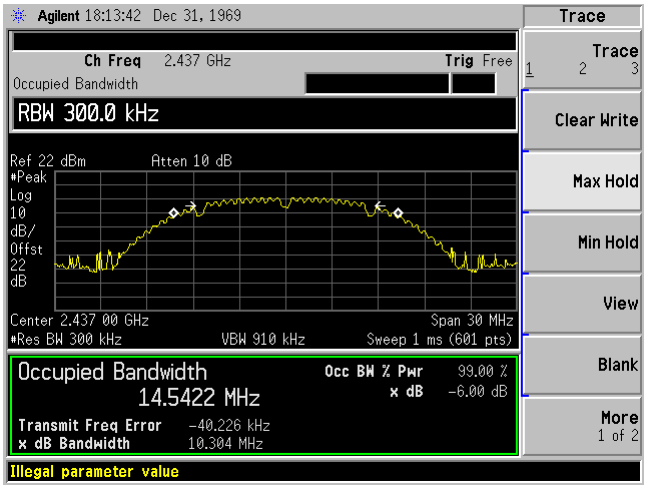
Low Channel 6 99% OBW



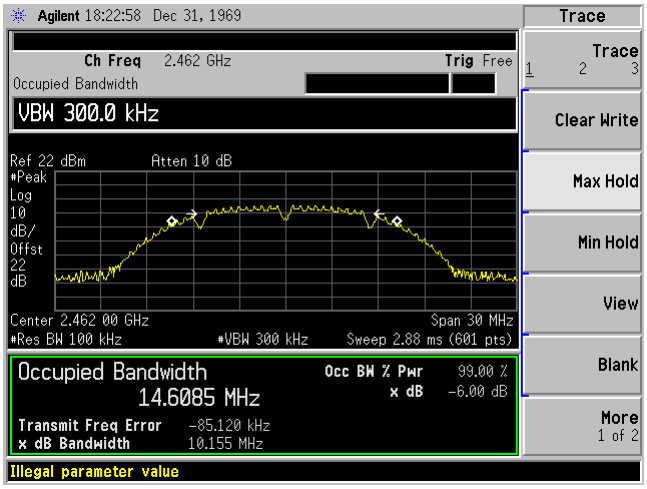
Mid Channel 6 dB OBW



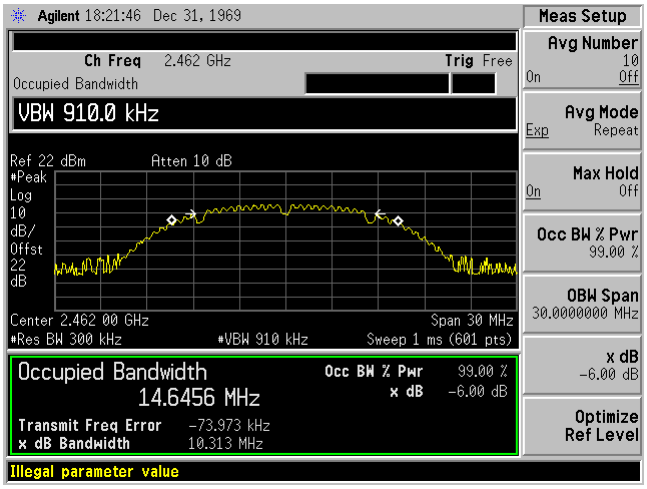
Mid Channel 99% dB OBW



High Channel 6 dB OBW

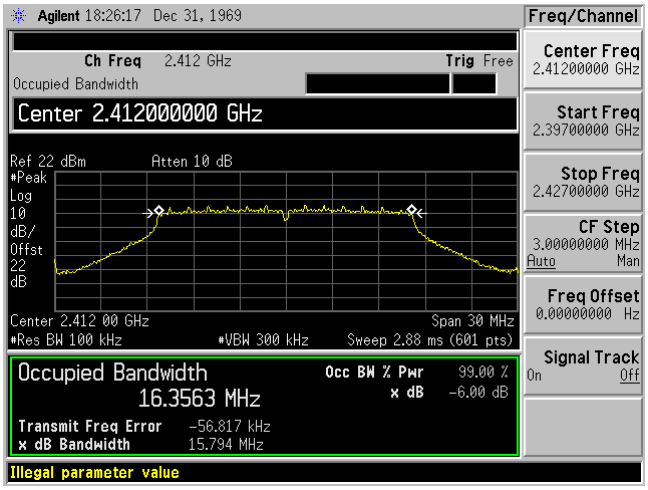


High Channel 99% dB OBW

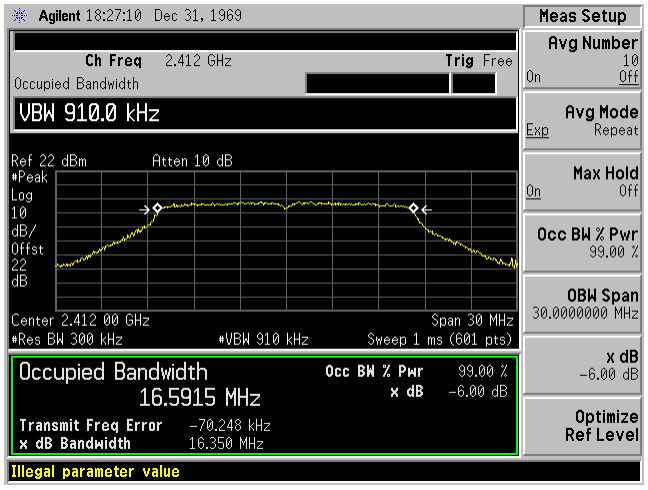


RADIO 1 802.11g mode

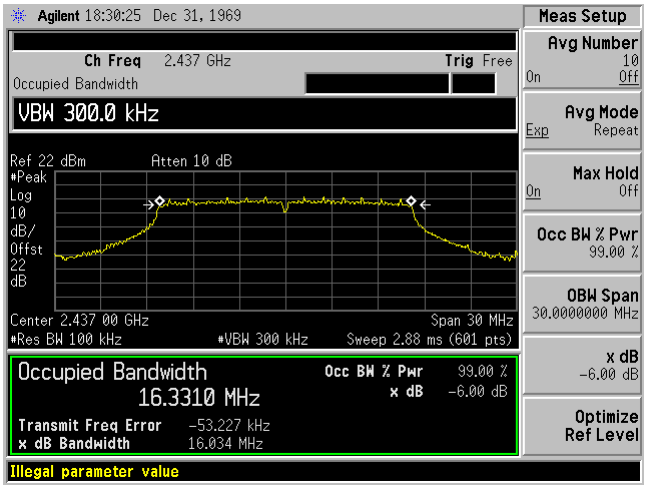
Low Channel 6 dB OBW



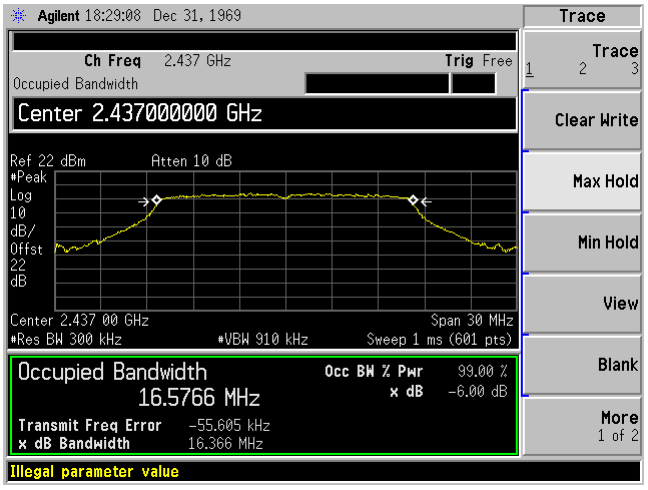
Low Channel 6 dB OBW



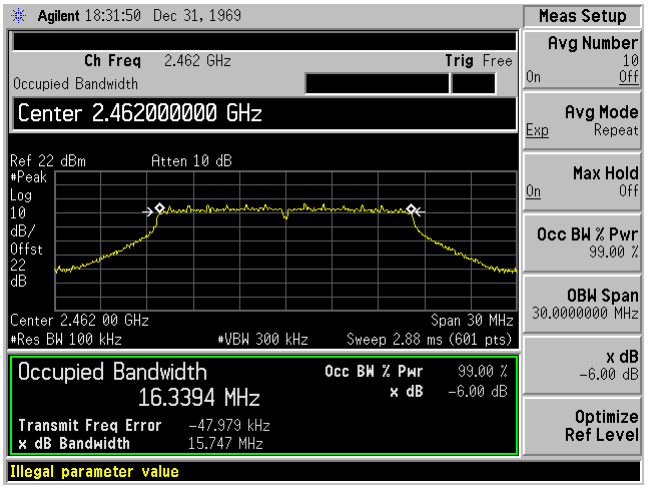
Mid Channel 6 dB OBW



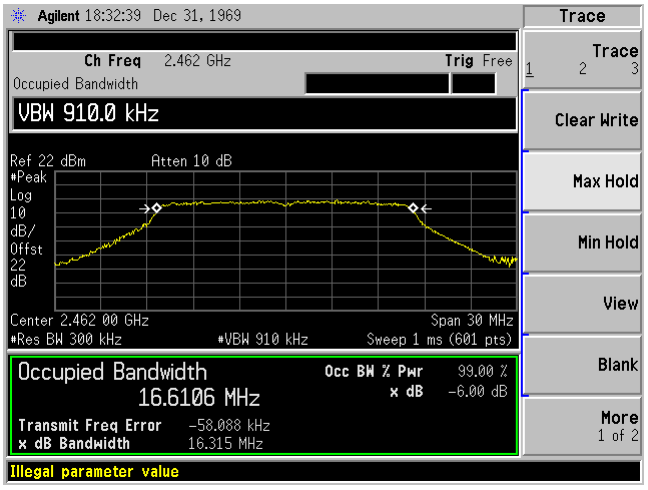
Mid Channel 99% dB OBW



High Channel 6 dB OBW

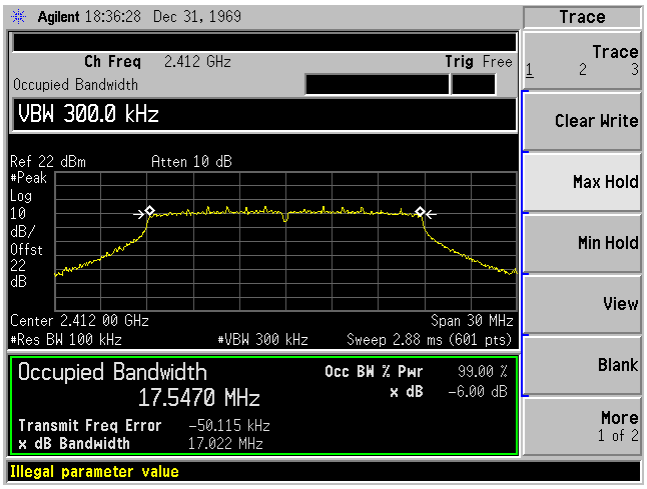


High Channel 99% dB OBW

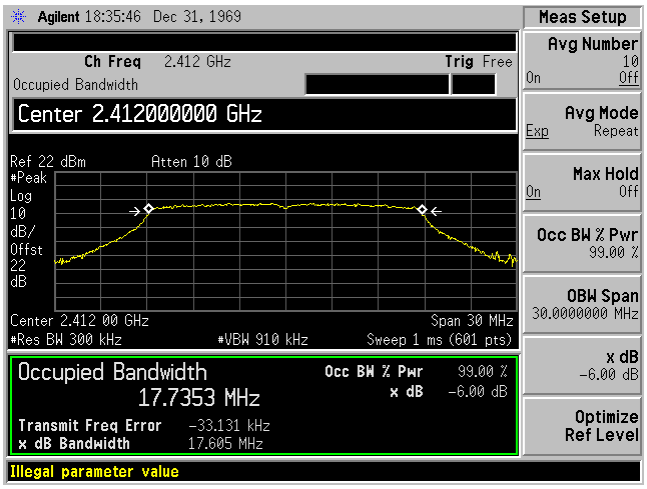


RADIO 1 802.11n20 mode

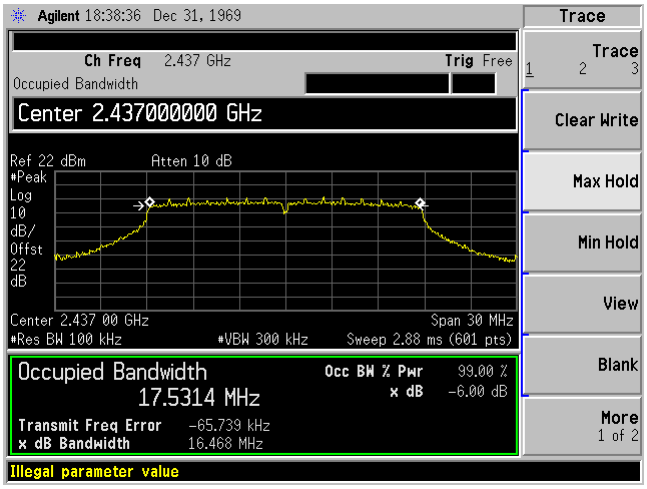
Low Channel 6 dB OBW



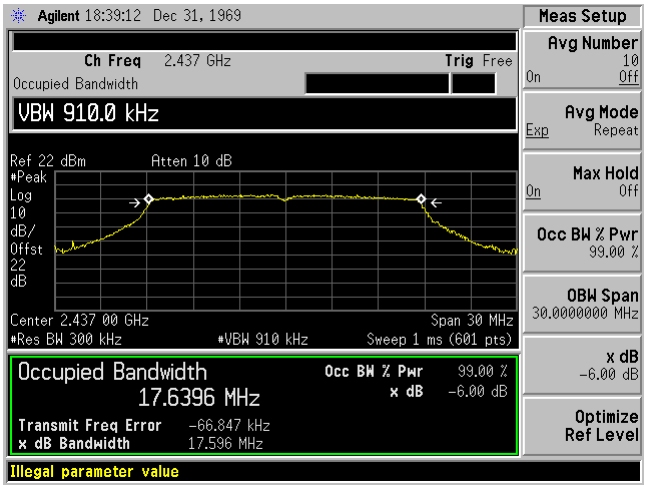
Low Channel 6 99% OBW



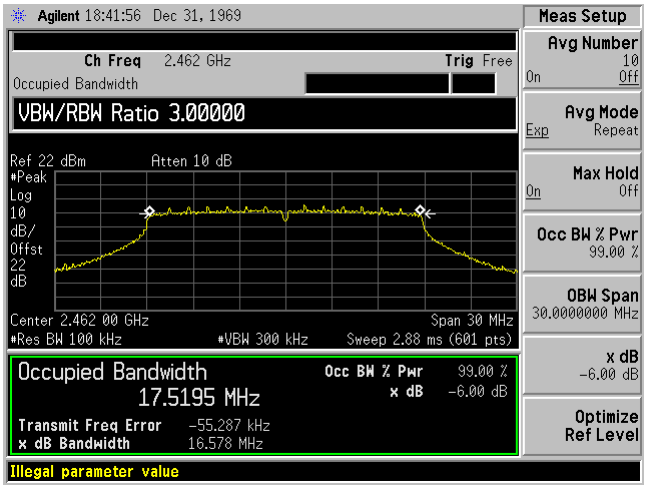
Mid Channel 6 dB OBW



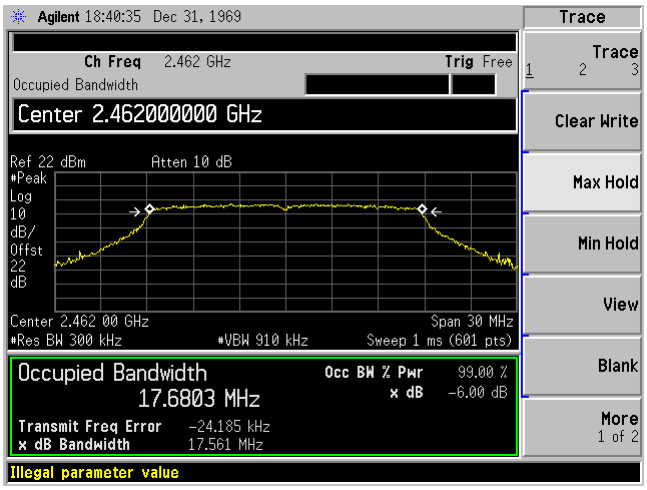
Mid Channel 99% dB OBW



High Channel 6 dB OBW



High Channel 99% dB OBW



9 FCC §15.247(b) (3) & ISEDC RSS-247 §5.4 (4) - Output Power Measurement

9.1 Applicable Standards

According to ECFR §15.247(b) (3) and ISEDC RSS-247 §5.4 (4) for systems using digital modulation in the 902~928 MHz, 2400~2483.5 MHz, and 5725~5850 MHz bands: 1 Watt.

9.2 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 9: Fundamental emission output power

9.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	MY48250238	2019-06-26	1 year
-	RF cable	-	-	Each time[1]	N/A
-	20 dB attenuator	-	-	Each time[1]	N/A
ETS- Lingerin	Power Sensor	7002-006	160097	2018-12-31	2 years

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

9.4 Test Environmental Conditions

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

The testing was performed by Tri Pham & Christian McCaig from 2020-05-13 to 2020-05-22 in RF site.

9.5 Test Results

RADIO 2 Average Output Power

Channel	Frequency (MHz)	Conducted Output Power (dBm)			Output Power Limit (dBm)	Result
		Antenna A	Antenna B	Total		
802.11b						
Low	2412	19.71	21.31	-	30	Pass
Middle	2437	23.34	23.28	-	30	Pass
High	2462	19.63	20.74	-	30	Pass
802.11g						
Low	2412	15.88	16.94	-	30	Pass
Middle	2437	23.33	23.3	-	30	Pass
High	2462	14.96	16.32	-	30	Pass
802.11n20						
Low	2422	16.07	15.32	18.72	29	Pass
Middle	2437	23.29	23.14	26.23	29	Pass
High	2462	14.41	13.37	16.93	29	Pass

Note 1: When the directional gain is greater than 6dBi, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain for 802.11n20 mode is 7 dBi calculated based on method specified in KDB 662911 D01.
Note 2: Duty Cycle correction factor has already been added to the measurement.

RADIO 1 Average Output Power

Channel	Frequency (MHz)	Conducted Output Power (dBm)	Output Power Limit (dBm)	Result
802.11b				
Low	2412	18.05	30	Pass
Middle	2437	23.14	30	Pass
High	2462	18.95	30	Pass
802.11g				
Low	2412	14.2	30	Pass
Middle	2437	21.26	30	Pass
High	2462	15.45	30	Pass
802.11n20				
Low	2412	13.55	30	Pass
Middle	2437	21.19	30	Pass
High	2462	14.47	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 ECFR §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

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 13: Band-edge measurements

10.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	MY48250238	2019-06-26	1 year
-	RF cable	-	-	Each time[1]	N/A
-	10 dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

10.4 Test Environmental Conditions

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

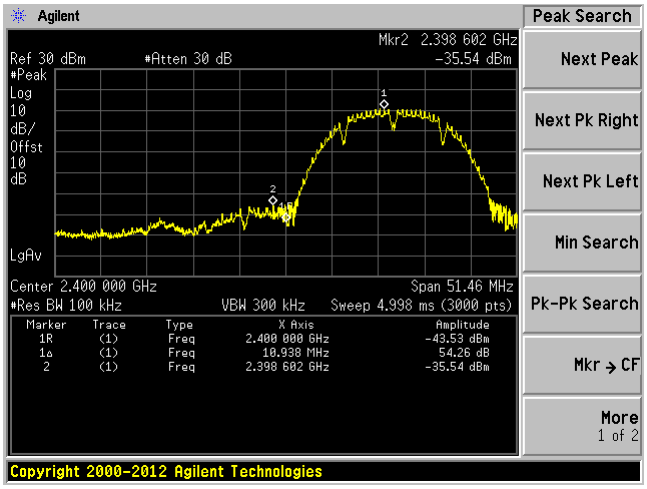
The testing was performed by Tri Pham & Christian McCaig from 2020-05-13 to 2020-05-22 in RF site.

10.5 Test Results

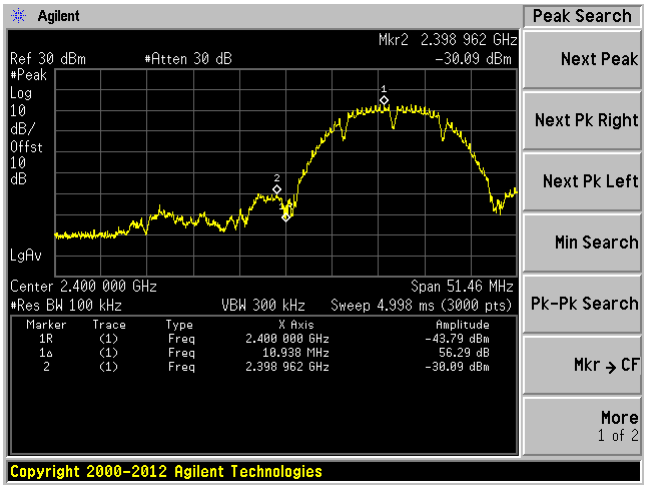
Radio 2

802.11 b mode

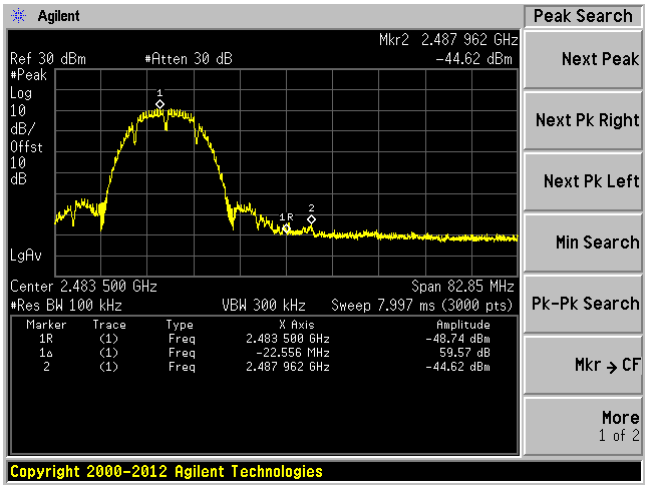
Low Channel Antenna A



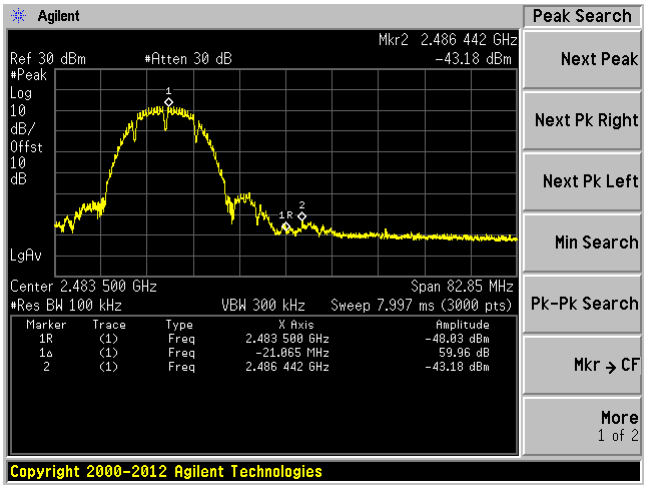
Low Channel Antenna B



High Channel Antenna A

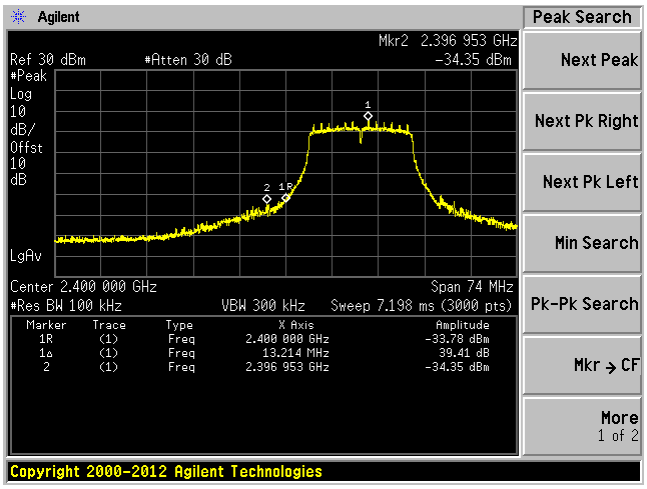


High Channel Antenna B

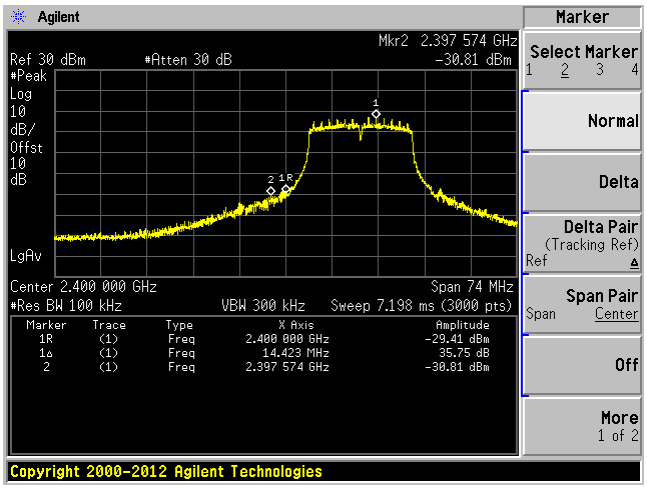


802.11 g mode

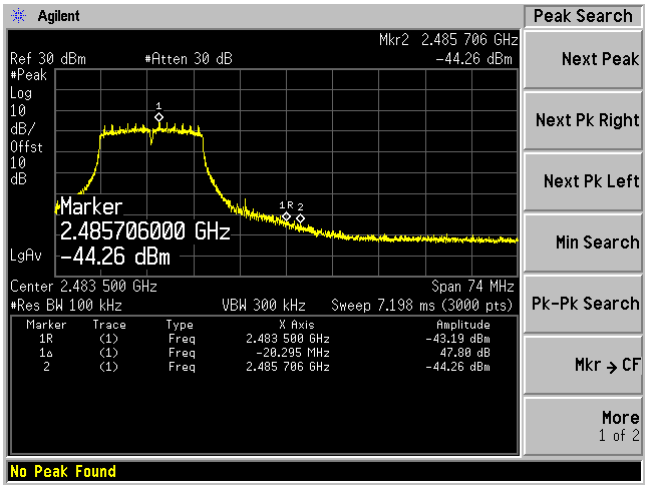
Low Channel Antenna A



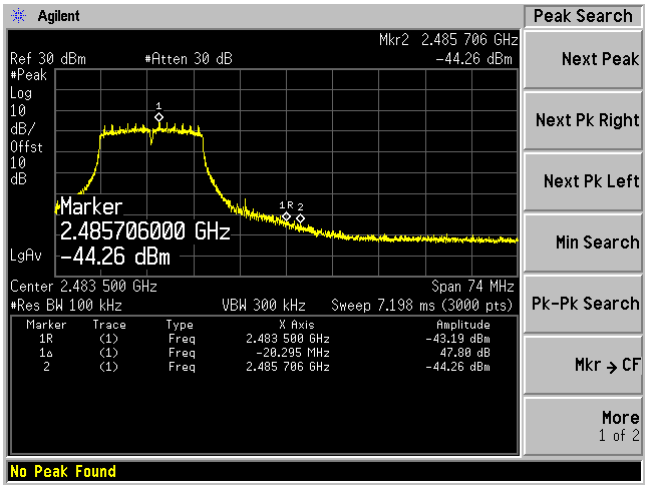
Low Channel Antenna B



High Channel Antenna A

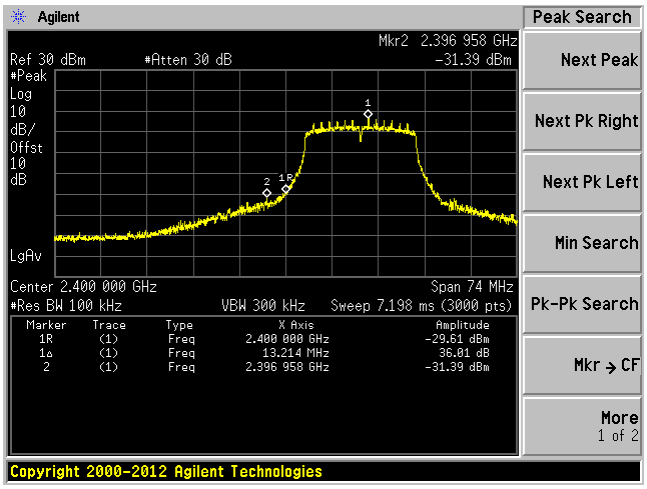


High Channel Antenna B

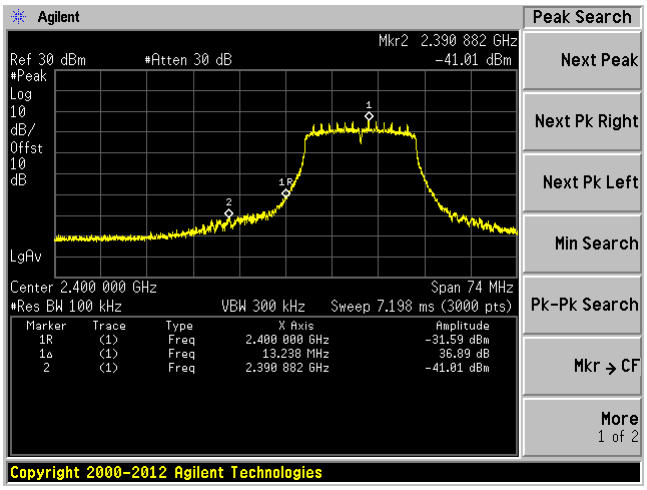


802.11 n20 mode

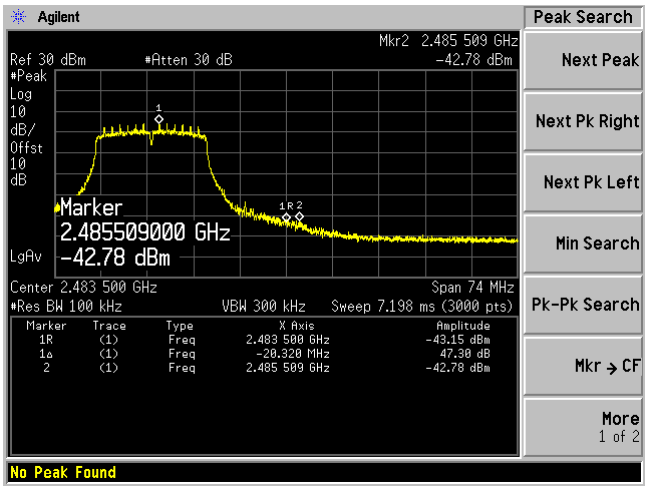
Low Channel Antenna A



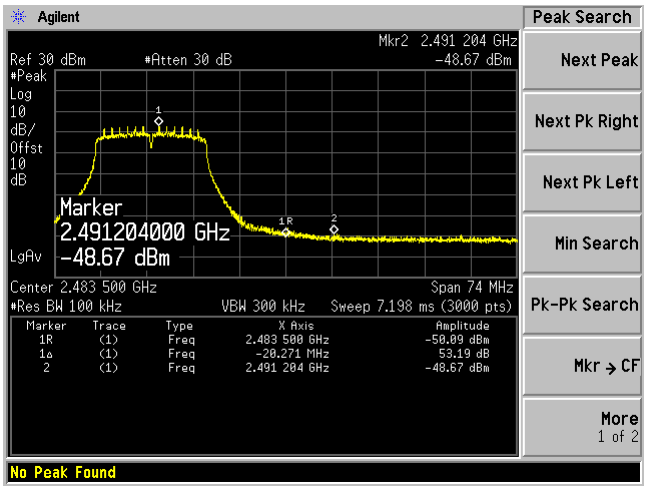
Low Channel Antenna B



High Channel Antenna A



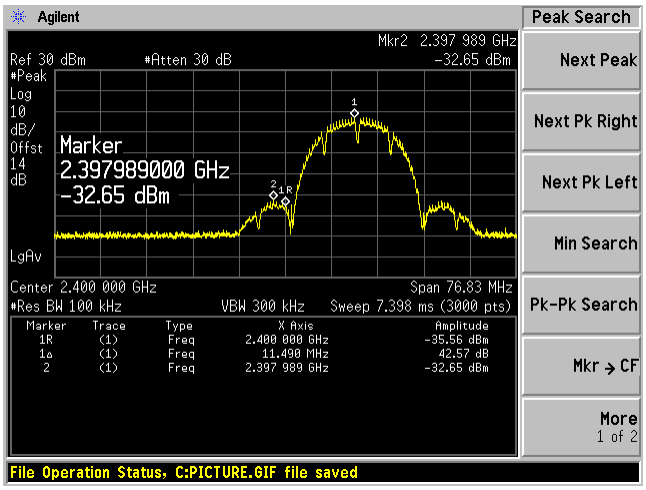
High Channel Antenna B



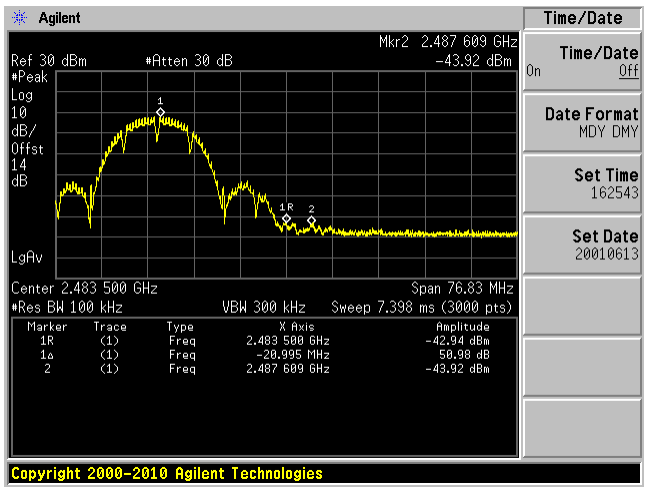
Radio 1

802.11 b mode

Low Channel

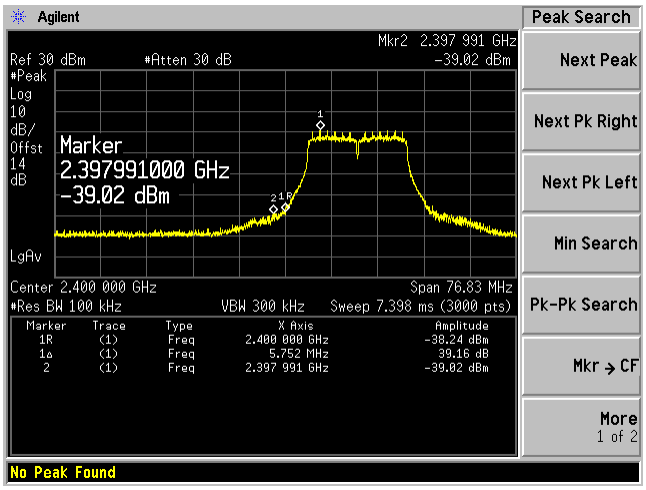


High Channel

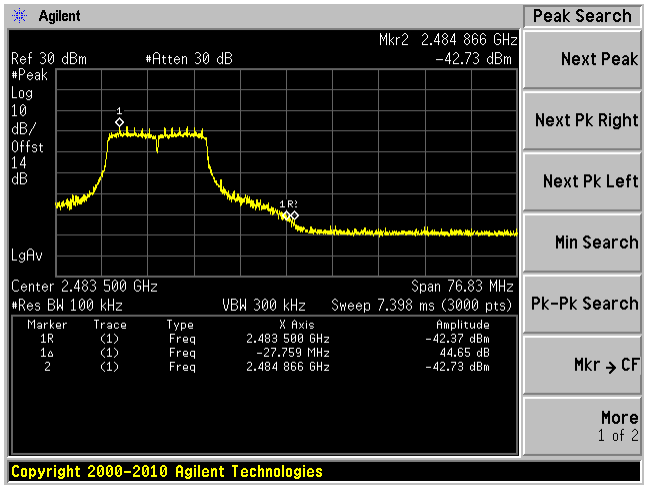


802.11 g mode

Low Channel

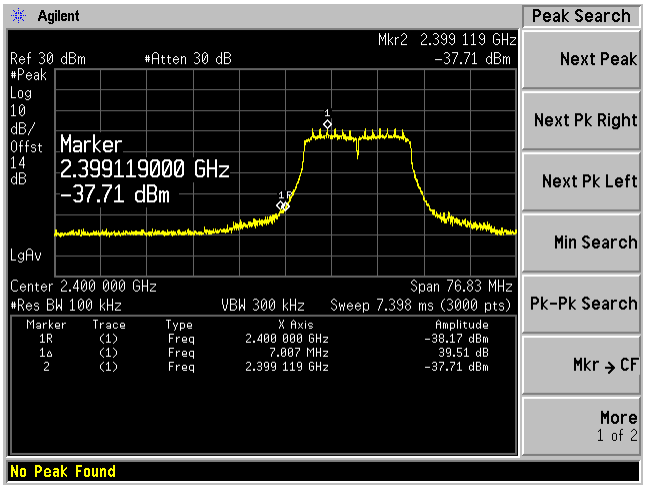


High Channel

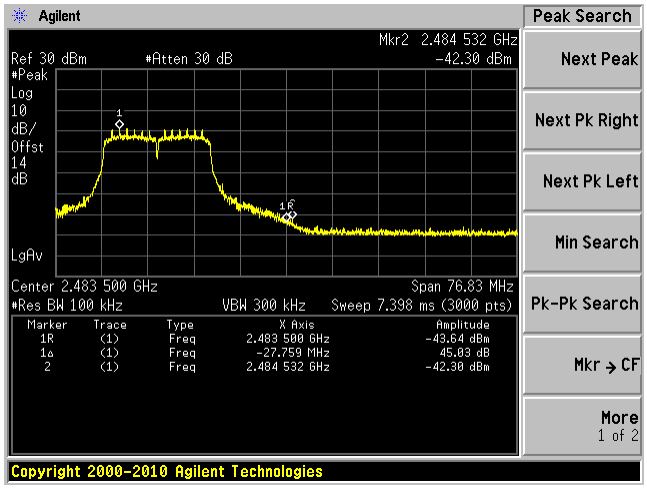


802.11 n20 mode

Low Channel



High Channel



11 FCC §15.247(e) & ISEDC RSS-247 §5.2(2) - 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 Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	MY48250238	2019-06-26	1 year
-	RF cable	-	-	Each time[1]	N/A
-	10 dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

11.4 Test Environmental Conditions

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

The testing was performed by Tri Pham & Christian McCaig from 2020-05-13 to 2020-05-22 in RF site.

11.5 Test Results

Radio 2

Channel	Frequency (MHz)	PSD (dBm/3kHz)		Corrected PSD (dBm/3kHz)		Limit (dBm/3kHz)
		Antenna A	Antenna B	Antenna A	Antenna B	
802.11b mode						
Low	2412	-4.05	-2.13	-3.9	-1.98	8
Middle	2437	2.10	0.60	2.25	0.75	8
High	2462	-3.28	-2.71	-3.13	-2.56	8
802.11g mode						
Low	2412	-6.82	-4.89	-6.38	-4.45	8
Middle	2437	0.91	0.74	1.35	1.18	8
High	2462	-8.59	-8.02	-8.15	-7.58	8
802.11n20 mode						
Low	2412	-10.12	-11.24	-7.22		7
Middle	2437	1.15	0.20	4.12		7
High	2462	-9.67	-12.20	-7.33		7

*Note 1: Corrected PSD (dBm/3kHz) = PSD(dBm/3kHz) + Duty Cycle Correction Factor

Note 2: When the directional gain is greater than 6dBi, similar to the total conducted output power, the total power spectrum density shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain for 802.11n20 mode is 7 dBi calculated based on method specified in KDB 662911 D01.

Radio 1

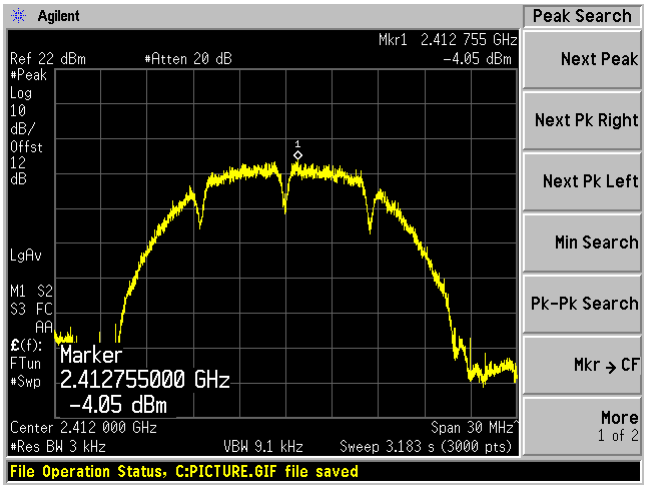
Channel	Frequency (MHz)	Power Spectral Density (dBm/3kHz)	Corrected PSD (dBm/3kHz)	Limit (dBm/3kHz)	Result
802.11b mode					
Low	2412	-7.45	-7.45	8	Pass
Middle	2437	0.33	0.33	8	Pass
High	2462	-7.18	-7.18	8	Pass
802.11g mode					
Low	2412	-14.35	-14.20	8	Pass
Middle	2437	-5.96	-5.81	8	Pass
High	2462	-12.15	-12.00	8	Pass
802.11n20 mode					
Low	2412	-14.39	-14.30	8	Pass
Middle	2437	-6.36	-6.27	8	Pass
High	2462	-12.11	-12.02	8	Pass

*Note: Corrected PSD (dBm/3kHz) = PSD(dBm/3kHz) + Duty Cycle Correction Factor

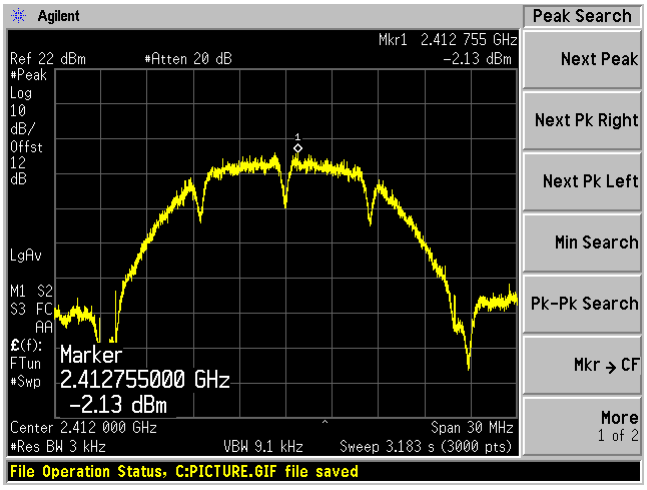
Please refer to the following plots for detailed test results

RADIO 2 802.11b mode

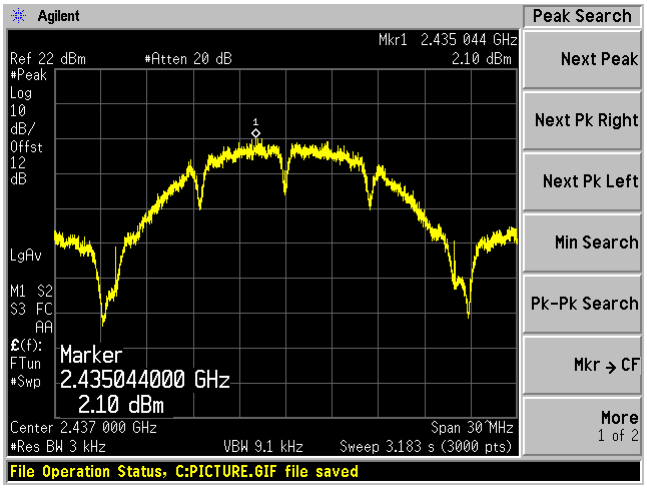
Low Channel Antenna A



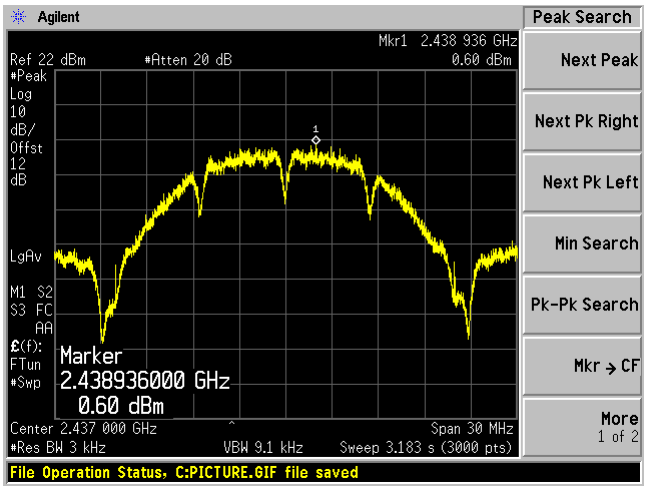
Low Channel Antenna B



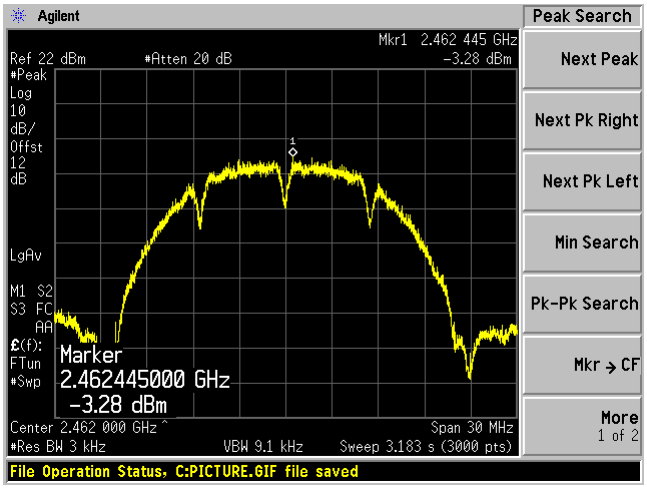
Mid Channel Antenna A



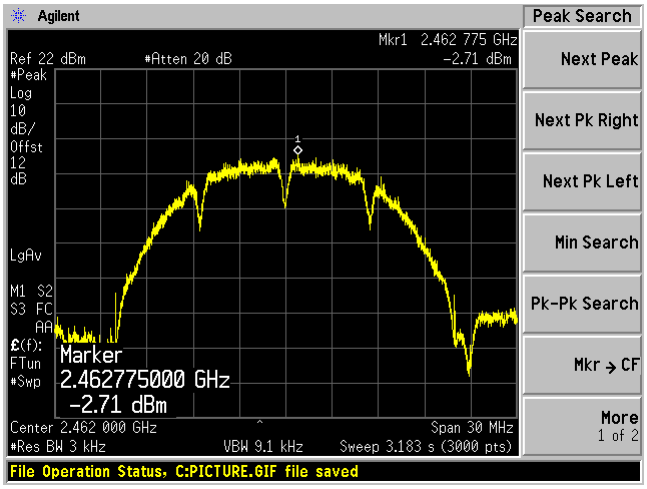
Mid Channel Antenna B



High Channel Antenna A

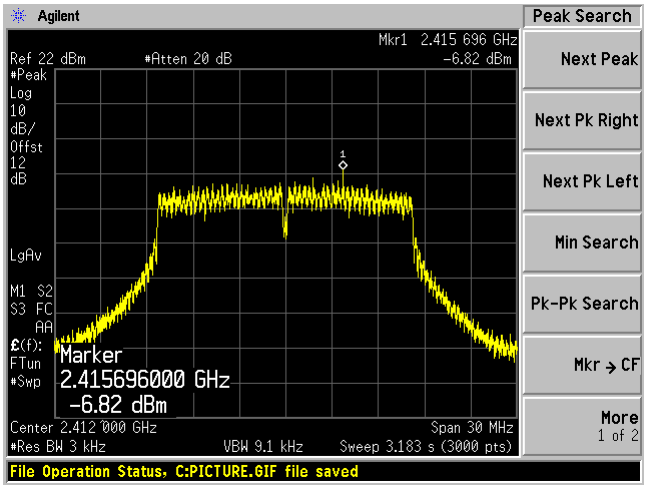


High Channel Antenna B

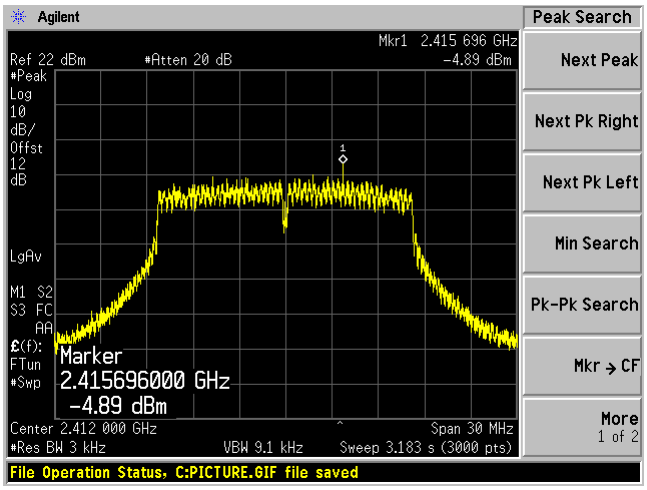


RADIO 2 802.11g mode

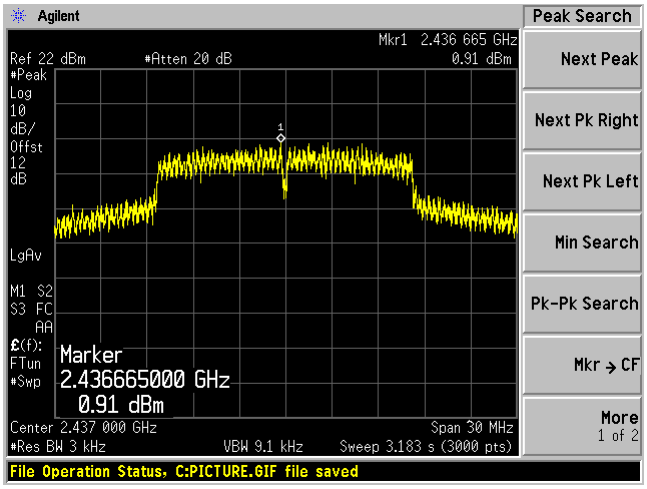
Low Channel Antenna A



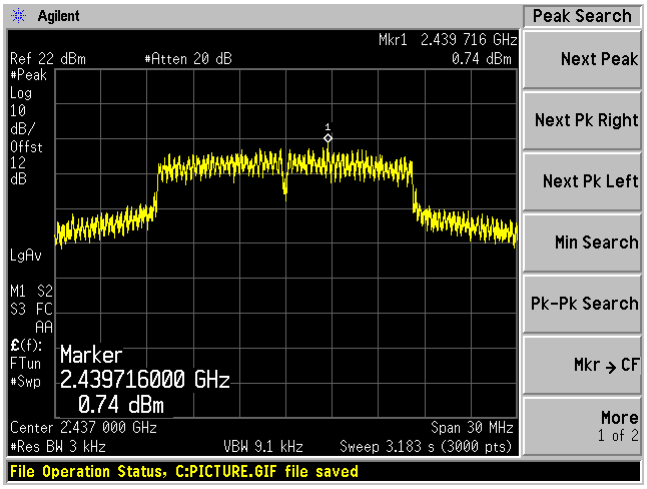
Low Channel Antenna B



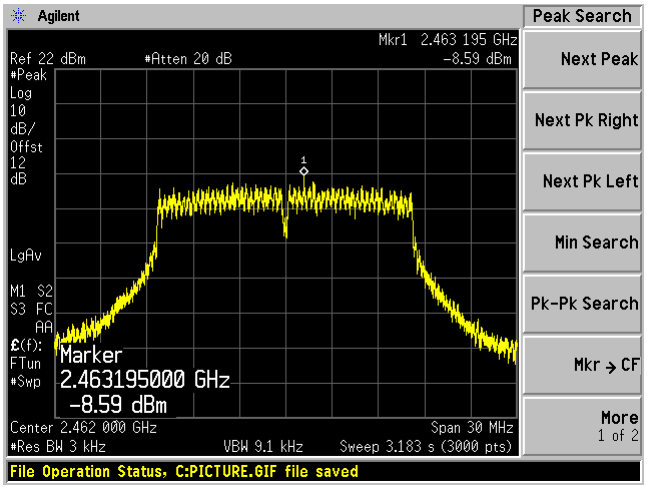
Mid Channel Antenna A



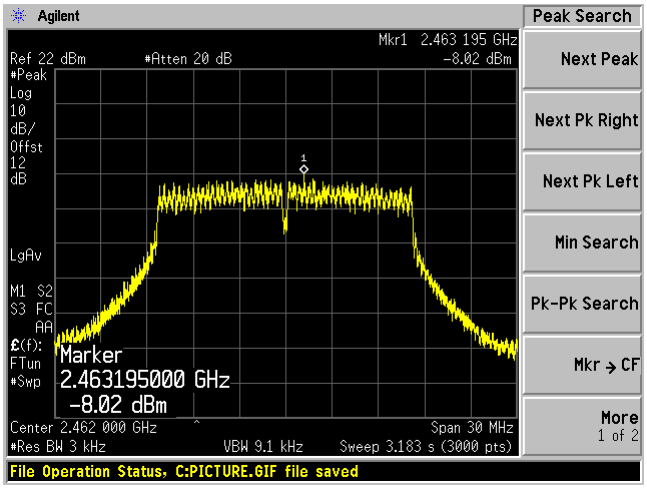
Mid Channel Antenna B



High Channel Antenna A

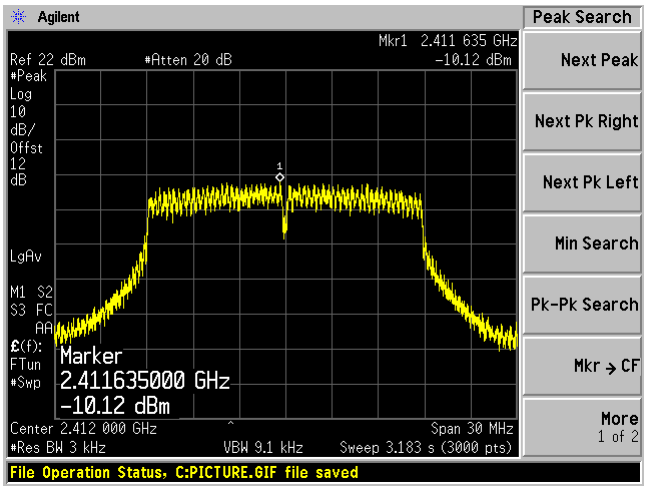


High Channel Antenna B

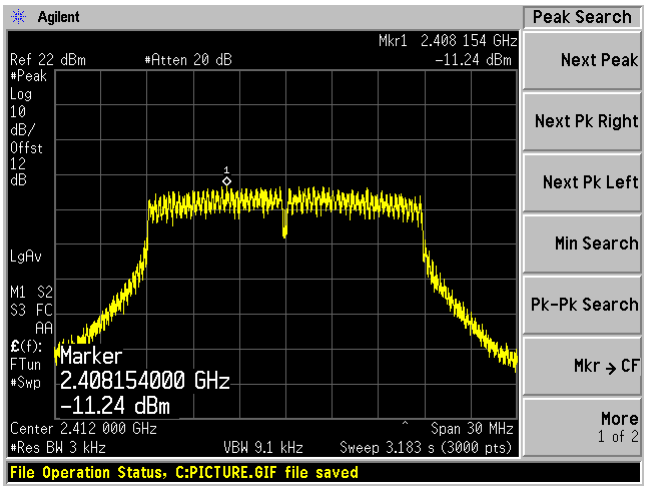


RADIO 2 802.11n20 mode

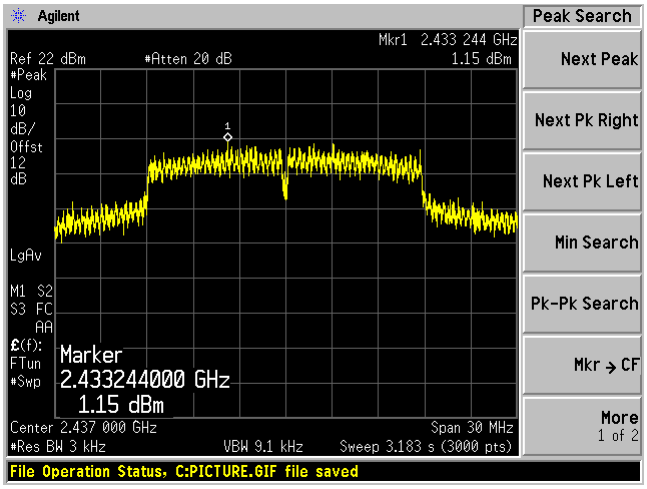
Low Channel Antenna A



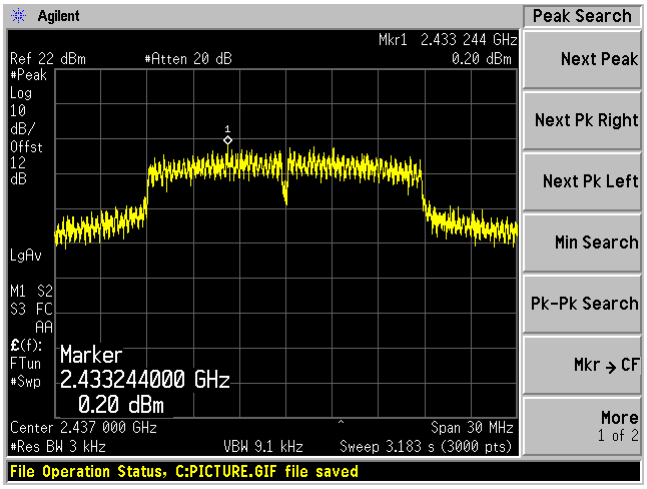
Low Channel Antenna B



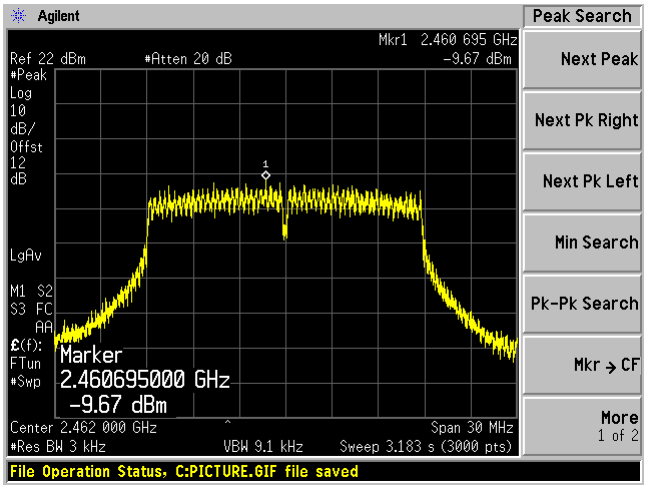
Mid Channel Antenna A



Mid Channel Antenna B



High Channel Antenna A



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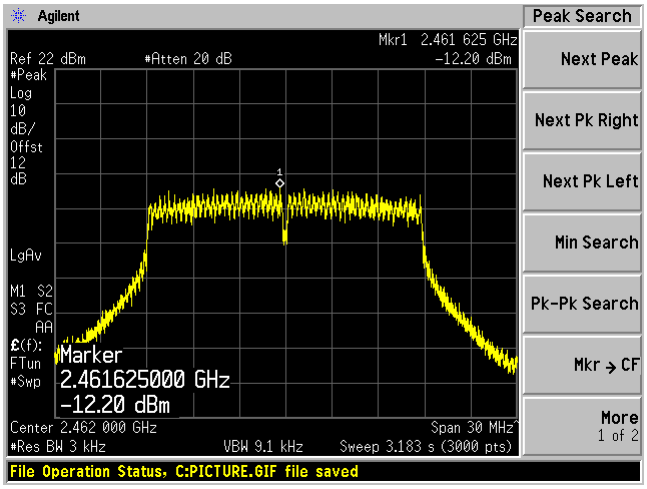
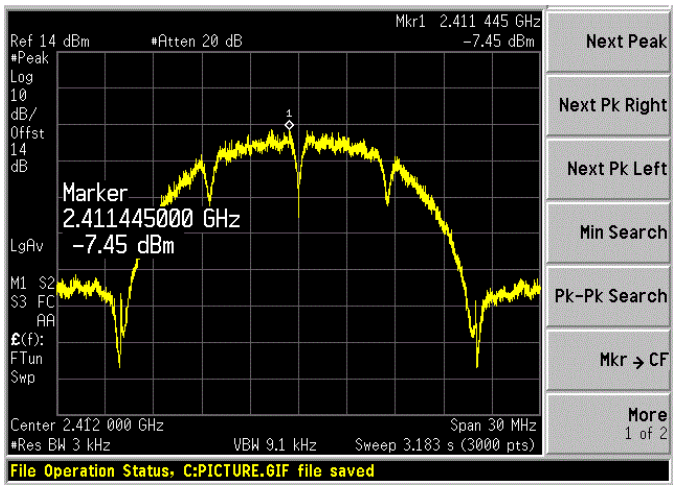
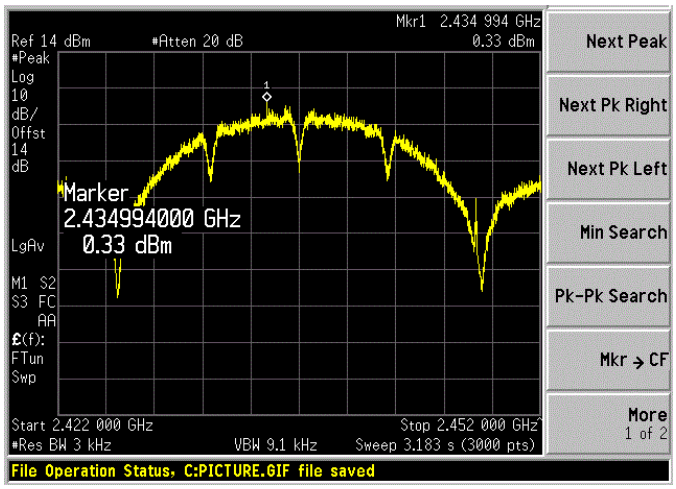


RADIO 1 802.11b mode

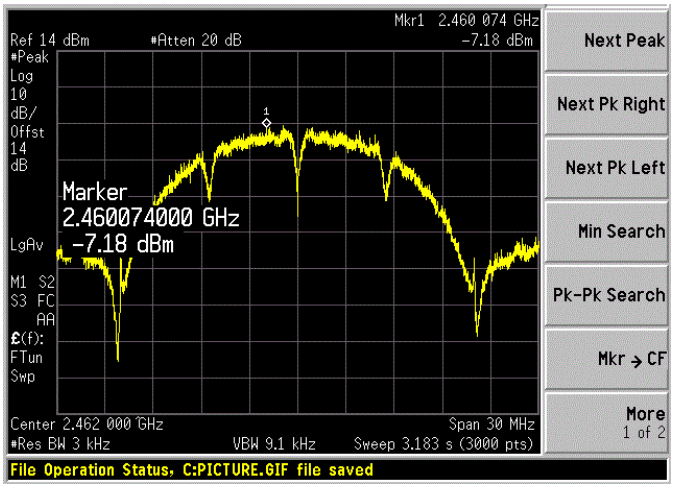
Low Channel



Mid Channel

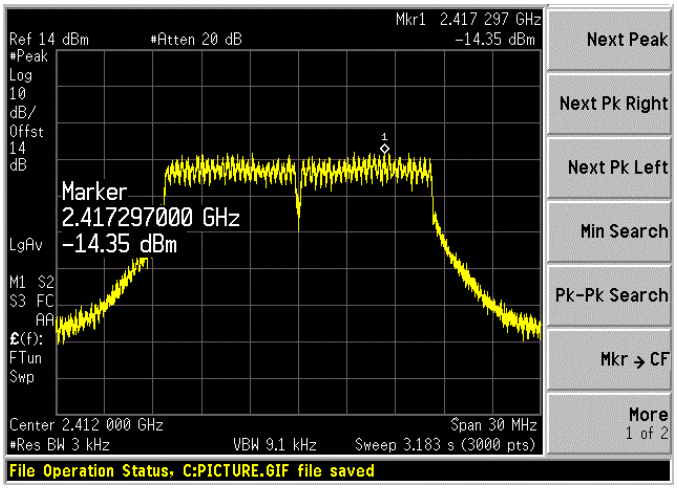


High Channel

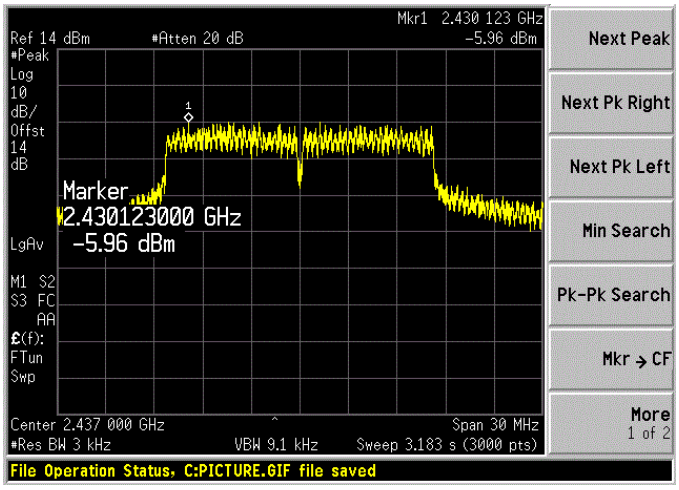


RADIO 1 802.11g mode

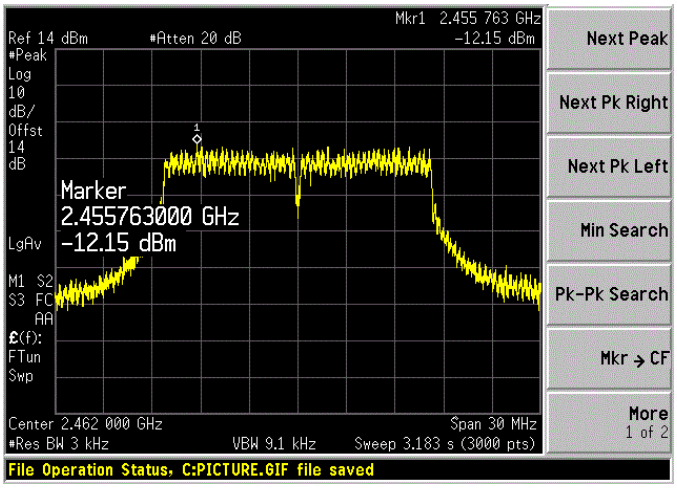
Low Channel



Mid Channel

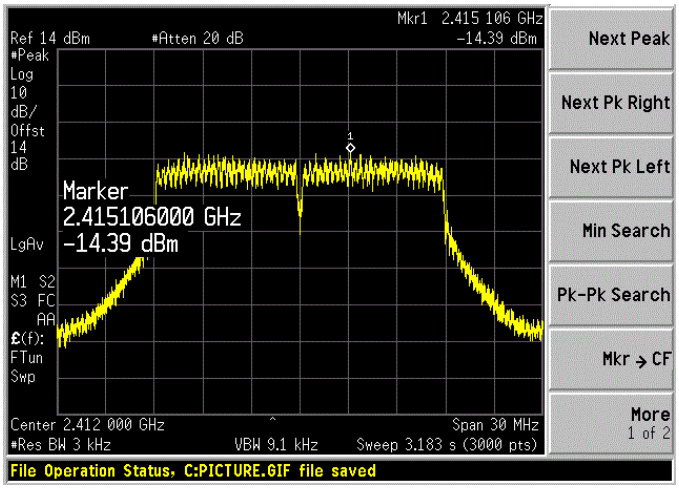


High Channel

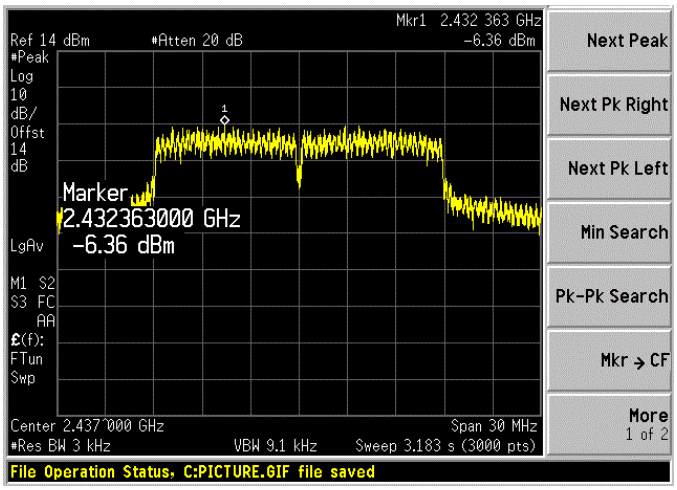


RADIO 1 802.11n20 mode

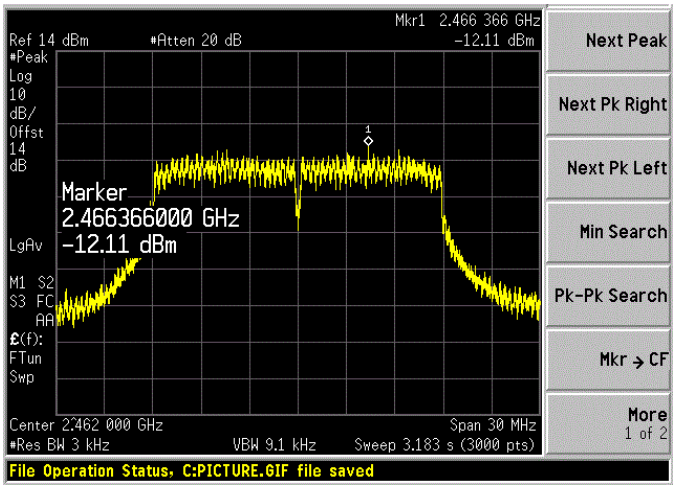
Low Channel



Mid Channel



High Channel



12 FCC §15.247(d) & ISEDC RSS-247 §5.5, RSS-GEN §8.9 - Spurious Emissions at Antenna Terminals

12.1 Applicable Standards

For ECFR §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 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.

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 Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	MY48250238	2019-06-26	1 year
-	RF cable	-	-	Each time[1]	N/A
-	10 dB attenuator	-	-	Each time[1]	N/A

Note[1]: cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

12.4 Test Environmental Conditions

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

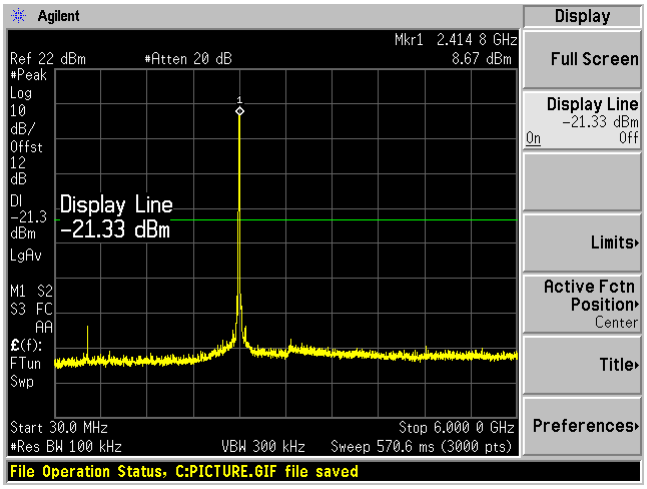
The testing was performed by Tri Pham & Christian McCaig from 2020-05-13 to 2020-05-22 in RF site.

12.5 Test Results

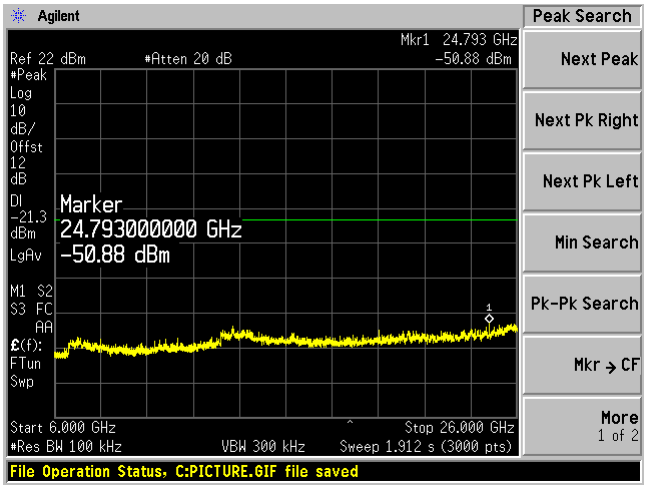
RADIO 2 802.11b mode

Antenna A Low Channel 2412MHz

30MHz – 6GHz

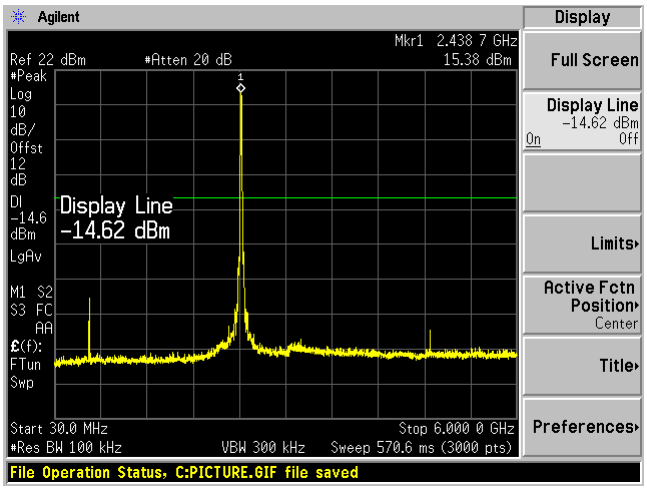


6GHz – 26GHz

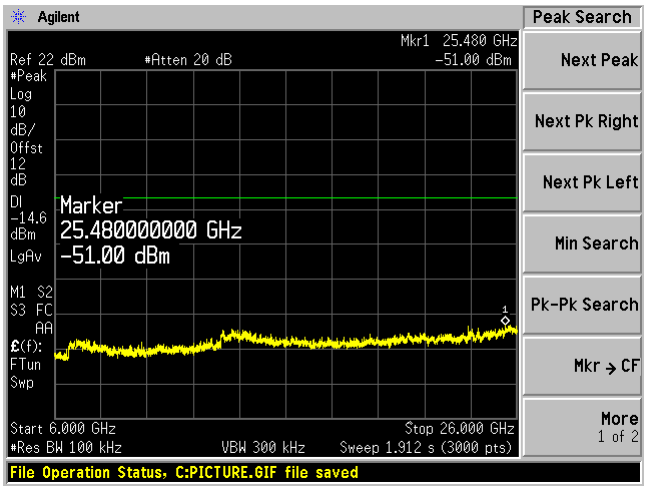


Antenna A Mid Channel 2437MHz

30MHz – 6GHz

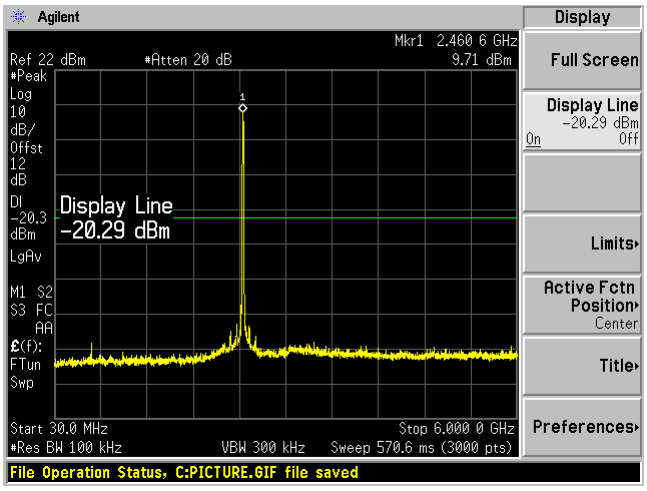


6GHz – 26GHz

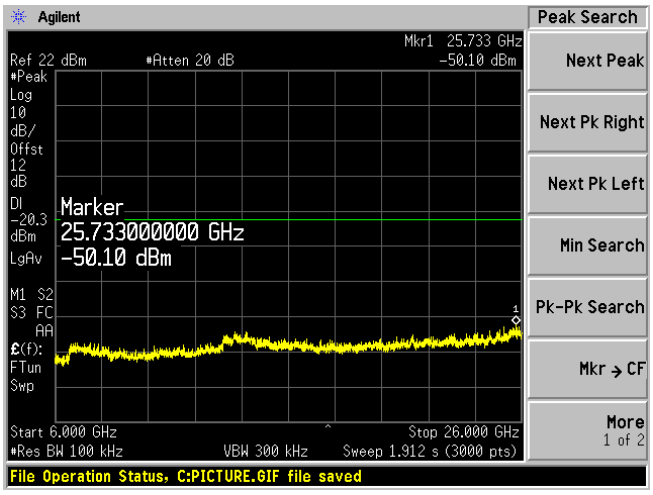


Antenna A High Channel 2462MHz

30MHz – 6GHz

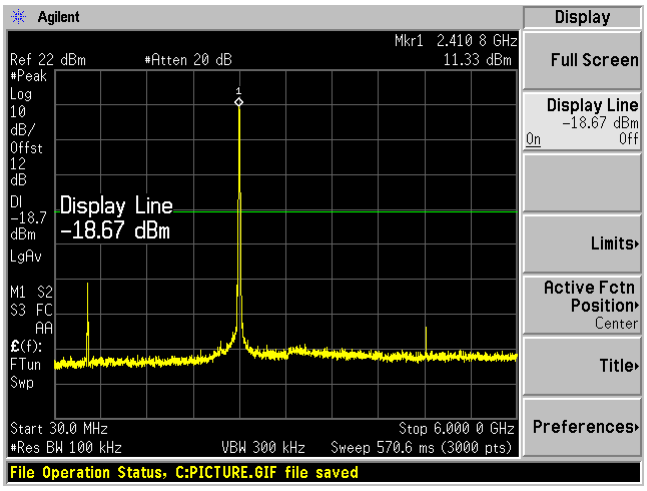


6GHz – 26GHz

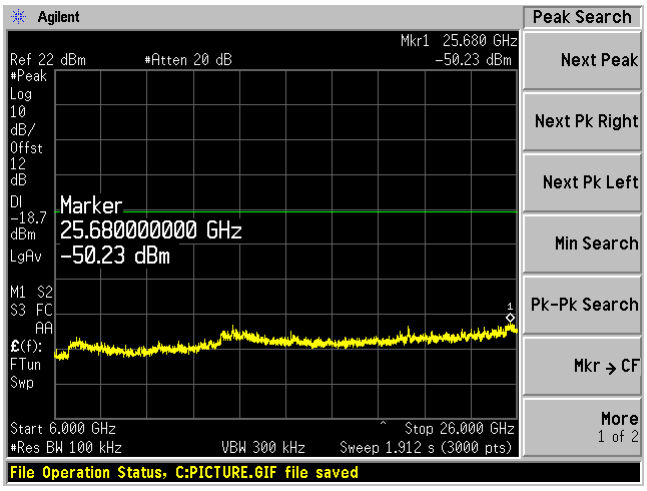


Antenna B Low Channel 2412MHz

30MHz – 6GHz

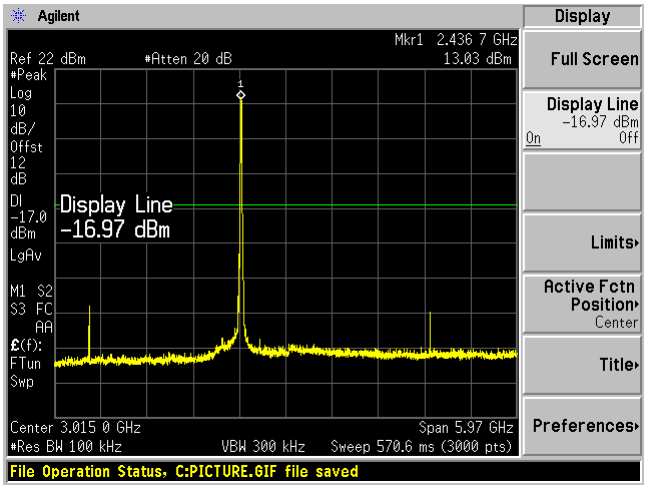


6GHz – 26GHz

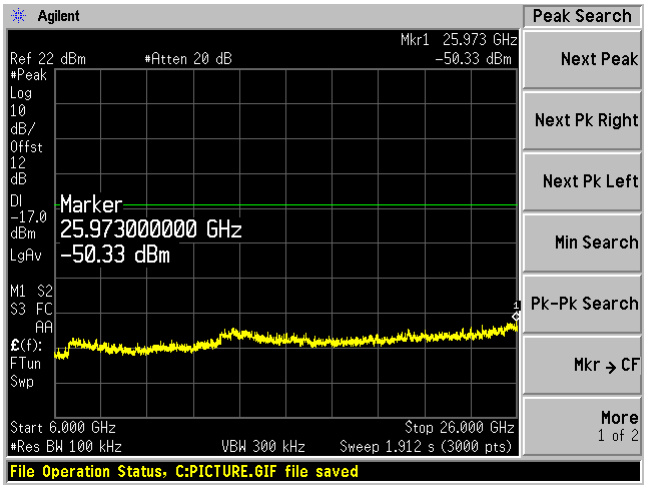


Antenna B Mid Channel 2437MHz

30MHz – 6GHz

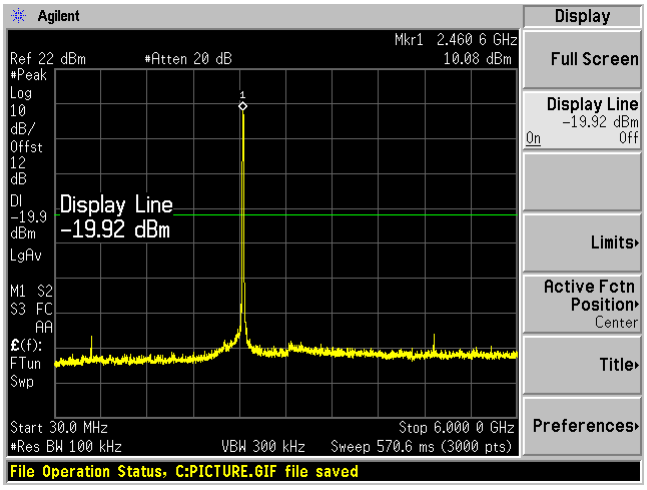


6GHz – 26GHz

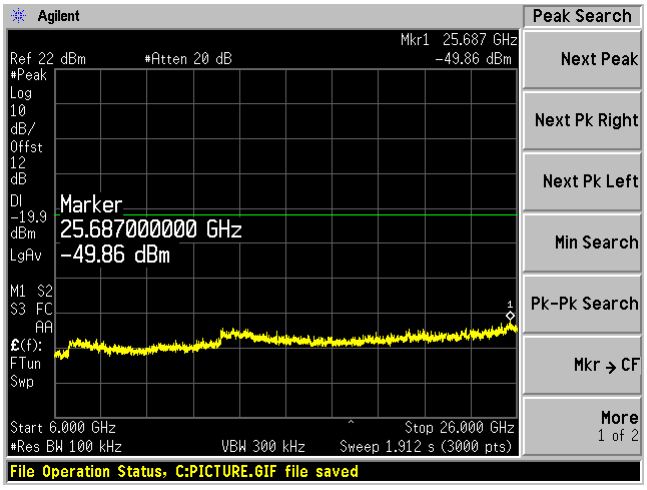


Antenna B High Channel 2462MHz

30MHz – 6GHz



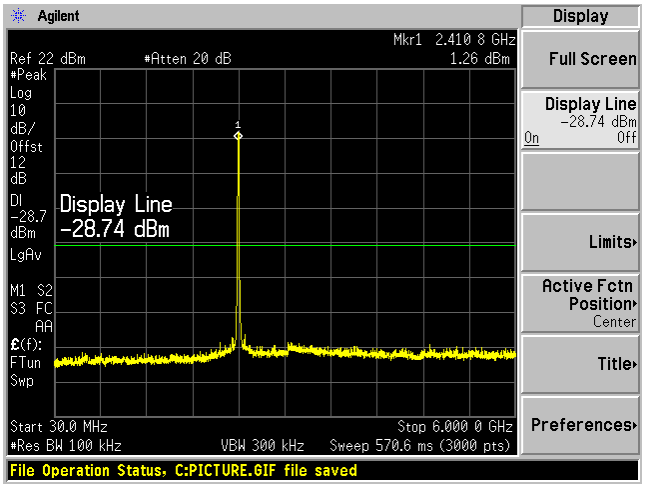
6GHz – 26GHz



RADIO 2 802.11g mode

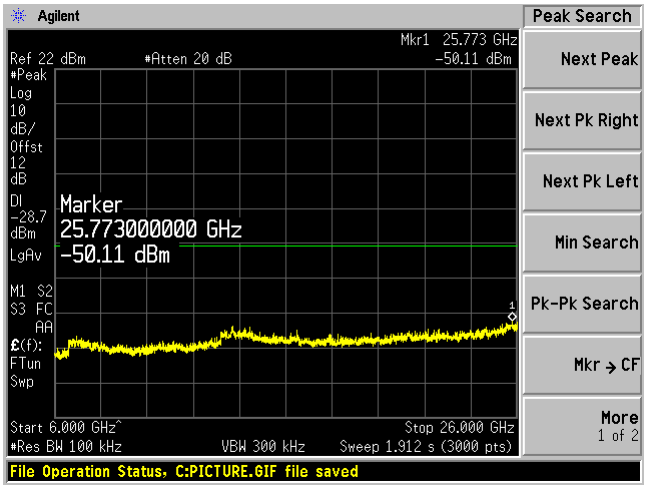
Antenna A Low Channel 2412MHz

30MHz – 6GHz



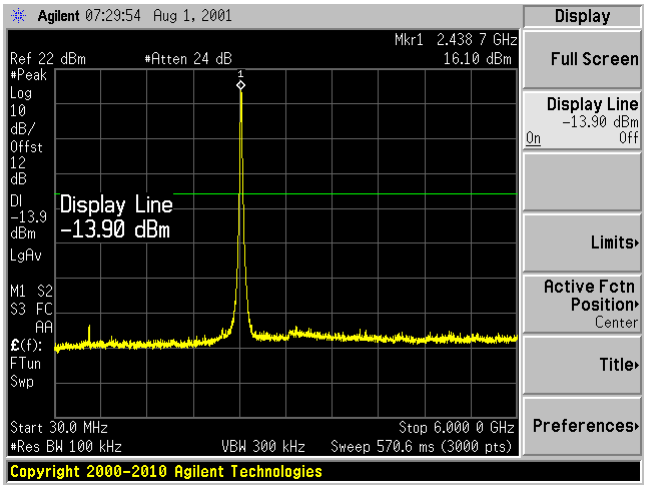
2.5

6GHz – 26GHz

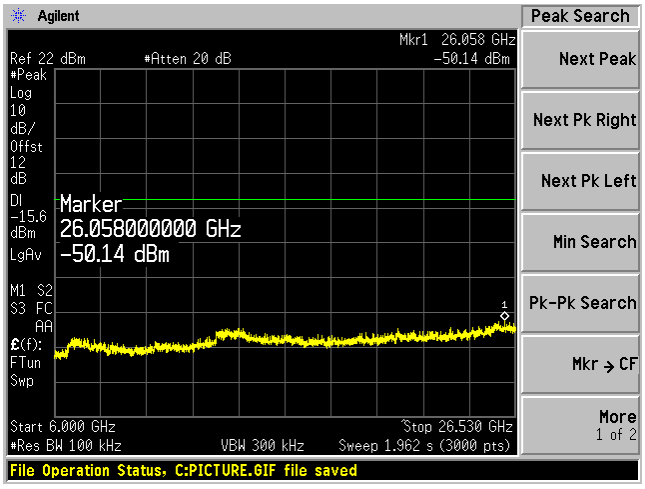


Antenna A Mid Channel 2437MHz

30MHz – 6GHz

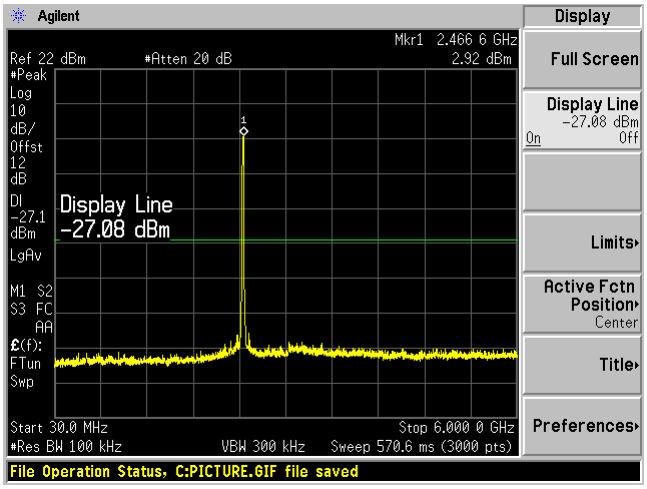


6GHz – 26GHz

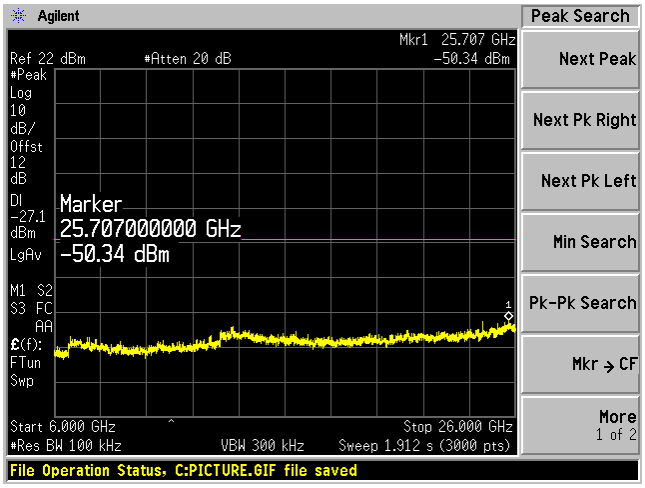


Antenna A High Channel 2462MHz

30MHz – 6GHz

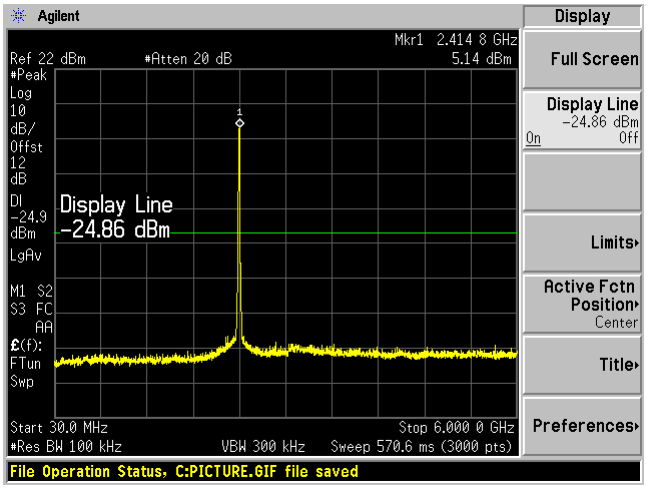


6GHz – 26GHz

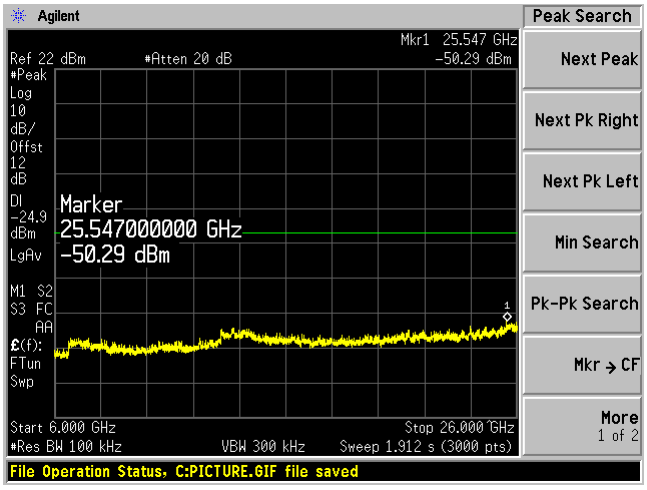


Antenna B Low Channel 2412MHz

30MHz – 6GHz

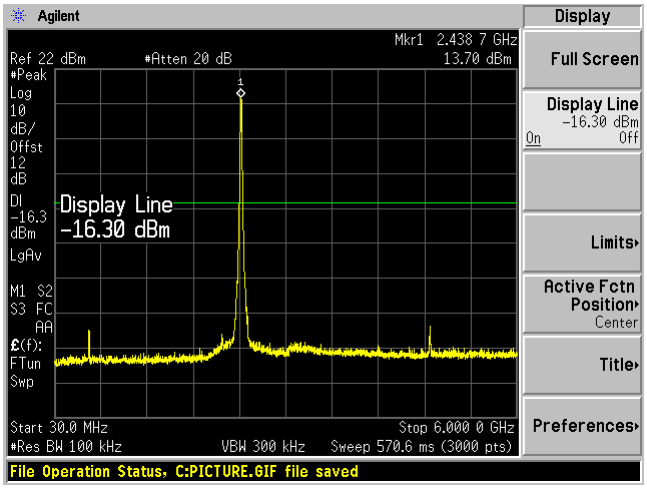


6GHz – 26GHz

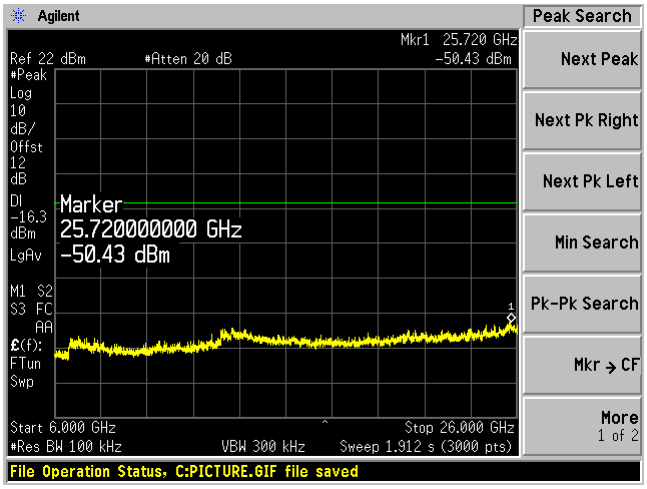


Antenna B Mid Channel 2437MHz

30MHz – 6GHz

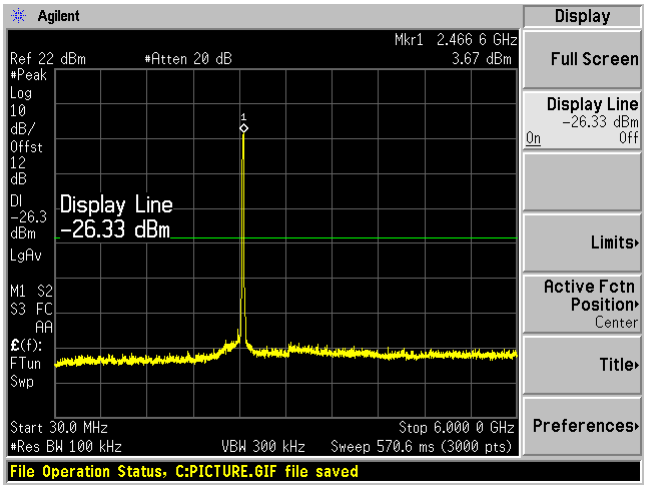


6GHz – 26GHz

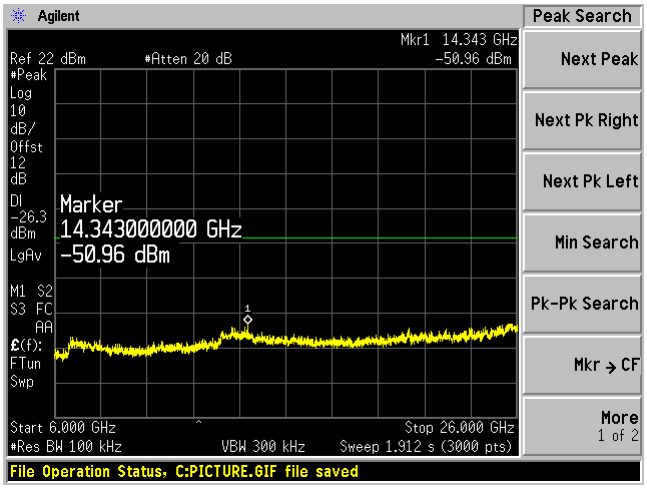


Antenna B High Channel 2462MHz

30MHz – 6GHz



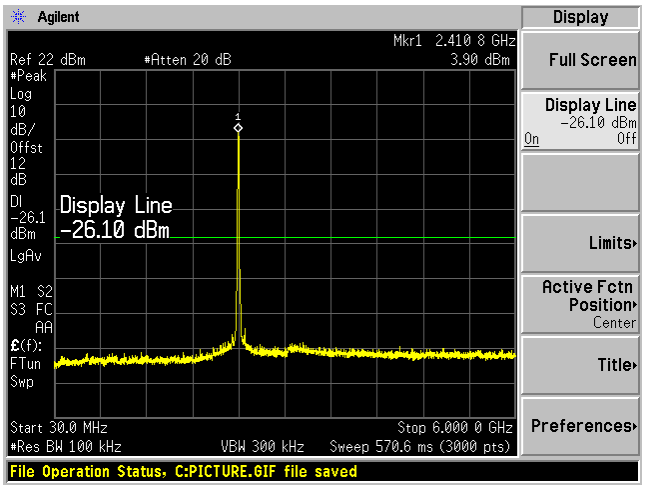
6GHz – 26GHz



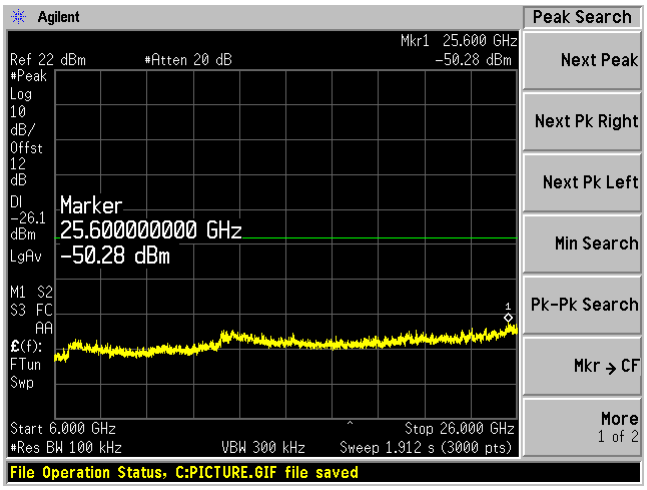
RADIO 2 802.11 n20 mode

Antenna A Low Channel 2412MHz

30MHz – 6GHz

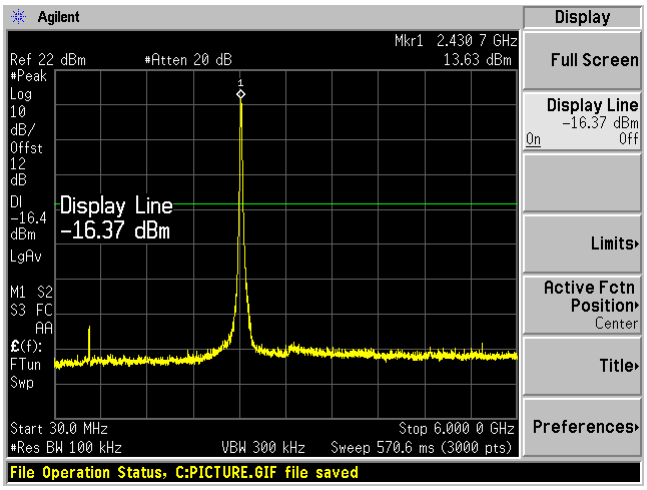


6GHz – 26GHz

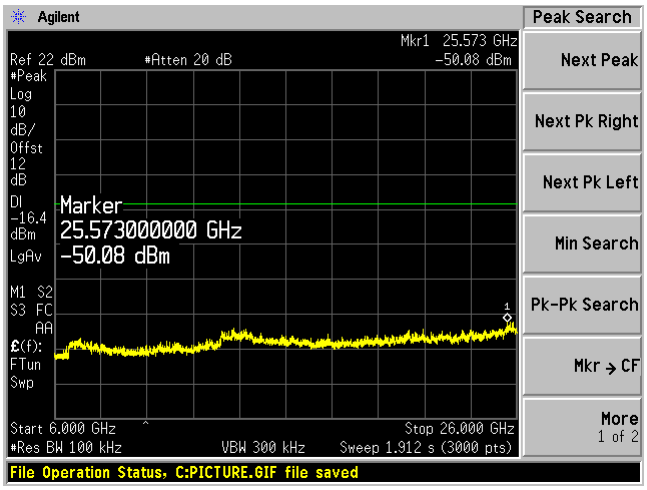


Antenna A Mid Channel 2437MHz

30MHz – 6GHz

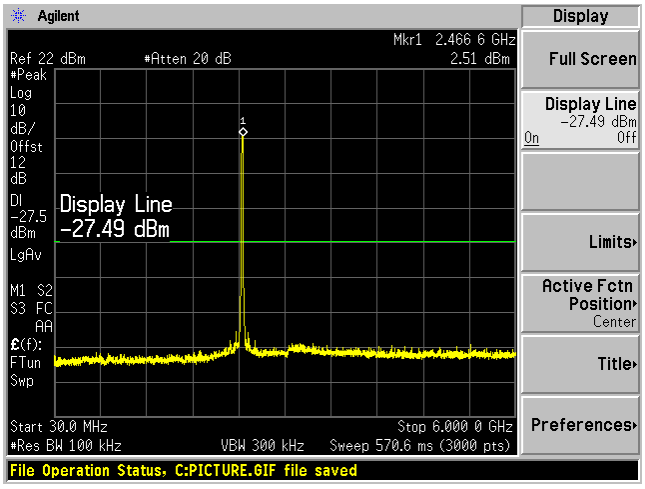


6GHz – 26GHz

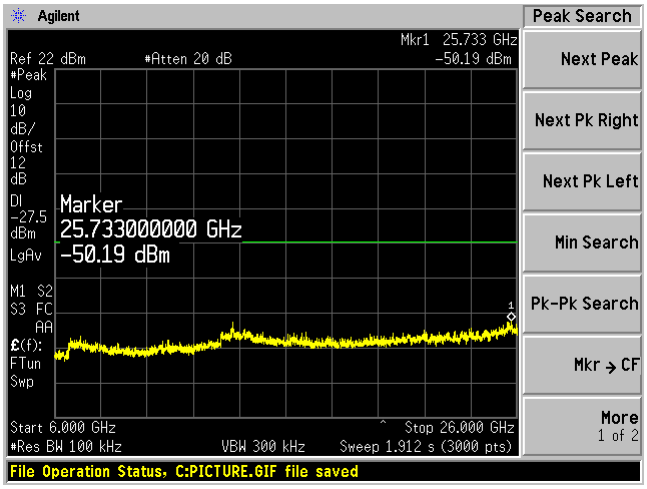


Antenna A High Channel 2462MHz

30MHz – 6GHz

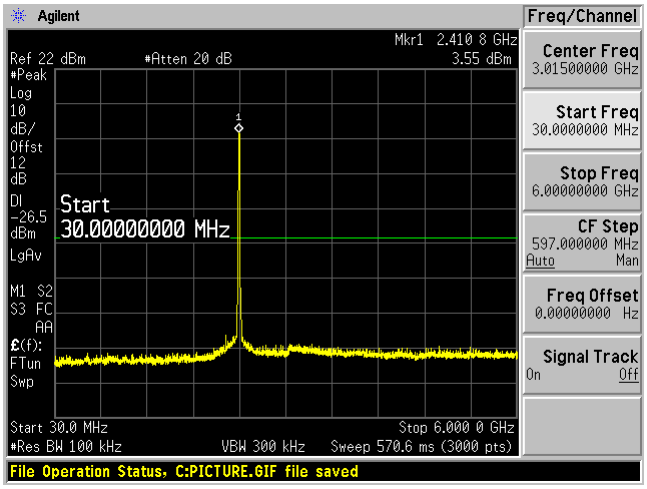


6GHz – 26GHz

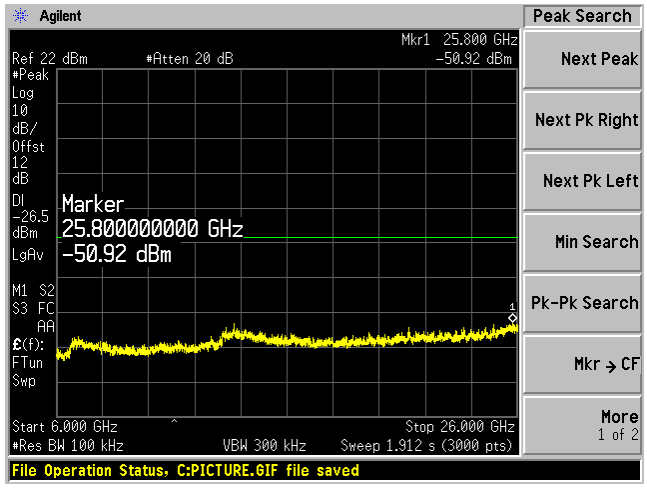


Antenna B Low Channel 2412MHz

30MHz – 6GHz

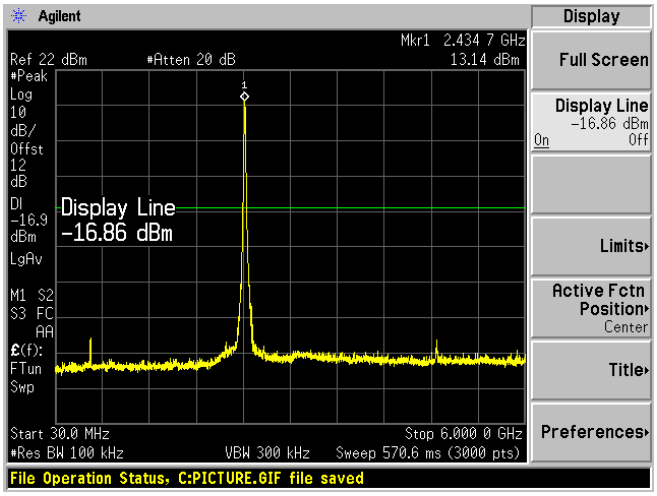


6GHz – 26GHz

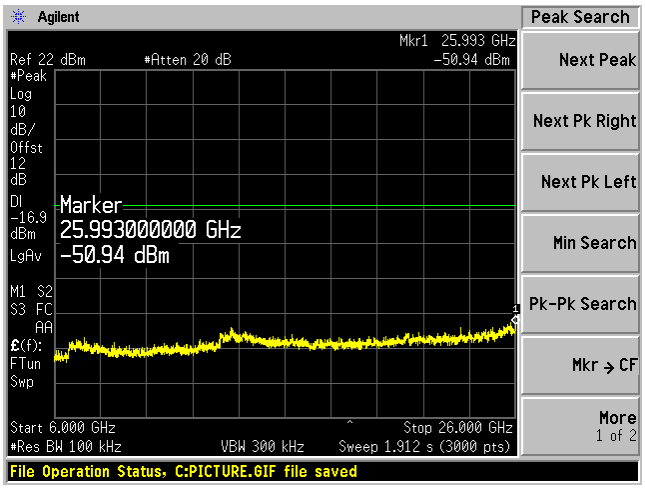


Antenna B Mid Channel 2437MHz

30MHz – 6GHz

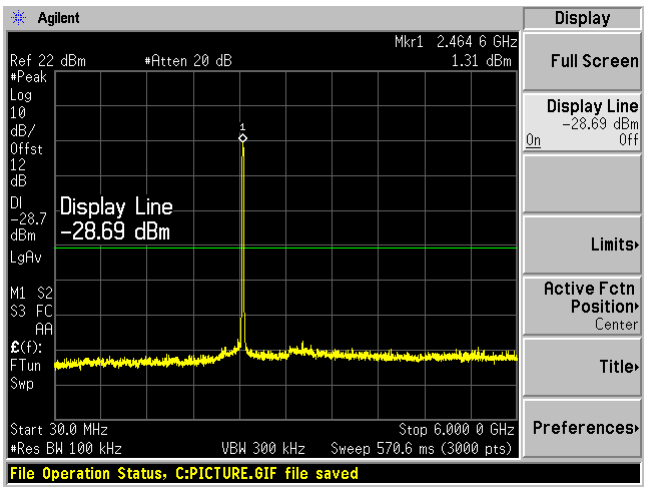


6GHz – 26GHz

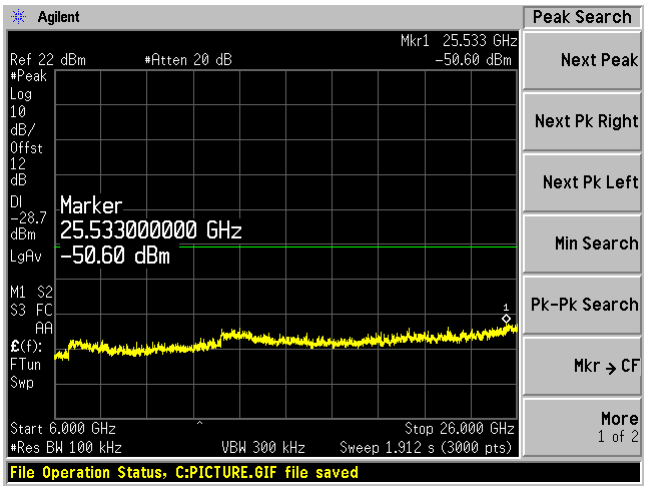


Antenna B High Channel 2462MHz

30MHz – 6GHz



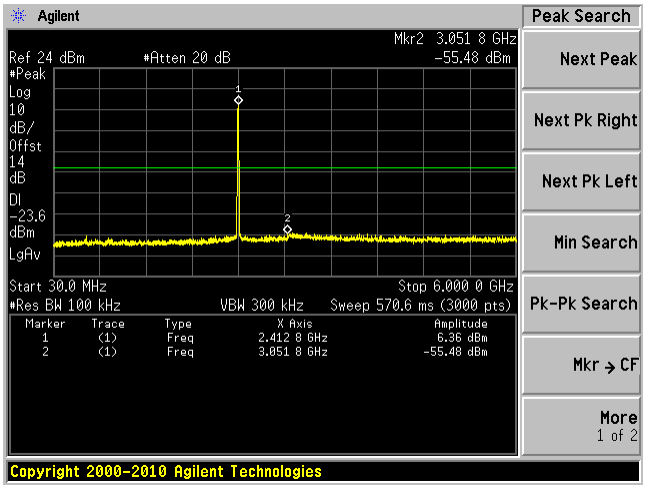
6GHz – 26GHz



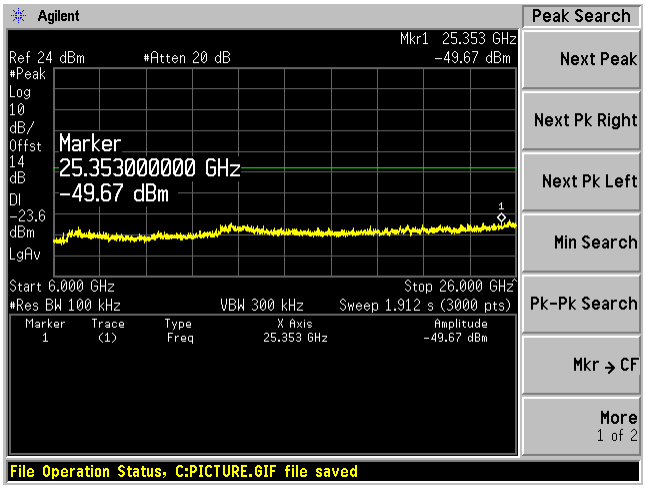
RADIO 1 802.11 b mode

Low Channel 2412MHz

30MHz – 6GHz

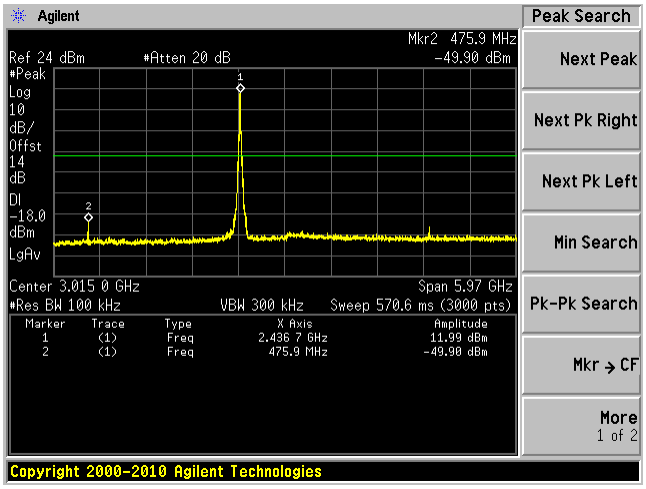


6GHz – 26GHz

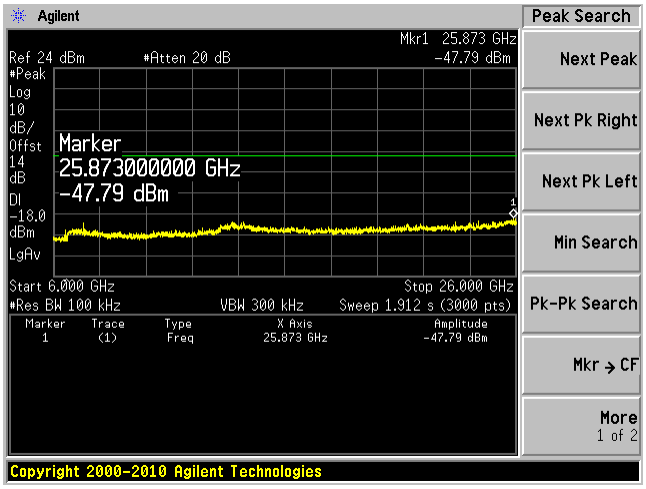


Mid Channel 2437MHz

30MHz – 6GHz

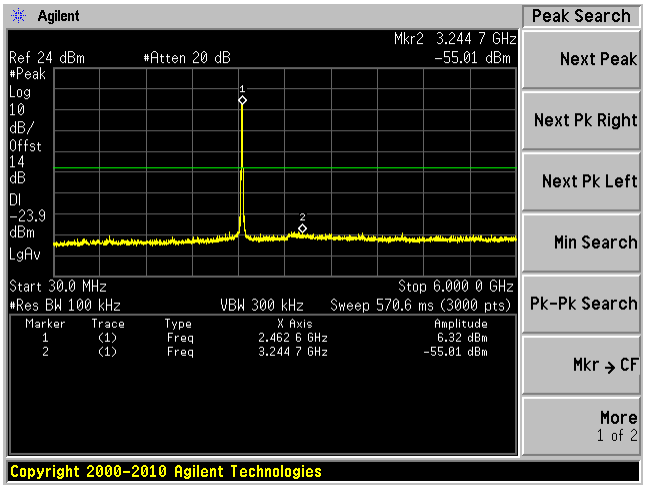


6GHz – 26GHz

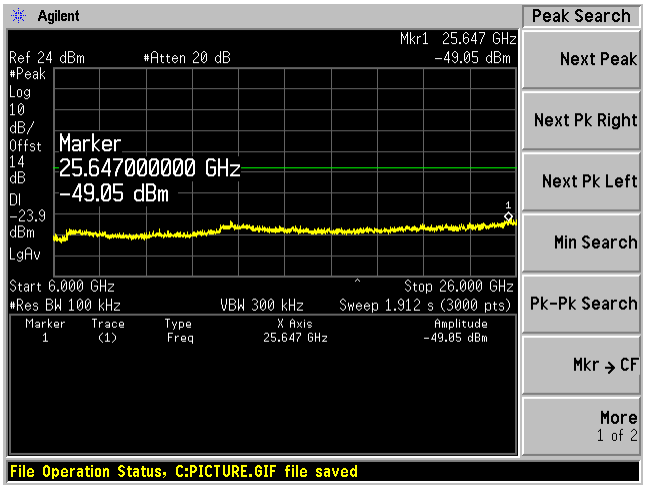


High Channel 2462MHz

30MHz – 6GHz



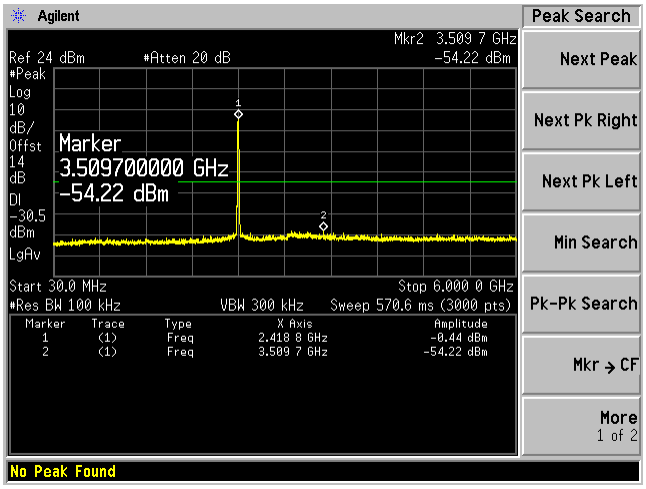
6GHz – 26GHz



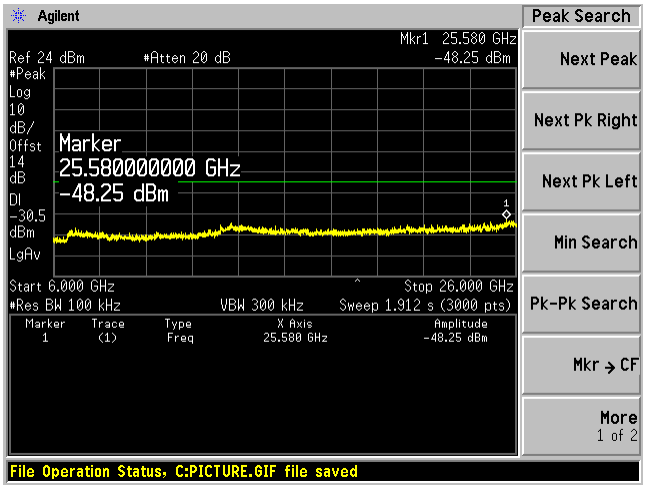
RADIO 1 802.11 g mode

Low Channel 2412MHz

30MHz – 6GHz

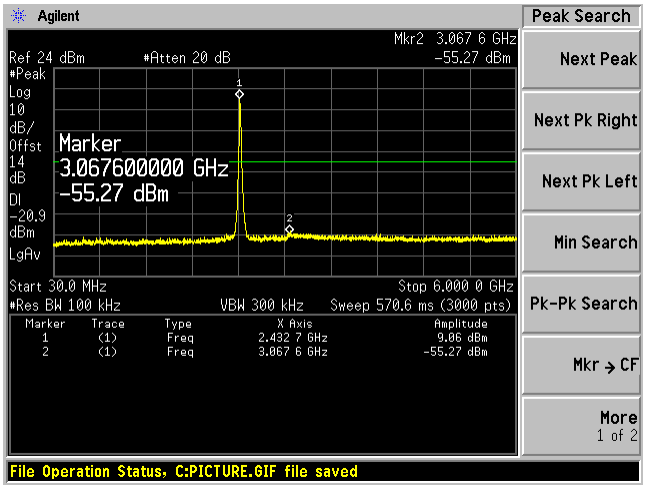


6GHz – 26GHz

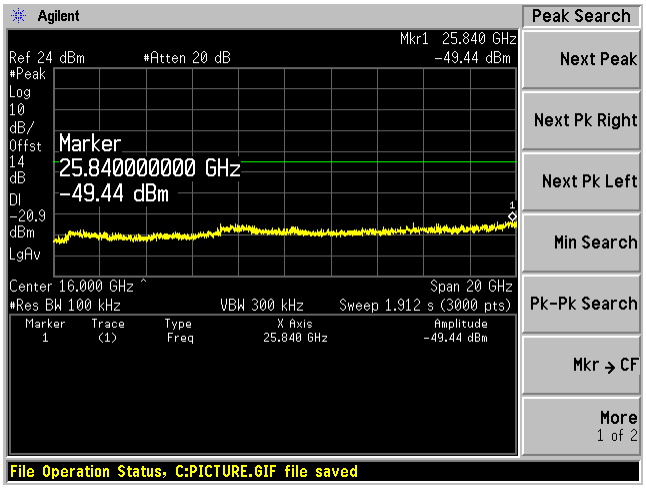


Mid Channel 2437MHz

30MHz – 6GHz

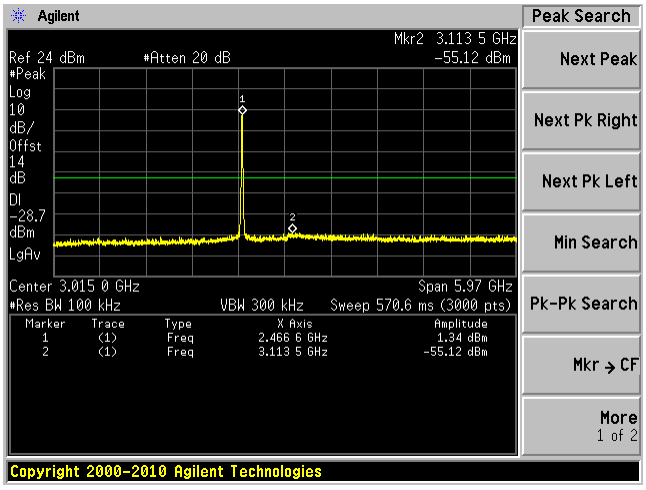


6GHz – 26GHz

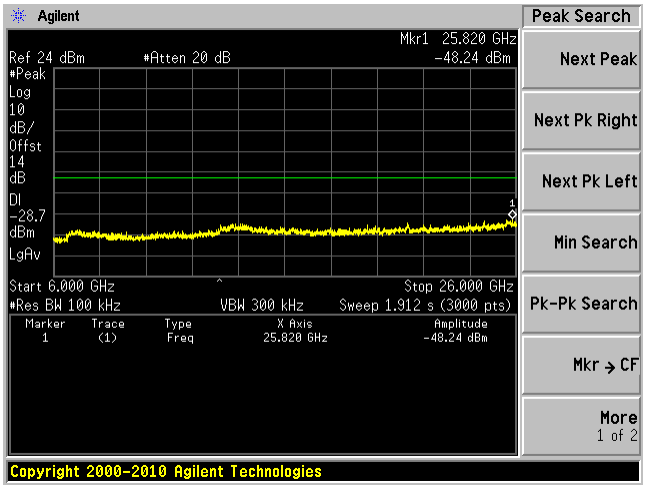


High Channel 2462MHz

30MHz – 6GHz



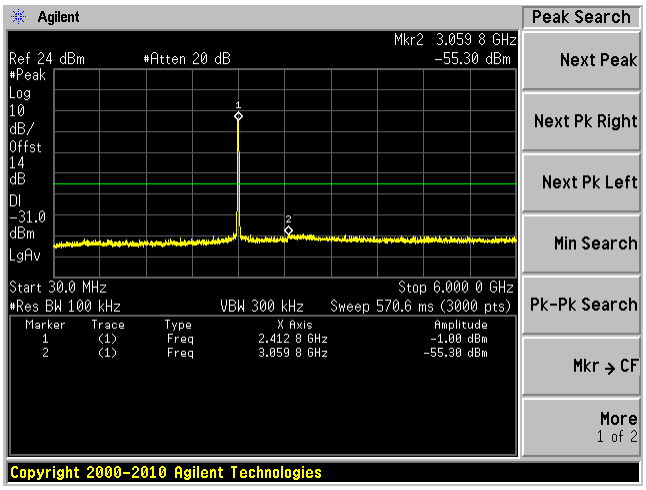
6GHz – 26GHz



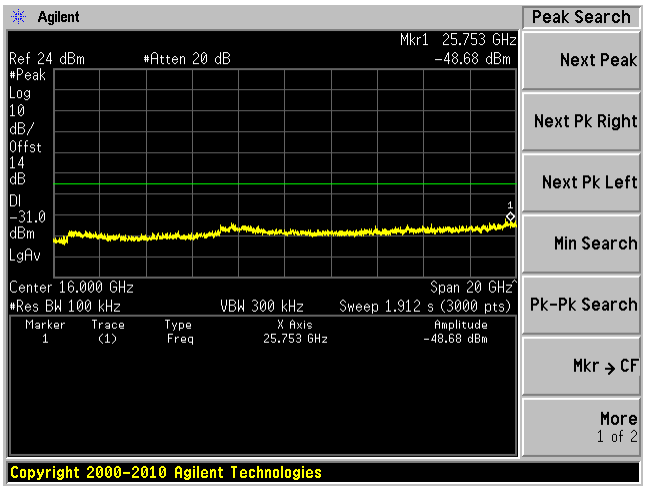
RADIO 1 802.11 n20 mode

Low Channel 2412MHz

30MHz – 6GHz

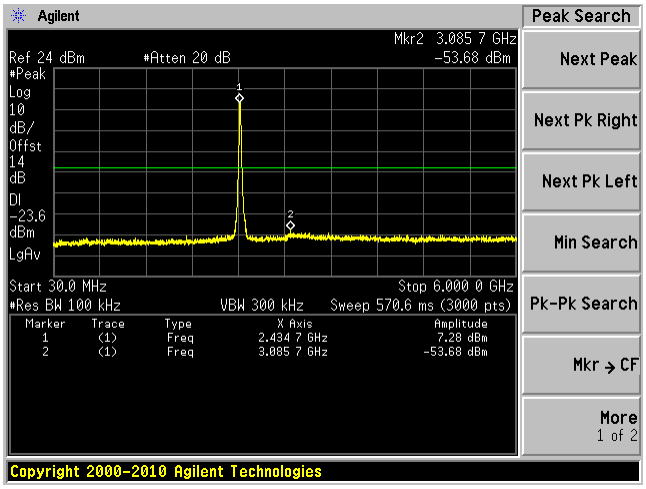


6GHz – 26GHz

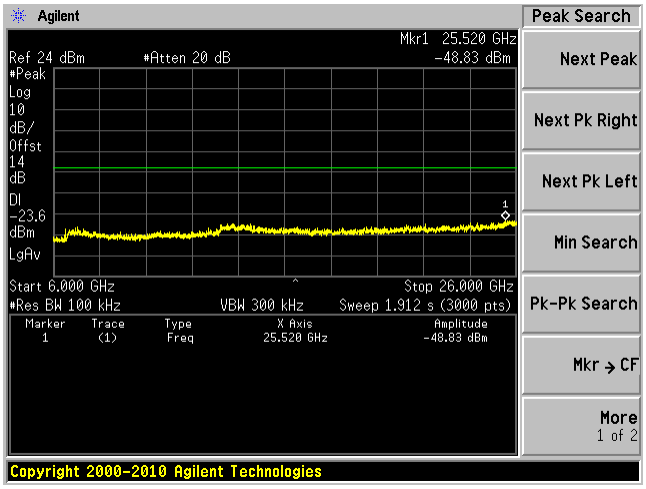


Mid Channel 2437MHz

30MHz – 6GHz

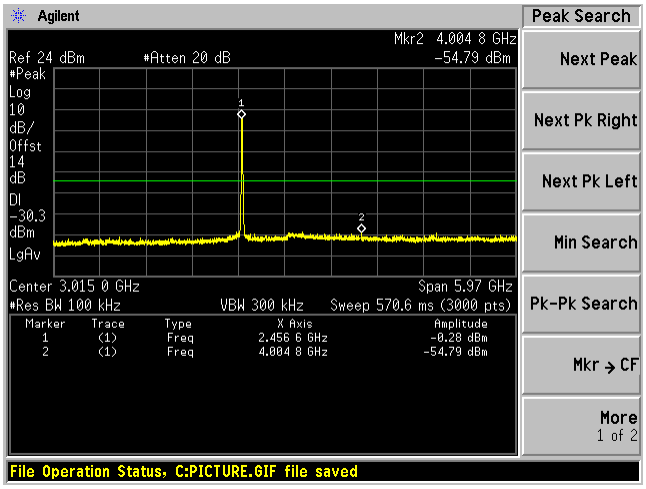


6GHz – 26GHz

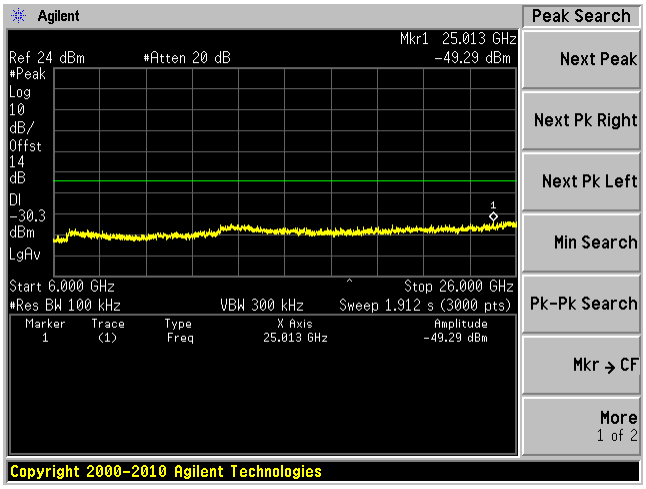


High Channel 2462MHz

30MHz – 6GHz



6GHz – 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.

13 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 17025:2005 *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 2nd day of October 2018.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3297.02
Valid to September 30, 2020
Revised June 5, 2019

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 ---