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TIMCO ENGINEERING, Inc.

An IIA Company

FCC PART 15.247
2.4 GHz DTS Test Report

APPLICANT	COBRA ELECTRONICS CORPORATION
ADDRESS	6500 WEST CORTLAND STREET CHICAGO IL 60707 USA
FCC ID	BBORDCAM
MODEL NUMBER	RADAR DETECTOR + DASH CAMERA
PRODUCT DESCRIPTION	RADAR DETECTOR
DATE SAMPLE RECEIVED	02/26/2019
FINAL TEST DATE	03/05/2019
TESTED BY	Franklin Rose
APPROVED BY	Tim Royer
TEST RESULTS	☒ PASS ☐ FAIL

Report Number	Report Version	Description	Issue Date
429CUT18_TestReport_	Rev1	Initial Issue	03/18/2019

TABLE OF CONTENTS

GENERAL REMARKS

Summary

The device under test does:

☒ Fulfill the general approval requirements as identified in this test report and was selected by the customer.

☐ Not fulfill the general approval requirements as identified in this test report

Attestations

This equipment has been tested in accordance with the standards identified in this test report. To the best of my knowledge and belief, these tests were performed using the measurement procedures described in this report.

All instrumentation and accessories used to test products for compliance to the indicated standards are calibrated regularly in accordance with ISO 17025 requirements.

I attest that the necessary measurements were made at:

Timco Engineering Inc.
849 NW State Road 45
Newberry, FL 32669
Designation #: US1070

Tested by:

Name and Title	Franklin Rose, Project Manager / EMC Testing Technician
Date	03/18/2019

Reviewed and Approved by:

Name and Title	Tim Royer, Project Manager / EMC Testing Engineer
Date	03/21/2019

GENERAL INFORMATION

EUT Information

EUT Description	RADAR DETECTOR + DASH CAMERA		
FCC ID	BBORDCAM		
Model Number	ROAD SCOUT		
EUT Power Source	☐110–120Vac, 50–60Hz	☒ DC Power	☐ Battery Operated
Test Item	☐ Prototype	☒ Pre-Production	☐ Production
Type of Equipment	☐ Fixed	☒ Mobile	☐ Portable
Antenna Connector	None		
Test Conditions	The temperature was 26ºC Relative humidity of 50%.		
Modification to the EUT	SMA connectors were added to the EUT.		
Applicable Standards	FCC CFR 47 Part 2, Part 15, Referring to ANSI C63.10-2013 for Test Procedures		
Test Facility	Timco Engineering Inc. at 849 NW State Road 45 Newberry, FL 32669 USA. Designation #: US1070		

Peripherals Used in Testing

Description	Type	Connector	Length
DELL LAPTOP	n/a	n/a	n/a
USB to UART	Cobra	USB to custom	2 ft.

Test Results Summary

FCC Rule Part No.	Test Item	Result
15.247(a)(2)	6 dB Bandwidth	**Pass**
2.1049(h)	99% Occupied Bandwidth	**Pass**
15.247(e)	Power Spectral Density	**Pass**
15.247(b)(3)	Power Output	**Pass**
15.247(d)	Bandedge	**Pass**
15.247(b)	Conducted Spurious Emissions	**Pass**
15.205, 15.209, 15.247(d)	Radiated Spurious Emissions	**Pass**
15.207	AC Powerline Conducted Emissions	**N / A**

Definition of EUT

RULE PART NO.: FCC PART 15.3

(i) *Class B digital device.* A digital device that is marketed for use in a residential environment notwithstanding use in commercial, business and industrial environments. Examples of such devices include, but are not limited to, personal computers, calculators, and similar electronic devices that are marketed for use by the general public.

NOTE: The responsible party may also qualify a device intended to be marketed in a commercial, business or industrial environment as a Class B device, and in fact is encouraged to do so, provided the device complies with the technical specifications for a Class B digital device. In the event that a particular type of device has been found to repeatedly cause harmful interference to radio communications, the Commission may classify such a digital device as a Class B digital device, regardless of its intended use.

(k) *Digital device.* (Previously defined as a computing device). An unintentional radiator (device or system) that generates and uses timing signals or pulses at a rate in excess of 9,000 pulses (cycles) per second and uses digital techniques; inclusive of telephone equipment that uses digital techniques or any device or system that generates and uses radio frequency energy for the purpose of performing data processing functions, such as electronic computations, operations, transformations, recording, filing, sorting, storage, retrieval, or transfer. A radio frequency device that is specifically subject to an emanation requirement in any other FCC Rule part or an intentional radiator subject to subpart C of this part that contains a digital device is not subject to the standards for digital devices, provided the digital device is used only to enable operation of the radio frequency device and the digital device does not control additional functions or capabilities.

NOTE: Computer terminals and peripherals that are intended to be connected to a computer are digital devices.

(o) *Intentional radiator.* A device that intentionally generates and emits radio frequency energy by radiation or induction.

MEASUREMENT STANDARDS

RULE PART NO.: FCC PART 15.31

(a) The following measurement procedures are used by the Commission to determine compliance with the technical requirements in this part. Except where noted, copies of these procedures are available from the Commission's current duplicating contractor whose name and address are available from the Commission's Consumer and Governmental Affairs Bureau at 1-888-CALL-FCC (1-888-225-5322).

(2) Unlicensed Personal Communications Service (UPCS) devices are to be measured for compliance using ANSI C63.17-2013: "American National Standard Methods of Measurement of the Electromagnetic and Operational Compatibility of Unlicensed Personal Communications Services (UPCS) Devices" (incorporated by reference, see §15.38).

(3) Other intentional radiators are to be measured for compliance using the following procedure: ANSI C63.10-2013 (incorporated by reference, see §15.38).

(e) For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

(l) Measurements of radio frequency emissions conducted to the public utility power lines shall be performed using a 50 ohm/50 uH line-impedance stabilization network (LISN).

(m) Measurements on intentional radiators or receivers, other than TV broadcast receivers, shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table:

Frequency range over which device operates	Number of frequencies	Location in the range of operation
1 MHz or less	1	Middle.
1 to 10 MHz	2	1 near top and 1 near bottom.
More than 10 MHz	3	1 near top, 1 near middle and 1 near bottom.

(o) The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

FREQUENCY RANGE OF MEASUREMENTS

RULE PART NO.: FCC PART 15.33

§15.33 Frequency range of radiated measurements.

(a) For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the frequency shown in this paragraph:

(1) If the intentional radiator operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

(2) If the intentional radiator operates at or above 10 GHz and below 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.

(3) If the intentional radiator operates at or above 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 200 GHz, whichever is lower, unless specified otherwise elsewhere in the rules.

(4) If the intentional radiator contains a digital device, regardless of whether this digital device controls the functions of the intentional radiator or the digital device is used for additional control or function purposes other than to enable the operation of the intentional radiator, the frequency range shall be investigated up to the range specified in paragraphs (a)(1) through (a)(3) of this section or the range applicable to the digital device, as shown in paragraph (b)(1) of this section, whichever is the higher frequency range of investigation.

Frequency Range(s) of EUT

BLE	2402 – 2480 MHz
Wifi 802.11 b/g/n HT20	2412 – 2462 MHz
Wifi 802.11 n HT40	2422 – 2462 MHz

Testing Frequencies for EUT

BLE	2402, 2440, 2480 MHz
Wifi 802.11 b/g/n HT20	2412, 2442, 2462 MHz
Wifi 802.11 n HT40	2422 – 2462 MHz

METHOD OF MEASUREMENT

RULE PART NO.: FCC PART 15.35

§15.35 Measurement detector functions and bandwidths.

The conducted and radiated emission limits shown in this part are based on the following, unless otherwise specified in this part:

(a) On any frequency or frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function and related measurement bandwidths, unless otherwise specified. The specifications for the measuring instrumentation using the CISPR quasi-peak detector can be found in ANSI C63.4-2014, clause 4 (incorporated by reference, see §15.38). As an alternative to CISPR quasi-peak measurements, the responsible party, at its option, may demonstrate compliance with the emission limits using measuring equipment employing a peak detector function as long at the same bandwidth as indicated for CISPR quasi-peak measurements are employed.

(b) 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. When average radiated emission measurements are specified in this part, including average emission measurements below 1000 MHz, there also is a limit on the peak level of the radio frequency emissions. Unless otherwise specified, *e.g.*, see §§15.250, 15.252, 15.253(d), 15.255, 15.256, and 15.509 through 15.519, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device, *e.g.*, the total peak power level. Note that the use of a pulse desensitization correction factor may be needed to determine the total peak emission level. The instruction manual or application note for the measurement instrument should be consulted for determining pulse desensitization factors, as necessary.

(c) Unless otherwise specified, *e.g.*, §§15.255(b), and 15.256(l)(5), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to Supplier's Declaration of Conformity.

DTS BANDWIDTH

Rule Part No.: FCC 15.247(a)(2)

Requirements:

§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

(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.

Test Method: ANSI C63.10 § 11.9.1.1

11.9.1.1 RBW ≥ DTS bandwidth

The following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement:

a) Set the RBW ≥ DTS bandwidth.

b) Set VBW ≥ [3 × RBW].

c) Set span ≥ [3 × RBW].

d) Sweep time = auto couple.

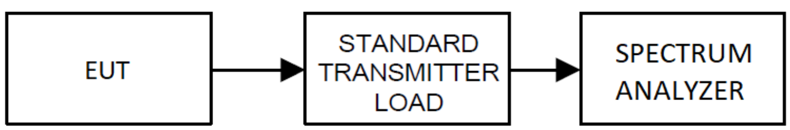
e) Detector = peak.

f) Trace mode = max hold.

g) Allow trace to fully stabilize.

h) Use peak marker function to determine the peak amplitude level.

Test Setup:



DTS BANDWIDTH

6 dB Occupied Bandwidth Measurement Table

Bluetooth Low Energy			
Frequency (MHz)	6 dB BW (KHz)	Limit (KHz)	Margin (KHz)
2402	658.66	≥ 500	158.66
2440	653.65	≥ 500	153.65
2480	663.66	≥ 500	163.66

Wifi 802.11 b			
Frequency (MHz)	6 dB BW (KHz)	Limit (KHz)	Margin (KHz)
2412	1009.62	≥ 500	509.62
2442	1009.62	≥ 500	509.62
2462	1009.62	≥ 500	509.62

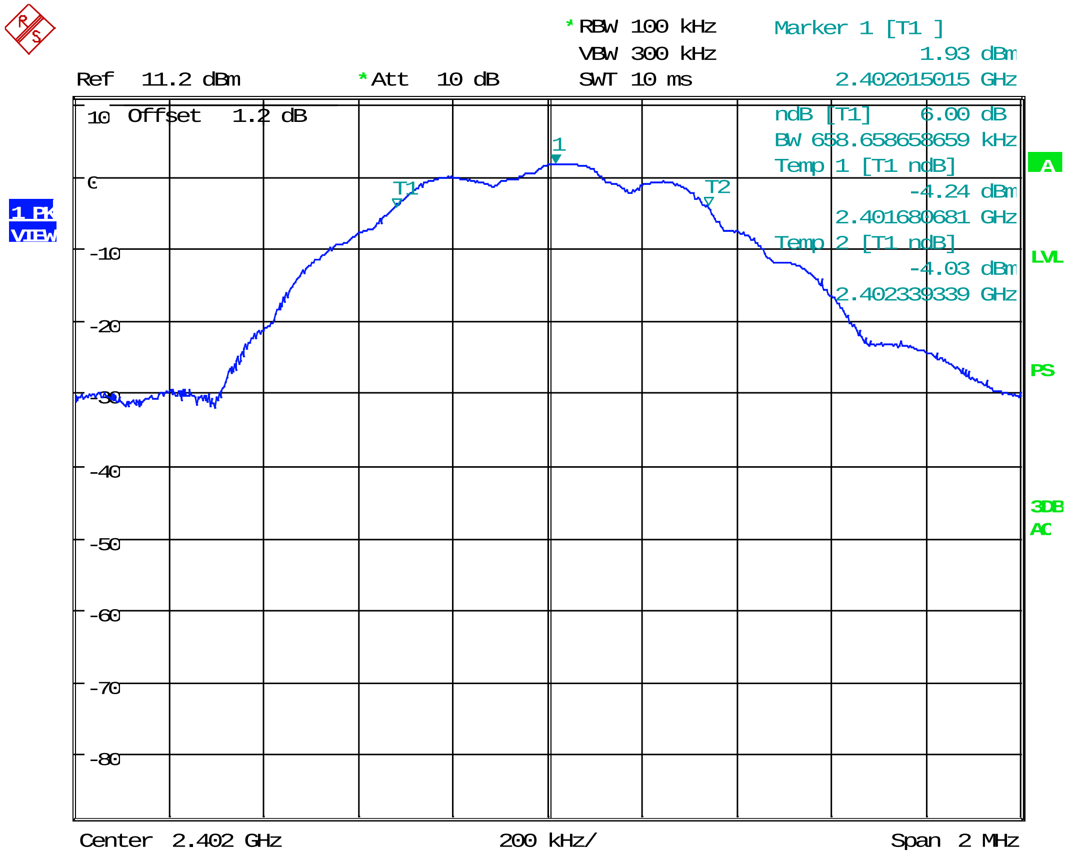
Wifi 802.11 g			
Frequency (MHz)	6 dB BW (KHz)	Limit (KHz)	Margin (KHz)
2412	1648.81	≥ 500	1148.81
2442	1646.81	≥ 500	1146.81
2462	1642.00	≥ 500	1142.00

Wifi 802.11 n HT20			
Frequency (MHz)	6 dB BW (KHz)	Limit (KHz)	Margin (KHz)
2412	1762.85	≥ 500	1262.85
2442	1757.79	≥ 500	1257.79
2462	1762.20	≥ 500	1262.20

Wifi 802.11 n HT40			
Frequency (MHz)	6 dB BW (KHz)	Limit (KHz)	Margin (KHz)
2422	3557.72	≥ 500	3057.72
2462	3541.04	≥ 500	3041.04

DTS BANDWIDTH

BLE 6 dB Bandwidth Plot, 2402 MHz



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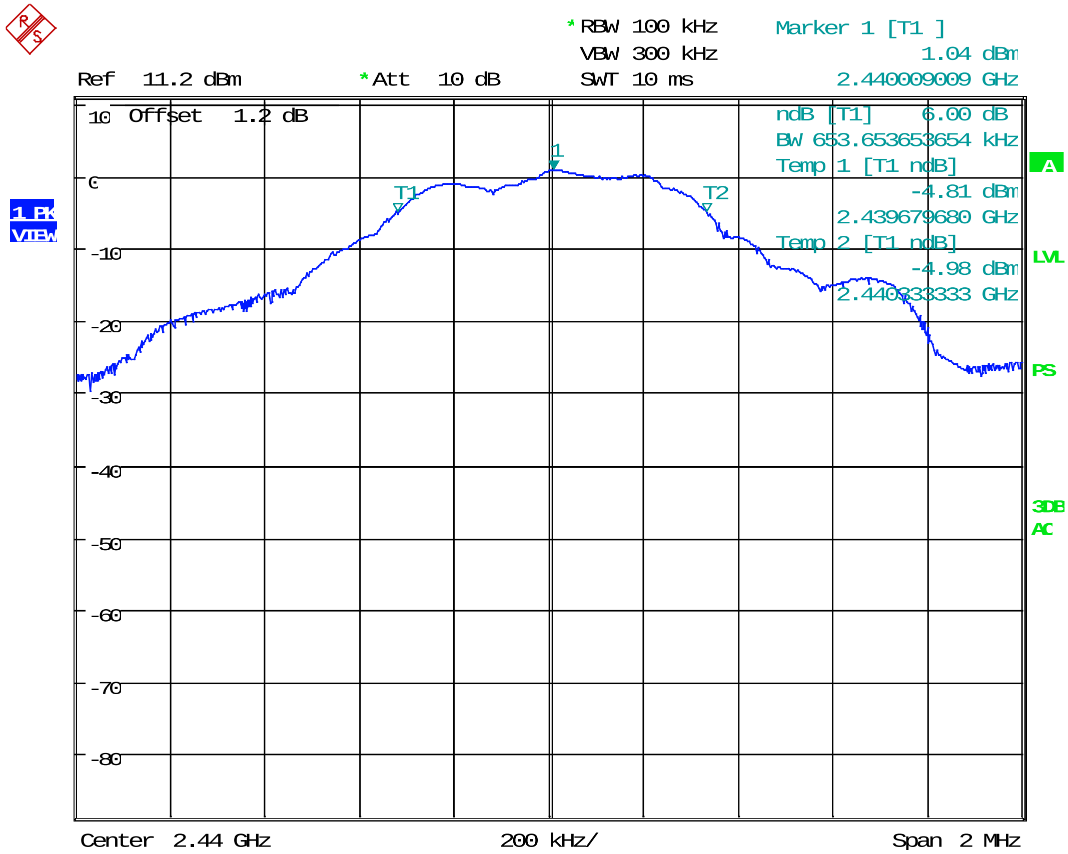
DTS BANDWIDTH

BLE 6 dB Bandwidth Plot, 2440 MHz



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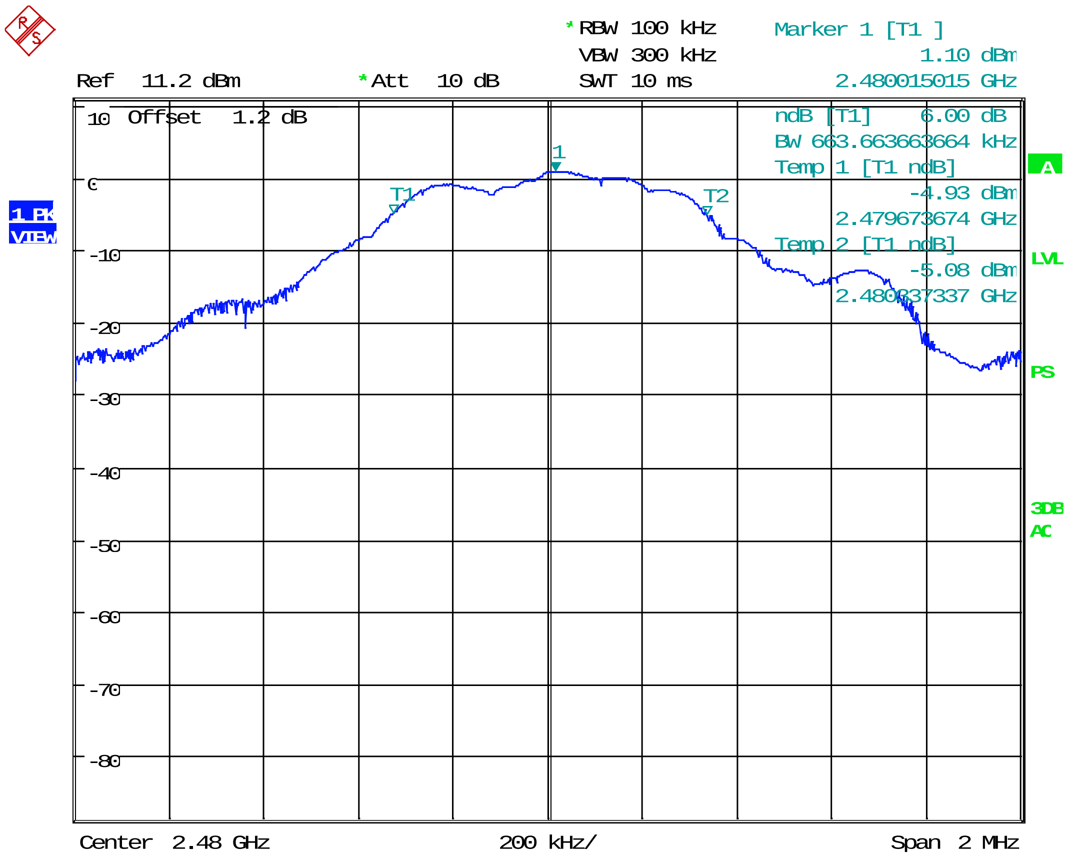
DTS BANDWIDTH

BLE 6 dB Bandwidth Plot, 2480 MHz



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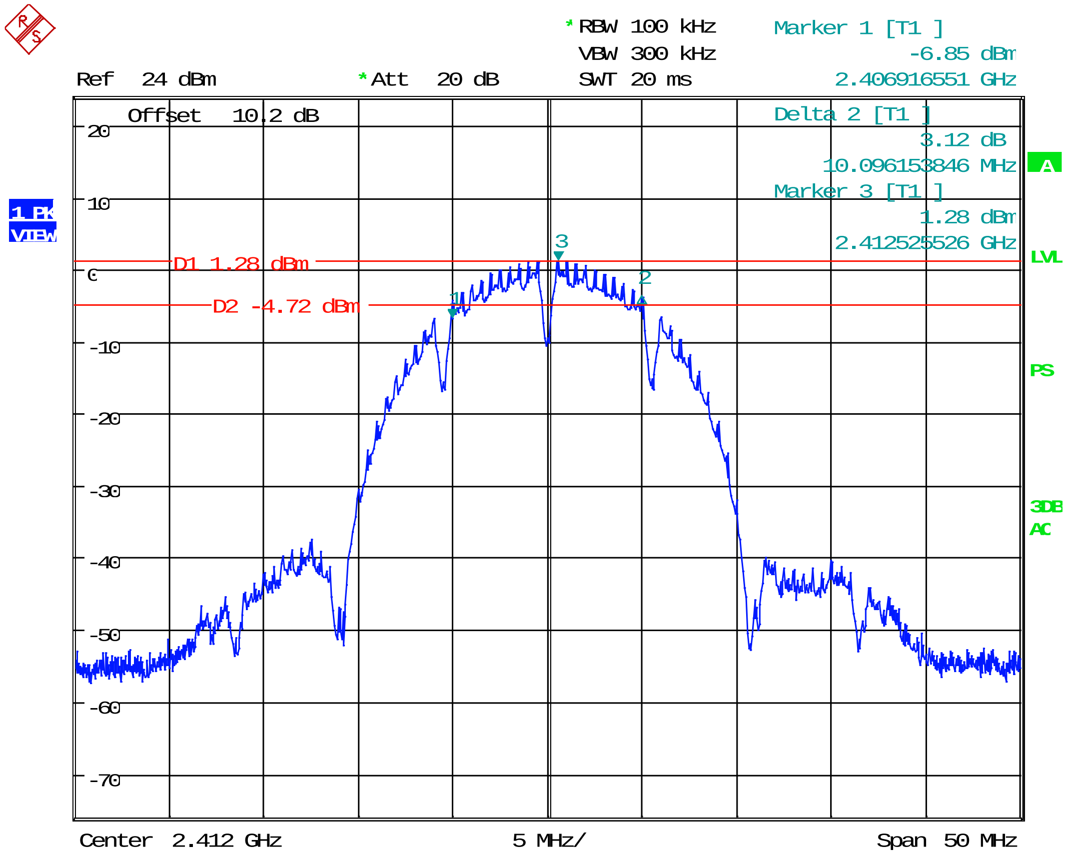
DTS BANDWIDTH

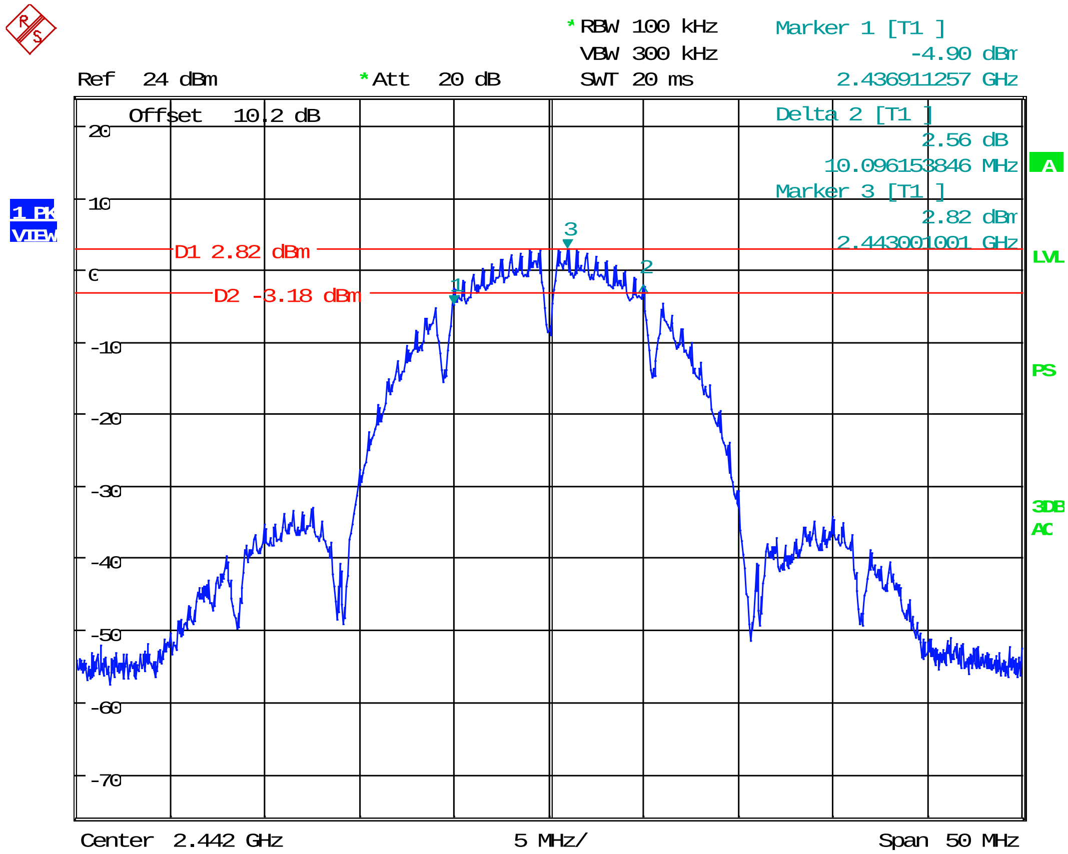
WIFI 802.11 b 6 dB Bandwidth Plot, 2412 MHz



Date: 28.FEB.2019 16:33:48

DTS BANDWIDTH

WIFI 802.11 b 6 dB Bandwidth Plot, 2442 MHz



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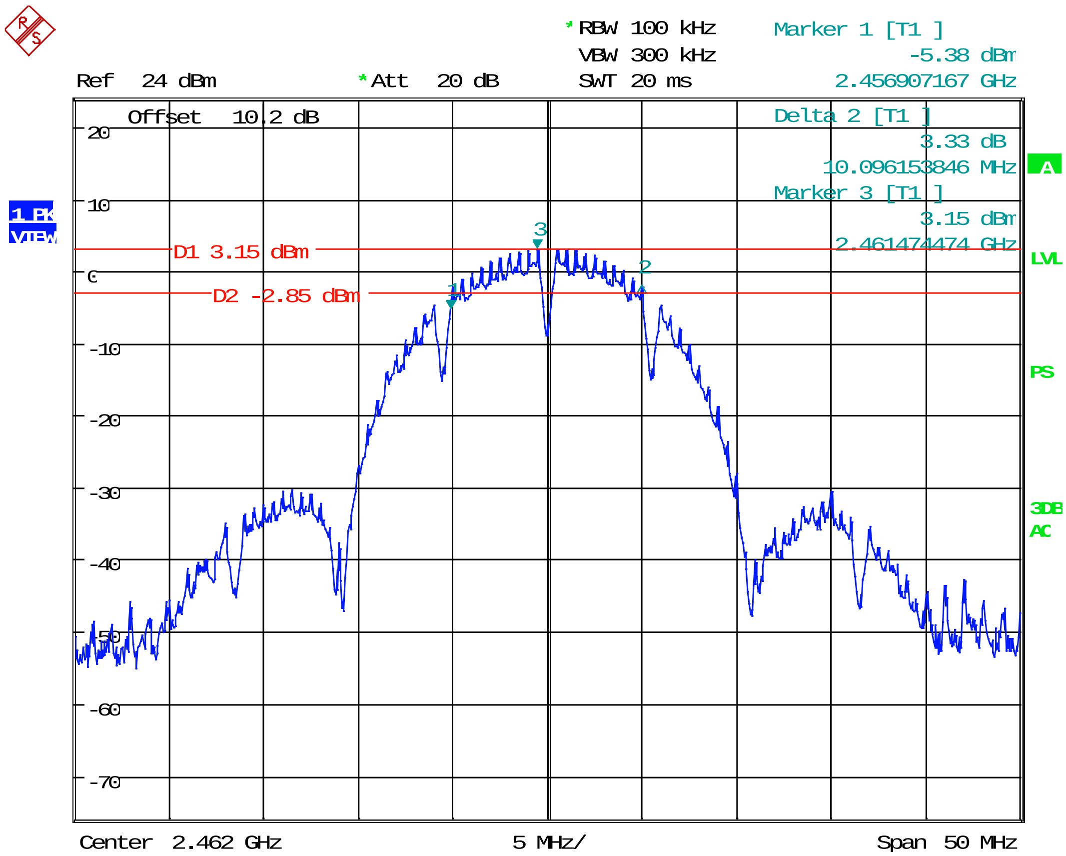
DTS BANDWIDTH

WIFI 802.11 b 6 dB Bandwidth Plot, 2462 MHz



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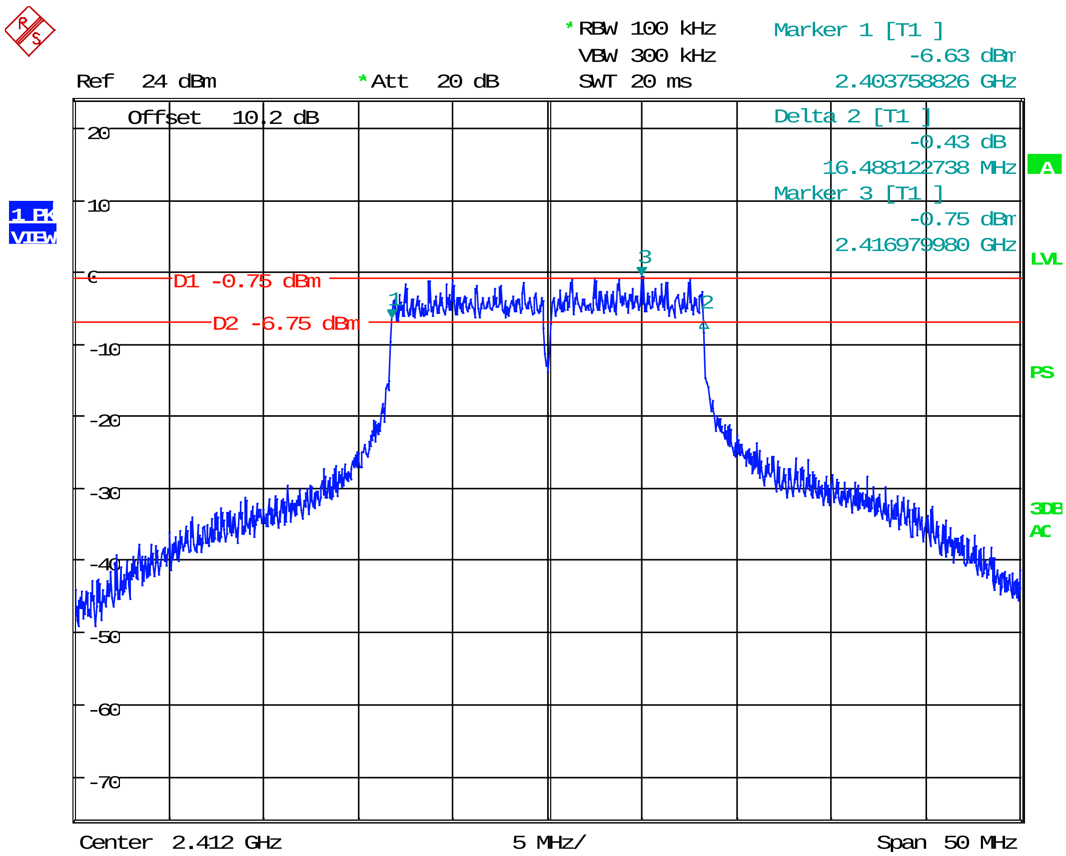
DTS BANDWIDTH

WIFI 802.11 g 6 dB Bandwidth Plot, 2412 MHz



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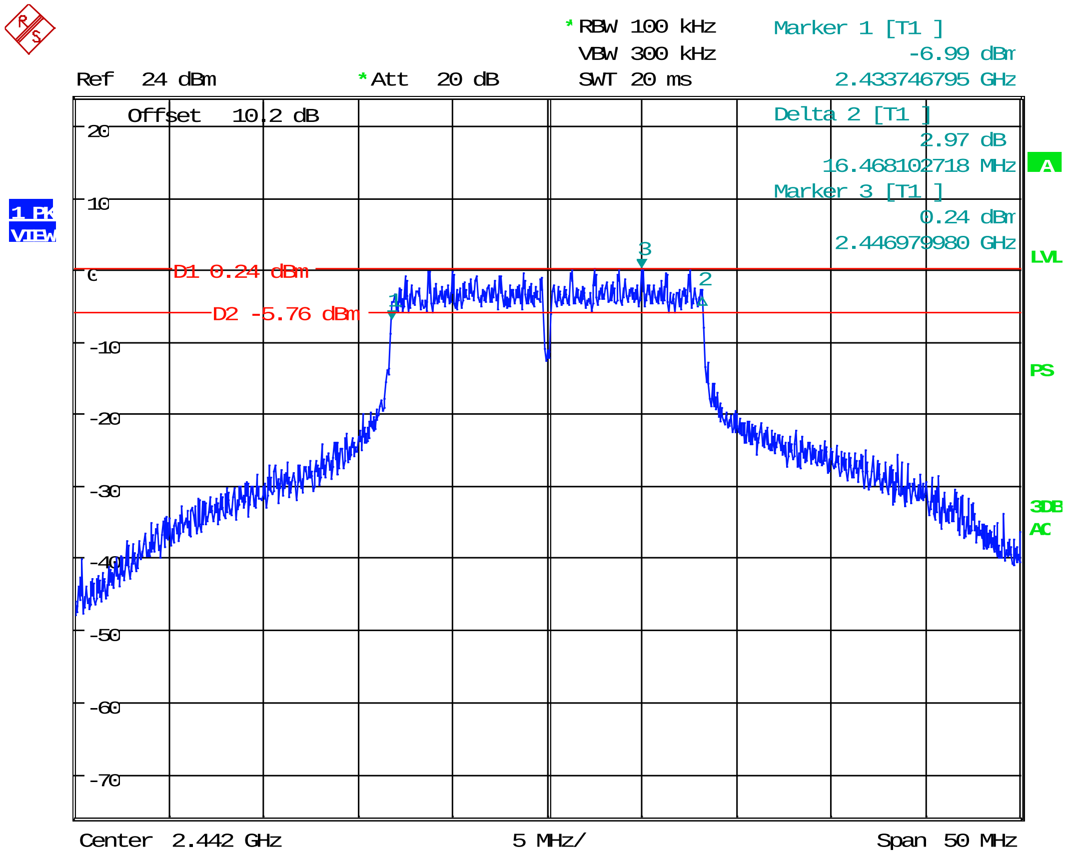
DTS BANDWIDTH

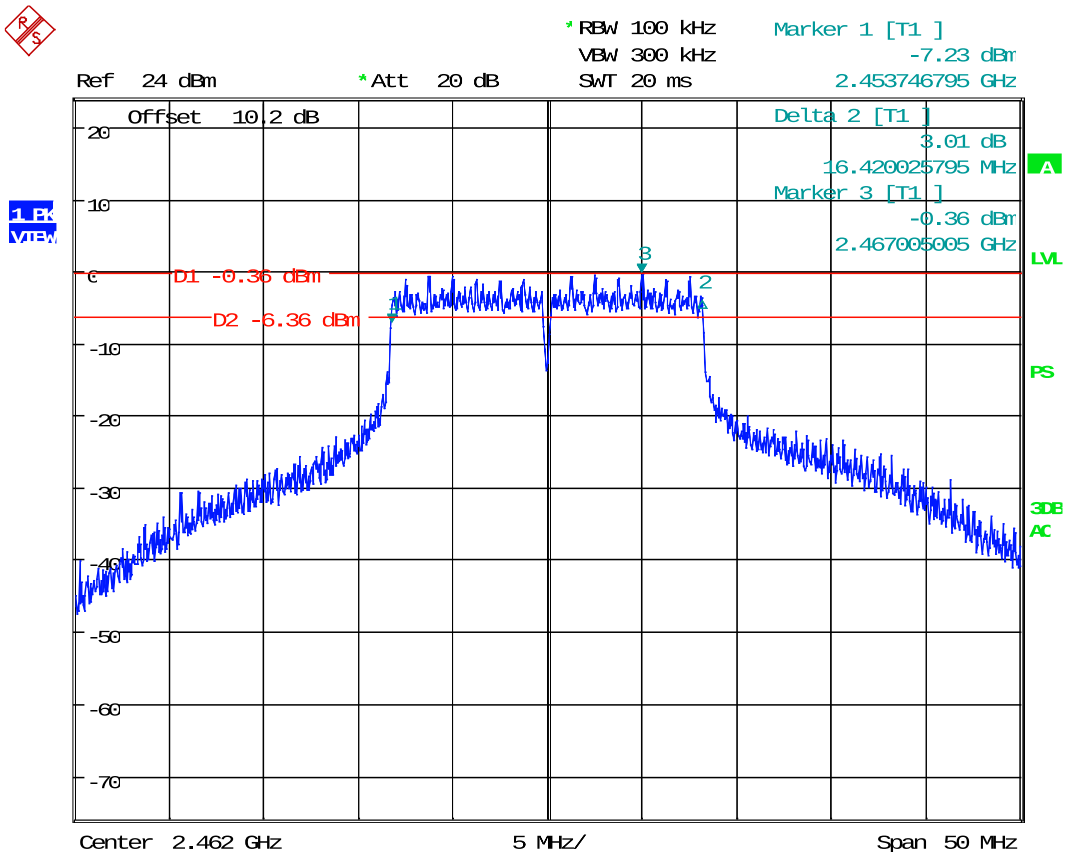
WIFI 802.11 g 6 dB Bandwidth Plot, 2442 MHz



Date: 28.FEB.2019 13:01:45

DTS BANDWIDTH

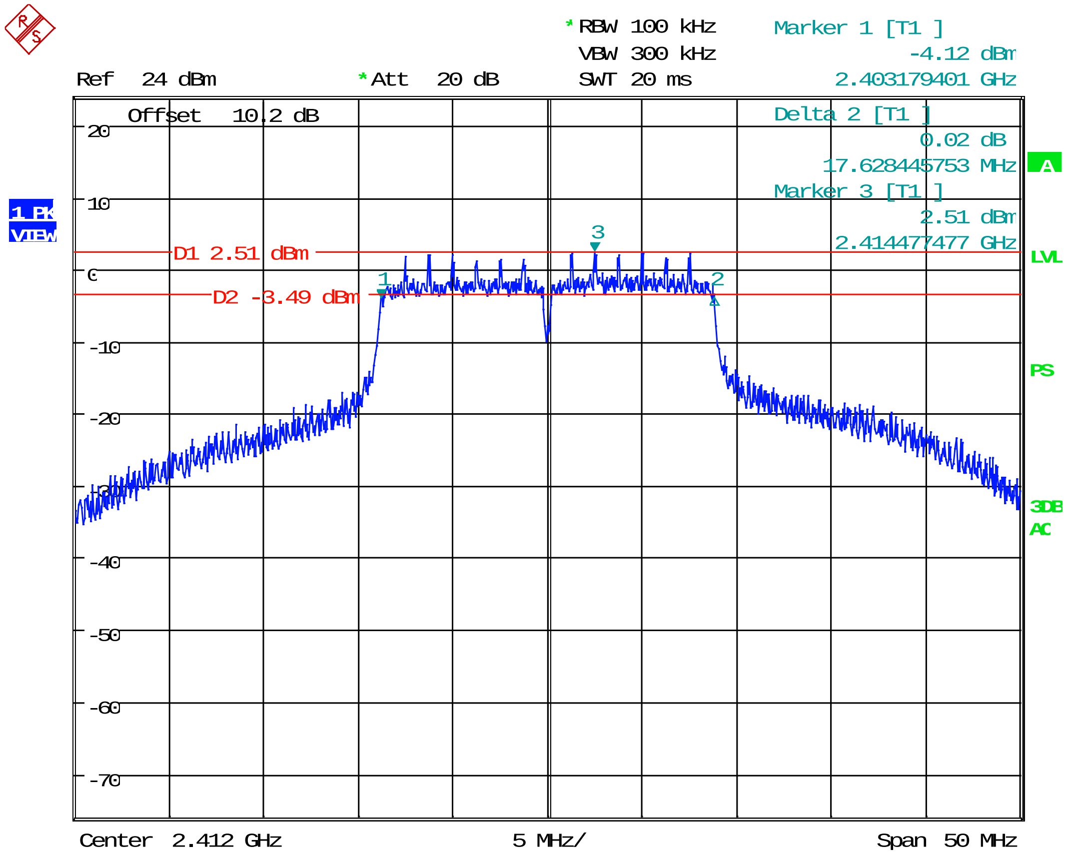
WIFI 802.11 g 6 dB Bandwidth Plot, 2462 MHz



Date: 28.FEB.2019 13:03:13

DTS BANDWIDTH

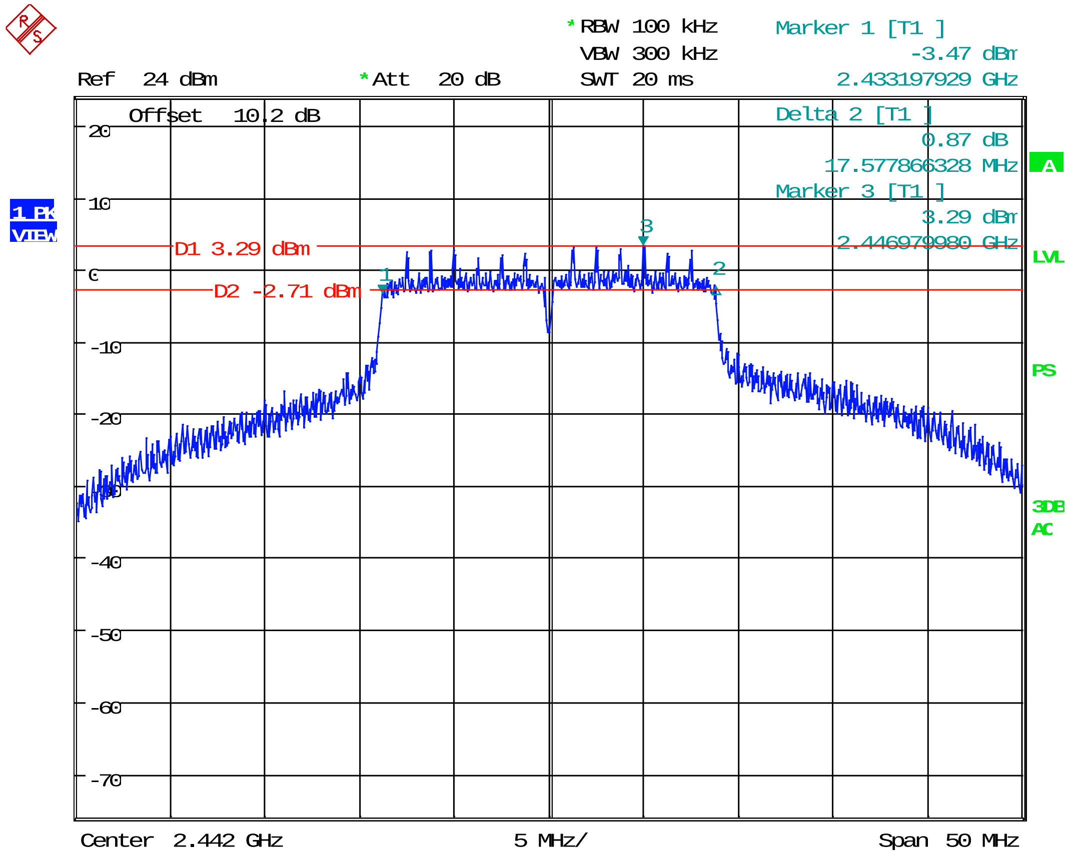
WIFI 802.11 n HT20 6 dB Bandwidth Plot, 2412 MHz



Date: 28.FEB.2019 10:46:17

DTS BANDWIDTH

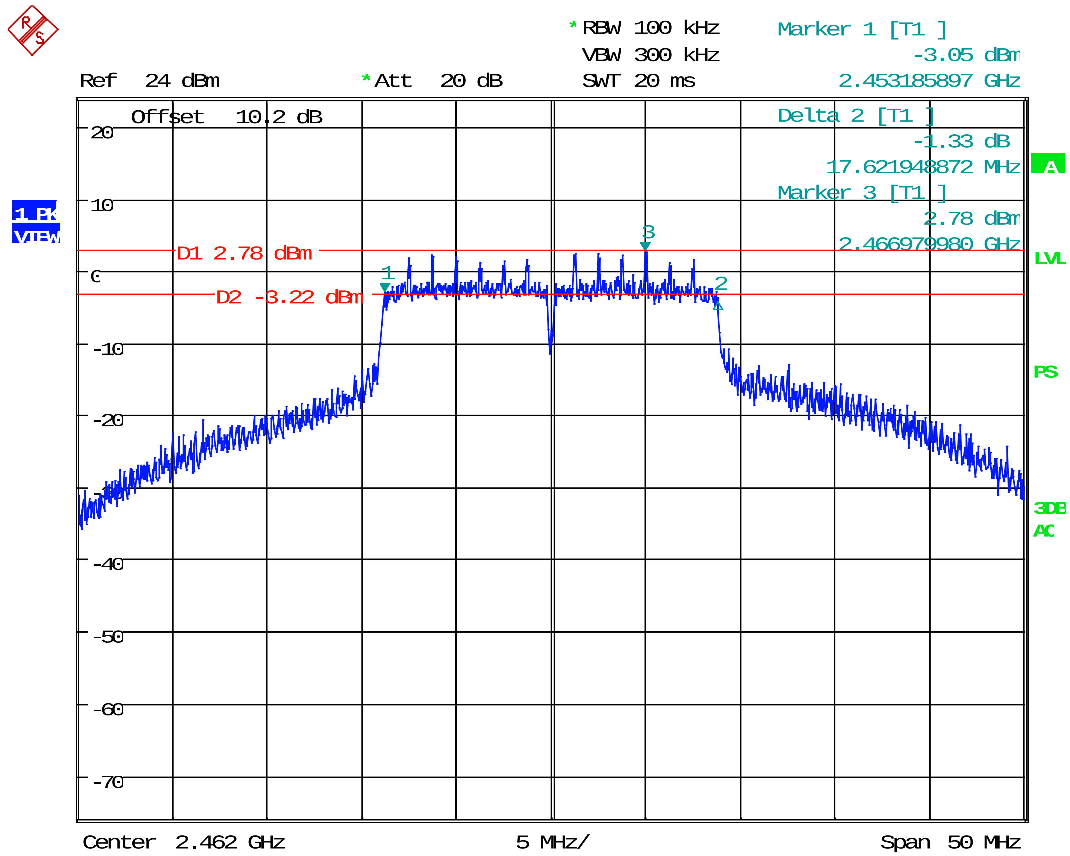
WIFI 802.11 n HT20 6 dB Bandwidth Plot, 2442 MHz



Date: 28.FEB.2019 10:51:04

DTS BANDWIDTH

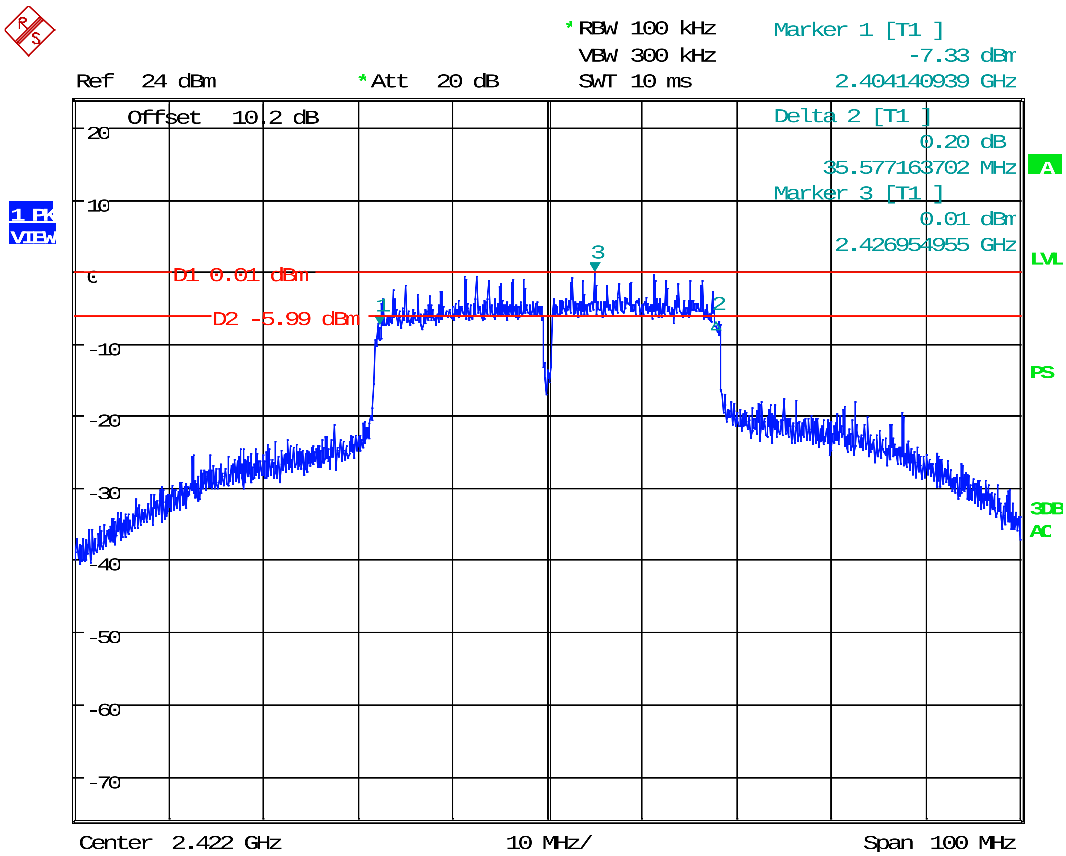
WIFI 802.11 n HT20 6 dB Bandwidth Plot, 2462 MHz



Date: 28.FEB.2019 10:53:51

DTS BANDWIDTH

WIFI 802.11 n HT40 6 dB Bandwidth Plot, 2422 MHz



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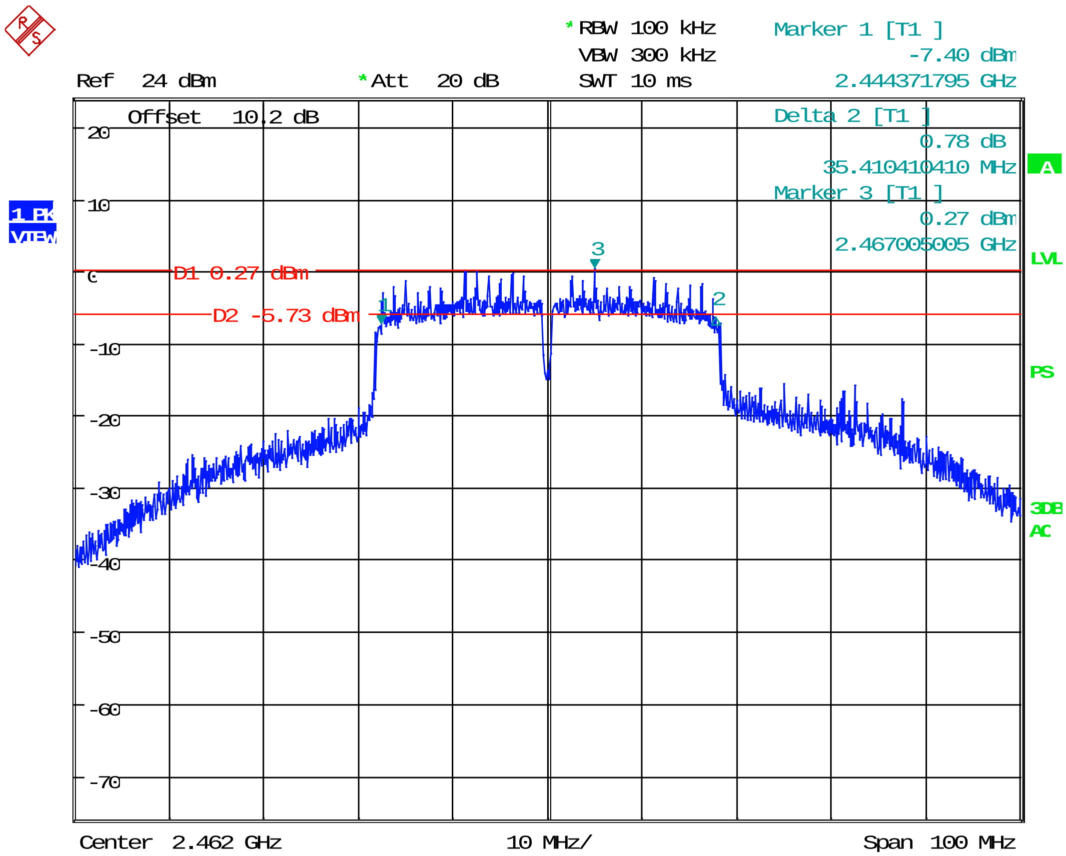
DTS BANDWIDTH

WIFI 802.11 n HT40 6 dB Bandwidth Plot, 2462 MHz



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OCCUPIED BANDWIDTH

Rule Part No.: FCC 2.1049(h)

Requirements:

§2.1049 Measurements required: Occupied bandwidth.

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable:

(h) Transmitters employing digital modulation techniques—when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the occupied bandwidth shall be shown for operation with any devices used for modifying the spectrum when such devices are optional at the discretion of the user.

Test Method: ANSI C63.10 § 6.9.3

6.9.3 Occupied bandwidth—power bandwidth (99%) measurement procedure

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:

a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.

b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.

c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.

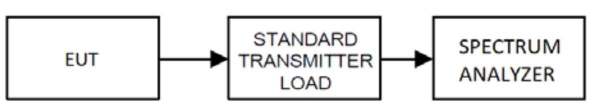
d) Step a) through step c) might require iteration to adjust within the specified range.

e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.

f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.

h) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

Test Setup:



OCCUPIED BANDWIDTH

99% OBW Measurement Table

Bluetooth Low Energy	
Frequency (MHz)	99% OBW (MHz)
2402	1.00988
2440	1.18744
2480	1.19022

Wifi 802.11 b	
Frequency (MHz)	99% OBW (MHz)
2412	14.98
2442	15.04
2462	15.17

Wifi 802.11 g	
Frequency (MHz)	99% OBW (MHz)
2412	17.64
2442	18.04
2462	18.04

Wifi 802.11 n HT20	
Frequency (MHz)	99% OBW (MHz)
2412	22.08
2442	26.32
2462	27.20

Wifi 802.11 n HT40	
Frequency (MHz)	99% OBW (MHz)
2422	47.68
2462	51.60

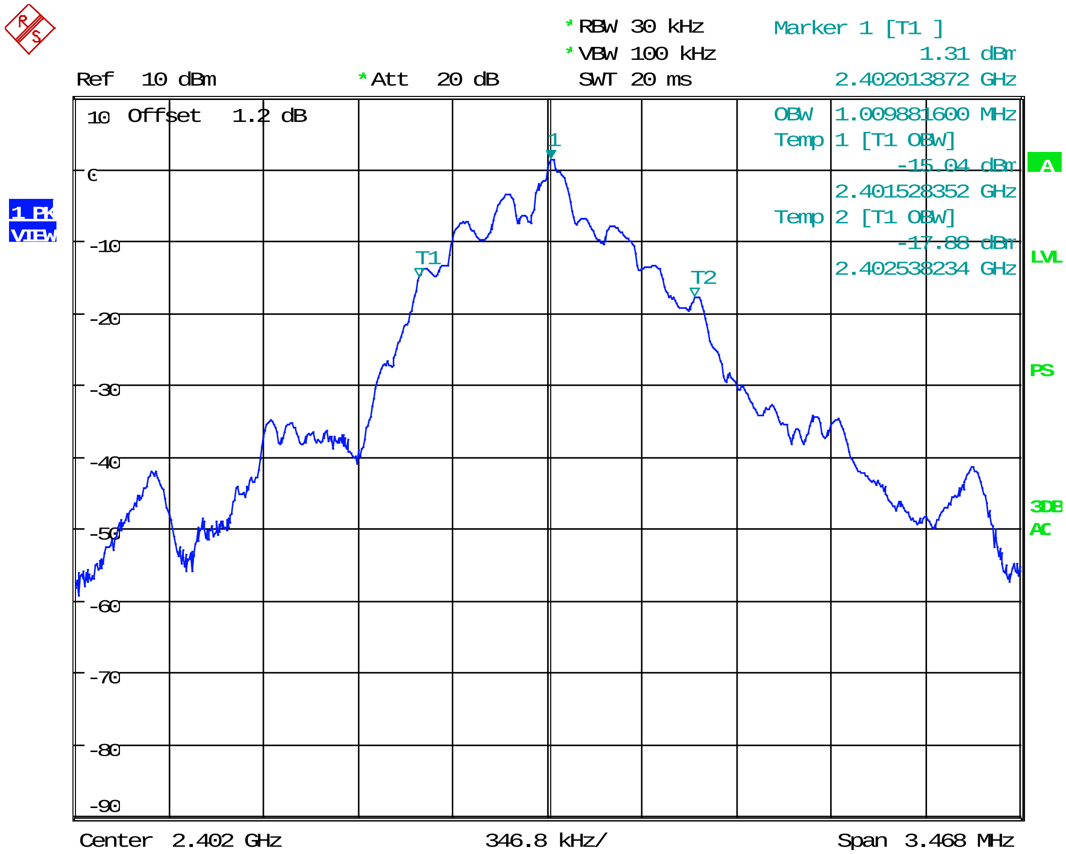
OCCUPIED BANDWIDTH

BLE 99% OBW Setup Calculation

Occupied Bandwidth Calculation			
Frequency (MHz)	Estimated 99% OBW (MHz)	Plot Setup Variable	Estimated Value (kHz)
2402	1.00	RBW	≥ 10
			≤ 50
		Span	≥ 1500
			≤ 5000
2440	1.00	RBW	≥ 10
			≤ 50
		Span	≥ 1500
			≤ 5000
2480	1.00	RBW	≥ 10
			≤ 50
		Span	≥ 1500
			≤ 5000

OCCUPIED BANDWIDTH

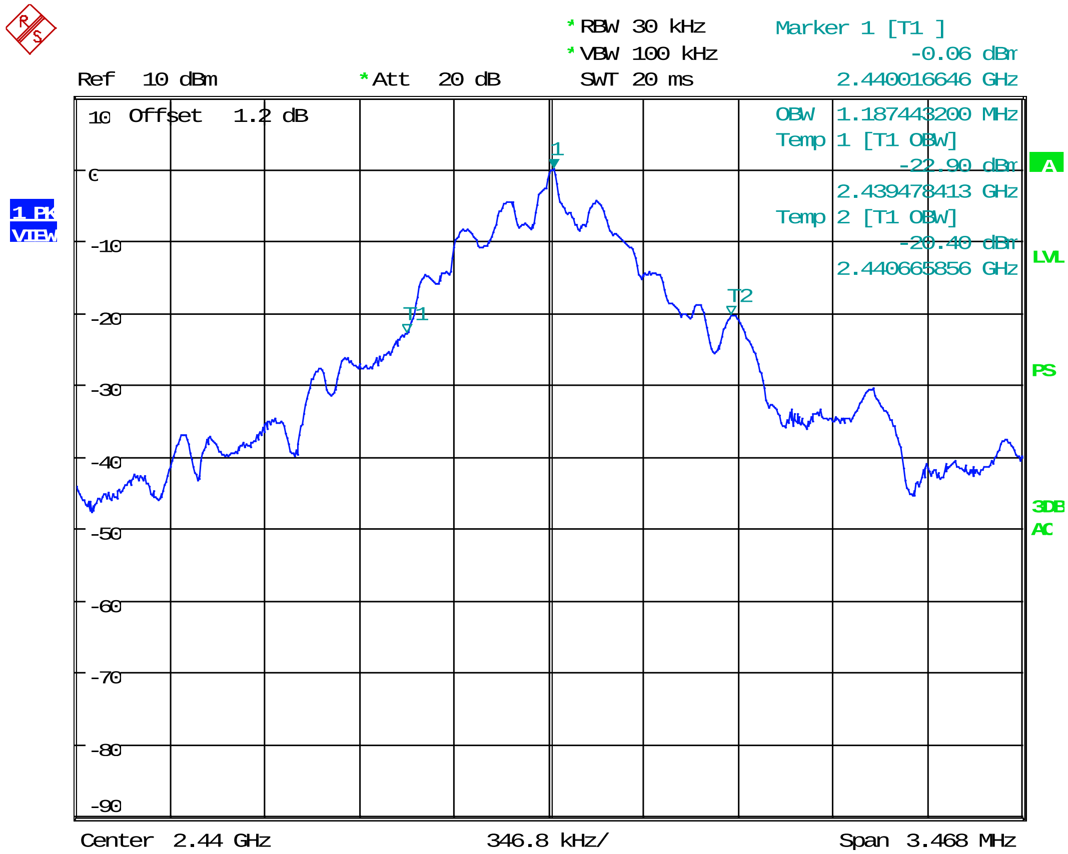
BLE 99% OBW Plot, 2402 MHz



Date: 27.FEB.2019 19:04:07

OCCUPIED BANDWIDTH

BLE 99% OBW Plot, 2440 MHz



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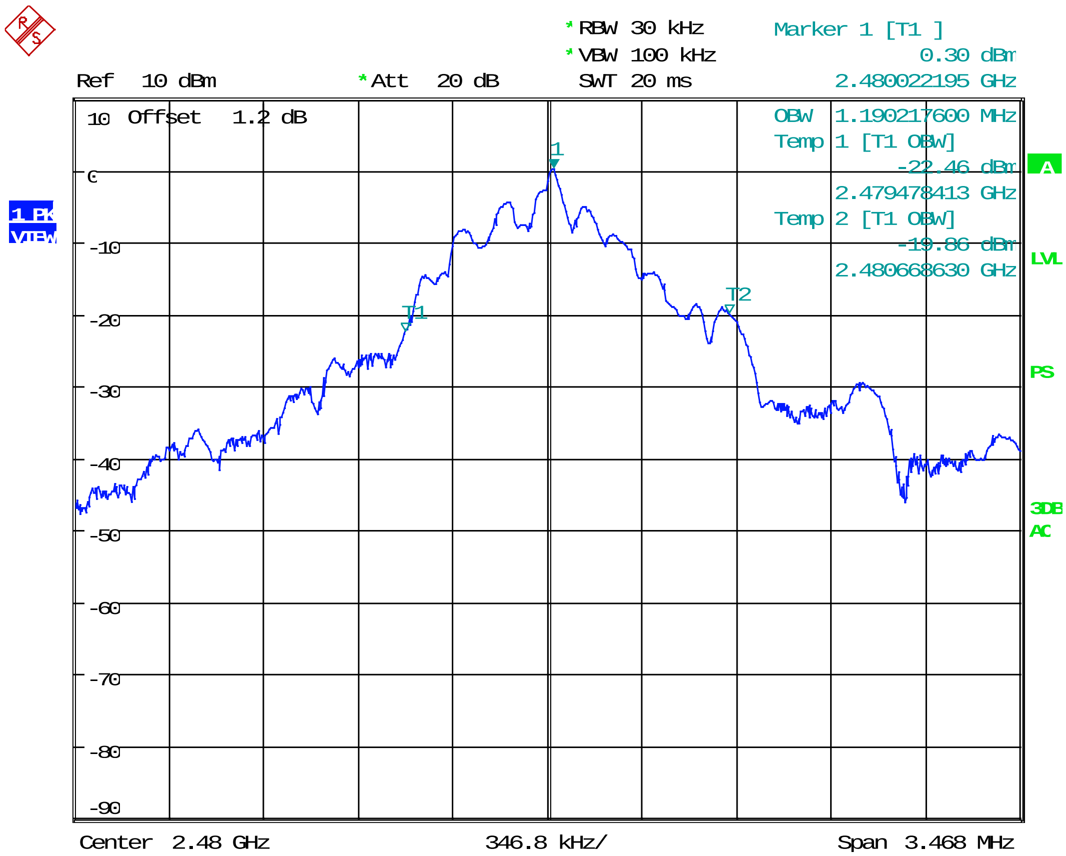
OCCUPIED BANDWIDTH

BLE 99% OBW Plot, 2480 MHz



Date: 27.FEB.2019 19:03:21

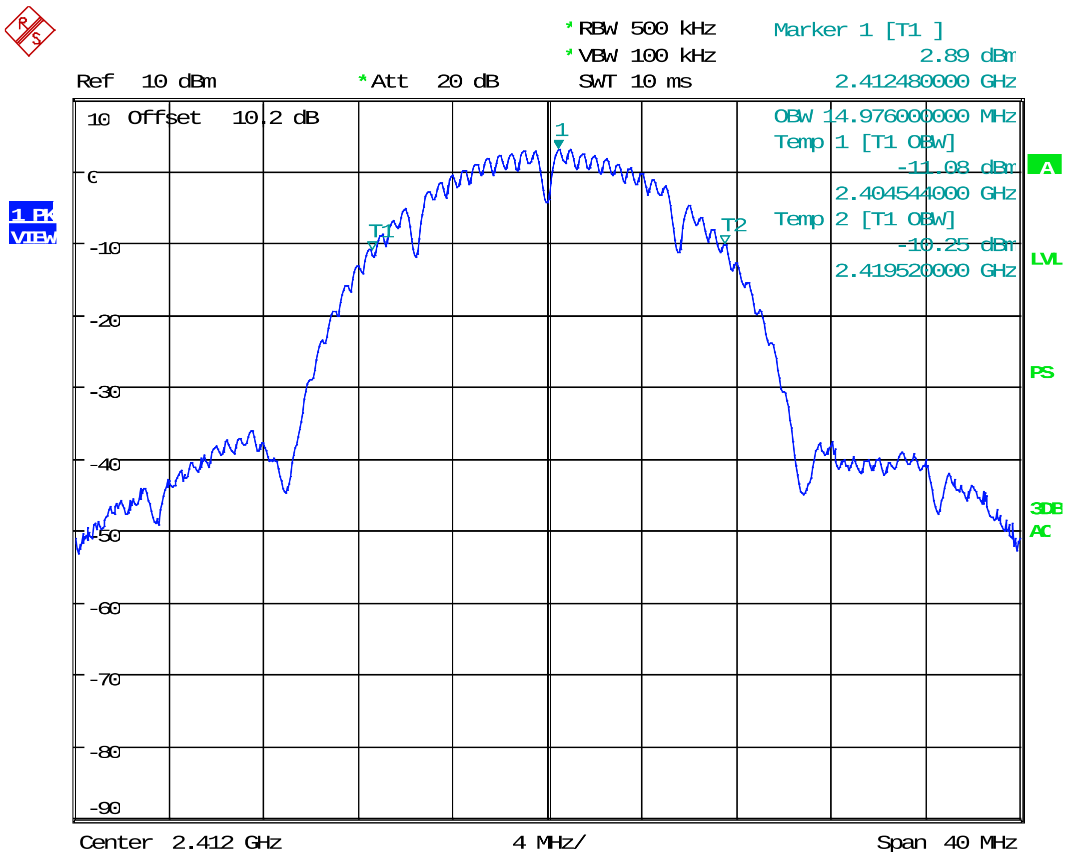
OCCUPIED BANDWIDTH

WIFI 802.11 b 99% OBW Setup Calculation

Occupied Bandwidth Calculation			
Frequency (MHz)	Estimated 99% OBW (MHz)	Plot Setup Variable	Estimated Value (kHz)
2412	20.00	RBW	≥ 200
			≤ 1000
		Span	≥ 30000
			≤ 100000
2442	20.00	RBW	≥ 200
			≤ 1000
		Span	≥ 30000
			≤ 100000
2462	20.00	RBW	≥ 200
			≤ 1000
		Span	≥ 30000
			≤ 100000

OCCUPIED BANDWIDTH

WIFI 802.11 b 99% OBW Plot, 2412 MHz



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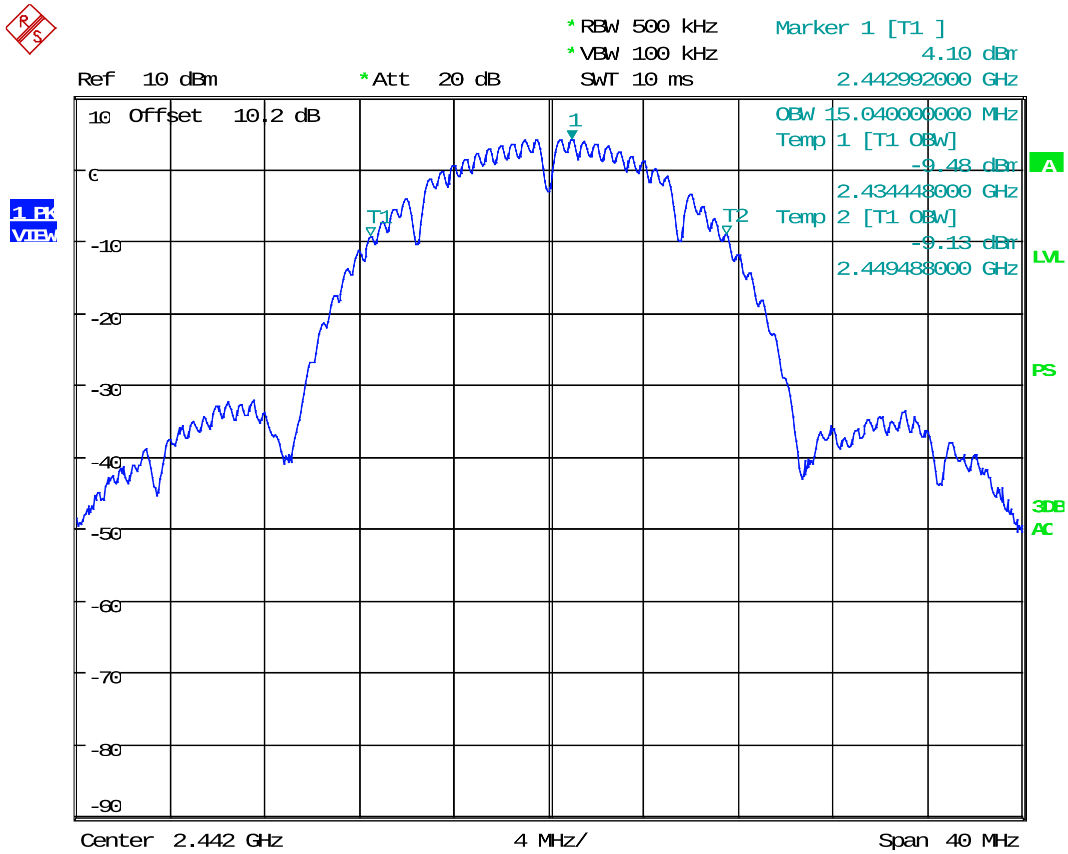
OCCUPIED BANDWIDTH

WIFI 802.11 b 99% OBW Plot, 2442 MHz



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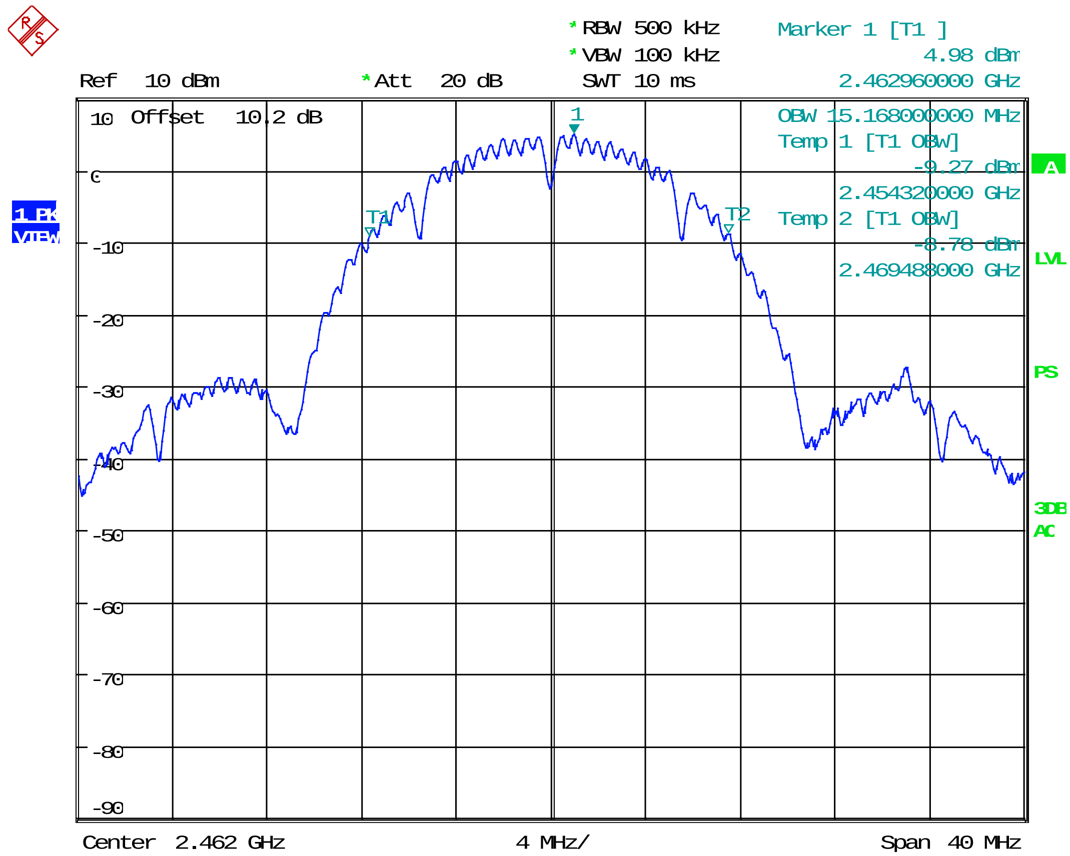
OCCUPIED BANDWIDTH

WIFI 802.11 b 99% OBW Plot, 2462 MHz



Date: 28.FEB.2019 16:40:06

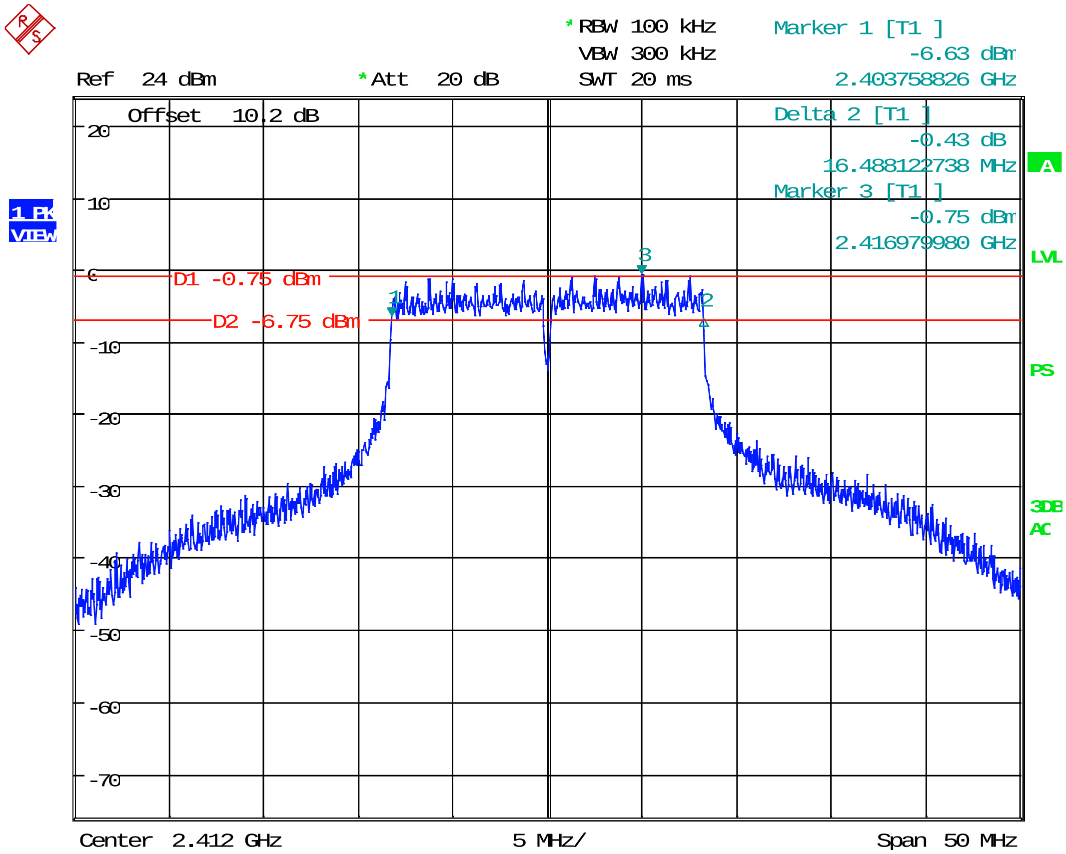
OCCUPIED BANDWIDTH

WIFI 802.11 g 99% OBW Setup Calculation

Occupied Bandwidth Calculation			
Frequency (MHz)	Estimated 99% OBW (MHz)	Plot Setup Variable	Estimated Value (kHz)
2412	20.00	RBW	≥ 200
			≤ 1000
		Span	≥ 30000
			≤ 100000
2442	20.00	RBW	≥ 200
			≤ 1000
		Span	≥ 30000
			≤ 100000
2462	20.00	RBW	≥ 200
			≤ 1000
		Span	≥ 30000
			≤ 100000

OCCUPIED BANDWIDTH

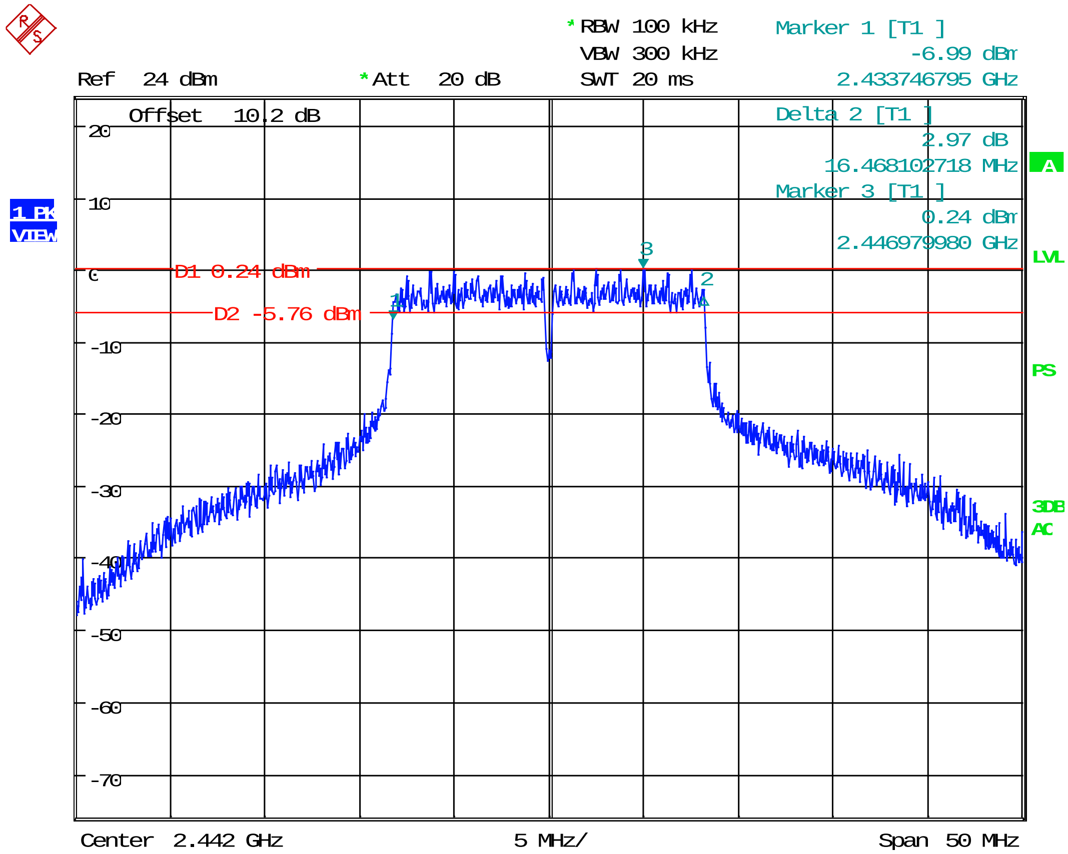
WIFI 802.11 g 99% OBW Plot, 2412 MHz



Date: 28.FEB.2019 12:57:56

OCCUPIED BANDWIDTH

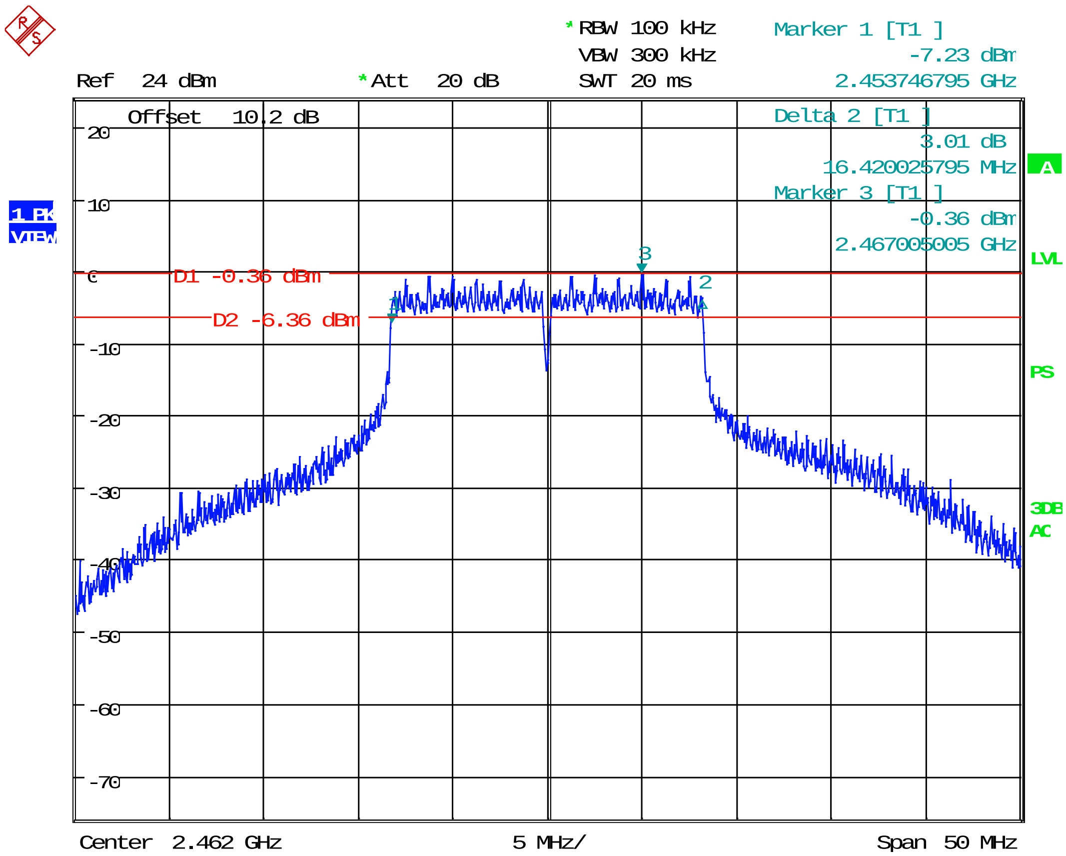
WIFI 802.11 g 99% OBW Plot, 2442 MHz



Date: 28.FEB.2019 13:01:45

OCCUPIED BANDWIDTH

WIFI 802.11 g 99% OBW Plot, 2462 MHz



Date: 28.FEB.2019 13:03:13

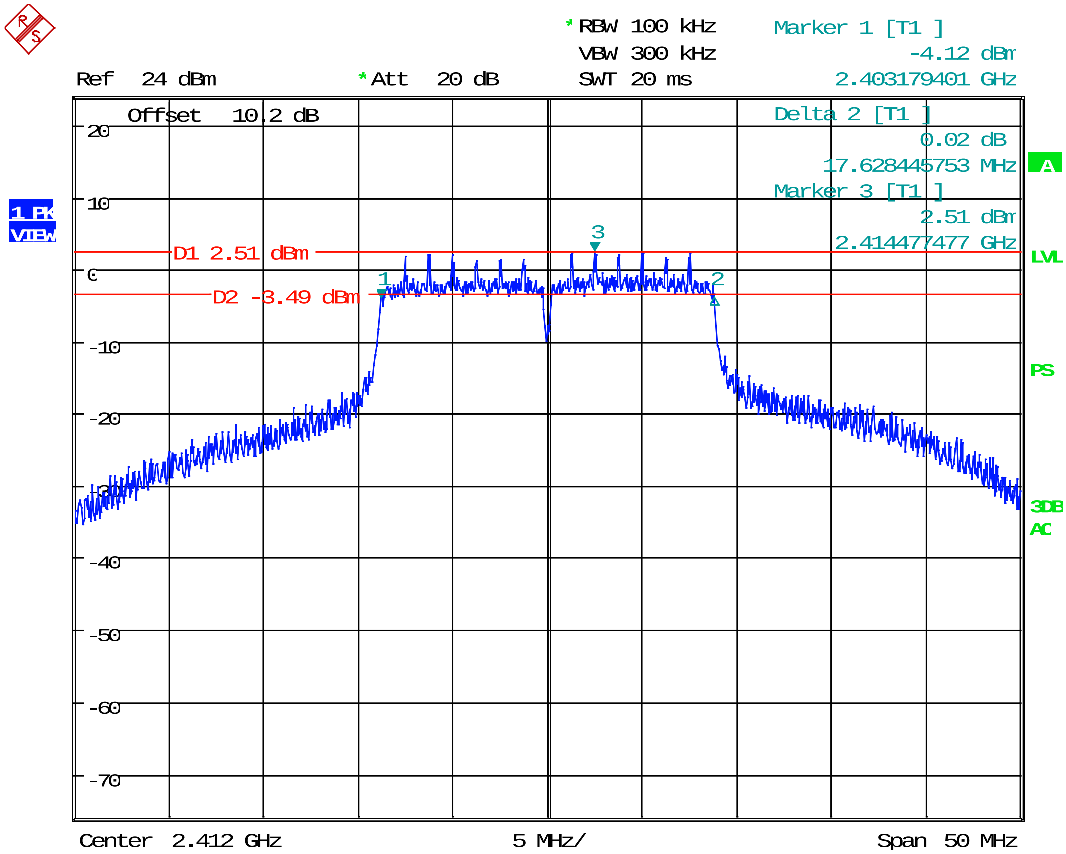
OCCUPIED BANDWIDTH

WIFI 802.11 n HT20 99% OBW Setup Calculation

Occupied Bandwidth Calculation			
Frequency (MHz)	**Estimated 99% OBW (MHz)**	**Plot Setup Variable**	**Estimated Value (kHz)**
2412	20.00	RBW	≥ 200
			≤ 1000
		Span	≥ 30000
			≤ 100000
2442	20.00	RBW	≥ 200
			≤ 1000
		Span	≥ 30000
			≤ 100000
2462	20.00	RBW	≥ 200
			≤ 1000
		Span	≥ 30000
			≤ 100000

OCCUPIED BANDWIDTH

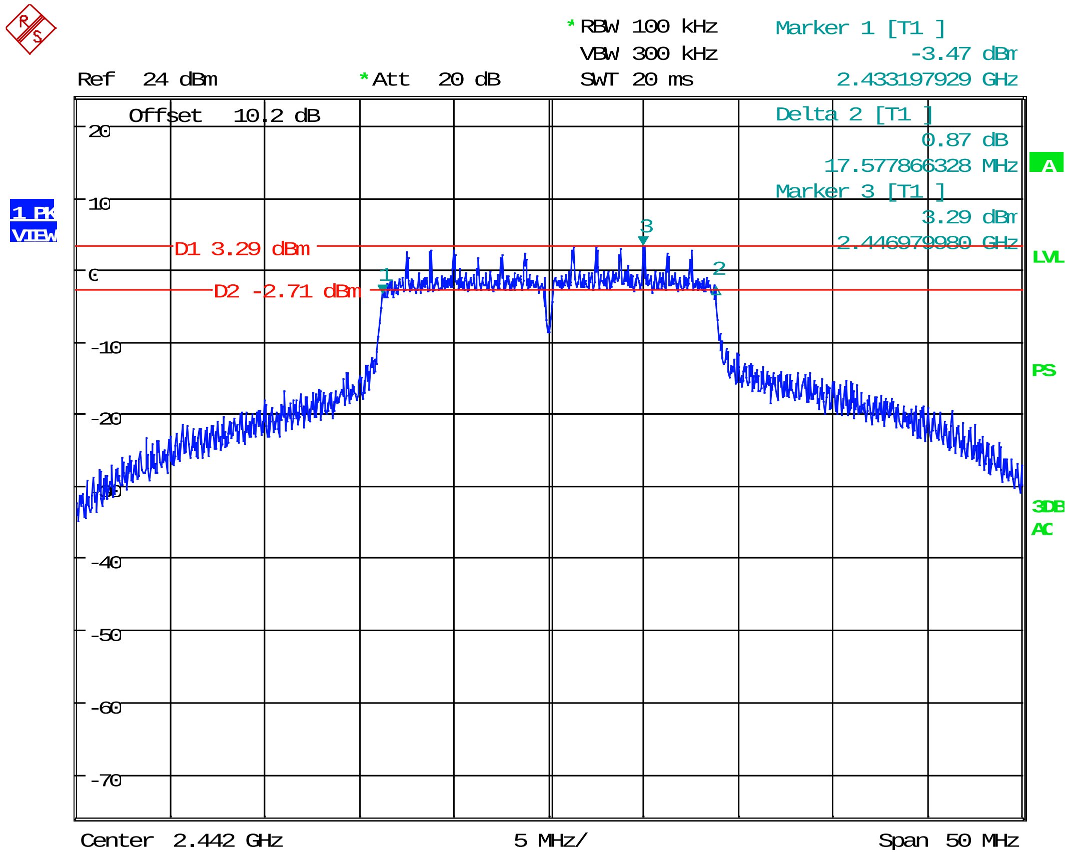
WIFI 802.11 n HT20 99% OBW Plot, 2412 MHz



Date: 28.FEB.2019 10:46:17

OCCUPIED BANDWIDTH

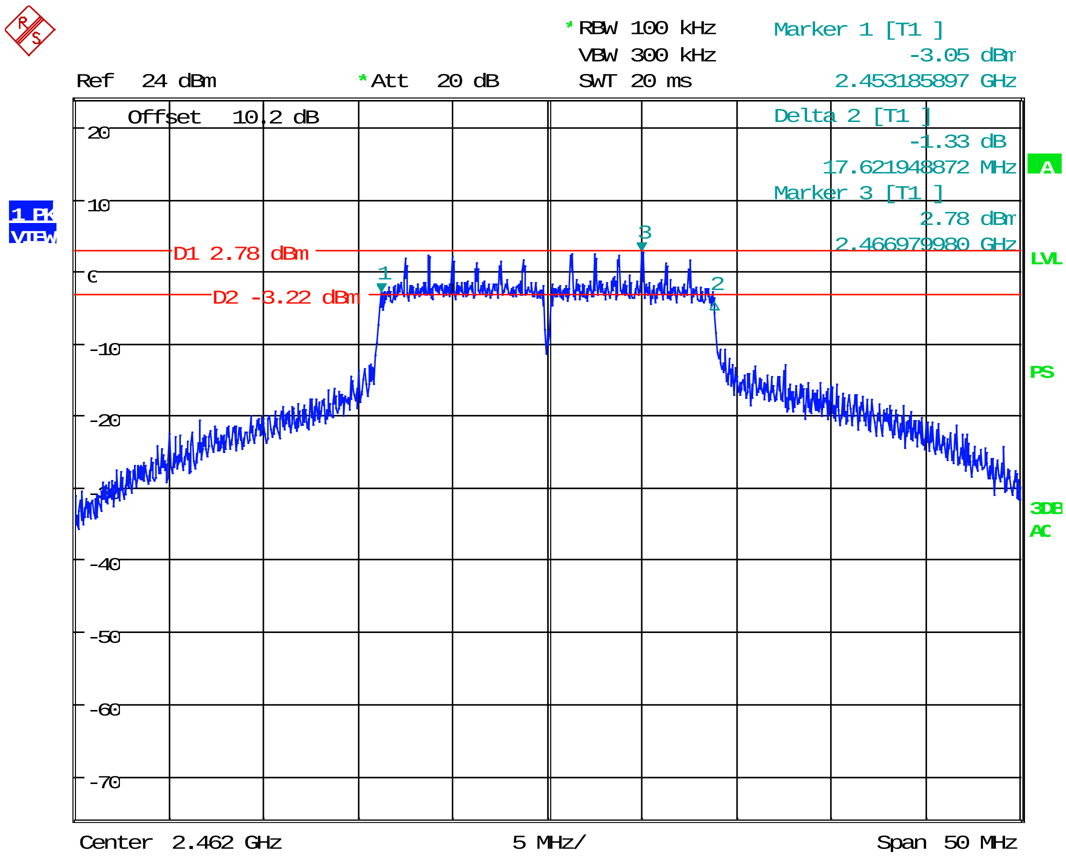
WIFI 802.11 n HT20 99% OBW Plot, 2442 MHz



Date: 28.FEB.2019 10:51:04

OCCUPIED BANDWIDTH

WIFI 802.11 n HT20 99% OBW Plot, 2462 MHz



Date: 28.FEB.2019 10:53:51

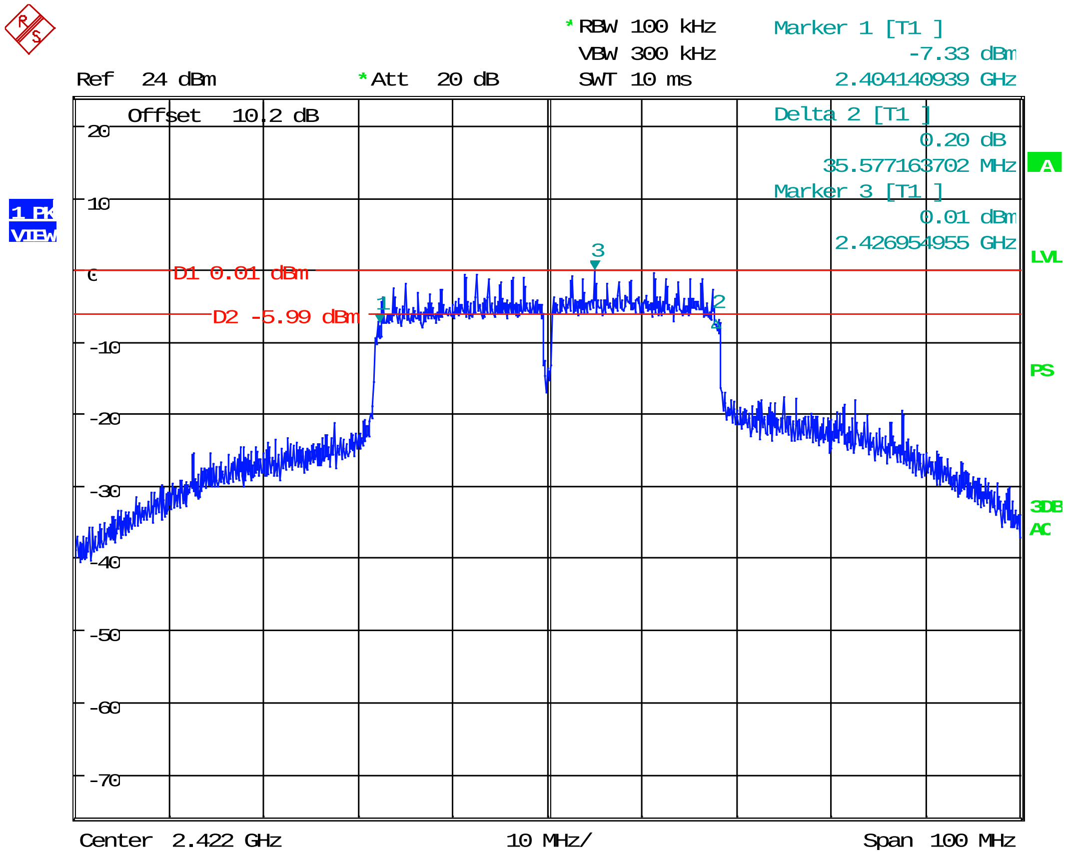
OCCUPIED BANDWIDTH

WIFI 802.11 n HT40 99% OBW Setup Calculation

Occupied Bandwidth Calculation			
Frequency (MHz)	Estimated 99% OBW (MHz)	Plot Setup Variable	Estimated Value (kHz)
2422	40.00	RBW	≥ 400
			≤ 2000
		Span	≥ 60000
			≤ 200000
2462	40.00	RBW	≥ 400
			≤ 2000
		Span	≥ 60000
			≤ 200000

OCCUPIED BANDWIDTH

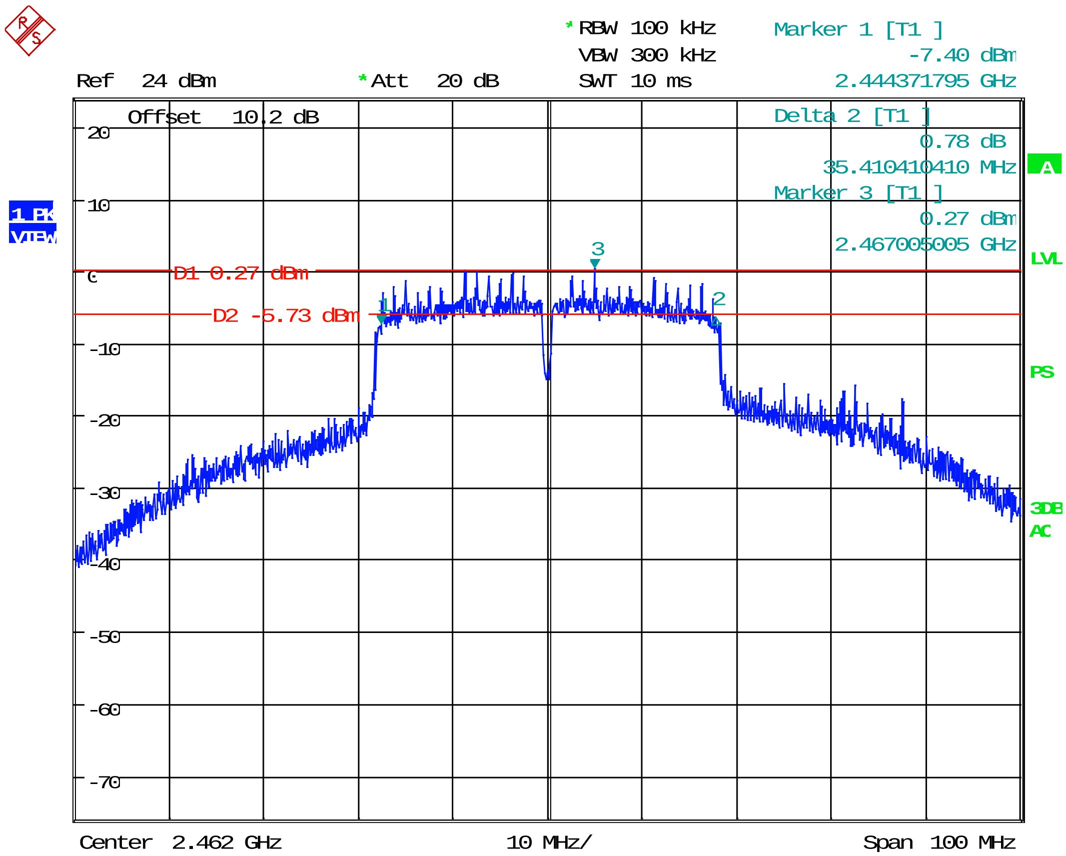
WIFI 802.11 n HT40 99% OBW Plot, 2422 MHz



Date: 28.FEB.2019 12:08:25

OCCUPIED BANDWIDTH

WIFI 802.11 n HT40 99% OBW Plot, 2462 MHz



Date: 28.FEB.2019 12:12:01

POWER OUTPUT

Rule Part No.: FCC 15.247(b)(3)

Requirements:

§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

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

Test Method:

Bluetooth Low Energy Power Output Measurement:

ANSI C63.10 § 11.9.1.1 Peak Power Method if RBW ≥ DTS Bandwidth

11.9.1.1 RBW ≥ DTS bandwidth

The following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement:

a) Set the RBW ≥ DTS bandwidth.

b) Set VBW ≥ [3 × RBW].

c) Set span ≥ [3 × RBW].

d) Sweep time = auto couple.

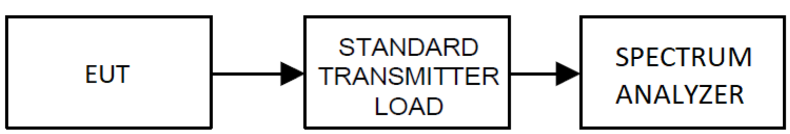
e) Detector = peak.

f) Trace mode = max hold.

g) Allow trace to fully stabilize.

h) Use peak marker function to determine the peak amplitude level.

Test Setup:



POWER OUTPUT

WiFi 802.11 b / g / n HT20 / HT40 Power Output Measurement:

KDB 558074 D01 15.247 Meas Guidance v05r01, s. 8.3.2

8.3.2 Maximum conducted (average) output power

8.3.2.1 General

Section 15.247 permits the maximum conducted (average) output power to be measured as an alternative to the maximum peak conducted output power for demonstrating compliance to the limit. When this option is exercised, the measured power is to be referenced to the OBW rather than the *DTS bandwidth* (see ANSI C63.10 for measurement guidance).

When using a spectrum analyzer or EMI receiver to perform these measurements, it shall be capable of utilizing a number of measurement points in each sweep that is greater than or equal to twice the span/RBW to set a bin-to-bin spacing of ≤ RBW/2 so that narrowband signals are not lost between frequency bins.

If possible, configure or modify the operation of the EUT so that it transmits continuously at its maximum power control level. The intent is to test at 100 % duty cycle; however a small reduction in duty cycle (to no lower than 98 %) is permitted, if required by the EUT for amplitude control purposes. Manufacturers are expected to provide software to the test lab to permit such continuous operation.

If continuous transmission (or at least 98 % duty cycle) cannot be achieved due to hardware limitations (*e.g.*, overheating), the EUT shall be operated at its maximum power control level, with the transmit duration as long as possible, and the duty cycle as high as possible during which sweep triggering/signal gating techniques may be used to perform the measurement over the transmission duration.

POWER OUTPUT

ANSI C63.10 § 11.9.2.2 Integrated Band Power Method

11.9.2.2 Measurement using a spectrum analyzer (SA)

11.9.2.2.1 Selection of test method

The proper test method is selected based on the following criteria:

a) **Method AVGSA-1** or **method AVGSA-1A (alternative)** shall be applied if either of the following conditions can be satisfied:

   1) The EUT transmits continuously (or with a $D \geq 98\%$).

   2) Sweep triggering can be implemented in such a way that the device transmits at the maximum power control level throughout the duration of each of the instrument sweeps to be averaged. This condition can generally be achieved by triggering the instrument's sweep if the duration of the sweep (with the instrument configured as in method AVGSA-1) is equal to or shorter than the duration T of each transmission from the EUT, and if those transmissions exhibit full power throughout their durations.

b) **Method AVGSA-2** or **method AVGSA-2A (alternative)** shall be applied if the conditions of the preceding item a) cannot be achieved and the transmissions exhibit a constant duty cycle during the measurement duration. Duty cycle will be considered to be constant if variations are less than ±2%.

c) **Method AVGSA-3** or **method AVGSA-3A (alternative)** shall be applied if the conditions of the preceding item a) and item b) cannot be achieved.

POWER OUTPUT

Selected Method of Measurement:

ANSI C63.10 § 11.9.2.2.2 Method AVGSA-1

11.9.2.2.2 Method AVGSA-1

Method AVGSA-1 uses trace averaging with the EUT transmitting at full power throughout each sweep. The procedure for this method is as follows:

a) Set span to at least 1.5 times the OBW.

b) Set RBW = 1% to 5% of the OBW, not to exceed 1 MHz.

c) Set VBW ≥ [3 × RBW].

d) Number of points in sweep ≥ [2 × span / RBW]. (This gives bin-to-bin spacing ≤ RBW / 2, so that narrowband signals are not lost between frequency bins.)

e) Sweep time = auto.

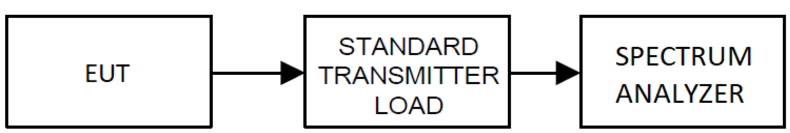
f) Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.

g) If transmit duty cycle < 98%, use a sweep trigger with the level set to enable triggering only on full power pulses. The transmitter shall operate at the maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no OFF intervals) or at duty cycle ≥ 98%, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to "free run."

h) Trace average at least 100 traces in power averaging (rms) mode.

i) Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function, with band limits set equal to the OBW band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.

Test Setup:



POWER OUTPUT

Conducted Power Output Measurement Tables

BLE Peak Conducted Power Output Measurement				
Frequency (MHz)	Power Output (dBm)	Power Output (mW)	Limit (mW)	Margin (mW)
2402	2.12	1.63	1000.00	998.37
2440	1.11	1.29	1000.00	998.71
2480	1.20	1.32	1000.00	998.68

WiFi 802.11 b Average Conducted Power Output Measurement				
Frequency (MHz)	Power Output (dBm)	Power Output (mW)	Limit (mW)	Margin (mW)
2412	13.24	21.09	1000.00	978.91
2442	14.66	29.24	1000.00	970.76
2462	15.16	32.81	1000.00	967.19

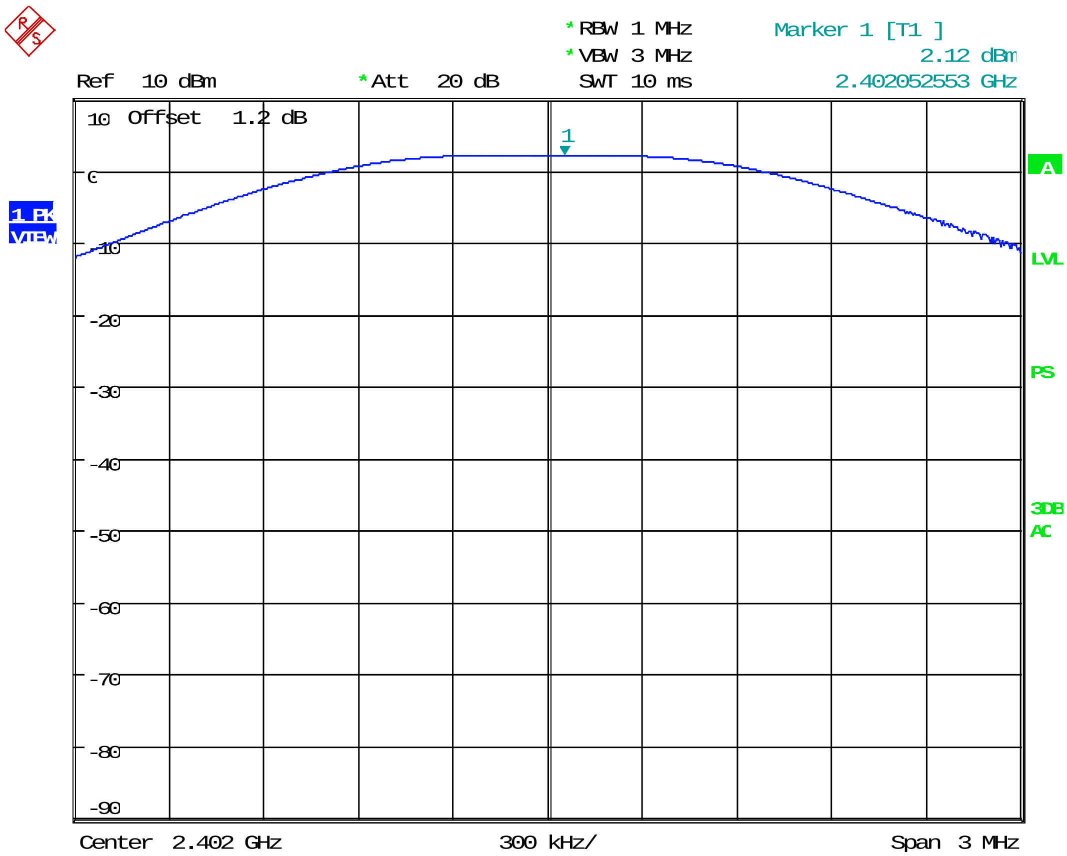
WiFi 802.11 g Average Conducted Power Output Measurement				
Frequency (MHz)	Power Output (dBm)	Power Output (mW)	Limit (mW)	Margin (mW)
2412	13.17	20.75	1000.00	979.25
2442	14.12	25.82	1000.00	974.18
2462	17.99	62.95	1000.00	937.05

WiFi 802.11 n HT20 Average Conducted Power Output Measurement				
Frequency (MHz)	Power Output (dBm)	Power Output (mW)	Limit (mW)	Margin (mW)
2412	15.61	36.39	1000.00	963.61
2442	16.36	43.25	1000.00	956.75
2462	15.82	38.19	1000.00	961.81

WiFi 802.11 n HT40 Average Conducted Power Output Measurement				
Frequency (MHz)	Power Output (dBm)	Power Output (mW)	Limit (mW)	Margin (mW)
2422	14.94	31.19	1000.00	968.81
2462	15.09	32.28	1000.00	967.72

POWER OUTPUT

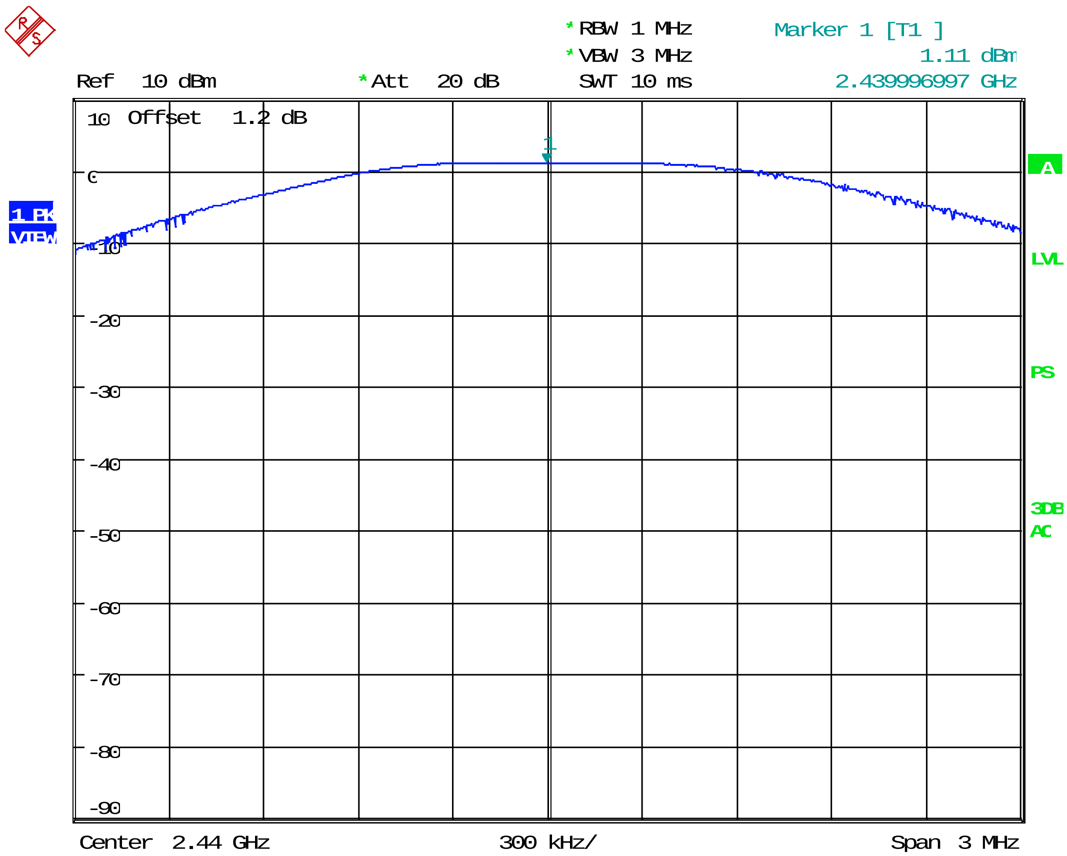
BLE Peak Power Output Plot, 2402 MHz



Date: 27.FEB.2019 19:05:12

POWER OUTPUT

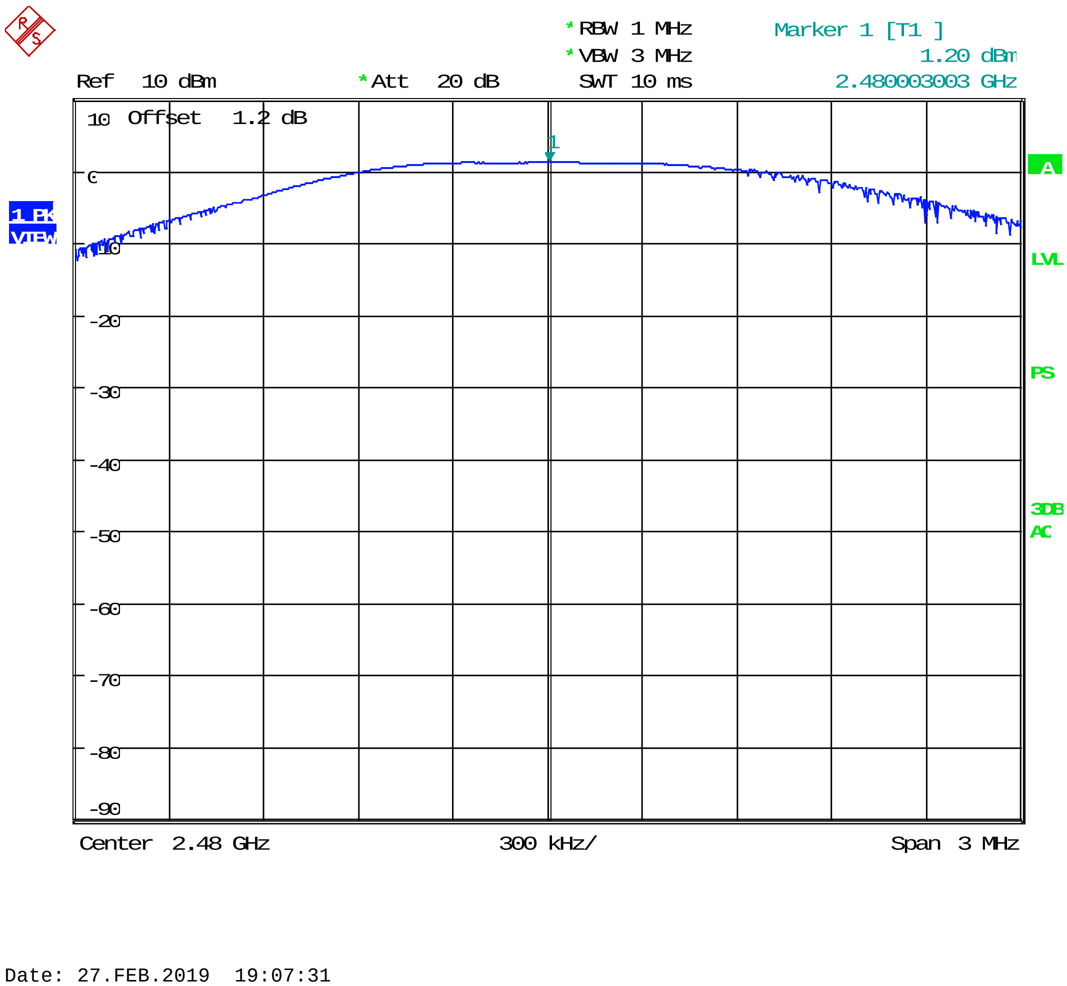
BLE Peak Power Output Plot, 2440 MHz



Date: 27.FEB.2019 19:06:06

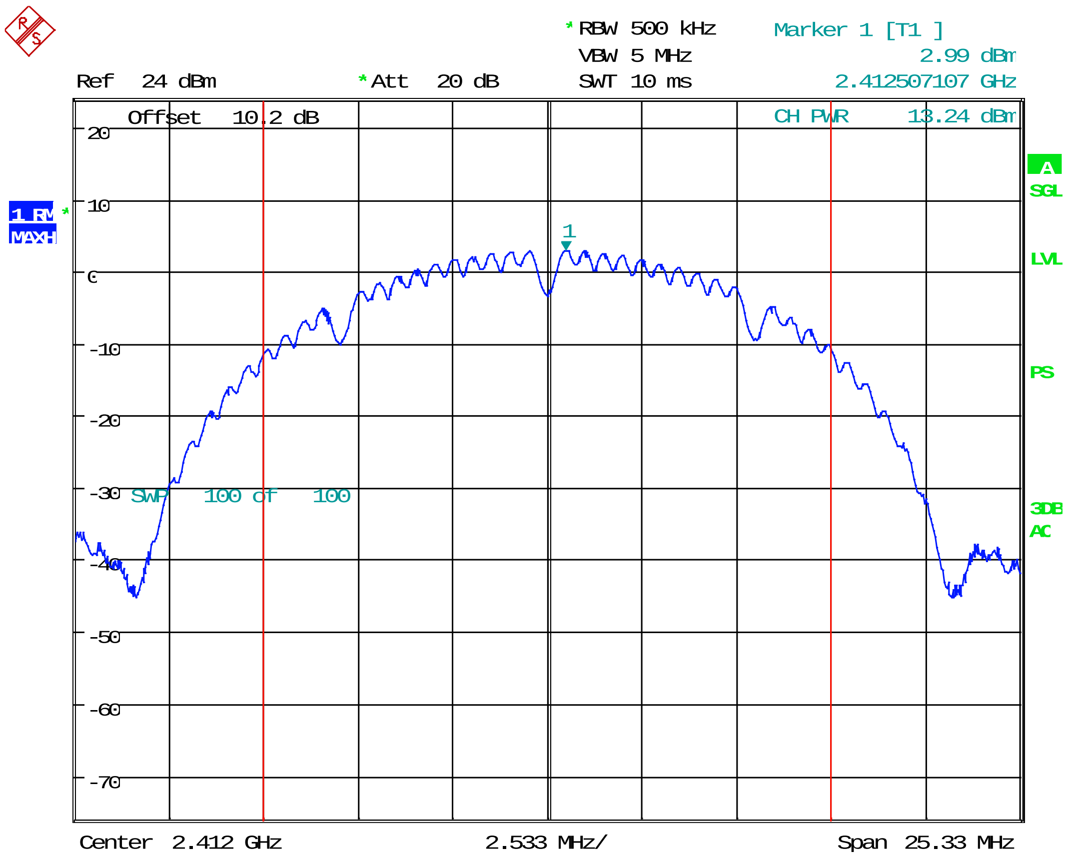
POWER OUTPUT

BLE Peak Power Output Plot, 2480 MHz



POWER OUTPUT

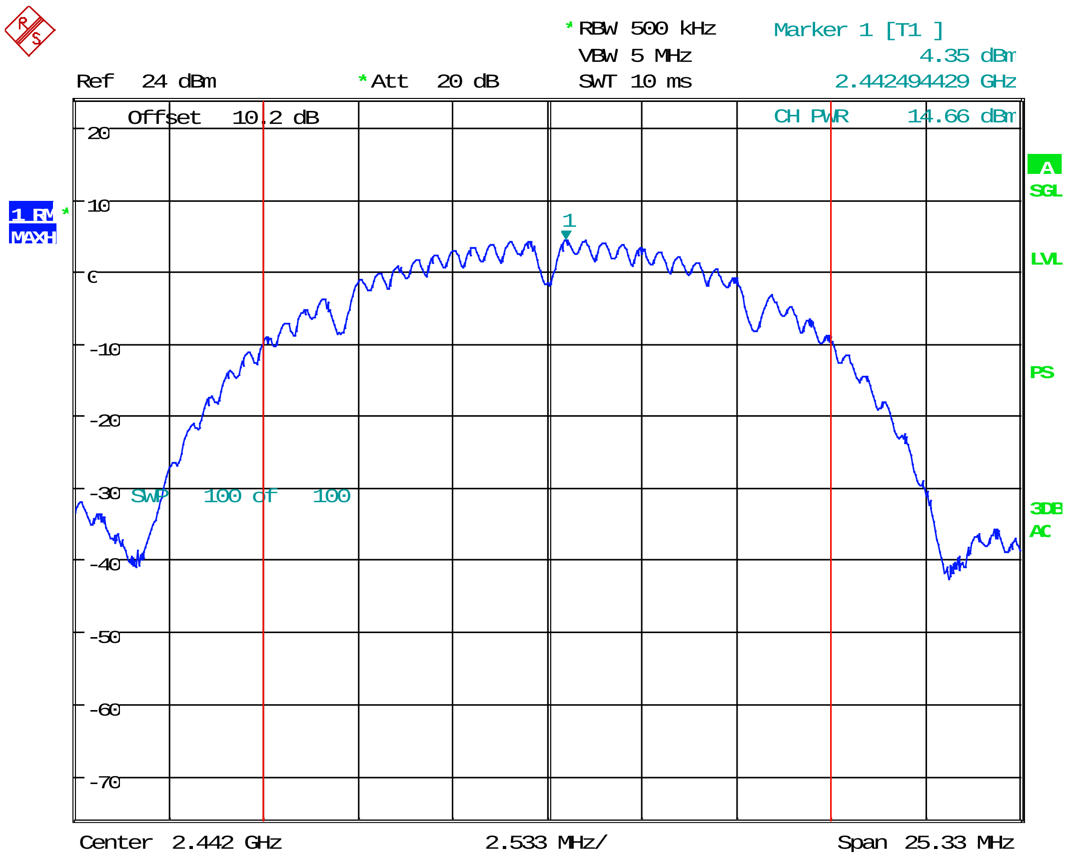
WiFi 802.11 b Average Power Output Plot, 2412 MHz, Integrated Method



Date: 28.FEB.2019 16:44:29

POWER OUTPUT

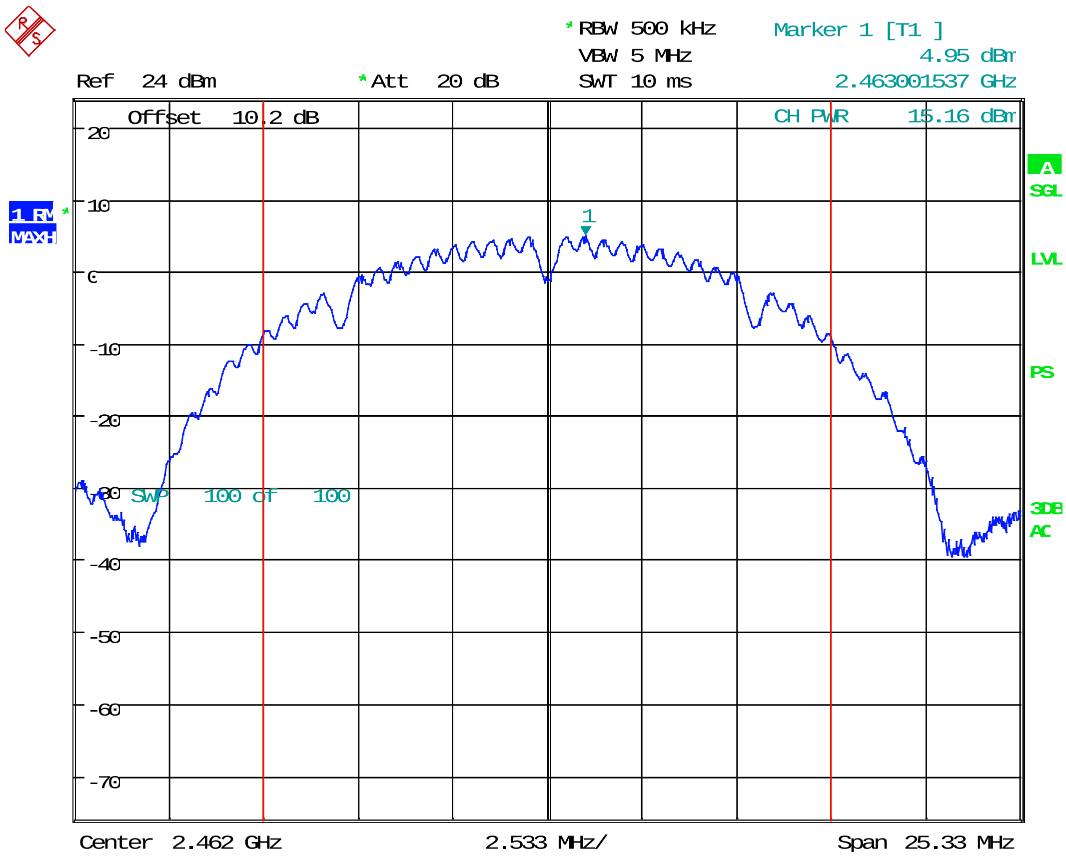
WiFi 802.11 b Average Power Output Plot, 2442 MHz, Integrated Method



Date: 28.FEB.2019 16:45:15

POWER OUTPUT

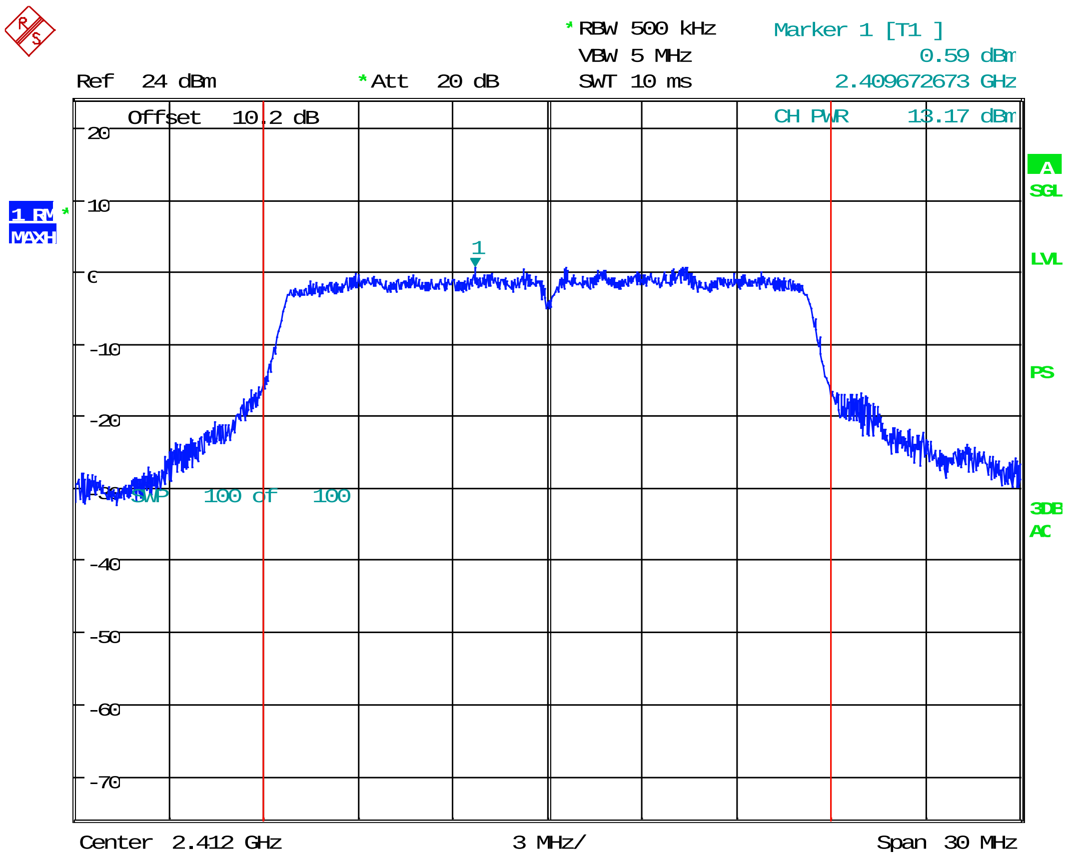
WiFi 802.11 b Average Power Output Plot, 2462 MHz, Integrated Method



Date: 28.FEB.2019 16:45:56

POWER OUTPUT

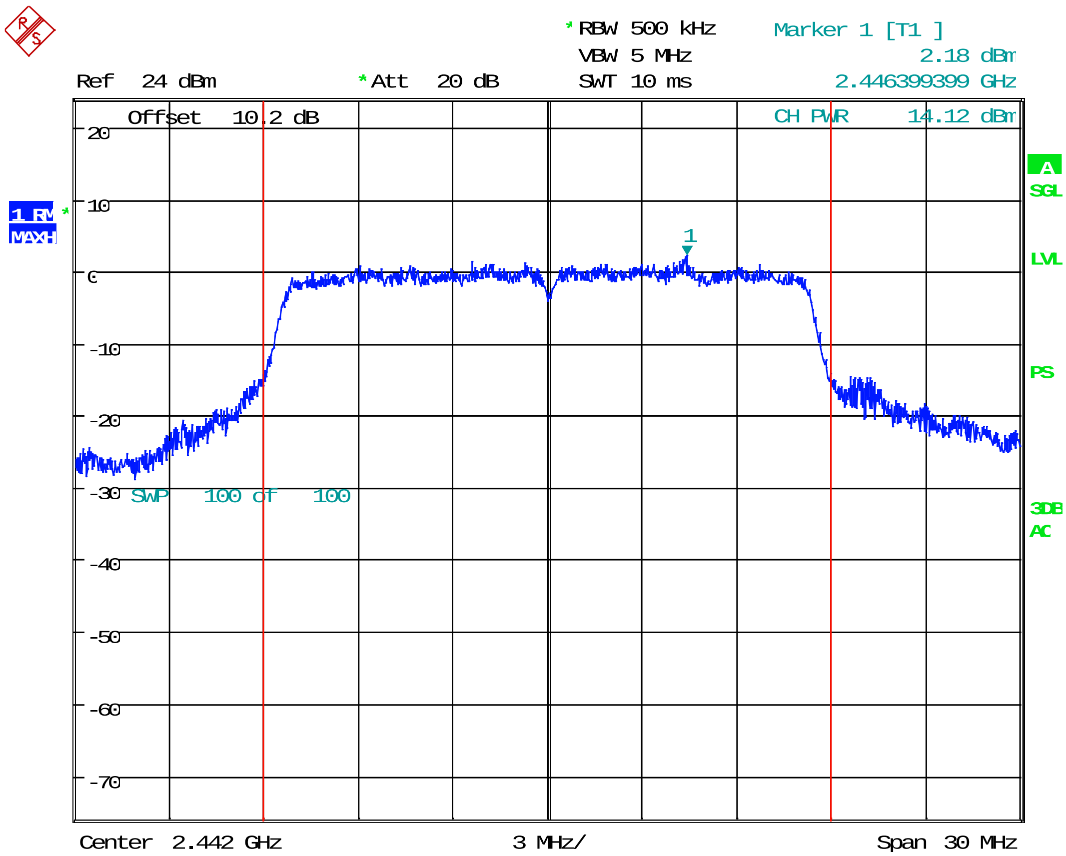
WiFi 802.11 g Average Power Output Plot, 2412 MHz, Integrated Method



Date: 28.FEB.2019 14:25:34

POWER OUTPUT

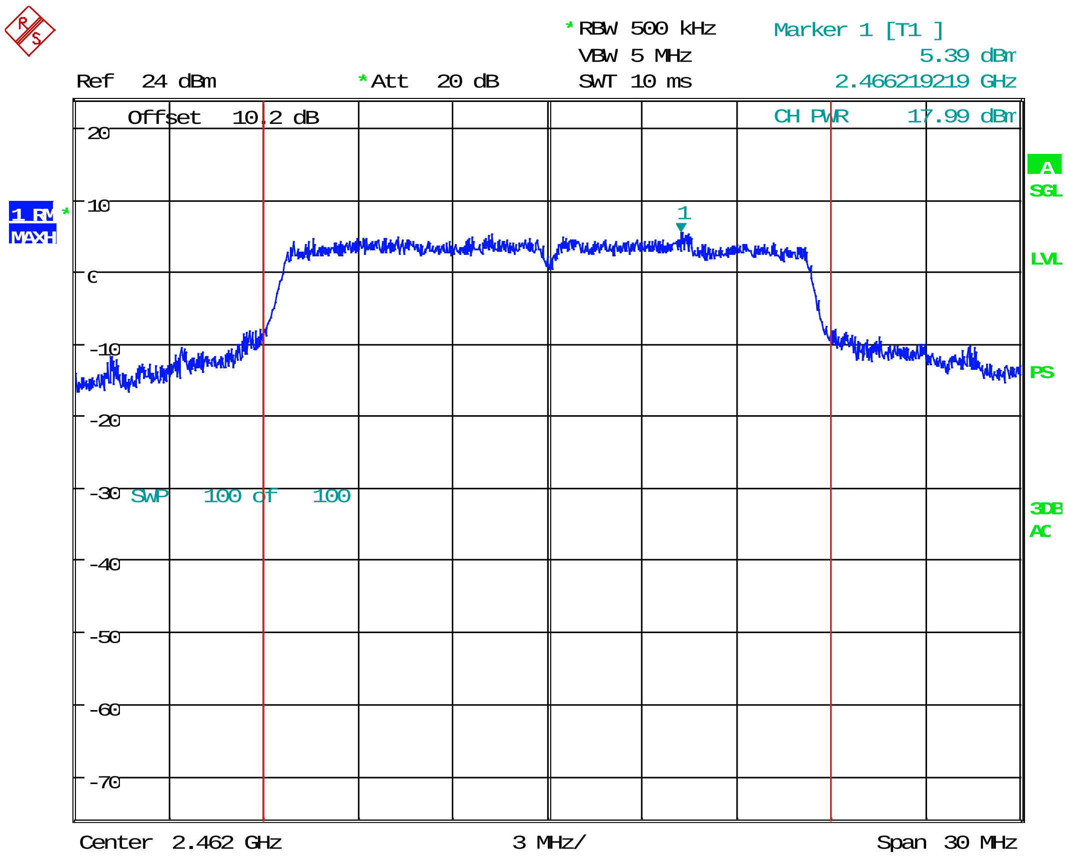
WiFi 802.11 g Average Power Output Plot, 2442 MHz, Integrated Method



Date: 28.FEB.2019 14:24:42

POWER OUTPUT

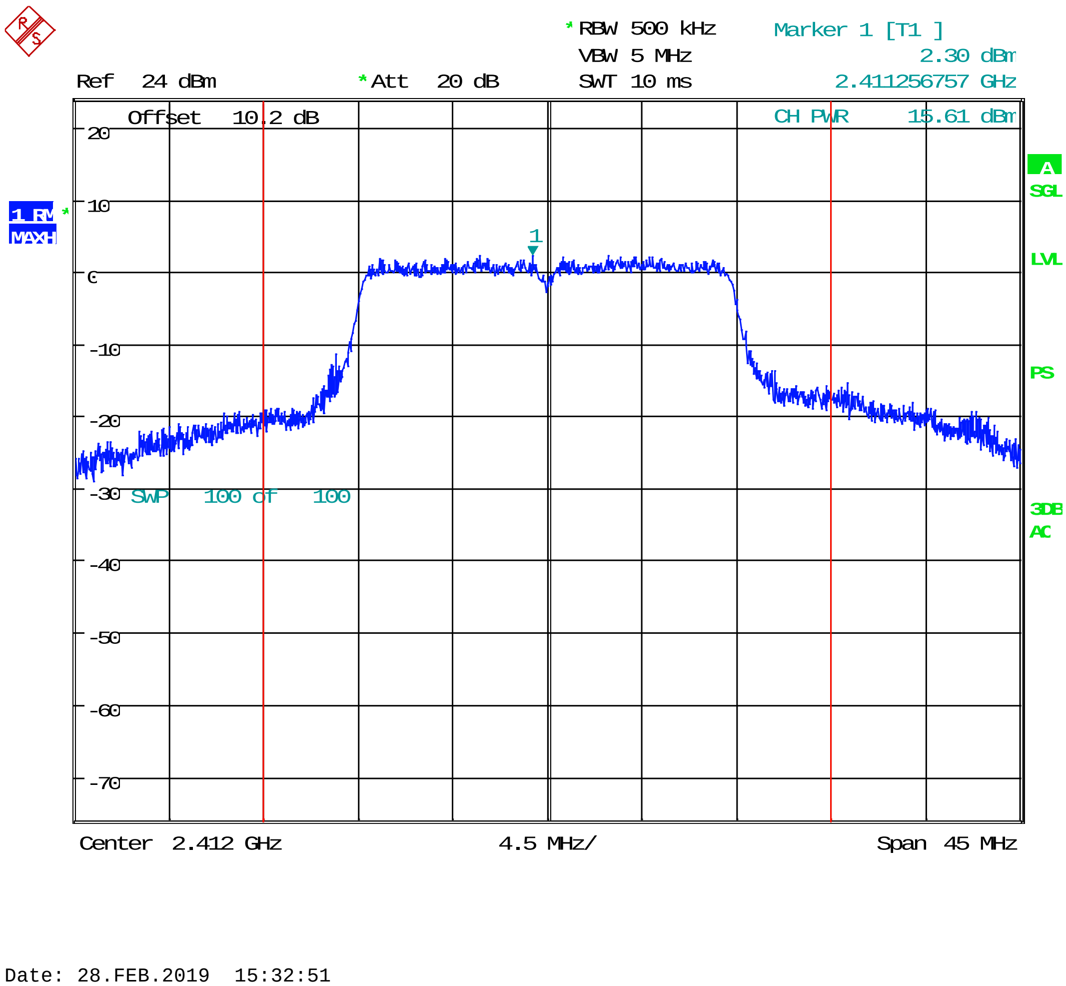
WiFi 802.11 g Average Power Output Plot, 2462 MHz, Integrated Method



Date: 28.FEB.2019 14:27:52

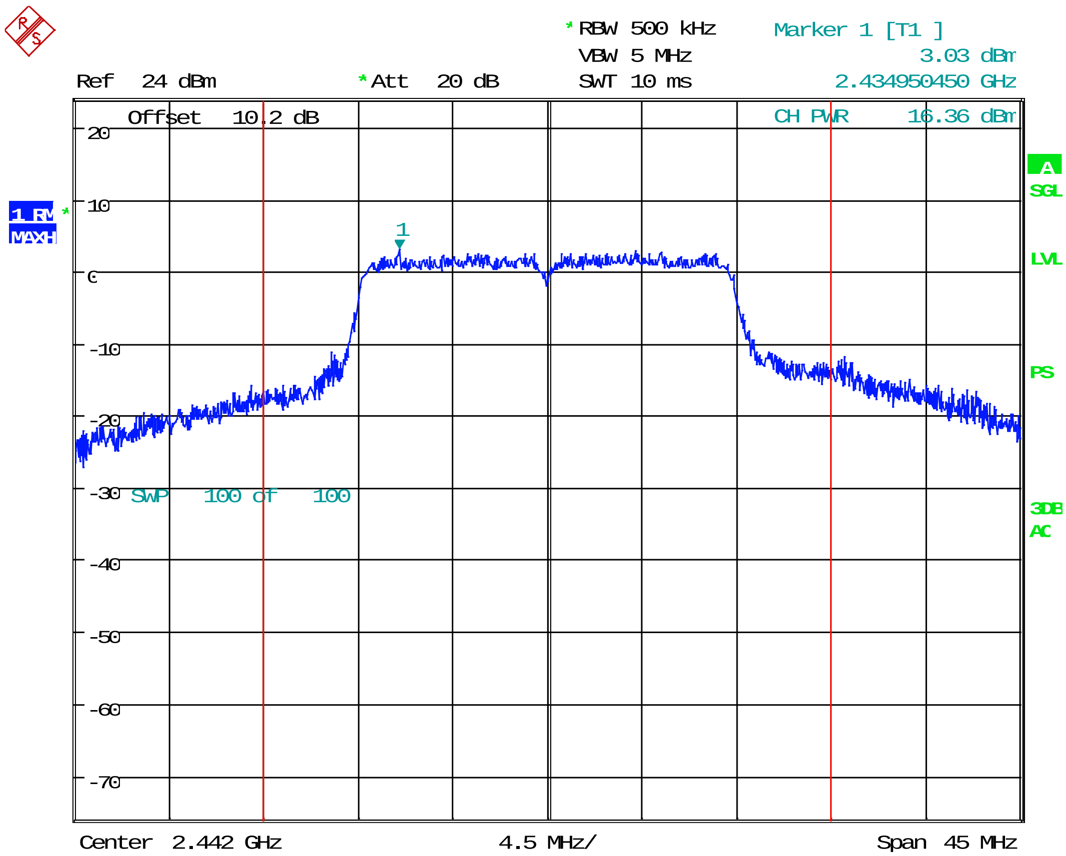
POWER OUTPUT

WiFi 802.11 n HT20 Average Power Output Plot, 2412 MHz, Integrated Method



POWER OUTPUT

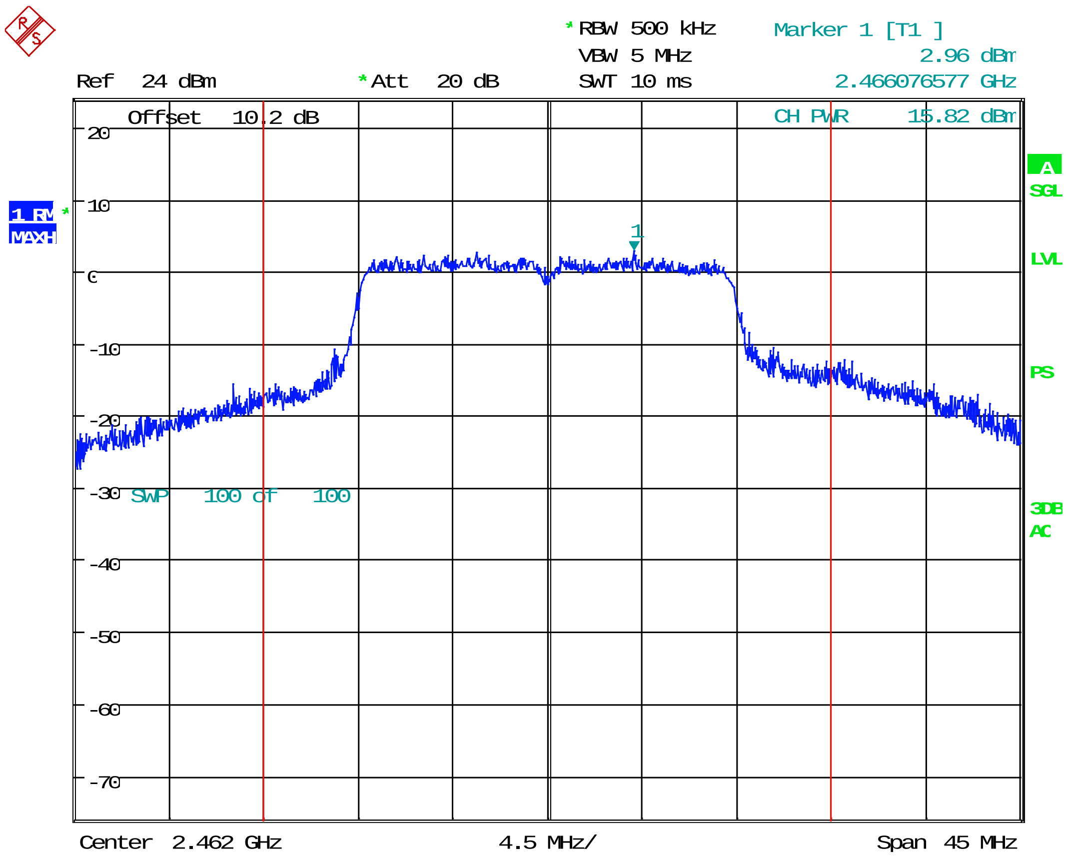
WiFi 802.11 n HT20 Average Power Output Plot, 2442 MHz, Integrated Method



Date: 28.FEB.2019 15:35:11

POWER OUTPUT

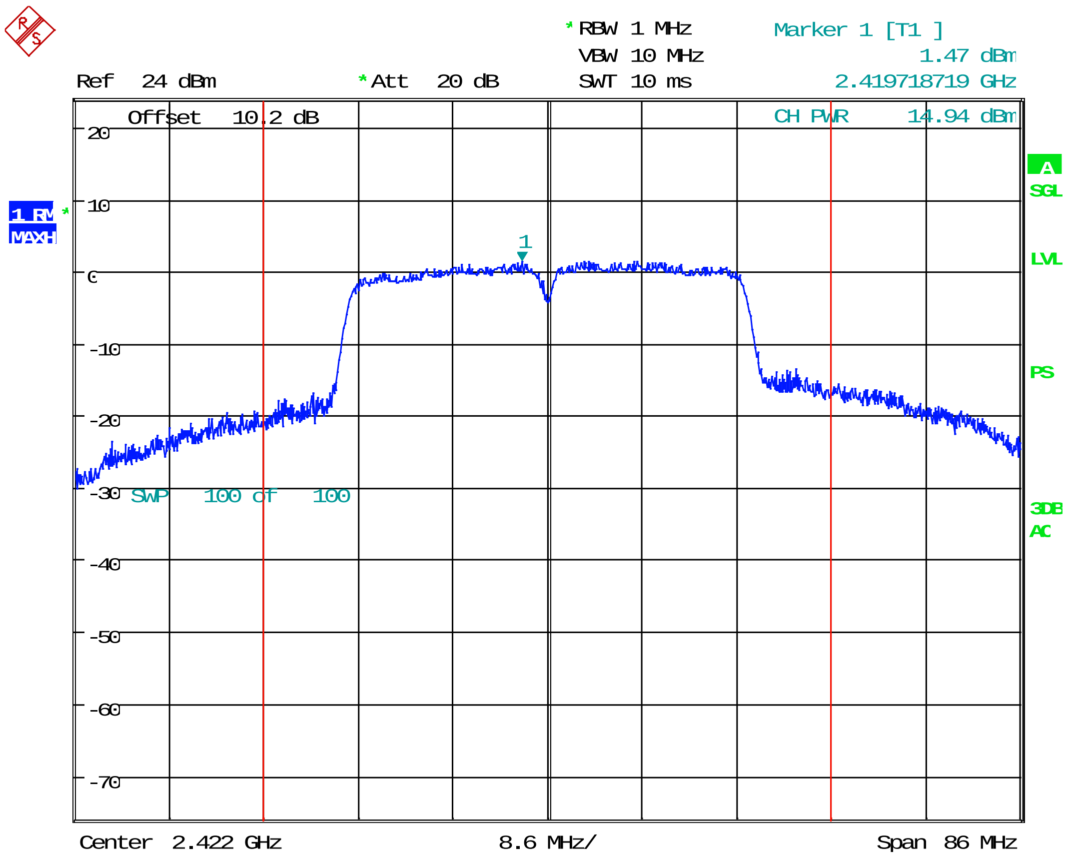
WiFi 802.11 n HT20 Average Power Output Plot, 2462 MHz, Integrated Method



Date: 28.FEB.2019 15:35:57

POWER OUTPUT

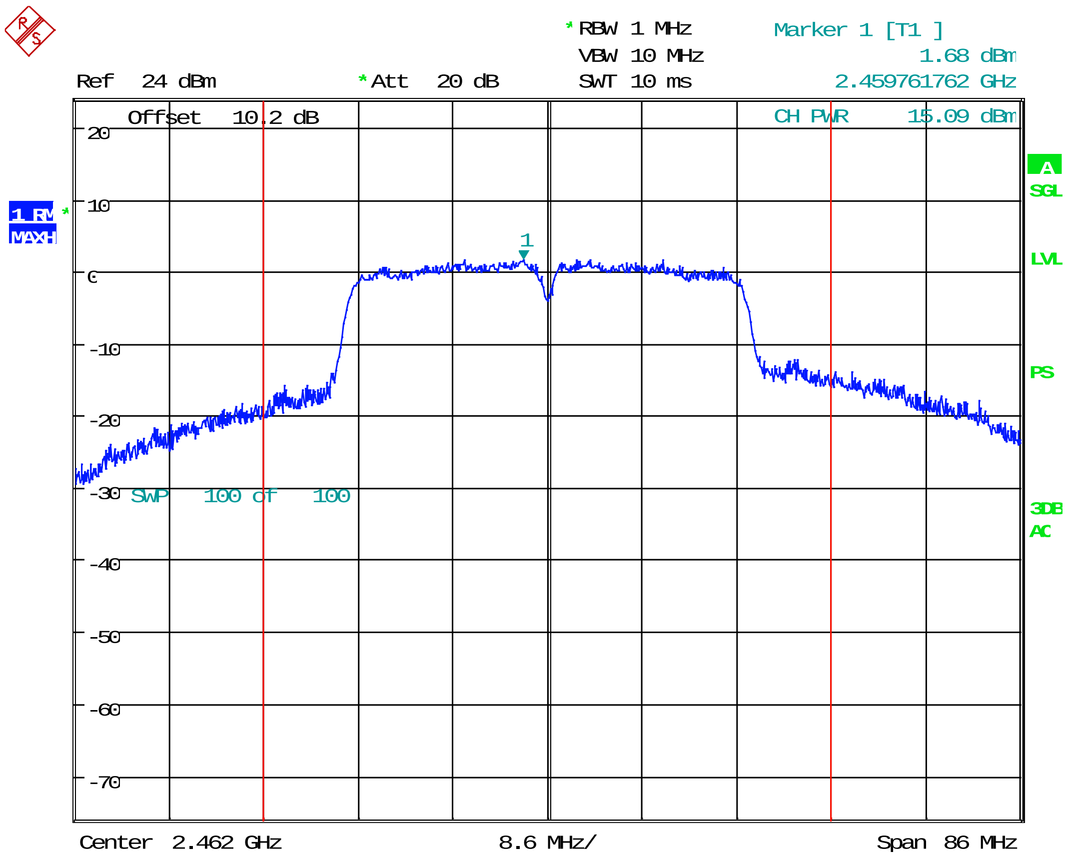
WiFi 802.11 n HT40 Average Power Output Plot, 2422 MHz, Integrated Method



Date: 28.FEB.2019 15:45:50

POWER OUTPUT

WiFi 802.11 n HT40 Average Power Output Plot, 2462 MHz, Integrated Method



Date: 28.FEB.2019 15:44:46

POWER SPECTRAL DENSITY

Rule Part No.: FCC 15.247(e)

Requirements:

§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

(e) 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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Test Method:

Bluetooth Low Energy Power Output Measurement:

ANSI C63.10 § 11.10 Maximum Power Spectral Density in the Fundamental

11.10.2 Method PKPSD (peak PSD)

The following procedure shall be used if maximum peak conducted output power was used to determine compliance, and it is optional if the maximum conducted (average) output power was used to determine compliance:

a) Set analyzer center frequency to DTS channel center frequency.

b) Set the span to 1.5 times the DTS bandwidth.

c) Set the RBW to 3 kHz ≤ RBW ≤ 100 kHz.

d) Set the VBW ≥ [3 × RBW].

e) Detector = peak.

f) Sweep time = auto couple.

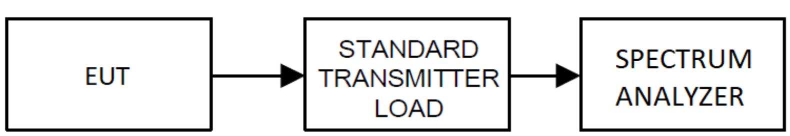
g) Trace mode = max hold.

h) Allow trace to fully stabilize.

i) Use the peak marker function to determine the maximum amplitude level within the RBW.

j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat.

Test Setup:



POWER SPECTRAL DENSITY

WiFi 802.11 b/g/n HT20/HT40 Power Output Measurement:

ANSI C63.10 § 11.10 Maximum Power Spectral Density in the Fundamental

11.10.3 Method AVGPSD-1

Method AVGPSD-1 uses trace averaging with EUT transmitting at full power throughout each sweep.

The following procedure may be used when the maximum (average) conducted output power was used to determine compliance to the fundamental output power limit. This is the baseline method for determining the maximum (average) conducted PSD level. If the instrument has a power averaging (rms) detector, then it must be used; otherwise, use the sample detector. The EUT must be configured to transmit continuously ($D \geq 98\%$), or else sweep triggering/signal gating must be implemented to ensure that measurements are made only when the EUT is transmitting at its maximum power control level (no transmitter OFF time to be considered):

a) Set instrument center frequency to DTS channel center frequency.

b) Set span to at least 1.5 times the OBW.

c) Set RBW to: 3 kHz ≤ RBW ≤ 100 kHz.

d) Set VBW ≥ [3 × RBW].

e) Detector = power averaging (rms) or sample detector (when rms not available).

f) Ensure that the number of measurement points in the sweep ≥ [2 × span / RBW].

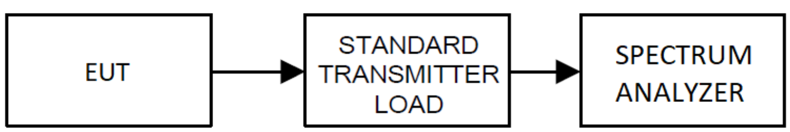
g) Sweep time = auto couple.

h) Employ trace averaging (rms) mode over a minimum of 100 traces.

i) Use the peak marker function to determine the maximum amplitude level.

j) If the measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced).

Test Setup:



POWER SPECTRAL DENSITY

Power Spectral Density Measurement Tables

BLE Peak Conducted PSD Measurement			
Frequency (MHz)	PSD (dBm)	Limit (dBm)	Margin (dBm)
2402	1.88	8.00	6.12
2440	0.92	8.00	7.08
2480	1.14	8.00	6.86

WiFi 802.11 b Average Conducted PSD Measurement			
Frequency (MHz)	PSD (dBm)	Limit (mW)	Margin (mW)
2412	0.61	8.00	7.39
2442	1.97	8.00	6.03
2462	2.57	8.00	5.43

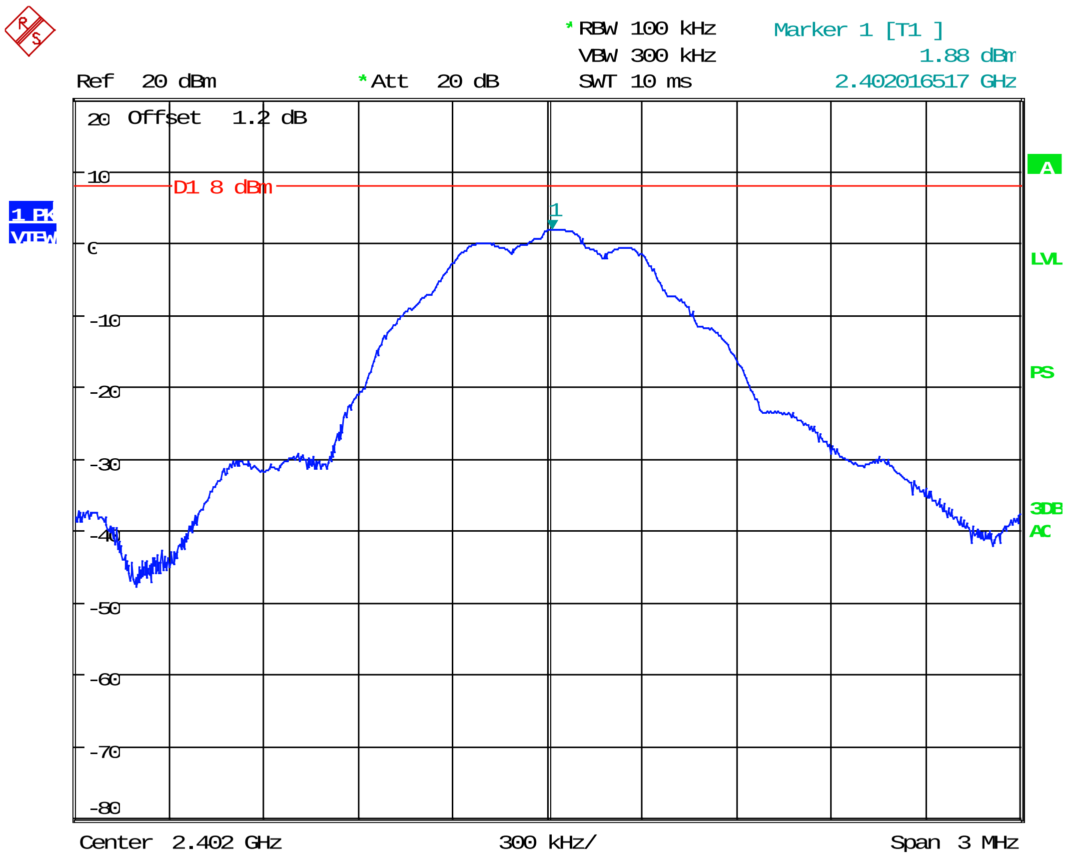
WiFi 802.11 g Average Conducted PSD Measurement			
Frequency (MHz)	PSD (dBm)	Limit (mW)	Margin (mW)
2412	-3.60	8.00	11.60
2442	-2.82	8.00	10.82
2462	1.32	8.00	6.68

WiFi 802.11 n HT20 Average Conducted PSD Measurement			
Frequency (MHz)	PSD (dBm)	Limit (mW)	Margin (mW)
2412	-2.22	8.00	10.22
2442	-1.63	8.00	9.63
2462	-2.27	8.00	10.27

WiFi 802.11 n HT40 Average Conducted PSD Measurement			
Frequency (MHz)	PSD (dBm)	Limit (mW)	Margin (mW)
2422	-4.42	8.00	12.42
2462	-4.49	8.00	12.49

POWER SPECTRAL DENSITY

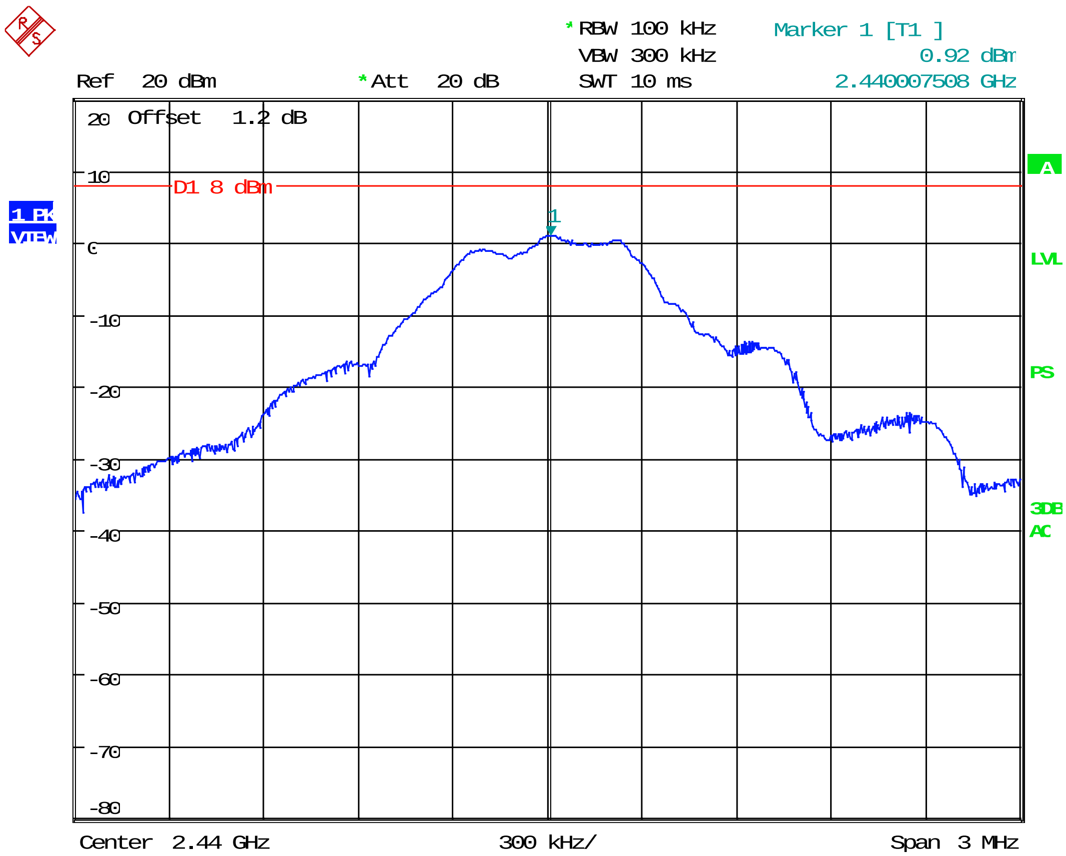
BLE PSD Plot, 2402 MHz



Date: 28.FEB.2019 17:24:41

POWER SPECTRAL DENSITY

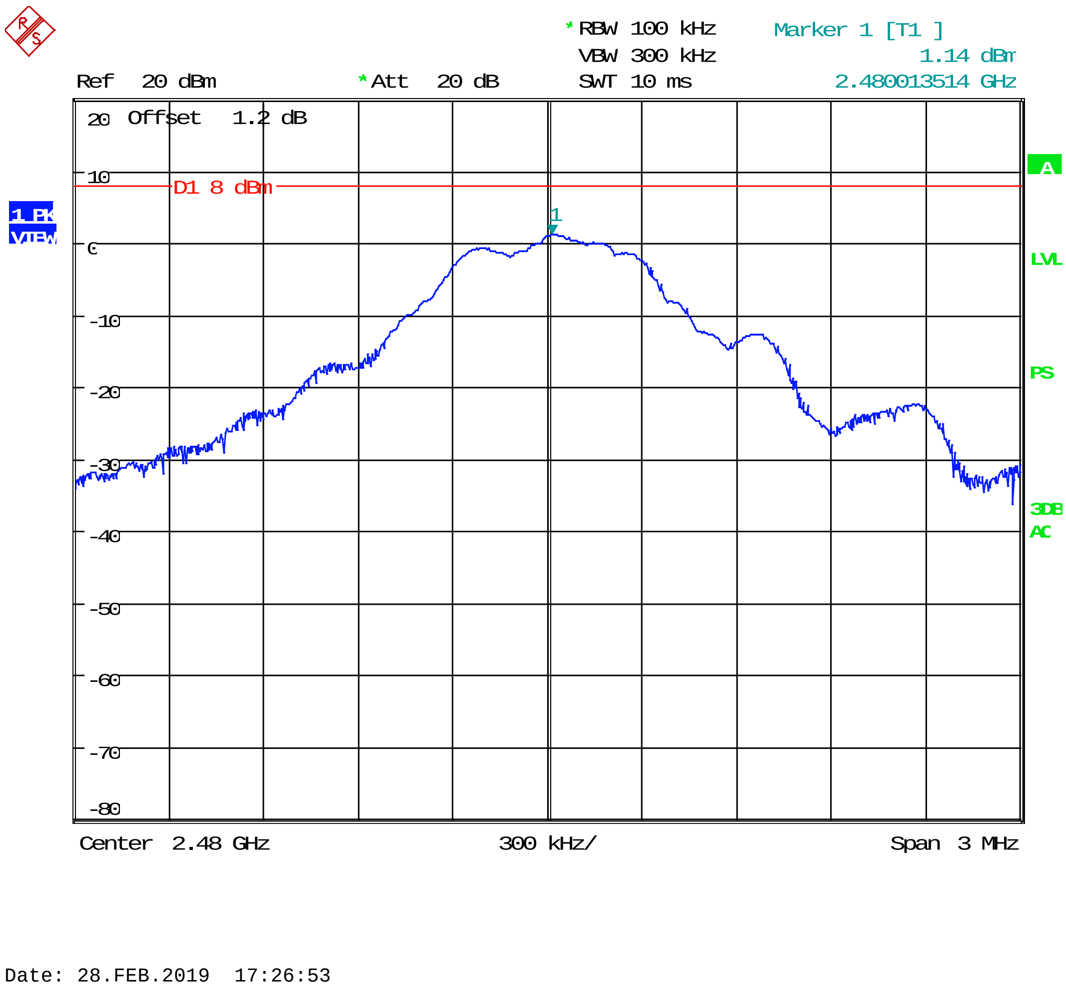
BLE PSD Plot, 2440 MHz



Date: 28.FEB.2019 17:25:54

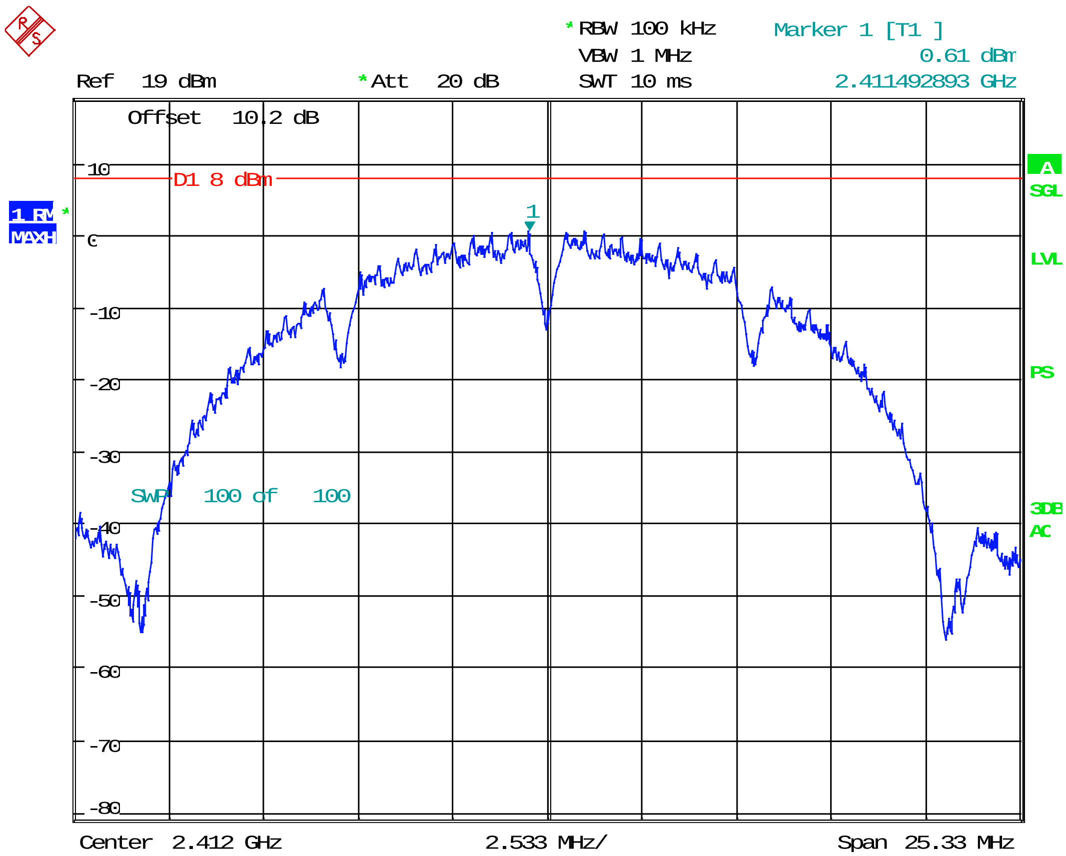
POWER SPECTRAL DENSITY

BLE PSD Plot, 2480 MHz



POWER SPECTRAL DENSITY

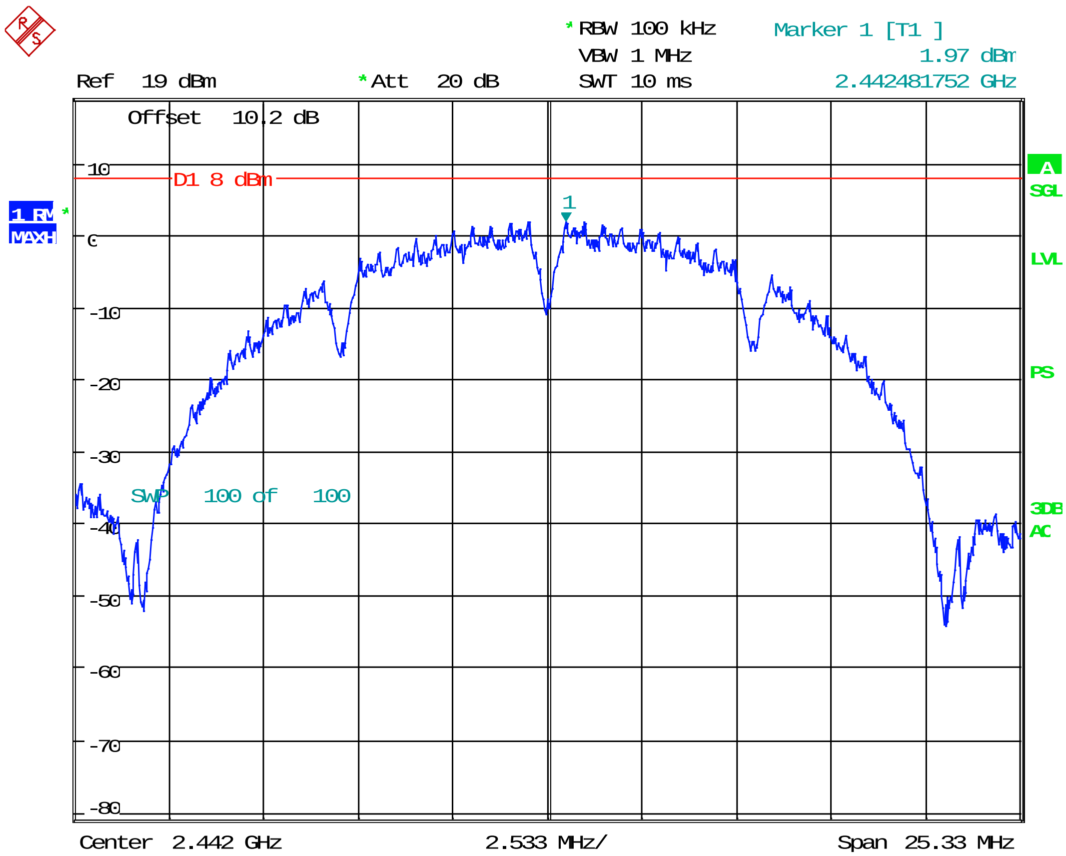
WiFi 802.11 b PSD Plot, 2412 MHz



Date: 28.FEB.2019 16:48:46

POWER SPECTRAL DENSITY

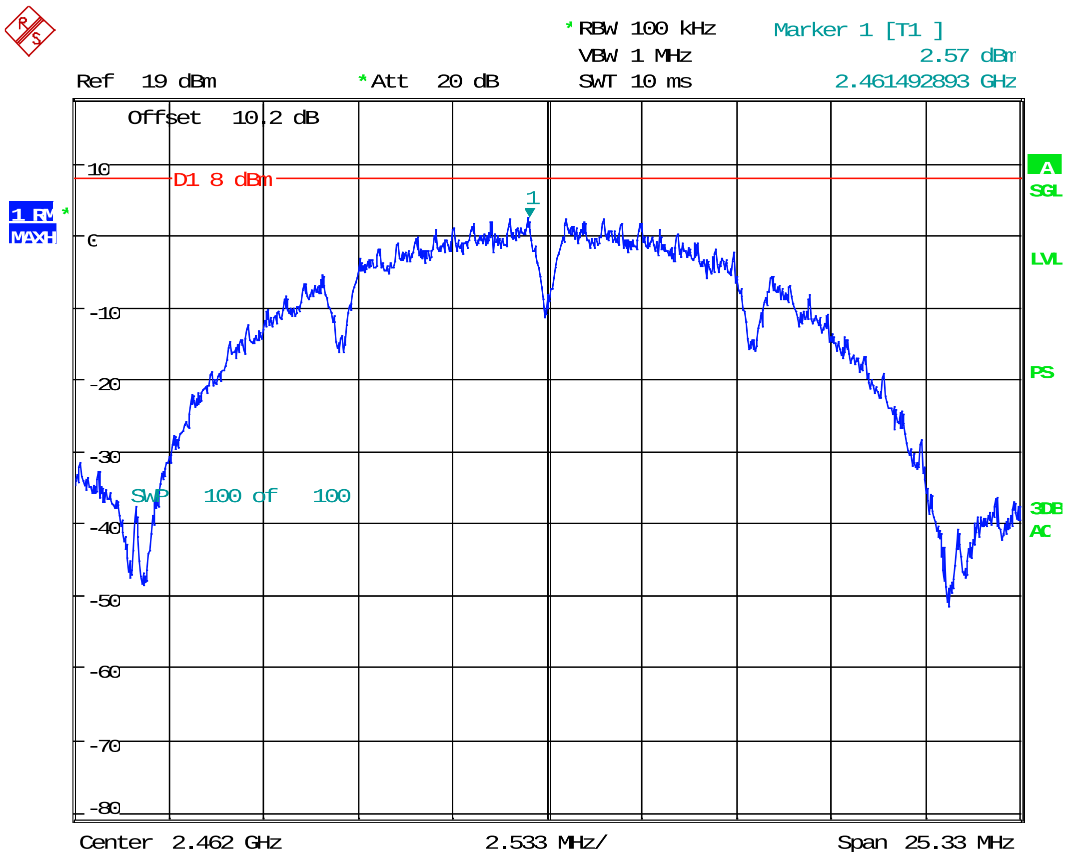
WiFi 802.11 b PSD Plot, 2442 MHz



Date: 28.FEB.2019 16:49:43

POWER SPECTRAL DENSITY

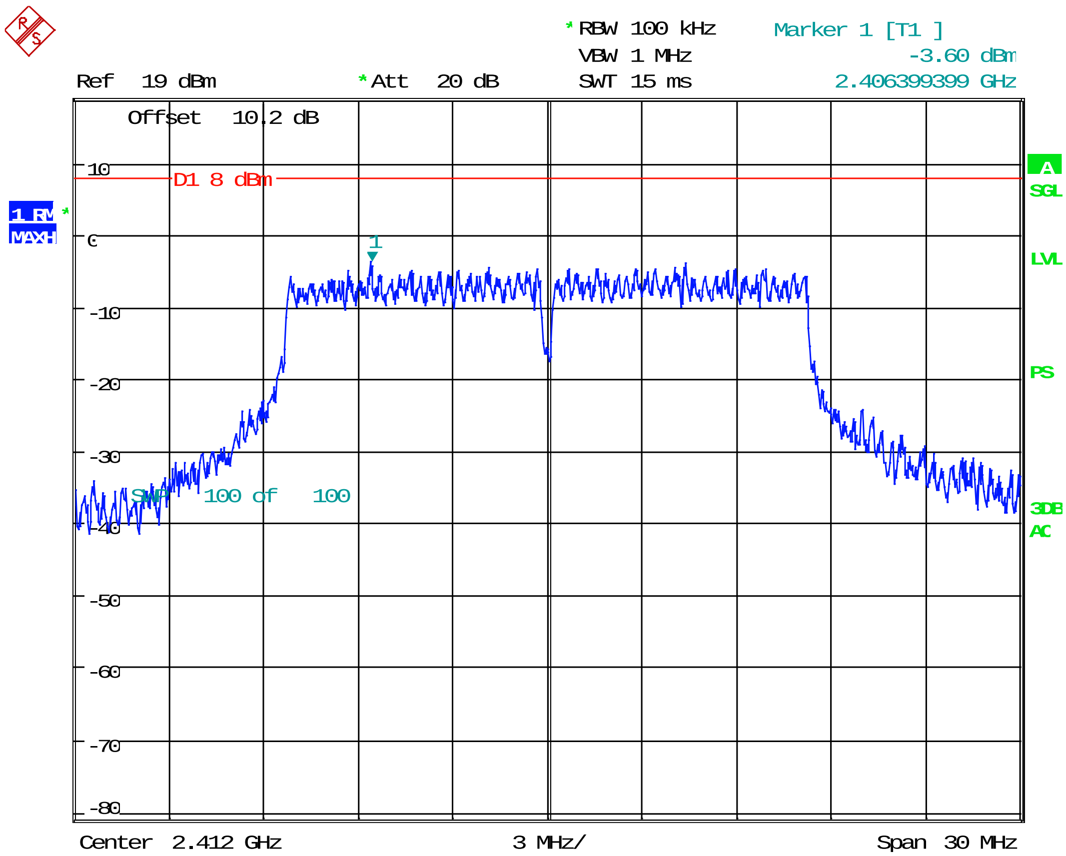
WiFi 802.11 b PSD Plot, 2462 MHz



Date: 28.FEB.2019 16:50:22

POWER SPECTRAL DENSITY

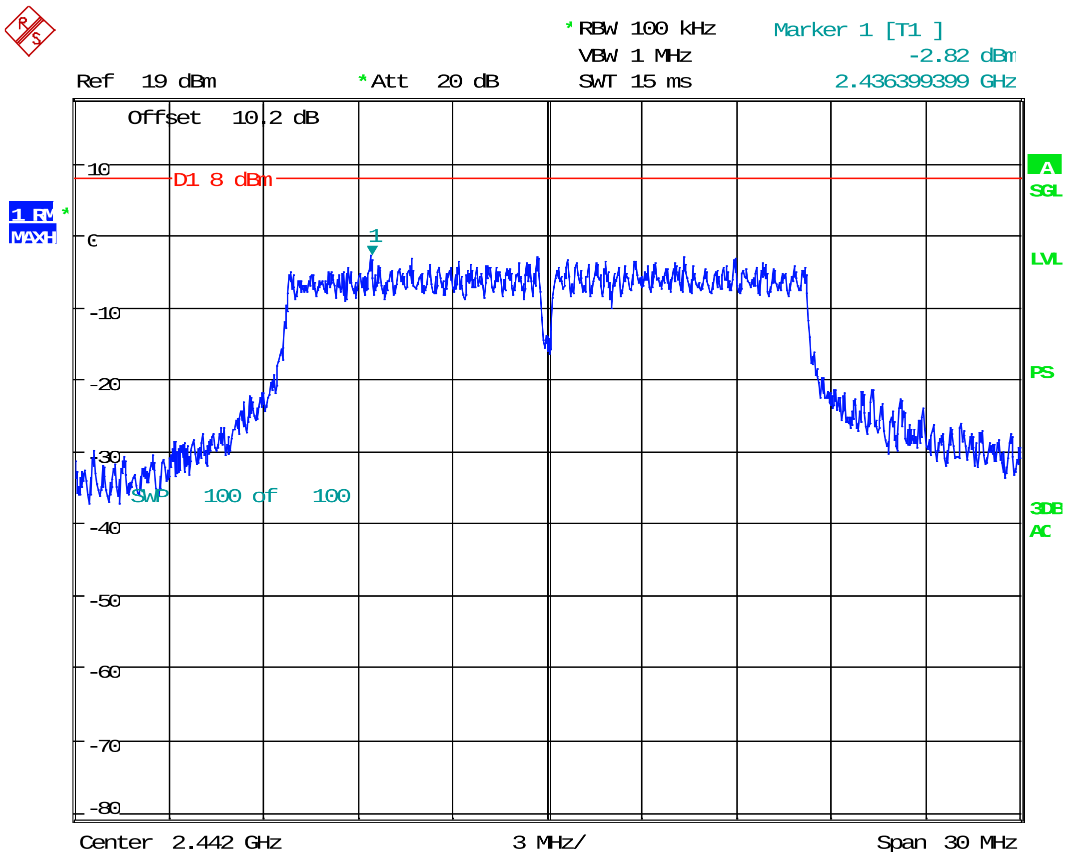
WiFi 802.11 g PSD Plot, 2412 MHz



Date: 28.FEB.2019 15:11:46

POWER SPECTRAL DENSITY

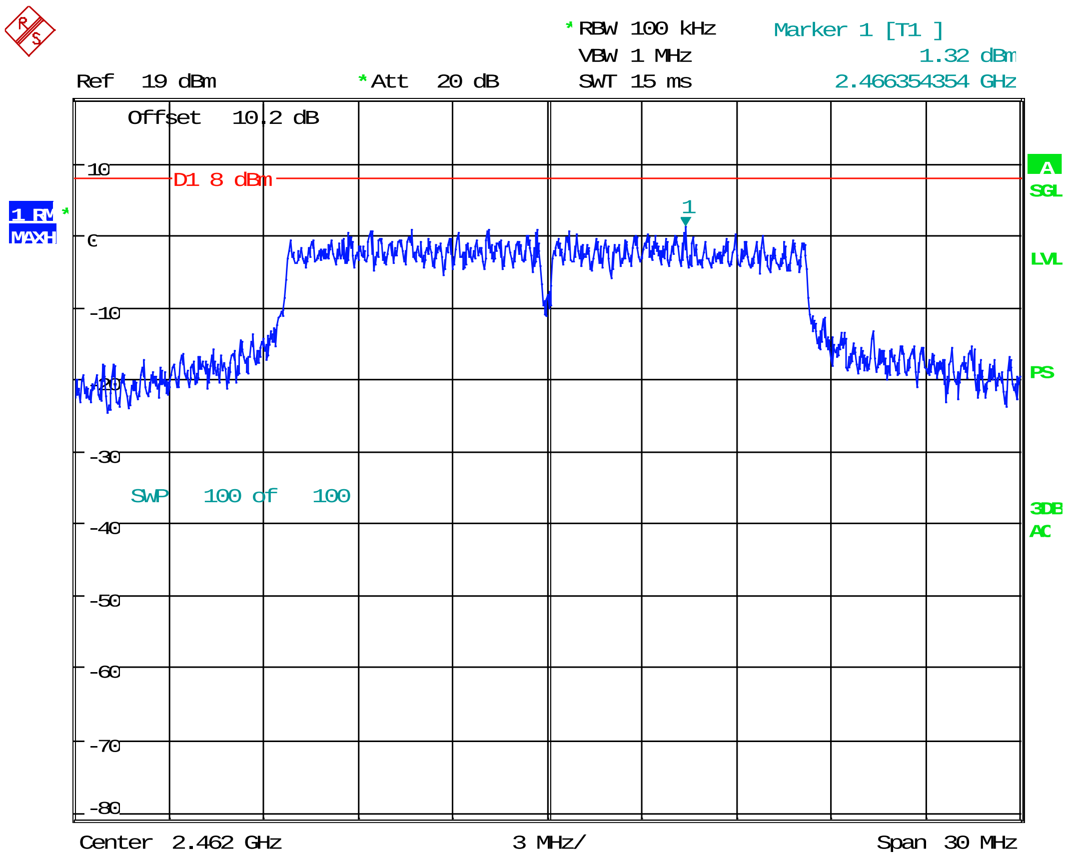
WiFi 802.11 g PSD Plot, 2442 MHz



Date: 28.FEB.2019 15:12:39

POWER SPECTRAL DENSITY

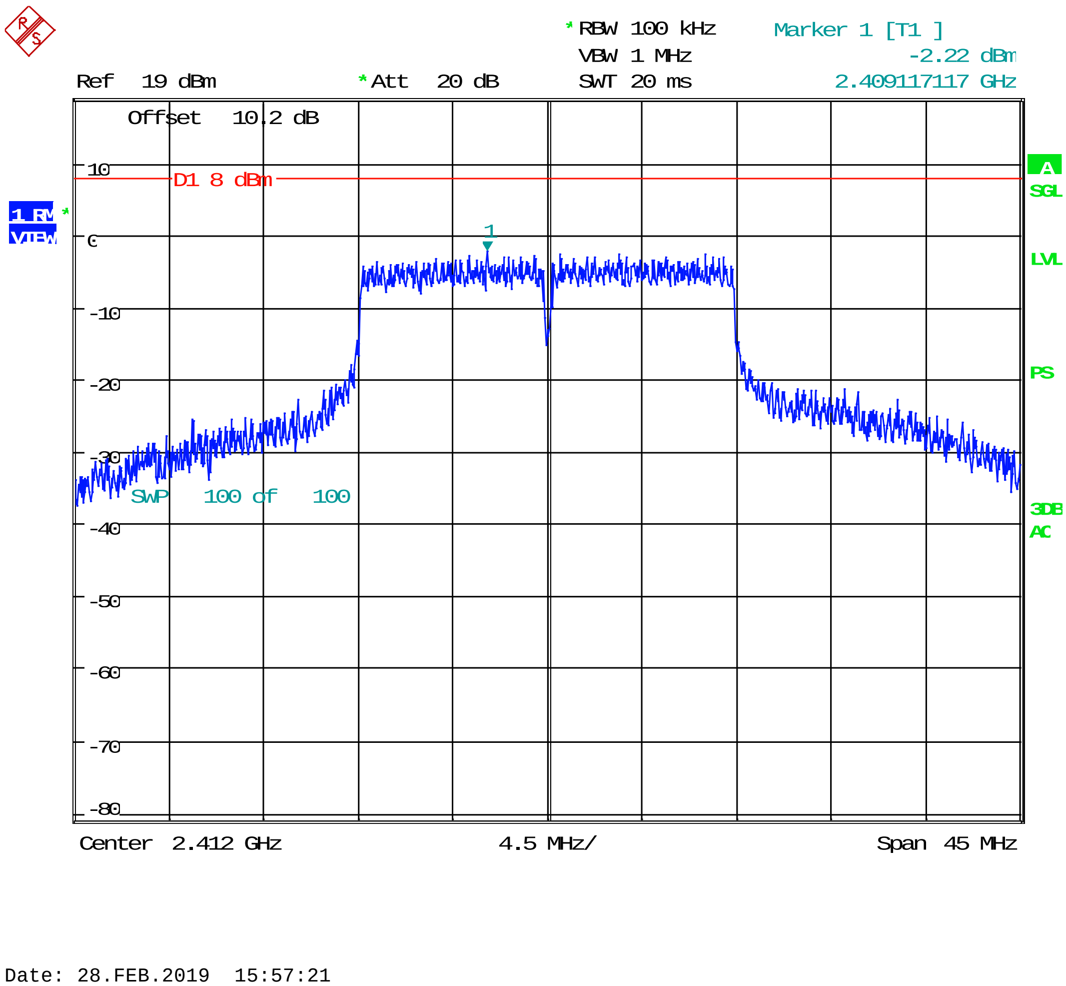
WiFi 802.11 g PSD Plot, 2462 MHz



Date: 28.FEB.2019 15:13:23

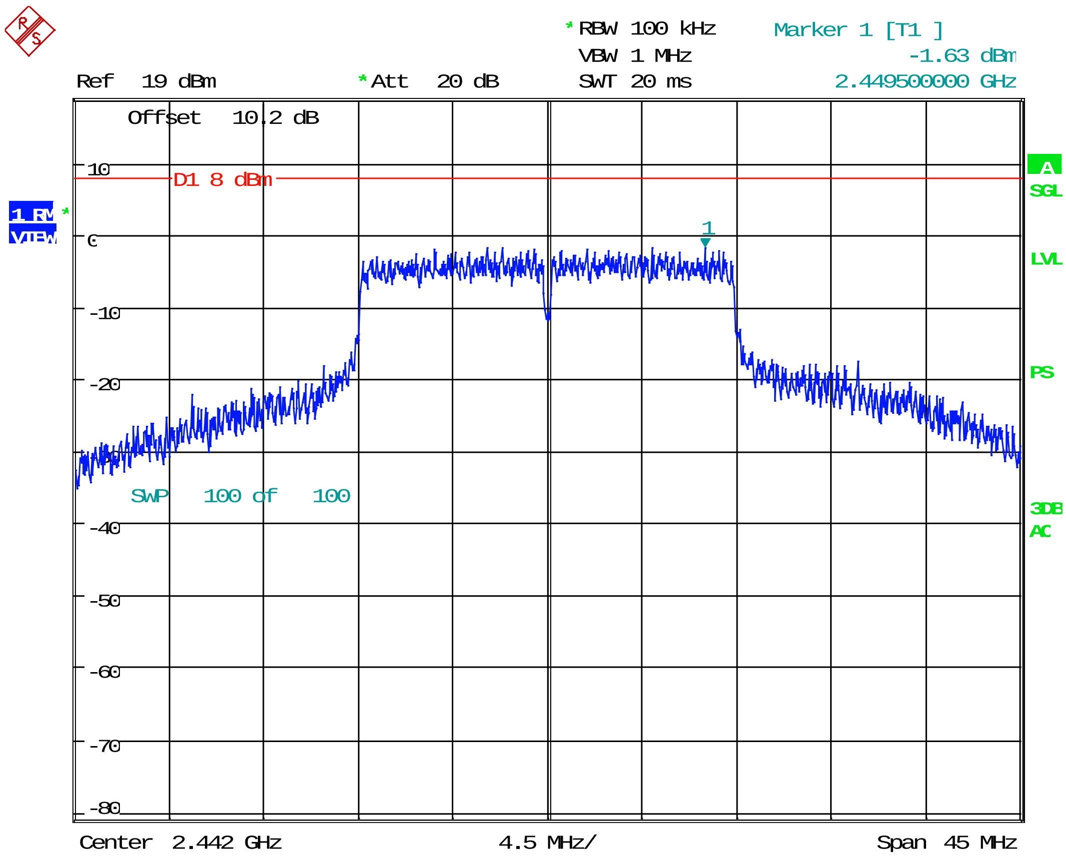
POWER SPECTRAL DENSITY

WiFi 802.11 n HT20 PSD Plot, 2412 MHz



POWER SPECTRAL DENSITY

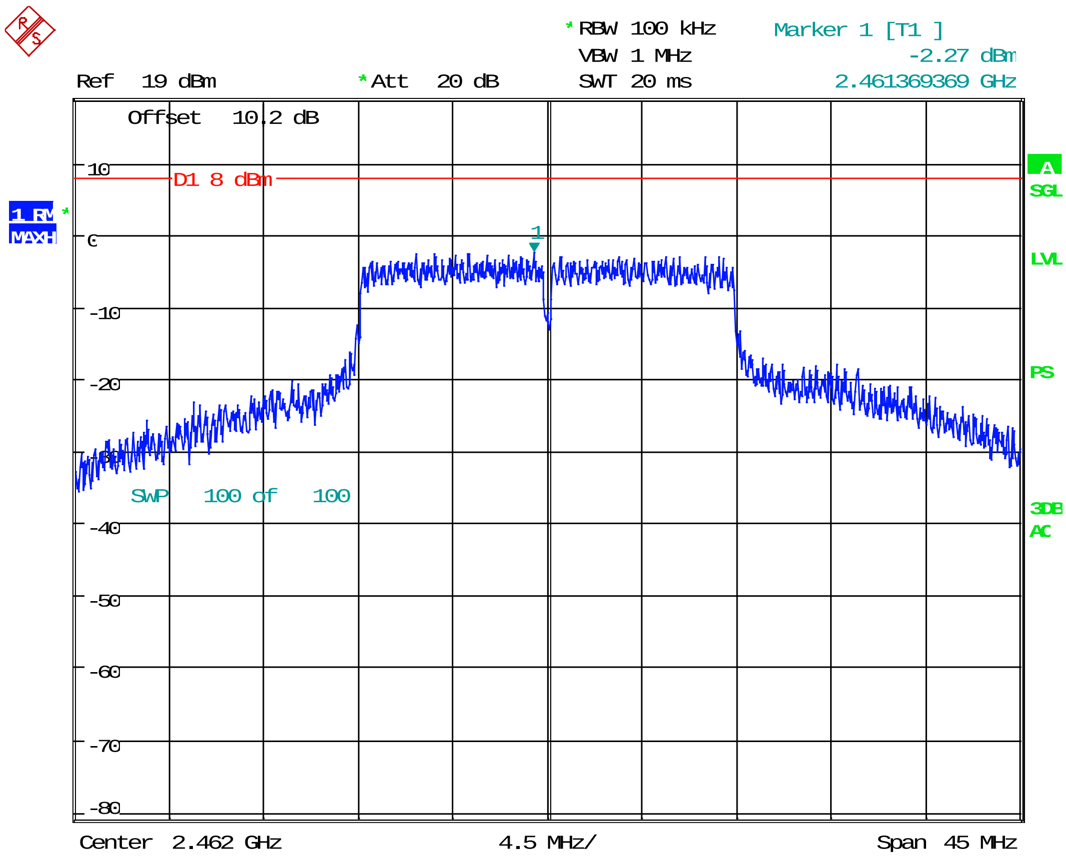
WiFi 802.11 n HT20 PSD Plot, 2442 MHz



Date: 28.FEB.2019 15:58:11

POWER SPECTRAL DENSITY

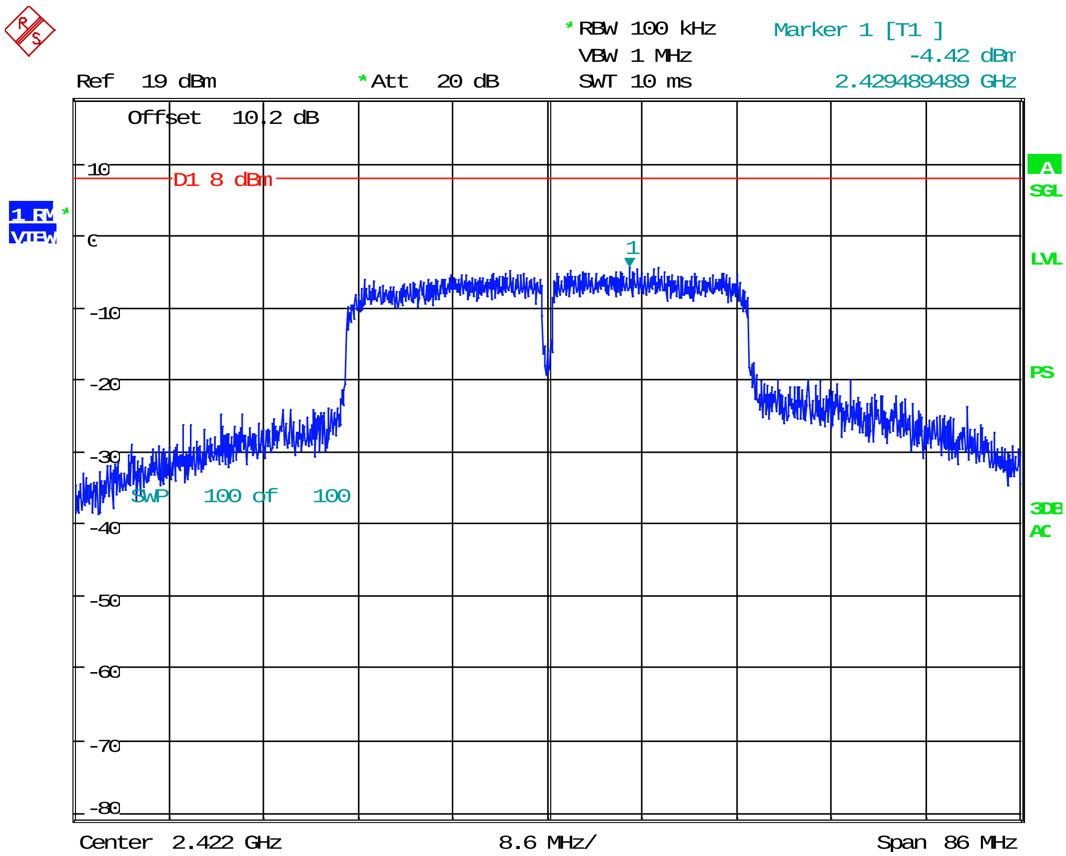
WiFi 802.11 n HT20 PSD Plot, 2462 MHz



Date: 28.FEB.2019 15:58:52

POWER SPECTRAL DENSITY

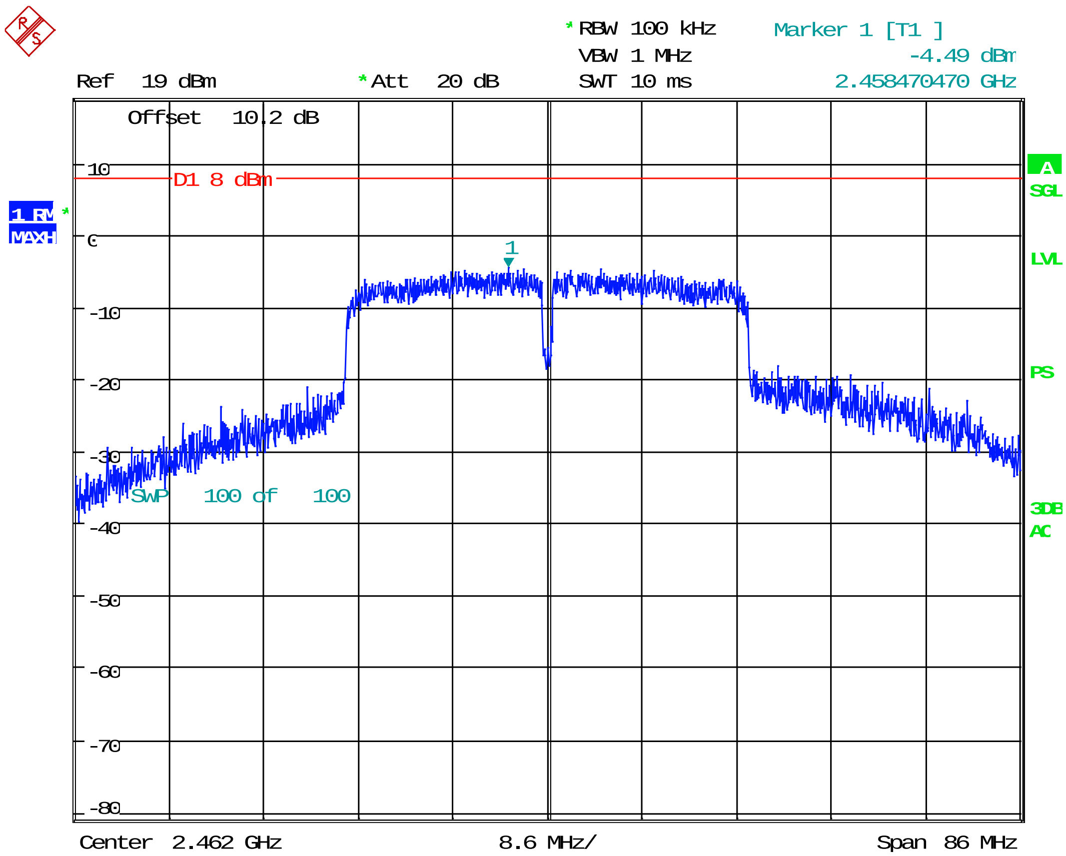
WiFi 802.11 n HT40 PSD Plot, 2422 MHz



Date: 28.FEB.2019 16:01:38

POWER SPECTRAL DENSITY

WiFi 802.11 n HT40 PSD Plot, 2462 MHz



Date: 28.FEB.2019 16:00:32

BANDEDGE EMISSIONS

Rule Part No.: FCC 15.247(d)

Requirements:

§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

(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)).

Test Method: KDB 558074 D01 15.247 Meas Guidance v05r01 8.7
ANSI C63.10 § 6.10.5 Restricted-band band-edge measurements

8.7 DTS band-edge emission measurements

8.7.1 General

When performing peak or average radiated measurements, emissions within 2 MHz of the authorized band edge may be measured using the marker-delta method described below. The integration method can be used when performing conducted or radiated average measurements.

8.7.2 Marker-delta method

The marker-delta method, as described in ANSI C63.10, can be used to perform measurements of the radiated unwanted emissions level at the band-edges provided that the 99 % OBW of the fundamental emission is within 2 MHz of the authorized band edge.

8.7.3 Integration method

Subclause 11.13.3 of ANSI C63.10 is applicable.

BANDEDGE EMISSIONS

6.10.5.2 Test methodology

The following test methodology shall be used for the restricted-band band-edge measurements:

a) For frequency-hopping systems, the hopping shall be turned OFF during this test.

b) Configure the spectrum analyzer settings as described in step e) (be sure to enter all losses between the unlicensed wireless device output and the spectrum analyzer).

c) Set the unlicensed wireless device to the lowest frequency channel.

d) Set the unlicensed wireless device to operate at maximum output power and 100% duty cycle, or equivalent "normal mode of operation" as specified in 6.10.3.

e) Perform the test as follows:

1) Span: Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.

2) Reference level offset: Corrected for gains and losses of test antenna factor, preamp gain and cable loss, so as to indicate field strength, in units of dBμV/m at 3 m, directly on the instrument display. Alternatively, the reference level offset may be set to zero and calculations shall be provided showing the conversion of raw measured data to the field strength in dBμV/m at 3 m.

3) Reference level: As required to keep the signal from exceeding the maximum spectrum analyzer input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.

4) Attenuation: Auto (at least 10 dB preferred).

5) Sweep time: Coupled.

BANDEDGE EMISSIONS

6) Resolution bandwidth:
   i) Below 150 kHz: 300 Hz or CISPR 200 Hz (CISPR 200 Hz required if using QP detector)
   ii) 150 kHz to 30 MHz: 10 kHz or CISPR 9 kHz, (CISPR 9 kHz required if using QP detector)
   iii) 30 MHz to 1000 MHz: 100 kHz or CISPR 120 kHz, (CISPR 120 kHz required if using QP detector)
   iv) Above 1 GHz: 1 MHz
7) Video bandwidth:
   i) VBW for Peak, Quasi-peak, or Average Detector Function: 3 × RBW
   ii) VBW for alternative average measurements using peak detector function; refer to 4.1.4.2.3
8) Detector (unless specified otherwise):
   i) QP below 1 GHz (however, peak detector measurements may be used to determine compliance with QP requirements).
   ii) Peak and average above 1 GHz
9) Trace: Max hold for final measurement; a combination of two traces, clear-write and max hold, is recommended for maximizing the emission.

f) Using the applicable procedure(s) of 6.4, 6.5, or 6.6, orient the EUT and measurement antenna positions to produce the highest emission level.

g) Set the marker on the emission at the restricted band edge, or on the highest modulation product within the restricted band, if this level is greater than that at the band edge.

h) Repeat step d) through step g) for every applicable modulation.

i) Repeat step d) through step h) for the highest gain of each type of antenna to be used with the EUT.

j) Set the EUT to the highest frequency channel and repeat step d) through step i).

k) The band-edge measurement shall be reported by providing plot(s) of the measuring instrument display; the axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

BANDEDGE EMISSIONS

6.10.6 Marker-delta method

6.10.6.1 General requirements

In making radiated band-edge measurements, there can be a problem obtaining meaningful data because a measurement instrument that is tuned to a band-edge frequency might also capture some in-band signals when using the specified RBW. In an effort to compensate for this problem, the following technique has been developed for determining band-edge compliance.

This method may be used only when the edge of the occupied bandwidth of the emission falls within two "standard bandwidths" of the restricted-band band-edge frequency, where "standard bandwidth" is the RBW required by the measurement procedure (generally, the "standard bandwidth," i.e., reference bandwidth, is 10 kHz for measurements below 30 MHz, 100 kHz for measurements between 30 MHz and 1000 MHz, and 1 MHz for measurements above 1 GHz). For this purpose, the occupied bandwidth is based on the 99% power bandwidth. Detailed explanations and examples of these constraints are given subsequently.

For example, for band-edge measurements in the restricted band that begins at 2483.5 MHz, a measurement bandwidth of 1 MHz is required. Therefore the "delta" technique may be used if the upper frequency edge of the occupied bandwidth of the fundamental emission is greater than or equal to 2481.5 MHz (2 MHz removed from the band edge). If the upper frequency edge of the occupied bandwidth is less than 2481.5 MHz, then radiated emissions within the restricted band shall be measured in the conventional manner. The report shall include photographs or plots of the measuring instrument display, with the lower and/or upper frequency limit(s), as applicable, clearly labeled.

Additionally this method may be used only when the emission being measured falls within two "standard bandwidths" of the restricted band band-edge frequency. For example, for band-edge measurements in the restricted band that begins at 2483.5 MHz, a measurement bandwidth of 1 MHz is required. Therefore the "delta" technique may be used if the restricted-band emission is between 2483.5 MHz and 2485.5 MHz. If the restricted-band emission is at a frequency greater than 2485.5 MHz, then radiated emissions within the restricted band shall be measured in the conventional manner.

BANDEDGE EMISSIONS

6.10.6.2 Marker-delta procedure

The following procedure shall be used for the marker-delta method:

a) Perform an in-band field strength measurement of the fundamental emission using the RBW and detector function required for the frequency being measured. For example, for a device operating in the 902 MHz to 928 MHz band,[56] use a 120 kHz RBW with a CISPR QP detector (a peak detector with 100 kHz RBW alternatively may be used). For transmitters operating above 1 GHz, use a 1 MHz RBW, a 3 MHz VBW, and a peak detector, as required.[58] Repeat the measurement with an average detector (or alternatively, a peak detector and reduced VBW). For pulsed emissions, other factors shall be included; see 4.1.4.2.6.

b) Choose an EMI receiver or spectrum analyzer span that encompasses both the peak of the fundamental emission and the band-edge emission under investigation. Set the instrument RBW to 1% of the total span (but never less than 30 kHz), with a VBW equal to or greater than three times the RBW. Record the peak levels of the fundamental emission and the relevant band-edge emission (i.e., run several sweeps in peak hold mode). Observe the stored trace and measure the amplitude delta between the peak of the fundamental and the peak of the band-edge emission. This is not an absolute field strength measurement; it is only a relative measurement to determine the amount by which the emission drops at the band edge relative to the highest fundamental emission level.

c) Subtract the delta measured in step b) from the field strengths measured in step a). The resulting field strengths (CISPR QP, average, or peak, as appropriate) are then used to determine band-edge emissions compliance, where required.[59]

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[57] Conducted testing may be an acceptable alternative to radiated testing for devices operating under certain regulatory requirements: examples include 47 CFR 15.247 and 47 CFR 15.407, as well as Annex 8 and Annex 9 of IC RSS-210. See FCC/KDB-789033 [B28] and FCC/KDB-558074 [B26].

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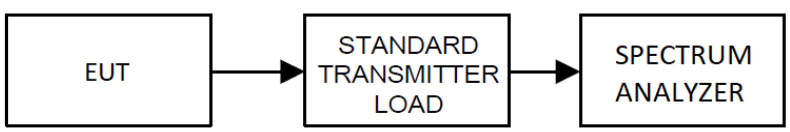
[58] See 47 CFR 15.35.
[59] See 47 CFR 15.205 or RSS-Gen.

Test Setup:

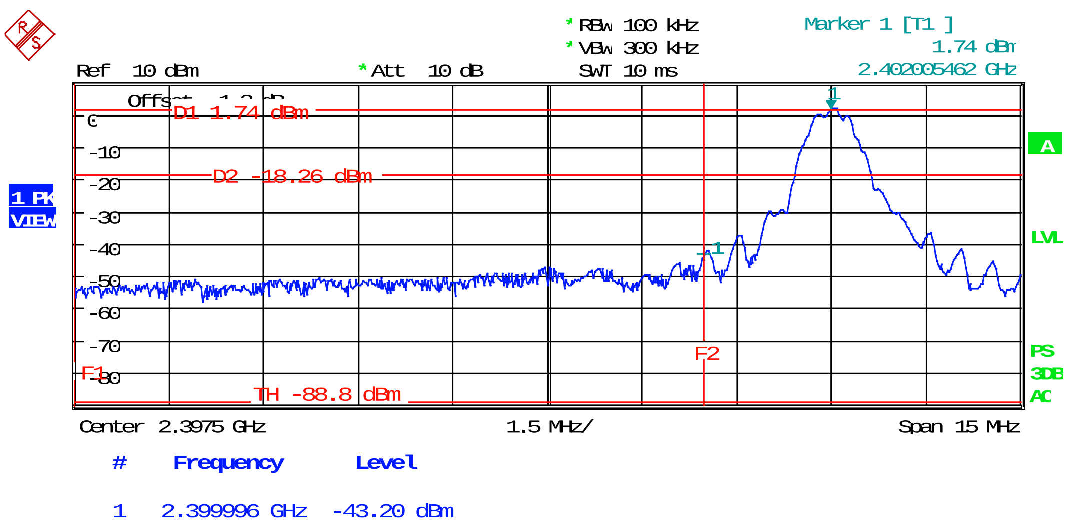


BANDEDGE EMISSIONS

BLE Upper Band Edge Table, Marker Delta Method

Measurement Detector	Antenna Polarization	Field Strength of Carrier (dBuV/m)	UBE Emission Level (dBc)	Field Strength of Emission (dBuV/m)	Emission Limit (dBuV/m)	Margin (dB)
PK	H	52.30	46.09	6.21	74.00	67.79
AV	H	38.80	46.09	-7.29	54.00	61.29

BLE Lower Band Edge Plot, Conducted Method



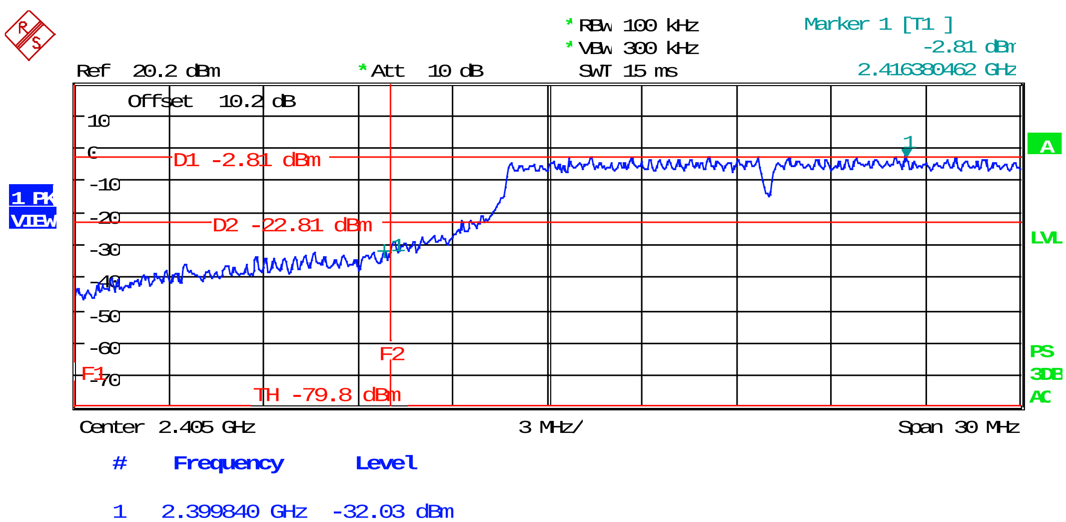
BANDEDGE EMISSIONS

WiFi 802.11 n HT20 Upper Band Edge Table, Integrated Method

Measurement Detector	Antenna Polarization	Field Strength of Carrier (dBuV/m)	UBE Emission Level (dBc)	Field Strength of Emission (dBuV/m)	Emission Limit (dBuV/m)	Margin (dB)
PK	H	104.36	43.95	60.41	74.00	13.59
AV	H	94.87	43.95	50.92	54.00	3.08

Note: 802.11 n HT20 was selected as the worst-case emission from among the 20 MHz WiFi channels

WiFi 802.11 n HT20 Lower Band Edge Plot, Conducted Method



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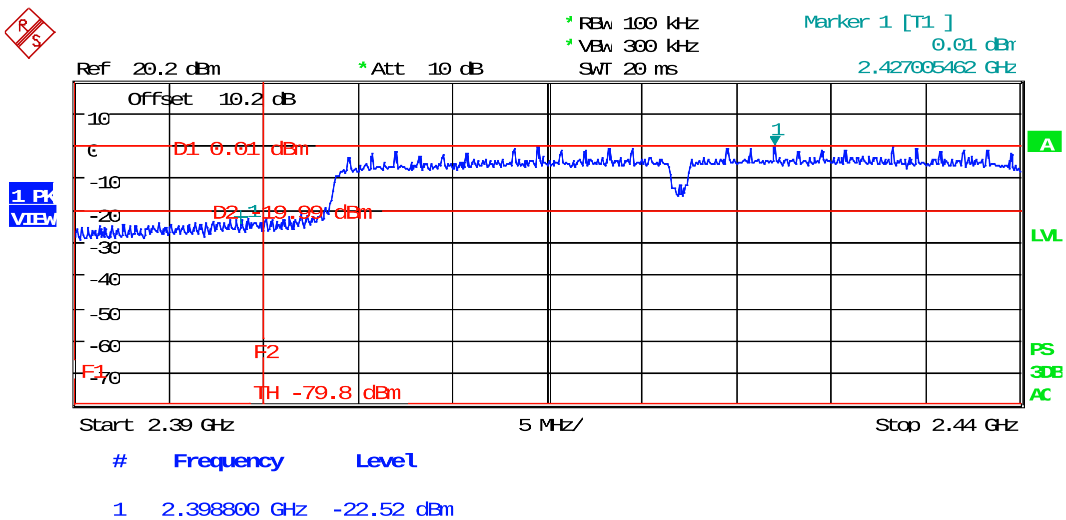
BANDEDGE EMISSIONS

WiFi 802.11 n HT40 Upper Band Edge Table, Integrated Method

Measurement Detector	Antenna Polarization	Field Strength of Carrier (dBuV/m)	UBE Emission Level (dBc)	Field Strength of Emission (dBuV/m)	Emission Limit (dBuV/m)	Margin (dB)
PK	H	100.67	38.77	61.90	74.00	12.10
AV	H	91.07	38.77	52.30	54.00	1.70

WiFi 802.11 n HT40 Lower Band Edge Plot, Conducted Method



Date: 28.FEB.2019 12:47:32

RADIATED SPURIOUS EMISSIONS

RULE PART NO.: FCC part 15.247(d), 15.205, 15.209

Requirements:

§15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

(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)).

§15.205 Restricted bands of operation.

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	([2])
13.36-13.41			

RADIATED SPURIOUS EMISSIONS

§15.209 Radiated emission limits; general requirements.

(a) Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency (MHz)	Limit (µV/m)	Limit (dBµV/m)
0.009 – 0.490	2400/F(in kHz) @ 300m	-
0.490 – 1.705	24000/F(in kHz) @ 30m	-
1.705 kHz – 30	30.0 @ 30 m	29.54 @ 30m
30 – 88	100.0	40.0
88 – 216	150.0	43.5
216 – 960	200.0	46.0
Above 960	500.0	54.0

§15.35 Measurement detector functions and bandwidths.

(b) 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. When average radiated emission measurements are specified in this part, including average emission measurements below 1000 MHz, there also is a limit on the peak level of the radio frequency emissions. Unless otherwise specified, *e.g.*, see §§15.250, 15.252, 15.253(d), 15.255, 15.256, and 15.509 through 15.519, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device, *e.g.*, the total peak power level. Note that the use of a pulse desensitization correction factor may be needed to determine the total peak emission level. The instruction manual or application note for the measurement instrument should be consulted for determining pulse desensitization factors, as necessary.

RADIATED SPURIOUS EMISSIONS

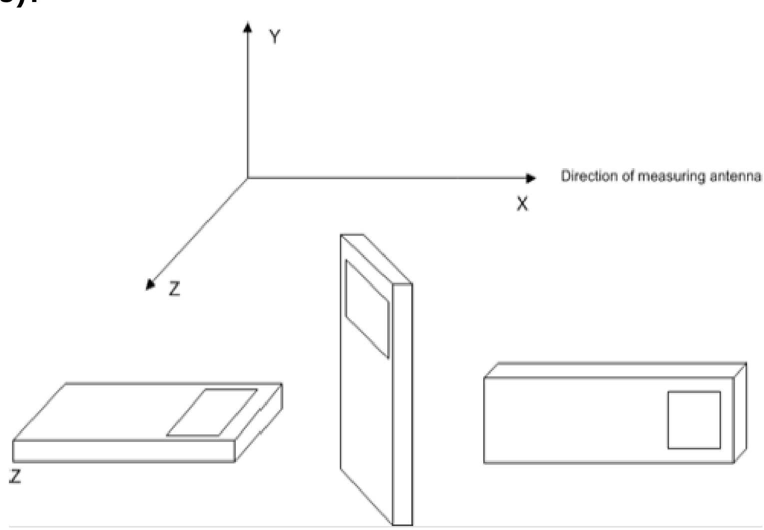
Test Procedure: ANSI C63.4 § Annex D Validation of radiated emissions standard test sites
ANSI C63.10 § 6.3 Common requirements radiated emissions
ANSI C63.10 § 6.5 Emissions between 30 & 1000 MHz
ANSI C63.10 § 6.6 Emissions above 1 GHz

Radiated Emissions Test Setup:

EUT setup and arrangement was completed as described in ANSI C63.4. Exploratory measurements were taken following different peripheral placement and cable manipulations as described in ANSI C63.4. A photo is provided of the Test setup to record the exact peripheral equipment and cable manipulation arrangement found to produce the highest possible level of radiated emissions.
The test procedure used for radiated emissions is described ANSI C63.4 using a spectrum analyzer. The resolution bandwidth used was 100 kHz with an appropriate sweep speed. The analyzer was calibrated in dB above a microvolt at the output of the antenna. All cable loss and antenna factors were calibrated to provide plots with correction factors applied to results using the formula and example described below. The video bandwidth of the analyzer was always greater than or equal to the resolution bandwidth, and a peak detector with max hold was used.

The unit under test was placed on a table 80 cm high and with dimensions of 1m by 1.5m. The table used for radiated measurements is capable of continuous rotation. When an emission was found, the table was rotated to produce the maximum signal strength. At this point, the antenna was raised and lowered from 1m to 4m. The antenna was placed in both the horizontal and verticals planes. The frequency was scanned from 30 MHz to 1.0 GHz. The EUT was measured in three parts of the tunable band of EUT and (3) orthogonal planes when necessary.

EUT Orientation(s):



RADIATED SPURIOUS EMISSIONS

Formula of Conversion Factors:

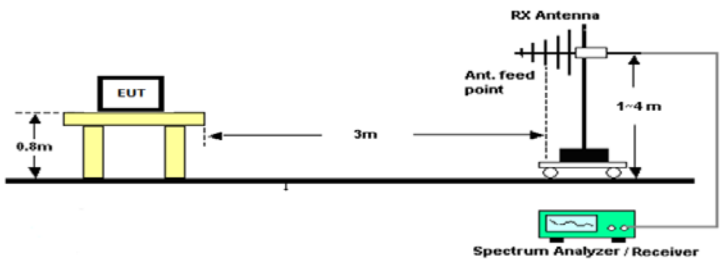
The field strength at 3m was established by adding the meter reading of the spectrum analyzer (which is set to read in units of dBµV) to the antenna correction factor supplied by the antenna manufacturer plus the coax loss. The antenna correction factors are stated in terms of dB. The gain of the preselector was accounted for in the spectrum analyzer meter reading.

Field Strength Correction Factor Conversion Example:

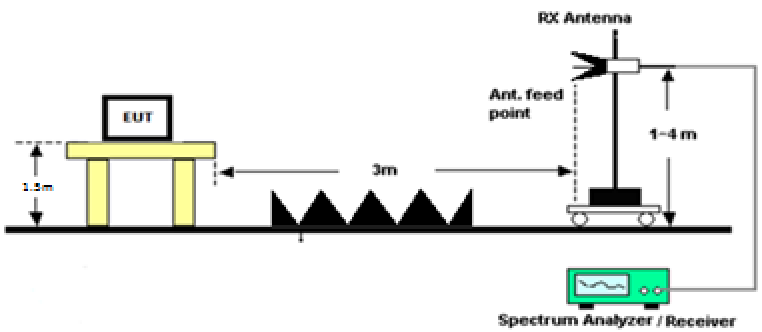
Freq (MHz)	Meter Reading	+ ACF	+CL	= FS
33	20 dBµV	+ 10.36 dB/m	+0.40 dB	=30.76 dBµV/m @ 3m

Test Setup:

Emissions 30 – 1000 MHz



Emissions above 1 GHz



RADIATED SPURIOUS EMISSIONS

Notes: The spectrum was measured from 9 KHz to 25 GHz. Six or more of the Spurious Emissions equal to or less than 20 dB from the limits are required to be reported, from the worst case orientation and worst case mode of operation.

Red Highlighted Emission Frequencies indicate Restricted Bands, per 15.205. The measurement of restricted bands were taken using an average detector, and shown to comply with the limit of 15.209; then using a peak detector, and shown to comply with the average limit of 15.209 + 20 dB (per 15.35(b)).

For all other emissions (in non-restricted bands) they are shown to comply with the limit of 15.247(d), 20 dBc in the case of power output established using Peak, and 30 dBc when power output was established using average.

Field Strength of the Fundamental

Mode of Operation	Tuned Frequency (MHz)	Emission Frequency (MHz)	Meter Reading (dBµV)	Measurement Detector	Antenna Polarity	Coax Loss (dB)	Correction Factor (dB/m)	Field Strength (dBµV/m)	15.247(d) Limit (dBc)	Calculated 15.247(d) Limit (dBµV/m)
BLE	2480.00	2480.00	52.30	PK	H	5.62	32.10	90.02	20.00	70.02
WiFi 802.11 n HT20	2462.00	2462.00	66.80	PK	H	5.62	31.94	104.36	20.00	84.36
WiFi 802.11 n HT40	2462.10	2462.20	63.10	PK	H	5.62	31.95	100.67	20.00	80.67

RADIATED SPURIOUS EMISSIONS

BLE Field Strength table

Mode of Operation	Tuned Frequency (MHz)	Emission Frequency (MHz)	Meter Reading (dBµV)	Measurement Detector	Antenna Polarity	Coax Loss (dB)	Correction Factor (dB/m)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
BLE	2402.00	4804.00	19.32	PK	H	7.08	33.93	60.33	74.00	13.67
BLE	2402.00	19216.10	-21.20	AV	H	16.00	44.73	39.53	54.00	14.47
BLE	2402.00	19216.10	-21.20	AV	V	16.00	44.73	39.53	54.00	14.47
BLE	2402.00	7206.00	5.33	PK	H	9.47	36.39	51.19	70.02	18.83
BLE	2402.00	7206.00	5.25	PK	V	9.47	36.39	51.11	70.02	18.91
BLE	2402.00	185.02	36.00	PK	H	1.58	13.50	51.08	70.02	18.94
BLE	2402.00	24020.00	-12.56	PK	H	17.93	45.25	50.62	70.02	19.40
BLE	2402.00	24020.00	-12.92	PK	V	17.93	45.25	50.26	70.02	19.76
BLE	2402.00	21618.00	-11.24	PK	V	16.90	44.29	49.95	70.02	20.07
BLE	2402.00	12010.10	-18.20	AV	H	12.45	39.08	33.33	54.00	20.67
BLE	2402.00	12010.10	-18.20	AV	V	12.45	39.08	33.33	54.00	20.67
BLE	2440.00	19520.10	-20.80	AV	H	15.78	44.71	39.69	54.00	14.31
BLE	2440.00	19520.10	-21.30	AV	V	15.78	44.71	39.19	54.00	14.81
BLE	2440.00	4880.00	15.20	PK	V	7.29	33.93	56.42	74.00	17.58
BLE	2440.00	7320.10	-11.50	AV	H	9.47	36.24	34.21	54.00	19.79
BLE	2440.00	7320.10	-11.70	AV	V	9.47	36.24	34.01	54.00	19.99
BLE	2440.00	17080.00	-7.54	PK	V	14.79	42.43	49.68	70.02	20.34
BLE	2440.00	12200.10	-18.20	AV	V	12.35	39.23	33.38	54.00	20.62
BLE	2440.00	4880.10	-7.90	AV	V	7.29	33.93	33.32	54.00	20.68
BLE	2440.00	12200.10	-18.30	AV	H	12.35	39.23	33.28	54.00	20.72
BLE	2480.00	22320.10	-21.20	AV	H	16.79	44.79	40.38	54.00	13.62
BLE	2480.00	22320.10	-21.40	AV	V	16.79	44.79	40.18	54.00	13.82
BLE	2480.00	19840.10	-21.60	AV	H	16.21	44.49	39.10	54.00	14.90
BLE	2480.00	19840.10	-21.70	AV	V	16.21	44.49	39.00	54.00	15.00
BLE	2480.00	185.02	37.20	PK	H	1.58	13.50	52.28	70.02	17.74
BLE	2480.00	17360.00	-5.23	PK	H	14.97	42.52	52.26	70.02	17.76
BLE	2480.00	4960.00	14.60	PK	V	7.49	33.96	56.05	74.00	17.95
BLE	2480.00	7440.10	-12.00	AV	V	9.56	36.01	33.57	54.00	20.43
BLE	2480.00	7440.10	-12.10	AV	H	9.56	36.01	33.47	54.00	20.53
BLE	2480.00	4960.00	11.80	PK	H	7.49	33.96	53.25	74.00	20.75
BLE	2480.00	17360.00	-8.22	PK	V	14.97	42.52	49.27	70.02	20.75
BLE	2480.00	12400.10	-18.60	AV	H	12.42	39.23	33.05	54.00	20.95

RADIATED SPURIOUS EMISSIONS

WiFi 802.11 n HT20 Field Strength table

Mode of Operation	Tuned Frequency (MHz)	Emission Frequency (MHz)	Meter Reading (dBµV)	Measurement Detector	Antenna Polarity	Coax Loss (dB)	Correction Factor (dB/m)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
Wifi 802.11 n HT20	2412.00	271.79	28.52	AV	H	2.07	13.88	34.64	46.02	11.38
WiFi 802.11 n HT20	2412.00	19296.10	-20.30	AV	V	15.88	44.73	40.31	54.00	13.69
WiFi 802.11 n HT20	2412.00	19296.10	-20.30	AV	H	15.88	44.73	40.31	54.00	13.69
WiFi 802.11 n HT20	2412.00	4824.10	-3.40	AV	V	7.14	33.94	37.68	54.00	16.32
Wifi 802.11 n HT20	2412.00	271.79	22.85	AV	V	2.07	13.88	28.96	46.02	17.06
WiFi 802.11 n HT20	2412.00	4824.10	-5.50	AV	H	7.14	33.94	35.58	54.00	18.42
WiFi 802.11 n HT20	2412.00	12060.00	2.90	PK	V	12.37	39.12	54.39	74.00	19.61
WiFi 802.11 n HT20	2412.00	12060.10	-18.10	AV	H	12.37	39.12	33.39	54.00	20.61
WiFi 802.11 n HT20	2412.00	12060.10	-18.20	AV	V	12.37	39.12	33.29	54.00	20.71
WiFi 802.11 n HT20	2442.00	19536.10	-21.60	AV	H	15.80	44.70	38.90	54.00	15.10
WiFi 802.11 n HT20	2442.00	19536.10	-21.60	AV	V	15.80	44.70	38.90	54.00	15.10
WiFi 802.11 n HT20	2442.00	4884.10	-5.10	AV	V	7.30	33.92	36.12	54.00	17.88
WiFi 802.11 n HT20	2442.00	4884.10	-6.00	AV	H	7.30	33.92	35.22	54.00	18.78
WiFi 802.11 n HT20	2442.00	12210.10	-18.30	AV	H	12.35	39.24	33.29	54.00	20.71
WiFi 802.11 n HT20	2442.00	12210.10	-18.30	AV	V	12.35	39.24	33.29	54.00	20.71
WiFi 802.11 n HT20	2462.00	22158.10	-21.30	AV	V	17.14	44.67	40.51	54.00	13.49
WiFi 802.11 n HT20	2462.00	22158.10	-21.30	AV	H	17.14	44.67	40.51	54.00	13.49
WiFi 802.11 n HT20	2462.00	19696.10	-20.80	AV	V	16.13	44.60	39.93	54.00	14.07
WiFi 802.11 n HT20	2462.00	19696.10	-20.80	AV	H	16.13	44.60	39.93	54.00	14.07
WiFi 802.11 n HT20	2462.00	4924.10	-3.30	AV	V	7.40	33.93	38.03	54.00	15.97
WiFi 802.11 n HT20	2462.00	4924.10	-5.80	AV	H	7.40	33.93	35.53	54.00	18.47
WiFi 802.11 n HT20	2462.00	12310.10	-18.50	AV	V	12.42	39.26	33.18	54.00	20.82
WiFi 802.11 n HT20	2462.00	12310.10	-18.60	AV	H	12.42	39.26	33.08	54.00	20.92

WiFi 802.11 n HT40 Field Strength table

Mode of Operation	Tuned Frequency (MHz)	Emission Frequency (MHz)	Meter Reading (dBµV)	Measurement Detector	Antenna Polarity	Coax Loss (dB)	Correction Factor (dB/m)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
WiFi 802.11 n HT40	2422.00	19376.10	-21.40	AV	V	15.49	44.72	38.81	54.00	15.19
WiFi 802.11 n HT40	2422.00	19376.10	-21.40	AV	H	15.49	44.72	38.81	54.00	15.19
WiFi 802.11 n HT40	2462.10	22158.10	-13.02	AV	H	17.14	44.67	48.79	54.00	5.21
WiFi 802.11 n HT40	2462.10	22158.10	-21.40	AV	H	17.14	44.67	40.41	54.00	13.59
WiFi 802.11 n HT40	2462.10	19696.10	-20.90	AV	H	16.13	44.60	39.83	54.00	14.17
WiFi 802.11 n HT40	2462.10	19696.10	-20.90	AV	V	16.13	44.60	39.83	54.00	14.17
WiFi 802.11 n HT40	2462.10	4924.10	-5.80	AV	H	7.40	33.93	35.53	54.00	18.47
WiFi 802.11 n HT40	2462.10	4924.10	-6.00	AV	V	7.40	33.93	35.33	54.00	18.67
Wifi 802.11 n HT40	2462.00	273.07	21.28	AV	V	2.06	14.01	26.38	46.02	19.64
WiFi 802.11 n HT40	2462.10	22158.00	-8.20	PK	H	17.14	44.67	53.61	74.00	20.39
WiFi 802.11 n HT40	2462.10	12310.10	-18.60	AV	H	12.42	39.26	33.08	54.00	20.92

TEST EQUIPMENT LIST

Device	Manufacturer	Model	Serial Number	Cal/Char Date	Due Date
CHAMBER	Panashield	3M	N/A	12/31/17	12/31/19
Antenna: Active Loop	ETS-Lindgren	6502	00062529	12/11/17	12/11/19
Antenna: Biconical 1057	Eaton	94455-1	1057	12/13/17	12/13/19
Antenna: Log-Periodic 1122	Electro-Metrics	LPA-25	1122	07/26/17	07/26/19
Antenna: Double-Ridged Horn/ETS Horn 1	ETS-Lindgren	3117	00035923	01/30/17	01/30/20
Antenna: Double-Ridged Horn 18-40 GHz	EMCO	3116	9011-2145	12/08/17	12/08/19
Coaxial Cable - Chamber 3 cable set (backup)	Micro-Coax	Chamber 3 cable set (backup)	KMKM-0244-02 KMKM-0670-01 KFKF-0197-00	02/27/19	02/27/21
Chamber Pre-amplifier	RF-LAMBDA	RLNA00M45GA	NA	02/27/19	02/27/21
Software: Field Strength Program	Timco	N/A	Version 4.10.7.0	N/A	N/A
EMI Test Receiver R & S ESU 40	Rohde & Schwarz	ESU 40	100320	08/28/18	08/28/20
Comb Generator	Com-Power Corp	CGO-515	291728	NA	NA
12 Volt Power Supply	Astron	RS-12A	9312779	NA	NA
Attenuator SMA 30dB 5W DC-18G	Pasternack	PE7013-30	#23	11/19/17	11/19/19
Attenuator SMA 3dB 5W DC-18G	Pasternack	PE7013-3	#20	11/19/17	11/19/19
Attenuator SMA 6dB 10W DC-18G	Pasternack	PE7016-6	#22	11/19/17	11/19/19
Coaxial Cable #102 - KMKM-0180-00 Aqua	Micro-Coax	UFB142A-0-0720-200200	225363-001 (#102)	As Used	03/06/21

*EMI RECEIVER SOFTWARE VERSION

The receiver firmware used was version 4.43 Service Pack 3

END OF REPORT