

EMC Test Report

Application for FCC Grant of Equipment Authorization Canada Certification

Innovation, Science and Economic Development Canada RSS-Gen Issue 4 / RSS-247 Issue 2 FCC Part 15 Subpart C

Model: Botvac D7 Connected

IC CERTIFICATION #: 12757A-LVJPJ
FCC ID: 2ABSSLVJPJ

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TEST SITE(S): National Technical Systems - Silicon Valley
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IC SITE REGISTRATION #: 2845B-4

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SCOPE

An electromagnetic emissions test has been performed on the Neato Robotics model Botvac D7 Connected, pursuant to the following rules:

RSS-Gen Issue 4 “General Requirements for Compliance of Radio Apparatus”

RSS-247 Issue 2 “Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices”

FCC Part 15 Subpart C

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards and as outlined in National Technical Systems - Silicon Valley test procedures:

ANSI C63.10-2013

FCC DTS Measurement Guidance KDB558074 D01 v04

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant Industry Canada performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

National Technical Systems - Silicon Valley is accredited by the A2LA, certificate number 0214.26, to perform the test(s) listed in this report, except where noted otherwise.

OBJECTIVE

The primary objective of the manufacturer is compliance with the regulations outlined in the previous section.

Prior to marketing in the USA, all unlicensed transmitters and transceivers require certification. Receive-only devices operating between 30 MHz and 960 MHz are subject to either certification or a manufacturer’s declaration of conformity, with all other receive-only devices exempt from the technical requirements.

Prior to marketing in Canada, Class I transmitters, receivers and transceivers require certification. Class II devices are required to meet the appropriate technical requirements but are exempt from certification requirements.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

STATEMENT OF COMPLIANCE

The tested sample of Neato Robotics model Botvac D7 Connected complied with the requirements of the following regulations:

RSS-Gen Issue 4 "General Requirements for Compliance of Radio Apparatus"

RSS-247 Issue 2 "Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices"

FCC Part 15 Subpart C

Maintenance of compliance is the responsibility of the manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the device with respect to the standards detailed in this test report.

The test results recorded herein are based on a single type test of Neato Robotics model Botvac D7 Connected and therefore apply only to the tested sample. The sample was selected and prepared by Pawel Orzechowski of Neato Robotics.

DEVIATIONS FROM THE STANDARDS

No deviations were made from the published requirements listed in the scope of this report.

TEST RESULTS SUMMARY

DIGITAL TRANSMISSION SYSTEMS (2400 – 2483.5MHz)

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result
15.247(a)	RSS 247 5.2	Digital Modulation	Systems uses OFDM / DSSS techniques	System must utilize a digital transmission technology	Complies
15.247 (a) (2)	RSS 247 5.2 (1)	6 dB Bandwidth	b: 10.0 MHz g: 15.1 MHz n20: 15.1 MHz	> 500 kHz	Complies
15.247 (b) (3)	RSS 247 5.4 (4)	Output Power (multipoint systems)	b: 12.4 dBm g: 18.5 dBm n20: 18.4 dBm EIRP = 0.12 W ^{Note 1}	1 Watt, EIRP limited to 4 Watts.	Complies
15.247(e)	RSS 247 5.2 (2)	Power Spectral Density	b: -4.5 dBm/10 kHz g: -5.1 dBm/10 kHz n20: -4.7 dBm/10 kHz	8 dBm/3 kHz	Complies
15.247(d)	RSS 247 5.5	Antenna Port Spurious Emissions 30 MHz – 25 GHz	All emissions below the -20 dBc limit	< -20 dBc	Complies
15.247(d) / 15.209	RSS 247 5.5	Radiated Spurious Emissions 9 kHz – 25 GHz	53.2 dBμV/m @ 4824.0 MHz (-0.7 dB)	Refer to the limits section (p19) for restricted bands, all others < -20 dBc	Complies
Note 1: EIRP calculated using antenna gains of 2.1 dBi for the highest EIRP system.					

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part	RSS Rule part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203	-	RF Connector	Integral antenna	Unique or integral antenna required	Complies
15.407 (b) (6)	RSS-Gen Table 3	AC Conducted Emissions	43.7 dBμV @ 0.160 MHz (-21.7 dB)	Refer to page 18	Complies
15.247 (i) 15.407 (f)	RSS 102	RF Exposure Requirements	Refer to MPE calculations in separate exhibit, RSS 102 declaration and User Manual statements.	Refer to OET 65, FCC Part 1 and RSS 102	Complies
-	RSS-Gen 8.3	User Manual	Integral antenna	Statement for products with detachable antenna	Complies
-	RSS-Gen 8.4	User Manual	Refer to the user manual	Statement for all products	Complies
-	RSP-100 RSS-Gen 6.6	Occupied Bandwidth	b: 14.5 MHz g: 17.2 MHz n20: 18.3 MHz	Information only	N/A

MEASUREMENT UNCERTAINTIES

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level and were calculated in accordance with UKAS document LAB 34.

Measurement Type	Measurement Unit	Frequency Range	Expanded Uncertainty
RF power, conducted (power meter)	dBm	25 to 7000 MHz	± 0.52 dB
RF power, conducted (Spectrum analyzer)	dBm	25 to 7000 MHz	± 0.7 dB
Conducted emission of transmitter	dBm	25 to 26500 MHz	± 0.7 dB
Conducted emission of receiver	dBm	25 to 26500 MHz	± 0.7 dB
Radiated emission (substitution method)	dBm	25 to 26500 MHz	± 2.5 dB
Radiated emission (field strength)	dB μ V/m	25 to 1000 MHz	± 3.6 dB
		1000 to 40000 MHz	± 6.0 dB
Conducted Emissions (AC Power)	dB μ V	0.15 to 30 MHz	± 2.4 dB

EQUIPMENT UNDER TEST (EUT) DETAILS**GENERAL**

The Neato Robotics model Botvac D7 Connected is a Robotic Vacuum cleaner. It is a floor standing equipment. The EUT is positioned on the table, above the ground plane in order to get accurate measurement results and in conformance with ANSI C63.10-2013 requirement. The electrical rating of the EUT is 100-240 Volts, 50/60 Hz, 0.5 Amps.

The sample was received on September 25, 2017 and tested on September 25, 26 and 27 and October 5 and 9, 2017. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
Neato Robotics	Botvac D7 Connected	Robotic Vacuum cleaner	WTD14514-C4EDBA8605A9	FCC ID: 2ABSSLVJPJ IC: 12757A-LVJPJ
Neato Robotics	DELTA Power Charger	Battery Charger	-	-

OTHER EUT DETAILS

The highest internal source of an EUT is defined as the highest frequency generated or used within the EUT or on which the EUT operates or tunes. In some cases, the highest internal source determines the frequency range of test for radiated emissions. The highest internal source of the EUT was declared as: 500 MHz

ANTENNA SYSTEM

Internal antenna (chip) with maximum 2.1 dBi gain at 2.4 GHz operating range.

ENCLOSURE

The EUT enclosure is primarily constructed of plastic. It measures approximately 34 cm wide by 32 cm deep by 8 cm high.

MODIFICATIONS

No modifications were made to the EUT during the time the product was at NTS Silicon Valley.

SUPPORT EQUIPMENT

No local support equipment was used during testing.

The following equipment was used as remote support equipment for emissions testing:

Company	Model	Description	Serial Number	FCC ID
DELL	Latitude	Laptop	-	-

Note: The computer was used to configure the EUT for radio testing. It was not connected to the EUT during the radiated emission tests.

EUT INTERFACE PORTS

The I/O cabling configuration during testing was as follows:

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
None	-	-	-	-

EUT OPERATION

During emissions testing the EUT was transmitting in a rated power and modulation specified in the test cases.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken at the test sites listed below. Pursuant to section 2.948 of the FCC's Rules and section 3.3 of RSP-100, construction, calibration, and equipment data has been filed with the Commission and with industry Canada.

Site	Designation / Registration Numbers		Location
	FCC	Canada	
Chamber 4	US0027	2845B-4	41039 Boyce Road Fremont, CA 94538-2435

ANSI C63.4-2014 recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement. The test site(s) contain separate areas for radiated and conducted emissions testing. The results from testing performed in this chamber have been correlated with results from an open area test site. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements of ANSI C63.4-2014.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.10-2013. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment or in a semi-anechoic chamber. The test sites are maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4-2014 guidelines and meet the Normalized Site Attenuation (NSA) requirements of ANSI C63.4-2014.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements. If the repetition frequency of the signal being measured is below 20 Hz, peak measurements are made in lieu of Quasi-Peak measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000 MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz, unless the signal is pulsed in which case the average (or video) bandwidth of the measuring instrument is reduced to onset of pulse desensitization and then increased.

INSTRUMENT CONTROL COMPUTER

Software is used to view and convert receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers. The software used for radiated and conducted emissions measurements is NTS EMI Test Software (rev 2.10)

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a 50 μ H Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 μ H CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A loop antenna is used below 30 MHz. For the measurement range 30 MHz to 1000 MHz either a combination of a biconical antenna and a log periodic or a bi-log antenna is used. Above 1000 MHz, horn antennas are used. The antenna calibration factors to convert the received voltage to an electric field strength are included with appropriate cable loss and amplifier gain factors to determine an overall site factor, which is then programmed into the test receivers or incorporated into the test software.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height. Measurements below 30 MHz are made with the loop antenna at a fixed height of 1m above the ground plane.

ANSI C63.10-2013 specifies that the test height above ground for table mounted devices shall be 80 centimeters for testing below 1 GHz and 1.5 m for testing above 1 GHz.

During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The regulations require that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.10-2013, and the worst-case orientation is used for final measurements.

CONDUCTED EMISSIONS

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord.

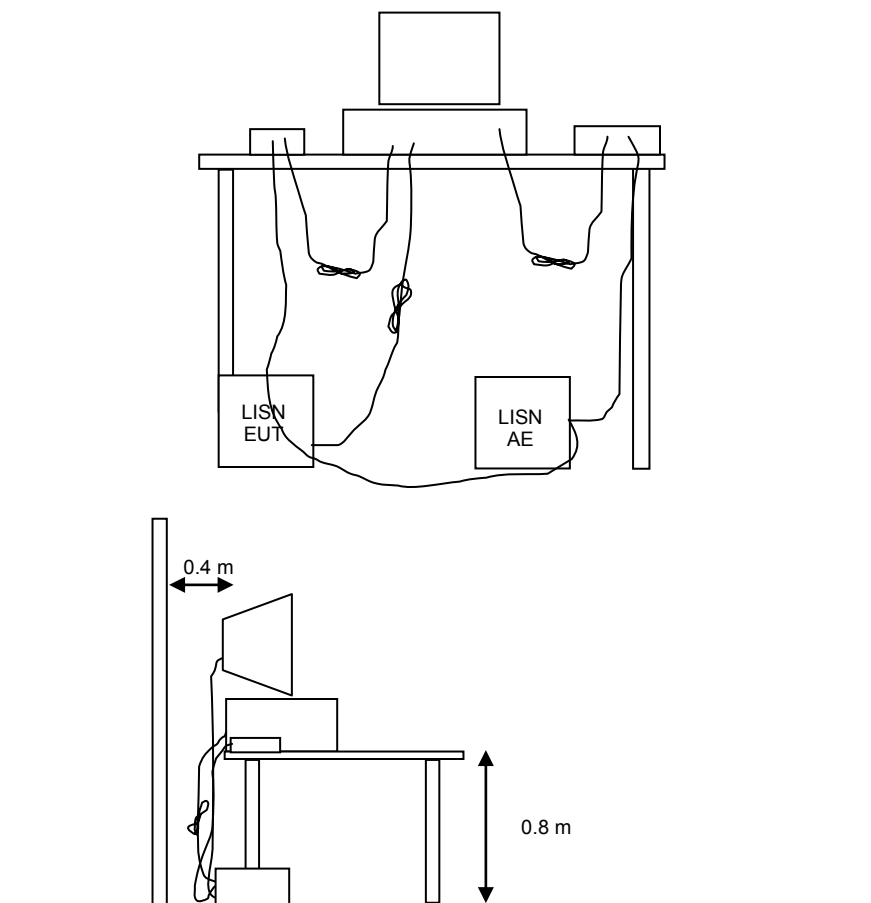


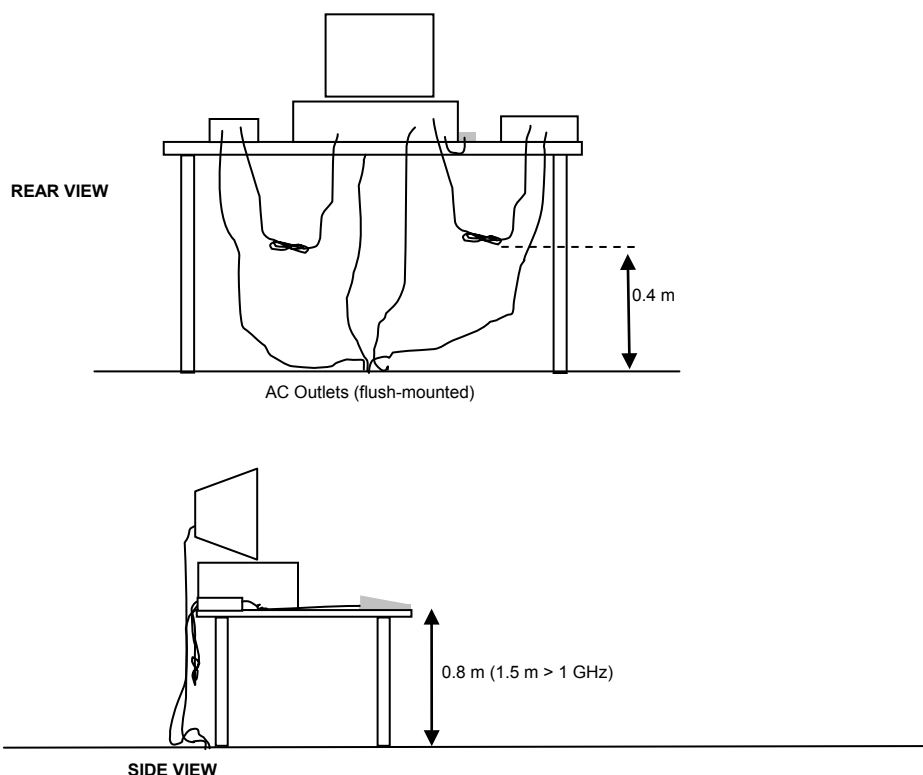
Figure 1 Typical Conducted Emissions Test Configuration

RADIATED EMISSIONS

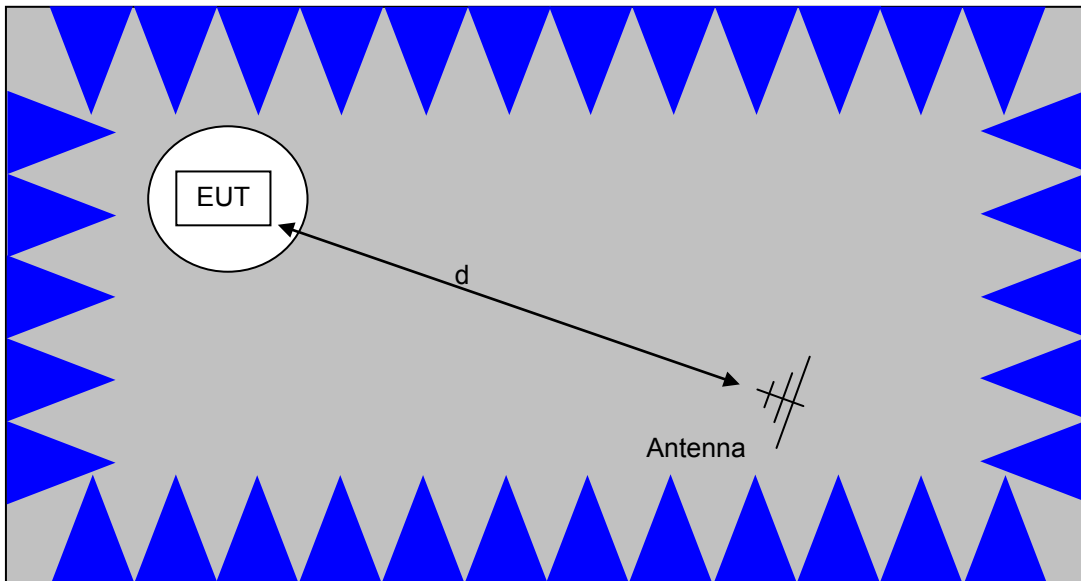
A preliminary scan of the radiated emissions is performed in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed, one scan for each antenna polarization (horizontal and vertical; loop parallel and perpendicular to the EUT). During the preliminary scans, the EUT is rotated through 360°, the antenna height is varied (for measurements above 30 MHz) and cable positions are varied to determine the highest emission relative to the limit. Preliminary scans may be performed in a fully anechoic chamber for the purposes of identifying the frequencies of the highest emissions from the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth, which results in the highest emission is then maintained while varying the antenna height from one to four meters (for measurements above 30 MHz, measurements below 30 MHz are made with the loop antenna at a fixed height of 1m). The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain.

When testing above 18 GHz, the receive antenna is located at 1 meter from the EUT and the antenna height is restricted to a maximum of 2.5 meters.

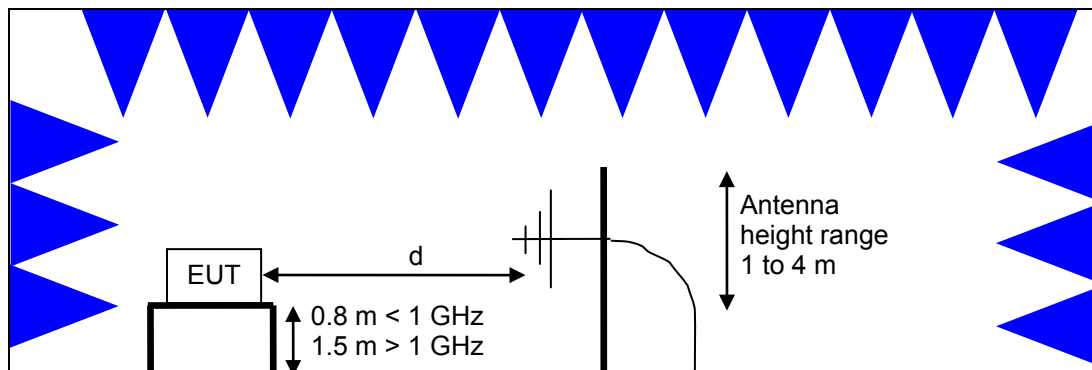


Typical Test Configuration for Radiated Field Strength Measurements



The anechoic materials on the walls and ceiling ensure compliance with the normalized site attenuation requirements of CISPR 16 / CISPR 22 / ANSI C63.4 for an alternate test site at the measurement distances used.

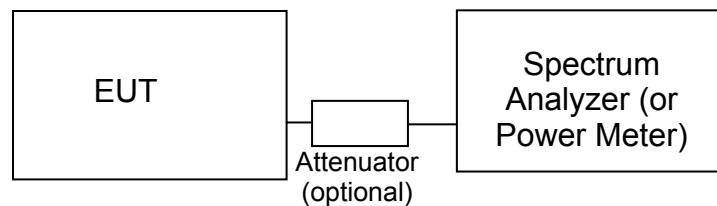
Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



Test Configuration for Radiated Field Strength Measurements
Semi-Anechoic Chamber, Plan and Side Views

CONDUCTED EMISSIONS FROM ANTENNA PORT

Direct measurements of power, bandwidth and power spectral density are performed, where possible, with the antenna port of the EUT connected to either the power meter or spectrum analyzer via a suitable attenuator and/or filter. These are used to ensure that the front end of the measurement instrument is not overloaded by the fundamental transmission.

Test Configuration for Antenna Port Measurements

Measurement bandwidths (video and resolution) are set in accordance with the relevant standards and NTS Silicon Valley's test procedures for the type of radio being tested. When power measurements are made using a resolution bandwidth less than the signal bandwidth the power is calculated by summing the power across the signal bandwidth using either the analyzer channel power function or by capturing the trace data and calculating the power using software. In both cases the summed power is corrected to account for the equivalent noise bandwidth (ENBW) of the resolution bandwidth used.

If power averaging is used (typically for certain digital modulation techniques), the EUT is configured to transmit continuously. Power averaging is performed using either the built-in function of the analyzer or, if the analyzer does not feature power averaging, using external software. In both cases the average power is calculated over a number of sweeps (typically 100). When the EUT cannot be configured to continuously transmit then either the analyzer is configured to perform a gated sweep to ensure that the power is averaged over periods that the device is transmitting or power averaging is disabled and a max-hold feature is used.

If a power meter is used to make output power measurements the sensor head type (peak or average) is stated in the test data table.

BANDWIDTH MEASUREMENTS

The 6 dB, 20 dB, 26 dB and/or 99% signal bandwidth are measured using the bandwidths recommended by ANSI C63.10-2014 and RSS-Gen Issue 4.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions are given in units of microvolts, and the limits for radiated emissions are given in units of microvolts per meter at a specified test distance. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dB μ V). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dB μ V/m). The results are then converted to the linear forms of μ V and μ V/m for comparison to published specifications.

For reference, converting the specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. These limits in both linear and logarithmic form are as follows:

CONDUCTED EMISSIONS SPECIFICATION LIMITS: FCC 15.207; FCC 15.107(a), RSS GEN

The table below shows the limits for the emissions on the AC power line from an intentional radiator and a receiver.

Frequency (MHz)	Average Limit (dB μ V)	Quasi Peak Limit (dB μ V)
0.150 to 0.500	Linear decrease on logarithmic frequency axis between 56.0 and 46.0	Linear decrease on logarithmic frequency axis between 66.0 and 56.0
0.500 to 5.000	46.0	56.0
5.000 to 30.000	50.0	60.0

GENERAL TRANSMITTER RADIATED EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from transmitters that fall in restricted bands¹.

Frequency Range (MHz)	Limit (μV/m)	Limit (dBμV/m @ 3m)
0.009-0.490	2400/F _{KHz} @ 300m	67.6-20*log ₁₀ (F _{KHz}) @ 300m
0.490-1.705	24000/F _{KHz} @ 30m	87.6-20*log ₁₀ (F _{KHz}) @ 30m
1.705 to 30	30 @ 30m	29.5 @ 30m
30 to 88	100 @ 3m	40 @ 3m
88 to 216	150 @ 3m	43.5 @ 3m
216 to 960	200 @ 3m	46.0 @ 3m
Above 960	500 @ 3m	54.0 @ 3m

¹ The restricted bands are detailed in FCC 15.205 and RSS-Gen Table 6

OUTPUT POWER LIMITS – DIGITAL TRANSMISSION SYSTEMS

The table below shows the limits for output power and output power density. Where the signal bandwidth is less than 20 MHz the maximum output power is reduced to the power spectral density limit plus 10 times the log of the bandwidth (in MHz).

Operating Frequency (MHz)	Output Power	Power Spectral Density
902 – 928	1 Watt (30 dBm)	8 dBm/3 kHz
2400 – 2483.5	1 Watt (30 dBm)	8 dBm/3 kHz
5725 – 5850	1 Watt (30 dBm)	8 dBm/3 kHz

The maximum permitted output power is reduced by 1 dB for every dB the antenna gain exceeds 6 dBi. Fixed point-to-point applications using the 5725 – 5850 MHz band are not subject to this restriction.

TRANSMIT MODE SPURIOUS RADIATED EMISSIONS LIMITS – FHSS and DTS SYSTEMS

The limits for unwanted (spurious) emissions from the transmitter falling in the restricted bands are those specified in the general limits sections of FCC Part 15 and RSS 210. All other unwanted (spurious) emissions shall be at least 20 dB below the level of the highest in-band signal level (30 dB if the power is measured using the sample detector/power averaging method).

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

Receiver readings are compared directly to the conducted emissions specification limit (decibel form) as follows:

$$R_r - S = M$$

where:

R_r = Receiver Reading in dB μ V

S = Specification Limit in dB μ V

M = Margin to Specification in +/- dB

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

A distance factor, when used for electric field measurements above 30MHz, is calculated by using the following formula:

$$F_d = 20 * \text{LOG}_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

For electric field measurements below 30MHz the extrapolation factor is either determined by making measurements at multiple distances or a theoretical value is calculated using the formula:

$$F_d = 40 * \text{LOG}_{10} (D_m/D_s)$$

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dB μ V/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dB μ V/m

L_s = Specification Limit in dB μ V/m

M = Margin in dB Relative to Spec

Appendix A Test Equipment Calibration Data

<u>Manufacturer</u>	<u>Description</u>	<u>Model</u>	<u>Asset #</u>	<u>Calibrated</u>	<u>Cal Due</u>
Radiated Band edge Measurement, 25-Sep-17					
EMCO	Antenna, Horn, 1-18 GHz	3115	786	12/21/2015	12/21/2017
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB 7	1756	7/8/2017	7/8/2018
Radiated Emissions, 1,000 - 25,000 MHz, 25-Sep-17					
EMCO	Antenna, Horn, 1-18 GHz	3115	786	12/21/2015	12/21/2017
Hewlett Packard	Spectrum Analyzer (SA40) Blue 9 kHz - 40 GHz	8564E (84125C)	1393	4/10/2017	4/10/2018
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	1683	5/17/2017	5/17/2018
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	8/31/2017	8/31/2018
A. H. Systems	Purple System Horn, 18-40GHz	SAS-574, p/n: 2581	2160	8/18/2017	8/18/2018
Radiated Emissions, 1,000 - 25,000 MHz, 26-Sep-17					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
EMCO	Antenna, Horn, 1-18 GHz	3115	786	12/21/2015	12/21/2017
Hewlett Packard	Spectrum Analyzer (SA40) Blue 9 kHz - 40 GHz	8564E (84125C)	1393	4/10/2017	4/10/2018
HP / Miteq	SA40 B Head HF preAmplifier, 18-40 GHz (w/1393)	TTA1840-45-5P-HG-S	1620	2/13/2017	2/13/2018
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	1683	5/17/2017	5/17/2018
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	8/31/2017	8/31/2018
A. H. Systems	Purple System Horn, 18-40GHz	SAS-574, p/n: 2581	2160	8/18/2017	8/18/2018
Radiated Emissions, 1,000 - 40,000 MHz, 26-Sep-17					
Hewlett Packard	High Pass filter, 8.2 GHz (Blu System)	P/N 84300-80039 (84125C)	1392	5/10/2017	5/10/2018
Micro-Tronics	Band Reject Filter, 5150-5350 MHz	BRC50703-02	2239	8/23/2017	8/23/2018
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
EMCO	Antenna, Horn, 1-18 GHz	3115	786	12/21/2015	12/21/2017
Hewlett Packard	Spectrum Analyzer (SA40) Blue 9 kHz - 40 GHz	8564E (84125C)	1393	4/10/2017	4/10/2018
HP / Miteq	SA40 B Head HF preAmplifier, 18-40 GHz (w/1393)	TTA1840-45-5P-HG-S	1620	2/13/2017	2/13/2018
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	1683	5/17/2017	5/17/2018
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	8/31/2017	8/31/2018
A. H. Systems	Purple System Horn, 18-40GHz	SAS-574, p/n: 2581	2160	8/18/2017	8/18/2018

<u>Manufacturer</u>	<u>Description</u>	<u>Model</u>	<u>Asset #</u>	<u>Calibrated</u>	<u>Cal Due</u>
Radiated Emissions, 30 - 1,000 MHz, 26-Sep-17					
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1548	10/12/2016	10/12/2018
Com-Power	Preamplifier, 30-1000 MHz	PA-103	1632	3/8/2017	3/8/2018
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB 7	1756	7/8/2017	7/8/2018
Radiated Emissions, 9kHz - 30 MHz, 26-Sep-17					
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB 7	1756	7/8/2017	7/8/2018
EMCO	Magnetic Loop Antenna, 9 kHz-30 MHz	AL-130	3003	8/9/2016	8/9/2018
Conducted Emissions - AC Power Ports, 26-Sep-17					
EMCO	LISN, 10 kHz-100 MHz	3825/2	1293	6/20/2017	6/20/2018
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	1594	8/18/2017	8/18/2018
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB 7	1756	7/8/2017	7/8/2018
RF Power measurements, 27-Sep-17					
Rohde & Schwarz	Power Meter, Single Channel	NRVS	1422	3/10/2017	3/10/2018
Rohde & Schwarz	Peak Power Sensor 100 uW - 2 Watts (w/ 20 dB pad, SN BJ5155)	NRV-Z32	1536	4/19/2017	4/18/2018
Agilent Technologies	USB Average Power Sensor	U2001A	2442	1/5/2017	1/5/2018
Antenna Port measurements, 27-Sep-17					
Agilent Technologies	3Hz -44GHz PSA Spectrum Analyzer	E4446A	2796	5/22/2017	5/22/2018
Agilent Technologies	USB Average Power Sensor	U2001A	2442	1/5/2017	1/5/2018
Radio Antenna Port (Power and Spurious Emissions), 09-Oct-17					
Rohde & Schwarz	Power Meter, Single Channel	NRVS	1422	3/10/2017	3/10/2018
Rohde & Schwarz	Peak Power Sensor 100 uW - 2 Watts (w/ 20 dB pad, SN BJ5155)	NRV-Z32	1536	4/19/2017	4/18/2018
Agilent Technologies	USB Average Power Sensor	U2001A	2442	1/5/2017	1/5/2018
Agilent Technologies	3Hz -44GHz PSA Spectrum Analyzer	E4446A	2796	5/22/2017	5/22/2018
Radiated Emissions, 1000 - 25,000 MHz, 09-Oct-17					
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	1/17/2017	1/17/2018
EMCO	Antenna, Horn, 1-18 GHz (SA40-Red)	3115	1142	9/29/2016	9/29/2018
HP / Miteq	SA40 R Head HF preAmplifier, 18-40 GHz (w/1148)	TTA1840-45-5P-HG-S	1145	9/8/2017	9/8/2018
Hewlett Packard	Spectrum Analyzer (SA40) Red 30 Hz -40 GHz	8564E (84125C)	1148	10/31/2016	11/1/2017
A. H. Systems	Spare System Horn, 18-40GHz	SAS-574, p/n: 2581	2162	8/4/2017	8/4/2019
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	2249	5/17/2017	5/17/2018

Appendix B Test Data

T105971 Pages 25 - 84



EMC Test Data

Client:	Neato Robotics	Job Number:	JD105849
Product	Botvac D7 Connected	T-Log Number:	T105971
System Configuration:		Project Manager:	Christine Krebill
Contact:	Pawel Orzechowski	Project Coordinator:	
Emissions Standard(s):	RSS-247, FCC 15.247, FCC 15E	Class:	B
Immunity Standard(s):		Environment:	

EMC Test Data

For The

Neato Robotics

Product

Botvac D7 Connected

Date of Last Test: 10/26/2017

Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Power vs. Data Rate

In normal operating modes the card uses power settings stored on EEPROM to set the output power. For a given nominal output power the actual transmit power normally is reduced as the data rate increases, therefore testing was performed at the data rate in the mode with highest power to determine compliance with the requirements.

The following power measurements were made using a GATED average power meter and with the device configured in a continuous transmit mode on Chain 1 at the various data rates in each mode to verify the highest power mode:

Sample Notes

Sample S/N: 2017-1613

Driver: 4.0.0.1389.0

Date of Test: 9/25/2017

Test Engineer: Deniz Demirci

Test Location: FT Ch#4

Config. Used: 1

Config Change: None

EUT Voltage: Battery operated

Mode	Data Rate	Power (dBm)	Power setting
802.11b	1	13.2	
	2	13.0	
	5.5	12.9	
	11	13.0	
802.11g	6	13.2	
	9	12.9	
	12	12.8	
	18	12.9	
	24	12.9	
	36	13.0	
	48	12.9	
	54	12.9	
802.11n 20 MHz	6.5	12.3	
	13	12.1	
	19.5	11.9	
	26	12.0	
	39	11.9	
	52	12.0	
	58.5	11.9	
	65	12.0	
	78	11.8	

Note : Power setting - the software power setting used during testing, included for reference only.

Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Duty Cycle

Duty cycle measurements performed on the worse case data rate for power.

Notes: Measurements taken with maximum RBW/VBW settings allowed.

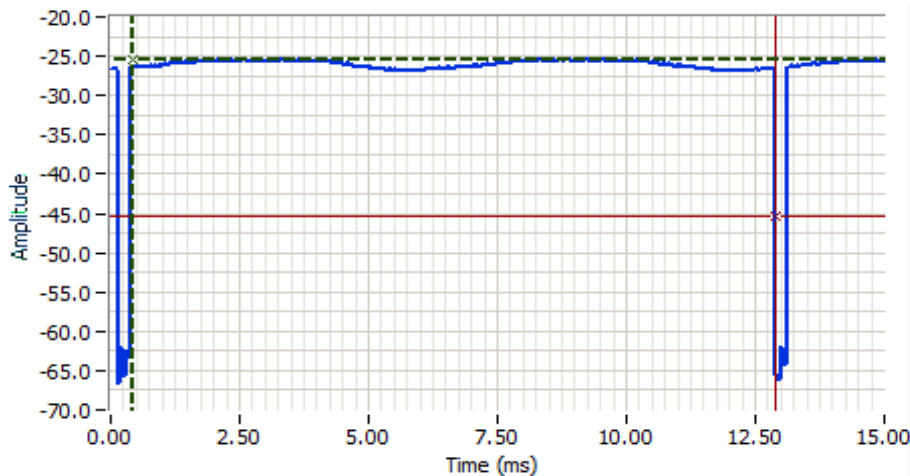
Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11b	1 Mbps	98.1%	Yes	12.461	0	0	10
11g	6 Mbps	95.5%	Yes	5.396	0.2	0.4	185
n20	6.5 Mbps	94.8%	Yes	4.521	0.2	0.5	221

* Correction factor when using RMS/Power averaging - $10 \cdot \log(1/x)$

** Correction factor when using linear voltage average - $20 \cdot \log(1/x)$

T = Minimum transmission duration

Client: Neato Robotics	Job Number: JD105849
Model: Botvac D7 Connected	T-Log Number: T105971
Contact: Pawel Orzechowski	Project Manager: Christine Krebill
Standard: RSS-247, FCC 15.247, FCC 15E	Project Coordinator: -
	Class: N/A



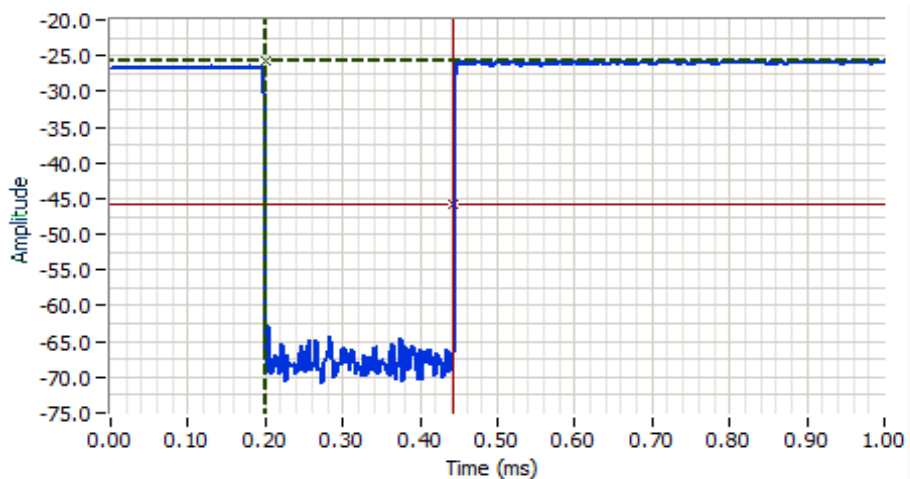
Analyzer Settings

Rohde&Schwarz,ESI
 CF: 2412.000 MHz
 SPAN: 0.000 MHz
 RB: 10.000 MHz
 VB: 10.000 MHz
 Detector: POS
 Attn: 10 DB
 RL Offset: 0.0 DB
 Sweep Time: 15.0ms
 Ref Lvl: -20.0 DBM

Comments

802.11b
 (1 Mbps)
 On time: 12.461 ms

Cursor 1	0.4297	-25.4		Delta Time (ms)	12.461
Cursor 2	12.8906	-45.4		Delta Amplitude	20.0



Analyzer Settings

Rohde&Schwarz,ESI
 CF: 2412.000 MHz
 SPAN: 0.000 MHz
 RB: 10.000 MHz
 VB: 10.000 MHz
 Detector: POS
 Attn: 10 DB
 RL Offset: 0.0 DB
 Sweep Time: 1.0ms
 Ref Lvl: -20.0 DBM

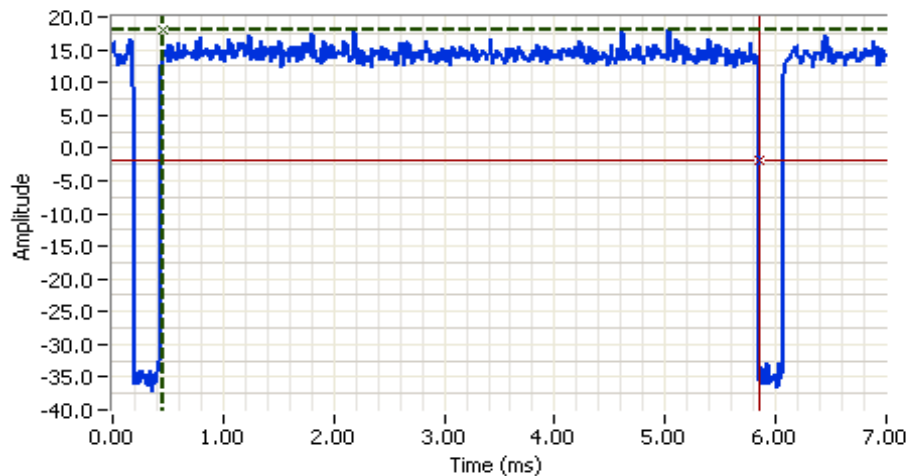
Comments

802.11b
 (1 Mbps)
 Off time: 0.242 ms

Cursor 1	0.2005	-25.8		Delta Time (ms)	0.242
Cursor 2	0.4427	-45.8		Delta Amplitude	20.0



Client: Neato Robotics	Job Number: JD105849
Model: Botvac D7 Connected	T-Log Number: T105971
Contact: Pawel Orzechowski	Project Manager: Christine Krebill
Standard: RSS-247, FCC 15.247, FCC 15E	Project Coordinator: -
	Class: N/A



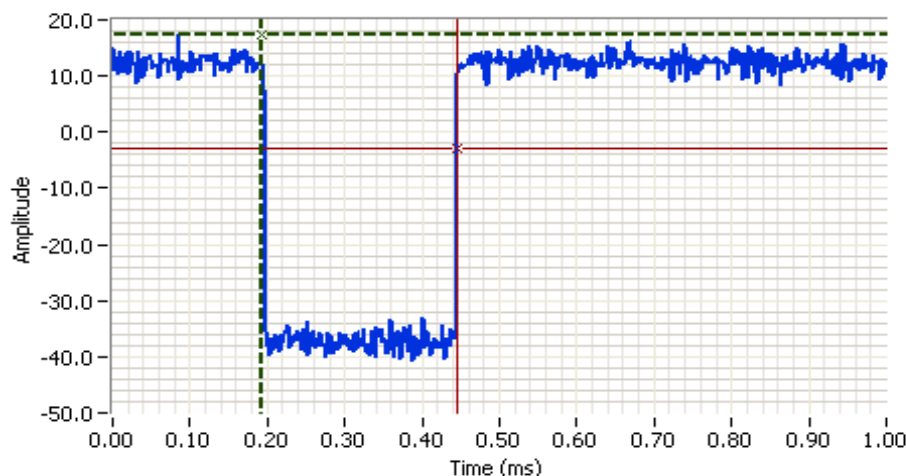
Analyzer Settings

Agilent Technologies, E4446A
 CF: 2412.000 MHz
 SPAN: 0.000 MHz
 RB: 10.000 MHz
 VB: 8.000 MHz
 Detector: PK (CISPR)
 Attn: 20 DB
 RL Offset: 20.0 DB
 Sweep Time: 7.0ms
 Ref Lvl: 30.0 DBM

Comments

802.11g
 (6 Mbps)
 On time: 5.396 ms

Cursor 1	0.4557	18.1		Delta Time (ms)	5.396
Cursor 2	5.8516	-1.9		Delta Amplitude	20.0



Analyzer Settings

Agilent Technologies, E4446A
 CF: 2412.000 MHz
 SPAN: 0.000 MHz
 RB: 10.000 MHz
 VB: 8.000 MHz
 Detector: PK (CISPR)
 Attn: 20 DB
 RL Offset: 20.0 DB
 Sweep Time: 1.0ms
 Ref Lvl: 30.0 DBM

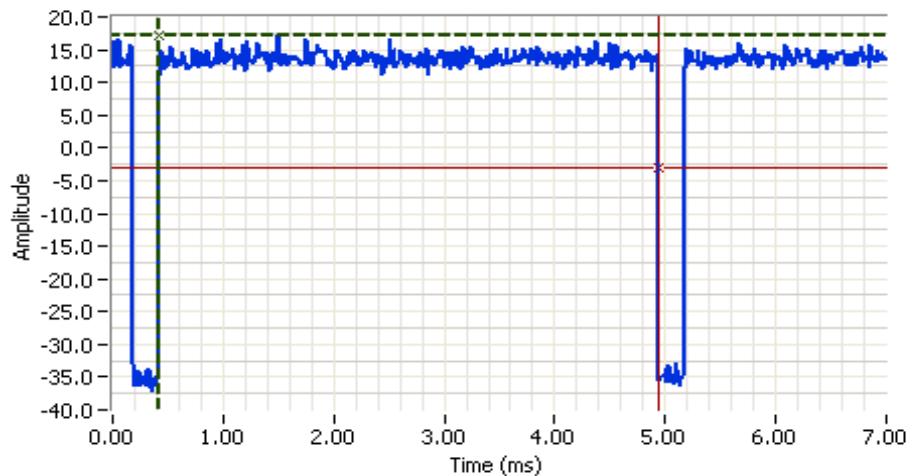
Comments

802.11g
 (6 Mbps)
 Off time: 0.253 ms

Cursor 1	0.1927	17.3		Delta Time (ms)	0.253
Cursor 2	0.4453	-2.7		Delta Amplitude	20.0



Client: Neato Robotics	Job Number: JD105849
Model: Botvac D7 Connected	T-Log Number: T105971
Contact: Pawel Orzechowski	Project Manager: Christine Krebill
Standard: RSS-247, FCC 15.247, FCC 15E	Project Coordinator: -
	Class: N/A

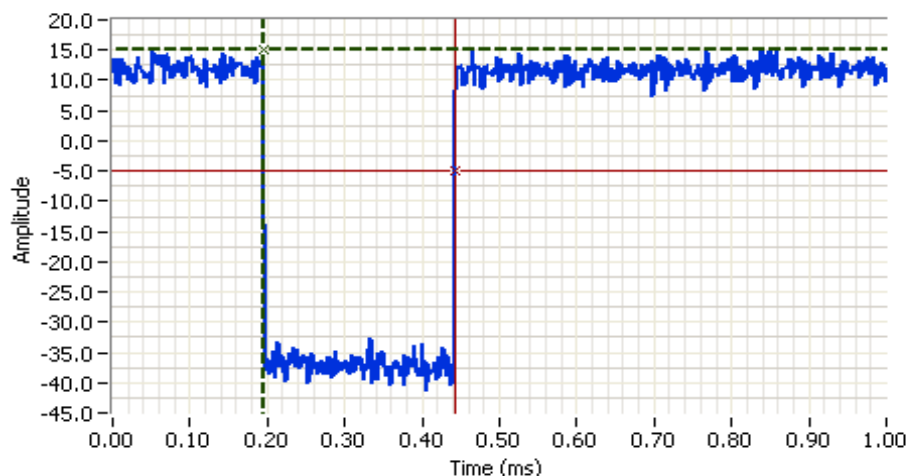


Analyzer Settings

Agilent Technologies, E4446A
 CF: 2412.000 MHz
 SPAN: 0.000 MHz
 RB: 10.000 MHz
 VB: 8.000 MHz
 Detector: PK (CISPR)
 Attn: 20 DB
 RL Offset: 20.0 DB
 Sweep Time: 7.0ms
 Ref Lvl: 30.0 DBM

Comments

802.11n
 (6.5 Mbps)
 On time: 4.521 ms



Analyzer Settings

Agilent Technologies, E4446A
 CF: 2412.000 MHz
 SPAN: 0.000 MHz
 RB: 10.000 MHz
 VB: 8.000 MHz
 Detector: PK (CISPR)
 Attn: 20 DB
 RL Offset: 20.0 DB
 Sweep Time: 1.0ms
 Ref Lvl: 30.0 DBM

Comments

802.11n
 (6.5 Mbps)
 Off time: 0.247 ms



Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

RSS-247 and FCC 15.247 (DTS) Antenna Port Measurements Power, PSD, Bandwidth and Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 9/27/2017, 10/09/2017
 Test Engineer: Deniz Demirci / M. Birgani
 Test Location: Fremont EMC Lab #4A

Config. Used: 1
 Config Change: None
 EUT Voltage: Battery operated

General Test Configuration

The EUT was connected to the spectrum analyzer or power meter via a suitable attenuator. All measurements were made on a single chain.

All measurements have been corrected to allow for the external attenuators used.

Ambient Conditions: Temperature: 24-25 °C
 Rel. Humidity: 40-43 %

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Summary of Results

Run #	Pwr setting	Avg Pwr	Test Performed	Limit	Pass / Fail	Result / Margin
1	-	-	Output Power	15.247(b)	Pass	b: 12.4 dBm g: 18.5 dBm n20: 18.4 dBm
2	-	-	Power spectral Density (PSD)	15.247(d)	Pass	b: -4.5 dBm/10kHz g: -5.1 dBm/10kHz n20: -4.7 dBm/10kHz
3	-	-	Minimum 6 dB Bandwidth	15.247(a)	Pass	b: 10.0 MHz g: 15.1 MHz n20: 15.1 MHz
3	-	-	99% Bandwidth	RSS GEN	-	b: 14.5 MHz g: 17.2 MHz n20: 18.3 MHz
4	-	-	Spurious emissions	15.247(b)	Pass	All emissions below the -20 dBc limit

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11b	1 Mbps	98.1%	Yes	12.461	0	0	10
11g	6 Mbps	95.5%	Yes	5.396	0.2	0.4	185
n20	6.5 Mbps	94.8%	Yes	4.521	0.2	0.5	221

Sample Notes

Sample S/N: 2017-1613

Driver: 4.0.0.1389.0

Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Run #1: Output Power

Mode: 11b

Power Setting ²	Frequency (MHz)	Output Power (dBm) ¹	mW	Antenna Gain (dBi)	Result	EIRP dBm	W	Output Power (dBm) ³	mW
	2412	11.7	14.8	2.1	Pass	13.8	0.024		
	2437	12.1	16.2	2.1	Pass	14.2	0.026		
	2462	12.4	17.4	2.1	Pass	14.5	0.028		

Mode: 11g

Power Setting ²	Frequency (MHz)	Output Power (dBm) ¹	mW	Antenna Gain (dBi)	Result	EIRP dBm	W	Output Power (dBm) ³	mW
	2412	17.9	61.7	2.1	Pass	20.0	0.100		
	2437	18.3	67.6	2.1	Pass	20.4	0.110		
	2462	18.5	70.8	2.1	Pass	20.6	0.115		

Mode: n20

Power Setting ²	Frequency (MHz)	Output Power (dBm) ¹	mW	Antenna Gain (dBi)	Result	EIRP dBm	W	Output Power (dBm) ³	mW
	2412	17.7	58.9	2.1	Pass	19.8	0.095		
	2437	18.2	66.1	2.1	Pass	20.3	0.107		
	2462	18.4	69.2	2.1	Pass	20.5	0.112		

Note 1: Output power measured using a peak power meter, spurious limit is -20dBc.

Average RF power - For reference only

Mode: 11b

Power Setting ²	Frequency (MHz)	Output Power (dBm) ¹	mW	Antenna Gain (dBi)	Result	EIRP dBm	W	Output Power (dBm) ³	mW
	2462	11.8	15.1	2.1	Pass	13.9	0.025		

Mode: 11g

Power Setting ²	Frequency (MHz)	Output Power (dBm) ¹	mW	Antenna Gain (dBi)	Result	EIRP dBm	W	Output Power (dBm) ³	mW
	2462	13.2	20.9	2.1	Pass	15.3	0.034		

Note 1: Output power measured using a gated average power meter for reference only

Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Run #2: Power spectral Density

Mode: 11b

Power Setting	Frequency (MHz)	PSD	Limit dBm/3kHz	Result
		(dBm/10kHz) ^{Note 1}		
	2411.4957	-4.5	8.0	Pass
	2437.8128	-5.2	8.0	Pass
	2462.6377	-5.0	8.0	Pass

Mode: 11g

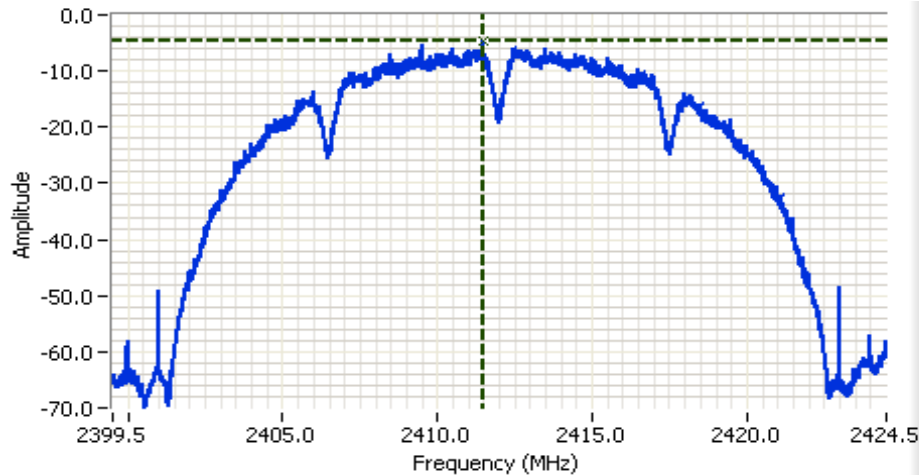
Power Setting	Frequency (MHz)	PSD	Limit dBm/3kHz	Result
		(dBm/10kHz) ^{Note 1}		
	2412.6210	-5.4	8.0	Pass
	2440.11\35	-5.1	8.0	Pass
	2463.8715	-5.1	8.0	Pass

Mode: n20

Power Setting	Frequency (MHz)	PSD	Limit dBm/3kHz	Result
		(dBm/10kHz) ^{Note 1}		
	2413.2462	-5.4	8.0	Pass
	2437.2626	-4.8	8.0	Pass
	2462.2626	-4.7	8.0	Pass

Note 1: Test performed per method PKSPD, in KDB 558074. Power spectral density measured using: $3\text{kHz} \leq \text{RBW} \leq 100\text{kHz}$, $\text{VBW}=3*\text{RBW}$, peak detector, span = $1.5*\text{DTS BW}$, auto sweep time, max hold.

Client: Neato Robotics	Job Number: JD105849
Model: Botvac D7 Connected	T-Log Number: T105971
Contact: Pawel Orzechowski	Project Manager: Christine Krebill
Standard: RSS-247, FCC 15.247, FCC 15E	Project Coordinator: -
	Class: N/A

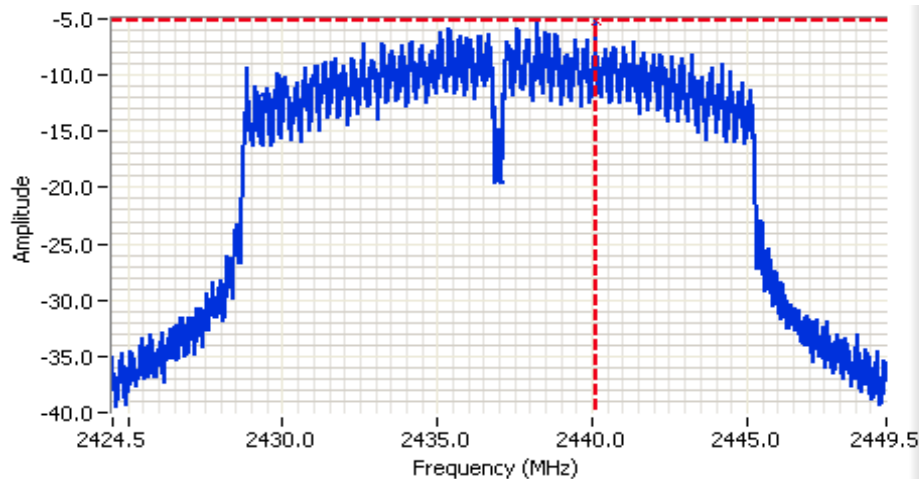
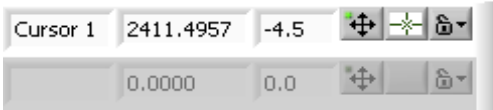


Analyzer Settings

Agilent Technologies, E4446A
 CF: 2412.000 MHz
 SPAN: 25.000 MHz
 RB: 10.0 kHz
 VB: 30.0 kHz
 Detector: POS
 Attn: 0 DB
 RL Offset: 20.0 DB
 Sweep Time: 239.1ms
 Ref Lvl: 8.0 DBM

Comments

802.11b
 PSD: -4.5 dBm/10kHz

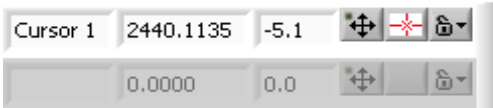


Analyzer Settings

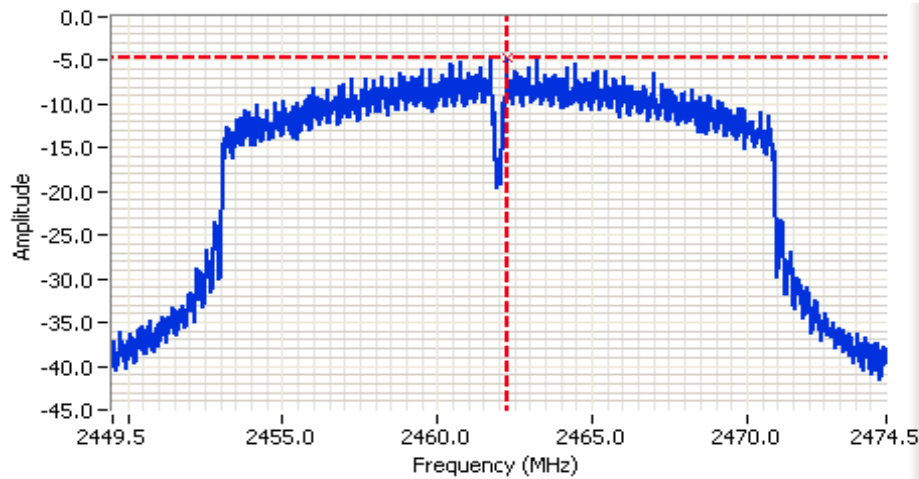
Agilent Technologies, E4446A
 CF: 2437.000 MHz
 SPAN: 25.000 MHz
 RB: 10.0 kHz
 VB: 30.0 kHz
 Detector: POS
 Attn: 10 DB
 RL Offset: 10.5 DB
 Sweep Time: 0.8s
 Ref Lvl: 6.5 DBM

Comments

802.11g
 PSD: -5.1 dBm/10kHz



Client: Neato Robotics	Job Number: JD105849
Model: Botvac D7 Connected	T-Log Number: T105971
Contact: Pawel Orzechowski	Project Manager: Christine Krebill
Standard: RSS-247, FCC 15.247, FCC 15E	Project Coordinator: -
	Class: N/A

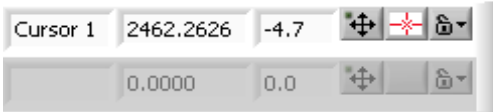


Analyzer Settings

Agilent Technologies, E4446A
 CF: 2462.000 MHz
 SPAN: 25.000 MHz
 RB: 10.0 kHz
 VB: 30.0 kHz
 Detector: POS
 Attn: 10 DB
 RL Offset: 10.5 DB
 Sweep Time: 0.8s
 Ref Lvl: 10.5 DBM

Comments

802.11n 20MHz
 PSD: -4.7 dBm/10kHz



Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Run #3: Signal Bandwidth

Mode: 11b

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting (kHz)	
		DTS	99%	6 dB	99%
	2412	10.0	14.5	100	300
	2437	10.1	14.5	100	300
	2462	10.0	14.5	100	300

Mode: 11g

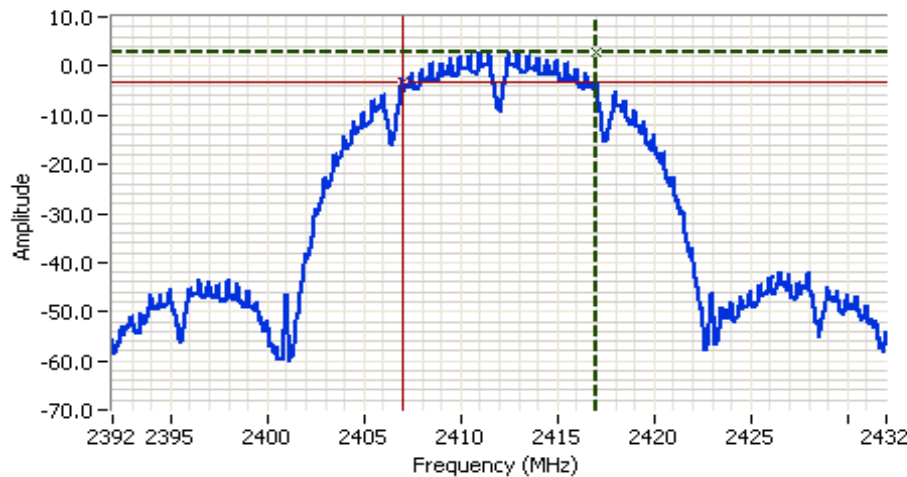
Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting (kHz)	
		DTS	99%	6 dB	99%
	2412	15.1	16.6	100	300
	2437	15.1	17.2	100	300
	2462	15.1	16.6	100	300

Mode: n20

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting (kHz)	
		DTS	99%	6 dB	99%
	2412	15.1	17.7	100	300
	2437	17.6	18.3	100	300
	2462	15.1	17.7	100	300

Note 1: DTS BW: RBW=100kHz, VBW $\geq 3 \times$ RBW, peak detector, max hold, auto sweep time, Span 2-5 times measured BW.
 99% BW: RBW=1-5% of 99%BW, VBW $\geq 3 \times$ RBW, peak detector, max hold, auto sweep time. Span 1.5-5 times OBW.

Client: Neato Robotics	Job Number: JD105849
Model: Botvac D7 Connected	T-Log Number: T105971
Contact: Pawel Orzechowski	Project Manager: Christine Krebill
Standard: RSS-247, FCC 15.247, FCC 15E	Project Coordinator: -
	Class: N/A



Analyzer Settings

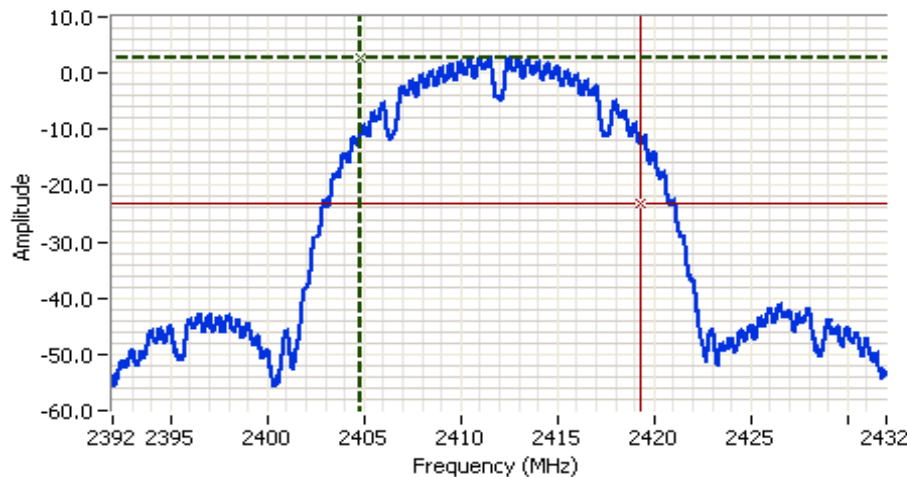
Agilent Technologies, E4446A
 CF: 2412.000 MHz
 SPAN: 40.000 MHz
 RB: 100 kHz
 VB: 300 kHz
 Detector: POS
 Attn: 0 dB
 RL Offset: 20.0 dB
 Sweep Time: 4.0ms
 Ref Lvl: 8.0 DBM

Comments

6dB BW: 10.043 MHz
 802.11b

Cursor 1 2417.0217 2.7
 Cursor 2 2406.9783 -3.3

Delta Freq. 10.043
 Delta Amplitude 6.0



Analyzer Settings

Agilent Technologies, E4446A
 CF: 2412.000 MHz
 SPAN: 40.000 MHz
 RB: 300 kHz
 VB: 910 kHz
 Detector: POS
 Attn: 0 dB
 RL Offset: 20.0 dB
 Sweep Time: 1.0ms
 Ref Lvl: 8.0 DBM

Comments

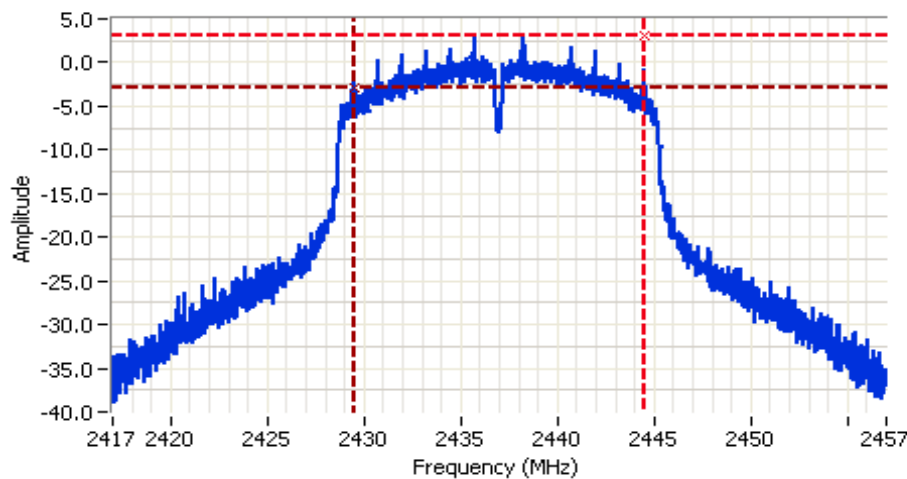
99% BW: 14.493 MHz
 802.11b

Cursor 1 2404.7733 2.7
 Cursor 2 2419.2667 -23.3

Delta Freq. 14.493
 Delta Amplitude 26.0



Client: Neato Robotics	Job Number: JD105849
Model: Botvac D7 Connected	T-Log Number: T105971
Contact: Pawel Orzechowski	Project Manager: Christine Krebill
Standard: RSS-247, FCC 15.247, FCC 15E	Project Coordinator: -
	Class: N/A



Analyzer Settings

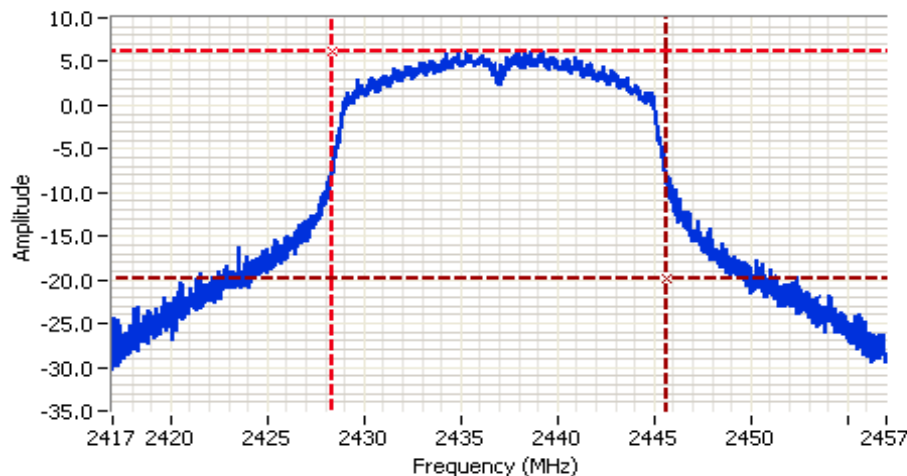
Agilent Technologies, E4446A
 CF: 2437.000 MHz
 SPAN: 40.000 MHz
 RB: 100 kHz
 VB: 300 kHz
 Detector: POS
 Attn: 10 DB
 RL Offset: 10.5 DB
 Sweep Time: 20.2ms
 Ref Lvl: 10.5 DBM

Comments

802.11g
 DTS BW: 15.1 MHz

Cursor 1 2444.5425 3.0
 Cursor 2 2429.4708 -3.0

Delta Freq. 15.072
 Delta Amplitude 6.0



Analyzer Settings

Agilent Technologies, E4446A
 CF: 2437.000 MHz
 SPAN: 40.000 MHz
 RB: 300 kHz
 VB: 910 kHz
 Detector: POS
 Attn: 10 DB
 RL Offset: 10.5 DB
 Sweep Time: 20.2ms
 Ref Lvl: 10.5 DBM

Comments

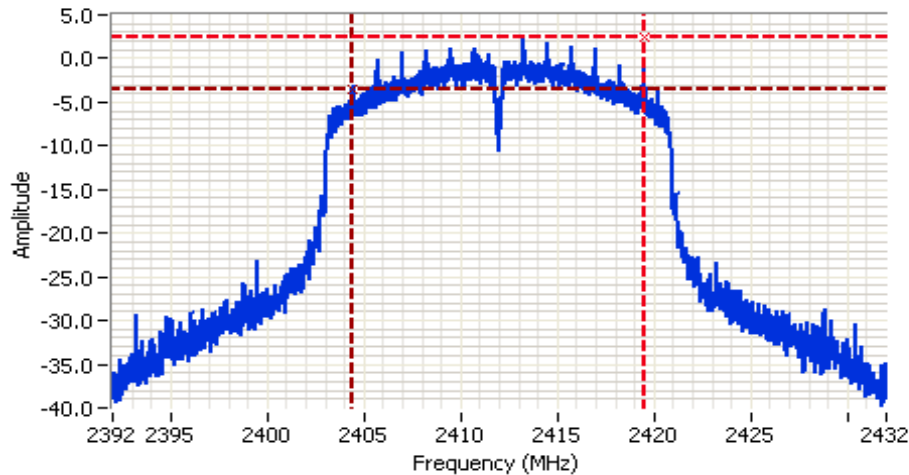
802.11g
 99% BW: 17.2 MHz

Cursor 1 2428.3867 6.2
 Cursor 2 2445.6133 -19.8

Delta Freq. 17.227
 Delta Amplitude 26.0



Client: Neato Robotics	Job Number: JD105849
Model: Botvac D7 Connected	T-Log Number: T105971
Contact: Pawel Orzechowski	Project Manager: Christine Krebill
Standard: RSS-247, FCC 15.247, FCC 15E	Project Coordinator: -
	Class: N/A



Analyzer Settings

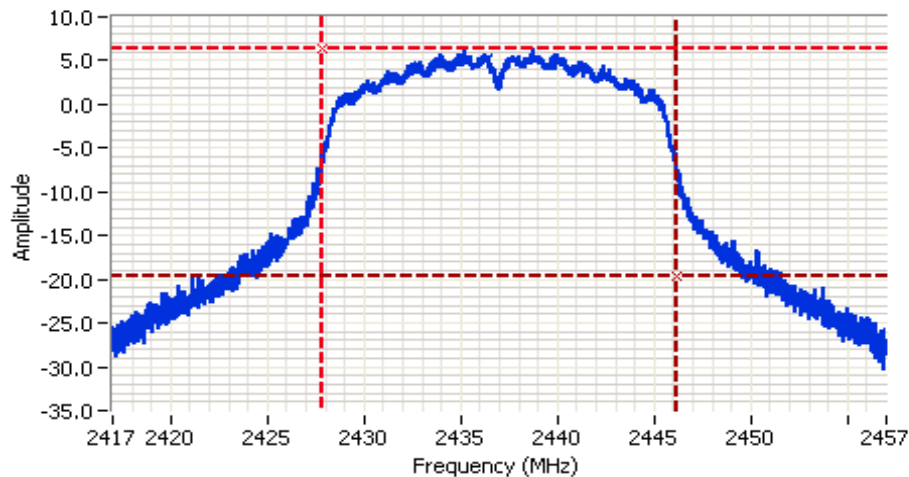
Agilent Technologies, E4446A
 CF: 2412.000 MHz
 SPAN: 40.000 MHz
 RB: 100 kHz
 VB: 300 kHz
 Detector: POS
 Attn: 10 DB
 RL Offset: 10.5 DB
 Sweep Time: 20.2ms
 Ref Lvl: 10.5 DBM

Comments

802.11n 20MHz
 DTS BW: 15.1 MHz

Cursor 1 2419.5425 2.4
 Cursor 2 2404.4441 -3.6

Delta Freq. 15.098
 Delta Amplitude 6.0



Analyzer Settings

Agilent Technologies, E4446A
 CF: 2437.000 MHz
 SPAN: 40.000 MHz
 RB: 300 kHz
 VB: 910 kHz
 Detector: POS
 Attn: 10 DB
 RL Offset: 10.5 DB
 Sweep Time: 20.2ms
 Ref Lvl: 10.5 DBM

Comments

802.11n 20MHz
 99% BW: 18.3 MHz

Cursor 1 2427.8400 6.4
 Cursor 2 2446.1467 -19.6

Delta Freq. 18.307
 Delta Amplitude 26.0



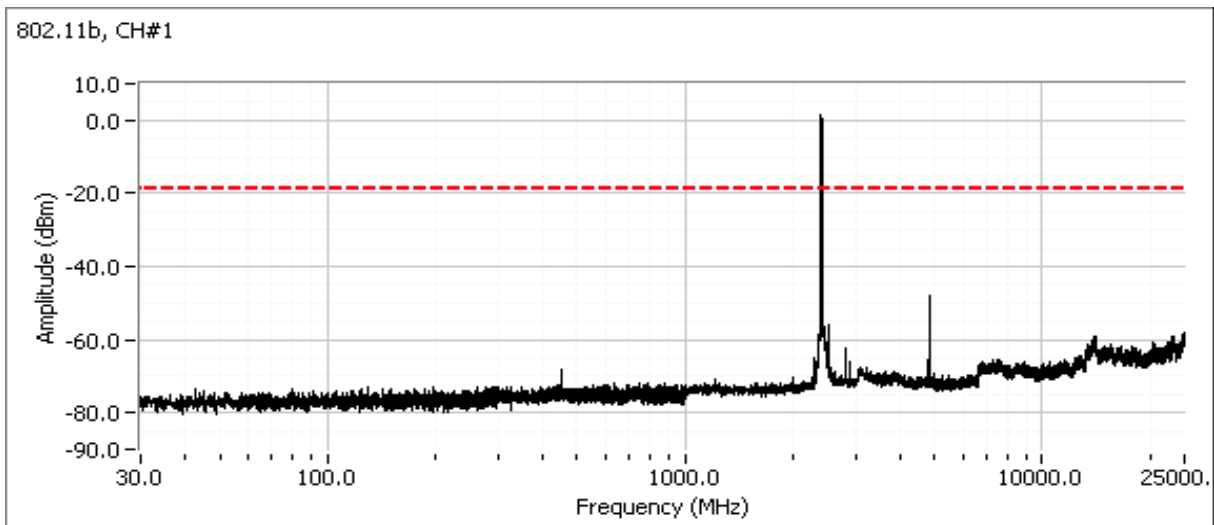
Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Run #4a: Out of Band Spurious Emissions

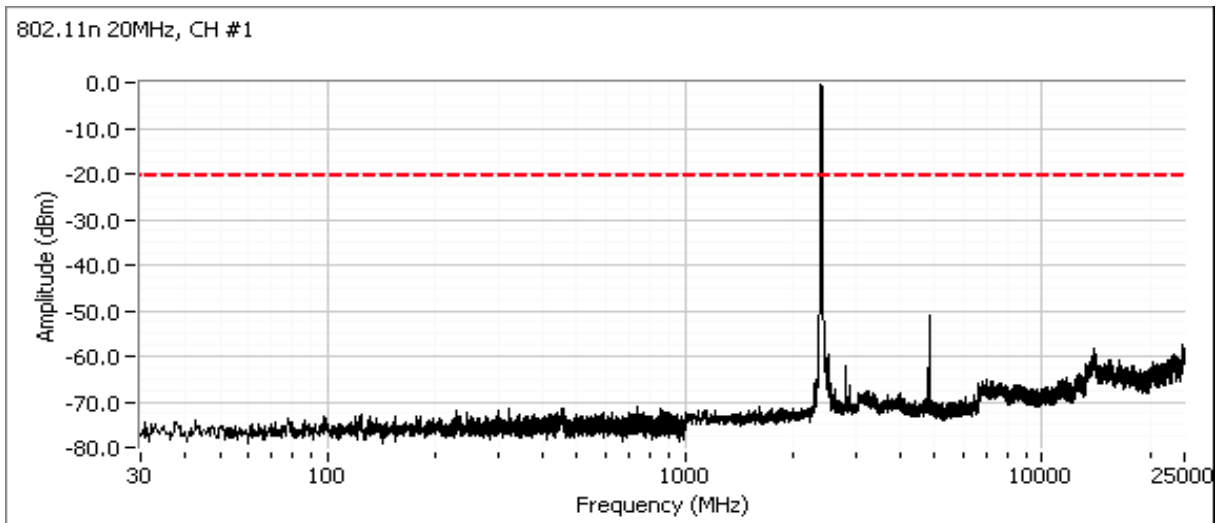
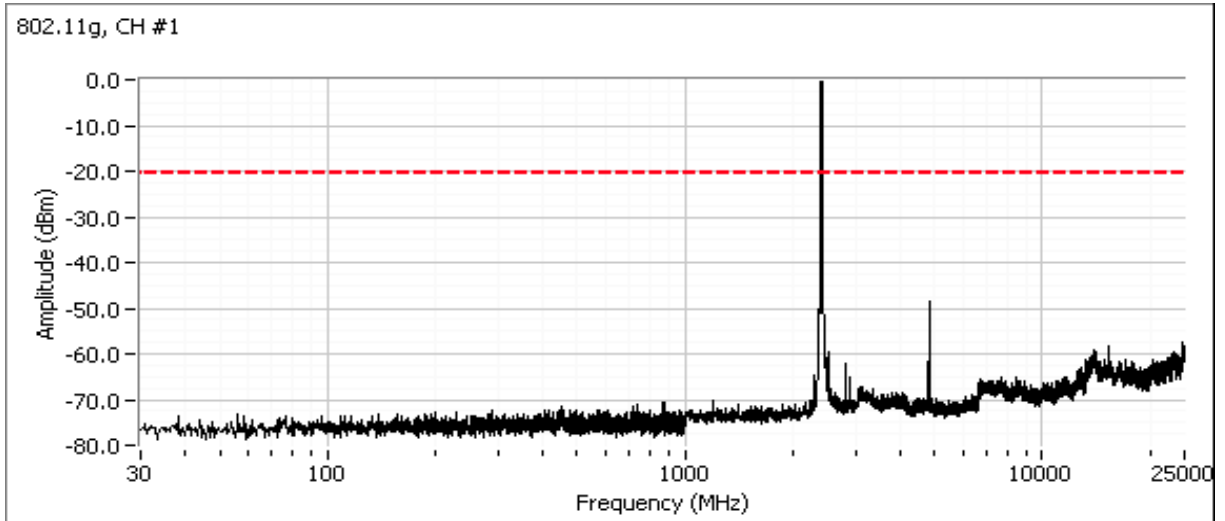
Frequency (MHz)	Power Setting	Mode	Limit	Result
2412		b	-20dBc	Pass
2437		b	-20dBc	Pass
2462		b	-20dBc	Pass
2412		g	-20dBc	Pass
2437		g	-20dBc	Pass
2462		g	-20dBc	Pass
2412		n20	-20dBc	Pass
2437		n20	-20dBc	Pass
2462		n20	-20dBc	Pass

RBW = 100 kHz and VBW = 300 kHz for all plots.

Plots for low channel

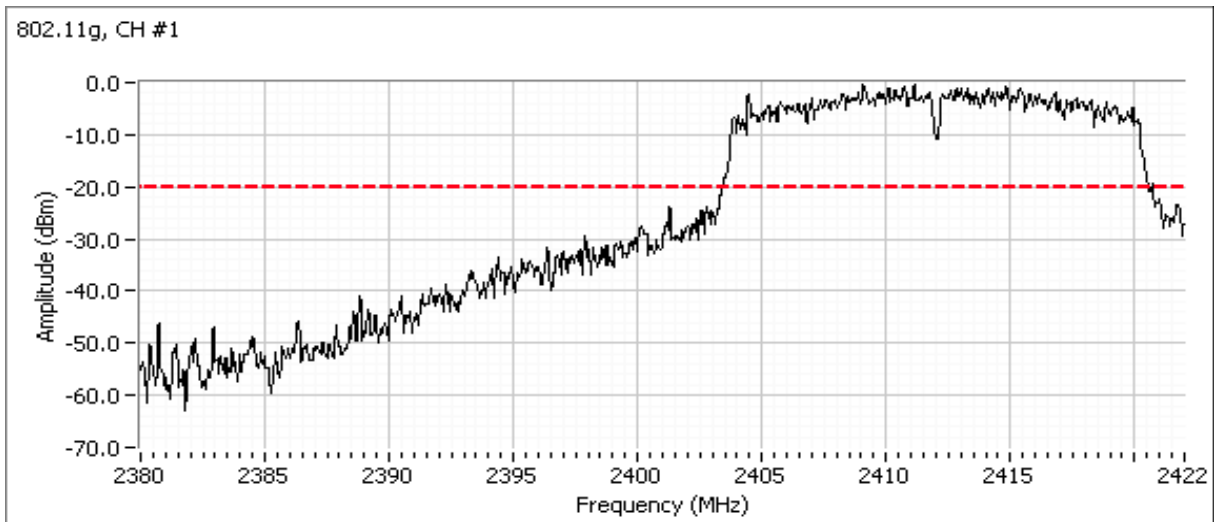
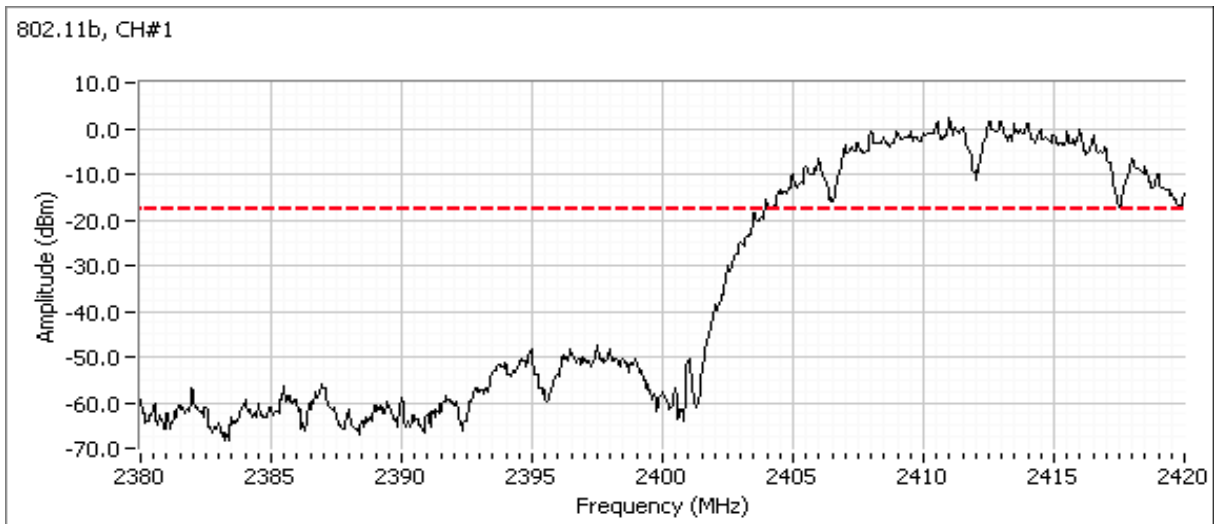


Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

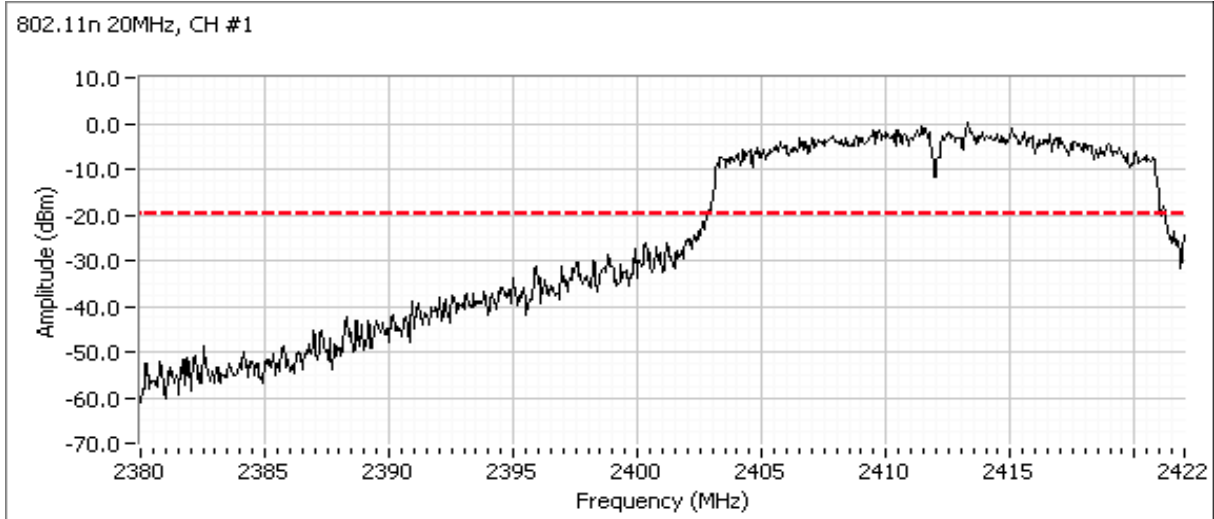


Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

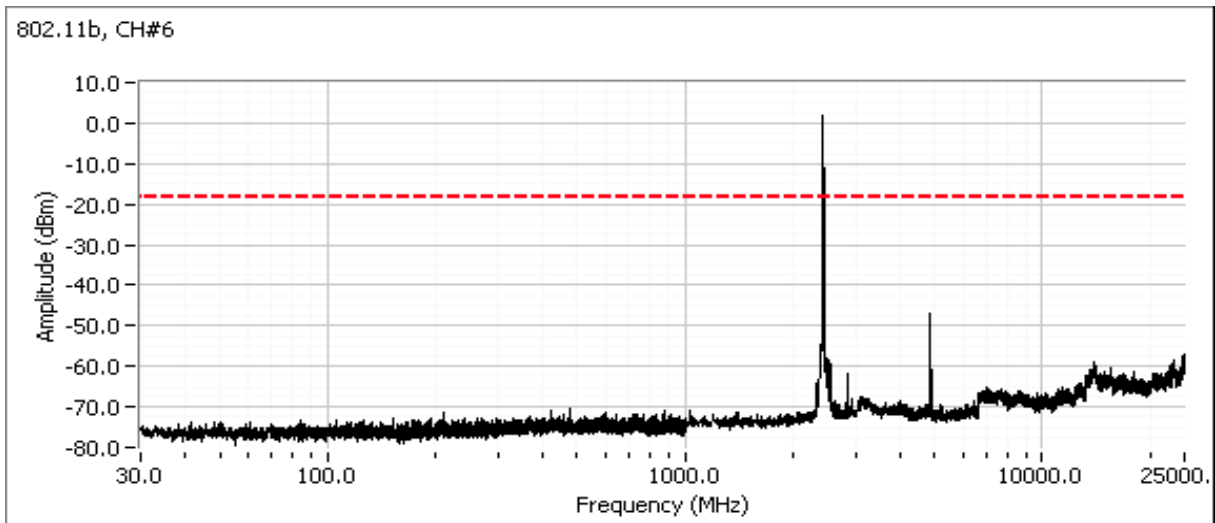
Additional plot showing compliance with -20 dBc limit from 2390 MHz to 2400 MHz. Radiated measurements used to show compliance with the limits in the restricted band below 2390 MHz.



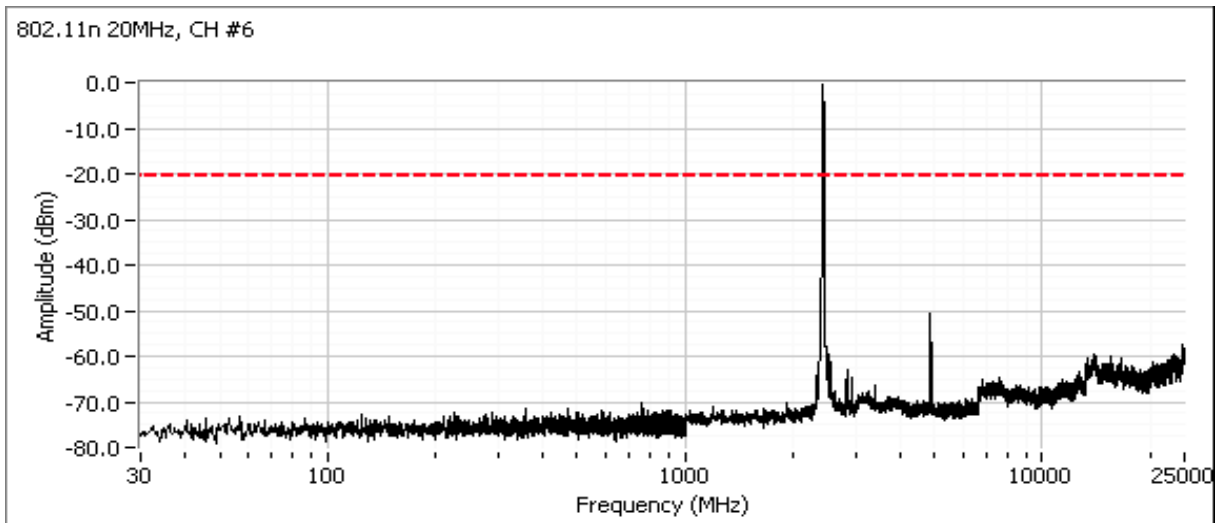
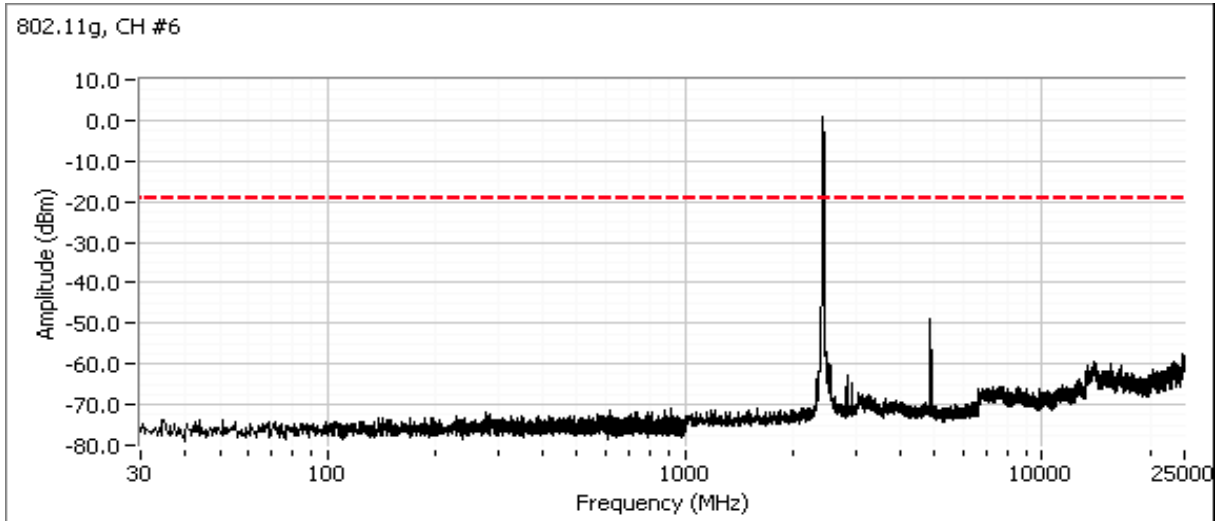
Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A



Plots for center channel

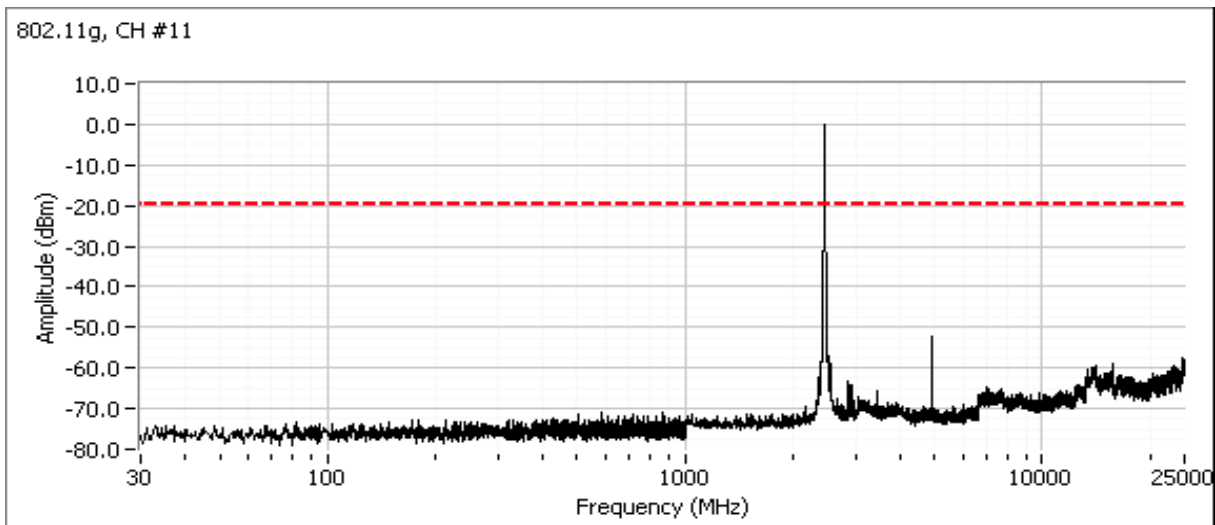
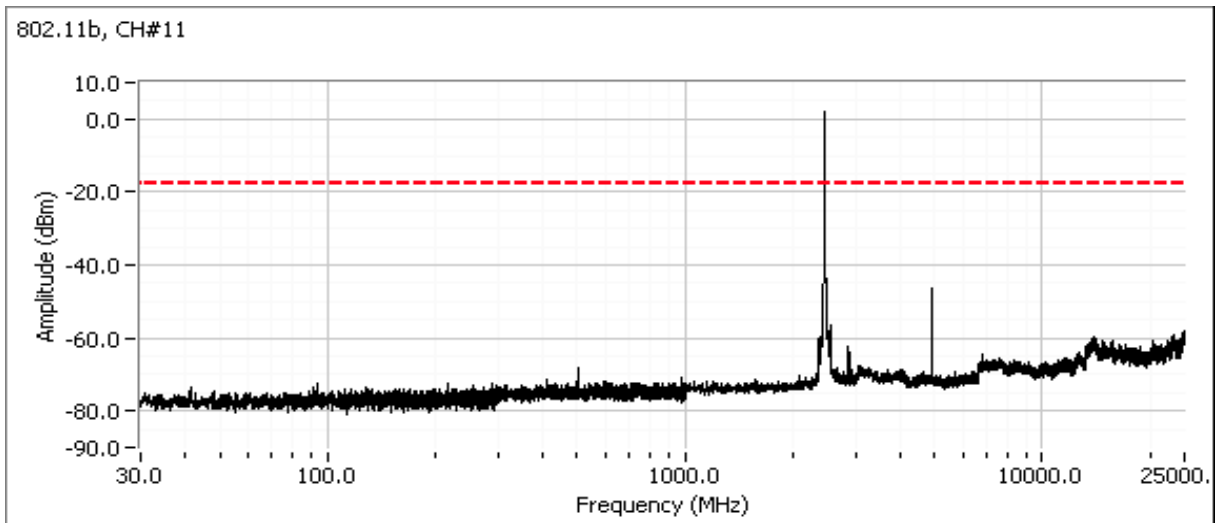


Client: Neato Robotics	Job Number: JD105849
Model: Botvac D7 Connected	T-Log Number: T105971
Contact: Pawel Orzechowski	Project Manager: Christine Krebill
Standard: RSS-247, FCC 15.247, FCC 15E	Project Coordinator: -
	Class: N/A

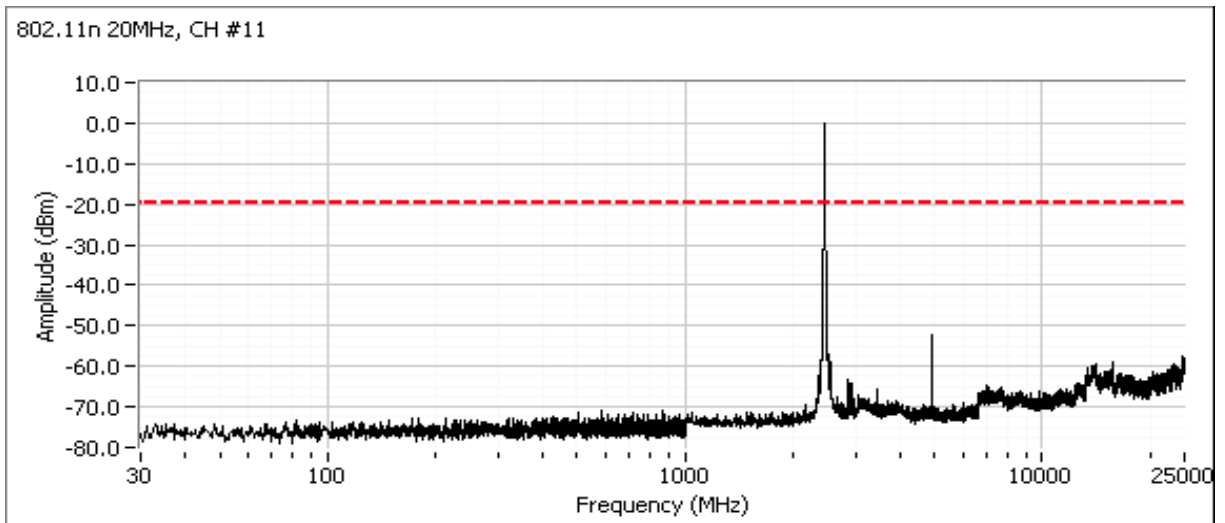
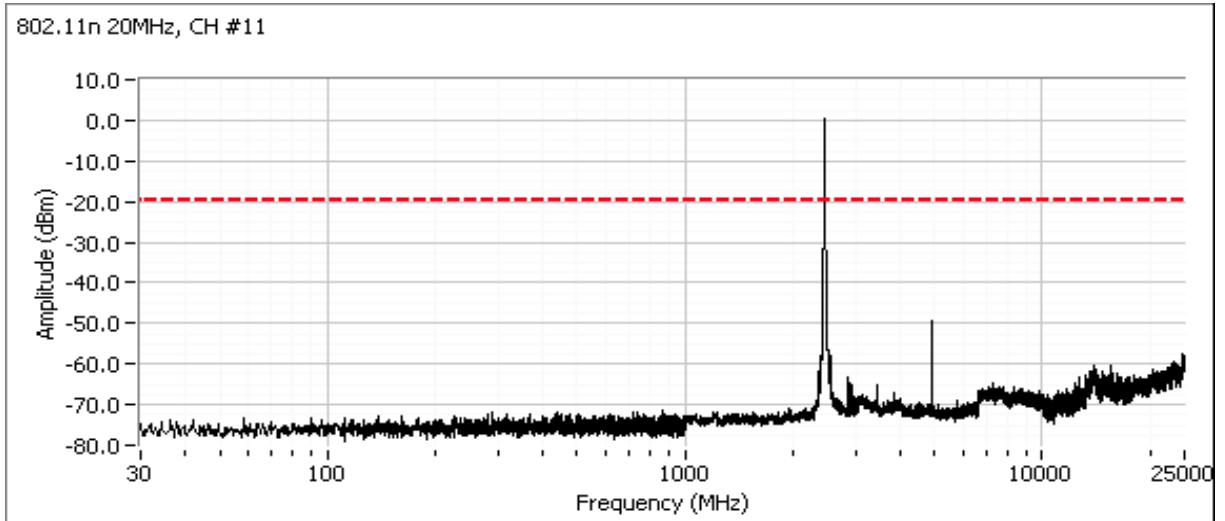


Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Plots for high channel



Client: Neato Robotics	Job Number: JD105849
Model: Botvac D7 Connected	T-Log Number: T105971
Contact: Pawel Orzechowski	Project Manager: Christine Krebill
Standard: RSS-247, FCC 15.247, FCC 15E	Project Coordinator: -
	Class: N/A



Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

RSS-247 and FCC 15.247 (DTS) Radiated Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT, unless otherwise noted.

Ambient Conditions:

Temperature: 21-24 °C

Rel. Humidity: 35-40 %

Summary of Results - Device Operating in the 2400-2483.5 MHz Band

Run #	Mode	Channel	Target Power	Power Setting	Test Performed	Limit	Result / Margin
1	b	1 2412 MHz			Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	45.8 dBµV/m @ 2386.9 MHz (-8.2 dB)
	b	11 2462 MHz			Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	39.9 dBµV/m @ 2487.5 MHz (-14.1 dB)
2	g	1 2412 MHz			Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	52.1 dBµV/m @ 2389.9 MHz (-1.9 dB)
	g	11 2462 MHz			Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	72.4 dBµV/m @ 2483.6 MHz (-1.6 dB)
3	n20	1 2412 MHz			Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	70.5 dBµV/m @ 2388.8 MHz (-3.5 dB)
	n20	11 2462 MHz			Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	72.1 dBµV/m @ 2483.7 MHz (-1.9 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Sample Notes

Sample S/N: DVT2_044 (945-0270)
 Firmware: 4.0.0.9999.0-0.4.0.0.1389.0

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074
 Peak measurements performed with: RBW=1 MHz, VBW=3 MHz, peak detector, max hold, auto sweep time
 Unless otherwise stated/noted, emission has a duty cycle $\geq 98\%$ and was measured using RBW=1MHz, VBW=10Hz, peak detector, linear average mode, auto sweep time, max hold.

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11b	1 Mb/s	0.98	Yes	12.461	0	0	10
11g	6 Mb/s	0.96	Yes	5.396	0.2	0.4	185
n20	MCS0	0.95	Yes	4.521	0.2	0.5	221

Measurement Specific Notes:

Note 1:	Emission in non-restricted band, but limit of 15.209 used.
Note 2:	Emission in non-restricted band, the limit was set 30dB below the level of the fundamental and measured in 100kHz.
Note 3:	Emission has a duty cycle $\geq 98\%$, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces
Note 4:	Emission has constant duty cycle $< 98\%$, average measurement performed: RBW=1MHz, VBW $> 1/T$ but not less than 10Hz, peak detector, linear averaging, auto sweep, trace average 100 traces, measurement corrected by Linear voltage correction factor
Note 5:	Emission has constant duty cycle $< 98\%$, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces, measurement corrected by Pwr correction factor
Note 6:	Emission has non constant duty cycle $< 98\%$, average measurement performed: RBW=1MHz, VBW $> 1/T$, peak detector, linear average mode, sweep time auto, max hold. Max hold for $50 \cdot (1/DC)$ traces
Note 7:	Emission has non constant duty cycle $< 98\%$, average measurement performed: RBW=1MHz, VBW $> 1/T$, RMS detector, sweep time auto, max hold. Max hold for $50 \cdot (1/DC)$ traces
Note 8:	Plots of the average and peak bandedge do not account for any duty cycle correction. Refer to the tabular results for final measurements.

Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Run #1: Radiated Bandedge Measurements

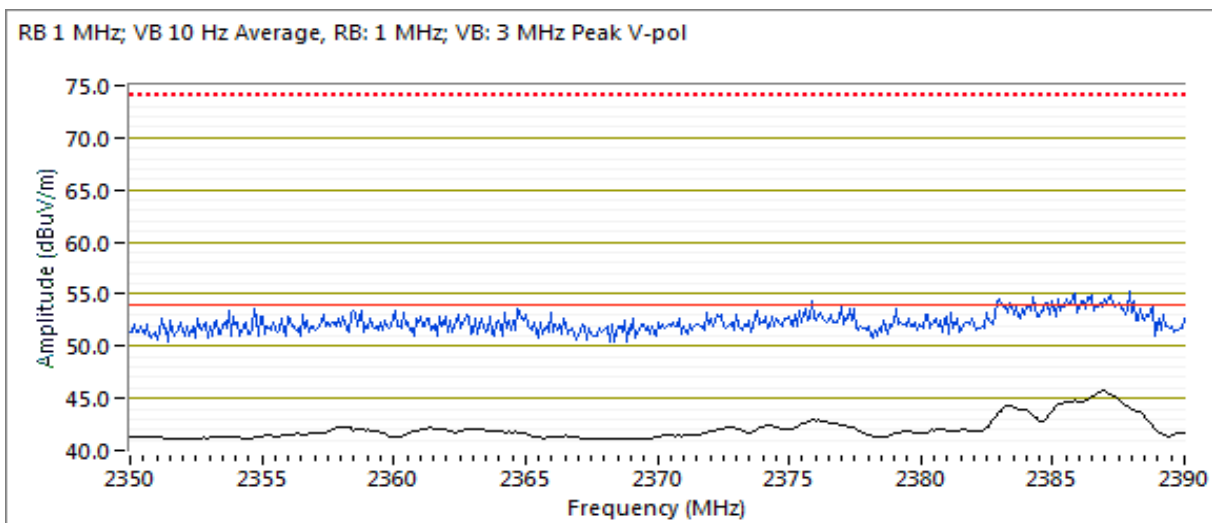
Date of Test: 9/25/2017
 Test Engineer: Deniz Demirci
 Test Location: FT Ch#4

Config. Used: 1
 Config Change: None
 EUT Voltage: Battery operated

Channel: 1 Mode: b Setting:
 Tx Chain: Main Data Rate: 1 Mb/s

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2386.890	45.8	V	54.0	-8.2	AVG	139	2.2	POS; RB 1 MHz; VB: 10 Hz
2386.950	42.3	H	54.0	-11.7	AVG	55	2.5	POS; RB 1 MHz; VB: 10 Hz
2387.260	55.7	V	74.0	-18.3	PK	139	2.2	POS; RB 1 MHz; VB: 3 MHz
2386.930	49.2	H	74.0	-24.8	PK	55	2.5	POS; RB 1 MHz; VB: 3 MHz



Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

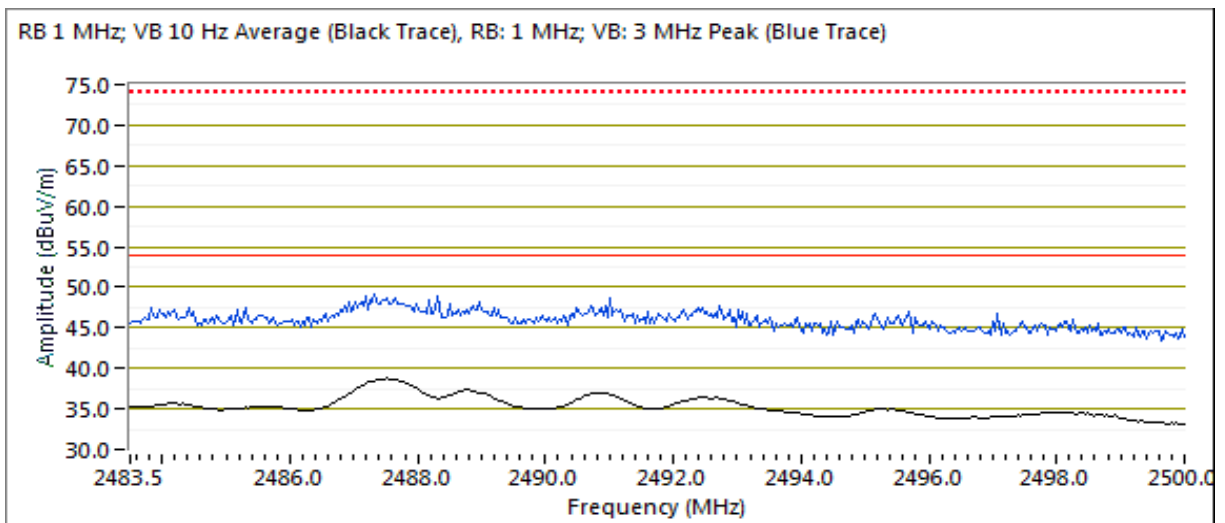
Date of Test: 9/25/2017
 Test Engineer: Mehran Birgani
 Test Location: FT Ch#4

Config. Used: 1
 Config Change: None
 EUT Voltage: Battery operated

Channel: 11 Mode: b Setting:
 Tx Chain: Main Data Rate: 1 Mb/s

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2487.540	39.9	H	54.0	-14.1	AVG	113	1.6	RB 1 MHz; VB: 10 Hz
2487.510	38.7	V	54.0	-15.3	AVG	141	2.1	RB 1 MHz; VB: 10 Hz
2487.710	50.5	H	74.0	-23.5	PK	113	1.6	RB 1 MHz; VB: 3 MHz
2487.290	49.4	V	74.0	-24.6	PK	141	2.1	RB 1 MHz; VB: 3 MHz



Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Run #2: Radiated Bandedge Measurements

Date of Test: 10/5/2017

Test Engineer: Mehran Birgani

Test Location: FT Ch#4

Config. Used: 1

Config Change: None

EUT Voltage: Battery operated

Channel: 1

Mode: g

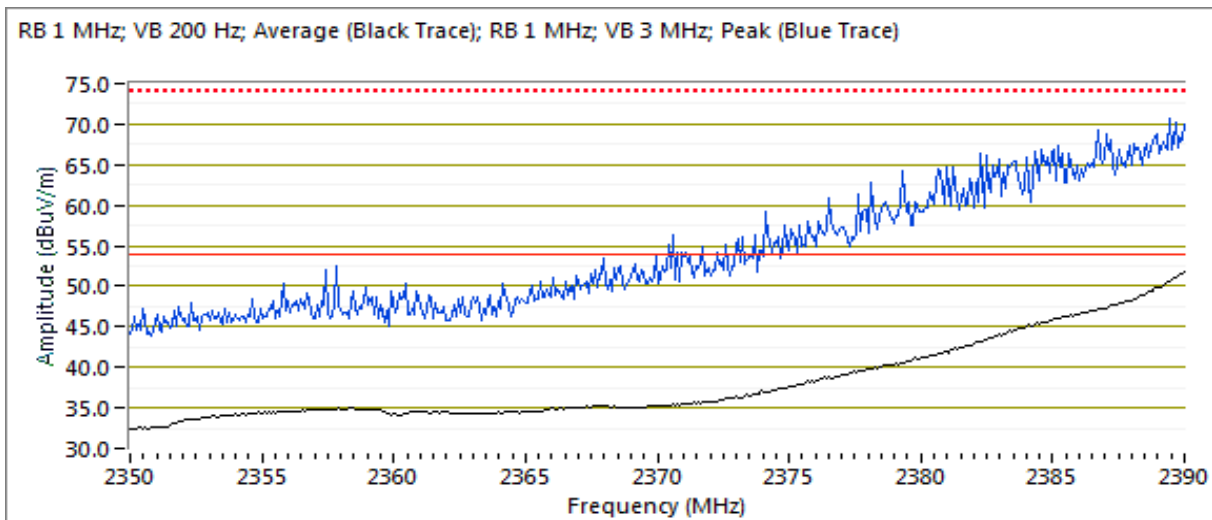
Setting:

Tx Chain: Main

Data Rate: 6 Mb/s

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2389.890	52.1	H	54.0	-1.9	AVG	274	1.3	Note 5; RB 1 MHz; VB: 200 Hz
2389.500	71.8	H	74.0	-2.2	PK	274	1.3	POS; RB 1 MHz; VB: 3 MHz
2389.950	49.6	V	54.0	-4.4	AVG	336	2.2	Note 5; RB 1 MHz; VB: 200 Hz
2385.730	68.9	V	74.0	-5.1	PK	336	2.2	POS; RB 1 MHz; VB: 3 MHz



Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

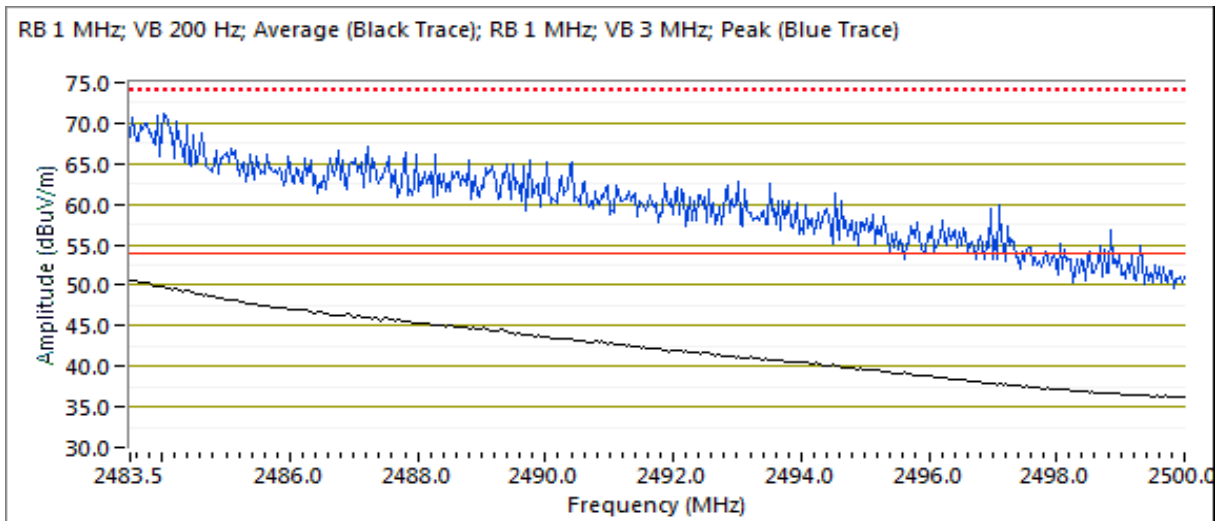
Date of Test: 10/5/2017
 Test Engineer: Mehran Birgani
 Test Location: FT Ch#4

Config. Used: 1
 Config Change: None
 EUT Voltage: Battery operated

Channel: 11 Mode: g Setting:
 Tx Chain: Main Data Rate: 6 Mb/s

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2483.580	72.4	H	74.0	-1.6	PK	280	1.4	POS; RB 1 MHz; VB: 3 MHz
2483.600	50.9	H	54.0	-3.1	AVG	280	1.4	POS; RB 1 MHz; VB: 200 Hz
2483.870	70.1	V	74.0	-3.9	PK	319	1.7	POS; RB 1 MHz; VB: 3 MHz
2483.640	48.6	V	54.0	-5.4	AVG	319	1.7	POS; RB 1 MHz; VB: 200 Hz



Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Run #3: Radiated Bandedge Measurements

Date of Test: 10/5/2017

Test Engineer: Mehran Birgani

Test Location: FT Ch#4

Config. Used: 1

Config Change: None

EUT Voltage: Battery operated

Channel: 1

Mode: n20

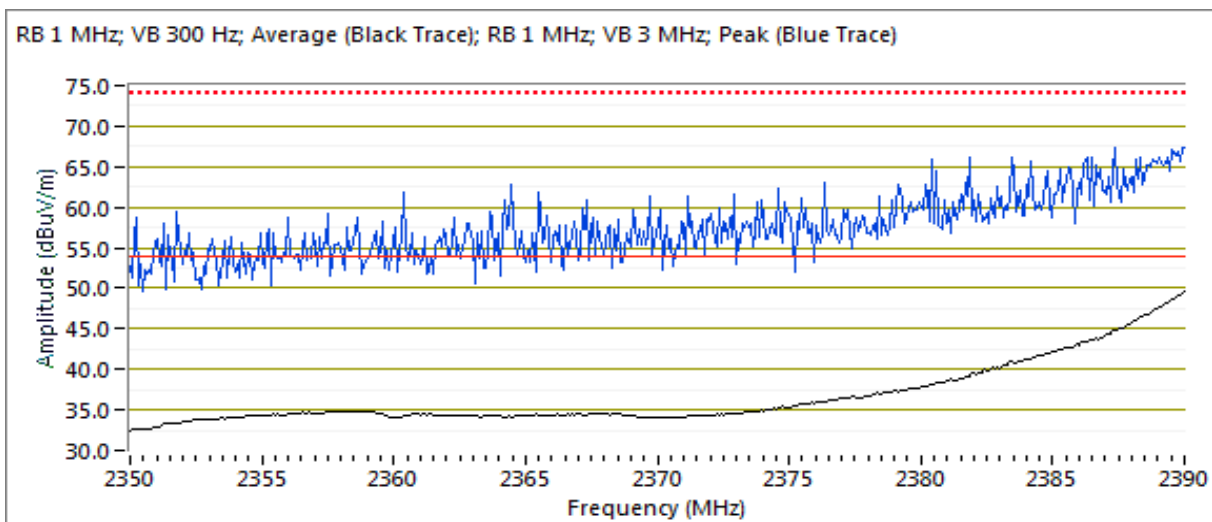
Setting:

Tx Chain: Main

Data Rate: MCS0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2388.790	70.5	H	74.0	-3.5	PK	279	1.3	POS; RB 1 MHz; VB: 3 MHz
2389.870	50.1	H	54.0	-3.9	AVG	279	1.3	Note 5; RB 1 MHz; VB: 300 Hz
2389.250	67.2	V	74.0	-6.8	PK	339	1.6	POS; RB 1 MHz; VB: 3 MHz
2389.940	46.5	V	54.0	-7.5	AVG	339	1.6	POS; RB 1 MHz; VB: 300 Hz



Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

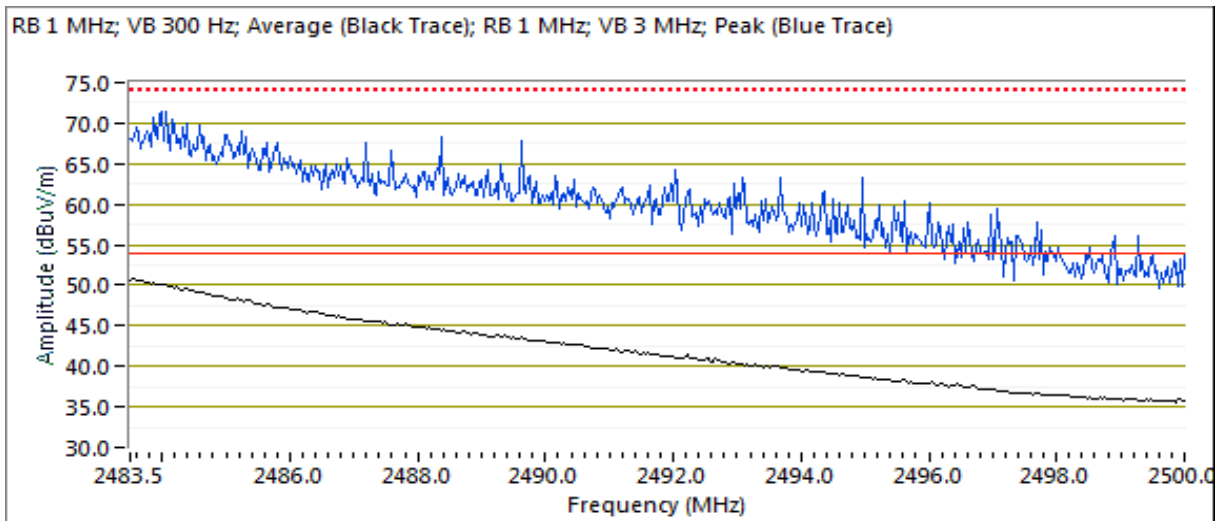
Date of Test: 10/5/2017
 Test Engineer: Mehran Birgani
 Test Location: FT Ch#4

Config. Used: 1
 Config Change: None
 EUT Voltage: Battery operated

Channel: 11 Mode: n20 Setting:
 Tx Chain: Main Data Rate: MCS0

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2483.670	72.1	H	74.0	-1.9	PK	277	1.6	POS; RB 1 MHz; VB: 3 MHz
2483.890	72.0	V	74.0	-2.0	PK	318	1.7	POS; RB 1 MHz; VB: 3 MHz
2483.520	50.9	H	54.0	-3.1	AVG	277	1.6	Note 5; RB 1 MHz; VB: 300 Hz
2483.710	49.3	V	54.0	-4.7	AVG	318	1.7	Note 5; RB 1 MHz; VB: 300 Hz



Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

RSS-247 and FCC 15.247 (DTS) Radiated Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT, unless otherwise noted.

Ambient Conditions:

Temperature: 21-24 °C

Rel. Humidity: 35-40 %

Summary of Results - Device Operating in the 2400-2483.5 MHz Band

Run #	Mode	Channel	Target Power	Power Setting	Test Performed	Limit	Result / Margin
1	b	1 - 2412MHz			Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	53.2 dBµV/m @ 4824.0 MHz (-0.7 dB)
	b	6 - 2437MHz			Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	52.9 dBµV/m @ 4874.0 MHz (-1.1 dB)
	b	11 - 2462MHz			Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	47.4 dBµV/m @ 4924.0 MHz (-6.6 dB)
Scans on center channel in all three OFDM modes to determine the worst case mode.							
2	g	6 - 2437MHz			Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	51.2 dBµV/m @ 4874.0 MHz (-2.8 dB)
	n20	6 - 2437MHz			Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	50.6 dBµV/m @ 4874.1 MHz (-3.4 dB)
Measurements on low and high channels in worst-case OFDM mode.							
3	g	1 - 2412MHz			Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	50.6 dBµV/m @ 4824.0 MHz (-3.4 dB)
	g	11 - 2462MHz			Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	45.3 dBµV/m @ 4924.0 MHz (-8.7 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Sample Notes

Sample S/N: DVT2_036 (945-0270)

Firmware: 0.4.0.0.1389.0

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074

Peak measurements performed with: RBW=1 MHz, VBW=3 MHz, peak detector, max hold, auto sweep time

Unless otherwise stated/noted, emission has duty cycle $\geq 98\%$ and was measured using RBW=1 MHz, VBW=10 Hz, peak detector, linear average mode, auto sweep time, max hold.

2.4GHz band reject filter used

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11b	1 Mbps	0.98	Yes	12.461	0	0	10
11g	6 Mbps	0.96	Yes	5.396	0.2	0.4	185
n20	MCS0	0.95	Yes	4.521	0.2	0.5	221

Measurement Specific Notes:

Note 1:	Emission in non-restricted band, but limit of 15.209 used.
Note 2:	Emission in non-restricted band, the limit was set 30dB below the level of the fundamental and measured in 100kHz.
Note 3:	Emission has a duty cycle $\geq 98\%$, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces
Note 4:	Emission has constant duty cycle $< 98\%$, average measurement performed: RBW=1MHz, VBW $> 1/T$ but not less than 10Hz, peak detector, linear averaging, auto sweep, trace average 100 traces, measurement corrected by Linear voltage correction factor
Note 5:	Emission has constant duty cycle $< 98\%$, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces, measurement corrected by Pwr correction factor
Note 6:	Emission has non constant duty cycle $< 98\%$, average measurement performed: RBW=1MHz, VBW $> 1/T$, peak detector, linear average mode, sweep time auto, max hold. Max hold for $50 \cdot (1/DC)$ traces
Note 7:	Emission has non constant duty cycle $< 98\%$, average measurement performed: RBW=1MHz, VBW $> 1/T$, RMS detector, sweep time auto, max hold. Max hold for $50 \cdot (1/DC)$ traces

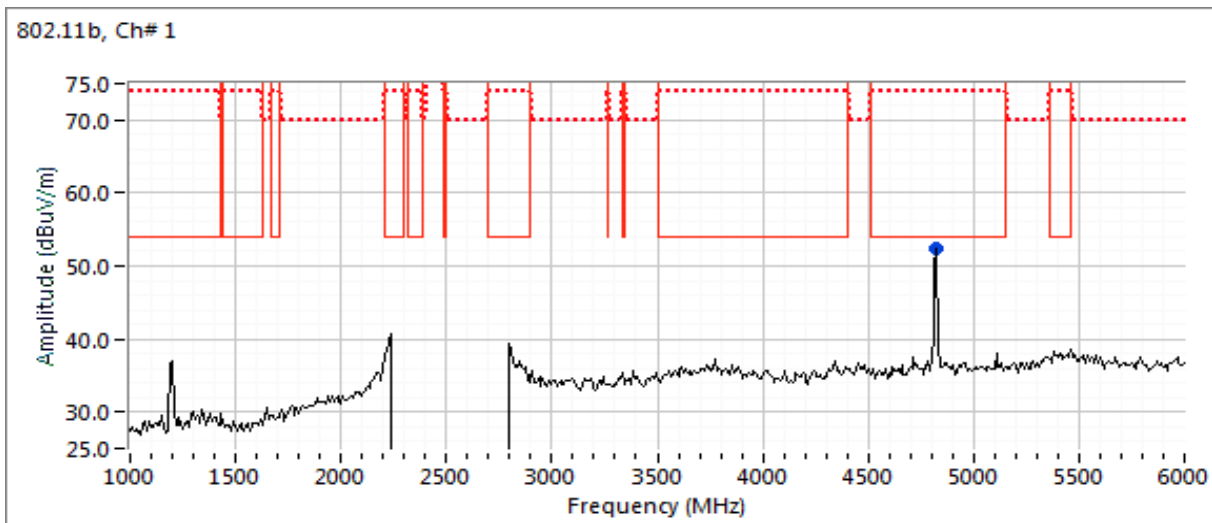
Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Run #1: Radiated Spurious Emissions, 1,000 - 25000 MHz. Operating Mode: 802.11b
 Date of Test: 9/26/2017 Config. Used: 1
 Test Engineer: Deniz Demirci Config Change: None
 Test Location: FT Ch#4 EUT Voltage: Battery operated

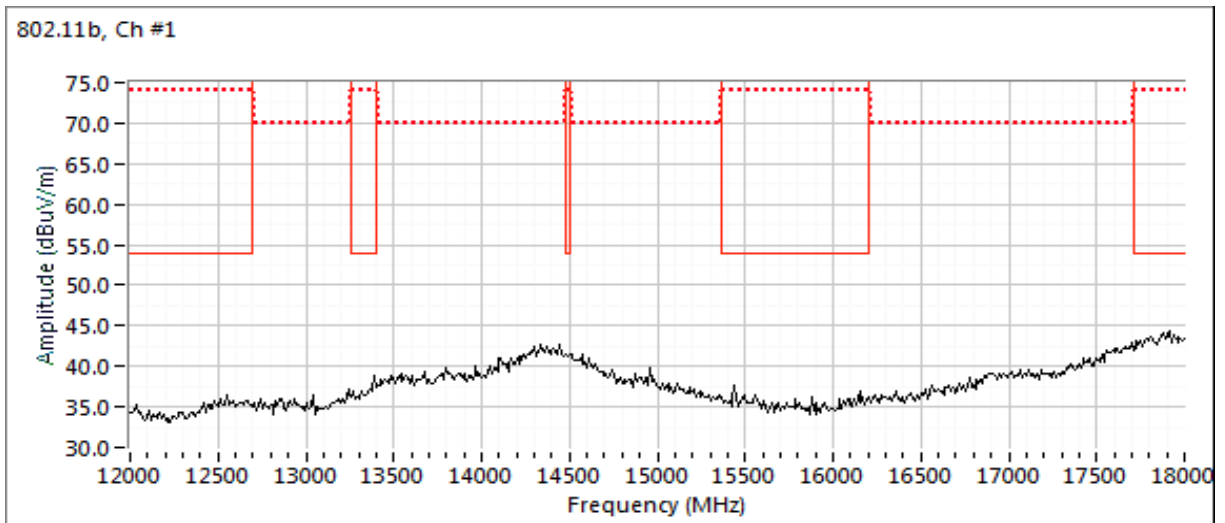
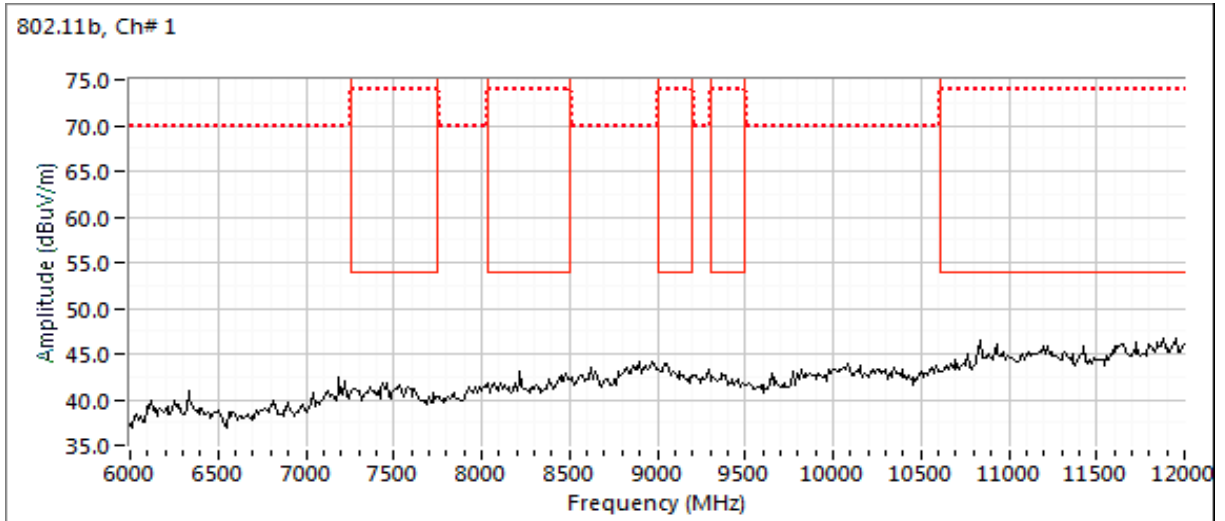
Run #1a: Low Channel

Channel: 1 Mode: b Setting:
 Tx Chain: Main Data Rate: 1 Mbps

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4823.970	53.2	H	54.0	-0.7	AVG	102	1.1	RB 1 MHz;VB 10 Hz;Peak
4824.050	55.2	H	74.0	-18.8	PK	102	1.1	RB 1 MHz;VB 3 MHz;Peak



Client: Neato Robotics	Job Number: JD105849
Model: Botvac D7 Connected	T-Log Number: T105971
Contact: Pawel Orzechowski	Project Manager: Christine Krebill
Standard: RSS-247, FCC 15.247, FCC 15E	Project Coordinator: -
	Class: N/A



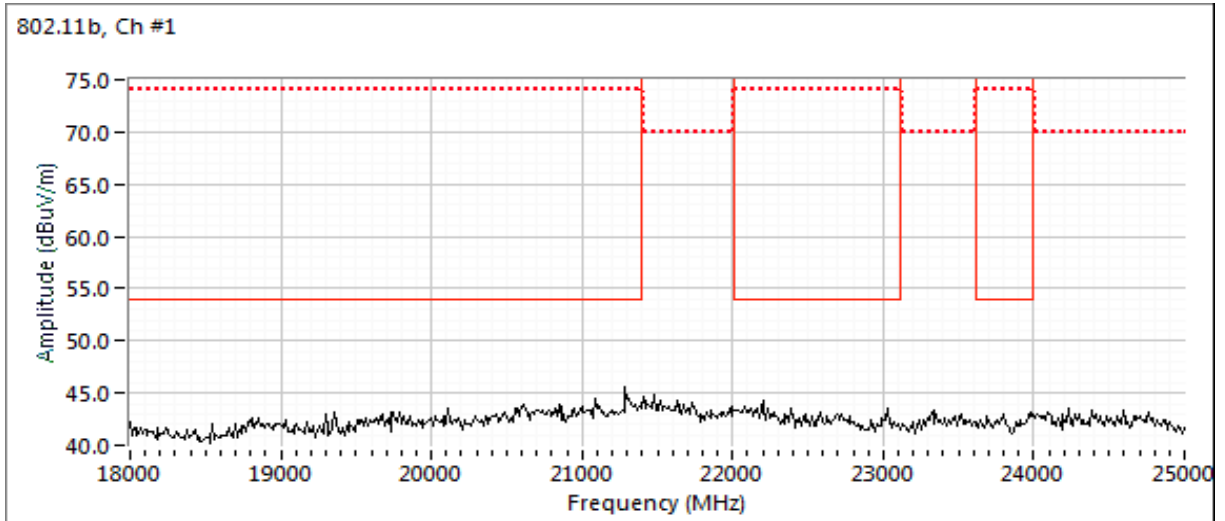


NTS

WE ENGINEER SUCCESS

EMC Test Data

Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A



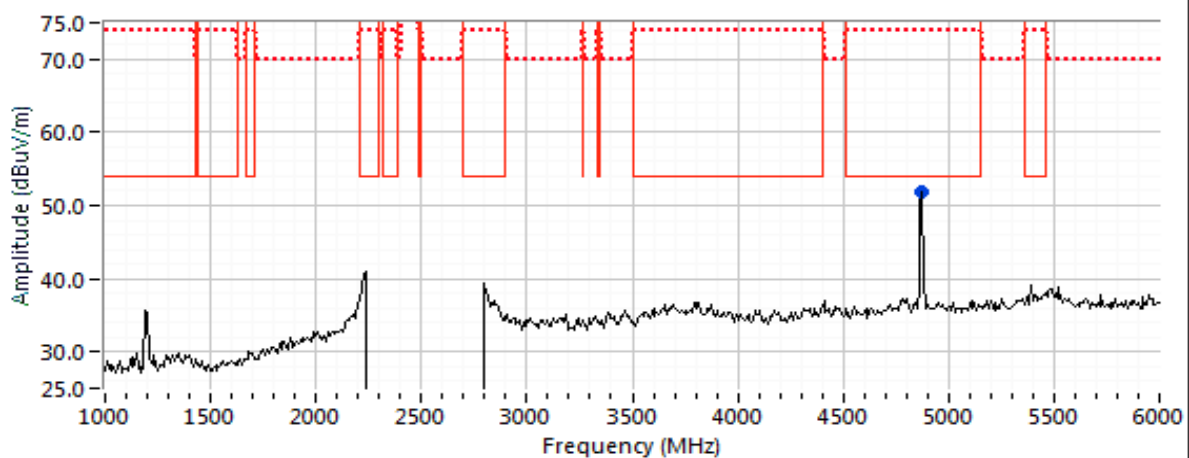
Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Run #1b: Center Channel

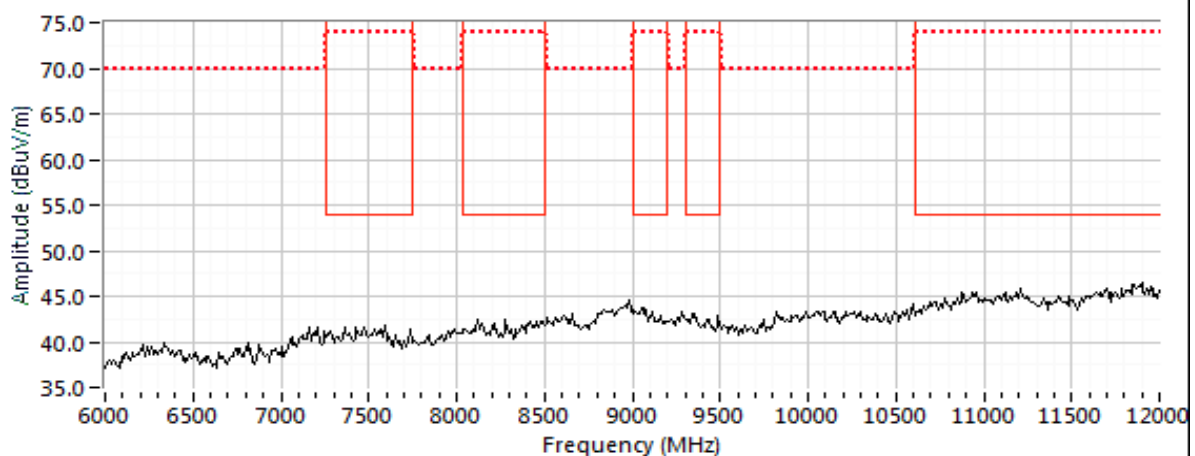
Channel: 6 Mode: b Setting:
 Tx Chain: Main Data Rate: 1 Mbps

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4873.970	52.9	H	54.0	-1.1	AVG	102	1.1	RB 1 MHz;VB 10 Hz;Peak
4874.080	55.0	H	74.0	-19.0	PK	102	1.1	RB 1 MHz;VB 3 MHz;Peak

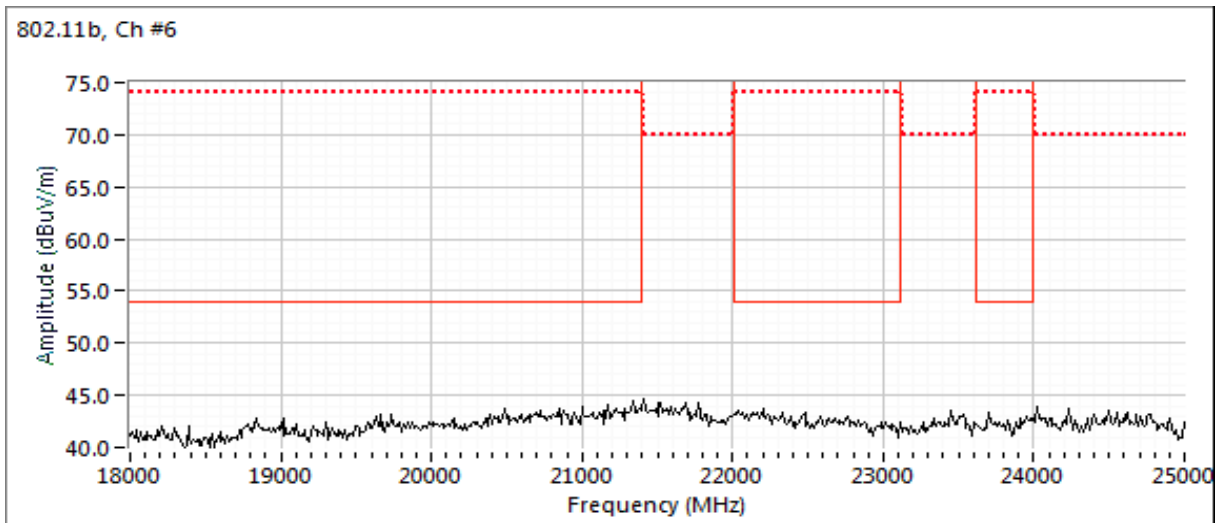
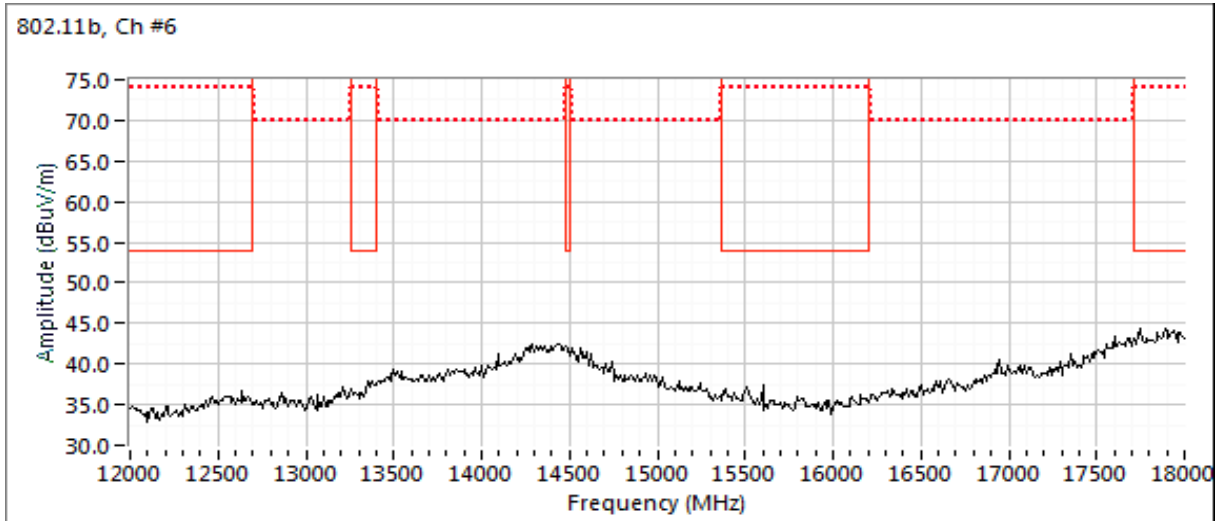
802.11b, Ch# 6



802.11b, Ch# 6



Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

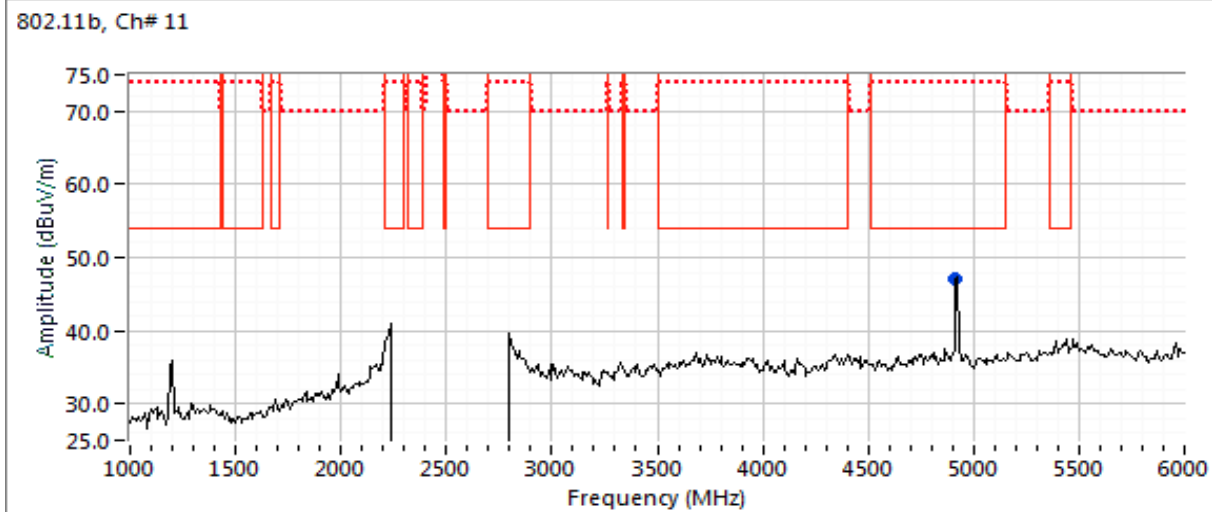


Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

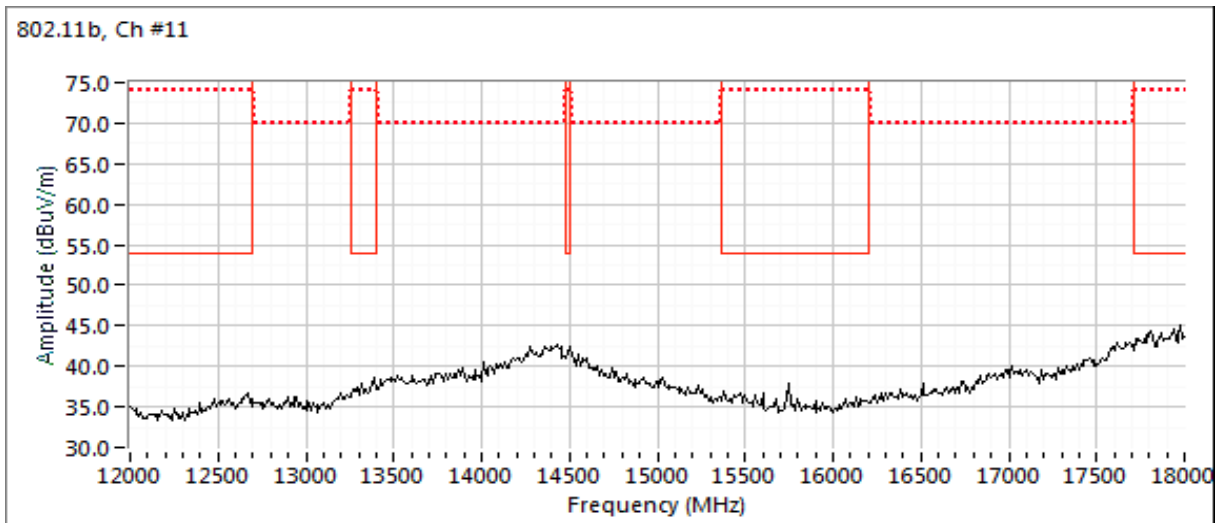
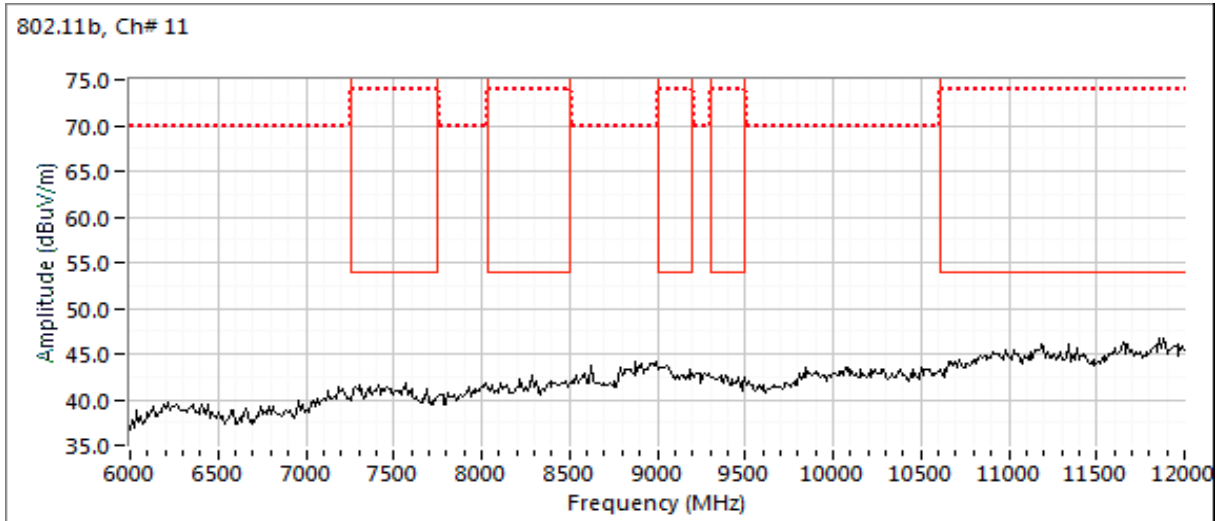
Run #1c: High Channel

Channel: 11 Mode: b Setting:
 Tx Chain: Main Data Rate: 1 Mbps

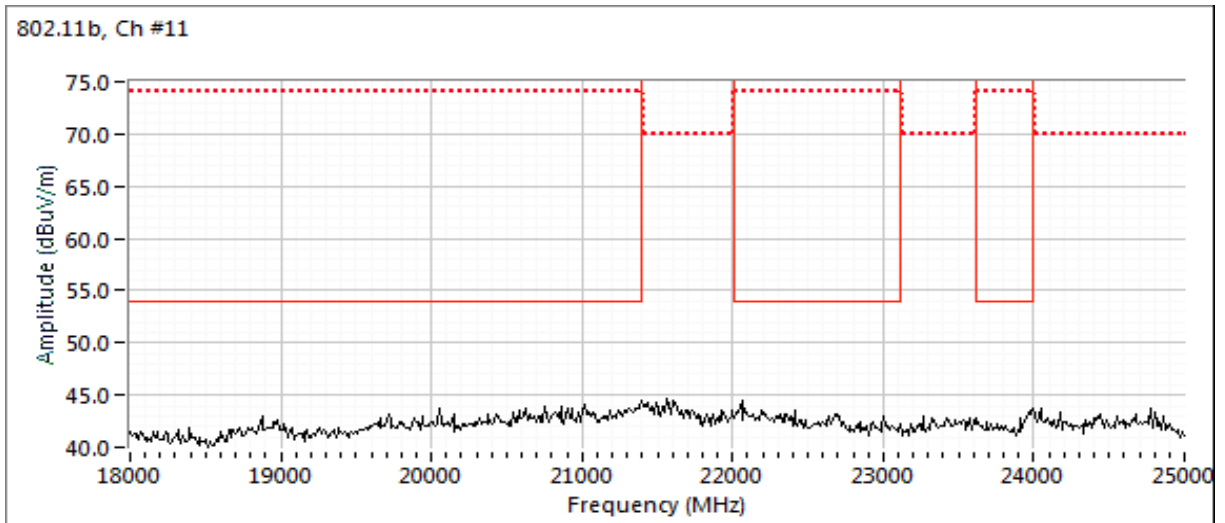
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4924.000	47.4	V	54.0	-6.6	AVG	57	2.4	RB 1 MHz;VB 10 Hz;Peak
4923.980	51.6	V	74.0	-22.4	PK	57	2.4	RB 1 MHz;VB 3 MHz;Peak



Client: Neato Robotics	Job Number: JD105849
Model: Botvac D7 Connected	T-Log Number: T105971
Contact: Pawel Orzechowski	Project Manager: Christine Krebill
Standard: RSS-247, FCC 15.247, FCC 15E	Project Coordinator: -
	Class: N/A



Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A



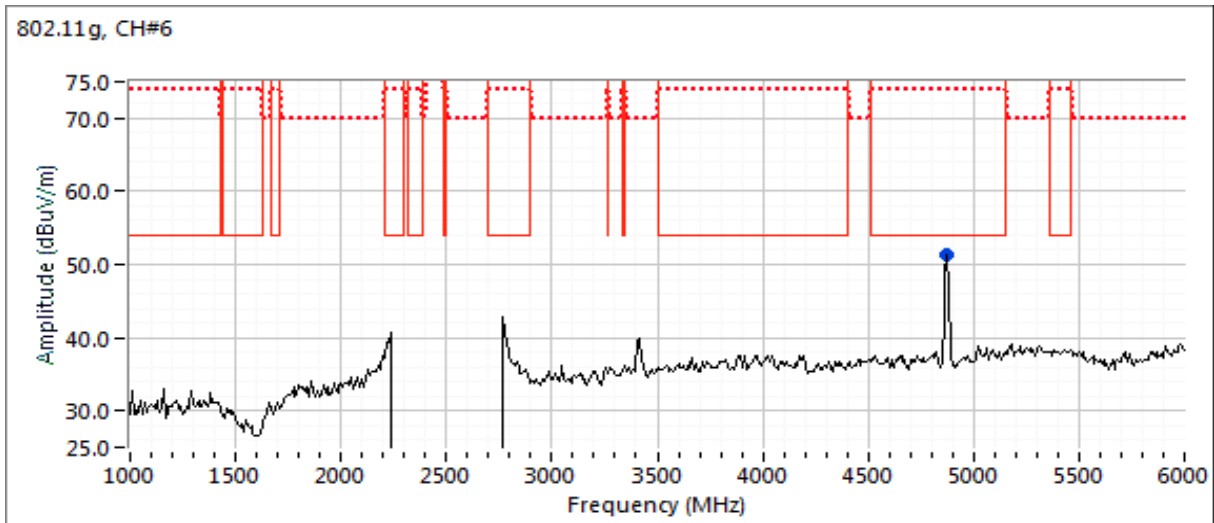
Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Run #2: Radiated Spurious Emissions, 1,000 - 25000 MHz. Operating Mode: OFDM
 Date of Test: 10/9/2017 Config. Used: 1
 Test Engineer: Rafael Varelas Config Change: None
 Test Location: FT Ch#4 EUT Voltage: Battery operated

Run #2a: Center Channel

Channel: 6 Mode: g Setting:
 Tx Chain: Main Data Rate: 6 Mbps

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4873.990	51.2	H	54.0	-2.8	Avg	269	1.1	RB 1 MHz;VB 300 Hz;Peak VAVG 10
4873.840	62.6	H	74.0	-11.4	PK	269	1.1	RB 1 MHz;VB 3 MHz;Peak

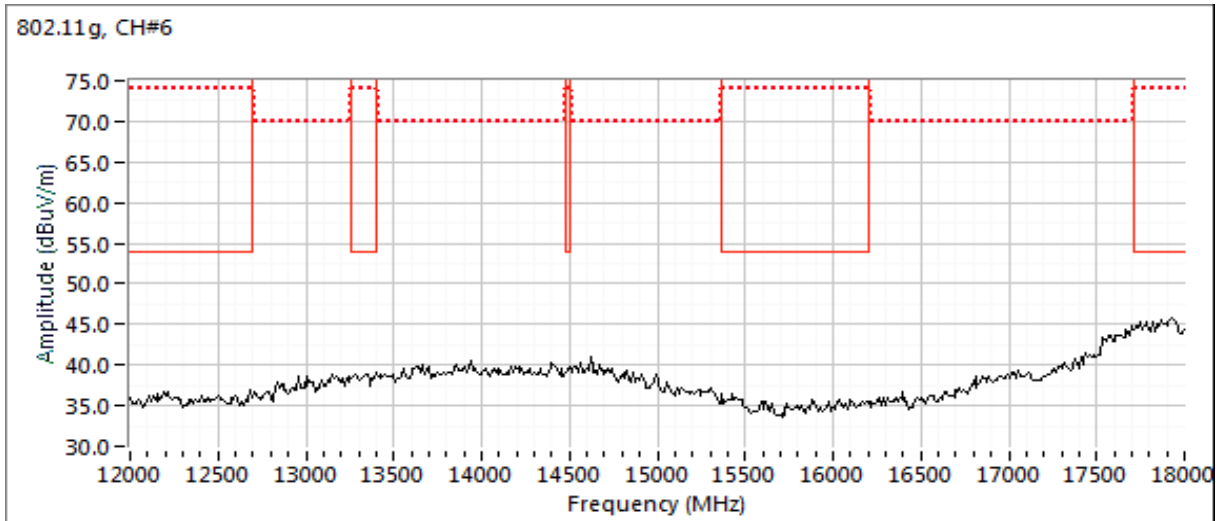
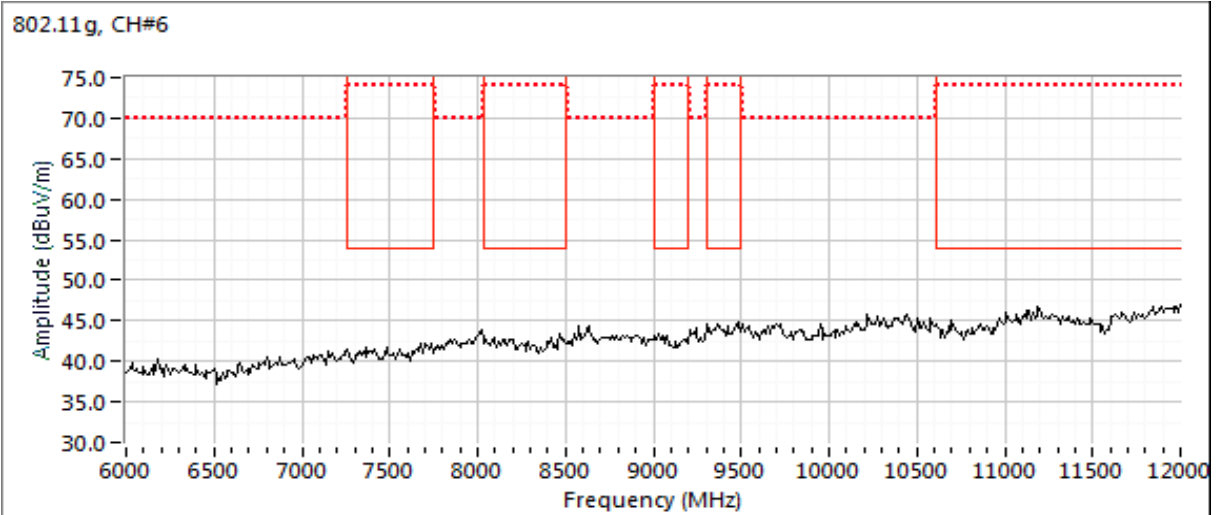


**NTS**

WE ENGINEER SUCCESS

EMC Test Data

Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

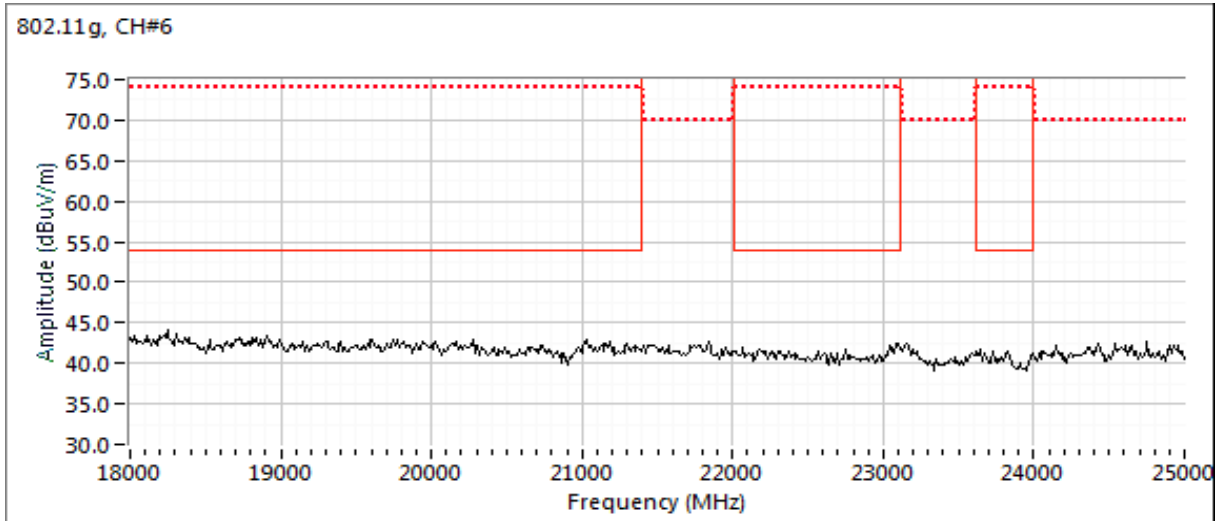


**NTS**

WE ENGINEER SUCCESS

EMC Test Data

Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

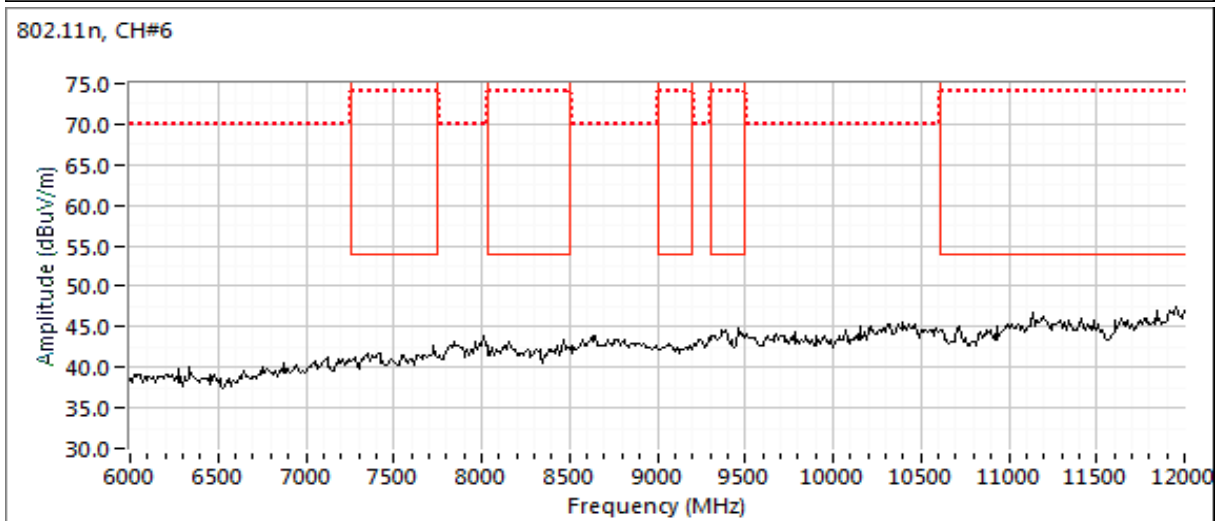
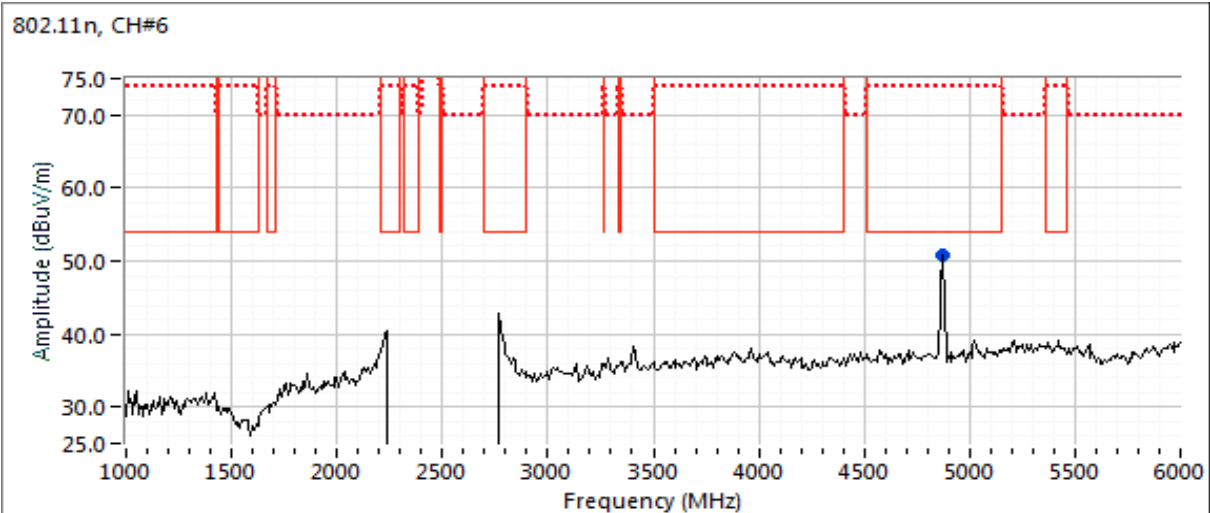


Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

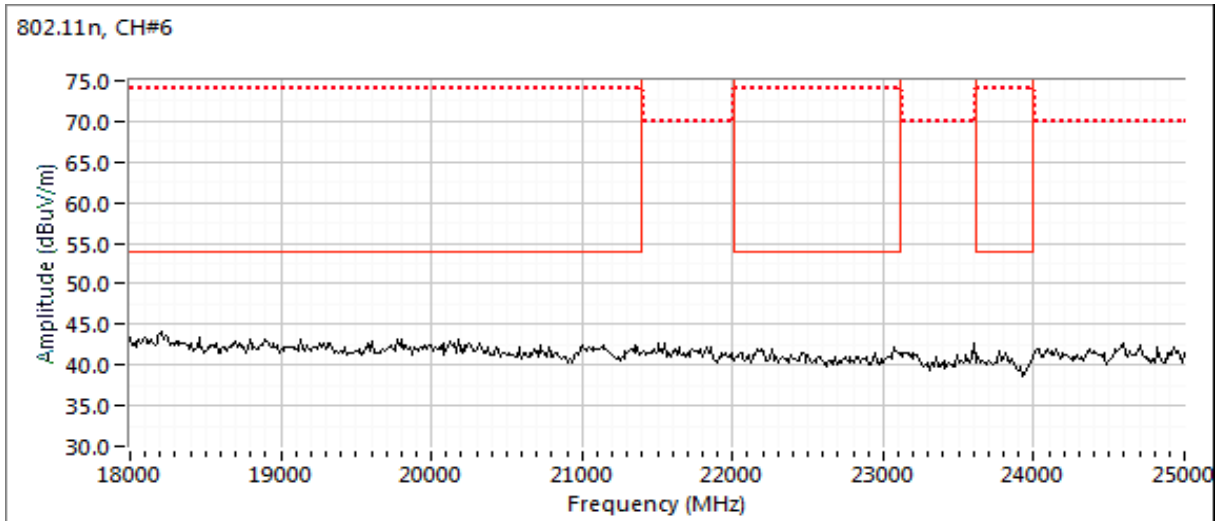
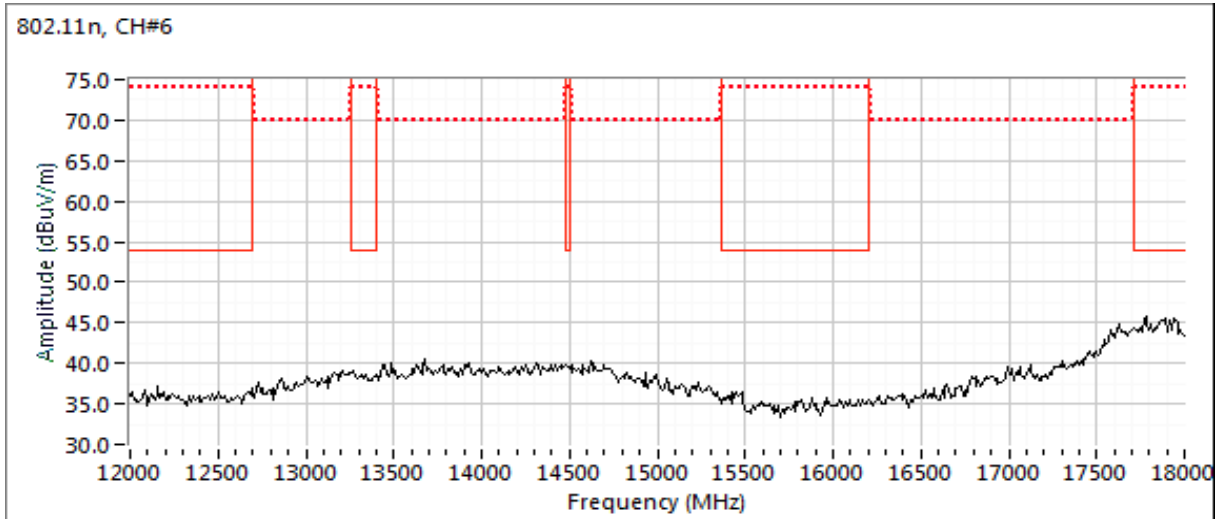
Run #2b: Center Channel

Channel: 6 Mode: n20 Setting:
 Tx Chain: Main Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4874.090	50.6	H	54.0	-3.4	Avg	268	1.0	RB 1 MHz;VB 300 Hz;Peak VAVG 10
4873.420	61.6	H	74.0	-12.4	PK	268	1.0	RB 1 MHz;VB 3 MHz;Peak



Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A



Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Run #3: Radiated Spurious Emissions, 1,000 - 25000 MHz. Operating Mode: Worse case from Run #2

Date of Test: 10/6/2017

Config. Used: 1

Test Engineer: M. Birgani / R. Varelas

Config Change: None

Test Location: FT Ch#4

EUT Voltage: Battery operated

Run #3a: Low Channel

Channel: 1

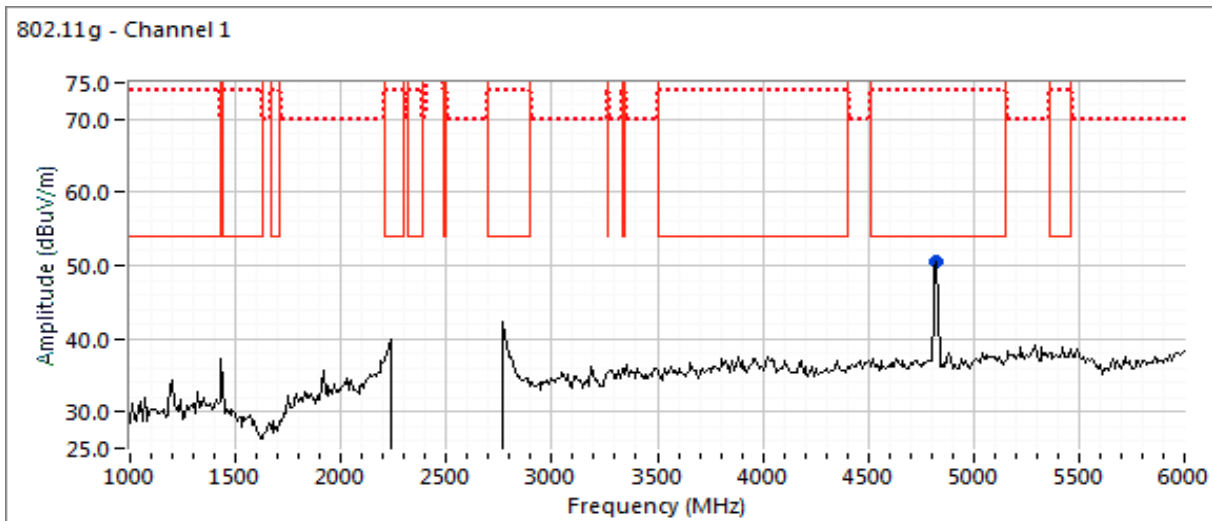
Mode: g

Setting:

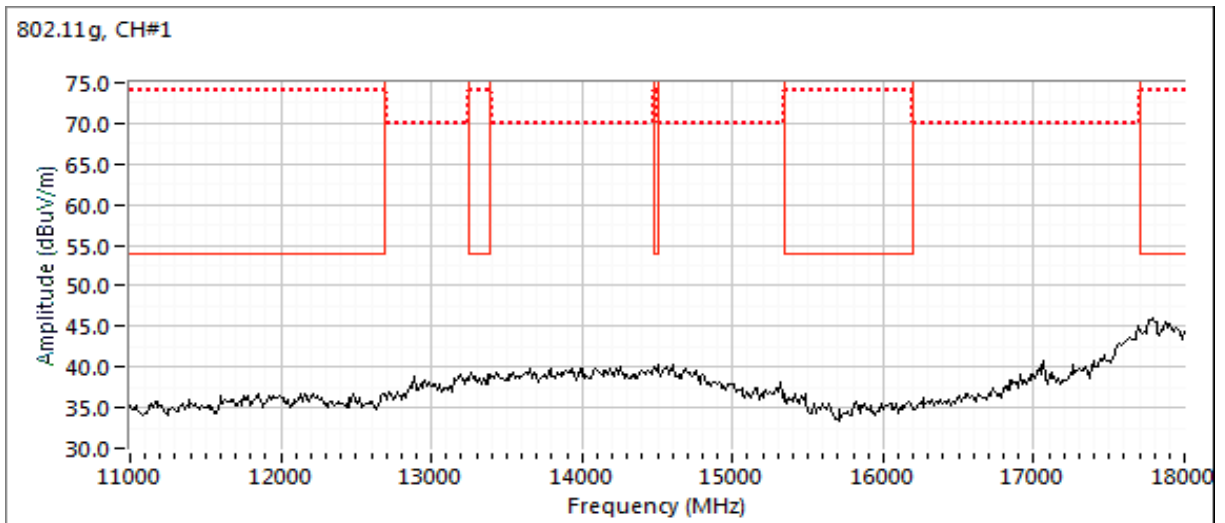
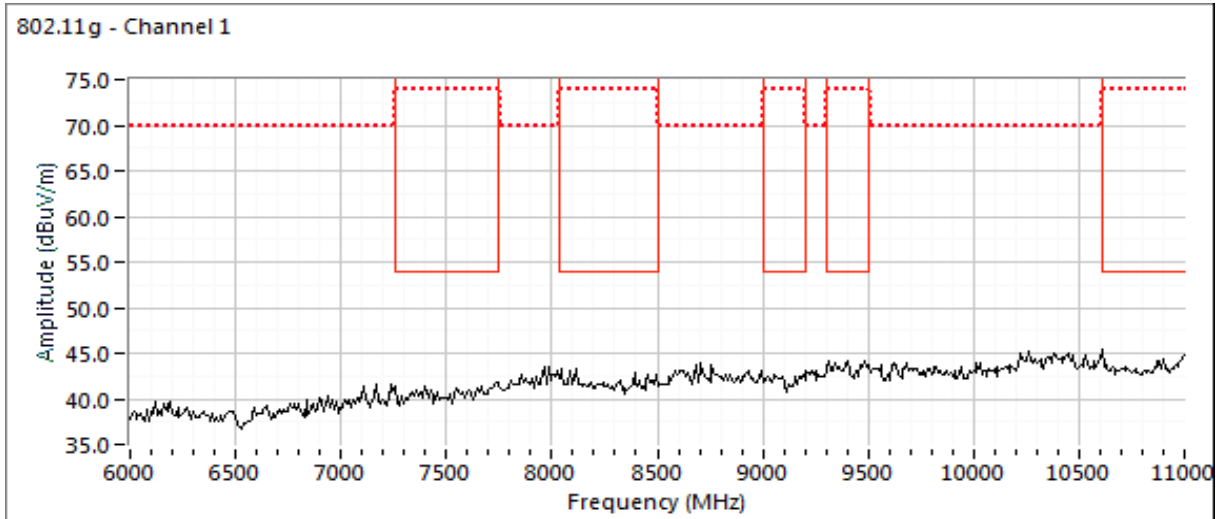
Tx Chain: Main

Data Rate: 6 Mbps

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4823.950	50.6	H	54.0	-3.4	AVG	290	2.1	Note 4; RB 1 MHz; VB: 200 Hz
4824.180	62.2	H	74.0	-11.8	PK	290	2.1	POS; RB 1 MHz; VB: 3 MHz
4823.980	50.5	V	54.0	-3.5	AVG	263	1.6	Note 4; RB 1 MHz; VB: 200 Hz
4824.150	62.5	V	74.0	-11.5	PK	263	1.6	POS; RB 1 MHz; VB: 3 MHz



Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

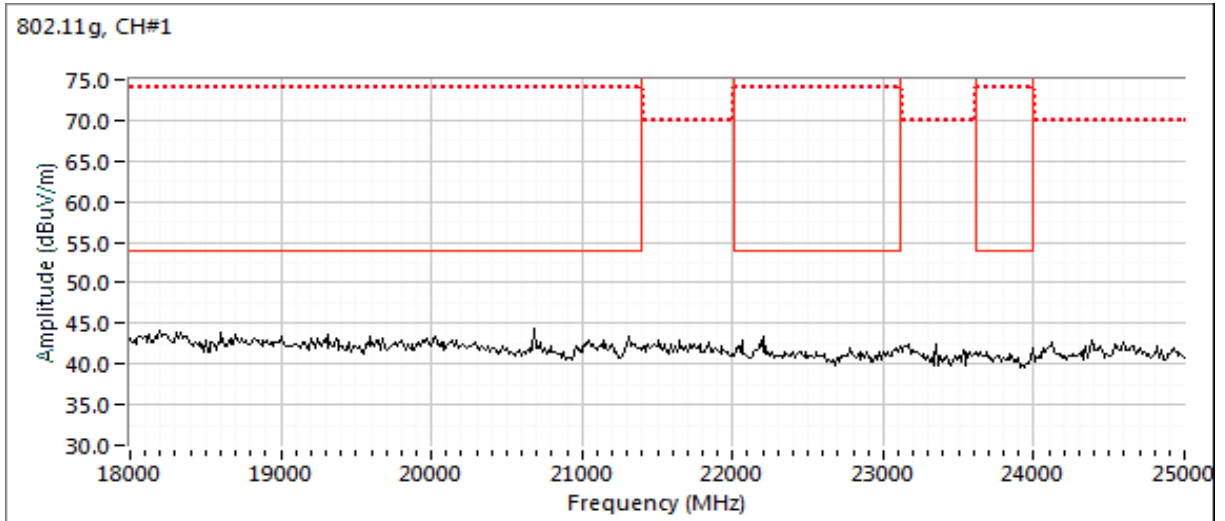


**NTS**

WE ENGINEER SUCCESS

EMC Test Data

Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A



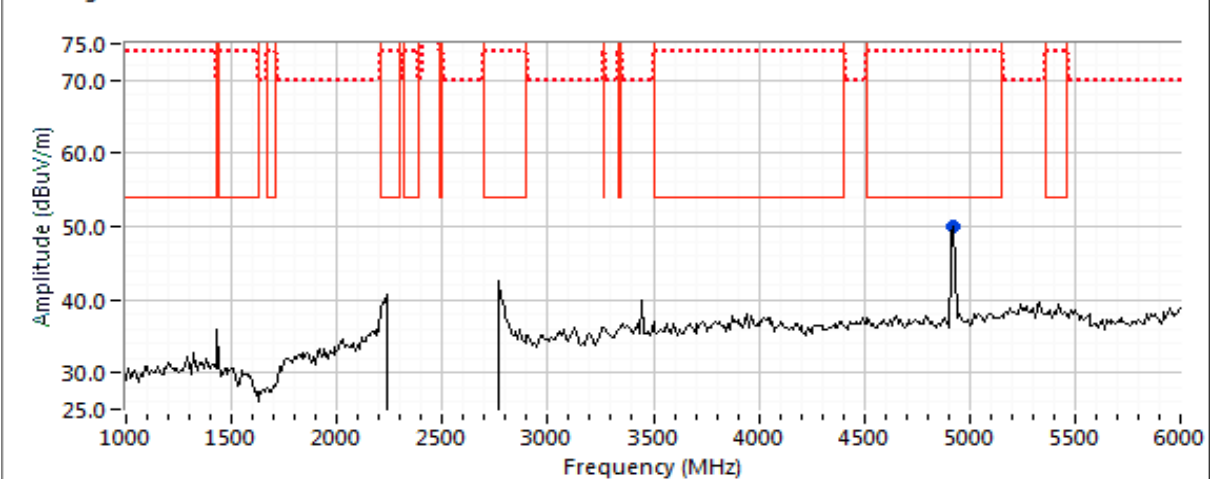
Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Run #3b: High Channel

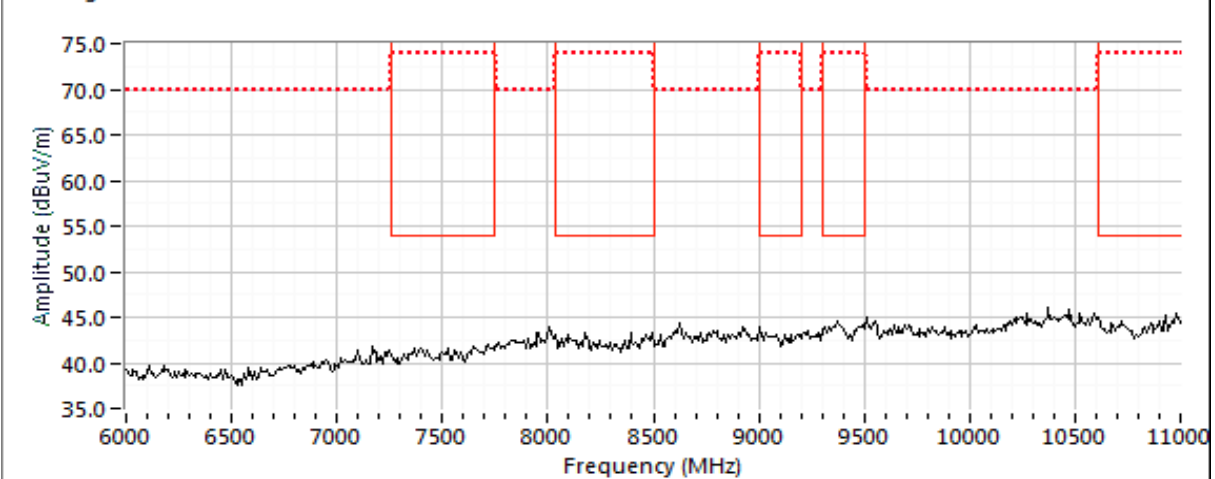
Channel: 11 Mode: g Setting:
 Tx Chain: Main Data Rate: 6 Mbps

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4924.040	45.3	V	54.0	-8.7	AVG	267	1.0	Note 4; RB 1 MHz;VB 300 Hz
4923.930	56.3	V	74.0	-17.7	PK	267	1.0	RB 1 MHz;VB 3 MHz;Peak

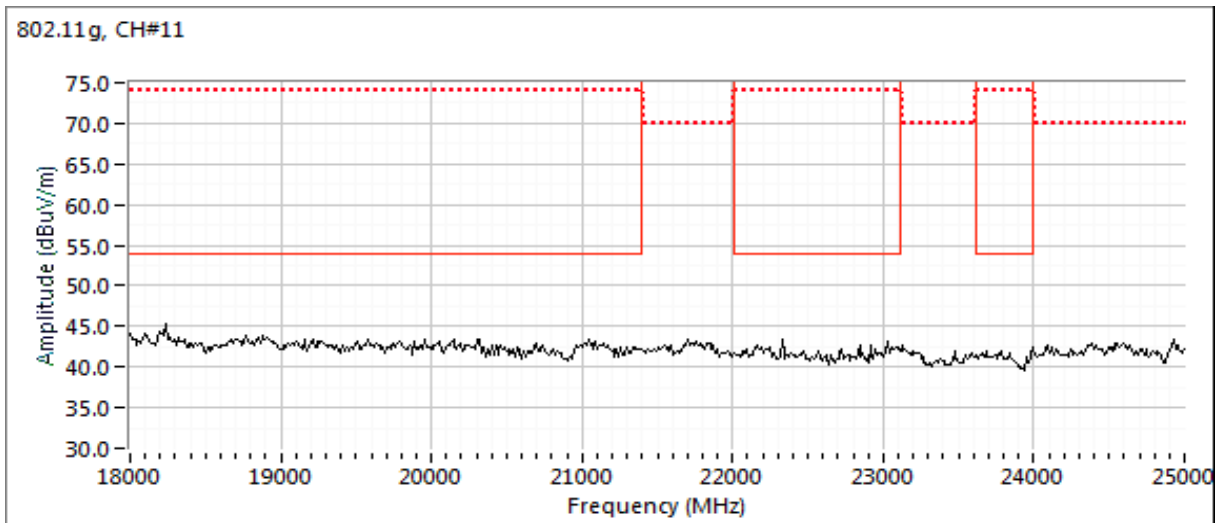
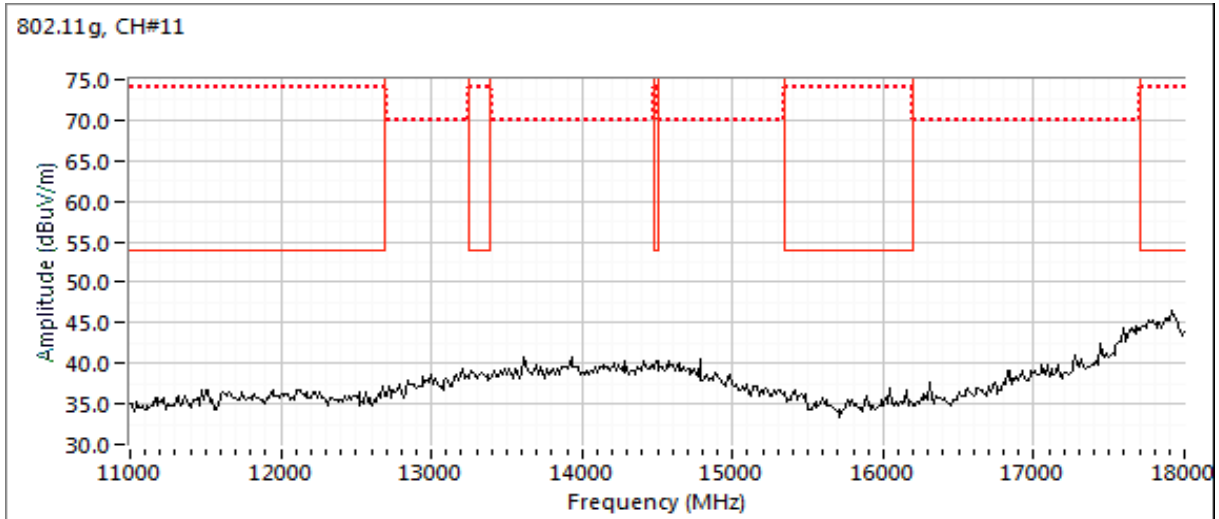
802.11g - Channel 11



802.11g - Channel 11



Client: Neato Robotics	Job Number: JD105849
Model: Botvac D7 Connected	T-Log Number: T105971
Contact: Pawel Orzechowski	Project Manager: Christine Krebill
Standard: RSS-247, FCC 15.247, FCC 15E	Project Coordinator: -
	Class: N/A



Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

RSS-247 and FCC 15.247 (DTS) Radiated Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT, unless otherwise noted.

Ambient Conditions:

Temperature: 21-24 °C

Rel. Humidity: 35-40 %

Summary of Results - Device Operating in the 2400-2483.5 MHz Band

Run #	Mode	Channel	Target Power	Power Setting	Test Performed	Limit	Result / Margin
1	b	6 - 2437MHz			Radiated Emissions, 9 kHz - 1 GHz	FCC Part 15.209 / 15.247(c)	29.2 dBµV/m @ 399.60 MHz (-14.3 dB)
2	n20	40 - 5200 MHz			Radiated Emissions, 9 kHz - 1 GHz	FCC Part 15.209 / 15.247(c)	31.2 dBµV/m @ 222.08 MHz (-12.3 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Sample Notes

Sample S/N: DVT2_036 (945-0270)

Firmware: 0.4.0.0.1389.0

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074

Peak measurements performed with: RBW=1 MHz, VBW=3 MHz, peak detector, max hold, auto sweep time

Unless otherwise stated/noted, emission has duty cycle $\geq 98\%$ and was measured using RBW=1 MHz, VBW=10 Hz, peak detector, linear average mode, auto sweep time, max hold.

2.4GHz band reject filter used

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11b	1 Mbps	0.98	Yes	12.461	0	0	10
n20	MCS0	0.95	Yes	4.521	0.2	0.5	221

Measurement Specific Notes:

Note 1:	Emission in non-restricted band, but limit of 15.209 used.
Note 2:	Emission in non-restricted band, the limit was set 30dB below the level of the fundamental and measured in 100kHz.
Note 3:	Emission has a duty cycle $\geq 98\%$, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces
Note 4:	Emission has constant duty cycle $< 98\%$, average measurement performed: RBW=1MHz, VBW $> 1/T$ but not less than 10Hz, peak detector, linear averaging, auto sweep, trace average 100 traces, measurement corrected by Linear voltage correction factor
Note 5:	Emission has constant duty cycle $< 98\%$, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces, measurement corrected by Pwr correction factor
Note 6:	Emission has non constant duty cycle $< 98\%$, average measurement performed: RBW=1MHz, VBW $> 1/T$, peak detector, linear average mode, sweep time auto, max hold. Max hold for $50 \cdot (1/DC)$ traces
Note 7:	Emission has non constant duty cycle $< 98\%$, average measurement performed: RBW=1MHz, VBW $> 1/T$, RMS detector, sweep time auto, max hold. Max hold for $50 \cdot (1/DC)$ traces



EMC Test Data

Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

Run #1: Radiated Spurious Emissions, 9 kHz - 1000 MHz.

Date of Test: 9/26/2017 0:00
 Test Engineer: Rafael Varelas
 Test Location: FT Ch#4

Config. Used: 1
 Config Change: None
 EUT Voltage: Battery operated

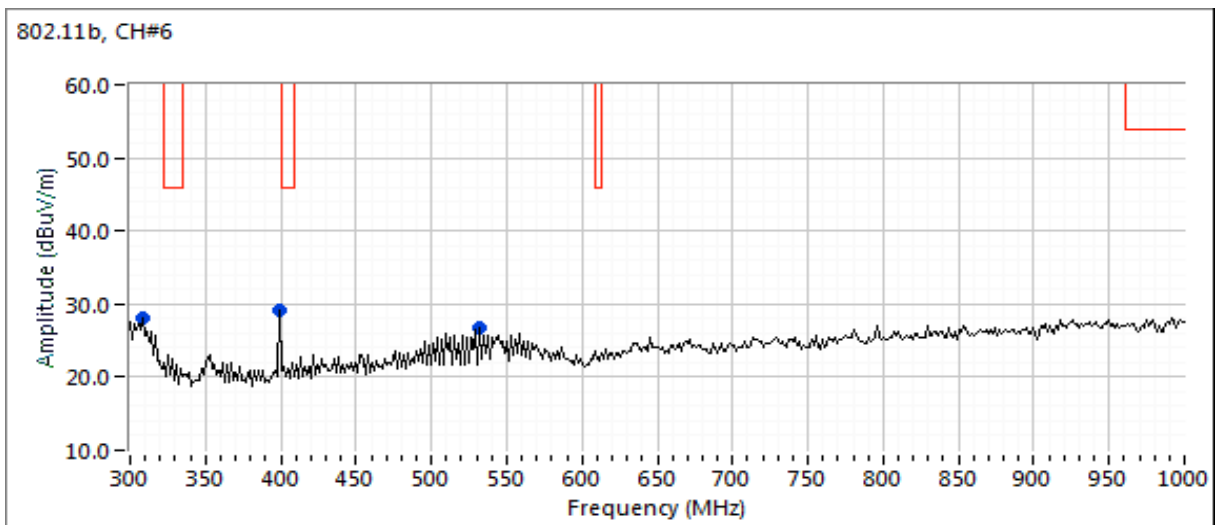
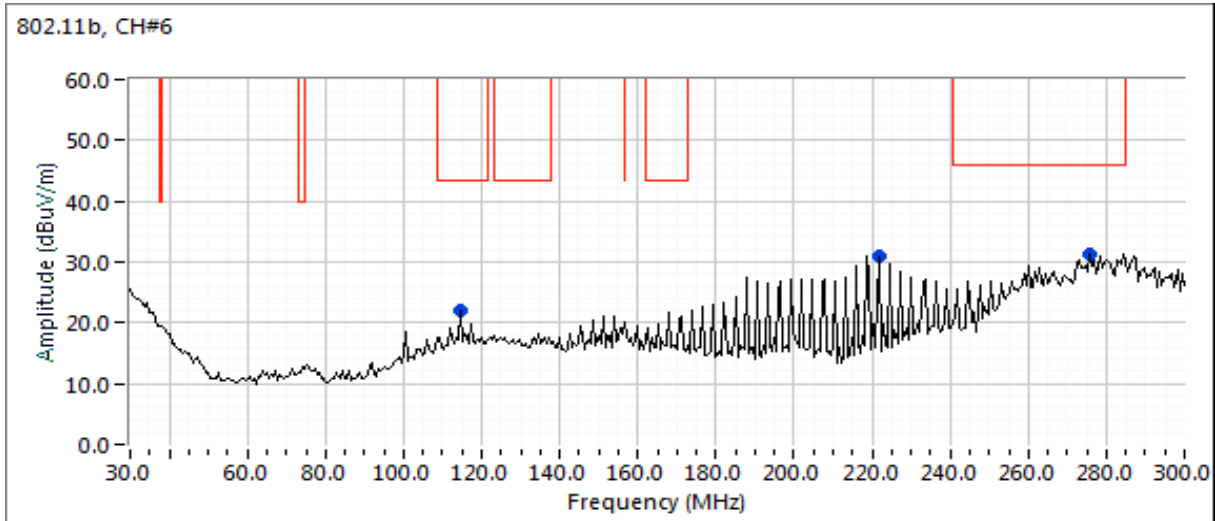
Run #1a: Center Channel - Operating Mode: 802.11b

Channel: 6 Mode: b Setting:
 Tx Chain: Main Data Rate: 1 Mbps

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
399.599	29.2	H	43.5	-14.3	Peak	195	1.0	Note 1
275.651	31.2	V	46.0	-14.8	Peak	14	1.0	
222.084	31.1	V	46.0	-14.9	Peak	18	1.0	Note 1
308.417	28.1	H	43.5	-15.4	Peak	345	1.0	Note 1
531.463	26.8	H	43.5	-16.7	Peak	32	1.5	Note 1
114.409	21.9	V	43.5	-21.6	Peak	296	3.0	

Note: Scans made between 9 kHz - 30 MHz and there were no significant emissions in this frequency range

Client: Neato Robotics	Job Number: JD105849
Model: Botvac D7 Connected	T-Log Number: T105971
Contact: Pawel Orzechowski	Project Manager: Christine Krebill
Standard: RSS-247, FCC 15.247, FCC 15E	Project Coordinator: -
	Class: N/A





EMC Test Data

Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	N/A

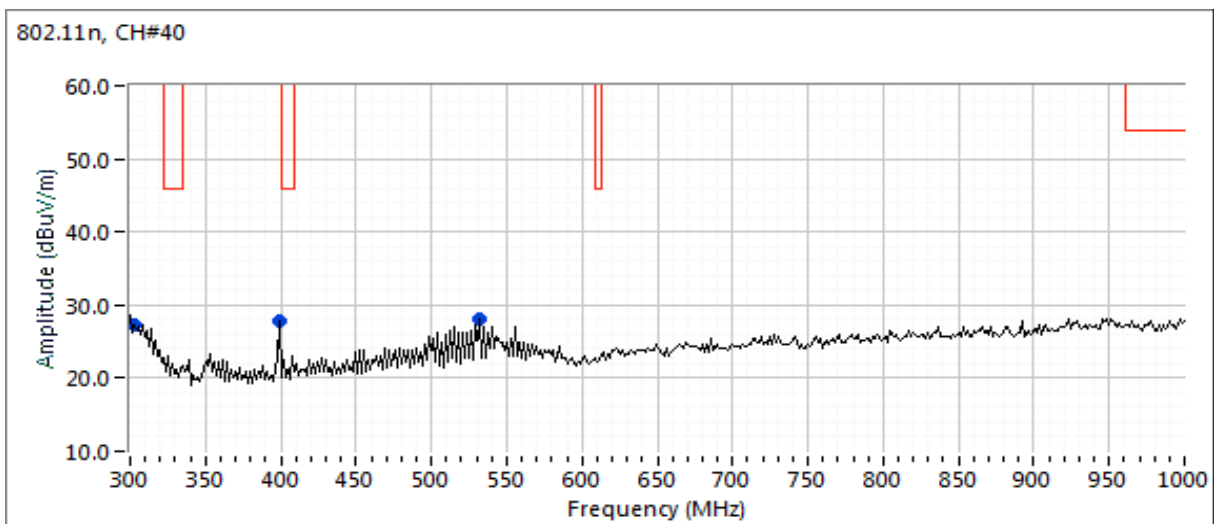
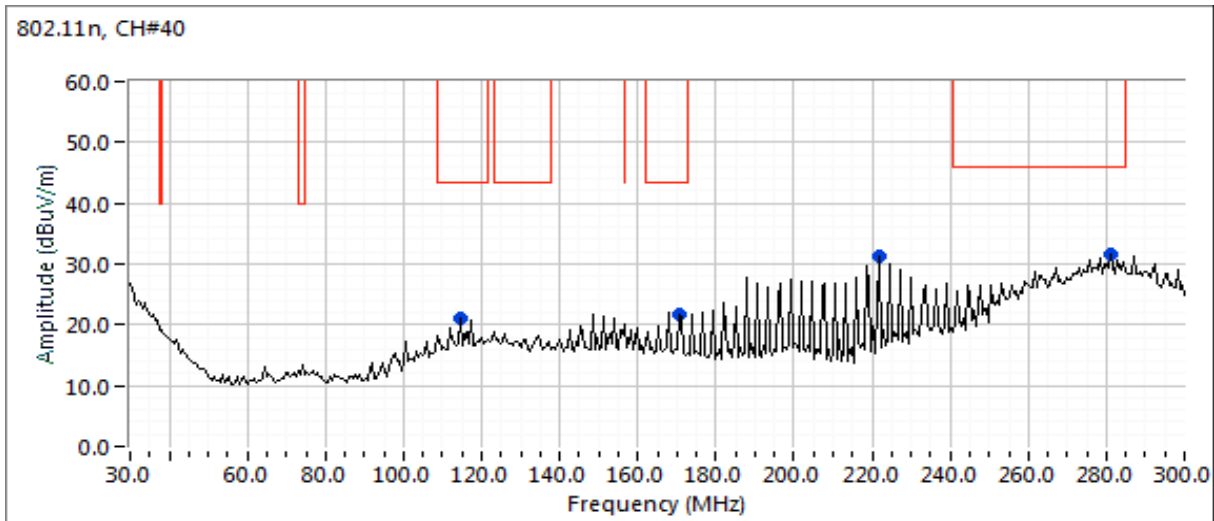
Run #1b: Center Channel - Operating Mode: 802.11n20

Channel: 40 Mode: n20 Setting:
Tx Chain: Main Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
222.084	31.2	V	43.5	-12.3	Peak	20	1.0	Note 1
281.062	31.5	V	46.0	-14.5	Peak	20	1.0	
531.463	28.1	V	46.0	-17.9	Peak	21	1.5	Note 1
399.599	27.9	V	46.0	-18.1	Peak	214	1.0	Note 1
302.806	27.3	H	46.0	-18.7	Peak	46	1.0	Note 1
170.681	21.8	H	43.5	-21.7	Peak	2	1.0	
114.409	21.2	V	43.5	-22.3	Peak	290	1.5	

Note: Scans made between 9 kHz - 30 MHz and there were no significant emissions in this frequency range

Client: Neato Robotics	Job Number: JD105849
Model: Botvac D7 Connected	T-Log Number: T105971
Contact: Pawel Orzechowski	Project Manager: Christine Krebill
Standard: RSS-247, FCC 15.247, FCC 15E	Project Coordinator: -
	Class: N/A





EMC Test Data

Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	B

Conducted Emissions

(NTS Silicon Valley, Fremont Facility, Semi-Anechoic Chamber)

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 9/26/2017
Test Engineer: Rafael varelas
Test Location: Fremont Chamber #4

Config. Used: 1
Config Change: None
EUT Voltage: 120V/60Hz

General Test Configuration

For tabletop equipment, the EUT was located on a wooden table inside the semi-anechoic chamber, 40 cm from a vertical coupling plane and 80cm from the LISN.

Ambient Conditions: Temperature: 22.4 °C
 Rel. Humidity: 38 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power, 120V/60Hz	Class B	Pass	43.7 dBμV @ 0.160 MHz (-21.7 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

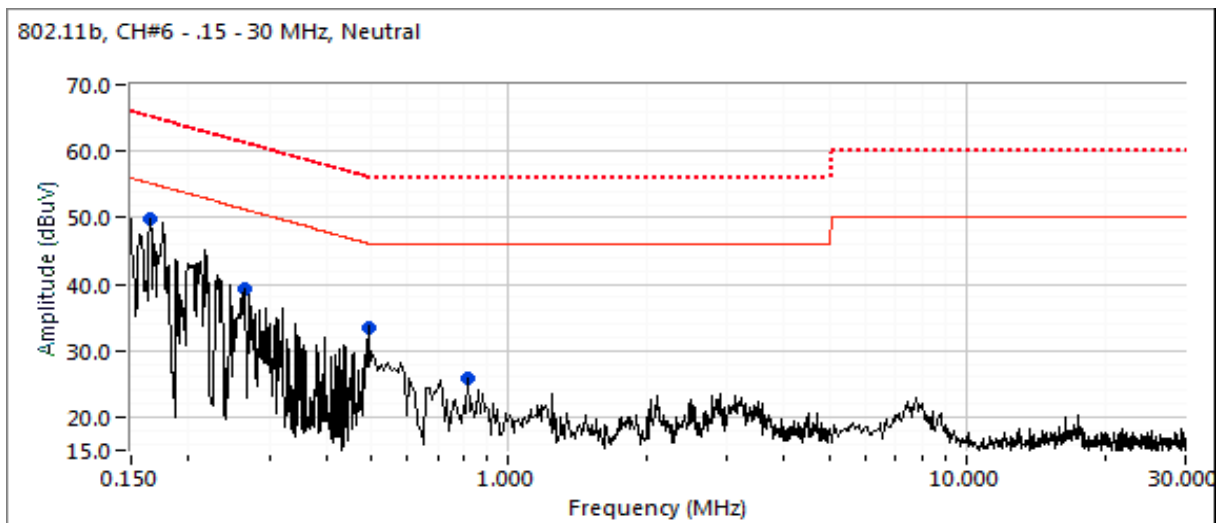
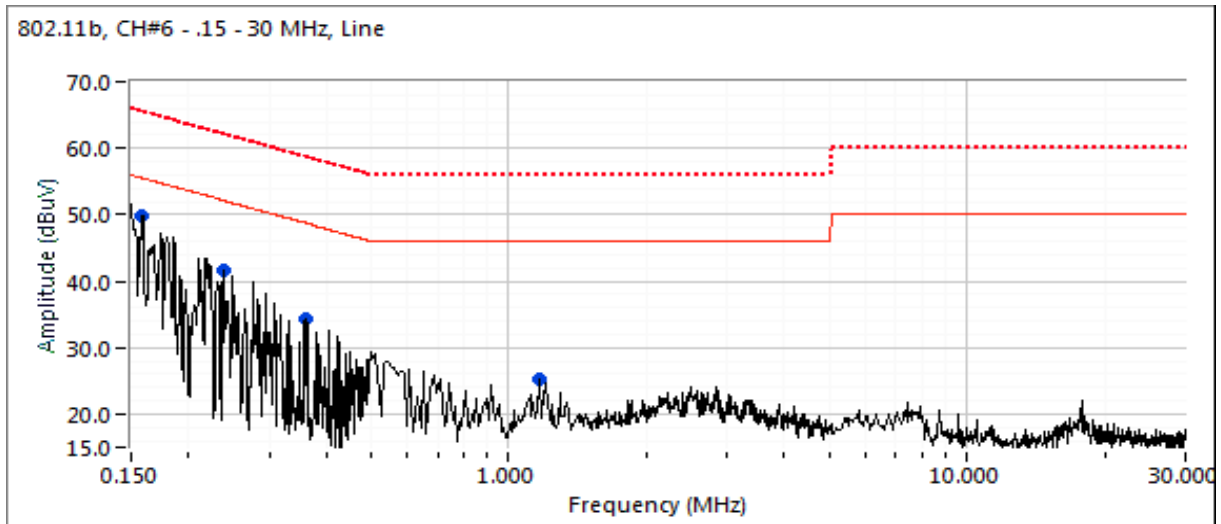
Sample Notes

Sample S/N: DVT2_036 (945-0270)
Firmware: 4.0.0.1398.0

Client: Neato Robotics	Job Number: JD105849
Model: Botvac D7 Connected	T-Log Number: T105971
Contact: Pawel Orzechowski	Project Manager: Christine Krebill
Standard: RSS-247, FCC 15.247, FCC 15E	Project Coordinator: -
	Class: B

Run #1: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz

802.11b Ch #6, transmitting continuously. Battery charging.



Client:	Neato Robotics	Job Number:	JD105849
Model:	Botvac D7 Connected	T-Log Number:	T105971
Contact:	Pawel Orzechowski	Project Manager:	Christine Krebill
Standard:	RSS-247, FCC 15.247, FCC 15E	Project Coordinator:	-
		Class:	B

Preliminary peak readings captured during pre-scan (peak readings vs. average limit)

Frequency MHz	Level dB μ V	AC Line	Class B		Detector QP/Ave	Comments
			Limit	Margin		
0.160	49.8	Line 1	55.5	-5.7	Peak	
0.238	41.5	Line 1	52.2	-10.7	Peak	
0.361	34.2	Line 1	48.7	-14.5	Peak	
1.143	25.3	Line 1	46.0	-20.7	Peak	
0.165	49.9	Neutral	55.2	-5.3	Peak	
0.263	39.4	Neutral	51.3	-11.9	Peak	
0.494	33.5	Neutral	46.1	-12.6	Peak	
0.846	25.7	Neutral	46.0	-20.3	Peak	

Final quasi-peak and average readings

Frequency MHz	Level dB μ V	AC Line	Class B		Detector QP/Ave	Comments
			Limit	Margin		
0.160	43.7	Line 1	65.4	-21.7	QP	QP (1.00s)
0.165	43.0	Neutral	65.2	-22.2	QP	QP (1.00s)
0.238	35.5	Line 1	62.2	-26.7	QP	QP (1.00s)
0.263	33.6	Neutral	61.3	-27.7	QP	QP (1.00s)
0.494	28.2	Neutral	56.1	-27.9	QP	QP (1.00s)
0.494	18.0	Neutral	46.1	-28.1	AVG	AVG (0.10s)
0.361	25.8	Line 1	58.7	-32.9	QP	QP (1.00s)
0.160	21.9	Line 1	55.4	-33.5	AVG	AVG (0.10s)
0.165	21.4	Neutral	55.2	-33.8	AVG	AVG (0.10s)
0.263	16.7	Neutral	51.3	-34.6	AVG	AVG (0.10s)
0.238	16.1	Line 1	52.2	-36.1	AVG	AVG (0.10s)
0.361	11.2	Line 1	48.7	-37.5	AVG	AVG (0.10s)
1.143	8.4	Line 1	46.0	-37.6	AVG	AVG (0.10s)
0.846	8.4	Neutral	46.0	-37.6	AVG	AVG (0.10s)
0.846	16.8	Neutral	56.0	-39.2	QP	QP (1.00s)
1.143	15.8	Line 1	56.0	-40.2	QP	QP (1.00s)

End of Report

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