TÜVRheinland®
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Emissions
Test Report

EUT Name: HSA-15

Model No.: HSA-15

CFR 47 Part 15.247: 2017

Prepared for:

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Revisions

Revision No.	Date MM/DD/YYYY	Reason for Change	Author
0	05/28/2018	Original Document	N/A

Note: Latest revision report will replace all previous reports.

Statement of Compliance

Manufacturer:	Harman International Industries Incorporated 636 Ellis St Mountain View CA 94043
Name of Equipment:	HSA-15
Model No.	HSA-15
Type of Equipment:	Intentional Radiator
Application of Regulations:	CFR 47 Part 15.247: 2017
Test Dates:	10 APR 2018 to 13 APR 2018

Guidance Documents:

Emissions: ANSI C63.10-2013

Test Methods:

Emissions: ANSI C63.10-2013

The electromagnetic compatibility test and documented data described in this report has been performed and recorded by TÜV Rheinland, in accordance with the standards and procedures listed herein. As the responsible authorized agent of the EMC laboratory, I hereby declare that the equipment described above has been shown to be compliant with the EMC requirements of the stated regulations and standards based on these results. If any special accessories and/or modifications were required for compliance, they are listed in the Executive Summary of this report.

This report must not be used to claim product endorsement by A2LA or any agency of the U.S. Government. This report shall not be reproduced except in full, without the written authorization of TÜV Rheinland of North America.

Isaac Aguilar		Arndt Stocker	
Test Engineer	Date May 28, 2018	A2LA Signatory	Date May 28, 2018

Testing Cert #3331.02 **US1131** **2932M-1**

1 Executive Summary

1.1 Scope

This report is intended to document the status of conformance with the requirements of the CFR 47 Part 15.247: 2017 based on the results of testing performed on 10 APR 2018 to 13 APR 2018 on the HSA-15 Model HSA-15 manufactured by Harman International Industries Incorporated. This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

1.2 Purpose

Testing was performed to evaluate the EMC performance of the EUT in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report. The 2412 MHz to 2462 MHz frequency band is covered in this document.

1.3 Summary of Test Results

Table 1: Summary of Test Results

Test	Test Method ANSI C63.10: 2013	Result
Spurious Emission in Transmitted Mode	CFR47 15.209, CFR47 15.247 (d)	**Complied**
Restricted Bands of Operation	CFR47 15.205	**Complied**
AC Power Conducted Emission	CFR47 15.207	**N/A**
Occupied Bandwidth	CFR47 15.247 (a)	**Complied**
Maximum Output Power	CFR47 15.247 (b)	**Complied**
Peak Power Spectral Density	CFR47 15.247 (e),	**Complied**
Out of Band Emission	CFR47 15.247 (d)	**Complied**
RF Exposure	CFR47 15.247 (i), 2.1093 RSS-102 Issue 5	--

Note: This test report covers 2400 MHz to 2483.5 MHz band.

1.4 Special Accessories

None

1.5 Equipment Modifications

None

2 Laboratory Information

2.1 Accreditations & Endorsements

2.1.1 US Federal Communications Commission

TÜV Rheinland of North America at 1279 Quarry Ln, Pleasanton, CA 94566 is recognized by the commission for performing testing services for the general public on a fee basis. These laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (US11311131). The laboratory scope of accreditation includes: Title 47 CFR Parts 15, 18, and 90. The accreditation is updated every 3 years.

2.1.2 NIST / A2LA

TÜV Rheinland of North America is accredited by the National Voluntary Laboratory Accreditation Program, which is administered under the auspices of the National Institute of Standards and Technology. The laboratory has been assessed and accredited in accordance with ISO Guide 17025:1999 and ISO 9002 (Lab Code Testing Cert #3331.02). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

2.1.3 Canada – Industry Canada

TÜV Rheinland of North America at the 1279 Quarry Ln, Pleasanton, CA 94566 address is accredited by Industry Canada for performing testing services for the general public on a fee basis. This laboratory test facilities have been fully described in reports submitted to and accepted by Industry Canada (File Number 2932M). This reference number is the indication to the Industry Canada Certification Officers that the site meets the requirements of RSS 212, Issue 1 (Provisional). The accreditation is updated every 3 years.

2.1.4 Japan – VCCI

The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) is a group that consists of Information Technology Equipment (ITE) manufacturers and EMC test laboratories. The purpose of the Council is to take voluntary control measures against electromagnetic interference from Information Technology Equipment, and thereby contribute to the development of a socially beneficial and responsible state of affairs in the realm of Information Technology Equipment in Japan. TÜV Rheinland of North America at 1279 Quarry Ln, Pleasanton, CA 94566 has been assessed and approved in accordance with the Regulations for Voluntary Control Measures.

VCCI Registration No. for Pleasanton: A-0031

2.1.5 Acceptance by Mutual Recognition Arrangement

The United States has an established agreement with specific countries under the Asia Pacific Laboratory Accreditation Corporation (APLAC) Mutual Recognition Arrangement. Under this agreement, all TÜV Rheinland at 1279 Quarry Ln, Pleasanton, CA 94566 test results and test reports within the scope of the laboratory NIST / A2LA accreditation will be accepted by each member country.

2.2 Test Facilities

All of the test facilities are located at 1279 Quarry Lane, Pleasanton, California 94566, USA. The 5015 Brandin Ct. Fremont CA 94538, USA location is considered a Pleasanton annex.

2.2.1 Emission Test Facility

The Semi-Anechoic chamber and AC Line Conducted measurement facility used to collect the radiated and conducted data has been constructed in accordance with ANSI C63.7:1992. The site has been measured in accordance with and verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4-2014, at a test distance of 3 and 5 meters. The site is listed with the FCC and accredited by A2LA (Lab Code Testing Cert #3331.02). The 3/5-meter semi-anechoic chamber used to collect the radiated data has been verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4-2014, at a test distance of 3 meter and 5 meters. A report detailing this site can be obtained from TÜV Rheinland of North America.

2.2.2 Immunity Test Facility

ESD, EFT, Surge, PQF: These tests are performed in an environmentally controlled room with a 3.7 m x 4.8 m x 3.175 mm thick aluminum floor connected to PE ground.

For ESD testing, tabletop equipment is placed on an insulated mat with a surface resistivity of 10^9 Ohms/square on a 1.6 m x 0.8 m x 0.8 m high non-conductive table with a 3.175 mm aluminum top (Horizontal Coupling Plane). The HCP is connected to the main ground plane via a low impedance ground strap through two 470-kΩ resistors. The Vertical Coupling Plane consists of an aluminum plate 50 cm x 50 cm x 3.175 mm thick. The VCP is connected to the main ground plane via a low impedance ground strap through two 470-kΩ resistors.

For EFT, Surge, PQF, the HCP and VCP are removed.

RF Field Immunity testing is performed in a 7.3m x 4.3m x 4.1m anechoic chamber.

RF Conducted and Magnetic Field Immunity testing is performed on a 4.8m x 3.7m x 3.175mm thick aluminum ground plane.

All test areas allow a minimum distance of 1 meter from the EUT to walls or conducting objects.

2.3 Measurement Uncertainty

Two types of measurement uncertainty are expressed in this report, per *ISO Guide To The Expression Of Uncertainty In Measurement*, 1st Edition, 1995.

The Combined Standard Uncertainty is the standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities; it is equal to the positive square root of the sum of the variances or co-variances of these other quantities, weighted according to how the measurement result varies with changes in these quantities. The term *standard uncertainty* is the result of a measurement expressed as a standard deviation.

2.3.1 Sample Calculation – radiated & conducted emissions

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBµV/m) = RAW - AMP + CBL + ACF

Where: RAW = Measured level before correction (dBµV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

Sample radiated emissions calculation @ 30 MHz

Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dBuV/m)

25 dBuV/m + 17.5 dB – 20 dB + 1.0 dB = 23.5 dBuV/m

2.3.2 Measurement Uncertainty

Per CISPR 16-4-2	**U_{lab}**	**U_{cispr}**
Radiated Disturbance @ 10 meters		
30 – 1,000 MHz	2.25 dB	4.51 dB
Radiated Disturbance @ 3 meters		
30 – 1,000 MHz	2.26 dB	4.52 dB
1 – 6 GHz	2.12 dB	4.25 dB
6 – 18 GHz	2.47 dB	4.93 dB
Conducted Disturbance @ Mains Terminals		
150 kHz – 30 MHz	1.09 dB	2.18 dB

Disturbance Power		
30 MHz – 300 MHz	3.92 dB	4.3 dB

Voltech PM6000A

The estimated combined standard uncertainty for harmonic current and flicker measurements is ± 5.0%.	Per CISPR 16-4-2 Methods

2.3.3 Measurement Uncertainty Immunity

The estimated combined standard uncertainty for ESD immunity measurements is ± 8.2%.	Per IEC 61000-4-2
The estimated combined standard uncertainty for radiated immunity measurements is ± 4.10 dB.	Per IEC 61000-4-3
The estimated combined standard uncertainty for conducted immunity measurements with CDN is ± 3.66 dB	Per IEC 61000-4-6
The estimated combined standard uncertainty for power frequency magnetic field immunity is ± 2.9%.	Per IEC 61000-4-8

Thermo KeyTek EMC Pro

The estimated combined standard uncertainty for EFT fast transient immunity measurements is ± 2.6%.
The estimated combined standard uncertainty for surge immunity measurements is ± 2.6%.
The estimated combined standard uncertainty for voltage variation and interruption measurements is ± 1.74%.

The expanded uncertainty at a level of 95% confidence is obtained by multiplying the combined standard uncertainty by a coverage factor of 2. Compliance criteria are not based on measurement uncertainty.

2.4 Calibration Traceability

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Measurement method complies with ANSI/NCSL Z540-1-1994 and ISO Standard 17025:2005. Equipment calibration records are kept on file at the test facility.

3 Product Information

3.1 Product Description

The Harman HSA-15, is a car OBD sensor for use in a motor vehicle. The device has the capability of operating in the following frequency bands: LTE 2, LTE 4, LTE 5, LTE 12, WCDMA 2, WCDMA 5 and WiFi 2.4 GHz.

3.2 Equipment Configuration

A description of the equipment configuration is given in the Test Plan Section. The EUT was tested as called for in the test standard and was configured and operated in a manner consistent with its intended use. The placement of the EUT system components was guided by the test standard and selected to represent typical installation conditions.

In the case of an EUT that can operate in more than one configuration, preliminary testing was performed to determine the configuration that produced maximum radiation.

The final configuration was selected to produce the worst case radiation for emissions testing and to place the EUT in the most susceptible state for immunity testing.

3.3 Operating Mode

A description of the operation mode is given in the Test Plan Section. In the case of an EUT that can operate in more than one state, preliminary testing was performed to determine the operating mode that produced maximum radiation.

The final operating mode was selected to produce the worst case radiation for emissions testing..

3.4 Unique Antenna Connector

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of CFR47 Parts 15.211, 15.213, 15.217, 15.219, or 15.221.

3.4.1 Results

Harman OBD II has integral antennas which cannot be removed without making the device unusable for transmission.

3.5 Duty Cycle

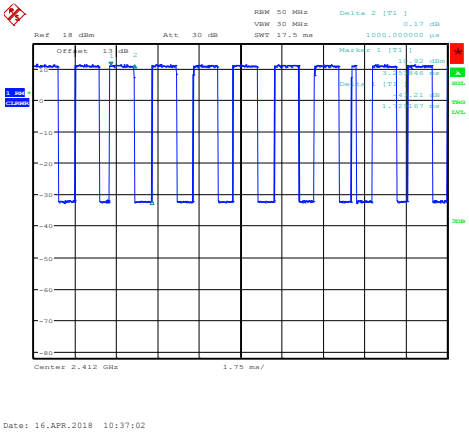
The duty cycle of the device was determined before testing was performed in order to choose the appropriate test methodology. Duty cycle was measured with a spectrum analyzer in zero span and calculated as the percentage between the transmitters on time over the signal period.

Duty cycle % = (Transmitter on time/Signal Period)*100

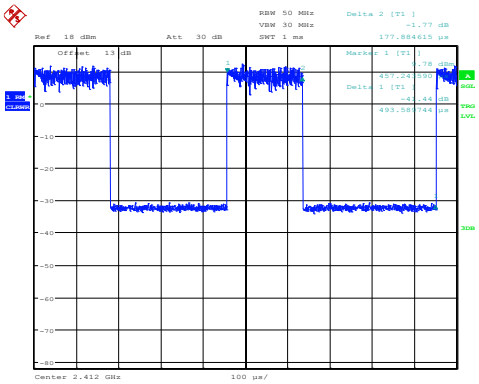
3.5.1 Results

Mode	Frequency	Duty Cycle
11b	2412 MHz	57%
11g	2412 MHz	36 %
11n	2412 MHz	65 %

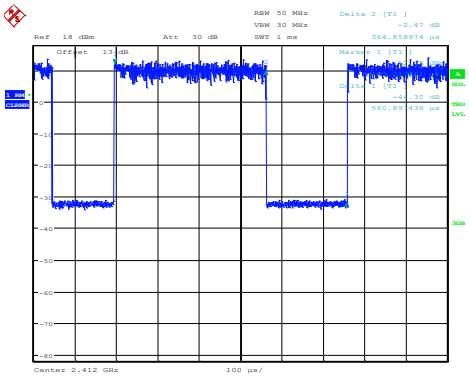
11b – Duty Cycle



11 g – Duty Cycle



11n – Duty Cycle



4 Emissions

Testing was performed in accordance with CFR 47 Part 15.247: 2017. These test methods are listed under the laboratory's A2LA Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices. Procedures described in section 8 of the standard were used.

4.1 Output Power Requirements

The maximum output power requirement is the maximum equivalent isotropic radiated power delivering at the transmitting antenna under specified conditions of measurements in the presence of modulation.

The maximum output power and harmonics shall not exceed CFR47 Part 15.247 (b):2017 and RSS 247: 2017 Sect. 5.4.4, and Sect. 6.2.4.

The maximum transmitted powers are

Band 2400-2483.5 MHz: 1 W

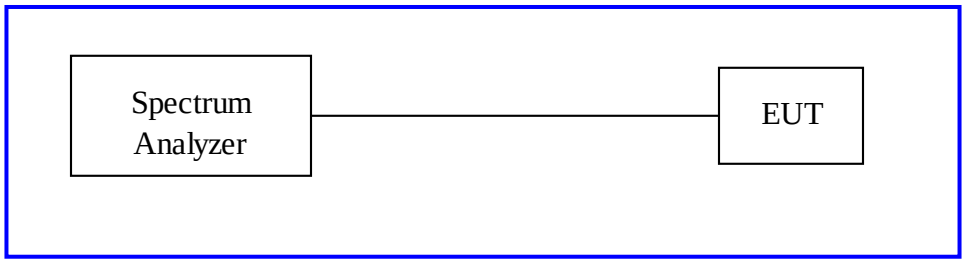
4.1.1 Test Method

The ANSI C63.10-2013 Section 11.9.2.2.2 and KDB 558074 D01 v04 section 9.2.2.6 conducted method was used to measure the channel power output. The measurements were conducted on 3 channels in each operating range per CFR47 Part 15.247(b): 2017 2400 MHz to 2483.5 MHz. The device was connected to a CMW500 which was used to set the frequency, modulation, data rate etc; traffic was generated using the CMW500. The device was connected to the spectrum analyzer with the following setting:

1. Span ≥ 1.5 times the OBW
2. Sweep Trigger = Free Run
3. RBW = 1 % to 5 % of the OBW not to exceed 1 MHz
4. VBW ≥ 3xRBW
5. Sweep Points ≥ 2 x span/RBW
6. Detector = RMS
7. Trace Mode = Max Hold

The trace was allowed to maximize, and the analyzers power integration function was used to calculate the power. All measurement system losses have been accounted for and inputted into the analyzer.

Test Setup:



4.1.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

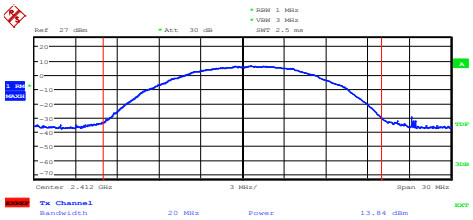
Table 2: RF Output Power at the Antenna Port – Test Results

Test Conditions: Conducted Measurement, Normal Temperature			
Antenna Type: FPC		**Power Setting:** See test plan	
Max. Directional Gain: + 1.0 dBi			
Signal State: Modulated			
Ambient Temp.: 22° C		**Relative Humidity:** 35%	
802.11b			
Operating Channel (MHz)	**Limit [dBm]**	**Max Power [dBm]**	**Margin [dB]**
2412.00	30.00	13.84	16.16
2437.00	30.00	12.72	17.28
2462.00	30.00	14.66	15.34
Note: All insertion loss and corrections are accounted for in the measurement plots.			
802.11g			
Operating Channel (MHz)	**Limit [dBm]**	**Max Power [dBm]**	**Margin [dB]**
2412.00	30.00	16.87	13.13
2437.00	30.00	15.47	14.53
2462.00	30.00	17.58	12.42
Note: All insertion loss and corrections are accounted for in the measurement plots.			

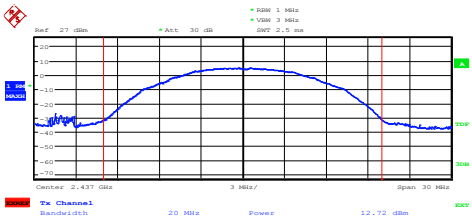
Table 3: RF Output Power at the Antenna Port – Test Results

Test Conditions: Conducted Measurement, Normal Temperature			
Antenna Type: FPC		**Power Setting:** See test plan	
Max. Directional Gain: + 1.0 dBi			
Signal State: Modulated			
Ambient Temp.: 22° C		**Relative Humidity:** 35%	
802.11n			
Operating Channel (MHz)	**Limit [dBm]**	**Max Power [dBm]**	**Margin [dB]**
2412.00	30.00	16.67	13.33
2437.00	30.00	15.99	14.01
2462.00	30.00	17.75	12.25
Note: All insertion loss and corrections are accounted for in the measurement plots.			

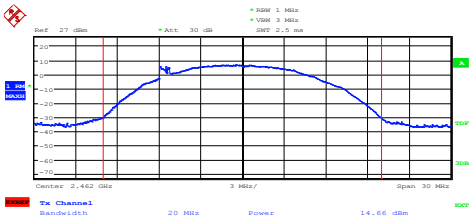
11b – 2412 MHz Power



11b – 2437 MHz Power



11 b – 2462 MHz Power



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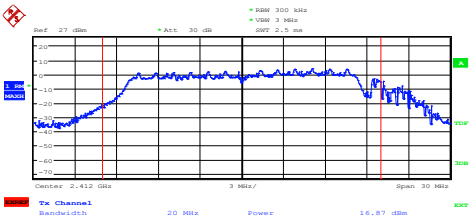
11 g - 2412 MHz Power



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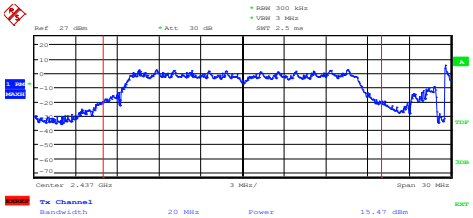

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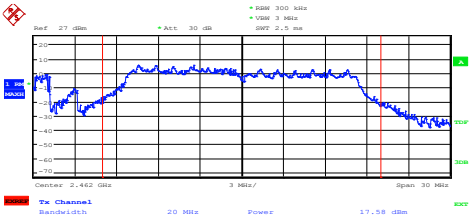
11g – 2462 MHz Power



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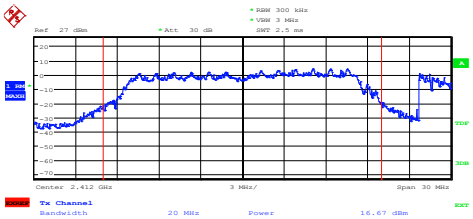
11n – 2412 MHz Power



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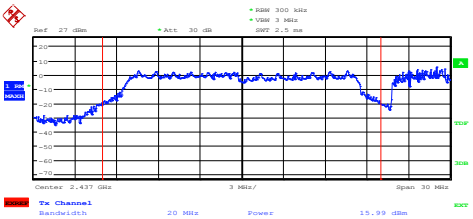
11n – 2437 MHz Power



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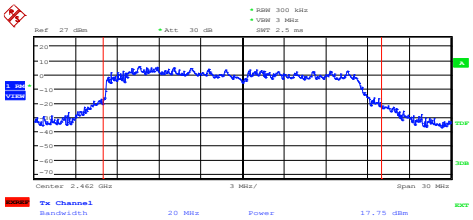
11n – 2462 MHz



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4.2 Occupied Bandwidth

The occupied bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency.

The 99% bandwidth is the bandwidth in which 99% of the transmitted power occupied.

The minimum 6 dB bandwidth shall be at least 500 kHz.

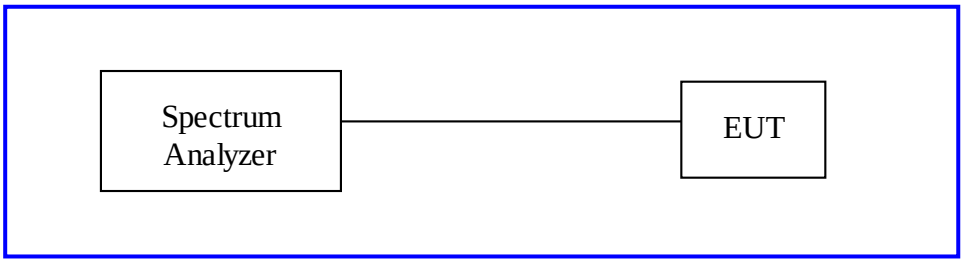
4.2.1 Test Method

The conducted method was used to measure the occupied bandwidth according to ANSI C63.10:2013 Section 11.8 and KDB 558074 v04. The measurement was performed with modulation per CFR47 15.247(a) (2) 2017 on three operating between frequency range; 2400 MHz to 2483.5 MHz. The device was connected to a CMW500 which was used to set the frequency, modulation, data rate etc; traffic was generated using the CMW500. The device was connected to the spectrum analyzer with the following setting:

1. RBW = 100 kHz
2. VBW = 3xRBW
3. Detector = Peak
4. Sweep = auto couple

The trace was allowed to maximize and the peak emission was determined. The bandwidth was measured from the two outermost amplitude points that were attenuated by 6 dB. All measurement system losses have been accounted for and inputted into the analyzer.

Test Setup:



4.2.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

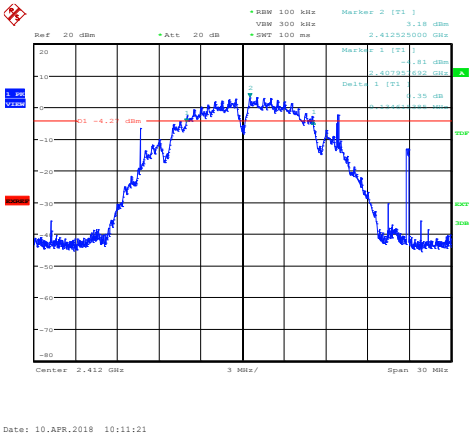
Table 4: Occupied Bandwidth – Test Results

Test Conditions: Conducted Measurement, Normal Temperature		
Antenna Type: FPC		**Power Setting:** See test plan
Max. Directional Gain: + 1.0 dBi		
Signal State: Modulated		
Ambient Temp.: 22° C		**Relative Humidity:** 35%
802.11b		
Frequency (MHz)	**6dB Bandwidth (MHz)**	**Limit (kHz)**
2412	9.13	>500
2437	9.52	>500
2462	8.66	>500
Note: None		
802.11g		
Frequency (MHz)	**6dB Bandwidth (MHz)**	**Limit (kHz)**
2412	16.05	>500
2437	16.51	>500
2462	15.83	>500
Note: None		

Table 5: Occupied Bandwidth – Test Results

Test Conditions: Conducted Measurement, Normal Temperature		
Antenna Type: FPC		**Power Setting:** See test plan
Max. Directional Gain: + 1.0 dBi		
Signal State: Modulated		
Ambient Temp.: 22° C		**Relative Humidity:** 35%
802.11n		
Frequency (MHz)	**6dB Bandwidth (MHz)**	**Limit (kHz)**
2412	15.71	>500
2437	16.41	>500
2462	16.82	>500
Note: None		

11b – 2412 MHz Bandwidth



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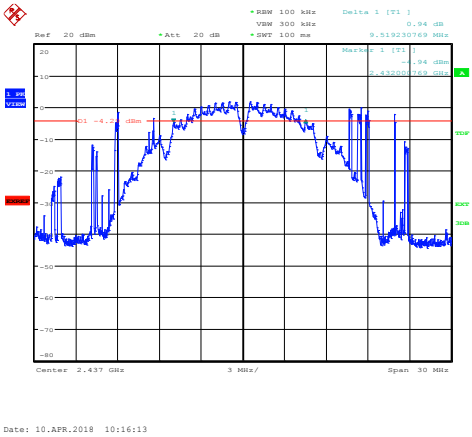
11b – 2437 MHz Bandwidth



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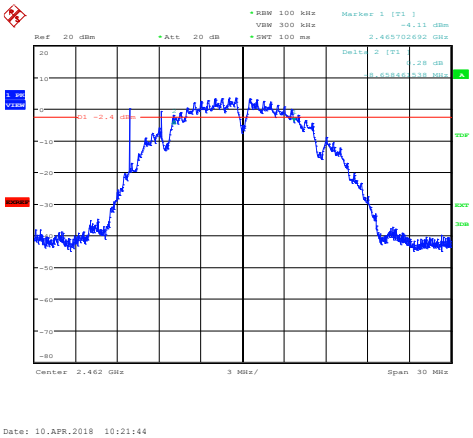
11b – 2462 MHz Bandwidth



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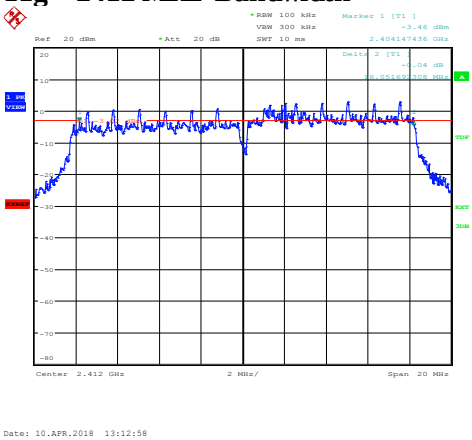
11g – 2412 MHz Bandwidth



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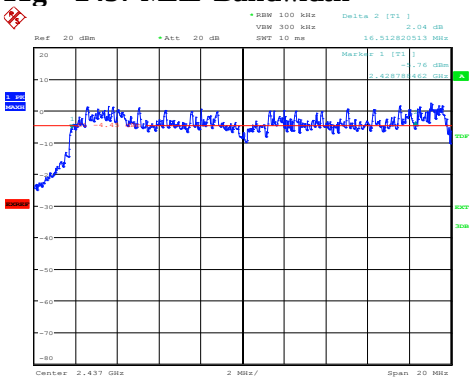
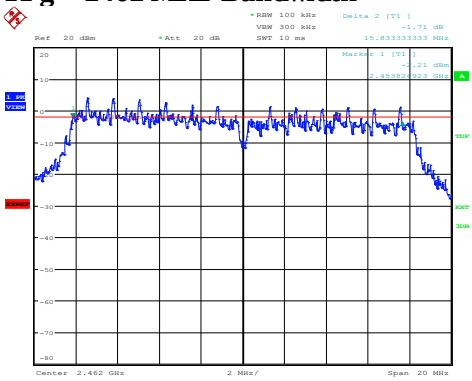
11g – 2437 MHz Bandwidth



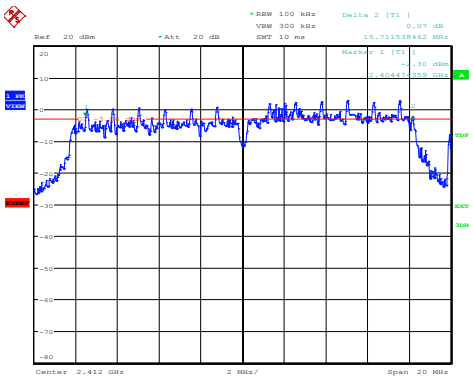
Date: 10.APR.2018 13:15:33

11 g – 2462 MHz Bandwidth



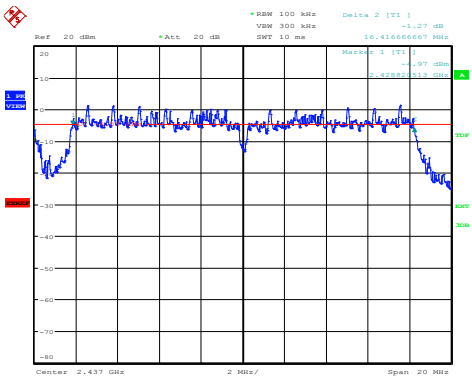
Date: 10.APR.2018 13:18:57

11n – 2412 MHz Bandwidth



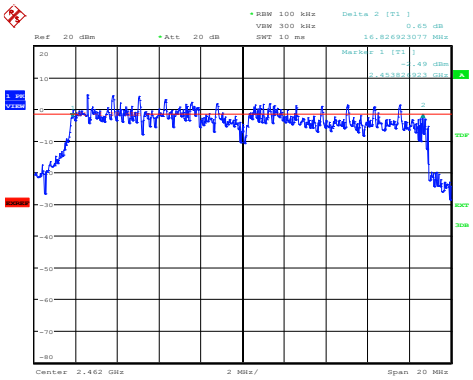
Date: 10.APR.2018 13:59:50

11n – 2437 MHz Bandwidth



Date: 10.APR.2018 14:03:12

11n -2462 MHz Bandwidth



Date: 10.APR.2018 14:44:16

4.3 Peak Power Spectral Density

According to the CFR47 Part 15.247 (e), the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

4.3.1 Test Method

The conducted method was used to measure the channel power output per ANSI C63.10-2013 Section 11.10.3 and KDB section 10.2 Method of PKPSD. The measurement was performed with modulation per CFR47 Part 15.247(e). The device was connected to a CMW500 which was used to set the frequency, modulation, data rate etc; traffic was generated using the CMW500. The device was connected to the spectrum analyzer with the following setting:

1. Span = 1.5 x DTS Bandwidth (to start)
2. RBW = 100 kHz
3. VBW $\geq$ 3 x RBW
4. Detector = Peak
5. Sweep time = auto couple
6. Trace Mode = Max Hold

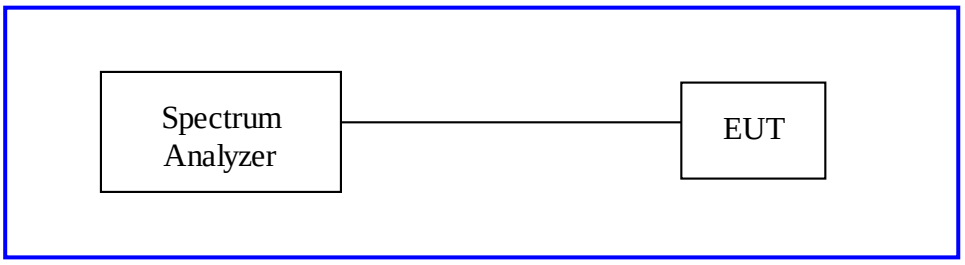
The trace is allowed to maximize and the peak marker function is used to find the peak power spectral density. If this value exceed exceeds the 8 dBm/kHz the analyzer RBW (no less than 3 kHz) is reduced and the measurement repeated. The final PSD is calculated to dBm/3 kHz when an RBW is not set to 3 kHz with the following function:

RBW Correction Factor = 10 Log (Analyzer RBW/3 kHz)

Corrected PSD (dBm/3 kHz) = Measured PSD – RBW Correction Factor

All measurement system losses have been accounted for and inputted into the analyzer.

Test Setup:



4.3.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

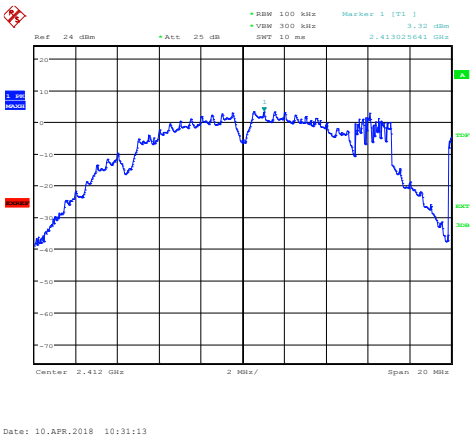
Table 6: Peak Power Spectral Density – Test Results

Test Conditions: Conducted Measurement, Normal Temperature					
Antenna Type: FPC				**Power Setting:** See test plan	
Max. Directional Gain: + 1.0 dBi					
Signal State: Modulated					
Ambient Temp.: 22° C				**Relative Humidity:** 35%	
802.11b					
Frequency (MHz)	**Max PSD (dBm/100 kHz)**	**RBW Correction factor (dB)**	**Limit (dBm/3 kHz)**	**Max PSD (dBm/3 KHz)**	**Margin [dB]**
2412	3.32	15.23	8.00	-11.91	19.91
2437	1.63	15.23	8.00	-13.60	21.60
2462	3.77	15.23	8.00	-11.46	19.46
Note: None					
802.11g					
Frequency (MHz)	**Max PSD (dBm/100 kHz)**	**RBW Correction factor (dB)**	**Limit (dBm/3 kHz)**	**Max PSD (dBm/3 KHz)**	**Margin [dB]**
2412	3.10	15.23	8.00	-12.13	20.13
2437	2.52	15.23	8.00	-12.71	20.71
2462	5.10	15.23	8.00	-10.13	18.13
Note: None					

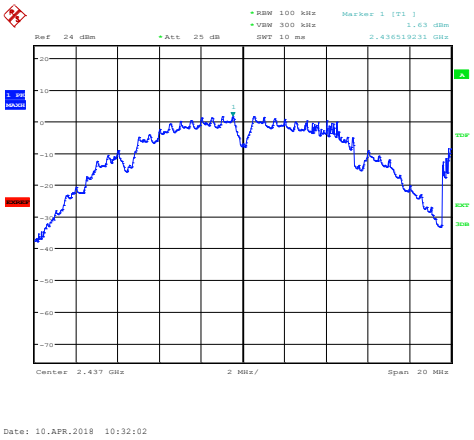
Table 7: Peak Power Spectral Density – Test Results Continues

Test Conditions: Conducted Measurement, Normal Temperature					
Antenna Type: FPC			**Power Setting:** See test plan		
Max. Directional Gain: + 1.0 dBi					
Signal State: Modulated					
Ambient Temp.: 22° C			**Relative Humidity:** 35%		
802.11n					
Frequency (MHz)	**Max PSD (dBm/100 kHz)**	**RBW Correction factor (dB)**	**Limit (dBm/3 kHz)**	**Max PSD (dBm/3 KHz)**	**Margin [dB]**
2412	4.88	15.23	8.00	-10.35	18.35
2437	2.13	15.23	8.00	-13.10	21.10
2462	4.30	15.23	8.00	-10.93	18.88
Note: None					

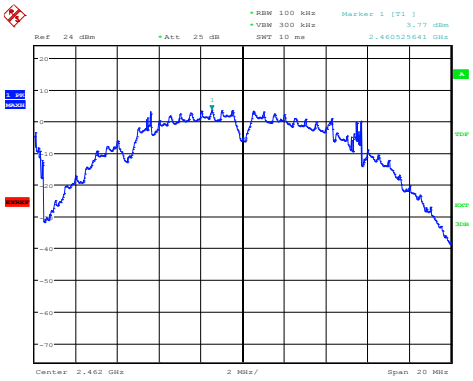
11b – 2412 MHz PSD



11b – 2437 MHz PSD

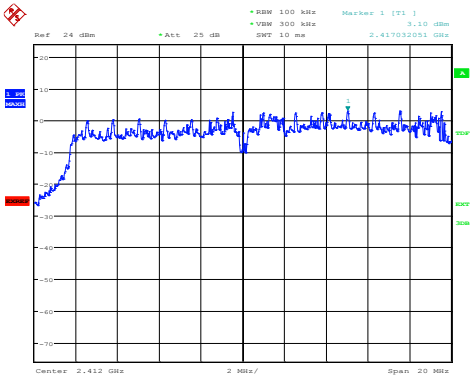


11b – 2462 MHz PSD



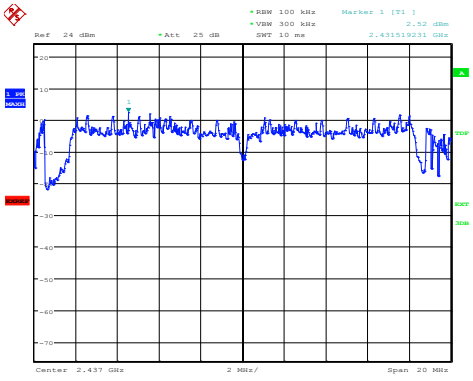
Date: 10.APR.2018 10:34:12

11g – 2412 MHz PSD



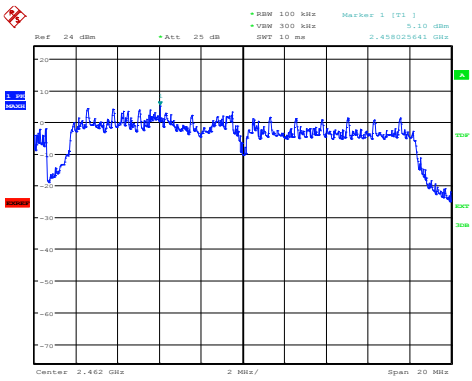
Date: 10.APR.2018 13:39:53

11g – 2437 MHz PSD



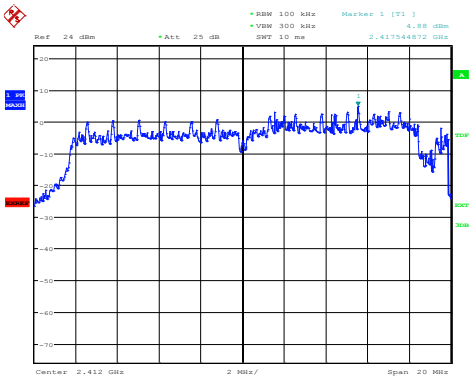
Date: 10.APR.2018 13:41:20

11g – 2462 MHz PSD



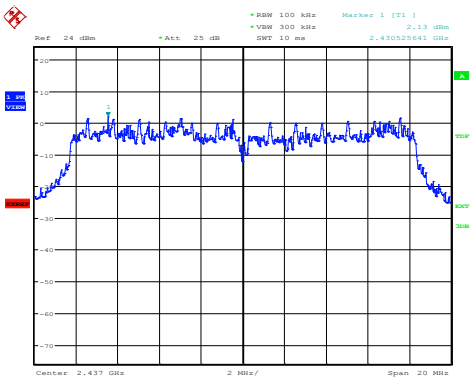
Date: 10.APR.2018 13:42:38

11n -2412 MHz PSD



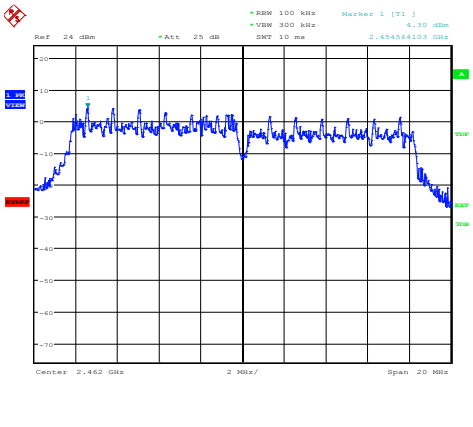
Date: 10.APR.2018 14:52:27

11n – 2437 MHz PSD



Date: 10.APR.2018 14:54:21

11n – 2462 MHz PSD



4.4 Out of Band Emissions

§2.1051 The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in §2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

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

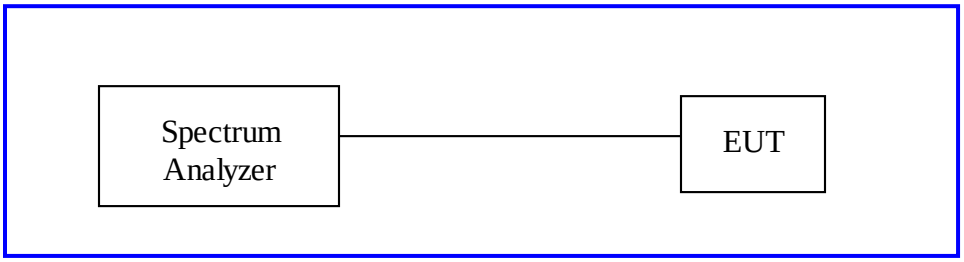
4.4.1 Test Method

KDB 558074 D01 v04 section 11 was used. The device was connected to a CMW500 which was used to set the frequency, modulation, data rate etc; traffic was generated using the CMW500. The 30 dBc level was determined from the maximum PSD measurement made in the previous section. The device was directly connected to a spectrum analyzer with the following settings:

1. Span set to encompass 30 MHz to the 10th harmonic of the fundamental frequency
2. RBW = 100 kHz
3. VBW = 300 kHz
4. Detector Peak
5. Sweep Time = auto couple
6. Trace Mode = max hold

The trace was allowed to maximize and maximum emissions reported. All measurement system losses have been accounted for and inputted into the analyzer.

Test Setup:



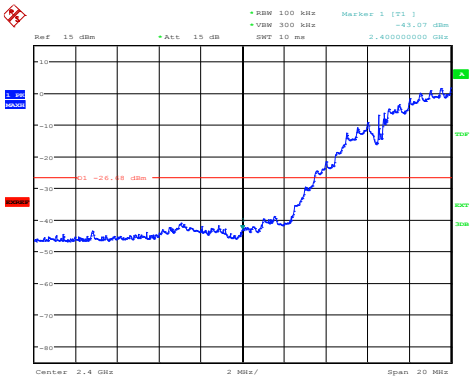
4.4.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 8: Emissions at the Band-Edge – Test Results

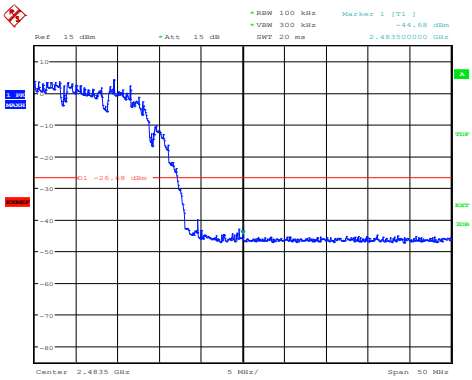
Test Conditions: Conducted Measurement, Normal Temperature				
Antenna Type: FPC			**Power Setting:** See test plan	
Max. Directional Gain: + 1.0				
Signal State: Modulated				
Ambient Temp.: 22° C			**Relative Humidity:** 35%	
Non-Restricted Frequency Band Emissions				
Freq. (MHz)	**Mode**	**Measured (dBm)**	**Limit (dBm)**	**Margin (dB)**
2400	11b	-43.07	-26.68	16.39
2483.5	11b	-44.68	-26.68	18.00
2400	11g	-34.26	-24.9	9.36
2483.5	11g	-44.80	-24.9	19.90
2400	11n HT20	-34.59	-25.12	9.47
2483.5	11n HT20	-47.13	-25.12	22.01
Note: 1. The worst case of each data rate is recorded.				

11b – 2412 MHz Bandedge



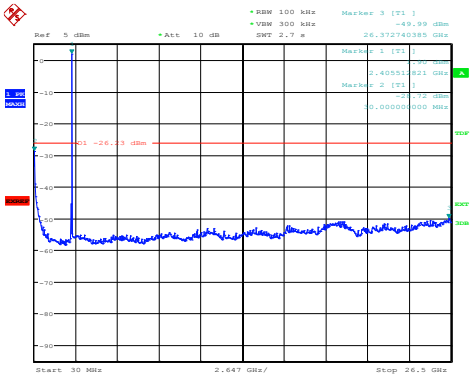
Date: 10.APR.2018 11:29:20

11b – 2462 MHz Bandedge



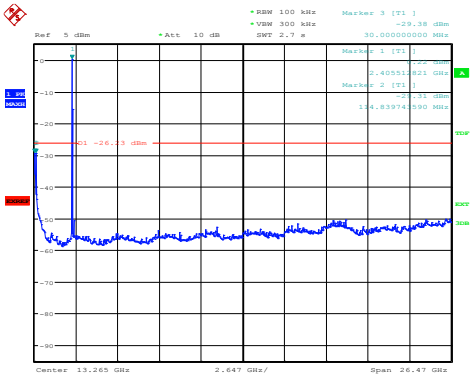
Date: 10.APR.2018 11:39:08

11b – 2412 MHz Conducted Emissions



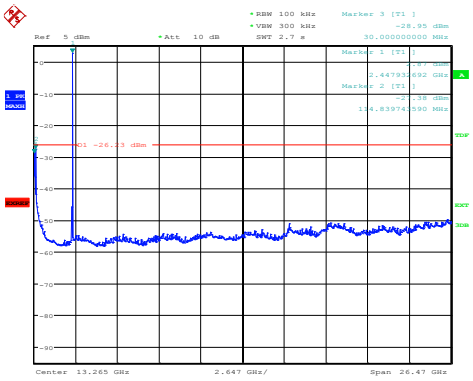
Date: 10.APR.2018 10:53:30

11b – 2437 MHz Conducted Emissions



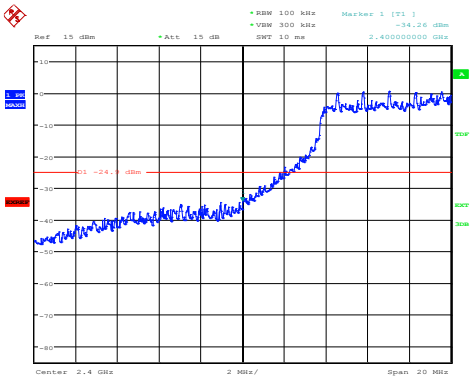
Date: 10.APR.2018 10:55:43

11b – 2462 MHz Conducted Emissions



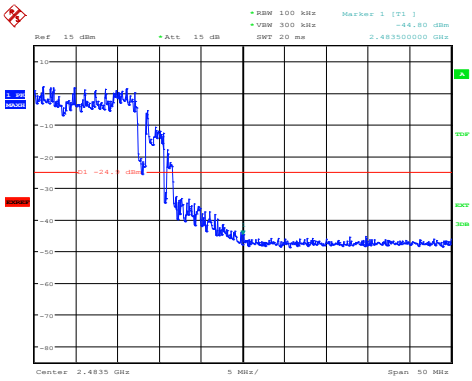
Date: 10.APR.2018 10:57:09

11g 2412 MHz Bandedge



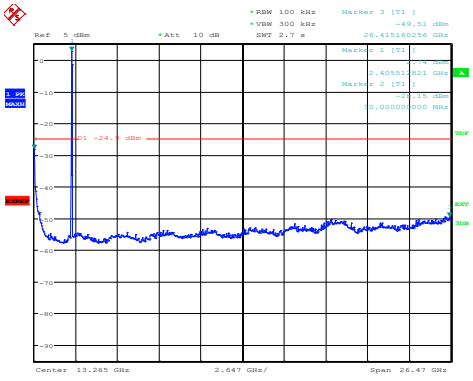
Date: 10.APR.2018 13:54:34

11g 2462 MHz Bandedge



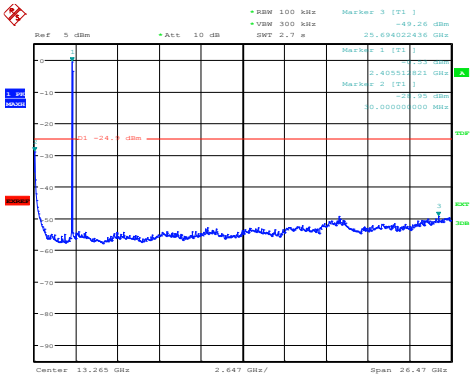
Date: 10.APR.2018 13:56:33

11g 2412 MHz Conducted Emissions



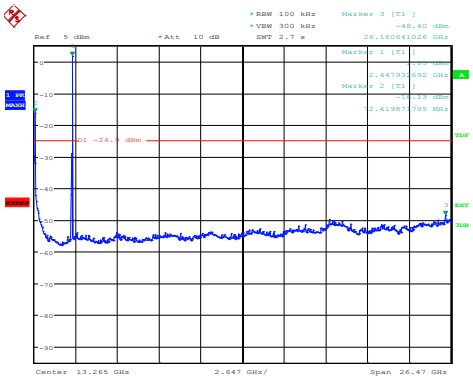
Date: 10.APR.2018 13:46:26

11g 2437 MHz Conducted Emissions



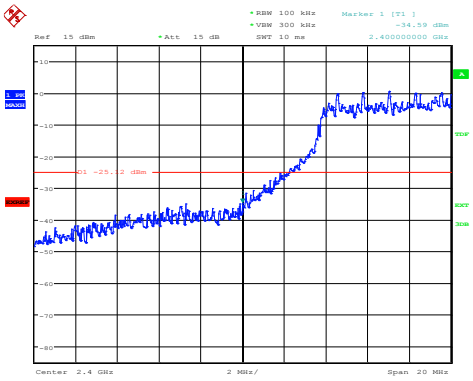
Date: 10.APR.2018 13:47:58

11g 2462 MHz Conducted Emissions



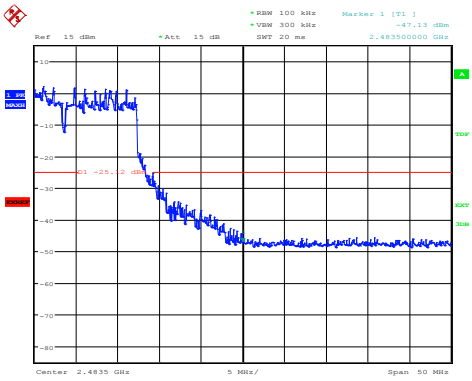
Date: 10.APR.2018 13:49:53

11n 2412 MHz Bandedge



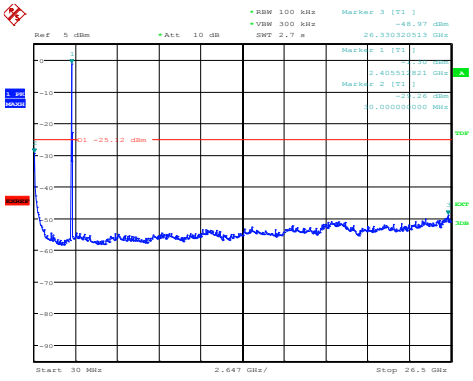
Date: 10.APR.2018 15:00:54

11n 2462 MHz Bandedge



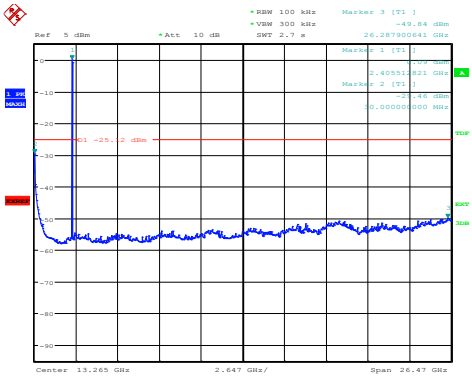
Date: 10.APR.2018 15:04:05

11n 2412 MHz Conducted Emissions



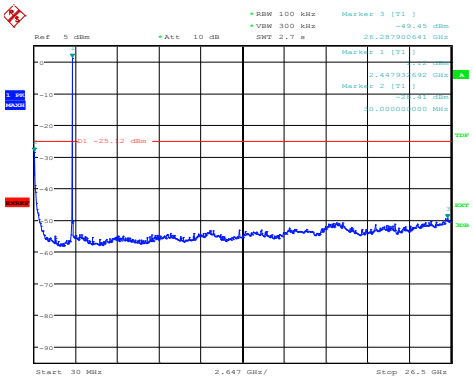
Date: 10.APR.2018 14:57:05

11n 2437 MHz Conducted Emissions



Date: 10.APR.2018 14:58:12

11n 2462 MHz Conducted Emissions



Date: 10.APR.2018 14:59:29

4.5 Transmit Spurious Emissions

Transmitter spurious emissions are emissions outside the frequency range of the equipment when the equipment is in transmit mode; per requirement of CFR47 15.205, 15.209, 15.247(d), RSS 247 Sect.5.5.

4.5.1 Test Methodology

4.5.1.1 Preliminary Test

A test program that controls instrumentation and data logging was used to automate the preliminary RF emission test procedure. The frequency range of interest was divided into sub-ranges to yield a frequency resolution of approximately 120 kHz and provide a reading at each frequency for no more than 12° of turntable rotation. For each frequency sub-range the turntable was rotated 360° while peak emission data was recorded and plotted over the frequency range of interest in horizontal and vertical antenna polarization's.

Preliminary emission profile testing was performed inside the anechoic chamber. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm (<1 GHz) and 150cm (>1 GHz) above the floor. The EUT was positioned as shown in the setup photographs. The receiving antenna was placed at a distance of 3m at a fixed height of 1m. Measurement equipment was located outside of the chamber. A video camera was placed inside the chamber to view the EUT.

4.5.1.2 Final Test

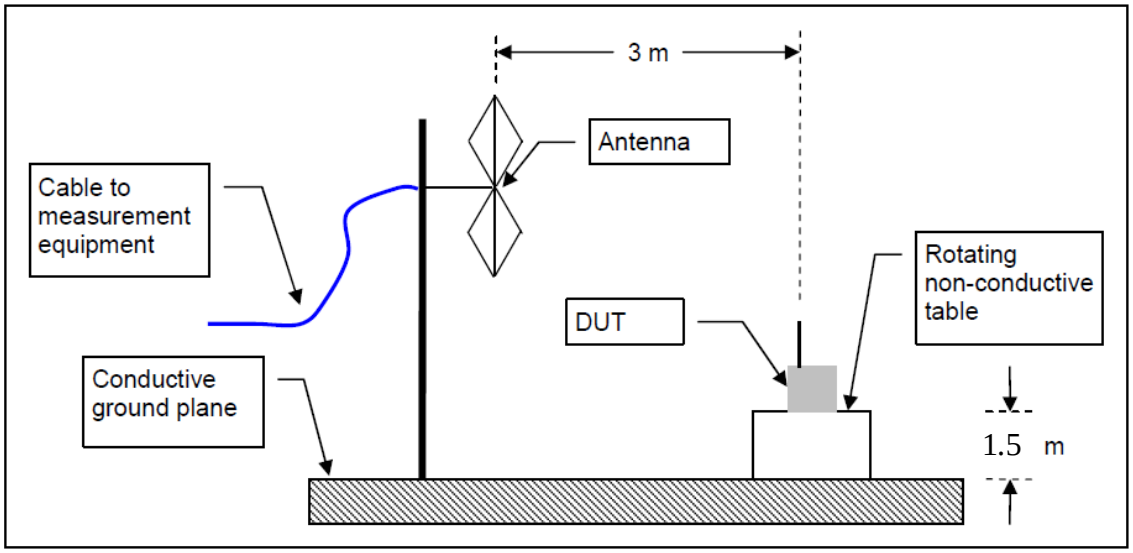
For each frequency measured, the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and placing the EUT at the position that produced maximum radiation. The six highest emissions relative to the limit were measured unless such emissions were more than 20 dB below the limit. If less than six emissions are within 20 dB of the limit, than the noise level of the receiver is measured at frequencies where emissions are expected. Multiples of all oscillator and microprocessor frequencies were also checked.

Final testing was performed on an NSA compliant test site. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm (<1 GHz) and 150cm (>1 GHz) above the ground plane. The placement of EUT and cables were the same as for preliminary testing and is shown in the setup photographs.

4.5.1.3 Deviations

None.

Test Setup:



4.5.2 Transmitter Spurious Emission Limit

The spurious emissions of the transmitter shall not exceed the values in CFR47 Part 15.205, 15.209: 2015 and RSS Gen Sect. 8.10: 2014.

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

All harmonics and spurious emission which are outside of the restricted band shall be 20dB below the in-band emission.

4.5.3 Test Results

The final measurement data was taken under the worst case operating modes, configurations, and/or cable positions. It also reflects the results including any modifications and/or special accessories listed in Sections 1.4 and test plan.

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

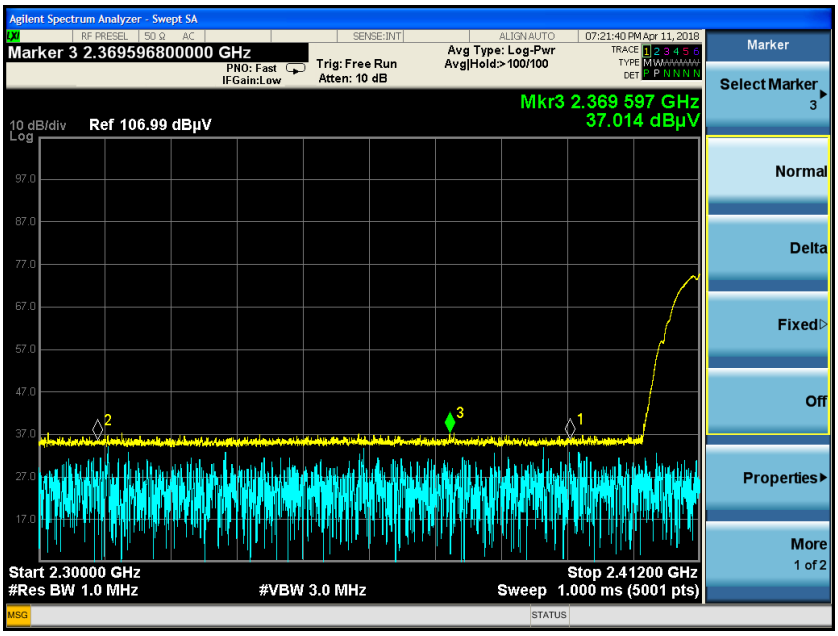
Table 9: Transmit Spurious Emission at Band-Edge Requirements

Test Conditions: Conducted Measurement, Normal Temperature									
Antenna Type: FPC						**Power Setting:** See test plan			
Max. Directional Gain: + 1.0 dBi									
Signal State: Modulated									
Ambient Temp.: 22° C						**Relative Humidity:** 35%			
Band-Edge Results									
Frequency (MHz)	Raw (dBµV/m)	Detector	Cable Loss (dB)	Antenna Gain (dBi)	Level (dBµV/m)	Pol (H/V)	Height (cm)	Limit (dBµV/m)	Margin (dBµV/m)
802.11 b									
2390	37.01	Peak	2.39	9.06	48.46	H	208	54	5.54
2390	37.32	Peak	2.39	9.06	48.77	V	164	54	5.23
2483.5	36.63	Peak	2.42	9.06	48.11	H	211	54	5.89
2483.5	37.40	Peak	2.42	9.06	48.88	V	181	54	5.12
802.11 g									
2390	37.45	Peak	2.39	9.06	48.90	H	194	54	5.10
2390	37.56	Peak	2.39	9.06	49.01	V	215	54	4.99
2483.5	36.52	Peak	2.42	9.06	48.00	H	192	54	6.00
2483.5	36.88	Peak	2.42	9.06	48.36	V	221	54	5.64
802.11 n									
2390	36.52	Peak	2.39	9.06	47.97	H	150	54	6.03
2390	37.37	Peak	2.39	9.06	48.82	V	239	54	5.18
2483.5	38.16	Peak	2.42	9.06	49.64	H	206	54	4.36
2483.5	36.95	Peak	2.42	9.06	48.43	V	218	54	5.57

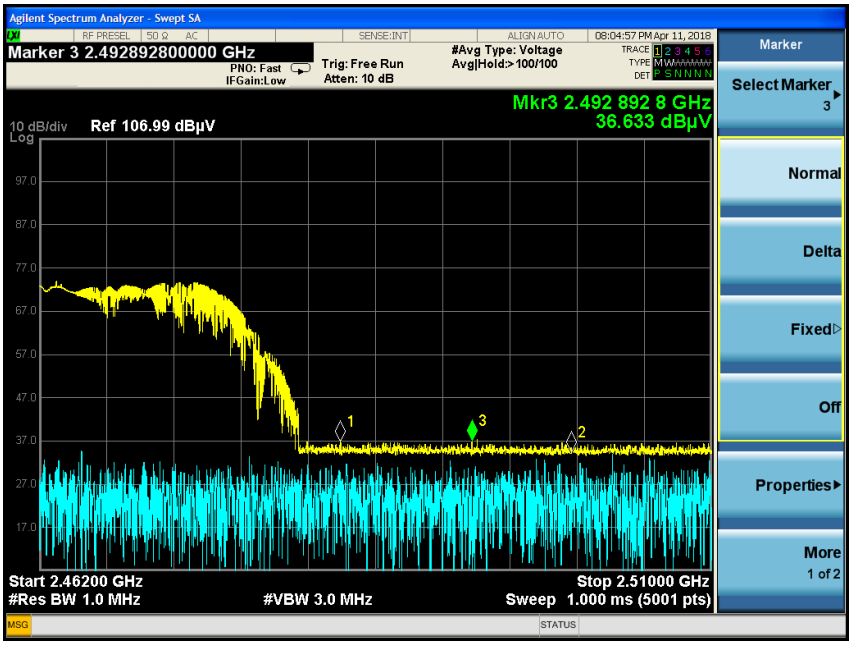
Note: 1. The emissions were measured at the adjacent restricted band of the fundamental signal.
2. All the band-edge measurements met the restricted band requirements of CFR47 15.205.
3. Device does not support 40 MHz bandwidth modulation.

4.5.4 Band-edge Data

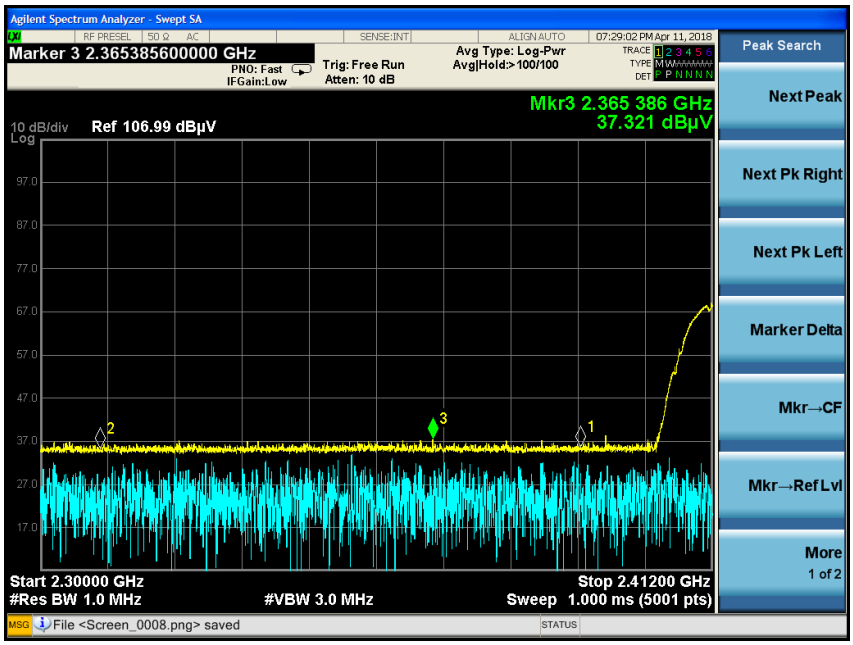
802.11b – 2390MHz Horizontal Polarization



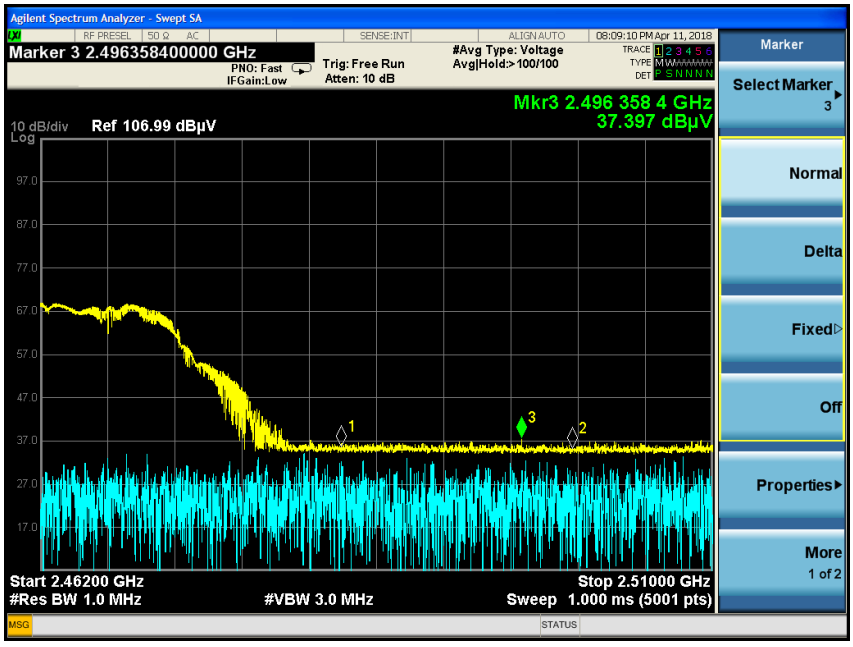
802.11b – 2483.5 MHz Horizontal Polarization



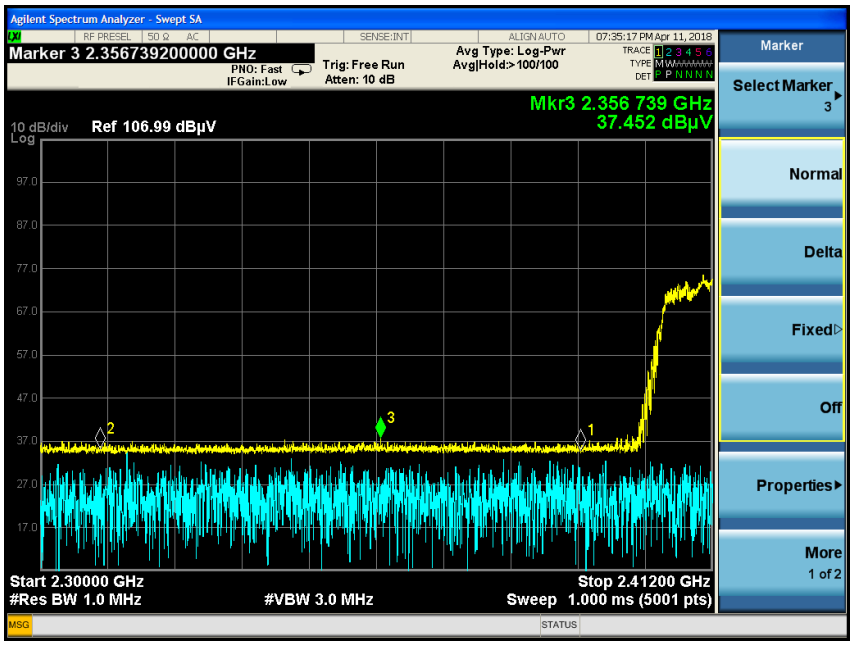
802.11b – 2390 MHz Vertical Polarization



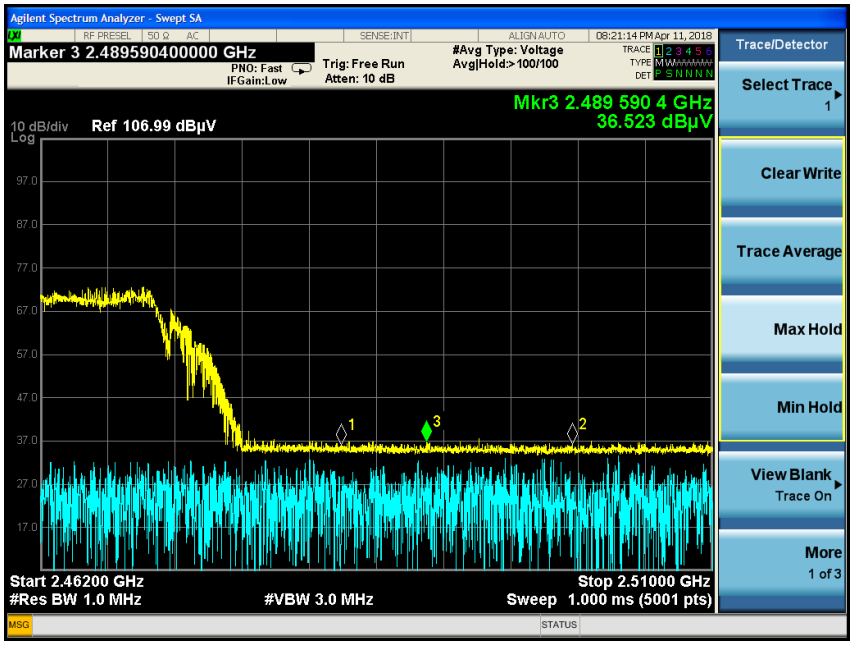
802.11 – 2483.5 MHz Vertical Polarization



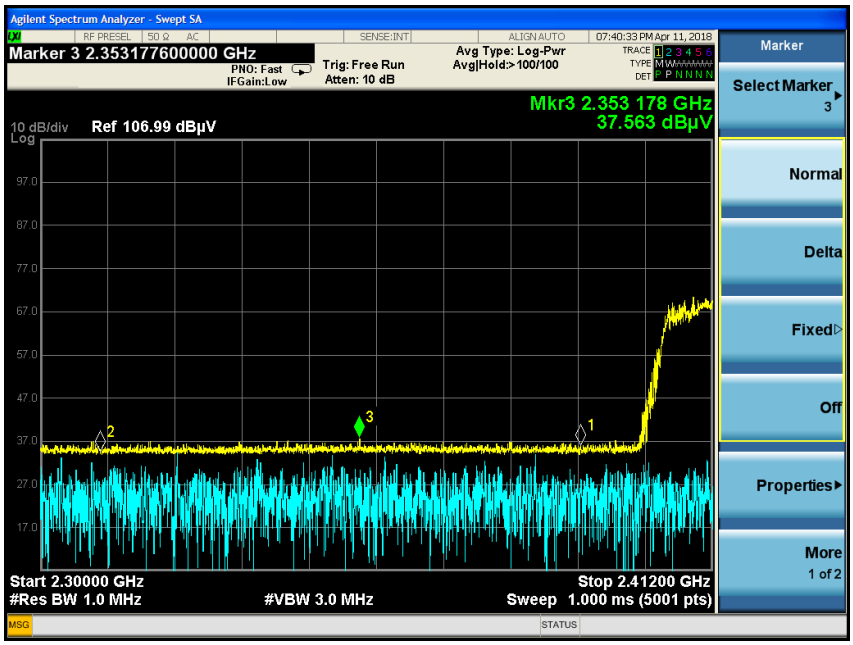
802.11g – 2390 MHz Horizontal Polarization



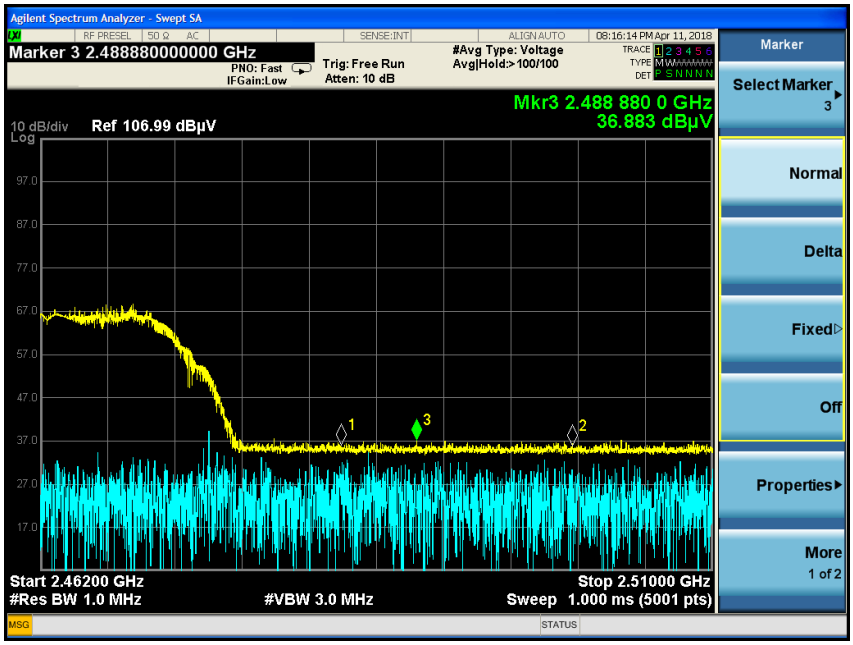
802.11g – 2483.5 MHz Horizontal Polarization



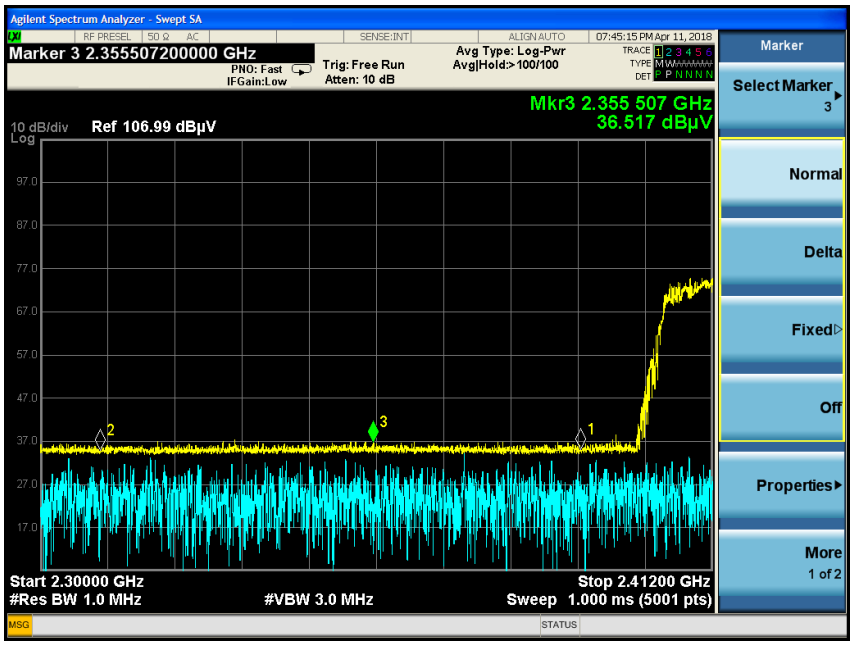
802.11 – 2390 MHz Vertical Polarization



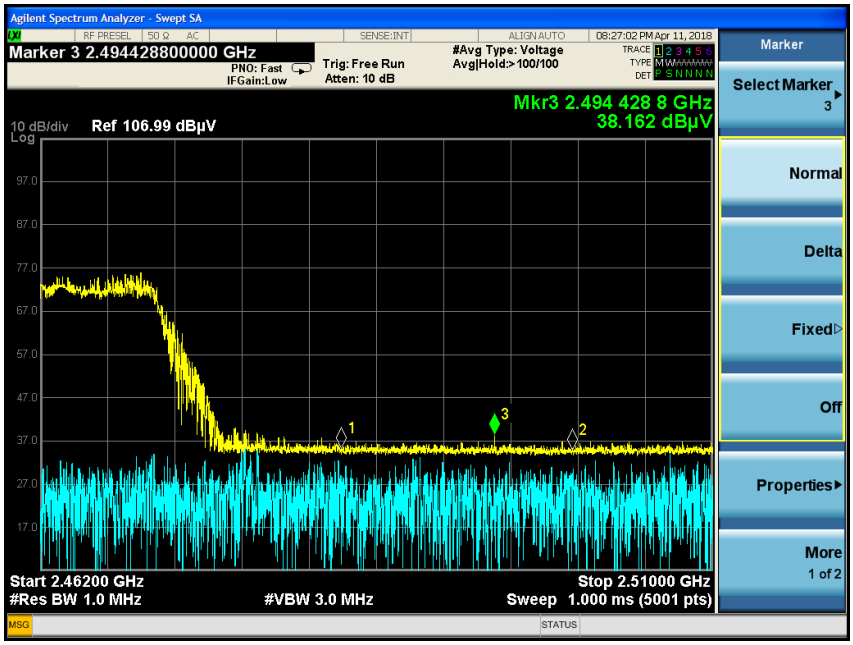
802.11 – 2483.5 MHz Vertical Polarization



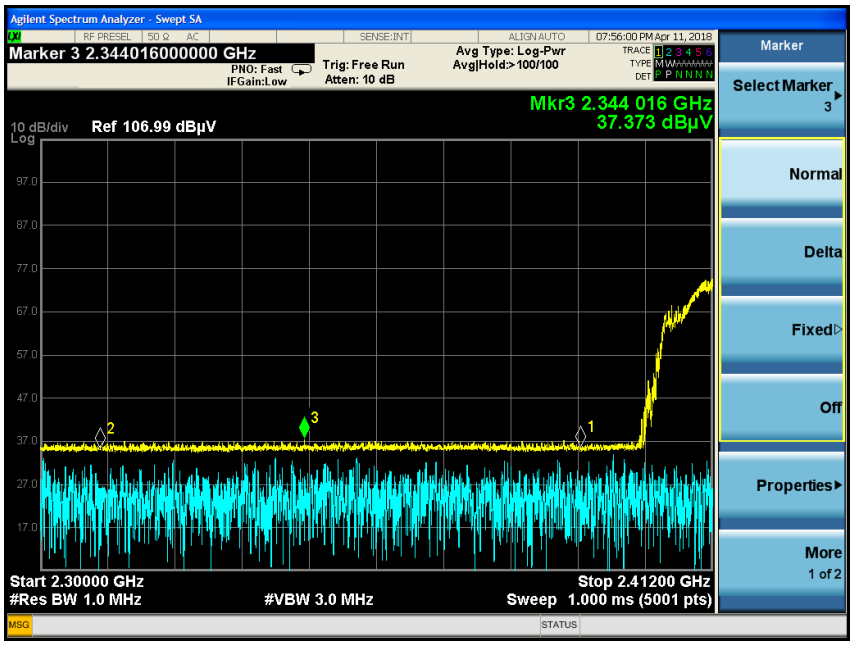
802.11n (20MHz) – 2390 MHz Horizontal Polarization



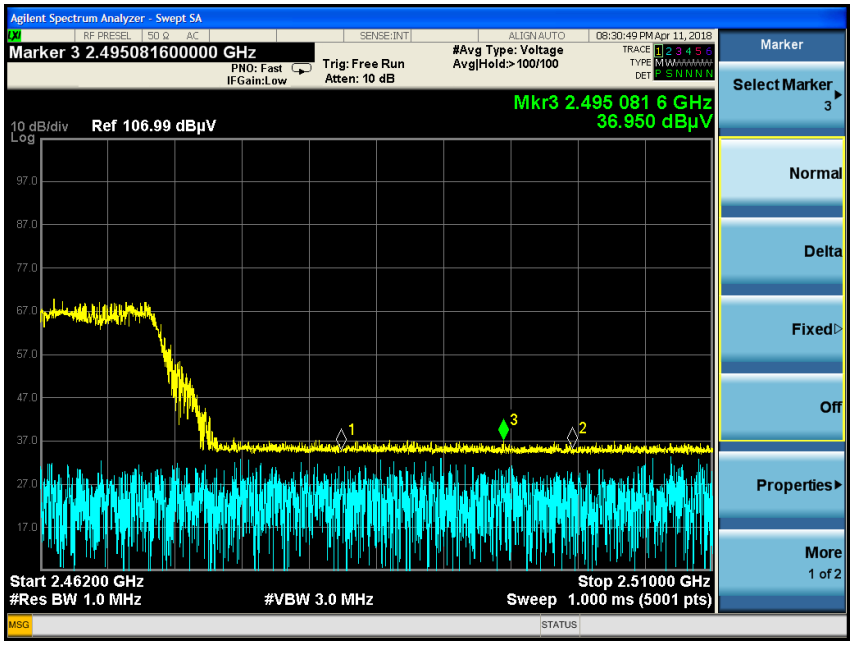
802.11n (20MHz) – 2483.5 MHz Horizontal Polarization



802.11n (20 MHz) – 2390 MHz Vertical Polarization



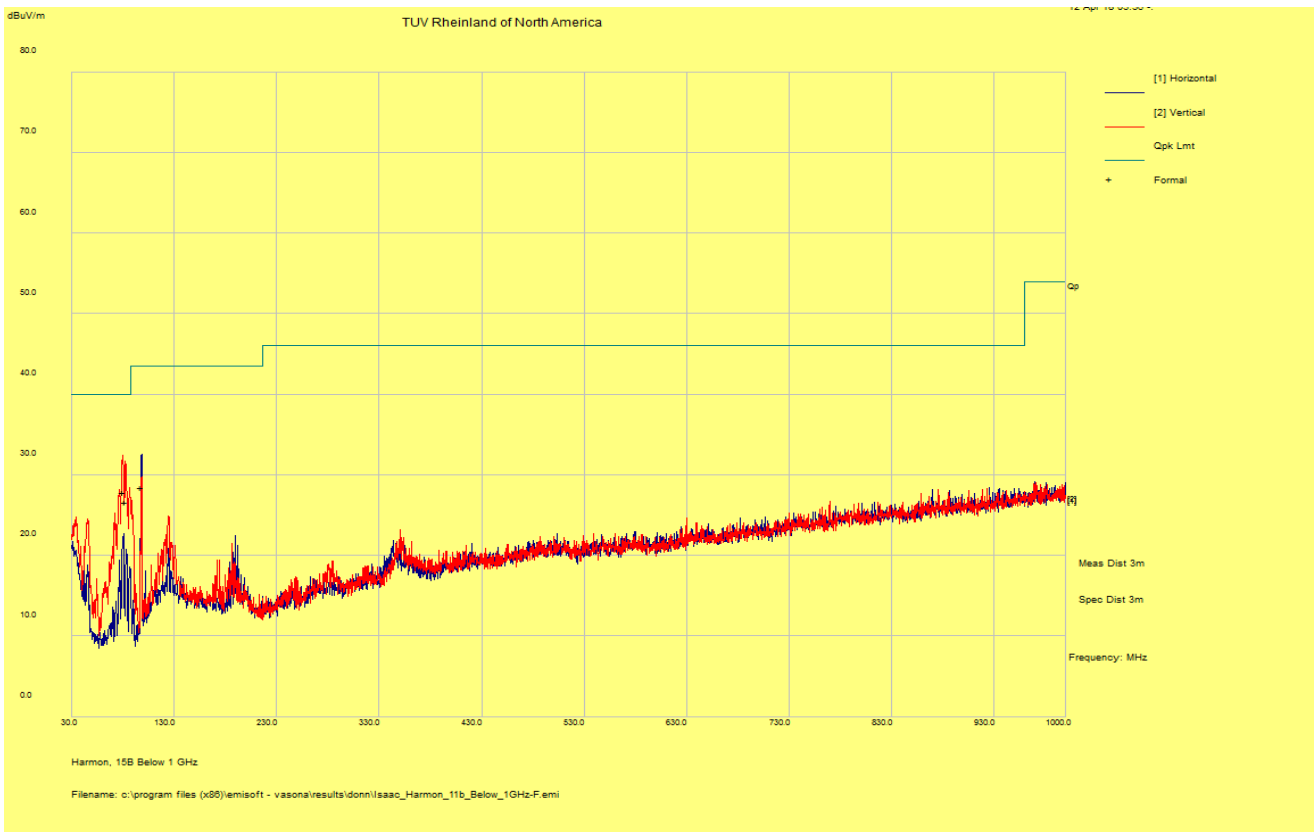
802.11n (20 MHz) – 2483.5 MHz Vertical Polarization



SOP 1 Radiated Emissions		Tracking #		Page 2 of 11
EUT Name	HSA-15	**Date**	April 11, 2018	
EUT Model	HSA-15	**Temp / Hum in**	23°/46	
EUT Serial	bd41b8d3	**Temp / Hum out**	N/A	
EUT Config.	802.11g Channel 12	**Line AC / Freq**	N/A	
Standard	FCC §15.209	**RBW / VBW**	120kHz/3MHz	
Dist/Ant Used	3 meter/Bi-Log Antenna	**Performed by**	Isaac Aguilar	

30 MHz – 1 GHz Transmit at 2462 MHz

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB
82.64469	44.86	2.49	-20.75	26.6	Quasi Max	V	121	18	40	-13.4
98.11469	44.56	2.54	-18.69	28.41	Quasi Max	H	230	44	43.5	-15.09
80.12531	45.99	2.48	-20.56	27.91	Quasi Max	V	177	304	40	-12.09



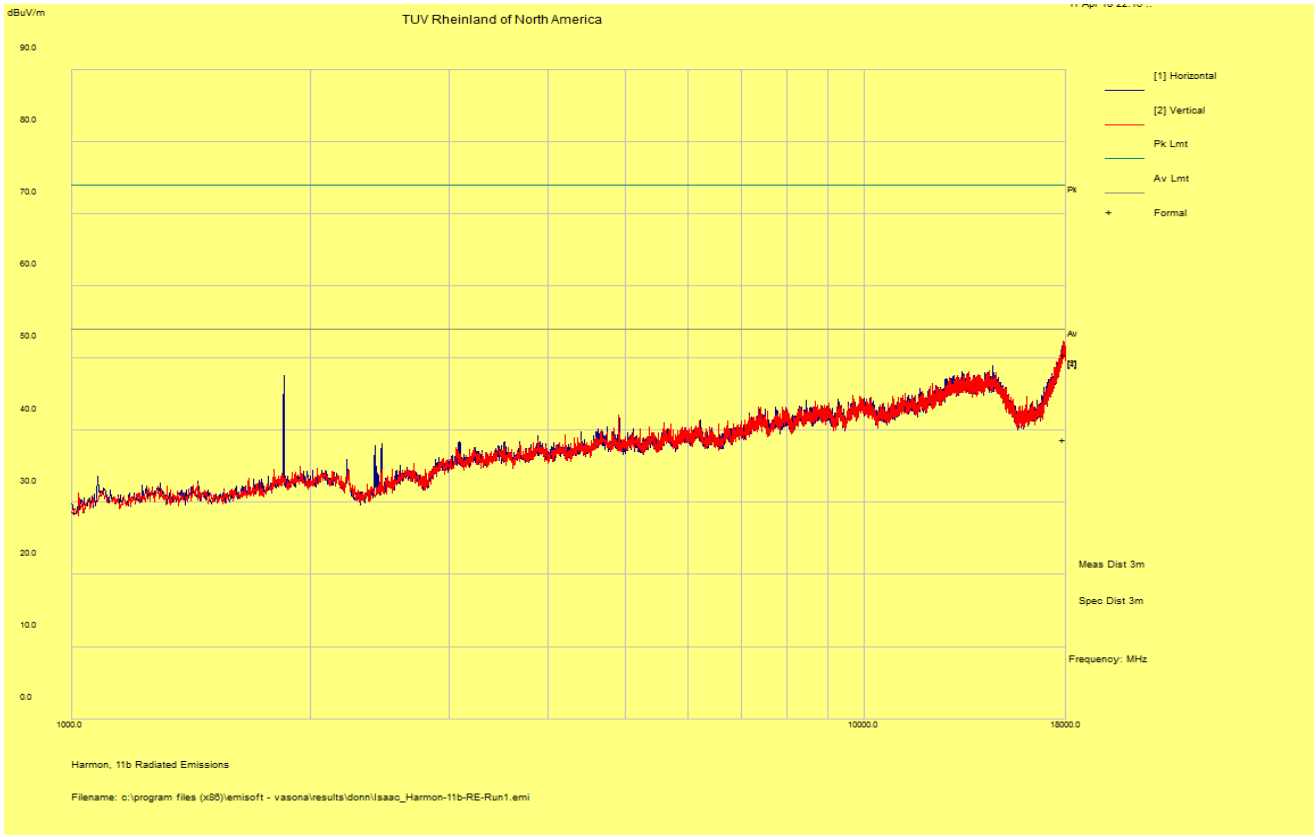
Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

Note: Worst case configuration was tested and report. Worst case configuration was determined by max power and PSD.

SOP 1 Radiated Emissions		Tracking #		Page 2 of 11
EUT Name	HSA-15	**Date**	April 11, 2018	
EUT Model	HSA-15	**Temp / Hum in**	23°/46	
EUT Serial	bd41b8d3	**Temp / Hum out**	N/A	
EUT Config.	802.11g Channel 12	**Line AC / Freq**	N/A	
Standard	§15.209	**RBW / VBW**	1MHz/3MHz	
Dist/Ant Used	3 meter/Horn Antenna	**Performed by**	Isaac Aguilar	

1 – 18 GHz Transmit at 2462 MHz

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB
17883.24	47.17	6.8	-3.46	50.51	Peak	V	185	240	74	-23.49
17883.24	35.37	6.8	-3.46	38.71	Average	V	185	240	54	-15.29



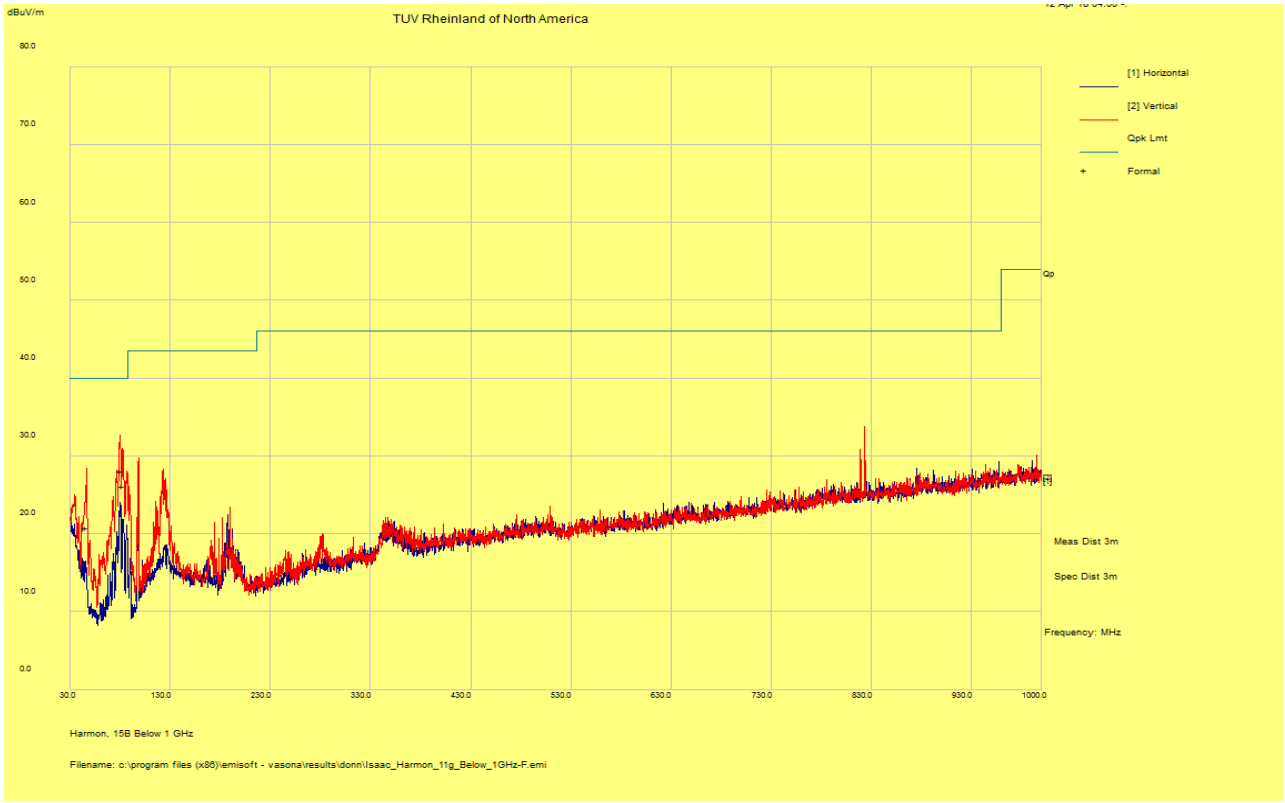
Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

Note: Worst case configuration was tested and report. Worst case configuration was determined by max power and PSD.

SOP 1 Radiated Emissions		Tracking #		Page 3 of 11
EUT Name	HSA-15	**Date**	April 11, 2018	
EUT Model	HSA-15	**Temp / Hum in**	23º/46	
EUT Serial	bd41b8d3	**Temp / Hum out**	N/A	
EUT Config.	802.11g Channel 12	**Line AC / Freq**	N/A	
Standard	§15.209	**RBW / VBW**	120 kHz/3MHz	
Dist/Ant Used	3 meter/Bi-Log Antenna	**Performed by**	Isaac Aguilar	

30 MHz – 1 GHz Transmit at 2462 MHz

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB
82.534688	44.42	2.49	-20.75	26.16	Quasi	V	128	4	40	-13.84
79.861563	46.18	2.48	-20.54	28.12	Quasi	V	150	33	40	-11.88
46.040625	36.48	2.36	-17.99	20.85	Quasi	V	135	338	40	-19.16



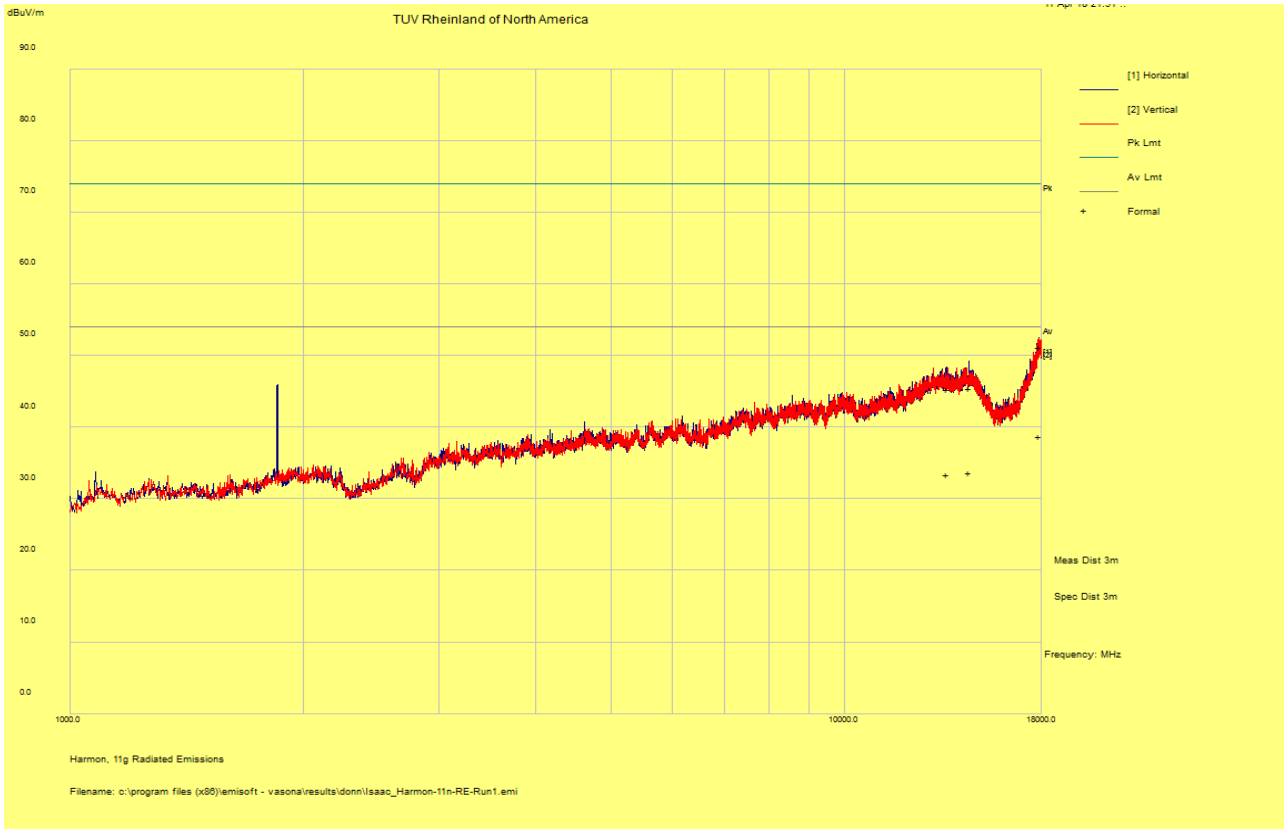
Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

Note: Worst case configuration was tested and report. Worst case configuration was determined by max power and PSD.

SOP 1 Radiated Emissions		Tracking #		Page 4 of 11
EUT Name	HSA-15	**Date**	April 11, 2018	
EUT Model	HSA-15	**Temp / Hum in**	23º/46	
EUT Serial	bd41b8d3	**Temp / Hum out**	N/A	
EUT Config.	802.11g Channel 12	**Line AC / Freq**	N/A	
Standard	§15.209	**RBW / VBW**	1MHz/3MHz	
Dist/Ant Used	3 meter/Horn Antenna	**Performed by**	Isaac Aguilar	

1 – 18 GHz Transmit at 2462 MHz

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB
17873.559	47.94	6.8	-3.51	51.23	Peak Max	H	202	188	74	-22.77
14524.084	48.89	6.25	-9.74	45.4	Peak Max	H	225	300	74	-28.6



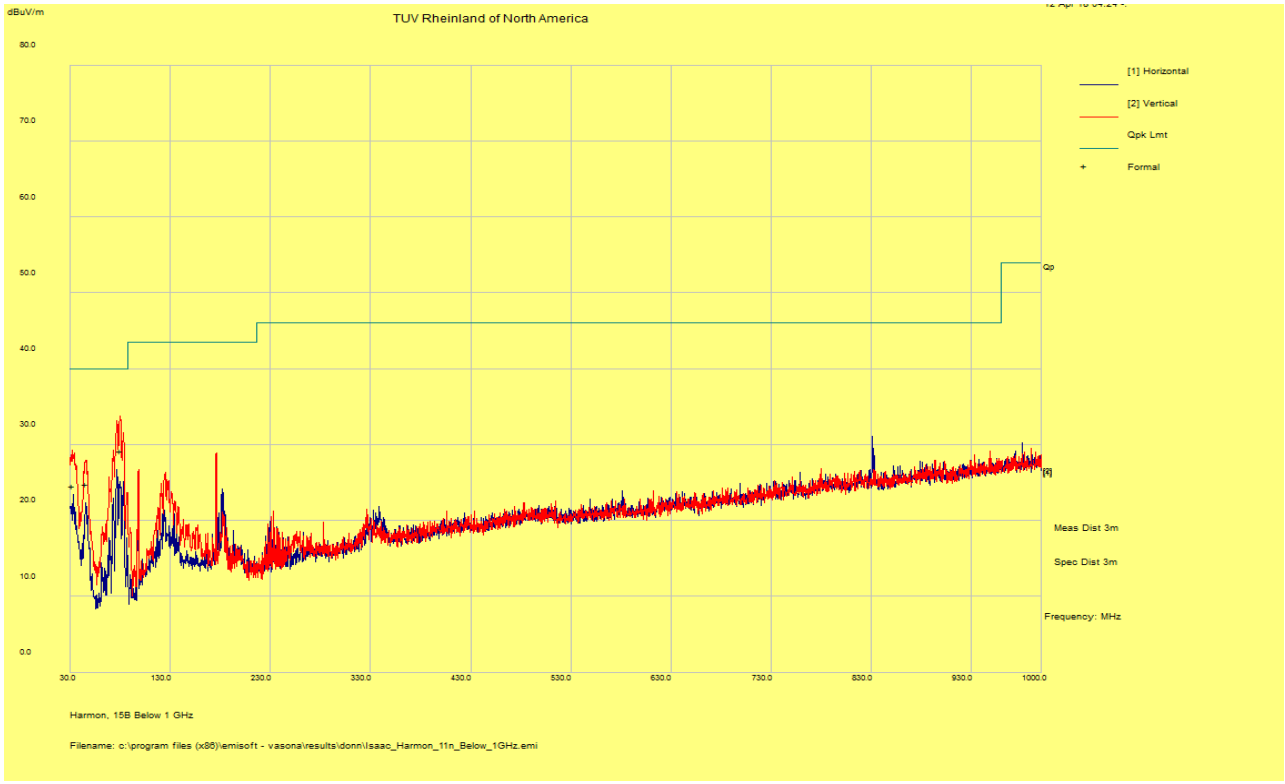
Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

Note: Worst case configuration was tested and report. Worst case configuration was determined by max power and PSD.

SOP 1 Radiated Emissions		Tracking #		Page 5 of 11
EUT Name	HSA-15	**Date**	April 11, 2018	
EUT Model	HSA-15	**Temp / Hum in**	23º/46	
EUT Serial	bd41b8d3	**Temp / Hum out**	N/A	
EUT Config.	802.11n Channel 12	**Line AC / Freq**	N/A	
Standard	§15.209	**RBW / VBW**	120 kHz/3MHz	
Dist/Ant Used	3 Meter/Bi-Log Antenna	**Performed by**	Isaac Aguilar	

30MHz – 1 GHz Transmit at 2462 MHz

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB
46.46125	40.65	2.36	-18.2	24.81	Quasi	V	106	32	40	-15.19
32.292813	31.27	2.29	-8.96	24.6	Quasi	V	153	87	40	-15.4
80.126875	47.3	2.48	-20.56	29.22	Quasi	V	196	221	40	-10.78



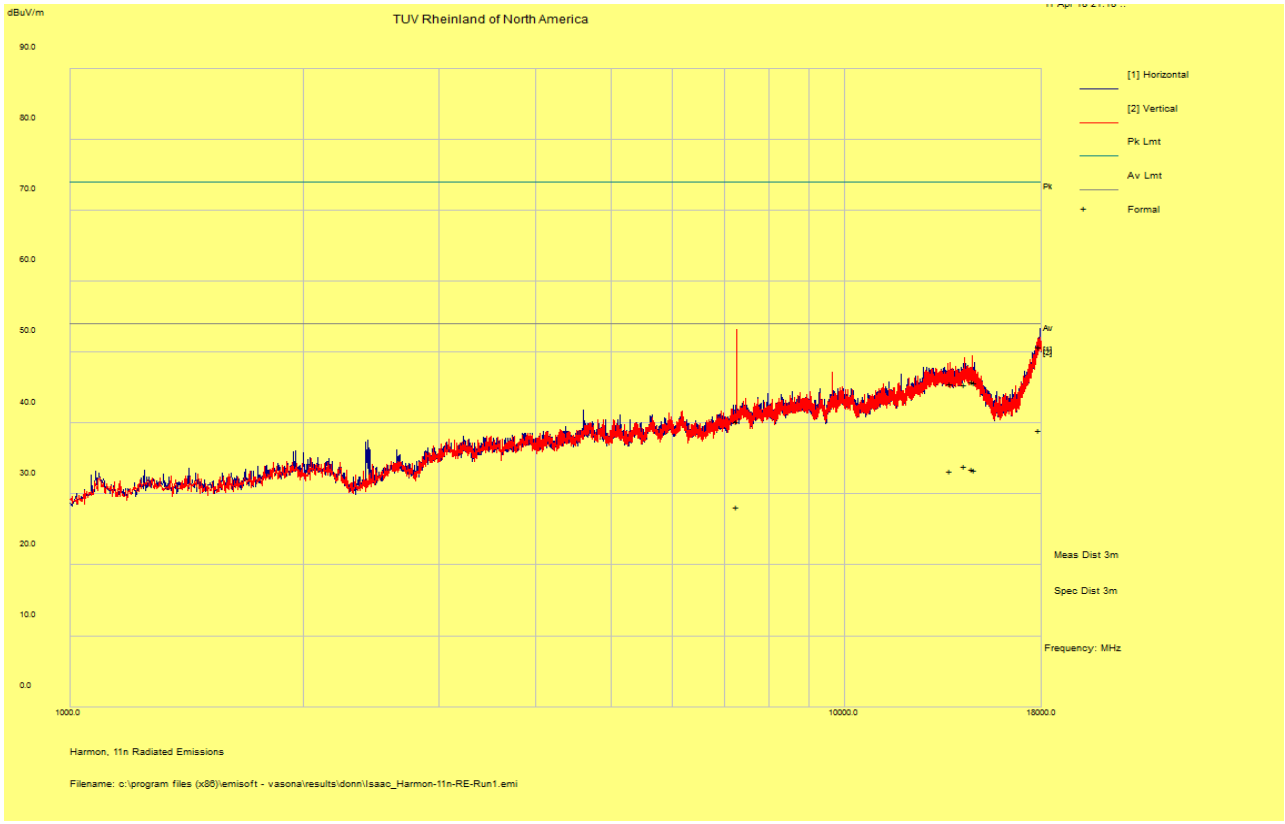
Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

Note: Worst case configuration was tested and report. Worst case configuration was determined by max power and PSD.

SOP 1 Radiated Emissions		Tracking #		Page 6 of 11
EUT Name	HSA-15	**Date**	April 11, 2018	
EUT Model	HSA-15	**Temp / Hum in**	23º/46	
EUT Serial	bd41b8d3	**Temp / Hum out**	N/A	
EUT Config.	802.11n Channel 12	**Line AC / Freq**	N/A	
Standard	§15.209	**RBW / VBW**	1MHz/3MHz	
Dist/Ant Used	3 Meter/ Horn Antenna	**Performed by**	Isaac Aguilar	

18 – 26 GHz Transmit at 2437 MHz (Mid Channel)

Frequency	Raw	Cable Loss	AF	Level	Detector	Polarity	Height	Azimuth	Limit	Margin
MHz	dBuV/m	dB	dB	dBuV/m		H/V	cm	deg	dBuV/m	dB
7267.64125	37.58	4.26	-13.71	28.14	Average	V	158	218	54	-25.86



Spec Margin = E-Field AVG - Limit, E-Field AVG = FIM AVG+ Total CF ± Uncertainty
Total CF= AF+ Cable Loss AF= Antenna factor + Preamp

Note: Worst case configuration was tested and report. Worst case configuration was determined by max power and PSD.

4.6 AC Conducted Emissions

Testing was performed in accordance with ANSI C63.4: 2014. These test methods are listed under the laboratory's A2LA Scope of Accreditation.

This test measures the levels emanating from the EUT's AC input port, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices.

The AC conducted emissions of equipment under test shall not exceed the values in CFR47 Part 15.207: 2017 and RSS Gen: 2017 Sect. 8.8.

4.6.1 Test Methodology

A test program that controls instrumentation and data logging was used to automate the AC Power Line Conducted emission test procedure. The frequency range of interest was divided into sub-ranges such as to yield a frequency resolution of 9 kHz. Each phase and neutral of the AC power line were measured with respect to ground. Measurements were performed using a set of 50µH / 50Ω LISNs.

Testing is performed in Lab 5. The setup photographs clearly identify which site was used. The vertical ground plane used in the semi-anechoic chamber is a 2m x 2m solid aluminum frame and panel, and it is bonded to the horizontal ground plane.

In the case of tabletop equipment, the EUT is placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane and 40cm from a vertical ground reference plane. The rear of the EUT was positioned flush with the backside of the table and directly over the LISNs. The power and I/O cables were routed over the edge of the table and bundled approximately 40cm from the ground plane. Support equipment was powered from a separate LISN.

4.6.1.1 Deviations

There were no deviations from this test methodology.

4.6.2 Test Results

No testing is required because EUT is DC powered and not connected to AC mains (Car Use only).

4.7 Maximum Permissible Exposure – Not Applicable

4.7.1 Test Methodology

In this section, we try to prove the safety of radiation harmfulness to the human body for our product. The KDB 447498 D01v06 General RF Exposure Guidance is followed. The Gain of the antenna used in this calculation is declared by the manufacturer, and the maximum average power input to the antenna is measured. Using the general SAR test exclusion guidance in Section 4.3 of KDB 447498 D01v06, we show that the device meets the SAR exclusion threshold found in Appendix A of KDB 447498 D01v06 and the SAR exemption limits found in table 1 of RSS-102 Issue 5.

ISED accepts the KDB 447498 D01v06 Procedure.

4.7.2 FCC KDB 447498 D01v06 – General SAR Test Exclusion Guidance

The SAR exclusion threshold conditions are listed:
1) The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by the following formula:

$$\text{Exclusion Threshold} = [\ P / d\ ] * [\sqrt{f}]$$

Where

P = max power of channel (including tune-up tolerance) in mW
d = min. test separation distance in mm
f = the RF channel transmit frequency in GHz
Power and distance are rounded to the nearest mW and mm before calculation
The result is rounded to one decimal place for comparison

Limits: ≤ 3.0 for 1-g SAR ≤ 7.5 for 10-g extremity SAR

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

4.7.3 EUT Operating Condition

The software provided by Manufacturer enabled the EUT to transmit data at lowest, middle and highest channel individually.

4.7.4 Classification

The antenna of the product, under normal condition, is less than 20cm away from the body of the user. This device is classified as a **Portable Device**.

4.7.5 Test Results

See SAR report for data results.

5 Test Equipment List

5.1 Equipment List

Equipment	Manufacturer	Model#	Serial/Inst #	Last Cal mm/dd/yyyy	Next Cal mm/dd/yyyy
Spectrum Analyzer	Rhode & Schwarz	FSU26	200050	10/24/2017	10/24/2018
Base Station	Rhode & Schwarz	CMW500	163510	10/24/2017	10/24/2018
Base Station	Rhode & Schwarz	CMW500	103915	12/20/2017	12/20/2018
Receiver	Agilent	N9038A	MY52260210	01/22/2018	01/22/2019
Receiver	Agilent	N9038A	MY51210195	01/24/2018	01/24/2019
Horn Antenna	Sunol Sciences	DRH-118	A040806	11/11/2017	11/11/2018
Bi-log Antenna	Sunol Sciences	JB3	A061907	11/20/2017	11/20/2018
Directional Coupler	Agilent	87301D Opt 240	14044A	N/A	N/A
Amplifier	MiTeq	TTA1800-30-HG	1842452	01/13/2018	01/13/2019
Amplifier	Hewlett-Packard	8447D	2944A06715	01/26/2018	01/26/2019
Notch Filter	Micro-Tronics	BRM50702	037	N/A	N/A

6 EMC Test Plan

6.1 Introduction

This section provides a description of the Equipment Under Test (EUT), configurations, operating conditions, and performance acceptance criteria. It is an overview of information provided by the manufacturer so that the test laboratory may perform the requested testing.

6.2 Customer

Table 10: Customer Information

Company Name	Harman International Industries Incorporated
Address	636 Ellis St
City, State, Zip	Mountain View CA 94043
Country	US
Phone	+1 (408) 318-8245

6.3 Equipment Under Test (EUT)

Table 11: EUT Specifications

EUT Specifications	
Dimensions	75 x 52 x 28.8 mm^3
DC Input	12 VDC
Operating Temperature Range:	-20° to 55° Celsius
Multiple Feeds:	☐ Yes and how many ☒ No
Hardware Version	V1.0
Part Number	N/A
RF Software Version	N/A
802.11-radio modules	
Operating Mode	802.11b, 802.11g, 802.11n HT20
Transmitter Frequency Band	2.4 GHz – 2.4835 GHz
Antenna Type	FPC
Antenna Gain	1.0 dBi
Modulation Type	☐ AM ☐ FM ☒ DSSS ☒ OFDM ☐ Other describe: 16QAM and 64 QAM
Data Rate	802.11b: 1, 2, 5.5, 11 Mbps 802.11g: 6, 9, 12, 18, 24, 36, 48, 54 Mbps 802.11n HT20: MCS 0, 1, 2, 3, 4, 5, 6, 7
TX/RX Chain (s)	Single; no beam forming
Directional Gain Type	☐ Uncorrelated ☐ Beam-Forming ☒ Other describe:
Type of Equipment	☐ Table Top ☐ Wall-mount ☐ Floor standing cabinet ☒ Other: OBD Sensor for car
Note: None.	

Table 14: Interface Specifications

Interface Type	Cabled with what type of cable?	Is the cable shielded?	Maximum potential length of the cable?	Metallic (M), Coax (C), Fiber (F), or Not Applicable?
USB	USB	☒ No	☒ Metric: 1.5 m	☒ N/A

Table 15: Supported Equipment

Equipment	Manufacturer	Model	Serial	Used for
Laptop	Hp	13-4103dx	5CD5428VQJ	Vysor
Note: None.				

Table 16: Description of Sample used for Testing

Device	Serial Number	Configuration	Used For
Harman OBD II	bd41b8da	Conducted/Radiated	Conducted Cellular test
Harman OBD II	bd41b8ac	Conducted/Radiated	Radiated Tests
Harman OBD II	bd41b8d3	Conducted	WiFi Testing

END OF REPORT