



Measurement of RF Emissions on a
Marvell MW300 Wi-Fi Module
On AC Host Logic Board Assembly No.
001D8088-4 and DC Host Logic Board
Assembly No. 001D8169-4

For Chamberlain Group, Inc.
300 Windsor Dr.
Oak Brook, IL 60126

P.O. Number 4900044619
Date Tested May 9 - 23, 2017
Test Personnel Tylar Jozefczyk, Mark Longinotti
Test Specification FCC "Code of Federal Regulations" Title 47, Part 15,
Subpart C, Section 15.247 for Digital
Modulation Intentional Radiators Operating within
The bands 902-928MHz, 2400-2483.5MHz, and
5725-5850MHz
Industry Canada RSS-GEN
Industry Canada RSS-247

Test Report By:

Tylar Jozefczyk
EMC Engineer

Requested By:

Adil S. Ahmed
Chamberlain Group, Inc.

Approved By:

Raymond J. Klouda
Registered Professional
Engineer of Illinois - 44894

Elite Electronic Engineering Inc.

1516 CENTRE CIRCLE
DOWNERS GROVE, IL 60515

TEL: 630 - 495 - 9770

FAX: 630 - 495 - 9785

www.elltetest.com

PARAGRAPH	DESCRIPTION OF CONTENTS	PAGE NO.
1.	Introduction.....	5
1.1.	Scope of Tests.....	5
1.2.	Purpose	5
1.3.	Deviations, Additions and Exclusions.....	5
1.4.	EMC Laboratory Identification	5
1.5.	Laboratory Conditions.....	5
2.	Applicable Documents.....	5
3.	EUT Setup and Operation	6
3.1.	General Description	6
3.1.1.	Power Input.....	6
3.1.2.	Grounding	6
3.2.	Operational Mode	6
3.3.	EUT Modifications.....	6
4.	Test Facility and Test Instrumentation	6
4.1.	Shielded Enclosure.....	6
4.2.	Test Instrumentation.....	6
4.3.	Calibration Traceability	6
4.4.	Measurement Uncertainty	7
5.	Test Procedures	7
5.1.	Powerline Conducted Emissions	7
5.1.1.	Requirements.....	7
5.1.2.	Procedures.....	7
5.1.3.	Results	8
5.2.	Peak Output Power.....	8
5.2.1.	Requirements.....	8
5.2.2.	Procedures.....	8
5.2.3.	Results	9
5.3.	Radiated Spurious Emissions Measurements.....	9
5.3.1.	Requirements.....	9
5.3.2.	Procedures.....	9
5.3.3.	Results	11
5.4.	Band Edge Compliance	11
5.4.1.	Requirement.....	11
5.4.1.	Procedures.....	11
5.4.2.1	Low Band Edge	11
5.4.2.2	High Band Edge.....	11
5.4.2.	Results	12
6.	Other Test Conditions	12
6.1.	Test Personnel and Witnesses.....	12
6.2.	Disposition of the EUT	12
7.	Conclusions.....	12

THIS REPORT SHALL NOT BE REPRODUCED, EXCEPT IN FULL, WITHOUT THE WRITTEN APPROVAL OF ELITE ELECTRONIC ENGINEERING INCORPORATED.



TABLE OF CONTENTS		
PARAGRAPH	DESCRIPTION OF CONTENTS	PAGE NO.
8.	Certification.....	12
9.	Equipment List.....	13

THIS REPORT SHALL NOT BE REPRODUCED, EXCEPT IN FULL, WITHOUT THE
WRITTEN APPROVAL OF ELITE ELECTRONIC ENGINEERING INCORPORATED.

REVISION HISTORY

Revision	Date	Description
—	19 June 2017	Initial release
A	20 June 2017	<ul style="list-style-type: none">- Changed title and headers from 1701505-01 to 1701505-01 Rev. A.- Changed test item from Liftmaster Garage Door Opener to Marvell MW300 Wi-Fi Module.- Changed title to “Measurement of RF Emissions on a Marvell MW300 Wi-Fi Module On AC Host Logic Board Assembly No. 001D8088-4 and DC Host Logic Board Assembly No. 001D8169-4”.- Added item description in section 1.1.

Measurement of RF Emissions from a Marvell MW300 Wi-Fi Module, Model No. 8587W and Model No. 8550W Transmitters

1. INTRODUCTION

1.1. Scope of Tests

This report represents the results of the series of radio interference measurements performed on a Chamberlain Group, Inc. Marvell MW300 Wi-Fi Module, Model No. 8587W and Model No. 8550W transmitters (hereinafter referred to as the EUT). The EUT is a digital modulation transmitter. The transmitter was designed to transmit in the 2400-2483.5MHz band using an internal antenna. Testing was performed to confirm that a transmitter that has limited modular approval continues to comply with the applicable requirements when placed in two new hosts. The EUT was manufactured and submitted for testing by Chamberlain Group, Inc. located in Elmhurst, IL.

1.2. Purpose

The test series was performed to determine if the EUT meets the conducted and radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.207 and 15.247 for Intentional Radiators. The test series was also performed to determine if the EUT meets the conducted RF emission requirements of the Industry Canada Radio Standards Specification, RSS-Gen, Section 7.2.4 and the radiated RF emission requirements of the Industry Canada Radio Standards Specification, RSS-247, Section 5. Testing was performed in accordance with ANSI C63.4-2014.

1.3. Deviations, Additions and Exclusions

There were no deviations, additions to, or exclusions from the test specification during this test series.

1.4. EMC Laboratory Identification

This series of tests was performed by Elite Electronic Engineering Incorporated of Downers Grove, Illinois. The laboratory is accredited by The American Association for Laboratory Accreditation (A2LA). A2LA Certificate Number: 1786.01.

1.5. Laboratory Conditions

The temperature at the time of the test was 23.2°C and the relative humidity was 41%.

2. APPLICABLE DOCUMENTS

The following documents of the exact issue designated form part of this document to the extent specified herein:

- Federal Communications Commission "Code of Federal Regulations", Title 47, Part 15, Subpart C, dated 1 October 2017
- ANSI C63.4-2014, "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz"
- ANSI C63.10-2013, " American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices"
- Industry Canada Radio Standards Specification, RSS-Gen, "General Requirements for Compliance of Radio Apparatus", Issue 4, November 2014
- Industry Canada Radio Standards Specification, RSS-247, "Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices", Issue 2, February 2017

3. EUT SETUP AND OPERATION

3.1. General Description

The EUT is a Chamberlain Group, Inc. Marvell MW300 Wi-Fi Module, Model No. 8587W and Model No. 8550W. A block diagram of the EUT setup is shown as Figure 1. The two units differ as follows:

- Representative AC LiftMaster Garage Door Opener Model No. 8587W incorporating Marvell MW300 Wi-Fi Module (reference FCC/IC ID: HBW8522 / 2666A-8522) soldered to AC host logic board 001D8088-4
- Representative DC LiftMaster Garage Door Opener Model No. 8550W incorporating Marvell MW300 Wi-Fi Module (reference FCC/IC ID: HBW8522 / 2666A-8522) soldered to DC host logic board 001D8169-4

3.1.1. Power Input

The EUT was powered with 120VAC through 1 meter, unshielded leads.

3.1.2. Grounding

The EUT was grounded only through the third wire of its input power cord.

3.2. Operational Mode

For all tests the EUT and all peripheral equipment were placed on an 80cm high non-conductive stand. The EUT was energized. The unit was programmed to operate in one of the following modes:

- Transmit in the 802.11b band with a 1Mbps rate
- Transmit in the 802.11g band with a 54Mbps rate
- Transmit in the 802.11n band

All three bands were tested with the same channels/frequencies:

- Channel 1 = 2412MHz
- Channel 6 = 2437MHz
- Channel 11 = 2462MHz

3.3. EUT Modifications

No modifications were required for compliance to the FCC 15.247 requirements.

4. TEST FACILITY AND TEST INSTRUMENTATION

4.1. Shielded Enclosure

All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. With the exception of the floor, the reflective surfaces of the shielded chamber are lined with ferrite tiles on the walls and ceiling. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2014 for site attenuation.

4.2. Test Instrumentation

The test instrumentation and auxiliary equipment used during the tests are listed in Table 9-1.

Conducted and radiated emission measurements were performed with a spectrum analyzer. This receiver allows measurements with the bandwidths and detector functions specified by the FCC.

4.3. Calibration Traceability

Test equipment is maintained and calibrated on a regular basis with a calibration interval not greater than two years. All calibrations are traceable to the National Institute of Standards and Technology (NIST).

4.4. Measurement Uncertainty

All measurements are an estimate of their true value. The measurement uncertainty characterizes, with a specified confidence level, the spread of values which may be possible for a given measurement system.

The measurement uncertainty for these tests is presented below:

Conducted Emissions Measurements		
Combined Standard Uncertainty	1.07	-1.07
Expanded Uncertainty (95% confidence)	2.1	-2.1

Radiated Emissions Measurements		
Combined Standard Uncertainty	2.26	-2.18
Expanded Uncertainty (95% confidence)	4.5	-4.4

5. TEST PROCEDURES

5.1. Powerline Conducted Emissions

5.1.1. Requirements

Per the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Per 15.207(a) and Industry Canada RSS-Gen section 7.2.4, all radio frequency voltages on the power lines of a transmitter shall be below the values shown below when using a quasi-peak or average detector:

Frequency MHz	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 – 0.5	66 decreasing with logarithm of frequency to 56	56 decreasing with logarithm of frequency to 46
0.5 - 5	56	46
5 - 30	60	50

Note 1: The lower limit shall apply at the transition frequencies.

Note 2: If the levels measured using the QP detector meet both the QP and the Average limits, the EUT is considered to have met both requirements and measurements do not need to be performed using the Average detector.

5.1.2. Procedures

The interference on each power lead of the EUT was measured by connecting the measuring equipment to the appropriate meter terminal of the Line Impedance Stabilization Network (LISN). The meter terminal of the LISN not under test was terminated with 50 ohms.

- The EUT was operated in the 802.11b mode for the 8587W unit.
- Measurements were first made on the 120VAC high line.
- The frequency range from 150 kHz to 30 MHz was broken up into smaller frequency sub-bands.
- Conducted emissions measurements were taken on the first frequency sub-band using a peak detector.

- e) The data thus obtained was then searched by the computer for the highest levels. Any emissions levels that were within 10dB of the average limit were then measured again using both a quasi-peak detector and an average detector. (If no peak readings were within 10dB of the average limit, quasi-peak and average readings were taken on the highest emissions levels measured during the peak detector scan.)
- f) Steps (d) and (e) were repeated for the remainder of the frequency sub-bands until the entire frequency range from 150kHz to 30MHz was investigated. The peak trace was automatically plotted. The plot also shows quasi-peak and average readings that were taken on discrete frequencies. A table showing the quasi-peak and average readings was also generated. This tabular data compares the quasi-peak and average conducted emissions to the applicable conducted emissions limits.
- g) Steps (c) through (f) were repeated on the 120VAC return line.
- h) Steps (a) through (g) were repeated for the 8550W unit.

5.1.3.Results

The plots of the peak, quasi-peak, and average conducted voltage levels acquired from each input power line with the EUT operated in the 802.11b mode are shown on pages 20 through 27. The tabular quasi-peak and average results from each input power line with the EUT operated in the 802.11b mode are also shown on pages 20 through 27. All power line conducted emissions measured from the EUT were within the specification limits. The emissions level closest to the limit (worst case) occurred at 0.275MHz. The emissions level at this frequency was 9.8dBμV within the limit. Photographs of the test configuration which yielded the highest or worst case, conducted emission levels are shown on Figure 2.

5.2. Peak Output Power

5.2.1.Requirements

Per section 15.247(b)(3), for systems using digital modulation the maximum peak output conducted power shall not be greater than 1.0W (30dBm). Per section 15.247(b)(4), this limit is based on the use of antennas with directional gains that do not exceed 6dBi. Since the limit allows for a 6dBi antenna gain, the maximum EIRP can be increased by 6dB to 4 Watt (36dBm).

A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released. Also, a transmitter activated automatically shall cease transmission within 5 seconds after activation.

5.2.2.Procedures

For the conducted emissions method, the output of the EUT was connected to the spectrum analyzer through 40dB of attenuation. The maximum meter reading was recorded. The peak power output was calculated for the low, middle and high channels.

The output of the EUT was connected to the spectrum analyzer through 40dB of attenuation. The EUT was set to transmit separately at the low, middle, and high channels. The resolution bandwidth (RBW) was set to greater than the 6dB bandwidth. The 'Max-Hold' function was engaged. The maximum meter reading was recorded. The peak power output was calculated for the low, middle and high channels.

For the radiated emissions method, the EUT was placed on the non-conductive stand and set to transmit. A dipole antenna (double ridged waveguide antenna for all measurements above 1GHz) was placed at a test distance of 3 meters from the EUT. The resolution bandwidth (RBW) of the spectrum analyzer was set to greater than the 6dB bandwidth. The EUT was maximized for worst case emissions (or maximum output power) at the measuring antenna. The maximum meter reading was recorded. The peak power output was measured for the low, middle and high channels.

The equivalent power was determined from the field intensity levels measured at 3 meters using the substitution method. To determine the emission power, a second dipole antenna (double ridged waveguide

antenna for all measurements above 1GHz) was then set in place of the EUT and connected to a calibrated signal generator. The output of the signal generator was adjusted to match the received level at the spectrum analyzer. The signal level was recorded. The reading was then corrected to compensate for cable loss (and antenna gain for all measurements above 1GHz), as required. The peak power output was calculated for low, middle, and high hopping frequencies.

5.2.3.Results

For antenna conducted emissions method, the results are presented on pages 28 through 39. The maximum peak conducted output power from the transmitter on the 8587W unit was 0.25W (24.0dBm), which is below the 1 Watt limit. The maximum peak conducted output power from the transmitter on the 8550W unit was 0.26W (24.2dBm), which is below the 1 Watt limit.

For radiated emissions method, the results are presented on pages 40 through 45. The maximum EIRP measured from the transmitter on the 8587W unit was 19.3dBm (0.085W), which is below the 4 Watt limit. The maximum EIRP measured from the transmitter on the 8550W unit was 24.1dBm (0.257W), which is below the 4 Watt limit.

5.3. Radiated Spurious Emissions Measurements

5.3.1.Requirements

Per section 15.247(d), in any 100kHz 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 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated emissions measurement. 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 comply with the radiated emission limits specified in §15.209(a).

Paragraph 15.209(a) has the following radiated emission limits:

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	3
30.0-88.0	100	3
88.0-216.0	150	3
216.0-960.0	200	3
Above 960	500	3

5.3.2.Procedures

All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. The walls and ceiling of the shielded chamber are lined with ferrite tiles. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2014 for site attenuation.

The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

Preliminary radiated emissions tests were performed to determine the emission characteristics of the EUT. For the preliminary test, a broadband measuring antenna was positioned at a 3 meter distance from the EUT. The entire frequency range from 30MHz to 25.0GHz was investigated using a peak detector function.

The final open field emission tests were then manually performed over the frequency range of 30MHz to

25.0GHz.

- 1) For all harmonics not in the restricted bands, the following procedure was used:
 - a) The field strength of the fundamental was measured using a double ridged waveguide antenna. The waveguide antenna was positioned at a 3 meter distance from the EUT. A peak detector with a resolution bandwidth of 100 kHz was used on the spectrum analyzer.
 - b) The field strengths of all of the harmonics not in the restricted band were then measured using a double-ridged waveguide antenna. The waveguide antenna was positioned at a 3 meter distance from the EUT. A peak detector with a resolution bandwidth of 100 kHz was used on the spectrum analyzer.
 - c) To ensure that maximum or worst case emission levels at the fundamental and harmonics were measured, the following steps were taken when measuring the fundamental emissions and the spurious emissions:
 - i) The EUT was rotated so that all of its sides were exposed to the receiving antenna.
 - ii) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.
 - iii) The measuring antenna was raised and lowered for each antenna polarization to maximize the readings.
 - iv) In instances where it was necessary to use a shortened cable between the measuring antenna and the spectrum analyzer, the measuring antenna was not raised or lowered to ensure maximized readings. Instead the EUT was rotated through all axis to ensure the maximum readings were recorded for the EUT.
 - d) All harmonics not in the restricted bands must be at least 20 dB below levels measured at the fundamental. However, attenuation below the general limits specified in §15.209(a) is not required.
- 2) For all emissions in the restricted bands, the following procedure was used:
 - a) The field strengths of all emissions below 1 GHz were measured using a bi-log antenna. The bi-log antenna was positioned at a 3 meter distance from the EUT. A peak detector with a resolution bandwidth of 100 kHz was used on the spectrum analyzer.
 - b) The field strengths of all emissions above 1 GHz were measured using a double-ridged waveguide antenna. The waveguide antenna was positioned at a 3 meter distance from the EUT. A peak detector with a resolution bandwidth of 1 MHz was used on the spectrum analyzer.
 - c) To ensure that maximum or worst case emission levels were measured, the following steps were taken when taking all measurements:
 - i) The EUT was rotated so that all of its sides were exposed to the receiving antenna.
 - ii) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.
 - iii) The measuring antenna was raised and lowered for each antenna polarization to maximize the readings.
 - iv) In instances where it was necessary to use a shortened cable between the measuring antenna and the spectrum analyzer, the measuring antenna was not raised or lowered to ensure maximized readings. Instead the EUT was rotated through all axis to ensure the maximum readings were recorded for the EUT.
 - d) For all radiated emissions measurements below 1 GHz, if the peak reading is below the limits listed in 15.209(a), no further measurements are required. If however, the peak readings exceed the limits listed in 15.209(a), then the emissions are remeasured using a quasi-peak detector.
 - e) For all radiated emissions measurements above 1 GHz, the peak readings must comply with the 15.35(b) limits. 15.35(b) states that when average radiated emissions measurements are specified, there also is a limit on the peak level of the radiated emissions. The limit on the peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test. Therefore, all peak readings above 1 GHz must be no greater than 20 dB above the limits specified in 15.209(a).
 - f) Next, for all radiated emissions measurements above 1GHz, the resolution bandwidth was set to 1MHz. The analyzer was set to linear mode with a 10Hz video bandwidth in order to simulate an average detector. An average reading was taken.

If the emission is pulsed, the reading can be adjusted by a "duty cycle correction factor" derived from

$20 \cdot \log(\text{on time}/100\text{msec})$. These readings must be no greater than the limits specified in 15.209(a).

5.3.3.Results

Preliminary radiated emissions plots of the EUT are shown on pages 46 through 193. Final radiated emissions data are presented on data pages 194 through 247. As can be seen from the data, all emissions measured from the EUT were within the specification limits. The emissions level closest to the limit (worst case) for model 8587W occurred at 4874MHz. The emissions level at this frequency was -4.7dB within the limit. The emissions level closest to the limit (worst case) for model 8550W occurred at 4824MHz. The emissions level at this frequency was -2.8dB within the limit. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figures 3 through 6.

5.4. Band Edge Compliance

5.4.1.Requirement

Per section 15.247(d), the emissions at the band-edges must be at least 20dB below the highest level measured within the band but attenuation below the general limits listed in 15.209(a) is not required.

5.4.1.Procedures

5.4.2.1 Low Band Edge

- 1) The EUT was setup inside the test chamber on a non-conductive stand.
- 2) A broadband measuring antenna was placed at a test distance of 3 meters from the EUT.
- 3) The EUT was set to transmit continuously at the channel closest to the low band-edge.
- 4) The EUT was maximized for worst case emissions at the measuring antenna. The maximum meter reading was recorded.
- 5) To determine the band edge compliance, the following spectrum analyzer settings were used:
 - a. Center frequency = low band-edge frequency.
 - b. Span = Wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation.
 - c. Resolution bandwidth (RBW) $\geq 1\%$ of the span.
 - d. The 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined.
 - e. The marker was set on the peak of the in-band emissions. A display line was placed 20dB down from the peak of the in-band emissions. All emissions which fall outside of the authorized band of operation must be below the 20dB down display line. (All emissions to the left of the center frequency (band-edge) must be below the display line.)
 - f. The analyzer's display was plotted using a 'screen dump' utility.

5.4.2.2 High Band Edge

- 1) The EUT was setup inside the test chamber on a non-conductive stand.
- 2) A broadband measuring antenna was placed at a test distance of 3 meters from the EUT.
- 3) The EUT was maximized for worst case emissions at the measuring antenna. A peak reading was taken with a resolution bandwidth of 1MHz and a video bandwidth of 1MHz or greater. An average reading was then taken with a resolution bandwidth of 1MHz and a video bandwidth of 10Hz. The maximum peak and average meter readings were recorded.
- 4) To determine the band edge compliance, the following spectrum analyzer settings were used:
 - a. Center frequency = high band-edge frequency.
 - b. Span = Wide enough to capture both the peak level of the fundamental emission and the band-edge emission under investigation.
 - c. Resolution bandwidth (RBW) = 1% of the span (but never less than 30kHz).
 - d. The 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined.
 - e. The marker was set on the peak of the in-band emissions. This level corresponds to

the maximized peak (or average) reading previously taken. The "marker-delta" method described in Public Notice DA 00-705 was then used to determine band edge compliance. The delta between the marker and the general limit (74dBuV/m or 54dBuV/m) was calculated by subtracting the general limit (74dBuV/m or 54dBuV/m) from the maximum reading taken with a 1MHz bandwidth. This delta represents how far below the marker the emissions outside of the authorized band of operation must be. A display line was placed at this level. All emissions which fall outside of the authorized band of operation must be below the display line. (All emissions to the right of the center frequency (band-edge) must be below the display line.)

- f. The analyzer's display was plotted using a 'screen dump' utility.

In accordance with paragraph 15.247(d), all emissions within 20dB of the peak amplitude level of the center frequency are required to be within a band less than 0.25% of the center frequency wide.

5.4.2. Results

Pages 248 through 257 show the radiated band-edge compliance results. As can be seen from these plots, the radiated emissions at the low end band edge are within the 20 dB down limits. The radiated emissions at the high end band edge are within the general limits.

6. OTHER TEST CONDITIONS

6.1. Test Personnel and Witnesses

All tests were performed by qualified personnel from Elite Electronic Engineering Incorporated.

6.2. Disposition of the EUT

The EUT and all associated equipment were returned to Chamberlain Group, Inc. upon completion of the tests.

7. CONCLUSIONS

It was determined that the Chamberlain Group, Inc. Marvell MW300 Wi-Fi Module, Model No. 8587W and Model No. 8550W, digital modulation transmitters, did fully meet the conducted and radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.207 and 15.247 for Intentional Radiators Operating within the 2400-2483.5 MHz band, when tested per ANSI C63.4-2014.

It was also determined that the Chamberlain Group, Inc. Marvell MW300 Wi-Fi Module, Model No. 8587W and Model No. 8550W, digital modulation transmitters, did fully meet the conducted and radiated RF emission requirements of the Industry Canada Radio Standards Specification, RSS-Gen Section 7.2.4 and RSS-247 Section 5, for transmitters, when tested per ANSI C63.4-2014.

8. CERTIFICATION

Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the test specifications.

The data presented in this test report pertains to the EUT at the test date. Any electrical or mechanical modification made to the EUT subsequent to the specified test date will serve to invalidate the data and void this certification.

This report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST or any agency of the Federal Government.

9. EQUIPMENT LIST

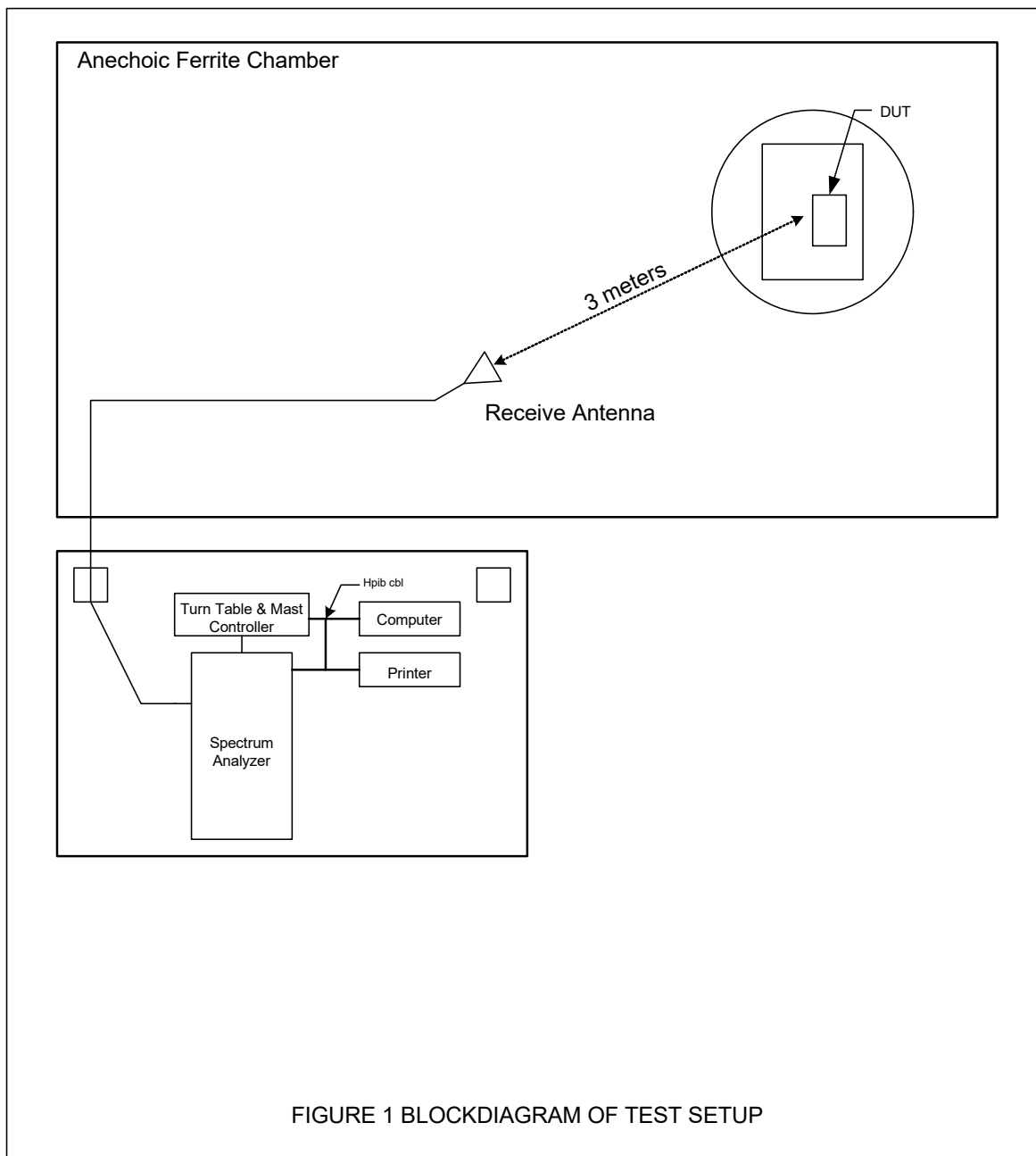
Table 9-1 Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
APW0	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-30-20G20R6G	PL2926/0646	20GHZ-26.5GHZ	3/22/2017	3/22/2018
APW3	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-35-120-5R0-10-12	PL2924	1GHZ-20GHZ	9/28/2016	9/28/2017
CDU3	LAPTOP COMPUTER						
CDX8	COMPUTER	ELITE	WORKSTATION			N/A	
CDY0	WORKSTATION	ELITE	WORKSTATION		WINDOWS 7	N/A	
GSFA	OSP-B157 OSP MODULE	ROHDE & SCHWARZ	OSP-B157	100867		9/9/2016	9/9/2017
GSFB	OSP120 BASE UNIT	ROHDE & SCHWARZ	OSP120	101246	---	9/9/2016	9/9/2017
NHG0	STANDARD GAIN HORN ANTENNA	NARDA	638	---	18-26.5GHZ	NOTE 1	
NTA2	BILOG ANTENNA	TESEQ	6112D	28040	25-1000MHz	11/27/2016	11/27/2017
NWQ1	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS-LINDGREN	3117	66655	1GHZ-18GHZ	4/4/2016	4/4/2018
NWQ2	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS LINDGREN	3117	66659	1GHZ-18GHZ	3/2/2016	3/2/2018
PLF2	CISPR16 50UH LISN	ELITE	CISPR16/70A	002	.15-30MHz	5/4/2017	5/4/2018
PLF4	CISPR16 50UH LISN	ELITE	CISPR16/70A	003	.15-30MHz	5/4/2017	5/4/2018
RBG0	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	101533	10HZ-44GHZ	11/10/2016	11/10/2017
RBG2	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	101591	2HZ-44GHZ	11/22/2016	11/22/2017
RBG3	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	101592	2HZ-44GHZ	1/11/2017	1/11/2018
SES0	24VDC POWER SUPPLY	P-TRANS	FS-32024-1M	001	18-27VDC	NOTE 1	
T1E0	10DB 25W ATTENUATOR	WEINSCHEL	46-10-43	AU1882	DC-18GHZ	5/2/2016	5/2/2018
VBR8	CISPR EN FCC CE VOLTAGE.exe						
WKA1	SOFTWARE, UNIVERSAL RCV EMI	ELITE	UNIV_RCV_EMI	1	---	I/O	
XLJN	5W, 50 OHM TERMINATION	JFW INDUSTRIES	50T-052	---	DC-2GHZ	7/7/2016	7/7/2018
XPR0	HIGH PASS FILTER	K&L MICROWAVE	11SH10-4800/X20000	001	4.8-20GHZ	9/14/2016	9/14/2017

I/O: Initial Only

N/A: Not Applicable

Note 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.



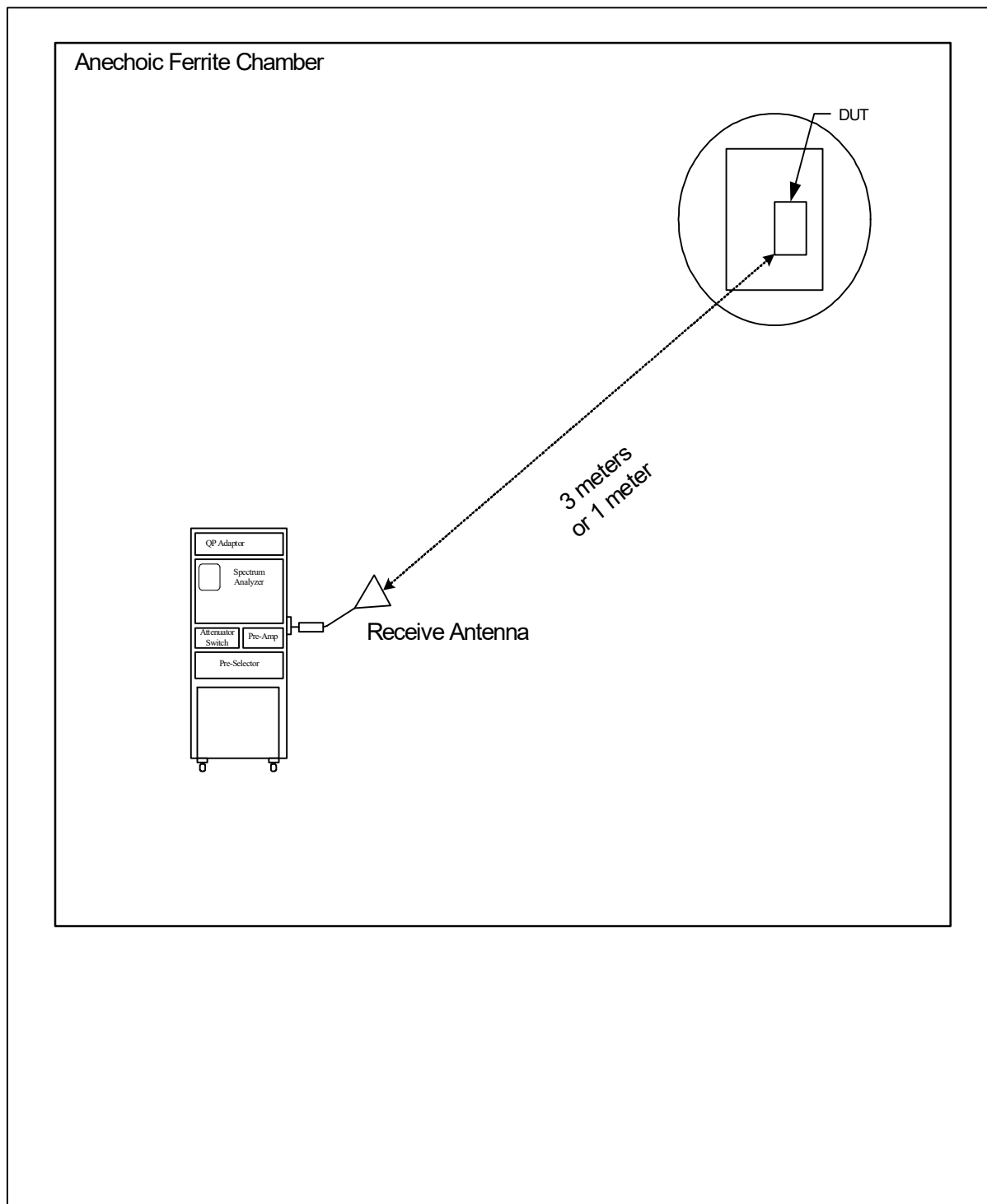
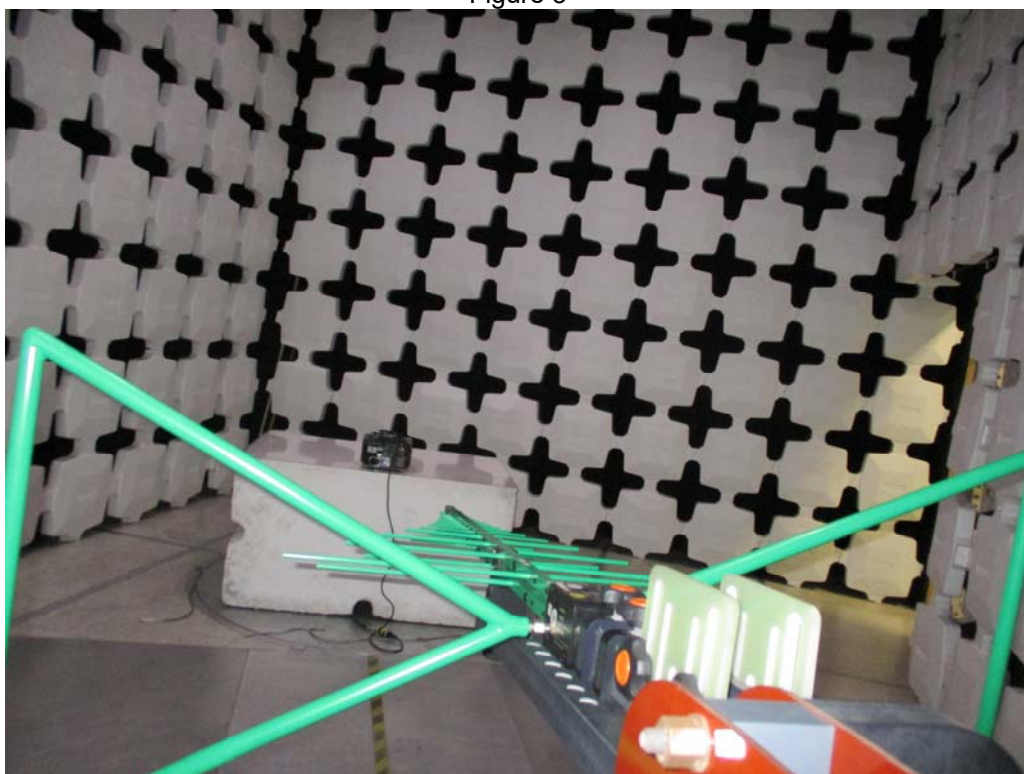


Figure 2



Test Setup for Conducted Emissions

Figure 3



Test Setup for Radiated Emissions, 30MHz to 1GHz – Horizontal Polarization



Test Setup for Radiated Emissions, 30MHz to 1GHz – Vertical Polarization

Figure 4

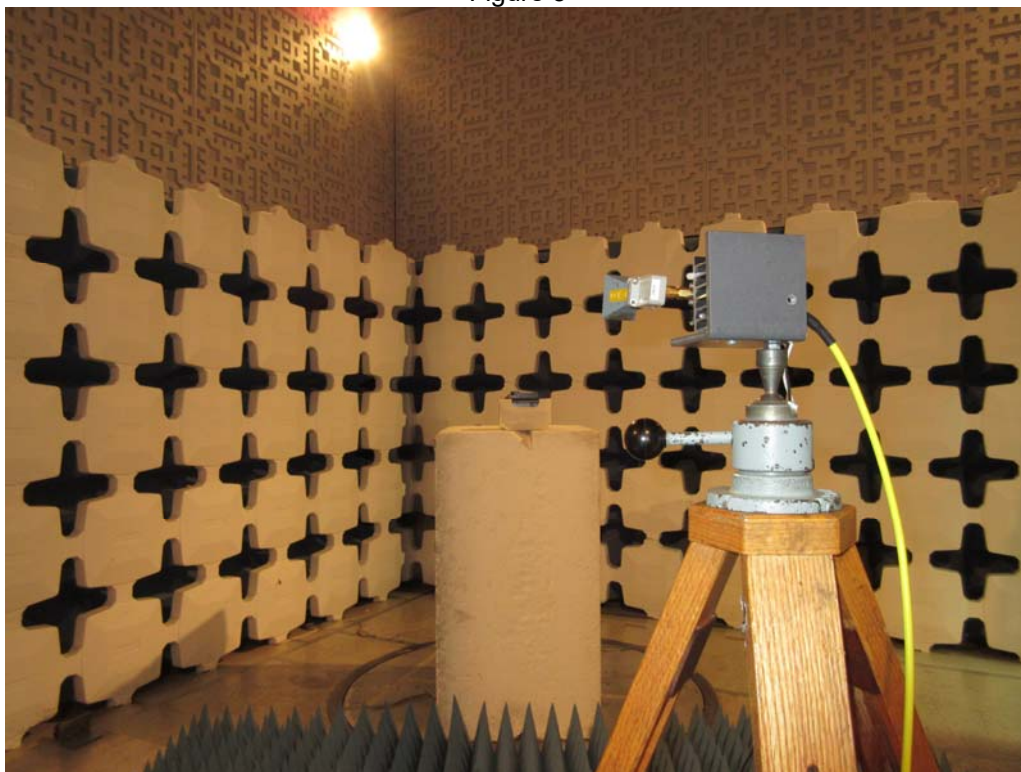


Test Setup for Radiated Emissions, 1 - 18GHz – Horizontal Polarization

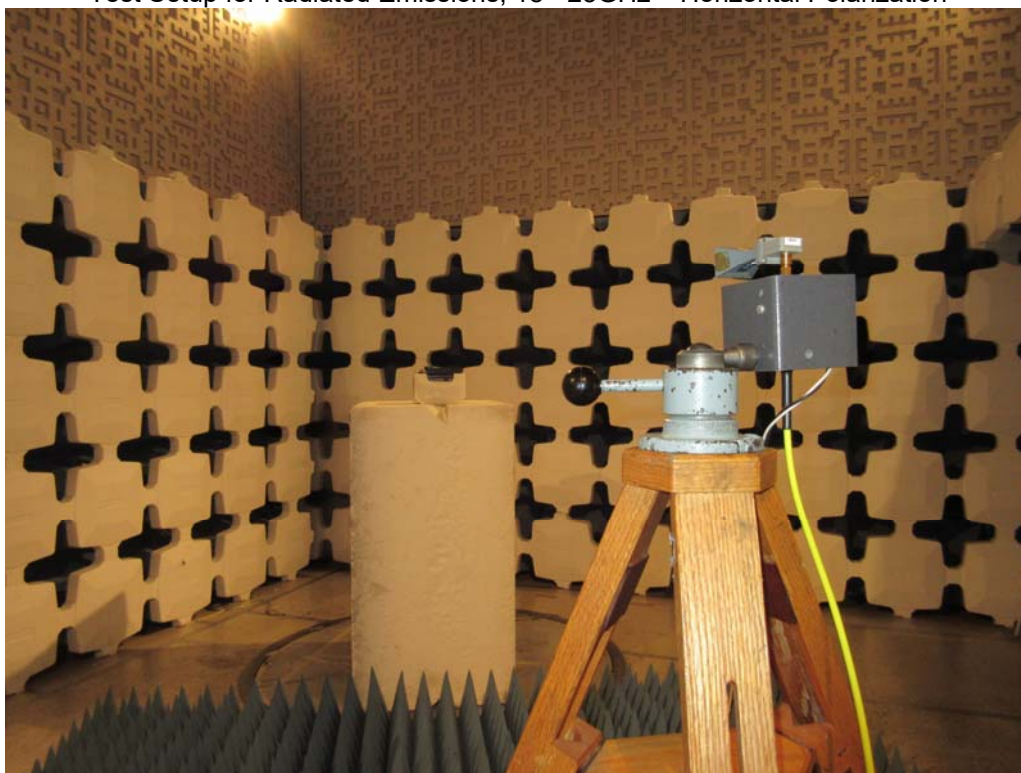


Test Setup for Radiated Emissions, 1 - 18GHz – Vertical Polarization

Figure 5



Test Setup for Radiated Emissions, 18 - 25GHz – Horizontal Polarization



Test Setup for Radiated Emissions, 18 - 25GHz – Vertical Polarization

FCC Part 15 Subpart B Conducted Emissions Test

Significant Emissions Data

VBR8 04/23/2015

Manufacturer : CHAMBERLAIN
 Model : LIFTMASTER AC
 DUT Revision : 1.0
 Serial Number :
 DUT Mode : NORMAL OPERATION
 Line Tested : 115V 60Hz HIGH LINE
 Scan Step Time [ms] : 30
 Meas. Threshold [dB] : -10
 Notes : TX @ 802.11B CH. 1
 Test Engineer : T. Jozefczyk
 Limit : Class B
 Test Date : May 09, 2017 01:46:41 PM
 Data Filter : Up to 80 maximum levels detected with 6 dB level excursion threshold over 5 dB margin below limit

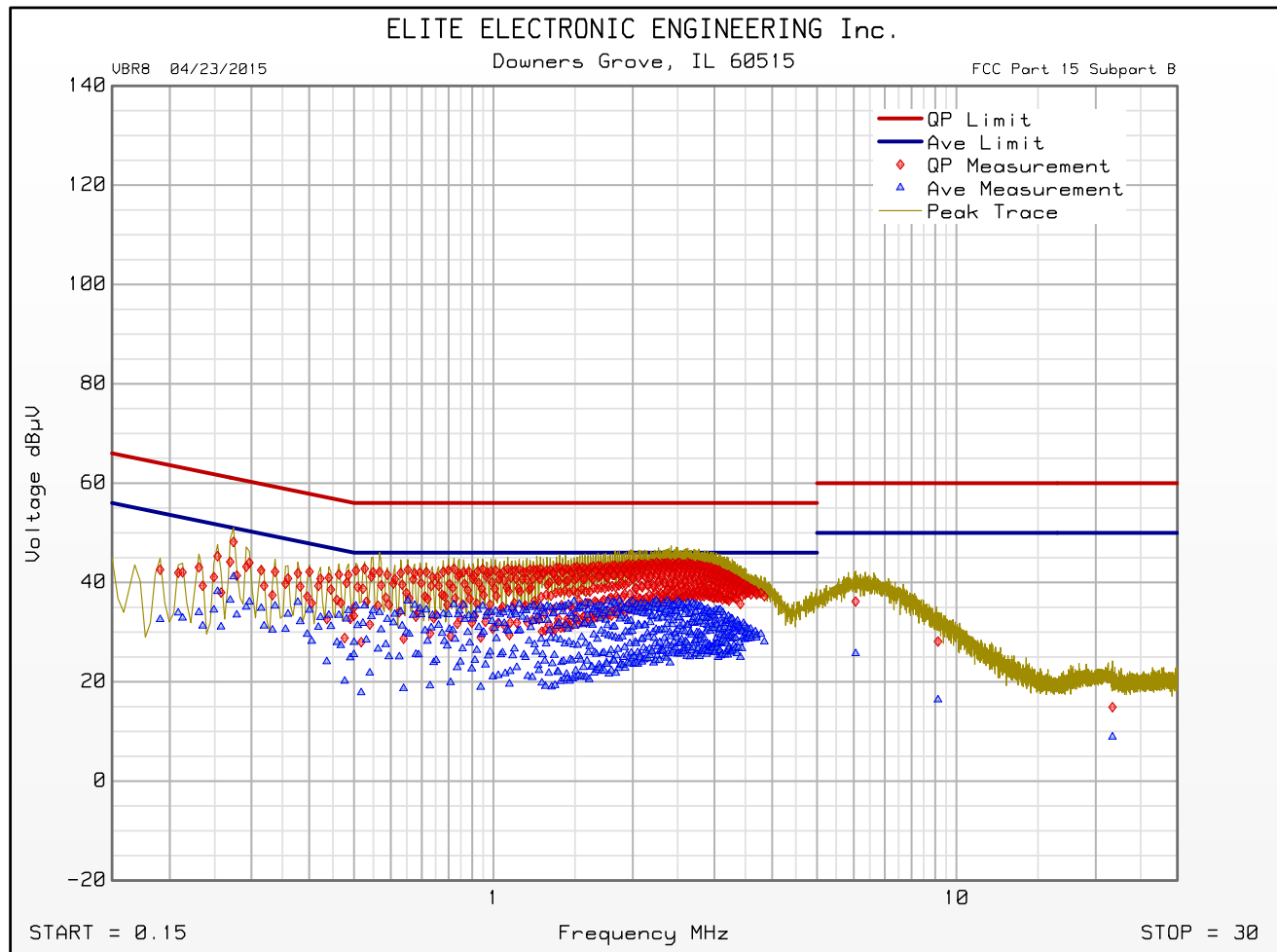
Freq MHz	Quasi-peak Level dBμV	Quasi-peak Limit dBμV	Excessive Quasi-peak Emissions	Average Level dBμV	Average Limit dBμV	Excessive Average Emissions
0.254	45.3	61.6		38.2	51.6	
0.275	48.2	61.0		41.2	51.0	
0.527	42.8	56.0		35.3	46.0	
0.822	42.8	56.0		35.6	46.0	
1.957	43.7	56.0		35.8	46.0	
2.250	44.0	56.0		36.4	46.0	
3.154	41.8	56.0		33.3	46.0	
6.058	36.2	60.0		25.7	50.0	
9.126	28.1	60.0		16.4	50.0	
21.731	14.9	60.0		8.9	50.0	



FCC Part 15 Subpart B Conducted Emissions Test Cumulative Data

VBR8 04/23/2015

Manufacturer : CHAMBERLAIN
Model : LIFTMASTER AC
DUT Revision : 1.0
Serial Number :
DUT Mode : NORMAL OPERATION
Line Tested : 115V 60Hz HIGH LINE
Scan Step Time [ms] : 30
Meas. Threshold [dB] : -10
Notes : TX @ 802.11B CH. 1
Test Engineer : T. Jozefczyk
Limit : Class B
Test Date : May 09, 2017 01:46:41 PM



Emissions Meet QP Limit
Emissions Meet Ave Limit

FCC Part 15 Subpart B Conducted Emissions Test

Significant Emissions Data

VBR8 04/23/2015

Manufacturer : CHAMBERLAIN
 Model : LIFTMASTER AC
 DUT Revision : 1.0
 Serial Number :
 DUT Mode : NORMAL OPERATION
 Line Tested : 115V 60Hz NEUTRAL LINE
 Scan Step Time [ms] : 30
 Meas. Threshold [dB] : -10
 Notes : TX @ 802.11B CH. 1
 Test Engineer : T. Jozefczyk
 Limit : Class B
 Test Date : May 09, 2017 01:59:03 PM
 Data Filter : Up to 80 maximum levels detected with 6 dB level excursion threshold over 5 dB margin below limit

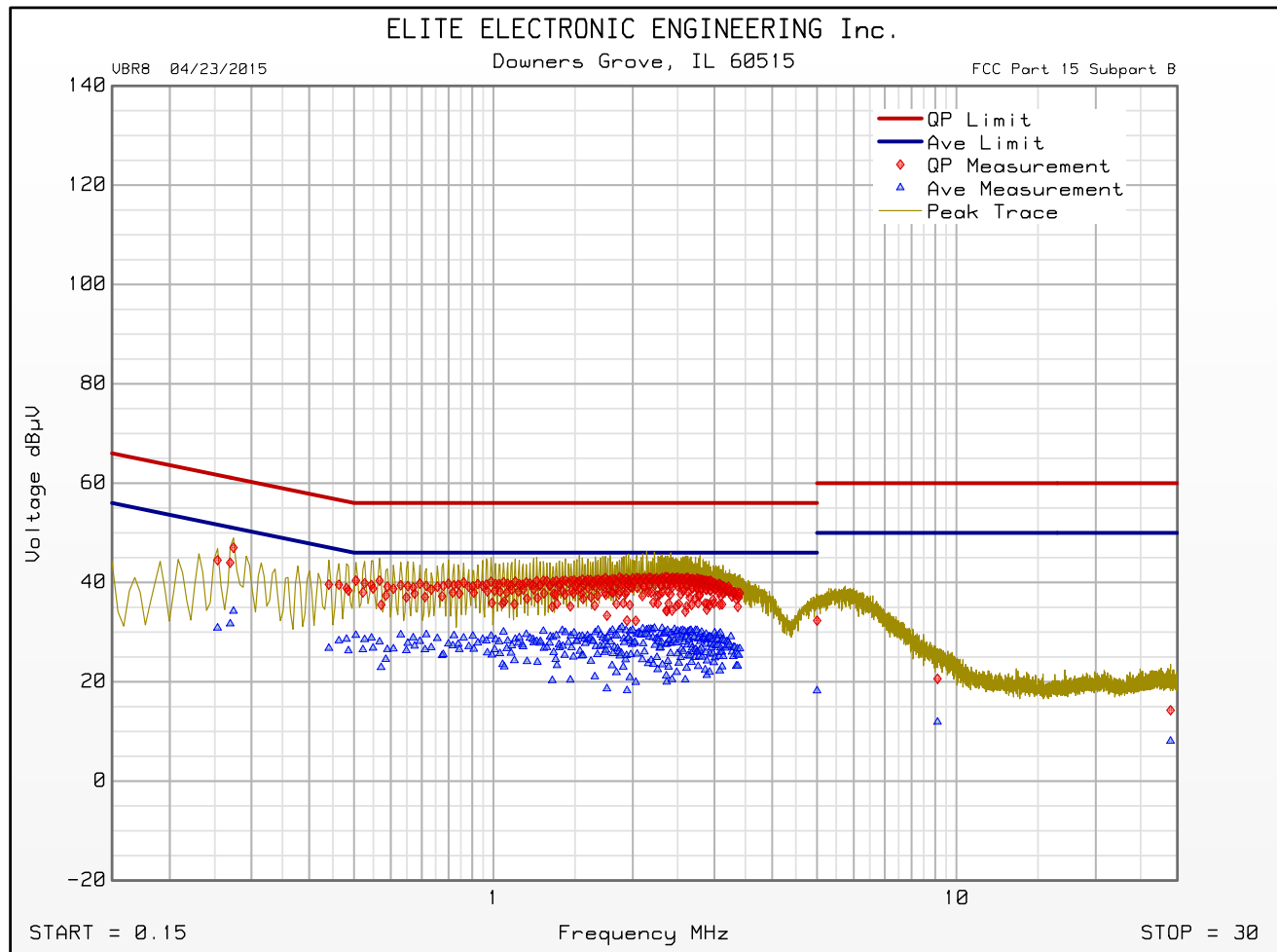
Freq MHz	Quasi-peak Level dBμV	Quasi-peak Limit dBμV	Excessive Quasi-peak Emissions	Average Level dBμV	Average Limit dBμV	Excessive Average Emissions
0.270	44.0	61.1		31.7	51.1	
0.505	40.4	56.0		29.4	46.0	
1.240	40.3	56.0		28.1	46.0	
1.871	41.0	56.0		30.5	46.0	
2.354	41.1	56.0		30.0	46.0	
3.217	39.2	56.0		28.0	46.0	
5.000	32.3	56.0		18.2	46.0	
9.104	20.6	60.0		11.9	50.0	
29.008	14.3	60.0		8.1	50.0	



FCC Part 15 Subpart B Conducted Emissions Test Cumulative Data

VBR8 04/23/2015

Manufacturer : CHAMBERLAIN
Model : LIFTMASTER AC
DUT Revision : 1.0
Serial Number :
DUT Mode : NORMAL OPERATION
Line Tested : 115V 60Hz NEUTRAL LINE
Scan Step Time [ms] : 30
Meas. Threshold [dB] : -10
Notes : TX @ 802.11B CH. 1
Test Engineer : T. Jozefczyk
Limit : Class B
Test Date : May 09, 2017 01:59:03 PM



Emissions Meet QP Limit
Emissions Meet Ave Limit

FCC Part 15 Subpart B Conducted Emissions Test

Significant Emissions Data

VBR8 04/23/2015

Manufacturer : CHAMBERLAIN
 Model : LIFTMASTER DC
 DUT Revision : 1.0
 Serial Number :
 DUT Mode : NORMAL OPERATION
 Line Tested : 115V 60Hz HIGH LINE
 Scan Step Time [ms] : 30
 Meas. Threshold [dB] : -10
 Notes : TX @ 802.11B CH. 1
 Test Engineer : T. Jozefczyk
 Limit : Class B
 Test Date : May 09, 2017 02:16:06 PM
 Data Filter : Up to 80 maximum levels detected with 6 dB level excursion threshold over 10 dB margin below limit

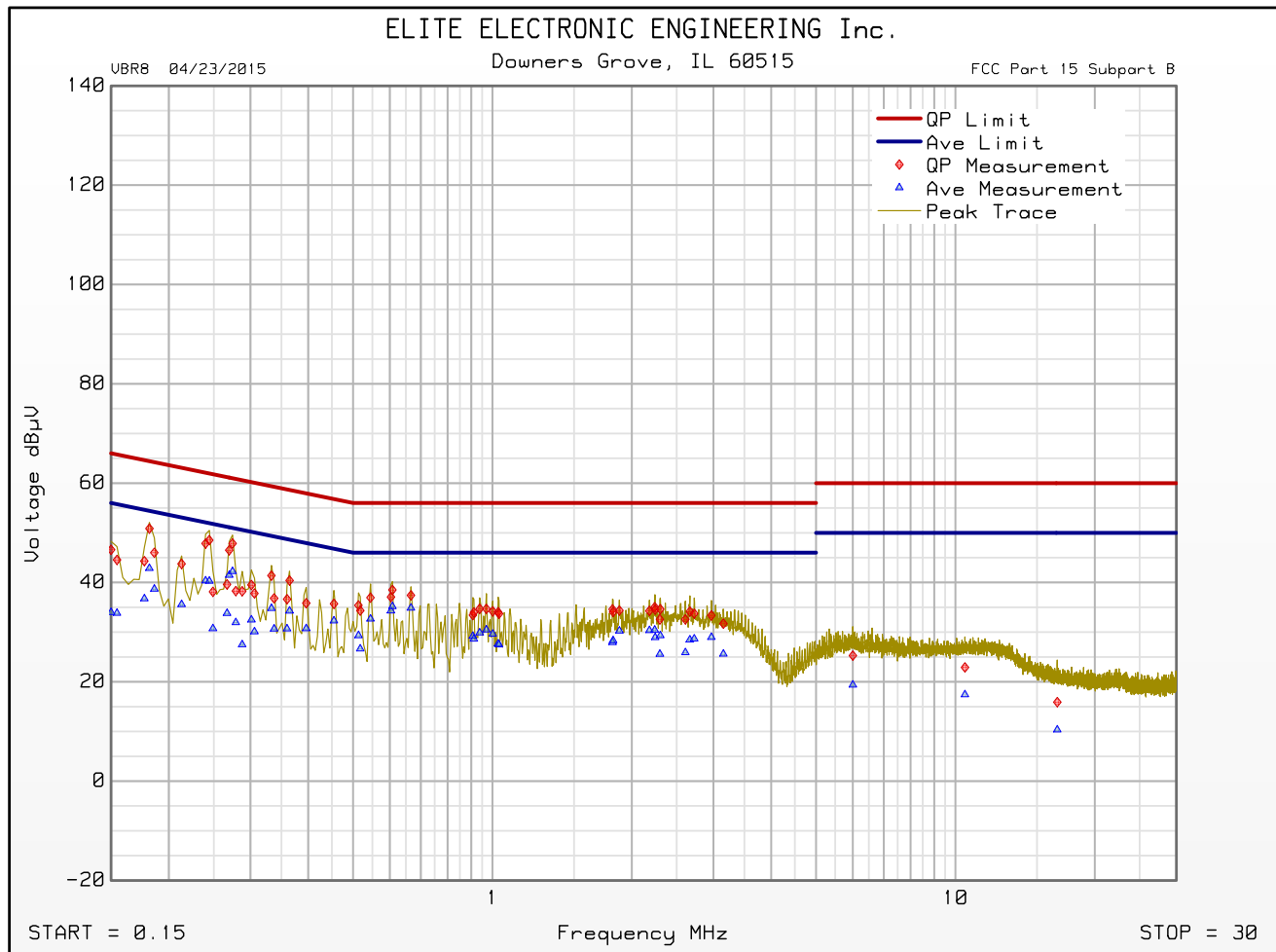
Freq MHz	Quasi-peak Level dBμV	Quasi-peak Limit dBμV	Excessive Quasi-peak Emissions	Average Level dBμV	Average Limit dBμV	Excessive Average Emissions
0.245	48.5	61.9		40.3	51.9	
0.275	47.9	61.0		42.2	51.0	
0.608	38.5	56.0		35.2	46.0	
0.939	34.7	56.0		29.9	46.0	
1.817	34.6	56.0		27.9	46.0	
2.241	35.0	56.0		30.5	46.0	
3.154	31.7	56.0		25.6	46.0	
6.004	25.3	60.0		19.4	50.0	
10.485	22.9	60.0		17.4	50.0	
16.597	15.9	60.0		10.4	50.0	



FCC Part 15 Subpart B Conducted Emissions Test Cumulative Data

VBR8 04/23/2015

Manufacturer : CHAMBERLAIN
Model : LIFTMASTER DC
DUT Revision : 1.0
Serial Number :
DUT Mode : NORMAL OPERATION
Line Tested : 115V 60Hz HIGH LINE
Scan Step Time [ms] : 30
Meas. Threshold [dB] : -10
Notes : TX @ 802.11B CH. 1
Test Engineer : T. Jozefczyk
Limit : Class B
Test Date : May 09, 2017 02:16:06 PM



Emissions Meet QP Limit
Emissions Meet Ave Limit

FCC Part 15 Subpart B Conducted Emissions Test

Significant Emissions Data

VBR8 04/23/2015

Manufacturer : CHAMBERLAIN
 Model : LIFTMASTER DC
 DUT Revision : 1.0
 Serial Number :
 DUT Mode : NORMAL OPERATION
 Line Tested : 115V 60Hz NEUTRAL LINE
 Scan Step Time [ms] : 30
 Meas. Threshold [dB] : -7
 Notes : TX @ 802.11B CH. 1
 Test Engineer : T. Jozefczyk
 Limit : Class B
 Test Date : May 09, 2017 02:09:30 PM
 Data Filter : Up to 80 maximum levels detected with 6 dB level excursion threshold over 7 dB margin below limit

Freq MHz	Quasi-peak Level dBμV	Quasi-peak Limit dBμV	Excessive Quasi-peak Emissions	Average Level dBμV	Average Limit dBμV	Excessive Average Emissions
0.245	47.0	61.9		39.0	51.9	
0.275	47.3	61.0		40.4	51.0	
0.608	38.0	56.0		35.3	46.0	
1.033	38.2	56.0		30.3	46.0	
1.336	35.7	56.0		31.8	46.0	
2.187	33.3	56.0		28.2	46.0	
3.280	28.8	56.0		24.7	46.0	
5.230	24.4	60.0		18.4	50.0	
11.057	23.1	60.0		17.5	50.0	
20.683	13.4	60.0		7.5	50.0	

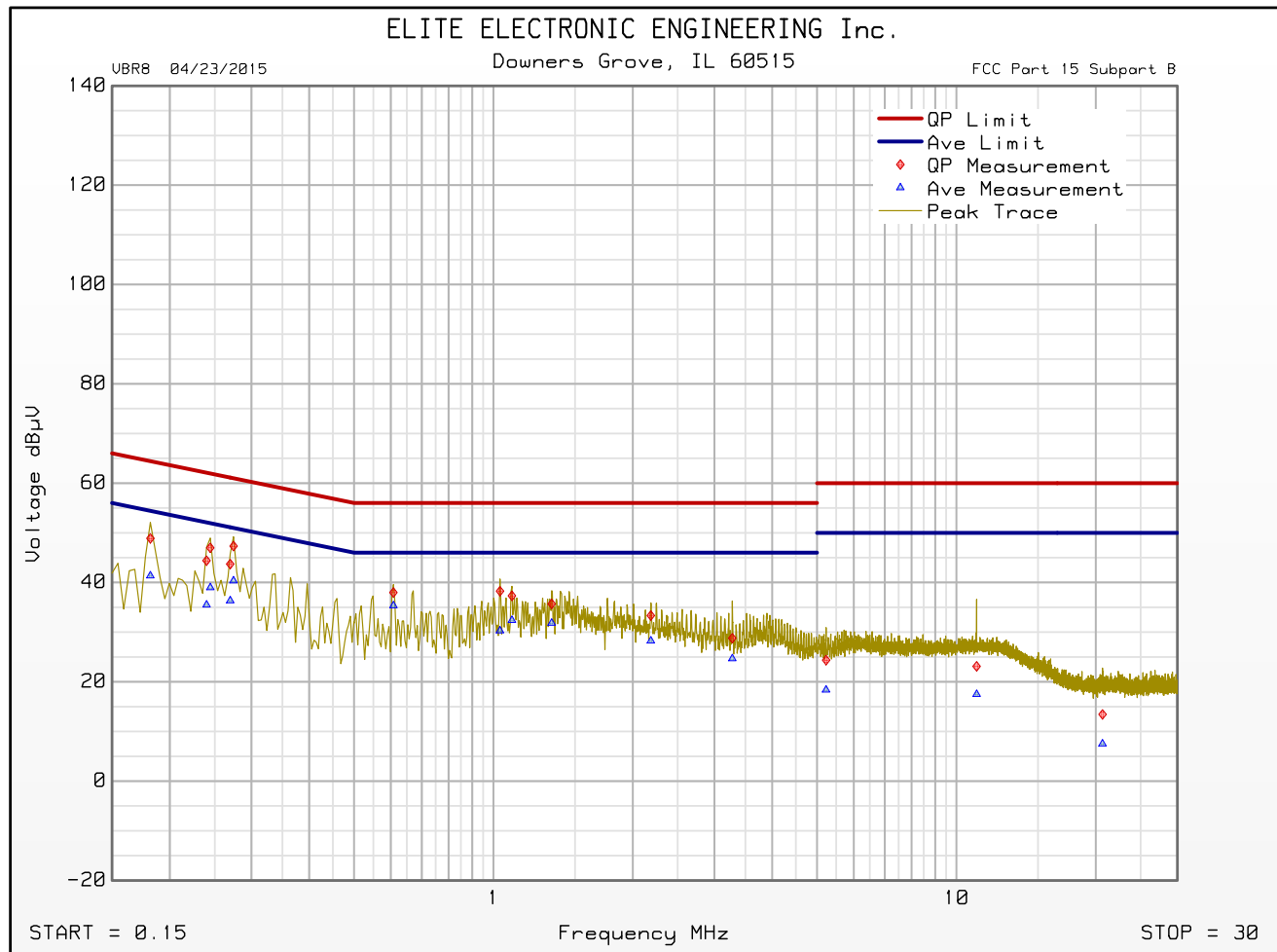


FCC Part 15 Subpart B Conducted Emissions Test

Cumulative Data

VBR8 04/23/2015

Manufacturer : CHAMBERLAIN
Model : LIFTMASTER DC
DUT Revision : 1.0
Serial Number :
DUT Mode : NORMAL OPERATION
Line Tested : 115V 60Hz NEUTRAL LINE
Scan Step Time [ms] : 30
Meas. Threshold [dB] : -7
Notes : TX @ 802.11B CH. 1
Test Engineer : T. Jozefczyk
Limit : Class B
Test Date : May 09, 2017 02:09:30 PM



Emissions Meet QP Limit
Emissions Meet Ave Limit

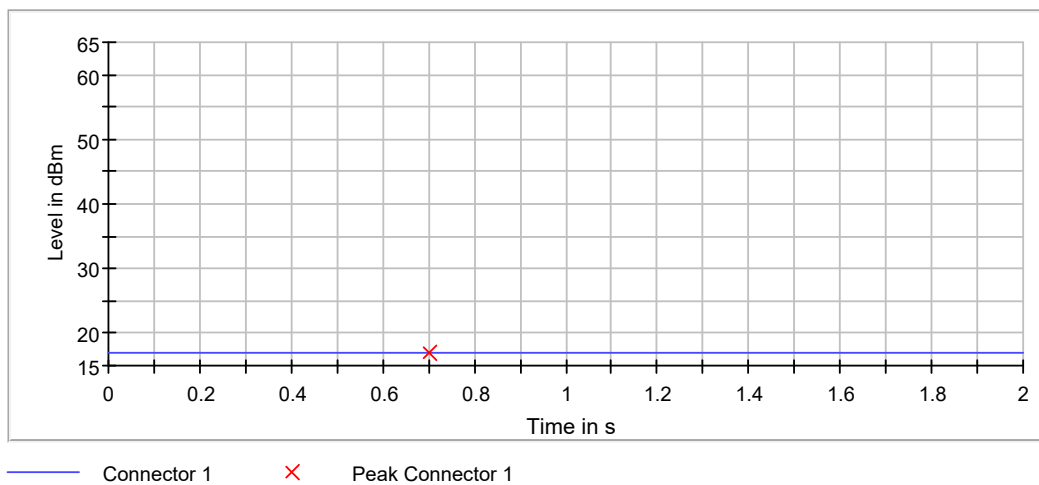
DATA PAGE

Manufacturer : Chamberlain Group, Inc.
 Test Item : Equipment Using Wide Band Modulations Other Than FHSS, Non-Adaptive
 : Transceiver
 Model No. : 8587W
 Test Mode : 802.11b
 Test Performed : Peak Output Power
 Test Date : May 10, 2017

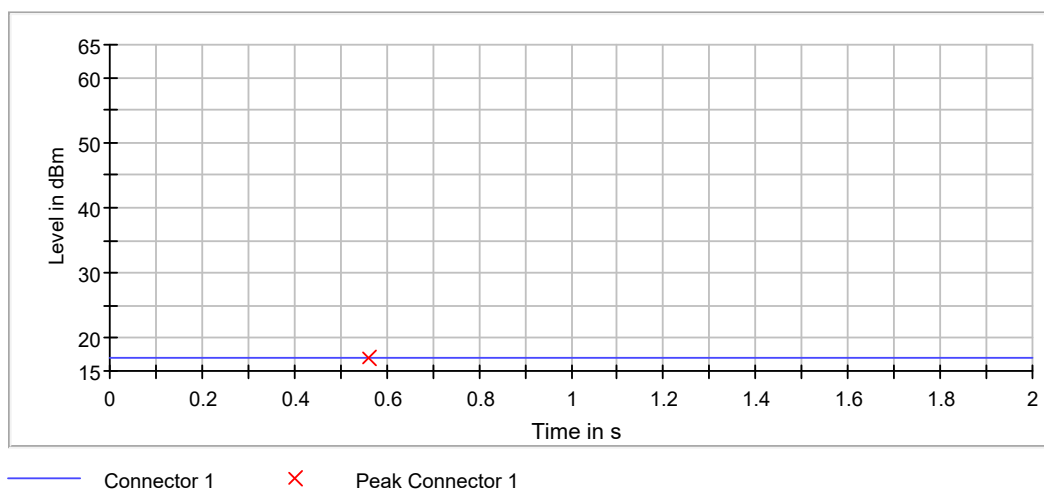
Peak Output Power

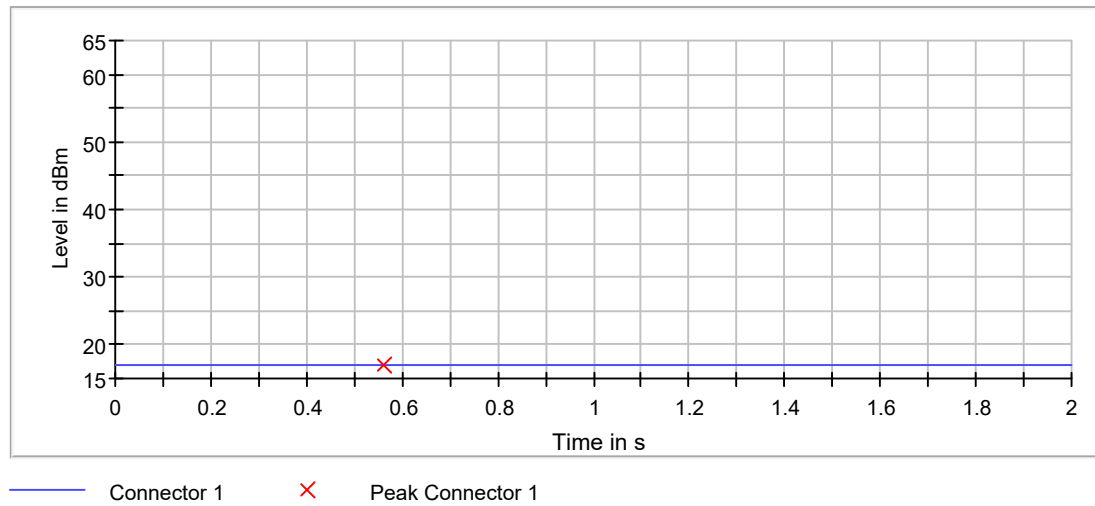
DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Result
2412.000000	17.1	30.0	PASS
2437.000000	17.0	30.0	PASS
2462.000000	17.0	30.0	PASS

Low Frequency:



Mid Frequency:



High Frequency:

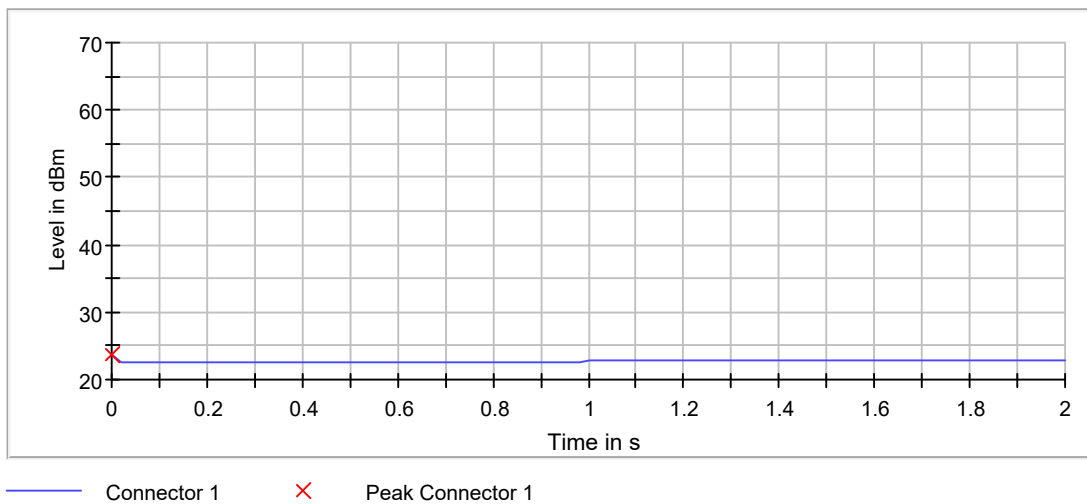
DATA PAGE

Manufacturer : Chamberlain Group, Inc.
 Test Item : Equipment Using Wide Band Modulations Other Than FHSS, Non-Adaptive
 : Transceiver
 Model No. : 8587W
 Test Mode : 802.11g
 Test Performed : Peak Output Power
 Test Date : May 10, 2017

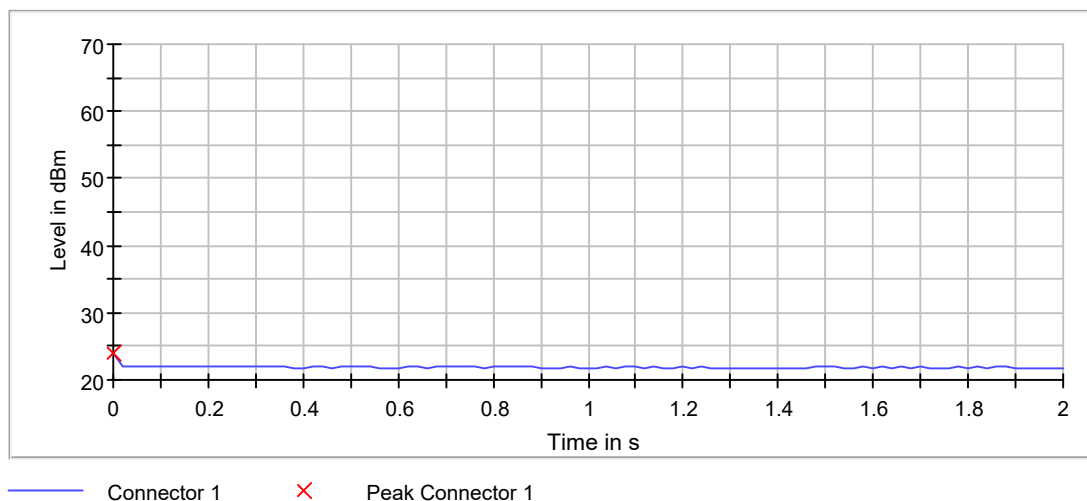
Peak Output Power

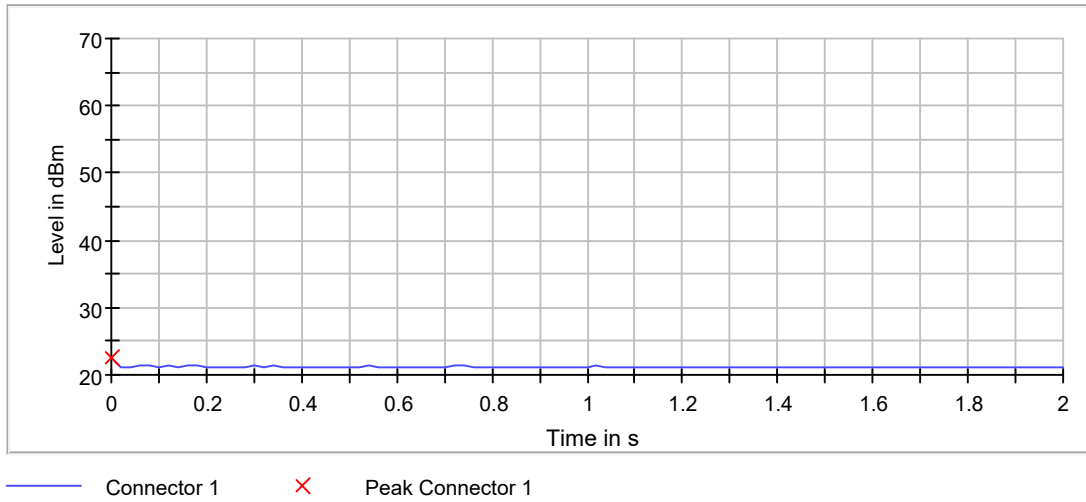
DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Result
2412.000000	23.7	30.0	PASS
2437.000000	24.0	30.0	PASS
2462.000000	22.6	30.0	PASS

Low Frequency:



Mid Frequency:



High Frequency:

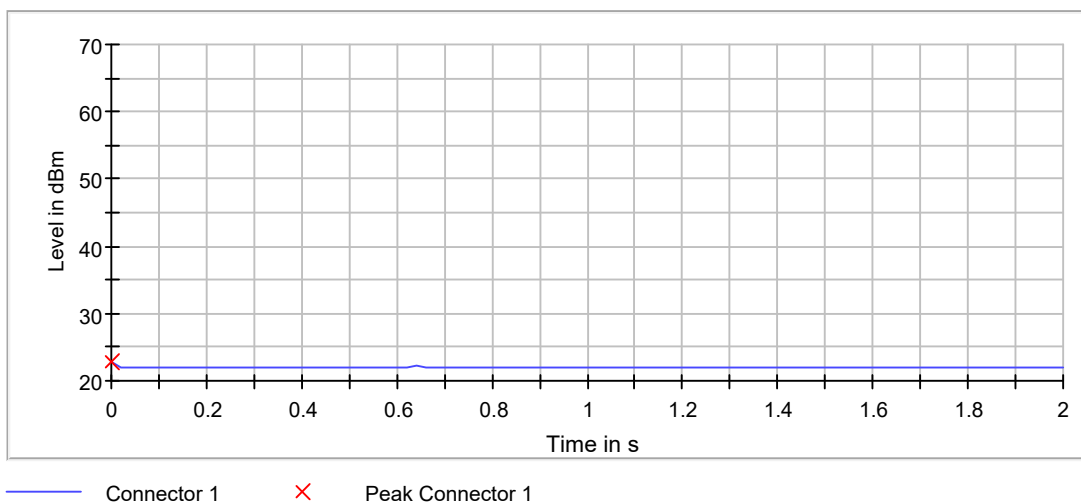
DATA PAGE

Manufacturer : Chamberlain Group, Inc.
 Test Item : Equipment Using Wide Band Modulations Other Than FHSS, Non-Adaptive
 : Transceiver
 Model No. : 8587W
 Test Mode : 802.11n
 Test Performed : Peak Output Power
 Test Date : May 10, 2017

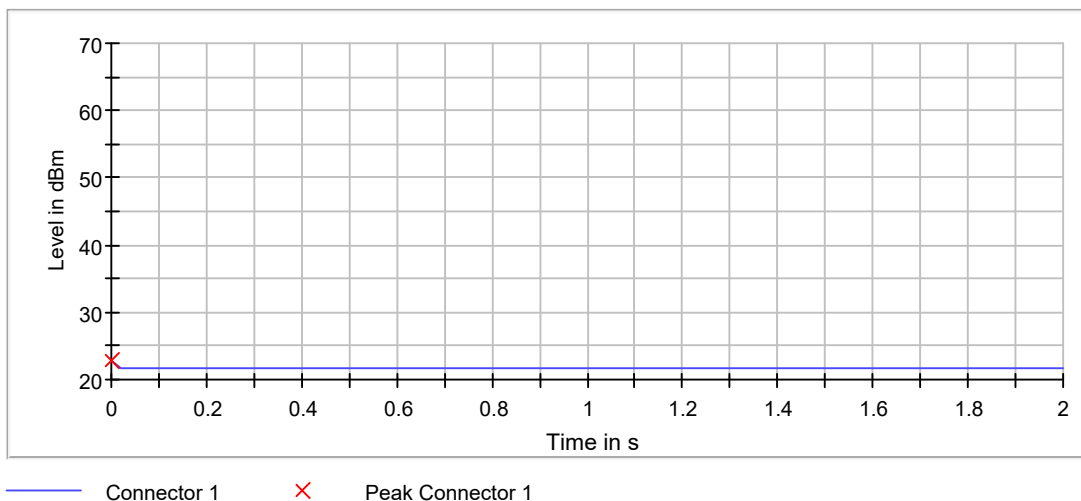
Peak Output Power

DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Result
2412.000000	22.9	30.0	PASS
2437.000000	22.8	30.0	PASS
2462.000000	21.3	30.0	PASS

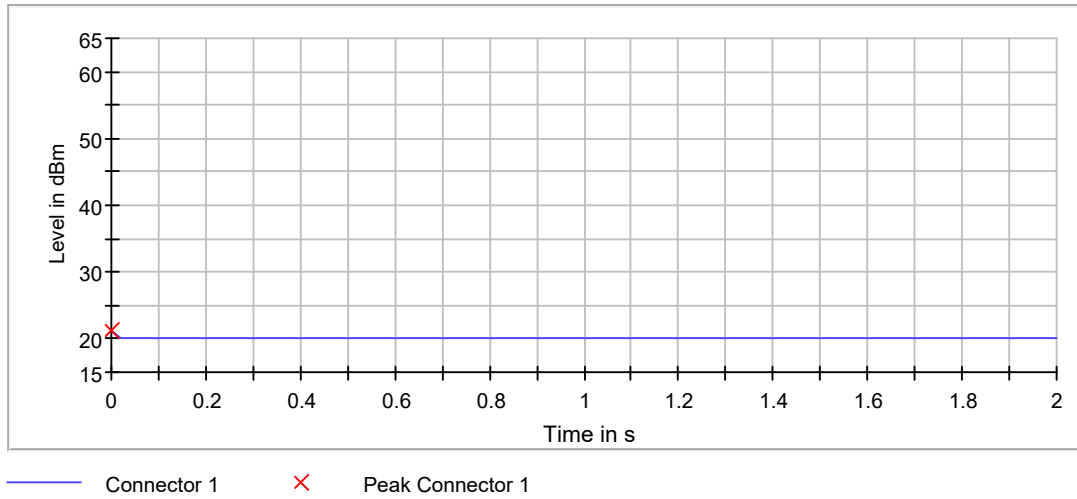
Low Frequency:



Mid Frequency:



High Frequency:



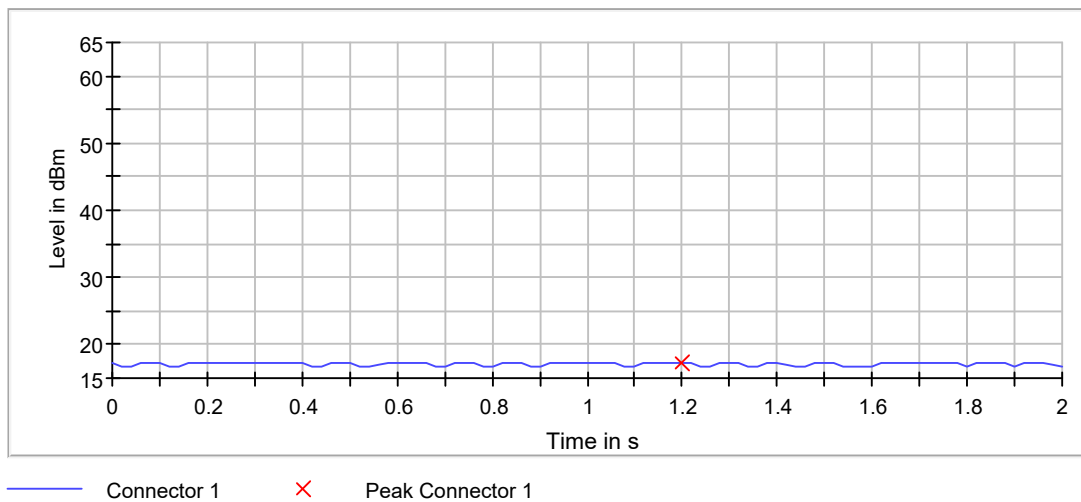
DATA PAGE

Manufacturer : Chamberlain Group, Inc.
 Test Item : Equipment Using Wide Band Modulations Other Than FHSS, Non-Adaptive
 : Transceiver
 Model No. : 8550W
 Test Mode : 802.11b
 Test Performed : Peak Output Power
 Test Date : May 9, 2017

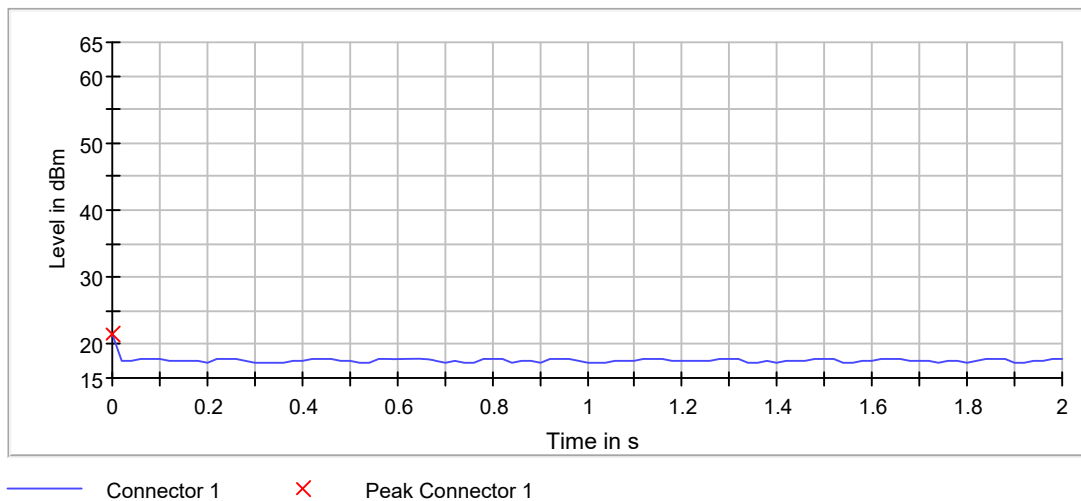
Peak Output Power

DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Result
2412.000000	17.2	30.0	PASS
2437.000000	21.6	30.0	PASS
2462.000000	16.4	30.0	PASS

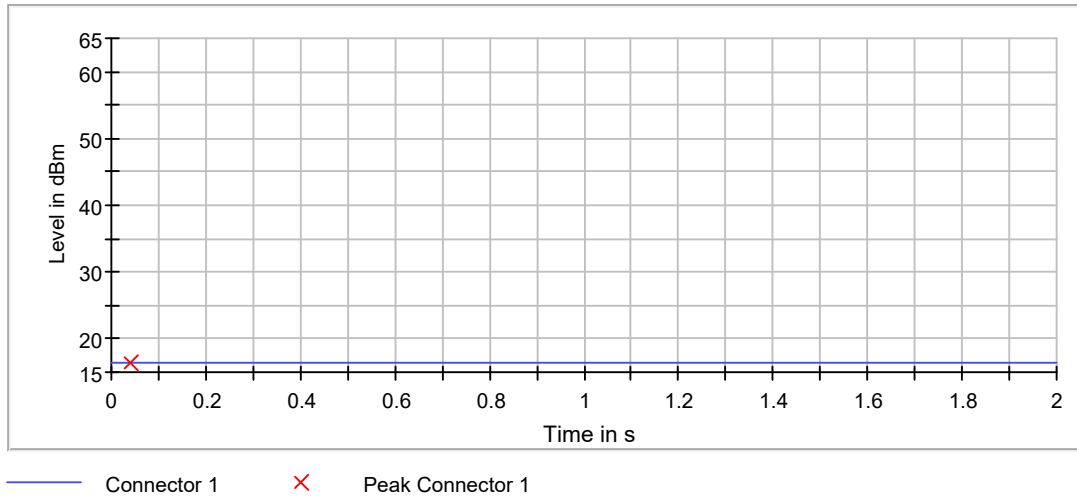
Low Frequency:



Mid Frequency:



High Frequency:



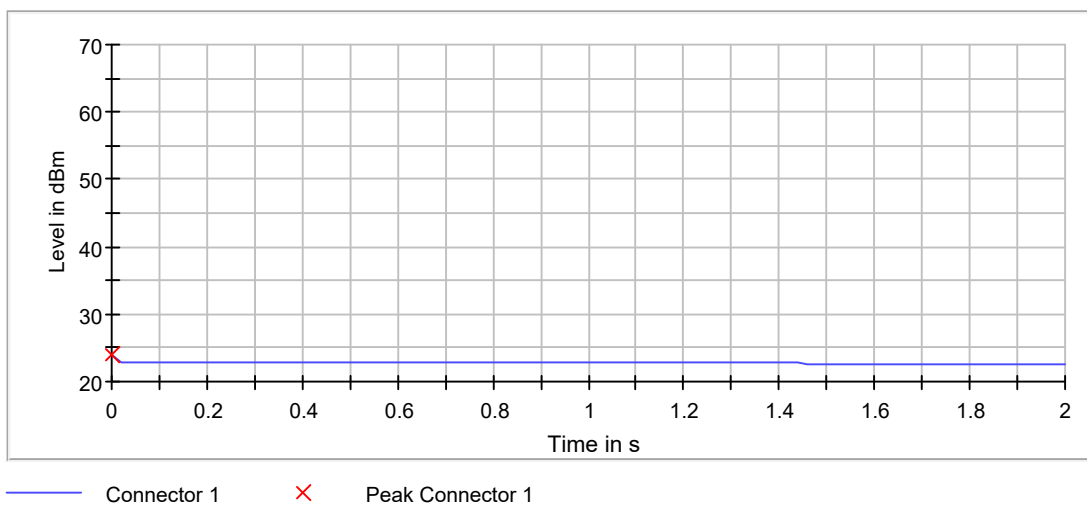
DATA PAGE

Manufacturer : Chamberlain Group, Inc.
 Test Item : Equipment Using Wide Band Modulations Other Than FHSS, Non-Adaptive
 : Transceiver
 Model No. : 8550W
 Test Mode : 802.11g
 Test Performed : Peak Output Power
 Test Date : May 9, 2017

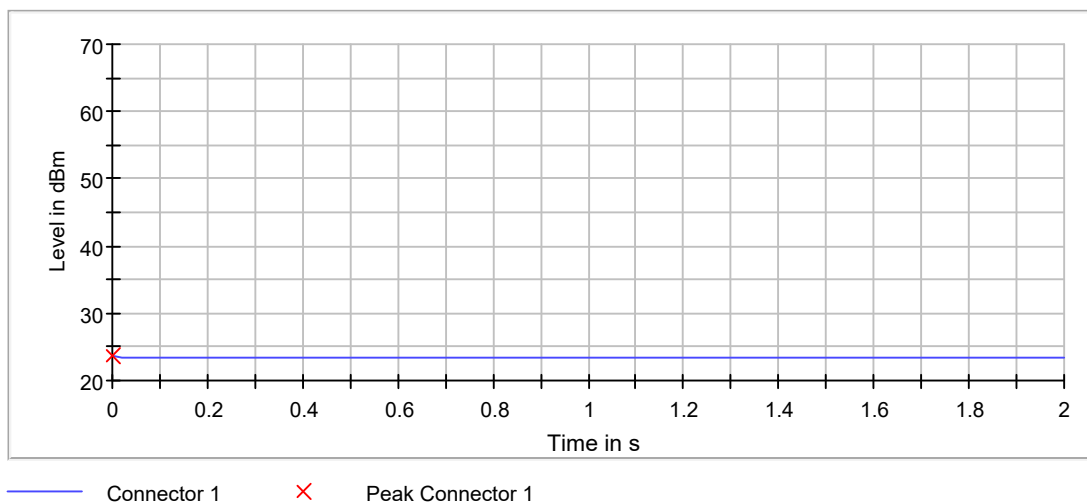
Peak Output Power

DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Result
2412.000000	23.8	30.0	PASS
2437.000000	23.8	30.0	PASS
2462.000000	22.4	30.0	PASS

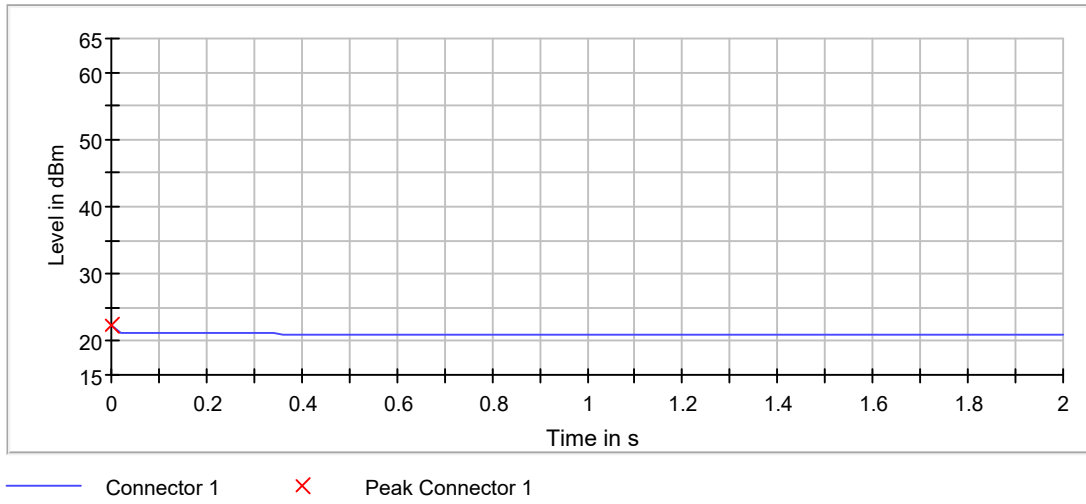
Low Frequency:



Mid Frequency:



High Frequency:



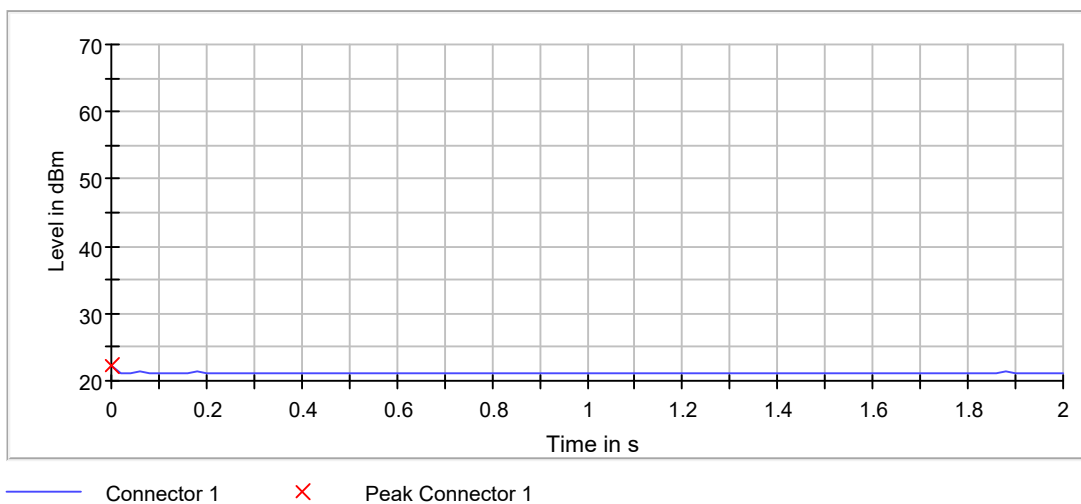
DATA PAGE

Manufacturer : Chamberlain Group, Inc.
 Test Item : Equipment Using Wide Band Modulations Other Than FHSS, Non-Adaptive
 : Transceiver
 Model No. : 8550W
 Test Mode : 802.11n
 Test Performed : Peak Output Power
 Test Date : May 9, 2017

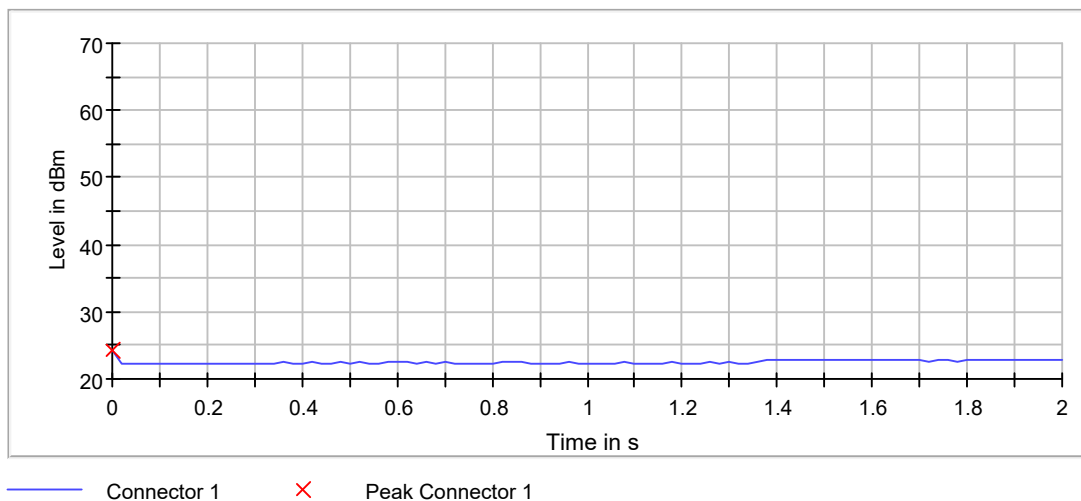
Peak Output Power

DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Result
2412.000000	22.4	30.0	PASS
2437.000000	24.2	30.0	PASS
2462.000000	21.8	30.0	PASS

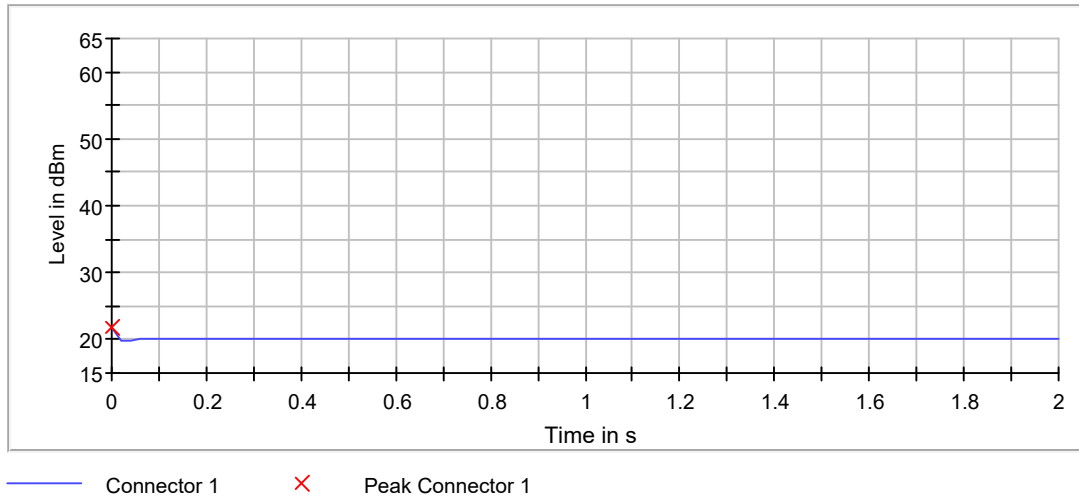
Low Frequency:



Mid Frequency:



High Frequency:





DATA PAGE

Manufacturer : Chamberlain Group, Inc.
Test Item : Marvell MW300 Wi-Fi Module
Model No. : 8587W
Mode : 802.11b
Test Specification : FCC-15.247, RSS-247 Peak Output Power
Date : May 9- 23, 2017

Freq. (MHz)	Ant Pol	Matched Sig. Gen. Reading (dBm)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	EIRP (dBm)
2412.00	H	12.5	5.9	2.8	15.6
2412.00	V	14.8	5.9	2.8	17.9
2437.00	H	8.2	4.8	3.5	9.5
2437.00	V	8.3	4.8	3.5	9.7
2462.00	H	5.6	4.9	3.5	7.0
2462.00	V	13.0	4.9	3.5	14.4



DATA PAGE

Manufacturer : Chamberlain Group, Inc.
Test Item : Marvell MW300 Wi-Fi Module
Model No. : 8587W
Mode : 802.11g
Test Specification : FCC-15.247, RSS-247 Peak Output Power
Date : May 9-23, 2017

Freq. (MHz)	Ant Pol	Matched Sig. Gen. Reading (dBm)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	EIRP (dBm)
2412.00	H	13.0	4.8	3.4	14.4
2412.00	V	17.0	4.8	3.4	18.4
2437.00	H	11.3	4.8	3.5	12.6
2437.00	V	17.3	4.8	3.5	18.7
2462.00	H	9.7	4.9	3.5	11.1
2462.00	V	16.4	4.9	3.5	17.8



DATA PAGE

Manufacturer : Chamberlain Group, Inc.
Test Item : Marvell MW300 Wi-Fi Module
Model No. : 8587W
Mode : 802.11n
Test Specification : FCC-15.247, RSS-247 Peak Output Power
Date : May 9-23, 2017

Freq. (MHz)	Ant Pol	Matched Sig. Gen. Reading (dBm)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	EIRP (dBm)
2412.00	H	14.3	4.8	3.4	15.7
2412.00	V	11.4	4.8	3.4	12.8
2437.00	H	11.2	4.8	3.5	12.5
2437.00	V	17.9	4.8	3.5	19.3
2462.00	H	10.4	4.9	3.5	11.8
2462.00	V	15.5	4.9	3.5	16.9

**DATA PAGE**

Manufacturer : Chamberlain Group, Inc.
Test Item : Marvell MW300 Wi-Fi Module
Model No. : 8550W
Mode : 802.11b
Test Specification : FCC-15.247, RSS-247 Peak Output Power
Date : May 9-15, 2017

Freq. (MHz)	Ant Pol	Matched Sig. Gen. Reading (dBm)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	EIRP (dBm)
2412.00	H	13.1	5.9	2.8	16.2
2412.00	V	16.8	5.9	2.8	19.9
2437.00	H	13.1	5.9	2.8	16.2
2437.00	V	15.0	5.9	2.8	18.2
2462.00	H	13.9	5.9	2.8	17.1
2462.00	V	14.8	5.9	2.8	17.9

**DATA PAGE**

Manufacturer : Chamberlain Group, Inc.
Test Item : Marvell MW300 Wi-Fi Module
Model No. : 8550W
Mode : 802.11g
Test Specification : FCC-15.247, RSS-247 Peak Output Power
Date : May 9-15, 2017

Freq. (MHz)	Ant Pol	Matched Sig. Gen. Reading (dBm)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	EIRP (dBm)
2412.00	H	17.8	5.9	2.8	20.9
2412.00	V	19.2	5.9	2.8	22.3
2437.00	H	18.8	5.9	2.8	21.9
2437.00	V	20.3	5.9	2.8	23.4
2462.00	H	17.4	5.9	2.8	20.6
2462.00	V	18.8	5.9	2.8	21.9



DATA PAGE

Manufacturer : Chamberlain Group, Inc.
Test Item : Marvell MW300 Wi-Fi Module
Model No. : 8550W
Mode : 802.11n
Test Specification : FCC-15.247, RSS-247 Peak Output Power
Date : May 9-15, 2017

Freq. (MHz)	Ant Pol	Matched Sig. Gen. Reading (dBm)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	EIRP (dBm)
2412.00	H	14.7	5.9	2.8	17.8
2412.00	V	20.9	5.9	2.8	24.0
2437.00	H	17.0	5.9	2.8	20.1
2437.00	V	20.9	5.9	2.8	24.1
2462.00	H	16.3	5.9	2.8	19.4
2462.00	V	17.9	5.9	2.8	21.1

