Measurement of RF Emissions from a Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip

For	Chamberlain Group, Inc. 300 Windsor Dr. Oak Brook, IL 60523
P.O. Number	4900060462
Date Tested	June 26 & July 1, 2019
Test Personnel	Tylar Jozefczyk
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:

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EMC Engineer

Requested By: Bill Carey
Chamberlain Group, Inc.

Approved By:

Raymond J. Klouda
Registered Professional
Engineer of Illinois - 44894

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TABLE OF CONTENTS

REVISION HISTORY

Revision	Date	Description
—	05 Aug 2019	Initial release

Measurement of RF Emissions from a Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip

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. Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip (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 integral antenna. The EUT was manufactured and submitted for testing by Chamberlain Group, Inc. located in Oak Brook, IL.

1.2. Purpose

The test series was performed to determine if the EUT meets the radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.247 for Intentional Radiators for a Class 2 Permissive Change for FCC ID No. HBW8522 (IC ID No. 2666A-8522).

The test series was also performed to determine if the EUT meets the radiated RF emission requirements of the Industry Canada Radio Standards Specification, RSS-247, Section 5 for transmitters for Class 2 Permissive Change.

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 25.1°C and the relative humidity was 37%.

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 2018
- 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"
- Federal Communications Commission Office of Engineering and Technology Laboratory Division Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under Section 15.247, October 4, 2012
- Industry Canada Radio Standards Specification, RSS-Gen, “General Requirements for Compliance of Radio Apparatus”, Issue 5, March 2019

- 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. Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip mounted on an evaluation printed circuit board. A block diagram of the EUT setup is shown as Figure 1.

3.1.1. Power Input

The EUT was powered from a 3.3VDC power source.

3.1.2. Peripheral Equipment

The following peripheral equipment was submitted with the EUT:

Item	Description
Laptop	Used to put the EUT in transmit mode.

3.1.3. Grounding

The EUT was not grounded.

3.2. Operational Mode

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

Mode	Description
802.11b	The EUT was turned on and set to transmit one of the following frequencies: - 2412MHz - 2462MHz
802.11g	
802.11n	
Note: Output Power and Spurious Emissions testing was only done to the 2462MHz frequency. Band Edge testing was done using the 2412MHz and 2462MHz frequencies.	

3.3. EUT Modifications

No modifications were required for compliance to FCC Part 15, Subpart C, Section 15.247.

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.

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.

Values of Expanded Measurement Uncertainty (95% Confidence) are presented below:

Measurement Type	Expanded Measurement Uncertainty
Conducted disturbance (mains port) (150 kHz – 30 MHz)	2.7
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (1 GHz – 6 GHz)	3.1
Radiated disturbance (electric field strength on an open area test site or alternative test site) (6 GHz – 18 GHz)	3.2

5. TEST PROCEDURES

5.1. Average Output Power

5.1.1.Requirements

Per section 15.247(b)(3), for systems using digital modulation the maximum average 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 Watts (36dBm).

5.1.2.Procedures

The EUT was placed on the non-conductive stand and set to transmit. A double ridged waveguide antenna 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 double ridged waveguide antenna 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, as required. The peak power output was calculated for low, middle, and high hopping frequencies.

5.1.3.Results

The results are presented on page 16. The maximum EIRP measured from the transmitter was 0.023W (13.62dBm), which is below the 1 Watt limit.

5.2. Radiated Spurious Emissions Measurements

5.2.1.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 30 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

RSS GEN section 8.9 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

Note 1: The emission limits for the ranges 9-90kHz and 110-490kHz are based on measurements employing a linear average detector.

General Field Strength Limits at Frequencies Above 30MHz	
Frequency (MHz)	Field Strength (microvolts/meter at 3m)
30 – 88	100
88 – 216	150
216.0 – 960	200
Above 960	500

5.2.2.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 25GHz was investigated using a peak detector function.

The final raidated emission tests were then manually performed over the frequency range of 30MHz to 25GHz.

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 trace with a resolution bandwidth of 100 kHz was used on the R&S receiver.
   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. An average trace with a resolution bandwidth of 100 kHz and a video bandwidth of 10Hz was used on the R&S receiver.
   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 R&S receiver, the measuring antenna was not raised or lowered to ensure maximized readings. Instead the EUT was rotated through all axes to ensure the maximum readings were recorded for the EUT.
   d) All harmonics not in the restricted bands must be at least 30 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 bilog antenna. The bilog antenna was positioned at a 3 meter distance from the EUT. A peak trace with a resolution bandwidth of 100 kHz was used on the R&S receiver.
   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 trace with a resolution bandwidth of 1 MHz was used on the R&S receiver.
   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 R&S receiver, the measuring antenna was not raised or lowered to ensure maximized readings. Instead the EUT was rotated through all axes 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 R&S receiver was set to linear mode with a 10Hz video bandwidth in order to simulate an

average detector. An average reading was then taken.

If the emission is pulsed, the reading can be adjusted by a “duty cycle correction factor” derived from 20*log(on time/100msec). These readings must be no greater than the limits specified in 15.209(a).

5.2.3.Results

Preliminary radiated emissions plots with the EUT transmitting at 802.11b, 802.11g, and 802.11n are shown on pages 17 through 28. Final radiated emissions data are presented on data pages 29 through 37. 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) occurred at 7386MHz in the 802.11g mode. The emissions level at this frequency was 20.13dB, within the limit. Photographs of the test configuration which yielded the highest (or worst case) radiated emission levels are shown in Figure 3.

5.3. Band Edge Compliance

5.3.1.Requirement

Per section 15.247(d), the emissions at the band edges must be at least 30dB below the highest level measured within the band but attenuation below the general limits listed in 15.209(a) is not required.

5.3.2.Procedures

5.4.2.1 Low Band Edge

1) The EUT was set up 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 R&S receiver settings were used:

   - Center Frequency = low band edge frequency.
   - 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.
   - RBW = ≥ 1% of the span.
   - Trace = Max-Hold

6) The receiver was allowed to scan until the envelope of the transmitter bandwidth was defined.
7) 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.)
8) A screenshot of the receiver's display was taken.

5.4.2.2 High Band Edge

1) The EUT was set up 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 receiver settings were used:

   - Center frequency = high band-edge frequency.
   - Span = Wide enough to capture both the peak level of the fundamental emission and the band-edge emission under investigation.

- RBW = 1% of the span (but never less than 30kHz).
- Trace = Max-Hold

5) 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.)
6) A screenshot of the receiver's display was taken.

In accordance with paragraph 15.231(c), 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.

5.3.3.Results

Pages 38 through 41 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 30 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. The test series was witnessed by Chamberlain Group, Inc. personnel.

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. Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip digital modulation transmitter did fully meet the radiated emission requirements for Class 2 Permissive Change for the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.247 for Intentional Radiators Operating within the 2400-2483.5MHz band, when tested per ANSI C63.4-2014.

It was also determined that the Chamberlain Group, Inc. Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip digital modulation transmitter did fully meet the radiated RF emission requirements for Class 2 Permissive Change for the Industry Canada Radio Standards Specification, 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 as operated by Chamberlain Group, Inc. personnel. 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
CDY0	WORKSTATION	ELITE	WORKSTATION		WINDOWS 7	N/A	
NWQ1	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS-LINDGREN	3117	66655	1GHZ-18GHZ	4/10/2018	4/10/2020
RBG3	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	101592	2HZ-44GHZ	2/20/2019	2/20/2020
WKA1	SOFTWARE, UNIVERSAL RCV EMI	ELITE	UNIV_RCV_EMI	1	---	I/O	

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.

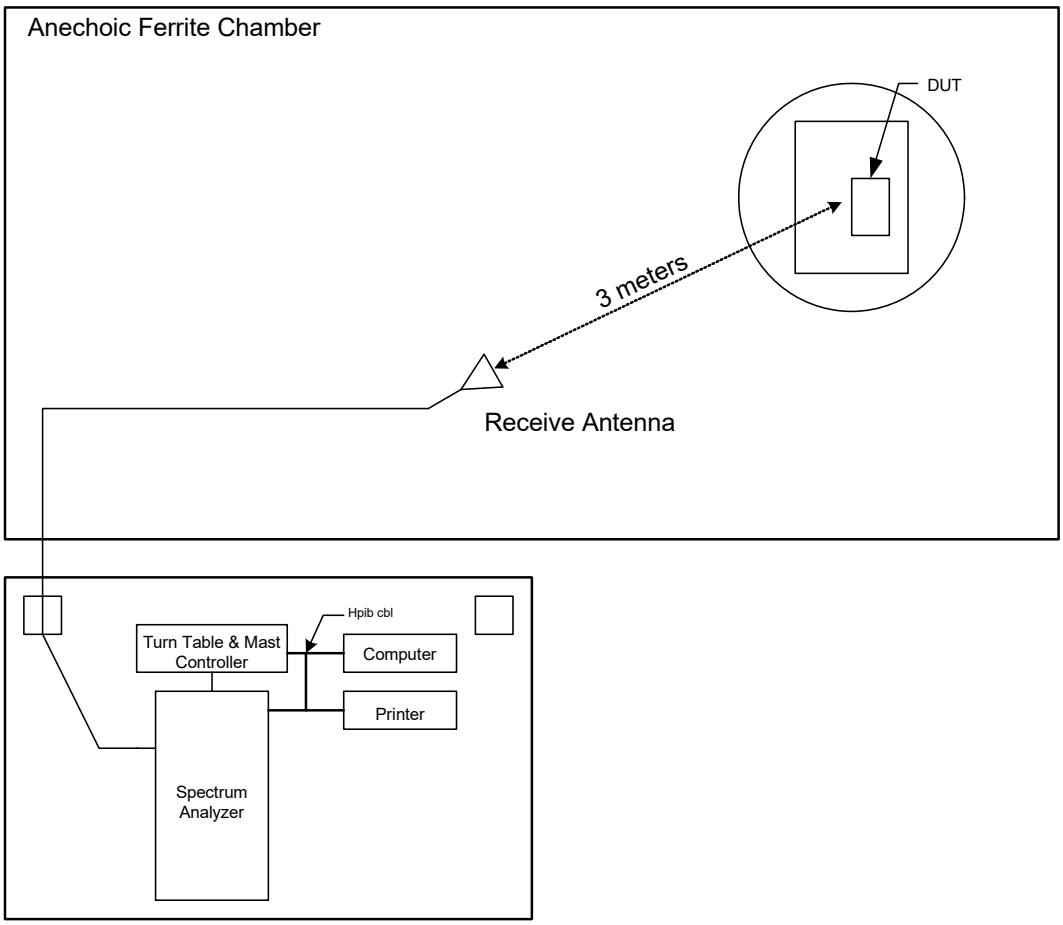


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

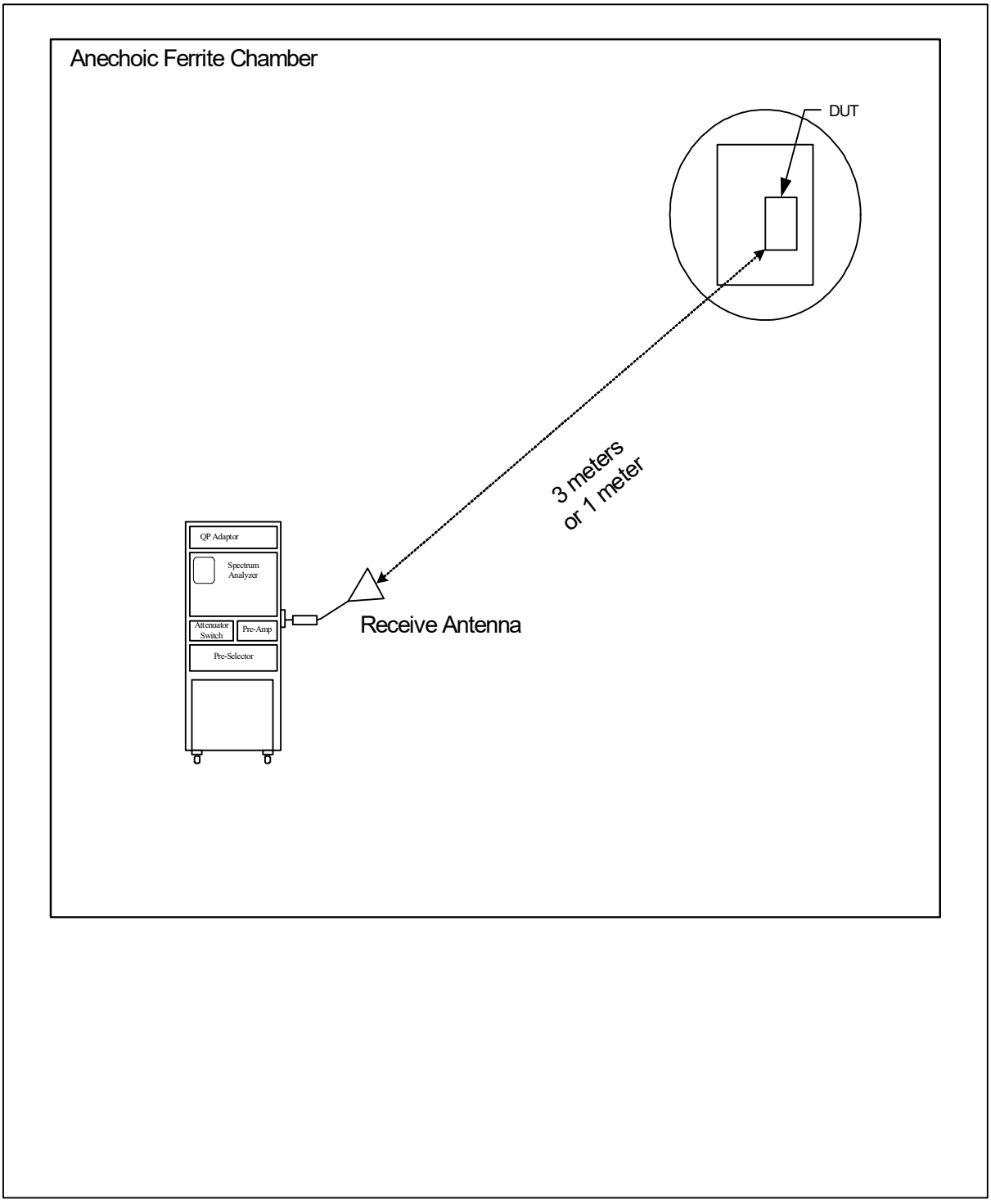
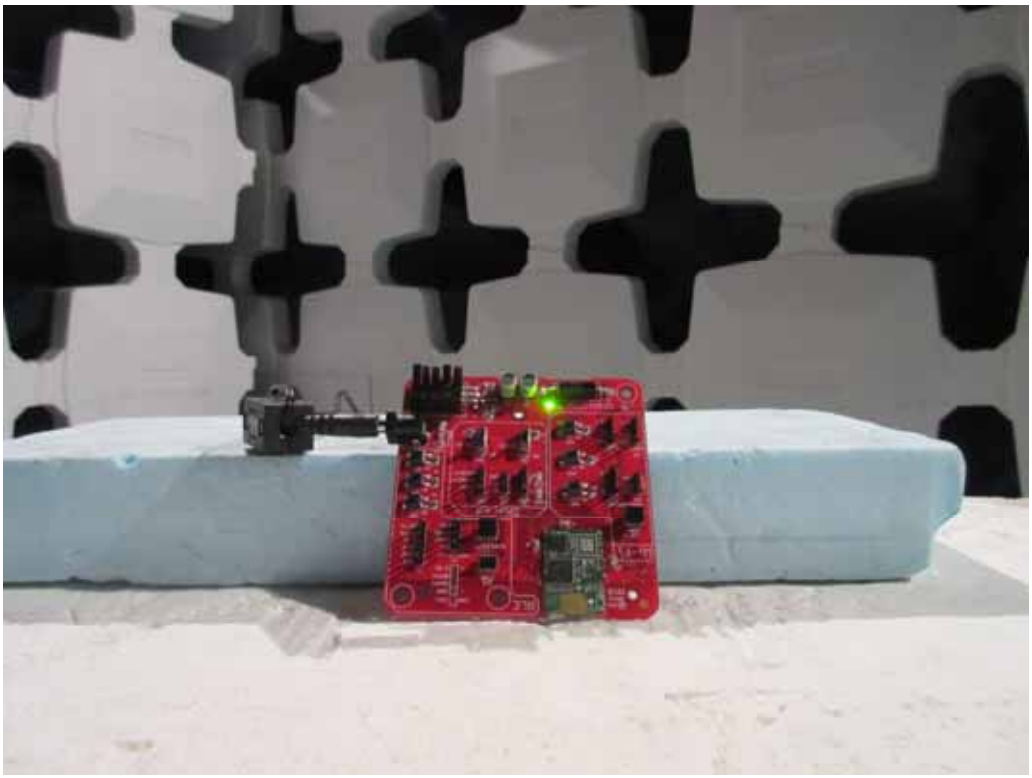

Anechoic Ferrite Chamber
DUT
3 meters
or 1 meter
QP Adaptor
Spectrum
Analyzer
Attenuator
Switch
Pre-Amp
Pre-Selector
Receive Antenna

Figure 2



Picture of Test Item

Figure 3

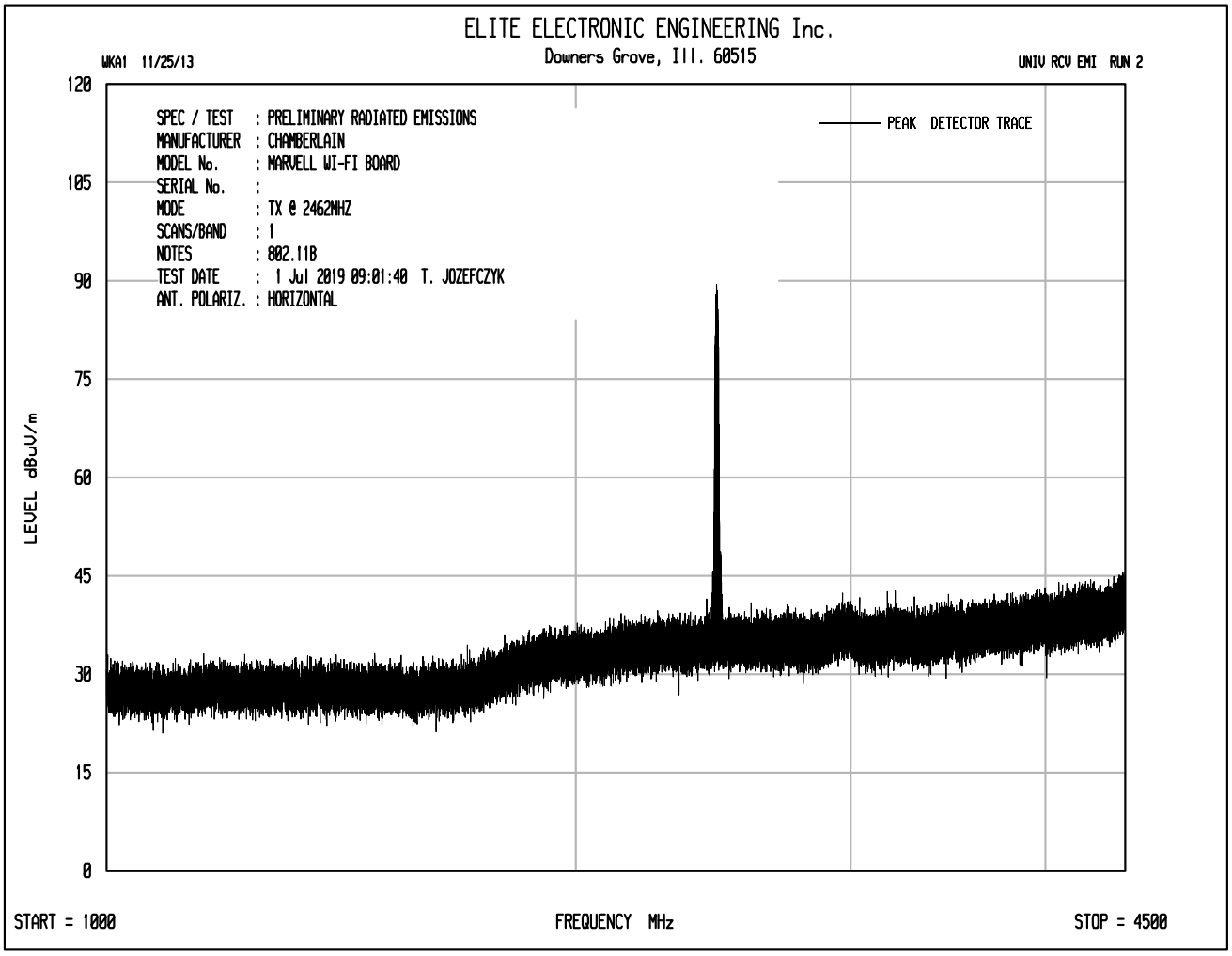
Test Setup for Radiated Emissions, 1 to 18GHz – Horizontal Polarization

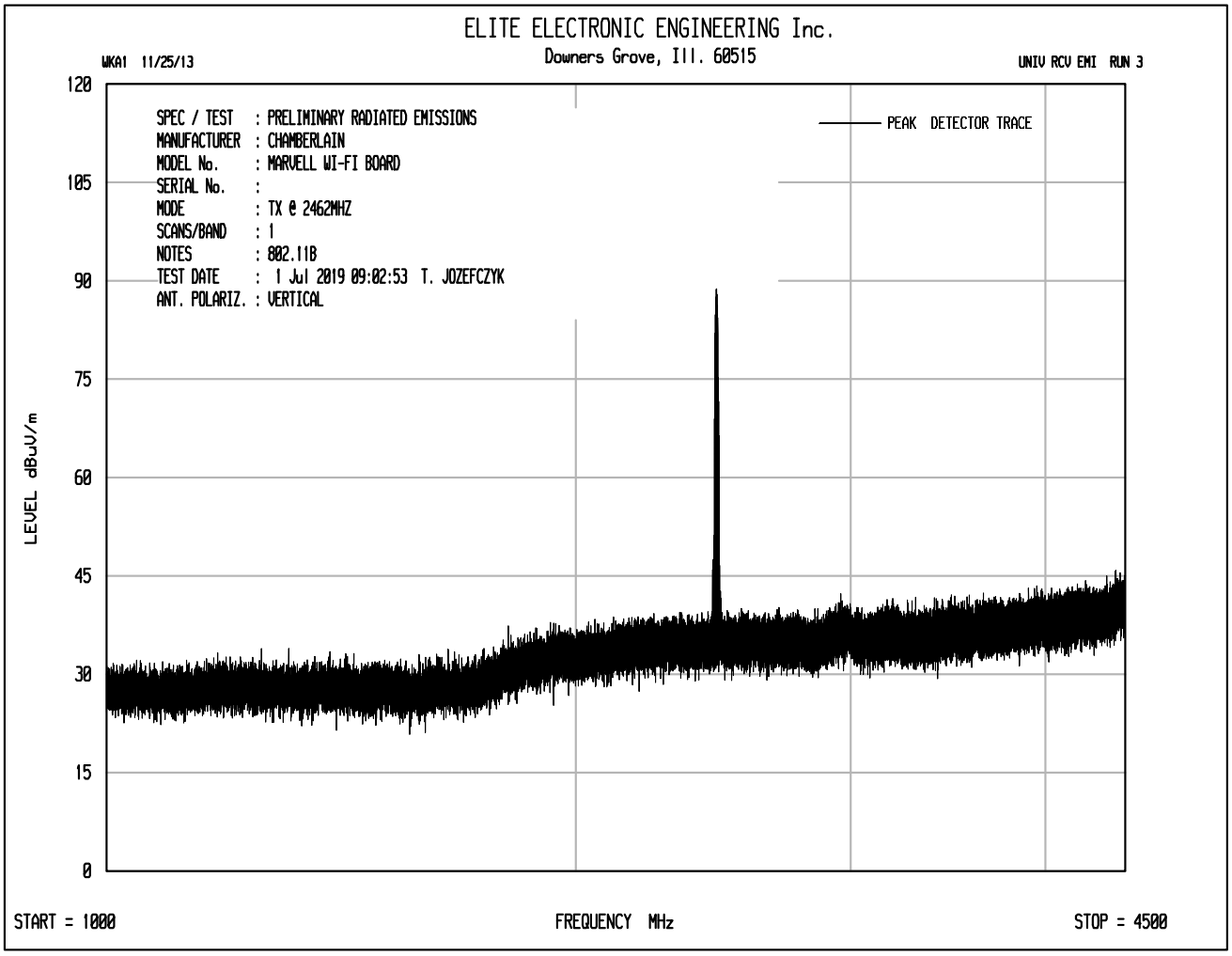
Test Setup for Radiated Emissions, 1 to 18GHz – Vertical Polarization

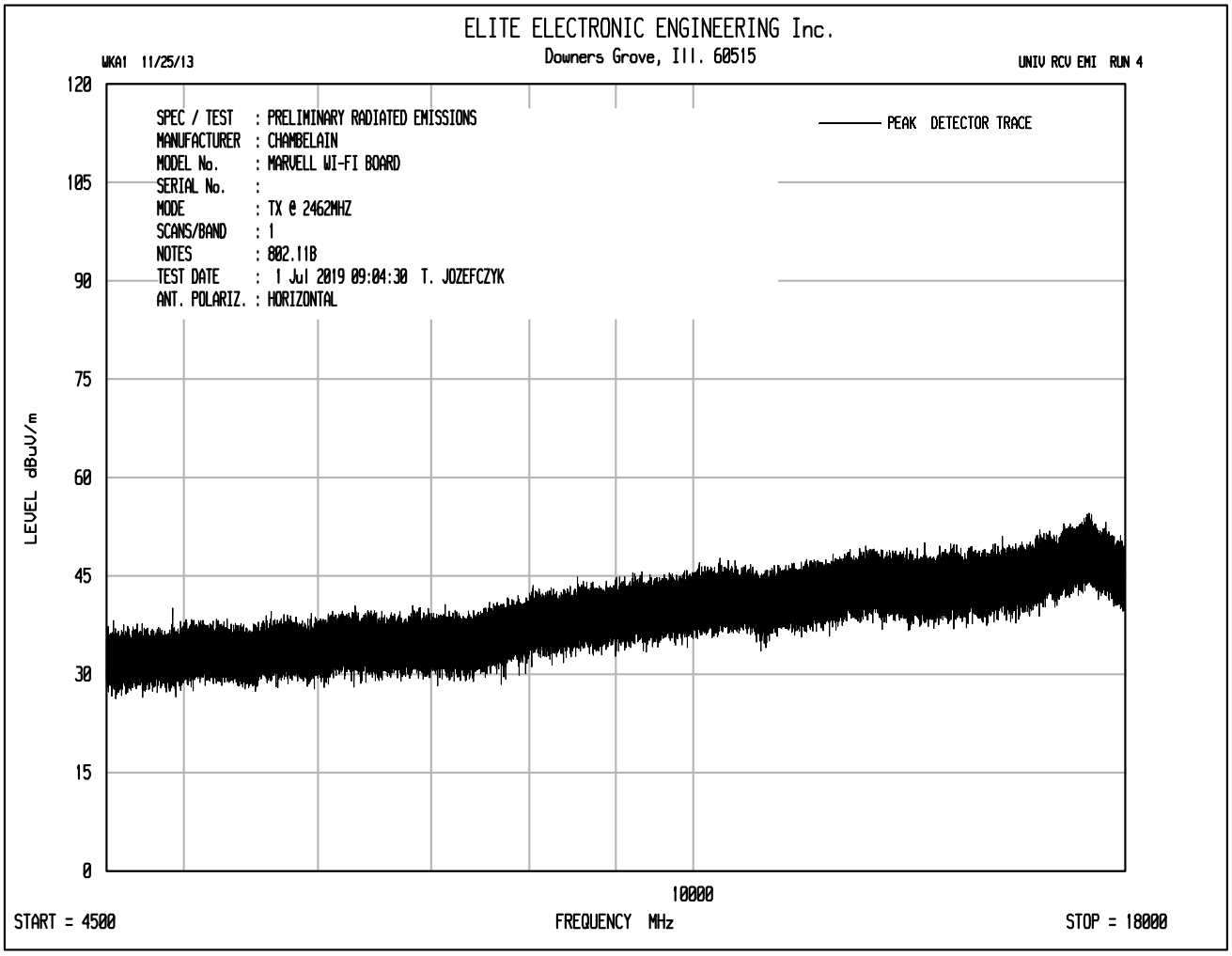
DATA PAGE	
MANUFACTURER	Chamberlain Group, Inc.
EUT	Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip
TEST	FCC §15.247, RSS-247 Output Power EIRP
MODE	802.11b, 802.11g, and 802.11n
DATE TESTED	June 26 & July 1, 2019
TEST PERFORMED BY	Tylar Jozefczyk
NOTES	Highest EIRP (each mode) 802.11b = 13.62dBm 802.11g = 10.82dBm 802.11n = 10.00dBm

OUTPUT POWER EIRP

Mode	Freq. (MHz)	Ant. Pol	Wide BW Meter Reading (dBµV)	Matched Sig. Gen. Reading (dBm)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
802.11b	2462.00	H	71.83	9.96	5.56	2.79	12.72	36.00	-23.28
	2462.00	V	72.49	10.85	5.56	2.79	13.62	36.00	-22.38
802.11g	2462.00	H	69.14	7.27	5.56	2.79	10.03	36.00	-25.97
	2462.00	V	69.69	8.05	5.56	2.79	10.82	36.00	-25.18
802.11n	2462.00	H	67.40	5.53	5.56	2.79	8.29	36.00	-27.71
	2462.00	V	68.87	7.23	5.56	2.79	10.00	36.00	-26.00


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 2
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : CHAMBERLAIN
MODEL No. : MARVELL WI-FI BOARD
SERIAL No. :
MODE : TX @ 2462MHZ
SCANS/BAND : 1
NOTES : 802.11B
TEST DATE : 1 Jul 2019 09:01:40 T. JOZEFCZYK
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 4500


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 3
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : CHAMBERLAIN
MODEL No. : MARVELL WI-FI BOARD
SERIAL No. :
MODE : TX @ 2462MHZ
SCANS/BAND : 1
NOTES : 802.11B
TEST DATE : 1 Jul 2019 09:02:53 T. JOZEFCZYK
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 4500


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 4
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : CHAMBELAIN
MODEL No. : MARVELL WI-FI BOARD
SERIAL No. :
MODE : TX @ 2462MHZ
SCANS/BAND : 1
NOTES : 802.11B
TEST DATE : 1 Jul 2019 09:04:30 T. JOZEFCZYK
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
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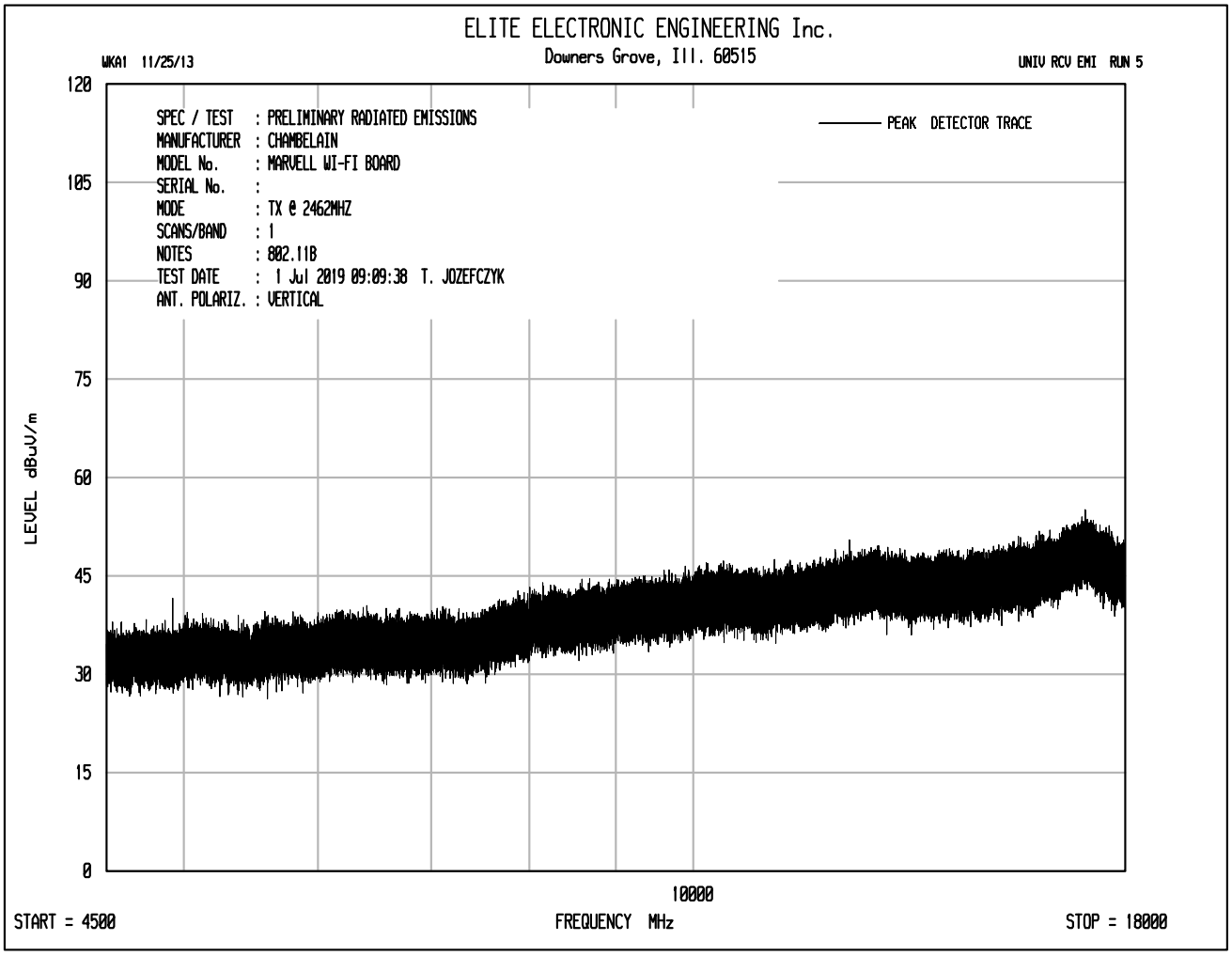
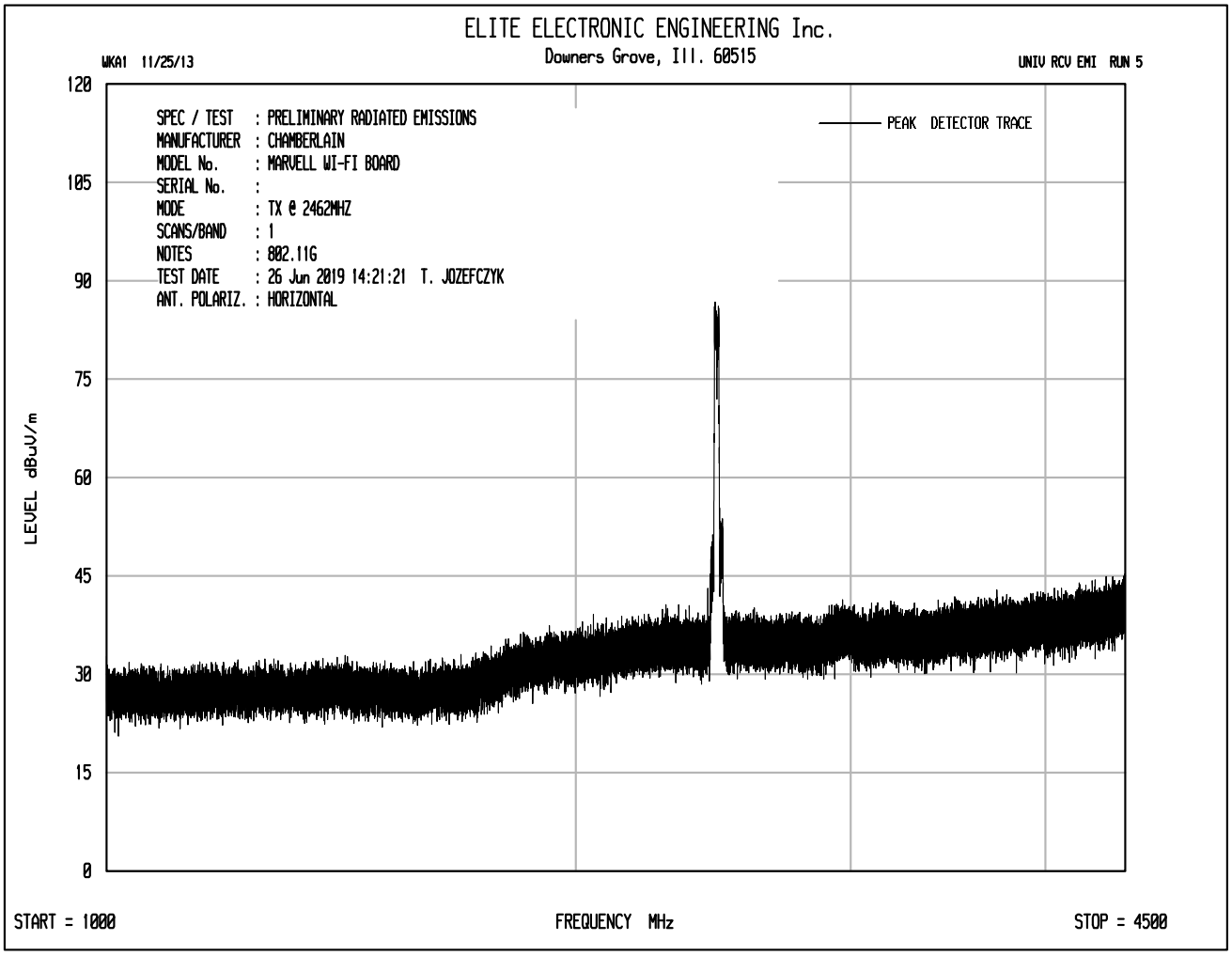
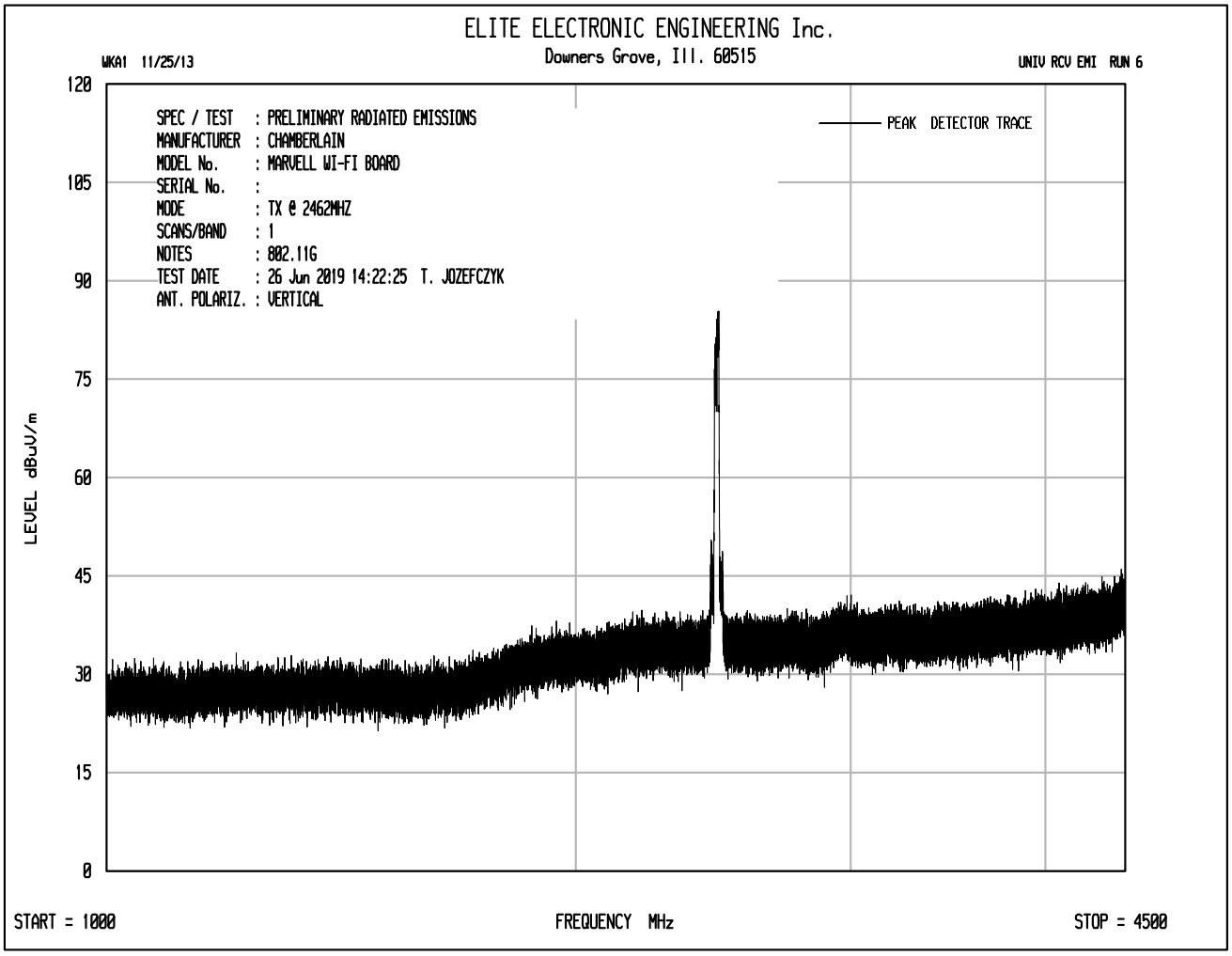
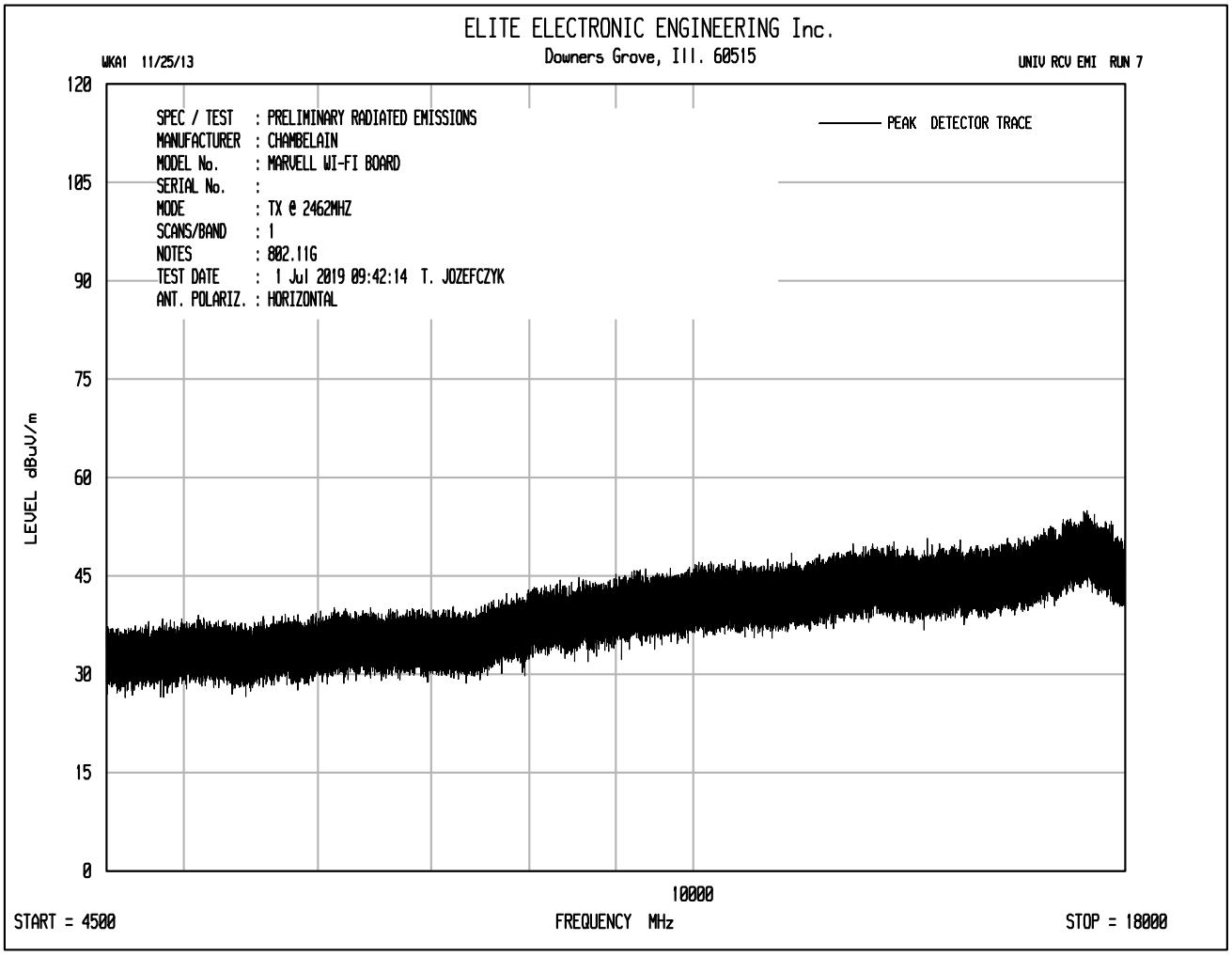
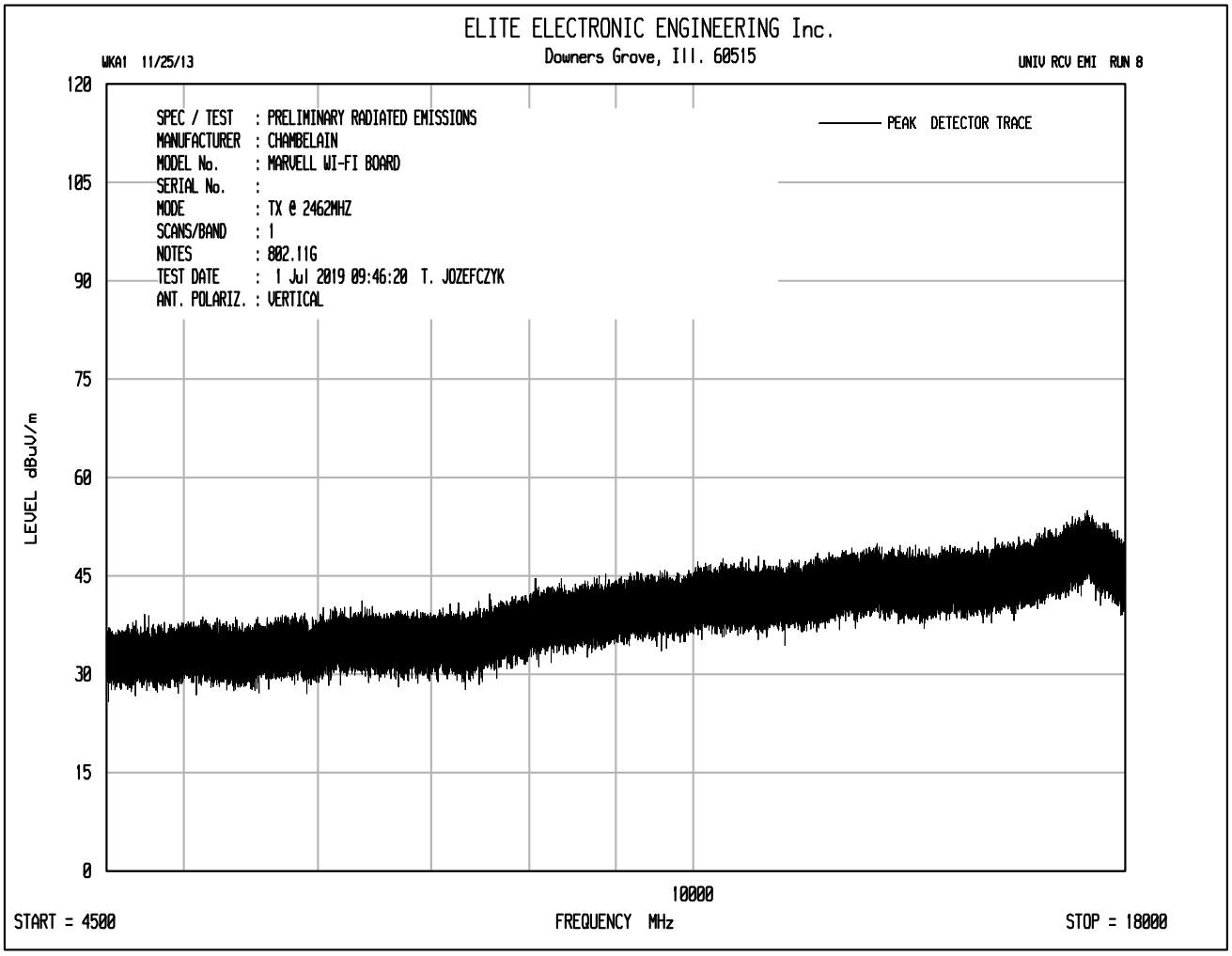
105
90
75
60
45
30
15
0
10000
START = 4500
FREQUENCY MHz
STOP = 18000

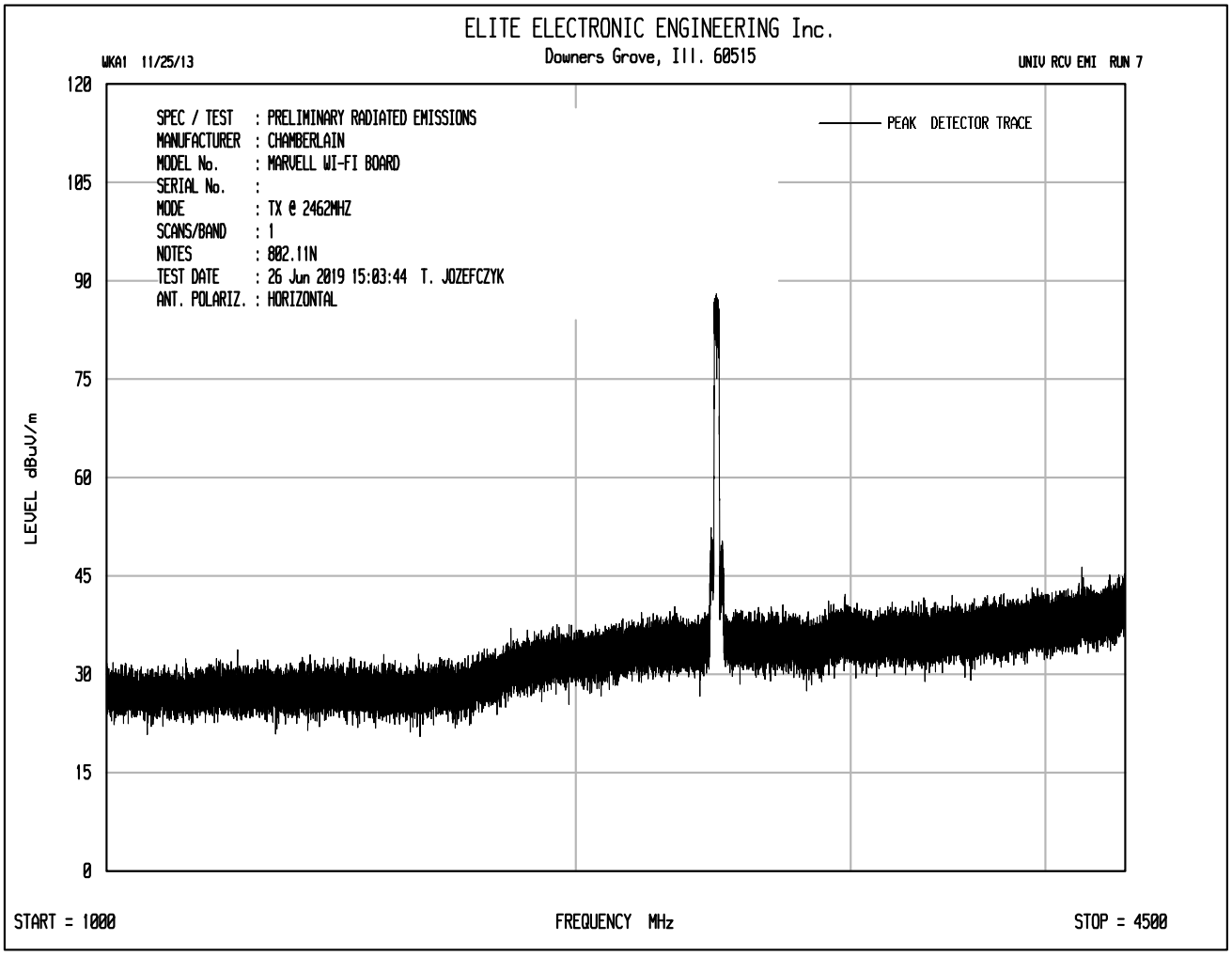

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 5
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : CHAMBELAIN
MODEL No. : MARVELL WI-FI BOARD
SERIAL No. :
MODE : TX @ 2462MHZ
SCANS/BAND : 1
NOTES : 802.11B
TEST DATE : 1 Jul 2019 09:09:38 T. JOZEFCZYK
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
10000
START = 4500
FREQUENCY MHz
STOP = 18000

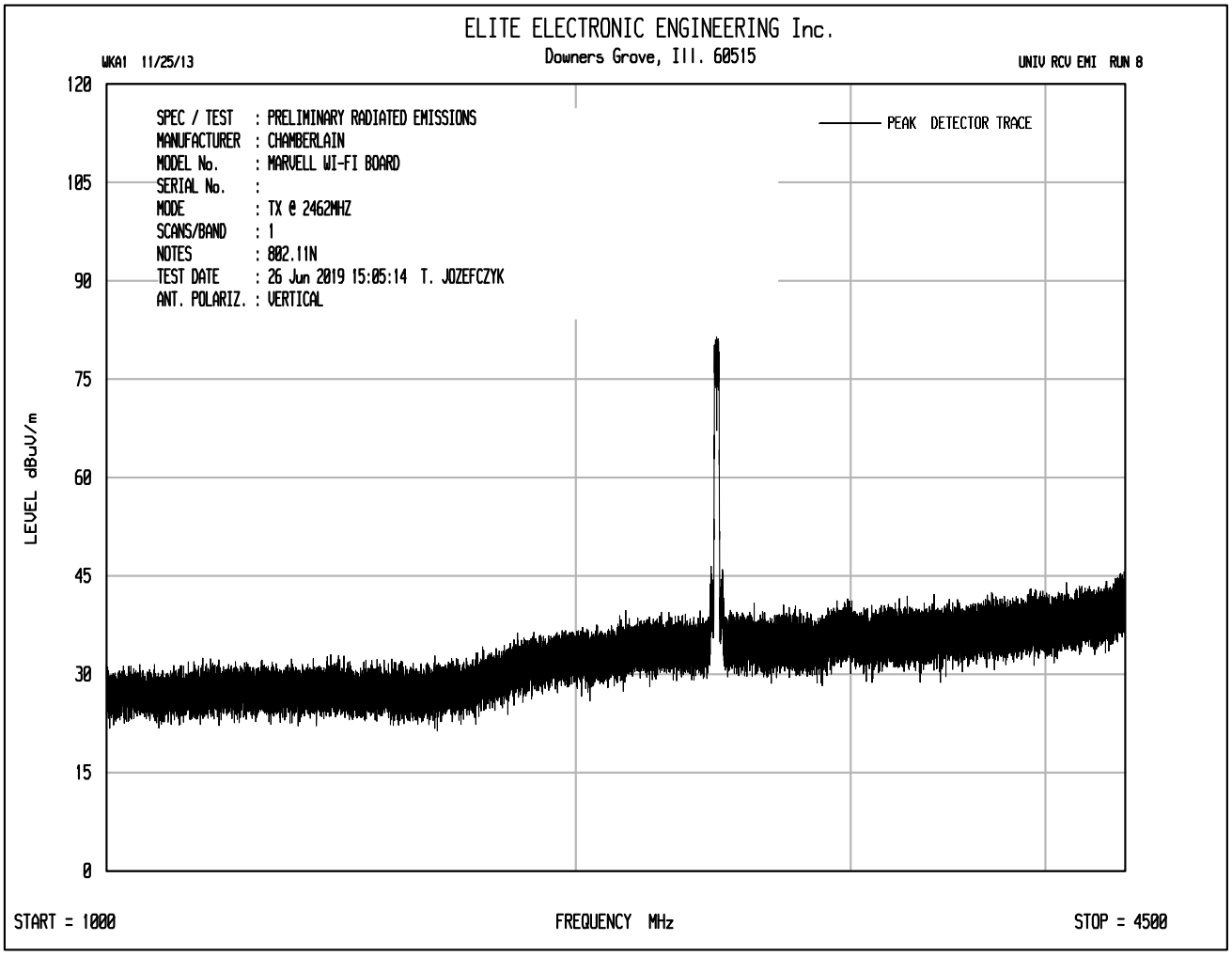

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 5
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : CHAMBERLAIN
MODEL No. : MARVELL WI-FI BOARD
SERIAL No. :
MODE : TX @ 2462MHZ
SCANS/BAND : 1
NOTES : 802.11G
TEST DATE : 26 Jun 2019 14:21:21 T. JOZEFCZYK
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 4500

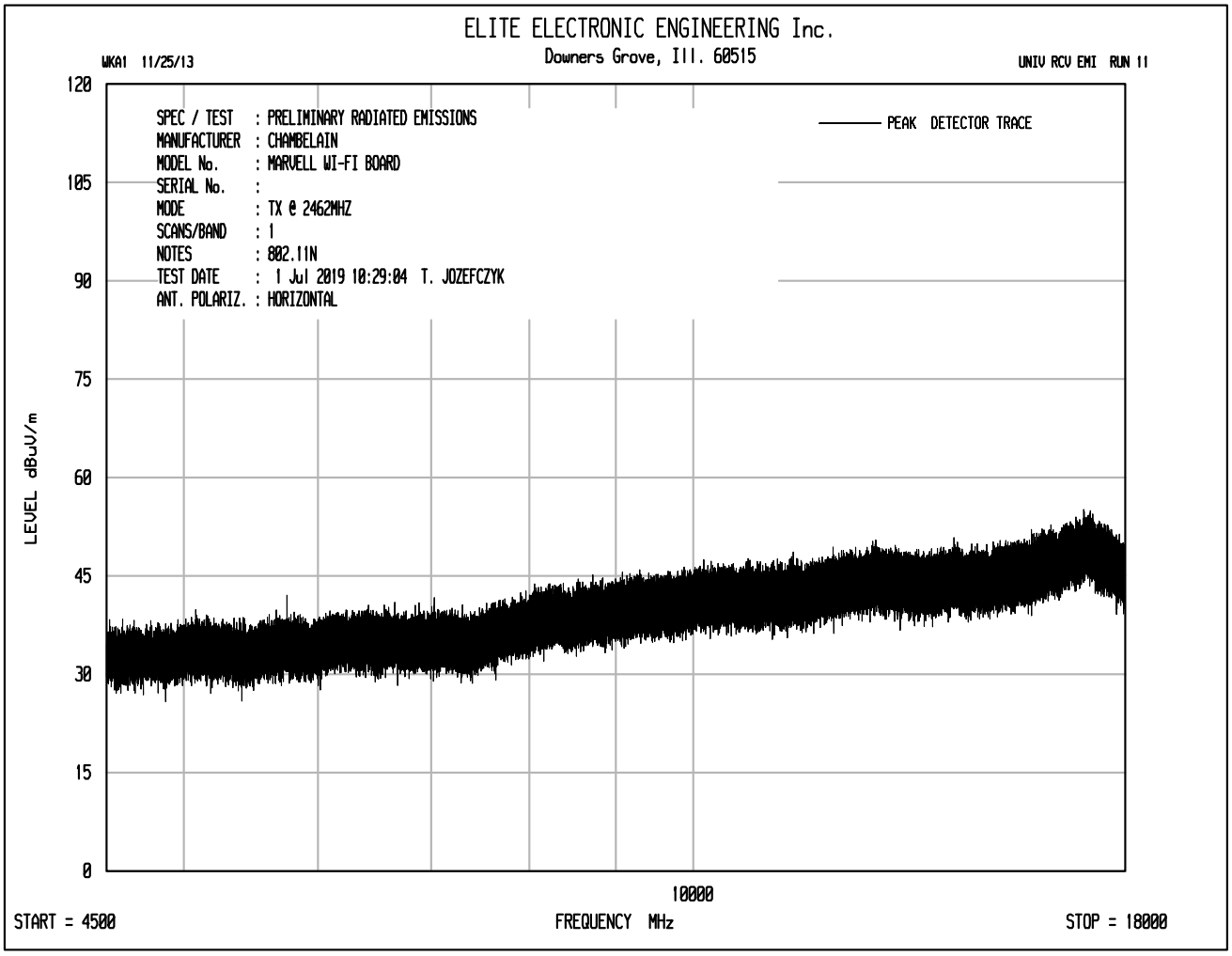

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 6
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : CHAMBERLAIN
MODEL No. : MARVELL WI-FI BOARD
SERIAL No. :
MODE : TX @ 2462MHZ
SCANS/BAND : 1
NOTES : 802.11G
TEST DATE : 26 Jun 2019 14:22:25 T. JOZEFCZYK
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 4500

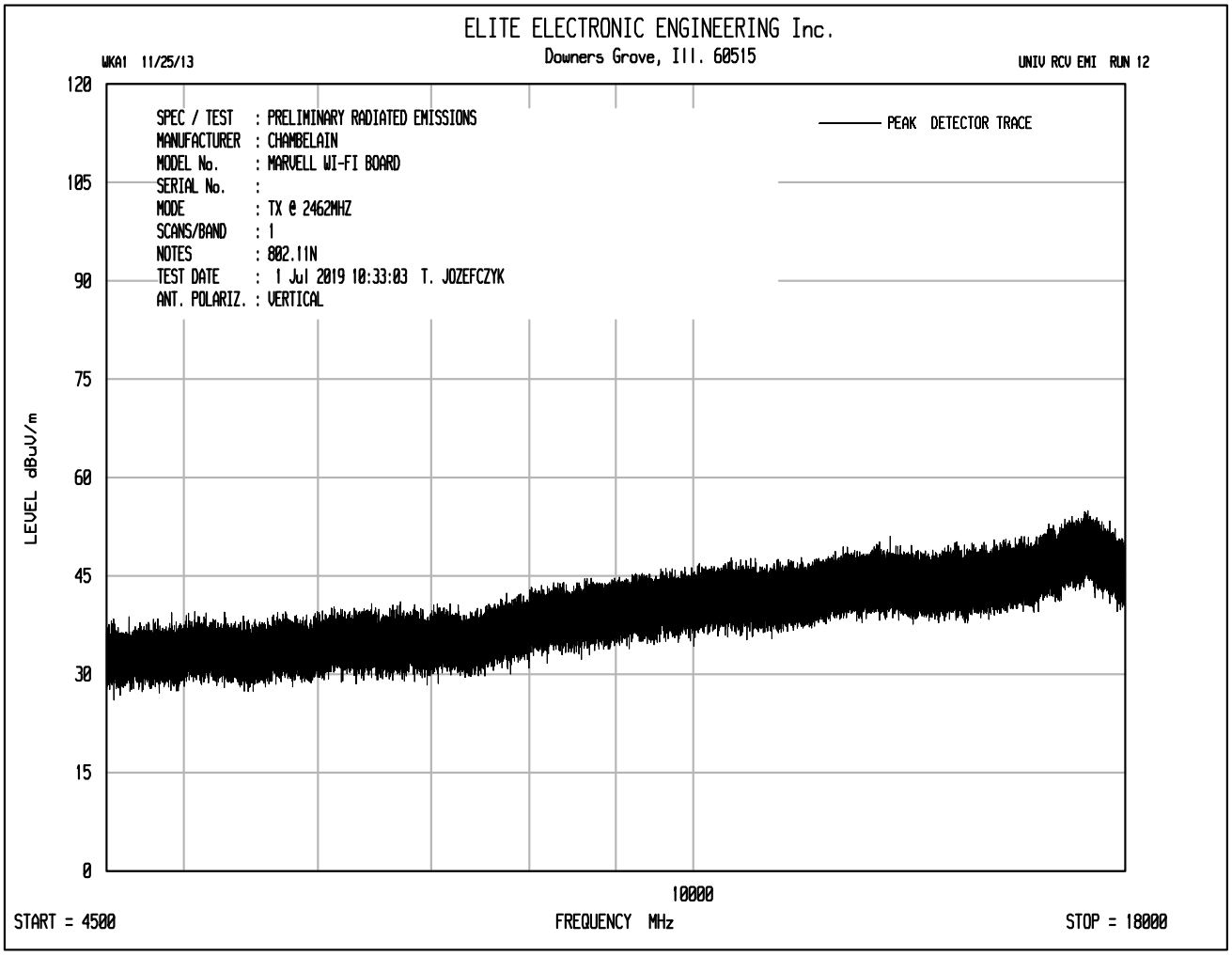

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 7
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : CHAMBELAIN
MODEL No. : MARVELL WI-FI BOARD
SERIAL No. :
MODE : TX @ 2462MHZ
SCANS/BAND : 1
NOTES : 802.11G
TEST DATE : 1 Jul 2019 09:42:14 T. JOZEFCZYK
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
10000
START = 4500
FREQUENCY MHz
STOP = 18000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 8
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : CHAMBELAIN
MODEL No. : MARVELL WI-FI BOARD
SERIAL No. :
MODE : TX @ 2462MHZ
SCANS/BAND : 1
NOTES : 802.11G
TEST DATE : 1 Jul 2019 09:46:20 T. JOZEFCZYK
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
10000
START = 4500
FREQUENCY MHz
STOP = 18000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 7
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : CHAMBERLAIN
MODEL No. : MARVELL WI-FI BOARD
SERIAL No. :
MODE : TX @ 2462MHZ
SCANS/BAND : 1
NOTES : 802.11N
TEST DATE : 26 Jun 2019 15:03:44 T. JOZEFCZYK
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 4500


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 8
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : CHAMBERLAIN
MODEL No. : MARVELL WI-FI BOARD
SERIAL No. :
MODE : TX @ 2462MHZ
SCANS/BAND : 1
NOTES : 802.11N
TEST DATE : 26 Jun 2019 15:05:14 T. JOZEFCZYK
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 4500


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 11
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : CHAMBELAIN
MODEL No. : MARVELL WI-FI BOARD
SERIAL No. :
MODE : TX @ 2462MHZ
SCANS/BAND : 1
NOTES : 802.11N
TEST DATE : 1 Jul 2019 10:29:04 T. JOZEFCZYK
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
10000
START = 4500
FREQUENCY MHz
STOP = 18000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 12
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : CHAMBELAIN
MODEL No. : MARVELL WI-FI BOARD
SERIAL No. :
MODE : TX @ 2462MHZ
SCANS/BAND : 1
NOTES : 802.11N
TEST DATE : 1 Jul 2019 10:33:03 T. JOZEFCZYK
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
10000
START = 4500
FREQUENCY MHz
STOP = 18000

DATA PAGE	
MANUFACTURER	Chamberlain Group, Inc.
EUT	Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip
TEST	FCC §15.247, RSS-247 Radiated Spurious Emissions – Harmonics in Non-Restricted Bands
MODE	802.11b – 2462MHz
DATE TESTED	June 26 & July 1, 2019
TEST PERFORMED BY	Tylar Jozefczyk
NOTES	

RADIATED SPURIOUS EMISSIONS

Freq. (MHz)	Ant. Pol.	Meter Reading (dBµV)	Ambient	CBL Fac. (dB)	Ant. Fac. (dB)	Pre Amp (dB)	Peak Total dBµV/m at 3m	Peak Total µV/m at 3m	Peak Limit µV/m at 3m	Margin (dB)
2462.00	H	62.13		3.49	33.59	0.00	99.21	91253.74		
2462.00	V	62.89		3.49	33.59	0.00	99.97	99598.02		
9848.00	H	39.35	Ambient	6.93	39.55	-39.53	46.29	206.31	5000.00	-27.69
9848.00	V	39.46	Ambient	6.93	39.55	-39.53	46.40	208.94	5000.00	-27.58

DATA PAGE	
MANUFACTURER	Chamberlain Group, Inc.
EUT	Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip
TEST	FCC §15.247, RSS-247 Radiated Spurious Emissions – Harmonics in Restricted Bands
MODE	802.11b – 2462MHz
DATE TESTED	June 26 & July 1, 2019
TEST PERFORMED BY	Tylar Jozefczyk
NOTES	

RADIATED SPURIOUS EMISSIONS

Freq. (MHz)	Ant. Pol.	Meter Reading (dBµV)	Ambient	CBL Fac. (dB)	Ant. Fac. (dB)	Pre Amp (dB)	Peak Total dBµV/m at 3m	Peak Total µV/m at 3m	Peak Limit µV/m at 3m	Margin (dB)
4924.00	H	50.68		4.89	36.80	-40.27	52.10	402.78	5000.00	-21.88
4924.00	V	50.94		4.89	36.80	-40.27	52.36	415.02	5000.00	-21.62
7386.00	H	49.50	Ambient	6.20	38.15	-40.05	53.80	489.54	5000.00	-20.18
7386.00	V	49.55	Ambient	6.20	38.15	-40.05	53.85	492.36	5000.00	-20.13

DATA PAGE	
MANUFACTURER	Chamberlain Group, Inc.
EUT	Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip
TEST	FCC §15.247, RSS-247 Radiated Spurious Emissions – Restricted Band Averages
MODE	802.11b – 2462MHz
DATE TESTED	June 26 & July 1, 2019
TEST PERFORMED BY	Tylar Jozefczyk
NOTES	

RADIATED SPURIOUS EMISSIONS

Freq. (MHz)	Ant. Pol.	Meter Reading (dBµV)	Ambient	CBL Fac. (dB)	Ant. Fac. (dB)	Pre Amp (dB)	Duty Cycle (dB)	Average Total dBµV/m at 3m	Average Total µV/m at 3m	Average Limit µV/m at 3m	Margin (dB)
4924.00	H	38.20		4.89	36.80	-40.27	0.00	39.62	95.73	500.00	-14.36
4924.00	V	37.23		4.89	36.80	-40.27	0.00	38.65	85.62	500.00	-15.33
7386.00	H	34.71	Ambient	6.20	38.15	-40.05	0.00	39.01	89.18	500.00	-14.97
7386.00	V	34.78	Ambient	6.20	38.15	-40.05	0.00	39.08	89.91	500.00	-14.90

DATA PAGE	
MANUFACTURER	Chamberlain Group, Inc.
EUT	Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip
TEST	FCC §15.247, RSS-247 Radiated Spurious Emissions – Harmonics in Non-Restricted Bands
MODE	802.11g – 2462MHz
DATE TESTED	June 26 & July 1, 2019
TEST PERFORMED BY	Tylar Jozefczyk
NOTES	

RADIATED SPURIOUS EMISSIONS

Freq. (MHz)	Ant. Pol.	Meter Reading (dBµV)	Ambient	CBL Fac. (dB)	Ant. Fac. (dB)	Pre Amp (dB)	Peak Total dBµV/m at 3m	Peak Total µV/m at 3m	Peak Limit µV/m at 3m	Margin (dB)
2462.00	H	59.22		3.49	33.59	0.00	96.30	65275.57		
2462.00	V	59.38		3.49	33.59	0.00	96.46	66489.14		
9848.00	H	38.91	Ambient	6.93	39.55	-39.53	45.85	196.12	5000.00	-28.13
9848.00	V	38.49	Ambient	6.93	39.55	-39.53	45.43	186.86	5000.00	-28.55

DATA PAGE	
MANUFACTURER	Chamberlain Group, Inc.
EUT	Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip
TEST	FCC §15.247, RSS-247 Radiated Spurious Emissions – Harmonics in Restricted Bands
MODE	802.11g – 2462MHz
DATE TESTED	June 26 & July 1, 2019
TEST PERFORMED BY	Tylar Jozefczyk
NOTES	

RADIATED SPURIOUS EMISSIONS

Freq. (MHz)	Ant. Pol.	Meter Reading (dBµV)	Ambient	CBL Fac. (dB)	Ant. Fac. (dB)	Pre Amp (dB)	Peak Total dBµV/m at 3m	Peak Total µV/m at 3m	Peak Limit µV/m at 3m	Margin (dB)
4924.00	H	49.83	Ambient	4.89	36.80	-40.27	51.25	365.23	5000.00	-22.73
4924.00	V	49.79	Ambient	4.89	36.80	-40.27	51.21	363.55	5000.00	-22.77
7386.00	H	49.44	Ambient	6.20	38.15	-40.05	53.74	486.17	5000.00	-20.24
7386.00	V	49.23	Ambient	6.20	38.15	-40.05	53.53	474.56	5000.00	-20.45

DATA PAGE	
MANUFACTURER	Chamberlain Group, Inc.
EUT	Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip
TEST	FCC §15.247, RSS-247 Radiated Spurious Emissions – Restricted Band Averages
MODE	802.11g – 2462MHz
DATE TESTED	June 26 & July 1, 2019
TEST PERFORMED BY	Tylar Jozefczyk
NOTES	

RADIATED SPURIOUS EMISSIONS

Freq. (MHz)	Ant. Pol.	Meter Reading (dBµV)	Ambient	CBL Fac. (dB)	Ant. Fac. (dB)	Pre Amp (dB)	Duty Cycle (dB)	Average Total dBµV/m at 3m	Average Total µV/m at 3m	Average Limit µV/m at 3m	Margin (dB)
4924.00	H	35.52	Ambient	4.89	36.80	-40.27	0.00	36.94	70.32	500.00	-17.04
4924.00	V	35.47	Ambient	4.89	36.80	-40.27	0.00	36.89	69.91	500.00	-17.09
7386.00	H	34.72	Ambient	6.20	38.15	-40.05	0.00	39.02	89.29	500.00	-14.96
7386.00	V	34.73	Ambient	6.20	38.15	-40.05	0.00	39.03	89.39	500.00	-14.95

DATA PAGE	
MANUFACTURER	Chamberlain Group, Inc.
EUT	Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip
TEST	FCC §15.247, RSS-247 Radiated Spurious Emissions – Harmonics in Non-Restricted Bands
MODE	802.11n – 2462MHz
DATE TESTED	June 26 & July 1, 2019
TEST PERFORMED BY	Tylar Jozefczyk
NOTES	

RADIATED SPURIOUS EMISSIONS

Freq. (MHz)	Ant. Pol.	Meter Reading (dBµV)	Ambient	CBL Fac. (dB)	Ant. Fac. (dB)	Pre Amp (dB)	Peak Total dBµV/m at 3m	Peak Total µV/m at 3m	Peak Limit µV/m at 3m	Margin (dB)
2462.00	H	57.11		3.49	33.59	0.00	94.19	51197.73		
2462.00	V	58.44		3.49	33.59	0.00	95.52	59669.26		
9848.00	H	39.20	Ambient	6.93	39.55	-39.53	46.14	202.78	5000.00	-27.84
9848.00	V	39.38	Ambient	6.93	39.55	-39.53	46.32	207.02	5000.00	-27.66

DATA PAGE	
MANUFACTURER	Chamberlain Group, Inc.
EUT	Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip
TEST	FCC §15.247, RSS-247 Radiated Spurious Emissions – Harmonics in Restricted Bands
MODE	802.11n – 2462MHz
DATE TESTED	June 26 & July 1, 2019
TEST PERFORMED BY	Tylar Jozefczyk
NOTES	

RADIATED SPURIOUS EMISSIONS

Freq. (MHz)	Ant. Pol.	Meter Reading (dBµV)	Ambient	CBL Fac. (dB)	Ant. Fac. (dB)	Pre Amp (dB)	Peak Total dBµV/m at 3m	Peak Total µV/m at 3m	Peak Limit µV/m at 3m	Margin (dB)
4924.00	H	49.93	Ambient	4.89	36.80	-40.27	51.35	369.46	5000.00	-22.63
4924.00	V	50.38	Ambient	4.89	36.80	-40.27	51.80	389.10	5000.00	-22.18
7386.00	H	49.51	Ambient	6.20	38.15	-40.05	53.81	490.10	5000.00	-20.17
7386.00	V	48.99	Ambient	6.20	38.15	-40.05	53.29	461.62	5000.00	-20.69

DATA PAGE	
MANUFACTURER	Chamberlain Group, Inc.
EUT	Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip
TEST	FCC §15.247, RSS-247 Radiated Spurious Emissions – Restricted Band Averages
MODE	802.11n – 2462MHz
DATE TESTED	June 26 & July 1, 2019
TEST PERFORMED BY	Tylar Jozefczyk
NOTES	

RADIATED SPURIOUS EMISSIONS

Freq. (MHz)	Ant. Pol.	Meter Reading (dBµV)	Ambient	CBL Fac. (dB)	Ant. Fac. (dB)	Pre Amp (dB)	Duty Cycle (dB)	Average Total dBµV/m at 3m	Average Total µV/m at 3m	Average Limit µV/m at 3m	Margin (dB)
4924.00	H	35.31	Ambient	4.89	36.80	-40.27	0.00	36.73	68.64	500.00	-17.25
4924.00	V	35.35	Ambient	4.89	36.80	-40.27	0.00	36.77	68.96	500.00	-17.21
7386.00	H	34.77	Ambient	6.20	38.15	-40.05	0.00	39.07	89.80	500.00	-14.91
7386.00	V	34.80	Ambient	6.20	38.15	-40.05	0.00	39.10	90.11	500.00	-14.88

DATA PAGE	
MANUFACTURER	Chamberlain Group, Inc.
EUT	Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip
TEST	FCC §15.247, RSS-247 Band Edge
MODE	802.11b – 2412MHz
DATE TESTED	June 26 & July 1, 2019
TEST PERFORMED BY	Tylar Jozefczyk
NOTES	

BAND EDGE – LOW

Date: 27.JUN.2019 00:07:56

DATA PAGE	
MANUFACTURER	Chamberlain Group, Inc.
EUT	Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip
TEST	FCC §15.247, RSS-247 Band Edge
MODE	802.11g – 2412MHz
DATE TESTED	June 26 & July 1, 2019
TEST PERFORMED BY	Tylar Jozefczyk
NOTES	

BAND EDGE – LOW

Date: 27.JUN.2019 00:20:30

DATA PAGE	
MANUFACTURER	Chamberlain Group, Inc.
EUT	Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip
TEST	FCC §15.247, RSS-247 Band Edge
MODE	802.11n – 2412MHz
DATE TESTED	June 26 & July 1, 2019
TEST PERFORMED BY	Tylar Jozefczyk
NOTES	

BAND EDGE – LOW

Date: 27.JUN.2019 00:31:29

DATA PAGE	
MANUFACTURER	Chamberlain Group, Inc.
EUT	Wi-Fi Module 001D9193-2 using Marvell MW300 Wi-Fi Chip
TEST	FCC §15.247, RSS-247 Band Edge
MODE	802.11n – 2412MHz
DATE TESTED	June 26 & July 1, 2019
TEST PERFORMED BY	Tylar Jozefczyk
NOTES	

BAND EDGE – HIGH - PEAK

Mode	Freq. (MHz)	Ant. Pol	Meter Reading (dBµV)	CBL Fac. (dB)	Ant. Fac. (dB)	Pre Amp (dB)	Peak Total dBµV/m at 3m	Peak Total µV/m at 3m	Peak Limit µV/m at 3m	Margin (dB)
802.11b	2483.50	H	22.05	3.50	33.65	0.00	59.20	912.22	5000.00	-14.78
	2483.50	V	24.81	3.50	33.65	0.00	61.96	1253.43	5000.00	-12.02
802.11g	2483.50	H	33.32	3.50	33.65	0.00	70.47	3338.88	5000.00	-3.51
	2483.50	V	34.32	3.50	33.65	0.00	71.47	3746.28	5000.00	-2.51
802.11n	2483.50	H	31.35	3.50	33.65	0.00	68.50	2661.34	5000.00	-5.48
	2483.50	V	33.99	3.50	33.65	0.00	71.14	3606.62	5000.00	-2.84

BAND EDGE – HIGH - AVERAGE

Mode	Freq. (MHz)	Ant. Pol	Meter Reading (dBµV)	CBL Fac. (dB)	Ant. Fac. (dB)	Pre Amp (dB)	Duty Cycle (dB)	Average Total dBµV/m at 3m	Average Total µV/m at 3m	Average Limit µV/m at 3m	Margin (dB)
802.11b	2483.50	H	10.27	3.50	33.65	0.00	0.00	47.42	235.02	500.00	-6.56
	2483.50	V	8.27	3.50	33.65	0.00	0.00	45.42	186.68	500.00	-8.56
802.11g	2483.50	H	15.59	3.50	33.65	0.00	0.00	52.74	433.61	500.00	-1.24
	2483.50	V	16.10	3.50	33.65	0.00	0.00	53.25	459.83	500.00	-0.73
802.11n	2483.50	H	14.62	3.50	33.65	0.00	0.00	51.77	387.79	500.00	-2.21
	2483.50	V	16.67	3.50	33.65	0.00	0.00	53.82	491.02	500.00	-0.16

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

ELITE ELECTRONIC ENGINEERING, INC.
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Downers Grove, IL 60515
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Email: sglaya@elitetest.com
Craig Fanning (EMC Lab Manager) Phone: 630 495 9770 ext. 112
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Email: sdolecki@elitetest.com
Website: www.elitetest.com

ELECTRICAL

Valid to: June 30, 2019 Certificate Number: 1786.01

In recognition of the successful completion of the A2LA Accreditation Program evaluation process, accreditation is granted to this laboratory to perform the following automotive electromagnetic compatibility and other electrical tests:

Test Technology:	Test Method(s)[1]:
Transient Immunity	ISO 7637-2; ISO 7637-3; ISO 16750-2:2012, Sections 4.6.3 and 4.6.4; CS-11979, Section 6.4; CS.00054, Section 5.9; EMC-CS-2009.1 (CI220); FMC1278 (CI220, CI221, CI222); GMW 3097, Section 3.5; SAE J1113-11; SAE J1113-12
Electrostatic Discharge (ESD)	ISO 10605 (2001, 2008); CS-11979 Section 7.0; CS.00054, Section 5.10; EMC-CS-2009.1 (CI 280); FMC1278 (CI280); SAE J1113-13; GMW 3097 Section 3.6
Conducted Emissions	CISPR 25 (2002, 2008), Sections 6.2 and 6.3; CISPR 25 (2016), Sections 6.3 and 6.4; CS-11979, Section 5.1; CS.00054, Sections 5.6.1 and 5.6.2; GMW 3097, Section 3.3.2; EMC-CS-2009.1 (CE 420); FMC1278 (CE420, CE421)
Radiated Emissions Anechoic	CISPR 25 (2002, 2008), Section 6.4; CISPR 25 (2016), Section 6.5; CS-11979, Section 5.3; CS.00054, Section 5.6.3; GMW 3097, Section 3.3.1; EMC-CS-2009.1 (RE 310); FMC1278 (RE310)
Vehicle Radiated Emissions	CISPR 12

Test Technology:	Test Method(s) [1]:
Bulk Current Injection (BCI)	ISO 11452-4; CS-11979, Section 6.1; CS.00054, Section 5.8.1; GMW 3097, Section 3.4.1; SAE J1113-4; EMC-CS-2009.1 (RI112); FMC1278 (RI112)
Bulk Current Injections (BCI) *(Closed Loop Method)*	ISO 11452-4; SAE J1113-4
Radiated Immunity Anechoic	ISO 11452-2; CS-11979, Section 6.2; CS.00054, Section 5.8.2; GMW 3097, Section 3.4.2; EMC-CS-2009.1 (RI114); FMC1278 (RI114); SAE J1113-21
Radiated Immunity Anechoic *(Radar Pulse Only)*	ISO 11452-2; CS-11979, Section 6.2; CS.00054, Section 5.8.2; GMW 3097, Section 3.4.2; EMC-CS-2009.1 (RI114); FMC1278 (RI114)
Radiated Immunity Reverb	ISO/IEC 61000-4-21; GMW 3097, Section 3.4.3; EMC-CS-2009.1 (RI114); FMC1278 (RI114); ISO 11452-11
Radiated Immunity *(Portable Transmitters)*	ISO 11452-9; EMC-CS-2009.1 (RI115); FMC1278 (RI115)
Vehicle Radiated Immunity (ALSE)	ISO 11451-2
Electrical Loads	ISO 16750-2, Sections 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.11, and 4.12
Dielectric Withstand Voltage	MIL-STD-202, Method 301; EIA-364-20D
Insulation Resistance	MIL-STD-202, Method 302; SAE/USCAR-2, Revision 6, Section 5.5.1; EIA-364-21D
Contact Resistance	MIL-STD-202, Method 307; SAE/USCAR-2, Revision 6, Section 5.3.1; EIA/ECA-364-23C; USCAR21-3 Section 4.5.3
DC Resistance	MIL-STD-202, Method 303
Contact Chatter	MIL-STD-202, Method 310; SAE/USCAR-2, Revision 6, Section 5.1.9
Voltage Drop	SAE/USCAR-2, Revision 6, Section 5.3.2; USCAR21-3 Section 4.5.6

Test Technology:	Test Method(s) [1]:
Emissions	
Radiated and Conducted (3m Semi-anechoic chamber, up to 40 GHz)	47 CFR, FCC Part 15 B (using ANSI C63.4:2014); 47 CFR, FCC Part 18 (using FCC MP-5:1986); ICES-003; ICES-005; IEC/CISPR 11, Ed. 4.1 (2004-06); AS/NZS CISPR 11 (2004); IEC/CISPR 11 Ed 5 (2009-05) + A1 (2010); KN 11 (2008-5) with RRL Notice No. 2008-3 (May 20, 2008); CISPR 11; EN 55011; KN 11; CNS 13803 (1997, 2003); CISPR 14-1; EN 55014-1; AS/NZS CISPR 14.1; KN 14-1; IEC/CISPR 22 (1997); EN 55022 (1998) + A1(2000); EN 55022 (1998) + A1(2000) + A2(2003); EN 55022 (2006); IEC/CISPR 22 (2008-09); AS/NZS CISPR 22 (2004); AS/NZS CISPR 22, 3rd Edition (2006); KN 22 (up to 6 GHz); CNS 13438 (up to 6 GHz); VCCI V-3 (up to 6 GHz); CISPR 32; EN 55032; KN 32
Current Harmonics	IEC 61000-3-2; EN 61000-3-2; KN 61000-3-2
Flicker and Fluctuations	IEC 61000-3-3; EN 61000-3-3; KN 61000-3-3
Immunity	
Electrostatic Discharge	IEC 61000-4-2, Ed. 1.2 (2001); IEC 61000-4-2 (1995) + A1(1998) + A2(2000); EN 61000-4-2 (1995); EN 61000-4-2 (2009-05); KN 61000-4-2 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); IEC 61000-4-2; EN 61000-4-2; KN 61000-4-2
Radiated Immunity	IEC 61000-4-3 (1995) + A1(1998) + A2(2000); IEC 61000-4-3, Ed. 3.0 (2006-02); IEC 61000-4-3, Ed. 3.2 (2010); KN 61000-4-3 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); IEC 61000-4-3; EN 61000-4-3; KN 61000-4-3
Electrical Fast Transient/Burst	IEC 61000-4-4, Ed. 2.0 (2004-07); IEC 61000-4-4, Ed. 2.1 (2011); IEC 61000-4-4 (1995) + A1(2000) + A2(2001); KN 61000-4-4 (2008-5); RRL Notice No. 2008-5 (May 20, 2008); IEC 61000-4-4; EN 61000-4-4; KN 61000-4-4
Surge	IEC 61000-4-5 (1995) + A1(2000); IEC 61000-4-5, Ed 1.1 (2005-11); EN 61000-4-5 (1995) + A1(2001); KN 61000-4-5 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); IEC 61000-4-5; EN 61000-4-5; KN 61000-4-5
Conducted Immunity	IEC 61000-4-6 (1996) + A1(2000); IEC 61000-4-6, Ed 2.0 (2006-05); IEC 61000-4-6 Ed. 3.0 (2008); KN 61000-4-6 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); EN 61000-4-6 (1996) + A1(2001); IEC 61000-4-6; EN 61000-4-6; KN 61000-4-6

Test Technology:	Test Method(s) [1]:
Power Frequency Magnetic Field Immunity	IEC 61000-4-8 (1993) + A1(2000); IEC 61000-4-8 (2009); EN 61000-4-8 (1994) + A1(2000); KN 61000-4-8 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); IEC 61000-4-8; EN 61000-4-8; KN 61000-4-8
Voltage Dips, Short Interrupts, and Line Voltage Variations	IEC 61000-4-11, Ed. 2 (2004-03); KN 61000-4-11 (2008-5); RRL Notice No. 2008-4 (May 20, 2008); IEC 61000-4-11; EN 61000-4-11; KN 61000-4-11
Ring Wave	IEC 61000-4-12, Ed. 2 (2006-09); EN 61000-4-12:2006; IEC 61000-4-12; EN 61000-4-12; KN 61000-4-12
Generic and Product Specific EMC Standards	IEC 61000-6-1; AS/NZS 61000-6-1; IEC 61000-6-2; AS/NZS 61000-6-2; EN 61000-6-3; AS/NZS 61000-6-3; IEC 61000-6-4; AS/NZS 61000-6-4; EN 50130-4; IEC 61326-1; IEC/CISPR 14-2; EN 55014-2; AS/NZS CISPR 14.2; KN 14-2; IEC/CISPR 24; AS/NZS CISPR 24; EN 55024; KN 24; IEC 60601-1-2; JIS T0601-1-2
Telecommunications Test Methods	Industry Canada CS-03, Part 1, Issue 9, Amendment 4 (2010): Analogue Terminal Equipment (TE); Industry Canada CS-03, Part II, Issue 9, Amendment 1 (2012): Digital TE Intended for Connection to 1.544 Mbps (DS-1) Digital Facilities; Industry Canada CS-03, Part III, Issue 9, August 2013: Acceptable Methods of Connection for Single Line and Multi-Line Terminal Equipment; Industry Canada CS-03, Part V, Issue 9, Amendment 1 (2009): Requirements and Test Methods for Magnetic Output from Handset Telephones for Hearing Aid Coupling and for Receive Volume Control; Industry Canada CS-03, Part VI, Issue 9, Amendment 1 (2012): ISDN TE; Industry Canada CS-03, Part VII, Issue 9, Amendment 4 (2012): Limited Distance Modem and Digital Subrate TE; Industry Canada CS-03, Part VIII, Issue 9, Amendment 4 (2009): Requirements and Test Methods for Digital Subscriber Line (xDSL) TE;

Test Technology:	Test Method(s) [1]:
Telecommunications Test Methods (Cont'd)	Terminal Equipment Network Protection Standards, FCC/ACTA Method - 47 CFR Part 68 - Analog and Digital: 68.302 (Parts C, D, E, F) Environmental simulation; 68.304 Leakage Current Limit; 68.306 Hazardous Voltage Limit; 68.308 Signal Power Limit; 68.310 Longitudinal Balance Limit; 68.312 On-hook Impedance Limit; 68.314 Billing Protection; 68.316 and 68.317 Hearing Aid Compatibility: Technical Standards; 68.302 Environmental Simulation (Parts A, B); T1.TRQ.6 (2001): Technical Requirements for SHDSL, HDSL2, HDSL4, Digital Subscriber Line Terminal Equipment to Prevent Harm to the Telephone Network; TIA/EIA TSB-31-D (2015): Part 68 Rational and Measurement Guidelines; ANSI/TIA-968-A (2003): Telephone Terminal Equipment, Technical Requirements for Connection of Terminal Equipment to the Telephone Network; ANSI/TIA-968-A-1 (2003): Telephone Terminal Equipment, Technical Requirements for Connection of Terminal Equipment to the Telephone Network - Addendum 1; ANSI/TIA-968-A-2 (2004): Telephone Terminal Equipment, Technical Requirements for Connection of Terminal Equipment to the Telephone Network - Addendum 2; ANSI/TIA-968-A-3 (2005): Telephone Terminal Equipment, Technical Requirements for Connection of Terminal Equipment to the Telephone Network - Addendum 3; TIA-968-B (2009): Telecommunication - Telephone Terminal Equipment - Technical Requirements for Connection of Terminal Equipment to the Telephone Network
European Radio Test Standards	ETSI EN 300 086-1; ETSI EN 300 086-2; ETSI EN 300 113-1; ETSI EN 300 113-2; ETSI EN 300 220-1; ETSI EN 300 220-2; ETSI EN 300 330-1; ETSI EN 300 330-2; ETSI EN 300 440-1; ETSI EN 300 440-2; ETSI EN 300 422-1; ETSI EN 300 422-2; ETSI EN 300 328; ETSI EN 301 893
Canadian Radio Tests	RSS-102; RSS-111; RSS-112; RSS-117; RSS-119; RSS-123; RSS-125; RSS-127; RSS-130; RSS-131; RSS-132; RSS-133; RSS-134; RSS-135; RSS-137; RSS-139; RSS-141; RSS-142; RSS-170; RSS-181; RSS-182; RSS-191; RSS-192; RSS-194; RSS-195; RSS-196; RSS-197; RSS-199; RSS-210; RSS-211; RSS-213; RSS-215; RSS-216; RSS-220; RSS-222; RSS-236; RSS-238; RSS-243; RSS-244; RSS-247; RSS-251; RSS-287; RSS-288; RSS-310; RSS-GEN

Test Technology:	Test Method(s) [1]:
Japan Radio Tests	Radio Law No. 131, Ordinance of MPT No. 37, 1981, MIC Notification No. 88:2004, Table No. 22-11; ARIB STD-T66, Regulation 18
Taiwan Radio Tests	LP-0002
Australia/New Zealand Radio Tests	AS/NZS 4268
Unlicensed Radio Frequency Devices *(3 Meter Semi-Anechoic Room)*	47 CFR FCC Part 15C, 15D, 15E, 15F, 15G, 15H (using ANSI C63.10:2013, ANSI C63.17:2013 and FCC KDB 905462 D02 (v02))
Licensed Radio Service Equipment	47 CFR FCC Parts 20, 22, 24, 25, 27, 73, 74, 80, 87, 90, 95, 96, 97, 101; ANSI/TIA-603-D; TIA-102.CAAA-D; ANSI C63.26:2015; FCC KDB 935210 D03 (v04); FCC KDB 935210 D04 (v02); FCC KDB 935210 D05 (v01r01)
Electrical Measurements and Simulation	FAA AC 150/5345-10H
AC Voltage / Current	FAA AC 150/5345-43G
(1mV to 5KV) 60 Hz	FAA AC 150/5345-44J
(0.1V to 250V) up to 500 MHz	FAA AC 150/5345-46D
(1µA to 150A) 60 Hz	FAA AC 150/5345-47C
DC Voltage / Current	FAA EB 67D
(1mV to 15KV) / (1µA to 10A)	
Power Factor / Efficiency / Crest Factor	
(Power to 30KW)	
Resistance	
(1mΩ to 4000MΩ)	
Surge	
(Up to 10KV / 5000A) (Combination Wave and Ring Wave)	

On the following products and materials:
Telecommunications Terminal Equipment (TTE), Radio Equipment, Network Equipment, Information Technology Equipment (ITE), Automotive Electronic Equipment, Automotive Hybrid Electronic Devices, Maritime Navigation and Radio Communication Equipment and Systems, Vehicles, Boats and Internal Combustion Engine Driven Devices, Automotive, Aviation, and General Lighting Products, Medical Electrical Equipment, Motors, Industrial, Scientific and Medical (ISM) Radio-Frequency Equipment, Household Appliances, Electric Tools, Low-voltage Switchgear and Control gear, Programmable Controllers, Electrical Equipment for Measurement, Control and Laboratory Use, Base Materials, Power and Data Transmission Cables and Connectors

[1] When the date, revision or edition of a test method standard is not identified on the scope of accreditation, the laboratory is required to be using the current version within one year of the date of publication, per part C., Section 1 of A2LA *R101 - General Requirements - Accreditation of ISO-IEC 17025 Laboratories*.

Testing Activities Performed in Support of FCC Declaration of Conformity and Certification in Accordance with 47 Code of Federal Regulations and FCC KDB 974614, Appendix A, Table A.1[2]

Rule Subpart/Technology	Test Method	Maximum Frequency (MHz)
Unintentional Radiators Part 15B	ANSI C63.4:2014	40000
Industrial, Scientific, and Medical Equipment Part 18	FCC MP-5 (February 1986)	40000
Intentional Radiators Part 15C	ANSI C63.10:2013	40000
Unlicensed Personal Communication Systems Devices Part 15D	ANSI C63.17:2013	40000
U-NIII without DFS Intentional Radiators Part 15E	ANSI C63.10:2013	40000
U-NIII with DFS Intentional Radiators Part 15E	FCC KDB 905462 D02 (v01)	40000
UWB Intentional Radiators Part 15F	ANSI C63.10:2013	40000
BPL Intentional Radiators Part 15G	ANSI C63.10:2013	40000
White Space Device Intentional Radiators Part 15H	ANSI C63.10:2013	40000
Commercial Mobile Services (FCC Licensed Radio Service Equipment) Parts 22 (cellular), 24, 25 (non-microwave), and 27	ANSI/TIA-603-D; TIA-102.CAAA-D	40000
General Mobile Radio Services (FCC Licensed Radio Service Equipment) Parts 22 (non-cellular), 90 (non-microwave), 95, 97, and 101 (non-microwave)	ANSI/TIA-603-D; TIA-102.CAAA-D	40000
Citizens Broadband Radio Services (FCC Licensed Radio Service Equipment) Part 96	ANSI/TIA-603-D; TIA-102.CAAA-D	40000
Maritime and Aviation Radio Services Parts 80 and 87	ANSI/TIA-603-D	40000

Testing Activities Performed in Support of FCC Declaration of Conformity and Certification in Accordance with 47 Code of Federal Regulations and FCC KDB 974614, Appendix A, Table A.1[2]

Rule Subpart/Technology	Test Method	Maximum Frequency (MHz)
Microwave and Millimeter Bands Radio Services Parts 25, 74, 90 (90Y, 90Z, DSRC), and 101	ANSI/TIA-603-D; TIA-102.CAAA-D	40000
Broadcast Radio Services Parts 73 and 74 (non-microwave)	ANSI/TIA-603-D; TIA-102.CAAA-D	40000
Signal Boosters Part 20 (Wideband Consumer Signal Boosters, Provider-specific signal boosters, and Industrial Signal Boosters)	FCC KDB 935210 D03 (v04); FCC KDB 935210 D04 (v02); FCC KDB 935210 D05 (v01r01)	40000

[2]Accreditation does not imply acceptance to the FCC equipment authorization program. Please see the FCC website (https://apps.fcc.gov/oetcf/eas/) for a listing of FCC approved laboratories.

Accredited Laboratory

A2LA has accredited

ELITE ELECTRONIC ENGINEERING INC.

Downers Grove, IL

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General requirements for the competence of testing and calibration laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009*).

Presented this 23rd day of October 2017.

President and CEO
For the Accreditation Council
Certificate Number 1786.01
Valid to June 30, 2019

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.