Measurement of Intermodulation Case Spurious Radiated Emissions From Part No. UAHLCA Rear View Mirror

For	Gentex Corporation 380 Riley Street Zeeland, MI 49464
P.O. Number	2640193
Date Tested	May 1, 2019
Test Personnel	Javier Cardenas
Test Specification	FCC "Code of Federal Regulations" Title 47 Part15, Subpart C, Section 15.247

Test Report By:

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REVISION HISTORY

Revision	Date	Description
—	14 May 2019	Initial release

Measurement of RF Emissions from a Rear View Mirror, Part No. UAHLCA

1. INTRODUCTION

1.1. Scope of Tests

This report presents the results of the series of intermodulation case spurious radiated emissions tests performed on a Rear View Mirror, Part No. UAHLCA, (hereinafter referred to as the Equipment Under Test (EUT)). The EUT was manufactured and submitted for testing by Gentex Corporation located in Zeeland, MI.

The EUT contains the following transmitter modules:

Homelink Module, 902-928MHz
Bluetooth module, 2400-2483.5MHz

1.2. Purpose

The test series was performed to determine if the EUT meets the intermodulation case spurious radiated emissions tests of the FCC "Code of Federal Regulations" Title 47:

- Part 15, Subpart C, Section 15.247
- Part 15, Subpart A, Section 15.31(k)
- Part 2, Subpart J, Section 2.947(f)

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 Lab Code: 1786-01.

1.5. Laboratory Conditions

The temperature at the time of the test was 21°C and the relative humidity was 20%.

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 2, Subpart J
- Federal Communications Commission "Code of Federal Regulations", Title 47, Part 15, Subpart A, Subpart C
- KDB 996369 D01 “Federal Communications Commission Office of Engineering and Technology Laboratory Division – Transmitter Module Equipment Authorization Guide” – October 23, 2015

3. EUT SETUP AND OPERATION

3.1. General Description

The EUT is a Gentex Corporation, Rear View Mirror, Part No. UAHLCA. A block diagram of the EUT setup is shown as Figure 1. A photograph of the EUT is shown as Figure 2.

3.1.1.Power Input

The EUT is powered with 13.5VDC.

3.1.2.Peripheral Equipment

The EUT was submitted with a laptop to program the EUT into the correct test mode.

3.1.3.Signal Input/Output Leads

No interconnect cables were submitted with the EUT.

3.1.4.Grounding

The EUT was ungrounded during the tests.

3.2. Operational Mode

For intermodulation tests, the unit was programmed to operate in the following mode:

- Homelink: Transmit at 914.75MHz
- Bluetooth: Transmit at 2440MHz

3.3. EUT Modifications

No modifications were required for compliance.

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 International System (SI) Units.

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. Intermodulation Case Spurious Radiated Measurements

5.1.1.Requirements

Per FCC KDB 996369 section VII and footnote 9, a transmitter module capable of transmitting simultaneously with another transmitter must be tested by following the simultaneous test procedures described in 15.31(k).

15.31(k) states that composite systems (i.e., systems that incorporate different devices contained in a single enclosure or in separate enclosures connected by wire or cable) shall be measured for compliance with the technical standards in accordance with the procedures in §2.947(f).

2.947(f) states that if the individual devices in a composite system are subject to different technical standards, each such device must comply with its specific standards. In no event may the measured emissions of the composite system exceed the highest level permitted for an individual component. Testing for compliance with the different standards shall be performed with all of the devices in the system functioning.

FCC 15.247

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).

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

5.1.2.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.

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 CISPR 16 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.

1. Preliminary radiated measurements were performed to determine the frequencies where the significant emissions might be found. With the EUT at one set position and the measurement antenna at a set height (i.e. without maximizing), the radiated emissions were measured using a peak detector and automatically plotted. The broadband measuring antenna was positioned at a 3 meter distance from the EUT. This data was then automatically plotted up through 18GHz. All preliminary tests were performed separately with the EUT operating in the intermodulation modes listed in Paragraph 3.3.

2. All significant broadband and narrowband signals found in the preliminary sweeps were then measured using a peak detector at a test distance of 3 meters. The measurements were made with a bilog antenna over the frequency range of 30-1000MHz and a double ridged waveguide antenna over the frequency range of 1GHz to 18GHz.

3. To ensure that maximum emission levels were measured, the following steps were taken:

    a. The EUT was rotated so that all of its sides were exposed to the receiving antenna.
    b. Since the measuring antennas are linearly polarized, both horizontal and vertical field components were measured.
    c. The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.

5.1.3.Results

The plots of the peak preliminary spurious radiated emissions are presented on pages 14 through 19. As can be seen from the data, the intermodulation product of simultaneous transmissions from the EUT did not generate any additional spurious radiated emissions that exceeded the limits. Photographs of the test setup are shown in Figure 3 through Figure 4.

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 Gentex Corporation upon completion of the tests.

7. CONCLUSIONS

The Gentex Corporation Rear View Mirror, Model No. UAHLCA did fully comply with the intermodulation case spurious radiated emissions requirements of FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.247, Part 15, Subpart A, Section 15.31(k) and Part 2, Subpart J Section 2.947(f).

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 A2LA, 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
APW11	PREAMPLIFIER	PMI	PE2-35-120-5R0-10-12-SFF	PL11685/1241	1GHZ-20GHZ	4/5/2018	4/5/2019
CDX8	COMPUTER	ELITE	WORKSTATION			N/A	
NWQ0	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS LINDGREN	3117	66657	1GHZ-18GHZ	5/31/2018	5/31/2020
RBG2	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	101591	2HZ-44GHZ	2/23/2018	2/23/2019
SMAH	POWER SUPPLY	MASTECH	HY3020EX	1014	30 Volt, 20 Amp	NOTE 1	
XPR0	HIGH PASS FILTER	K&L MICROWAVE	11SH10-4800/X20000	001	4.8-20GHZ	9/12/2017	9/12/2019

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.

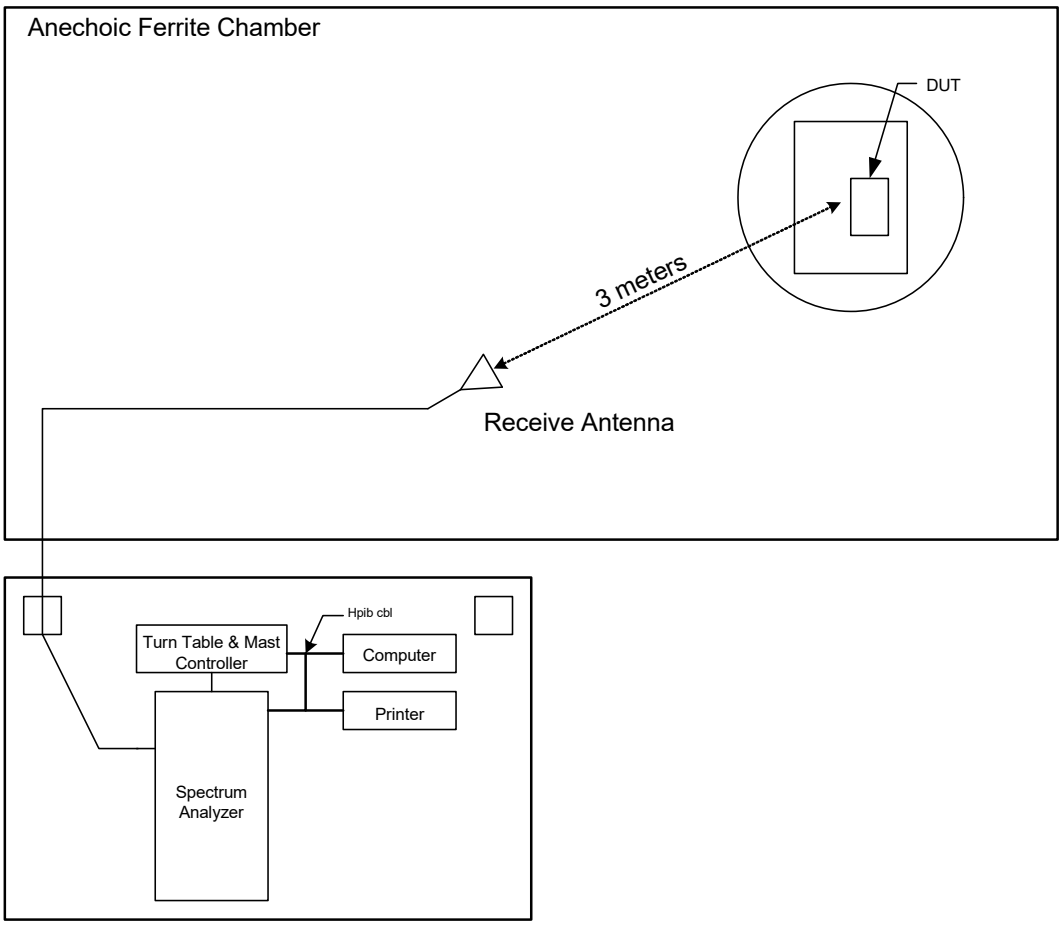
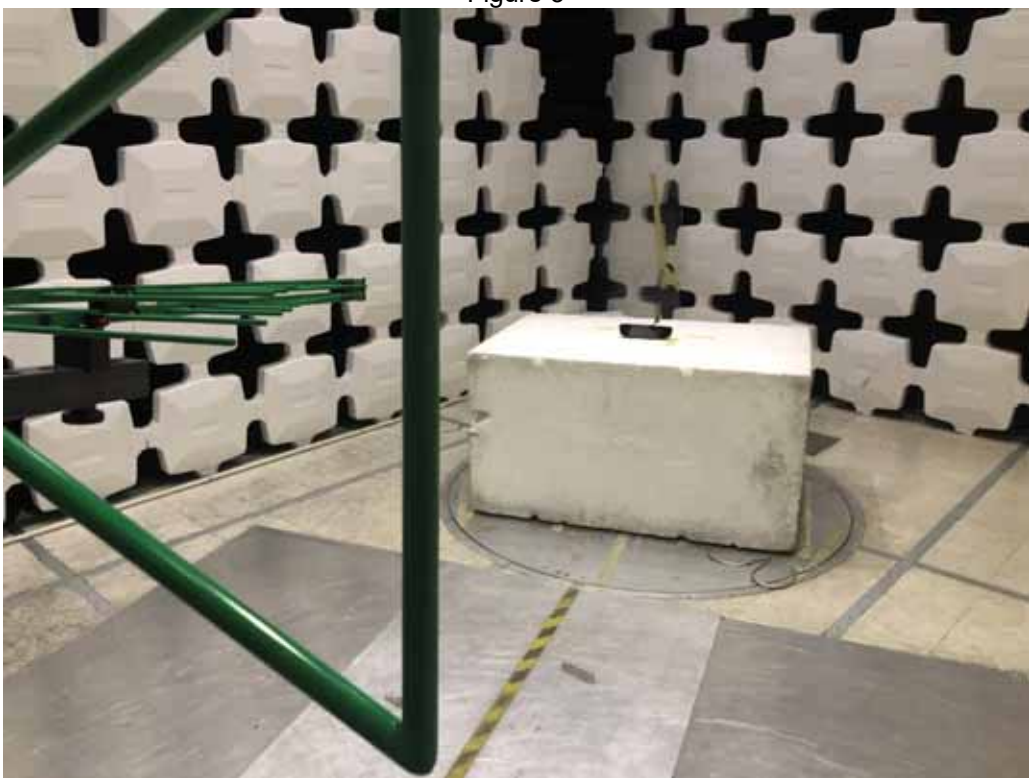


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2

Photograph of the EUT

Figure 3

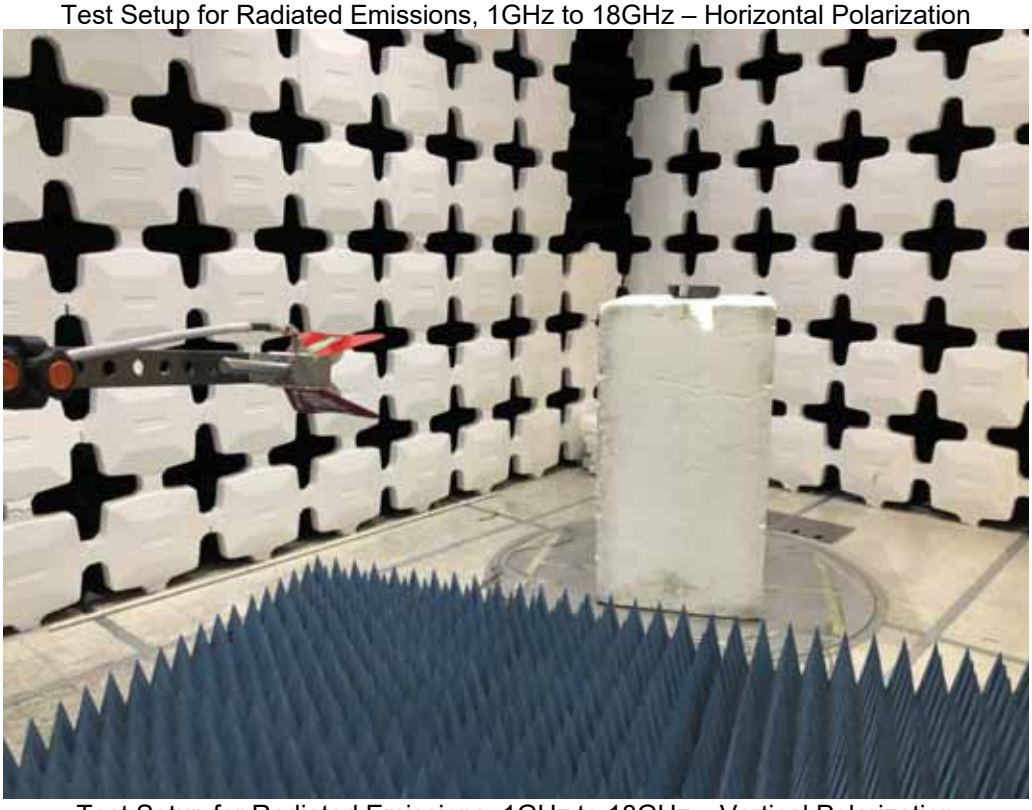


Test Setup for Radiated Emissions, 30MHz to 1GHz – Horizontal Polarization

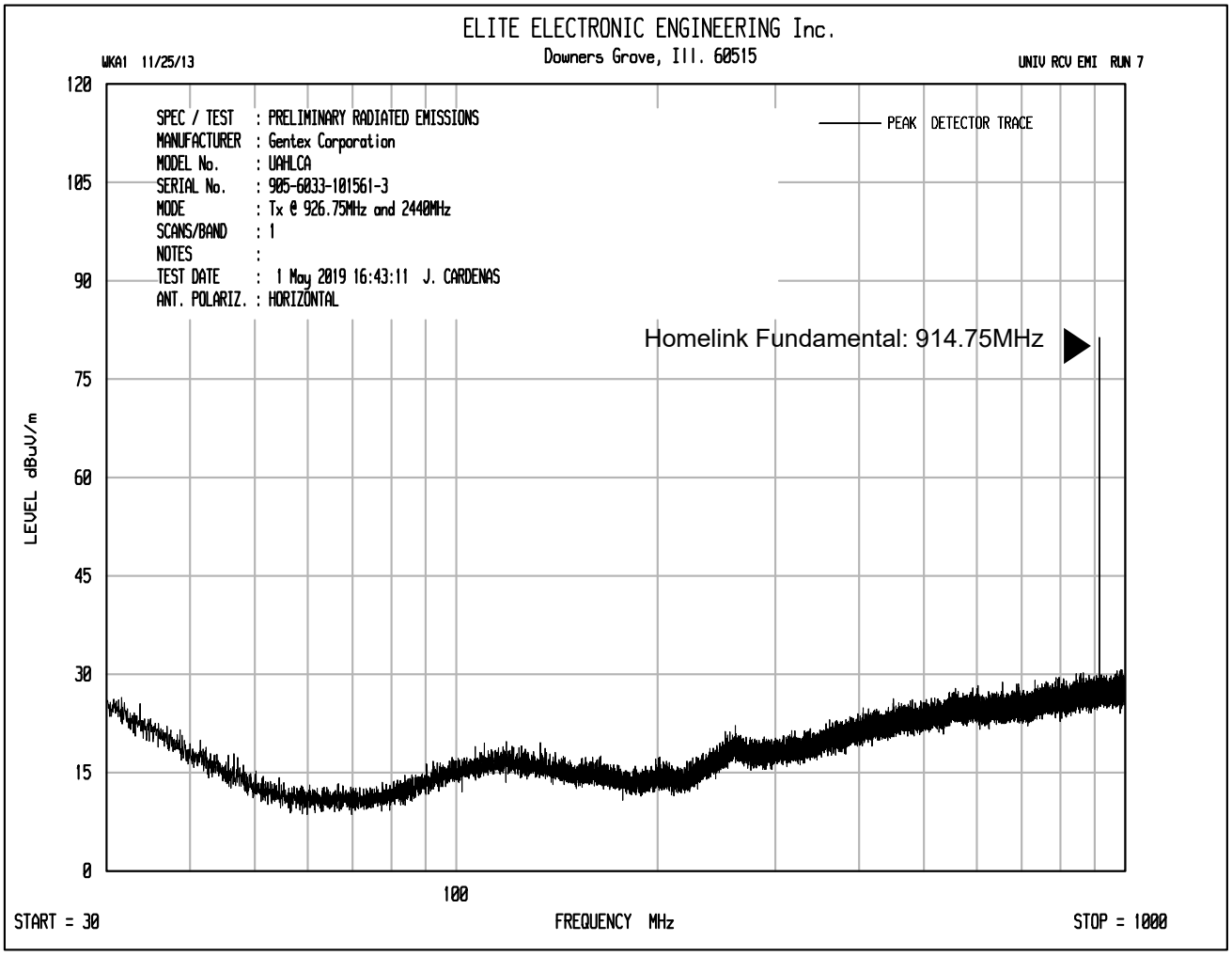
Test Setup for Radiated Emissions, 30MHz to 1GHz – Vertical Polarization

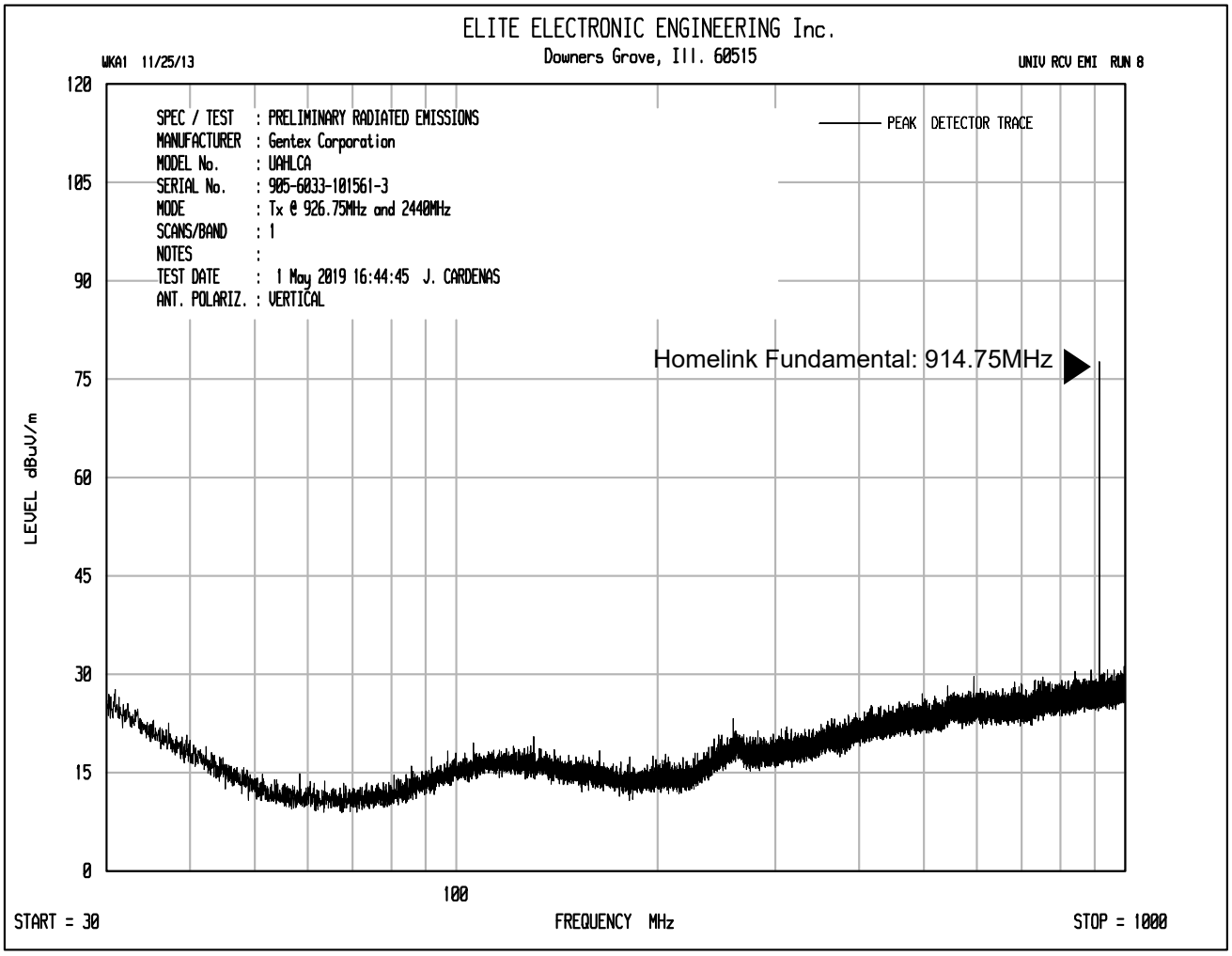
Figure 4

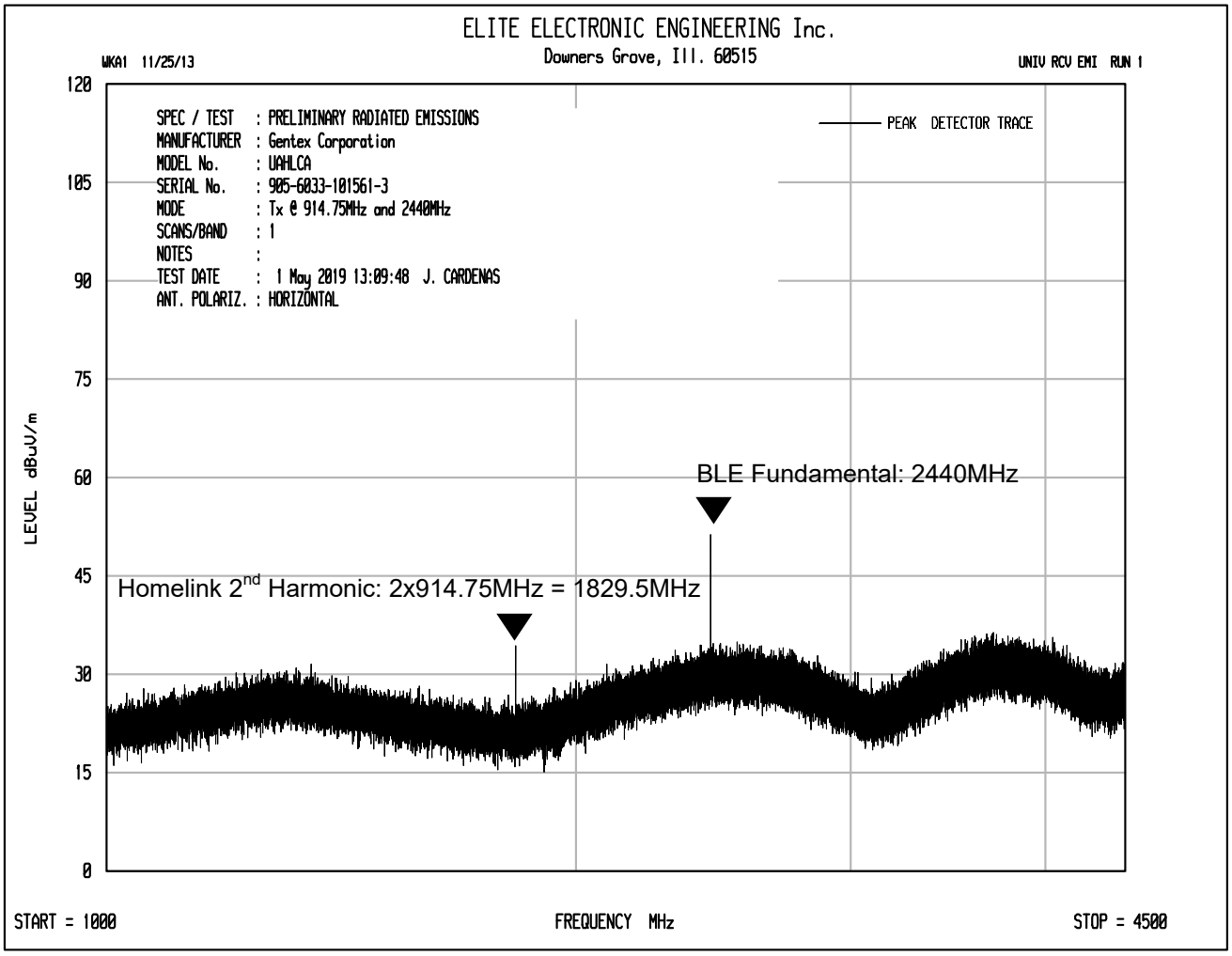
Test Setup for Radiated Emissions, 1GHz to 18GHz – Horizontal Polarization

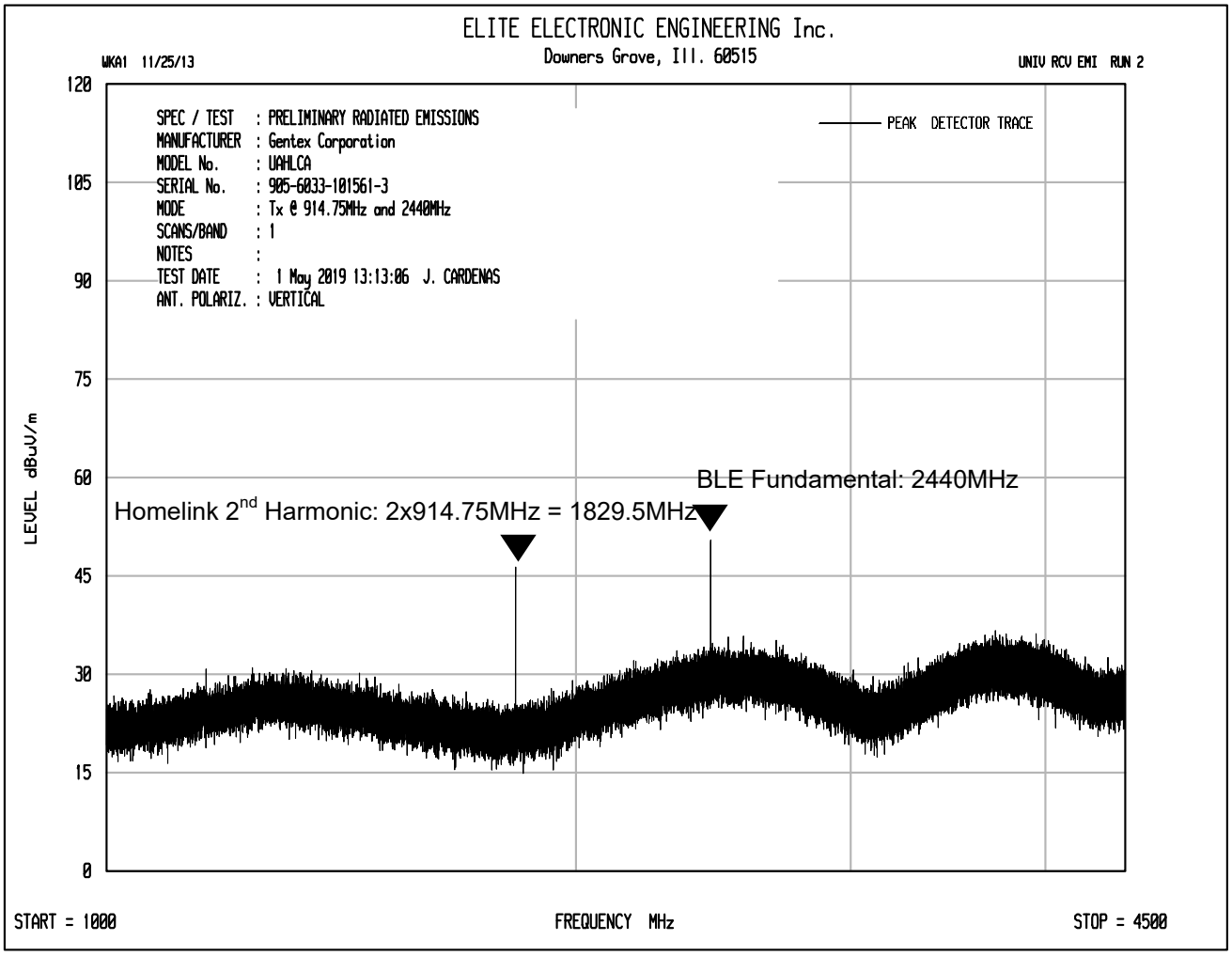


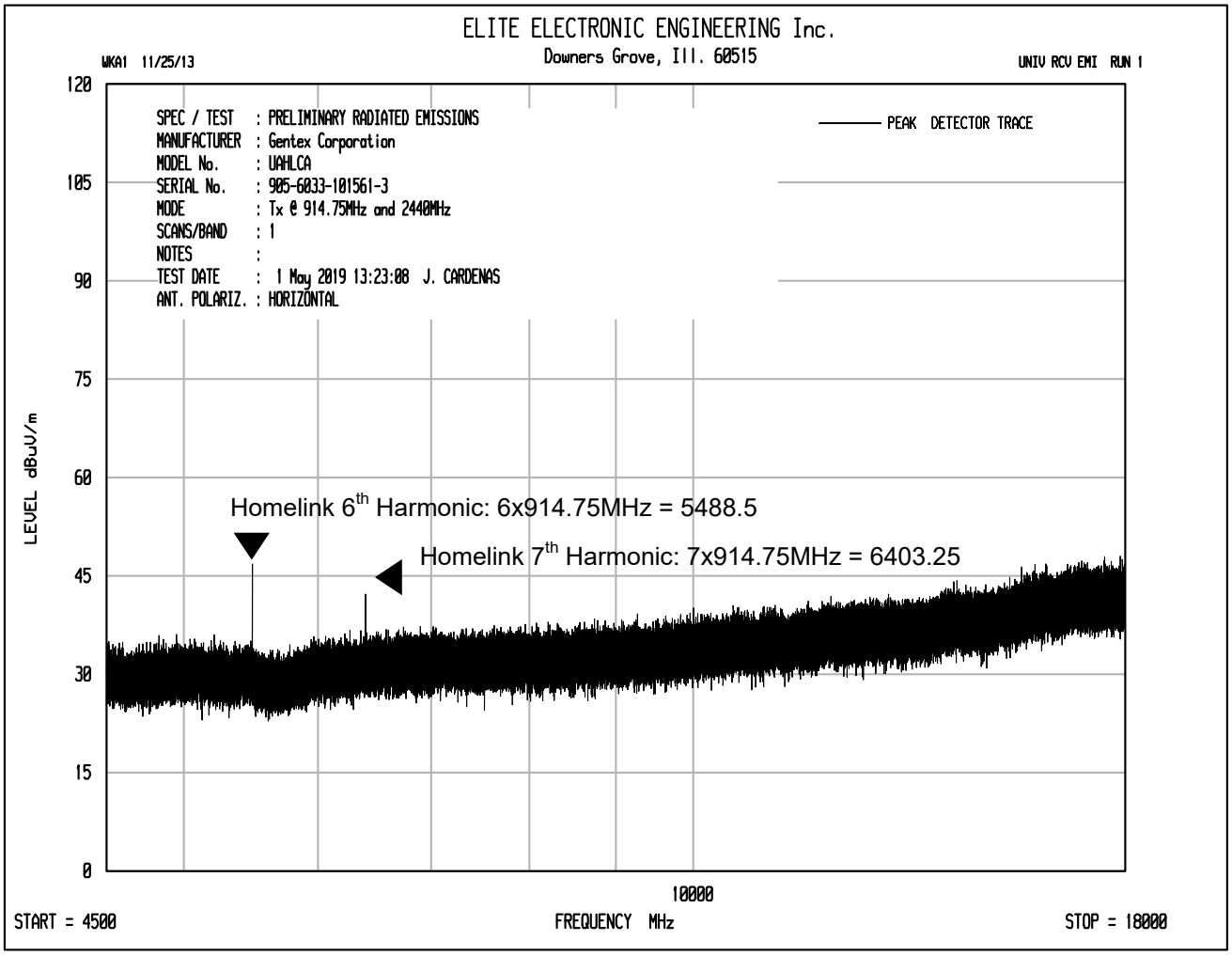
Test Setup for Radiated Emissions, 1GHz to 18GHz – Vertical Polarization

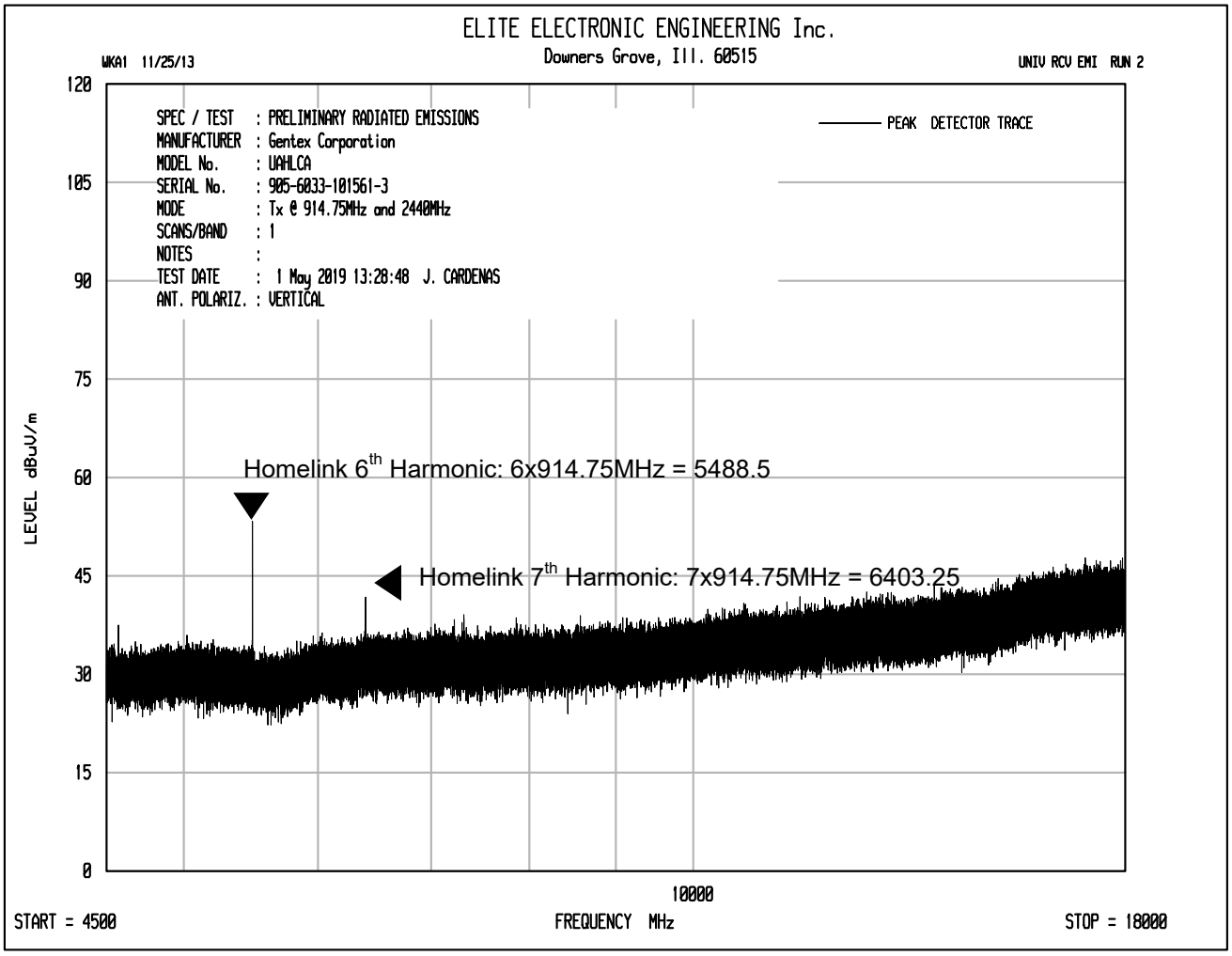

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 7
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : Gentex Corporation
MODEL No. : UAHLCA
SERIAL No. : 985-6033-101561-3
MODE : Tx @ 926.75MHz and 2440MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 1 May 2019 16:43:11 J. CARDENAS
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
Homelink Fundamental: 914.75MHz
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
100
START = 30
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 8
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : Gentex Corporation
MODEL No. : UAHLCA
SERIAL No. : 985-6033-101561-3
MODE : Tx @ 926.75MHz and 2440MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 1 May 2019 16:44:45 J. CARDENAS
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
Homelink Fundamental: 914.75MHz
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
100
START = 30
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 1
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : Gentex Corporation
MODEL No. : UAHLCA
SERIAL No. : 985-6033-101561-3
MODE : Tx @ 914.75MHz and 2440MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 1 May 2019 13:09:48 J. CARDENAS
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
BLE Fundamental: 2440MHz
Homelink 2nd Harmonic: 2x914.75MHz = 1829.5MHz
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 2
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : Gentex Corporation
MODEL No. : UAHLCA
SERIAL No. : 985-6033-101561-3
MODE : Tx @ 914.75MHz and 2440MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 1 May 2019 13:13:06 J. CARDENAS
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
Homelink 2nd Harmonic: 2x914.75MHz = 1829.5MHz
BLE Fundamental: 2440MHz
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 1
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : Gentex Corporation
MODEL No. : UAHLCA
SERIAL No. : 905-6033-101561-3
MODE : Tx @ 914.75MHz and 2440MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 1 May 2019 13:23:08 J. CARDENAS
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
Homelink 6th Harmonic: 6x914.75MHz = 5488.5
Homelink 7th Harmonic: 7x914.75MHz = 6403.25
10000
START = 4500
FREQUENCY MHz
STOP = 18000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 2
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : Gentex Corporation
MODEL No. : UAHLCA
SERIAL No. : 905-6033-101561-3
MODE : Tx @ 914.75MHz and 2440MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 1 May 2019 13:28:48 J. CARDENAS
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
Homelink 6th Harmonic: 6x914.75MHz = 5488.5
Homelink 7th Harmonic: 7x914.75MHz = 6403.25
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
10000
START = 4500
FREQUENCY MHz
STOP = 18000