GENTEX CORPORATION

Technical Report to the FCC
Gentex Corporation

Model: UAHL5H
FCC ID: NZLUAHL5H
ISED: 4112A-UAHL5H

11/13/2023

A report concerning approval for Gentex Corporation model UAHL5H
Please issue grant immediately upon review.

Measurements Made by:

Bolay Pacheco
Digitally signed by Bolay Pacheco
Date: 2023.11.15 13:08:41 -05'00'

Bolay Pacheco
Laboratory Validation Engineer III
Gentex Corporation

Measurements Reviewed by:

Daniel Brasier
Digitally signed by Daniel Brasier
Date: 2023.11.17 11:06:03 -05'00'

Dan Brasier
Laboratory Development Engineer II
Gentex Corporation

Measurements Made and Report Prepared by:

Patricia Klawitter
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Date: 2023.11.20 09:42:35 -05'00'

Patricia Klawitter
Laboratory Validation Engineer I
Gentex Corporation

Report Approved by:

Jason Vargo Laboratory Lab Manager I
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Date: 2023.11.15 14:11:17 -05'00'

Jason Vargo
Laboratory Manager I
Gentex Corporation

Report Prepared, and Submitted by:

Brian Miller
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Date: 2023.11.15 12:57:30 -05'00'

Brian Miller
Laboratory Group Leader – Regulatory II
Gentex Corporation

Test Report Revision

REV Number	Date	Author	Description
1	11/13/2023	Patricia Klawitter	

Results relate only to the items tested as received.

Compliance has been evaluated based on the Lab Manual section 7.6.2. The decision rule used regarding measurement uncertainty was to determine results solely on whether the measured values met the defined acceptance criteria without factoring in measurement uncertainty values.

1. General Information

1.1. Product Description

The Gentex Corporation HomeLink OEM device that is installed into a rearview mirror of an automobile. The installation is provided by trained technicians during the manufacture of the automobile. It is powered by the 12 Volt system of the automobile.

The unit is supplied to the automobile manufacturer without harness. For testing purposes, a typical assembly and 2-conductor cable harness were used to power the unit.

The antenna system is an integral part of the unit. It cannot be altered nor replaced by the user. The service of this system is only available from the Automobile Manufacturer's Dealerships and Gentex Corporation.

1.2. Related Grants

This device will have functionality that is covered under 47 CFR Part 15.231 and Part 15.247 and ISED Canada RSS-210 and RSS-247. The device will have FCC ID # of NZLUAHL5H and ISED ID # of 4112A-UAHL5H.

1.3. Test Methodology

Radiated Emissions testing was performed according to ANSI C63.4:2014. The power source for this product is a 12V automotive vehicle battery, thus conducted emissions measurements are not required. The DUT was tested by placing it in RX mode with a signal generator transmitting to a loop antenna within proximity of the DUT. The emissions sweeps were performed with the signal generator transmitting a CW signal at the low, mid, and high frequency of the intentional radiator frequency bands.

The unit is supplied to the automobile manufacturer without harness. For testing purposes, a 2-conductor cable harness was used to interface to the unit.

The DUT was tested in receive mode only.

1.4. Test Facility

The 3-meter semi-anechoic chamber where these measurements were taken is located on the grounds of Gentex Corporation's Corporate Labs, in the city of Zeeland, county of Ottawa, state of Michigan, United States of America.

For radiated measurements above 1 GHz, RF absorbing material is placed between the antenna and EUT in accordance with ANSI C63.4:2014 Section 5.5 and chamber manufacturer's instructions.

Tabletop testing was conducted on a 3m turntable described in the site recertification report. The 3m chamber has been added to our A2LA scope of accreditation on 4/18/2019 and includes accreditation to ANSI C63.4:2014, ANSI C63.10:2013, and C63.26:2015. Our 3m chamber is registered with the ISED under Site# 4112A-2 and FCC under registration number 357351.

Corporate Mailing/Shipping Address	Site Address
Gentex Corporation	Gentex Corporation
600 N. Centennial Street	380 Riley Street
Zeeland, MI 49464	Zeeland, MI 49464

1.5. Accreditation

The Gentex Corporate EMC Lab is accredited to ISO/IEC 17025 by the American Association for Laboratory Accreditation (A2LA). Our laboratory scope and accreditation certificate #2529.01 are available from their web site www.a2la.org. Our scope of accreditation covers ANSI C63.4:2014, ANSI C63.10:2013, ANSI C63.26:2015 and Radiated Emissions at 3m, FCC 47 CFR Part 90, ISED RSS-137.

2. Product Labeling

2.1. Identifiers

The FCC Identifier assigned is FCC ID: NZLUAHL5H. The ISED certification number is 4112A-UAHL5H. These identifiers will be labeled on the product housing.

The label will be printed on a label, which will be placed on the exterior of the housing and permanently affixed.

Because of the small size of the device and because the installation is inside a portion of the automobile, the following statements will appear in the user's manual. Refer to attachment "Users Manual.pdf" for the entire text of the user's manual.

> "The receiver portion of the device complies with FCC rule Part 15. Operation is subject to the following two conditions:
> (1) This device may not cause harmful interference,
> (2) This device must accept any interference that may be received including interference that may cause undesired operation.
> WARNING: The transmitter has been tested and complies with FCC and ISED rules. Changes or modifications not expressly approved by the party responsible for the compliance could void the user's authority to operate the device."
>
> This equipment complies with FCC and ISED radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance. This transmitter must be at least 20cm from the user and must not be co-located or operating in conjunction with any other antenna or transmitter.

The term "ISED:" before the certification/registration number only signifies that ISED technical specifications were met.

ISED: 4112A-UAHL5H FCC ID: NZLUAHL5H

2.2. Label Drawing and Location on Product

The label drawing is included in the "Label.pdf" attachment.

A diagram showing the location of the label on the assembly is included in the "Label Location.pdf" attachment.

3. Test Configuration

Radiated Emission measurements presented in the report were made in accordance with ANSI C63.4-2014. The EUT was placed on a 1 x 1.5m non-metallic table elevated 80cm above a conducting ground plane for all measurements. The harness was run down the edge of the table to a power supply connection on the turntable. The power supply is located beneath the floor of the chamber.

For radiated measurements above 1 GHz, RF absorbing material is placed between the antenna and EUT in accordance with ANSI C63.4:2014 Section 5.5 and chamber manufacturer's instructions.

4. Conducted Emissions Measurements

Conducted Measurements are not required for this product.

5. Radiated Emissions Data

5.1. Date(s) Tested: 11/2/2023-11/6/2023

5.2. Test Method Deviations: None

5.3. Temperature and Humidity conditions

	Measured Value	Unit
Temperature	20.9-22.9	ºC
Humidity	39.5-44.3	%R.H.

5.4. Summary of Results

Measurement		Margin	Frequency
Worst case Digital Emission	33.48 dBuV/m	-6.52 dB	31.83 MHz

- **Measurement Uncertainty:** The standard uncertainty of measurement has been determined in accordance with the ISO Guide to the Expression of Uncertainty in Measurements. The estimation of measurement uncertainty reported is the expanded uncertainty for a coverage factor of k=2.26 and confidence interval of approximately 95%.

  Expanded Uncertainty $U_{(k=2.26)}$ is as follows:

  - Radiated Emissions – Bicon (30-250 MHz): 4.7 dB
  - Radiated Emissions – LPA (250-1000 MHz): 5.6 dB
  - Radiated Emissions – DRWG (26.5 GHz): 4.9 dB
  - Frequency: 0.12ppm

5.5. Test Equipment Setup and Procedure

5.5.1. Test Equipment Used

Description	Model #	ID Number	Cal Due
EMCO Biconical Antenna [30-250 MHz]	3110B	H6189	5/6/2024
EMCO LPA Antenna [250-1000MHz]	3148	H6192	5/3/2024
Com-Power Double Ridged Waveguide [1-18GHz]	AHA-118	8893	12/16/2025
Rohde & Schwarz ESW Receiver	ESW26	9860	1/18/2024
Cables, attenuator and port feed through	various	CF GCL	4/30/2024
Sonoma preamplifier	310N, 32dB	S/N:273123	12/31/2023
3m Chamber SW	N/A	SW30	3/31/2024
Gentex Emissions SW	N/A	SW48	3/31/2024
Megaphase Cable	GC29-N1N1-360	CBL 153	4/30/2024
Megaphase Cable	GC29-N1N1-192	CBL 143	4/30/2024
Signal Generator	SMB100A	6368	9/16/2024
Preamplifier	310N,32dB	273123	12/31/2023
EMCO LPA Antenna [250-1000MHz]	3148	H6193	5/3/2024
ETS-Lindgren Boresight Tower	2171B	Tower 2	VBU
ETS-Lindgren Shielded Enclosure	3M Chamber	PJ2246	12/30/2023
Omega Environmental Conditions	iBTHX-W Virtual	8292	10/2/2024
Stanley Tape Measure	N/A	6539	6/19/2026
Fluke Multimeter	87	H4554	1/5/2024
ETS-Lindgren Absorber Material	EHP-12PCL	Absorber 1	VBU

EMI Receiver Settings Emissions:

Detector Function: Quasi-Peak
Resolution Bandwidth: 120 kHz (below 1GHz)
1MHz (above 1GHz)

For the testing, the EUT was placed at the center of a non-conducting table 80cm above the ground plane pursuant to ANSI C63.4:2014 for stand-alone equipment. The 2-conductor harness was run straight down from the center of the turntable to a power supply sitting at the base of the table.

Equipment is placed in one of the three orthogonal orientations, End, Side, and Flat where applicable. The DUT was tested in in-vehicle position only similar to the flat orientation, see test setup photos for details. These orientations are described below in Figure 6.2.1.

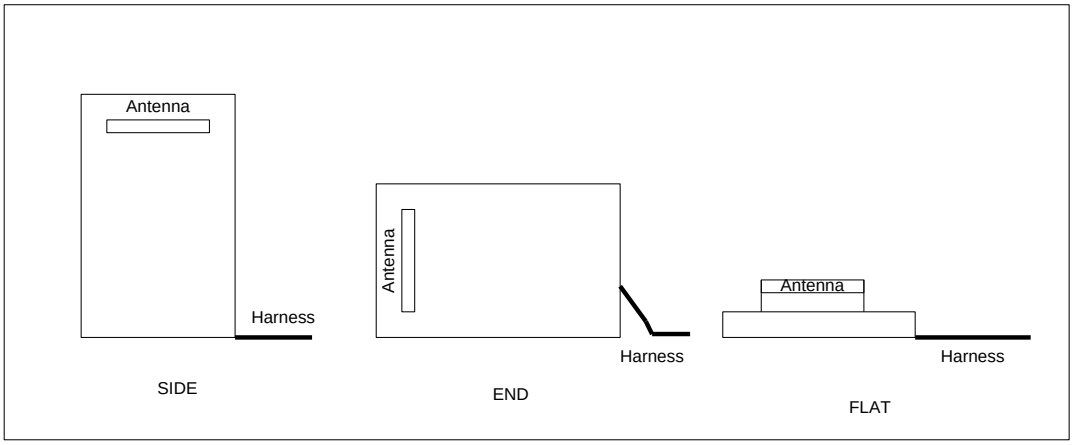

Figure 6.2.1 EUT Orthogonal Orientations

While in the prescribed orientation, the vertical antenna positioner sweeps in elevation from 1 to 4m in height until the operator finds the peak. The 3m turntable is then rotated through 360 degrees until a peak is found. The table is stopped at the peak location and the peak in elevation re-verified. Procedure is repeated for applicable orientations/measurement antenna polarizations.

6. Class B Emissions

The transmitter spurious radiation emissions were measured in a 3m semi-anechoic chamber. The design utilizes a permanently attached antenna system and offers no provision for antenna replacement. The DUT was placed on a turntable elevated as required above the ground plane at a distance of 3 meters from the measurement antenna. For RX mode, emissions sweeps were performed with a loop antenna in proximity of the DUT and connected to a signal generator. An emissions sweep was performed with the signal generator transmitting a CW signal for each low, mid, and high frequency of the intentional radiator frequency range to be certified.

The turntable was rotated through 360 degrees to locate the position registering the maximum amplitude emission. The frequency spectrum was then searched for spurious emissions generated from the transmitter. Raising and lowering the measurement antenna and rotating the turntable to maximize the emission. A Biconical Antenna was used for measuring emissions from for 30-200 MHz, Log Antenna for 200-1000 MHz, and Double Ridge Wave Guide Horn for 1-5 GHz. Emissions were measured in dBuV/m at 3 meters.

Data was taken per 47CFR Part 2.1051 and applicable parts of 47CFR Part 15B. The DUT demonstrated compliance with the specifications of Paragraphs 47CFR 2.1051, 2.1057.

7. Formula and Sample Calculation

The EMI Receiver used for making the measurements in this report automatically corrects for cable correction and antenna factors using values stored in memory taken from the most recent calibration (in the case of antenna factors), periodic cable loss measurements, and preamplifier gain.

Formula 1: FS(dBuV/m) = M(dBuV) + AF(dB/m) + CF(dB) – AG(dB)

The presented field strength is computed by the EMI Receiver by taking the measured level and adding to it the antenna factor and cable loss corrections. The measurements presented were gathered using the EMI Receiver's peak-hold capability.

8. Measurement Settings

30 - 200MHz:

Sweep 1: CISPR Average - 120 kHz
Segment: 1
Start Frequency: 30 MHz
End Frequency: 88 MHz
Band: Band 1
Detector: CISPR Average
Sweep Mode: FFT
Attenuator: 5 dB
Pre-Amp: Off
Max Hold Trace Mode: Off
Bandwidth Filter: EMI (6dB)
RBW: 120 kHz
Step Size: 50 kHz
Dwell Time: 1000ms
Notch Filter (2.4 - 2.5 GHz): Disabled
Notch Filter (5.725 - 5.875 GHz): Disabled

Sweep 2: QuasiPeak - 120 kHz
Segment: 5
Start Frequency: 30 MHz
End Frequency: 88 MHz
Band: Band 1
Detector: QuasiPeak
Sweep Mode: FFT
Attenuator: 5 dB
Pre-Amp: Off
Max Hold Trace Mode: Off
Bandwidth Filter: EMI (6dB)
RBW: 120 kHz
Step Size: 50 kHz
Dwell Time: 1000ms
Notch Filter (2.4 - 2.5 GHz): Disabled
Notch Filter (5.725 - 5.875 GHz): Disabled

Sweep 1: CISPR Average - 120 kHz
Segment: 2
Start Frequency: 88 MHz
End Frequency: 216 MHz
Band: Band 2
Detector: CISPR Average
Sweep Mode: FFT
Attenuator: 5 dB
Pre-Amp: Off
Max Hold Trace Mode: Off
Bandwidth Filter: EMI (6dB)
RBW: 120 kHz
Step Size: 50 kHz
Dwell Time: 1000ms
Notch Filter (2.4 - 2.5 GHz): Disabled
Notch Filter (5.725 - 5.875 GHz): Disabled

Sweep 2: QuasiPeak - 120 kHz
Segment: 6
Start Frequency: 88 MHz
End Frequency: 216 MHz
Band: Band 2
Detector: QuasiPeak
Sweep Mode: FFT
Attenuator: 5 dB
Pre-Amp: Off
Max Hold Trace Mode: Off
Bandwidth Filter: EMI (6dB)
RBW: 120 kHz
Step Size: 50 kHz
Dwell Time: 1000ms
Notch Filter (2.4 - 2.5 GHz): Disabled
Notch Filter (5.725 - 5.875 GHz): Disabled

200 - 1000MHz:

Sweep 1: CISPR Average - 120 kHz
Segment: 3
Start Frequency: 216 MHz
End Frequency: 960 MHz
Band: Band 3
Detector: CISPR Average
Sweep Mode: FFT
Attenuator: 5 dB
Pre-Amp: Off
Max Hold Trace Mode: Off
Bandwidth Filter: EMI (6dB)
RBW: 120 kHz
Step Size: 50 kHz
Dwell Time: 1000ms
Notch Filter (2.4 - 2.5 GHz): Disabled
Notch Filter (5.725 - 5.875 GHz): Disabled

Sweep 2: QuasiPeak - 120 kHz
Segment: 7
Start Frequency: 216 MHz
End Frequency: 960 MHz
Band: Band 3
Detector: QuasiPeak
Sweep Mode: FFT
Attenuator: 5 dB
Pre-Amp: Off
Max Hold Trace Mode: Off
Bandwidth Filter: EMI (6dB)
RBW: 120 kHz
Step Size: 50 kHz
Dwell Time: 1000ms
Notch Filter (2.4 -2.5 GHz): Disabled
Notch Filter (5.725 – 5.875 GHz): Disabled

Sweep 1: CISPR Average - 120 kHz
Segment: 4
Start Frequency: 960 MHz
End Frequency: 1000 MHz
Band: Band 4
Detector: CISPR Average
Sweep Mode: FFT
Attenuator: 5 dB
Pre-Amp: Off
Max Hold Trace Mode: Off
Bandwidth Filter: EMI (6dB)
RBW: 120 kHz
Step Size: 50 kHz
Dwell Time: 1000ms
Notch Filter (2.4 - 2.5 GHz): Disabled
Notch Filter (5.725 - 5.875 GHz): Disabled

Sweep 2: QuasiPeak - 120 kHz
Segment: 8
Start Frequency: 960 MHz
End Frequency: 1000 MHz
Band: Band 4
Detector: QuasiPeak
Sweep Mode: FFT
Attenuator: 5 dB
Pre-Amp: Off
Max Hold Trace Mode: Off
Bandwidth Filter: EMI (6dB)
RBW: 120 kHz
Step Size: 50 kHz
Dwell Time: 1000ms
Notch Filter (2.4 - 2.5 GHz): Disabled
Notch Filter (5.725 - 5.875 GHz): Disabled

1000 – 5000Mhz:

Sweep 3: CISPR Average - 1000 kHz
Segment: 9
Start Frequency: 1000 MHz
End Frequency: 5000 MHz
Band: Band 5
Detector: CISPR Average
Sweep Mode: FFT
Attenuator: 5 dB
Pre-Amp: Off
Max Hold Trace Mode: Off
Bandwidth Filter: EMI (6dB)
RBW: 1000 kHz
Step Size: 500 kHz
Dwell Time: 5ms
Notch Filter (2.4 - 2.5 GHz): Disabled
Notch Filter (5.725 - 5.875 GHz): Disabled

Sweep 4: Peak - 1000 kHz
Segment: 10
Start Frequency: 1000 MHz
End Frequency: 5000 MHz
Band: Band 5
Detector: Peak
Sweep Mode: FFT
Attenuator: 5 dB
Pre-Amp: Off
Max Hold Trace Mode: Off
Bandwidth Filter: EMI (6dB)
RBW: 1000 kHz
Step Size: 500 kHz
Dwell Time: 5ms
Notch Filter (2.4 - 2.5 GHz): Disabled
Notch Filter (5.725 - 5.875 GHz): Disabled

Test Mode	Detector	Frequency (MHz)		Worst-Case Orientation	Antenna Polarization	Frequencies (MHz)	Emission (dBuV/m)	Limit (dBuV/m)	Margin (dB)
		Start	Stop						
RX	Quasi-Peak	30	88	End	H	31.83	33.48	40	-6.52
RX	Quasi-Peak	30	88	Flat	V	32.31	33.39	40	-6.61
RX	Quasi-Peak	88	216	Side	H	89.4	24.53	43.5	-18.97
RX	Quasi-Peak	88	216	Flat	H	116.68	26.97	43.5	-16.53
RX	Quasi-Peak	88	216	Flat	H	118.95	23.48	43.5	-20.02
RX	Quasi-Peak	88	216	Flat	H	119	21.93	43.5	-21.57
RX	Quasi-Peak	88	216	Side	H	127.1	32.54	43.5	-10.96
RX	Quasi-Peak	88	216	Flat	H	131.16	31.24	43.5	-12.26
RX	Quasi-Peak	88	216	Side	H	138.2	29.83	43.5	-13.67
RX	Quasi-Peak	88	216	Flat	V	166.65	23.05	43.5	-20.45
RX	Quasi-Peak	216	1000	Flat	V	221.9	10.23	46	-35.77
RX	Quasi-Peak	216	1000	Side	V	250	13.33	46	-32.67
RX	Quasi-Peak	216	1000	End	V	311.75	20.03	46	-25.97
RX	Quasi-Peak	216	1000	Side	V	350	21.01	46	-24.99
RX	Quasi-Peak	216	1000	Side	H	374.99	31.65	46	-14.35
RX	Quasi-Peak	216	1000	Flat	V	438.23	16.89	46	-29.11
RX	Quasi-Peak	216	1000	Flat	V	500	25.1	46	-20.9
RX	Quasi-Peak	216	1000	Side	H	530	19.36	46	-26.64
RX	Quasi-Peak	216	1000	Side	H	625	25.68	46	-20.32
RX	Quasi-Peak	216	1000	Side	V	750	37.13	46	-8.87
RX	Quasi-Peak	216	1000	Side	H	811	22.35	46	-23.65
RX	Quasi-Peak	216	1000	Flat	V	938.2	23.91	46	-22.09
RX	Peak	1000	5000	Side	V	1052	34.56	74	-39.44
RX	Peak	1000	5000	Side	H	1425	35.26	74	-38.74
RX	Peak	1000	5000	Side	H	1444	35.64	74	-38.36
RX	Peak	1000	5000	Flat	V	1873	35.26	74	-38.74
RX	Peak	1000	5000	Side	H	1959	35.26	74	-38.74
RX	Peak	1000	5000	Side	V	3591	41.88	74	-32.12
RX	Peak	1000	5000	Flat	H	3844	41.85	74	-32.15
RX	Peak	1000	5000	Side	H	3863	41.66	74	-32.34
RX	Peak	1000	5000	End	V	3917	43.26	74	-30.74
RX	Peak	1000	5000	Flat	H	4469	40.68	74	-33.32
RX	Average	1000	5000	Side	V	1052	24.89	54	-29.11
RX	Average	1000	5000	Side	V	1425	28.95	54	-25.05
RX	Average	1000	5000	Flat	H	1444	28.65	54	-25.35
RX	Average	1000	5000	Side	H	1873	26.21	54	-27.79
RX	Average	1000	5000	End	V	1959	34.25	54	-19.75
RX	Average	1000	5000	End	H	3591	36.215	54	-17.785
RX	Average	1000	5000	End	V	3844	34.52	54	-19.48
RX	Average	1000	5000	End	V	3863	34.78	54	-19.22
RX	Average	1000	5000	Flat	V	3917	36.85	54	-17.15
RX	Average	1000	5000	End	V	4469	33.64	54	-20.36