GENTEX CORPORATION

A Smarter Vision®

Technical Report to the FCC and Industry Canada Regarding Gentex Corporation - Homelink© V

Model: AECHL5 Family
FCC ID: NZLAECHL5
IC: 4112A-AECHL5

Emission Designator: 90K0L1D
12/17/2013

A report concerning approval for Gentex Corporation Homelink® model AECHL5 family certification.
Please issue grant immediately upon review.

Measurements Made by:

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Measurements Reviewed by:

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Report and Application Prepared by:

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Report Approved and Submitted by:

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GENTEX CORPORATION

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1. General Information

1.1. Product Description:

The Gentex Corporation HomeLink® HL5 Universal Garage Door Opener is a low-power transceiver OEM device that is installed into an overhead area of the automobile. The installation is provided by trained technicians during the course of the manufacture of the automobile. It is powered by the 12 Volt system of the automobile.

This Universal Garage Door Opener has the capability to

1. Learn the frequency and bit code format of the user's existing garage door remote control devices and
2. Reproduce and transmit the frequency and bit code format to remotely operate the user's garage door.

The unit is designed for the periodic operation of a control signal, which typically activates a garage door opener receiver.

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 to the unit.

The unit is only operational when the user depresses the control button. It becomes inactive after release of the control button.

The three-button HomeLink® unit replaces up to three hand-held transmitters. In addition to the typical operation of the garage door, the unit will learn the radio frequency codes of other transmitter types to activate entry door locks, estate gates, security systems, and home or office lighting.

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

The family certification consists of the following models: ECCHLA, ECCHLB, and BECHLA.

Family Device Features and PCB's:

Model	Description	System PCB Number	Transmit PCB Number
ECCHLA	Auto Dimming w/ Compass	705-1768	705-1733
ECCHLB	Base – Auto Dimming	705-1814	705-1733

BECHLA	Base – Auto Dimming with Chrome Ring	705-2179	705-1733

1.2. Related Grants

This device will have functionality that is covered under CFR 47 15.247. The device will have a FCC ID # of NZLAECHL5 and an IC ID # of 4112A-AECHL5 under both rule parts. A separate report is submitted for functionality covered under CFR 47 15.247.

1.3. Test Methodology

Radiated Emissions testing was performed according to ANSI C63.4-2003. The power source for this product is a 12V automotive vehicle battery, thus conducted emissions measurements are not required.

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.

1.4. Test Facility

The Open Area Test Site where these measurements were taken, is located on the grounds of Gentex Corporation's Technical Campus, in the city of Holland, county of Ottawa, state of Michigan, United States of America. The site is a fully enclosed 10m weather-protected OATS. All structure materials above the conducting ground-plane are non-metallic and consist of wood, laminated lumber, fiberglass, glue, plastic, or fiberglass reinforced plastic. The site contains a 15-foot diameter turntable capable of supporting large cars and light trucks under test. Tabletop testing was conducted on a smaller 3m turntable described in the site recertification report. The test site has been fully described in a reports filled with the FCC and Industry Canada. The report filed with the FCC is dated November 10, 2013, was accepted by the FCC in a letter dated November 15, 2013. The report filled with Industry Canada, dated November 10, 2013, was accepted via a letter dated November 20, 2013. Our OATS is registered with the IC under file number IC# 4112A

1.5. Accreditation

The Gentex Corporate EMC Lab is accredited to ISO 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 Radiated Emissions at 3m, FCC 47 CFR Part 15, and IC RSS-210.

2. Product Labeling

The FCC Identifier assigned is FCC ID: NZLAECHL5. The Industry Canada certification number is 4112A-AECHL5. These identifiers will be labeled on the product housing.

The label will be imprinted on the exterior of the mirror housing using molding tool that will permanently affix the label.

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.

> "This device complies with FCC rules Part 15 and with Industry Canada RSS-210. 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 Industry Canada rules. Changes or modifications not expressly approved by the party responsible for the compliance could void the user's authority to operate the device."

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

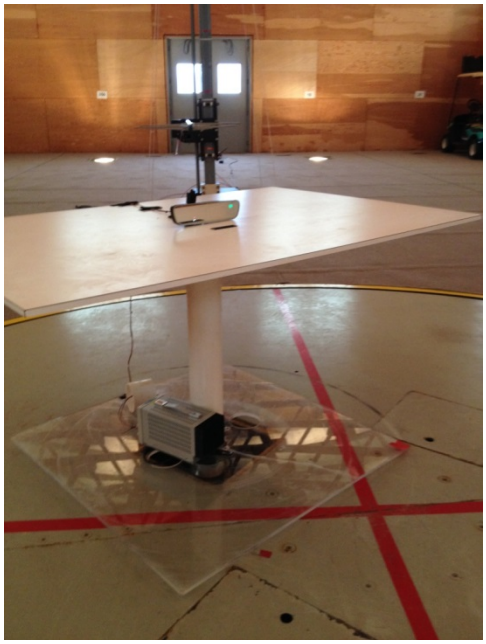
IC: 4112A-AECHL5 MODEL/FCC ID: NZLAECHL5

2.1. Label Drawing and Location on Product.

The label drawing an location of the label on the assembly is included in the "Label Drawing_Label Location.pdf" attachment.

3. Test Configuration

Radiated Emission measurements presented in the report were made in accordance with ANSI C63.4 Figure 9(c). The EUT was placed on a 1 x 1.5m non-metallic table elevated 80cm above a conducting ground plane. The harness was run to the long edge of the table and dropped to a power supply sitting at base of the table.

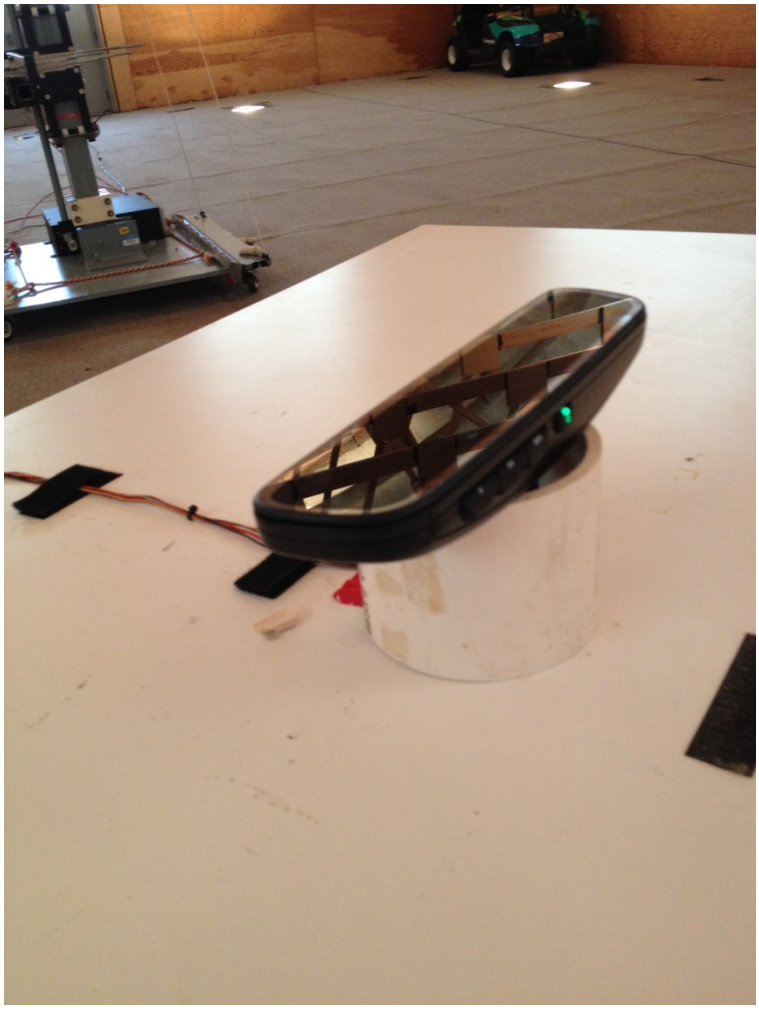


4. Block Diagram

For system block diagram please refer to attachment named “Block Diagram.pdf”

5. Test Setup Photographs

Test Setup Side



Test Setup Flat

Test Set Up End

6. Conducted Emissions Measurements

Conducted Measurements are not required for this product.

7. Radiated Emissions Data

7.1. Summary of Results

- Measurements of the transmit output field strength were taken with the DUT trained to 288, 310, 365, and 433MHz at 30%, 50% and 80% duty cycles. A **worst-case Peak emission of 82.97dBuV/m** occurred with the DUT trained to 288MHz, 30% duty cycle.
- The **worst-case Average emission Level (74.4dBuV/m)** remained 0.9**dB below the FCC and IC limits** (75.3 dBuV/m) for this type of device.
- The **worst-case harmonic measurement of 65.29 dBuV/m was found at 3464 MHz**, the eight harmonic of 433 MHz at 50% duty cycle. **A margin of 1.5dB to the prescribed limit was noted.** When adjusted for the duty cycle.
- This module exhibits pulsed operation characteristics.
- Measurements were taken of the 20dB occupied bandwidth. The transmitter had a maximum occupied bandwidth of 90kHz when the DUT is trained to 433 MHz, 30% duty cycle.
- This device has a worst case digital emission of 32.15BuV/m at 54.78MHz when set to transmit at 365MHz a margin of 7.85dB to the FCC Class B and relevant IC limit is maintained.
- The output power of the DUT increased by no more than 0.53dB when the input voltage was varied from 6 to 18 Volts. The device does not operate when the input voltage is below 7V and power reduced to 82.77dBuV/m at 7V.
- The device was found to be incapable of operating in restricted bands.
- The device deactivated immediately after the activation button is depressed. Less than 5 sec.
- The worst case receiver spurious emissions measurement was made at the mid-point of the receiver band capability. A measurement of 167.25uV/m at 3m, at the tuned frequency of 649 MHz leaving the margin of 32.75dB.
- Additional testing was performed to ensure compliance with the restricted bands. The following fundamentals were utilized: 375, 392, 415, 416.5, 421, 430, and 434MHz to test compliance of harmonics within the restricted bands. The worst case emission was found at 3332MHz, with a fundamental of 416.5MHz, and **a margin of 2.82dB.**

7.2. Test Equipment Used

Description	Model #	Serial Number	Last Cal Date	Cal Due
EMCO Biconical Antenna [20-300 MHz]	3110B	9906-3309	02/20/2012	02/20/2014
EMCO LPA Antenna [200-2000MHz]	3148	9908-1076	01/20/1012	01/20/2014
Electro-metrics Double Ridged Guide [1-18GHz]	RGA-60	6147	09/05/13	09/05/2015
Agilent E-series EMC Analyzer	E4407B	US41192569	10/16/2012	1/01/2014
Amplifier Research	LN1G11	310377	12/31/2013	12/31/2014

7.3. Test Equipment Setup and Procedure

Spectrum Analyzer Settings Emissions:

Detector Function	:Peak
Resolution Bandwidth	:120kHz (below 1GHz)
	:1MHz (above 1GHz)
Video Bandwidth:	:300kHZ (below 1GHz)
	:3MHz (above 1GHz)

Spectrum Analyzer Settings Occupied Bandwidth:

Detector	:Peak
Resolution Bandwidth	:3 MHz (to determine peak level)
	:10 kHz (to determine occupied bandwidth)
Video Bandwidth	:3 MHz (to determine peak level)
	:30 kHz (to determine occupied bandwidth)

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 for stand-alone equipment. The 2-conductor cable harness was routed to the edge of the long side of the table then down to the power supply located on the turntable base.

Equipment is placed in one of the three orthogonal orientations, End, Side, and Flat. These orientations are described below in Figure 7.3.1.

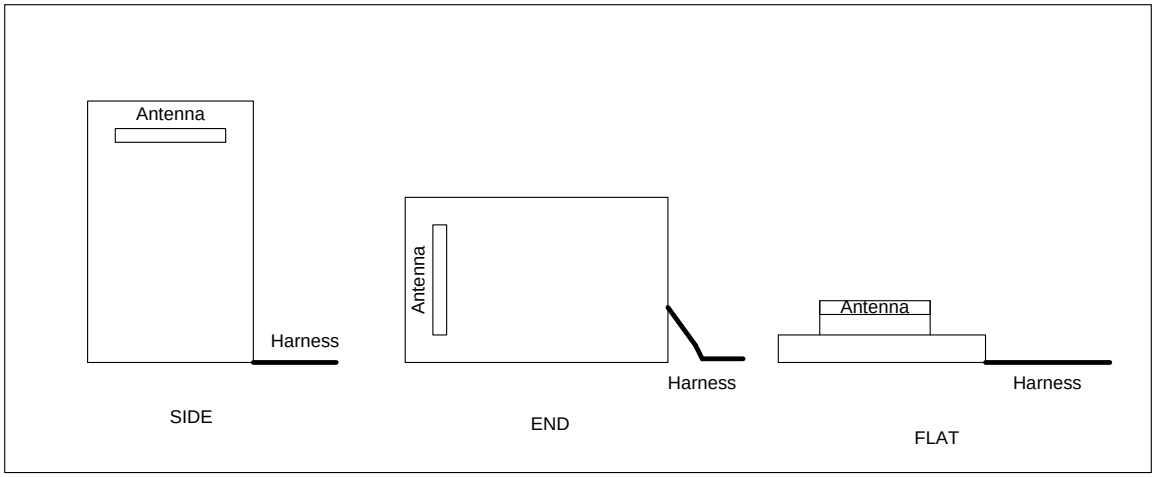


Figure 7.3.1 EUT Orthogonal Orientations

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.

7.4. Measured Data

7.4.1. Measurements of Fundamentals and Harmonics

Measurements described in this section were taken according to ANSI C63.4-2003 on the Gentex Corporation 3m test table.

7.4.1.1 DUT Tuned to 288MHz(Fundamental)

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
288	End	H	30	82.97	-10.46	72.5	73.8	1.3
288	End	H	50	78.32	-6.02	72.3	73.8	1.5
288	End	H	80	72.54	-1.94	70.6	73.8	**3.2**

*Measurements include Cable corrections and Antenna Factors

7.4.1.2 DUT Tuned to 310MHz (Fundamental)

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement * (dBuV/m)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
310	Flat	H	30	83.74	-10.5	73.3	75.3	2.0
310	Flat	H	50	80.4	-6.0	74.4	75.3	0.9
310	Flat	H	80	74.6	-1.9	72.7	75.3	**2.7**

* Measurements include Cable corrections and Antenna Factors

7.4.1.3 DUT Tuned to 365MHz (Fundamental)

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
365	End	H	30	83.87	-10.5	73.4	78.2	4.8
365	End	H	50	80.53	-6.0	74.5	78.2	3.7
365	End	H	80	74.74	-1.9	72.8	78.2	**5.4**

* Measurements include Cable corrections and Antenna Factors

7.4.1.4 DUT Tuned to 433MHz (Fundamental)

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
433	Side	V	30	86.68	-10.5	76.2	80.8	4.6
433	Side	V	50	83.14	-6.0	77.1	80.8	3.7
433	Side	V	80	76.52	-1.9	74.6	80.8	**6.2**

* Measurements include Cable corrections and Antenna Factors

7.4.1.5 288MHz (Harmonics)

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
576	End	H	30	47.48	-10.5	37.0	53.8	**16.8**
576	End	H	50	44.58	-6.0	38.6	53.8	15.3
576	End	H	80	39.13	-1.9	37.2	53.8	16.6
864	End	V	30	57.83	-10.5	47.4	53.8	6.5
864	End	V	50	55.3	-6.0	49.3	53.8	4.6
864	End	V	80	48.66	-1.9	46.7	53.8	7.1
1152	End	V	30	52.26	-10.5	41.8	53.8	12.0
1152	End	V	50	50.74	-6.0	44.7	53.8	9.1
1152	End	V	80	47.69	-1.9	45.8	53.8	8.1
1440	Side	H	30	53.24	-10.5	42.8	53.8	11.1
1440	Side	H	50	51.29	-6.0	45.3	53.8	8.6
1440	Side	H	80	49.01	-1.9	47.1	53.8	6.8
1728	Side	H	30	55.67	-10.5	45.2	53.8	8.6
1728	Side	H	50	53.38	-6.0	47.4	53.8	6.5
1728	Side	H	80	50.34	-1.9	48.4	53.8	5.4
2016	Side	H	30	55.73	-10.5	45.3	53.8	8.6
2016	Side	H	50	53.25	-6.0	47.2	53.8	6.6
2016	Side	H	80	50.7	-1.9	48.8	53.8	5.1
2304	End	V	30	59.34	-10.5	48.9	53.8	5.0
2304	End	V	50	58.2	-6.0	52.2	53.8	1.7
2304	End	V	80	54.21	-1.9	52.3	53.8	1.6
2592	Side	H	30	54.73	-10.5	44.3	53.8	9.6
2592	Side	H	50	51.02	-6.0	45.0	53.8	8.8
2592	Side	H	80	48.91	-1.9	47.0	53.8	6.9
2880	End	H	30	52.53	-10.5	42.1	53.8	11.8
2880	End	H	50	52.42	-6.0	46.4	53.8	7.4
2880	End	H	80	49.68	-1.9	47.7	53.8	6.1

* Measurements include Cable corrections and Antenna Factors

7.4.1.6 310MHz (Harmonics)

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
620	End	V	30	44.55	-10.5	34.1	55.3	21.2
620	End	V	50	42.03	-6.0	36.0	55.3	19.3
620	End	V	80	37.51	-1.9	35.6	55.3	19.7
930	Side	V	30	57.32	-10.5	46.9	55.3	8.4
930	Side	V	50	52.45	-6.0	46.4	55.3	8.9
930	Side	V	80	47.68	-1.9	45.7	55.3	9.6
1240	End	V	30	52.43	-10.5	42.0	54.0	12.0
1240	End	H	50	49.52	-6.0	43.5	54.0	10.5
1240	End	H	80	46.47	-1.9	44.5	54.0	**9.5**
1550	Flat	H	30	55.67	-10.5	45.2	54.0	8.8
1550	Flat	H	50	52.8	-6.0	46.8	54.0	7.2
1550	Flat	H	80	47.89	-1.9	46.0	54.0	8.0
1860	Side	H	30	53.15	-10.5	42.7	55.3	12.6
1860	Side	H	50	51.23	-6.0	45.2	55.3	10.1
1860	Side	H	80	49.25	-1.9	47.3	55.3	8.0
2170	Side	H	30	55.87	-10.5	45.4	55.3	9.9
2170	Side	H	50	52.68	-6.0	46.7	55.3	8.6
2170	Side	H	80	51.6	-1.9	49.7	55.3	5.6
2480	Side	V	30	58.27	-10.5	47.8	55.3	7.5
2480	Side	V	50	55.85	-6.0	49.8	55.3	5.5
2480	Side	V	80	52.78	-1.9	50.8	55.3	4.5
2790	Side	H	30	49.97	-10.5	39.5	54.0	14.5
2790	Side	H	50	49.97	-6.0	43.9	54.0	10.1
2790	Side	H	80	49.97	-1.9	48.0	54.0	6.0
3100	End	V	30	58.86	-10.5	48.4	55.3	6.9
3100	End	V	50	56.95	-6.0	50.9	55.3	4.4
3100	End	V	80	52.86	-1.9	50.9	55.3	4.4

*Measurements include Cable corrections and Antenna Factors

7.4.1.7 365MHz (Harmonics)

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
730	End	V	30	47.05	-10.5	36.6	58.2	21.6
730	End	V	50	44.07	-6.0	38.0	58.2	20.2
730	End	V	80	39.95	-1.9	38.0	58.2	20.2
1095	End	V	30	58.76	-10.5	48.3	54.0	5.7
1095	End	V	50	55.8	-6.0	49.8	54.0	4.2
1095	End	V	80	53.95	-1.9	52.0	54.0	2.0
1460	End	V	30	55.69	-10.5	45.2	54.0	8.8
1460	End	V	50	52.21	-6.0	46.2	54.0	7.8
1460	End	V	80	49.27	-1.9	47.3	54.0	**6.7**
1825	End	V	30	52.27	-10.5	41.8	58.2	16.4
1825	End	V	50	50.41	-6.0	44.4	58.2	13.8
1825	End	V	80	52.71	-1.9	50.8	58.2	7.4
2190	Side	H	30	60.57	-10.5	50.1	58.2	8.1
2190	Side	H	50	59.82	-6.0	53.8	58.2	4.4
2190	Side	H	80	55.45	-1.9	53.5	58.2	4.7
2555	Side	H	78	53.38	-2.2	51.2	58.2	7.0
2555	Side	H	79	50.64	-2.0	48.6	58.2	9.6
2555	Side	H	80	48.78	-1.9	46.8	58.2	11.4
2920	Side	H	30	62.81	-10.5	52.4	58.2	5.8
2920	Side	H	50	59.82	-6.0	53.8	58.2	4.4
2920	Side	H	80	55.45	-1.9	53.5	58.2	4.7
3285	Flat	H	30	52.86	-10.5	42.4	58.2	15.8
3285	Flat	H	50	51.72	-6.0	45.7	58.2	12.5
3285	Flat	H	80	50.47	-1.9	48.5	58.2	9.7
3650	Flat	H	30	52.36	-10.5	41.9	54.0	12.1
3650	Flat	H	50	50.33	-6.0	44.3	54.0	9.7
3650	Flat	H	80	48.59	-1.9	46.7	54.0	7.3

* Measurements include Cable corrections and Antenna Factors

7.4.1.8 433 MHz (Harmonics)

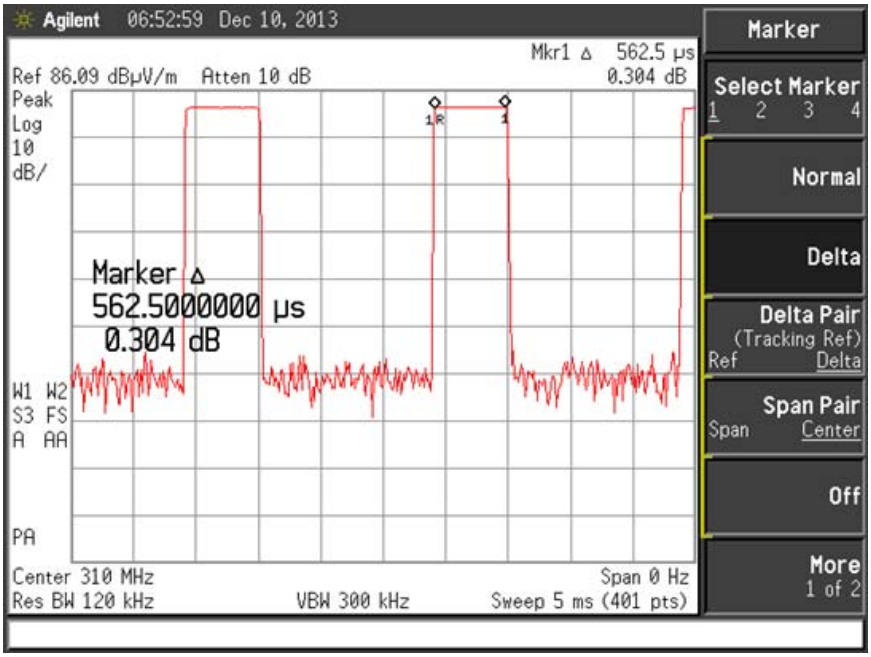
Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
866	End	V	30	57.09	-10.5	46.6	60.8	14.2
866	End	V	50	52.79	-6.0	46.8	60.8	14.0
866	End	V	80	46.74	-1.9	44.8	60.8	16.0
1299	End	V	30	58.4	-10.5	47.9	60.8	12.9
1299	End	V	50	55.12	-6.0	49.1	60.8	11.7
1299	End	V	80	50.81	-1.9	48.9	60.8	11.9
1732	Side	H	30	59.65	-10.5	49.2	54.0	4.8
1732	Side	H	50	56.5	-6.0	50.5	54.0	3.5
1732	Side	H	80	52.48	-1.9	50.5	54.0	**3.5**
2165	Side	H	30	59.54	-10.5	49.1	60.8	11.7
2165	Side	H	50	56.25	-6.0	50.2	60.8	10.6
2165	Side	H	80	52.84	-1.9	50.9	60.8	9.9
2598	End	V	30	62.5	-10.5	52.0	60.8	8.8
2598	End	V	50	59.55	-6.0	53.5	60.8	7.3
2598	End	V	80	54.59	-1.9	52.7	60.8	8.1
3031	Side	H	30	55.72	-10.5	45.3	60.8	15.5
3031	Side	H	50	53.34	-6.0	47.3	60.8	13.5
3031	Side	H	80	49.48	-1.9	47.5	60.8	13.3
3464	End	V	30	68.93	-10.5	58.5	60.8	2.3
3464	End	V	50	65.29	-6.0	59.3	60.8	1.5
3464	End	V	80	61.06	-1.9	59.1	60.8	1.7
3897	End	V	30	52.21	-10.5	41.8	54.0	12.2
3897	End	V	50	51.6	-6.0	45.6	54.0	8.4
3897	End	V	80	50.31	-1.9	48.4	54.0	5.6
4330	Side	H	30	52.68	-10.5	42.2	54.0	11.8
4330	Side	H	50	50.22	-6.0	44.2	54.0	9.8
4330	Side	H	80	49.85	-1.9	47.9	54.0	6.1

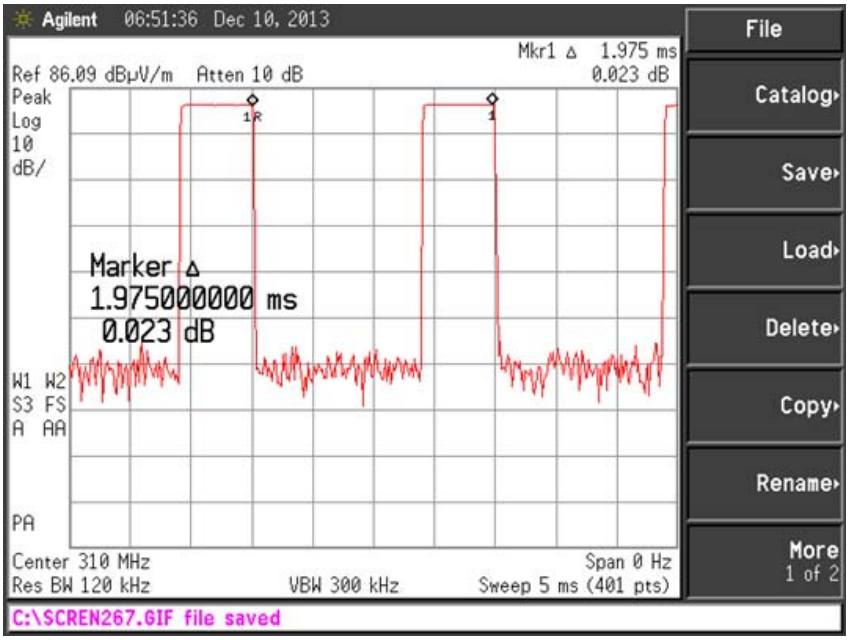
* Measurements include Cable corrections and Antenna Factors

7.4.2 Pulsed Operation

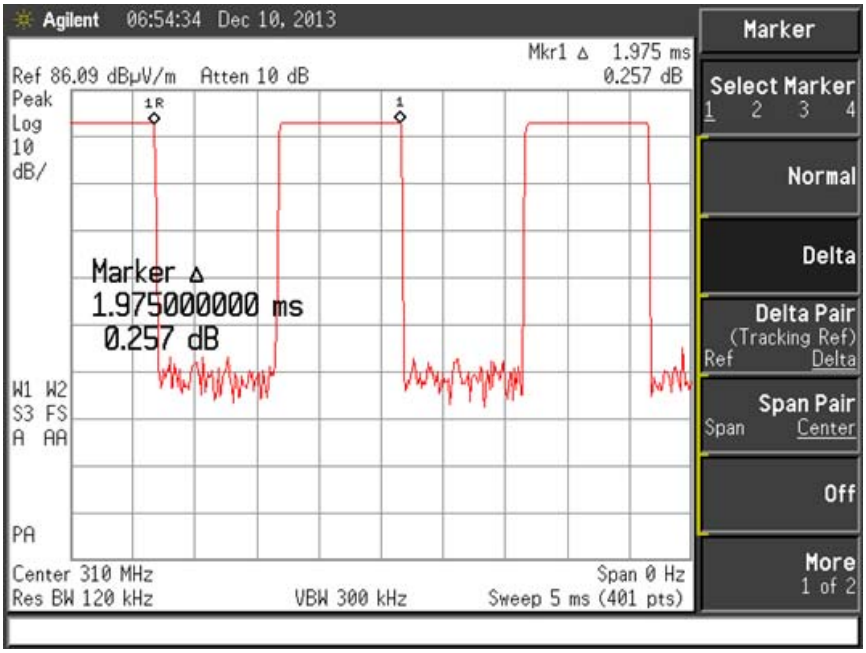
The Homelink© transmitter tested here transmits pulses using amplitude modulation with varying duty cycle. Verification of pulse operation at 30, 50 and 80% duty cycles is provided here. Measurements were taken at 310MHz with the span set to zero on the E4407B spectrum analyzer. The duty cycle is 500Hz.

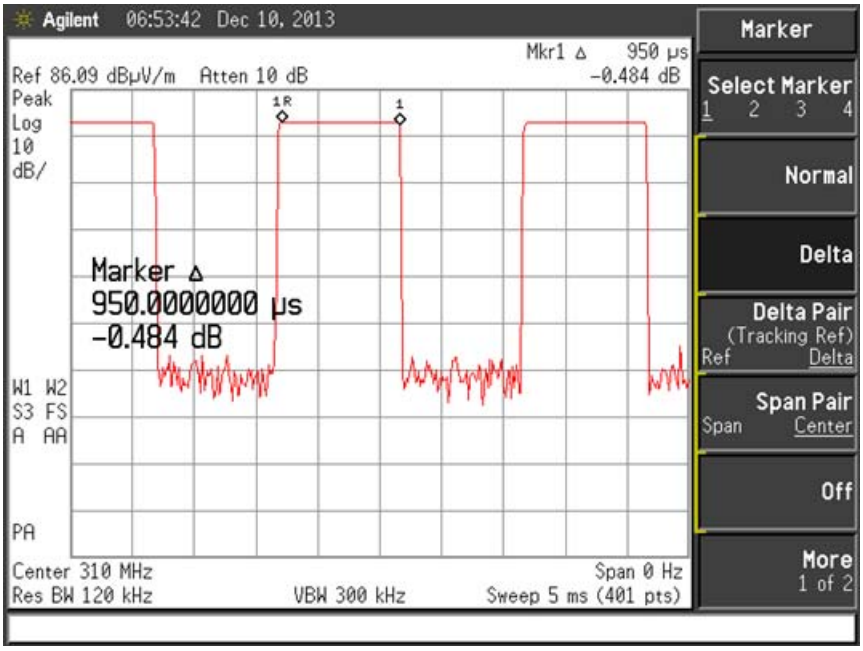
7.4.2.1 30% Duty Cycle



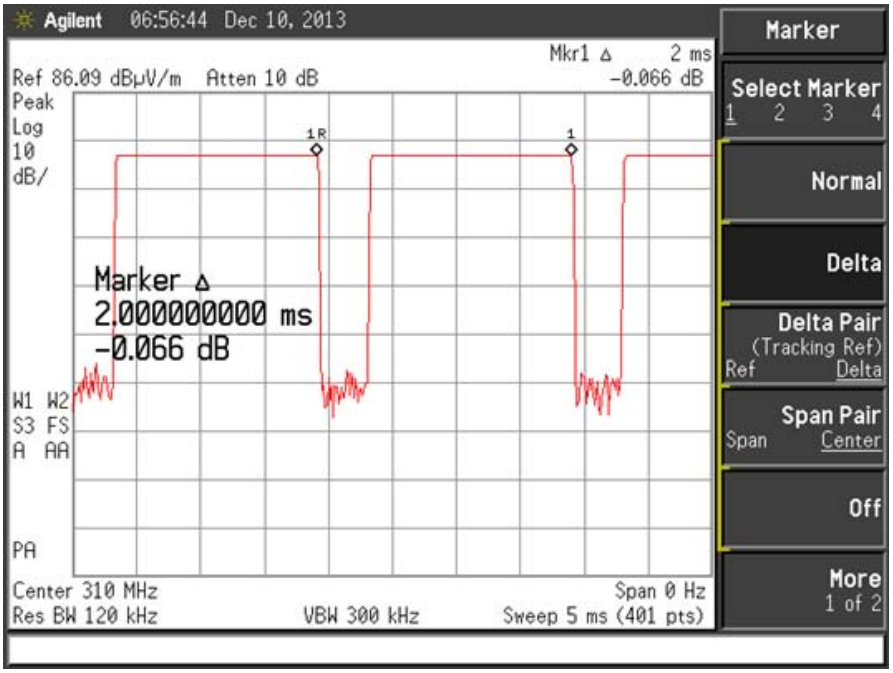


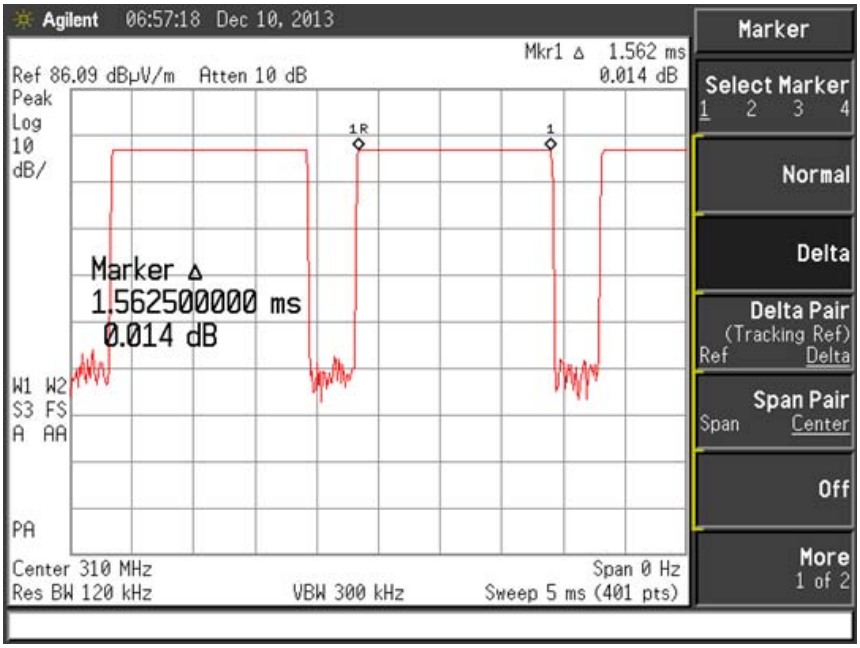
7.4.2.2 50% Duty Cycle





7.4.2.2 80% Duty Cycle





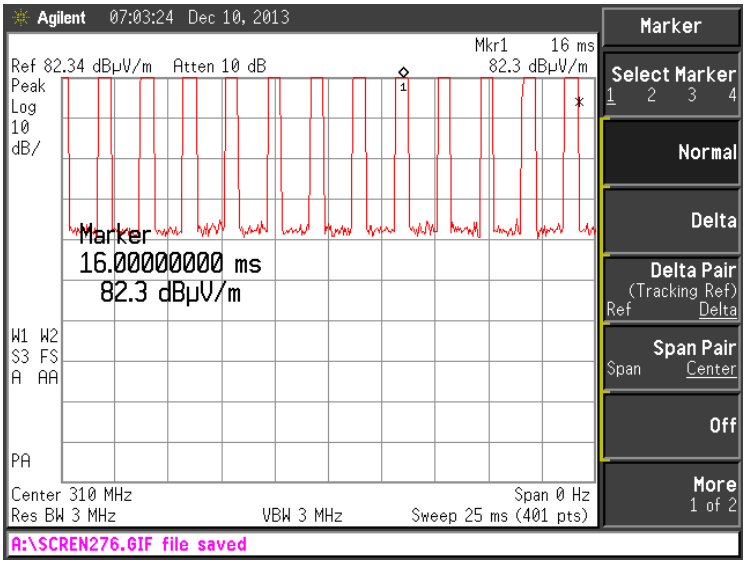
7.4.3 Occupied Bandwidth

Occupied bandwidth measurements were taken at 288, 310, and 433 MHz. The occupied bandwidth was determined using the 20dB measurement method.

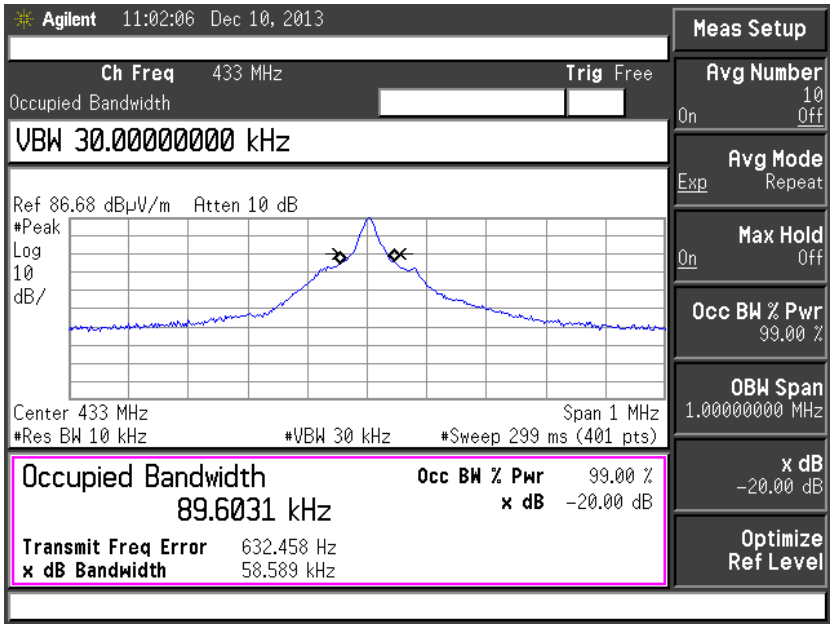
7.4.3.1 Occupied Bandwidth Measurement

Frequency (MHz)	Duty Cycle (%)	Occupied Bandwidth (kHz)	Limit (kHz)
288	30	74.00	720
	50	71.00	720
	80	71.00	720
310	30	69.00	775
	50	70.00	775
	80	70.00	775
365	30	68.00	1045
	50	69.00	1045
	80	69.00	1045
433	30	90.00	1045
	50	74.00	1045
	80	72.00	1045

7.4.3.2 Example of Occupied Bandwidth measurement



Measuring Peak Reference Level



Measuring Occupied Bandwidth at –20dB points

7.4.3.3 Emission Spectrum

Pre-scan measurements were taken inside a semi-anechoic chamber to investigate the possibility of other spurious emissions from the DUT.

Emissions were noted and measured on the Gentex Corporation OATS, all measurements were found to be near or below the ambient noise level and well below the FCC and IC limits for spurious emissions. A summary is presented below in section 7.4.4.1

Measurement settings:

Resolution BW :20kHz
Video Bandwidth :300kHz
Detector :Peak

Note: Pre-scan measurements were made in a semi-anechoic chamber using a Rohde & Schwarz EMI Test Receiver. The semi-anechoic chamber and test receiver are part of the Gentex Corporation Corporate EMC Lab.

7.4.3.4 Summary of Emissions Measurements Taken on OATS

Transmitting Frequency (MHz	**Frequency (MHz)**	**DUT Orientation**	**Antenna Polarization**	Field Strength (dBuV/m)	Limit (dBuV/m)	Margin (dB)
288	43.56	Flat	H	23.26	40	16.74
	65.95	Flat	H	23.11	40	16.89
	92.55	Flat	H	25.62	40	14.38
310	42.35	Flat	H	24.56	40	15.44
	51.65	Side	V	34.56	40	5.44
	55.47	Flat	H	28.59	40	11.41
365	44.56	Flat	H	26.75	40	13.25
	54.78	Flat	H	32.15	40	7.85
	121.02	Flat	H	26.85	40	13.15
433	112.35	Flat	H	26.55	40	13.45
	145.24	Flat	H	29.84	40	10.16
	164.21	Flat	H	28.56	40	11.44

ambient

Measurements were made using a peak detector with Resolution BW of 120kHz and Video BW of 300kHz. Cable losses and correction factors are included in measurement.

7.5 Receiver Spurious Emissions

The receiver circuit spurious emissions were measured in accordance to Industry Canada RSS-GEN Issue 2 Section 4.10 and ANSI C63.4-2003.

The band midpoint over which the receiver is designed to operate is 368 MHz. The Homelink 5 is supplied with commands to place it into diagnostic / manufacturing mode, and tune the receiver to the midpoint frequency.

The search for spurious emissions was conducted over a range of 286MHz (The lowest oscillator frequency used by the receiver) to 1350 MHz (3 times the highest tunable frequency of 450MHz).

To determine the orientation of the device at which the worst case emissions would occur, exploratory measurements were taken using a diagnostic command to transmit at the midpoint frequency of 368 MHz. The device was then set to receive using a manufacturing diagnostic command. Refer to 7.5.1 for setup photograph. The device under test is on its side, with the antenna in horizontal polarization.

7.5.1 Setup Photograph for Receiver spurious emissions

Measurements from 286MHz to 1 GHz were made with the spectrum analyzer using the peak detection method. The resolution bandwidth setting was 120 kHz. **At the fundamental frequency, 365 MHz, the receiver spurious emissions measurement was 129.57V/m at 3m, remaining 70.43 uV/m below the limit.**

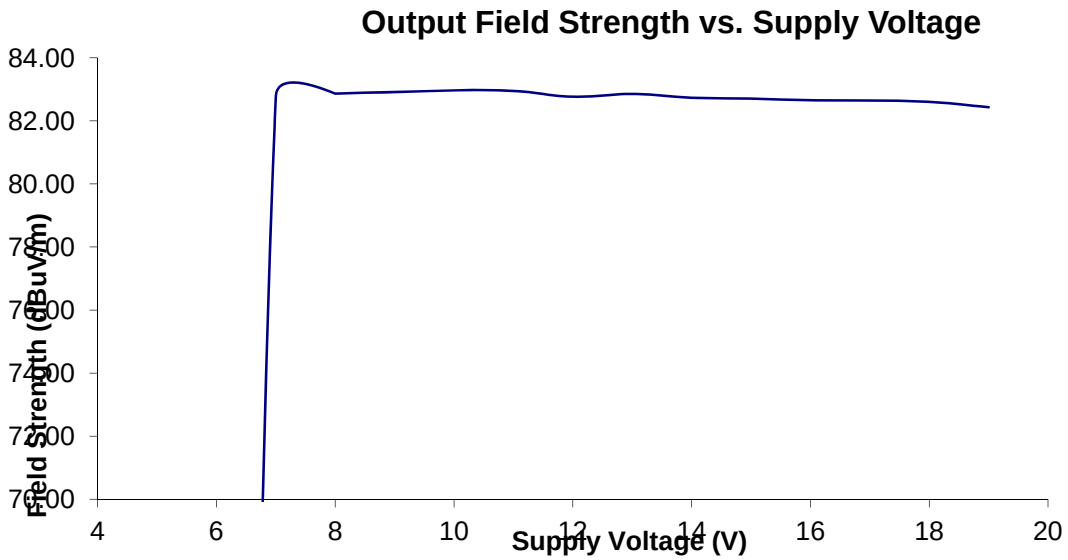
Receive Frequency (MHz)	Frequency (MHz)	DUT Orientation	Antenna Polarization	Field Strength (uV/m)	Limit (uV/m)	Margin (uV/m)
365	296	End	H	124.25	200	75.75
	323	End	H	129.57	200	70.43
	377	End	H	102.34	200	97.66
	379	End	H	104.25	200	95.75
	649	End	H	167.25	200	32.75
	999	End	H	131.44	500	368.56
	1000	End	H	135.26	500	364.74
	1037	End	H	145.26	500	354.74
	1040	End	H	136.54	500	363.46
	1110	End	H	124.15	500	375.85
	1155	End	H	131.11	500	368.89
	1195	End	H	178.59	500	321.41
	1199	End	H	195.4	500	304.6
	1350	End	H	167.58	500	332.42

Ambient

7.6 Variation of Supply Voltage

Measurements of the variation in output field strength due to variation in the supply voltage were taken in accordance with 15.31(e) . The DUT was configured to transmit at 310MHz, 30% Duty Cycle. Values presented are not corrected for duty cycle.

7.6.1 Plot of output power over supply voltage



7.6.2 Output power as a function of supply voltage (288MHz 30% Duty Cycle)

Voltage	Field Strength (dBuV/m)
6	
7	82.77
8	82.86
9	82.91
10	82.96
11	82.95
12	82.76
13	82.85
14	82.73
15	82.7
16	82.65
17	82.64
18	82.6
19	82.43

7.7 Verification of Non-Operation in Restricted Bands

An exercise was undergone to verify that the device was not able to learn and thereby transmit in a restricted band. During this exercise it was found that the device firmware prevents the device from learning any frequency within 1MHz of any restricted band listed in RSS-210 Issue 7, Table 1 and 47 CFR 15.205.

This exercise is described as follows:

HomeLink Operating Frequencies

HomeLink Operating Frequencies

HomeLink is designed to transmit from 286 – 436 MHz, with the exception of two regions:

- 321 – 336.4 MHz
- 398.9 – 411 MHz

HomeLink will only transmit at frequencies it is able to train to, therefore to verify HomeLink does not **transmit** outside the designated regions, we must verify that HomeLink does not **train** to signals outside the designated regions.

To verify this, I set up an Agilent E4421B signal generator to output a 400 Hz square wave with 100% modulation depth and amplitude -5.00 dBm. I then verified that HomeLink would train to this signal only when it was transmitted at the proper frequencies. Specifically, I tested various frequencies in the vicinity of the banned region boundaries, and verified that HomeLink trained when it saw a signal at a valid frequency, and did not train when it saw a signal at a banned frequency. In the instances where HomeLink trained to a valid frequency, I then verified that HomeLink transmitted at that same frequency.

One thing that should be noted: HomeLink margin of error is approximately 100 kHz. Therefore I cannot say that HomeLink will adhere to the specified limits with absolute precision. This is why we guard-banded the FCC banned frequencies by 1 MHz. For example, the FCC bans transmissions below 285 MHz. By setting HomeLink's lower limit to 286 MHz, we guarantee that HomeLink will not operate below 285 MHz, and in all likelihood, HomeLink will not operate below 285.8 MHz.

In addition to the banned frequencies, there also exists certain "harmonic avoidance frequency regions" which HomeLink will train to, but will shift the transmit frequency so as not to generate harmonics at particular frequencies. All these frequency regions are listed below, and the table on the following pages shows the exact frequencies tested.

FCC Banned Regions: (HomeLink does not train to the following frequencies) 240 – 285 MHz 322 – 335.4 MHz 399.9 – 410 MHz	**Harmonic Avoidance Regions:** (HomeLink trains to the following frequencies but transmits on the edges of these bands) 303.5 MHz – 307.5 MHz 417.5 MHz – 420.5 MHz

HomeLink V Banned Frequency Testing

Frequency (MHz)	Part 15 Status	Result	Pass/Fail	Comments
285.0	banned	would not train	Pass	
285.5	allowed (guardband region)	would not train	Pass	
286.0	allowed (guardband region)	would not train	Pass	
287.0	allowed	trained	Pass	
303.5	allowed	trained	Pass	
304.0	allowed	trained	Pass	Frequency shifted to 303.5 MHz
304.5	allowed	trained	Pass	Frequency shifted to 303.5 MHz
305.0	allowed	trained	Pass	Frequency shifted to 303.5 MHz
305.5	allowed	trained	Pass	Frequency shifted to 303.5 MHz
306.0	allowed	trained	Pass	Frequency shifted to 307.5 MHz
306.5	allowed	trained	Pass	Frequency shifted to 307.5 MHz

307.0	allowed	trained	Pass	Frequency shifted to 307.5 MHz
307.5	allowed	trained	Pass	
319.0	allowed	trained	Pass	
320.0	allowed	trained	Pass	
320.5	allowed	trained	Pass	
321.0	allowed (guardband region)	trained	Pass	
322.0	banned	would not train	Pass	
323.0	banned	would not train	Pass	
324.0	banned	would not train	Pass	
325.0	banned	would not train	Pass	
326.0	banned	would not train	Pass	
327.0	banned	would not train	Pass	
328.0	banned	would not train	Pass	
329.0	banned	would not train	Pass	
330.0	banned	would not train	Pass	
331.0	banned	would not train	Pass	
332.0	banned	would not train	Pass	
333.0	banned	would not train	Pass	
334.0	banned	would not train	Pass	
335.0	banned	would not train	Pass	
336.0	allowed (guardband	would not train	Pass	

	region)			

337.0	allowed (guardband region)	trained	Pass	
338.0	allowed	trained	Pass	
398.0	allowed	trained	Pass	
399.0	allowed (guardband region)	would not train	Pass	While this is a valid frequency, HomeLink guardbands this region to ensure it doesn't train to 399.9 MHz
399.5	allowed (guardband region)	would not train	Pass	While this is a valid frequency, HomeLink guardbands this region to ensure it doesn't train to 399.9 MHz
400.0	banned	would not train	Pass	
401.0	banned	would not train	Pass	
402.0	banned	would not train	Pass	
403.0	banned	would not train	Pass	
404.0	banned	would not train	Pass	
405.0	banned	would not train	Pass	
406.0	banned	would not train	Pass	
407.0	banned	would not train	Pass	
408.0	banned	would not train	Pass	
409.0	banned	would not train	Pass	
410.0	banned	would not train	Pass	
410.5	allowed (guardband region)	would not train	Pass	
411.0	allowed (guardband	trained	Pass	

	region)			
411.5	allowed	trained	Pass	
412.0	allowed	trained	Pass	
418.0	allowed	trained	Pass	Frequency shifted to 417.5 MHz
418.5	allowed	trained	Pass	Frequency shifted to 417.5 MHz
419.0	allowed	trained	Pass	Frequency shifted to 420.5 MHz
419.5	allowed	trained	Pass	Frequency shifted to 420.5 MHz
420.0	allowed	trained	Pass	Frequency shifted to 420.5 MHz
437.0	allowed	would not train	Pass	HomeLink only operates up to 436 MHz
440.0	allowed	would not train	Pass	HomeLink only operates up to 436 MHz
440.5	allowed	would not train	Pass	HomeLink only operates up to 436 MHz
441.0	allowed	would not train	Pass	HomeLink only operates up to 436 MHz
442.0	allowed	would not train	Pass	HomeLink only operates up to 436 MHz

7.8 Formulas and Sample Calculation

7.8.1 Adjustment to account for duty cycle

The spectrum analyzers 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) and periodic cable loss measurements.

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

The presented field strength is computed by the spectrum analyzer by taking the measured level and adding to it the antenna factor and cable loss corrections. The measurement presented in gathered using the spectrum analyzer's peak-hold capability.

Formula 2: Average Level(dBuV/m) = Peak Level (dBuV/m) + duty cycle factor(dB).

The peak measurement is adjusted to an average level by a duty cycle described below.

The duty cycle factor to apply is determined for the duty cycles of 30%, 50%, and 80% as follows:

For 30% (0.30):	duty cycle factor(dB) = 20*Log(0.3) = -10.46
For 50% (0.50):	duty cycle factor(dB) = 20*Log(0.5) = -6.02
For 80% (0.80):	duty cycle factor(dB) = 20*Log(0.8) = -1.94

Example calculation:
With the EUT programmed with a 30% duty cycle a measurement of 74 dBuV/m is taken (about 5000 uV/m), the adjusted level would be:

74 + (-10.46) = 63.54 dBuV/m (example)

7.8.2 Calculation of IC Limits from Table 4, RSS-210 and 47 CFR Part 15.231.

The prescribed limit in the range of 260 MHz to 470 MHz is stated as a linear interpolation between 3750 uV/m and 12500 uV/m. The equation used to calculate the limit using this criteria is:

FCC limit = 41.67 * f – 7083.33
(Where 'f' is the measurement frequency in MHz.)

The limit is dBuV/m is then:

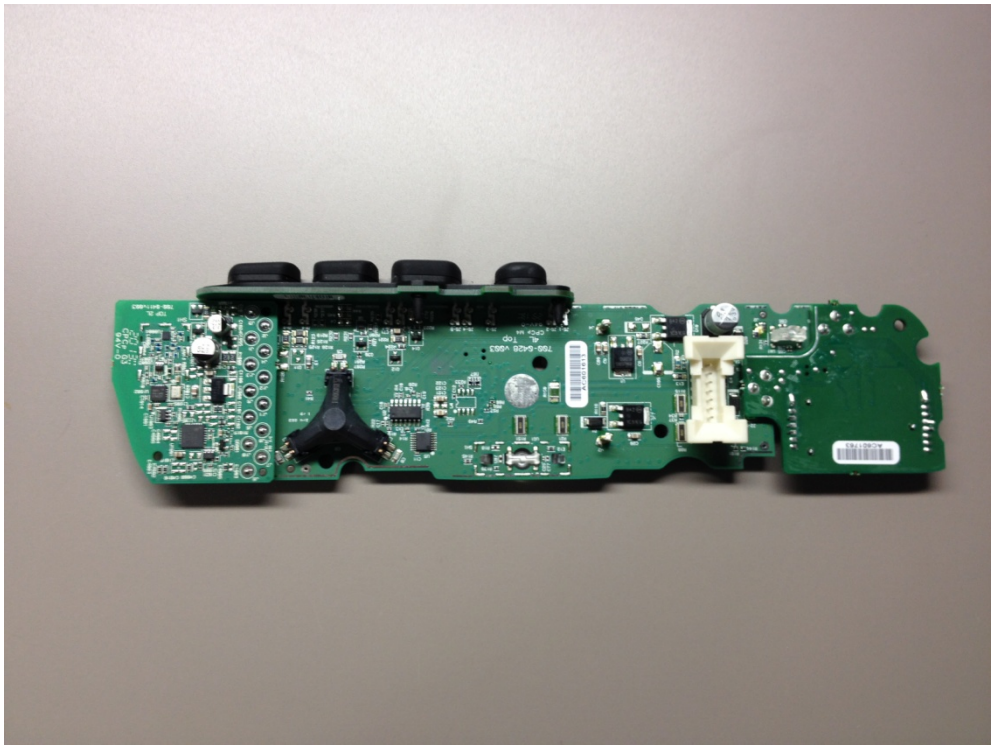
dB limit = 20 * log10(FCC limit uV/m) = 20*log10(41.67*f – 7083.33)
(log10 is used to indicated the use of a base 10 logarithm)

This results in the following limits for the fundamentals:

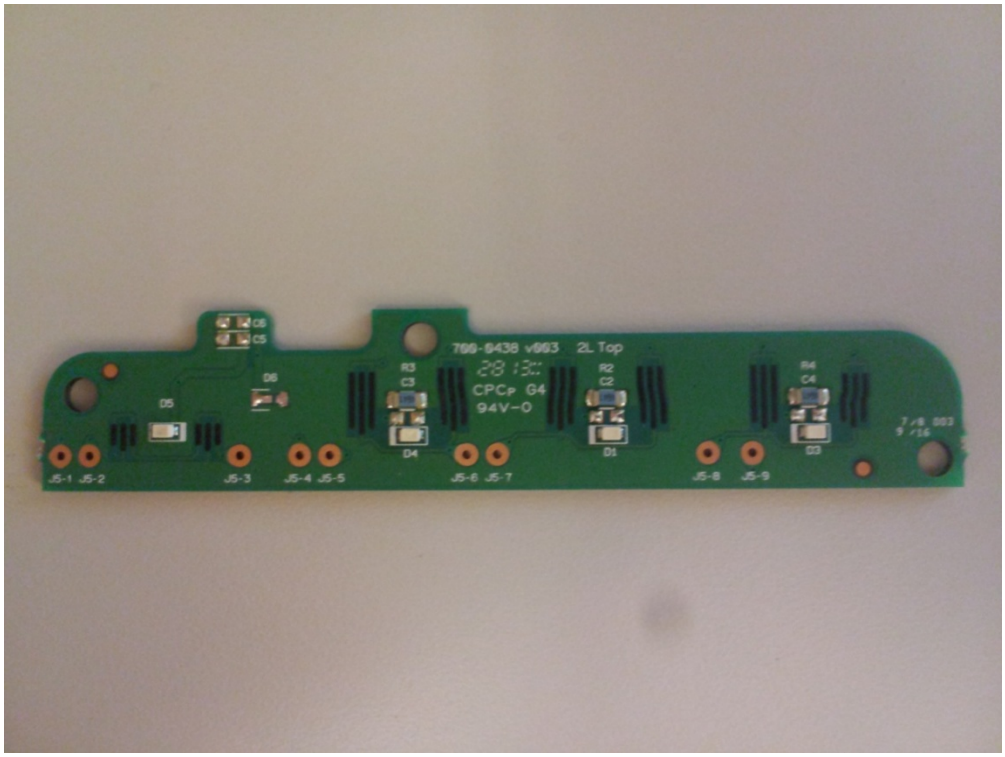
288MHz	20*log10(4917.6)	= 73.8 dBuV/m
310MHz	20*log10(5834.4)	= 75.3 dBuV/m
390MHz	20*log10(9168.0)	= 79.2 dBuV/m
433MHz	20*log10(10959.8)	= 80.8 dBuV/m

8. Photos of Product Tested

8.1 Front View – Printed Circuit Board



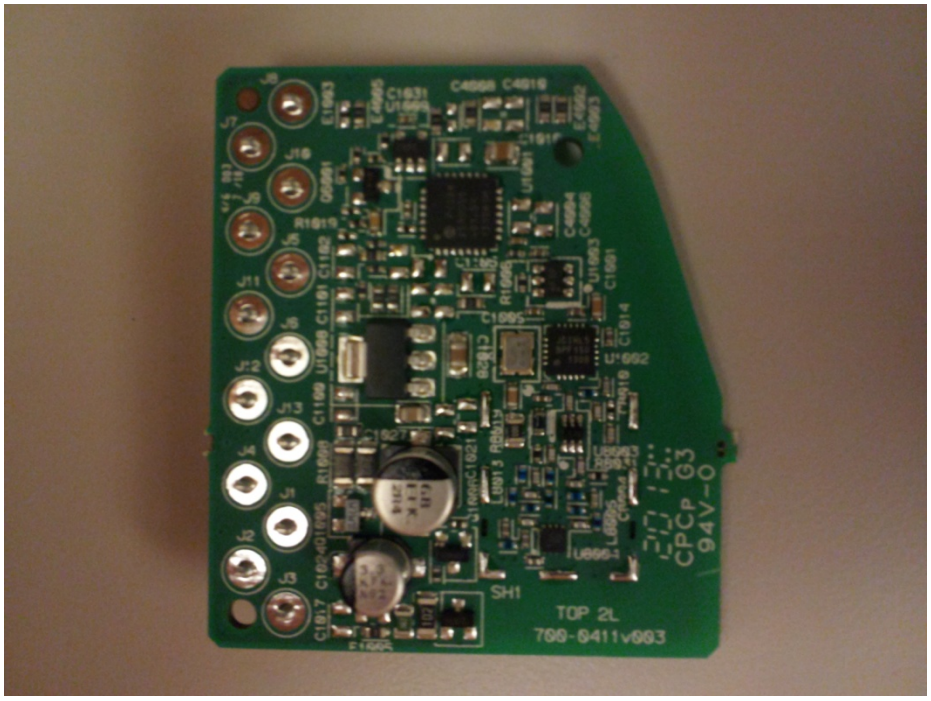
8.2 Rear View – Printed Circuit Board

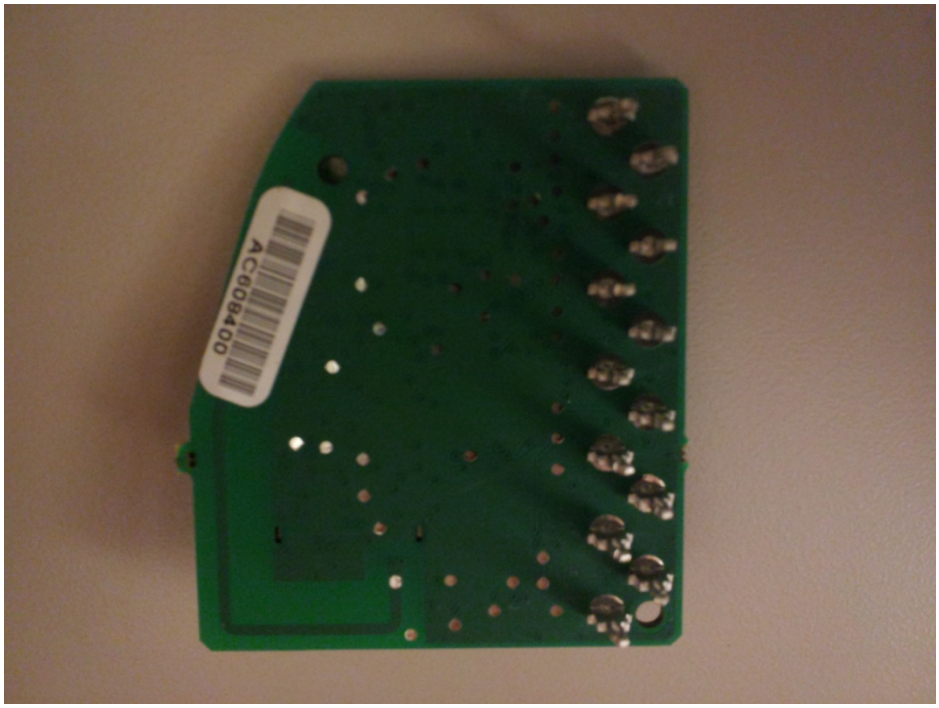


8.3 Unit Disassembled

8.3.1 Housing & PCB Board Internal View

8.3.2 Close-up of Homelink RF Section


TOP 2L
760-6411v003
94V-0


AC009400

Other Attachments and Description

9.1 User Manual

Please refer to attachment “User_manual.pdf”.

9.2 Schematics / Tuning Information

For schematics please refer to attachment “Schematics.pdf”.

9.3 Emission Designation

According to TRC-43, the emission designation for this product is 90KL1D. Where “90K” is the highest measured occupied bandwidth, “L” indicates the device uses pulse width modulation, “1” indicates the modulation as being single channel, digital information and “D” indicates that data is being transmitted.

9.4 Theory of Operation

Please refer to attachment “Theory_of_operation”

9.5 Label Drawing and Location on Complete Assembly

For a drawing of the label, refer to attachment “LABEL Drawing_Label_Location.”

For a drawing of the position of the label on the finished assembly refer to

“LABEL Drawing_Label_Location”.