Technical Report to the FCC Regarding Johnson Controls Interiors, L.L.C. Homelink© III Model: ACTLHL3

FCC ID: CB2ACTLHL3
Form 731 Confirmation #EA805341
11/19/2004

A report concerning a Class II change to the original grant of CB2ACTLHL3 dated 7/10/03.
Please issue grant immediately upon review.
Confidentiality applied to the following sections according to 47 CFR 0.459:

- Circuit Block Diagrams, attachment “hl_bd.pdf”
- Theory/Description of Operation “theory_op.pdf”
- Schematics attachment “schematics.pdf”

Measurements Made by:

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Report and Application Prepared by
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1. General Information

1.1. Product Description:

The Johnson Controls Interiors HomeLink® HL3 Universal Garage Door Opener is a low-power transceiver OEM device that is installed into an overhead console 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 Johnson Controls Interiors, LLC.

1.2. Related Grants

REF# **EA494510**
This product was originally certified under the FCC ID: CB2ACTLHL3 granted 7/10/03.

REF#EA504983
A Class II change was submitted and approved to allow for a change to the software controlled power level settings for those setting controlling the 390MHz region. Testing was done at the vehicle level to account for attenuation caused by installing the EUT in the Acura TL automobile.

REF#EA471316
The same power level settings were used to qualify in the Acura TL (#EA504983 above) were used to qualify the device in the Acura MDX automobile. Our agreement with the commission requires a separate Class II certification for each model automobile in which the Homelink® is installed.

This report covers further changes to the Non-Volatile Memory (NVM) setting controlling the power output in each of 6 frequency regions. Specifically, this report covers testing of the new settings in the Acura MDX automobile. This report has been submitted in addition to the (separate) report for the Acura TL.

1.3. Test Methodology

Radiated Emissions testing was done according to ANSI C63.4-2000. The power source for this product is a 12V automotive vehicle battery, thus conducted emissions measurements are not required.

Most measurements were performed according to methodology outlined in communication with the FCC submitted as miscellaneous exhibit "vehicle_level.pdf". In all cases the guidelines provided by ANSI C63.4-2000 were followed where possible. Exceptions are noted if present. Measurements were taken at 10m on the JCI OATS.

For remaining tests a 2-conductor cable harness was used to supply power to the unit for tabletop measurements. Tabletop measurements were taken at 3m on the JCI OATS.

1.4. Test Facility

The Open Area Test Site where these measurements were taken, is located on the grounds of Johnson Controls Automotive Interiors System's Edgar D. Prince 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. It has been fully described in a report filled with the FCC and Industry Canada. The report filled with the FCC is, dated October 19, 1999, was accepted by the FCC in a letter dated December, 20 1999. The report filled with Industry Canada, dated January 31, 2000, was accepted via a letter dated February 29, 2000. The site was re-certified with the FCC on December 27, 2002 and with the IC on January 27, 2003.

2. Product Labeling

The FCC Identifier assigned is FCC ID: CB2ACTLHL3. The Industry Canada certification number is 279B-ACTLHL3. These identifier will be imprinted on a 1"X1.5" high temperature polyester matte white label.

The label will be placed on the exterior of the HL3 housing using an acrylic adhesive 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 "user_man.pdf" for the entire text of the user's manual.

> "This device complies with Part 15 of the FCC rules and with RSS-210 of the Industry Canada. 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."

2.1. Label Drawing and Location on Product.

The label drawing as well as a sketch of the label location on product packaging is available in “label.pdf”

3. Test Configuration

Radiated Emissions measurements presented in the report were made in accordance with ANSI C63.4-2000. EUT emissions were measured at 10m. The EUT was installed in its intended position in the Acura MDX automobile. (see attachment “MDX_hl.jpg”)

The occupied bandwidth and spurious emissions measurements were taken at 3m according to ANSI C63.4-2000. A 1.5m harness was used to supply power the to the EUT during testing. Additional pre-scan measurements for spurious emissions were taken in the Johnson Controls absorber-lined shielded enclosure.

A picture of the vehicle level measurement setup is available as an attachment named “MDX_test.jpg”

A picture of the bench level radiated test setup is available as an attachment named “test_setup.jpg”

4. Block Diagram

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

5. Test Setup Photographs

For test setup photos please refer to attachment named “test_setup_end.jpg”
For test setup photos please refer to attachment named “test_setup_side.jpg”
For test setup photos please refer to attachment named “test_setup_flat.jpg”

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, and 418 MHz at 30, 50 and 80% duty cycles. A **worst-case average corrected emission of 69.76 dBuV/m** occurred with the DUT trained to 310 MHz, 50% duty cycle. The worst-case emission remained **slightly below the FCC limit** (69.8 dBuV/m) for this type of device.
- Measurements were taken at 340, 365, and 390 MHz in order to evaluate the effect of the changes made in those regions to the limits. A worst-case average emission of 66.6 dBuV/m was measured at 390 MHz presenting a margin of 2.2dB to the FCC limit.
- The **worst-case harmonic measurement of 54 dBuV/m** was found at 836 MHz, the second harmonic of 288 MHz at 30% duty cycle. **A margin of 0.3 dB to the prescribed FCC limit was noted.**
- This module exhibits pulsed operation characteristics.
- Measurements were taken of the 20dB occupied bandwidth. The transmitter had a maximum occupied bandwidth of 489 kHz when the DUT is trained to 418 MHz, 80% duty cycle.
- This device has no measurable Class B emissions.
- The output power of the DUT varied by no more than 0.2dB when the input voltage was varied from 6 to 18 Volts. The device does not operate when the input voltage is below 8V.

- 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 device uses coarse and fine pulses to tune the transmit antenna. At 418 MHz, 30% duty cycle the field strength of the pulses average 4908 uV/m over 100 msec. This represents a margin on 9.6 dB to the FCC limit.

7.2. Test Equipment Used

Description	Model #	Serial Number	Last Cal Date	Cal Due
EMCO Biconical Antenna (20-300 MHz)	3110B	9906-3309	10/21/03	10/21/05
EMCO LPA Antenna (200-2000MHz)	3148	9908-1076	10/21/03	10/21/05
Electro-metrics Double Ridged Guide (1-18GHz)	RGA-60	6147	10/21/03	10/21/05
Agilent E-series EMC Analyzer	E4407B	US41192569	10/26/04	10/26/05
HP Preamp	8447D	1937A03135	10/09/03	11/17/2004*
Rohde & Schwarz EMI Test Receiver 7GHz	EMI 7	1088.749.07	7/20/04	7/20/05

***Note:** *The HP Pre-amp used for some measurements was given a deviation by our calibration department in order to allow completion of testing in a timely manner.*

7.3. Test Equipment Setup and Procedure

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

For the tabletop testing, the EUT was placed at the center of a non-conducting table 80 cm 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.

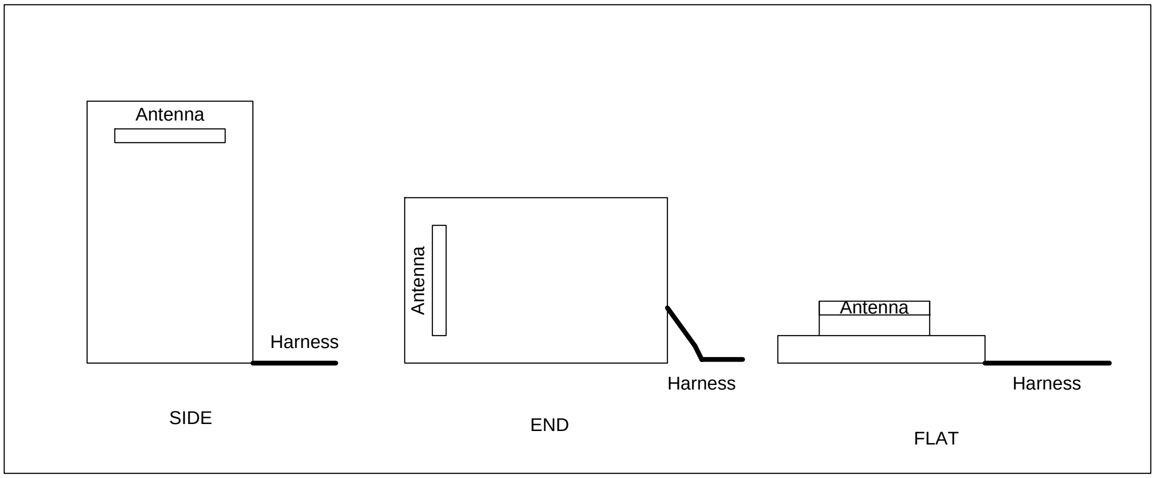


Figure 7.3.1 EUT Orthogonal Orientations

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.

For vehicle level measurements, the EUT is fixed in the “flat” position as installed in the vehicle. The antenna positioner is then swept from 1 to 4m at 10m from the center of the vehicle level turntable until the elevation peak is found. The vehicle is then rotated through 360 degrees until the azimuth peak is found. The turntable is stopped at the maximum elevation and the peak elevation re-verified.

7.4. Measured Data

7.4.1. Measurements of Fundamentals and Harmonics

Measurements described in this section were taken at 10m according to ANSI C63.4-2000 in the Acura MDX Vehicle.

7.4.1.1. DUT Tuned to 288MHz (Fundamental)

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	Correction Factor (dB)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
288	Flat (V)	V	30	70	0	-10.5	59.5	63.4	**3.8**
288	Flat (V)	V	50	65.3	0	-6.0	59.3	63.4	4.1
288	Flat (V)	V	80	60.6	0	-1.9	58.7	63.4	4.7

* Measurements include Cable corrections and Antenna Factors
**(V) indicated measurements done in the vehicle

7.4.1.2. DUT Tuned to 310MHz (Fundamental)

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	Correction Factor (dB)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
310	Flat (V)	V	30	72.7	0	-10.46	62.24	64.90	**2.7**
310	Flat (V)	V	50	67.8	0	-6.02	61.78	64.90	3.1
310	Flat (V)	V	80	63.8	0	-1.94	61.86	64.90	3.0

* Measurements include Cable corrections and Antenna Factors
**(V) indicated measurements done in the vehicle

7.4.1.3. DUT Tuned to 418MHz (Fundamental)

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	Correction Factor (dB)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
418	Flat (V)	H	30	80	0	-10.46	69.54	69.8	0.3
418	Flat (V)	H	50	75.8	0	-6.02	69.78	69.8	**0.0**
418	Flat (V)	H	80	71.7	0	-1.94	69.76	69.8	**0.0**

* Measurements include Cable corrections and Antenna Factors
**(V) indicated measurements done in the vehicle

7.4.1.4. 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	Flat(V)	V	30	54	-10.46	43.54	43.8	**0.3**
576	Flat(V)	V	50	47.46	-6.02	41.44	43.8	2.4
576	Flat(V)	V	80	41.72	-1.94	39.78	43.8	4.0
864	Flat(V)	V	30	Ambient	-10.46	N/A	43.8	N/A
864	Flat(V)	V	50	Ambient	-6.02	N/A	43.8	N/A
864	Flat(V)	V	80	Ambient	-1.94	N/A	43.8	N/A
1152	Flat(V)	H	30	45.6	-10.46	35.14	43.6	8.5
1152	Flat(V)	H	50	40.5	-6.02	34.48	43.6	9.1
1152	Flat(V)	H	80	36.2	-1.94	34.26	43.6	9.3
1440	Flat(V)	H	30	40.6	-10.46	30.14	43.6	13.5
1440	Flat(V)	H	50	40.1	-6.02	34.08	43.6	9.5
1440	Flat(V)	V	80	39	-1.94	37.06	43.6	6.5
1728	Flat(V)	V	30	43.1	-10.46	32.64	43.8	11.2
1728	Flat(V)	V	50	40.1	-6.02	34.08	43.8	9.7
1728	Flat(V)	H	80	38.5	-1.94	36.56	43.8	7.2
2016	Flat(V)	V	30	46.3	-10.46	35.84	43.8	8.0
2016	Flat(V)	H	50	45.3	-6.02	39.28	43.8	4.5
2016	Flat(V)	H	80	43.2	-1.94	41.26	43.8	2.5
2304	Flat(V)	V	30	Noise Floor	-10.46	N/A	43.8	N/A
2304	Flat(V)	V	50	Noise Floor	-6.02	N/A	43.8	N/A
2304	Flat(V)	V	80	Noise Floor	-1.94	N/A	43.8	N/A
2592	Flat(V)	V	30	Noise Floor	-10.46	N/A	43.8	N/A
2592	Flat(V)	V	50	Noise Floor	-6.02	N/A	43.8	N/A
2592	Flat(V)	V	80	Noise Floor	-1.94	N/A	43.8	N/A
2880	Flat(V)	V	30	Noise Floor	-10.46	N/A	43.8	N/A
2880	Flat(V)	V	50	Noise Floor	-6.02	N/A	43.8	N/A
2880	Flat(V)	V	80	Noise Floor	-1.94	N/A	43.8	N/A

7.4.1.5. 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	Flat(V)	V	30	52.5	-10.46	42.06	44.90	2.8
620	Flat(V)	V	50	46.7	-6.02	40.70	44.90	4.2
620	Flat(V)	V	80	40.4	-1.94	38.46	44.90	6.4
930	Flat(V)	V	30	Ambient	-10.46	Ambient	44.90	Ambient
930	Flat(V)	V	50	Ambient	-6.02	Ambient	44.90	Ambient
930	Flat(V)	V	80	Ambient	-1.94	Ambient	44.90	Ambient
1240	Flat(V)	V	30	52.5	-10.46	42.04	43.60	1.6
1240	Flat(V)	H	50	39.3	-6.02	33.28	43.60	10.3
1240	Flat(V)	H	80	39.9	-1.94	37.96	43.60	5.6
1550	Flat(V)	V	30	50.9	-10.46	40.44	43.60	3.2
1550	Flat(V)	H	50	44.3	-6.02	38.28	43.60	5.3
1550	Flat(V)	H	80	44.2	-1.94	42.26	43.60	1.3
1860	Flat(V)	V	30	Ambient	-10.46	Ambient	44.90	Ambient
1860	Flat(V)	V	50	Ambient	-6.02	Ambient	44.90	Ambient
1860	Flat(V)	V	80	Ambient	-1.94	Ambient	44.90	Ambient
2170	Flat(V)	V	30	Noise	-10.46	Noise	44.90	Noise
2170	Flat(V)	V	50	Noise	-6.02	Noise	44.90	Noise
2170	Flat(V)	V	80	Noise	-1.94	Noise	44.90	Noise
2480	Flat(V)	V	30	Noise	-10.46	Noise	44.90	Noise
2480	Flat(V)	V	50	Noise	-6.02	Noise	44.90	Noise
2480	Flat(V)	V	80	Noise	-1.94	Noise	44.90	Noise
2790	Flat(V)	V	30	Noise	-10.46	Noise	44.90	Noise
2790	Flat(V)	V	50	Noise	-6.02	Noise	44.90	Noise
2790	Flat(V)	V	80	Noise	-1.94	Noise	44.90	Noise
3100	Flat(V)	V	30	Noise	-10.46	Noise	44.90	Noise
3100	Flat(V)	V	50	Noise	-6.02	Noise	44.90	Noise
3100	Flat(V)	V	80	Noise	-1.94	Noise	44.90	Noise

7.4.1.6. 418MHz (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)
836	Flat(V)	H	30	46.0	-10.46	35.56	49.8	14.2
836	Flat(V)	V	50	47.3	-6.02	41.28	49.8	8.5
836	Flat(V)	V	80	44.2	-1.94	42.26	49.8	7.5
1254	Flat(V)	V	30	Ambient	-10.46	Ambient	49.8	Ambient
1254	Flat(V)	V	50	Ambient	-6.02	Ambient	49.8	Ambient
1254	Flat(V)	V	80	Ambient	-1.94	Ambient	49.8	Ambient
1672	Flat(V)	V	30	48.9	-10.46	38.44	43.6	5.2
1672	Flat(V)	V	50	42.0	-6.02	35.98	43.6	7.6
1672	Flat(V)	H	80	41.6	-1.94	39.66	43.6	3.9
2090	Flat(V)	H	30	49.8	-10.46	39.34	49.8	10.5
2090	Flat(V)	V	50	43.6	-6.02	37.58	49.8	12.2
2090	Flat(V)	V	80	43.2	-1.94	41.27	49.8	8.5
2508	Flat(V)	V	30	41.9	-10.46	31.44	49.8	18.4
2508	Flat(V)	H	50	45.5	-6.02	39.48	49.8	10.3
2508	Flat(V)	H	80	46.7	-1.94	44.76	49.8	5.0
2926	Flat(V)	V	30	Noise	-10.46	Noise	49.8	Noise
2926	Flat(V)	V	50	Noise	-6.02	Noise	49.8	Noise
2926	Flat(V)	V	80	Noise	-1.94	Noise	49.8	Noise
3344	Flat(V)	V	30	Noise	-10.46	Noise	49.8	Noise
3344	Flat(V)	V	50	Noise	-6.02	Noise	49.8	Noise
3344	Flat(V)	V	80	Noise	-1.94	Noise	49.8	Noise
3762	Flat(V)	V	30	Noise	-10.46	Noise	49.8	Noise
3762	Flat(V)	V	50	Noise	-6.02	Noise	49.8	Noise
3762	Flat(V)	V	80	Noise	-1.94	Noise	49.8	Noise
4180	Flat(V)	V	30	Noise	-10.46	Noise	49.8	Noise
4180	Flat(V)	V	50	Noise	-6.02	Noise	49.8	Noise
4180	Flat(V)	V	80	Noise	-1.94	Noise	49.8	Noise

7.4.1.7. Additional test data: 340 MHz Fundamental (in vehicle) (Acura MDX)

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	Correction Factor (dB)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit ** (dBuV/m)	Margin (dB)
340	In Vehicle	V	30	75.6	0	-10.46	65.14	66.5	1.4
340	In Vehicle	V	50	71.1	0	-6.02	65.08	66.5	1.5
340	In Vehicle	V	80	66.6	0	-1.94	64.66	66.5	1.9

* Measurements include Cable corrections and Antenna Factors
** Measurements Taken at 10m so Limit is adjusted to 10m limit

7.4.1.8. Additional test data: 365 MHz Fundamental (in vehicle) (Acura MDX)

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	Correction Factor (dB)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit ** (dBuV/m)	Margin (dB)
365	In Vehicle	H	30	77.3	0	-10.46	66.84	67.7	0.9
365	In Vehicle	V	50	73.3	0	-6.02	67.28	67.7	0.4
365	In Vehicle	V	80	68.2	0	-1.94	66.26	67.7	1.4

* Measurements include Cable corrections and Antenna Factors
** Measurements Taken at 10m so Limit is adjusted to 10m limit

7.4.1.9. Additional test data: 390 MHz Fundamental (in vehicle) (Acura MDX)

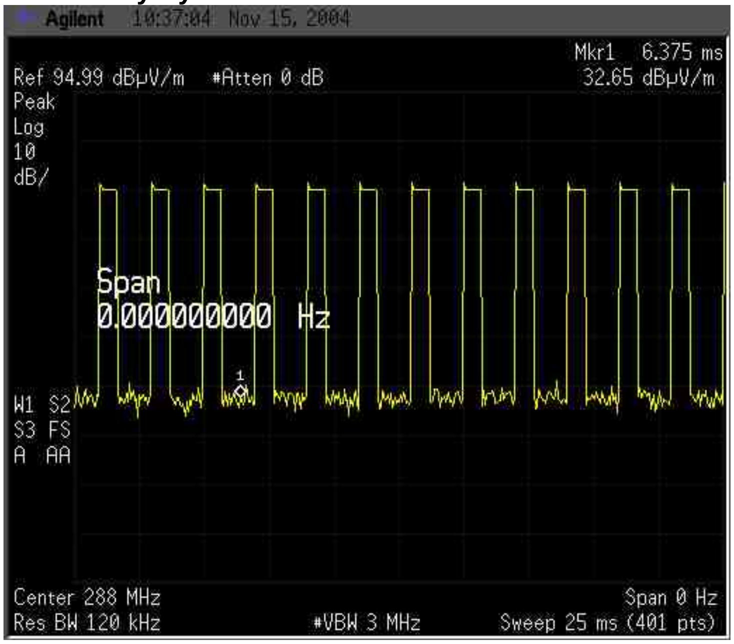
Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	Correction Factor (dB)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit ** (dBuV/m)	Margin (dB)
390	In Vehicle	V	30	78.4	0	-10.46	67.94	68.8	0.9
390	In Vehicle	V	50	73.1	0	-6.02	67.08	68.8	1.7
390	In Vehicle	V	80	68.5	0	-1.94	66.56	68.8	2.2

* Measurements include Cable corrections and Antenna Factors
** Measurements Taken at 10m so Limit is adjusted to 10m limit

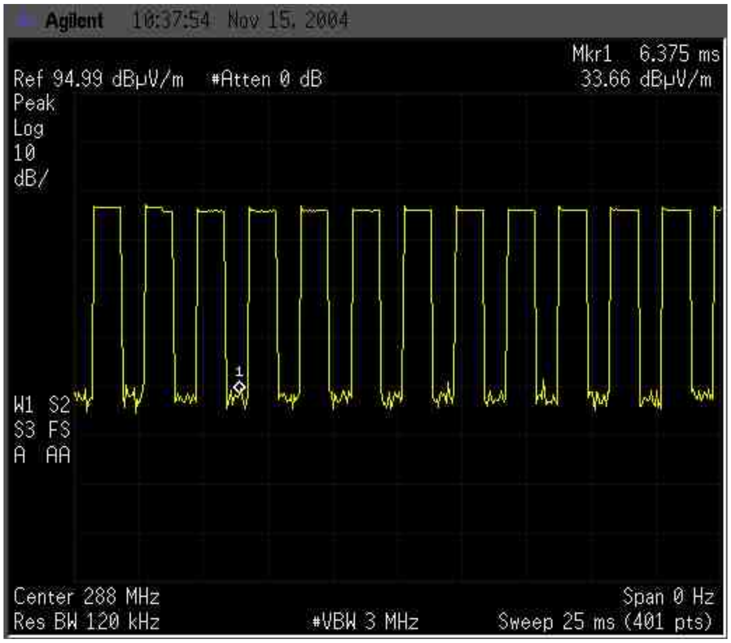
7.4.2. Pulsed Operation

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 288MHz with the span set to zero on the E7402A spectrum analyzer.

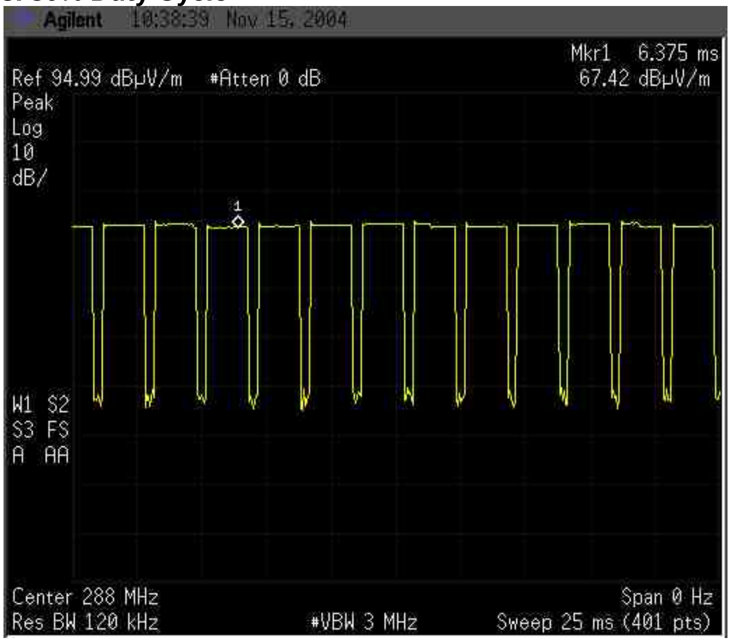
7.4.2.1. 30% Duty Cycle



7.4.2.2. 50% Duty Cycle



7.4.2.3. 80% Duty Cycle



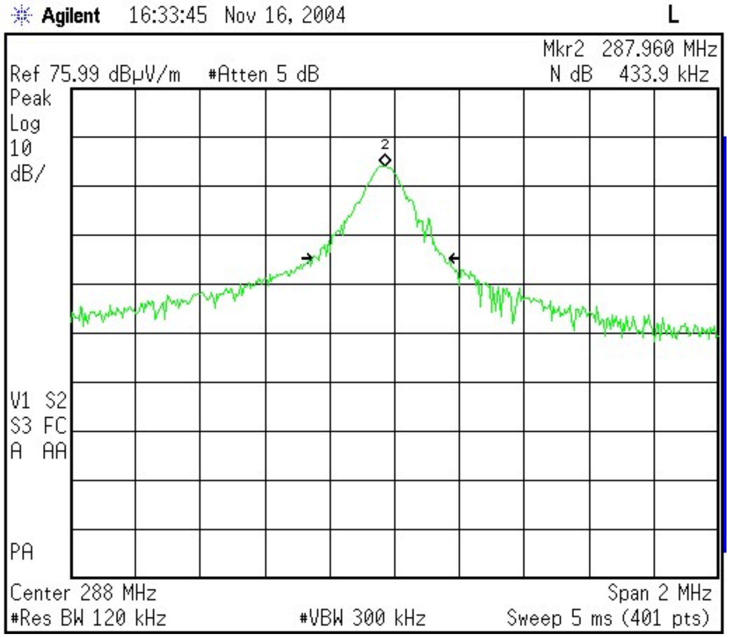
7.4.3. Occupied Bandwidth

Occupied bandwidth measurements were taken at 288, 310, and 418 MHz. The occupied bandwidth was determined using the 20dB measurement method.

7.4.3.1. Occupied Bandwidth Measurements

Frequency (MHz)	Duty Cycle (%)	Occupied Bandwidth (MHz)	Limit (MHz)
288	30	0.434	0.72
	50	0.449	0.72
	80	0.459	0.72
310	30	0.459	0.775
	50	0.439	0.775
	80	0.479	0.775
418	30	0.409	1.045
	50	0.423	1.045
	80	0.489	1.045

7.4.3.2. Example of Occupied Bandwidth measurement (288 MHz 30% Duty Cycle)



7.4.4. Emission Spectrum

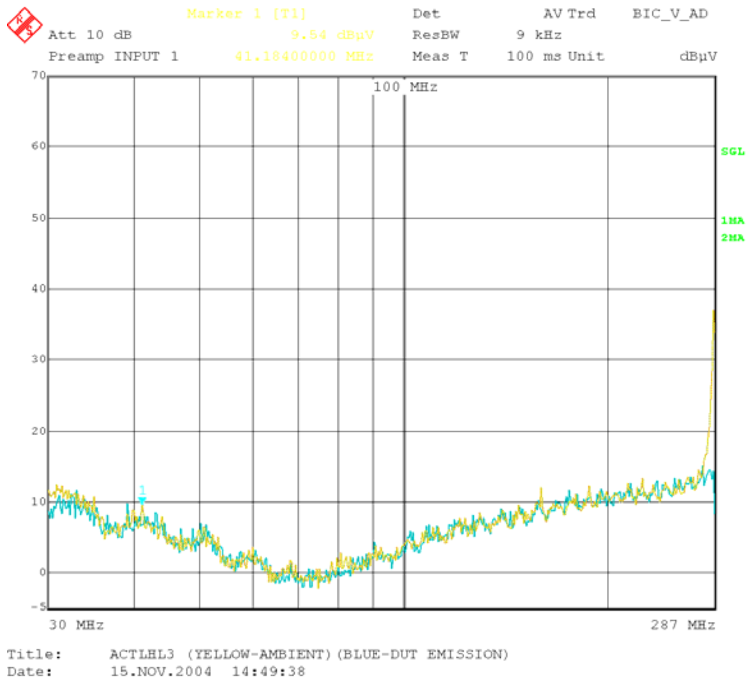
Measurements were taken inside a semi-anechoic chamber to investigate the possibility of other spurious emissions from the DUT. Screen captures presented below in sections 7.4.4.1-3 show the spurious emissions observed with the DUT trained to 288, 310, and 418MHz with a 30% Duty cycle.

Emissions were noted and measured on the JCI OATS, all measurements were found to be near or below the ambient noise level and well below the FCC limits for spurious emissions. A summary is presented below in section 7.4.4.4

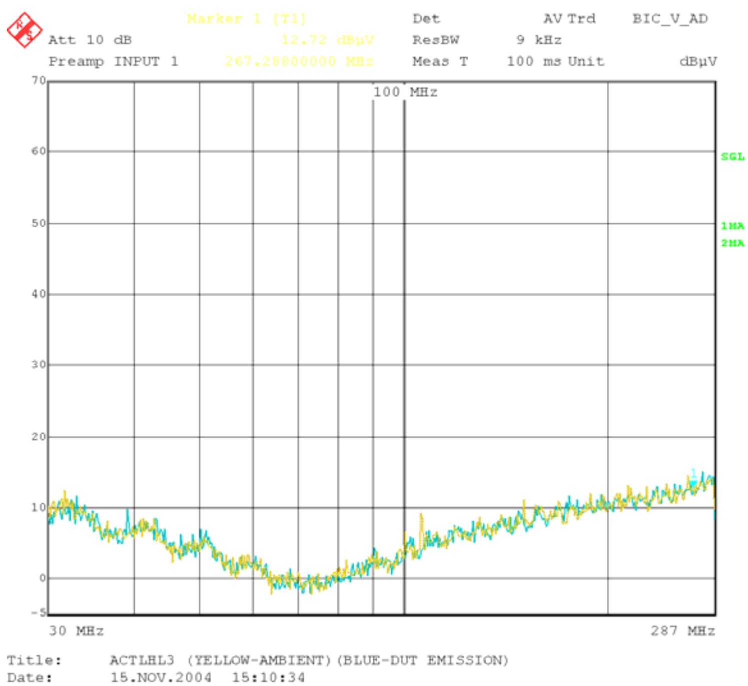
Measurement settings:

Resolution BW 120kHz
Video Bandwidth: 300kHz
Detector: Peak

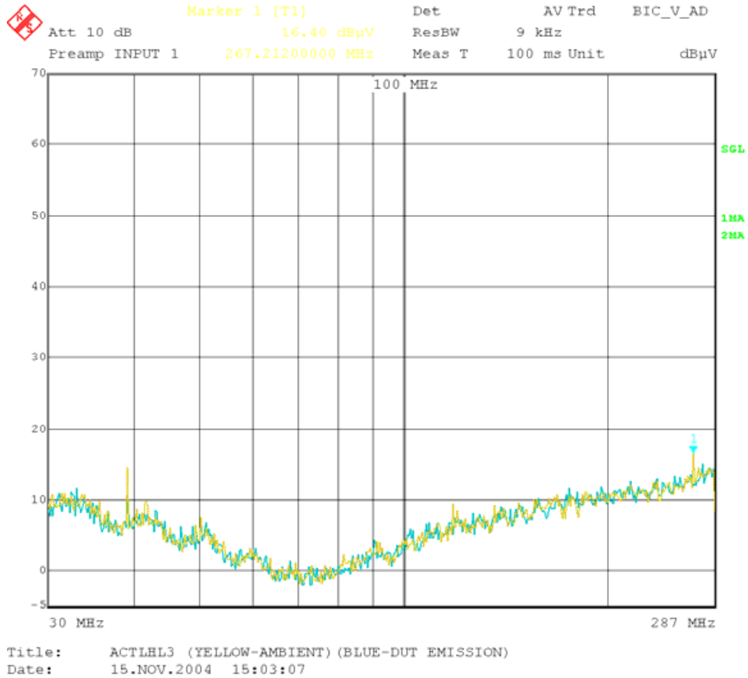
7.4.4.1. 288 MHz



7.4.4.2. 310 MHz



7.4.4.3. 418 MHz



Note: Pre-scan measurements were made in a semi-anechoic chamber using a Rohde & Schwarz EMI Test Receiver 7GHz. The semi-anehoic chamber and test receiver are part of the Johnson Control Electronics Validation Group.

7.4.4.4. Summary of Emissions Measurements Taken on OATS

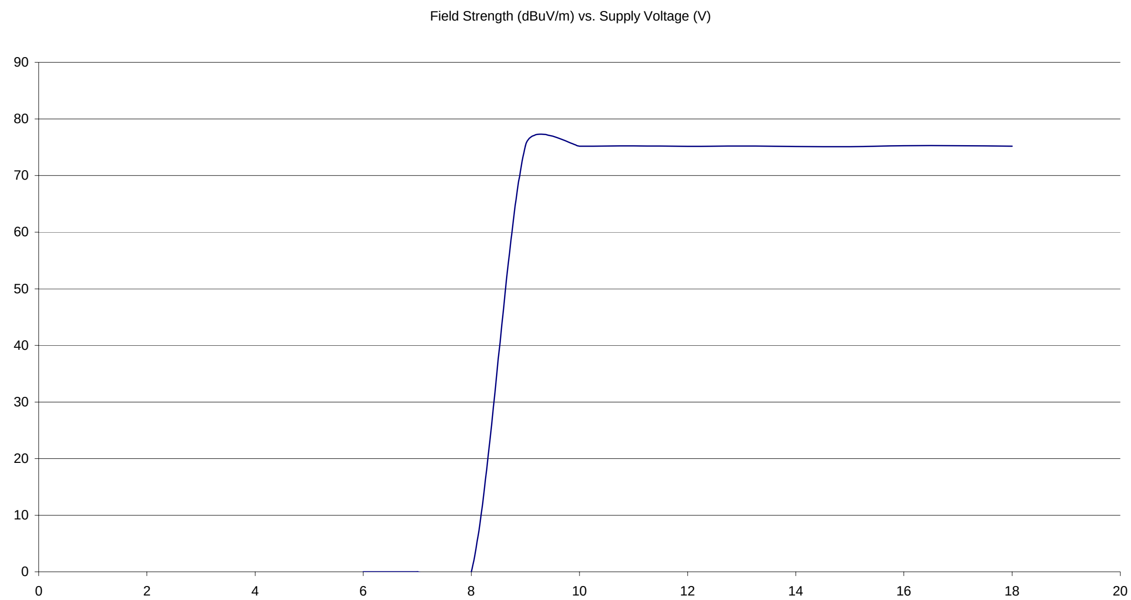
EUT Frequency (MHz)	Frequency (MHz)	Measure-ment (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
288	31.2	35.7	40	4.3
	41.184	26.5	40	13.5
	159.368	25.2	40	14.8
	225.352	24.11	40	15.89
310	31.768	35.85	40	4.15
	150.208	23.6	40	16.4
	227.888	25.29	40	14.71
	244.012	26	40	14
418	39.188	30.1	40	9.9
	41.708	25.6	40	14.4
	81.868	23.9	40	16.1
	118.596	24.3	40	15.7
	267.212	26.6	40	13.4

Note: All measurements were indistinguishable from noise. A strong local ambient signal is present near 30 MHz. Measurements were made using a peak detector with Resolution BW of 120 kHz and Video BW of 300 kHz.

7.4.5. 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).

7.4.5.1. Plot of output power over supply voltage



7.4.5.2. Output power as a function of supply voltage

Supply Voltage (V)	Measured Field Strength (dBuV/m)
6	No Op
7	No Op
8	No Op
9	75.25
10	75.21
11	75.27
12	75.18
13	75.22
14	75.13
15	75.12
16	75.3
17	75.29
18	75.21

7.4.6. 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 47 CFR 15.205.

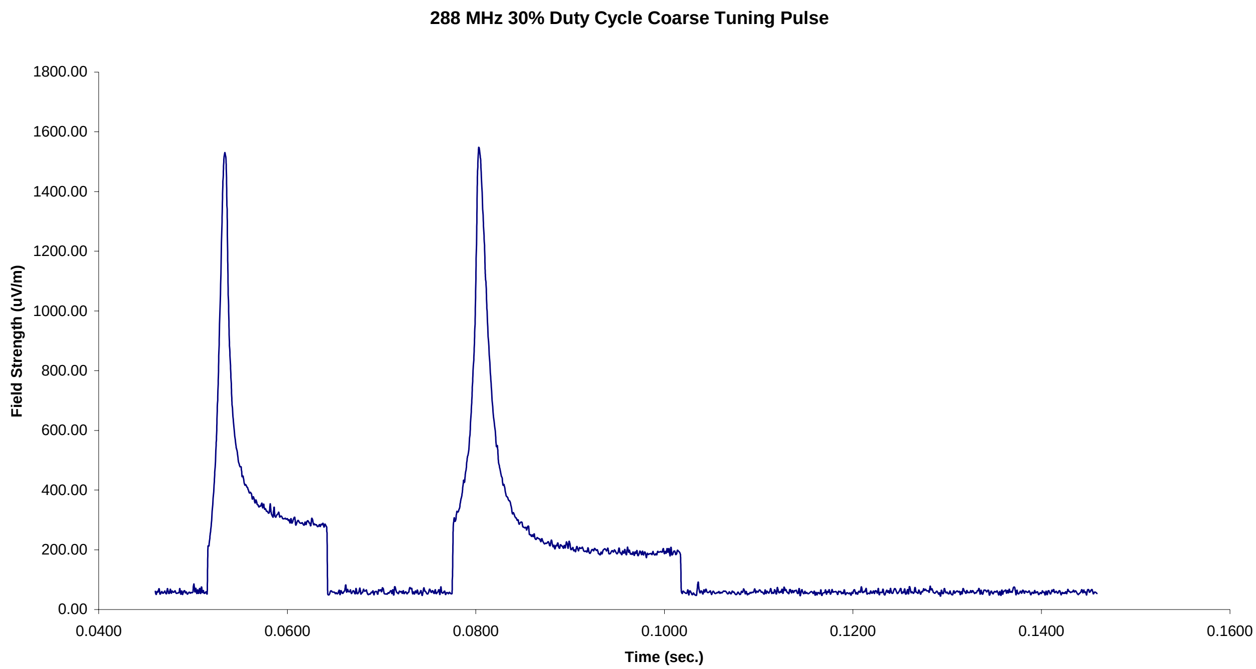
7.4.7. Verification of De-activation after 5 seconds

This device stops transmitting once the activation button in depressed.

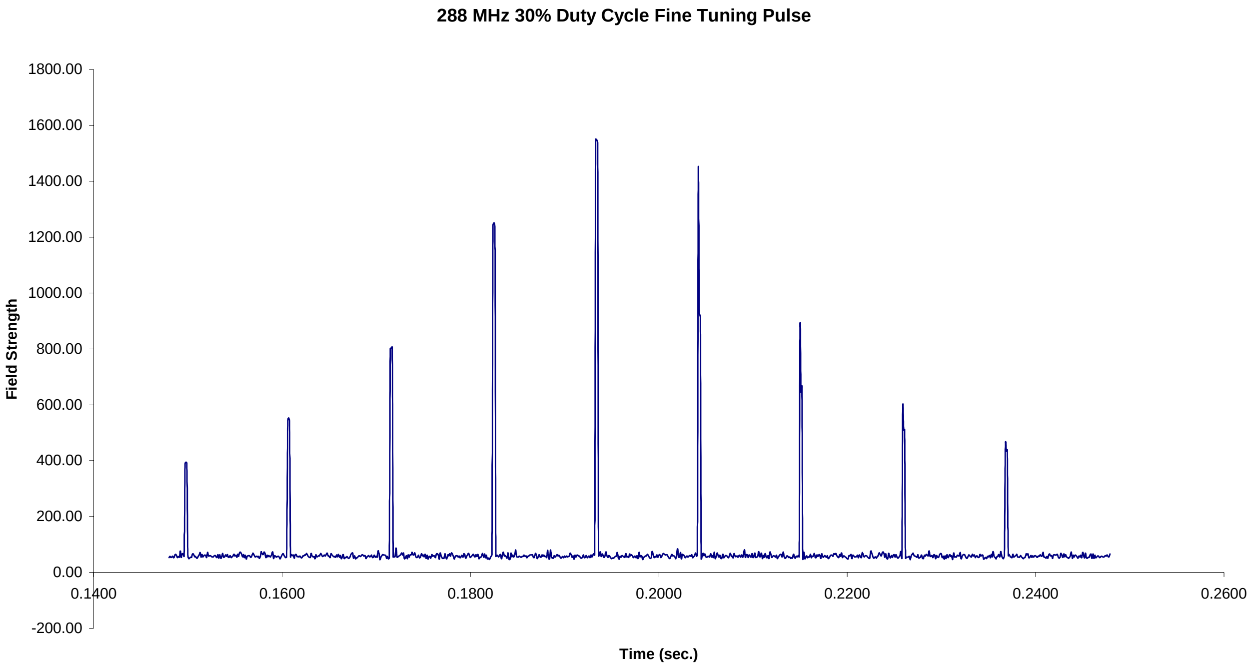
7.4.8. Tuning Pulse Measurements

This device uses pulses to tune the antenna prior to transmission. Measurements of these tuning pulses over 100msec windows show that these pulses are below the FCC limits for operation in this band. A summary of measurements is presented in section 7.4.8.7. Tuning pulse measurements were taken at 288, 310, and 418 MHz at a duty cycle of 30%.

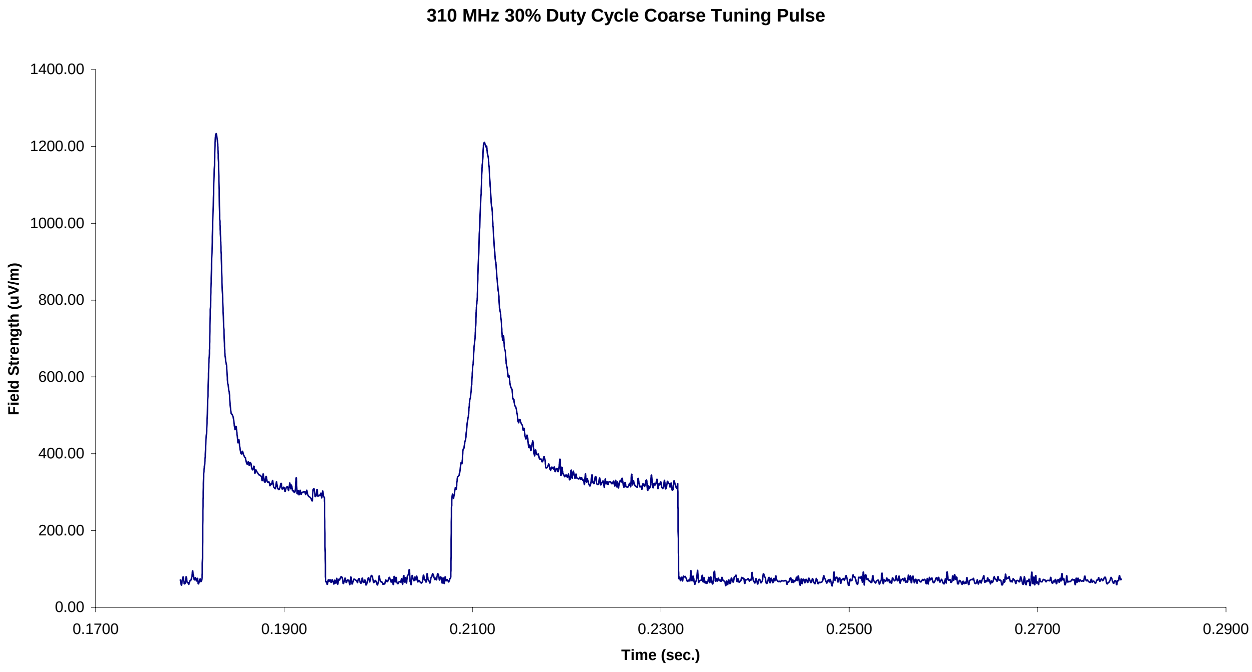
7.4.8.1. Coarse Tuning Pulse (288MHz)



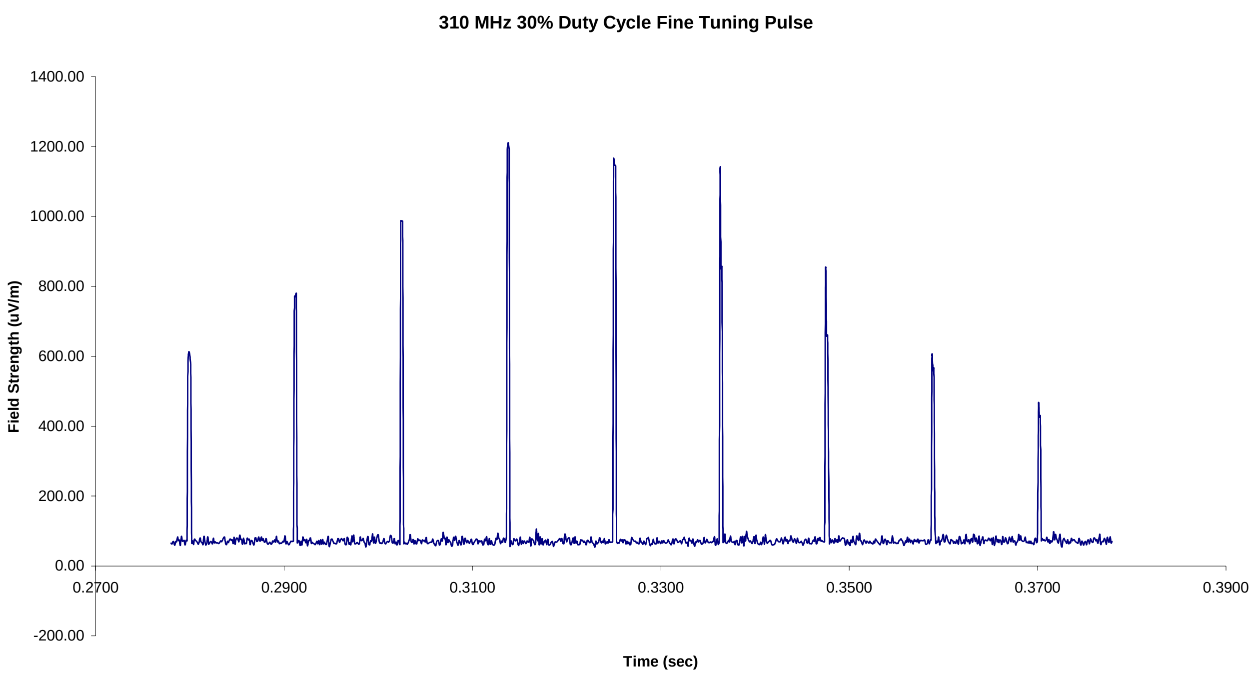
7.4.8.2. Fine Tuning Pulse (288MHz)



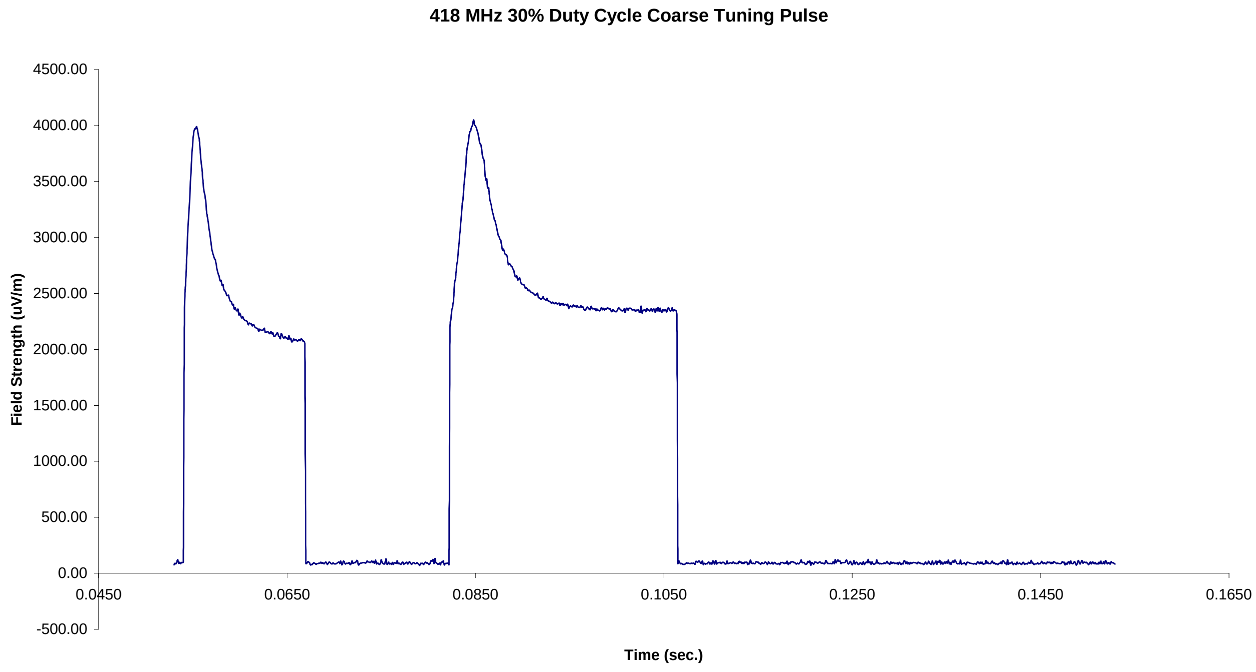
7.4.8.3. Coarse Tuning Pulse (310MHz)



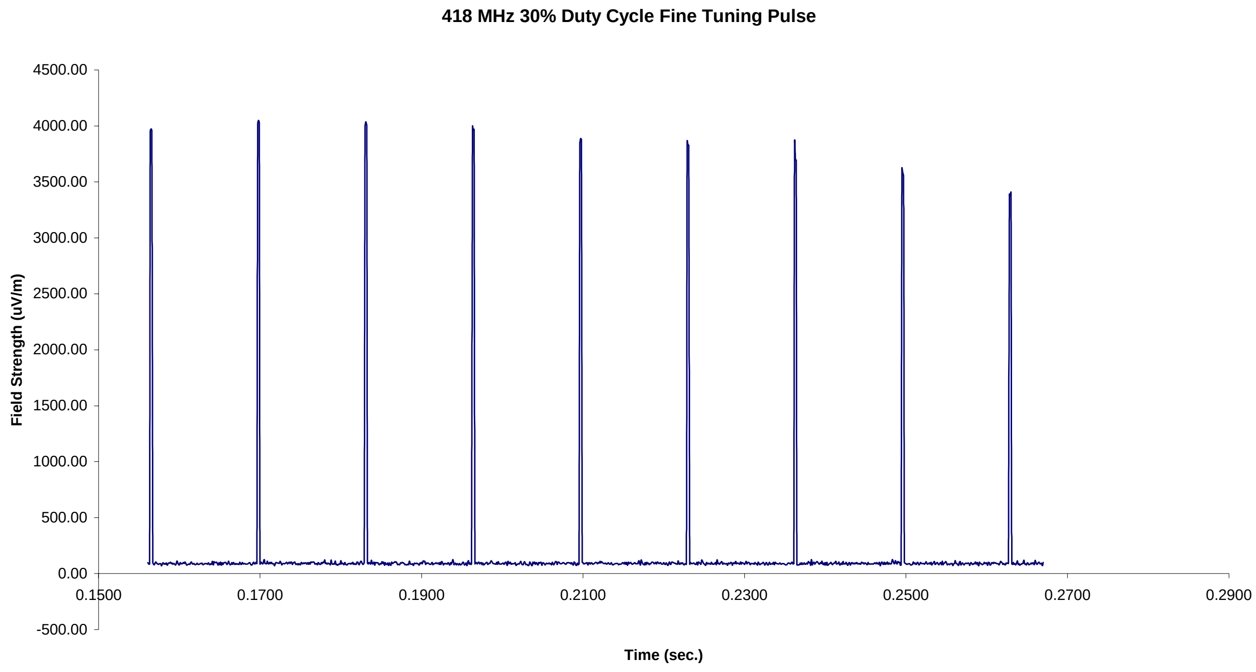
7.4.8.4. Fine Tuning Pulse (310MHz)



7.4.8.5. Coarse Tuning Pulse (418 MHz)



7.4.8.6. Fine Tuning Pulse (418MHz)



7.4.8.7. Summary of Tuning Pulse Measurements

	Frequency (MHz)	Average (uV/m)	Limit (uV/m)	Margin (dB)
Coarse	288	173	1476	18.6
	310	209	1751	18.4
	418	1023	3102	9.6

	Frequency (MHz)	Average (uV/m)	Limit (uV/m)	Margin (dB)
Fine	288	79	1476	25.4
	310	92	1751	25.6
	418	182	3102	24.6

7.5. Formulas and Sample Calculations

7.5.1. 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)

7.5.2. Calculation of FCC limits from 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
418MHz	20*log10(10334.7) = 80.3 dBuV/

NOTE: An adjustment of 10.45dB is used to adapt limits for 10m measurements.

8. Photos of Product Tested

8.1. Front View

Please refer to attachment named "front_view.jpg"

8.2. Rear View

Please refer to attachment named "rear_view.jpg"

8.3. Unit Disassembled

Please refer to attachment named "d_assym.jpg"

8.4. Light Board

Please refer to attachment named "light_front.jpg"
Please refer to attachment named "light_back.jpg"

8.5. Homelink© Accessory Board

Please refer to attachment named "hl3_front.jpg"
Please refer to attachment named "hl3_back.jpg"

9. 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”.
For tuning information please refer to attachment “tuning.pdf”.

9.3. Theory of Operation

For schematics please refer to attachment “theory_op.pdf”