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

FCC ID: CB2ACTLHL3
Form 731 Confirmation #: EA504983
7/29/2003

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 12volt 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

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

1.3. Test Methodology

Radiated Emissions testing was done according to ANSI C63.4-1992. 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.

Additional 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 C63.4-1992 were followed where possible. Exceptions are noted if present.

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 C63.4-1992 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.

A picture of the 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

The tests results presented in this report evaluate the EUT under to 47 CFR Part 15 subpart c. Additionally, the test method and exceptions approved by the FCC in communications (submitted with the report as an additional exhibit) were also applied. Normal testing of this device evaluates the EUT at 288, 310 and 418 MHz at 30, 50, and 80% duty cycles. For these tests the highest radiated emission measurement occurred at 310 MHz, side orientation and 30% duty cycle, in this configuration a horizontally polarized antenna measured a margin of 2.98dB to the FCC limits at this frequency. Harmonics measurements revealed a worst-case margin of 4.89 dB at 576 MHz. This situation was observed with the measurement antenna horizontally aligned and the EUT in the End orientation, the programmed duty cycle was 30%.

The purpose of this submission is to make a change to the EUT power setting in accordance with the vehicle level test method approved by the FCC. The change in question was made to the power settings at region near 390MHz. Measurements were taken at 10 m with the EUT installed in a 2004 Acura TL. With the measurement antenna in the vertical orientation and the duty cycle set to 30% the worst-case emission was found to be 1.6 dB below the FCC limit at 390 MHz. When measured at 3 m on the test table worst case emissions were found to be over the limit by 0.7dB when the EUT was in the side orientation and the measurement antenna was oriented horizontally. The worst-case harmonic also was found in this EUT orientation at 780 MHz. The margin to the FCC limit was for the 780 MHz harmonic was found to be 14.4 dB. These measurements indicate that the meets the criteria for a vehicle level certification.

Additional measurements were made to determine: occupied bandwidth, spurious emissions other than harmonics, variation of supply voltage, non-operation in restricted bands, deactivation after 5 seconds, also met the criteria set forth by the commission. Measurements of the tuning pulse, present in the original report, were also made and found to be below the FCC limit by 0.2 dB at 418 MHz, 30% duty cycle**.**

7.2. Test Equipment Used

Description	Model #	Serial Number	Last Cal Date	Cal Due
EMCO Biconical Antenna (20-300 MHz)	**3110B**	**9906-3309**	**10/21/02**	**10/21/03**
EMCO LPA Antenna (200-2000MHz)	**3148**	**9908-1076**	**10/21/02**	**10/21/03**
Electro-metrics Double Ridged Guide (1-18GHz)	**RGA-60**	**6147**	**10/21/02**	**10/21/03**
Agilent E-series EMC	**E7402A**	**7508**	**11/05/02**	**11/05/03**

Analyzer				
HP Preamp	**8447D**	**1937A03135**	**10/09/02**	**10/09/03**

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 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.

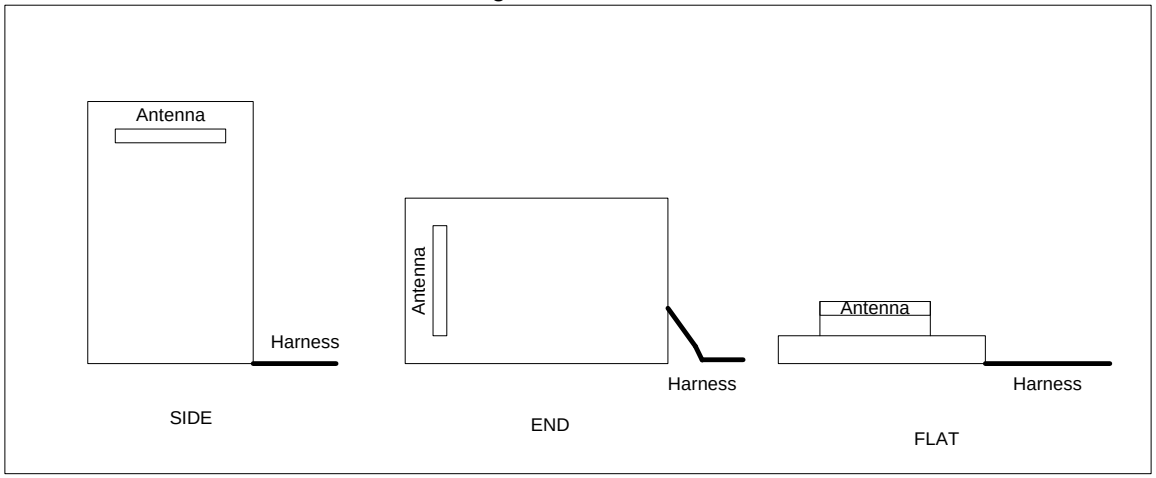


Figure 7.3.1 EUT Orthogonal Orientations

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.

7.4. Measured Data

7.4.1. Measurements of Fundamentals and Harmonics

Measurements described in this section were taken according to ANSI C63.4-1992 on the Johnson Controls 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)	Correction Factor (dB)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
288	Side	H	30	79.1	0	-10.5	68.6	73.8	5.2
288	Side	H	50	74	0	-6.0	68.0	73.8	5.9
288	Side	H	80	70.7	0	-1.9	68.8	73.8	**5.1**

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	Side	H	30	82.8	0	-10.46	72.34	75.32	**2.98**
310	Side	H	50	77.9	0	-6.02	71.88	75.32	3.44
310	Side	H	80	73.9	0	-1.94	71.96	75.32	3.36

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	Side	H	30	87.6	0	-10.46	77.14	80.28	**3.14**
418	Side	H	50	83.1	0	-6.02	77.08	80.28	3.21
418	Side	H	80	78.9	0	-1.94	76.96	80.28	3.32

7.4.1.4. 288MHz (Harmonics)

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)
576	End	H	30	59.4	0	-10.46	48.94	53.83	4.89
576	End	H	50	53.8	0	-6.02	47.78	53.83	6.05
576	End	H	80	46.2	0	-1.94	44.26	53.83	9.57
864	Flat	V	30	49.8	0	-10.46	39.34	53.83	14.49
864	Flat	V	50	49.8	0	-6.02	43.78	53.83	10.05
864	Flat	V	80	49.8	0	-1.94	47.86	53.83	5.97
1152	Flat	H	30	39.6	0	-10.46	29.14	53.83	24.69
1152	Flat	V	50	37.9	0	-6.02	31.88	53.83	21.95
1152	Flat	V	80	37.5	0	-1.94	35.56	53.83	18.27
1440	End	H	30	50.6	0	-10.46	40.14	53.83	13.69
1440	Flat	V	50	50.1	0	-6.02	44.08	53.83	9.75
1440	End	H	80	49.8	0	-1.94	47.86	53.83	5.97
1728	Side	V	30	41.8	0	-10.46	31.34	53.83	22.49
1728	Side	V	50	41.5	0	-6.02	35.48	53.83	18.35
1728	Side	V	80	41.2	0	-1.94	39.26	53.83	14.57
2016	Side	V	30	42	0	-10.46	31.54	53.83	22.29
2016	Side	V	50	42	0	-6.02	35.98	53.83	17.85
2016	Side	V	80	42	0	-1.94	40.06	53.83	13.77
2304	Side	V	30	42	0	-10.46	31.54	53.83	22.29
2304	Side	V	50	42	0	-6.02	35.98	53.83	17.85
2304	Side	V	80	42	0	-1.94	40.06	53.83	13.77
2592	Side	V	30	42	0	-10.46	31.54	53.83	22.29
2592	Side	V	50	42	0	-6.02	35.98	53.83	17.85
2592	Side	V	80	42	0	-1.94	40.06	53.83	13.77
2880	Side	V	30	42	0	-10.46	31.54	53.83	22.29
2880	Side	V	50	42	0	-6.02	35.98	53.83	17.85
2880	Side	V	80	42	0	-1.94	40.06	53.83	13.77

Ambient Noise

* Measurements include Cable corrections and Antenna Factors

7.4.1.5. 310MHz (Harmonics)

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)
620	End	H	30	59.4	0	-10.46	48.94	55.32	6.38
620	End	H	50	51.3	0	-6.02	45.28	55.32	10.04
620	End	V	80	45.8	0	-1.94	43.86	55.32	11.46
930	Flat	H	30	41.5	0	-10.46	31.04	55.32	24.28
930	Side	H	50	35.2	0	-6.02	29.18	55.32	26.14
930	Flat	H	80	32.1	0	-1.94	30.16	55.32	25.16
1240	Side	V	30	42.3	0	-10.46	31.84	55.32	23.48
1240	End	V	50	40.8	0	-6.02	34.78	55.32	20.54
1240	End	H	80	38.5	0	-1.94	36.56	55.32	18.76
1550	Flat	H	30	48.5	0	-10.46	38.04	55.32	17.28
1550	Flat	H	50	47.1	0	-6.02	41.08	55.32	14.24
1550	Side	V	80	43.1	0	-1.94	41.16	55.32	14.16
1860	End	H	30	41.1	0	-10.46	30.64	55.32	24.68
1860	Side	H	50	40.5	0	-6.02	34.48	55.32	20.84
1860	End	V	80	40.9	0	-1.94	38.96	55.32	16.36
2170	Side	V	30	41.6	0	-10.46	31.14	55.32	24.18
2170	Side	V	50	41.6	0	-6.02	35.58	55.32	19.74
2170	Side	V	80	41.6	0	-1.94	39.66	55.32	15.66
2480	End	V	30	45.5	0	-10.46	35.04	55.32	20.28
2480	End	V	50	45.5	0	-6.02	39.48	55.32	15.84
2480	End	V	80	45.5	0	-1.94	43.56	55.32	11.76
2790	Side	V	30	42	0	-10.46	31.54	55.32	23.78
2790	Side	V	50	42	0	-6.02	35.98	55.32	19.34
2790	Side	V	80	42	0	-1.94	40.06	55.32	15.26
3100	End	V	30	41.2	0	-10.46	30.74	55.32	24.58
3100	End	V	50	41.2	0	-6.02	35.18	55.32	20.14
3100	End	V	80	41.2	0	-1.94	39.26	55.32	16.06

Ambient Noise

7.4.1.6. 418MHz (Harmonics)

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)
836	Flat	H	30	62.4	0	-10.46	51.94	60.28	8.34
836	Side	H	50	52.7	0	-6.02	46.68	60.28	13.61
836	End	H	80	49.8	0	-1.94	47.86	60.28	12.42
1254	End	V	30	46.5	0	-10.46	36.04	60.28	24.24
1254	End	V	50	44.6	0	-6.02	38.58	60.28	21.71
1254	End	H	80	41.8	0	-1.94	39.86	60.28	20.42
1672	Flat	V	30	45.2	0	-10.46	34.74	60.28	25.54
1672	Side	H	50	44.5	0	-6.02	38.48	60.28	21.81
1672	Flat	H	80	42.9	0	-1.94	40.96	60.28	19.32
2090	End	V	30	44.5	0	-10.46	34.04	60.28	26.24
2090	End	V	50	44.5	0	-6.02	38.48	60.28	21.81
2090	End	V	80	44.5	0	-1.94	42.56	60.28	17.72
2508	Side	V	30	41.3	0	-10.46	30.84	60.28	29.44
2508	Side	V	50	41.3	0	-6.02	35.28	60.28	25.01
2508	Side	V	80	41.3	0	-1.94	39.36	60.28	20.92
2926	Flat	V	30	40.7	0	-10.46	30.24	60.28	30.04
2926	Flat	V	50	40.7	0	-6.02	34.68	60.28	25.61
2926	Flat	V	80	40.7	0	-1.94	38.76	60.28	21.52
3344	Flat	V	30	39.7	0	-10.46	29.24	60.28	31.04
3344	Flat	V	50	39.7	0	-6.02	33.68	60.28	26.61
3344	Flat	V	80	39.7	0	-1.94	37.76	60.28	22.52
3762	Side	V	30	40	0	-10.46	29.54	60.28	30.74
3762	Side	V	50	40	0	-6.02	33.98	60.28	26.31
3762	Side	V	80	40	0	-1.94	38.06	60.28	22.22
4180	End	V	30	40.6	0	-10.46	30.14	60.28	30.14
4180	End	V	50	40.6	0	-6.02	34.58	60.28	25.71
4180	End	V	80	40.6	0	-1.94	38.66	60.28	21.62

Ambient Noise

7.4.1.7. 390 MHz Fundamental (in vehicle)

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	Vehicle	V	30	77.6	0	-10.5	67.1	68.8	**1.6**
390	Vehicle	V	50	72.8	0	-6.0	66.8	68.8	2.0
390	Vehicle	V	80	68.3	0	-1.9	66.4	68.8	2.4

* Measurements include Cable corrections and Antenna Factors
** 3m extrapolated to 10m

7.4.1.8. 390 MHz Fundamental (on table)

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	Side	H	30	90	0	-10.5	79.5	79.2	-0.3
390	Side	H	50	85.5	0	-6.0	79.5	79.2	-0.2
390	Side	H	80	80.5	0	-1.9	78.6	79.2	**0.7**

* Measurements include Cable corrections and Antenna Factors

7.4.1.9. 390 MHz Harmonics

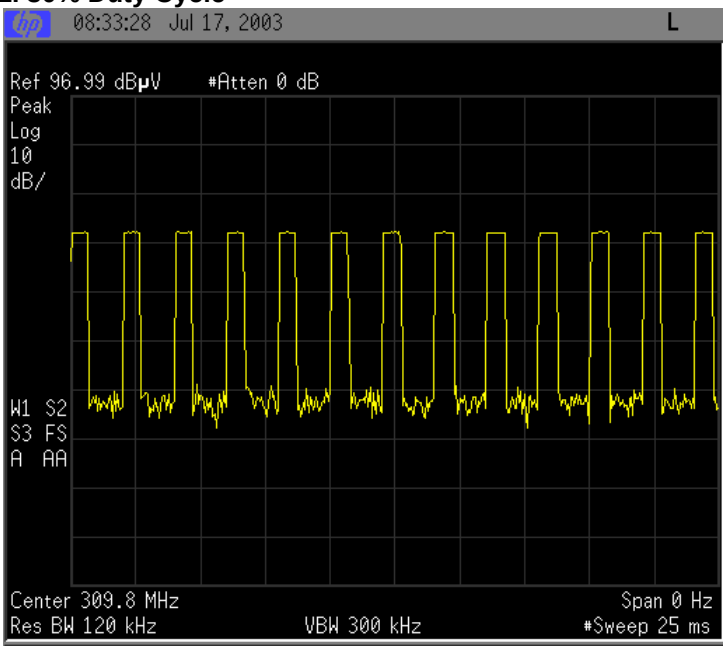
Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	Correction Factor (dB)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
780	End	H	30	55.3	0	-10.46	44.84	59.24	14.40
780	End	H	50	49.8	0	-6.02	43.78	59.24	15.46
780	End	H	80	43.9	0	-1.94	41.96	59.24	17.28
1170	Side	V	30	47.6	0	-10.46	37.14	59.24	22.10
1170	End	V	50	41.4	0	-6.02	35.38	59.24	23.86
1170	Side	V	80	39.7	0	-1.94	37.76	59.24	21.48
1560	Flat	H	30	49.1	0	-10.46	38.64	59.24	20.60
1560	Side	V	50	47.3	0	-6.02	41.28	59.24	17.96
1560	Side	V	80	39.7	0	-1.94	37.76	59.24	21.48
1950	Flat	H	30	50.2	0	-10.46	39.74	59.24	19.50
1950	End	V	50	45.9	0	-6.02	39.88	59.24	19.36
1950	End	V	80	44.7	0	-1.94	42.76	59.24	16.48
2340	Side	V	30	41.3	0	-10.46	30.84	59.24	28.40
2340	Side	V	50	41.3	0	-6.02	35.28	59.24	23.96
2340	Side	V	80	41.3	0	-1.94	39.36	59.24	19.88
2730	End	V	30	43.5	0	-10.46	33.04	59.24	26.20
2730	End	V	50	43.5	0	-6.02	37.48	59.24	21.76
2730	End	V	80	43.5	0	-1.94	41.56	59.24	17.68
3120	Side	V	30	43.6	0	-10.46	33.14	59.24	26.10
3120	Side	V	50	43.6	0	-6.02	37.58	59.24	21.66
3120	Side	V	80	43.6	0	-1.94	41.66	59.24	17.58
3510	Flat	V	30	44.8	0	-10.46	34.34	59.24	24.90
3510	Flat	V	50	44.8	0	-6.02	38.78	59.24	20.46
3510	Flat	V	80	44.8	0	-1.94	42.86	59.24	16.38
3900	Flat	V	30	44.7	0	-10.46	34.24	59.24	25.00
3900	Flat	V	50	44.7	0	-6.02	38.68	59.24	20.56
3900	Flat	V	80	44.7	0	-1.94	42.76	59.24	16.48

Ambient Noise
* Measurements include Cable corrections and Antenna Factors

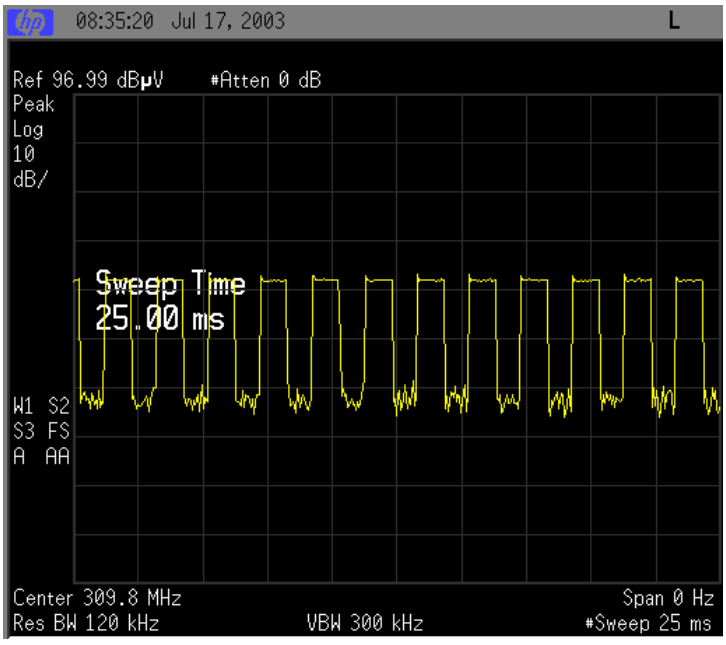
7.4.2. Pulsed Operation

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 E7402A spectrum analyzer.

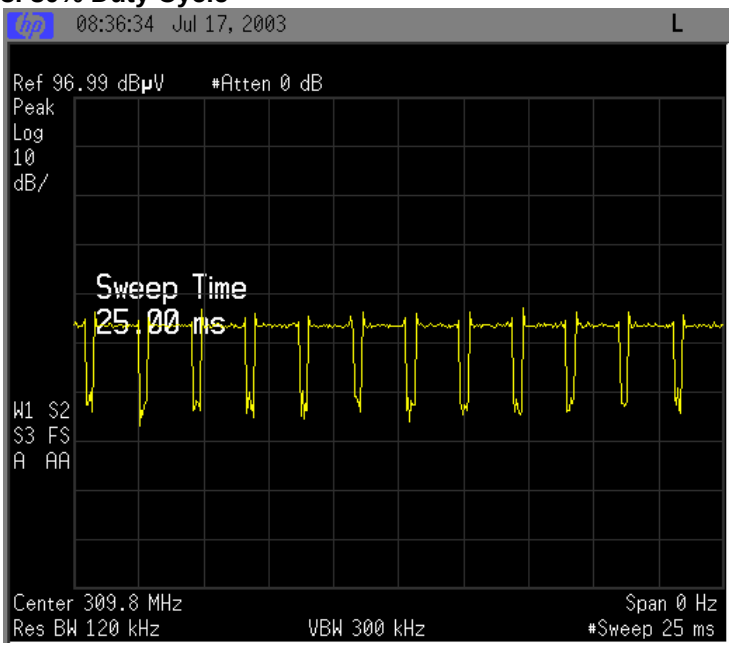
7.4.2.1. 30% Duty Cycle



7.4.2.2. 50% Duty Cycle



7.4.2.3. 80% Duty Cycle



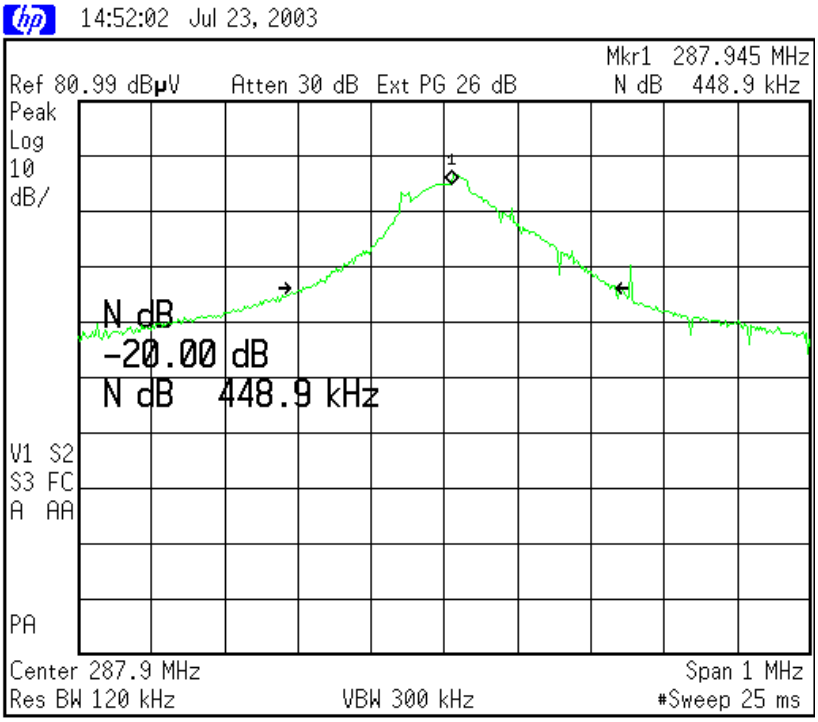
7.4.3. Occupied Bandwidth

Occupied bandwidth measurements were taken at 288, 310, and 418 MHz. The occupied bandwidth was determined by finding the points where the signal attenuated 20dB down from the peak. The difference between the two points in frequency was found to be the occupied bandwidth.

7.4.3.1. Occupied Bandwidth Measurements

Frequency (MHz)	Duty Cycle (%)	20dB low (MHz)	20dB high (MHz)	Occ BW (MHz)	Limit (Mhz)
288	30	287.85	288.30	0.45	0.72
288	50	287.73	288.16	0.43	0.72
288	80	287.76	288.17	0.42	0.72
310	30	309.65	310.15	0.50	0.78
310	50	309.70	310.20	0.50	0.78
310	80	309.65	310.10	0.45	0.78
418	30	417.79	418.35	0.56	1.05
418	50	417.70	418.18	0.48	1.05
418	80	417.75	418.17	0.43	1.05

7.4.3.2. Example of Occupied Bandwidth measurement (288MHz 50% Duty Cycle)



7.4.4. Emission Spectrum

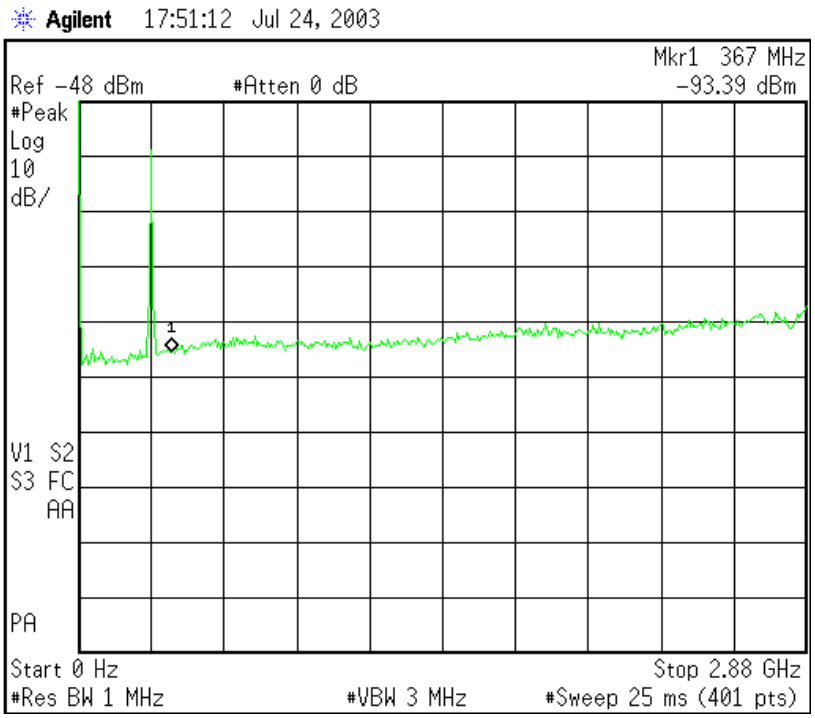
Measurements were taken inside a semi-anechoic chamber to investigate the possibility of other spurious emissions from the DUT. Screen captures presented below in sections 7.4.4.1-3 show the spurious emissions observed with the DUT trained to 288, 310, and 418MHz with a 30% Duty cycle.

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

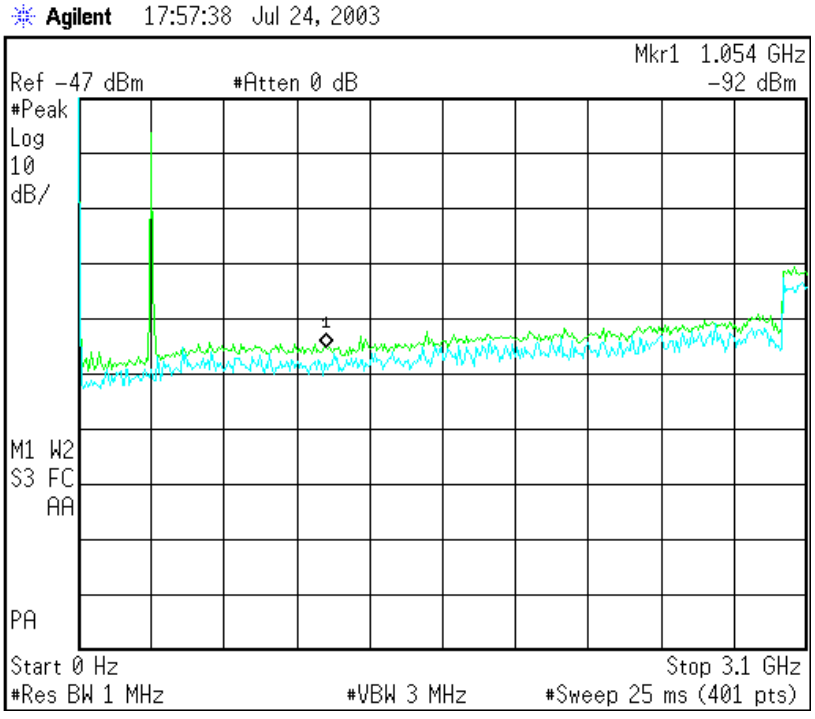
Measurement settings:

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

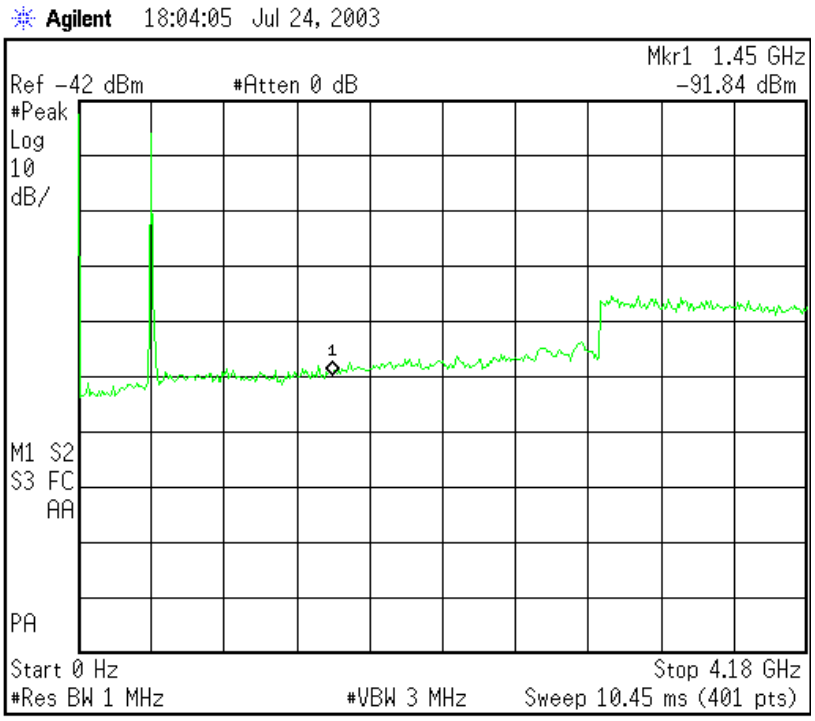
7.4.4.1. 288 MHz



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 Agilent E4407B spectrum analyzer.

7.4.4.4. Summary of Emissions Measurements Taken on OATS

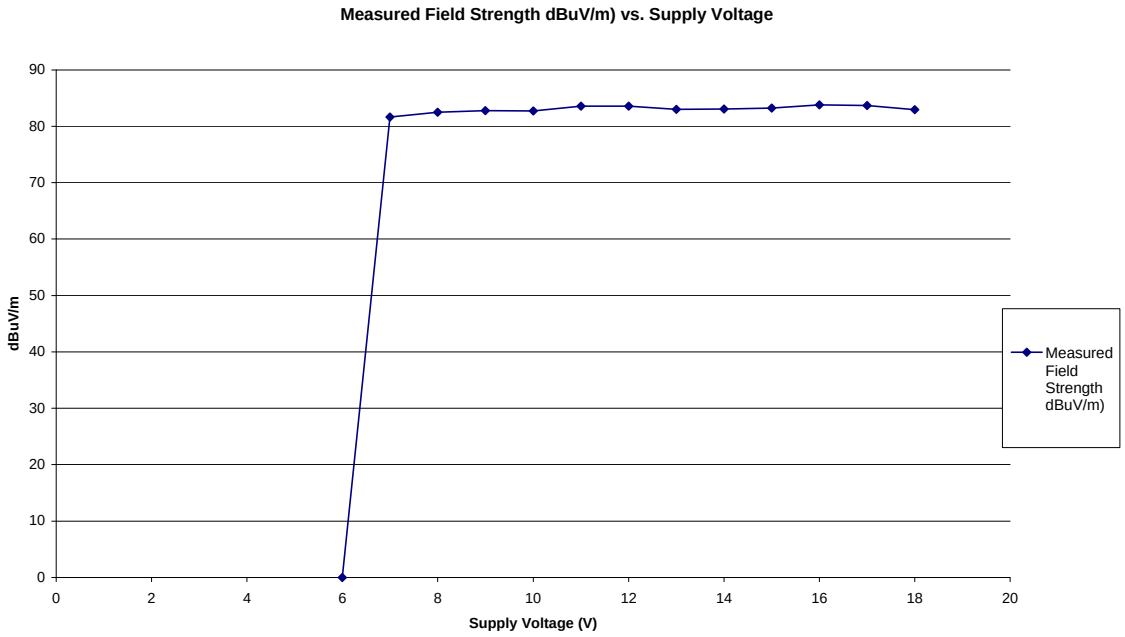
DUT Trained Frequency (MHz)	Frequency (MHz)	Measurement (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
288	31.6	39.4	40	0.6
	32.6	33.7	40	6.3
	51.2	33.37	40	6.63
310	55.11	26.8	40	13.2
418	31	36.05	40	3.95
	55.48	26.88	40	13.12

Note: All measurements were indistinguishable from noise. A strong local ambient signal is present near 30 MHz. Measurements were made using a quasi-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

Voltage	Measured Field Strength dBuV/m)
6	no op
7	81.63
8	82.53
9	82.77
10	82.71
11	83.59
12	83.56
13	83.04
14	83.06
15	83.25
16	83.82
17	83.69
18	82.95

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.

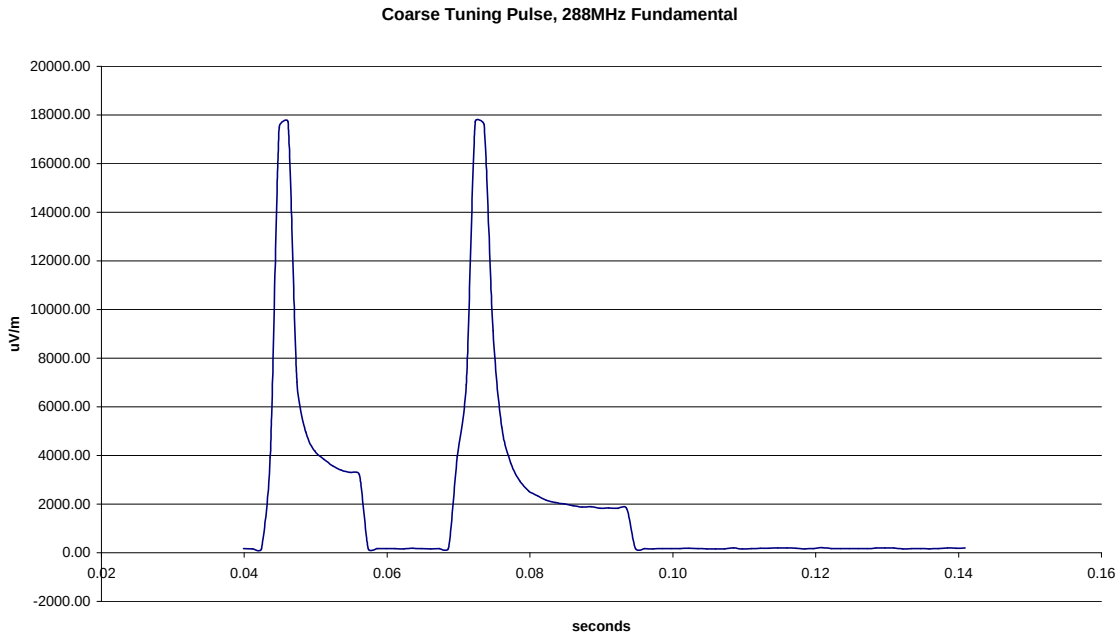
7.4.7. Verification of De-activation after 5 seconds

This device stops transmitting once the activation button in depressed.

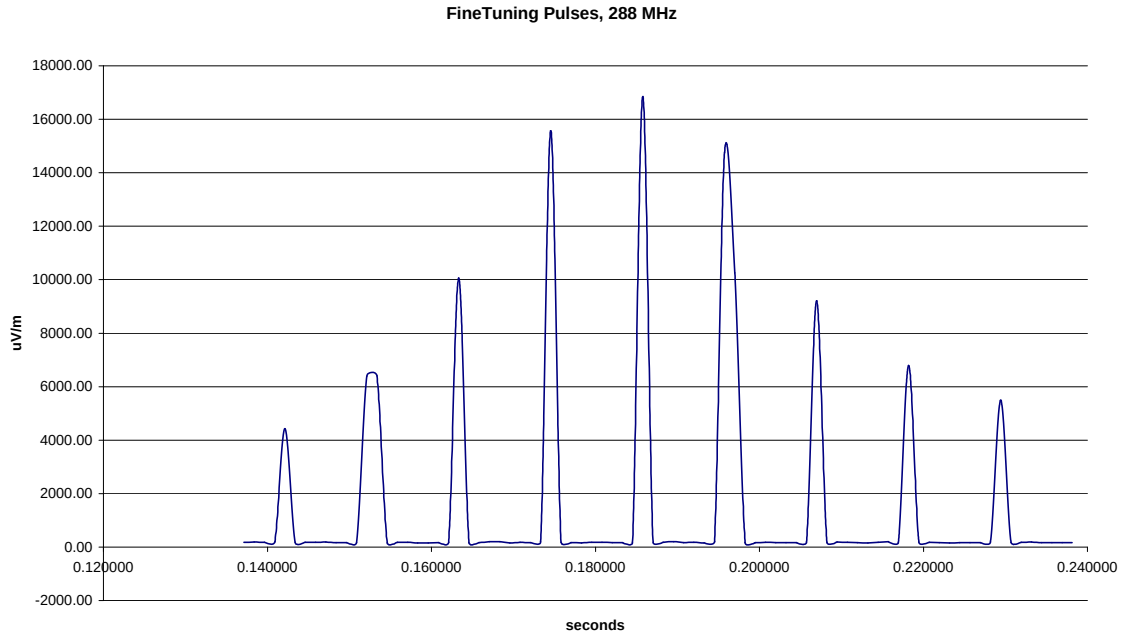
7.4.8. Tuning Pulse Measurements

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%.

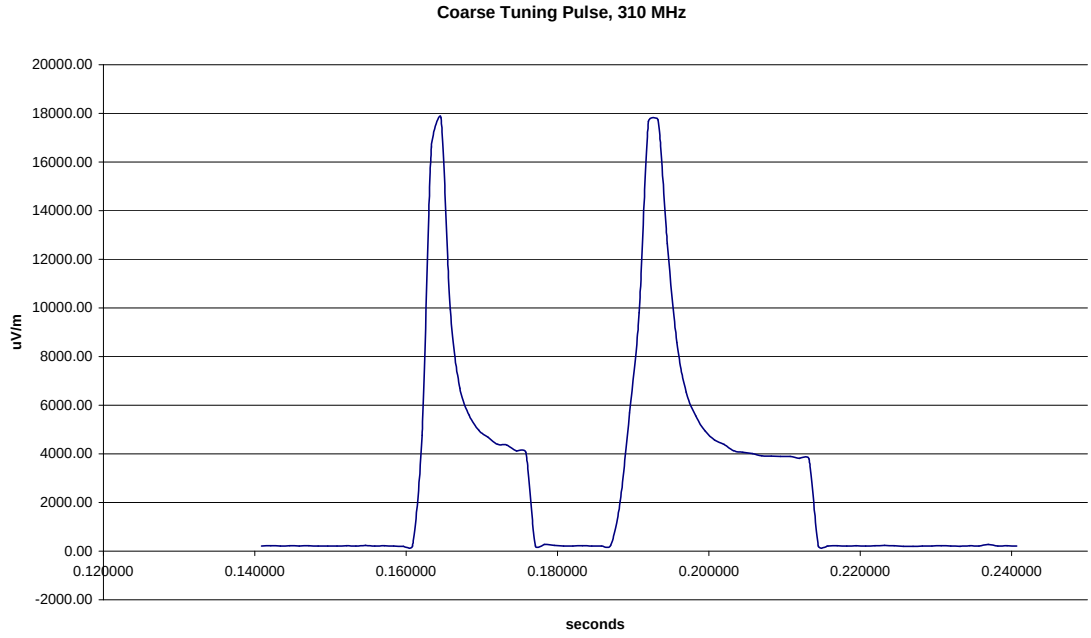
7.4.8.1. Coarse Tuning Pulse (288MHz)



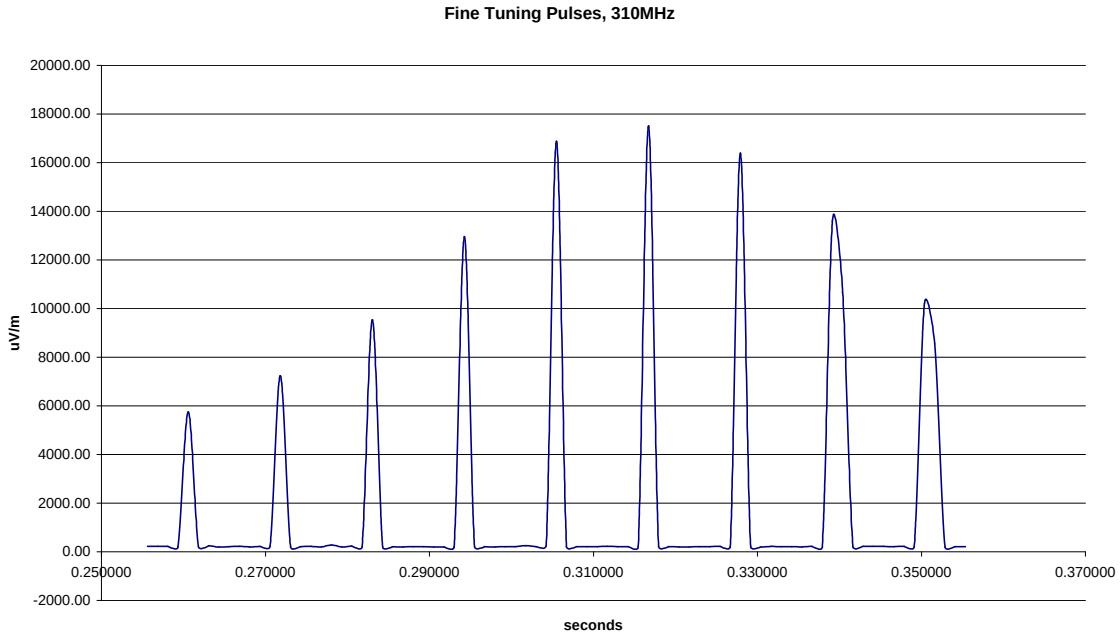
7.4.8.2. Fine Tuning Pulse (288MHz)



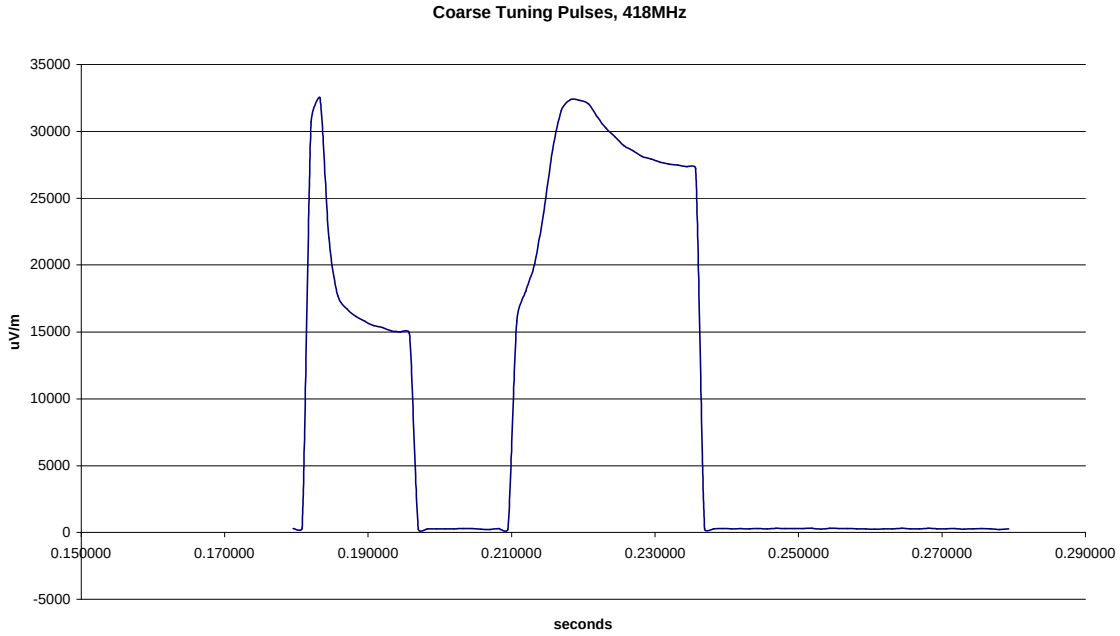
7.4.8.3. Coarse Tuning Pulse (310MHz)



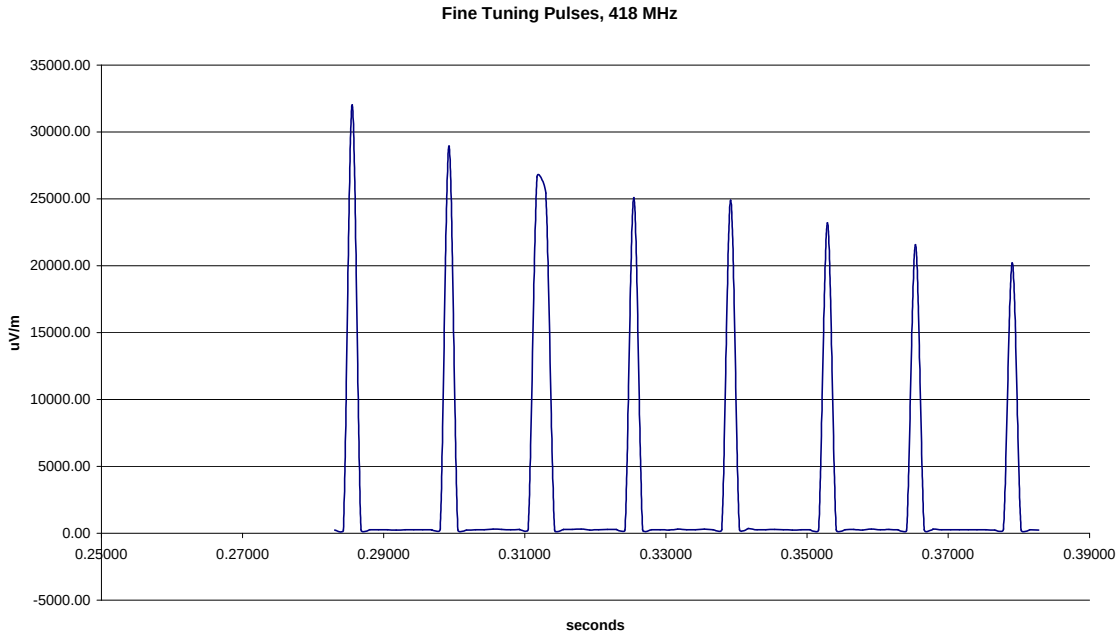
7.4.8.4. Fine Tuning Pulse (310MHz)



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	2110	4917	7.3
	310	2892	5833	6.1
	418	10093	10333	0.2

	Frequency (MHz)	Average (uV/m)	Limit (uV/m)	Margin (dB)
Fine	288	1450	4917	10.6
	310	1783	5833	10.3
	418	3061	10333	10.6

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/m

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”