November 28, 2005

Technical Report to the FCC and IC Regarding Johnson Controls Interiors, L.L.C. Homelink© III Model: CB2MOTHL3 FCC ID: CB2MOTHL3 IC: 279B-MOTHL3 11/28/2005

A report concerning approval for Johnson Controls Homelink® model CB2MOTHL3
Please issue grant immediately upon review.
Confidentiality applied to the following sections according to 47 CFR 0.459 and RSP-100:

Circuit Block Diagrams, attachment "hl_block_diag.pdf"
Theory/Description of Operation "theory_op.pdf"
Schematics attachment "schematics.pdf"

Measurements Made by:

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Measurements Observed 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 available as an aftermarket accessory intended for fitment in automobiles and motorcycles. It is powered by two 12V batteries, size 23A.

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.

Because this unit is intended for use with batteries only, no harness was used during testing.

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

None.

1.3. Test Methodology

Radiated Emissions testing was done according to ANSI C63.4-2003. The power source for this product is two (23A) 12V batteries included with the device, thus conducted emissions measurements are not required.

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. The test site has been fully described in a reports 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. Our OATS is registered with the IC under file number IC 3593.

1.5. Accreditation

The Johnson Controls, Inc. - Electronics Validation Lab is accredited to ISO 17025 by the American Association for Laboratory Accreditation (A2LA). Our laboratory scope and accreditation certificate (#1869.01) 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: CB2MOTHL3. The Industry Canada certification number is 279B-MOTHL3. These identifiers will be embossed on the product housing.

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 Figure 9(c). The EUT was placed on a 1 x 1.5m non-metallic table elevated 80cm above a conducting ground plane.

A picture of the radiated test setup is included below

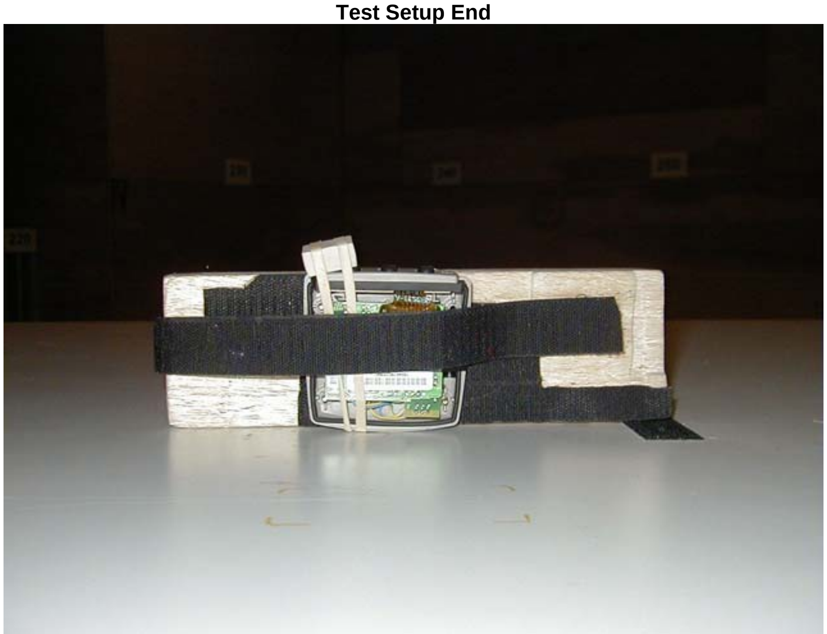
4. Block Diagram

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

5. Test Setup Photographs

Test Setup Flat

Test Setup End



Test Setup Side

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 emission of 72.4 dBuV/m** occurred with the DUT trained to 418 MHz, 50% duty cycle. The worst-case emission remained **2.9 dB below the FCC and IC limits** (75.3 dBuV/m) for this type of device.
- The **worst-case harmonic measurement of 58.5 dBuV/m** was found at 576 MHz, the second harmonic of 288 MHz at 50% duty cycle**. A margin**

of 1.4 dB 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 158 kHz when the DUT is trained to 418 MHz, 30% duty cycle.
- This device has a worst case Class B emission of 39.3 dBuV/m at 80 MHz when set to transmit at 288 MHz a margin of 0.7 dB to the Class B limit is maintained.
- 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 7445 uV/m over 100 msec. This represents a margin on 2.4 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**	**7/15/05**	**7/15/07**
EMCO LPA Antenna (200-2000MHz)	**3148**	**9908-1076**	**7/14/05**	**7/14/07**
Electro-metrics Double Ridged Guide (1-18GHz)	**RGA-60**	**6147**	**10/21/03**	**10/21/05**
A.H. Systems Bicon Antenna	**SAS-540**	**599**	**8/1/05**	**8/1/06**
Agilent E-series EMC Analyzer	**E4407B**	**US41192569**	**10/18/05**	**10/18/06**
HP Spectrum Analyzer	**8591A**	**S919A00107**	**10/17/05**	**10/17/06**

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)
1 kHz (to determine occupied bandwidth)
Video Bandwidth: 3 MHz (to determine peak level)
3 kHz (to determine occupied bandwidth)

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. (Note: There is no harness used for this product)

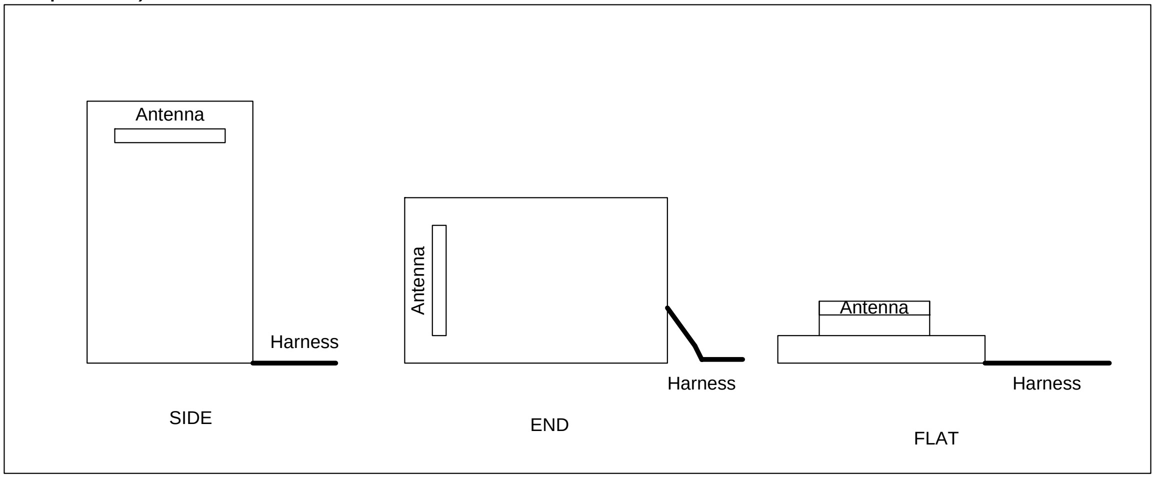


Figure 7.3.1 EUT Orthogonal Orientations

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 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)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
288	Side	H	30	80.89	-10.46	70.4	73.8	3.4
288	Side	H	50	76.53	-6.02	70.5	73.8	3.3
288	Side	H	80	72.76	-1.94	70.8	73.8	**3.0**

* 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	Side	H	30	82.71	-10.5	72.3	75.3	3.1
310	Side	H	50	77.83	-6.0	71.8	75.3	3.5
310	Side	H	80	74.35	-1.9	72.4	75.3	**2.9**

* Measurements include Cable corrections and Antenna Factors

7.4.1.3. DUT Tuned to 418MHz (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)
418	End	V	30	83.92	-10.5	73.5	80.3	6.8
418	End	V	50	81.26	-6.0	75.2	80.3	**5.0**
418	End	V	80	76.58	-1.9	74.6	80.3	5.6

* Measurements include Cable corrections and Antenna Factors

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	H	30	60.78	-10.5	50.3	53.8	3.5
576	Flat	H	50	58.5	-6.0	52.5	53.8	**1.4**
576	Flat	H	80	54.3	-1.9	52.4	53.8	1.5
864	Flat	V	30	Ambient	-10.5	N/A	53.8	N/A
864	Flat	V	50	Ambient	-6.0	N/A	53.8	N/A
864	Flat	V	80	Ambient	-1.9	N/A	53.8	N/A
1152	Flat	H	30	46.83	-10.5	36.4	53.8	17.5
1152	Side	H	50	45.72	-6.0	39.7	53.8	14.1
1152	Side	H	80	42.61	-1.9	40.7	53.8	13.2
1440	Side	H	30	49.86	-10.5	39.4	53.8	14.4
1440	Flat	H	50	45.34	-6.0	39.3	53.8	14.5
1440	Side	H	80	44.42	-1.9	42.5	53.8	11.4
1728	Flat	H	30	45.91	-10.5	35.5	53.8	18.4
1728	Flat	H	50	38.47	-6.0	32.4	53.8	21.4
1728	Flat	H	80	38.24	-1.9	36.3	53.8	17.5
2016	Side	H	30	50.8	-10.5	40.3	53.8	13.5
2016	Side	H	50	46.95	-6.0	40.9	53.8	12.9
2016	Side	H	80	45.62	-1.9	43.7	53.8	10.2
2304	Side	V	30	Noise	-10.5	N/A	53.8	N/A
2304	Side	V	50	Noise	-6.0	N/A	53.8	N/A
2304	Side	V	80	Noise	-1.9	N/A	53.8	N/A
2592	Flat	V	30	Noise	-10.5	N/A	53.8	N/A
2592	Flat	V	50	Noise	-6.0	N/A	53.8	N/A
2592	Flat	V	80	Noise	-1.9	N/A	53.8	N/A
2880	Flat	V	30	Noise	-10.5	N/A	53.8	N/A
2880	Flat	V	50	Noise	-6.0	N/A	53.8	N/A
2880	Flat	V	80	Noise	-1.9	N/A	53.8	N/A

Ambient   Noise Floor

* 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)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
619	End	H	30	59.68	-10.5	49.2	55.3	**6.1**
619	End	H	50	50.49	-6.0	44.5	55.3	10.8
619	End	H	80	48.4	-1.9	46.5	55.3	8.8
928.5	Flat	V	30	Ambient	-10.5	N/A	55.3	N/A
928.5	Flat	V	50	Ambient	-6.0	N/A	55.3	N/A
928.5	Flat	V	80	Ambient	-1.9	N/A	55.3	N/A
1238	Flat	H	30	50.81	-10.5	40.4	54.0	13.6
1238	Side	V	50	42.35	-6.0	36.3	54.0	17.7
1238	Flat	V	80	41.35	-1.9	39.4	54.0	14.6
1547.5	Flat	H	30	44.88	-10.5	34.4	54.0	19.6
1547.5	Flat	H	50	43.89	-6.0	37.9	54.0	16.1
1547.5	Flat	H	80	44.02	-1.9	42.1	54.0	11.9
1857	Flat	V	30	Ambient	-10.5	N/A	55.3	N/A
1857	Flat	V	50	Ambient	-6.0	N/A	55.3	N/A
1857	Flat	V	80	Ambient	-1.9	N/A	55.3	N/A
2166.5	Flat	V	30	Noise	-10.5	N/A	55.3	N/A
2166.5	Flat	V	50	Noise	-6.0	N/A	55.3	N/A
2166.5	Flat	V	80	Noise	-1.9	N/A	55.3	N/A
2476	Flat	V	30	Noise	-10.5	N/A	55.3	N/A
2476	Flat	V	50	Noise	-6.0	N/A	55.3	N/A
2476	Flat	V	80	Noise	-1.9	N/A	55.3	N/A
2785.5	Flat	V	30	Noise	-10.5	N/A	54.0	N/A
2785.5	Flat	V	50	Noise	-6.0	N/A	54.0	N/A
2785.5	Flat	V	80	Noise	-1.9	N/A	54.0	N/A
3095	Flat	V	30	Noise	-10.5	N/A	55.3	N/A
3095	Flat	V	50	Noise	-6.0	N/A	55.3	N/A
3095	Flat	V	80	Noise	-1.9	N/A	55.3	N/A

Ambient   Noise Floor

* Measurements include Cable corrections and Antenna Factors

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	H	30	64.71	-10.5	54.3	60.3	**6.0**
836	Flat	H	50	57.56	-6.0	51.5	60.3	8.7
836	Flat	H	80	49.67	-1.9	47.7	60.3	12.6
1254	Flat	H	30	54.88	-10.5	44.4	60.3	15.9
1254	Flat	H	50	51.46	-6.0	45.4	60.3	14.8
1254	Flat	H	80	49.25	-1.9	47.3	60.3	13.0
1672	End	H	30	45.44	-10.5	35.0	54.0	19.0
1672	Side	V	50	44.69	-6.0	38.7	54.0	15.3
1672	Side	V	80	43.95	-1.9	42.0	54.0	12.0
2090	End	V	30	49.51	-10.5	39.1	60.3	21.2
2090	Side	V	50	46.95	-6.0	40.9	60.3	19.4
2090	Side	V	80	46.47	-1.9	44.5	60.3	15.8
2508	Side	V	30	Noise	-10.5	N/A	60.3	N/A
2508	Side	V	50	Noise	-6.0	N/A	60.3	N/A
2508	Side	V	80	Noise	-1.9	N/A	60.3	N/A
2926	Side	V	30	Noise	-10.5	N/A	60.3	N/A
2926	Side	V	50	Noise	-6.0	N/A	60.3	N/A
2926	Side	V	80	Noise	-1.9	N/A	60.3	N/A
3344	Side	V	30	Noise	-10.5	N/A	60.3	N/A
3344	Side	V	50	Noise	-6.0	N/A	60.3	N/A
3344	Side	V	80	Noise	-1.9	N/A	60.3	N/A
3762	Side	V	30	Noise	-10.5	N/A	54.0	N/A
3762	Side	V	50	Noise	-6.0	N/A	54.0	N/A
3762	Side	V	80	Noise	-1.9	N/A	54.0	N/A
4180	Side	V	30	Noise	-10.5	N/A	54.0	N/A
4180	Side	V	50	Noise	-6.0	N/A	54.0	N/A
4180	Side	V	80	Noise	-1.9	N/A	54.0	N/A

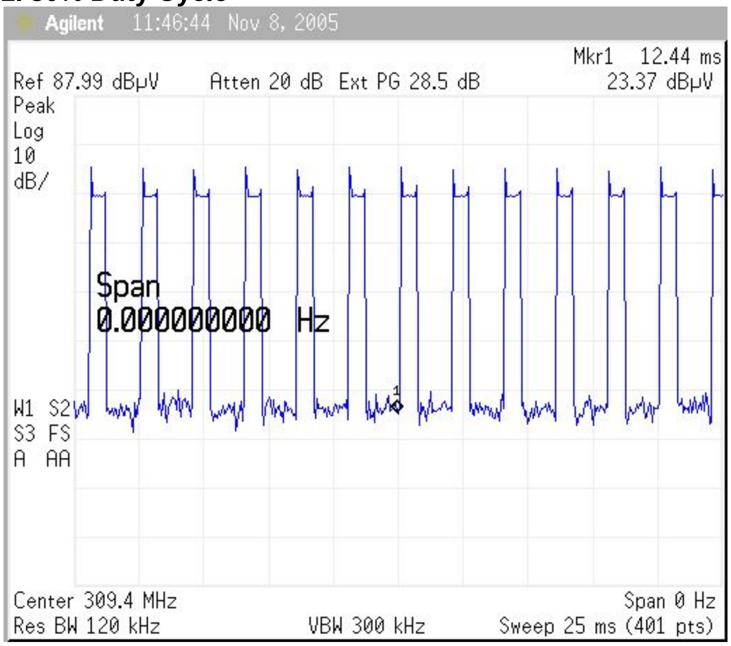
Noise

* Measurements include Cable corrections and Antenna Factors

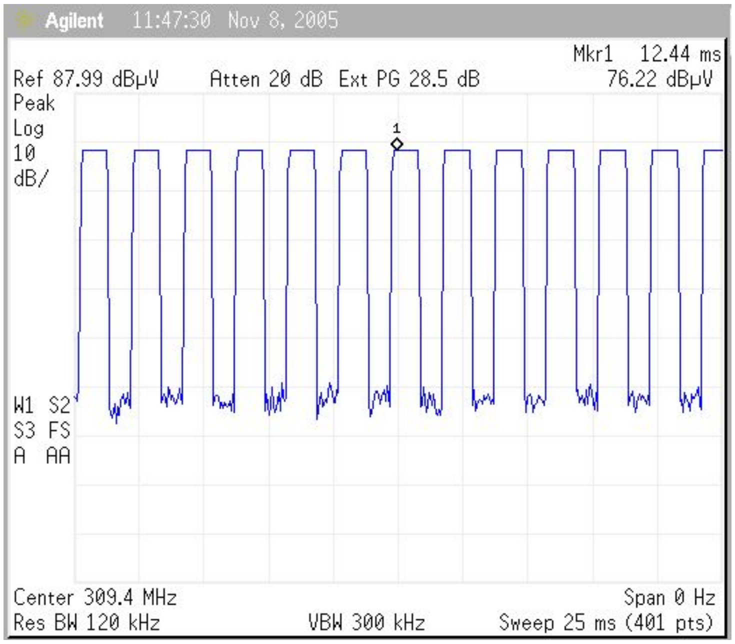
7.4.2. Pulsed Operation

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 288MHz with the span set to zero on the E7407B spectrum analyzer.

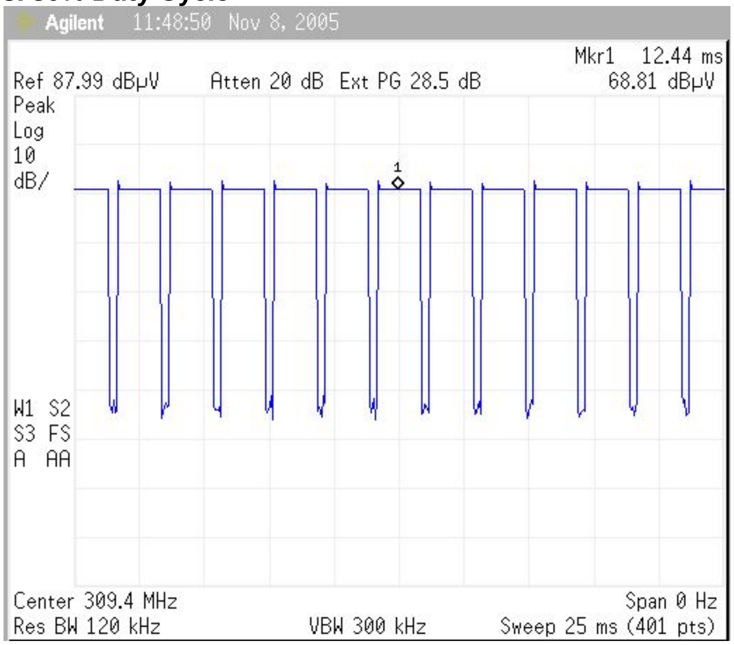
7.4.2.1. 30% Duty Cycle



7.4.2.2. 50% Duty Cycle



7.4.2.3. 80% Duty Cycle



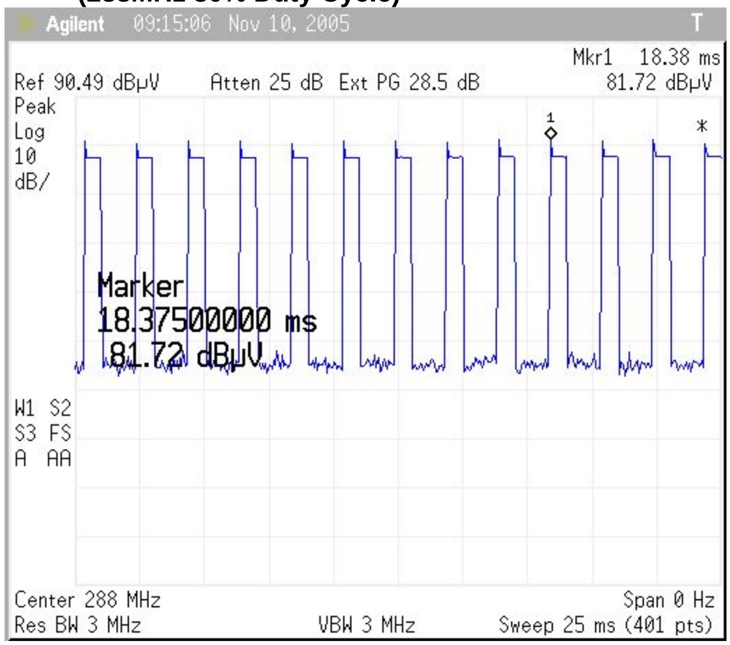
7.4.3. Occupied Bandwidth

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

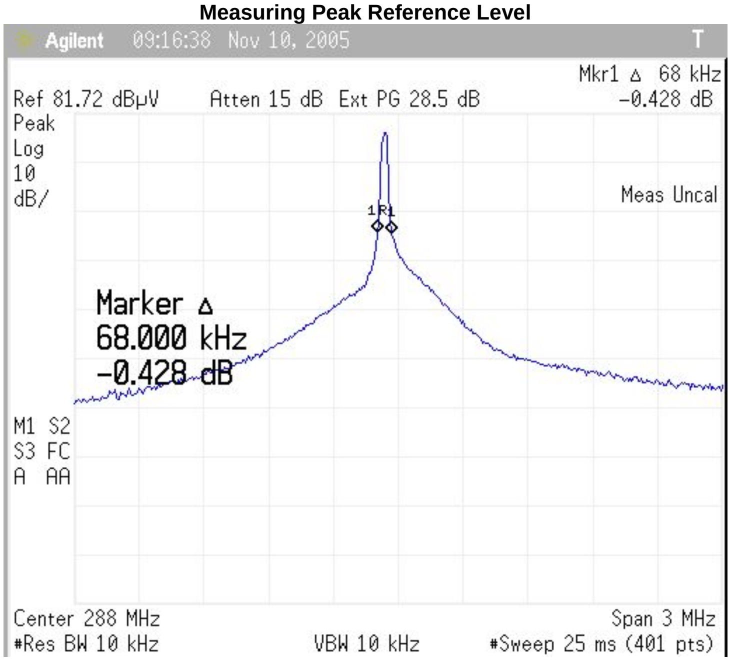
7.4.3.1. Occupied Bandwidth Measurement

Frequency (MHz)	Duty Cycle (%)	Occupied Bandwidth (kHz)	Limit (kHz)
288	30	68	720
	50	68	720
	80	68	720
310	30	68	775
	50	75	775
	80	75	775
418	30	158	1045
	50	150	1045
	80	83	1045

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



Measuring Peak Reference Level



Measuring Occupied Bandwidth at –20dB points

7.4.4. Emission Spectrum

Prescan 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 JCI 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 7.4.4.4

Measurement settings:
- Resolution BW 120kHz
- Video Bandwidth: 300kHz
- Detector: Peak

Note: Pre-scan measurements were made in a semi-anechoic chamber using a HP8591 spectrum analyzer and AR LN1000 Pre-amplifier .

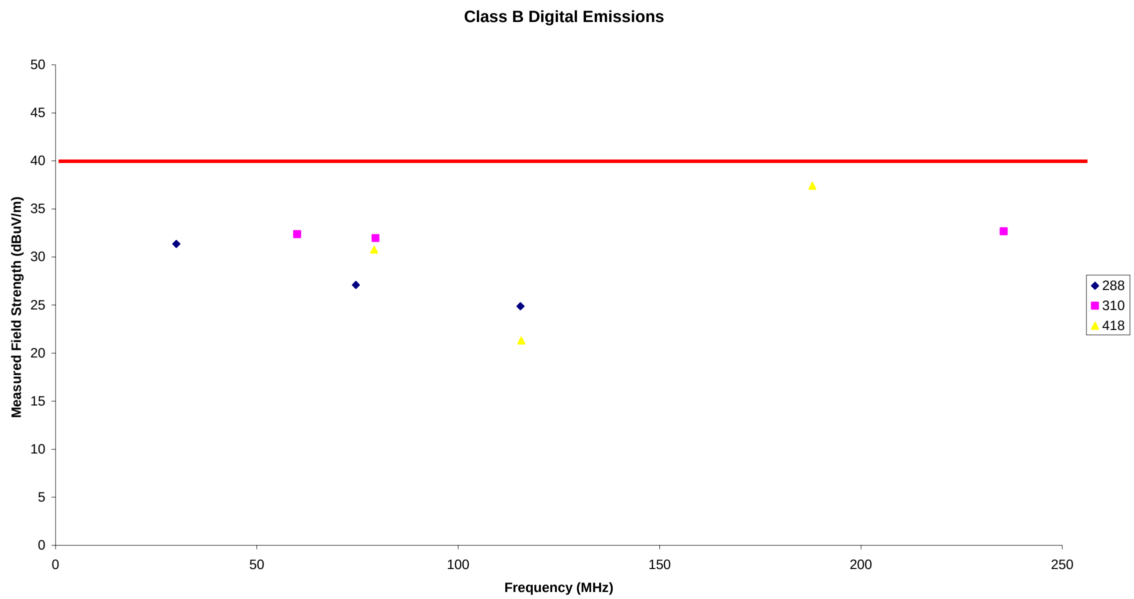
7.4.4.1. Summary of Emissions Measurements Taken on OATS

Transmitting Frequency (MHz)	Emission Frequency (MHz)	Measurement (dBuV/m)	Limit (dBuV/m)	Margin (dB)
288	30	31.36	40	8.64
	74.58	27.09	40	12.91
	115.45	24.88	40	15.12
310	60	32.38	40	7.62
	79.48	31.97	40	8.03
	235.48	32.68	40	7.32
418	79.12	30.77	40	9.23
	115.64	21.31	40	18.69
	187.95	37.42	40	2.58

Local ambient present

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

7.4.4.2. Plot of Class B Emissions relative to FCC Limit



7.4.5. Variation of Supply Voltage

This device was tested with new batteries in accordance with 15.31(e)

7.4.6. Verification of Non-Operation in Restricted Bands

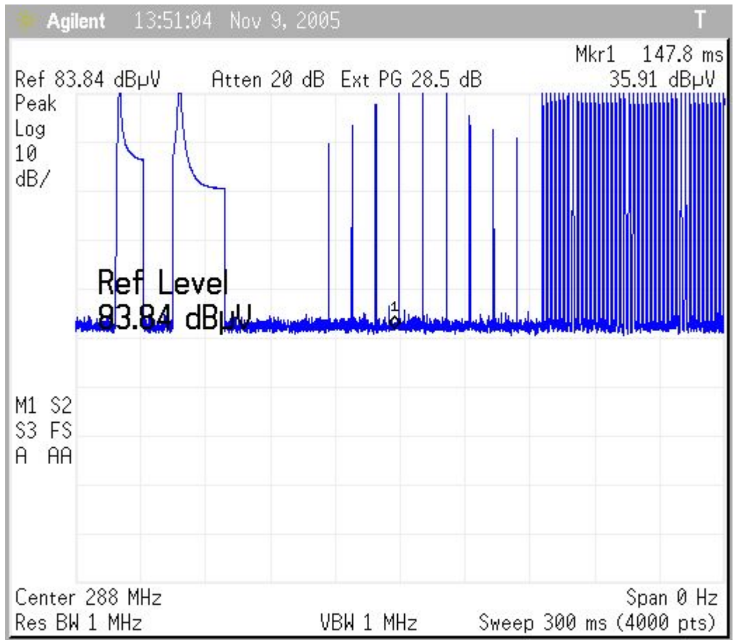
An exercise was undergone to verify that the device was not able to learn and thereby transmit in a restricted band. During this exercise it was found that the device firmware prevents the device from learning any frequency within 1MHz of any restricted band listed in 47 CFR 15.205 and RSS-210, Table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

7.4.7. Verification of De-activation after 5 seconds

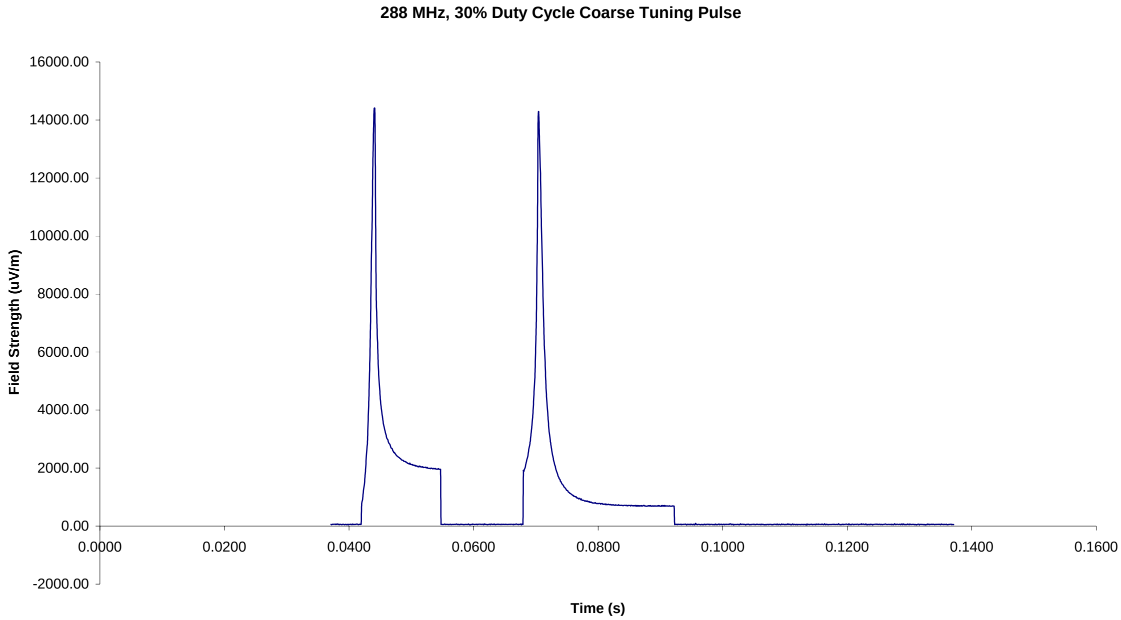
This device stops transmitting once the activation button in depressed.

7.4.8. Tuning Pulse Measurements

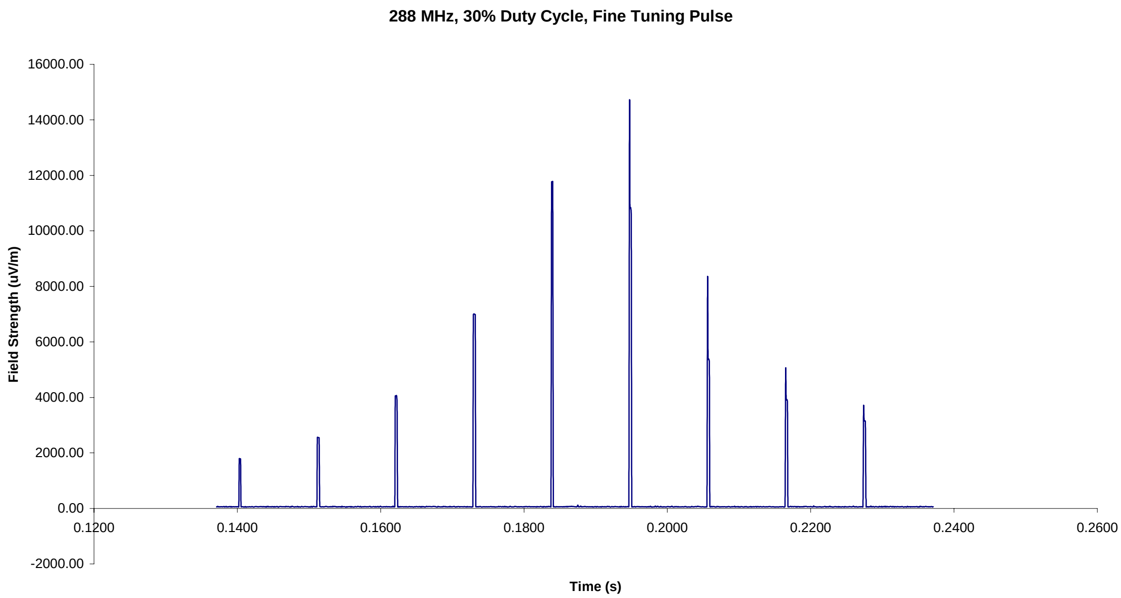
This device uses pulses to tune the antenna prior to transmission. Measurements of these tuning pulses over 100 msec windows show that these pulses are below the FCC limits for operation in this band. A summary of measurements is presented in section 7.4.8.7. Tuning pulse measurements were taken at 288, 310, and 418 MHz at a duty cycle of 30%. Settings in the screen capture below were not used to make the measurements presented in section 7.4.8.7.



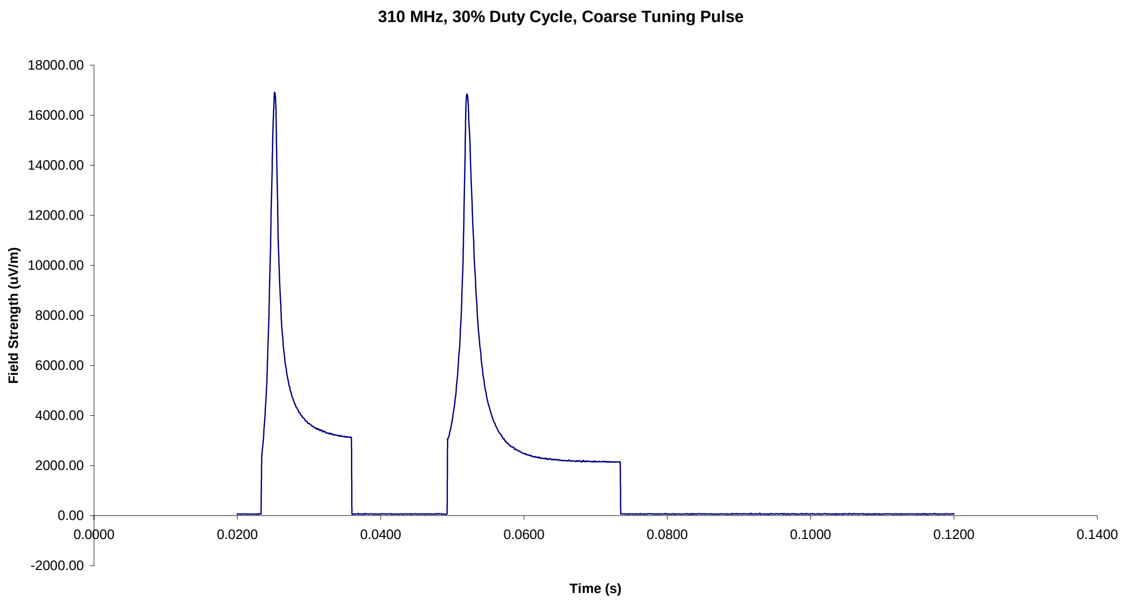
7.4.8.1. Coarse Tuning Pulse (288MHz)



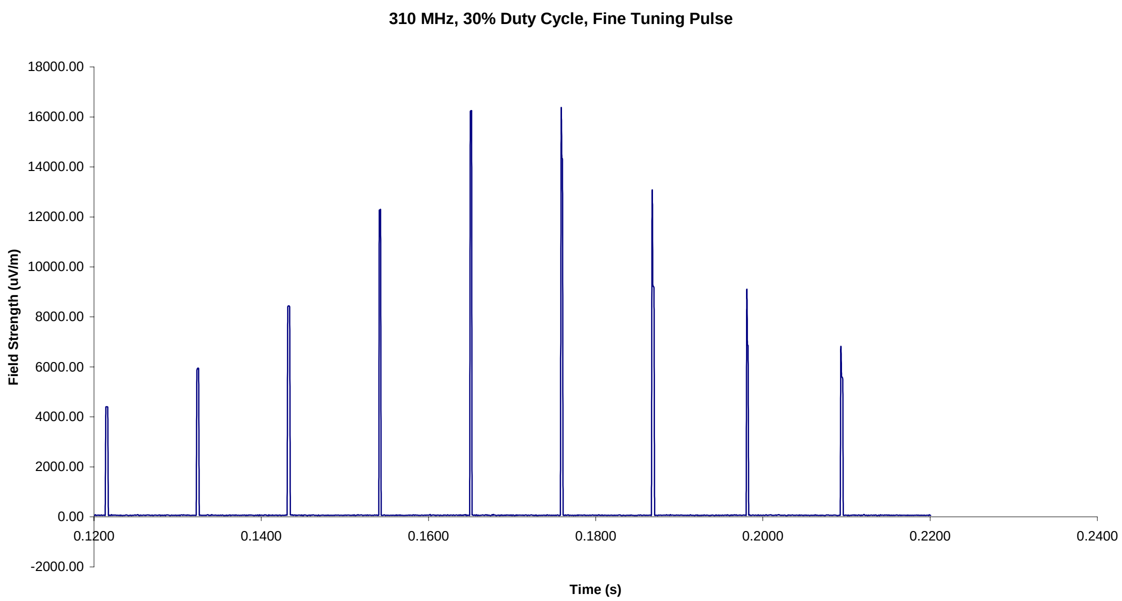
7.4.8.2. Fine Tuning Pulse (288MHz)



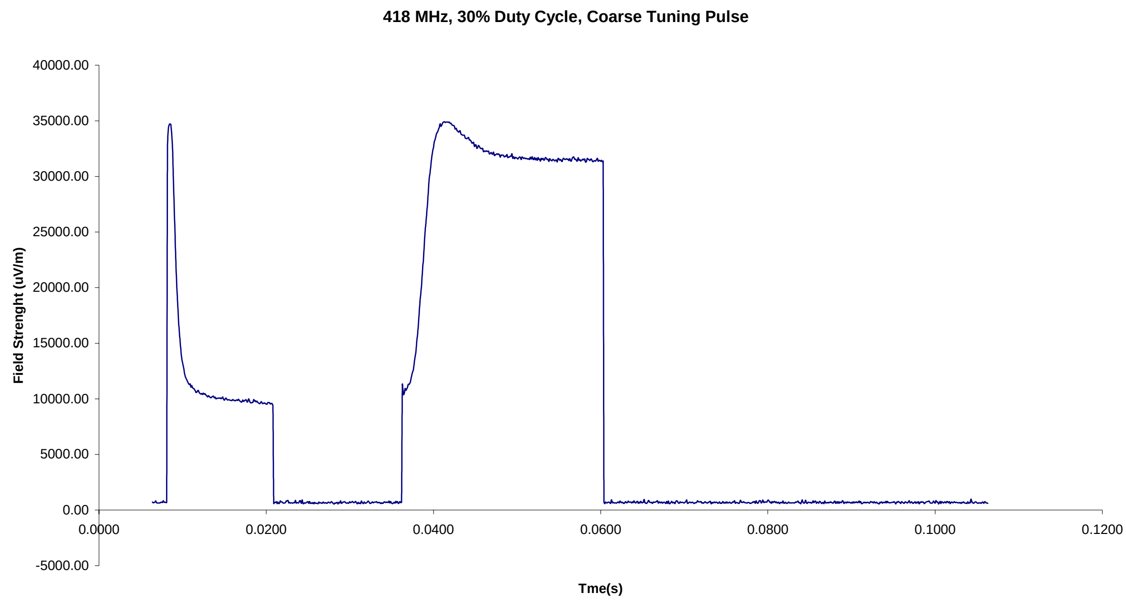
7.4.8.3. Coarse Tuning Pulse (310MHz)



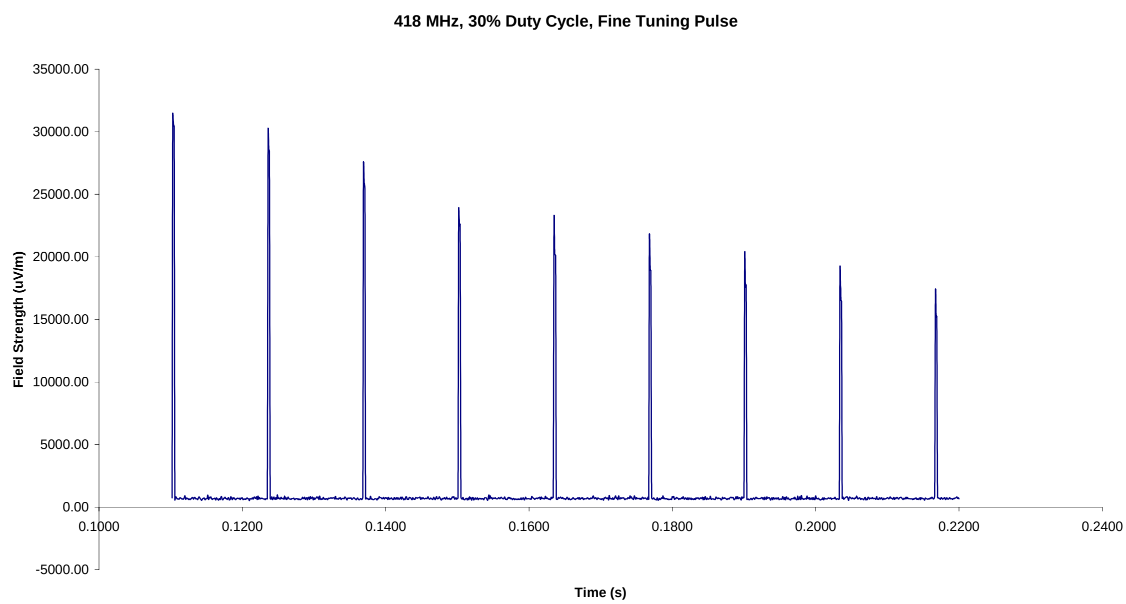
7.4.8.4. Fine Tuning Pulse (310MHz)



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

Measurement Settings:
Resolution Bandwidth: 1MHz
Video Bandwidth: 3 MHz
Sweep Time: 400 msec.
For this measurement 4000 points were recorded and the values averaged over 100 msec. windows that captured either the coarse or fine tuning pulses.

	Frequency (MHz)	Average (uV/m)	Limit (uV/m)	Margin (dB)
Coarse	288	1724	4915	9.1
	310	1569	5831	11.4
	418	7445	9806	**2.4**

	Frequency (MHz)	Average (uV/m)	Limit (uV/m)	Margin (dB)
Fine	288	353	4915	22.9
	310	285	5831	26.2
	418	1117	9806	18.9

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 and RSS-210.

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/IC 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:

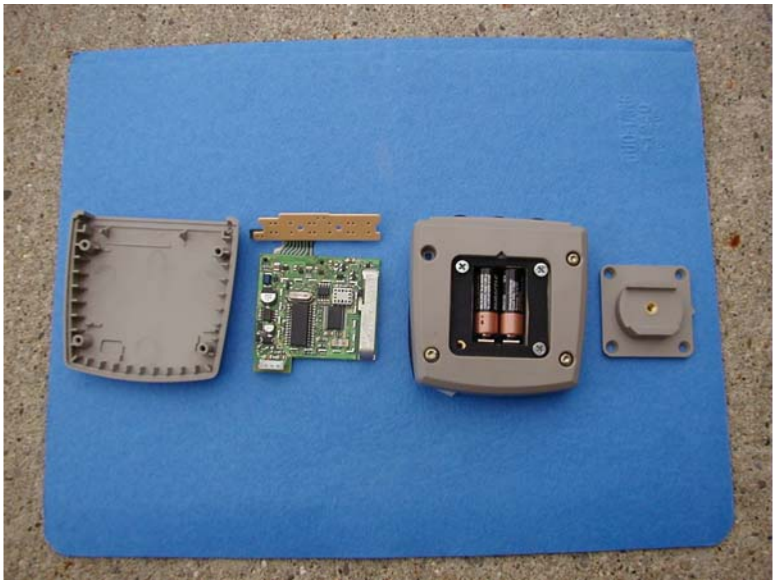
288MHz	20*log10(4917.6) = 73.8 dBuV/m
310MHz	20*log10(5834.4) = 75.3 dBuV/m
390MHz	20*log10(9168.0) = 79.2 dBuV/m
418MHz	20*log10(10334.7) = 80.3 dBuV/m

8. Photos of Product Tested

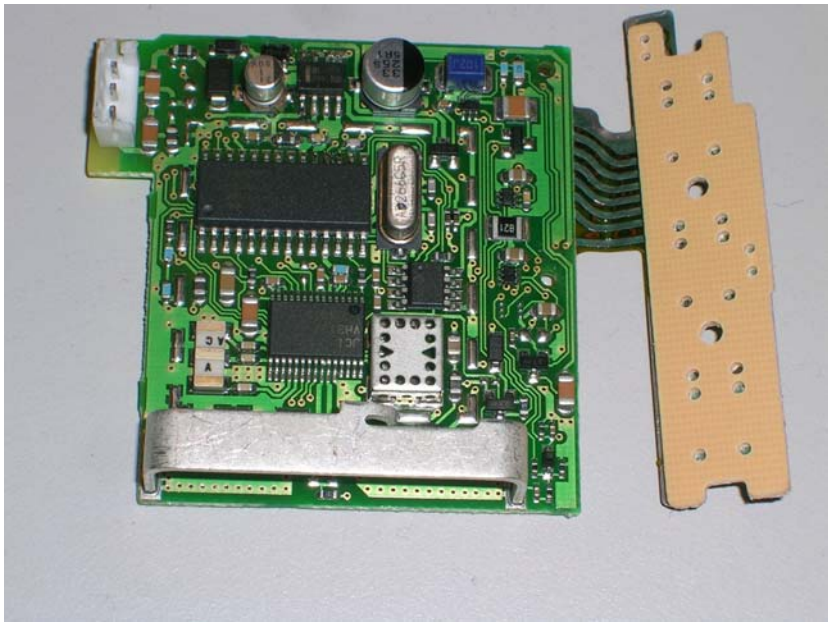
8.1. Front View

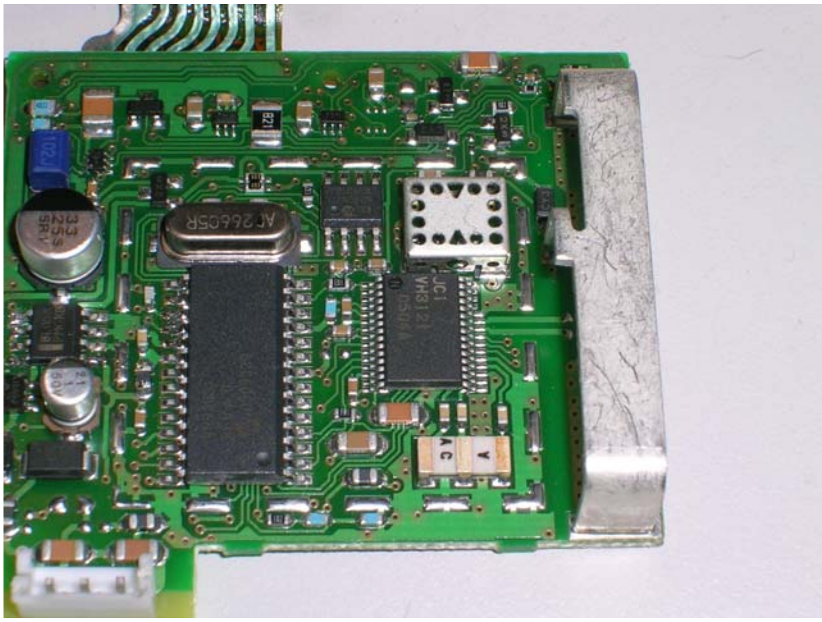
8.2. Rear View

8.3. Unit Disassembled



8.4. Homelink© Board





9. Other Attachments and Description

9.1. User Manual

Please refer to attachment “user_manual.pdf”.

9.2. Theory of Operation

Stand Alone HomeLink® Module Description of Operation

The HomeLink® transmitter is a radio frequency transceiver device whose primary function is to determine both frequency and bit code format of typical garage door remote control devices and identically re-transmit them to the original garage door opener receiver.

The on-board microcontroller maintains the operational frequency band as 288MHz to 420MHz, excluding forbidden bands of 303.5 to 305.5MHz, 322 to 335.4MHz and 399.9 to 410 MHz by at least 1 MHz spacing.

The “training” operation is performed by scanning the legal frequencies with a single conversion superheterodyne receiver, looking for valid garage door opener bit code formats. After the training sequence, the frequency, bit code and attenuator setting is stored in non-volatile memory (NVM). The IF of the superheterodyne receiver section is 10.7MHz.

On subsequent power ups, the NVM data is recalled. The VCO is set on the desired RF carrier frequency. The antenna is coarse tuned by sweeping twice around the expected tuning point. It is the fine tuned with 9 pulses. The voltage controlled oscillator (VCO) is then modulated with the appropriate garage door opener bit code from the NVM.

In addition to being frequency and data format adaptive. The HomeLink® transmitter also adjusts the RF amplitude level based upon the duty cycle. During the training sequence, the duty factor of the incoming bit code format is evaluated by the microcontroller determining the greatest amount of on-time in a 100 mS window. The duty factor is then used to adjust the output power in a range of 80% (1.9 dB) to a maximum limit to 30% (10.5 dB) duty cycle. A 9 bit attenuator is adjusted by a closed loop power control algorithm in the microcontroller.

Also, the microcontroller adjusts the output level as a result of the learned frequency of operation. The firmware maintains information relative to the allowable field intensity limits. As the allowable limit increase with frequency of operation the microcontroller adjusts the output level to increase with the increase in transmit frequency.

9.3. Emission Designation

According to TRC-43, the emission designation for this product is 149KL1D. Where “149K” is the highest measured occupied bandwidth (149 kHz), “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. Schematics/ Tuning Information

Programming the Homelink © III
(Tuning Information)

To clear memory:

1. Press the two outside buttons until the indicator LED flashes. This indicates the memory values have been cleared.
2. Holding the hand-held transmitter to be copied 3-6 inches from the Homelink © III and simultaneously, activate the hand-held transmitter and one of the Homelink © III buttons until the indicator LED flashes rapidly. The frequency and bit pattern information are now stored in the Homelink © III non-volatile memory (NVM). At this point the Homelink © III can be used as a substitute from for the Original transmitter.

When a Homelink © III button is pressed four things happen:

1. A Voltage Controlled Oscillator (VCO) is set to desired RF carrier frequency (recalled from the NVM).
2. The antenna is coarse tuned by sweeping twice around the expected tuning point.
3. The antenna is fine tuned by 9 pulses of approximately 210 uS in duration with 11 mS off.
4. The VCO is then modulated with the appropriate garage door opener bit code from the NVM.

Schematics have been submitted with this report as the file “schematics.pdf”