March 24, 2006

Technical Report to the FCC and Industry Canada Regarding Johnson Controls Interiors, L.L.C. Homelink®III Model: CB2ACTLHL3 IC: 279B-ACTLHL3 3/24/2006 Emission Designation: 560KL1D

A report concerning a Class II permissive change to the original grant of CB2ACTLHL3 dated 5/28/2003.

Please issue grant immediately upon review.

Confidentiality applied to the following sections according to 47 CFR 0.459 and RSP-100 section 10:

- Circuit Block Diagrams
- Theory/Description of Operation
- Schematics

Measurements Made by:

Robert Bultema
RF Test Site Technician
Johnson Controls Interiors, LLC.

Measurements Observed by:

Jeremy Bos
RF Test Site Manager
Johnson Controls Interiors, LLC.

Report and Application Prepared by
Jeremy Bos
RF Test Site Manager
Johnson Controls Interiors, LLC.

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

This product was originally certified under the IC: 279B-ACTLHL3 granted 5/28/03. REF# 18413.

This report includes measurements from the two Class II reports filed in August 2003 (Submission # 48278 and #48471to the IC) for CB2ACTLHL3, which covered the installation of the CB2ACTHL3 into the Acura TL and MDX respectively. The intent of this report is to expand the number of vehicles using this model Homelink III® transmitter to three by adding the Acura RDX. As such, only the transmitter fundamental measurements were taken at the Homelink® low, mid, and high frequencies (288, 310, and 418 MHz). All other data included is copied from the original August 2003 report when data was originally taken on our 3m turntable for the module, independent of the vehicle.

1.3. Test Methodology

Radiated Emissions testing was done 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.

Additional measurements were performed according to methodology outlined in communication with the Industry Canada submitted as miscellaneous exhibit "vehicle_level_ic.pdf". In all cases the guidelines provided by ANSI C63.4-2003 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. The site 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 16, 2006 and with the IC on December 28, 2006. IC Reference OATS File # IC 3593.

2. Product Labeling

The FCC ID for this device is CB2ACTLHL3. The Industry Canada certification number is 279B-ACTLHL3. These identifiers will be imprinted on a 1"X1.5" high temperature polyester matte white label.

The label will be placed on the exterior of the CB2ACTLHL3 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 C63.4-2003. 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.

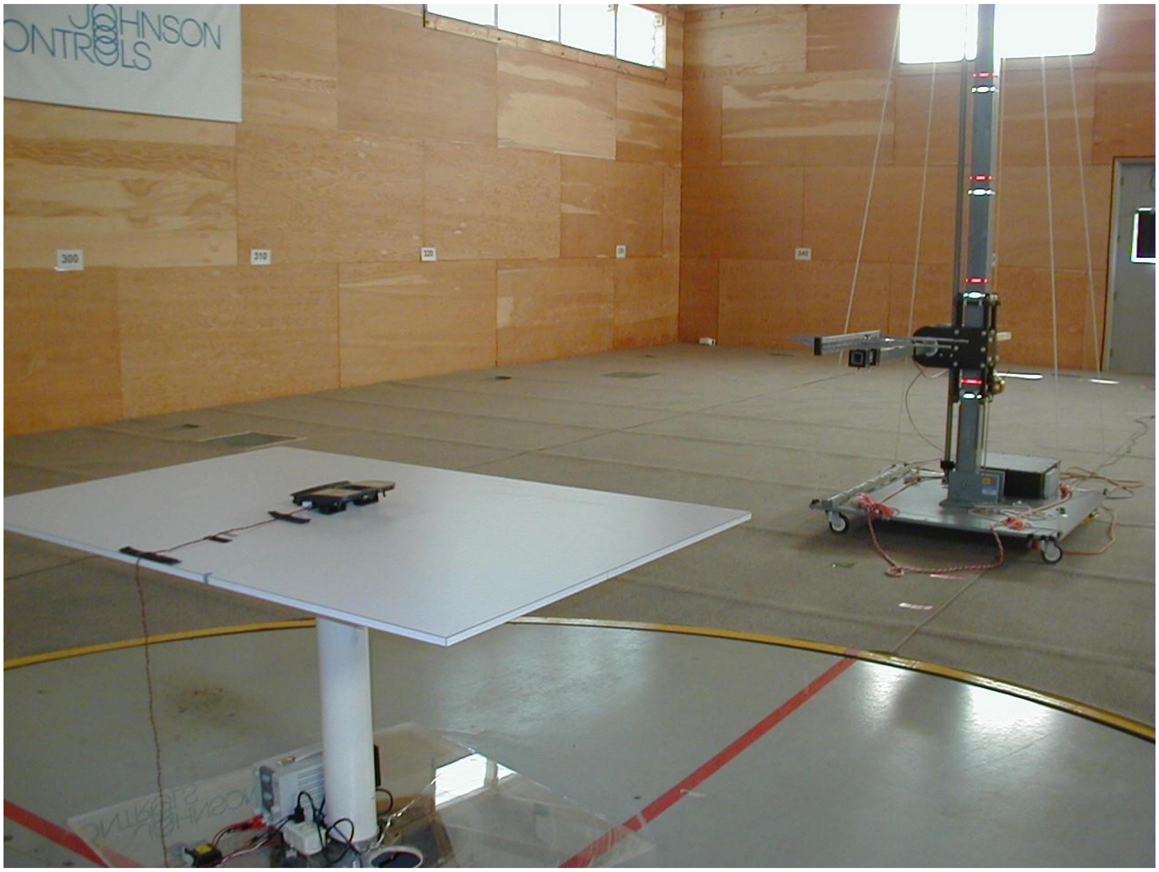
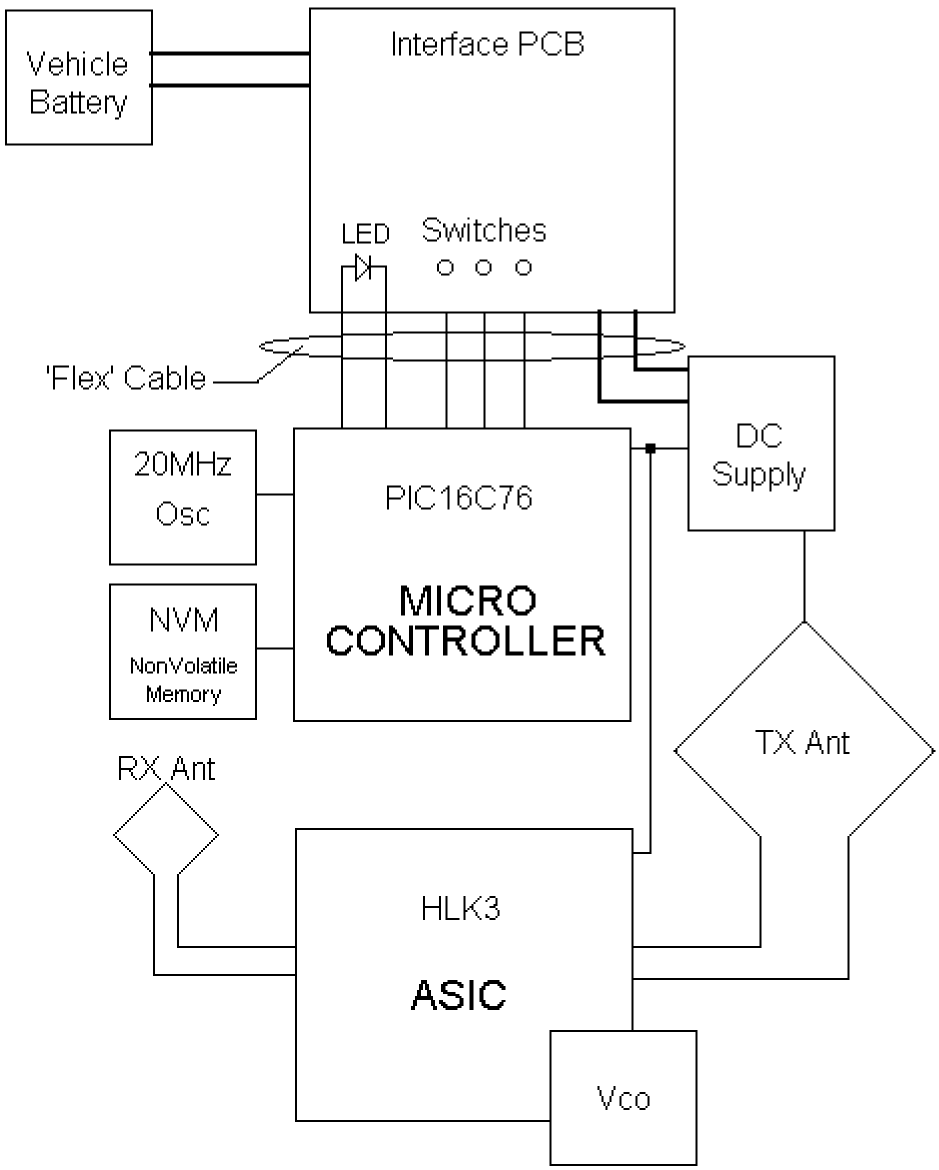


Figure 3.1 The JCI 3m Radiated Emissions Test Setup.

For vehicle level measurements, the product was installed in the factory intent location. For the Acura TL, MDX, and RDX, the Homelink is installed in a lighting board module in the overhead of the vehicle. See Figure 5.3 for a representation.

Figure 3.2 Example of vehicle level test setup.

Block Diagram



Tuning Range:
288-321MHz, 336.4-398.9MHz, 411-420MHz

Homelink® III Block Diagram

4. Test Setup Photographs

Figure 5.1 EUT in the "End" orientation.

Figure 5.2 EUT in the "Flat" orientation.

Figure 5.3 EUT in the "side" orientation.

Figure 5.3 EUT as installed for vehicle level testing ("V" orientation).

5. Conducted Emissions Measurements

Conducted Measurements are not required for this product.

6. Radiated Emissions Data

6.1. Summary of Results

- Measurements of the transmit output field strength were taken with the DUT trained to 288, 310, and 433 MHz at 30, 50 and 80% duty cycles. The worst-case fundamental measurement occurred with the DUT trained to 418 MHz, 30% duty cycle. The worst-case emission of 66.9 dBuV/m remained **3.0 dB below** the FCC and IC limits for this type of device when adjusted for duty cycle. This measurements was taken in the Acura RDX vehicle on March 6,2006 at 10m.

- The worst-case harmonic was found at 576 MHz, the second harmonic of 288 MHz at 30% duty cycle. The emission of 48.9 dBuV/m maintained a margin of 4.9 dB to the applicable FCC and IC limit when adjusted for the duty cycle. This measurement is carried-forward from the August, 2003 report.
- This module exhibits pulsed operation characteristics.
- Measurements were taken of the 20dB occupied bandwidth. The transmitter had a maximum occupied bandwidth of 560 kHz when the DUT is trained to 418 MHz, 30% duty cycle.
- This device has a worst case Class B emission of 39.4 dBuV/m at 31.6 MHz when set to transmit at 288 MHz a margin of 0.6 dB to the Class B limit is maintained.
- The output power of the DUT varied by no more than +/- 1dB when the input voltage was varied from 6 to 18 Volts. The device does not operate when the input voltage is below 7V. The required operating range for this product is 9-16 VDC
- 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 pulses to tune the transmit antenna. At 418 MHz, 30% duty cycle the field strength of the pulses average 10093 over 100 msec. This represents a margin on 0.2 dB to the FCC limit.

6.2. 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**
Agilent E-series EMC Analyzer	**E4407B**	**US41192569**	**10/18/05**	**10/18/06**
HP Spectrum Analyzer	**8591A**	**S919A00107**	**10/17/05**	**10/17/06**

6.3. 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 transmitter fundamental measurements, the Acura RDX vehicle was centered on the site's vehicle turntable. Emissions were then measured for horizontal and vertical receive antenna orientations according to ANSI C63.4-2003.

For the all remaining measurements, 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.

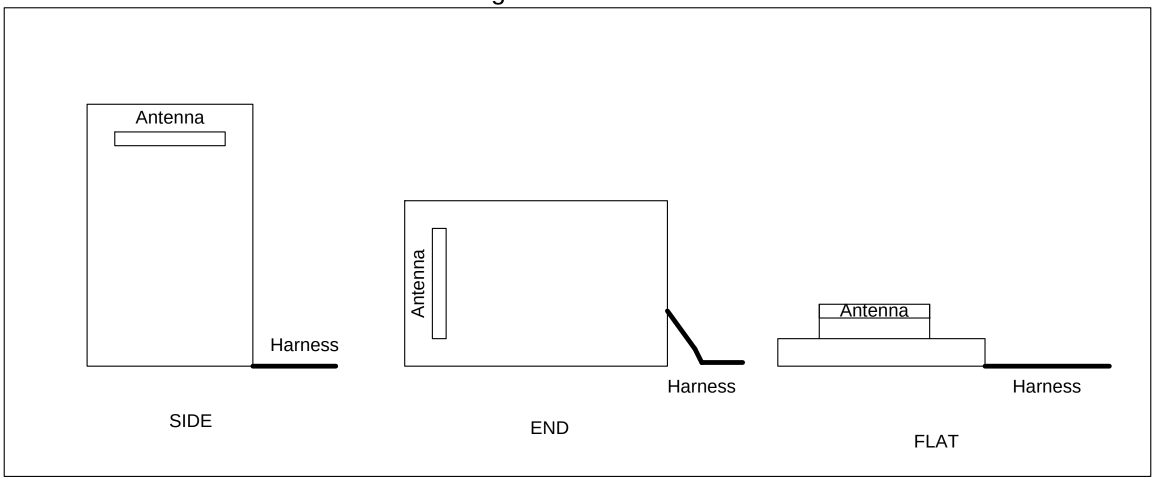


Figure 7.3.1 EUT Orthogonal Orientations

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

6.4. Measured Data

6.4.1. Measurements of Fundamentals and Harmonics

Measurements described in this section were taken according to ANSI C63.4-2003 on the Johnson Controls 10m (for measurements in the vehicle) and on the 3m test table for harmonics.

6.4.1.1. DUT Tuned to 288MHz (in vehicle)

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	V	30	64.1	-10.5	53.7	63.4	9.7
288	Side	V	50	57.9	-6.0	51.9	63.4	11.5
288	Side	V	80	58.4	-1.9	56.4	63.4	**6.9**

* Measurements include Cable corrections and Antenna Factors

6.4.1.2. DUT Tuned to 310MHz (in vehicle)

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	67.2	-10.5	56.8	64.9	8.1
310	Side	H	50	64.6	-6.0	58.6	64.9	6.3
310	Side	H	80	60.5	-1.9	58.6	64.9	**6.3**

* Measurements include Cable corrections and Antenna Factors

6.4.1.3. DUT Tuned to 418MHz (in vehicle)

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	Side	H	30	77.3	-10.5	66.9	69.8	**3.0**
418	Side	H	50	71.8	-6.0	65.8	69.8	4.0
418	Side	H	80	68.1	-1.9	66.1	69.8	3.7

* Measurements include Cable corrections and Antenna Factors

6.4.1.4. 288MHz (Harmonics, on 3m table 8/2003)

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

6.4.1.5. 310MHz (Harmonics, on 3m table 8/2003)

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

6.4.1.6. 418MHz (Harmonics, on 3m table 8/2003)

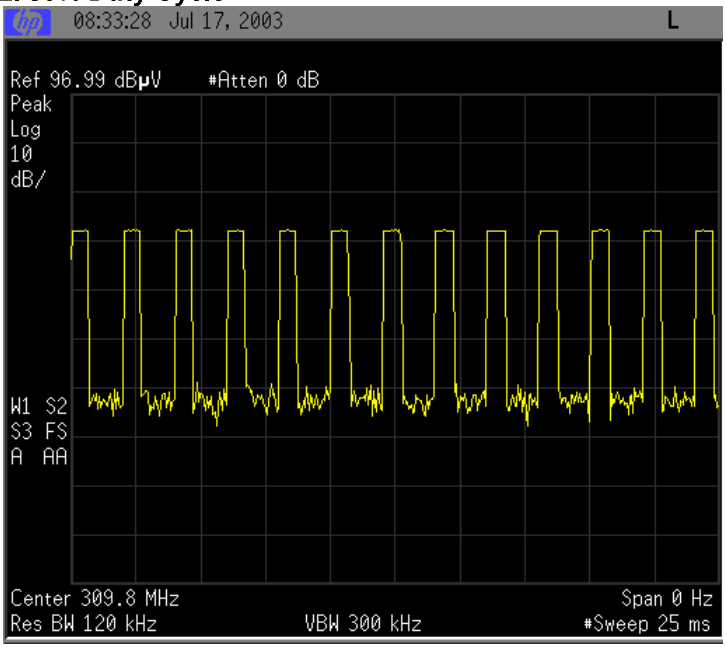
Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	Correction Factor (dB)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
836	Flat	H	30	62.4	0	-10.46	51.94	60.28	8.34
836	Side	H	50	52.7	0	-6.02	46.68	60.28	13.61
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

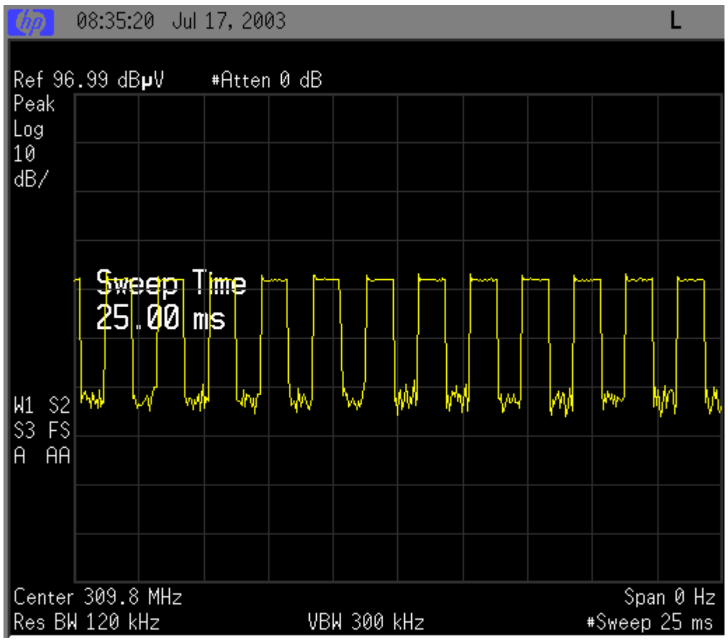
6.4.2. Pulsed Operation

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.

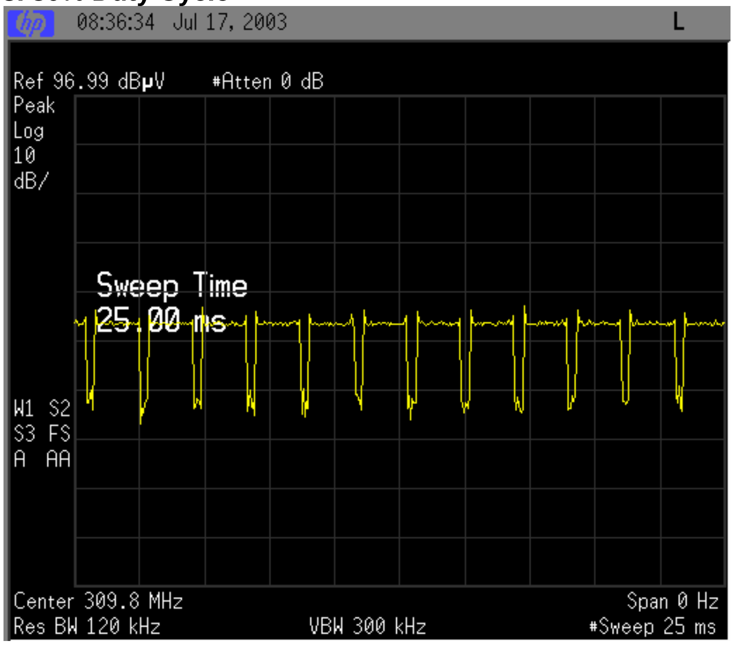
6.4.2.1. 30% Duty Cycle



6.4.2.2. 50% Duty Cycle



6.4.2.3. 80% Duty Cycle



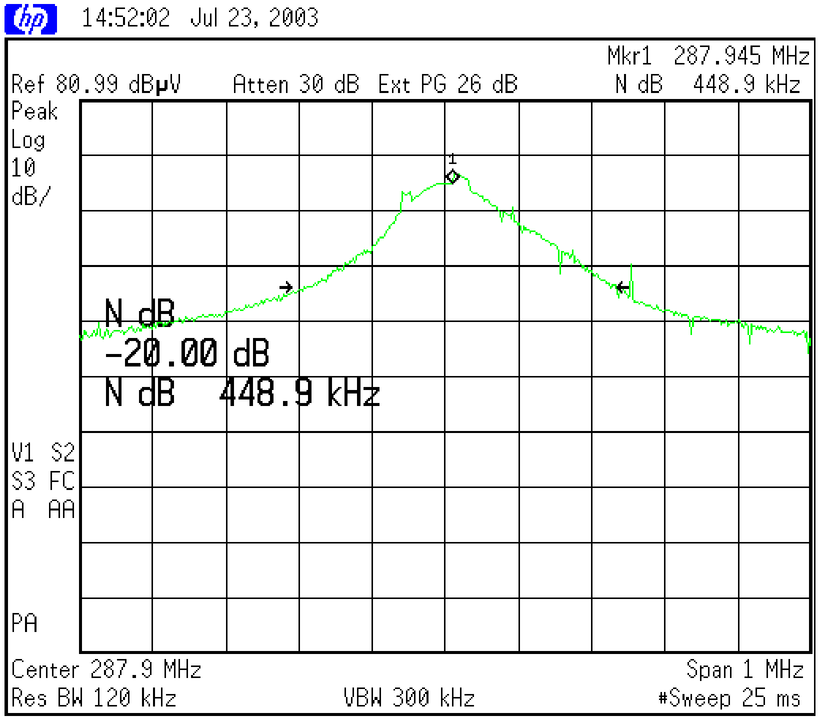
6.4.3. Occupied Bandwidth

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.

6.4.3.1. 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

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



6.4.4. Emission Spectrum

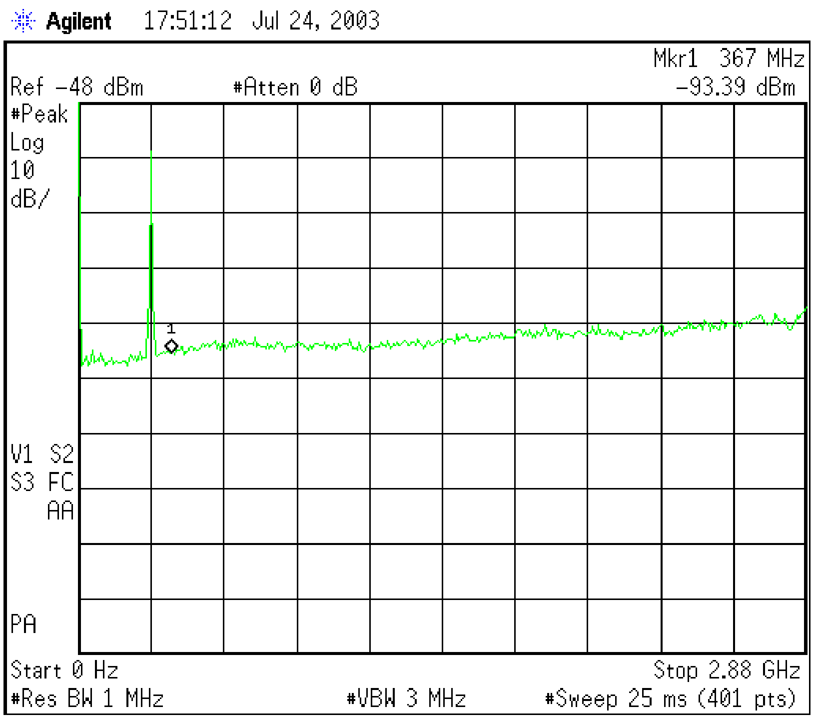
Measurements were taken inside a semi-anechoic chamber to investigate the possibility of other spurious emissions from the DUT. Screen captures presented below in sections 7.4.4.1-3 show the spurious emissions observed with the DUT trained to 288, 310, and 418MHz with a 30% Duty cycle.

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 IC limits for spurious emissions. A summary is presented below in section 7.4.4.4

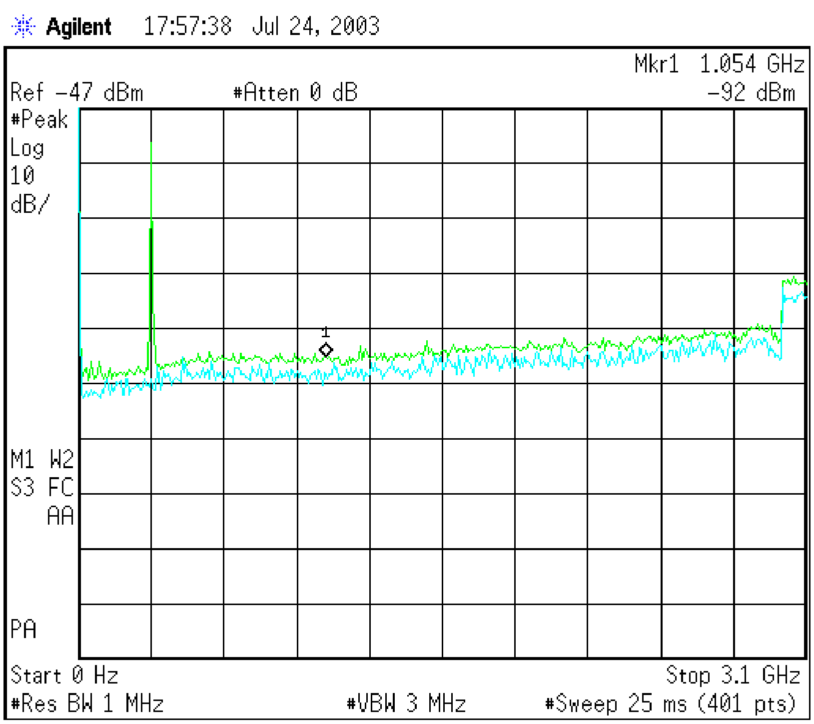
Measurement settings:

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

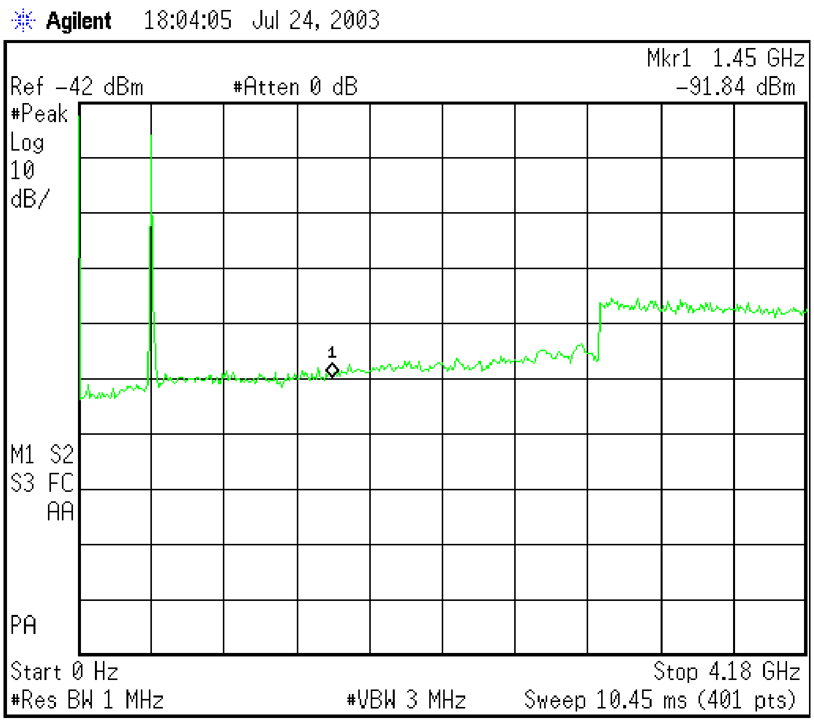
6.4.4.1. 288 MHz



6.4.4.2. 310 MHz



6.4.4.3. 418 MHz



Note: Pre-scan measurements were made in a semi-anechoic chamber using a Agilent E4407B spectrum analyzer. This room and equipment are part of the JCI EMC Validation Lab.

6.4.4.4. Summary of Emissions Measurements Taken on OATS

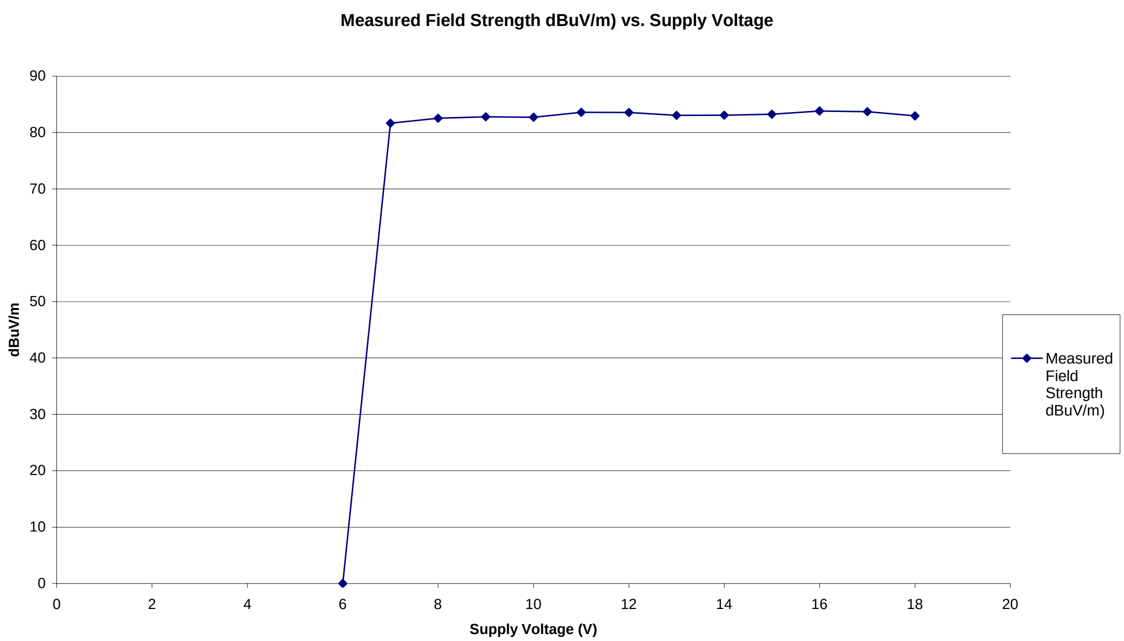
DUT Trained Frequency (MHz)	Frequency (MHz)	Measurement (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
288	31.6	39.4	40	0.6
	32.6	33.7	40	6.3
	51.2	33.37	40	6.63
310	55.11	26.8	40	13.2
418	31	36.05	40	3.95
	55.48	26.88	40	13.12

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.

6.4.5. Variation of Supply Voltage

Measurements of the variation in output field strength due to variation in the supply voltage were taken in accordance with 47 CFR 15.31(e) of the FCC Rules.

6.4.5.1. Plot of output power over supply voltage



6.4.5.2. 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

6.4.6. 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 RSS-210 Issue 6, Table 2 and 47 CFR 15.205

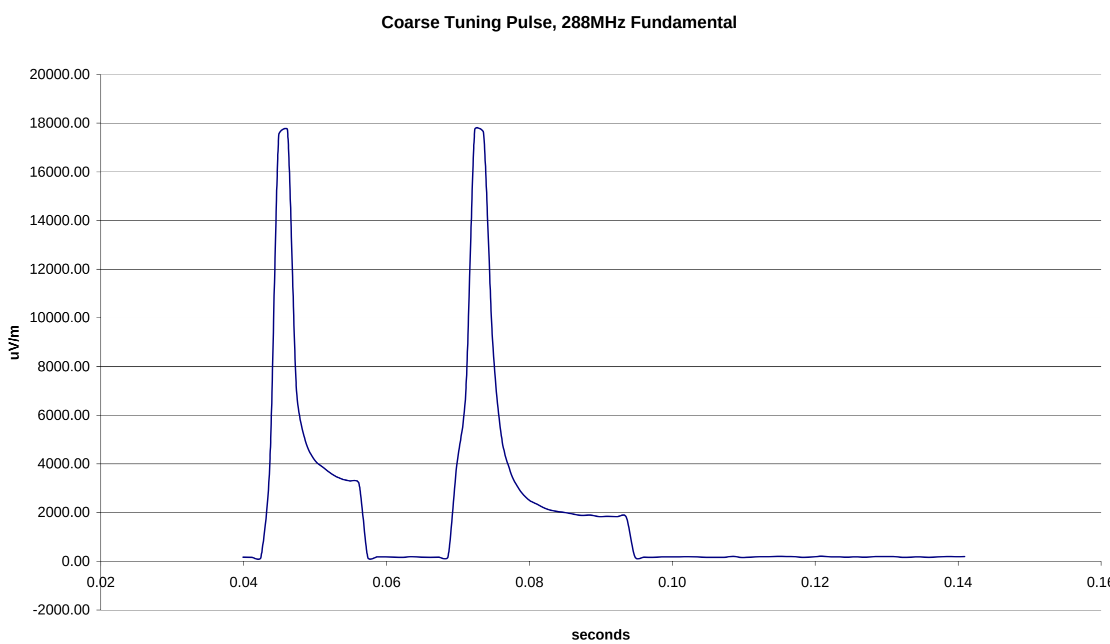
6.4.7. Verification of De-activation after 5 seconds

This device stops transmitting once the activation button in depressed.

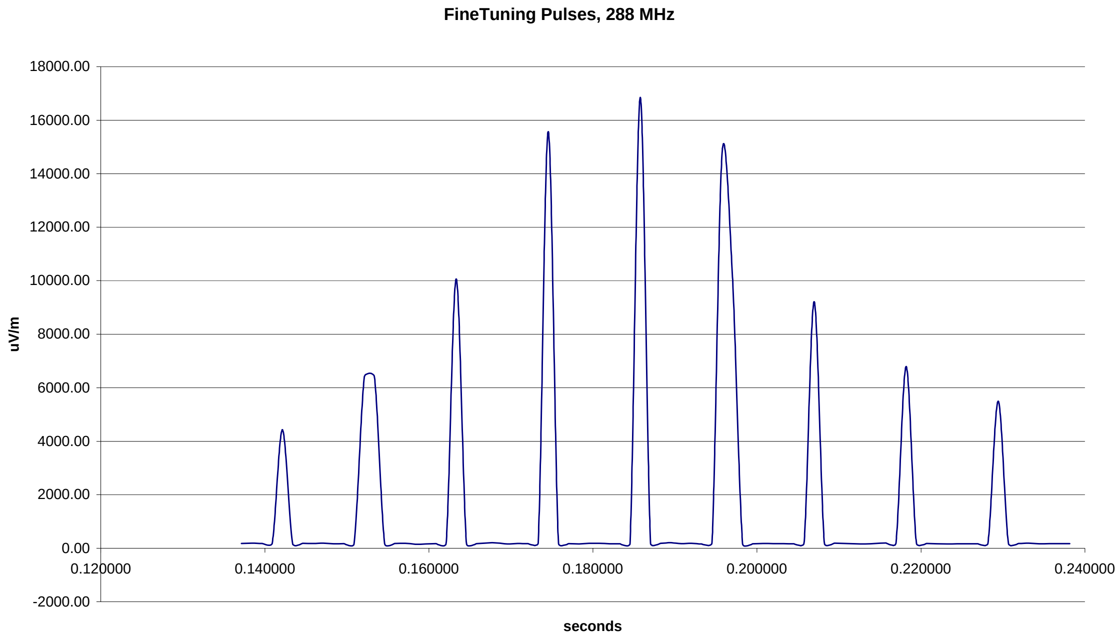
6.4.8. Tuning Pulse Measurements

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 IC 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%.

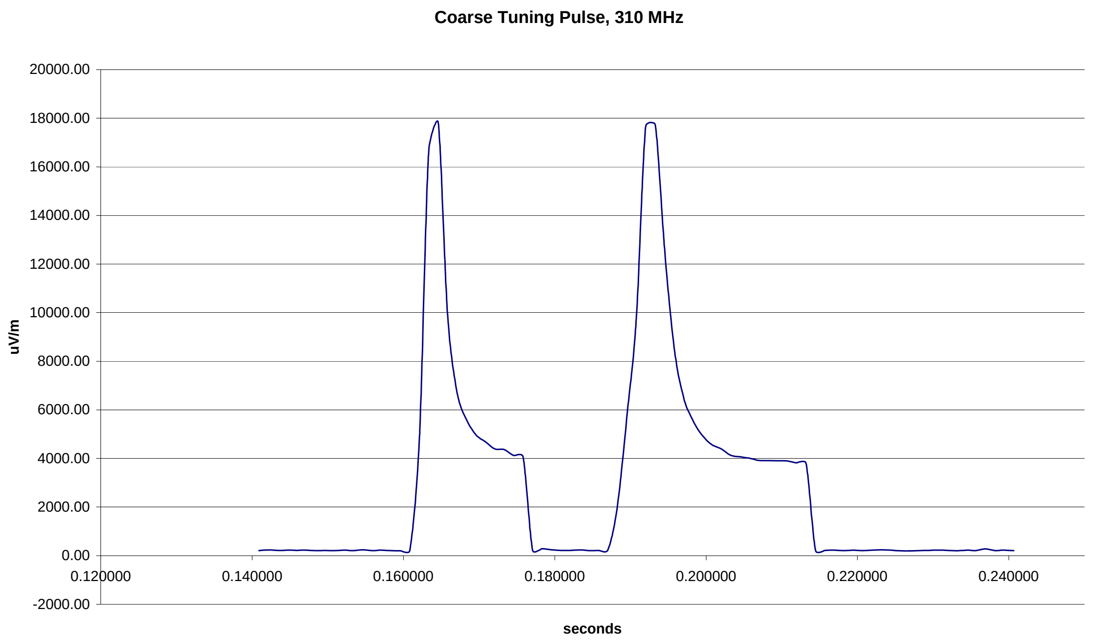
6.4.8.1. Coarse Tuning Pulse (288MHz)



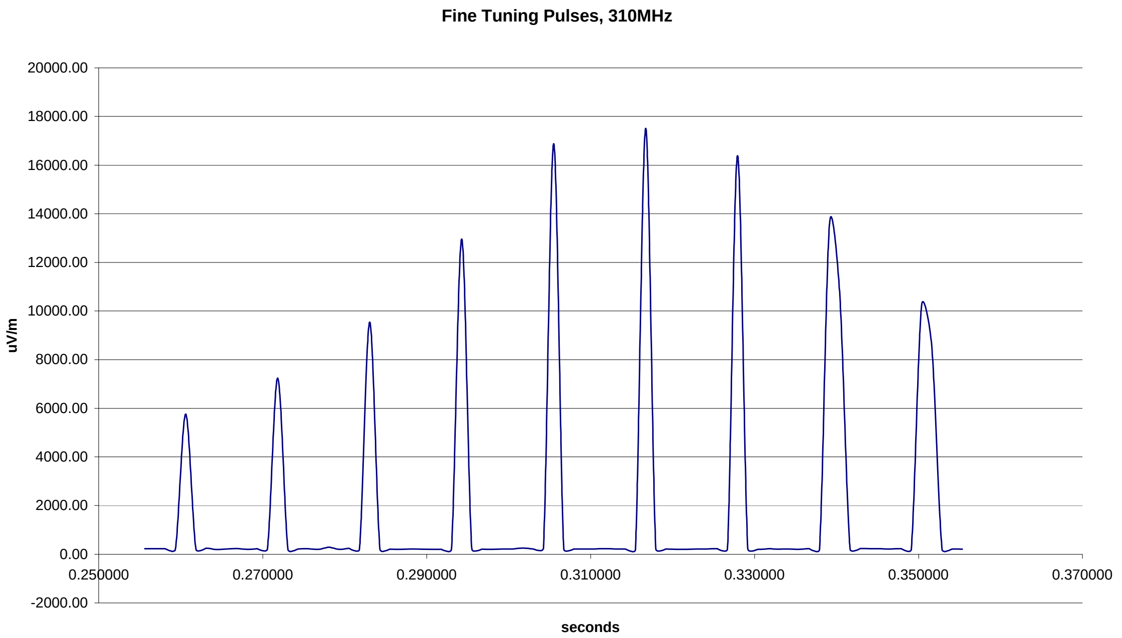
6.4.8.2. Fine Tuning Pulse (288MHz)



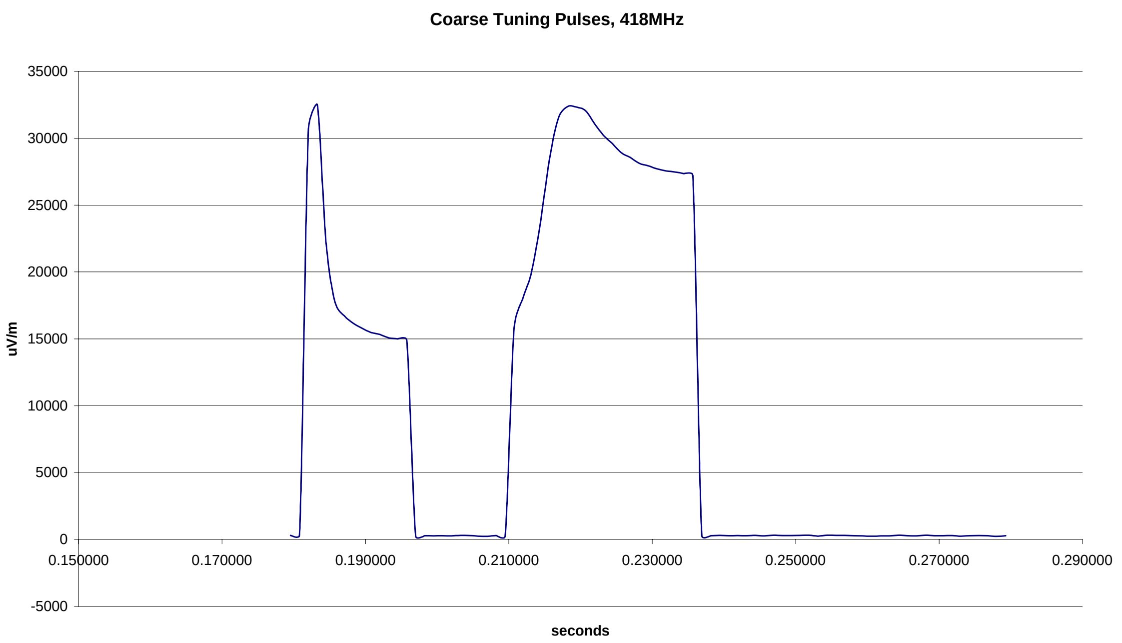
6.4.8.3. Coarse Tuning Pulse (310MHz)



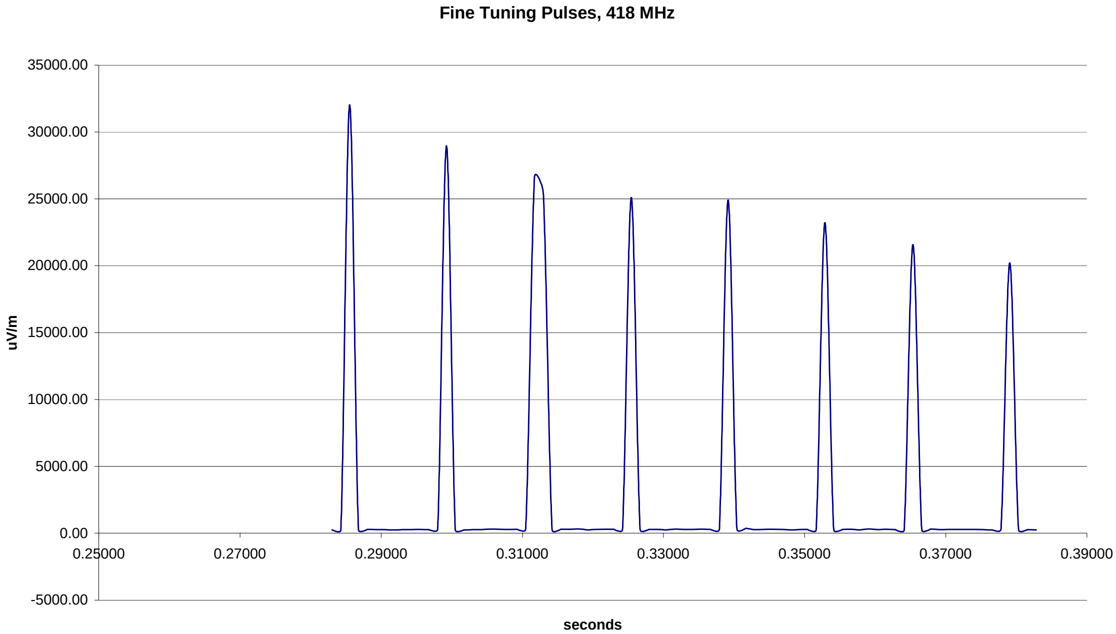
6.4.8.4. Fine Tuning Pulse (310MHz)



6.4.8.5. Coarse Tuning Pulse (418 MHz)



6.4.8.6. Fine Tuning Pulse (418MHz)



6.4.8.7. 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

6.5. Formulas and Sample Calculations

6.5.1. 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)

6.5.2. Calculation of IC Limits from Table 1, 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:

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

In addition 10m limits were extrapolated from 3 to 10m using the following calculation

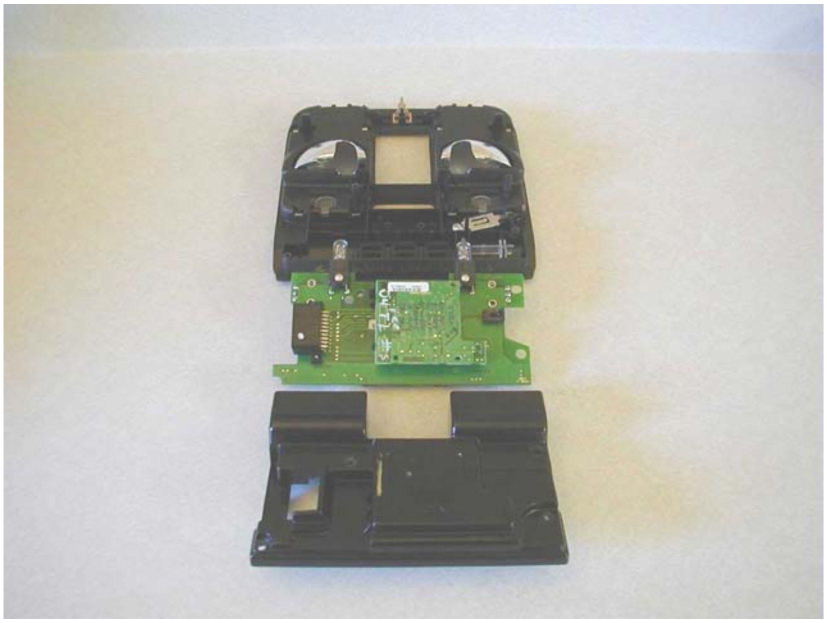
Adjustment to limit (dB) = 20*log10(10/3) = 10.46 dB
10m limits were increased by 10.46 dB to accommodate the change in test distance.

7. Photos of Product Tested

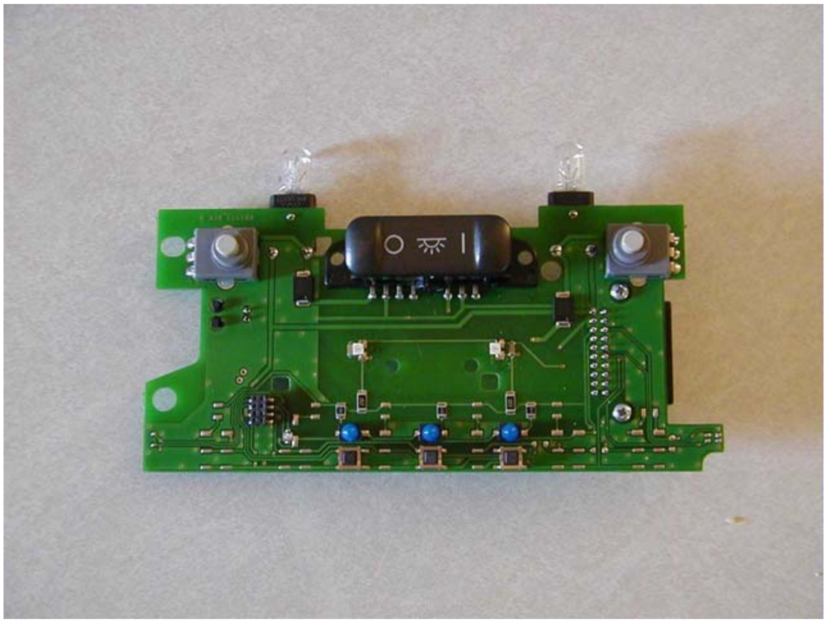
7.1. Front View

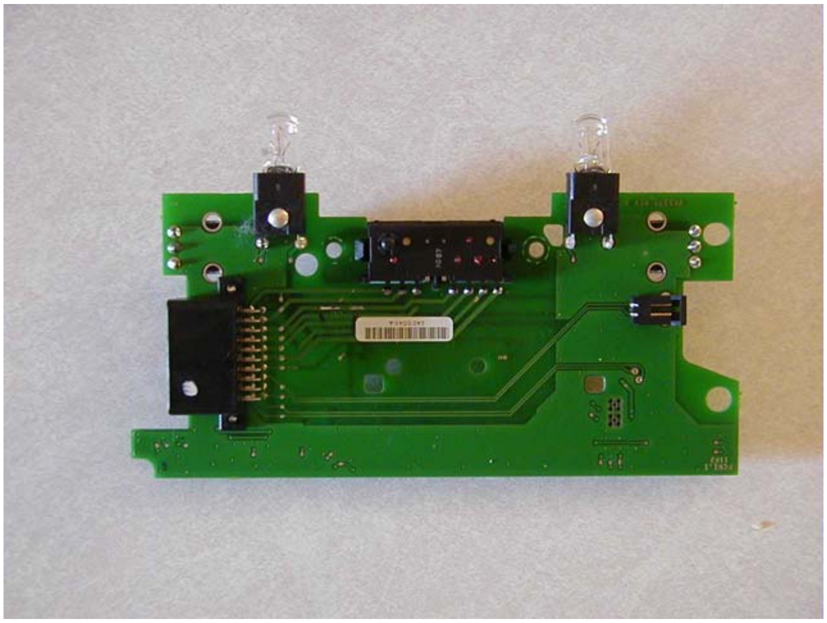
7.2. Rear View

7.3. Unit Disassembled

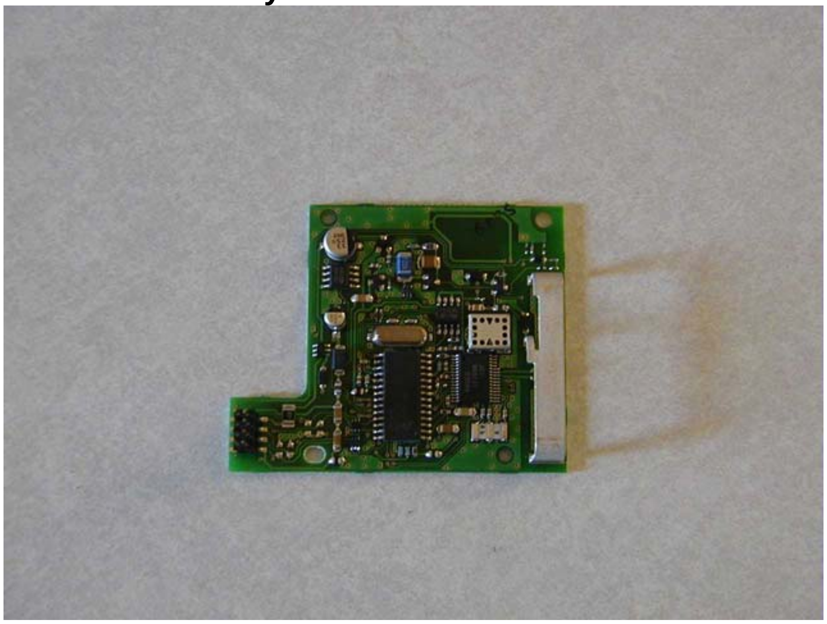


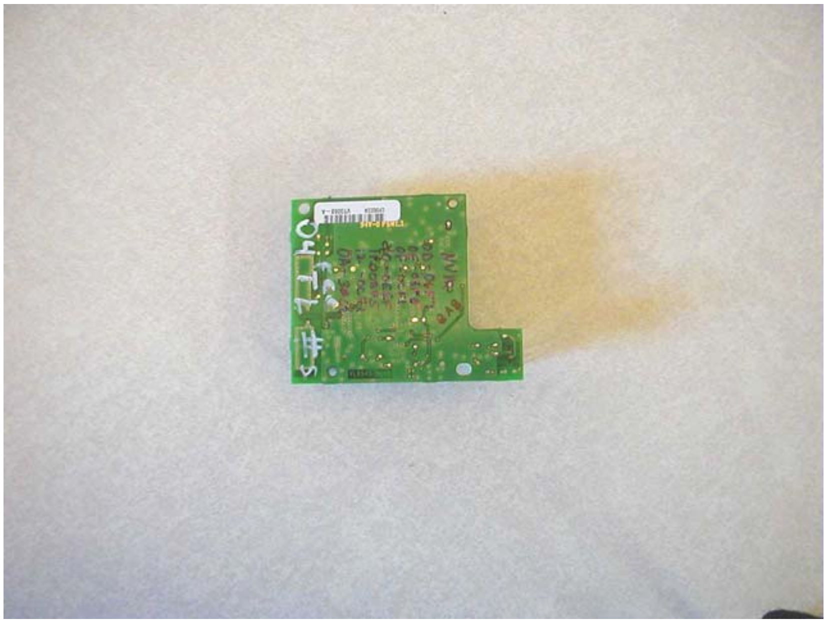
7.4. Light Board





7.5. Homelink® Accessory Board





8. Other Attachments and Description

8.1. User Manual

Please refer to attachment "user_manual.pdf".

8.2. 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.

8.3. Emission Designation

According to TRC-43, the emission designation for this product is 560KL1D. Where "560K" is the highest measured occupied bandwidth (560 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.

8.4. 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”