February 29th, 2008

Technical Report to the FCC and Industry Canada Regarding Johnson Controls Interiors, L.L.C. Homelink© IV

Model : CB2HONUMHL4
FCC ID : CB2HONUMHL4
IC : 279B- HONUMHL4
Emission Designator : 290KL1D
02/29/08

A report concerning approval for Johnson Controls Homelink® model CB2HONUMHL4
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, attachment :	"Block Diagram.pdf"
Theory/Description of Operation :	"Theory_op.pdf"
Schematics attachment :	"Schematics.pdf & part list.pdf"

Measurements Made by:

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Measurements Observed by:

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1. General Information

1.1. Product Description:

The Johnson Controls Interiors HomeLink® HL4 Universal Garage Door Opener is a low-power transceiver OEM device that is installed into an overhead area of the automobile. The installation is provided by trained technicians during the course of the manufacture of the automobile. It is powered by the 12 Volt system of the automobile.

This Universal Garage Door Opener has the capability to

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

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

The unit is supplied to the automobile manufacturer without harness. For testing purposes a typical assembly and 2-conductor cable harness were used to power to the unit.

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

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

The antenna system is an integral part of the unit. It cannot be altered nor replaced by the user. Service of this system is only available from the Automobile Manufacturer's Dealerships and 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 a 12V automotive vehicle battery, thus conducted emissions measurements are not required.

The unit is supplied to the automobile manufacturer without harness. For testing purposes a 2-conductor cable harness was used to interface to the unit.

1.4. Test Facility

The Open Area Test Site where these measurements were taken, is located on the grounds of 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 December 16 2005, was accepted by the FCC in a letter dated December, 28 2005. The report filled with Industry Canada, dated December 15, 2005, was accepted via a letter dated December 28, 2005. The site was re-certified with the FCC on December 28, 2005 and with the IC on December 28, 2005. 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 (#1425.02) 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: CB2HONUMHL4. The Industry Canada certification number is 279B- HONUMHL4. These identifiers will be labeled on the product housing.

The label will be placed on the exterior of the HL4 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.

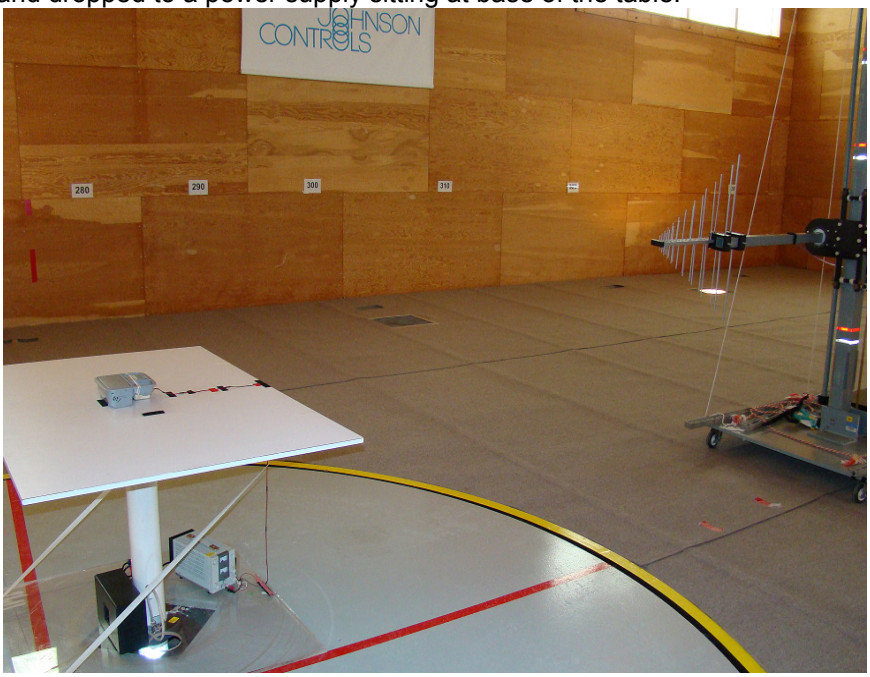
WARNING: The transmitter has been tested and complies with FCC and Industry Canada rules. Changes or modifications not expressly approved by the party responsible for the compliance could void the user's authority to operate the device."

2.1. Label Drawing and Location on Product.

The label drawing is included in the "LABEL Drawing_Label_Location" attachment.
A drawing showing the location of the label on the assembly is included in the "LABEL Drawing_Label_Location" attachment.

3. Test Configuration

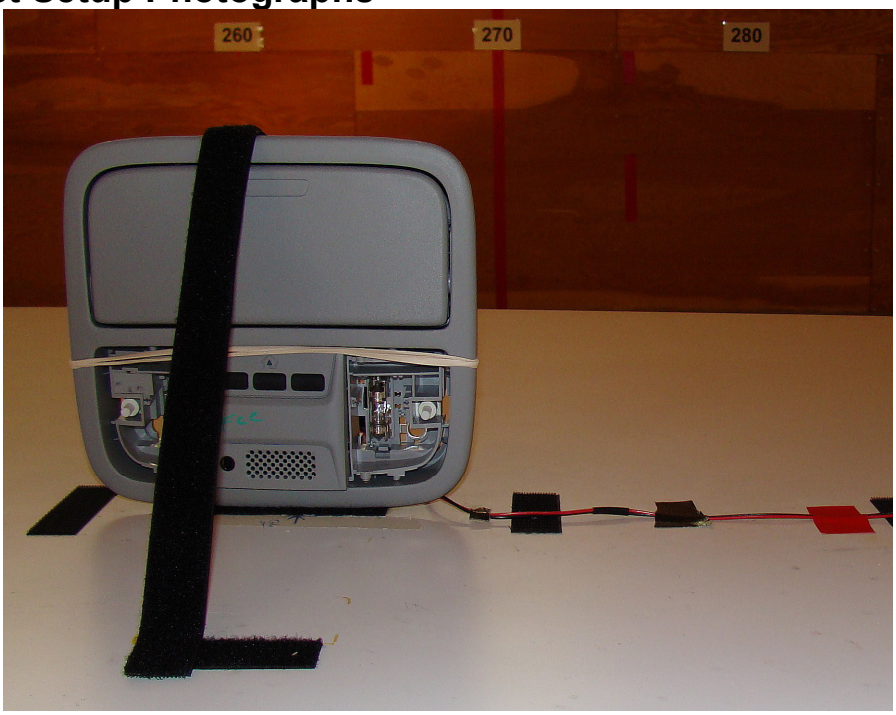
Radiated Emission measurements presented in the report were made in accordance with ANSI C63.4 Figure 9(c). The EUT was placed on a 1 x 1.5m non-metallic table elevated 80cm above a conducting ground plane. The harness was run to the long edge of the table and dropped to a power supply sitting at base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

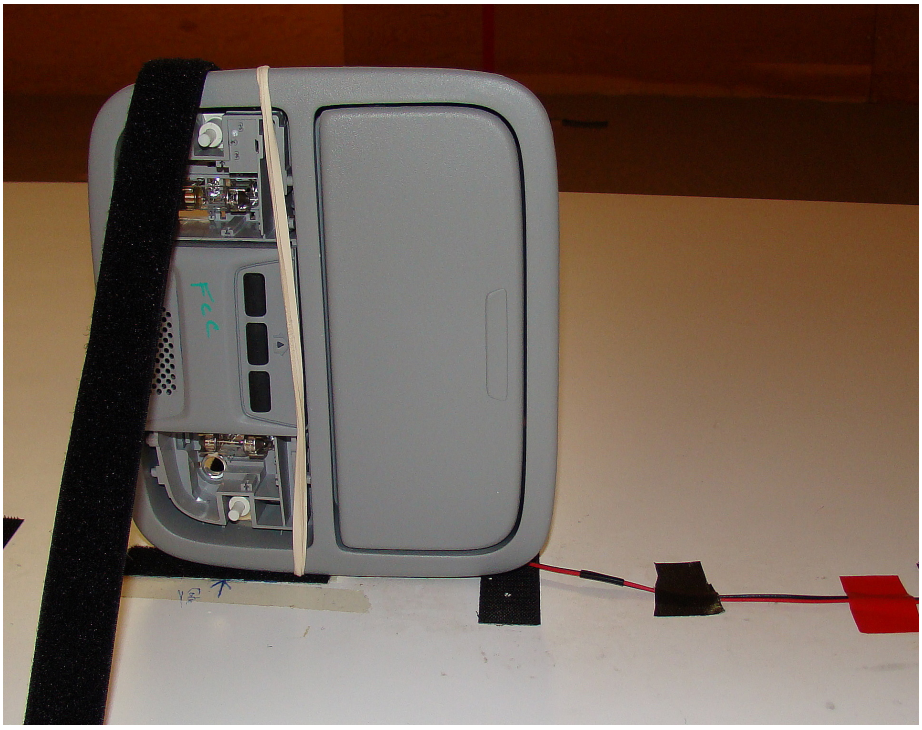


4. Block Diagram

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

5. Test Setup Photographs





Test Setup Side

Test Setup Flat

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 433 MHz at 30%, 50% and 80% duty cycles. A **worst-case emission of 81.31 dBuV/m** occurred with the DUT trained to 433 MHz, 80% duty cycle. The worst-case emission remained **1.4 dB below the FCC and IC limits** (82.8 dBuV/m) for this type of device.
- The **worst-case harmonic measurement of 49.78 dBuV/m** was found at 1440 MHz, the forth harmonic of 288 MHz at 80% duty cycle. **A margin of 6.0 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 290kHz when the DUT is trained to 288 MHz, 30% duty cycle.
- This device has a worst case digital emission of 36.51 dBuV/m at 40.56 MHz when set to transmit at 433MHz a margin of 3.49 dB to the FCC Class B and relevant IC limit is maintained.
- The output power of the DUT increased by no more than 0.91 dB when the input voltage was varied from 6 to 18 Volts. The device does not operate when the input voltage is below 7V and power reduced to 79.45 dBuV/m at 7V.
- The device was found to be incapable of operating in restricted bands.
- The device deactivated immediately after the activation button is depressed. Less than 5 sec.
- The device uses pulses to tune the transmit antenna. At 433 MHz, 30% duty cycle the field strength of the pulses average 596 uV/m over 100 msec. This represents a margin on 25.3 dB to the IC and FCC limits.

7.2. Test Equipment Used

Description	Model #	Serial Number	Last Cal Date	Cal Due
EMCO Biconical Antenna [20-300 MHz]	**3110B**	**9906-3309**	**09/14/07**	**09/14/09**
EMCO LPA Antenna [200-2000MHz]	**3148**	**9908-1076**	**09/14/07**	**09/14/09**
Electro-metrics Double Ridged Guide [1-18GHz]	**RGA-60**	**6147**	**01/02/07**	**01/02/09**

Agilent E-series EMC Analyzer	**E4407B**	**US41192569**	**10/04/07**	**10/04/08**
HP Spectrum Analyzer	**8591A**	**S919A00107**	**10/04/07**	**10/04/08**

7.3. Test Equipment Setup and Procedure

Spectrum Analyzer Settings Emissions:

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

Spectrum Analyzer Settings Occupied Bandwidth:

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

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

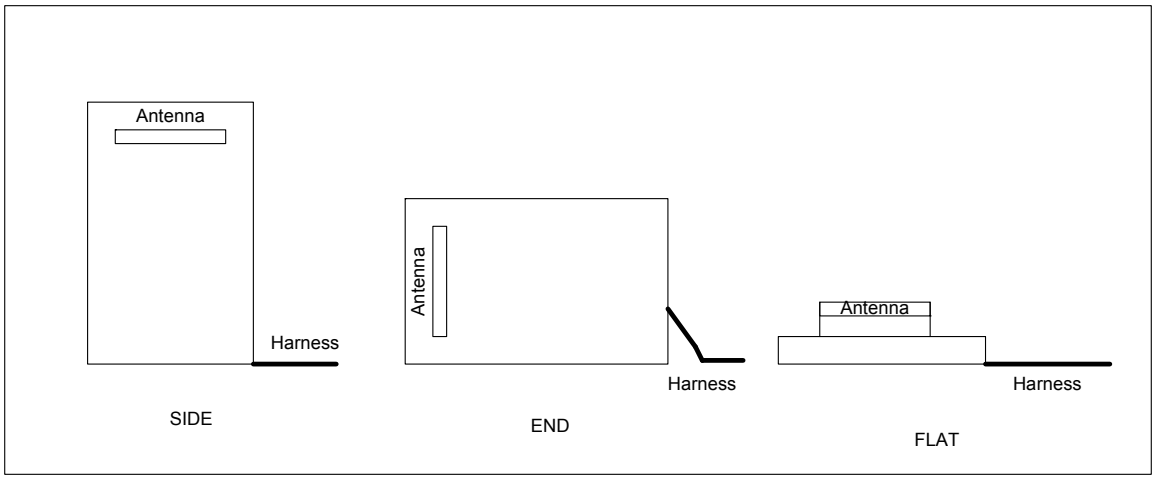


Figure 7.3.1 EUT Orthogonal Orientations

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 C63.4-2003 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	Flat	H	30	80.37	-10.46	69.9	73.8	3.9
288	Side	H	50	77.28	-6.02	71.3	73.8	2.6
288	Side	H	80	73.81	-1.94	71.9	73.8	**2.0**

* 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	82.84	-10.5	72.4	75.3	2.9
310	Side	H	50	77.87	-6.0	71.8	75.3	3.5
310	Side	H	80	75.12	-1.9	73.2	75.3	**2.1**

* Measurements include Cable corrections and Antenna Factors

7.4.1.3 DUT Tuned to 433MHz (Fundamental)

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
433	Flat	V	30	88.65	-10.5	78.2	80.8	2.6
433	Flat	H	50	84.17	-6.0	78.1	80.8	2.6
433	End	V	80	81.31	-1.9	79.4	80.8	**1.4**

* 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	V	30	53.38	-10.5	42.9	53.8	**10.9**
576	End	V	50	52.08	-6.0	46.1	53.8	7.8
576	Flat	V	80	42.71	-1.9	40.8	53.8	13.1
864	Side	H	30	Ambient	-10.5	N/A	53.8	N/A
864	Side	H	50	Ambient	-6.0	N/A	53.8	N/A
864	Side	H	80	Ambient	-1.9	N/A	53.8	N/A
1152	Flat	H	30	53.1	-10.5	42.6	53.8	11.2
1152	End	H	50	51.22	-6.0	45.2	53.8	8.6
1152	Flat	H	80	46.37	-1.9	44.4	53.8	9.4
1440	Side	V	30	51.92	-10.5	41.5	53.8	12.4
1440	End	V	50	52.52	-6.0	46.5	53.8	7.3
1440	End	V	80	49.78	-1.9	47.8	53.8	6.0
1728	Side	V	30	51.2	-10.5	40.7	53.8	13.1
1728	Side	V	50	50.18	-6.0	44.2	53.8	9.7
1728	Flat	V	80	47.21	-1.9	45.2	53.8	8.6
2016	End	V	30	50.6	-10.5	40.1	53.8	13.7
2016	End	V	50	50.31	-6.0	44.3	53.8	9.5
2016	Side	H	80	47.66	-1.9	45.7	53.8	8.1
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

* Measurements include Cable corrections and Antenna Factors

Noise Ambient

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	H	30	53.39	-10.5	42.9	55.3	12.4
620	Side	H	50	50.39	-6.0	44.4	55.3	10.9
620	End	H	80	47.1	-1.9	45.2	55.3	10.2
930	Side	V	30	52.27	-10.5	41.8	55.3	13.5
930	Side	V	50	48.96	-6.0	42.9	55.3	12.4
930	Flat	V	80	47.52	-1.9	45.6	55.3	9.7
1240	Side	H	30	51.04	-10.5	40.6	54.0	13.4

1240	Side	H	50	47.06	-6.0	41.0	54.0	13.0
1240	Side	H	80	46.34	-1.9	44.4	54.0	**9.6**
1550	End	V	30	50.88	-10.5	40.4	54.0	13.6
1550	End	V	50	48.12	-6.0	42.1	54.0	11.9
1550	End	H	80	48.05	-1.9	46.1	54.0	7.9
1860	Side	V	30	Noise	-10.5	N/A	55.3	N/A
1860	Side	H	50	Noise	-6.0	N/A	55.3	N/A
1860	Side	H	80	Noise	-1.9	N/A	55.3	N/A
2170	End	V	78	Noise	-2.2	N/A	52.0	N/A
2170	End	V	79	Noise	-2.0	N/A	53.0	N/A
2170	End	V	80	Noise	-1.9	N/A	54.0	N/A
2480	End	H	30	Noise	-10.5	N/A	55.3	N/A
2480	End	H	50	Noise	-6.0	N/A	55.3	N/A
2480	End	H	80	Noise	-1.9	N/A	55.3	N/A
2790	Side	H	30	Noise	-10.5	N/A	54.0	N/A
2790	Side	H	50	Noise	-6.0	N/A	55.3	N/A
2790	Side	H	80	Noise	-1.9	N/A	55.3	N/A
3100	End	V	30	Noise	-10.5	N/A	55.3	N/A
3100	End	V	50	Noise	-6.0	N/A	55.3	N/A
3100	End	V	80	Noise	-1.9	N/A	55.3	N/A

Noise

Measurements include Cable corrections and Antenna Factors

7.4.1.6 433 MHz (Harmonics)

Frequency (MHz)	Orientation (Flat/End/Side)	Measurement Polarization (H/V)	Duty Cycle (%)	Measurement* (dBuV/m)	Duty Cycle Correction (dB)	Average Level (dBuV/m)	FCC Limit (dBuV/m)	Margin (dB)
866	Side	V	30	62.16	-10.5	51.7	60.8	9.1
866	Side	V	50	58.02	-6.0	52.0	60.8	8.8
866	Side	V	80	52.57	-1.9	50.6	60.8	10.2
1299	End	V	30	55.06	-10.5	44.6	60.8	16.2
1299	Side	V	50	53.55	-6.0	47.5	60.8	13.3
1299	Side	V	80	53.1	-1.9	51.2	60.8	9.6
1732	Side	V	30	50.04	-10.5	39.6	54.0	14.4
1732	Side	V	50	48.81	-6.0	42.8	54.0	11.2
1732	Side	V	80	48.42	-1.9	46.5	54.0	**7.5**
2165	End	H	30	47.34	-10.5	36.9	60.8	23.9
2165	Side	V	50	Noise	-6.0	Noise	60.8	N/A
2165	Side	V	80	48.03	-1.9	41.6	60.8	14.7
2598	End	H	30	Noise	-10.5	Noise	60.8	N/A
2598	End	H	50	Noise	-6.0	Noise	60.8	N/A
2598	End	H	80	Noise	-1.9	Noise	60.8	N/A
3031	Side	H	30	Noise	-10.5	Noise	60.8	N/A
3031	Side	H	50	Noise	-6.0	Noise	60.8	N/A
3031	Side	H	80	Noise	-1.9	Noise	60.8	N/A
3464	Side	V	30	Noise	-10.5	Noise	60.8	N/A
3464	Side	V	50	Noise	-6.0	Noise	60.8	N/A

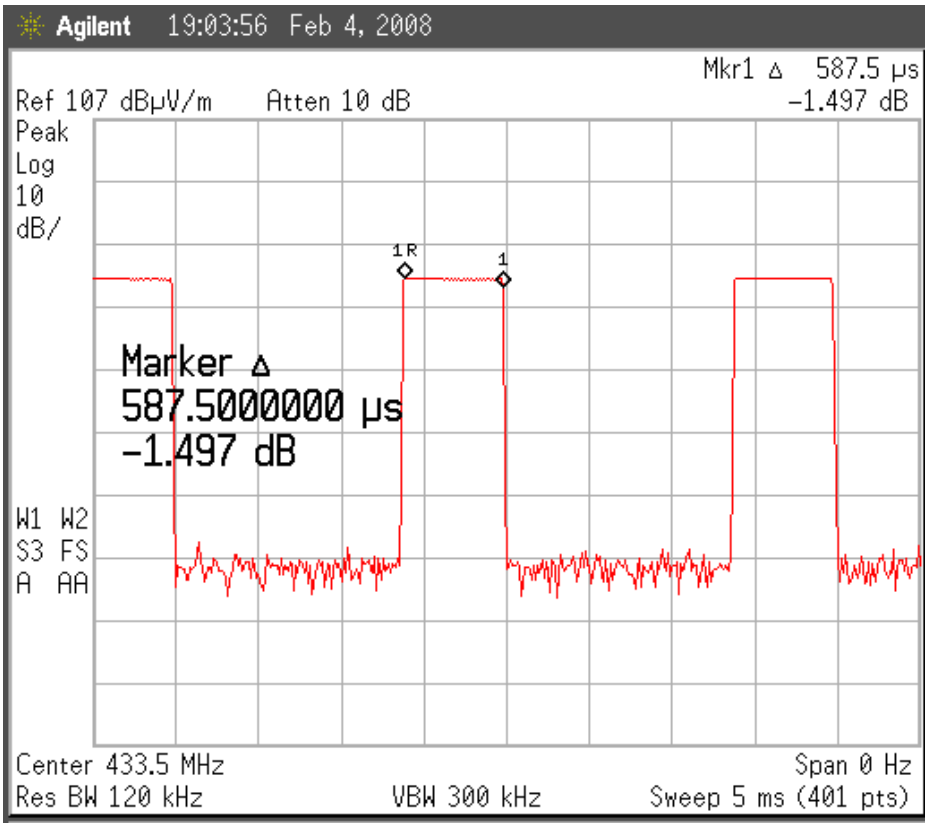
3464	Side	V	80	Noise	-1.9	Noise	60.8	N/A
3897	End	V	30	Noise	-10.5	Noise	54.0	N/A
3897	End	V	50	Noise	-6.0	Noise	60.8	N/A
3897	End	V	80	Noise	-1.9	Noise	60.8	N/A
4330	End	V	30	Noise	-10.5	Noise	54.0	N/A
4330	End	V	50	Noise	-6.0	Noise	60.8	N/A
4330	End	V	80	Noise	-1.9	Noise	60.8	N/A

* Measurements include Cable corrections and Antenna Factors

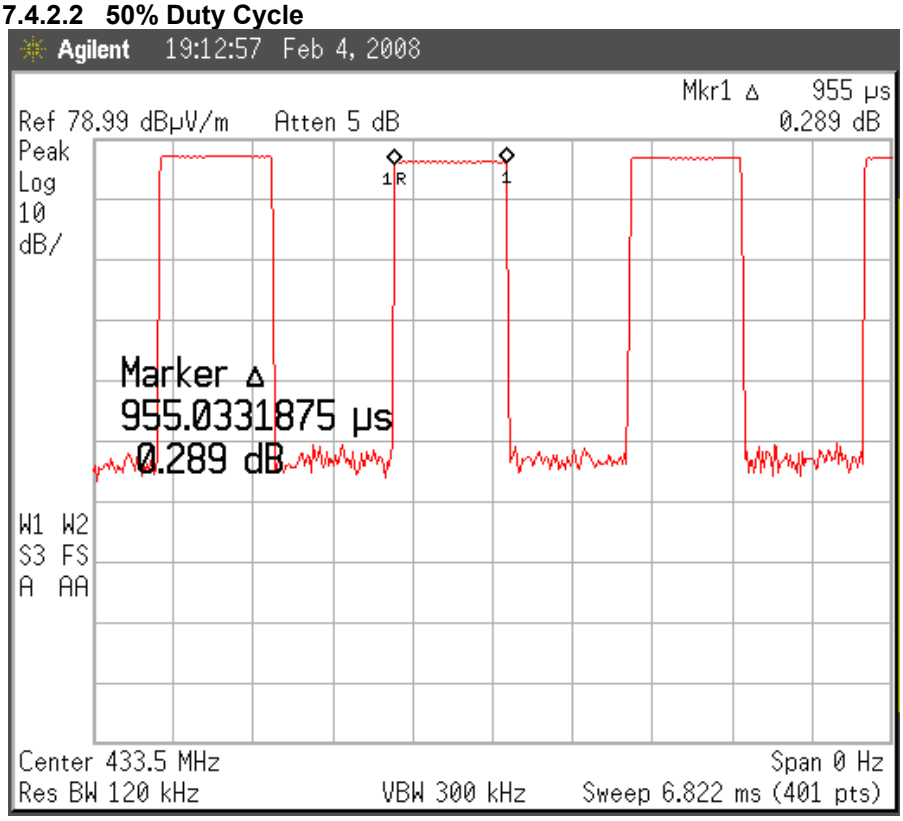
7.4.2 Pulsed Operation

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 309.5MHz with the span set to zero on the E4407B spectrum analyzer.

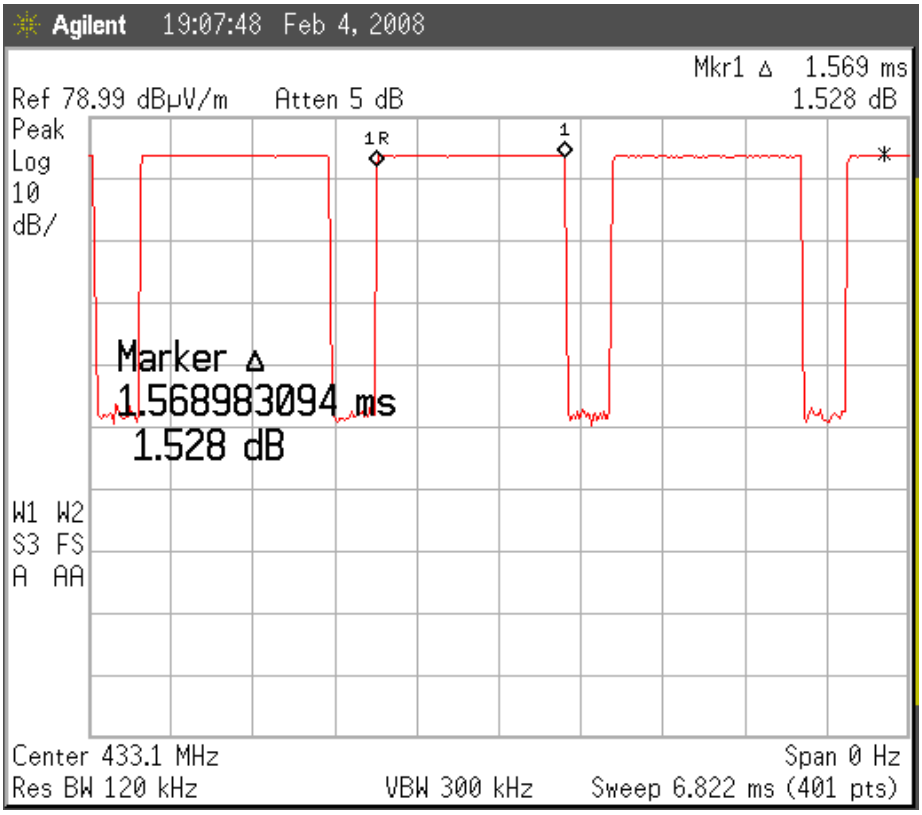
7.4.2.1 30% Duty Cycle



7.4.2.2 50% Duty Cycle



7.4.2.3 80% Duty Cycle



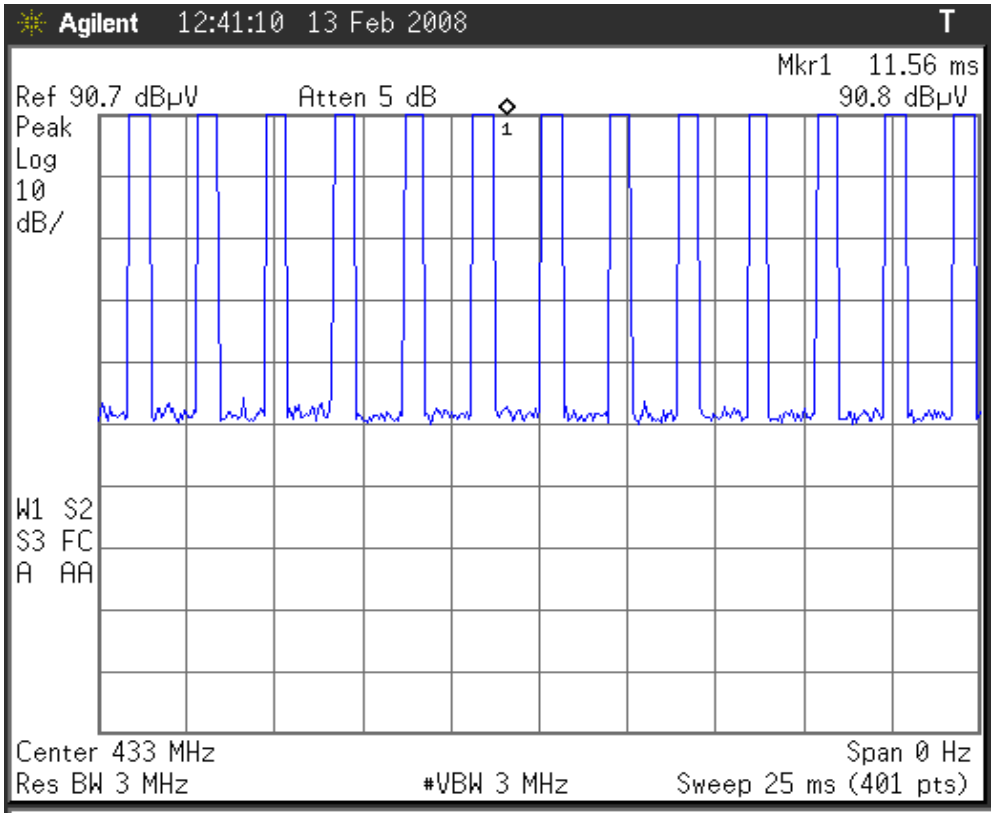
7.4.3 Occupied Bandwidth

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

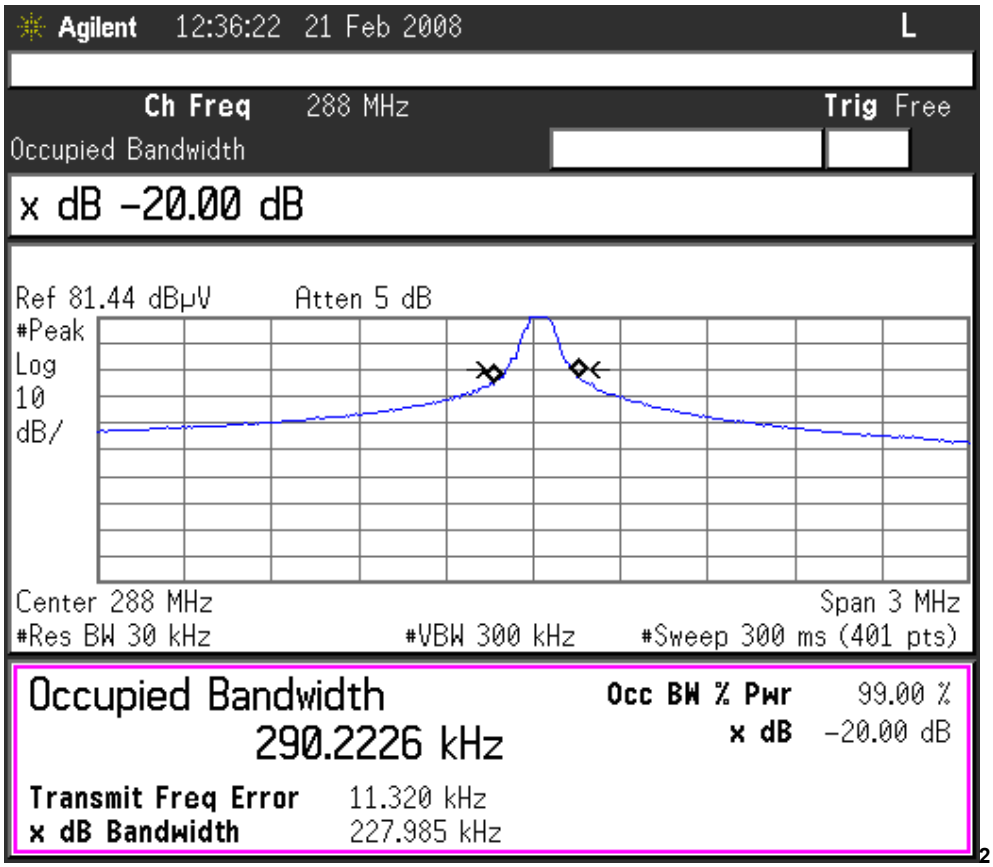
7.4.3.1 Occupied Bandwidth Measurement

Frequency (MHz)	Duty Cycle (%)	Occupied Bandwidth (kHz)	Limit (kHz)
288	30	290	720
	50	106	720
	80	99	720
310	30	97	775
	50	94	775
	80	97	775
433	30	154	1045
	50	132	1045
	80	124	1045

7.4.3.2 Example of Occupied Bandwidth measurement (433MHz 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 7.4.4.1

Measurement settings:

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

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

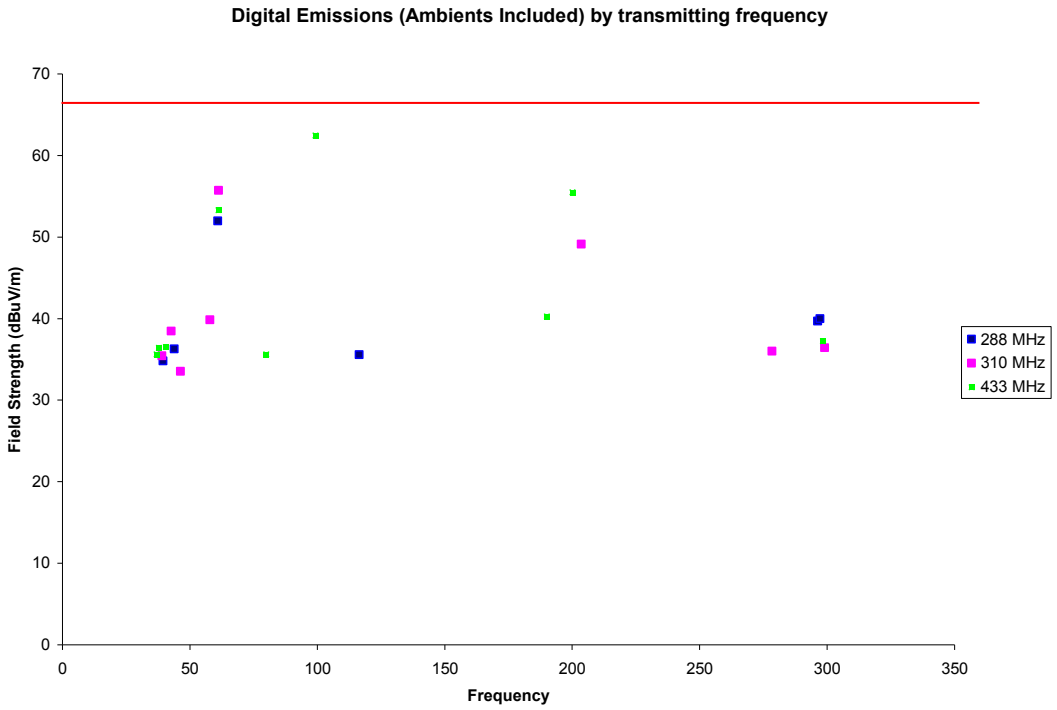
7.4.4.1 Summary of Emissions Measurements Taken on OATS

Transmitting Frequency (MHz	Frequency (MHz)	DUT Orientation	Antenna Polarization	Field Strength (dBuV/m)	Limit (dBuV/m)	Margin (dB)
288	39.48	Flat	H	34.79	40	5.21
	43.98	Side	H	36.27	40	3.73
	61	Side	H	51.99	40	-11.99
	116.46	Side	H	35.59	40	4.41
	296.34	Flat	V	39.69	40	0.31
	297.18	Side	H	39.99	40	0.01
310	39.12	Side	H	35.44	40	4.56
	42.66	Flat	H	38.45	40	1.55
	46.32	Side	H	33.53	40	6.47
	57.96	Flat	H	39.83	40	0.17
	61.238	Flat	V	55.71	40	-15.71
	203.55	Side	H	49.13	40	-9.13
	278.46	Side	H	36.01	40	3.99
	299.1	Flat	V	36.42	40	3.58
433	**36.9**	Side	V	35.61	40	4.39
	37.8	Flat	H	36.43	40	3.57
	40.56	Flat	H	36.51	40	3.49
	61.23	Flat	H	53.31	40	-13.31
	79.98	Side	V	35.61	40	4.39
	99.3	Flat	H	62.44	40	-22.44
	190.02	Flat	H	40.26	40	-0.26
	200.04	Flat	H	55.51	40	-15.51
	298.32	Flat	H	37.23	40	2.77

Ambient

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. Local ambient measurements are not present on scatter-plot.

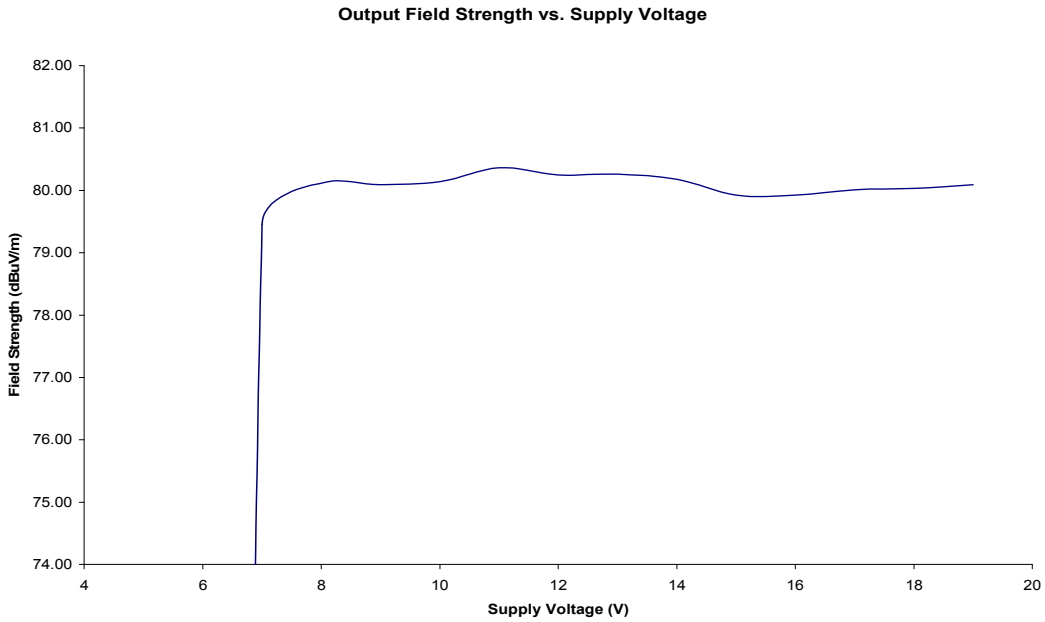
7.4.4.2 Plot of Class B Emissions relative to FCC Limit



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). The DUT was configured to transmit at 433 MHz, 30% Duty Cycle. Values presented are not corrected for duty cycle.

7.4.5.1 Plot of output power over supply voltage



7.4.5.2 Output power as a function of supply voltage

Voltage	Field Strength (dBuV/m)
6	0
7	79.45
8	80.11
9	80.09
10	80.14
11	80.36
12	80.25
13	80.26
14	80.18
15	79.92
16	79.92
17	80.01
18	80.03
19	80.09
20	0

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

7.4.7 Verification of De-activation after 5 seconds

This device stops transmitting once the activation button is released.

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 7.4.8.4. Tuning pulse measurements were taken at 288, 310, and 433 MHz at a duty cycle of 30%. Settings in the