February 15, 2005

Technical Report to the FCC Regarding Johnson Controls Interiors, L.L.C. Homelink© III Model: CB2GTX2HL3 FCC ID: CB2GTX2HL3 2/15/2005

A report concerning approval for Johnson Controls Homelink® model CB2GTX2HL3
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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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.

This particular Homelink® model is enclosed inside a self-dimming mirror made by Gentex Corporation of Zeeland, MI. There is no interaction between the mirror and the Homelink apart from a supplied power connection. The Homelink® is tested in the mirror to provide an accurate representation of the product as it is available to the product customer (automotive OEMs) and would be installed into an automobile as a rear-view mirror. A variant of this device also includes an Remote Keyless Entry module supplied by another manufacturer and a base model with reduced features. The model tested was found to have the strongest transmitter emissions when all three parts are similarly tuned.

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 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: CB2GTX2HL3. The Industry Canada certification number is 279B-GTX2HL3. These identifiers will be embossed on the product housing.

The label will be placed on the HL3 PCB 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. 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 “end.jpg”
For test setup photos please refer to attachment named “side.jpg”
For test setup photos please refer to attachment named “flat.jpg”

6. Conducted Emissions Measurements

Conducted Measurements are not required for this product.

7. Radiated Emissions Data

7.1. Summary of Results

- Measurements of the transmit output field strength were taken with the DUT trained to 288, 310, and 418 MHz at 30, 50 and 80% duty cycles. A **worst-case emission of 72.9 dBuV/m** occurred with the DUT trained to 288 MHz, 30% duty cycle. The worst-case emission remained approximately **1 dB below the FCC limit** (73.8 dBuV/m) for this type of device.
- The **worst-case harmonic measurement of 47.8 dBuV/m** was found at 579 MHz, the fifth harmonic of 288 MHz at 80% duty cycle. **A margin of 6.0 dB to the prescribed FCC 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 88 kHz when the DUT is trained to 418 MHz, 30% duty cycle.
- This device has a worst case Class B emission of 37.85 dBuV/m at 35.724 MHz when set to transmit at 310 MHz a margin of 2.15 dB to the Class B limit is maintained.
- The output power of the DUT varied by no more than 0.2dB when the input voltage was varied from 6 to 18 Volts. The device does not operate when the input voltage is below 8V.
- The device was found to be incapable of operating in restricted bands.
- The device deactivated immediately after the activation button is depressed. Less than 5 sec.
- The device uses coarse and fine pulses to tune the transmit antenna. At 418 MHz, 30% duty cycle the field strength of the pulses average 5219 uV/m over 100 msec. This represents a margin on 5.5 dB to the FCC limit.

7.2. Test Equipment Used

Description	Model #	Serial Number	Last Cal Date	Cal Due
EMCO Biconical Antenna (20-300 MHz)	**3110B**	**9906-3309**	**10/21/03**	**10/21/05**
EMCO LPA	**3148**	**9908-1076**	**10/21/03**	**10/21/05**

Antenna (200-2000MHz)				
Electro-metrics Double Ridged Guide (1-18GHz)	**RGA-60**	**6147**	**10/21/03**	**10/21/05**
Agilent E-series EMC Analyzer	**E4407B**	**US41192569**	**10/26/04**	**10/26/05**
Rohde & Schwarz EMI Test Receiver 7GHz	**EMI 7**	**1088.749.07**	**7/20/04**	**7/20/05**

7.3. Test Equipment Setup and Procedure

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

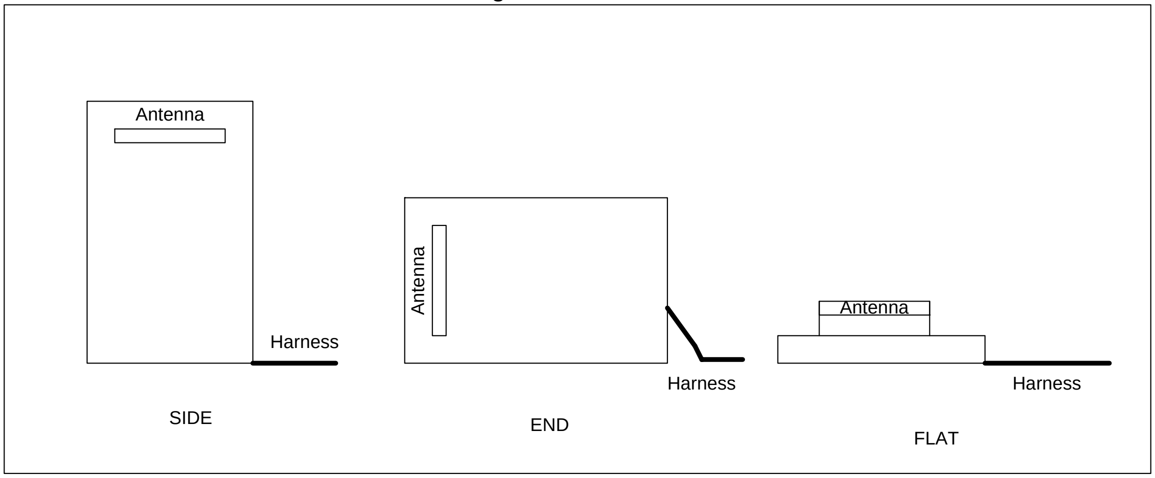


Figure 7.3.1 EUT Orthogonal Orientations

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	End	H	30	82.97	-10.46	72.5	73.8	1.3
288	End	H	50	78.44	-6.02	72.4	73.8	1.4
288	End	H	80	74.81	-1.94	72.9	73.8	**1.0**

* 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	End	H	30	83.5	-10.5	73.0	75.3	2.3
310	End	H	50	79.08	-6.0	73.1	75.3	2.3
310	End	H	80	75.73	-1.9	73.8	75.3	**1.5**

* 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	Flate	V	30	89.45	-10.5	79.0	80.3	**1.3**
418	Flate	V	50	84.65	-6.0	78.6	80.3	1.7
418	Flate	V	80	80.5	-1.9	78.6	80.3	1.7

* 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	End	H	30	53.4	-10.5	42.9	53.8	10.9
576	End	H	50	51.93	-6.0	45.9	53.8	7.9
576	End	H	80	49.76	-1.9	47.8	53.8	**6.0**
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	Side	H	30	44.27	-10.5	33.8	53.8	20.0
1152	End	V	50	41.25	-6.0	35.2	53.8	18.6
1152	End	V	80	41.33	-1.9	39.4	53.8	14.4
1440	End	V	30	51.35	-10.5	40.9	53.8	12.9
1440	End	V	50	49.35	-6.0	43.3	53.8	10.5
1440	End	V	80	48.81	-1.9	46.9	53.8	7.0
1728	Side	V	30	48.84	-10.5	38.4	53.8	15.5
1728	Side	V	50	47.57	-6.0	41.5	53.8	12.3
1728	Side	V	80	47.35	-1.9	45.4	53.8	8.4
2016	Side	V	30	44.97	-10.5	34.5	53.8	19.3
2016	Side	V	50	44.71	-6.0	38.7	53.8	15.1
2016	Side	V	80	44.99	-1.9	43.1	53.8	10.8
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)
620	Side	H	30	53.39	-10.5	42.9	55.3	12.4
620	Side	H	50	49.99	-6.0	44.0	55.3	11.3
620	Side	H	80	49.35	-1.9	47.4	55.3	**7.9**
930	Side	H	30	Ambient	-10.5	N/A	55.3	N/A
930	Side	H	50	Ambient	-6.0	N/A	55.3	N/A
930	Side	H	80	Ambient	-1.9	N/A	55.3	N/A
1240	Flat	V	30	50.8	-10.5	40.3	54.0	13.7
1240	Flat	V	50	47.79	-6.0	41.8	54.0	12.2
1240	Flat	V	80	46.74	-1.9	44.8	54.0	9.2
1550	End	V	30	48.29	-10.5	37.8	54.0	16.2
1550	End	V	50	47.85	-6.0	41.8	54.0	12.2
1550	End	V	80	47.67	-1.9	45.7	54.0	8.3
1860	Side	H	30	47.63	-10.5	37.2	55.3	18.1
1860	Side	H	50	47.35	-6.0	41.3	55.3	14.0
1860	Side	H	80	47.58	-1.9	45.6	55.3	9.7
2170	End	V	30	Noise	-10.5	N/A	55.3	N/A
2170	End	V	50	Noise	-6.0	N/A	55.3	N/A
2170	End	V	80	Noise	-1.9	N/A	55.3	N/A
2480	End	V	30	Noise	-10.5	N/A	55.3	N/A
2480	Flat	V	50	Noise	-6.0	N/A	55.3	N/A
2480	End	V	80	Noise	-1.9	N/A	55.3	N/A
2790	Side	H	30	Ambient	-10.5	N/A	54.0	N/A
2790	End	V	50	Ambient	-6.0	N/A	54.0	N/A
2790	End	V	80	Ambient	-1.9	N/A	54.0	N/A
3100	Side	V	30	Noise	-10.5	N/A	55.3	N/A
3100	Side	V	50	Noise	-6.0	N/A	55.3	N/A
3100	Side	V	80	Noise	-1.9	N/A	55.3	N/A

Ambient — Ambient too strong to take measurement at 930, cell tower.

* 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	End	V	30	58.48	-10.5	48.0	60.3	12.3
836	End	V	50	55.14	-6.0	49.1	60.3	11.2
836	End	V	80	52.74	-1.9	50.8	60.3	9.5
1254	End	V	30	47.84	-10.5	37.4	60.3	22.9
1254	End	V	50	46.52	-6.0	40.5	60.3	19.8
1254	End	V	80	45.78	-1.9	43.8	60.3	16.4
1672	Side	H	30	49.83	-10.5	39.4	54.0	14.6
1672	End	V	50	48.57	-6.0	42.5	54.0	11.5
1672	End	V	80	47.55	-1.9	45.6	54.0	**8.4**
2090	Side	H	30	55.13	-10.5	44.7	60.3	15.6
2090	Side	H	50	52.93	-6.0	46.9	60.3	13.4
2090	Side	H	80	52.36	-1.9	50.4	60.3	9.9
2508	End	H	30	49.32	-10.5	38.9	60.3	21.4
2508	End	H	50	48.58	-6.0	42.6	60.3	17.7
2508	End	H	80	47.77	-1.9	45.8	60.3	14.5
2926	Flat	V	30	Noise	-10.5	N/A	60.3	N/A
2926	End	H	50	Noise	-6.0	N/A	60.3	N/A
2926	End	H	80	Noise	-1.9	N/A	60.3	N/A
3344	End	V	30	Noise	-10.5	N/A	60.3	N/A
3344	End	V	50	Noise	-6.0	N/A	60.3	N/A
3344	End	V	80	Noise	-1.9	N/A	60.3	N/A
3762	End	V	30	Noise	-10.5	N/A	54.0	N/A
3762	End	V	50	Noise	-6.0	N/A	54.0	N/A
3762	End	V	80	Noise	-1.9	N/A	54.0	N/A
4180	End	V	30	Noise	-10.5	N/A	54.0	N/A
4180	End	V	50	Noise	-6.0	N/A	54.0	N/A
4180	End	V	80	Noise	-1.9	N/A	54.0	N/A

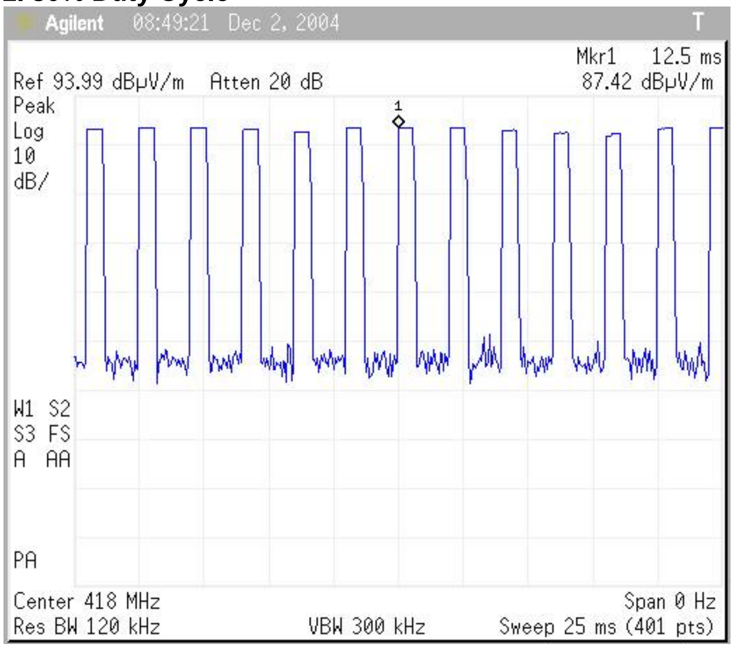
Ambient   Noise Floor

* Measurements include Cable corrections and Antenna Factors

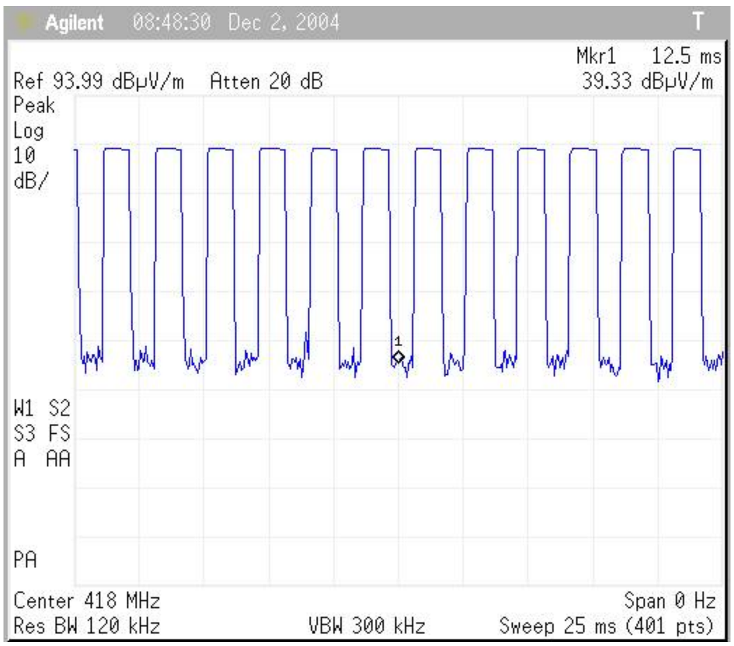
7.4.2. Pulsed Operation

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 E7407B spectrum analyzer.

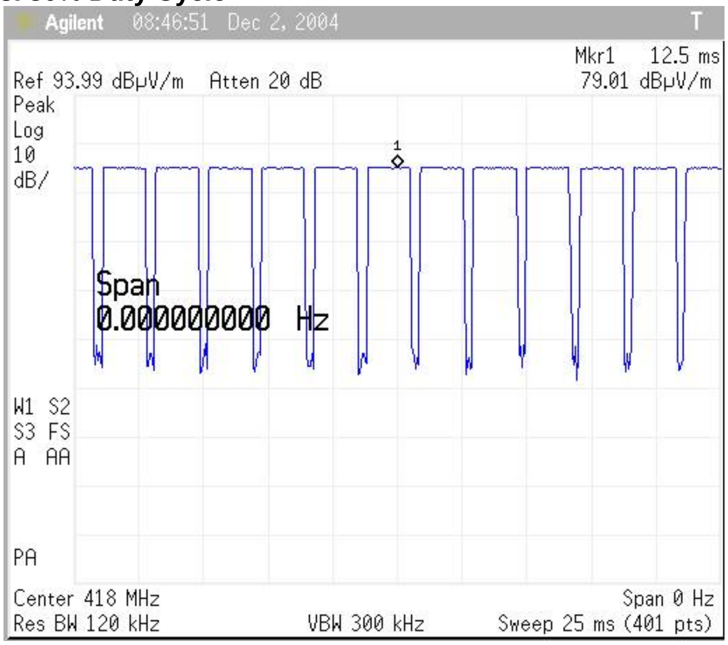
7.4.2.1. 30% Duty Cycle



7.4.2.2. 50% Duty Cycle



7.4.2.3. 80% Duty Cycle



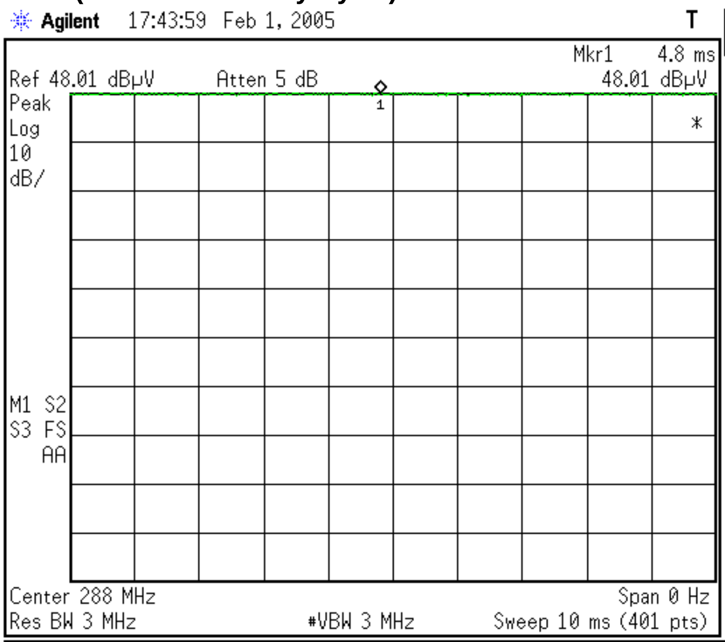
7.4.3. Occupied Bandwidth

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

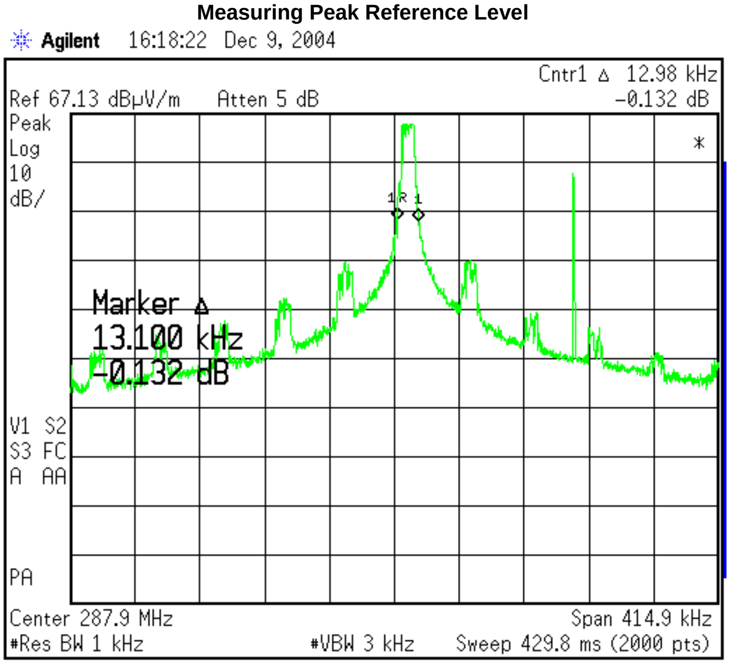
7.4.3.1. Occupied Bandwidth Measurement

Frequency (MHz)	Duty Cycle (%)	Occupied Bandwidth (kHz)	Limit (kHz)
288	30	9.2	720
	50	10	720
	80	8.8	720
310	30	13.6	775
	50	11.3	775
	80	10.2	775
418	30	88	1045
	50	15.6	1045
	80	26.4	1045

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



Measuring Peak Reference Level



Measuring Occupied Bandwidth

7.4.4. Emission Spectrum

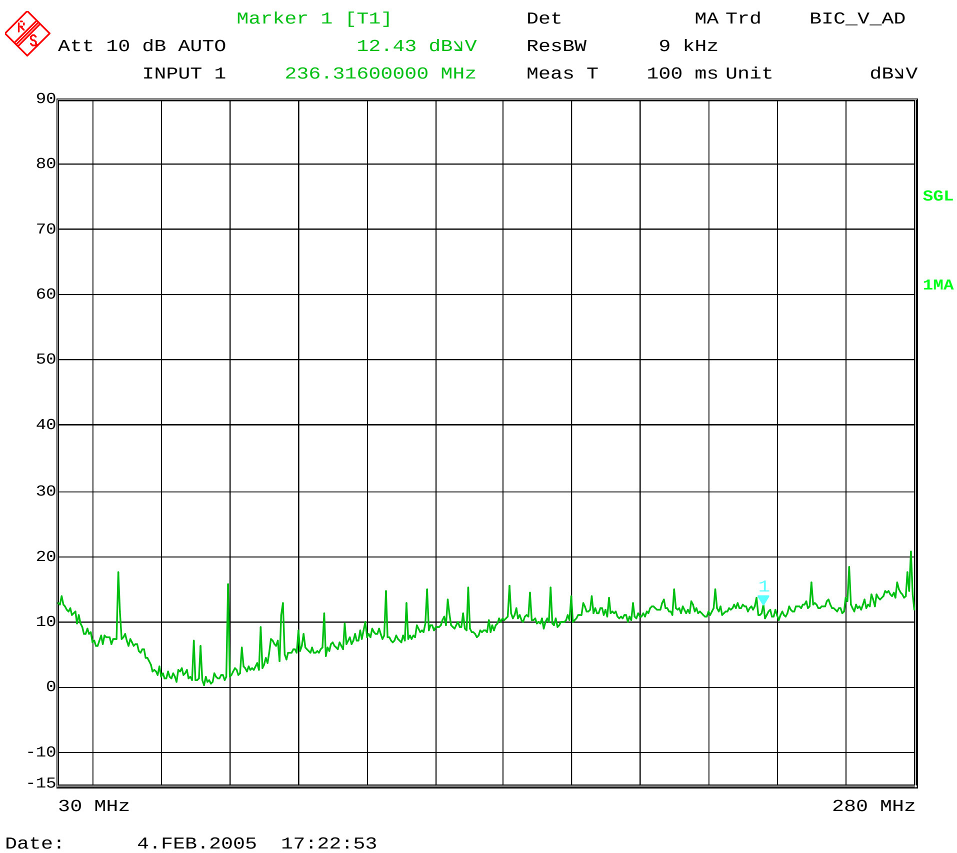
Prescan Measurements were taken inside a semi-anechoic chamber to investigate the possibility of other spurious emissions from the DUT. Screen captures presented below in sections 7.4.4.1-3 show the spurious emissions observed with the DUT trained to 288, 310, and 418MHz with a 30% Duty cycle.

A relay was used to reset the DUT, the emissions of the relay (without DUT connected) are shown as the green trace.

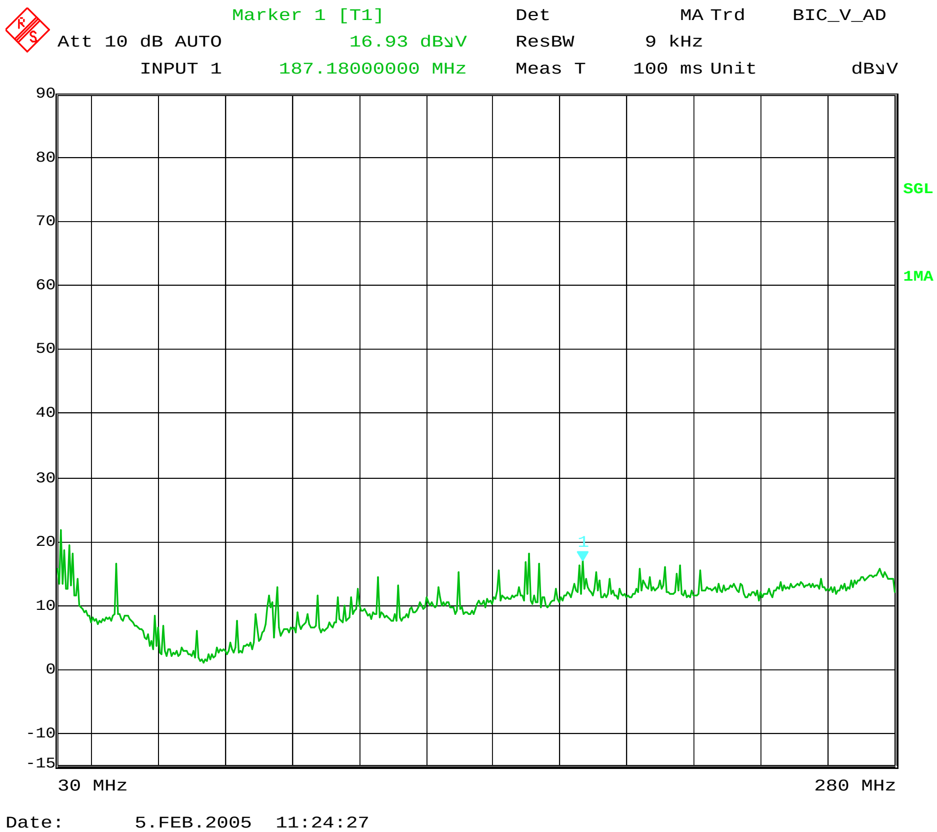
Emissions were noted and measured on the JCI OATS, all measurements were found to be near or below the ambient noise level and well below the FCC limits for spurious emissions. A summary is presented below in section 7.4.4.4

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

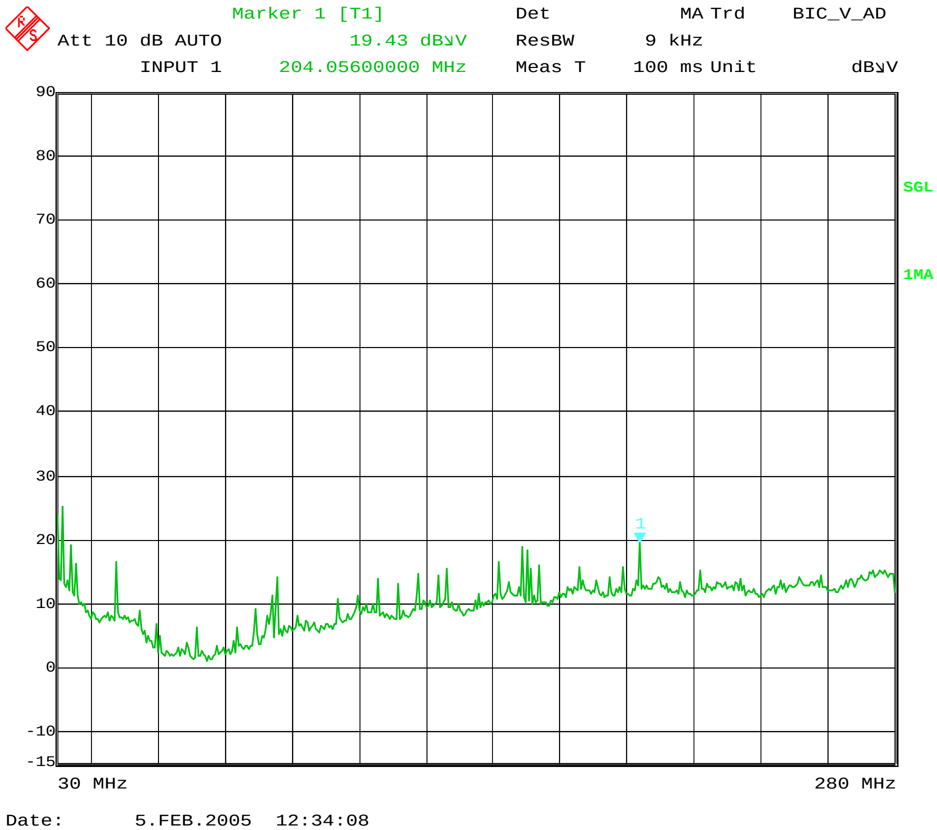
7.4.4.1. 288 MHz



7.4.4.2. 310 MHz


Marker 1 [T1]
Att 10 dB AUTO
16.93 dBμV
INPUT 1
187.18000000 MHz
Det
MA Trd
BIC_V_AD
ResBW
9 kHz
Meas T
100 ms Unit
dBμV
90
80
70
60
50
40
30
20
10
0
-10
-15
SGL
1MA
30 MHz
280 MHz
Date: 5.FEB.2005 11:24:27

7.4.4.3. 418 MHz



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

For this particular product the transmitter is sold in 3 different self-dimming mirrors. All three mirrors were evaluated and the configuration showing the worst case Class B emissions was evaluated. The results are presented below.

7.4.4.4. Summary of Emissions Measurements Taken on OATS

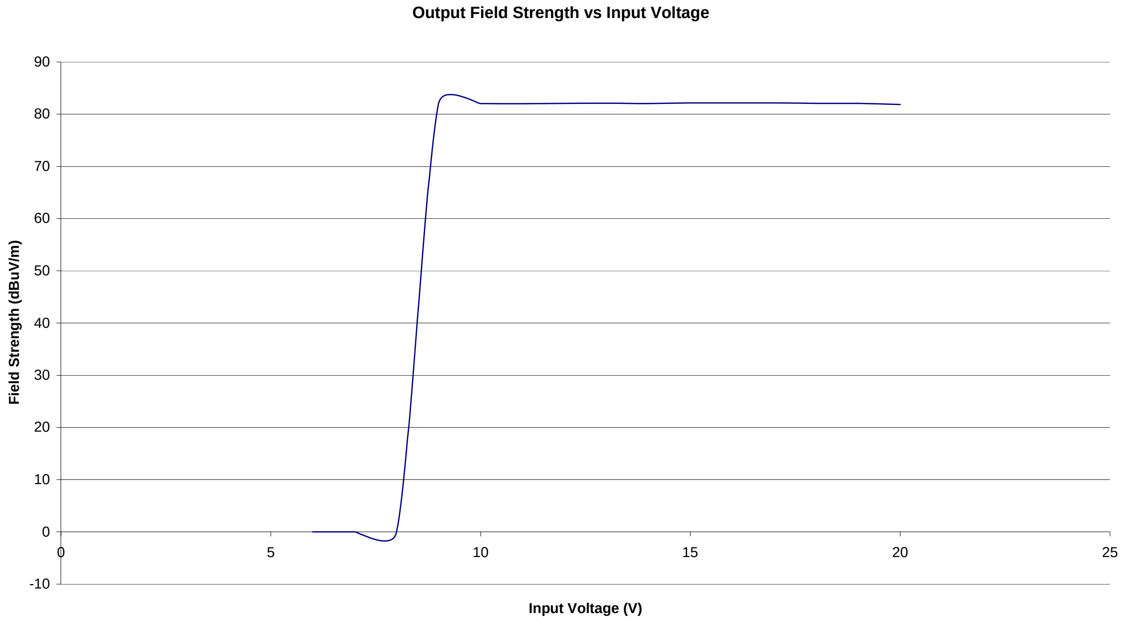
Transmitting Frequency (MHz	Frequency (MHz)	Worst Case Emission (dBuV/m)	Class B Limit (dBuV/m)	Margin (dB)
288	48.012	34.62	40	5.38
	95.612	Ambient	43.5	N/A
	102.024	Ambient	43.5	N/A
	126.032	37.8	43.5	5.7
	150.64	37.88	43.5	5.62
	168.044	37.58	43.5	5.92
	186.048	Ambient	43.5	N/A
	191.096	29.65	43.5	13.85
	198.052	30.11	43.5	13.39
	279.024	28.74	46	17.26
310	31.152	37.89	40	**2.11**
	33.7	35.22	40	4.78
	48.012	36.84	40	3.16
	93.524	Ambient	43.5	N/A
	96.024	Ambient	43.5	N/A
	126.032	37.19	43.5	6.31
	150.04	36.95	43.5	6.55
	171.1	38.95	43.5	4.55
	187.18	38.21	43.5	5.29
418	31.688	35.28	40	4.72
	34.232	27.61	40	12.39
	48.012	Ambient	40	N/A
	94.48	Ambient	43.5	N/A
	96.024	Ambient	43.5	N/A
	126.036	Ambient	43.5	N/A
	146.24	36.57	43.5	6.93
	169.072	39.02	43.5	4.48
	170.344	36.95	43.5	6.55
	204.056	38.74	43.5	4.76

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.

7.4.5. 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 310MHz, 30% 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	no op
7	no op
8	no op
9	82.03
10	82.03
11	82.01
12	82.07
13	82.09
14	82.03
15	82.17
16	82.15
17	82.17
18	82.06

7.4.6. Verification of Non-Operation in Restricted Bands

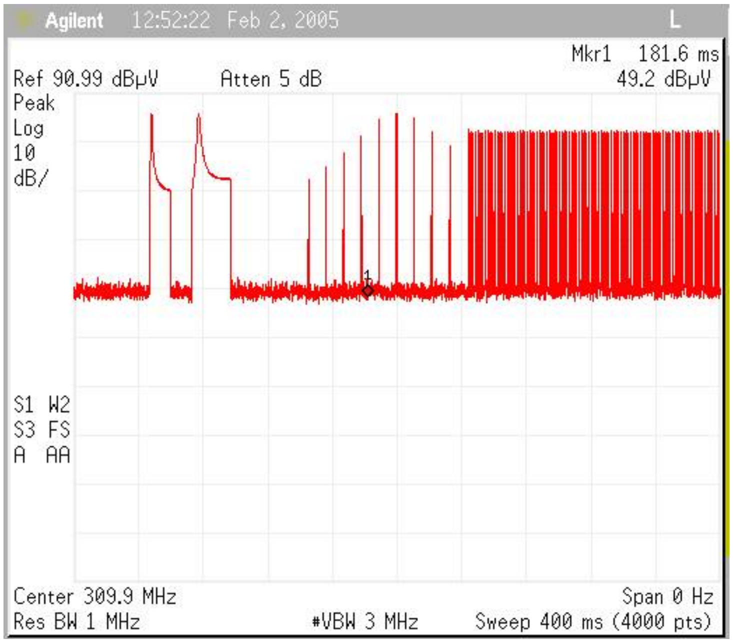
An exercise was undergone to verify that the device was not able to learn and thereby transmit in a restricted band. During this exercise it was found that the device firmware prevents the device from learning any frequency within 1MHz of any restricted band listed in 47 CFR 15.205.

7.4.7. Verification of De-activation after 5 seconds

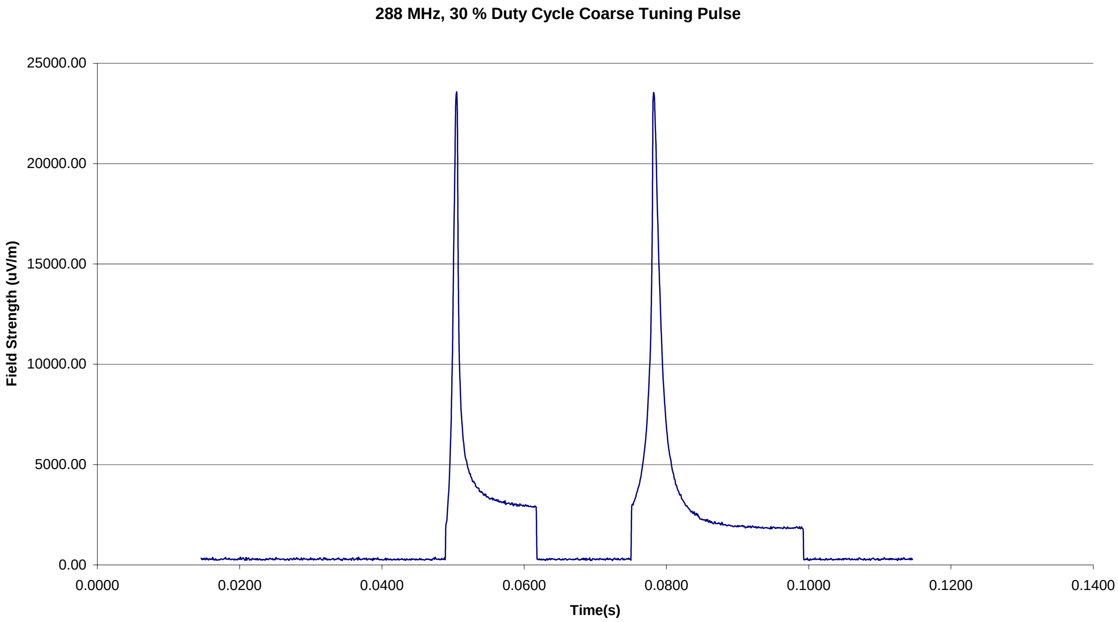
This device stops transmitting once the activation button in depressed.

7.4.8. Tuning Pulse Measurements

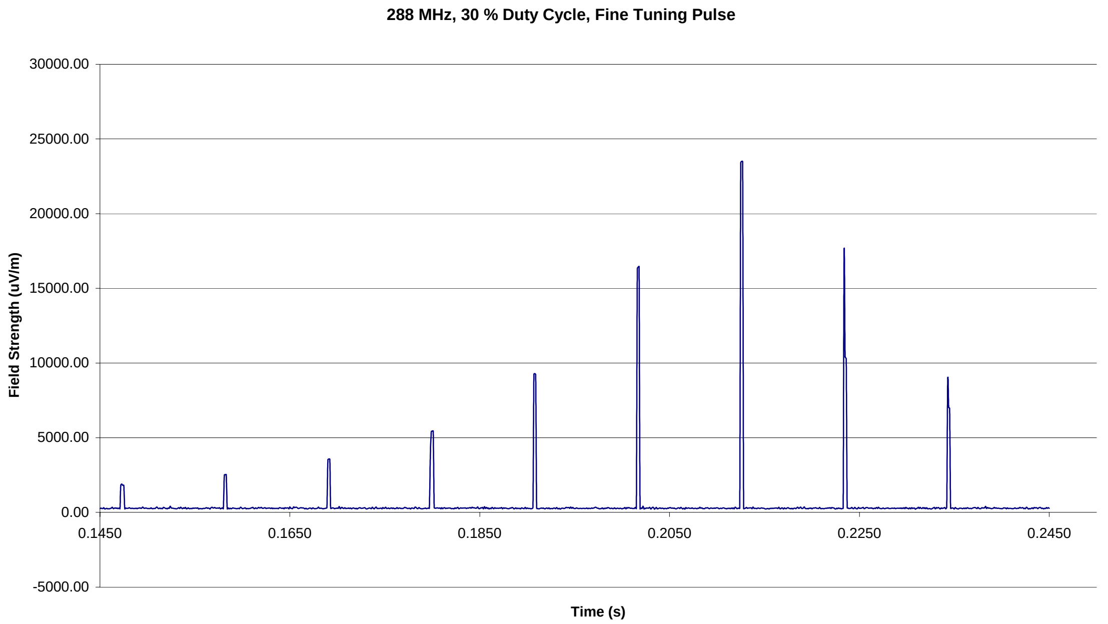
This device uses pulses to tune the antenna prior to transmission. Measurements of these tuning pulses over 400 msec windows show that these pulses are below the FCC limits for operation in this band. A summary of measurements is presented in section 7.4.8.7. Tuning pulse measurements were taken at 288, 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.



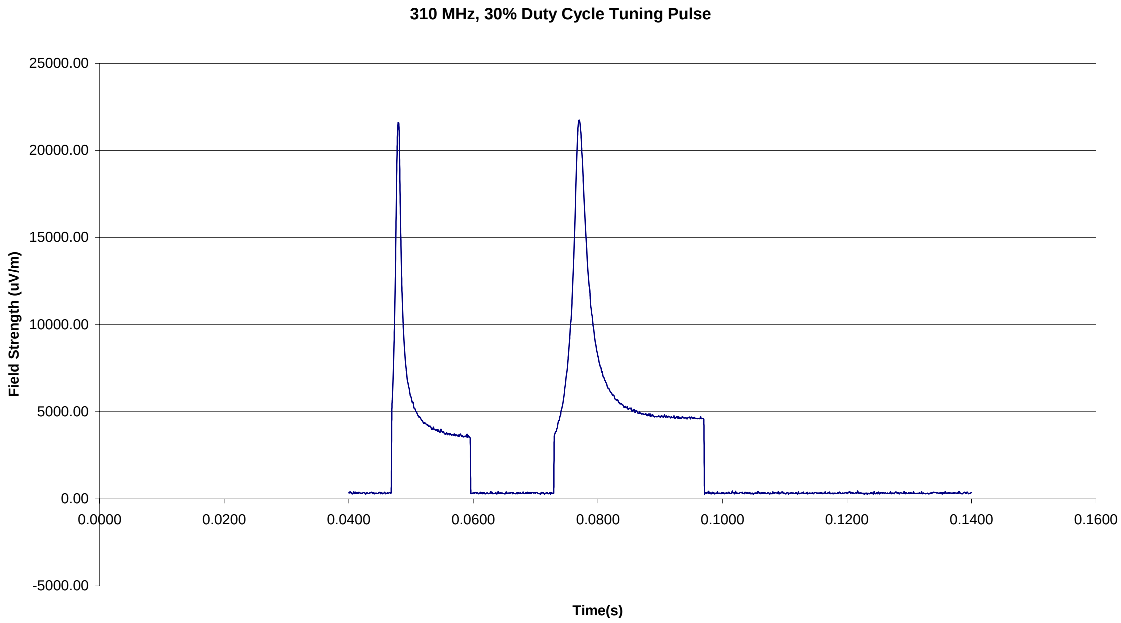
7.4.8.1. Coarse Tuning Pulse (288MHz)



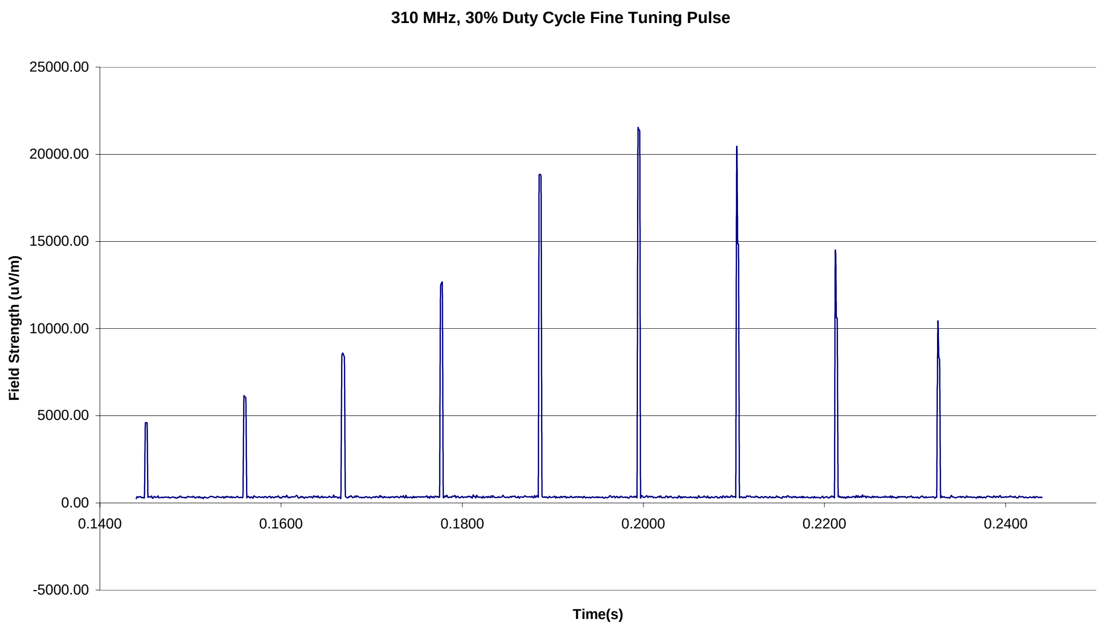
7.4.8.2. Fine Tuning Pulse (288MHz)



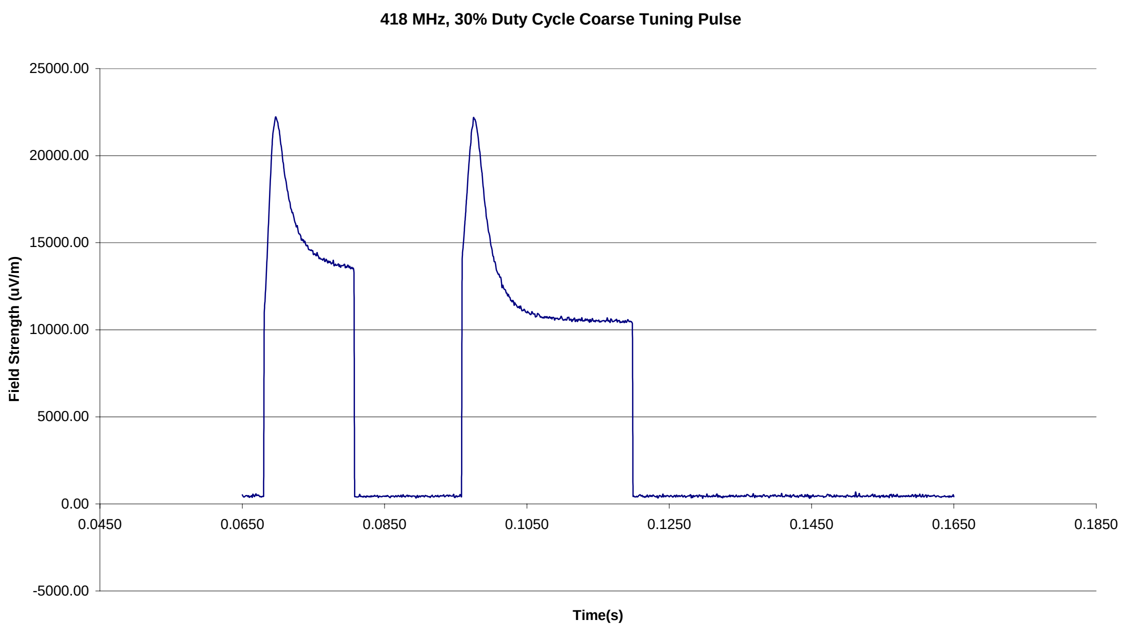
7.4.8.3. Coarse Tuning Pulse (310MHz)



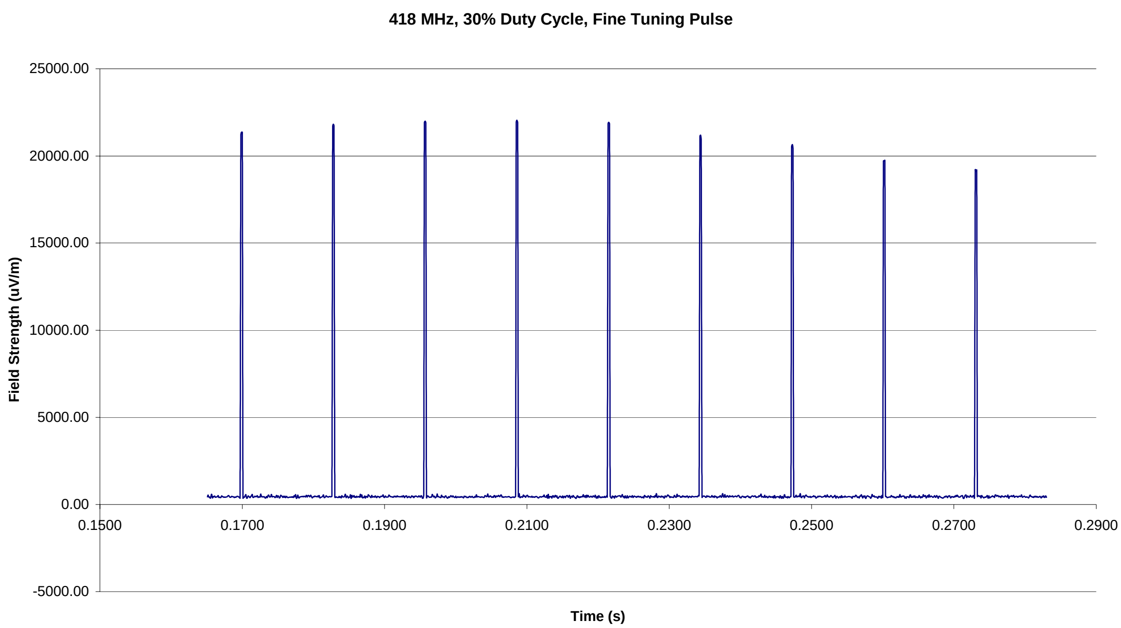
7.4.8.4. Fine Tuning Pulse (310MHz)



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	1712	4915	9.2
	310	2613	5831	7.0
	418	5219	9806	**5.5**

	Frequency (MHz)	Average (uV/m)	Limit (uV/m)	Margin (dB)
Fine	288	527	4915	19.4
	310	655	5831	19.0
	418	915	9806	20.6

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 (Base)
Please refer to attachment named “basefront.jpg”

8.2. Rear View (Base)
Please refer to attachment named “baserear.jpg”

8.3. Unit Disassembled (Base)
Please refer to attachment named “baseassm.jpg”

8.4. Mirror Application Board (Base)
Please refer to attachment named “basemirf.jpg”
Please refer to attachment named “basemirr.jpg”

8.5. Homelink Location in Mirror Housing (Base)
Please refer to attachment named “basehl3.jpg”

8.6. Front View (Smart Beam)
Please refer to attachment named “smrtfrnt.jpg”

8.7. Rear View (Smart Beam)
Please refer to attachment named “smrtrear.jpg”

8.8. Unit Dissassembled (Smart Beam)
Please refer to attachment named “smrtmirr.jpg”

8.9. Mirror Application Board (SmartBeam)
Please refer to attachment named “smrtmirf.jpg”
Please refer to attachment named “smrtmirr.jpg”

8.10. Homelink® Location in housing (SmartBeam)
Please refer to attachment named “smrthl3.jpg”

8.11. Front View (SmartBeam w/RKE)
Please refer to attachment named “rkefrnt.jpg”

8.12. Rear View (Smart Beam w/RKE)
Please refer to attachment named “rkerear.jpg”

8.13. Unit Dissassembled (Smart Beam w/RKE)
Please refer to attachment named “rkeassm.jpg”

8.14. Mirror Application Board (SmartBeam w/RKE)
Please refer to attachment named “rkemirf.jpg”
Please refer to attachment named “rkemirr.jpg”

8.15. Homelink® Location in housing (SmartBeam w/RKE)
Please refer to attachment named “rkehl33.jpg”
Please refer to attachment named “rkerke.jpg (closeup of RKE module)

8.16. Homelink© Board
Please refer to attachment named “front.jpg”
Please refer to attachment named “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”