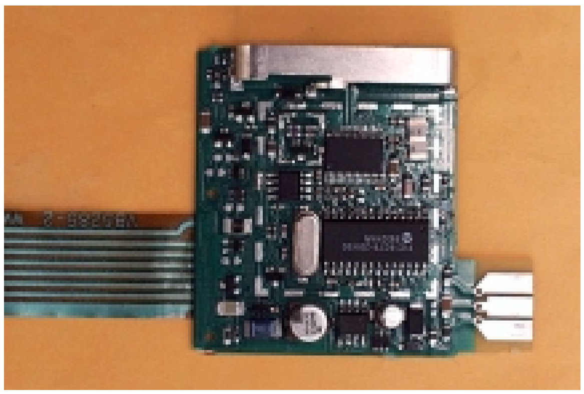
AHD
EMC Laboratory
92723 M-152, Dowagiac, MI 49047 USA
Phone: (616) 424-7014
www.ahde.com

EXHIBIT K: REPORT OF MEASUREMENTS [2.1033(B6)]

Test Report for FCC ID: CB2OHHL3

FCC Part 2.1031, Part 15 Subpart C(15.231)

Report #20000287F
Issued 4/17/00



TRANSMITTER MODEL CB2OHHL3 OF HOMELINK® III SERIES

Prepared for: Mr. David Blaker
Johnson Controls Interiors, LLC
One Prince Center
Holland, MI 49423

Test Date(s): January 19 thru February 18, 2000

data recorded by

Ted Chaffee, NCE
Test Engineer, AHD

witnessed by

David Blaker
Craig Harder

This report prepared by:

Ted Chaffee, NCE
Technical Manager/Test Engineer, AHD

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Statements Concerning this Report

Test Traceability:
The calibration of all measuring and test equipment and the measured data using this equipment are traceable to the National Institute for Standards and Technology (NIST).

Limitations on results:
The test results contained in this report relate only to the Item(s) tested. Any electrical or mechanical modification made to the test item subsequent to the test date shall invalidate the data presented in this report. Any electrical or mechanical modification made to the test item subsequent to this test date shall require an evaluation to verify continued compliance.

Limitations on copying:
This report shall not be reproduced, except in full, without the written approval of AHD.

Limitations of the report:
This report shall not be used to claim product endorsement by NVLAP, FCC, or any agency of the US Government.

Statement of Test Results Uncertainty: Following the guidelines of NAMAS publication NIS81 and NIST Technical Note 1297, the Measurement Uncertainty at a 95% confidence level is determined to be: ±3.6 dB

Manufacturer/Applicant [2.1033(b1)]

The manufacturer and applicant:

JOHNSON CONTROLS INTERIORS, LLC.
One Prince Center
Holland, Michigan 49423

Measurement/Test Site Facility & Equipment

Test Site [2.948, 2.1033(b6)]

The AHD test facility is centered on 9 acres of rural property near Sister Lakes, Michigan. The mailing address is 92723 M-152, Dowagiac, Michigan 49047. This test facility is NVLAP accredited (LabCode 200129-0). It has been fully described in a report filed with the FCC and Industry Canada. The report filed with the FCC is, dated November 5, 1996, was accepted by the FCC in a letter dated January 15, 1997, (31040/SIT 1300F2). The report filed with Industry Canada, dated August 11, 1998, was accepted via a letter dated September 1, 1998, (file:IC3161).

Measurement Equipment Used [2.947(d), 15.31(b)]

Equipment	Model	S/N	Last Cal Date	Calibration Interval
HP EMI Receiver system	HP 8546A			
RF Filter Section	HP-85460A	3448A00283	22-Jun-99	12 month
RF Receiver Section	HP-85462A	3625A00342	22-Jun-99	12 month
EMCO BiconiLog Antenna	3142	1077	07-Sep-99	12 months
(3-M) Type 129FF Ultra Flex LowLoss	RG58/U	9910-12	29-Oct-99	6 months
University of Mich Double Ridge Horn	0.2 - 5.0GHz	C	16-Mar-99	12 months
6 ft. Andrew DF4 Heliax		9912-02	13-Dec-99	12 months

Measurement Environment

The tests were performed with the equipment under test, and measurement equipment inside the all-weather enclosure. Ambient temperature was 22deg.C., the relative humidity 40%.

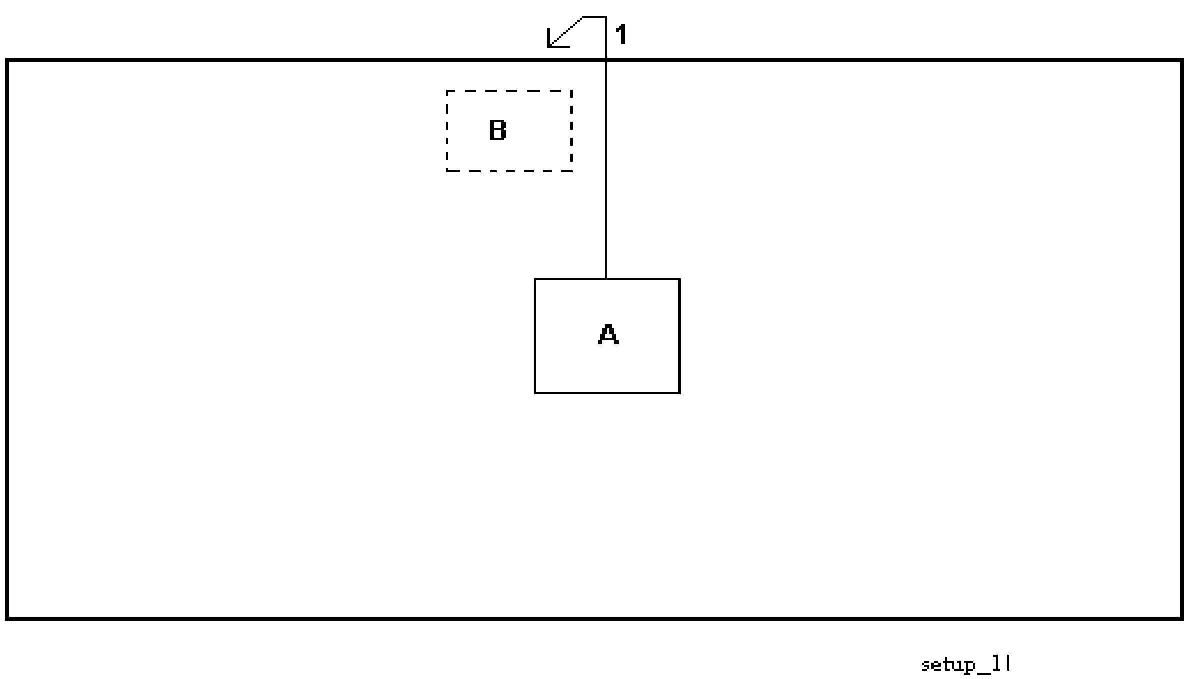
Tested Configuration /Setup: [2.1033(b8)]

Support Equipment & Cabling

Setup Diagram Legend	Description	Model	Serial No. / Part No.	EMC Consideration
A	[EUT] Universal Garage Door Opener	[JCI] CB2OHHL3	--	FCC ID: CB2OHHL3
B	12V DC Power Supply	[Kikusui] PAB 18-3	47263914	Located on the turntable base below the EUT table.
1	Power Supply Cable Harness	--	--	2 meters, Unshielded, 2-lead lightly twisted cable harness.

Setup Diagram

Note: Setup photographs are located in Attached Electronic File, Exhibit L.



BASIC EUT SETUP
(Legend designation is above)

Summary of Results:

1. This test series evaluated the Equipment Under Test, CB2OHHL3, to FCC Part 15, SubPart C.
2. The system tested is compliant to the requirement of CFR 47, FCC Part 15, SubPart C for periodic operation in the allowed frequency bands above 70MHz, (Part 15.231).
3. The equipment under test was received on January 19, 2000 and this test series commenced on January 19, 2000.
4. The line conducted emission testing does not apply to this product. The device is powered from a 12 volt automobile source.
5. The preliminary scan for spurious emissions conducted in a shielded room showed no observable spurious emissions other than the harmonics of the fundamental transmit frequency.
6. The frequencies selected for final evaluation include 288MHz, 310MHz, and 418MHz. This is in accordance with 47 CFR 15.31(m). The 310MHz was selected as a mid-range frequency because it is the predominant frequency used in controlling garage doors. Past correspondence with the FCC regarding the selection of frequencies and test setup suggest this judgment as appropriate.
7. Occupied Band Width of the transmitted signal, at the 20dB point, nearest the limit was measured to be 585KHz. This measurement occurred when measuring the W220 configuration with the EUT transmitting at 288MHz with a pulse modulation of 30% duty cycle. This measurement is within the allowed 720KHz bandwidth.
8. The field strength level of the fundamental was measured for 288MHz, 310MHz, and 418MHz. The evaluation showed the emission nearest the limit occurred while operating in the GMT configuration at 310MHz with 500Hz pulsed modulation at a 50% duty cycle. The EUT was positioned on the ‘side’ and the receive antenna oriented in the horizontal polarization. This signal was measured to be 1.2dB below the limit of 75.3dBuV/m (5,821uV/m).
9. The evaluation of the field strength levels of the harmonics showed the emission nearest the limit occurred while operating in the W220 configuration at 288MHz with 500Hz pulsed modulation at 30% duty cycle. The EUT was positioned on the ‘flat’; and the receive antenna oriented in the vertical polarization. This signal, at 576MHz, was measured to be14.2dB below the limit of 53.8dBuV/m (492uV/m).
10. Digital Spurious Emissions: The are no detectable spurious emissions associated with the digital portion of the CB2OHHL3.
11. The average value of the coarse tune pulses over a 100mSec time, nearest the limit, occurred at 418MHz. The average measurement was determined to be 4004uV/m which is 8.2dB below the limit of 10,333uV/m..
12. The average value of the fine tune pulses over a 100mSec time, nearest the limit, occurred at 310MHz. The average measurement was determined to be 801uV/m which is 17.2dB below the limit of 5833uV/m.

Changes made to achieve compliance

1. NONE

Standards Applied to Test: [2.1033(b6)]

ANSI C63.4 - 1992, Appendix I
CFR47 FCC Part 2, Part 15, SubPart C, 15.231 Intentional Radiator; SubPart B, Digital Device

Test Methodology: [2.1033(b6)]

The pictures in this report, showing test setups, indicate the agreed upon configuration of testing for this product-type.

For the testing, the EUT was placed at the center of the table 80cm above the ground plane pursuant to ANSI C63.4 for stand-alone equipment. The 8-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.

The line conducted emission testing was not performed on this product. In its final configuration the product is powered from an automobile 12 volt system only.

Justification of test configurations:

Homelink™ OH test method

Homelink™ is a single product that can be adapted to a variety of OEM vehicles. Each vehicle manufacturer uniquely customizes the appearance of the product to fit the rest of their vehicle. These variations include packaging, backlighting, power connector, button position, shape, style and feel, also indicator LED color. To support these many variations, a two-part approach is used. A standard main board contains the RF circuitry, antenna, microcontroller, power supply, etc on a rigid PCB. Connected to this is a flexible PCB, referred to as the “flex” or “flex switch board”, that contains the 3 or 4 user buttons, an indicator LED and optional LED or incandescent backlighting. A lap solder joint permanently connects the two. The combined assembly is housed in plastic module for assembly into the vehicle. Since this is often installed in the overhead of a vehicle it is referred to as the overhead version, or “OH”.

Research in test method

The total number of vehicles using Homelink™ is quite large, though multiple vehicles may use identical module, there are still eighteen variations. There are three additional variations that receive power through the flex circuit that are not included in this submittal. To certify the Homelink™ product by testing of all variations would be a huge task. We decided to narrow the tested variations through engineering judgment and testing.

The main PCB has the antenna and all the RF circuitry, but the switch board unintentionally affect the emissions in two ways. The first effect of the flex switch board is as a reflector or re-radiator effect, distorting the typical figure-8 antenna pattern, causing peaks to shift in location and amplitude based on it's size and shape. Second, even though the design uses a balanced drive that minimizes the ground currents, there are imbalances causing some RF current flows on the ground plane. So, the extent of the ground plane on the switch board will have some influence on emissions.

Based on the above, all flex switch boards were grouped by physical size and shape and whether or not it has a ground connection. By grouping button and LED variations on the same PCB, we have nine unique variations. From this we selected four with the considerations given above; short, medium, long and the one with the largest ground plane.

Vehicle identification	JCI Part number	Size (inches)	Total length (inches)	Ground plane	Used in pretest	Notes
R129	VB3011	1.1 x 2.2	1.1	No	✔	Shortest
300N	VG5942	2.3 x 2	2.3	Yes	✔	Medium length, has ground plane
GMT-800	VB5285	3.3 x 2.8	3.3	Yes	✔	Longest straight
W220	VB6426	3.4 x 4.3	4.9 (two bends)	No	✔	Longest total length
LS400	VA8205	2.2 x 2.5	2.2	Yes		Similar in size to 300N
R170 and others	VB3887 and others	2.2 x 2.2	2.2	Yes		Similar in size to 300N
Range Rover	VB3637	2.9 x 2.2	2.9	No		Between 300N and GMT800 in size
Discovery and others	VB3005 and others	1.1 x 2.2	1.1	Yes		Same size as R129
BMW 5/7	VB4585	1.6 x 1.9	1.6	Yes - minimal		Between R129 and 300N in size

The positioning on the two boards depends on the plastic housing. To find the maximum emissions it was decided to extend the switch board fully. Also, the connection between the switch board and main board is flexible in position or angle. It was decided to position it three ways, coplanar to the main board (0°), positioned above the main board (+90°), and below (-90°).

Pretest

With a practical number of measurements defined we could begin the pretest. Above the 7th harmonic was often in the noise floor, so this data wasn't taken in the pretest. Testing above 1GHz used a horn antenna in only one polarization. Above the 3rd harmonic, the first set of data showed little variation with flex angle compared to the margin to the limit so it was skipped in the rest of the pretest. Shown in the table below is the margin to the limit and the variation being the max variation seen when just the flex angle was changed. **The power level of the pretest parts were adjusted higher than in the final testing, and do exceed the limits.**

	288 MHz		310 MHz		390 MHz	
Harmonic	Margin (dB)	Variation (dB)	Margin (dB)	Variation (dB)	Margin (dB)	Variation (dB)
1	4.9	4.7	3.8	5.5	3.3	2.9
2	-3.4	3.6	-5.4	7.6	-6.9	3.3
3	-23.7	3.2	-19.0	4.2	-16.6	2.0
4	-29.1	2.2	-31.4	5.4	-21.5	4.0
5	-24.7	2.6	-21.5	4.8	-27.4	4.1
6	-29.6	2.1	-33.0	3.9	-36.5	3.0
7	-31.5	1.8	-30.8	1.9	-31.7	2.3

The general pretest sequence is as follows:

4 flex switch boards fully extended in 3 DUT orientations (flat, side, end)
with 3 flex angles (0°, +90°, -90°)
at 3 fundamental frequencies
up to the 7th harmonic
with 2 polarizations (only 1 above 1 GHz).

The results are summarized in the three tables that follow. The peaks are in bold. Units are dBμ V/m at 3m.

288 MHz

Harmonic	Limit at 30% duty cycle.	300N Max	R129 Max	W220 Max	GMT800 Max
1	84.3	**89.2** **Side H +90°**	88.5 Side H +90°	87.8 Side H 0°	**89.2** **Side H +90°**
2	64.3	60.9 Flat H 0°	66.5 Flat H 0°	**71.2** **Flat H -90°**	65.2 End H +90°
3	64.3	40.6 End V +90°	**45.2** **End V**	**45.2** **Flat H**	44.8 Flat H
4	64.5	35.4 End +90°	36.2 Flat	**36.9** **End**	31.7 Flat
5	64.5	39.8 End +90°	41.0 End	**44.5** **Flat**	40.6 Flat
6	64.3	34.7 Flat +90°	**37.4** **End**	36.4 End	34.4 Flat
7	64.3	32.8 Flat 0°	32.8 Flat	**33.5** **End**	**33.5** **End**

310 MHz

Harmonic	Limit at 30% duty cycle.	300N Max	R129 Max	W220 Max	GMT800 Max
1	85.8	89.6 Side H +90°	88.9 Side H 0°	89.9 Side H +90°	**91.5** **Side H +90°**
2	65.8	60.4 Flat H 0°	63.6 End H +90°	**69.5** **Flat H -90°**	62.8 Flat H 0°
3	65.8	**46.8** **Flat V +90°**	45.8 Flat H	44.8 Flat H	44.3 Side V
4	64.5	33.1 End +90°	**37.8** **Flat**	36.4 Flat	32.3 Flat
5	64.5	43.0 End +90°	43.0 Flat	**43.4** **Flat**	41.3 Flat
6	65.8	32.8 End +90°	34.2 End	32.9 End	**34.6** **End**
7	65.8	**35.0** **End 0°**	34.6 Flat	**35.0** **End**	34.2 End

390 MHz

Harmonic	Limit at 30% duty cycle.	300N Max	R129 Max	W220 Max	GMT800 Max
1	89.7	93.0 End V +90°	93.1 Side H +90°	93.0 End V 0°	**95.3** **Side H +90°**
2	69.7	62.8 Flat H 0°	63.3 End H +90°	64.5 End H -90°	**65.9** **Flat H 0°**
3	64.5	47.9 Side V -90°	**50.2** **Flat H**	46.1 End V	42.4 Flat
4	64.5	43.0 Flat –90°	42.8 Flat	**45.2** **End**	44.0 End
5	69.7	42.3 Flat +90°	38.9 Side	**43.6** **Flat**	41.4 Flat
6	69.7	33.2 Side +90°	31.8 Side	33.2 Flat	**35.2** **End**
7	64.5	**32.8** **End 0°**	31.4 End	31.5 Flat	29.2 Flat

The results of the pretesting show

1. GMT800 have the highest fundamental at all frequencies. 300N is equal at one frequency.
2. Either GMT800 or W220 have the highest 2^{nd} harmonic.
3. The 3^{rd} harmonic and above are well below the limit (14.3 dB margin worst case). Beyond 5^{th} harmonic the measurement is at the noise floor. More peaks occur with the W220 than with the others.

Justification Conclusion

From these results the final selected test method was selected. All units will be rotated to 3 orientations (flat, side and end) and both vertical and horizontal antenna polarization will be measured for final testing. The testing will be as shown:

1. Fundamental with GMT 800 switch board in the switch board in the +90◦ position.
2. The 2nd harmonic will be tested on two parts, GMT 800 in the 0◦ position and W220 in the –90◦ position.
3. The 3rd to the 10th harmonic with the W220 in the 0◦ position.

In the testing the RF output was lowered to allow suitable margin below the fundamental limits, this also reduced the harmonic levels. During testing we looked for any variation from the pretest selection methods, but didn't see any. We selected our test method and final data to represent the worst case emission possible with the Homelink™ OH.

Radiated Methodology

The system was placed upon a 1 x 1.5 meter non-metallic table 80cm above the open field site ground plane in the prescribed setup per ANSI C63.4, Figure 9(c).

The table sits upon a remote controlled turntable. The receiving antenna, located at the appropriate standards distance of 3 or 10 meters from the table center, is also remote controlled.

The principle settings of the EMI Receiver for radiated testing include:

IF Bandwidth:	120KHz	for frequencies less than 1GHz.
	1 MHz	for frequencies greater than 1GHz.
Detector Function:	Peak Mode	
	The Average levels were determined mathematically based upon the duty cycle of the pulsed modulation of the transmitted signal.	

At frequencies up to 1000MHz a BiconiLog broadband antenna was used for measurements.

At frequencies above 1000MHz a double-ridge Horn broadband antenna was used for measurements.

When using the Horn antenna the EUT position was raised to bring the EUT directly into the receive beam-width of the Horn antenna. Also, because the horn receive beamwidth is narrow and insensitive to the reflective component of the source emission, it was judged that the three orthogonal positions of the EUT and one polarization of the Horn antenna is sufficient to capture all the emission patterns of the EUT.

During the evaluation the EUT was transmitting continuously.

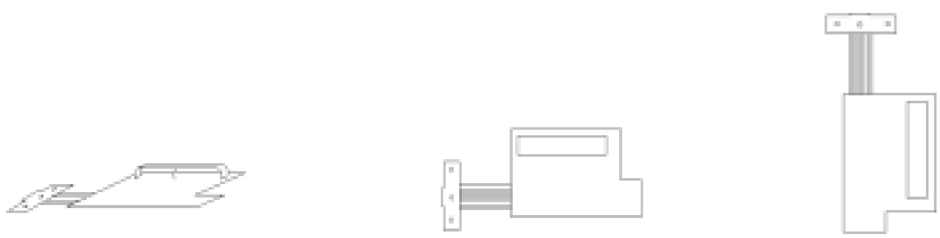
The turntable was rotated 360 degrees and the receiving antenna height varied from 1 to 4 meters to search out the highest emissions.

Preliminary tests were done at several transmit frequencies. The final measurements were made at a low band frequency (288MHz), a mid band frequency (310MHz), and a high band frequency (418MHz) pursuant to the requirements of 47CFR 15.31(m). At each frequency the EUT was placed in three orthogonal positions. At each position a 500Hz pulse modulation was adjusted to a 30%, 50%, and 80% duty cycle. At each duty cycle, measurements were taken with the receive antenna in vertical and horizontal positions.

The unit was evaluated up to the tenth harmonic of the fundamental as an intentional radiator, and up to 1000MHz as a digital device.

The orthogonal positions are:

Flat Side End



THE HP8546A EMI Receiver has stored in memory the antenna and coax correction factors used in this test. The resultant Field Strength (FS) in dBuV/m presented by the HP8546A is the summation in decibels (dB) of the Received Level (RF), the Antenna Correction Factor (AF), and the Cable Loss Factor (CF).

Formula 1: $FS(dBuV/m) = RF(dBuV) + AF(dB/m) + CF(dB)$

The resultant Field Strength measurement is recorded using the peak hold detector of the HP8546A.

This recorded peak level is further corrected, by calculation, to an average level by a factor determined by the duty cycle of the pulsed modulation. The duty cycle factor is determined as outlined in Appendix I4 of the standard ANSI C63.4:1992.

Formula 2: Average Level(uV/m) = [Peak Level(uV/m)] x [duty cycle factor].

Formula 2a: Average Level(dBuV/m) = Peak Level)dBuV/m) + duty cycle factor(dB).

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

SAMPLE CALCULATION:

A measured peak level of 50% duty cycle pulse modulated signal is 500uV/m.
Calculated to dBuV/m is 20*Log(500) = 53.98dBuV/m Peak level.
Applying the duty cycle factor: Avg. Level(dBuV/m) = 53.98 - 6.02dB = 47.96dBuV/m.