LS RESEARCH, LLC
WIRELESS PRODUCT DEVELOPMENT
ACCREDITED
Testing Cert. 1255.01
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TEST REPORT # 311066 Tx
LSR Job #: C-1155

Compliance Testing of:
Wireless Indoor Air Sensor

Test Date(s):
May 20th – June 3rd 2011

Prepared For:
Jaromir Cechak
Honeywell
1985 Douglas Drive North
Golden Valley, MN 55422

In accordance with:
Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Industry Canada (IC) RSS 210 Annex 8
Frequency Hopping Spread Spectrum (FHSS) Operating in the
Frequency Band 902 MHz – 928 MHz

This Test Report is issued under the Authority of:
Peter Feilen, EMC Engineer

Signature: Peter Feilen Date: 07.07.11

Test Report Reviewed by:	Project Engineer:
Shane Rismeyer, EMC Engineer	Peter Feilen, EMC Engineer
Signature: Date: 07.13.11	Signature: Peter Feilen Date: 07.12.11

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EXHIBIT 1. INTRODUCTION

1.1 - Scope

References:	FCC Part 15, Subpart C, Section 15.247. RSS GEN issue 3 and RSS 210 issue 8 Annex 8
Title:	FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15. IC : Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
Purpose of Test:	To gain FCC and IC Certification Authorization for Low-Power License-Exempt Transmitters.
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
Environmental Classification:	Commercial, Industrial or Business Residential

1.2 – Normative References

Publication	Title
47 CFR, Parts 0-15 (FCC)	Code of Federal Regulations - Telecommunications
RSS 210 Issue 8 Annex 8	Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
ANSI C63.4	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
CISPR 16-1-1	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus.
FCC ET Docket No. 99-231	Amendment to FCC Part 15 of the Commission's Rules Regarding Spread Spectrum Devices.

1.3 - LS Research, LLC Test Facility

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) as conforming to ISO/IEC 17025, 2005 "General Requirements for the Competence of Calibration and Testing Laboratories".

LS Research, LLC's scope of accreditation includes all test methods listed herein, unless otherwise noted. Accreditation status can be verified at A2LA's web site: www.a2la.net.

1.4 – Location of Testing

All testing was performed at the following location utilizing the facilities listed below, unless otherwise noted.

LS Research, LLC
W66 N220 Commerce Court
Cedarburg, Wisconsin, 53012 USA,

List of Facilities Located at LS Research, LLC:

Compact Chamber
Semi-Anechoic Chamber
Open Area Test Site (OATS)

1.5 – Test Equipment Utilized

A complete list of equipment utilized in testing is provided in Appendix A of this test report. Calibration dates are indicated in Appendix A. All test equipment is calibrated by a calibration laboratory accredited to the requirements of ISO/IEC 17025, and traceable to the SI standard.

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 – Client Information

Manufacturer Name:	Honeywell
Address:	1985 Douglas Drive, Golden Valley, MN 55422
Contact Name:	Martin Plouffe

2.2 - Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	IAS
Model Number:	C7189R100
Serial Number:	Radiated measurements 47343015000569 Conducted measurements 47343015000604

2.3 - Associated Antenna Description

The Antenna associated with the device is 915 MHz Johanson Technology ceramic chip antenna.

2.4 - EUT'S Technical Specifications

EUT Frequency Range (in MHz)	903.0 MHz – 926.4 MHz
RF Power in Watts	
Minimum:	0.00361
Maximum:	0.009772
Max Conducted Output Power (in dBm)	9.9 dBm
Field Strength at 3 meters	104.6 dBµV/m
Occupied Bandwidth (99% BW)	116.6 kHz
Type of Modulation	FSK
Emission Designator	117KF1D
EIRP	8.65 mW
Transmitter Spurious (worst case) at 3 meters	59.8 dBµV/m at 4632 MHz
Stepped (Y/N)	N
Step Value:	N/A
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Microprocessor Model # (if applicable)	Texas Instrument MSP430F5524
Antenna Information	
Detachable/non-detachable	Non-detacheable
Type	Ceramic Chip
Gain (Measured over a conducting ground plane)	-1.43 dBi
EUT will be operated under FCC Rule Part(s)	15.247
EUT will be operated under RSS Rule Part(s)	RSS 210
Modular Filing	☐ Yes ☒ No
Portable or Mobile?	Mobile

RF Technical Information:

Type of Evaluation (check one)		SAR Evaluation: Device Used in the Vicinity of the Human Head
		SAR Evaluation: Body-worn Device
	X	RF Evaluation

If RF Evaluation checked above, test engineer to complete the following:

Evaluated against exposure limits: ☒ General Public Use ☐ Controlled Use
Duty Cycle used in evaluation: 100 %
Standard used for evaluation: OET 65
Measurement Distance: 20 cm
RF Value: 0.01421 ☐ V/m ☐ A/m ☒ W/m^2
☐ Measured ☐ Computed ☒ Calculated

2.5 - Product Description

The purpose of the IAS is to produce a RedLinkII enabled wireless accessory which can be used for control or viewing (at thermostat) of temperature and humidity within an occupied space when used with a RedLinkII enabled thermostat.

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 - Climate Test Conditions

Temperature:	71 ° F
Humidity:	34 %
Pressure:	741 mmHg

3.2 - Applicability & Summary Of EMC Emission Test Results

FCC and IC Paragraph	Test Requirements	Compliance (Yes/No)
FCC : 15.207 IC : RSS GEN sect. 7.2.2	Power Line Conducted Emissions Measurements	N/A
FCC : 15.247 (a)(1) IC : RSS 210 A8.1 (a)	20 dB Bandwidth	Yes
FCC : 15.247(b) & 1.1310 IC : RSS 210 A8.4	Maximum Output Power	Yes
FCC : 15.247(i), 1.1307, 1.1310, 2.1091 & 2.1093 IC : RSS 102	RF Exposure Limit	Yes
FCC :15.247(d) IC : RSS 210 A8.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC:15.247 (a)(1)(i)(iii) IC: RSS 210 (b)	Carrier Frequency Separation	Yes
FCC:15.247 (a)(1)(i),(ii),(iii) IC: RSS 210 (c),(d),(e)	Number of hopping channels	Yes
FCC:15.247 (a)(1)(i),(ii),(iii) IC: RSS 210 (c),(d),(e)	Time of occupancy (Dwell Time)	Yes
FCC : 15.247(b), IC : RSS 210 A8.2(b), section 2.2, 2.6 and 2.7	Transmitter Radiated Emissions	Yes
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices (RSS GEN and RSS 210 of IC) and the associated Radio Receiver has also been tested and found to comply with Part 15, Subpart B – Radio Receivers (RSS GEN and RSS 210 of IC). The Receiver Test Report is available upon request.		

3.3 - Modifications Incorporated In The EUT For Compliance Purposes

☐ None ☒ Yes (explain below)

The power setting on the EUT was set at C2 for testing. Refer to the table below for output power relation to power setting:

Channel Frequency (MHz)	Power (dBm)	Limit (dBm)	Margin (dB)	Power Level
903.0	9.9	30.0	20.1	C2
914.6	9.8	30.0	20.2	C2
926.4	9.7	30.0	20.3	C2
903.0	10.8	31.0	20.2	C0
914.6	10.8	32.0	21.2	C0
926.4	10.9	33.0	22.1	C0

3.4 - Deviations & Exclusions From Test Specifications

☒ None ☐ Yes (explain below)

EXHIBIT 4. DECLARATION OF CONFORMITY

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.247, and Industry Canada RSS-210, Issue 8, Annex 8 (section 8.1).

Note: If some emissions are seen to be within 3 dB of their respective limits; as these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

EXHIBIT 5. RADIATED EMISSIONS TEST

5.1 - Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15, RSS GEN and ANSI C63.4. The EUT was placed on an 80cm high non-conductive pedestal, centered on a flush mounted 2-meter diameter turntable inside a 3 meter Semi-Anechoic, FCC listed Chamber. The EUT was operated in continuous transmit mode for final testing using power as provided by two AA batteries. The unit has the capability to operate on 3 channels, controllable via buttons on the front/face of the EUT.

The applicable limits apply at a 3 meter distance. Measurements above 4 GHz were performed at a 1.0 meter separation distance. The calculations to determine these limits are detailed in the following pages. Please refer to Appendix A for a complete list of test equipment. The test sample was operated on one of three (3) standard channels: low (903MHz), middle (914.6MHz) and high (926.4MHz) to comply with FCC Part 15.31(m). The channels and operating modes were changed via a single button on the front/face of the EUT.

5.2 - Test Procedure

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 30 MHz to 10000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, and a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz A Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 10 GHz. The maximum radiated RF emissions between 30MHz to 4 GHz were found by raising and lowering the sense antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities. Between 4GHz to 10GHz, the sense antenna was raised and lowered between 1 and 1.8 meters in height.

The EUT was positioned in its intended orientation.

5.3 - Test Equipment Utilized

A list of the test equipment and antennas utilized for the Radiated Emissions test can be found in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. All calibrations of the antennas used were performed at a calibration laboratory accredited to ISO 17025, and are traceable to the SI standard. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and an EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into the EMI Receiver database. As a result, the data taken from the EMI Receiver accounts for the antenna correction factor as well as cable loss or other corrections, and can therefore be entered into the database as a corrected meter reading. The EMI Receiver was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 300 kHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 1 MHz). From 4 GHz to 10 GHz, a Spectrum Analyzer and an EMCO Horn Antenna were used.

5.4 - Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 and Canada RSS-210, Issue 8 (2010), Annex 8 for an FHSS transmitter. The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

5.5 - Calculation of Radiated Emissions Limits and reported data.

Reported data:

For both fundamental and spurious emissions measurement, the data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBµV/m) + Antenna correction Factor + Cable factor (dB) + Miscellaneous factors when applicable (dB) – amplification factor when applicable (dB).

Generic example of reported data at 200 MHz:

Reported Measurement data = 18.2 (raw receiver measurement) + 15.8 (antenna factor) + 1.45 (cable factor) = 35.45 (dBµV/m).

As specified in 15.247 (d) and RSS 210 A8.5, radiated emissions that fall within the restricted band described in 15.205(c) for FCC and section 2.2 of RSS 210 for IC, must comply with the general emissions limit.

The following table depicts the general radiated emission limits above 30 MHz. These limits are obtained from Title 47 CFR, Part 15.209, for radiated emissions measurements. These limits were applied to any signals found in the 15.205 restricted bands. The mentioned limits correspond to those limits listed in RSS GEN.

Frequency (MHz)	3 m Limit µV/m	3 m Limit (dBµV/m)	1 m Limit (dBµV/m)
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
960-24,000	500	54.0	63.5

Sample conversion of field strength (µV/m to dBµV/m):
dBµV/m = 20 log $_{10}$ (100)= 40 dBµV/m (from 30-88 MHz)

For measurements made at 1.0 meter, a 9.5 dB correction has been invoked.

960 MHz to 10,000 MHz
500µV/m or 54.0 dB/µV/m at 3 meters
54.0 + 9.5 = 63.5 dB/µV/m at 1 meter

5.6 - Radiated Emissions Test Data Chart

Manufacturer:	Honeywell					
Date(s) of Test:	June 30, July 1, 2, 2011					
Project Engineer(s):	Peter Feilen					
Test Engineer(s):	Peter Feilen					
Voltage:	3.0 VDC					
Operation Mode:	continuous transmit, modulated					
Environmental Conditions in the Lab:	Temperature: 71˚F Relative Humidity: 34 %					
EUT Power:		Single Phase ___VAC		3 Phase ___VAC		
	X	Battery		Other: Bench DC supply		
EUT Placement:	X	80cm non-conductive pedestal		10cm Spacers		
EUT Test Location:	X	3 Meter Semi-Anechoic FCC Listed Chamber		3/10m OATS		
Measurements:		Pre-Compliance		Preliminary	X	Final
Detectors Used:	X	Peak	X	Quasi-Peak	X	Average

The following table depicts the level radiated Fundamental Emission:

Frequency (MHz)	Antenna Polarity	EUT Orientation	Ht (m)	Azimuth (deg)	Peak (dBuV/m)	Quasi-Peak (dBuV/m)	Quasi-Peak Limit (dBuV/m)	Margin (dB)
903.0	Horizontal	Horizontal	1.00	276	104.7	104.6	131.2	26.6
914.6	Horizontal	Horizontal	1.00	270	103.5	103.5	131.2	27.8
926.4	Horizontal	Horizontal	1.00	279	100.9	100.8	131.2	30.4

Notes:

1. H: Horizontal, V: Vertical
2. Refer to exhibit 5.5 on explanation of how data is reported.

RADIATED EMISSIONS DATA CHART (continued)

The following table depicts the level of significant radiated **harmonic** emissions of channel 903.0 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (deg)	EUT Orientation	Antenna Polarity	Peak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2709	1.34	0	VERT	VERT	47.1	45.4	54.0	8.6
3612	1.31	343	VERT	VERT	47.7	44.8	54.0	9.2
4515	1.03	173	VERT	HORIZ	57.0	54.8	63.5	8.7
5418	1.05	17	SIDE	VERT	55.8	53.4	63.5	10.1
7224	1.02	351	VERT	VERT	50.1	46.0	63.5	17.5
8127	1.02	318	VERT	HORIZ	57.7	55.4	63.5	8.1
9030	1.05	7	VERT	VERT	55.9	53.0	63.5	10.5

The following table depicts the level of significant radiated **harmonic** emissions of channel 914.6 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (deg)	EUT Orientation	Antenna Polarity	Peak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2743	1.29	0	VERT	VERT	49.3	47.8	54.0	6.2
3658	1.49	0	VERT	VERT	47.5	44.7	54.0	9.3
5487	1.21	351	VERT	HORIZ	58.4	56.4	63.5	7.1
7316	1.11	8	VERT	VERT	54.8	50.5	63.5	13.0
8231	1.03	317	VERT	HORIZ	58.0	55.4	63.5	8.1
9146	1.02	10	VERT	VERT	55.7	51.3	63.5	12.2

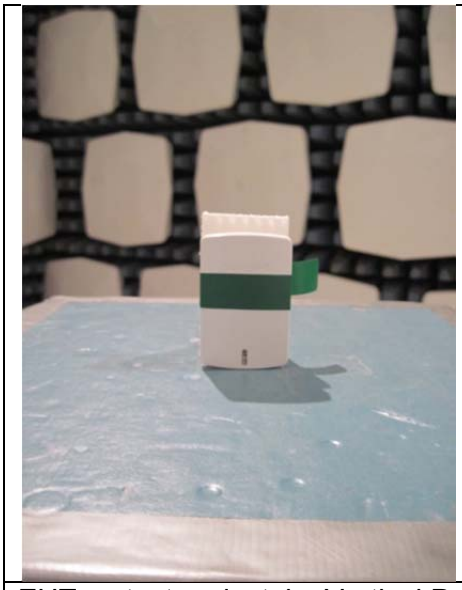
The following table depicts the level of significant radiated **harmonic** emissions of channel 926.4 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (deg)	EUT Orientation	Antenna Polarity	Peak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2779	1.27	0	VERT	VERT	47.1	45.0	54.0	9.0
3705	1.1	0	VERT	VERT	46.9	45.1	54.0	8.9
4632	1.03	190	SIDE	VERT	60.9	59.8	63.5	3.7
7411	1.13	339	VERT	VERT	56.5	53.9	63.5	9.6
8337	1.05	314	VERT	HORIZ	55.2	50.9	63.5	12.6

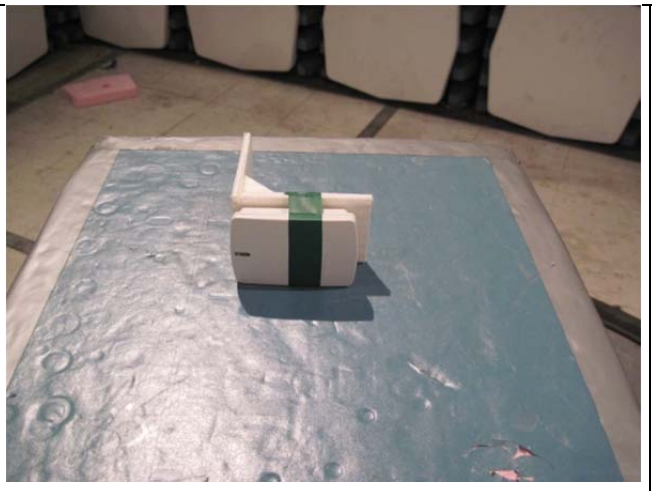
Notes:

1. Measurements above 4 GHz were made at 1 meters of separation from the EUT. The limits were adjusted to reflect this measurement distance.
2. H: Horizontal, V: Vertical
3. Refer to exhibit 5.5 on explanation of how data is reported.

5.7 - Test Setup Photo(s) – Radiated Emissions Test



EUT on test pedestal – Vertical Position



EUT on test pedestal – Side Position

EUT from the front – Flat (horizontal) position

EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE

This test was not performed since the EUT is battery operated.

EXHIBIT 7. OCCUPIED BANDWIDTH

7.1 - Limits

For an FHSS system operating in the 902 to 928 MHz band, the maximum allowable 20dB bandwidth is 500 kHz.

7.2 - Method of Measurements

Industry Canada (IC RSS GEN 4.6.1) requires the measurement of the 99% bandwidth while CFR 47 part 15.247 requires the measurement of the 20dB bandwidth. For this portion of the tests, a direct measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to a spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings there by allowing direct measurements, without the need for any further corrections. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. A bandwidth measurement function that is built into the spectrum analyzer was used to measure the appropriate bandwidths.

7.3 - Test Data

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Channel	99%	20dB
903.0	**98.79**	**106.46**
914.6	**106.37**	**116.61**
926.4	**104.75**	**116.37**

The closest bandwidth to the limit of 500 kHz is 116.37 kHz which is 383.63 kHz below the limit.

EXHIBIT 8. BAND EDGE MEASUREMENTS

8.1 - Method of Measurements

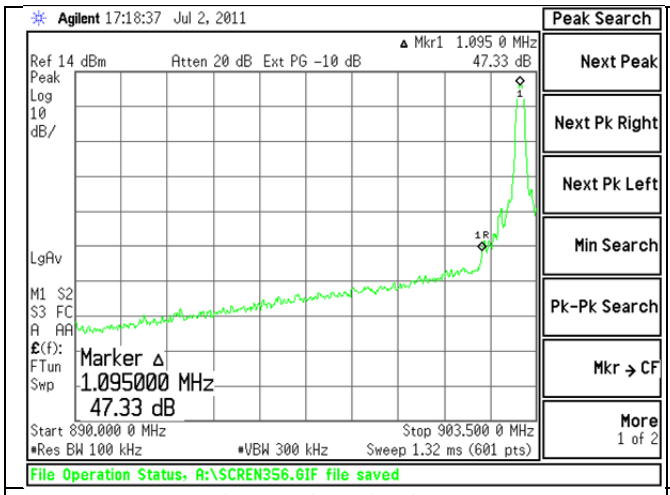
FCC 15.247(d) require a measurement of spurious emission levels to be at least 20 dB lower than the fundamental emission level, in particular at the Band-Edges where the intentional radiator operates. Also, RSS 210 Section 2.2 requires that unwanted emissions meet limits listed in RSS GEN and also to the limits in the applicable annex. The following screen captures demonstrate compliance of the intentional radiator at the 902 - 928 MHz Band-Edges. The EUT was operated in continuous transmit mode with continuous modulation, with internally generated data as the modulating source. The EUT was operated at the lowest channel for the investigation of the lower Band-Edge, and at the highest channel for the investigation of the higher Band-Edge.

The Band-edge measurements were performed conducted. The conducted measurement of band-edge was performed to satisfy FCC 15.247(d).

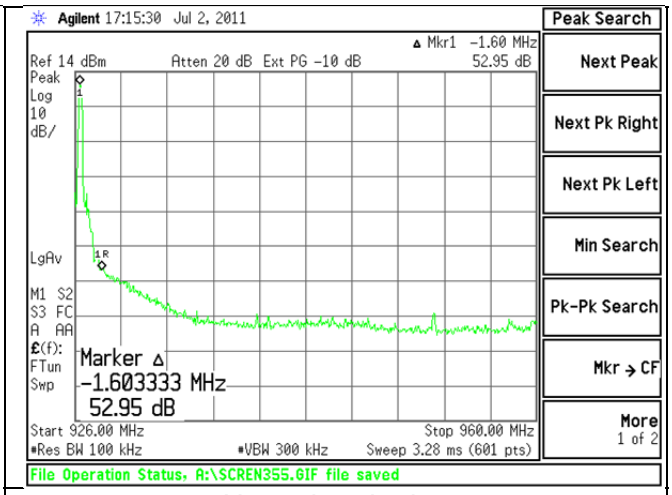
Conducted measurements of the spurious emission were performed with a measurement bandwidth of 100kHz.

8.2. Band edge captures.

A. Continuously transmitting and modulated

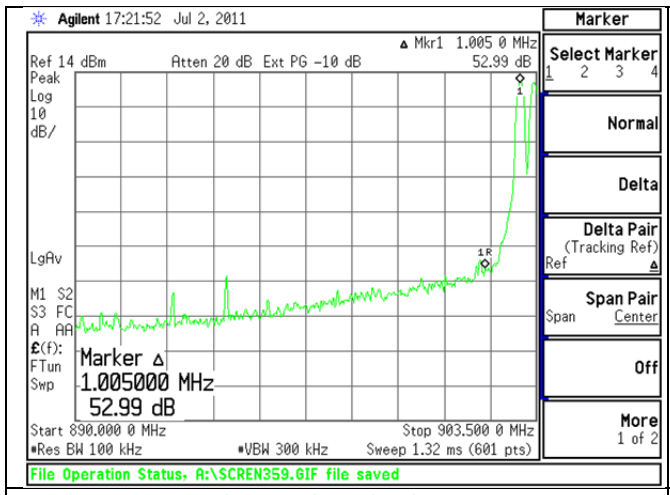


Lower band edge

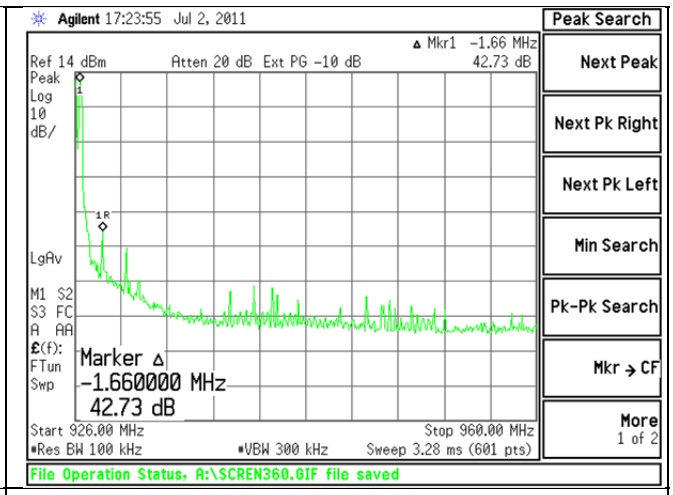


Upper band edge

B. Hopping mode



Lower band edge



Upper band edge

EXHIBIT 9. POWER OUTPUT (CONDUCTED): 15.247(b)

9.1 - Method of Measurements

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings there by allowing direct measurements without the need for any further corrections. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with the appropriate resolution bandwidth, with measurements from a peak detector presented in the chart below.

9.2 - Test Data

Chan	Power (dBm)	Limit	Margin
903.0	**9.9**	30.0	20.1
914.6	**9.8**	30.0	20.2
926.4	**9.7**	30.0	20.3

EXHIBIT 10. CONDUCTED SPURIOUS EMISSIONS: 15.247(d)

10.1 - Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 db below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

10.2 – Conducted Harmonic And Spurious RF Measurements

FCC Part 15.247(d) and IC RSS 210 A8.5 both require a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, thereby allowing direct readings of the measurements made without the need for any further corrections. A spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with measurements from a peak detector presented in the chart below. Screen captures were acquired and any noticeable spurious and harmonic signals were identified and measured.

10.3 - Test Data

Freq\Chan	LOW	MID	HIGH
fo	**9.9**	**9.8**	**9.7**
2fo	**-32.8**	**-33.0**	**-33.4**
3fo	**-52.4**	**-52.5**	**-53.9**
4fo	**-73.6**	**-73.0**	**-72.2**
5fo	**-63.0**	**-62.9**	**-64.0**
6fo	**-68.5**	**-71.4**	**-71.3**
7fo	**-71.1**	**Note 2**	**-73.6**
8fo	**-75.2**	**-74.0**	**-75.2**
9fo	**-61.3**	**-58.9**	**-56.1**
10fo	**-70.5**	**-73.8**	**Note 2**

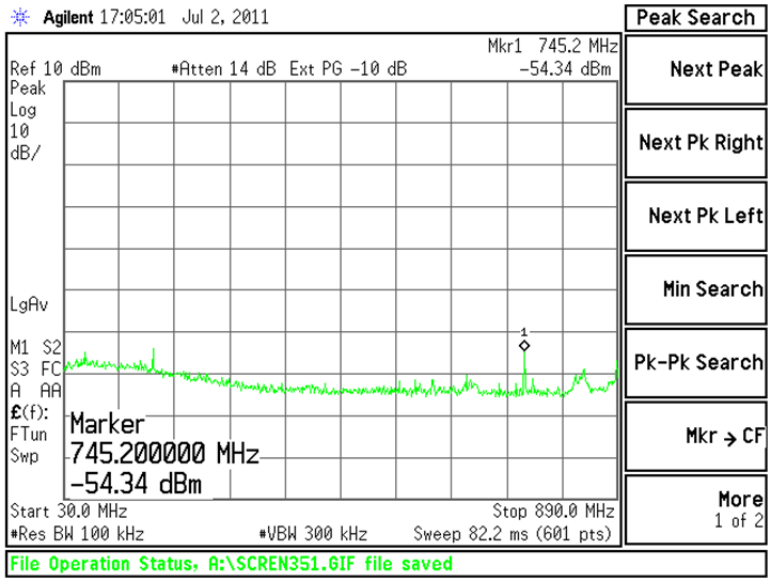
Note:
1. **All reported data are in dBm**.
2. **Spurious emission buried within system noise floor**.

The table below lists other notable spurious emissions other than the harmonics.

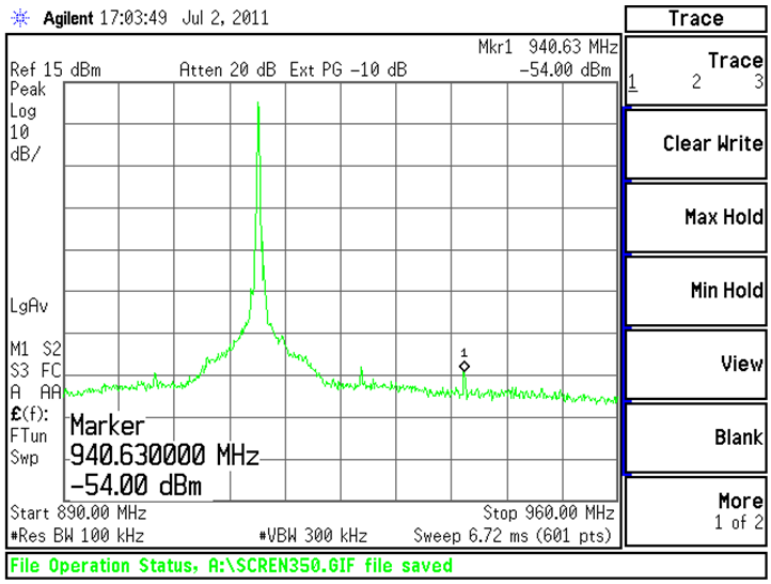
Freq(MHz)	Channel	level(dBm)
2467.00	low	-62.2
1801.00	mid	-58.1
940.63	mid	-54.0
745.20	mid	-54.3
169.00	high	-54.8
758.10	high	-57.1
952.42	high	-55.0
900.38	high	-55.1

10.4 – Screen Captures – Spurious Radiated Emissions

30 MHz to 890 MHz



890 MHZ to 960 MHz



960 MHZ to 1000 MHz

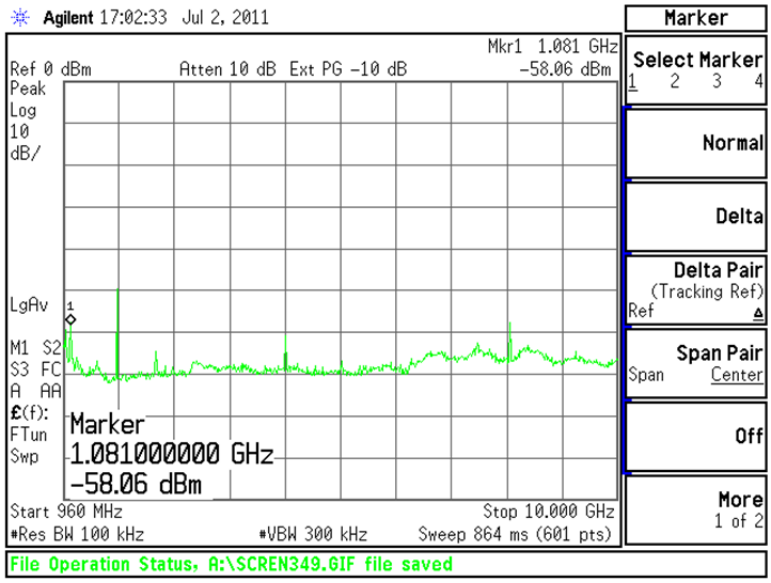


EXHIBIT 11. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

The power and frequency stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the power and frequency at the appropriate frequency markers. Power was supplied by an external bench-type DC power supply and was varied ±15% from the nominal.

2.55 VDC		3.00 VDC		3.45 VDC		
Power (dBm)	Frequency (Hz)	Power (dBm)	Frequency (Hz)	Power (dBm)	Frequency (Hz)	Channel
9.9	902994300	**9.9**	902994300	**9.9**	902994300	903
9.8	914591300	**9.8**	914591300	**9.8**	914591300	914.6
9.7	926388600	**9.7**	926388600	**9.7**	926388600	926.4

The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characteristics were well behaved, and the system returned to the same state of operation as before the power cycle.

Transmitter stops transmitting when supply voltage drops below 1.5 VDC.

EXHIBIT 12. CHANNEL PLAN AND SEPARATION

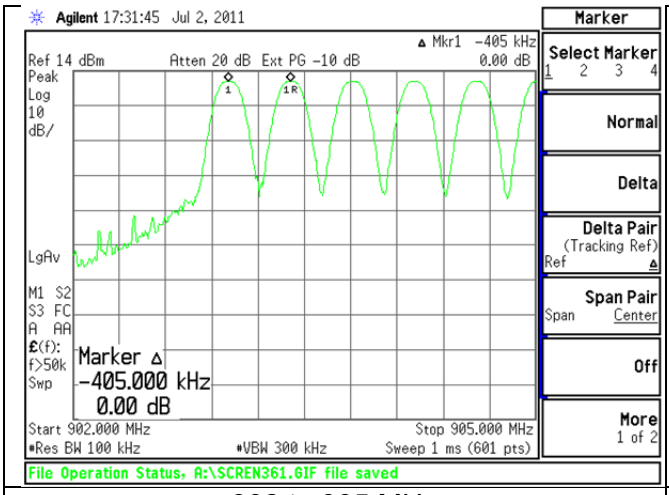
A spectrum analyzer was used with a resolution bandwidth of 100 kHz to measure the channel separation of the EUT.

RANGE (MHz)	Number of Channels	Separation min (kHz)	Separation max (kHz)
902-905	5.5	390.00	405.00
905-910	10.5	400.00	408.00
910-915	10.0	392.00	408.00
915-920	11.5	400.00	608.00
920-925	8.5	400.00	1992.00
925-928	4.0	392.00	400.00

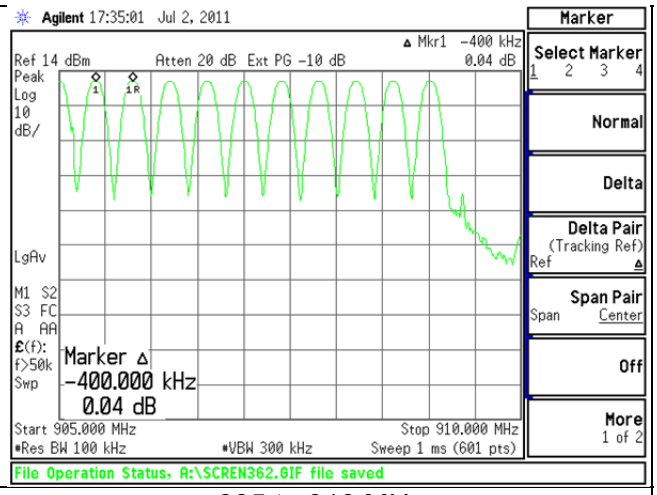
The maximum and minimum channel-separations measured for this device are 1992 kHz and 390 kHz respectively. The maximum 20dB bandwidth of the device, as reported in the previous section is 116 kHz, requiring at 50 channels at minimum. This EUT satisfies the minimum number of hopping channels which is 50.

The following plots describe this spacing, and also establish the channel separation and plan.

12.1 - Screen Captures – Channel Separation

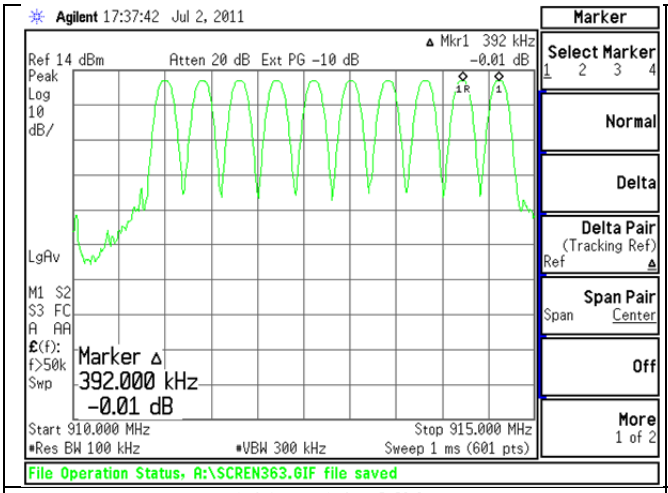


902 to 905 MHz

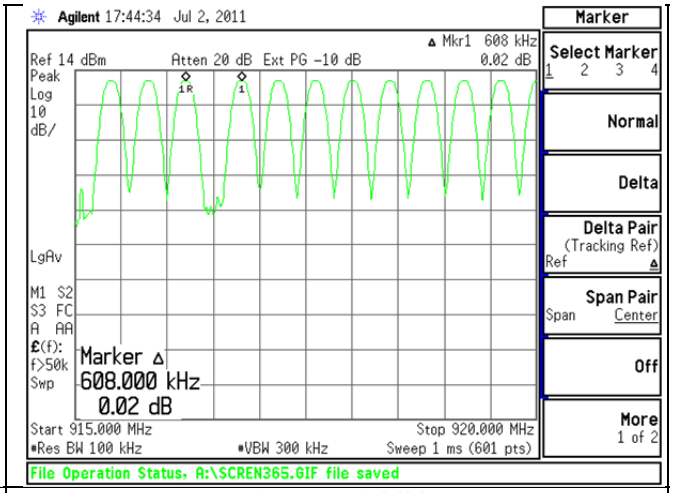


905 to 910 MHz

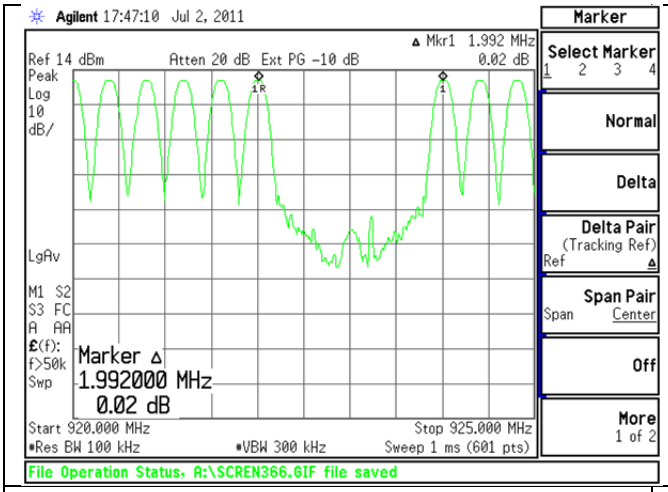
Screen Captures – Channel Separation *(continued)*



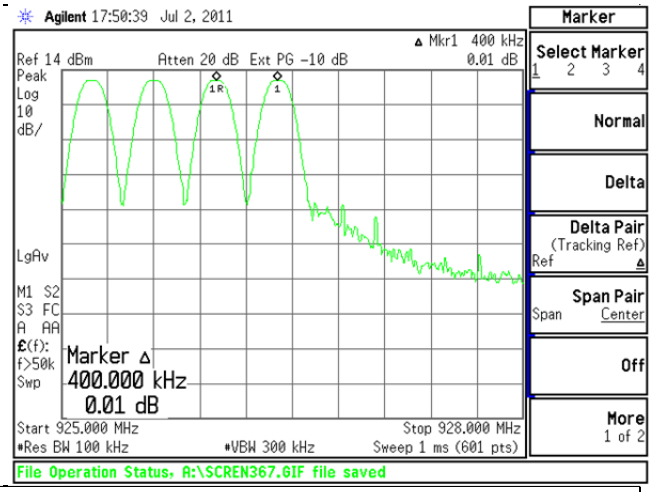
910 to 915 MHz



915 to 920 MHz



920 to 925 MHz



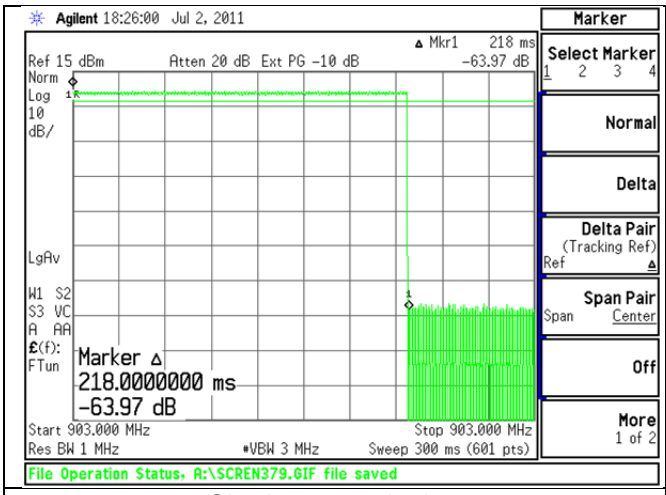
925 to 928 MHz

EXHIBIT 13. CHANNEL OCCUPANCY.

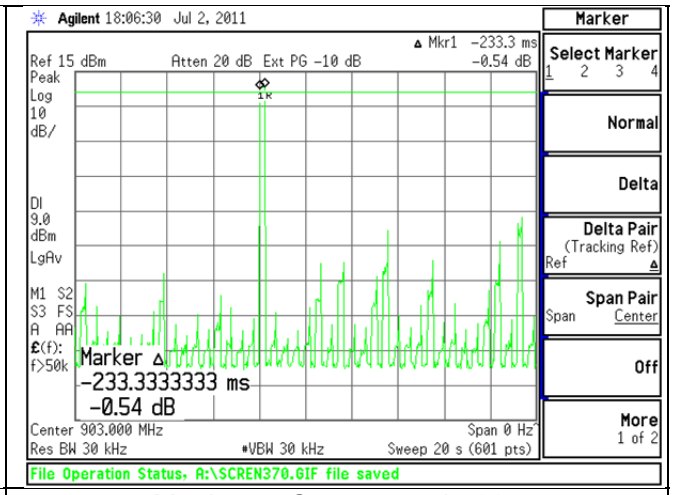
Part 15.247(a)(1)(i) requires an average channel occupancy, for this device, of no more than 400 milliseconds in a 20second window .The channel occupancy for this EUT was measured using a spectrum analyzer, set to zero-span at the frequency of interest. With the analyzer in peak-hold mode, the transmission lengths can be measured by adjusting the sweep rate of the analyzer. A suitable sweep rate was used to measure the channel occupancy at the low, mid and high channels. The longest time any transmission will occur on a single channel is **218 ms**. The maximum occupancy in a **20** second window is **1** (one) transmission cycle which translates to **218 ms**.

13.1 Time occupancy captures.

Channel 903 MHz

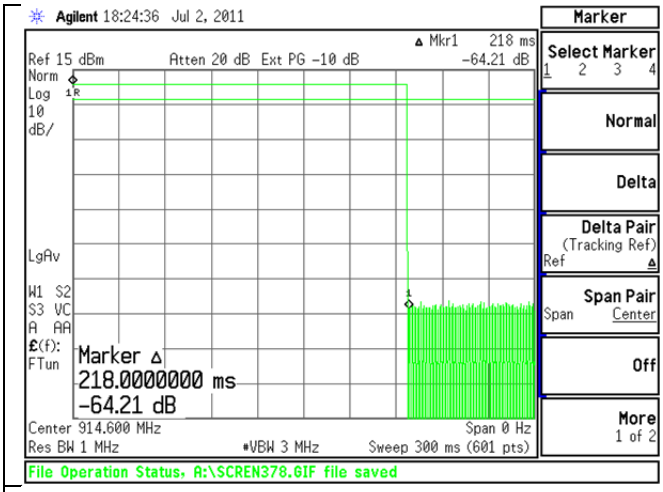


Single transmission

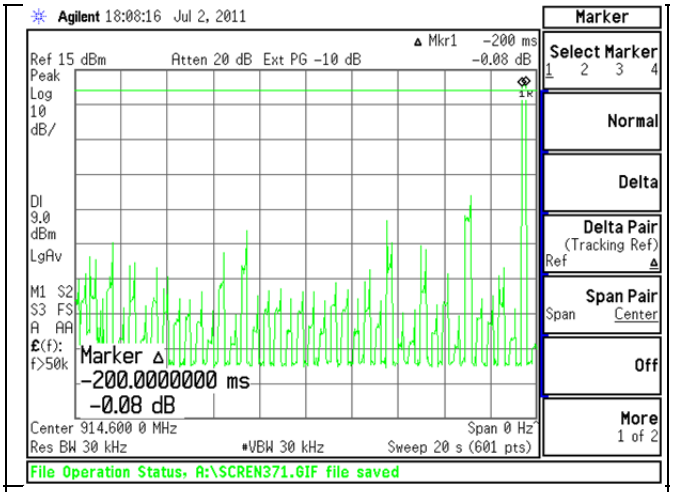


Maximum Occupancy in 20s

Channel 914.6 MHz

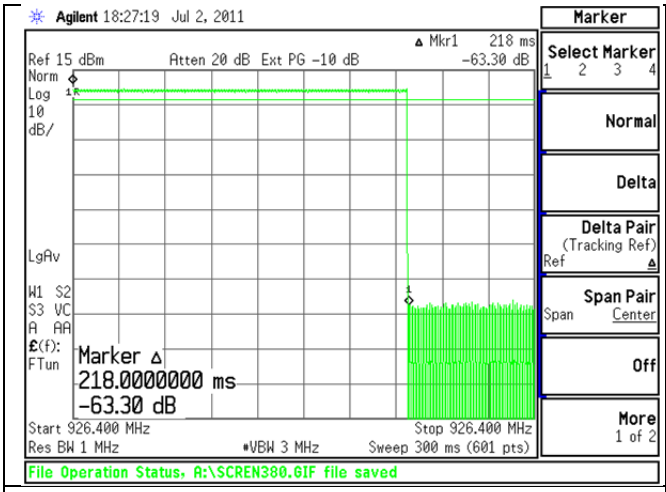


Single transmission

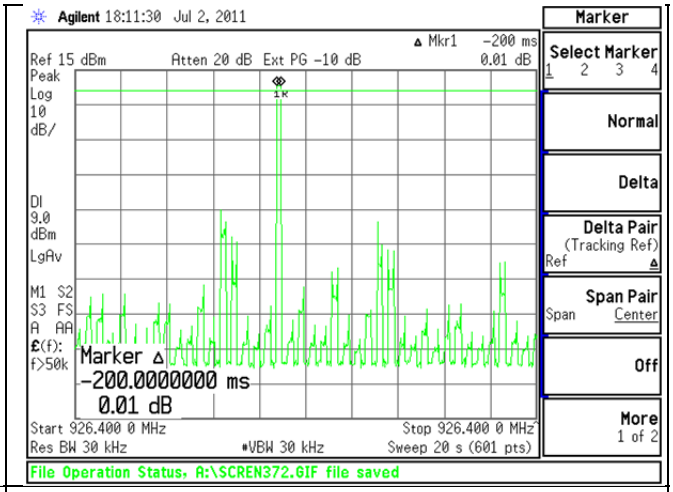


Maximum Occupancy in 20s

Channel 926.4 MHz



Single transmission



Maximum Occupancy in 20s

EXHIBIT 14. EQUAL CHANNEL USAGE

Note: This section is provided by the manufacturer.

The hop set frequency index sequence for this test is: 17, 42, 23, 48, 46, 21, 7, 32, 49, 24, 40, 15, 18, 43, 25, 0, 22, 47, 45, 20, 6, 31, 4, 29, 33, 8, 2, 27, 44, 19, 5, 30, 16, 41, 39, 14, 3, 28, 1, 26, 12, 37, 36, 11, 38, 13, 9, 34, 35, 10 and repeat

This sample hop sequence shows equal usage of all channels

Each EUT has its own pseudorandom frequency sequence use for the transmitting channel. The transmit sequences are derived from a 15 bit seed value chosen randomly and automatically at the time the system is commissioned with client devices. The characteristics of the pseudorandom frequency sequence are:

- Each possible random seed value results in a unique pseudorandom frequency sequence.
- Each of the 50 frequencies occurs in the sequence once and only once before the sequence repeats.
- There are no circumstances or special conditions that skip frequencies in the sequence.

Once chosen, the sequence does not change unless re-commissioned.

EXHIBIT 15. PSEUDORANDOM HOPPING SEQUENCE.

Note: This section is provided by the manufacturer.

The hop set frequency index sequence for this test is: 17, 42, 23, 48, 46, 21, 7, 32, 49, 24, 40, 15, 18, 43, 25, 0, 22, 47, 45, 20, 6, 31, 4, 29, 33, 8, 2, 27, 44, 19, 5, 30, 16, 41, 39, 14, 3, 28, 1, 26, 12, 37, 36, 11, 38, 13, 9, 34, 35, 10 and repeat

This sample hop sequence shows equal usage of all channels

Each EUT has its own pseudorandom frequency sequence use for the transmitting channel. The transmit sequences are derived from a 15 bit seed value chosen randomly and automatically at the time the system is commissioned with client devices. The characteristics of the pseudorandom frequency sequence are:

- Each possible random seed value results in a unique pseudorandom frequency sequence.
- Each of the 50 frequencies occurs in the sequence once and only once before the sequence repeats.
- There are no circumstances or special conditions that skip frequencies in the sequence.

Once chosen, the sequence does not change unless re-commissioned.

EXHIBIT 16. RECEIVER SYNCHRONIZATION AND INPUT BANDWIDTH.

Note: This section is provided by the manufacturer.

At the core of the radio block is an integrated transceiver, CC1101 manufactured by Texas Instruments. The CC1101 is configured by the RF protocol microcontroller to operate at frequencies as determined by a frequency sequencing algorithm. The bandwidth, transmit power, and modulation rate and type are set identically for all of the 50 frequencies utilized by this system.
The protocol microcontroller provides the commissioned network with a synchronization signal periodically.

APPENDIX A – Test Equipment List

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 6-Jul-2011 Type Test : Radiated Emissions Job # : C-1221

Prepared By: Peter Customer : Honeywell Quote #: 311156

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960014	EMI Receiver-filter section	HP	85460A	3448A00296	10/29/2010	10/29/2011	Active Calibration
2	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	10/19/2010	10/19/2011	Active Calibration
3	AA 960150	Bicon Antenna	ETS	3110B	0003-3346	10/19/2010	10/19/2011	Active Calibration
4	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	4/27/2011	4/27/2012	Active Calibration
5	EE 960147	Pre-Amp	Adv. Micro	WLA612	123101	1/4/2011	1/4/2012	Active Calibration
6	AA 960155	900MHz High Pass Filter	KWM	HPF-L-14185	7272-03	2/28/2011	2/28/2012	Active Calibration
7	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	1/4/2011	1/4/2012	Active Calibration
8	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/22/2010	9/22/2011	Active Calibration
9	AA 960142	Phaseflex	Gore	EMOCJOCJO36.0	4943263	9/23/2010	9/23/2011	Active Calibration
10	AA 960143	Phaseflex	Gore	EKD01D01048.0	5546519	9/22/2011	9/22/2012	Active Calibration

Project Engineer: Peter Fielen Quality Assurance:

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 28-Jun-2011 Type Test : Band-Edge Job # : C-1221

Prepared By: Peter Customer : Honeywell Quote #: 311156

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960014	EMI Receiver-filter section	HP	85460A	3448A00296	10/29/2010	10/29/2011	Active Calibration
2	EE 960013	EMI Receiver	HP	8546A System	3617A00320;3448A	10/29/2010	10/29/2011	Active Calibration
3	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	10/19/2010	10/19/2011	Active Calibration

Project Engineer: Peter Fielen Quality Assurance:

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 3-Jul-2011 Type Test : Occupied Bandwidth (6dB & 20dB), Cond Power Job # : C-1221

Prepared By: Peter Customer : Honeywell Quote #: 311156

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/22/2010	9/22/2011	Active Calibration
2	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/1/2011	6/1/2012	Active Calibration

Project Engineer: Peter Fielen Quality Assurance:

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 3-Jul-2011 Type Test : Power Spectral Density, Cond Spurious Emissions Job # : C-1221

Prepared By: Peter Customer : Honeywell Quote #: 311156

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/22/2010	9/22/2011	Active Calibration
2	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	6/1/2011	6/1/2012	Active Calibration

Project Engineer: Peter Fielen Quality Assurance:

APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2009		
ANSI C63.10	2009		
CISPR 11	2009-05	2009-12 P	
CISPR 12	2007-05		
CISPR 14-1	2005-11	2008-11	
CISPR 14-2	2001-11	2001-11	2008-05
CISPR 16-1-1 Note 1	2010-01		
CISPR 16-1-2 Note 1	2003	2004-04	2006-07
CISPR 22	2008-09		
CISPR 24	1997-09	2001-07	2002-10
EN 55011	2007-05		
EN 55014-1	2006		
EN 55014-2	1997		
EN 55022	2006	2007	
EN 60601-1-2	2007-03		
EN 61000-3-2	2006-05		
EN 61000-3-3	2008-12		
EN 61000-4-2	2009-05		
EN 61000-4-3	2006-07	2008-05	
EN 61000-4-4	2004		
EN 61000-4-5	2006-12		
EN 61000-4-6	2009-05		
EN 61000-4-8	1994	2001	
EN 61000-4-11	2004-10		
EN 61000-6-1	2007-02		
EN 61000-6-2	2005-12		
EN 61000-6-3	2007-02		
EN 61000-6-4	2007-02		
FCC 47 CFR, Parts 0-15, 18, 90, 95	2008		
FCC Public Notice DA 00-1407	2000		
FCC ET Docket # 99-231	2002		
FCC Procedures	2007		
ICES 001	2006-06		
ICES 002	2009-08		
ICES 003	2004-02		
IEC 60601-1-2 Note 1	2007-03		
IEC 61000-3-2	2005-11	2008-03	2009-02
IEC 61000-3-3	2008-06		
IEC 61000-4-2	2008-12		
IEC 61000-4-3	2008-04	incl in 2008-04	2009-12 FD

STANDARD #	DATE	Am. 1	Am. 2
IEC 61000-4-4	2004-07	2010-10	
IEC 61000-4-5	2005-11		
IEC 61000-4-6	2008-10		
IEC 61000-4-8	2009-09		
IEC 61000-4-11	2004-03		
IEC 61000-6-1	2005-03		
IEC 61326-1	2006-06		
ISO 14982	1998-07		
MIL Std. 461E	1999-08		
RSS GEN	2007-06		
RSS 119	2007-06		
RSS 123	1999-11		
RSS 125	2000-03		
RSS 131	2003-07		
RSS 136	2002-10		
RSS 137	2009-02		
RSS 210	2007-06		
RSS 213	2005-12		
RSS 243	2005-11		
RSS 310	2007-06		

Note 1: Test not on LSR Scope of Accreditation.

APPENDIX C - Uncertainty Statement

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k=2.

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.24 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.8 dB
Radiated Emissions	10-Meter OATS, Biconical Antenna	4.18 dB
Radiated Emissions	10-Meter OATS, Log Periodic Antenna	3.92 dB
Conducted Emissions	Shielded Room/EMCO LISN	1.60 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	1.128 Volts/Meter
Conducted Immunity	3 Volts level	1.0 V

APPENDIX D – EUT firmware instructions.

1. LCD and keyboard hardware is used for FCC.
    a. LCD has four different sections
        i. Top = Mode (FR1, FT1, FT2, Q1, Q2)
        ii. Left = Frequency (Low, Mid, High)
        iii. Right = Antenna (A, B, AB)
        iv. Bottom = Data Modulation (Modulated, Unmodulated)
    b. Keyboard has 4 buttons
        i. Button 1 (first starting from the left) : Mode selection
        ii. Button 2 (second starting from the left) : Frequency selection
        iii. Button 3 (third starting from the left) : Antenna selection
        iv. Button 4 (fourth starting from the left) : Data Modulation selection
    c. Button and LCD behavior.
        i. LCD will be constantly on. LCD will display at all time the Mode, the Frequency, the Antenna and the Data Modulation.
        ii. Button action will be processed on button press. LCD will change to indicate the new parameter on button press.
2. FCC modes (FR1, FT1 and FT2) and Qualification modes (Q1 and Q2)
    a. Mode selection
        i. RX mode FR1 is enabled at power up. “Fr1” is displayed on the LCD top section. If button 1 is pressed in Q2 mode, the software will enter FR1 mode.
            1. Default Settings for FR1 mode
                a. Antenna A
                b. Freq low
        ii. If button 1 is pressed when in FR1 mode, the software then enter TX mode FT1. “Ft1” is displayed on the LCD top section.
            1. Default Settings for FT1 mode
                a. Antenna A
                b. Freq low
                c. Modulated Data
        iii. If button 1 is pressed when in FT1 mode, the software then enter TX mode FT2. “Ft2” is displayed on the LCD top section.
            1. Default setting for FT2 mode
                a. Antenna A
                b. Modulated Data
        iv. If button 1 is pressed when in FT2 mode, the software then enter into mode Q1. “q1” is displayed on the LCD top section.
            1. Default setting for Q1 mode
                a. Antenna A
        v. If button 1 is pressed when in Q1 mode, the software then enter into mode Q2. “q2” is displayed on the LCD top section.
            1. Setting for Q2 mode
                a. TWO_ANTENNAS macro defined
                b. TWO_ANTENNAS macro removed

b. Freq Switch (low, mid, high)
    i. Low Frequency is selected at power up. “LO” is displayed on the LCD left section. If button 2 is pressed in High frequency, the software will switch to Low frequency.
    ii. If button 2 is pressed in Low frequency, the software will switch to Mid frequency. “M” is displayed on the LCD right section.
    iii. If button 2 is pressed in Mid frequency, the software will switch to High frequency. “HI” is displayed on the LCD right section.
c. Ant Switch (Ant A, Ant B, Ant AB)
    i. Antenna A is selected at power up. “A” is displayed on the LCD right section. If button 3 is pressed while using antenna B, the software will switch to antenna A.
    ii. If button 3 is pressed while using antenna A, the software will switch to antenna B. “B” is displayed on LCD right section.
    iii. If button 3 is pressed while using antenna B and if TWO_ANTENNAS macro is defined, the software will switch to antenna AB. “AB” is displayed on LCD left section.
d. Modulation Switch (Modulated data, Un-modulated data)
    i. Modulated data is selected at power up. “M” is displayed on LCD bottom section. If button 4 is pressed in Unmodulated data mode, the software will enter Modulated data mode.
    ii. If button 4 is pressed while in Modulated data mode, the software will switch to Unmodulated data mode. “Un” is displayed on LCD bottom section.
e. Freq Switch would not apply to FT2, Q1 and Q2 modes (when button 2 is pressed, LCD does not display new frequency mode)
f. Antenna Switch would not apply to Q2 mode (when button 3 is pressed, LCD does not display new antenna).
g. Modulation Switch would not apply to FR1, Q1 and Q2 modes (when button 4 is pressed, LCD does not display new modulation mode).
h. In Baily Thermostat, only 1 antenna is used. The antenna cannot be disabled. So Antenna switch will have no effect.
i. When in FT1 or Q1 mode, Antenna switch is replaced by PowerLevel. “C0”, “C2”, “C4”, “C6” and “C8” may be displayed on the LCD right section. If button 3 is pressed in “C8”, it reverts to “C0”.