LS Research, LLC

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ENGINEERING TEST REPORT # 308247 TX TCB
LSR Job #: C-345

Compliance Testing of:
Epsilon Wall Module
Programmable Model # TH6320R1004

Test Date(s):

April 30-May 28, 2008

Prepared For:
Honeywell International
1985 Douglas Drive North
Golden Valley, MN 55422-3992

In accordance with:
Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247 FHSS TX
Frequency Hopping Spread Spectrum Operating in the
Frequency Band 902 MHz – 928 MHz

This Test Report is issued under the Authority of:
Kenneth L. Boston, Sr. EMC Engineer

Signature: Date: August 14, 2008

Test Report Reviewed by:
Teresa A. White, Quality Manager

Signature:
Date: August 15, 2008

Tested by:
Laura Bott, EMC Engineer

Signature:
Date: August 15, 2008

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1.1 SCOPE

References:	FCC Part 15, Subpart C, Section 15.247
Title:	Telecommunication – Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	To gain FCC Certification Authorization for Digital Modulation Transmitters operating in the Frequency Band of 902 MHz – 928 MHz
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	Year	Title
47 CFR, Parts 0-15 (FCC)	2007	Code of Federal Regulations - Telecommunications
ANSI C63.4	2003	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	2006 A2: 2007	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus.
CISPR 16-2-1	2003	Specification for radio disturbance and immunity measuring apparatus and methods. Part 201: Conducted disturbance measurement.
FCC Public Notice DA 00-1407	2000	Part 15 Unlicensed Modular Transmitter Approval
FCC ET Docket No. 99-231	2002	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) to conform 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. A copy of the accreditation may be accessed on our web site: www.lsr.com. Accreditation status can be verified at A2LA's web site: www.a2la2.net.

1.4 LOCATION OF TESTING

All testing was performed at LS Research, LLC, W66 N220 Commerce Court, Cedarburg, Wisconsin, 53012 USA, utilizing the facilities listed below, unless otherwise noted.

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 in accordance with A2LA standards.

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 CLIENT INFORMATION

Manufacturer Name:	**Honeywell International**
Address:	**1985 Douglas Drive North Golden Valley, MN 55422-3992**
Contact Person:	**Robert D Juntunen**
Contact Phone:	**763.954.4839**
Contact Email:	**robert.d.juntunen@honeywell.com**

2.2 EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information has been supplied by the applicant.

Product Name:	Epsilon Wall Module (Programmable and Nonprogrammable)
Model Number:	Programmable: TH6320R1004
Serial Number:	Engineering Units

2.3 ASSOCIATED ANTENNA DESCRIPTION

The C7089 utilizes a PCB strip antenna, combined with a two element raised bar element, with a gain of 5.19 dBm (measured).

2.4 EUT'S TECHNICAL SPECIFICATIONS

Additional Information:

Frequency Range (in MHz)	902-928 MHz
RF Power in Watts	0.013 Watts (at 902.9 MHz)
Conducted Output Power (in dBm)	11.18 dBm (at 902.9 MHz)
Operating Voltage	3.0 VDC
Field Strength (and at what distance)	111.6 dBµV/m t 3 meters (at 902.9 MHz)
Occupied Bandwidth (99% BW)	124.1 kHz
Type of Modulation	FSK
Emission Designator	F1D124k
EIRP (in mW)	43.35 mW
Transmitter Spurious (worst case)	56.89 dBµV/m at 1 meter (at 9264 MHz)
Frequency Tolerance %, Hz, ppm	n/a
Microprocessor Model # (if applicable)	ATMEGA6490V
Antenna Information	
Detachable/non-detachable	Non-Detachable
Type	strip
Gain (in dBi)	5.19 dBi (calculated from measurements)
EUT will be operated under FCC Rule Part(s)	47 CFR 15.247 and 15.207 IC: RSS-GEN, 2007 and RSS-210, Issue 7, 2007
Portable/Mobile	☐ Portable ☒ Mobile
Table-Top	☐ Yes ☒ No
Modular Filing	☐ Yes ☒ No

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 Bulletin 65, IC Safety Code 6
- Measurement Distance: 3 m
- RF Value: 0.000008624 ☐ V/m ☐ A/m ☒ W/m^2
  ☒ Measured ☐ Computed ☐ Calculated

2.5 PRODUCT DESCRIPTION

The TH6320R1004 is a battery powered, two-way RF device. The circuit card contains a partitioned radio block, the major hardware components of that block are shown below. The board also contains two microcontrollers, power supply circuitry, basic sensor conditioning circuitry, LCD, and a seven button interface.

At the core of the radio block is an integrated transceiver, CC1101 manufactured by Texas Instruments. This radio is digitally controlled relative to its mode of operation through the SPI port noted in the block diagram. The part is configured by the 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 the all of the 50 frequencies utilized by this system. Channel spacing is defined at a minimum of 400Khz. All frequencies are generated by the CC1101 via integral frequency synthesizer which is clocked by the 26Mhz crystal, Xtal.

PHOTO

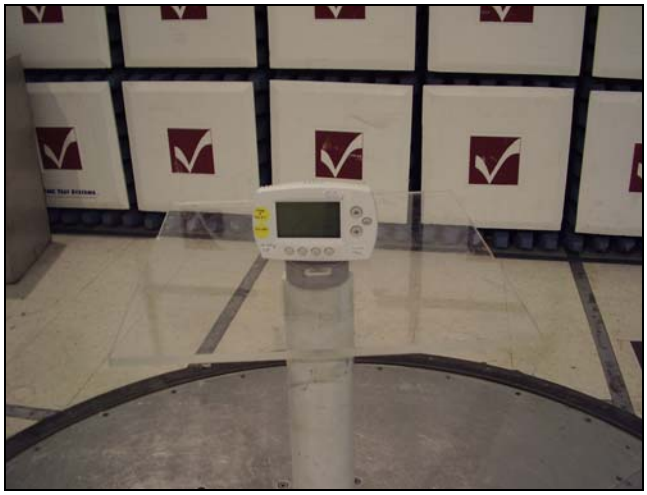


EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTING

3.1 CLIMATE TEST CONDITIONS

Temperature:	20-25°C
Humidity:	30-60%
Pressure:	86-106 kPa

3.2 APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Paragraph	Test Requirements	Compliance (yes/no)
15.207	Power Line Conducted Emissions Measurements	n/a
15.247(a)(1)	Bandwidth of an FHSS System	Yes
15.247(b) & 1.1310	Maximum Output Power	Yes
15.247(i), 1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
15.247(d)	RF Spurious Emissions	Yes
15.247(b), 15.209 & 15.205	Transmitter Radiated Emissions	Yes
The transmit circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart C, and the associated Radio Receiver and digital circuitry has also been tested and found to comply with Part 15, Subpart B – Radio Receivers. The Receiver Test Report is available upon request.		

3.3 MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

☐ **None** ☒ **Yes (explain below)**

RF shield was placed on radio module.

3.4 DEVIATIONS & EXCLUSIONS FROM TEST SPECIFICATIONS

☒ **None** ☐ **Yes (explain below)**

3.5 TEST SPECIFICATIONS AND RELATED DOCUMENTS

Document	Date	Title
FCC CFR Title 47	2007	Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15-Radio Frequency Device
ANSI C63.4	2003	Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
IC RSS-210 Issue 7	2007	Low Power License-Exempt Radio Communication Devices (All Frequency Bands)
IC RSS-212 Issue 1		Test Methods for Radio Equipment
RSS-GEN	2007	General Requirements and Information for the Certification of Radio Communication Equipment

The test procedures used are in accordance with ANSI document C63.4-2003, "Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The specific procedures are described herein. Radiated testing was performed at an antenna to EUT distance of 3 meters. The antenna was raised and lowered from 1 to 4 meters.

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 7 (2007), Annex 8 (section 8.1) for a Frequency Hopping Spread Spectrum (FHSS) Transmitter.

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

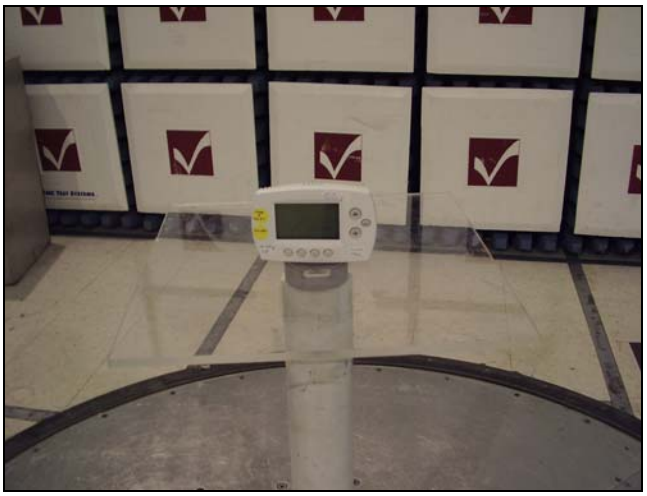
5.1 Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15 and ANSI C63.4-2003. 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, where the measurement antenna is 3 meters from the EUT radiating element.

The EUT was tested in continuous transmit mode. Power was supplied to the EUT by two "AA" batteries. The unit has the capability to operate on 50 channels, controllable via buttons on the front of the unit.

The radiated emissions limits for unintentional radiators, denoted in FCC §15.109 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 (902.9 MHz), middle (914.9 MHz) and high (926.4 MHz) to comply with FCC § 15.35.

5.2 Test Setup Photo(s) – Radiated Emissions Test



5.3 Test Procedure

Radiated Emissions measurements were performed on the programmable and non-programmable versions of the Epsilon Wall Module from 30 - 1000 MHz in a 3 meter Semi-Anechoic, FCC listed Chamber. The radiated RF emission levels were manually noted at discrete turntable azimuths and measurement antenna heights, corresponding to peak emission levels at various frequencies. 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 were found by rotating the EUT 360°, and raising and lowering the antenna between 1 and 4 meters, using both horizontal and vertical antenna polarities.

The battery voltage was checked frequently, and the batteries were replaced as necessary.

The EUT was rotated along three orthogonal axes during the investigations to find the highest emission levels.

5.4 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 an N.I.S.T. traceable site. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and a HP 8546A EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into the HP 8546A EMI Receiver database. As a result, the data taken from the HP 8546A 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 HP 8546A 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 10GHz, an HP E4446A Spectrum Analyzer and an EMCO Horn Antenna were used.

Test Equipment	Manufacturer	Model No.	Serial No.
EMI Receiver	HP	8546A	3617A00320
EMI Receiver Pre-Select.	HP	85460A	3448A00296
Spectrum Analyzer	Agilent	E4446A	US45300564
Spectrum Analyzer	HP	E4407B	US39160256
Log Periodic Antenna	EMCO	93146	9701-4855
Horn Antenna	EMCO	3115	6907
Bicon Antenna	EMCO	93110B	9702-2918
Pre-Amp (5-18 GHz)	Adv. Microwave	WLA612	0123101
Pre-Amp (18-25 GHz)	Adv. Microwave	WLA622-4	0123001
Horn Antenna – Std. Gain	EMCO	3160-09	9809-1120

5.5 Test Results

The EUT was found to meet the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 for an FHSS transmitter [Canada RSS-210, Issue 7 (2007), Annex 8 (section 8.1). The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

5.6 CALCULATION OF RADIATED EMISSIONS LIMITS

The maximum peak output power of an intentional radiator in the 902-928 MHz band, as specified in Title 47 CFR 15.247 (b)(1), is 1 Watt. The harmonic and spurious RF emissions, as measured in any 100 kHz bandwidth, as specified in 15.247 (d), shall be at least 20 dB below the measured power of the desired signal, and must also meet the requirements described in 15.205(c).

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.

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 from field strength μV/m to dBμV/m:
$dB\mu V/m = 20 \log_{10} (100)$
= 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

5.7 RADIATED EMISSIONS TEST DATA CHART

3 Meter Measurements of Electromagnetic Radiated Emissions
Test Standard: 47 CFR, Part 15.205 and 15.247(FHSS)
Frequency Range Inspected: 30 MHz to 10000 MHz

Manufacturer:	Honeywell International					
Date(s) of Test:	April 30 & May 11, 28, 2008					
Test Engineer(s):	Laura Bott					
Voltage:	3 VDC					
Operation Mode:	Normal, continuous transmit, C.W. Mode					
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %					
EUT Power:		Single Phase ___VAC		3 Phase ___VAC		
	√	Battery		Other:		
EUT Placement:	√	80cm non-conductive table		10cm Spacers		
EUT Test Location:	√	3 Meter Semi-Anechoic FCC Listed Chamber		3/10m OATS		
Measurements:		Pre-Compliance		Preliminary	√	Final
Detectors Used:	√	Peak	√	Quasi-Peak	√	Average

Note: There were no significant radiated emissions from this product under 902 MHz.

Fundamental Measurements

Frequency (MHz)	Height (m)	Azimuth (degree)	QP Reading (dBµV/m)	QP Limit (dBµV/m)	Margin (dB)	Antenna Polarity
902	1.23	187	111.6	125	13.4	Horizontal
914.6	1	166	110.5	125	14.5	Horizontal
926.3	1.52	0	109.8	125	15.2	Horizontal

RADIATED EMISSIONS DATA CHART

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on the Programmable EWM, Channel 1:

Frequency (MHz)	Height (m)	Azimuth (degree)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity
1805.8	1	0	40.45 Note 2	91.6	51.15	Horizontal
2708.7	1	0	44.22 Note 2	54	9.78	Horizontal
3611.6	1	0	47.5 Note 2	54	6.5	Vertical
4514.5	1	0	47.81 Note 2	63.5	15.69	Vertical
5417.4	1	310	54.06	63.5	9.44	Horizontal
6320.3	1	54	52.93	101.6	48.67	Horizontal
7223.2	1	0	51.05 Note 2	101.6	50.55	Vertical
8126.1	1	0	51.36 Note 2	63.5	12.14	Vertical
9029	1.18	186	54.88	63.5	8.62	Vertical

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on the Programmable EWM, Channel 25:

Frequency (MHz)	Height (m)	Azimuth (degree)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity
1829.2	1	0	40.72 Note 2	90.5	49.78	Vertical
2743.8	1	0	45.49 Note 2	54	8.51	Vertical
3658.4	1	0	47.31 Note 2	54	6.69	Horizontal
4573	1	0	49.41 Note 2	63.5	14.09	Vertical
5487.6	1	321	51.23 Note 2	100.5	49.27	Horizontal
6402.2	1	0	52.14 Note 2	100.5	48.36	Horizontal
7316.8	1	138	51.6	63.5	11.9	Vertical
8231.4	1	0	51.49 Note 2	63.5	12.01	Vertical
9146	1	82	55.92	63.5	7.58	Horizontal

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on the Programmable EWM, Channel 50:

Frequency (MHz)	Height (m)	Azimuth (degree)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity
1852.8	1	0	41.27 Note 2	89.8	48.53	Vertical
2779.2	1	0	43.98 Note 2	54	10.02	Vertical
3705.6	1	0	47.12 Note 2	54	6.88	Vertical
4632	1	0	47.57 Note 2	63.5	15.93	Horizontal
5558.4	1	250	52.5	99.8	47.3	Vertical
6484.8	1	0	52.14	99.8	47.66	Horizontal
7411.2	1	0	50.32 Note 2	63.5	13.18	Vertical
8337.6	1	0	50.75 Note 2	63.5	12.75	Horizontal
9264	1	319	56.89	99.8	42.91	Vertical

Notes

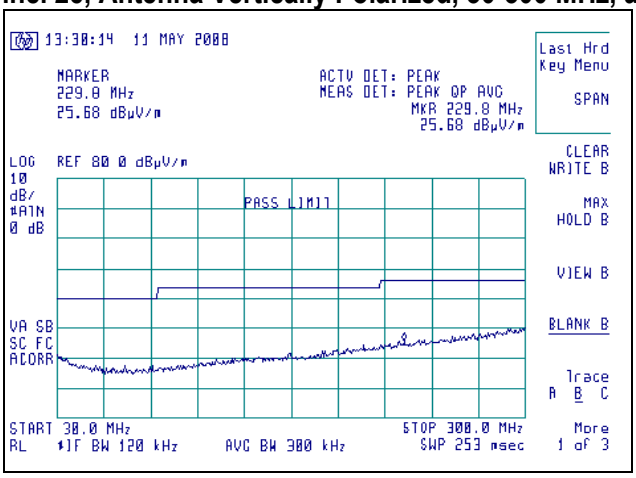
1) Measurements between 4 and 10 GHz were made at 1 meters of separation from the EUT.
2) Measurement at receiver system noise floor.

5.8 Screen Captures - Radiated Emissions Testing

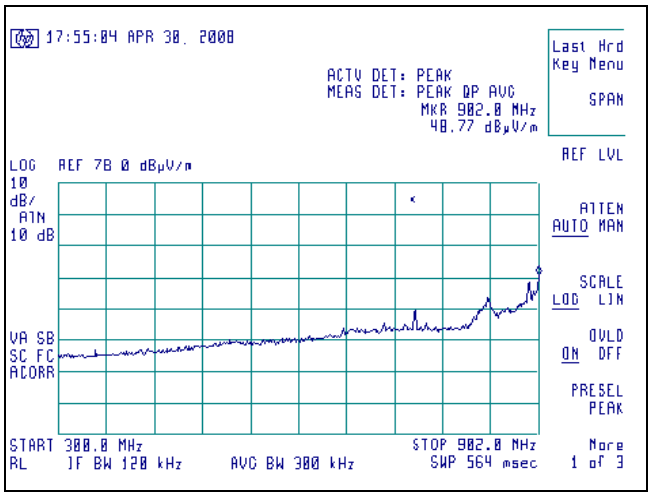
These screen captures represent Peak emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 1, 25, or 50, with the sense antenna both in vertical and horizontal polarity.

Channel 25, Antenna Vertically Polarized, 30-300 MHz, at 3m

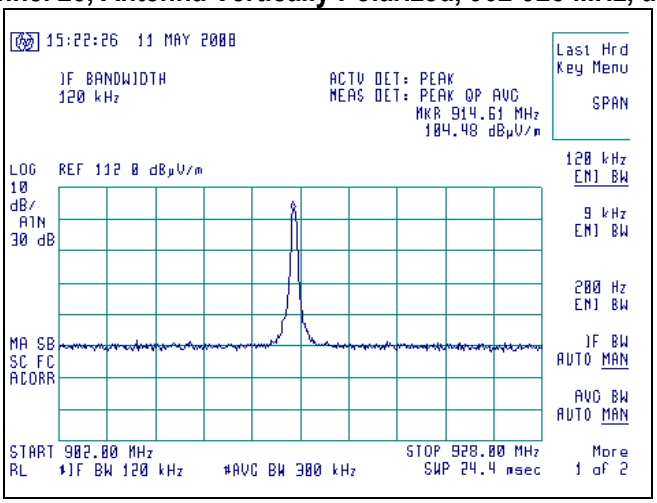


Channel 25, Antenna Vertically Polarized, 300-902 MHz, at 3m

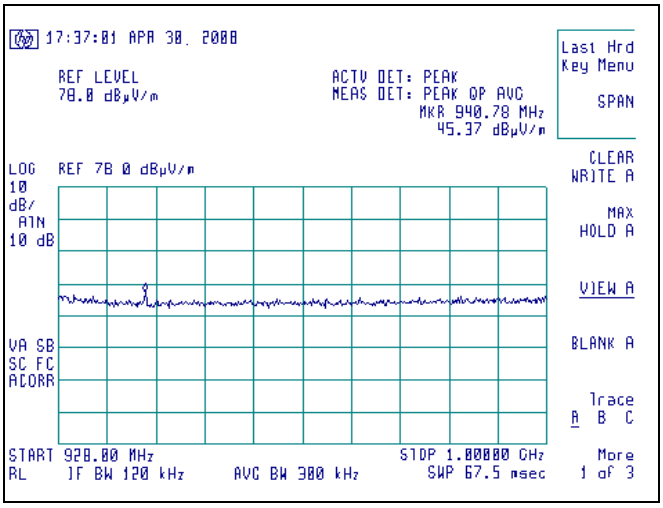


Screen Captures - Radiated Emissions Testing *(continued)*

Channel 25, Antenna Vertically Polarized, 902-928 MHz, at 3m

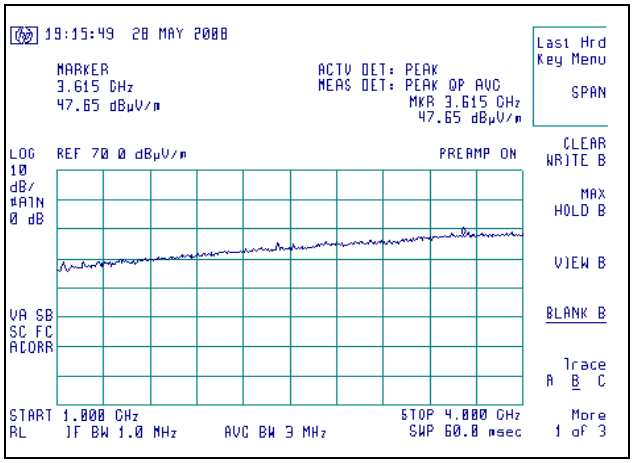


Channel 25, Antenna Vertically Polarized, 928-1000 MHz, at 3m



Screen Captures - Radiated Emissions Testing *(continued)*

Channel 1, Antenna Vertically Polarized, 1000-4000 MHz, at 3m



Channel 50, Antenna Horizontally Polarized, 4000-10000 MHz, at 1m

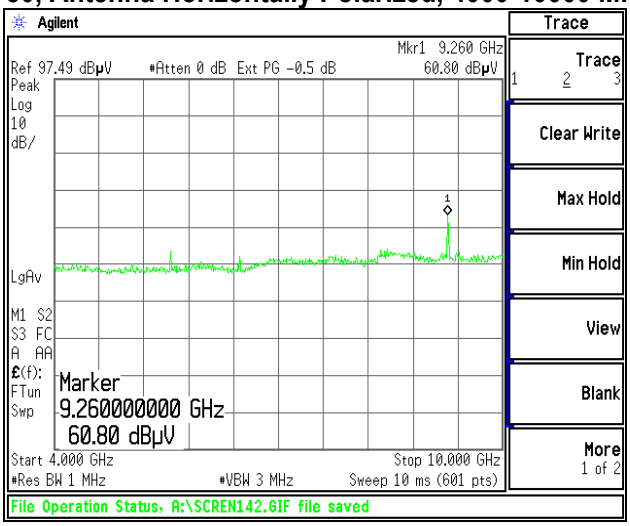


EXHIBIT 6. OCCUPIED BANDWIDTH: 15.247(a)(1)

6.1 Limits

For a Frequency Hopping Spread Spectrum, the -20 dBc bandwidth shall be at most 250 kHz.

6.2 Method of Measurements

Refer to ANSI C63.4 (2003) and FCC Procedures (2007) for FHSS Systems operating under 15.247.

The bandwidth requirement found in FCC Part 15.247(a)(1)(i) requires a maximum -20dBc occupied bandwidth of 500 kHz. 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 the HP E4446A spectrum analyzer. The loss from the cable was added on the analyzer as gain offset settings, there by allowing direct measurements without the need for any further corrections. A Hewlett Packard model E4446A spectrum analyzer was used with the resolution bandwidth set to 30 kHz for this portion of the tests. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used in peak-hold mode while measurements were made, as presented in the chart below.

6.3 Test Data

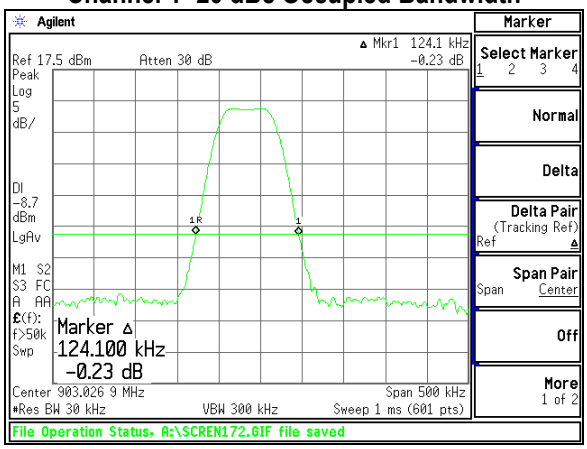
Channel	Center Frequency (MHz)	Measured -6 dBc Occupied Bandwidth (kHz)	Measured -20 dBc Occupied Bandwidth (kHz)	Maximum -20 dBc Occupied Bandwidth Limit (kHz)
1	902.9	83	124.1	250
25	914.5	82.3	122.6	250
50	926.4	82.9	122.2	250

6.4 Test Equipment List

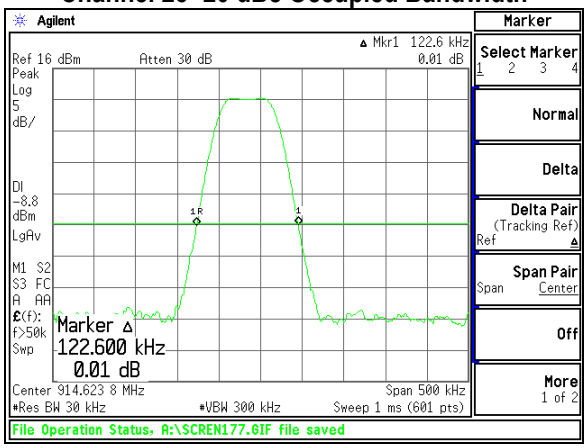
Test Equipment	Manufacturer	Model No.	Serial No.
Spectrum Analyzer	Agilent	E4407B	US39160256
Spectrum Analyzer	Agilent	E4446A	US45300564

6.5 Screen Captures - OCCUPIED BANDWIDTH

Channel 1 -20 dBc Occupied Bandwidth



Channel 25 -20 dBc Occupied Bandwidth



Channel 50 -20 dBc Occupied Bandwidth

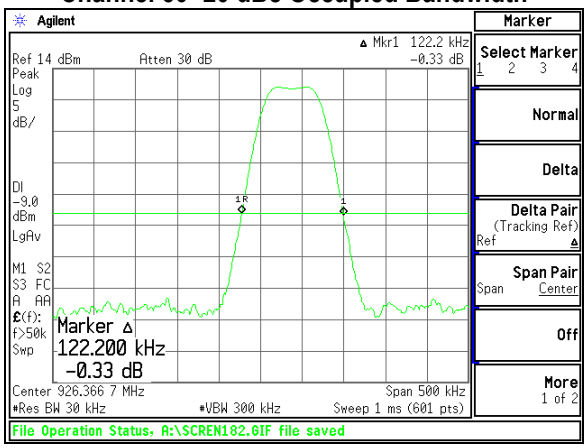


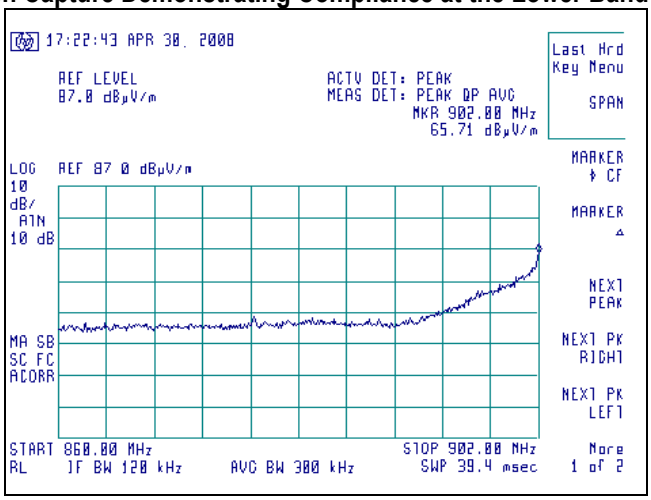
EXHIBIT 7. BAND-EDGE MEASUREMENTS

7.1 Method of Measurements

FCC 15.247(d) requires 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. 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 Upper and Lower Band-Edge limit, in this case, would be -20 dBc with respect to the fundamental level.

Screen Capture Demonstrating Compliance at the Lower Band-Edge



Screen Capture Demonstrating Compliance at the Higher Band-Edge

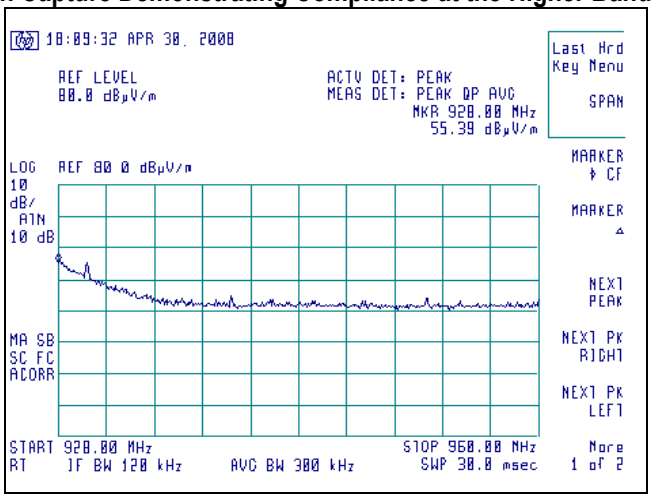


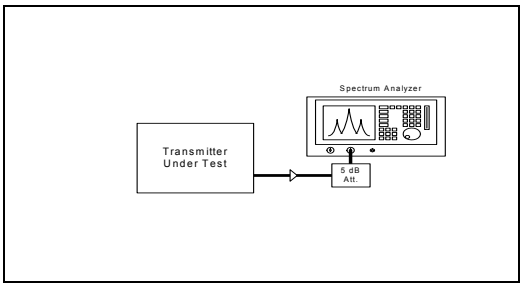
EXHIBIT 8. POWER OUTPUT (CONDUCTED): 15.247(b)

8.1 Method of Measurements

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable connected to the front of the spectrum analyzer. The loss from the cable was accounted for via a correction factor file which was loaded onto the analyzer prior to measurement. The unit was configured to run in a continuous transmit mode. The measurements from a peak detector presented in the chart below.

Channel	Center Frequency (MHz)	Measured Power (dBm)	Limit (dBm)	Margin (dB)	Calculated EIRP (dBm)	EIRP Limit (dBm)	Calculated EIRP (mw)
1	902.9	11.18	30	18.82	16.37	36.0	43.35
25	914.5	11.14	30	18.86	16.33	36.0	42.95
50	926.4	10.92	30	19.08	16.11	36.0	40.83

(1) EIRP Calculation:
EIRP = (Peak power at antenna terminal in dBm) + (EUT Antenna gain in dBi)



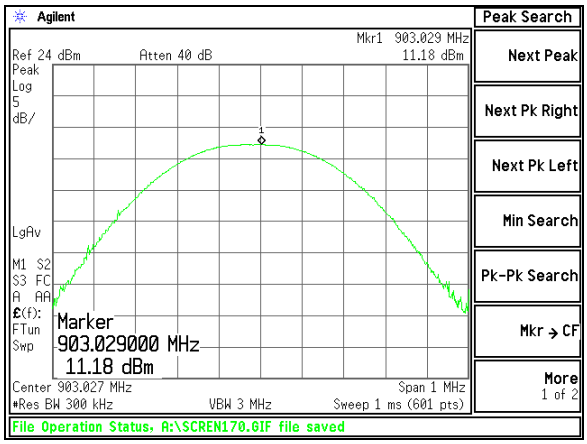
Measured Radiated RF power output (in watts): 0.043 W
Measured Conducted RF Power Output (in Watts): 0.013 W
Manufacturer Declared RF Power Output (in Watts): 0.01 W

8.2 Test Equipment List

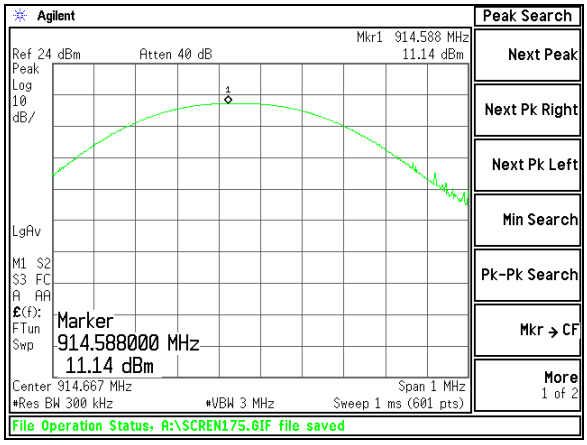
Test Equipment	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Agilent	E4446A	US45300564	To 44 GHz

8.3 Screen Captures – Power Output (Conducted)

Channel 1



Channel 25



Channel 50

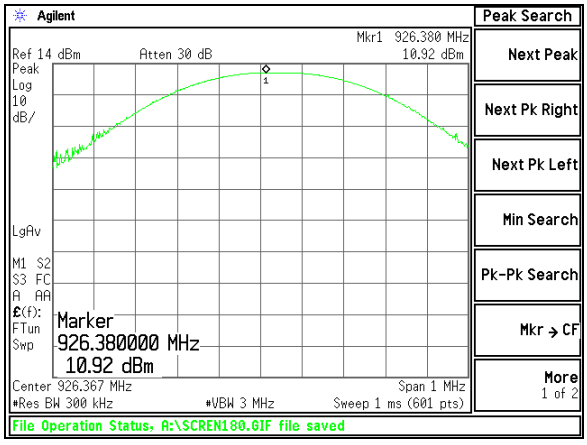


EXHIBIT 9. CHANNEL OCCUPANCY

Due to the nature of the transmission, testing to the standard was not possible. Below is an excerpt from the manufacturer's declaration which is in Appendix B

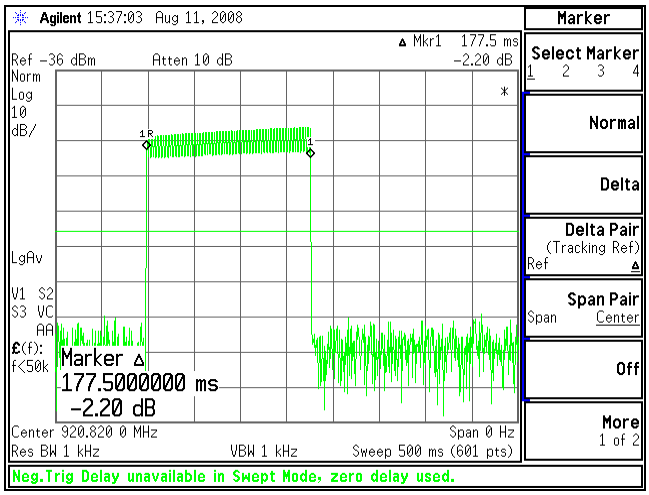
*A typical transmission on air time is less than 40ms, but not ever greater than 180ms. (*The customer sent additional information indicating that transmissions occur one time per minute.) Each TH5320R1002 has its own pseudorandom frequency sequence for transmitting and has knowledge of the central host hop sequence to receive information. The transmit sequences are derived from a 15 bit seed value chosen randomly and automatically at the time the thermostat is commissioned with a central host device, during installation. 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.
• See table 1 for the frequency channel plan and table 2 for a representative hop sequence generated by the algorithm.

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

According to the customer, the unit was programmed to a condition where the packet size of the data transmission is the size it will be in the field; however, the test mode transmits more frequently than it will in practice. All the while, the test mode exhibits passing features whereas the time on each channel is less than 400 ms in a 20 second span.

The image below shows the length of a single data packet transmission, which is 177.5 ms.



The following graph indicates that a single channel is not used more than once in a 20 second span.

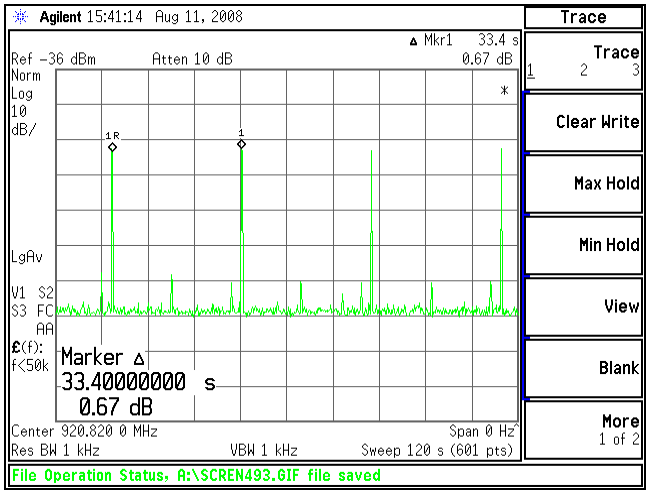


EXHIBIT 10. SPURIOUS CONDUCTED EMISSIONS: 15.247(d)

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.

For data from the radiated measurements, please refer to section 5.6 of this report.

FCC Part 15.247(d) requires 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. The cable calibration file was loaded into the spectrum analyzer to compensate for the loss of the cable between the antenna port of the EUT to the spectrum analyzer. A Hewlett Packard model E4446A 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. 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.

No significant emissions could be noted within -50 dBc of the fundamental level for this product.

	Channel 1	Channel 25	Channel 50
	Power in dBm		
Fundamental	11.43	11.31	11.06
2nd Harmonic	-49.76	-49.22	-48.72
3rd Harmonic	-55.46	-66.42	-63.51
4th Harmonic	-76.4	-79.52	-80.83
5th Harmonic	-83.32	-82.12	*Note 1*
6th Harmonic	-53.4	-56.87	-60.47
7th Harmonic	-67.65	-77.41	-81.69
8th Harmonic	-50.8	-51.02	-55.2
9th Harmonic	-75.62	-77.86	-78.92
10th Harmonic	-69.46	-72.85	-68.81

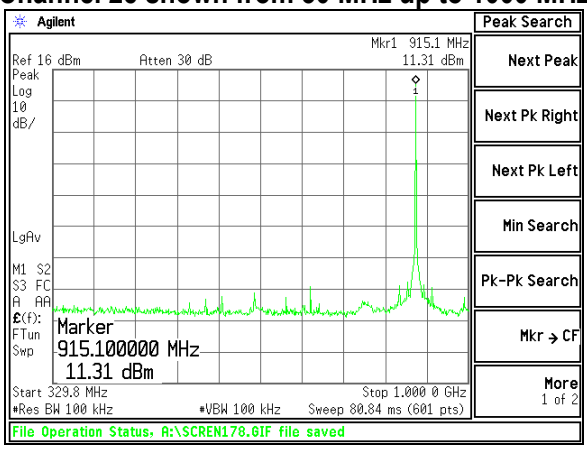
Notes:
(1) Measurement at system noise floor.

10.2 Test Equipment List

Test Equipment	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer	Agilent	E4446A	US45300564	To 44 GHz

10.3 Screen Captures – Spurious Emissions

Channel 25 shown from 30 MHz up to 1000 MHz



Channel 25 shown from 1000 MHz up to 10000 MHz

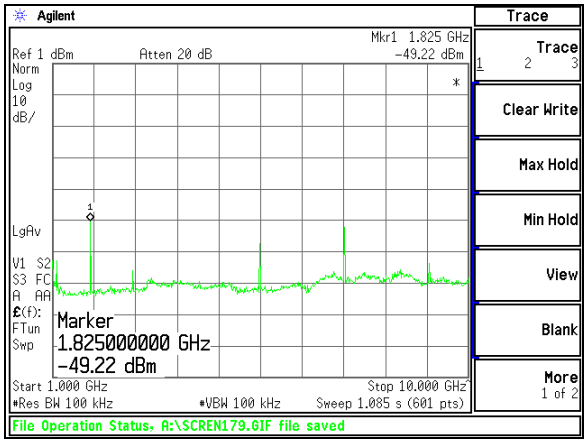


EXHIBIT 11. CHANNEL PLAN AND SEPARATION

An HP E4407B spectrum analyzer was used with a resolution bandwidth of10 kHz to measure the channel separation of the EUT.

The minimum and maximum channel-separations measured for this device are 388 kHz and 400 kHz respectively. The maximum occupied bandwidth of the device, as reported in the previous section is 132 kHz. The following plots describe this spacing, and also establish the channel separation and plan.

Please refer to Appendix B for the customer provided channel plan.

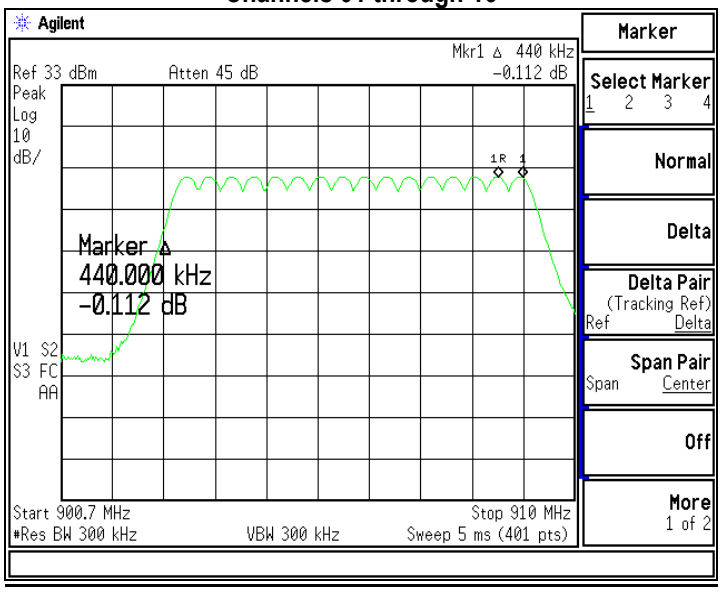
11.1 Test Data

Frequency Span	Number of Channels	Minimum Separation (kHz)
902 – 910 MHz	16	400
910.5 – 915 MHz	10	398
915 – 922.5 MHz	17	388
922.5 – 928.5 MHz	7	400

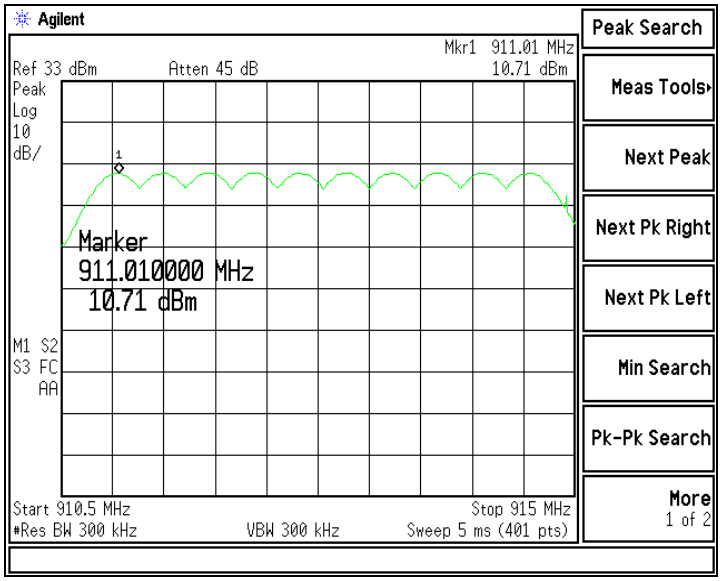
The system meets the minimum requirement of utilizing the following channels, as well as maintaining a minimum channel separation of 388 kHz, which is greater than the -20 dBc OCCBW of 132 kHz.

11.2 Screen Captures – Channel Separation

Channels 01 through 16

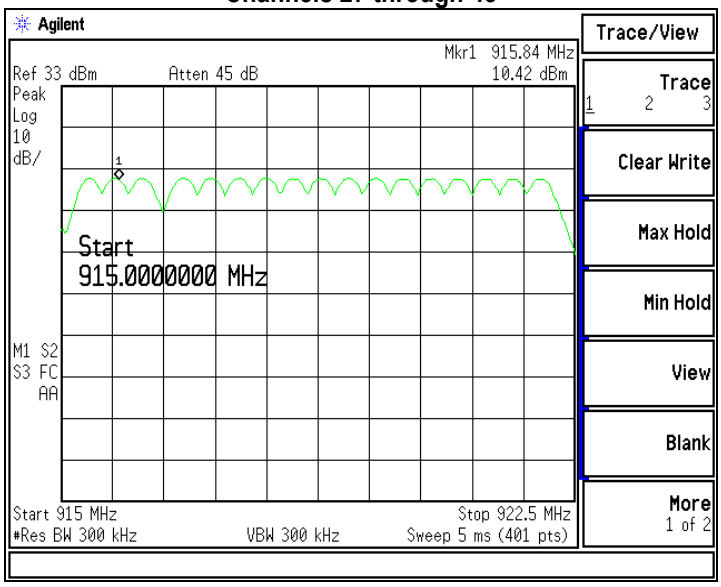


Channels 17 through 26



Screen Captures – Channel Separation *(continued)*

Channels 27 through 43



Channels 43 through 50

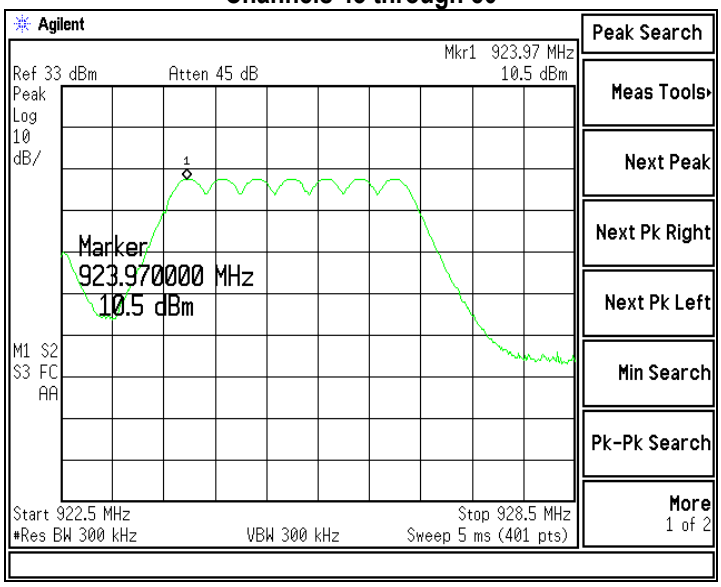


EXHIBIT 12. EQUAL CHANNEL USAGE

Due to the nature of the transmission, testing to the standard was not possible. Below is an excerpt from the manufacturer's declaration which is in Appendix B.

Table 2 (typical hop sequence)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Transmission #
6	31	33	8	48	23	26	1	17	42	38	13	19	44	35	10	Channel used
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Transmission #
9	34	37	12	0	25	3	28	16	41	24	49	18	43	45	20	Channel used
32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	Transmission #
21	46	30	5	7	32	47	22	29	4	40	15	14	39	27	2	Channel used
48	49	50														Transmission #
11	36	repeat														Channel used

This sample hop sequence shows equal usage of all channels

EXHIBIT 13. PSEUDORANDOM HOPPING PATTERN

Below is an excerpt from the manufacturer's declaration which is in Appendix B

Table 2 (typical hop sequence)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Transmission #
6	31	33	8	48	23	26	1	17	42	38	13	19	44	35	10	Channel used
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Transmission #
9	34	37	12	0	25	3	28	16	41	24	49	18	43	45	20	Channel used
32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	Transmission #
21	46	30	5	7	32	47	22	29	4	40	15	14	39	27	2	Channel used
48	49	50														Transmission #
11	36	repeat														Channel used

This sample hop sequence shows usage of all channels and randomness of channel selections.

EXHIBIT 14. MPE CALCULATIONS

The following MPE calculations are based on a circuit board strip antenna, with a measured ERP of 111.6 dBµV/m, at 3 meters, and conducted RF power of +11.18 dBm as presented to the antenna. The calculated gain of this antenna, based on the ERP measurements is 5.19 dBi

Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density
P = power input to the antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal:	11.18	(dBm)
Maximum peak output power at antenna input terminal:	13.122	(mW)
Antenna gain(typical):	5.19	(dBi)
Maximum antenna gain:	3.304	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	900	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	0.6	(mW/cm^2)
Power density at prediction frequency:	0.008624	(mW/cm^2)
Maximum allowable antenna gain:	23.6	(dBi)
Margin of Compliance at 20 cm =	18.4	dB

APPENDIX A

Test Equipment List

Asset #	Manufacturer	Model #	Serial #	Description	Date	Due
AA960008	EMCO	3816/2NM	9701-1057	Line Impedance Stabilization Network	12/6/07	12/6/08
AA960031	HP	119474A	3107A01708	Transient Limiter	Note 1	Note 1
AA960077	EMCO	93110B	9702-2918	Biconical Antenna	9/19/07	9/19/08
AA960078	EMCO	93146	9701-4855	Log-Periodic Antenna	9/19/07	9/19/08
AA960081	EMCO	3115	6907	Double Ridge Horn Antenna	12/04/07	12/04/08
CC00221C	Agilent	E4407B	US39160256	Spectrum Analyzer	1/11/07	1/11/08
EE960004	EMCO	2090	9607-1164	Device Controller	N/A	N/A
EE960013	HP	8546A	3617A00320	Receiver RF Section	9/20/07	9/20/08
EE960014	HP	85460A	3448A00296	Receiver Pre-Selector	9/20/07	9/20/08
EE960073	Agilent	E4446A	US45300564	Spectrum Analyzer	8/17/07	8/17/08
N/A	LSC	Cable	0011	3 Meter ½" Armored Cable	Note 1	Note 1
N/A	LSC	Cable	0050	10 Meter RG 214 Cable	Note 1	Note 1
N/A	Pasternack	Attenuator	N/A	10 dB Attenuator	Note 1	Note 1

Note 1 - Equipment calibrated within a traceable system.

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