



W66 N220 Commerce Court • Cedarburg, WI 53012 • Phone: 262.375.4400 • Fax: 262.375.4248

[www.lsr.com](http://www.lsr.com)

**TEST REPORT # 310365**  
**LSR Job #: C-1081**

**Compliance Testing of:**  
**Thermostat THX9321R1000**  
**Thermostat THX9421R5005**

**Test Date(s):**  
December 16<sup>th</sup> 2010  
January 1<sup>st</sup>, 12<sup>th</sup>, 13<sup>th</sup>, and 31<sup>st</sup> 2011  
February 1<sup>st</sup> 2011

**Prepared For:**  
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: Thomas Smith

*Thomas T. Smith*

Signature:

Date: 02.23.11

Test Report Reviewed by:  
Ryan M. Urness

Signature:

*Ryan M. Urness*

Date: 02.18.11

Project Engineer:  
Khairul Aidi Zainal, Senior EMC Engineer.

Signature:

*Khairul Aidi Zainal*

Date: 02.23.11

This Test Report may not be reproduced, except in full, without written approval of LS Research, LLC.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 2 of 53

## TABLE OF CONTENTS

EXHIBIT 1. INTRODUCTION .....	6
1.1 - Scope.....	6
1.2 – Normative References .....	6
1.3 - LS Research, LLC Test Facility .....	7
1.4 – Location of Testing.....	7
1.5 – Test Equipment Utilized .....	7
EXHIBIT 2. PERFORMANCE ASSESSMENT .....	8
2.1 – Client Information .....	8
2.2 - Equipment Under Test (EUT) Information .....	8
2.3 - Associated Antenna Description .....	8
2.4 - EUT'S Technical Specifications .....	9
2.5 - Product Description.....	10
EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS .....	11
3.1 - Climate Test Conditions.....	11
3.2 - Applicability & Summary Of EMC Emission Test Results .....	11
3.3 - Modifications Incorporated In The EUT For Compliance Purposes .....	12
3.4 - Deviations & Exclusions From Test Specifications .....	12
EXHIBIT 4. DECLARATION OF CONFORMITY .....	13
EXHIBIT 5. RADIATED EMISSIONS TEST.....	14
5.1 - Test Setup.....	14
5.2 - Test Procedure .....	14
5.3 - Test Equipment Utilized .....	15
5.4 - Test Results .....	15
5.5 - Calculation of Radiated Emissions Limits and reported data.....	16
5.6 - Radiated Emissions Test Data Chart.....	17
5.7 - Test Setup Photo(s) – Radiated Emissions Test .....	22
5.8 - Screen Captures - Radiated Emissions Test .....	23
EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE .....	26
6.1 - Test Setup.....	26
6.2 - Test Procedure .....	26
6.3 - Test Equipment Utilized .....	26

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 3 of 53

6.4 - Test Results .....	26
6.5 - FCC Limits of Conducted Emissions at the AC Mains Ports .....	27
6.6 – Conducted Emissions Test Data Chart .....	28
6.7 - Test Setup Photo(s) – Conducted Emissions Test .....	29
6.8 - Screen Captures – Conducted Emissions Test .....	29
EXHIBIT 7. OCCUPIED BANDWIDTH .....	30
7.1 - Limits.....	30
7.2 - Method of Measurements .....	30
7.3 - Test Data .....	31
7.4 - Screen Captures - Occupied Bandwidth.....	31
EXHIBIT 8. BAND EDGE MEASUREMENTS .....	33
8.1 - Method of Measurements .....	33
8.2. Band edge captures.....	34
8.2.1 Radiated band edge.....	34
8.2.2 Conducted band edge.....	35
EXHIBIT 9. POWER OUTPUT (CONDUCTED): 15.247(b).....	36
9.1 - Method of Measurements .....	36
9.2 - Test Data .....	36
9.4 - Screen Captures – Power Output (Conducted) .....	37
EXHIBIT 10. CONDUCTED SPURIOUS EMISSIONS: 15.247(d).....	38
10.1 - Limits.....	38
10.2 – Conducted Harmonic And Spurious RF Measurements .....	38
10.3 - Test Data .....	39
10.4 – Screen Captures – Spurious Radiated Emissions .....	40
EXHIBIT 11. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS.....	41
EXHIBIT 12. CHANNEL PLAN AND SEPARATION.....	42
12.1 - Screen Captures – Channel Separation .....	42
EXHIBIT 13. CHANNEL OCCUPANCY.....	44
13.1 Time occupancy captures.....	44
EXHIBIT 14. EQUAL CHANNEL USAGE .....	46
EXHIBIT 15. PSEUDORANDOM HOPPING SEQUENCE.....	47
EXHIBIT 16. RECEIVER SYNCHRONIZATION AND INPUT BANDWIDTH.....	48
EXHIBIT 17. MPE CALCULATIONS .....	49
APPENDIX A – Test Equipment List.....	50

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 4 of 53

APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO .....	51
APPENDIX C - Uncertainty Statement.....	52
APPENDIX D – EUT firmware instructions. ....	53

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 5 of 53

## EXHIBIT 1. INTRODUCTION

### 1.1 - Scope

References:	FCC Part 15, Subpart C, Section 15.247 and 15.209 RSS GEN and RSS 210 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	Year	Title
47 CFR, Parts 0-15 (FCC)	2009-10	Code of Federal Regulations - Telecommunications
RSS 210 Annex 8	2010	Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
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	2006-03 A1: 2006-09 A2: 2007-07	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus.
FCC ET Docket No. 99-231	2002	Amendment to FCC Part 15 of the Commission's Rules Regarding Spread Spectrum Devices.
ANSI C63.10	2009	American National Standard for testing Unlicensed Wireless Devices

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 6 of 53

### **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. Accreditation status can be verified at A2LA's web site: [www.a2la2.net](http://www.a2la2.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 in accordance with A2LA standards.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 7 of 53

## EXHIBIT 2. PERFORMANCE ASSESSMENT

### 2.1 - Client Information

Manufacturer Name:	Honeywell
Address:	1985 Douglas Drive, Golden Valley, MN 55422
Contact Name:	Dave Mulhouse

### 2.2 - Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	Thermostat
Model Number:	THX9321R1000 THX9421R5005
Serial Number:	50575015000487 (With Relays) 51133035000004 (No Relays)

### 2.3 - Associated Antenna Description

There are two antennas (Antenna A and Antenna B) of the same type used in the product. Both antennas are PCB trace with bar element. Signal is routed to the appropriate antenna via a switch.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 8 of 53



## 2.4 - EUT'S Technical Specifications

EUT Frequency Range (in MHz)	903.0 MHz – 926.4 MHz
RF Power in Watts (Radiated measurement)	
Minimum:	0.0095 Watts
Maximum:	0.0198 Watts
Max Conducted Output Power (in dBm)	11.2 dBm at 903.0 MHz
Field Strength at 3 meters	Antenna A: 108.2 dBμV/m Antenna B: 106.4 dBμV/m
Occupied Bandwidth (99% BW)	62.9 kHz
Type of Modulation	FSK
Emission Designator	62K9F1D
EIRP	19.8 milliWatts
Transmitter Spurious (worst case) at 3 meters	61.4 dBμV/m (1806 MHz)
Stepped (Y/N)	N
Step Value:	N/A
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Microprocessor Model # (if applicable)	MSP430F5524
Antenna Information	
Detachable/non-detachable	Non-Detacheable
Type	PCB trace with bar element
Gain (Measured over a conducting ground plane)	1.77dBi
EUT will be operated under FCC Rule Part(s)	Title 47 part 15.247
EUT will be operated under RSS Rule Part(s)	RSS 210
Modular Filing	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
Portable or Mobile?	Mobile

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 9 of 53

**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: 0.03942

☐ V/m ☐ A/m ☒ W/m<sup>2</sup>  
☐ Measured ☐ Computed ☒ Calculated

**2.5 - Product Description**

The device is a line powered thermostat with an integrated graphic color user interface; it provides temperature and humidity information. Depending on the model, it can also output relay logic to control HVAC equipment for residential and light commercial applications.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 10 of 53

## EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

### 3.1 - Climate Test Conditions

Temperature:	71° F
Humidity:	35%
Pressure:	739 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	YES
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(c), 15.209 & 15.205 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.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 11 of 53

### **3.3 - Modifications Incorporated In The EUT For Compliance Purposes**

☒ None

☐ Yes (explain below)

### **3.4 - Deviations & Exclusions From Test Specifications**

☒ None

☐ Yes (explain below)

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 12 of 53

## 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 Annex 8.

*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.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 13 of 53

## 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 C63.4-2003. 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. The EUT was operated in continuous transmit mode for final testing using power as provided by a variable AC power supply. The unit has the capability to operate on 3 channels, controllable via the EUT menu which is accessible through the touch screen display.

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 the EUT menu which is accessible through the touch screen display.

### **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.

Two models (THX9321R1000 and THXR5005) were tested. The radio portion on both models is identical. The only difference is the capability to output relay logic. In addition, measurements show that general emissions of both models are similar hence only data of the model with relay capabilities are presented.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 14 of 53

### **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, 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.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 15 of 53

## **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 (dB $\mu$ V/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 (dB $\mu$ V/m).**

As specified in 15.247 (d) and RSS 210 A8.2 (b), radiated emissions that fall within the restricted band described in 15.205(c) for FCC and section 2.2, 2.6 and 2.7 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 210 section 2.7.

Frequency (MHz)	3 m Limit $\mu$ V/m	3 m Limit (dB $\mu$ V/m)	1 m Limit (dB $\mu$ V/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 ( $\mu$ V/m to dB $\mu$ V/m):

$\text{dB}\mu\text{V/m} = 20 \log_{10} (100) = 40 \text{ dB}\mu\text{V/m}$  (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

500 $\mu$ V/m or 54.0 dB/ $\mu$ V/m at 3 meters

54.0 + 9.5 = 63.5 dB/ $\mu$ V/m at 1 meter

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 16 of 53



## 5.6 - Radiated Emissions Test Data Chart

3 Meter Measurements of Electromagnetic Radiated Emissions  
Frequency Range Inspected: 30 MHz to 10000 MHz

Manufacturer:	Honeywell					
Date(s) of Test:	January 1 <sup>st</sup> , 12 <sup>th</sup> , 13 <sup>th</sup> , February 1 <sup>st</sup> ,					
Project Engineer(s):	Khairul Aidi Zainal					
Test Engineer(s):	Shane Resmeiwer, Khairul Aidi Zainal, Peter Feilen					
Voltage:	24 VAC					
Operation Mode:	continuous transmit, modulated					
Environmental Conditions in the Lab:	Temperature: 71 °F Relative Humidity: 35 %					
EUT Power:	X	Single Phase 24VAC		3 Phase	VAC	
		Battery		Other: Bench DC supply		
EUT Placement:	X	80cm non-conductive table		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:

FREQ (MHz)	ANT	EUT	HEIGHT (m)	AZIMUTH (°)	Q.PEAK (dBµV/m)	LIMIT (dBµV/m)	MARGIN (dB)	NOTES
903.00	H	V	1.47	322	108.2	131.2	23.0	3
914.60	H	V	1.34	342	107.4	131.2	23.8	3
926.40	H	V	1.42	335	107.4	131.2	23.8	3
903.00	V	V	1.15	280	106.4	131.2	24.8	4
914.60	V	V	1.13	299	105.5	131.2	25.7	4
926.40	H	V	1.33	159	105.0	131.2	26.2	4

Notes:

1. H: Horizontal, V: Vertical, S: Side, F: Flat
2. Refer to exhibit 5.5 on explanation of how data is reported.
3. Antenna A.
4. Antenna B.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 17 of 53

## RADIATED EMISSIONS DATA CHART (continued)

### A. Antenna A

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

Antenna Polarization	Frequency (MHz)	Peak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (°)	EUT Orientation
Horizontal	1806	62.1	61.4	88.2	26.8	160.0	339	Vertical
	2709	Note 4						
	3612	Note 4						
	4515	Note 4						
Horizontal	5418	50.0	46.9	63.5	16.6	123.3	188	Vertical
Horizontal	6321	51.5	48.4	97.7	49.3	111.9	190	Vertical
Vertical	7224	52.4	48.8	97.7	48.9	115.0	68	Vertical
	8127	Note 4						
Vertical	9030	50.2	43.6	63.5	19.9	101.5	166	Vertical

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

Antenna Polarization	Frequency (MHz)	Peak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (°)	EUT Orientation
Horizontal	1829	61.6	60.9	87.4	26.5	159.0	339	Vertical
	2744	Note 4						
	3658	Note 4						
	4573	Note 4						
Horizontal	5488	49.1	46.2	96.9	50.7	113.2	179	Vertical
Vertical	6402	51.2	48.1	96.9	48.8	122.2	10	Vertical
Vertical	7317	50.4	45.5	63.5	18.0	105.9	62	Vertical
	8231	Note 4						
Vertical	9146	50.0	43.3	63.5	20.2	104.8	167	Vertical

#### Notes:

- Measurements above 4 GHz were made at 1 meters of separation from the EUT. The limits were adjusted to reflect this measurement distance.
- H: Horizontal, V: Vertical, S: Side, F: Flat
- Refer to exhibit 5.5 on explanation of how data is reported.
- Emissions buried within system noise floor.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 18 of 53

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

Antenna Polarization	Frequency (MHz)	Peak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (°)	EUT Orientation
Horizontal	1853	60.1	59.3	87.4	28.1	153.0	338	Vertical
	2779	Note 4						
	3706	Note 4						
	4632	Note 4						
Horizontal	5559	51.1	47.5	96.9	49.4	118.9	120	Vertical
Vertical	6485	50.8	46.6	96.9	50.3	118.3	15	Vertical
Vertical	7411	49.5	43.4	63.5	20.1	114.0	91	Vertical
	8338	Note 4						
Vertical	9264	50.7	42.8	96.9	54.1	100.0	178	Vertical

#### B. Antenna B

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

Antenna Polarization	Frequency (MHz)	Peak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (°)	EUT Orientation
Horizontal	1806	62.1	61.4	88.2	26.8	160.0	339	Vertical
	2709	Note 4						
	3612	Note 4						
	4515	Note 4						
Horizontal	5418	50.0	46.9	63.5	16.6	123.3	188	Vertical
Horizontal	6321	51.5	48.4	97.7	49.3	111.9	190	Vertical
Vertical	7224	52.4	48.8	97.7	48.9	115.0	68	Vertical
	8127	Note 4						
Vertical	9030	50.2	43.6	63.5	19.9	101.5	166	Vertical

#### 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, S: Side, F: Flat
3. Refer to exhibit 5.5 on explanation of how data is reported.
4. Emissions buried within system noise floor.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 19 of 53

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

Antenna Polarization	Frequency (MHz)	Peak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (°)	EUT Orientation
Vertical	1829	59.5	58.6	85.5	26.9	142.0	164	Vertical
	2744	Note 4						
	3658	Note 4						
	4573	Note 4						
Horizontal	5488	48.9	45.0	95.0	50.0	121.9	176	Vertical
Vertical	6402	51.4	47.2	95.0	47.8	123.6	9	Vertical
Vertical	7317	56.0	54.8	63.5	8.7	105.0	91	Vertical
	8231	Note 4						
Vertical	9146	49.9	42.8	63.5	20.7	102.7	186	Vertical

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

Antenna Polarization	Frequency (MHz)	Peak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (°)	EUT Orientation
Vertical	1853	55.8	55.7	85.0	29.3	119.0	286	Vertical
	2779	Note 4						
	3706	Note 4						
	4632	Note 4						
Horizontal	5558	51.4	48.8	94.6	45.8	118.1	114	Vertical
Vertical	6485	50.7	47.3	94.6	47.3	114.4	3	Vertical
Vertical	7411	57.0	56.1	63.5	7.4	110.0	81	Vertical
	8338	Note 4						
Vertical	9264	50.2	42.3	94.6	52.3	101.9	187	Vertical

**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, S: Side, F: Flat
3. Refer to exhibit 5.5 on explanation of how data is reported.
4. Emissions buried within system noise floor.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 20 of 53

## RADIATED EMISSIONS DATA CHART (continued)

The following table depicts the level of significant radiated emissions **other** than fundamentals and its harmonics:

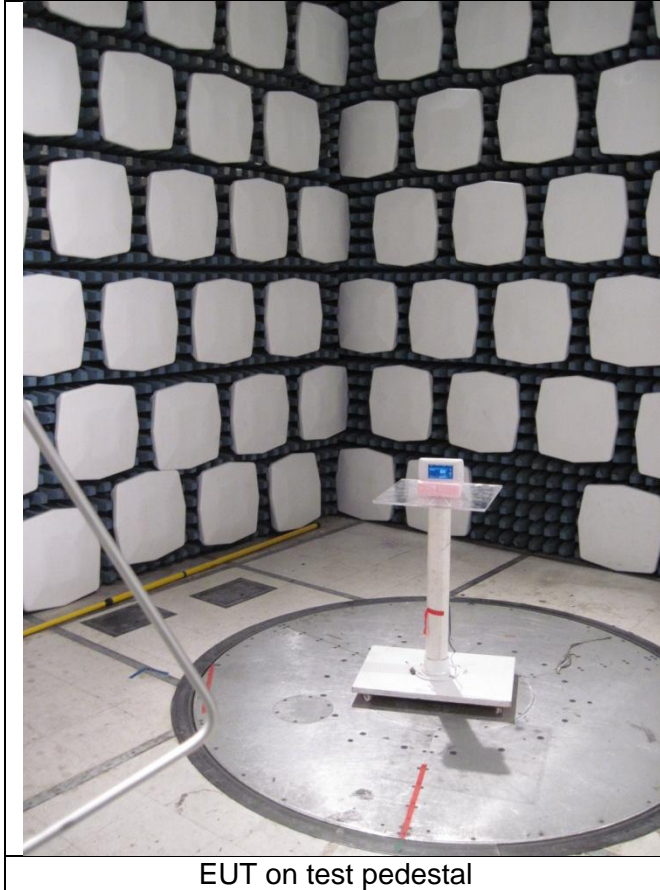
Frequency (MHz)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dBμV/m)	Quasi Peak Limit (dBμV/m)	Margin (dB)	Antenna Polarity	EUT orientation
67.9	1.00	0	26.6	40.0	13.4	V	V
60.1	1.00	0	26.3	40.0	13.7	V	V
176.9	1.88	0	30.1	43.5	13.4	V	V
298.1	1.00	0	26.1	46.0	19.9	H	V
841.0	1.00	0	31.9	46.0	14.1	H	V
825.9	1.00	0	27.7	46.0	18.3	V	V
971.4	1.00	0	23.2	54.0	30.8	V	V
962.7	1.00	0	30.9	54.0	23.1	V	V

### Notes:

1. Measurements below 4 GHz were made at a separation distance of 3 meters.
2. H: Horizontal, V: Vertical, S: Side, F: Flat
3. Refer to exhibit 5.5 on explanation of how data is reported.
4. Emissions listed in the table are independent of channel.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 21 of 53

## **5.7 - Test Setup Photo(s) - Radiated Emissions Test**

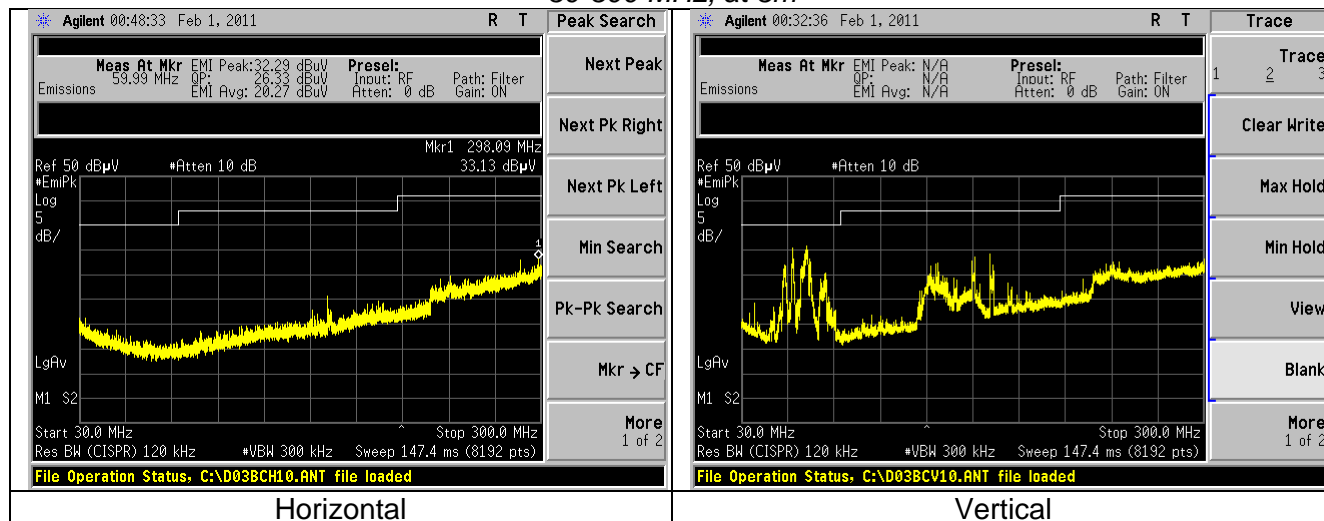


Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 22 of 53

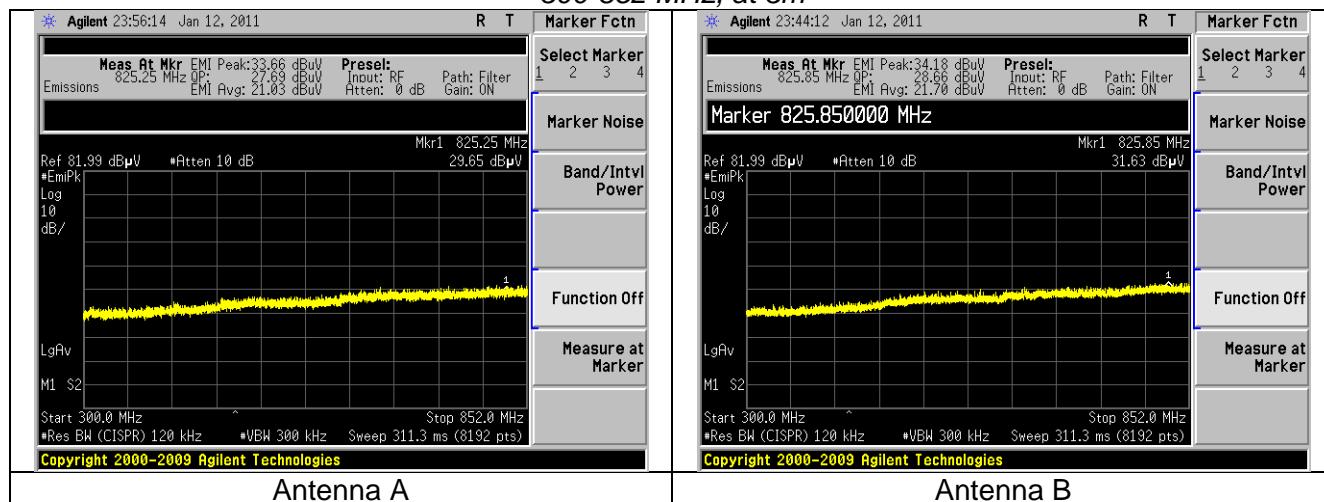
## 5.8 - Screen Captures - Radiated Emissions Test

These screen captures represent Peak Emissions. The signature scans shown here are representative of the worst case emissions.

30-300 MHz, at 3m



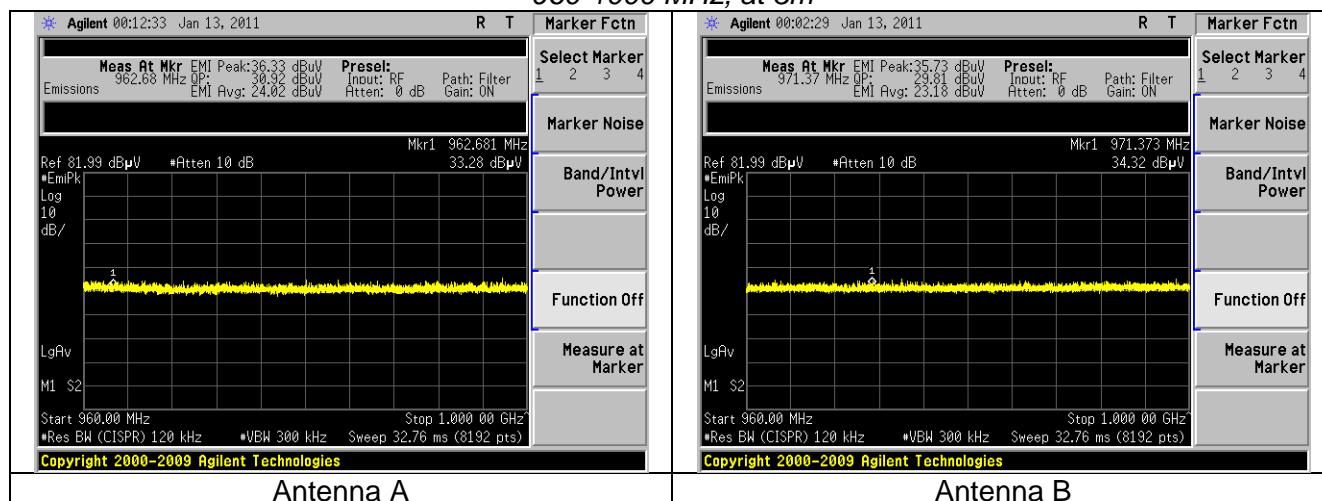
300-852 MHz, at 3m



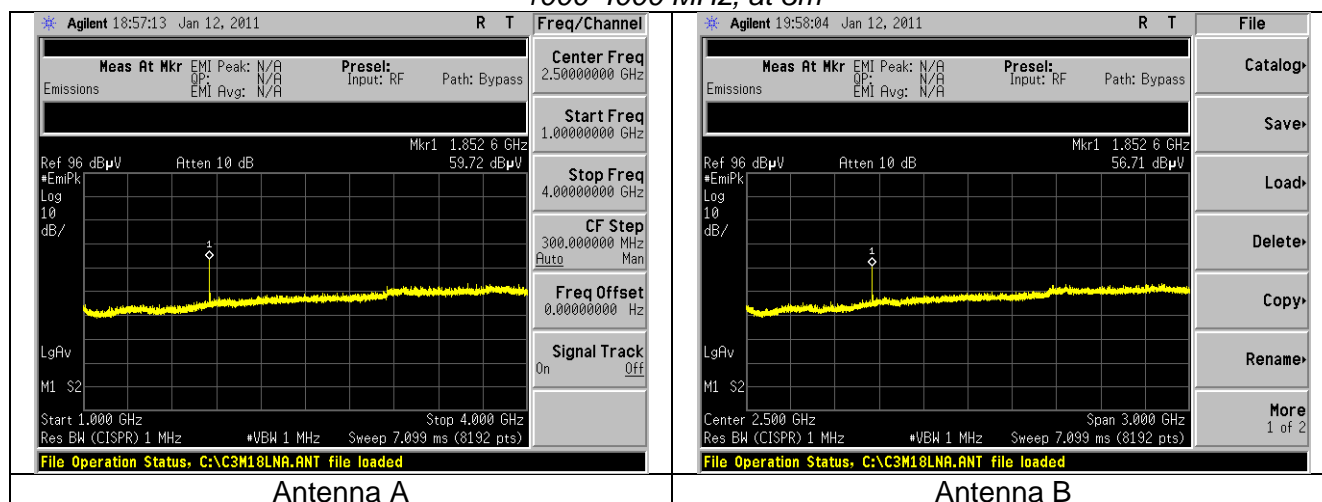
Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 23 of 53

## Screen Captures - Radiated Emissions Testing (continued)

### 960-1000 MHz, at 3m



### 1000-4000 MHz, at 3m

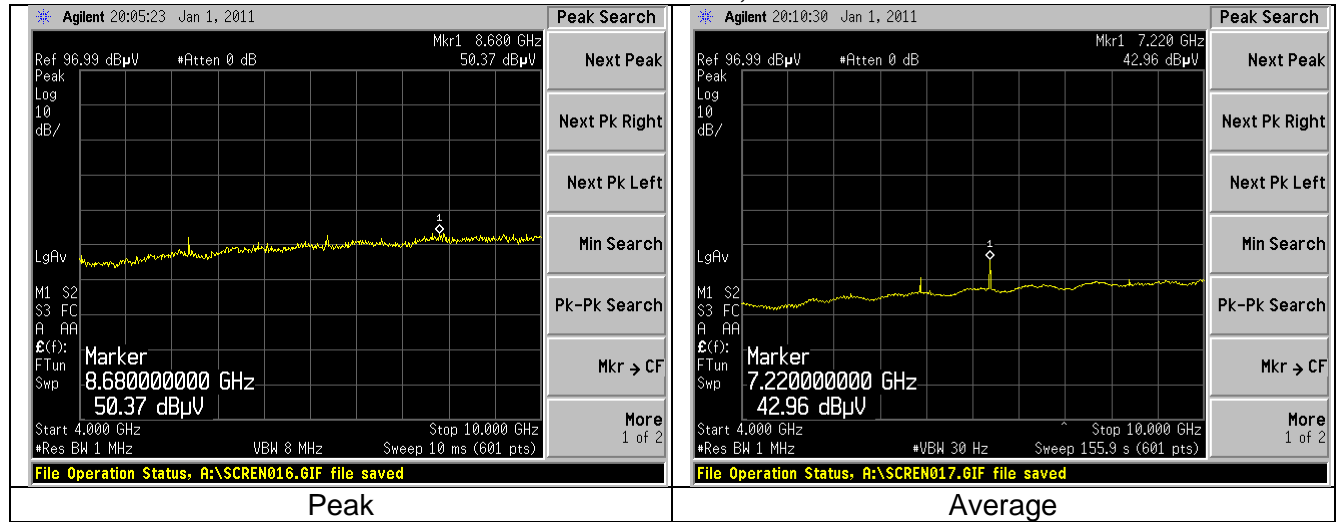


Note: The scan for the ranges of 852 – 903 MHz and 926 - 960 MHz are in Exhibit 8 (Band-edges)

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 24 of 53



# 4000-10000 MHz, at 1m



Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 25 of 53

## EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE

### **6.1 - Test Setup**

The test area and setup are in accordance with ANSI C63.4-2003 and with Title 47 CFR, FCC Part 15, Industry Canada RSS-210 and RSS GEN. The EUT was placed on a non-conductive fixture with a height of 80 cm above the reference ground plane. The EUT's power cable was plugged into a 50Ω (ohm), 50/250 μH Line Impedance Stabilization Network (LISN). The AC power supply of 24VAC was provided using a variable AC power supply and put through an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to the EMI Receiver. The EMCO LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

### **6.2 - Test Procedure**

The EUT was investigated in continuous modulated transmit mode for this portion of the testing. The appropriate frequency range and bandwidths were selected on the EMI Receiver, and measurements were made. The bandwidth used for these measurements is 9 kHz, as specified in CISPR 16-1, Section 1, Table 1, for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30 MHz. Final readings were then taken and recorded.

### **6.3 - Test Equipment Utilized**

A list of the test equipment and accessories utilized for the Conducted Emissions test is provided 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 cables are calibrated and checked periodically for conformance. The emissions are measured on an EMI Receiver, which has automatic correction for all factors stored in memory and allows direct readings to be taken.

### **6.4 - Test Results**

The EUT was found to **MEET** the Conducted Emission requirements of FCC Part 15.207 Conducted Emissions for an Intentional Radiator. See the Data Charts and Graphs for more details of the test results.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 26 of 53

## **6.5 - FCC Limits of Conducted Emissions at the AC Mains Ports**

Frequency Range (MHz)	Class B Limits (dB $\mu$ V)		Measuring Bandwidth
	Quasi-Peak	Average	
0.150 -0.50 *	66-56	56-46	RBW = 9 kHz VBW $\geq$ 9 kHz for QP VBW = 1 Hz for Average
0.5 – 5.0	56	46	
5.0 – 30	60	50	
* The limit decreases linearly with the logarithm of the frequency in this range.			

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 27 of 53

## 6.6 – Conducted Emissions Test Data Chart

Frequency Range inspected: 150 KHz to 30 MHz

Manufacturer:	Honeywell				
Date(s) of Test:	January 31 <sup>st</sup> 2011				
Test Engineer:	Khairul Aidi Zainal				
Voltage:	24 VAC				
Operation Mode:	continuous transmit, modulated				
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %				
Test Location:	x	AC Mains Test Site			Chamber
EUT Placed On:	x	40cm from Vertical Ground Plane			10cm Spacers
	x	80cm above Ground Plane			Other:
Measurements:		Pre-Compliance		Preliminary	x Final
Detector Used:		Peak	x	Quasi-Peak	x Average

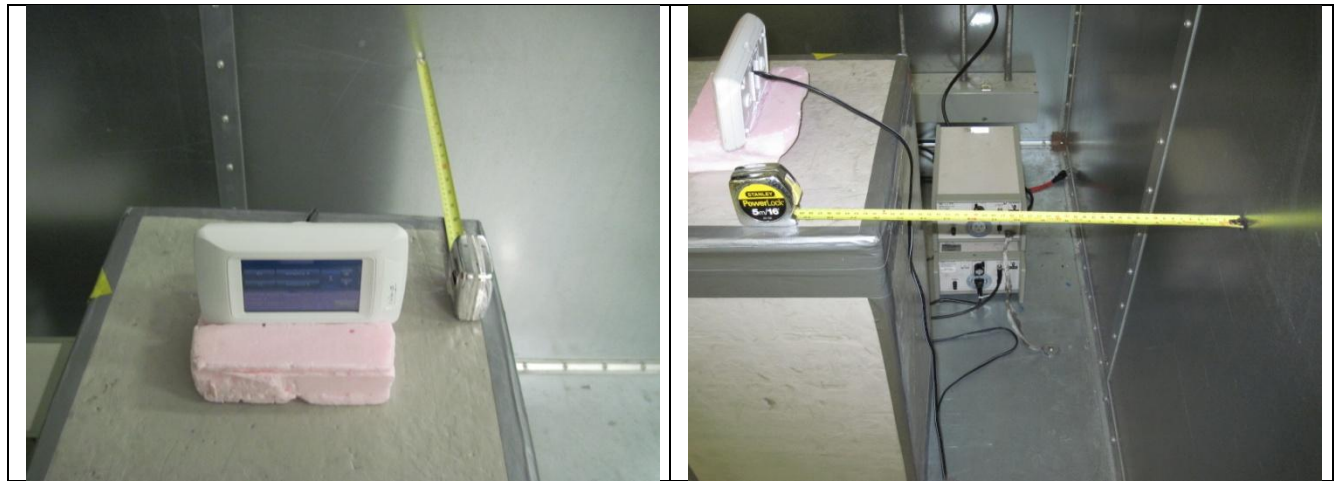
		QUASI-PEAK			AVERAGE		
Frequency (MHz)	Line	Reading (dBμV)	Limit (dBμV)	Margin (dB)	Reading (dBμV)	Limit (dBμ V)	Margin (dB)
0.159	1.0	52.0	65.5	13.5	40.9	55.5	14.6
0.317	1.0	46.6	59.8	13.2	36.5	49.8	13.3
0.477	1.0	43.5	56.4	12.9	32.3	46.4	14.1
0.159	2.0	52.7	65.5	12.8	41.6	55.5	13.9
0.318	2.0	47.5	59.8	12.3	36.4	49.8	13.4
0.914	2.0	38.2	56.0	17.8	26.6	46.0	19.4

Notes:

- 1) The EUT exhibited similar emissions across the Low, Middle and High channels tested.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 28 of 53

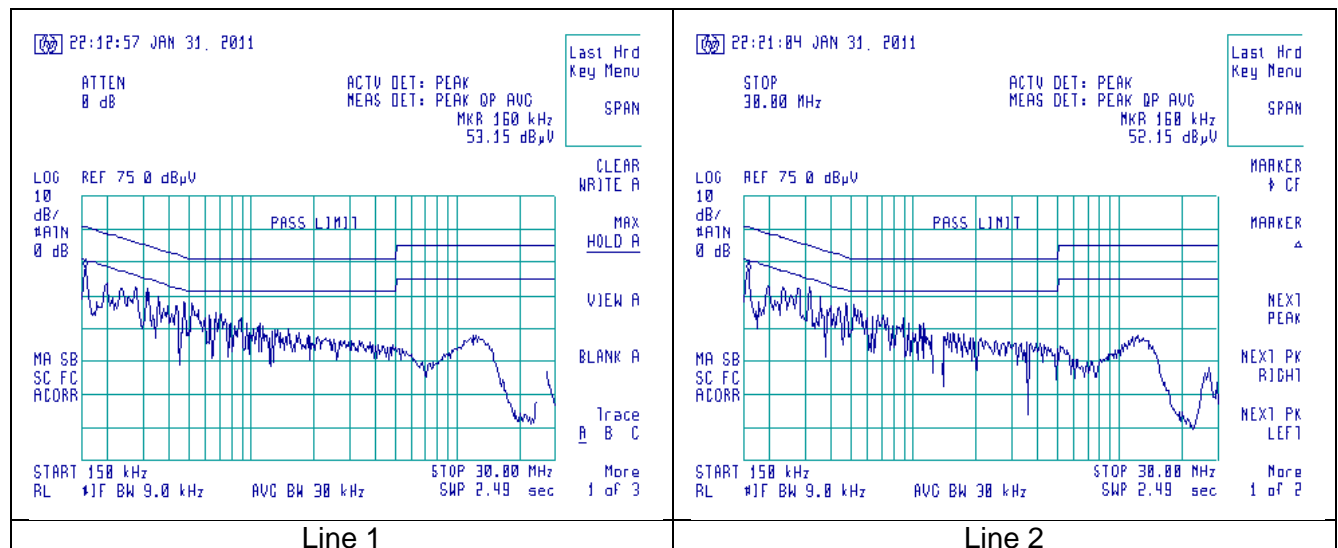
## 6.7 - Test Setup Photo(s) – Conducted Emissions Test



## 6.8 - Screen Captures – Conducted Emissions Test

These screen captures represent Peak Emissions. For conducted emission measurements, both a Quasi-Peak detector function and an Average detector function are utilized. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.207 and RSS GEN 7.2.2 (Table 2).

The signature scans shown here are from the middle channel chosen as being a good representative of channels.



Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 29 of 53

## 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.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 30 of 53

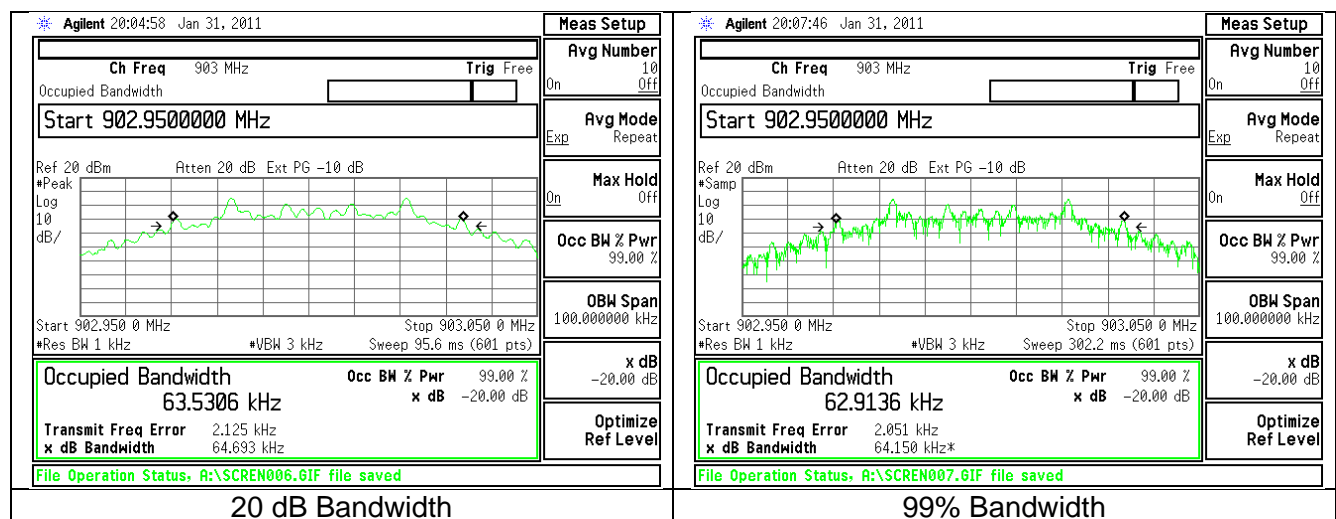
## 7.3 - Test Data

Occupied bandwidth (kHz)		
Channel	20dB	99%
903.0	64.7	62.9
914.6	64.7	62.9
926.4	64.7	62.9

The closest bandwidth to the 20dB limit of 500 kHz is 64.7 kHz which is 435.3 kHz below the limit.

## 7.4 - Screen Captures - Occupied Bandwidth

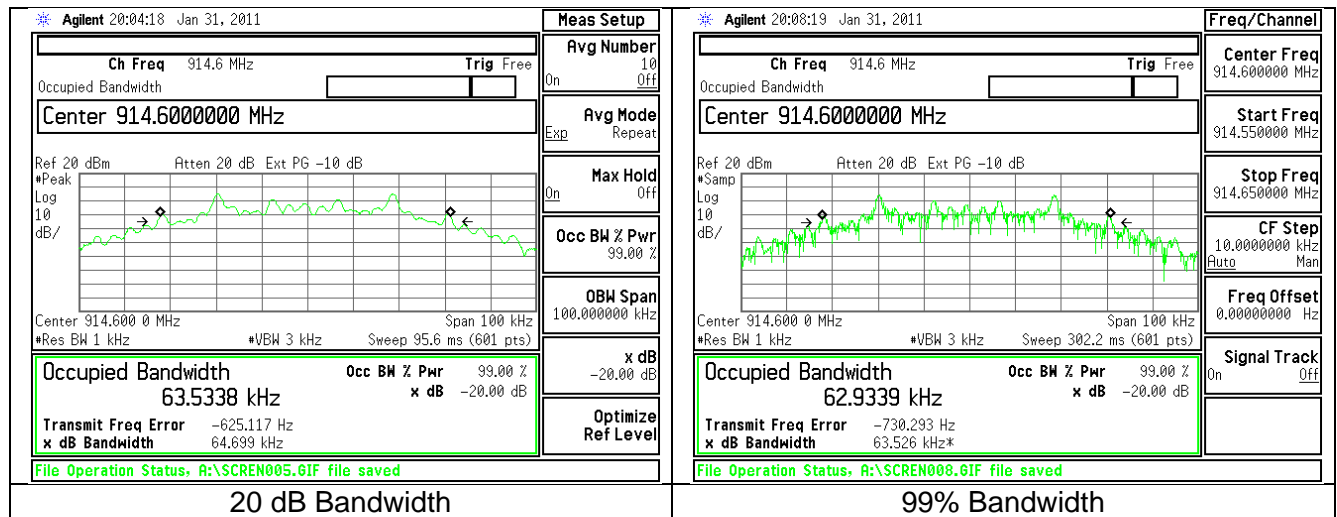
### A. Low channel



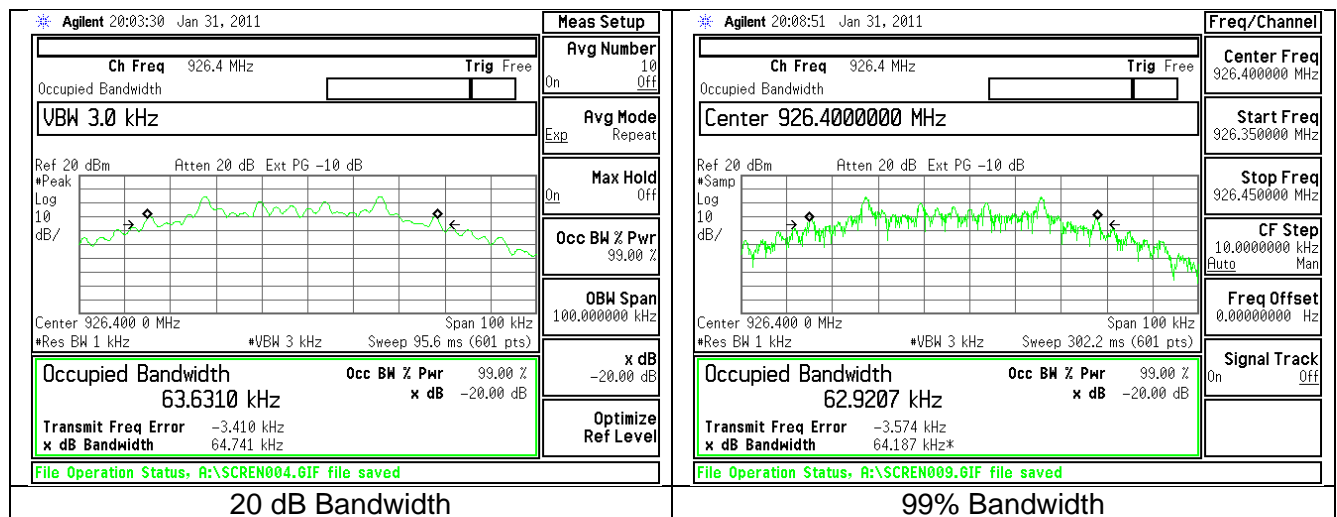
Note: In measuring the 20dB bandwidth, the measurement setup was set to maximum hold.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 31 of 53

## B. Mid channel



## C. High channel



Note: In measuring the 20dB bandwidth, the measurement setup was set to maximum hold.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 32 of 53



## EXHIBIT 8. BAND EDGE MEASUREMENTS

### **8.1 - Method of Measurements**

FCC 15.209(b) and 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 tables 2 and 3 of the same standard 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 both radiated and conducted. The radiated measurement was performed to satisfy FCC 15.209 and 15.205 while the conducted measurement of band-edge was performed to satisfy FCC 15.247(d).

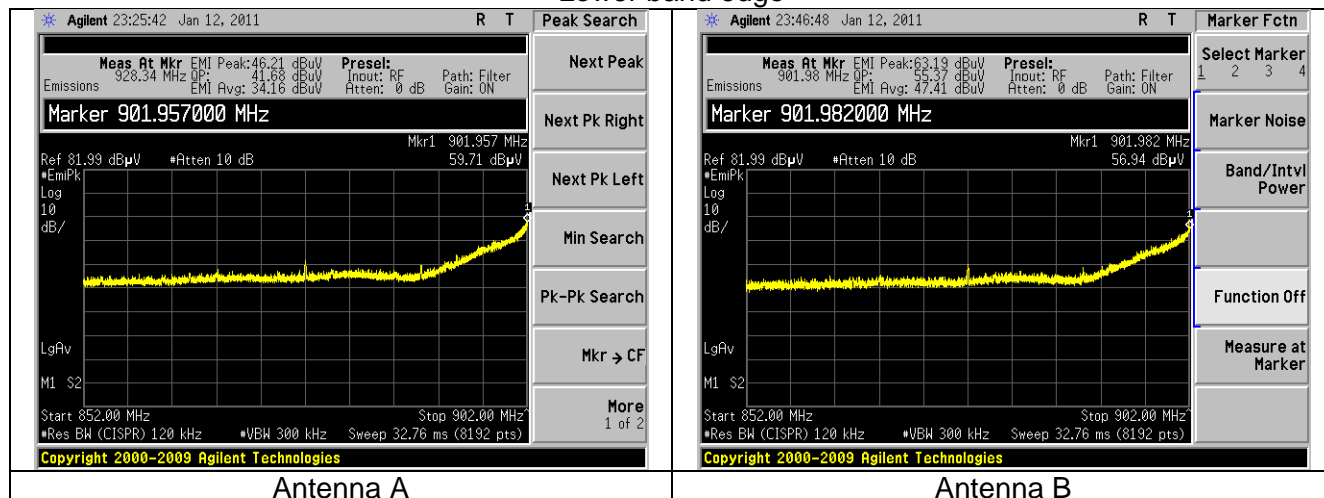
All radiated measurements were performed using receiver bandwidth specifications as outlined in ANSI 63.4. Conducted measurements of the spurious emission were performed with a measurement bandwidth of 100kHz.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 33 of 53

## 8.2. Band edge captures.

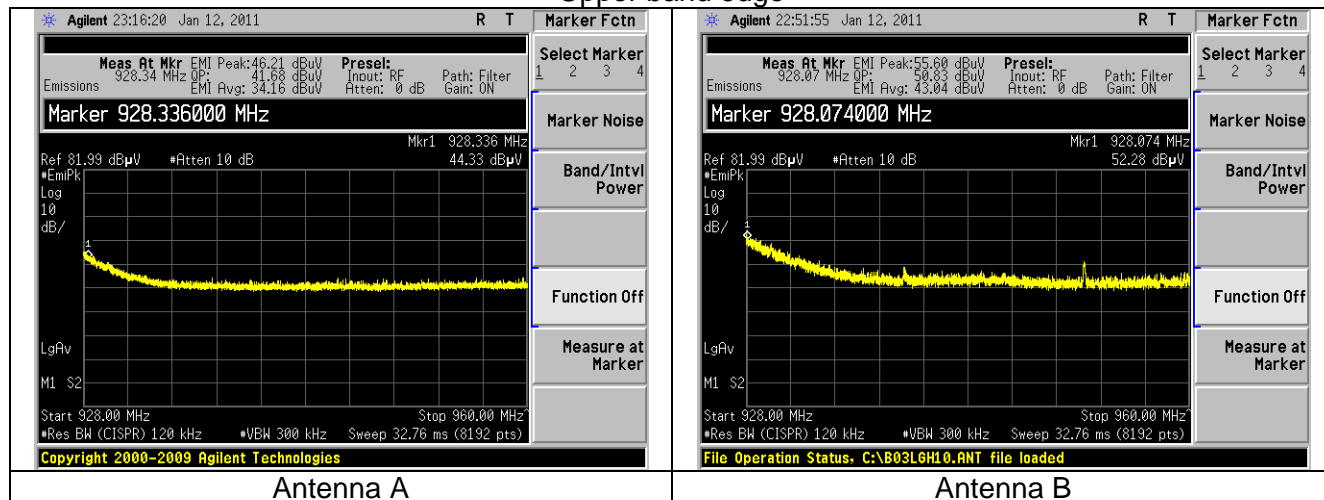
### 8.2.1 Radiated band edge.

#### Lower band edge



The limit at this band-edge is 20 dB below the fundamental.

#### Upper band edge

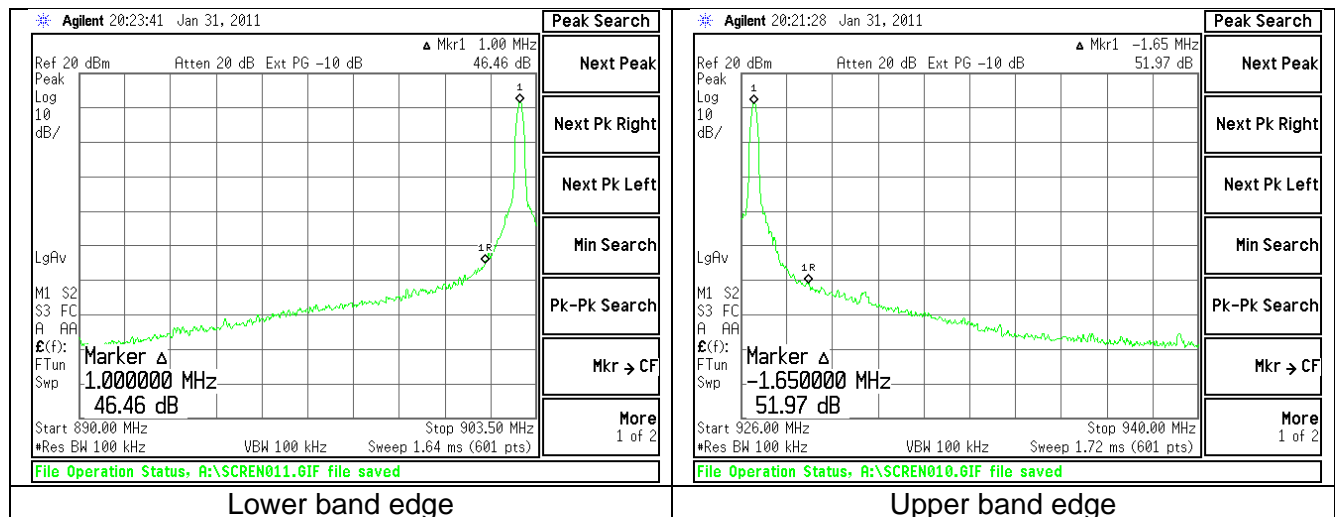


The limit at this band-edge is 20 dB below the fundamental.

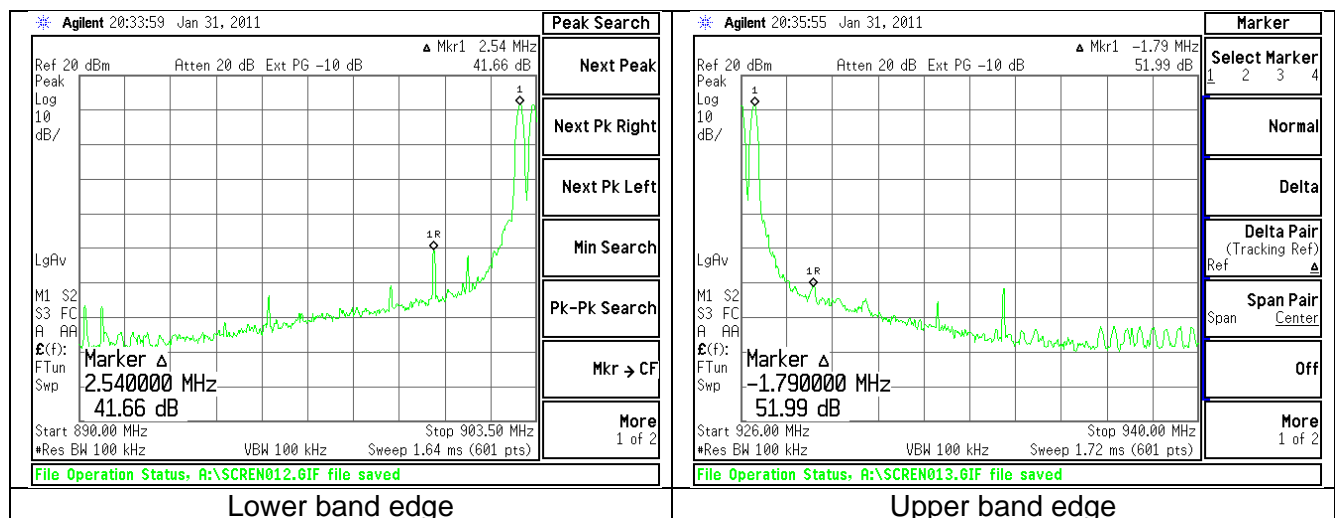
Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 34 of 53

## 8.2.2 Conducted band edge.

### A. Continuously transmitting and modulated.



### B. Hopping mode.



Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 35 of 53

## 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.

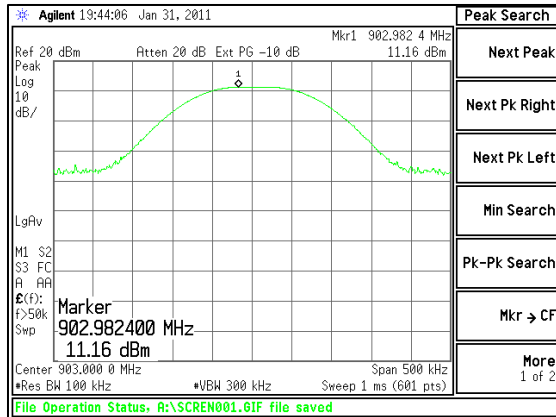
### **9.2 - Test Data**

Chan (MHz)	Power (dBm)	Limit (dBm)	Margin (dB)
903.0	11.2	30.0	18.8
914.6	11.1	30.0	18.9
926.4	10.9	30.0	19.1

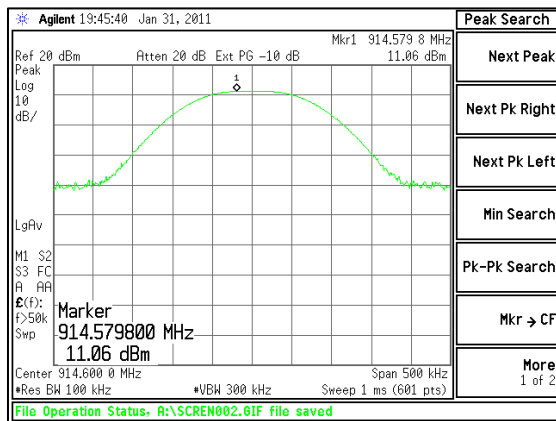
Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 36 of 53

## 9.4 - Screen Captures - Power Output (Conducted)

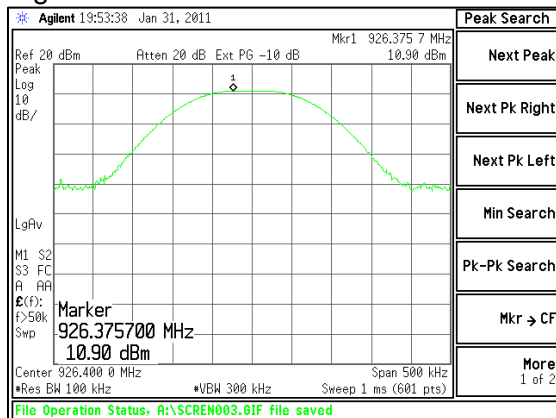
### A. Low channel



### B. Middle channel



### C. High channel



Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 37 of 53

## 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.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 38 of 53

### **10.3 - Test Data**

	Channel low	Channel middle	Channel high
Fundamental	10.9	11.1	10.9
2 <sup>nd</sup> Harmonic	-41.1	-42.1	-46.3
3 <sup>rd</sup> Harmonic	-55.7	-53.1	-56.2
4 <sup>th</sup> Harmonic	Note 2	Note 2	Note 2
5 <sup>th</sup> Harmonic	Note 2	Note 2	Note 2
6 <sup>th</sup> Harmonic	-76.1	-76.4	-76.4
7 <sup>th</sup> Harmonic	-55.8	-54.9	-55.6
8 <sup>th</sup> Harmonic	-51.0	-52.3	-52.0
9 <sup>th</sup> Harmonic	-67.0	-69.0	-67.4
10 <sup>th</sup> Harmonic	-63.9	-61.3	-60.4

**Note:**

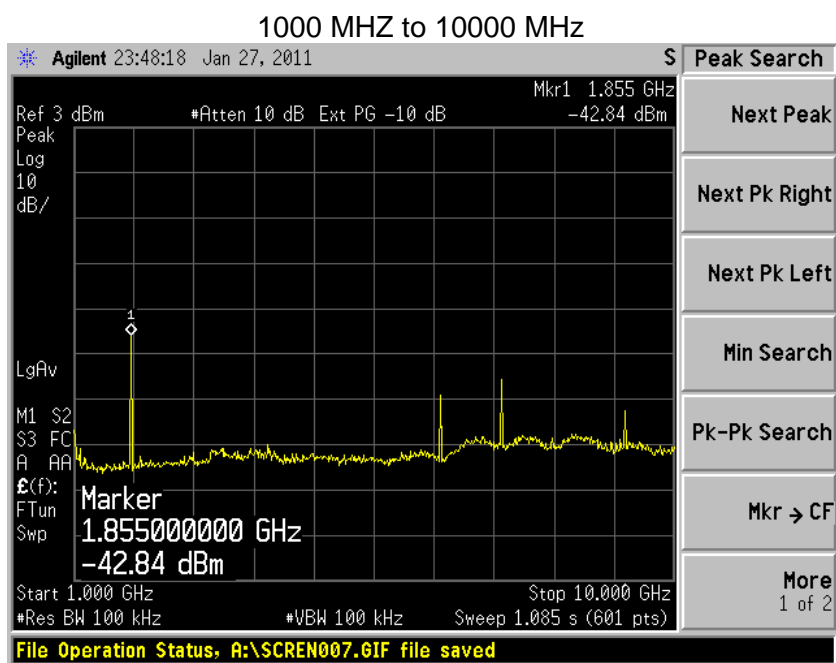
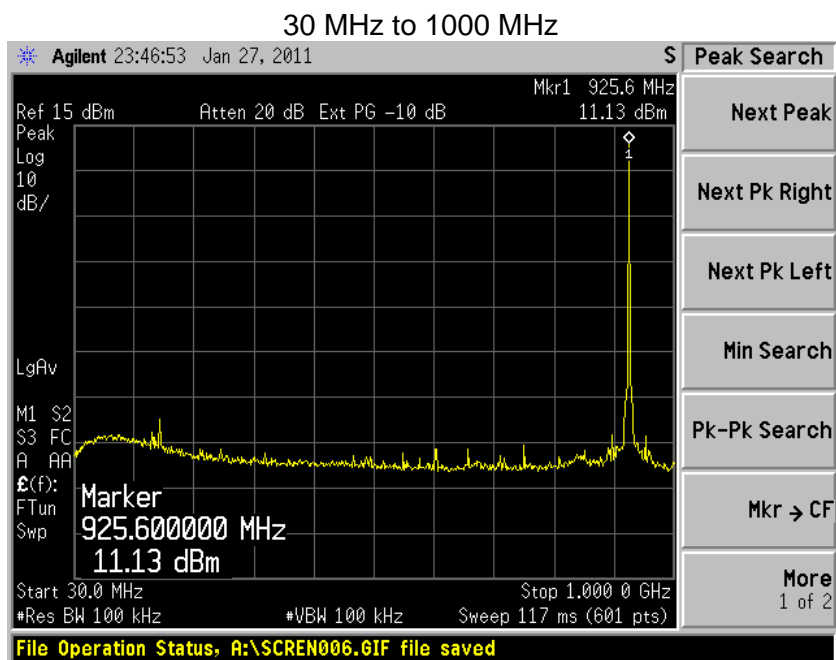
1. All reported data are in dBm.
2. Spurious emission buried within system noise floor.

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

Freq(MHz)	Chan	level(dBm)
169.20	MID	-49.4
169.20	HIGH	-51.6
169.20	Low	-50.4

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 39 of 53

## 10.4 – Screen Captures – Spurious Radiated Emissions



Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 40 of 53



## 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 a variable AC power supply and was varied  $\pm 15\%$  from the nominal.

20.4 VAC		24.0 VAC		27.6 VAC	
Power (dBm)	Frequency (Hz)	Power (dBm)	Frequency (Hz)	Power (dBm)	Frequency (Hz)
11.2	903017600	11.2	903017600	11.2	902982000
11.1	914580700	11.1	914581100	11.1	914580700
11.0	926415100	11.0	926376900	11.0	926376500

The table below shows the frequency drift on each channel:

Channel	max	min	freq drift (Hz)
LOW	903017600	902982000	35600
MIDDLE	914581100	914580700	400
HIGH	926415100	926376500	38600

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.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 41 of 53

## EXHIBIT 12. CHANNEL PLAN AND SEPARATION

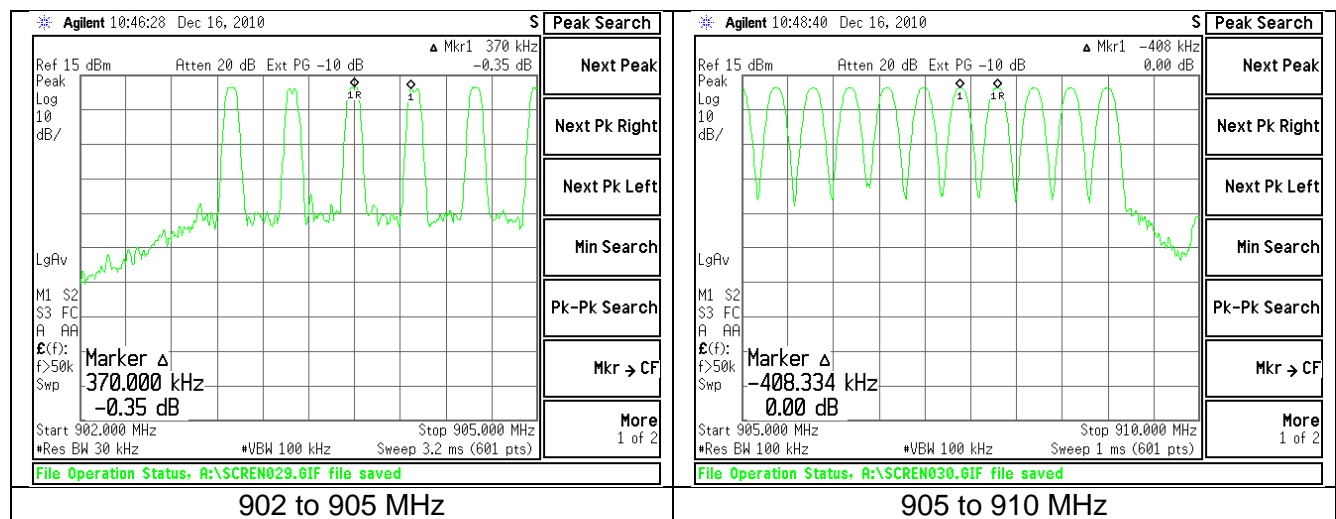
A spectrum analyzer was used with a resolution bandwidth of 100 kHz and 30kHz (when appropriate) to measure the channel separation of the EUT.

The minimum and maximum channel-separations measured for this device are 600 kHz and 320 kHz respectively. The maximum 20dB bandwidth of the device, as reported in the previous section is 64.7kHz. The following plots describe this spacing, and also establish the channel separation and plan.

This EUT also satisfies the minimum number of hopping channels which is 50.

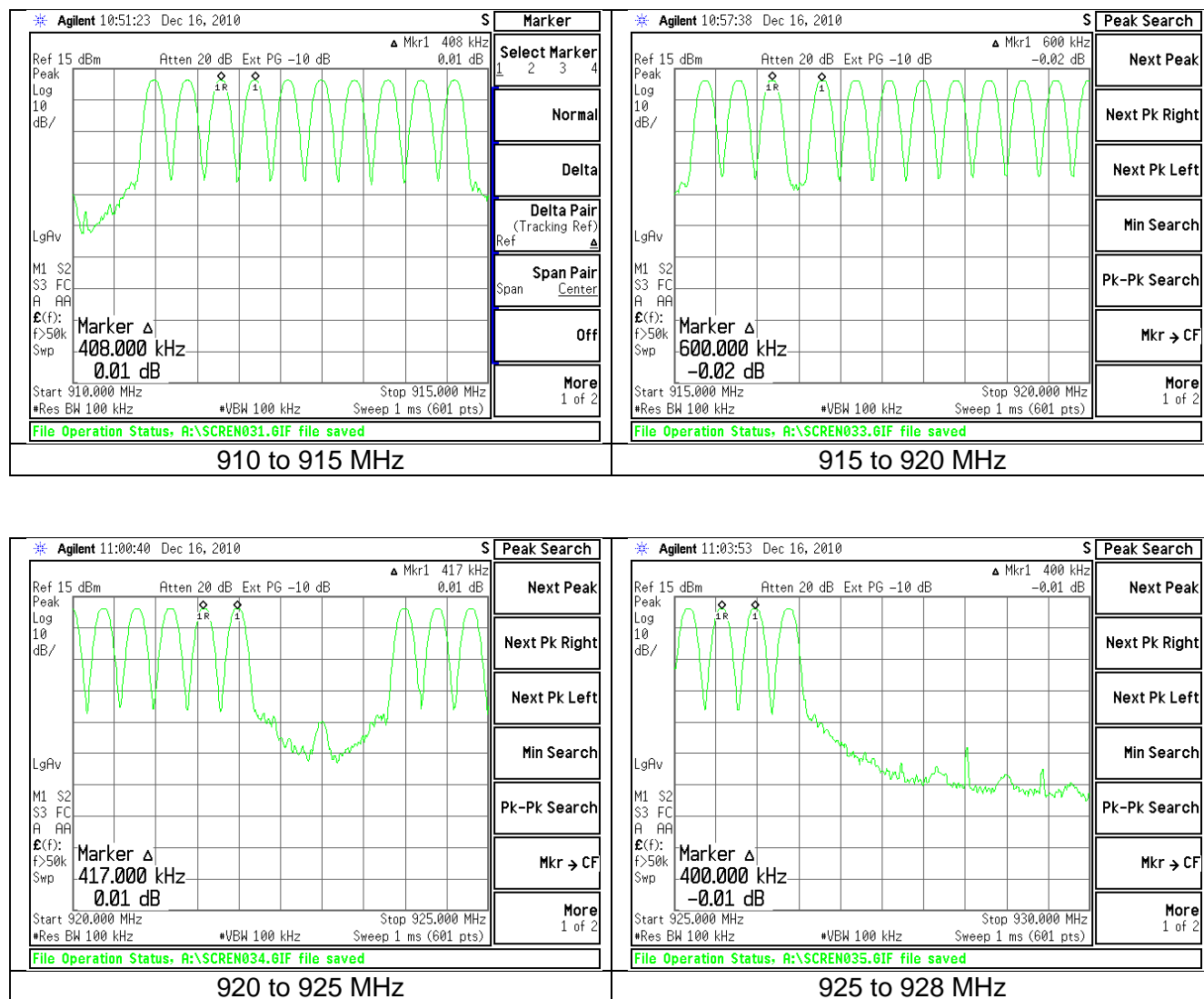
RANGE (MHz)	# OF CHANS
902-905	5.5
905-910	10.5
910-915	10.0
915-920	11.5
920-925	8.5
925-930	4.0

### 12.1 - Screen Captures – Channel Separation



Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 42 of 53

## Screen Captures – Channel Separation (continued)

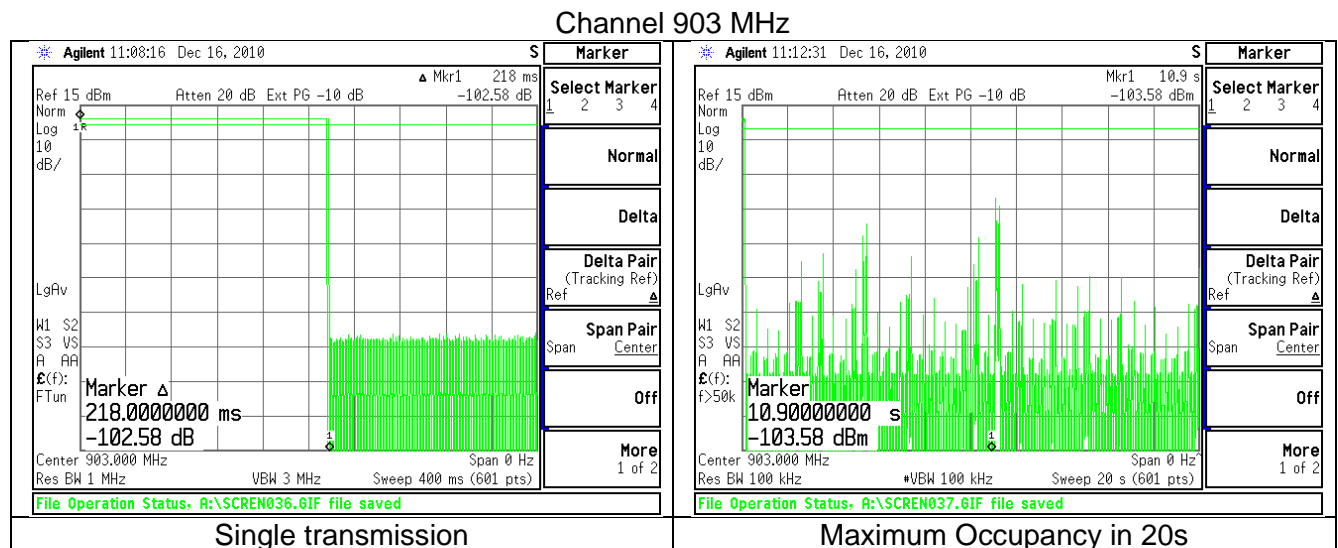


Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 43 of 53

## EXHIBIT 13. CHANNEL OCCUPANCY.

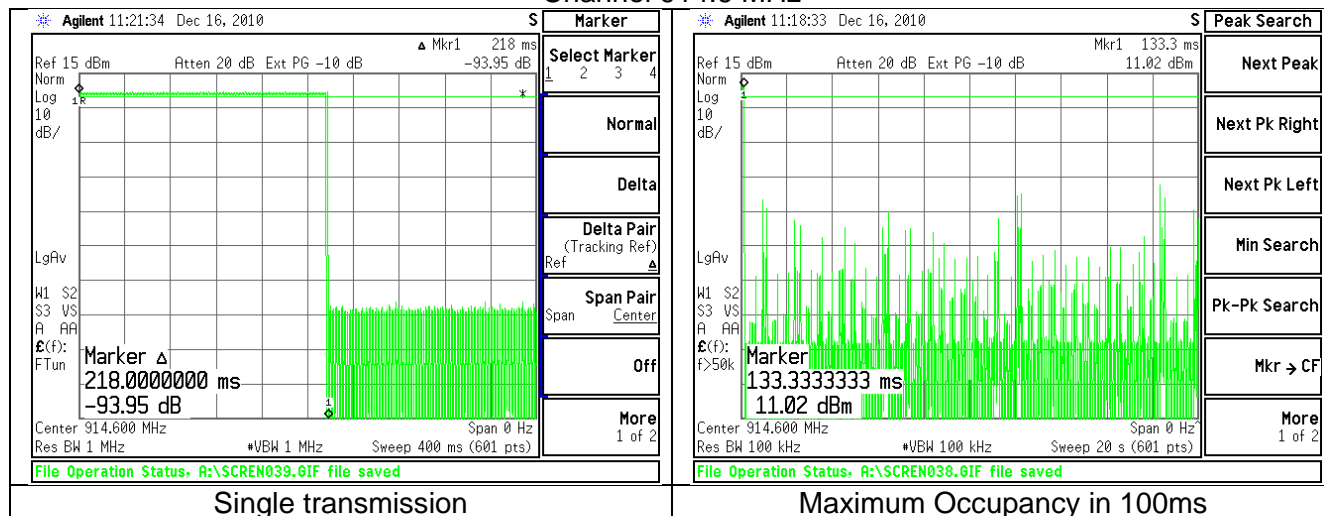
Part 15.247(a)(1)(iii) requires an average channel occupancy, for this device, of no more than 400 milliseconds in a 20second window .The channel occupancy for this EUT was measured using a spectrum analyzer, set to zero-span at the frequency of interest. With the analyzer in peak-hold mode, the transmission 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.

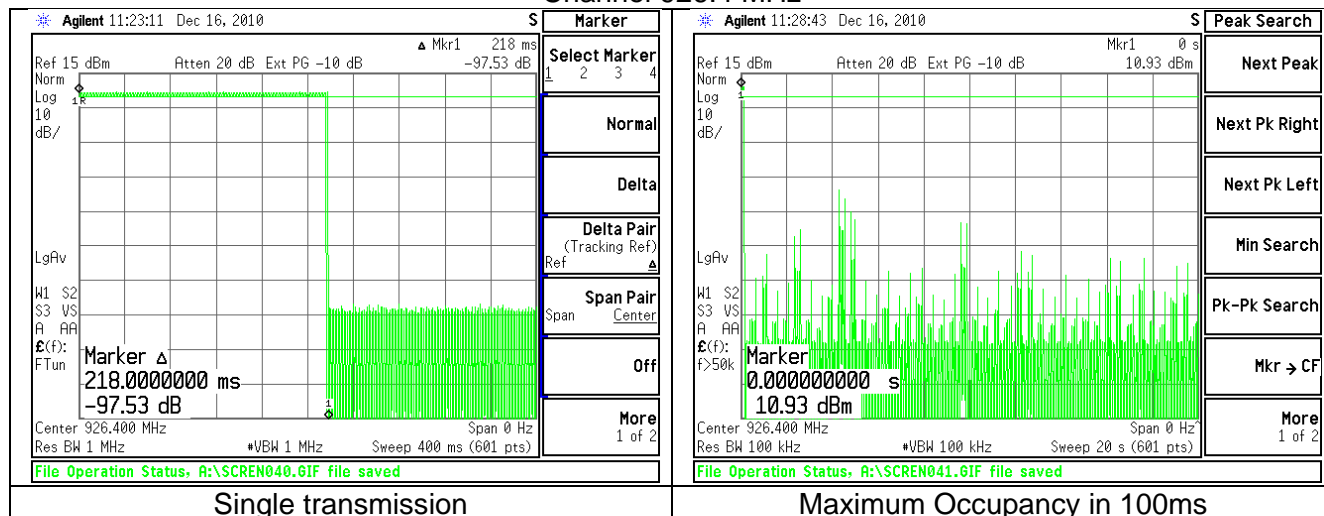


Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 44 of 53

### Channel 914.6 MHz



### Channel 926.4 MHz



Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 45 of 53

## EXHIBIT 14. EQUAL CHANNEL USAGE

Note: This section is provided by the manufacturer.

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

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.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 46 of 53

## EXHIBIT 15. PSEUDORANDOM HOPPING SEQUENCE.

Note: This section is provided by the manufacturer.

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.

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.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 47 of 53

## 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.

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 48 of 53



## EXHIBIT 17. MPE CALCULATIONS

The following MPE calculations are based on a measured ERP of 108.2.1 dBμV/m at 3m and conducted RF power of +11.2 dBm as presented to the antenna. The calculated gain of this antenna, based on the ERP measurements (over a conducting ground plane) is 1.77 dBi.

<u>Prediction of MPE limit at a given distance</u>			
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:	11.20	(dBm)	
Maximum peak output power at antenna input terminal:	13.183	(mW)	
Antenna gain(typical):	1.77	(dBi)	
Maximum antenna gain:	1.503	(numeric)	
Prediction distance:	20	(cm)	
Prediction frequency:	915	(MHz)	
MPE limit for uncontrolled exposure at prediction frequency:	0.6	(mW/cm <sup>2</sup> )	
Power density at prediction frequency:	0.003942	(mW/cm <sup>2</sup> )	
Margin of Compliance at	20	cm =	21.8 dB

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 49 of 53

## APPENDIX A – Test Equipment List



**LS RESEARCH LLC**  
Wireless Product Development  
Equipment Calibration

Date : 7-Jan-2011

Type Test : AC Mains Emissions

Job # : C-1081

Prepared By: Aidi

Customer : Honeywell

Quote #: 310365

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 960072	Transient Limiter	HP	11947A	3107A02515	10/8/2010	10/8/2011	Active Calibration
3	AA 960008	LISN	EMCO	3816/2NM	9701-1057	1/4/2011	1/4/2012	Active Calibration



**LS RESEARCH LLC**  
Wireless Product Development  
Equipment Calibration

Date : 7-Jan-2011

Type Test : Antenna port conducted measurements

Job # : C-1081

Prepared By: Aidi

Customer : Honeywell

Quote #: 310365

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	6/4/2010	6/4/2011	Active Calibration



**LS RESEARCH LLC**  
Wireless Product Development  
Equipment Calibration

Date : 7-Jan-2011

Type Test : Radiated Emissions

Job # : C-1081

Prepared By: Aidi

Customer : Honeywell

Quote #: 310365

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960146	Std. Gain Horn Ant. w/preamp	Adv. Micro	WLA622-4	123001	10/13/2010	10/13/2011	Active Calibration
2	EE 960156	RF Preselector	Agilent	N9039A	MY46520110	6/7/2010	6/7/2011	Active Calibration
3	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48250225	6/7/2010	6/7/2011	Active Calibration
4	AA 960150	Bicon Antenna	ETS	3110B	0003-3346	10/19/2010	10/19/2011	Active Calibration
5	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	10/19/2010	10/19/2011	Active Calibration
6	AA 960158	Double Ridge Horn Antenna	EMCO	3117	109300	8/19/2010	8/19/2011	Active Calibration
7	EE 960159	0.8 - 21GHz LNA	Mini-Circuits	ZVA-213X-S+	740411007	8/19/2010	8/19/2011	Active Calibration
8	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	11/9/2010	11/9/2011	Active Calibration

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 50 of 53

## APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO

STANDARD #	DATE	Am. 1	Am. 2		STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2003				IEC 61000-4-4	2004-07	2010-10	
ANSI C63.10	2009				IEC 61000-4-5	2005-11		
CISPR 11	2009-05	2009-12 P			IEC 61000-4-6	2008-10		
CISPR 12	2007-05				IEC 61000-4-8	2009-09		
CISPR 14-1	2005-11	2008-11			IEC 61000-4-11	2004-03		
CISPR 14-2	2001-11	2001-11	2008-05		IEC 61000-6-1	2005-03		
CISPR 16-1-1 Note 1	2010-01				IEC 61326-1	2006-06		
CISPR 16-1-2 Note 1	2003	2004-04	2006-07		ISO 14982	1998-07		
CISPR 22	2008-09				MIL Std. 461E	1999-08		
CISPR 24	1997-09	2001-07	2002-10		RSS GEN	2010-12		
EN 55011	2009				RSS 119	2007-06		
EN 55022	2006	2007			RSS 131	2003-07		
EN 60601-1-2	2007-03				RSS 136	2002-10		
EN 61000-3-2	2006-05				RSS 137	2009-02		
EN 61000-3-3	2008-12				RSS 210	2010-12		
EN 61000-4-2	2009-05				RSS 213	2005-12		
EN 61000-4-3	2006-07	2008-05			RSS 243	2010-02		
EN 61000-4-4	2004				RSS 310	2007-06		
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	2009							
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					

Note 1: Test not on LSR Scope of Accreditation.

P=Project FD= Final Draft

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 51 of 53

## **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

<b>Measurement Type</b>	<b>Particular Configuration</b>	<b>Uncertainty Values</b>
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

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 52 of 53

## **APPENDIX D – EUT firmware instructions.**

### **Instructions for Alpha XTR software operation**

Code used:

alpha version 4 XTR (appears as 0.248 in equipment status)

alpha debug TI code 9.31.04 (this will not display while using the XTR code)

From the home screen press the 'Menu' button in the top right corner.

Press the down arrow until 'Self test' is shown and press it.

Press 'RF XTR' button.

This will get you to the XTR test menu and has 4 different modes to choose from:

#### **Rx Mode**

This is standard receive mode and will allow you to chose antenna A or B.

While in this mode the device will be able to synch with the Perl test script and reply to the messages contained in it.

#### **Tx Mode**

Is this mode the device transmits FSK with automatic changing frequency and antenna every 8 seconds. The pattern is as follows.

Antenna A at 903.999Mhz

Antenna B at 903.399Mhz

Antenna A at 914.196Mhz

Antenna B at 914.596Mhz

Antenna A at 925.994Mhz

Antenna B at 926.394Mhz

This pattern will loop continuously.

#### **Tx Mode (manual)**

This mode will allow you to choose Transmit or Receive mode, Antenna A or B, and a specific channel from the following:

0 = 903.999Mhz

1 = 914.196Mhz

2 = 925.994Mhz

#### **Tx Mode (fast)**

This mode is transmit only and will hop frequency at 1 second intervals.

Antenna can be changed by pressing antenna A or B buttons.

Pressing 'Hold' will cause the next hop to be delayed until one of the following buttons is pressed.

Pressing 'Cont' resumes hopping in sequential order.

Pressing 'Random' resumes hopping in pseudo-random order.(press twice if in hold)

NOTE: antenna A activates the vertical (side) antenna and B is the horizontal (top) antenna

Prepared For: Honeywell	EUT: Thermostat	LS Research, LLC
Report #310365	Model #: THX9321R1000 THX9421R5005	Template: 15.247 FHSS template
LSR Job #:C-1081	Serial #: 50575015000487 (With Relays) 51133035000004 (No Relays)	Page 53 of 53