

LS Research, LLC

W66 N220 Commerce Court • Cedarburg, WI 53012 • USA

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www.lsr.com

ENGINEERING TEST REPORT # 308186 TX v2

Compliance Testing of:

Home Heartbeat Temperature Sensor

Model # 70D5015G01

Test Date(s):

June 25, 27, 30; July 2 & 6, 2008

Prepared For:

Eaton Corporation

Attn.: Dhananjay Lal

170 Industry Drive

Pittsburgh, PA 15275

In accordance with:

Federal Communications Commission (FCC)

Part 15, Subpart C, Section 15.247

**Digital Modulation Transmitters (DTS) Operating in the
Frequency Band 2400 MHz – 2483.5 MHz**

This Test Report is issued under the Authority of:

Khairul Aidi Zainal, Sr. EMC Engineer

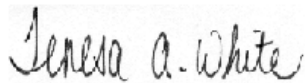


Signature:

Date: Sept. 3, 2008

Test Report Reviewed by:

Teresa A. White, Quality Manager

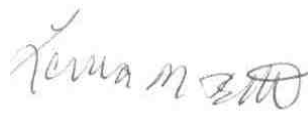


Signature:

Date: Sept. 3, 2008

Tested by:

Laura Bott, EMC Engineer



Signature:

Date: Sept. 3, 2008

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LSC Revision Control

Date	Revision #	Revised By
9-06-06	2.0	AS/TAW

EXHIBIT 1. INTRODUCTION

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 2400 MHz – 2483.5 MHz
Test Procedures:	Both conducted and radiated emissions measurements were performed 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 from 9 kHz to 40 GHz.
Environmental Classification:	<ul style="list-style-type: none"> • Commercial, Industrial or Business • Residential

1.2 NORMATIVE REFERENCES

Publication	Year	Title
47 CFR, Parts 0-15 (FCC)	2005	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	2003	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.
FCC Procedures	2005, 03-23	Measurement of Digital Transmission Systems operating under Section 15.247.

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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.

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EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 CLIENT INFORMATION

Manufacturer Name:	Eaton Corporation
Address:	170 Industry Drive Pittsburgh, PA 15275
Contact Person:	Dhananjay Lal 412.787.6560 DhananjayLal@eaton.com

2.2 EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information has been supplied by the applicant.

Product Name:	HOMEHeartbeat Temperature Sensor
Model Number:	70D5015G01
Serial Number:	n/a

2.3 ASSOCIATED ANTENNA DESCRIPTION

The antenna used on the Home Heartbeat Temperature Sensor is a 2.45 GHz ceramic chip antenna manufactured by Johanson Technology.

Part Number: 2450AT18A100

Frequency Range: 2400-2500 MHz

Peak Gain: 0.5 dBi

Average Gain: -0.5 dBi

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2.4 EUT'S TECHNICAL SPECIFICATIONS

Additional Information:

Frequency Range (in MHz)	2400-2483.5
RF Power in Watts	0.026 Watts
Conducted Output Power (in dBm)	14.08 dBm
Field Strength (and at what distance)	107.6 dB μ V/m at 3 meters
Occupied Bandwidth (99% BW) kHz	2708 kHz
Type of Modulation	O-QPSK
Emission Designator	2M70G1D
EIRP (in mW)	28.71 mW
Transmitter Spurious (worst case)	66.80 dB μ V/m at 1 meter
Frequency Tolerance %, Hz, ppm	n/a
Microprocessor Model # (if applicable)	Atmel ATmega64L-8MI
Antenna Information	
Detachable/non-detachable	non-detachable
Type	chip
Gain (in dBi)	0.5 dBi
EUT will be operated under FCC Rule Part(s)	15.247
Modular Filing	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No

RF Technical Information:

Type of Evaluation (check one)	<input type="checkbox"/>	SAR Evaluation: Device Used in the Vicinity of the Human Head
	<input type="checkbox"/>	SAR Evaluation: Body-worn Device
	<input checked="" type="checkbox"/>	RF Evaluation

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

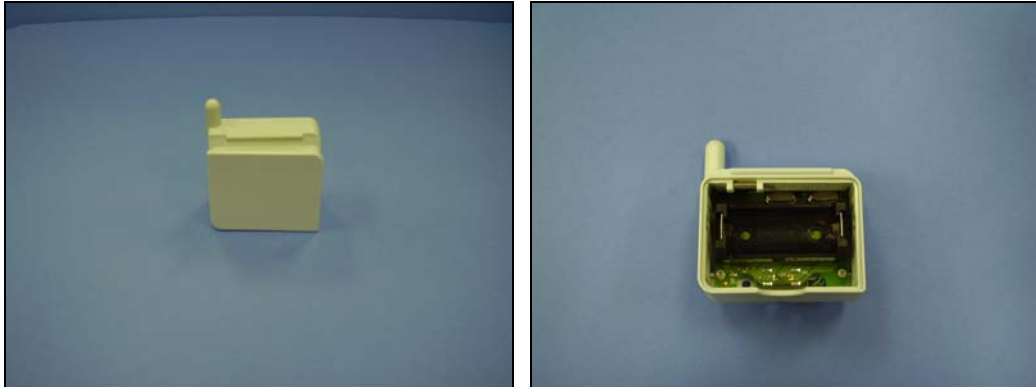
- Evaluated against exposure limits: General Public Use Controlled Use
- Duty Cycle used in evaluation: 4 %
- Standard used for evaluation: OET 65
- Measurement Distance: 3 m
- RF Value: 0.2399 V/m A/m W/m²
 Measured Computed Calculated

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2.5 PRODUCT DESCRIPTION

This device is part of the Home Heartbeat monitoring system. It acts as a temperature sensor to alert the user of unexpected temperature changes in the home. This battery operated sensor will provide a message burst. The unit operates on a self contained 3.0 V Lithium (CR123) battery. It operates in the 2.4 GHz ISM frequency band with 5 MHz channel spacing. The transmitter uses IEEE 802.15.4 modulation format, so all data is generated on board.

PHOTO (Optional)



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EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

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	Yes
15.247(a)(2)	6 dB Bandwidth of a Digital Modulation 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(c)	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(d)	Transmitted Power Spectral Density of a Digital Modulation System	Yes
15.247(c), 15.209 & 15.205	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 and the associated Radio Receiver 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)

Channel f (2480 MHz) is not used in order to meet upper band edge compliance.

3.4 DEVIATIONS & EXCLUSIONS FROM TEST SPECIFICATIONS

None Yes (explain below)

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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), Section Annex 8 (section 8.2) for a Digital Spread Spectrum (DTS) 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.

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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 normal, continuous transmit mode. Power was supplied to the EUT by a CR123 (3V) Lithium battery. The unit has the capability to operate on three channels, controllable via programming with hyperterminal through a serial port on a laptop computer.

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 (2405 MHz), middle (2440 MHz) and high (2475 MHz) to comply with FCC § 15.35.

5.2 Test Procedure

Radiated Emissions measurements were performed on the EUT from 30-25000 MHz. Measurements from 30-1000 were taken 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, and an EMCO horn antenna was used to measure from 18-25 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.

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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 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 5 GHz to 18 GHz, an HP E4407B Spectrum Analyzer and an EMCO Horn Antenna were used. From 18 GHz to 25 GHz, the HP E4407B Spectrum Analyzer with a standard gain horn, and preamp were used.

Test Results

The EUT was found to meet the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 for a DTS transmitter [Canada RSS-210, Issue 7 (2007), Annex 8 (section 8.2)]. The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

5.4 Test Equipment List

Test Equipment	Manufacturer	Model No.	Serial No.
EMI Receiver	HP	8546A	3617A00320
EMI Receiver Pre-Select.	HP	85460A	3448A00296
Spectrum Analyzer	Agilent	E4446A	US45300564
Log Periodic Antenna	EMCO	93146	9701-4855
Horn Antenna	EMCO	3115	6907
Bicon Antenna	EMCO	93110B	9702-2918
Pre-Amp	Adv. Microwave	WLA612	1145A04094
Horn Antenna – Std. Gain	EMCO	3160-09	9809-1120

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5.5 CALCULATION OF RADIATED EMISSIONS LIMITS

The maximum peak output power of an intentional radiator in the 2400-2483.5 MHz band, as specified in Title 47 CFR 15.247 (b)(3), is 1 Watt. The harmonic and spurious RF emissions, 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 $\mu\text{V/m}$	3 m Limit (dB $\mu\text{V/m}$)	1 m Limit (dB $\mu\text{V/m}$)
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 from field strength $\mu\text{V/m}$ to dB $\mu\text{V/m}$:

$$\begin{aligned} \text{dB}\mu\text{V/m} &= 20 \log_{10} (100) \\ &= 40 \text{ dB}\mu\text{V/m (from 30-88 MHz)} \end{aligned}$$

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

$$\begin{aligned} &960 \text{ MHz to } 10,000 \text{ MHz} \\ &500\mu\text{V/m or } 54.0 \text{ dB}/\mu\text{V/m at } 3 \text{ meters} \\ &54.0 + 9.5 = 63.5 \text{ dB}/\mu\text{V/m at } 1 \text{ meter} \end{aligned}$$

For measurements made at 0.3 meter, a 20 dB correction has been invoked.

$$\begin{aligned} &960 \text{ MHz to } 10,000 \text{ MHz} \\ &500\mu\text{V/m or } 54.0 \text{ dB}/\mu\text{V/m at } 3 \text{ meters} \\ &54.0 + 20 = 74 \text{ dB}/\mu\text{V/m at } 0.3 \text{ meters} \end{aligned}$$

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5.6

RADIATED EMISSIONS DATA CHART

3 Meter Measurements of Electromagnetic Radiated Emissions

Test Standard: 47CFR, Part 15.205 and 15.247(DTS)

Frequency Range Inspected: 30 MHz to 25000 MHz

Manufacturer:	Eaton Corporation					
Date(s) of Test:	June 27, 30, July 2, & 6, 2008					
Test Engineer(s):	Laura Bott					
Voltage:	3 VDC					
Operation Mode:	Normal, continuous transmit, modulated 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

The following table depicts the level a sample of the radiated RF emissions found:

Frequency (MHz)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dBμV/m)	Quasi Peak Limit (dBμV/m)	Margin (dB)	Antenna Polarity	EUT orientation
621.1	1.00	0	22.1	46.0	23.9	Horizontal	Vertical
854.8	1.00	0	25.7	46.0	20.3	Vertical	Vertical
287.0	1.00	0	22.4	46.0	23.6	Vertical	Vertical
226.8	1.00	0	18.5	46.0	27.5	Horizontal	Horizontal

*Note: There were no significant radiated emissions found below 1 GHz.

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RADIATED EMISSIONS DATA CHART (continued)

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 0:

Frequency (MHz)	Height (m)	Azimuth (degree)	Avg Reading (dB μ V/m)	Avg Limit (dB μ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
2405	1.16	173	107.60	125	17.4	Horizontal	Side
4810	1.2	79	60.39	63.5	3.11	Vertical	Flat
7215	1.28	154	66.80	97.6	30.8	Horizontal	Vertical
9620	1	27	63.06	97.6	34.54	Horizontal	Flat
12025	1.02	80	57.64	63.5	5.86	Horizontal	Vertical
14430	1	107	45.84	97.6	51.76	Vertical	Flat
16835	1	130	48.96	97.6	48.64	Horizontal	Flat
19240	1	0	41.79	74	32.21	Horizontal	Vertical
21645	1	0	37.28	107.6	70.32	Horizontal	Flat
24050	1	0	37.84	107.6	69.76	Vertical	Vertical

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 7:

Frequency (MHz)	Height (m)	Azimuth (degree)	Avg Reading (dB μ V/m)	Avg Limit (dB μ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
2440	1.14	150	106.70	125	18.3	Horizontal	Side
4880	1.25	152	56.27	63.5	7.23	Vertical	Vertical
7320	1.13	110	66.19	63.5	-2.69	Horizontal	Flat
9760	1.05	138	53.32	96.7	43.38	Horizontal	Vertical
12200	1.00	120	58.71	63.5	4.79	Horizontal	Vertical
14640	1.00	177	47.49	96.7	49.21	Vertical	Flat
17080	1.02	106	49.79	96.7	46.91	Horizontal	Vertical
19520	1.00	60	42.54	74	31.46	Vertical	Vertical
21960	1.00	0	36.72	106.7	69.98	Horizontal	Vertical
24400	1.00	0	36.69	106.7	70.01	Vertical	Vertical

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel e:

Frequency (MHz)	Height (m)	Azimuth (degree)	Avg Reading (dB μ V/m)	Avg Limit (dB μ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
2475	1.00	102	106.10	125	18.9	Vertical	Side
4950	1.22	112	64.19	63.5	-0.69	Vertical	Vertical
7425	1.14	115	64.76	63.5	-1.26	Horizontal	Vertical
9900	1.05	120	53.24	95.7	42.46	Horizontal	Vertical
12375	1.06	109	54.75	63.5	8.75	Horizontal	Vertical
14850	1.00	168	44.63	95.7	51.07	Vertical	Flat
17325	1.00	307	46.22	95.7	49.48	Horizontal	Side
19800	1.00	0	37.70	74	36.3	Vertical	Side
22275	1.00	0	35.58	74	38.42	Horizontal	Vertical
24750	1.00	0	37.57	105.7	68.13	Horizontal	Vertical

Notes:

- 1) A Quasi-Peak Detector was used in measurements below 1 GHz, and a Peak as well as an Average Detector was used in measurements above 1 GHz. Only the results from the Average detector are published in the table above. The peak detector was used to ensure the peak emissions did not exceed 20 dB above the limits.
- 2) Measurements above 4 GHz were made at 1 meters of separation from the EUT, and at 0.3 m separation for frequencies between 18 – 25 GHz.
- 3) Measurement at receiver system noise floor.
- 4) For measurements of the fundamental power, because of spectral bandwidth, the receiver was set to RBW=VBW=3 MHz.
- 5) A relaxation of the limit is invoked based on the average duty factor of the transmitter on-air-time. Justification appears in Appendix C. The measurements have been recalculated and reduced by 4 dB as justified by the averaging factor.

Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 15 of 37

5.7 Test Setup Photo(s) – Radiated Emissions Test

Vertical Orientation



Side Orientation



Flat Orientation



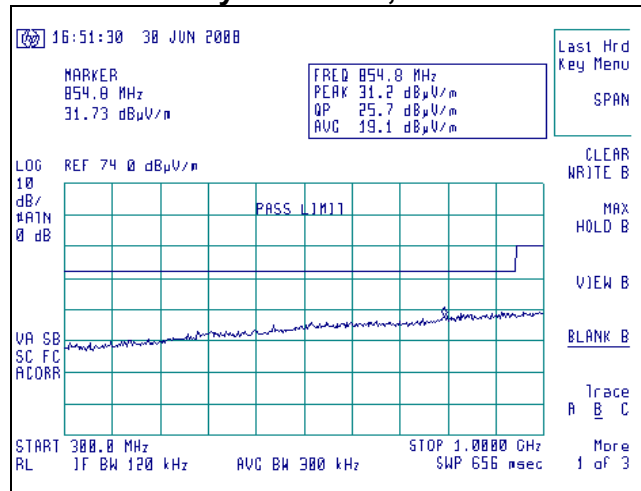
Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 16 of 37

5.8 Screen Captures - Radiated Emissions Testing

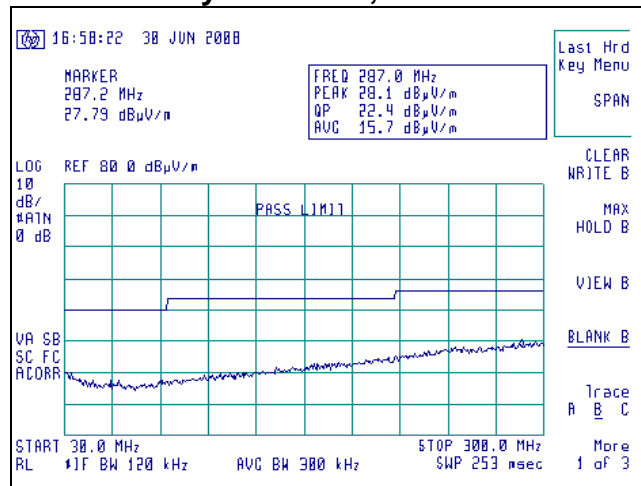
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured on channels 0, 7, or e, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

Channel 7, Antenna Vertically Polarized, EUT Vertical 30-300 MHz, at 3m



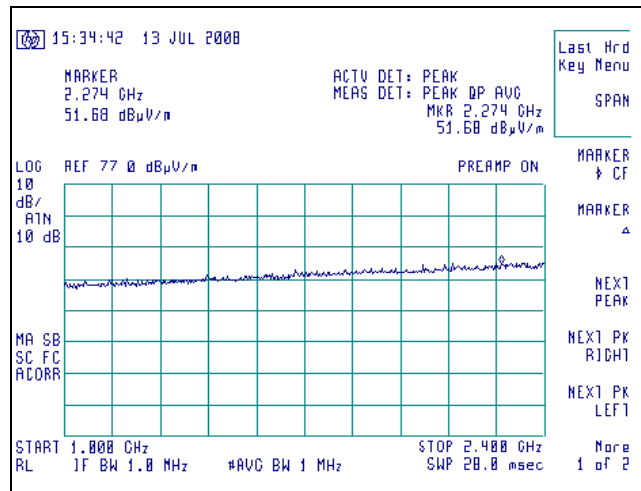
Channel 7, Antenna Vertically Polarized, EUT Vertical 300-1000 MHz, at 3m



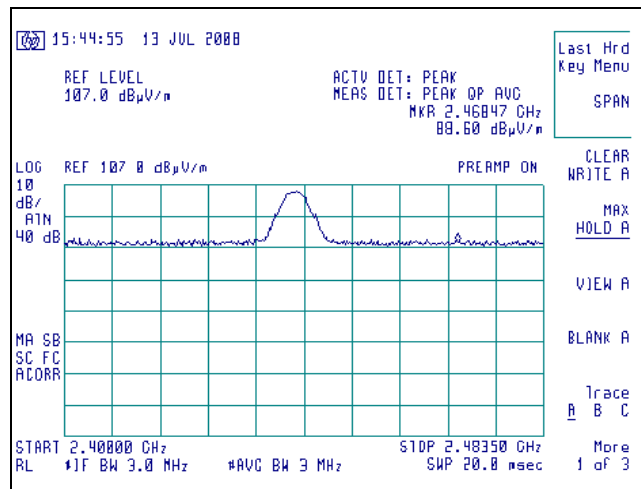
Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 17 of 37

Screen Captures - Radiated Emissions Testing (continued)

Channel 7, Antenna Horizontally Polarized, EUT on Side 1000-2400 MHz, at 3m



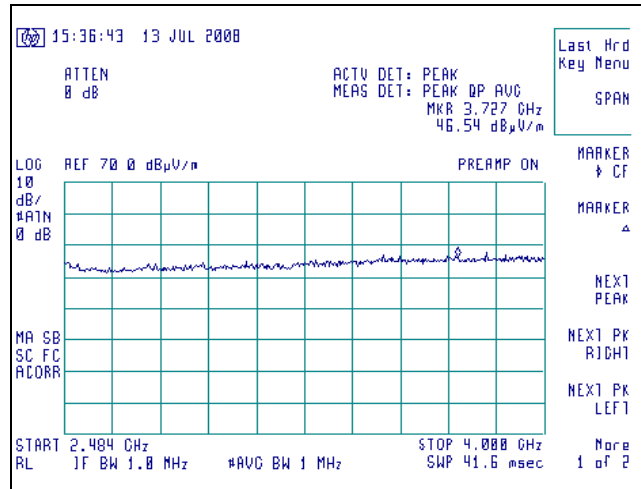
Channel 7, Antenna Horizontally Polarized, EUT on Side 2400-2483.5 MHz, at 3m



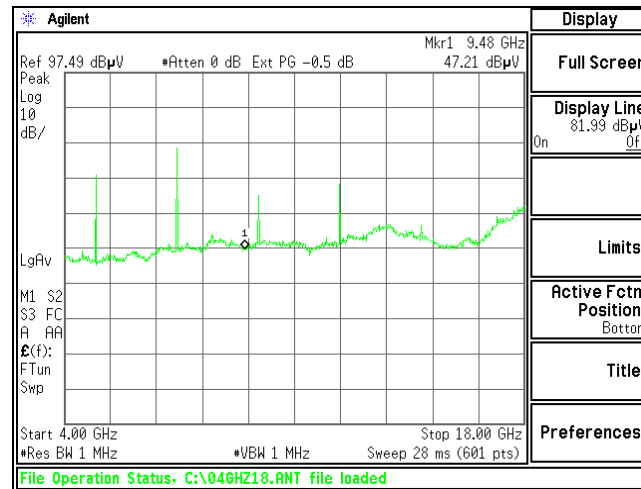
Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 18 of 37

Screen Captures - Radiated Emissions Testing (continued)

Channel 7, Antenna Horizontally Polarized, EUT on Side, 2484.0-4000 MHz, at 3m



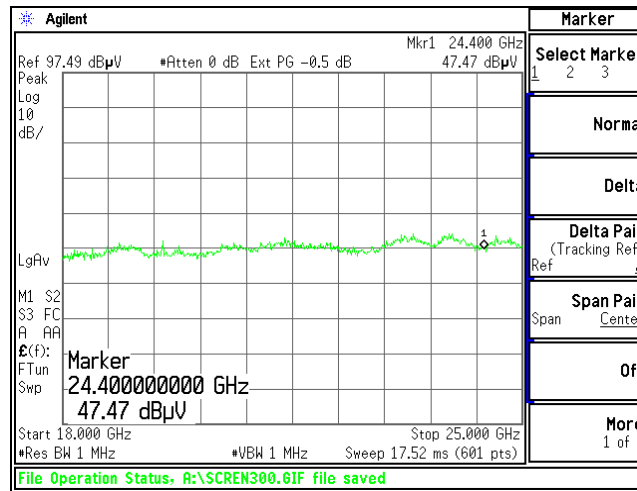
Channel e, Antenna Horizontally Polarized, EUT Vertical, 4000-18000 MHz, at 1m



Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 19 of 37

Screen Captures - Radiated Emissions Testing (continued)

Channel 7, Antenna Vertically Polarized, EUT Vertical, 18000-25000 MHz, at 30cm



Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 20 of 37

EXHIBIT 6. OCCUPIED BANDWIDTH: 15.247(a)(2)

6.1 Limits

For a Digital Modulation System, the 6 dB bandwidth shall be at least 500 kHz.

6.2 Method of Measurements

Refer to ANSI C63.4 and FCC Procedures (March 23, 2005) for Digital Transmission Systems operating under 15.247.

The transmitter output was connected to the Spectrum Analyzer. The bandwidth of the fundamental frequency was measured with the Spectrum Analyzer using 100 kHz RBW and VBW=300 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. An attenuator was placed in series with the cable to protect the spectrum analyzer. Correction factors for the RF cable were loaded onto the spectrum analyzer and the loss from the attenuator was added on the analyzer as gain offset.

The EUT was configured to run in a continuous transmit, modulated mode. The spectrum analyzer was used in peak-hold mode while measurements were made, as presented in the chart below.

Test Data

Channel	Center Frequency (MHz)	Measured -6 dBc Occupied Bandwidth (kHz)	Minimum -6 dBc Limit (kHz)	Measured -20 dBc Occupied Bandwidth (kHz)
0	2405	1617	500	2667
7	2440	1600	500	2683
e	2475	1617	500	2708

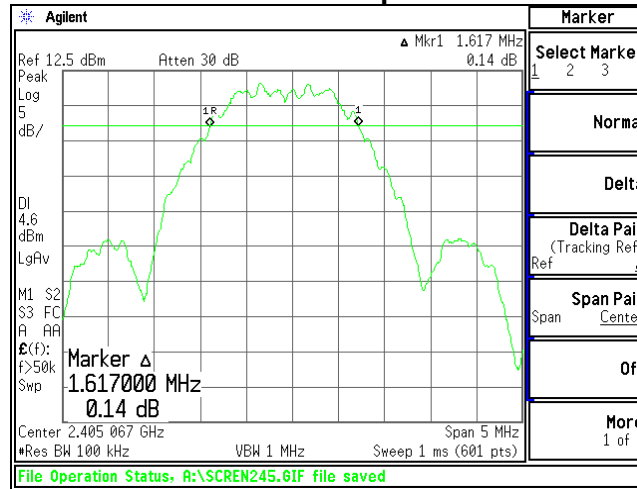
6.3 Test Equipment List

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

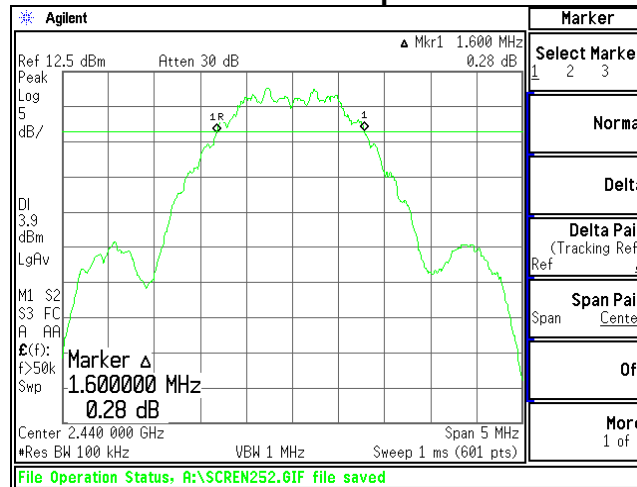
Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 21 of 37

6.4 Screen Captures - OCCUPIED BANDWIDTH

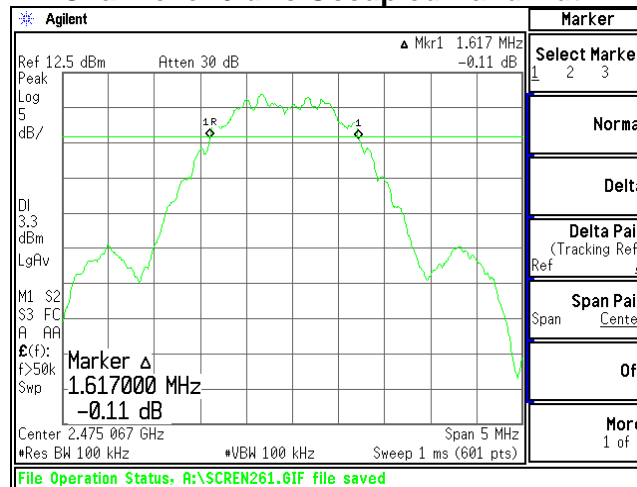
Channel 0 -6 dBc Occupied Bandwidth



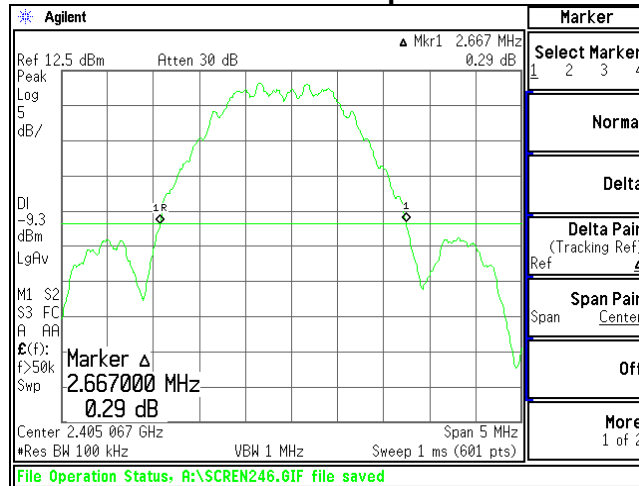
Channel 7 -6 dBc Occupied Bandwidth



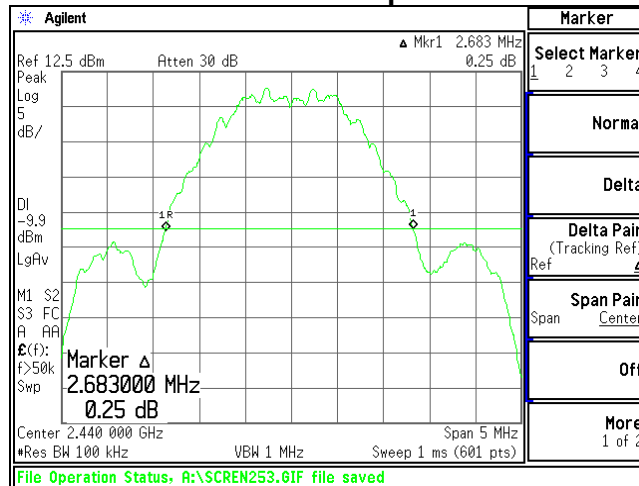
Channel e -6 dBc Occupied Bandwidth



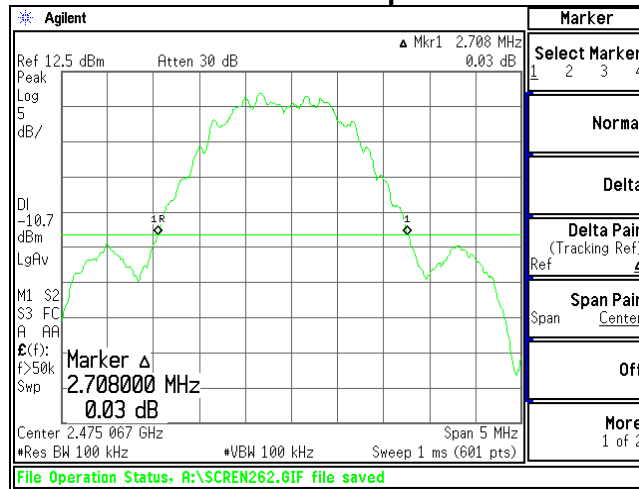
Channel 0 -20 dBc Occupied Bandwidth



Channel 7 -20 dBc Occupied Bandwidth



Channel e -20 dBc Occupied Bandwidth



Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 23 of 37

EXHIBIT 7. BAND-EDGE MEASUREMENTS

7.1 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. The following screen captures demonstrate compliance of the intentional radiator at the 2400-2483.5 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.

Lower Band-Edge Limit,

2.39 GHz = +54 dBμV/m at 3m

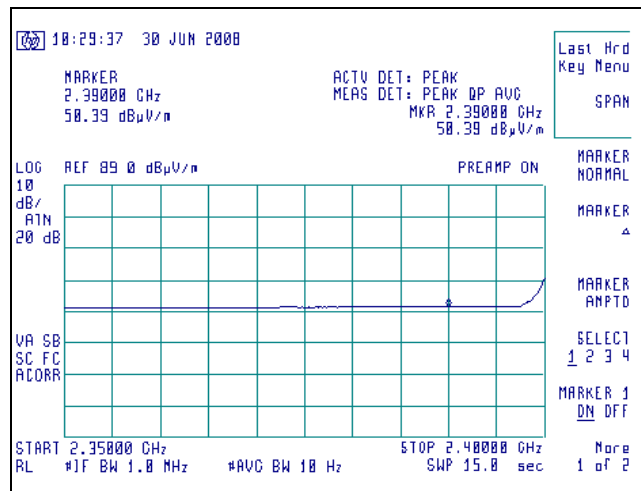
2.40 GHz = -20 dBc with respect to the peak fundamental radiated emissions.

Upper Band-Edge Limit,

2.4835 GHz = -e + 54 dBμV/m at 3m.

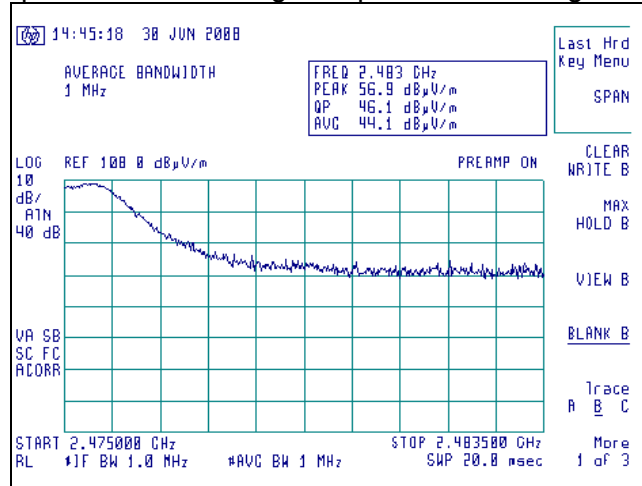
Frequency (MHz)	Peak Reading (dBμV/m)	Avg Reading (dBμV/m)	Avg Limit (dBμV/m)	Margin (dB)	Antenna Polarity	EUT orientation
2390	60.88	50.39	54	3.61	Horizontal	Side
2400	70.15	59.74	87.6	27.86	Horizontal	Side
2483.5	56.9	44.1	54	9.9	Horizontal	Side

Screen Capture Demonstrating Compliance at the Lower Band-Edge



Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 24 of 37

Screen Capture Demonstrating Compliance at the Higher Band-Edge



Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 25 of 37

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

8.1 Method of Measurements

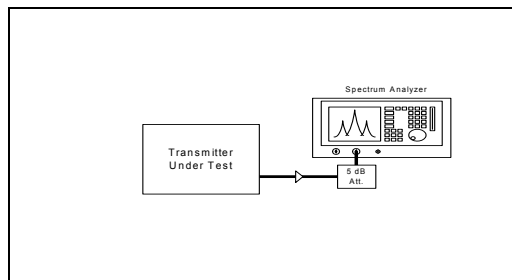
The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. Correction factors for the RF cable were loaded onto the spectrum analyzer and the loss from the attenuator was added on the analyzer as gain offset. The unit was configured to run in a continuous transmit mode. The spectrum analyzer was used with resolution and video bandwidths set to 3 MHz, and a span of 5 MHz, with measurements from a peak detector presented in the chart below.

8.2 Test Data

Channel	Center Frequency (MHz)	Measured Power (dBm)	Limit (dBm)	Margin (dB)	Calculated EIRP (dBm)	EIRP Limit (dBm)	Calculated EIRP (mw)
0	2405	14.08	30	15.92	14.58	36.0	28.71
7	2440	13.22	30	16.78	13.72	36.0	23.55
e	2475	12.82	30	17.18	13.32	36.0	21.48

(1) EIRP Calculation:

$$\text{EIRP} = (\text{Peak power at antenna terminal in dBm}) + (\text{EUT Antenna gain in dBi})$$



Rated RF power output (in watts): 0.1 Watts

Measured RF Power Output (in Watts): 0.025 Watts

Declared RF Power Output (in Watts): 0.1 Watts

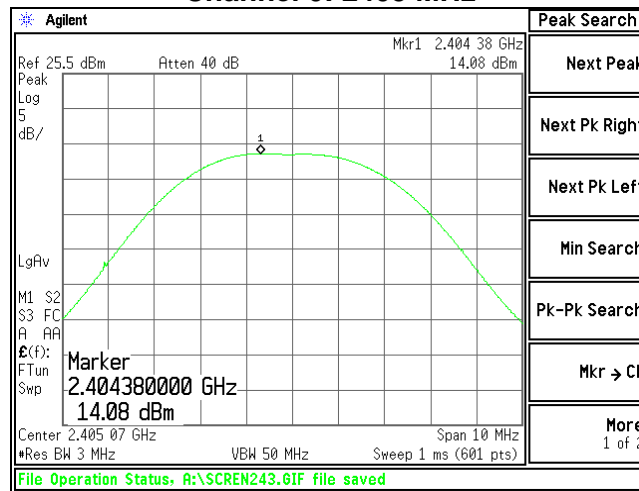
8.3 Test Equipment List

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

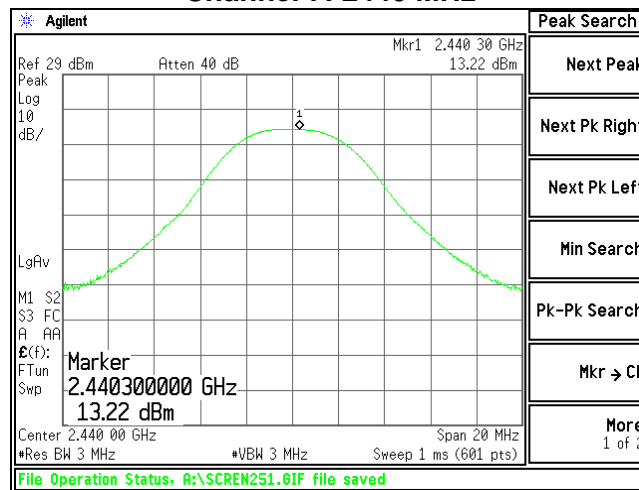
Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 26 of 37

8.4 Screen Captures – Power Output (Conducted)

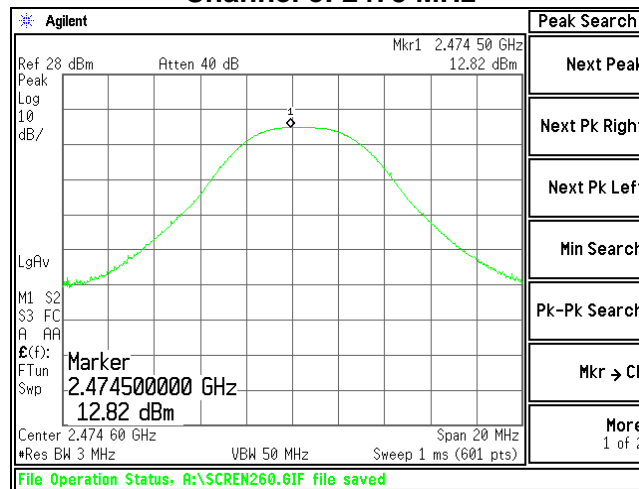
Channel 0: 2405 MHz



Channel 7: 2440 MHz



Channel e: 2475 MHz



Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 27 of 37

EXHIBIT 9. POWER SPECTRAL DENSITY: 15.247(e)

9.1 Limits

For digitally modulate systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

In accordance with FCC Part 15.247(e), the peak power spectral density should not exceed +8 dBm in any 3 kHz band. This measurement was performed along with the conducted power output readings performed as described in previous sections. The peak output frequency for each representative frequency was scanned, with a narrow bandwidth, and reduced sweep, and a power density measurement was performed using the utility built into the HP Analyzer. The resultant density was then corrected to a 3 kHz bandwidth.

9.2 Test Equipment List

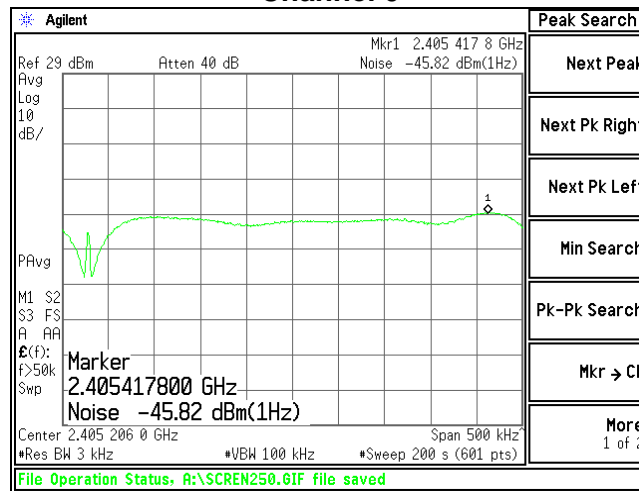
Test Equipment	Manufacturer	Model No.	Serial No.
Spectrum Analyzer	Agilent	E4446A	US45300564

9.3 Test Data

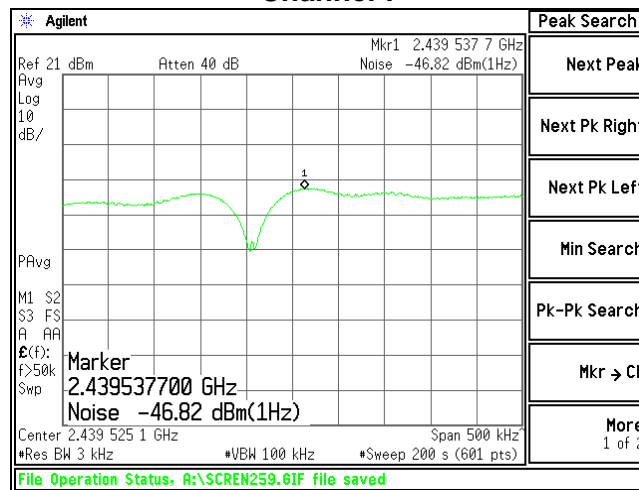
Channel	Center Frequency (MHz)	Measured Channel Power (dBm/1Hz)	3 kHz Correction (dB)	Corrected Power Measurement (dBm/3kHz)	Limit (dBm)	Margin
0	2405	-45.82	34.77	-11.05	8.0	19.1
7	2440	-46.82	34.77	-12.05	8.0	20.1
e	2475	-47.52	34.77	-12.75	8.0	20.8

9.4 Screen Captures – Power Spectral Density

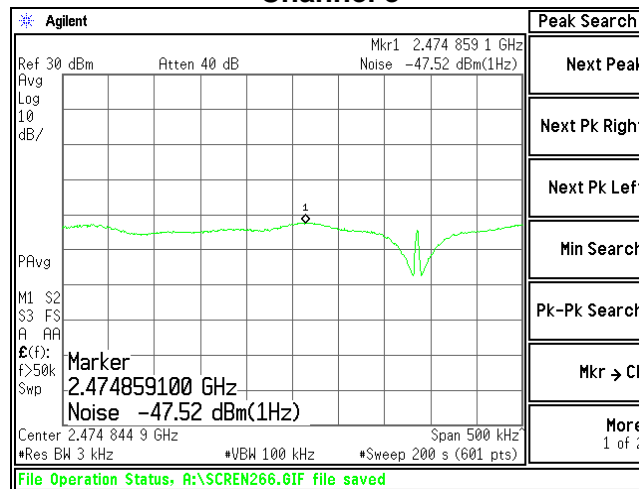
Channel 0



Channel 7



Channel e



Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 29 of 37

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.

10.2 Test Equipment List

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

10.3 Test Data

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

	Channel 0	Channel 7	Channel e
	Power in dBm		
Fundamental	10.02	8.2	10.52
2nd Harmonic	-50.97	-41.93	-47.77
3rd Harmonic	-62.94	-60.53	-61.58
4th Harmonic	-70.41	-66.78	-83.08
5th Harmonic	-78.87	-73.74	-77.02
6th Harmonic	-71.62	<i>Note 1</i>	-83.63
7th Harmonic	-78.43	-74.01	-79.54
8th Harmonic	-79.76	<i>Note 1</i>	<i>Note 1</i>
9th Harmonic	<i>Note 1</i>	<i>Note 1</i>	<i>Note 1</i>
10th Harmonic	<i>Note 1</i>	<i>Note 1</i>	<i>Note 1</i>

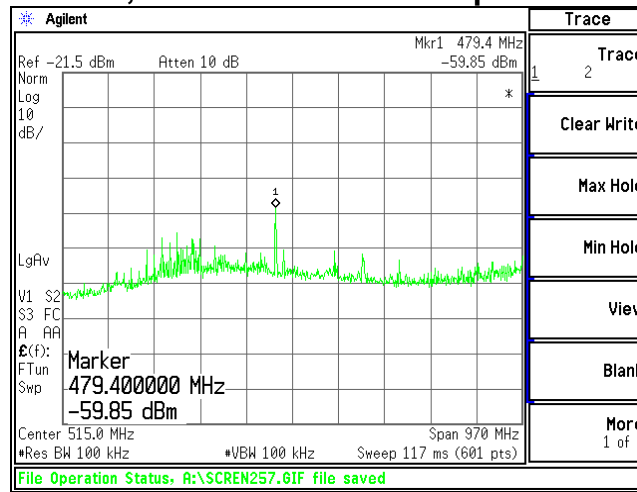
Notes:

(1) Measurement at system noise floor.

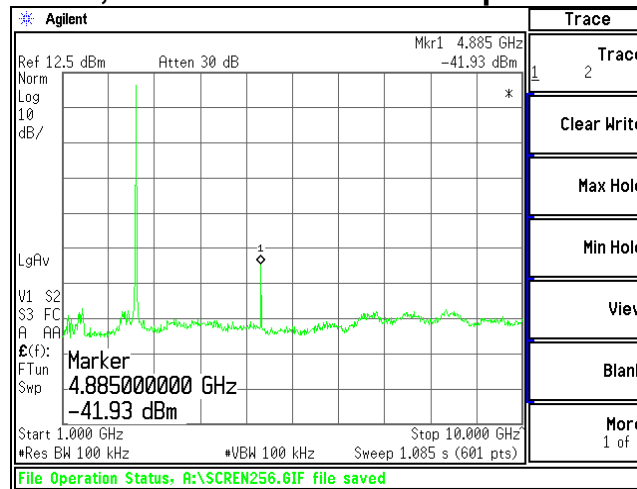
Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 30 of 37

10.4 Screen Captures – Spurious Radiated Emissions

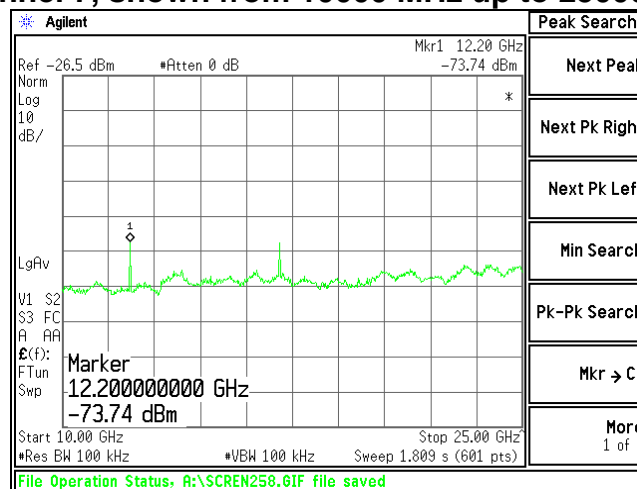
Channel 7, shown from 30 MHz up to 1000 MHz



Channel 7, shown from 1000 MHz up to 10000 MHz



Channel 7, shown from 10000 MHz up to 25000 MHz



Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 31 of 37

EXHIBIT 11. MPE CALCULATIONS

The following MPE calculations are based on a 2.45 GHz chip antenna, with a conducted RF power of 14.08 dBm as presented to the antenna. The max gain for the antenna, denoted on the manufacturer's data sheet is 0.5 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:	14.08 (dBm)
Maximum peak output power at antenna input terminal:	25.586 (mW)
Antenna gain(typical):	0.5 (dBi)
Maximum antenna gain:	1.122 (numeric)
Prediction distance:	20 (cm)
Prediction frequency:	2400 (MHz)
MPE limit for uncontrolled exposure at prediction frequency:	0.6 (mW/cm ²)
Power density at prediction frequency: 0.0057 (mW/cm ²)	
Maximum allowable antenna gain: 20.714 (dBi)	
Margin of Compliance at	20 cm = 20.214 dB

Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 32 of 37

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 1/2" 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

Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 33 of 37

Appendix B

Antenna Specification(s)

JT1_Antenna-2450AT18A100_10-03.pdf - Adobe Acrobat Standard

File Edit View Document Comments Forms Tools Advanced Window Help

Create PDF Combine Files Export Start Meeting Secure Sign Review & Comment

1 / 3 75% Find

"High Frequency Ceramic Solutions"

2.45 GHz Antenna P/N 2450AT18A100
 Detail Specification: 09/03/03 Page 1 of 3

General Specifications		Input Power	
Part Number	2450AT18A100	500mW max.	
Frequency Range	2400 - 2600 Mhz	Impedance	50 Ω
Peak Gain	0.5 dBi typ. (XZ-V)	Operating Temperature	-40 to +85°C
Average Gain	-0.5 dBi typ. (XZ-V)	Reel Quantity	3,000
Return Loss	9.5 dB min.		

No.	Function	Terminal Configuration
1	Feeding Point	2
2	NC	1

Mechanical Dimensions

T	in	mm
L	0.126 ± 0.008	3.20 ± 0.20
W	0.093 ± 0.008	1.80 ± 0.20
T	0.051 ± 0.004/0.008	1.30 ± 0.1/0.2
a	0.020 ± 0.012	0.50 ± 0.30

Mounting Considerations
 Mount these devices with brown mark facing up. Units: mm
 Line width should be designed to provide 50Ω impedance matching characteristics.

a) Without Matching Circuits

b) With Matching Circuits

Prepared For: Eaton, Corp	Model #: 70D5015G01	LS Research, LLC
EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 34 of 37

Appendix C

Justifications of Average Duty Factor Calculations

A request for relaxation of the limits has been made, for this product, based on the duty cycle of the transmitter in normal operation. The requested relaxation is for 4 dB, to be invoked when comparing measurements to the limits for radiated RF harmonic emissions, and if needed, to the band-edge limits.

The following is a description of the transmit duty cycle as presented by the manufacturer.

Worst-Case Duty factor for the transmitter "On-Time" is 62.6%, yielding a relaxation allowance of 4 dB.

IEEE 802.15.4 2.4 GHz PHY		
Data Rate	250000 bits / sec 31250 bytes / sec	
Symbols/byte	2 sym / bytes	
Symbol Timing	62500 sym / sec	
Byte Timing	0.000016 sec / sym 0.000032 sec / byte	
PHY PSDU	6 bytes	4 Preamble, SPD, Length
Max Length	127 bytes	
Total Packet Length	133 bytes	
Maximum Time TX PKT	0.004256 sec	
Long Frame Scenario:		
	1) TX Frame 2) Wait for ACK 3) Wait for LIFS 4) Repeat	Assume Frame is Data Frame
Long InterFrame Spacing (Slotted w/ ACK)		
Long Frame	127 bytes	
Data Frame Payload	102 bytes	
ACK Frame	5 bytes	
tack	12 sym	
LIFS	40 sym	
ACK Frame	11 bytes	
Backoff Period	20 sym	
Maximum Backoff	7	Random between 0 and 7
Backoff Required	2	
Backoff Time	60 sym	
Transmit Time		
TX Time (Packet)	0.004256	
TX Time (ACK)	0.000352	
Total TX Time (sec)	0.004608	
Off Time		
Backoff Time	0.00192	
tack(minimum)	0.000192	
LIFS	0.00064	
Total Off Time	0.002752	
Duty Cycle (On /total)	62.61%	Represents MAC only performance

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EUT: HOMEHeartbeat Temp Sensor	IC: 6182A-HHB2BATR	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 308186 TX	FCC ID #: TSV-HHB2BATR	Page 35 of 37

MAC Constants

maxBE	5
aMaxFrameResponseTime	1220 symbols
aMaxFrameRetries	3
aUnitBackoffPeriod	20 symbols
macAckWaitDuration	54 symbols
macBattLifeExtPeriods	6 Backoff periods
macMaxCSMABackoffs	4
macMinBE	3
aMinLIFSPeriod	40 symbols
aMinSIFSPeriod	12 symbols
aMinCAPLength	440 symbols
NB	0
CW	2
BE	3

Short InterFrame Spacing (Slotted w/ ACK)

Short Frame	18 bytes
Data Frame Payload	18 bytes
ACK Frame	5 bytes
tack	12 sym
SIFS	12 sym
ACK Frame	11 bytes
Backoff Period	20 sym
Maximum Backoff	7
Backoff Required	2
Backoff Time	60 sym

Random between 0 and 7

Transmit Time

TX Time (Packet)	0.000768
TX Time (ACK)	0.000352
Total TX Time (sec)	0.00112

Off Time

Backoff Time	0.00192
tack(minimum)	0.000192
SIFS	0.000192
Total Off Time	0.002304

Duty Cycle (On /total) 32.71%

Network Based Calculation

Long InterFrame Spacing (Slotted w/ ACK)		
Long Frame	127	bytes
Data Frame Payload	102	bytes
ACK Frame	5	bytes
tack	12	sym
LIFS	625	sym
ACK Frame	11	bytes
Backoff Period	20	sym
Maximum Backoff	7	
Backoff Required	2	
Backoff Time	60	sym

Single hop data indicates 10 ms interpacket spacing

Random between 0 and 7

Transmit Time	
TX Time (Packet)	0.004256
TX Time (ACK)	0.000352
Total TX Time (sec)	0.004608

Off Time	
Backoff Time	0.00192
tack(minimum)	0.000192
LIFS	0.01
Total Off Time	0.012112

Duty Cycle (On /total) 27.56%

Calculated Network Performance

Alternative calculation

Max radio throughput 250000 bps
 Measured throughput single hop 66816 bps

Max test network results 44544 (packet payload)

Duty Cycle 26.73%

Measured Network Performance

Use for FCC Calculations 27%