

LS Research, LLC

W66 N220 Commerce Court • Cedarburg, WI 53012 • USA

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www.lsr.com

ENGINEERING TEST REPORT # 307434 TX Project #R-490

Compliance Testing of:

Kohler 2.4 GHz RF Remote

Model Name: Fountain Head Bath Remote

Test Date(s):

February 27, 28, March 3,5,& 6, 2008

Prepared For:

Kohler Co.

Attn: Ken Noworatzky

444 Highland Drive

Kohler, WI 53044

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:

Brian E. Petted, VP of Engineering



Signature:

Date: April 7, 2008

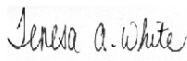
Test Report Reviewed by:

Teresa A. White, Quality Manager

Tested by:

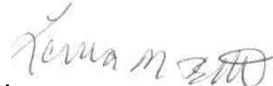
Laura Bott, EMC Engineer

Signature:



Date: April 7, 2008

Signature:



Date: April 7, 2008

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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:	Kohler Co
Address:	444 Highland Drive Kohler, WI 53044
Contact Person:	Ken Noworatzky (920) 459-1533 ken.noworatzky@kohler.com

2.2 EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information has been supplied by the applicant.

Product Name:	2.4 GHz RF Remote
Model Name:	Fountain Head Bath Remote
Serial Number:	07420550

2.3 ASSOCIATED ANTENNA DESCRIPTION

This device has a PCB trace inverted F antenna with a -2.01 dBi gain.

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2.4 EUT'S TECHNICAL SPECIFICATIONS

Additional Information:

Frequency Range (in MHz)	2400-2483.5
RF Power in Watts	0.010 Watts
Conducted Output Power (in dBm)	10.21 dBm
Field Strength (and at what distance)	106.9 dB μ V/m @ 3 meters
Occupied Bandwidth (99% BW)	2.667 MHz
Type of Modulation	O-QPSK
Emission Designator	G1D1M6
EIRP (in mW)	8.20 mW
Transmitter Spurious (worst case)	64.8 DB μ V/m
Frequency Tolerance %, Hz, ppm	100
Microprocessor Model # (if applicable)	CC2430F128
Antenna Information	
Detachable/non-detachable	Non-detachable
Type	Trace, inverted F
Gain (in dBi)	-2.01 dBi
EUT will be operated under FCC Rule Part(s)	Title 47 §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:

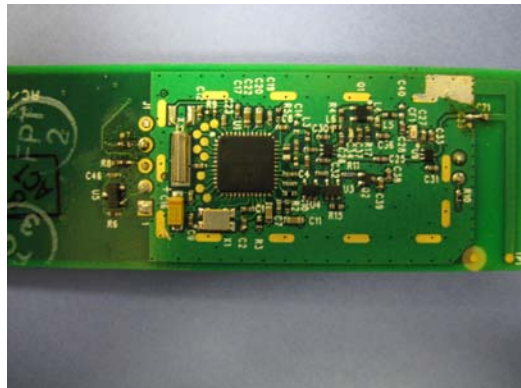
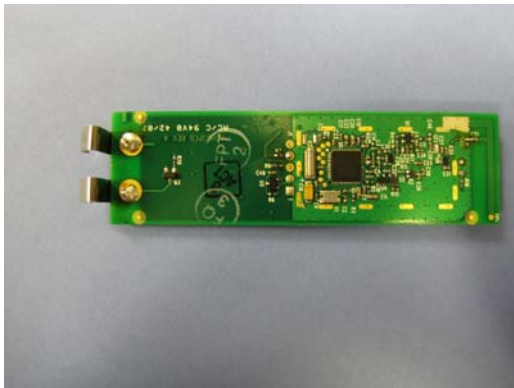
- Evaluated against exposure limits: General Public Use Controlled Use
- Duty Cycle used in evaluation: 0 %
- Standard used for evaluation: OET 65
- Measurement Distance: 3 m
- RF Value: 0.2214 V/m A/m W/m²
 Measured Computed Calculated

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2.5 PRODUCT DESCRIPTION

The 2.4 GHz Kohler module is used as a remote control for bath products. It is an 802.15.4 transceiver built around the TI CC2430 chip. It operates in the 2.4GHz ISM band on 15 channels with 5 MHz spacing (2405 – 2475 MHz). The modulation is O-QPSK with half sine filtering running at a chip rate of 2 Mcps (DSSS). The data is generated entirely by the on board transceiver. It consists of the CC2430 RF transceiver with an integrated microcontroller, external RF power amplifier, and an onboard antenna

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)

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 continuous modulated transmit mode. Power was supplied to the EUT by two AAA batteries. The unit has the capability to operate on 15 channels, three of which were used for testing purposes, and were selected via pull down resistors.

The radiated emissions limits for unintentional radiators, denoted in FCC §15.109 apply at a 3 meter distance. Measurements above 5 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 from 30 - 25000 MHz were performed on the EUT 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 18 GHz, and a standard gain Horn Antenna with a pre-amplifier was used to measure emissions from 18-25 GHz at a 0.3m separation distance. 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 tested in three orthogonal positions (vertical, side and flat) and measurements were made in horizontal and vertical polarities 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 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

5.4 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.

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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 $\mu\text{V/m}$:

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

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:	Kohler Co				
Date(s) of Test:	February 27, 28, and March 5, 2008				
Test Engineer(s):	Laura Bott				
Voltage:	3 VDC				
Operation Mode:	Normal, continuous modulated transmit				
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 of significant spurious radiated RF emissions found:

[Radiated Emissions Template.xlsx](#)

Frequency (MHz)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
297.8	1.00	0	23.0	46.0	23.0	Vertical	Flat
111.7	1.00	0	12.1	43.5	31.4	Vertical	Flat
282.5	1.00	0	22.0	46.0	24.0	Horizontal	Flat
269.0	1.00	0	21.3	46.0	24.7	Horizontal	Side
250.2	1.00	0	21.0	46.0	25.0	Vertical	Side
245.5	1.00	0	21.0	46.0	25.0	Vertical	Vertical
263.0	1.00	0	20.9	46.0	25.1	Horizontal	Vertical
980.7	1.00	0	28.1	54.0	25.9	Horizontal	Vertical
884.4	1.00	0	26.4	46.0	19.6	Vertical	Vertical
999.9	1.00	0	27.7	54.0	26.3	Vertical	Side
856.7	1.00	0	26.3	46.0	19.7	Horizontal	Side
901.7	1.00	0	27.1	46.0	18.9	Horizontal	Flat
867.2	1.00	0	26.1	46.0	19.9	Vertical	Flat

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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 (dBμ V/m)	Avg Limit (dBμ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
2405	1.27	0	103.3	125	21.7	Horizontal	Side
4810	1.16	31	48.53	63.5	14.97	Horizontal	Flat
7215	1	153	49.39	93.3	43.91	Vertical	Side
9620	1.14	118	50.45	93.3	42.85	Vertical	Flat
12025	1	0	37.11 ^{*Note 3}	63.5	26.39	Horizontal	Flat
14430	1	0	39.09 ^{*Note 3}	93.3	54.21	Horizontal	Flat
16835	1	0	41.1 ^{*Note 3}	93.3	52.2	Horizontal	Side
19240	1	0	47.52 ^{*Note 3}	74	26.48	Vertical	Vertical
21645	1	0	47.34 ^{*Note 3}	103.3	55.96	Vertical	Vertical
24050	1	0	49.16 ^{*Note 3}	103.3	54.14	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 (dBμ V/m)	Avg Limit (dBμ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
2440	1.14	283	100.8	125	24.2	Vertical	Vertical
4880	1	25	53.79	63.5	9.71	Horizontal	Flat
7320	1	110	46.73	63.5	16.77	Vertical	Side
9760	1	133	57.69	90.8	33.11	Vertical	Flat
12200	1	0	38.47 ^{*Note 3}	63.5	25.03	Vertical	Vertical
14640	1	0	41.59 ^{*Note 3}	90.8	49.21	Horizontal	Vertical
17080	1	0	43.34 ^{*Note 3}	90.8	47.46	Horizontal	Side
19520	1	0	47.66 ^{*Note 3}	74	26.34	Vertical	Vertical
21960	1	0	48.79 ^{*Note 3}	100.8	52.01	Vertical	Vertical
24400	1	0	50.66 ^{*Note 3}	100.8	50.14	Vertical	Vertical

The following table depicts the level of significant radiated RF fundamental and harmonic emissions seen on Channel 14:

Frequency (MHz)	Height (m)	Azimuth (degree)	Avg Reading (dBμ V/m)	Avg Limit (dBμ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
2475	1	0	101.1	125	23.9	Vertical	Flat
4950	1.1	96	52.99	63.5	10.51	Vertical	Side
7425	1.03	323	52.38	63.5	11.12	Vertical	Flat
9900	1	134	64.8	91.1	26.3	Vertical	Flat
12375	1	161	45.2	63.5	18.3	Horizontal	Side
14850	1	0	49.4 ^{*Note 3}	91.1	41.7	Horizontal	Vertical
17325	1	0	44.07 ^{*Note 3}	91.1	47.03	Horizontal	Flat
19800	1	0	47.66 ^{*Note 3}	74	26.34	Vertical	Vertical
22275	1	0	48.25 ^{*Note 3}	74	25.75	Vertical	Vertical
24750	1	0	47.77 ^{*Note 3}	101.1	53.33	Vertical	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 5 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.

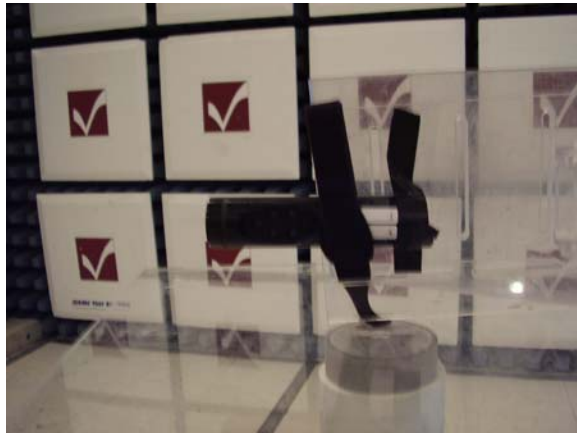
Prepared For: Kohler, CO	Model #: Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 307434 TX	Customer FCC ID #: n/a	Page 15 of 35

5.7 Test Setup Photo(s) – Radiated Emissions Test

Vertical Orientation



Side Orientation



Flat Orientation



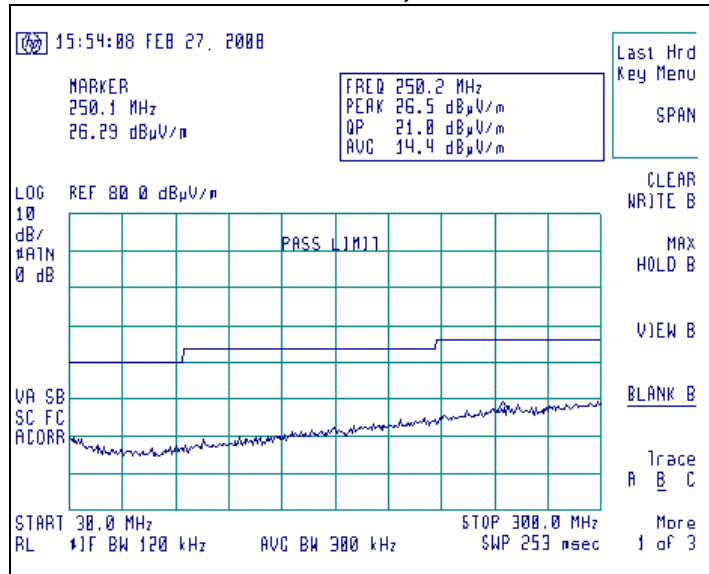
Prepared For: Kohler, CO	Model #:Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 307434 TX	Customer FCC ID #: n/a	Page 16 of 35

5.8 Screen Captures - Radiated Emissions Testing

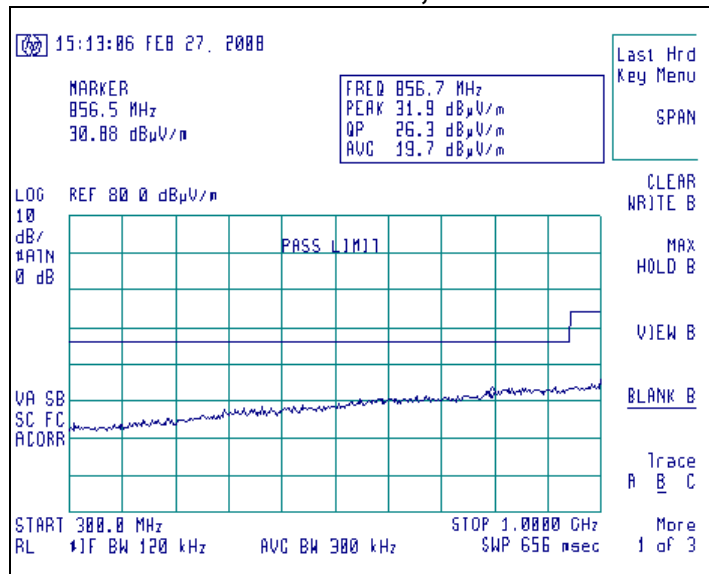
These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

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

Channel 7, Antenna Horizontally Polarized, EUT on side 30-300 MHz, at 3m



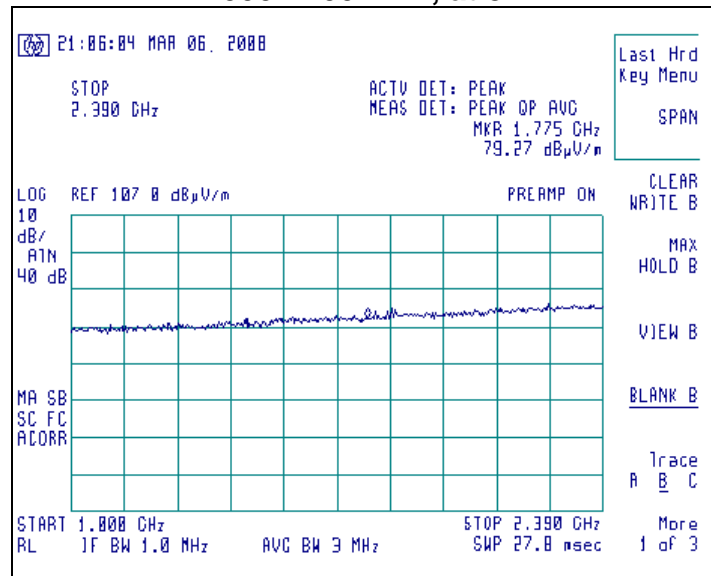
Channel 7, Antenna Horizontally Polarized, EUT on side 300-1000 MHz, at 3m



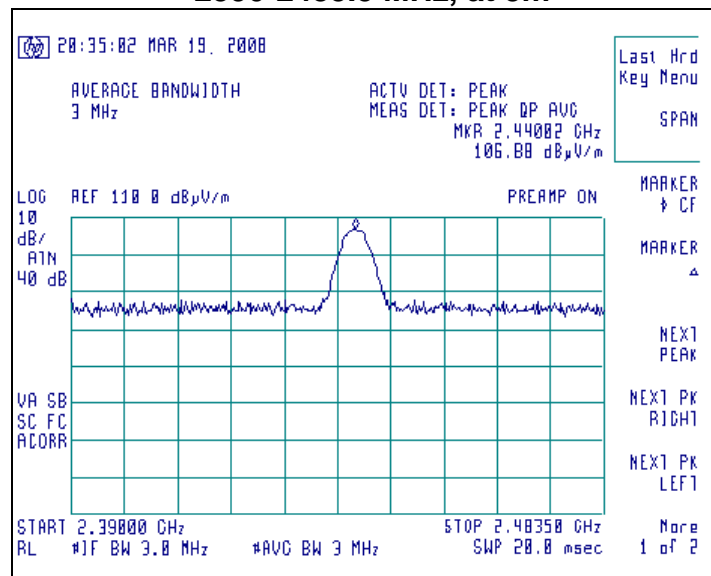
Prepared For: Kohler, CO	Model #:Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 307434 TX	Customer FCC ID #: n/a	Page 17 of 35

Screen Captures - Radiated Emissions Testing (continued)

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



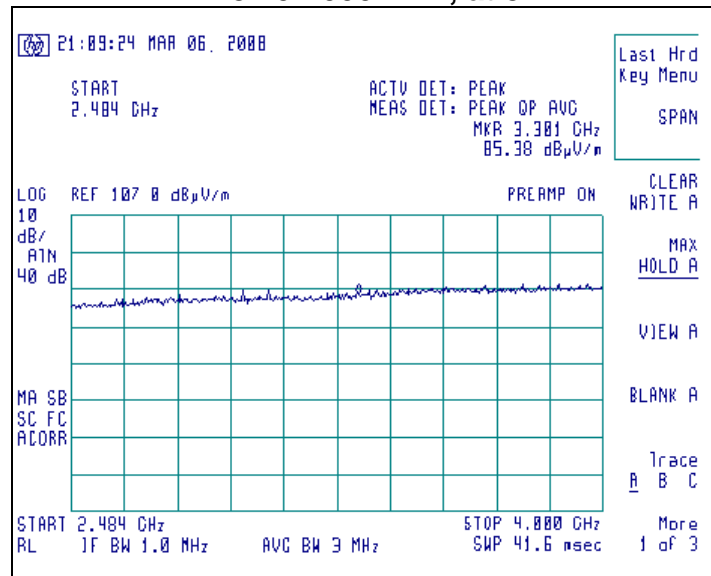
**Channel 7, Antenna Horizontally Polarized, EUT on Side
2390-2483.5 MHz, at 3m**



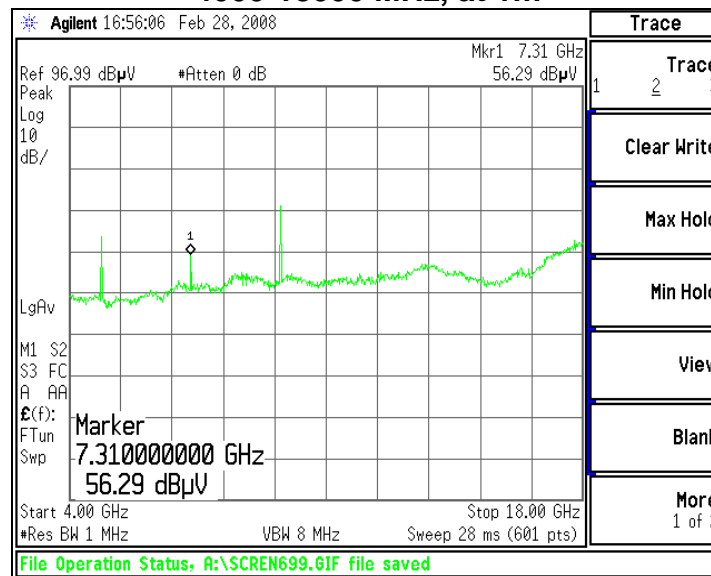
Prepared For: Kohler, CO	Model #:Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 307434 TX	Customer FCC ID #: n/a	Page 18 of 35

Screen Captures - Radiated Emissions Testing (continued)

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



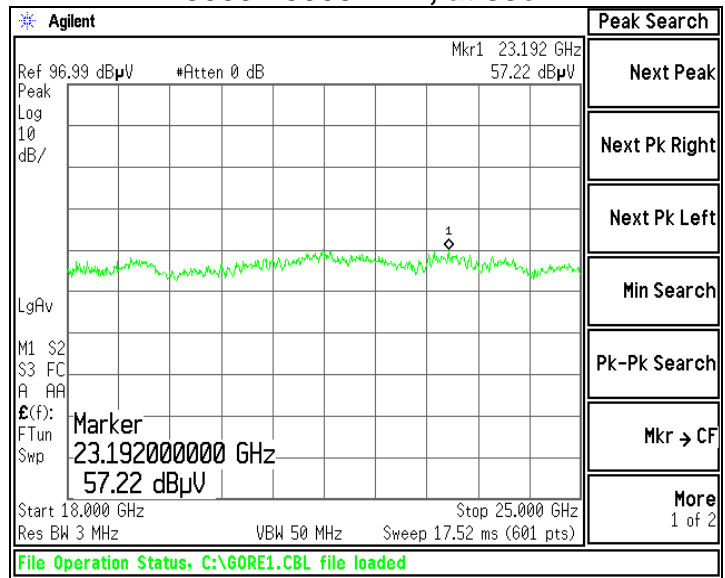
**Channel 7, Antenna Horizontally Polarized, EUT Flat,
4000-18000 MHz, at 1m**



Prepared For: Kohler, CO	Model #:Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 307434 TX	Customer FCC ID #: n/a	Page 19 of 35

Screen Captures - Radiated Emissions Testing (continued)

**Channel 0, Antenna Horizontally Polarized, EUT Flat
18000-25000 MHz, at 30cm**



Prepared For: Kohler, CO	Model #:Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 307434 TX	Customer FCC ID #: n/a	Page 20 of 35

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 E4407B 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.

6.3 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	1600	500	2667
7	2440	1592	500	2650
14	2475	1600	500	2658

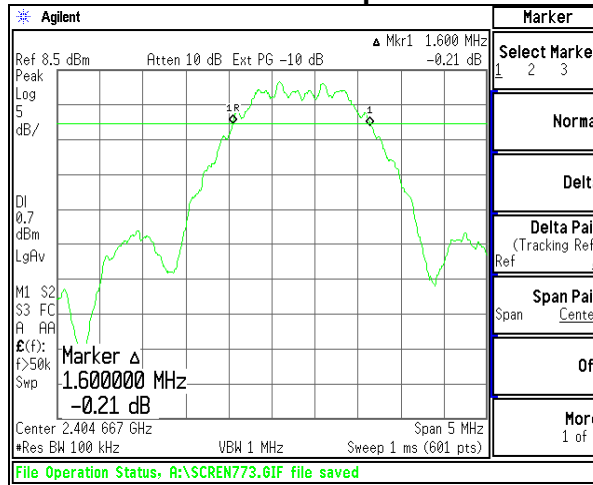
6.4 Test Equipment List

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

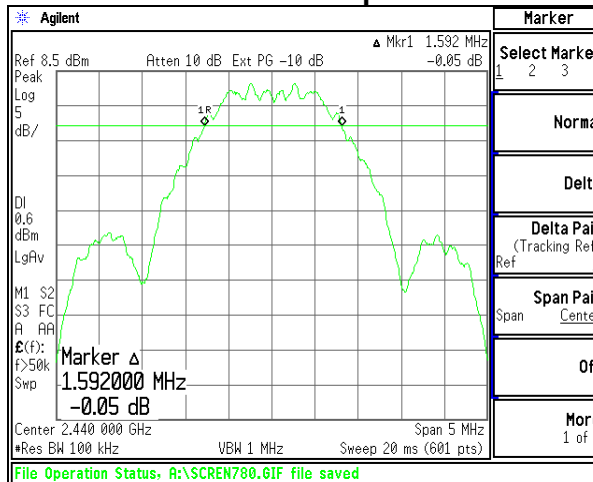
Prepared For: Kohler, CO	Model #:Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 307434 TX	Customer FCC ID #: n/a	Page 21 of 35

6.5 Screen Captures - OCCUPIED BANDWIDTH

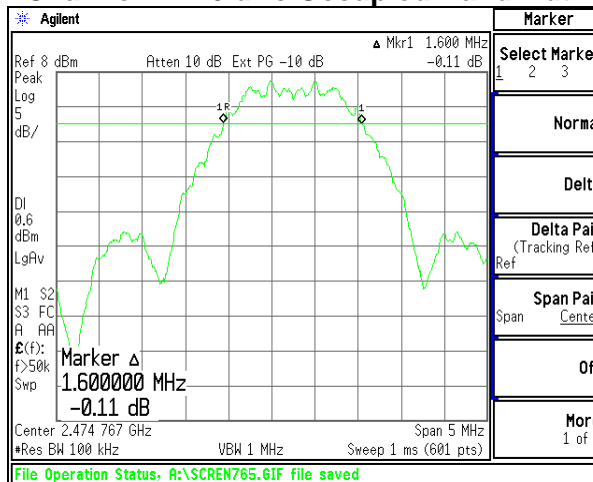
Channel 0: -6 dBc Occupied Bandwidth



Channel 7: -6 dBc Occupied Bandwidth

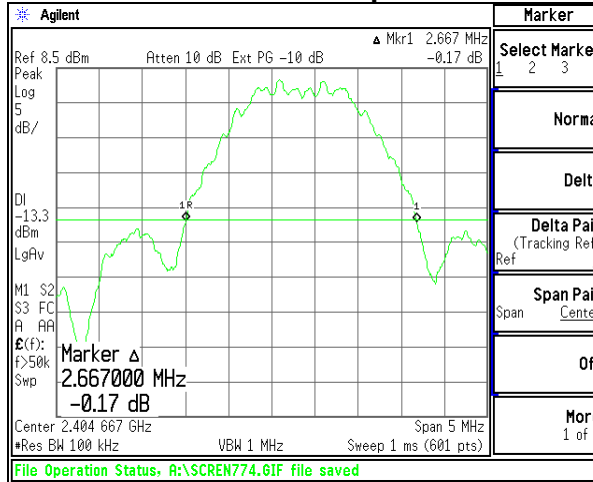


Channel 14: -6 dBc Occupied Bandwidth

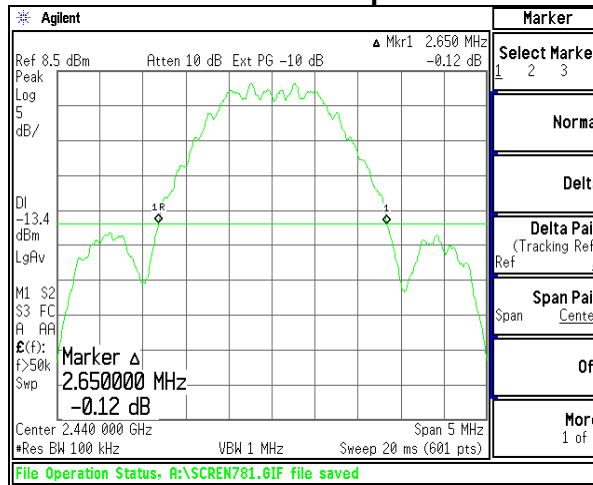


Prepared For: Kohler, CO	Model #:Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 307434 TX	Customer FCC ID #: n/a	Page 22 of 35

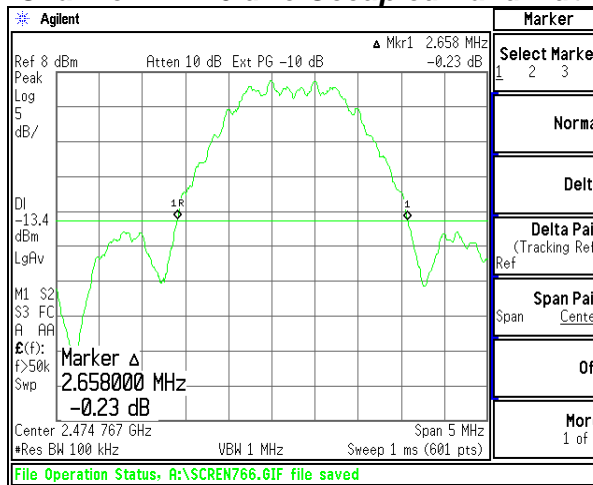
Channel 0: -20 dBc Occupied Bandwidth



Channel 7: -20 dBc Occupied Bandwidth



Channel 14: -20 dBc Occupied Bandwidth



Prepared For: Kohler, CO	Model #: Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
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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 dB μ V/m at 3m

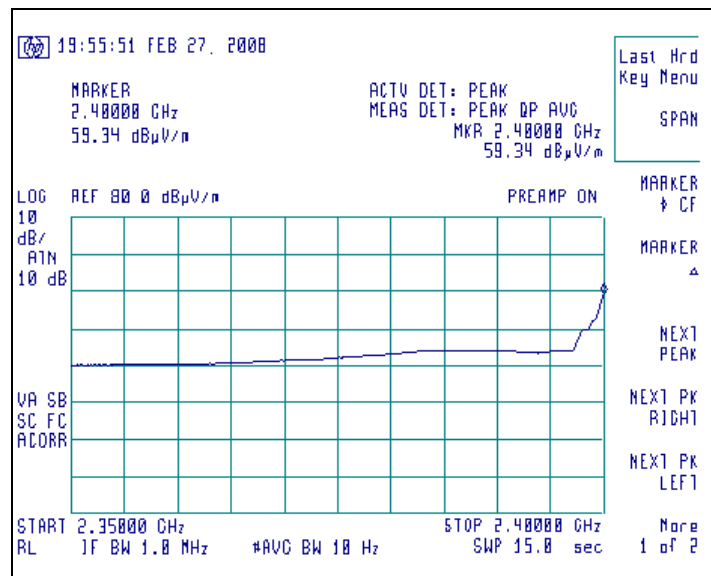
2.40 GHz = -20 dBc with respect to the peak fundamental radiated emissions.

Upper Band-Edge Limit,

2.4835 GHz = + 54 dB μ V/m at 3m.

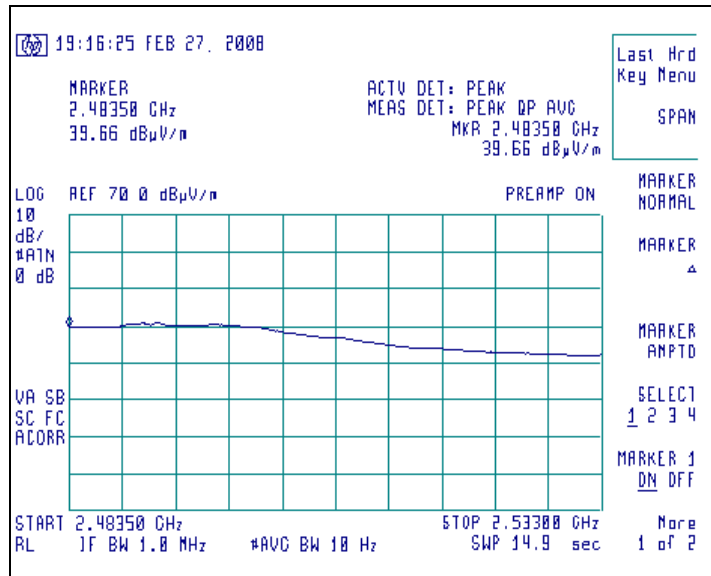
Frequency (MHz)	Height (m)	Azimuth (degree)	Avg Reading (dB μ V/m)	Avg Limit (dB μ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
2390	1.27	0	44.13	54	9.87	Horizontal	Side
2405	1.27	0	59.34	83.3	23.96	Horizontal	Side
2483.5	1.0	0	39.66	54	14.34	Vertical	Flat

Screen Capture Demonstrating Compliance at the Lower Band-Edge



Prepared For: Kohler, CO	Model #:Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 307434 TX	Customer FCC ID #: n/a	Page 24 of 35

Screen Capture Demonstrating Compliance at the Higher Band-Edge



Prepared For: Kohler, CO	Model #:Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 307434 TX	Customer FCC ID #: n/a	Page 25 of 35

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

8.1 Method of Measurements

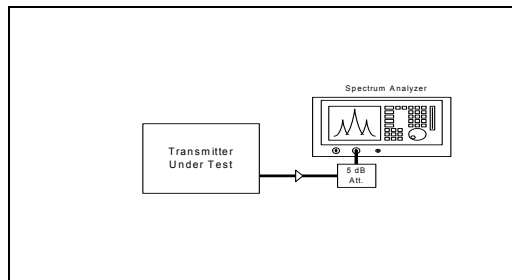
The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. Correction factors for the RF cable were loaded onto the spectrum analyzer and the loss from the attenuator was added on the analyzer as gain 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	10.08	30	19.92	8.07	36.0	6.41
7	2440	10.13	30	19.87	8.12	36.0	6.49
14	2475	10.21	30	19.79	8.20	36.0	6.61

(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): 0.01Watts

Measured RF Power Output (in Watts): 0.0105 Watts

Declared RF Power Output (in Watts): 0.01Watts

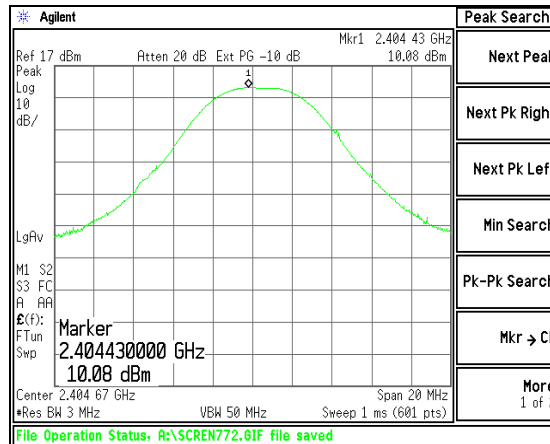
8.3 Test Equipment List

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

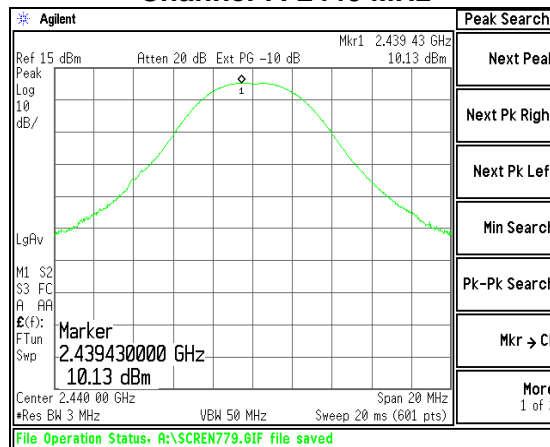
Prepared For: Kohler, CO	Model #:Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
Report #: 307434 TX	Customer FCC ID #: n/a	Page 26 of 35

8.4 Screen Captures – Power Output (Conducted)

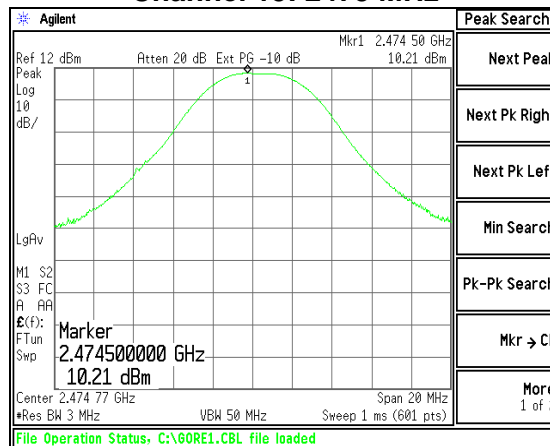
Channel 0: 2405 MHz



Channel 7: 2440 MHz



Channel 15: 2475 MHz



Prepared For: Kohler, CO	Model #:Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
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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. The power spectral density was calculated from the marker noise function as follows:

$$\text{Marker Noise} + 10 \log (3000 \text{ Hz}) = \text{PSD}$$

9.2 Test Equipment List

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

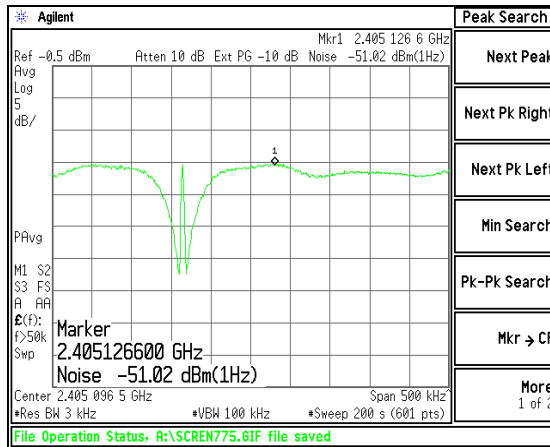
9.3 Test Data

Transmitter Channel	Frequency (MHz)	RF Power Level in 3 kHz BW (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Comments Pass/Fail
0	2405	-16.25	8.0	24.3	Pass
7	2440	-16.43	8.0	24.4	Pass
14	2475	-16.16	8.0	24.2	Pass

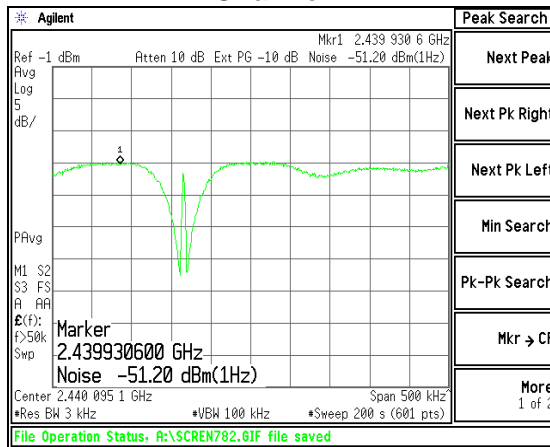
Prepared For: Kohler, CO	Model #:Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
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9.4 Screen Captures – Power Spectral Density

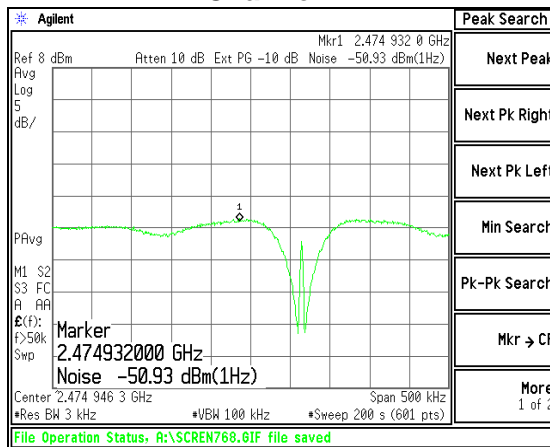
Channel 0



Channel 7



Channel 14



Prepared For: Kohler, CO	Model #: Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
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EXHIBIT 10. SPURIOUS CONDUCTED EMISSIONS: 15.247(d)

10.1 Limits

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

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

FCC Part 15.247(d) requires a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable. The cable calibration file was loaded into the spectrum analyzer to compensate for the loss of the cable between the antenna port of the EUT to the spectrum analyzer. A Hewlett Packard model E4446A spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The unit was configured to run in a continuous transmit mode. The spectrum analyzer was used with measurements from a peak detector presented in the chart below. Screen captures were acquired and any noticeable spurious and harmonic signals were identified and measured.

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

	Channel 0	Channel 7	Channel 14
Fundamental	+ 5.40(dBm)	+ 6.51 (dBm)	+ 5.91 (dBm)
2 nd Harmonic	- 64.98 (dBm)	Note (1)	Note (1)
3 rd Harmonic	Note (1)	Note (1)	Note (1)
4 th Harmonic	- 55.24 (dBm)	- 50.65 (dBm)	- 46.42(dBm)
5 th Harmonic	Note (1)	Note (1)	Note (1)
6 th Harmonic	Note (1)	Note (1)	Note (1)
7 th Harmonic	Note (1)	Note (1)	Note (1)
8 th Harmonic	Note (1)	Note (1)	Note (1)
9 th Harmonic	Note (1)	Note (1)	Note (1)
10 th Harmonic	Note (1)	Note (1)	Note (1)

Notes:

(1) Measurement at system noise floor.

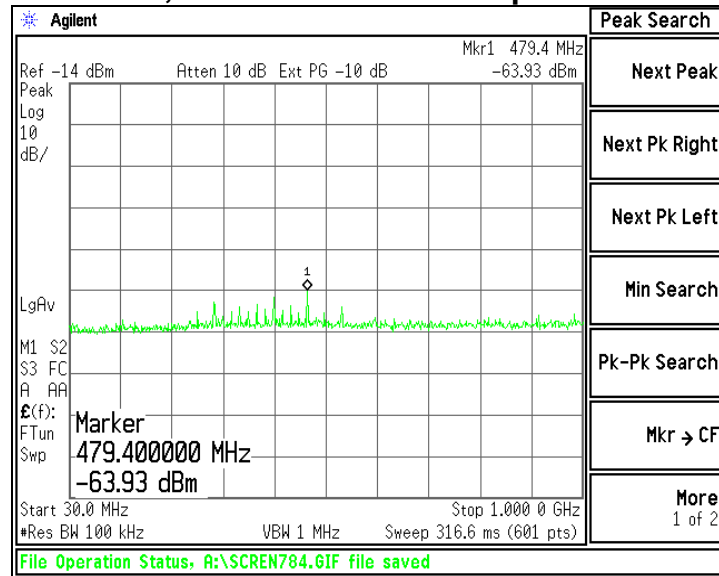
10.2 Test Equipment List

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

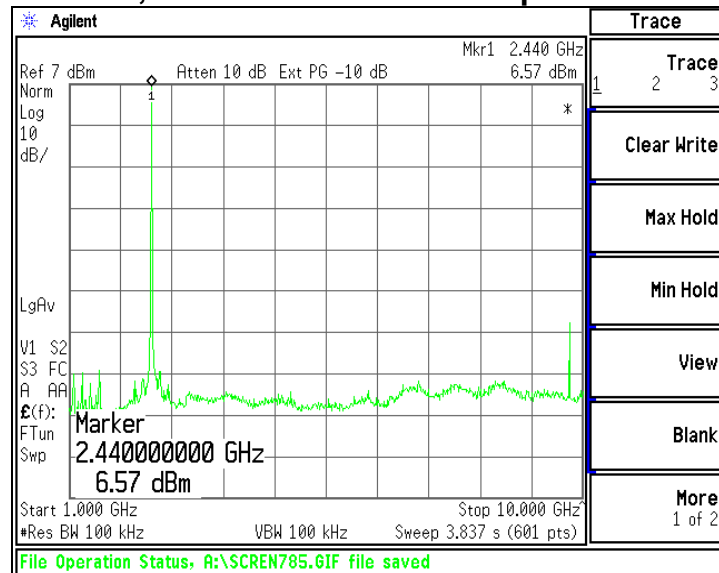
Prepared For: Kohler, CO	Model #:Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
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10.3 Screen Captures – Spurious Conducted Emissions

Channel 7, shown from 30 MHz up to 1000 MHz

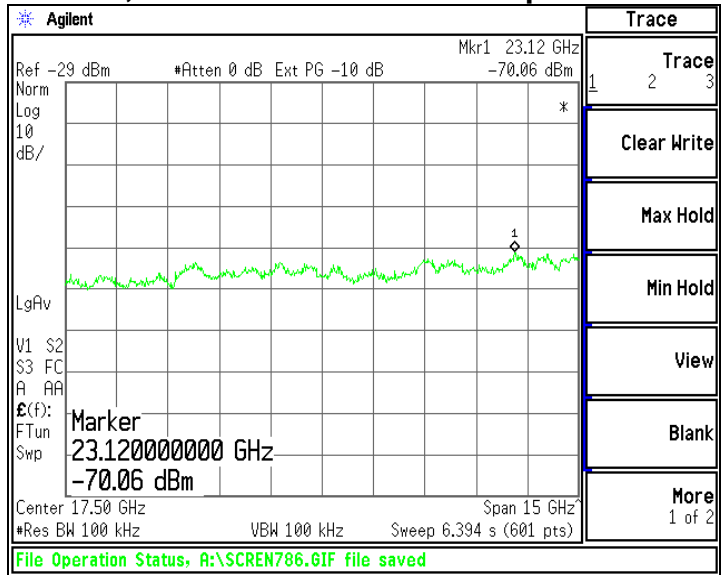


Channel 7, shown from 1000 MHz up to 10000 MHz



Prepared For: Kohler, CO	Model #:Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
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Channel 7, shown from 10000 MHz up to 25000 MHz



Prepared For: Kohler, CO	Model #:Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
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EXHIBIT 11. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATION

The 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 frequency at the appropriate frequency markers. The transmitter of the EUT placed in modulated continuous transmit mode. Power was supplied by an external bench-type variable power supply, and the frequency of operation was monitored using the spectrum analyzer.

In this case, the EUT uses a single type operates on a nominal voltage of 3.0 VDC. The test was performed to measure the stability of the frequency and power at $\pm 15\%$ of the nominal operating voltage: 2.55V and 3.45V.

A spectrum analyzer was used to measure the frequency at the appropriate frequency markers. For this test, the EUT was placed in continuous transmit CW mode. Power to the EUT was supplied by an external bench-type variable power supply. The frequency of operation was monitored using the spectrum analyzer with RBW=VBW=10Hz settings while the voltage was varied.

	DC/AC Voltage Source		
	2.55 VDC	3 VDC	3.45 VDC
Channel 0	2405.008000 (MHz)	2405.008300 (MHz)	2405.008300 (MHz)
Channel 7	2440.010500 (MHz)	2440.010100 (MHz)	2440.010400 (MHz)
Channel E	2475.009900 (MHz)	2475.009900 (MHz)	2475.010300 (MHz)

The RF Power Output of the EUT was also monitored in a separate test, also using a Spectrum Analyzer with RBW=VBW=3 MHz setting while the voltage was varied.

	DC/AC Voltage Source		
	2.55 VDC	3 VDC	3.45 VDC
Channel 0	9.588 (dBm)	9.737 (dBm)	9.790 (dBm)
Channel 7	9.993 (dBm)	10.278 (dBm)	10.182 (dBm)
Channel E	9.673 (dBm)	9.960 (dBm)	9.031 (dBm)

No anomalies were noted in the measured transmit power, which varied less than 1 dB during the voltage variation tests.

EXHIBIT 12. LOW THRESHOLD CALCULATIONS

Frequency Range: 2402-2480MHz

Low threshold = $60/f(\text{GHz}) \text{ mW} = 60 / 2.480 = 24.19\text{mW}$

Conducted Output Power Measured (dBm) = 10.21 dBm

Antenna Gain (dBi) = -2.01 dBi

EIRP = 6.61 mW

Conducted Output Power (mW) = 10.495 mW

Since both Conducted output power and EIRP are below the low threshold, device complies with FCC's RF radiation exposure limits for general population/uncontrolled exposure category for a portable device without SAR evaluation.

Prepared For: Kohler, CO	Model #:Fountain Head Bath Remote	LS Research, LLC
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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: Kohler, CO	Model #:Fountain Head Bath Remote	LS Research, LLC
EUT: 2.4 GHz Remote	Serial #: 07420550	Template: 15.247 DTS TX (V2 9-06-06)
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