



L.S. Compliance, Inc.

W66 N220 Commerce Court
Cedarburg, WI 53012
262-375-4400 Fax: 262-375-4248

Assigned Engineer: Abtin Spantman

Compliance Testing of:

Whirlpool Remote Transmitter

Prepared For:

Kohler Company
Attn.: Mr. Ronald Bauer
444 Highland Drive
Kohler, WI 53044

Test Report Number:

303204 TX

Test Dates:

March 25th and 31st, 2003

All results of this report relate only to the items that were tested. This report may not be reproduced, except in full, without written approval of L.S. Compliance, Inc.

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1. L.S. Compliance in Review

L. S. Compliance, Inc. is located in Cedarburg, Wisconsin – United States.

We may be contacted by:

Mail: L. S. Compliance, Inc.
W66 N220 Commerce Court
Cedarburg, Wisconsin 53102

Phone: 262-375-4400
Fax: 262-375-4248
E-Mail: eng@lsr.com

As an EMC testing laboratory, our accreditation and assessments are recognized through the following:

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005
With electrical (EMC) Scope of Accreditation
A2LA Certificate Number: **1255.01**

U.S. Conformity Assessment Body (CAB) Validation

Validated by the European Commission as a U.S. conformity assessment Body operating under the U.S./EU, Mutual Recognition Agreement (MRA) operating under the European Union EMC Directive 89/336/EEC, Article 10.2
Date of Validation: **January 16, 2001**

Federal Communications Commission (FCC) – USA

Listing of 3 Meter Semi-Anechoic Chamber based on 47CFR 2.948
FCC Registration Number: **90756**

Listing of 3 and 10 Meter OATS based on 47CFR 2.948
FCC Registration Number: **90757**

Industry Canada

On-file, 3 Meter Semi-Anechoic Chamber based on 47CFR 2.948
File Number: **IC 3088**

On-file 3 and 10 meter OATS based on RSS-210
File Number: **IC 3088-A**

2. A2LA Certificate of Accreditation



**THE AMERICAN
ASSOCIATION
FOR LABORATORY
ACCREDITATION**

ACCREDITED LABORATORY

A2LA has accredited

L.S. COMPLIANCE, INC.
Cedarburg, WI

for technical competence in the field of

Electrical Testing

The accreditation covers the specific tests and types of tests listed on the agreed scope of accreditation. This laboratory meets the requirements of ISO/IEC 17025 - 1999 "General Requirements for the Competence of Testing and Calibration Laboratories" and any additional program requirements in the identified field of testing. Testing and calibration laboratories that comply with this International Standard also operate in accordance with ISO 9001 or ISO 9002 (1994).

Presented this 26th day of March 2003.



Peter Abney

President
For the Accreditation Council
Certificate Number 1255.01
Valid to January 31, 2005

For tests or types of tests to which this accreditation applies,
please refer to the laboratory's Electrical Scope of Accreditation.

3. A2LA Scope of Accreditation



American Association for Laboratory Accreditation

SCOPE OF ACCREDITATION TO ISO/IEC 17025-1999

L.S. COMPLIANCE, INC.
W66 N220 Commerce Court
Cedarburg, WI 53012
James Blaha Phone: 262 375 4400

ELECTRICAL (EMC)

Valid to: January 31, 2005

Certificate Number: 1255-01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following tests:




<u>Test</u>	<u>Test Method(s)</u>
<i>Emissions</i>	
Conducted Emissions Continuous/Discontinuous	Code of Federal Regulations (CFR) 47, FCC Method Parts 15 and 18 using ANSI C63.4; EN: 55011, 55022, 55081-1, 55081-2; CISPR: 11, 22; CNS 13438
Radiated Emissions	Code of Federal Regulations (CFR) 47, FCC Method Parts 15 and 18 using ANSI C63.4; EN: 55011, 55022, 55081-1, 55081-2; CISPR: 11,22; CNS 13438
Current Harmonics	EN 61000-3-2
Voltage Fluctuations & Flicker	EN 61000-3-3
<i>Immunity</i>	
Conducted Immunity Fast Transients/Burst	IEC: 1000-4-4, 801-4; EN: 61000-4-4, 50082-1, 50082-2
Surge	IEC: 1000-4-5, 801-5; ENV 50142; EN: 61000-4-5, 50082-1, 50082-2
RF Fields	IEC: 1000-4-6, 801-6; ENV 50141; EN: 61000-4-6, 50082-1, 50082-2
Voltage Dips/Interruptions	IEC 1000-4-11; EN: 61000-4-11, 50082-1, 50082-2

Laura M. Robinson

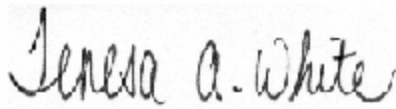
(A2LA Cert. No. 1255.01) 03/26/03
5301 Buckeystown Pike, Suite 350 • Frederick, MD 21704-8373 • Phone: 301-644 3248 • Fax: 301-662 2974



4. Validation Letter – U.S. Competent Body for EMC Directive 89/336/EEC

 <p>1901-2001 NIST CENTENNIAL</p>	 <p>DEPARTMENT OF COMMERCE UNITED STATES OF AMERICA</p>	<p>UNITED STATES DEPARTMENT OF COMMERCE National Institute of Standards and Technology Gaithersburg, Maryland 20899-</p>
<p>January 16, 2001</p>		
<p>Mr. James J. Blaha L.S. Compliance Inc. W66 N220 Commerce Court Cedarburg, WI 53012-2636</p>		
<p>Dear Mr. Blaha:</p>		
<p>I am pleased to inform you that the European Commission has validated your organization's nomination as a U.S. Conformity Assessment Body (CAB) for the following checked (✓) sectoral annex(es) of the U.S.-EU Mutual Recognition Agreement (MRA).</p>		
<p><input checked="" type="checkbox"/> Electromagnetic Compatibility-Council Directive 89/336/EEC, Article 10(2) <input type="checkbox"/> Telecommunication Equipment-Council Directive 98/13/EC, Annex III <input type="checkbox"/> Telecommunication Equipment-Council Directive 98/13/EC, Annex III and IV Identification Number: <input type="checkbox"/> Telecommunication Equipment-Council Directive 98/13/EC, Annex V Identification Number:</p>		
<p>This validation is only for the location noted in the address block, unless otherwise indicated below.</p>		
<p><input checked="" type="checkbox"/> Only the facility noted in the address block above has been approved. <input type="checkbox"/> Additional EMC facilities: <input type="checkbox"/> Additional R&TTE facilities:</p>		
<p>Please note that an organization's validations for various sectors of the MRA are listed on our web site at http://ts.nist.gov/mra. You may now participate in the conformity assessment activities for the operational period of the MRA as described in the relevant sectoral annex or annexes of the U.S.-EU MRA document.</p>		
<p>NIST will continue to work with you throughout the operational period. All CABs validated for the operational phase of the Agreement must sign and return the enclosed CAB declaration form, which states that each CAB is responsible for notifying NIST of any relevant changes such as accreditation status, liability insurance, and key staff involved with projects under the MRA. Please be sure that you fully understand the terms under which you are obligated to operate as a condition of designation as a CAB. As a designating authority, NIST is responsible for monitoring CAB performance to ensure continued competence under the terms of the MRA.</p>		
		

5. Signature Page



April 21, 2003

Prepared By:

Teresa A. White, Document Coordinator

Date

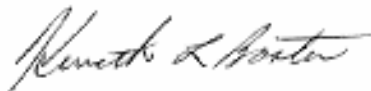


April 21, 2003

Tested By:

Abtin Spantman, EMC Engineer

Date



April 21, 2003

Approved By:

Kenneth L. Boston, EMC Lab Manager
PE #31926 Licensed Professional Engineer
Registered in the State of Wisconsin, United States

Date

6. Product and General Information

Manufacturer: Kohler Company
Description: Whirlpool Remote Transmitter
Serial Number: Engineering Unit
Frequency: 433.92 FSK

Environmental Conditions in the Test Lab:

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

7. Introduction

On March 25th and 31st, 2003, a series of Radiated Emissions tests were performed on one sample of the Kohler Whirlpool Remote Transmitter, here forth referred to as the "*Equipment Under Test*" or "*EUT*". This product operates by means of 3 VDC (2, 'AAA' batteries).

These tests were performed using the test procedure outlined in ANSI C63.4, 2001 for intentional radiators, and in accordance with the limits set forth in FCC Part 15.231, for a periodic operation of a low power transmitter.

8. Purpose

The tests were performed in order to determine the compliance of the EUT, with limits contained in various provisions of Title 47CFR, FCC Part 15, including: 15.205, 15.209, 15.231 (a), 15.231 (b) and 15.231(c).

All radiated emission tests were performed to measure the emissions in the frequency bands described in Section 12i of this report, and to determine whether said emissions are below the limits established by the aforementioned standards.

These tests were performed in accordance with the procedures described in the American National Standard for methods of measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4, 2001).

Also used as a reference for the EMI Receiver specification is the International Special Committee on Radio Interference – CISPR 16-1, 2002.

9. Product Description

The Whirlpool Remote Transmitter is a low power wireless device similar to a key fob. It operates on a frequency of 433.920 MHz sending FSK data with a frequency deviation of 40 kHz. Transmission is enabled only while a key is pressed. It is used to control the functions of various Kohler Whirlpool bathtub products.

10. Test Requirements

The EUT was tested for Radiated Emissions, and for compliance with the limits set forth by 47 CFR, FCC Parts 15.205, 15.209, 15.231(a), 15.231(b) and 15.231(c) for manually operated periodic transmitters, as well as for compliance with Industry Canada, RSS-210, for low power license-exempt radio-communication devices.

11. Summary of Test Report

The Equipment Under Test (EUT) was found to **MEET** the requirements as described within the specifications of Title 47 CFR, FCC Part 15.231 and RSS-210, Section 6.1 for a low power transmitter.

12. Radiated Emission Test

12a. Test Setup

The EUT was operated within the 3 Meter FCC listed Semi-Anechoic Chamber, located at L.S. Compliance, Inc., Cedarburg, Wisconsin. The EUT was placed on an 80cm high non-conductive pedestal, which was centered on the flush-mounted 2m diameter metal turntable. The EUT was configured to run in a continuous transmit mode during the 15.231(a) and 15.231(b) measurements. The EUT was then returned to normal operation for testing of the data packet length and occupied bandwidth.

12b. Test Procedure

The fundamental and spurious (harmonic) emissions of the transmitter were tested for compliance to Title 47CFR, FCC Parts 15.231(a), and 15.231(b) limits for manually operated periodic devices.

The EUT was tested from the lowest frequency generated by the transmitter (without going below 9kHz) to the 10th harmonic of the fundamental frequency generated by the device. The appropriate limits were also observed when any spurious signals were located within any of the restricted bands as described in FCC Part 15.205(a).

The EUT was placed on an 80 cm high non-conductive pedestal, with the Antenna Mast placed 3 m from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 200 MHz, a Log Periodic Antenna was used to measure emissions from 200 MHz to 1000 MHz, and a Double Ridged Waveguide Horn Antenna was used to measure emissions above 1 GHz.

The EUT was programmed to operate in a continuous transmit mode. The resultant signals from the fundamental harmonics, and spurious signals were maximized by rotating the turntable 360 degrees, and by raising and lowering the Antenna between 1 and 4 meters. The EUT was also given different orientations to determine the maximum signal levels, using both horizontal and vertical antenna polarities.

12c. Test Results

No significant emissions were found aside from the transmitter fundamental and harmonics. The unit was scanned for emissions, over the range of 30 MHz to 4500 MHz to establish compliance with FCC Parts 15.231 and 15.205 while in a continuous transmit mode. At frequencies below the fundamental, no spurious signals, other than the noise floor of the system could be found within 20 dB of the limits. A numeric list of measured emissions appears in Section 12i of this report.

12d. Occupied Bandwidth

In addition to measuring the levels of radiated emissions, the occupied bandwidth of the transmitter was measured. In accordance with FCC Part 15.231(c), the 20dB bandwidth of the transmitted signal should be within a window of 0.25% of the center carrier frequency. The resolution bandwidth was set to the closest available filter setting on the HP 8546A EMI Receiver that corresponded to 5% of the allowable bandwidth determined in the calculation mentioned above, without going below the resolution bandwidth of 10 kHz, as dictated in ANSI C63.4-2001 Section 13.1.7.

The sample was activated to transmit in a continuous (normal) mode and was placed on the aforementioned test configuration within the 3 Meter Chamber. The transmitted signal was received on a Log Periodic Antenna and fed to the HP 8546A EMI Receiver, where the fundamental frequency was displayed, and a plot of the occupied bandwidth was produced. Results can be seen in the plots and in Appendix A. The bandwidth was seen to be 110 kHz, which is within the limit allowed.

12e. Test Equipment Utilized, Radiated Emissions

A list of the test equipment used for the tests can be found in Appendix B. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. All antenna calibrations were performed at a N.I.S.T. traceable site, and the resultant correction factors were entered into the HP 8546A EMI Receiver software database.

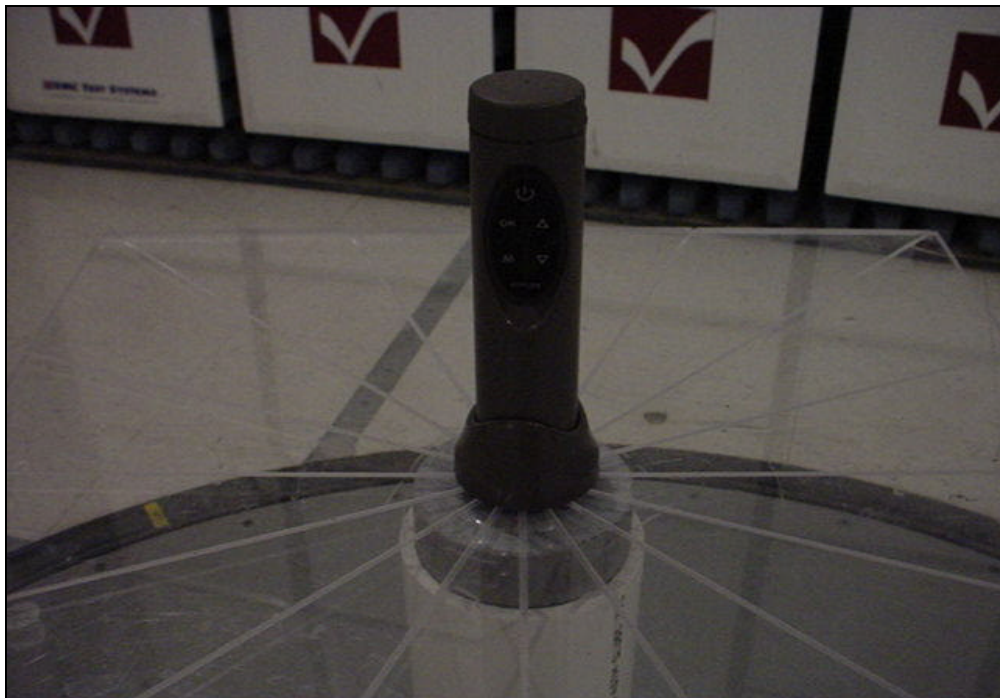
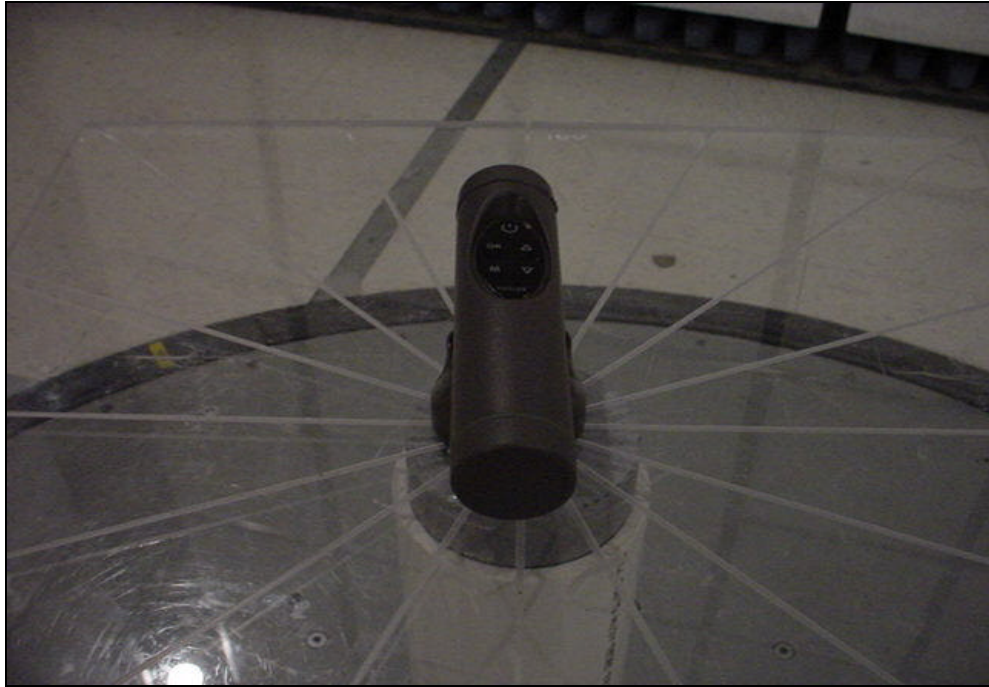
The connecting cables used were also measured for loss using a calibrated Signal Generator and the HP 8546A EMI Receiver. The resulting loss factors were entered into the HP 8546A EMI Receiver database. This allowed for automatic change in the antenna correction factor. The resulting data taken from the HP 8546A EMI Receiver is an actual reading and can be entered into the database as a corrected meter reading.

When a reading is taken using the Peak Detector, a duty cycle correction factor can be applied for conversion to an average reading. This operation can be used when measuring short-duration bursts of data transmission, under FCC Part 15.231.

The resulting average reading can then be compared to the appropriate limit in order to determine compliance with the limits. The HP 8546A EMI Receiver was operated with a bandwidth of 120 kHz when receiving signals below 1 GHz, and with a bandwidth of 1 MHz when receiving signals above 1 GHz, in accordance with CISPR 16.

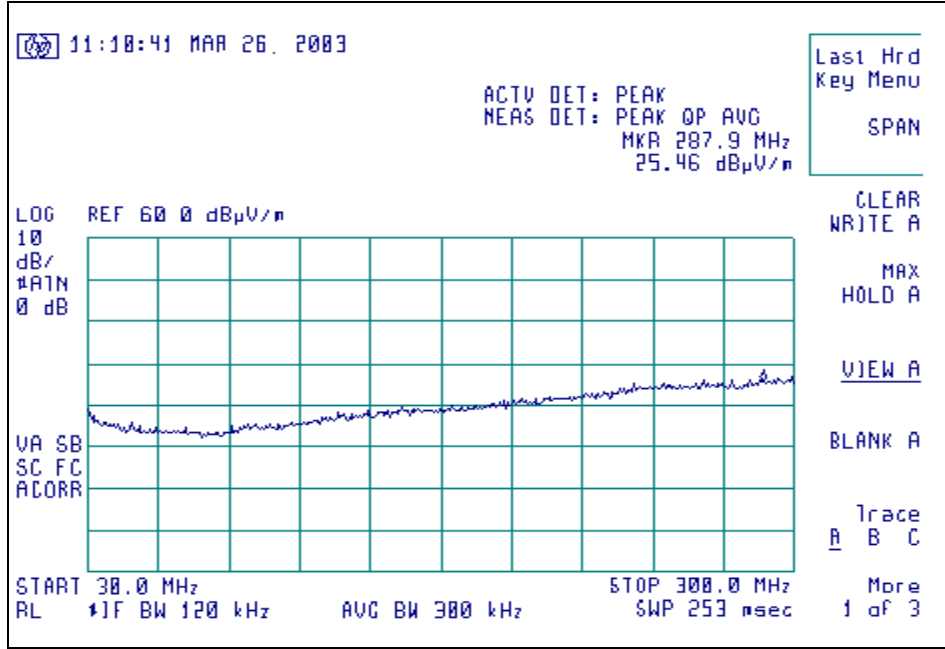
The Peak, Quasi-Peak and Average Detector functions were all used.

12f. Photos of Setup for Radiated Emissions Test

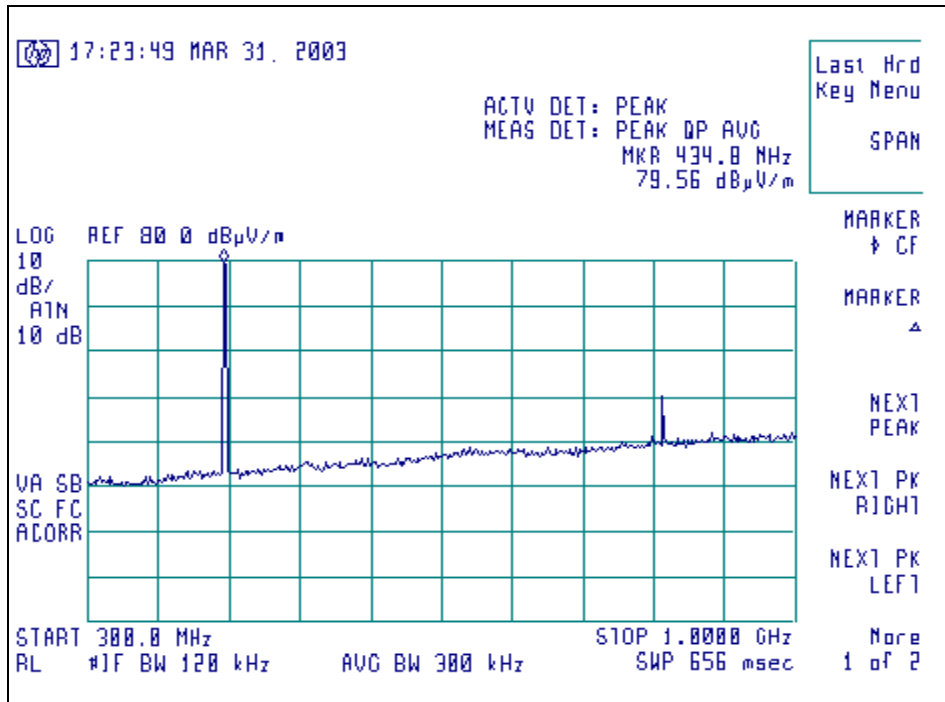


12g. Signature Scans – Radiated Emissions

Radiated Emissions, 30 MHz – 300 MHz, Vertical Polarity, EUT Vertical

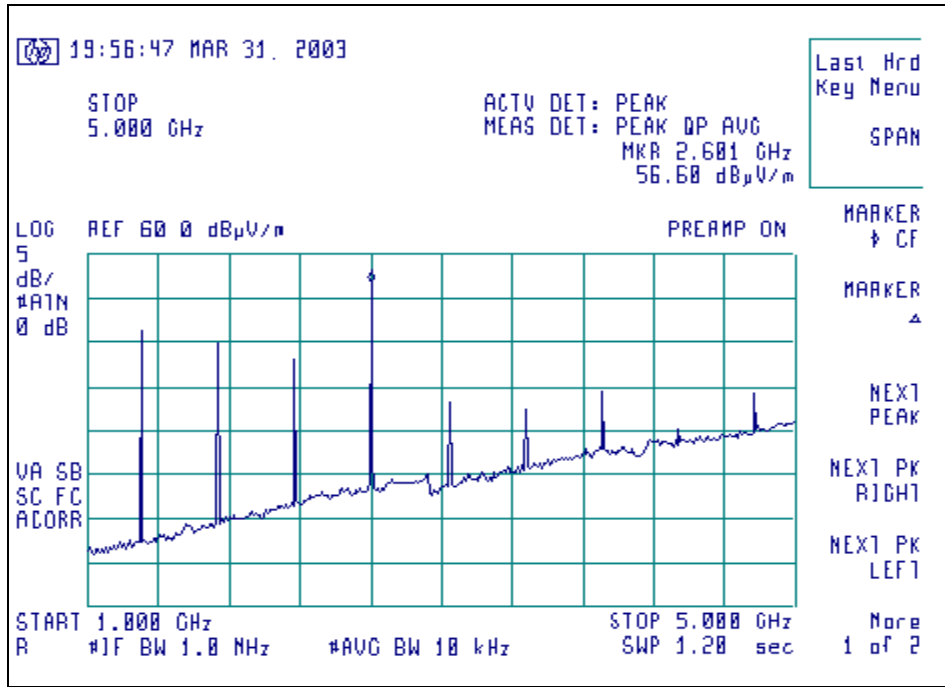


Radiated Emissions, 300 MHz – 1000 MHz, Vertical Polarity, EUT Vertical

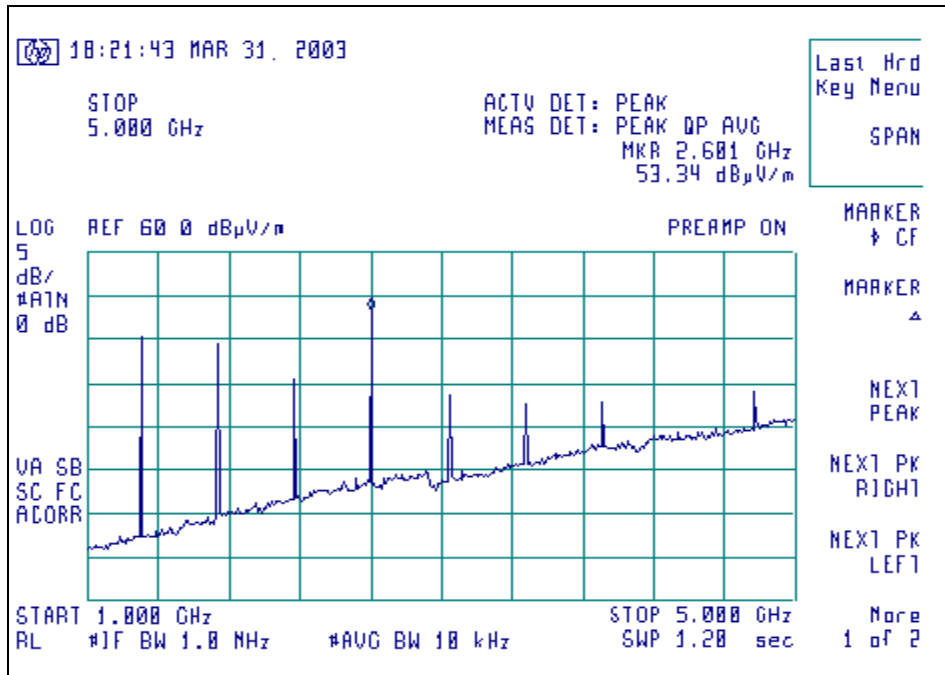


12g. Signature Scans – Radiated Emissions (continued)

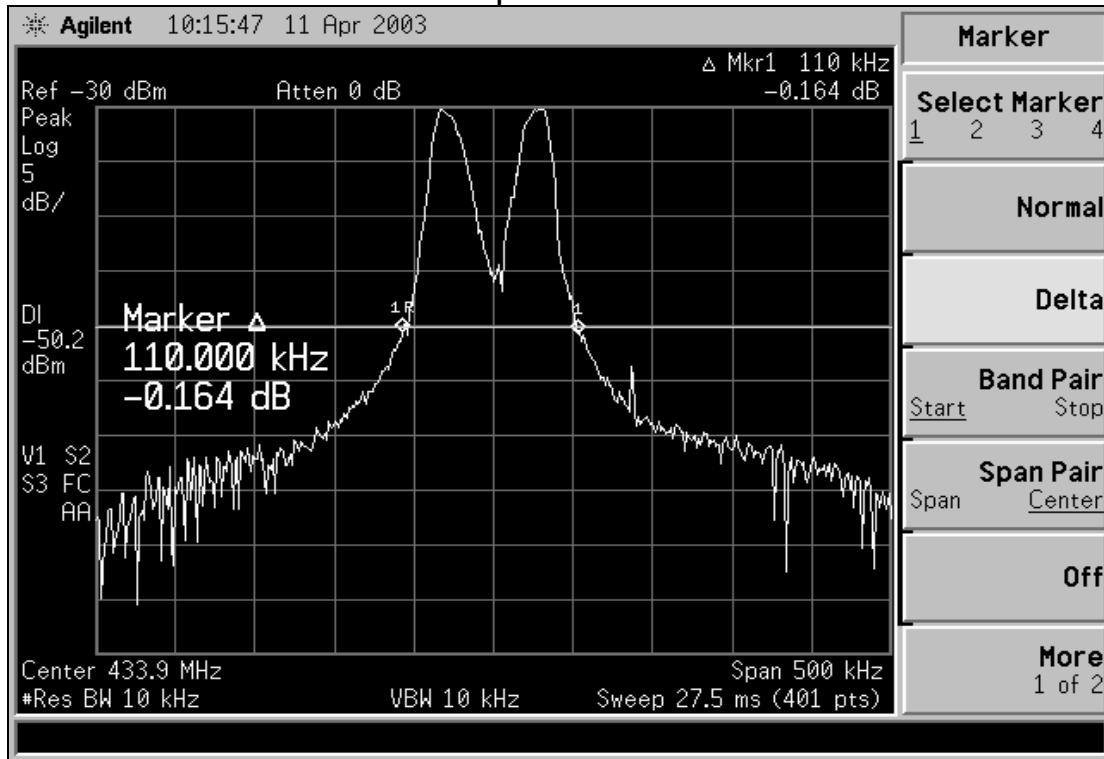
Radiated Emissions, 1 GHz – 5 GHz, Vertical Polarity, EUT on side



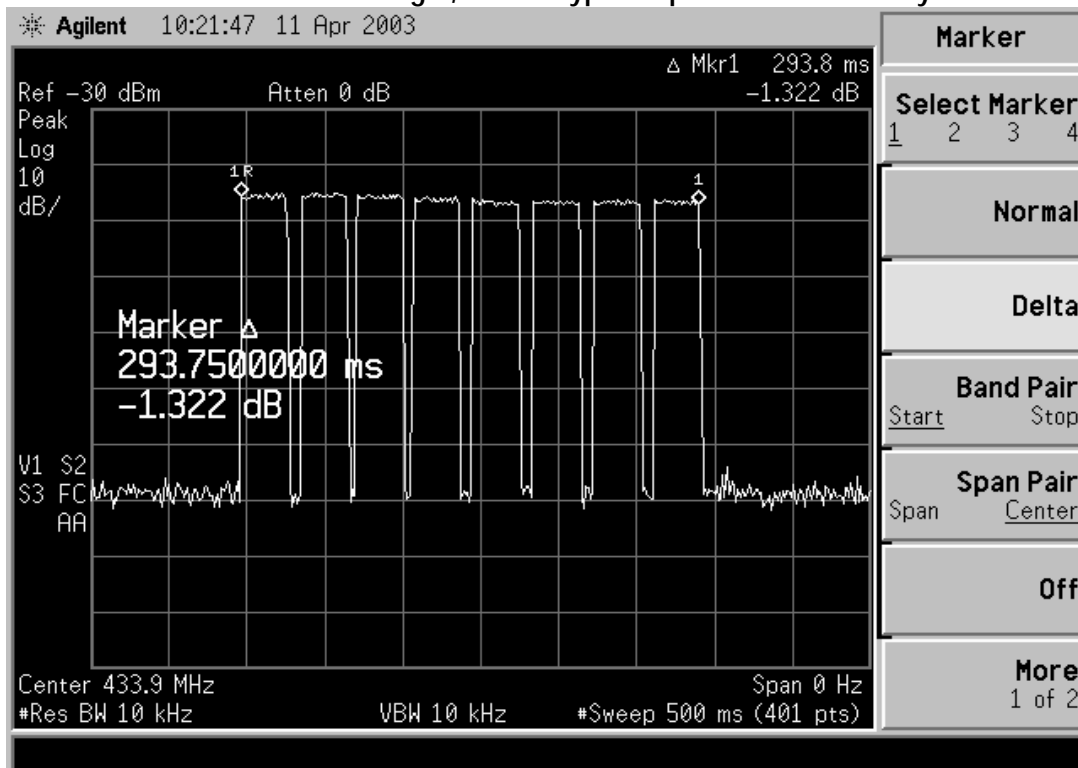
Radiated Emissions, 1 GHz – 5 GHz, Horizontal Polarity, EUT on side



12g. Signature Scans – Radiated Emissions (continued)
Occupied Bandwidth

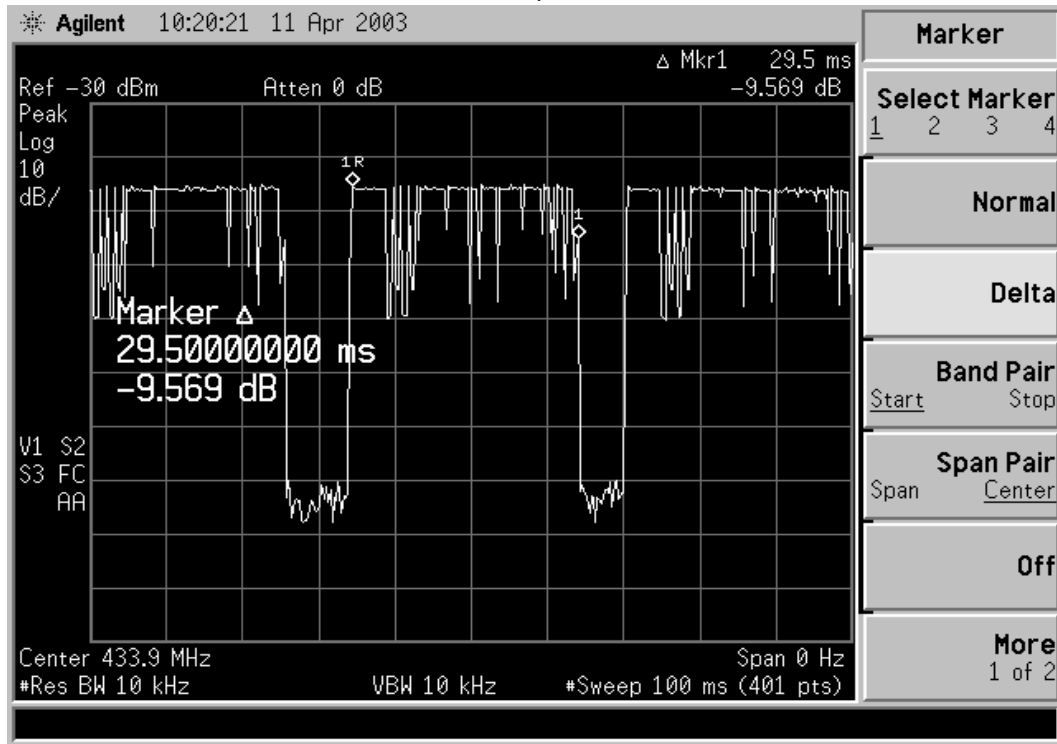


Detail of Packet Length, when keypad depressed momentarily

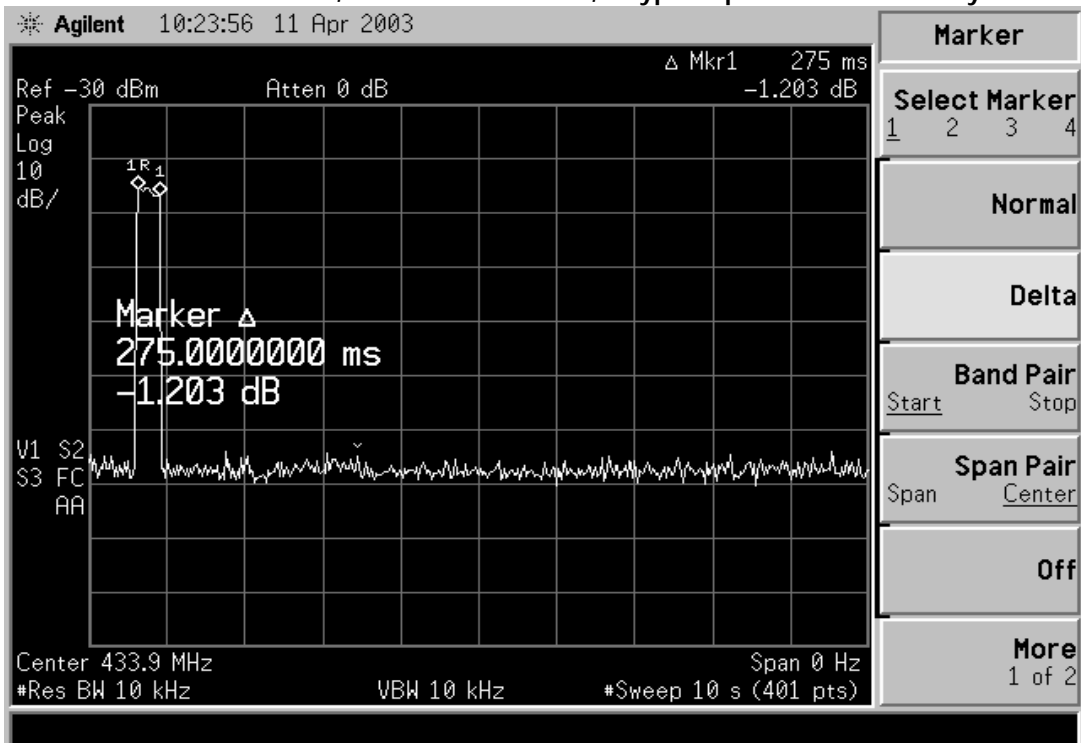


12h. Data Packet Detail – Radiated Emissions

Data Packet Detail, 100 m.s. Window



Data Packet Detail, 10 Second Window, Keypad operated momentarily



**12i. Measurement of Electromagnetic Radiated Emission
Within the 3 Meter Semi-Anechoic FCC Listed Chamber**

Manufacturer: Kohler Company
Dates of Test: March 25th and 31st, 2003
Description: Whirlpool Remote Transmitter
Serial: Engineering Unit
Test

Specifications: FCC Parts 15.231(e) and 15.209

Distance: 3 Meters			Frequency Range Inspected: 30 MHz to 4500 MHz			
Configuration: Continuous Data Transmit						
Detector(s) Used:	v	Peak		Quasi-Peak		Average

Test Equipment Used:

EMI Receiver: HP 8546A	Log Periodic Antenna: EMCO 93146
Double-Ridged Wave Guide/Horn Antenna: EMCO 3115	Biconical Antenna: EMCO 3110B

The following table depicts the level of significant radiated fundamental and harmonic emissions found. All values are peak, with no duty cycle correction applied.

Frequency (MHz)	Antenna Polarity	Height (Meters)	Azimuth (0°-360°)	EMI Meter Reading (dBµV/m)	15.231b Limit (dBµV/m)	Margin (dB)
* 433.9	V	1.15	275	80.0	80.8	0.8
867.8	H	1.0	90	55.2	60.8	5.6
1301.8	V	1.1	45	51.7	54.0	2.3
1735.7	H	1.15	315	50.3	60.8	10.5
2169.6	V	1.2	35	49.2	60.8	11.6
2603.5	V	1.2	85	57.7	60.8	3.1
3037.4	H	1.0	320	46.6	60.8	14.2
3471.4	V	2.5	115	44.3	60.8	16.5
3905.3	V	2.1	130	46.4	54.0	7.6
* 4339.2	V	1.2	0	42.7	54.0	11.3

Note: A Peak Detector was used for all measurements.

* EUT sitting vertical, all other measurements with EUT laying horizontal.

12j. Test Results

No significant emissions were found aside from the transmitter fundamental and several harmonics. The unit was scanned for emissions, over the range of 30 MHz to 4500 MHz to establish compliance with FCC Parts 15.205, 15.209, 15.231(a), 15.231(b) and 15.231(c) while in continuous transmit mode. At frequencies below the fundamental, no spurious signals, other than the noise floor of the system could be found within 20 dB of the limits.

APPENDIX A

Calculations

Manufacturer: Kohler Company

Description: Whirlpool Remote Transmitter

CALCULATION OF RADIATED EMISSIONS LIMITS FOR FCC PARTS 15.209, and 15.231(b) (260-470 MHz)

FIELD STRENGTH OF FUNDAMENTAL FREQUENCIES:

The calculation involves a linear interpolation of 3750 to 12500 $\mu\text{V/m}$ over 260-470 MHz, where field strength of the fundamental frequency (f_0) when 260= f_0 =470 MHz, can be found by: $3750 + 41.6667(f_0-260)$, where f_0 is in MHz.

FIELD STRENGTH OF SPURIOUS/HARMONIC FREQUENCIES:

The spurious and harmonic emissions are subject to the limits expressed in FCC Parts 15.205, and 15.209, if within the restricted bands, and dictated by the following calculation elsewhere.

The calculation involves a linear interpolation of 375 to 1250 $\mu\text{V/m}$ over 260 to 470 MHz, where field strength of the harmonic frequencies ($2f_0, 3f_0\dots$), when 260= f_0 =470 MHz, can be found by: $375 + 4.1667(f_0 - 260)$, where f_0 is in MHz.

Above 470 MHz, the limit on the spurious and harmonic emissions is 1,250 $\mu\text{V/m}$ @ 3m.

At fundamental frequency $f_0 = 433.92$ MHz

Fundamental Limit: $3750 + 41.6667 (433.92-260) = 10996.7 \mu\text{V/m @ 3m}$

Harmonic Limit: $375 + 4.1667 (433.92-260) = 1099.7 \mu\text{V/m @ 3m}$

Frequency (MHz)	Fundamental Limit ($\mu\text{V/m @ 3m}$)	Fundamental Limit (dB $\mu\text{V/m @ 3m}$)	Harmonic Limit ($\mu\text{V/m @ 3m}$)	Harmonic Limit (dB $\mu\text{V/m @ 3m}$)
433.9	10997	80.83	1099.7	60.83

DUTY CYCLE CORRECTION FACTOR CALCULATION

For a graphical presentation of the data packets from the transmitter, refer to the plots on Page 16. These images were captured on an HP E4407 Spectrum Analyzer, brought close to the EUT. The transmitter was functioning in normal operating mode, and activated by pressing one of the transmit buttons.

Average (Relaxation) Factor

The transmitter sends a burst of 8 packets of about 30 m.s. duration; with short wait times between the eight packets. During each packet, the duty cycle is 100% because the modulation method is FSK. The 8 packet transmission is the shortest length transmission, when a button is pressed momentarily. More packets are sent if the button is held down, and stop within approximately 300 m.s. of the release of the button. Refer to the plots on Pages 15 and 16 for this illustration.

In order to allow for some flexibility in packet structure by the manufacturer, no duty cycle correction has been applied.

OCCUPIED BANDWIDTH CALCULATIONS

FCC Part 15.231(c) states that the bandwidth of a manually operated device shall be no wider than 0.25% of the center frequency for devices operating between 70 MHz and 900 MHz.

Said bandwidth is determined at the -20 dB reference to peak carrier points.

Refer to the set of screen captures in the plots on Page 15, showing the actual occupied bandwidth of the transmitters as measured. The allowed bandwidth for this EUT is 1,084.8 kHz.

APPENDIX B

Test Equipment List

Asset #	Manufacturer	Model #	Serial #	Description	Calibration Information	
					Date	Due Date
AA960007	EMCO	3115	99111-4198	Double Ridge Horn Antenna	12-06-02	12-06-03
AA960008	FCC	3816/2NM	9701/1057	16 AMP LISN	09-19-02	09-19-03
AA960031	HP	11947A	3107A01708	Transient Limiter	10-03-00	Note 1*
AA960077	EMCO	93110B	9702-2918	Biconical Antenna	09-19-02	09-19-03
AA960078	EMCO	93146	9701-4855	Log-Periodic Antenna	09-19-02	09-19-03
CC000221	HP	E4407b	Us39160256	26.5 GHz Spectrum Analyzer	10-28-02	10-28-03
EE960004	EMCO	2090	9607-1164	Device Controller	N/A	N/A
EE960013	HP	8546A	3617A00320	Receiver RF Section	09-20-02	09-20-03
EE960014	HP	85460A	3448A00296	Receiver Pre-Selector	09-20-02	09-20-03
N/A	LSC	Cable	0011	3 meter ½" Armored Cable	06-07-02	06-07-03
N/A	LSC	Attenuator		10 db Attenuator		N/A

Note 1* - Equipment calibrated within a traceable system.

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	4.80 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 Meter Chamber, 3 Volts/Meter	1.128 Volts/Meter
Conducted Immunity	3 Volt level	1.0 V