



Electromagnetic Compatibility Test Report

Tests Performed on a Sage Products, Inc.¹

Bluetooth Hand Hygiene Dispenser, Model 8888

Radiometrics Document RP-8016



Product Detail:

FCC ID: 2ADY3-8888

Equipment type: 2.4 GHz transmitter

Test Standards:

US CFR Title 47, Chapter I, FCC Part 15 Subpart C

FCC Part 15 CFR Title 47: 2014

This report concerns: Original Grant for Certification

FCC Part 15.249

Tests Performed For:

Sage Products, Inc.
3909 Three Oaks Road
Cary, IL 60013

Test Facility:

Radiometrics Midwest Corporation
12 East Devonwood
Romeoville, IL 60446
(815) 293-0772

Test Date(s): (Month-Day-Year)

January 7-8, 2015

Document RP-8016 Revisions:

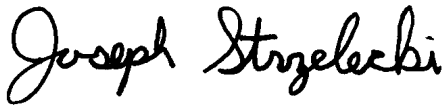
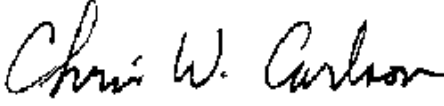
Rev.	Issue Date	Affected Sections	Revised By
0	January 21, 2015		
1	January 28, 2015	3.1, 10.2, 10.1.3	Joseph Strzelecki

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1 ADMINISTRATIVE DATA

<i>Equipment Under Test:</i>	
A Sage Products, Inc., Bluetooth Hand Hygiene Dispenser Model: 8888 Serial Number: none This will be referred to as the EUT in this Report	
<i>Date EUT Received at Radiometrics: (Month-Day-Year)</i>	<i>Test Date(s): (Month-Day-Year)</i>
January 6, 2015	January 7-8, 2015
<i>Test Report Written By:</i>	<i>Tests were not Witnessed by Personnel from:</i>
Joseph Strzelecki Senior EMC Engineer	Sage Products, Inc.
<i>Radiometrics' Personnel Responsible for Test:</i>	<i>Test Report Approved By</i>
 01/21/2015 Joseph Strzelecki Senior EMC Engineer NARTE EMC-000877-NE	 01/21/2015 Chris W. Carlson Director of Engineering NARTE EMC-000921-NE

2 TEST SUMMARY AND RESULTS

The EUT (Equipment Under Test) is a Bluetooth Hand Hygiene Dispenser, Model 8888, manufactured by Sage Products, Inc. The detailed test results are presented in a separate section. The following is a summary of the test results.

Emissions Tests Results

Environmental Phenomena	Frequency Range	Basic Standard	Test Result
RF Radiated Emissions	30-25,000 MHz	RSS-210 & FCC Part 15	Pass
Occupied Bandwidth Test	Fundamental Freq.	RSS-210 & FCC Part 15	Pass

Note: The RSS-210 specification is not currently covered in Radiometrics' Scope of Accreditation. This is technically very similar to FCC, CFR 47 Part 15 which is on Radiometrics scope.

2.1 RF Exposure Compliance Requirements

Since the power output is 1.4 mW, the EUT meets the FCC requirement for RF exposure and is exempt from RSS-102 SAR and RF exposure evaluations. There are no power level adjustments and the antenna is permanently attached. The detailed calculations for RF Exposure are presented in a separate document.

3 EQUIPMENT UNDER TEST (EUT) DETAILS

3.1 EUT Description

The EUT is a Bluetooth Hand Hygiene Dispenser, Model 8888, manufactured by Sage Products, Inc. The EUT was in good working condition during the tests, with no known defects.

3.1.1 FCC Section 15.203 & RSS-GEN Antenna Requirements

The antenna is permanently attached to the printed circuit board. The antenna is internal to the EUT and it is not readily available to be modified by the end user. Therefore, it meets the 15.203 Requirements.

3.2 Related Submittals

Sage Products, Inc. is not submitting any other products simultaneously for equipment authorization related to the EUT.

4 TESTED SYSTEM DETAILS

4.1 Tested System Configuration

The system was configured for testing in a typical fashion. The EUT was placed on an 80-cm high, nonconductive test stand. The testing was performed in conditions as close as possible to installed conditions. Wiring was consistent with manufacturer's recommendations.

The EUT was tested as a stand-alone device. Power was supplied with a new battery.

The identification for all equipment, plus descriptions of all cables used in the tested system, are:

Tested System Configuration List

Item	Description	Type*	Manufacturer	Model Number	Serial Number
1	Bluetooth Hand Hygiene Dispenser	E	Sage Products, Inc.	8888	Sample 1

* Type: E = EUT, P = Peripheral, S = Support Equipment; H = Host Computer

4.2 Special Accessories

No special accessories were used during the tests in order to achieve compliance.

4.3 Equipment Modifications

No modifications were made to the EUT at Radiometrics' test facility in order to comply with the standards listed in this report.

5 TEST SPECIFICATIONS AND RELATED DOCUMENTS

Document	Date	Title
FCC CFR Title 47	2014	Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 - Radio Frequency Devices
ANSI C63.4-2009	2009	Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2009	2009	American National Standard for Testing Unlicensed Wireless Devices

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

6 RADIOMETRICS' TEST FACILITIES

The results of these tests were obtained at Radiometrics Midwest Corp. in Romeoville, Illinois, USA. Radiometrics 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". Radiometrics' Lab Code is 121191 and Certification Number is 1495.01. Radiometrics' scope of accreditation includes all of the test methods listed herein. A copy of the accreditation can be accessed on our web site (www.radiomet.com). Radiometrics accreditation status can be verified at A2LA's web site (www.a2la2.org).

The following is a list of shielded enclosures located in Romeoville, Illinois used during the tests:

Chamber E: Is a custom made anechoic chamber that measures 52' L X 30' W X 18' H. The walls and ceiling are fully lined with RF absorber. Pro-shield of Collinsville, Oklahoma manufactured the chamber. The floor has a 9' x 9' section of microwave absorber for testing above 1 GHz.

Test Station F: Is an area that measures 10' D X 12' W X 10' H. The floor and back wall are metal shielded. This area is used for conducted emissions measurements.

A separate ten-foot long, brass plated, steel ground rod attached via a 6 inch copper braid grounds each of the above chambers. Each enclosure is also equipped with low-pass power line filters.

The FCC has accepted these sites as test site number US1065. The FCC test site Registration Number is 732175. Details of the site characteristics are on file with the Industry Canada as site number IC8727A-1.

A complete list of the test equipment is provided herein. The calibration due dates are indicated on the equipment list. The equipment is calibrated in accordance to ANSI/NCSL Z540-1 with traceability to the National Institute of Standards and Technology (NIST).

7 DEVIATIONS AND EXCLUSIONS FROM THE TEST SPECIFICATIONS

There were no deviations or exclusions from the test specifications.

8 CERTIFICATION

Radiometrics Midwest Corporation certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specification and the data contained herein was taken with calibrated test equipment. The results relate only to the EUT listed herein.

9 TEST EQUIPMENT TABLE

RMC ID	Manufacturer	Description	Model No.	Serial No.	Frequency Range	Cal Period	Cal Date
AMP-05	RMC/Celeritek	Pre-amplifier	MW110G	1001	1.0-12GHz	12 Mo.	07/01/14
AMP-20	Avantek	Pre-amplifier	SF8-0652	15221	8-18GHz	12 Mo.	01/17/14
AMP-22	Anritsu	Pre-amplifier	MH648A	M23969	0.1-1200MHz	12 Mo.	01/15/14
AMP-29	HP / Agilent	Amplifier	11975A	2304A00158	2-8 GHz	12 Mo.	01/09/15
ANT-13	EMCO	Horn Antenna	3115	2502	1.0-18GHz	24 Mo.	12/01/14
ANT-44	Impossible Machine	Super Log Antenna	SL-20M2G	1002	20-2000MHz	24 Mo.	12/10/13
ATT-05	Pasternack	Attenuator (6 dB)	PE7021-6	RMC5	DC-1.5GHz	24 Mo.	04/29/14
HPF-01	Solar	High Pass Filter	7930-100	HPF-1	0.15-30MHz	24 Mo.	01/24/14
MXR-02	HP / Agilent	Harmonic Mixer	11970K	2332A00489	18-26.5GHz	12 Mo.	01/09/15
REC-11	Hewlett Packard	Spectrum Analyzer	E7405A	US39110103	9Hz-26.5GHz	12 Mo.	06/17/14
THM-02	Fluke	Temp/Humid Meter	971	93490471	N/A	24 Mo.	06/27/13

Note: All calibrated equipment is subject to periodic checks.

10 TEST SECTIONS

10.1 Radiated RF Emissions

Radiated emission measurements were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. The radiated emission measurements were performed with a spectrum analyzer. The bandwidth used from 150 kHz to 30 MHz is 9 or 10 kHz and the bandwidth from 30 MHz to 1000 MHz is 100 or 120 kHz. Above 1 GHz, a 1 MHz bandwidth is used. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists.

From 30 to 1000 MHz, an Anritsu spectrum analyzer was used. For tests from 1 to 25 GHz, an HP 8566 spectrum analyzer was used. For tests from 1 to 10 GHz, a high pass filter was used to reduce the fundamental emission. A harmonic mixer was used from 18 to 25 GHz. Figure 4 herein lists the details of the test equipment used during radiated emissions tests.

The EUT was rotated through three orthogonal axis as per 13.1.4.1 of ANSI C63.4 during the radiated tests.

Final radiated emissions measurements were performed inside of an anechoic chamber at a test distance of 3 meters. The anechoic chamber is designated as Chamber E. This Chamber meets the Site Attenuation requirements of ANSI C63.4 and CISPR 16-1. Chamber E is located at 12 East Devonwood Ave. Romeoville, Illinois EMI test lab.

The entire frequency range from 30 to 25,000 MHz was slowly scanned with particular attention paid to those frequency ranges which appeared high. Measurements were performed using two antenna polarizations, (vertical and horizontal). The worst case emissions were recorded. All measurements may be performed using either the peak, average or quasi-peak detector functions. If the peak detector data exceeds or is marginally close to the limits, the measurements are repeated using a quasi-peak detector or average function as required by the specification for final determination of compliance.

The detected emission levels were maximized by rotating the EUT, adjusting the positions of all cables, and by scanning the measurement antenna from 1 to 4 meters above the ground.

10.1.1 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and by subtracting the Amplifier Gain from the measured reading. The basic equation is as follows:

$$FS = RA + AF + CF - AG + HPF + PKA$$

Where: FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

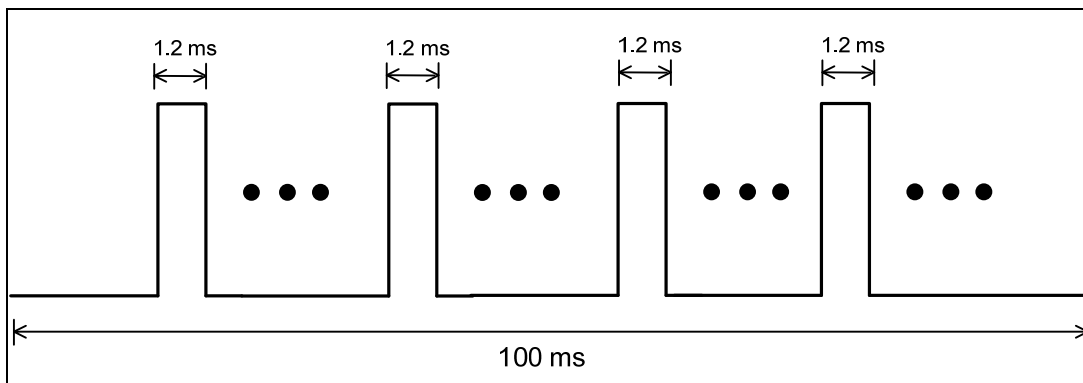
PKA = Peak to Average Factor (This is zero for non-average measurements)

The Peak to average factor is used when average measurements are required. It is calculated by the highest duty cycle in percent over any 100mS transmission. The factor in dB is $20 * \text{Log}(\text{Duty cycle}/100)$.

10.1.2 Duty Cycle

The Peak to average factor is calculated by the highest duty cycle in percent over any 100mS transmission. The factor in dB is $20 * \text{Log}(\text{Duty cycle}/100)$. The transmitter operates for a maximum duration of 4.5 ms in any 100 ms interval for a **4.8%** maximum duty cycle.

$$20 \text{ Log}(4.8\text{mSec}/100\text{mSec}) = -26.4 \text{ dB Peak to average Correction factor.}$$



Testing of the Sage Products, Inc., Model 8888, Bluetooth Hand Hygien Dispenser

10.1.3 Radiated Emissions Test Results

Test Date	01/07/2015
Test Distance	3 Meters
Specification	FCC Part 15 Subpart C & RSS-210
Tested by	Richard Tichgelaar
Abbreviations	P = peak; Q = QP Pol = Antenna Polarization; V = Vertical; H = Horizontal; Antenna Type ANT-44 for 30-1000 MHz; ANT-13 Above 1 GHz Corr. Factors = Antenna factor + cable Loss – Preamp gain

Results below 1 GHz

Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Ant Factor	Cable/amp Factors	Dist Fact dB	EUT dBuV/m	Limit dBuV/m	Margin Under Limit dB	Note
32.8	35.2	P	H	16.8	-28.3	0.0	23.7	40.0	16.3	1
80.1	34.5	P	H	7.0	-27.9	0.0	13.6	40.0	26.4	1
102.1	40.8	P	H	9.8	-27.8	0.0	22.9	43.5	20.6	1
162.6	36.7	P	H	10.5	-27.6	0.0	19.7	43.5	23.8	1
188.4	38.6	P	H	9.4	-27.5	0.0	20.5	43.5	23.0	1
207.6	39.0	P	H	10.6	-27.4	0.0	22.2	43.5	21.3	1
258.1	39.7	P	H	12.9	-27.5	0.0	25.1	46.0	20.9	1
296.3	37.0	P	H	13.0	-27.2	0.0	22.7	46.0	23.3	1
362.5	34.2	P	H	15.7	-27.3	0.0	22.5	46.0	23.5	1
418.1	38.8	P	H	16.9	-27.0	0.0	28.6	46.0	17.4	1
498.1	34.4	P	H	17.4	-26.6	0.0	25.2	46.0	20.8	1
542.5	33.5	P	H	18.1	-26.9	0.0	24.7	46.0	21.3	1
560.0	35.7	P	H	19.2	-26.8	0.0	28.0	46.0	18.0	1
675.0	35.9	P	H	20.3	-26.2	0.0	30.0	46.0	16.0	1
743.8	37.3	P	H	20.1	-26.2	0.0	31.2	46.0	14.8	1
876.3	34.8	P	H	21.5	-25.5	0.0	30.7	46.0	15.3	1
33.3	35.2	P	V	16.7	-28.3	0.0	23.6	40.0	16.4	1
98.2	42.3	P	V	8.9	-27.8	0.0	23.4	43.5	20.1	1
103.7	41.5	P	V	10.4	-27.8	0.0	24.2	43.5	19.3	1
119.1	41.6	P	V	14.3	-27.8	0.0	28.1	43.5	15.4	1
174.6	35.1	P	V	9.6	-27.5	0.0	17.2	43.5	26.3	1
185.6	36.7	P	V	9.4	-27.5	0.0	18.6	43.5	24.9	1
255.0	38.8	P	V	12.9	-27.5	0.0	24.2	46.0	21.8	1
296.9	38.0	P	V	13.1	-27.2	0.0	23.8	46.0	22.2	1
326.9	42.8	P	V	14.2	-27.2	0.0	29.8	46.0	16.2	1
334.4	33.3	P	V	14.5	-27.3	0.0	20.5	46.0	25.5	1
347.5	37.3	P	V	15.6	-27.3	0.0	25.5	46.0	20.5	1
413.1	44.1	P	V	16.6	-27.0	0.0	33.7	46.0	12.3	1
521.3	34.2	P	V	19.1	-26.7	0.0	26.6	46.0	19.4	1
640.0	38.1	P	V	19.4	-26.5	0.0	31.0	46.0	15.0	1
685.0	34.6	P	V	20.3	-26.1	0.0	28.7	46.0	17.3	1
735.0	40.3	P	V	19.8	-26.1	0.0	34.0	46.0	12.0	1
760.0	34.1	P	V	20.8	-26.2	0.0	28.7	46.0	17.3	1
846.3	34.5	P	V	22.2	-25.5	0.0	31.2	46.0	14.8	1
880.0	33.7	P	V	21.6	-25.5	0.0	29.8	46.0	16.2	1
991.3	35.2	P	V	22.5	-24.3	0.0	33.4	54.0	20.6	1

Testing of the Sage Products, Inc., Model 8888, Bluetooth Hand Hygien Dispenser

Test Date: 01/08/2015

Tested by: Richard Tichelaar

Fundamental and Harmonic Emissions above 1 GHz

		Spectrum Analyzer Readings dBuV									EUT	Peak	Ave	Peak	Ave	Margin
hrm	Tx	Peak		Ave		Peak		Ave		Corr.	Emission	Tot. FS		Limit		Under
#	Freq	Vertical Polarization				Horizontal Polarization				Fact.	Freq MHz	dBuV/m		dBuV/m		Limit
		X	Y	Z	Max	X	Y	Z	Max							
1	2402	82.4	87.4	82.1	61.0	82.4	77.9	85.6	59.2	3.0	2402.0	90.4	64.0	114	94	23.6
BE	2402	46.5	51.5	46.2	25.1	46.5	42.0	49.7	23.3	3.0	2400.0	54.5	28.1	74	54	19.5
2	2402	40.6	35.2	37.4	14.2	37.1	41.8	38.2	15.4	10.8	4804.0	52.6	26.2	74	54	21.4
3	2402	36.5	34.9	36.6	10.2	36.4	36.5	36.9	10.5	12.3	7206.0	49.2	22.8	74	54	24.8
1	2440	82.2	85.6	82.3	59.2	84.9	78.3	86.2	59.8	3.5	2440.0	89.7	63.3	114	94	24.3
2	2440	40.2	35.0	37.4	13.8	38.0	38.8	38.7	12.4	10.7	4880.0	50.9	24.5	74	54	23.1
3	2440	36.7	35.5	36.7	10.3	38.5	36.7	37.2	12.1	12.8	7320.0	51.3	24.9	74	54	22.7
1	2480	80.2	83.9	80.5	57.5	86.0	78.0	81.7	59.6	3.8	2480.0	89.8	63.4	114	94	24.2
BE	2480	39.7	43.4	40.0	17.0	45.5	37.5	41.2	19.1	3.8	2483.5	49.3	22.9	74	54	24.7
2	2480	38.3	38.5	37.5	12.1	38.5	41.2	37.8	14.8	10.2	4960.0	51.4	25.0	74	54	22.6
3	2480	35.7	37.6	37.1	11.2	37.6	37.4	37.6	11.2	13.3	7440.0	50.9	24.5	74	54	23.1
Column numbers (see below for explanations)																
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Column #1. hrm = Harmonic; BE = Band Edge emissions

Column #2. Frequency of Transmitter.

Column #3. Uncorrected readings from the spectrum analyzer with First Axis Rotation.

Column #4. Uncorrected readings from the spectrum analyzer with Second Axis Rotation.

Column #5. Uncorrected readings from the spectrum analyzer with Third Axis Rotation.

Column #6. Average Reading based on peak reading reduced by the Duty cycle correction of 40 dB

Column #7. Uncorrected readings from the spectrum analyzer with First Axis Rotation.

Column #8. Uncorrected readings from the spectrum analyzer with Second Axis Rotation.

Column #9. Uncorrected readings from the spectrum analyzer with Third Axis Rotation.

Column #10. Average Reading based on peak reading reduced by the Duty cycle correction of 40 dB

Column #11. Corr. Factors = Cable Loss – Preamp Gain + Antenna Factor

Column #12. Frequency of Tested Emission

Column #13. Highest peak field strength at listed frequency.

Column #14. Highest Average field strength at listed frequency.

Column #15. Peak Limit.

Column #16. Average Limit.

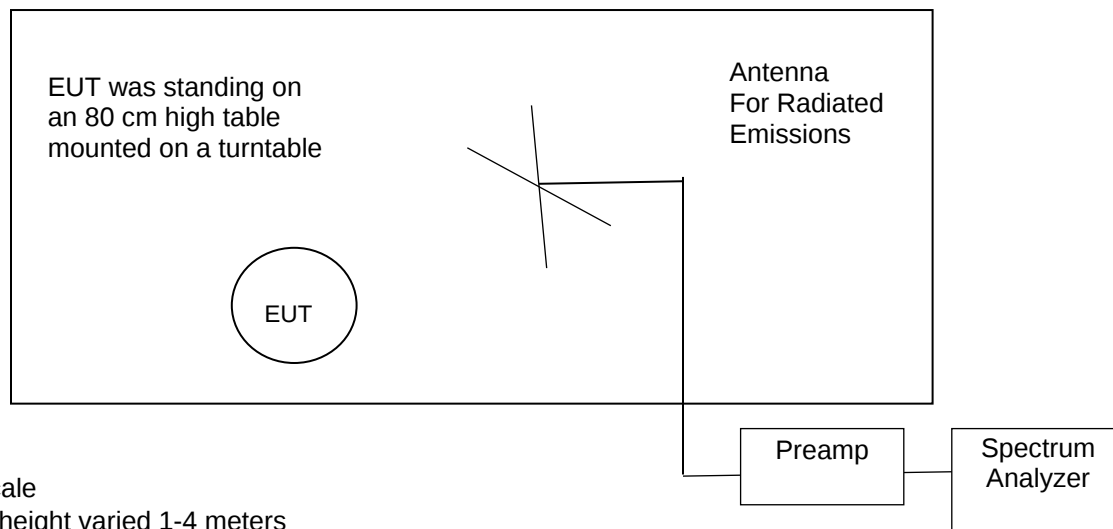
Column #17. The margin (last column) is the worst case margin under the peak or average limits for that row.

Overall Judgment: Passed by at least 9.1 dB

No Emissions were detected from 1000 to 25,000 MHz, within 15 dB of the limits.

Figure 1. Drawing of Radiated Emissions Setup

Chamber E, anechoic

**Notes:**

- Not to Scale
- Antenna height varied 1-4 meters
- Distance from antenna to tested system is 3 meters
- AC cords not shown. They are connected to AC outlet with low-pass filter on turntable

Frequency Range	Receive Antenna	Pre-Amplifier	Spectrum Analyzer
30 to 1000 MHz	ANT-44	AMP-22	REC-11
1 to 10 GHz	ANT-13	AMP-05	REC-11
10 to 25 GHz	ANT-13	AMP-20	REC-11

10.2 Occupied Bandwidth Data

The occupied bandwidth of the RF output was measured using a spectrum analyzer. The bandwidth was measured using the peak detector function and a narrow resolution bandwidth.

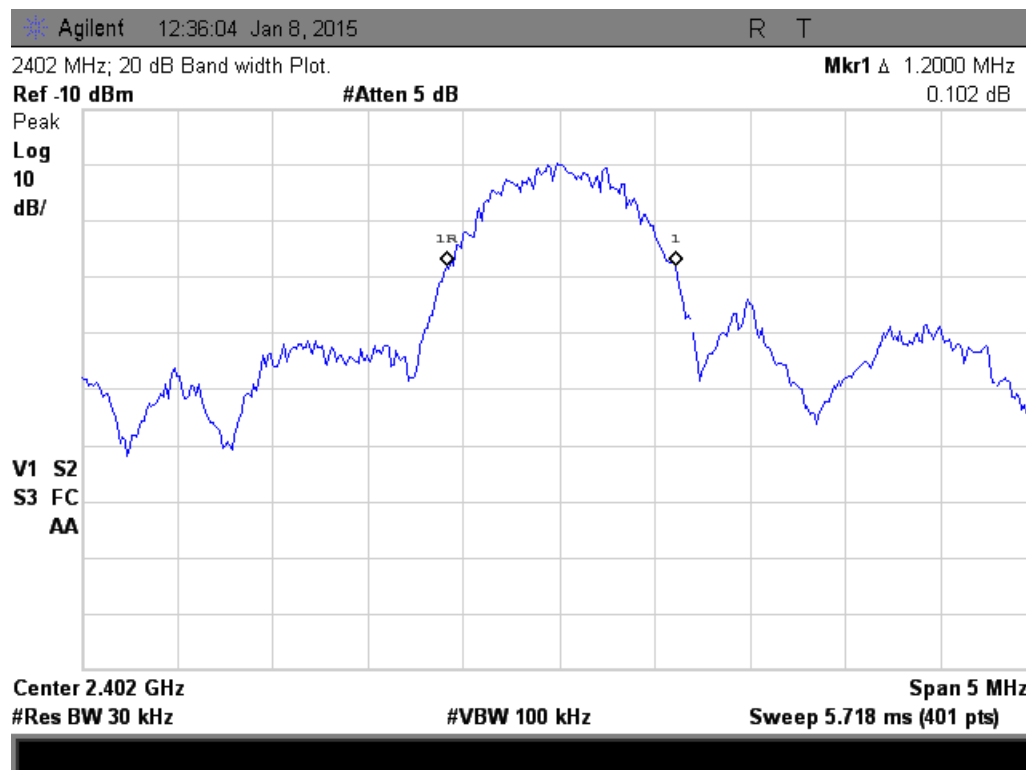
A broadband antenna was used to receive the modulated signal. The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation. The spectrum analyzer display was digitized and plotted. A limit was drawn on the plots based on the level of the modulated carrier. The plots of the occupied bandwidth for the EUT are supplied on the following page.

Test Date: 01/08/2015

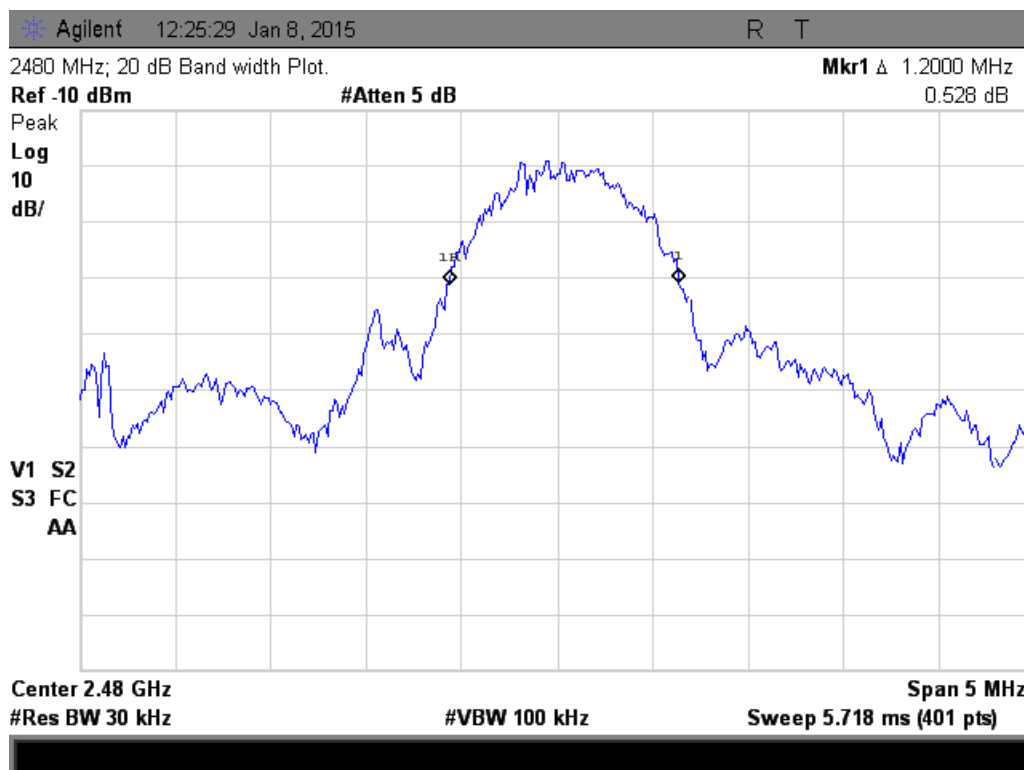
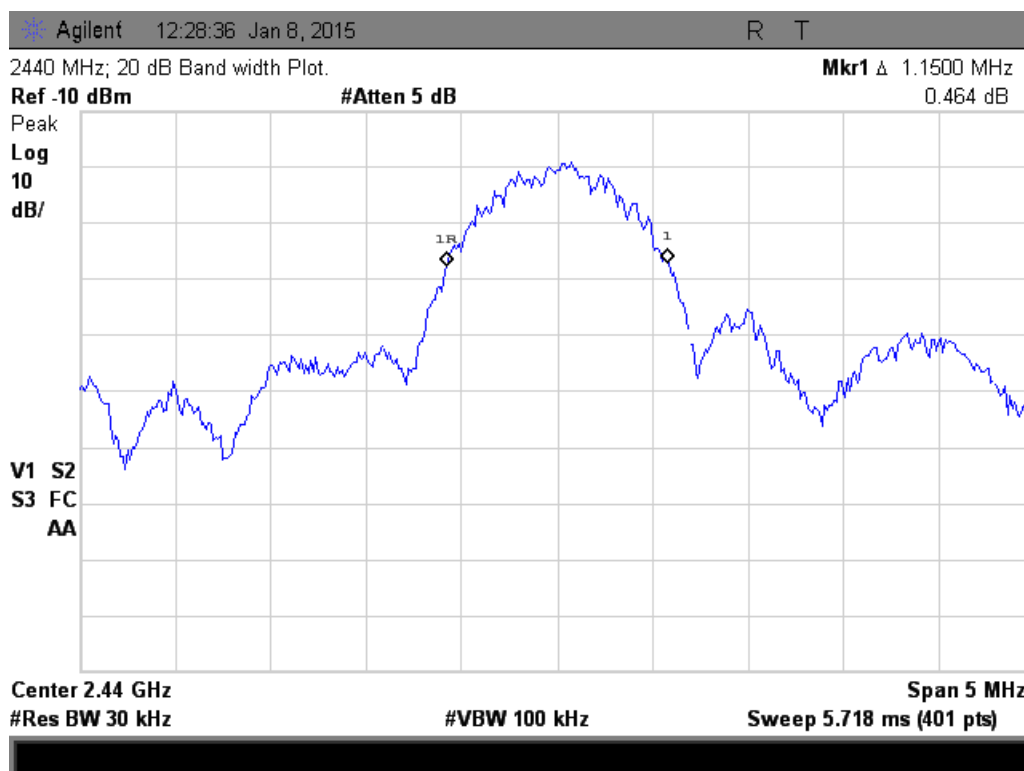
Tested by: Richard Tichgelaar

Channel	20 dB EBW MHz
2402	1.200
2440	1.150
2480	1.200

Figure 2. Occupied Bandwidth Plots



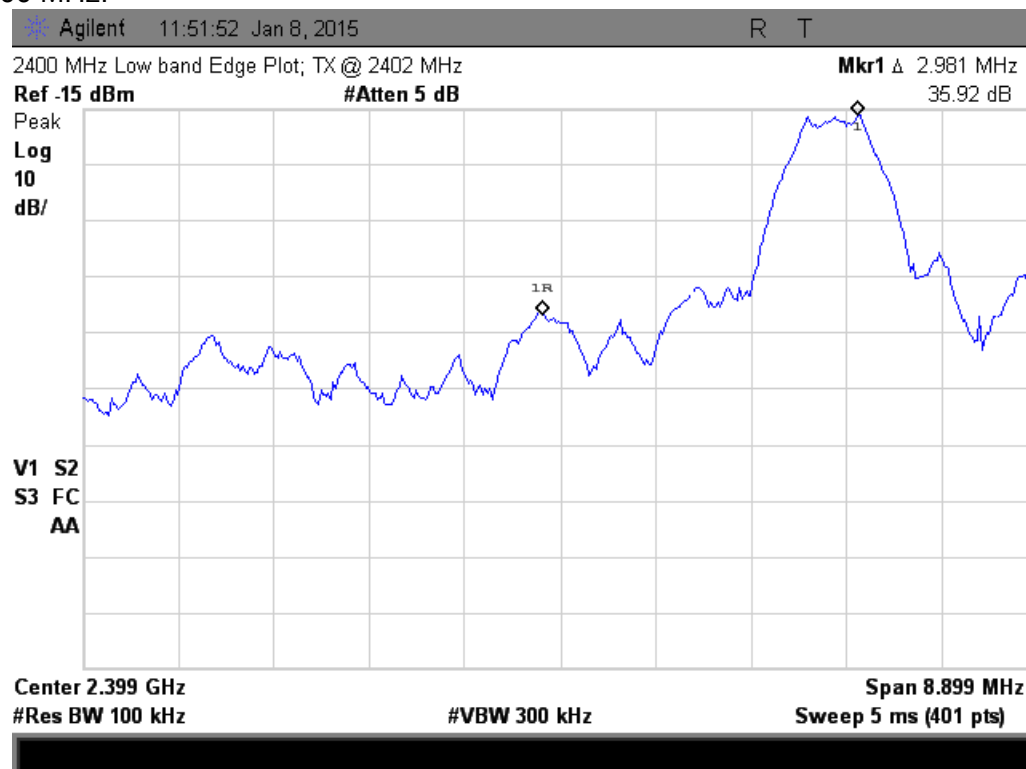
Testing of the Sage Products, Inc., Model 8888, Bluetooth Hand Hygien Dispenser



10.3 Band-edge Compliance of RF Conducted Emissions

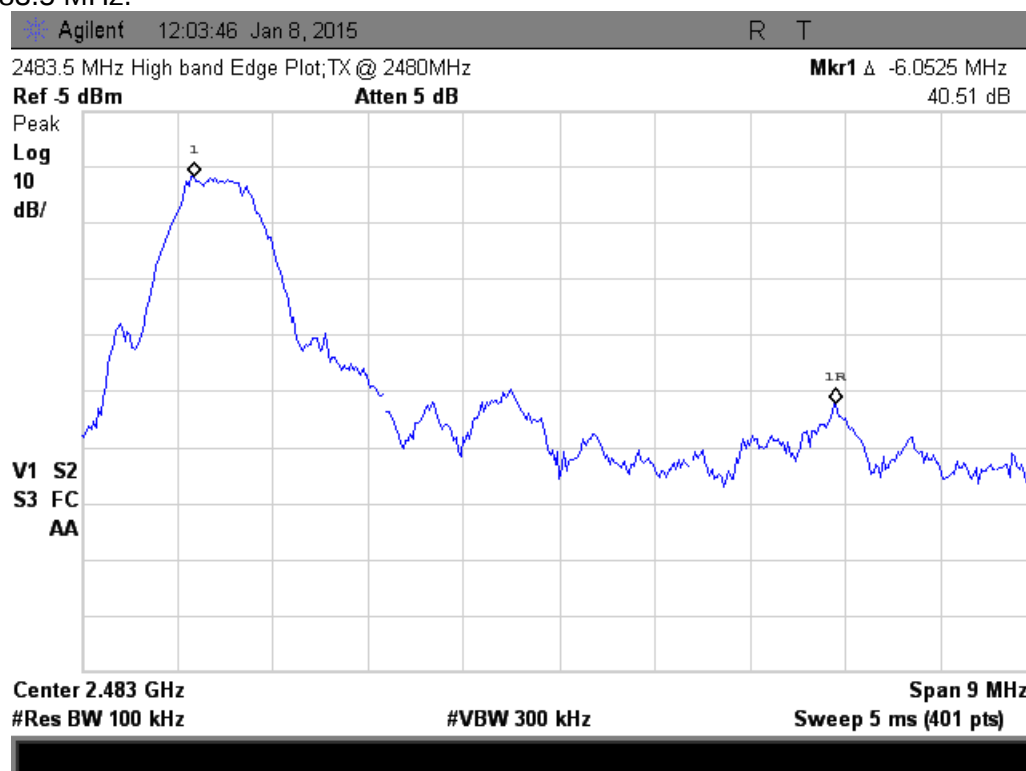
The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation at the band-edge, with the EUT set to the lowest frequency. The trace was allowed to stabilize.

Delta from 2400 MHz.



Testing of the Sage Products, Inc., Model 8888, Bluetooth Hand Hygien Dispenser

Delta from 2483.5 MHz.



Channel	Reading at Band Edge	
	Freq. (MHz)	Delta (dB)
2402 Lower Band edge	2400	35.9
2480 Upper Band edge	2483.5	40.5

These results were used in the Band edge calculations on page 9 herein.

It was fully compliant with the general field strength limits of 15.209 at the band edge using the delta-marker method, section 6.9.3 of ANSI C63.10-2009.

Judgment: Passed by 19.5 dB