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Electromagnetic Emissions Test Report and Application for Grant of Equipment Authorization pursuant to FCC Part 15, Subpart C Specifications for an Intentional Radiator on the Vocera Communications Model: Communications Badge

FCC ID:	QGZ-B1000
GRANTEE:	Vocera Communications 20230 Steven Creek Blvd., Suite C Cupertino, CA 95014
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
REPORT DATE:	June 27, 2002
FINAL TEST DATE:	June 19, 2002

AUTHORIZED SIGNATORY: _____

Juan Martinez
Sr. EMC Engineer

TABLE OF CONTENTS

SCOPE

An electromagnetic emissions test has been performed on the Vocera Communications Voice over 802.11b model Communications Badge pursuant to Subpart C of Part 15 of FCC Rules for intentional radiators. Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in ANSI C63.4-1992 as outlined in Elliott Laboratories test procedures.

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant FCC performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

The test results recorded herein are based on a single type test of the Vocera Communications model Communications Badge and therefore apply only to the tested sample. The sample was selected and prepared by Karl Hannested of Vocera Communications.

OBJECTIVE

The primary objective of the manufacturer is compliance with Subpart C of Part 15 of FCC Rules for the radiated and conducted emissions of intentional radiators. Certification of these devices is required as a prerequisite to marketing as defined in Part 2 the FCC Rules.

Certification is a procedure where the manufacturer or a contracted laboratory makes measurements and submits the test data and technical information to the FCC. The FCC issues a grant of equipment authorization upon successful completion of their review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

STATEMENT OF COMPLIANCE

The tested sample of Vocera Communications model Communications Badge complied with the requirements of Subpart C of Part 15 of the FCC Rules for low power intentional radiators.

Maintenance of FCC compliance is the responsibility of the manufacturer. Any modification of the product, which may result in increased emission, should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

EMISSION TEST RESULTS

The following emissions tests were performed on the Vocera Communications model Communications Badge. The actual test results are contained in an exhibit of this report.

LIMITS OF CONDUCTED INTERFERENCE VOLTAGE

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.207.

The following measurement was extracted from the data recorded during the conducted emissions scan and represents the highest amplitude emission relative to the specification limit. The actual test data and any correction factors are contained in an exhibit of this report.

120V, 60Hz

Frequency MHz	Level dBuV	Power Lead	FCC 15.207 Limit	FCC 15.207 Margin	Detector QP/Ave	Comments
0.660	34.7	N	48.0	-13.3	QP	

LIMITS OF ANTENNA CONDUCTED EMISSIONS

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.247.

The Radiated Emission replaced 15.247(a) (c) antenna conducted measurement. The EUT's antenna is permanently attached, so no antenna measurements were possible. The actual test data and any correction factors are contained an exhibit of this report.

LIMITS OF RADIATED INTERFERENCE FIELD STRENGTH

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.247 and 15.209 in the case of emissions falling within the frequency bands specified in Section 15.205.

The following measurement was extracted from the data recorded during the radiated electric field emissions scan and represents the highest amplitude emission relative to the specification limit. The actual test data and any correction factors are contained in an exhibit of this report.

Frequency MHz	Level dBuV/m	Pol v/h	FCC 15.247/15.209 Limit	FCC 15.247/15.209 Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
17232.88	42.6	H	54.0	-11.4	Avg	0	1.2	

LIMITS OF POWER, BANDWIDTH, AND POWER SPECTRAL DENSITY

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.247.

The maximum power output was 16.1 dBm on channel 6. The minimum 6-dB bandwidth was 9.17 Megahertz on channel 1. The minimum PSD was 10.22 dBm. The actual test data and any correction factors are contained in an exhibit of this report.

MEASUREMENT UNCERTAINTIES

ISO Guide 25 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level and were calculated in accordance with NAMAS document NIS 81.

Measurement Type	Frequency Range (MHz)	Calculated Uncertainty (dB)
Conducted Emissions	0.15 to 30	± 2.4
Radiated Emissions	30 to 1000	± 3.2

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Vocera Communications model Communications Badge is a Voice over 802.11b used for In-building communication. The sample was received on May 29, 2002 and tested on June 19, 2002. The EUT consisted of the following component(s):

Manufacturer/Model/Description	Serial Number
Vocera/Communications Badge/In-building communication device	N/A

INPUT POWER

The EUT input is rated at 3.4Vdc. The EUT contained the following input power components during emissions testing. The EUT is sold with a battery charger, but EUT is can operate while charging:

Description	Manufacturer	Model
Battery Charger	Vocera	N/A

ENCLOSURE

The EUT enclosure is primarily constructed of fabricated sheet steel. It measures approximately 0.5 cm wide by 0.15 cm deep by 11 cm high.

EMI SUPPRESSION DEVICES

EUT did not require any EMI suppression devices to comply with the emissions

MODIFICATIONS

The EUT did not require any modifications in order to comply with the emission specifications

SUPPORT EQUIPMENT

No local support equipment was used during emissions testing:

No remote support equipment was used during emissions testing:

EXTERNAL I/O CABLING

The I/O cabling configuration during emissions testing was as follows:

Cable Description	Length (m)	From Unit/Port	To Unit/Port
Power Cable	1	DC	AC/DC adaptor

TEST SOFTWARE

Was programmed to continuously transmit at 11Mbps at maximum output power. The transmitter was set to the low, middle, and high channel.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on June 19, 2002 at the Elliott Laboratories Open Area Test Site #4 located at 684 West Maude Avenue, Sunnyvale, California. The test site contains separate areas for radiated and conducted emissions testing. Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data has been filed with the Commission.

The FCC recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement with the exception of predictable local TV, radio, and mobile communications traffic. The test site contains separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent FCC requirements.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing are performed in conformance with ANSI C63.4-1992. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment. The test site is maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 guidelines.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz.

INSTRUMENT CONTROL COMPUTER

The receivers utilize either a Rohde & Schwarz EZM Spectrum Monitor/Controller or contain an internal Spectrum Monitor/Controller to view and convert the receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers.

The Spectrum Monitor provides a visual display of the signal being measured. In addition, the controller or a personal computer run automated data collection programs which control the receivers. This provides added accuracy since all site correction factors, such as cable loss and antenna factors are added automatically.

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a fifty microhenry Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 uH CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

POWER METER

A power meter and thermister mount are used for all direct output power measurements from transmitters as they provide a broadband indication of the power output.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A biconical antenna is used to cover the range from 30 MHz to 300 MHz and a log periodic antenna is utilized from 300 MHz to 1000 MHz. Narrowband tuned dipole antennas are used over the entire 30 to 1000 MHz range for precision measurements of field strength. Above 1000 MHz, a horn antenna is used. The antenna calibration factors are included in site factors programmed into the test receivers.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height.

ANSI C63.4 specifies that the test height above ground for table mounted devices shall be 80 centimeters. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The FCC requires that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.4, and the worst-case orientation is used for final measurements.

CONDUCTED EMISSIONS

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord.

RADIATED EMISSIONS

Radiated emissions measurements are performed in two phases as well. A preliminary scan of emissions is conducted in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed from 30 MHz up to the frequency required by the regulation specified on page 1. One or more of these is with the antenna polarized vertically while the one or more of these is with the antenna polarized horizontally. During the preliminary scans, the EUT is rotated through 360°, the antenna height is varied and cable positions are varied to determine the highest emission relative to the limit.

A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth which results in the highest emission is then maintained while varying the antenna height from one to four meters. The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain. Emissions which have values close to the specification limit may also be measured with a tuned dipole antenna to determine compliance.

PSD, Power output, 6-dB Occupied Bandwidth were measured using the radiated method. All corrections factors were applied to the measurements. All radiated measurements for PSD and Power output were converted from a dBuV/m to a dBm values using the free-space conversion factor of 95.3 dB. All measurements were performed for the low, middle, and high channel of the EUT. For results please refer to data under the exhibit of this report.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions are given in units of microvolts, and the limits for radiated emissions are given in units of microvolts per meter at a specified test distance. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBuV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBuV/m). The results are then converted to the linear forms of uV and uV/m for comparison to published specifications.

For reference, converting the specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. These limits in both linear and logarithmic form are as follows:

CONDUCTED EMISSIONS SPECIFICATION LIMITS, SECTION 15.207

Frequency Range (MHz)	Limit (uV)	Limit (dBuV)
0.450 to 30.000	250	48

RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.209

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
0.009-0.490	$2400/F_{KHz}$ @ 300m	$67.6-20*\log_{10}(F_{KHz})$ @ 300m
0.490-1.705	$24000/F_{KHz}$ @ 30m	$87.6-20*\log_{10}(F_{KHz})$ @ 30m
1.705 to 30	30 @ 30m	29.5 @ 30m
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

Receiver readings are compared directly to the conducted emissions specification limit (decibel form) as follows:

$$R_r - B = C$$

and

$$C - S = M$$

where:

R_r = Receiver Reading in dBuV

B = Broadband Correction Factor*

C = Corrected Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

* Broadband Level - Per ANSI C63.4, 13 dB may be subtracted from the quasi-peak level if it is determined that the emission is broadband in nature. If the signal level in the average mode is six dB or more below the signal level in the peak mode, the emission is classified as broadband.

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements. A distance factor, when used for electric field measurements, is calculated by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_s = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

EXHIBIT 1: Test Equipment Calibration Data

Radiated Emissions, 1 - 24000 GHz, 20-Jun-02
Engineer: jmartinez

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	868	12	3/11/2002	#######
Miteq	Pre-amp, 1-18GHz	AFS44	1346	12	1/7/2002	1/7/2003

Radiated Emissions, 1 - 24000 GHz, 20-Jun-02
Engineer: jmartinez

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
Hewlett Packard	High Pass filter, 3.5GHz	P/N 84300-80038	1157	12	3/1/2002	3/1/2003
Hewlett Packard	Spectrum Analyzer, 9KHz - 22GHz	8593EM	1319	12	4/5/2002	4/5/2003
Hewlett Packard	Spectrum Analyzer 9kHz - 40 GHz	8564E (84125C)	1393	12	2/21/2002	#######

Conducted and Radiated Emissions, 21-Jun-02
Engineer: Rafael

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
Elliott Laboratories	Biconical Antenna, 30-300 MHz	EL30.300	54	12	1/4/2002	1/4/2003
Elliott Laboratories	FCC / CISPR LISN	LISN-3, OATS	304	12	6/5/2002	6/5/2003
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	1242	12	10/9/2001	10/9/2002
EMCO	Log Periodic Antenna, 0.2-2 GHz	3148	1347	12	10/16/2001	10/16/2002
Filtek	High Pass Filter, 1GHz	HP12/1000-5BA	955	12	3/12/2002	3/12/2003
Hewlett Packard	EMC Spectrum Analyzer, Opt. 026 ¸9 KHz -26.5GHz	8593EM	1141	12	3/11/2002	3/11/2003
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	12	1/15/2002	1/15/2003
Rohde & Schwarz	Test Receiver, 9kHz-2750MHz	ESCS 30 EMI	1337	12	12/26/2001	12/26/2002

EXHIBIT 2: Test Data Log Sheets

ELECTROMAGNETIC EMISSIONS

TEST LOG SHEETS

AND

MEASUREMENT DATA

T 47390 16 Pages
T 47702 9 Pages

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EMC Test Data

Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47390
		Proj Eng:	David Bare
Contact:	Karl Hannestad		
Emissions Spec:	FCC 15.247; RSS-210	Class:	-
Immunity Spec:	-	Environment:	-

EMC Test Data

For The

Vocera

Model

Badge

Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47390
		Proj Eng:	David Bare
Contact:	Karl Hannestad		
Emissions Spec:	FCC 15.247; RSS-210	Class:	-
Immunity Spec:	-	Environment:	-

EUT INFORMATION

General Description

The EUT is a Voice over 802.11b transmitter which is designed for In-builing communications. Normally, the EUT would be placed on a table top during operation. The EUT was, therefore, treated as table-top equipment during testing to simulate the end user environment. The electrical rating of the EUT is 3.4Vdc.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Vocera	Badge	Voice over 802.11b	-	-

Other EUT Details

Antenna Connector Requirement per 15.203 & RSS-210 (e2)

Manufacturer	antenna	Gain (dBi)	-	-
Vocera	Permanent attach	-	-	-

EUT Enclosure

The EUT enclosure is primarily constructed of fabricated sheet steel. It measures approximately 0.5 cm wide by 0.15 cm deep by 11 cm high.

Modification History

Mod. #	Test	Date	Modification
1			
2			
3			

Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47390
		Proj Eng:	David Bare
Contact:	Karl Hannestad		
Emissions Spec:	FCC 15.247; RSS-210	Class:	-
Immunity Spec:	-	Environment:	-

Test Configuration #1

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None				

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None				

Interface Ports

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
None				

EUT Operation During Emissions

Was programmed to continuously transmit at 11Mbps at maximum output power. The transmitter was set to the low, middle, and high channel.

Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47390
		Proj Eng:	David Bare
Contact:	Karl Hannestad		
Spec:	FCC 15.247; RSS-210	Class:	N/A

Radiated Emissions

Test Specifics

Objective: The objective of this test session is to perform Final Qualification testing of the EUT with respect to the specification listed above.

Date of Test: 6/19/2002
Test Engineer: jmartinez
Test Location: SVOATS #4

Config. Used: 1
Config Change: None
EUT Voltage: 3.4 Vdc

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT. All measurements were by radiated method. The antenna of transmitter is permanently attach.

Ambient Conditions:

Temperature: 15°C
Rel. Humidity: 56%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1a	RE, 30 - 24000 MHz - Spurious Emissions	15.209 / 15.247(c) & RSS-210 (e1)	Pass	-12.7dB @ 16884.01MHz
1b	RE, 30 - 24000 MHz - Spurious Emissions	15.209 / 15.247(c) & RSS-210 (e1)	Pass	-12.8dB @ 17059.32MHz
1c	RE, 30 - 24000 MHz - Spurious Emissions	15.209 / 15.247(c) & RSS-210 (e1)	Pass	-11.4dB @ 17232.881MHz
2	6dB Bandwidth	15.247(a)	Pass	Refer to run
3	Output Power	15.247(b) & RSS-210 (b)	Pass	Refer to run
4	Power Spectral Density (PSD)	15.247(d) & RSS-210 (b)	Pass	Refer to run
5	Bandedge Measurements	15.209 / 15.247(c) & RSS-210 (e1)	Pass	-.8 dB @ 2412 MHz

Modifications Made During Testing:

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Elliott

EMC Test Data

Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47390
		Proj Eng:	David Bare
Contact:	Karl Hannestad		
Spec:	FCC 15.247; RSS-210	Class:	N/A

Run #1a: Radiated Spurious Emissions, 30-2483.5 MHz. Low Channel @ 2412 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
16884.01	41.3	V	54.0	-12.7	Avg	0	1.1	Note 2
16883.63	41.2	H	54.0	-12.8	Avg	341	1.3	Note 2
14471.11	40.2	H	54.0	-13.8	Avg	2	1.3	Note 2
14471.60	39.7	V	54.0	-14.3	Avg	0	1.1	Note 2
12059.46	38.5	V	54.0	-15.5	Avg	0	1.1	Note 2
12060.39	38.4	H	54.0	-15.6	Avg	0	1.3	Note 2
9647.082	36.6	V	54.0	-17.4	Avg	348	1.1	Note 2
9648.039	36.6	H	54.0	-17.4	Avg	3	1.3	Note 2
7235.528	35.9	V	54.0	-18.1	Avg	345	1.1	
7236.343	35.9	H	54.0	-18.1	Avg	358	1.3	
16884.23	53.5	V	74.0	-20.5	Pk	0	1.1	Note 2
16883.70	53.4	H	74.0	-20.6	Pk	341	1.3	Note 2
14472.73	52.2	H	74.0	-21.8	Pk	2	1.3	Note 2
14472.24	52.0	V	74.0	-22.0	Pk	0	1.1	Note 2
4823.045	31.4	H	54.0	-22.6	Avg	0	1.3	
12059.57	51.2	V	74.0	-22.8	Pk	0	1.1	Note 2
12060.65	51.1	H	74.0	-22.9	Pk	0	1.3	Note 2
4824.061	30.7	V	54.0	-23.3	Avg	0	1.1	
9647.321	49.0	V	74.0	-25.0	Pk	348	1.1	Note 2
9647.809	48.7	H	74.0	-25.3	Pk	3	1.3	Note 2
7235.721	48.1	V	74.0	-25.9	Pk	345	1.1	
7236.386	48.0	H	74.0	-26.0	Pk	358	1.3	
4823.664	43.8	H	74.0	-30.2	Pk	0	1.3	
4824.078	43.4	V	74.0	-30.6	Pk	0	1.1	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.
Note 2:	No harmonic emissions detected after the third harmonic. Readings are noise floor measurements.

Elliott

EMC Test Data

Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47390
		Proj Eng:	David Bare
Contact:	Karl Hannestad		
Spec:	FCC 15.247; RSS-210	Class:	N/A

Run #1b: Radiated Spurious Emissions, 30-2483.5 MHz. Center Channel @ 2437 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
17059.32	41.2	V	54.0	-12.8	Avg	0	1.0	Note 2
17058.97	41.1	H	54.0	-12.9	Avg	0	1.3	Note 2
14621.18	41.0	H	54.0	-13.0	Avg	0	1.3	Note 2
14621.04	40.9	V	54.0	-13.1	Avg	0	1.0	Note 2
9747.913	39.1	H	54.0	-14.9	Avg	0	1.3	Note 2
12184.36	38.2	V	54.0	-15.8	Avg	0	1.0	Note 2
12185.56	37.8	H	54.0	-16.2	Avg	0	1.3	Note 2
7310.275	36.6	H	54.0	-17.4	Avg	325	1.3	
9748.251	36.4	V	54.0	-17.6	Avg	360	1.0	Note 2
7310.854	36.1	V	54.0	-17.9	Avg	0	1.0	
17058.71	53.9	V	74.0	-20.1	Pk	0	1.0	Note 2
17058.94	53.5	H	74.0	-20.5	Pk	0	1.3	Note 2
14621.80	53.3	H	74.0	-20.7	Pk	0	1.3	Note 2
14621.96	53.0	V	74.0	-21.0	Pk	0	1.0	Note 2
4873.417	31.2	H	54.0	-22.8	Avg	2	1.3	
4874.053	30.9	V	54.0	-23.1	Avg	352	1.0	
12184.55	50.9	V	74.0	-23.1	Pk	0	1.0	Note 2
12185.72	50.9	H	74.0	-23.1	Pk	0	1.3	Note 2
9748.002	50.3	H	74.0	-23.7	Pk	0	1.3	Note 2
7310.930	49.3	V	74.0	-24.7	Pk	0	1.0	
9748.540	49.3	V	74.0	-24.7	Pk	360	1.0	Note 2
7311.537	48.7	H	74.0	-25.3	Pk	325	1.3	
4874.521	44.1	H	74.0	-29.9	Pk	2	1.3	
4875.002	43.9	V	74.0	-30.1	Pk	352	1.0	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.
Note 2:	No harmonic emissions detected after the third harmonic. Readings are noise floor measurements.

Elliott

EMC Test Data

Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47390
		Proj Eng:	David Bare
Contact:	Karl Hannestad		
Spec:	FCC 15.247; RSS-210	Class:	N/A

Run #1c: Radiated Spurious Emissions, 30-2483.5 MHz. High Channel @ 2462 MHz

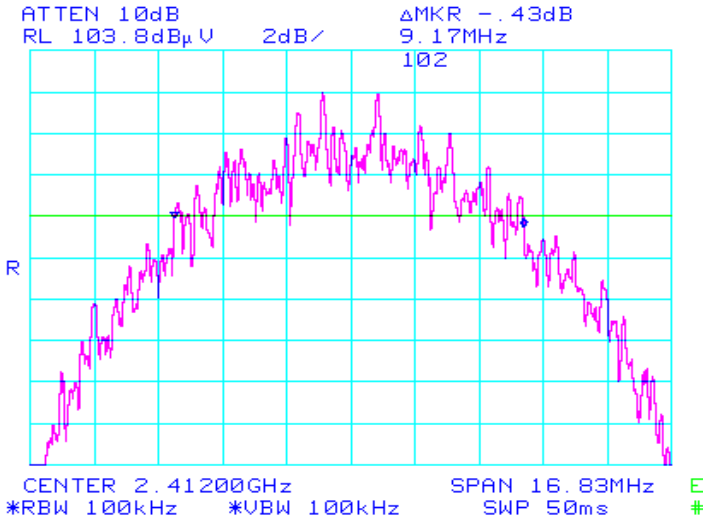
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
17232.88	42.6	H	54.0	-11.4	Avg	0	1.2	Note 2
17232.92	42.5	V	54.0	-11.5	Avg	0	1.1	Note 2
14772.03	41.6	H	54.0	-12.4	Avg	360	1.2	Note 2
14770.74	41.4	V	54.0	-12.6	Avg	0	1.1	Note 2
12309.29	38.2	V	54.0	-15.8	Avg	0	1.1	Note 2
12309.44	38.2	H	54.0	-15.8	Avg	0	1.2	Note 2
9847.149	36.1	V	54.0	-17.9	Avg	341	1.1	Note 2
7384.579	35.7	V	54.0	-18.3	Avg	5	1.1	
7386.211	35.4	H	54.0	-18.6	Avg	358	1.2	
17233.62	55.2	H	74.0	-18.8	Pk	0	1.2	Note 2
17232.97	54.9	V	74.0	-19.1	Pk	0	1.1	Note 2
14771.10	54.5	H	74.0	-19.5	Pk	360	1.2	Note 2
14772.17	53.4	V	74.0	-20.6	Pk	0	1.1	Note 2
4923.211	31.2	V	54.0	-22.8	Avg	352	1.1	
4923.885	30.8	H	54.0	-23.2	Avg	0	1.2	
12309.64	50.3	H	74.0	-23.7	Pk	0	1.2	Note 2
12308.83	50.2	V	74.0	-23.8	Pk	0	1.1	Note 2
7386.142	48.8	H	74.0	-25.2	Pk	358	1.2	
9847.039	48.5	V	74.0	-25.5	Pk	341	1.1	Note 2
7386.097	47.5	V	74.0	-26.5	Pk	5	1.1	
4924.109	43.4	V	74.0	-30.6	Pk	352	1.1	
4923.247	43.0	H	74.0	-31.0	Pk	0	1.2	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.
Note 2:	No harmonic emissions detected after the third harmonic. Readings are noise floor measurements.

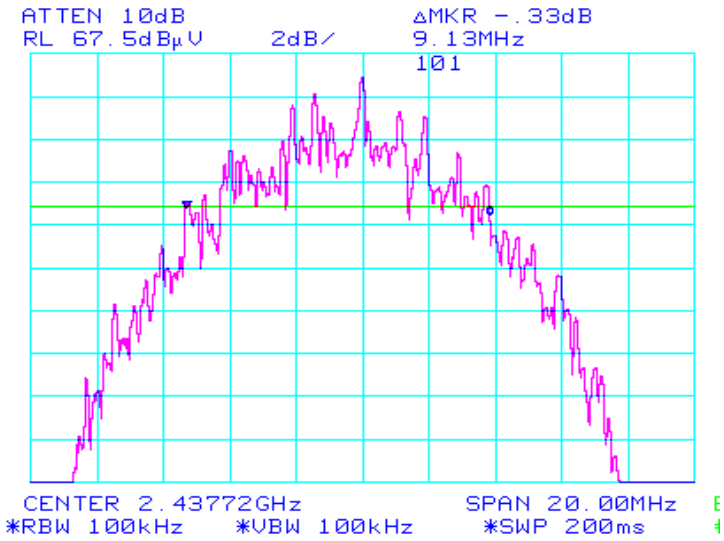
Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47390
		Proj Eng:	David Bare
Contact:	Karl Hannestad		
Spec:	FCC 15.247; RSS-210	Class:	N/A

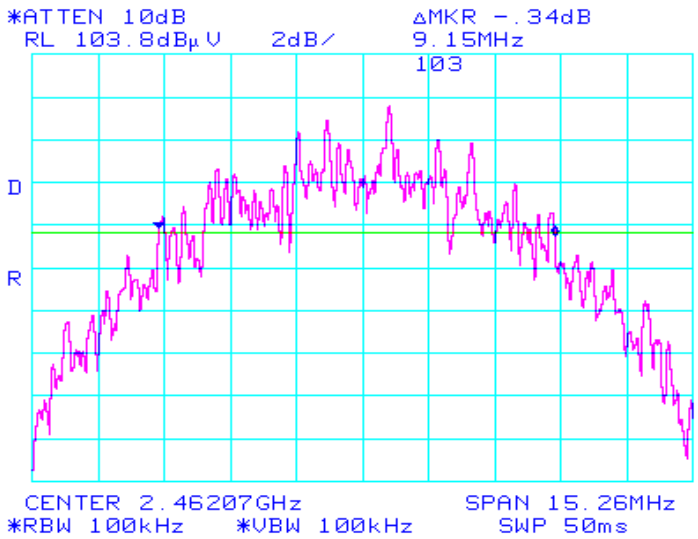
Run #2: Signal Bandwidth

Channel	Frequency (MHz)	Resolution Bandwidth	6dB Signal Bandwidth	Graph reference #
Low	2412	100 kHz	9.17 MHz	102
Mid	2437	100 kHz	9.13 MHz	101
High	2462	100 kHz	9.15 MHz	103



Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47390
		Proj Eng:	David Bare
Contact:	Karl Hannestad		
Spec:	FCC 15.247; RSS-210	Class:	N/A



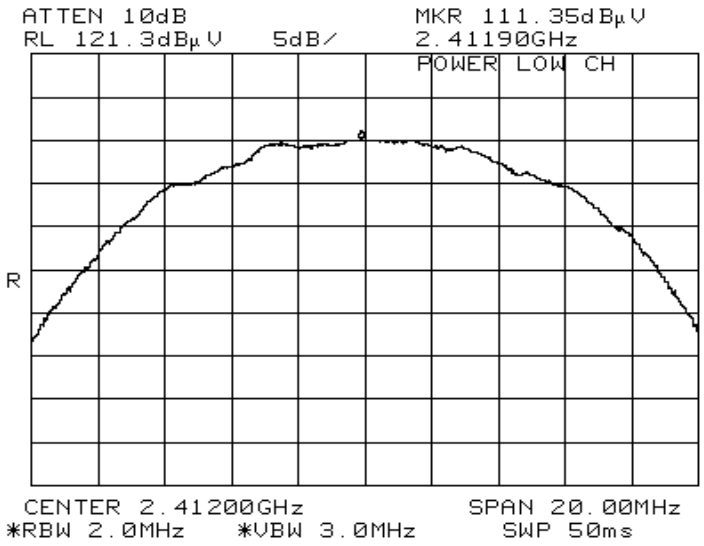


Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47390
		Proj Eng:	David Bare
Contact:	Karl Hannestad		
Spec:	FCC 15.247; RSS-210	Class:	N/A

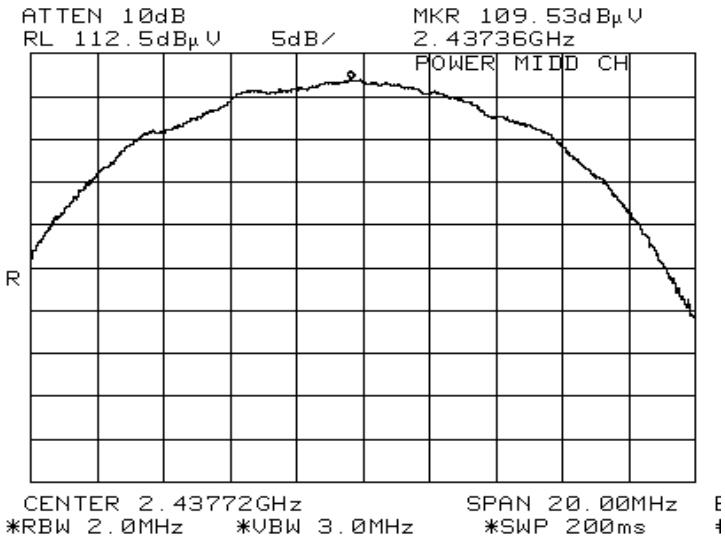
Run #3: Output Power

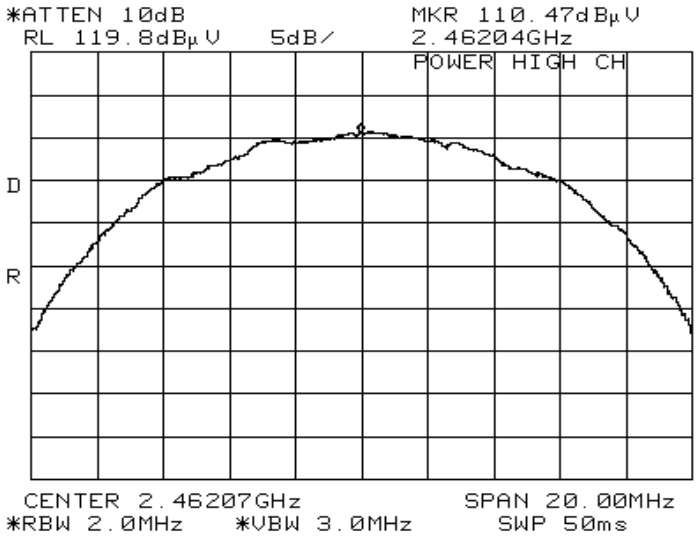
Channel	Frequency (MHz)	Field Strength at 3m	Antenna Pol. (H/V)	Res BW	Output Power
Low	2412	102	H	2 MHz	6.7
Mid	2437	104	H	2 MHz	8.7
High	2462	106.2	H	2 MHz	10.9
Low	2412	111.4	V	2 MHz	16.1
Mid	2437	109.4	V	2 MHz	14.1
High	2462	110.4	V	2 MHz	15.1

Note 1:	95.3 dB convertion factor sample formula included on a seperate documente label "free space conversion"
Note 2:	Plots have the correction factor included. Readings in dBuV are actually in dBuV/m after correction factor applied.



Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47390
		Proj Eng:	David Bare
Contact:	Karl Hannestad		
Spec:	FCC 15.247; RSS-210	Class:	N/A



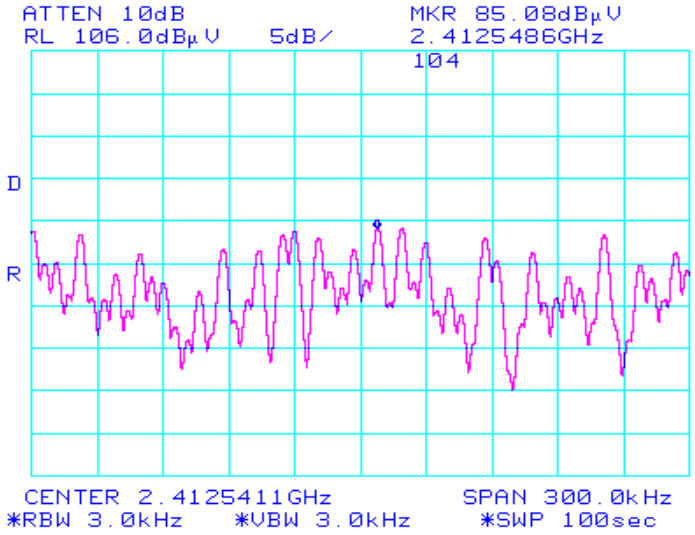


Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47390
		Proj Eng:	David Bare
Contact:	Karl Hannestad		
Spec:	FCC 15.247; RSS-210	Class:	N/A

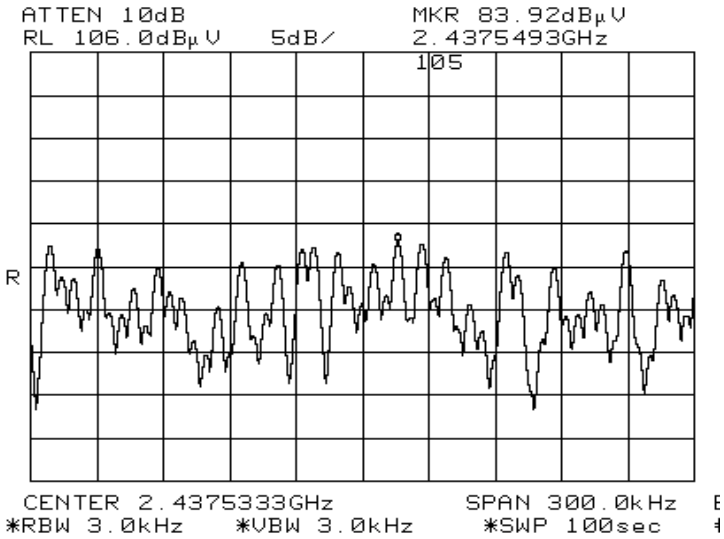
Run #4: Power Spectral Density

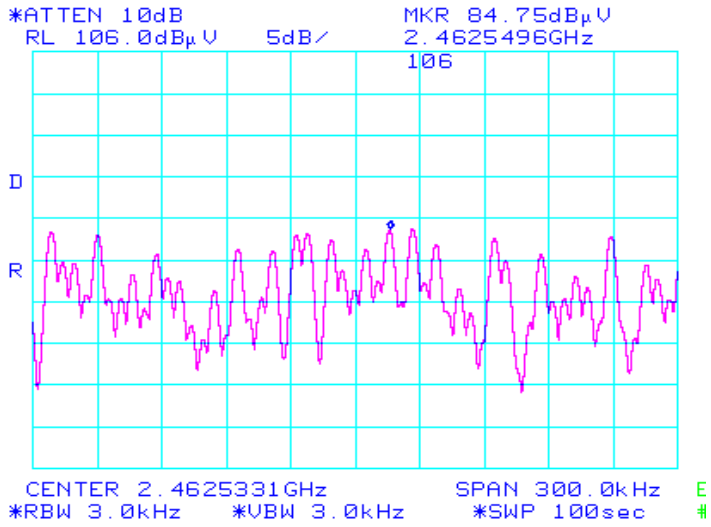
Channel	Frequency	Res BW	P.S.D. (averaged over 1 second in a 3kHz bandwidth)	Graph reference #
	(MHz)	(kHz)	(dBm)	
Low	2412	3	-10.19	104
Mid	2437	3	-11.35	105
High	2462	3	-10.52	106

Note 1:	Plots have the correction factor included. Field strength was converted to dBm by subtracting the measured value by 95.3 dB (measured value in dBuV/m - 95.3 dB). The Antenna and cable loss are the correction factor.



Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47390
		Proj Eng:	David Bare
Contact:	Karl Hannestad		
Spec:	FCC 15.247; RSS-210	Class:	N/A





Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47390
		Proj Eng:	David Bare
Contact:	Karl Hannestad		
Spec:	FCC 15.247; RSS-210	Class:	N/A

Run# 5: Bandedge measurements

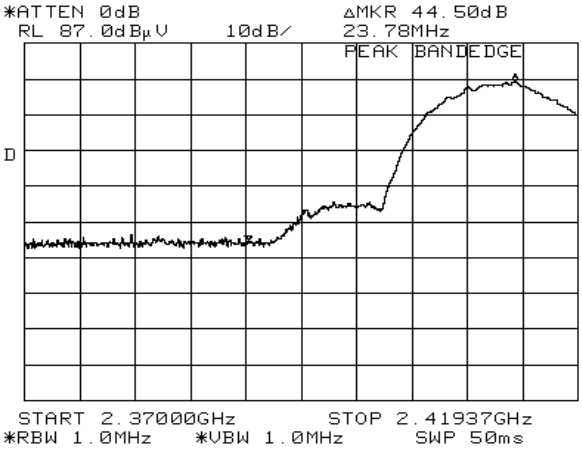
Band Edge Measurements:

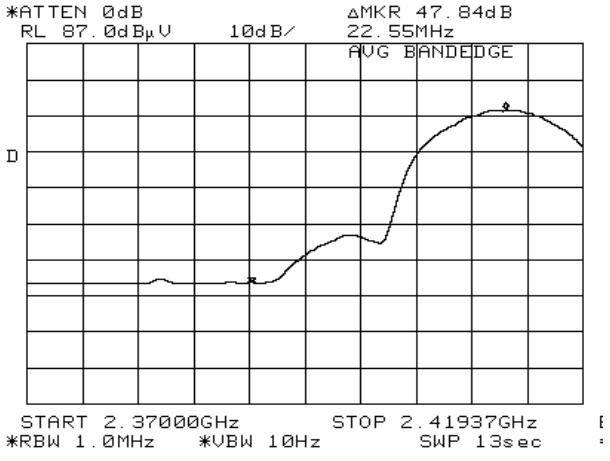
For signals in the restricted bands immediately above and below the 2.39 to 2.4835 GHz allocated band a measurement was made of the amplitude of the spurious emissions with respect to the intentional signals. The relative amplitude, in dBc, was then applied to the average and peak field strength of the intentional signal made on the OATS to calculate the field strength of the unintentional signals.

Plots Showing Out-Of-Band Emissions (Peak RBW=VBW=1MHz; Average RBW = 1MHz, VBW = 10Hz)

2.39 GHz band edge, EUT operating on the lowest channel 1

The highest signal in the 2.39 GHz band was -44.5 dBc (Peak) / -47.84 dBc (Average)



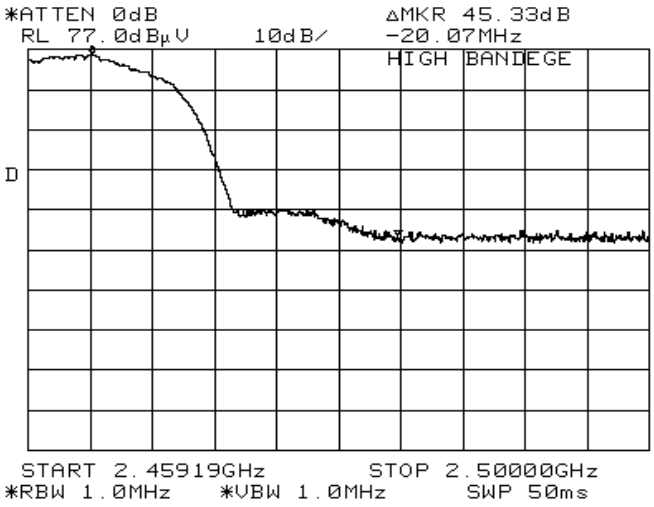


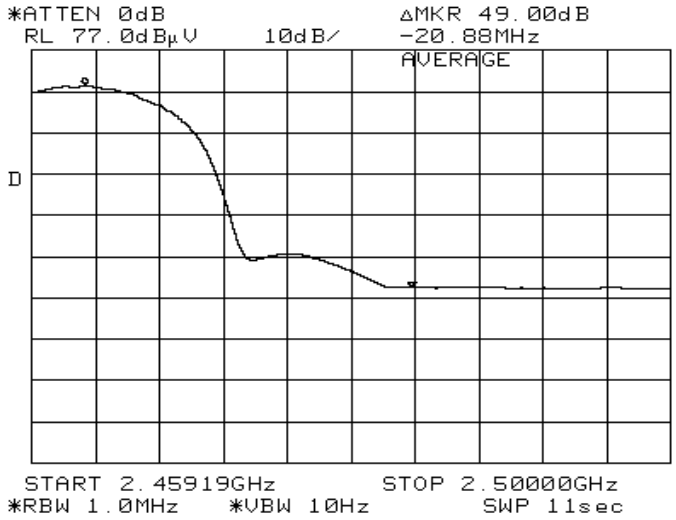
Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47390
		Proj Eng:	David Bare
Contact:	Karl Hannestad		
Spec:	FCC 15.247; RSS-210	Class:	N/A

2.4835 GHz band edge EUT operating on channel 11 (highest channel):

The highest signal in the 2.4835 GHz band was -45.33 dBc (Peak) / - 49.0 dBc (Average)

Peak Bandedge Plot





Elliott

EMC Test Data

Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47390
		Proj Eng:	David Bare
Contact:	Karl Hannestad		
Spec:	FCC 15.247; RSS-210	Class:	N/A

Fundamental signal measurements (to calculate the band edge field strengths):

Frequency	Level	Pol	15.209 / 15.407		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2410.766	107.2	V	-	-	Pk	240	1.4	RBW = VBW = 1 MHz
2411.017	101.0	V	-	-	Avg	240	1.4	RBW = 1MHz, VBW = 10Hz
2413.292	103.8	H	-	-	Pk	260	1.9	RBW = VBW = 1 MHz
2412.766	96.9	H	-	-	Avg	260	1.9	RBW = 1MHz, VBW = 10Hz
2463.247	108.0	V	-	-	Pk	248	1.1	RBW = VBW = 1 MHz
2462.786	101.2	V	-	-	Avg	248	1.1	RBW = 1MHz, VBW = 10Hz
2463.260	99.4	H	-	-	Pk	203	1.9	RBW = VBW = 1 MHz
2462.802	92.4	H	-	-	Avg	203	1.9	RBW = 1MHz, VBW = 10Hz

Band Edge Field Strength Calculations

Frequency	Level	Pol	15.209 / 15.407		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2412.0	62.7	v	74.0	-11.3	Pk			Note 1
2412.0	53.2	v	54.0	-0.8	Avg			Note 1
2412.0	59.3	h	74.0	-14.7	Pk			Note 1
2412.0	49.1	h	54.0	-4.9	Avg			Note 1
2483.5	62.7	v	74.0	-11.3	Pk			Note 2
2483.5	52.2	v	54.0	-1.8	Avg			Note 2
2483.5	54.1	v	74.0	-19.9	Pk			Note 2
2483.5	43.4	v	54.0	-10.6	Avg			Note 2

Note 1:	EUT operating on the lowest channel available. Signal level calculated using the relative measurements in run #5 (-44.5 dBc for peak and -47.84 dBc for average) applied to the highest peak and average field strength measurements of the fundamental signal level.
Note 2:	EUT operating on highest channel available. Signal level calculated using the relative measurements in run #5 (-45.33 dBc for peak and -49.0 dBc for average) applied to the highest peak and average field strength measurements of the fundamental signal level.

Elliott

EMC Test Data

Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47702
		Proj Eng:	
Contact:	Karl Hannestad		
Emissions Spec:	FCC part 15	Class:	B
Immunity Spec:	N/A	Environment:	N/A

EMC Test Data

For The

Vocera

Model

Badge

Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47702
		Proj Eng:	
Contact:	Karl Hannestad		
Emissions Spec:	FCC part 15	Class:	B
Immunity Spec:	N/A	Environment:	N/A

EUT INFORMATION

General Description

The EUT is a Voice over 802.11b transmitter which is designed for In-builing communications. Normally, the EUT would be placed on a table top during operation. The EUT was, therefore, treated as table-top equipment during testing to simulate the end user environment. The electrical rating of the EUT is 3.4Vdc.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Vocera	Badge	Transmitter	-	-

EUT Enclosure

The EUT enclosure is primarily constructed of fabricated sheet steel. It measures approximately 0.5 cm wide by 0.15 cm deep by 11 cm high.

Modification History

Mod. #	Test	Date	Modificaiton
1	-	-	None

Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47702
		Proj Eng:	
Contact:	Karl Hannestad		
Emissions Spec:	FCC part 15	Class:	B
Immunity Spec:	N/A	Environment:	N/A

Test Configuration #1

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None				

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None				

Cradle Interface Port

		Cable(s)		
EUT Port	Connected To	Description	Shielded or Unshielded	Length(m)
DC	AC/DC Adaptor	Power cable	Unshielded	1

EUT Operation During Emissions

The EUT was in the Transmit Mode during testing for 30-1000MHz and Stand-By Mode for 1-2.7GHz.

Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47702
		Proj Eng:	Enter on cover sheet
Contact:	Karl Hannestad		
Spec:	FCC part 15	Class:	B

Conducted Emissions - Power Ports

Test Specifics

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test:	6/21/2002	Config. Used:	1
Test Engineer:	Rafael	Config Change:	None
Test Location:	SVOATS #1	EUT Voltage:	Battery

General Test Configuration

For tabletop equipment, the EUT was located on a wooden table, 40 cm from a vertical coupling plane and 80cm from the LISN. A second LISN was used for all local support equipment.

Ambient Conditions:

Temperature: 14.4°C

Rel. Humidity: 78%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power 120V/60Hz	FCC 15.207	Pass	-13.3dB @ .66MHz

Modifications Made During Testing:

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Elliott

EMC Test Data

Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47702
		Proj Eng:	Enter on cover sheet
Contact:	Karl Hannestad		
Spec:	FCC part 15	Class:	B

Run #1: AC Power Port Conducted Emissions, 0.45 - 30MHz, 120V/60Hz

EUT placed on cradle

Frequency	Level	AC	FCC 15.207		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.660	34.7	N	48.0	-13.3	QP	
0.460	33.6	N	48.0	-14.4	QP	
0.610	31.5	L	48.0	-16.5	QP	
0.850	30.1	N	48.0	-17.9	QP	
0.470	28.2	L	48.0	-19.8	QP	
0.770	26.8	L	48.0	-21.2	QP	

Elliott

EMC Test Data

Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47702
		Proj Eng:	Enter on cover sheet
Contact:	Karl Hannestad		
Spec:	FCC part 15	Class:	B

Radiated Emissions

Test Specifics

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test:	6/21/2002	Config. Used:	1
Test Engineer:	Rafael	Config Change:	None
Test Location:	SVOATS #1	EUT Voltage:	Battery

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated emissions testing.

On the OATS, the measurement antenna was located 3 meters from the EUT for the measurement range 30 - 1000 MHz and 3m from the EUT for the frequency range 1 - 2.7 GHz.

Note, **preliminary** testing indicates that the emissions were maximized by orientation of the EUT and elevation of the measurement antenna. **Maximized** testing indicated that the emissions were maximized by orientation of the EUT, elevation of the measurement antenna, and manipulation of the EUT's interface cables.

Note, for testing above 1 GHz, the FCC specifies the limit as an average measurement. In addition, the FCC states that the peak reading of any emission above 1 GHz, can not exceed the average limit by more than 20 dB.

Ambient Conditions:

Temperature: 14.4°C

Rel. Humidity: 78%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
2	RE, 30 - 1000MHz - Maximized Emissions	FCC B	Pass	-13.8dB @ 43.98MHz
3	RE, 1000 - 2700 MHz Maximized Emissions	FCC B	Pass	No emissions detected

Modifications Made During Testing:

No modifications were made to the EUT during testing

Elliott

EMC Test Data

Client:	Vocera	Job Number:	J47369
Model:	Badge	T-Log Number:	T47702
		Proj Eng:	Enter on cover sheet
Contact:	Karl Hannestad		
Spec:	FCC part 15	Class:	B

Deviations From The Standard

No deviations were made from the requirements of the standard.

Run #1: Preliminary Radiated Emissions, 30-1000 MHz

Transmit Mode, EUT placed on cradle

Frequency	Level	Pol	FCC B		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
43.980	26.2	v	40.0	-13.8	QP	15	1.0	
35.970	26.1	v	40.0	-13.9	QP	300	1.0	
47.980	25.6	v	40.0	-14.4	QP	100	1.0	
39.957	24.9	v	40.0	-15.1	QP	315	1.0	
43.970	24.8	v	40.0	-15.2	QP	0	1.0	
43.980	22.9	h	40.0	-17.1	QP	185	1.8	
39.957	22.4	h	40.0	-17.6	QP	360	2.1	
196.000	25.4	v	43.5	-18.1	QP	325	1.0	
31.960	21.4	v	40.0	-18.6	QP	0	1.0	
35.970	21.1	h	40.0	-18.9	QP	0	1.5	
245.000	25.9	h	46.0	-20.1	QP	360	1.7	
196.000	23.4	h	43.5	-20.1	QP	300	1.6	
245.000	23.6	v	46.0	-22.4	QP	25	1.0	

Run #2: Maximized Readings From Run #1

Transmit Mode, EUT placed on cradle

Frequency	Level	Pol	FCC B		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
43.980	26.2	v	40.0	-13.8	QP	25	1.0	
35.970	26.1	v	40.0	-13.9	QP	300	1.0	
47.980	25.6	v	40.0	-14.4	QP	90	1.0	
39.957	24.9	v	40.0	-15.1	QP	300	1.0	
43.970	24.8	v	40.0	-15.2	QP	0	1.0	
43.980	22.9	h	40.0	-17.1	QP	185	1.8	

Run #3: Maximized readings, 1000 - 2700 MHz

Measurements made at 3m per FCC requirements.

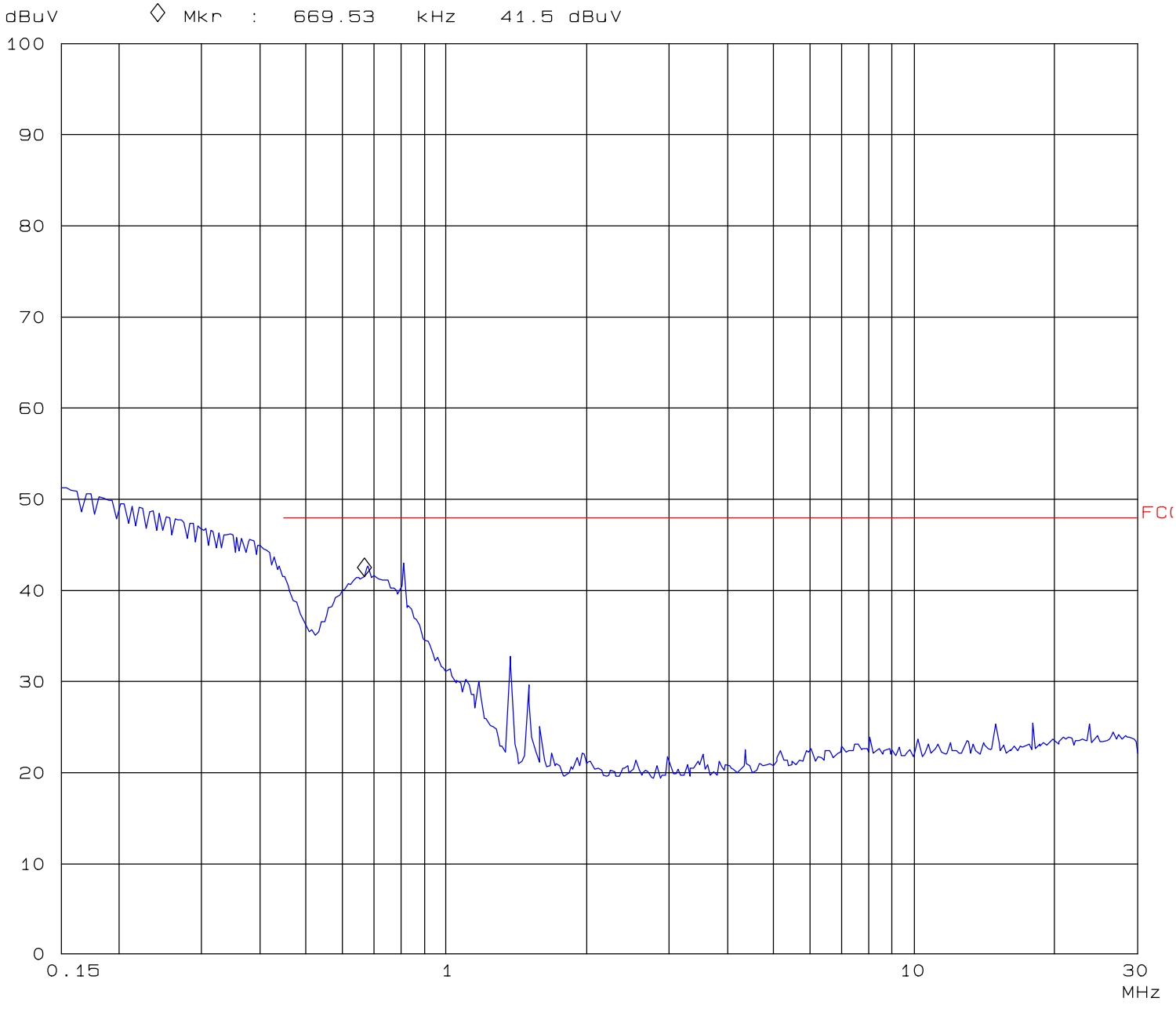
Tested the EUT in the Stand-By Mode, no significant frequencies were observed.

EUT placed on cradle

Elliott Laboratories
Conducted Emissions

21. Jun 02 23:51

EUT:	Commbagde
Manuf:	Vocera
Op Cond:	120V/60Hz
Operator:	Rafael Varelas
Test Spec:	FCC B
Comment:	J47369 / T47702
	Run 1 Neutral



Elliott Laboratories
Conducted Emissions

21. Jun 02 23:46

EUT:	Commbagde
Manuf:	Vocera
Op Cond:	120V/60Hz
Operator:	Rafael Varelas
Test Spec:	FCC B
Comment:	J47369 / T47702
	Run 1 Line