EMC Test Report

Application for Grant of Equipment Authorization

Industry Canada RSS-Gen Issue 3 / RSS 210 Issue 8
FCC Part 15 Subpart C

Models: ST-654-031, ST-618-030, ST-621-030, ST-621-030-NSN, ST-618-030-NSN, ST-654-031-NSN

IC CERTIFICATION #:	2404A-654T2
FCC ID:	KL7-654T-V4
APPLICANT:	Savi Technology, Inc. 351 E. Evelyn Ave. Mountain View, CA 94041
TEST SITE(S):	Elliott Laboratories 41039 Boyce Road. Fremont, CA. 94538-2435
IC SITE REGISTRATION #:	2845B-5
REPORT DATE:	February 28, 2012
REISSUE DATE:	March 1, 2012
FINAL TEST DATES:	November 11, 2011
TOTAL NUMBER OF PAGES:	37

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ACCREDITED
Testing Cert #0214.26

REVISION HISTORY

Rev#	Date	Comments	Modified By
-	2-28-2012	First release	
1	3-1-2012	Reissued to correct statements in the test log and add additional models tested to the EUT table	Dave Guidotti

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SCOPE

An electromagnetic emissions test has been performed on the Savi Technology, Inc. model ST-654-031, pursuant to the following rules:

Industry Canada RSS-Gen Issue 3
RSS 210 Issue 8 "Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment"
FCC Part 15 Subpart C

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards and as outlined in Elliott Laboratories test procedures:

ANSI C63.4:2003

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant Industry Canada 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.

OBJECTIVE

The primary objective of the manufacturer is compliance with the regulations outlined in the previous section.

Prior to marketing in the USA, all unlicensed transmitters and transceivers require certification. Receive-only devices operating between 30 MHz and 960 MHz are subject to either certification or a manufacturer's declaration of conformity, with all other receive-only devices exempt from the technical requirements.

Prior to marketing in Canada, Class I transmitters, receivers and transceivers require certification. Class II devices are required to meet the appropriate technical requirements but are exempt from certification requirements.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's 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.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions 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.).

STATEMENT OF COMPLIANCE

The tested sample of Savi Technology, Inc. model ST-654-031 complied with the requirements of the following regulations:

Industry Canada RSS-Gen Issue 3
RSS 210 Issue 8 "Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment"
FCC Part 15 Subpart C

Maintenance of compliance is the responsibility of the manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the device with respect to the standards detailed in this test report.

The test results recorded herein are based on a single type test of Savi Technology, Inc. model ST-654-031 and therefore apply only to the tested sample. The sample was selected and prepared by John Hattick of Savi Technology, Inc.

DEVIATIONS FROM THE STANDARDS

No deviations were made from the published requirements listed in the scope of this report.

TEST RESULTS SUMMARY

MOMENTARILY OPERATED DEVICES – CONTROL SIGNALS

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result
15.231 (a) (1)	RSS 210 A1.1.1 (1)	Duration of manually activated transmissions	No manually activated transmissions	< 5 seconds	Complies
15.231 (a) (2)	RSS 210 A1.1.1 (2)	Duration of automatically activated transmissions	< 5 seconds [1]	< 5 seconds	Complies
15.231 (a) (3)	RSS 210 A1.1.1 (3)	Transmissions at predetermined / regular intervals	No transmissions at regular intervals	Such transmissions are not permitted	Complies
15.231 (a) (4)	RSS 210 A1.1.1 (4)	Pendency of transmissions used during emergencies	Not applicable, no emergency conditions		Complies
15.231 (b)	RSS 210 Table 4	Fundamental Signal Strength	80.4dBµV/m @ 433.93MHz (-0.4dB)	Refer to table in limits section	Complies
15.231 (b) / 15.209	RSS 210 Table 2 / 4	Radiated Spurious Emissions, 30 - 4400 MHz	35.8dBµV/m @ 3905.01MHz (-18.2dB)	Refer to table in limits section	Complies
15.231 (c)	RSS 210 A1.1.3	Bandwidth	187 kHz	< 0.5% of operating frequency	Complies
15.231 (d)	RSS 210 A1.1.4	Frequency Stability - 40.66 – 40.70 MHz band			N/A

Note – As the device can be placed in any position on a container was tested in all three orthogonal orientations. Special software was loaded into the device to allow continuous transmission for ease of testing.

MOMENTARILY OPERATED DEVICES – DATA SIGNALS OR SIGNALS AT PREDETERMINED INTERVALS

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result
15.231 (e)	RSS 210 A1.1.5	Duration of transmissions	[1]	< 1 second	Complies
15.231 (e)	RSS 210 A1.1.5	Period between transmissions		> 30 times duration of signal and > 10s	Complies
15.231 (e)	RSS 210 Table 5	Fundamental Signal Strength	72.4dBµV/m @ 433.93MHz (-0.5dB)	Refer to table in limits section	Complies
15.231 (e) / 15.209	RSS 210 Table 5	Radiated Spurious Emissions, 30 - 4400 MHz	36.7dBµV/m @ 867.742 MHz (-16.2dB)	Refer to table in limits section	Complies
15.231 (c)	RSS 210 A1.1.3	Bandwidth	187 kHz	< 0.5% of operating frequency	Complies
15.231 (d)	RSS 210 A1.1.4	Frequency Stability - 40.66 – 40.70 MHz band	-	-	N/A

[1] Refer to the operational description included with this application for detailed description and timing diagrams for transmission duration

Note 1 – Refer to the operational description included with this application for detailed description and timing diagrams for transmission duration.
Note 2 – As the device is intended for hand-held operation it was tested in all three orthogonal orientations.

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part	RSS Rule part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203	-	RF Connector	Antenna is integral to the device	Unique or integral antenna required	Complies
15.207	RSS GEN Table 2	AC Conducted Emissions	Battery operated	-	N/A
15.109	RSS GEN 7.2.3 Table 1	Receiver spurious emissions	>15dB below the limit	Refer to table in Standard	Complies
15.247 (b) (5) 15.407 (f)	RSS 102	RF Exposure Requirements	Refer to RSS 102 declaration.	Refer to RSS 102	Complies
-	RSP 100 RSS GEN 7.1.5	User Manual	Statement in documents provided to the user	Statement required regarding non-interference	Complies
-	RSP 100 RSS GEN 7.1.5	User Manual	No detachable antenna	Statement for products with detachable antenna	Complies
-	RSP 100 RSS GEN 4.4.1	99% Bandwidth	179 kHz	Information only	N/A

MEASUREMENT UNCERTAINTIES

ISO/IEC 17025 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 UKAS document LAB 34.

Measurement Type	Measurement Unit	Frequency Range	Expanded Uncertainty
Radiated emission (field strength)	dBµV/m	25 to 1000 MHz	± 3.6 dB
		1000 to 40000 MHz	± 6.0 dB
Conducted Emissions (AC Power)	dBµV	0.15 to 30 MHz	± 2.4 dB

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Savi Technology, Inc. models ST-654-031, ST-618-030, ST-621-030, ST-621-030-NSN, ST-618-030-NSN, ST-654-031-NSN are RF Tagging devices which are designed to identify the container to which they are attached to the Savi System. Normally, the EUT would be mounted to a container or similar piece of equipment. The EUT was treated as table-top equipment during testing to simulate the end user environment. The EUT is battery operated.

The sample was received on November 11, 2011 and tested on November 11, 2011. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	Tag ID
Savi Technology	ST-654-031	Tag	3773958634	18712651500010
Savi Technology	ST-654-031	Tag	3773958691	18712651500067
Savi Technology	ST-654-031	Tag	3773958693	18712651500069

OTHER EUT DETAILS

A response from the EUT is initiated by a 123 kHz signal from a Savi SignPost or 433.92 MHz signal from a Savi Reader. Upon receiving the initiation signal the EUT transmits a signal at 433.92 MHz. This signal is comprised of SignPost ID and Tag ID.
A response from the EUT is initiated by a 433.92 MHz Savi Reader signal. Upon receiving the initiation signal the EUT transmits a signal at 433.92 MHz. This signal is comprised of Tag ID.
Refer to the operation description for an enumeration of transmission types.
There are 2 other variants of this product (ST-618 and ST-621 series). The ST-654-031 represents the most configured version of the tag and was considered to be the the worst case of the three series products with respect to EMC performance. All tests were performed on a sample of the ST-654-031 and the results are considered to represent the worst of the three products.
The ST-618-030 and ST-618-030-NSN are the same as the ST-654-031 except the USB port is not provided. The ST-621-030 and ST-621-030-NSN are the same as the ST-654-031 except the USB port and the 2K Database Memory are not provided. The ST-618-030-NSN, ST-621-030-NSN and ST-654-031-NSN are the same as the ST-618-030, ST-621-030 and ST-654-031 respectively except that they include an additional label that contains customer specific information.

ANTENNA SYSTEM

The EUT antenna is a Loop
The antenna is integral to the device, thereby meeting the requirements of FCC 15.203.

ENCLOSURE

The EUT enclosure is primarily constructed of plastic and is provided with a plastic mounting bracket. It measures approximately 5.5 cm wide by 3 cm deep by 15.5 cm high.

MODIFICATIONS

No modifications were made to the EUT during the time the product was at Elliott.

SUPPORT EQUIPMENT

No support equipment was used during testing.

EUT INTERFACE PORTS

No cables were connected to the EUT during testing.
Note: The USB port was not connected during testing. Savi Technology stated that this is for configuration and/or service purposes and therefore would not normally be connected.

EUT OPERATION

The transmitter was set to continuous wave transmission at 433.92 MHz for transmitter related tests and in receive mode for receiver related tests.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken at the test sites listed below. Pursuant to section 2.948 of the FCC's Rules and section 3.3 of RSP-100, construction, calibration, and equipment data has been filed with the Commission and with industry Canada.

Site	Registration Numbers		Location
	FCC	Canada	
Chamber 5	211948	2845B-5	41039 Boyce Road Fremont, CA 94538-2435

ANSI C63.4:2003 recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement. The test site(s) contain separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements of ANSI C63.4:2003.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.4:2003. 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 or in a semi-anechoic chamber. The test sites are maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4:2003 guidelines and meet the Normalized Site Attenuation (NSA) requirements of ANSI C63.4:2003.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1-1 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. If the repetition frequency of the signal being measured is below 20Hz, peak measurements are made in lieu of Quasi-Peak 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, unless the signal is pulsed in which case the average (or video) bandwidth of the measuring instrument is reduced to onset of pulse desensitization and then increased.

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.

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 loop antenna is used below 30 MHz. For the measurement range 30 MHz to 1000 MHz either a combination of a biconical antenna and a log periodic or a bi-log antenna is used. Above 1000 MHz, horn antennas are used. The antenna calibration factors to convert the received voltage to an electric field strength are included with appropriate cable loss and amplifier gain factors to determine an overall site factor, which is then programmed into the test receivers or incorporated into the test software.

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. Measurements below 30 MHz are made with the loop antenna at a fixed height of 1m above the ground plane.

ANSI C63.4:2003 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 regulations require 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 C63.4:2003, 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.

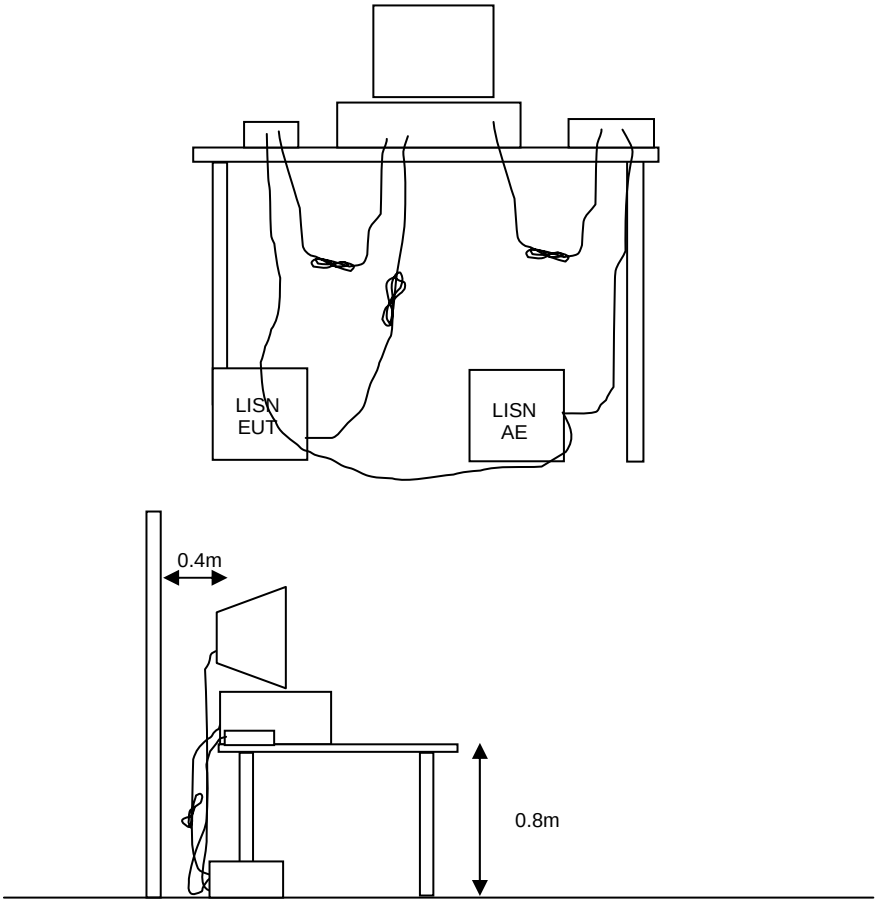


Figure 1 Typical Conducted Emissions Test Configuration

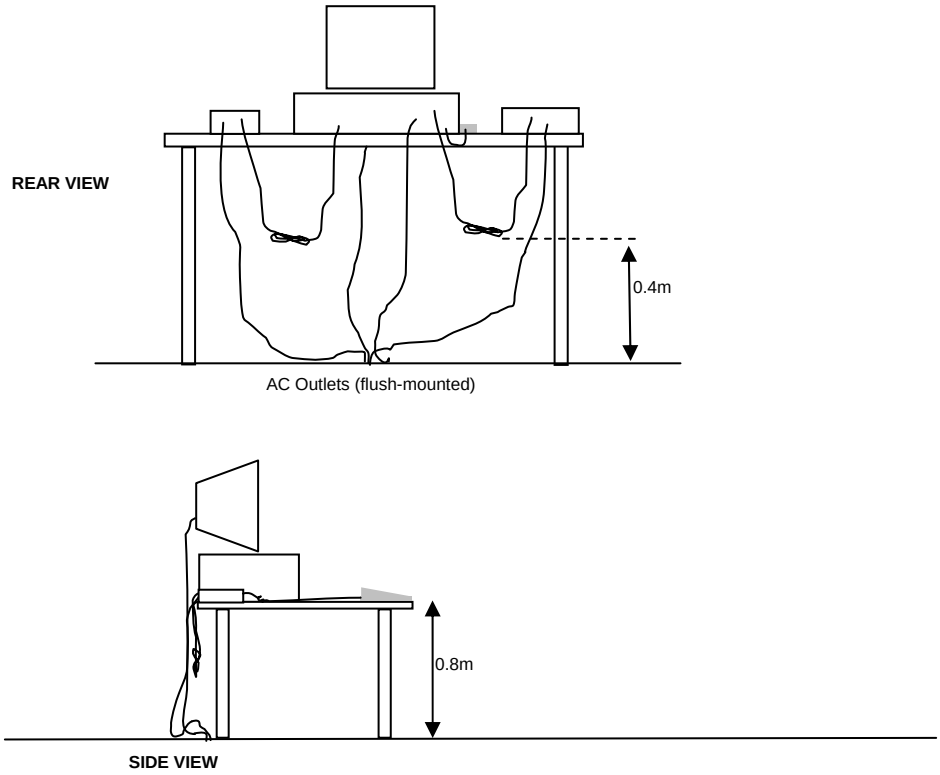
RADIATED EMISSIONS

A preliminary scan of the radiated emissions is performed in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed, one scan for each antenna polarization (horizontal and vertical; loop parallel and perpendicular to the EUT). During the preliminary scans, the EUT is rotated through 360˚, the antenna height is varied (for measurements above 30 MHz) and cable positions are varied to determine the highest emission relative to the limit. Preliminary scans may be performed in a fully anechoic chamber for the purposes of identifying the frequencies of the highest emissions from the EUT.

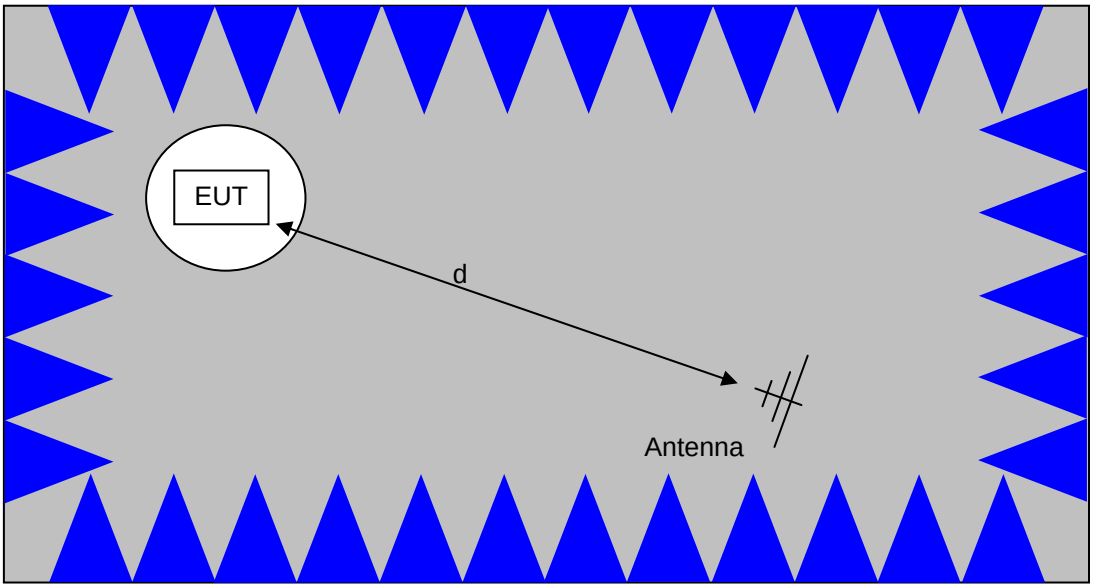
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

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 (for measurements above 30 MHz, measurements below 30 MHz are made with the loop antenna at a fixed height of 1m). 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.

When testing above 18 GHz, the receive antenna is located at 1meter from the EUT and the antenna height is restricted to a maximum of 2.5 meters.

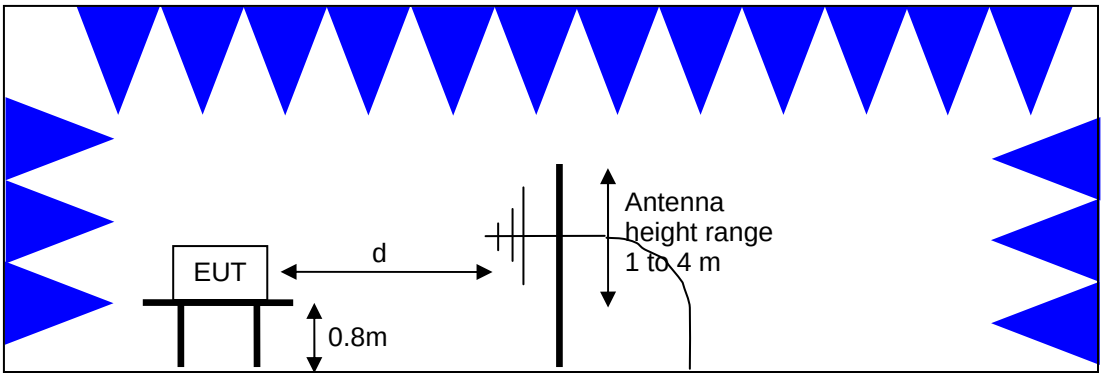


Typical Test Configuration for Radiated Field Strength Measurements



The anechoic materials on the walls and ceiling ensure compliance with the normalized site attenuation requirements of CISPR 16 / CISPR 22 / ANSI C63.4 for an alternate test site at the measurement distances used.

Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



Test Configuration for Radiated Field Strength Measurements
Semi-Anechoic Chamber, Plan and Side Views

BANDWIDTH MEASUREMENTS

The 6dB, 20dB and/or 26dB signal bandwidth is measured in using the bandwidths recommended by ANSI C63.4. When required, the 99% bandwidth is measured using the methods detailed in RSS GEN.

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:

GENERAL TRANSMITTER RADIATED EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from transmitters that fall in restricted bands[2] (with the exception of transmitters operating under FCC Part 15 Subpart D and RSS 210 Annex 9), the limits for all emissions from a low power device operating under the general rules of RSS 310 (tables 3 and 4), RSS 210 (table 2) and FCC Part 15 Subpart C section 15.209.

Frequency Range (MHz)	Limit (uV/m)	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 @ 3m	40 @ 3m
88 to 216	150 @ 3m	43.5 @ 3m
216 to 960	200 @ 3m	46.0 @ 3m
Above 960	500 @ 3m	54.0 @ 3m

[2] The restricted bands are detailed in FCC 15.203, RSS 210 Table 1 and RSS 310 Table 2

RADIATED FUNDAMENTAL AND SPURIOUS EMISSIONS – MOMENTARILY OPERATED DEVICES

The table below shows the limits for both the fundamental and spurious emissions for control signals. The limits for data signals, or signals with predetermined transmissions, are given in the second table

Operating Frequency (MHz)	Fundamental Field Strength (microvolts/m)	Spurious Emissions (microvolts/m)
70 - 130	1250	125
130 - 174	1250 - 3750	125 - 375
174 – 260	3750	375
260 – 470	3750 – 12,500	375 - 1250
Above 470	12,500	1250

Spurious Emissions Limits – Control Signals

Operating Frequency (MHz)	Fundamental Field Strength (microvolts/m)	Spurious Emissions (microvolts/m)
70 - 130	500	50
130 - 174	500 - 1500	50 - 150
174 – 260	1500	150
260 – 470	1500 – 5000	150 - 500
Above 470	5000	500

Spurious Emissions Limits – Data Signals

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

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

$$R_r - S = M$$

where:

R_r = Receiver Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

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 above 30MHz, 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

For electric field measurements below 30MHz the extrapolation factor is either determined by making measurements at multiple distances or a theoretical value is calculated using the formula:

$$F_d = 40*LOG_{10} (D_m/D_s)$$

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

SAMPLE CALCULATIONS - FIELD STRENGTH TO EIRP CONVERSION

Where the radiated electric field strength is expressed in terms of the equivalent isotropic radiated power (eirp), or where a field strength measurement of output power is made in lieu of a direct measurement, the following formula is used to convert between eirp and field strength at a distance of d (meters) from the equipment under test:

$$E = \frac{1000000 \sqrt{30 P}}{d} \quad \text{microvolts per meter}$$

where P is the eirp (Watts)

For a measurement at 3m the conversion from a logarithmic value for field strength (dBuV/m) to an eirp power (dBm) is -95.3dB.

Appendix A Test Equipment Calibration Data

Radiated Emissions, 30 - 4400 MHz, 11-Nov-11

Manufacturer	Description	Model	Asset #	Cal Due
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	5/18/2012
EMCO	Antenna, Horn, 1-18 GHz	3115	786	12/11/2011
Filtek	Filter, 1 GHz High Pass	HP12/1000-5BA	955	5/4/2012
Hewlett Packard	SpecAn 9 kHz - 40 GHz, FT (SA40) Blue	8564E (84125C)	1393	8/9/2012
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1657	5/28/2012
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1756	4/6/2012

Appendix B Test Data

T85452 Pages 23 - 36

Client:	Savi Technology	Job Number:	J85371
Model:	Eagle Tag	T-Log Number:	T85452
		Account Manager:	Sheareen Washington
Contact:	John Hattick		-
Emissions Standard(s):	FCC 15.231(a) & (e), 15.240	Class:	-
Immunity Standard(s):		Environment:	-

EMC Test Data

For The

Savi Technology

Model

Eagle Tag

Date of Last Test: 2/2/2012

Client:	Savi Technology	Job Number:	J85371
Model:	Eagle Tag	T-Log Number:	T85452
		Account Manager:	Shearen Washington
Contact:	John Hattick		
Standard:	FCC 15.231(a) & (e), 15.240	Class:	-

Radiated Emissions

(Elliott Laboratories Fremont Facility, Semi-Anechoic Chamber)

Test Specific Details

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: 12/23/2011
Test Engineer: Rafael Varelas
Test Location: Fremont Chamber #4
Config. Used: 2
Config Change: None
EUT Voltage: 3.6Vdc

General Test Configuration

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

The test distance and extrapolation factor (if applicable) are detailed under each run description.

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.

Ambient Conditions:

Temperature: 22.3 °C
Rel. Humidity: 34 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
2	Radiated Emissions 30 - 1000 MHz, Maximized	EN55022 Class A	Pass	16.6dBµV/m @ 114.86MHz (-23.4dB)
3	Radiated Emissions 1 GHz - 2 GHz Maximized	FCC Class A	Pass	27.6dBµV/m @ 1490.8MHz (-21.9dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

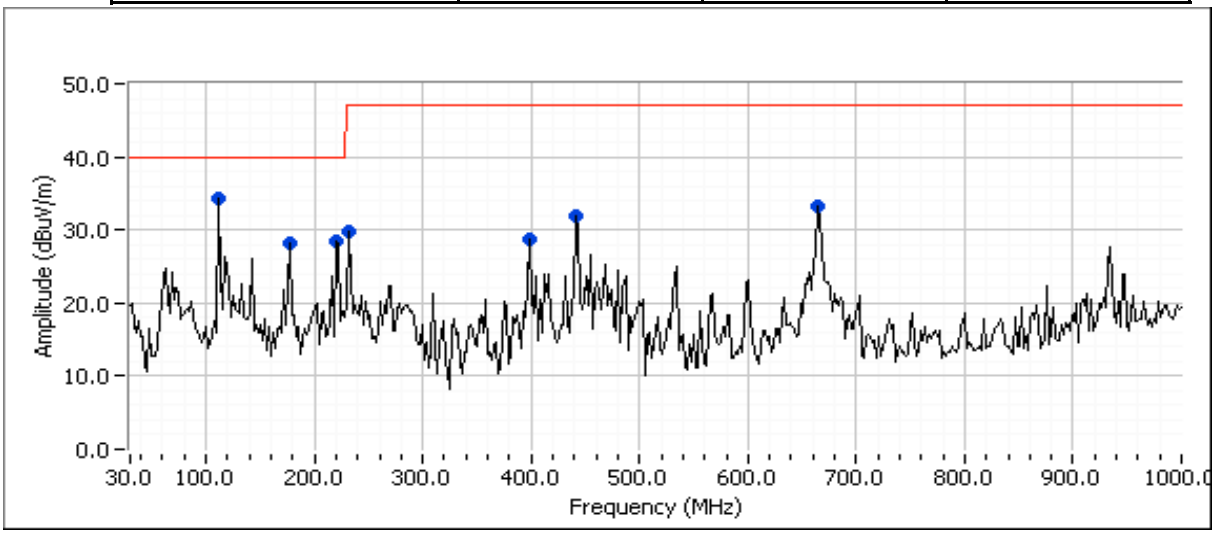
No deviations were made from the requirements of the standard.

Client:	Savi Technology	Job Number:	J85371
Model:	Eagle Tag	T-Log Number:	T85452
		Account Manager:	Sheareen Washington
Contact:	John Hattick		
Standard:	FCC 15.231(a) & (e), 15.240	Class:	-

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

Tag ID:18712651500067

Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
30 - 1000 MHz	5	10	-6.0



Preliminary peak readings captured during pre-scan

Frequency	Level	Pol	EN55022 Class A		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
114.860	34.3	H	40.0	-5.7	Peak	338	1.5	
177.181	28.1	H	40.0	-11.9	Peak	133	1.0	
216.934	28.5	H	40.0	-11.5	Peak	271	1.5	
233.204	29.9	H	47.0	-17.1	Peak	18	1.5	
398.455	28.7	H	47.0	-18.3	Peak	148	1.0	
441.122	31.9	H	47.0	-15.1	Peak	300	1.5	
663.075	33.2	H	47.0	-13.8	Peak	334	2.0	

Preliminary quasi-peak readings (no manipulation of EUT interface cables)

Frequency	Level	Pol	EN55022 Class A		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
114.860	16.6	H	40.0	-23.4	QP	349	2.2	QP (1.00s)
663.075	20.9	H	47.0	-26.1	QP	332	1.0	QP (1.00s)
441.122	13.5	H	47.0	-33.5	QP	285	1.0	QP (1.00s)
216.934	9.6	H	40.0	-30.4	QP	174	1.2	QP (1.00s)
398.455	16.0	H	47.0	-31.0	QP	146	1.0	QP (1.00s)
177.181	6.0	H	40.0	-34.0	QP	131	1.0	QP (1.00s)
233.204	6.1	H	47.0	-40.9	QP	17	1.0	QP (1.00s)

Client:	Savi Technology	Job Number:	J85371
Model:	Eagle Tag	T-Log Number:	T85452
		Account Manager:	Sheareen Washington
Contact:	John Hattick		
Standard:	FCC 15.231(a) & (e), 15.240	Class:	-

Run #2: Maximized Readings From Run #1

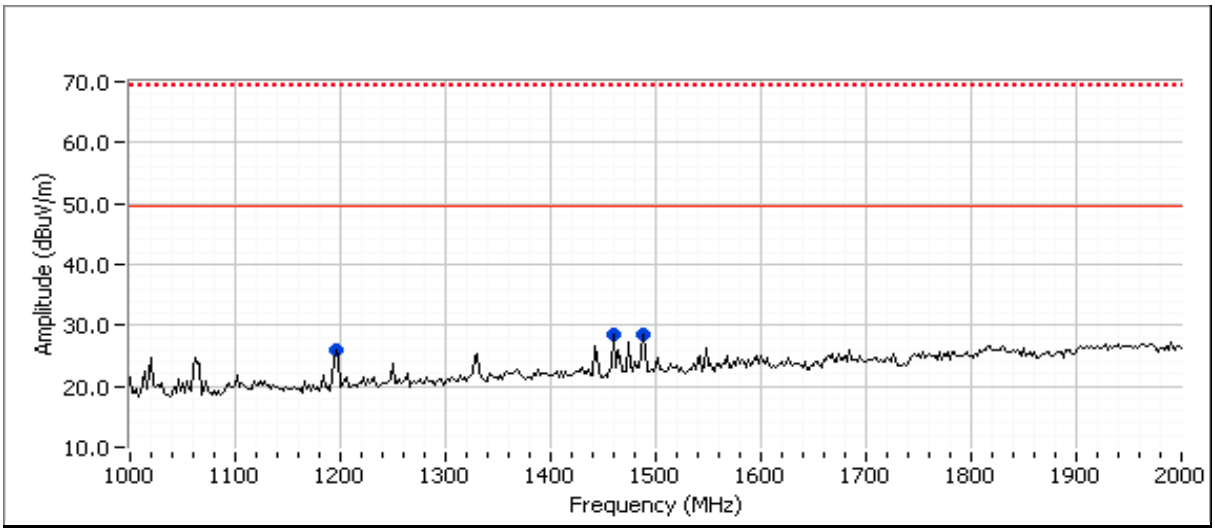
Maximized quasi-peak readings (includes manipulation of EUT interface cables)

Frequency	Level	Pol	EN55022 Class A		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
114.860	16.6	H	40.0	-23.4	QP	349	2.2	QP (1.00s)
663.075	20.9	H	47.0	-26.1	QP	332	1.0	QP (1.00s)
216.934	9.6	H	40.0	-30.4	QP	174	1.2	QP (1.00s)
398.455	16.0	H	47.0	-31.0	QP	146	1.0	QP (1.00s)
441.122	13.5	H	47.0	-33.5	QP	285	1.0	QP (1.00s)
177.181	6.0	H	40.0	-34.0	QP	131	1.0	QP (1.00s)

Client:	Savi Technology	Job Number:	J85371
Model:	Eagle Tag	T-Log Number:	T85452
		Account Manager:	Sheareen Washington
Contact:	John Hattick		
Standard:	FCC 15.231(a) & (e), 15.240	Class:	-

Run #3: Maximized Readings, 1000 - 2000 MHz
Tag ID:18712651500067

Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
1000 - 18000 MHz	3	10	-10.5



Preliminary peak readings captured during pre-scan (peak readings vs. average limit)

Frequency	Level	Pol	FCC Class A		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1490.750	28.4	H	49.5	-21.1	Peak	71	1.5	
1461.970	28.5	H	49.5	-21.0	Peak	77	1.5	
1200.170	25.8	V	49.5	-23.7	Peak	54	2.0	

Final peak and average readings

Frequency	Level	Pol	FCC Class A		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1490.750	27.6	H	49.5	-21.9	AVG	73	1.8	AVG (0.10s)
1490.750	40.3	H	69.5	-29.2	PK	73	1.8	PK (0.10s)
1461.970	27.3	H	49.5	-22.2	AVG	78	1.0	AVG (0.10s)
1461.970	40.1	H	69.5	-29.4	PK	78	1.0	PK (0.10s)

Note 1:	Above 1 GHz, the limit is based on an average measurement. In addition, the peak reading of any emission above 1 GHz can not exceed the average limit by more than 20 dB.

Client:	Savi Technology	Job Number:	J85371
Model:	Eagle Tag	T-Log Number:	T85452
		Account Manager:	Sheareen Washington
Contact:	John Hattick		
Standard:	FCC 15.231(a) & (e), 15.240	Class:	-

Radiated Emissions

(Elliott Laboratories Fremont Facility, Semi-Anechoic Chamber)

Test Specific Details

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

Date of Test: 11/11/2011
Test Engineer: John Caizzi
Test Location: Fremont Chamber #5
Config. Used: See Run 1.
Config Change: none
EUT Voltage: Battery, 3.6 VDC primary cell

General Test Configuration

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

The test distance and extrapolation factor (if applicable) are detailed under each run description.

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.

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	Fundamental Field Strength	FCC 15.231(a)	Pass	80.4dBµV/m @ 433.93MHz (-0.4dB)
1	Radiated Spurious Emissions 30 - 4400 MHz, Maximized		Pass	35.8dBµV/m @ 3905.01MHz (-18.2dB)

Modifications Made During Testing

Modifications are detailed under each run description.

Deviations From The Standard

No deviations were made from the requirements of the standard.

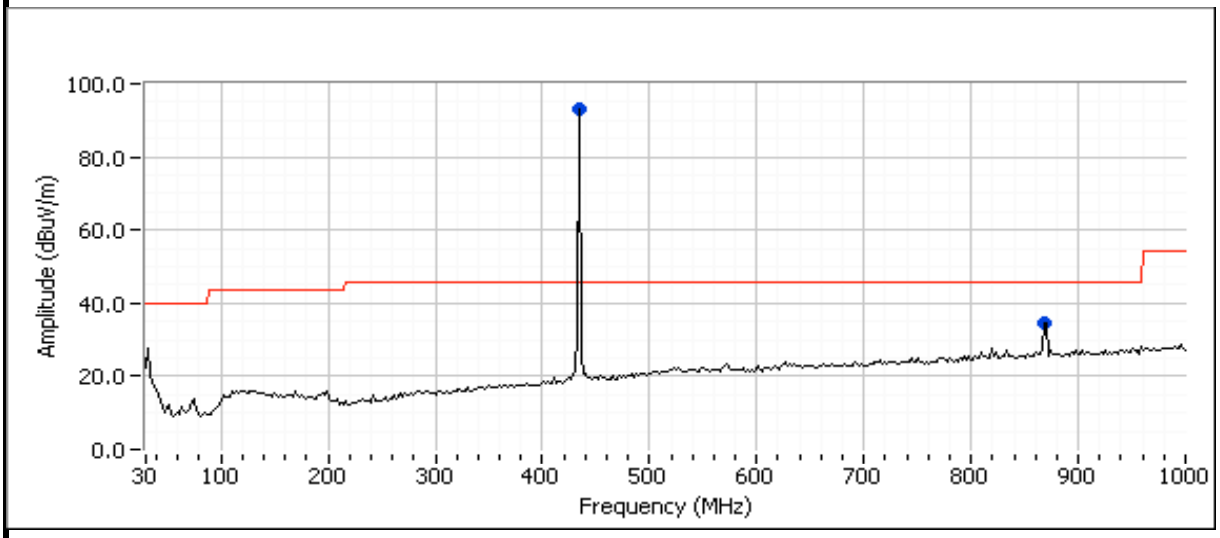
Note

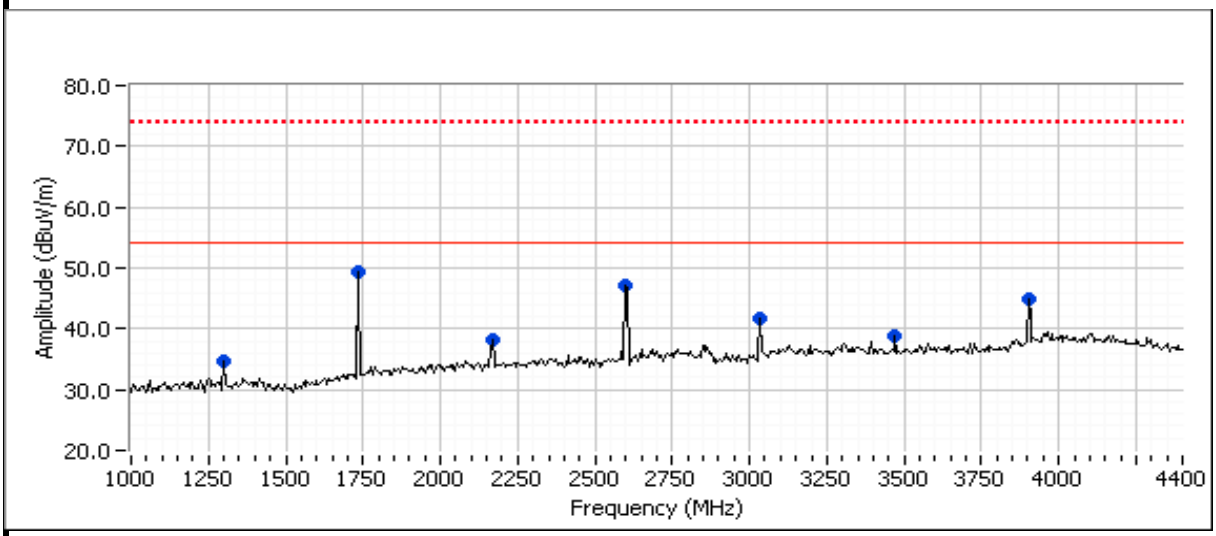
Preliminary tests in three orentations identified that the highest emsisions were observed with the EUT positioned vertically with the battery up.

Client:	Savi Technology	Job Number:	J85371
Model:	Eagle Tag	T-Log Number:	T85452
		Account Manager:	Sheareen Washington
Contact:	John Hattick		
Standard:	FCC 15.231(a) & (e), 15.240	Class:	-

Run #1: Radiated Emissions, 30 - 4400 MHz

Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
30 - 1000 MHz	3	3	0.0





Client:	Savi Technology	Job Number:	J85371
Model:	Eagle Tag	T-Log Number:	T85452
		Account Manager:	Sheareen Washington
Contact:	John Hattick		
Standard:	FCC 15.231(a) & (e), 15.240	Class:	-

Frequency	Level	Pol	FCC 15.231(a)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
433.927	80.4	V	80.8	-0.4	Avg	288	1.14	Note 2
433.927	92.4	V	100.8	-8.4	PK	288	1.14	
867.742	36.7	V	60.8	-24.1	QP	236	1.89	
1300.330	*34.7*	*V*	*54.0*	*-19.3*	*Peak*	*274*	*1.30*	*Note 1*
1731.000	*49.5*	*V*	*60.8*	*-11.3*	*Peak*	*228*	*1.00*	
2167.330	*38.3*	*V*	*60.8*	*-22.5*	*Peak*	*283*	*1.00*	
2598.000	*47.1*	*V*	*60.8*	*-13.7*	*Peak*	*1*	*1.60*	
3034.330	*41.7*	*H*	*60.8*	*-19.1*	*Peak*	*281*	*1.60*	
3470.670	*38.9*	*H*	*60.8*	*-21.9*	*Peak*	*264*	*1.90*	
3901.330	*45.0*	*H*	*54.0*	*-9.0*	*Peak*	*281*	*1.60*	
1735.720	38.5	V	60.8	-22.3	AVG	232	1.01	Note 2
1735.500	50.5	V	80.8	-30.3	PK	232	1.01	
2603.480	36.5	V	60.8	-24.3	AVG	337	1.30	Note 2
2603.270	48.5	V	80.8	-32.3	PK	337	1.30	
3905.010	35.8	H	54.0	-18.2	AVG	262	1.03	Note 2
3905.810	47.8	H	74.0	-26.2	PK	262	1.03	
3037.410	34.1	H	60.8	-26.7	AVG	260	1.13	Note 2
3037.810	46.1	H	80.8	-34.7	PK	260	1.13	

Note 1:	Pk readings vs avg limit during scan
Note 2:	Avg value calculated from pk reading by adjusting for the 25% duty cycle of the EUT (subtracting 12 dB).
Note 3:	All peak emissions other than the fundamental and harmonics of the trasnmitter were more than 15dB below the limit for receivers.

Client:	Savi Technology	Job Number:	J85371
Model:	Eagle Tag	T-Log Number:	T85452
		Account Manager:	Sheareen Washington
Contact:	John Hattick		
Standard:	FCC 15.231(a) & (e), 15.240	Class:	-

Antenna Port Measurements

Test Specific Details

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

General Test Configuration

When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators and cables used. although the EUT does not have an antenna port, a temporary antenna port was fitted for the measurements.

Ambient Conditions:

Temperature: 23 °C

Rel. Humidity: 43 %

Summary of Results

Run #	Test Performed	Limit	Result	Value / Margin
1	99% Bandwidth (center channel)	RSS-GEN	N/A	179 kHz
1	20 dB bandwidth	15.239, RSS 210	Pass	187 kHz

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.

Client:	Savi Technology	Job Number:	J85371
Model:	Eagle Tag	T-Log Number:	T85452
		Account Manager:	Sheareen Washington
Contact:	John Hattick		
Standard:	FCC 15.231(a) & (e), 15.240	Class:	-

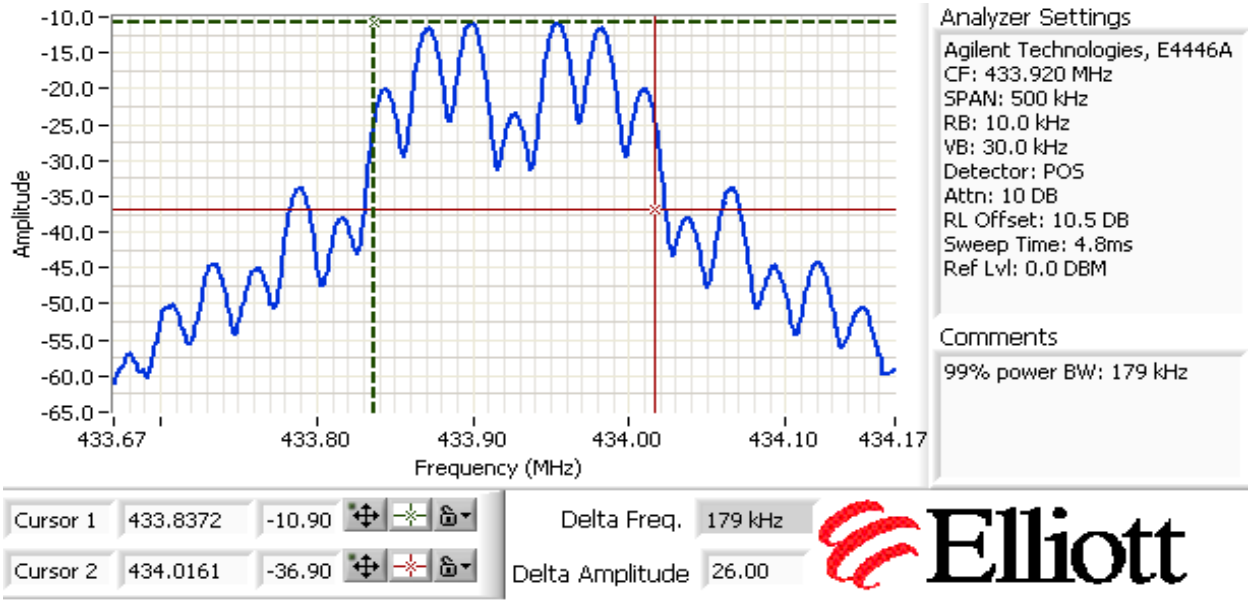
Run #1: Bandwidth Measurement(s)

Date of Test: 2/1/2012 8:59
Test Engineer: Jack Liu
Test Location: Fremont EMC Lab #4

Config. Used: 1
Config Change: None
EUT Voltage: Internal Battery 3.6Vdc

Frequency (MHz)	Resolution Bandwidth	Video Bandwidth	99% Bandwidth
	10	30	179 kHz

Note 1:	99% bandwidth measured in accordance with RSS GEN, with RB > 1% of the span and VB > 3xRB

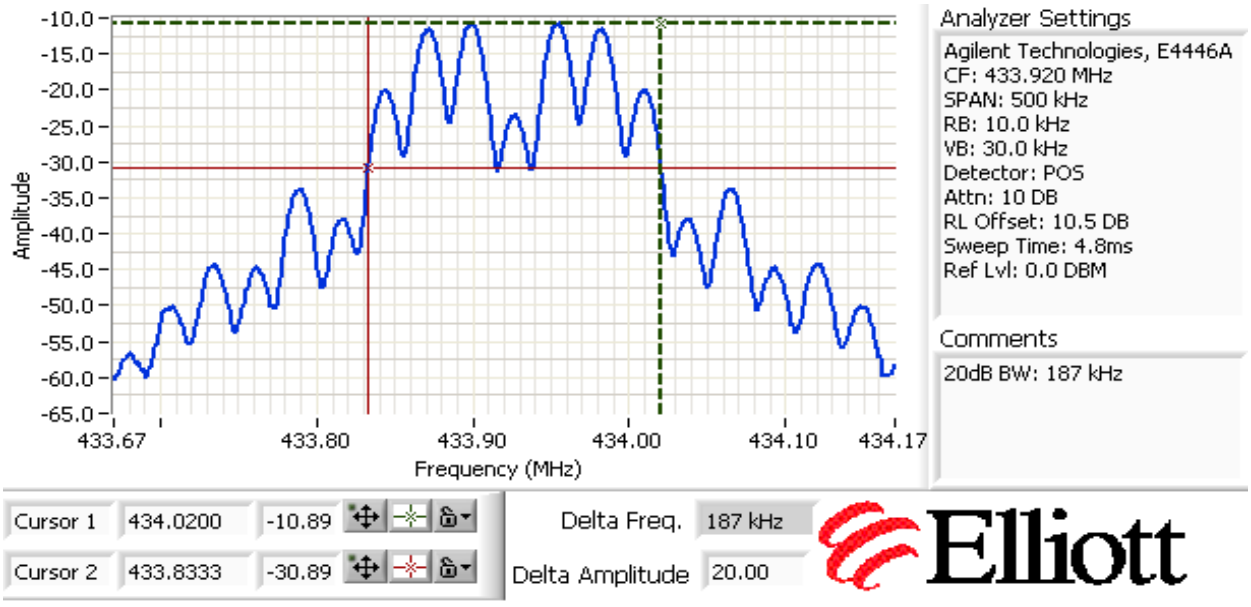


Client:	Savi Technology	Job Number:	J85371
Model:	Eagle Tag	T-Log Number:	T85452
		Account Manager:	Sheareen Washington
Contact:	John Hattick		
Standard:	FCC 15.231(a) & (e), 15.240	Class:	-

Compliance with 15.231 bandwidth and transmit time requirements

Frequency (MHz)	Resolution Bandwidth	Video Bandwidth	20dB BW (kHz)	15.231 Limit (kHz)
433.9	10	30	187	1084.75

Note 1:	20dB bandwidth measured using a resolution bandwidth at least 1% of the maximum permitted bandwidth.



Compliance with 15.231 duration of transmissions and time between transmissions:

Refer to the operational description for plots and detailed description as to how the device complies with the transmit time and period between transmissions.

Client:	Savi Technology	Job Number:	J85371
Model:	Eagle Tag	T-Log Number:	T85452
		Account Manager:	Sheareen Washington
Contact:	John Hattick		
Standard:	FCC 15.231(a) & (e), 15.240	Class:	-

Radiated Emissions

(Elliott Laboratories Fremont Facility, Semi-Anechoic Chamber)

Test Specific Details

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

Date of Test: 11/11/2011
Test Engineer: John Caizzi
Test Location: Fremont Chamber #5
Config. Used: See Run 1.
Config Change: none
EUT Voltage: Battery, 3.6 VDC primary cell

General Test Configuration

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

The test distance and extrapolation factor (if applicable) are detailed under each run description.

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.

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	Fundamental Field Strength	FCC 15.231(e)	Pass	72.4dBµV/m @ 433.93MHz (-0.5dB)
1	Radiated Spurious Emissions 30 - 4400 MHz, Maximized		Pass	36.7dBµV/m @ 867.742 MHz (-16.2dB)

Modifications Made During Testing

Modifications are detailed under each run description.

Deviations From The Standard

No deviations were made from the requirements of the standard.

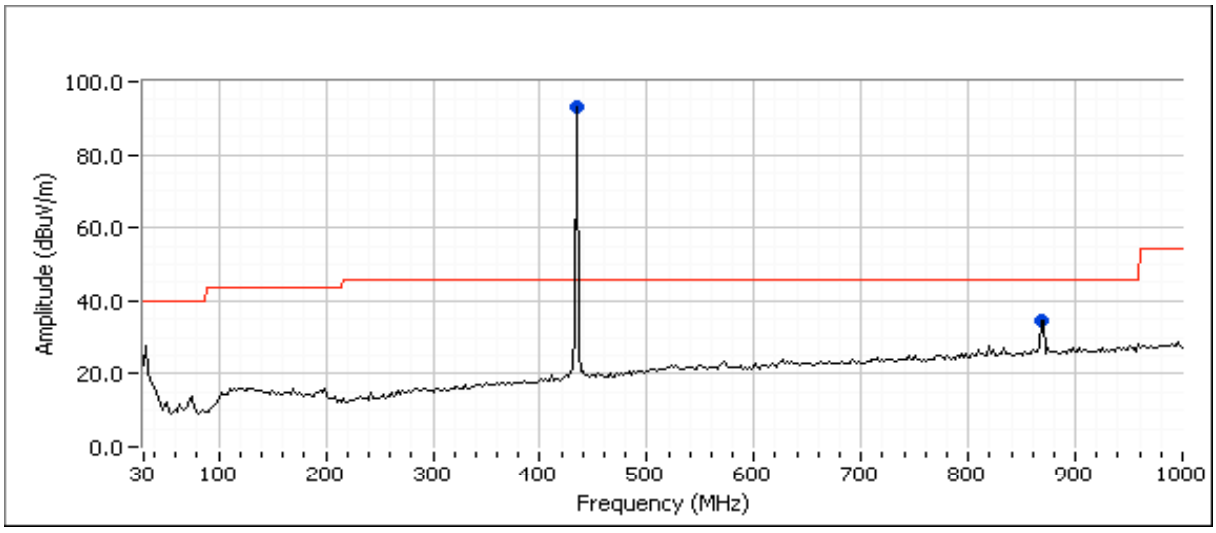
Note

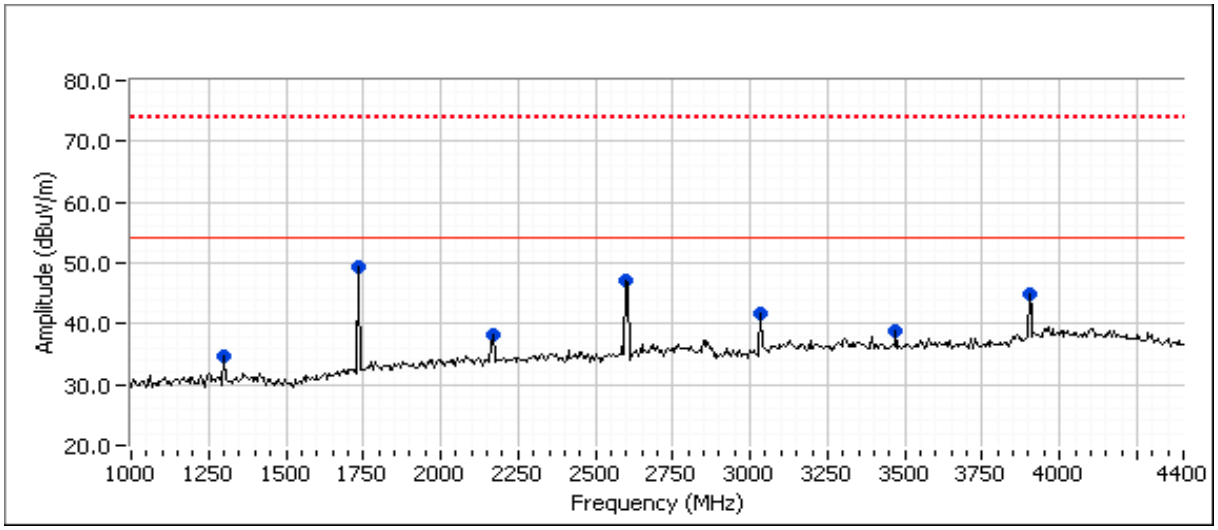
Preliminary tests in three orentations identified that the highest emsisions were observed with the EUT positioned vertically with the battery up.

Client:	Savi Technology	Job Number:	J85371
Model:	Eagle Tag	T-Log Number:	T85452
		Account Manager:	Sheareen Washington
Contact:	John Hattick		
Standard:	FCC 15.231(a) & (e), 15.240	Class:	-

Run #1: Radiated Emissions, 30 - 4400 MHz

Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
30 - 1000 MHz	3	3	0.0





Client:	Savi Technology	Job Number:	J85371
Model:	Eagle Tag	T-Log Number:	T85452
		Account Manager:	Sheareen Washington
Contact:	John Hattick		
Standard:	FCC 15.231(a) & (e), 15.240	Class:	-

Frequency	Level	Pol	FCC 15.231(e)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
433.927	72.4	V	72.9	-0.5	Avg	288	1.1	Note 2
433.927	92.4	V	92.9	-0.5	PK	288	1.1	
867.742	36.7	V	52.9	-16.2	QP	236	1.9	
1300.330	*34.7*	*V*	*54.0*	*-19.3*	*Peak*	*274*	*1.3*	*Note 1*
1731.000	*49.5*	*V*	*54.0*	*-4.5*	*Peak*	*228*	*1.0*	
2167.330	*38.3*	*V*	*54.0*	*-15.7*	*Peak*	*283*	*1.0*	
2598.000	*47.1*	*V*	*54.0*	*-6.9*	*Peak*	*1*	*1.6*	
3034.330	*41.7*	*H*	*54.0*	*-12.3*	*Peak*	*281*	*1.6*	
3470.670	*38.9*	*H*	*54.0*	*-15.1*	*Peak*	*264*	*1.9*	
3901.330	*45.0*	*H*	*54.0*	*-9.0*	*Peak*	*281*	*1.6*	
1735.720	30.5	V	*54.0*	-23.5	AVG	232	1.0	Note 2
1735.500	50.5	V	74.0	-23.5	PK	232	1.0	
2603.480	28.5	V	54.0	-25.5	AVG	337	1.3	Note 2
2603.270	48.5	V	74.0	-25.5	PK	337	1.3	
3905.010	27.8	H	54.0	-26.2	AVG	262	1.0	Note 2
3905.810	47.8	H	74.0	-26.2	PK	262	1.0	
3037.410	26.1	H	54.0	-27.9	AVG	260	1.1	Note 2
3037.810	46.1	H	74.0	-27.9	PK	260	1.1	

Note 1:	Pk readings vs avg limit during scan
Note 2:	Avg value calculated from pk reading by adjusting for the 10% duty cycle of the EUT (subtracting 20 dB).

End of Report

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marks the last page of this test report.