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Electromagnetic Emissions Test Report In Accordance With Industry Canada Radio Standards Specification 210 And FCC Part 15 Sections 15.209, 15.231, 15.240 on the Savi Technology, Inc. Transmitter Model: ST-662

UPN:	2404A-662T
FCC ID:	KL7-662T-V1
GRANTEE:	Savi Technology, Inc. 615 Tasman Drive Sunnyvale, CA 94089-1707
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Ave Sunnyvale, CA 94086
REPORT DATE:	February 27, 2006
FINAL TEST DATE:	February 3, February 10 and February 17, 2006

AUTHORIZED SIGNATORY: Mark Briggs

Mark Briggs
Principal Engineer

A2LA ACCREDITED
2016-01

Equipment Name and Model:

Transceiver ST-662

Manufacturer:

Savi Technology, Inc.
615 Tasman Drive
Sunnyvale, CA 94089-1707

Tested to applicable standard:
RSS210, Issue 5, February 1996
Low Power License-Exempt Radio Communication Devices

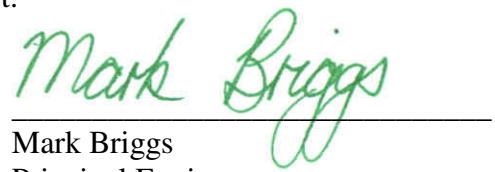
Test Report Prepared For:
Eugene Schlindwein
Savi Technology, Inc.
615 Tasman Drive
Sunnyvale, CA 94089-1707

Measurement Facility Description Filed With Department of Industry:

Departmental Acknowledgement Number: IC2845 SV2 Dated August 16, 2007

Declaration of Compliance

I declare that the testing was performed or supervised by me; that the test measurements were made in accordance with the above mentioned departmental standards (through the use of ANSI C63.4:2003 as detailed in section 5.3 of RSS-210, Issue 5); and that the equipment performed in accordance with the data submitted in this report.



Signature	
Name	Mark Briggs
Title	Principal Engineer
	Elliott Laboratories Inc.
Address	684 W. Maude Ave
	Sunnyvale, CA 94086
	USA
Date:	February 27, 2006

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SCOPE

An electromagnetic emissions test has been performed on the Savi Technology, Inc. model ST-662 pursuant to Subpart C of Part 15 of FCC Rules for intentional radiators and Industry Canada Radio Standards Specification RSS-210 for Low Power, License-Exempt Radio Communication Devices. Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in ANSI C63.4:2003 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 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.

The test results recorded herein are based on a single type test of the Savi Technology, Inc. model ST-662 and therefore apply only to the tested sample. The sample was selected and prepared by Eugene Schlindwein of Savi Technology, Inc.

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 and Industry Canada RSS-210 for Low Power, License-Exempt Radio Communication Devices. Certification of these devices is required as a prerequisite to marketing as defined in Part 2 the FCC Rules and Industry Canada Radio Standards Procedure RSP-100.

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.

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-662 complied with the requirements of Subpart C of Part 15 of the FCC Rules for low power intentional radiators and Industry Canada specification RSS 210 for Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands).

Maintenance of FCC 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.

TEST RESULTS SUMMARY

MOMENTARILY OPERATED DEVICES – CONTROL SIGNALS

FCC Part 15 Reference	RSS Reference	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	Response to Hello: 10ms Read response: 5s or less	< 5 seconds	Complies
15.231 (a) (3)	RSS 210 A1.1.1 (3)	Transmissions at predetermined / regular intervals	No predetermined transmissions	Such transmissions are not permitted	Complies
15.231 (a) (4)	RSS 210 A1.1.1 (4)	Pendency of transmissions used during emergencies	Not applicable	-	Complies
15.231 (b)	RSS 210 Table 4	Fundamental Signal Strength, 433.9MHz	69.7dBµV/m (3054.9µV/m) @ 433.878MHz	80.8dBuV/m (Avg) 100.8dBuV/m (Pk)	Complies (-11.1dB)
15.231 (b) / 15.209	RSS 210 Table 2 / 4	Radiated Spurious Emissions, 30-4400 MHz	45.3dBµV/m (184.1µV/m) @ 867.758MHz	Refer to standard	Complies (-15.5dB)
15.231 (c)	RSS 210 A1.1.3	Bandwidth	442kHz	< 1.08 MHz	Complies
15.231 (d)	RSS 210 A1.1.4	Frequency Stability - 40.66 – 40.70 MHz band	N/A	-	N/A

Note 1 – Refer to the operational description included with this application for detailed description and timing diagrams for transmission duration.
Note 2 – The device was tested in all three orthogonal orientations.

MOMENTARILY OPERATED DEVICES – DATA SIGNALS OR SIGNALS AT PREDETERMINED INTERVALS

FCC Part 15 Reference	RSS Reference	Description	Measured Value / Comments	Limit / Requirement	Result
15.231 (e)	RSS 210 A1.1.5	Duration of transmissions	10ms for the beacon mode	< 1 second	Complies
15.231 (e)	RSS 210 A1.1.5	Period between transmissions	Beacon mode and short read mode: 10ms duration and quiet period of 10s Long read mode 1s duration and quiet period of 30s or more	> 30 times duration of signal and > 10s	Complies
15.231 (e)	RSS 210 Table 5	Fundamental Signal Strength, 433.9MHz	69.7dBµV/m (3054.9µV/m)	72.9 dBuV/m (Avg) 92.9 dBuV/m (Pk)	Complies (-3.2dB)
15.231 (e) / 15.209	RSS 210 Table 5	Radiated Spurious Emissions, 30-4400 MHz	45.3dBµV/m @ 867.758MHz	Refer to standard	Complies (-0.7dB)
15.231 (c)	RSS 210 A1.1.3	Bandwidth	442kHz	< 1.08 MHz	Complies
15.231 (d)	RSS 210 A1.1.4	Frequency Stability - 40.66 – 40.70 MHz band	N/A	-	N/A

Note 1 – Refer to the operational description included with this application for detailed description and timing diagrams for transmission duration.
Note 2 – The device was tested in all three orthogonal orientations.

RFID DEVICES OPERATING IN THE 433.5 – 434.5MHz BANDS

FCC Part 15 Reference	RSS Reference	Description	Measured Value / Comments	Limit / Requirement	Result
15.240 (a)	RSS 210 A5	Location of operation	The tag is triggered by a reader to send transmissions under 15.240. User information and location of these Readers is applicable to the Readers and not the Tag.	Must be limited to commercial and industrial areas	
15.240 (f)	-	Information to user		Notification of geographic limitations	
15.240 (b)	RSS 210 A5 (1)	Duration of transmissions	Tag read response: 60s or less	< 60s with 10s silent period	Complies
15.240 (b)	RSS 210 A5 (2)	Fundamental Signal Strength	77.7dBµV/m (7673.6µV/m) @	11000uV/m avg 55000uV/m pk	Complies (-3.1dB)
15.240 (c) / 15.209	RSS 210 Table 2	Radiated Spurious Emissions, 30 MHz – 4339 MHz	45.3dBµV/m (184.1µV/m) @ 867.758MHz	Table 2	Complies (-0.7dB)

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Part 15 Section	RSS 210 Section	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203	-	RF Connector	Integral antenna	Unique rf connector or integral antenna	Complies
15.109	RSS GEN 7.2.3 Table 1	Receiver spurious emissions	38.1dBµV/m (80.4µV/m) @ 867.540MHz	Refer to standards	Complies (-7.9dB)
-	RSS GEN	99% bandwidth	147kHz	Reference only	N/A
15.207	RSS GEN Table 2	AC Conducted Emissions	Not applicable, device is battery powered and is not intended to be powered from another source	Refer to standard	N/A

MEASUREMENT UNCERTAINTIES

ISO Guide 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	Frequency Range (MHz)	Calculated Uncertainty (dB)
Conducted Emissions	0.15 to 30	± 2.4
Radiated Emissions	30 to 1000	± 3.6

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Savi Technology, Inc. model ST-662 is an RF Tagging device which is designed to identify the container to which it is attached to the Savi RFID System.

Normally, the EUT would be mounted to a container or similar piece of equipment. The EUT was treated as tabletop equipment during testing to simulate the end user environment, and tested oriented in all three orthogonal axes.

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 when initiated by a SignPost and just the Tag ID when initiated by a Reader.

The sample was received on February 3, 2006 and tested on February 3, February 10 and February 17, 2006. The EUT consisted of the following component(s):

Manufacturer	Model	Description	Serial Number	FCC ID
Savi	ST-662	RFID tag	-	KL7-662T-V1

ENCLOSURE

The EUT enclosure is primarily constructed of plastic. Model ST-662 measures approximately 7.5 cm wide by3 cm deep by 6.5 cm high.

MODIFICATIONS

The EUT did not require modifications during testing in order to comply with emissions specifications.

SUPPORT EQUIPMENT

No support equipment was used during emissions testing.

EUT INTERFACE PORTS

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

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

EUT OPERATION

The EUT was configured to transmit continuously.

ANTENNA SYSTEM

The antenna is integral to the device.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on February 3, February 10 and February 17, 2006at the Elliott Laboratories Open Area Test Site #2 located at 684 West Maude Avenue, Sunnyvale, California. 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.

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 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 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. The test site is maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4:2003 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. 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 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 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.

ANSI C63.4:2003 and RSS 212 secify 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.

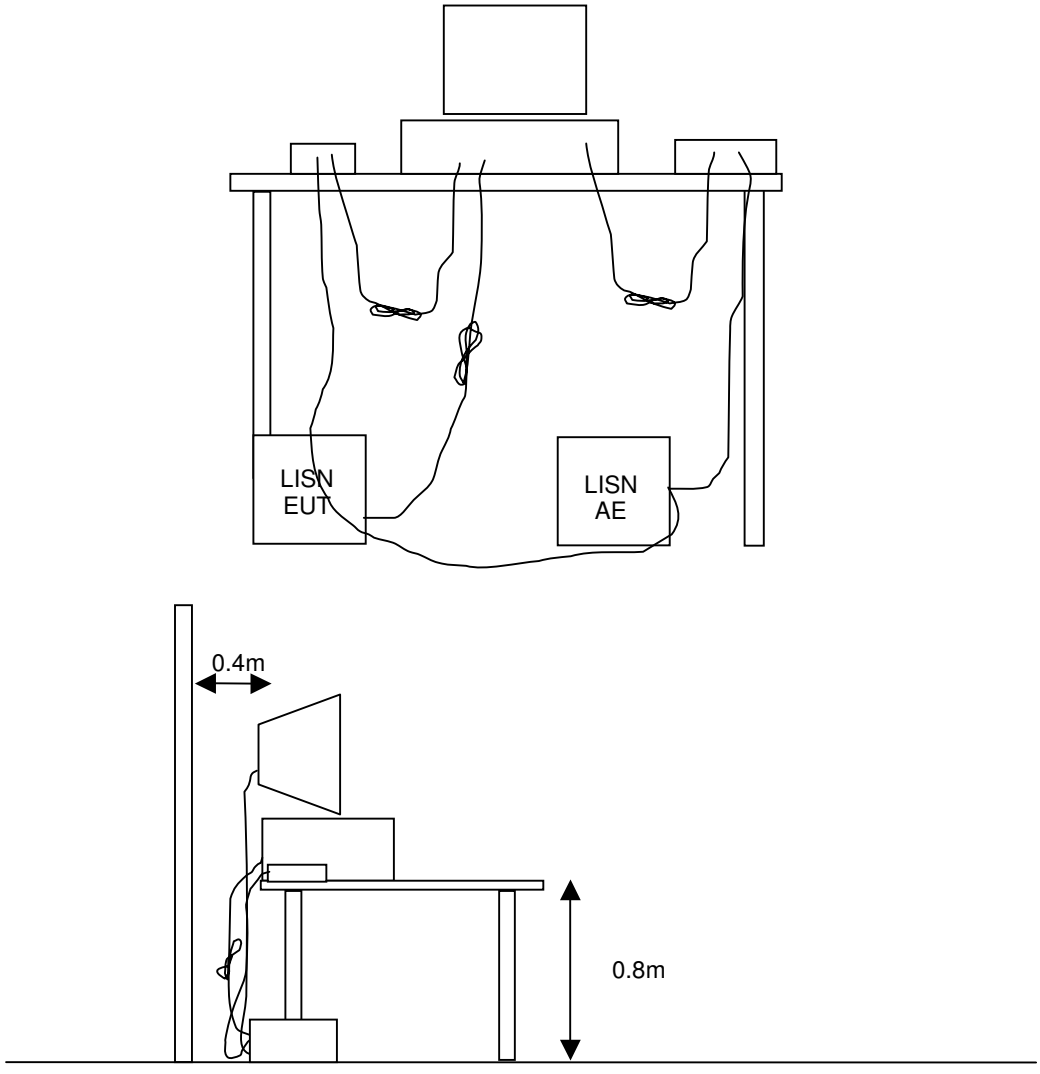
TEST PROCEDURES

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

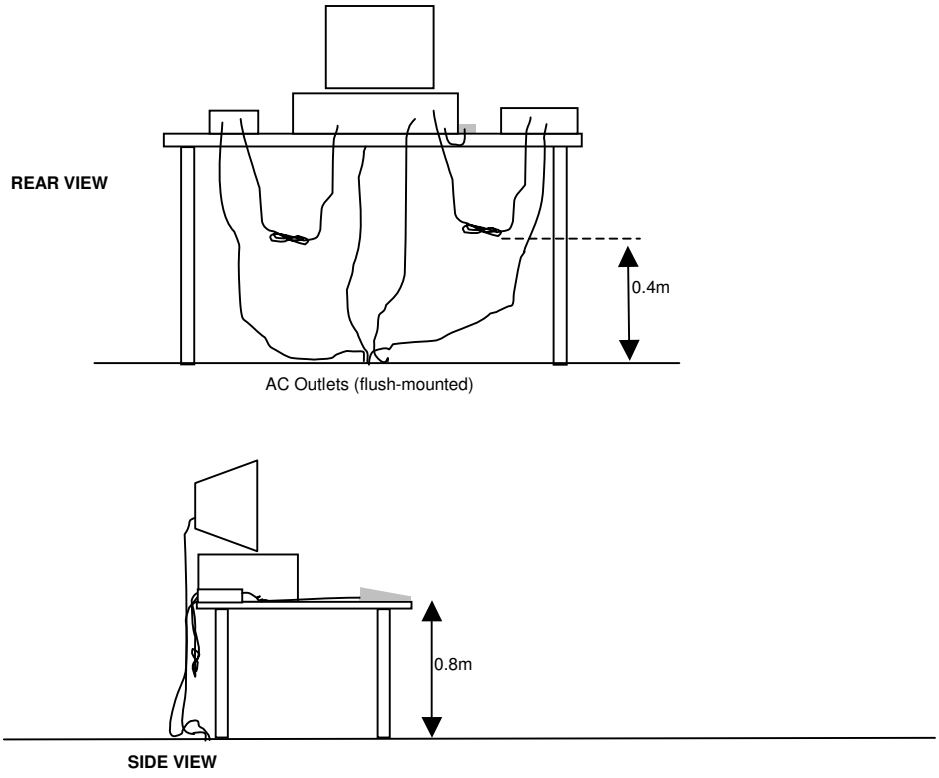
Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the 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.



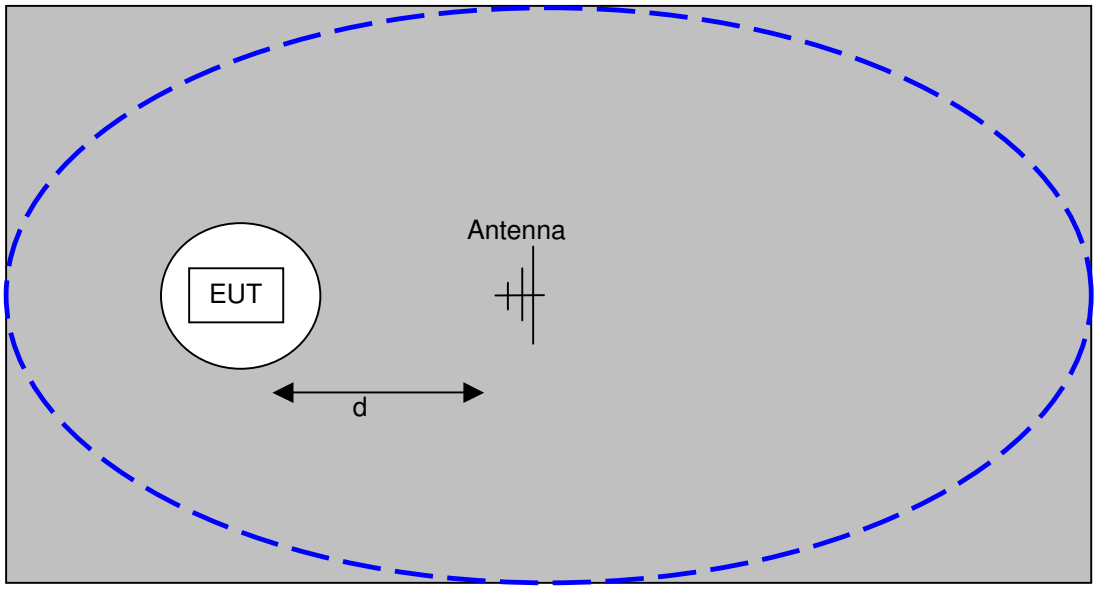
Radiated emissions measurements are performed in two phases as well. A preliminary scan of emissions is conducted in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed from 30 MHz up to the frequency required by the regulation 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. 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.

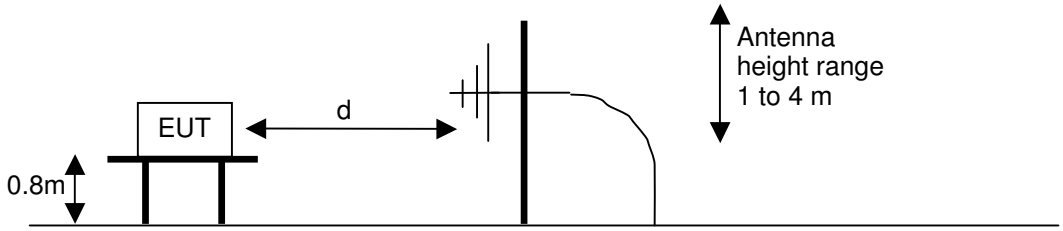
Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth, which results in the highest emission is then maintained while varying the antenna height from one to four meters. 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.



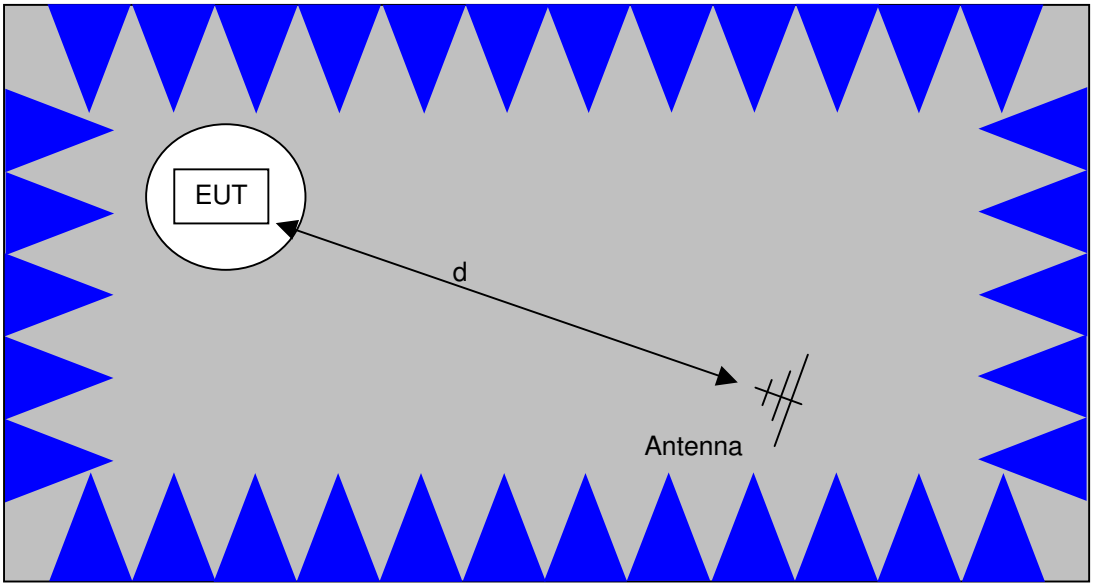
Typical Test Configuration for Radiated Field Strength Measurements



The ground plane extends beyond the ellipse defined in CISPR 16 / CISPR 22 / ANSI C63.4 and is large enough to accommodate test distances (d) of 3m and 10m. Refer to the test data tables for the actual measurement distance.

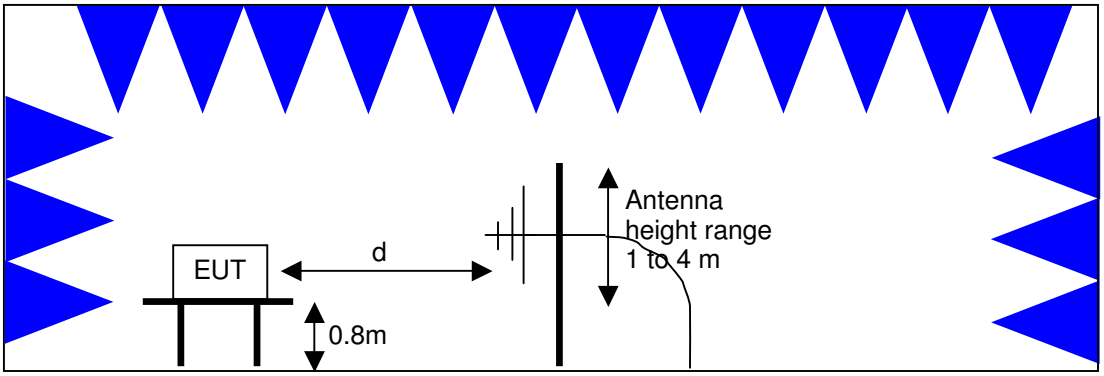


Test Configuration for Radiated Field Strength Measurements
OATS- Plan and Side Views



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

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: FCC 15.207; FCC 15.107(a), RSS GEN

The table below shows the limits for the emissions on the AC power line from an intentional radiator and a receiver.

Frequency (MHz)	Average Limit (dBuV)	Quasi Peak Limit (dBuV)
0.150 to 0.500	Linear decrease on logarithmic frequency axis between 56.0 and 46.0	Linear decrease on logarithmic frequency axis between 66.0 and 56.0
0.500 to 5.000	46.0	56.0
5.000 to 30.000	50.0	60.0

GENERAL RADIATED EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from transmitters that fall in restricted bands[1] (with the exception of transmitters operating under FCC Part 15 Subpart D) and the limits for all emissions for a low power device operating under the general rules of RSS 210, FCC Part 15 Subpart C.

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

RADIATED 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

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

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

RECEIVER SPURIOUS EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for emissions from the receiver as detailed in FCC Part 15.109, RSS 210 table 2, RSS GEN table 1.

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
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:

$$R_r - S = M$$

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 3m from the equipment under test:

$$E = \frac{1000000 \sqrt{30 P}}{3} \text{ microvolts per meter}$$

where P is the eirp (Watts)

EXHIBIT 1: Test Equipment Calibration Data

1 Page

Radiated Emissions, 30 - 4,400 MHz, 10-Feb-06
Engineer: David Bare

Manufacturer	Description	Model #	Asset #	Cal Due
Hewlett Packard	EMC Spectrum Analyzer 9kHz - 6.5GHz	8595EM	787	10-Jan-07
Filtek	High Pass Filter, 1GHz	HP12/1000-5BA	957	18-Apr-06
EMCO	Horn antenna, D. Ridge 1-18GHz (SA40 system antenna)30Hz sunnyvale	3115	1142	11-Jun-06
EMCO	Log Periodic Antenna, 0.2-2 GHz	3148	1321	30-Mar-07
Rohde & Schwarz	Test Receiver, 0.009-2750 MHz	ESN	1332	23-May-06
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	21-Nov-06

Radiated Emissions, 500 - 1,500 MHz, 17-Feb-06
Engineer: Chris Byleckie

Manufacturer	Description	Model #	Asset #	Cal Due
Hewlett Packard	EMC Spectrum Analyzer, 9KHz - 22GHz	8593EM	1319	28-Mar-06
EMCO	Log Periodic Antenna, 0.2-2 GHz	3148	1321	30-Mar-07
Rohde & Schwarz	Test Receiver, 0.009-2750 MHz	ESN	1332	23-May-06
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	786	28-Nov-06
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	13-Jan-07

EXHIBIT 2: Test Measurement Data

11 Pages

Elliott

EMC Test Data

Client:	Savi Technologies	Job Number:	J62764
Model:	ST-661 & ST-662	Test-Log Number:	T62765
		Project Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Emissions Spec:	15.231(a)/(e); 15.240; RSS 210	Class:	-
Immunity Spec:	-	Environment:	-

EMC Test Data

For The

Savi Technologies

Model

ST-661 & ST-662

Date of Last Test: 3/23/2006

Client:	Savi Technologies	Job Number:	J62764
Model:	ST-661 & ST-662	Test-Log Number:	T62765
		Project Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Emissions Spec:	15.231(a)/(e); 15.240; RSS 210	Class:	-
Immunity Spec:	-	Environment:	-

EUT INFORMATION

General Description

The EUT is an RF Tagging device which is designed to identify the container to which it is attached to the Savi RFID 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.

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 when initiated by a SignPost and just the Tag ID when initiated by a Reader.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Savi	ST-661	RFID tag	-	KL7-661T-V1
Savi	ST-662	RFID tag	-	KL7-662T-V1

Other EUT Details

The ST-661 and ST-662 are similar in design with minor differences in the battery cell and enclosure size.

EUT Antenna (Intentional Radiators Only)

The antenna is integral to the device.

EUT Enclosure

The EUT enclosure is primarily constructed of plastic. Model ST-661 measures approximately 5.5 cm wide by 3 cm deep by 6.5 cm high. Model ST-662 measures approximately 7.5 cm wide by 3 cm deep by 6.5 cm high.

Modification History

Mod. #	Test	Date	Modification
1			
2			
3			

Modifications applied are assumed to be used on subsequent tests unless otherwise stated as a further modification.

Client:	Savi Technologies	Job Number:	J62764
Model:	ST-661 & ST-662	T-Log Number:	T62765
		Project Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Emissions Spec:	15.231(a)/(e); 15.240; 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	-	-	-	-

Cabling and Ports

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

EUT Operation During Emissions Tests

Receive Mode: The EUT was in a stand-by/receive mode, with the circuits active but not transmitting.
Transmit Mode: The EUT was configured to transmit continuously.

Client:	Savi Technologies	Job Number:	J62764
Model:	ST-661 & ST-662	T-Log Number:	T62765
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Spec:	15.231(a)/(e); 15.240; RSS 210	Class:	-

Radiated Emissions FCC 15.231 - Model 662

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: 2/10/2006
Test Engineer: David Bare
Test Location: SVOATS #2
Config. Used: 1
Config Change: None
EUT Voltage: Battery

General Test Configuration

The EUT was located on the turntable for radiated emissions testing.

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: 21 °C
Rel. Humidity: 46 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 433.92MHz, Fundamental	15.231(a)	Pass	77.7dBµV/m (7673.6µV/m) @ 433.878MHz (-3.1dB)
2	RE, 30 - 4400MHz, Maximized Emissions	15.231(a)	Pass	45.3dBµV/m (184.1µV/m) @ 867.758MHz (-15.5dB)
3	RE, 433.92MHz, Fundamental	15.231(e)	Pass	69.7dBµV/m (3054.9µV/m) @ 433.878MHz (-3.2dB)
4	RE, 30 - 4400MHz, Maximized Emissions	15.231(e)	Pass	45.3dBµV/m @ 867.758MHz (-0.7dB)
5	Transmitter Bandwidth	15.231/ RSS 210	Pass	442kHz
5	99% Bandwidth	RSS GEN	Pass	147kHz

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 Technologies	Job Number:	J62764
Model:	ST-661 & ST-662	T-Log Number:	T62765
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Spec:	15.231(a)/(e); 15.240; RSS 210	Class:	-

Run #1: Fundamental Measurement of 433.878
Model 662, Base line Power Setting of 21

Frequency	Level	Pol	15.231(a)		Detector	Azimuth	Height	Comments	
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters		
433.878	77.7	H	80.8	-3.1	Avg	130	1.0		Note 1
433.878	73.5	H	80.8	-7.3	Avg	360	1.4		Note 1
433.878	73.4	V	80.8	-7.4	Avg	300	1.3		Note 1
433.878	72.3	V	80.8	-8.5	Avg	360	1.2		Note 1
433.878	89.7	H	100.8	-11.1	Pk	130	1.0	Side Position	
433.878	66.6	H	80.8	-14.2	Avg	67	1.0		Note 1
433.878	66.0	V	80.8	-14.8	Avg	70	1.3		Note 1
433.878	85.5	H	100.8	-15.3	Pk	360	1.4	Lay down Position	
433.878	85.4	V	100.8	-15.4	Pk	300	1.3	Lay down Position	
433.878	84.3	V	100.8	-16.5	Pk	360	1.2	Up right Position	
433.878	78.6	H	100.8	-22.2	Pk	67	1.0	Up right Position	
433.878	78.0	V	100.8	-22.8	Pk	70	1.3	Side Position	

Note 1:	Duty cycle is 25% . A -12dB correction was used to determine the average level from the peak reading

Run #2: Maximized Radiated Spurious Emissions, 30-4400 MHz
ST-662 Tag, set for continuous transmission to facilitate testing at a PWR setting of 21

Frequency	Level	Pol	15.231(a)		Detector	Azimuth	Height	Comments	
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters		
867.758	45.3	v	60.8	-15.5	Pk	120	1.1	EUT upright	Note 1
867.758	44.4	v	60.8	-16.4	Pk	225	1.3	EUT on side	Note 1
867.758	44.1	h	60.8	-16.7	Pk	120	1.0	EUT flat on table	Note 1
1301.678	36.5	h	54.0	-17.5	Avg	57	1.0	EUT flat on table	Note 2
1301.678	36.3	v	54.0	-17.8	Avg	88	1.0	EUT upright	Note 2
867.758	42.9	h	60.8	-17.9	Pk	230	1.0	EUT upright	Note 1
1301.678	35.5	v	54.0	-18.6	Avg	85	1.0	EUT on side	Note 2
867.758	42.2	v	60.8	-18.6	Pk	0	1.3	EUT flat on table	Note 1
867.758	41.8	h	60.8	-19.0	Pk	340	1.0	EUT on side	Note 1
1301.678	34.8	h	54.0	-19.2	Avg	48	1.0	EUT on side	Note 2
1301.678	48.5	h	74.0	-25.5	PK	57	1.0	EUT flat on table	
1301.678	48.3	v	74.0	-25.8	PK	88	1.0	EUT upright	
1301.678	47.5	v	74.0	-26.6	PK	85	1.0	EUT on side	
1301.678	46.8	h	74.0	-27.2	PK	48	1.0	EUT on side	

Note 1:	Peak reading, QP Limit
Note 2:	Duty cycle is 25% . A -12dB correction was used to determine the average level from the peak reading

Client:	Savi Technologies	Job Number:	J62764
Model:	ST-661 & ST-662	T-Log Number:	T62765
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Spec:	15.231(a)/(e); 15.240; RSS 210	Class:	-

Run #3: Fundamental Measurement of 433.878
Model 662, Base line Power Setting of 21

Frequency	Level	Pol	FCC 15.231(e)		Detector	Azimuth	Height	Comments	
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters		
433.878	69.7	H	72.9	-3.2	Avg	130	1.0		Note 1
433.878	89.7	H	92.9	-3.2	Pk	130	1.0	Side Position	
433.878	85.5	H	92.9	-7.4	Pk	360	1.4	Lay down Position	
433.878	65.5	H	72.9	-7.4	Avg	360	1.4		Note 1
433.878	85.4	V	92.9	-7.5	Pk	300	1.3	Lay down Position	
433.878	65.4	V	72.9	-7.5	Avg	300	1.3		Note 1
433.878	84.3	V	92.9	-8.6	Pk	360	1.2	Up right Position	
433.878	64.3	V	72.9	-8.6	Avg	360	1.2		Note 1
433.878	58.6	H	72.9	-14.3	Avg	67	1.0		Note 1
433.878	78.6	H	92.9	-14.3	Pk	67	1.0	Up right Position	
433.878	78.0	V	92.9	-14.9	Pk	70	1.3	Side Position	
433.878	58.0	V	72.9	-14.9	Avg	70	1.3		Note 1

Note 1:	Duty cycle is 10% . A -20dB correction was used to determine the average level from the peak reading

Run #4: Maximized Radiated Emissions, 30-4400 MHz
EUT set for continuous transmission to facilitate testing at a PWR setting of 21
ST-662 Tag

Frequency	Level	Pol	15.231(e)		Detector	Azimuth	Height	Comments	
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters		
867.758	45.3	v	46.0	-0.7	Pk	120	1.1	EUT upright	Note 1
867.758	44.4	v	46.0	-1.6	Pk	225	1.3	EUT on side	Note 1
867.758	44.1	h	46.0	-1.9	Pk	120	1.0	EUT flat on table	Note 1
867.758	42.9	h	46.0	-3.1	Pk	230	1.0	EUT upright	Note 1
867.758	42.2	v	46.0	-3.8	Pk	0	1.3	EUT flat on table	Note 1
867.758	41.8	h	46.0	-4.2	Pk	340	1.0	EUT on side	Note 1
1301.678	48.5	h	74.0	-25.5	PK	57	1.0	EUT flat on table	
1301.678	28.5	h	54.0	-25.5	Avg	57	1.0	EUT flat on table	Note 2
1301.678	28.3	v	54.0	-25.7	Avg	88	1.0	EUT upright	Note 2
1301.678	48.3	v	74.0	-25.8	PK	88	1.0	EUT upright	
1301.678	27.5	v	54.0	-26.5	Avg	85	1.0	EUT on side	Note 2
1301.678	47.5	v	74.0	-26.6	PK	85	1.0	EUT on side	
1301.678	46.8	h	74.0	-27.2	PK	48	1.0	EUT on side	
1301.678	26.8	h	54.0	-27.2	Avg	48	1.0	EUT on side	Note 2
1301.678	24.3	v	54.0	-29.7	Avg	229	2.4	EUT flat on table	Note 2
1301.678	44.3	v	74.0	-29.7	PK	229	2.4	EUT flat on table	
1301.678	23.6	h	54.0	-30.4	Avg	193	1.0	EUT upright	Note 2
1301.678	43.6	h	74.0	-30.4	PK	193	1.0	EUT upright	

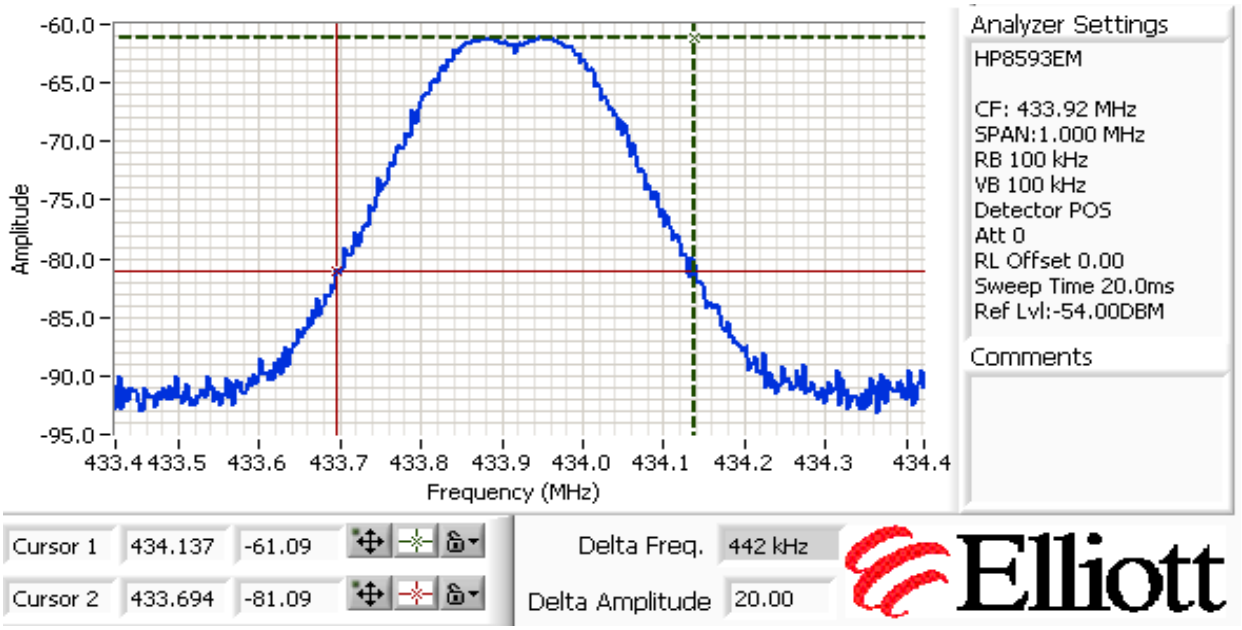
Note 1:	Peak reading, QP Limit
Note 2:	Duty cycle is 10% . A -20dB correction was used to determine the average level from the peak reading

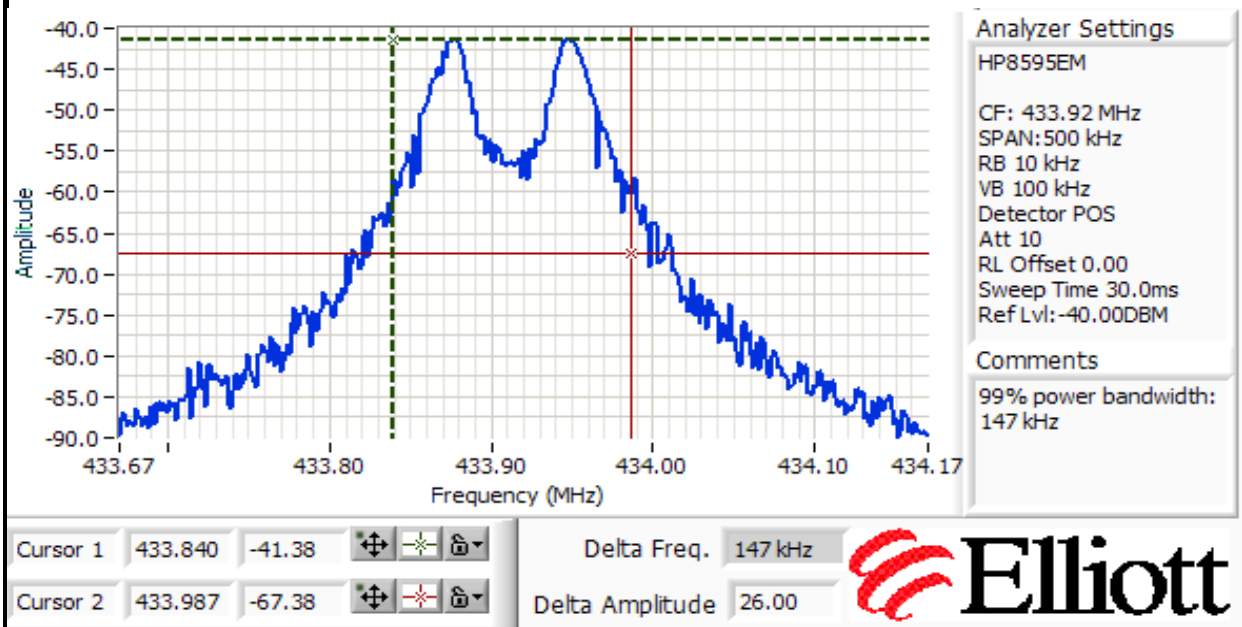
Client:	Savi Technologies	Job Number:	J62764
Model:	ST-661 & ST-662	T-Log Number:	T62765
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Spec:	15.231(a)/(e); 15.240; RSS 210	Class:	-

Run #5: Transmit Mode (433.92 MHz) - Bandwidth

Date of Test: 2/17/2006 Config. Used: 1
Test Engineer: Chris Byleckie Config Change: none
Test Location: SVOATS #2 EUT Voltage: Internal Battery

Signal bandwidth was measured to be 442kHz (see graph below - RB=VB=100kHz).
The maximum permitted bandwidth is 0.25% of the fundamental signal level = 1.08MHz





Client:	Savi Technologies	Job Number:	J62764
Model:	ST-661 & ST-662	T-Log Number:	T62765
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Spec:	15.231(a)/(e); 15.240; RSS 210	Class:	-

FCC 15.240 / RSS 210 A5 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: 2/10/2006
Test Engineer: David Bare
Test Location: SVOATS #2
Config. Used: 1
Config Change: None
EUT Voltage: Battery

General Test Configuration

The EUT was located on the turntable for radiated emissions testing.

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: 21 °C
Rel. Humidity: 46 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
3	RE, **ST 662,** 433.92MHz, Fundamental	15.240	Pass	77.7dBµV/m (7673.6µV/m) @ 433.878MHz (-3.1dB)
4	RE, **ST 662**, 30 - 4400MHz, Maximized Emissions	15.240	Pass	45.3dBµV/m (184.1µV/m) @ 867.758MHz (-0.7dB)

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:	Savi Technologies	Job Number:	J62764
Model:	ST-661 & ST-662	T-Log Number:	T62765
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Spec:	15.231(a)/(e); 15.240; RSS 210	Class:	-

Run #3: Fundamental Measurement of 433.878
Model 662, Base line Power Setting of 21

Frequency	Level	Pol	15.240		Detector	Azimuth	Height	Comments	
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters		
433.878	77.7	H	80.8	-3.1	Avg	130	1.0		Note 1
433.878	89.7	H	94.8	-5.1	Pk	130	1.0	Side Position	
433.878	73.5	H	80.8	-7.3	Avg	360	1.4		Note 1
433.878	73.4	V	80.8	-7.4	Avg	300	1.3		Note 1
433.878	72.3	V	80.8	-8.5	Avg	360	1.2		Note 1
433.878	85.5	H	94.8	-9.3	Pk	360	1.4	Lay down Position	
433.878	85.4	V	94.8	-9.4	Pk	300	1.3	Lay down Position	
433.878	84.3	V	94.8	-10.5	Pk	360	1.2	Up right Position	
433.878	66.6	H	80.8	-14.2	Avg	67	1.0		Note 1
433.878	66.0	V	80.8	-14.8	Avg	70	1.3		Note 1
433.878	78.6	H	94.8	-16.2	Pk	67	1.0	Up right Position	
433.878	78.0	V	94.8	-16.8	Pk	70	1.3	Side Position	

Note 1:	Duty cycle is 25% . A -12dB correction was used to determine the average level from the peak reading

Run #4: Maximized Radiated Emissions, 30-4400 MHz

Frequency	Level	Pol	15.240		Detector	Azimuth	Height	Comments	
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters		
867.758	45.3	v	46.0	-0.7	Pk	120	1.1	EUT upright	Note 1
867.758	44.4	v	46.0	-1.6	Pk	225	1.3	EUT on side	Note 1
867.758	44.1	h	46.0	-1.9	Pk	120	1.0	EUT flat on table	Note 1
867.758	42.9	h	46.0	-3.1	Pk	230	1.0	EUT upright	Note 1
867.758	42.2	v	46.0	-3.8	Pk	0	1.3	EUT flat on table	Note 1
867.758	41.8	h	46.0	-4.2	Pk	340	1.0	EUT on side	Note 1
1301.678	36.5	h	54.0	-17.5	Avg	57	1.0	EUT flat on table	Note 2
1301.678	36.3	v	54.0	-17.7	Avg	88	1.0	EUT upright	Note 2
1301.678	35.5	v	54.0	-18.5	Avg	85	1.0	EUT on side	Note 2
1301.678	34.8	h	54.0	-19.2	Avg	48	1.0	EUT on side	Note 2
1301.678	34.3	v	54.0	-19.7	Avg	229	2.4	EUT flat on table	Note 2
1301.678	31.6	h	54.0	-22.4	Avg	193	1.0	EUT upright	Note 2
1301.678	48.5	h	74.0	-25.5	PK	57	1.0	EUT flat on table	
1301.678	48.3	v	74.0	-25.8	PK	88	1.0	EUT upright	
1301.678	47.5	v	74.0	-26.6	PK	85	1.0	EUT on side	
1301.678	46.8	h	74.0	-27.2	PK	48	1.0	EUT on side	
1301.678	44.3	v	74.0	-29.7	PK	229	2.4	EUT flat on table	
1301.678	43.6	h	74.0	-30.4	PK	193	1.0	EUT upright	

Note 1:	Peak reading, QP Limit
Note 2:	Duty cycle is 25% . A -12dB correction was used to determine the average level from the peak reading

Client:	Savi Technologies	Job Number:	J62764
Model:	ST-661 & ST-662	T-Log Number:	T62765
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Spec:	15.231(a)/(e); 15.240; RSS 210	Class:	-

FCC 15.109/ RSS GEN Receiver Radiated Emissions - ST-662

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: 2/17/2006
Test Engineer: Chris Byleckie
Test Location: SVOATS #2
Config. Used: 1
Config Change: None
EUT Voltage: Battery

General Test Configuration

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

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

Ambient Conditions:

Temperature: 7 °C
Rel. Humidity: 83 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
2	RE, 30 - 1000MHz, Maximized Emissions, Model 662	FCC 15.110	Pass	38.1dBµV/m (80.4µV/m) @ 867.540MHz (-7.9dB)

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.

Elliott

EMC Test Data

Client:	Savi Technologies	Job Number:	J62764
Model:	ST-661 & ST-662	T-Log Number:	T62765
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Spec:	15.231(a)/(e); 15.240; RSS 210	Class:	-

Run #2: Preliminary Radiated Emissions, 30-1000 MHz
ST-662

Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
30 - 1000 MHz	3	3	0

Frequency	Level	Pol	15.209		Detector	Azimuth	Height	Comments	
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters		
867.540	38.1	V	46.0	-7.9	QP	156	1.0	EUT on side	
433.770	37.8	V	46.0	-8.2	QP	0	1.4	EUT upright	
867.540	37.5	H	46.0	-8.5	QP	213	1.0	EUT on side	
867.540	37.3	H	46.0	-8.7	QP	241	1.0	EUT upright	
433.770	37.0	H	46.0	-9.0	QP	20	1.0	EUT on side	
867.540	36.5	V	46.0	-9.5	QP	137	1.0	EUT upright	
433.770	36.4	V	46.0	-9.6	QP	101	1.6	EUT on side	
867.540	35.4	V	46.0	-10.6	QP	330	1.0	EUT Flat	
867.540	35.4	H	46.0	-10.6	QP	44	1.0	EUT Flat	
433.770	34.6	V	46.0	-11.4	QP	190	1.3	EUT Flat	
433.770	34.1	H	46.0	-11.9	QP	207	1.0	EUT upright	
433.770	33.1	H	46.0	-12.9	QP	279	1.0	EUT Flat	
1301.310	40.0	V	54.0	-14.0	QP	232	1.0	EUT Flat	Note 1
1301.310	39.8	H	54.0	-14.2	QP	300	1.0	EUT Flat	Note 1
1301.310	39.8	H	54.0	-14.2	QP	125	1.0	EUT on side	Note 1
1301.310	39.7	V	54.0	-14.3	QP	360	1.0	EUT on side	Note 1
1301.310	39.6	V	54.0	-14.4	QP	209	1.0	EUT upright	Note 1
1301.310	39.6	H	54.0	-14.4	QP	308	1.0	EUT upright	Note 1

Note 1:	Peak reading , average limit