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Electromagnetic Emissions Test Report In Accordance With Industry Canada Radio Standards Specification 210 And FCC Part 15 Sections 15.231, 15.240 on the Savi Technology, Inc. Transmitter Model: ST-676-I, ST-675-I and ST-656-I

UPN:	2404A-676T
FCC ID:	KL7-676T-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:	October 3, 2005
FINAL TEST DATE:	August 12, September 9 and September 20, 2005

AUTHORIZED SIGNATORY: Mark Briggs

Mark Briggs
Principal Engineer

ACCREDITED
2016-01

Equipment Name and Model:

Transceiver ST-676-I, ST-675-I and ST-656-I

Manufacturer:

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

Tested to applicable standard:

Industry Canada RSS-Gen Issue 1
RSS 210 Issue 6 "Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment"

Test Report Prepared For:

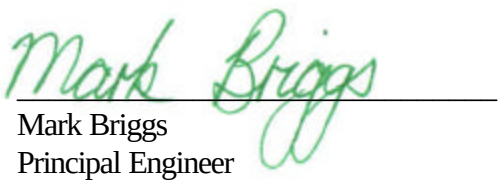
Eugene Schlindwein
Savi Technology, Inc.
615 Tasman Drive
Sunnyvale, CA 94089-1707

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 referenced by FCC Part 15 and by section 1.0 of RSS-212, Issue 1, "Test Facilities and Test Methods for Radio Equipment" / RSS-Gen Issue 1); and that the equipment performed in accordance with the data submitted in this report.

Signature 
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Date: October 3, 2005

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SCOPE

An electromagnetic emissions test has been performed on the Savi Technology, Inc. model ST-676-I pursuant to the following rules:

Industry Canada RSS-Gen Issue 1
RSS 210 Issue 6 "Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment"
FCC Part 15 Subpart B (Receivers)
FCC Part 15 Subpart C (15.231 and 14.240)

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
RSS-212 Issue 1 Test Facilities and Test Methods for Radio Equipment

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-676-I and therefore apply only to the tested sample. The sample was selected and prepared by Eugene Schlindwein of Savi Technology, Inc.. The data is considered representative of all models in the series (ST-656-I, ST-676-I and ST-675-I).

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-676-I, ST-675-I and ST-656-I complied with the requirements of:

Industry Canada RSS-Gen Issue 1
RSS 210 Issue 6 "Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment"
FCC Part 15 Subpart B (Receivers)
FCC Part 15 Subpart C – 15.240
FCC Part 15 Subpart C requirements for momentarily operated devices

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.).

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	N/A – all transmissions automatically activated		N/A
15.231 (a) (2)	RSS 210 A1.1.1 (2)	Duration of automatically activated transmissions	10ms (triggered by UHF/LF reader) 5 seconds (25% duty cycle)	< 5 seconds	Complies
15.231 (a) (3)	RSS 210 A1.1.1 (3)	Transmissions at predetermined / regular intervals	Transmissions triggered by a reader, triggered by external stimulus or person	Such transmissions are not permitted	Complies
15.231 (a) (4)	RSS 210 A1.1.1 (4)	Pendency of transmissions used during emergencies	N/A		N/A
15.231 (b)	RSS 210 Table 4	Fundamental Signal Strength @ 433.920MHz	Avg: 76.6dBuV/m (6760.8µV/m) Peak: 90.6dBµV/m	Avg: 80.8 dBuV/m	Complies (-4.2dB)
15.231 (b) / 15.209	RSS 210 Table 2 / 4	Radiated Spurious Emissions, 30 - 4340MHz	50.0dBµV/m (316.2µV/m) @ 2603.5MHz	Refer to standard	Complies (-10.8dB)
15.231 (c)	RSS 210 A1.1.3	Bandwidth	340kHz	< 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.

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 every 10s to 9hrs or 330ms every 10s	< 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 @ 433.920MHz	Peak: 90.6dBµV/m (33884.4µV/m) Avg: 70.6dBuV/m (3388µV/m)	Avg: 72.9dBuV/m	Complies (-2.3dB)
15.231 (e) / 15.209	RSS 210 Table 5	Radiated Spurious Emissions, 30 - 4340MHz	50.0dBµV/m (316.2µV/m) @ 2603.5MHz	Refer to standard	Complies (-4.0dB)
15.231 (c)	RSS 210 A1.1.3	Bandwidth	340kHz	< 1.08 MHz	Complies

Note 1 – Refer to the operational description included with this application for detailed description and timing diagrams for transmission duration.

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	Location of	Transmissions under this	Must be limited to	Complies

	A5	operation	rule part are limited by the location of the readers.	commercial and industrial areas	
15.240 (f)	-	Information to user	Transmissions under this section are initiated by a reader. The geographic limitations apply to the reader – refer also to the operational decsription.	Notification of geographic limitations	
15.240 (b)	RSS 210 A5 (1)	Duration of transmissions	60 seconds (20% duty cycle) followed by a silent period > 10s	< 60s with 10s silent period	Complies
15.240 (b)	RSS 210 A5 (2)	Fundamental Signal Strength @ 433.920MHz	Avg: 78.6dBµV/m (8511.4µV/m) @ 433.919MHz Pk: 90.6 dBµV/m	11000uV/m avg 55000uV/m pk	Complies (-2.2dB)
15.240 (c) / 15.209	RSS 210 Table 2	Radiated Spurious Emissions, 30 MHz – 4339 MHz	41.9dBµV/m (124.5µV/m) @ 867.840MHz	Table 2	Complies (-4.1dB)
	RSP 100 RSS GEN 4.4.1	99% Bandwidth	340kHz	Information only	N/A

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 antennas	Unique connector	Complies
15.109	RSS GEN 7.2.3 Table 1	Receiver spurious emissions	30.2 dBuV/m (32.4 uV/m) @ 423.22 MHz	15.109 / RSS GEN table 1	Complies (-15.8dB)
15.207	RSS GEN Table 2	AC Conducted Emissions	Not applicable – the device is battery powered and is ont intended to be powered, directly or indirectly, from an AC power source.		

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. models ST-676-I, ST-675-I and ST-656-I are RFID tags that contain a transceiver operating at 433.92MHz. They also have a receiver that operates at 123 kHz.

Normally, the EUTs would be mounted to a container in a specific orientation. The EUTs were placed on a table in this orientation during testing.

The sample was received on August 12, 2005 and tested on August 12, September 9 and September 20, 2005. The EUT consisted of the following component(s):

Manufacturer	Model	Description	Serial Number	FCC ID
Savi	ST-676-I, ST-675-I and ST-656-I	RFID Tag	406141	KL7-676T-V1

OTHER EUT DETAILS

There are three versions of the tag - as detailed below. As the ST-676-I represents the most configured version of the tag it was considered to be the worst-case of the three models with respect to EMC performance. All tests were performed on a sample of the ST-676-I and the results are considered to represent the worst case of all 3 models.

- **The ST-656-I** is the basic RFID Tag intended for mounting on ISO Container Doors. The circuit card and battery are housed in a cover inside the locked door to prevent vandalism and theft of the battery. The UHF and Low Frequency Antennas and an audible buzzer are mounted in a protective low profile plastic case on the outside of the door.

- **The ST-676-I** is constructed similarly, except for the addition of internal door security and environmental sensors whose measurements can be monitored during a journey to detect unauthorized entry into the container. Sensor data may also be stored during a journey for later read-out and decision making over a serial or RF interface.

- **The ST-675-I** is a variant of the ST-676 which deletes the environmental sensors except for the Light Sensor.

ENCLOSURE

The EUT enclosure is primarily constructed of plastic covers over all circuitry/antenna, secured to a steel bracket. It measures approximately 19 cm wide by 10 cm deep by 12 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

For transmitter emissions the transmitter set to continuously transmit at 433 MHz. For receive-mode emissions the receiver was set to continuously receive at 423 MHz.

ANTENNA SYSTEM

The antenna system used with the Savi Technology, Inc. model ST-676-I, ST-675-I and ST-656-I consists of integral 433.9 MHz used for the transceiver and an integral antenna for the 123/132kHz receiver.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on August 12, September 9 and September 20, 2005at 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.

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.

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 C63.4:2003 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 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 C63.4:2003, 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

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.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

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 and 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

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

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

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

EXHIBIT 1: Test Equipment Calibration Data

1 Page

Radiated Emissions, 30 - 4,000 MHz (8/12/2005), 08-Nov-05

Manufacturer	Description	Model #	Asset #	Cal Due
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	487	13-May-06
Hewlett Packard	EMC Spectrum Analyzer 9kHz - 6.5GHz	8595EM	780	26-May-06
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	26-Apr-06
EMCO	Biconical Antenna, 30-300 MHz	3110B	1320	25-Aug-05
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

Radiated Emissions, 30 - 5,000 MHz, 9/9/2005, 08-Nov-05

Manufacturer	Description	Model #	Asset #	Cal Due
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	487	13-May-06
Hewlett Packard	EMC Spectrum Analyzer 9kHz - 6.5GHz	8595EM	780	26-May-06
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	26-Apr-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	Biconical Antenna, 30-300 MHz	3110B	1497	15-Jun-06

EXHIBIT 2: Test Measurement Data

11 Pages

Elliott

EMC Test Data

Client:	Savi Technology, Inc.	Job Number:	J60588
Model:	ST-676-I	T-Log Number:	T61142
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Emissions Spec:	FCC 15.240, 15.231a, 15.231e	Class:	Radio
Immunity Spec:	-	Environment:	-

EMC Test Data

For The

Savi Technology, Inc.

Model

ST-676-I

Date of Last Test: 9/20/2005

Client:	Savi Technology, Inc.	Job Number:	J60588
Model:	ST-676-I	T-Log Number:	T61142
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Emissions Spec:	FCC 15.240, 15.231a, 15.231e	Class:	Radio
Immunity Spec:	-	Environment:	-

EUT INFORMATION

General Description

The EUT is a RFID tag that contains a transceiver operating at 433.92MHz. It also has a receiver that operates at 123 kHz. Normally, the EUT would be mounted to a container in a specific orientation. The EUT was placed on a table in this orientation during testing.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Savi	ST-676-I	RFID Tag	-	

Other EUT Details

There are three versions of the tag - as detailed below. As the ST-676-I represents the most configured version of the tag it was considered to be the worst-case of the three models with respect to EMC performance. All tests were performed on a sample of the ST-676-I and the results are considered to represent the worst case of all 3 models.

• The ST-656-I is the basic RFID Tag intended for mounting on ISO Container Doors. The circuit card and battery are housed in a cover inside the locked door to prevent vandalism and theft of the battery. The UHF and Low Frequency Antennas and an audible buzzer are mounted in a protective low profile plastic case on the outside of the door.

• The ST-676-I is constructed similarly, except for the addition of internal door security and environmental sensors whose measurements can be monitored during a journey to detect unauthorized entry into the container. Sensor data may also be stored during a journey for later read-out and decision making over a serial or RF interface.

• The ST-675-I is a variant of the ST-676 which deletes the environmental sensors except for the Light Sensor.

EUT Antenna

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

EUT Enclosure

The EUT enclosure is primarily constructed of plastic covers over all circuitry/antenna, secured to a steel bracket. It measures approximately 19 cm wide by 10 cm deep by 12 cm high.

Modification History

Mod. #	Test	Date	Modification
1			

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

Client:	Savi Technology, Inc.	Job Number:	J60588
Model:	ST-676-I	T-Log Number:	T61142
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Emissions Spec:	FCC 15.240, 15.231a, 15.231e	Class:	Radio
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 Cabling and Ports

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

EUT Operation During Emissions Tests

Transmitter set to continously transmit at 433 MHz for transmitter-related tests and in a continuous receive mode for receiver-related tests.

Client:	Savi Technology, Inc.	Job Number:	J60588
Model:	ST-676-I	T-Log Number:	T61142
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Spec:	FCC 15.240, 15.231a, 15.231e	Class:	Radio

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: 8/12/2005
Test Engineer: Juan Martinez
Test Location: SVOATS #2

Config. Used: 1
Config Change: None
EUT Voltage: Battery operated

General Test Configuration

The EUTwas located on the turntable for radiated emissions testing.

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

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: 27 °C
Rel. Humidity: 47 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 433.92 MHz, Fundamental	FCC 15.231(a)	Pass	76.6dBµV/m (6760.8µV/m) @ 433.920MHz (-4.2dB)
2	RE, 2nd - 4339.2 MHz, Tx Spurious Emissions	FCC 15.231(a)	Pass	50.0dBµV/m (316.2µV/m) @ 2603.5MHz (-10.8dB)
3	RE, 423.22 - 1269.66 MHz, Rx Spurious Emissions	FCC 15.109	Pass	30.2 dBuV/m (32.4 uV/m) @ 423.22 MHz (-15.8dB)
4	Tranmsitter Bandiwdth	15.231 RSS 210	Pass	490 kHz

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.

Client:	Savi Technology, Inc.	Job Number:	J60588
Model:	ST-676-I	T-Log Number:	T61142
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Spec:	FCC 15.240, 15.231a, 15.231e	Class:	Radio

Run #1: Fundamental
Measurements taken at 3 meters
Power setting resistor = 24k ohm

Frequency	Level	Pol	FCC 15.231(a)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
433.920	78.6	v	80.8	-2.2	Avg	0	1.1	Note 1
433.920	90.6	v	100.8	-10.2	Pk	0	1.1	Note 1
433.920	69.3	h	80.8	-11.5	Avg	287	1.0	Note 1
433.920	81.3	h	100.8	-19.5	Pk	287	1.0	Note 1

Note 1:	Duty cycle is 25% so a -12 dB was used to determine the average value from the measured peak reading.

Run #2: Tx Spurious Emissions, 2nd - 4339.2 MHz
Measurements taken at 3 meters

Frequency	Level	Pol	FCC 15.231(a)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2603.520	50.0	H	60.8	-10.8	PK	192	1.9	Peak reading, Average limit
3470.993	49.2	V	60.8	-11.7	PK	23	1.0	Peak reading, Average limit
2169.593	48.4	V	60.8	-12.4	PK	196	1.8	Peak reading, Average limit
3038.618	48.3	H	60.8	-12.5	PK	62	1.0	Peak reading, Average limit
3038.850	48.0	V	60.8	-12.8	PK	195	1.0	Peak reading, Average limit
3470.175	47.7	H	60.8	-13.1	PK	88	1.0	Peak reading, Average limit
2169.600	47.5	H	60.8	-13.3	PK	202	1.6	Peak reading, Average limit
2603.520	45.6	V	60.8	-15.2	PK	118	1.0	Peak reading, Average limit
1301.768	42.1	V	60.8	-18.8	PK	77	1.0	Peak reading, Average limit
867.840	41.9	h	60.8	-18.9	Pk	53	1.0	Peak reading, QP limit
2169.608	41.1	H	60.8	-19.7	PK	191	1.7	Peak reading, Average limit
2169.615	39.9	V	60.8	-21.0	PK	179	2.0	Peak reading, Average limit
1301.708	38.1	H	60.8	-22.7	PK	257	2.0	Peak reading, Average limit
867.840	38.0	v	60.8	-22.8	Pk	329	1.0	Peak reading, QP limit
1735.665	37.5	V	60.8	-23.3	PK	81	1.0	Peak reading, Average limit
1735.695	36.4	H	60.8	-24.4	PK	145	2.0	Peak reading, Average limit

Client:	Savi Technology, Inc.	Job Number:	J60588
Model:	ST-676-I	T-Log Number:	T61142
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Spec:	FCC 15.240, 15.231a, 15.231e	Class:	Radio

Run #3: Rx Spurious Emissions, 423.22 - 1269.66 MHz
Measurements taken at 3 meters

Frequency	Level	Pol	FCC Class B		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1269.638	38.2	H	54.0	-15.8	PK	286	1.0	Peak reading, Avg limit
423.220	30.2	h	46.0	-15.8	QP	5	1.0	
1271.145	36.9	V	54.0	-17.1	PK	360	1.0	Peak reading, Avg limit
846.440	27.7	v	46.0	-18.3	QP	18	1.3	
846.440	27.5	h	46.0	-18.5	QP	192	1.0	
423.220	21.8	v	46.0	-24.2	QP	350	1.1	

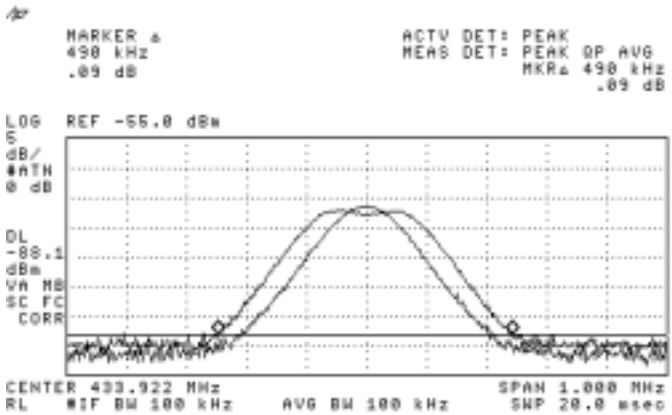
Run #4: Transmit Mode (433.92 MHz) - Bandwidth

Date of Test: 9/27/2005
Test Engineer: Chris Byleckie
Test Location: SVOATS #2

Config. Used: 1
Config Change: none
EUT Voltage: Internal Battery

Temperature: 32 °C
Rel. Humidity: 51 %

Signal bandwidth was measured to be 340kHz (see graph below - RB=VB=100kHz).
The maximum permitted bandwidth is 0.25% of the fundamental signal level = 1.08MHz



Client:	Savi Technology, Inc.	Job Number:	J60588
Model:	ST-676-I	T-Log Number:	T61142
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Spec:	FCC 15.240, 15.231a, 15.231e	Class:	Radio

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: 8/12/2005
Test Engineer: Juan Martinez
Test Location: SVOATS #2

Config. Used: 1
Config Change: None
EUT Voltage: Battery operated

General Test Configuration

The EUTwas located on the turntable for radiated emissions testing.

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

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: 27 °C
Rel. Humidity: 47 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 433.92 MHz, Fundamental	FCC 15.231(e)	Pass	90.6dBµV/m (33884.4µV/m) @ 433.920MHz (-2.3dB)
2	RE, 2nd - 4339.2 MHz, Tx Spurious Emissions	FCC 15.231(e)	Pass	50.0dBµV/m (316.2µV/m) @ 2603.5MHz (-4.0dB)
3	RE, 423.22 - 1269.66 MHz, Rx Spurious Emissions	FCC 15.109	Pass	30.2 dBuV/m (32.4 uV/m) @ 423.22 MHz (-15.8dB)
4	Transmitter Bandwidth	15.231 RSS 210	Pass	490 kHz

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.

Elliott

EMC Test Data

Client:	Savi Technology, Inc.	Job Number:	J60588
Model:	ST-676-I	T-Log Number:	T61142
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Spec:	FCC 15.240, 15.231a, 15.231e	Class:	Radio

Run #1: Fundamental

Measurements taken at 3 meters

Power setting resistor = 24k ohm

Frequency	Level	Pol	FCC 15.231(e)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
433.920	90.6	v	92.9	-2.3	Pk	0	1.1	Note 1
433.920	70.6	v	72.9	-2.3	Avg	0	1.1	Note 1
433.920	81.3	h	92.9	-11.6	Pk	287	1.0	Note 1
433.920	61.3	h	72.9	-11.6	Avg	287	1.0	Note 1

Note 1:	Duty cycle is 10% so a -20 dB was used to determine the average value from the measured peak reading.

Run #2: Tx Spurious Emissions, 2nd - 4339.2 MHz

Measurements taken at 3 meters

Frequency	Level	Pol	FCC 15.231(e)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2603.520	50.0	H	54.0	-4.0	PK	192	1.9	Peak reading, Average limit
867.840	41.9	h	46.0	-4.1	Pk	53	1.0	Peak reading, QP limit
3470.993	49.2	V	54.0	-4.9	PK	23	1.0	Peak reading, Average limit
2169.593	48.4	V	54.0	-5.6	PK	196	1.8	Peak reading, Average limit
3038.618	48.3	H	54.0	-5.7	PK	62	1.0	Peak reading, Average limit
3038.850	48.0	V	54.0	-6.0	PK	195	1.0	Peak reading, Average limit
3470.175	47.7	H	54.0	-6.3	PK	88	1.0	Peak reading, Average limit
2169.600	47.5	H	54.0	-6.5	PK	202	1.6	Peak reading, Average limit
867.840	38.0	v	46.0	-8.0	Pk	329	1.0	Peak reading, QP limit
2603.520	45.6	V	54.0	-8.4	PK	118	1.0	Peak reading, Average limit
1301.768	42.1	V	54.0	-12.0	PK	77	1.0	Peak reading, Average limit
2169.608	41.1	H	54.0	-12.9	PK	191	1.7	Peak reading, Average limit
2169.615	39.9	V	54.0	-14.2	PK	179	2.0	Peak reading, Average limit
1301.708	38.1	H	54.0	-15.9	PK	257	2.0	Peak reading, Average limit
1735.665	37.5	V	54.0	-16.5	PK	81	1.0	Peak reading, Average limit
1735.695	36.4	H	54.0	-17.6	PK	145	2.0	Peak reading, Average limit

Client:	Savi Technology, Inc.	Job Number:	J60588
Model:	ST-676-I	T-Log Number:	T61142
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Spec:	FCC 15.240, 15.231a, 15.231e	Class:	Radio

Run #3: Rx Spurious Emissions, 423.22 - 1269.66 MHz
Measurements taken at 3 meters

Frequency	Level	Pol	FCC Class B		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1269.638	38.2	H	54.0	-15.8	PK	286	1.0	Peak reading, Avg limit
423.220	30.2	h	46.0	-15.8	QP	5	1.0	
1271.145	36.9	V	54.0	-17.1	PK	360	1.0	Peak reading, Avg limit
846.440	27.7	v	46.0	-18.3	QP	18	1.3	
846.440	27.5	h	46.0	-18.5	QP	192	1.0	
423.220	21.8	v	46.0	-24.2	QP	350	1.1	

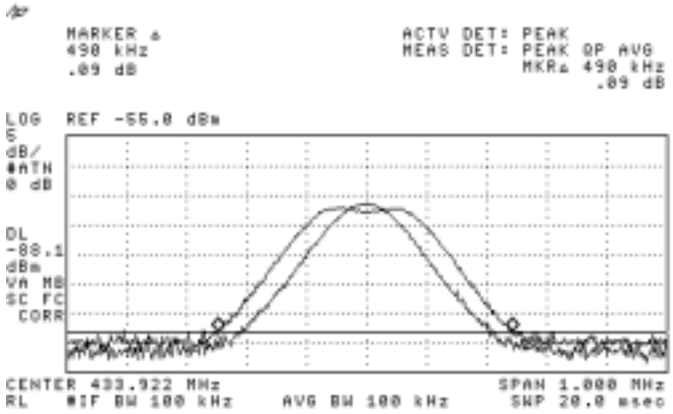
Run #4: Transmit Mode (433.92 MHz) - Bandwidth

Date of Test: 9/27/2005
Test Engineer: Chris Byleckie
Test Location: SVOATS #2

Config. Used: 1
Config Change: none
EUT Voltage: Internal Battery

Temperature: 32 °C
Rel. Humidity: 51 %

Signal bandwidth was measured to be 340kHz (see graph below - RB=VB=100kHz).
The maximum permitted bandwidth is 0.25% of the fundamental signal level = 1.08MHz



Client:	Savi Technology, Inc.	Job Number:	J60588
Model:	ST-676-I	T-Log Number:	T61142
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Spec:	FCC 15.240, 15.231a, 15.231e	Class:	Radio

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: 9/9/2005
Test Engineer: Juan Martinez
Test Location: SVOATS #2
Config. Used: 1
Config Change: None
EUT Voltage: Battery operated

General Test Configuration

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

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

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: 20 °C
Rel. Humidity: 41 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 433.92 MHz, Fundamental	FCC 15.240	Pass	78.6dBµV/m (8511.4µV/m) @ 433.919MHz (-2.2dB)
1	RE, Transmitter Spurious	FCC 15.240	Pass	41.9dBµV/m (124.5µV/m) @ 867.840MHz (-4.1dB)

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.

Client:	Savi Technology, Inc.	Job Number:	J60588
Model:	ST-676-I	T-Log Number:	T61142
		Account Manager:	Esther Zhu
Contact:	Gene Schlindwein		
Spec:	FCC 15.240, 15.231a, 15.231e	Class:	Radio

Run #1: Fundamental
Measurements taken at 3 meters
Increase resistor to increase power (24k ohm)

Frequency	Level	Pol	FCC 15.240		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
433.919	78.6	V	80.8	-2.2	Avg	347	1.0	
433.920	90.6	V	94.8	-4.2	Pk	347	1.0	
433.919	69.3	H	80.8	-11.5	Avg	287	1.0	
433.920	81.3	H	94.8	-13.5	Pk	287	1.0	

Note 1:	Average value calculated from the peak value by applying a duty cycle correction factor of 12dB to account for a maximum duty cycle of 25% in any 100ms period (i.e. the on-time in any 100ms period is always 20ms or less). Refer to section 6.3.3 fo the operational description.

Run #2: Tx Spurious Emissions, 2nd - 4339.2 MHz
Measurements taken at 3 meters

Frequency	Level	Pol	FCC 15.240		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
867.840	41.9	h	46.0	-4.1	Pk	53	1.0	Peak reading, QP limit
867.840	38.0	v	46.0	-8.0	Pk	329	1.0	Peak reading, QP limit
1301.768	42.1	V	54.0	-12.0	PK	77	1.0	Peak reading, Average limit
2169.608	41.1	H	54.0	-12.9	PK	191	1.7	Peak reading, Average limit
2169.615	39.9	V	54.0	-14.2	PK	179	2.0	Peak reading, Average limit
1301.708	38.1	H	54.0	-15.9	PK	257	2.0	Peak reading, Average limit
1735.665	37.5	V	54.0	-16.5	PK	81	1.0	Peak reading, Average limit
1735.695	36.4	H	54.0	-17.6	PK	145	2.0	Peak reading, Average limit

EXHIBIT 3: Photographs of Test Configurations

2 Pages

EXHIBIT 4: Detailed Photographs of Savi Technology, Inc. Model ST-676-I, ST-675-I and ST-656-I

External Photographs 2 pages
Internal Photographs 5 pages

EXHIBIT 5: Block Diagram of Savi Technology, Inc. Model ST-676-I, ST-675-I and ST-656-I

2 Pages

EXHIBIT 6: Schematic Diagrams of Savi Technology, Inc. Model ST-676-I, ST-675-I and ST-656-I

233-04857-001Rev_8B Tag schematic	3 pages
233-04869-001 Rev_12 Antenna schematic	2 pages
233-04900-001 Rev_3 Pot schematic	1 page
233-04907-001Rev-1 Tag schematic	4 pages

EXHIBIT 7: Theory of Operation for Savi Technology, Inc. Model ST-676-I, ST-675-I and ST-656-I

18 Pages

EXHIBIT 8: Advertising Literature

Savi_SensorTag_676-I_v1 Ad lit	2 pages
Savi_ST-656-I_v1 Ad Lit	2 pages

EXHIBIT 9: Operator's Manual

SaviTag_ST_656_FCCstmtA	1 page
SaviTag_ST_67X_FCCstmtA	1 page
ST-656-I_InstallGuide	20 pages
ST-676-I_InstallGuide	20 pages