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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 on the Savi Technology, Inc. Transmitter Model: SaviTag ST-654

UPN:	2404A-654T1
FCC ID:	KL7-654T-V2
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:	April 25, 2005
FINAL TEST DATE:	April 12 and April 21, 2005

AUTHORIZED SIGNATORY: Mark Briggs

Mark Briggs
Vice President of Engineering

ACCREDITED
2016-01

Equipment Name and Model:

Transceiver _SaviTag ST-654

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

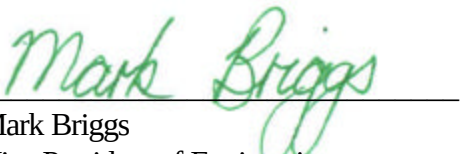
Test Report Prepared For:
Eugene Schlindwein
Savi Technology, Inc.
615 Tasman Drive
Sunnyvale, CA 94089-1707

Measurement Facility Description Filed With Department of Industry:

Departmental Acknowledgement Number: IC4549 3, Dated July 3, 1997

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 Vice President of Engineering
Elliott Laboratories Inc.
Address 684 W. Maude Ave
Sunnyvale, CA 94086
USA

Date: April 25, 2005

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SCOPE

An electromagnetic emissions test has been performed on the Savi Technology, Inc. model SaviTag ST-654 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.

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 SaviTag ST-654 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 SaviTag ST-654 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.

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 (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

TEST RESULTS SUMMARY

15.231 / RSS 210 Section 6.1

FCC Part 15 Section	RSS 210 Section	Description	Comments	Result
15.207 / 15.107		AC Conducted Emissions, 0.15 – 30 MHz	Not applicable – the device is only intended to be powered from internal batteries	N/A
	6.6 / 7.4	AC Conducted emissions 0.45 – 30 MHz		N/A
15.231 (a) (1)	6.1.1(a) (1)	Duration of manually activated transmission	Not applicable – the device is not manually controlled	N/A
15.231 (a) (2)	6.1.1(a) (2)	Duration of automatically activated transmission	Not applicable – all transmissions operate under 15.231(e)	N/A
15.231 (a) (3)	6.1.1(a) (3)	Transmissions at predetermined / regular intervals are not permitted		
15.231 (a) (4)	6.1.1(a) (4)	Pendency of transmissions used during emergencies involving fire, security, and safety of life	Not applicable – there are no such transmissions	N/A
15.231 (b)	6.1.1(b) / Table 1	Transmitter Radiated Emissions, 433.92 MHz	Not applicable – all transmissions operate under 15.231(e)	N/A
15.231 (b)	6.1.1(b) / Table 1	Transmitter Radiated Spurious Emissions, 30-4330 MHz		N/A
15.231 (c)	6.1.1 (c)	Bandwidth	340kHz	Pass
15.231 (d)	6.1.1 (d)	Frequency Stability		N/A
15.231 (e)	6.1.1 (e)	Transmitter Radiated Emissions, 433.92 MHz	91.4dBµV/m pk (37153.5µV/m) @ 433.928MHz (-1.5dB)	Pass
15.231 (e)	6.1.1 (e)	Transmitter Radiated Spurious Emissions, 30-4330 MHz	40.4dBµV/m pk (104.8µV/m) @ 1301.7MHz (-13.6dB)	Pass
15.231 (e)	6.1.1 (e)	Duration of transmission	Transmissions never exceed 1 second in duration and there is a quote time between successive transmissions of at least 30 times the duration and never less than 10 seconds.	Pass
15.109	7.3	Receiver Spurious Emissions	27.4dBµV/m (23.4µV/m) @ 423.232MHz (-18.6dB)	Pass

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 may be installed in any orientation it was tested in all three orthogonal orientations.

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 NAMAS document NIS 81.

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

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Savi Technology, Inc. model SaviTag ST-654 is an RFID Tag designed to identify the container to which it is attached. 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.

The sample was received on April 12, 2005 and tested on April 12 and April 21, 2005. The EUT consisted of the following component(s):

Manufacturer	Model	Description	Serial Number	FCC ID
Savi Technology	ST-654-XXX	Tag	404361	KL7-654T-V2

OTHER EUT DETAILS

The EUT transmits at 433.92MHz using FSK modulated pulses, each pulse being 10ms long. During radio performance and emissions testing the device was configured to transmit continuously for transmitter-related tests and in a continuous receive mode for receiver tests. The EUT also contains a passive receiver operating at 123 kHz.

The EUT is a redesigned version of the ST-645-001 approved under FCC ID KL7-654T-V1. The modifications include a new ASIC and an improved antenna.

ENCLOSURE

The EUT enclosure is primarily constructed injection molded plastic. It measures approximately 15.875 cm wide by 5.4cm deep by 2.86cm high.

MODIFICATIONS

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

SUPPORT EQUIPMENT and INTERFACE PORTS

The EUT has no interface ports and, therefore, no support equipment was required during testing.

EUT OPERATION

The EUT was configured to continuously transmit a CW signal, a modulated signal or to be in a continuous receive mode.

ANTENNA SYSTEM

The antennas are integrated into the device.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on April 12 and April 21, 2005 at the Elliott Laboratories Open Area Test Site #1 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

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

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

CONDUCTED EMISSIONS SPECIFICATION LIMITS, SECTION 15.207 & 15.107(a)

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

CONDUCTED EMISSIONS SPECIFICATION LIMITS, RSS 210

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

FUNDAMENTAL AND HARMONIC LIMITS 15.231 (b) / RSS 210 Table 1

The table below shows the limits for both the Fundamental and Harmonic emissions for each frequency band of operation detailed in Section 15.231 (b) for control signals.

Operating Frequency (MHz)	Field strength (microvolts/m)	Harmonics (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

FUNDAMENTAL AND HARMONIC LIMITS 15.231 (e)/RSS 210 Table 4

The table below shows the limits for both the Fundamental and Harmonic emissions (that do not fall in restricted bands) for each frequency band of operation detailed in Section 15.231 (e) for data signals.

Operating Frequency (MHz)	Field strength (microvolts/m)	Harmonics (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

RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.209 / RSS 210 Table 3

The table below shows the limits for the spurious emissions from transmitters that fall in restricted bands 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 @ 3m)	Limit (dBuV/m @ 3m)
0.009-0.490	$2400/F_{KHz}$ @ 300m	$67.6-20*\log_{10}(F_{KHz})$ @ 300m
0.490-1.705	$24000/F_{KHz}$ @ 30m	$87.6-20*\log_{10}(F_{KHz})$ @ 30m
1.705 to 30	30 @ 30m	29.5 @ 30m
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.109 / RSS 210 Table 3 (RECEIVER)

The table below shows the limits for emissions from the receiver.

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 - 6,500 MHz, 12-Apr-05
Engineer: Chris Byleckie

Manufacturer	Description	Model #	Asset #	Cal Due
Hewlett Packard	EMC Spectrum Analyzer 9kHz - 6.5GHz	8595EM	787	17-Dec-05
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	13-Jan-06
Filtek	High Pass Filter, 1GHz	HP12/1000-5BA	957	26-Mar-06
Rohde & Schwarz	Test Receiver, 9kHz-2750MHz	ESCS 30	1337	12-Jan-06
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	1242	19-Oct-06
EMCO (ETS-Lindgren)	Log Periodic Antenna, 0.2-2 GHz	3148	1595	01-Jun-05

Radiated Emissions, 9kHz - 30MHz, 21-Apr-05
Engineer: Mark Briggs

Manufacturer	Description	Model #	Asset #	Cal Due
Hewlett Packard	EMC Spectrum Analyzer 30Hz - 40 GHz, Sunnyvale	8564E (84125C)	1148	09-Jun-05
EMCO	Magnetic Loop Antenna, 10kHz-30MHz	6502	1299	20-Dec-06

Radiated Emissions, 30 - 4,000 MHz, 14-Apr-05
Engineer: Adam LaCourse

Manufacturer	Description	Model #	Asset #	Cal Due
Elliott Laboratories	Log Periodic Antenna 300-1000 MHz	EL300.1000	55	06-Dec-05
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	786	08-Nov-05
Hewlett Packard	Microwave Preamplifier 0.5-26.5GHz	83017A	1257	22-Sep-05
Hewlett Packard	RF Preamplifier, 100 kHz - 1.3 GHz	8447E	1606	28-Jul-05

Final radiated measurements, 25-Apr-05
Engineer: Peter Sales

Manufacturer	Description	Model #	Asset #	Cal Due
Elliott Laboratories	Tunable Dipole Antenna	(White) (410-1000 MHz)	323	07-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	12-May-05
Rohde & Schwarz	Peak Power Sensor 100uW - 2 Watts	NRV-Z32	1423	01-Mar-06
Rohde & Schwarz	Power Meter, Single Channel	NRVS	1534	01-Mar-06

EXHIBIT 2: Test Measurement Data

8 Pages

Elliott

EMC Test Data

Client:	Savi	Job Number:	J59254
Model:	ST-654-XXX	T-Log Number:	T59395
		Account Manager:	Rod Wong
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC 15.231(e); EN 300 330; EN 300 220	Class:	-
Immunity Spec:	EN 301 489-3	Environment:	-

EMC Test Data

For The

Savi

Model

ST-654-XXX

Date of Last Test: 5/4/2005

Elliott

EMC Test Data

Client:	Savi	Job Number:	J59254
Model:	ST-654-XXX	T-Log Number:	T59395
		Account Manager:	Rod Wong
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC 15.231(e); EN 300 330; EN 3	Class:	-
Immunity Spec:	EN 301 489-3	Environment:	-

EUT INFORMATION

General Description

The ST-654 series devices are RFID Tags designed to identify the container to which they are attached. 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.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Savi Technology	ST-654-XXX	Tag	404361	

Other EUT Details

The EUT transmits at 433.92MHz using FSK modulated pulses, each pulse being 10ms long. During radio performance and emissions testing the device was configured to transmit continuously for transmitter-related tests and in a continuous receive mode for receiver tests.

The EUT is a redesigned version of the ST-645-001 approved under FCC ID KL7-654T-V1. The modifications include a new ASIC andan improved antenna.

EUT Enclosure

The EUT enclosure is primarily constructed injection molded plastic. It measures approximately 15.875 cm wide by 5.4cm deep by 2.86cm 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	Job Number:	J59254
Model:	ST-654-XXX	T-Log Number:	T59395
		Account Manager:	Rod Wong
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC 15.231(e); EN 300 330; EN 3	Class:	-
Immunity Spec:	EN 301 489-3	Environment:	-

Test Configuration #1

Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None				

Interface Cabling and Ports

The EUT has no interface ports.

EUT Operation During Emissions Tests

The EUT was confiugred to continuously transmit a CW signal, a modulated signal or to be in a continuous receive mode.

EUT Operation During Immunity

The EUT was tested in three different modes:

Stand-By Mode: The EUT was positioned on the table in a stand-by mode (transmitter inactive, receiver active). A near field probe was placed beside the EUT and used to monitor 433 MHz to verify that the device did not transmit.

433 MHz Receive / Transmit Mode: A Savi reader was located beside the EUT. The reader was controlled by a remote PC to send an interrogation request at 433 MHz and then report back the ID of the tag. The reader repeated this cycle at ~ 3 second intervals. The PC recorded the number of successful collections and the number of missed collections (i.e. cycles where the tag's response was not received).

123kHz Receive / 433 MHz Transmit Mode: A SignPost and a reader were located close to the EUT and controlled by a PC to initiate a response from the Tag via the Signpost (at 123kHz) and then listen for the tag's response by the reader at 433 MHz. The cycle was repeated at ~ 3 second intervals. The PC recorded the number of successful collections and the number of missed collections (i.e. cycles where the tag's response was not received).

Performance Criteria - EN 301 489-3

Criterion A: In Receive/Transmit modes the EUT shall respond to interrogations from the reader or signpost by transmitting its ID. The software should show no missed collections. Missed collections are acceptable when the test signal is at either the transmit or the receive frequency. In stand-by mode there shall be no transmissions from the tag.

Criterion B: In Receive/Transmit modes the EUT may fail to respond to interrogations from the reader or signpost during the test provided that it responds upon completion of the test. In stand-by mode there shall be no transmissions from the tag.

Client:	Savi	Job Number:	J59254
Model:	ST-654-XXX	T-Log Number:	T59395
		Account Manager:	Rod Wong
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231(e); EN 300 330; EN 300 220	Class:	-

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: Refer to run details
Test Engineer: Refer to run details
Test Location: Refer to run details
Config. Used: 1
Config Change: none
EUT Voltage: Internal Battery

General Test Configuration

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

The measurement antenna was located 3 or 10 meters from the EUTas detailed in the individual run descriptions.

Ambient Conditions:

Refer to details under each run.

Summary of Results

Run #	Test Performed	Limit	Result	Margin/Value
1	RE, 433.92 MHz, Transmitter	15.231 (e) / RSS 210	Pass	91.4dBµV/m (37153.5µV/m) @ 433.928MHz (-1.5dB)
1	RE, 30 -4333 MHz, Tx Spurious	15.231 (e) / RSS 210	Pass	40.4dBµV/m (104.8µV/m) @ 1301.7MHz (-13.6dB)
2	Tranmsitter Bandiwdth	15.231 RSS 210	Pass	340 kHz
3	RE, 30 - 1300MHz, Receive Mode @ 3m	15.109/RSS 210	Pass	27.4dBµV/m (23.4µV/m) @ 423.232MHz (-18.6dB)

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.

EMC Test Data

Client:	Savi	Job Number:	J59254
Model:	ST-654-XXX	T-Log Number:	T59395
		Account Manager:	Rod Wong
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231(e); EN 300 330; EN 300 220	Class:	-

Run #1: Radiated Emissions, 30 - 4333 MHz: Transmit Mode (433.92 MHz) - 10mS Data and Control Signals.
3-orientations of the EUT tested 16k ohm resistor to set power level

Date of Test: 4/12/2005
Test Engineer: Chris Byleckie
Test Location: SVOATS #1

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

Temperature: 15 °C
Rel. Humidity: 51 %

Fundamental Signal, tested at 3m

Frequency	Level	Pol	15.231(e)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
433.928	91.4	H	92.9	-1.5	Pk	23	1.0	EUT on its side
433.928	71.4	H	72.9	-1.5	Avg	23	1.0	EUT on its side
433.928	89.4	V	92.9	-3.5	Pk	18	1.2	EUT Upright
433.928	69.4	V	72.9	-3.5	Avg	18	1.2	EUT Upright
433.928	86.9	V	92.9	-6.0	Pk	109	1.3	EUT flat
433.928	66.9	V	72.9	-6.0	Avg	109	1.3	EUT flat
433.928	85.1	H	92.9	-7.8	Pk	160	1.0	EUT flat
433.928	65.1	H	72.9	-7.8	Avg	160	1.0	EUT flat
433.928	84.3	H	92.9	-8.6	Pk	89	1.2	EUT Upright
433.928	64.3	H	72.9	-8.6	Avg	89	1.2	EUT Upright
433.928	77.8	V	92.9	-15.1	Pk	300	1.3	EUT on its side
433.928	57.8	V	72.9	-15.1	Avg	300	1.3	EUT on its side

Run #1 continued on next page

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EMC Test Data

Client:	Savi	Job Number:	J59254
Model:	ST-654-XXX	T-Log Number:	T59395
		Account Manager:	Rod Wong
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231(e); EN 300 330; EN 300 220	Class:	-

Run #1 continued - Spurious Signals, tested at 3m

Frequency	Level	Pol	15.231(e)		Detector	Azimuth	Height	Comments	
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters		
1301.700	40.4	V	54.0	-13.6	Avg	177	2.0	EUT Upright	
1301.700	60.4	V	74.0	-13.6	Pk	177	2.0	EUT Upright	
1301.700	39.4	V	54.0	-14.6	Avg	192	1.0	EUT flat	
1301.700	59.4	V	74.0	-14.6	Pk	192	1.0	EUT flat	
1301.700	36.1	V	54.0	-17.9	Avg	295	1.0	EUT on its side	
1301.700	56.1	V	74.0	-17.9	Pk	295	1.0	EUT on its side	
1301.700	35.5	H	54.0	-18.5	Avg	75	1.0	EUT Upright	
1301.700	55.5	H	74.0	-18.5	Pk	75	1.0	EUT Upright	
1301.700	34.7	H	54.0	-19.3	Avg	256	1.0	EUT flat	
1301.700	54.7	H	74.0	-19.3	Pk	256	1.0	EUT flat	
867.856	31.4	H	52.9	-21.5	Avg	215	1.3	EUT Upright	Note 2
867.856	51.4	H	72.9	-21.5	Pk	215	1.3	EUT Upright	Note 2
1301.700	31.5	H	54.0	-22.5	Avg	57	1.0	EUT on its side	
1301.700	51.5	H	74.0	-22.5	Pk	57	1.0	EUT on its side	
867.856	28.2	H	52.9	-24.7	Avg	36	1.0	EUT flat	Note 2
867.856	48.2	H	72.9	-24.7	Pk	36	1.0	EUT flat	Note 2
867.856	26.6	V	52.9	-26.3	Avg	176	1.5	EUT flat	Note 2
867.856	46.6	V	72.9	-26.3	Pk	176	1.5	EUT flat	Note 2
867.856	24.8	V	52.9	-28.1	Avg	183	1.0	EUT Upright	Note 2
867.856	44.8	V	72.9	-28.1	Pk	183	1.0	EUT Upright	Note 2
1735.600	24.5	V	54.0	-29.5	Avg	0	1.0	EUT flat	
1735.600	44.5	V	74.0	-29.5	Pk	0	1.0	EUT flat	
1735.600	24.4	H	54.0	-29.6	Avg	0	1.0	EUT on its side	
1735.600	44.4	H	74.0	-29.6	Pk	0	1.0	EUT on its side	
1735.600	23.9	H	54.0	-30.1	Avg	0	1.0	EUT flat	
1735.600	43.9	H	74.0	-30.1	Pk	0	1.0	EUT flat	
1735.600	23.9	V	54.0	-30.1	Avg	0	1.0	EUT Upright	
1735.600	43.9	V	74.0	-30.1	Pk	0	1.0	EUT Upright	
1735.600	23.8	V	54.0	-30.2	Avg	0	1.0	EUT on its side	
1735.600	43.8	V	74.0	-30.2	Pk	0	1.0	EUT on its side	
1735.600	22.5	H	54.0	-31.5	Avg	0	1.0	EUT Upright	
1735.600	42.5	H	74.0	-31.5	Pk	0	1.0	EUT Upright	
867.856	21.1	V	52.9	-31.8	Avg	213	1.5	EUT on its side	Note 2
867.856	41.1	V	72.9	-31.8	Pk	213	1.5	EUT on its side	Note 2
867.856	20.2	H	52.9	-32.7	Avg	165	1.0	EUT on its side	Note 2
867.856	40.2	H	72.9	-32.7	Pk	165	1.0	EUT on its side	Note 2

Note 1:	All average measurements calculated from the peak measurements using an average correction factor of 20dB. The correction factor is based on a duty cycle of less than 10% in any 100mS period.
Note 2:	Signal Substitution

Client:	Savi	Job Number:	J59254
Model:	ST-654-XXX	T-Log Number:	T59395
		Account Manager:	Rod Wong
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231(e); EN 300 330; EN 300 220	Class:	-

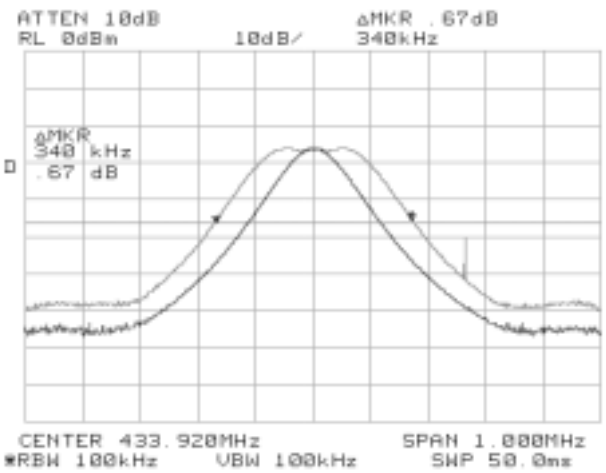
Run #2: Transmit Mode (433.92 MHz) - Bandwidth

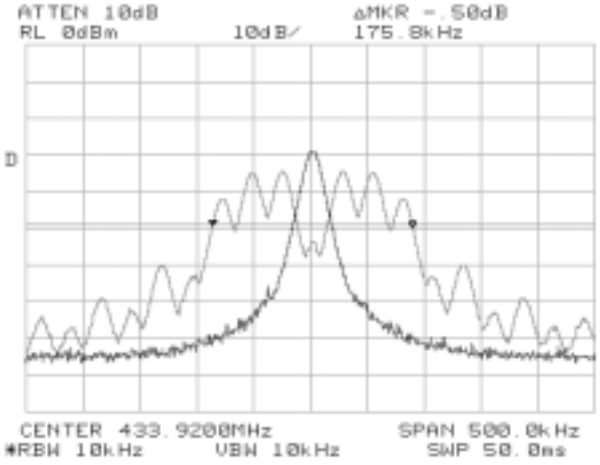
Date of Test: 4/21/2005
Test Engineer: Mark Briggs
Test Location: Chamber #2

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

Temperature: 17 °C
Rel. Humidity: 45 %

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





Purple trace = unmodulated signal, green = modulated signal.

Transmission timing:

There are two types of transmissions - a signpost signal and a data signal.

The signpost signal consists of three 10ms pulses with a randomized spacing of at least 90ms between pulses such that the transmission length does not exceed 330mS. This also ensures that the maximum duty cycle is 10% (no more than 1 pulse in a 100ms period. This transmission can be repeated at intervals of no less than 10 seconds. This meets the requirements of 15.231(e) and RSS 210 ( ) which restricts the maximum transmission time to 1 second and the minimum time between transmissions to no less than either 10 seconds or 30 times the transmission time.

The data signal consists of ten, 10ms pulses with 90ms between pulses, giving a total transmission time of 1 second. This also ensures that the maximum duty cycle is 10% (no more than 1 pulse in a 100ms period. This transmission can be repeated at intervals of no less than 30 seconds. This meets the requirements of 15.231(e) and RSS 210 ( ) which restricts the maximum transmission time to 1 second and the minimum time between transmissions to no less than either 10 seconds or 30 times the transmission time.

Plots showing the transmission timing and a detailed explanation of operation are included in the manufacturer's Operational Description.

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EMC Test Data

Client:	Savi	Job Number:	J59254
Model:	ST-654-XXX	T-Log Number:	T59395
		Account Manager:	Rod Wong
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231(e); EN 300 330; EN 300 220	Class:	-

Run #3: Radiated Emissions, 30 - 1300 MHz: Receiver and Digital Device (Rx LO @ 423.2 MHz)

Date of Test: 4/12/2005
Test Engineer: Chris Byleckie
Test Location: sVOATS #1

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

Temperature: 15 °C
Rel. Humidity: 51 %

Tested at 3m

Frequency	Level	Pol	15.109/RSS 210		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
423.232	27.4	h	46.0	-18.6	QP	60	1.0	EUT Upright
423.232	26.7	v	46.0	-19.3	QP	0	1.5	EUT flat
423.232	26.5	h	46.0	-19.5	QP	78	1.0	EUT on its side
423.232	26.3	v	46.0	-19.7	QP	0	1.2	EUT Upright
423.232	24.8	v	46.0	-21.2	QP	317	1.3	EUT on its side
846.464	24.5	h	46.0	-21.5	QP	0	1.0	EUT flat
423.232	23.8	h	46.0	-22.2	QP	11	1.0	EUT flat
846.464	23.6	v	46.0	-22.4	QP	0	1.0	EUT on its side
846.464	23.6	h	46.0	-22.4	QP	0	1.0	EUT Upright
846.464	23.3	v	46.0	-22.7	QP	0	1.0	EUT Upright
846.464	23.2	h	46.0	-22.8	QP	0	1.0	EUT on its side
846.464	23.2	v	46.0	-22.8	QP	0	1.0	EUT flat