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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-654T
FCC ID: KL7-654T-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 23, 2004

FINAL TEST DATE: February 21, 2004

AUTHORIZED SIGNATORY: Mark Briggs

Mark Briggs
Vice President of Engineering

ACCREDITED

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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 C63.4-1992 as outlined in Elliott Laboratories test procedures.

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant 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 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 (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 (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

TEST RESULTS SUMMARY

FCC Part 15 Section	RSS 210 Section	Description	Comments	Result
15.207 / 15.107		AC Conducted Emissions, 0.15 – 30 MHz	Not applicable – the EUT is powered from internal batteries.	N/A
	6.6 / 7.4	AC Conducted emissions 0.45 – 30 MHz	Not applicable – the EUT is powered from internal batteries.	N/A
15.231 (a) (1)	6.1.1(a) (1)	Duration of manually activated transmission	Not applicable – the device only sends data transmissions	N/A
15.231 (a) (2)	6.1.1(a) (2)	Duration of automatically activated transmission	Not applicable – the device only sends data transmissions	N/A
15.231 (a) (3)	6.1.1(a) (3)	Transmissions at predetermined / regular intervals are not permitted	Not applicable – the device only sends data transmissions	N/A
15.231 (a) (4)	6.1.1(a) (4)	Pendency of transmissions used during emergencies involving fire, security, and safety of life	Not applicable	N/A
15.231 (b)	6.1.1(b) / Table 1	Transmitter Radiated Emissions	Not applicable – the device only sends data transmissions	N/A
15.231 (b)	6.1.1(b) / Table 1	Transmitter Radiated Spurious Emissions	Not applicable – the device only sends data transmissions	N/A
15.231 (c)	6.1.1 (c)	Bandwidth	Bandwidth = 400kHz	Pass
15.231 (d)	6.1.1 (d)	Frequency Stability	N/A	N/A
15.231 (e)	6.1.1 (e)	Transmitter Radiated Emissions, 433.92 MHz MHz	-2.7dB @ 433.928MHz	Pass
15.231 (e)	6.1.1 (e)	Transmitter Radiated Spurious Emissions, 30-4333 MHz	-2.1dB @ 1301.7MHz	Pass
15.231 (e)	6.1.1 (e)	Duration of transmissions	All transmissions are less than 1 second in duration. The period between transmissions is a minimum of either 10 seconds or 30 times the transmission's duration	Pass
15.109	7.3	Receiver Spurious Emissions	-10.8dB @ 423.232MHz	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 is intended for hand-held operation 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 series of devices are RF Tagging devices 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 table-top equipment during testing to simulate the end user environment. It was tested in all three orthogonal orientations.

There are two models covered by this application, ST-645-001 and ST-645-002. The only difference between the two is that the –001 model has 128k of user memory and the –002 option has 240K of user memory.

The sample was received on February 21, 2004 and tested on February 21, 2004. The EUT consisted of the following component(s):

Manufacturer/Model/Description	Serial Number
Savi Technology ST-654-001 Tag	200001

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 required the following modifications in order to comply with the specifications:

Mod. #	Test	Date	Modification
1	RE	2/21/2004	16 kohm resistor placed in R21 to set output power level.

SUPPORT EQUIPMENT

No local or remote support equipment was used during testing. The devices is intended to be used in a stand-alone configuration with no connections to peripheral devices.

EUT INTERFACE PORTS

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

Cable Description	Length (m)	From Unit/Port	To Unit/Port
None	-	-	-

EUT OPERATION

In Transmit mode, the EUT continuously transmitted a CW signal at 433.92 MHz. In Receive mode, the EUT was powered on to receive a signal at 433.92 MHz

ANTENNA SYSTEM

The antenna system used with the Savi Technology, Inc. model SaviTag ST-654 consists of an antenna integral to the device.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on February 21, 2004 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 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 C63.4-1992.

CONDUCTED EMISSIONS CONSIDERATIONS

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

RADIATED EMISSIONS CONSIDERATIONS

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

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

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

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

INSTRUMENT CONTROL COMPUTER

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

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

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

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

FILTERS/ATTENUATORS

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

ANTENNAS

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

ANTENNA MAST AND EQUIPMENT TURNTABLE

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

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

INSTRUMENT CALIBRATION

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

TEST PROCEDURES

EUT AND CABLE PLACEMENT

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

CONDUCTED EMISSIONS

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

RADIATED EMISSIONS

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

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

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

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

2 Pages

Radiated Emissions, 300 - 4339.25MHz, 21-Feb-04
Engineer: Marissa Faustino

Manufacturer	Description	Model #	Asset #	Cal Due
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	786	28-Feb-04
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	12-Jan-05
Filtek	High Pass Filter, 1GHz	HP12/1000-5BA	956	11-Mar-04
Hewlett Packard	EMC Spectrum Analyzer, 9KHz - 22GHz	8593EM	1319	20-Nov-04
EMCO	Log Periodic Antenna, 0.2-2 GHz	3148	1321	31-Mar-04
Rohde & Schwarz	Test Receiver, 0.009-2000 MHz	ESN	1332	24-Jul-04

Radiated Emissions, pre-scan, 01-Mar-04
Engineer: Mark Briggs

Manufacturer	Description	Model #	Asset #	Cal Due
EMCO	Biconical Antenna, 30-300 MHz	3110B	1320	20-Aug-04
Electro Metrics	Conical log spiral antenna	LCA-25	1291	15-Apr-04
Hewlett Packard	RF Preamplifier, 100 kHz - 1.3 GHz	8447E	1606	22-Jul-04

EXHIBIT 2: Test Measurement Data

The following data includes conducted emission measurements of the Savi Technology, Inc. model SaviTag ST-654 and maximized radiated emissions measurements of the complete system.

7 Pages

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EMC Test Data

Client:	Savi Technology	Job Number:	J54188
Model:	ST-654-0X	T-Log Number:	T54270
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC 15.231,15.109,RSS 210	Class:	-
Immunity Spec:	-	Environment:	-

EMC Test Data

For The

Savi Technology

Model

ST-654-0X

Date of Last Test: 2/23/2004

Client:	Savi Technology	Job Number:	J54188
Model:	ST-654-0X	T-Log Number:	T54270
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC 15.231,15.109,RSS 210	Class:	-
Immunity Spec:	-	Environment:	-

EUT INFORMATION

General Description

The ST-654 series of devices are RF Tagging devices 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 table-top equipment during testing to simulate the end user environment.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Savi Technology	ST-654-001	Tag	200001	KL7-654T-V1

Other EUT Details

The EUT transmits at 433.92MHz using FSK modulated pulses, each pulse being 10ms long. During testing the device was configured to transmit continuously.

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	RE	2/21/2004	16 kohm resistor placed in R21

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

Client:	Savi Technology	Job Number:	J54188
Model:	ST-654-0X	T-Log Number:	T54270
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC 15.231,15.109,RSS 210	Class:	-
Immunity Spec:	-	Environment:	-

Test Configuration #1

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
none				

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
none				

Interface Cabling and Ports

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
Serial	not connected			

The serial port is not intended for connection during normal operation. It is used for maintenance purposes only (e.g. programming). During normal operation the device is attached to a contained and interrogated via the 433 MHz transceiver functions.

EUT Operation During Emissions

In Transmit mode , the EUT continuously transmitted a CW signal at 433.92 MHz. In Receive mode, the EUT was powered on to receive a signal at 433.92 MHz

Client:	Savi Technology	Job Number:	J54188
Model:	ST-654-0X	T-Log Number:	T54270
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231,15.109,RSS 210	Class:	-

Radiated Emissions - Transmit and Receive Mode

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: 2/21/2004
Test Engineer: Marissa Faustino
Test Location: SVOATS #1
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.

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: 10 °C
Rel. Humidity: 93 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 433.92 MHz, Transmitter	15.231 (e) / RSS 210	Pass	-2.7dB @ 433.928MHz
1	RE, 30 -4333 MHz, Tx Spurious	15.231 (e) / RSS 210	Pass	-2.1dB @ 1301.7MHz
1	Tranmsitter Bandiwdth	15.231 RSS 210	Pass	20dB BW = 400kHz
2	RE, 30 - 1300MHz, Receive Mode @ 3m	15.109/RSS 210	Pass	-10.8dB @ 423.232MHz
3	RE, 30-1000 MHz	EN 55011 A	Pass	-2.7dB @ 867.840MHz

Modifications Made During Testing:

The following modification was made to the EUT in order to comply with the requirements of the standard:
1) 16 kilohm resistor placed in R21to set the output signal level.

Deviations From The Standard

No deviations were made from the requirements of the standard.

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EMC Test Data

Client:	Savi Technology	Job Number:	J54188
Model:	ST-654-0X	T-Log Number:	T54270
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231,15.109,RSS 210	Class:	-

Run #1: Radiated Emissions, 30 - 4333 MHz: Transmit Mode (433.92 MHz) - 10mS Data and Control Signals.
3-orientations of the EUT tested, R21 set to 16kohm
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	90.2	V	92.9	-2.7	Pk	56	1.2	EUT upright, antenna pointing down
433.928	70.2	V	72.9	-2.7	Avg	56	1.2	EUT upright, antenna pointing down

Spurious Signals, tested at 3m

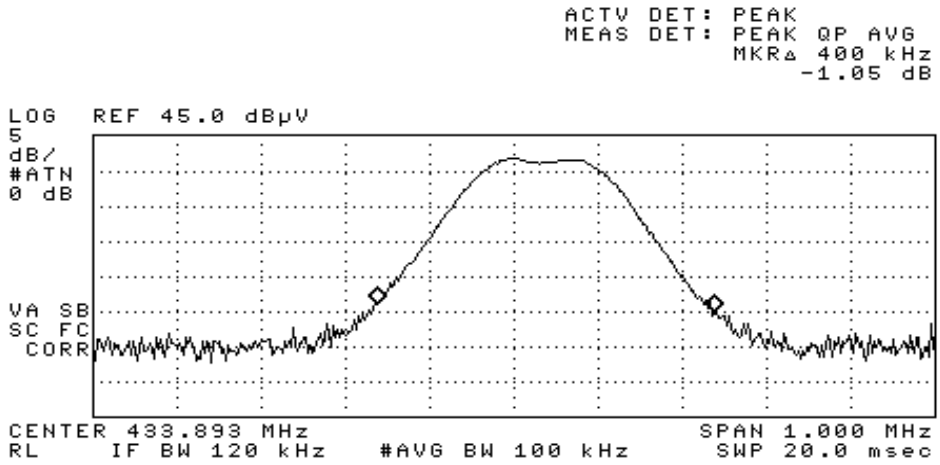
Frequency	Level	Pol	15.231(e)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1301.700	71.9	V	74.0	-2.1	Pk	81	1.1	EUT flat
1301.700	51.9	V	54.0	-2.1	Avg	81	1.1	EUT flat
1301.700	71.8	V	74.0	-2.2	Pk	103	1.0	EUT Upright
1301.700	51.8	V	54.0	-2.2	Avg	103	1.0	EUT Upright
1301.700	71.5	V	74.0	-2.5	Pk	285	1.0	EUT on its side
1301.700	51.5	V	54.0	-2.5	Avg	285	1.0	EUT on its side
1301.700	70.2	H	74.0	-3.8	Pk	143	1.0	EUT flat
1301.700	50.2	H	54.0	-3.8	Avg	143	1.0	EUT flat
1301.700	70.2	H	74.0	-3.8	Pk	143	1.0	EUT on its side
1301.700	50.2	H	54.0	-3.8	Avg	143	1.0	EUT on its side
1301.700	68.3	H	74.0	-5.7	Pk	80	1.0	EUT Upright
1301.700	48.3	H	54.0	-5.7	Avg	80	1.0	EUT Upright
867.840	36.0	V	52.9	-16.9	Avg	256	1.2	EUT upright, worst case orientation
867.840	56.0	V	72.9	-16.9	Pk	244	1.0	EUT upright, worst case orientation
1735.600	56.1	V	74.0	-17.9	Pk	93	1.0	EUT flat
1735.600	36.1	V	54.0	-17.9	Avg	93	1.0	EUT flat
867.840	34.7	H	52.9	-18.2	Avg	81	1.0	EUT upright, worst case orientation
867.840	54.7	H	72.9	-18.2	Pk	81	1.0	EUT upright, worst case orientation
1735.600	55.4	V	74.0	-18.6	Pk	184	1.0	EUT on its side
1735.600	35.4	V	54.0	-18.6	Avg	184	1.0	EUT on its side
1735.600	53.0	V	74.0	-21.0	Pk	120	1.7	EUT Upright
1735.600	33.0	V	54.0	-21.0	Avg	120	1.7	EUT Upright
1735.600	52.8	H	74.0	-21.2	Pk	202	1.0	EUT on its side
1735.600	32.8	H	54.0	-21.2	Avg	202	1.0	EUT on its side
1735.600	52.0	H	74.0	-22.0	Pk	28	1.0	EUT flat
1735.600	32.0	H	54.0	-22.0	Avg	28	1.0	EUT flat
1735.600	47.7	H	74.0	-26.3	Pk	258	1.0	EUT Upright
1735.600	27.7	H	54.0	-26.3	Avg	258	1.0	EUT Upright

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.
Notes:	The field strength was highest with the EUT oriented in the upright position. Preliminary testing had shown that the levels were ~ 2dB lower with the unit lying flat or on its side.

Client:	Savi Technology	Job Number:	J54188
Model:	ST-654-0X	T-Log Number:	T54270
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231,15.109,RSS 210	Class:	-

Run #1: Transmit Mode (433.92 MHz) - 10mS Data and Control Signals (continued)

Signal bandwidth was measured to be 400kHz (see graph below).



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.

Elliott

EMC Test Data

Client:	Savi Technology	Job Number:	J54188
Model:	ST-654-0X	T-Log Number:	T54270
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231,15.109,RSS 210	Class:	-

Run #2: Radiated Emissions, 30 - 1300 MHz: Receive Mode (LO @ 423.2 MHz)

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	34.3	h	46.0	-11.7	QP	156	1.0	EUT on its side
846.464	34.2	h	46.0	-11.8	QP	360	1.0	EUT on its side
846.464	33.8	v	46.0	-12.2	QP	5	1.5	EUT on its side
423.232	30.2	v	46.0	-15.8	QP	177	1.1	EUT on its side
423.232	35.2	h	46.0	-10.8	QP	361	1.0	EUT flat
846.464	34.4	h	46.0	-11.6	QP	204	1.0	EUT flat
846.464	33.8	v	46.0	-12.2	QP	62	1.0	EUT flat
423.232	31.0	v	46.0	-15.0	QP	193	1.0	EUT flat
846.464	33.9	h	46.0	-12.1	QP	18	1.0	EUT Upright
846.464	33.9	v	46.0	-12.1	QP	362	1.0	EUT Upright
423.232	29.9	h	46.0	-16.1	QP	281	1.0	EUT Upright
423.232	29.6	v	46.0	-16.4	QP	175	1.0	EUT Upright

Run #3: Radiated Emissions, 30 - 1000 MHz: EN 60601-1-2

Transmit Mode (Tested at 10m)

Frequency	Level	Pol	EN 55011 A		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
867.840	44.3	h	47.0	-2.7	QP	250	1.0	
867.840	42.2	v	47.0	-4.8	QP	0	1.0	