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Electromagnetic Emissions Test Report and Application for Grant of Equipment Authorization pursuant to FCC Part 15, Subpart C Specifications for an Intentional Radiator on the Savi Technology, Inc. Model: EchoPoint Tag, Model ST-602-01

FCC ID:	KL7-612T-V1
GRANTEE:	Savi Technology, Inc. 615 Tasman Drive Sunnyvale, CA. 94089-1707
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
REPORT DATE:	December 13, 2001
FINAL TEST DATE:	November 15, 2001
AUTHORIZED SIGNATORY:	Mark Briggs Director of Engineering

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SCOPE

An electromagnetic emissions test has been performed on the Savi Technology model EchoPoint Tag, Model ST-602-01 pursuant to Subpart C of Part 15 of FCC Rules for intentional radiators. 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 FCC 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 model EchoPoint Tag, Model ST-602-01 and therefore apply only to the tested sample. The sample was selected and prepared by Eugene Schlindwein of Savi Technology, Inc.

This report was revised on December 13, 2001 to reflect the limits of 15.231(e) for the Beacon Mode.

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. Certification of these devices is required as a prerequisite to marketing as defined in Part 2 the FCC Rules.

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.

STATEMENT OF COMPLIANCE

The tested sample of Savi Technology, Inc. model EchoPoint Tag, Model ST-602-01 complied with the requirements of Subpart C of Part 15 of the FCC Rules for low power intentional radiators.

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.).

EMISSION TEST RESULTS

The following emissions tests were performed on the Savi Technology model EchoPoint Tag, Model ST-602-01. The actual test results are contained in an exhibit of this report.

LIMITS OF CONDUCTED INTERFERENCE VOLTAGE

The requirements of FCC 15.207 do not apply to this device. The EUT is designed to operate from an internal battery cell. It is not intended to be operated, directly or indirectly, from an AC mains power supply.

LIMITS OF RADIATED FIELD STRENGTH – FUNDAMENTAL SIGNAL

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.231(b) for a device operating under part 15.231(e) of the FCC's rules. By meeting the radiated emissions limits of 15.231(e) the device also meets the radiated emissions requirements of 15.231(a).

The following measurement was extracted from the data recorded during the radiated electric field emissions scan and represents the highest amplitude emission relative to the specification limit. The actual test data and any correction factors are contained in an exhibit of this report.

Frequency MHz	Level dBuV/m	Pol v/h	15.231 (e) Limit	15.231(e) Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
433.920	92.6	v	92.8	-0.2	Pk	70	1.1	EUT upright

LIMITS OF RADIATED FIELD STRENGTH – SPURIOUS SIGNALS

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.231(e) for spurious signals. The limits detailed in 15.209 were applied to emissions falling within the frequency bands specified in Section 15.205. All other emissions were subjected to the limits detailed in 15.231 for a device operating under section 15.231(e). By meeting the radiated emissions limits of 15.231(e) the device also meets the radiated emissions requirements of 15.231(a).

The following measurement was extracted from the data recorded during the radiated electric field emissions scan and represents the highest amplitude emission relative to the specification limit. The actual test data and any correction factors are contained in an exhibit of this report.

Frequency MHz	Level dBuV/m	Pol v/h	15.231 (e) Limit	15.231(e) Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
1301.760	70.3	h	74.0	-3.7	Pk	350	1.2	EUT flat on its back,

20dB BANDWIDTH MEASUREMENT

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.231. The 26 dB bandwidth was 448 kHz. The actual test data and any correction factors are contained in an exhibit of this report.

TIME OF TRANSMISSION

The intentional transmission from the device when operating in SignPost mode is considered to be a control signal and so the requirements of 15.231(a) apply. The theory of operations details how the maximum length of transmission is less than 5mS, meeting the maximum permitted time of 5 seconds detailed in 15.231(a). The theory of operations also details how the transmission on a random basis.

The intentional transmission from the device when operating in Beacon mode is also considered to be a control signal, but due to the periodic nature of the transmissions (one every 10 seconds) the requirements of 15.231(e) apply. The theory of operations details how the maximum length of transmission is less than 5mS, meeting the maximum permitted time of 1 second detailed in 15.231(e) and occurs only once in any 10 second period.

MEASUREMENT UNCERTAINTIES

ISO Guide 25 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	± 3.2

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Savi Technology model EchoPoint Tag, Model ST-602-01 is an rf tag which is designed to be used as part of an inventory tracking system. Normally, the EUT would be mounted to a piece of capital equipment. The EUT was treated as table-top equipment during testing to simulate the end user environment.

The EUT is self-contained, with no interface ports for connection to external power or signal lines. It is powered via on-board cells.

The sample was received on November 2, 2001 and tested on November 15, 2001. The EUT consisted of the following component(s):

Manufacturer/Model/Description	Serial Number
Savi ST-602-01 433MHz RF Tag	2000001

OTHER EUT DETAILS

The EUT is designed to receive commands from a SignPost transmitter at 132kHz. It then responds by transmitting an ID code using FSK at 433.92MHz. This signal is received by a SaviReader.

ENCLOSURE

The EUT enclosure is primarily constructed of plastic. It measures approximately 4 cm wide by 2 cm deep by 6 cm high.

MODIFICATIONS

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

SUPPORT EQUIPMENT

No support equipment was used during emissions testing.

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

The EUT was configured to transmit in Beacon Mode (transmitting its ID code at periodic intervals.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on November 15, 2001 at the Elliott Laboratories Open Area Test Site #2 located at 684 West Maude Avenue, Sunnyvale, California. The test site contains separate areas for radiated and conducted emissions testing. Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data has been filed with the Commission.

The FCC 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 FCC requirements.

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 and 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.

POWER METER

A power meter and thermister mount are used for all direct output power measurements from transmitters as they provide a broadband indication of the power output.

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

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

RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.231(b)

Fundamental Frequency (MHz)	Field Strength of Fundamental (microvolts/meter)	Field Strength of Spurious Emissions (microvolts/meter)*
260 - 470	3,750 to 12,500 **	375 to 1,250 **

* For emissions falling in the restricted bands detailed in 15.205, the limits of 15.209 apply.
** linear interpolations

RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.231(e)

Fundamental Frequency (MHz)	Field Strength of Fundamental (microvolts/meter)	Field Strength of Spurious Emissions (microvolts/meter)*
260 - 470	1,500 to 5,000 **	150 to 500 **

* For emissions falling in the restricted bands detailed in 15.205 and frequencies where the limits of 15.231(e) are lower than those in 15.209, the limits of 15.209 apply.
** linear interpolations

RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.209

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

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

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

$$R_r - B = C$$

and

$$C - S = M$$

where:

R_r = Receiver Reading in dBuV

B = Broadband Correction Factor*

C = Corrected Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

* Broadband Level - Per ANSI C63.4, 13 dB may be subtracted from the quasi-peak level if it is determined that the emission is broadband in nature. If the signal level in the average mode is six dB or more below the signal level in the peak mode, the emission is classified as broadband.

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, 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

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

Preliminary Scans in Anechoic Chamber, 13-Nov-01 03:32 PM
Engineer: Mark

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
A.H. Systems	Biconical Antenna, 20-200 MHz	SAS-200/540H	866	12	3/16/2001	#######
EMCO	Conical Log Spiral Antenna	3101	608	12	5/2/2001	5/2/2002
Hewlett Packard	EMC Spectrum Analyzer 9kHz - 6.5GHz	8595EM	780	12	1/30/2001	#######
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	487	12	3/31/2001	#######
EMCO	Magnetic Loop Antenna, 10k-30MHz	6502	296	12	12/27/2000	#######
Hewlett Packard	Microwave Preamplifier 0.5-26.5GHz	83017A	1257	12	10/16/2001	#######
Hewlett Packard	RF Preamplifier 100 kHz -1.3 GHz	8447D	789	12	12/13/2000	#######

Radiated Emissions, 30 - 6500 MHz, 15-Nov-01 11:56 PM
Engineer: Vishal

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
EMCO	Biconical Antenna, 30-300 MHz	3110B	1320	12	5/23/2001	#######
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	1242	12	10/9/2001	#######
EMCO	Log Periodic Antenna, 0.2-1 GHz	3146	1294	12	3/27/2001	#######
Hewlett Packard	EMC Spectrum Analyzer 9kHz - 6.5GHz	8595EM	787	12	2/14/2001	#######
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	12	1/25/2001	#######
Rohde & Schwarz	Test Receiver, 20-1300 MHz	ESVP	1317	12	5/9/2001	5/9/2002

Radiated Emissions, 30 - 6500 MHz, 20-Nov-01 05:34 PM
Engineer: mfaustino

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
Solar Electronics Co	1.0 Ohm Precision resistor, 1MHz □50W, 7 Vmax, +/-1%	Type 7144-1.0	1088	12		
Elliott Laboratories	1500 Ohm Conducted Probe	EL1500	249	12□	1/22/2001	#######
Hewlett Packard	EMC Spectrum Analyzer 9kHz - 6.5GHz	8595EM	787	12	2/14/2001	#######
Filtek	High Pass Filter, 1GHz	HP12/1000-5BA	956	12	3/22/2001	#######
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	487	12	3/31/2001	#######
EMCO	Horn antenna, D. Ridge 1-18GHz (SA40 system antenna)	3115	1142	12	1/29/2001	#######
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	12	1/25/2001	#######
Rohde & Schwarz	Test Receiver, 20-1300 MHz	ESVP	1317	12	5/9/2001	5/9/2002

EXHIBIT 2: Test Data Log Sheets

ELECTROMAGNETIC EMISSIONS

TEST LOG SHEETS

AND

MEASUREMENT DATA

T45356 7 Pages

Elliott

EMC Test Data

Client:	Savi	Job Number:	J45253
Model:	ST-602-01	T-Log Number:	T45356
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC Part 15.231	Class:	-
Immunity Spec:	-	Environment:	-

EMC Test Data

For The

Savi

Model

ST-602-01

Client:	Savi	Job Number:	J45253
Model:	ST-602-01	T-Log Number:	T45356
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC Part 15.231	Class:	-
Immunity Spec:	-	Environment:	-

EUT INFORMATION

General Description

The EUT is an rf tag which is designed to be used as part of an inventory tracking system. Normally, the EUT would be mounted to a piece of capital equipment. The EUT was treated as table-top equipment during testing to simulate the end user environment.

The EUT is self contained, with no interface ports for connection to external power or signal lines. It is powered via on-board cells.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Savi	ST-602-01 (ver 4.09)	433MHz RF Tag	2000001	

Other EUT Details

The EUT is designed to receive commands from a SignPost transmitter at 132kHz. It then responds by transmitting an ID code using FSK at 433.92MHz. This signal is received by a SaviReader.

EUT Enclosure

The EUT enclosure is primarily constructed of plastic. It measures approximately 4 cm wide by 2 cm deep by 6 cm high.

Modification History

Mod. #	Test	Date	Modification
1			
2			
3			

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EMC Test Data

Client:	Savi	Job Number:	J45253
Model:	ST-602-01	T-Log Number:	T45356
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC Part 15.231	Class:	-
Immunity Spec:	-	Environment:	-

Test Configuration #1

Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
none required				

Interface Ports

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

EUT Operation During Emissions

The EUT was configured to either transmit in Beacon Mode (transmitting its ID code at periodic intervals) or configured to be in stand-by/Receive mode.

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EMC Test Data

Client:	Savi	Job Number:	J45253
Model:	ST-602-01	T-Log Number:	T45356
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC Part 15.231	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: 15-Nov
Test Engineer: Vishal Narayan
Test Location: SVOATS #2

Config. Used: 1
Config Change: None
EUT Voltage: Internal Batteries

General Test Configuration

The EUT was located on a 0.8m high wooden table on the turntable for radiated emissions testing perfromed in the anechoic chamber. The EUT was tested in all three ortogonal axes.
On the OATS, the measurement antenna was located 3 meters from the EUT.
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: 13.2°C
Rel. Humidity: 93%

Summary of Results

Run #	Test Performed	Limit	Result	Comment
1	Fundamental Signal @ 433.92MHz	FCC 15.231(e)	Pass	-.2dB @ 433.92MHz
2	Transmitter Spurious Emissions	FCC 15.231(e)	Pass	-3.7dB @ 1301.76MHz
3	Bandwidth	15.231	Pass	448kHz

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.

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EMC Test Data

Client:	Savi	Job Number:	J45253
Model:	ST-602-01	T-Log Number:	T45356
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC Part 15.231	Class:	-

Run #1: Maximized Radiated Emissions, Fundamental Signal at 433.92MHz

Frequency	Level	Pol	15.231(e)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
433.920	92.6	v	92.8	-0.2	Pk	70	1.1	EUT upright
433.920	72.6	v	72.8	-0.2	Avg	70	1.1	EUT upright
433.920	90.6	v	92.8	-2.2	Pk	260	1.0	EUT on its side
433.920	70.6	v	72.8	-2.2	Avg	260	1.0	EUT on its side
433.920	87.9	h	92.8	-4.9	Pk	170	2.0	EUT flat on its back
433.920	67.9	h	72.8	-4.9	Avg	170	2.0	EUT flat on its back
433.920	86.5	h	92.8	-6.3	Pk	0	1.3	EUT on its side
433.920	66.5	h	72.8	-6.3	Avg	0	1.3	EUT on its side
433.920	85.3	h	92.8	-7.5	Pk	330	3.7	EUT upright
433.920	65.3	h	72.8	-7.5	Avg	330	3.7	EUT upright
433.920	75.4	v	92.8	-17.4	Pk	70	2.3	EUT flat on its back
433.920	55.4	v	72.8	-17.4	Avg	70	2.3	EUT flat on its back

Note 1:	Average readings calculated from the peak readings by adding the average correction factor of -20dB to the peak reading.
Note 2:	Limits of 15.231(e) used.

Elliott

EMC Test Data

Client:	Savi	Job Number:	J45253
Model:	ST-602-01	T-Log Number:	T45356
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC Part 15.231	Class:	-

Run #2: Maximized Radiated Emissions - Spurious Emissions 30MHz - 4334 MHz

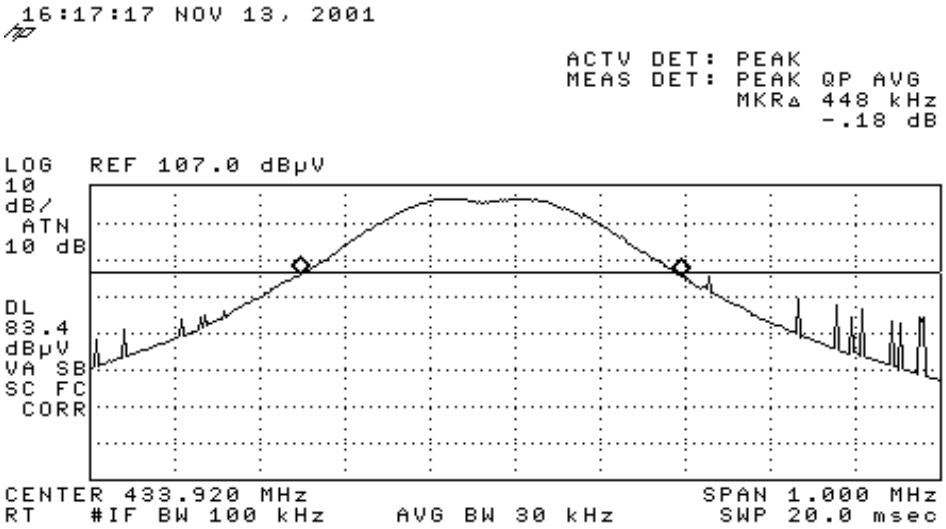
Frequency	Level	Pol	15.231(b)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1301.760	70.3	h	74.0	-3.7	Pk	350	1.2	EUT flat on its back,
1301.760	50.3	h	54.0	-3.7	Avg	350	1.2	EUT flat on its back,
1301.760	69.2	v	74.0	-4.8	Pk	80	1.0	EUT upright,
1301.760	49.2	v	54.0	-4.8	Avg	80	1.0	EUT upright,
1301.760	48.1	h	54.0	-5.9	Avg	340	1.2	EUT on its side,
1301.760	68.1	h	74.0	-5.9	Pk	340	1.2	EUT on its side,
1301.760	46.8	v	54.0	-7.2	Avg	60	1.5	EUT on its side,
1301.760	66.8	v	74.0	-7.2	Pk	60	1.5	EUT on its side,
1301.760	64.6	v	74.0	-9.4	Pk	90	1.9	EUT flat on its back,
1301.760	44.6	v	54.0	-9.4	Avg	90	1.9	EUT flat on its back,
1735.680	62.8	v	74.0	-11.2	Pk	80	1.0	EUT upright
1735.680	42.8	v	54.0	-11.2	Avg	80	1.0	EUT upright
1301.760	55.2	h	74.0	-18.8	Pk	150	1.0	EUT upright,
1301.760	35.2	h	54.0	-18.8	Avg	150	1.0	EUT upright,
867.840	61.5	h	72.8	-11.3	Pk	150	2.7	EUT flat on its back
867.840	41.5	h	52.8	-11.3	Avg	150	2.7	EUT flat on its back
867.840	58.5	h	72.8	-14.3	Pk	20	1.0	EUT on its side
867.840	38.5	h	52.8	-14.3	Avg	20	1.0	EUT on its side
1735.680	58.4	h	74.0	-15.7	Pk	360	1.0	EUT on its side
1735.680	38.4	h	54.0	-15.7	Avg	360	1.0	EUT on its side
867.840	56.0	v	80.8	-24.8	Pk	20	1.0	EUT flat on its back
867.840	36.0	v	60.8	-24.8	Avg	20	1.0	EUT flat on its back
1735.680	54.8	h	74.0	-19.2	Pk	190	1.0	EUT upright
1735.680	34.8	h	54.0	-19.2	Avg	190	1.0	EUT upright
867.840	54.7	v	72.8	-18.1	Pk	70	1.0	EUT on its side
867.840	34.7	v	52.8	-18.1	Avg	70	1.0	EUT on its side
867.840	48.6	v	72.8	-24.2	Pk	80	1.0	EUT upright
867.840	28.6	v	52.8	-24.2	Avg	80	1.0	EUT upright
867.840	47.0	h	72.8	-25.8	Pk	80	1.0	EUT upright
867.840	27.0	h	52.8	-25.8	Avg	80	1.0	EUT upright

Note 1:	Average readings calculated from the peak readings by adding the average correction factor of -20dB to the peak reading.
Note 2:	Limits of 15.231(e) used below 1Ghz for emissions not in restricted bands. Above 1GHz the general limit from 15.209 is used as it permits higher levels of emissions.

Client:	Savi	Job Number:	J45253
Model:	ST-602-01	T-Log Number:	T45356
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC Part 15.231	Class:	-

Run #3: 20dB Bandwidth and duty cycle

The 20dB bandwidth was measured to be 448 kHz (see plot below). The maximum permitted bandwidth is 1.085 MHz



Duty cycle: There are never more than two transmissions in a 125mS period. The maximum on time was 5mS for a single transmission. The average correction factor to be applied to peak readings is, therefore, 20Log(10/100) = -20dB.