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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 and FCC Part 15, Subpart B Specifications for a Receiver on the Savi Technology, Inc. Models: 644 and 645 Tags

FCC ID:	KL7-640T-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:	September 26, 2002
FINAL TEST DATE:	June 18 - June 20, September 4, 2002

AUTHORIZED SIGNATORY: _____

Mark Briggs
Director of Engineering

TABLE OF CONTENTS

SCOPE

An electromagnetic emissions test has been performed on the Savi Technology, Inc. models 645 and 646 Tags pursuant to Subpart C of Part 15 of FCC Rules for intentional radiators and Subpart B of Part 15 of FCC Rules for receivers. 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 transceiver 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 single type tests of the Savi Technology, Inc. models 645 and 646 Tags and therefore apply only to the tested samples. The samples were selected and prepared by Eugene Schlindwein of Savi Technology, Inc.

OBJECTIVE

The primary objective of the manufacturer is compliance with Subparts B and C of Part 15 of FCC Rules for the radiated and conducted emissions of intentional radiators and receivers. 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 samples of Savi Technology, Inc. models 645 and 646 Tags complied with the requirements of Subpart C of Part 15 of the FCC Rules for low power intentional radiators and the requirements of Subpart B of Part 15 of the FCC Rules for receivers operating between 30 MHz and 960 MHz.

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, Inc. models ST-644 and ST-645 Tags. The actual test results are contained in an exhibit of this report.

LIMITS OF CONDUCTED INTERFERENCE VOLTAGE

The limits detailed in FCC Rules Part 15 Section 15.207 for the conducted interference voltage on AC power leads do not apply to the 640 series of tags as they are powered from internal batteries and cannot be powered, directly or indirectly, from the AC mains.

LIMITS OF RADIATED FIELD STRENGTH - RECEIVER

The EUT tested complied with the limits detailed in FCC Rules Part 15 FCC Rules Part 15 Section 15.109(a) for a receiver.

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.

30 – 900 MHz, Receive Mode LO @433.72 MHz, ST-644

Frequency MHz	Level dBuV/m	Pol v/h	Class B Limit	Class B Margin	Detector Pk/QP/Avg	Azimuth Degrees	Height Meters	Comments
867.618	44.1	h	46.0	-1.9	QP	60	1.0	EUT Upright

30 – 900 MHz, Receive Mode LO @433.72 MHz, ST-645

Frequency MHz	Level dBuV/m	Pol v/h	Class B Limit	Class B Margin	Detector Pk/QP/Avg	Azimuth Degrees	Height Meters	Comments
867.560	41.8	h	46.0	-4.2	QP	75	1.0	EUT on its side

BANDWIDTH

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.231(c). The 20dB bandwidth was 455kHz.

DUTY CYCLE CALCULATION

The maximum duty cycle permitted for all signals is 10% (refer to the Theory of Operations for details) when measured over any 100mS period. This corresponds to a minimum average duty cycle correction factor of –20 dB to be applied to peak readings to calculate the average level of the signal.

PERIOD OF OPERATION

All transmissions consist of a pulse train of 10ms pulses, 1 pulse every 100ms (duty cycle = 10%). The pulse train transmission lasts for less than 1 second and there is a silent period of the longer of 30 times the transmission period or 10 seconds between successive transmissions, thereby meeting the timing requirements of 15.231(e). Refer to the Theory of Operations for more details. Timing plots are attached to the test data.

LIMITS OF RADIATED FIELD STRENGTH –INTENTIONAL RADIATOR

The EUT tested complied with the radiated field strength limits detailed in FCC Rules Part 15 Section 15.231(e) and 15.209 in the case of emissions falling within the frequency bands specified in Section 15.205.

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.

30 – 4500 MHz, ST-644

Frequency	Level	Pol	15.231(e)		Detector	Azimuth	Height	
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	Comments
433.878	91.6	V	92.9	-1.3	Pk	130	1.3	EUT upright

30 – 4500 MHz, ST-645

Frequency	Level	Pol	15.231(e)		Detector	Azimuth	Height	
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	Comments
433.878	91.7	V	92.9	-1.2	Pk	79	1.1	EUT upright

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, Inc.640 series of RFID Tagging devices are designed to identify the container to which they are attached when used as a part of the Savi Control System.
There are three models that make up the 640 series – ST- 644, ST-645 andST-646.

All three use the same rf circuitry on PCB CCA 810-02900-00, but they use different stuffing options to enable auxiliary functions. These stuffing options do not affect the rf circuitry. The ST-644 does not use any options. The ST-645 and ST-646 use stuffing options to connect to a small daughter card that connects to a sensor. The magnetic coil sensor for the ST-645 detects if a bolt has been removed to trigger an alarm transmission. The ST-646 uses an optical sensor is used to detect if a cable is cut.

All of the 640 series use Lithium cell batteries for power (the ST-645 uses two cells, the others only one).

Only models ST-644 and ST-645 were submitted for testing. The model ST-646 sensor is not yet available. It is anticipated that data for the ST-646 would be submitted at a later data to file for a Permissive Change to the FCC ID KL7-640T-V1.

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 ST-644 sample was received on June 18, 2002 and tested on June 18, June 19 and June 20, 2002. This sample had the components for the ST-644 and ST-645 installed in all of the stuffing options but did not have the sensor attached. The ST-645 sample was received and tested on September 4, 2002.

The EUTs tested consisted of the following component(s):

Manufacturer/Model/Description	Serial Number
Savi Technology, Inc. 644 Tag	644005
Savi Technology, Inc. 645 Tag	none

ENCLOSURE

The EUT enclosure is primarily constructed of Injection molded ABS plastic. It measures approximately 15.7cm long by 4.3cm wide by 3cm high.

SUPPORT EQUIPMENT

No support equipment was used during emissions testing.

EXTERNAL I/O CABLING

The 640 series of tags do not have interface ports that would connect to external cables.

EUT OPERATION

The EUT was either set to transmit continuously or to receive-only during testing.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on June 18, June 19 and June 20, 2002 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 are performed in conformance with ANSI C63.4-1992. Measurements are made with the EUT connected to the public power network through 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 Range (MHz)	Limit (uV)	Limit (dBuV)
0.450 to 30.000	250	48

FUNDAMENTAL AND HARMONIC LIMITS 15.231 (b)

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)

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

The table below shows the limits for the spurious emissions from transmitters that fall in restricted bands.

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(a) (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:

$$R_r - B = C$$

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

Radiated Emissions, 30 - 4000 MHz, 18-Jun-02
Engineer: Marissa

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
EMCO	Biconical Antenna, 30-300 MHz	3110B	801	12	5/13/2002	5/13/2003
EMCO	Log Periodic Antenna, 0.3-1 GHz	3146A	364	12	8/28/2001	8/28/2002
Rohde & Schwarz	Test Receiver, 0.009-2000 MHz	ESN	1332	12	4/16/2002	4/16/2003

Radiated Emissions, 30MHz - 6.5 GHz, 21-Jun-02
Engineer: Vishal

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
Elliott Laboratories	Biconical Antenna, 30-300 MHz	EL30.300	54	12	1/4/2002	1/4/2003
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	1242	12	10/9/2001	10/9/2002
EMCO	Log Periodic Antenna, 0.2-2 GHz	3148	1347	12	10/16/2001	10/16/2002
Filtek	High Pass Filter, 1GHz	HP12/1000-5BA	955	12	3/12/2002	3/12/2003
Hewlett Packard	EMC Spectrum Analyzer, Opt. 026 ¸9 KHz -26.5GHz	8593EM	1141	12	3/11/2002	3/11/2003
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	12	1/15/2002	1/15/2003
Rohde & Schwarz	Test Receiver, 9kHz-2750MHz	ESCS 30 EMI	1337	12	12/26/2001	12/26/2002

Radiated Emissions, 30 - 4400MHz, 04-Sep-02
Engineer: Chris

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
Elliott Laboratories	Biconical Antenna, 30-300 MHz	EL30.300	773	12	3/5/2002	3/5/2003
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	786	12	3/2/2002	3/2/2003
EMCO	Log Periodic Antenna, 0.2-2 GHz	3148	1321	12	4/23/2002	4/23/2003
Rohde & Schwarz	Test Receiver, 20-1300 MHz	ESVP	1317	12	5/3/2002	5/3/2003
Hewlett Packard	EMC Spectrum Analyzer 9kHz - 6.5GHz	8595EM	780	12	2/11/2002	2/11/2003
Filtek	High Pass Filter, 1GHz	HP12/1000-5BA	956	12	3/12/2002	3/12/2003
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	12	1/15/2002	1/15/2003

EXHIBIT 2: Test Data Log Sheets

ELECTROMAGNETIC EMISSIONS

TEST LOG SHEETS

AND

MEASUREMENT DATA

T47622 12 Pages
Timing Verification 1 Page
Bandwidth and timing plots 4 Pages

Elliott

EMC Test Data

Client:	Savi Technology, Inc.	Job Number:	J47363
Model:	644, 645 and 646 Tags	T-Log Number:	T47622
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC 15.231(e)	Class:	-
Immunity Spec:	-	Environment:	-

EMC Test Data

For The

Savi Technology, Inc.

Model

644, 645 and 646 Tags

Client:	Savi Technology, Inc.	Job Number:	J47363
Model:	644, 645 and 646 Tags	T-Log Number:	T47622
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC 15.231(e)	Class:	-
Immunity Spec:	-	Environment:	-

EUT INFORMATION

General Description

The 640 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, Inc.	ST-645-02	Tag	See individual tests	KL7-640T-V1

Other EUT Details

The 640 series of Tags consists of the following models:

EUT Enclosure

The EUT enclosure is primarily constructed of Injection molded ABS plastic. It measures approximately 15.7cm long by 4.3cm wide by 3cm high.

Modification History

Mod. #	Test	Date	Modification
1			

Client:	Savi Technology, Inc.	Job Number:	J47363
Model:	644, 645 and 646 Tags	T-Log Number:	T47622
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC 15.231(e)	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 Ports

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

EUT Operation During Emissions

The EUT was either set to transmit or standby mode during testing. In transmit mode the device was operating continuously. Correction factors were applied to all peak readings signals related to the transmit signal to calculate the average value of the signal based on a 10% duty cycle as detailed in the Theory of Operations. The Theory of Operations also includes plots showing the duty cycle of the system.

Client:	Savi Technology, Inc.	Job Number:	J47363
Model:	644, 645 and 646 Tags	T-Log Number:	T47622
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231(e)	Class:	-

Radiated Emissions

Test Specifics

Objective: The objective of this test session is to perform final qualification testing of the 645 Tag with respect to the specification listed above.

Date of Test: 9/4/2002
Test Engineer: Chris Byleckie
Test Location: SVOATS #2
Config. Used: 1
Config Change:
EUT Voltage: internal batteries

General Test Configuration

The EUT was located on the turntable for radiated emissions testing.
On the OATS, the measurement antenna was located 3 meters from the EUT.
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:

	9/4/2002
Temperature:	23°C
Rel. Humidity:	46%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 433.92MHz fundamental	FCC 15.231(e)	Pass	-1.2dB @ 433.878MHz
2	RE, 433.92MHz Tx Mode, Spurious Emissions	FCC 15.231(e)	Pass	-13.0dB @ 867.840MHz
3	RE, 433.7MHz Rx Mode, LO and Second Harmonic	FCC 15.209	Pass	-4.2dB @ 867.560MHZ

Modifications Made During Testing:

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Savi Technology, Inc.	Job Number:	J47363
Model:	644, 645 and 646 Tags	T-Log Number:	T47622
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231(e)	Class:	-

EUT S/N 25

Run #1: Radiated Emissions, 30 - 4000 MHz: Transmit Mode (433.92 MHz) - 10mS Signal.

3-orientations of the EUT tested

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	
433.878	91.7	V	92.9	-1.2	Pk	79	1.1	EUT upright
433.878	71.7	V	72.9	-1.2	Avg	79	1.1	EUT upright
433.878	79.2	H	92.9	-13.7	Pk	272	1.0	EUT upright
433.878	59.2	H	72.9	-13.7	Avg	272	1.0	EUT upright
433.878	83.4	V	92.9	-9.5	Pk	122	1.0	EUT on its side
433.878	63.4	V	72.9	-9.5	Avg	122	1.0	EUT on its side
433.878	87.4	H	92.9	-5.5	Pk	251	1.0	EUT on its side
433.878	67.4	H	72.9	-5.5	Avg	251	1.0	EUT on its side
433.878	86.0	V	92.9	-6.9	Pk	92	1.1	EUT flat
433.878	66.0	V	72.9	-6.9	Avg	92	1.1	EUT flat
433.878	88.9	H	92.9	-4.0	Pk	85	1.0	EUT flat
433.878	68.9	H	72.9	-4.0	Avg	85	1.0	EUT flat

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.

Run #2: Radiated Emissions, 30 - 4400 MHz: Transmit Mode (433.92 MHz) - 10mS Signal

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	
867.840	59.9	V	72.9	-13.0	Pk	0	1.1	EUT upright
867.840	39.9	V	52.9	-13.0	Avg	0	1.1	EUT upright
867.840	49.6	H	72.9	-23.3	Pk	128	1.0	EUT upright
867.840	29.6	H	52.9	-23.3	Avg	128	1.0	EUT upright
867.840	53.6	V	72.9	-19.3	Pk	303	1.0	EUT on its side
867.840	33.6	V	52.9	-19.3	Avg	303	1.0	EUT on its side
867.840	55.2	H	72.9	-17.7	Pk	41	1.0	EUT on its side
867.840	35.2	H	52.9	-17.7	Avg	41	1.0	EUT on its side
867.840	62.1	V	72.9	-10.8	Pk	71	1.2	EUT flat
867.840	32.1	V	52.9	-20.8	Avg	71	1.2	EUT flat
867.840	59.0	H	72.9	-13.9	Pk	63	1.0	EUT flat
867.840	39.0	H	52.9	-13.9	Avg	63	1.0	EUT flat
1301.700	44.9	V	74.0	-29.1	Pk	208	1.0	EUT flat
1301.700	24.9	V	54.0	-29.1	Avg	208	1.0	EUT flat
1735.600	51.2	V	74.0	-22.8	Pk	0	1.0	EUT flat

continued on following page ...

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EMC Test Data

Client:	Savi Technology, Inc.	Job Number:	J47363
Model:	644, 645 and 646 Tags	T-Log Number:	T47622
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231(e)	Class:	-

...continued from previous page

Frequency	Level	Pol	15.231(e)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1735.600	31.2	V	54.0	-22.8	Avg	0	1.0	EUT flat
2169.500	48.9	V	74.0	-25.1	Pk	181	1.0	EUT flat
2169.500	28.9	V	54.0	-25.1	Avg	181	1.0	EUT flat
2603.400	44.3	V	74.0	-29.7	Pk	0	1.0	EUT flat
2603.400	24.3	V	54.0	-29.7	Avg	0	1.0	EUT flat
3037.300	47.0	V	74.0	-27.0	Pk	0	1.0	EUT flat
3037.300	27.0	V	54.0	-27.0	Avg	0	1.0	EUT flat
3471.200	46.2	V	74.0	-27.8	Pk	0	1.0	EUT flat
3471.200	26.2	V	54.0	-27.8	Avg	0	1.0	EUT flat
3905.100	48.1	V	74.0	-25.9	Pk	0	1.0	EUT flat
3905.100	28.1	V	54.0	-25.9	Avg	0	1.0	EUT flat
4339.000	48.8	V	74.0	-25.2	Pk	0	1.0	EUT flat
4339.000	28.8	V	54.0	-25.2	Avg	0	1.0	EUT flat
1301.700	43.1	H	74.0	-30.9	Pk	51	1.6	EUT flat
1301.700	23.1	H	54.0	-30.9	Avg	51	1.6	EUT flat
1735.600	48.2	H	74.0	-25.8	Pk	174	1.4	EUT flat
1735.600	28.2	H	54.0	-25.8	Avg	174	1.4	EUT flat
2169.500	46.4	H	74.0	-27.6	Pk	134	1.0	EUT flat
2169.500	26.4	H	54.0	-27.6	Avg	134	1.0	EUT flat
2603.400	44.4	H	74.0	-29.6	Pk	0	1.0	EUT flat
2603.400	24.4	H	54.0	-29.6	Avg	0	1.0	EUT flat
3037.300	45.8	H	74.0	-28.2	Pk	0	1.0	EUT flat
3037.300	25.8	H	54.0	-28.2	Avg	0	1.0	EUT flat
3471.200	46.3	H	74.0	-27.7	Pk	0	1.0	EUT flat
3471.200	26.3	H	54.0	-27.7	Avg	0	1.0	EUT flat
3905.100	47.5	H	74.0	-26.5	Pk	0	1.0	EUT flat
3905.100	27.5	H	54.0	-26.5	Avg	0	1.0	EUT flat
4339.000	48.0	H	74.0	-26.0	Pk	0	1.0	EUT flat
4339.000	28.0	H	54.0	-26.0	Avg	0	1.0	EUT flat
1301.700	45.8	V	74.0	-28.2	Pk	271	1.0	EUT Upright
1301.700	25.8	V	54.0	-28.2	Avg	271	1.0	EUT Upright
1735.600	52.5	V	74.0	-21.6	Pk	290	1.0	EUT Upright
1735.600	32.5	V	54.0	-21.6	Avg	290	1.0	EUT Upright
2169.500	48.9	V	74.0	-25.1	Pk	80	1.5	EUT Upright
2169.500	28.9	V	54.0	-25.1	Avg	80	1.5	EUT Upright
2603.400	47.7	V	74.0	-26.3	Pk	0	1.0	EUT Upright
2603.400	27.7	V	54.0	-26.3	Avg	0	1.0	EUT Upright
3037.300	44.7	V	74.0	-29.3	Pk	0	1.0	EUT Upright
3037.300	24.7	V	54.0	-29.3	Avg	0	1.0	EUT Upright

continued on following page ...

Client:	Savi Technology, Inc.	Job Number:	J47363
Model:	644, 645 and 646 Tags	T-Log Number:	T47622
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231(e)	Class:	-

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Frequency	Level	Pol	15.231(e)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
3471.200	47.0	V	74.0	-27.0	Pk	0	1.0	EUT Upright
3471.200	27.0	V	54.0	-27.0	Avg	0	1.0	EUT Upright
3905.100	48.1	V	74.0	-25.9	Pk	0	1.0	EUT Upright
3905.100	28.1	V	54.0	-25.9	Avg	0	1.0	EUT Upright
4339.000	48.6	V	74.0	-25.4	Pk	0	1.0	EUT Upright
4339.000	28.6	V	54.0	-25.4	Avg	0	1.0	EUT Upright
1301.700	44.0	H	74.0	-30.0	Pk	237	1.4	EUT Upright
1301.700	24.0	H	54.0	-30.0	Avg	237	1.4	EUT Upright
1735.600	51.4	H	74.0	-22.6	Pk	287	1.0	EUT Upright
1735.600	31.4	H	54.0	-22.6	Avg	287	1.0	EUT Upright
2169.500	51.6	H	74.0	-22.4	Pk	317	1.7	EUT Upright
2169.500	31.6	H	54.0	-22.4	Avg	317	1.7	EUT Upright
2603.400	48.7	H	74.0	-25.3	Pk	0	1.0	EUT Upright
2603.400	25.7	H	54.0	-28.3	Avg	0	1.0	EUT Upright
3037.300	45.2	H	74.0	-28.8	Pk	0	1.0	EUT Upright
3037.300	25.2	H	54.0	-28.8	Avg	0	1.0	EUT Upright
3471.200	47.6	H	74.0	-26.4	Pk	0	1.0	EUT Upright
3471.200	27.6	H	54.0	-26.4	Avg	0	1.0	EUT Upright
3905.100	47.7	H	74.0	-26.3	Pk	0	1.0	EUT Upright
3905.100	27.7	H	54.0	-26.3	Avg	0	1.0	EUT Upright
4339.000	48.8	H	74.0	-25.2	Pk	0	1.0	EUT Upright
4339.000	28.8	H	54.0	-25.2	Avg	0	1.0	EUT Upright
1301.700	45.5	V	74.0	-28.5	Pk	334	1.0	EUT on its side
1301.700	25.5	V	54.0	-28.5	Avg	334	1.0	EUT on its side
1735.600	51.6	V	74.0	-22.4	Pk	255	1.0	EUT on its side
1735.600	31.6	V	54.0	-22.4	Avg	255	1.0	EUT on its side
2169.500	50.9	V	74.0	-23.1	Pk	338	1.0	EUT on its side
2169.500	30.9	V	54.0	-23.1	Avg	338	1.0	EUT on its side
2603.400	43.4	V	74.0	-30.6	Pk	0	1.0	EUT on its side
2603.400	23.4	V	54.0	-30.6	Avg	0	1.0	EUT on its side
3037.300	45.8	V	74.0	-28.2	Pk	0	1.0	EUT on its side
3037.300	25.8	V	54.0	-28.2	Avg	0	1.0	EUT on its side
3471.200	47.6	V	74.0	-26.4	Pk	0	1.0	EUT on its side
3471.200	27.6	V	54.0	-26.4	Avg	0	1.0	EUT on its side
3905.100	48.8	V	74.0	-25.2	Pk	0	1.0	EUT on its side
3905.100	28.4	V	54.0	-25.6	Avg	0	1.0	EUT on its side
4339.000	49.1	V	74.0	-24.9	Pk	0	1.0	EUT on its side
4339.000	29.1	V	54.0	-24.9	Avg	0	1.0	EUT on its side
1301.700	43.3	H	74.0	-30.8	Pk	81	1.0	EUT on its side

continued on following page ...

Client:	Savi Technology, Inc.	Job Number:	J47363
Model:	644, 645 and 646 Tags	T-Log Number:	T47622
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231(e)	Class:	-

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Frequency	Level	Pol	15.231(e)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1301.700	23.3	H	54.0	-30.7	Avg	81	1.0	EUT on its side
1735.600	48.2	H	74.0	-25.8	Pk	192	1.0	EUT on its side
1735.600	28.2	H	54.0	-25.8	Avg	192	1.0	EUT on its side
2169.500	47.4	H	74.0	-26.6	Pk	117	1.0	EUT on its side
2169.500	27.4	H	54.0	-26.6	Avg	117	1.0	EUT on its side
2603.400	45.8	H	74.0	-28.2	Pk	0	1.0	EUT on its side
2603.400	25.8	H	54.0	-28.2	Avg	0	1.0	EUT on its side
3037.300	45.2	H	74.0	-28.8	Pk	0	1.0	EUT on its side
3037.300	25.2	H	54.0	-28.8	Avg	0	1.0	EUT on its side
3471.200	46.5	H	74.0	-27.5	Pk	0	1.0	EUT on its side
3471.200	26.5	H	54.0	-27.5	Avg	0	1.0	EUT on its side
3905.100	47.4	H	74.0	-26.6	Pk	0	1.0	EUT on its side
3905.100	27.4	H	54.0	-26.6	Avg	0	1.0	EUT on its side
4339.000	50.1	H	74.0	-23.9	Pk	0	1.0	EUT on its side
4339.000	30.1	H	54.0	-23.9	Avg	0	1.0	EUT on its side

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.

Run #3: Radiated Emissions, 30 - 900 MHz: Receive Mode (LO @ 433.78 MHz)

Tested at 3m

Frequency	Level	Pol	15.209(a)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
867.560	41.8	h	46.0	-4.2	QP	75	1.0	EUT on its side
433.780	37.5	h	46.0	-8.5	QP	237	1.0	EUT on its side
433.780	32.0	v	46.0	-14.0	QP	110	1.0	EUT on its side
867.560	30.4	v	46.0	-15.6	QP	317	1.0	EUT on its side
867.560	38.9	v	46.0	-7.1	QP	53	1.2	EUT flat
433.780	37.8	h	46.0	-8.2	QP	247	1.0	EUT flat
867.560	34.7	h	46.0	-11.3	QP	139	1.0	EUT flat
433.780	31.3	v	46.0	-14.7	QP	286	1.1	EUT flat
867.560	38.5	h	46.0	-7.5	QP	305	1.0	EUT Upright
433.780	38.1	v	46.0	-7.9	QP	0	1.0	EUT Upright
867.560	37.5	v	46.0	-8.5	QP	351	1.0	EUT Upright
433.780	31.9	h	46.0	-14.1	QP	236	1.0	EUT Upright

Client:	Savi Technology, Inc.	Job Number:	J47363
Model:	644, 645 and 646 Tags	T-Log Number:	T47622
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231(e)	Class:	-

Radiated Emissions

Test Specifics

Objective: The objective of this test session is to perform final qualification testing of the 644 (with all optiotns stuffed) with respect to the specification listed above.

Date of Test:	6/20/2002	Config. Used:	1
Test Engineer:	Vishal Narayan	Config Change:	None
Test Location:	SVOATS #2	EUT Voltage:	internal batteries

General Test Configuration

The EUT was located on the turntable for radiated emissions testing.
On the OATS, the measurement antenna was located 3 meters from the EUT.
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 measuremen
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°C
Rel. Humidity:	69%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
2	RE, 433.92MHz fundamental	FCC 15.231(e)	Pass	-1.3dB @ 433.878MHz
3	RE, 433.92MHz Tx Mode, Spurious Emissions	FCC 15.231(e)	Pass	-13.1dB @ 867.84MHz
4	RE, 433.7MHz Rx Mode, LO and Second Harmonic	FCC 15.209	Pass	-1.9dB @ 867.618433.8188

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 Technology, Inc.	Job Number:	J47363
Model:	644, 645 and 646 Tags	T-Log Number:	T47622
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231(e)	Class:	-

Run #1: Radiated Emissions, 30 - 4000 MHz: Transmit Mode (433.92 MHz) - 10mS Signal.
3-orientations of the EUT tested, test distance = 3m
Power Level =17Hex

Frequency	Level	Pol	15.231(e)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
433.878	91.6	V	92.9	-1.3	Pk	130	1.3	EUT upright
433.878	71.6	V	72.9	-1.3	Avg	130	1.3	EUT upright
433.878	85.7	H	92.9	-7.2	Pk	90	1.0	EUT upright
433.878	65.7	H	72.9	-7.2	Avg	90	1.0	EUT upright
433.878	81.0	V	92.9	-11.9	Pk	90	1.3	EUT on its side
433.878	61.0	V	72.9	-11.9	Avg	90	1.3	EUT on its side
433.878	90.0	H	92.9	-2.9	Pk	60	1.0	EUT on its side
433.878	70.0	H	72.9	-2.9	Avg	60	1.0	EUT on its side
433.878	81.9	V	92.9	-11.0	Pk	330	1.1	EUT flat
433.878	61.9	V	72.9	-11.0	Avg	330	1.1	EUT flat
433.878	90.5	H	92.9	-2.4	Pk	180	1.0	EUT flat
433.878	70.5	H	72.9	-2.4	Avg	180	1.0	EUT flat

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.

Run #2: Radiated Emissions, 30 - 4400 MHz: Transmit Mode (433.92 MHz) - 10mS Signal
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	
867.840	39.8	V	52.9	-13.1	Avg	130	1.3	EUT upright
867.840	59.8	V	72.9	-13.1	Pk	130	1.3	EUT upright
867.840	39.4	H	52.9	-13.5	Avg	110	1.0	EUT flat
867.840	59.4	H	72.9	-13.5	Pk	110	1.0	EUT flat
867.840	37.9	H	52.9	-15.0	Avg	170	1.0	EUT on its side
4339.000	59.0	V	74.0	-15.0	Pk	0	1.2	EUT Upright
4339.000	39.0	V	54.0	-15.0	Avg	0	1.2	EUT Upright
867.840	57.9	H	72.9	-15.0	Pk	170	1.0	EUT on its side
867.840	36.5	H	52.9	-16.4	Avg	110	1.0	EUT upright
867.840	56.5	H	72.9	-16.4	Pk	110	1.0	EUT upright
1735.600	57.2	V	74.0	-16.8	Pk	100	1.0	EUT on its side
1735.600	37.2	V	54.0	-16.8	Avg	100	1.0	EUT on its side
2169.500	56.6	V	74.0	-17.4	Pk	100	1.0	EUT flat
2169.500	36.6	V	54.0	-17.4	Avg	100	1.0	EUT flat
867.840	34.2	V	52.9	-18.7	Avg	0	1.3	EUT flat
867.840	54.2	V	72.9	-18.7	Pk	0	1.3	EUT flat

continued on following page ...

Client:	Savi Technology, Inc.	Job Number:	J47363
Model:	644, 645 and 646 Tags	T-Log Number:	T47622
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231(e)	Class:	-

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Frequency	Level	Pol	15.231(e)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
3905.100	55.1	V	74.0	-18.9	Pk	360	1.3	EUT Upright
3905.100	35.1	V	54.0	-18.9	Avg	360	1.3	EUT Upright
3905.100	55.1	H	74.0	-18.9	Pk	180	1.0	EUT Upright
3905.100	35.1	H	54.0	-18.9	Avg	180	1.0	EUT Upright
4339.000	54.9	H	74.0	-19.1	Pk	180	1.0	EUT Upright
4339.000	34.9	H	54.0	-19.1	Avg	180	1.0	EUT Upright
2169.500	54.6	V	74.0	-19.4	Pk	100	1.0	EUT Upright
2169.500	34.6	V	54.0	-19.4	Avg	100	1.0	EUT Upright
2169.500	54.5	V	74.0	-19.5	Pk	100	1.0	EUT on its side
2169.500	34.5	V	54.0	-19.5	Avg	100	1.0	EUT on its side
1735.600	54.4	V	74.0	-19.6	Pk	300	1.3	EUT Upright
1735.600	34.4	V	54.0	-19.6	Avg	300	1.3	EUT Upright
3471.200	53.2	V	74.0	-20.8	Pk	0	1.2	EUT Upright
3471.200	33.2	V	54.0	-20.8	Avg	0	1.2	EUT Upright
2169.500	53.2	H	74.0	-20.8	Pk	160	1.4	EUT Upright
2169.500	33.2	H	54.0	-20.8	Avg	160	1.4	EUT Upright
3471.200	53.0	H	74.0	-21.0	Pk	360	1.0	EUT Upright
3471.200	33.0	H	54.0	-21.0	Avg	360	1.0	EUT Upright
3037.300	51.5	H	74.0	-22.5	Pk	360	1.0	EUT Upright
3037.300	31.5	H	54.0	-22.5	Avg	360	1.0	EUT Upright
867.840	30.2	V	52.9	-22.7	Avg	70	1.0	EUT on its side
3037.300	31.3	V	54.0	-22.7	Avg	360	1.1	EUT Upright
867.840	50.2	V	72.9	-22.7	Pk	70	1.0	EUT on its side
3037.300	51.3	V	74.0	-22.7	Pk	360	1.1	EUT Upright
2603.400	51.1	H	74.0	-22.9	Pk	0	1.4	EUT Upright
2603.400	31.1	H	54.0	-22.9	Avg	0	1.4	EUT Upright
2169.500	51.0	H	74.0	-23.0	Pk	140	1.6	EUT flat
2169.500	31.0	H	54.0	-23.0	Avg	140	1.6	EUT flat
2603.400	50.9	V	74.0	-23.1	Pk	0	1.3	EUT Upright
2603.400	30.9	V	54.0	-23.1	Avg	0	1.3	EUT Upright
2603.400	30.8	H	54.0	-23.2	Avg	150	1.5	EUT flat
2603.400	50.8	H	74.0	-23.2	Pk	150	1.5	EUT flat
1735.600	29.8	H	54.0	-24.2	Avg	170	1.0	EUT on its side
1735.600	49.8	H	74.0	-24.2	Pk	170	1.0	EUT on its side
1301.700	48.5	V	74.0	-25.5	Pk	110	1.0	EUT flat
1301.700	28.5	V	54.0	-25.5	Avg	110	1.0	EUT flat
1301.700	47.9	V	74.0	-26.1	Pk	270	1.0	EUT Upright
1301.700	27.9	V	54.0	-26.1	Avg	270	1.0	EUT Upright
1301.700	27.3	H	54.0	-26.7	Avg	130	1.0	EUT on its side

continued on following page ...

Client:	Savi Technology, Inc.	Job Number:	J47363
Model:	644, 645 and 646 Tags	T-Log Number:	T47622
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231(e)	Class:	-

...continued from previous page

Frequency	Level	Pol	15.231(e)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1301.700	47.3	H	74.0	-26.7	Pk	130	1.0	EUT on its side
1301.700	46.6	V	74.0	-27.4	Pk	340	1.0	EUT on its side
1301.700	26.6	V	54.0	-27.4	Avg	340	1.0	EUT on its side
1735.600	25.8	H	54.0	-28.2	Avg	140	1.0	EUT flat
1301.700	25.8	H	54.0	-28.2	Avg	120	1.4	EUT Upright
1735.600	45.8	H	74.0	-28.2	Pk	140	1.0	EUT flat
1301.700	45.8	H	74.0	-28.2	Pk	120	1.4	EUT Upright
1735.600	45.5	H	74.0	-28.5	Pk	160	1.0	EUT Upright
1735.600	25.5	H	54.0	-28.5	Avg	160	1.0	EUT Upright
1301.700	45.0	H	74.0	-29.0	Pk	130	1.0	EUT flat
1301.700	25.0	H	54.0	-29.0	Avg	130	1.0	EUT flat

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.

Run #4: Radiated Emissions, 30 - 900 MHz: Receive Mode (LO @ 433.72 MHz)
Tested at 3m, 6/19/02

Frequency	Level	Pol	15.209(a)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
867.618	43.2	h	46.0	-2.8	QP	350	1.0	EUT on its side Signal Sub
867.618	38.7	v	46.0	-7.3	QP	290	1.6	EUT on its side Signal Sub
433.819	37.2	h	46.0	-8.8	QP	0	1.0	EUT on its side
433.819	34.8	v	46.0	-11.2	QP	250	1.5	EUT on its side
867.618	41.3	h	46.0	-4.7	QP	180	1.0	EUT flat Signal Sub
433.819	39.6	h	46.0	-6.4	QP	20	1.0	EUT flat
867.618	39.5	v	46.0	-6.5	QP	230	1.2	EUT flat Signal Sub
433.819	33.0	v	46.0	-13.0	QP	310	1.0	EUT flat
867.618	44.1	h	46.0	-1.9	QP	60	1.0	EUT Upright Signal Sub
867.618	42.5	v	46.0	-3.5	QP	340	1.5	EUT Upright Signal Sub
433.819	41.9	v	46.0	-4.1	QP	230	1.1	EUT Upright
433.819	33.3	h	46.0	-12.7	QP	260	1.0	EUT Upright

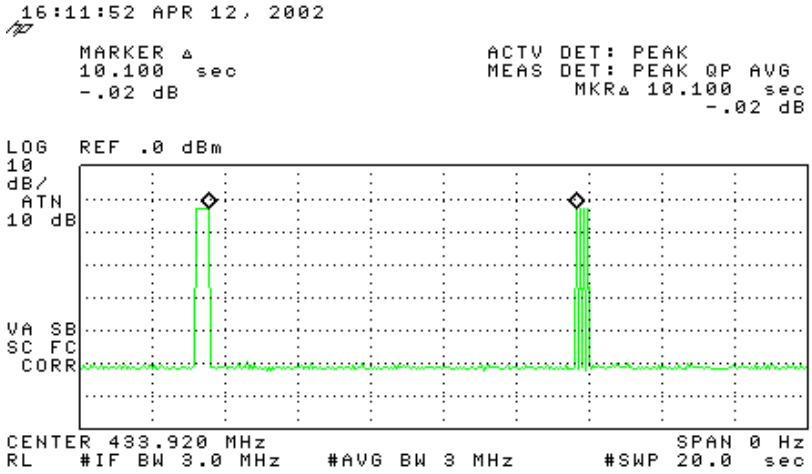
Timing Verification

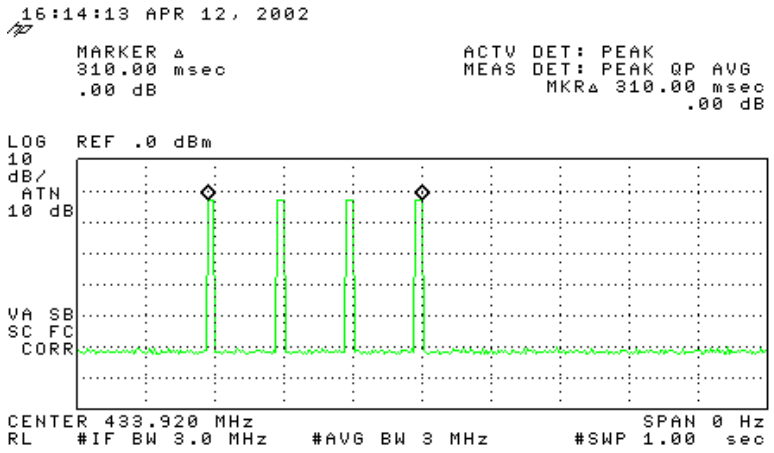
The following plots were made to demonstrate the timing of the transmissions from the Savi ST-60X and ST-64X series of tags. The actual tag used during testing was an ST-602, but both tag series use the same firmware. These plots are representative of the transmission timing for both the 640 and 604 series.

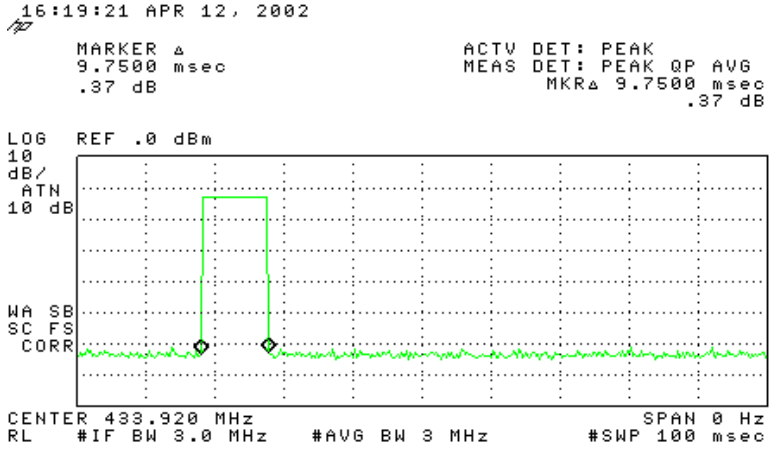
The graphs show:

A 10.1 second interval between successive transmissions;
A total of four pulses per transmission, each pulse separated by a 90mS period, giving a total transmission time of 310mS;
An individual pulse width of 10mS.

The timing of the pulses meets the requirements of FCC 15.231(e) as the transmission time is less than 1 second and the silent period is greater than 30 times the duration of each transmission and greater than 10 seconds.

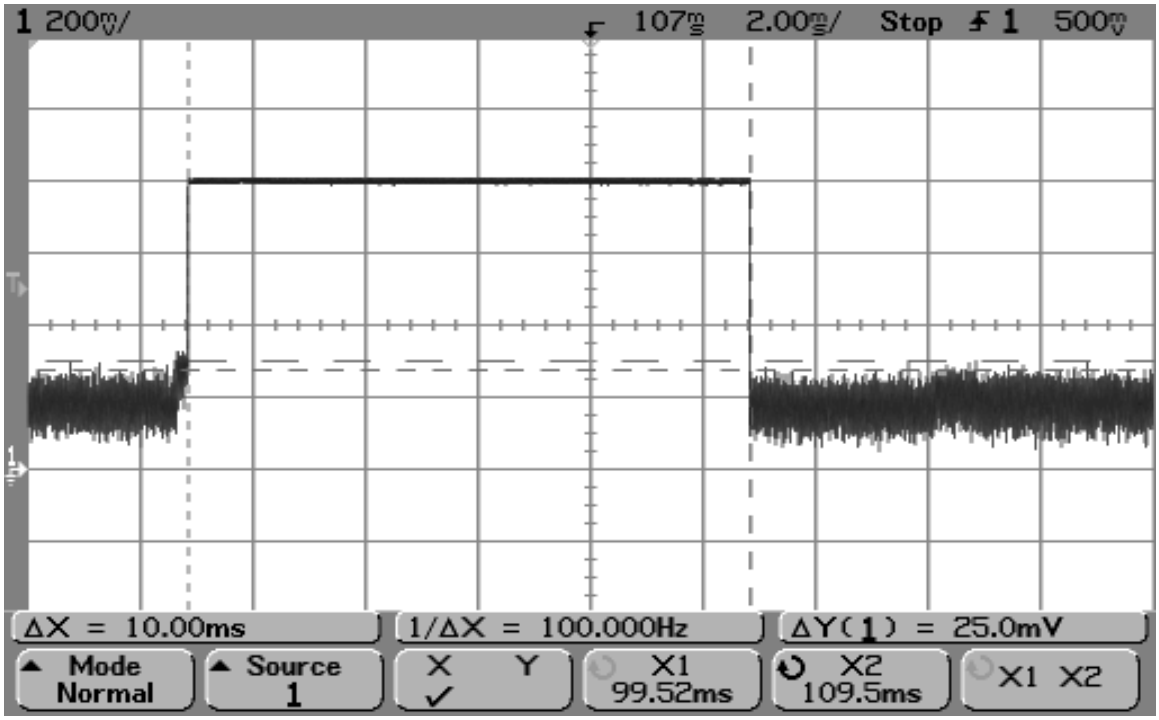




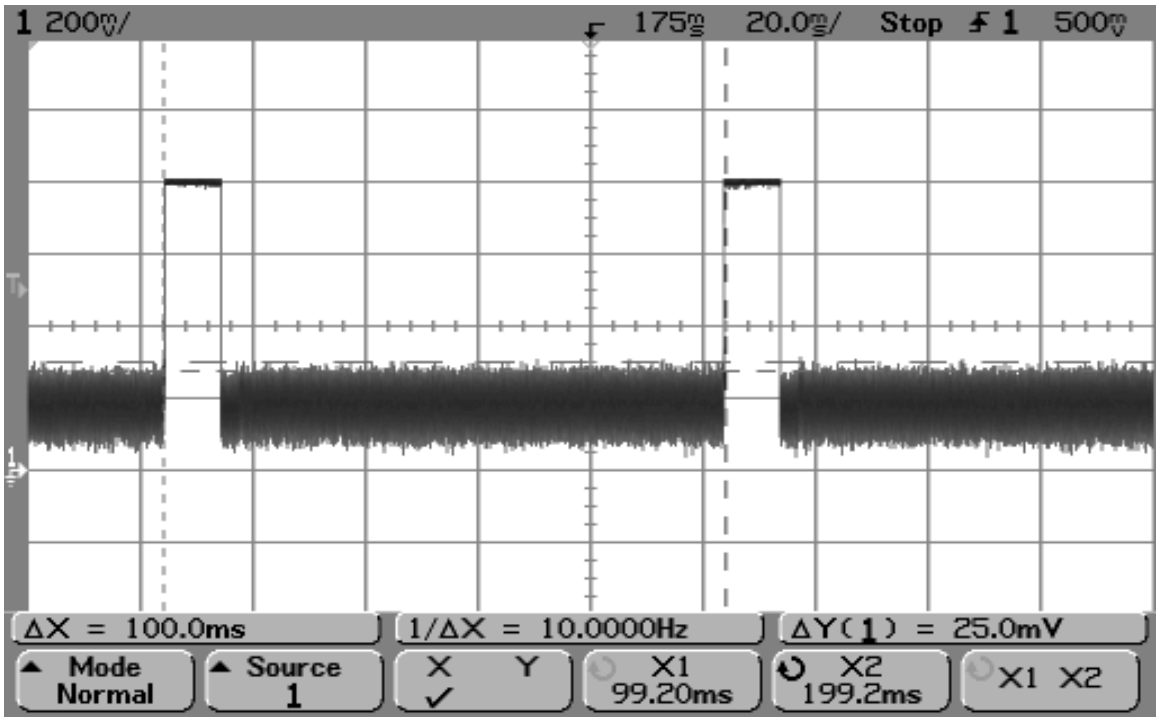


ST-64X-XX Duty Cycle/Bandwidth Plots

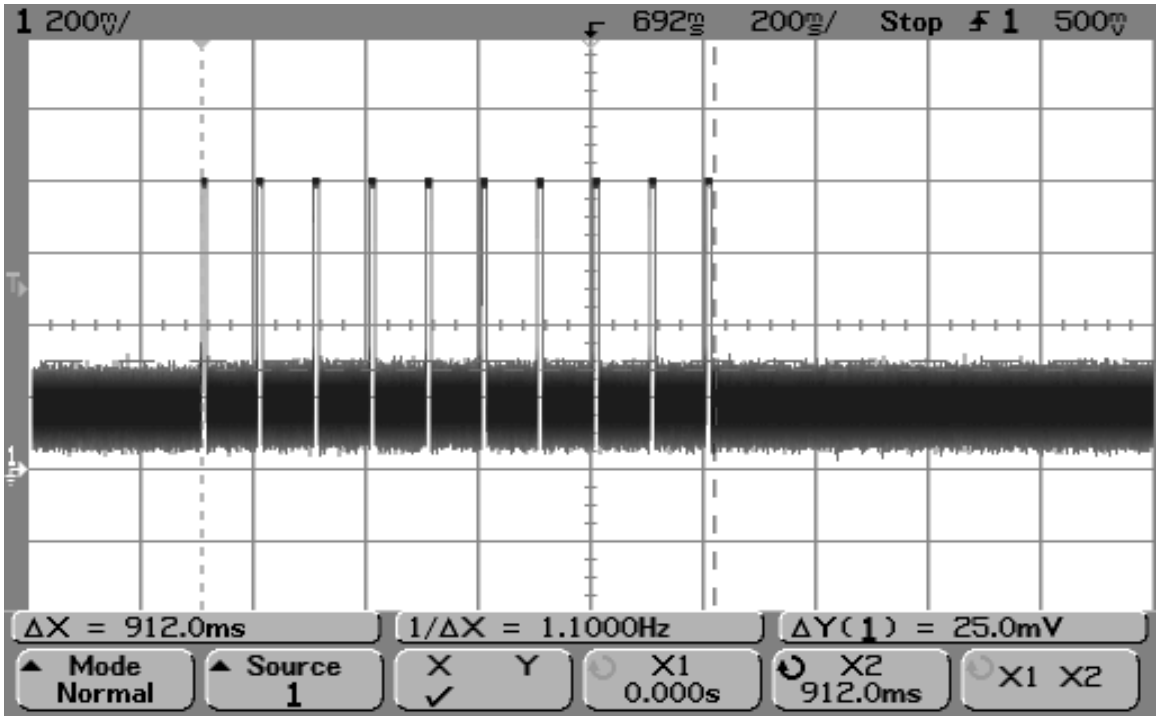
ST-64X-XX Single Data Pulse (10 msec)



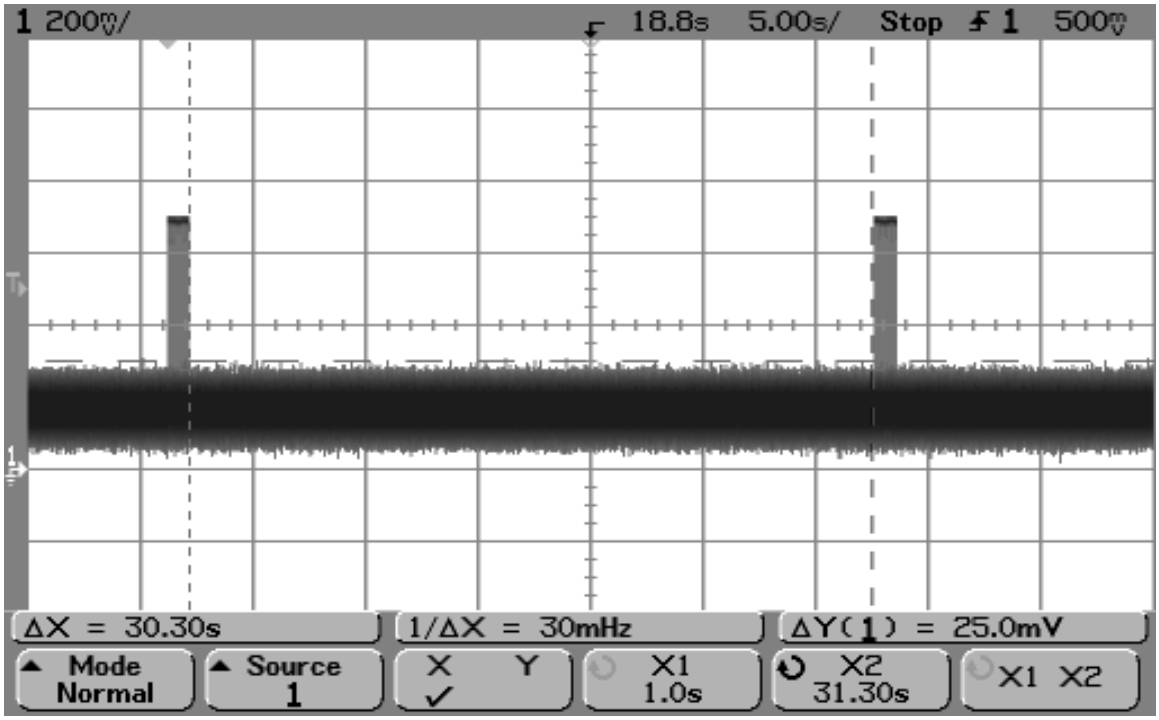
ST-64X-XX Data Pulse within 100 msec period



ST-64X-XX Data Pulses within 1 second period

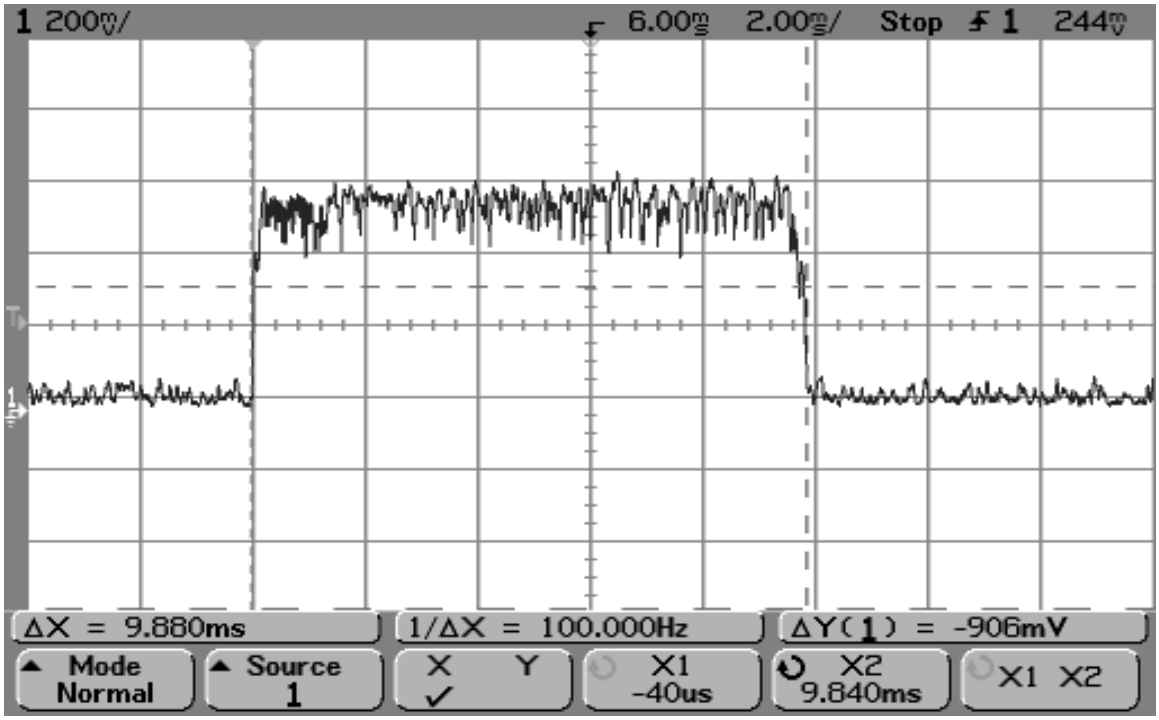


ST-64X-XX Data Pulses with 30 second silent period between transmissions

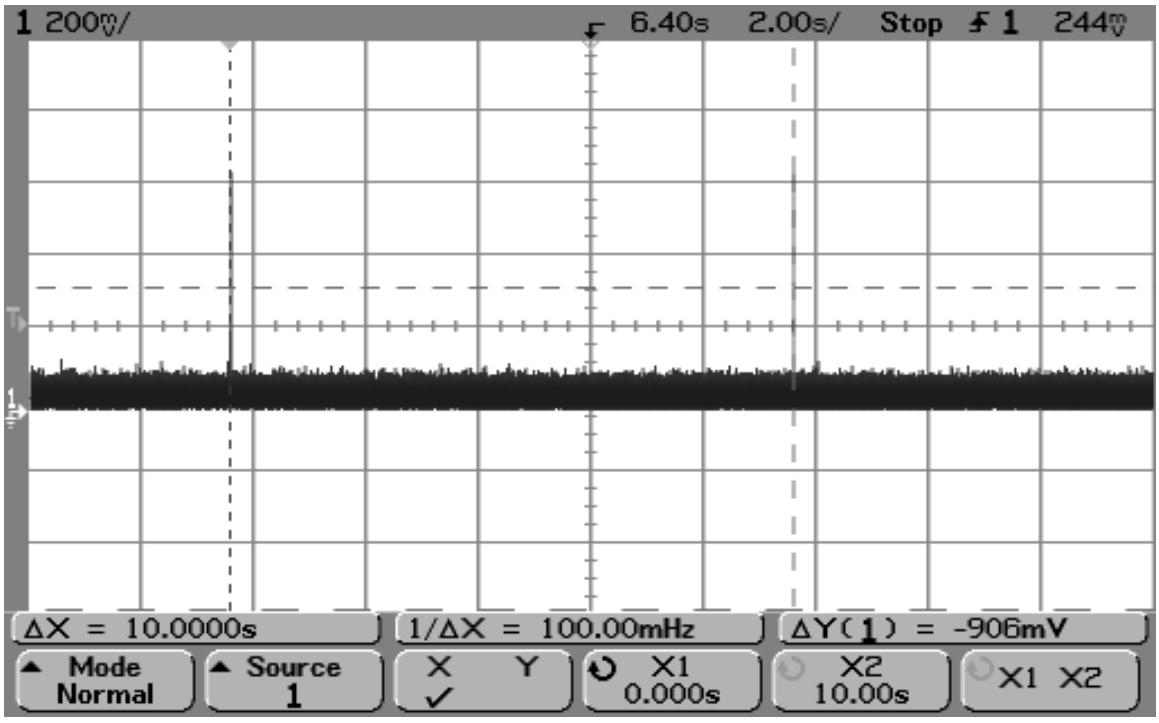


ST-64X-XX Beacon Duty Cycle Plots

ST-64X-XX Single Beacon Pulse (10 msec)



ST-64X-XX Beacon Pulses with 10 second silent period between transmissions



ST-64X-XX: 20 dB Bandwidth Measurement