Elliott

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October 21, 1999

Chief, Equipment Authorization Branch,
Authorization and Evaluation Division,
Office of Engineering and Technology
FEDERAL COMMUNICATIONS COMMISSION
P.O. Box 358315
Pittsburgh, PA 15251-5315

Gentlemen:

The enclosed documents constitute a formal submittal and application for a Grant of Equipment Authorization pursuant to Subpart C of Part 15 of FCC Rules (CFR 47) regarding intentional radiators. Data within this report demonstrates that the equipment tested complies with the FCC limits for intentional radiators.

Elliott Laboratories, as duly authorized agent prepared this submittal. A copy of the letter of our appointment as agent is enclosed.
If there are any questions or if further information is needed, please contact Elliott Laboratories for assistance.

Sincerely,

Mark Briggs
Mark R. Briggs
Manager, EMC Consulting Services

MRB/dmg
Enclosures: Agent Authorization Letter
Emissions Test Report with Exhibits

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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: SaviTag 410

FCC ID:	KL7-410T-V2
GRANTEE:	Savi Technology, Inc. 450 National Avenue Mountain View, CA. 94043-2238
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
REPORT DATE:	October 21, 1999
FINAL TEST DATE:	October 5, 1999
AUTHORIZED SIGNATORY:	Mark Briggs Mark R. Briggs Manager, EMC Consulting Services

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SCOPE

An electromagnetic emissions test has been performed on the Savi Technology, Inc. model SaviTag 410 pursuant to Subpart C of Part 15 of FCC Rules for intentional radiators and Subpart B of Part 15 of FCC Rules for a receiver/digital device. 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 device 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, Inc. model SaviTag 410 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 Subparts B and C of Part 15 of FCC Rules for the radiated and conducted emissions of intentional radiators, recievers and digital devices. 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 SaviTag 410 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, Inc. model SaviTag 410. The actual test results are contained in an exhibit of this report.

LIMITS OF CONDUCTED INTERFERENCE VOLTAGE

This test was not performed as the EUT is a battery-operated device

LIMITS OF RADIATED INTERFERENCE FIELD STRENGTH- FUNDAMENTAL

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.231 (e).

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	Level	Pol	15.231(e)		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
433.948	91.8	V	92.9	-1.1	Pk	0	1.1	Fundamental
433.948	71.8	V	72.9	-1.1	Avg	0	1.1	Fundamental

EMISSION BANDWIDTH

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.231 (c). The 20dB bandwidth of the emission was measured to be approximately 356 kHz which is less than 1.08 MHz (0.25% of the fundamental emission frequency of 433.948 MHz)

LIMITS OF RADIATED INTERFERENCE FIELD STRENGTH- TRANSMITTER SPURIOUS

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.231 (e) and Section 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 – 4340 MHz

Frequency	Level	Pol	15.231 (e)		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4339.480	35.8	V	54.0	-18.2	Avg	0	1.0	Tenth Harmonic

LIMITS OF RADIATED INTERFERENCE FIELD STRENGTH- RECEIVER/DIGITAL DEVICE

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.109 (a) for a Class B digital device and 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 – 1000 MHz

Frequency	Level	Pol	15.109 Class B		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
423.185	38.3	V	46.0	-7.7	QP	0	1.1	LO frequency

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. model SaviTag 410 is a transceiver that is used with one of the series of SAVI gate readers. The SaviTag receives/transmits at 433.948 MHz and uses 423.185 MHz as its local oscillator frequency. The EUT is an active RFID tag which is designed to track a container to which it is attached. (Information is sent from the TAG by means of RF to a reader that sends it to the host computer for processing.) The sample was received on October 5, 1999 and tested on October 5, 1999. The EUT consisted of the following component(s):

Manufacturer/Model/Description	Serial Number	FCC ID
Savi Tech./ ST-410-108/ Transceiver	1112	KL7-410T-V2
Savi Tech./ ST-410-108/ Transceiver	1111	KL7-410T-V2

Note: Sample s/n 1112 was configured in receive mode and sample s/n 1111 was configured to transmit continuously.

INPUT POWER

The EUT used batteries for power. No Power supply or filters are used.

PRINTED WIRING BOARDS

The EUT contained the following printed wiring boards during emissions testing:

Manufacturer/Description	Assembly #	Rev.	Serial #	Crystals (MHz)
Savi Tech. Main Board	810-01800-001	AA	1112	8
Savi Tech. Main Board	810-01800-001	AA	1111	8

Note: Sample s/n 1112 was configured in receive mode and sample s/n 1111 was configured to transmit continuously.

SUBASSEMBLIES

The EUT did not contain subassembly modules during emissions testing:

ENCLOSURE

The EUT enclosure is primarily constructed of a polymeric material. It measures approximately 7 cm wide by 2 cm deep by 22 cm high.

EMI SUPPRESSION DEVICES

The EUT did not contain EMI suppression devices during emissions testing:

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.

EXTERNAL I/O CABLING

No I/O cabling was used during emissions testing.

EUT OPERATION DURING TESTING

For testing the receiver/digital device the EUT was operating continuously in receive mode with a local oscillator at 423.185 MHz. For testing the transmitter functions the EUT was transmitting continuously.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on October 5, 1999 at the Elliott Laboratories Open Area Test Site #3 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.

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

No conducted emissions were applied to the device as it is battery powered.

RADIATED EMISSIONS SPECIFICATION LIMITS, TRANSMITTER SPURIOUS

For spurious emissions from the transmitter the limit of 15.231 (e) of 52.9 dBuV/m was used except for:

1) Frequencies where the general limits of 15.209 permitted higher field strengths
2) Spurious emissions from the transmitter falling in the restricted bands listed in FCC Part 15 section 15.205

The limits used for these two exceptions were taken from FCC Part 15.209 as detailed below:

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, RECEIVER/DIGITAL DEVICE

The following limits, detailed in 15.109 (a), were applied to spurious emissions from the receiver and digital device:

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

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

Test Equipment List - SVOATS#3

September 16, 1999

	Manufacturer/Description		Model	Asset #	Interval	Last Cal	Cal Due
☑	Elliott Laboratories	300-1000 MHz Log Periodic	EL300.1000	55	12	9/26/98	9/26/99
☑	Elliott Laboratories	Biconical Antenna, 30-300 MHz	EL30.300	773	12	11/3/98	11/3/99
☐	EMCO	D. Ridge Horn Antenna, 1-18GHz	3115	487	12	3/24/99	3/24/2000
☑	EMCO	D. Ridge Horn Antenna, 1-18GHz	3115	786	12	1/15/99	1/15/2000
☐	EMCO	D. Ridge Horn Antenna, 1-18GHz	3115	868	12	9/22/98	9/22/99
☐	Filtek	High Pass Filter	HP12/1000-5BA	955	12	4/17/99	4/17/2000
☑	Filtek	High Pass Filter	HP12/1000-5BA	956	12	4/17/99	4/17/2000
☐	Filtek	High Pass Filter	HP12/1000-5BA	957	12	4/17/99	4/17/2000
☐	Fischer	LISN	FCC-LISN-50/2	810	12	2/2/99	2/2/2000
☐	Fluke Mfg Co	Signal Generator.	6062A	852	N/A		
☑	Hewlett Packard	EMC Receiver /Analyzer	8595EM	780	12	1/4/99	1/4/2000
☐	Hewlett Packard	EMC Recever /Analyzer	8595EM	787	12	11/23/98	11/23/99
☐	Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	263, (F303)	12	8/3/99	8/3/2000
☑	Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	12	11/25/98	11/25/99
☐	Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	12	11/12/98	11/12/99
☐	Hewlett Packard	Power Meter	432A	259, (F304)	12	2/17/99	2/17/2000
☐	Hewlett Packard	Spectrum Analyzer	8563E	284, (F194)	12	1/18/99	1/18/2000
☐	Hewlett Packard	Thermistor Mount	478A	652	12	2/17/99	2/17/2000
☐	Narda West	EMI Filter 2.4 GHz, High Pass	60583 HPF-161	248	12	4/23/99	4/23/2000
☐	Narda West	EMI Filter 5.6 GHz, High Pass	60583 HXF370	247	12	4/29/99	4/29/2000
☐	Narda West	High Pass Filter	HPF 180	821	12	8/10/99	8/10/2000
☐	Rohde& Schwarz	Pulse Limiter	ESH3 Z2	812	12	12/8/98	12/8/99
☐	Rohde & Schwarz	Test Receiver, 0.009-30 MHz	ESH3	215, (F197)	12	2/17/99	2/17/2000
☐	Rohde & Schwarz	Test Receiver, 20-1300 MHz	ESVP			1/11/99	1/11/2000
☑	Rohde & Schwarz	Test Receiver, 20-1300MHz	ESVP	273	12	9/9/99	9/9/2000

File Number: D34036/D34037

Date: 10.06.99

Engr: Jerry Hill

All calibration of equipment is traceable to a national standard of measurement such as NIST.

EXHIBIT 2:Test Data Log Sheets

ELECTROMAGNETIC EMISSIONS

TEST LOG SHEETS

AND

MEASUREMENT DATA

T 34036 6 Pages
T 34037 6 Pages
Bandwidth Measurement 1 page graph

Elliott

EMC Test Log

Client:	Savi Tech	Date:	10/05/99	Test Engr:	Jerry Hill
Product:	SaviTag 410	File:	T34036	Proj. Eng:	Mark Briggs
Objective:	Final Qualification.	Site:	SVOATS #3	Contact:	Gene Schlindwein
Spec:	FCC Part 15	Page:	1 of 4	Approved:	
Revision	1.0				

Ambient Conditions	
Temperature:	17.2 °C
Humidity:	77.0 % RH

Test Objective

The objective of this test session is to perform final qualification testing of the EUT defined below relative to the FCC requirements for an unlicensed, low-power transmitter, a receiver and a digital device.

Note: This unit has been tested and submitted to the FCC. The device is being retested because of the following modifications:

1. Transmitter Oscillator – The Transmitter Oscillator Frequency can be changed by varying the value of a fixed Capacitor. This fixed Capacitor changes the resonant frequency of the SAW Resonator.
2. Receiver Oscillator – The Receiver Oscillator Frequency can be changed by varying the value of a fixed Capacitor. This fixed Capacitor changes the resonant frequency of the SAW Resonator.
3. Post-Detection Circuit – The amplification and filtering for the Detected Signal in the receiver now uses Operational Amplifiers in place of a circuit using Discrete Components (Inverters).
4. Gate Wakeup Circuit – The amplification in the Gate Wakeup Receiver has been modified to increase stability over voltage and temperature extremes.

Test Summary

Run #1 - Preliminary radiated emissions, 30–1000MHz. Sorted by Margin.

Results: FCC B -7.7 dB QP @ 423.185 MHz Vertical

Run #2 - Maximized Radiated Emissions from Run #1, Sorted by Margin.

PASS Results: FCC B -7.7 dB QP @ 423.185 MHz Vertical

Run #3 - Maximized radiated emissions, 1000–4340 MHz. Sorted by Margin.

PASS Results: FCC B -13.1 dB Avg @ 3471.360 MHz Vertical

Client:	Savi Tech	Date:	10/05/99	Test Engr:	Jerry Hill
Product:	SaviTag 410	File:	T34036	Proj. Eng:	Mark Briggs
Objective:	Final Qualification.	Site:	SVOATS #3	Contact:	Gene Schlindwein
Spec:	FCC Part 15	Page:	2 of 4	Approved:	
Revision	1.0				

Equipment Under Test (EUT) General Description

The EUT is a receiver that is used with an intentional radiator that transmits at 433.948 MHz and uses 423.185 MHz as its local oscillator frequency. The EUT is an active RFID tag which is designed to track a container to which it is attached. (Information is sent from the TAG by means of RF to a reader that sends it to the host computer for processing.)

Normally, the EUT would be permanently attached to the side of a container. For the purposes of EMC testing the EUT was treated as tabletop equipment and placed on upright on the tabletop to simulate the orientation of the device in its intended environment.

The transmitter and receiver circuitry in the device tested is common to the SaviTag 410 product family. The differences between the various members of this product family are in the size of the memory module (2, 8, or 128 KB), the beeper (enabled or disabled) and the directional wakeup option (enabled or disabled), as detailed in the attached product list. The unit tested was the ST-410-108 which is considered representative of the worst case configuration of the product family.

The EUT is a battery operated device.

Equipment Under Test (EUT)

Manufacturer/Model/Description	Serial Number	FCC ID Number
Savi Tech./ ST-410-108/ Transceiver	1112	KL7-410T-V2 Pending

Note: This sample was configured to receive continuously.

Power Supply and Line Filters

The EUT used batteries for power. No Power supply or filters are used.

Printed Wiring Boards in EUT

Manufacturer/Description	Assembly #	Rev.	Serial Number	Crystals (MHz)
Savi Tech. Main Board	810-01800-001	AA	1112	8

Client:	Savi Tech	Date:	10/05/99	Test Engr:	Jerry Hill
Product:	SaviTag 410	File:	T34036	Proj. Eng:	Mark Briggs
Objective:	Final Qualification.	Site:	SVOATS #3	Contact:	Gene Schlindwein
Spec:	FCC Part 15	Page:	3 of 4	Approved:	
Revision	1.0				

Subassemblies in EUT

Manufacturer/Description	Assembly Number	Rev.	Serial Number
None	-	-	-

EUT Antenna

The antenna is connected internally and is not user-accessible, thereby meeting the requirements of 15.203, as the EUT's antenna port is internal.

EUT Enclosure(s)

The EUT enclosure is primarily constructed of a polymeric material. It measures approximately 7 cm wide by 2 cm deep by 22 cm high.

EMI Suppression Devices (filters, gaskets, etc.)

Description	Manufacturer	Part Number
None	-	-

Modifications

No modifications were made to the EUT.

Local Support Equipment

Manufacturer/Model/Description	Serial Number	FCC ID Number
None	-	-

Remote Support Equipment

Manufacturer/Model/Description	Serial Number	FCC ID Number
None	-	-

Client:	Savi Tech	Date:	10/05/99	Test Engr:	Jerry Hill
Product:	SaviTag 410	File:	T34036	Proj. Eng:	Mark Briggs
Objective:	Final Qualification.	Site:	SVOATS #3	Contact:	Gene Schlindwein
Spec:	FCC Part 15	Page:	4 of 4	Approved:	
Revision	1.0				

Interface Cabling

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

EUT Operation During Testing

The EUT was set to receive with a local oscillator at 423.185 MHz .

General Test Conditions

During radiated testing, the EUT was operated on batteries. The EUT and all local support equipment were located on the turntable for radiated testing.

Test Data Tables

See attached data

Emissions Test Data

Client:	Savi Tech	Date:	10.05.99	Test Engr:	Jerry Hill
Product:	Savi Tag 410	File:	T34036	Proj. Engr:	Mark Briggs
Objective	Final Qual.	Site:	SVOATS #3	Contact:	Gene Schlindwein
Spec:	FCC part 15.109	Distance:	3 m	Approved:	

Ambient Conditions
Temperature: 17.2 °C
Humidity: 77 % RH

Setup : EUT setting on center of table in the center of the turntable.
No support equipment needed.

Run #1: Preliminary radiated emissions, 30-1000 MHz (receive mode)
Stepped 8MHz, 10MHz and scanned full range.

Frequency	Level	Pol	FCC B	FCC B	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
423.185	38.3	v	46.0	-7.7	QP	0	1.1	LO frequency
846.366	32.3	h	46.0	-13.7	QP	0	2.0	noise floor
423.185	30.4	h	46.0	-15.6	QP	0	1.0	LO frequency
48.136	21.3	v	40.0	-18.7	QP	0	1.0	near noise floor
48.136	20.0	h	40.0	-20.0	QP	0	2.0	near noise floor
240.136	22.1	v	46.0	-23.9	QP	0	1.0	near noise floor
240.136	22.1	h	46.0	-23.9	QP	0	2	near noise floor

Run #2: Maximized readings from run #1. Sorted by margin. (receive mode)
Measurements made at 3m per FCC requirements.

Frequency	Level	Pol	FCC B	FCC B	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
423.185	38.3	v	46.0	-7.7	QP	0	1.1	LO frequency
846.366	32.3	h	46.0	-13.7	QP	0	2.0	noise floor
423.185	30.4	h	46.0	-15.6	QP	0	1.0	LO frequency
48.136	21.3	v	40.0	-18.7	QP	0	1.0	near noise floor
48.136	20.0	h	40.0	-20.0	QP	0	2.0	near noise floor
240.136	22.1	v	46.0	-23.9	QP	0	1.0	near noise floor
240.136	22.1	h	46.0	-23.9	QP	0	2	near noise floor

Elliott

Emissions Test Data

Client:	Savi Tech	Date:	10.05.99	Test Engr:	Jerry Hill
Product:	Savi Tag 410	File:	T34036	Proj. Engr:	Mark Briggs
Objective	Final Qual.	Site:	SVOATS #3	Contact:	Gene Schlindwein
Spec:	FCC part 15.109	Distance:	3 m	Approved:	

Run #3: Maximized readings, 1000 - 4340 MHz. Sorted by margin. (receive mode)
Measurements made at 3m per FCC requirements.

Frequency	Level	Pol	FCC B	FCC B	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
3471.360	40.9	v	54.0	-13.1	Avg	0	1.0	noise floor
3471.360	40.9	h	54.0	-13.1	Avg	0	1.0	noise floor
3037.440	40.0	v	54.0	-14.0	Avg	0	1.0	noise floor
3037.440	39.6	h	54.0	-14.4	Avg	0	1.0	noise floor
3471.360	53.6	h	74.0	-20.4	Pk	0	1.0	noise floor
3471.360	53.4	v	74.0	-20.6	Pk	0	1.0	noise floor
3037.440	53.1	v	74.0	-20.9	Pk	0	1.0	noise floor
3037.440	51.6	h	74.0	-22.4	Pk	0	1.0	noise floor
1301.760	30.7	h	54.0	-23.3	Avg	0	1.6	noise floor
1301.760	30.6	v	54.0	-23.4	Avg	0	1.6	noise floor
1301.760	43.4	h	74.0	-30.6	Pk	0	1.6	noise floor
1301.760	42.7	v	74.0	-31.3	Pk	0	1.6	noise floor

Note 1:	**No EUT emissions detected this range.**

Client:	Savi Tech	Date:	10/05/99	Test Engr:	Jerry Hill
Product:	SaviTag 410 (new Rev.)	File:	T34037	Proj. Eng:	Mark Briggs
Objective:	Final Qualification.	Site:	SVOATS #3	Contact:	Gene Schlindwein
Spec:	FCC Part 15	Page:	1 of 4	Approved:	
Revision	1.0				

Ambient Conditions	
Temperature:	16.7 °C
Humidity:	80.0 % RH

Test Objective

The objective of this test session is to perform final qualification testing of the EUT defined below relative to the FCC requirements for an unlicensed, low-power transmitter, a receiver and a digital device.

Note: This unit has been tested and submitted to the FCC. It was re-tested for a Class II Permissive Change because of the following modifications:

1. Transmitter Oscillator – The Transmitter Oscillator Frequency can be changed by varying the value of a fixed Capacitor. This fixed Capacitor changes the resonant frequency of the SAW Resonator.
2. Receiver Oscillator – The Receiver Oscillator Frequency can be changed by varying the value of a fixed Capacitor. This fixed Capacitor changes the resonant frequency of the SAW Resonator.
3. Post-Detection Circuit – The amplification and filtering for the Detected Signal in the receiver now uses Operational Amplifiers in place of a circuit using Discrete Components (Inverters).
4. Gate Wakeup Circuit – The amplification in the Gate Wakeup Receiver has been modified to increase stability over voltage and temperature extremes.

Test Summary

Run #1 - Fundamental Transmission

PASS	Results: FCC 15.231(e)	-1.1 dB	Pk	@ 433.948 MHz	Vertical
		-1.1 dB	Avg	@ 433.948 MHz	Vertical

Note: Average Reading obtained by applying the average correction factor (20dB) from the peak reading.

Run #2 - Maximized Radiated Spurious Emissions, 30–4340MHz.

PASS	Results: FCC 15.231(e)	-18.2 dB	Pk	@ 4339.480 MHz	Vertical
		-18.2 dB	Avg	@ 4339.480 MHz	Vertical

Equipment Under Test (EUT) General Description

The EUT is an intentional radiator that transmits at 433.948 MHz and uses 423.185 MHz as its local oscillator frequency. The EUT is an active RFID tag that is designed to track a container to which is attached. (Information is sent from the TAG by means of RF to a reader that sends it to the host computer for processing.)

Normally, the EUT would be permanently attached to the side of a container. For the purposes of EMC testing the EUT was treated as table-top equipment and placed on upright on the tabletop to simulate the orientation of the device in its intended environment.

The transmitter and receiver circuitry in the device tested is common to the SaviTag 410 product family. The differences between the various members of this product family are in the size of the memory module (2, 8, or 128 KB), the beeper (enabled or disabled) and the directional wakeup option (enabled or disabled), as detailed in the attached product list. The unit tested was the ST-410-108 which is considered representative of the worst case configuration of the product family.

The EUT is a battery operated device.

Equipment Under Test (EUT)

Manufacturer/Model/Description	Serial Number	FCC ID Number
Savi Tech./ ST-410-108 / Transceiver	1111	KL7-410T-V2 Pending

Note: This sample was configured to transmit continuously.

Power Supply and Line Filters

The EUT uses batteries for power. No Power supply or filters used.

Printed Wiring Boards in EUT

Manufacturer/Description	Assembly #	Rev.	Serial Number	Crystals (MHz)
Savi Tech. Main Board	810-01800-001	A	1111	8

Client:	Savi Tech	Date:	10/05/99	Test Engr:	Jerry Hill
Product:	SaviTag 410 (new Rev.)	File:	T34037	Proj. Eng:	Mark Briggs
Objective:	Final Qualification.	Site:	SVOATS #3	Contact:	Gene Schlindwein
Spec:	FCC Part 15	Page:	3 of 4	Approved:	
Revision	1.0				

Subassemblies in EUT

Manufacturer/Description	Assembly Number	Rev.	Serial Number
None	-	-	-

EUT Antenna

The antenna is connected internally and is not user-accessible, thereby meeting the requirements of 15.203, as the EUT's antenna port is internal.

EUT Enclosure(s)

The EUT enclosure is primarily constructed of fabricated sheet steel. It measures approximately 7 cm wide by 2 cm deep by 22 cm high.

EMI Suppression Devices (filters, gaskets, etc.)

Description	Manufacturer	Part Number
None	-	-

Modifications

No modifications were made to the EUT.

Local Support Equipment

Manufacturer/Model/Description	Serial Number	FCC ID Number
None	-	-

Remote Support Equipment

Manufacturer/Model/Description	Serial Number	FCC ID Number
None	-	-

Client:	Savi Tech	Date:	10/05/99	Test Engr:	Jerry Hill
Product:	SaviTag 410 (new Rev.)	File:	T34037	Proj. Eng:	Mark Briggs
Objective:	Final Qualification.	Site:	SVOATS #3	Contact:	Gene Schlindwein
Spec:	FCC Part 15	Page:	4 of 4	Approved:	
Revision	1.0				

Interface Cabling

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

EUT Operation During Testing

The EUT was set to operate transmitting continuously at 433.948 MHz .

General Test Conditions

During radiated testing, the EUT was operated on batteries. The EUT was located on the turntable for radiated testing.

Test Data Tables

See attached data

EMISSIONS TEST DATA

Client:	Savi Tech	Date:	10.05.99	Test Engr:	Jerry Hill
Product:	SaviTag 410 (new Rev.)	File:	T34037	Proj. Engr:	Mark Briggs
Objective	Final Qual.	Site:	SVOATS #3	Contact:	Gene Schlindwein
Spec:	FCC part 15.231	Distance:	3 m	Approved:	

Ambient Conditions
Temperature: 16.7 °C
Humidity: 80 % RH

This unit was tested and sumitted to FCC before as (FCC ID# KL7-410T-V1).
This unit is being retested because of the following modifications.
The new FCC ID # KL7-410T-V2.

1. Transmitter Oscillator - The Transmitter Oscillator Frequency can be changed by varying the value of a fixed Capacitor. This fixed Capacitor changes the resonant frequency of the SAW Resonator.

2. Receiver Oscillator- The Receiver Oscillator Frequency can be changed by varying the value of a fixed Capacitor. This fixed Capacitor changes the resonanat frequency of the SAW Resonator.

3. Post-Detection Circuit- The amplification and filtering for the Detected Signal in the Receiver now uses Operational Amplifiers in place of a circuit using Discrete Components(Inverters).

4. Gate Wakeup Circuit- The amplification in the Gate Wakeup Receiver has been modified to increase stability over voltage and temperature extremes.

These changes will be updated in the block diagram and schematics.

Run #a: Measurement of Pulse Width. Taken from previous test session D23405 Run #1).

Pulse width was measured to be 4.86 mS (GPH 001a), with only one pulse in a 200mS period (GPH 001b).
Average correction factor is 20Log(4.86/100) = -26.3dB. Maximum permitted is -20dB.
All average measurements will be calculated from the peak measurements with the device set to transmit continuously.

Run #1: Maximized radiated emissions, Fundamental Frequency (general device operating under 15.231(e), Frequency above 30MHz)
Measurement distance is 3m.

Frequency	Level	Polarity	FCC 15.231(e)		Detector	Azimuth	Height	Comments
MHz	dBuV	H/V	Limit	Margin	Pk/QP/Avg	degrees	meters	
433.948	91.8	v	92.9	**-1.1**	Pk	0	1.1	120 kHz BW pk.
433.948	77.0	h	92.9	-15.9	Pk	119	1.0	120 kHz BW pk.
433.948	71.8	h	72.9	**-1.1**	Avg	119	1.0	Average (Note 1)
433.948	57.0	v	72.9	-15.9	Avg	0	1.1	Average (Note 1)

Note 1: Average readings obtained by applying the average correction factor (-20dB) from the peak reading as described in Run #a. Pulse width was measured to be 4.86 mS in the last test session.

EMISSIONS TEST DATA

Client:	Savi Tech	Date:	10.05.99	Test Engr:	Jerry Hill
Product:	SaviTag 410 (new Rev.)	File:	T34037	Proj. Engr:	Mark Briggs
Objective	Final Qual.	Site:	SVOATS #3	Contact:	Gene Schlindwein
Spec:	FCC part 15.231	Distance:	3 m	Approved:	

Run #2: Max. radiated emissions, spurious emissions from device, 30 MHz - 4340 MHz

Measurement distance is 3m **Fundamental Frequency :** 433.948

All average readings of signals related to the fundamental transmit signal have been calculated from the peak readings using the -20dB correction factor as detailed in Run a above.

Frequency	Level	Pol	FCC 15.231(e)		Detector	Azimuth	Height	Comments
MHz	dBuV/m	H/V	Limit	Margin	Pk/QP/Avg	degrees	meters	
4339.480	35.8	v	54.0	-18.2	Avg	0	1.0	noise floor
4339.480	55.8	v	74.0	-18.2	Pk	0	1.0	noise floor
3905.532	35.4	v	54.0	-18.6	Avg	0	1.0	noise floor
3905.532	55.4	v	74.0	-18.6	Pk	0	1.0	noise floor
4339.480	35.4	h	54.0	-18.6	Avg	0	2.0	noise floor
4339.480	55.4	h	74.0	-18.6	Pk	0	2.0	noise floor
3905.532	34.6	h	54.0	-19.4	Avg	0	2.0	noise floor
3905.532	54.6	h	74.0	-19.4	Pk	0	2.0	noise floor
867.896	33.2	v	52.9	-19.7	QP	177	1.0	
867.896	33.1	h	52.9	-19.8	QP	180	2.0	
3037.636	33.0	h	54.0	-21.0	Avg	0	2.0	noise floor
3037.636	53.0	h	74.0	-21.0	Pk	0	2.0	noise floor
3471.584	33.0	v	54.0	-21.0	Avg	0	1.0	noise floor
3471.584	53.0	v	74.0	-21.0	Pk	0	1.0	noise floor
3471.584	32.8	h	54.0	-21.2	Avg	0	2.0	noise floor
3471.584	52.8	h	74.0	-21.2	Pk	0	2.0	noise floor
2603.688	32.5	v	54.0	-21.5	Avg	19	1.0	
2603.688	52.5	v	74.0	-21.5	Pk	19	1.0	
3037.636	31.8	v	54.0	-22.2	Avg	0	1.0	noise floor
3037.636	51.8	v	74.0	-22.2	Pk	0	1.0	noise floor
2603.688	31.0	h	54.0	-23.0	Avg	0	2.0	noise floor
2603.688	51.0	h	74.0	-23.0	Pk	0	2.0	noise floor
2169.740	30.0	v	54.0	-24.0	Avg	40	1.0	
2169.740	50.0	v	74.0	-24.0	Pk	40	1.0	
2169.740	29.4	h	54.0	-24.6	Avg	0	2.0	noise floor
2169.740	49.4	h	74.0	-24.6	Pk	0	2.0	noise floor
1735.792	28.4	v	54.0	-25.6	Avg	32	1.3	
1735.792	48.4	v	74.0	-25.6	Pk	32	1.3	
1735.792	26.6	h	54.0	-27.4	Avg	0	2.0	noise floor
1735.792	46.6	h	74.0	-27.4	Pk	0	2.0	noise floor
1301.844	24.0	v	54.0	-30.0	Avg	325	1.0	
1301.844	44.0	v	74.0	-30.0	Pk	325	1.0	
1301.844	23.4	h	54.0	-30.6	Avg	229	2.0	noise floor
1301.844	43.4	h	74.0	-30.6	Pk	229	2.0	noise floor

Savi Technology
SaviTag 410
20 dB Bandwidth
R34267

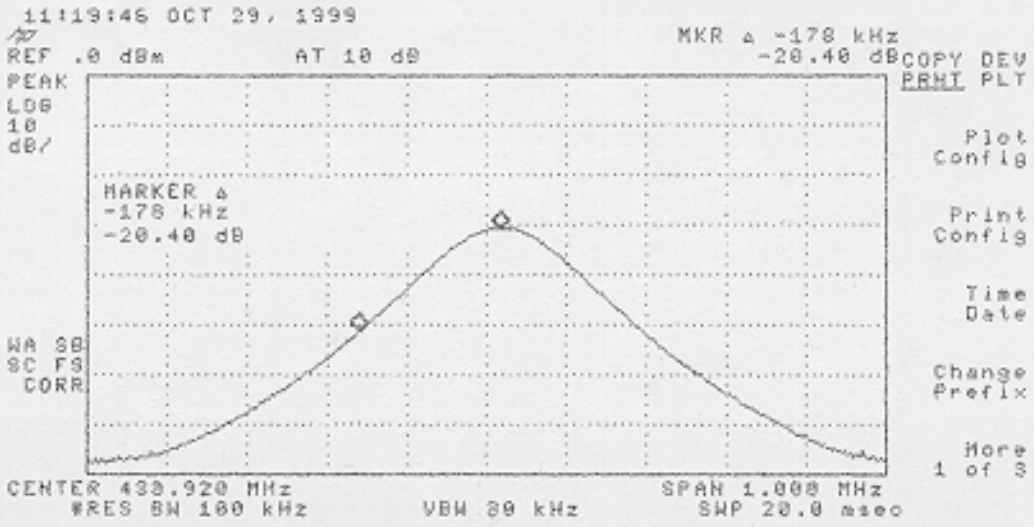
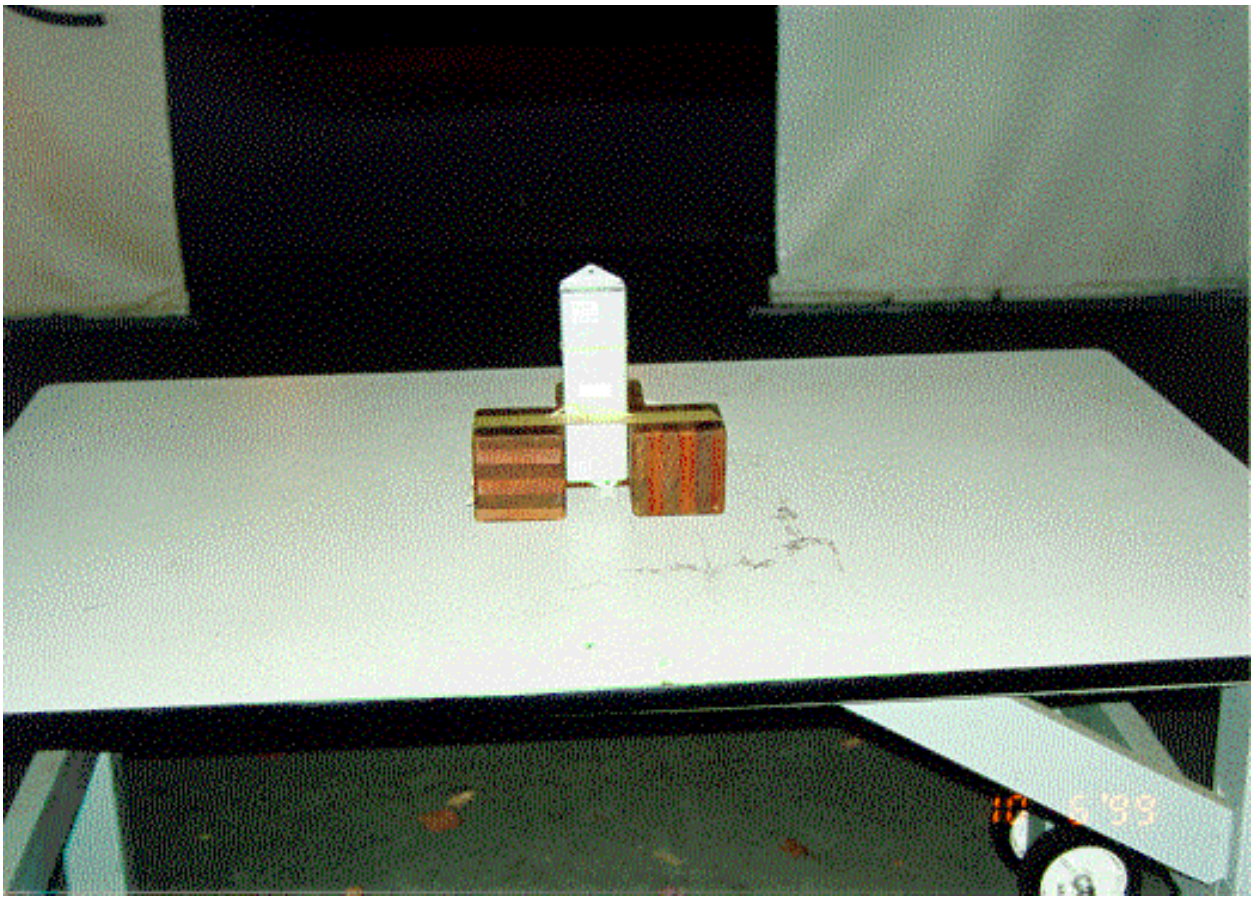


EXHIBIT 3:Radiated Emissions Test Configuration Photographs



APPENDIX 3: Radiated Emissions Test Configuration Photographs

EXHIBIT 4:Proposed FCC ID Label & Label Location

EXHIBIT 5: Detailed Photographs of Savi Technology, Inc. Model SaviTag 410Construction

6 Pages

EXHIBIT 6: Operator's Manual for Savi Technology, Inc. Model SaviTag 410

25 Pages

EXHIBIT 7: Block Diagram of Savi Technology, Inc. Model SaviTag 410

1 Pages

EXHIBIT 8: Schematic Diagrams for Savi Technology, Inc. Model SaviTag 410

7 Pages

EXHIBIT 9: Theory of Operation for Savi Technology, Inc. Model SaviTag 410

1 Pages