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: MobileReader 410R

FCC ID:	KL7410R-M1
GRANTEE:	Savi Technology, Inc. 450 National Avenue Mountain View, CA 94043
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
REPORT DATE:	January 11, 1999
FINAL TEST DATE:	December 17, 1998

AUTHORIZED SIGNATORY: _____

Mark Briggs
Manager, EMC Consulting Services

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SCOPE

An electromagnetic emissions test has been performed on the Savi Technology active RFID interrogator model MobileReader 410R 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 MobileReader 410R and therefore apply only to the tested sample. The sample was selected and prepared by Vikram Verma of Savi Technology, Inc..

OBJECTIVE

The primary objective of the manufacturer is compliance with Subpart C of Part 15 of FCC Rules for the radiated and conducted emissions of intentional radiators. 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 model MobileReader 410R 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 MobileReader 410R. The actual test results are contained in an exhibit of this report.

LIMITS OF CONDUCTED INTERFERENCE VOLTAGE

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.207.

The following measurement was extracted from the data recorded during the conducted 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.

0.45 - 30 MHz, 120V/60Hz

Frequency MHz	Level dBuV	Power Lead	FCC B Limit	FCC B Margin	Detector Function	Comments
0.4500	39.0	Neutral	48.0	-9.0	QP	

LIMITS OF RADIATED INTERFERENCE FIELD STRENGTH - SPURIOUS EMISSIONS

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.231. 15.231 (b) limits were applied to control signals and 15.231 (e) limits were applied to data signals.

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.

Control Signal

Frequency MHz	Level dBuV/m	Pol v/h	15.231e Limit	15.231e Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
3037.400	32.4	v	60.8	**-28.4**	Avg	240	1.1	

Data Signal

Frequency MHz	Level dBuV/m	Pol v/h	15.231e Limit	15.231e Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
3037.4	35.8	v	54.0	**-15.2**	Avg	290	1.2	

Wake-Up signal

Frequency MHz	Level dBuV/m	Pol v/h	15.231e Limit	15.231e Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
3037.4	49.6	v	60.8	**-11.2**	Avg	290	1.0	

LIMITS OF RADIATED INTERFERENCE FIELD STRENGTH - INTENTIONAL EMISSIONS

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.231. 15.231 (b) limits were applied to control signals and 15.231 (e) limits were applied to data signals.

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.

Control Signal

Frequency MHz	Level dBuV/m	Pol v/h	15.231e Limit	15.231e Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
433.905	77.3	v	80.8	**-3.5**	Avg	170	1.0	

Data Signal

Frequency MHz	Level dBuV/m	Pol v/h	15.231e Limit	15.231e Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
433.905	71.1	v	72.9	**-1.8**	Avg	350	1.0	

Wake-Up signal

Frequency MHz	Level dBuV/m	Pol v/h	15.231e Limit	15.231e Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
433.905	80.0	v	80.8	**-0.8**	Avg	180	1.0	

PERIODIC OPERATION

All control signals (Wake-up and control signals) have a maximum on time of 2.5 seconds, meeting the 5 second maximum permitted under 15.231 (a). In addition, the initiation of the interrogation signals is random (dependent upon the operator) and does not occur at predetermined intervals.

Data signals meet the maximum permitted duration detailed in 15.231 (e) with a duration of 12mS.

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

COMPLIANCE EXPLANATION

When the measurement uncertainties (see above section) associated with the emission test methods and equipment used are taken into consideration there are four possible results as detailed below:

Complied
All measurements recorded were below the specification limit by a margin greater than the measurement uncertainty.

Probably Complied
One or more measurements recorded were below the specification limit by a margin less than the measurement uncertainty. It is not possible to determine that the unit complied with a 95% confidence level from the results. There is a high probability that the product tested does comply.

Probably Did Not Comply
One or more measurements recorded were above the specification limit by a margin less than the measurement uncertainty. It is not possible to determine that the unit failed to comply with a 95% confidence level from the results. There is a high probability that the product tested does not comply.

Did Not Comply
One or more measurements recorded exceeded the specification limit by a margin greater than the measurement uncertainty.

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Savi Technology model MobileReader 410R is a n active RFID interrogator (Reader) which is designed to interrogate RF tags. (Information is sent from the TAG by means of RF to the reader which sends it to the host computer for processing). The sample was received and tested on December 17, 1998. The EUT consisted of the following component(s):

Manufacturer/Model/Description	Serial Number
Savi Tech/SMR-410R-200/SaviMobileReader410R	98032400481

INPUT POWER

The EUT used the following external AC-DC adapter but normally is battery (6V nickel plated cadmium) operated:

Description	Manufacturer	Model
External AC Adapter 120VAC to 10VDC	Ubternec	047793

PRINTED WIRING BOARDS

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

Manufacturer/Description	Assembly #	Rev.	Serial #	Crystals (MHz)
RF Comm	810-01464-1001	L	15	433.92

SUBASSEMBLIES

The EUT contained the following subassembly modules during emissions testing:

Manufacturer/Description	Assembly #	Rev.	Serial Number
None			

ENCLOSURE

The EUT enclosure is primarily constructed of polymeric material. It measures approximately 10 cm wide by 25 cm deep by 22 cm high.

EMI SUPPRESSION DEVICES

The EUT contained the following EMI suppression devices during emissions testing:

Description	Manufacturer	Part Number
metal shield	Savi	714-01285-001

SUPPORT EQUIPMENT

The following equipment was used as local support equipment for emissions testing:

Manufacturer/Model/Description	Serial Number	FCC ID Number
HP 2225D+ Printer	2920S44197	DSI6XU2225

EXTERNAL I/O CABLING

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

Cable Description	Length (m)	From Unit/Port	To Unit/Port
Serial	2.0	EUT serial	Printer

TEST SOFTWARE

For all radiated emissions measurements of the fundamental and spurious emissions from the transmitter, the device was configured to transmit continuously at 433.9 MHz. Pulse width measurements of the signals that would be transmitted were made to determine the average correction factor to be applied to the peak measurements.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on December 17, 1998 at the Elliott Laboratories Open Area Test Site #1 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 which are 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)

Control signals were subject to the following limits:

Frequency (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
Fundamental (433.92 MHz)	10,997	80.8
Spurious Emissions	1,100	60.8

RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.231 (e)

Data signals were subject to the following limits:

Frequency (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
Fundamental (433.92 MHz)	4,399	72.9
Spurious Emissions	440	52.9*

*Above 1GHz the general limit of 54 dBµV/m from 15.209 was used per 15.231 (b) (3).

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

Test Equipment List - SVOATS#1

December 9, 1998

Manufacturer/Description		Model	Asset #	Interval	Last Cal	Cal Due
☐ Elliott Laboratories	FCC / CISPR LISN	LISN-3, OATS	304	12	6/24/98	6/24/99
☐ EMCO	Biconical Antenna, 30-300 MHz	3110B	363	12	4/8/98	4/8/99
☐ EMCO	D. Ridge Horn Antenna, 1-18GHz	3115	487	12	6/18/98	6/18/99
☑ EMCO	D. Ridge Horn Antenna, 1-18GHz	3115	~~786~~ 868	12	11/13/97	5/13/99
☑ EMCO	Log Periodic Antenna, 0.3-1 GHz	3146A	364	12	4/8/98	4/8/99
☐ Hewlett Packard	EMC Receiver /Analyzer	8595EM	780	24	10/24/97	10/24/99
☐ Hewlett Packard	EMC Receiver /Analyzer	8595EM	787	12	11/23/98	11/23/99
☐ Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	263, (F303)	12	6/8/98	6/8/99
☐ 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	3/10/98	3/10/99
☐ Hewlett Packard	Spectrum Analyzer	8563E	284, (F194)	24	1/14/98	1/14/2000
☑ Hewlett Packard	Spectrum Analyzer, 9 KHz-6.5 GHz	8595E-041-103-	Metric, 885	12	5/11/98	5/11/99
☐ Hewlett Packard	Thermistor Mount	478A	652	12	3/10/98	3/10/99
☐ Narda West	High Pass Filter	HPF 180	821	12	8/10/98	8/10/99
☐ Narda-West	EMI Filter 2.4 GHz, High Pass	60583 HPF-161	248	12	8/10/98	8/10/99
☐ Narda-West	EMI Filter 5.6 GHz, High Pass	60583 HXF370	247	12	8/10/98	8/10/99
☐ Rohde & Schwarz	10 dB Pad / Pulse Limiter	ESH3Z2	372	12	6/22/98	6/22/99
☑ Rohde & Schwarz	Test Receiver, 0.009-30 MHz	ESH3	215, (F197)	12	1/16/98	1/16/99
☑ Rohde & Schwarz	Test Receiver, 20-1300MHz	ESVP	273	12	8/6/98	8/6/99

File Number: T29612

Date: 12/17/98

Engr: Rudy Emy

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

T29612 12 Pages

Elliott

EMC Test Log

Client:	Savi Technology	Date:	12/17/98	Test Engr:	Rudy Suy
Product:	Savi MobileReader 410R	File:	T29612	Proj. Eng:	Mark Briggs
Objective:	Final Qualification	Site:	SVOATS #1	Contact:	Gene Schlindwein
Spec:	FCC Part 15 Sub-part C	Page:	1 of 4	Approved:	

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.

Test Summary

Run #1 - Fundamental Measurement @ 433.894MHz for **Control Signal**

PASS Results: FCC §15.231(a) -3.5 dB Pk @ 433.905 MHz Vertical
-3.5 dB Ave @ 433.905.MHz Vertical

Run #1a - Maximized Spurious Emissions Scan, 30-4500 MHz

PASS Results: FCC §15.231(a) -28.4 dB Pk @ 3037.400 MHz Vertical
-28.4 dB Ave @ 3037.400 .MHz Vertical

Run #2 - Fundamental Measurement @ 433.905MHz for **Data Signal**

PASS Results: FCC §15.231(e) -1.8 dB Ave @ 433.905 .MHz Vertical

Run #2a - Maximized Spurious Emissions Scan, 30-4500 MHz

PASS Results: FCC §15.231(e) -18.2 dB Ave @ 3037.400 .MHz Vertical

Run #3 - Fundamental Measurement @ 433.905MHz for **Wake-Up Signal**

PASS Results: FCC §15.231(a) -0.8 dB Ave @ 433.905 .MHz Vertical

Run #3a - Maximized Spurious Emissions Scan, 30-4500 MHz

PASS Results: FCC §15.231(a) -11.2 dB Ave @ 3037.400 .MHz Vertical

Run #4 - Conducted Emissions Scan of EUT, 0.15-30.00 MHz, **120V, 60Hz**

PASS Results: FCC B -9.0 dB QP @ 0.4500 MHz Neutral

Equipment Under Test (EUT) General Description

The EUT is an active RFID interrogator (Reader) which is designed to interrogate RF tags. (Information is sent from the TAG by means of RF to the reader which sends it to the host computer for processing).

Normally, the EUT would be hand held during operation. For the purposes of EMC testing the EUT was treated as table-top equipment.

Equipment Under Test (EUT)

Manufacturer/Model/Description	Serial Number	FCC ID Number
Savi Tech/SMR-410R-200/SaviMobileReader410R	98032400481	TBD

Power Supply and Line Filters

The EUT used the following external AC-DC adapter but normally is battery (6V nickel plated cadmium) operated.:

Description	Manufacturer	Model
External AC Adapter 120VAC to 10VDC	Ubternec	047793

Printed Wiring Boards in EUT

The following information was provided by the manufacturer:

Manufacturer/Description	Assembly #	Rev.	Serial Number	Crystals (MHz)
RF Comm	810-01464-1001	L	15	433.92

Subassemblies in EUT

Manufacturer/Description	Assembly Number	Rev.	Serial Number
none			

EUT Enclosure(s)

The EUT enclosure is primarily constructed of polymeric material. It measures approximately 10 cm wide by 25 cm deep by 22 cm high.

EMI Suppression Devices (filters, gaskets, etc.)

The following information was provided by the manufacturer:

Description	Manufacturer	Part Number
metal shield	Savi	714-01285-001

Local Support Equipment

Manufacturer/Model/Description	Serial Number	FCC ID Number
HP 2225D+ Printer	2920S44197	DSI6XU2225

Remote Support Equipment

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

Interface Cabling

Cable Description	Length (m)	From Unit/Port	To Unit/Port
Serial	2.0	EUT serial	Printer

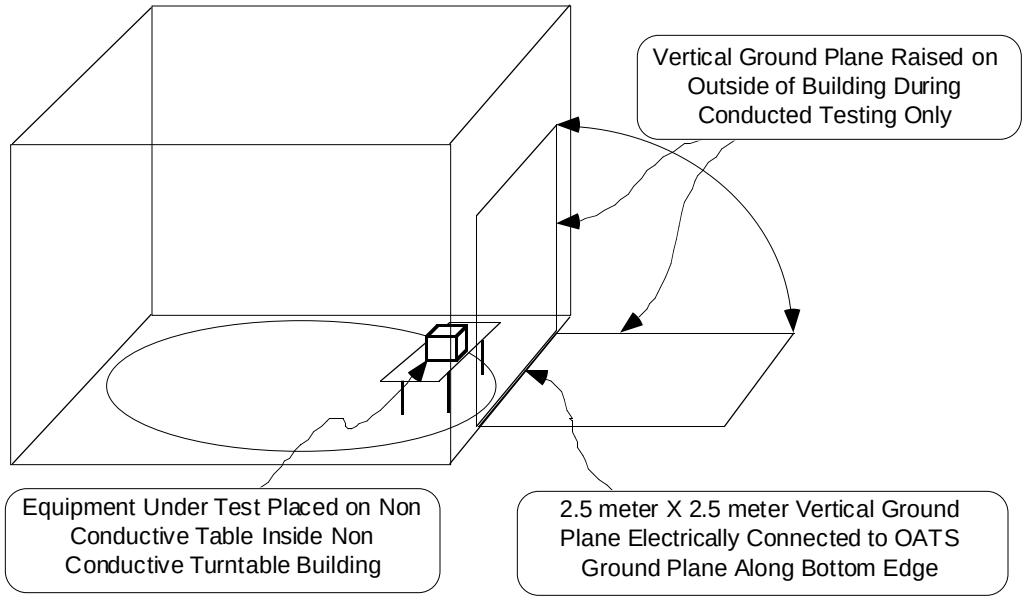
Test Software

For all radiated emissions measurements of the fundamental and spurious emissions from the transmitter, the device was configured to transmit continuously at 433.9 MHz.

General Test Conditions

During radiated emissions testing, the EUT's power adapter was connected to 120V, 60Hz power. The EUT and all local support equipment were located on the turntable for radiated testing and conducted testing.

During conducted emissions testing, the EUT was connected to 120V, 60Hz power input as noted. A 2.5 meter X 2.5 meter ground plane was raised to a vertical position 40 cm from the EUT as shown below:



Test Data Tables

See attached data (3 pages + graphs)

Elliott

Emissions Test Data

Client:	Savi Technology	Date:	12/17/98	Test Engr:	Rudy Suy
Product:	Savi MobileReader 410R	File:	T29612	Proj. Engr:	Mark Briggs
Objective:	Final Qualification	Site:	SVOATS #1	Contact:	Gene Schlindwein
Spec:	Fcc Part 15 Sub-part C	Distance:	3 m	Approved:	

Run #1: Fundamental signals @ 433.894 MHz.

Control signal - operates under 15.231(a)

The control signal is a 6.9mS pulse - average measurements obtained by subtracting 20dB from peak measurements.

Frequency	Level	Pol	FCC 15.231	FCC 15.231	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
433.905	97.3	v	100.8	**-3.5**	Pk	170	1.0	120 KHz measurement bandwidth
433.905	77.3	v	80.8	**-3.5**	Avg	170	1.0	Corrected From Peak Reading
433.905	92.2	h	100.8	**-8.6**	Pk	0	1.0	120 KHz measurement bandwidth
433.905	72.2	h	80.8	**-8.6**	Avg	0	1.0	Corrected From Peak Reading

Run #1b: Spurious emissions - Control signal - operates under 15.231(a)

The control signal is a 6.9mS pulse - average measurements obtained by subtracting 20 dB from peak measurements. Emissions in restricted bands subject to 15.209 limit, all others subject to 15.231(a) limit.

Frequency	Level	Pol	15.231e	15.231e	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
867.840	40.3	v	80.8	**-40.5**	Pk	170	1.0	120KHz measurement bandwidth
867.840	20.3	v	60.8	**-40.5**	Avg	170	1.0	Corrected From Peak Reading
867.840	38.7	h	80.8	**-42.1**	Pk	180	1.0	120KHz measurement bandwidth
867.840	18.7	h	60.8	**-42.1**	Avg	180	1.0	Corrected From Peak Reading
3037.400	52.4	v	80.8	**-28.4**	Pk	240	1.1	1MHz RBW
3037.400	32.4	v	60.8	**-28.4**	Avg	240	1.1	Corrected From Peak Reading
3037.400	51.1	h	80.8	**-29.7**	Pk	300	1.3	1MHz RBW
3037.400	31.1	h	60.8	**-29.7**	Avg	300	1.3	Corrected From Peak Reading
2169.500	50.6	v	80.8	**-30.2**	Pk	340	1.0	1MHz RBW
2169.500	30.6	v	60.8	**-30.2**	Avg	340	1.0	Corrected From Peak Reading
2169.500	30.5	h	60.8	**-30.3**	Avg	200	1.7	Corrected From Peak Reading
2169.500	50.5	h	80.8	**-30.3**	Pk	200	1.7	1MHz RBW
2603.500	29.8	v	60.8	**-31.0**	Avg	230	1.3	Corrected From Peak Reading
2603.500	49.8	v	80.8	**-31.0**	Pk	230	1.3	1MHz RBW
2603.500	48.4	h	80.8	**-32.4**	Pk	260	1.4	1MHz RBW
2603.500	28.4	h	60.8	**-32.4**	Avg	260	1.4	Corrected From Peak Reading

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Emissions Test Data

Client:	Savi Technology	Date:	12/17/98	Test Engr:	Rudy Suy
Product:	Savi MobileReader 410R	File:	T29612	Proj. Engr:	Mark Briggs
Objective:	Final Qualification	Site:	SVOATS #1	Contact:	Gene Schlindwein
Spec:	Fcc Part 15 Sub-part C	Distance:	3 m	Approved:	

Run #2: Fundamental signals @ 433.905 MHz.

Data signal - operates under 15.231(e)

The data signal is a 12mS pulse - average measurements obtained by subtracting 18.4 dB from peak measurements

Frequency	Level	Pol	FCC 15.231	FCC 15.231	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
433.905	71.1	v	72.9	**-1.8**	Avg	350	1.0	Corrected From Peak Reading
433.905	89.5	v	92.9	**-3.4**	Pk	350	1.0	120 KHz measurement bandwidth
433.905	65.8	h	72.9	**-7.1**	Avg	0	1.0	Corrected From Peak Reading
433.905	84.2	h	92.9	**-8.7**	Pk	0	1.0	120 KHz measurement bandwidth

Run #2b: Spurious emissions - Data signal - operates under 15.231(e)

The data signal is a 12mS pulse - average measurements obtained by subtracting 18.4 dB from peak measurements
Emissions in restricted bands and all emissions above 1GHz subject to 15.209 limit, others subject to 15.231(e) limit.

Frequency	Level	Pol	15.231e	15.231e	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
867.840	13.2	v	52.9	**-39.7**	Avg	0	1.0	Corrected From Peak reading
867.840	11.6	h	52.9	**-41.3**	Avg	60	1.4	Corrected From Peak reading
867.840	31.6	v	72.9	**-41.3**	Pk	0	1.0	120KHz measurement bandwidth
867.840	30.0	h	72.9	**-42.9**	Pk	60	1.4	120KHz measurement bandwidth
3037.400	35.8	v	60.8	**-25.0**	Avg	290	1.2	Corrected From Peak Reading
3037.400	54.2	v	80.8	**-26.6**	Pk	290	1.2	1MHz RBW
3037.400	34.1	h	60.8	**-26.7**	Avg	300	1.2	Corrected From Peak Reading
3037.400	52.5	h	80.8	**-28.3**	Pk	300	1.2	1MHz RBW
2603.500	31.9	v	60.8	**-28.9**	Avg	300	1.2	Corrected From Peak Reading
2603.500	30.8	h	60.8	**-30.0**	Avg	250	1.0	Corrected From Peak Reading
2169.500	30.8	h	60.8	**-30.0**	Avg	200	1.0	Corrected From Peak Reading
2603.500	50.3	v	80.8	**-30.5**	Pk	300	1.2	1MHz RBW
2169.500	29.7	v	60.8	**-31.1**	Avg	0	1.1	Corrected From Peak Reading
2603.500	49.2	h	80.8	**-31.6**	Pk	250	1.0	1MHz RBW
2169.500	49.2	h	80.8	**-31.6**	Pk	200	1.0	1MHz RBW
2169.500	48.1	v	80.8	**-32.7**	Pk	0	1.1	1MHz RBW

Client:	Savi Technology	Date:	12/17/98	Test Engr:	Rudy Suy
Product:	Savi MobileReader 410R	File:	T29612	Proj. Engr:	Mark Briggs
Objective:	Final Qualification	Site:	SVOATS #1	Contact:	Gene Schlindwein
Spec:	Fcc Part 15 Sub-part C	Distance:	3 m	Approved:	

Run #3: Fundamental signals @ 433.907 MHz.
Wake-Up signal - operates under 15.231(a)

The wake-up signal is a 2.5 second pulse -peak and average measurements taken directly from test receiver.

Frequency	Level	Pol	FCC 15.231	FCC 15.231	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
433.907	80.0	v	80.8	**-0.8**	Avg	180	1.0	120 KHz measurement bandwidth
433.907	74.1	h	80.8	**-6.7**	Avg	180	1.0	120 KHz measurement bandwidth
433.907	80.7	v	100.8	**-20.1**	Pk	0	1.0	120 KHz measurement bandwidth
433.907	74.5	h	100.8	**-26.3**	Pk	0	1.0	120 KHz measurement bandwidth

Run #3b: Spurious emissions - Wake-Up signal - operates under 15.231(a)

The wake-up signal is a 2.5 second pulse -peak and average measurements taken directly from test receiver or analyzer. Emissions in restricted bands subject to 15.209 limit, all others subject to 15.231(a) limit.

Frequency	Level	Pol	15.231e	15.231e	Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
867.814	31.3	v	80.8	**-49.5**	Pk	20	1.0	120KHz measurement bandwidth
867.814	20.3	v	60.8	**-40.5**	Avg	20	1.0	120KHz measurement bandwidth
867.814	31.0	h	80.8	**-49.8**	Pk	0	1.0	120KHz measurement bandwidth
867.814	19.9	h	60.8	**-40.9**	Avg	0	1.0	120KHz measurement bandwidth
3037.400	49.6	v	60.8	**-11.2**	Avg	290	1.0	1MHz bandwidth
3037.400	43.3	h	60.8	**-17.5**	Avg	300	1.0	1MHz bandwidth
2603.500	42.1	v	60.8	**-18.7**	Avg	230	1.0	1MHz bandwidth
2169.500	41.2	v	60.8	**-19.6**	Avg	350	1.2	1MHz bandwidth
2603.500	39.7	h	60.8	**-21.1**	Avg	250	1.0	1MHz bandwidth
2169.500	38.0	h	60.8	**-22.8**	Avg	210	1.0	1MHz bandwidth
3037.400	54.3	v	80.8	**-26.5**	Pk	290	1.0	1MHz bandwidth
3037.400	51.0	h	80.8	**-29.9**	Pk	300	1.0	1MHz bandwidth
2603.500	50.1	v	80.8	**-30.7**	Pk	230	1.0	1MHz bandwidth
2169.500	48.4	v	80.8	**-32.4**	Pk	350	1.2	1MHz bandwidth
2603.500	48.1	h	80.8	**-32.7**	Pk	250	1.0	1MHz bandwidth
2169.500	46.5	h	80.8	**-34.3**	Pk	210	1.0	1MHz bandwidth

Run #4: Conducted Emissions, 120V/60Hz

Frequency	Level	Power	FCC B	FCC B	Detector	Comments
MHz	dBuV	Lead	Limit	Margin	Function	
0.4500	39.0	Neutral	48.0	**-9.0**	QP	
0.4500	38.4	Line 1	48.0	**-9.6**	QP	
0.5001	33.2	Line 1	48.0	**-14.8**	QP	
0.5438	29.7	Neutral	48.0	**-18.3**	QP	
0.6370	28.1	Neutral	48.0	**-19.9**	QP	
0.6490	27.2	Line 1	48.0	**-20.8**	QP	

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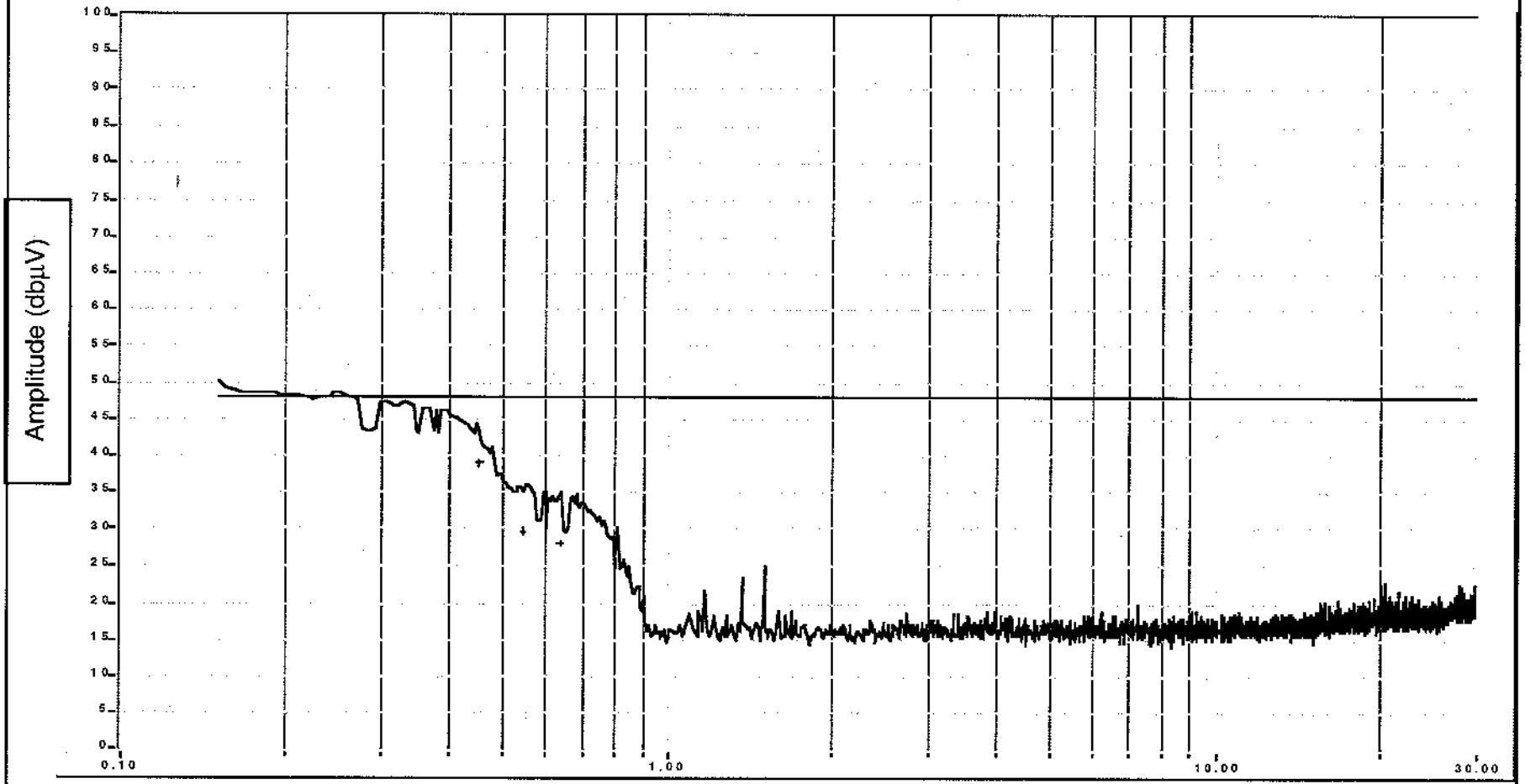
SVOATS #1: Savi Tech. Savi MobileReader 410R Run

Spec:
FCCB

Mains Lead
Neutral



120V, 60Hz. NEUTRAL

Scan
Peak
Quasi-peak
Average
QuasiPeak Limit 2

12/17/98

Rudy Suy

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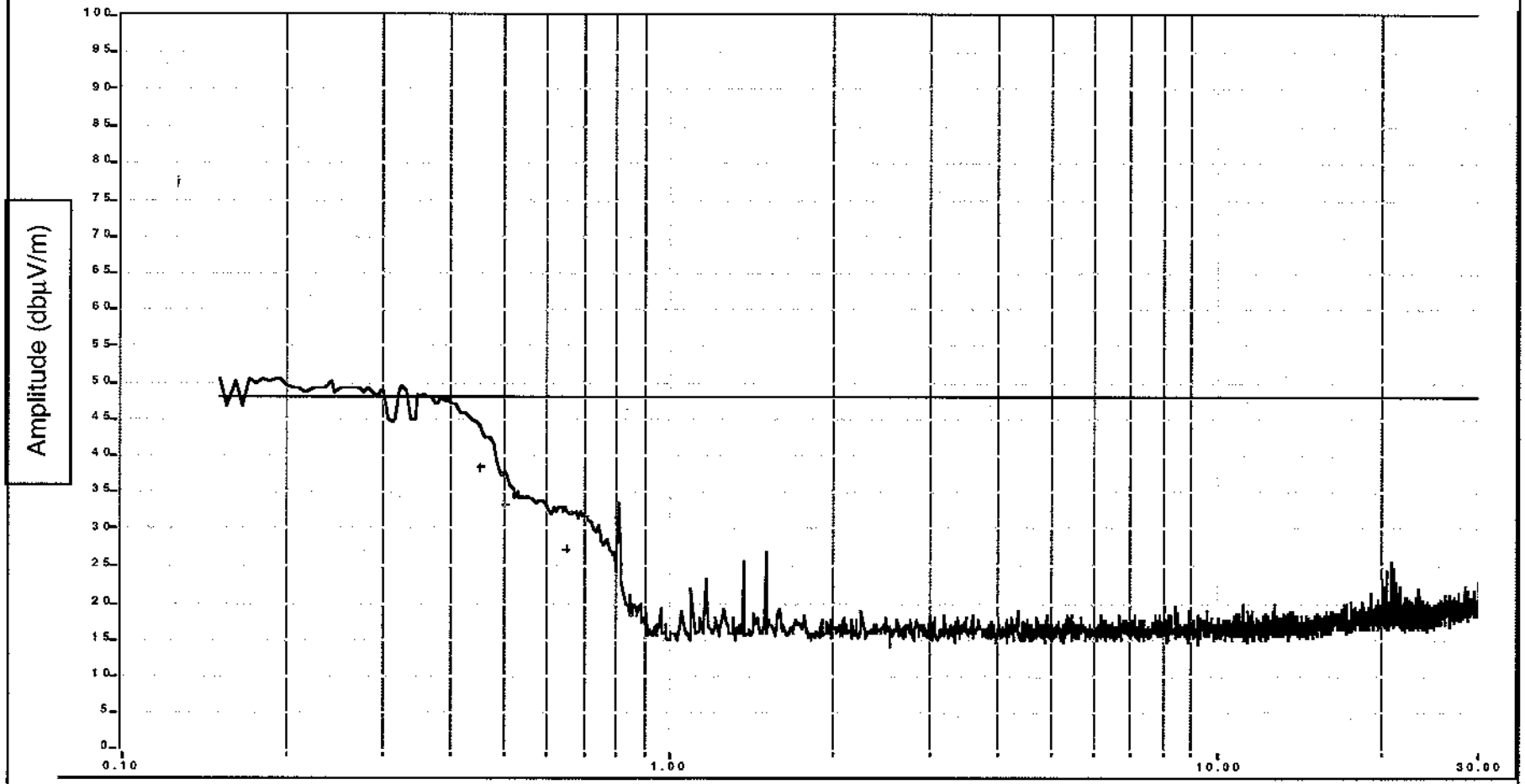
SVOATS #1: Savi Tech. Savi MobileReader 410R Run

Spec:
FCC B

Mains Lead
Line 1

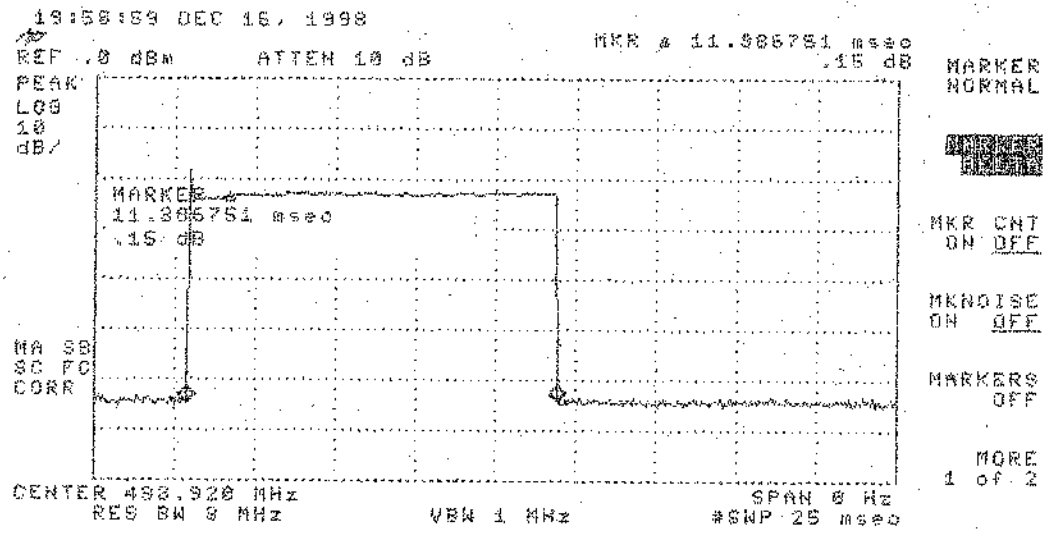


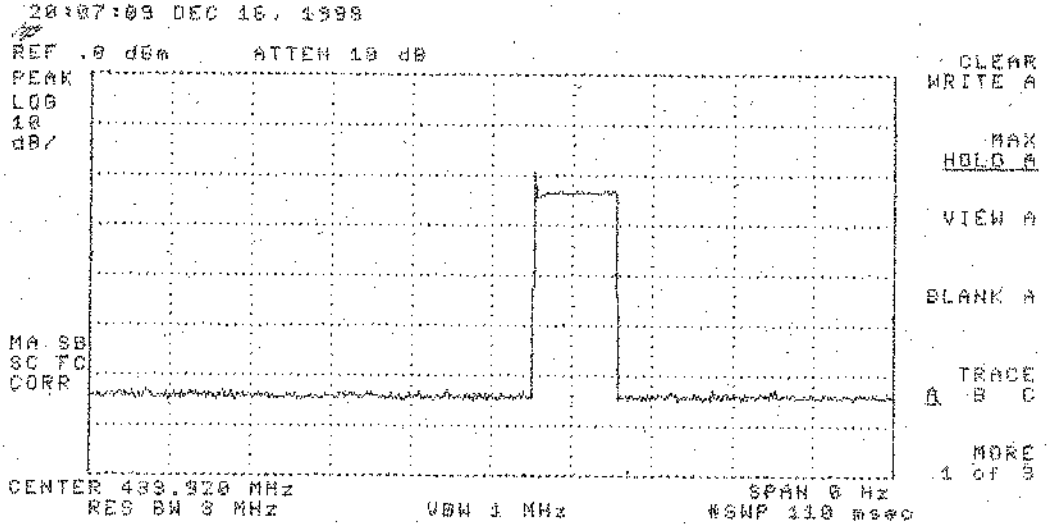
120V, 60Hz. LINE

Scan
Peak
Quasi-peak
Average
QuasiPeak
Limit 2

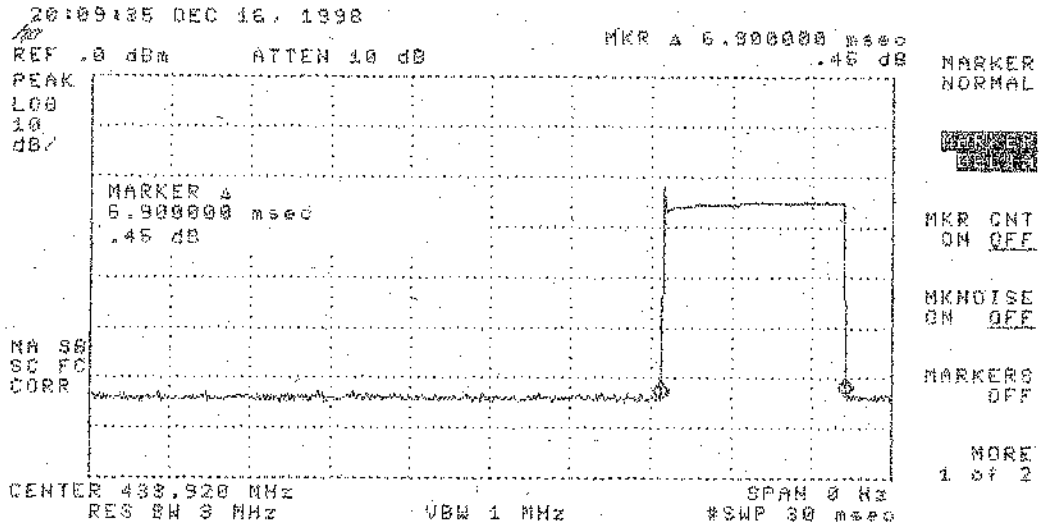
12/17/98

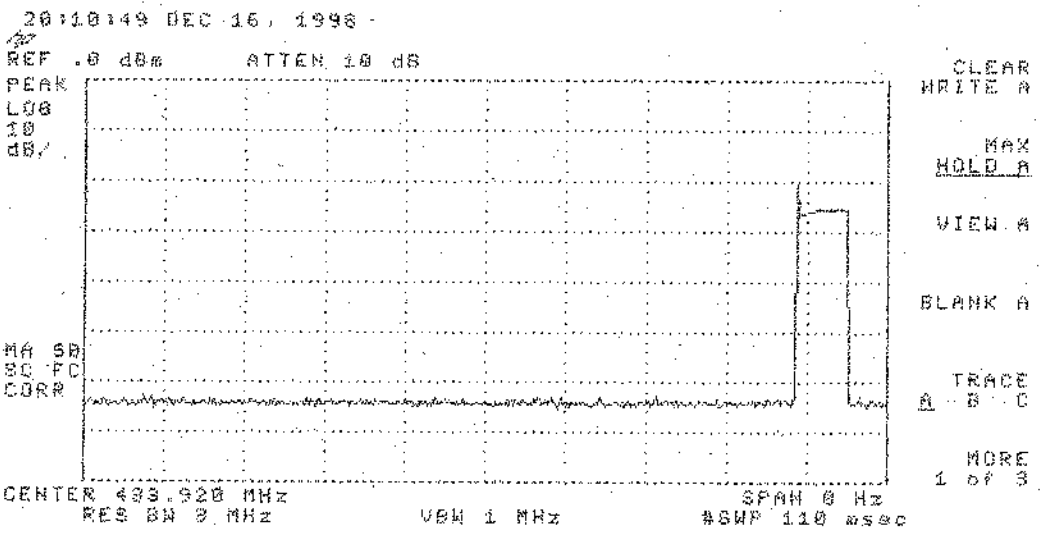
Rudy Suy


19:58:59 DEC 16, 1998
REF .0 dBm
ATTEN 10 dB
MKR Δ 11.385751 mseo
.15 dB
PEAK
LOG
10
dB/
MARKER
11.385751 mseo
.15 dB
MA SB
SC FC
CORR
CENTER 433.920 MHz
RES BW 8 MHz
VBW 1 MHz
SPAN 0 Hz
#SWP 25 mseo
MARKER
NORMAL
MKR CNT
ON OFF
MKNOISE
ON OFF
MARKERS
OFF
MORE
1 of 2

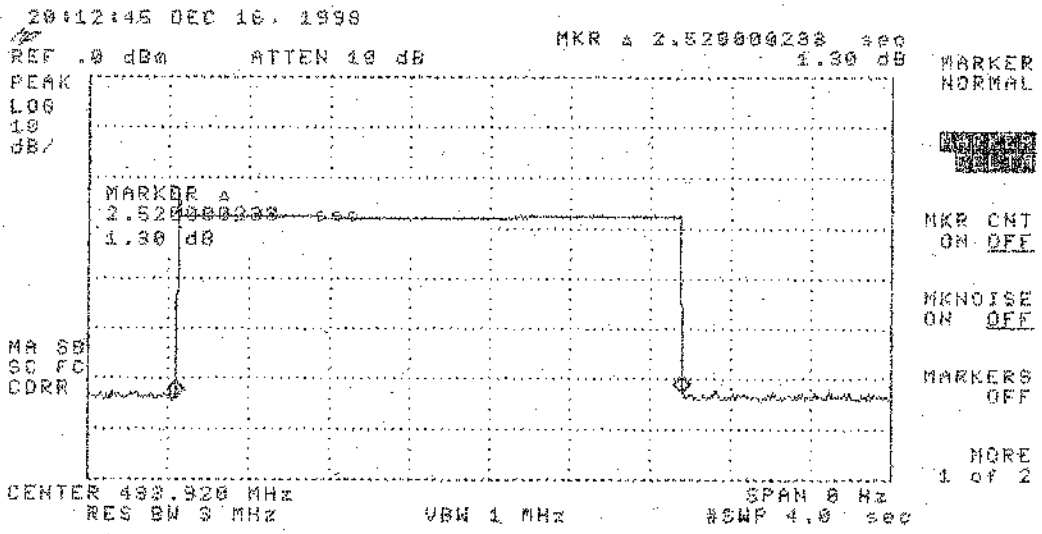

20:07:09 DEC 16, 1998
REF .0 dBm
ATTEN 10 dB
PEAK
LOG
10
dB/
MA SB
SC FC
CORR
CENTER 433.920 MHz
RES BW 8 MHz
VBW 1 MHz
SPAN 0 Hz
#SWP 110 mseo
CLEAR
WRITE A
MAX
HOLD A
VIEW A
BLANK A
TRACE
A B C
MORE
1 of 3

DATA


20:09:35 DEC 16, 1998
MKR Δ 6.900000 msec
REF .0 dBm
ATTEN 10 dB
.45 dB
PEAK
LOG
10
dB/
MARKER Δ
6.900000 msec
.45 dB
MA SB
SC FC
CORR
CENTER 433.920 MHz
SPAN 0 Hz
RES BW 3 MHz
VBW 1 MHz
#SWP 30 msec
MARKER
NORMAL
MKR CNT
ON OFF
MKNOISE
ON OFF
MARKERS
OFF
MORE
1 of 2


20:10:49 DEC 16, 1998
REF .0 dBm
ATTEN 10 dB
PEAK
LOG
10
dB/
MA SB
SC FC
CORR
CENTER 433.920 MHz
SPAN 0 Hz
RES BW 3 MHz
VBW 1 MHz
#SWP 110 msec
CLEAR
WRITE A
MAX
HOLD A
VIEW A
BLANK A
TRACE
A B C
MORE
1 of 3

CONTROL


20:12:45 DEC 16, 1998
MKR Δ 2.520000233 sec
REF .0 dBm
ATTEN 10 dB
1.30 dB
PEAK
LOG
10
dB/
MARKER Δ
2.520000233 sec
1.30 dB
MA SB
SC FC
CORR
MARKER
NORMAL
MKR CNT
ON OFF
MKNOISE
ON OFF
MARKERS
OFF
MORE
1 of 2
CENTER 433.920 MHz
SPAN 0 Hz
RES BW 3 MHz
VBW 1 MHz
#SWP 4.0 sec

WAKE UP

EXHIBIT 3: Radiated Emissions Test Configuration Photographs

EXHIBIT 3: Radiated Emissions Test Configuration Photographs

EXHIBIT 4: Conducted Emissions Test Configuration Photographs

EXHIBIT 4: Conducted Emissions Test Configuration Photographs

EXHIBIT 5: Proposed FCC ID Label & Label Location

EXHIBIT 6:Detailed Photographs of Savi Technology Model MobileReader 410R Construction

9 Pages

EXHIBIT 7:Operator's Manual for Savi Technology Model MobileReader 410R

24 Pages

EXHIBIT 8:Block Diagram of Savi Technology Model MobileReader 410R

1 Page

EXHIBIT 9:Schematic Diagrams for Savi Technology Model MobileReader 410R

4 Pages

EXHIBIT 10:Theory of Operation for Savi Technology Model MobileReader 410R