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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: ULD Reader

FCC ID:	KL7-SATS-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:	August 10, 2000
FINAL TEST DATE:	July 26, July 27 and July 28, 2000
AUTHORIZED SIGNATORY:	David W. Bare Principal Engineer

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

SCOPE

An electromagnetic emissions test has been performed on the Savi Technology, Inc. model ULD Reader 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, Inc. model ULD Reader and therefore apply only to the tested sample. The sample was selected and prepared by Eugene Schlindwein of Savi Technology, Inc.

OBJECTIVE

The primary objective of the manufacturer is compliance with Subpart C of Part 15 of FCC Rules for the radiated and conducted emissions of intentional radiators. 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 ULD Reader 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 ULD Reader. 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 – 30.00 MHz, 120V/ 60Hz

Frequency MHz	Level dBuV	Power Lead	FCC 15.207 Limit	FCC 15.207 Margin	Detector QP/Ave	Comments
0.5273	39.5	Neutral	48	-8.5	QP	

LIMITS OF INTENTIONAL AND SPURIOUS RADIATED EMISSION FIELD STRENGTH

The EUT tested complies with the limits detailed in FCC Rules Part 15 Section 15.209.

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. All readings were extrapolated to the specified distance.

Fundamental Field Strength

Tested in Mode 0									
Frequency	Level	Antenna	Distance	Level	FCC 15.209		Detector	Height	Comments
kHz	dBuV/m	Dist.	Correction	dBuV/m	Limit	Margin	Pk/QP/Avg	meters	
125.0	78.7	30.0	-53.4	25.3	25.7	-0.4	PK	1.0	Open Loop
Tested in Mode 1									
Frequency	Level	Antenna	Distance	Level	FCC 15.209		Detector	Height	Comments
kHz	dBuV/m	Dist.	Correction	dBuV/m	Limit	Margin	Pk/QP/Avg	meters	
125.0	77.4	30.0	-54.5	22.9	25.7	-2.8	PK	1.0	Open Loop

Spurious Emissions

Tested in Mode 0									
Frequency	Level	Antenna	Distance	Level	FCC 15.209		Detector	Height	Comments
kHz	dBuV/m	Dist.	Correction	dBuV/m	Limit	Margin	Pk/QP/Avg	meters	
1125.0	40.8	10.0	-19.1	21.7	26.6	-4.9	QP	1.0	Open Loop - Ambient
Tested in Mode 1									
Frequency	Level	Antenna	Distance	Level	FCC 15.209		Detector	Height	Comments
kHz	dBuV/m	Dist.	Correction	dBuV/m	Limit	Margin	Pk/QP/Avg	meters	
1125.0	42.5	10.0	-19.1	23.4	26.6	-3.2	QP	1.0	Open Loop - Ambient

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 ULD Reader is a RF tag reader/transmitter, which is designed to transmit a signal at 125 KHz and receive a return signal from a passive RF tag. Normally, the EUT would be placed under a pallet conveyor. The EUT was, therefore, placed on a tabletop emissions testing for convenience. The electrical rating of the EUT is 115/230V, 50/60 Hz, 2 Amps.

The sample was received on July 26, 2000 and tested on July 26, July 27 and July 28, 2000. The EUT consisted of the following component(s):

Manufacturer	Model	Description	Serial Number
Savi Technology	ULD Reader/ SR-120R-ULD1	RF Tag Reader/Transmitter	Prototype

ENCLOSURE

The EUT enclosure is primarily constructed of fabricated sheet aluminum steel and plastic cover. It measures approximately 255cm wide by 19cm deep by 14cm high.

MODIFICATIONS

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

SUPPORT EQUIPMENT

No support equipment was used during emissions testing.

EUT INTERFACE PORTS

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

		Cable(s)		
EUT Port	Connected To	Description	Shielded or Unshielded	Length (m)
RS-232	EUT	Unterminated Multicoductor	Shielded	1.0

EUT OPERATION

The EUT was configured such that it constantly transmits in each mode.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on July 26, July 27 and July 28, 2000 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 loop antenna is used to cover the frequency range from 10 KHz to 30MHz. 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 frequency 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 15.209

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
0.009-0.490	$2400/F_{KHz}$ @ 300m	$67.6-20*\log_{10}(F_{KHz})$ @ 300m
0.490-1.705	$24000/F_{KHz}$ @ 30m	$87.6-20*\log_{10}(F_{KHz})$ @ 30m
1.705 to 30	30 @ 30m	29.5 @ 30m
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

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

$$R_r - B = C$$

and

$$C - S = M$$

where:

R_r = Receiver Reading in dBuV

B = Broadband Correction Factor*

C = Corrected Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

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

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements. A distance factor, when used for electric field measurements, is calculated by using the following formula:

$$F_d = 40*LOG_{10} (D_m/D_s)$$

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 - 1000 MHz and 125 kHz, 27-Jul-00 10:18 PM
Engineer: Mbirgani

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
EMCO	Biconical Antenna, 30-300 MHz	3110B	801	11	12/01/1999	12/01/2000
EMCO	Log Periodic Antenna, 0.3-1 GHz	3146A	802	12	01/20/2000	01/20/2001
EMCO	Magnetic Loop Antenna, 10k-30MHz	6502	296	12	11/29/1999	11/29/2000
Rohde & Schwarz	Test Receiver, 0.009-2000 MHz	ESN	775	12	06/16/2000	06/16/2001

Conducted and Radiated Emissions, 28-Jul-00 10:57 PM
Engineer: Rafael

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
EMCO	Magnetic Loop Antenna, 10k-30MHz	6502	296	12	11/29/1999	11/29/2000
Fischer Custom Comm.	LISN, Freq. 0.9 -30 MHz,16 Amp	FCC-LISN-50/250-16-2	1079	12	06/12/2000	06/12/2001
Rohde & Schwarz	Test Receiver, 20-1300 MHz	ESVP	M002	12	11/18/1999	11/18/2000

EXHIBIT 2: Test Data Log Sheets

ELECTROMAGNETIC EMISSIONS

TEST LOG SHEETS

AND

MEASUREMENT DATA

T 38618 15 Pages

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EMC Test Data

Client:	Savi Technology	Job Number:	J38469
Model:	ULD Reader	T-Log Number:	T38618
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC 15.209	Class:	A
Immunity Spec:		Environment:	

EMC Test Data

For The

Savi Technology

Model

ULD Reader

Elliott

EMC Test Data

Client:	Savi Technology	Job Number:	J38469
Model:	ULD Reader	T-Log Number:	T38618
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC 15.209	Class:	A
Immunity Spec:		Environment:	

EUT INFORMATION

General Description

The EUT is a RF tag reader/transmitter, which is designed to transmit a signal at 125 KHz and receive a return signal from a passive RF tag. Normally, the EUT would be placed under a pallet conveyor. The EUT was, therefore, placed on a tabletop emissions testing for convenience. The electrical rating of the EUT is 115/230V, 50/60 Hz, 2 Amps.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Savi Technology	ULD Reader/ SR-120R-ULD1	RF Tag Reader/Transmitter	Prototype	KL7-SATS-V1

EUT Enclosure

The EUT enclosure is primarily constructed of fabricated sheet aluminum steel and plastic cover . It measures approximately 255cm wide by 19cm deep by 14cm high.

Modification History

Mod. #	Test	Date	Modificaiton
1			
2			
3			

Client:	Savi Technology	Job Number:	J38469
Model:	ULD Reader	T-Log Number:	T38618
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC 15.209	Class:	A
Immunity Spec:		Environment:	

Test Configuration Information (1)

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None				

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None				

EUT Interface Ports

		Cable(s)		
EUT Port	Connected To	Description	Shielded or Unshielded	Length(m)
RS-232	EUT	Unterminated Multiconductor	Shielded	1.0

EUT Operation During Emissions

The EUT was configured such that it constantly transmits in each mode.

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EMC Test Data

Client:	Savi Technology	Job Number:	J38469
Model:	ULD Reader	T-Log Number:	T38618
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC 15.209	Class:	A

Radiated Emissions

Test Specifics

Objective: The objective of this test session is to perform final qualification testing the EUT relative to the specification defined above.

Date of Test: 07/27/2000
Test Engineer: Mehran Birgani
Test Location: OATS #2

Config. Used: 1
Config Change: None
EUT Voltage: 230V/ 50Hz

General Test Configuration

The EUT was located on the turntable for radiated emissions testing.

For radiated emissions testing between 30 and 1000 MHz, the measurement antenna was located at 10 meters distance from the EUT, unless otherwise noted. For testing above 1 GHz, the measurement antenna was located 3 meters from the EUT. For the intentional portion testing between .009 to 30 MHz was peformed with the loop antenna placed at different distances 10, 20, and 30 Meters. The corrected readings were extrapolated to the specified distance.

Ambient Conditions:

Temperature: 18°C
Rel. Humidity: 72%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 30 - 1000MHz Preliminary Emissions	FCC A	Pass	-10.9 dB @ 448.05MHz
2	RE, Maximized Emissions from Run 1	FCC A	Pass	-10.9 dB @ 448.05MHz
3	RE, Fundamental Frequency (Mode 0)	FCC 15.209	Pass	-0.4 dB @ 125.00 kHz
4	RE, Fundamental Frequency (Mode 1)	FCC 15.209	Pass	-2.8 dB @ 125.00 kHz

Modifications Made During Testing: None

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EMC Test Data

Client:	Savi Technology	Job Number:	J38469
Model:	ULD Reader	T-Log Number:	T38618
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC 15.209	Class:	A

Run #1: Preliminary Radiated Emissions, 30-1000 MHz

*Measured in OATS #2 at 10m and no extrapolation was used.

Frequency	Level	Pol	FCC Class A		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
448.048	35.5	V	46.4	-10.9	QP	155	1.0	
128.848	31.1	V	43.5	-12.4	QP	330	1.0	
456.048	33.4	V	46.4	-13.0	QP	153	1.0	
128.010	28.7	V	43.5	-14.8	QP	360	1.0	
416.044	31.3	V	46.4	-15.1	QP	153	1.0	
119.988	27.8	V	43.5	-15.7	QP	320	1.0	
432.046	30.3	V	46.4	-16.1	QP	153	1.0	
464.050	30.1	V	46.4	-16.3	QP	158	1.0	
416.044	28.3	H	46.4	-18.1	QP	71	4.0	
112.010	24.9	V	43.5	-18.6	QP	10	1.0	
432.046	26.6	H	46.4	-19.8	QP	71	4.0	
448.048	26.2	H	46.4	-20.2	QP	33	4.0	
128.030	20.1	H	43.5	-23.4	QP	15	4.0	

Run #2: Maximized Readings from Run #1

Frequency	Level	Pol	FCC Class A		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
448.048	35.5	V	46.4	-10.9	QP	155	1.0	
128.848	31.1	V	43.5	-12.4	QP	330	1.0	
456.048	33.4	V	46.4	-13.0	QP	153	1.0	
128.010	28.7	V	43.5	-14.8	QP	360	1.0	
416.044	31.3	V	46.4	-15.1	QP	153	1.0	
119.988	27.8	V	43.5	-15.7	QP	320	1.0	

Client:	Savi Technology	Job Number:	J38469
Model:	ULD Reader	T-Log Number:	T38618
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC 15.209	Class:	A

Run #3: Maximized Radiated Emissions, Fundamental Frequency (general device operating under 15.209, Frequency in range 9kHz - 30MHz)

Notes - for frequencies below 30 MHz the extrapolation factor is 40Log (Dm/Ds) where Dm is measurement distance and Ds is specification distance. For frequencies below 490kHz the measurement distance is 300m and for frequencies between 490kHz and 30MHz the measurement distance is 30m.

Tested in Mode 0

Frequency	Level	Antenna					Detector	Height	Comments
kHz	dBuV/m	Dist.					Pk/QP/Avg	meters	
125.0	105.7	10.0					PK	1.0	Open Loop
125.0	99.8	10.0					PK	1.0	Close Loop

Tested in Mode 0

Frequency	Level	Antenna					Detector	Height	Comments
kHz	dBuV/m	Dist.					Pk/QP/Avg	meters	
125.0	88.1	20.0					PK	1.0	Open Loop
125.0	85.5	20.0					PK	1.0	Close Loop

Tested in Mode 0

Frequency	Level	Antenna	Distance	Level	FCC 15.209		Detector	Height	Comments
kHz	dBuV/m	Dist.	Correction	dBuV/m	Limit	Margin	Pk/QP/Avg	meters	
125.0	78.7	30.0	-53.4	25.3	25.7	-0.4	PK	1.0	Open Loop
125.0	76.7	30.0	-53.4	23.3	25.7	-2.4	PK	1.0	Close Loop

Determining extrapolation factor for fundamentals below 490 kHz

Highest level at 10m	105.7	From 10 to 30, factor is:	-56.6
Highest level at 20m	88.1	From 20 to 30 the factor is:	-53.4
Highest level at 30m	78.7	From 10 to 20 the factor is:	-58.5
		Worst case factor is:	**-53.4**

If this factor is greater than 40 it should be used.

Client:	Savi Technology	Job Number:	J38469
Model:	ULD Reader	T-Log Number:	T38618
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC 15.209	Class:	A

Run #4: Maximized Radiated Emissions, Fundamental Frequency (general device operating under 15.209, Frequency in range 9kHz - 30MHz)

Notes - for frequencies below 30 MHz the extrapolation factor is 40Log (Dm/Ds) where Dm is measurement distance and Ds is specification distance. For frequencies below 490kHz the measurement distance is 300m and for frequencies between 490kHz and 30MHz the measurement distance is 30m.

Tested in Mode 1

Frequency	Level	Antenna					Detector	Height	Comments
kHz	dBuV/m	Dist.					Pk/QP/Avg	meters	
125.0	105.0	10.0					PK	1.0	Open Loop
125.0	99.0	10.0					PK	1.0	Close Loop

Tested in Mode 1

Frequency	Level	Antenna					Detector	Height	Comments
kHz	dBuV/m	Dist.					Pk/QP/Avg	meters	
125.0	87.0	20.0					PK	1.0	Open Loop
125.0	84.6	20.0					PK	1.0	Close Loop

Tested in Mode 1

Frequency	Level	Antenna	Distance	Level	FCC 15.209		Detector	Height	Comments
kHz	dBuV/m	Dist.	Correction	dBuV/m	Limit	Margin	Pk/QP/Avg	meters	
125.0	77.4	30.0	-54.5	22.9	25.7	-2.8	PK	1.0	Open Loop
125.0	76.1	30.0	-54.5	21.6	25.7	-4.1	PK	1.0	Close Loop

Determining extrapolation factor for fundamentals below 490 kHz

Highest level at 10m	105.0	From 10 to 30, factor is:	-57.8
Highest level at 20m	87.0	From 20 to 30 the factor is:	-54.5
Highest level at 30m	77.4	From 10 to 20 the factor is:	-59.8
		Worst case factor is:	**-54.5**

If this factor is greater than 40 it should be used.

Elliott

EMC Test Data

Client:	Savi Technology	Job Number:	J38469
Model:	ULD Reader	T-Log Number:	T38618
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC 15.209	Class:	A

Radiated Emissions

Objective: The objective of this test session is to perform final qualification testing the EUT relative to the specification defined above.

Date of Test:	07/28/2000	Config. Used:	1
Test Engineer:	Rafael Varelas	Config Change:	None
Test Location:	OATS #1	EUT Voltage:	230V/ 50Hz

General Test Configuration

The EUT was located on the turntable for radiated emissions testing.

For the intentional portion testing between .009 to 30 MHz was peformed with the loop antenna placed at 10 Meters. The reading was extrapolated to the specified distance.

Ambient Conditions:

Temperature: 18°C

Rel. Humidity: 77%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, Spurious Emission 125 - 1125 kHz (Mode 0)	FCC 15.209	Pass	-4.9 @ 1125 KHz
2	RE, Spurious Emission 125 - 1125 kHz (Mode 1)	FCC 15.209	Pass	-3.2 @ 1125 KHz

Modifications Made During Testing: Same as testing on 6/13/2000 at chamber #2.

Elliott

EMC Test Data

Client:	Savi Technology	Job Number:	J38469
Model:	ULD Reader	T-Log Number:	T38618
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC 15.209	Class:	A

Run #1: Maximized Radiated Emissions of Spurious Emission 0.250 - 1.125 MHz

Notes - for frequencies below 30 MHz the extrapolation factor is 40Log (Dm/Ds) where Dm is measurement distance and Ds is specification distance. For frequencies below 490kHz the measurement distance is 300m and for frequencies between 490kHz and 30MHz the measurement distance is 30m.

Tested in Mode 0

Frequency	Level	Antenna	Distance	Level	FCC 15.209		Detector	Height	Comments
kHz	dBuV	Dist.	Correction	dBuV/m	Limit	Margin	Pk/QP/Avg	meters	
1125.0	40.8	10.0	-19.1	21.7	26.6	-4.9	QP	1.0	Open Loop - Ambient
875.0	42.4	10.0	-19.1	23.3	28.8	-5.4	QP	1.0	Open Loop-Partial ambient
1000.0	39.8	10.0	-19.1	20.7	27.6	-6.9	QP	1.0	Open Loop-Partial ambient
750.0	40.2	10.0	-19.1	21.1	30.1	-9.0	QP	1.0	Open Loop - Ambient
500.0	42.0	10.0	-19.1	22.9	33.6	-10.7	QP	1.0	Open Loop, note 1
625.0	35.4	10.0	-19.1	16.3	31.7	-15.4	QP	1.0	Open Loop - Ambient
250.0	54.6	10.0	-78.9	-24.3	19.6	-43.9	PK	1.0	Open Loop
375.0	45.3	10.0	-78.9	-33.6	16.1	-49.7	PK	1.0	Open Loop

Note 1	Signal below noise floor

Run #2: Maximized Radiated Emissions of Spurious Emission 0.250 - 1.125 MHz

Notes - for frequencies below 30 MHz the extrapolation factor is 40Log (Dm/Ds) where Dm is measurement distance and Ds is specification distance. For frequencies below 490kHz the measurement distance is 300m and for frequencies between 490kHz and 30MHz the measurement distance is 30m.

Tested in Mode 1

Frequency	Level	Antenna	Distance	Level	CC 15.209		Detector	Height	Comments
kHz	dBuV	Dist.	Correction	dBuV/m	Limit	Margin	Pk/QP/Avg	meters	
1125.0	42.5	10.0	-19.1	23.4	26.6	-3.2	QP	1.0	Open Loop - Ambient
1000.0	40.9	10.0	-19.1	21.8	27.6	-5.8	QP	1.0	Open Loop-Partial ambient
750.0	42.5	10.0	-19.1	23.4	30.1	-6.7	QP	1.0	Open Loop - Ambient
875.0	40.1	10.0	-19.1	21.0	28.8	-7.7	QP	1.0	Open Loop-Partial ambient
500.0	42.0	10.0	-19.1	22.9	33.6	-10.7	QP	1.0	Open Loop - Note 1
625.0	38.8	10.0	-19.1	19.7	31.7	-12.0	QP	1.0	Open Loop - Ambient
375.0	55.6	10.0	-78.9	-23.3	16.1	-39.4	PK	1.0	Open Loop
250.0	44.5	10.0	-78.9	-34.4	19.6	-54.0	PK	1.0	Open Loop

Note 1	Signal below noise floor

Elliott

EMC Test Data

Client:	Savi Technology	Job Number:	J38469
Model:	ULD Reader	T-Log Number:	T38618
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC 15.209	Class:	A

Conducted Emissions

Test Specifics

Objective: The objective of this test session is to perform final qualification testing the EUT relative to the specification(s) defined above.

Date of Test: 07/27/2000
Test Engineer: Rafael Varelas
Test Location: SVOATS #1

Config. Used: 1
Config Change:
EUT Voltage: 230V/50 Hz or 120V/60Hz

General Test Configuration

For tabletop equipment, the EUT was located on a wooden table, 40 cm from a vertical coupling plane. The LISN was located 80 cm from the EUT.

Ambient Conditions:

Temperature: 20°C
Rel. Humidity: 76%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power 230V/50Hz	EN55022 Class A	Pass	-20.9dB @ .1753MHz
2	CE, AC Power 120V/60Hz	EN55022 Class A	Pass	-21.5dB @ .2405MHz
3	CE, AC Power 120V/60Hz	Fcc 15.207	Pass	-8.5 dB @ .5273 MHz

Modifications Made During Testing: None

Elliott

EMC Test Data

Client:	Savi Technology	Job Number:	J38469
Model:	ULD Reader	T-Log Number:	T38618
		Proj Eng:	Mark Briggs
Contact:	Eugene Schlindwein		
Spec:	FCC 15.209	Class:	A

Run #1: AC Power Port Conducted Emissions, 0.15 - 30 MHz 230 V / 50 Hz

Frequency	Level	Power	EN55022A		Detector	Comments
MHz	dBµV	Lead	Limit	Margin	QP/Ave	
0.1753	58.1	Neutral	79.0	-20.9	QP	
0.1507	58.5	Line 1	79.0	-20.5	QP	
0.346	46.7	Neutral	79.0	-32.3	QP	
1.875	29.5	Line 1	60.0	-30.5	AV	
0.2841	43.8	Line 1	79.0	-35.2	QP	
13.1263	31.5	Neutral	60.0	-28.5	AV	
1.8764	27.3	Neutral	60.0	-32.7	AV	
13.2506	30.5	Line 1	60.0	-29.5	AV	
13.1263	38.8	Neutral	73.0	-34.2	QP	
0.2841	25.6	Line 1	66.0	-40.4	AV	
13.2506	32.2	Line 1	73.0	-40.8	QP	
1.875	28	Line 1	73.0	-45.0	QP	
0.346	20.4	Neutral	66.0	-45.6	AV	
1.8764	27.2	Neutral	73.0	-45.8	QP	
0.1753	23.5	Neutral	66.0	-42.5	AV	
0.1507	22.5	Line 1	66.0	-43.5	AV	

Run #2: AC Power Port Conducted Emissions, 0.15 - 30 MHz 120 V / 60 Hz

Frequency	Level	Power	EN55022A		Detector	Comments
MHz	dBµV	Lead	Limit	Margin	QP/Ave	
0.2405	57.5	Line 1	79.0	-21.5	QP	
0.2427	57.4	Neutral	79.0	-21.6	QP	
0.5273	39.5	Neutral	73.0	-33.5	QP	
13.6284	32.3	Neutral	60.0	-27.7	AV	
0.569	34.1	Line 1	73.0	-38.9	QP	
12.0033	26.2	Line 1	60.0	-33.8	AV	
13.6284	36	Neutral	73.0	-37.0	QP	
0.2427	26.4	Neutral	66.0	-39.6	AV	
0.569	20.3	Line 1	60.0	-39.7	AV	
0.5273	20.2	Neutral	60.0	-39.8	AV	
0.2405	20.9	Line 1	66.0	-45.1	AV	
12.0033	28.9	Line 1	73.0	-44.1	QP	

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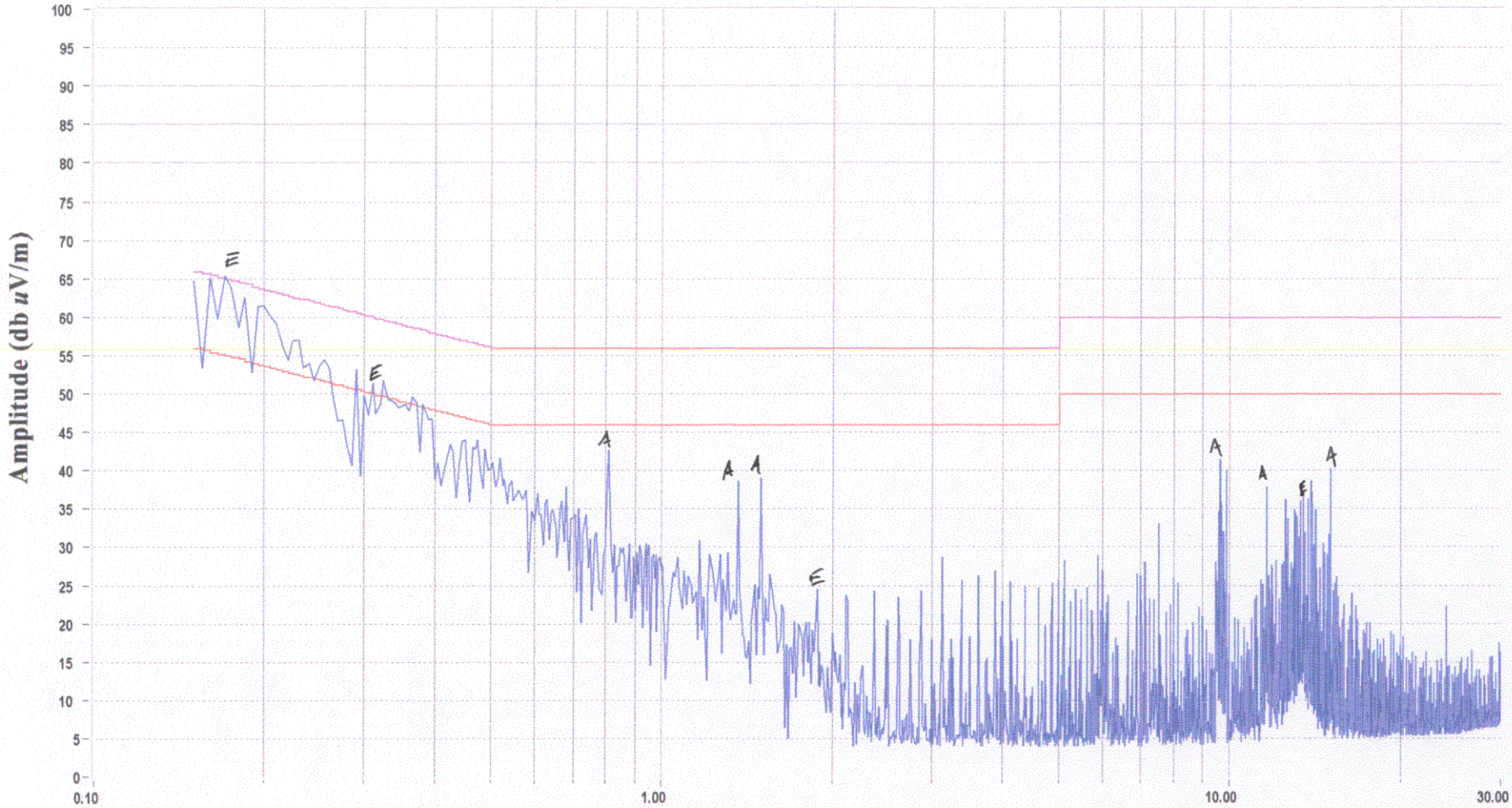
SVOATS #1: Savi Technology ULD Reader Run 1

T38618

Spec:
EN55022B

Mains Lead
Line 1



230V/50Hz. E = EUT, A = Ambient

Scan
Peak
Quasi-peak
Average
Average Limit
QuasiPeak Limit

7/26/00

Rafael Varelas

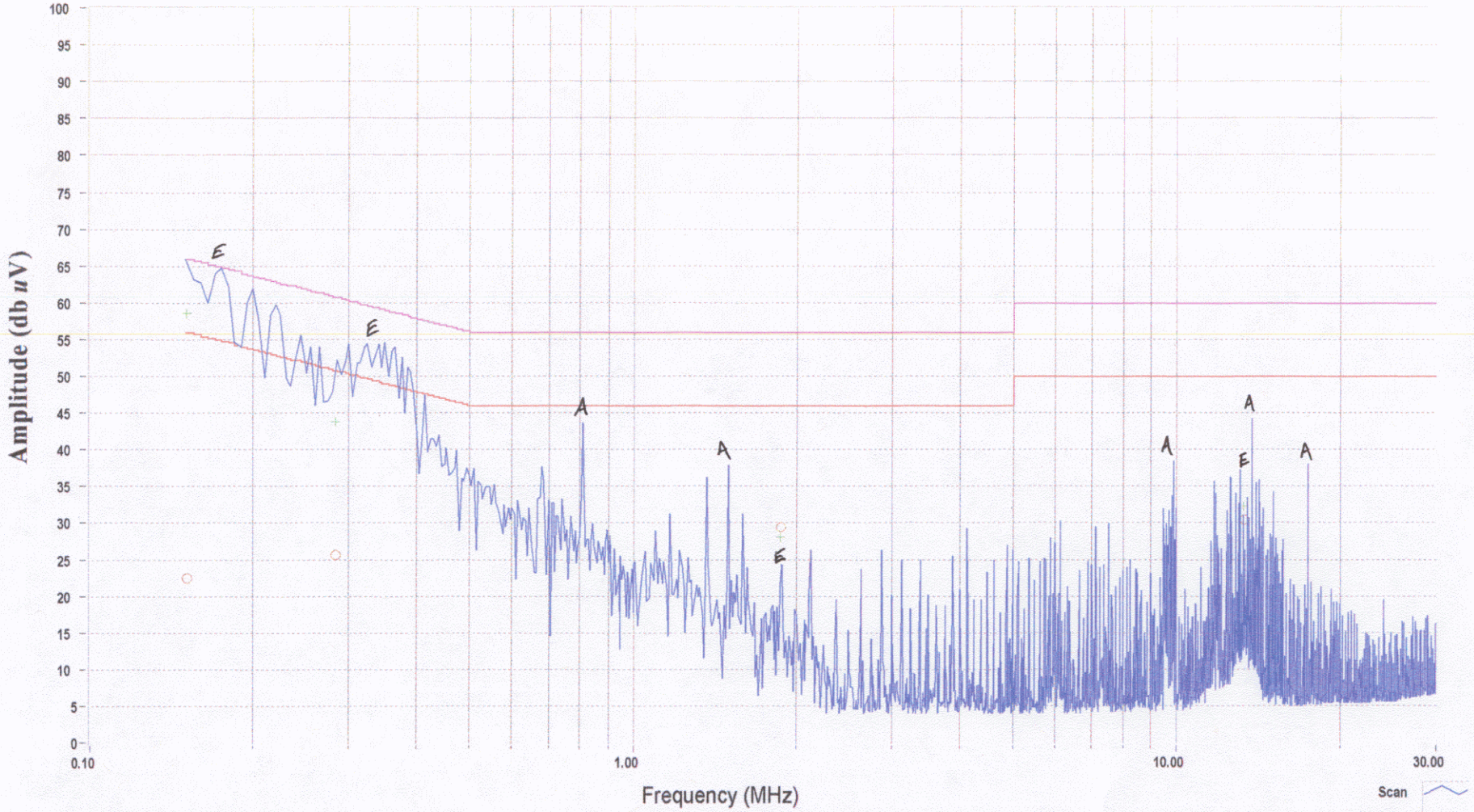
Elliott

SVOATS #1: Savi Technology ULD Reader Run 1

T38618

Spec:
EN55022B

Mains Lead
Neutral



230V/50Hz. E = EUT, A = Ambient

Scan
Peak
Quasi-peak
Average
Average Limit
QuasiPeak Limit

7/28/00

Rafael Varelas

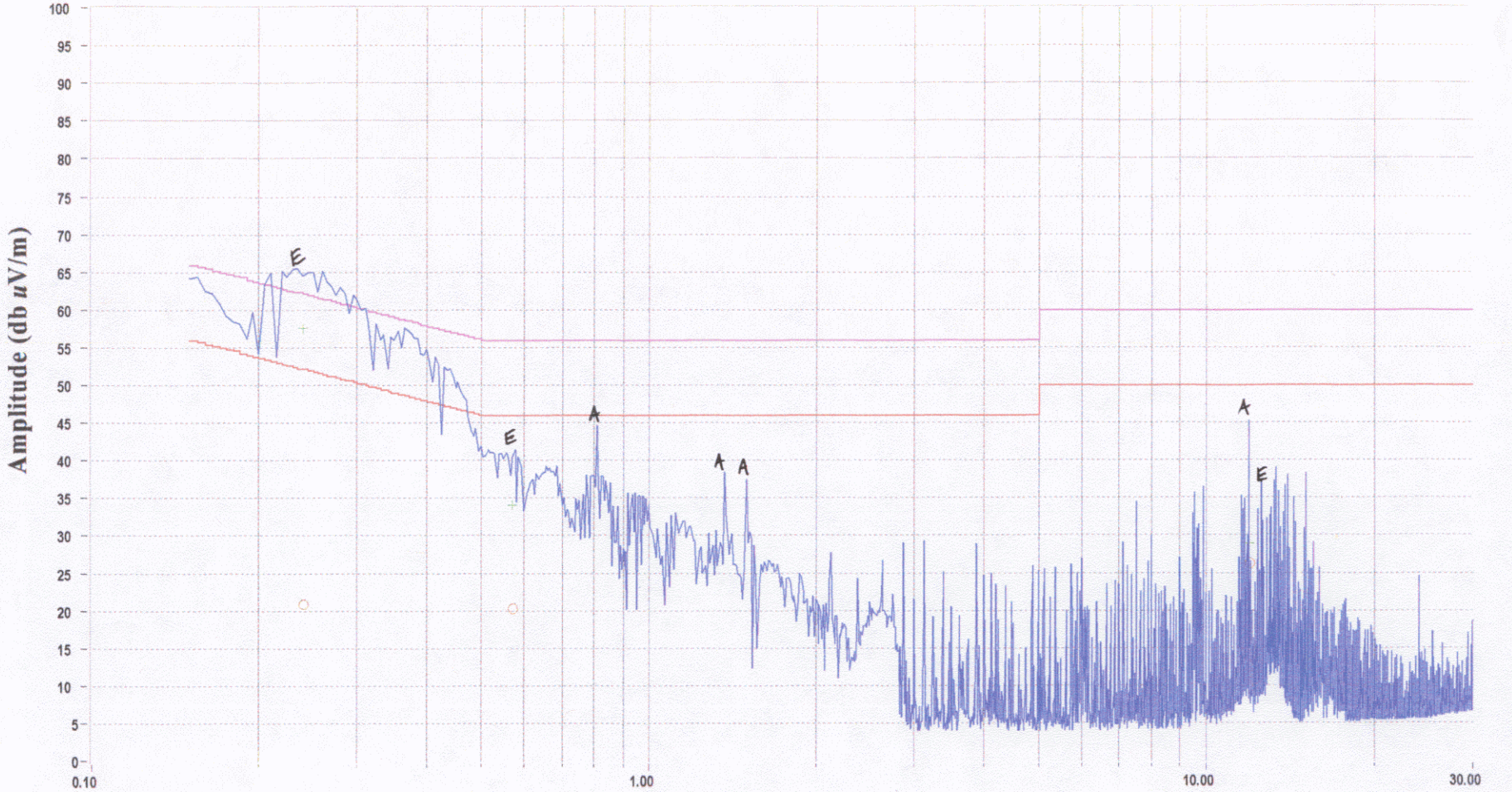
Elliott

SVOATS #1: Savi Technology ULD Reader Run 2

T38618

Spec:
EN55022B

Mains Lead
Line 1



120V/60Hz. E = EUT, A = Ambient

Scan
Peak
Quasi-peak
Average
Average Limit
QuasiPeak Limit

7/28/00

Rafael Varelas

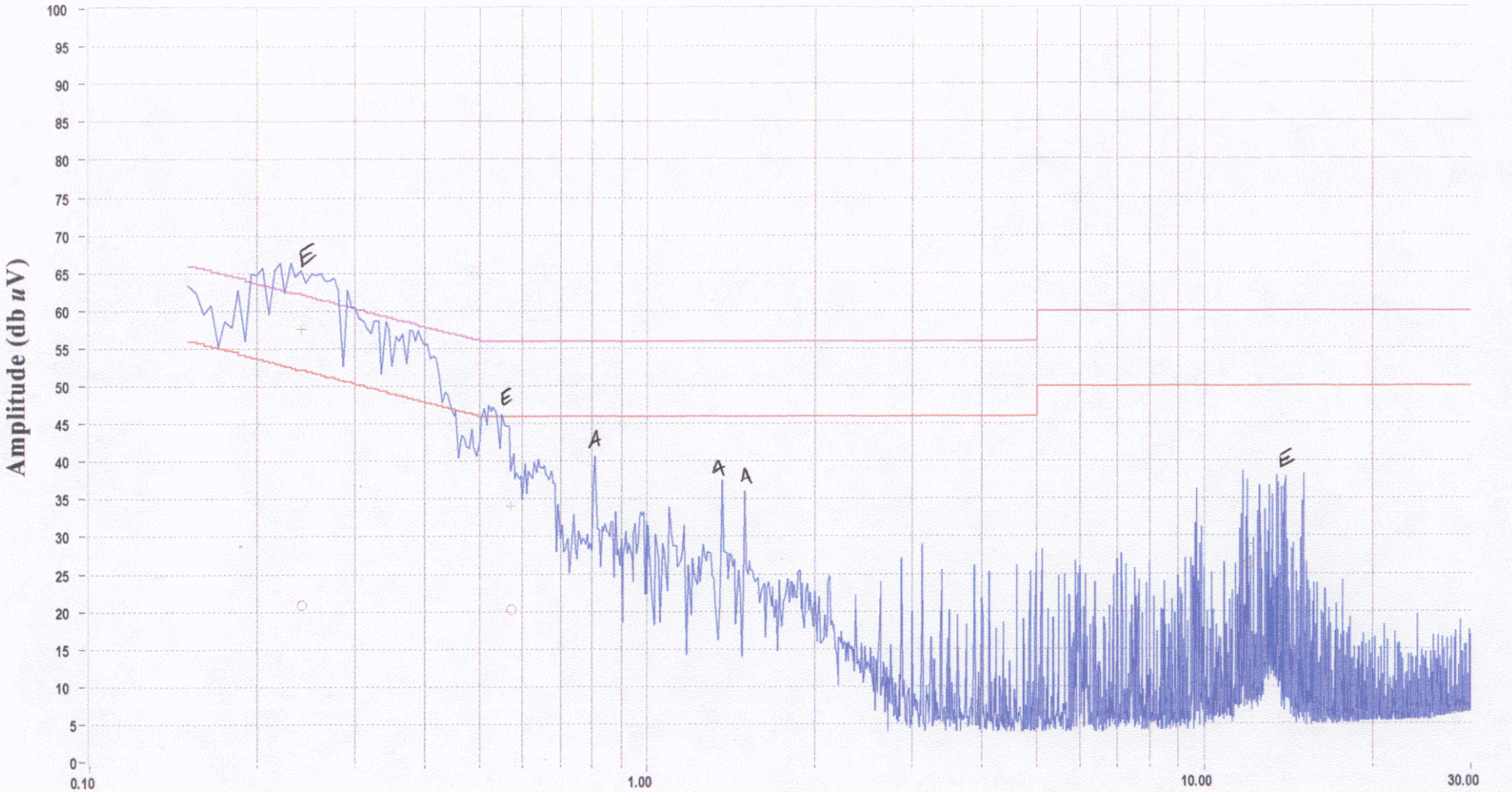
Elliott

SVOATS #1: Savi Technology ULD Reader Run 2

T38618

Spec:
EN55022B

Mains Lead
Neutral



120V/60Hz. E = EUT, A = Ambient

Scan
Peak
Quasi-peak
Average
Average Limit
QuasiPeak Limit

7/28/00

Rafael Varelas

EXHIBIT 3: Radiated Emissions Test Configuration Photographs

APPENDIX 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, Inc. Model ULD Reader Construction

5 Pages

EXHIBIT 7: Operator's Manual for Savi Technology, Inc. Model ULD Reader

46 Pages

EXHIBIT 8: Block Diagram of Savi Technology, Inc. Model ULD Reader

1 Page

EXHIBIT 9: Schematic Diagrams for Savi Technology, Inc. Model ULD Reader

7 Pages

EXHIBIT 10: Theory of Operation for Savi Technology, Inc. Model ULD Reader

1 Page