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Electromagnetic Emissions Test Report In Accordance With Industry Canada Radio Standards Specification 210 And FCC Part 15 Sections 15.209, 15.231 on the Savi Technology, Inc. Transmitter Model: EchoPoint Series SR-650-101 Fixed Reader

UPN:	2404A-650R
FCC ID:	KL7-650R-V1
GRANTEE:	Savi Technology, Inc. 615 Tasman Drive Sunnyvale, CA. 94089-1707
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Ave Sunnyvale, CA 94086
REPORT DATE:	January 14, 2004
FINAL TEST DATE:	January 8, 2004
AUTHORIZED SIGNATORY:	Mark Briggs Vice President of Engineering

Equipment Name and Model:

Transceiver, EchoPoint Series SR-650-101 Fixed Reader

Manufacturer:

Savi Technology, Inc.

Tested to applicable standard:
RSS210, Issue 5, February 1996
Low Power License-Exempt Radio Communication Devices
FCC Part 15 Subpart C

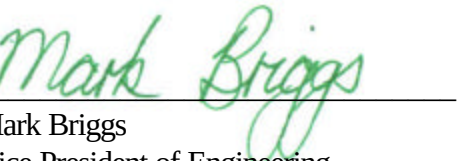
Test Report Prepared For:
Eugene Schlindwein
Savi Technology, Inc.
615 Tasman Drive
Sunnyvale, CA. 94089-1707
USA

Measurement Facility Description Filed With Department of Industry:

Departmental Acknowledgement Number: IC2845 **SV1**, Dated July 3, 1997

Declaration of Compliance

I declare that the testing was performed or supervised by me; that the test measurements were made in accordance with the above mentioned departmental standards (through the use of ANSI C63.4 as detailed in section 5.3 of RSS-210, Issue 5); and that the equipment performed in accordance with the data submitted in this report.



Signature _____
Name Mark Briggs
Title Vice President of Engineering
Elliott Laboratories Inc.
Address 684 W. Maude Ave
Sunnyvale, CA 94086
USA

Date: January 14, 2004

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

SCOPE

An electromagnetic emissions test has been performed on the Savi Technology, Inc. model EchoPoint Series SR-650-101 Fixed Readerpursuant to Subpart C of Part 15 of FCC Rules for intentional radiators and Industry Canada Radio Standards Specification RSS-210 for Low Power, License-Exempt Radio Communication Devices. 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 Industry Canada 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 EchoPoint Series SR-650-101 Fixed Readerand 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 and Industry Canada RSS-210 for Low Power, License-Exempt Radio Communication Devices. Certification of these devices is required as a prerequisite to marketing as defined in Part 2 the FCC Rules and Industry Canada Radio Standards Procedure RSP-100.

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.

Maintenance of 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.).

STATEMENT OF COMPLIANCE

The tested sample of the Savi Technology's EchoPoint Series SR-650-101 Fixed Reader complied with the requirements of Subpart C of Part 15 of the FCC Rules for low power intentional radiators and Industry Canada specification RSS 210 for Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands).

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.).

TEST RESULTS SUMMARY

15.231 / RSS 210 Section 6.1

FCC Part 15 Section	RSS 210 Section	Description	Comments	Result
15.207 / 15.107		AC Conducted Emissions, 0.15 – 30 MHz	-1.8dB @ 0.414 MHz	Pass
	6.6 / 7.4	AC Conducted emissions 0.45 – 30 MHz	TBD	Pass
15.231 (a) (1)	6.1.1(a) (1)	Duration of manually activated transmission	Not applicable, no manually activated transmissions	N/A
15.231 (a)(2) 15.231 (e)	6.1.1(a) (2) 6.1.1(e)	Duration of automatically activated transmission	5 seconds or less for control signals (Wake-Up and Control signals) 1 second or less for control signals (Wake-Up and Control signals) Refer to the operational description for detailed description and timing diagrams.	Pass
15.231 (a) (3)	6.1.1(a) (3)	Transmissions at predetermined / regular intervals are not permitted	All transmissions are triggered via the end-user. Refer to the operational description for detailed information.	Pass
15.231 (a) (4)	6.1.1(a) (4)	Pendency of transmissions used during emergencies involving fire, security, and safety of life	Not applicable	N/A
15.231 (b)	6.1.1(b) / Table 1	Transmitter Radiated Emissions, 433.92 MHz	77.1dBuV/m Peak; 77.0dBuV/m Average.	Pass
15.231 (b)	6.1.1(b) / Table 1	Transmitter Radiated Spurious Emissions, 30-4339.2 MHz	57.7dBuV/m m @ 867.8 MHz Average (-3.1dB)	Pass
15.231 (c)	6.1.1 (c)	Bandwidth	Measured bandwidth was 440 kHz. The maximum permitted is 0.25% of the fundamental frequency (1MHz)	Pass
15.231 (d)	6.1.1 (d)	Frequency Stability	N/A for devices operating at 433.926 MHz	Pass
15.231 (e)	6.1.1 (e)	Transmitter Radiated Emissions, 433.92 MHz	81.6dBuV/m Peak; 71.1dBuV/m Average (-1.8dB)	Pass
15.231 (e)	6.1.1 (e)	Transmitter Radiated Spurious Emissions, 30-4339.2 MHz	50.5dBuV/m @ 867.8 MHz Average (-2.4dB)	Pass
15.109	7.3	Receiver Spurious Emissions	-20.4dB @ 846.440MHz	Pass

Note 2 – Wake-up Control Signal was measured against the 15.231(a) and RSS 210 6.1.1 (a) limits for control signals. The pulsed control signals were measured against the 15.231(e) and RSS210 6.1.1(e) limits for data signals.

Note 3 – Pulsed data and control signals have a maximum duty cycle of 30%. Pulsed data signals are transmitted for no more than 5 seconds. Pulsed control signals are transmitted for no more than 1 second.

MEASUREMENT UNCERTAINTIES

ISO Guide 17025 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	± 3.6

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Savi Technology, Inc. model EchoPoint Series SR-650-101 Fixed Reader is an RFID tag reader which is designed to track asset tags that use Savi's 433.92 MHz transceivers. Normally, the EUT would be pole-mounted during operation. The EUT was treated as table-top equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 92-125/184-250 VAC, 50/60 Hz, 300 mA, 12-24 VDC, 500 mA.

The sample was received on December 8, 2003 and tested on January 8, 2004. The EUT consisted of the following component(s):

Manufacturer/Model/Description	Serial Number
Savi Technology, Inc. SR-650-101 Fixed Reader	0001

ENCLOSURE

The EUT enclosure is primarily constructed of plastic. It measures approximately 6.5 cm wide by 2.5 cm deep by 9 cm high.

MODIFICATIONS

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

SUPPORT EQUIPMENT

No local support equipment was used during testing

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

Manufacturer	Model	Description	Serial Number
Savi	410R	SaviReader	
IBM	2635	Laptop PC	78-VA248 97/11

EUT INTERFACE PORTS

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

Port	Connected To	Cable(s)		
		Description	Shielded / Unshielded	Length (m)
Ethernet	Laptop	CAT 5	Unshielded	30
	410R	multiwire	Unshielded	30
	410R	multiwire	Unshielded	30
AC in	AC Mains	3 wire	Unshielded	2

EUT OPERATION

During transmitter testing the EUT was continuously transmitting at the appropriate output level for Wake-up or pulsed data/control signals. For digital device and receiver tests the EUT was pinged over the ethernet connection by the remote laptop and in a receive-only mode.

ANTENNA SYSTEM

The antenna system used with the Savi Technology, Inc. model EchoPoint Series SR-650-101 Fixed Reader is permanently attached and an integral part of the system.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on January 8, 2004 at the Elliott Laboratories Open Area Test Site located at 684 West Maude Avenue, Sunnyvale, California. Pursuant to section 2.948 of the FCC's Rules and section 3.3 of RSP-100, construction, calibration, and equipment data has been filed with the Commission.

ANSI C63.4 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 requirements of ANSI C63.4-1992.

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 & Schwarz EZM Spectrum Monitor/Controller or contain an internal Spectrum Monitor/Controller to view and convert the receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers.

The Spectrum Monitor provides a visual display of the signal being measured. In addition, the controller or a personal computer run automated data collection programs which control the receivers. This provides added accuracy since all site correction factors, such as cable loss and antenna factors are added automatically.

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a fifty microhenry Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 uH CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A biconical antenna is used to cover the range from 30 MHz to 300 MHz and a log periodic antenna is utilized from 300 MHz to 1000 MHz. Narrowband tuned dipole antennas are used over the entire 30 to 1000 MHz range for precision measurements of field strength. Above 1000 MHz, a horn antenna is used. The antenna calibration factors are included in site factors programmed into the test receivers.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height.

ANSI C63.4 specifies that the test height above ground for table mounted devices shall be 80 centimeters. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The FCC requires that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.4, and the worst-case orientation is used for final measurements.

CONDUCTED EMISSIONS

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord.

RADIATED EMISSIONS

Radiated emissions measurements are performed in two phases as well. A preliminary scan of emissions is conducted in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed from 30 MHz up to the frequency required by the regulation specified on page 1. One or more of these is with the antenna polarized vertically while the one or more of these is with the antenna polarized horizontally. During the preliminary scans, the EUT is rotated through 360°, the antenna height is varied and cable positions are varied to determine the highest emission relative to the limit.

A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth, which results in the highest emission is then maintained while varying the antenna height from one to four meters. The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain. Emissions, which have values close to the specification limit may also be measured with a tuned dipole antenna to determine compliance.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions are given in units of microvolts, and the limits for radiated emissions are given in units of microvolts per meter at a specified test distance. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBuV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBuV/m). The results are then converted to the linear forms of uV and uV/m for comparison to published specifications.

For reference, converting the specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. These limits in both linear and logarithmic form are as follows:

CONDUCTED EMISSIONS SPECIFICATION LIMITS, SECTION 15.207 & 15.107(a)

The table below shows the limits for the emissions on the AC power line from an intentional radiator and a receiver.

Frequency (MHz)	Average Limit (dBuV)	Quasi Peak Limit (dBuV)
0.150 to 0.500	Linear decrease on logarithmic frequency axis between 56.0 and 46.0	Linear decrease on logarithmic frequency axis between 66.0 and 56.0
0.500 to 5.000	46.0	56.0
5.000 to 30.000	50.0	60.0

CONDUCTED EMISSIONS SPECIFICATION LIMITS, RSS 210

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

FUNDAMENTAL AND HARMONIC LIMITS 15.231 (b) / RSS 210 Table 1

The table below shows the limits for both the Fundamental and Harmonic emissions for each frequency band of operation detailed in Section 15.231 (b) for control signals.

Operating Frequency (MHz)	Field strength (microvolts/m)	Harmonics (microvolts/m)
70 - 130	1250	125
130 - 174	1250 - 3750	125 - 375
174 – 260	3750	375
260 – 470	3750 – 12,500	375 - 1250
Above 470	12,500	1250

FUNDAMENTAL AND HARMONIC LIMITS 15.231 (e)/RSS 210 Table 4

The table below shows the limits for both the Fundamental and Harmonic emissions (that do not fall in restricted bands) for each frequency band of operation detailed in Section 15.231 (e) for data signals.

Operating Frequency (MHz)	Field strength (microvolts/m)	Harmonics (microvolts/m)
70 - 130	500	50
130 - 174	500 - 1500	50 - 150
174 – 260	1500	150
260 – 470	1500 – 5000	150 - 500
Above 470	5000	500

RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.209 / RSS 210 Table 3

The table below shows the limits for the spurious emissions from transmitters that fall in restricted bands and the limits for all emissions for a low power device operating under the general rules of RSS 210 and FCC Part 15 Subpart C.

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

RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.109 / RSS 210 Table 3 (RECEIVER)

The table below shows the limits for emissions from the receiver.

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

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

$$R_r - S = M$$

where:

R_r = Receiver Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

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 above 30MHz, 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

For electric field measurements below 30MHz the extrapolation factor is either determined by making measurements at multiple distances or a theoretical value is calculated using the formula:

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

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

1 Page

Radiated Emissions, 30 -4,500 MHz, 08-Jan-04
Engineer: Chris Byleckie

Manufacturer	Description	Model #	Assett #	Cal Due
Elliott Laboratories	Biconical Antenna, 30-300 MHz	EL30.300	773	18-Mar-04
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	24-Jan-04
Filtek	High Pass Filter, 1GHz	HP12/1000-5BA	956	11-Mar-04
Hewlett Packard	High Pass filter, 1.5GHz	P/N 84300-80037	1158	17-Apr-04
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	1242	09-Oct-04
Hewlett Packard	EMC Spectrum Analyzer, 9KHz - 22GHz	8593EM	1319	20-Nov-04
EMCO	Log Periodic Antenna, 0.2-2 GHz	3148	1321	31-Mar-04
Rohde & Schwarz	Test Receiver, 0.009-2000 MHz	ESN	1332	24-Jul-04

Conducted Emissions - AC Power Ports, 08-Jan-04
Engineer: Chris Byleckie

Manufacturer	Description	Model #	Assett #	Cal Due
Fischer Custom Comm.	LISN, Freq. 0.9 -30 MHz,16 Amp	FCC-LISN-50/250-16-2	1079	01-Jul-04
Rohde & Schwarz	Test Receiver, 0.009-2000 MHz	ESN	1332	24-Jul-04
Rohde& Schwarz	Pulse Limiter	ESH3 Z2	1398	10-Jan-04

EXHIBIT 2: Test Measurement Data

The following data includes conducted emission measurements of the Savi Technology, Inc. model EchoPoint Series SR-650-101 Fixed Reader and maximized radiated emissions measurements of the complete system.

T53969 12 Pages

Elliott

EMC Test Data

Client:	Savi	Job Number:	J53950
Model:	SR-650-101	T-Log Number:	T53969
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Emissions Spec:	EN 301 893-4; FCC 15	Class:	B
Immunity Spec:	EN 301 893-4	Environment:	-

EMC Test Data

For The

Savi

Model

SR-650-101

Date of Last Test: 1/23/2004

Client:	Savi	Job Number:	J53950
Model:	SR-650-101	T-Log Number:	T53969
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Emissions Spec:	EN 301 893-4; FCC 15	Class:	B
Immunity Spec:	EN 301 893-4	Environment:	-

EUT INFORMATION

General Description

The EUT is an RFID tag reader which is designed to track asset tags that use Savi's 433.92 MHz transceivers. Normally, the EUT would be pole-mounted during operation. The EUT was treated as table-top equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 92-125/184-250 VAC, 50/60 Hz, 300 mA, 12-24 VDC, 500 mA.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Savi Technology	SR-650-101	Fixed Reader	0001	KL7-650R-V1

Other EUT Details

For EN 301 893 purposes the device is considered to be Class 2 equipment.

EUT Enclosure

The EUT enclosure is primarily constructed of plastic. It has a diameter of 30 cm (12 in.) and a height of 14 cm (5.5 in.).

Modification History

Mod. #	Test	Date	Modification
1	-	-	None

Modifications applied are assumed to be used on subsequent tests unless otherwise stated as a further modification.

Elliott

EMC Test Data

Client:	Savi	Job Number:	J53950
Model:	SR-650-101	T-Log Number:	T53969
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Emissions Spec:	EN 301 893-4; FCC 15	Class:	B
Immunity Spec:	EN 301 893-4	Environment:	-

Test Configuration #1 (emissions)

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None				

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
Savi	410R	SaviReader		
IBM	2635	Laptop PC	78-VA248 97/11	

Interface Cabling and Ports

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
Ethernet	Laptop	CAT 5	Unshielded	30
Savi Net In	410R	multiwire	Unshielded	30
Savi Net thru	410R	multiwire	Unshielded	30
AC in	AC Mains	3 wire	Unshielded	2

Note: The RS-232 port was not connected as the manufacturer stated that this is for configuration and servicing purposes and therefore would not normally be connected.

EUT Operation During Emissions

The EUT was continuously transmitting for transmitter mode tests. For receiver/digital device tests the EUT was pinged by the laptop and in a receive mode.

Client:	Savi	Job Number:	J53950
Model:	SR-650-101	T-Log Number:	T53969
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Spec:	EN 301 893-4; FCC 15	Class:	B

Radiated Emissions - Transmitter Fundamental and Spurious

Test Specifics

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

Date of Test: 1/8/2004
Test Engineer: Chris Byleckie
Test Location: SV OATS # 2
Config. Used: 1
Config Change: None
EUT Voltage: 120V/60Hz

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated emissions testing. Remote support equipment was located approximately 30 meters from the test area with all I/O connections running on top of the groundplane.

Unless otherwise specified, the measurement antenna was located 3 meters from the EUT.

Ambient Conditions:

Temperature: 16 °C
Rel. Humidity: 56 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 30 -4300 MHz, Wake-Up Transmissions	FCC 15.231(a) / RSS 210	Pass	57.7dBuV/m@867.8 MHz (-3.1dB)
2	RE, 30 -4300 MHz, Control and Data Transmissions	FCC 15.231(e) / RSS 210	Pass	50.5dBuV/m@867.8 MHz (-2.4dB)
3	Second Harmonic	IEC 60601-1-2	Fail	**+4.7dB @ 867.8MHz**
4	20dB Bandwidth	FCC 15.231	Pass	440 kHz

Modifications Made During Testing:

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Elliott

EMC Test Data

Client:	Savi	Job Number:	J53950
Model:	SR-650-101	T-Log Number:	T53969
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Spec:	EN 301 893-4; FCC 15	Class:	B

Run #1: Radiated Emissions, 30-4300 MHz - Wake-Up Control Signal

Note: the Wake-Up signal is a continuous signal that is transmitted for 2.5 seconds on the first transmitter and then 2.5 seconds on the second transmitter. See note 1.

Fundamental - Tx #1

Frequency	Level	Pol	FCC 15.231(a)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
433.920	76.7	v	100.8	-24.1	Pk	179	1.0	
433.920	76.6	v	80.8	-4.2	Avg	179	1.0	
433.920	77.1	h	100.8	-23.7	Pk	269	1.0	
433.920	77.0	h	80.8	-3.8	Avg	269	1.0	

Measurements of spurious emissions made with the highest output transmitter active (note 1).

Frequency	Level	Pol	FCC 15.231 (a)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
867.840	57.7	v	60.8	-3.1	Avg	271	1.1	
867.840	57.8	v	80.8	-23.0	Pk	271	1.1	
1301.760	31.4	v	54.0	-22.6	Avg	0	1.0	In restricted band
1301.760	44.0	v	74.0	-30.0	Pk	0	1.0	In restricted band
1735.680	38.7	v	60.8	-22.1	Avg	0	1.0	
1735.680	48.5	v	80.8	-32.3	Pk	0	1.0	
2169.600	38.3	v	60.8	-22.5	Avg	0	1.0	Noise floor
2169.600	50.6	v	80.8	-30.2	Pk	0	1.0	Noise floor
3037.440	39.5	v	60.8	-21.3	Avg	0	1.0	Noise floor
3037.440	51.8	v	80.8	-29.0	Pk	0	1.0	Noise floor
867.840	55.4	h	60.8	-5.4	Avg	67	1.0	
867.840	55.5	h	80.8	-25.3	Pk	67	1.0	
1301.760	31.6	h	54.0	-22.4	Avg	0	1.0	In restricted band
1301.760	43.8	h	74.0	-30.2	Pk	0	1.0	In restricted band
1735.680	33.8	h	60.8	-27.0	Avg	0	1.0	Noise floor
1735.680	46.2	h	80.8	-34.6	Pk	0	1.0	Noise floor
2169.600	38.4	h	60.8	-22.4	Avg	0	1.0	Noise floor
2169.600	51.9	h	80.8	-28.9	Pk	0	1.0	Noise floor
3037.440	41.5	h	60.8	-19.3	Avg	0	1.0	Noise floor
3037.440	54.8	h	80.8	-26.0	Pk	0	1.0	Noise floor

Note 1:	Preliminary measurements on both transmitters demonstrated that transmitter #1 produced the highest signal level. All measurements were, therefore, made on transmitter # 1.
Note 2:	Peak and average measurements below 1GHz made using the test receiver's detectors and a 120kHz bandwidth. Peak measurements above 1GHz were made using RBW=VBW=1MHz. The VBW was reduced to 10Hz for average measurements.

Client:	Savi	Job Number:	J53950
Model:	SR-650-101	T-Log Number:	T53969
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Spec:	EN 301 893-4; FCC 15	Class:	B

Run #3: Radiated Emissions, 30-4300 MHz -Pulsed Data and Control Signal

The EUT transmits four different control commands (Wake-Up, Hello, Sleep and Find) plus data signals. Apart from the wake-up command (measured above in run #1) which is a continuous signal, all other commands have a duty cycle that is less than 30mS in a 100ms period. The Theory of Operations details how the different types of transmissions meet the timing requirements for control signals or data signals.

The limit for control signals is specified in 15.231(a) and for data signals in 15.231(e). As the 15.231(e) limit is more stringent than the 15.231(a) limit, the unit was placed into a continuous transmit mode and the measurements were made against the limits of 15.231(e) for the pulsed control and data signals.

Average readings were calculated from the peak readings by applying a duty cycle correction factor based on the highest duty cycle of all pulsed transmissions (30% in any 100mS period equals a duty cycle correction of -10.5dB). By meeting the limit for data signals, all of the pulsed transmission meet the requirements with respect to field strength of fundamental and spurious emissions for both control and data signals.

Fundamental

Frequency	Level	Pol	FCC 15.231(e)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
433.920	71.1	v	72.9	-1.8	Avg	0	1.3	EUT on its back
433.920	70.9	h	72.9	-2.0	Avg	264	1.0	EUT on its back
433.920	81.6	v	92.9	-11.3	Pk	0	1.3	EUT on its back
433.920	81.4	h	92.9	-11.5	Pk	264	1.0	EUT on its back

Measurements of spurious emissions made with the highest output transmitter active (note 1).

Frequency	Level	Pol	FCC 15.231 (e)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
867.840	50.5	v	52.9	-2.4	Avg	268	1.1	Note 2
867.840	46.0	h	52.9	-6.9	Avg	67	1.1	Note 2
1735.680	43.2	v	54.0	-10.8	Avg	348	1.0	
3037.440	42.3	v	54.0	-11.7	Avg	0	1.0	Noise floor
867.840	61.0	v	72.9	-11.9	Pk	268	1.1	
3037.440	40.6	h	54.0	-13.4	Avg	0	1.0	Noise floor
2169.600	40.4	v	54.0	-13.6	Avg	0	1.0	Noise floor
2169.600	40.1	h	54.0	-13.9	Avg	0	1.0	Noise floor
1735.680	39.9	h	54.0	-14.1	Avg	145	1.0	
867.840	56.5	h	72.9	-16.4	Pk	67	1.1	
1301.760	36.9	v	54.0	-17.1	Avg	85	1.0	Restricted band
1301.760	35.0	h	54.0	-19.0	Avg	0	1.3	Restricted band
1735.680	53.7	v	74.0	-20.3	Pk	348	1.0	
3037.440	52.8	v	74.0	-21.2	Pk	0	1.0	Noise floor
3037.440	51.1	h	74.0	-22.9	Pk	0	1.0	Noise floor
2169.600	50.9	v	74.0	-23.1	Pk	0	1.0	Noise floor
2169.600	50.6	h	74.0	-23.4	Pk	0	1.0	Noise floor
1735.680	50.4	h	74.0	-23.6	Pk	145	1.0	
1301.760	47.4	v	74.0	-26.6	Pk	85	1.0	Restricted band
1301.760	45.5	h	74.0	-28.5	Pk	0	1.3	Restricted band

test notes are on the following page ...

Client:	Savi	Job Number:	J53950
Model:	SR-650-101	T-Log Number:	T53969
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Spec:	EN 301 893-4; FCC 15	Class:	B

...test notes for run #2

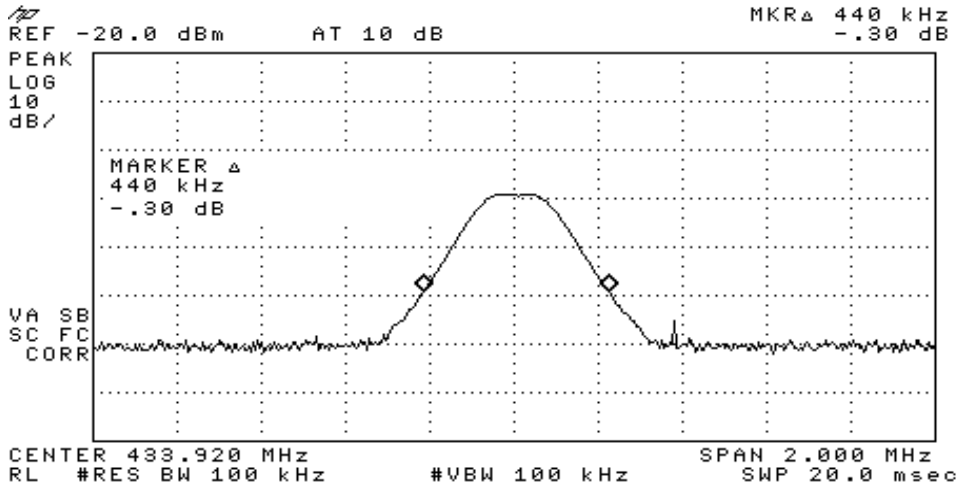
Note 1:	Preliminary measurements on both transmitters demonstrated that transmitter #1 produced the highest signal level. All measurements were made on transmitter # 1.
Note 2:	Average measurements are calculated from the peak reading by subtracting 10.5dB to account for a 30% duty cycle. Peak readings made using RBW=VBW = 120kHz below 1GHz, RBW=VBW=1MHz above 1GHz.

Run #3: Radiated Emissions, 30-1000 MHz - Harmonics versus IEC 60601-1-2 limit.

The highest signal level at the second harmonic from the previous runs was measured at 10m:

Frequency	Level	Pol	EN55011 A		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
867.840	51.7	v	47.0	**4.7**	QP	356	1.7	
867.840	49.5	h	47.0	**2.5**	QP	54	1.0	

Run #4: 20dB Bandwidth



Client:	Savi	Job Number:	J53950
Model:	SR-650-101	T-Log Number:	T53969
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Spec:	EN 301 893-4; FCC 15	Class:	B

Radiated Emissions - Receiver Spurious & Digital Device

Test Specifics

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

Date of Test: 1/8/2004
Test Engineer: Chris Byleckie
Test Location: SV OATS # 2
Config. Used: 1
Config Change: None
EUT Voltage: 120V/60Hz

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated emissions testing. Remote support equipment was located approximately 30 meters from the test area with all I/O connections running on top of the groundplane.

Unless otherwise specified, the measurement antenna was located 3 meters from the EUT.

Note, **preliminary** testing indicates that the emissions were maximized by orientation of the EUT and elevation of the measurement antenna. **Maximized** testing indicated that the emissions were maximized by orientation of the EUT, elevation of the measurement antenna, and manipulation of the EUT's interface cables.

Note, for testing above 1 GHz, the FCC specifies the limit as an average measurement. In addition, the FCC states that the peak reading of any emission above 1 GHz, can not exceed the average limit by more than 20 dB.

Ambient Conditions:

Temperature: 16 °C
Rel. Humidity: 56 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
2	RE, 30 - 2000 MHz, Digital Device Emissions	FCC 15.109 / RSS 210	Pass	-12.9dB @ 92.156MHz
2	RE, 30 - 2000 MHz, Receiver Spurious Emissions	FCC 15.109 / RSS 210	Pass	-20.4dB @ 846.440MHz
3	RE, 30 - 1000 MHz	IEC 60601-1-2 Class A	Pass	-16.4dB @ 92.156MHz

Modifications Made During Testing:

No modifications were made to the EUT during testing

Client:	Savi	Job Number:	J53950
Model:	SR-650-101	T-Log Number:	T53969
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Spec:	EN 301 893-4; FCC 15	Class:	B

Deviations From The Standard

No deviations were made from the requirements of the standard.

Run #1: Radiated Emissions, 30-2000 MHz - Receive Mode

Frequency	Level	Pol	FCC15.109/RSS 210		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
92.156	30.6	V	43.5	-12.9	QP	0	1.0	Signal substitution
66.818	20.2	H	40.0	-19.8	QP	0	1.0	Signal substitution
846.440	25.6	v	46.0	-20.4	QP	0	1.0	Lo 2nd
423.220	24.6	v	46.0	-21.4	QP	177	1.0	LO
161.528	20.8	H	43.5	-22.7	QP	127	2.8	
846.440	21.2	h	46.0	-24.8	QP	0	1.5	Lo 2nd
139.416	18.2	H	43.5	-25.3	QP	58	1.7	
423.220	20.6	h	46.0	-25.4	QP	226	1.7	LO
46.072	14.1	H	40.0	-25.9	QP	0	2.0	Noise floor
39.993	13.5	H	40.0	-26.5	QP	50	1.8	
35.306	10.6	H	40.0	-29.4	QP	0	2.0	Noise floor
149.150	13.3	H	43.5	-30.2	QP	0	2.0	Noise floor
114.185	12.9	H	43.5	-30.6	QP	0	1.0	Noise floor

Note 1:	**The third harmonic of the LO was more than 20dB below the limit.**

Run #2: Maximized Readings From Run #1

Frequency	Level	Pol	FCC15.109/RSS 210		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
92.156	30.6	V	43.5	-12.9	QP	0	1.0	Signal substitution
66.818	20.2	H	40.0	-19.8	QP	0	1.0	Signal substitution
846.440	25.6	v	46.0	-20.4	QP	0	1.0	Lo 2nd
423.220	24.6	v	46.0	-21.4	QP	177	1.0	LO
161.528	20.8	H	43.5	-22.7	QP	127	2.8	
846.440	21.2	h	46.0	-24.8	QP	0	1.5	Lo 2nd

Elliott

EMC Test Data

Client:	Savi	Job Number:	J53950
Model:	SR-650-101	T-Log Number:	T53969
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Spec:	EN 301 893-4; FCC 15	Class:	B

Run #3: Radiated Emissions,IEC 60601-1-2 Class A limit.

The highest signal level at the second harmonic from the previous runs was measured at 10m:

Frequency	Level	Pol	EN55011 A		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
92.156	30.6	V	47.0	-16.4	QP	0	1.0	Signal substitution
846.440	25.6	v	47.0	-21.4	QP	0	1.0	Lo 2nd
423.220	24.6	v	47.0	-22.4	QP	177	1.0	LO
846.440	21.2	h	47.0	-25.8	QP	0	1.5	Lo 2nd
161.528	20.8	H	47.0	-26.2	QP	127	2.8	
66.818	20.2	H	47.0	-26.8	QP	0	1.0	Signal substitution

Note - measurements made at 3m and compared to the EN 55011 Class A limit for a 10m measurement.

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EMC Test Data

Client:	Savi	Job Number:	J53950
Model:	SR-650-101	T-Log Number:	T53969
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Spec:	EN 301 893-4; FCC 15	Class:	B

Conducted Emissions - Power Ports

Test Specifics

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

Date of Test: 1/8/2004
Test Engineer: Chris Byleckie
Test Location: SVOATS #2

Config. Used: 1
Config Change: Nonoe
EUT Voltage: 120V/60Hz

General Test Configuration

For tabletop equipment, the EUT was located on a wooden table, 40 cm from a vertical coupling plane and 80cm from the LISN. Remote support equipment was located approximately 30 meters from the test area. All I/O connections were running on top of the groundplane.

Ambient Conditions:

Temperature: 16 °C
Rel. Humidity: 56 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
2	CE, AC Power,120V/60Hz	15.207 / EN 301 489-3	Pass	-1.8dB @ 0.414MHz
2	CE, AC Power,120V/60Hz	RSS210	Pass	-5.1dB @ 0.513MHz

Modifications Made During Testing:

Modifications are detailed under each run description.

Deviations From The Standard

No deviations were made from the requirements of the standard.

Elliott

EMC Test Data

Client:	Savi	Job Number:	J53950
Model:	SR-650-101	T-Log Number:	T53969
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Spec:	EN 301 893-4; FCC 15	Class:	B

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

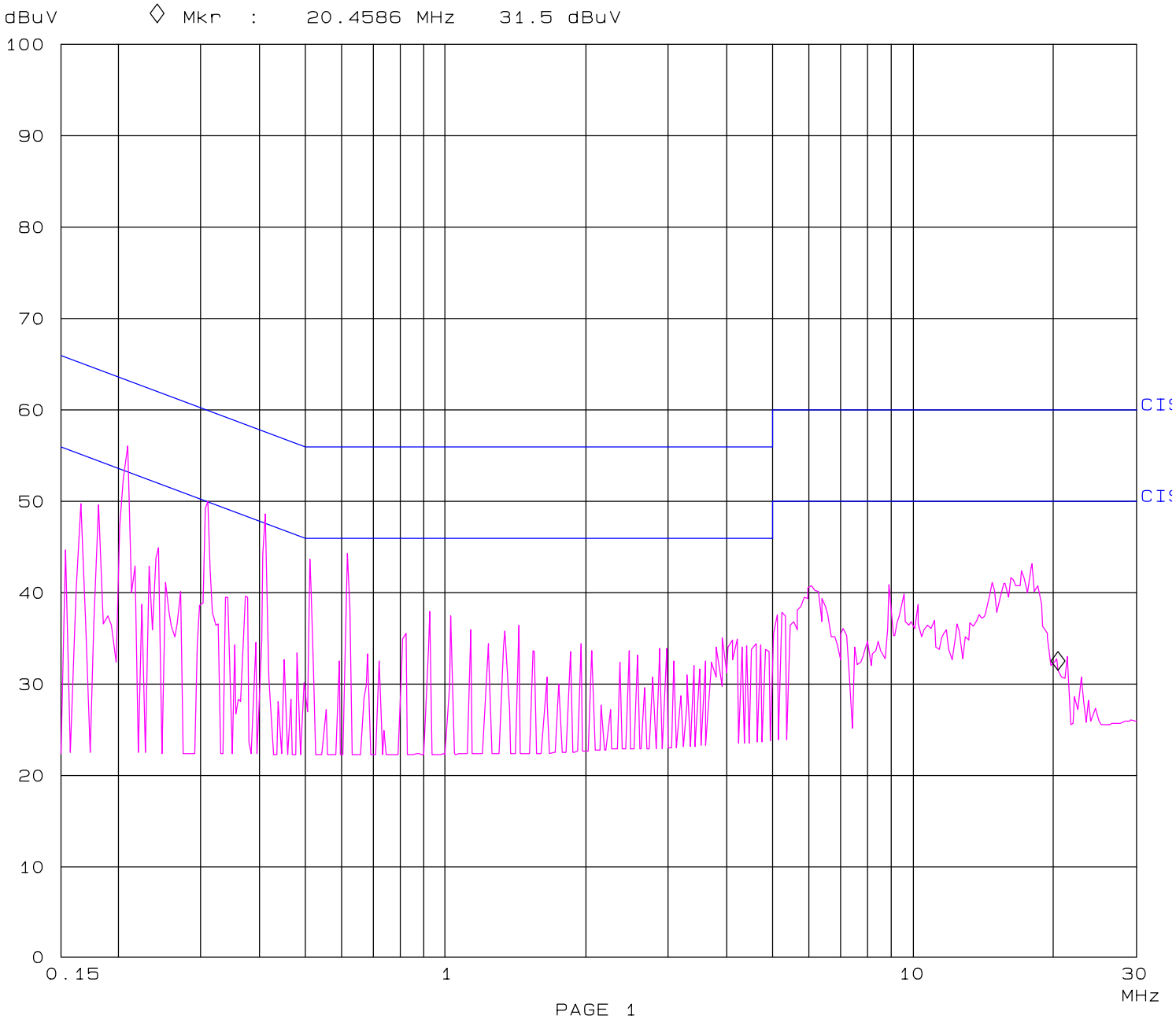
Frequency	Level	AC	EN55022 B/15.207		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.414	45.8	Line	47.6	-1.8	Average	
0.204	51.0	Line	53.4	-2.4	Average	
0.414	44.8	Neutral	47.6	-2.8	Average	
0.207	50.3	Neutral	53.3	-3.0	Average	
0.309	44.1	Line	50.0	-5.9	Average	
0.309	42.7	Neutral	50.0	-7.3	Average	
0.204	55.6	Line	63.4	-7.8	QP	
0.207	54.8	Neutral	63.3	-8.5	QP	
0.414	46.4	Line	57.6	-11.2	QP	
0.414	45.5	Neutral	57.6	-12.1	QP	
0.309	47.0	Line	60.0	-13.0	QP	
0.309	45.8	Neutral	60.0	-14.2	QP	

Frequency	Level	AC	RSS210		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.513	42.9	Line	48.0	-5.1	QP	
0.513	41.6	Neutral	48.0	-6.4	QP	
0.925	41.3	Line	48.0	-6.7	QP	
17.166	40.7	Neutral	48.0	-7.3	QP	
17.261	40.1	Line	48.0	-7.9	QP	
6.060	38.8	Line	48.0	-9.2	QP	
6.063	38.3	Neutral	48.0	-9.7	QP	
0.925	36.3	Neutral	48.0	-11.7	QP	

Elliott Laboratories
Ac Conducted Emissions

26. Jan 04 19:43

EUT:	SR-650-101
Manuf:	Savi
Op Cond:	120V/60hz
Operator:	Mark Briggs
Test Spec:	Class B
Comment:	T54193
	Run 2 - Neutral

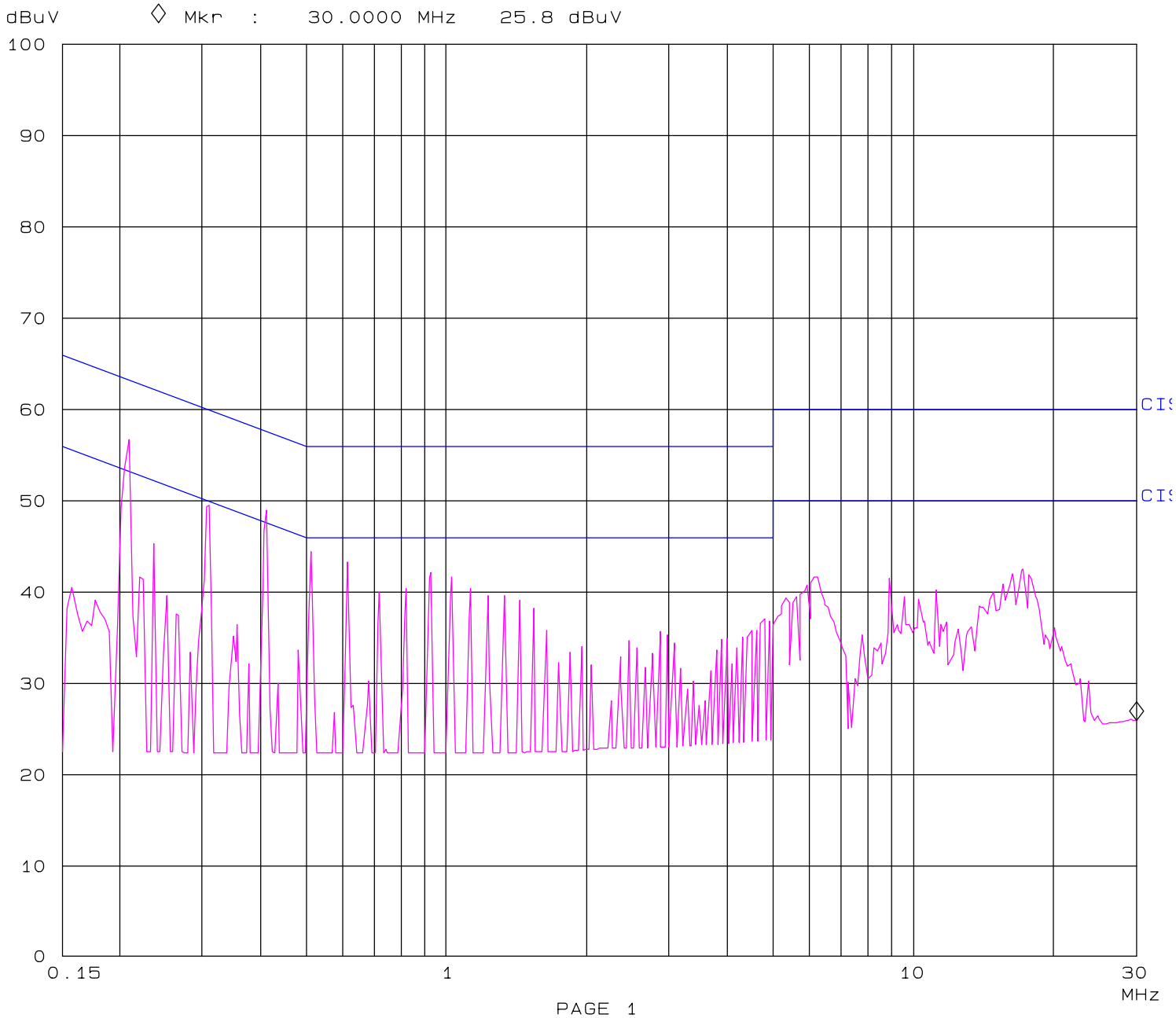


Elliott Laboratories

Ac Conducted Emissions

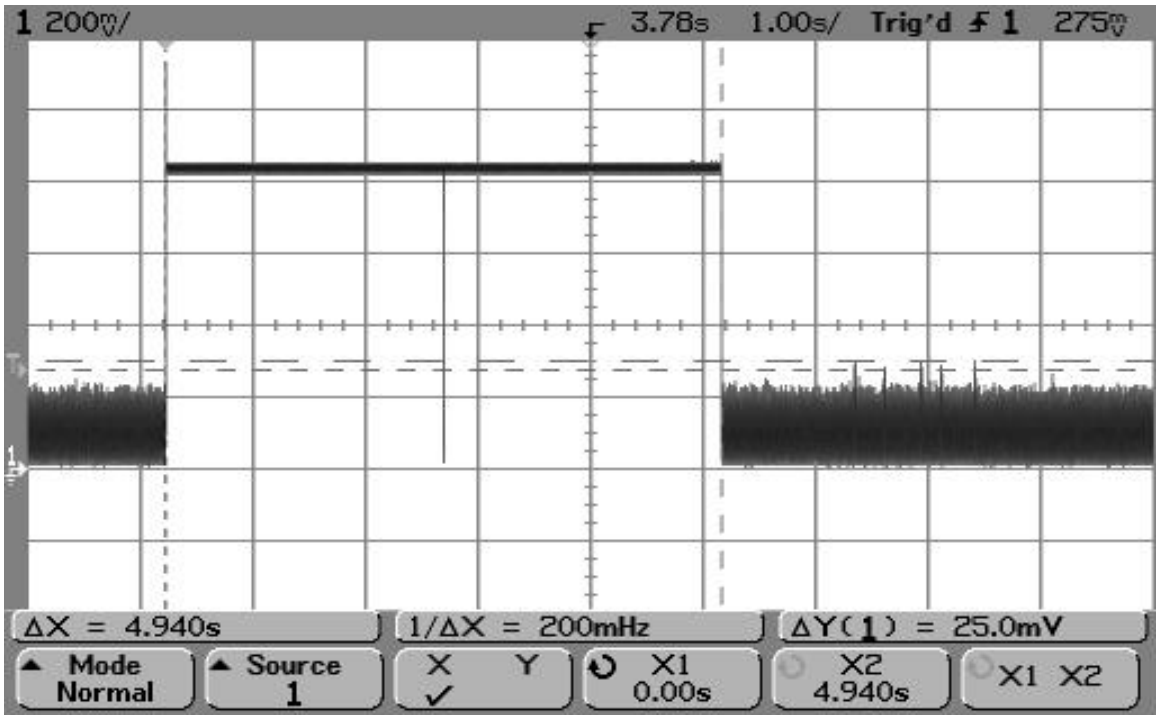
26. Jan 04 19:30

EUT:	SR-650-101
Manuf:	Savi
Op Cond:	120V/60hz
Operator:	Mark Briggs
Test Spec:	Class B
Comment:	T54193
	Run **2** - Line

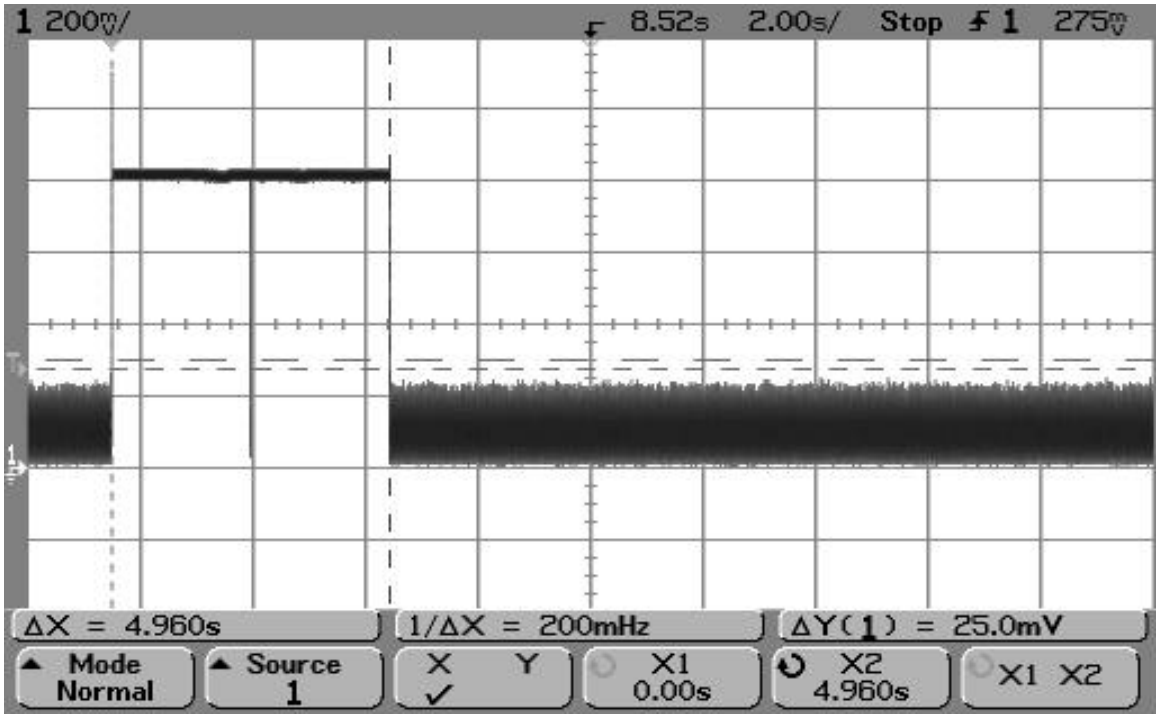


SR-650-101 Duty Cycle Plots

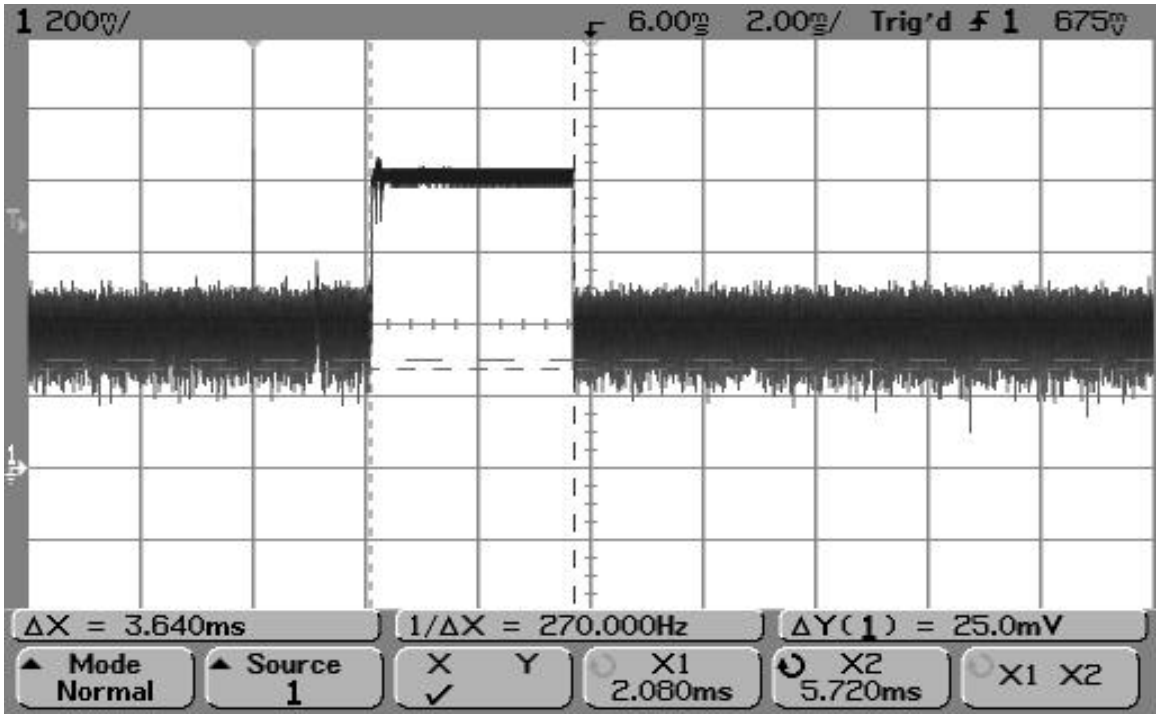
SR-650-101 Wake-Up Pulse of less than 5 seconds



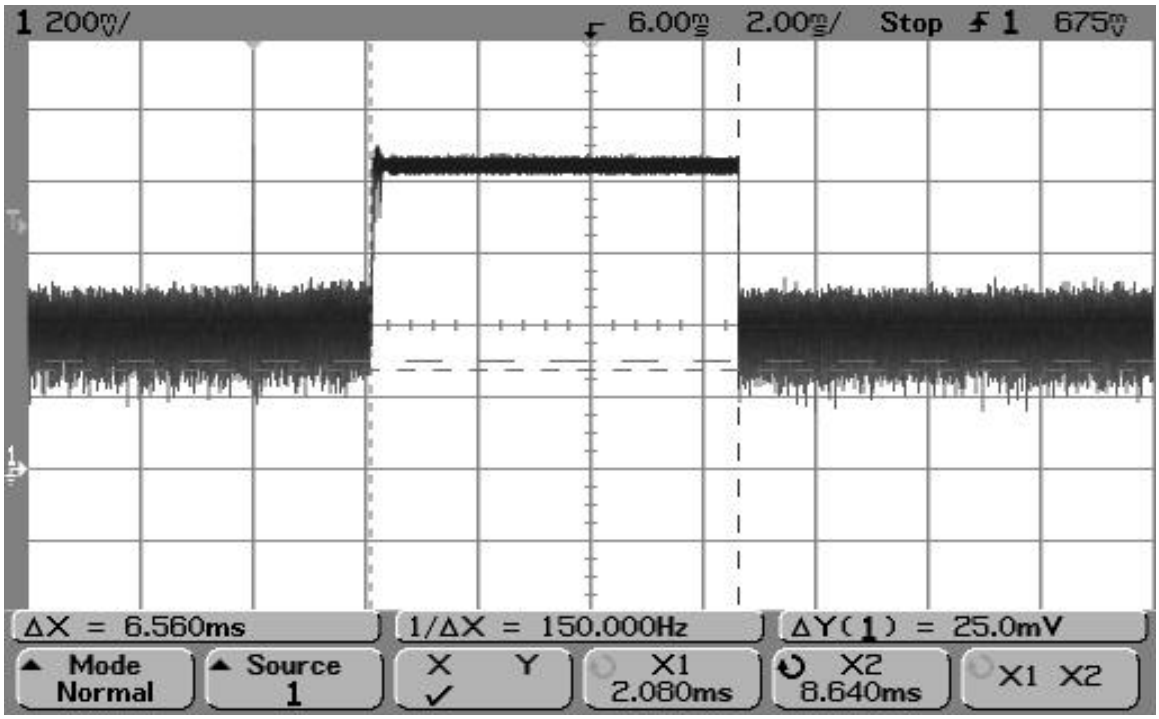
SR-650-101 Wake-Up Pulse over 20 second period



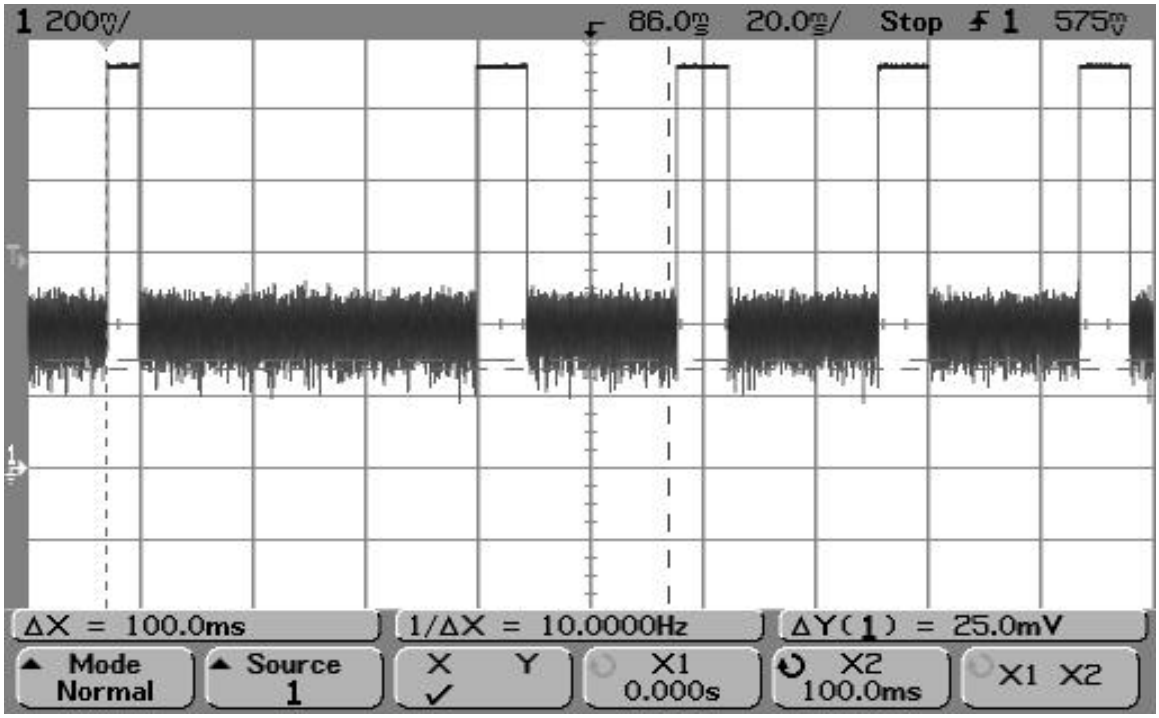
SR-650-101: Hello Pulse (3.64 msec)



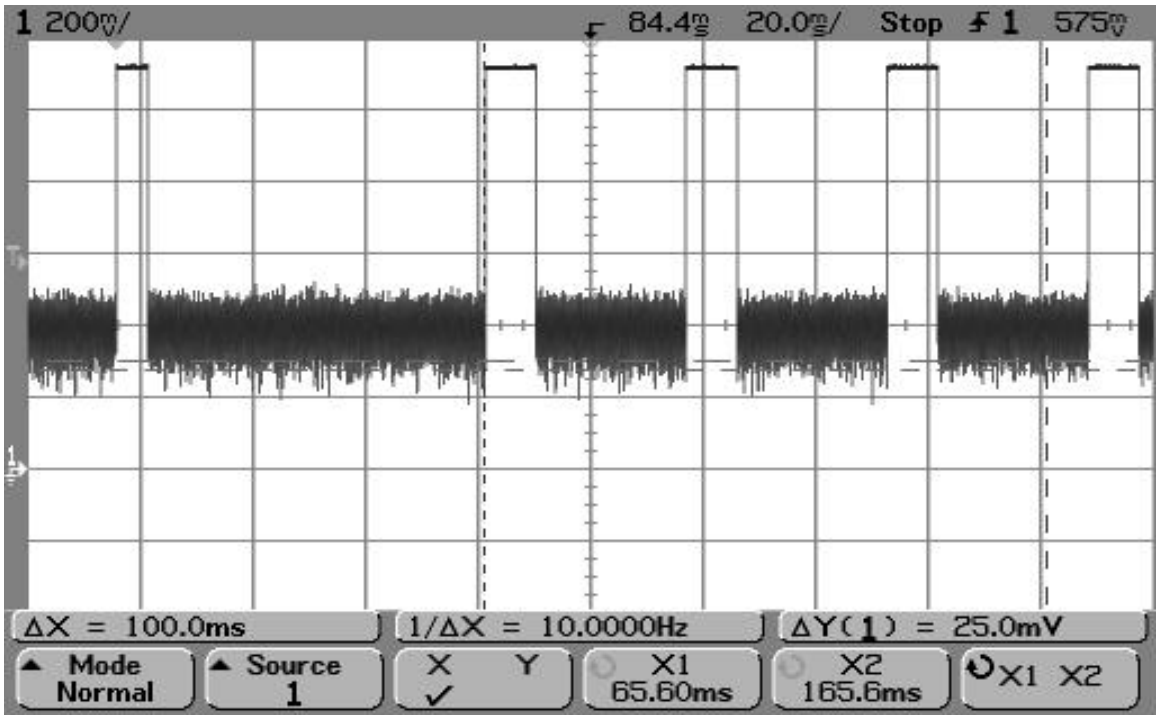
SR-650-101: Sleep Pulse (6.56 msec)



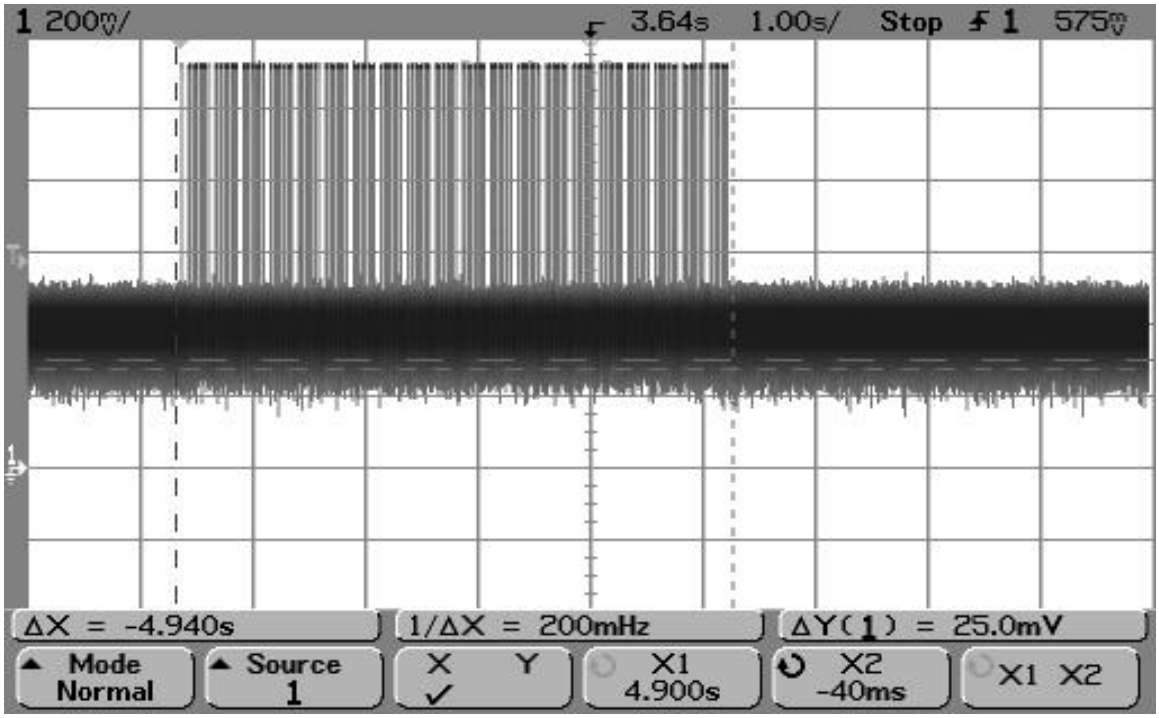
SR-650-101: Maximum number of Hello and Sleep Pulses in a 100 msec period



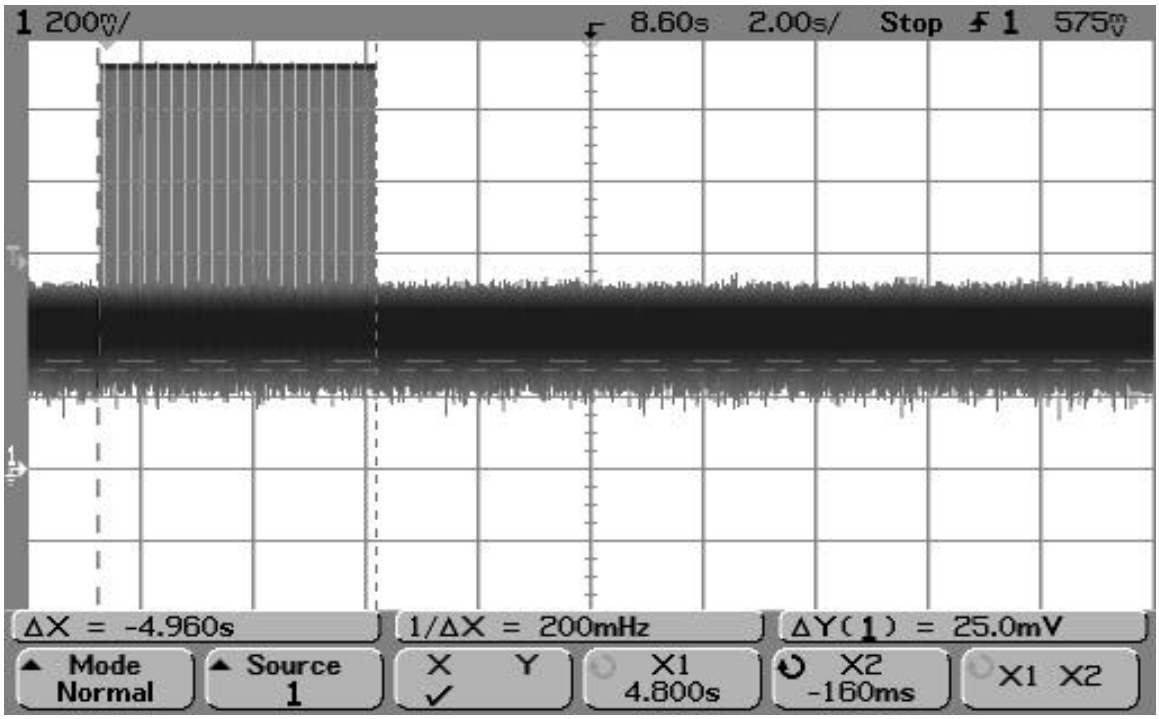
SR-650-101: Maximum number of Sleep Pulses in a 100 msec period



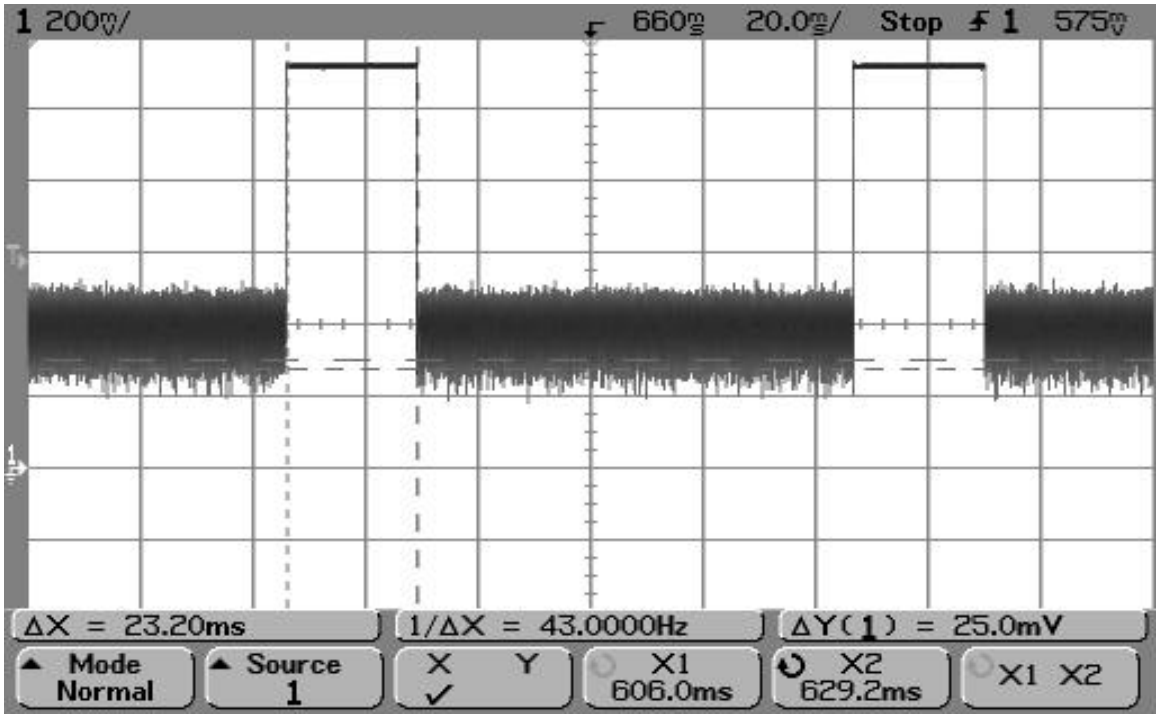
SR-650-101: Hello and Sleep Transmissions - 5 second limit (over 10 second period)



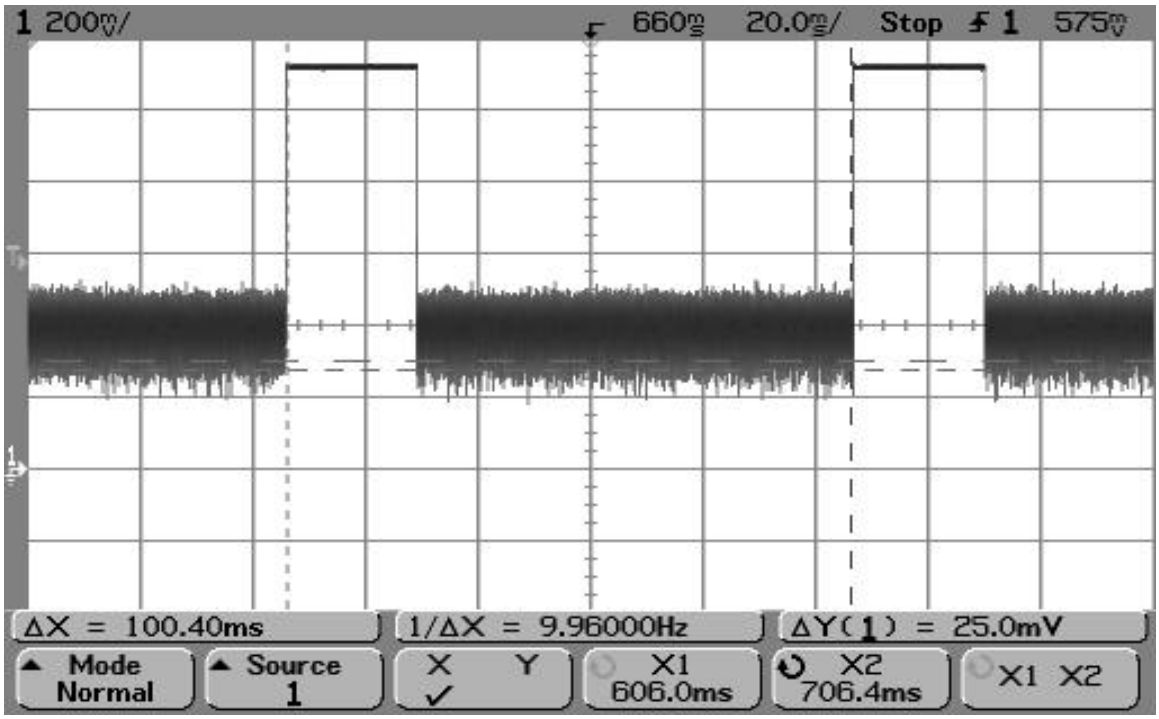
SR-650-101: Hello and Sleep Transmissions - 5 second limit (over 20 second period)



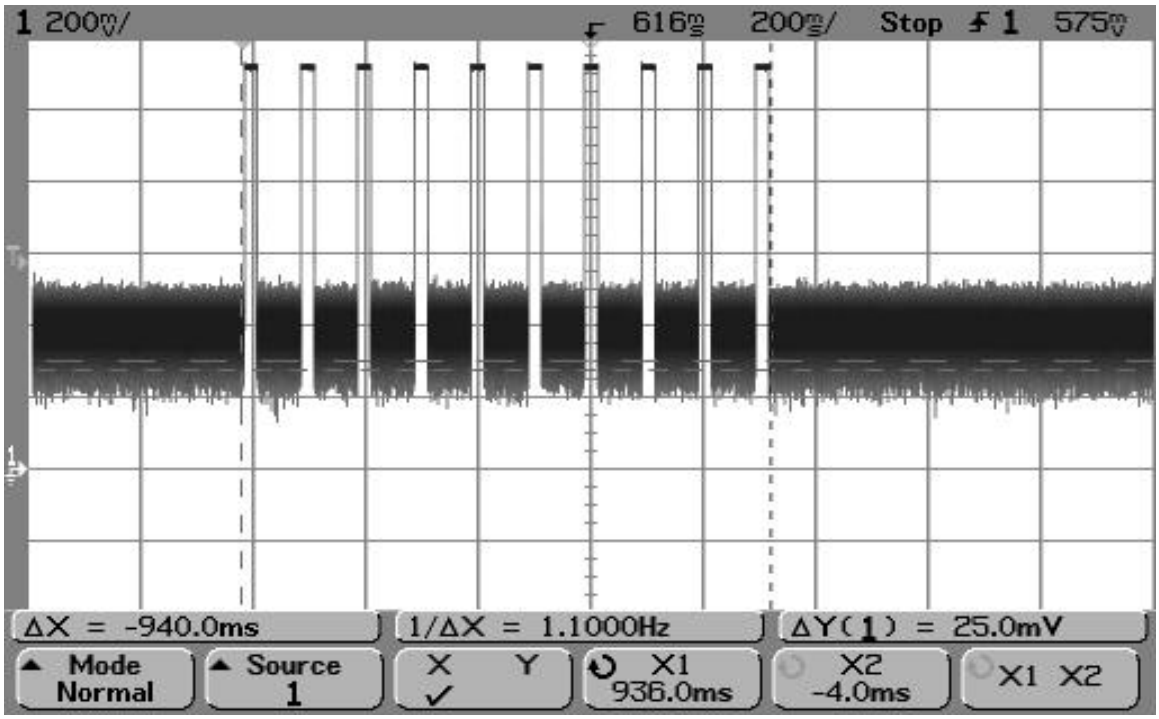
SR-650-101: Data Pulse (23.2 msec)



SR-650-101: Number of Data Pulses in 100 msec period



SR-650-101: Maximum Data Pulses in one second period



SR-650-101: 30 second silent period between Data Transmissions

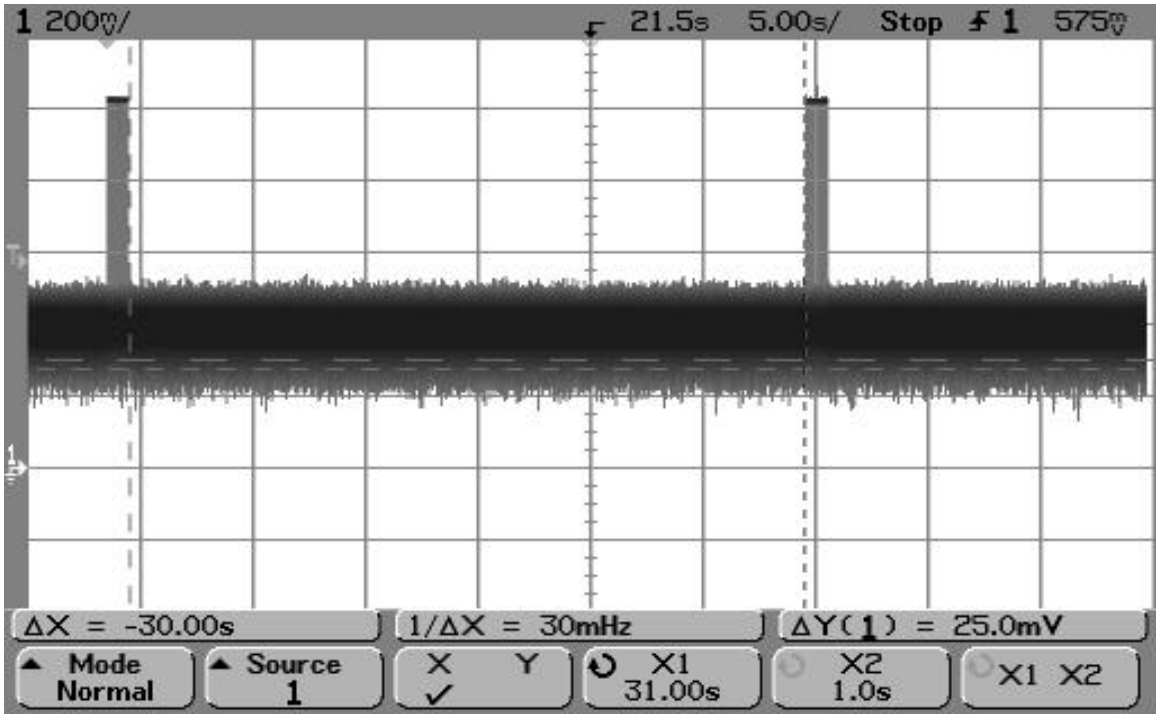


EXHIBIT 3: Test Configuration Photographs

Uploaded as A Separate Attachment

EXHIBIT 4: Label and Label Locattion

Uploaded as A Separate Attachment

EXHIBIT 5: Detailed Photographs of Savi Technology, Inc. Model EchoPoint Series SR-650-101 Fixed Reader Construction

Uploaded as A Separate Attachment

EXHIBIT 6: Block Diagram of Savi Technology, Inc. Model EchoPoint Series SR-650-101 Fixed Reader

EXHIBIT 7: Schematic Diagrams of Savi Technology, Inc. Model EchoPoint Series SR-650-101 Fixed Reader

Uploaded as A Separate Attachment

EXHIBIT 8: Theory of Operation for Savi Technology, Inc. Model EchoPoint Series SR-650-101 Fixed Reader

EXHIBIT 9: Advertising Literature

Uploaded as A Separate Attachment

EXHIBIT 10: Operator's Manual

Uploaded as A Separate Attachment