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Electromagnetic Emissions Test Report and Application for Grant of Equipment Authorization pursuant to FCC Part 15, Subpart C Specifications for an Intentional Radiator and FCC Part 15, Subpart B Specifications for a Receiver on the Savi Technology, Inc. Model: ECHOPOINT READER, MODEL SR-640-101

FCC ID:	KL7-600R-V2
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 28, 2002
FINAL TEST DATE:	July 31, 2002

AUTHORIZED SIGNATORY: Mark Briggs

Mark Briggs
Director of Engineering

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SCOPE

An electromagnetic emissions test has been performed on the Savi Technology, Inc. model ECHOPOINT READER, MODEL SR-640-101 pursuant to Subpart C of Part 15 of FCC Rules for intentional radiators and Subpart B of Part 15 of FCC Rules for receivers. Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in ANSI C63.4-1992 as outlined in Elliott Laboratories test procedures.

The transceiver above has been tested in a simulated typical installation to demonstrate compliance with the relevant FCC performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

The test results recorded herein are based on a single type test of the Savi Technology, Inc. model ECHOPOINT READER, MODEL SR-640-101 and therefore apply only to the tested sample. The sample was selected and prepared by Eugene Schlindwein of Savi Technology, Inc.

OBJECTIVE

The primary objective of the manufacturer is compliance with Subparts B and C of Part 15 of FCC Rules for the radiated and conducted emissions of intentional radiators and receivers. Certification of these devices is required as a prerequisite to marketing as defined in Part 2 the FCC Rules.

Certification is a procedure where the manufacturer or a contracted laboratory makes measurements and submits the test data and technical information to the FCC. The FCC issues a grant of equipment authorization upon successful completion of their review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

STATEMENT OF COMPLIANCE

The tested sample of Savi Technology, Inc. model ECHOPOINT READER, MODEL SR-640-101 complied with the requirements of Subpart C of Part 15 of the FCC Rules for low power intentional radiators and the requirements of Subpart B of Part 15 of the FCC Rules for receivers operating between 30 MHz and 960 MHz.

Maintenance of FCC compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

EMISSION TEST RESULTS

The following emissions tests were performed on the Savi Technology, Inc. model ECHOPOINT READER, MODEL SR-640-101. 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 for an intentional radiator and Part 15 Section 15.107(a) for a receiver.

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.

120V/60Hz

Frequency MHz	Level dBuV	Power Lead	12.207 / 15.107(a) Limit	Margin	Detector QP/Ave	Comments
3.6876	29.7	Line 1	46.0	-16.3	AV	

LIMITS OF RADIATED FIELD STRENGTH - RECEIVER

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

The following measurement was extracted from the data recorded during the radiated electric field emissions scan and represents the highest amplitude emission relative to the specification limit. The actual test data and any correction factors are contained in an exhibit of this report.

30 – 1000 MHz

Frequency MHz	Level dBuV/m	Pol v/h	Class B Limit	Margin	Detector Pk/QP/Avg	Azimuth Degrees	Height Meters	Comments
423.252	28.0	v	46.0	-18.0	QP	360	1.2	Receiver LO

BANDWIDTH

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

DUTY CYCLE CALCULATION

Data signal transmissions consist of a pulse train of 23ms pulses, 1 pulse every 100ms (duty cycle = 23%). The pulse train transmission lasts for 0.94s and there is a silent period of 31s between successive transmissions, thereby meeting the timing requirements of 15.231(e).

The Wake-Up control signal lasts for 4.94 seconds and is a random transmission triggered by a motion detector or operator. The timing of this signal meets the requirements of 15.231(a).

The "Hello" control pulse lasts for 3.64ms and the "Sleep" control pulse lasts for 6.56ms. The maximum duty cycle of these transmissions is three "Sleep" pulses in any 100ms period (19.68ms per 100ms, or 20% duty cycle). The combination of a single "Hello" pulse plus "Sleep" pulses lasts for 4.94 seconds. As the transmission of these pulses is triggered by a collection event they are random in nature. The "Hello"/"Sleep" transmissions meet the timing requirements of 15.231(a).

PERIOD OF OPERATION

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.231(a) for control signals and 15.231(e) for data signals. Refer to the Theory of Operations for more details.

LIMITS OF RADIATED FIELD STRENGTH –INTENTIONAL RADIATOR

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

The following measurement was extracted from the data recorded during the radiated electric field emissions scan and represents the highest amplitude emission relative to the specification limit. The actual test data and any correction factors are contained in an exhibit of this report.

Wake-Up Control Signal, 30MHz – 4340MHz

Frequency MHz	Level dBuV/m	Pol v/h	15.231(a) Limit	15.231(a) Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
433.920	75.7	v	80.8	-5.1	Pk	333	1.4	Transmitter #2, Note 1

Data and Control Signals, 30MHz – 4340MHz

Frequency MHz	Level dBuV/m	Pol v/h	15.231(e) Limit	15.231(e) Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
433.920	70.7	H	72.9	-2.2	Avg	245	1.0	See note below

Note: A duty cycle correction factor of –10.5dB (corresponding to a duty cycle of 33%) was used at the time of the test. The actual worst-case duty cycle will be 23% for the data signals and 20% for the Hello and Sleep control signals. Both data and control signals were subjected to the more restrictive limits of 15.231(e). By meeting the 15.231(e) limits the control signals also met the requirements of 15.231(a).

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 ECHOPOINT READER, MODEL SR-640-101 is a transceiver, which is designed to operate at 433.92 MHz. The EUT can operate from either AC power (230V/50Hz or 120V/60Hz) or from dc power. In addition the system has mutually exclusive RS 232 and RS 485 interface ports. The RS 232 interface is intended to connect to an RS232 to ethernet adapter. The electrical rating of the EUT is 92-125/184-250 VAC, 50/60 Hz, 200/100 mA, 6-15 VDC, 300 mA.

The EUT is identical in all respects to Savi's previous version of the SR-640 except for a re-designed transmitter board.

The sample was received on July 31, 2002 and tested on July 31, 2002.

The EUT consisted of the following component(s):

Manufacturer	Model	Description	Serial Number	FCC ID
Savi	EchoPoint Reader, Model SR-640-101	433.92MHz Transceiver	40027	KL7-600R-V2

ENCLOSURE

The EUT enclosure is primarily constructed of plastic with an internal conductive paint coating. It measures approximately 30 cm (12 in.) diameter x 14 cm (5.5 in.) high.

SUPPORT EQUIPMENT

No local support equipment was used during emissions testing.

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

Manufacturer	Model	Description	Serial Number	FCC ID
IBM	2635	Laptop	78-VA24897/11	ANO9611TBOON

EXTERNAL I/O CABLING

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

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
AC Power	AC power	-	unshielded	2
RS485 In	Laptop	-	unshielded	30
RS485 through	SaviReader	-	unshielded	30

The system has both RS232 and RS485 interface ports. Only one interface protocol is supported at a time (i.e. they are mutually exlcusive). This test configuration was used for evaluating the RS 485 interface)

EUT OPERATION

Transmit Mode:

The system was configured to continuously transmit a CW signal at the maximum output power permitted in the current revision of firmware. The laptop was continuously acquiring data from the EUT.

Receive Mode:

The product was configured to receive with the transmitter disabled.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on July 31, 2002 at the Elliott Laboratories Open Area Test Site #3 located at 684 West Maude Avenue, Sunnyvale, California. The test site contains separate areas for radiated and conducted emissions testing. Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data has been filed with the Commission.

The FCC recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement with the exception of predictable local TV, radio, and mobile communications traffic. The test site contains separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent FCC requirements.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.4-1992. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment. The test site is maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 guidelines.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz.

INSTRUMENT CONTROL COMPUTER

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

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

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

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

FILTERS/ATTENUATORS

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

ANTENNAS

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

ANTENNA MAST AND EQUIPMENT TURNTABLE

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

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

INSTRUMENT CALIBRATION

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

TEST PROCEDURES

EUT AND CABLE PLACEMENT

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

CONDUCTED EMISSIONS

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

RADIATED EMISSIONS

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

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

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

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

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

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

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

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

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

FUNDAMENTAL AND HARMONIC LIMITS 15.231 (b)

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

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

FUNDAMENTAL AND HARMONIC LIMITS 15.231 (e)

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

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

RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.209

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

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

RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.109(a) (RECEIVER)

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

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

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

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

$$R_r - B = C$$

and

$$C - S = M$$

where:

R_r = Receiver Reading in dBuV

B = Broadband Correction Factor*

C = Corrected Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

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

SAMPLE CALCULATIONS - RADIATED EMISSIONS

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

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_s = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

EXHIBIT 1: Test Equipment Calibration Data

Conducted and Radiated Emissions, 31-Jul-02
Engineer: psales

Manufacturer	Description	Model #	Assett #	Cal interval	Last Calibrated	Cal Due
Elliott Laboratories	Biconical Antenna, 30-300 MHz	DM-105-T1	382	12	8/22/2001	8/22/2002
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	1242	12	10/9/2001	10/9/2002
EMCO	LISN, 10kHz-100MHz	3825/2	1292	12	4/24/2002	4/24/2003
EMCO	Log Periodic Antenna, 0.2-2 GHz	3148	1404	12	2/26/2002	2/26/2003
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	12	1/23/2002	1/23/2003
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	372	12	7/18/2002	7/18/2003
Hewlett Packard	Spectrum Analyzer, 9KHz - 22GHz	8593EM	1319	12	4/5/2002	4/5/2003
Rohde & Schwarz	Test Receiver, 0.009-30 MHz	ESH3	1316	12	5/6/2002	5/6/2003
Rohde & Schwarz	Test Receiver, 20-1300MHz	ESVP	273	12	2/6/2002	2/6/2003

EXHIBIT 2: Test Data Log Sheets

ELECTROMAGNETIC EMISSIONS

TEST LOG SHEETS

AND

MEASUREMENT DATA

T48115 11 Pages
Bandwidth and Timing Plots 7 Pages

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EMC Test Data

Client:	Savi	Job Number:	J47977
Model:	SR-640-101 Reader	T-Log Number:	T48115
		Proj Eng:	Mark Briggs
Contact:	Gene Schlindwein		
Emissions Spec:	FCC 15.231(a),(e); Subpart B	Class:	-
Immunity Spec:	EN 301 489-3	Environment:	-

EMC Test Data

For The

Savi

Model

SR-640-101 Reader

Client:	Savi	Job Number:	J47977
Model:	SR-640-101 Reader	T-Log Number:	T48115
		Proj Eng:	Mark Briggs
Contact:	Gene Schlindwein		
Emissions Spec:	FCC 15.231(a),(e); Subpart B	Class:	-
Immunity Spec:	EN 301 489-3	Environment:	-

EUT INFORMATION

General Description

The EUT is a transceiver which is designed to operate at 433.92 MHz. The EUT can operate from either AC power (230V/50Hz or 120V/60Hz) or from dc power. In addition the system has mutually exclusive RS 232 and RS 485 interface ports. The RS 232 interface is intended to connect to an RS232 to ethernet adapter.

The electrical rating of the EUT is 92-125/184-250 VAC, 50/60 Hz, 200/100 mA, 6-15 VDC, 300 mA

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Savi	SR-640-101	433.92MHz Transceiver	40027	KL7-600R-V2

EUT Enclosure

The EUT enclosure is primarily constructed of plastic with an internal conductive paint coating. It measures approximately 30 cm (12 in.) diameter x 14 cm (5.5 in.) high.

Modification History

Mod. #	Test	Date	Modification
1			

Client:	Savi	Job Number:	J47977
Model:	SR-640-101 Reader	T-Log Number:	T48115
		Proj Eng:	Mark Briggs
Contact:	Gene Schlindwein		
Emissions Spec:	FCC 15.231(a),(e); Subpart B	Class:	-
Immunity Spec:	EN 301 489-3	Environment:	-

Test Configuration #1

Local Support Equipment

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

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
IBM	2635	Laptop	78-VA24897/11	ANO9611TBOON

Interface Ports

		Cable(s)		
Port	Connected To	Description	Shielded or Unshielded	Length(m)
AC Power	AC power	-	unshielded	2
RS485 In	Laptop	-	unshielded	30
RS485 through	SaviReader	-	unshielded	30

EUT Operation During Emissions

Transmit Mode

The system was configured to continuously transmit a CW signal at the maximum output power permitted in the current revision of firmware. The laptop was continuously acquiring data from the EUT.

Receive Mode

The product was configured to receive with the transmitter disabled.

Client:	Savi	Job Number:	J47977
Model:	SR-640-101 Reader	T-Log Number:	T48115
		Proj Eng:	Mark Briggs
Contact:	Gene Schlindwein		
Spec:	FCC 15.231(a),(e); Subpart B	Class:	-

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: 7/31/2002
Test Engineer: Pete Sales
Test Location: SVOATS #3

Config. Used: 1
Config Change: None
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. A second LISN was used for all local support equipment. Remote support equipment was located approximately 30 meters away from the test area, with all I/O connections routed overhead.

Ambient Conditions:

Temperature: 23°C
Rel. Humidity: 59%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power 120V/60Hz	15.107/15.207	Pass	-16.3dB @ 3.688MHz

Modifications Made During Testing:

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

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EMC Test Data

Client:	Savi	Job Number:	J47977
Model:	SR-640-101 Reader	T-Log Number:	T48115
		Proj Eng:	Mark Briggs
Contact:	Gene Schlindwein		
Spec:	FCC 15.231(a),(e); Subpart B	Class:	-

Run #1: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz

Frequency	Level	AC	15.107 / 15.207		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
3.6876	29.7	Line 1	46.0	-16.3	AV	
0.5662	34.3	Neutral	56.0	-21.7	QP	
0.5723	33.0	Line 1	56.0	-23.0	QP	
0.6895	29.5	Neutral	56.0	-26.5	QP	
0.1702	38.1	Line 1	64.9	-26.8	QP	
3.6876	28.8	Line 1	56.0	-27.2	QP	
0.5662	11.4	Neutral	46.0	-34.6	AV	
0.5723	11.3	Line 1	46.0	-34.7	AV	
0.6895	10.1	Neutral	46.0	-35.9	AV	
3.6782	7.7	Neutral	46.0	-38.3	AV	
0.1702	13.6	Line 1	54.9	-41.3	AV	
3.6782	9.8	Neutral	56.0	-46.2	QP	

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EMC Test Data

Client:	Savi	Job Number:	J47977
Model:	SR-640-101 Reader	T-Log Number:	T48115
		Proj Eng:	Mark Briggs
Contact:	Gene Schlindwein		
Spec:	FCC 15.231(a),(e); Subpart B	Class:	-

Radiated Emissions

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: 7/31/2002
Test Engineer: Pete Sales
Test Location: SVOATS #3

Config. Used: 1
Config Change:
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 routed overhead.

On the OATS, the measurement antenna was located 10 meters from the EUT for the measurement range 30 - 1000 MHz and 3m from the EUT for the frequency range 1 - 10 GHz.

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: 23°C
Rel. Humidity: 59%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, Preliminary Scan 30 - 4339 MHz	FCC 15.231 (a)	Pass	-5.1dB @ 433.92MHz
2	RE, Preliminary Scan 30 - 1000 MHz	FCC 15.231 (e)	Pass	-2.2dB @ 433.920MHz
3	RE, Preliminary Scan 30 - 4339 MHz	FCC 15.109	Pass	-18dB @ 423.252MHz

Client:	Savi	Job Number:	J47977
Model:	SR-640-101 Reader	T-Log Number:	T48115
		Proj Eng:	Mark Briggs
Contact:	Gene Schlindwein		
Spec:	FCC 15.231(a),(e); Subpart B	Class:	-

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.

Run #1: Preliminary Radiated Emissions, 30-4339 MHz, Transmitter #2 - "Wake-Up Signal

Measurements made at 3m per FCC requirements.

The wake-up signal is a control signal that meets the requirements of 15.231(a).

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	75.7	v	80.8	-5.1	Pk	333	1.4	Transmitter #2, Note 1
433.920	74.4	v	80.8	-6.4	Pk	337	1.4	Transmitter #2, Note 1
433.920	74.4	h	80.8	-6.4	Pk	234	1.0	Transmitter #2, Note 1
433.920	73.0	h	80.8	-7.8	Pk	243	1.0	Transmitter #2, Note 1
433.920	73.4	v	80.8	-7.4	Pk	349	1.4	Transmitter #1, Note 1
433.920	73.2	h	80.8	-7.6	Pk	241	1.0	Transmitter #1, Note 1
Measurements of spuroius emissions made with the highest output transmitter active (#2)								
Frequency	Level	Pol	FCC 15.231 (a)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2601.608	53.7	h	60.8	-7.1	Pk	212	1.3	Ambient with EUT signal, Note 1
2601.608	52.0	v	60.8	-8.8	Pk	330	1.0	Ambient with EUT signal, Note 1
1303.148	43.9	h	54.0	-10.1	Pk	21	1.0	Note 1
1303.148	43.8	v	54.0	-10.2	Pk	15	1.0	Note 1
2171.238	48.3	v	60.8	-12.5	Pk	0	1.0	Noise Floor, Note 1
2169.600	48.0	h	60.8	-12.8	Pk	0	1.0	Noise Floor, Note 1
1737.455	47.2	v	60.8	-13.6	Pk	94	1.0	Note 1
1737.455	46.2	h	60.8	-14.6	Pk	360	1.0	Note 1
867.840	45.0	v	60.8	-15.8	QP	305	1.0	Ambient, No EUT signal
867.840	38.0	h	60.8	-22.8	QP	296	1.0	Ambient, No EUT signal

Note 1:	Peak reading, average limit

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EMC Test Data

Client:	Savi	Job Number:	J47977
Model:	SR-640-101 Reader	T-Log Number:	T48115
		Proj Eng:	Mark Briggs
Contact:	Gene Schlindwein		
Spec:	FCC 15.231(a),(e); Subpart B	Class:	-

Run #2: Preliminary Radiated Emissions 30 - 4339 MHz, Transmitter - Data and Control Signals

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) all other commands have a duty cycle that is less than 30mS in a 100ms period.
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). 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 control and data signals.

The Theory of Operations details how the different types of transmissions meet the timing requirements for control signals or data signals.
Measurements made at 3m per FCC requirements with transmitter #2 continuously transmitting.

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	70.7	H	72.9	-2.2	Avg	245	1.0	Note 1
433.920	69.1	V	72.9	-3.8	Avg	343	1.6	Note 1
433.920	81.2	H	92.9	-11.7	Pk	245	1.0	
433.920	79.6	V	92.9	-13.3	Pk	343	1.6	
2169.569	48.5	V	54.0	-5.5	Pk	8	1.0	Peak reading, average limit
1737.296	47.1	V	54.0	-6.9	Pk	99	1.0	Peak reading, average limit
1302.943	44.4	V	54.0	-9.6	Pk	108	1.0	Peak reading, average limit
867.830	40.0	V	52.9	-12.9	QP	360	1.0	Ambient + EUT signal
2603.482	40.6	V	54.0	-13.4	Pk	360	1.0	Peak reading, average limit, Note 2
3037.390	40.2	V	54.0	-13.8	Pk	0	1.0	Peak reading, average limit, Note 2
3471.308	41.9	V	54.0	-12.1	Pk	360	1.0	Peak reading, average limit, Note 2
3905.225	44.6	V	54.0	-9.4	Pk	28	1.0	Peak reading, average limit, Note 2
4339.134	43.4	V	54.0	-10.6	Pk	360	1.0	Peak reading, average limit, Note 2
1301.742	46.8	H	54.0	-7.2	Pk	0	1.0	Peak reading, average limit
1735.656	46.7	H	54.0	-7.3	Pk	360	1.0	Peak reading, average limit
867.830	38.6	H	52.9	-14.3	QP	0	1.0	Ambient + EUT signal
2169.565	39.0	H	54.0	-15.0	Pk	0	1.0	Peak reading, average limit, Note 2
2603.485	41.9	H	54.0	-12.1	Pk	360	1.0	Peak reading, average limit, Note 2
3037.394	38.8	H	54.0	-15.2	Pk	360	1.0	Peak reading, average limit, Note 2
3471.303	42.5	H	54.0	-11.5	Pk	0	1.0	Peak reading, average limit, Note 2
3905.221	44.2	H	54.0	-9.8	Pk	360	1.0	Peak reading, average limit, Note 2
4339.130	43.4	H	54.0	-10.6	Pk	0	1.0	Peak reading, average limit, Note 2

Note 1:	Average reading calculated from peak reading use a duty cycle correction factor of 10.5dB for a worst case duty cycle of 30% over any 100ms period.
Note 2:	Noise floor

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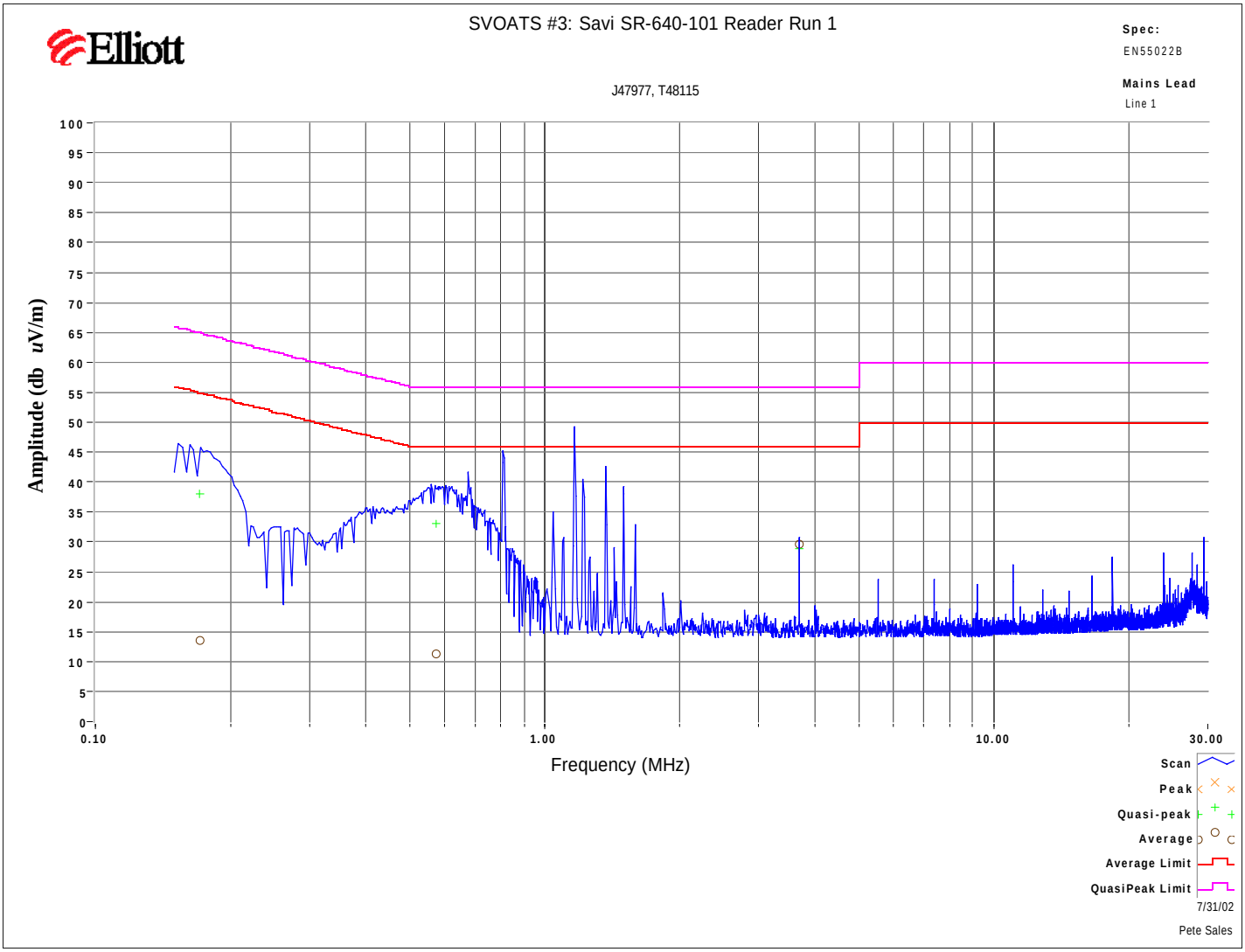
EMC Test Data

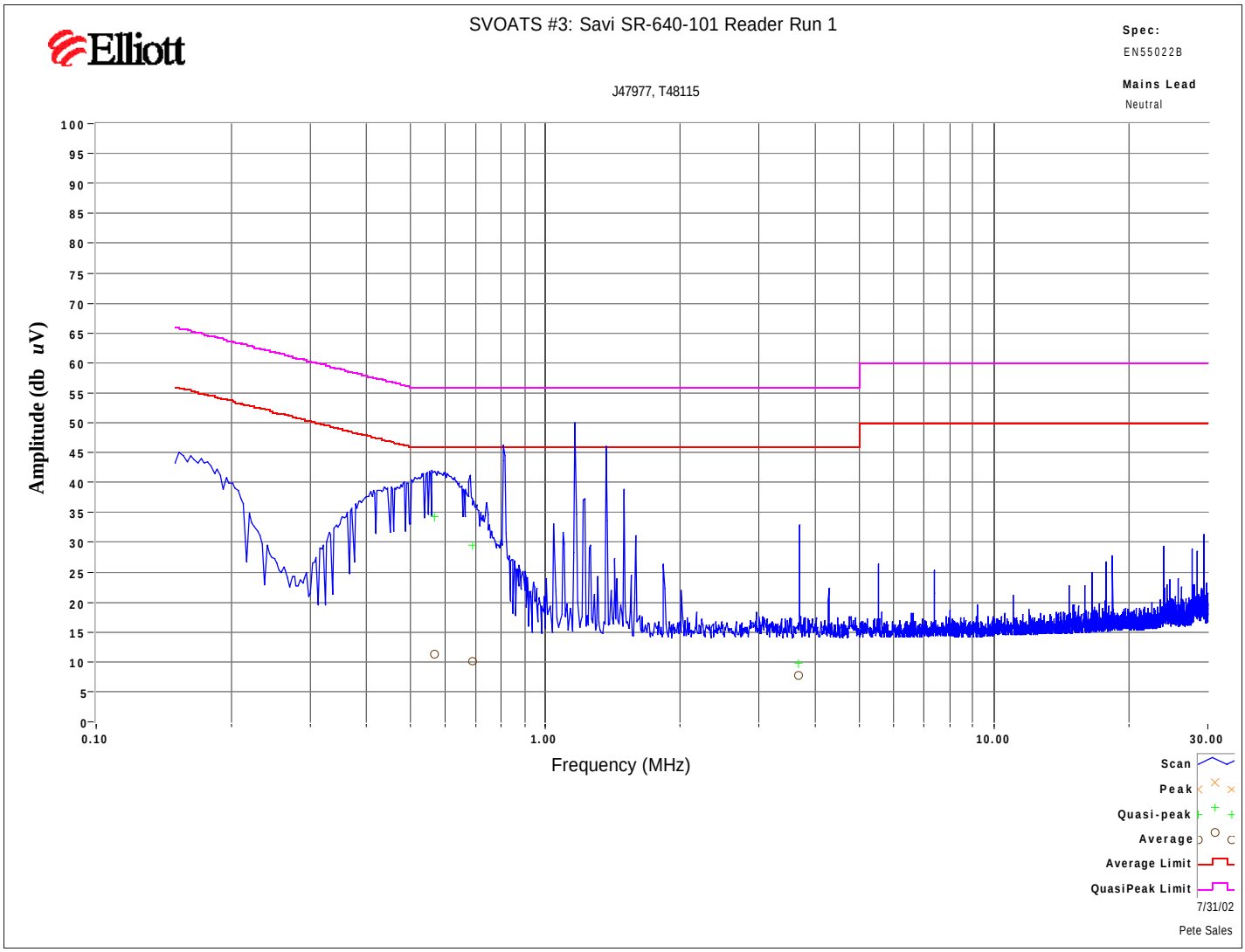
Client:	Savi	Job Number:	J47977
Model:	SR-640-101 Reader	T-Log Number:	T48115
		Proj Eng:	Mark Briggs
Contact:	Gene Schlindwein		
Spec:	FCC 15.231(a),(e); Subpart B	Class:	-

Run #3: Maximized Radiated emissions, 30 - 1000 MHz: Receiver-related spurious emissions

RS 485 Mode - Digital Device and Receiver

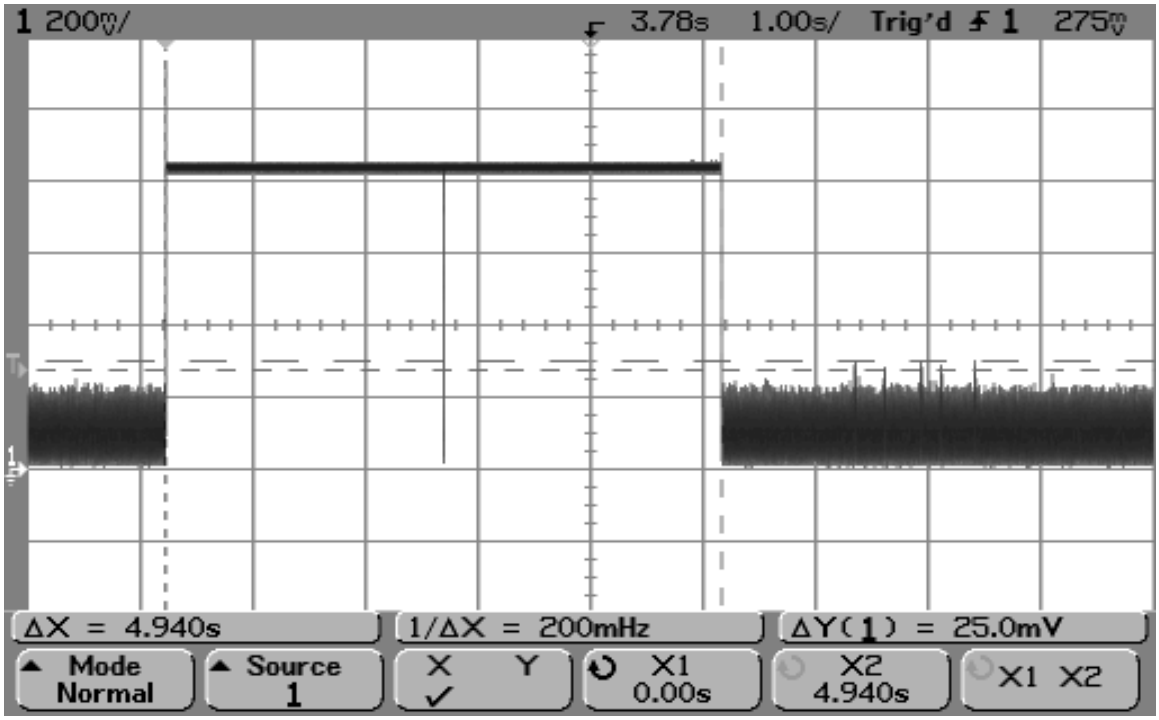
Frequency	Level	Pol	FCC 15.109		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
423.252	28.0	v	46.0	-18.0	QP	360	1.2	Receiver LO
423.252	23.8	h	46.0	-22.2	QP	343	1.8	Receiver LO
846.504	23.6	v	46.0	-22.4	QP	15	1.0	
846.504	23.3	h	46.0	-22.7	QP	296	1.0	


Elliott
SVOATS #3: Savi SR-640-101 Reader Run 1
Spec:
EN55022B
Mains Lead
Line 1
J47977, T48115
Amplitude (db uV/m)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0.10
1.00
10.00
30.00
Frequency (MHz)
Scan
Peak
Quasi-peak
Average
Average Limit
QuasiPeak Limit
7/31/02
Pete Sales

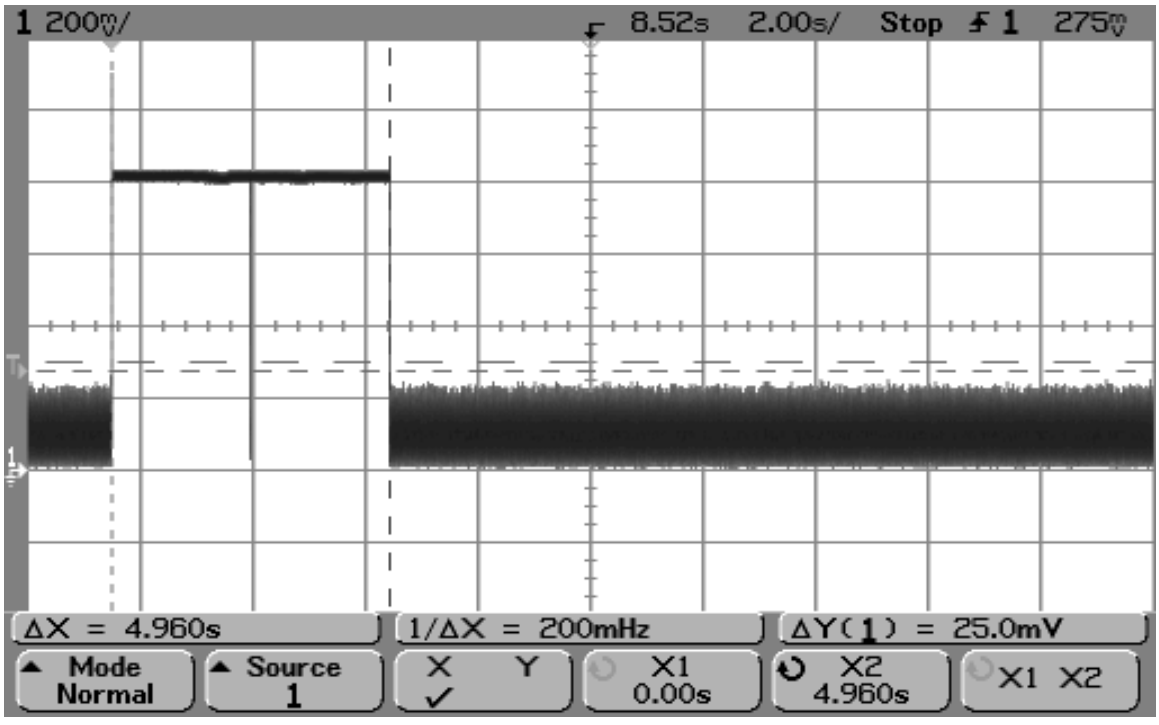

Elliott
SVOATS #3: Savi SR-640-101 Reader Run 1
Spec:
EN55022B
Mains Lead
Neutral
J47977, T48115
Amplitude (db uV)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0.10
1.00
10.00
30.00
Frequency (MHz)
Scan
Peak
Quasi-peak
Average
Average Limit
QuasiPeak Limit
7/31/02
Pete Sales

SR-640-101 Duty Cycle/Bandwidth Plots

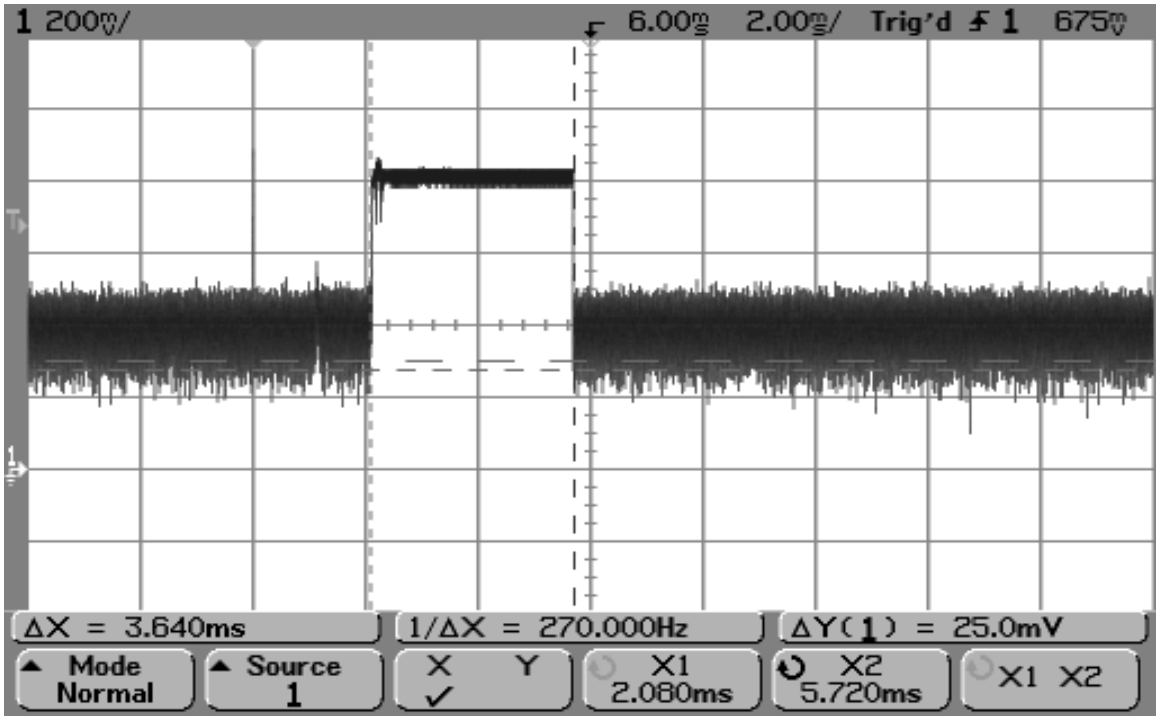
SR-640-101 Wake-Up Pulse of less than 5 seconds



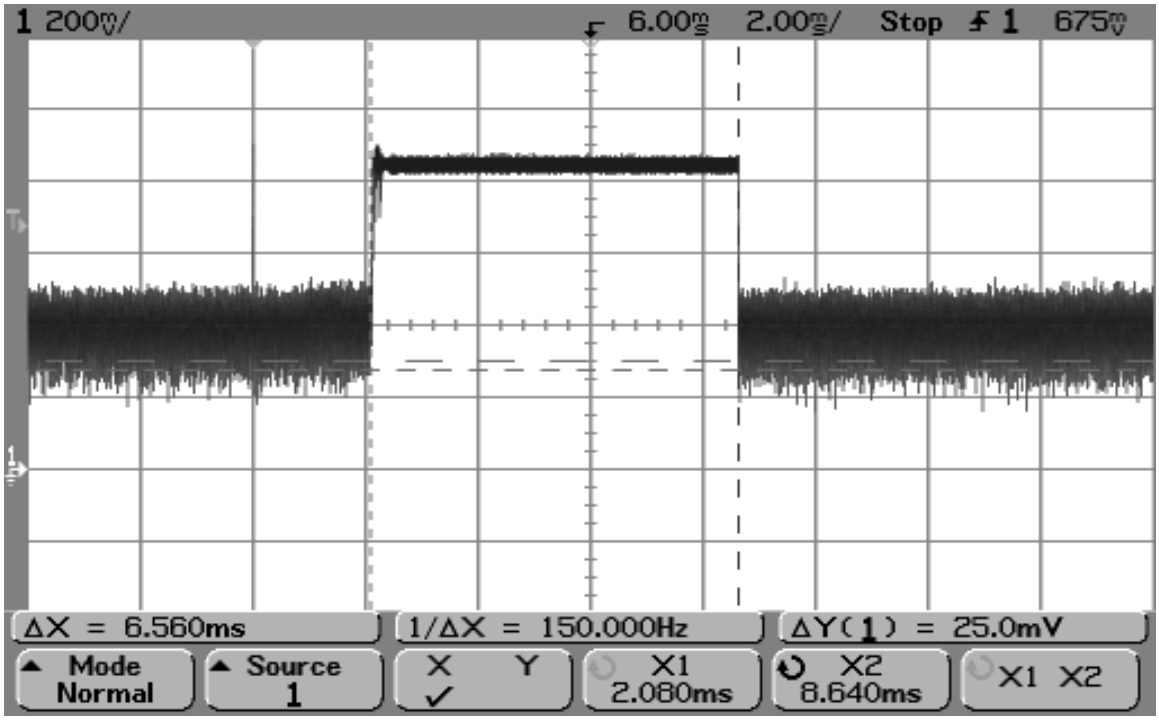
SR-640-101 Wake-Up Pulse over 20 second period



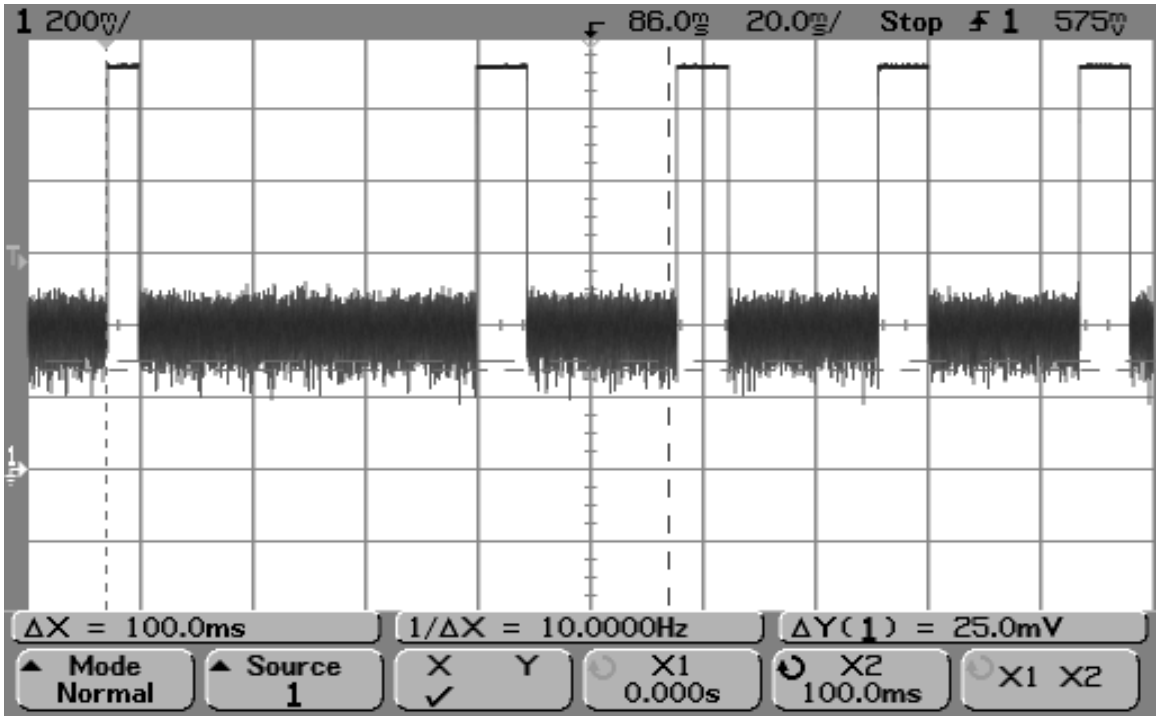
SR-640-101: Hello Pulse (3.64 msec)



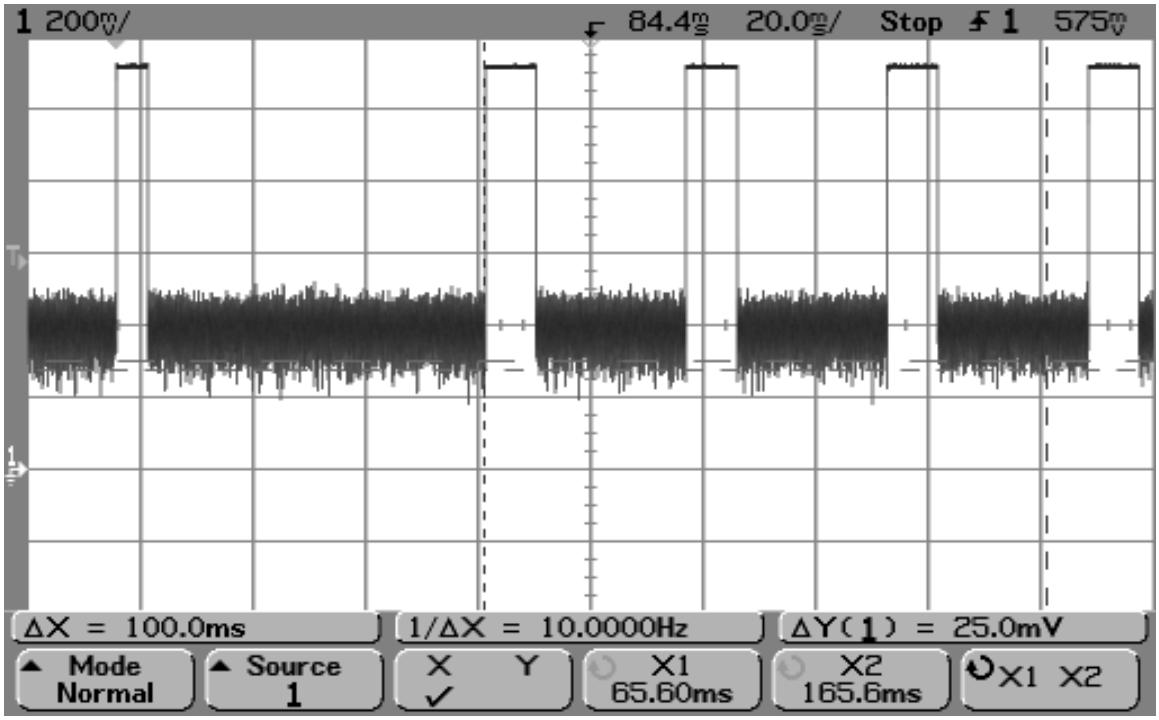
SR-640-101: Sleep Pulse (6.56 msec)



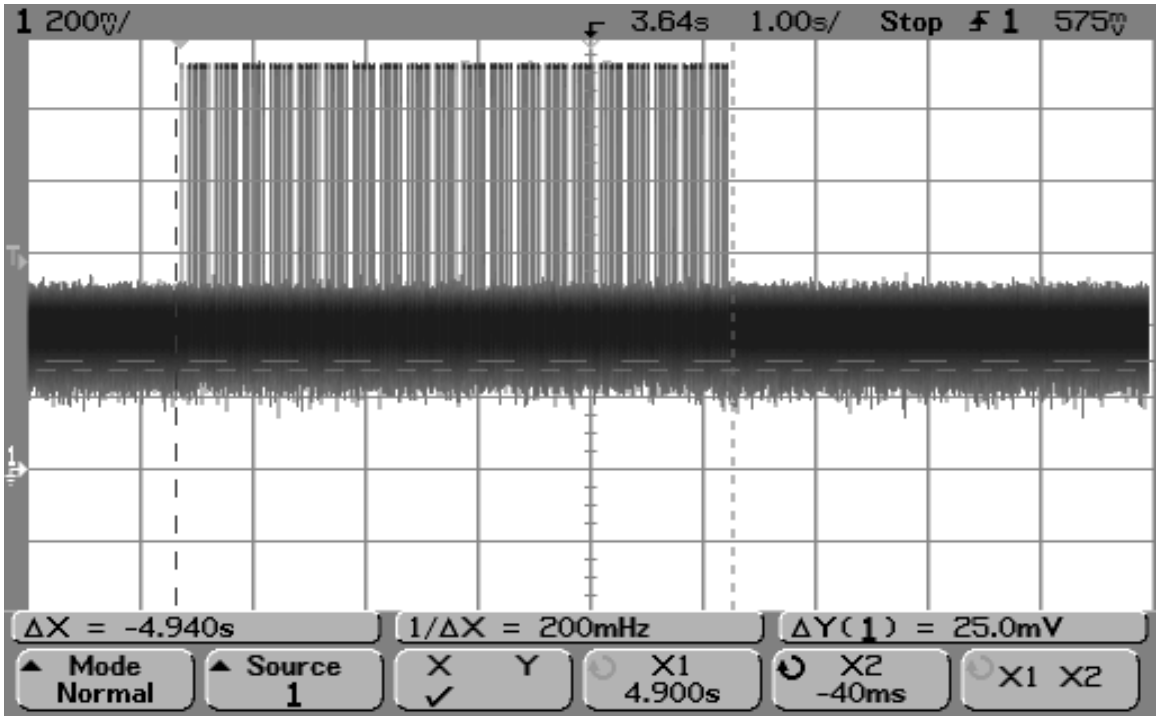
SR-640-101: Maximum number of Hello and Sleep Pulses in a 100 msec period



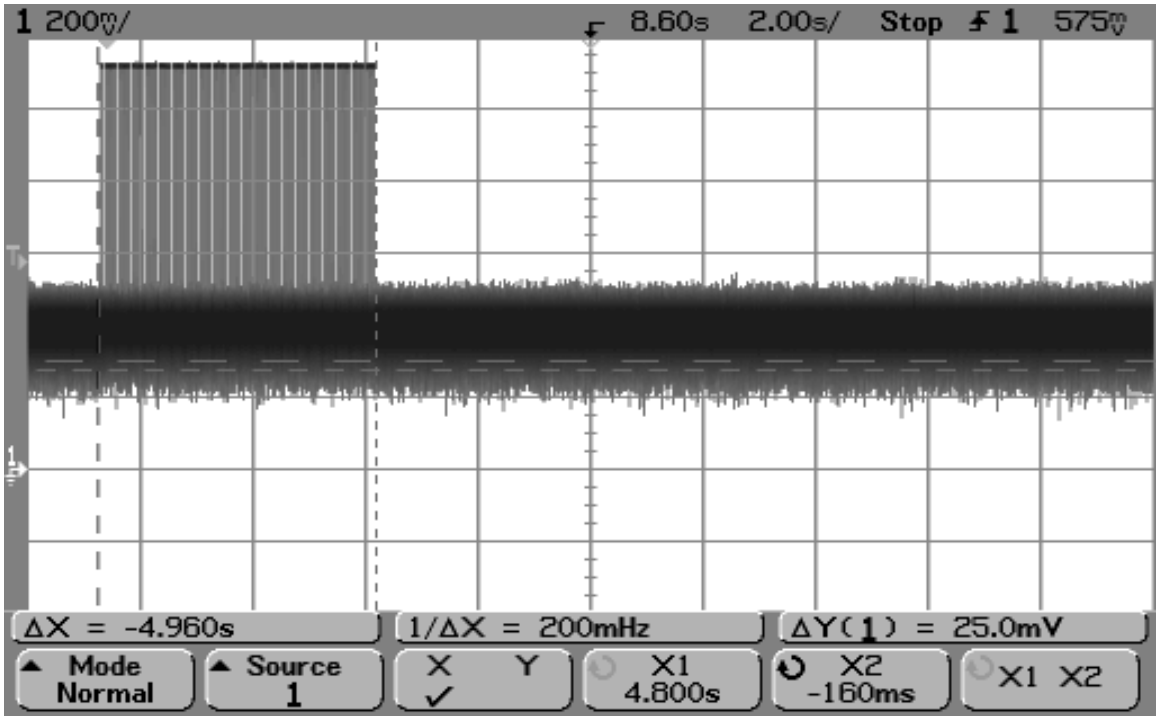
SR-640-101: Maximum number of Sleep Pulses in a 100 msec period



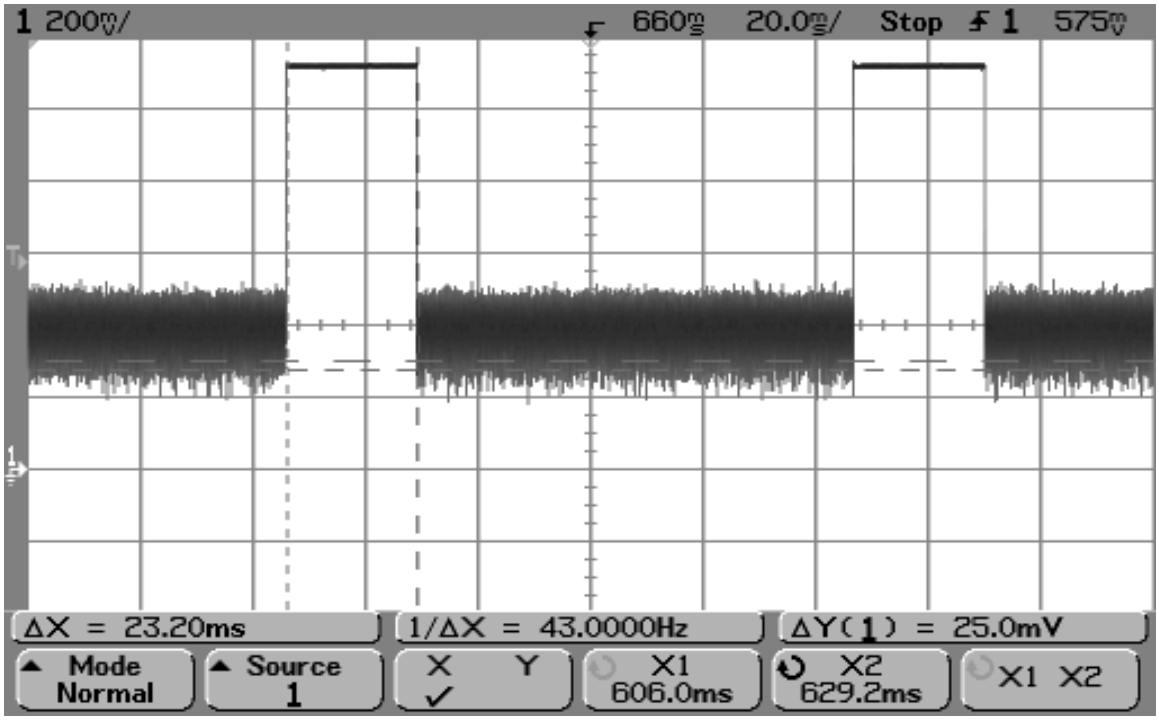
SR-640-101: Hello and Sleep Transmissions - 5 second limit (over 10 second period)



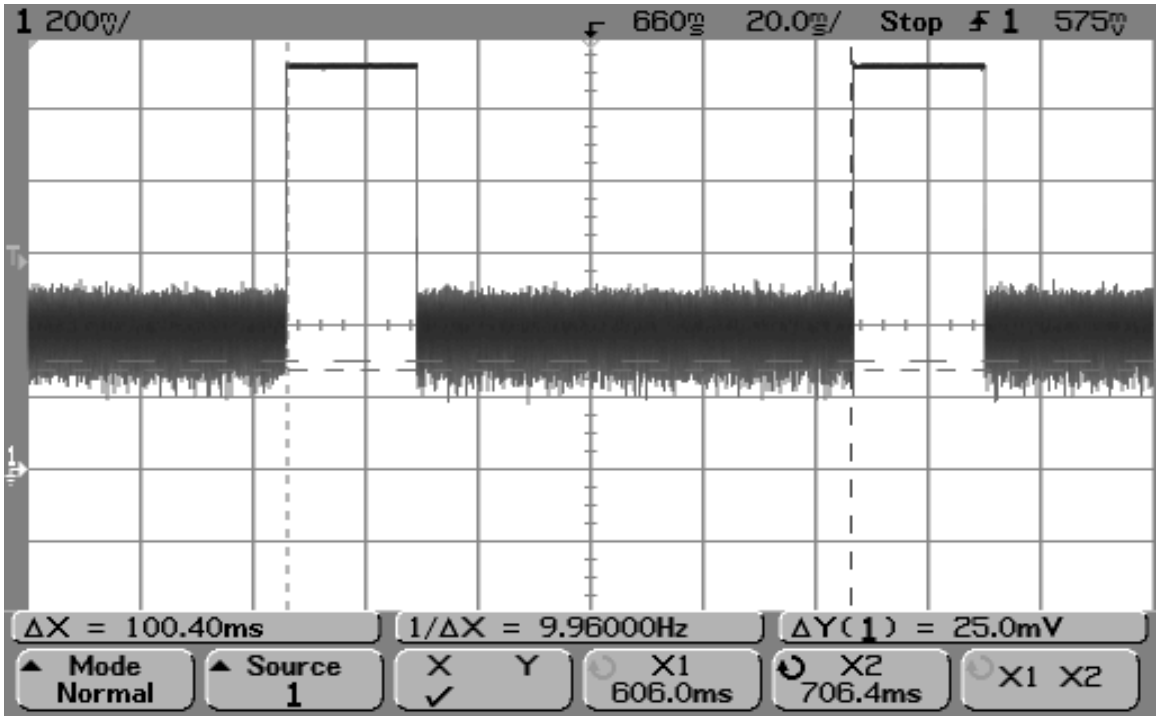
SR-640-101: Hello and Sleep Transmissions - 5 second limit (over 20 second period)



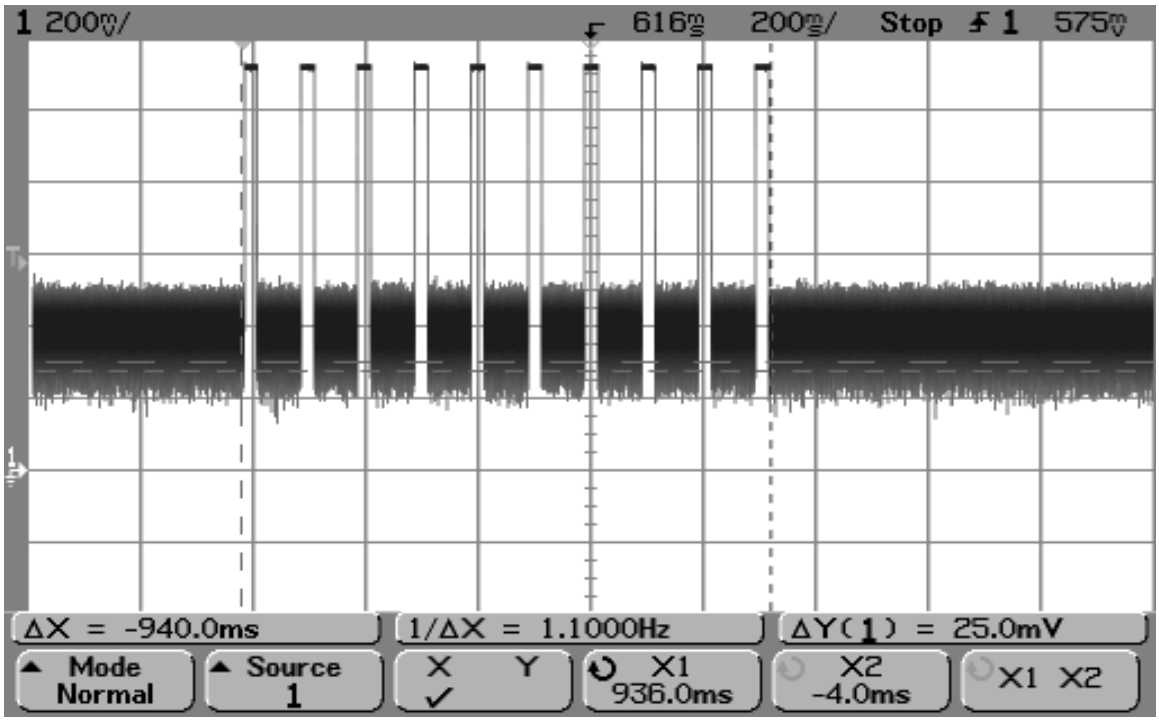
SR-640-101: Data Pulse (23.2 msec)



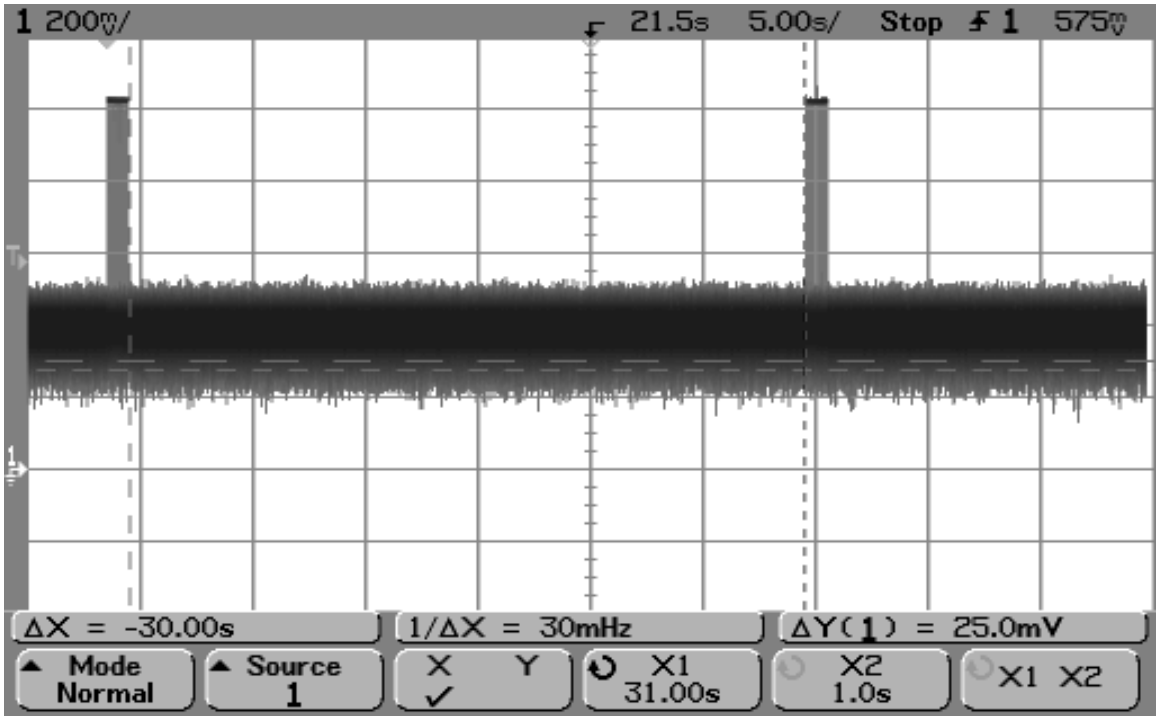
SR-640-101: Number of Data Pulses in 100 msec period



SR-640-101: Maximum Data Pulses in one second period



SR-640-101: 30 second silent period between Data Transmissions



SR-640-101: 20 dB Bandwidth Measurement