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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: SMR-650P-21X

UPN:	2404A-650P1
FCC ID:	KL7-650MR-V2
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:	April 14, 2004
FINAL TEST DATE:	December 8, December 9, December 11, 2003 and April 6, 2004
AUTHORIZED SIGNATORY:	Juan Martinez Senior EMC Engineer

ACCREDITED

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SCOPE

An electromagnetic emissions test has been performed on the Savi Technology, Inc. model SMR-650P-21X pursuant 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 SMR-650P-21X 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 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 Savi Technology, Inc. model SMR-650P-21X 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 License-Exempt Radiocommunication Devices (All Frequency Bands).

Maintenance of FCC compliance is the responsibility of the manufacturer. Any modification of the product may result in increased emissions and should be checked to ensure compliance is still 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	-5.6dB @ 1.169MHz	Pass
	6.6 / 7.4	AC Conducted emissions 0.45 – 30 MHz	-3.7dB @ 1.169MHz	Pass
15.231 (a) (1)	6.1.1(a) (1)	Duration of manually activated transmission	N/A	
15.231 (a) (2)	6.1.1(a) (2)	Duration of automatically activated transmission	5 seconds or less for control signals (Wake-Up and Control signals) Refer to the operational description for detailed description and timing diagrams.	
15.231 (a) (3)	6.1.1(a) (3)	Transmissions at predetermined / regular intervals are not permitted	All transmissions are triggered via the Personal Data Terminal by the end-user. Refer to the operational description for detailed description and timing diagrams.	
15.231 (a) (4)	6.1.1(a) (4)	Pendency of transmissions used during emergencies involving fire, security, and safety of life	Not applicable	
15.231 (b)	6.1.1(b) / Table 1	Transmitter Radiated Emissions, 433.92 MHz	79.9dBuV/m Peak (compared to average limit).	Pass (-0.9dB)
15.231 (b)	6.1.1(b) / Table 1	Transmitter Radiated Spurious Emissions, 30-4339.2 MHz	44.3dBuV/m Peak @ 1301.76 MHz (-8.8dB) Highest spurious level was in Wake-Up mode.	Pass (-8.8dB)
15.231 (c)	6.1.1 (c)	Bandwidth	Measured bandwidth was 448 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	N/A
15.231 (e)	6.1.1 (e)	Duration of transmission	1 second or less - Refer to the operational description for detailed description and timing diagrams.	Pass
15.231 (e)	6.1.1 (e)	Transmitter Radiated Emissions, 433.92 MHz	92.2dBuV/m Peak; 72.2dBuV/m Average.	Pass (-0.7dB)
15.231 (e)	6.1.1 (e)	Transmitter Radiated Spurious Emissions, 30-4339.2 MHz	32.6dBuV/m Average @ 867.8 MHz (-20.3dB)	Pass (-20.3B)
15.109	7.3	Receiver Spurious Emissions	-13.0dB @ 1269.6 MHz	Pass (-13.0dB)

Note 2 – As the device is intended for hand-held operation it was tested in all three orthogonal orientations.

15.209 / RSS 210 Table 3 – Operation at 123 kHz

FCC Part 15 Section	RSS 210 Section	Description	Comments	Result
15.207 / 15.107		AC Conducted Emissions, 0.15 – 30 MHz	-5.7dB @ 1.169MHz	Pass
	6.6 / 7.4	AC Conducted emissions 0.45 – 30 MHz	-3.6dB @ 1.169MHz	Pass
15.209	6.2.1	Transmitter Fundamental Signal Emissions, 0.123 MHz	-7.9dBuV/m @ 123 kHz	Complies (note 1)
15.231 (b)	6.2.1	Transmitter Radiated Spurious Emissions, 0.123 – 1.3 MHz	All spurious emissions from the 123kHz transmitter were more than 20dB below the limit.	Complies (note 1)
	RSP 100	Bandwidth	14 kHz	N/A

Note 1 – As the device is intended for hand-held operation it was tested in all three orthogonal orientations. Measurements in the table above were taken on a model SMR-650P-110 that contains the same low frequency transmitter circuit as the SMR-650P-210.

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 SMR-650P-21x transceiver is designed to communicate with Savi's RFID tags. The device transmits at 123 kHz and at 433.92 MHz to initiate responses from tags within its vicinity. The tag's transmit at 433.92 MHz, so the EUT also contains a receiver operating at 433.92 MHz.

The device has a serial (RS-232) interface to connect directly to a hand held PC or similar device and operates from internal, rechargeable batteries. The device has an external DC input used to recharge the batteries via adapter. It is intended to be used as a hand held device although it can operate while connected to the external AC-DC adapter.

The 433.92 MHz transceiver operates under section 15.231 of the FCC rules. The 433.92 MHz transmissions consist of both data and control signals. When operating under 15.231 rules, the data signals are 10 mS long and have a duty cycle of no more than 10% measured in any 100 mS period. There are two types of control signals, one that has a 24% duty cycle and another, the Wake-Up signal that is a 2.5 second transmission.

The EUT is intended to be used as a hand-held device. The EUT was, therefore, treated as table-top equipment during testing to simulate the end-user environment. The electrical rating of the EUT adapter is 100-240VAC, 50-60Hz, 0.2A.

SMR-650P-21x has an external antenna for 433 MHz and the SMR-650P-11x uses an internal antenna. The x indicates the type of connector (the -210 and -110 use a DB9 connector and the -211 and -111 use a proprietary connector). The test data in this report for the 123kHz transmissions was taken on a model SMR-650P-110. The 433.92 MHz transceiver measurements were measured from the model SMR-650P-210. The SMR-650P-110 and SMR-650P-111 have already been approved by Industry Canada and the FCC. Certification is being requested for the SMR-650P-210 and SMR-650P-211. The original 123kHz transmitter data is applicable to both the 2xx and 1xx series since they use identical circuitry and the only differences between the two series (11x versus 211x) is the location of the 433.92MHz transceiver's antenna and the removal of the low power 433.92 MHz transmissions under FCC 15.209 and table 3 of RSS 210.

The sample was received on December 8, 2003 and April 6, 2004 and tested on December 8, December 9 and December 11, 2003 and April 6, 2004. The EUT consisted of the following component(s):

Manufacturer/Model/Description	Serial Number
Savi Technology, Inc. SMR-650P-210 Transceiver	443504030001

ENCLOSURE

The EUT enclosure is primarily constructed of plastic. It measures approximately 6.5 cm wide by 2.5 cm deep by 15 cm high.

MODIFICATIONS

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

SUPPORT EQUIPMENT

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

Manufacturer/Model/Description	Serial Number	FCC ID Number
Winbook Winbook XL Laptop Computer	H1106587	DoC
PowDec WP050501 Charger	WP050501-1.3	None

No remote support equipment was used during emissions testing.

EUT INTERFACE PORTS

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

Port	Connected To	Cable(s)		
		Description	Shielded / Unshielded	Length (m)
Serial	Laptop	DB9	Shielded	0.2
DC	Charger	Multiwire	Shielded	2

EUT OPERATION

The EUT was set to continuously transmit at either 433.92 MHz with no modulation.

ANTENNA SYSTEM

The antenna system used with the Savi Technology, Inc. model SMR-650P-21X consists of an integral antenna that is mounted to the outside of the device.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on December 8, December 9 and December 11, 2003 and April 6, 2004at the Elliott Laboratories Open Area Test Site #1 & 2 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

2 Pages

Radiated Emissions, 30 - 4339.25MHz, 08-Dec-03
Engineer: Marissa Faustino

Manufacturer	Description	Model #	Assett #	Cal Due
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	487	24-Apr-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	EMC Spectrum Analyzer, Opt. 026 □9 KHz - 26.5GHz	8593EM	1141	19-Mar-04
EMCO	Log Periodic Antenna, 0.2-1 GHz	3146	1294	17-Apr-04
Rohde & Schwarz	Test Receiver, 9kHz-2750MHz	ESCS 30	1337	27-Dec-03

Radiated Emissions, 30 - 2,000 MHz, 09-Dec-03
Engineer: Joseph Cadigal

Manufacturer	Description	Model #	Assett #	Cal Due
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	10-Jan-04
Filtek	High Pass Filter, 1GHz	HP12/1000-5BA	955	03-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

Radiated Emissions, 30 - 2,000 MHz, 11-Dec-03
Engineer: Yu Chien Ho

Manufacturer	Description	Model #	Assett #	Cal Due
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	10-Jan-04
Filtek	High Pass Filter, 1GHz	HP12/1000-5BA	956	11-Mar-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, 11-Dec-03
Engineer: Yu Chien Ho

Manufacturer	Description	Model #	Assett #	Cal Due
Elliott Laboratories	FCC / CISPR LISN	LISN-3, OATS	304	01-Jul-04
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

Radiated Emissions, 30 - 1000 MHz, 18-Dec-03
Engineer: jmartinez

Manufacturer	Description	Model #	Assett #	Cal interval
EMCO	Biconical Antenna, 30-300 MHz	3110B	801	12
EMCO	Log Periodic Antenna, 0.2-1 GHz	3146	1294	12
Rohde & Schwarz	Test Receiver, 9kHz-2750MHz	ESCS 30	1337	12

Radiated Emissions, 30 - 6,500 MHz, 07-Apr-04
Engineer: Juan Martinez

Manufacturer	Description	Model #	Asset #	Cal Due
Rohde & Schwarz	Test Receiver, 20-1300MHz	ESVP	273	13-Feb-05
Hewlett Packard	EMC Spectrum Analyzer 9kHz - 6.5GHz	8595EM	780	26-Feb-05
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	23-Jan-05
Filtek	High Pass Filter, 1GHz	HP12/1000-5BA	957	26-Mar-05
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	1242	09-Oct-04
EMCO	Log Periodic Antenna, 0.2-2 GHz	3148	1404	17-Nov-04
EMCO	Biconical Antenna, 30-300 MHz	3110B	1497	15-Jan-05

EXHIBIT 2: Test Measurement Data

The following data includes conducted emissions measurements of the Savi Technology, Inc. model SMR-650P-110, Radiated emissions form the 123kHz transmitter for the model SMR-650P-110 and radiated emissions from the 433.92 MHz transceiver for the model SMR-650P-210. The models SMR-650P-110 and SMR-650P-210 are identical in all respects with the exception that the –210 uses an integral, but external antenna and the –110 uses an integral, internally-mounted antenna. Therefore the data for the 123kHz transmitter applies to the SMR-650P-210.

T53670 (SMR-650P-110 Test Data)	15 Pages
T53670 (AC Conducted Emissions)	6 Pages
T55145 (SMR-650P-210 Test Data)	10 Pages

Elliott

EMC Test Data

Client:	Savi	Job Number:	J53657
Model:	SMR-650P-110	T-Log Number:	T53670
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Emissions Spec:	EN55022,FCC 15.231, 15.209	Class:	A/B
Immunity Spec:	EN 301 489-3, EN60601-1-2	Environment:	-

EMC Test Data

For The

Savi

Model

SMR-650P-110

Date of Last Test: 1/16/2004

Client:	Savi	Job Number:	J53657
Model:	SMR-650P-110	T-Log Number:	T53670
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Emissions Spec:	EN55022,FCC 15.231, 15.209	Class:	A/B
Immunity Spec:	EN 301 489-3, EN60601-1-2	Environment:	-

EUT INFORMATION

General Description

The EUT is a transceiver which is designed to communicate with Savi's RFID tags. The device transmits at 123 kHz and at 433.92 MHz to initiate responses from tags within its vicinity. The tags transmit at 433.92 MHz, so the EUT also contains a receiver operating at 433.92 MHz. The device has a serial (RS-232) interface to connect directly to a hand held PC or similar device and operates from internal, rechargeable batteries. The device has an external DC input used to recharge the batteries via adapter. It is intended to be used as a hand held device although it can operate while connected to the external AC-DC adapter. The 123 kHz transmitter operates under part 15.209 of the FCC's rules. The 433.92 MHz transceiver operates under sections 15.209 and 15.231 of the FCC rules. The 433.92 MHz transmissions consist of both data and control signals. When operating under 15.231 rules, the data signals are 10 mS long and have a duty cycle of no more than 10% measured in any 100 mS period. There are two types of control signals, one that has a 24% duty cycle and another, the Wake-Up signal that is a 2.5 second transmission. When operated under 15.209 rules, 433.92 MHz transmissions may be continuous.
The EUT is intended to be used as a hand-held device. The EUT was, therefore, treated as table-top equipment during testing to simulate the end-user environment. The electrical rating of the EUT adapter is 100-240VAC, 50-60Hz, 0.2A.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Savi Technology, Inc.	SMR-650P-110	Transceiver	443503120001	KL7-650MR-V1

EUT 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.

Modification History

Mod. #	Test	Date	Modification
1	RI	1/9/2004	The capacitor in the external LC tank for the receiver FM demodulator was adjusted to properly tune the LC tank.

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:	J53657
Model:	SMR-650P-110	T-Log Number:	T53670
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Emissions Spec:	EN55022,FCC 15.231, 15.209	Class:	A/B
Immunity Spec:	EN 301 489-3, EN60601-1-2	Environment:	-

Test Configuration #2

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
Winbook	Winbook XL	Laptop Computer	H1106587	DoC
IBM	ThinkPad	Laptop Computer	78-48-24897/11	ANO9611TBOON
PowDec	WP05050I	Charger	WP05050I-1.3	none

Note the WinBook was used for digital device emissions tests. The IBM Thinkpad laptop was used for all other tests. The laptop was used to terminate the serial port. The actual serial peripheral would be a hand-held Personal Data Terminal and not a PC (the EUT is not considered to be a PC peripheral). The PDT's do not have the operating software to control the EUT as required for the tests (continuously transmitting).

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
none				

Interface Cabling and Ports

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
Serial	Laptop	DB9	Shielded	0.2
DC	Charger	Multiwire	Shielded	2

EUT Operation During Emissions

The EUT was set to continuously transmit at either 123kHz or 433.92 MHz with no modulation.

Elliott

EMC Test Data

Client:	Savi	Job Number:	J53657
Model:	SMR-650P-110	T-Log Number:	T53670
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Spec:	EN55022,FCC 15.231, 15.209	Class:	A/B

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: 12/9/2003
Test Engineer: Joseph Cadigal
Test Location: SVOATS #2

Config. Used: 2
Config Change: none
EUT Voltage: 120V/60Hz

General Test Configuration

The 123kHz MHz transmitter was set to maximum output level during the test.
The measurement antenna was located 3m and/or 10m from the EUT. The measurement data has been extrapolated to the appropriate distance.
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.

Ambient Conditions:

Temperature: 19°C
Rel. Humidity: 69%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 0.123 - 1.23 MHz	FCC 15.209	Pass	see below

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:	J53657
Model:	SMR-650P-110	T-Log Number:	T53670
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Spec:	EN55022,FCC 15.231, 15.209	Class:	A/B

Run #1: Radiated Emissions, 0.009 - 1000 MHz: Transmit Mode (132kHz)
sn: 0443503120001

Measurements of the fundamental signal were made on the OATS at test distances of 3m and 10m and are recorded in the table below.

Frequency	Level	AF	Level	Pol	Detector	Azimuth	Height	Comments
kHz	dBµV	dBm^{-1}	dBµV/m	(O / I)	Pk/QP/Avg	degrees	meters	
flat								
123.000	91.5	10.4	**101.9**	O	Pk	269	1.0	Tested at 3m - Note 1
123.000	82.5	10.4	92.9	I	Pk	256	1.0	Tested at 3m - Note 1
side								
123.000	87.8	10.4	98.2	O	Pk	200	1.0	Tested at 3m - Note 1
123.000	88.2	10.4	98.6	I	Pk	159	1.0	Tested at 3m - Note 1
standing								
123.000	80.3	10.4	90.7	O	Pk	89	1.0	Tested at 3m - Note 1
123.000	81.6	10.4	92.0	I	Pk	155	1.0	Tested at 3m - Note 1
flat								
123.000	62.8	10.4	**73.2**	O	Pk	49	1.0	Tested at 10m - Note 2
123.000	58.9	10.4	69.3	I	Pk	152	1.0	Tested at 10m - Note 2
side								
123.000	62.3	10.4	72.7	O	Pk	264	1.0	Tested at 10m - Note 2
123.000	58.5	10.4	68.9	I	Pk	174	1.0	Tested at 10m - Note 2
standing								
123.000	59.1	10.4	69.5	O	Pk	225	1.0	Tested at 10m - Note 2
123.000	52.7	10.4	63.1	I	Pk	135	1.0	Tested at 10m - Note 2

Note 1:	The maximum signal level was with the device oriented **101.9 dBuV/m EUT laying flat**
Note 2:	The maximum signal level was with the device oriented **73.2 dBuV/m EUT laying flat**
Note 3:	Polarization of O indicates the loop was facing the EUT, I indicates that the loop was perpendicular to the EUT.

Elliott

EMC Test Data

Client:	Savi	Job Number:	J53657
Model:	SMR-650P-110	T-Log Number:	T53670
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Spec:	EN55022,FCC 15.231, 15.209	Class:	A/B

Extrapolation Factor Calculation:

Level at 3m:	101.9	dBµV/m
Level at 10m:	73.2	dBµV/m
Extrapolation from 3m to 10m:	54.9	dB
Extrapolation from 10m to 300m:	**81.1**	(This factor used to calculate the level in the table below)

Frequency	Level	FCC 15.209		Detector	Azimuth	Height	Comments
KHz	dBµV/m	Limit	Margin	Pk/QP/Avg	degrees	meters	
123	-7.9	25.8	-33.7	Pk	89	1.0	Note 1
246	-	19.8	>20dB	Pk	-	-	Note 2
369	-	16.3	>20dB	Pk	-	-	Note 2
492	-	33.8	>20dB	Pk	-	-	Note 3
615	-	31.8	>20dB	Pk	-	-	Note 3
738	-	30.2	>20dB	Pk	-	-	Note 3
861	-	28.9	>20dB	Pk	-	-	Note 3
984	-	27.7	>20dB	Pk	-	-	Note 3
1107	-	26.7	>20dB	Pk	-	-	Note 3
1230	-	25.8	>20dB	Pk	-	-	Note 3

Note 1:	Level calculated by applying the extrapolation factor calculated from the measurements at 3m and 10m to the measurement recorded at 10m.
Note 2:	Preliminary measurements showed there to be no significant signals at a distance of 3m from the EUT other than the fundamental signal. Apart from the fundamental transmission, all signals below 490kHz were less than 52dBuV/m (1.85dBuA/m) at a distance of 3m, which is equivalent to a level of -28dBuV/m at the specification distance of 300m if using the suggested extrapolation factor of 40log(measurement distance/specification distance).
Note 3:	Preliminary measurements showed there to be no significant signals at a distance of 3m from the EUT other than the fundamental signal. All signals above 490kHz were less than 43.4dBuV/m (-8.2dBuA/m) at a distance of 3m, which is equivalent to a level of 3.4dBuV/m at the specification distance of 30m if using the suggested extrapolation factor of 40log(measurement distance/specification distance).

Client:	Savi	Job Number:	J53657
Model:	SMR-650P-110	T-Log Number:	T53670
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Spec:	EN55022,FCC 15.231, 15.209	Class:	A/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: 12/11/2003
Test Engineer: Yu-Chien Ho
Test Location: SVOATS #2
Config. Used: 2
Config Change: None
EUT Voltage: Refer to individual run

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.

Ambient Conditions:

Temperature: 13.3 °C
Rel. Humidity: 46 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power, 120V/60Hz	EN 55022 B	Pass	-5.6dB @ 1.169MHz
2	CE, AC Power,120V/60Hz	EN 55022 B	Pass	-5.7dB @ 1.169MHz
3	CE, AC Power, 230V/50Hz	EN 55022 B	Pass	-4.5dB @ 0.742MHz

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:	J53657
Model:	SMR-650P-110	T-Log Number:	T53670
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Spec:	EN55022,FCC 15.231, 15.209	Class:	A/B

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

Frequency	Level	AC	EN55022 B		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
1.169	40.4	Neutral	46.0	-5.6	Average	
1.023	40.2	Line	46.0	-5.8	Average	
1.169	39.3	Line	46.0	-6.7	Average	
0.877	38.4	Neutral	46.0	-7.6	Average	
1.169	44.3	Neutral	56.0	-11.7	QP	
1.169	44.1	Line	56.0	-11.9	QP	
1.023	43.5	Line	56.0	-12.5	QP	
0.877	42.3	Neutral	56.0	-13.7	QP	
0.150	39.7	Neutral	56.0	-16.3	Average	
0.150	39.2	Line	56.0	-16.8	Average	
0.150	43.8	Neutral	66.0	-22.2	QP	
0.150	43.5	Line	66.0	-22.5	QP	

Frequency	Level	AC	RSS 210		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
1.169	44.3	Neutral	48.0	-3.7	QP	
1.169	44.1	Line	48.0	-3.9	QP	
1.023	43.5	Line	48.0	-4.5	QP	
0.877	42.3	Neutral	48.0	-5.7	QP	

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

Frequency	Level	AC	EN55022 B		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
1.169	40.3	Line	46.0	-5.7	Average	
1.023	40.2	Line	46.0	-5.8	Average	
1.170	39.8	Neutral	46.0	-6.2	Average	
0.877	38.3	Neutral	46.0	-7.7	Average	
1.169	44.4	Line	56.0	-11.6	QP	
1.170	44.3	Neutral	56.0	-11.7	QP	
1.023	43.5	Line	56.0	-12.5	QP	
0.877	42.3	Neutral	56.0	-13.7	QP	
0.150	39.8	Neutral	56.0	-16.2	Average	
0.150	39.4	Line	56.0	-16.6	Average	
0.150	43.9	Neutral	66.0	-22.1	QP	
0.150	43.6	Line	66.0	-22.4	QP	

Elliott

EMC Test Data

Client:	Savi	Job Number:	J53657
Model:	SMR-650P-110	T-Log Number:	T53670
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Spec:	EN55022,FCC 15.231, 15.209	Class:	A/B

Run #3: AC Power Port Conducted Emissions, 0.15 - 30MHz, 230V/50Hz
UHF

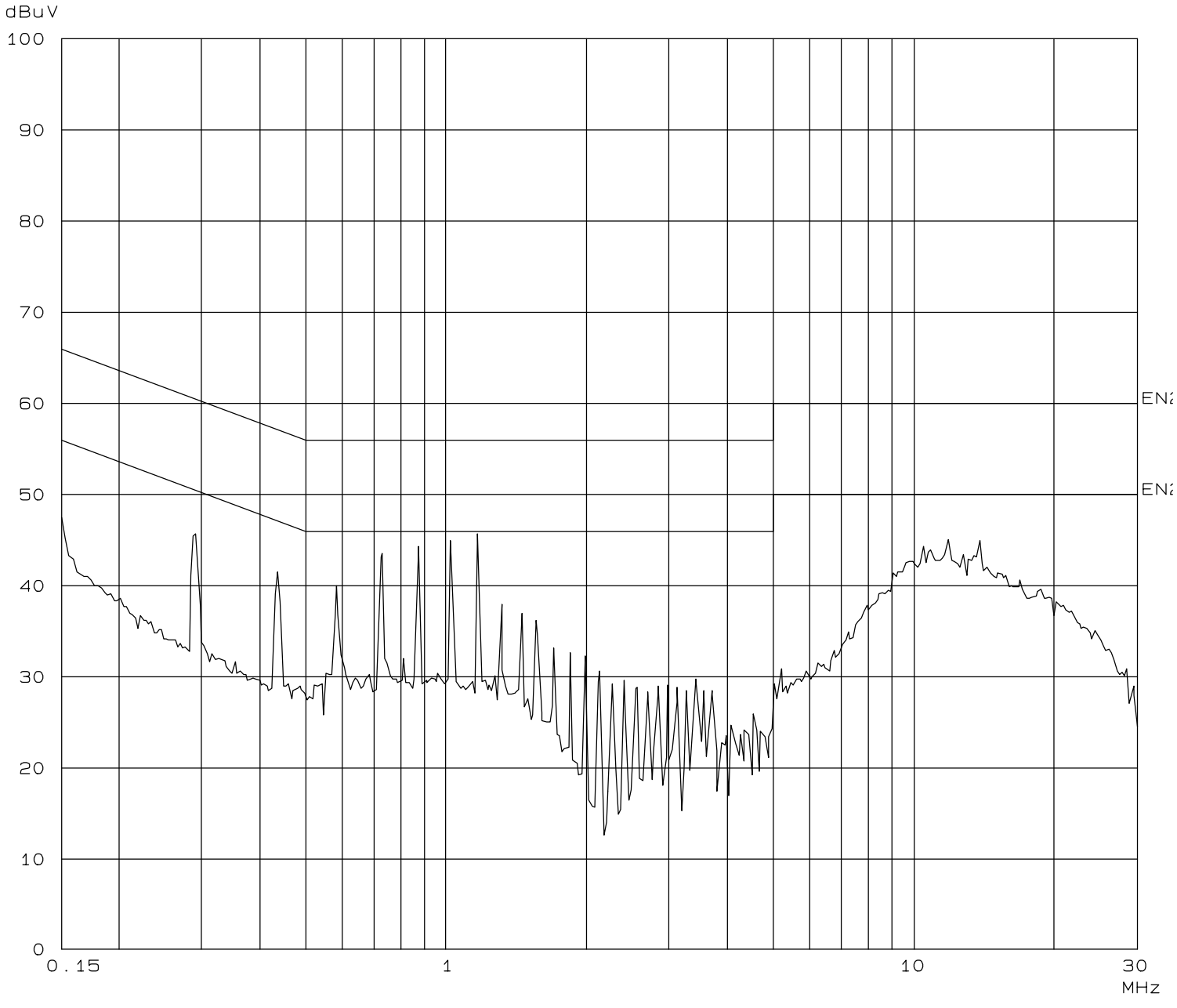
Frequency	Level	AC	EN55022 B		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.742	41.5	Line	46.0	-4.5	Average	
1.040	40.2	Line	46.0	-5.8	Average	
1.188	40.0	Line	46.0	-6.0	Average	
0.444	40.1	Neutral	47.0	-6.9	Average	
0.891	37.0	Line	46.0	-9.0	Average	
0.889	36.0	Neutral	46.0	-10.0	Average	
1.188	44.9	Line	56.0	-11.1	QP	
1.040	43.6	Line	56.0	-12.4	QP	
0.150	43.3	Line	56.0	-12.7	Average	
0.150	42.4	Neutral	56.0	-13.6	Average	
0.742	42.0	Line	56.0	-14.0	QP	
0.891	41.4	Line	56.0	-14.6	QP	
0.444	40.6	Neutral	57.0	-16.4	QP	
0.889	39.4	Neutral	56.0	-16.6	QP	
0.150	49.3	Neutral	66.0	-16.7	QP	
0.150	48.7	Line	66.0	-17.3	QP	

Elliott Laboratories
AC Conducted Emissions

11. Dec 03 14: 49

Operator: Yu-Chien Ho
Comment: Savi
SMR-650-110-111
J53657 / T53670

UHF Test, 120V / 60Hz
Run No.1 120V Line

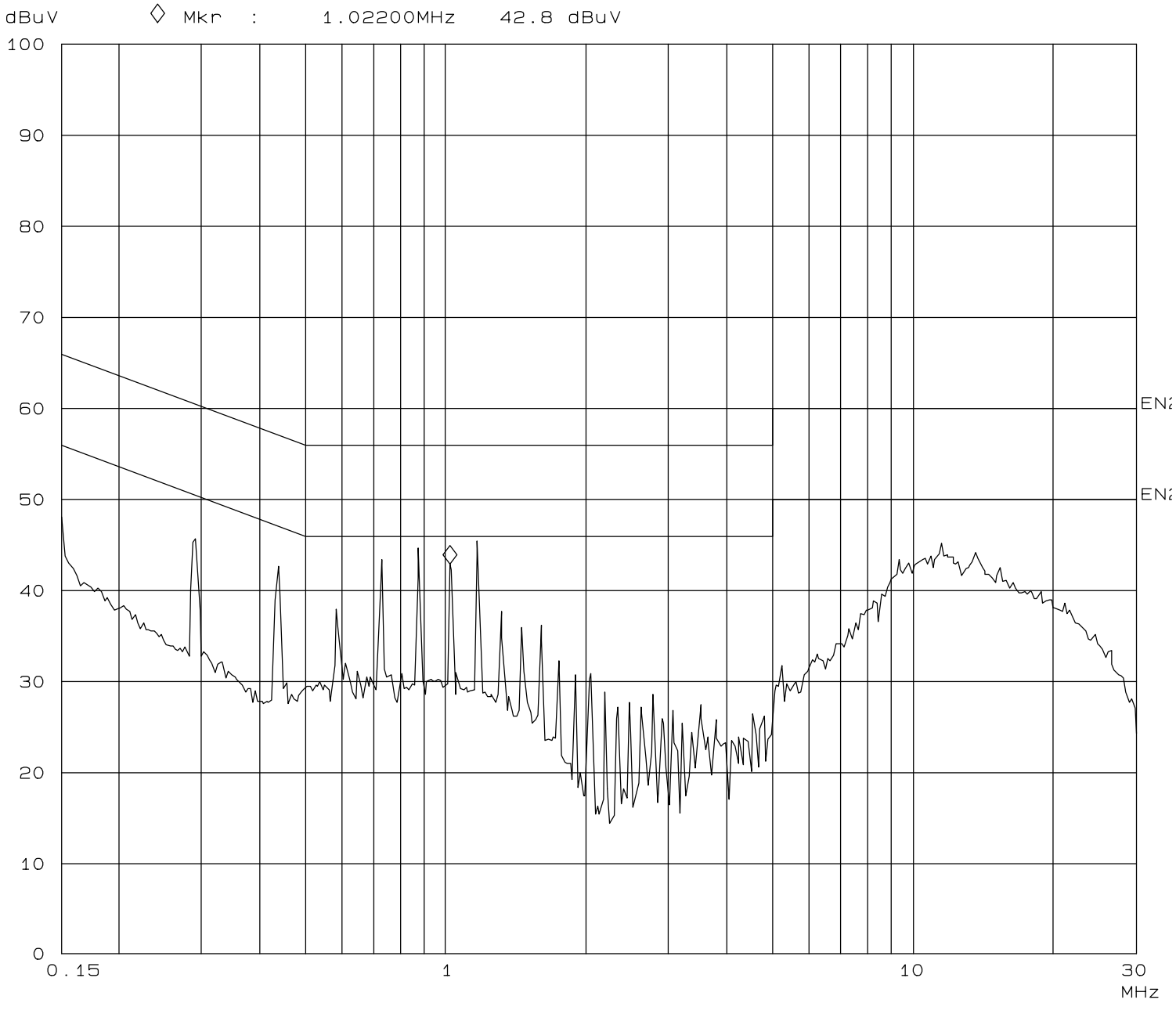


Elliott Laboratories
AC Conducted Emissions

11. Dec 03 14:59

Operator: Yu-Chien Ho
Comment: Savi
SMR-650-110-111
J53657 / T53670

UHF Test, 120V / 60Hz
Run No.1 120V Neutral

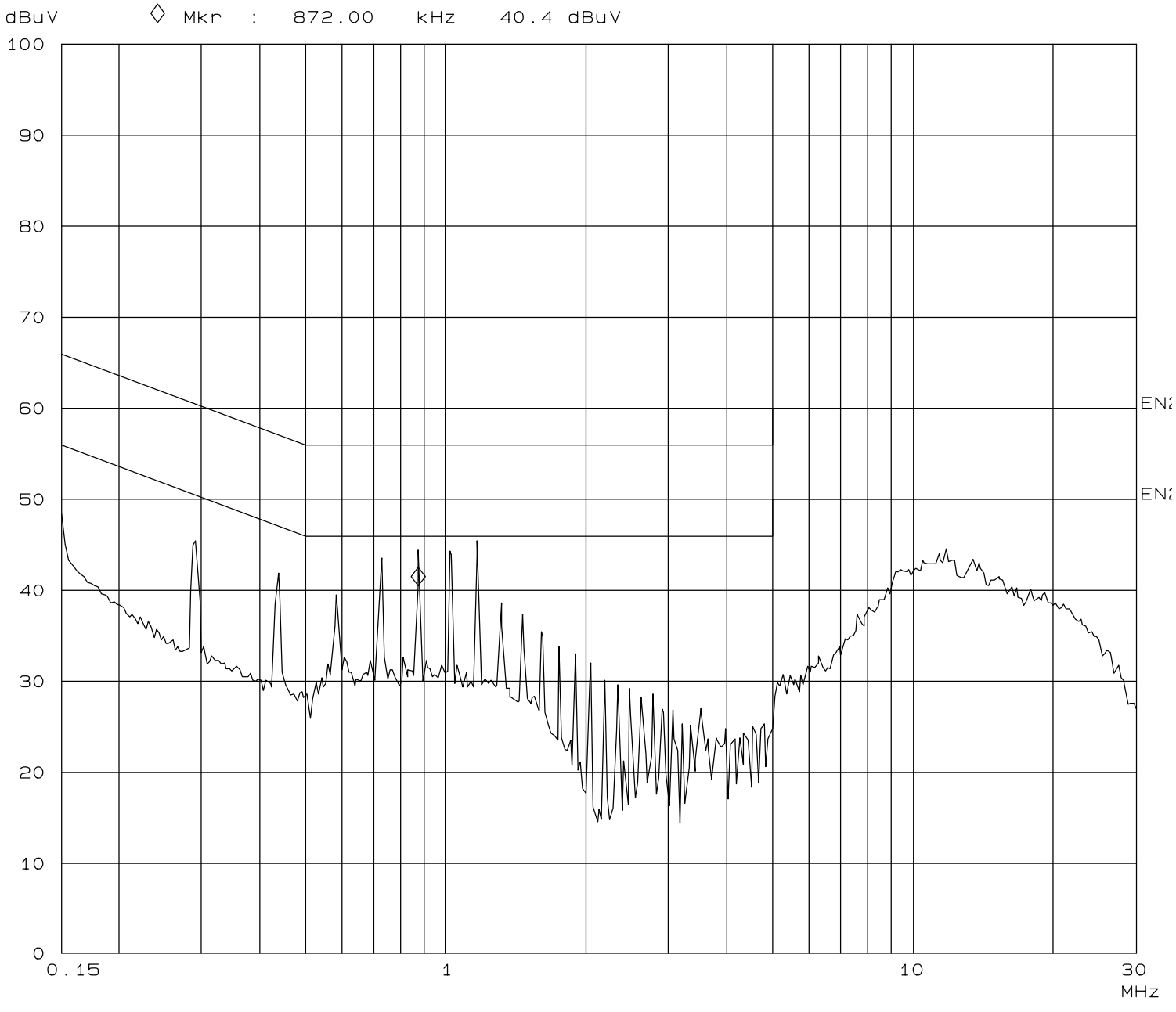


Elliott Laboratories
AC Conducted Emissions

11. Dec 03 15: 10

Operator: Yu-Chien Ho
Comment: Savi
SMR-650-110-111
J53657 / T53670

LHF Test, 120V / 60Hz
Run No.2 120V Line

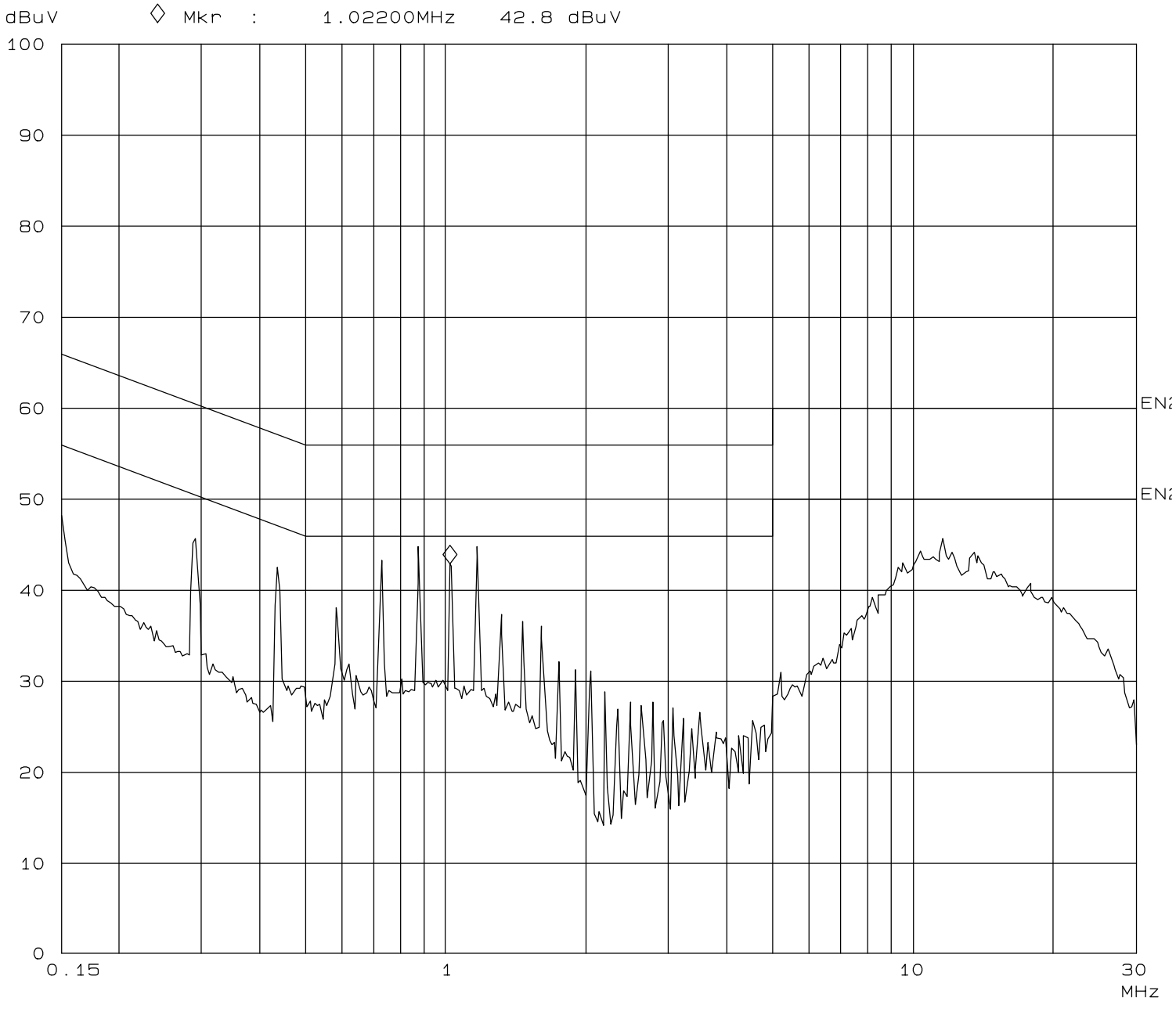


Elliott Laboratories
AC Conducted Emissions

11. Dec 03 15: 18

Operator: Yu-Chien Ho
Comment: Savi
SMR-650-110-111
J53657 / T53670

LHF Test, 120V / 60Hz
Run No.2 120V Neutral

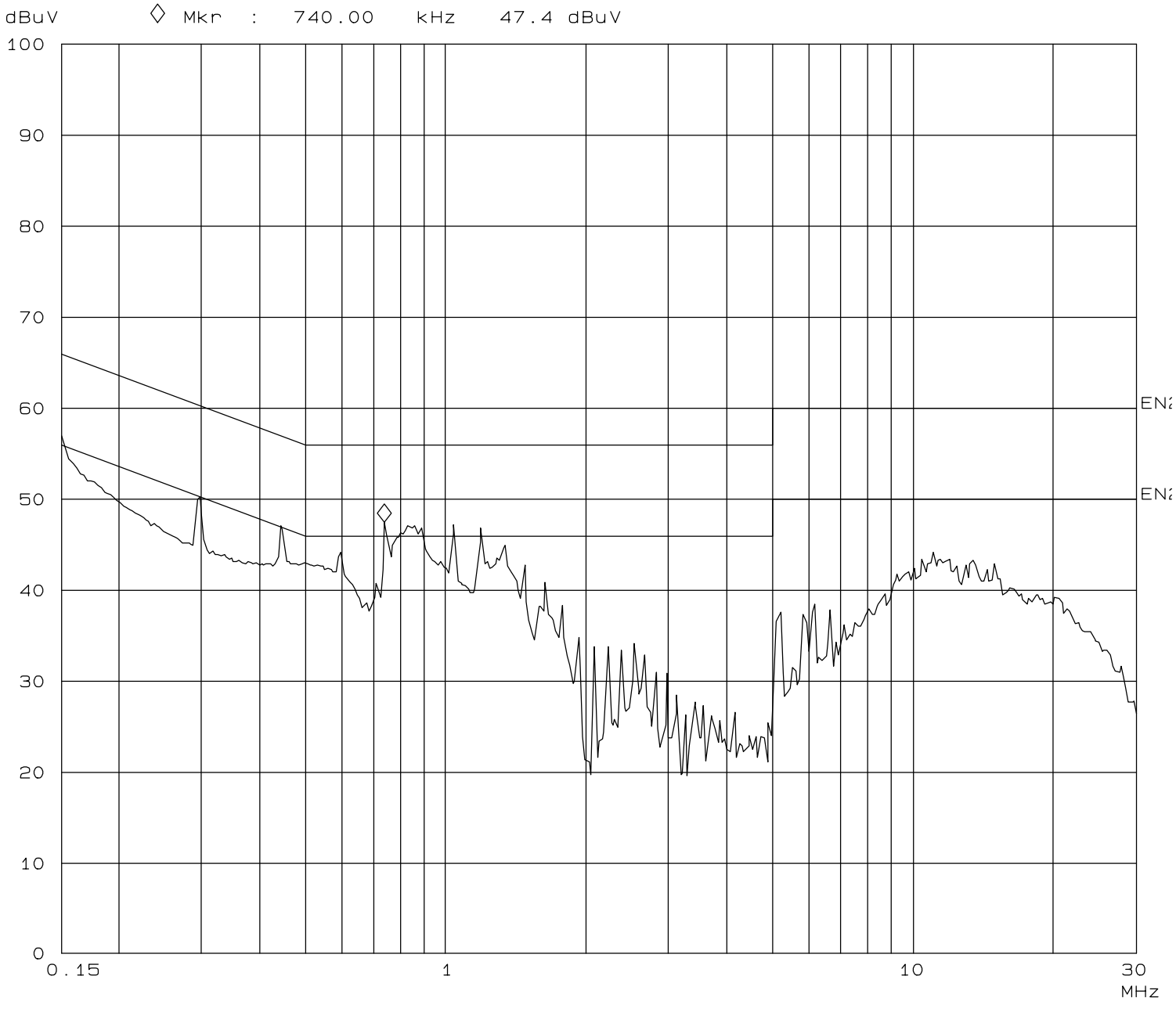


Elliott Laboratories
AC Conducted Emissions

11. Dec 03 15:28

Operator: Yu-Chien Ho
Comment: Savi
SMR-650-110-111
J53657 / T53670

UHF Test, 230V / 50Hz
Run No.3 230V Line

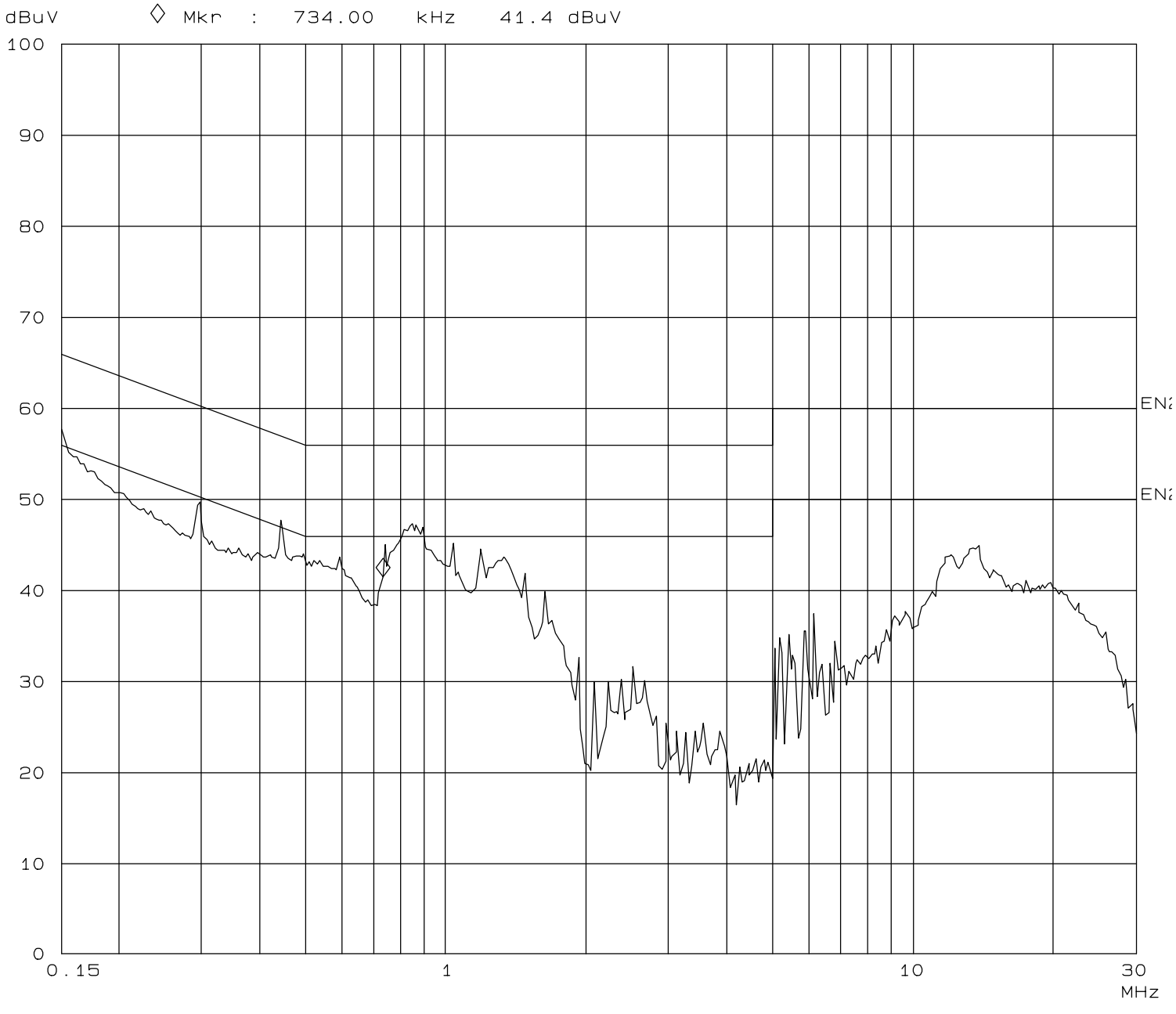


Elliott Laboratories
AC Conducted Emissions

11. Dec 03 15: 47

Operator: Yu-Chien Ho
Comment: Savi
SMR-650-110-111
J53657 / T53670

UHF Test, 230V / 50Hz
Run No.3 230V Neutral



Elliott

EMC Test Data

Client:	Savi	Job Number:	J53657
Model:	SMR-650P-110	T-Log Number:	T53670
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Emissions Spec:	EN55022,FCC 15.231, 15.209	Class:	A/B
Immunity Spec:	EN 301 489-3, EN60601-1-2	Environment:	-

EMC Test Data

For The

Savi

Model

SMR-650P-110

Date of Last Test: 1/16/2004

Client:	Savi	Job Number:	J53657
Model:	SMR-650P-110	T-Log Number:	T53670
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Emissions Spec:	EN55022,FCC 15.231, 15.209	Class:	A/B
Immunity Spec:	EN 301 489-3, EN60601-1-2	Environment:	-

EUT INFORMATION

General Description

The EUT is a transceiver which is designed to communicate with Savi's RFID tags. The device transmits at 123 kHz and at 433.92 MHz to initiate responses from tags within its vicinity. The tags transmit at 433.92 MHz, so the EUT also contains a receiver operating at 433.92 MHz. The device has a serial (RS-232) interface to connect directly to a hand held PC or similar device and operates from internal, rechargeable batteries. The device has an external DC input used to recharge the batteries via adapter. It is intended to be used as a hand held device although it can operate while connected to the external AC-DC adapter. The 123 kHz transmitter operates under part 15.209 of the FCC's rules. The 433.92 MHz transceiver operates under sections 15.209 and 15.231 of the FCC rules. The 433.92 MHz transmissions consist of both data and control signals. When operating under 15.231 rules, the data signals are 10 mS long and have a duty cycle of no more than 10% measured in any 100 mS period. There are two types of control signals, one that has a 24% duty cycle and another, the Wake-Up signal that is a 2.5 second transmission. When operated under 15.209 rules, 433.92 MHz transmissions may be continuous.
The EUT is intended to be used as a hand-held device. The EUT was, therefore, treated as table-top equipment during testing to simulate the end-user environment. The electrical rating of the EUT adapter is 100-240VAC, 50-60Hz, 0.2A.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Savi Technology, Inc.	SMR-650P-110	Transceiver	443503120001	KL7-650MR-V1

EUT 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.

Modification History

Mod. #	Test	Date	Modification
1	RI	1/9/2004	The capacitor in the external LC tank for the receiver FM demodulator was adjusted to properly tune the LC tank.

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

Client:	Savi	Job Number:	J53657
Model:	SMR-650P-110	T-Log Number:	T53670
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Emissions Spec:	EN55022,FCC 15.231, 15.209	Class:	A/B
Immunity Spec:	EN 301 489-3, EN60601-1-2	Environment:	-

Test Configuration #2

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
Winbook	Winbook XL	Laptop Computer	H1106587	DoC
IBM	ThinkPad	Laptop Computer	78-48-24897/11	ANO9611TBOON
PowDec	WP05050I	Charger	WP05050I-1.3	none

Note the WinBook was used for digital device emissions tests. The IBM Thinkpad laptop was used for all other tests. The laptop was used to terminate the serial port. The actual serial peripheral would be a hand-held Personal Data Terminal and not a PC (the EUT is not considered to be a PC peripheral). The PDT's do not have the operating software to control the EUT as required for the tests (continuously transmitting).

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
none				

Interface Cabling and Ports

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
Serial	Laptop	DB9	Shielded	0.2
DC	Charger	Multiwire	Shielded	2

EUT Operation During Emissions

The EUT was set to continuously transmit at either 123kHz or 433.92 MHz with no modulation.

Client:	Savi	Job Number:	J53657
Model:	SMR-650P-110	T-Log Number:	T53670
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Spec:	EN55022,FCC 15.231, 15.209	Class:	A/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: 12/11/2003
Test Engineer: Yu-Chien Ho
Test Location: SVOATS #2
Config. Used: 2
Config Change: None
EUT Voltage: Refer to individual run

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.

Ambient Conditions:

Temperature: 13.3 °C
Rel. Humidity: 46 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power, 120V/60Hz	EN 55022 B	Pass	-5.6dB @ 1.169MHz
2	CE, AC Power,120V/60Hz	EN 55022 B	Pass	-5.7dB @ 1.169MHz
3	CE, AC Power, 230V/50Hz	EN 55022 B	Pass	-4.5dB @ 0.742MHz

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:	J53657
Model:	SMR-650P-110	T-Log Number:	T53670
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Spec:	EN55022,FCC 15.231, 15.209	Class:	A/B

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

Frequency	Level	AC	EN55022 B		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
1.169	40.4	Neutral	46.0	-5.6	Average	
1.023	40.2	Line	46.0	-5.8	Average	
1.169	39.3	Line	46.0	-6.7	Average	
0.877	38.4	Neutral	46.0	-7.6	Average	
1.169	44.3	Neutral	56.0	-11.7	QP	
1.169	44.1	Line	56.0	-11.9	QP	
1.023	43.5	Line	56.0	-12.5	QP	
0.877	42.3	Neutral	56.0	-13.7	QP	
0.150	39.7	Neutral	56.0	-16.3	Average	
0.150	39.2	Line	56.0	-16.8	Average	
0.150	43.8	Neutral	66.0	-22.2	QP	
0.150	43.5	Line	66.0	-22.5	QP	

Frequency	Level	AC	RSS 210		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
1.169	44.3	Neutral	48.0	-3.7	QP	
1.169	44.1	Line	48.0	-3.9	QP	
1.023	43.5	Line	48.0	-4.5	QP	
0.877	42.3	Neutral	48.0	-5.7	QP	

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

Frequency	Level	AC	EN55022 B		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
1.169	40.3	Line	46.0	-5.7	Average	
1.023	40.2	Line	46.0	-5.8	Average	
1.170	39.8	Neutral	46.0	-6.2	Average	
0.877	38.3	Neutral	46.0	-7.7	Average	
1.169	44.4	Line	56.0	-11.6	QP	
1.170	44.3	Neutral	56.0	-11.7	QP	
1.023	43.5	Line	56.0	-12.5	QP	
0.877	42.3	Neutral	56.0	-13.7	QP	
0.150	39.8	Neutral	56.0	-16.2	Average	
0.150	39.4	Line	56.0	-16.6	Average	
0.150	43.9	Neutral	66.0	-22.1	QP	
0.150	43.6	Line	66.0	-22.4	QP	

EMC Test Data

Client:	Savi	Job Number:	J53657
Model:	SMR-650P-110	T-Log Number:	T53670
		Account Manager:	Robert Holt
Contact:	Eugene Schlindwein		
Spec:	EN55022,FCC 15.231, 15.209	Class:	A/B

Run #3: AC Power Port Conducted Emissions, 0.15 - 30MHz, 230V/50Hz
UHF

Frequency	Level	AC	EN55022 B		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.742	41.5	Line	46.0	-4.5	Average	
1.040	40.2	Line	46.0	-5.8	Average	
1.188	40.0	Line	46.0	-6.0	Average	
0.444	40.1	Neutral	47.0	-6.9	Average	
0.891	37.0	Line	46.0	-9.0	Average	
0.889	36.0	Neutral	46.0	-10.0	Average	
1.188	44.9	Line	56.0	-11.1	QP	
1.040	43.6	Line	56.0	-12.4	QP	
0.150	43.3	Line	56.0	-12.7	Average	
0.150	42.4	Neutral	56.0	-13.6	Average	
0.742	42.0	Line	56.0	-14.0	QP	
0.891	41.4	Line	56.0	-14.6	QP	
0.444	40.6	Neutral	57.0	-16.4	QP	
0.889	39.4	Neutral	56.0	-16.6	QP	
0.150	49.3	Neutral	66.0	-16.7	QP	
0.150	48.7	Line	66.0	-17.3	QP	

Elliott

EMC Test Data

Client:	Savi Technology, Inc.	Job Number:	J55096
Model:	SMR-650P-210	T-Log Number:	T55145
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC 15.231, RSS-210, FCC 15.109	Class:	A / Radio
Immunity Spec:		Environment:	

EMC Test Data

For The

Savi Technology, Inc.

Model

SMR-650P-210

Date of Last Test: 4/6/2004

Client:	Savi Technology, Inc.	Job Number:	J55096
Model:	SMR-650P-210	T-Log Number:	T55145
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC 15.231, RSS-210, FCC 15.10	Class:	A / Radio
Immunity Spec:	Enter immunity spec on cover	Environment:	

EUT INFORMATION

General Description

The EUT is a transceiver which is designed to communicate with Savi's RFID tags. The 433.92 MHz to initiate responses from tags within its vicinity. The tags transmit at 433.92 MHz, so the EUT also contains a receiver operating at 433.92 MHz. The device has a serial (RS-232) interface to connect directly to a hand held PC or similar device and operates from internal, rechargeable batteries. The device has an external DC input used to recharge the batteries via adapter. It is intended to be used as a hand held device although it can operate while connected to the external AC-DC adapter. The 433.92 MHz transceiver operates under sections 15.209 and 15.231 of the FCC rules. The 433.92 MHz transmissions consist of both data and control signals. When operating under 15.231 rules, the data signals are 10 mS long and have a duty cycle of no more than 10% measured in any 100 mS period. There are two types of control signals, one that has a 24% duty cycle and another, the Wake-Up signal that is a 2.5 second transmission. When operated under 15.209 rules, 433.92 MHz transmissions may be continuous.

The EUT is intended to be used as a hand-held device. The EUT was, therefore, treated as table-top equipment during testing to simulate the end-user environment. The electrical rating of the EUT adapter is 100-240VAC, 50-60Hz, 0.2A.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Savi Technology, Inc.	SMR-650P-210	Transceiver	443504030001	TBD

EUT Enclosure

The EUT enclosure is primarily constructed of plastic. It measures approximately 6.5 cm wide by 2.5 cm deep by 15 cm high.

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.

Client:	Savi Technology, Inc.	Job Number:	J55096
Model:	SMR-650P-210	T-Log Number:	T55145
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Emissions Spec:	FCC 15.231, RSS-210, FCC 15.10	Class:	A / Radio
Immunity Spec:	Enter immunity spec on cover	Environment:	

Test Configuration #1

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
Winbook	Winbook XL	Laptop Computer	H1106587	DoC
PowDec	WP05050I	Charger	WP05050I-1.3	none

Note the WinBook was used for digital device emissions tests. The laptop was used to terminate the serial port. The actual serial peripheral would be a hand-held Personal Data Terminal and not a PC (the EUT is not considered to be a PC peripheral). The PDT's do not have the operating software to control the EUT as required for the tests (continuously transmitting).

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
none				

Interface Cabling and Ports

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
Serial	Laptop	DB9	Shielded	0.2
DC	Charger	Multiwire	Shielded	2

EUT Operation During Emissions

The EUT was set to continuously transmit at either 433.92 MHz with no modulation.

Client:	Savi Technology, Inc.	Job Number:	J55096
Model:	SMR-650P-210	T-Log Number:	T55145
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231, RSS-210, FCC 15.109	Class:	A / Radio

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: 4/6/2004
Test Engineer: Juan Martinez
Test Location: SVOATS #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.

Unless otherwise specified, the measurement antenna was located 3m from the EUT for the frequency range 30MHz - 6.5 GHz.

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: 11 °C
Rel. Humidity: 59 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 30-1300, Receive-Mode	FCC 15.109/RSS 210	Pass	-13.0dB @ 1269.68 MHz
2	RE, 30 - 1000MHz: Rx Harmonics	EN55011A	Pass	-23.1dB @ 423.222MHz

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 Technology, Inc.	Job Number:	J55096
Model:	SMR-650P-210	T-Log Number:	T55145
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231, RSS-210, FCC 15.109	Class:	A / Radio

Run #1: Radiated Emissions, 30-1300MHz Receive-Mode (FCC 15.109/RSS 210)

Frequency	Level	Pol	15.109/RSS 210		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
Laying Flat								
423.200	27.0	h	46.0	-19.0	QP	34	1.0	LO
846.400	19.8	h	46.0	-26.2	QP	0	1.0	LO x 2
1269.600	35.0	h	54.0	-19.0	Avg	0	1.0	LO x 3; Peak Reading, Avg Limit
423.200	25.6	v	46.0	-20.4	QP	196	1.0	LO
846.400	19.8	v	46.0	-26.2	QP	0	1.0	LO x 2
1269.600	41.0	v	54.0	-13.0	Avg	0	1.0	LO x 3; Peak Reading, Avg Limit
Side								
423.200	29.4	h	46.0	-16.6	QP	360	1.0	LO
846.400	19.2	h	46.0	-26.8	QP	0	1.0	LO x 2
1269.600	36.0	h	54.0	-18.0	Avg	0	1.0	LO x 3; Peak Reading, Avg Limit
423.200	21.5	v	46.0	-24.5	QP	316	1.0	LO
846.400	19.2	v	46.0	-26.8	QP	0	1.0	LO x 2
1269.600	40.2	v	54.0	-13.8	Avg	0	1.0	LO x 3; Peak Reading, Avg Limit
Up								
423.200	20.1	h	46.0	-25.9	QP	160	1.7	LO
846.400	19.4	h	46.0	-26.6	QP	246	1.7	LO x 2
1269.600	38.2	h	54.0	-15.8	Avg	0	1.0	LO x 3; Peak Reading, Avg Limit
423.200	26.1	v	46.0	-19.9	QP	181	1.0	LO
846.400	21.6	v	46.0	-24.4	QP	231	1.0	LO x 2
1269.600	40.1	v	54.0	-13.9	Avg	0	1.0	LO x 3; Peak Reading, Avg Limit

Run #2: Radiated Emissions, Receiver emissions for EN 60601-1-2 (Tested at 10m)

EUT tested operating at its maximum power and in the orientation that generated the highest signal level at 3m

Frequency	Level	Pol	EN 55011 A		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
423.222	23.9	h	47.0	-23.1	QP	144	2.8	LO, side
846.400	18.7	h	47.0	-28.3	QP	150	2.0	LO x 2,standing

Client:	Savi Technology, Inc.	Job Number:	J55096
Model:	SMR-650P-210	T-Log Number:	T55145
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231, RSS-210, FCC 15.109	Class:	A / Radio

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: 4/6/2004
Test Engineer: Jmartinez
Test Location: SVOATS #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.

Unless otherwise specified, the measurement antenna was located 10 meters from the EUT for the measurement range 30 - 1000 MHz (EN55011 A) and 3m from the EUT for the frequency range 30 MHz - 6.5 GHz (FCC 15.231)

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.

Ambient Conditions:

Temperature: 11 °C
Rel. Humidity: 59 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 30 - 4339.25MHz, Pulsed Data Signals	FCC 15.231(e)	Pass	-0.7dB @ 433.92 MHz
2	20-dB Bandwidth	15.231(c)	Pass	448 kHz
3	RE, 30 - 1000MHz: Tx Harmonics	EN55011A	Pass	-6.8dB @ 867.800MHz

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 Technology, Inc.	Job Number:	J55096
Model:	SMR-650P-210	T-Log Number:	T55145
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231, RSS-210, FCC 15.109	Class:	A / Radio

Run #1: Radiated Emissions, 30-4339.250MHz Data Signals with 10% duty cycle (20dB ACF)
sn: 0443504030001

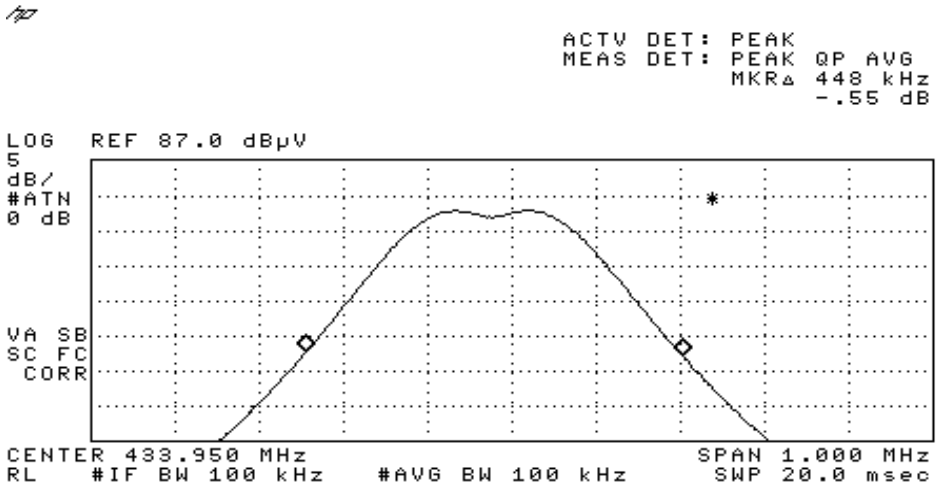
Frequency	Level	Pol	FCC 15.231(e)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
Laying Flat								
433.926	87.2	v	92.9	-5.7	Pk	20	1.0	Fundamental Signal (Setting of 5)
433.926	67.2	v	72.9	-5.7	Avg	20	1.0	Fundamental Signal (Setting of 5)
433.926	**92.0**	h	92.9	-0.9	Pk	186	1.9	Fundamental Signal (Setting of 5)
433.926	72.0	h	72.9	-0.9	Avg	186	1.9	Fundamental Signal (Setting of 5)
867.800	42.3	v	72.9	-30.6	Pk	178	1.0	
867.800	22.3	v	52.9	-26.4	Avg	178	1.0	
867.800	49.0	h	72.9	-23.9	Pk	175	1.2	
867.800	29.0	h	52.9	-27.9	Avg	175	1.2	
1301.760	47.6	h	74.0	-26.4	Pk	48	1.0	
1301.760	27.6	h	54.0	-28.5	Avg	48	1.0	
1301.760	48.5	v	54.0	-31.7	Avg	155	1.2	
1301.760	28.5	v	74.0	-45.5	Pk	155	1.2	
Sideways.								
433.926	86.9	v	92.9	-6.0	Pk	238	1.1	Fundamental Signal (Setting of 5)
433.926	66.9	v	72.9	-6.0	Avg	238	1.1	Fundamental Signal (Setting of 5)
433.926	**92.2**	h	92.9	-0.7	Pk	184	2.0	Fundamental Signal (Setting of 5)
433.926	72.2	h	72.9	-0.7	Avg	184	2.0	Fundamental Signal (Setting of 5)
867.800	43.2	v	72.9	-29.7	Pk	267	1.0	
867.800	23.2	v	52.9	-26.4	Avg	267	1.0	
867.800	44.2	h	72.9	-28.7	Pk	164	1.2	
867.800	24.2	h	52.9	-27.9	Avg	164	1.2	
1301.760	51.4	h	74.0	-22.6	Pk	203	1.1	
1301.760	31.4	h	54.0	-28.5	Avg	203	1.1	
1301.760	51.1	v	54.0	-31.7	Avg	150	1.1	
1301.760	31.1	v	74.0	-42.9	Pk	150	1.1	
Standing								
433.926	90.0	v	92.9	-2.9	Pk	167	1.0	Fundamental Signal (Setting of 5)
433.926	70.0	v	72.9	-2.9	Avg	167	1.0	Fundamental Signal (Setting of 5)
433.926	85.5	h	92.9	-7.4	Pk	360	1.0	Fundamental Signal (Setting of 5)
433.926	65.5	h	72.9	-7.4	Avg	360	1.0	Fundamental Signal (Setting of 5)
867.800	52.6	v	72.9	-20.3	Pk	213	1.0	
867.800	32.6	v	52.9	-26.4	Avg	213	1.0	
867.800	42.7	h	72.9	-30.2	Pk	158	1.0	
867.800	22.7	h	52.9	-27.9	Avg	158	1.0	
1301.760	48.2	h	74.0	-25.8	Pk	150	1.0	
1301.760	28.2	h	54.0	-28.5	Avg	150	1.0	
Continue on next page....								

Client:	Savi Technology, Inc.	Job Number:	J55096
Model:	SMR-650P-210	T-Log Number:	T55145
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231, RSS-210, FCC 15.109	Class:	A / Radio

1301.760	50.1	v	54.0	-31.7	Avg	228	1.0	
1301.760	30.1	v	74.0	-43.9	Pk	228	1.0	

Note - Average values are caluclated from the peak measurement by applying a -12dB correction factor assuming a duty cycle of no more than 25% in any 100ms period. The orientation of the device that produced the highest signal level at the fundamental frequency (433.9 MHz) had been previously determined during preliminary testing. All other signals were measured with the device in all three orientations to determine the worst case.

Run #2: 20dB Bandwidth



Run #3: Radiated Emissions, Transmitted Signal harmonics below 1GHz for EN 60601-1-2 (Tested at 10m)

EUT tested operating at its maximum power and in the orientation that generated the highest signal level at 3m

Frequency	Level	Pol	EN 55011 A		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
867.800	40.2	H	47.0	-6.8	QP	225	2.8	
867.800	40.1	V	47.0	-6.9	QP	190	1.6	

Client:	Savi Technology, Inc.	Job Number:	J55096
Model:	SMR-650P-210	T-Log Number:	T55145
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231, RSS-210, FCC 15.109	Class:	A / Radio

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: 4/6/2004
Test Engineer: Jmartinez
Test Location: SVOATS #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.

Unless otherwise specified, the measurement antenna was located3m from the EUT for the frequency range 30MHz - 6.5 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.

Ambient Conditions:

Temperature: 11 °C
Rel. Humidity: 59 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 30 - 4339.25MHz, Wake-Up Signal	FCC 15.231(a)	Pass	-0.9dB @ 433.926 MHz

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 Technology, Inc.	Job Number:	J55096
Model:	SMR-650P-210	T-Log Number:	T55145
		Account Manager:	Rob Holt
Contact:	Eugene Schlindwein		
Spec:	FCC 15.231, RSS-210, FCC 15.109	Class:	A / Radio

Run #1: Radiated Emissions, 30-4339.250MHz Wake-Up Control Signal
sn: 0443504030001

Frequency	Level	Pol	FCC 15.231(a)		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
Laying Flat								
433.926	79.9	h	80.8	-0.9	Pk	180	1.8	Fundamental Signal (Setting of 17)
433.926	73.4	v	80.8	-7.4	Pk	217	1.0	Fundamental Signal (Setting of 17)
1301.760	44.3	h	54.0	-9.7	Pk	209	1.0	
1301.760	45.2	v	54.0	-8.8	Pk	164	1.2	
867.800	43.4	h	60.8	-17.4	Pk	169	1.2	
867.800	43.2	v	60.8	-17.6	Pk	220	1.0	

Note - Testing was performed with the EUT in all three orientations during the measurements for the control signal. As the control signal and wake-up signals use the same curcuitry, measurements of the Wake-Up signal were made with the device in the orinetations that produced the highest signal levels during the pulsed control signal measurements.

EXHIBIT 3: Photographs of Test Configurations

4 Pages

EXHIBIT 4: Detailed Photographs of Savi Technology, Inc. Model SMR-650P-21X

7 Pages

EXHIBIT 5: Block Diagram of Savi Technology, Inc. Model SMR-650P-21X

EXHIBIT 6: Label and Label Location of Savi Technology, Inc. Model SMR-650P-21X

EXHIBIT 7: Schematic Diagrams of Savi Technology, Inc. Model SMR-650P-21X

7 Pages

EXHIBIT 8: Theory of Operation for Savi Technology, Inc. Model SMR-650P-21X

4 Pages

EXHIBIT 9: Advertising Literature

2 Pages

EXHIBIT 10: Operator's Manual

37 Pages