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# *Electromagnetic Emissions Test Report and Application for Grant of Equipment Authorization pursuant to FCC Part 15, Subpart C Specifications for an Intentional Radiator on the Savi Technology, Inc. Model: SMR-640P-101*

FCC ID: KL7-600MR-V1

GRANTEE: Savi Technology, Inc.
615 Tasman Drive
Sunnyvale, CA. 94089-1707

TEST SITE: Elliott Laboratories, Inc.
684 W. Maude Avenue
Sunnyvale, CA 94086

REPORT DATE: June 7, 2002

FINAL TEST DATE: May 31, 2002

AUTHORIZED SIGNATORY: _____
Mark Briggs
Director of Engineering

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## *SCOPE*

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

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

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

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

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

## *OBJECTIVE*

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

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

## *STATEMENT OF COMPLIANCE*

The tested sample of Savi Technology, Inc. model SMR-640P-101 complied with the requirements of Subpart C of Part 15 of the FCC Rules for low power intentional radiators.

Maintenance of FCC compliance is the responsibility of the manufacturer. Any modification of the product that 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 SMR-640P-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.

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.

| Frequency MHz | Level dBuV | Power Lead | FCC Limit | FCC Margin | Detector QP/Ave | Comments |
|---|---|---|---|---|---|---|
| 0.5442 | 38.8 | Neutral | 48.0 | -9.2 | QP | |

### *LIMITS OF RADIATED INTERFERENCE FIELD STRENGTH*

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

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

| Frequency MHz | Level dBuV/m | Pol v/h | FCC Limit | FCC Margin | Detector Pk/QP/Avg | Azimuth degrees | Height meters | Comments |
|---|---|---|---|---|---|---|---|---|
| 132 | -26.9 | O | 25.2 | -52.1 | QP | 60 | 1.0 | Note 1* |

*Level calculated by applying an extrapolation factor calculated from measurements at 3m and 10m to the measurement recorded at 10m.

### *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 SMR-640P-101 is a transceiver, which is designed to communicate with Savi's RFID tags. The device transmits at 132kHz and at 433.92 MHz to initiate responses form tags within its vicinity. The Tag's transmit at a frequency of 433.92 MHz, so the EUT also contains a receiver operating at 433.92 MHz.

The device has a serial (RS232) 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 132kHz transmitter operates under part 15.209 of the FCC's rules. The 433 MHz transceiver operates under section 15.231 of the FCC rules. The 433MHz transmissions consist of both data signals and control signals. The data signals are 10mS long and have a duty cycle of no more than 10% measured in a 100mS period. There are two types of control signal, one that has the same parameters as the data signals and another, the Wake-Up signal, which is a 2.5second transmission.

The 10mS data signals were tested against the requirements of 15.231(e). The Wake-Up control signal and pulsed control signals were tested against the requirements of 15.231(a).

The sample was received on May 29, 2002 and tested on May 29, 2002, May 31, 2002, June 3, 2002.

The EUT consisted of the following component(s):

| Manufacturer | Model | Description | Serial Number |
|---|---|---|---|
| Savi | SMR-640P-101 | Mobile reader | 0386505020006 |

### *ENCLOSURE*

The EUT enclosure is primarily constructed of plastic.

### *MODIFICATIONS*

The EUT did not require modifications in order to comply with the emissions specifications

***SUPPORT EQUIPMENT***

The following equipment was used as local support equipment while testing the emissions from the 132kHz transmitter and 433MHz transceiver:

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

No remote support equipment was used during emissions testing.

***EXTERNAL I/O CABLING***

The I/O cabling configuration while testing the radiated emissions from the transmitters was as follows:

| Port | Connected To | Cable(s) | | |
|---|---|---|---|---|
| | | Description | Shielded or Unshielded | Length(m) |
| RS232 | Not connected | 30cm integral cable | | |
| DC | AC-DC adapter | | unshielded | |

The I/O cabling configuration while testing the radiated emissions from the receiver and during conducted emissions tests was as follows:

| Port | Connected To | Cable(s) | | |
|---|---|---|---|---|
| | | Description | Shielded or Unshielded | Length(m) |
| EUT RS232 | Laptop | 30cm integral cable | shielded | 0.3 |
| EUT DC | AC-DC adapter | 2-wire | unshielded | 1 |
| Printer Parallel | Laptop Parallel | Multiconductor | shielded | 3 |

***EUT OPERATION***

Radiated
The EUT was transmitting at either 433 MHz or 132 KHz or was placed in receive-only mode.

Conducted
The 132kHz transmitter was operating and the laptop was running a batch file that created a scrolling 'H' pattern on the screen. The test was not repeated with the 433 MHz transmitter operating as the 132kHz mode was determined to be the worst-case mode.

## *TEST SITE*

### *GENERAL INFORMATION*

Final test measurements were taken on May 31, 2002 at the Elliott Laboratories Open Area Test Site #2 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 are performed in conformance with ANSI C63.4-1992. Measurements are made with the EUT connected to the public power network through 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 ranges 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***

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

***RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.209***

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

***SAMPLE CALCULATIONS - CONDUCTED EMISSIONS***

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

$$R_r - B = C$$

and

$$C - S = M$$

where:

$R_r$ = Receiver Reading in dBuV

B = Broadband Correction Factor*

C = Corrected Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

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

***SAMPLE CALCULATIONS - RADIATED EMISSIONS***

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

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

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*

**Radiated Emissions Preliminary Scans, 24-May-02**
**Engineer: Mark**

| Manufacturer | Description | Model # | Assett # | Cal interval | Last Calibrated | Cal Due |
|---|---|---|---|---|---|---|
| EMCO | Conical Log Spiral Antenna | 3101 | 608 | 12 | 5/15/2002 | 5/15/2003 |
| EMCO | Magnetic Loop Antenna, 10k-30MHz | 6502 | 296 | 12 | 1/16/2002 | 1/16/2003 |
| Hewlett Packard | Microwave Preamplifier 0.5-26.5GHz | 83017A | 1257 | 12 | 10/16/2001 | 10/16/2002 |
| Hewlett Packard | RF Preamplifier, 100 kHz - 1.3 GHz | 8447D | 999 | 12 | 4/24/2002 | 4/24/2003 |
| Hewlett Packard | Spectrum Analyzer, 9KHz - 22GHz | 8593EM | 1319 | 12 | 4/5/2002 | 4/5/2003 |
| AH Systems | Biconical Antenna | SAS-200/540H | 686 | 12 | 5/8/2002 | 5/8/2003 |
| Dorado | Horn Antenna 1-12GHz | | 1258 | 12 | 11/18/2001 | 11/18/2002 |

**Radiated Emissions, 30 - 1000 MHz, 29-May-02**
**Engineer: Vishal**

| Manufacturer | Description | Model # | Assett # | Cal interval | Last Calibrated | Cal Due |
|---|---|---|---|---|---|---|
| EMCO | Log Periodic Antenna, 0.3-1 GHz | 3146A | 364 | 12 | 8/28/2001 | 8/28/2002 |
| Rohde & Schwarz | Test Receiver, 0.009-2000 MHz | ESN | 1332 | 12 | 4/16/2002 | 4/16/2003 |

**Conducted and Radiated Emissions, 31-May-02**
**Engineer: mfaustino**

| Manufacturer | Description | Model # | Assett # | Cal interval | Last Calibrated | Cal Due |
|---|---|---|---|---|---|---|
| Elliott Laboratories | FCC / CISPR LISN | LISN-3, OATS | 304 | 12 | 6/14/2001 | 6/14/2002 |
| EMCO | Magnetic Loop Antenna, 10k-30MHz | 6502 | 296 | 12 | 1/16/2002 | 1/16/2003 |
| EMCO | Biconical Antenna, 30-300 MHz | 3110B | 801 | 12 | 5/13/2002 | 5/13/2003 |
| EMCO | Log Periodic Antenna, 0.3-1 GHz | 3146A | 364 | 12 | 8/28/2001 | 8/28/2002 |
| Rohde& Schwarz | Pulse Limiter | ESH3 Z2 | 1398 | 12 | 2/7/2002 | 2/7/2003 |
| Rohde & Schwarz | Test Receiver, 0.009-2000 MHz | ESN | 1332 | 12 | 4/16/2002 | 4/16/2003 |
| Solar Electronics | Support Equipment LISN, 0.150-30.0 MHz | 8012-50-R-24-BNC | 305 | 12 | 7/30/2001 | 7/30/2002 |

**Radiated Emissions, 1 - 4.0 GHz, 03-Jun-02**
**Engineer: mfaustino**

| Manufacturer | Description | Model # | Assett # | Cal interval | Last Calibrated | Cal Due |
|---|---|---|---|---|---|---|
| EMCO | Horn Antenna, D. Ridge 1-18GHz | 3115 | 1242 | 12 | 10/9/2001 | 10/9/2002 |
| Filtek | High Pass Filter, 1GHz | HP12/1000-5BA | 956 | 12 | 3/12/2002 | 3/12/2003 |
| Hewlett Packard | EMC Spectrum Analyzer, Opt. 026 ¸9 KHz -26.5GHz | 8593EM | 1141 | 12 | 3/11/2002 | 3/11/2003 |
| Hewlett Packard | Microwave Preamplifier, 1-26.5GHz | 8449B | 870 | 12 | 1/15/2002 | 1/15/2003 |

# *EXHIBIT 2: Test Data Log Sheets*

***ELECTROMAGNETIC EMISSIONS***

***TEST LOG SHEETS***

***AND***

***MEASUREMENT DATA***

T47386 13 Pages

Elliott

# EMC Test Data

| | | | |
|---|---|---|---|
| Client: | Savi | Job Number: | J47361 |
| Model: | SAVI SMR-640P-101 | T-Log Number: | T47386 |
| | | Proj Eng: | Mark Briggs |
| Contact: | Eugene Schlindwein | | |
| Emissions Spec: | FCC 15 B, 15.209, 15.231 | Class: | A |
| Immunity Spec: | - | Environment: | - |

# EMC Test Data

For The

## Savi

Model

**SAVI SMR-640P-101**

| | | | |
|---|---|---|---|
| Client: | Savi | Job Number: | J47361 |
| Model: | SAVI SMR-640P-101 | T-Log Number: | T47386 |
| | | Proj Eng: | Mark Briggs |
| Contact: | Eugene Schlindwein | | |
| Emissions Spec: | FCC 15 B, 15.209, 15.231 | Class: | A |
| Immunity Spec: | - | Environment: | - |

# EUT INFORMATION

## General Description

The EUT is a transceiver which is designed to communicate with Savi's RFID tags. The device transmits at 132kHz and at 433.92 MHz to initiate responses form tags within its vicinity. The Tag's transmit at a frequency of 433.92 MHz, so the EUT also contains a receiver operating at 433.92 MHz.

The device has a serial (RS232) 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 132kHz transmitter operates under part 15.209 of the FCC's rules. The 433 MHz transceiver operates under section 15.231 of the FCC rules. The 433MHz transmissions consist of both data signals and control signals. The data signals are 10mS long and have a duty cycle of no more than 10% measured in a 100mS period. There are two types of control signal, one that has a 24% duty-cycle and another, the Wake-Up signal, that is a 2.5second transmission.
The data signals were tested against the requirements of 15.231(e). The control signals were tested against the requirements of 15.231(a).

## Equipment Under Test

| Manufacturer | Model | Description | Serial Number | FCC ID |
|---|---|---|---|---|
| Savi | SMR-640P-101 | Mobile reader | 0386505020006 | |

## EUT Enclosure

The EUT enclosure is primarily constructed of plastic.

## Modification History

| Mod. # | Test | Date | Modification |
|---|---|---|---|
| 1 | - | - | None |

| | | | |
|---|---|---|---|
| Client: | Savi | Job Number: | J47361 |
| Model: | SAVI SMR-640P-101 | T-Log Number: | T47386 |
| | | Proj Eng: | Mark Briggs |
| Contact: | Eugene Schlindwein | | |
| Emissions Spec: | FCC 15 B, 15.209, 15.231 | Class: | A |
| Immunity Spec: | - | 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 |
|---|---|---|---|---|
| None | | | | |

## Interface Ports

| | | Cable(s) | | |
|---|---|---|---|---|
| Port | Connected To | Description | Shielded or Unshielded | Length(m) |
| RS232 | Not connected | 30cm integral cable | | |
| DC | AC-DC adapter | | unshielded | |

## EUT Operation During Emissions

The EUT was transmitting at either 433 MHz or 132 KHz.

| | | | |
|---|---|---|---|
| Client: | Savi | Job Number: | J47361 |
| Model: | SAVI SMR-640P-101 | T-Log Number: | T47386 |
| | | Proj Eng: | Mark Briggs |
| Contact: | Eugene Schlindwein | | |
| Emissions Spec: | FCC 15 B, 15.209, 15.231 | Class: | A |
| Immunity Spec: | - | Environment: | - |

# Test Configuration #2 (Digital Device Testing)

## Local Support Equipment

| Manufacturer | Model | Description | Serial Number | FCC ID |
|---|---|---|---|---|
| IBM | 2635 | Laptop | 78-VA24897/11 | ANO9611TBOON |
| Epson | P952A | Printer | ADA0013241 | BKMFBP952A |

## Remote Support Equipment

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

## Interface Ports

| | | Cable(s) | | |
|---|---|---|---|---|
| Port | Connected To | Description | Shielded or Unshielded | Length(m) |
| EUT RS232 | Laptop | 30cm integral cable | shielded | 0.3 |
| EUT DC | AC-DC adapter | 2-wire | unshielded | 1 |
| Printer Parallel | Laptop Parallel | Multiconductor | shielded | 3 |

## EUT Operation During Emissions

The EUT was placed in receive-only mode and the laptop was running a batch file that created a scrolling 'H' pattern on the screen.

| | | | |
|---|---|---|---|
| Client: | Savi | Job Number: | J47361 |
| Model: | SAVI SMR-640P-101 | T-Log Number: | T47386 |
| | | Proj Eng: | Mark Briggs |
| Contact: | Eugene Schlindwein | | |
| Spec: | FCC 15 B, 15.209, 15.231 | Class: | A |

# 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: 5/31/2002
Test Engineer: Marissa Faustino
Test Location: SVOATS #2

Config. Used: #2
Config Change: The 132kHz Tx was on
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: 19°C
Rel. Humidity: 69%

## Summary of Results

| Run # | Test Performed | Limit | Result | Margin |
|---|---|---|---|---|
| 1 | CE, AC Power 230V/50Hz | EN 301 489-3 | Pass | -2.25dB @ .405MHz |
| 2 | CE, AC Power 120V/60Hz | FCC Class B / 15.207 | Pass | -9.2dB @ .544MHz |

## 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: | J47361 |
| Model: | SAVI SMR-640P-101 | T-Log Number: | T47386 |
| | | Proj Eng: | Mark Briggs |
| Contact: | Eugene Schlindwein | | |
| Spec: | FCC 15 B, 15.209, 15.231 | Class: | A |

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

| Frequency | Level | AC | EN 301 489-3 | | Detector | Comments |
|---|---|---|---|---|---|---|
| MHz | dBµV | Line | Limit | Margin | QP/Ave | |
| 0.4050 | 45.5 | Neutral | 47.8 | -2.3 | Average | |
| 0.5100 | 43.2 | Line | 46.0 | -2.8 | Average | |
| 0.4080 | 44.8 | Line | 47.7 | -2.9 | Average | |
| 0.5070 | 42.0 | Neutral | 46.0 | -4.0 | Average | |
| 0.2048 | 42.6 | Line | 53.4 | -10.8 | Average | |
| 0.4050 | 45.9 | Neutral | 57.8 | -11.9 | QP | |
| 0.5100 | 43.9 | Line | 56.0 | -12.1 | QP | |
| 0.4080 | 45.2 | Line | 57.7 | -12.5 | QP | |
| 0.5070 | 43.4 | Neutral | 56.0 | -12.6 | QP | |
| 0.2048 | 43.0 | Line | 63.4 | -20.4 | QP | |
| 0.1530 | 42.7 | Neutral | 65.8 | -23.1 | QP | |
| 0.1530 | 14.1 | Neutral | 55.8 | -41.7 | Average | |

**Run #2: AC Power Port Conducted Emissions, 0.45 - 30MHz, 120V/60Hz**

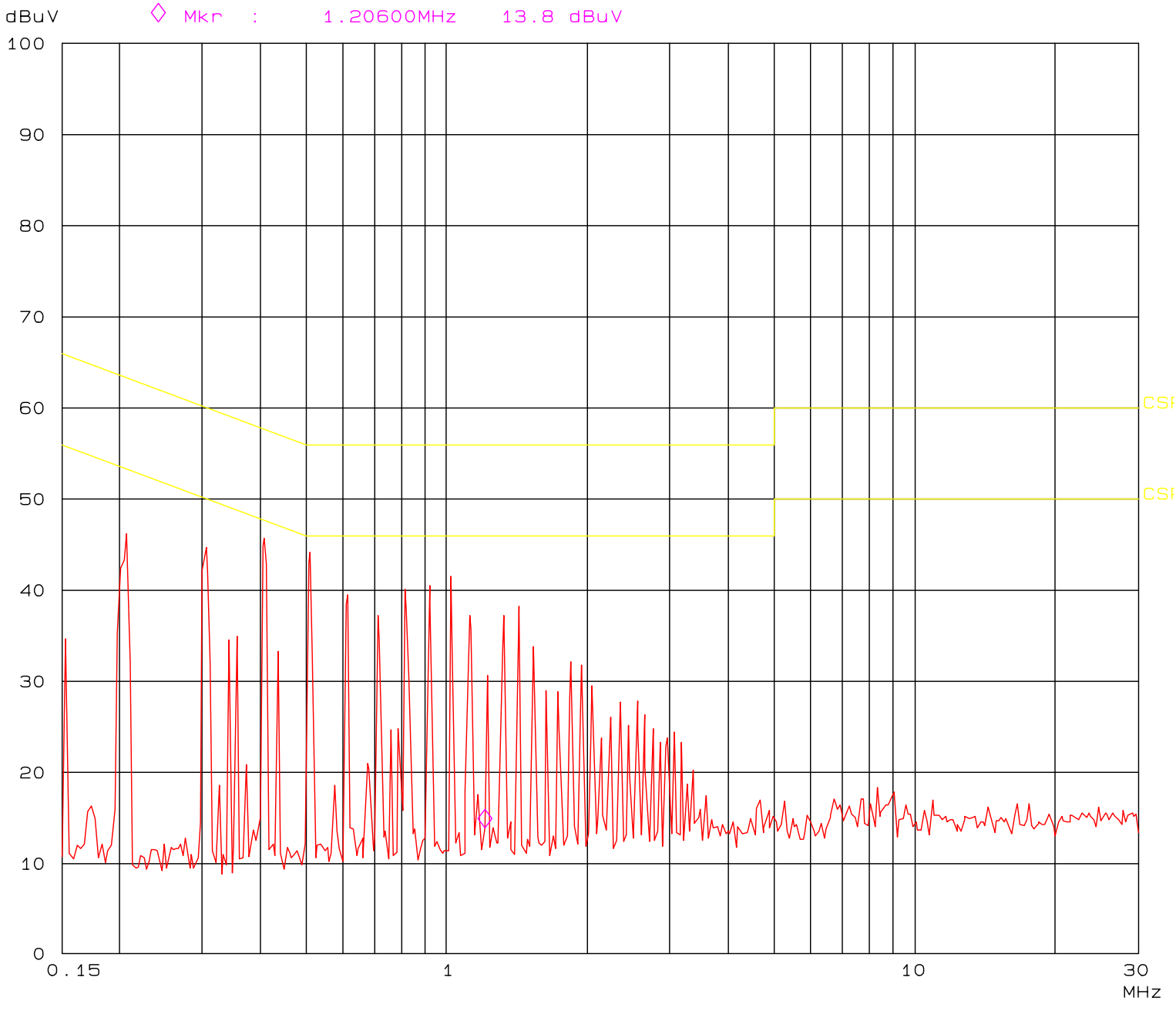
| Frequency | Level | AC | FCC 15.109B, 15.209 | | Detector | Comments |
|---|---|---|---|---|---|---|
| MHz | dBµV | Line | Limit | Margin | QP/Ave | |
| 0.5442 | 38.8 | Neutral | 48.0 | -9.2 | QP | |
| 0.6330 | 38.7 | Neutral | 48.0 | -9.3 | QP | |
| 0.6355 | 38.4 | Line | 48.0 | -9.6 | QP | |
| 0.5449 | 37.9 | Line | 48.0 | -10.1 | QP | |
| 1.2719 | 37.4 | Line | 48.0 | -10.6 | QP | |
| 1.2703 | 37.3 | Neutral | 48.0 | -10.7 | QP | |

# Elliott LaboratoriesInc.

31. May 02 14:39

## Conducted Emissions

Operator: Marissa Fausitno
Comment: Savi Technology
SMR-600P-102
EN 301 489-3
Run 1
230V/50Hz
Line

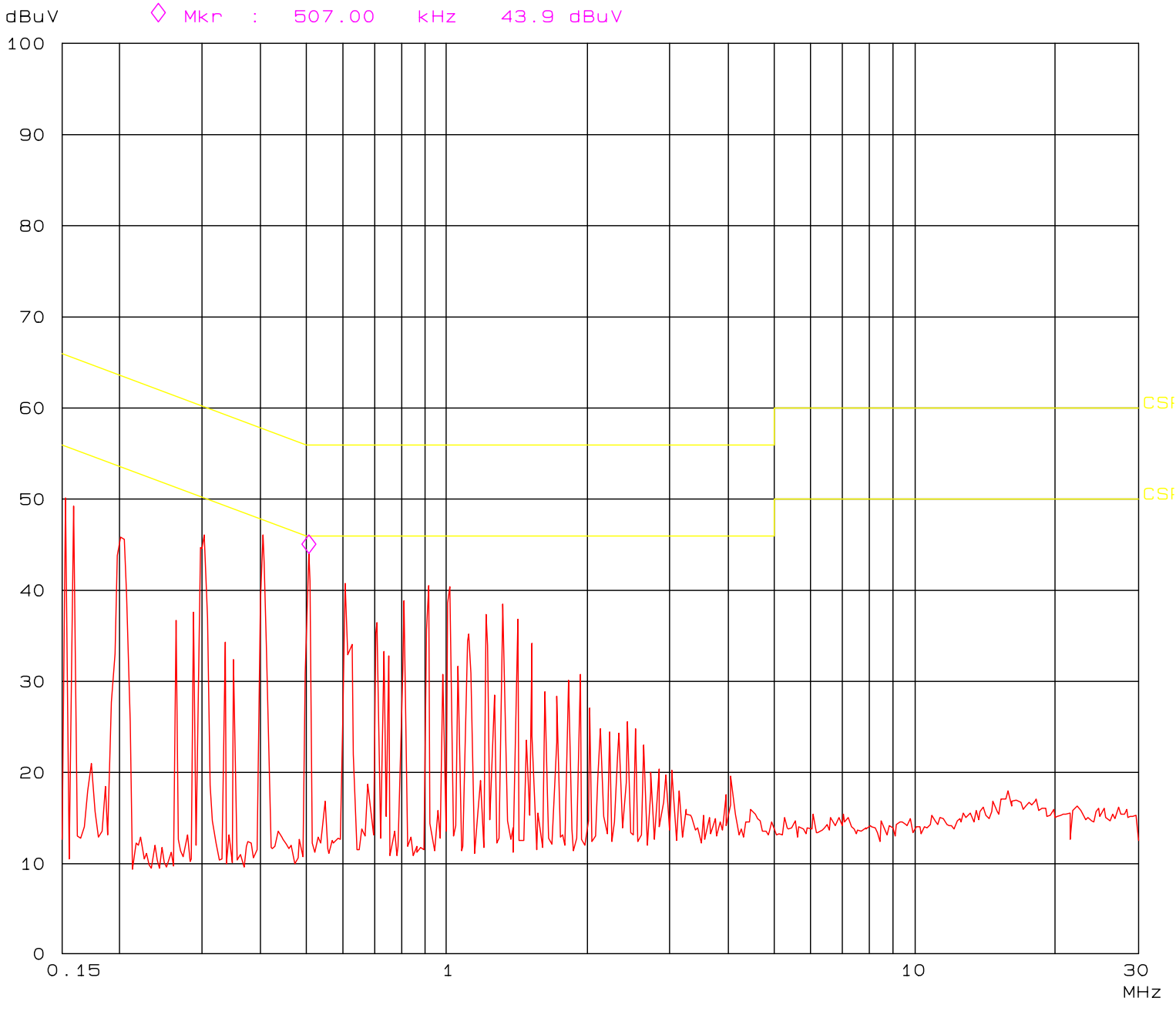


# Elliott LaboratoriesInc.

31. May 02 14:46

## Conducted Emissions

Operator: Marissa Fausitno
Comment: Savi Technology
SMR-600P-102
EN 301 489-3
Run 1
230V/50Hz
Neutral

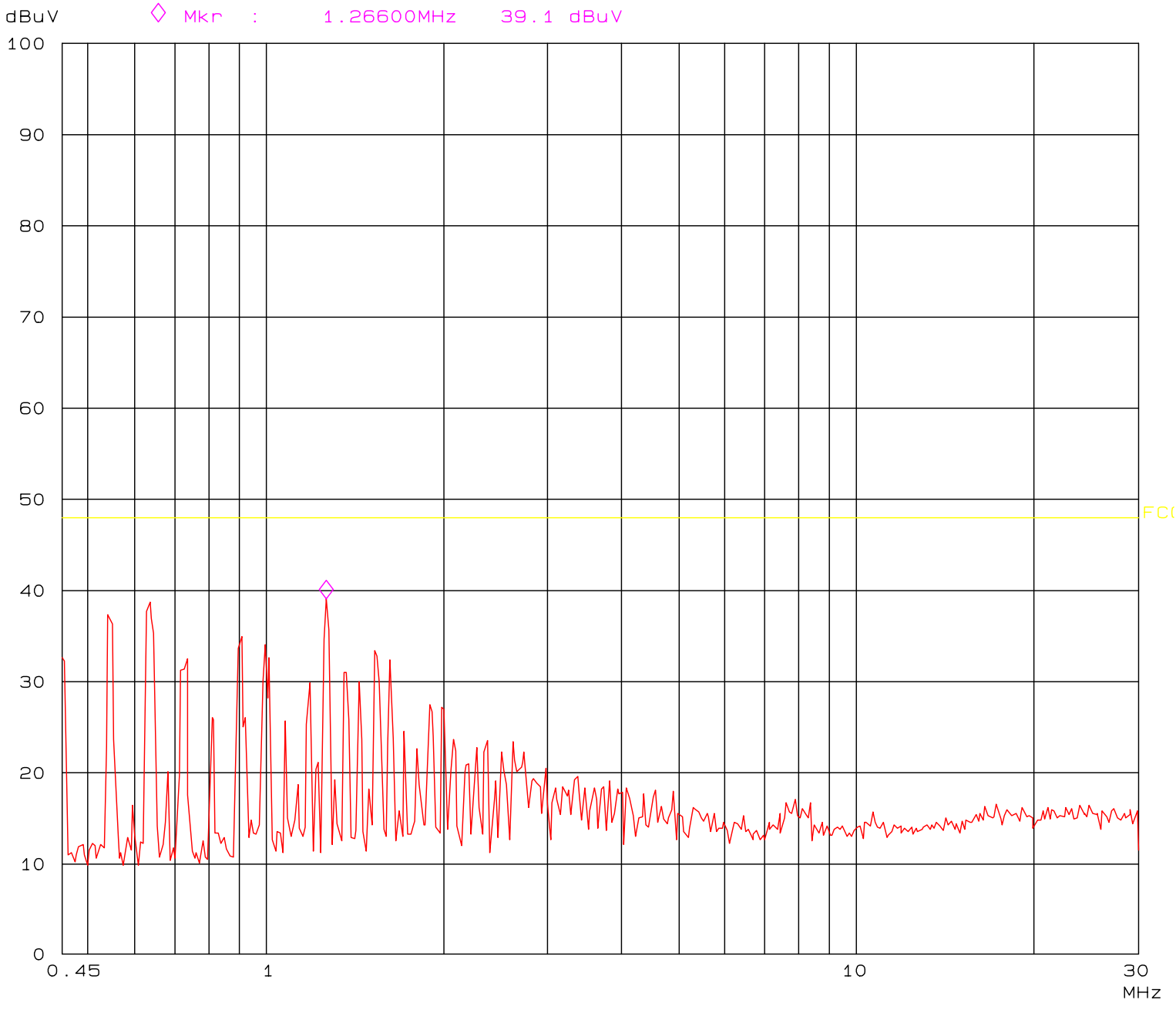


# Elliott LaboratoriesInc.

31. May 02 15:03

## Conducted Emissions

Operator: Marissa Fausitno
Comment: Savi Technology
SMR-600P-102
FCC Class B
Run 2
120V/60Hz
Line

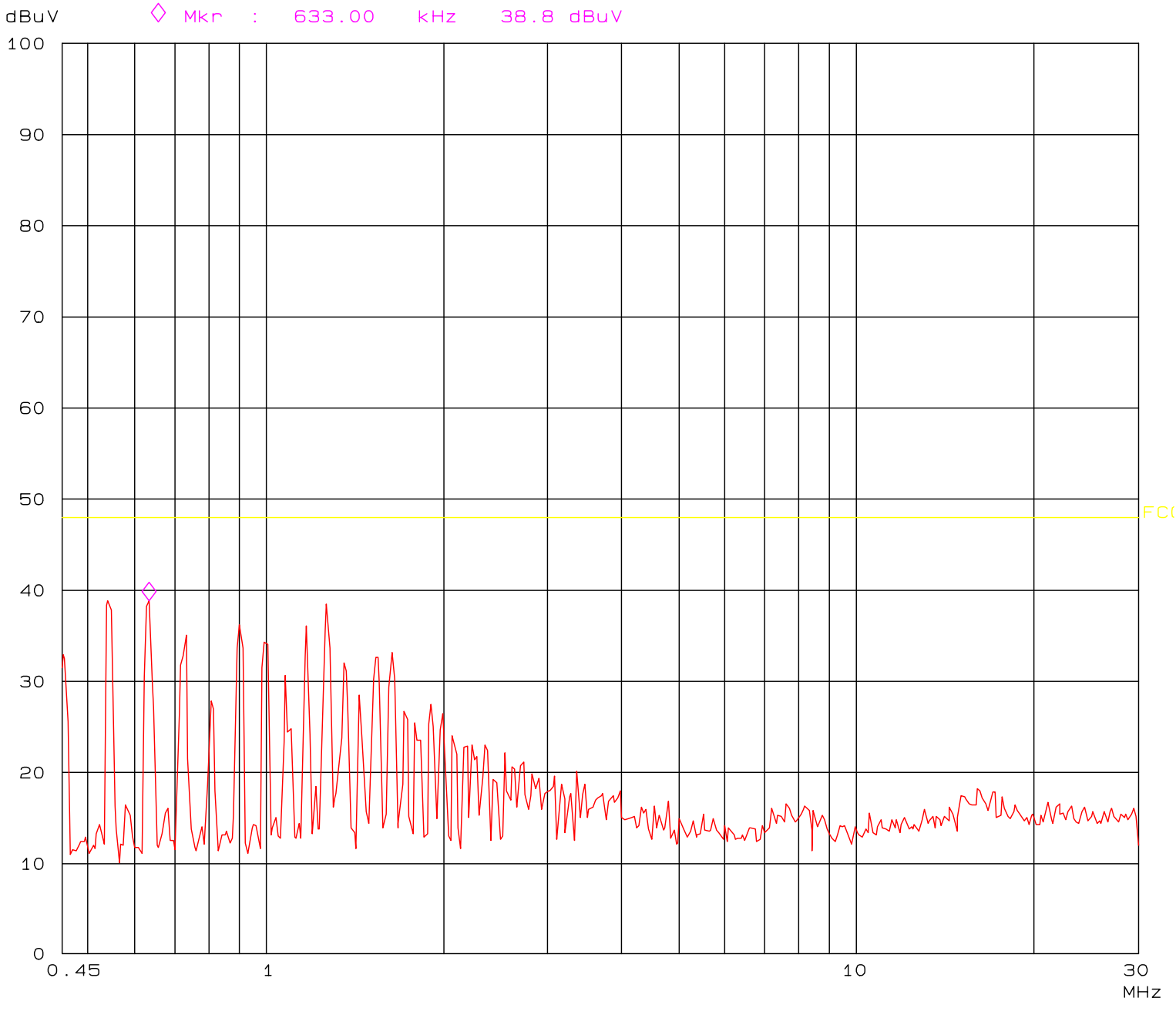


# Elliott LaboratoriesInc.

31. May 02 14:58

## Conducted Emissions

Operator: Marissa Fausitno
Comment: Savi Technology
SMR-600P-102
FCC Class B
Run 2
120V/60Hz
Neutral



Elliott

# EMC Test Data

| | | | |
|---|---|---|---|
| Client: | Savi | Job Number: | J47361 |
| Model: | SAVI SMR-640P-101 | T-Log Number: | T47386 |
| | | Proj Eng: | Mark Briggs |
| Contact: | Eugene Schlindwein | | |
| Spec: | FCC 15 B, 15.209, 15.231 | Class: | A |

## Radiated Emissions - 132kHz Transmitter (FCC 15.209)

### 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: 5/31/2002
Test Engineer: Marissa Faustino
Test Location: SVOATS #2

Config. Used: #1
Config Change: N/A
EUT Voltage 120V/60Hz

### General Test Configuration

The 132kHz 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, 0.132 - 1.32 MHz | FCC 15.209 | Pass | -52.08dB @ 132KHz |

### Modifications Made During Testing:

Modifications are detailed under each run description.

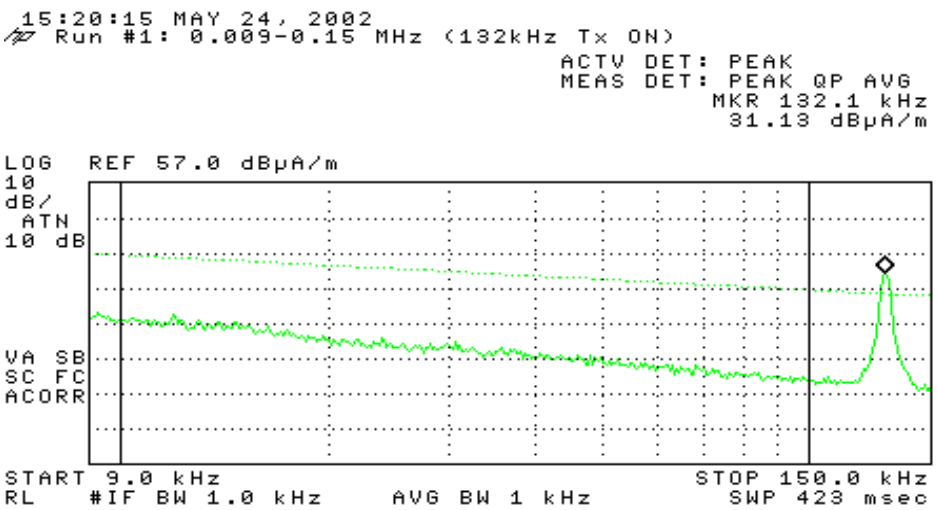
### Deviations From The Standard

No deviations were made from the requirements of the standard.

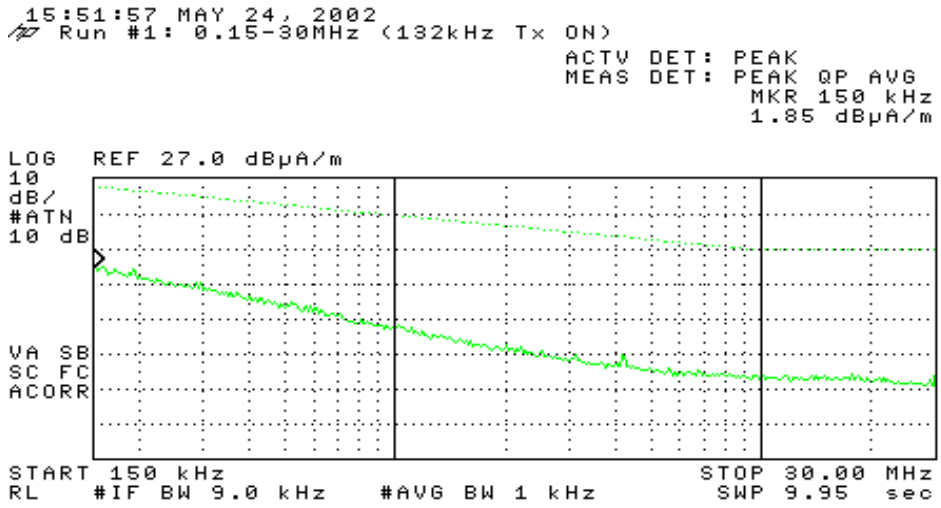
| | | | |
|---|---|---|---|
| Client: | Savi | Job Number: | J47361 |
| Model: | SAVI SMR-640P-101 | T-Log Number: | T47386 |
| | | Proj Eng: | Mark Briggs |
| Contact: | Eugene Schlindwein | | |
| Spec: | FCC 15 B, 15.209, 15.231 | Class: | A |

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

Preliminary measurements were made on 5/24/2002 in an anechoic chamber. The plots below show the emissions from the device compared against the EN 300 330 limits.




Note: Used RBW = 1kHz rather than 200Hz to obtain a quicker sweep time



Elliott

# EMC Test Data

| | | | |
|---|---|---|---|
| Client: | Savi | Job Number: | J47361 |
| Model: | SAVI SMR-640P-101 | T-Log Number: | T47386 |
| | | Proj Eng: | Mark Briggs |
| Contact: | Eugene Schlindwein | | |
| Spec: | FCC 15 B, 15.209, 15.231 | Class: | A |

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 | |
| 132.000 | 74.4 | 10.4 | 84.8 | O | Pk | 59 | 1.0 | Tested at 3m - Note 1 |
| 132.000 | 45.2 | 10.4 | 55.6 | O | Pk | 60 | 1.0 | Tested at 10m - Note 2 |

| | |
|---|---|
| Note 1: | The maximum signal level was with the device oriented **upright.** |
| Note 2: | The maximum signal level was with the device oriented **upright.** |
| Note 3: | Polarization of O indicates the loop was facing the EUT, I indicates that the loop was perpendicular to the EUT. |

**Extrapolation Factor Calculation:**

| | | |
|---|---|---|
| Level at 3m: | 84.8 | dBµV/m |
| Level at 10m: | 55.6 | dBµV/m |
| Extrapolation from 3m to 10m: | 55.8 | dB |
| Extrapolation from 10m to 300m: | **82.5** | (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 | |
| 132 | -26.9 | 25.2 | -52.1 | QP | 60 | 1.0 | Note 1 |
| 264 | - | 19.2 | >20dB | QP | - | - | Note 2 |
| 396 | - | 15.7 | >20dB | QP | - | - | Note 2 |
| 528 | - | 33.2 | >20dB | QP | - | - | Note 3 |
| 660 | - | 31.2 | >20dB | QP | - | - | Note 3 |
| 792 | - | 29.6 | >20dB | QP | - | - | Note 3 |
| 924 | - | 28.3 | >20dB | QP | - | - | Note 3 |
| 1056 | - | 27.1 | >20dB | QP | - | - | Note 3 |
| 1188 | - | 26.1 | >20dB | QP | - | - | Note 3 |
| 1320 | - | 25.2 | >20dB | QP | - | - | 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). |