Elliott

Elliott Laboratories Inc.
www.elliottlabs.com
684 West Maude Avenue
Sunnyvale, CA 94086-3518
408-245-7800 Phone
408-245-3499 Fax

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 Model: Savi GateReader 410R

FCC ID:	KL7-410GR-V11
GRANTEE:	Savi Technology, Inc. 450 National Avenue Mountain View, CA 94043
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
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TEST ENGINEER:	Rudy Suy
AUTHORIZED SIGNATORY:	Mark Briggs Mark Briggs Manager, EMC Consulting Services

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SCOPE

An electromagnetic emissions test has been performed on the Savi Technology transmitter model Savi GateReader 410R 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.

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 model Savi GateReader 410R 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.

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

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on December 11, 1997 and April 9, 1998 at the Elliott Laboratories Open Area Test Site located at 684 West Maude Avenue, Sunnyvale, California. Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data has been filed with the Commission.

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

CONDUCTED EMISSIONS CONSIDERATIONS

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

RADIATED EMISSIONS CONSIDERATIONS

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

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

AN EMI receiver as specified in CISPR 16 is used for emissions measurements. The ESH3 receiver 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 particular 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

A Rohde and Schwarz EZM Spectrum Monitor/Controller is utilized to convert the receiver measurements to the field strength at the antenna, 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.

The EZM provides a visual display of the signal being measured. In addition, the EZM Spectrum Monitor runs the automated data collection programs which control both 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 50 uH LISNs used were manufactured by Fischer Custom Communications, model LISN-3 in combination with a 250 uH Fischer Custom Communications LISN-3 CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

POWER METER

A power meter and thermister mount are used for all output power measurements from transmitters as they provides a broadband indication of the power output. The power meter used was the Hewlett Packard model 432A, S/N 992-05509 and the thermister mount was the Hewlett Packard model 478A, S/N 46397.

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 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 which are programmed into the test receivers

ANTENNA MAST AND EQUIPMENT TURNTABLE

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

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

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An appendix 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 to 1000 MHz. 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

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

RADIATED EMISSIONS SPECIFICATION LIMITS - FUNDAMENTAL

Fundamental Frequency (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
433.92 – §15.231(a)	10,996.7	80.8
433.92 – §15.231(e)	4398.7	72.9

RADIATED EMISSIONS SPECIFICATION LIMITS - SPURIOUS EMISSIONS IN RESTRICTED BANDS

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
0.009-0.490	$2400/F_{KHz}$ @ 300m	$67.6-20*\log_{10}(F_{KHz})$ @ 300m
0.490-1.705	$24000/F_{KHz}$ @ 30m	$87.6-20*\log_{10}(F_{KHz})$ @ 30m
1.705 to 30	30 @ 30m	29.5 @ 30m
30 to 88	100	40.0
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

RADIATED EMISSIONS SPECIFICATION LIMITS - OTHER SPURIOUS

Fundamental Frequency (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
433.92 – §15.231(a)	1099.7	60.8
433.92 – §15.231(e)	439.9	52.9 *

* Above 1000 MHz limits for restricted bands (54 dBμV/m) were used.

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

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Savi Technology model Savi GateReader 410R is a an asset tag reader which is designed to interface with the SaviTag 410 by sending control signals and receiving data (recognition codes) from the TAGs. In addition, it can also transmit data. For control signals the transmitter will be subject to the requirements of §15.231(a) and for data signals it will be subject to the requirements of §15.231(e), both of which govern pulsed transmissions. In addition the system contains a 2.4 GHz transmitter that will be operating under §15.249.

The transmitter and receiver circuitry in the device tested is common to all of the Savi GateReader 410R series (SR-410GR-041 & -021) family of readers. The difference between the -041 and -021 is that the -041 has 4 Gate transmitters while the -021 has only 2. The sample was received on December 11, 1997 and tested December 11, 1997 and April 9, 1998. The EUT consisted of the following component(s):

Manufacturer/Model/Description	Serial Number	FCC ID Number
Savi Tech. SR-410GR-041 Gate Reader Controller	3820	none *
Savi Tech SRA-GR-201 2.4 GHz Primary Gate Reader	Production unit	KL7-410GR-V12
Savi Tech SRA-GR-201 2.4 GHz Secondary Gate Reader	Production unit	KL7-410GR-V12
Savi Tech SRA-GR-201 2.4 GHz Primary Gate Reader	Production unit	KL7-410GR-V12
Savi Tech SRA-GR-201 2.4 GHz Secondary Gate Reader	Production unit	KL7-410GR-V12
Savi Tech SR-410-GR 433 MHz RF Unit	Production unit	KL7-410GR-V11

* Class A Digital Device

The results from testing the SR-410GR-041 also represent model SR-410GR-021 (2 gate Tx/Antenna) since the 410-GR-410 contains more options (4 Gate readers).

ENCLOSURE

The EUT's enclosures are primarily constructed of polymeric plastic. The control box measures varies, the 433 MHz RF unit measures 26.5 cm x 22.5 cm x 16.cm, and the 2.4GHz primary and secondary RF units measures 17.5 cm x 16.2 cm x 10.6 cm in dimensions.

INPUT POWER

The EUT input is rated at 120/240, 50/60 Hz. The EUT contained the following input power components during emissions testing:

Description	Manufacturer	Model
Power Supply	Computer Product	NFN40-7610

EMI SUPPRESSION DEVICES

The EUT contained the following EMI suppression devices during emissions testing:

Description	Manufacturer	Part Number
Ferrite on RF Comm module cable, 2-4GHz Tx cables and power	Steward	28B2029-0A0
Ferrite	Steward	28B2025-0A0

PRINTED WIRING BOARDS

The Savi Technology model Savi GateReader 410R contained the following printed wiring boards during emissions testing:

Manufacturer/Description	Assembly #	Rev.	Serial #	Crystals (MHz)
Lon work Module	810-01295-001	B	-	10
Savi Tech. Interrogator 3.0	810-01290-001	A	168-174	16
Savi Tech. Regulator board	810-01630-001	A	none	none
Savi Tech. RF Comm (x2)	810-01285-001	A	none	433.92(Tx)

SUPPORT EQUIPMENT

No support equipment was used during emissions testing.

EXTERNAL I/O CABLING

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

Cable Description	Length (m)	From Unit/Port	To Unit/Port
Unshielded (10 conductor) x2	100	Controller	Gate Tx Primary
Unshielded (10 conductor) x2	100	Controller	433M RF module
Unshielded (5 conductor) x2	100	Gate Tx Primary	Gate Tx Secondary (gate wake-up)

Note: The serial port was not connected during testing. The manufacturer stated that this port is used purely for maintenance and configuration purposes and is not used under normal operating conditions.

ANTENNA SYSTEM

The antenna system for the 2.4 GHz transmitter is contained within the enclosure of the Savi Tech SRA-GR-x01 2.4 GHz Primary and Secondary Gate Readers. The Primary and Secondary Gate Readers contain identical rf circuits, the only difference between the two is that the primary connects directly to the controller and the secondary connects to the primary. Both transmitters cannot operate simultaneously.

The antenna system for the 433.92 MHz transmitters is entirely contained within the enclosure of the 433 MHz RF unit.

TEST MODES

The pulse widths of the control and data signals were measured with the system transmitting the relevant data or control signal. For all radiated emissions measurements of the fundamental and spurious emissions from the transmitter, the device was configured to transmit the wake-up, control or data signal continuously from each of the two transmitter/antenna combinations at 433.92 MHz. The peak readings recorded were then corrected using the pulse width measurements to calculate the average readings.

For test on the 2.45 GHz transmitter the unit was set to operate in typical pulsed mode to measure the pulse width. The pulsed width measurement was then used to correct the peak measurements of the fundamental and harmonics with the system transmitting continuously.

For all radiated emissions measurements from the receiver and digital circuitry, the device was configured to receive continuously at 433.92 MHz.

TEST RESULTS

TEST DATA ANALYSIS - CONDUCTED

The following measurements were extracted from the data recorded during the conducted emissions scan and represent the highest amplitude peaks relative to the specification limit. The actual test data and correction factors are contained in the appendices of this report.

Conducted Emissions, 0.45-30.0 MHz,
Sorted by Margin, 120 V, 60 Hz. Transmitter #1

Frequency MHz	Level dBuV	Power Lead	FCCB Limit	FCCB Margin	Detector QP/Ave	Comments
17.9992	45.5	neutral	48.0	-2.5	QP	Note 1
17.8208	45.2	line	48.0	-2.8	QP	Note 1
21.1318	39.2	line	48.0	-8.8	QP	
21.0888	38.2	neutral	48.0	-9.8	QP	
27.8326	35.8	line	48.0	-12.2	QP	
28.0366	35.8	neutral	48.0	-12.2	QP	

Conducted Emissions, 0.45-30.0 MHz,
Sorted by Margin, 120 V, 60 Hz. Transmitter #2

Frequency MHz	Level dBuV	Power Lead	FCCB Limit	FCCB Margin	Detector QP/Ave	Comments
17.9644	46.4	neutral	48.0	-1.6	QP	Note 1
18.0470	45.9	line	48.0	-2.1	QP	Note 1
19.9842	39.7	line	48.0	-8.3	QP	
20.1000	39.2	neutral	48.0	-8.8	QP	
28.0000	38.0	line	48.0	-10.0	QP	
27.9526	36.6	neutral	48.0	-11.4	QP	

Note 1: FCC part 15.207 (b) does not apply to this signal.

TEST DATA ANALYSIS - FUNDAMENTAL @ 433.923 MHz (§15.231)

The following measurements were extracted from the data recorded during the radiated electric field emissions scan and represent the highest amplitude peaks relative to the specification limit. The actual test data and correction factors are contained in the appendices of this report.

Pulse Width Of Actual Transmitted Signals

Signal	Pulse Width	Comments
Data	12 mS in 100 mS	Meets 15.231(e). Average correction factor for radiated emission is 18.4 dB.
Control	6.7 mS in 100 mS	Meets 15.231(a). Average correction factor for radiated emission is 20dB.
Control - Wake-Up	5.0 Seconds	Meets 15.231(a). No average correction factor can be radiated measurements.

Maximized Radiated Emissions - Fundamental of 433.92 MHz signals

Control Signal - Transmitter #2 (worst case)

Frequency	Level	Pol	15.231(a)	15.231(a)	Azimuth	Height	
MHz	dBuV/m	v/h	Limit	Margin	degrees	meters	Comments
433.923	99.3	v	100.8	-1.5	50	1.2	120 kHz BW Pk.
433.923	79.3	v	80.8	-1.5	50	1.2	Average (Note 2)
433.923	92.8	h	100.8	-8.0	80	1.1	120 kHz BW Pk
433.923	72.8	h	80.8	-8.0	80	1.1	Average (Note 2)

Note 2: Average correction factor of -20.0 dB was used to calculate Average Reading from Peak measurement.

Wake-Up Control Signal - Transmitter #1 (worst case)

Frequency	Level	Pol	15.231(a)	15.231(a)	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	degrees	meters	
433.876	78.4	v	80.8	-2.4	110	1.3	Average
433.876	77.1	h	80.8	-3.7	0	1.4	Average
433.876	79.2	v	100.8	-21.6	110	1.3	Peak
433.876	77.3	h	100.8	-23.5	0	1.4	Peak

Data Signal - Transmitter #2 (worst case)

Frequency	Level	Pol	15.231(e)	15.231(e)	Azimuth	Height	
MHz	dBuV/m	v/h	Limit	Margin	degrees	meters	Comments
433.876	70.9	v	72.9	-2.0	70	1.0	Average (Note 1)
433.876	89.3	v	92.9	-3.6	70	1.0	120 kHz BW Pk.
433.876	68.3	h	72.9	-4.6	150	1.5	Average (Note 1)
433.876	86.7	h	92.9	-6.2	150	1.5	120 kHz BW Pk

Note 1: Average correction factor of -18.4dB was used to calculate Average Reading from Peak measurement.

TEST DATA ANALYSIS - RADIATED HARMONIC AND SPURIOUS (§15.231)

The following measurements were extracted from the data recorded during the radiated electric field emissions scan and represent the highest amplitude peaks relative to the specification limit. The actual test data and correction factors are contained in the appendices of this report.

Maximized Radiated Spurious Emissions Scan, 30-4340 MHz
QP, Peak and Average Readings Sorted by Margin

Control Signal - Transmitter #1 (worst case)

Frequency	Level	Pol	15.231(a)	15.231(a)	Azimuth	Height	
MHz	dBuV/m	v/h	Limit	Margin	degrees	meters	Comments
3470.900	55.3	v	74.0	-18.7	90	1.3	Peak Reading (Restricted Band)
3470.900	35.3	v	54.0	-18.7	90	1.3	Average Reading (Restricted Band)
3037.150	56.5	v	80.8	-24.3	10	1.4	Peak Reading
3037.150	36.5	v	60.8	-24.3	10	1.4	Average Reading
2169.280	55.6	v	80.8	-25.2	80	1.2	Peak Reading
2169.280	35.6	v	60.8	-25.2	80	1.2	Average Reading
2169.280	55.4	h	80.8	-25.4	80	1.3	Peak Reading
2169.280	35.4	h	60.8	-25.4	80	1.3	Average Reading
3037.150	53.9	h	80.8	-26.9	90	1.0	Peak Reading
3037.150	33.9	h	60.8	-26.9	90	1.0	Average Reading

Note: Average correction factor of -20.0 dB was used to calculate Average Reading from Peak measurement.

Maximized Radiated Spurious Emissions Scan, 30-4340 MHz
QP, Peak and Average Readings Sorted by Margin

Wake-Up Control Signal - Transmitter #1 (worst case)

Frequency	Level	Pol	15.231(a)	15.231(a)	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	degrees	meters	
2169.280	53.4	v	60.8	-7.4	190	1.1	Peak Reading, Ave. Limit
2169.280	53.0	h	60.8	-7.8	110	1.1	Peak Reading, Ave. Limit
3037.150	52.9	v	60.8	-7.9	0	1.1	Peak Reading, Ave. Limit
3037.150	51.7	h	60.8	-9.1	60	1.1	Peak Reading, Ave. Limit
3037.440	56.0	h	60.8	-4.8	260	1.0	Peak Reading, Ave. Limit
3037.440	55.3	v	60.8	-5.5	320	1.4	Peak Reading, Ave. Limit

TTEST DATA ANALYSIS - RADIATED HARMONIC AND SPURIOUS ((§15.231)

Maximized Radiated Spurious Emissions Scan, 30-4340 MHz
QP, Peak and Average Readings Sorted by Margin

Data Signal - Transmitter #2 (worst case)

Frequency	Level	Pol	15.231(e)	15.231(e)	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	degrees	meters	
2603.290	38.1	v	54.0	-15.9	190	1.0	Average Reading
3037.300	37.9	h	54.0	-16.1	200	1.0	Average Reading
3037.300	36.7	v	54.0	-17.3	80	1.0	Average Reading
2603.290	56.5	v	74.0	-17.5	190	1.0	Peak Reading
3037.300	56.3	h	74.0	-17.7	200	1.0	Peak Reading
3037.300	55.1	v	74.0	-18.9	80	1.0	Peak Reading
3471.000	54.6	v	74.0	-19.4	180	1.0	Peak Reading
2603.290	54.5	h	74.0	-19.5	240	1.0	Peak Reading
2169.500	52.9	v	74.0	-21.1	40	1.0	Peak Reading
2169.500	52.8	h	74.0	-21.2	180	1.0	Peak Reading

Note 1: Average correction factor of -18.4dB was used to calculate Average Reading from Peak measurement.

EXHIBIT A

Test Equipment Calibration

Test Equipment List - SVOATS#1

	Manufacturer/Description		Model	Asset #	Interval	Last Cal	Cal Due
☑	Elliott Laboratories	FCC / CISPR LISN	LISN-3, OATS	304	12	6/5/97	6/5/98
☑	EMCO	Double Ridge Horn Antenna, 1-18	3115	487	12	6/3/97	6/3/98
☑	EMCO	Biconical Antenna, 30-300 MHz	3110B	363	12	4/8/98	4/8/99
☑	EMCO	Log Periodic Antenna, 0.3-1 GHz	3146A	364	12	4/8/98	4/8/99
☐	EMCO	Double Ridge Horn Antenna, 1-18	3115	786	12	11/13/97	5/13/99
☐	Hewlett Packard	Power Meter	432A	259, (F304)	12	3/10/98	3/10/99
☑	Hewlett Packard	Spectrum Analyzer	8563E	284, (F194)	24	1/14/98	1/14/2000
☑	Hewlett Packard	Microwave Preamplifier, 1-26.5	8449B	263, (F303)	12	6/6/97	6/6/98
☐	Hewlett Packard	Thermistor Mount	478A	652	12	3/10/98	3/10/99
☐	Hewlett Packard	EMC Receiver /Analyzer	8595EM	780	24	10/24/97	10/24/99
☐	Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	12	11/10/97	11/10/98
☐	Hewlett Packard	EMC Receiver /Analyzer	8595EM	787	12	10/27/97	10/27/98
☐	Narda-West	EMI Filter 5.6 GHz, High Pass	60583 HXF370	247	12	4/22/97	4/22/98
☐	Narda-West	EMI Filter 2.4 GHz, High Pass	60583 HPF-161	248	12	4/22/97	4/22/98
☐	Rohde & Schwarz	10 dB Pad / Pulse Limiter, 50W	ESH3 Z2	371	12	7/24/96	7/24/97
☑	Rohde & Schwarz	10 dB Pad / Pulse Limiter	ESH3 Z2	372	12	6/17/97	6/17/98
☑	Rohde & Schwarz	Test Receiver	ESN	775	12	6/30/97	6/30/98
☑	Solar Electronics	High Pass Filter, fc = 8 kHz	7930-8.0	277	12	7/18/97	7/18/98

File Number: _____

Date: _____

Engr: _____

EXHIBIT B

Test Measurement Data

The following data includes conducted emission measurements of the Savi Technology model Savi GateReader 410R and maximized radiated emissions measurements of the complete system.

ELLIOTT LABORATORIES

EMC Test Log

Client Name	Savi Tech.	Date	12/11/97	Test Engineer	Rudy Suy
Product	Savi GateReader 410R	Page	1 of 11	Project Engineer	Mark Briggs
Test Type	Final Qualification	File	T24475	Client Contact	Gene Schlindwein
Specification	FCC	Site	SV OATS #1	Approved	MPB

Test Objective

The objective of this test session is to perform final qualification testing of the EUT defined below relative to the FCC requirements for an unlicensed, low-power transmitter, a receiver and a digital device. Test data is in this test log is for Certification of the Transmitter and has been taken from T23714 (12/11/97). AC power line conducted emissions data and radiated measurements on the 2.4GHz transmitter are to be found in T26235.

Test Summary

Run #1 - Pulse Width Measurement - Control Signal

PASS The maximum permitted pulse length under §15.231(a) is 5 seconds.

The pulse width for the control signal was measured to be 6.7 mS in a 100 mS period. Since the maximum permitted ACF is 20dB, the average values for all signals related to the transmitted control signal will be calculated by correcting the peak measurement recorded with the EUT transmitting continuously by -20dB.

Run #2 - Pulse Width Measurement - Data Signal

PASS The maximum permitted pulse length under §15.231(e) is 1 second.

The pulse width for the control signal was measured to be 12 mS in a 100ms period. Average values for all signals related to the transmitted control signal will be calculated by correcting the peak measurement recorded with the EUT transmitting continuously by -18.4dB.

Run #3 - Pulse Width Measurement - Wake-UP Signal

PASS Pulse width was measured to be 5.0 Seconds. The maximum permitted is 5.0 Seconds.

Run #4 - Measurement of fundamental emission field strength (Transmitter #1 - Control Signal).

PASS Results: FCC §15.231(a) -3.0 dB Ave @ 433.923.MHz Horizontal

Client Name	Savi Tech.	Date	12/11/97	Test Engineer	Rudy Suy
Product	Savi GateReader 410R	Page	2 of 11	Project Engineer	Mark Briggs
Test Type	Final Qualification	File	T24475	Client Contact	Gene Schlindwein
Specification	FCC	Site	SV OATS #1	Approved	MPB

Run #5 - Maximized Radiated Spurious Emissions Scan, 30-4340 MHz (Transmitter #1 - Control Signal)

PASS Results: §15.231(a) -18.7 dB Ave @ 3470.900.MHz Vertical

(Note, the limits in §15.209 were used for emissions falling in restricted bands).

Run #6 - Measurement of fundamental emission field strength (Transmitter #1 - "Wake-Up" Control Signal).

PASS Results: FCC §15.231(a) -2.4 dB Ave @ 433.923.MHz Vertical

Run #7 - Maximized Radiated Spurious Emissions Scan, 30-4340 MHz (Transmitter #1 - "Wake-Up" Control Signal)

PASS Results: §15.231(a) -7.4 dB Peak @ 2169.280.MHz Vertical

Run #8 - Measurement of fundamental emission field strength (Transmitter #1- Data Signal).

PASS Results: FCC §15.231(e) -2.1 dB Ave @ 433.923.MHz Horizontal

Run #9 - Maximized Radiated Spurious Emissions Scan, 30-4340 MHz (Transmitter #1- Data Signal)

PASS Results: §15.231(e) -16.6 dB Ave @ 3471.000.MHz Vertical

Run #10 - Measurement of fundamental emission field strength (Transmitter #2 - Control Signal).

PASS Results: FCC §15.231(a) -1.5 dB Peak @ 433.923MHz Vertical

ELLIOTT LABORATORIES

EMC Test Log

Client Name	Savi Tech.	Date	12/11/97	Test Engineer	Rudy Suy
Product	Savi GateReader 410R	Page	3 of 11	Project Engineer	Mark Briggs
Test Type	Final Qualification	File	T24475	Client Contact	Gene Schlindwein
Specification	FCC	Site	SV OATS #1	Approved	MFB

Run #11 - Maximized Radiated Spurious Emissions Scan, 30-4340 MHz (Transmitter #2 - Control Signal)

PASS Results: §15.231(a) -24.6 dB Peak @ 3037.150MHz Horizontal

Run #12 - Measurement of fundamental emission field strength (Transmitter #2 - "Wake-Up" Control Signal).

PASS Results: FCC §15.231(a) -2.5dB Ave @ 433.876 MHz Vertical

Run #13 - Maximized Radiated Spurious Emissions Scan, 30-4340 MHz (Transmitter #2 - "Wake-Up" Control Signal)

PASS Results: §15.231(a) -9.2 dB Peak @ 3037.150 MHz Vertical

Run #14 - Measurement of fundamental emission field strength (Transmitter #2- Data Signal).

PASS Results: FCC §15.231(e) -2.0 dB Ave @ 433.923MHz Vertical

Run #15 - Maximized Radiated Spurious Emissions Scan, 30-4340 MHz (Transmitter #2- Data Signal)

PASS Results: §15.231(e) -15.9 dB Ave @ 2603.290MHz Vertical

Client Name	Savi Tech.	Date	12/11/97	Test Engineer	Rudy Suy
Product	Savi GateReader 410R	Page	4 of 11	Project Engineer	Mark Briggs
Test Type	Final Qualification	File	T24475	Client Contact	Gene Schlindwein
Specification	FCC	Site	SV OATS #1	Approved	MRB

Equipment Under Test (EUT) General Description

The EUT is an asset tag reader which is designed to interface with the SaviTag 410 by sending control signals and receiving data (recognition codes) from the TAGs. In addition, it can also transmit data. For control signals the transmitter will be subject to the requirements of §15.231(a) and for data signals it will be subject to the requirements of §15.231(e), both of which govern pulsed transmissions. In addition the system contains a 2.4 GHz transmitter that will be operating under §15.249.

Normally, the EUT will be attached to a pole or similar structure. For the purposes of EMC testing the EUT was treated as table-top equipment and placed to simulate the orientation of the device in its intended use.

Equipment Under Test (EUT)

The system tested comprised of the following components:

Manufacturer/Model/Description	Serial Number	FCC ID Number
Savi Tech. SR-410GR-041 Gate Reader Controller	Production unit	none*
Savi Tech SRA-GR-201 2.4 GHz Primary Gate Reader	Production unit	KL7-410-GR-V12
Savi Tech SRA-GR-201 2.4 GHz Secondary Gate Reader	Production unit	KL7-410-GR-V12
Savi Tech SRA-GR-201 2.4 GHz Primary Gate Reader	Production unit	KL7-410-GR-V12
Savi Tech SRA-GR-2012.4 GHz Secondary Gate Reader	Production unit	KL7-410-GR-V12
Savi Tech SR-410-GR 433 MHz RF Unit	Production unit	KL7-410-GR-V11

* Class A digital device

Local Support Equipment

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

Client Name	Savi Tech.	Date	12/11/97	Test Engineer	Rudy Suy
Product	Savi GateReader 410R	Page	5 of 11	Project Engineer	Mark Briggs
Test Type	Final Qualification	File	T24475	Client Contact	Gene Schlindwein
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Remote Equipment

Manufacturer/Model/Description	Serial Number	FCC ID Number
Savi Tech. SaviReader CP-1010A-2 Reader	1825	KL7-INT-V3

Power Supply and Line Filters

Description	Manufacturer	Model
Power Supply	Computer Products	Savi p/n 810-0081-002

Interface Cabling

Cable Description	Length (m)	From Unit/Port	To Unit/Port
Unshielded	30.0	EUT (RS-485)	Not Terminated
Unshielded (10 conductor) x2	100	Controller	Gate Tx Primary
Unshielded (10 conductor) x2	100	Controller	433M RF module
Unshielded (5 conductor) x2	100	Gate Tx Primary	Gate Tx Secondary (gate wake-up)

Note: The serial port was not connected during testing. The manufacturer stated that this port is used purely for maintenance and configuration purposes and is not used under normal operating conditions.

Antenna

The antennae for the EUT are contained within the enclosures of the individual Gate Reader Units. There are two transmitter/antenna pairs within each of the 433 MHz Transmitters - measurements were made on each antenna

Printed Wiring Boards in EUT

Manufacturer/Description	Assembly #	Rev.	Serial Number	Crystals (MHz)
Lon work Module	810-01295-001	B	-	10
Savi Tech. Interrogator 3.0	810-01290-001	A	168--174	16
Savi Tech. Regulator board	810-01630-001	A	none	none
Savi Tech. RF Comm (x2)	810-01285-001	A	none	433.92(Tx)

Client Name	Savi Tech.	Date	12/11/97	Test Engineer	Rudy Suy
Product	Savi GateReader 410R	Page	6 of 11	Project Engineer	Mark Briggs
Test Type	Final Qualification	File	T24475	Client Contact	Gene Schlindwein
Specification	FCC	Site	SV OATS #1	Approved	MRB

General Test Conditions

During radiated testing, the EUT was connected to 120V, 60Hz power input. The EUT and all local support equipment were located on the turntable for radiated testing and conducted testing.

Operating Conditions During Testing

To measure the pulse width the device was configured to operate as intended to transmit the appropriate pulsed signal. The pulse width was measured over a 100 mS period and is the total "on-time" over that period.

For all radiated emissions measurements of the fundamental and spurious emissions from the transmitter, the device was configured to transmit the wake-up, control or data signal continuously from each of the two transmitter/antenna combinations. Average correction factors were then applied to each measurement based upon the pulse width measurements for each type of signal.

For all radiated emissions measurements from the receiver and digital circuitry, the device was configured to receive continuously at 433.92 MHz.

EUT Enclosure(s)

The EUT's enclosures are primarily constructed of polymeric plastic. The control box measures varies, the 433 MHz RF unit measures 26.5 cm x 22.5 cm x 16.cm, and the 2.4GHz primary and secondary RF units measures 17.5 cm x 16.2 cm x 10.6 cm in dimensions.

Client Name	Savi Tech.	Date	12/11/97	Test Engineer	Rudy Suy
Product	Savi GateReader 410R	Page	7 of 11	Project Engineer	Mark Briggs
Test Type	Final Qualification	File	T24475	Client Contact	Gene Schlindwein
Specification	FCC	Site	SV OATS #1	Approved	MRB

Test Data Tables

Run #1 - Pulse Width Measurement - Control Signal

Pulse width was measured to be 6.7 mS (GPH 001a), with only one pulse in a 100ms period (GPH 002b). Average correction factor is, therefore, -20 dB. All average measurements of the control signal-related emissions will be calculated from the peak measurements with the device set to transmit continuously.

Run #2 - Pulse Width Measurement - Data Signal

Pulse width was measured to be 12 mS (GPH 001a), with only one pulse in a 200ms period (GPH 001b). Average correction factor is 20Log(12/100) = -18.4dB. All average measurements of the data signal-related emissions will be calculated from the peak measurements with the device set to transmit continuously.

Run #3 - Pulse Width Measurement - Wake-UP Signal

Pulse width was measured to be 5.0 Second. The maximum permitted is 5.0 Second.

Run #4 - Measurement of fundamental emission field strength (Transmitter #1 - Control Signal).

Frequency MHz	Level dBuV/m	Pol v/h	15.231(a) Limit	15.231(a) Margin	Azimuth degrees	Height meters	Comments
433.923	97.8	h	100.8	**-3.0**	60	1.6	120 kHz BW Pk
433.923	77.8	h	80.8	**-3.0**	60	1.6	Average (Note 2)
433.923	96.5	v	100.8	**-4.3**	150	1.4	120 kHz BW Pk.
433.923	76.5	v	80.8	**-4.3**	150	1.4	Average (Note 2)

Note 2: Average correction factor of -20.0 dB (refer run #1) was used to calculate Average Reading from Peak measurement.

Client Name	Savi Tech.	Date	12/11/97	Test Engineer	Rudy Suy
Product	Savi GateReader 410R	Page	8 of 11	Project Engineer	Mark Briggs
Test Type	Final Qualification	File	T24475	Client Contact	Gene Schlindwein
Specification	FCC	Site	SV OATS #1	Approved	MRB

Run #5 - Maximized Radiated Spurious Emissions Scan, 30-4340 MHz (Transmitter #1 - Control Signal)

Frequency MHz	Level dBuV/m	Pol v/h	15.231(a) Limit	15.231(a) Margin	Azimuth degrees	Height meters	Comments
3470.900	55.3	v	74.0	-18.7	90	1.3	Peak Reading (Restricted Band)
3470.900	35.3	v	54.0	-18.7	90	1.3	Average Reading (Restricted Band)
3037.150	56.5	v	80.8	-24.3	10	1.4	Peak Reading
3037.150	36.5	v	60.8	-24.3	10	1.4	Average Reading
2169.280	55.6	v	80.8	-25.2	80	1.2	Peak Reading
2169.280	35.6	v	60.8	-25.2	80	1.2	Average Reading
2169.280	55.4	h	80.8	-25.4	80	1.3	Peak Reading
2169.280	35.4	h	60.8	-25.4	80	1.3	Average Reading
3037.150	53.9	h	80.8	-26.9	90	1.0	Peak Reading
3037.150	33.9	h	60.8	-26.9	90	1.0	Average Reading

Note 1: Average correction factor of -20.0 dB (refer run #1) was used to calculate Average Reading from Peak measurement.

Run #6 - Measurement of fundamental emission field strength (Transmitter #1 - "Wake-Up" Control Signal).

Frequency MHz	Level dBuV/m	Pol v/h	15.231(a) Limit	15.231(a) Margin	Azimuth degrees	Height meters	Comments
433.876	78.4	v	80.8	**-2.4**	110	1.3	Average
433.876	77.1	h	80.8	**-3.7**	0	1.4	Average
433.876	79.2	v	100.8	**-21.6**	110	1.3	Peak
433.876	77.3	h	100.8	**-23.5**	0	1.4	Peak

Run #7 - Maximized Radiated Spurious Emissions Scan, 30-4340 MHz (Transmitter #1 - "Wake-Up" Control Signal)

Frequency MHz	Level dBuV/m	Pol v/h	15.231(a) Limit	15.231(a) Margin	Azimuth degrees	Height meters	Comments
2169.280	53.4	v	60.8	**-7.4**	190	1.1	Peak Reading, Ave. Limit
2169.280	53.0	h	60.8	**-7.8**	110	1.1	Peak Reading, Ave. Limit
3037.150	52.9	v	60.8	**-7.9**	0	1.1	Peak Reading, Ave. Limit
3037.150	51.7	h	60.8	**-9.1**	60	1.1	Peak Reading, Ave. Limit
3037.440	56.0	h	60.8	**-4.8**	260	1.0	Peak Reading, Ave. Limit
3037.440	55.3	v	60.8	**-5.5**	320	1.4	Peak Reading, Ave. Limit

Client Name	Savi Tech.	Date	12/11/97	Test Engineer	Rudy Suy
Product	Savi GateReader 410R	Page	9 of 11	Project Engineer	Mark Briggs
Test Type	Final Qualification	File	T24475	Client Contact	Gene Schlindwein
Specification	FCC	Site	SV OATS #1	Approved	MRB

Run #8 - Measurement of fundamental emission field strength (Transmitter #1- Data Signal).

Frequency MHz	Level dBuV/m	Pol v/h	15.231(e) Limit	15.231(e) Margin	Azimuth degrees	Height meters	Comments
433.868	70.8	h	72.9	**-2.1**	100	1.7	Average (Note 1)
433.868	64.8	v	72.9	**-8.1**	180	1.2	Average (Note 1)
433.868	89.2	h	92.9	**-3.7**	100	1.7	120 kHz BW Pk
433.868	83.2	v	92.9	**-9.7**	180	1.2	120 kHz BW Pk.

Note 1: Average correction factor of -18.4dB (refer run #2) was used to calculate Average Reading from Peak measurement.

Run #9 - Maximized Radiated Spurious Emissions Scan, 30-4340 MHz (Transmitter #1- Data Signal)

Frequency MHz	Level dBuV/m	Pol v/h	15.231(e) Limit	15.231(e) Margin	Azimuth degrees	Height meters	Comments
3471.000	37.4	v	54.0	**-16.6**	130	1.1	Average (Note 1)
3471.000	36.9	h	54.0	**-17.1**	110	1.1	Average (Note 1)
3037.323	35.9	v	54.0	**-18.1**	60	1.2	Average (Note 1)
3471.000	55.8	v	74.0	**-18.2**	130	1.1	Peak Reading
3471.000	55.3	h	74.0	**-18.7**	110	1.1	Peak Reading
3037.323	54.3	v	74.0	**-19.7**	60	1.2	Peak Reading
3037.323	34.1	h	54.0	**-19.9**	150	1.1	Average (Note 1)
2603.153	53.4	v	74.0	**-20.6**	140	1.2	Peak Reading
3037.323	52.6	h	74.0	**-21.4**	150	1.1	Peak Reading
2169.500	50.8	v	74.0	**-23.2**	160	1.2	Peak Reading
2169.500	50.5	h	74.0	**-23.5**	140	1.1	Peak Reading

Note 1: Average correction factor of -18.4dB (refer run #2) was used to calculate Average Reading from Peak measurement.

Run #10 - Measurement of fundamental emission field strength (Transmitter #2 - Control Signal).

Frequency MHz	Level dBuV/m	Pol v/h	15.231(a) Limit	15.231(a) Margin	Azimuth degrees	Height meters	Comments
433.923	92.8	h	100.8	**-8.0**	80	1.1	120 kHz BW Pk
433.923	72.8	h	80.8	**-8.0**	80	1.1	Average (Note 2)
433.923	99.3	v	100.8	**-1.5**	50	1.2	120 kHz BW Pk.
433.923	79.3	v	80.8	**-1.5**	50	1.2	Average (Note 2)

Note 2: Average correction factor of -20.0 dB (refer run #1) was used to calculate Average Reading from Peak measurement.

Client Name	Savi Tech.	Date	12/11/97	Test Engineer	Rudy Suy
Product	Savi GateReader 410R	Page	10 of 11	Project Engineer	Mark Briggs
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Run #11 - Maximized Radiated Spurious Emissions Scan, 30-4340 MHz (Transmitter #2 - Pulsed Control Signal)

Frequency MHz	Level dBuV/m	Pol v/h	15.231(a) Limit	15.231(a) Margin	Azimuth degrees	Height meters	Comments
3037.150	56.2	h	80.8	**-24.6**	140	1.0	Peak Reading
3037.150	36.2	h	60.8	**-24.6**	140	1.0	Ave Reading
3037.150	56.0	v	80.8	**-24.8**	50	1.0	Peak Reading
3037.150	36.0	v	60.8	**-24.8**	50	1.0	Ave Reading
2169.280	55.2	v	80.8	**-25.6**	140	1.0	Peak Reading
2169.280	35.2	v	60.8	**-25.6**	140	1.0	Ave Reading
2169.280	48.8	h	80.8	**-32.0**	150	1.0	Peak Reading
2169.280	28.8	h	60.8	**-32.0**	150	1.0	Ave Reading

Note 1: Average correction factor of -20.0 dB (refer run #1) was used to calculate Average Reading from Peak measurement.

Run #12 - Measurement of fundamental emission field strength (Transmitter #2 - "Wake-Up" Control Signal).

Frequency MHz	Level dBuV/m	Pol v/h	15.231(a) Limit	15.231(a) Margin	Azimuth degrees	Height meters	Comments
433.876	78.3	v	80.8	**-2.5**	10	1.2	Average
433.876	69.2	h	80.8	**-11.6**	80	1.2	Average
433.876	78.5	v	100.8	**-22.3**	10	1.2	Peak
433.876	70.0	h	100.8	**-30.8**	80	1.2	Peak

Run #13 - Maximized Radiated Spurious Emissions Scan, 30-4340 MHz (Transmitter #2 - "Wake-Up" Control Signal)

Frequency MHz	Level dBuV/m	Pol v/h	15.231(a) Limit	15.231(a) Margin	Azimuth degrees	Height meters	Comments
3037.150	51.6	v	60.8	**-9.2**	0	1.3	Peak Reading, Ave. Limit
2169.280	51.6	h	60.8	**-9.2**	140	1.2	Peak Reading, Ave. Limit
3037.150	51.1	h	60.8	**-9.7**	100	1.2	Peak Reading, Ave. Limit
2169.280	49.2	v	60.8	**-11.6**	300	1.2	Peak Reading, Ave. Limit

Client Name	Savi Tech.	Date	12/11/97	Test Engineer	Rudy Suy
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Test Type	Final Qualification	File	T24475	Client Contact	Gene Schlindwein
Specification	FCC	Site	SV OATS #1	Approved	MRB

Run #14 - Measurement of fundamental emission field strength (Transmitter #2- Data Signal).

Frequency MHz	Level dBuV/m	Pol v/h	15.231(e) Limit	15.231(e) Margin	Azimuth degrees	Height meters	Comments
433.876	70.9	v	72.9	**-2.0**	70	1.0	Average (Note 1)
433.876	89.3	v	92.9	**-3.6**	70	1.0	120 kHz BW Pk.
433.876	68.3	h	72.9	**-4.6**	150	1.5	Average (Note 1)
433.876	86.7	h	92.9	**-6.2**	150	1.5	120 kHz BW Pk

Note 1: Average correction factor of -18.4dB (refer run #2) was used to calculate Average Reading from Peak measurement.

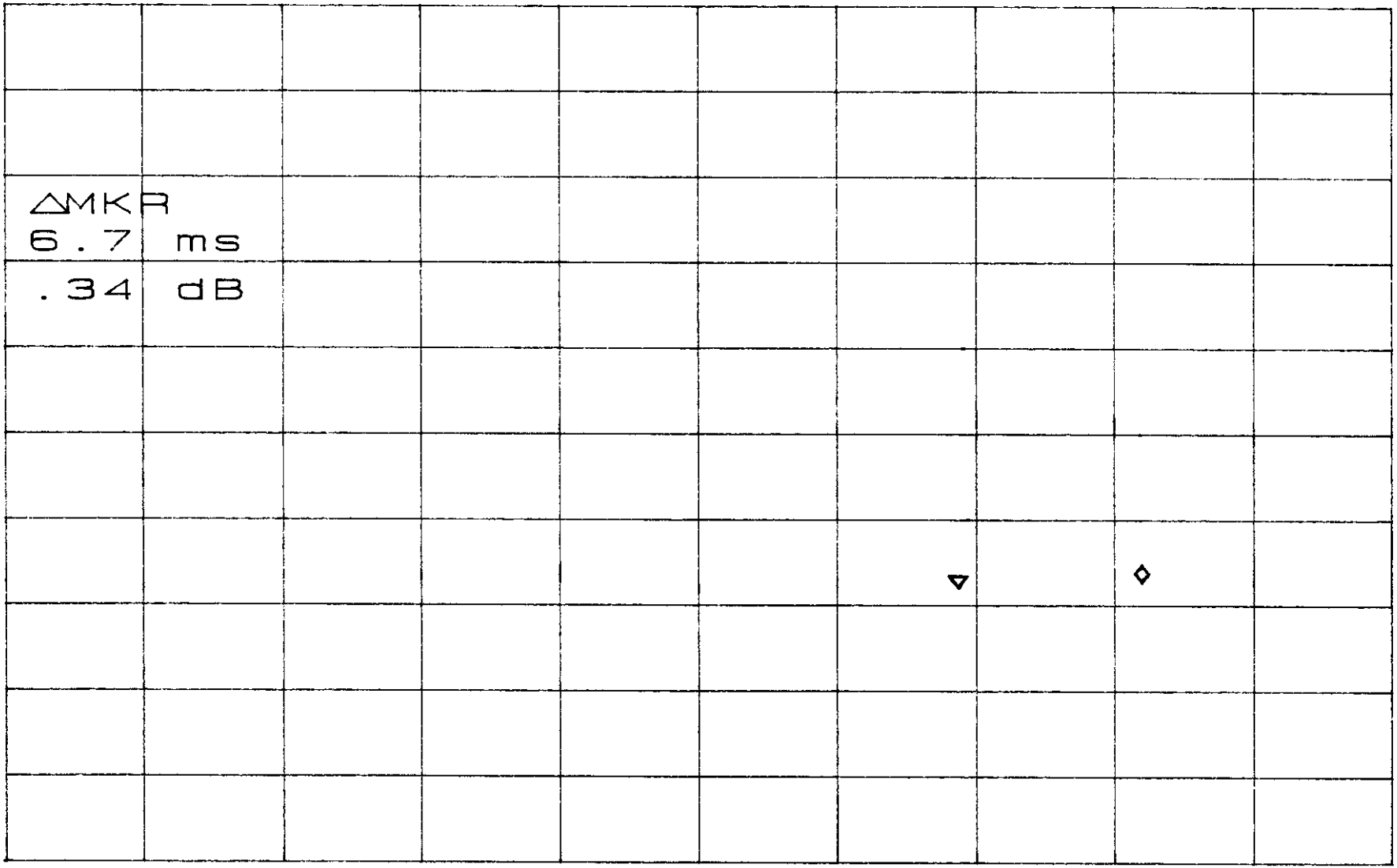
Run #15 - Maximized Radiated Spurious Emissions Scan, 30-4340 MHz (Transmitter #2- Data Signal)

Frequency MHz	Level dBuV/m	Pol v/h	15.231(e) Limit	15.231(e) Margin	Azimuth degrees	Height meters	Comments
2603.290	38.1	v	54.0	-15.9	190	1.0	Average Reading
3037.300	37.9	h	54.0	-16.1	200	1.0	Average Reading
3037.300	36.7	v	54.0	-17.3	80	1.0	Average Reading
2603.290	56.5	v	74.0	-17.5	190	1.0	Peak Reading
3037.300	56.3	h	74.0	-17.7	200	1.0	Peak Reading
3037.300	55.1	v	74.0	-18.9	80	1.0	Peak Reading
3471.000	54.6	v	74.0	-19.4	180	1.0	Peak Reading
2603.290	54.5	h	74.0	-19.5	240	1.0	Peak Reading
2169.500	52.9	v	74.0	-21.1	40	1.0	Peak Reading
2169.500	52.8	h	74.0	-21.2	180	1.0	Peak Reading

Note 1: Average correction factor of -18.4dB (refer run #2) was used to calculate Average Reading from Peak measurement.

*ATTEN 10dB
RL 72.0dBμV

ΔMKR .34dB
5dB/
6.7ms

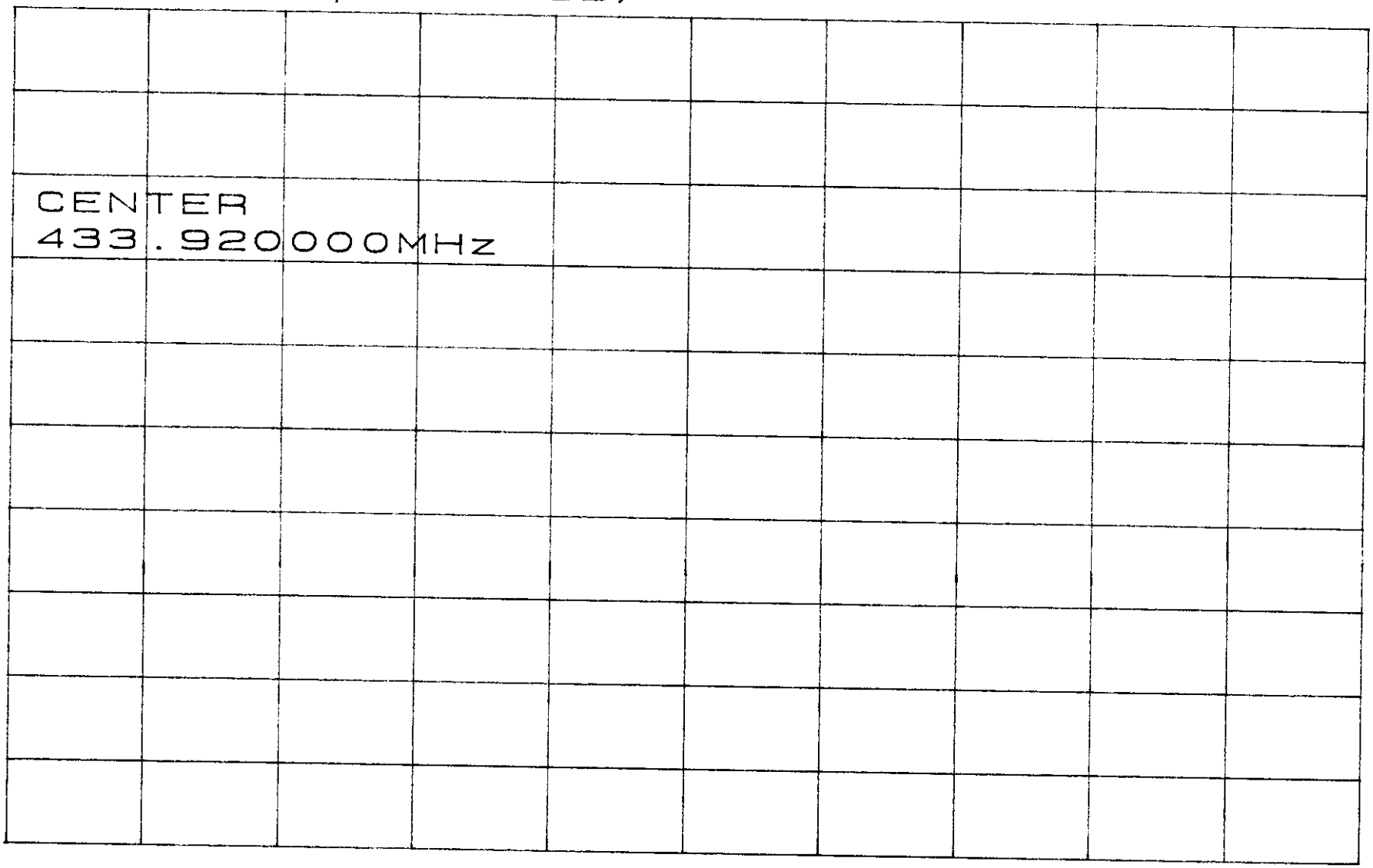


CENTER 433.920000MHz
SPAN 0Hz
*RBW 1.0MHz
*VBW 1.0MHz
*SWP 50ms

GPH/T23714/0012

*ATTEN 10dB

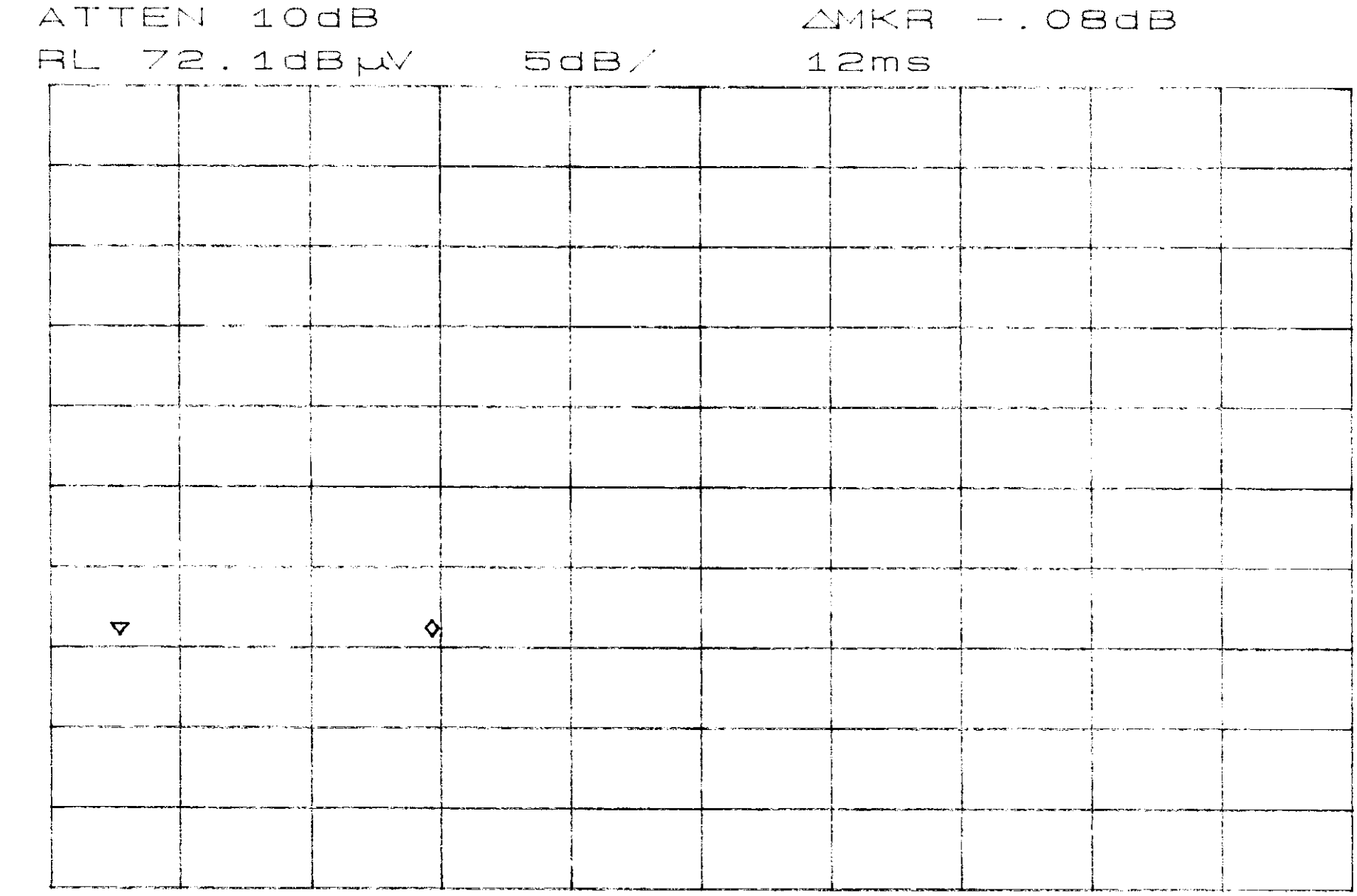
RL 72.0dBμV 5dB/



CENTER 433.920000MHz SPAN 0Hz

*RBW 1.0MHz *VBW 1.0MHz *SWP 100ms

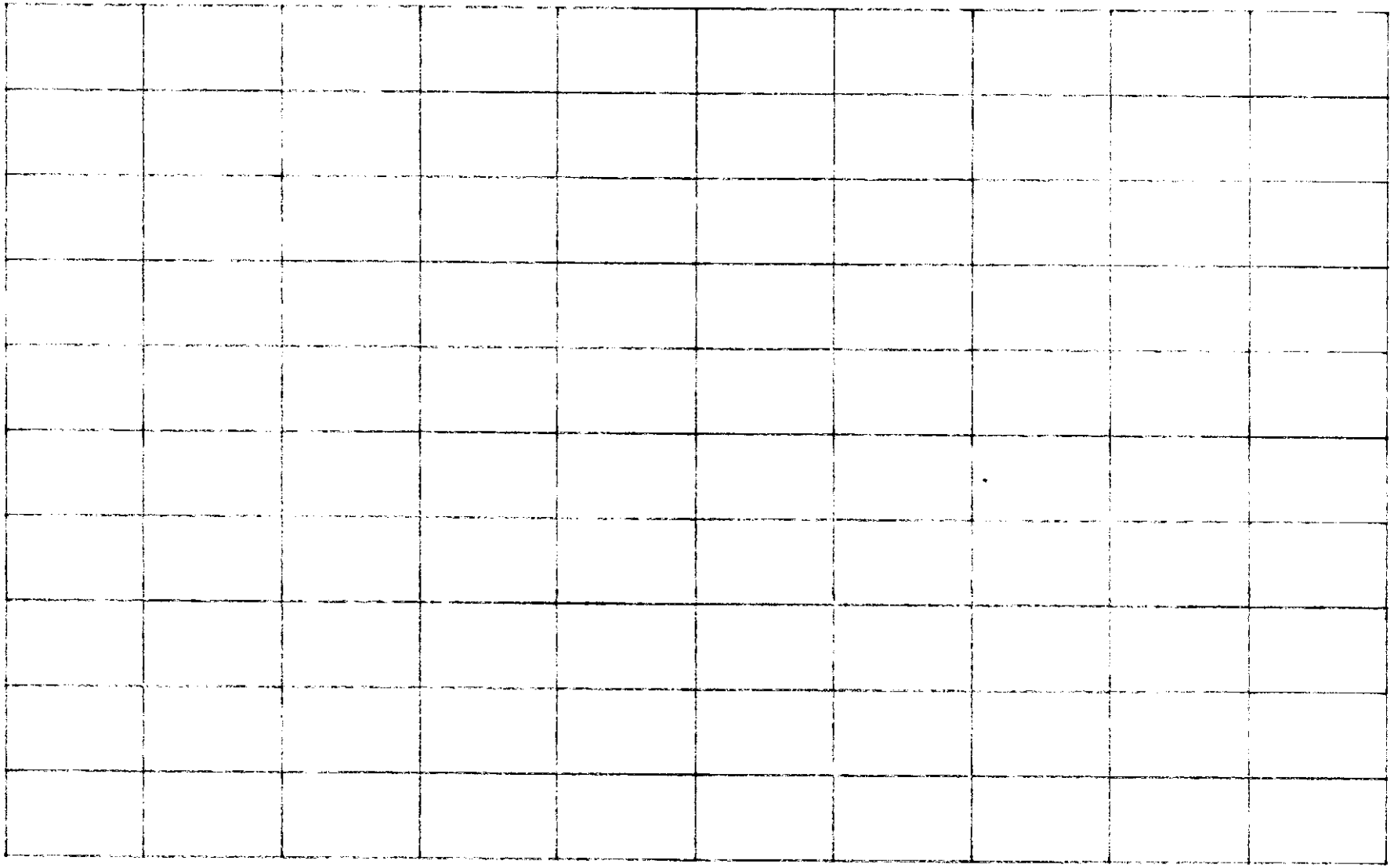
GPH/T23714/0016



GPH/T23714/1002a

ATTEN 10dB

RL 72.1dBμV 5dB/



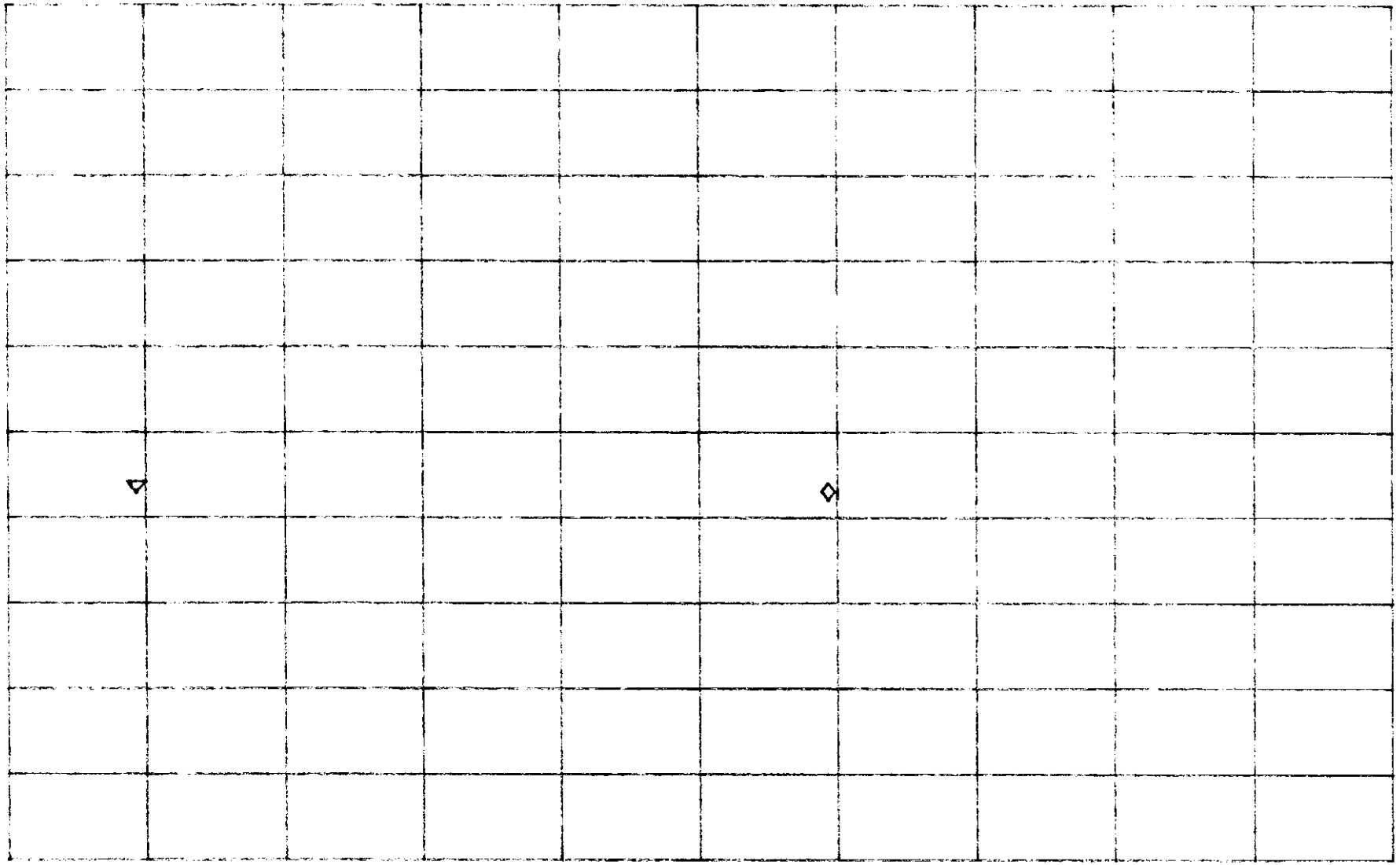
CENTER 433.920000MHz SPAN 0Hz

*RBW 1.0MHz *VBW 1.0MHz *SWP 100ms

GPH/723714/002b

ATTEN 10dB ΔMKR −.42dB

RL 67.1dBμV 5dB/ 5.0sec



CENTER 433.920000MHz SPAN 0Hz

RBW 1.0MHz VBW 1.0MHz *SWP 10sec

GPH/T23714/003

ELLIOTT LABORATORIES

EMC Test Log

Client Name	Savi Tech.	Date	4/9/98	Test Engineer	Rudy Suy
Product	Savi GateReader 410R	Page	1 of 6	Project Engineer	Mark Briggs
Test Type	Final Qualification	File	T26235	Client Contact	Gene Schlindwein
Specification	FCC	Site	SV OATS #1	Approved	MB

Test Objective

The objective of this test session is to perform final qualification testing of the EUT defined below relative to the FCC requirements for an unlicensed, low-power transmitter. Test data is in this test log is for Certification of the 2.4 GHz Transmitter and has been taken from T26142 (4/9/98). Data for the 433 MHz transmitters can be found in T24475.

Test Summary

Run #1 - Conducted Emissions, 0.45-30MHz, 120V/60Hz (Transmitter 1)

PASS Results: FCC §15.207 -2.8 dB QP @ 17.9992 MHz Line

Run #2 - Conducted Emissions, 0.45-30MHz, 120V/60Hz (Transmitter 2)

PASS Results: FCC §15.207 -1.6 dB QP @ 17.9644 MHz Neutral

Run #3 - Measurement of fundamental emission field strength (Transmitter #1 - 2.45GHz).

PASS Results: FCC §15.249 -6.3 dB Ave @ 2451.900MHz Vertical

Run #4 - Maximized Radiated Spurious Emissions Scan, 2451.9-24519 MHz (Transmitter #1 - 2.45GHz).

PASS Results: FCC §15.249 -15.6 dB Ave @ 9807.560MHz Vertical

Client Name	Savi Tech.	Date	4/9/98	Test Engineer	Rudy Suy
Product	Savi GateReader 410R	Page	2 of 6	Project Engineer	Mark Briggs
Test Type	Final Qualification	File	T26235	Client Contact	Gene Schlindwein
Specification	FCC	Site	SV OATS #1	Approved	MRB

Equipment Under Test (EUT) General Description

The EUT is an asset tag reader which is designed to interface with the SaviTag 410 by sending control signals and receiving data (recognition codes) from the TAGs. In addition, it can also transmit data. For control signals the transmitter will be subject to the requirements of §15.231(a) and for data signals it will be subject to the requirements of §15.231(e), both of which govern pulsed transmissions. In addition the system contains a 2.4 GHz transmitter that will be operating under §15.249.

Normally, the EUT will be attached to a pole or similar structure. For the purposes of EMC testing the EUT was treated as table-top equipment and placed to simulate the orientation of the device in its intended use.

Equipment Under Test (EUT)

Manufacturer/Model/Description	Serial Number	FCC ID Number
Savi Tech. SR-410GR-041 Gate Reader Controller	3820	none*
Savi Tech SRA-GR-201 2.4 GHz Primary Gate Reader	Production unit	KL7-410-GR-V12
Savi Tech SRA-GR-201 2.4 GHz Secondary Gate Reader	Production unit	KL7-410-GR-V12
Savi Tech SRA-GR-201 2.4 GHz Primary Gate Reader	Production unit	KL7-410-GR-V12
Savi Tech SRA-GR-2012.4 GHz Secondary Gate Reader	Production unit	KL7-410-GR-V12
Savi Tech SR-410-GR 433 MHz RF Unit	Production unit	KL7-410-GR-V11

This model also represents model SR-410GR-021(2 gate Tx/Antenna)

* Class A digital device

Local Support Equipment

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

Client Name	Savi Tech.	Date	4/9/98	Test Engineer	Rudy Suy
Product	Savi GateReader 410R	Page	3 of 6	Project Engineer	Mark Briggs
Test Type	Final Qualification	File	T26235	Client Contact	Gene Schlindwein
Specification	FCC	Site	SV OATS #1	Approved	MPB

Remote Equipment

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

Power Supply and Line Filters

Description	Manufacturer	Model
Power Supply	Computer Product	NFN40-7610

Interface Cabling

Cable Description	Length (m)	From Unit/Port	To Unit/Port
Unshielded (10 conductor) x2	100	Controller	Gate Tx Primary
Unshielded (10 conductor) x2	100	Controller	433M RF module
Unshielded (5 conductor) x2	100	Gate Tx Primary	Gate Tx Secondary (gate wake-up)

Note: The serial port was not connected during testing. The manufacturer stated that this port is used purely for maintenance and configuration purposes and is not used under normal operating conditions.

Antenna

The antenna system for the 2.4 GHz transmitter is contained within the enclosure of the Savi Tech SRA-GR-201 2.4 GHz Primary and Secondary Gate Readers. The Primary and Secondary Gate Readers contain identical rf circuits, the only difference between the two is that the primary connects directly to the controller and the secondary connects to the primary. Both transmitters cannot operate simultaneously.

Printed Wiring Boards in EUT

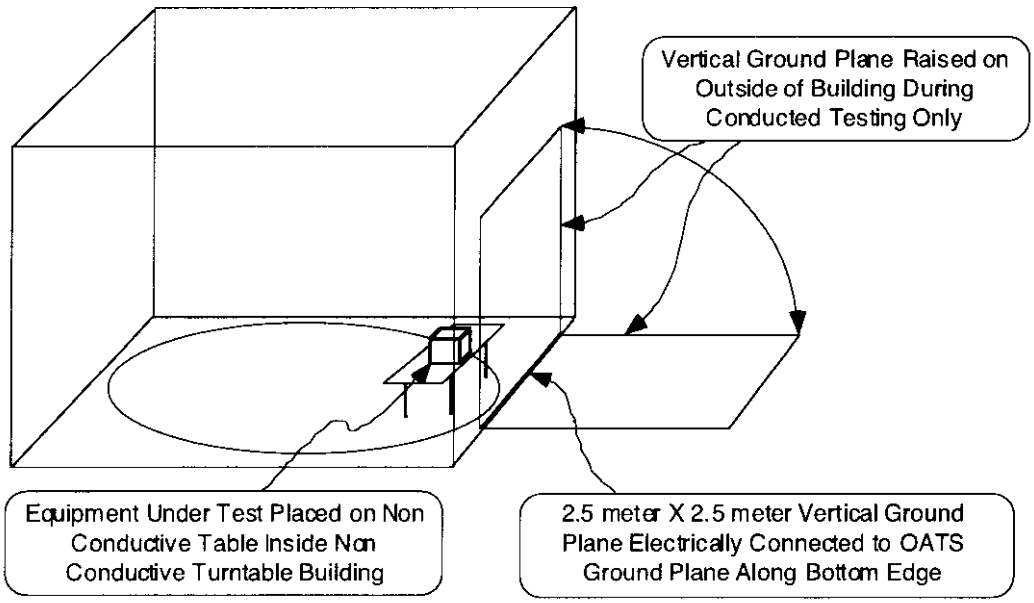
Manufacturer/Description	Assembly #	Rev.	Serial Number	Crystals (MHz)
Lon work Module	810-01295-001	B	-	10
Savi Tech. Interrogator 3.0	810-01290-001	A	168--174	16
Savi Tech. Regulator board	810-01630-001	A	none	none
Savi Tech. RF Comm (x2)	810-01285-001	A	none	433.92(Tx)

Client Name	Savi Tech.	Date	4/9/98	Test Engineer	Rudy Suy
Product	Savi GateReader 410R	Page	4 of 6	Project Engineer	Mark Briggs
Test Type	Final Qualification	File	T26235	Client Contact	Gene Schlindwein
Specification	FCC	Site	SV OATS #1	Approved	MRB

General Test Conditions

During radiated testing, the EUT was connected to 120V, 60Hz power input. The EUT and all local support equipment were located on the turntable for radiated testing and conducted testing.

During conducted emissions testing, the EUT was connected to 120V, 60Hz power input. A 2.5 meter X 2.5 meter ground plane is raised to a vertical position 40 cm from the EUT as shown below:



Operating Conditions During Testing

It was not possible to accurately measure the pulse width, therefore the average correction factor applied to peak readings was based upon the theory of operations for the device. This states that the unit will transmit for a maximum of 40mS in a 100mS period. During that 40mS the transmitter output is blanked and modulated in such a fashion that the overall duty cycle is 25%. this gives a total on time of 10mS (max) in a 100mS period and an average correction factor of 20dB.

For all radiated emissions measurements of the fundamental and spurious emissions from the transmitter, the device was configured to transmit continuously. Average correction factors were then applied to each measurement based upon the duty cycle of the EUT (see above).

Client Name	Savi Tech.	Date	4/9/98	Test Engineer	Rudy Suy
Product	Savi GateReader 410R	Page	5 of 6	Project Engineer	Mark Briggs
Test Type	Final Qualification	File	T26235	Client Contact	Gene Schlindwein
Specification	FCC	Site	SV OATS #1	Approved	MRB

EUT Enclosure(s)

The EUT's enclosures are primarily constructed of polymeric plastic. The control box measures varies, the 433 MHz RF unit measures 26.5 cm x 22.5 cm x 16.cm, and the 2.4GHz primary and secondary RF units measures 17.5 cm x 16.2 cm x 10.6 cm in dimensions.

Test Data Tables

Run #1 - Conducted Emissions, 0.45-30MHz, 120V/60Hz (Tx).Transmitter #1

Frequency MHz	Level dBuV	Power Lead	FCC B Limit	FCC B Margin	Detector QP/Ave	Comments
17.9992	45.5	neutral	48.0	**-2.5**	QP	Note 1
17.8208	45.2	line	48.0	**-2.8**	QP	Note 1
21.1318	39.2	line	48.0	**-8.8**	QP	
21.0888	38.2	neutral	48.0	**-9.8**	QP	
27.8326	35.8	line	48.0	**-12.2**	QP	
28.0366	35.8	neutral	48.0	**-12.2**	QP	

Run #2 - Conducted Emissions, 0.45-30MHz, 120V/60Hz (Tx).Transmitter #2

Frequency MHz	Level dBuV	Power Lead	FCC B Limit	FCC B Margin	Detector QP/Ave	Comments
17.9644	46.4	neutral	48.0	**-1.6**	QP	Note 1
18.0470	45.9	line	48.0	**-2.1**	QP	Note 1
19.9842	39.7	line	48.0	**-8.3**	QP	
20.1000	39.2	neutral	48.0	**-8.8**	QP	
28.0000	38.0	line	48.0	**-10.0**	QP	
27.9526	36.6	neutral	48.0	**-11.4**	QP	

Note 1: FCC part 15.207 (b) does not apply to this signal.

Client Name	Savi Tech.	Date	4/9/98	Test Engineer	Rudy Suy
Product	Savi GateReader 410R	Page	6 of 6	Project Engineer	Mark Briggs
Test Type	Final Qualification	File	T26235	Client Contact	Gene Schlindwein
Specification	FCC	Site	SV OATS #1	Approved	MRB

Run #3 - Measurement of fundamental emission field strength (Transmitter #1 - 2.45GHz). Note #2 apply to this Run.

Frequency MHz	Level dBuV/m	Pol v/h	15.249 Limit	15.249 Margin	Azimuth degrees	Height meters	Comments
2451.900	87.7	v	94.0	**-6.3**	240	1.6	Average
2451.900	107.7	v	114.0	**-6.3**	240	1.6	Peak
2451.900	83.8	h	94.0	**-10.2**	190	1.5	Average
2451.900	103.8	h	114.0	**-10.2**	190	1.5	Peak

Note 2: Average correction factor of -20.0 dB ware used to calculate Average Reading from Peak measurement.

Run #4 - Maximized Radiated Spurious Emissions Scan, 2451.9-24519 MHz Note #2 apply to this Run.

Frequency MHz	Level dBuV/m	Pol v/h	15.249 Limit	15.249 Margin	Azimuth degrees	Height meters	Comments
9807.560	58.4	v	74.0	**-15.6**	150	1.4	Peak Reading
9807.560	38.4	v	54.0	**-15.6**	150	1.4	Ave. Reading
7355.400	57.2	v	74.0	**-16.8**	60	1.3	Peak Reading
7355.400	37.2	v	54.0	**-16.8**	60	1.3	Ave. Reading
9807.560	56.8	h	74.0	**-17.2**	180	1.3	Peak Reading
9807.560	36.8	h	54.0	**-17.2**	180	1.3	Ave. Reading
7355.400	56.1	h	74.0	**-17.9**	120	1.2	Peak Reading
7355.400	36.1	h	54.0	**-17.9**	120	1.2	Ave. Reading
4903.800	55.6	v	74.0	**-18.4**	80	1.3	Peak Reading
4903.800	35.6	v	54.0	**-18.4**	80	1.3	Ave. Reading
4903.800	54.0	h	74.0	**-20.0**	190	1.2	Peak Reading
4903.800	34.0	h	54.0	**-20.0**	190	1.2	Ave. Reading

Note 2: Average correction factor of -20.0 dB ware used to calculate Average Reading from Peak measurement.

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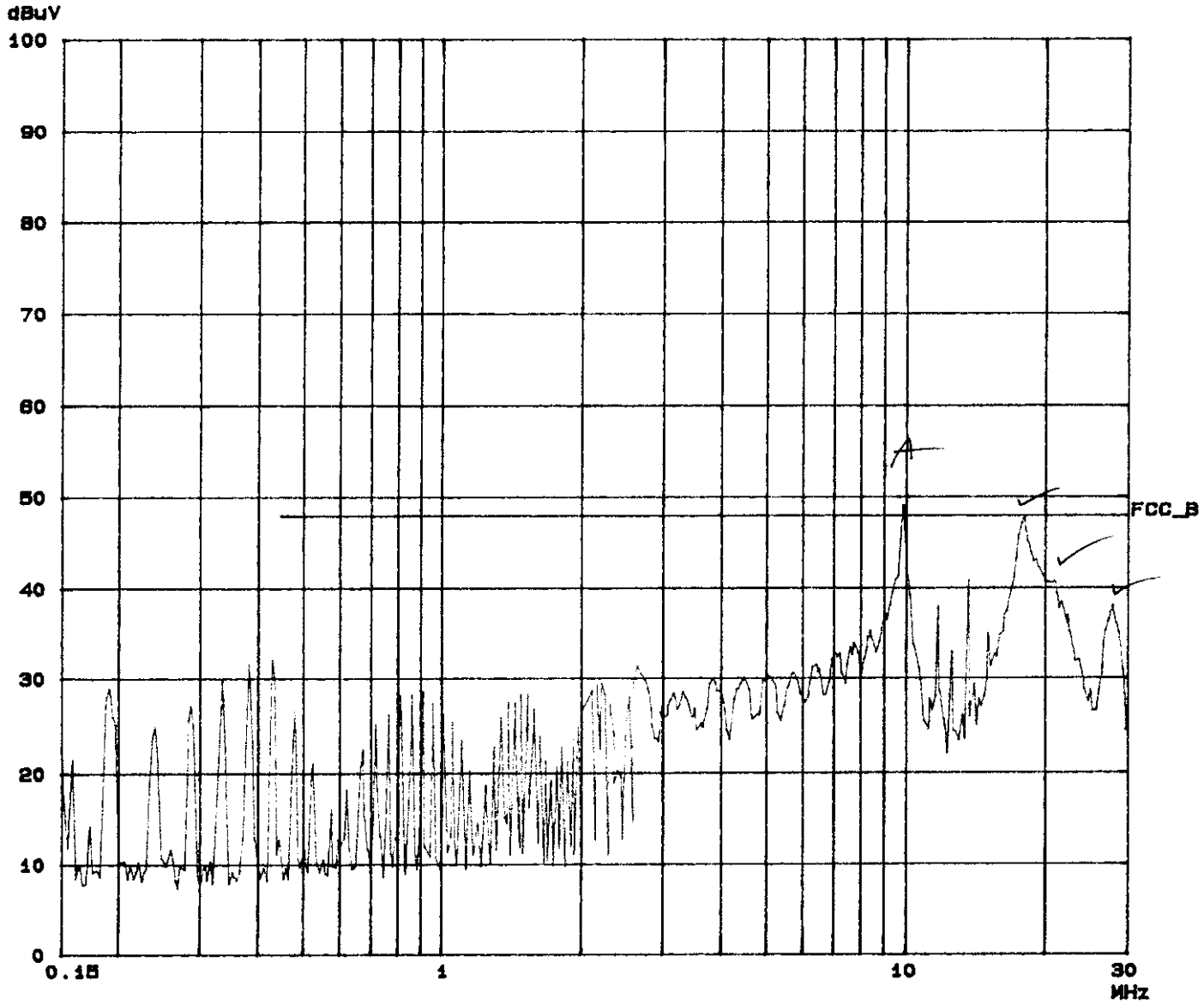
05. Aug 98 19:56

Conducted

Operator: Rudy Suy
Comment: Savi Tech.
SR-4106R-041 (new PS) Tx 1 ON
T26142 Run 2
120V, 60Hz
A=Ambient, √=EUT
NEUTRAL

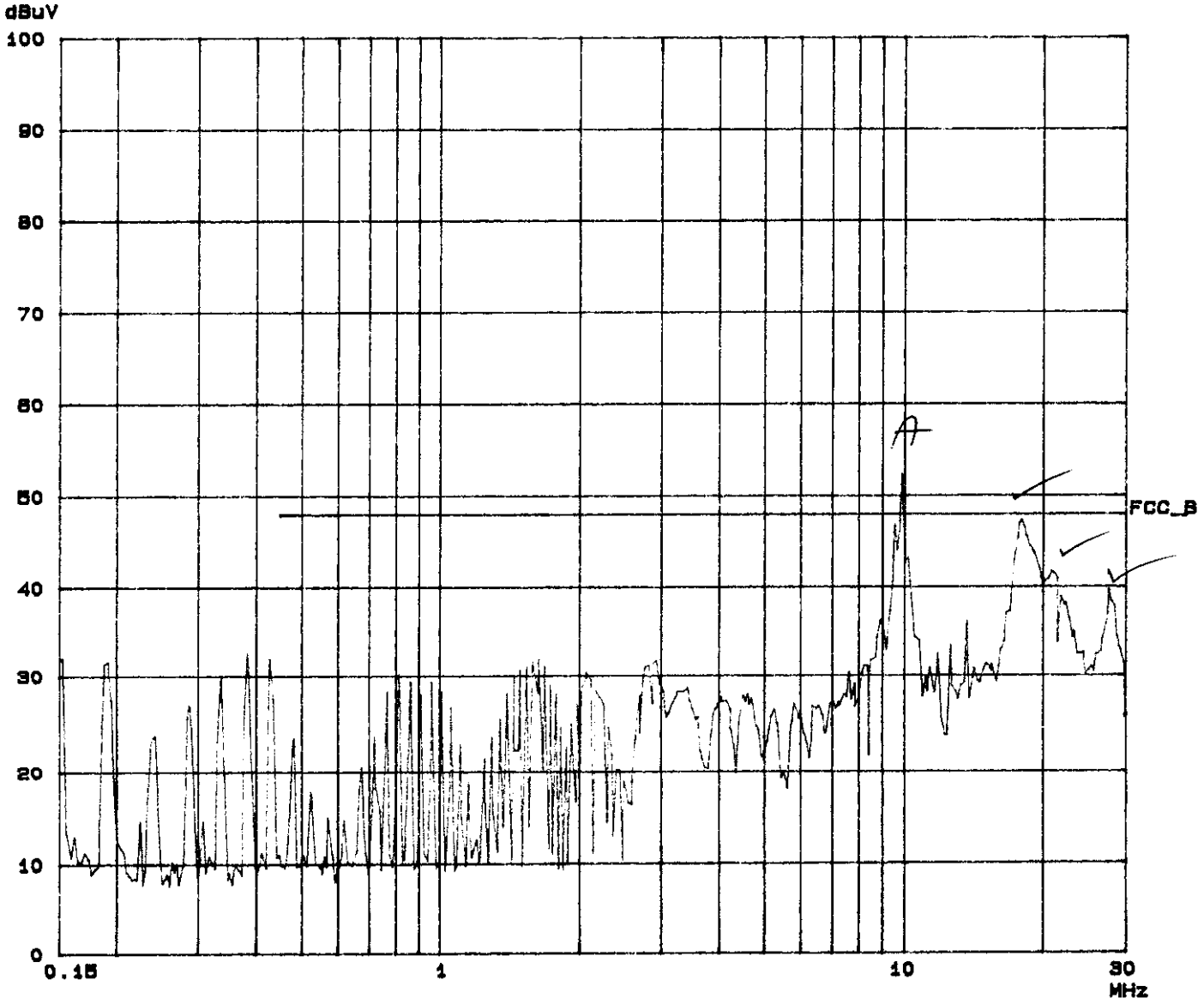


Elliott Laboratories

05. Aug 98 19:48

Conducted

Operator: Rudy Suy
Comment: Savi Tech.
SR-4106R-041 (new PS) Tx 1 ON
T28142 Run 2
120V, 60Hz
A=Ambient, √=EUT
LINE

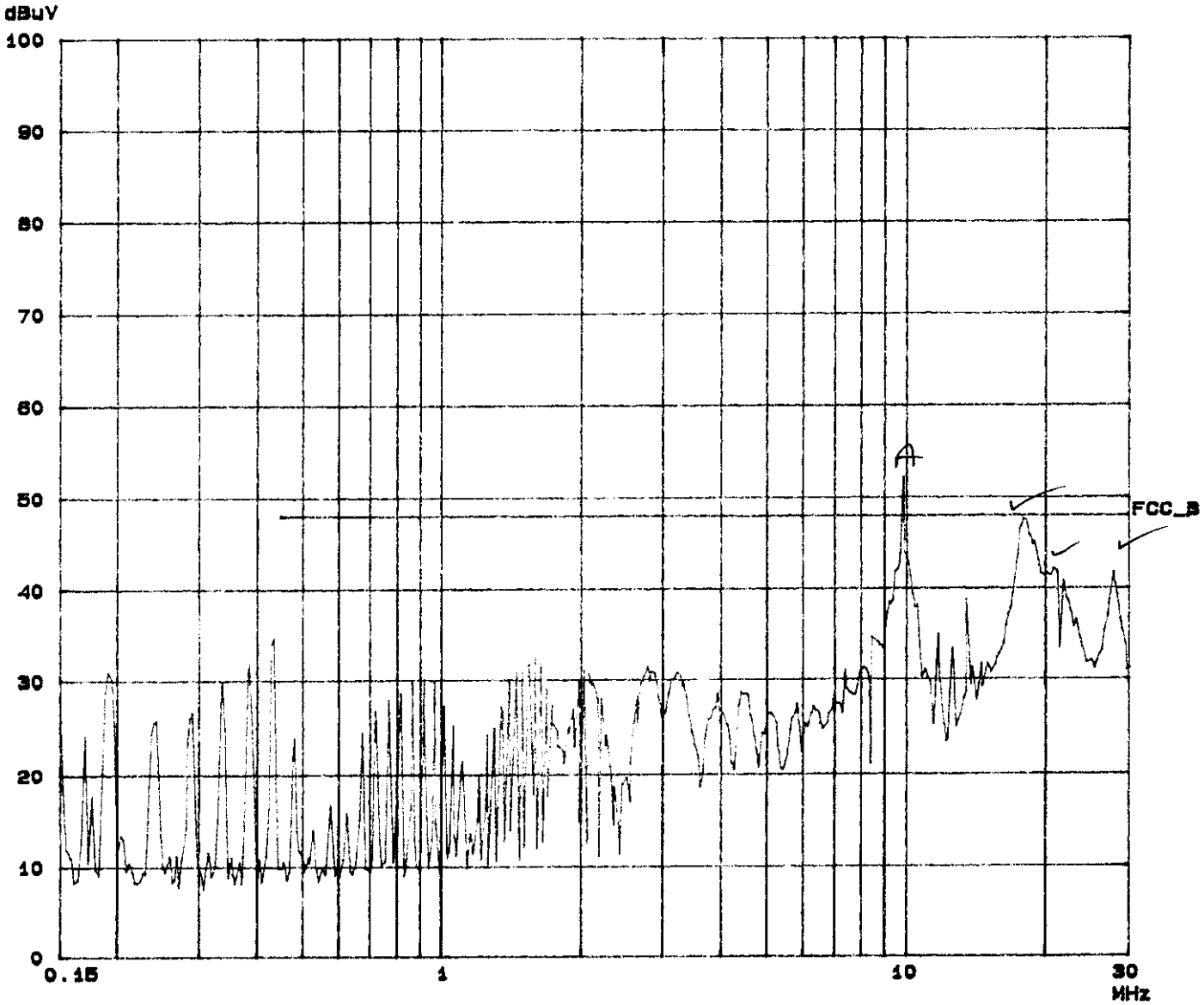


Elliott Laboratories

05. Aug 98 20:24

Conducted

Operator: Rudy Suy
Comment: Savi Tech.
SR-4106R-041 (new PS) Tx 2 ON
T26142 Run 3
120V, 60Hz
A=Ambient, V=EUT
LINE



Elliott Laboratories

05. Aug 98 20: 17

Conducted

Operator: Rudy Suy
Comment: Savi Tech.
SR-4100R-041 (new PS) Tx 2 ON
T26142 Run 3
120V, 60Hz
A=Ambient, ✓=EUT
NEUTRAL

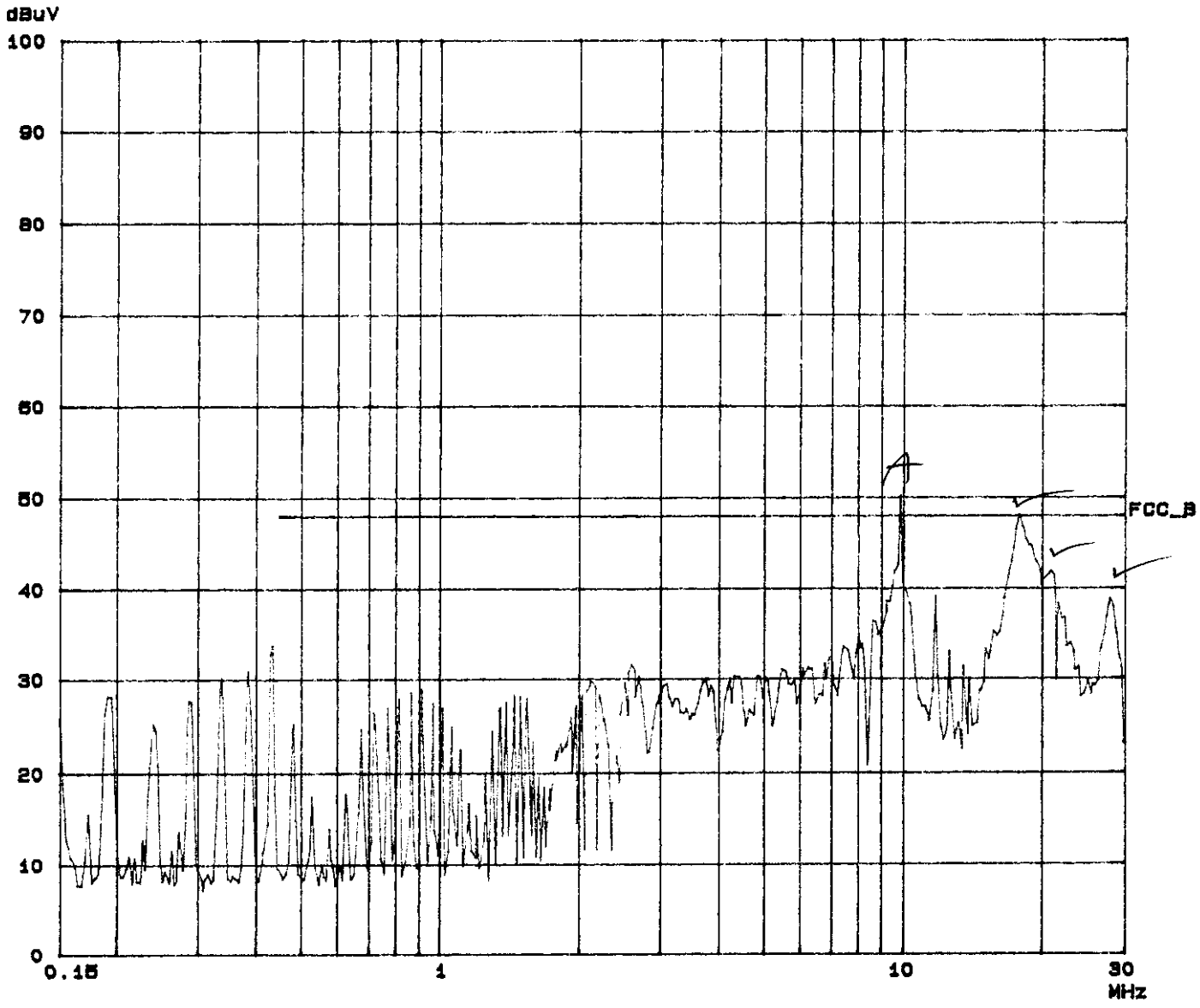


EXHIBIT C

Photographs of Test Configurations