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Submitted to:

**Federal Communications Commission
Equipment Approval Services**

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April 1998

**FCC Application for Type Certification
of an Intentional Radiator**

INVOCON INC.

**Invonet RDGU Unit
Wireless Data Acquisition System
(Transmitter Portion)**

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Certificate of Compliance

Manufacturer: INVOCON, Inc.

Model: IVC 9010

Serial #: 03

FCC ID: NJM0929156

Test Dates: March through July 1998

I, Jeffrey A. Lenk, for Professional Testing (EMI), Inc., being familiar with the FCC rules and test procedures have reviewed the test setup, measurement data and this report. I believe them to be true and accurate. The **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** was tested and found to be in compliance with FCC Part 15 for Intentional Radiators.

Jeffrey A. Lenk
President

1.0 Equipment Under Test (EUT) Description

The **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** is a remote data gathering unit used for measurement of strain on road bridges. Strain gauges are attached to the bridge then fed into the four input ports on the front of the unit. The data from their ports is fed to the control unit (CDCU) via a spread spectrum data link. The CDCU portion of this system was submitted for approval (and has received technical and administrative approval) to the FCC under FCC ID Number NJM0919156.

The **Remote Data Gathering Unit (RDGU)** was tested with all ports loaded in a typical manner. Strain gauges were attached to all ports and the unit was being polled continuously from the CDCU at the maximum transfer rate.

The **INVOCON, Inc. Remote Data Gathering Unit (RDGU)** with Direct Sequence Spread Spectrum Radio is designed for use in an industrial/commercial application only. Specific test requirements include the following:

47 CFR 15.247(a)(2)	Minimum Bandwidth
47 CFR 15.247(b)	Peak Output Power
47 CFR 15.247(c)	Out-of-Band Emissions
& 47CFR 15.205	Restricted Bands of Operation
47 CFR 15.247(d)	Spectral Power Density
47 CFR 15.247(e)	Processing Gain
47 CFR 15.207	Conducted Emissions
47 CFR 15.209	Radiated Emissions
47 CFR 1.310	Maximum Permissible Exposure (MPE)
47 CFR 15.203	Antenna Requirement

The system tested consisted of the following components:

<u>Manufacturer & Model #</u>	<u>Serial #</u>	<u>FCC ID #</u>	<u>Description</u>
INVOCON, Inc., IVC 9010 Monitor	03	NJM0929156	Bridge Remote Unit
INVOCON, Inc., IVC 9010-10 Model 95822/OT7	N/A	N/A	Power Supply
<u>System Peripherals:</u>			
Dell, SK-1000REW	P/N 00081730, Rev. D	G7UR26SK	Keyboard
Dell, D82SHT	8287839	L5ACPD100SF	Monitor
Microsoft, P/N 98952	00022439	C3KKMP5	Mouse
Dell, MMS	9KZ14	Declaration of Conformity	Computer
INVOCON, Inc., IVC 9010 Monitor	12	NJM0919156	Bridge Terminal Unit
INVOCON, Inc., IVC 9010-10 Model 95822/OT7	N/A	N/A	Power Supply

The equipment within this report was tested to verify its compliance with FCC Rule Part 15, for Intentional Radiators.

1.1 Equipment Under Test (EUT) Operation

For all tests described in this report, the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** was equipped with four sensors and was constantly polled from a remote interrogator unit (CDCU). This mode results in the highest emission levels from this item.

2.0 Minimum Bandwidth Measurements

Measurements were made on the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** to verify compliance with the bandwidth requirements of §15.247(a)(2).

2.1 Test Procedure

The tests were performed in a 12' X 16' RayProof modular shielded room. A Hewlett Packard 8566B Spectrum Analyzer utilizing an IF/video bandwidth of 100 kHz/300 kHz was used to record the output profile of the transmitter.

2.2 Test Criteria

Section 15.247(a)(2) requires a minimum 6 dB bandwidth of 500 kHz.

2.3 Test Results

The **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** operates over the frequency range 902 to 928 MHz. Testing was performed on three separate channels, centered at 906, 912 and 924 MHz (Channels 1, 3 and 7 respectively). The output of the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** was first reduced 30 dB through the use of external attenuation, and then directed to the input of the spectrum analyzer. Measurements were performed utilizing a spectrum analyzer IF/video bandwidth of 100 kHz/300 kHz.

The measured bandwidths were as follows:

	MINIMUM BANDWIDTH (MHz)	
	<u>Measured</u>	<u>Specified</u>
Channel 1	1.50	0.5
Channel 3	1.61	0.5
Channel 7	1.60	0.5

Plots for minimum bandwidth are contained in Appendix A of this report. The **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** met the §15.247(a)(2) minimum bandwidth requirements.

3.0 Peak Output Power Measurements

Measurements were made on the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** to verify compliance with the peak output power requirements of §15.247(b).

3.1 Test Procedure

Testing was performed in a controlled laboratory environment. A Hewlett Packard 8566B Spectrum Analyzer utilizing an IF/video bandwidth of 3 MHz/3 MHz was used to record the output profile of the transmitter.

3.2 Test Criteria

Section 15.247(b) allows for a maximum peak output power of 1 watt. Additionally, if the gain of the transmitting antenna exceeds 6 dBi, the allowed maximum peak output power shall be reduced by the amount, in dB, that the gain of the antenna exceeds 6 dBi.

3.3 Test Results

The **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** operates over the frequency range 902 to 928 MHz. Testing was performed on three separate channels, centered at 906, 912 and 924 MHz (Channels 1,3 and 7 respectively). The output of the **Remote Data Gathering Unit (RDGU)** was reduced 31 dB through the use of external attenuation, and then directed to the input of the spectrum analyzer. Measurements were performed utilizing a spectrum analyzer IF/video bandwidth of 3 MHz/3 MHz.

The measured peak output powers were as follows:

	PEAK OUTPUT POWER (Watts)	
	<u>Measured</u>	<u>Specified</u>
Channel 1	0.31	1.0
Channel 3	0.34	1.0
Channel 7	0.32	1.0

The transmit antenna provided with the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** has a directional gain of 2 dBi; therefore no reduction is required in the maximum allowed peak power output limit of 1 watt. Plots for peak output power are contained in Appendix B of this report. The **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** met the §15.247(b) peak output power requirements.

4.0 Spectral Density Measurements

Measurements were made on the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** to verify compliance with the conducted spectral density power requirements of §15.247(b).

4.1 Test Procedure

Testing was performed in a controlled laboratory environment. The procedure for these measurements was based on Appendix C of FCC Docket Number 96-8 (FCC Reference Number 97-114), 'Guidance on Measurements for Direct Sequence Spread Spectrum Systems'.

4.2 Test Criteria

Section 15.247(d) states that the transmit power density averaged over any 1 second interval shall not be greater than +8 dBm in any 3 kHz bandwidth inside the transmit channel band.

4.3 Test Results

Data plots for these measurements are contained in Appendix B of this document. Data was taken for channels 906, 012 and 924 MHz. Maximum detected emissions from these plots were all below the +8 dBm limit specified by Part 15.247.

5.0 Processing Gain Evaluation

An evaluation of the processing gain for the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** to verify compliance with the processing gain requirements of §15.247(e).

5.1 Evaluation Procedure

Determination of the process gain for this device is based on the product of the jamming margin, the output signal to noise ratio, and the system path/implementation losses. The process gain is determined by the following formula:

$$G_p = M_j + L_{sys} - (S/N)_{out}$$

where:

G_p = Processing Gain

M_j = Jamming Margin

$(S/N)_{out}$ = Output Signal to Noise ratio.

This figure is set to 13 dB, which corresponds to a bit error rate of 10^{-5} (worst case rate specified by the manufacturer).

L_{sys} = System Implementation Losses.

This figure was set to a value of 0 dB, which is the worst case value for this figure.

5.2 Evaluation Criteria

Section 15.247(e) states that the processing gain of a direct sequence spread spectrum system shall be at least 10 dB. The processing gain shall be determined from the ratio in dB of the signal to noise ratio with the spreading code turned off to the signal to noise ratio with the signal turned on.

5.3 Evaluation Results

Datasheets containing this information is contained in Appendix E. These sheets are the same exhibit used by Proxim for the original acceptance of this device. A total of 3 units were tested for compliance with this specification by Proxim. The lowest processing gain was 11.4 dB on Unit #1. The frequency offset for this test condition was -0.90 MHz. The rf module produced by Proxim that is used in the **Invocon Inc., Wireless Data Acquisition System** meets the 10 dB process gain requirement stated by Part 15.247(e) by a margin of 1.4 dB.

6.0 Out-of-Band Emission Measurements

Measurements were made on the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** to verify compliance with the out-of-band emission requirements of §15.247(c). Measurements were performed for both antenna conducted and radiated out-of-band emissions.

6.1 Antenna Conducted Out-of-Band Emission Measurements

6.1.1 Test Procedure

The tests were performed in controlled laboratory environment. A Hewlett Packard 8566B Spectrum Analyzer utilizing an IF/video bandwidth of 100 kHz/300 kHz was used to record the output profile. Testing was performed over the frequency range 30 MHz to 10 GHz. Emissions detected outside the frequency band 902 to 928 MHz were compared to the maximum emission detected in-band when measured with a detection system bandwidth of 100 kHz.

6.1.2 Test Criteria

Section 15.247(c) requires that all out-of-band emissions conducted on the RF antenna port be a minimum 20 dB below the measured level of the carrier (-20 dBc).

6.1.3 Test Results

The **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** operates over the frequency range 902 to 928 MHz. Testing was performed with the device tuned to three separate channels, centered at 906, 912 and 924 MHz (Channels 1, 3 and 7 respectively). The output of the INVOCON, Inc., Remote Data Gathering Unit (RDGU) was reduced 30 dB through the use of external attenuation, and then directed to the input of the spectrum analyzer. Measurements were performed utilizing a spectrum analyzer IF/video bandwidth of 100 kHz/300 kHz.

The data sheet for antenna conducted out-of-band emissions is contained in Appendix C of this report. All measured emissions outside the 902 to 928 MHz band were greater than 20 dB below the carrier; therefore, the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** met the §15.247(c) antenna conducted out-of-band emission requirements.

6.2 Radiated Out-of-Band Emission Measurements

Radiated emissions measurements were made to determine the radiated noise produced by the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** transmitter, not to include any emissions associated with the modulation products of the spreading sequence, the information sequence nor the carrier frequency and its harmonics. Such emissions were measured and reported in §4.2 of this report, as applicable. All measurements were performed on an "Open-Field" test site. A "Description of Measurement Facilities" has been submitted to the FCC and approved pursuant to §2.948 of CFR 47 of the FCC rules.

6.2.1 Test Procedure

A Hewlett Packard 8566B Spectrum Analyzer utilizing an IF/video bandwidth of 1 MHz/10 Hz was used to measure any detected emissions falling within the restricted bands of §15.205 and to verify compliance with the spurious emission requirements of 15.247(c). Testing was performed over the frequency range 30 GHz to 10 GHz. Preliminary testing was performed at a measurement distance of 1 meter. Final measurements were performed at a distance of 3 meters. The **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** was rotated 360° in the azimuth plane while the measurement antenna was raised and lowered to determine the orientation for maximum emissions.

6.2.2 Test Criteria

Section 15.247(c) requires that all radiated harmonics be reduced 20 dB below the carrier level or meet the requirements of §15.209(a), using whichever results in the least amount of attenuation.

In addition, Section §15.205 requires that all emissions falling within the restricted emission bands listed in 15.205 meet the limits specified in §15.209(a) regardless of the level of these emissions versus the fundamental.

6.2.3 Test Results

The **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** operates over the frequency range 902 to 928 MHz. Testing was performed with the device tuned to three separate channels, centered at 906, 912 and 924 MHz (Channels 1, 3 and 7 respectively). Measurements were performed utilizing a spectrum analyzer IF/video bandwidth of 1 MHz/10 Hz, with the unit set for continuous transmission of data.

Radiated out-of-band emission data sheets are contained in Appendix D of this report. Plots for determination of duty cycle are contained in Appendix E. The **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** met the §15.247(c) and 15.205 radiated out-of-band emission requirements.

7.0 Conducted Emissions Measurements

Conducted emissions measurements were made to determine the line-to-ground radio noise from the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** external power supply power-input terminals which connect to the public utility lines.

7.1 Test Procedure

The tests were performed in a 12' X 16' RayProof modular shielded room. The measurements were taken using an EMCO model 3825/2 Line Impedance Stabilization Network (LISN). A Hewlett Packard Spectrum Analyzer in association with a Quasi-Peak Adapter were used to record the conducted emissions. The Quasi-Peak Adapter utilizes a measurement bandwidth of 9 kHz.

The power cord length in excess of the distance between the EUT and LISN was wrapped in a "figure eight" pattern around two non-metallic 9 centimeter high pegs, 2 centimeters in diameter at a spacing of 6 centimeters on center. The unit was checked for variation in emission amplitude for both pen and for handheld operation.

7.2 Test Criteria

The §15.207 conducted emission limits are given below:

Frequency (MHz)	Maximum RF Line Voltage	
	(μ V)	(dB μ V)
0.45 to 30.0	250	48

7.3 Test Results

The **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** operates over the frequency range 902 to 928 MHz. Testing was performed on three separate channels, centered at 906, 912 and 924 MHz (Channels 1, 3 and 7 respectively).

Conducted test data is contained in Appendix F of this report. The **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** met the §15.207 conducted emission requirements.

8.0 Frequency Stability Measurements

Measurements were made on the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** to verify compliance with the frequency stability requirements of §15.31(e) and 15.215(c). Under these specifications, the EUT is tested to verify satisfactory frequency stability versus changes in the amplitude of the primary power for operation from the AC mains. For the battery powered option, the EUT shall be tested with the battery assembly fully charged.

8.1 Test Procedure

The EUT was placed on a non-conductive turntable with the antenna port connected to a spectrum analyzer through a 20 dB attenuator. The **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** operates over the frequency range 902 to 928 MHz. Testing was performed with the device tuned to Channel 1 (906 MHz). Previous test results had shown no significant change between the emission profiles for this unit versus channel setting. The EUT was operated with four sensor cables and was constantly polled from a remote interrogator (CDCU) unit.

Power to the input terminals of the AC to DC power adapter was varied from 100 to 140VAC at a nominal frequency of 60 Hz. The nominal AC mains power for this system is 120 VAC which is listed on the label for the AC to DC converter. The center frequency and center frequency power level was recorded at 5 volt intervals over this range.

8.2 Test Criteria

When combined, Sections 15.31(e) and 15.215(c) indicate that the output frequency of the transmitter shall remain within the central 80% appropriate channel band with AC mains power varied from 85% to 115% of the nominal value. For battery powered units, the EUT shall meet this criteria when tested with a fully charged battery supply. Based on this criteria, no significant drift of the frequency shall occur under these conditions. While 15.215(c) is a recommendation, for the purposes of this test it is viewed as a requirement.

8.3 Test Results

Data for this test is located in the Appendix of this report. No significant movement of the center frequency was detected over the AC input variation range. The stability of the unit was also verified under battery power.

The **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** meets the frequency stability requirements for frequency stability versus AC mains input variation based on the criteria listed above.

9.0 Maximum Permissible Exposure (MPE) Measurements

Measurements were made on the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** to verify compliance with the Maximum Permissible Exposure Requirements (MPE) of §1.310, Table 1 (B). Due to size and weight of the EUT, the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** is not practical for use within 20 cm of a human. This unit is 24 X 8 X 2 inches and must be used with a separate computer with a parallel interface port. Based on the intended use for this product, the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** would be used in an industrial desktop, uncontrolled environment. This analysis indicates that the appropriate guidelines for indicating compliance with the radio frequency radiation exposure limits would be MPE type criteria for an uncontrolled environment.

9.1 Test Procedure

The testing was performed in a 20' by 26' by 10' shielded enclosure with anechoic material placed throughout the enclosure to minimize reflections. The EUT was placed on a non-conductive turntable with the antenna in a vertical polarization. A standard personal computer was used to control the EUT during testing.

The **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** operates over the frequency range 902 to 928 MHz. Testing was performed with the device tuned to Channel 1 (906 MHz). Previous test results had shown no significant change between the emission profiles for this unit versus channel setting. The EUT was operated in a mode that polled for all possible remote units at the same time. This mode provides the highest signal density for this unit.

An initial survey was made to determine an appropriate height to perform the measurements and verify test heights & locations. This survey indicated that the highest signal strength for this test was obtained at a height of 15 cm from the reference plane of the unit. Measurements of field strength were made at 45 degree intervals around the EUT at three different heights versus the bottom of the EUT.

9.2 Test Criteria

Section 1.1310, Table 1 (B), indicates a maximum permissible exposure level of $f/1500$ (f = frequency in MHz) mW/cm^2 for transmitter operating between 300 and 1500 MHz. Based on discussions with the FCC, evaluation of MPE requirements may be made based on equivalent electric field calculations for a 377Ω (air) system. For a nominal frequency of 836.520 MHz, the MPE for the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** is:

$$\text{MPE} = 906.00/1500 = 0.604 \text{ mW}/\text{cm}^2$$

Based on a 377Ω (air) impedance, the equivalent electric field for this level is derived as:

$$P = \frac{E^2}{R}$$

Where:

$$\begin{aligned} P &= 0.604 \text{ mW}/\text{cm}^2 \\ &= 0.604 \times 10^{-3} \text{ W}/\text{cm}^2 \end{aligned}$$

and :

$$R = 377 \Omega$$

Solving for E:

$$\begin{aligned} E &= (P \cdot R)^{1/2} \\ &= (0.604 \times 10^{-3} * 377)^{1/2} \text{ V}/\text{cm} \end{aligned}$$

MPE Limit for the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** = 47.7 V/m

9.3 Test Results

The **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** meets the §1.1310 criteria for maximum permissive exposure. Data for this test is located in the Appendix of this report.

10.0 Antenna Requirement

An analysis of the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** was performed to determine compliance with Section 15.203 of the Rules. This section requires specific handling and control of antennas used for devices subject to regulation under the Intentional Radiator portions of Part 15.

10.1 Evaluation Procedure

The structure and application of the **INVOCON, Inc., Remote Data Gathering Unit (RDGU)** were analyzed with respect to the rules. This unit has a detachable antenna using a standard SMA type connector, but is only market to and used by technicians involved in strain inspection and monitoring of highway bridges.

10.2 Evaluation Criteria

Section 15.203 of the rules states that the subject device must meet at least one of the following criteria:

- (a) Antenna be permanently attached to the unit.
- (b) Antenna must use a unique type of connector to attach to the EUT.
- (c) Unit must be professional installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

10.3 Test Results

The **Invocon Inc., Wireless Data Acquisition System** meets this portion of the rules based on criteria (c). This device is only used monitoring of strain gauges attached to roadway bridges. Due to the nature of this work, the system will only be installed by trained bridge maintenance personnel. In addition, this system will only be marketed to companies and industries related to roadway bridge construction and maintenance. The manual of this system will be modified to include a statement that requires that installation and use of this system is limited to professionally trained personnel.

This approach to compliance with this portion of the rules was reviewed and concurred with by Mr. Dichoso of the FCC via e-mail and during a discussion of this product between Mr. Dichoso & Mr. John O'Brien of Professional Testing at the FCC Laboratory on February 18, 1998.

11.0 List of Test Equipment

A list of the test equipment utilized to perform the conducted and radiated emission measurements is given below. The date of calibration is given for each.

<u>Device</u>	<u>Description</u>	<u>Date Last Calibrated</u>	<u>Calibration Due</u>
HP 8567A	Spectrum Analyzer	02/10/97	02/10/98
HP 85650A	Quasi Peak Adapter	02/10/97	02/10/98
HP 8566B	Spectrum Analyzer	09/22/97	09/22/98
HP 85650A	Quasi Peak Adapter	02/10/97	02/10/98
HP 8447F	Preamplifier	10/23/97	10/23/98
Electro-Metrics BPA-1000	Broadband Pre-Amp	04/30/97	10/30/97
EMCO 3108	Biconical Antenna	07/22/97	07/22/98
EMCO 3146	Log Periodic Antenna	07/22/97	07/22/98
HP 8591E	Spectrum Analyzer	08/11/97	08/11/98
Omni-Spectra PN 2021-6383-10	Directional Coupler	03/03/98	03/03/99
Schwarzbeck 8127 LISN	LISN	02/28/97	02/28/98
EMCO 3115	Double Ridged Horn Antenna	04/30/97	04/30/98

Appendix A

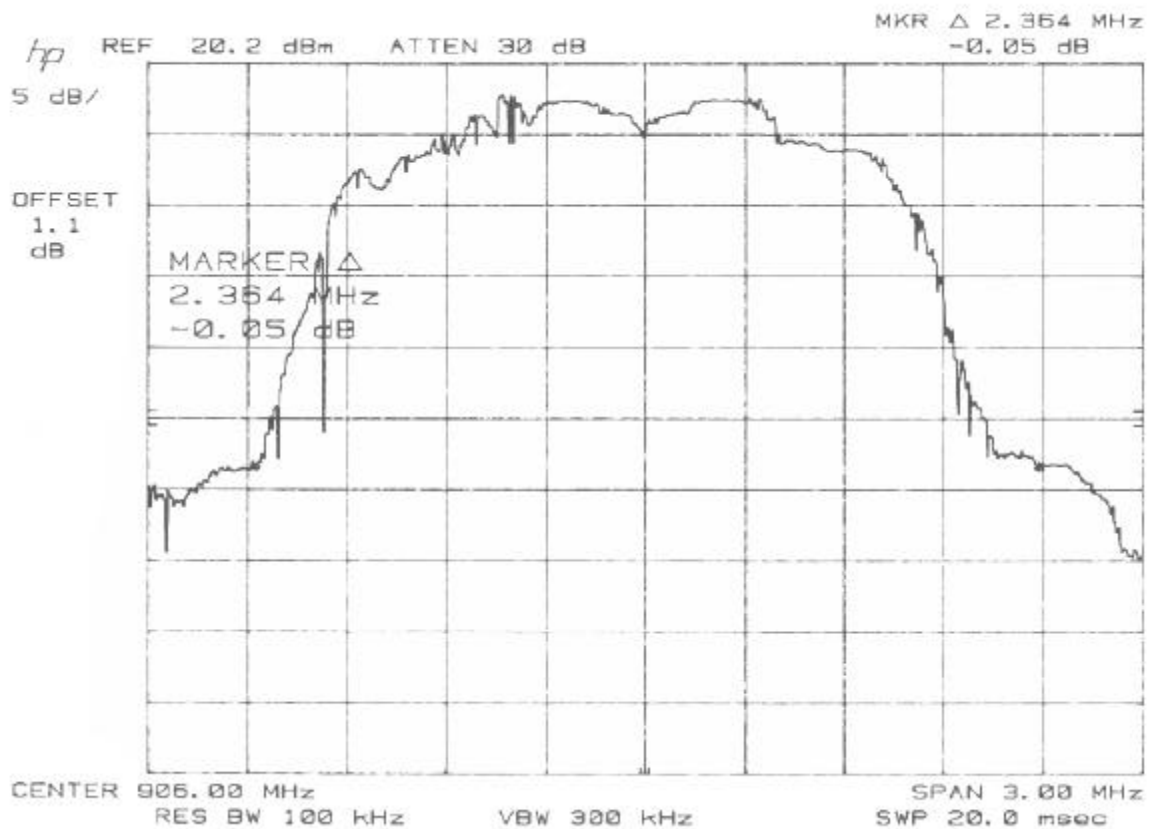
Minimum Bandwidth Test Data

Minimum Bandwidth Data Sheet**INVOCON, Inc.
Remote Data Gathering Unit (RDGU)**

SERIAL #: 03

PROJECT #: 99-068

DATE: March 27, 1998



COMMENT #1: Channel Setting = 1 (Center Frequency = 906 MHz)

COMMENT #2: 6dB Bandwidth = 1.50 MHz. 26 dB Bandwidth shown on the graph.

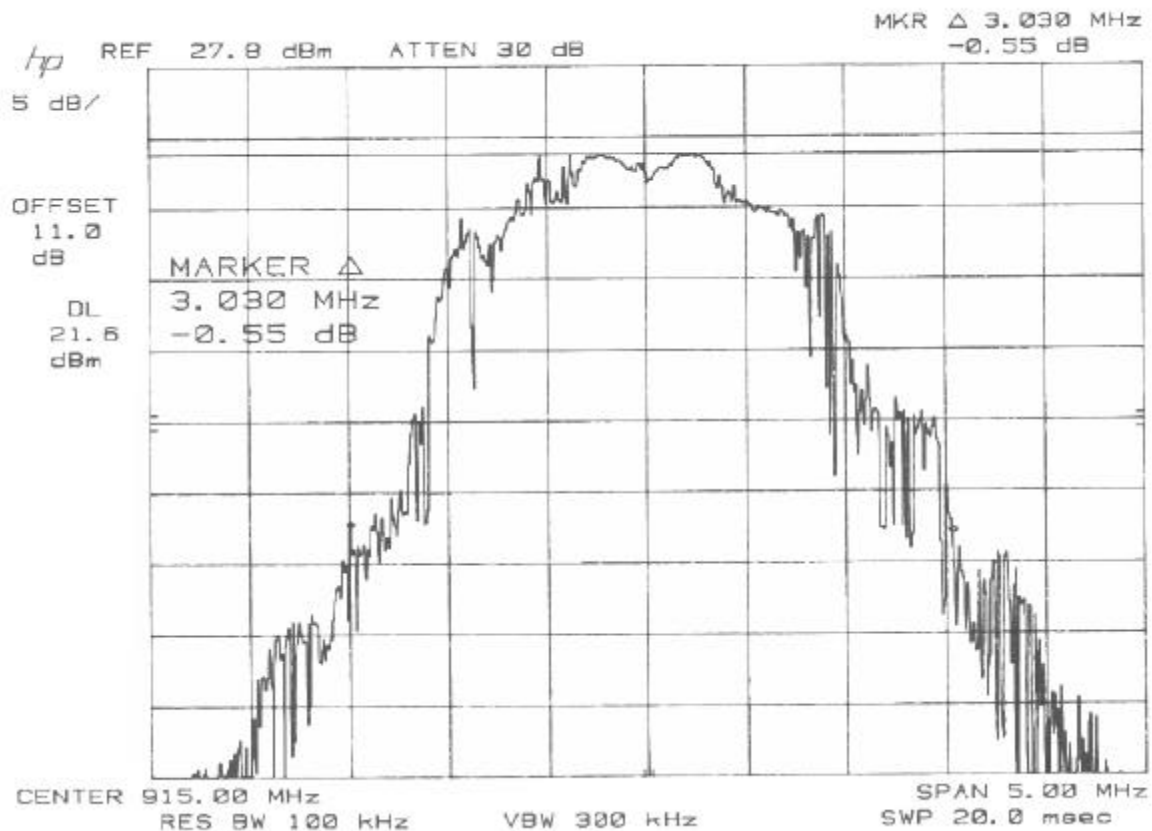
TEST ENGINEER: _____ APPROVED BY: _____
John O'Brien Jeffery Lenk

Minimum Bandwidth Data Sheet**INVOCON, Inc.
Remote Data Gathering Unit (RDGU)**

SERIAL #: 03

PROJECT #: 99-068

DATE: March 27, 1998



COMMENT #1: Channel Setting = 4 (Center Frequency = 915 MHz)

COMMENT #2: 6dB Bandwidth = 1.61 MHz. 26 dB Bandwidth shown on the graph.

TEST ENGINEER: _____ APPROVED BY: _____

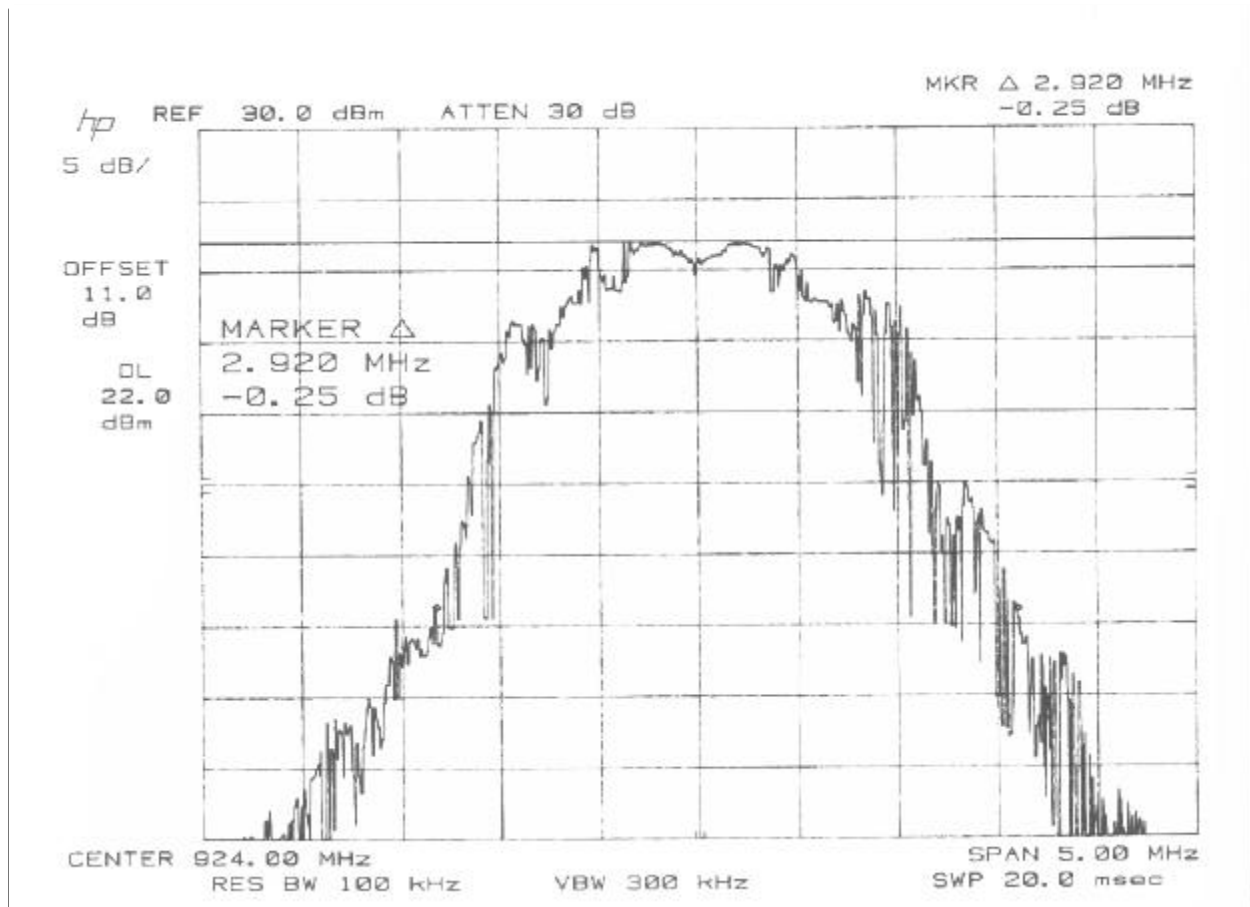
John O'Brien Jeffery Lenk

Minimum Bandwidth Data Sheet**INVOCON, Inc.
Remote Data Gathering Unit (RDGU)**

SERIAL #: 03

PROJECT #: 99-068

DATE: March 27, 1998



COMMENT #1: Channel Setting = 7 (Center Frequency = 924 MHz)

COMMENT #2: 6dB Bandwidth = 1.60 MHz. 26 dB Bandwidth shown on the graph.

TEST ENGINEER: _____ APPROVED BY: _____

John O'Brien Jeffery Lenk

Appendix B

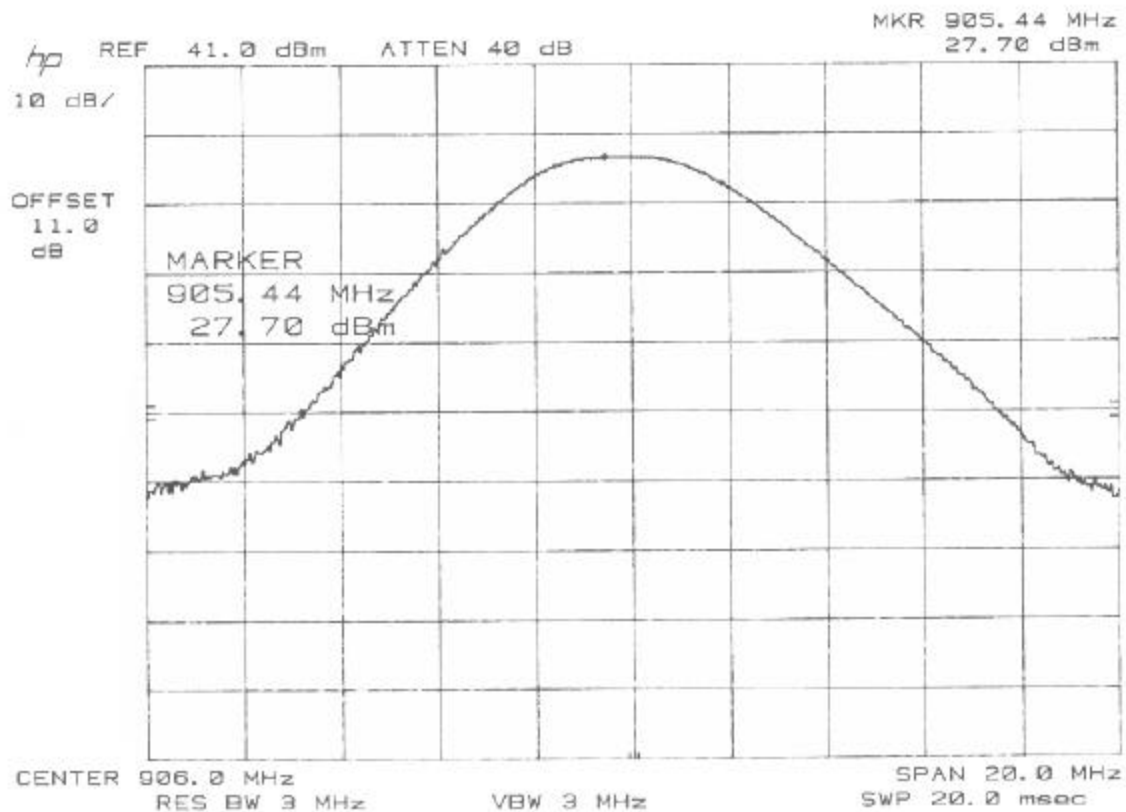
Peak Power and Spectral Density Test Data

Conducted Peak Power Data Sheet**INVOCON, Inc.
Remote Data Gathering Unit (RDGU)**

SERIAL #: 03

PROJECT #: 99-068

DATE: March 27, 1998



COMMENT #1: Channel Setting = 1 (Center Frequency = 906 MHz)

COMMENT #2: Peak Power = 27.70 dBm

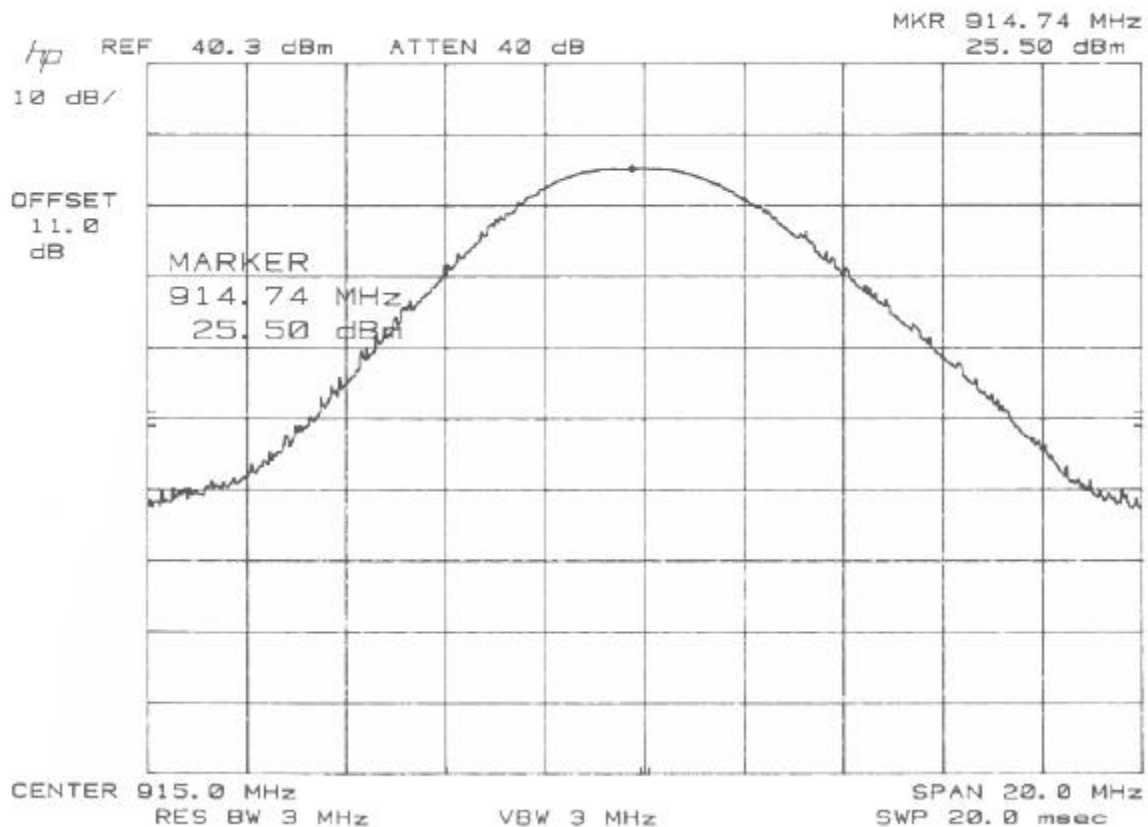
TEST ENGINEER: _____ APPROVED BY: _____
John O'Brien Jeffery Lenk

Conducted Peak Power Data Sheet**INVOCON, Inc.
Remote Data Gathering Unit (RDGU)**

SERIAL #: 03

PROJECT #: 99-068

DATE: March 27, 1998



COMMENT #1: Channel Setting = 4 (Center Frequency = 915 MHz)

COMMENT #2: Peak Power = 25.50 dBm

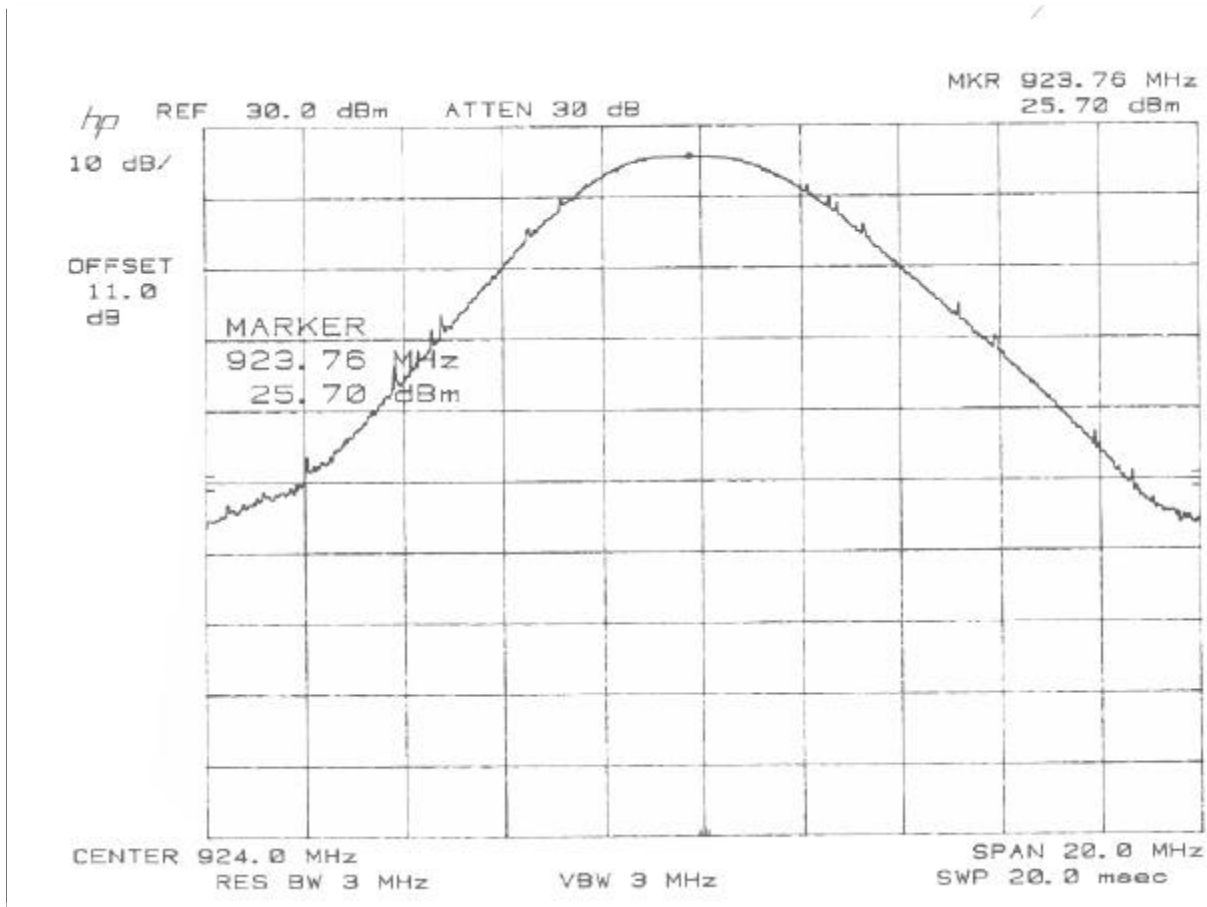
TEST ENGINEER: _____ APPROVED BY: _____
John O'Brien Jeffery Lenk

Conducted Peak Power Data Sheet**INVOCON, Inc.
Remote Data Gathering Unit (RDGU)**

SERIAL #: 03

PROJECT #: 99-068

DATE: March 27, 1998



COMMENT #1: Channel Setting = 7 (Center Frequency = 924 MHz)

COMMENT #2: Peak Power = 25.70 dBm

TEST ENGINEER: _____ APPROVED BY: _____
John O'Brien Jeffery Lenk

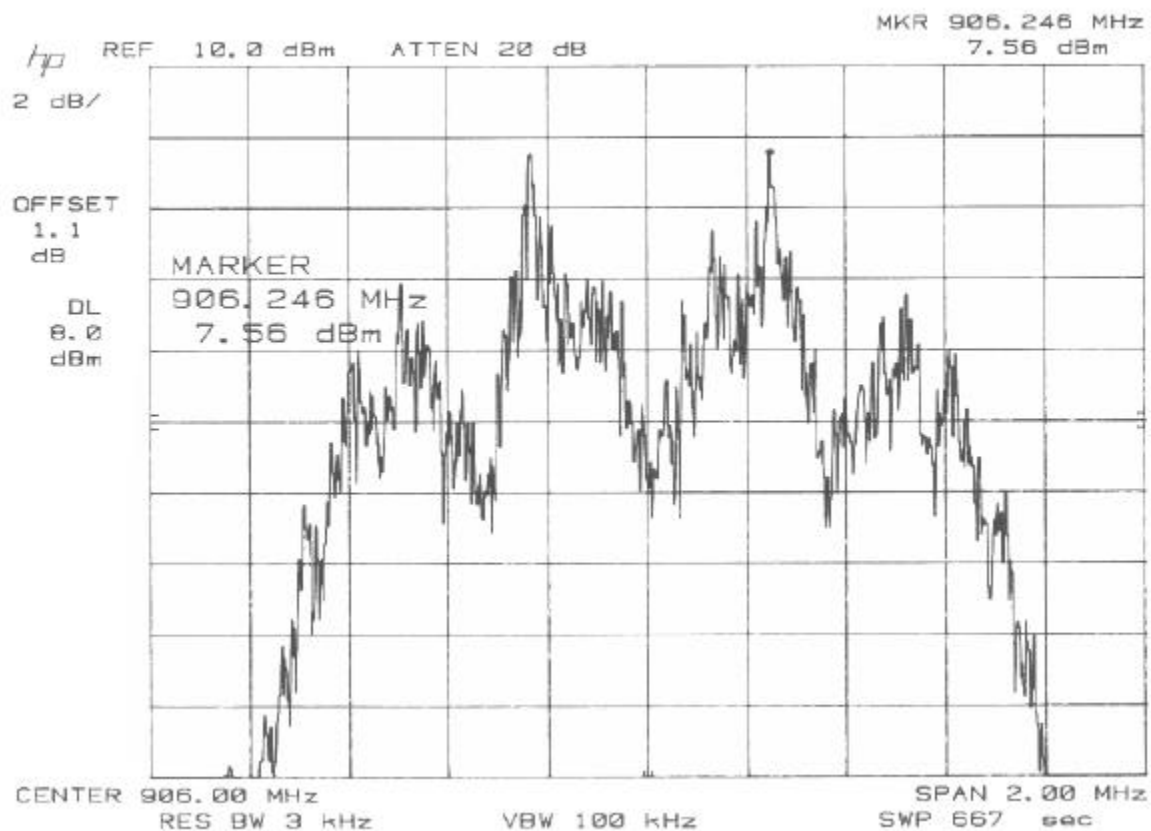
Spectral Density Data Sheet

INVOCON, Inc.
Remote Data Gathering Unit (RDGU)

SERIAL #: 03

PROJECT #: 99-068

DATE: March 27, 1998



COMMENT #1: Channel Setting = 1 (Center Frequency = 906 MHz)

COMMENT #2: Peak Spectral Density = 7.56 dBm

TEST ENGINEER: _____ APPROVED BY: _____
 John O'Brien Jeffery Lenk

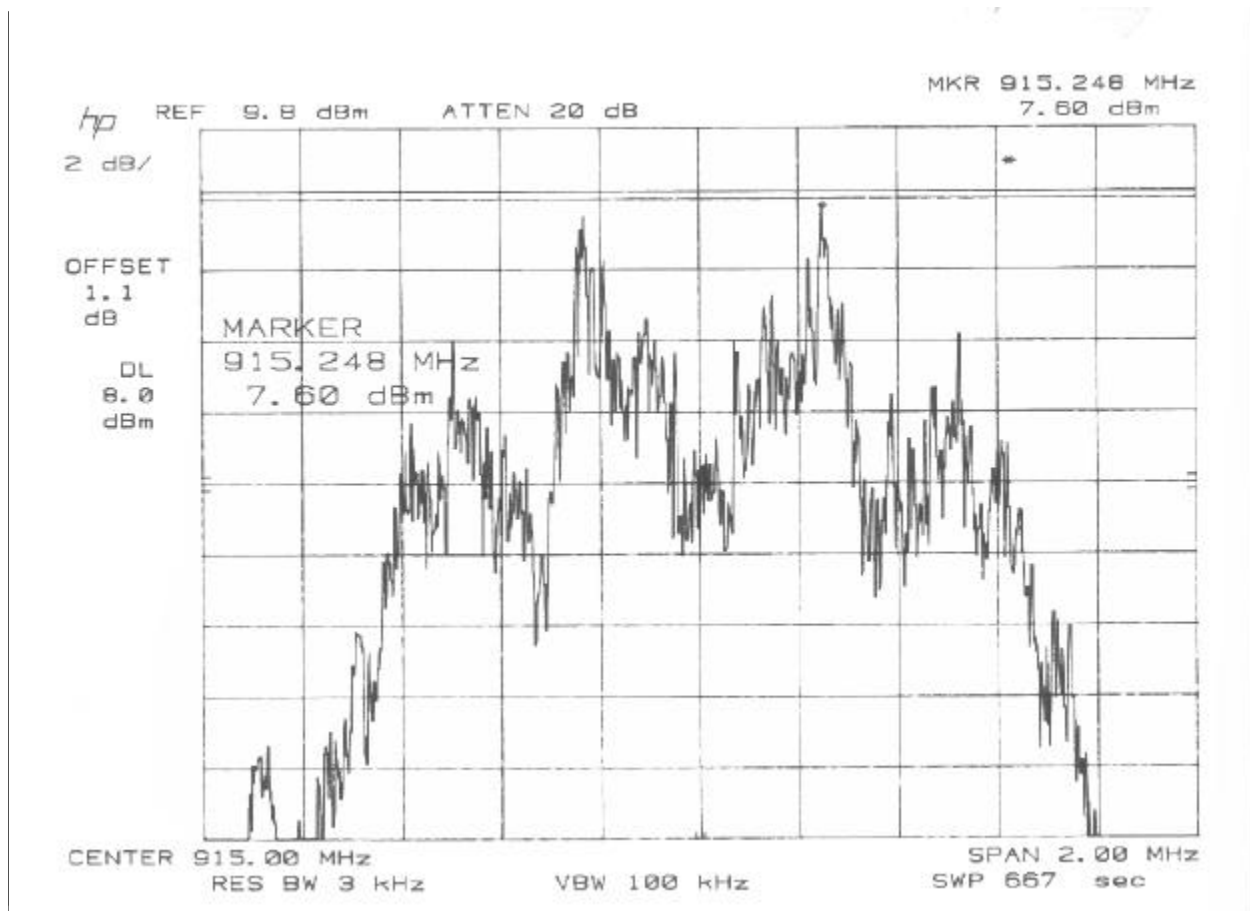
Spectral Density Data Sheet

INVOCON, Inc.
Remote Data Gathering Unit (RDGU)

SERIAL #: 03

PROJECT #: 99-068

DATE: March 27, 1998



COMMENT #1: Channel Setting = 4 (Center Frequency = 915 MHz)

COMMENT #2: Peak Spectral Density = 7.60 dBm

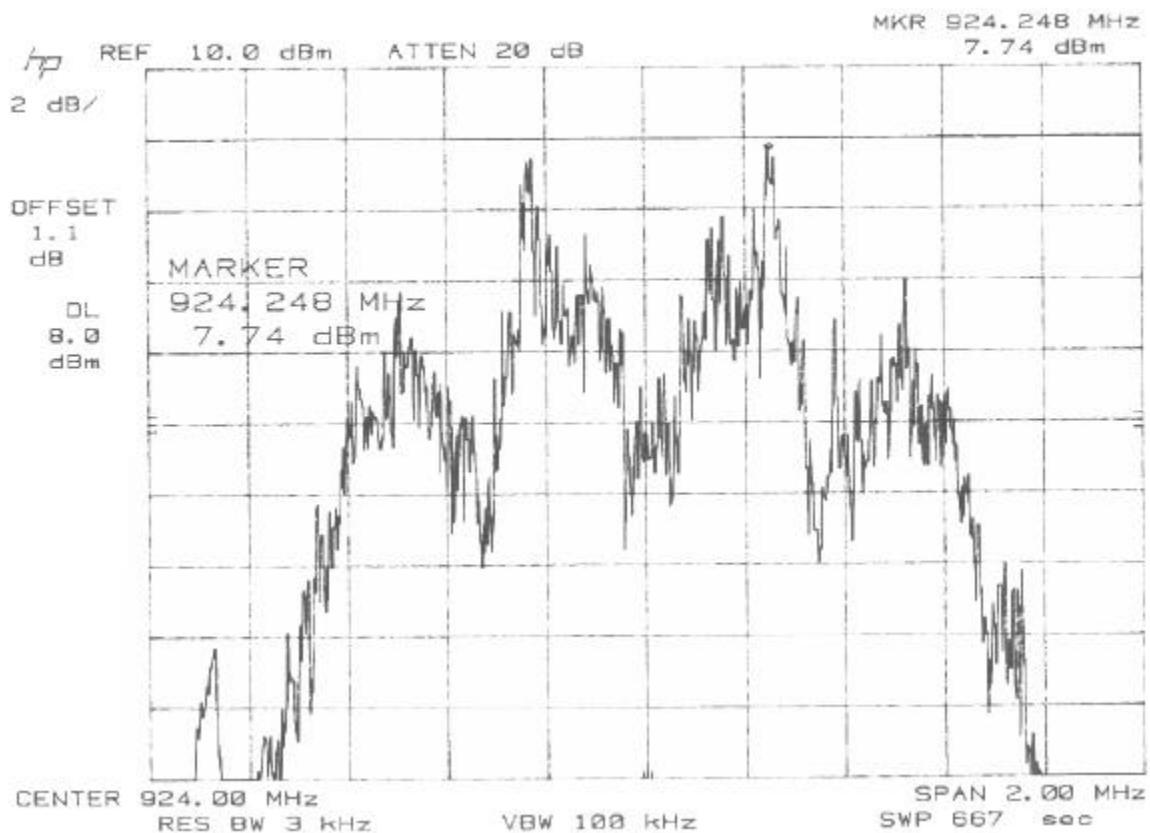
TEST ENGINEER: _____ **APPROVED BY:** _____
 John O'Brien Jeffery Lenk

Spectral Density Data Sheet**INVOCON, Inc.
Remote Data Gathering Unit (RDGU)**

SERIAL #: 03

PROJECT #: 99-068

DATE: March 27, 1998



COMMENT #1: Channel Setting = 7 (Center Frequency = 924 MHz)

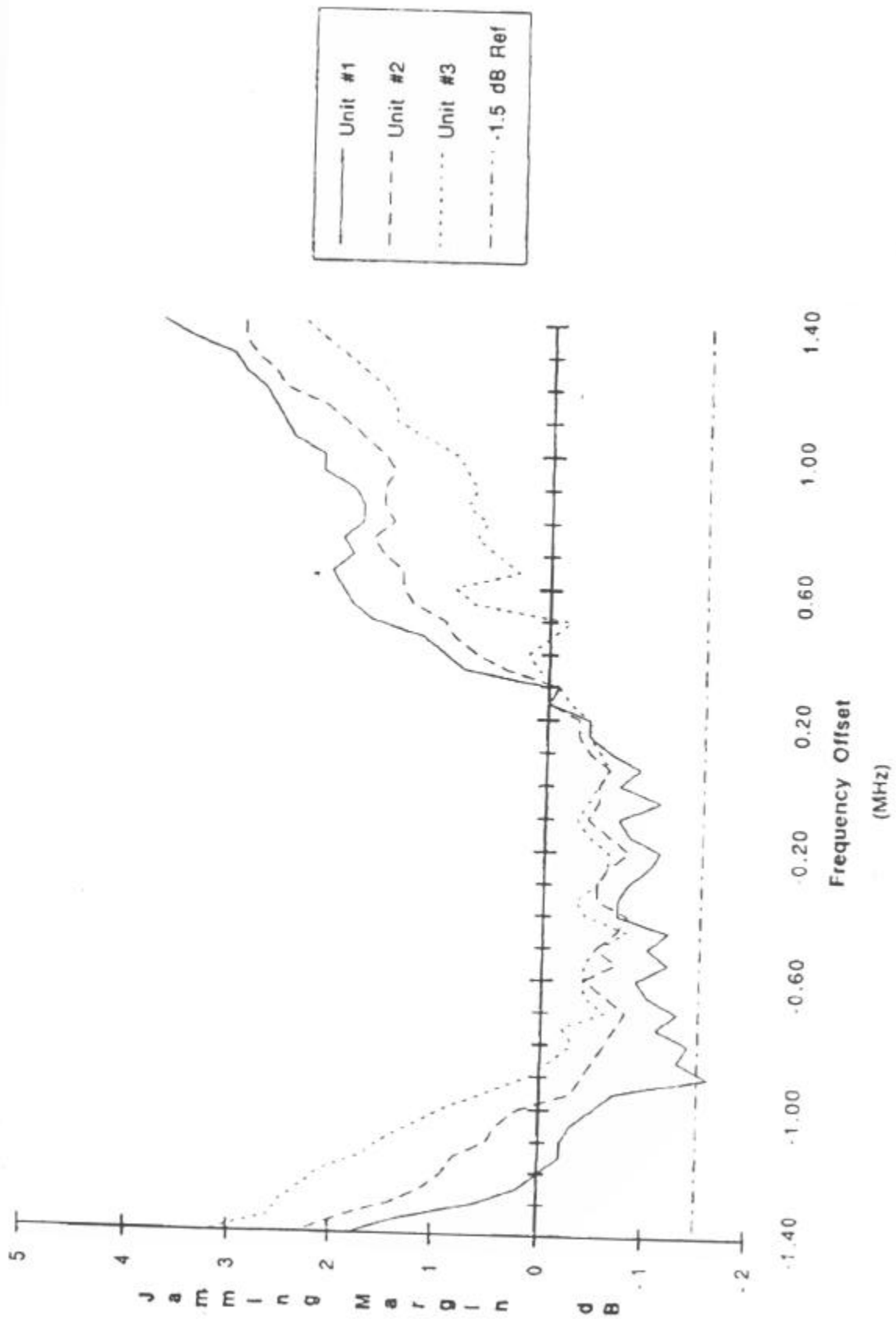
COMMENT #2: Peak Spectral Density = 7.74 dBm

TEST ENGINEER: _____ **APPROVED BY:** _____
John O'Brien Jeffery Lenk

Appendix C

Processing Gain Analysis Data

JAMMING MARGIN (dB) MJ				PROCESSING GAIN (dB) Gp			
Test Frequency = 915 MHz		Formula for Processing gain		$Gp = [L_{sys} + (S/N)_{out}] = MJ$			
Test Frequency range ± 1.4 MHz Where $L_{sys} = 0$ dB (worst case)				$(S/N)_{out} = 13$ dB for 10 ⁻⁵ BER			
Frequency Offset (MHz)	Unit #1 Jamming Margin	Unit #1 Processing gain	Unit #2 Jamming Margin	Unit #2 Processing gain	Unit #3 Jamming Margin	Unit #3 Processing gain	Unit #3
1.40	3.8	16.8	3.0	16.0	2.4		15.4
1.35	3.5	16.5	3.0	16.0	2.2		15.2
1.30	3.1	16.1	2.9	15.9	2.0		15.0
1.25	3.0	16.0	2.7	15.7	1.8		14.8
1.20	2.8	15.8	2.6	15.6	1.6		14.6
1.15	2.7	15.7	2.2	15.2	1.5		14.5
1.10	2.6	15.6	2.0	15.0	1.5		14.5
1.05	2.5	15.5	1.8	14.8	1.2		14.2
1.00	2.2	15.2	1.6	14.6	0.9		13.9
0.95	2.2	15.2	1.5	14.5	0.8		13.8
0.90	1.9	14.9	1.6	14.6	0.7		13.7
0.85	1.8	14.8	1.6	14.6	0.8		13.8
0.80	1.8	14.8	1.5	14.5	0.6		13.6
0.75	2.0	15.0	1.7	14.7	0.7		13.7
0.70	1.9	14.9	1.6	14.6	0.5		13.5
0.65	2.1	15.1	1.4	14.4	0.3		13.3
0.60	2.0	15.0	1.4	14.4	0.9		13.9
0.55	1.9	14.9	1.3	14.3	0.7		13.7
0.50	1.7	14.7	1.0	14.0	-0.2		12.8
0.45	1.2	14.2	0.9	13.9	0.0		13.0
0.40	1.0	14.0	0.7	13.7	0.2		13.2
0.35	0.8	13.8	0.4	13.4	0.1		13.1
0.30	0.0	13.0	-0.1	12.9	-0.1		12.9
0.25	0.0	13.0	0.0	13.0	-0.2		12.8
0.20	-0.4	12.6	-0.3	12.7	-0.4		12.6
0.15	-0.4	12.6	-0.3	12.7	-0.4		12.6
0.10	-0.6	12.4	-0.4	12.6	-0.5		12.5
0.05	-0.9	12.1	-0.6	12.4	-0.6		12.4
0.00	-0.7	12.3	-0.5	12.5	-0.5		12.5
-0.05	-1.1	11.9	-0.5	12.5	-0.4		12.6
-0.10	-0.7	12.3	-0.4	12.6	-0.3		12.7
-0.15	-0.8	12.2	-0.6	12.4	-0.4		12.6
-0.20	-1.1	11.9	-0.8	12.2	-0.6		12.4
-0.25	-1.0	12.0	-0.6	12.4	-0.6		12.4
-0.30	-0.8	12.2	-0.5	12.5	-0.5		12.5
-0.35	-0.7	12.3	-0.5	12.5	-0.3		12.7
-0.40	-0.7	12.3	-0.8	12.2	-0.4		12.6
-0.45	-1.2	11.8	-0.7	12.3	-0.8		12.2
-0.50	-1.0	12.0	-0.5	12.5	-0.5		12.5
-0.55	-1.2	11.8	-0.7	12.3	-0.4		12.6
-0.60	-0.9	12.1	-0.4	12.6	-0.4		12.6
-0.65	-1.0	12.0	-0.6	12.4	-0.4		12.6
-0.70	-1.3	11.7	-0.8	12.2	-0.6		12.4
-0.75	-1.1	11.9	-0.7	12.3	-0.2		12.8
-0.80	-1.4	11.6	-0.6	12.4	-0.3		12.7
-0.85	-1.3	11.7	-0.5	12.5	-0.1		12.9
-0.90	-1.6	11.4	-0.4	12.6	0.1		13.1
-0.95	-0.7	12.3	-0.3	12.7	0.5		13.5
-1.00	-0.5	12.5	0.2	13.2	0.9		13.9
-1.05	-0.3	12.7	0.4	13.4	1.2		14.2
-1.10	-0.2	12.8	0.5	13.5	1.5		14.5
-1.15	-0.2	12.8	0.8	13.8	1.7		14.7
-1.20	0.0	13.0	0.9	13.9	2.1		15.1
-1.25	0.2	13.2	1.1	14.1	2.3		15.3
-1.30	0.6	13.6	1.4	14.4	2.5		15.5
-1.35	1.3	14.3	1.9	14.9	2.6		15.6
-1.40	1.8	14.8	2.3	15.3	3.2		16.2



Appendix D

Antenna Conducted Out-of-Band Emissions Test Data

FCC Part 15.247 Conducted Data Sheet**INVOCON, Inc.
Remote Data Gathering Unit (RDGU)**

SERIAL #: 03

DATE: March 28, 1998

DETECTOR FUNCTION: Peak

LINE MEASURED: Antenna

PROJECT #: 99-068

Frequency Measured (MHz)	Recorded Level (dBm)	Cable Loss (dB)	Corrected Level (dBm)	Limit Peak dBm)	Margin (dB)
906.30	17.5	1.0	18.5	Reference	Reference
907.500	-15.2	1.0	-14.2	-1.5	-12.7
921.70	-30.5	1.0	-29.5	-1.5	-28.0
929.60	-29.1	1.0	-28.1	-1.5	-26.6
938.20	-24.3	1.0	-23.3	-1.5	-21.8
986.00	-46.7	1.0	-45.7	-1.5	-44.2
1812.00	-38.9	1.4	-37.5	-1.5	-36.0
2714.00	-36.4	1.6	-34.8	-1.5	-33.3
3617.00	-43.7	1.9	-41.8	-1.5	-40.3
4523.00	-27.6	2.3	-25.3	-1.5	-23.8
5430.00	-43.7	2.8	-40.9	-1.5	-39.4
9060.00	-53.7	3.1	-50.6	-1.5	-49.1

COMMENT #1: Channel Setting = 1 (Center Frequency = 906 MHz)

COMMENT #2: All readings above 1 GHz are ambient measurements.

TEST ENGINEER: _____ **APPROVED BY:** _____
 John O'Brien Jeffery Lenk

FCC Part 15.247 Conducted Data Sheet**INVOCON, Inc.
Remote Data Gathering Unit (RDGU)**

SERIAL #: 03

DATE: March 28, 1998

DETECTOR FUNCTION: Peak

LINE MEASURED: Antenna

PROJECT #: 99-068

Frequency Measured (MHz)	Recorded Level (dBm)	Cable Loss (dB)	Corrected Level (dBm)	Limit Peak dBm)	Margin (dB)
915.1	21.5	1.0	22.5	Reference	Reference
917.5	-30.0	1.0	-29.0	1.5	-30.5
938.7	-27.7	1.0	-26.7	1.5	-28.2
946.9	-23.9	1.0	-22.9	1.5	-24.4
995.3	-20.7	1.0	-19.7	1.5	-21.2
1829.0	-41.8	1.4	-40.4	1.5	-41.9
2741.0	-34.7	1.8	-32.9	1.5	-34.4
4568.0	-39.7	2.3	-37.4	1.5	-38.9
5485.0	-40.7	2.8	-37.9	1.5	-39.4
9150.0	-43.7	4.0	-39.7	1.5	-41.2

COMMENT #1: Channel Setting = 4 (Center Frequency = 915 MHz)

COMMENT #2: All readings above 1 GHz are ambient measurements.

TEST ENGINEER: _____ APPROVED BY: _____
 John O'Brien Jeffery Lenk

FCC Part 15.247 Conducted Data Sheet

INVOCON, Inc.
Remote Data Gathering Unit (RDGU)

SERIAL #: 03

DATE: March 28, 1998

DETECTOR FUNCTION: Peak

LINE MEASURED: Antenna

PROJECT #: 99-068

Frequency Measured (MHz)	Recorded Level (dBm)	Cable Loss (dB)	Corrected Level (dBm)	Limit Peak dBm)	Margin (dB)
923.6	22.1	1.0	23.1	Reference	Reference
927.0	-24.3	1.0	-23.3	2.1	-25.4
940.5	-27.2	1.0	-26.2	2.1	-28.3
948.2	-23.9	1.0	-22.9	2.1	-25.0
955.8	-20.4	1.0	-19.4	2.1	-21.5
1849.0	-33.1	1.4	-31.7	2.1	-33.8
2765.0	-41.3	1.6	-39.7	2.1	-41.8
3689.0	-32.1	1.9	-30.2	2.1	-32.3
5890.0	-39.3	2.3	-37.0	2.1	-39.1
9236.0	-50.4	4.0	-46.4	2.1	-48.5

COMMENT #1: Channel Setting = 7 (Center Frequency = 924 MHz)

COMMENT #2: All readings above 1 GHz are ambient measurements.

TEST ENGINEER: _____ **APPROVED BY:** _____
 John O'Brien Jeffery Lenk

Appendix E

Radiated Out-of-Band Emissions Test Data

Radiated Out-of-Band Emissions Data Sheet

INVOCON, Inc.
Remote Data Gathering Unit (RDGU)

SERIAL #: 03
 DATE: July 8, 1998
 PROJECT #: 99-068

MEASUREMENT DISTANCE (m): 3 (1)
 ANTENNA POLARIZATION: Vertical
 DETECTOR FUNCTION: Quasi-Peak

Freq. (MHz)	EUT Dir. (Deg.)	Antenna Elevation Meters	Recorded Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
924.0	99.0	1.0	97.0	23.0	2.0	122.0	Ref	Ref
1848.0	99.0	1.0	26.9	25.9	2.8	55.6	111.5	-55.9
2772.0	99.0	1.0	4.8	30.0	3.1	37.9	63.5	-25.6
3696.0	99.0	1.0	8.0	32.1	4.0	44.1	63.5	-19.4
4620.0	99.0	1.0	6.6	32.4	4.2	43.2	63.5	-20.3
5544.0	99.0	1.0	3.3	33.4	5.0	41.7	111.5	-69.8
6468.0	99.0	1.0	14.3	34.8	3.6	52.7	111.5	-58.8
7392.0	99.0	1.0	11.1	35.2	4.5	50.8	63.5	-12.7
8316.0	99.0	1.0	11.2	37.2	4.5	52.9	63.5	-10.6
9240.0	99.0	1.0	11.7	37.1	4.4	53.2	111.5	-58.3

Corrected Level = Recorded Level + Antenna Factor + Cable Loss

COMMENT #1: All measurements below 1 GHz performed at 3 meters. All others performed at 1 meter. Limits adjusted accordingly.

COMMENT #2: All measurements above 1 GHz are detection system noise floor.

TEST ENGINEER: _____ APPROVED BY: _____
 John O'Brien Jeffery Lenk

Radiated Out-of-Band Emissions Data Sheet**INVOCON, Inc.
Remote Data Gathering Unit (RDGU)**

SERIAL #: 03
 DATE: July 8, 1998
 PROJECT #: 99-068

MEASUREMENT DISTANCE (m): 3 (1)
 ANTENNA POLARIZATION: Horizontal
 DETECTOR FUNCTION: Quasi-Peak

Freq. (MHz)	EUT Dir. (Deg.)	Antenna Elevation Meters	Recorded Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
924.0	99.0	1.0	81.1	23.0	2.0	106.1	Ref	Ref
1848.0	99.0	1.0	29.3	25.9	2.8	58.0	111.5	-53.5
2772.0	99.0	1.0	28.5	30.0	3.1	61.6	63.5	-1.9
3696.0	99.0	1.0	7.5	32.1	4.0	43.6	63.5	-19.9
4620.0	99.0	1.0	5.4	32.4	4.2	42.0	63.5	-21.5
5544.0	99.0	1.0	6.8	33.4	5.0	45.2	111.5	-66.3
6468.0	99.0	1.0	12.2	34.8	3.6	50.6	111.5	-60.9
7392.0	99.0	1.0	9.3	35.2	4.5	49.0	63.5	-14.5
8316.0	99.0	1.0	11.8	37.2	4.5	53.5	63.5	-10.0
9240.0	99.0	1.0	10.6	37.1	4.4	52.1	111.5	-59.4

$$\text{Corrected Level} = \text{Recorded Level} + \text{Antenna Factor} + \text{Cable Loss}$$

COMMENT #1: All measurements below 1 GHz performed at 3 meters. All others performed at 1 meter. Limits adjusted accordingly. 15.247 Limit based on fundamental measured in vertical polarization (highest of the two fundamental measurements).

COMMENT #2: All measurements above 1 GHz are detection system noise floor.

TEST ENGINEER: _____ APPROVED BY: _____
 John O'Brien Jeffery Lenk

Appendix F

Conducted Emissions Test Data

FCC Part 15.207 Conducted Data Sheet**INVOCON, Inc.
Remote Data Gathering Unit (RDGU)**

SERIAL #: 03

DATE: July 16, 1998

DETECTOR FUNCTION: Quasi-Peak

LINE MEASURED: Neutral

PROJECT #: 99-068

Frequency Measured (MHz)	Recorded Level (dBuV)	Cable Loss (dB)	LISN Factor (dB)	Corrected Level (dBuV)	Limit Quasi-Peak (dBuV)	Margin (dB)
0.53	34.5	0.1	1.1	35.7	48.0	-12.3
0.657	35.6	0.1	1.1	36.8	48.0	-11.2
0.70	35.3	0.1	1.1	36.5	48.0	-11.5
15.91	16.0	0.7	1.8	18.5	48.0	-29.5
22.84	19.4	0.9	2.4	22.7	48.0	-25.3
29.29	20.5	1.0	3.2	24.7	48.0	-23.3

COMMENT #1: 120VAC/60Hz; Transmit mode

COMMENT #2:

TEST ENGINEER: _____ APPROVED BY: _____
 John O'Brien Jeffery Lenk

FCC Part 15.207 Conducted Data Sheet**INVOCON, Inc.
Remote Data Gathering Unit (RDGU)**

SERIAL #: 03

DATE: July 16, 1998

DETECTOR FUNCTION: Quasi-Peak

LINE MEASURED: Phase

PROJECT #: 99-068

Frequency Measured (MHz)	Recorded Level (dBuV)	Cable Loss (dB)	LISN Factor (dB)	Corrected Level (dBuV)	Limit Quasi-Peak (dBuV)	Margin (dB)
0.68	20.4	0.1	1.1	21.6	48.0	-26.4
0.760	34.7	0.1	1.1	35.9	48.0	-12.1
0.83	32.9	0.1	1.1	34.1	48.0	-13.9
15.79	20.9	0.7	2.1	23.7	48.0	-24.3
22.95	19.4	0.9	3.2	23.5	48.0	-24.5
29.89	19.9	1.0	4.4	25.3	48.0	-22.7

COMMENT #1: 120VAC/60Hz; Transmit mode

COMMENT #2:

TEST ENGINEER: _____ **APPROVED BY:** _____
 John O'Brien Jeffery Lenk

Appendix G

Frequency Stability Test Data

Frequency Stability vs. AC Power Supply Voltage Data Sheet**INVOCON, Inc.
Remote Data Gathering Unit (RDGU)**PROJECT #: 99-068
DATE: May 22, 1998
\\

SERIAL #: SN 03

AC Line Voltage (V)	Center Frequency (MHz)	Power Level (dBm)	Frequency Deviation (kHz)
100	923.765	13.55	-235.0
105	923.770	13.26	-230.0
110	923.775	12.16	-225.0
115	923.770	13.97	-230.0
120	923.765	14.00	-235.0
125	923.765	13.78	-235.0
130	923.770	13.76	-230.0
135	923.765	13.48	-235.0
140	923.765	14.19	-235.0

COMMENT #1: Nominal line voltage: 120 VAC per manufacturer

TEST ENGINEER: _____ APPROVED BY: _____
 John O'Brien Jeffery Lenk

Appendix H

Maximum Permissible Exposure Test Data

Maximum Permissible Exposure Data Sheet**INVOCON, Inc.
Remote Data Gathering Unit (RDGU)**PROJECT #: 99-068
DATE: July 13, 1998

SERIAL #: SN 03

Orientation (Degrees)	Maximum Field Level (V/m)	Limit (V/M)	Margin
0.0	3.20	47.7	-44.50
45.0	3.40	47.7	-44.30
90.0	3.60	47.7	-44.1
135.0	2.90	47.7	-44.8
180.0	2.88	47.7	-44.82
215.0	2.96	47.7	-44.74
270.0	31.00	47.7	-16.70
315.0	3.14	47.7	-44.56

COMMENT #1: Probe Height = 10 cm Height determined as being worst case during an initial survey of the device prior to formal testing.

COMMENT #2: Limit derivation described in body of report

COMMENT #3: Channel Setting = 7

COMMENT #4 All measurements made with the probe centered 20 cm from the antenna of the device. Measurements made at 135 through 315 degrees were made with the probe near or over the main metal case of the EUT.

TEST ENGINEER: _____ **APPROVED BY:** _____
 John O'Brien Jeffery Lenk