APREL Laboratories

Certification Report on

Maximum Permissible Exposure Evaluation with Respect to FCC Rule Part 47CFR §2.1091

Research in Motion Ltd.

R902M-2-O Radio Modem and 3dBd Larsen NMO 3E 900B SMA Antenna

Date: 25 March, 1999

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CERTIFICATION REPORT

Subject: Maximum Permissible Exposure Evaluation with Respect to FCC Rule Part 47CFR §2.1091

Product: OEM Radio-Modem with 3dBd Vehicle-Top Mounting Antenna

FCC ID #: L6AR902M-2-O

Model: R902M-2-O Radio-Modem and NMO 3E 900B SMA Antenna

Client: Research in Motion Limited

Address: 295 Phillip Street
Waterloo, Ontario
Canada, N2L 3W8

Project #: RIMB- R902M2O Larsen NMO 3E 900B SMA -3167

Prepared by: APREL Laboratories
51 Spectrum Way
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Submitted by ____________ Date: 25 Mar 99
Dr. Paul G. Cardinal
Director, Laboratories

Approved by ____________ Date: 25 Mar 99
Dr. Jacek J. Wojcik, P. Eng.

REGISTERED PROFESSIONAL ENGINEER
J. J. Wojcik
PROVINCE OF ONTARIO

FCC ID: L6AR902M-2-O
Client : Research in Motion Limited
Equipment : OEM Radio-Modem attached to a Larsen Vehicle-Top Mounting Antenna
Part No. : R902M-2-O Radio-Modem and NMO 3E 900B SMA Antenna
Serial No. : Pre-production sample

ENGINEERING SUMMARY

This report contains the results of the maximum permissible exposure (MPE) evaluation performed on the equipment under test (EUT) which was comprised of a Research in Motion R902M-2-O OEM radio-modem, an IBM 760ED ThinkPad laptop, attached to a Larsen Vehicle-Top Mounting Antenna. The tests were carried out in accordance with the applicable requirements of FCC rules found in 47CFR §2.1091 and the standards ANSI/IEEE C95.1-1992 and C95.3-1992.

The methodology and results for the test are described in the appropriate section of this report.

The EUT will not exceed the MPE requirements beyond a distance of 23 cm for 896 - 901MHz band.

TABLE OF CONTENTS

1. ACRONYMS

EUT	Equipment Under Test
FCC	Federal Communications Commission
MPE	Maximum Permissible Exposure
N/A	Not Applicable
NTS	Not To Scale
OATS	Open Area Test Site
OEM	Original Equipment Manufacturer
QA	Quality Assurance
RIM	Research in Motion

2. INTRODUCTION

2.1. GENERAL

This report describes the Maximum Permissible Exposure (MPE) tests for a Research in Motion R902M-2-O OEM radio-modem, an IBM 760ED ThinkPad laptop, and a Larsen NMO 3E 900B vehicle-top mounted 3dBd antenna, the combination hereinafter called the EUT (Equipment Under Test).

2.2. SCOPE

MPE evaluation was performed on the EUT in accordance with the requirements of the FCC rules for RF compliance found in 47CFR §2.1091 and the standard ANSI/IEEE C95.3-1992, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave. This Engineering Report contains the following:

- Methodology as to how the tests were performed.
- Test results and analysis.
- Identification of the test equipment used for the testing.
- Test set-up diagram.

2.3. SCHEDULE

The MPE tests were completed on 12^{th} March, 1999.

2.4. APPLICABLE DOCUMENTS

FCC Rule Part 47CFR §2.1091

ANSI/IEEE C95.1-1992, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300GHz.

ANSI/IEEE C95.3-1992, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave.

OET Bulletin 65 (Edition 97-01), Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields.

3. TEST SAMPLE

The MPE tests described in this procedure was performed on:

- Research in Motion Model R902M-2-O OEM radio-modem (see specification sheets in Appendix A and figure 3.1
- IBM ThinkPad Laptop Model 760ED, FCC ID ANOGCF2704AT, Type 9546-U9A, S/N 78-ACPW2 97/02
- Larsen Model NMO 3E 900 B SMA 3dBd Superflex enclosed coil vehicle-mounted antenna (see specification sheets in Appendix B)

Figure 3.1 Photograph of R902M-2-O OEM Radio Modem

4. GENERAL REQUIREMENTS

4.1. LOCATION OF TEST FACILITIES

The tests were performed by APREL Laboratories at APREL's test facility located in Nepean, Ontario, Canada. The laboratory operates a 3 and 10 meter Open Area Test Site (OATS) measurement facility. The test site is calibrated to ANSI C63.4-1992.

A description of the measurement facility in accordance with the radiated and AC line conducted test site criteria in ANSI C63.4-1992 is on file with the Federal Communications Commission and is in compliance with the requirements of Section 2.948 of the Commissions rules and regulations. APREL's registration number is 31070/SIT(1300F2).

APREL is accredited by Standard Council of Canada, under the PALCAN program (ISO Guide 25). All equipment used is calibrated or verified in accordance with the intent of AQAP-6/MIL-STD-45662. APREL is also accredited by Industry Canada (formerly DOC) and recognised by the Federal Communications Commission (FCC).

4.2. PERSONNEL

Radiation Hazard technical staff member, Heike Wuenschmann, carried out all MPE tests.

4.3. FAILURE CRITERIA

The equipment under test was considered to have failed if any of the following occurred:

When the MPE limits exceeded those permitted by appropriate limits defined by the FCC.

4.4. POWER SOURCE REQUIRED

The following nominal DC Power was maintained during the test:

Voltage: 4.4 VDC (12 VDC cell with a voltage regulator)

4.5. TOLERANCE

The following tolerances on test conditions, exclusive of equipment accuracy, were maintained:

Voltage: ± 1%

5. TEST INSTRUMENTATION & CALIBRATION

5.1. GENERAL

APREL Laboratories, located in Nepean, Ontario is equipped with the necessary instrumentation to ensure accurate measurement of all data recorded during the tests outlined in this document. To ensure continued accuracy, each instrument is re-calibrated at intervals established by APREL and based on standards traceable to the National and International Standards. Accuracy surveillance is a function of APREL Quality Assurance.

5.2. MPE TEST EQUIPMENT REQUIRED

The test equipment required to perform the MPE testing was selected from the equipment available at APREL.

5.3. CALIBRATION REQUIREMENTS

All test equipment instrumentation required for MPE qualification testing was calibrated and controlled.

6. ELECTRICAL/MECHANICAL DESCRIPTION

The MPE Test Program was performed on one OEM radio-modem attached to an IBM ThinkPad laptop computer and a Larsen vehicle-top mounting antenna, the combination hereinafter called the EUT. The test sample consisted of the components supplied by the customer and described below.

6.1. TEST UNIT DESCRIPTION

The two watt R902M-2-O OEM radio-modem transceiver equipped with a Larsen 3dBd Superflex enclosed coil antenna and controlled by an IBM ThinkPad laptop computer, consisted of the following components:

Part Number	Description
R902M-2-O	RIM OEM radio-modem
PCB-02120-001-Rev.A	RIM interface board (ITB)
SRB01519/9743D59235	RIM execution lock
760ED Think Pad	IBM Laptop computer
NMO 3E 900 B SMA	Larsen 3 dBd Superflex enclosed coil
0820-0004	6 Gates 2 V 25 AH BC DC cells
VR 4.4	APREL 4.4 VDC voltage regulator

6.2. MPE TEST SETUP

The EUT antenna shall be installed in the centre of a ground plane simulating the rooftop of a vehicle. The other components shall be located underneath this ground plane to simulate operation from inside of the vehicle (see Figures 6.2.1 and 6.2.2).

The vehicle simulator shall be positioned on the turntable in the OATS in such a way that the antenna will be located on the centre of rotation.

The EUT shall be connected to the 4.4 VDC power supply.

For the selection and placement of the measuring probe, the requirements of ANSI/IEEE C95.3-1992 shall be met.

Figure 6.2.1. Photograph of the Setup.

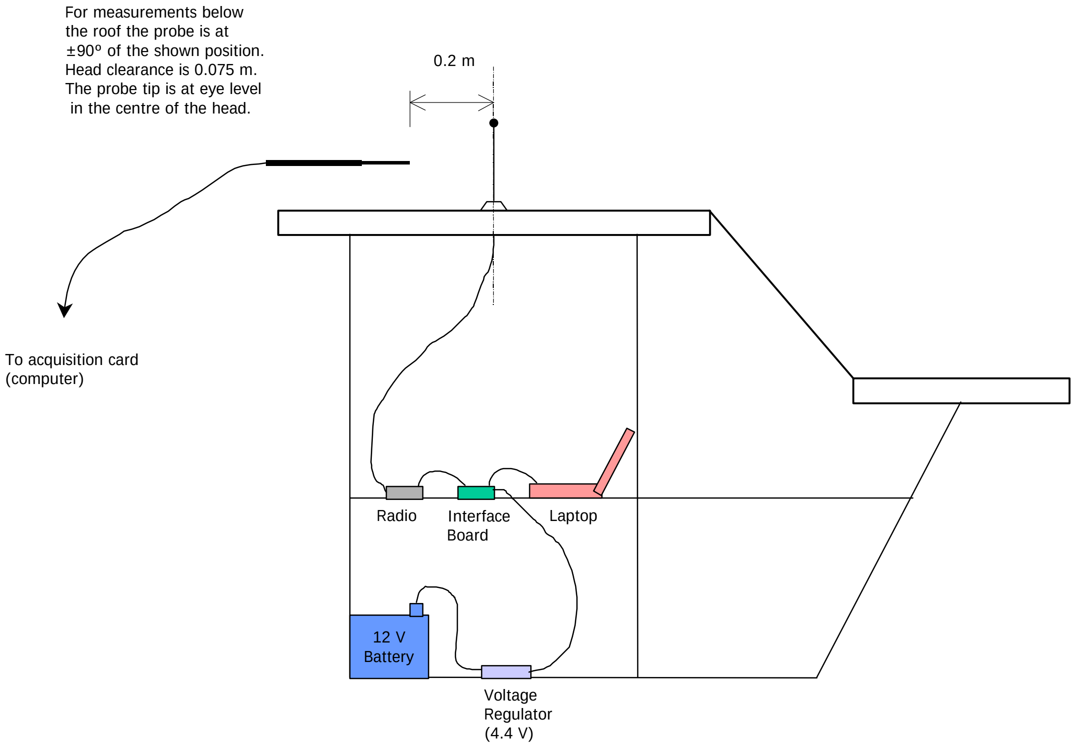


Figure 6.2.2. Elevation View of the Setup.

7. MAXIMUM PERMISSIBLE EXPOSURE (MPE) TEST

7.1. PURPOSE

This test method is used to verify that the EUT meets the MPE requirements as defined in the criteria for general population/uncontrolled exposure when operating at maximum power levels and in all operating modes.

7.2. TEST EQUIPMENT

Description	Manufacturer	Model No.
E-Field Probe	Narda	8021B

7.3. CRITERIA

Power Density Limits – The EUT shall not generate a power density beyond the limits in the frequency band listed in the left hand column of Table 7.3.1, and the power density given in the right hand column. The power density shall be measured 20 cm from the radiating antenna axis above the vehicle-top simulating ground plane, as well as in the approximate location of the head of possible vehicle drivers or passengers below the ground plane (see Figure 7.3.1). The measured values shall be recorded.

Table 7.3.1

Power Density Limits
for General Population/Uncontrolled Exposure

Frequency Range	**Power Density (mW/cm^2)**
300 - 1500 MHz	f/1500

Note: f = frequency in MHz

The measurements shall be performed at one transmitting frequency, the highest of the high, middle or low channels, with the EUT operating at the full rated output power.

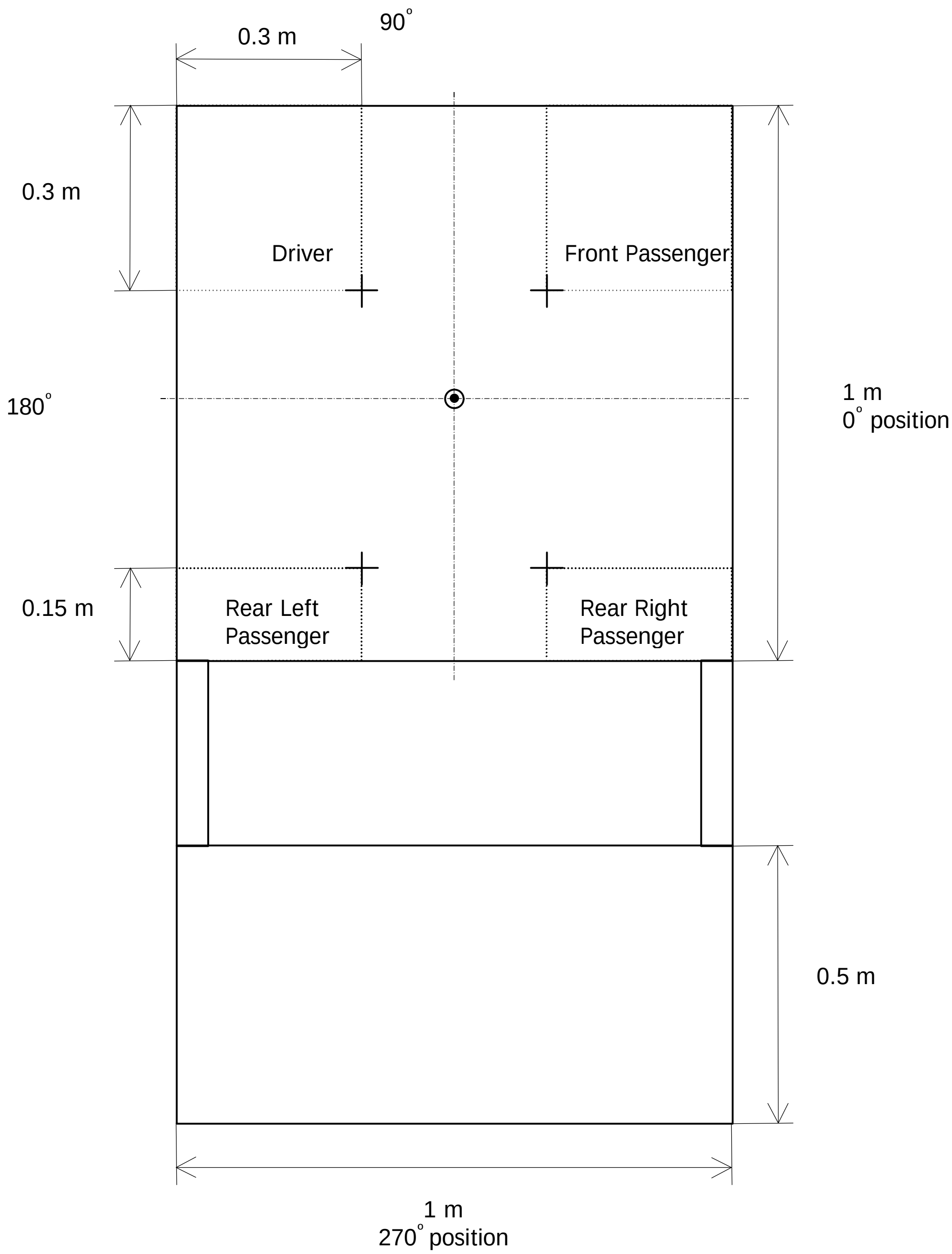


Figure 7.3.1. Plan View of Vehicle Simulator and Setup.

7.4. TEST PROCEDURE

a) The probe shall be positioned close to, and parallel to, the vehicle rooftop simulation with its tip 20 cm from the radiating antenna, and its axis normal to the antenna.

b) Rotate the turntable so that the probe is at the 0° position (see Figure 7.3.1).

c) Turn on the EUT and allow sufficient time for stabilisation. Turn on the transmitter and simulate normal operation conditions. Operate the transmitter at full rated output power.

d) Determine the location of the maximum power density: locate the maximum emissions by scanning vertically along the EUT's antenna. Take and record measurements of the power density at a number of points along the length of the antenna as well as just past its tip.

e) At every 45° of rotation take and record a measurement of the power density near the maximum power density height and for at least the following locations (as appropriate):

- half the maximum power density height
- height halfway between the maximum power density height and the tip of the radiating antenna
- just above the tip of the antenna

f) Turn off the EUT.

g) Position the probe under the vehicle rooftop simulating ground plane in the approximate location of the centre of the head of a potential driver of the simulated vehicle (see Figures 6.2.2 and 7.3.1).

h) Turn on the EUT and allow a sufficient time for stabilisation. Turn on the transmitter and simulate normal operation conditions. Operate the transmitter at full rated output power.

i) Take and record the measurement of the power density at this location.

j) Turn off the EUT.

k) Repeat steps g) through j) for the positions of the other potential occupants of the simulated vehicle as shown in Figure 7.3.1.

7.5. RESULTS

Table 7.5.1 presents the results of the measurements made along the length of the antenna in order to find the location of the maximum power density (the Larsen NMO 3E 900B antenna has a height of 31 cm). Column 1 shows the height at which the measurements were taken and column 2 shows the result ("total" indicates that this is the sum of the power density measured by each of the three orthogonal sensors in the probe). The cable loss associated with the supplied 17ft Belden 8240 cable was adjusted to the nominal loss for a 6 foot length. Column 3 indicates the correction for the excess cable loss (11ft × 0.16 dB/ft) that was applied to measured power density (column 2) to obtain the final adjusted power density.

The data in Table 7.5.1 is presented in Figure 7.5.1.

Figure 7.5.1

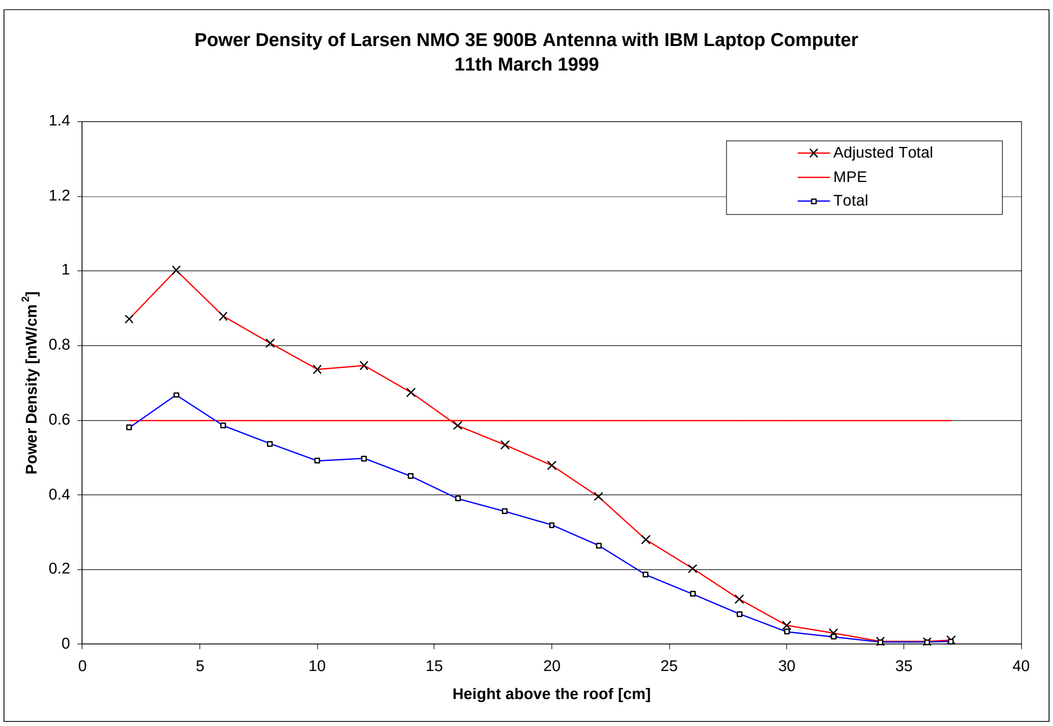


Table 7.5.1

Power Density Measured
at 0° as a Function of Height

Height	Total	Excess cable loss	Adjusted total	MPE
[cm]	[mW/cm^2]	[dB]	[mW/cm^2]	[mW/cm^2]
2	0.58	1.76	0.87	0.6
4	0.67	1.76	1.00	0.6
6	0.59	1.76	0.88	0.6
8	0.54	1.76	0.81	0.6
10	0.49	1.76	0.74	0.6
12	0.50	1.76	0.75	0.6
14	0.45	1.76	0.67	0.6
16	0.39	1.76	0.59	0.6
18	0.36	1.76	0.53	0.6
20	0.32	1.76	0.48	0.6
22	0.26	1.76	0.40	0.6
24	0.19	1.76	0.28	0.6
26	0.13	1.76	0.20	0.6
28	0.08	1.76	0.12	0.6
30	0.03	1.76	0.05	0.6
32	0.02	1.76	0.03	0.6
34	0.01	1.76	0.01	0.6
36	0.00	1.76	0.01	0.6
37	0.01	1.76	0.01	0.6

Table 7.5.2 presents the results of the measurements made around the antenna at every 45° of rotation. Column 1 shows the angle at which the measurements were taken and columns 2 through 5 show the final adjusted power density at the different measurement heights. The measured exposure level is determined by averaging the adjusted total power density along a vertical line up to the height of a tall typical individual, taken here as 6ft or 180cm. Since the height for the rooftop of the simulated vehicle is 143cm, then the averaging is over those measurements made between 0 and 37cm above the simulated vehicle rooftop. Column 6 shows the results of this averaging.

Table 7.5.2

Power Density Measured
at every 45° as a Function of Height

						Averaged Values of 0 to 37 cm
Degree	H1 [cm]	H2 [cm]	H3 [cm]	H4 [cm]	MPE	
[°]	2	12	24	37	[mW/cm^2]	
0	0.8709	0.7459	0.2799	0.0109	0.6	0.4769
45	1.1436	0.8257	0.1759	0.0099	0.6	0.5388
90	0.7546	0.5960	0.2588	0.0045	0.6	0.4035
135	0.9114	0.7931	0.3289	0.0285	0.6	0.5155
180	1.0954	1.0129	0.3254	0.0228	0.6	0.6141
225	1.1468	0.7456	0.2438	0.0489	0.6	0.5463
270	1.0014	0.8939	0.4841	0.3462	0.6	0.6814
315	1.1072	0.8162	0.3047	0.0161	0.6	0.5611
360	0.8709	0.7459	0.2799	0.0109	0.6	0.4769

The data in Table 7.5.2 is presented in Figure 7.5.2.

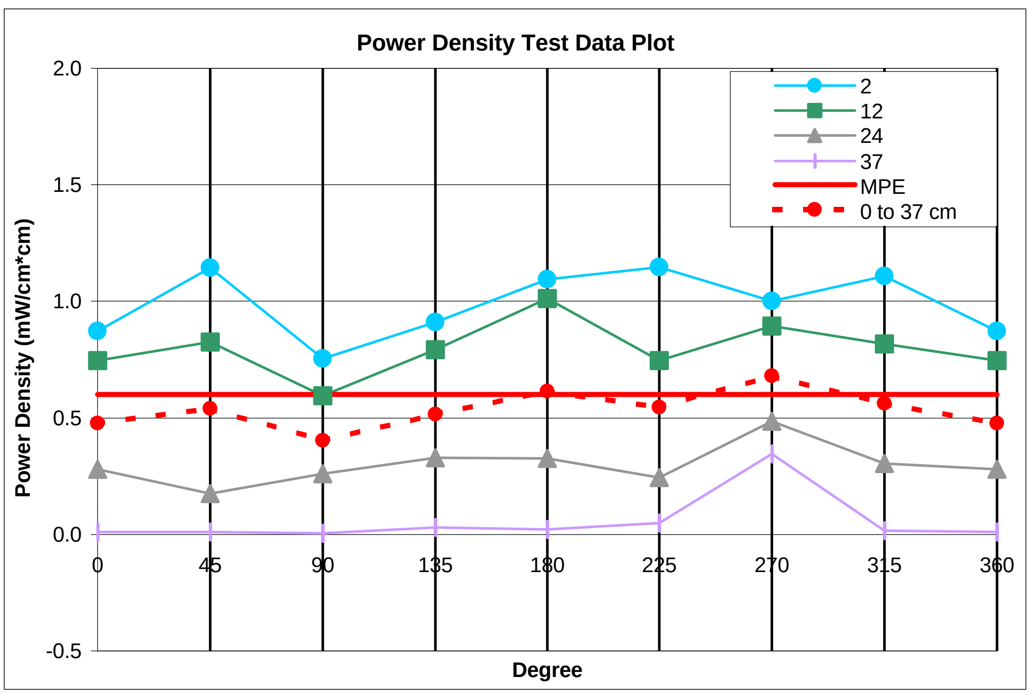


Figure 7.5.2.

Measurements were made below the simulated vehicle rooftop, in the approximate location of the centre of the head of potential occupants. It was assumed that this typical position occurred 17.5cm below the roof of the simulated vehicle (the clearance between the top of an occupant's head and a vehicle's roof is ~3" (7.5cm) and distance between the top of the head and the eyes is ~4" (10cm)). Figure 7.3.1 shows the location of measurements for the four potential occupants. Table 7.5.3 presents the results of the measurements. Column 1 shows the position at which the measurements were taken and column 2 shows the result ("total" indicates that this is the sum of the power density measured by each of the three orthogonal sensors in the probe). The cable loss associated with the supplied 17ft Belden 8240 cable was adjusted to the nominal loss for a 6 foot length. Column 3 indicates the correction for the excess cable loss (11ft × 0.16 dB/ft) that was applied to the measured power density (column 2) to obtain the final adjusted power density (column 4).

Table 7.5.3

Power Density Measured
at Position of Potential Vehicle Occupants

Position	Total	Excess cable loss	Adjusted Total	MPE Limit
	[mW/cm^2]	[dB]	[mW/cm^2]	[mW/cm^2]
driver	0.06	1.76	0.09	0.6
front passenger	0.22	1.76	0.33	0.6
rear left	0.05	1.76	0.07	0.6
rear right	0.00	1.76	0.01	0.6

7.6. DISCUSSION

The maximum exposure determined for this EUT was 0.68 mW/cm^2 at a distance of 20 cm from the antenna. The MPE in this band (896 - 901 MHz) is 0.6mW/cm^2. These measurements were performed with the maximum duty cycle of 100 % and a maximum power at 2 W (33 dBm). RIM has found that due to the 0.5 dB tolerance in the calibration tool the radio modem could have an absolute maximum power of 2.25 W (33.5 dBm). It was determined by proportional scaling that the maximum power exposure level at 20 cm would be 0.76 mW/cm^2.

Since the power density will decrease in proportion to the square of the distance from the antenna then the EUT will meet the MPE limit at distances greater than 22.6 cm from the antenna.

8. CONCLUSION

The EUT consisting of a Research in Motion R902M-2-O OEM radio-modem, an IBM 760ED ThinkPad laptop, and a Larsen NMO 3E 900B antenna will not exceed the MPE requirements for the 896 – 901 MHz band provided that the antenna is installed at least 23 cm from any edge of a vehicle rooftop. This can be accomplished by putting a prominent warning in the equipment manual as to how the antenna should be installed.

APPENDIX A

Transmitter Specifications

RIM 902M
OEM radio-modem for Mobitex

High Performance for OEMs

The RIM 902M radio-modem is a high-performance digital RF transceiver designed for system integration by original equipment manufacturers. Operating in the 900 MHz frequency range, the RIM 902M is compatible with Mobitex wide-area wireless data communication networks.

Providing high tolerance to noise generated by nearby microprocessors, the RIM 902M is ideal for integration into Mobitex terminals and embedded applications, including compact devices with minimal shielding or physical separation of the terminal unit and the radio-modem. Typical applications include:

- Hand-held terminals
- Laptop Computers
- Telemetry
- Automatic Vehicle Location/Transport
- POS/ATM
- Alarming
- Vending Machines

Efficient Power Management
Power consumption is a critical issue for mobile products because end-users want long-lasting devices without heavy battery packs. The RIM 902M sets new power consumption standards for OEM-style radio-modems by reducing stand-by power consumption to only 0.2 mA, and transmit power to as low as 600 mA.

Small and Lightweight
Based on a single-board design, the RIM 902M has a footprint significantly smaller then a business card. Uncommonly thin and lightweight, the RIM 902M is ideal for hand-held computers and installation in existing equipment enclosures.

Powerful and Efficient Transmitter
The RIM 902M transmitter can supply a full 2 Watts to the antenna, enhancing in-building and fringe-area use. When close to a network base-station, the RIM 902M conserves battery power by quickly decreasing output power to as little as 62 mW. The RIM 902M extends battery life, providing consistent transmitting performance efficiency throughout its range of operational voltage.

Noise Immunity
The RIM 902M includes ground-breaking technology that minimizes interference from RF noise generated by nearby electronics. Noise immunity significantly extends battery life, increases message exchange reliability, and will increase the effective range of operation of the RIM 902M compared to other radio-modems. And since the RIM 902M is not de-sensitized by RF noise emitted by nearby electronics, it is ideal for integration into products such as handheld terminals where shielding or physical separation is not possible.

Powerful Software Tools
The RIM 902M includes two link-level serial interface protocols: Radio Access Protocol (RAP) and MASC. RAP is significantly more efficient than the older MASC protocol and is specifically designed for embedded-system applications. RAP dramatically shortens the time needed to develop a wireless solution because a RAP interface will typically only require about 1-3 Kbytes compared to 10-50 Kbytes for a comparable MASC implementation. This reduced code footprint makes software maintenance easier and eliminates the need for a third-party API.

Set-up & Diagnostic Firmware
The RIM 902M firmware includes a simple-to-use utility that can display the Mobitex Access Number, RSSI level, battery status and various network and diagnostic parameters. Accessed with a standard PC-based terminal emulation program, this utility can be used to switch the RIM 902M between different Mobitex networks or "ping" the network to confirm the modem is fully operational on the network.

RIM 902M
OEM radio-modem for Mobitex

Developer's Kit
The RIM 902M Developer's Kit helps system designers and engineers start interfacing the RIM 902M OEM radio-modem to the target device in minutes.

The kit offers all of the following tools and accessories to begin using the RIM 902M:

- RIM 902M OEM radio-modem
- Magnetic-mount +3 dBd antenna
- Interface and Test Board including:
  - TTL-to-RS232 level conversion and FPC cable connector
  - DB-9 serial port for RS-232 connection to the host computer
  - Regulated power for the RIM 902M
  - LED indicators show when the RIM 902M is receiving power, transmitting, or exchanging data with the host
  - Test points for the 22-pin data cable
- Cables (data, power and antenna)
- Power supply (AC to DC)
- DB-9 to DB-9 straight through serial cable
- Protocol analyzer
- Hardware Integrator's Guide
- Programmer's Guide to RAP and MPAKs: *Protocols for Mobitex wireless communications*

Protocol Analyzer
The Developer's Kit includes a Mobitex-aware serial-line protocol analyzer which captures and interprets traffic between the RIM 902M and the terminal. MobiView is a powerful development tool that can significantly simplify application testing. Data capture and display options include raw or ASCII serial, MASC, network, or transport protocol interpreted.

Hardware Integrator's Guide
The Hardware Integrator's Guide includes helpful information about the RIM 902M, such as:

- Hardware design recommendations
- Suppliers of cables, connectors, and antennas
- Antenna matching guidelines
- Schematics for power supplies and RS-232 serial port interfaces
- Software development suggestions and tools.
- Detailed electrical and serial port specifications

Technical Specifications
Mechanical & environmental properties
- Weight: 36 g (1.26 oz.)
- Footprint: 42 x 67.5 mm (1.65" x 2.65")
- Thickness: 8.4 mm (0.3")
- Serial connector: 22 pin FPC connector
- MMCX Antenna cable connector
- Tested to IEC 68-2-6 Part 2 for vibration
- Operating temperature: -30°C to +70°C (at 5-95% relative humidity, non-condensing)
- Storage temperature: -40°C to +85°C
-

RF properties
- Transmit frequency: 896-902 MHz
- Transmit power range: 62 mW to 2.0 W at antenna port
- Transmitter can reduce output power by up to 15 dBm (to 62 mW) to balance radio link and conserve power
- Receive frequency: 935-941 MHz
- Receive sensitivity: -118 dBm
- 8000 bps 0.3 BT GMSK
- FCC Parts 15 & 90 (FCC Identifier: L6AR902M-2-O) pending
- Industry Canada RSS 119 (certification # pending)

Power supply & typical current usage
- Single power supply; operating range: 4.25 to 4.75 VDC
- Maximum off current consumption: 20µA
- Battery save stand-by mode: as low as 0.2 mA
- Receive / express stand-by mode: 66 mA
- Transmit mode: 1900 mA
- Average current usage: 22mA (based on 94% standby, 5% receive, 1% transmit)
-

Serial communications
- 3.0 V asynchronous serial port
- 7 bit with parity (MASC) or 8 with no parity (RAP)
- Link speed: 1200-9600 bps
- Link level protocols: Radio Access Protocol (RAP) and Mobitex Asynchronous Communications (MASC)
-

Other features
- Single line to turn radio on/off
- Software can activate radio
- Flow control options: Hardware, Xon/Xoff, or None
- Radio parameters stored at power down
- Terminal devices may power-down while radio-modem remains operational
- Certified by BellSouth Wireless Data to meet Mobitex Interface Specifications (MIS) including standard MIS features such as personal subscriptions, ESN verification, switching between different Mobitex networks, and frame and continuous modes.

APPENDIX B

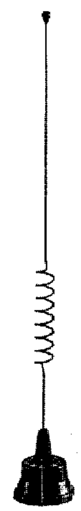
Antenna Specifications

NM03E900BSMA

NM03E900B / NMOKUDSMA
INSTALLED

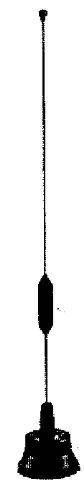
Date Manufactured:
09/20/96

Mobile Cellular, SMR, Data 800/900 MHz



3dB open coil antenna, standard NMO base

3dB open coil antenna, standard NMO base, heavy duty whip



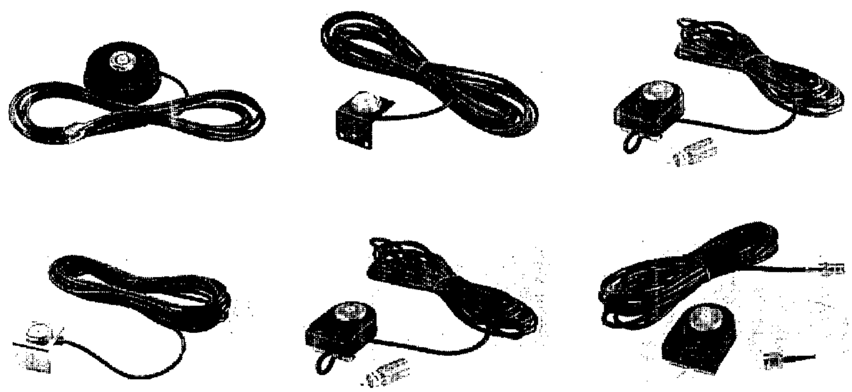
3dB SuperFlex enc. coil antenna, standard NMO base

MODEL	FREQUENCY
NMO 3 800 B	806-866 MHz
NMO 3 825 B	825-896 MHz
NMO 3 900 B	890-960 MHz
SPECIFICATIONS	
GAIN	3dB
TYPE	5/8 over 1/4 wave
VSWR	1.5:1 or less
COLOR	Black
WHIP	.070, open coil
COAX	Order separately
BASE SIZE	1 5/8"
POWER RATING	200 watts
MAX HEIGHT	13 3/4"

MODEL	FREQUENCY
NMO3HD800B	806-866 MHz
NMO3HD825B	824-896 MHz
NMO3HD900B	890-960 MHz
SPECIFICATIONS	
GAIN	3dB
TYPE	5/8 over 1/4 wave
VSWR	1.5:1 or less
COLOR	Black
WHIP	.100, open coil
COAX	Order separately
BASE SIZE	1 5/8"
POWER RATING	200 watts
MAX HEIGHT	13 3/4"

MODEL	FREQUENCY
NMO 3E 800 B	806-866 MHz
NMO 3E 825 B	825-896 MHz
NMO 3E 900 B	890-960 MHz
SPECIFICATIONS	
GAIN	3dB
TYPE	5/8 over 1/4 wave
VSWR	1.5:1 or less
COLOR	Black
WHIP	.070, enc. coil
COAX	Order separately
BASE SIZE	1 5/8"
POWER RATING	200 watts
MAX HEIGHT	13 1/2"

Mounts



MODEL	CONNECTOR
NMO MM R DS	None
NMO MM R DS FME	FME CRIMP (Installed)
NMO MM R DS MPL	MPL CRIMP
NMO MM R DS N	N CRIMP
NMO MM R DS PL	PL-259T
NMO MM R DS TNC	TNC CRIMP
SPECIFICATIONS	
SIZE	3 1/2" Round
TYPE	Motorola Style Round Mag Mount
COAX	12' RG-58A/U Dual Shield
PULL STRENGTH	90#

MODEL	CONNECTOR
NMO TMB DS	None
SPECIFICATIONS	
SIZE	1 3/4" x 1 3/4"
TYPE	Motorola Style Trunk Gutter Bracket, Chrome
COAX	17' RG-58A/U Dual Shield

MODEL	CONNECTOR
NMO TMB B	PL-259
SPECIFICATIONS	
SIZE	1 3/4" x 1 3/4"
TYPE	Motorola Style Trunk Gutter Bracket, Black
COAX	17' RG-58A/U

MODEL	CONNECTOR
NMO TLP	PL-259
SPECIFICATIONS	
SIZE	2 1/2" x 2"
TYPE	Motorola Style Trunk Lid Mount
COAX	17' RG-58A/U

MODEL	CONNECTOR
NMO TLP DS	None
SPECIFICATIONS	
SIZE	2 1/2" x 2"
TYPE	Motorola Style Trunk Lid Mount
COAX	17' RG-58A/U Dual Shield

MODEL	CONNECTOR
NMO TLP SC UD	None
SPECIFICATIONS	
SIZE	2 1/2" x 2"
TYPE	Motorola Style Trunk Lid Mount
COAX	1' RG174, 16' RG-58A/U Dual Shield

APREL Laboratories

Certification Report on

Maximum Permissible Exposure Evaluation with Respect to FCC Rule Part 47CFR §2.1091

Research in Motion Ltd.

R902M-2-O Radio Modem and 0dBd Austin 200160 500C Antenna

Date: 25 March, 1999

51 Spectrum Way Nepean ON K2R 1E6
Tel: (613) 820-2730 Fax: (613) 820-4161
email: info@aprel.com

CERTIFICATION REPORT

Subject: Maximum Permissible Exposure Evaluation with Respect to FCC Rule Part 47CFR §2.1091

Product: OEM Radio-Modem with 0dBd Austin Vehicle-Top Mounting Antenna

FCC ID #: L6AR902M-2-O

Model: R902M-2-O Radio-Modem and 200160 500C Flextop Mobile Motorola Mount Antenna

Client: Research in Motion Limited

Address: 295 Phillip Street
Waterloo, Ontario
Canada, N2L 3W8

Project #: RIMB- R902M2O Austin 500C-3168

Prepared by: APREL Laboratories
51 Spectrum Way
Nepean, Ontario
K2R 1E6

Submitted by Paul G Cardinal Date: 25 Mar 99
Dr. Paul G. Cardinal
Director, Laboratories

Approved by Date: 25 Mar 99
Dr. Jacek J. Wojcik, P. Eng.

REGISTERED PROFESSIONAL ENGINEER J. J. Wojcik PROVINCE OF ONTARIO

CERTIFICATION REPORT

Subject:	Maximum Permissible Exposure Evaluation with Respect to FCC Rule Part 47CFR §2.1091
Product:	OEM Radio-Modem with 0dBd Austin Vehicle-Top Mounting Antenna
FCC ID #:	L6AR902M-2-O
Model:	R902M-2-O Radio-Modem and 200160 500C Flextop Mobile Motorola Mount Antenna
Client:	Research in Motion Limited
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Prepared by: APREL Laboratories
51 Spectrum Way
Nepean, Ontario
K2R 1E6

Submitted by ______________________________ Date: __________________
Dr. Paul G. Cardinal
Director, Laboratories

Approved by ______________________________ Date: __________________
Dr. Jacek J. Wojcik, P. Eng.

FCC ID: L6AR902M-2-O
Client : Research in Motion Limited
Equipment : OEM Radio-Modem attached to a Austin Vehicle-Top Mounting Antenna
Part No. : R902M-2-O Radio-Modem and 200160 500C Flextop Mobile Motorola Mount Antenna
Serial No. : Pre-production Sample

ENGINEERING SUMMARY

This report contains the results of the maximum permissible exposure (MPE) evaluation performed on the equipment under test (EUT) which was comprised of a Research in Motion R902M-2-O OEM radio-modem, an IBM 760ED ThinkPad laptop, and an Austin Model 200160 500C Flextop mobile Motorola mount antenna. The tests were carried out in accordance with the applicable requirements of FCC rules found in 47CFR §2.1091 and the standards ANSI/IEEE C95.1-1992 and C95.3-1992.

The methodology and results for the test are described in the appropriate section of this report.

The EUT will not exceed the MPE requirements beyond 20 cm for the 896 - 901MHz band.

TABLE OF CONTENTS

1. ACRONYMS

EUT	Equipment Under Test
FCC	Federal Communications Commission
MPE	Maximum Permissible Exposure
N/A	Not Applicable
NTS	Not To Scale
OATS	Open Area Test Site
OEM	Original Equipment Manufacturer
QA	Quality Assurance
RIM	Research in Motion

2. INTRODUCTION

2.1. GENERAL

This report describes the Maximum Permissible Exposure (MPE) tests for a Research in Motion R902M-2-O OEM radio-modem, an IBM 760ED ThinkPad laptop, and an Austin Model 200160 500C Flextop mobile Motorola vehicle-top mounted 0dBd antenna, the combination hereinafter called the EUT (Equipment Under Test).

2.2. SCOPE

MPE evaluation was performed on the EUT in accordance with the requirements of the FCC rules for RF compliance found in 47CFR §2.1091 and the standard ANSI/IEEE C95.3-1992, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave. This Engineering Report contains the following:

- Methodology as to how the tests were performed.
- Test results and analysis.
- Identification of the test equipment used for the testing.
- Test set-up diagram.

2.3. SCHEDULE

The MPE tests were completed on 12th March, 1999.

2.4. APPLICABLE DOCUMENTS

FCC Rule Part 47CFR §2.1091

ANSI/IEEE C95.1-1992, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300GHz.

ANSI/IEEE C95.3-1992, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave.

OET Bulletin 65 (Edition 97-01), Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields.

3. TEST SAMPLE

The MPE tests described in this procedure was performed on:

- Research in Motion Model R902M-2-O OEM radio-modem (see specification sheets in Appendix A and figure 3.1
- IBM ThinkPad Laptop Model 760ED, FCC ID ANOGCF2704AT, Type 9546-U9A, S/N 78-ACPW2 97/02
- Austin Model 200160 500C Flextop mobile Motorola mount 0dBd antenna (see specification sheets in Appendix B)

Figure 3.1 Photograph of R902M-2-O OEM Radio Modem

4. GENERAL REQUIREMENTS

4.1. LOCATION OF TEST FACILITIES

The tests were performed by APREL Laboratories at APREL's test facility located in Nepean, Ontario, Canada. The laboratory operates a 3 and 10 meter Open Area Test Site (OATS) measurement facility. The test site is calibrated to ANSI C63.4-1992.

A description of the measurement facility in accordance with the radiated and AC line conducted test site criteria in ANSI C63.4-1992 is on file with the Federal Communications Commission and is in compliance with the requirements of Section 2.948 of the Commissions rules and regulations. APREL's registration number is 31070/SIT(1300F2).

APREL is accredited by Standard Council of Canada, under the PALCAN program (ISO Guide 25). All equipment used is calibrated or verified in accordance with the intent of AQAP-6/MIL-STD-45662. APREL is also accredited by Industry Canada (formerly DOC) and recognised by the Federal Communications Commission (FCC).

4.2. PERSONNEL

Radiation Hazard technical staff member, Heike Wuenschmann, carried out all MPE tests.

4.3. FAILURE CRITERIA

The equipment under test was considered to have failed if any of the following occurred:

When the MPE limits exceeded those permitted by appropriate limits defined by the FCC.

4.4. POWER SOURCE REQUIRED

The following nominal DC Power was maintained during the test:

Voltage: 4.4 VDC (12 VDC cell with a voltage regulator)

4.5. TOLERANCE

The following tolerances on test conditions, exclusive of equipment accuracy, were maintained:

Voltage: ± 1%

5. TEST INSTRUMENTATION & CALIBRATION

5.1. GENERAL

APREL Laboratories, located in Nepean, Ontario is equipped with the necessary instrumentation to ensure accurate measurement of all data recorded during the tests outlined in this document. To ensure continued accuracy, each instrument is re-calibrated at intervals established by APREL and based on standards traceable to the National and International Standards. Accuracy surveillance is a function of APREL Quality Assurance.

5.2. MPE TEST EQUIPMENT REQUIRED

The test equipment required to perform the MPE testing was selected from the equipment available at APREL.

5.3. CALIBRATION REQUIREMENTS

All test equipment instrumentation required for MPE qualification testing was calibrated and controlled.

6. ELECTRICAL/MECHANICAL DESCRIPTION

The MPE Test Program was performed on one OEM radio-modem attached to an IBM ThinkPad laptop computer and a Austin vehicle-top mounting antenna, the combination hereinafter called the EUT. The test sample consisted of the components supplied by the customer and described below.

6.1. TEST UNIT DESCRIPTION

The two watt R902M-2-O OEM radio-modem transceiver equipped with an Austin Model 200160 500C Flextop mobile Motorola vehicle-top mounted 0dBd antenna and controlled by an IBM ThinkPad laptop computer, consisted of the following components:

Part Number	**Description**
R902M-2-O	RIM OEM radio-modem
PCB-02120-001-Rev.A	RIM interface board (ITB)
SRB01519/9743D59235	RIM execution lock
760ED Think Pad	IBM Laptop computer
200160 500C	Austin 500C Flextop mobile Motorola mount 0dBd antenna
0820-0004	6 Gates 2 V 25 AH BC DC cells
VR 4.4	APREL 4.4 VDC voltage regulator

6.2. MPE TEST SETUP

The EUT antenna shall be installed in the centre of a ground plane simulating the rooftop of a vehicle. The other components shall be located underneath this ground plane to simulate operation from inside of the vehicle (see Figures 6.2.1 and 6.2.2).

The vehicle simulator shall be positioned on the turntable in the OATS in such a way that the antenna will be located on the centre of rotation.

The EUT shall be connected to the 4.4 VDC power supply.

For the selection and placement of the measuring probe, the requirements of ANSI/IEEE C95.3-1992 shall be met.

Figure 6.2.1. Photograph of the Setup.

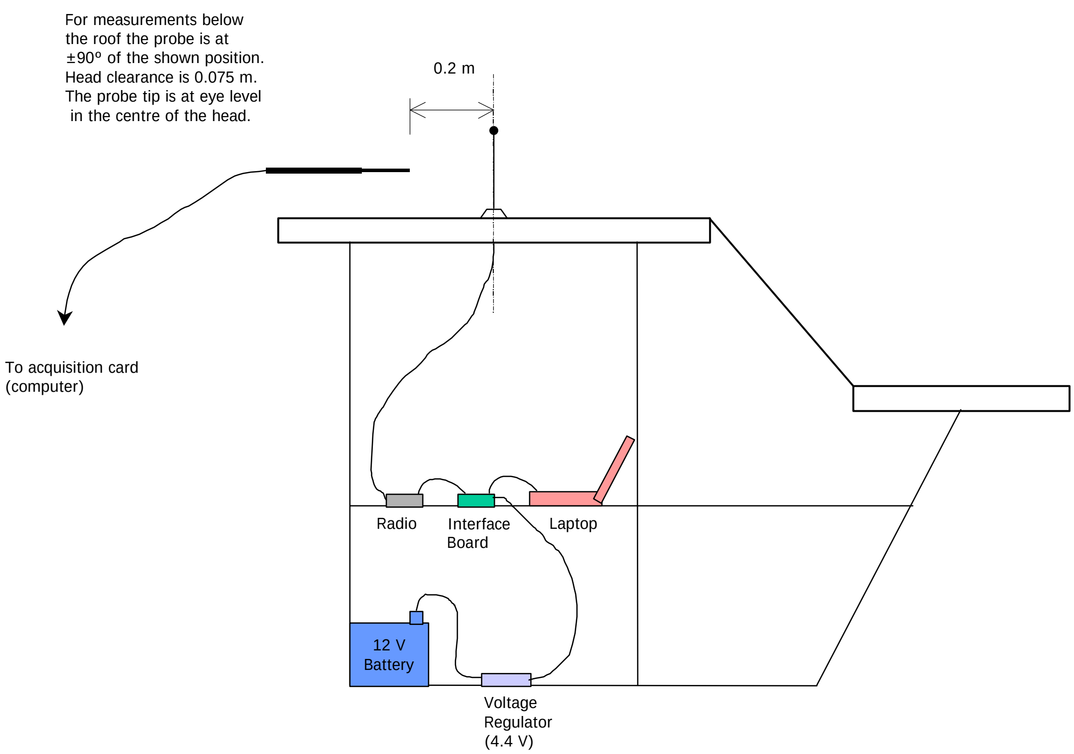


Figure 6.2.2. Elevation View of the Setup.

7. MAXIMUM PERMISSIBLE EXPOSURE (MPE) TEST

7.1. PURPOSE

This test method is used to verify that the EUT meets the MPE requirements as defined in the criteria for general population/uncontrolled exposure when operating at maximum power levels and in all operating modes.

7.2. TEST EQUIPMENT

Description	**Manufacturer**	**Model No.**
E-Field Probe	Narda	8021B

7.3. CRITERIA

Power Density Limits – The EUT shall not generate a power density beyond the limits in the frequency band listed in the left hand column of Table 7.3.1, and the power density given in the right hand column. The power density shall be measured 20 cm from the radiating antenna axis above the vehicle-top simulating ground plane, as well as in the approximate location of the head of possible vehicle drivers or passengers below the ground plane (see Figure 7.3.1). The measured values shall be recorded.

Table 7.3.1

Power Density Limits
for General Population/Uncontrolled Exposure

Frequency Range	**Power Density (mW/cm^2)**
300 - 1500 MHz	f/1500

Note: f = frequency in MHz

The measurements shall be performed at one transmitting frequency, the highest of the high, middle or low channels, with the EUT operating at the full rated output power.

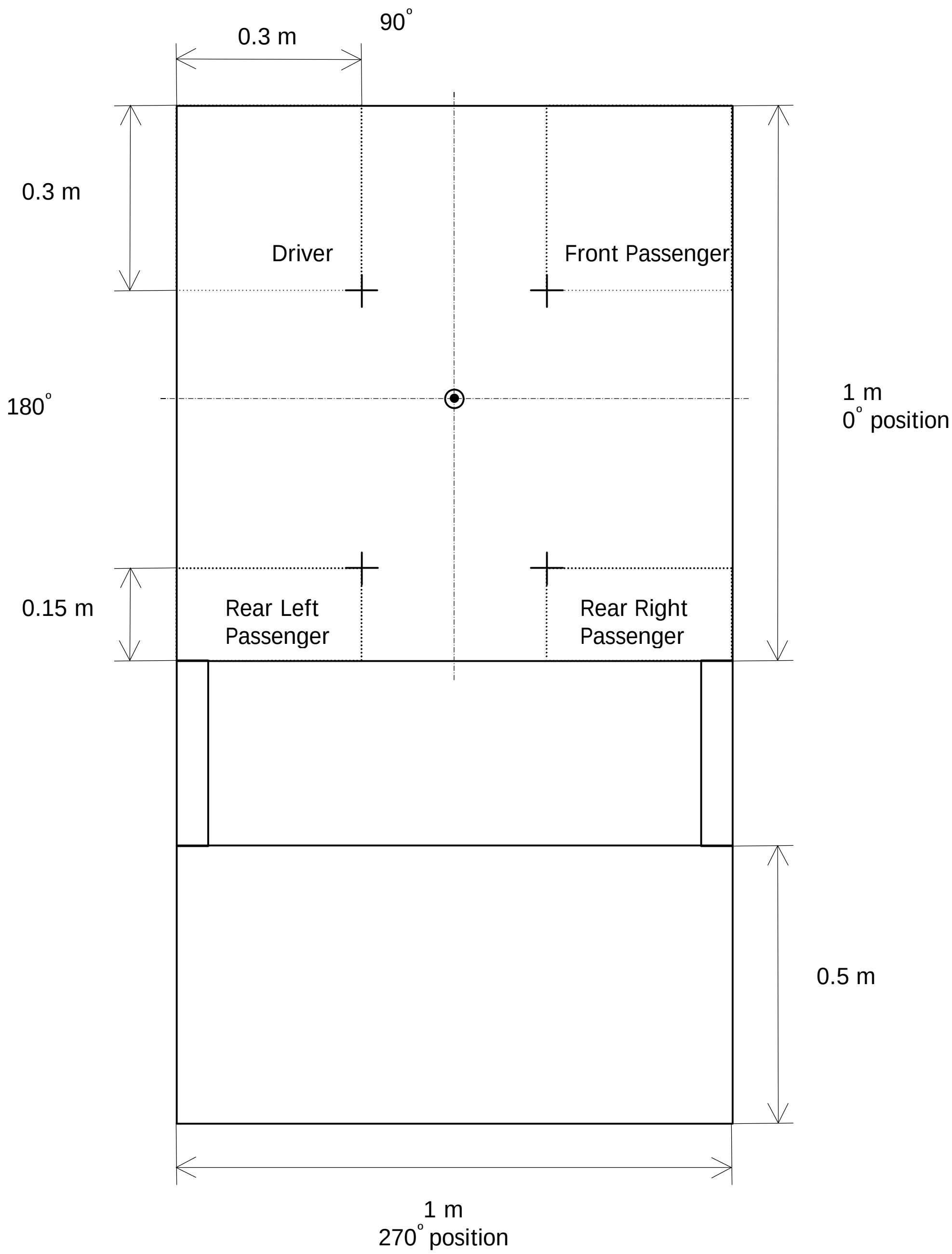


Figure 7.3.1. Plan View of Vehicle Simulator and Setup.

7.4. TEST PROCEDURE

a) The probe shall be positioned close to, and parallel to, the vehicle rooftop simulation with its tip 20 cm from the radiating antenna, and its axis normal to the antenna.

b) Rotate the turntable so that the probe is at the 0° position (see Figure 7.3.1).

c) Turn on the EUT and allow sufficient time for stabilisation. Turn on the transmitter and simulate normal operation conditions. Operate the transmitter at full rated output power.

d) Determine the location of the maximum power density: locate the maximum emissions by scanning vertically along the EUT's antenna. Take and record measurements of the power density at a number of points along the length of the antenna as well as just past its tip.

e) At every 45° of rotation take and record a measurement of the power density near the maximum power density height and for at least the following locations (as appropriate):

- half the maximum power density height
- height halfway between the maximum power density height and the tip of the radiating antenna
- just above the tip of the antenna

f) Turn off the EUT.

g) Position the probe under the vehicle rooftop simulating ground plane in the approximate location of the centre of the head of a potential driver of the simulated vehicle (see Figures 6.2.2 and 7.3.1).

h) Turn on the EUT and allow a sufficient time for stabilisation. Turn on the transmitter and simulate normal operation conditions. Operate the transmitter at full rated output power.

i) Take and record the measurement of the power density at this location.

j) Turn off the EUT.

k) Repeat steps g) through j) for the positions of the other potential occupants of the simulated vehicle as shown in Figure 7.3.1.

7.5. RESULTS

Table 7.5.1 presents the results of the measurements made along the length of the antenna in order to find the location of the maximum power density (Austin 500C Flextop mobile Motorola mount 0dBd antenna has a height of 29 cm). Column 1 shows the height at which the measurements were taken and column 2 shows the result ("total" indicates that this is the sum of the power density measured by each of the three orthogonal sensors in the probe). The cable loss associated with the supplied 17ft Belden 8240 cable was adjusted to the nominal loss for a 6 foot length. Column 3 indicates the correction for the excess cable loss (11ft × 0.16 dB/ft) that was applied to measured power density (column 2) to obtain the final adjusted power density.

The data in Table 7.5.1 is presented in Figure 7.5.1.

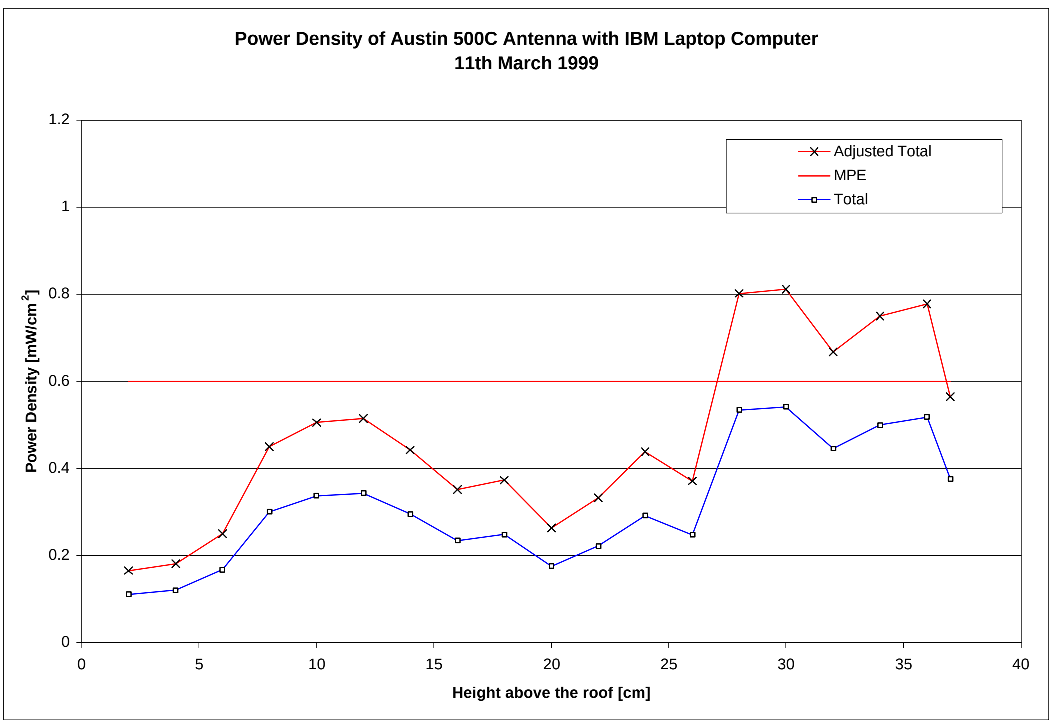


Figure 7.5.1

Table 7.5.1

Power Density Measured
at 0° as a Function of Height

Height	Total	Excess cable loss	Adjusted total	MPE
[cm]	[mW/cm²]	[dB]	[mW/cm²]	[mW/cm²]
2	0.11	1.76	0.17	0.6
4	0.12	1.76	0.18	0.6
6	0.17	1.76	0.25	0.6
8	0.30	1.76	0.45	0.6
10	0.34	1.76	0.51	0.6
12	0.34	1.76	0.52	0.6
14	0.30	1.76	0.44	0.6
16	0.23	1.76	0.35	0.6
18	0.25	1.76	0.37	0.6
20	0.18	1.76	0.26	0.6
22	0.22	1.76	0.33	0.6
24	0.29	1.76	0.44	0.6
26	0.25	1.76	0.37	0.6
28	0.53	1.76	0.80	0.6
30	0.54	1.76	0.81	0.6
32	0.45	1.76	0.67	0.6
34	0.50	1.76	0.75	0.6
36	0.52	1.76	0.78	0.6
37	0.38	1.76	0.56	0.6

Table 7.5.2 presents the results of the measurements made around the antenna at every 45° of rotation. Column 1 shows the angle at which the measurements were taken and columns 2 through 5 show the final adjusted power density at the different measurement heights. The measured exposure level is determined by averaging the adjusted total power density along a vertical line up to the height of a tall typical individual, taken here as 6ft or 180cm. Since the height for the rooftop of the simulated vehicle is 143cm, then the averaging is over those measurements made between 0 and 37cm above the simulated vehicle rooftop. Column 6 shows the results of this averaging.

Table 7.5.2

Power Density Measured
at every 45° as a Function of Height

Angular Position [°]	Adjusted Total Power Density H1 [cm] 2	H2 [cm] 12	H3 [cm] 24	H4 [cm] 37	Averaged Values of 0 to 37 cm [mW/cm²]	MPE [mW/cm²]
0	0.1659	0.5152	0.4383	0.5649	0.4211	0.6
45	0.1472	0.3843	0.2385	0.2701	0.2601	0.6
90	0.2220	0.4524	0.3127	0.5695	0.3892	0.6
135	0.2602	0.4646	0.2896	0.5571	0.3929	0.6
180	0.1008	0.2688	0.1293	0.4746	0.2433	0.6
225	0.2154	0.5191	0.3035	0.4720	0.3775	0.6
270	0.1630	0.3566	0.2991	0.4212	0.3100	0.6
315	0.2526	0.5191	0.3092	0.4273	0.3770	0.6
360	0.1659	0.5152	0.4383	0.5649	0.4211	0.6

The data in Table 7.5.2 is presented in Figure 7.5.2.

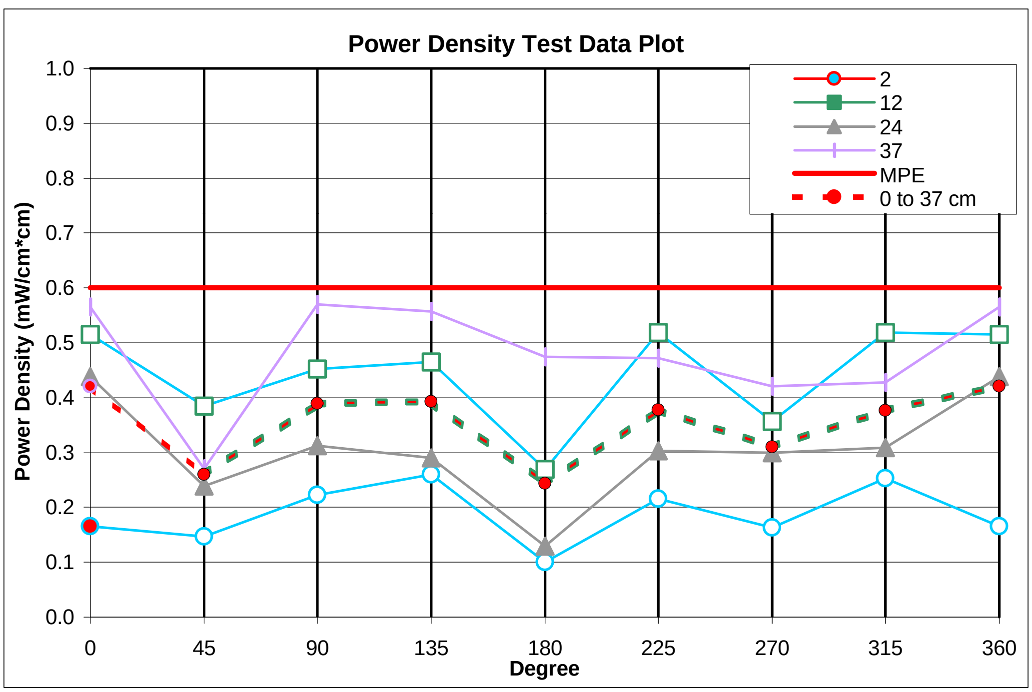


Figure 7.5.2.

Measurements were made below the simulated vehicle rooftop, in the approximate location of the centre of the head of potential occupants. It was assumed that this typical position occurred 17.5cm below the roof of the simulated vehicle (the clearance between the top of an occupant's head and a vehicle's roof is ~3" (7.5cm) and distance between the top of the head and the eyes is ~4" (10cm)). Figure 7.3.1 shows the location of measurements for the four potential occupants. Table 7.5.3 presents the results of the measurements. Column 1 shows the position at which the measurements were taken and column 2 shows the result ("total" indicates that this is the sum of the power density measured by each of the three orthogonal sensors in the probe). The cable loss associated with the supplied 17ft Belden 8240 cable was adjusted to the nominal loss for a 6 foot length. Column 3 indicates the correction for the excess cable loss (11ft × 0.16 dB/ft) that was applied to the measured power density (column 2) to obtain the final adjusted power density (column 4).

Table 7.5.3

Power Density Measured
at Position of Potential Vehicle Occupants

Position	Total	Excess cable loss	Adjusted Total	MPE Limit
	[mW/cm^2]	[dB]	[mW/cm^2]	[mW/cm^2]
driver	0.11	1.76	0.17	0.6
front passenger	0.01	1.76	0.02	0.6
rear left	0.01	1.76	0.02	0.6
rear right	0.04	1.76	0.06	0.6

7.6. DISCUSSION

The maximum exposure determined for this EUT was 0.42 mW/cm^2 at a distance of 20 cm from the antenna. These measurements were performed with the maximum duty cycle of 100 % and a maximum power at 2 W (33 dBm).

RIM has found that due to the 0.5 dB tolerance in the calibration tool the radio modem could have an absolute maximum power of 2.25 W (33.5 dBm). It was determined by proportional scaling that the maximum power exposure level at 20 cm would be 0.47 mW/cm^2.

8. CONCLUSION

The EUT consisting of a Research in Motion R902M-2-O OEM radio-modem, an IBM 760ED ThinkPad laptop, and an Austin 500C antenna will not exceed the MPE requirements beyond 20 cm for the 896 – 901 MHz band. The maximum power exposure level determined at 20 cm was 0.47 mW/cm^2.

APPENDIX A

Transmitter Specifications

RIM 902M

OEM radio-modem for Mobitex

High Performance for OEMs

The RIM 902M radio-modem is a high-performance digital RF transceiver designed for system integration by original equipment manufacturers. Operating in the 900 MHz frequency range, the RIM 902M is compatible with Mobitex wide-area wireless data communication networks.

Providing high tolerance to noise generated by nearby microprocessors, the RIM 902M is ideal for integration into Mobitex terminals and embedded applications, including compact devices with minimal shielding or physical separation of the terminal unit and the radio-modem. Typical applications include:

- Hand-held terminals
- POS/ATM
- Laptop Computers
- Alarming
- Telemetry
- Vending Machines
- Automatic Vehicle Location/Transport

Efficient Power Management

Power consumption is a critical issue for mobile products because end-users want long-lasting devices without heavy battery packs. The RIM 902M sets new power consumption standards for OEM-style radio-modems by reducing stand-by power consumption to only 0.2 mA, and transmit power to as low as 600 mA.

Small and Lightweight

Based on a single-board design, the RIM 902M has a footprint significantly smaller then a business card. Uncommonly thin and lightweight, the RIM 902M is ideal for hand-held computers and installation in existing equipment enclosures.

Powerful and Efficient Transmitter

The RIM 902M transmitter can supply a full 2 Watts to the antenna, enhancing in-building and fringe-area use. When close to a network base-station, the RIM 902M conserves battery power by quickly decreasing output power to as little as 62 mW. The RIM 902M extends battery life, providing consistent transmitting performance efficiency throughout its range of operational voltage.

Noise Immunity

The RIM 902M includes ground-breaking technology that minimizes interference from RF noise generated by nearby electronics. Noise immunity significantly extends battery life, increases message exchange reliability, and will increase the effective range of operation of the RIM 902M compared to other radio-modems. And since the RIM 902M is not de-sensitized by RF noise emitted by nearby electronics, it is ideal for integration into products such as handheld terminals where shielding or physical separation is not possible.

Powerful Software Tools

The RIM 902M includes two link-level serial interface protocols: Radio Access Protocol (RAP) and MASC. RAP is significantly more efficient than the older MASC protocol and is specifically designed for embedded-system applications. RAP dramatically shortens the time needed to develop a wireless solution because a RAP interface will typically only require about 1-3 Kbytes compared to 10-50 Kbytes for a comparable MASC implementation. This reduced code footprint makes software maintenance easier and eliminates the need for a third-party API.

Set-up & Diagnostic Firmware

The RIM 902M firmware includes a simple-to-use utility that can display the Mobitex Access Number, RSSI level, battery status and various network and diagnostic parameters. Accessed with a standard PC-based terminal emulation program, this utility can be used to switch the RIM 902M between different Mobitex networks or "ping" the network to confirm the modem is fully operational on the network.

RIM 902M
OEM radio-modem for Mobitex

Developer's Kit
The RIM 902M Developer's Kit helps system designers and engineers start interfacing the RIM 902M OEM radio-modem to the target device in minutes.

The kit offers all of the following tools and accessories to begin using the RIM 902M:

- RIM 902M OEM radio-modem
- Magnetic-mount +3 dBd antenna
- Interface and Test Board including:
  - TTL-to-RS232 level conversion and FPC cable connector
  - DB-9 serial port for RS-232 connection to the host computer
  - Regulated power for the RIM 902M
  - LED indicators show when the RIM 902M is receiving power, transmitting, or exchanging data with the host
  - Test points for the 22-pin data cable

- Cables (data, power and antenna)
- Power supply (AC to DC)
- DB-9 to DB-9 straight through serial cable
- Protocol analyzer
- Hardware Integrator's Guide
- Programmer's Guide to RAP and MPAKs: *Protocols for Mobitex wireless communications*

Protocol Analyzer
The Developer's Kit includes a Mobitex-aware serial-line protocol analyzer which captures and interprets traffic between the RIM 902M and the terminal. MobiView is a powerful development tool that can significantly simplify application testing. Data capture and display options include raw or ASCII serial, MASC, network, or transport protocol interpreted.

Hardware Integrator's Guide
The Hardware Integrator's Guide includes helpful information about the RIM 902M, such as:

- Hardware design recommendations
- Suppliers of cables, connectors, and antennas
- Antenna matching guidelines
- Schematics for power supplies and RS-232 serial port interfaces
- Software development suggestions and tools.
- Detailed electrical and serial port specifications

Technical Specifications
Mechanical & environmental properties
- Weight: 36 g (1.26 oz.)
- Footprint: 42 x 67.5 mm (1.65" x 2.65")
- Thickness: 8.4 mm (0.3")
- Serial connector: 22 pin FPC connector
- MMCX Antenna cable connector
- Tested to IEC 68-2-6 Part 2 for vibration
- Operating temperature: -30°C to +70°C (at 5-95% relative humidity, non-condensing)
- Storage temperature: -40°C to +85°C

RF properties
- Transmit frequency: 896-902 MHz
- Transmit power range: 62 mW to 2.0 W at antenna port
- Transmitter can reduce output power by up to 15 dBm (to 62 mW) to balance radio link and conserve power
- Receive frequency: 935-941 MHz
- Receive sensitivity: -118 dBm
- 8000 bps 0.3 BT GMSK
- FCC Parts 15 & 90 (FCC Identifier: L6AR902M-2-O) pending
- Industry Canada RSS 119 (certification # pending)

Power supply & typical current usage
- Single power supply; operating range: 4.25 to 4.75 VDC
- Maximum off current consumption: 20µA
- Battery save stand-by mode: as low as 0.2 mA
- Receive / express stand-by mode: 66 mA
- Transmit mode: 1900 mA
- Average current usage: 22mA (based on 94% standby, 5% receive, 1% transmit)

Serial communications
- 3.0 V asynchronous serial port
- 7 bit with parity (MASC) or 8 with no parity (RAP)
- Link speed: 1200-9600 bps
- Link level protocols: Radio Access Protocol (RAP) and Mobitex Asynchronous Communications (MASC)

Other features
- Single line to turn radio on/off
- Software can activate radio
- Flow control options: Hardware, Xon/Xoff, or None
- Radio parameters stored at power down
- Terminal devices may power-down while radio-modem remains operational
- Certified by BellSouth Wireless Data to meet Mobitex Interface Specifications (MIS) including standard MIS features such as personal subscriptions, ESN verification, switching between different Mobitex networks, and frame and continuous modes.

APPENDIX B

Antenna Specifications

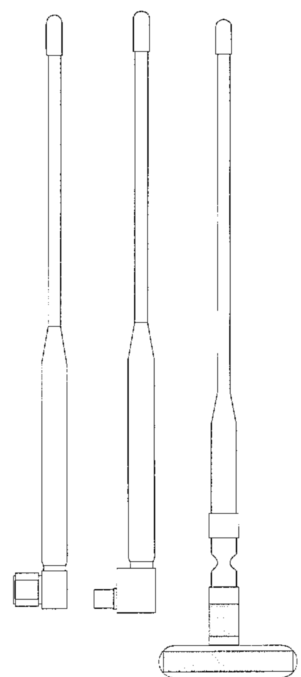
Austin Antenna Ltd.

'The World Leader in Multiband Technology"

500C Antennas for PCS/PCN

894 - 940 MHz, 2.0 - 2.5 GHz

The 500C family of antennas employs a unique Austin patented design utilizing state-of-the-art resonant cavity techniques to achieve high performance. The UHF/Microwave element is operational as a ground-independent ½ wave radiator. It is isolated from the feedline by the resonant cavity, which also produces a 50 ohm match. This isolation combined with the elevation of the feedpoint produces a superior radiation pattern, which provides a spherical envelope, affording excellent satellite reception. Because the antenna is ground independent it does not require a metal ground plane and is equally efficient on a handheld unit or a fiberglass structure as well as a normal mobile application. Antennas are available to receive or transmit over a broad range from UHF into GHz allowing coverage for assigned commercial and personal communication frequencies.



Terminations include a variety of connectors including Motorola/NMO, TNC, BNC, SMA, SMB, straight or right angle, screw-on or slip-on versions, and can be provided with reverse polarity. The antenna is illustrated to the right with a right angle SMA screw-on, a right angle SMB slip-on and a Motorola/NMO connector. The mobile version includes a neoprene spring to prevent breakage. Antenna lengths range from 4 to 9 inches depending on frequency and termination selected. Austin antennas mean maximum convenience.

The small antenna size and variety of terminating connector arrangements make this a family of antennas ideal for small, handheld data sets and unobtrusive mobile applications.

10 Main Street, Gonic, N.H. 03839 Tel: (603) 335-6339 Fax: (603) 335-1756

Austin Antenna Ltd.

"The World Leader in Multiband Technology"

Specifications 500CPCS

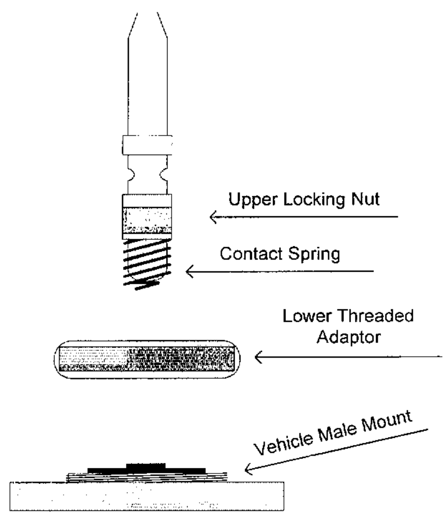
Electrical	895-940	2200-2500	Units
Center Frequency	915	2250-2450	MHz
Bandwidth @ SWR < 2.0	60	110	MHz
Max Power Input	25	25	Watts
Impedance	50	50	Ohms
Mechanical			
Length	< 9	< 9	Inches
Weight	< 1.5	< 1.5	Ounces
Exterior	Black	Black	
Terminations	BNC, TNC, SMA, SMB, Straight, Right angle, Slip-on, Screw-on, Standard or Reverse	BNC, TNC, SMA, SMB, Straight, Right angle, Slip-on, Screw-on, Standard or Reverse	

Special Installation Instructions for Model 500C with Motorola Type Mount

Contact spring protrusion may be adjusted for any mount height by unscrewing the lower threaded adaptor and then re-locking and sealing with the upper locking nut. One method s to remove the lower adaptor and screw it on the vehicle mount. Then screw the antenna through the adaptor to make contact. Be careful not to squash the spring contact.

Once installed the antenna may be removed as an assembly by unscrewing the unit.

Note: a light smear of silicon grease is suggested on all seals.



10 Main Street, Gonic, N.H. 03839 Tel: (603) 335-6339 Fax: (603) 335-1756

Austin Antenna Ltd.

"The World Leader in Multiband Technology"

Austin Antenna
Product Number Master File

Antenna Model #	200160
Antenna Name	500C 900-956 MHz Flextop Mobile Motorola Mount
Antenna Type	Omnidirectional Vehicular (Mobile) Antenna 900 MHz
Description	Standard ground independent antenna for 900 MHz flextop. Not supplied with cable kit. Mag Mount and Body Mount available. Black. Has non-metallic spring base.
Frequency Range	900-956 MHz or tuned to exact frequency 900-1000 MHz
Power Rating	100 Watts
Gain dBd	0
VSWR Bandwidth MHz	35 MHz @ 1.5:1 50 MHz 2:1
Connector Type	Motorola Mount Cable kits have N, UHF, BNC, TNC, SMA
Size (inches)	9
Weight (lbs net)	1

Antenna Model #	204825
Antenna Name	Body Mount, Motorola Type, ¾" hole SMA (M) conn
Antenna Type	N/A
Description	Body Mount for vehicular use. All brass construction fits ¾" hole. Supplied with 15 ft. RG-58/U Foam coax. SMB (M) Crimp connector supplied (not attached to cable).
Frequency Range	0-900 MHz
Power Rating	100 Watts
Gain dBd	N/A
VSWR Bandwidth MHz	0-900 MHz
Connector Type	SMB (Male) for RG-58/U Foam
Size (inches)	
Weight (lbs net)	1

10 Main Street, Gonic, N.H. 03839 Tel: (603) 335-6339 Fax: (603) 335-1756

APREL Laboratories

Certification Report on

Maximum Permissible Exposure Evaluation with Respect to FCC Rule Part 47CFR §2.1091

Research in Motion Ltd.

R902M-2-O Radio Modem and 3dBd Antenna Company Eclipse II Antenna

Date: 25 March, 1999

51 Spectrum Way Nepean ON K2R 1E6
Tel: (613) 820-2730 Fax: (613) 820-4161
email: info@aprel.com

CERTIFICATION REPORT

Subject:	Maximum Permissible Exposure Evaluation with Respect to FCC Rule Part 47CFR §2.1091
Product:	OEM Radio-Modem with 3dBd Antenna Company Magnet Vehicle-Top Mounting Antenna
FCC ID #:	L6AR902M-2-O
Model:	R902M-2-O Radio-Modem and Eclipse II Magnet Mount Antenna
Client:	Research in Motion Limited
Address:	295 Phillip Street Waterloo, Ontario Canada, N2L 3W8
Project #:	Project #: RIMB- R902M2O Antenna Company Eclipse II -3169
Prepared by:	APREL Laboratories 51 Spectrum Way Nepean, Ontario K2R 1E6

Submitted by ____________ Date: 25 Mar 99
Dr. Paul G. Cardinal
Director, Laboratories

Approved by ____________ Date: 25 Mar 99
Dr. Jacek J. Wojcik, P. Eng.

REGISTERED PROFESSIONAL ENGINEER
J. J. Wojcik
PROVINCE OF ONTARIO

CERTIFICATION REPORT

Subject: Maximum Permissible Exposure Evaluation with Respect to FCC Rule Part 47CFR §2.1091

Product: OEM Radio-Modem with 3dBd Antenna Company Magnet Vehicle-Top Mounting Antenna

FCC ID #: L6AR902M-2-O

Model: R902M-2-O Radio-Modem and Eclipse II Magnet Mount Antenna

Client: Research in Motion Limited

Address: 295 Phillip Street
Waterloo, Ontario
Canada, N2L 3W8

Project #: Project #: RIMB- R902M2O Antenna Company Eclipse II -3169

Prepared by: APREL Laboratories
51 Spectrum Way
Nepean, Ontario
K2R 1E6

Submitted by ______________________________ Date: __________________
Dr. Paul G. Cardinal
Director, Laboratories

Approved by ______________________________ Date: __________________
Dr. Jacek J. Wojcik, P. Eng.

FCC ID: L6AR902M-2-O
Client : Research in Motion Limited
Equipment : OEM Radio-Modem attached to a 3 dBd Antenna Company Magnet Vehicle-Top Mounting Antenna
Part No. : R902M-2-O Radio-Modem and Eclipse II Antenna
Serial No. : Pre-production Sample

ENGINEERING SUMMARY

This report contains the results of the maximum permissible exposure (MPE) evaluation performed on the equipment under test (EUT) which was comprised of a Research in Motion R902M-2-O OEM radio-modem, an IBM 760ED ThinkPad laptop attached to an Antenna Company Eclipse II Vehicle-Top Mounting Antenna. The tests were carried out in accordance with the applicable requirements of FCC rules found in 47CFR §2.1091 and the standards ANSI/IEEE C95.1-1992 and C95.3-1992.

The methodology and results for the test are described in the appropriate section of this report.

The EUT will not exceed the MPE requirements beyond 20 cm for the 896 - 901MHz band.

TABLE OF CONTENTS

1. ACRONYMS

EUT	Equipment Under Test
FCC	Federal Communications Commission
MPE	Maximum Permissible Exposure
N/A	Not Applicable
NTS	Not To Scale
OATS	Open Area Test Site
OEM	Original Equipment Manufacturer
QA	Quality Assurance
RIM	Research in Motion

2. INTRODUCTION

2.1. GENERAL

This report describes the Maximum Permissible Exposure (MPE) tests for a Research in Motion R902M-2-O OEM radio-modem, an IBM 760ED ThinkPad laptop, and an Antenna Company Eclipse II vehicle-top mounted 0 dBd antenna, the combination hereinafter called the EUT (Equipment Under Test).

2.2. SCOPE

MPE evaluation was performed on the EUT in accordance with the requirements of the FCC rules for RF compliance found in 47CFR §2.1091 and the standard ANSI/IEEE C95.3-1992, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave. This Engineering Report contains the following:

- Methodology as to how the tests were performed.
- Test results and analysis.
- Identification of the test equipment used for the testing.
- Test set-up diagram.

2.3. SCHEDULE

The MPE tests were completed on 12th March, 1999.

2.4. APPLICABLE DOCUMENTS

FCC Rule Part 47CFR §2.1091

ANSI/IEEE C95.1-1992, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300GHz.

ANSI/IEEE C95.3-1992, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave.

OET Bulletin 65 (Edition 97-01), Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields.

3. TEST SAMPLE

The MPE tests described in this procedure was performed on:

- Research in Motion Model R902M-2-O OEM radio-modem (see specification sheets in Appendix A and figure 3.1
- IBM ThinkPad Laptop Model 760ED, FCC ID ANOGCF2704AT, Type 9546-U9A, S/N 78-ACPW2 97/02
- Antenna Company Eclipse II 3 dBd magnet vehicle-mounted antenna (see specification sheets in Appendix B)

Figure 3.1 Photograph of R902M-2-O OEM Radio Modem

4. GENERAL REQUIREMENTS

4.1. LOCATION OF TEST FACILITIES

The tests were performed by APREL Laboratories at APREL's test facility located in Nepean, Ontario, Canada. The laboratory operates a 3 and 10 meter Open Area Test Site (OATS) measurement facility. The test site is calibrated to ANSI C63.4-1992.

A description of the measurement facility in accordance with the radiated and AC line conducted test site criteria in ANSI C63.4-1992 is on file with the Federal Communications Commission and is in compliance with the requirements of Section 2.948 of the Commissions rules and regulations. APREL's registration number is 31070/SIT(1300F2).

APREL is accredited by Standard Council of Canada, under the PALCAN program (ISO Guide 25). All equipment used is calibrated or verified in accordance with the intent of AQAP-6/MIL-STD-45662. APREL is also accredited by Industry Canada (formerly DOC) and recognised by the Federal Communications Commission (FCC).

4.2. PERSONNEL

Radiation Hazard technical staff member, Heike Wuenschmann, carried out all MPE tests.

4.3. FAILURE CRITERIA

The equipment under test was considered to have failed if any of the following occurred:

When the MPE limits exceeded those permitted by appropriate limits defined by the FCC.

4.4. POWER SOURCE REQUIRED

The following nominal DC Power was maintained during the test:

Voltage: 4.4 VDC (12 VDC cell with a voltage regulator)

4.5. TOLERANCE

The following tolerances on test conditions, exclusive of equipment accuracy, were maintained:

Voltage: ± 1%

5. TEST INSTRUMENTATION & CALIBRATION

5.1. GENERAL

APREL Laboratories, located in Nepean, Ontario is equipped with the necessary instrumentation to ensure accurate measurement of all data recorded during the tests outlined in this document. To ensure continued accuracy, each instrument is re-calibrated at intervals established by APREL and based on standards traceable to the National and International Standards. Accuracy surveillance is a function of APREL Quality Assurance.

5.2. MPE TEST EQUIPMENT REQUIRED

The test equipment required to perform the MPE testing was selected from the equipment available at APREL.

5.3. CALIBRATION REQUIREMENTS

All test equipment instrumentation required for MPE qualification testing was calibrated and controlled.

6. ELECTRICAL/MECHANICAL DESCRIPTION

The MPE Test Program was performed on one OEM radio-modem attached to an IBM ThinkPad laptop computer and an Antenna Company Eclipse II Magnet vehicle-top mounting antenna, the combination hereinafter called the EUT. The test sample consisted of the components supplied by the customer and described below.

6.1. TEST UNIT DESCRIPTION

The two watt R902M-2-O OEM radio-modem transceiver equipped with an Eclipse II magnet mount antenna and controlled by an IBM ThinkPad laptop computer, consisted of the following components:

Part Number	Description
R902M-2-O	RIM OEM radio-modem
PCB-02120-001 Rev. A	RIM interface board (ITB)
SRB01519/9743D59235	RIM execution lock
760ED Think Pad	IBM Laptop computer
Eclipse II	Antenna Co. 3dBd vehicle top magnet mount antenna
0820-0004	6 Gates 2 V 25 AH BC DC cells
VR 4.45	APREL 4.4 VDC voltage regulator

6.2. MPE TEST SETUP

The EUT antenna shall be installed in the centre of a ground plane simulating the rooftop of a vehicle. The other components shall be located underneath this ground plane to simulate operation from inside of the vehicle (see Figures 6.2.1 and 6.2.2).

The vehicle simulator shall be positioned on the turntable in the OATS in such a way that the antenna will be located on the centre of rotation.

The EUT shall be connected to the 4.4 VDC power supply.

For the selection and placement of the measuring probe, the requirements of ANSI/IEEE C95.3-1992 shall be met.

Figure 6.2.1. Photograph of the Setup.

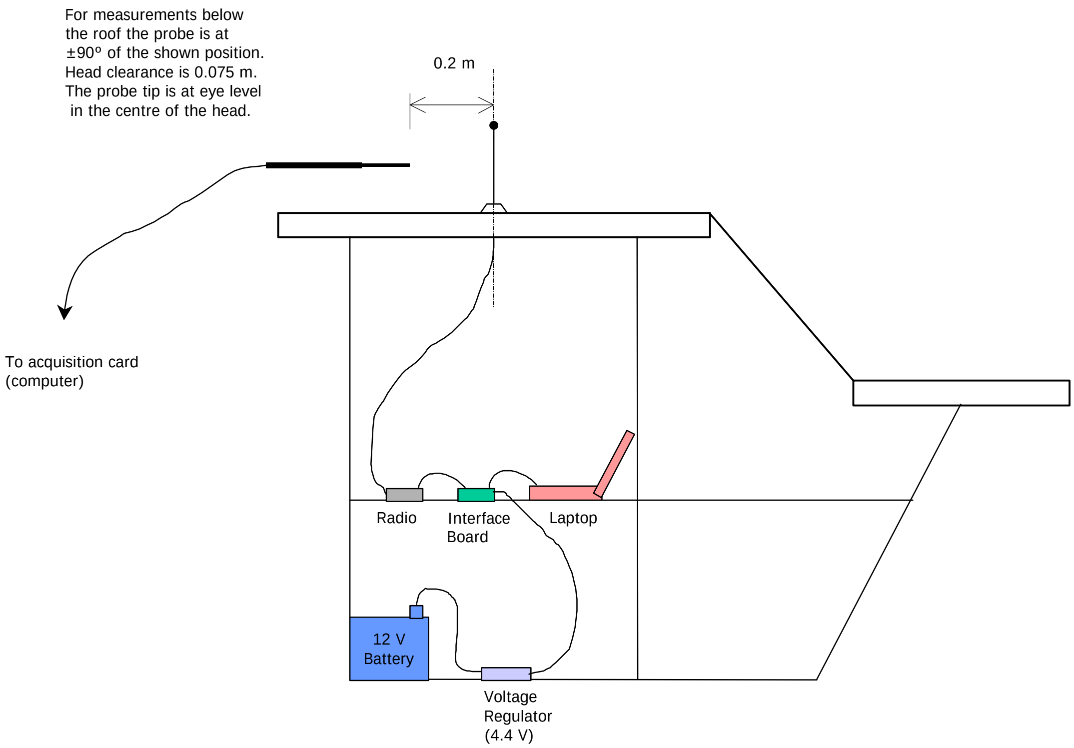


Figure 6.2.2. Elevation View of the Setup.

7. MAXIMUM PERMISSIBLE EXPOSURE (MPE) TEST

7.1. PURPOSE

This test method is used to verify that the EUT meets the MPE requirements as defined in the criteria for general population/uncontrolled exposure when operating at maximum power levels and in all operating modes.

7.2. TEST EQUIPMENT

Description	**Manufacturer**	**Model No.**
E-Field Probe	Narda	8021B

7.3. CRITERIA

Power Density Limits – The EUT shall not generate a power density beyond the limits in the frequency band listed in the left hand column of Table 7.3.1, and the power density given in the right hand column. The power density shall be measured 20 cm from the radiating antenna axis above the vehicle-top simulating ground plane, as well as in the approximate location of the head of possible vehicle drivers or passengers below the ground plane (see Figure 7.3.1). The measured values shall be recorded.

Table 7.3.1

Power Density Limits
for General Population/Uncontrolled Exposure

Frequency Range	**Power Density (mW/cm^2)**
300 - 1500 MHz	f/1500

Note: f = frequency in MHz

The measurements shall be performed at one transmitting frequency, the highest of the high, middle or low channels, with the EUT operating at the full rated output power.

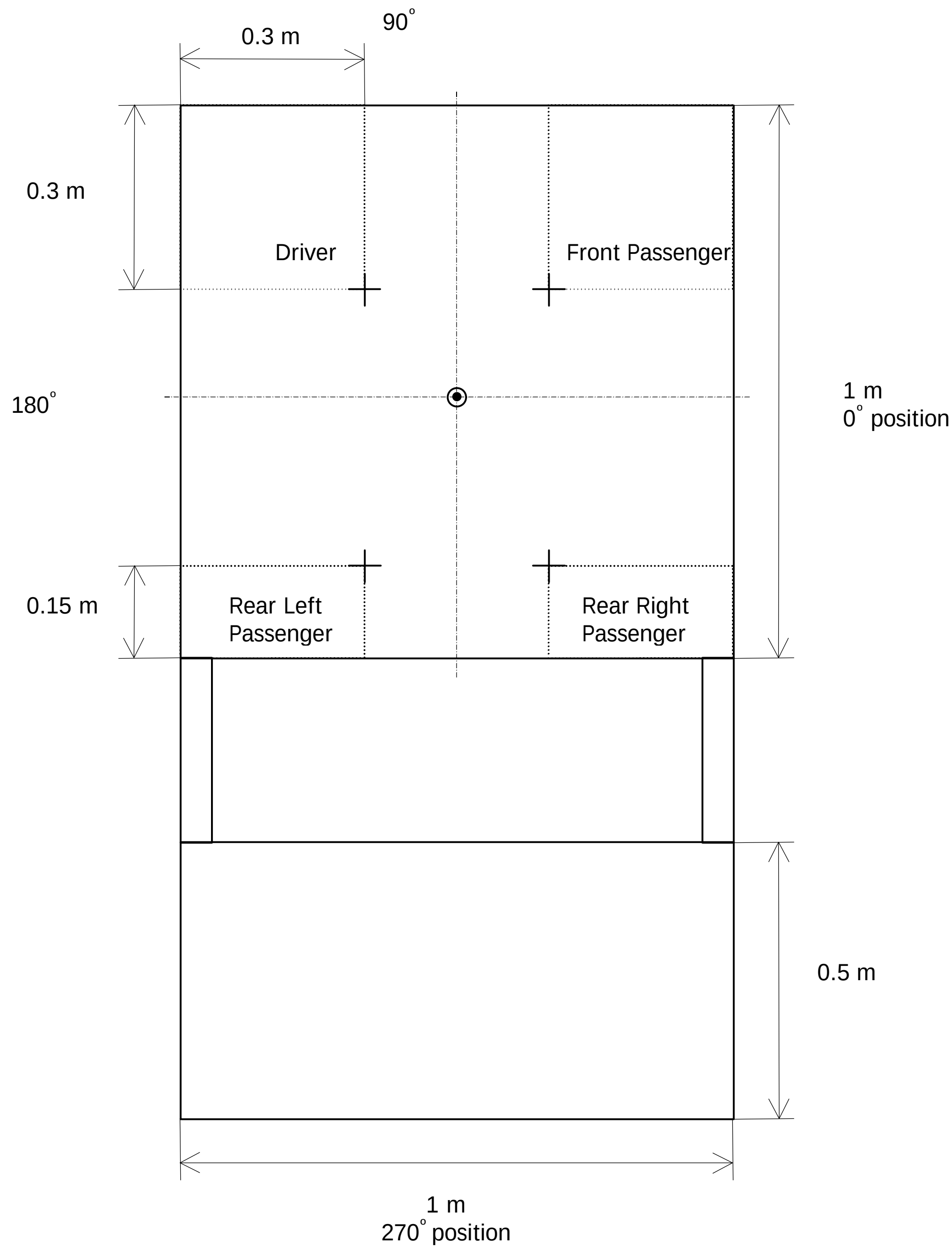


Figure 7.3.1. Plan View of Vehicle Simulator and Setup.

7.4. TEST PROCEDURE

a) The probe shall be positioned close to, and parallel to, the vehicle rooftop simulation with its tip 20 cm from the radiating antenna, and its axis normal to the antenna.

b) Rotate the turntable so that the probe is at the 0° position (see Figure 7.3.1).

c) Turn on the EUT and allow sufficient time for stabilisation. Turn on the transmitter and simulate normal operation conditions. Operate the transmitter at full rated output power.

d) Determine the location of the maximum power density: locate the maximum emissions by scanning vertically along the EUT's antenna. Take and record measurements of the power density at a number of points along the length of the antenna as well as just past its tip.

e) At every 45° of rotation take and record a measurement of the power density near the maximum power density height and for at least the following locations (as appropriate):

- half the maximum power density height
- height halfway between the maximum power density height and the tip of the radiating antenna
- just above the tip of the antenna

f) Turn off the EUT.

g) Position the probe under the vehicle rooftop simulating ground plane in the approximate location of the centre of the head of a potential driver of the simulated vehicle (see Figures 6.2.2 and 7.3.1).

h) Turn on the EUT and allow a sufficient time for stabilisation. Turn on the transmitter and simulate normal operation conditions. Operate the transmitter at full rated output power.

i) Take and record the measurement of the power density at this location.

j) Turn off the EUT.

k) Repeat steps g) through j) for the positions of the other potential occupants of the simulated vehicle as shown in Figure 7.3.1.

7.5. RESULTS

Table 7.5.1 presents the results of the measurements made along the length of the antenna in order to find the location of the maximum power density (Eclipse II antenna has a height of 32 cm). Column 1 shows the height at which the measurements were taken and column 2 shows the result ("total" indicates that this is the sum of the power density measured by each of the three orthogonal sensors in the probe). The cable loss associated with the supplied RG 58 A/U cable was adjusted to the nominal loss for a 6 foot length. Column 3 indicates the correction for the excess cable loss (6ft × 0.16 dB/ft) that was applied to measured power density (column 2) to obtain the final adjusted power density.

The data in Table 7.5.1 is presented in Figure 7.5.1.

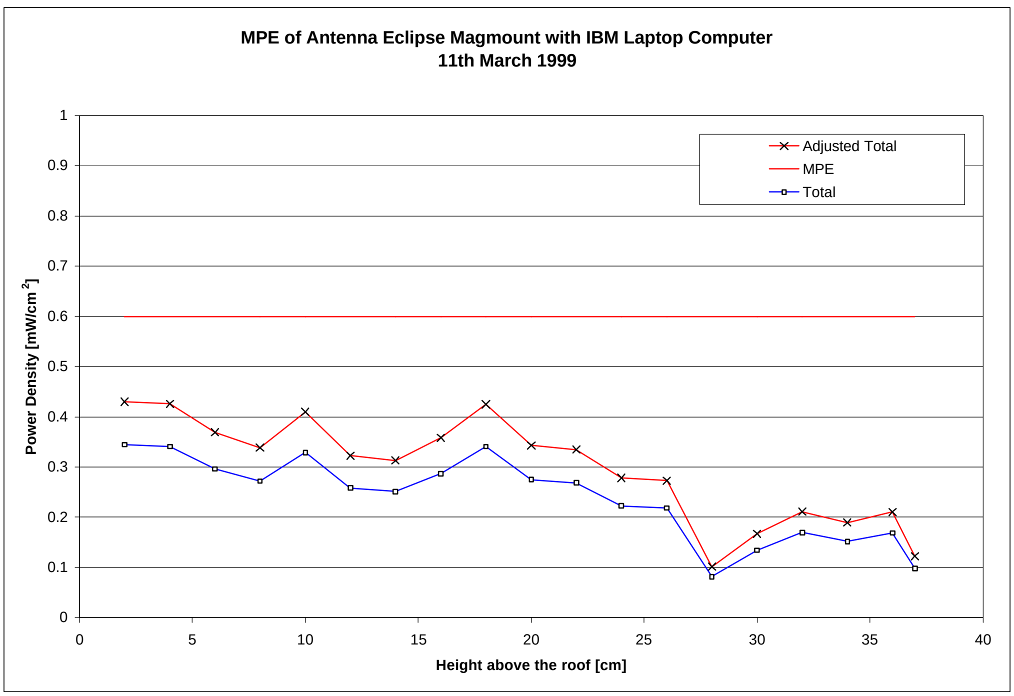


Figure 7.5.1

Table 7.5.1

Power Density Measured
at 0° as a Function of Height

Height	Total	Excess cable loss	Adjusted total	Limit
[cm]	[mW/cm^2]	[dB]	[mW/cm^2]	[mW/cm^2]
2	0.34	0.96	0.43	0.6
4	0.34	0.96	0.43	0.6
6	0.30	0.96	0.37	0.6
8	0.27	0.96	0.34	0.6
10	0.33	0.96	0.41	0.6
12	0.26	0.96	0.32	0.6
14	0.25	0.96	0.31	0.6
16	0.29	0.96	0.36	0.6
18	0.34	0.96	0.43	0.6
20	0.27	0.96	0.34	0.6
22	0.27	0.96	0.33	0.6
24	0.22	0.96	0.28	0.6
26	0.22	0.96	0.27	0.6
28	0.08	0.96	0.10	0.6
30	0.13	0.96	0.17	0.6
32	0.17	0.96	0.21	0.6
34	0.15	0.96	0.19	0.6
36	0.17	0.96	0.21	0.6
37	0.10	0.96	0.12	0.6

Table 7.5.2 presents the results of the measurements made around the antenna at every 45° of rotation. Column 1 shows the angle at which the measurements were taken and columns 2 through 5 show the final adjusted power density at the different measurement heights. The measured exposure level is determined by averaging the adjusted total power density along a vertical line up to the height of a tall typical individual, taken here as 6ft or 180cm. Since the height for the rooftop of the simulated vehicle is 143cm, then the averaging is over those measurements made between 0 and 37cm above the simulated vehicle rooftop. Column 6 shows the results of this averaging.

Table 7.5.2

Power Density Measured
at every 45° as a Function of Height

Angular Position [°]	Adjusted Total Power Density H1 [cm] 2	H2 [cm] 12	H3 [cm] 24	H4 [cm] 37	Averaged Values of 0 to 37 cm [mW/cm^2]	MPE [mW/cm^2]
0	0.4301	0.3222	0.2783	0.1226	0.2883	0.6
45	0.6632	0.4333	0.3224	0.0338	0.3632	0.6
90	0.1879	0.2299	0.1603	0.0548	0.1582	0.6
135	0.4572	0.5530	0.2750	0.1891	0.3686	0.6
180	0.4170	0.2518	0.2307	0.1036	0.2508	0.6
225	0.4931	0.3867	0.1578	0.0237	0.2653	0.6
270	0.5436	0.3795	0.2583	0.1390	0.3301	0.6
315	0.5176	0.3366	0.1852	0.1919	0.3078	0.6
360	0.4301	0.3222	0.2783	0.1226	0.2883	0.6

The data in Table 7.5.2 is presented in Figure 7.5.2.

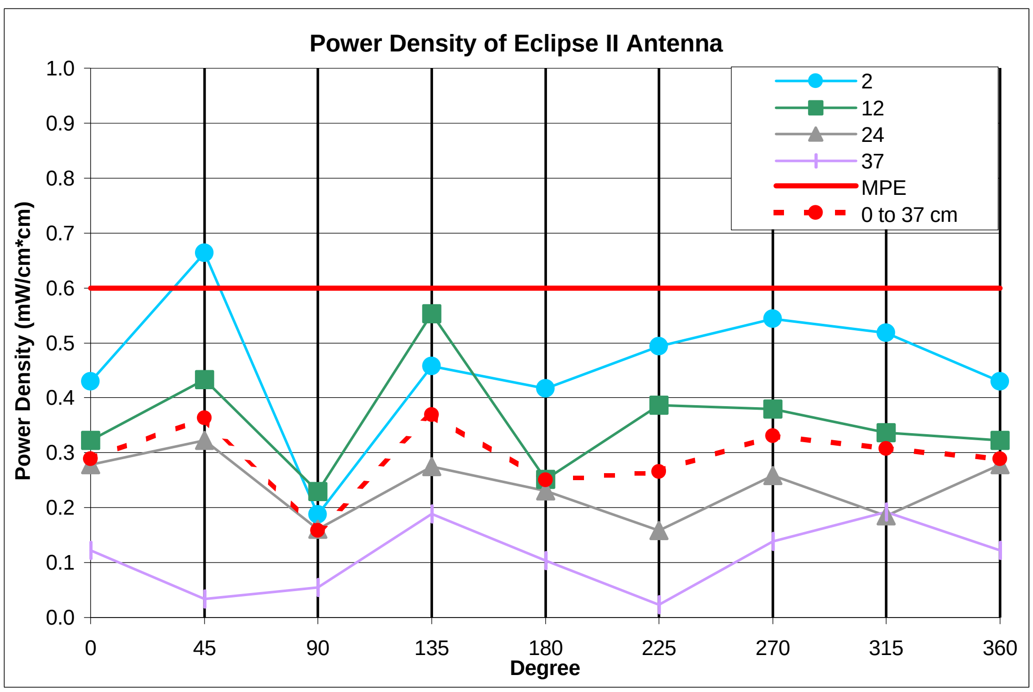


Figure 7.5.2.

Measurements were made below the simulated vehicle rooftop, in the approximate location of the centre of the head of potential occupants. It was assumed that this typical position occurred 17.5cm below the roof of the simulated vehicle (the clearance between the top of an occupant's head and a vehicle's roof is ~3" (7.5cm) and distance between the top of the head and the eyes is ~4" (10cm)). Figure 7.3.1 shows the location of measurements for the four potential occupants. Table 7.5.3 presents the results of the measurements. Column 1 shows the position at which the measurements were taken and column 2 shows the result ("total" indicates that this is the sum of the power density measured by each of the three orthogonal sensors in the probe). The cable loss associated with the supplied 12ft RG 58 A/U cable was adjusted to the nominal loss for a 6 foot length. Column 3 indicates the correction for the excess cable loss (6ft × 0.16 dB/ft) that was applied to the measured power density (column 2) to obtain the final adjusted power density (column 4).

Table 7.5.3

Power Density Measured
at Position of Potential Vehicle Occupants

Position	Total	Excess cable loss	Adjusted Total	MPE Limit
	[mW/cm^2]	[dB]	[mW/cm^2]	[mW/cm^2]
driver	0.00	0.96	0.00	0.6
front passenger	0.01	0.96	0.01	0.6
rear left	0.09	0.96	0.09	0.6
rear right	0.20	0.96	0.20	0.6

7.6. DISCUSSION

The maximum exposure determined for this EUT was 0.37 mW/cm^2 at a distance of 20 cm from the antenna. These measurements were performed with the maximum duty cycle of 100 % and a maximum power at 2 W (33 dBm).

RIM has found that due to the 0.5 dB tolerance in the calibration tool the radio modem could have an absolute maximum power of 2.25 W (33.5 dBm). It was determined by proportional scaling that the maximum power exposure level at 20 cm would be 0.41 mW/cm^2.

8. CONCLUSION

The EUT consisting of a Research in Motion R902M-2-O OEM radio-modem, an IBM 760ED ThinkPad laptop, and an Antenna Company Eclipse II antenna will not exceed the MPE requirements beyond 20 cm for the 896 – 901 MHz band. The maximum power exposure level determined at 20 cm was 0.41 mW/cm^2.

APPENDIX A

Transmitter Specifications

RIM 902M

OEM radio-modem for Mobitex

High Performance for OEMs

The RIM 902M radio-modem is a high-performance digital RF transceiver designed for system integration by original equipment manufacturers. Operating in the 900 MHz frequency range, the RIM 902M is compatible with Mobitex wide-area wireless data communication networks.

Providing high tolerance to noise generated by nearby microprocessors, the RIM 902M is ideal for integration into Mobitex terminals and embedded applications, including compact devices with minimal shielding or physical separation of the terminal unit and the radio-modem. Typical applications include:

- Hand-held terminals
- Laptop Computers
- Telemetry
- Automatic Vehicle Location/Transport
- POS/ATM
- Alarming
- Vending Machines

Efficient Power Management

Power consumption is a critical issue for mobile products because end-users want long-lasting devices without heavy battery packs. The RIM 902M sets new power consumption standards for OEM-style radio-modems by reducing stand-by power consumption to only 0.2 mA, and transmit power to as low as 600 mA.

Small and Lightweight

Based on a single-board design, the RIM 902M has a footprint significantly smaller then a business card. Uncommonly thin and lightweight, the RIM 902M is ideal for hand-held computers and installation in existing equipment enclosures.

Powerful and Efficient Transmitter

The RIM 902M transmitter can supply a full 2 Watts to the antenna, enhancing in-building and fringe-area use. When close to a network base-station, the RIM 902M conserves battery power by quickly decreasing output power to as little as 62 mW. The RIM 902M extends battery life, providing consistent transmitting performance efficiency throughout its range of operational voltage.

Noise Immunity

The RIM 902M includes ground-breaking technology that minimizes interference from RF noise generated by nearby electronics. Noise immunity significantly extends battery life, increases message exchange reliability, and will increase the effective range of operation of the RIM 902M compared to other radio-modems. And since the RIM 902M is not de-sensitized by RF noise emitted by nearby electronics, it is ideal for integration into products such as handheld terminals where shielding or physical separation is not possible.

Powerful Software Tools

The RIM 902M includes two link-level serial interface protocols: Radio Access Protocol (RAP) and MASC. RAP is significantly more efficient than the older MASC protocol and is specifically designed for embedded-system applications. RAP dramatically shortens the time needed to develop a wireless solution because a RAP interface will typically only require about 1-3 Kbytes compared to 10-50 Kbytes for a comparable MASC implementation. This reduced code footprint makes software maintenance easier and eliminates the need for a third-party API.

Set-up & Diagnostic Firmware

The RIM 902M firmware includes a simple-to-use utility that can display the Mobitex Access Number, RSSI level, battery status and various network and diagnostic parameters. Accessed with a standard PC-based terminal emulation program, this utility can be used to switch the RIM 902M between different Mobitex networks or "ping" the network to confirm the modem is fully operational on the network.

RIM 902M

OEM radio-modem for Mobitex

Developer's Kit

The RIM 902M Developer's Kit helps system designers and engineers start interfacing the RIM 902M OEM radio-modem to the target device in minutes.

The kit offers all of the following tools and accessories to begin using the RIM 902M:

- RIM 902M OEM radio-modem
- Magnetic-mount +3 dBd antenna
- Interface and Test Board including:
    - TTL-to-RS232 level conversion and FPC cable connector
    - DB-9 serial port for RS-232 connection to the host computer
    - Regulated power for the RIM 902M
    - LED indicators show when the RIM 902M is receiving power, transmitting, or exchanging data with the host
    - Test points for the 22-pin data cable

- Cables (data, power and antenna)
- Power supply (AC to DC)
- DB-9 to DB-9 straight through serial cable
- Protocol analyzer
- Hardware Integrator's Guide
- Programmer's Guide to RAP and MPAKs: *Protocols for Mobitex wireless communications*

Protocol Analyzer

The Developer's Kit includes a Mobitex-aware serial-line protocol analyzer which captures and interprets traffic between the RIM 902M and the terminal. MobiView is a powerful development tool that can significantly simplify application testing. Data capture and display options include raw or ASCII serial, MASC, network, or transport protocol interpreted.

Hardware Integrator's Guide

The Hardware Integrator's Guide includes helpful information about the RIM 902M, such as:

- Hardware design recommendations
- Suppliers of cables, connectors, and antennas
- Antenna matching guidelines
- Schematics for power supplies and RS-232 serial port interfaces
- Software development suggestions and tools.
- Detailed electrical and serial port specifications

Technical Specifications

Mechanical & environmental properties

- Weight: 36 g (1.26 oz.)
- Footprint: 42 x 67.5 mm (1.65" x 2.65")
- Thickness: 8.4 mm (0.3")
- Serial connector: 22 pin FPC connector
- MMCX Antenna cable connector
- Tested to IEC 68-2-6 Part 2 for vibration
- Operating temperature: -30°C to +70°C
  (at 5-95% relative humidity, non-condensing)
- Storage temperature: -40°C to +85°C
-

RF properties

- Transmit frequency: 896-902 MHz
- Transmit power range: 62 mW to 2.0 W at antenna port
- Transmitter can reduce output power by up to 15 dBm (to 62 mW) to balance radio link and conserve power
- Receive frequency: 935-941 MHz
- Receive sensitivity: -118 dBm
- 8000 bps 0.3 BT GMSK
- FCC Parts 15 & 90 (FCC Identifier: L6AR902M-2-O) pending
- Industry Canada RSS 119 (certification # pending)

Power supply & typical current usage

- Single power supply; operating range: 4.25 to 4.75 VDC
- Maximum off current consumption: 20µA
- Battery save stand-by mode: as low as 0.2 mA
- Receive / express stand-by mode: 66 mA
- Transmit mode: 1900 mA
- Average current usage: 22mA (based on 94% standby, 5% receive, 1% transmit)
-

Serial communications

- 3.0 V asynchronous serial port
- 7 bit with parity (MASC) or 8 with no parity (RAP)
- Link speed: 1200-9600 bps
- Link level protocols: Radio Access Protocol (RAP) and Mobitex Asynchronous Communications (MASC)
-

Other features

- Single line to turn radio on/off
- Software can activate radio
- Flow control options: Hardware, Xon/Xoff, or None
- Radio parameters stored at power down
- Terminal devices may power-down while radio-modem remains operational
- Certified by BellSouth Wireless Data to meet Mobitex Interface Specifications (MIS) including standard MIS features such as personal subscriptions, ESN verification, switching between different Mobitex networks, and frame and continuous modes.

APPENDIX B

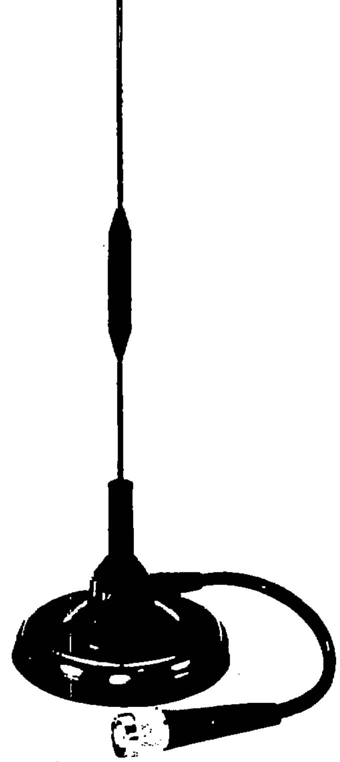
Antenna Specifications

THE ANTENNA COMPANY™

9110- TNC connector
9115- Mini-UHF connector
9119- SAP connector

GSM/ETACS

The ECLIPSE II Magnet Mount Cellular Antenna



The ECLIPSE II Magnet Mount incorporates features that clearly define it a proven performer, and outstanding performance booster, for portable and transportable phones.

The small magnetic base gives it an aerodynamic look, and allows for compact storage. A specially formulated rubber boot fits snugly over the magnetic base to prevent scratching of the vehicle surface.

An extended strain relief where cable enters the base, assures uncompromising performance and durability.

The ECLIPSE II is made in the USA and is backed by a LIFETIME WARRANTY.

FEATURES

- Provides service in fringe areas where reception is poor.
- Mounts in seconds.
- Stranded centre conductor cable for maximum magnetic strength.
- Connector with extended protective strain relief.
- Power balanced magnet delivers maximum magnetic strength.
- UV stabilized rubber boot protects vehicle surface.
- Made in the USA.
- Lifetime warranty.
- GSM and ETACS compatible.

ELECTRICAL SPECIFICATIONS	
Power Input	60 Watts
Gain	3dB
Frequency Range	872-960
VSWR	Less than 1.5 over specified range
Impedance	50 Ohms

MECHANICAL SPECIFICATIONS	
Height of Mast	35.6 cm
Mount Type	Magnetic Mount
Connector	TNC/Mini-UHF/SAP Factory-crimped with strain relief
Cable	RG58 A/U, 4 m., 95% shielded with stranded centre conductor
Outside Metal Parts	All stainless steel and brass

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