MOTOROLA

ACCREDITED

CGISS EME Test Laboratory
8000 West Sunrise Blvd
Fort Lauderdale, FL. 33322

MPE Compliance Test Report

Date of Report:	March 16, 2004
Report Revision(s):	Rev. O
Device Manufacturer:	Motorola
Device Description:	GM3688, EM400, CM300; 25W VHF (R1) 136-162 MHz; 32 channel Marlin + mini-UHF Display
Classification:	Occupational/Controlled Exposure
FCC ID:	ABZ99FT3048
Device Model:	PMUD1938A

Test Period:	2/25/04 & 2/26/04
Responsible Engineer:	Jim Fortier (Elect. Principle Staff Engineer)
Test Engineer:	Stephen Whalen (Sr. EME Engineer)
Author:	Michael Sailsman (Global EME Regulatory Affairs Liaison)

Note: Based on the information and the testing results provided herein, the undersigned certifies that when used as stated in the operating instructions supplied, said product complies with all applicable national and international reference standards and guidelines.

Signature on file 3/19/04

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Date Approved

TABLE OF CONTENTS

1.0 Product Description

2.0 Offered Options and Accessories

3.0 Measurement Standards

4.0 Data Collection Consideration

5.0 Measurement System Uncertainty Levels

6.0 Method of Measurement

- 6.1 EME measurements made on trunk mounted antennas
  - 6.1.1 External vehicle EME measurement
  - 6.1.2 Internal vehicle EME measurement
- 6.2 EME Measurements made on center roof mounted antennas
  - 6.2.1 External vehicle EME measurements
  - 6.2.2 Internal vehicle EME measurement

7.0 Test Site

8.0 Measurement System/Equipment

9.0 Test Unit Description

10.0 Test Set-Up Description

11.0 Test Results

- Table 1 149.000 MHz external E-field assessment at the trunk w/ antenna model HAD4007A
- Table 2 149.000 MHz internal E-field assessment at the trunk w/ antenna model HAD4007A
- Table 3 149.000 MHz external H-field assessment at the trunk w/ antenna model HAD4007A
- Table 4 149.000 MHz internal H-field assessment at the trunk w/ antenna model HAD4007A
- Table 5 149.000 MHz external H-field assessment at the roof w/ antenna model HAD4007A
- Table 6 149.000 MHz internal H-field assessment at the roof w/ antenna model HAD4007A
- Table 7 149.000 MHz external E-field assessment at the roof w/ antenna model HAD4007A
- Table 8 149.000 MHz internal E-field assessment at the roof w/ antenna model HAD4007A
- Table 9 156.400 MHz external E-field assessment at the trunk w/ antenna model HAD4008A
- Table 10 156.400 MHz internal E-field assessment at the trunk w/ antenna model HAD4008A
- Table 11 156.400 MHz external H-field assessment at the trunk w/ antenna model HAD4008A

Table 12 156.400 MHz internal H-field assessment at the trunk w/ antenna model HAD4008A
Table 13 156.400 MHz external H-field assessment at the roof w/ antenna model HAD4008A
Table 14 156.400 MHz internal H-field assessment at the roof w/ antenna model HAD4008A
Table 15 156.400 MHz external E-field assessment at the roof w/ antenna model HAD4008A
Table 16 156.400 MHz internal E-field assessment at the roof w/ antenna model HAD4008A
Table 17 140.025 MHz external E-field assessment at the trunk w/ antenna model HAD4006A
Table 18 140.025 MHz internal E-field assessment at the trunk w/ antenna model HAD4006A
Table 19 140.025 MHz external H-field assessment at the trunk w/ antenna model HAD4006A
Table 20 140.025 MHz internal H-field assessment at the trunk w/ antenna model HAD4006A
Table 21 140.025 MHz external H-field assessment at the roof w/ antenna model HAD4006A
Table 22 140.025 MHz internal H-field assessment at the roof w/ antenna model HAD4006A
Table 23 140.025 MHz external E-field assessment at the roof w/ antenna model HAD4006A
Table 24 140.025 MHz internal E-field assessment at the roof w/ antenna model HAD4006A
Table 25 156.400 MHz external E-field assessment at the trunk w/ antenna model HAD4014A
Table 26 156.400 MHz internal E-field assessment at the trunk w/ antenna model HAD4014A
Table 27 156.400 MHz external H-field assessment at the trunk w/ antenna model HAD4014A
Table 28 156.400 MHz internal H-field assessment at the trunk w/ antenna model HAD4014A
Table 29 156.400 MHz external H-field assessment at the roof w/ antenna model HAD4014A
Table 30 156.400 MHz internal H-field assessment at the roof w/ antenna model HAD4014A
Table 31 156.400 MHz external E-field assessment at the roof w/ antenna model HAD4014A
Table 32 156.400 MHz internal E-field assessment at the roof w/ antenna model HAD4014A
Table 33 161.975 MHz external E-field assessment at the trunk w/ antenna model RAD4000A
Table 34 161.975 MHz internal E-field assessment at the trunk w/ antenna model RAD4000A
Table 35 161.975 MHz external H-field assessment at the trunk w/ antenna model RAD4000A
Table 36 161.975 MHz internal H-field assessment at the trunk w/ antenna model RAD4000A
Table 37 161.975 MHz external H-field assessment at the roof w/ antenna model RAD4000A

Table 38 161.975 MHz internal H-field assessment at the roof w/ antenna model RAD4000A
Table 39 161.975 MHz external E-field assessment at the roof w/ antenna model RAD4000A
Table 40 161.975 MHz internal E-field assessment at the roof w/ antenna model RAD4000A
Table 41 140.025 MHz external E-field assessment at the trunk w/ antenna model HAD4006A (90º assessment)
Table 42 161.975 MHz external H-field assessment at the trunk w/ antenna model HAD4006A (90º assessment)
Table 43 156.4 MHz external E-field assessment at the trunk w/ antenna model HAD4014A (90º assessment)
Table 44 156.4 MHz external H-field assessment at the trunk w/ antenna model HAD4014A (90º assessment)
Table 45 140.025 MHz external E-field assessment at the trunk w/ antenna model HAD4006A (45º assessment)
Table 46 161.975 MHz external H-field assessment at the trunk w/ antenna model HAD4006A (45º assessment)
Table 47 156.400 MHz external E-field assessment at the trunk w/ antenna model HAD4014A (45º assessment)
Table 48 156.400 MHz external H-field assessment at the trunk w/ antenna model HAD4014A (45º assessment)

12.0 Conclusion

APPENDIX A: Antenna Location Drawing
APPENDIX B: Calibration Certificates for E-Field and H-Field probes
APPENDIX C: Photos and Descriptive Details of Assessed Antennas
APPENDIX D: Computational EME SAR Compliance Assessment

REVISION HISTORY

Date	Revision	Comments
3/16/04	O	Release of Pilot Results

1.0 Product Description

FCC ID: ABZ99FT3048, model PMUD1938A (GM3688, EM400, CM300) is a mobile transceiver that utilizes frequency modulation (FM) half duplex transmission technology. The intended use of the radio is Push-To-Talk (PTT) while the device is properly installed in a vehicle with the offered external antennas mounted at the center of the roof or trunk. This device will be marketed to and used by employees solely for work-related operations, such as public safety agencies, e.g. police, fire and emergency medical. User training is the responsibility of these agencies which can be expected to employ the usage instructions, safety information and operational cautions set forth in the user's manual, instructional sessions or other means. Motorola also makes available to its customers training classes on the proper use of two-way radios and wireless data devices. This device is classified as Occupational/Controlled Exposure. However, In accordance with FCC requirements, the passengers inside the vehicle and the bystanders external to the vehicle are evaluated to the General Population/Uncontrolled Exposure Limits. The transmit frequency band is 136-162 MHz. The nominal power of the device is 25 watts with a maximum conducted power output of 28 watts.

2.0 Offered Options and Accessories

Antenna

HAD4007A	144.0-150.8 MHz ¼ wave 2.15dBi antenna; 49.0cm (Fixed)
HAD4008A	150.8-162.0 MHz ¼ wave 2.15dBi antenna; 45.6cm (Fixed)
HAD4006A	136.0-144.0 MHz ¼ wave 2.15dBi antenna; 52.0cm (Fixed)
RAD4198A	136.0-144.0 MHz ¼ wave 2.15dBi antenna; 52.0cm (Fixed)
RAD4199A	144.0-150.8 MHz ¼ wave 2.15dBi antenna; 49.0cm (Fixed)
RAD4200A	150.8-162.0 MHz ¼ wave 2.15dBi antenna; 45.6cm (Fixed)
HAD4014A	140.0-174.0 MHz 5.65dBi gain antenna; 116.8cm (Trimmed)
RAD4000A	136.0-174.0 MHz 5.15dBi gain antenna; 118.5cm (Trimmed)

3.0 Measurement Standards

Measurements were performed according to FCC Limits Per 47 CFR 2.1091 (d) for General Population/Uncontrolled RF Exposure as well as with the recommended guidelines in IEEE/ANSI C95.1-1999.

For frequencies ranging from 136-162 MHz the MPE (Maximum Permissible Exposure) limit to electromagnetic energy in equivalent plane wave free-space power density is 0.2 mW/cm^2.

4.0 Data Collection Consideration

Power density testing was performed with DUT installed in a 1991 Ford Taurus (4-door). Measurement data was taken with the vehicle running at idle and the vehicle battery measuring 14.0 volts.

5.0 Measurement System Uncertainty Levels

The information below presents an estimate of the possible errors that are associated with the measurement system.

Description	Error
NARDA Survey Meter	**± 3%**
Repeatability Accuracy	**± 7%**

6.0 Method of Measurement

6.1 EME measurements made on trunk mounted antennas

(for reference, see Antenna Location Layout drawings in Appendix)

6.1.1 External vehicle EME measurement

(Antenna mounted at trunk center)

With the survey meter and probe, take ten (10) measurements, at the standard test distance of 60 cm to the antenna, from the back of the vehicle in a vertical line and then average the results. These measurements are taken and recorded at every twenty (20) centimeters over a range starting at twenty (20) centimeters above ground and ending at 2.0 meters; this would be representative of a person standing behind a vehicle during a mobile radio transmission.

Using the highest MPE configuration from above, repeat two additional MPE tests at the vehicle/trunk corner (45 degree radial) and on the side of the vehicle adjacent to the trunk (90 degree radial, directly opposite center trunk mounted antenna) while maintaining twenty (20) centimeter separation between the probe sensor and vehicle body.

For the current test vehicle, the antenna to probe sensor separation distance is 99.5 cm (45 degree radial) and 104 cm (90 degree radial)

Note: the distance from the trunk-mounted antenna to the edge of the vehicle is 26cm and the distance from the edge of the vehicle's trunk to the MPE vertical line assessment is 34cm (trunk to edge of bumper is 10cm). The radial distance measured at 45° from corner of trunk to vertical test line is 99.5cm. The radial distance measured at 90° from the side of the trunk is 104cm.

6.1.2 Internal vehicle EME measurement
(Antenna mounted at trunk center)

While rotating survey meter probe through 180 degrees to ensure that the highest level is found, scan the inside of the vehicle, both front and back seating areas, for the highest level in each location. After the highest level is found, scan vertically making two (2) additional measurements within an area approximately 40 cm wide (representing the width of a person) so as to have a total of three (3) measured points as indicated below that will be averaged.

a) Head area

b) Chest area

c) Lower Trunk area

6.2 EME measurements made on center roof mounted antennas
(for reference, see Antenna Location Layout drawings in Appendix)

6.2.1 External vehicle EME measurement
(Antenna mounted at roof center)

With the survey meter and probe, take ten (10) measurements, at the standard test distance of 60 cm from the vehicle-mounted antenna, in a vertical line and then average the results. These measurements are taken and recorded at every twenty (20) centimeters over a range starting at twenty (20) centimeters above ground and ending at 2.0 meters; this would be representative of a person standing next to a vehicle during a mobile radio transmission.

Note: Actual test distance was 110cm (60cm from antenna to roof edge; 30cm from roof edge to edge of car door; 20cm vertical test line to car door); this is the closest distance that can be achieved to an antenna mounted to the center of the vehicle used for MPE compliance assessment.

6.2.2 Internal vehicle EME measurement
(Antenna mounted at roof center)

While rotating survey meter probe through 180 degrees to ensure that the highest level is found, scan the inside of the vehicle, both front and back seating areas, for the highest level in each location. After the highest level is found, scan vertically making two (2) additional measurements within an area approximately 40 cm wide (representing the width of a person) so as to have a total of three (3) measured points as indicated below that will be averaged.

a) Head area

b) Chest area

c) Lower Trunk area

7.0 Test Site

The test site is the Motorola Commercial Government Industrial Solution Sector (CGISS) world wide electromagnetic exposure (EME) open area test site located at 8000 W. Sunrise Blvd., Plantation, FL. 33322.

8.0 Measurement System/Equipment

The minimum equipment required will mainly consist of a test vehicle, radio frequency radiation test set consisting of an Electromagnetic Radiation Survey Meter, E-Field Test Probes, and typical antenna configurations.
Below are the test equipment used to assess compliance:

a) Automobile: 1991 Ford Taurus, 4-Door

b) E-Field Survey Meter - NARDA Model 8718 (01108); Cal. date: 4/14/03

c) E-Field (Electric Field) Probe - NARDA Model 8722B (13001); Cal. date: 5/6/03

d) H-Field (Magnetic field) Probe – NARDA Model 8731 (03006); Cal. Date: 3/21/03

e) Antennas - (1/4 wave 2.15dBi, 5.15dBi, and 5.65dBi gain antennas)

9.0 Test Unit Description

Power density measurements were performed on a representative sample of model number PMUD1938A. The serial number of the tested radio was 019TAA1211. The frequency band of the DUT is 136-162 MHz; the tested frequencies were 140.025, 149.0, 156.4, and 161.975 MHz. The ¼ wave 2.15dBi, 5.15dBi, and 5.65dBi gain mobile antennas listed in section 2.0 were used to assess compliance to the applicable MPE limits.

10.0 Test Set-Up Description

The following are the standard mobile antenna test configurations used for this product. (for reference, see Antenna Location Layout drawings in the Appendix)

a) The ¼ wave 2.15dBi antenna models HAD4007A, HAD4008A, and HAD4006A, as well as 5.15dBi gain antenna model RAD4000A and 5.65dBi gain antenna model HAD4014A were mounted at the center of the roof and trunk of the test vehicle. Assessments were made internal and external to the test vehicle at the specified distances stated in sections 6.0, 11.0, and APPENDIX A. Note that the offered antenna models RAD4199A, RAD4200A, and RAD4198A were not tested due to their similarities in frequency band and antenna lengths to models HAD4007A, HAD4008A, and HAD4006A respectively.

11.0 Test Results

Below is the raw MPE data for all measured grid points. Results are based on a 50% duty cycle with the radio operating in accordance with the User Manual instructions. The bolded power density results represent the highest MPE results observed.

Raw MPE Data; Test Frequencies and measured Po (W):
140.025 MHz (Po=28.9), 149.000 MHz (Po=28.6), 156.400 MHz (Po=27.1), 161.975 MHz (Po=28.3),
Meter reads in % of controlled limit; controlled limit = 1.00 mW/cm^2 for 30-300 MHz
(Cal factors presented herein are automatically accounted for in the meter used for assessments)
General Population MPE limits = 0.20mW/cm^2 or 1.6mW/g (Bystanders & Passengers)
External Vehicle Power Density (Pwr. Den. (cal.)) = average over body/2
Internal Vehicle Power Density (Pwr. Den. (cal.)) = average over (head/chest/lower trunk)/2
Pwr Density Max Calc.= (RF Po Max/Initial Power)*Pwr Density Calc. (initial power > max power)

Note: The average over the body test methodology is consistent with IEEE/ANSI C95.1-1999 guidelines

Table 1

External Vehicle MPE Assessment @ 149 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	HAD4007A	2.15	60	E	0.82	0.284	28.6	0.142	0.142
Measurement Grid									
Test Position	**Height (cm)**	**% of Control Limit**		**Test Position**	**Height (cm)**	**% of Control Limit**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	7.8%		6	120	50.3%		1	0.2
2	40	15.6%		7	140	44.5%			
3	60	20.4%		8	160	36.7%			
4	80	29.3%		9	180	25.1%			**RF Po (*Max)**
5	100	40.1%		10	200	14.3%			28.0

Table 2

Internal Vehicle MPE Assessment @ 149 MHz										
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2)**		**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
						Back	**Front**			
Trunk (cnt)	HAD4007A	2.15	Highest Reading	E	0.82	1.006	0.051	28.6	0.503	**0.503**
Measurement Grid										
Test Position		**% of Control Limit Head**		**% of Control Limit Chest**		**% of Control Limit Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat		185.7%		90.3%		25.7%		IEEE Uncontrolled Limit:		0.2
Front Seat		6.2%		3.1%		6.0%			**RF Po (*Max):**	28.0

Table 3

External Vehicle MPE Assessment @ 149 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	HAD4007A	2.15	60	H	0.98	0.304	28.6	0.152	0.152
Measurement Grid									
Test Position	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		**Test Position**	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	0.190		6	120	0.420		1.0	0.2
2	40	0.170		7	140	0.380			
3	60	0.250		8	160	0.350			
4	80	0.330		9	180	0.240			**RF Po (*Max)**
5	100	0.430		10	200	0.280			28.0

Table 4

Internal Vehicle MPE Assessment @ 149 MHz										
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2)**		**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
						Back	**Front**			
Trunk (cnt)	HAD4007A	2.15	Highest Reading	H	0.98	0.367	0.120	28.6	0.183	0.183
Measurement Grid										
Test Position		**Magnetic Field Strength Head**		**Magnetic Field Strength Chest**		**Magnetic Field Strength Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat		0.460		0.320		0.320		IEEE Uncontrolled Limit:		0.2
Front Seat		0.150		0.110		0.100			**RF Po (*Max):**	28.0

Table 5

External Vehicle MPE Assessment @ 149 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Roof (cnt)	HAD4007A	2.15	110	H	0.98	0.234	28.6	0.117	0.117
Measurement Grid									
Test Position	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		**Test Position**	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	0.120		6	120	0.220		1.0	0.2
2	40	0.130		7	140	0.290			
3	60	0.150		8	160	0.340			
4	80	0.170		9	180	0.350			**RF Po (*Max)**
5	100	0.190		10	200	0.380			28.0

Table 6

Internal Vehicle MPE Assessment @ 149 MHz										
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2)**		**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
						Back	**Front**			
Roof (cnt)	HAD4007A	2.15	Highest Reading	H	0.98	0.160	0.157	28.6	0.080	0.080
Measurement Grid										
Test Position		**Magnetic Field Strength Head**		**Magnetic Field Strength Chest**		**Magnetic Field Strength Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat		0.210		0.130		0.140		IEEE Uncontrolled Limit:		0.2
Front Seat		0.160		0.150		0.160			**RF Po (*Max):**	28.0

Table 7

External Vehicle MPE Assessment @ 149 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Roof (cnt)	HAD4007A	2.15	110	E	0.82	0.098	28.6	0.049	0.049
Measurement Grid									
Test Position	**Height (cm)**	**% of Control Limit**		**Test Position**	**Height (cm)**	**% of Control Limit**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	1.7%		6	120	12.1%		1	0.2
2	40	2.1%		7	140	18.3%			
3	60	2.9%		8	160	20.6%			
4	80	2.6%		9	180	18.4%			**RF Po (*Max)**
5	100	6.1%		10	200	13.1%			28.0

Table 8

Internal Vehicle MPE Assessment @ 149 MHz										
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2)**		**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
						Back	**Front**			
Roof (cnt)	HAD4007A	2.15	Highest Reading	E	0.82	0.179	0.040	28.6	0.089	0.089
Measurement Grid										
Test Position		**% of Control Limit Head**		**% of Control Limit Chest**		**% of Control Limit Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat		33.6%		14.3%		5.7%		IEEE Uncontrolled Limit:		0.2
Front Seat		2.9%		3.8%		5.4%			**RF Po (*Max):**	28.0

Table 9

External Vehicle MPE Assessment @ 156.4 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	HAD4008A	2.15	60	E	0.83	0.309	27.1	0.154	0.160
Measurement Grid									
Test Position	**Height (cm)**	**% of Control Limit**		**Test Position**	**Height (cm)**	**% of Control Limit**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	9.8%		6	120	55.3%		1	0.2
2	40	19.4%		7	140	48.1%			
3	60	25.5%		8	160	36.7%			
4	80	30.3%		9	180	24.1%			**RF Po (*Max)**
5	100	46.8%		10	200	12.9%			28.0

Table 10

Internal Vehicle MPE Assessment @ 156.4 MHz										
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2)**		**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
						Back	**Front**			
Trunk (cnt)	HAD4008A	2.15	Highest Reading	E	0.83	0.404	0.065	27.1	0.202	0.209
Measurement Grid										
Test Position		**% of Control Limit Head**		**% of Control Limit Chest**		**% of Control Limit Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat		67.5%		34.1%		19.7%		IEEE Uncontrolled Limit:		0.2
Front Seat		8.1%		6.6%		4.7%			**RF Po (*Max):**	28.0

Table 11

External Vehicle MPE Assessment @ 156.4 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	HAD4008A	2.15	60	H	0.98	0.321	27.1	0.161	0.166
Measurement Grid									
Test Position	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		**Test Position**	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	0.200		6	120	0.480		1.0	0.2
2	40	0.180		7	140	0.400			
3	60	0.280		8	160	0.330			
4	80	0.390		9	180	0.240			**RF Po (*Max)**
5	100	0.470		10	200	0.240			28.0

Table 12

Internal Vehicle MPE Assessment @ 156.4 MHz										
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2)**		**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
						Back	**Front**			
Trunk (cnt)	HAD4008A	2.15	Highest Reading	H	0.98	0.213	0.133	27.1	0.107	0.110
Measurement Grid										
Test Position		**Magnetic Field Strength Head**		**Magnetic Field Strength Chest**		**Magnetic Field Strength Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat		0.250		0.200		0.190		IEEE Uncontrolled Limit:		0.2
Front Seat		0.170		0.110		0.120			**RF Po (*Max):**	28.0

Table 13

External Vehicle MPE Assessment @ 156.4 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Roof (cnt)	HAD4008A	2.15	110	H	0.98	0.223	27.1	0.112	0.115
Measurement Grid									
Test Position	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		**Test Position**	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	0.110		6	120	0.200		1.0	0.2
2	40	0.110		7	140	0.270			
3	60	0.150		8	160	0.380			
4	80	0.160		9	180	0.320			**RF Po (*Max)**
5	100	0.180		10	200	0.350			28.0

Table 14

Internal Vehicle MPE Assessment @ 156.4 MHz										
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2)**		**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
						Back	**Front**			
Roof (cnt)	HAD4008A	2.15	Highest Reading	H	0.98	0.137	0.140	27.1	0.070	0.072
Measurement Grid										
Test Position		**Magnetic Field Strength Head**		**Magnetic Field Strength Chest**		**Magnetic Field Strength Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat		0.170		0.120		0.120		IEEE Uncontrolled Limit:		0.2
Front Seat		0.170		0.140		0.110			**RF Po (*Max):**	28.0

Table 15

External Vehicle MPE Assessment @ 156.4 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Roof (cnt)	HAD4008A	2.15	110	E	0.83	0.099	27.1	0.049	0.051
Measurement Grid									
Test Position	**Height (cm)**	**% of Control Limit**		**Test Position**	**Height (cm)**	**% of Control Limit**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	1.3%		6	120	11.2%		1	0.2
2	40	2.2%		7	140	18.3%			
3	60	2.7%		8	160	22.1%			
4	80	2.5%		9	180	18.8%			**RF Po (*Max)**
5	100	6.0%		10	200	13.4%			28.0

Table 16

Internal Vehicle MPE Assessment @ 156.4 MHz										
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2)**		**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
						Back	**Front**			
Roof (cnt)	HAD4008A	2.15	Highest Reading	E	0.83	0.122	0.057	27.1	0.061	0.063
Measurement Grid										
Test Position		**% of Control Limit Head**		**% of Control Limit Chest**		**% of Control Limit Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat		21.6%		10.3%		4.7%		IEEE Uncontrolled Limit:		0.2
Front Seat		4.0%		6.2%		6.8%			**RF Po (*Max):**	28.0

Table 17

External Vehicle MPE Assessment @ 140.025 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	HAD4006A	2.15	60	E	0.81	0.254	28.9	0.127	0.127
Measurement Grid									
Test Position	**Height (cm)**	**% of Control Limit**		**Test Position**	**Height (cm)**	**% of Control Limit**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	5.0%		6	120	45.6%		1	0.2
2	40	11.1%		7	140	40.3%			
3	60	18.8%		8	160	29.9%			
4	80	27.6%		9	180	21.2%			**RF Po (*Max)**
5	100	39.3%		10	200	15.3%			28.0

Table 18

Internal Vehicle MPE Assessment @ 140.025 MHz										
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2)**		**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
						Back	**Front**			
Trunk (cnt)	HAD4006A	2.15	Highest Reading	E	0.81	0.603	0.065	28.9	0.301	0.301
Measurement Grid										
Test Position		**% of Control Limit Head**		**% of Control Limit Chest**		**% of Control Limit Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat		120.1%		43.2%		17.5%		IEEE Uncontrolled Limit:		0.2
Front Seat		6.8%		5.1%		7.5%			**RF Po (*Max):**	28.0

Table 19

External Vehicle MPE Assessment @				140.025 MHz					
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	HAD4006A	2.15	60	H	0.99	0.345	28.9	0.173	0.173
Measurement Grid									
Test Position	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		**Test Position**	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	0.210		6	120	0.500		1.0	0.2
2	40	0.220		7	140	0.510			
3	60	0.280		8	160	0.360			
4	80	0.340		9	180	0.300			**RF Po (*Max)**
5	100	0.480		10	200	0.250			28.0

Table 20

Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2)** Back	Front	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	HAD4006A	2.15	Highest Reading	H	0.99	0.440	0.140	28.9	0.220	0.220
Measurement Grid										
Test Position		**Magnetic Field Strength Head**		**Magnetic Field Strength Chest**		**Magnetic Field Strength Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat		0.540		0.310		0.470		IEEE Uncontrolled Limit:		0.2
Front Seat		0.160		0.130		0.130			**RF Po (*Max):**	28.0

Table 21

External Vehicle MPE Assessment @ 140.025 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Roof (cnt)	HAD4006A	2.15	110	H	0.99	0.253	28.9	0.127	0.127
Measurement Grid									
Test Position	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		**Test Position**	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	0.120		6	120	0.210		1.0	0.2
2	40	0.130		7	140	0.330			
3	60	0.180		8	160	0.360			
4	80	0.180		9	180	0.430			**RF Po (*Max)**
5	100	0.180		10	200	0.410			28.0

Table 22

Internal Vehicle MPE Assessment @ 140.025 MHz										
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2) Back**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2) Front**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Roof (cnt)	HAD4006A	2.15	Highest Reading	H	0.99	0.197	0.250	28.9	0.125	0.125
Measurement Grid										
Test Position		**Magnetic Field Strength Head**		**Magnetic Field Strength Chest**		**Magnetic Field Strength Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat		0.200		0.190		0.220		IEEE Uncontrolled Limit:		0.2
Front Seat		0.290		0.240		0.220			**RF Po (*Max):**	28.0

Table 23

External Vehicle MPE Assessment @ 140.025 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Roof (cnt)	HAD4006A	2.15	110	E	0.81	0.085	28.9	0.043	0.043
Measurement Grid									
Test Position	**Height (cm)**	**% of Control Limit**		**Test Position**	**Height (cm)**	**% of Control Limit**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	2.4%		6	120	9.7%		1	0.2
2	40	4.1%		7	140	15.3%			
3	60	5.0%		8	160	16.6%			
4	80	3.1%		9	180	13.4%			**RF Po (*Max)**
5	100	4.4%		10	200	11.2%			28.0

Table 24

Internal Vehicle MPE Assessment @ 140.025 MHz										
						Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2)				
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Back**	**Front**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Roof (cnt)	HAD4006A	2.15	Highest Reading	E	0.81	0.168	0.049	28.9	0.084	0.084
Measurement Grid										
Test Position		**% of Control Limit Head**		**% of Control Limit Chest**		**% of Control Limit Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat		36.2%		9.8%		4.5%		IEEE Uncontrolled Limit:		0.2
Front Seat		6.4%		3.8%		4.5%			**RF Po (*Max):**	28.0

Table 25

External Vehicle MPE Assessment @ 156.4 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	HAD4014A	5.65	60	E	0.83	0.215	27.1	0.107	0.111
Measurement Grid									
Test Position	**Height (cm)**	**% of Control Limit**		**Test Position**	**Height (cm)**	**% of Control Limit**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	1.2%		6	120	30.3%		1	0.2
2	40	2.2%		7	140	42.0%			
3	60	4.5%		8	160	39.4%			
4	80	9.1%		9	180	36.7%			**RF Po (*Max)**
5	100	18.8%		10	200	30.5%			28.0

Table 26

Internal Vehicle MPE Assessment @ 156.4 MHz										
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2) Back**	**Front**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	HAD4014A	5.65	Highest Reading	E	0.83	0.075	0.010	27.1	0.037	0.039
Measurement Grid										
Test Position		**% of Control Limit Head**		**% of Control Limit Chest**		**% of Control Limit Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat		12.3%		7.3%		2.8%		IEEE Uncontrolled Limit:		0.2
Front Seat		0.7%		1.1%		1.2%			**RF Po (*Max):**	28.0

Table 27

External Vehicle MPE Assessment @ 156.4 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	HAD4014A	5.65	60	H	0.98	0.311	27.1	0.156	0.161
Measurement Grid									
Test Position	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		**Test Position**	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	0.130		6	120	0.170		1.0	0.2
2	40	0.130		7	140	0.400			
3	60	0.140		8	160	0.580			
4	80	0.150		9	180	0.670			**RF Po (*Max)**
5	100	0.140		10	200	0.600			28.0

Table 28

Internal Vehicle MPE Assessment @ 156.4 MHz										
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2)**		**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
						Back	**Front**			
Trunk (cnt)	HAD4014A	5.65	Highest Reading	H	0.98	0.137	0.113	27.1	0.068	0.071
Measurement Grid										
Test Position		**Magnetic Field Strength Head**		**Magnetic Field Strength Chest**		**Magnetic Field Strength Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat		0.150		0.130		0.130		IEEE Uncontrolled Limit:		0.2
Front Seat		0.120		0.110		0.110			**RF Po (*Max):**	28.0

Table 29

External Vehicle MPE Assessment @ 156.4 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Roof (cnt)	HAD4014A	5.65	110	H	0.98	0.180	27.1	0.090	0.093

Measurement Grid							
Test Position	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**	**Test Position**	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**	IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	0.100	6	120	0.130	1.0	0.2
2	40	0.110	7	140	0.200		
3	60	0.110	8	160	0.250		
4	80	0.120	9	180	0.280		**RF Po (*Max)**
5	100	0.130	10	200	0.370		28.0

Table 30

Internal Vehicle MPE Assessment @ 156.4 MHz										
						Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2)				
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Back**	**Front**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Roof (cnt)	HAD4014A	5.65	Highest Reading	H	0.98	0.000	0.000	27.1	<0.001	<0.001

Measurement Grid						
Test Position	**Magnetic Field Strength Head**	**Magnetic Field Strength Chest**	**Magnetic Field Strength Lower Trunk**	IEEE Controlled Limit:		1.0
Back Seat	0.000	0.000	0.000	IEEE Uncontrolled Limit:		0.2
Front Seat	0.000	0.000	0.000		**RF Po (*Max):**	28.0

Table 31

External Vehicle MPE Assessment @ 156.4 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Roof (cnt)	HAD4014A	5.65	110	E	0.83	0.057	27.1	0.028	0.029
Measurement Grid									
Test Position	**Height (cm)**	**% of Control Limit**		**Test Position**	**Height (cm)**	**% of Control Limit**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	0.6%		6	120	3.5%		1	0.2
2	40	1.0%		7	140	7.2%			
3	60	0.9%		8	160	10.6%			
4	80	0.5%		9	180	14.3%			**RF Po (*Max)**
5	100	1.5%		10	200	16.5%			28.0

Table 32

Internal Vehicle MPE Assessment @ 156.4 MHz										
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2)**		**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
						Back	**Front**			
Roof (cnt)	HAD4014A	5.65	Highest Reading	E	0.83	0.016	0.010	27.1	0.008	0.008
Measurement Grid										
Test Position		**% of Control Limit Head**		**% of Control Limit Chest**		**% of Control Limit Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat		2.4%		1.5%		0.9%		IEEE Uncontrolled Limit:		0.2
Front Seat		1.0%		1.2%		0.8%			**RF Po (*Max):**	28.0

Table 33

External Vehicle MPE Assessment @ 161.975 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	RAD4000A	5.15	60	E	0.84	0.185	28.3	0.092	0.092
Measurement Grid									
Test Position	**Height (cm)**	**% of Control Limit**	**Test Position**	**Height (cm)**	**% of Control Limit**	IEEE Controlled Limit	IEEE Uncontrolled Limit		
1	20	1.4%	6	120	22.1%	1	0.2		
2	40	2.1%	7	140	32.8%				
3	60	4.0%	8	160	32.5%				
4	80	9.2%	9	180	35.7%		**RF Po (*Max)**		
5	100	14.7%	10	200	30.2%		28.0		

Table 34

Internal Vehicle MPE Assessment @ 161.975 MHz										
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2) Back**	**Front**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	RAD4000A	5.15	Highest Reading	E	0.84	0.072	0.031	28.3	0.036	0.036
Measurement Grid										
Test Position	**% of Control Limit Head**	**% of Control Limit Chest**	**% of Control Limit Lower Trunk**	IEEE Controlled Limit:	1.0					
Back Seat	9.3%	8.2%	4.2%	IEEE Uncontrolled Limit:	0.2					
Front Seat	3.2%	2.7%	3.3%	**RF Po (*Max):**	28.0					

Table 35

External Vehicle MPE Assessment @ 161.975 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	RAD4000A	5.15	60	H	0.98	0.285	28.3	0.143	0.143
Measurement Grid									
Test Position	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		**Test Position**	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	0.130		6	120	0.140		1.0	0.2
2	40	0.130		7	140	0.280			
3	60	0.130		8	160	0.520			
4	80	0.150		9	180	0.610			**RF Po (*Max)**
5	100	0.130		10	200	0.630			28.0

Table 36

Internal Vehicle MPE Assessment @ 161.975 MHz										
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2)**		**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
						Back	**Front**			
Trunk (cnt)	RAD4000A	5.15	Highest Reading	H	0.98	0.167	0.137	28.3	0.083	0.083
Measurement Grid										
Test Position			**Magnetic Field Strength Head**		**Magnetic Field Strength Chest**	**Magnetic Field Strength Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat			0.170		0.160	0.170		IEEE Uncontrolled Limit:		0.2
Front Seat			0.150		0.130	0.130			**RF Po (*Max):**	28.0

Table 37

External Vehicle MPE Assessment @ 161.975 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Roof (cnt)	RAD4000A	5.15	110	H	0.98	0.149	28.3	0.075	0.075
Measurement Grid									
Test Position	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		**Test Position**	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	0.000		6	120	0.120		1.0	0.2
2	40	0.000		7	140	0.190			
3	60	0.100		8	160	0.230			
4	80	0.100		9	180	0.310			**RF Po (*Max)**
5	100	0.110		10	200	0.330			28.0

Table 38

Internal Vehicle MPE Assessment @ 161.975 MHz										
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2)**		**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
						Back	**Front**			
Roof (cnt)	RAD4000A	5.15	Highest Reading	H	0.98	0.000	0.000	28.3	0.000	0.000
Measurement Grid										
Test Position		**Magnetic Field Strength Head**		**Magnetic Field Strength Chest**		**Magnetic Field Strength Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat		0.000		0.000		0.000		IEEE Uncontrolled Limit:		0.2
Front Seat		0.000		0.000		0.000			**RF Po (*Max):**	28.0

Table 39

External Vehicle MPE Assessment @ 161.975 MHz									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Roof (cnt)	RAD4000A	5.15	110	E	0.84	0.049	28.3	0.025	0.025
Measurement Grid									
Test Position	**Height (cm)**	**% of Control Limit**		**Test Position**	**Height (cm)**	**% of Control Limit**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	0.4%		6	120	3.8%		1	0.2
2	40	0.7%		7	140	5.4%			
3	60	0.9%		8	160	8.5%			
4	80	1.9%		9	180	11.2%			**RF Po (*Max)**
5	100	2.2%		10	200	14.4%			28.0

Table 40

Internal Vehicle MPE Assessment @ 161.975 MHz										
Antenna Location	**Antenna**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Head, Chest, Lower Trunk Back/Front seats (mW/cm^2)**		**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
						Back	**Front**			
Roof (cnt)	RAD4000A	5.15	Highest Reading	E	0.84	0.021	0.011	28.3	0.011	0.011
Measurement Grid										
Test Position		**% of Control Limit Head**		**% of Control Limit Chest**		**% of Control Limit Lower Trunk**		IEEE Controlled Limit:		1.0
Back Seat		3.4%		2.1%		0.9%		IEEE Uncontrolled Limit:		0.2
Front Seat		0.7%		1.2%		1.3%			**RF Po (*Max):**	28.0

Table 41

External Vehicle MPE Assessment @						140.025 MHz		(90 º assessment)	
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	HAD4006A	2.15	104	E	0.81	0.249	28.9	0.124	0.124
Measurement Grid									
Test Position	**Height (cm)**	**% of Control Limit**		**Test Position**	**Height (cm)**	**% of Control Limit**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	11.5%		6	120	38.6%		1	0.2
2	40	24.7%		7	140	33.4%			
3	60	30.3%		8	160	26.3%			
4	80	22.0%		9	180	18.7%			**RF Po (*Max)**
5	100	31.5%		10	200	11.6%			28.0

Table 42

External Vehicle MPE Assessment @						161.975 MHz		(90 º assessment)	
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	HAD4006A	2.15	104	H	0.99	0.178	28.9	0.089	0.089
Measurement Grid									
Test Position	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		**Test Position**	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	0.000		6	120	0.240		1.0	0.2
2	40	0.000		7	140	0.280			
3	60	0.070		8	160	0.300			
4	80	0.080		9	180	0.310			**RF Po (*Max)**
5	100	0.180		10	200	0.320			28.0

Table 43

External Vehicle MPE Assessment @						156.4 MHz		(90 º assessment)	
Antenna Location	Antenna Model	Gain (dBi)	Meas. Distance (cm)	E/H Field	Calibration Factor	Average over Body (mW/cm^2)	Initial Power (W)	Pwr. Density Calc. (mW/cm^2)	Pwr. Density Max Calc. (mW/cm^2)
Trunk (cnt)	HAD4014A	5.65	104	E	0.83	0.088	27.1	0.044	0.045
Measurement Grid									
Test Position	Height (cm)	% of Control Limit		Test Position	Height (cm)	% of Control Limit		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	2.8%		6	120	7.9%		1	0.2
2	40	3.4%		7	140	13.1%			
3	60	3.4%		8	160	16.6%			
4	80	2.7%		9	180	17.3%			RF Po (*Max)
5	100	4.6%		10	200	15.7%			28.0

Table 44

External Vehicle MPE Assessment @						156.4 MHz		(90 º assessment)	
Antenna Location	Antenna Model	Gain (dBi)	Meas. Distance (cm)	E/H Field	Calibration Factor	Average over Body (mW/cm^2)	Initial Power (W)	Pwr. Density Calc. (mW/cm^2)	Pwr. Density Max Calc. (mW/cm^2)
Trunk (cnt)	HAD4014A	5.65	104	H	0.98	0.049	27.1	0.025	0.025
Measurement Grid									
Test Position	Height (cm)	Meas. Pwr. Density (mW/cm^2)		Test Position	Height (cm)	Meas. Pwr. Density (mW/cm^2)		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	0.000		6	120	0.000		1.0	0.2
2	40	0.000		7	140	0.000			
3	60	0.000		8	160	0.070			
4	80	0.000		9	180	0.160			RF Po (*Max)
5	100	0.000		10	200	0.260			28.0

Table 45

External Vehicle MPE Assessment @						140.025 MHz		(45 º assessment)	
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	HAD4006A	2.15	99.5	E	0.81	0.202	28.9	0.101	0.101
Measurement Grid									
Test Position	**Height (cm)**	**% of Control Limit**		**Test Position**	**Height (cm)**	**% of Control Limit**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	5.6%		6	120	32.1%		1	0.2
2	40	13.4%		7	140	30.3%			
3	60	18.3%		8	160	24.7%			
4	80	22.4%		9	180	15.5%			**RF Po (*Max)**
5	100	29.3%		10	200	9.9%			28.0

Table 46

External Vehicle MPE Assessment @						161.975 MHz		(45 º assessment)	
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	HAD4006A	2.15	99.5	H	0.99	0.178	28.9	0.089	0.089
Measurement Grid									
Test Position	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		**Test Position**	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**		IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	0.000		6	120	0.240		1.0	0.2
2	40	0.070		7	140	0.220			
3	60	0.190		8	160	0.200			
4	80	0.260		9	180	0.170			**RF Po (*Max)**
5	100	0.220		10	200	0.210			28.0

Table 47

External Vehicle MPE Assessment @ 156.4 MHz (45 º assessment)									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	HAD4014A	5.65	99.5	E	0.83	0.098	27.1	0.049	0.050

Measurement Grid							
Test Position	**Height (cm)**	**% of Control Limit**	**Test Position**	**Height (cm)**	**% of Control Limit**	IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	1.7%	6	120	10.5%	1	0.2
2	40	2.3%	7	140	16.3%		
3	60	2.5%	8	160	21.5%		
4	80	2.7%	9	180	19.9%		**RF Po (*Max)**
5	100	4.2%	10	200	15.9%		28.0

Table 48

External Vehicle MPE Assessment @ 156.4 MHz (45 º assessment)									
Antenna Location	**Antenna Model**	**Gain (dBi)**	**Meas. Distance (cm)**	**E/H Field**	**Calibration Factor**	**Average over Body (mW/cm^2)**	**Initial Power (W)**	**Pwr. Density Calc. (mW/cm^2)**	**Pwr. Density Max Calc. (mW/cm^2)**
Trunk (cnt)	HAD4014A	5.65	99.5	H	0.98	0.042	27.1	0.021	0.022

Measurement Grid							
Test Position	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**	**Test Position**	**Height (cm)**	**Meas. Pwr. Density (mW/cm^2)**	IEEE Controlled Limit	IEEE Uncontrolled Limit
1	20	0.000	6	120	0.000	1.0	0.2
2	40	0.000	7	140	0.000		
3	60	0.000	8	160	0.080		
4	80	0.000	9	180	0.170		**RF Po (*Max)**
5	100	0.000	10	200	0.170		28.0

12.0 Conclusion

Depending on the test frequency, compliance assessments were performed with an output power range of 27.1W to 28.9W. The maximum RF power allowable will be equal to the upper limit of the final test factory transmit power specification of 28W. The highest power density result scaled to the maximum allowable power output is 0.50mW/cm^2.

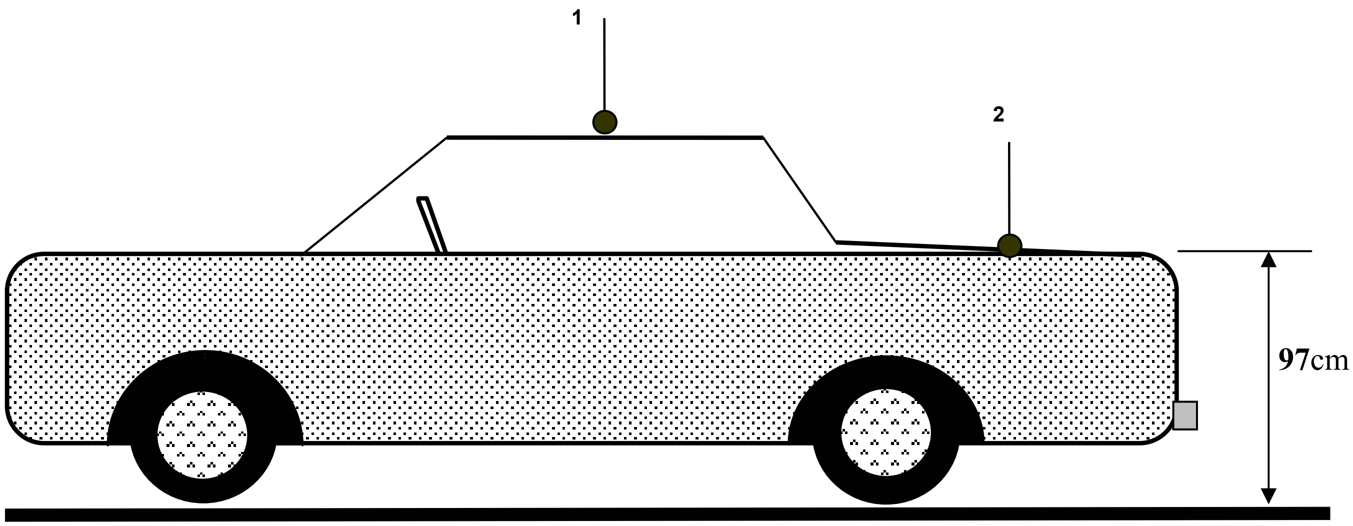
The MPE results presented herein demonstrate compliance to the applicable Occupational/Controlled exposure limits.
The computational assessment of the specific MPE non-compliant passenger test conditions presented in APPENDIX D demonstrates compliance to the applicable General Population/Uncontrolled S.A.R. exposure limits.

Notes:
1) Tables 2, 10, 18, and 20 reflect the worst-case passenger test configuration conditions that exceed the applicable MPE power density specification limits. Each of these test conditions was analyzed computationally to assess performance to the applicable S.A.R. exposure specification limits. APPENDIX D of this report presents computational EME compliance assessment results for FCC ID: ABZ99FT3048 performed by the Motorola Corporate Research Lab located in Plantation Florida using a commercial code based on FDTD (Finite Difference Time Domain) methodology. The computational results are provided herein in order to demonstrate the EME compliance of this device with respect to the IEEE Std C95.1-1999 specific absorption rate (S.A.R.) exposure limits. The computational results show that this device, when used with the offered antennas in accordance with the user manual instructions, exhibits a maximum peak 1-g average S.A.R. of 0.39mW/g for passengers internal to the vehicle.

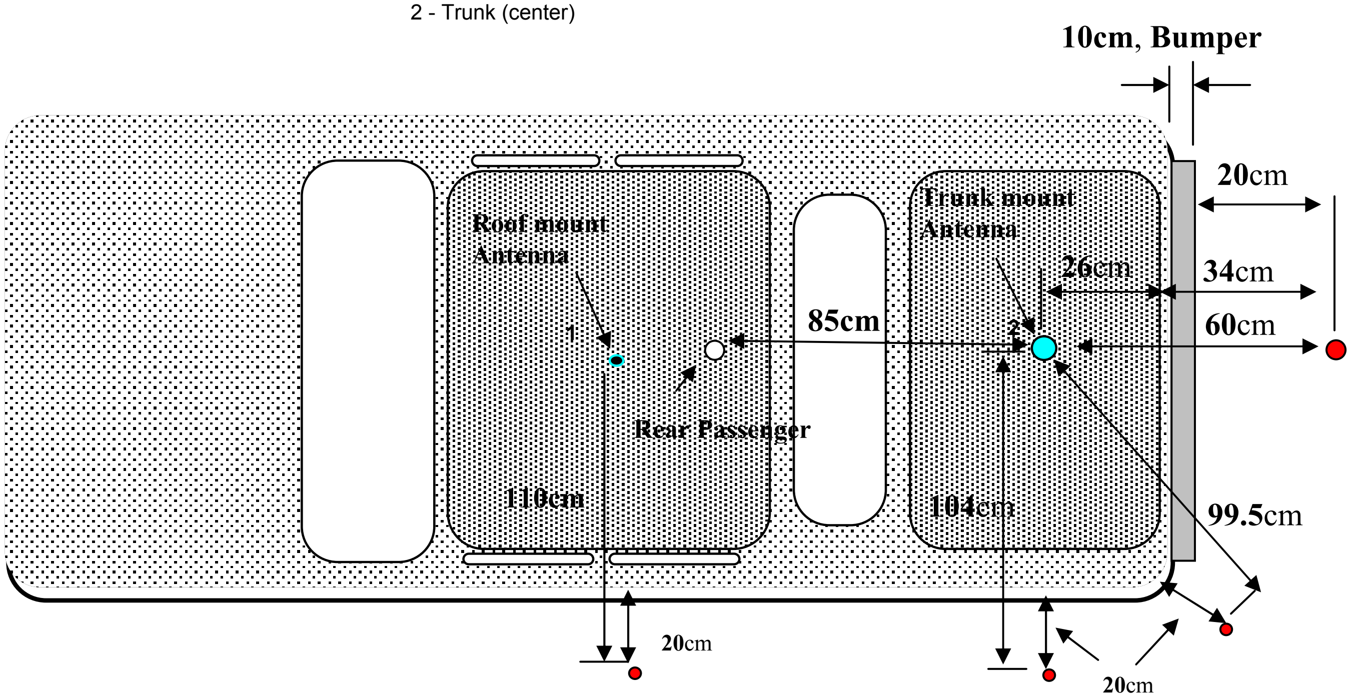
2) As presented in tables 41-48 in section 11.0 above MPE testing was performed at the trunk corners (45^O radial) and on the side of vehicle adjacent to trunk (90^O radial) in order to confirms that the worst case MPE test configuration is behind the vehicle.

APPENDIX A

Antenna Location Drawing with Test Locations Identified



1 - Roof (center)
2 - Trunk (center)



Note: • Test Locations

APPENDIX B

Calibration Certificates for E-Field and H-Field probes

E-FIELD PROBE CALIBRATION CERTIFICATE

L-3 communications
Narda Microwave-East

Certificate of Calibration

L-3 Communications, Narda Microwave-East, hereby certifies that the referenced RF Radiation Hazard monitoring equipment has been calibrated in accordance with MIL-STD-45662A, ANSI Z540, ISO 10012 and ISO 9001.

The measured values were determined by comparision with our standards, which are traceable to the National Institute of Standards and Technology to the extent allowed by NIST's calibration facilities.

Customer: MOTOROLA
SCHAUMBURG, IL 60168-0429

Certificate #: 35740 1

Model #:	8722B	Serial #:	13001
Description:	RAD MONITOR 8722B	PO #:	NP776106
Date Calibrated:	05/06/2003	R.O. #:	35740

Vince Donovan
Manager of Instruments Assembly and Test

John C. Stine
Director of Quality Assurance

H-FIELD PROBE CALIBRATION CERTIFICATE

PRNRH003

L3 communications
Narda Microwave-East

Certificate of Calibration

L-3 Communications, Narda Microwave-East, hereby certifies that the referenced RF Radiation Hazard monitoring equipment has been calibrated in accordance with MIL-STD-45662A, ANSI Z540, ISO 10012 and ISO 9001.

The measured values were determined by comparision with our standards, which are traceable to the National Institute of Standards and Technology to the extent allowed by NIST's calibration facilities.

Customer: MOTOROLA
SCHAUMBURG, IL 60168-0429

Certificate #: 33484 1

Model #: 8731

Serial #: 03006

Description: RAD MONITOR

PO #: NP372037

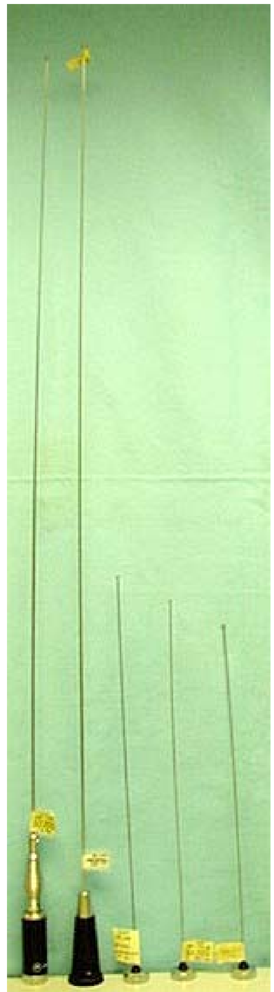
Date Calibrated: 03/21/2003

R.O. #: 33484

Vince Donovan
Manager of Instruments Assembly and Test

John C. Stine
Director of Quality Assurance

APPENDIX C
Photos and Descriptive Details of Assessed Antennas



From left to right: HAD4014A, RAD4000A, HAD4006A, HAD4007A, HAD4008A

APPENDIX D
Computational EME SAR Compliance Assessment

MOTOROLA LABS

COMPUTATIONAL EME COMPLIANCE ASSESSMENT OF THE GM3688 VHF MOBILE RADIO, MODEL # PMUD1938A, FCC ID ABZ99FT3048

March 5, 2004

Giorgi Bit-Babik and Antonio Faraone

Motorola Corporate EME Research Lab, Plantation, Florida

Introduction

This report summarizes the computational [numerical modeling] analysis performed to document compliance of the GM3688 VHF, Model Number PMUD1938A, Mobile Radio and vehicle-mounted antennas with the Federal Communications Commission (FCC) guidelines for human exposure to radio frequency (RF) emissions. The radio operates in the 136 - 162 MHz frequency band.

This computational analysis supplements the measurements conducted to evaluate the FCC *maximum permissible exposure* (MPE) limits for this mobile device. All test conditions (three total) that did not conform with applicable MPE limits were analyzed to determine whether those conditions complied with the *specific absorption rate* (SAR) limits for general public exposure (1.6 W/kg averaged over 1 gram of tissue) set forth in FCC guidelines, which are based on the IEEE standard [1]. To this end a commercial code based on Finite-Difference-Time-Domain (FDTD) methodology was employed to carry out the computational analysis. It is well established and recognized within the scientific community that SAR is the primary dosimetric quantity used to evaluate the human body's absorption of RF energy and that MPEs are in fact derived from SAR. Accordingly, the SAR computations provide a scientifically valid and more accurate estimate of human exposure to RF energy.

Method

The simulation code employed is XFDTD™ v5.3, by Remcom Inc., State College, PA. This computational suite features a heterogeneous full body standing model (High Fidelity Body Mesh), derived from the so-called Visible Human [2], discretized in 5 mm voxels. The dielectric properties of 23 body tissues are automatically assigned by XFDTD™ at any specific frequency. The "seated" man model was obtained from the standing model by modifying the articulation angles at the hips and the knees. Details of the computational method and model are provided in the Appendix to this report, following the structure outlined in Appendix B.III of the Supplement C to the FCC OET Bulletin 65.

The car model has been imported into XFDTD™ from the CAD file of a sedan car having dimensions 4.98 m (L) x 1.85 m (W) x 1.18 m (H), and discretized in 5mm voxels. The wheels and part of the hood were omitted in order to fit within the computational memory (3 GB) available. These omissions would not be expected to affect the exposure calculations in any event. The antenna position is in the center of the trunk and 85 cm from the passenger when the passenger is in the center of the back seat, so as to replicate the experimental conditions used in MPE measurements. Figures 1, Figure 2 and Figure 3 show cross-sectional images of the XFDTD computational models for the passenger.

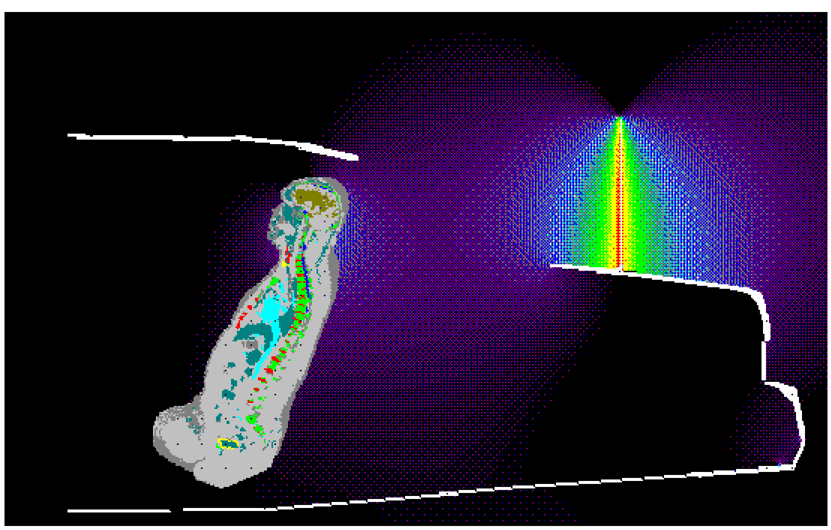


Figure 1: Car passenger model exposed to a quarter wave antenna operating at 149 MHz Lateral view including a time snapshot of the H-field distribution.

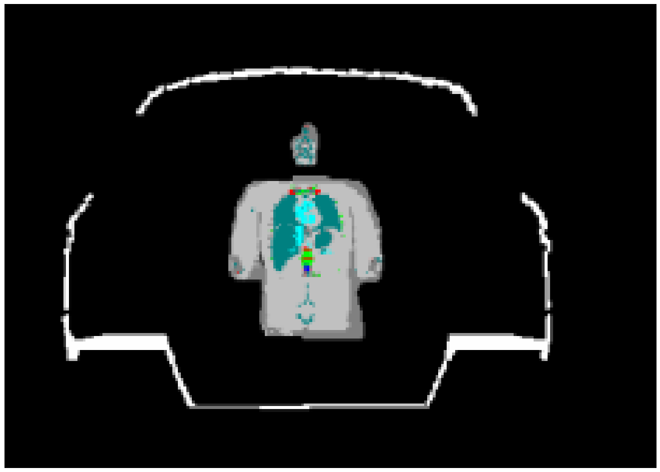


Figure 2: Car passenger model exposed to a quarter wave antenna. Front view.

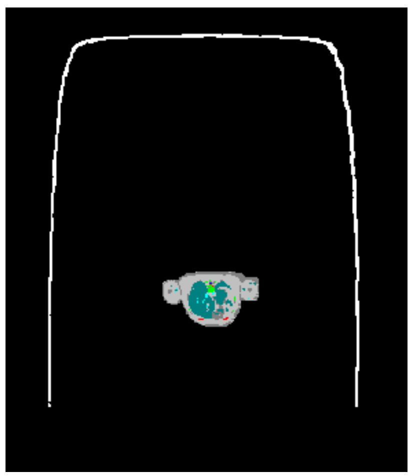


Figure 3: Car passenger model exposed to a quarter wave antenna. Top view.

The computational code employs a time-harmonic excitation to produce a steady state electromagnetic field in the exposed body. Subsequently, the corresponding SAR distribution is automatically processed in order to determine the whole-body and 1-g average SAR. The product maximum output power is 28 W rms. Since the ohmic losses in the cable and in the car materials, as well as the mismatch losses at the antenna feed-point, are neglected, and source-based time averaging (50% talk time) is employed, all computational results is to be normalized to half of it, i.e., 14 W *rms* net output power.

Results of SAR computations for car passengers

The three test conditions requiring SAR computations are summarized in Table I, together with the antenna data and the SAR results. The passenger is located in the center of the rear seat, where the maximum power density was measured. We also analyzed one case at 149 MHz with the passenger located near the door, to verify the exposure level. In this case the 1-g SAR is significantly lower than for the center position of the passenger and the whole body average is 24% higher. All the transmit frequency, antenna length, and passenger location combinations reported in Table I have been simulated individually. The maximum peak 1-g SAR is 0.39 W/kg, while the maximum whole-body average SAR is 0.0092 W/kg. An example of SAR distribution in the passenger model when it is located at the center of the rear seat is reported in Fig. 4. An example of the SAR distribution when the passenger is located on the side near the door is reported in Fig. 5a.

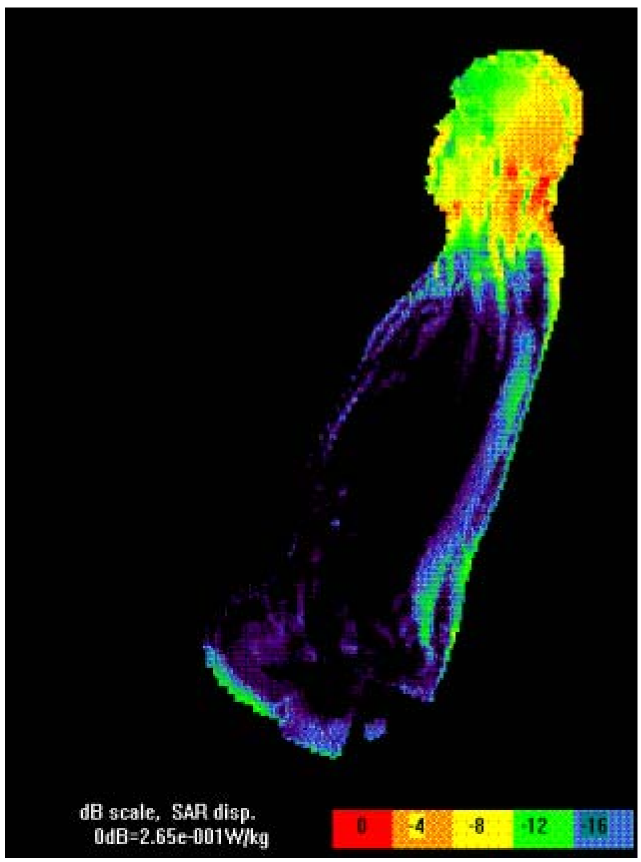
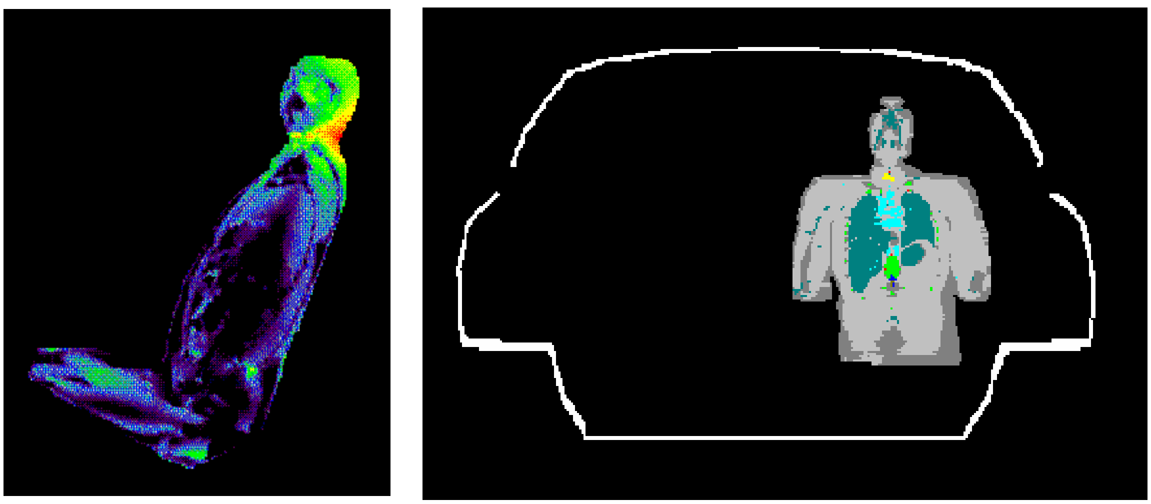


Figure 4: SAR distribution in the passenger model placed in the center of the rear seat, with a trunk-mount antenna operating at 164 MHz.

Table I: Results of SAR computations for passenger in the back seat exposed (50% talk-time) from a trunk-mounted antenna.

Freq	Antenna		Passenger Centered		Passenger near Door	
MHz	Kit #	Act/Sim Length	1-g SAR	WB-SAR	1-g SAR	WB-SAR
140 MHz	HAD4006A	52 cm	0.34 W/kg	0.0068 W/kg		
149 MHz	HAD4007A	49 cm	0.39 W/kg	0.0074 W/kg	0.169 W/kg	0.0092 W/kg
156.4 MHz	HAD4008A	45.5 cm	0.34 W/kg	0.0064 W/kg		



(a) (b)

Figure 5: SAR distribution in the passenger model through the plane where the peak SAR occurs (a) placed laterally in the back seat (b), with a trunk-mount antenna operating at 149 MHz.

Conclusions

Under the test conditions described for evaluating passenger exposure to the RF electromagnetic fields emitted by vehicle-mounted antennas used in conjunction with this mobile radio product, the present analysis shows that the computed SAR values are compliant with the FCC exposure limits for the general public.

References

[1] IEEE Standard C95.1-1999. *IEEE Standard for Safety Levels with Respect to Human Exposure to RF Electromagnetic Fields*, 3 kHz to 300 GHz.

[2] http://www.nlm.nih.gov/research/visible/visible_human.html

APPENDIX: SPECIFIC INFORMATION FOR SAR COMPUTATIONS

This appendix follows the structure outlined in Appendix B.III of the Supplement C to the FCC OET Bulletin 65. Most of the information regarding the code employed to perform the numerical computations has been adapted from the XFDTD™ v5.3 User Manual. Remcom Inc., owner of XFDTD™, is kindly acknowledged for the help provided.

1) Computational resources

a) A four-processor server (Mod. PowerEdge 6650, by Dell Computers Inc.) equipped with four 1.4 GHz Xeon microprocessors and 4 GB D-RAM (3 GB available for running applications) was employed for all simulations.

b) The memory requirement was between 2 GB and 3 GB in all cases. Using the above-mentioned server with all four processors operating concurrently, the typical simulation would run for 16 hours.

2) FDTD algorithm implementation and validation

a) We employed a commercial code (XFDTD™ v5.3, by Remcom Inc.) that implements the classical Yee's FDTD formulation [1]. The solution domain was discretized according to a rectangular grid with a uniform 5 mm step in all directions. Sub-gridding was not used. Liao's absorbing boundary conditions [2] are set at the domain boundary to simulate free space radiation processes. The excitation is a lumped voltage generator with 50-ohm source impedance. The code allows selecting *wire objects* without specifying their radius. We used a wire to represent the antenna. The car body is modeled by solid metal. We did not employ the "thin wire" algorithm in XFDTD™ since the antenna radius was never smaller than one-fifth the voxel dimension. In fact, the XFDTD™ manual specifies that

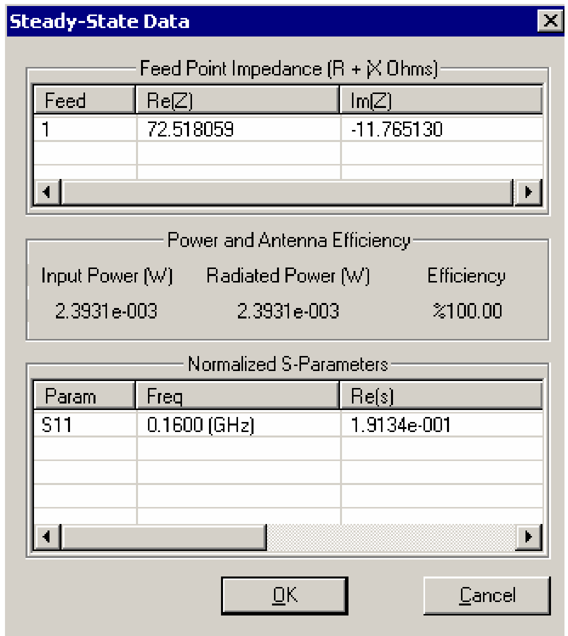
"Thin Wire materials may be used in special situations where a wire with a radius much smaller than the cell size is required… However, in cases where the wire radius is important to the calculation and is less than approximately 1/5 the cell size, the thin wire material may be used to accurately simulate the correct wire dimensions."

The voxel size in all our simulations was 5 mm, and the antenna radius is always at least 1 mm (1 mm for the short quarter-wave antennas), so there was no need to specify a "thin wire" material.

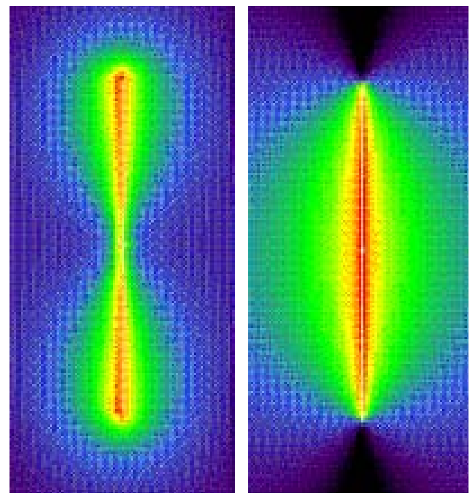
b) XFDTD™ is one of the most successful commercial codes for electromagnetic simulations. It has gone through extensive validation and has proven its accuracy over time in many different applications. One example is provided in [3].

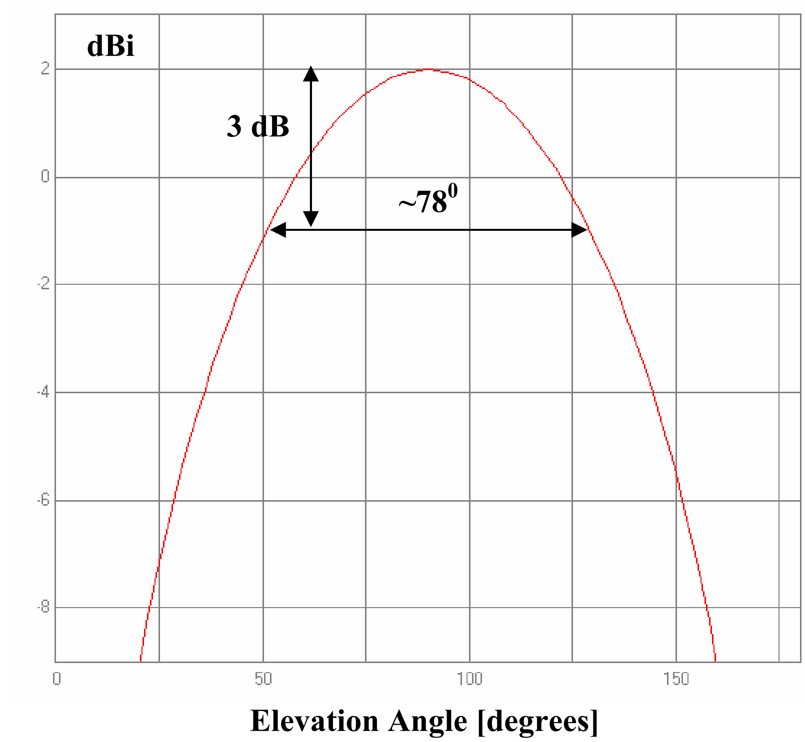
We carried out a validation of the code algorithm by running the canonical test case involving a half-wave wire dipole. The dipole is 0.475 times the free space wavelength at

160 MHz, i.e., 88.5 cm long. The discretization used in the model was uniform in all directions and equal to 5 mm, so the dipole was 177 cells long. Also in this case, the "thin wire" model was not needed. The following picture shows XFDTD™ outputs regarding the antenna feed-point impedance (72.6 – j 11.8 ohm), as well as qualitative distributions of the total E and H fields near the dipole. The radiation pattern is shown as well (one lobe in elevation). As expected, the 3 dB beamwidth is about 78 degrees.

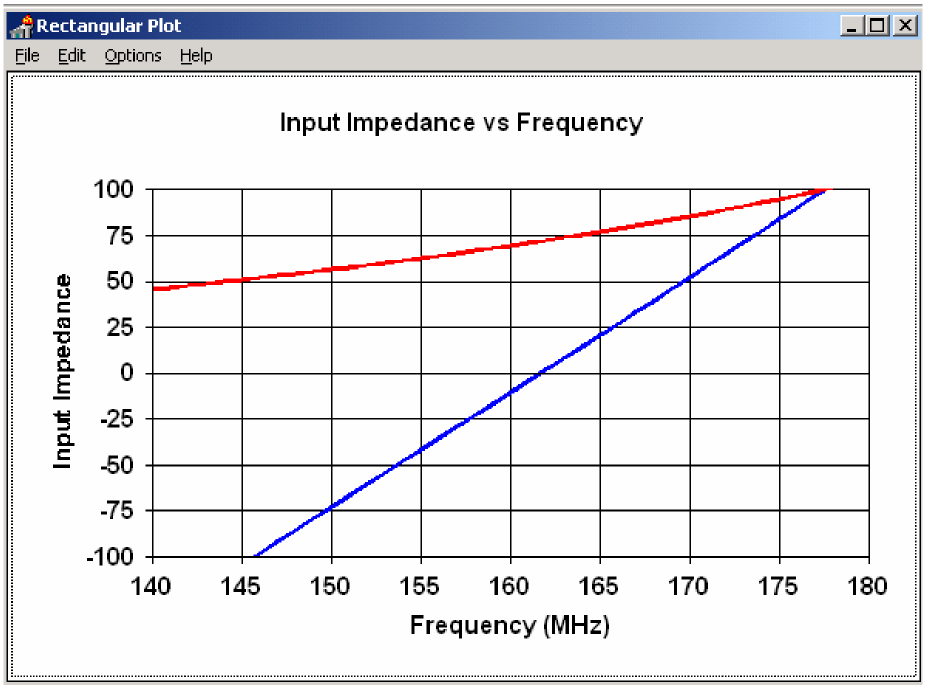


Total E-field | Total H-field





We also compared the XFDTD™ result with the results derived from NEC [4], which is a code based on the method of moments. In this case, we used a dipole with radius 1 mm, length 88.5 cm, and the discretization is 5 mm. The corresponding input impedance at 160 MHz is 69.5-j10.5 ohm. Its frequency dependence is reported in the following figure.



This validation ensures that the input impedance calculation is carried out correctly in XFDTD™, thereby enabling accurate estimates of the radiated power. It further ensures that the wire model employed in XFDTD™, which we used to model the antennas, produces physically meaningful current and fields distributions. Both these aspects ensure that the field quantities are correctly computed both in terms of absolute amplitude and relative distribution.

3) Computational parameters

a) The following table reports the main parameters of the FDTD model employed to perform our computational analysis:

PARAMETER	X	Y	Z
Voxel size	5 mm	5 mm	5 mm
Domain size for passenger computations (in voxels)	400	489	419
Time step	Exactly equal to Courant limit (typically 10 *ps* at this frequency, with the body model)		
Objects separation from FDTD boundary (voxels)	>10	>10	>10
Number of time steps	6000 in all simulations		
Excitation	Sinusoidal (approx. 9 periods)		

b) In order to fit the model within a grid size that would not use up the available memory, we chopped the hood of the car.

4) Phantom model implementation and validation

a) The FDTD mesh of a male human body was created using digitized data in the form of transverse color images. The data is from the *visible human project* sponsored by the National Library of Medicine (NLM) and is available via the Internet (http://www.nlm.nih.gov/research/visible/visible_human.html). The male data set consists of MRI, CT and anatomical images. Axial MRI images of the head and neck and longitudinal sections of the rest of the body are available at 4 mm intervals. The MRI images have 256 pixel by 256 pixel resolution. Each pixel has 12 bits of gray tone resolution. The CT data consists of axial CT scans of the entire body taken at 1 mm intervals at a resolution of 512 pixels by 512 pixels where each pixel is made up of 12 bits of gray tone. The axial anatomical images are 2048 pixels by 1216 pixels where each pixel is defined by 24 bits of color. The anatomical cross sections are also at 1 mm intervals and coincide with the CT axial images. There are 1871 cross sections. The XFDTD™ High Fidelity Body Mesh uses 5x5x5 mm cells and has dimensions 136 x 87 x 397. Dr. Michael Smith and Dr. Chris Collins of the Milton S. Hershey Medical Center, Hershey, Pa, created the High Fidelity Body mesh. Details of body model creation are given in the *methods* section in [5]. The body mesh contains 23 tissues materials. Measured values for the tissue parameters for a broad frequency range are included with the mesh data. The correct values are interpolated from the table of measured data and entered into the appropriate mesh variables. The tissue conductivity and permittivity variation *vs.* frequency is included in the XFDTD™ calculation by a multiple-pole approximation to the Cole-Cole approximated tissue parameters reported by Camelia Gabriel, Ph.D., and Sami Gabriel, M. Sc. (http://www.brooks.af.mil/AFRL/HED/hedr/reports/dielectric/home.html).

One example of the accuracy of XFDTD™ for computing SAR has been provided in [6]. The study reported in [6] is relative to a large-scale benchmark of measurement and computational tools carried out within the IEEE Standards Coordinating Committee 34, Sub-Committee 2.

5) Tissue dielectric parameters

a) The following table reports the dielectric properties used by XFDTD™ for the 23 body tissue materials in the High Fidelity Body Mesh at 160 MHz.

#	Tissue	ε_r	σ (S/m)	Density (kg/m^3)
1	skin	50.1	0.49	1125
2	tendon, pancreas, prostate, aorta, liver, other	59.0	0.63	1151
3	fat, yellow marrow	5.8	0.04	943
4	cortical bone	15.4	0.08	1850
5	cancellous bone	25.8	0.17	1080
6	blood	63.9	1.65	1057
7	muscle, heart, spleen, colon, tongue	73.1	0.85	1059
8	gray matter, cerebellum	70.6	0.74	1035.5
9	white matter	50.8	0.42	1027.4
10	CSF	74.0	2.29	1000
11	sclera/cornea	61.5	0.94	1151
12	vitreous humor	68.5	1.52	1000
13	bladder	19.0	0.28	1132
14	nerve	43.6	0.41	1112
15	cartilage	53.4	0.53	1171
16	gall bladder bile	86.0	1.50	928
17	thyroid	65.6	0.72	1035.5
18	stomach/esophagus	78.3	1.03	1126
19	lung	52.2	0.59	563
20	kidney	72.0	1.02	1147
21	testis	72.3	0.99	1158
22	lens	57.1	0.61	1163
23	small intestine	88.8	1.86	1153

b) The tissue types and dielectric parameters used in the SAR computation are appropriate for determining the highest exposure expected for normal device operation, because they are derived from measurements performed on real biological tissues (http://www.brooks.af.mil/AFRL/HED/hedr/reports/dielectric/home.html).

c) The tabulated list of the dielectric parameters used in phantom models is provided at point 5(a). As regards the device (car plus antenna), we used perfect electric conductors.

6) Transmitter model implementation and validation

a) The essential features that must be modeled correctly for the particular test device model to be valid are:

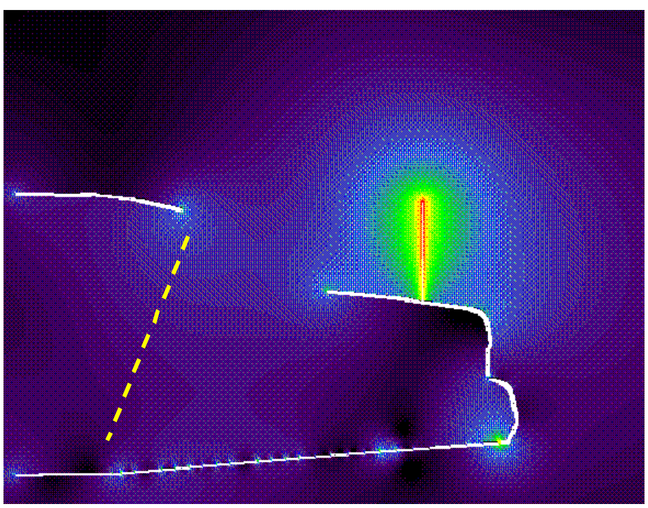
- Car body. We developed one very similar to the car used for MPE measurements, so as to be able to correlate measured and simulated field values. The model was imported in XFDTD™ from a CAD model that is commercially available at http://www.3dcadbrowser.com/
- Antenna. We used a straight wire in all cases.
- Antenna location. We used the same location, used in the MPE measurements.

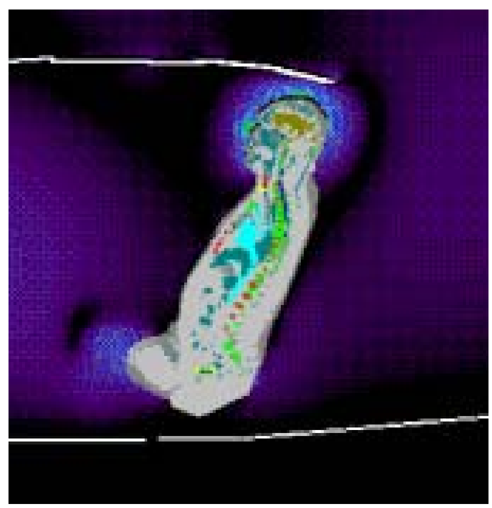
The car model does not include wheels in order to reduce its complexity. The pavement has not been included in the model. The passenger model was validated for similar antenna and frequency conditions by comparing the MPE measurements at one of VHF frequencies (164 MHz) 42 cm monopole antenna used for the VHF mobile radio analyzed previously (FCC ID#ABZ99FT3046). The results are presented below, following definitions for the equivalent power densities (based on E or H-field).

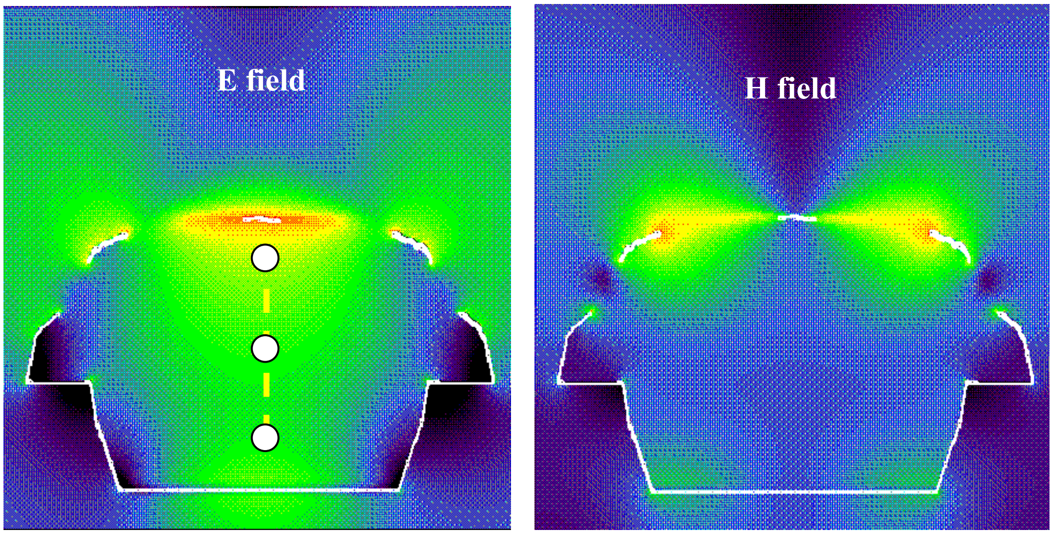
$$S_E = \frac{|\mathbf{E}|^2}{2\eta}, \quad S_H = \frac{\eta}{2}|\mathbf{H}|^2, \quad \eta = 377\,\Omega$$

<u>Passenger with 42 cm monopole antenna (HAD4009A 164 MHz)</u>

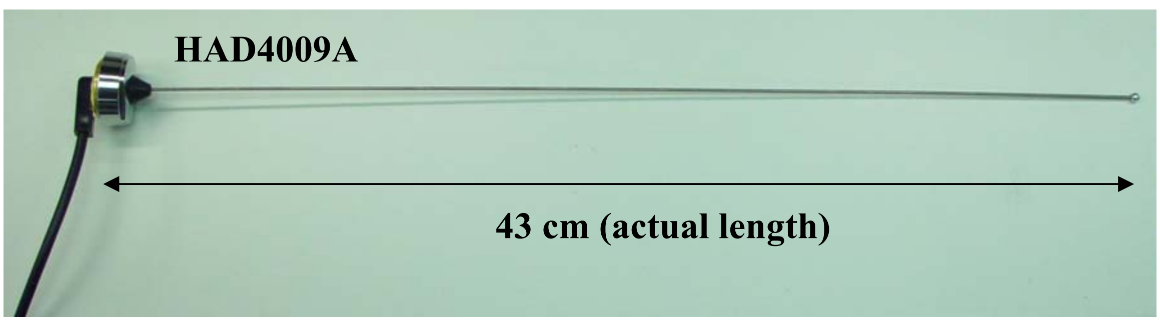
The following figures of the test model show the empty car model, where the yellow dotted line represents the back seat, as it can be observed from the right-hand side figure showing the passenger. The comparison has been performed by taking the computed steady-state field values at the locations corresponding to the head, chest, and legs along the yellow line and comparing them with the corresponding measurements. Such a comparison is carried out at the same rms power level (56.5 W) used in the measurements. Steady-state E-field and H-field distributions at a vertical plane transverse to the car and crossing the passenger's head are displayed as well. Finally, a picture of the antenna is shown.







The highest exposure occurs in the middle of the backseat, which is also the case in the measurements. Therefore, the field values were determined on the yellow line centered at the middle of the backseat, approximately at the three locations that are shown by white dots. In actuality, the line is inclined so as to follow the inclination of the passenger's back, as shown previously.



Because the peak exposure occurs in the center of the back seat, that was where we placed the passenger model to perform the SAR evaluations presented in the report. However, it can be observed that the H-field distribution features peaks near the lateral edges of the rear window. That is the reason why we also carried out one SAR computation by placing the passenger laterally in the back seat, in order to determine whether the SAR would be higher in this case.

As done in the measurements, the equivalent power density (S) is computed from the E-field, the H-field being much lower. The following table reports the E-field values computed by XFDTD™ at the three locations, and the corresponding power density.

Location	E-field magnitude (V/m)	S (W/m^2)
Head	1.0	1.33E-03
Chest	0.45	2.69E-04
Lower Trunk area	0.32	1.36E-04
	Average S	**5.77E-04**

The input impedance is 28.2-j27 ohm, therefore the radiated power (considering the mismatch to the 50 ohm unitary voltage source) is 2.06E-3 W. The scaled-up power density for 56.5 W radiated power is 15.8 W/m^2, corresponding to 1.58 mW/cm^2. Measurements gave an average of 1.29 mW/cm^2, which is in good agreement.

The simulations tend to overestimate the average power density levels, which is understandable since there are no ohmic losses and perfect impedance matching is enforced in the computational models. Based on these results, we conclude that the simulation will produce slight exposure overestimates (about 22%).

b) Descriptions and illustrations showing the correspondence between the modeled test device and the actual device, with respect to shape, size, dimensions and near-field radiating characteristics, are found in the main report.

c) Verification that the test device model is equivalent to the actual device for predicting the SAR distributions descends from the fact that the car and antenna size and location in the numerical model correspond to those used in the measurements.

d) The peak SAR is in the neck region for the passenger, which is in line with MPE measurements and predictions.

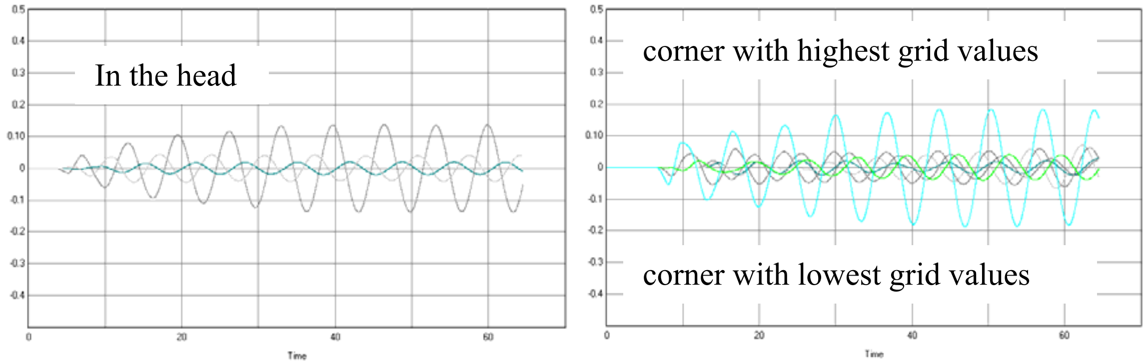
7) Test device positioning

a) A description of the device test positions used in the SAR computations is provided in the SAR report.

b) Illustrations showing the separation distances between the test device and the phantom for the tested configurations are provided in the SAR report.

8) Steady state termination procedures

a) The criteria used to determine that sinusoidal steady-state conditions have been reached throughout the computational domain for terminating the computations are based on the monitoring of field points to make sure they converge. We placed the "field sensor" between the car and the domain boundary at different locations, and one inside the head of the model. We used isotropic E and H field "sensors", meaning that all three components of the fields are monitored at these points. The following figures show an example of the time waveforms at the field point sensors in the head and in two opposite points in the computational domain. In the latter case, we selected points near the lowest and highest grid index points. They are shown together in the figure. The highest field levels are observed for the higher index point, as it is closer to the antenna. In all cases, the field reaches the steady-state after a few cycles.



b) 6000 time steps were used, with a time step approximately equal to 10 *ps* (meeting the Courant criterion), which corresponds to approximately 9 wave cycles at 149 MHz.

c) The XFDTD™ algorithm determines the field phasors by using the so-called "two-equations two-unknowns" method. Details of the algorithm are explained in [7].

9) Computing peak SAR from field components

a) The twelve E-field phasors at the edges of each Yee voxel are combined to yield the SAR associated to that voxel. In particular, the average is performed on the SAR values computed at the 12 edges of each voxel. Notice that in XFDTD™ the dielectric tissue properties are assigned to the voxel edges, thereby allowing said averaging procedure.

b) The IEEE Standards Coordinating Committee 34, Sub-Committee 2 draft standard P1529 (June 2000) discusses several algorithms for volumetric SAR averaging. It states that "It is observed that while the 12 components algorithm is the most appropriate from the mathematical point of view, the differences in 1g SAR calculated with either the 12 or 6 component methods are negligible for practical mesh resolutions (below 5mm). On the other hand, it is shown that the 3 components approach may lead to significant errors." XFDTD™ employs the 12-component method, which is the one recommended in the draft standard, thus providing the best achievable accuracy.

10) One-gram averaged SAR procedures

a) XFDTD™ computes the Specific Absorption Rate (SAR) in each complete cell containing lossy dielectric material and with a non-zero material density. To be considered a complete cell, the twelve cell edges must belong to lossy dielectric materials. The averaging calculation uses an interpolation scheme for finding the averages. Cubical spaces centered on a cell are formed and the mass and average SAR of the sample cubes are found. The size of the sample cubes increases until the total mass of the enclosed exceeds either 1 or 10 grams. The mass and average SAR value of each cube is saved and used to interpolate the average SAR values at either 1 or 10 grams. The interpolation is performed using two methods (polynomial fit and rational function fit) and the one with the lowest error is chosen. The sample cube must meet some conditions to be considered valid. The cube may contain some non-tissue cells, but some checks are performed on the distribution of the non-tissue cells. A valid cube will not contain an entire side or corner of non-tissue cells.

b) The sample cube increases in odd-numbered steps (1x1x1, 3x3x3, 5x5x5, etc) to remain centered on the desired cell. Since the visible human model employed herein has 5 mm resolution, the one-gram SAR is computed by averaging first over 1x1x1 voxels, corresponding to 0.125 cm^3 (not enough yet), and then over a 3x3x3 voxel cube, corresponding to about 3.4 cm^3, which is enough to include 1-g, and finally over a 5x5x5 voxel cube, corresponding to about 15.6 cm^3, which includes 10-g. The 1-g average SAR is computed by interpolating these three data points. This procedure is repeated in the surroundings of each voxel that is constituted by lossy materials, so as to determine the 1-g and/or 10-g SAR distributions.

c) As mentioned at points 10(a) and 10(b), the 1- gram average SAR is determined by interpolating the average SAR for the 1x1x1 , 3x3x3, and the 5x5x5 data points, corresponding to 0.125 cm^3, 3.4 cm^3, and 15.6 cm^3, respectively. Because the interpolation is carried out across three data points, the error introduced should be negligible because the interpolating curve crosses exactly the data points.

11) Total computational uncertainty – We derived an estimate for the uncertainty of FDTD methods in evaluating SAR by referring to [6]. In Fig. 7 in [6] it is shown that the deviation between SAR estimates using the XFDTD™ code and those measured with a compliance system are typically within 10% when the probe is away from the phantom surface so that boundary effects are negligible. In that example, the simulated SAR always exceeds the measured SAR.

As discussed in 6(a), a conservative bias has been introduced in the model so as to reduce concerns regarding the computational uncertainty related to the car modeling, antenna modeling, and phantom modeling. The results of the comparison between measurements and simulations presented in 6(a) suggest that the present model produces an overestimate of the exposure. Such a conservative bias should eliminate the need for including uncertainty considerations in the SAR assessment.

12) Test results for determining SAR compliance

a) Illustrations showing the SAR distribution of dominant peak locations produced by the test transmitter, with respect to the phantom and test device, are provided in the SAR report.

b) The input impedance and the total power radiated under the impedance match conditions that occur at the test frequency are provided by XFDTD™. XFDTD™ computes the input impedance by following the method outlined in [8], which consists in performing the integration of the steady-state magnetic field around the feed point edge to compute the steady-state feed point current (*I*), which is then used to divide the feed-gap steady-state voltage (*V*). The net *rms* radiated power is computed as

$$P_{XFDTD} = \frac{1}{2}\mathrm{Re}\left\{VI^*\right\}$$

Both the input impedance and the net rms radiated power are provided by XFDTD™ at the end of each individual simulation.

We normalize the SAR to such a power, thereby obtaining SAR per radiated Watt (*normalized SAR*) values for the whole body and the 1-g SAR. Finally, we multiply such normalized SAR values times the max power rating of the device under test. In this way, we obtain the exposure metrics for 100% talk-time, i.e., without applying source-based time averaging.

c) For mobile radios, 50% source-based time averaging is applied by multiplying the SAR values determined at point 12(b) times a 0.5 factor.

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