MOTOROLA SOLUTIONS

ACCREDITED
TESTING CERT # 2518.01

DECLARATION OF COMPLIANCE: MPE/SAR ASSESSMENT

EME Test Laboratory
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Date of Report: March 6, 2013
Report Revision: O
Report ID: SR11083 MPE Auto rpt XPR 2500 VHF Rev O 130306

Responsible Engineer:	Stephen C. Whalen (Principal Staff EME Test Engineer)
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Date(s) Tested:	11/26/2012 - 11/28/2012; 12/4/2012 - 12/5/2012; 12/7/2012; 2/12/2013
Manufacturer/Location:	Motorola Solutions, Schaumburg, IL
Date submitted for test:	11/07/2012
DUT Description:	XPR 2500 VHF 136-174 MHz, 25-45W, Radio with Alphanumeric Display Control Head
Test TX mode(s):	CW
Max. Power output:	54W
TX Frequency Bands:	136-174MHz
Signaling type:	Analog [FM] and TDMA 1:2 [4FSK]
Model(s) Tested:	PMUD3240A
Model(s) Certified:	PMUD3240A
Serial Number(s):	776TNV0131
Classification:	Occupational/Controlled Environment
FCC ID:	ABZ99FT3091 Part 22 & 90 VHF (150.8-173.4MHz) Results outside FCC bands are not applicable for FCC compliance demonstration.
IC:	109AB-99FT3091 IC bands; VHF (138-174MHz) Results outside IC bands are not applicable for IC compliance demonstration.

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 the national and international reference standards and guidelines listed in section 3.0 of this report. This report shall not be reproduced without written approval from an officially designated representative of the Motorola Solutions Inc. EME Laboratory.
I attest to the accuracy of the data and assume full responsibility for the completeness of these measurements.
This reporting format is consistent with the suggested guidelines of the TIA TSB-159 April 2006
The results and statements contained in this report pertain only to the device(s) evaluated herein.

Deanna Zakharia
EME Lab Senior Resource Manager and Laboratory Director

Approval Date: 3/12/2013

Certification Date: 3/12/2013

Certification No.: L1130305P

Document Revision History

Date	Revision	Comments
03/06/2013	O	Initial release

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1.0 Introduction

This report details the test setup, test equipment and test results of Maximum Permissible Exposure (MPE) performed at Motorola Solutions' outside test site and Specific Absorption Rate (SAR) simulations for product model PMUD3240A.

2.0 Abbreviations / Definitions

BS: Bystander
CNR: Calibration Not Required
CW: Continuous Wave
DUT: Device Under Test
EME: Electromagnetic Energy
4FSK: 4 Level Frequency Shift Keying
FM: Frequency Modulation
MPE: Maximum Permissible Exposure
NA: Not Applicable
PB: Passenger Backseat
PF: Passenger Front seat
PTT: Push to Talk
SAR: Specific Absorption Rate
TDMA: Time Division Multiple Access

3.0 Referenced Standards and Guidelines

This product is designed to comply with the following applicable national and international standards and guidelines.

- United States Federal Communications Commission, Code of Federal Regulations; Rule Part 47CFR § 1.1310, § 2.1091 (d) and § 2.1093 for RF Exposure, where applicable.
- Federal Communications Commission, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields", OET Bulletin 65, Supplement C (Edition 01-01), FCC, Washington, D.C.: June 2001.
- American National Standards Institute (ANSI) / Institute of Electrical and Electronics Engineers (IEEE) C95. 1-1999
- American National Standards Institute (ANSI) / Institute of Electrical and Electronics Engineers (IEEE) C95. 1-1992. Specific to FCC rules and regulations.
- Institute of Electrical and Electronics Engineers (IEEE) C95.3-2002
- International Commission on Non-Ionizing Radiation Protection (ICNIRP) 1998
- Ministry of Health (Canada) Safety Code 6 (2009), Limits of Human Exposure to Radio frequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz

4.0 Power Density Limits

Table 1 – Occupational / Controlled Exposure Limits

Frequency Range (MHz)	FCC OET Bulletin 65 Supplement C	ICNIRP	IEEE C95.1 1992/1999	IEEE C95.1 2005	RSS 102 issue 4 - 2010
	mW/cm^2	W/m^2	mW/cm^2	W/m^2	W/m^2
30 - 300	1.0				*10.0
10 - 400		10.0			
100 - 300			1.0	10.0	
300 - 1,500	f/300				f/30
300 - 3,000			f/300	f/30	
400 - 2,000		f/40			
1,500 - 15,000					50.0
1,500 - 100,000	5.0				
2,000 – 300,000		50.0			
3,000 - 300,000			10.0	100.0	

*Power density limit is applicable at frequencies greater than 100MHz

Table 2 – General Population / Uncontrolled Exposure Limits

Frequency Range (MHz)	FCC OET Bulletin 65 Supplement C	ICNIRP	IEEE C95.1 1992/1999	IEEE C95.1 2005	RSS 102 issue 4 – 2010
	mW/cm^2	W/m^2	mW/cm^2	W/m^2	W/m^2
30 – 300	0.2				*2.0
10 – 400		2.0			
100 – 300			0.2		
100 – 400				2.0	
300 – 1,500	f/1,500				f/150
400 – 2,000		f/200		f/200	
300 – 15,000			f/1,500		
1,500 – 15,000					10.0
1,500 – 100,000	1.0				
2,000 – 100,000				10.0	
2,000 – 300,000		10.0			

*Power density limit is applicable at frequencies greater than 100MHz

5.0 N_c Test Channels

The number of test channels are determined by using Equation 1 below. This equation is available in FCC's KDB 447498. The test channels are appropriately spaced across the antenna's frequency range.

Equation 1 – Number of test channels
$N_c = \text{Round}\ \{[100(f_{high} - f_{low})/f_c]^{0.5} \times (f_c / 100)^{0.2}\}$

where N_c is the number of test channels, f_{high} and f_{low} are the highest and lowest frequencies within the transmission band, f_c is the mid-band frequency, and frequencies are in MHz.

6.0 Measurement Equipment

Table 3 – Equipment

Equipment Type	Model #	SN	Calibration Date	Calibration Due Date
Automobile	2003 Ford Crown Victoria, 4-Door	NA	NA	NA
Survey Meter Probe – E-Field Probe - H-Field	ETS Model HI-2200 ETS Model E100 ETS Model H200	00086316 00109011 00142394	08/15/2012	08/15/2013

E-field measurements are in mW/cm^2.
H-field measurements are in A/m.

7.0 Measurement System Uncertainty Levels

Table 4 - Uncertainty Budget for Near Field Probe Measurements

	Tol. (± %)	Prob. Dist.	Divisor	u_i (±%)	v_i
Measurement System					
Probe Calibration	6.0	N	1.00	6.0	∞
Survey Meter Calibration	3.0	N	1.00	3.0	∞
Hemispherical Isotropy	8.0	R	1.73	4.6	∞
Linearity	5.0	R	1.73	2.9	∞
Pulse Response	1.0	R	1.73	0.6	∞
RF Ambient Noise	3.0	R	1.73	1.7	∞
RF Reflections	8.0	R	1.73	4.6	∞
Probe Positioning	10.0	R	1.73	5.8	∞
Test sample Related					
Antenna Positioning	3.0	N	1.00	3.0	∞
Power drift	5.0	R	1.73	2.9	∞
Combined Standard Uncertainty		RSS		12.2	∞
Expanded Uncertainty (95% CONFIDENCE LEVEL)		k=2		24	

8.0 Product and System Description

Model PMUD3240A is a mobile transceiver that utilizes analog and digital two-way radio communications. The analog modulation scheme uses Frequency Modulation (FM). Digital modes use 4FSK modulation (4-Level Frequency Shift Keying) and a TDMA 1:2 protocol that allocates portions of the RF signal by dividing time into two slots (2 slots TDMA). Transmission from a unit or base station is accommodated in time-slot lengths of 30 milliseconds and frame lengths of 60 milliseconds. This product supports voice in analog mode, and both voice and data modes in digital mode.

The maximum duty cycle for TDMA is 1:2 (50%) and is controlled by software. The FM signal is continuous. However, because of hand shaking or Push-To-Talk (PTT) between users and/or base stations a conservative 50% duty cycle is applied. The TDMA mode was not tested because its duty cycle is inherently 50% and would include an additional 50% duty cycle for PTT.

The intended use of the radio is PTT while the device is properly installed in a vehicle with an external antenna mounted at 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.

Accordingly this product 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.

(Note that “Bystanders” as used herein are people other than operator)

9.0 Additional Options and Accessories

Refer to Table 5 for complete list of tested antennas.

10.0 Test Set-Up Description

Assessments were performed with mobile radio installed in the test vehicle while engine was at idle, at the specified distances and test locations indicated in sections 11.0, 12.0 and Appendix A.

All antennas described in Table 5 were considered in order to develop the test plan for this product. Antennas were installed and tested per their appropriate mount locations (Roof / Trunk) and defined test channels.

11.0 Method of Measurement with trunk mounted antenna(s)

11.1 External/Bystander vehicle MPE measurements

Antenna is located at the center of the trunk. Refer to Appendix A for antenna location and distance.

MPE measurements for bystander (BS) conditions are determined by taking the average of (10) measurements in a 2 m vertical line for each of the (3) bystander test locations indicated in Appendix A with 20 cm height increments, with antenna to probe sensor separation distances of 90 cm directly behind vehicle and 104 cm (45 degree radial) and 110.5 cm (90 degree radial). The separation distance used for testing is defined from the antenna where as the RF safety booklet defines the same distance from the vehicle body to ensure that the assessment is applicable to other vehicles The measurement probe is positioned orthogonal to antenna (typically parallel to ground with a vertically mounted antenna) and aimed directly at the antenna's axis. These measurements are representative of persons other than the operator standing next to the vehicle.

Each of the offered antennas mounted at the center of the trunk were assessed at the rear of the vehicle while maintaining a minimum of twenty (20) centimeter separation distance between the probe sensor and vehicle body. The worst case antenna was then tested at a 45º radial at the corner of the trunk, and 90º radial at the side of the trunk.

Note: The distance from the centered trunk-mounted antenna to the rear edge of the vehicle is 42cm and the distance from the rear edge of the vehicle to the survey probe sensor is 48cm.

11.2 Internal/Passenger vehicle MPE measurements

Antenna is located toward the center of the trunk at a minimum 85cm from backseat passenger. Users are instructed, per installation manual, to mount antennas on the roof only if a minimum 85cm cannot be achieved. Refer to Appendix A for antenna location and distance.

MPE measurements for passenger front seat (PF) and backseat (PB) conditions are determined by taking the average of the (3) measurements (Head, Chest, and Lower Trunk) inside the vehicle for both the front and back seats.

The backseat is a bench seat and therefore each position (Head, Chest & Lower Trunk) were scanned across (horizontally) the seat starting from the middle of the seat to the edge of the seat stopping 20 cm from the vehicle door. Similar process was used in the front bucket seat.

The probe handle is oriented parallel (horizontal) to the ground and pointed towards the back of the vehicle. The probe handle is not oriented normal to the seat surface. The probe head (incorporating the field sensors) is scanned continuously (using the max-hold function available in the meter) along three test axes which are parallel to the seat angle (intended as the line determined by the intersection of the plane of the seat and the plane of the backrest) and are 20 cm from the seat surface. One test axis is at the Head height, another is at the Chest height, and another is at the Lower Trunk height. The maximum field level value recorded for each test axis is logged. The MPE is determined by averaging these three maximum values regardless of the geometrical location where they were observed.

For instance, the locations of the three maxima may lie on different vertical (relative to ground) lines.

This approach leads to results that are representative of the exposure of vehicle occupants since it is based on an average across the body portions closest to the antenna for both trunk and roof mount positions, and is conservatively biased because the highest results for each test axis are combined, e.g. the highest head exposure could be in the middle of the seat while the highest lower trunk exposure could be closer to the door.

12.0 Method of Measurement with roof mounted antenna(s)

12.1 External/Bystander vehicle MPE measurements

Antenna is located at the center of the roof. Refer to Appendix A for antenna location and distance.

MPE measurements for bystander (BS) conditions are determined by taking the average of (10) measurements in a 2m vertical line for the test location indicated in Appendix A with 20cm increments at the test distance of 117cm from the antenna under test. The measurement probe is positioned orthogonal to antenna (typically parallel to ground with a vertically mounted antenna) and aimed directly at the antenna's axis. These measurements are representative of persons other than the operator standing next to the vehicle.

Note: Actual test distance was approximately 117cm from centered roof-mounted antenna to the probe element (97cm from antenna to edge of car door and 20cm from the edge of the car door to the survey probe sensor); this is the closest distance that can be achieved to a centered roof-mounted antenna used for MPE compliance assessment herein.

12.2 Internal/Passenger vehicle MPE measurements

Antenna is located at the center of the roof. Refer to Appendix A for antenna location and distance.

MPE measurements for passenger front seat (PF) and backseat (PB) conditions are determined by taking the average of the (3) measurements (Head, Chest, and Lower Trunk) inside the vehicle for both the front and back seats.

The backseat is a bench seat and therefore each position (Head, Chest & Lower Trunk) were scanned across (horizontally) the seat starting from the middle of the seat to the edge of the seat stopping 20 cm from the vehicle door. Similar process was used in the front bucket seat.

The probe handle is oriented parallel (horizontal) to the ground and pointed towards the back of the vehicle. The probe handle is not oriented normal to the seat surface. The probe head (incorporating the field sensors) is scanned continuously (using the max-hold function available in the meter) along three test axes which are parallel to the seat angle (intended as the line determined by the intersection of the plane of the seat and the plane of the backrest) and are 20 cm from the seat surface. One test axis is at the Head height, another is at the Chest height, and another is at the Lower Trunk height. The maximum field level value recorded for each test axis is logged. The MPE is determined by averaging these three maximum values regardless of the geometrical location where they were observed. For instance, the locations of the three maxima may lie on different vertical (relative to ground) lines.

This approach leads to results that are representative of the exposure of vehicle occupants since it is based on an average across the body portions closest to the antenna for both trunk and roof mount positions, and is conservatively biased because the highest results for each test axis are combined, e.g. the highest head exposure could be in the middle of the seat while the highest lower trunk exposure could be closer to the door.

13.0 MPE Calculations

The final MPE results for this mobile radio are presented in section 15.0 Tables 6 - 13. These results are based on 50% duty cycle for PTT.

Below is an explanation of how the MPE results are calculated. Refer to Appendix D for MPE measurement results and calculations.

External to vehicle (Bystander) - 10 measurements are averaged over the body (*Avg_over_body*).
Internal to vehicle (Passengers) - 3 measurements are averaged over the body (*Avg_over_body*).

The Average over Body test methodology is consistent with IEEE/ANSI C95.3-2002 guidelines.

Therefore;

Equation 2 – Power Density Calculation *(Calc._P.D.)*

$$Calc.\_P.D. = (Avg\_over\_body) * (probe\_frequency\_cal\_factor) * (duty\_cycle)$$

Note1: The highest "average" cal factors from the calibration certificates were selected for the applicable frequency range. Linear interpretation was used to determine "probe_frequency_cal_factor" for the specific test frequencies.

Note 2: The E-field probe calibration certificate's frequency cal factors were determined by measuring V/m. The survey meter's results were measured in power density (mW/cm^2) and therefore the "probe_frequency_cal_factor" was squared in equation 2 to account for these results.

Note 3: The H-field probe calibration certificate's frequency cal factors were determined by measuring A/m. The survey meter's results were measured in A/m and therefore the "Avg_over_body" A/m results were converted to power density (mW/cm^2) using the equation 3. H-field measurements are only applicable to frequencies below 300MHz.

Equation 3 – Converting A/m to mW/cm^2

$$mW / cm\^{}2 = (A / m)\^{}2 * 37.699$$

Equation 4 – Power Density Maximum Calculation

$$Max\_Calc.\_P.D. = P.D.\_calc * \frac{\max\_output\_power}{initial\_output\_power}$$

Note 4: For initial output power> max_output_power; max_output_power / initial output power = 1

14.0 Antenna Summary

Table 5 below summarizes the tested antennas and their descriptions, mount location (roof/trunk), overlap of FCC bands, number of test channels per FCC KDB 447498 (FCC N_c) and actual number of tested channels (Actual N_c). This information was used to determine the test configurations presented in this report.

Table 5

#	Antenna Model	Frequency Range (MHz)	Physical Length (cm)	Gain (dBi)	Remarks	Mount Location (Roof/Trunk)	Overlap FCC Bands	FCC N_c	Actual N_c
1	HAD4006A	136-144	52.0	2.15	1/4 wave, wire	R	NA	NA	3
2	HAD4007A	146-150.8	49.0	2.15	1/4 wave, wire	R	150.8	1	3
3	HAD4008A	150.8-162	45.5	2.15	1/4 wave, wire	R	150.8-162	3	3
4	HAD4009A	162-174	43.0	2.15	1/4 wave, wire	R	162-173.4	3	3
5	*HAD4022A	132-174	130.0 118.3 113.8 102.7 96.5 89.9	5.15	5/8 wave, wire	R/T	150.8-173.4	5	6

* Antennas trimmed per test frequency.

15.0 Test Results Summary

The following tables below summarize the MPE results for each test configuration: antenna location, test positions (BS-Bystander, PB-Passenger Backseat, PF-Passenger Front seat), E/H field measurements, angle, antenna model & freq. range, maximum output power, initial power, TX frequency, max calculated power density results, applicable FCC/IEEE/ICNIRP specification limits and % of the applicable specification limits.

Table 6

Bystander MPE assessment for trunk mounted antennas

Trunk/ Roof	Test Position	E/H Field	Angle (Degree)	Antenna Model	Max Pwr (W)	Initial Pwr (W)	Tx Freq (MHz)	Max Calc. P.D. (mW/ cm^2)	FCC & ICNIRP Limit	% To Spec Limit
Trunk	BS	E	0	HAD4022A (132-174MHz)	54.0	52.1	138.0125	0.10	0.20	51.4
						52.5	144.4000	0.11	0.20	56.3
						53.0	150.8000	0.10	0.20	51.3
						53.0	158.3000	0.10	0.20	51.4
						53.0	165.9000	0.11	0.20	54.5
						52.1	173.4000	0.12	0.20	59.1
			45			52.1	173.4000	0.15	0.20	74.1
			90			52.1	173.4000	0.14	0.20	69.4

Table 7

Passenger MPE assessment for trunk mounted antennas

Trunk/ Roof	Test Position	E/H Field	Angle (Degree)	Antenna Model	Max Pwr (W)	Initial Pwr (W)	Tx Freq (MHz)	Max Calc. P.D. (mW/ cm^2)	FCC & ICNIRP Limit	% To Spec Limit
Trunk	PB	E	NA	HAD4022A (132-174MHz)	54.0	52.1	138.0125	0.04	0.20	19.4
						52.5	144.4000	0.12	0.20	59.8
						53.0	150.8000	0.24	0.20	118.4*
						53.0	158.3000	0.32	0.20	160.5*
						53.0	165.9000	0.43	0.20	215.6*
						52.1	173.4000	0.28	0.20	140.1*

* Test configuration exceeds MPE FCC/ICNIRP spec limit.

Table 7 (continued)
Passenger MPE assessment for trunk mounted antennas

Trunk/ Roof	Test Position	E/H Field	Angle (Degree)	Antenna Model	Max Pwr (W)	Initial Pwr (W)	Tx Freq (MHz)	Max Calc. P.D. (mW/ cm^2)	FCC & ICNIRP Limit	% To Spec Limit
Trunk	PF	E	NA	HAD4022A (132-174MHz)	54.0	52.1	138.0125	0.01	0.20	3.9
						52.5	144.4000	0.02	0.20	12.0
						53.0	150.8000	0.04	0.20	22.5
						53.0	158.3000	0.03	0.20	14.7
						53.0	165.9000	0.05	0.20	23.5
						52.1	173.4000	0.07	0.20	37.1

Table 8
Bystander MPE assessment for trunk mounted antennas

Trunk/ Roof	Test Position	E/H Field	Angle (Degree)	Antenna Model	Max Pwr (W)	Initial Pwr (W)	Tx Freq (MHz)	Max Calc. P.D. (mW/ cm^2)	FCC & ICNIRP Limit	% To Spec Limit
Trunk	BS	H	0	HAD4022A (132-174MHz)	54.0	52.1	138.0125	0.07	0.20	36.6
						52.5	144.4000	0.09	0.20	45.5
						53.0	150.8000	0.10	0.20	50.9
						53.0	158.3000	0.10	0.20	47.8
						53.0	165.9000	0.11	0.20	52.9
						52.1	173.4000	0.11	0.20	55.1
			45			52.1	173.4000	0.18	0.20	89.6
			90			52.1	173.4000	0.18	0.20	88.9

Table 9

Passenger MPE assessment for trunk mounted antennas

Trunk/ Roof	Test Position	E/H Field	Angle (Degree)	Antenna Model	Max Pwr (W)	Initial Pwr (W)	Tx Freq (MHz)	Max Calc. P.D. (mW/ cm^2)	FCC & ICNIRP Limit	% To Spec Limit
Trunk	PB	H	NA	HAD4022A (132-174MHz)	54.0	52.1	138.0125	0.06	0.20	32.1
						52.5	144.4000	0.13	0.20	64.1
						53.0	150.8000	0.17	0.20	86.0
						53.0	158.3000	0.21	0.20	106.5*
						53.0	165.9000	0.29	0.20	146.0*
						52.1	173.4000	0.22	0.20	109.0*
	PF	H	NA	HAD4022A (132-174MHz)	54.0	52.1	138.0125	0.01	0.20	4.5
						52.5	144.4000	0.02	0.20	11.0
						53.0	150.8000	0.05	0.20	27.1
						53.0	158.3000	0.02	0.20	10.5
						53.0	165.9000	0.03	0.20	14.2
						52.1	173.4000	0.04	0.20	20.7

* Test configuration exceeds MPE FCC/ICNIRP spec limit.

Table 10

Bystander MPE assessment for roof mounted antennas

Trunk/ Roof	Test Position	E/H Field	Angle (Degree)	Antenna Model	Max Pwr (W)	Initial Pwr (W)	Tx Freq (MHz)	Max Calc. P.D. (mW/ cm^2)	FCC & ICNIRP Limit	% To Spec Limit
Roof	BS	E	NA	HAD4006A (136-144MHz)	54.0	52.1	138.0125	0.06	0.20	28.5
						52.3	140.0125	0.06	0.20	30.3
						53.8	143.9875	0.06	0.20	30.1
				HAD4007A (146-150.8MHz)	54.0	52.9	146.0125	0.06	0.20	31.2
						53.0	148.4000	0.06	0.20	32.0
						53.0	150.8000	0.06	0.20	30.7
				HAD4008A (150.8-162MHz)	54.0	53.0	150.8000	0.06	0.20	28.1
						53.7	156.4000	0.06	0.20	32.2
						53.4	162.0000	0.06	0.20	29.3
				HAD4009A (162-174MHz)	54.0	53.5	162.0125	0.05	0.20	27.5
						53.3	167.7000	0.06	0.20	32.4
						52.1	173.4000	0.06	0.20	32.4
				HAD4022A (132-174MHz)	54.0	52.1	138.0125	0.04	0.20	19.6
						52.5	144.4000	0.04	0.20	21.9
						53.0	150.8000	0.05	0.20	25.1
						53.0	158.3000	0.05	0.20	25.7
						53.0	165.9000	0.06	0.20	28.3
						52.1	173.4000	0.06	0.20	30.2

Table 11

Passenger MPE assessment for roof mounted antennas

Trunk/ Roof	Test Position	E/H Field	Angle (Degree)	Antenna Model	Max Pwr (W)	Initial Pwr (W)	Tx Freq (MHz)	Max Calc. P.D. (mW/ cm^2)	FCC & ICNIRP Limit	% To Spec Limit
Roof	PB	E	NA	HAD4006A (136-144MHz)	54.0	52.1	138.0125	0.09	0.20	45.4
						52.3	140.0125	0.13	0.20	63.9
						53.8	143.9875	0.11	0.20	56.4
				HAD4007A (146-150.8MHz)	54.0	52.9	146.0125	0.08	0.20	39.6
						53.0	148.4000	0.05	0.20	27.0
						53.0	150.8000	0.08	0.20	38.0
				HAD4008A (150.8-162MHz)	54.0	53.0	150.8000	0.07	0.20	35.9
						53.7	156.4000	0.07	0.20	33.7
						53.4	162.0000	0.05	0.20	24.0
				HAD4009A (162-174MHz)	54.0	53.5	162.0125	0.05	0.20	23.1
						53.3	167.7000	0.06	0.20	27.5
						52.1	173.4000	0.04	0.20	20.1
				HAD4022A (132-174MHz)	54.0	52.1	138.0125	0.04	0.20	21.4
						52.5	144.4000	0.03	0.20	15.1
						53.0	150.8000	0.03	0.20	15.2
						53.0	158.3000	0.01	0.20	6.0
						53.0	165.9000	0.03	0.20	15.7
						52.1	173.4000	0.03	0.20	15.6

Table 11 (continued)

Passenger MPE assessment for roof mounted antennas

Trunk/ Roof	Test Position	E/H Field	Angle (Degree)	Antenna Model	Max Pwr (W)	Initial Pwr (W)	Tx Freq (MHz)	Max Calc. P.D. (mW/ cm^2)	FCC & ICNIRP Limit	% To Spec Limit
Roof	PF	E	NA	HAD4006A (136-144MHz)	54.0	52.1	138.0125	0.03	0.20	16.7
						52.3	140.0125	0.03	0.20	17.1
						53.8	143.9875	0.04	0.20	20.6
				HAD4007A (146-150.8MHz)	54.0	52.9	146.0125	0.04	0.20	19.6
						53.0	148.4000	0.05	0.20	23.6
						53.0	150.8000	0.03	0.20	17.0
				HAD4008A (150.8-162MHz)	54.0	53.0	150.8000	0.03	0.20	15.5
						53.7	156.4000	0.02	0.20	12.5
						53.4	162.0000	0.02	0.20	10.6
				HAD4009A (162-174MHz)	54.0	53.5	162.0125	0.02	0.20	10.8
						53.3	167.7000	0.02	0.20	8.1
						52.1	173.4000	0.01	0.20	6.5
				HAD4022A (132-174MHz)	54.0	52.1	138.0125	0.01	0.20	4.2
						52.5	144.4000	0.01	0.20	5.3
						53.0	150.8000	0.01	0.20	6.2
						53.0	158.3000	0.01	0.20	4.4
						53.0	165.9000	0.01	0.20	4.7
						52.1	173.4000	0.01	0.20	6.5

Table 12

Bystander MPE assessment for roof mounted antennas

Trunk/ Roof	Test Position	E/H Field	Angle (Degree)	Antenna Model	Max Pwr (W)	Initial Pwr (W)	Tx Freq (MHz)	Max Calc. P.D. (mW/ cm^2)	FCC & ICNIRP Limit	% To Spec Limit
Roof	BS	H	NA	HAD4006A (136-144MHz)	54.0	52.1	138.0125	0.06	0.20	28.5
						52.3	140.0125	0.06	0.20	28.0
						53.8	143.9875	0.06	0.20	30.4
				HAD4007A (146-150.8MHz)	54.0	52.9	146.0125	0.05	0.20	24.2
						53.0	148.4000	0.05	0.20	25.9
						53.0	150.8000	0.05	0.20	24.8
				HAD4008A (150.8-162MHz)	54.0	53.0	150.8000	0.05	0.20	23.3
						53.7	156.4000	0.06	0.20	28.5
						53.4	162.0000	0.05	0.20	25.4
				HAD4009A (162-174MHz)	54.0	53.5	162.0125	0.05	0.20	24.2
						53.3	167.7000	0.05	0.20	27.3
						52.1	173.4000	0.06	0.20	28.5
				HAD4022A (132-174MHz)	54.0	52.1	138.0125	0.03	0.20	14.7
						52.5	144.4000	0.03	0.20	14.9
						53.0	150.8000	0.04	0.20	18.2
						53.0	158.3000	0.04	0.20	19.5
						53.0	165.9000	0.04	0.20	21.2
						52.1	173.4000	0.05	0.20	24.4

Table 13

Passenger MPE assessment for roof mounted antennas

Trunk/ Roof	Test Position	E/H Field	Angle (Degree)	Antenna Model	Max Pwr (W)	Initial Pwr (W)	Tx Freq (MHz)	Max Calc. P.D. (mW/ cm^2)	FCC & ICNIRP Limit	% To Spec Limit
Roof	PB	H	NA	HAD4006A (136-144MHz)	54.0	52.1	138.0125	0.06	0.20	30.1
						52.3	140.0125	0.07	0.20	35.9
						53.8	143.9875	0.07	0.20	34.5
				HAD4007A (146-150.8MHz)	54.0	52.9	146.0125	0.04	0.20	18.9
						53.0	148.4000	0.02	0.20	12.1
						53.0	150.8000	0.07	0.20	36.4
				HAD4008A (150.8-162MHz)	54.0	53.0	150.8000	0.07	0.20	33.9
						53.7	156.4000	0.03	0.20	14.0
						53.4	162.0000	0.05	0.20	23.9
				HAD4009A (162-174MHz)	54.0	53.5	162.0125	0.06	0.20	28.7
						53.3	167.7000	0.06	0.20	30.1
						52.1	173.4000	0.03	0.20	15.4
				HAD4022A (132-174MHz)	54.0	52.1	138.0125	0.03	0.20	15.3
						52.5	144.4000	0.03	0.20	12.8
						53.0	150.8000	0.04	0.20	19.1
						53.0	158.3000	0.05	0.20	26.8
						53.0	165.9000	0.04	0.20	22.4
						52.1	173.4000	0.02	0.20	11.8

Table 13 (continued)

Passenger MPE assessment for roof mounted antennas

Trunk/ Roof	Test Position	E/H Field	Angle (Degree)	Antenna Model	Max Pwr (W)	Initial Pwr (W)	Tx Freq (MHz)	Max Calc. P.D. (mW/ cm^2)	FCC & ICNIRP Limit	% To Spec Limit
Roof	PF	H	NA	HAD4006A (136-144MHz)	54.0	52.1	138.0125	0.02	0.20	11.5
						52.3	140.0125	0.03	0.20	15.7
						53.8	143.9875	0.05	0.20	23.4
				HAD4007A (146-150.8MHz)	54.0	52.9	146.0125	0.04	0.20	21.5
						53.0	148.4000	0.04	0.20	21.8
						53.0	150.8000	0.04	0.20	21.8
				HAD4008A (150.8-162MHz)	54.0	53.0	150.8000	0.04	0.20	20.1
						53.7	156.4000	0.02	0.20	12.5
						53.4	162.0000	0.02	0.20	8.2
				HAD4009A (162-174MHz)	54.0	53.5	162.0125	0.02	0.20	8.2
						53.3	167.7000	0.01	0.20	5.8
						52.1	173.4000	0.01	0.20	7.0
				HAD4022A (132-174MHz)	54.0	52.1	138.0125	0.01	0.20	3.1
						52.5	144.4000	0.01	0.20	6.3
						53.0	150.8000	0.01	0.20	7.2
						53.0	158.3000	0.01	0.20	5.8
						53.0	165.9000	0.01	0.20	4.6
						52.1	173.4000	0.01	0.20	4.5

16.0 Conclusion

The assessments for this device were performed with an output power range as indicated in section 15.0 Tables 6 - 13. The maximum allowable output power is equal to the upper limit of the final test factory transmit power specification of 54W .The highest power density results for the mobile device scaled to the maximum allowable power output are indicated in the Tables 14 and 15 for internal/passenger to the vehicle, and external/bystander to the vehicle.

Table 14: Maximum MPE RF Exposure Summary

Designator	Frequency (MHz)	Passenger (mW/cm²)	Bystander (mW/cm²)
Overall	136-174	*0.43	0.18
FCC	150.8-173.4	*0.43	0.18
IC	138-174	*0.43	0.18

These MPE results herein demonstrate compliance to the FCC/IEEE/ICNIRP Occupational/Controlled Exposure limit. FCC rules require compliance for Passengers and Bystanders to the FCC General Population/Uncontrolled limits. Although MPE is a convenient method of demonstrating compliance, SAR is recognized as the "basic restriction". For those configurations exceeding the MPE limit noted * in section 15 Tables 6 thru 13, compliance to the FCC SAR General Population/ Uncontrolled limit of 1.6mW/g is demonstrated in Appendix E via SAR computational analysis.

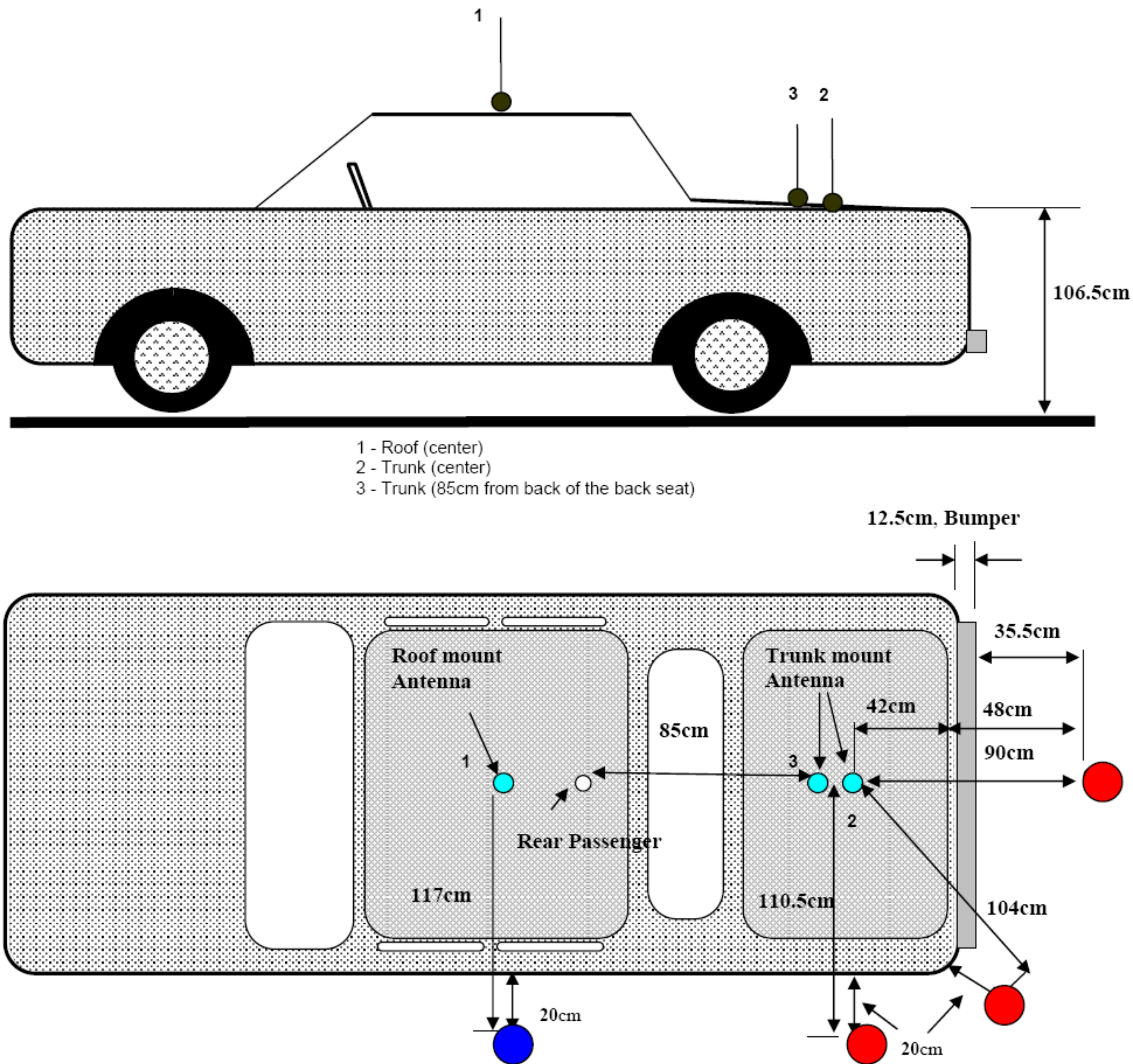
The computational results show that this device, when used with the offered antennas in accordance with the user manual instructions, exhibits the maximum average SAR values as indicated in the table below.

Table 15: Maximum Average SAR Summary

Designator	Frequency (MHz)	SAR 1g (mW/g)	SAR 10g (mW/g)
Overall	136-174	0.46	0.34
FCC	150.8-173.4	0.46	0.34
IC	138-174	0.46	0.34

Appendix A - Illustration of Antenna Locations and Test Distances

90cm Trunk Distance

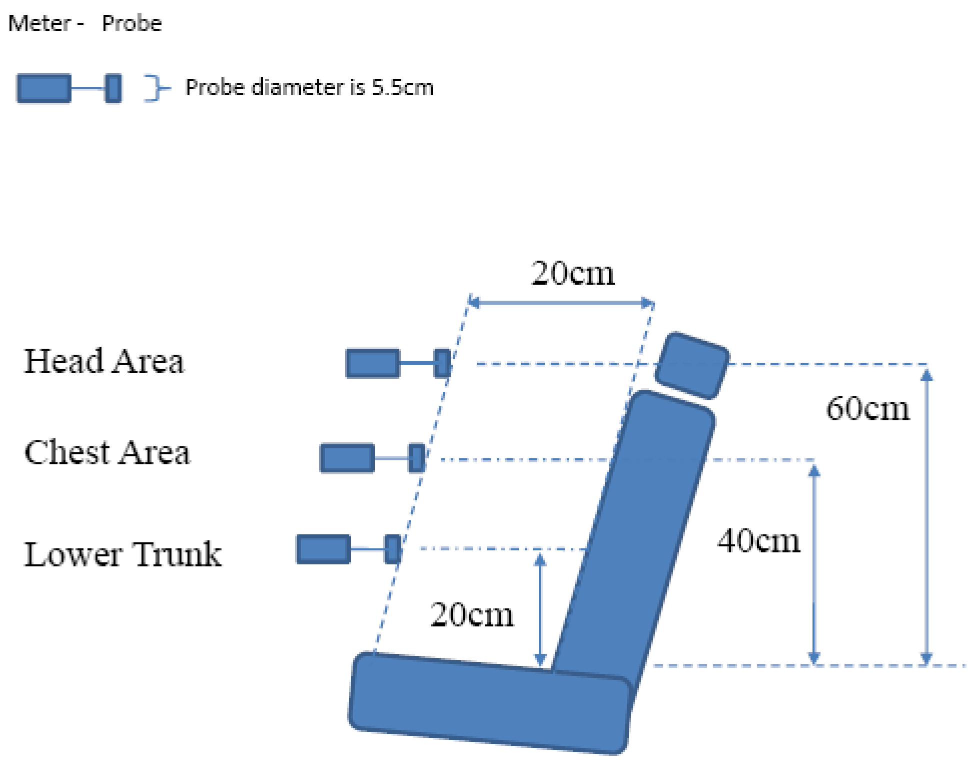


By-Stander Test Locations

- Roof Mount (blue)
- Trunk Mount (red)

Note: The distance from the centered trunk-mounted antenna to the edge of the vehicle is 42cm and the distance from the edge of the vehicle to the survey probe sensor is 48cm.

Seat scan areas
(Applicable to both front and back seats)



Appendix B - Probe Calibration Certificates

Service Test Report
QAF 1126, 03/11
Report ID: 92746

ETS·LINDGREN
An ESCO Technologies Company
1301 Arrow Point Drive
Cedar Park, Texas 78613
(512) 531-6498

ETS·LINDGREN
Tracking #: S000025310
Equipment Check
Attested by TDO Date: 15-Aug-12

Certificate of Test Conformance

Page 1 of 1

Reference: S 000025310

Customer: LOCKHEED MARTIN (MS)

The instrument listed below has been tested and verified to Internal Quality Standards. Test data is Not Applicable. Equipment used during instrument testing is controlled by laboratory compliance with ISO/IEC 17025-2005 and ANSI/NCSL Z540-1-1994 using ETS-Lindgren Quality Management System internal procedures.

Manufacturer	ETS-Lindgren
Instrument Type	RF Survey Meter
Model	HI-2200
Serial Number/ID	00086316

Status In
In Tolerance
Date Completed
15-Aug-12
Status Out
Compliant with Internal Quality Standards

Remarks
Functional test performed.

I would like to take this opportunity to express our appreciation for using ETS-Lindgren for your EMI test equipment services and I am looking forward to continued business with your organization. Please feel free to contact our offices at (512) 531-6400, if you have any questions regarding this report.

Sincerely,

Terry D. O'Neill
Calibration Manager

Date Attested: 15-Aug-12

ACCREDITED
Calibration Laboratory
Certificate 1007.01

Cert I.D.: 92745

ETS·LINDGREN
An ESCO Technologies Company
1301 Arrow Point Drive
Cedar Park, Texas 78613
(512) 531-6498

ETS·LINDGREN
An ESCO Technologies Company
Tracking 000025310 Ltd Cal
By GC Date 15-Aug-12
Next Cal Due
www.ets-lindgren.com

Certificate of Calibration Conformance

Page 1 of 3

The instrument identified below has been individually calibrated in compliance with the following standard(s):

IEEE 1309 - 2005, Institute of Electrical and Electronics Engineers, Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas from 9 kHz to 40 GHz

Environment: Laboratory MTE is maintained in a temperature controlled environment with ambient conditions from 18 to 28 C, relative humidity less than 90%. The instrument under test has been calibrated in a suitable environment using an EMCO TEM Cell 5101C, GTEM! 5305 and an RF Shielded EMC Chamber which is conducive to maintaining accurate and reliable measurement quality.

Manufacturer:	ETS-Lindgren	**Operating Range:**	100kHz - 5GHz
Model Number:	E100	**Instrument Type:**	Isotropic Probe > 1 GHz
Serial Number/ ID:	00109011	**Date Code:**	
Tracking Number:	S 000025310	**Alternate ID:**	
Date Completed:	15-Aug-12	**Customer:**	LOCKHEED MARTIN (MS)
Test Type:	Standard Field, Field Strength		

Calibration Uncertainty: Std Field Method 10kHz - 18000 MHz, +/-0.7 dB, 26.5GHz - 40GHz,+/- 3.96 dB
k=2, (95% Confidence Level)

Test Remarks: Special Calibration - Additional frequency points provided per customer request. Probe calibrated with HI-2200 s/n 00086316.

Calibration Traceability: All Measuring and Test Equipment (MTE) identified below are traceable to the SI units through the National Institute for Standards and Technology (NIST) or other recognized National Metrology Institute. Calibration Laboratory and Quality System controls are compliant with ISO/IEC 17025-2005 and ANSI/NCSL Z540-1-1994.

Standards and Equipment Used:
Make / Model / Name / S/N / Recall Date

Agilent/HP	8648C	Signal Generator	3623A03573	01-Feb-13
Agilent	E4419B	Power Meter	MY45104171	29-Sep-12
Agilent/HP	8648C	Signal Generator	3847A04406	01-Feb-13
Agilent	E4419B	Power Meter	MY45103242	01-Feb-13
Rohde & Schwarz	857.8008.02	Power Meter NRvD	100451	26-Mar-13
Hewlett Packard	83620B	Signal Generator	3722A00541	01-Feb-13
Rohde & Schwarz	SMB 100A	Signal Generator	101558	14-Mar-13

Condition of Instrument Upon Receipt:
In Tolerance to Internal Quality Standards

On Release:
In Tolerance to Internal Quality Standards

Calibration Completed By
George Cisneros, Calibration Technician

Attested and Issued on 15-Aug-12
Terry D. O'Neill, Calibration Manager

CALIBRATION REPORT

Electric Field Sensor

Model	S/N
E100	00109011
HI-2200	00086316

Date: 15 Aug 2012

New Instrument
_ Other
_ Out of Tolerance
X Within Tolerance

Frequency Response

Frequency Response		Nominal Field	Cal Factor*	Deviation
	MHz	V/m	(Eapplied/Eindicated)	dB
1	1	20	1.04	-0.33
2	15	20	1.00	0.03
3	30	20	1.00	0.03
4	75	20	1.00	0.04
5	100	20	0.99	0.07
6	150	20	0.98	0.14
7	200	20	0.96	0.38
8	250	20	0.97	0.25
9	300	20	0.97	0.28
10	400	20	0.97	0.26
11	500	20	1.00	-0.02
12	600	20	1.05	-0.44
13	700	20	1.07	-0.55
14	800	20	1.04	-0.37
15	900	20	1.03	-0.28
16	1000	20	0.96	0.36
17	2000	20	0.99	0.07
18	2450	20	1.01	-0.06
19	3000	20	1.03	-0.22
20	3500	20	0.99	0.10
21	4000	20	1.00	-0.01
22	5000	20	1.28	-2.14
23	5500	20	1.31	-2.35
24	6000	20	1.32	-2.43

* Corrected electric field values (V/m) can be obtained by multiplying the Cal Factor with the indicated E field readings.

Linearity

maximum linearity deviation is 0.1 dB

(measurements taken from 0.3 V/m to 800 V/m at 27.12 MHz)

Test Conditions

Calibration performed at ambient room temperature: 23 ±3°C

Page 2 of 3

ETS-LINDGREN
An ESCO Technologies Company

PROBE ROTATIONAL RESPONSE

Model	E100
S/N	00109011
Date	Date of Calibration 15 August 2012
Time	03:54:44 PM
Isotropy *	+ 0.272 dB/ -0.272 dB

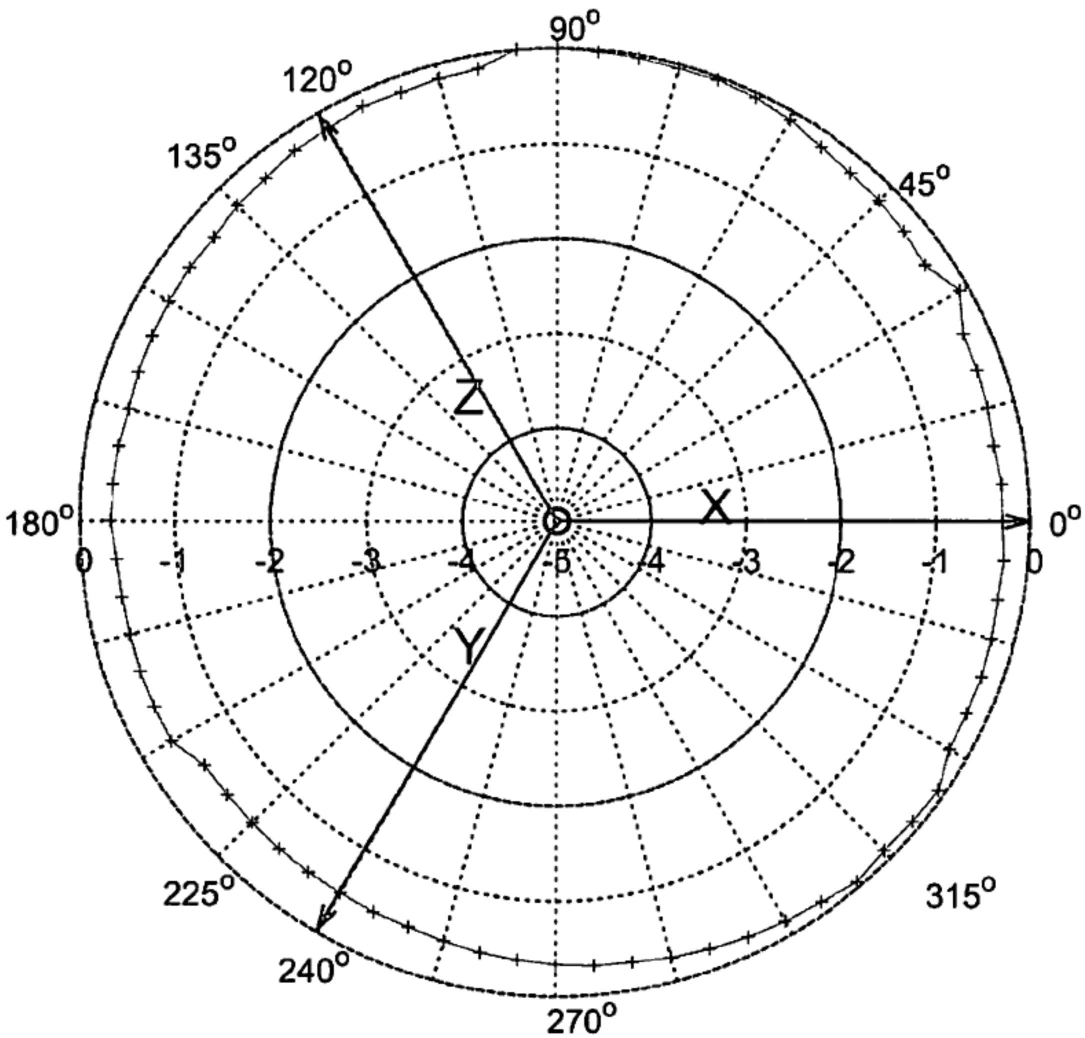


Figure 1: Probe Isotropic Response Chart.

Isotropic response is measured in a 20 V/m field at 400 MHz
*Isotropy is the maximum deviation from the geometric mean as defined by IEEE 1309-2005.

Page 3 of 3

ilac-MRA ACCREDITED Calibration Laboratory Certificate 1207.01

ETS-LINDGREN™
An ESCO Technologies Company
1301 Arrow Point Drive
Cedar Park, Texas 78613
(512) 531-6498

ETS-LINDGREN An ESCO Technologies Company
Track# S000025310 Ltd Cal ☐
By GC Date 15-Aug-12
Next Cal Due
www.ets-lindgren.com

Cert I.D.: 92747

Certificate of Calibration Conformance

Page 1 of 2

The instrument identified below has been individually calibrated in compliance with the following standard(s):

IEEE 1309 - 2005, Institute of Electrical and Electronics Engineers, Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas from 9 kHz to 40 GHz

Environment: Laboratory MTE is maintained in a temperature controlled environment with ambient conditions from 18 to 28 C, relative humidity less than 90%. The instrument under test has been calibrated in a suitable environment using an EMCO TEM Cell 5101C, GTEM! 5305 and an RF Shielded EMC Chamber which is conducive to maintaining accurate and reliable measurement quality.

Manufacturer:	ETS-Lindgren	**Operating Range:**	5-300MHz / 30mA/m-10A/m
Model Number:	H200	**Instrument Type:**	Isotropic Magnetic Field Probe (2)
Serial Number/ ID:	*00142394*	**Date Code:**	
Tracking Number:	**S 000025310**	**Alternate ID:**	
Date Completed:	15-Aug-12	**Customer:**	LOCKHEED MARTIN (MS)
Test Type:	Standard Field, Field Strength		

Calibration Uncertainty: Direct Field Method 1.15dB
k=2, (95% Confidence Level)

Test Remarks: Present probe replaced s/n 00149020 due to a failed Y-axis which was unrepairable - Probe calibrated with HI-2200 s/n 00086316 - Special Cailbration - Additional frequency points provided per customer request.

Calibration Traceability: All Measuring and Test Equipment (M/TE) identified below are traceable to the SI units through the National Institute for Standards and Technology (NIST) or other recognized National Metrology Institute. Calibration Laboratory and Quality System controls are compliant with ISO/IEC 17025-2005 and ANSI/NCSL Z540-1-1994.

Standards and Equipment Used:
Make / Model / Name / S/N / Recall Date

HP	8648C	Sig Gen	3836A04299	01-Feb-13
Hewlett Packard	E4419B	Power Meter	US39250717	01-Feb-13

Condition of Instrument
Upon Receipt:
In Tolerance to Internal Quality Standards

On Release:
In Tolerance to Internal Quality Standards

Calibration Completed By
George Cisneros, Calibration Technian

Attested and Issued on 15-Aug-12
Terry D. O'Neill, Calibration Manager

CALIBRATION REPORT

Magnetic Field Sensor

Model	*S/N*
H200	00142394
HI-2200	00086316

As received, the instrument was found:
- ______ Within Tolerance
- ______ Out of Tolerance
- __X__ (New Instrument)

Frequency Response

Frequency Response	*MHz*	*Nominal Field* *A/m*	*Cal Factor** (Happlied/Hindicated)	*Deviation* *dB*
1	10	0.08	1.05	-0.46
2	15	0.08	1.02	-0.14
3	30	0.08	1.01	-0.06
4	50	0.08	0.99	0.04
5	75	0.08	0.98	0.19
6	100	0.08	0.94	0.53
7	150	0.08	0.91	0.86
8	175	0.08	0.89	1.00
9	200	0.08	0.85	1.42
10	250	0.08	0.77	2.22
11	300	0.08	0.74	2.61

* Corrected magnetic field values (A/m) can be obtained by multiplying the Cal Factor with the indicated H field readings.

Linearity

Maximum linearity deviation is 0.03 dB

(measurements taken from 30 mA/m to 9 A/m at 27.12 MHz)

Test Conditions

Calibration performed at ambient room temperature: 23 ±3°C

The above sensor was calibrated to factory specifications. This calibration is performed per IEEE 1309 standard. All equipment used are traceable to US National Institute of Standards and Technology (NIST).

Page 2 of 2

Appendix C - Photos of Assessed Antennas

(Refer to Exhibit 7B)

Appendix D – MPE Measurement Results

MPE measurement data for Bystander

D.U.T. Info.								Probe Info.			Bystander (BS) Positions													
Ant Loc.	**Ant. Model/ Desc.**	**Ant. Gain (dBi)**	**Ant. Meas. Dist. (cm)**	**Tx Freq (MHz)**	**Max Pwr (W)**	**Initial Pwr (W)**	**Test Mode**	**E/H Field**	**Probe Cal. Factor**	**Test Pos.**	**20 cm**	**40 cm**	**60 cm**	**80 cm**	**100 cm**	**120 cm**	**140 cm**	**160 cm**	**180 cm**	**200 cm**	**DUT Max. TX Factor**	**Avg. over Body (mW/ cm2)**	**Calc. P.D. (mW/ cm2)**	**Max Calc. P.D. (mW/ cm2)**
Trunk	HAD4022A (132-174MHz)	5.15	90	138.0125	54.0	52.1	CW	E	0.97	BS	0.029	0.042	0.060	0.096	0.163	0.264	0.355	0.371	0.337	0.328	0.5	0.205	0.099	0.10
Trunk	HAD4022A (132-174MHz)	5.15	90	144.4	54.0	52.5	CW	E	0.96	BS	0.039	0.064	0.100	0.146	0.207	0.299	0.364	0.367	0.350	0.345	0.5	0.228	0.109	0.11
Trunk	HAD4022A (132-174MHz)	5.15	90	150.8	54.0	53	CW	E	0.96	BS	0.047	0.085	0.112	0.147	0.178	0.260	0.310	0.325	0.323	0.311	0.5	0.210	0.101	0.10
Trunk	HAD4022A (132-174MHz)	5.15	90	158.3	54.0	53	CW	E	0.95	BS	0.039	0.068	0.089	0.130	0.178	0.261	0.341	0.353	0.345	0.318	0.5	0.212	0.101	0.10
Trunk	HAD4022A (132-174MHz)	5.15	90	165.9	54.0	53	CW	E	0.95	BS	0.040	0.064	0.078	0.110	0.216	0.305	0.419	0.369	0.346	0.304	0.5	0.225	0.107	0.11
Trunk	HAD4022A (132-174MHz)	5.15	90	173.4	54.0	52.1	CW	E	0.94	BS	0.035	0.060	0.080	0.122	0.242	0.356	0.423	0.411	0.374	0.325	0.5	0.243	0.114	0.12
45																								
Trunk	HAD4022A (132-174MHz)	5.15	90cm (actual 104cm)	173.4	54.0	52.1	CW	E	0.94	BS	0.142	0.245	0.271	0.293	0.405	0.430	0.381	0.327	0.293	0.256	0.5	0.304	0.143	0.15
90																								
Trunk	HAD4022A (132-174MHz)	5.15	90cm (actual 110.5cm)	173.4	54.0	52.1	CW	E	0.94	BS	0.114	0.177	0.151	0.238	0.401	0.444	0.405	0.361	0.304	0.253	0.5	0.285	0.134	0.14

MPE calculations are defined in section 13.0.

MPE measurement data for Passenger

D.U.T. Info.								Probe Info.			Passenger Positions						
Ant Loc.	Ant. Model/ Desc.	Ant. Gain (dBi)	Ant. Meas. Dist. (cm)	Tx Freq (MHz)	Max Pwr (W)	Initial Pwr (W)	Test Mode	E/H Field	Probe Cal. Factor	Test Pos.	Head	Chest	Lower Trunk	DUT Max. TX Factor	Avg. over Body (mW/ cm2)	Calc. P.D. (mW/ cm2)	Max Calc. P.D. (mW/ cm2)
Trunk	HAD4022A (132-174MHz)	5.15	NA	138.0125	54.0	52.1	CW	E	0.97	PB	0.090	0.079	0.062	0.5	0.077	0.037	0.04
Trunk	HAD4022A (132-174MHz)	5.15	NA	144.4	54.0	52.5	CW	E	0.96	PB	0.268	0.244	0.215	0.5	0.242	0.116	0.12
Trunk	HAD4022A (132-174MHz)	5.15	NA	150.8	54.0	53	CW	E	0.96	PB	0.471	0.520	0.462	0.5	0.484	0.232	0.24
Trunk	HAD4022A (132-174MHz)	5.15	NA	158.3	54.0	53	CW	E	0.95	PB	0.671	0.790	0.529	0.5	0.663	0.315	0.32
Trunk	HAD4022A (132-174MHz)	5.15	NA	165.9	54.0	53	CW	E	0.95	PB	0.629	1.015	1.029	0.5	0.891	0.423	0.43
Trunk	HAD4022A (132-174MHz)	5.15	NA	173.4	54.0	52.1	CW	E	0.94	PB	0.589	0.493	0.644	0.5	0.575	0.270	0.28
Trunk	HAD4022A (132-174MHz)	5.15	NA	138.0125	54.0	52.1	CW	E	0.97	PF	0.010	0.017	0.019	0.5	0.015	0.007	0.01
Trunk	HAD4022A (132-174MHz)	5.15	NA	144.4	54.0	52.5	CW	E	0.96	PF	0.050	0.058	0.038	0.5	0.049	0.023	0.02
Trunk	HAD4022A (132-174MHz)	5.15	NA	150.8	54.0	53	CW	E	0.96	PF	0.134	0.091	0.051	0.5	0.092	0.044	0.04
Trunk	HAD4022A (132-174MHz)	5.15	NA	158.3	54.0	53	CW	E	0.95	PF	0.095	0.048	0.039	0.5	0.061	0.029	0.03
Trunk	HAD4022A (132-174MHz)	5.15	NA	165.9	54.0	53	CW	E	0.95	PF	0.081	0.098	0.112	0.5	0.097	0.046	0.05
Trunk	HAD4022A (132-174MHz)	5.15	NA	173.4	54.0	52.1	CW	E	0.94	PF	0.131	0.165	0.161	0.5	0.152	0.072	0.07

MPE calculations are defined in section 13.0.

MPE measurement data for Bystander

D.U.T. Info.								Probe Info.			Bystander (BS) Positions													
Ant Loc.	Ant. Model/ Desc.	Ant. Gain (dBi)	Ant. Meas. Dist.	Tx Freq (MHz)	Max Pwr (W)	Initial Pwr (W)	Test Mode	E/H Field	Probe Cal. Factor	Test Pos.	20 cm	40 cm	60 cm	80 cm	100 cm	120 cm	140 cm	160 cm	180 cm	200 cm	DUT Max. TX Factor	Avg. over Body (mW/ cm2)	Calc. P.D. (mW/ cm2)	Max Calc. P.D. (mW/ cm2)
Trunk	HAD4022A (132-174MHz)	5.15	90	138.0125	54.0	52.1	CW	H	0.92	BS	0.027	0.025	0.028	0.040	0.054	0.069	0.088	0.104	0.114	0.116	0.5	0.067	0.071	0.07
Trunk	HAD4022A (132-174MHz)	5.15	90	144.4	54.0	52.5	CW	H	0.91	BS	0.037	0.035	0.039	0.051	0.067	0.083	0.098	0.110	0.118	0.115	0.5	0.075	0.089	0.09
Trunk	HAD4022A (132-174MHz)	5.15	90	150.8	54.0	53	CW	H	0.91	BS	0.037	0.030	0.043	0.059	0.077	0.095	0.109	0.118	0.119	0.113	0.5	0.080	0.100	0.10
Trunk	HAD4022A (132-174MHz)	5.15	90	158.3	54.0	53	CW	H	0.90	BS	0.037	0.035	0.046	0.061	0.077	0.092	0.104	0.112	0.113	0.107	0.5	0.078	0.094	0.10
Trunk	HAD4022A (132-174MHz)	5.15	90	165.9	54.0	53	CW	H	0.90	BS	0.033	0.037	0.050	0.069	0.087	0.101	0.111	0.116	0.115	0.106	0.5	0.083	0.104	0.11
Trunk	HAD4022A (132-174MHz)	5.15	90	173.4	54.0	52.1	CW	H	0.89	BS	0.035	0.039	0.054	0.072	0.090	0.103	0.113	0.118	0.116	0.104	0.5	0.084	0.106	0.11
45																								
Trunk	HAD4022A (132-174MHz)	5.15	90cm (actual 104cm)	173.4	54.0	52.1	CW	H	0.89	BS	0.071	0.085	0.101	0.111	0.118	0.129	0.124	0.119	0.117	0.101	0.5	0.108	0.173	0.18
90																								
Trunk	HAD4022A (132-174MHz)	5.15	90cm (actual 110.5cm)	173.4	54.0	52.1	CW	H	0.89	BS	0.060	0.081	0.101	0.122	0.127	0.128	0.123	0.119	0.112	0.099	0.5	0.107	0.172	0.18

MPE calculations are defined in section 13.0.

MPE measurement data for Passenger

D.U.T. Info.								Probe Info.			Passenger Positions						
Ant Loc.	Ant. Model/ Desc.	Ant. Gain (dBi)	Ant. Meas. Dist. (cm)	Tx Freq (MHz)	Max Pwr (W)	Initial Pwr (W)	Test Mode	E/H Field	Probe Cal. Factor	Test Pos.	Head	Chest	Lower Trunk	DUT Max. TX Factor	Avg. over Body (mW/ cm2)	Calc. P.D. (mW/ cm2)	Max Calc. P.D. (mW/ cm2)
Trunk	HAD4022A (132-174MHz)	5.15	NA	138.0125	54.0	52.1	CW	H	0.92	PB	0.071	0.083	0.033	0.5	0.062	0.062	0.06
Trunk	HAD4022A (132-174MHz)	5.15	NA	144.4	54.0	52.5	CW	H	0.91	PB	0.116	0.084	0.068	0.5	0.089	0.125	0.13
Trunk	HAD4022A (132-174MHz)	5.15	NA	150.8	54.0	53	CW	H	0.91	PB	0.127	0.095	0.090	0.5	0.104	0.169	0.17
Trunk	HAD4022A (132-174MHz)	5.15	NA	158.3	54.0	53	CW	H	0.90	PB	0.156	0.112	0.083	0.5	0.117	0.209	0.21
Trunk	HAD4022A (132-174MHz)	5.15	NA	165.9	54.0	53	CW	H	0.90	PB	0.174	0.148	0.089	0.5	0.137	0.287	0.29
Trunk	HAD4022A (132-174MHz)	5.15	NA	173.4	54.0	52.1	CW	H	0.89	PB	0.142	0.121	0.093	0.5	0.119	0.210	0.22
Trunk	HAD4022A (132-174MHz)	5.15	NA	138.0125	54.0	52.1	CW	H	0.92	PF	0.027	0.023	0.020	0.5	0.023	0.009	0.01
Trunk	HAD4022A (132-174MHz)	5.15	NA	144.4	54.0	52.5	CW	H	0.91	PF	0.044	0.034	0.033	0.5	0.037	0.021	0.02
Trunk	HAD4022A (132-174MHz)	5.15	NA	150.8	54.0	53	CW	H	0.91	PF	0.074	0.053	0.048	0.5	0.058	0.053	0.05
Trunk	HAD4022A (132-174MHz)	5.15	NA	158.3	54.0	53	CW	H	0.90	PF	0.042	0.032	0.036	0.5	0.037	0.021	0.02
Trunk	HAD4022A (132-174MHz)	5.15	NA	165.9	54.0	53	CW	H	0.90	PF	0.050	0.043	0.035	0.5	0.043	0.028	0.03
Trunk	HAD4022A (132-174MHz)	5.15	NA	173.4	54.0	52.1	CW	H	0.89	PF	0.058	0.053	0.044	0.5	0.052	0.040	0.04

MPE calculations are defined in section 13.0.

MPE measurement data for Bystander

D.U.T. Info.								Probe Info.			Bystander (BS) Positions													
Ant Loc.	Ant. Model/ Desc.	Ant. Gain (dBi)	Ant. Meas. Dist. (cm)	Tx Freq (MHz)	Max Pwr (W)	Initial Pwr (W)	Test Mode	E/H Field	Probe Cal. Factor	Test Pos.	20 cm	40 cm	60 cm	80 cm	100 cm	120 cm	140 cm	160 cm	180 cm	200 cm	DUT Max. TX Factor	Avg. over Body (mW/ cm2)	Calc. P.D. (mW/ cm2)	Max Calc. P.D. (mW/ cm2)
Roof	HAD4006A (136-144MHz)	2.15	90	138.0125	54.0	52.1	CW	H	0.92	BS	0.025	0.035	0.042	0.052	0.062	0.068	0.073	0.077	0.077	0.076	0.5	0.059	0.055	0.06
Roof	HAD4006A (136-144MHz)	2.15	90	140.0125	54.0	52.3	CW	H	0.92	BS	0.025	0.033	0.040	0.054	0.061	0.068	0.072	0.077	0.077	0.076	0.5	0.058	0.054	0.06
Roof	HAD4006A (136-144MHz)	2.15	90	143.9875	54.0	53.8	CW	H	0.91	BS	0.027	0.038	0.056	0.058	0.063	0.072	0.075	0.077	0.079	0.078	0.5	0.062	0.061	0.06
Roof	HAD4007A (146-150.8MHz)	2.15	90	146.0125	54.0	52.9	CW	H	0.91	BS	0.018	0.028	0.035	0.050	0.059	0.065	0.070	0.076	0.076	0.074	0.5	0.055	0.047	0.05
Roof	HAD4007A (146-150.8MHz)	2.15	90	148.4	54.0	53	CW	H	0.91	BS	0.022	0.031	0.036	0.051	0.059	0.068	0.073	0.077	0.078	0.076	0.5	0.057	0.051	0.05
Roof	HAD4007A (146-150.8MHz)	2.15	90	150.8	54.0	53	CW	H	0.91	BS	0.019	0.030	0.033	0.049	0.060	0.069	0.073	0.075	0.077	0.073	0.5	0.056	0.049	0.05
Roof	HAD4008A (150.8-162MHz)	2.15	90	150.8	54.0	53	CW	H	0.91	BS	0.016	0.023	0.033	0.048	0.060	0.068	0.072	0.075	0.075	0.071	0.5	0.054	0.046	0.05
Roof	HAD4008A (150.8-162MHz)	2.15	90	156.4	54.0	53.7	CW	H	0.90	BS	0.025	0.029	0.040	0.054	0.066	0.079	0.075	0.080	0.081	0.080	0.5	0.061	0.057	0.06
Roof	HAD4008A (150.8-162MHz)	2.15	90	162	54.0	53.4	CW	H	0.90	BS	0.025	0.027	0.037	0.050	0.064	0.069	0.071	0.074	0.077	0.080	0.5	0.057	0.050	0.05
Roof	HAD4009A (162-174MHz)	2.15	90	162.0125	54.0	53.5	CW	H	0.90	BS	0.022	0.030	0.037	0.049	0.061	0.067	0.069	0.072	0.075	0.078	0.5	0.056	0.048	0.05
Roof	HAD4009A (162-174MHz)	2.15	90	167.7	54.0	53.3	CW	H	0.90	BS	0.027	0.032	0.040	0.054	0.063	0.067	0.068	0.075	0.081	0.087	0.5	0.059	0.054	0.05
Roof	HAD4009A (162-174MHz)	2.15	90	173.4	54.0	52.1	CW	H	0.89	BS	0.022	0.029	0.042	0.056	0.065	0.068	0.071	0.079	0.085	0.090	0.5	0.061	0.055	0.06
Roof	HAD4022A (132-174MHz)	5.15	90	138.0125	54.0	52.1	CW	H	0.92	BS	0.021	0.025	0.028	0.034	0.036	0.039	0.044	0.053	0.065	0.076	0.5	0.042	0.028	0.03
Roof	HAD4022A (132-174MHz)	5.15	90	144.4	54.0	52.5	CW	H	0.91	BS	0.021	0.026	0.028	0.031	0.036	0.042	0.048	0.057	0.067	0.075	0.5	0.043	0.029	0.03
Roof	HAD4022A (132-174MHz)	5.15	90	150.8	54.0	53	CW	H	0.91	BS	0.015	0.025	0.030	0.037	0.044	0.051	0.057	0.065	0.073	0.081	0.5	0.048	0.036	0.04
Roof	HAD4022A (132-174MHz)	5.15	90	158.3	54.0	53	CW	H	0.90	BS	0.018	0.027	0.033	0.039	0.045	0.052	0.059	0.067	0.076	0.085	0.5	0.050	0.038	0.04
Roof	HAD4022A (132-174MHz)	5.15	90	165.9	54.0	53	CW	H	0.90	BS	0.020	0.023	0.028	0.038	0.050	0.055	0.061	0.073	0.082	0.092	0.5	0.052	0.042	0.04
Roof	HAD4022A (132-174MHz)	5.15	90	173.4	54.0	52.1	CW	H	0.89	BS	0.023	0.030	0.032	0.044	0.052	0.058	0.065	0.077	0.087	0.093	0.5	0.056	0.047	0.05

MPE calculations are defined in section 13.0.

MPE measurement data for Passenger

D.U.T. Info.								Probe Info.			Passenger Positions						
Ant Loc.	Ant. Model/ Desc.	Ant. Gain (dBi)	Ant. Meas. Dist. (cm)	Tx Freq (MHz)	Max Pwr (W)	Initial Pwr (W)	Test Mode	E/H Field	Probe Cal. Factor	Test Pos.	Head	Chest	Lower Trunk	DUT Max. TX Factor	Avg. over Body (mW/ cm2)	Calc. P.D. (mW/ cm2)	Max Calc. P.D. (mW/ cm2)
Roof	HAD4006A (136-144MHz)	2.15	NA	138.0125	54.0	52.1	CW	E	0.97	PB	0.152	0.211	0.179	0.5	0.181	0.088	0.09
Roof	HAD4006A (136-144MHz)	2.15	NA	140.0125	54.0	52.3	CW	E	0.96	PB	0.218	0.290	0.266	0.5	0.258	0.124	0.13
Roof	HAD4006A (136-144MHz)	2.15	NA	143.9875	54.0	53.8	CW	E	0.96	PB	0.209	0.262	0.231	0.5	0.234	0.112	0.11
Roof	HAD4007A (146-150.8MHz)	2.15	NA	146.0125	54.0	52.9	CW	E	0.96	PB	0.097	0.193	0.195	0.5	0.162	0.078	0.08
Roof	HAD4007A (146-150.8MHz)	2.15	NA	148.4	54.0	53	CW	E	0.96	PB	0.042	0.136	0.153	0.5	0.110	0.053	0.05
Roof	HAD4007A (146-150.8MHz)	2.15	NA	150.8	54.0	53	CW	E	0.96	PB	0.073	0.182	0.211	0.5	0.155	0.075	0.08
Roof	HAD4008A (150.8-162MHz)	2.15	NA	150.8	54.0	53	CW	E	0.96	PB	0.067	0.168	0.205	0.5	0.147	0.070	0.07
Roof	HAD4008A (150.8-162MHz)	2.15	NA	156.4	54.0	53.7	CW	E	0.96	PB	0.095	0.186	0.138	0.5	0.140	0.067	0.07
Roof	HAD4008A (150.8-162MHz)	2.15	NA	162	54.0	53.4	CW	E	0.95	PB	0.100	0.080	0.120	0.5	0.100	0.048	0.05

MPE calculations are defined in section 13.0.

MPE measurement data for Passenger

D.U.T. Info.								Probe Info.			Passenger Positions						
Ant Loc.	Ant. Model/ Desc.	Ant. Gain (dBi)	Ant. Meas. Dist. (cm)	Tx Freq (MHz)	Max Pwr (W)	Initial Pwr (W)	Test Mode	E/H Field	Probe Cal. Factor	Test Pos.	Head	Chest	Lower Trunk	DUT Max. TX Factor	Avg. over Body (mW/ cm2)	Calc. P.D. (mW/ cm2)	Max Calc. P.D. (mW/ cm2)
Roof	HAD4009A (162-174MHz)	2.15	NA	162.0125	54.0	53.5	CW	E	0.95	PB	0.098	0.079	0.112	0.5	0.096	0.046	0.05
Roof	HAD4009A (162-174MHz)	2.15	NA	167.7	54.0	53.3	CW	E	0.95	PB	0.109	0.079	0.155	0.5	0.114	0.054	0.06
Roof	HAD4009A (162-174MHz)	2.15	NA	173.4	54.0	52.1	CW	E	0.94	PB	0.113	0.048	0.086	0.5	0.082	0.039	0.04
Roof	HAD4022A (132-174MHz)	5.15	NA	138.0125	54.0	52.1	CW	E	0.97	PB	0.078	0.088	0.089	0.5	0.085	0.041	0.04
Roof	HAD4022A (132-174MHz)	5.15	NA	144.4	54.0	52.5	CW	E	0.96	PB	0.033	0.074	0.077	0.5	0.061	0.029	0.03
Roof	HAD4022A (132-174MHz)	5.15	NA	150.8	54.0	53	CW	E	0.96	PB	0.034	0.069	0.084	0.5	0.062	0.030	0.03
Roof	HAD4022A (132-174MHz)	5.15	NA	158.3	54.0	53	CW	E	0.95	PB	0.032	0.030	0.012	0.5	0.025	0.012	0.01
Roof	HAD4022A (132-174MHz)	5.15	NA	165.9	54.0	53	CW	E	0.95	PB	0.050	0.065	0.080	0.5	0.065	0.031	0.03
Roof	HAD4022A (132-174MHz)	5.15	NA	173.4	54.0	52.1	CW	E	0.94	PB	0.079	0.050	0.063	0.5	0.064	0.030	0.03
Roof	HAD4006A (136-144MHz)	2.15	NA	138.0125	54.0	52.1	CW	E	0.97	PF	0.060	0.075	0.064	0.5	0.066	0.032	0.03
Roof	HAD4006A (136-144MHz)	2.15	NA	140.0125	54.0	52.3	CW	E	0.96	PF	0.080	0.063	0.064	0.5	0.069	0.033	0.03
Roof	HAD4006A (136-144MHz)	2.15	NA	143.9875	54.0	53.8	CW	E	0.96	PF	0.058	0.081	0.118	0.5	0.086	0.041	0.04

MPE calculations are defined in section 13.0.

MPE measurement data for Passenger

D.U.T. Info.								Probe Info.			Passenger Positions						
Ant Loc.	Ant. Model/ Desc.	Ant. Gain (dBi)	Ant. Meas. Dist. (cm)	Tx Freq (MHz)	Max Pwr (W)	Initial Pwr (W)	Test Mode	E/H Field	Probe Cal. Factor	Test Pos.	Head	Chest	Lower Trunk	DUT Max. TX Factor	Avg. over Body (mW/ cm2)	Calc. P.D. (mW/ cm2)	Max Calc. P.D. (mW/ cm2)
Roof	HAD4007A (146-150.8MHz)	2.15	NA	146.0125	54.0	52.9	CW	E	0.96	PF	0.062	0.066	0.112	0.5	0.080	0.038	0.04
Roof	HAD4007A (146-150.8MHz)	2.15	NA	148.4	54.0	53	CW	E	0.96	PF	0.065	0.096	0.128	0.5	0.096	0.046	0.05
Roof	HAD4007A (146-150.8MHz)	2.15	NA	150.8	54.0	53	CW	E	0.96	PF	0.045	0.056	0.108	0.5	0.070	0.033	0.03
Roof	HAD4008A (150.8-162MHz)	2.15	NA	150.8	54.0	53	CW	E	0.96	PF	0.049	0.050	0.091	0.5	0.063	0.030	0.03
Roof	HAD4008A (150.8-162MHz)	2.15	NA	156.4	54.0	53.7	CW	E	0.96	PF	0.025	0.048	0.082	0.5	0.052	0.025	0.02
Roof	HAD4008A (150.8-162MHz)	2.15	NA	162	54.0	53.4	CW	E	0.95	PF	0.022	0.043	0.067	0.5	0.044	0.021	0.02
Roof	HAD4009A (162-174MHz)	2.15	NA	162.0125	54.0	53.5	CW	E	0.95	PF	0.021	0.049	0.065	0.5	0.045	0.021	0.02
Roof	HAD4009A (162-174MHz)	2.15	NA	167.7	54.0	53.3	CW	E	0.95	PF	0.036	0.029	0.036	0.5	0.034	0.016	0.02
Roof	HAD4009A (162-174MHz)	2.15	NA	173.4	54.0	52.1	CW	E	0.94	PF	0.020	0.032	0.028	0.5	0.027	0.013	0.01
Roof	HAD4022A (132-174MHz)	5.15	NA	138.0125	54.0	52.1	CW	E	0.97	PF	0.026	0.013	0.011	0.5	0.017	0.008	0.01
Roof	HAD4022A (132-174MHz)	5.15	NA	144.4	54.0	52.5	CW	E	0.96	PF	0.023	0.013	0.029	0.5	0.022	0.010	0.01
Roof	HAD4022A (132-174MHz)	5.15	NA	150.8	54.0	53	CW	E	0.96	PF	0.019	0.018	0.039	0.5	0.025	0.012	0.01
Roof	HAD4022A (132-174MHz)	5.15	NA	158.3	54.0	53	CW	E	0.95	PF	0.012	0.018	0.025	0.5	0.018	0.009	0.01
Roof	HAD4022A (132-174MHz)	5.15	NA	165.9	54.0	53	CW	E	0.95	PF	0.017	0.017	0.024	0.5	0.019	0.009	0.01
Roof	HAD4022A (132-174MHz)	5.15	NA	173.4	54.0	52.1	CW	E	0.94	PF	0.025	0.031	0.024	0.5	0.027	0.013	0.01

MPE measurement data for Bystander

D.U.T. Info.								Probe Info.			Bystander (BS) Positions													
Ant Loc.	Ant. Model/ Desc.	Ant. Gain (dBi)	Ant. Meas. Dist. (cm)	Tx Freq (MHz)	Max Pwr (W)	Initial Pwr (W)	Test Mode	E/H Field	Probe Cal. Factor	Test Pos.	20 cm	40 cm	60 cm	80 cm	100 cm	120 cm	140 cm	160 cm	180 cm	200 cm	DUT Max. TX Factor	Avg. over Body (mW/ cm2)	Calc. P.D. (mW/ cm2)	Max Calc. P.D. (mW/ cm2)
Roof	HAD4006A (136-144MHz)	2.15	90	138.0125	54.0	52.1	CW	H	0.92	BS	0.025	0.035	0.042	0.052	0.062	0.068	0.073	0.077	0.077	0.076	0.5	0.059	0.055	0.06
Roof	HAD4006A (136-144MHz)	2.15	90	140.0125	54.0	52.3	CW	H	0.92	BS	0.025	0.033	0.040	0.054	0.061	0.068	0.072	0.077	0.077	0.076	0.5	0.058	0.054	0.06
Roof	HAD4006A (136-144MHz)	2.15	90	143.9875	54.0	53.8	CW	H	0.91	BS	0.027	0.038	0.056	0.058	0.063	0.072	0.075	0.077	0.079	0.078	0.5	0.062	0.061	0.06
Roof	HAD4007A (146-150.8MHz)	2.15	90	146.0125	54.0	52.9	CW	H	0.91	BS	0.018	0.028	0.035	0.050	0.059	0.065	0.070	0.076	0.076	0.074	0.5	0.055	0.047	0.05
Roof	HAD4007A (146-150.8MHz)	2.15	90	148.4	54.0	53	CW	H	0.91	BS	0.022	0.031	0.036	0.051	0.059	0.068	0.073	0.077	0.078	0.076	0.5	0.057	0.051	0.05
Roof	HAD4007A (146-150.8MHz)	2.15	90	150.8	54.0	53	CW	H	0.91	BS	0.019	0.030	0.033	0.049	0.060	0.069	0.073	0.075	0.077	0.073	0.5	0.056	0.049	0.05
Roof	HAD4008A (150.8-162MHz)	2.15	90	150.8	54.0	53	CW	H	0.91	BS	0.016	0.023	0.033	0.048	0.060	0.068	0.072	0.075	0.075	0.071	0.5	0.054	0.046	0.05
Roof	HAD4008A (150.8-162MHz)	2.15	90	156.4	54.0	53.7	CW	H	0.90	BS	0.025	0.029	0.040	0.054	0.066	0.079	0.075	0.080	0.081	0.080	0.5	0.061	0.057	0.06
Roof	HAD4008A (150.8-162MHz)	2.15	90	162	54.0	53.4	CW	H	0.90	BS	0.025	0.027	0.037	0.050	0.064	0.069	0.071	0.074	0.077	0.080	0.5	0.057	0.050	0.05

MPE calculations are defined in section 13.0.

MPE measurement data for Bystander

D.U.T. Info.								Probe Info.			Bystander (BS) Positions													
Ant Loc.	Ant. Model/ Desc.	Ant. Gain (dBi)	Ant. Meas. Dist.	Tx Freq (MHz)	Max Pwr (W)	Initial Pwr (W)	Test Mode	E/H Field	Probe Cal. Factor	Test Pos.	20 cm	40 cm	60 cm	80 cm	100 cm	120 cm	140 cm	160 cm	180 cm	200 cm	DUT Max. TX Factor	Avg. over Body (mW/ cm2)	Calc. P.D. (mW/ cm2)	Max Calc. P.D. (mW/ cm2)
Roof	HAD4009A (162-174MHz)	2.15	90	162.0125	54.0	53.5	CW	H	0.90	BS	0.022	0.030	0.037	0.049	0.061	0.067	0.069	0.072	0.075	0.078	0.5	0.056	0.048	0.05
Roof	HAD4009A (162-174MHz)	2.15	90	167.7	54.0	53.3	CW	H	0.90	BS	0.027	0.032	0.040	0.054	0.063	0.067	0.068	0.075	0.081	0.087	0.5	0.059	0.054	0.05
Roof	HAD4009A (162-174MHz)	2.15	90	173.4	54.0	52.1	CW	H	0.89	BS	0.022	0.029	0.042	0.056	0.065	0.068	0.071	0.079	0.085	0.090	0.5	0.061	0.055	0.06
Roof	HAD4022A (132-174MHz)	5.15	90	138.0125	54.0	52.1	CW	H	0.92	BS	0.021	0.025	0.028	0.034	0.036	0.039	0.044	0.053	0.065	0.076	0.5	0.042	0.028	0.03
Roof	HAD4022A (132-174MHz)	5.15	90	144.4	54.0	52.5	CW	H	0.91	BS	0.021	0.026	0.028	0.031	0.036	0.042	0.048	0.057	0.067	0.075	0.5	0.043	0.029	0.03
Roof	HAD4022A (132-174MHz)	5.15	90	150.8	54.0	53	CW	H	0.91	BS	0.015	0.025	0.030	0.037	0.044	0.051	0.057	0.065	0.073	0.081	0.5	0.048	0.036	0.04
Roof	HAD4022A (132-174MHz)	5.15	90	158.3	54.0	53	CW	H	0.90	BS	0.018	0.027	0.033	0.039	0.045	0.052	0.059	0.067	0.076	0.085	0.5	0.050	0.038	0.04
Roof	HAD4022A (132-174MHz)	5.15	90	165.9	54.0	53	CW	H	0.90	BS	0.020	0.023	0.028	0.038	0.050	0.055	0.061	0.073	0.082	0.092	0.5	0.052	0.042	0.04
Roof	HAD4022A (132-174MHz)	5.15	90	173.4	54.0	52.1	CW	H	0.89	BS	0.023	0.030	0.032	0.044	0.052	0.058	0.065	0.077	0.087	0.093	0.5	0.056	0.047	0.05

MPE calculations are defined in section 13.0.

MPE measurement data for Passenger

D.U.T. Info.								Probe Info.			Passenger Positions						
Ant Loc.	**Ant. Model/ Desc.**	**Ant. Gain (dBi)**	**Ant. Meas. Dist. (cm)**	**Tx Freq (MHz)**	**Max Pwr (W)**	**Initial Pwr (W)**	**Test Mode**	**E/H Field**	**Probe Cal. Factor**	**Test Pos.**	**Head**	**Chest**	**Lower Trunk**	**DUT Max. TX Factor**	**Avg. over Body (mW/ cm2)**	**Calc. P.D. (mW/ cm2)**	**Max Calc. P.D. (mW/ cm2)**
Roof	HAD4006A (136-144MHz)	2.15	NA	138.0125	54.0	52.1	CW	H	0.92	PB	0.065	0.060	0.056	0.5	0.060	0.058	0.06
Roof	HAD4006A (136-144MHz)	2.15	NA	140.0125	54.0	52.3	CW	H	0.92	PB	0.068	0.067	0.063	0.5	0.066	0.069	0.07
Roof	HAD4006A (136-144MHz)	2.15	NA	143.9875	54.0	53.8	CW	H	0.91	PB	0.061	0.068	0.070	0.5	0.066	0.069	0.07
Roof	HAD4007A (146-150.8MHz)	2.15	NA	146.0125	54.0	52.9	CW	H	0.91	PB	0.048	0.048	0.050	0.5	0.049	0.037	0.04
Roof	HAD4007A (146-150.8MHz)	2.15	NA	148.4	54.0	53	CW	H	0.91	PB	0.050	0.037	0.030	0.5	0.039	0.024	0.02
Roof	HAD4007A (146-150.8MHz)	2.15	NA	150.8	54.0	53	CW	H	0.91	PB	0.072	0.069	0.062	0.5	0.068	0.071	0.07
Roof	HAD4008A (150.8-162MHz)	2.15	NA	150.8	54.0	53	CW	H	0.91	PB	0.074	0.065	0.057	0.5	0.065	0.067	0.07
Roof	HAD4008A (150.8-162MHz)	2.15	NA	156.4	54.0	53.7	CW	H	0.90	PB	0.054	0.040	0.034	0.5	0.043	0.028	0.03
Roof	HAD4008A (150.8-162MHz)	2.15	NA	162	54.0	53.4	CW	H	0.90	PB	0.066	0.059	0.042	0.5	0.056	0.047	0.05
Roof	HAD4009A (162-174MHz)	2.15	NA	162.0125	54.0	53.5	CW	H	0.90	PB	0.071	0.064	0.048	0.5	0.061	0.057	0.06
Roof	HAD4009A (162-174MHz)	2.15	NA	167.7	54.0	53.3	CW	H	0.90	PB	0.075	0.066	0.046	0.5	0.062	0.059	0.06
Roof	HAD4009A (162-174MHz)	2.15	NA	173.4	54.0	52.1	CW	H	0.89	PB	0.049	0.049	0.036	0.5	0.045	0.030	0.03

MPE calculations are defined in section 13.0.

MPE measurement data for Passenger

D.U.T. Info.								Probe Info.			Passenger Positions						
Ant Loc.	Ant. Model/ Desc.	Ant. Gain (dBi)	Ant. Meas. Dist. (cm)	Tx Freq (MHz)	Max Pwr (W)	Initial Pwr (W)	Test Mode	E/H Field	Probe Cal. Factor	Test Pos.	Head	Chest	Lower Trunk	DUT Max. TX Factor	Avg. over Body (mW/ cm2)	Calc. P.D. (mW/ cm2)	Max Calc. P.D. (mW/ cm2)
Roof	HAD4022A (132-174MHz)	5.15	NA	138.0125	54.0	52.1	CW	H	0.92	PB	0.030	0.061	0.038	0.5	0.043	0.029	0.03
Roof	HAD4022A (132-174MHz)	5.15	NA	144.4	54.0	52.5	CW	H	0.91	PB	0.041	0.041	0.038	0.5	0.040	0.025	0.03
Roof	HAD4022A (132-174MHz)	5.15	NA	150.8	54.0	53	CW	H	0.91	PB	0.054	0.051	0.042	0.5	0.049	0.037	0.04
Roof	HAD4022A (132-174MHz)	5.15	NA	158.3	54.0	53	CW	H	0.90	PB	0.036	0.081	0.059	0.5	0.059	0.053	0.05
Roof	HAD4022A (132-174MHz)	5.15	NA	165.9	54.0	53	CW	H	0.90	PB	0.056	0.059	0.046	0.5	0.054	0.044	0.04
Roof	HAD4022A (132-174MHz)	5.15	NA	173.4	54.0	52.1	CW	H	0.89	PB	0.039	0.040	0.038	0.5	0.039	0.023	0.02
Roof	HAD4006A (136-144MHz)	2.15	NA	138.0125	54.0	52.1	CW	H	0.92	PF	0.037	0.038	0.037	0.5	0.037	0.022	0.02
Roof	HAD4006A (136-144MHz)	2.15	NA	140.0125	54.0	52.3	CW	H	0.92	PF	0.037	0.052	0.042	0.5	0.044	0.030	0.03
Roof	HAD4006A (136-144MHz)	2.15	NA	143.9875	54.0	53.8	CW	H	0.91	PF	0.053	0.065	0.046	0.5	0.055	0.047	0.05

MPE calculations are defined in section 13.0.

MPE measurement data for Passenger

D.U.T. Info.								Probe Info.			Passenger Positions						
Ant Loc.	Ant. Model/ Desc.	Ant. Gain (dBi)	Ant. Meas. Dist.	Tx Freq (MHz)	Max Pwr (W)	Initial Pwr (W)	Test Mode	E/H Field	Probe Cal. Factor	Test Pos.	Head	Chest	Lower	DUT Max. TX Factor	Avg. over Body (mW/ cm2)	Calc. P.D. (mW/ cm2)	Max Calc. P.D. (mW/ cm2)
Roof	HAD4007A (146-150.8MHz)	2.15	NA	146.0125	54.0	52.9	CW	H	0.91	PF	0.049	0.057	0.050	0.5	0.052	0.042	0.04
Roof	HAD4007A (146-150.8MHz)	2.15	NA	148.4	54.0	53	CW	H	0.91	PF	0.054	0.057	0.046	0.5	0.052	0.043	0.04
Roof	HAD4007A (146-150.8MHz)	2.15	NA	150.8	54.0	53	CW	H	0.91	PF	0.054	0.060	0.043	0.5	0.052	0.043	0.04
Roof	HAD4008A (150.8-162MHz)	2.15	NA	150.8	54.0	53	CW	H	0.91	PF	0.048	0.056	0.047	0.5	0.050	0.040	0.04
Roof	HAD4008A (150.8-162MHz)	2.15	NA	156.4	54.0	53.7	CW	H	0.90	PF	0.042	0.043	0.036	0.5	0.040	0.025	0.02
Roof	HAD4008A (150.8-162MHz)	2.15	NA	162	54.0	53.4	CW	H	0.90	PF	0.032	0.033	0.033	0.5	0.033	0.016	0.02
Roof	HAD4009A (162-174MHz)	2.15	NA	162.0125	54.0	53.5	CW	H	0.90	PF	0.034	0.031	0.033	0.5	0.033	0.016	0.02
Roof	HAD4009A (162-174MHz)	2.15	NA	167.7	54.0	53.3	CW	H	0.90	PF	0.031	0.022	0.029	0.5	0.027	0.011	0.01
Roof	HAD4009A (162-174MHz)	2.15	NA	173.4	54.0	52.1	CW	H	0.89	PF	0.040	0.024	0.026	0.5	0.030	0.013	0.01

MPE calculations are defined in section 13.0.

MPE measurement data for Passenger

D.U.T. Info.								Probe Info.			Passenger Positions						
Ant Loc.	**Ant. Model/ Desc.**	**Ant. Gain (dBi)**	**Ant. Meas. Dist. (cm)**	**Tx Freq (MHz)**	**Max Pwr (W)**	**Initial Pwr (W)**	**Test Mode**	**E/H Field**	**Probe Cal. Factor**	**Test Pos.**	**Head**	**Chest**	**Lower Trunk**	**DUT Max. TX Factor**	**Avg. over Body (mW/ cm2)**	**Calc. P.D. (mW/ cm2)**	**Max Calc. P.D. (mW/ cm2)**
Roof	HAD4022A (132-174MHz)	5.15	NA	138.0125	54.0	52.1	CW	H	0.92	PF	0.019	0.022	0.017	0.5	0.019	0.006	0.01
Roof	HAD4022A (132-174MHz)	5.15	NA	144.4	54.0	52.5	CW	H	0.91	PF	0.024	0.032	0.028	0.5	0.028	0.012	0.01
Roof	HAD4022A (132-174MHz)	5.15	NA	150.8	54.0	53	CW	H	0.91	PF	0.029	0.034	0.027	0.5	0.030	0.014	0.01
Roof	HAD4022A (132-174MHz)	5.15	NA	158.3	54.0	53	CW	H	0.90	PF	0.031	0.029	0.022	0.5	0.027	0.011	0.01
Roof	HAD4022A (132-174MHz)	5.15	NA	165.9	54.0	53	CW	H	0.90	PF	0.026	0.021	0.026	0.5	0.024	0.009	0.01
Roof	HAD4022A (132-174MHz)	5.15	NA	173.4	54.0	52.1	CW	H	0.89	PF	0.029	0.022	0.021	0.5	0.024	0.009	0.01

MPE calculations are defined in section 13.0.

Appendix E - SAR Simulation Report

MOTOROLA SOLUTIONS

COMPUTATIONAL EME COMPLIANCE ASSESSMENT OF THE XPR 2500, MODEL# PMUD3240A MOBILE RADIO.

February 4, 2013

William Elliott, Giorgi Bit-Babik, Ph.D., and Antonio Faraone, Ph.D.
Motorola Solutions EME Research Lab, Plantation, Florida

Introduction

This report summarizes the computational [numerical modeling] analysis performed to document compliance of the XPR 2500, Model Number PMUD3240A 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 136-174 MHz frequency band.

This computational analysis supplements the measurements conducted to evaluate the compliance of the exposure from this mobile radio with respect to applicable *maximum permissible exposure* (MPE) limits. All test conditions (4 in 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 and 0.08 W/kg averaged over the whole body) set forth in FCC guidelines, which are based on the IEEE C95.1-1999 standard [1]. The same test conditions were also analyzed to determine compliance with the SAR limits set forth in the ICNIRP [3] guidelines and IEEE Std. C95.1-2005 standard [4] (2.0 W/kg averaged over 10 gram of tissue and 0.08 W/kg averaged over the whole body). In total 8 independent simulations have been performed addressing exposure of passenger to the VHF mobile radio with trunk-mount antennas.

For all simulations 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 relevant estimate of human exposure to RF energy.

Method

The simulation code employed is XFDTD™ v7.2, 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 3 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.

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 with maximum resolution of 5 mm. The Figure 1 below show both the CAD model and the photo of the actual car This CAD model has been incorporated into the IEC/IEEE 62704-2 draft standard.

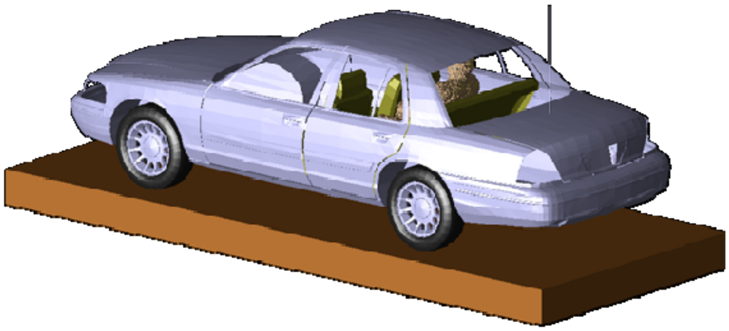


Figure 1: The photo picture of the car used in field measurements and the corresponding CAD model used in simulations

For passenger exposure, the antenna position is on the trunk and the distance of trunk mounted antenna from the passenger head when the passenger is located in the center of the back seat was set at 85 cm, to replicate the experimental conditions used in MPE measurements. According to the IEC/IEEE 62704-2 draft standard (February, 2012) for exposure simulations from vehicle mount antennas the lossy dielectric slab with 30 cm thickness, dielectric constant of 8 and conductivity of 0.01 S/m has been introduced in the computational model to properly account for the effect of the ground (pavement) on exposure.

Figure 2 shows some of the XFDTD™ computational models used for passenger exposure to trunk mounted antennas

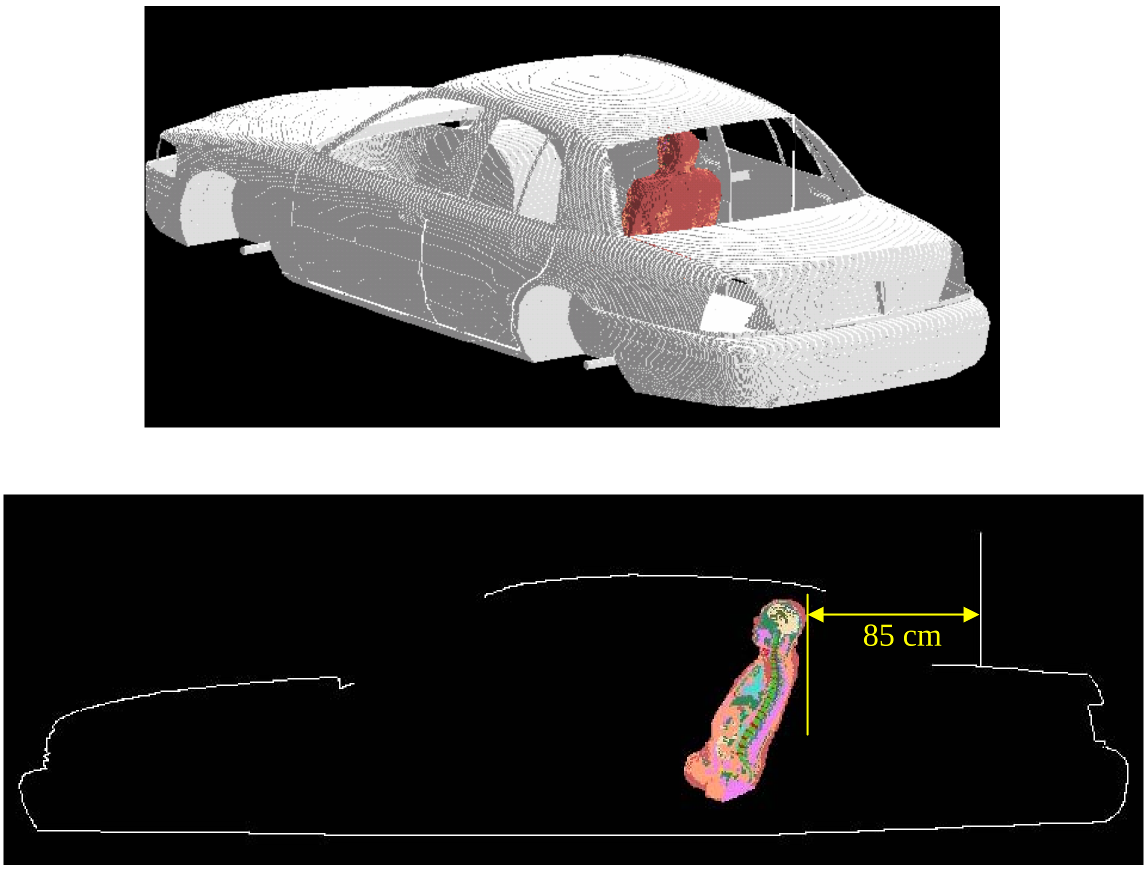


Figure 2: Passenger model exposed to a trunk-mount antenna: XFDTD geometry.
The antenna is mounted at 85 cm from the passenger located in the center of the back seat.

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, 1-g, and 10-g average SAR. The maximum average output power from mobile radio antenna is 54 W. 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 are normalized to half of it, i.e., 27 W average net output power.

Results of SAR computations for car passengers

The test conditions requiring SAR computations are summarized in Table I, together with the antenna data, the SAR results, and power density (P.D.) as obtained from the measurements in the corresponding test conditions. The conditions are for antennas mounted on the trunk. The antenna length in Table I includes the 1.8 cm magnetic mount base used in measurements to position the antenna on the vehicle. The same length was used in simulation model. The passenger is located in the center or on the side of the rear seat. The passenger model is surrounded by air, as the seat, which is made out of poorly conductive fabrics, is not included in the computational model. All the transmit frequency, antenna length, and passenger location combinations reported in Table I have been simulated individually.

Table I: Results of the SAR computations for passenger exposure (50% talk-time).

Mount location	Antenna Kit #	Antenna length (cm)	Freq [MHz]	P.D. (mw/cm^2)	Exposure location	SAR [W/kg]		
						1-g	10-g	WB
Trunk	HAD4022A	113.8	150.8	0.24	Back Center	0.23	0.12	0.010
					Back Side	0.14	0.09	0.009
		102.7	158.3	0.32	Back Center	0.27	0.17	0.013
					Back Side	0.22	0.16	0.011
		87.5	165.9	0.43	Back Center	0.32	0.21	0.016
					Back Side	0.39	0.34	0.014
		89.9	173.4	0.28	Back Center **Fig 3&4**	0.46	0.31	0.017
					Back Side	0.36	0.23	0.014

The SAR distribution in the passenger model in the exposure condition that gave highest 1-g SAR is reported in Figure 3 (173.4 MHz, passenger in the center of the back seat, HAD4022A antenna).

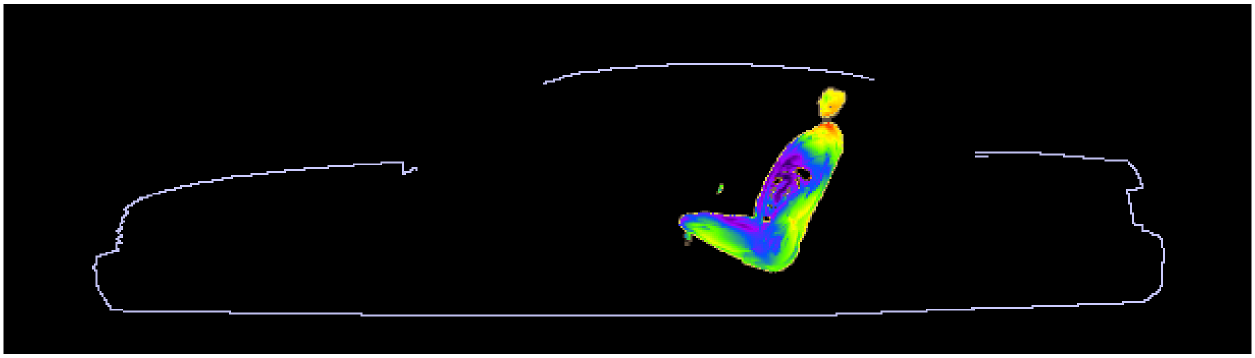
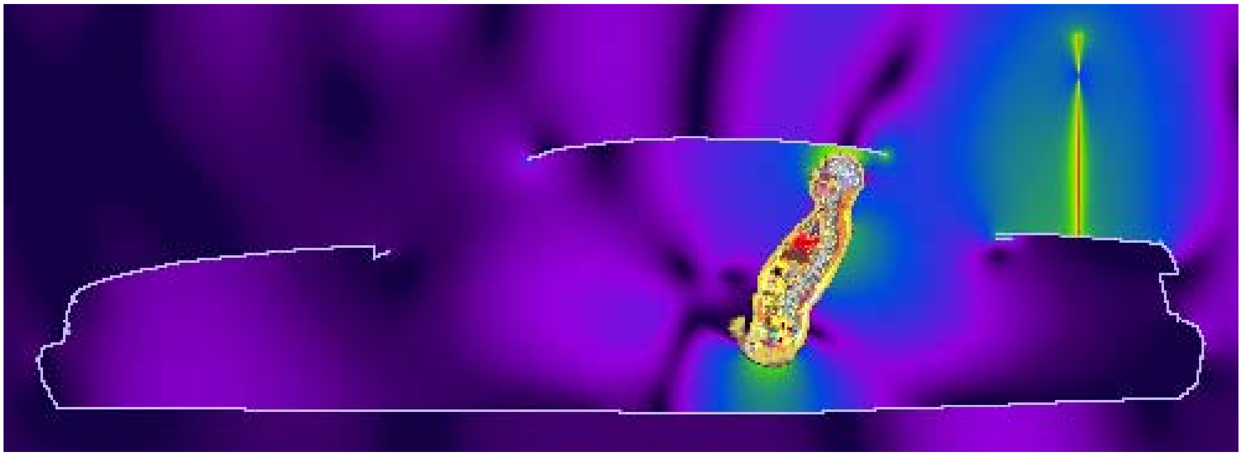
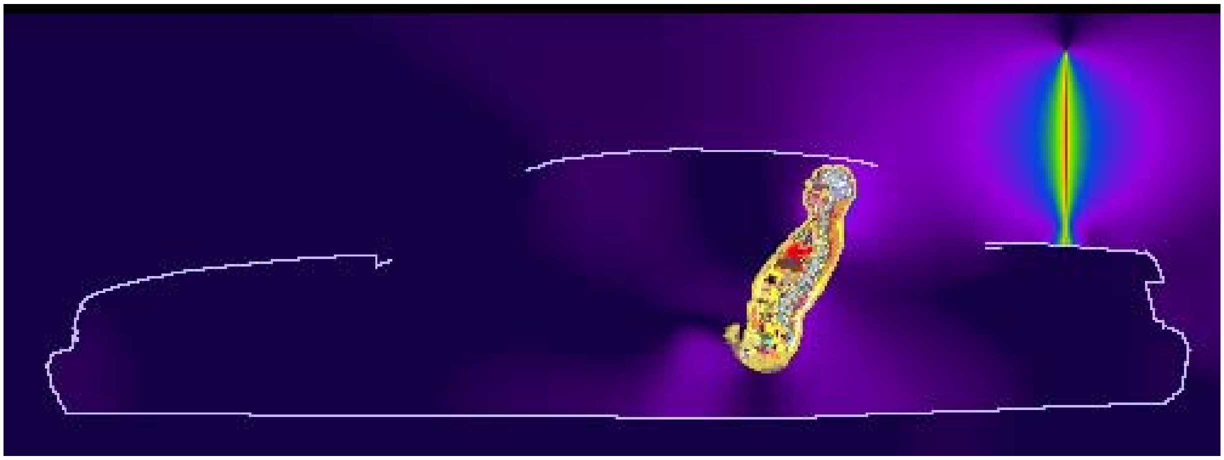


Figure 3. SAR distribution at 173.4 MHz in the passenger model located in the center of the back seat, produced by the trunk-mount HAD4022A antenna. The contour plot is relative to the plane where the peak 1-g average SAR for this exposure condition occurs.

The two pictures below in Figure 4 show the E and H field distributions in the plane of the antenna corresponding to the condition in Figure 3.



a)



b)

Figure 4. (a) E-field distribution corresponding to exposure condition of Figure 3, and (b) H-field distribution corresponding to exposure condition of Figure 3.

The highest 1-g SAR was produced in the passenger exposure condition with HAD4022A antenna at 173.4 MHz (passenger in the center of the back seat).

The overall maximum peak 1-g SAR in all simulated conditions is 0.46 W/kg, less than the 1.6 W/kg limit, while the overall maximum peak 10-g SAR is 0.34 W/kg, less than the 2.0 W/kg limit. The maximum whole-body average SAR is 0.017 W/kg, less than the 0.08 W/kg limit.

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 as well as with the corresponding ICNIRP and IEEE Std. C95.1-2005 SAR limits.

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

[3] ICNIRP (International Commission on Non-Ionising Radiation Protection). 1998. *Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)*. Health Phys. 74:494–522.

[4] IEEE. 2005. *IEEE standard for safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz*, IEEE Std C95.1-2005

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 draft IEC/IEEE 62704-1 and 62704-2 standards, and from the XFDTD™ User Manuals. Remcom Inc., owner of XFDTD™, is kindly acknowledged for the help provided.

1) Computational resources

a) A multiprocessor system equipped with two Intel Xeon X5570 quad-core CPUs and four Tesla C1060 GPUs was employed for all simulations.

b) The memory requirement was from 7 GB to 12 GB. Using the above-mentioned system with 8-cores operating concurrently, the typical simulation would run for 6-10 hours and with all four GPUs activated by the XFDTD version 7.2 this time would be from 60-180 min.

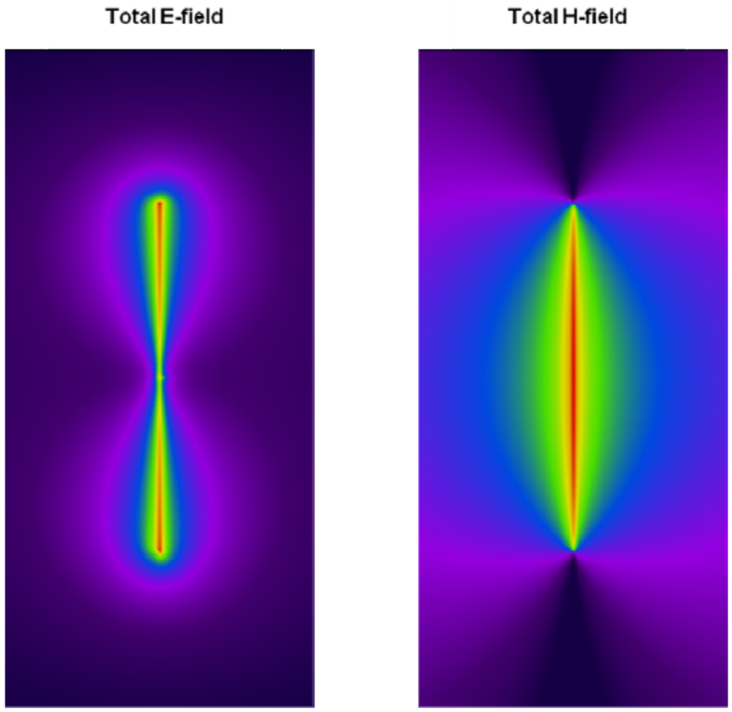
2) FDTD algorithm implementation and validation

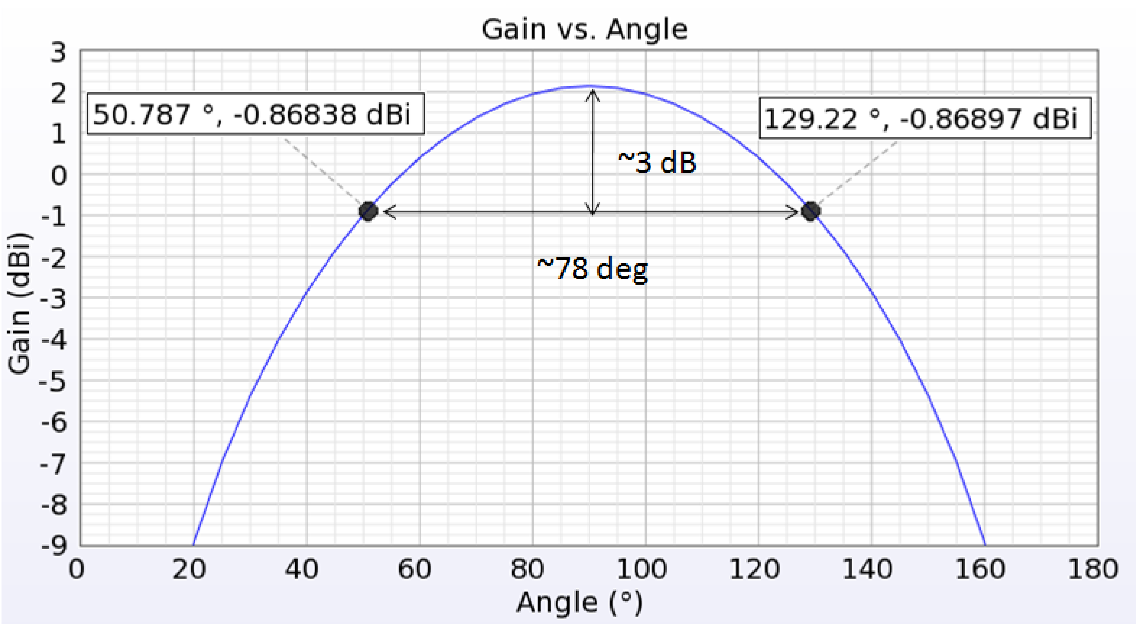
a) We employed a commercial code (XFDTD™ v7.2, by Remcom Inc.) that implements the Yee's FDTD formulation [1]. The solution domain was discretized according to a rectangular grid with an adaptive 3-10 mm step in all directions. Sub-gridding was not used. Seven-layer PML absorbing boundary conditions 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 since within the adaptive grid the minimum resolution of 3 mm was specified and used to model the antenna and the antenna wire radius was never smaller than one-fifth of the voxel dimension. In fact, the XFDTD™ manual specifies that "In most cases, standard PEC material will serve well as a wire. However, in cases where the wire radius is important to the calculation and is less than 1/4 the length of the average cell edge, the thin wire material may be used to accurately simulate the correct wire diameter." The maximum voxel dimension in the plane normal to the antenna in all our simulations was 3 mm, and the antenna radius is always at least 1 mm (1 mm for the short quarter-wave antennas and 1.5 mm for the long gain antennas), so there was no need to specify a "thin wire" material.

Because the field impinges on the bystander or passenger model at a distance of several tens of voxels from the antenna, the details of antenna wire modeling are not expected to have significant impact on the exposure level.

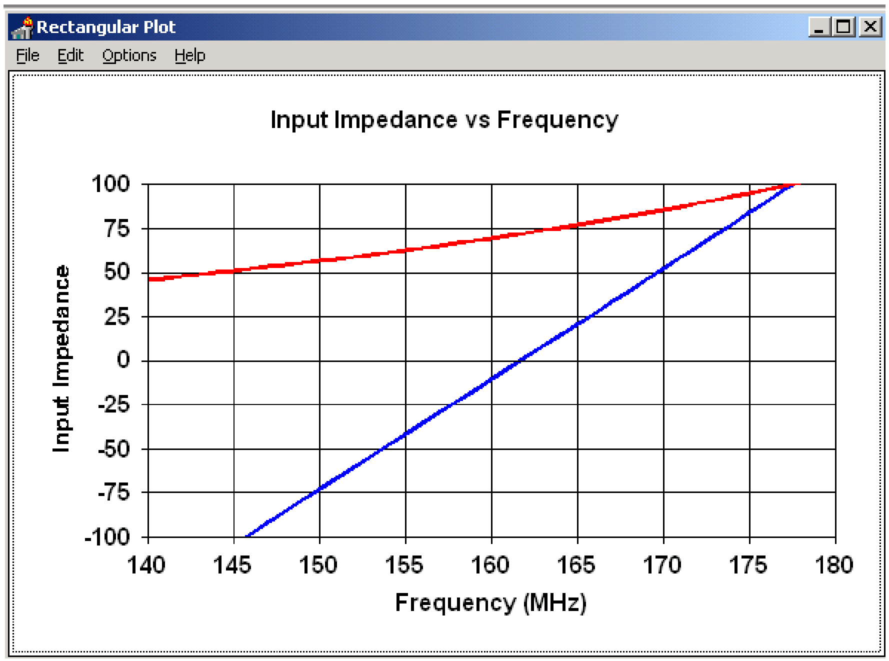
b) XFDTD™ is one of the most widely employed commercial codes for electromagnetic simulations. It has gone through extensive validation and has proven its accuracy over time in many different applications. One example is provided in [3].

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 to model the dipole was 5 mm. Also in this case, the "thin wire" model was not needed. The following picture shows XFDTD™ outputs regarding the antenna feed-point impedance (70.5 – j 6.0 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.





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	3-10 mm	3-10 mm	1-10 mm
Maximum domain dimensions employed for passenger computations with the trunk-mount antennas	397	910	559
Maximum domain dimensions employed for bystander computations with the trunk-mount antennas	449	791	709
Time step	About 0.7 of the Courant limit (typically 5 *ps*)		
Objects separation from FDTD boundary (mm)	>200	>200	>200
Number of time steps	Enough to reach at least -60 dB convergence		
Excitation	Sinusoidal (not less than 10 periods)		

4) Phantom model implementation and validation

a) The human body models (bystander and/or passenger) employed in our simulations are those defined in the draft IEEE 62704-2 standard. They are originally based on data from the *visible human project* sponsored by the National Library of Medicine (NLM) (http://www.nlm.nih.gov/research/visible/visible_human.html). The original 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. 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 final bystander and passenger model was generated for the IEEE 62704-2 standard from the above dataset using the Varipose softwar, Remocm Inc., The body mesh contains 39 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 in [11].

a) The XFDTD™ High Fidelity Body Mesh model correctly represents the anatomical structure and the dielectric properties of body tissues, so it is appropriate for determining the highest exposure expected for normal device operation.

b) 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 computed for the 39 body tissue materials in the employed human body models at 150 MHz.

#	Tissue	ε_r	σ (S/m)	Density (kg/m^3)
1	bile	85.3	1.60	928
2	body fluid	71.3	1.26	1050
3	eye cornea	69.0	1.07	1051
4	fat	12.2	0.07	911
5	lymph	65.7	0.81	1035
6	mucous membrane	59.2	0.56	1102
7	toe, finger, and nails	14.4	0.07	1908
8	nerve spine	42.3	0.36	1075
9	muscle	62.2	0.73	1090
10	heart	80.7	0.79	1081
11	white matter	50.3	0.35	1041
12	stomach	73.3	0.92	1088
13	glands	65.7	0.81	1028
14	blood vessel	54.0	0.49	1102
15	liver	61.7	0.53	1079
16	gall bladder	71.3	1.06	1071
17	spleen	78.8	0.86	1089
18	cerebellum	74.6	0.85	1045
19	cortical bone	14.4	0.07	1908
20	cartilage	51.4	0.50	1100
21	ligaments	50.8	0.50	1142
22	skin	61.5	0.54	1109
23	large intestine	73.8	0.72	1088
24	tooth	14.4	0.07	2180
25	grey_matter	70.1	0.60	1045
26	eye lens	41.7	0.32	1076
27	outer lung	61.9	0.59	1050
28	small intestine	83.4	1.72	1030
29	eye sclera	63.5	0.93	1032
30	inner lung	28.3	0.32	394
31	pancreas	65.7	0.81	1087
32	blood	71.3	1.26	1050
33	cerebro_spinal_fluid	81.2	2.16	1007
34	eye vitreoushumor	69.1	1.51	1005
35	kidneys	85.0	0.88	1066
36	bone marrow	13.2	0.16	1029
37	bladder	21.4	0.30	1086
38	testicles	70.3	0.94	1082
39	cancellous bone	25.5	0.19	1178

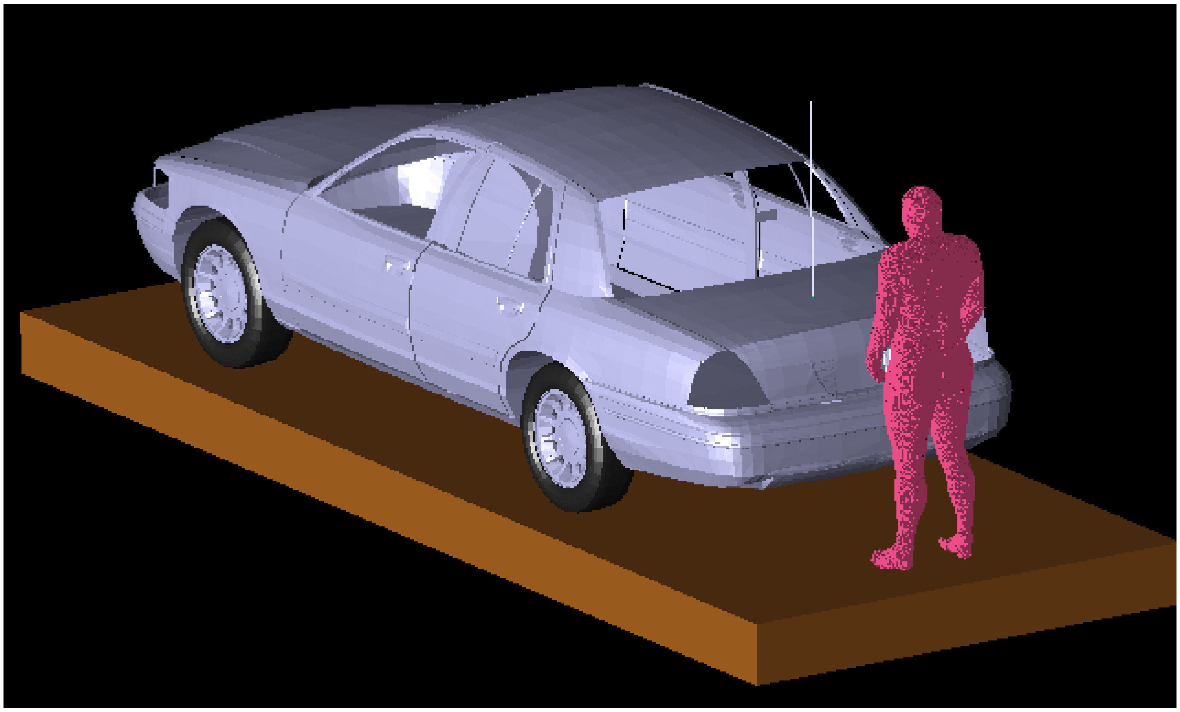
b) The tissue types and dielectric parameters used in the SAR computation are appropriate for determining the highest exposure expected for normal device operation, because they are derived from measurements performed on real biological tissues (XFDTD, Reference Manual Version 6.4, Remcom, Inc.).

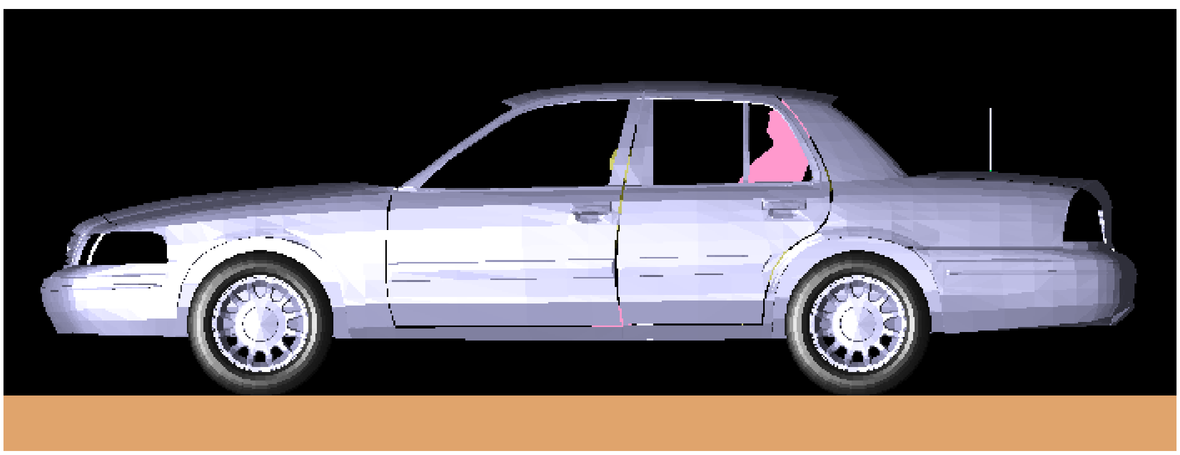
c) The tabulated list of the dielectric parameters used in phantom models is provided at point 5(a). As regards the device (car plus antenna), we used perfect electric conductors.

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. The car model is very similar to the car used for MPE measurements, so as to be able to correlate measured and simulated field values. This car model has been developed for the SAR computational draft standard IEC/IEEE 62704-2.
- Antenna. We used a straight wire, even when the gain antenna has a base coil for tuning. All the coil does is compensating for excess capacitance due to the antenna being slightly longer than half a wavelength. We do not need to do that in the model, as we used normalization with respect to the net radiated power, which is determined by the input resistance only. In this way, we neglect mismatch losses and artificially produce an overestimation of the SAR, thereby introducing a conservative bias in the model. This simulation model was also validated by comparing the computed and measured near-field distributions in the condition with antenna mounted on the reference ground plane and showed good agreement experimental data [9].
- Antenna location. We used the same location, relative to the edge of the car trunk, the backseat, or the roof, used in the MPE measurements. The following pictures show a lateral and a perspective view of the bystander and passenger model.



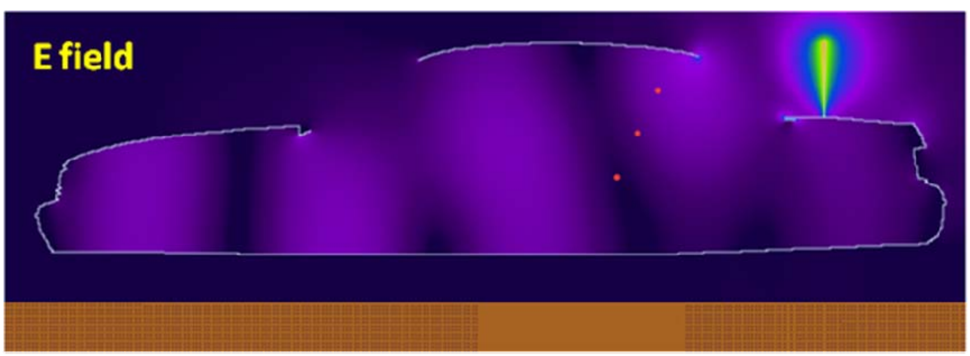


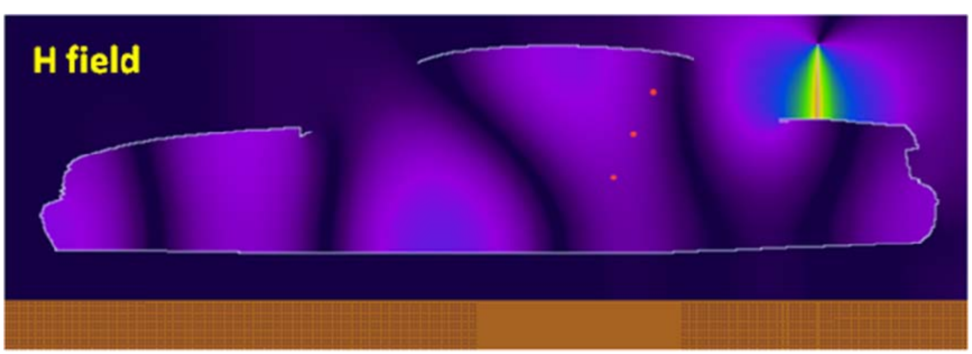
The car model is constituted by perfect electric conductor and does not include wheels in order to reduce its complexity. The passenger model is surrounded by air, as the seat, which is made out of poorly conductive fabrics, is not included in the computational model. The pavement has not been included in the model. The passenger and bystander models were validated for similar antenna and frequency conditions by comparing the MPE measurements at two VHF frequencies (146 MHz and 164 MHz) for antennas used for a VHF mobile radio analyzed previously in 2003 (FCC ID#ABZ99FT3046). The corresponding MPE measurements are reported in the compliance report relative to FCC ID#ABZ99FT3046. The comparison results are presented below, according to following definitions for the equivalent power densities (based on E or H-field):

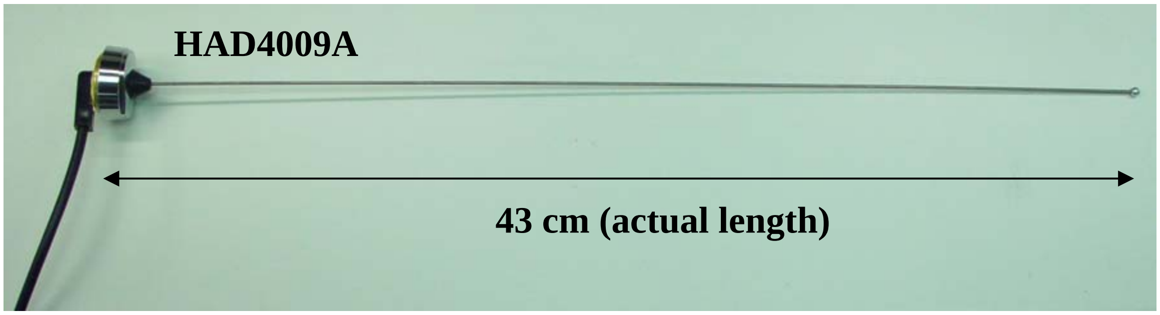
$$S_E = \frac{|\mathbf{E}|^2}{2\eta}, \quad S_H = \frac{\eta}{2}|\mathbf{H}|^2, \quad \eta = 377\,\Omega$$

<u>Passenger with 43 cm monopole antenna (HAD4009A 164 MHz)</u>

The following figures of the test model show the empty car model, where the red dotted line represents the location of the passenger in the back seat, as it can be observed from the complete model picture above. The comparison has been performed by taking the computed steady-state field values at the red dots locations corresponding to the head, chest, and lower trunk area and comparing them with the corresponding measurements. Such a comparison is carried out at the same average power level (56.5 W) used in the measurements. Steady-state E-field and H-field distributions at a vertical crossing the passenger’s head are displayed as well. Finally, a picture of the antenna is shown.

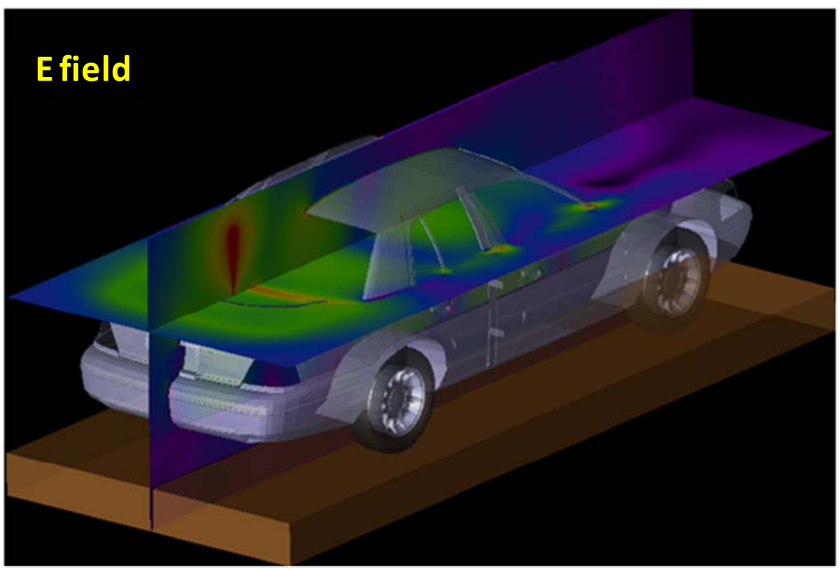


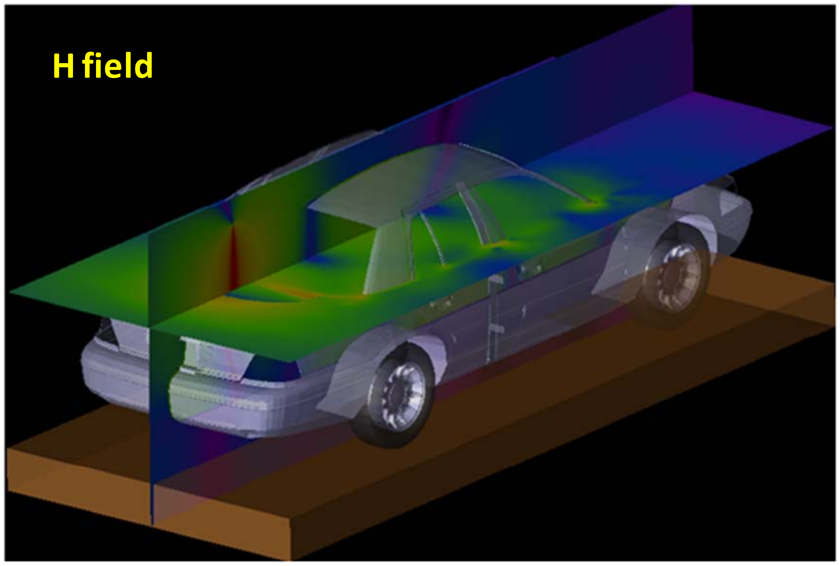




The highest exposure occurs in the middle of the backseat, which is also the case in the measurements. Therefore, the field values were determined on the yellow line centered at the middle of the backseat, approximately at the three locations that are shown by white dots. In actuality, the line is inclined 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.



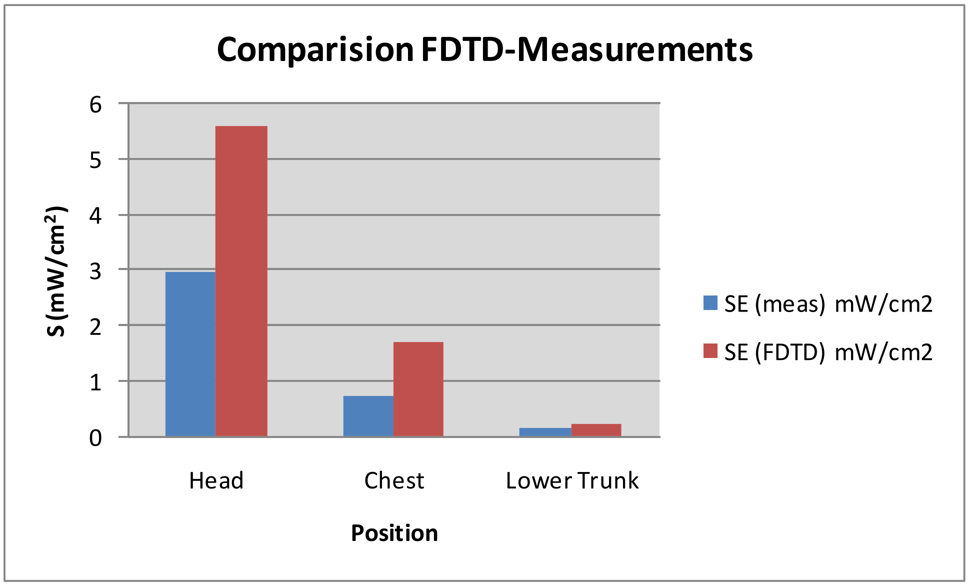


As done in the measurements, the equivalent power density (S) is computed from the E-field, the H-field being much lower. The following table reports the E-field values computed by XFDTD™ at the three locations, and the corresponding power density.

Location	E-field magnitude (V/m)	S (W/m^2)
Head	1.27	2.14E-03
Chest	0.70	6.55E-04
Lower Trunk area	0.20	7.70E-05
	Average S	**9.57E-04**

The input impedance is 24.8-j11.9 ohm, therefore the radiated power (considering the mismatch to the 50 ohm unitary voltage source) is 2.16E-3 W. The scaled-up power density for 56.5 W radiated power is 25.0 W/m^2, corresponding to 2.50 mW/cm^2. Measurements gave an average of 1.29 mW/cm^2, which is a reasonable overestimation considering conservativeness of simulations model. The following table and the graph show a comparison between the simulated power density and the measured one (see also MPE report in FCC ID#ABZ99FT3046, Table 43), normalized to 56.5 W radiated.

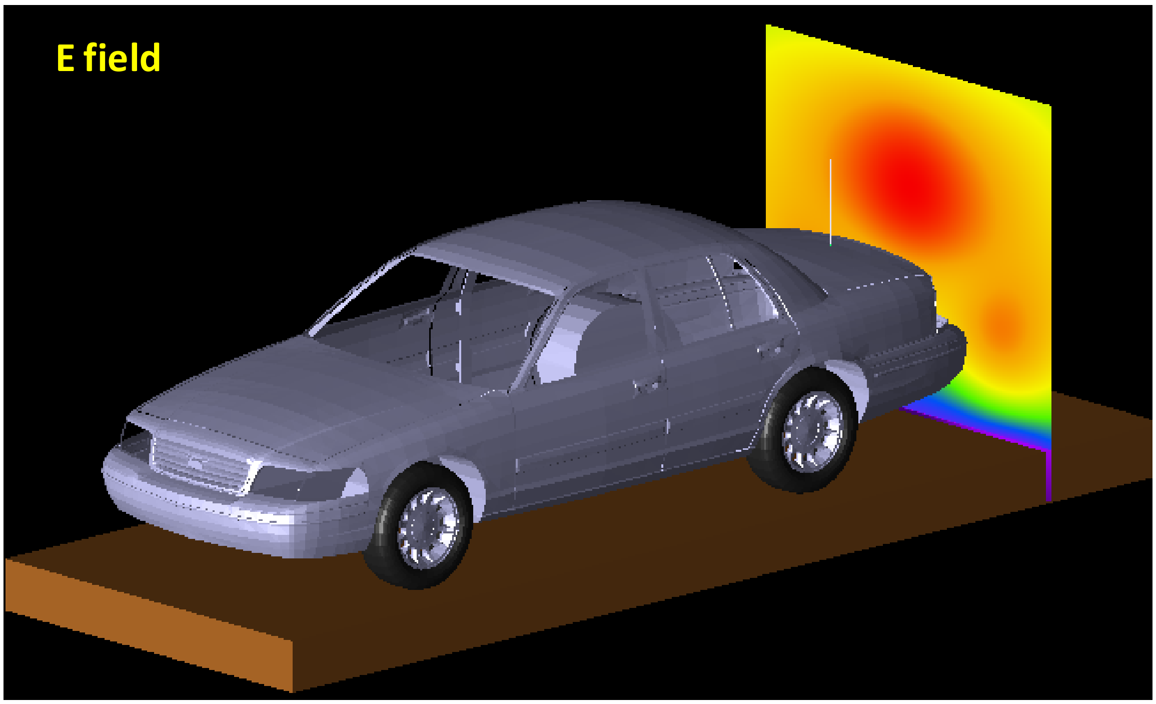
Position	SE (meas) mW/cm^2	SE (FDTD) mW/cm^2
Head	2.98	5.59
Chest	0.74	1.71
Lower Trunk	0.14	0.2

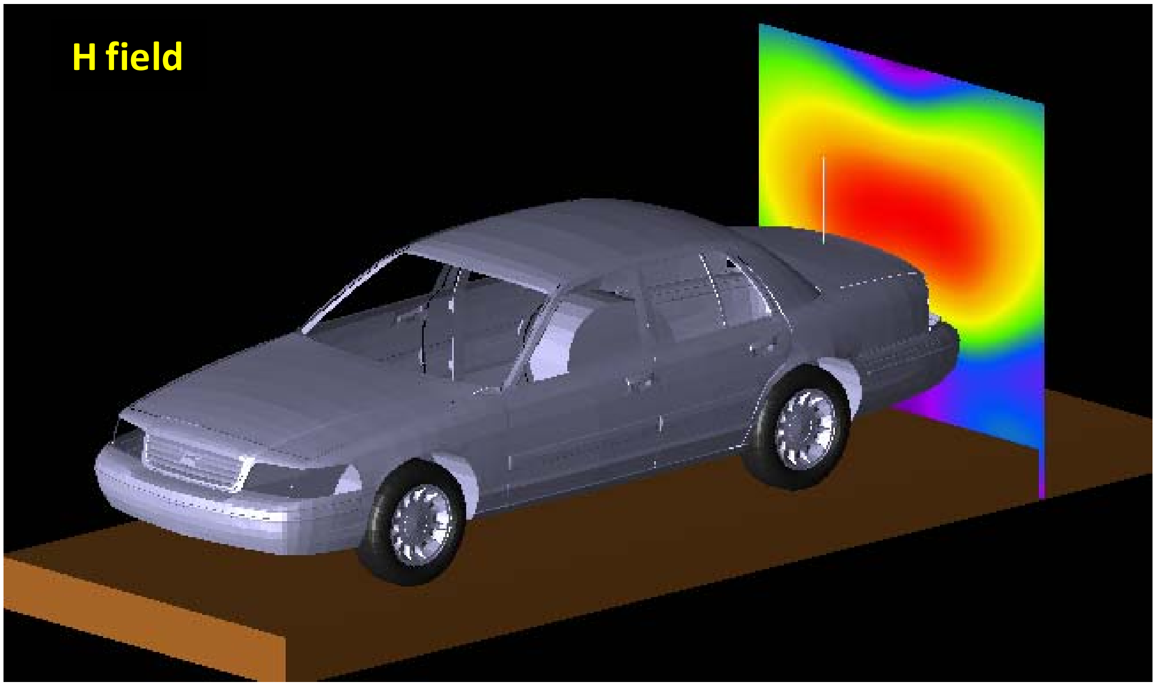


<u>Bystander with 48 cm monopole antenna (HAD4007A 146 MHz)</u>

The following figures show the E-field and H-field distributions across a vertical plane passing for the antenna and cutting the car in half. As done in the measurements, the MPE is computed from both E-field and H-field distributions, along the yellow dotted line at 10 points spaced 20 cm apart from each other up to 2 m in height. These lines and the field evaluation points are approximately indicated in the figures. The E-field and H-field distributions in the vertical plane placed at 60 cm from the antenna, are shown as well. The points where the fields are sampled to determine the equivalent power density (S) are approximately indicated by the white dots. A picture of the antenna is not reported because it is identical to the HAD4009A except for the length.


H field
60 cm
(0 mm, 200 mm, 0 mm)


E field

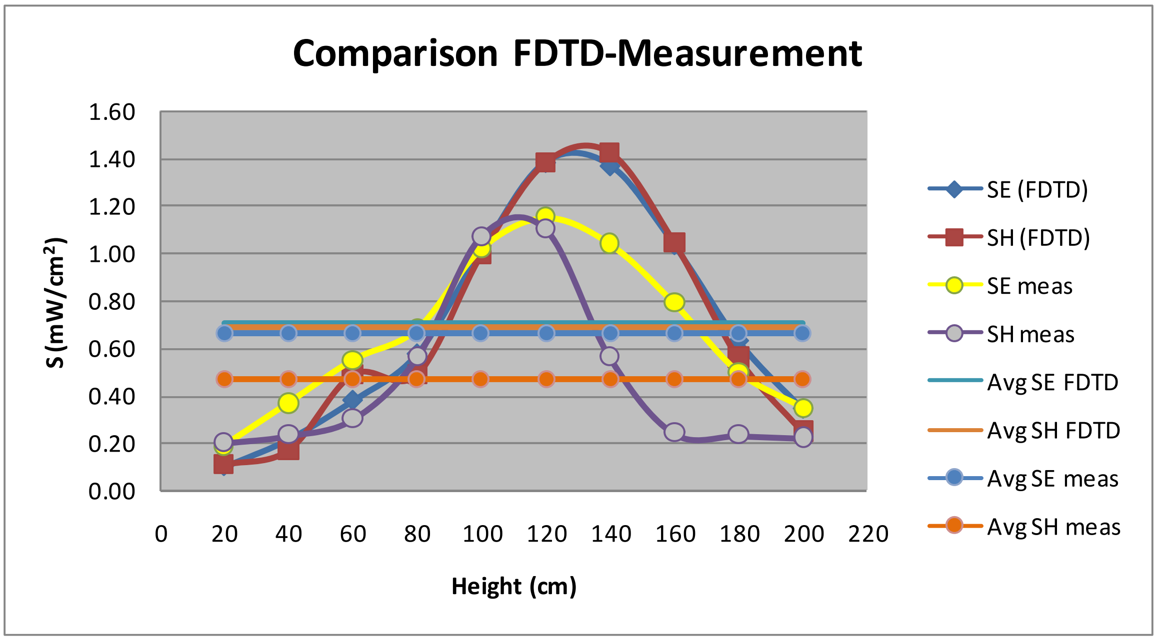


The following table reports the field values computed by XFDTD™ and the corresponding power density values. The average exposure levels are computed as well.

Height (cm)	E (V/m)	S_E (W/m^2)	H (A/m)	S_H (W/m^2)
20	1.84E-01	4.50E-05	5.10E-04	4.89E-05
40	2.71E-01	9.71E-05	6.38E-04	7.68E-05
60	3.58E-01	1.70E-04	1.08E-03	2.20E-04
80	4.42E-01	2.59E-04	1.54E-03	2.20E-04
100	5.85E-01	4.55E-04	1.82E-03	4.48E-04
120	6.86E-01	6.24E-04	1.85E-03	6.23E-04
140	6.82E-01	6.17E-04	1.58E-03	6.42E-04
160	5.93E-01	4.67E-04	1.16E-03	4.72E-04
180	4.63E-01	2.84E-04	7.67E-04	2.52E-04
200	3.41E-01	1.55E-04	4.94E-04	1.11E-04
	Average S_E	**3.17E-04**	**Average S_H**	**3.11E-04**

The input impedance is 33.7-j3.0 ohm, therefore the radiated power (considering the mismatch to the 50 ohm unitary voltage source) is 2.40E-3 W. The scaled-up power density values for 53.2 W radiated power are 7.03 W/m^2 (E), and 6.90 W/m^2 (H), that correspond to 0.70 mW/cm^2 (E), and 0.69 mW/cm^2 (H). Measurements yielded average power density of 0.664 mW/cm^2 (E), and 0.471 mW/cm^2 (H), i.e., which are in good agreement with the simulations. The following table and graph show a comparison between the simulated power density and the measured one, based on E (see MPE report in FCC ID#ABZ99FT3046, Table 1) or H fields (see MPE report in FCC ID#ABZ99FT3046, Table 13), normalized to 53.2 W radiated.

Height (cm)	SE (meas) mW/cm²	SE (FDTD) mW/cm²	SH (meas) mW/cm²	SH (FDTD) mW/cm²	Avg SE meas mW/cm²	Avg SE FDTD mW/cm²	Avg SH meas mW/cm²	Avg SH FDTD mW/cm²
20	0.19	0.10	0.2	0.11	0.664	0.703	0.471	0.690
40	0.37	0.22	0.23	0.17				
60	0.55	0.38	0.3	0.49				
80	0.68	0.57	0.56	0.49				
100	1.02	1.01	1.07	0.99				
120	1.15	1.38	1.1	1.38				
140	1.04	1.37	0.56	1.42				
160	0.79	1.03	0.24	1.05				
180	0.5	0.63	0.23	0.56				
200	0.35	0.34	0.22	0.25				



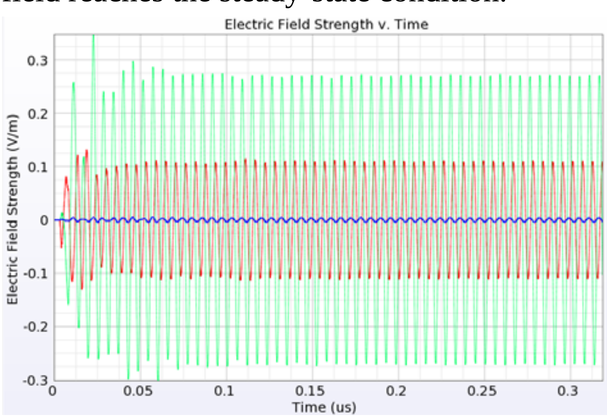
7) Test device positioning

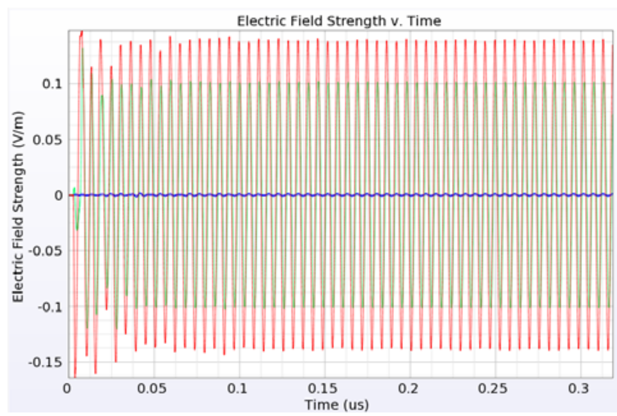
a) A description of the device test positions used in the SAR computations is provided in the SAR report.

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. The simulation projects were set to automatically track the field values throughout computational domain by means of XFDTD simulation control feature which ensures that "*convergence is reached when near-zone data shows a constant amplitude sine wave – when all transients have died down and the only variation left is sinusoidal. In this case "convergence" is tested on the average electric field in the space for its deviation from a pure sine wave. XFDTD automatically places points throughout the space for this purpose*." [XFDTD Reference Manual, version. 6.4 and version 7.2]. This convergence threshold was set to -50 dB.
In addition for at least one passenger and one bystander exposure condition, we placed one "field sensor" near the antenna, others between the body and the domain boundary at different locations, and one inside the head of the model. In all simulations, isotropic E-field sensors were placed at opposite sides of the computational domain. 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 two points of the computational domain. We selected points close to antenna as well as furthest one. 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 condition.





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 SAR for an individual voxel is computed according to the draft IEEE 62704-1 standard. In particular, the three components of the electric field are computed in the center of each voxel and then the SAR is computed as below:

$$SAR = \sigma_{voxel} \frac{|E_x|^2 + |E_y|^2 + |E_z|^2}{2\rho_{voxel}},$$

where σ_{voxel} and ρ_{voxel} are the conductivity and the mass density of the voxel.

10) One-gram and ten-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. Using the SAR values computed for each voxel of the model the averaging calculation employs the method and specifications defined in the draft IEEE 62704-1 standard to generate one-gram and ten-gram average SAR.

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 between 4% and 36%. 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 average radiated power is computed as

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

Both the input impedance and the net average 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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