MOTOROLA SOLUTIONS

COMPUTATIONAL EME COMPLIANCE ASSESSMENT OF THE XPR MODEL AAM28JQN9RA1AN (PMUD2567C)(IC MODEL: PMUD2567CBMNAA) MOBILE RADIO

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Introduction

This report summarizes the computational [numerical modeling] analysis performed to document compliance of the XPR Series Model Number AAM28JQN9RA1AN (PMUD2567C)(IC MODEL: PMUD2567CBMNAA) Mobile Radio and vehicle-mounted antennas with the US Federal Communications Commission (FCC), Innovation, Science and Economic Development (ISED) Canada and ICNIRP guidelines for human exposure to radio frequency (RF) emissions. The radio operates in the following frequency bands:

Regions	Bands	Frequency Band (MHz)
FCC US	LMR VHF	150.8-173.4
ISED Canada	LMR VHF	138-174
Overall (Other regions)	LMR VHF	136-174

This computational analysis supplements the measurements conducted to evaluate the compliance of the exposure from this mobile radio with respect to applicable *reference levels*, which in the following will be referred to as *maximum permissible exposure* (MPE) limits.[1] A total of 5 test conditions that did not conform with FCC MPE limit and 21 test conditions did not conform with ISED MPE limit were considered 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 [2] and Health Canada guidelines [1]. A total of 5 test conditions did not conform with ICNIRP

[1] This choice is made for process efficiency, since "MPE" is used in the United States. In this way, chances of making editorial mistakes that may then require extended interactions with the report examiner are reduced.

guideline MPE limit were considered to determine whether those conditions complied with SAR limits set forth in, ICNIRP guidelines [4] and IEEE Std. C95.1-2019 standard [5] (2.0 W/kg averaged over 10 gram of tissue and 0.08 W/kg averaged over the whole body).

Employing SAR simulation reduction considerations[2], a total of 18 configurations (requiring a total of 36 numerical simulations) have been performed, all of them addressing the exposure of the bystander and back seat passenger to the VHF mobile radio featuring trunk-mount and roof-mount antennas.

For all simulations a commercial code (XFDTD™ v7.6.0, by Remcom Inc, State College, PA, USA) based on the 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 represents the *basic restriction* for RF energy exposure up to 6 GHz and that MPE limits are in fact derived from SAR limits. Accordingly, the SAR computations provide a scientifically valid and more relevant estimate of RF energy exposures.

Method

The XFDTD™ v7.6.0 computational suite enable simulating the heterogeneous full human body model defined according to the IEC/IEEE 62704-2:2017 standard and derived from the so-called Visible Human [3], discretized in 3 mm cubic-edge voxels. The IEC/IEEE 62704-2:2017 dielectric properties for 39 body tissues are automatically assigned by XFDTD™ at the specific simulation frequency. The "seated" man model representing the passenger 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 A to this report. The evaluation of the computational uncertainties and results of the benchmark validations are provided in the Appendix B attached to this report. The XFDTD code validation performed by Remcom Inc. according to the IEEE/IEC 62704-2:2017 standard requirements are provided in conjunction with this report.

The car model has been imported into XFDTD™ from the CAD file of the sedan vehicle defined in the IEEE/IEC 62704-2:2017 standard, having dimensions 4.98 m (L) x 1.85 m (W) x 1.18 m (H), and discretized with the minimum resolution of 3 mm and the maximum resolution of 8 mm. Figure 1 below shows both the vehicle CAD model and a picture of the actual vehicle.

[2] SAR simulation reduction is described in the SAR Simulations Reduction Considerations section of this report.

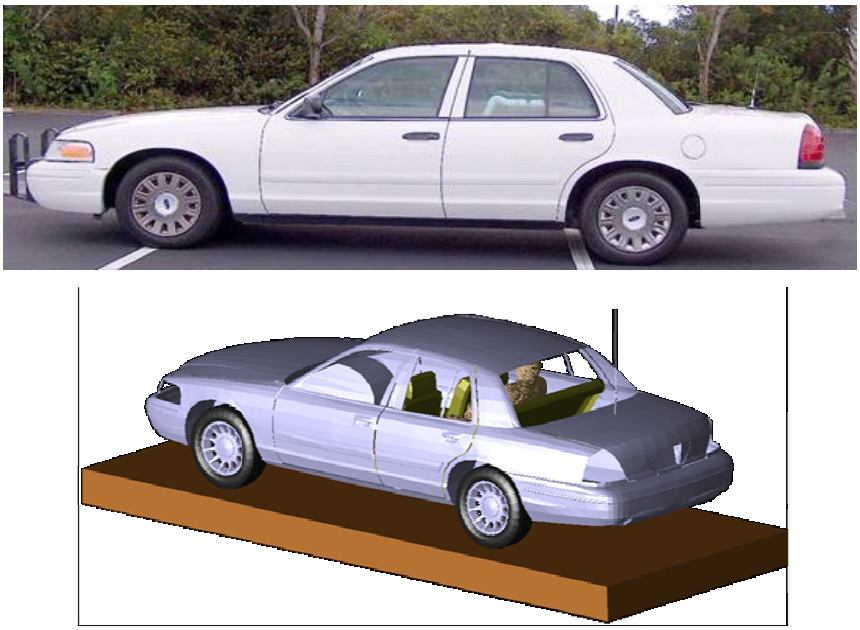


Figure 1: Picture of the vehicle and corresponding CAD model used in XFDTD™ simulations

For back seat passenger exposures, the antenna is positioned on the trunk at 85 cm distance from the passenger model head when the passenger model is located in the center of the back seat, replicating the experimental conditions used in MPE measurements. Figure 2 and Figure 3 shows the XFDTD™ computational models used for passenger exposure to trunk and roof mount antennas.

For bystander exposure, the antenna position is in the center of the trunk, as to replicate the experimental conditions used in MPE measurements. Figure 4 and 5 shows some of the XFDTD™ computational models used for bystander exposure.

According to the IEC/IEEE 62704-2:2017 standard a lossy dielectric slab featuring 30 cm thickness, relative dielectric constant 8 and conductivity 0.01 S/m has been introduced in the computational model to properly account for the effect of the ground (pavement) on exposure.

The computational code employs a time-harmonic field excitation to produce a steady-state electromagnetic field in the exposed body model. Subsequently, the corresponding SAR distribution is automatically processed in order to determine the whole-body SAR and peak spatial average SAR distribution.

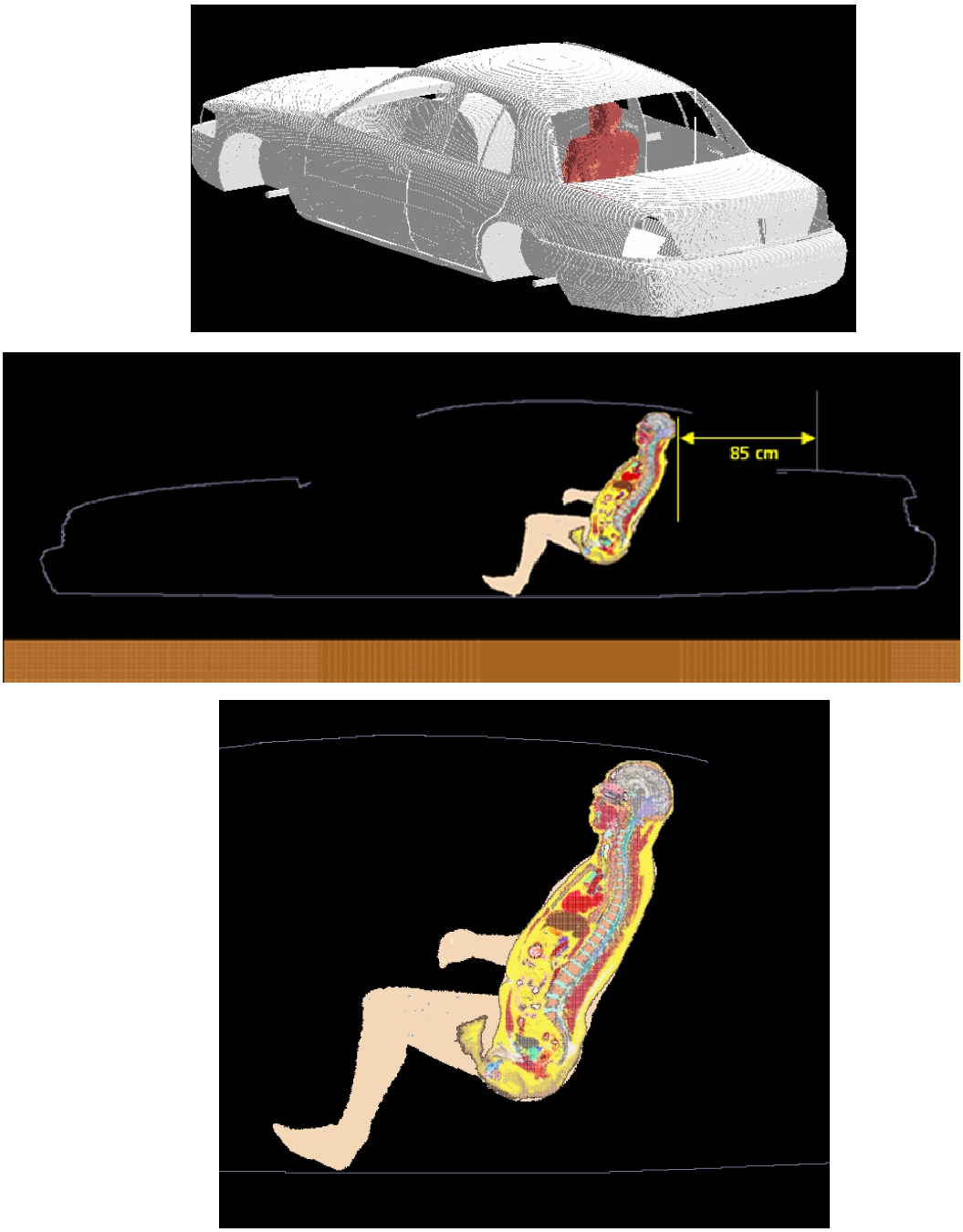


Figure 2: Passenger (back seat) model exposed to a trunk-mount antenna: XFDTD™ geometry. The antenna is installed at 85 cm from the passenger located in the center of the back seat.

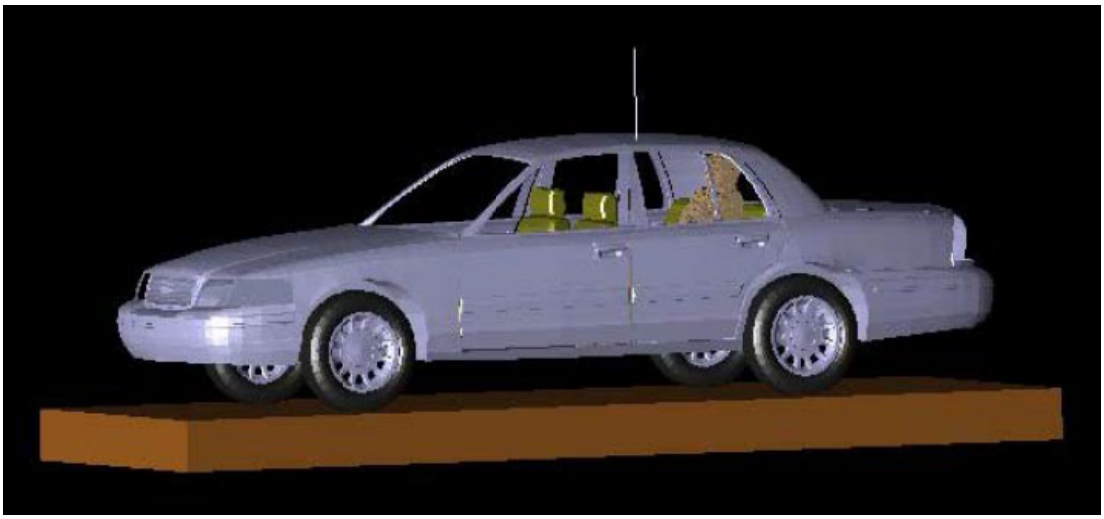


Figure 3: Passenger (back seat) model exposed to a roof-mount antenna: XFDTD™ geometry.

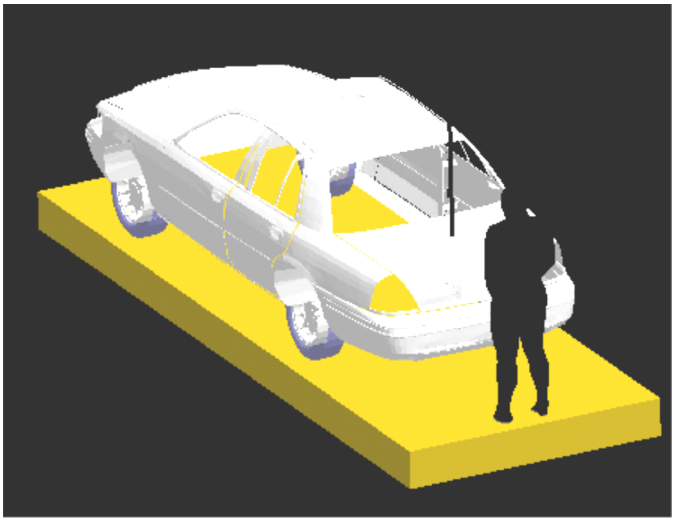


Figure 4a

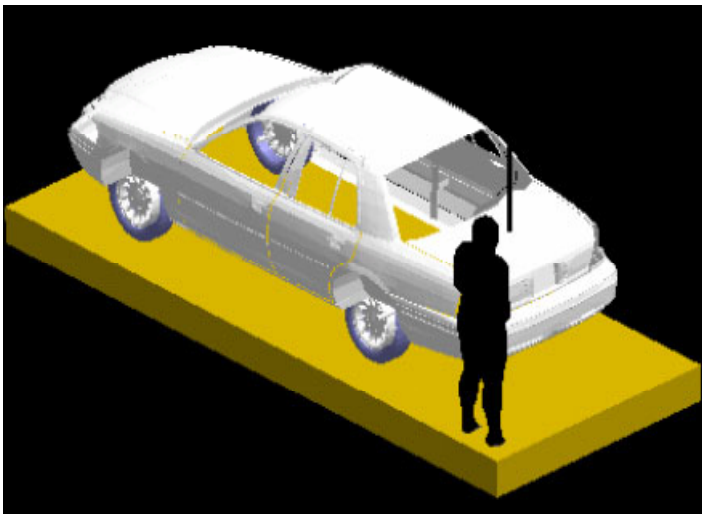


Figure 4b

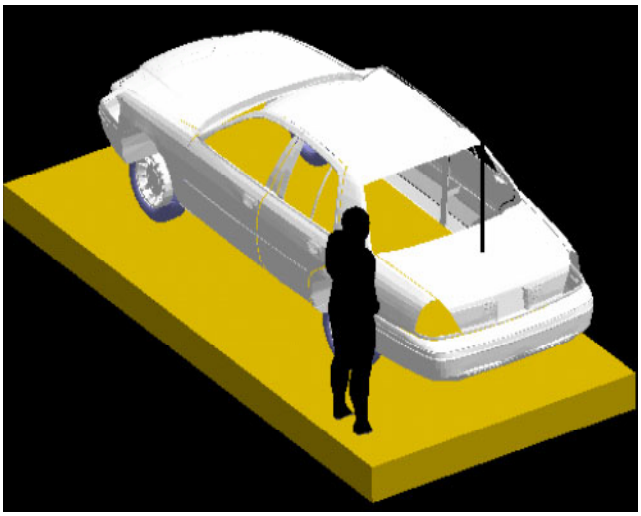


Figure 4c

Figure 4(a.b.c): Bystander model exposed to a trunk-mount antenna: XFDTD™ geometry. Bystander is located at the back, on the corner or at the side of the car replicating the measurement conditions.

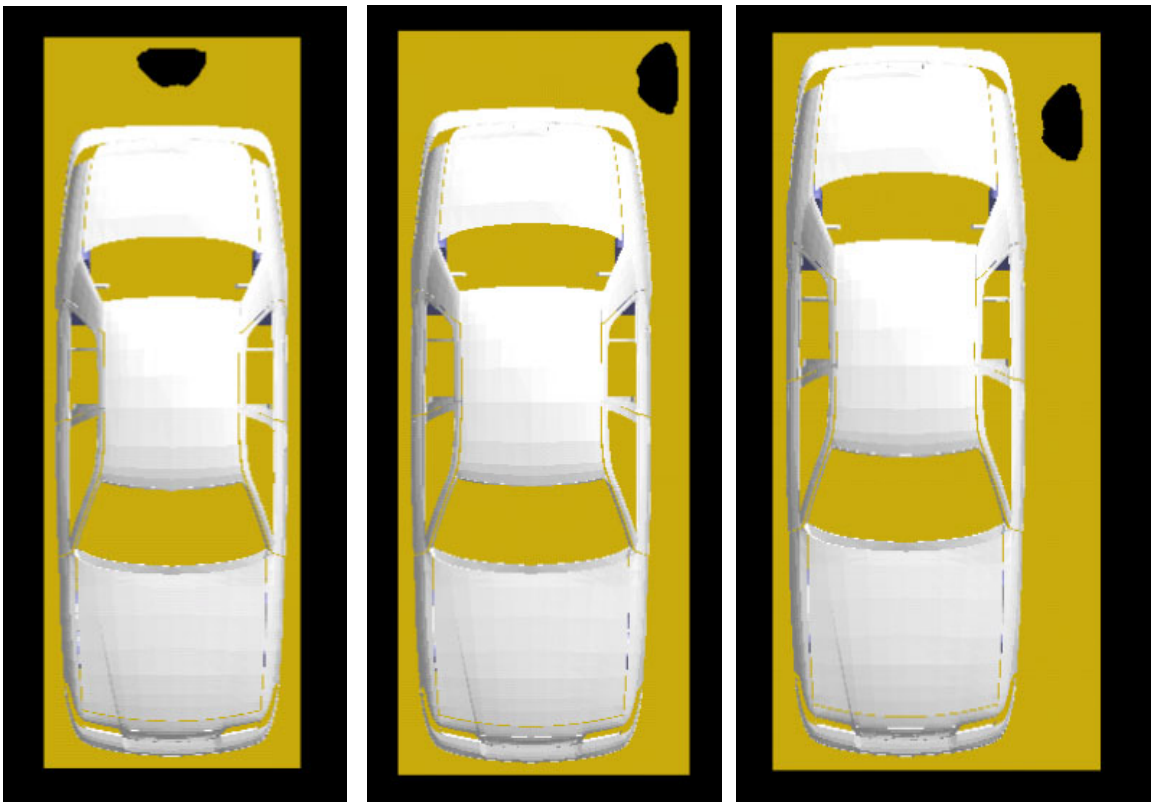


Figure 5: Top view of bystander exposure model four different locations relative to the vehicle model that replicate the measurement conditions.

The maximum average output power from mobile radio antenna is 54W (136-174 MHz). Since the ohmic losses in the vehicle materials, as well as the mismatch losses at the antenna feed-point are neglected, while source-based time averaging (50% talk time for to push-to-talk operation) for the VHF mobile radio were employed, all computational results are normalized to half of the VHF mobile radio maximum average net output power, i.e., 27W (136-174 MHz), minus the corresponding minimum insertion loss in excess of 0.5 dB of the feed cables supplied with the antennas, in accordance with the IEC/IEEE 62704-2:2017 standard provisions.

Results of SAR computations for car passengers and bystanders

The test conditions requiring SAR computations are summarized in Table 1 (Bystanders) and Table 2 (Passengers), together with the antenna data, the SAR results, and power density (P.D.) as obtained from the MPE measurements in the corresponding test conditions. The conditions are for antennas mounted on the center of the trunk and roof. The antenna length listed in the tables includes the height of the 1.8 cm magnetic mount base used in MPE measurements to position the antenna on the vehicle. The same length was then used in the corresponding simulation model.

The passenger is located in the center or on the side of the rear seat corresponding to the respective configurations defined in the IEC/IEEE 62704-2-2017 standard. The bystander is located at the measurement distance from the transmit antenna as described in the MPE report and assessed for front and rear exposure.

All the transmit frequency, antenna length, and passenger/bystander location reported in Table 1 and Table 2 have been simulated individually. These tables also include the interpolated adjustment factor and corresponding SAR scaled values following requirement of the IEC/IEEE 62704-2-2017 standard.

Table 1a: Computed and adjusted SAR results for Bystanders exposure

(Configurations exceeding FCC MPE limits)

Mount Location	Antenna Kit#	Antenna Length (cm)	Freq (MHz)	P.D. (mW/cm^2)	Exposure Location	Computed SAR (W/kg)		Interpolated Adjustment Factors		Adjusted SAR Results (W/kg)	
						1 g	WB	1 g	WB	1 g	WB
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	98.3	165.0125	0.21	45 Deg. Front	0.20	0.007	1.33	1.95	0.27	0.015
					45 Deg. Rear **(Figure 6 & 7)**	0.32	0.008	1.33	1.95	**0.43**	0.015
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	98.3	165.0125	0.20	90 Deg. Front	0.20	0.009	1.33	1.95	0.27	**0.018**
					90 Deg. Rear	0.26	0.009	1.33	1.95	0.35	0.017

Notes:
*Antenna length trimmed to frequency
Bold Blue – the highest adjusted SAR results for the respective frequency band.

Table 1b: Computed and adjusted SAR results for Bystanders exposure

(Configurations exceeding ISED MPE limits)

Mount Location	Antenna Kit#	Antenna Length (cm)	Freq (MHz)	P.D. (mW/cm^2)	Exposure Location	Computed SAR (W/kg)		Interpolated Adjustment Factors		Adjusted SAR Results (W/kg)	
						1 g	WB	1 g	WB	1 g	WB
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	120.3	144.0000	0.18	0 Deg. Front	0.15	0.007	1.31	1.97	0.19	0.015
					0 Deg. Rear	0.25	0.007	1.31	1.97	0.33	0.014
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	115.8	150.8000	0.15	0 Deg. Front	0.16	0.008	1.30	1.90	0.21	0.015
					0 Deg. Rear	0.27	0.007	1.30	1.90	0.35	0.014
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	104.5	158.0125	0.17	0 Deg. Front	0.17	0.007	1.32	1.92	0.23	0.014
					0 Deg. Rear	0.28	0.007	1.32	1.92	0.37	0.014
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	98.3	165.0125	0.19	0 Deg. Front	0.28	0.011	1.33	1.95	0.37	**0.020**
					0 Deg. Rear **(Figure 8 & 9)**	0.38	0.010	1.33	1.95	**0.50**	0.019
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	91.7	173.0125	0.16	0 Deg. Front	0.13	0.008	1.35	1.97	0.17	0.015
					0 Deg. Rear	0.21	0.007	1.35	1.97	0.29	0.014
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	98.3	#165.0125	0.21	45 Deg. Front	0.20	0.007	1.33	1.95	0.27	0.015
					45 Deg. Rear	0.32	0.008	1.33	1.95	0.43	0.015
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	98.3	#165.0125	0.20	90 Deg. Front	0.20	0.009	1.33	1.95	0.27	0.018
					90 Deg. Rear	0.26	0.009	1.33	1.95	0.35	0.017

Notes:
Bold Blue – the highest adjusted SAR results for the respective frequency band.
* - Antenna length trimmed to frequency
# - Same SAR simulation configuration as Table 1a

Table 1c: Computed and adjusted SAR results for Bystanders exposure

(Configurations exceeding ICNIRP MPE limits)

Mount Location	Antenna Kit#	Antenna Length (cm)	Freq (MHz)	P.D. (mW/cm^2)	Exposure Location	Computed SAR (W/kg)		Interpolated Adjustment Factors		Adjusted SAR Results (W/kg)	
						10 g	WB	10 g	WB	10 g	WB
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	98.3	#165.0125	0.21	45 Deg. Front	0.15	0.007	1.33	1.33	0.20	0.015
					45 Deg. Rear **(Figure 6 & 7)**	0.21	0.008	1.33	1.33	**0.28**	0.015
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	98.3	#165.0125	0.20	90 Deg. Front	0.13	0.009	1.33	1.33	0.18	**0.018**
					90 Deg. Rear	0.15	0.009	1.33	1.33	0.20	0.017

Notes:
*Antenna length trimmed to frequency
Bold Blue – the highest adjusted SAR results for the respective frequency band.

Table 2a: Computed and adjusted SAR results for Passenger exposure
(Configurations exceeding FCC MPE limits)

Mount Location	Antenna Kit#	Antenna Length (cm)	Freq (MHz)	P.D. (mW/cm^2)	Exposure Location	Computed SAR (W/kg)		Interpolated Adjustment Factors		Adjusted SAR Results (W/kg)	
						1 g	WB	1 g	WB	1 g	WB
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	104.5	158.0125	0.25	Back Center	0.25	0.011	1.91	2.41	0.48	0.027
					Back Side	0.19	0.010	4.14	2.99	0.78	0.029
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	98.3	165.0125	0.54	Back Center	0.25	0.011	1.93	2.42	0.48	0.027
					Back Side **(Figure 10 & 11)**	0.20	0.009	4.09	2.98	**0.82**	0.028
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	97.1	173.0125	0.66	Back Center	0.25	0.013	1.94	2.43	0.49	0.032
					Back Side	0.19	0.011	4.03	2.97	0.77	**0.032**

Notes:
Bold Blue – the highest adjusted SAR results for the respective frequency band.
* - Antenna length trimmed to frequency

Table 2b: Computed and adjusted SAR results for Passenger exposure
(Configurations exceeding ISED MPE limits)

Mount Location	Antenna Kit#	Antenna Length (cm)	Freq (MHz)	P.D. (mW/cm^2)	Exposure Location	Computed SAR (W/kg)		Interpolated Adjustment Factors		Adjusted SAR Results (W/kg)	
						1 g	WB	1 g	WB	1 g	WB
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	120.3	144.0000	0.17	Back Center	0.35	0.015	1.82	2.31	0.63	0.034
					Back Side	0.12	0.009	3.93	2.83	0.49	0.026
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	115.8	150.8000	0.16	Back Center	0.22	0.010	1.90	2.40	0.42	0.024
					Back Side	0.12	0.006	4.19	3.00	0.49	0.019
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	104.5	#158.0125	0.25	Back Center	0.25	0.011	1.91	2.41	0.48	0.027
					Back Side	0.19	0.010	4.14	2.99	0.78	0.029
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	98.3	#165.0125	0.54	Back Center	0.25	0.011	1.93	2.42	0.48	0.027
					Back Side **(Figure 10 & 11)**	0.20	0.009	4.09	2.98	**0.82**	0.028
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	97.1	#173.0125	0.66	Back Center	0.25	0.013	1.94	2.43	0.49	0.032
					Back Side	0.19	0.011	4.03	2.97	0.77	**0.032**

Notes:
Bold Blue – the highest adjusted SAR results for the respective frequency band.
* - Antenna length trimmed to frequency
# - Same SAR simulation configuration as Table 2a

Table 2b (Continued): Computed and adjusted SAR results for Passenger exposure
(Configurations exceeding ISED MPE limits)

Mount Location	Antenna Kit#	Antenna Length (cm)	Freq (MHz)	P.D. (mW/cm^2)	Exposure Location	Computed SAR (W/kg)		Interpolated Adjustment Factors		Adjusted SAR Results (W/kg)	
						1 g	WB	1 g	WB	1 g	WB
Roof	HAD4006A, 1/4 wave (136-144MHz)	53.8	138.0000	0.14	Back Center	0.09	0.004	1.25	1.75	0.11	0.007
					Back Side	0.19	0.006	1.05	2.21	0.20	0.013
Roof	HAD4008A, 1/4 wave (150.8-162MHz)	47.3	162.0000	0.18	Back Center	0.03	0.001	1.35	1.90	0.03	0.003
					Back Side	0.05	0.001	1.03	2.42	0.05	0.004
Roof	HAD4009A, 1/4 wave (162-174MHz)	44.8	165.0125	0.16	Back Center	0.02	0.001	1.37	1.89	0.02	0.002
					Back Side	0.05	0.001	1.04	2.43	0.05	0.003
Roof	RAD4224A, 1/4 wave (150.8-162MHz)	46.1	162.0000	0.16	Back Center	0.03	0.001	1.35	1.90	0.03	0.003
					Back Side	0.05	0.001	1.03	2.42	0.05	0.004
Roof	RAD4225A, 1/4 wave (146-150.8MHz)	49.1	150.8000	0.15	Back Center	0.10	0.003	1.30	1.90	0.13	0.006
					Back Side	0.20	0.004	1.00	2.40	0.20	0.009
Roof	RAD4226A, 1/4 wave (136-144MHz)	52.1	138.0000	0.14	Back Center	0.09	0.004	1.25	1.75	0.11	0.007
					Back Side	0.19	0.006	1.05	2.21	0.20	0.014

Notes:
Bold Blue – the highest adjusted SAR results for the respective frequency band.
* - Antenna length trimmed to frequency

Table 2c: Computed and adjusted SAR results for Passenger exposure
(Configurations exceeding ICNIRP MPE limits)

Mount Location	Antenna Kit#	Antenna Length (cm)	Freq (MHz)	P.D. (mW/cm^2)	Exposure Location	Computed SAR (W/kg)		Interpolated Adjustment Factors		Adjusted SAR Results (W/kg)	
						10 g	WB	10 g	WB	10 g	WB
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	104.5	158.0125	0.25	Back Center	0.16	0.011	2.01	2.41	0.32	0.027
					Back Side	0.13	0.010	4.34	2.99	0.58	0.029
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	98.3	165.0125	0.54	Back Center	0.16	0.011	2.02	2.42	0.32	0.027
					Back Side **(Figure 10 & 11)**	0.18	0.009	4.29	2.98	**0.75**	0.028
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	97.1	173.0125	0.66	Back Center	0.16	0.013	2.03	2.43	0.33	0.032
					Back Side	0.12	0.011	4.24	2.97	0.51	**0.032**

Notes:
Bold Blue – the highest adjusted SAR results for the respective frequency band.
* - Antenna length trimmed to frequency

The SAR distribution in the bystander exposure condition that gave the highest adjusted 1-g SAR (VHF mobile radio) for FCC and ICNIRP is reported in Figure 6. (165.0125 MHz, bystander back (rear) at the 45 degree angle of the vehicle trunk, HAD4022A antenna installed on the trunk).

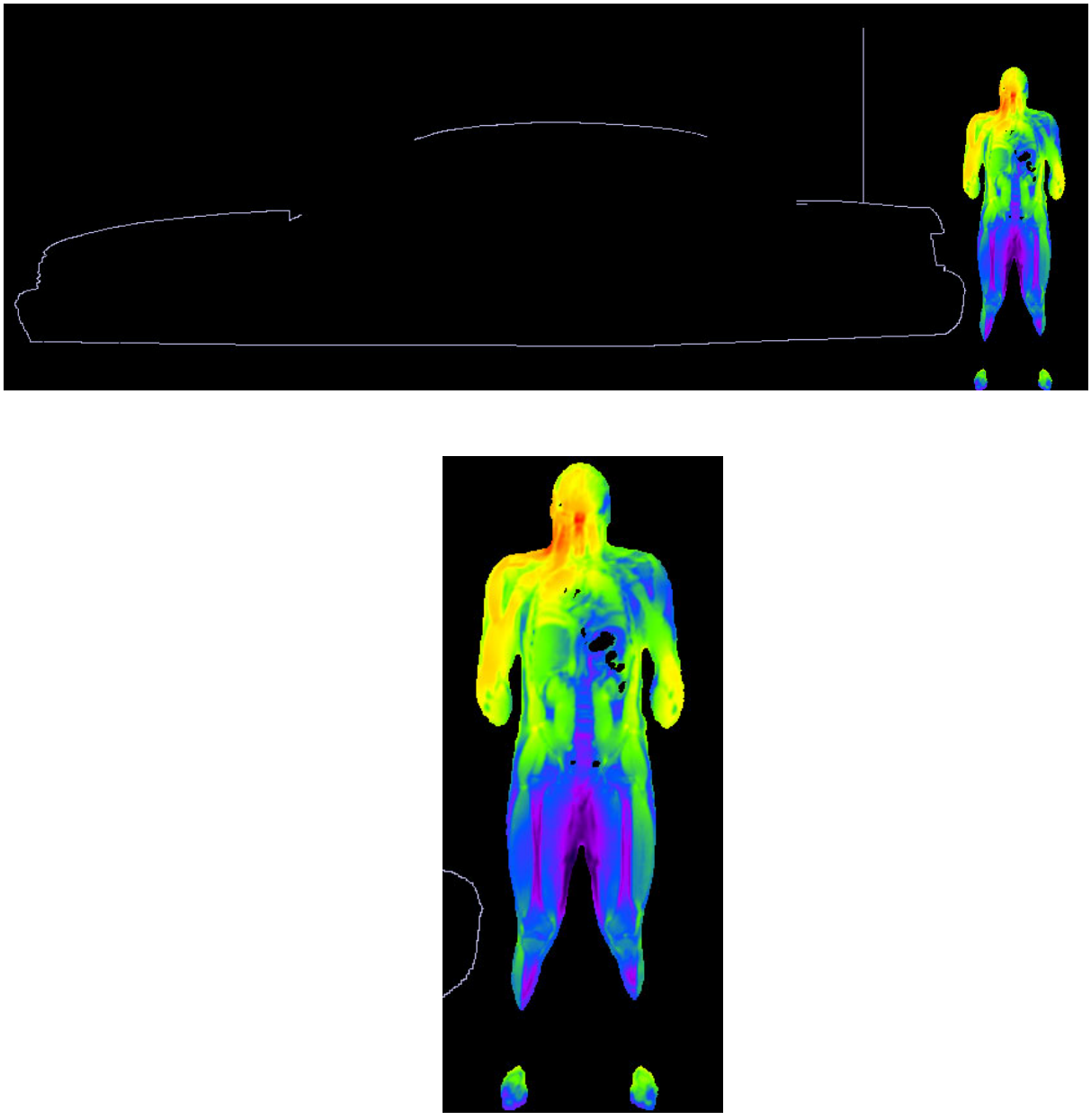
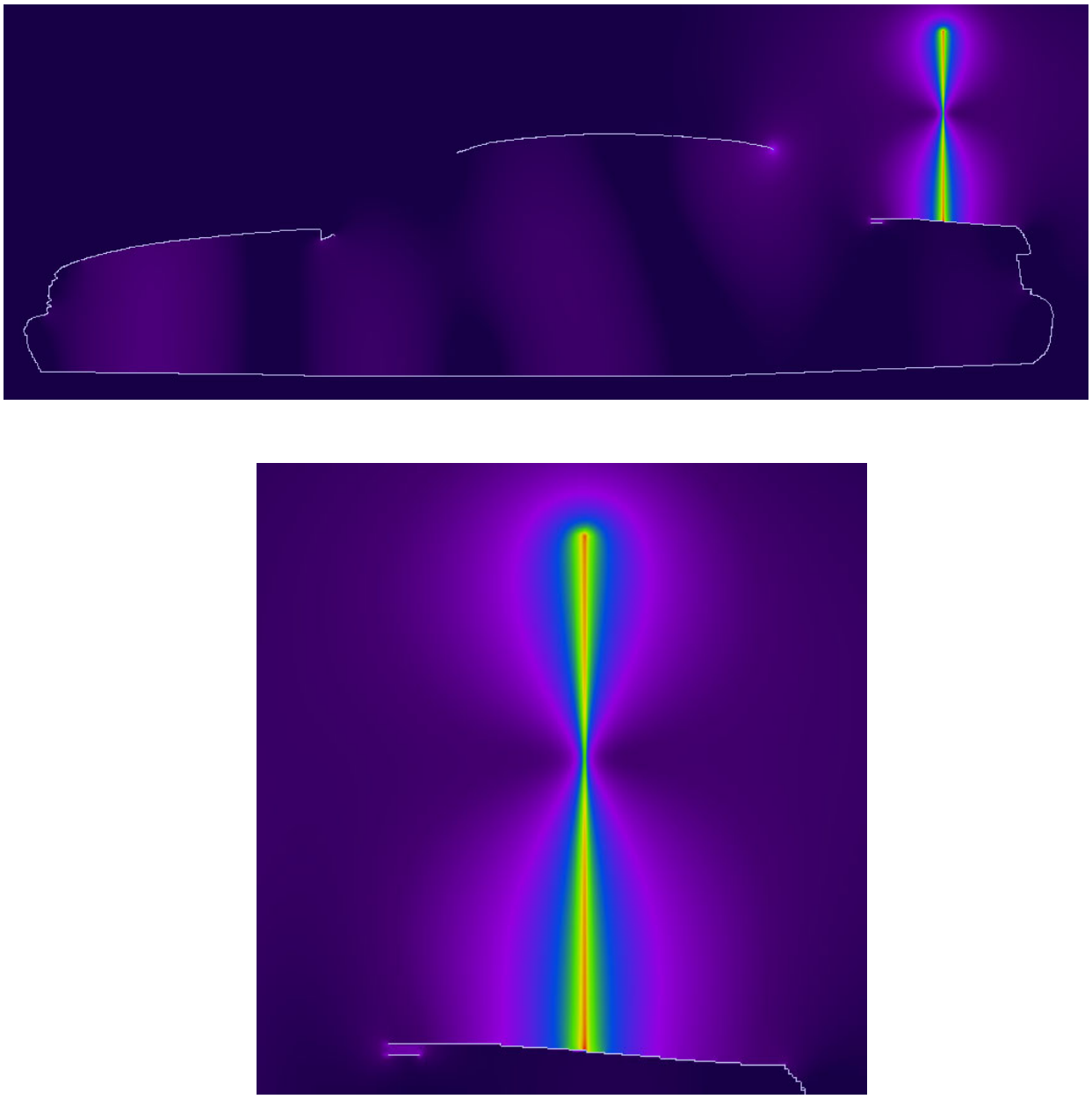
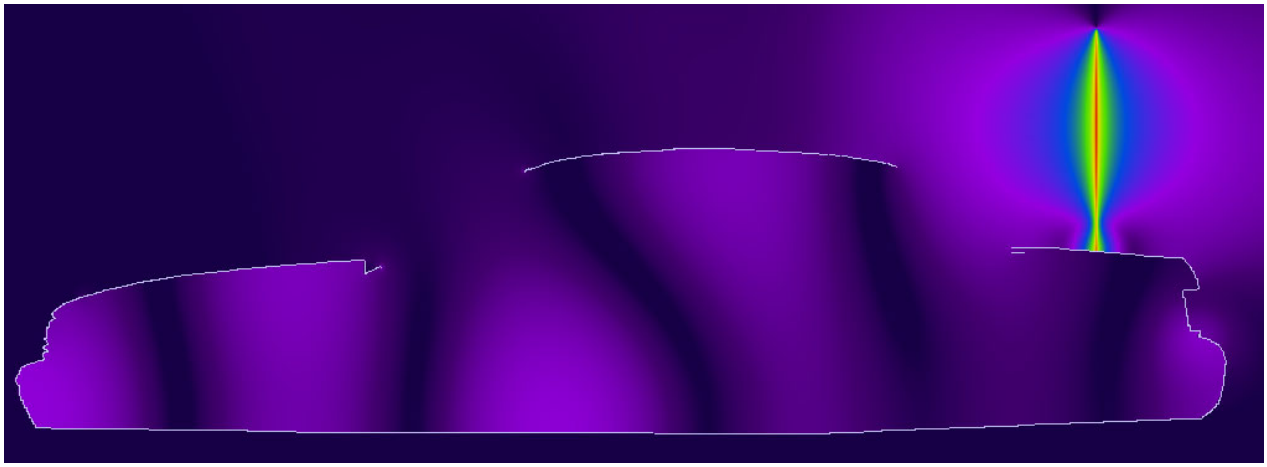


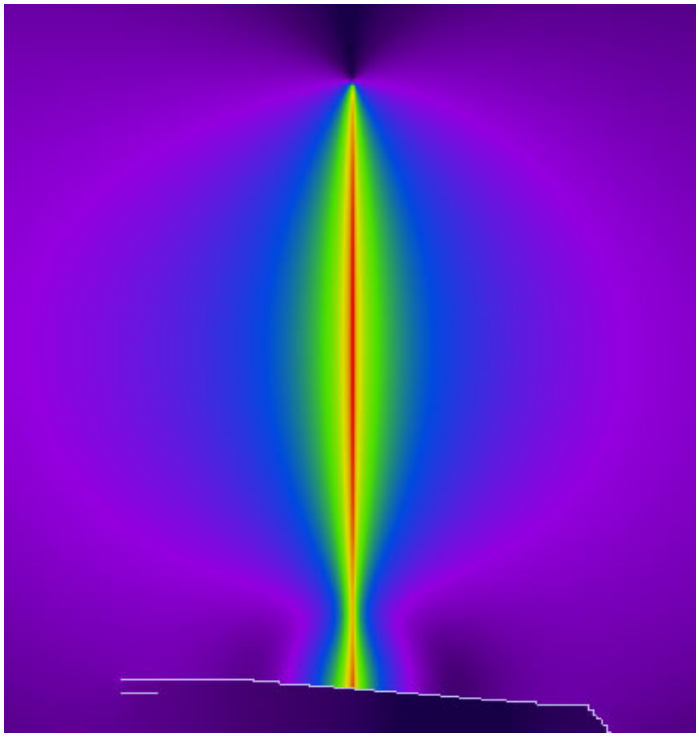
Figure 6. SAR distribution at 165.0125 MHz in the bystander model located at the 45 degree angle of the vehicle trunk, produced by the trunk-mount HAD4022A antenna. The SAR distribution plot is relative to the plane where the peak 1-g average SAR for this exposure condition occurs.

The plots in Figure 7 illustrate the E and H field distributions in the plane of the antenna corresponding to the exposure condition resulting in the SAR distribution in Figure 6.



a)





b)

Figure 7. (a) E-field magnitude distribution corresponding to exposure condition of Figure 6, and (b) H-field magnitude distribution corresponding to exposure condition of Figure 6.

The SAR distribution in the bystander exposure condition that gave the highest adjusted 1-g SAR (VHF mobile radio) for ISED is reported in Figure 6. (165.0125 MHz, bystander back (rear) at the 0 degree angle of the vehicle trunk, HAD4022A antenna installed on the trunk).

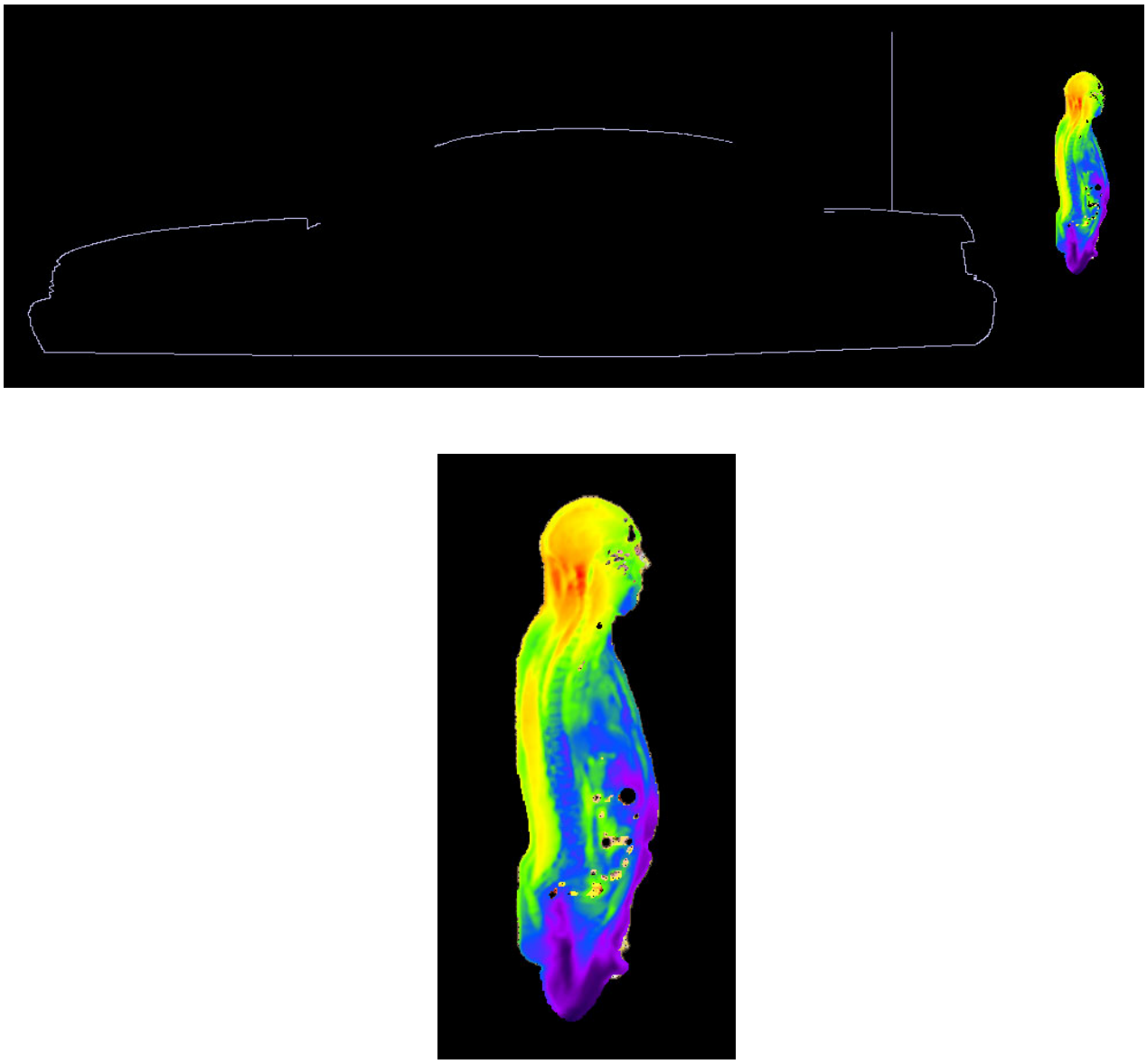
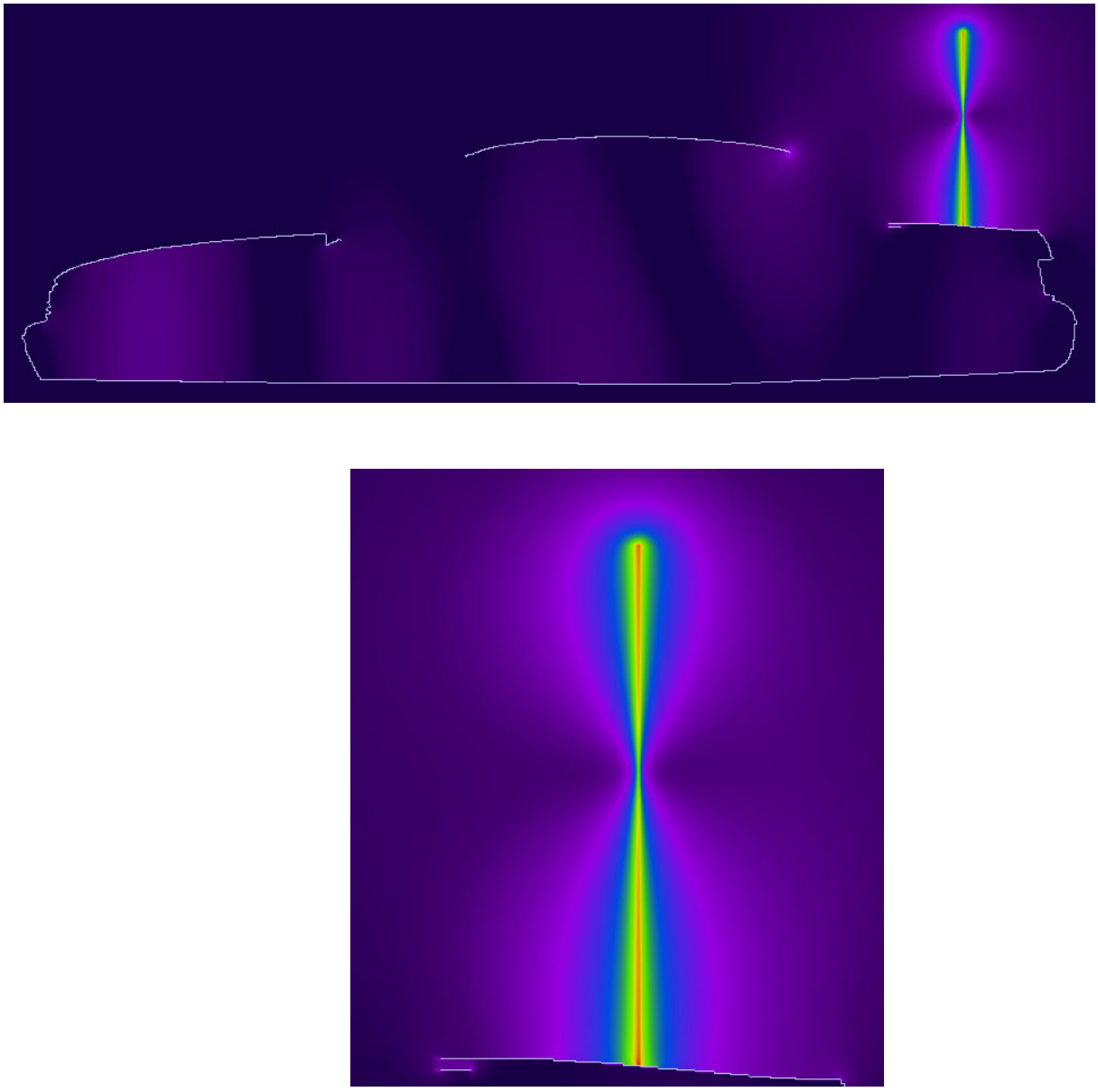
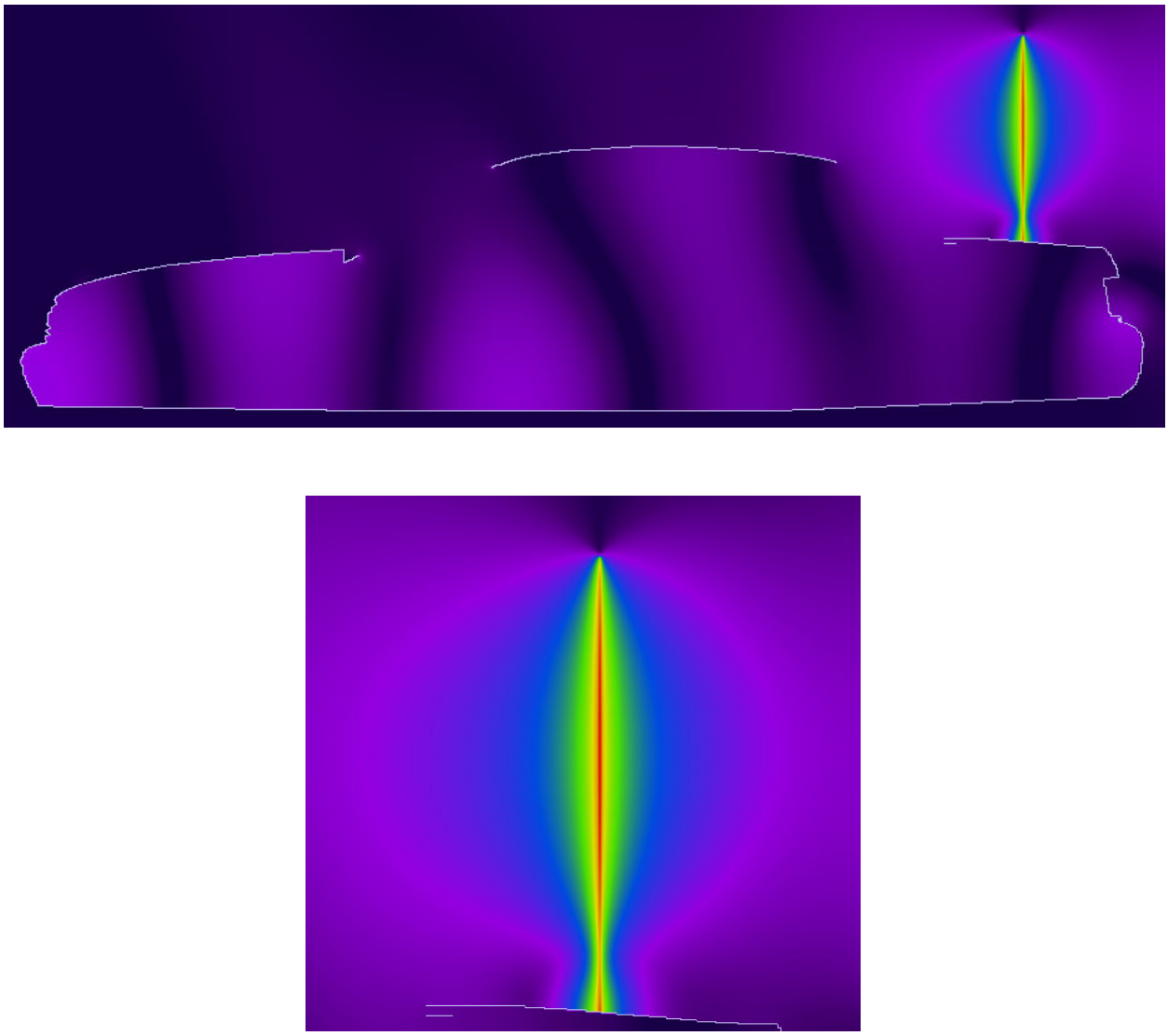


Figure 8. SAR distribution at 165.0125 MHz in the bystander model located at the 0 degree angle of the vehicle trunk, produced by the trunk-mount HAD4022A antenna. The SAR distribution plot is relative to the plane where the peak 1-g average SAR for this exposure condition occurs.

The plots in Figure 9 illustrate the E and H field distributions in the plane of the antenna corresponding to the exposure condition resulting in the SAR distribution in Figure 8.



a)



b)

Figure 9. (a) E-field magnitude distribution corresponding to exposure condition of Figure 8, and (b) H-field magnitude distribution corresponding to exposure condition of Figure 8.

The SAR distribution in the passenger exposure condition that gave the highest adjusted 1-g SAR (VHF mobile radio) for FCC, ISED and ICNIRP is reported in Figure 8. (165.0125 MHz, passenger on the side of the back seat, HAD4022A antenna installed on the trunk).

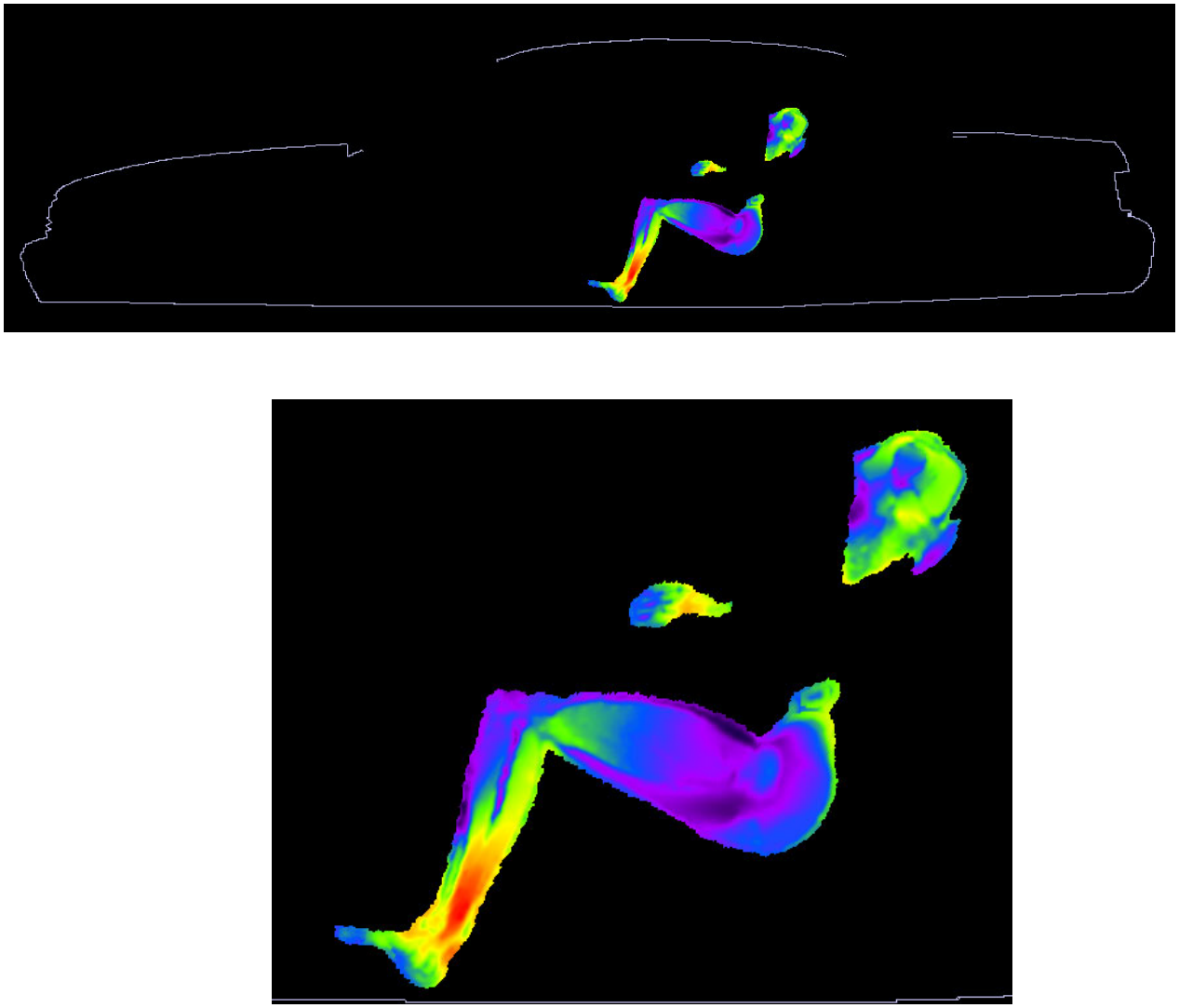
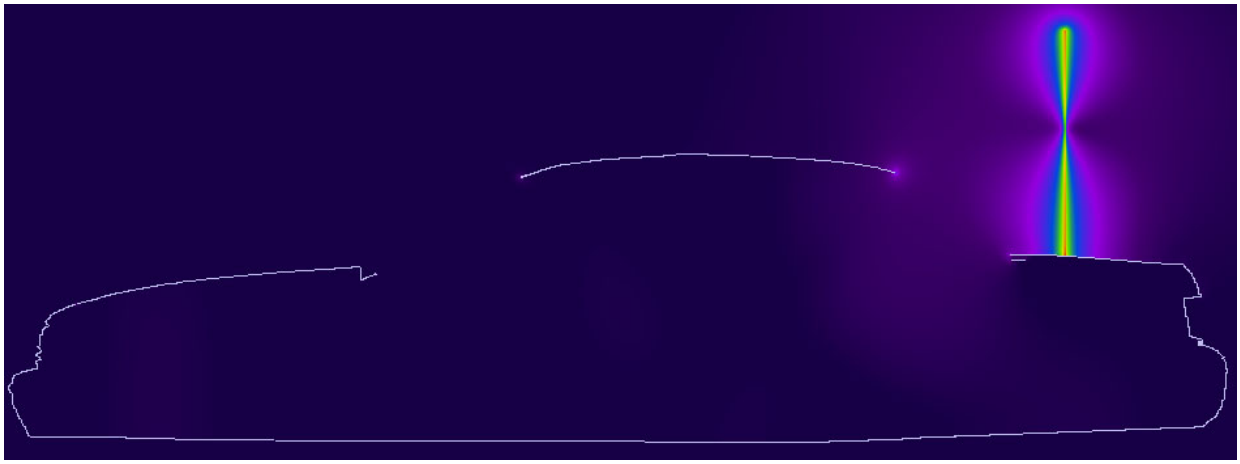
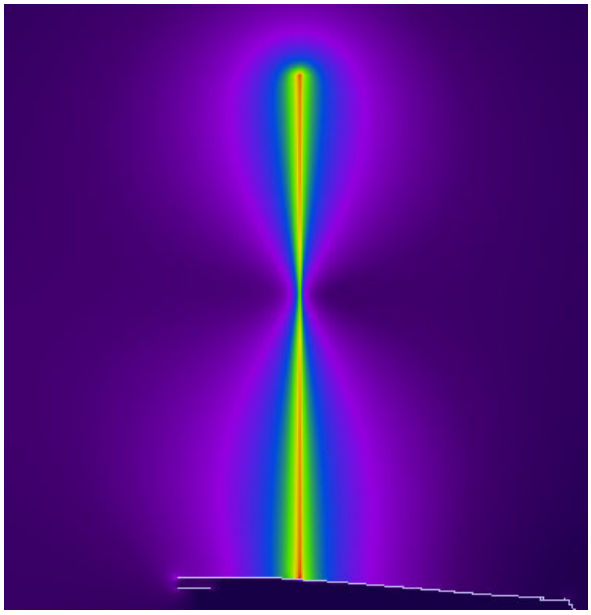


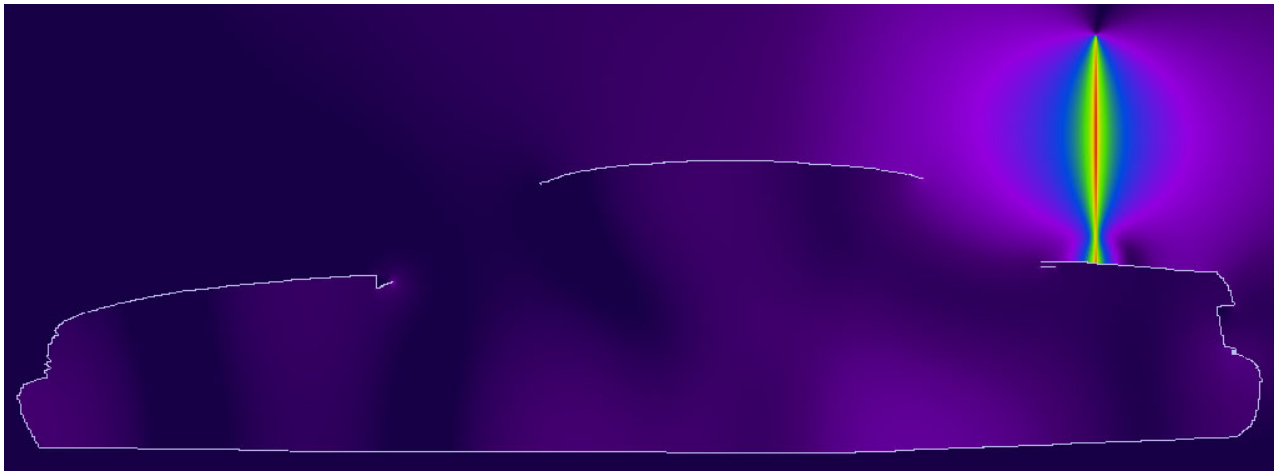
Figure 10. SAR distribution 165.0125 MHz in the passenger model located on the side of the back seat, produced by the trunk-mount HAD4022A antenna. The SAR distribution plot is relative to the plane where the peak 1-g average SAR for this exposure condition occurs.

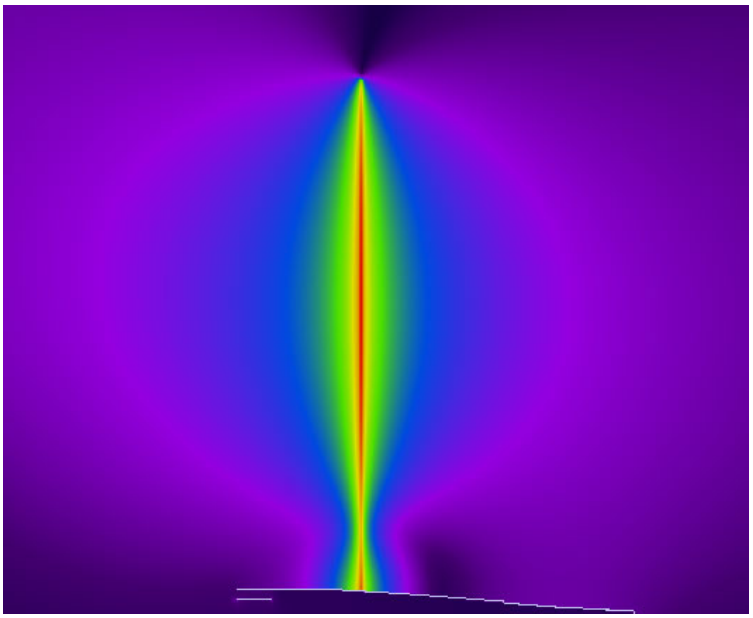
The plots in Figure 11 illustrate the E and H field distributions in the plane of the antenna corresponding to the exposure condition resulting in the SAR distribution in Figure 10.





a)





b)

Figure 11. (a) E-field magnitude distribution corresponding to exposure condition of Figure 10, and (b) H-field magnitude distribution corresponding to exposure condition of Figure 10.

SAR Simulation Reduction Considerations

Per the Response to Inquiry to FCC Tracking Number 528198, for a particular antenna that has more than one configuration which exceeds the MPE limit, SAR evaluations shall begin with the highest MPE configuration (mount location and frequency channel). If the SAR value is less than 50% of the SAR limit, no further SAR evaluation is needed for that antenna.

If the highest MPE configuration SAR value is above 50% of the SAR limit, a subsequent SAR simulation shall be performed on the subsequent highest MPE configuration (ranked in descending percentage of the MPE limit). If the subsequent adjusted SAR value is below 75% of the limit, no further SAR evaluation is needed for that antenna, otherwise further SAR simulations for the remaining antenna configurations shall continue until the adjusted SAR value is below 75% of the SAR limit.

Table 3 and Table 4 below list all the configurations that did not conform to applicable MPE limits (ranked in descending percentage of the MPE limit), to which the aforementioned SAR simulation reduction considerations were applied.

Table 3a: SAR Simulation Reduction Considerations for Bystander

(FCC US)

Mount Location	Antenna Kit#	Freq (MHz)	P.D. (mW/cm^2)	FCC Limit (mW/cm^2)	% To FCC Spec Limit	Exposure Location	Adjusted SAR Results (W/kg)		SAR Simulation Reduction
							1 g	WB	
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	165.0125	0.21	0.20	103.4	45 Deg. Front	0.27	0.015	
						45 Deg. Rear	0.43	0.015	
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	165.0125	0.20	0.20	100.8	90 Deg. Front	0.27	0.018	
						90 Deg. Rear	0.35	0.017	

Note:
*Antenna length trimmed to frequency

Table 3b: SAR Simulation Reduction Considerations for Bystander (ISED Canada)

Mount Location	Antenna Kit#	Freq (MHz)	P.D. (mW/cm^2)	ISED Limit (mW/cm^2)	% To ISED Spec Limit	Exposure Location	Adjusted SAR Results (W/kg)		SAR Simulation Reduction
							1 g	WB	
Trunk	* HAD4022A, 5/8 Wave (132 -174 MHz)	173.0125	0.16	0.13	507.9	0 Deg. Front	0.47	0.017	
						0 Deg. Rear	0.31	0.017	
		165.0125	0.19	0.13	421.2	0 Deg. Front	0.32	0.012	
						0 Deg. Rear	0.18	0.012	
		158.0125	0.17	0.13	190.7	0 Deg. Front	0.32	0.012	
						0 Deg. Rear	0.18	0.012	
		144.0000	0.18	0.13	129.3	0 Deg. Front	0.42	0.014	
						0 Deg. Rear	0.21	0.015	
		150.8000	0.15	0.13	126.2	0 Deg. Front	0.42	0.014	
						0 Deg. Rear	0.25	0.014	
Trunk	* HAD4022A, 5/8 Wave (132 -174 MHz)	173.0125	0.25	0.13	193.5	45 Deg. Front	0.28	0.015	
						45 Deg. Rear	0.34	0.014	
Trunk	* HAD4022A, 5/8 Wave (132 -174 MHz)	173.0125	0.24	0.13	189.2	90 Deg. Front	0.43	0.018	
						90 Deg. Rear	0.25	0.018	

Note:
*Antenna length trimmed to frequency

Table 3c: SAR Simulation Reduction Considerations for Bystander (ICNIRP)

Mount Location	Antenna Kit#	Freq (MHz)	P.D. (mW/cm^2)	ICNIRP Limit (mW/cm^2)	% To ICNIRP Spec Limit	Exposure Location	Adjusted SAR Results (W/kg)		SAR Simulation Reduction
							10 g	WB	
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	165.0125	0.21	0.20	103.4	45 Deg. Front	0.20	0.015	
						45 Deg. Rear	0.28	0.015	
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	165.0125	0.20	0.20	100.8	90 Deg. Front	0.18	0.018	
						90 Deg. Rear	0.20	0.017	

Note:
*Antenna length trimmed to frequency

Table 4a: SAR Simulation Reduction Considerations for Passenger

(FCC US)

Mount Location	Antenna Kit#	Freq (MHz)	P.D. (mW/cm^2)	FCC Limit (mW/cm^2)	% To FCC Spec Limit	Exposure Location	Adjusted SAR Results (W/kg)		SAR Simulation Reduction
							1 g	WB	
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	173.0125	0.66	0.20	327.8	Back Center	0.49	0.032	
						Back Side	0.77	0.032	
		165.0125	0.54	0.20	271.9	Back Center	0.48	0.027	
						Back Side	0.82	0.028	
		158.0125	0.25	0.20	123.1	Back Center	0.48	0.027	
						Back Side	0.78	0.029	

Note:
*Antenna length trimmed to frequency

Table 4b: SAR Simulation Reduction Considerations for Passenger (ISED Canada)

Mount Location	Antenna Kit#	Freq (MHz)	P.D. (mW/cm^2)	ISED Limit (mW/cm^2)	% To ISED Spec Limit	Exposure Location	Adjusted SAR Results (W/kg)		SAR Simulation Reduction
							1 g	WB	
Trunk	* HAD4022A, 5/8 Wave (132 -174 MHz)	173.0125	0.66	0.13	507.9	Back Center	0.49	0.032	
						Back Side	0.77	0.032	
		165.0125	0.54	0.13	421.2	Back Center	0.48	0.027	
						Back Side	0.82	0.028	
		158.0125	0.25	0.13	190.7	Back Center	0.48	0.027	
						Back Side	0.78	0.029	
		144.0000	0.17	0.13	129.3	Back Center	0.63	0.034	
						Back Side	0.49	0.026	
		150.8000	0.16	0.13	126.2	Back Center	0.42	0.024	
						Back Side	0.49	0.019	

Note:
*Antenna length trimmed to frequency

Table 4b (Continued): SAR Simulation Reduction Considerations for Passenger (ISED Canada)

Mount Location	Antenna Kit#	Freq (MHz)	P.D. (mW/cm^2)	ISED Limit (mW/cm^2)	% To ISED Spec Limit	Exposure Location	Adjusted SAR Results (W/kg)		SAR Simulation Reduction
							1 g	WB	
Roof	HAD4006A, 1/4 wave (136-144MHz)	138.0000	0.14	0.13	110.9	Back Center	0.11	0.007	
						Back Side	0.20	0.013	
Roof	HAD4008A, 1/4 Wave (150.8-162 MHz)	162.0000	0.18	0.13	136.4	Back Center	0.03	0.003	
						Back Side	0.05	0.004	
		156.4000	0.15	0.13	116.3				The highest MPE configuration has SAR below 50% of the limit
Roof	HAD4009A, 1/4 Wave (162-174 MHz)	165.0125	0.16	0.13	126.9	Back Center	0.02	0.002	
						Back Side	0.05	0.003	
		162.0000	0.15	0.13	117.5				The highest MPE configuration has SAR below 50% of the limit
		173.0125	0.13	0.13	104.1				
Roof	RAD4224A, 1/4 wave (150.8-162MHz)	162.0000	0.16	0.13	122.2	Back Center	0.03	0.003	
						Back Side	0.05	0.004	
Roof	RAD4225A, 1/4 wave (146-150.8MHz)	150.8000	0.15	0.13	113.3	Back Center	0.13	0.006	
						Back Side	0.20	0.009	
Roof	RAD4226A, 1/4 wave (136-144MHz)	138.0000	0.14	0.13	107.7	Back Center	0.11	0.007	
						Back Side	0.20	0.014	

Table 4c: SAR Simulation Reduction Considerations for Passenger (ICNIRP)

Mount Location	Antenna Kit#	Freq (MHz)	P.D. (mW/cm^2)	ICNIRP Limit (mW/cm^2)	% To ICNIRP Spec Limit	Exposure Location	Adjusted SAR Results (W/kg)		SAR Simulation Reduction
							10 g	WB	
Trunk	*HAD4022A, 5/8 Wave (132 -174 MHz)	173.0125	0.66	0.20	327.8	Back Center	0.33	0.032	
						Back Side	0.51	0.032	
		165.0125	0.54	0.20	271.9	Back Center	0.32	0.027	
						Back Side	0.75	0.028	
		158.0125	0.25	0.20	123.1	Back Center	0.32	0.027	
						Back Side	0.58	0.029	

Note:
*Antenna length trimmed to frequency

Results of SAR Computations

From all simulated results, the highest peak 1-g, peak 10-g and whole-body average SAR values were identified. The maximum peak 1-g SAR is 0.82 W/kg, less than the 1.6 W/kg limit, the maximum peak 10-g SAR is 0.75 W/kg, less than the 2.0 W/kg limit, and the maximum whole-body average SAR for is 0.032 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 product, the present analysis shows that the computed SAR values are compliant with the FCC and ISED Canada exposure limits for the general public as well as with the corresponding ICNIRP and IEEE Std. C95.1-2019 SAR limits.

References

[1] Health Canada Safety Code 6 (2015). Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz.

[2] United States Federal Communication Commission, “Evaluating compliance with FCC guidelines for human exposure to radiofrequency electromagnetic fields,” OET Bulletin 65 (Ed. 97-01), August 1997.

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

[4] 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.

[5] IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz. IEEE Std C95.1-2019 (Revision of IEEE Std C95.1-2005/ Incorporates IEEE Std C95.1-2019/Cor 1-2019) .