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Investigation of the Effect of Metallic Frames on 4G Eyewear Antennas

By:

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Abstract: In this paper, we investigate the effect of metallic eyewear frames on the reflection coefficient, the radiation pattern and the specific absorption rate (SAR) of 4G antennas integrated in eyewear. The antennas used in the study are Coupling Element type, with appropriate matching networks to cover simultaneously the 700-960MHz and 1.7-2.7GHz frequency bands. Two different antenna locations are evaluated: behind the user's ear and at the opposite corner of the printed circuit board, close to the eye. Compared to the case without metallic frame, the matching and radiation patterns are slightly affected. Although there is a redistribution of the SAR hotspots inside the head, the change in the 1g and 10g SAR values are marginal as a result of including the metallic frame.

Keywords: Smart eyewear, coupling element, matching network, 4G, LTE, metallic frame.

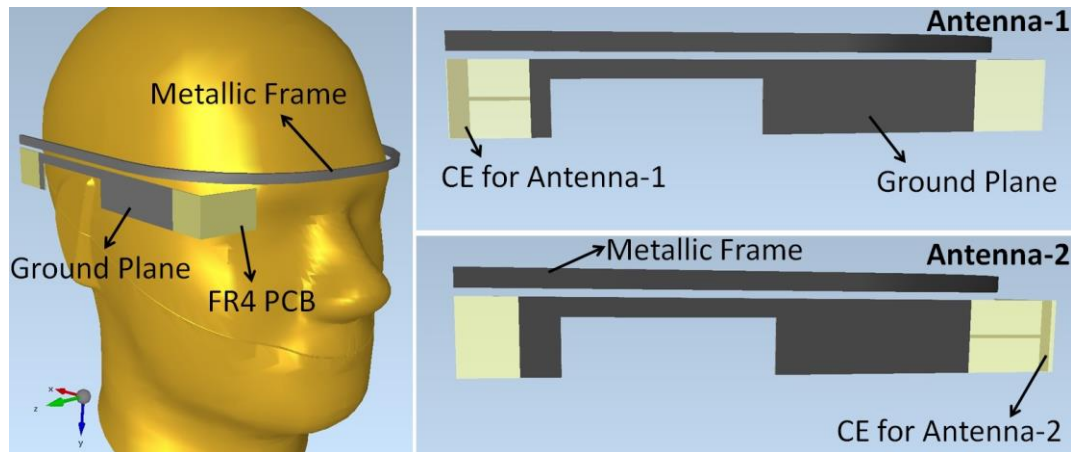
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INTRODUCTION

- Antennas for 4G cellular eyewear were previously proposed by the authors in “**Feasibility study of 4G cellular antennas for eyewear communicating devices**” IEEE AWPL, vol. 12, pp. 1704-1707, 2013
- Coupling element with matching network operating in the 700-960MHz & 1.7-2.7GHz frequency bands

Hypothesis: Metallic frames of the eyewear device will affect the reflection coefficient, radiation patterns and specific absorption rate

ANTENNA MODELS WITH METALLIC FRAME

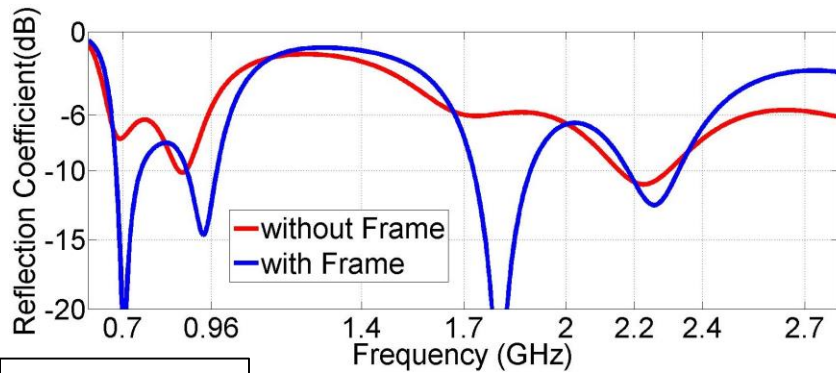


Antenna-1:
CE behind the ear

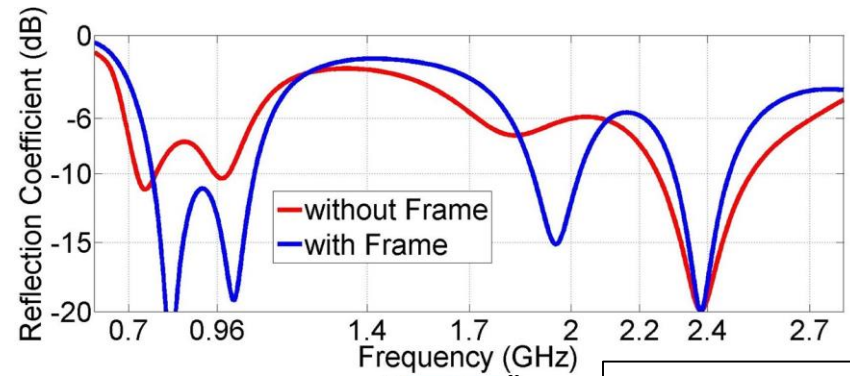
Antenna-2:
CE close to the eye

- T-shaped coupling elements printed directly on FR4 substrate
- Curved metallic frame placed 2mm above the PCB

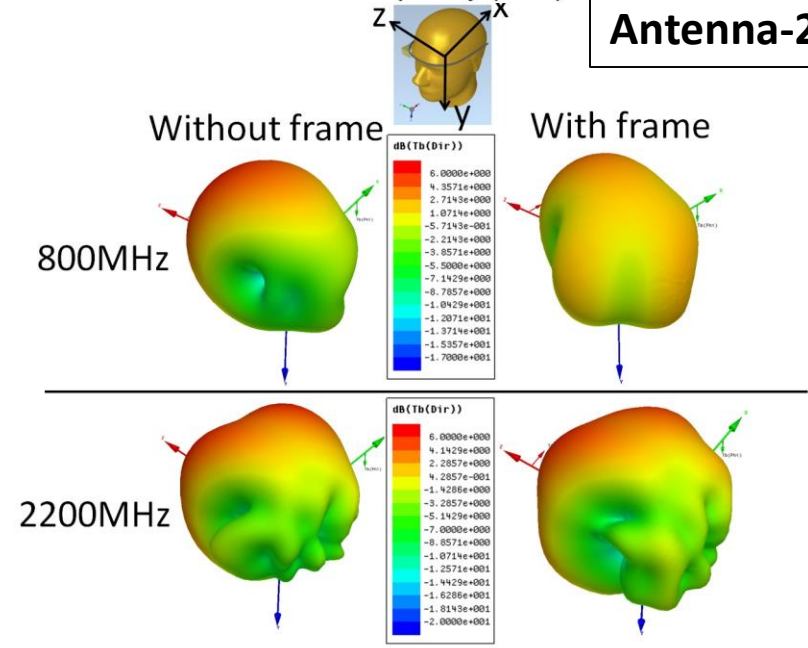
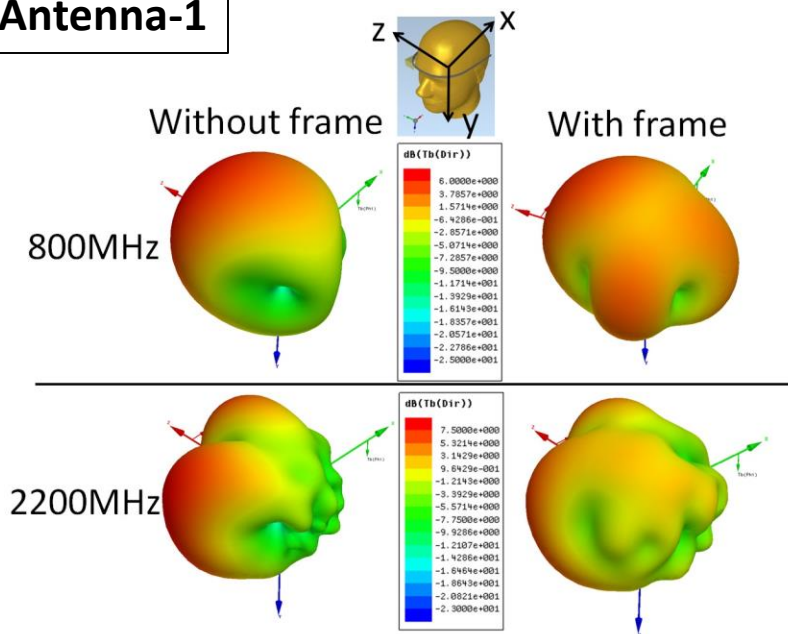
S_{11} & RADIATION PATTERNS ON SAM HEAD



Antenna-1

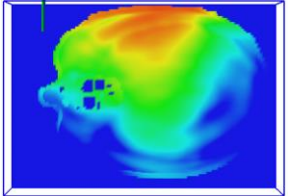
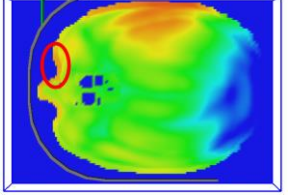
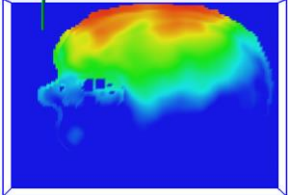
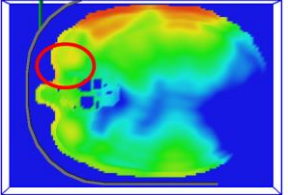


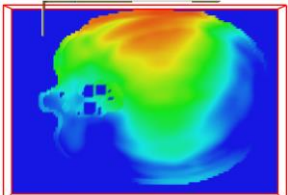
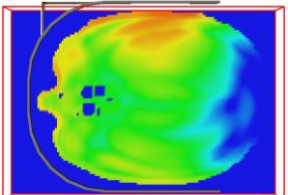
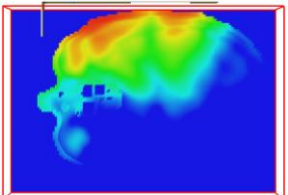
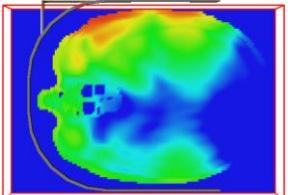
Antenna-2



- Slight detuning due to the metallic frame
- Two additional radiated lobes are created in the lower-band due to the induced currents on the metallic frame

SAR WITH THE METALLIC FRAME

SAR of Antenna-1	No metallic frame	With metallic frame
835MHz		
1900MHz		

SAR of Antenna-2	No metallic frame	With metallic frame
835MHz		
1900MHz		

- Currents on the metal frame increase the SAR on the far side of the head and in the eyes (secondary hot-spots)

SAR WITH THE METALLIC FRAME

SAR values normalized to 0.25W	Frequency (MHz)	1g SAR		10g SAR	
		No frame	With frame	No frame	With frame
Antenna-1	835	1.75	1.45	1.12	0.85
	1900	2.70	2.50	1.29	1.15
	2200	3.40	3.31	1.55	1.44
	2500	4.55	4.38	2.03	1.89
Antenna-2	835	1.92	1.25	1.14	0.72
	1900	3.60	2.25	1.40	1.01
	2200	3.70	3.76	1.68	1.67
	2500	3.45	3.36	1.47	1.15

➤ SAR with metallic frame is slightly lower than SAR without frame

CONCLUSION

- Radiation patterns of the eyewear change significantly in the lower-band due to induced currents on the metallic frame
- Max.1g/10g SAR levels show minor deviation due to the metallic frame
- Increase the local SAR on the far side of the head
- Creation of secondary hot-spots in specific tissues like the eye