Folded patch design

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INDEX TERMS antenna, antenna design, patch, folded patch, resonance, radiation, microwave

I. INTRODUCTION

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Parameter	Value	
Feed coefficients $[A]$	$\begin{bmatrix} C_{-2} \\ C_{-1} \\ C_0 \\ C_1 \\ C_2 \end{bmatrix} = \begin{bmatrix} 9.6 \\ 29.8 \\ 41.2 \\ 29.8 \\ 9.6 \end{bmatrix}$	
Tapering efficiency	$\eta_T = 79\,\%$	
Beamwidth	Tchebyshev $50.6°$	Uniform $34.8°$

TABLE 1: Parametri materiali

vehicula.

II. TCHEBYSHEV ARRAY FACTOR DESIGN

The design of the Tchebyshev array factor will be made with five elements and a lobe/side lobe ratio of **R = 41.58 dB**. In order to minimize the beamwidth, let's look for the optimal inter-spacing:

$$d_{\max} = \lambda \left[1 - \frac{1}{2\pi} \arccos\left(\frac{3 - x_1}{1 + x_1}\right)\right] \quad \text{with} \quad d_{\max} \in \left[\frac{\lambda}{2}, \lambda\right] \tag{1}$$

III. RECTANGULAR FOLDED PATCH DESIGN

A. MESH DENSITY REFINEMENT

A FR4 substrate thickness of $h_{sub} = 0.8\,mm$ has been selected so it could be considered as a thin one:

$$\lambda_{sub} = 0.0652\,m \quad \rightsquigarrow \quad \frac{h_{sub}}{\lambda_{sub}} \cong \frac{1}{81}$$

In case of thin substrates ($h/\lambda \leq 1/50$), the `Antenna Toolbox` suggests to mesh the antenna using dielectric in auto mode. The other two available substrate thicknesses ($1.0\,mm$ and $1.6\,mm$) have not been adopted because the `Antenna Toolbox` reference doesn't give any information about accuracy of the results in case of $h_{sub} \in \left(\frac{\lambda}{50}, \frac{\lambda}{10}\right)$.

B. PATCH PARAMETERS

$$L + W - w_{SC} = \frac{\lambda}{4} + h_{sub} \tag{2a}$$

$$W = \frac{\lambda_0}{2} \sqrt{\frac{2}{\varepsilon_r + 1}} \tag{2b}$$

$$BW_E = 2 \arccos \sqrt{\frac{7.03\,\lambda_0^2}{4\,(3\,L_e^2 + h^2)\,\pi^2}} \tag{3a}$$

$$BW_H = 2 \arccos \sqrt{\frac{1}{2 + k_0\,W}} \tag{3b}$$

$$\ell_{\text{feed}} = \frac{L}{\pi} \arccos \sqrt{\frac{R_{in}}{R_r}} \tag{4}$$

C. OVERALL ARRAY PERFORMANCE EVALUATION

IV. REFERENCE EXAMPLES

- Basic format for books:
  J. K. Author, "Title of chapter in the book," in Title of His Published Book, xth ed. City of Publisher, (only U.S. State), Country: Abbrev. of Publisher, year, ch. x, sec. x, pp. xxx–xxx.
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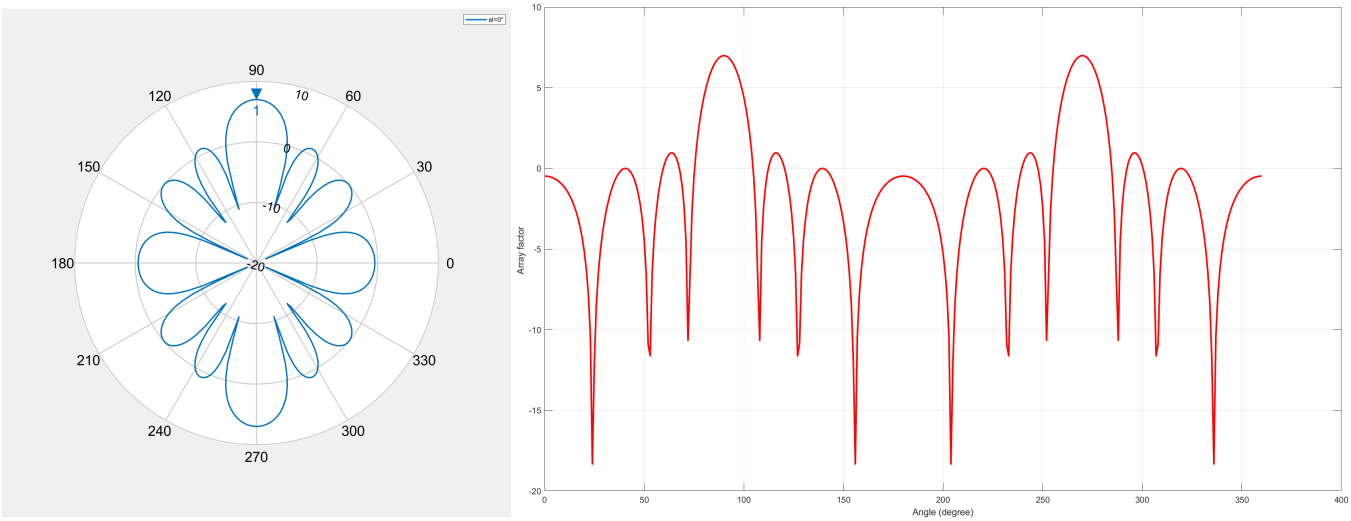

(a) (b)

FIGURE 1: Array factor polar (a) and rectangular (b) diagrams

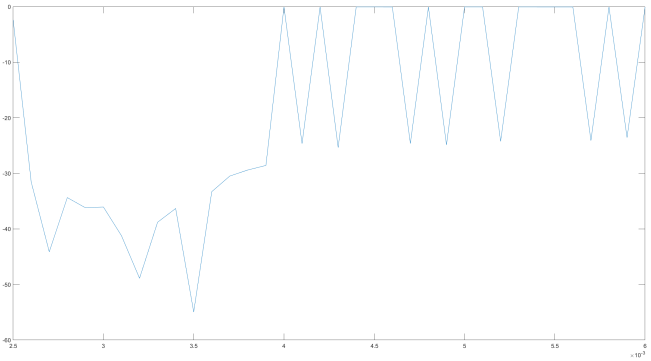

FIGURE 2: Minimum of the reflection coefficient Γ [dB] in the frequency range $2.0 \div 2.2$ GHz depending on the varying mesh density level

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- Article number in reference examples:
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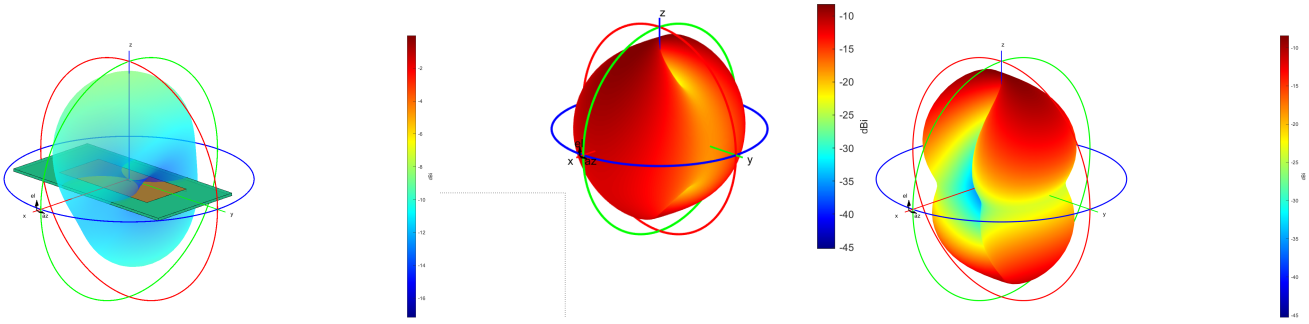
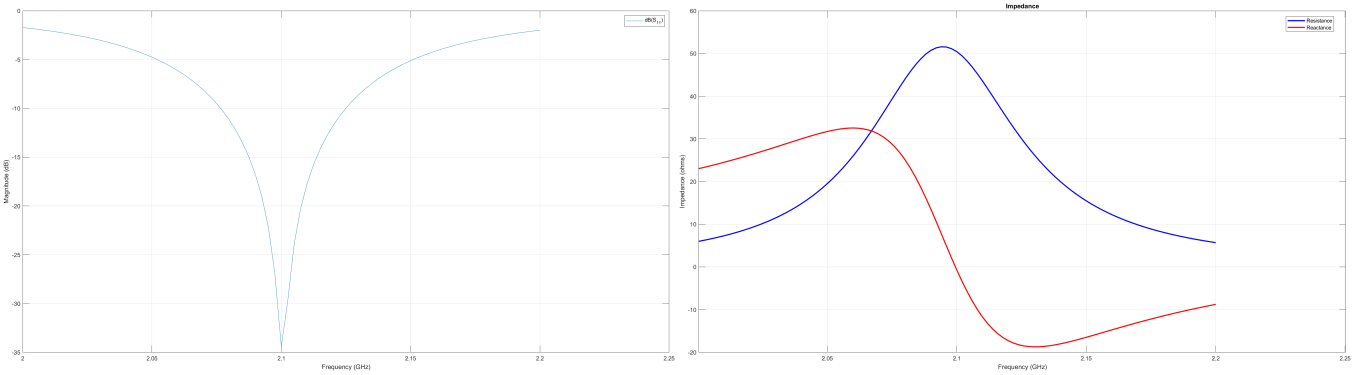


(a) (b) (c)

FIGURE 3: Gain pattern (a), gain pattern with vertical polarization (b) and with the horizontal one (c)



(a) (b)

FIGURE 4: Reflection coefficient (left) and impedances (right) plots depending on $f \in 2.0 \div 2.1$ GHz

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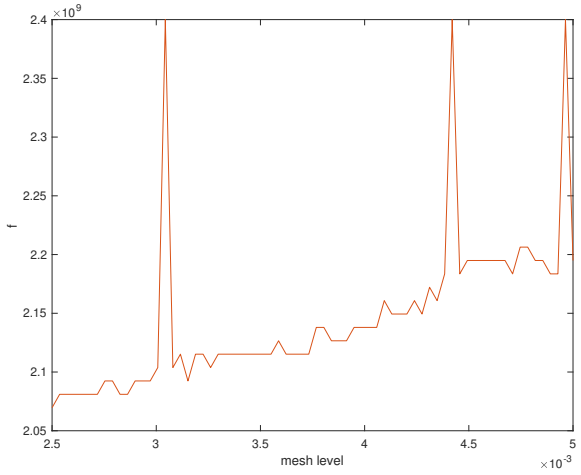

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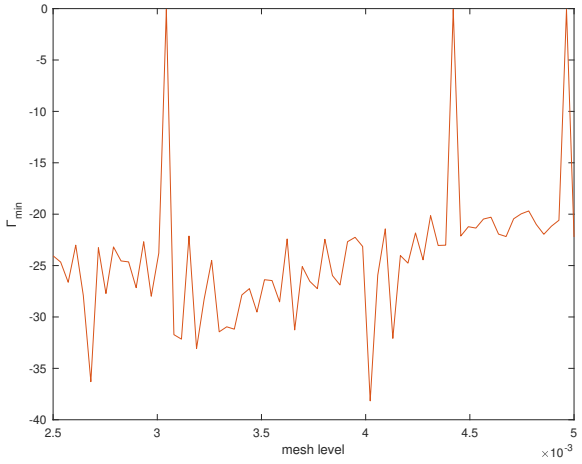

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Mr. Author's awards and honors include the Frew Fellowship (Australian Academy of Science), the I. I. Rabi Prize (APS), the European Frequency and Time Forum Award, the Carl Zeiss Research Award, the William F. Meggers Award and the Adolph Lomb Medal (OSA).