Comments on “Simple and Accurate Formula for the Resonant Frequency of the Equilateral Triangular Microstrip Patch Antenna”

P. Mythili and Annapurna Das

Index Terms—Microstrip patch antenna, resonance capacitance.

In the above communication, the authors have given a formula for the resonant frequency of an equilateral triangular microstrip patch antenna. They have used the capacitance formula of a circular microstrip disk given by [2, Eq. (23)], which takes into account the fringing field effects. The capacitance formula given by [1] is

\[
C = \frac{a^2 \pi \varepsilon_{r} \varepsilon_0}{h} \left[ 1 + \frac{2h}{\pi \varepsilon_{r} a} \left\{ \ln \left( \frac{a}{2h} \right) + \left( 1.41 \varepsilon_r + 1.77 \right) \right\} \right. \\
\left. + \frac{h}{a} \left( 0.268 \varepsilon_r + 1.65 \right) \right] \tag{1}
\]

where \(a\) is the radius of the circular microstrip disk. For an equilateral triangular microstrip patch antenna with sides of length \(a_{eq}\), the corresponding fringing capacitance of an equivalent circular microstrip disk of same area is given by

\[
C = \frac{a_{eq}^2 \pi \varepsilon_{r} \varepsilon_0}{h} \left[ 1 + \frac{2h}{\pi \varepsilon_{r} a_{eq}} \left\{ \ln \left( \frac{a_{eq}}{2h} \right) + \left( 1.41 \varepsilon_r + 1.77 \right) \right\} \right. \\
\left. + \frac{h}{a_{eq}} \left( 0.268 \varepsilon_r + 1.65 \right) \right] \tag{2}
\]

where \(a_{eq}\) is given by (3).

Equation (6) is not in agreement with (4) and, hence, the resonance frequencies calculated from (6) are not in agreement with results obtained from (4). Table I gives the correctly computed results.

Table I

<table>
<thead>
<tr>
<th>Modes</th>
<th>Measured resonant frequency (GHz)</th>
<th>Calculated resonant frequency (GHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reported [4]</td>
<td>Correctly calculated</td>
</tr>
<tr>
<td>TM1r-1</td>
<td>1.280</td>
<td>1.289</td>
</tr>
<tr>
<td>TM1l-2</td>
<td>2.242</td>
<td>2.233</td>
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<td>TM2r-2</td>
<td>2.550</td>
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<td>TM2l-3</td>
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<td>3.411</td>
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<tr>
<td>TM3r-3</td>
<td>3.824</td>
<td>3.868</td>
</tr>
</tbody>
</table>

\[ a = 10 \text{ cm}, \varepsilon_r = 2.32, h = 0.159 \text{ cm}. \]

The effective side length \(l_{ef}\) of the triangular microstrip patch antenna is calculated by an approach given in [2] and implemented in [3]. The authors have followed the same approach for the calculation of effective side length \(l_{ef}\). Following the procedure of the paper cited, the formula for \(l_{ef}\) is obtained as

\[
l_{ef} = l \left( \frac{a_{ef}}{a_{eq}} \right) \tag{4}
\]

where \(a_{ef}\) is given by (3).

Equation (6) is not in agreement with (4) and, hence, the resonance frequencies calculated from (6) are not in agreement with results obtained from (4). Table I gives the correctly computed results.

**REFERENCES**

