Electromagnetic Design of
flexIble SensOrs

Report 89.B ARPACK+ABC

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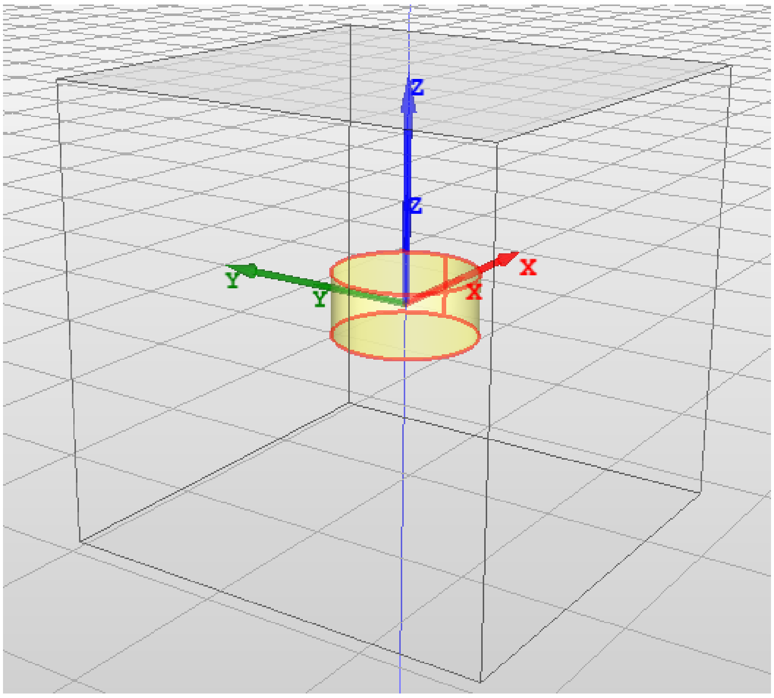

Figure 1: Dielectric cylinder

1 Test Structure

TABLE II
MEASURED RESONANT FREQUENCIES AND Q-FACTORS OF VARIOUS MODES OF AN ISOLATED CYLINDRICAL DIELECTRIC RESONATOR. ϵ_r = 38.0, DIAMETER=12.83mm, HEIGHT=5.62mm. SD — STANDARD DEVIATION CV —- COEFFICIENT OF VARIATION

Mode	Res. Freq. (GHz)	M,N	Qtot	SD	CV(%)	Qd[1]	Q_{rad}
$TE_{01\delta}$	3.9672	18,43	46.2	2.38	5.15	8850	46.4
$HEM_{11\delta}$	5.1800	41,74	30.2	0.95	3.16	6780	30.3
$HEM_{12\delta}$	5.4032	46,22	43.0	1.45	3.37	6500	43.3
$TE_{01\delta}$	6.1328	72,13	57.5	6.07	10.56	5730	58.1
$HEM_{11\delta}$	6.3280	6,5	325.8	3.24	1.00	5550	346.1

[1] Found using manufacturer's data

Figure 2: Dielectric cylinder - the reference results from the paper.

- Defined in:
  Accurate Measurement of Q-Factors of Isolated Dielectric Resonators R. K. Mongia, Member, IEEE, C. L. Larose, Member, IEEE, S. R. Mishra, Member, IEEE, and P. Bhartia, Fellow, IEEE

2 Linearization

The original FEM equation:

$$\mathbf{Se} - k_0^2\mathbf{Me} + jk_0\mathbf{Re} = 0 \tag{1}$$

Assuming $\lambda = l_0$, we obtain the characteristic polynomial:

$$P(\lambda) = -\lambda^2\mathbf{M} + \lambda\mathbf{R} + \mathbf{S} = 0 \tag{2}$$

Four linearization formulas have been considered, symmetric and non-symmetric, taken from eq. (28) and (29):

- Zekios, Constantinos L., Peter C. Allilomes, and George A. Kyriacou. "DC and Imaginary spurious modes suppression for both unbounded and lossy structures." IEEE Transactions on Microwave Theory and Techniques 63.7 (2015): 2082-2093.

$$\left(\lambda \begin{bmatrix} \mathbf{0} & -\mathbf{M} \\ -\mathbf{M} & j\mathbf{R} \end{bmatrix} + \begin{bmatrix} \mathbf{M} & \mathbf{0} \\ \mathbf{0} & \mathbf{S} \end{bmatrix}\right) \begin{bmatrix} \mathbf{u} \\ \mathbf{e} \end{bmatrix} = \begin{bmatrix} \mathbf{0} \\ \mathbf{0} \end{bmatrix}, \tag{3}$$

3 Results obtained using eigs

The ABC is placed on the 40×40×40 mm box surface. The results (in GHz) obtained using *eigs*() function, using shift: $\sigma = 83.83$, corresponding to $f = 4GHz$, $n = 15132$. Obtained frequencies:

3.9997 + 0.0527i
5.1983 + 0.0773i
5.2127 + 0.0784i
5.4623 + 0.0540i
5.4723 + 0.0543i
6.1515 + 0.0398i
6.3403 + 0.0096i
6.4080 + 0.0102i

f_R relative error (in %):

-0.2073
-0.1171
-0.2087
-0.3773
-0.4413
-0.1192
-0.0783
-0.5109

Reference quality factor Q:

46.4000
30.3000
30.3000
43.3000
43.3000
58.1000
346.1000
346.1000

Obtained quality factor Q:

37.9243
33.6052
33.2606
50.5896
50.4157
77.2575
330.5920
313.6666

Quality factor Q relative error (in %):

-18.2666
10.9084
9.7710
16.8350
16.4335
32.9732
-4.4808
-9.3711