EDISON

Electromagnetic Design of
flexIble SensOrs

FNP Team-Tech

Report 89.C ARPACK+ABC

dr eng. Grzegorz Fotyga
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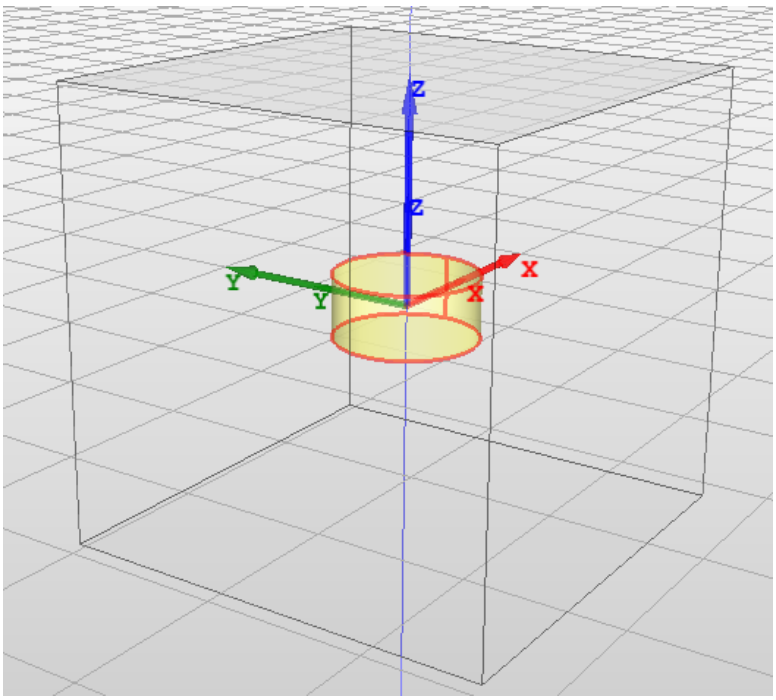

Figure 1: Dielectric cylinder

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 ARPACK

The ABC is placed on the 40×40×40 mm box surface, number of variables: $n = 15132$. The results (in GHz) obtained using ARPACK with shift: $f = 4.7GHz$, $nev = 6$, $tol = 1e-12$, :

3.977054455212000 + 0.279075777363000i
3.999682629206000 + 0.052732480595000i
5.198347018424000 + 0.077344291494000i
5.212692832258000 + 0.078361381305000i
5.462309489204000 + 0.053985819778000i
5.472351960435000 + 0.054273327443000i

where the nonphysical frequencies are denoted using bold font. The corresponding quality factor Q:

7.125402449455436
37.924279154670025
33.605240399850729
33.260598176345532
50.590224541055967
50.414745310965877

The figures below (3-7) show the E field pattern for subsequent modes. Cf:
Kajfez, Darko, and Ahmed A. Kishk. "Dielectric resonator antenna-possible candidate for adaptive antenna arrays." Proceedings VITEL 2002, International Symposium on Telecommunications, Next Generation Networks and Beyond. 2002.

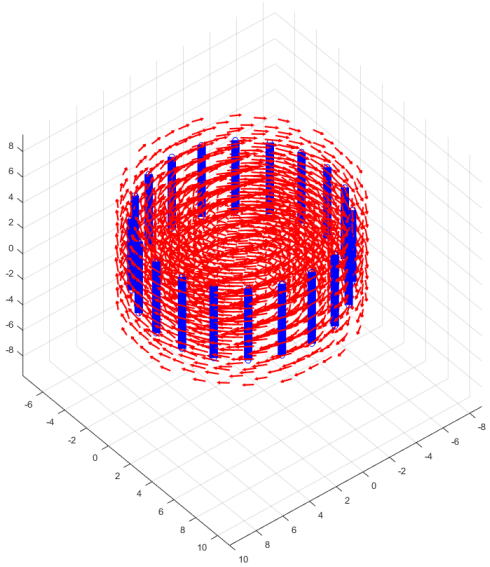

Figure 3: 3.99 GHz, $TE_{10\delta}$

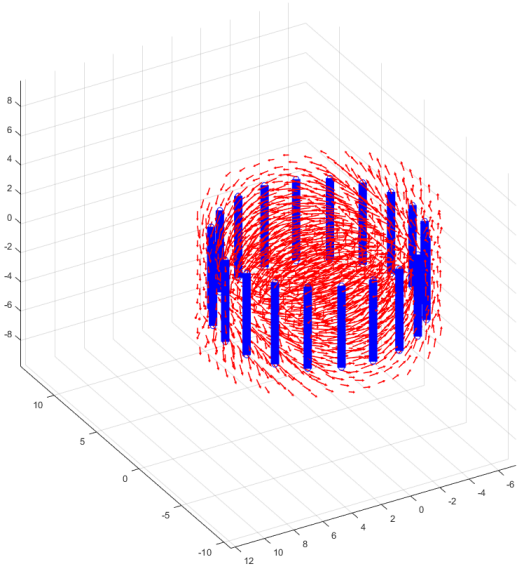

Figure 4: 5.19 GHz, $HEM_{11\delta}$

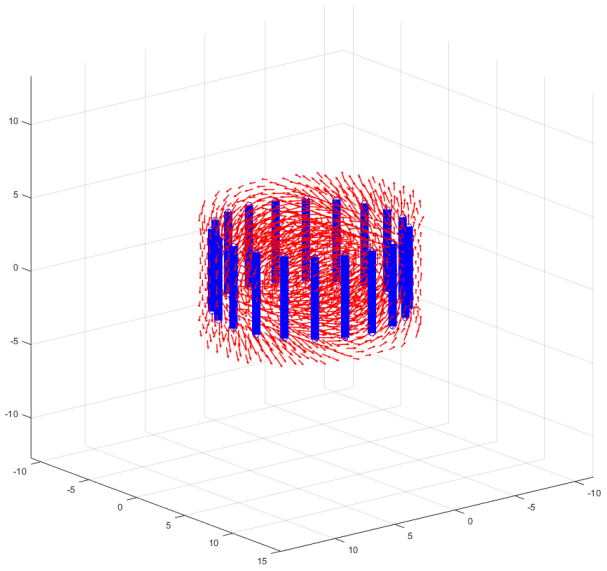

Figure 5: 5.21 GHz, $HEM_{11\delta}$

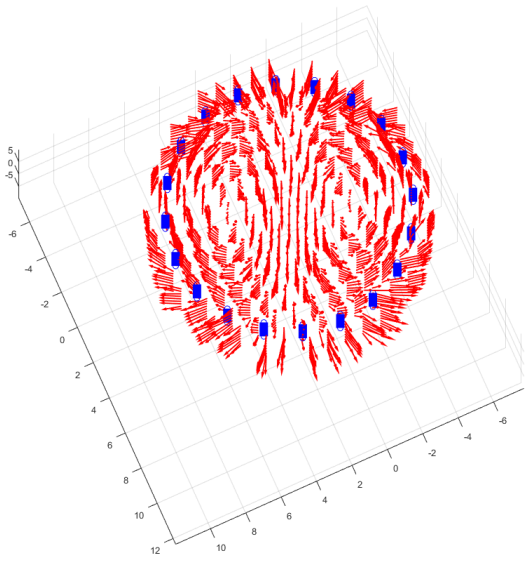

Figure 6: 5.46 Ghz, $HEM_{12\delta}$

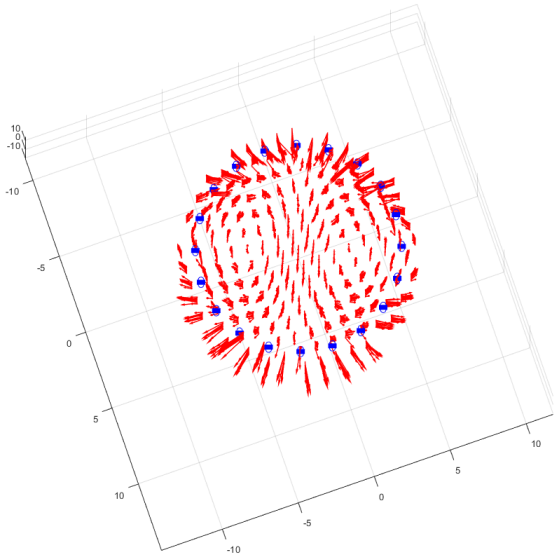

Figure 7: 5.47 GHz, $HEM_{12\delta}$