

Team Workshop Problem 18

Waveguide Loaded Cavity

(First version July 25, 1992)

Reference: N.M. Kroll and X.T. Lin, "Efficient Computer Determination of the Properties of Waveguide Loaded Cavities", SLAC-PUB-5296, July 1990, pp.1-16.

Geometry:

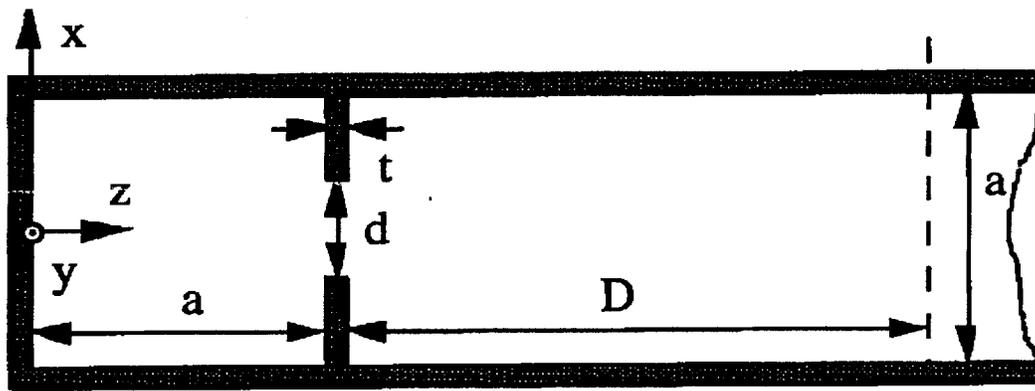


Fig. 1 Square cavity coupled to a rectangular waveguide through a centered inductive iris. The inner height of the structure is b .

Statement of the problem:

Find the resonant frequency, the Q-factor and the complex reflection coefficient of a square-shaped TE_{101} -cavity coupled to a rectangular waveguide through a centered symmetrical inductive iris. The geometry of the arrangement and the coordinate system are shown in Fig. 1 above. The height of the structure is everywhere b . The waveguide extends to infinity in the z -direction. Hence, it is considered to be matched at all frequencies and for all modes.

The waveguide is air-filled and carries a TE_{10} wave incident from $z = +$. The iris has a thickness $t = a/32$ (note that this differs slightly from the dimensions given in the reference above).

Consider the following three cases:

- i) All walls are perfectly conducting ($\sigma = \infty$) (2D problem)
- ii) All walls are made of coin silver ($\sigma = 4.7 \times 10^7$ S/m) (3D problem)
- iii) All walls are made of electrolytic copper ($\sigma = 5.75 \times 10^7$ S/m) (3D problem)

Assume that in all cases the wall thickness is much larger than the skin depth.

Observables to be determined:

For the three cases specified above, find

- a) the resonant frequency of the TE₁₀₁-mode,
- b) the total Q-factor of the cavity. (This Q-factor will be the external Q in the lossless case, and the loaded Q in the lossy cases),
- c) the complex reflection coefficient (absolute magnitude and phase) at a distance $D = 2a$ from the iris wall ($z = 3a+t$) within $\pm 10\%$ of the resonant frequency,

for WR(90) ($a=0.9$ in., $b=0.4$ in) and WR(28) ($a=0.28$ in., $b=0.14$ in) and for the following normalized widths of the iris: $d/a = 0.5, 0.65, 0.70,$ and 0.75 .

Extra credit:

At the resonant frequency, provide:

- 2D plots of E_y within the cavity and the waveguide between $z=0$ and $z=2a+t$
- 1D plots of E_y across the iris at $z=a+t/2$.
- Plots of the surface current density on the cavity walls, both sides of the iris, t and on the waveguide walls up to a distance $z = 2a+t$