1 No PEC backing

The computed zeros for the structure with no PEC backing as shown in 1 are obtained through Halley's method performed on the denominator expression:

$$\mathcal{D} = 1 - \overleftarrow{\Gamma}_2 \overrightarrow{\Gamma}_2 e^{-2jk_{z2}d_1} \tag{1}$$

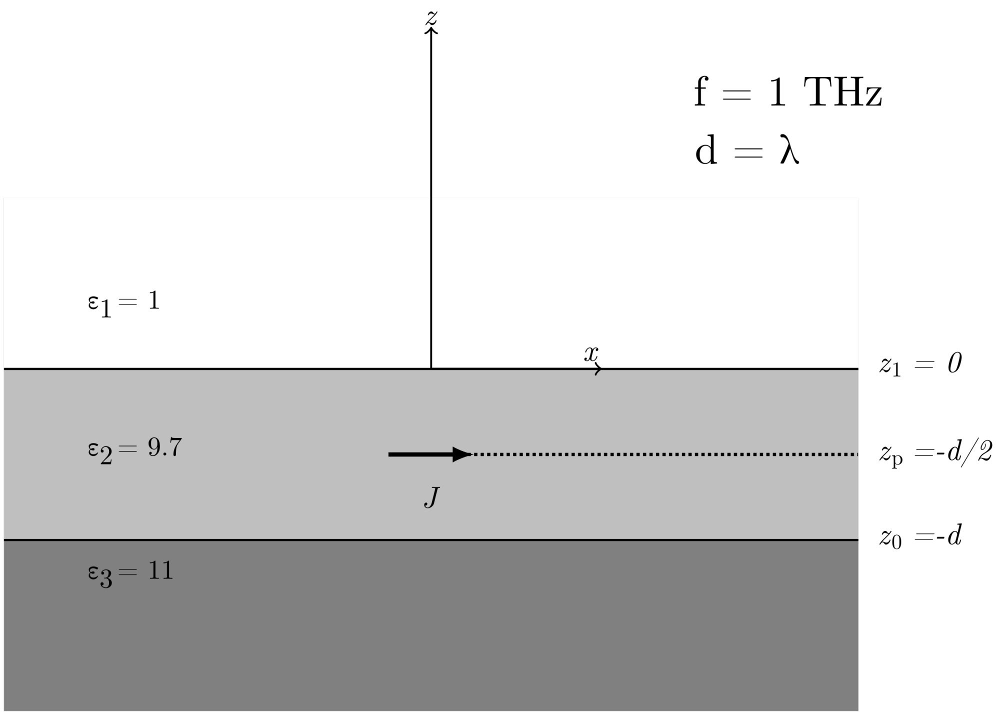

Figure 1: Structure with no PEC base

where $d_1 = z_1 - z_0$ and $\overleftarrow{\Gamma}_2$ and $\overrightarrow{\Gamma}_2$ are the left and right looking reflection coefficients from the middle layer:

$$\overleftarrow{\Gamma}_2 = \frac{Z_3 - Z_2}{Z_3 + Z_2} \tag{2a}$$

$$\overrightarrow{\Gamma}_2 = \frac{Z_1 - Z_2}{Z_1 + Z_2} \tag{2b}$$

An evaluation of $\mathcal{D}$ as in (1) computed zeros is shown in Fig. 2.

2 PEC backing

With PEC backing as shown in 3:

$\overleftarrow{\Gamma}_2$ now becomes:

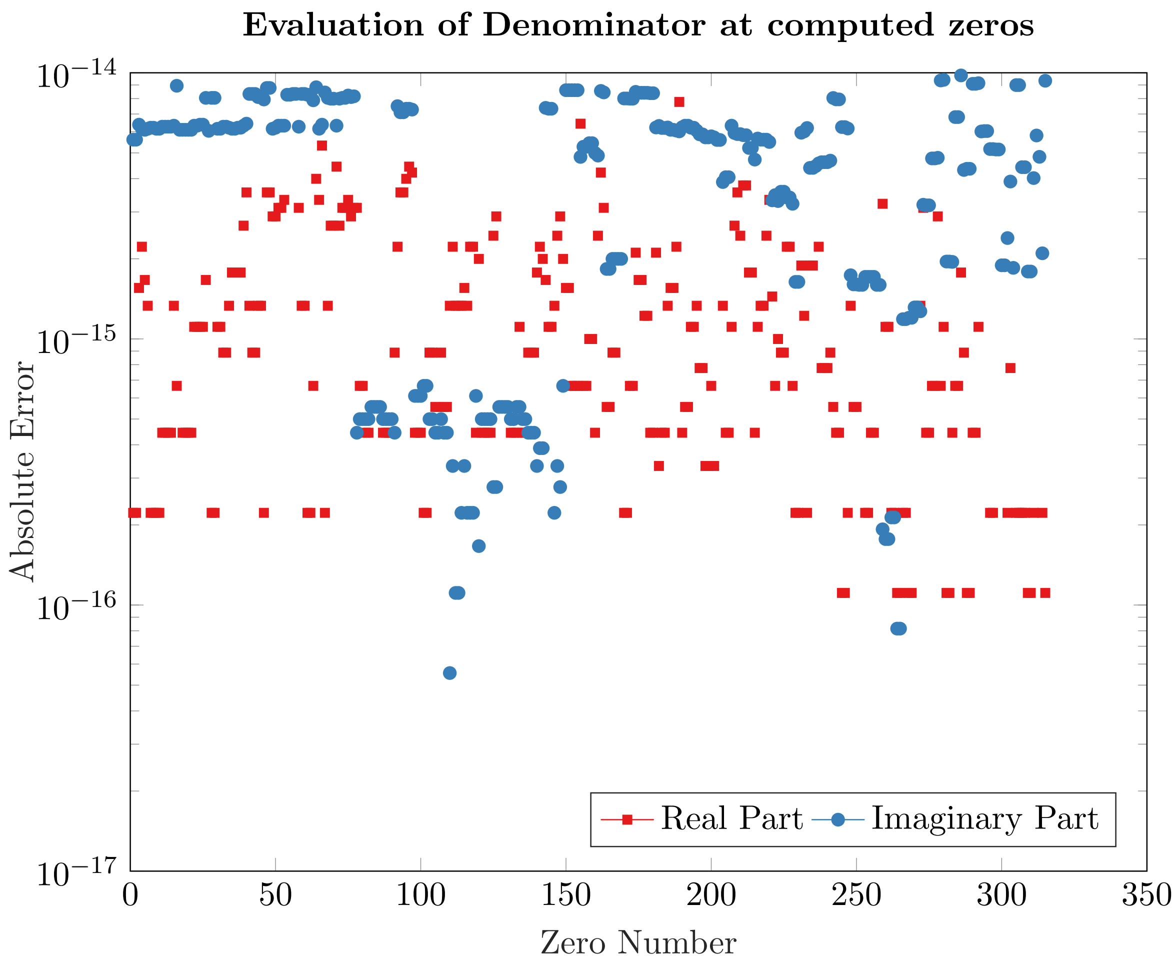

Figure 2: Evaluation of (1) at computed zeros

$$\overleftarrow{\Gamma}_2 = \frac{\Gamma_{3,2} - exp(-4jk_{z3}d)}{1 - \Gamma_{3,2}exp(-4jk_{z3}d)} \tag{3}$$

where $\Gamma_{3,2}$ is:

$$\Gamma_{3,2} = \frac{Z_3 - Z_2}{Z_3 + Z_2} \tag{4}$$

The evaluation of $\mathcal{D}$ with a PEC base is shown in Fig. 4.
A comparison of zeros of two cases in the complex k_ρ-plane is illustrated in Fig. 5

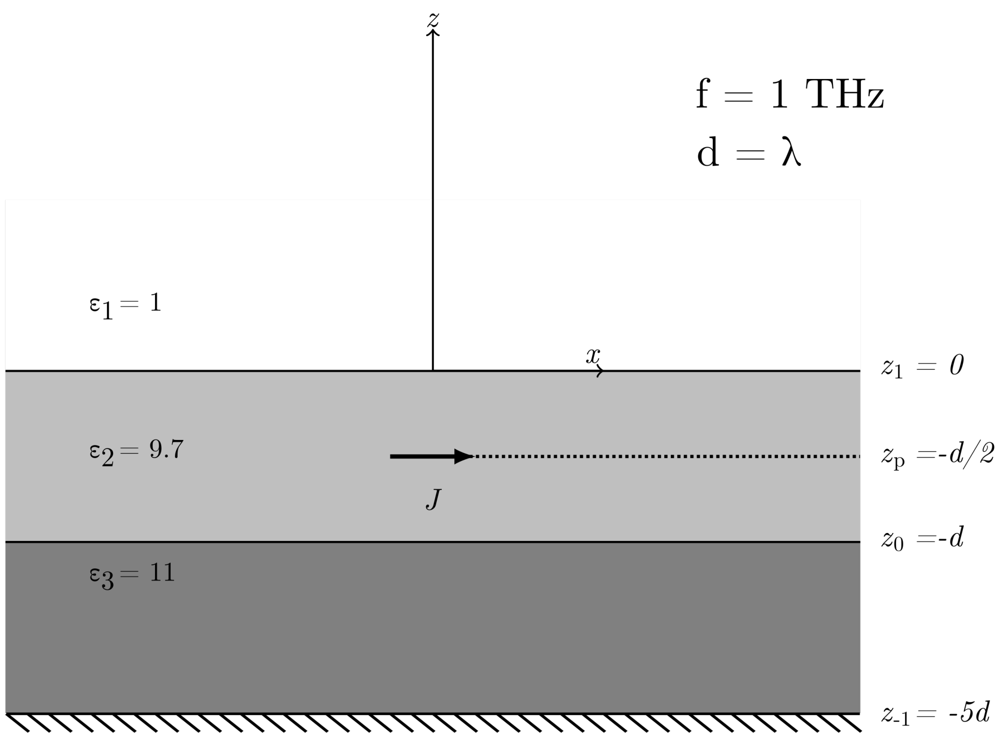

Figure 3: Structure with PEC base

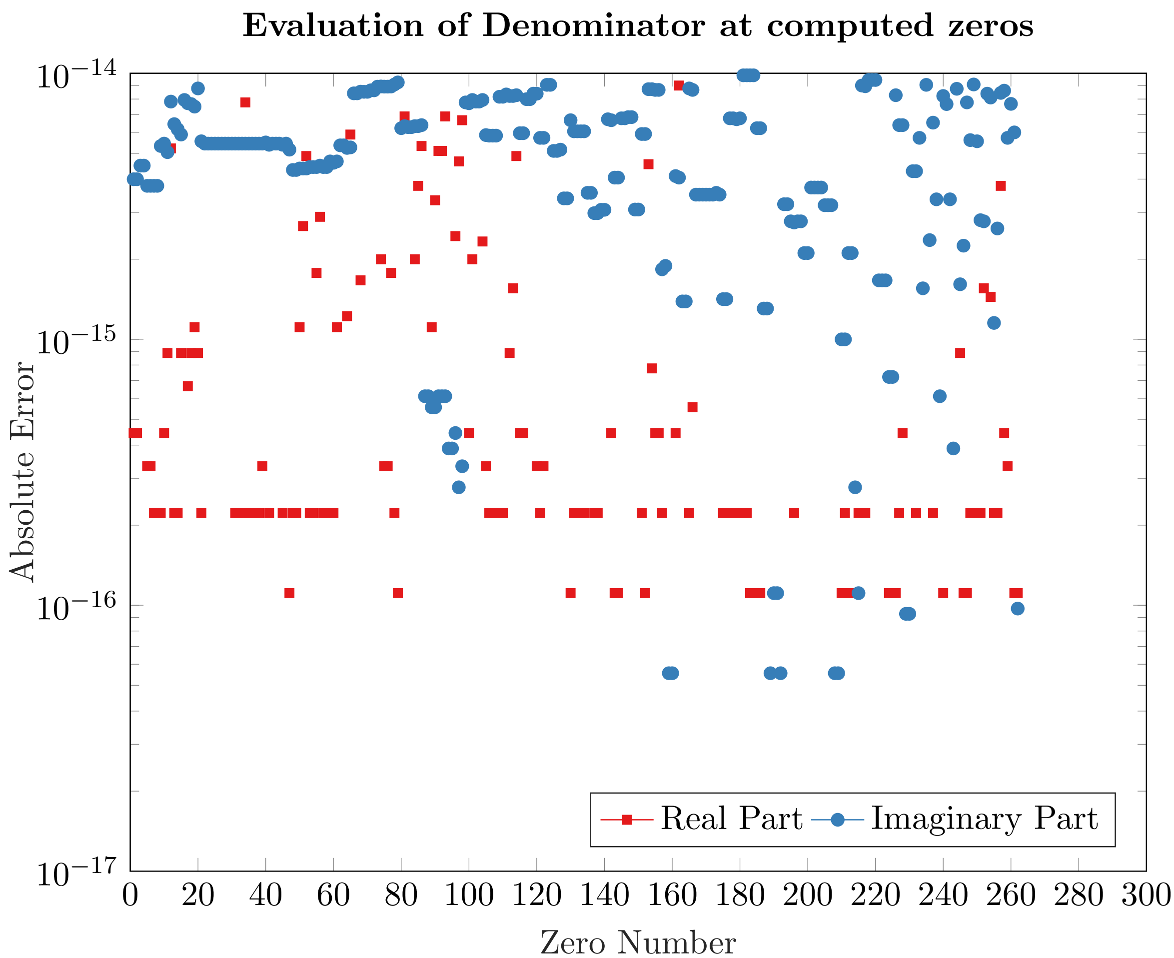

Figure 4: Evaluation of (1) at computed zeros with PEC

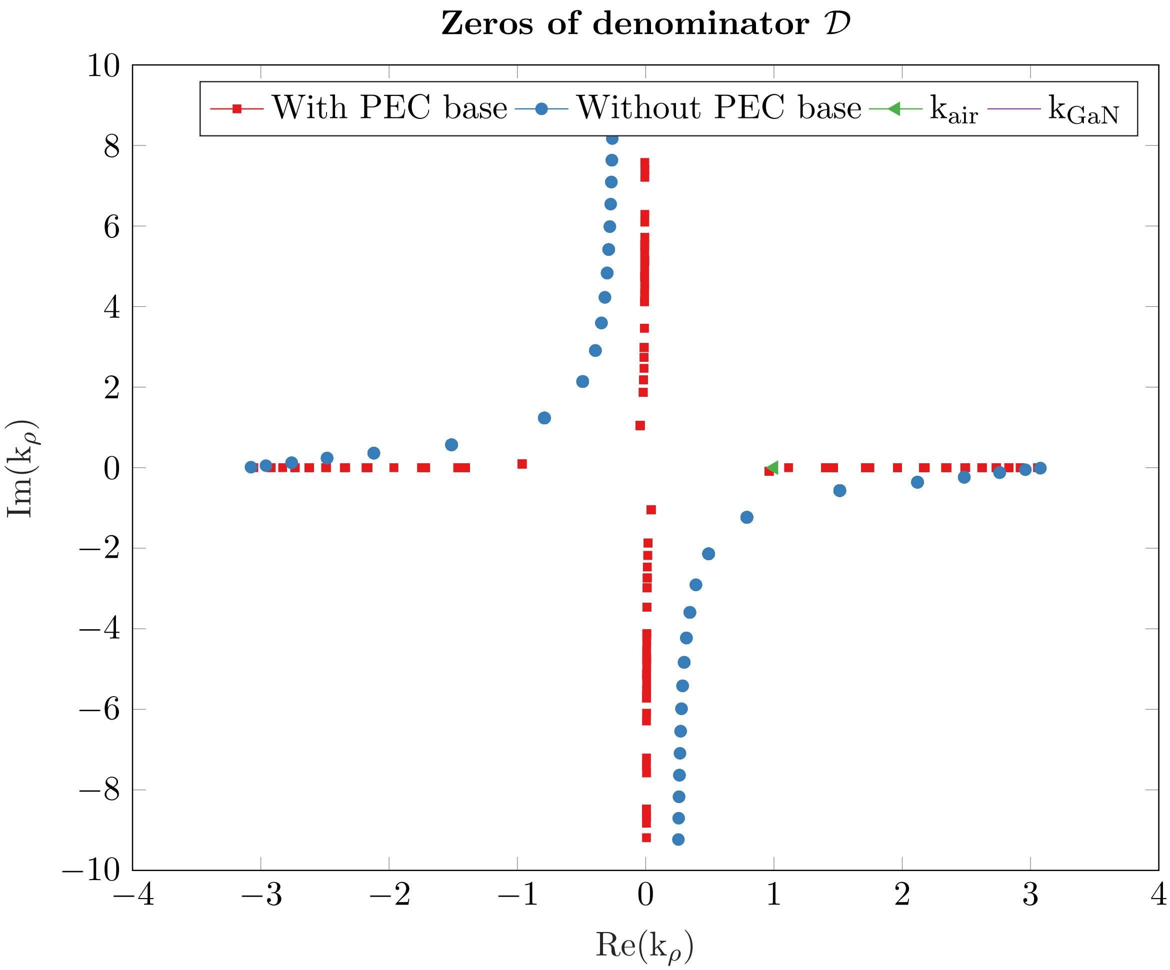

Figure 5: Zeros in the complex plane