Program for Calculating Imittance for Infinitely long IDTs with Finite Thickness

SYNC Version 3.1

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November 25, 2006

1 Outline

This computer program calculates input impedance per period of infinitely long interdigital transducer. The finite element method (FEM) is employed for the electrode regin, and distance among the FEM sampling points are weighted so as to make the convergence rapid. In the program, electrode cross section is assumed to be rectangular for simplicity. Supported substrate materials are $LiNbO_3$, $LiTaO_3$, $Li_2B_7O_4$, GaAs, quartz, $La_4Ga_5SiO_{14}$ and $KNbO_3$, with either Al or Au as the grating metal.

2 Usage

Type "sync" for execution.

1. "Enter File Name" where the output data will be stored. Note that, if the file already exists, the file will be overwritten and the former data will be erased.

2. "Enter 1-11 for LNOW(arner), LNON(akagawa), LNOK(ovacs), LTOW(arner), LTOS(mith), LTOK(ovacs), LBO, GaAs, quartz, LGS and KNO" for specifying the substrate materials. If you enter other value, the program will be terminated.

3. "Enter Axis & Angle" for specifying the rotation of the substrate and "To proceed next step, enter 0 for axis". For example, if desired substrate cut and SAW propagation direction is specified by the Euler angles $(45, 30, -20)$ in degree, type

3,45 <CR>
1,30 <CR>
3,-20 <CR>
0,0 <CR>

Then the program prints the bulk wave velocities whose wavenumbers are parallel to the surface and the effective permittivity $\epsilon(\infty)/\epsilon_0$ of the substrate. If the piezoelectricity is coupled and/or decoupled with some displacement components u_i unproperly, the program displays its situation and returns to step 2.

4. " Enter 1 for Al, 2 for Au or 3 for Cu" to specify the film material. Then the program prints two bulk wave velocities in the film.

5. "Enter Nmax, Nxd, Nyd, vnorm, w/p, and h/p" where w, p, h are the strip line-width, periodicity and height (see Fig. 1). The integer N_{max} represents the number of Floquet expansions to be included for the calculation. The integers N_{xd} and N_{yd} represent numbers of FEM subdivions for $w/2$ and h, respectively. The value V_{norm} represents arbitrary value used for the frequency normalization. Hereafter the operation frequency is normalized by V_{norm}/p. For returning to step 2, enter "0 0 0 0 0 0 0".

6. "Enter fs, fe and fint" where f_s, f_e, f_{int} are the start, end and interval, respectively, of frequencies where the IDT properties are to be estimated. After typing, the program tabulates relative frequency, conductance, susceptance, resistance and and reactance. These immitances are normalized by $\omega\epsilon(\infty)$ When all of the iteration complete, the program reexecutes this step. For returning to step 2, enter "0 0 0 0".

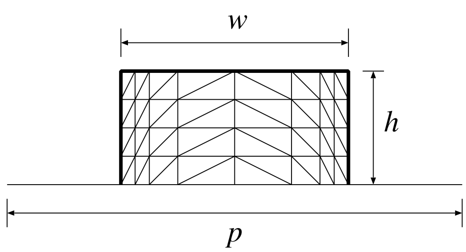

Figure 1: FEM mesh. In this case, $w/p = 0.5$, $h/p = 0.125$, $N_{xd} = 4$ and $N_{yd} = 4$.

2.1 Note

1. Although the reason is uncertain, even "Nmax" and "Nxd" should be used for fast convergence.

2. Maximum values of "Nxd", and "Nyd" are limited by available memory size of user's computer. That is, they must satisfy following relations:

$$c_1 \times (2 \times \mathrm{Nxd} + 1) \times (\mathrm{Nyd} + 1) \leq \mathrm{npm}$$

and

$$2 \times \mathrm{Nxd} + 1 \leq \mathrm{npa}$$

where

$$c_1 = \begin{cases} 2 & \text{for sync4 \& sync3} \\ 1 & \text{for sync2} \end{cases}$$

and "npm" and "npa" are the parameters defined in the software source-code. Note that their default values are 300 and 100, respectively.

3. In the software, the temperature is assumed to be 25°C. It can be adjusted by specifying the parameter "temp" in the main routines in "sync.f".

4. In the software, the electrode cross section is assumed to be rectangular. The software is also able to analyze the trapezoid case by specifying the parameter "aspect" in the main routines in "sync.f". Note that "aspect" is defined by $(b-a)/h$ where a and b are the upper and lower lengths, respectively, and h is the electrode height.