Program for Calculating Input Admittance of Infinitely-Long Multi-Electrode IDT with Finite Thickness

MSYNC Version 3.0

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1 Outline

This computer program calculates the input admittance per period of infinitely-long IDTs with finite thickness and multiple fingers. The finite element method (FEM) is employed for the electrode region, 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 $LiNbO_3$, $LiTaO_3$, $Li_2B_4O_7$, GaAs, quartz, $La_3Ga_5SiO_{12}$ and $KNbO_3$ with either Al, Au or Cu as the IDT metal. The use of msyncd, msynct, msyncq and msynch are mostly the same. The msyncd supports only the case where two fingers exists per period whereas the msynct supports the case where three fingers are involved per period. Although the msyncq and msynch support the four-electrode and six-electrode cases, respectively, they support only the case where left and right halves of the structure are equivalent and their electric polarity is alternate.

2 Usage

Type "msyncd", "msynct", "msyncq" or "msynch" 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.

5. "Enter 0(+–), 1(++-), 2(+-+), 3(+-I), 4(+I-), 5(I+-)" for msynct, "Enter 0(++), 1(+o), 2(o+)" for msyncq, and "Enter 0(+II), 1(I+I), 2(II+), 3(++I), 4(+I+), 5(I++), 6(+++)", where + and - indicate that the corresponding finger is connected to bus-bars whereas I does the finger is isolated.

6. "Enter Nmax, Nxd, Nyd, vnorm, d1/p, d2/p, w1/p, w2/p, h1/p and h2/p" for FEMSDD and "Enter Nmax, Nxd, Nyd, vnorm, d1/p, d2/p, d3/p, w1/p, w2/p, w3/p, h1/p, h2/p and h3/p" where w_i, p_i, h_i are the line-width, periodicity and height of strip-i (see Fig. 1). The integer "Nmax" represents the number of Floquet expansions to be included for the calculation. The integers "Nxd" and "Nyd" represent numbers of FEM subdivisions 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".

7. "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, and determined input admitance Y and impedance $Z = Y^{-1}$. Note that Y is 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".

8. 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 "msyn??.f".

9. 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 "msyn??.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.

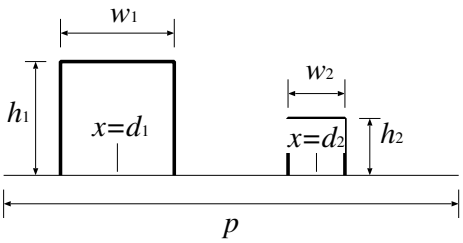

Figure 1: Electrode parameters. In this case, $w_1/p = 0.25$, $w_2/p = 0.125$, $h_1/p = 0.25$, $h_2/p = 0.125$, $d_1/p = -0.125$ and $d_2/p = 0.1875$. As for the definition of N_{xd} and N_{yd}, refer to Fig. 1 in the FEMSDA manual.