Program for Calculating Frequency Response of Resonators by Coupling of Modes Theory

COM Version 1.0

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July 11, 1997

To Compile

make LB45p1 (LN128p1, LT112p1, LT36p1, LB47p1, QT36p1)

make LB45p2 (LN128p2, LT112p2, LT36p2, LB47p2, QT36p2)

1 Summary

The software calculates the frequency response of SAW resonators by using the coupling-of-modes (COM) theory fully described in [1]. Two kinds of softwares are prepared: one is for the one-port resonators whereas the other is for the two-port resonators. Since each component of devices such as input and output IDTs and gratings are implemented as a subroutine in the softwares, simulators for various SAW device structures such as IIDT-type filters and Ladder-type filters can be developed only by simply modifying their main routines. COM parameters for AT-cut quartz (QT36), 128°YX-$LiNbO_3$ (LN128), 36°YX-$LiTaO_3$ (LT36), X-112°Y $LiTaO_3$ (LT112), 45°YZ-$Li_2B_4O_7$ (LB45), and (0,47°,90°) $Li_2B_4O_7$ (LB47) have already been calculated as a function of Al film thickness by the author, and their values have already bend implemented in the subroutines named QT36.f, LN128.f, LT36.f, LT112.f, LB45.f and LB47.f for respective materials.

2 Usage

2.1 SAWR1P

SAWR1P simulates one-port resonators. Prior to its execution, following data must be stored in a file.

```
501         # number of frequency point
0.15d-6     # film thickness in meter
12.d0       # aperture / IDT period
15.d-6      # IDT period in meter
20.0        # IDT length/IDT periodicity (finger-pairs)
15.d-6      # twice of reflector periodicity in meter
100.0       # reflector length / (twice of reflector periodicity)
-0.125      # (gap between reflector and IDT)/(IDT periodicity)
0.002       # assumed propagation loss (dB/lambda)
1.0         # correction factor for SAW velocity
1.0         # correction factor for electromechanical coupling factor
1.0         # correction factor for reflection coefficient
```

1. "Enter file name" where the input data are stored. If the file name is "sawr1p.dat", you can skip this by entering <CR>. Then the program prints the SSBW cut-off frequency, and upper and lower frequencies of the stopband.

2. "Enter fs and fe in MHz" where f_s and f_e are the start and stop frequencies for the tabulation. Then the program starts to calculate G (S), B (S) and their angle $\tan^{-1}(G/B)$, the results will be stored into the file "@".

3. After tabulating, the program will be terminated automatically when all of the iteration finishes.

2.2 SAWR2P

SAWR2P simulates one-port resonators. Prior to its execution, following data must be stored in a file.

```
501         # number of frequency point
0.15d-6     # film thickness in meter
20.d0       # aperture / IDT period
15.d-6      # IDT period in meter
20.0        # IDT length/IDT periodicity (finger-pairs)
15.d-6      # twice of reflector periodicity in meter
100.0       # reflector length / (twice of reflector periodicity)
12d0        # (gap between IDTs)/(IDT periodicity)
```

```
-0.125      # (gap between reflector and IDT)/(IDT periodicity)
0.001       # assumed propagation loss (dB/lambda)
1.0         # correction factor for SAW velocity
1.0         # correction factor for electromechanical coupling factor
1.0         # correction factor for reflection coefficient
```

1. "Enter file name" where the input data are stored. If the file name is "sawr2p.dat", you can skip this by entering <CR>. Then the program prints the SSBW cut-off frequency, and upper and lower frequencies of the stopband.

2. "Enter fs and fe in MHz" where f_s and f_e are the start and stop frequencies for the tabulation. Then the program starts to calculate complex values of S_{11} and S_{12}, and $|S_{11}|$ and $|S_{12}|$, and the results will be stored into the file "@".

3. After tabulating, the program will be terminated automatically when all of the iteration finishes.

3 Notes

1. The subroutines "fical", "focal" and "fgcal" are for the [F] matrices for the input and output IDTs and the gap, respectively. Reflectors at the both ends are treated within the main routine.

References

[1] K.Hashimoto and M.Yamaguchi:'General-Purpose Simulator for Leaky Surface Acoustic Wave Devices Based on Coupling-of-Modes Theory', Proc. IEEE Ultrasonics Symp. (1996) pp.117-122.