Thesis abstract

Avishek Adhikary
Dept. of Electrical Engg., IIT Kharagpur

Fractors have constant phase angle behaviour, but, they are generally capacitive in nature, i.e., their impedance phases lie in the fourth quadrant. However, using typical generalized impedance converter (GIC) circuits, one can obtain fractors in any of the four quadrants, thus, broadening the scope of applications. The design and realization of these four quadrant fractors from given specifications and their application in electrical circuits are elaborated in the present thesis.

First, a set of design guidelines are proposed for the RC ladder network so that fractors of given α, F, constant phase zone (CPZ) and phase band can be realized. Next, using this RC ladder based factor in a typical grounded GIC circuit, tunable fractors are realized in all of the four quadrants. Such four quadrant fractors are named as, Type I, Type II, Type III and Type IV fractors. This work also studies the effects of non-idealities of op amps on the phase and magnitude response of such GIC-emulated fractors. Here, two typical non-ideal characteristics are considered, i.e, finite open loop gain and finite unity gain frequency. Based on these studies, conditions are derived for the minimum phase and magnitude errors. From these conditions, suitable guidelines are proposed for Type I and Type II fractor design. Several practical realizations and experimental results are presented in this context.

Next, different high-quality factor FO circuits are designed using such GIC based Type II fractor. This includes the practical realization of tunable FO series and parallel resonators, FO bandpass filter and FO notch filter. It is shown that the GIC based fractors offer negative real impedance which helps to achieve high Q factor in the said FO circuits. Besides, varying one of the GIC resistors one can tune the fractance of a GIC-based fractor. This in turns helps to tune FO resonators and filters in practice.

Finally, the realization of a typical carbon nanotube (CNT) based, single component fractor is presented. It is a packaged electrochemical fractor with CPZ more than six decades and shelf life for more than 18 months. Detail study on different configurations of such CNT based fractors is presented in this context. As one of its applications, few practical examples of tunable resonators, made by proposed single component fractor, are also presented.