ABSTRACT

Simulated Inductor & its application for analog circuits and a newly proposed circuit in lieu of existing circuit and its various applications

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Any analog circuit is constructed using the passive component namely the resistor, inductor and the capacitor along with other active sources and devices. In the present scenario where nano has gained prominent place in the field of electronics, it shows that miniaturization of components is on the lead. It is easy to shrink the dimensions of resistors and capacitors but it is demonstrated that it is not realistic to accomplish an equivalent reduction in the dimension of inductors. It is well known that, the very basic ingredient in the formation of any circuit for any applications is the inductor. At low and very low frequencies the utility of inductors is very much narrowed for the reason that (i) it holds large number of turns and hence hulking. (ii) It prevents its implementation in integrated circuits and is not companionable with hottest IC technology (iii) large value of inductor reduces the quality factor (iv) it spawns harmonic distortion (v) as inductors are liable to act as antennas it picks up noise and electromagnetic waves and hence causes Electromagnetic Interference. Thus it limits itself in diverse areas. But the use of inductors in analog circuits has wide applications. Hence there is a need for one to one replacement of inductor by other component or a circuit which simulates the effect of inductor. It ought to work fine at all range of frequencies as the impedance offered by the
inductor is dependent on frequency. Simulated inductor endows an alternate way of realizing huge value of inductor at low frequencies.

The key to the above is the simulation of inductor using the active element operational amplifier and the passive elements resistor and capacitor. This simulated inductor obtained from the Generalised Impedance Converter is used for replacing only the grounded inductor. In case if the inductor is floating, some sought of transformation is used which results in a new element termed the grounded Frequency Dependent Negative Resistance. Even this transformation in some circuits again makes the FDNR itself floating and hence some techniques are used to make it to work as a grounded one depending upon the prerequisite of the circuit. The importance of the passive components in electronics lies in its application in analog circuits. Hence to begin with, the simulated inductor is first validated by simulation and experimentation and then its usage is assessed by applying it in various applications. The application of simulated L in analog circuits tested in this thesis includes various analog filters, active tuned amplifiers, oscillators and audio power amplifiers. All are validated using simulation and the simulation is done using one of the effective analog simulators Personal Simulation Program with Integrated Circuit Emphasis (PSPICE) and some analysis is done using MAtrix LABoratory (MATLAB). Few results are experimentally validated also.

The above mentioned simulated inductor is used for replacing inductor in which Quality factor is not the important criteria and hence theoretically acts as an ideal L. But there are certain cases in which the lossy inductor has to be replaced wherein the internal resistance of the lossy inductor is very low and affects the performance. In such cases, a new simulated inductor circuit has been newly proposed and it is named as SUJA simulated Inductor (named
after the student and the guide of this thesis). This newly proposed simulated inductor makes use of the concept of negative resistance which compensates and thus eliminates the internal resistance of the lossy inductor thereby increasing the quality factor. The applications of such simulated inductor (SUJA) in analog filters, oscillators etc. are presented. But this SUJA simulated inductor is used for substituting the grounded inductor only. Even though few applications in analog circuits are presented in this thesis without any constraint, the simulated inductor cannot be realized physically.