

Preface

In spite of all electronic systems prominently being dominated by digital circuits and systems, the analog circuits have neither become obsolete nor avoidable. In fact, despite the dominance of digital circuits, analog circuits and techniques continue to be indispensable and unavoidable in many areas since all real life signals are analog in nature. Thus, several types of processing of natural signals or interface of such signals with digital processing circuits has to be necessarily carried out by analog circuits. Also, many basic functions such as amplification, rectification, continuous-time filtering, analog-to-digital conversion and digital-to-analog conversion etc. need analog circuits and techniques.

Traditionally, the integrated circuit (IC) op-amp has usually been considered to be the workhorse of all analog circuit designs. However, over the years, it was found that there are many situations such as realization of voltage controlled current sources, current controlled current sources, instrumentation amplifiers, non-inverting integrators and non-inverting differentiators etc., where the traditional voltage mode op-amp (VOA)-based circuits suffer from two drawbacks namely employment of more than the minimum required number of passive components and requirement of perfect matching of several of them (due to which any mismatch may not only deteriorate the performance of the intended circuits but may also lead to instability in some cases). Furthermore, VOA-based amplifiers exhibit a gain bandwidth conflict and their frequency range of operation is limited by the effect of finite gain bandwidth product (GBP) of the op-amps on one hand and due to the slew-induced distortion (resulting due to finite slew rate of the op-amps) on the other hand. Consequently, there has been continuous search for alternative analog circuit building blocks to overcome these difficulties while still matching the versatility of the VOAs in realizing almost all kinds of analog functions.

During the past four decades, many alternative new analog circuit building blocks have been proposed out of which only the Operational Transconductance Amplifiers, Current Conveyors and Current Feedback Operational Amplifiers have been made available as of-the-shelf ICs and have therefore attracted the attention of educators, researchers and circuit designers worldwide who have explored their various applications. Among these building blocks, the current

feedback operational amplifier (CFOA), sometimes also referred as operational trans-impedance amplifier, has received notable attention in literature because of its two very significant properties namely, a very high slew rate (theoretically infinite; practically as high as several thousand volts per μs as against a very modest $0.5 \text{ V}/\mu\text{s}$ for the general purpose and most popular $\mu\text{A}741$ type op-amp) and its capability of offering gain bandwidth decoupling (thereby implying the feasibility of maintaining essentially a constant bandwidth and variable gain, for low to medium values of the gains). Though CFOAs have some limitations as compared to the traditional VOAs, their advantageous features coupled by their versatility and flexibility, particularly of a specific type which has its compensation pin accessible externally, overshadows their demerits in a number of applications.

This monograph is basically concerned with CFOAs and their applications and includes an extensive discussion about various types of CFOAs, the basic circuits realizable using them, their merits and demerits and their applications in the realization of continuous time analog filters, simulation of inductors and other type of impedances, synthesis of sinusoidal oscillators and miscellaneous linear and non-linear applications (including a variety of relaxation oscillators and chaotic circuits). Also covered are numerous examples of the use of CFOAs in realizing a number of other newly proposed active circuit building blocks. The monograph closes by giving a brief account of the recent developments in the design of bipolar and CMOS CFOAs, a discussion about various modified forms of CFOAs proposed in the recent literature from time to time, outlining the current directions of research in this area and including a supplementary list of references for further reading.

It is hoped that this monograph, which contains a comprehensive collection of over 200 CFOA-based analog circuits with their relevant theory and design/performance details, should turn out to be a useful source of reference for academicians (both educators and students), practicing engineers and anybody interested in analog circuit design using CFOAs. Readers may also find a number of interesting and challenging problems worthy of further investigations, from the various suggestions given in the respective chapters of this monograph.

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