Guest Editorial

Today's demands on circuits for analog signal processing in telecommunication, measurement, signal sensing, control, and other areas, are extreme in some cases. The well-known design compromises, for example between attainable precision and speed or between bandwidth and stability, are ever harder to reach. The type of active circuit components used plays a key role here. The still popular OTAs (Operational Transconductance Amplifier) are a desirable alternative to conventional operational amplifiers, particularly for high-frequency applications. There is a comeback of the current conveyors today. It is evident that some modifications of the conventional conveyor structures can result in functional blocks with interesting application potentials. In addition, hundreds of studies of various applications of circuit elements of more recent origin such as Current Differencing Buffered Amplifier (CDBA), Operational Transresistance Amplifier (OTRA), Current Differencing Transconductance Amplifier (CDTA), and others have been appearing in technical literature every year. The set of unconventional active components with potential utilization in various fields of electronic industry is, thus, continuously expanding.

The aim of this issue is to bring together the state-of-the-art research papers that address various aspects of modern active components for voltage, current, and mixed signal processing. The papers selected are representative of some of the current problems, such as the need for qualitative new principles of circuits for voltage-, current-, and mixed-mode signal processing, IC implementation of active circuit elements, universal biquads, oscillators, circuits for modern signal-to-signal conversion and other processing, as well as software tools to support the above innovative activities.

The first paper deals with Operational Mirror Amplifier (OMA). This special modification of OTA, employing two identical current outputs and theoretically infinite transconductance gm, was introduced by Huijsing and Veelenturf in 1981. Due to its voltage input, current output and zero differential input voltage in negative-feedback applications, OMA is an interesting active component with the character of operation between the Voltage-Feedback Amplifier (voltage -type of input and output) and True-Current Operational Amplifier (current-type of input and output). In comparison to the early work from 1981, Soltan, Madian and Soliman propose now a CMOS implementation of the OMA in order to match the low-voltage low-power requirements.

The next four papers address some implementation and application problems of Current-Feedback Operational Amplifiers (CFOA).

Siripruchyanun et al. propose the so-called Current Controlled Current Feedback Amplifier (CC-CFA), which overcomes the current problems concerning the electronic control of applications employing conventional CFOAs. In contrast to the CFOA, the input part of the CC-CFA is represented by the well-known Current-Controlled 2nd-generation Current Conveyor, whose x-conductance is proportional to the bias current. In their extensive paper, the authors propose a CC-CFA design in BiCMOS technology with the focus on reducing the offset problems. In addition, numerous application examples are given in order to demonstrate the integration of two features - the simplicity of the circuit topology and the electronic control availability.

In the third paper, Madian, Mahmoud and Soliman propose an electronically configurable analog block based on CFOA. In addition to the CFOA, this analog circuit with a flexible architecture contains three MOS nonlinearity cancellation cells, two programmable capacitor arrays, a set of MOS switches, and a configurable shift register. Via this register, the internal sub-blocks can be mutually interconnected according to the user's requirements. CMOS realizations of the individual blocks are described, including the results of SPICE analysis. As an example, the realization of more types of frequency filter is presented.

An interesting fusion of the ideas from the last two papers could be the electronically configurable analog block based on the CC-CFA.

An example of the low-voltage implementation of CMOS-CFOA is represented by a paper by Nagaria, Krishna and Singh. Their proposed CMOS structure is optimized for both the 0.35um and 0.25um CMOS TSMC technologies, utilizing low supply voltages of ±0.75V. For the latter technology, the authors achieved an excellent coincidence of high output swing and bandwidth of the amplifier.

Implementation of electronically controlled integrators and also differentiators is investigated in the next paper. Thus, the paper by Nagaria uses the Current-Feedback Amplifier and a commercial analog multiplier in the feed-forward and feedback connections with the aim to obtain voltage-controlled integrator and differentiator blocks with both the single and the differential input capabilities. Valuable analysis of nonlinear effects and experimental results are included.

The next two papers by Maheshwari show interesting applications of Differential Voltage Current Conveyors (DVCC). The first of them describes a current-mode first-order building block for designing higher-order filters. The beauty of this approach consists in the fact that all the sub-blocks of the filter have an identical structure. Interconnecting their terminals in several ways leads to various transfer functions. The second paper introduces a universal voltage-mode single-DVCC 2nd-order filter, resembling a cleft RC Wien cell with the DVCC clamped inside it.

Papers No. 10, 11, and 12 deal with applications of CDTA. Biolek, Biolkova, and Kolka present a critical review of single-CDTA biquads published before. A matching problem is addressed that should be solved in applications where multiple-output OTAs as well as copies of currents are utilized. Based on this critical analysis, some improvements are suggested in the frame of the single-CDTA topology discussed. Also, the so-called ZC-CDTA (Z-Copy CDTA) is proposed as a useful generalization of conventional CDTA, providing a copy of current flowing through the z-terminal.

All-pass (AP) filters are widely used in analog signal processing. The first-order AP sections can be easily employed via active blocks such as CDBA or CDTA, which contain the Current Differencing Unit (CDU) as their input stage. This approach is also used by Shah, Quadri and Iqbal in paper No. 11. Their CDTA-based all-pass filter utilizes the internal OTA stage of the CDTA as a cell for converting the output current of the CDU into the output voltage. As a result, they present a transadmittance-type first-order all-pass filter using a single CDTA and a floating RC pair. For a correct operation, the voltage output must be properly buffered.

The following paper by Prasad, Bhaksar, and Singh proposes a realization of single-resistance-controlled sinusoidal oscillator. It is the first publication of such a circuit which requires only one CDTA. The proposed configuration also includes two capacitors and two resistors. The oscillating frequency is controlled by one of the resistors without affecting the oscillation condition, which is independently established by the CDTA transconductance. The proposed oscillator was successfully tested by constructing the CDTA with commercially available Current-Feedback OpAmps and OTAs.

The Switched-Current (SI) technique is of much promise for newly developed mixed-signal circuits and building blocks. Fakhfakh et al. present an improved topology of class-AB SI memory cell that follows from a systematic procedure for small-signal circuit synthesis via the nullator and norator approach. The authors describe an interesting heuristic method of the optimization of SI cells, taking into account two conflicting performances, i.e. the Signal-To-Noise-Ratio and the cell's response time. In their second paper, the topical problem of optimal sizing of integrated inductance-capacitance voltage-controlled oscillators (LC VCO's) is analyzed. The proposed solution helps the designer to find optimum sizes of inductors and channel widths that minimize the VCO's phase noise, satisfying constraints such as the occupied area and maximum power dissipation. Two concrete examples of optimizing the phase noise of cross-coupled oscillators were presented.

Computer programs for simulating the above circuits belong to inevitable tools for their analysis, design and optimization. SPICE-like or other similar programs, based on numerical algorithms, offer only quantitative results, mostly in the form of graphs, which cannot instruct the user how to understand why the results are as they are. On the other hand, programs for symbolic analysis also generate the essential sub-results, i.e. analytical equations, from which the important connections between the circuit and its behavior can be read. The last paper by Kolka, Biolek, and Biolkova describe a useful program tool for symbolic analysis of circuits employing both the behavioral and full SPICE models of active elements without any limitation to their type. Among other things, it can be useful in the analysis and design of frequency filters and oscillators, employing arbitrary types of current conveyors, OTAs, CDBAs, CDTAs, etc.

The number of high-quality contributions, submitted to this Special Issue for their prospective publication, was so high that, taking into account also the limited scope of the Issue, the task of guest editors was extremely difficult. In the end, several very good papers could not be included. We thank the reviewers who were willing to score the manuscripts in extremely short terms but in the required quality. We are proud that most of them belong to worldwide authorities on the field.

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Professor Senani is listed in several editions of Marquis' Who's Who series (published from N.J., USA); several Biographical publications of International Biographical Centre, Cambridge and a number of other international biographical directories.

Ahmed M. Soliman was born in Cairo, Egypt, on November 22, 1943. He received the B.Sc. degree with honors from Cairo University, Cairo, Egypt, in 1964, the M.S. and Ph.D. degrees from the University of Pittsburgh, Pittsburgh, PA., U.S.A., in 1967 and 1970, respectively, all in Electrical Engineering. He is currently Professor at Electronics and Communications Engineering Department, Cairo University, Egypt.

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