LOW-VOLTAGE CURRENT-MODE ANALOG CIRCUIT STRUCTURES AND THEIR APPLICATIONS

By

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integrated circuits

CERTFICATE

This is to certify that the thesis entitled, "**LOW-VOLTAGE CURRENT-MODE ANALOG CIRCUIT STRUCTURES AND THEIR APPLICATIONS**", being submitted by Mr. S. S. Rajput to the Indian Institute of Technology, Delhi, for the award of the degree of 'Doctor of Philosophy' in the Department of Electrical Engineering, is a record of bonafide research work carried out by him.

Mr. S. S. Rajput has worked under my guidance and supervision and has fulfilled the requirements for the submission of this thesis, which to my knowledge has reached the requisite standard.

The results contained in this work have not been submitted in part or full, to any other University or Institute for the award of any degree.

Jamuar

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DEDICATED

TO

MY FATHER SRI NATTHU SINGH

&

MY MOTHER SMT. BISNO DEVI

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(S. S. Rajput)

ABSTRACT

Low-voltage and low-power mixed mode circuit design has gained importance in recent time due to the advent of portable electronic system and mobile communication system. The present investigation is primarily concerned with the study and design of low-voltage, low-power circuits and their applications in linear and nonlinear circuit design. Current-mode design techniques, which offer voltage independent high bandwidth analog circuits, have been used to design three new low-voltage high performance current mirrors (LVCMs) in the present study. Using these LVCMs, four voltage buffer (VB) structures have been designed. Adaptive biasing technique has been introduced to enhance the input current range, decrease the input compliance and reduce the undesirable offset current in the LVCM. To increase the LVCM bandwidth, resistive and capacitive compensations have also been used. Resultant LVCMs have input currents in the range of 1 μA to 500 μA with a bandwidth of 2.5 GHz. These voltage buffers have near rail-to-rail input output voltage swings and a bandwidth of approximately 500 MHz. These LVCMs and VBs use ±1.0 V power supply. Sensitivity and temperature analysis have been carried out for these proposed structures.

Analog signal processing cells like current conveyors (CCs), current feedback amplifiers (CFAs), operational floating amplifiers (OFAs) etc., are the current mode replacements of operational amplifiers. The LVCMs and VBs have been used in the design of new low-voltage analog signal processing (ASP) cells and eight new structures operating at ±1.0 V for CCII, one CCI and one CCIII have been proposed. These

structures have a bandwidth of 200 MHz. Two CFA structures, which use CCII as basic cells, have also been designed. All these structures operates at ±1.0 V supply voltage and have a bandwidth of approximately 120 MHz. Two OFC structures have also been obtained by suitably modifying the CCII structures. The use of OFCs in development of current amplifiers, voltage amplifiers has been demonstrated. Finally some linear and nonlinear applications of the ASP cells are demonstrated. They include current amplifiers, voltage amplifiers, current square rooter, current squarer, wave shaping circuits and log and anti-log amplifiers. The current sensing capability has been used to demonstrate the use of CCs in built in self-test structures. ASP cells have also been used in some special type of linear as well as non-linear applications like exponential current source, current electrometers and space plasma simulations.

The proposed design could not be realized in silicon owing to non-availability of foundry facility at the place of study. All the results presented in this investigation are based on the P-Spice simulations using level 3 model parameters for 0.8-micron CMOS technology. These results match the theoretical predictions.

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