Chapter 4
Dynamic Body Bias: A Transistor-Level Technique for the Design of Low-Voltage CMOS Analog Circuits

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ABSTRACT

The demand for portable device applications has grown immensely. For such applications, low voltage and low power operation is an essential prerequisite to prevent overheating and ensure reliable functioning. Low voltage operation curtails the total number, weight, and dimensions of batteries, and low power consumption extends battery life. The shrinking size of MOS transistors in CMOS processes necessitates the use of lower supply voltages. Since the threshold voltage of MOS transistor is not diminished at the same rate as the power supply voltage, analog designers face problems due to shrinking voltage headroom. One of the findings that can overcome the issues introduced by comparably high threshold voltages is based on the enactment of body bias approach. In such a solution, a relatively small potential is applied at body terminal of a MOS transistor to adjust its threshold voltage. This chapter discussed that body bias approach is an attractive opportunity for utilizing the body effect positively to improve the performance of low voltage-integrated circuits.

BACKGROUND

The demand for portable had held electronic and implantable device applications

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has grown immensely in the last few decades. For such applications, low voltage and low power operation is an essential prerequisite to prevent overheating and ensure reliable functioning without failure. Low voltage operation is preferred for possible curtailment in the total number, weight and dimensions of batteries and low power consumption extends the operation period for battery powered devices. The shrinking size of MOS transistors in CMOS processes necessitates the use of lower supply voltages. Since the threshold voltage of MOS transistor is not diminished at the same rate as the power supply voltage, analog designers face problems due to shrinking voltage headroom. At reduced supply voltage, diminishing headroom sets new challenges to ameliorate or even prolong the circuit performance. One of the findings, which can overcome the issues introduced by comparably high threshold voltages, is based on the enactment of body bias approach. In such a solution, a relatively small potential is applied at body terminal of a MOS transistor to adjust its threshold voltage. Reconfiguring the MOS transistor in this way broaden the applicability of basic CMOS analog building blocks to low supply voltages. Body effect in a MOS transistor was contemplated in the past as an exclusive source of unwanted second order effects. The main objective of this chapter is to apprise about that how body bias approach is an attractive opportunity for utilizing the body effect positively to improve the performance of low voltage integrated circuits. Also, as the power supply voltage approaches the transistor threshold voltage, the circuit performance becomes extremely sensitive to process variations and temperature alterations. Body bias approach not only augments the performance, but also improves the circuit robustness against process and temperature variations. Body bias approach accredits a heterogeneity of effective body bias techniques. These bias techniques require triple-well CMOS technology for implementation, although at slightly higher cost but it's free from latch-up and is more immune to noise. In this chapter, the basic principle of dynamic body bias approach has been explained. The inspiration towards minimizing supply voltages and power consumption in mixed-signal integrated circuits is expanding demand for battery-operated portable electronic devices. However, this cutback in the supply voltage primarily affects the performance of CMOS analog circuits in terms of dynamic range, noise, speed, linearity, gain and bandwidth. The importance of dynamic body bias technique to circumvent these limitations and improve the performance of circuits capable of operating under low supply voltage is explained. Various reported applications of dynamic body bias technique in analog circuits have been reviewed. It is also emphasized that for implementation and fabrication of DBB technique, triple-well CMOS technology is necessary. This technology is explained with the help of a cross section figure. A small signal model is very important when it comes to design of analog circuits. Therefore small signal model of a dynamic body biased MOS transistor is provided. Author has also discussed various modification in small signal