The first Asia-Pacific Conference on Circuits and Systems will be held in Sydney, Australia at the Hyatt Kinggate Hotel, December 8-11, 1992. This is a biennial IEEE-sponsored conference to be held in Region 10 countries in rotation. The first conference focuses on VLSI circuits and systems. There will be three parallel sessions classified into two types: lecture sessions, and poster sessions that are followed by open interactive discussions at the poster location. The conference will include ninety papers, four keynote speeches, and intensive panel discussions on CAD framework. The papers will cover the areas of VLSI CAD (System and Architecture Design, Framework, Logic synthesis and Verification, Circuit Simulation and Physical Design), Graph Theory, Digital & Analog Signal Processing, Image Processing and Neural Networks. For further information contact: Professor Graham Hellestrand at +61-2-697-4028 or Professor Isao Shirakawa +81-6-877-5111 ext. 5111.

— *Shigetaka Takagi*

Nordic Project Advances BiCMOS Technology

Norway, Finland and Denmark are well on their way to exploiting the advantages of analog BiCMOS technology. The joint project for developing the technology, now ending its first year, brings the European industry one step closer to building high-performance devices such as ASICs.

After years with pure digital solutions to real-time instrumentation systems, analog solutions are now gaining. By integrating analog circuits with digital circuits and even sensors on the same silicon, manufacturers are closing in on high processing power, good noise immunity and low power consumption. Indeed, the merge of BiCMOS analog-digital technology, where bipolar transistors and MOS transistors can be combined on the same integrated circuit, is now proving its worth.

The Nordic Industrial Analog Design (NIADE) project is a strong industry-driven project where results are directly related to actual products. The Nordic electronic industry and several industrial users of electronics will soon take advantage of the possibilities provided by these technologies. Nordic electronics had previously

Designer's Casebook

Current-Mode Minimax Circuit

Roelof F. Wassenaar
MESA Research Institute
Twente University
Enschede, The Netherlands

The minimum-maximum (minimax) circuit selects the minimum and maximum of two input currents, I_A and I_B . Four transistors in matched pairs, M_1 - M_4 , are operated in the saturation region.

The current in M_4 is always the minimum of the two input currents, I_A and I_B , and $I_1 + I_2$ is the maximum current. Given that current I_2 flows through M_2 and M_3 , the transistors' gate-source voltages must be the same. Thus, by Kirchhoff's law, the loop $M_1M_2M_3$ and M_4 results in equal gate-source voltages for M_1 and M_4 . Because M_1 and M_4 are assumed equal, their currents must be the same. Since I_4 is equal to I_A , and $I_B = I_2 + I_4 = I_2 + I_A$, I_B must be larger than I_A . So, transistor M_4 carries the minimum input current, I_A .

Now assume I_A is held constant and I_B is decreasing. Then $I_4 = I_{MIN}$, and I_4 remains equal to I_A until I_B reaches the same value as I_A . Then I_2 becomes zero. M_2 and M_3 turn off and are no longer an

active part of the circuit. Therefore, by further decreasing I_B below the constant value of I_A , it can only flow through M_4 . Thus $I_4 = I_{MIN} = \min(I_A, I_B)$.

Obviously, $I_1 + I_2 + I_4$ must be equal to $I_A + I_B$. Since I_4 is equal to the minimum of I_A and I_B (say I_A), then $I_1 + I_2$ must be equal to the maximum of I_A and I_B (I_B).

The aspect ratio of M_1 and M_4 should be chosen smaller than that of M_2 and M_3 in order to keep M_3 in saturation for a large dynamic range of input currents. Because the behavior of the circuit is based on matched devices and is independent of the relationship between the drain current and the gate-source voltage, transistor pairs may operate in strong, moderate and weak inversion. Therefore, the circuit can also be implemented in bipolar technology. An application of the circuit in adaptive biasing is discussed in [1]. The circuit however, has many useful applications in modern signal processing.

References

1. E. Seevinck, R.F. Wassenaar, W. de Jager, "Universal adaptive biasing principle for micropower amplifiers," Digest of Technical Papers ESSCIRC 1984, Edinburgh pp. 59-62, Sept. 1984.