Innovations

BiCMOS 5HPE: A New Silicon Germanium Technology for High-Frequency RF Applications

Natalie B. Feilchenfeld, Steven J. Astravas, Matthew D. Gallagher, Samuel Gibson, and Jerry J. Twomey

Since their original introduction into manufacturing in 1997, silicon germanium (SiGe) technologies have been used in a diverse set of wireless applications (global positioning systems, cellular base stations, and handsets), wired applications (optical communications standards OC-192 and OC-768), and storage applications (PRML read channels and magneto-resistive preamplifiers). SiGe technology is gaining greater acceptance, and the need for targeted technologies has become important. BiCMOS 5HPE (SiGe 5HPE) is a qualified IBM technology that has been specifically developed to meet wireless application requirements and offers a rich device set and can help reduce wafer-build time and cost. Its key elements are:

- Reduced fabrication time
- Lower cost than other IBM SiGe technologies
- Compatible with Lithium-ion battery technology
- Both NPN and PNP bipolar devices
- 5-V CMOS with isolation wells for both NMOS and PMOS devices
- Diverse set of R, L, and C passive elements
- Comprehensive RF quality simulation models for all devices

Silicon Germanium Technologies from IBM

The SiGe bipolar transistor was developed to address the need for transistors with low-noise characteristics and the high-frequency response required by many modern electronic applications. Introduction of a graded SiGe profile into the base enables further device modifications which can result in a transistor with lower noise and higher speed than conventional silicon devices.

In any real application, the excellent transistor performance can only be fully exploited when coupled with other process features such as high-quality passive devices and CMOS technology. The family of IBM SiGe technologies listed in Table 1 has consistently set the pace for bipolar speed and performance [1,2,3]. The variety of devices available within each of these technologies makes them capable of a wide range of applications; for example, BiCMOS 6HP meets the requirements of both PRML read-channel and wireless global-positioning-system (GPS) applications.

Table 1. SiGe Foundry Technologies.

Technology	Lithographic Generation	Applications
BiCMOS 5HP	0.5 µm	Base stations, mobile phone handsets
BiCMOS 6HP	0.25 µm	PRML read channels, wireless, mobile phone handsets
BiCMOS 7HP	0.18 µm	High-speed data, OC-768

The success of these general offerings in the marketplace has led to customers requesting more specialized technologies specific to their products and applications. The requirements of the wireless/RF industry were for a technology that offered a combination of enhanced passive device performance, low cost, and fast wafer-build time to provide optimum design flexibility.

RF/Wireless Application Requirements...Transceiver on a Chip?

In response to the explosive demand for consumer wireless devices, cellular phones have become commodity devices. Ever-improving technology capability, adoption of new telecommunications standards, government sales of bandwidth, and, most importantly, consumer demand have each played a role in this increase. As products mature and come under intense cost and market pressures, the technologies used evolve to meet specific demands.

Major users of wireless semiconductor technology include manufacturers of personal mobile-phone handsets, base stations, wireless LANs, and GPS receivers, with the projected industry growth shown in Figure 1. Because manufacturers of these different products all require lower costs and faster time to market, semiconductor product development teams have been motivated to integrate multiple applications on a single chip wherever feasible — with the goal of designing a *transceiver on a chip*.

The transceiver of a mobile phone can be constructed by placing multiple discrete components on a circuit board or, alternately, incorporating some of the functions on the same semiconductor chip, but only if the semiconductor process technology includes inductors, varactors, and resistors that compete in cost and performance with their stand-alone counterparts. On-chip integration *can* reduce costs by eliminating the packaging,

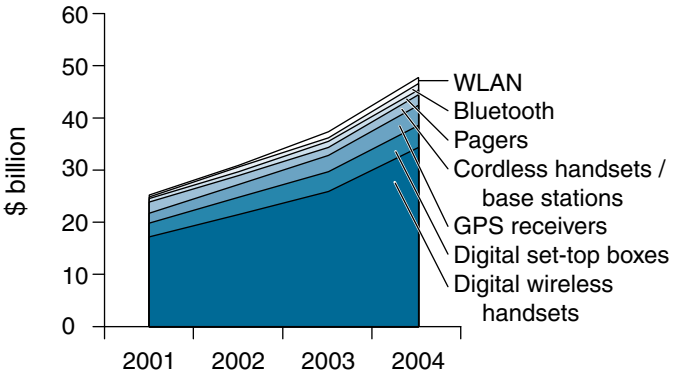

Figure 1. Semiconductor total available market for wireless applications. (Source: Gartner Dataquest August 2000, June 2001, and August 2001; Cahners, June 2001; Merrill Lynch, March 2000; and AFX News Limited, June 2001.)

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