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Moore's Law Running Strong Nearly 50 Years Later

Scott L. Spencer
Publisher



The International Solid-State Circuits Conference (ISSCC) is a leading global forum for the presentation of advances in solid-state circuits and systems-on-a-chip. ISSCC 2013, held last month in San Francisco, was the 60th annual Conference. In 1954, seven years after the transistor was invented by William Shockley, John Bardeen, and Walter Brattain, the first "Conference on Transistor Circuits" was held in Philadelphia by the IRE, a predecessor of the IEEE—and the first wave of electronic miniaturization was under way.

Soon transistor circuit design evolved into integrated-circuit design, and along came Gordon Moore's 1965 observation that the number of components in integrated circuits had doubled at regular intervals from the invention of the integrated circuit in 1958 until 1965. His observation was published in a magazine article, "*Cramming More Components onto Integrated Circuits.*" Along with this he predicted that the trend would continue for at least another 10 years. At the time Dr. Moore had no idea how accurate his prediction might be. In fact, years later he remarked, "*I never expected it to be precise. I was trying to get the message across that this was going to be the cheap way to make electronics putting a lot of it on a chip rather than building it up from individual components soldered together.*" Nevertheless, his vision and the accuracy with which he was able to predict the future of integration remain uncanny.

Based on published reports, the presentations made at this year's ISSCC2013 reaffirmed the essence of Moore's Law, as higher levels of integration remain the trend. Increasingly we are seeing more functionality, often with a single die containing the front-end, a synthesizer, and base-band in complex millimeter-wave designs, coupled with efforts to radically improve receiver designs to eliminate unnecessary and bulky duplexers and SAW filters.

Nanotubes to Replace Silicon? Not so Fast

But could advances in material technology ultimately signal an end to the microelectronic era defined by Moore's Law? In the next decade or so, circuits etched on silicon will likely become as small as they can physically become, ushering in an era of new advanced materials like carbon nanotubes to take their place. At ISSCC 2013, researchers from Stanford University demonstrated a simple microelectronic circuit composed of 44 transistors fabricated entirely from carbon nanotubes. It is believed that the

Stanford demonstration is the first time a complete working circuit has been created and shown publicly.

In oscillators, millimeter-wave amplifiers, and PAs, the papers presented at ISSCC indicate a clear trend in the continuing push for higher frequency in CMOS and BiCMOS. Due to high spatial resolution and the use of micro-miniature antennas, an emerging trend is the increasing complexity of systems operating in the 60-to-200 GHz range. With much of the frequency spectrum already crowded, researchers are continuing to target frequencies above 60 GHz, particularly for applications in imaging and radar. Another movement is the integration of millimeter-wave antennas onto silicon substrates.

Case in point: at ISSCC Frankfurt based Silicon Radar, in conjunction with the University of Karlsruhe and partner Bosch, demonstrated a functional radar sensor with integrated antenna that transmits and receives signals at 120 GHz. Taking advantage of Silicon-Germanium BiCMOS technology, designers envision extremely fast bipolar transistors with transmit frequencies up to 300 GHz and Metal Oxide Semiconductors on the same chip. The result could be fully functional radar systems with dimensions of just a few millimeters.

NAB Just Around the Corner

In a few weeks *HFE* will be in Las Vegas for the National Association of Broadcasters (NAB) show. The annual meeting attracts over 90,000 visitors and 1,500 exhibitors from 150 countries together on nearly 1 million square feet of exhibit space. Although NAB is highly diverse in scope, covering all forms of media in every stage of life from content to consumption, a primary element of the exhibition is "content distribution" including broadcast, fiber, mobile, broadband video, streaming and more. For this reason several of the advertisers and companies frequently mentioned on the pages of *HFE* are attending NAB

to strengthen their position in addressing emerging opportunities in the broadcast arena.

Start Planning for IMS 2013

The Exhibition Managers for IMS 2013 have confirmed that *High Frequency Electronics* will again be the exclusive sponsor for this year's Opening Reception in Seattle. As the

sponsor of last year's Opening Reception, we were pleased with the large turnout of conference delegates and IMS staff and volunteers. For those unable to attend last year, I encourage you to attend in Seattle in order to renew old acquaintances and make new ones, as well.

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