HIGH FREQUENCY
ELECTRONICS

Editorial Director
Gary Breed
gary@highfrequencyelectronics.com
Tel: 608-437-9800
Fax: 608-437-9801

Publisher
Scott Spencer
scott@highfrequencyelectronics.com
Tel: 603-472-8261
Fax: 603-471-0716

Associate Publisher
Tim Burkhard
tim@highfrequencyelectronics.com
Tel: 707-544-9977
Fax: 707-544-9375

Associate Editor
Katie Landmark
katie@highfrequencyelectronics.com
Tel: 608-437-9800
Fax: 608-437-9801

Business Office
High Frequency Electronics
7 Colby Court, Suite 7-436
Bedford, NH 03110

Editorial and Production Office
High Frequency Electronics
104 S. Grove Street
Mount Horeb, WI 53572

Also Published Online at
www.highfrequencyelectronics.com

Subscriptions
Sue Ackerman
Tel: 651-292-0629
Fax: 651-292-1517
circulation@highfrequencyelectronics.com

BPA WORLDWIDE

High Frequency Electronics (USPS 024-316) is published monthly by Summit Technical Media, LLC, 3 Hawk Dr., Bedford, NH 03110. Vol. 8 No. 5, May 2009. Periodicals Postage Paid at Manchester, NH and at additional mailing offices.

POSTMASTER: Send address corrections to *High Frequency Electronics*, PO Box 10621, Bedford, NH 03110-0621.

Subscriptions are free to qualified technical and management personnel involved in the design, manufacture and distribution of electronic equipment and systems at high frequencies.

SUMMIT
Technical Media LLC

Engineering Education Needs to Cover Large, Complex Systems

Gary Breed
Editorial Director

The recent WAMICON conference included a session on engineering education. Although the main topic was the way various schools are incorporating RF/microwave/wireless engineering into the core curriculum, other important subjects were covered as well. For example, the discussions repeatedly noted concerns about declining engineering school enrollments and the (corresponding?) decline of math and science performance among U.S. students.

The session also revealed some of the changes in the way engineering is applied, and how educators should address them. At the top of that list was the design of large, complex systems. Large systems for power distribution and telephone service have been around for a long time, but even those systems have increased in complexity. The telephone networks are no longer simply copper wires and switches, but have evolved into the Internet, a very complex “network of many networks” that now includes fiber, coax, RF and microwave transmission technologies, along with large-scale software systems to manage the data traffic. The power grid has expanded to include complex load management systems, even down to individual appliances in customers’ homes. It has also become a two-way system, accepting power contributions from widely-distributed solar and wind energy sources, large and small.

The description of “large and complex” also fits systems on a much smaller physical scale—such as SoC or SIP technology, even single-die ICs with millions of transistors. Nano-scale systems that add mechanical devices to IC electronics are developing rapidly, with the goal of shrinking highly-complex functions to save costs and reduce size. When many such devices are interconnected into even larger systems, the total complexity taxes the imagination!

Currently, the means of learning about very large systems is a combination of industry R&D and academic research by professors and advanced Ph.D. candidates. Large, complex systems require this high level of competence; the actual design methods are not going to be taught at the undergraduate level—but the concept should be introduced and major issues identified to prepare BSEEs for their future careers.

In geographically large systems, some of the issues are: timing and synchronization, signal routing and switching, error detection and correction, coordination of different transmission media, decision-making parameters, and many others. System reliability and security is a critical overall factor.

At the microtechnology level, complex systems have similar timing, routing, switching and other data management issues. But instead of distance, these systems must deal with problems arising from proximity, including interconnection quality, high speed signal integrity, self-interference (cross-talk, clock feed-through), power supply distribution and thermal management.

Because micro-scale devices are difficult to divide into modular blocks, testing and verification of their operation can be extremely difficult. In some cases, test points and measurement circuitry must be built into the devices to enable testing and monitoring that would otherwise be impossible.

Many of these concepts can be included in core undergraduate courses. In computing and data communications, the discussion might begin with, “What if we have tens of thousands of individual communications links that must be interconnected and coordinated?” In an introductory section on wireless communications, it might center on the cellular concept, “Expand one signal path to tens of paths at one site, then hundreds of sites in an area, routed through backhaul channels and sent to another regional system somewhere else.”

The priority of various areas of engineering keep changing. When I was in school, Junior Lab was electro-magnetics—but it involved rotating machinery, not RF and microwaves! Today, both wireless technology and large systems can easily be justified for inclusion into the core EE curriculum.

Spaces or No Spaces

In this issue’s Design Notes column (on page 72), I decided to look into the subject of proper written presentation of numbers and units. With a recent trend of eliminating the space between them (6.0dB rather than 6.0 dB), an investigation seemed appropriate.

As you will see, I was unable to find *any* published style guide that recommends this practice! Beyond our preferences on this topic, however, the short article identifies several style guide resources that can help you write your technical papers, application notes and reports with greater clarity.

From May 2009 *High Frequency Electronics*