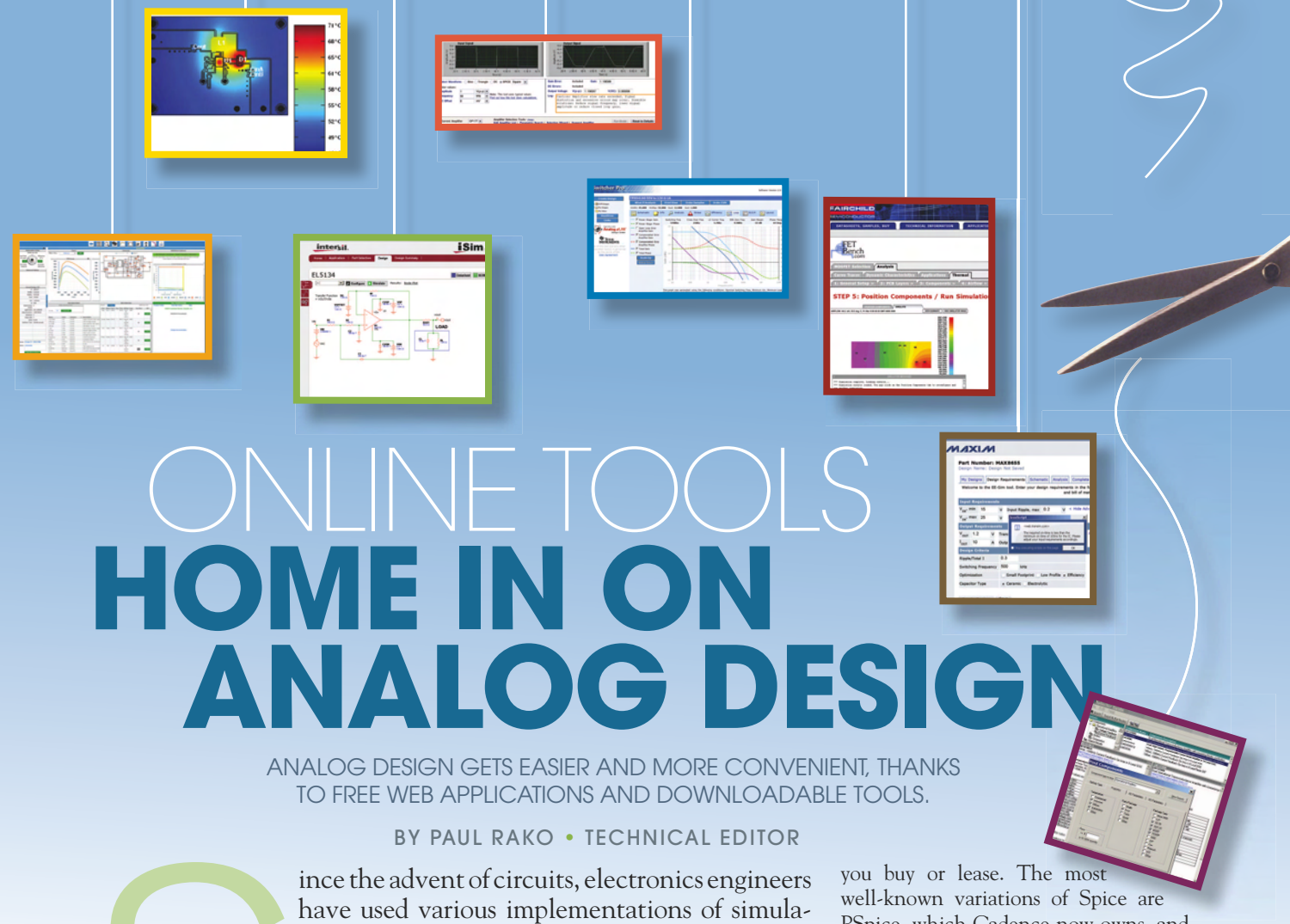

ONLINE TOOLS
HOME IN ON ANALOG DESIGN

ANALOG DESIGN GETS EASIER AND MORE CONVENIENT, THANKS TO FREE WEB APPLICATIONS AND DOWNLOADABLE TOOLS.

BY PAUL RAKO • TECHNICAL EDITOR

Since the advent of circuits, electronics engineers have used various implementations of simulation tools. These tools are especially important in analog design, for which specifications may span many decades of magnitude, and changing one component can have unknown effects on other—perhaps unrelated—components. Analog systems are also becoming more complex: Switching regulators once operated at 20 kHz, but modern chips can work at 4 or even 8 MHz. Modern signal paths also have stringent noise and accuracy requirements. Interface signals clock data at gigahertz frequencies. These signals can interact or be susceptible to interference from both internal and external sources, causing circuits to behave unreliably. These signals may also radiate excessive noise, preventing your product from passing FCC (Federal Communications Commission) certification.

Tools to aid designers of analog circuits have been around for a long time, with each decade bringing innovations in analog-design help. For example, analog designers as far back as the 1950s simulated circuits using Teledeltos, an electrosensitive paper that responded to an electric current by turning from light gray or blue to dark black. In the 1960s, IBM's ECAP (electronic-circuit-analysis program), with 7000 program lines, was available to help engineers with their circuit designs. A decade later, in the 1970s, a team at the University of California—Berkeley created Spice, which is now available as packaged software that you buy or lease. The most well-known variations of Spice are PSpice, which Cadence now owns, and Intusoft's ICap4 analog- and mixed-signal circuit-simulation package. Altium also offers a version of Spice, and National Instruments' Electronics Workbench Multisim Spice has attained great popularity in academia due to its intuitive and novel user interface.

Analog-simulation tools have evolved immensely since the early days. For example, in 1972, Berkeley Spice required you to type a netlist on punch cards using a mainframe. Today, National Instruments' Electronics Workbench lets you draw a schematic and then drag virtual test equipment over the nodes to simulate and evaluate circuit performance. National Semiconductor's Webench simulation package runs on the company's servers to perform analysis of the circuits you design online, and Analog Devices' Web package uses Multisim to perform the same tasks. Another noteworthy Spice version, Linear Technology's LTSpice, excels at simu-

lating switching power-supply circuits, a difficult proposition, considering the nonlinear nature of the rectification diodes and transformer magnetic components these power supplies employ.

Other forms of packaged software tools include The MathWorks' Matlab and PTC's MathCAD. These math programs use generalized circuit equations or even Z transforms to solve for the response of digital-power chips. Field solvers use a physical model and Maxwell's equations to predict the performance of your circuit (**Reference 1**). Engineers use all these tools to help with analog design, but packaged tools lack the instantaneous application assistance that you can achieve by running an application on the Web.

WEB TOOLS DEBUT

Web tools began to emerge a decade ago when companies began to publish data sheets on their Web sites in PDF (portable-document-format) files. Engineers no longer needed to squeeze data books under copy-machine covers to document their designs; they could easily print them from manufacturers' Web sites. Companies then began to offer not only data sheets, but also selector guides to help customers select parts. Many of these selector guides started life as printed handouts.

By the 1990s, however, selector guides had evolved into downloadable programs that would allow parametric searches. National Semiconductor developed one of these programs, a Windows application that uses the Perl programming language to perform parametric searches. The company also developed the PalmGuide, which runs on Palm and Hewlett-Packard PDAs (personal digital assistants). The nonintrusive program does not use the Windows registry or leave any files or other detritus on your computer. And, for every parameter you enter in the selector guide, Palmuide indicates how many parts fit within all the parameters (**Figure 1**). For example, if you ask for some impossible combination of parameters—say, noise of 1 nV/$\sqrt{\text{Hz}}$ and current consumption of 1 µA—you would immediately see that no such part exists. With these tools, FAEs (field-application engineers), for example, can keep selection guides, such as National Semiconductor's guide for amplifiers, on their PDAs so they can easily help customers find the right parts without using laptop computers. Texas Instruments, Analog Devices, and a host of other companies also offer programs to help engineers select parts.

AT A GLANCE

- Tools to aid designers of analog circuits have been around for a long time, with each decade bringing innovations in analog-design help.
- Packaged tools lack the immediate application assistance that you can achieve by running an application on the Web.
- By the 1990s, selector guides had evolved into downloadable programs that would allow parametric searches.
- The broad-market analog companies are not the only ones that provide design tools.
- Many companies make it easy to register for the tools.
- The prominence of online-design tools is evident in the way that the major analog companies organize their home pages.
- A smart FAE (field-application engineer) is the best free design tool there is.

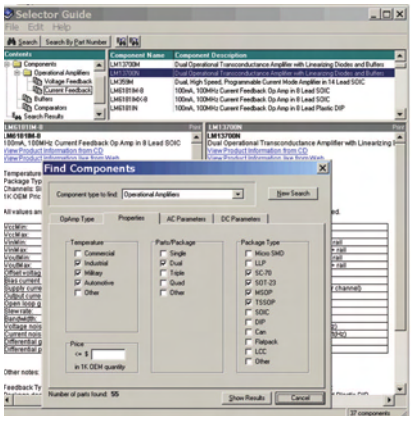

Figure 1 National Semiconductor's amplifier-selection guide shows you how many parts still match your criteria so you don't waste time looking for parts that don't exist.

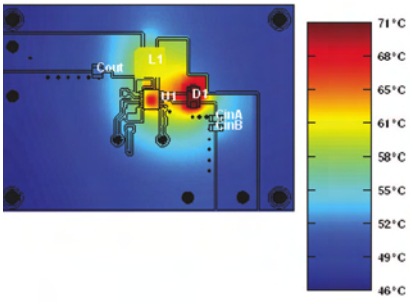

Figure 2 National Semiconductor's Webench online-design simulator analyzes the thermal performance of your switching-power-supply design.

The next logical step for manufacturers was to publish the selector guides on the Web. These Web tools require no software downloads, and, because little data traverses the Web in either direction, the programs worked even back in the days when engineers used dial-up connections to access the pages. Today, all analog companies offer Web-based selector guides, many of which provide the same functions as packaged software and allow semiconductor manufacturers clues about which selector guides and parts are popular with customers.

The next step in the evolution was the emergence of online-design programs. National Semiconductor led the way with Webench. The development of this online tool was a natural outcome of the DOS software that the company had developed in 1993 to help engineers design systems with its Simple Switcher product family.

In 2000, the company introduced WebTherm, which it co-developed with Flomerics. The tool simulates the thermal behavior of an electronic PCB (printed-circuit board) with components (**Figure 2**). Also in 2000, the company enhanced Webench with Build-It, a feature that allows engineers to order a custom power-supply kit or a fully assembled and tested board matching their design requirements to verify their designs. Webench runs Intusoft Spice in the background on National's servers, yielding the benefit of not overloading your machine. Today, tools are available to help you design filters and amplifier circuits, to select the signal path for temperature or pressure sensors, and to design LED-driver circuits (**Figure 3**).

Other vendors followed National

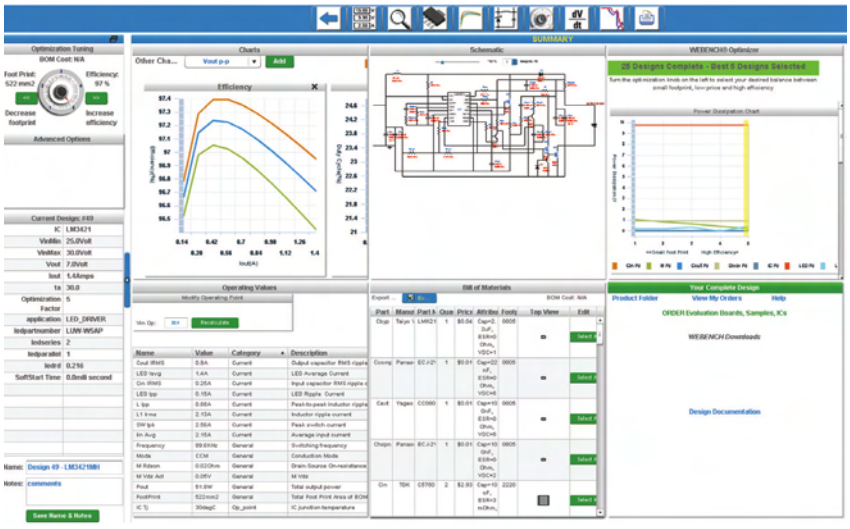

Figure 3 Webench has an LED-driver-design function with a powerful interface (courtesy National Semiconductor).

Figure 4 Texas Instruments' new SwitcherPro design software works both online and as a downloadable executable for your computer.

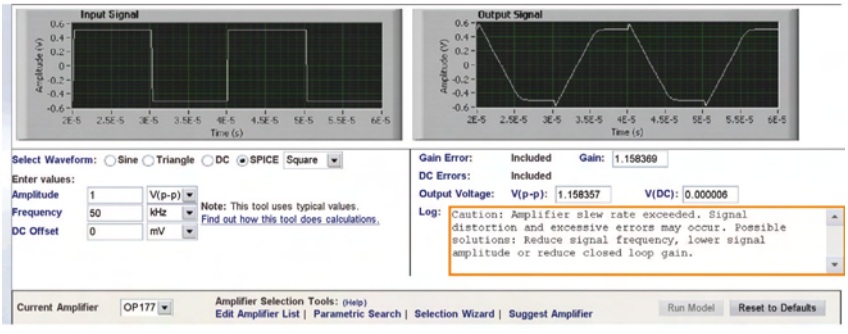

Figure 5 Analog Devices' ADIsim warns you if you have created a condition in which the design would not work.

Semiconductor's lead. For example, Texas Instruments offers both a selector guide and the downloadable Tina-TI Spice program. TI developed Tina-TI Spice in partnership with DesignSoft, which offers the Tina simulator. In addition, TI offers the downloadable FilterPro filter designer, a mathematical-analysis program that indicates the theoretical performance of filters using characteristics about their passive components and amplifiers. TI also offers the online or downloadable SwitcherPro switching-power-supply designer (**Figure 4**). With the tool, engineers who are not working online can continue to design their circuits. Both the downloadable and the online versions of the tool offer approximately the same speed, according to Rich Nowakowski, a TI product-marketing engineer.

To complement this power-supply-design program, the company also offers the downloadable ADCPro, ClockPro, and MDACBufferPro programs for multiplying DACs and publishes a variety of simple online tools to help you design electronic systems. For example, the JavaScript-powered, four-band-color-coded calculator illustrates a conventional through-hole resistor and lets you identify the color bands using drop-down menus. The program then gives you the value of the resistor with that color code.

TI has also developed dozens of online calculators to help you with everything from choosing two standard resistors to achieve a user-specified voltage-divider value to more complicated tasks, such as calculating the component values to design a single-ended to fully differential amplifier circuit. Rounding out TI's offerings are downloadable tools for calculating ISM (industrial/scientific/medical)-band loop filters and programs for selecting the component values for buck-switching regulators.

Another successful analog company offering online tools, Analog Devices, has teamed up with test-and-measurement powerhouse National Instruments to create the ADIsim online-design program to help you design op-amp and switching-power-supply circuits (**Figure 5**). Invoking two levels of calculations, the tool helps you select parts and then calculates the performance of a circuit

Figure 6 Maxim's EE-Sim provides a dialog box to warn you that the circuit will not work unless you change the specifications or the part.

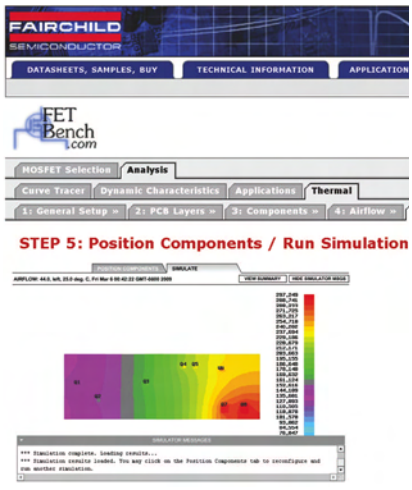

Figure 7 Fairchild's FETBench lets you see thermal performance on a PCB that you specify.

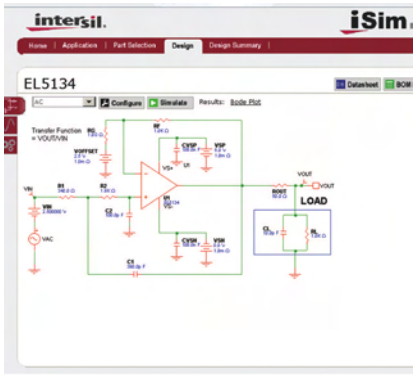

Figure 8 Intersil's iSim program can help you design both switching power supplies and amplifier circuits.

from specific design equations. Once you are happy with this approximation, you can invoke a full Spice simulation that uses the Multisim simulator from National Instruments subsidiary Electronics Workbench. Analog Devices also lets you download a free version of Multisim that works with the company's parts. The company also offers the ADIsimDAC DAC-design tool and ADIsimRF, the downloadable version of which can help you calculate RF parameters, such as gain, noise figure, and power consumption. Another downloadable tool, ADIsimPLL, provides design help and evaluation for PLL (phase-locked-loop) design.

New to the online-simulation-tool-provider list is analog stalwart Maxim Integrated Products. Although the company has only recently begun to provide powerful online tools, it has made up for its late entry by getting many things right. As with most analog-semiconductor manufacturers, Maxim prefaced its online-design-tool development with an online-parametric-selection guide. The tool recalculates the screen and changes with the subsequent selection sliders whenever you make a selection, meaning that you will always have choices, according to Erin Mannas, the company's Web-content engineer.

Maxim also now provides the EE-Sim online-design environment (**Figure 6**), which the company envisions as a further step in product selection. Once you select a part that the software supports, you receive a link to start the EE-Sim application. As of March, the environment supported only four parts, but Maxim plans this year to add an array of supported parts. Rather than use a classic Spice engine, Maxim uses SIMetrix Technologies' Simplis. This package does not do matrix math in an iterative fashion like Spice. Instead, the models are piecewise-linear approximations of diode curves and transistor characteristics. The simulations run at high speed, more than making up for the small sacrifice in accuracy. According to Eric Schlaepfer, Maxim's strategic-application engineer, the program reaches results in 10 times less time than does a classic Spice program. You can download the program so you can work on simulations without hooking up to the Web. Like TI, Maxim offers a variety of simple design calculators, such as a tool for creating the data to drive a pattern generator for making waveforms.

The broad-market analog companies are not the only ones that provide you with design tools. Microchip, for example, offers MAPS (Microchip advanced parts selector), and Power Integrations offers the downloadable PIExpert tool to help you design switching power supplies, including high-power resonant supplies that also have PFC (power-factor correction). Fairchild offers the FETBench online program, which it developed with Transim Technology and which Intersil and NXP also employ. The FETBench environment can help you choose FETs; then, you can use Fairchild's Ansys-powered WebSIMThermal application to see the thermal performance of the part in a specified environment of board size, airflow, and part arrangement (**Figure 7**). Fairchild even lets you define your own parts so you can use this tool for any PCB thermal problem. Intersil offers the iSim Web tool, which helps you design and simulate power-supply and op-amp circuits (**Figure 8**). A downloadable version lets you capture schematics and evaluate circuit performance.

International Rectifier offers a suite of online-design tools that can help you design PFC circuits and simple buck regulators. These tools lack the ability to perform full thermal analysis, but they can save time when you need to design this type of circuit. When you hit the "analyze" button, the application generates a PDF file of your design that you can submit to your manager or use in a design review. International Rectifier also offers calculators for motor control and downloadable software to help you design lighting ballasts, along with bus-converter-design assistants that pro-

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vide a selection of parts for various converter topologies, such as full-bridge, half-bridge, and forward converters. The company's Web site offers design support for the iMotion motor-control engine, which lets you develop custom control algorithms.

ASSURING YOUR SECURITY

Like all other professionals, engineers are very concerned about the security and privacy of their online data. Many companies make it easy to register for their tools. Maxim, for example, requires only an e-mail address and a password. Analog Devices, on the other hand, requires no registration to use its online tools. The company once tried requiring users to register, but users wouldn't stay at the Web site long enough to do so. "We could tell by click rate that a user would go to the registration page and then say 'to heck with it' and go away," says Dave Kress, director of application engineering. He estimates that the percentage of would-be customers bailing out before registering is 30 to 50%. "We felt that we were not getting the job done," he says.

The prominence of online-design tools is evident in the way that the major analog companies organize their home pages. For example, both TI's and Analog Devices' home pages have three broad categories—products, applications, and design support—with the support category leading to all their tools. Intersil's Web page has both product and design-resource columns. National Semiconductor has integrated Webench into its entire site, allowing you to enter the tool from the top down or from a part-specific area. Entering the tool from National Semiconductor's LM5574 part area calls up a function in Webench that lets you use a knob to dial in the efficiency or the size of the design.

Online and downloadable design tools are just two arrows in your quiver. Many analog companies also offer online Spice models, reference designs, IBIS (input/output-buffer-information) models, BSDL (boundary-scan-description-language) models, and technical libraries. For example, TI has introduced the E2E Community, allowing engineers to share their success stories and—just as important—their failures. Also, keep in mind that FAEs will help if you ask. A smart FAE is the best free design tool there is. **EDN**

REFERENCE

1 Rako, Paul; "Beyond Spice," *EDN*, Jan 18, 2007, pg 41, www.edn.com/article/CA6406716.

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