Success Story

University of Virginia Teaches PCB Design With NI AWR Design Environment

Company Profile

Founded in 1836, the University of Virginia (UVA) Engineering School is the third oldest engineering school in a public university in the U.S. The school combines research and educational opportunities at the undergraduate and graduate levels as part of UVA, a consistently top-ranked public institution. Within the engineering school undergraduate programs, courses in engineering, ethics, mathematics, the sciences, and the humanities are available to build a strong foundation for careers in engineering and other professions. The abundant research opportunities complement the curriculum and educate young men and women to become thoughtful leaders in technology and society.

The Design Challenge

UVA is dedicated to providing significant hands-on experiences in RF and microwave circuit design, including layout and testing of printed circuit boards (PCBs). For example, the RF and Wireless Circuits course that Prof. N. Scott Barker teaches covers the basics of impedance matching, noise, distortion, and RF building blocks (low-noise amplifiers, mixers, voltage-controlled oscillators). These topics are motivated through a semester-long project of designing, building, testing, and fielding a weather satellite receiver to receive and demodulate the automatic picture transmission (APT) signal. The APT is currently transmitted by three polar orbiting environmental satellites (POESs) operated by the U.S. Department of Commerce National Oceanic and Atmospheric Administration (NOAA). Although the signal is low resolution, it is broadcast in the meteorological satellite band from 137-138 MHz using frequency modulation, which enables interesting yet relatively easy RF circuit design. The APT provides near real-time infrared images of the Earth, which are good for observing cloud cover.

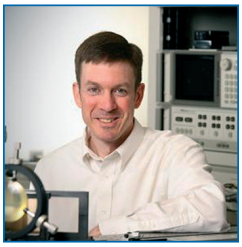
The Solution

In order to complete the satellite receiver design within one semester, Prof. Barker's course tightly integrates seven lab projects that include five PCB designs in which each student does his/her own design and layout, which is then manufactured by PCB manufacturer Advanced Circuits. The PCB designs include LC matching networks, a pre-matched amplifier (using the Mini-Circuits ERA-2), a low-noise amplifier (using a silicon germanium [SiGe] transistor), a voltage-controlled oscillator (VCO) based on the MAX2606 integrated VCO, and a mixer based on the SA602A Gilbert cell multiplier. The VCO is controlled using an ADF4110 phase-locked loop [PLL] board designed by Prof. Barker that the students program using an MSP430 LaunchPad microcontroller.

The labs associated with each of these PCB designs has the students assembling (yes, soldering is required) and measuring their boards using NI test equipment, including the NI PXIe-5632 vector network analyzer and the NI PXIe-5644R vector signal transceiver. Every PCB includes SMA connectors for testing and eventual assembly of the entire system. To complete the receiver, Prof. Barker supplies a custom-designed LC bandpass filter and FM demodulator board.

University of Virginia Engineering

Application:
RF PCB
Software:
NI AWR Design Environment
Microwave Office



"Using NI AWR software in my RF and microwave classes and labs has given my students strong hands-on experience, as well as a better system view of how and why components interact as they do. Since adopting NI AWR Design Environment, the size of my course has tripled to over 30 students. I'm hoping to learn Visual System Simulator™ (VSS) in the near future and figure out how to utilize it to enhance my course as well."

– N. Scott Barker
Professor
University of Virginia
virginia.edu

At the end of the semester the students form teams to assemble (Figure 1) and test the entire receiver by connecting the individual boards utilizing the best individually-designed PCB components. The teams then have the opportunity to locate one of the weather satellites using tracking software and attempt to capture the signal as the satellite passes overhead (Figure 2). The output of the FM demodulator is centered at 2.4 kHz and can easily be recorded on any available smartphone or laptop for subsequent data processing via shareware.

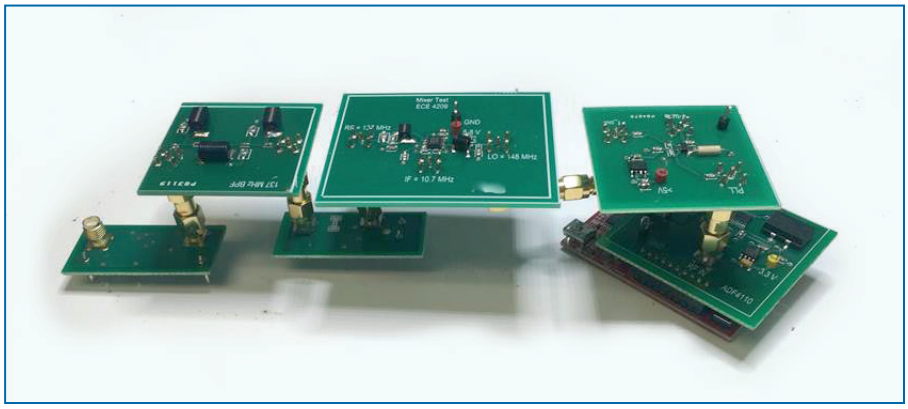


Figure 1: Photograph of student designed receiver being assembled.

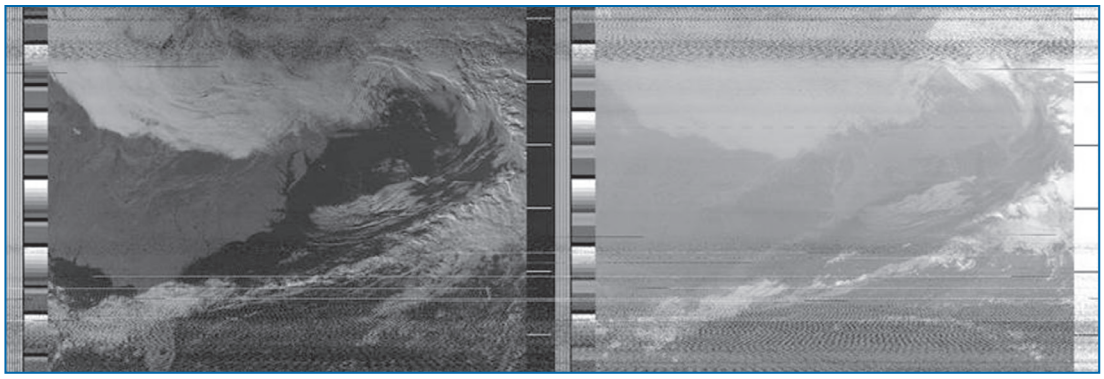


Figure 2: Satellite images captured by University of Virginia students.

Why NI AWR Design Environment

Prof. Barker chose NI AWR Design Environment™ for his classes because of its usability, which enables his students to come up the learning curve very quickly. He also likes the powerful script writing capability and the complete integration of the schematic and layout features. For the students, the RF class is the first course using something other than SPICE that is still spice-relatable. It is a nice bridge into frequency-domain versus pure time-domain simulations.

While the engineering school originally used a competing computer-aided design suite, those tools had a steep learning curve and were difficult to figure out when the students wanted to send their designs out for fabrication. Several years ago Prof. Barker spotted NI AWR software at the International Microwave Symposium (IMS), got a quick demo of how easy it is to export PCB designs for fabrication, and made the switch that day. He says the intuitive nature of the software makes it very efficient to use and helps the students stay on track with their designs and not get lost in the details of how to use the software.

A key benefit of the software for Prof. Barker is that he can customize a library for the course and make it available to the students with the elements/parts pre-defined and the scripts already built into it. NI AWR software reflects the real world, showing students what their job will entail in the future.

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