Engineering 90 : Topic Selection
Aron Dobos, Advisor: Lynne Molter
22 September 2005

Overview

I propose to build a high speed time domain reflectometer (TDR) instrument. TDR technology is used for cable and transmission line characterization, in geotechnology for determining groundwater and soil properties, and in the oil industry for locating oil reserves. The instrument I intend to build will probably focus around cable characterization, although few (if any) changes would be necessary to extend its usefulness into other arenas. The first priority for the instrument is to produce accurate waveforms with minimal jitter, and second, to minimize power consumption for potential use in field applications.

Preliminary Details

The device will be based around the Analog Devices ADuC7026 32-bit ARM microcontroller that provides 4 built-in D/A converters as well as a 12 channel 12-bit A/D converter with 1GS/s capability. External analog circuitry will be required for the step generator, as well as an external timer circuit for precise setting of the sampling delay, since the device will be working in equivalent time mode. The ADuC7026 has 8k SRAM and 62k FLASH, which will be enough for acquiring at least a 2048 data point waveform before transferring the acquisition to the host device, although an external memory interface on the microcontroller exists if larger waveforms are desired.

The instrument will provide a 16-bit wide (8-bit data, 8-bit control) logic level communication interface with a detailed data transfer protocol definition for connection to either a PC parallel port, an 8051-based Cypress Ez-USB module, or even an Motorola Dragonball-VZ based embedded Linux system. This allows the TDR to be included in a wide variety of target devices with a straightforward communication mechanism.

Main Tasks and Obstacles

The project will involve a variety of tasks including device-level C programming (and potentially ARM assembly), designing high speed analog circuitry, and building with surface mount technologies. The main “unknowns” at this point are designing the step generator circuit for very high speed operation and reliably assembling surface mount components.

Background

My primary interest in engineering currently is analog circuit design and embedded systems integration, and this project provides an opportunity for both. I wrote for the E75 Electromagnetic Theory class a paper on TDR technology, and ran some tests using a high speed Tektronix oscilloscope to visualize the process.

Resources

I will be consulting with my advisor Lynne Molter primarily, and perhaps also at times with Erik Cheever, although I have not formally requested him as an advisor for the project. I will also be seeking some assistance from my father who has much experience with very high frequency analog circuit design.