University of Toronto
Department of Electrical and Computer Engineering
ECE241F: Digital Systems - Fall 1996

Hardware Lab #4 - Using Small Programmable Logic Devices

Note: You will need the *University of Toronto PAL Device Laboratory Manual.*

In the previous labs you have constructed a number of circuits using Small Scale Integration (SSI - a few gates per chip) technology. One of your observations should have been that there was a huge number of wires and chips that you needed to implement even very simple functions. For modern implementations of digital systems, a significant factor in the cost of a system is the number of chips, no matter how complex the chip. Therefore, it is important to be able to use *higher density* chips, meaning that you want to put as much functionality as possible into one chip.

The purpose of this lab is to become familiar with the use of small programmable logic devices (PLDs), also known as Programmable Array Logic (PALs). PLDs are one of the most common means for implementing small logic functions that were previously done using SSI. The programmable aspect means that they use *uncommitted logic*, which is then specified by the user, not the manufacturer.

Part A - Introduction to PALs

Preparation: Read pages 1 through 20 of the PAL Devices manual (up to the end of section 2.2.10). Do the parts of the tutorial that can be done using the ABEL software, which does not include the programming and testing of the PAL (i.e. all but sections 2.2.7 and 2.2.8, and any programming and testing after that). This will show you how to design a basic combinational circuit, add a flip-flop and how to make a shift register.

You will need to do this either on the ECF "spark13 to spark29" machines (where the abel program is located in /local/packages/bin), or the ECE ugsparc machines (where the abel program is located in /local/bin).

In The Lab: For this part, do the parts of the tutorial exercise indicated above that require programming and testing of the devices, up to the end of Section 2.2.10. The testing should be done in two ways: by the programming unit (which tests the device as it sits in the programmer), as indicated, and by you inside using the digital board set up. Show your working circuits to a TA. Since you did the majority of the work as preparation, you will have plenty of time to do part B.

Part B

You will be given a circuit specification during the lab period that you will design, implement and test in a PAL. You will be able to access the ECF and ECE ugsparc workstations from within the lab, as described on page 43 of the PAL manual. Demonstrate that the circuit works to a TA.

Other

Read Appendix of the PAL manual for useful information on computer access and device programming.