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CHAPTER 11
Programmable Logic Devices

Programmable logic is the means by which a large segment of engineers implement their custom logic, whether that logic is a simple I/O port or a complex state machine. Most programmable logic is implemented with some type of HDL that frees the engineer from having to derive and minimize Boolean expressions each time a new logical relationship is designed. The advantages of programmable logic include rapid customization with relatively limited expense invested in tools and support.

The widespread availability of flexible programmable logic products has brought custom logic design capabilities to many individuals and smaller companies that would not otherwise have the financial and staffing resources to build a fully custom IC. These devices are available in a wide range of sizes, operating voltages, and speeds, which all but guarantees that a particular application can be closely matched with a relevant device. Selecting that device requires some research, because each manufacturer has a slightly different specialty and range of products.

Programmable logic technology advances rapidly, and manufacturers are continually offering devices with increased capabilities and speeds. After completing this chapter and learning about the basic types of devices that are available, it is recommended that you to browse through the latest manufacturers' data sheets to get updated information. Companies such as Altera, Atmel, Cypress, Lattice, QuickLogic, and Xilinx provide detailed data sheets on their web sites and also tend to offer bundled development software for reasonable prices.

11.1 CUSTOM AND PROGRAMMABLE LOGIC

Beyond using discrete 7400 ICs, custom logic is implemented in larger ICs that are either manufactured with custom masks at a factory or programmed with custom data images at varying points after fabrication. Custom ICs, or *application specific integrated circuits* (ASICs), are the most flexible option because, as with anything custom, there are fewer constraints on how application specific logic is implemented. Because custom ICs are tailored for a specific application, the potential exists for high clock speeds and relatively low unit prices. The disadvantages to custom ICs are long and expensive development cycles and the inability to make quick logic changes. Custom IC development cycles are long, because a design must generally be frozen in a final state before much of the silicon layout and circuit design work can be completed. Engineering charges for designing a custom mask set (not including the logic design work) can range from $50,000 to well over $1 million, depending on the complexity. Once manufactured, the logic can't simply be altered, because the logic configuration is an inherent property of the custom design. If a bug is found, the time and money to alter the mask set can approach that of the initial design itself.