Application Specific Integrated Circuit (ASIC) Technology

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Chapter 1

Introduction to ASIC Technology

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I. OVERVIEW

An application specific integrated circuit (ASIC) can be defined in the broadest sense as an IC designed for a particular application or end-use such as in a compact disc player or a telecommunications system. ASICs stand in sharp contrast to standard IC products such as memories or microprocessors which are typically designed for use in a wide range of applications. In addition to being a class of IC products, ASICs also define a design style or methodology which is based on the extensive use of computer-aided design (CAD) tools and systems. ASICs are typically designed, at least in part, by someone other than the semiconductor vendor's personnel. Most often, the designer is the customer. This fact, coupled with differences in design objectives such as performance, area, and time to market, further differentiates ASICs from other types of IC designs. ASICs have driven an expansion of the semiconductor industry, have fundamentally altered the IC business, and have resulted in a significant increase in the number of IC designs and designers. The rapid growth of ASICs has

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required advances in a number of different areas of semiconductor technology including design, process, manufacturing, test, packaging, and CAD. Widespread utilization and the rapid evolution of ASIC technology are expected to continue in the 1990s. Integrated Circuit Engineering of Scottsdale, Arizona predicts that the worldwide merchant market for ASICs will more than double between 1988 and 1993, that one out of every five dollars spent on all types of ICs in 1993 will be devoted to ASICs, and that in 1993 over half of the logic market will be ASICs [1]. These predictions of growth clearly indicate the rapidly increasing importance of ASICs in the IC and electronic systems marketplaces.

A. Historical Perspective

The history of ASICs can be traced back more than 20 years to the masked read-only memory (ROM). Gate arrays and standard cells came into existence in the 1970s. However, it was during the decade of the 1980s that ASIC technology really assumed an important leading edge position in the worldwide IC marketplace. During the 1980s, numerous new merchant semiconductor vendors specializing in ASICs came into existence, and established broad line suppliers entered the ASIC business. By the end of the decade, Japanese semiconductor vendors had established a dominant position in the ASIC marketplace. For example, in 1988, 55% of the world's CMOS gate array designs were done in Japan as compared to 35% done by U.S. suppliers, and in 1989, Japanese firms took half of all merchant and captive gate array design wins [2]. By 1990, several broad line U.S. suppliers had re-thought or abandoned their ASIC strategies after finding the job-shop and service nature of the ASIC business difficult to integrate with more traditional high-volume approaches. Nevertheless, many U.S. vendors including both ASIC "specialists" and broad line suppliers are continuing to compete very effectively in the highly aggressive ASIC marketplace.

B. Classification of ASICs

The history of ASIC technology can be characterized by the evolution and proliferation of ASIC design styles [3]. Although CMOS gate arrays have been dominant, numerous other types of ASICs have been brought to market in the past several years. One possible representative classification of ASICs is presented in Fig. 1. As shown in the figure, ASICs can be grouped into four broad categories: (1) full-custom, (2) semi-custom, (3) field-programmable logic devices (FPLDs), and (4) linear arrays.

The semi-custom category of Fig. 1 includes those types of devices which are most often equated with ASICs: gate arrays and cell-based ICs. The first