Lattice Semiconductor Corporation

Corporate Profile

General

Lattice Semiconductor Corporation (the "Company") designs, develops and markets high performance programmable logic devices ("PLDs") and related development system software. The Company is the inventor and world's leading supplier of in-system programmable ("ISP™") PLDs. PLDs are standard semiconductor components that can be configured by the end customer as specific logic functions. PLDs enable the end customer to shorten design cycle times and reduce development costs. Lattice was founded in 1983 and is based in Hillsboro, Oregon.

PLD Market Background

Logic circuits are found in a wide range of today's electronic systems including communications equipment, computers, peripherals, instrumentation, industrial controls and military systems. According to Dataquest Incorporated, a semiconductor market research firm, logic accounted for approximately 28% of the estimated $113 billion worldwide digital integrated circuit market in 1995. The logic market encompasses, among other segments, standard transistor-transistor logic ("TTL"), custom-designed application specific integrated circuits ("ASICs", which include conventional gate-arrays, standard cells and full custom logic circuits), and PLDs.

Manufacturers of electronic systems are increasingly challenged to bring differentiated products to market quickly. These competitive pressures often preclude the use of custom-designed ASICs, which generally entail significant design risks and time delay. Standard logic products, an alternative to custom-designed ASICs, limit a manufacturer's flexibility to adequately customize an end system. Programmable logic addresses this inherent dilemma. PLDs are standard products, purchased by systems manufacturers in a "blank" state, that can be custom configured into a virtually unlimited number of specific logic functions by programming the device with electrical signals. PLDs give system designers the ability to quickly create their own custom logic functions to provide product differentiation and rapid time to market.

Several common types of PLDs currently coexist in the marketplace, each offering customers a particular set of benefits. These include low-density PLDs (less than 1,000 gates) and high-density PLDs (greater than 1,000 gates). High-density PLDs include both complex PLDs ("CPLDs," up to 25,000 gates) and field programmable gate arrays ("FPGAs," up to 50,000 gates).

Technology

The Company believes that electrically erasable CMOS ("$E^2CMOS^{®}$") is the preferred process technology for both high-density CPLDs and low-density PLDs due to its inherent performance, reprogrammability and testability benefits. E^2CMOS, through its fundamental ability to be programmed and erased electronically, serves as the foundation for the Company's ISP product families.

In-System Programmability (ISP)

Lattice's ISP Product Families

The Company has pioneered the development of a family of products called Lattice ISP devices, based on a proprietary technology, which affords it a competitive advantage in the high-density CPLD market. In contrast to standard PLD programming technologies, ISP products allow the system designer to configure and reconfigure the PLD without removing the device from the system board. Standard E^2CMOS programmable logic devices require 12-volt electrical signals and therefore must be removed from the printed circuit board and programmed using stand alone, specialized hardware, while ISP devices can be programmed with standard 5-volt or 3.3-volt electrical signals. ISP products enhance flexibility, providing a number of important benefits to a system manufacturer across the full spec-

trum of an electronic system product cycle. ISP devices allow customers to reduce design cycle times, accelerate time to market, reduce prototyping costs, reduce manufacturing costs and lower inventory requirements. ISP devices can also provide customers the opportunity to perform simplified and cost-effective field reconfiguration through a data file transferred by computer disk or telephone line. The Company's ISP product families include all of the Company's high-density CPLDs as well as the popular low density architecture, GAL22V10.

E²CMOS Process Technology

The Company's current high- and low-density PLD offerings are based on the Company's proprietary E²CMOS manufacturing process technology, termed UltraMOS®. The Company's current production processes, UltraMOS IV, UltraMOS V and UltraMOS VI are sub-micron CMOS technologies.

In comparison to bipolar technology, at one time the dominant technology for low-density PLDs, E²CMOS technology consumes less power and generates less heat while operating at comparable speed. Additionally, in contrast to one-time-programmable bipolar PLDs, E²CMOS PLDs are fully erasable and reprogrammable, providing greater end customer design flexibility and allowing the PLD manufacturer to fully test all programmable elements in a device prior to shipment. An alternative CMOS technology, Erasable Programmable Read Only Memory ("EPROM"), provides the same low power consumption benefits as E²CMOS, but requires ultraviolet light exposure for erasure, necessitating expensive quartz windowed packages and limiting testability. Antifuse and Static Random Access Memory ("SRAM") technologies, used primarily in the manufacture of high-density FPGAs, offer certain advantages for very dense logic devices, but also have significant drawbacks when compared with E²CMOS. Antifuse technology is non-erasable, non-reprogrammable and subject to lengthy initial programming times that can hinder usage in volume production applications. SRAM technology is volatile (erases when electrical power is removed), and as such programmable SRAM FPGAs require additional non-volatile memory, typically on a separate device, to store programming code. This adds cost and printed circuit board area to a design, and results in the devices not being completely functional at initial system power-up.

Products

High-Density CPLDs

The Company first entered the high-density market in 1992 and currently offers four distinct families of ispLSI® products, each consisting of multiple devices. All families offer an in-system programmable version of each device. The Company is currently shipping over 175 speed, package and temperature range combinations of high-density CPLDs.

ispLSI 1000/E: The Company's original high-density family utilizes an innovative, proprietary architecture incorporating familiar GAL®-like logic building blocks. This family offers performance of up to 110 MHz, with propagation delays as low as 10 nanoseconds, densities of 2,000 to 8,000 gates, and is available in surface mount packages ranging from 44- to 128-pins. In fiscal 1996, the Company introduced the ispLSI 1000E family, an enhancement of the ispLSI 1000 family based on a more advanced sub-micron process technology. The ispLSI 1000E family offers enhanced performance of up to 125 MHz, with propagation delays as low as 7.5 nanoseconds.

ispLSI 2000: The ispLSI 2000 family utilizes an architecture designed for input/output ("I/O") intensive applications and offers industry leading CPLD performance. This family provides performance of up to 180 MHz, with propagation delays as low as 5.0 nanoseconds, densities of 1,000 to 6,000 gates, and 44- to 176-pin standard surface mount packages. The Company recently introduced the ispLSI 2000LV family, an extension of the ispLSI 2000 family, that operates using the emerging 3.3-volt power supply standard. Offered with a range of density, performance and package specifications, the ispLSI 2000LV family is targeted towards emerging high-growth, low-voltage system applications in the computing and communication markets.

ispLSI 3000: The ispLSI 3000 family incorporates an enhanced logic architecture to target higher density applications while retaining high performance. It offers densities of 7,000 to 14,000 gates, and performance of up to 125 MHz, with propagation delays as low as 7.5 nanoseconds. Available in 160- to 304-pin surface mount packages, the 3000 family also incorporates boundary scan test, an attractive feature that provides enhanced testing capabilities important for complex systems.

ispLSI 6000: Introduced in the first calendar quarter of 1996, the ispLSI 6000 family extends the Company's high-density CPLD density range to 25,000 gates. This family utilizes an innovative cell-based architecture that combines a general purpose high-density CPLD with memory and other function specific circuit blocks. Offered with performance of up to 70 MHz, and with propagation delays as low as 15 nanoseconds, the ispLSI 6000 family allows integration of complete logic

subsystems in the communications, computing and multimedia markets.

Software Development Tools

All of the Company's high-density products are supported by the Company's pDS® software development tools and pDS+™ software development tools (referred to as "fitters"). Designed to be a low cost, fully integrated development tool, pDS runs under the Microsoft Windows operating system on a personal computer. pDS software allows a customer to enter and verify a logic design, perform logic minimization, assign I/O pins and critical speed paths, and execute automatic place and route tasks. Designed to provide a low cost method to incorporate the Company's high-density CPLD products into standard development environments, pDS+ software leverages customers' existing investment in third-party CAE tools. pDS+ software supports all popular third party CAE development tool environments running on IBM compatible personal computers as well as workstations from Sun Microsystems and Hewlett-Packard. The Company offers pDS+ products supporting common third party CAE design tool environments, including Cadence, CUPL, Data I/O ABEL, Data I/O Synario, Exemplar, Isdata, Mentor Graphics, OrCAD, Synopsys and ViewLogic. In fiscal 1996, the Company released new versions of its existing pDS and pDS+ software development tools to enhance performance, functionality and ease of use.

The Company also provides several software algorithms that support in-system programming of the Company's ISP devices. These software products include ispCODE™, ispDOWNLOAD™, ispREMOTE™ and ispATE™. ispATE enables ISP to be integrated into automatic test equipment ("ATE") on the manufacturing floor.

During fiscal 1996, the number of installed seats of the Company's software development tools, as measured by the Company, grew from over 5,000 to over 10,000. The Company plans to continue to enhance and expand its development tool offerings.

Low-Density PLDs

The Company offers the industry's broadest line of low-density CMOS PLDs based on its 16 families of GAL products offered in over 200 speed, power, package and temperature range combinations. GAL devices range in complexity from approximately 200 to 1,000 logic gates and are typically assembled in 20-, 24- and 28-pin standard dual in-line packages and in 20- and 28-pin standard plastic leaded chip carrier packages. The Company offers the industry standard GAL16V8, GAL20V8, GAL22V10, GAL20RA10 and GAL20XV10 architectures in a variety of speed grades, with propagation delays as low as 3.5 nanoseconds, the highest performance in the industry. The Company extended its GAL line by introducing a family of 3.3-volt industry standard architectures, the GAL16LV8, GAL20LV8 and the GAL22LV10 in a variety of speed grades, with propagation delays as low as 3.5 nanoseconds, the highest performance in the industry. Offered with a range of power consumption specifications, these devices are targeted towards emerging high-growth, low-voltage system applications in the computing and communication markets. The Company is currently selling the GAL16V8D-3 and GAL16LV8D-3, providing 3.5ns performance at both 5V and 3.3V supplies. These are the fastest PLDs available on the world market today. The Company also offers several innovative proprietary extension architectures, the ispGAL22V10, GAL26CV12, GAL18V10, GAL16VP8, GAL20VP8, GAL6001/2, GAL16V8Z and GAL20V8Z, each of which is optimized for specific applications. These product families offer industry leading performance levels, typically with propagation delays as low as 7.5 nanoseconds.

The Company's GAL products are supported by industry standard software and hardware development tools marketed by independent manufacturers specifically for PLD applications.

Lattice's Family of 3.3 Volt GAL Devices offers Speeds of 3.5ns

Corporate Profile

Operations

The Company does not manufacture its silicon wafers. The Company has historically maintained strategic relationships with large semiconductor manufacturers in order to source its finished silicon wafers, allowing the Company to focus its internal resources on product, process and market development. In addition, assembly is performed for the Company by outside suppliers. The Company performs most test operations and all reliability and quality assurance processes internally, as the Company believes it can add significant customer value in these areas. The Company has achieved ISO 9001 quality certification, an indication of the Company's high internal operational standards.

Marketing, Sales and Customers

The Company sells its products directly to end customers through a network of independent sales representatives and indirectly through a network of distributors. The Company utilizes a direct sales management and field applications engineering organization in combination with manufacturers representatives and distributors to reach a broad base of potential end customers. The Company's end customers are primarily original equipment manufacturers in the fields of communications, computing, peripherals, instrumentation, industrial controls and military systems. The Company believes its distribution channel is a cost-effective means of reaching end customers.

At March 30, 1996, the Company had 19 sales representatives and five distributors in the United States and Canada. In North America, Arrow Electronics, Inc., Hamilton Hallmark, Insight Electronics, Inc. and Marshall Industries provide nationwide distribution, while Future Electronics provides regional distribution coverage in Canada. The Company has established sales channels in over 25 foreign countries through a network of over 30 sales representatives and distributors. Approximately one-half of the Company's North American sales and most of its foreign sales are made through distributors.

LATTICE SEMICONDUCTOR CORPORATION
5555 Northeast Moore Court
Hillsboro, Oregon 97124 U.S.A.
Tel.: (503) 681-0118
FAX: (503) 681-3037
http://www.latticesemi.com

November 1996