ALPHATEC

Alphatec Group
Alphatec Electronics Public Co., Ltd.
Times Square Building, 19th Floor
246 Sukhumvit Road
Bangkok, Thailand 10110
Telephone: (66) (2) 229-4678
Fax: (66) (2) 229-4677
Web Site: www.alphatec.com

IC Manufacturer

Regional Headquarters/Representative Locations

North America: Alphatec Group, Alphatec Electronics Corporation • Santa Clara, California
Telephone: (408) 567-1100 • Fax: (408) 567-1111

Financial History ($M)

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<th>1995</th>
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Company Overview and Strategy

Alphatec Group is an affiliation of 13 companies that comprise the world’s second largest independent provider of semiconductor-related manufacturing services. Such services include wafer fabrication (in 1998), test program development, IC packaging and testing, and final assembly of end-use products.

Alphatec’s first company, Alphatec Electronics PCL, was founded in 1988 through the acquisition of an existing IC assembly and test business. Since then, Alphatec has expanded substantially through a series of other acquisitions. In 1993, Alphatec Group purchased from Olin Corporation, Alphatec USA, a quick-turn assembly and test operation in Mantecca, California. Also in 1993, assembly and test service provider NS Electronics Bangkok was formed through a combination equipment, facility, and technology purchase agreement with National Semiconductor. In 1994, the AT&T Telecommunications Products Thai Ltd. operation became AlphaSource Manufacturing Solutions PCL, a provider of PCB assembly, testing plastic injection, and final assembly of end-use electronics products. Digital Testing Services (DTS) became an Alphatec Group member in 1995, followed by Thai Micro Systems in 1996. Also in 1996, operations began at Alphatec Electronics Corp. of Shanghai, a new IC packaging service joint venture between Alphatec Electronics PCL, Microchip Technology, Inc., and other Chinese investors.
Alphatec announced plans for its first IC wafer fabrication facility in 1994. Construction of the $1.2 billion Thai fab, named Submicron Technology PCL, began in 1995 and volume production of 200mm wafers is scheduled to begin in mid-1998.

In April 1997, Texas Instruments pulled out of a $1.4 billion joint DRAM venture with Charn Uswachoke, founder and CEO of Alphatec. Under the deal two companies were to be formed: Alpha-TI Semiconductor, a $1.2 billion 16M and 64M DRAM fab; and Alpha Memory, a $200 million assembly and test facility. Reasons cited for TI’s withdrawal include weakness in the DRAM market and a poor Thai economy. Construction of both facility shells was completed, but no capital equipment orders were ever placed. Mr. Uswachoke and Alphatec are said to be aggressively pursuing alternative means for completing and continuing both facilities, independent of TI. The fab facility will likely begin operations a year or year-and-half later than originally planned.

Management

Charn Uswachoke  Chief Executive Officer and Founder, Alphatec Electronics PCL
Niel Dial     President, Alphatec Electronics PCL
Bob Mollerstuen  President and Chief Group Operating Officer, Alphatec Group
H.K. Foo     General Manager, Alphatec Electronics Corp. of Shanghai
Greg V. German  President, AlphaSource Manufacturing Solutions PCL
Sassan Raissi  President and General Manager, DTS
George Shaw  President and General Manager, Alphatec USA
Udom Udompanyavit  President, NS Electronics Bangkok
Harry Van Wickle  President, Alphatec Electronics Corporation
K.Y. Wong  President, Thai Micro Systems
Willem de Vries  Vice President, Asian Manufacturing
Ed Pausa     Vice President, Joint Venture Manufacturing
Tom Reynolds  Vice President, Sales and Marketing, Alphatec Group

Products and Processes

As already mentioned, Alphatec’s manufacturing services span the entire spectrum from wafer fabrication (in 1998), test program development, and IC packaging and testing, to the final assembly of end-use products. Alphatec’s foundry services will include the fabrication of ICs using 0.5μm CMOS technology transferred from partner Rockwell Semiconductor. Submicron Technology also has access to Rockwell’s 0.35μm technology.
Semiconductor Fabrication Facilities

Submicron Technology Public Co., Ltd.
123/1 Keerasup Building, 2nd Floor
Sukhapibal Road
Kannayao, Bueng-goom
Bangkok, Thailand 10230
Telephone: (66) (2) 948-5470
Fax: (66) (2) 948-5489
Cleanroom size: 50,000 square feet, Class 0.1 SMIF
Capacity (wafers/week): 5,000
Wafer size: 200mm
Processes: CMOS, BiCMOS
Products: Foundry services
Feature sizes: 0.5μm, 0.65μm
(Operations began in mid-1998.)

Key Agreements

• Submicron Technology and Rockwell Semiconductor Systems signed a five-year technology-transfer and wafer supply partnership in early 1996. Under the agreement, Submicron Technology licensed Rockwell’s 0.5μm and 0.35μm CMOS process technologies, and in turn, will guarantee Rockwell 25 percent of its wafer output.
ANGSTREM

Angstrem
103460 Zelenograd
Russia
Telephone: (7) (095) 531-1470/2515
Fax: (7) (095) 531-2756/0306

IC Manufacturer

Employees 3,600

Company Overview and Strategy

Angstrem was established in 1963 to produce hybrid ICs, and beginning in 1973 the company began producing monolithic ICs as well. In the former Soviet Union, Angstrem was the leader in CMOS IC technology. In fact, all Soviet CMOS technology was developed by Angstrem. It was the original and main experimental plant for the Soviet Union microelectronics industry. In 1990, Angstrem began commercial production as part of the Soviet conversion program, and in April 1993, Angstrem became a private company.

The company also produces consumer electronic goods (e.g., calculators, computer games, and toys) that are based on captive IC production. Export sales account for about two-thirds of total sales. Most of its sales are to "second tier" Western, East European, or other countries (e.g., India, Hong Kong, Singapore, Turkey, South Africa, and Hungary).

Angstrem desires to gain technical and managerial assistance from North American companies and investors in the microelectronics industry to become more competitive in western world markets.

Management

Valery L. Dzhkhunian, Ph.D. Director General
Anatoly I. Sukhoparov, Ph.D. Deputy Director General
Alexander L. Shabalin Manager, Strategic Planning and Development
Vladimir S. Stravnitsky Head of Foreign Relations Department
Vyacheslav S. Ryzhkin Chief of Foreign Relations

Products and Processes

In 1991, 36 percent of Angstrem's plant output was memory ICs (DRAMs, SRAMs, and EPROMs). However, the company stopped production of memory ICs, as well as microprocessors, in 1993 as part of a restructuring plan it is still carrying out. The bulk of its IC production uses CMOS technology.
Semiconductor Fabrication Facilities

In 1996, Angstrom completed construction of a 150mm wafer fab that the company originally began constructing in 1989. Construction was put on hold during the 1990-1991 timeframe due to the collapse of the former Soviet Union.

Angstrom
103460 Zelenograd
Russia
Cleanroom size: 21,500 square feet (Class 10)
Capacity (wafers/week): 2,875
Wafer size: 100mm
Processes: CMOS, bipolar, BiCMOS
Products: Consumer electronics ICs, logic ICs
Feature sizes: 1.2μm-2.0μm
 (installing 0.8μm process)

Angstrom
103460 Zelenograd
Russia
Cleanroom size: 25,000 square feet (Class 10)
Capacity (wafers/week): 500
Wafer size: 150mm
Processes: CMOS, bipolar, BiCMOS
Products: Consumer electronics ICs, logic ICs
Feature sizes: 0.8μm-2.0μm
ADVANCED SEMICONDUCTOR MANUFACTURING (ASMC)

Advanced Semiconductor Manufacturing Corp. of Shanghai
385 Hong Cao Road
Shanghai 200233, China
Telephone: (86) (21) 64851900
Fax: (86) (21) 64851056
Web Site: www.asmcs.com

IC Manufacturer

Company Overview and Strategy

Advanced Semiconductor Manufacturing Corp. of Shanghai (ASMC) was established in 1995 when Nortel (then Northern Telecom) of Canada made an agreement with Philips Electronics of the Netherlands and the Chinese government to jointly own and operate Philips' semiconductor fabrication facility in Shanghai. Formerly known as Philips Semiconductor Corp. of Shanghai, the operation manufactured ICs primarily for Philips' own television sets.

As ASMC, the operation now functions as an independent foundry, owned 38 percent by Philips, 34 percent by Nortel, and 28 percent by Chinese banks. It is a QS-9000 certified wafer foundry providing subcontract manufacturing to international companies. Currently, ASMC's customers include several IC manufacturers in the U.S. and Europe. It is looking to add additional customers, including both IC manufacturers and fabless IC suppliers. Meanwhile, services for local design houses are also being developed.

Management

John Montesi  President
Jon Marco       Chief Technical Officer

Products and Processes

As a wafer foundry, ASMC targets the niche technology market. Its current process capabilities include 3.0μm bipolar with voltages up to 60 volts, 3.0μm SACMOS (self-aligned contact CMOS) with an EEPROM option, 1.0μm CMOS double-level metal and double-level polysilicon, and 8.0μm powerMOS. Some of these processes are licensed from the company's technical partners for use in producing wafers for design houses.

Wafer testing is an optional service. ASMC can also arrange for local assembly and final testing of devices.
Semiconductor Fabrication Facilities

ASMC
Cao He Jing Hi-Tech Park
Shanghai, China
Fab 1
Cleanroom size: 16,150 square feet, Class 10
Capacity (wafers/week): 3,750
Wafer size: 125mm
Processes: CMOS, bipolar, powerMOS
Products: Linear ICs, discretes
Feature sizes: 3.0μm-8.0μm

ASMC
Cao He Jing Hi-Tech Park
Shanghai, China
Fab 2
Cleanroom size: 16,150 square feet, Class 1
Capacity (wafers/week): 3,750 (1,250 currently)
Wafer size: 150mm
Process: CMOS
Products: Foundry
Feature sizes: 0.8μm, 1.0μm

Key Agreements

- Both Philips Semiconductors and Nortel have technology transfer cooperation agreements with ASMC.
BHARAT ELECTRONICS LTD. (BEL)

Bharat Electronics Ltd.
Integrated Circuits Division
Bangalore Complex
Jalahalli, Bangalore 560 013
India
Telephone: (91) (80) 8382626
Fax: (91) (80) 3832927/2322
Web Site: www.bel-india.co.

IC Manufacturer

Employees (Integrated Circuits Division) 210

Regional Headquarters/Representative Locations

North America: Bharat Electronics Ltd. • Garden City, New York
Telephone: (516) 248-4020 • Fax: (516) 741-5894

Company Overview and Strategy

Bharat Electronics Ltd. (BEL) is a government of India enterprise which was started in 1954 to meet the professional electronics requirements of the country in the defense sector. It has grown into a multi-product, multi-technology company with sales over $300 million. Its products include radar, communication, and broadcast/television equipment; semiconductor devices; high-power vacuum devices; and television tubes. Additional offerings of BEL include telecommunications consulting, test and packaging services, and contract manufacturing.

BEL's Integrated Circuits Division was started in 1970 in technical collaboration with M/S RCA of the U.S. to manufacture linear bipolar and digital CMOS ICs. Today, the division manufactures a wide range of linear bipolar circuits and digital CMOS circuits for the telecommunications, consumer electronics, computer, and professional markets.

To support its commitment to new product development, BEL established its Central Research Labs (CRL) where development is focused on futuristic technologies in the areas of signal processing, computing, communications systems, materials and devices, microelectronics, and manufacturing.

Management

R. Ranganathan  General Manager, Semiconductors
V. Muthuswamy  Additional General Manager, ICs
H.V. Ananda, Ph.D.  Deputy General Manager, Design Centre and Mask Fab
D.A. Mohan  Deputy General Manager, Marketing
Products and Processes

Linear Integrated Circuits:
- Operational amplifiers
- Voltage comparators and regulators
- Telecom circuits
- Special function circuits
- Radio/Audio circuits
- Television circuits
- Automotive electronics circuits

Digital Integrated Circuits:
- Standard TTL circuits
- Low-power schottky TTLs
- CMOS CD4000 series
- CMOS 74HC series

Besides the manufacture and sale of ICs, Bharat Electronics also undertakes contract jobs for external customers in the areas of design, mask manufacture, test, and assembly.

Semiconductor Fabrication Facilities

Bharat Electronics Ltd.
Bangalore Complex
Jalahalli, Bangalore 560 013
India
Wafer size: 100mm
Processes: Bipolar, CMOS
Products: Linear and digital ICs
Feature size: 5.0μm
Chartered Semiconductor Manufacturing Ltd. (CSM)
60 Woodlands Industrial Park, Street 2
Singapore 738406
Telephone: (65) 362-2838
Fax: (65) 362-2938

IC Manufacturer

Regional Headquarters/Representative Locations

North American: Chartered Semiconductor Manufacturing, Inc. • Milpitas, California
Telephone: (408) 456-2720 • Fax: (408) 456-2712 • Web Site: www.csminc.com

Europe: Chartered Semiconductor Manufacturing • Germering, Germany
Telephone: (49) (89) 84108-599 • Fax: (49) (89) 84108-601

Financial History ($M)

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Company Overview and Strategy

Chartered Semiconductor Manufacturing Ltd. (CSM) is a dedicated foundry, providing advanced technology wafer manufacturing services for the global semiconductor industry. It was the first high technology semiconductor company in Singapore to create, produce, and market leading edge ICs. Today, Chartered manufactures ICs for such diverse applications as graphics, communications, computing, and networking, as well as backbone technologies like memories.

Chartered’s services include chip design assistance, mask making, wafer fabrication, wafer sort, assembly, and test. Customers can choose from a comprehensive portfolio of design services and products, including standard cell and gate array libraries, I/Os, memory compilers, datapaths, and intellectual property cells. The company also offers customers a turnkey solution that includes some or all of Chartered’s services.

Chartered was established in 1987 as a captive foundry. In 1991, the company became a pure, independent foundry. Chartered is part of Singapore Technologies Semiconductors (STS), a group of companies that provide a full range of services for the semiconductor industry. STS is a strategic business unit of Singapore Technologies, a holding company that comprises more than 100 companies whose total revenues exceed $3.2 billion.
Management

Tan Bock Seng  President and Chief Executive Officer
Kwek Buck Chye  Chief Financial and Administrative Officer
Chris Chi  Senior Vice President, Operations
Tom Gurnee  Senior Vice President, Business Development
Ray Hawkins  Senior Vice President, Worldwide Sales and Marketing
Rick Hodgman  Vice President, Operations, and General Manager,
             Chartered Silicon Partners Pte. Ltd.
Ben A. Lee  Vice President, Marketing
C.K. Lau  Director, Research and Development

Products and Processes

Chartered offers a full complement of leading-edge CMOS processes ranging from 0.8µm to 0.35µm line widths, with a 0.25µm process in development. Technologies offered include digital, analog, mixed-signal, EEPROM, ROM, SRAM, and flash memory, as well as embedded logic/memory. Options include multiple voltages/poly/metal. For designs requiring high performance and low contact resistance, customers can also select a salicide option, which Chartered has used in volume production since the 0.8µm process generation.

Semiconductor Fabrication Facilities

In April 1997, Chartered announced the development of a new joint venture foundry company with partner, Hewlett-Packard, and the Economic Development Board of Singapore. The new venture, called Chartered Silicon Partners, will be located adjacent to Chartered's exiting facilities in the Woodlands Industrial Park in Singapore. Construction of a 200mm wafer manufacturing facility is expected to begin in September 1997 with production beginning in mid-1999. HP will receive a specified amount of wafers (0.35µm and 0.25µm ASICs) from the venture in exchange for its investment, while the remaining capacity will be offered as part of Chartered’s usual foundry services.

Chartered Semiconductor Manufacturing Ltd.
No. 2 Science Park Drive
Singapore Science Park
Singapore 0511
Fab I
Cleanroom: 35,000 square feet (Class 10)
Capacity (wafers/week): 6,000
Wafer size: 150mm
Process: CMOS
Products: Foundry services
Feature sizes: 0.8µm-0.6µm

Chartered Semiconductor Manufacturing Ltd.
60 Woodlands Industrial Park D
Street 2
Singapore 738406
Fab II
Cleanroom size: 70,000 square feet (Class 1 SMIF)
Capacity (wafers/week): 7,500
Wafer size: 200mm
Process: CMOS
Products: Foundry services
Feature sizes: 0.6µm-0.35µm (0.25µm capability)
Chartered Semiconductor Manufacturing Ltd.
60 Woodlands Industrial Park D
Street 2
Singapore 738406
Fab III
Cleanroom size: 92,000 square feet (Class 1 SMIF)
Capacity (wafers/week): 8,250
Wafer size: 200mm
Process: CMOS
Products: Foundry services
Feature sizes: 0.5μm-0.25μm (0.18μm capability)
(Operational in 2H97).

Key Agreements

- In 1996, Chartered established a technical and marketing agreement with Excellent Design Inc. Under the agreement, Chartered will supply Excellent with design rules, Spice models, and process data that Excellent will use to create the methodology and tools to produce libraries optimized for Chartered's deep-submicron processes. The agreement will last three years and will cover all the technologies Chartered intends to develop during that period. Chartered also signed a similar agreement with Aspec Technology.

- Since early 1994, Chartered has made several strategic agreements with semiconductor companies—with or without their own fabrication facilities—that have involved investments in Chartered in exchange for guaranteed wafer output. Those companies include Actel, Alliance Semiconductor, Analog Devices, Brooktree (bought by Rockwell), LSI Logic, Rockwell Semiconductor Systems, and Standard Microsystems. In addition, Chartered has process technology alliances with VLSI Technology and Toshiba.
FARADAY TECHNOLOGY

Faraday Technology Corporation
7F, 9, Prosperity First Road
Science-Based Industrial Park
Hsinchu, Taiwan
Telephone: (886) (3) 5787888
Fax: (886) (3) 5787889

Employees 80

Fabless IC Supplier

Regional Headquarters/Representative Locations

North America: ASIC Semiconductor International Corp. • Los Altos, California
Telephone: (415) 968-8855 • Fax: (415) 968-8885

Company Overview and Strategy

Faraday Technology Corp. was established in 1993 by UMC and former members of National Semiconductor, Daisy, and Cadence. The company designs and supplies CMOS gate array and standard cell ASICs.

As part of an alliance with UMC and its affiliates, USI, UICC, and USC, Faraday is also responsible for supporting UMC’s internal ASSP requirements as well as for supporting all 14 of UMC’s partners in its four newly established 200mm wafer foundry joint ventures.

Management

K.C. Shih Vice Chairman
H.P. Lin President
Horshow Chang Vice President

Products and Processes

Faraday's ASIC products include high-performance, high-density 0.6μm three-layer-metal CMOS gate arrays, 0.5μm three-layer-metal CMOS standard cells, and 0.35μm three- and four-layer-metal CMOS standard cells.
**Gate Arrays**

**FG6000A series**
- 0.6μm single poly and double or triple metal CMOS process
- 3,000 to 104,100 usable gates
- 68 to 296 I/Os
- 3V, 5V, and mixed-voltage applications supported
- Propagation delay: 250ps

**New series (2Q97)**
- 0.4μm three- or four-layer-metal CMOS
- 10,000 to 150,000 usable gates
- Up to 352 I/Os
- 3V, 5V, and mixed-voltage applications supported
- Propagation delay: 200ps

**Standard Cells**

**FS5000A series**
- 0.8μm single poly, double metal CMOS process
- Cell library consists of up to 300 internal core macrocells
- Design can contain up to 72K of high-speed asynchronous SRAM
- Propagation delay: 300ps

**FS7000B series**
- 0.5μm single poly and double or triple metal CMOS process
- Cell library consists of up to 300 internal core macrocells
- Design can contain up to 64K of high-speed asynchronous SRAM
- 3V, 5V, and mixed-voltage applications supported
- Propagation delay: 200ps

**FS8000A series**
- 0.35μm single poly, three- and four-layer-metal CMOS process
- Cell library consists of up to 500 internal core macrocells and 500 I/O cells.
- Design can contain up to 72K of high-speed asynchronous SRAM
- Propagation delay: 60ps

**Semiconductor Fabrication Facilities**

Faraday's ASICs are manufactured by UMC, USI, UICC, and USC in Taiwan using Faraday's CMOS process technologies.
HOLTEK MICROELECTRONICS

Holtek Microelectronics Inc.
No. 5 Creation Road II
Science-Based Industrial Park
Hsinchu, Taiwan
Telephone: (886) (3) 5784888
Fax: (886) (3) 5770879
Web Site: www.holtek.com

IC Manufacturer

Regional Headquarters/Representative Locations

North America: Holmate Technology Corporation • San Jose, California
Telephone: (408) 894-9046 • Fax: (408) 894-0838

Financial History ($M)

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<td>960</td>
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Company Overview and Strategy

Holtek Microelectronics Inc. was established in 1983 as an ASIC design house, but in 1989 added a 125mm wafer fab. Today, Holtek is a manufacturer of not only ASICs, but also consumer electronics ICs, PC peripheral, and communication ICs. The company was the first in Taiwan to design and manufacture 4- and 8-bit microcontrollers.

During 1996, Holtek initiated a major company reorganization, focusing its efforts on three main business units: Sales and Product Development, Fab I operations, and Fab II operations. Holtek also renewed its commitment to maintain a diversified product line by focusing future product development on PC peripherals, microcontrollers, one-time programmable (OTP) 8-bit MCUs, non-volatile memory products, and high-level telecom products such as network ICs and digital signal processors.

In addition to a variety of planned new product developments, Holtek’s commitment to the future can also be demonstrated by its major investment in a new 0.25μm 200mm wafer manufacturing facility.
Holtek Microelectronics

Management

Jack Lee
Chairman

Keith Wu
President

Products and Processes

The following provides a sampling of various Holtek products.

**ASIC**
- Gate Arrays
- Standard Cells
- Full Custom ICs

**Microcontroller**
- 4-bit MCUs
- 8-bit MCUs

**Memory**
- Mask ROMs
- SRAMs
- EEPROMs
- EPROMs
- OTPROMs

**PC Peripheral**
- I/O Series
- Keyboard Series
- Mouse Series
- Misc. Series

**Consumer**
- Speech Synthesizer Series
- Voice Processor Series
- Melody Series
- Tone Series
- Remote Series
- LCD Driver Series
- Power Manager Series
- Home Appliance Series

**Telecom**
- All-in-one Dialers
- Dialer IDD Lock Dialers
- French Dialers
- ABR Dialers
- Talking Dialers
- Pager ICs
- Digital Answering Machine ICs

**Semiconductor Fabrication Facilities**

<table>
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<tr>
<th>Facility</th>
<th>Location</th>
<th>Cleanroom size</th>
<th>Capacity (wafers/week)</th>
<th>Wafer size</th>
<th>Process</th>
<th>Products</th>
<th>Feature sizes</th>
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<tr>
<td>Fab I</td>
<td>No. 5 Creation Road II</td>
<td>16,500 square feet (Class 10)</td>
<td>7,500</td>
<td>125mm</td>
<td>CMOS</td>
<td>MCUs, ASICs, ASSPs, memories</td>
<td>0.6μm-1.2μm</td>
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<td>Fab II</td>
<td>No. 5 Creation Road II</td>
<td>5,000 square feet (Class 1)</td>
<td>1,500 (8,750 by 2001)</td>
<td>200mm</td>
<td>CMOS</td>
<td>MCUs, ASICs, ASSPs, foundry</td>
<td>0.25μm-0.5μm (Operational by January 1998)</td>
</tr>
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</table>
HUAJING ELECTRONICS

China Huajing Electronics Group Corporation
14 Liangxi Road
Wuxi, Jiangsu, China
Telephone: (86) (510) 6707123
Fax: (86) (510) 6701391

IC Manufacturer

Company Overview and Strategy

Founded in 1960, China Huajing Electronics has grown into the largest solely state-owned microelectronics manufacturer in China. Huajing manufactures a wide range of MOS, bipolar, and BiCMOS integrated circuits and discrete semiconductor products for applications such as communications, computer systems, instrumentation and metering, automobile electronics, power supply, machinery, and consumer electronics.

Approximately 60 percent of Huajing’s MOS IC output is exported, while only about 5 percent of its traditional bipolar and discrete devices are exported.

Management

Guang Ping Su President
Jiang Fu Lai Vice President
Guo Yong Fu Vice President

Products and Processes

Huajing’s semiconductor products include analog ICs, ASICs, microprocessors and controllers, memory ICs, BiCMOS ICs, full-custom ICs, thick-film hybrids, and discretes.

For MOS production, Huajing uses 100mm and 125mm wafers with 3.0μm to 2.0μm technology, and for bipolar, it uses 100mm wafers with 5.0μm to 3.0μm technology and 125mm wafers with 3.0μm to 2.0μm technology. The company also is pushing its CMOS lines for foundry production. Huajing is said to be manufacturing microcontrollers for Seiko Epson and logic ICs for Fujitsu.

Semiconductor Fabrication Facilities

Huajing is expected to complete construction of a new 150mm wafer fab during 1997. The facility will produce MOS ICs with 0.8μm to 1.0μm feature size technology obtained from Lucent Technologies. When complete, the fab will have the capacity to produce about 2,500 wafers per week.
China Huajing Electronics Group  
14 Liangxi Road  
Wuxi, Jiangsu, China  
Capacity (wafers/week): 8,750  
Wafer sizes: 100mm, 125mm (upgrading to 150mm)  
Processes: MOS, bipolar, BiCMOS, CMOS  
Products: Linear ICs, ASICs, MPUs, MCUs, memory ICs, BiCMOS ICs, discretes, hybrids  
Feature sizes: 1.25μm-5.0μm (upgrading to submicron)

Key Agreements

- In early 1995, Huajing licensed some of Toshiba’s older 1M DRAM technology, making it the first of China’s state-run companies to field DRAMs.
HUALON MICROELECTRONICS (HMC)

Hualon Microelectronics Corporation
Science-Based Industrial Park
Number 1, R&D 4th Road
Hsinchu, Taiwan
Telephone: (886) (3) 5774945
Fax: (886) (3) 5774305

IC Manufacturer

Regional Headquarters/Representative Locations

North America: Hualon Microelectronics Corporation • San Francisco, California
Telephone: (415) 288-0390 • Fax: (415) 288-0399

Financial History ($M)

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<td>25</td>
<td>25</td>
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<tr>
<td>Capital Expenditures</td>
<td>5</td>
<td>80</td>
<td>60</td>
<td>50</td>
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<tr>
<td>Employees</td>
<td>850</td>
<td>850</td>
<td>1,100</td>
<td>1,150</td>
<td>1,170</td>
</tr>
</tbody>
</table>

Company Overview and Strategy

Hualon Microelectronics Corporation (HMC) is part of the Hualon Group, a conglomerate with over $2.5 billion in annual sales. The Hualon Group first invested in the semiconductor industry in 1984 by establishing Chino-Excel Technology (CET), an IC assembly house. Then in 1987, HMC's fab was constructed.

HMC is a broad-based manufacturer of integrated circuits and discrete devices. The company is divided into seven major business units: memory, foundry, microcomponent, ASIC, CCD, consumer, and telecommunications.

Management

D.M. Oung                                        President and Chief Executive Officer
C.F. Hsu                                         Research and Development Manager
H.S. Huang                                      Plant Manager
Gene Tsai                                       Vice Plant Manager
Chiu-Chung Jung                                  Director, Sales and Marketing
# Products and Processes

<table>
<thead>
<tr>
<th>Memory ICs</th>
<th>ASICs</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROMs up to 16M in density, EPROMs up to 256K, EEPROMs up to 1M, SRAMs up to 1M</td>
<td>Gate arrays and standard cells</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Microcomponent ICs</th>
<th>CCDs</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-bit and 8-bit MCUs, 4-bit, 8-bit, and 16-bit DSPs, GUI and SVGA circuits, mass storage controllers, network ICs, and PC chipsets</td>
<td>Image sensors, bar code chipsets, fax scanner ICs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Consumer ICs</th>
<th>Telecom ICs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speech synthesizer and recognition, watch, and calculator circuits</td>
<td>Dialers and controllers, receivers, cordless phone controllers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Foundry Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5μm to 3.0μm silicon gate</td>
</tr>
</tbody>
</table>

HMC's current facilities operate with CMOS, BiCMOS, and NMOS processes down to 0.5μm.

## Semiconductor Fabrication Facilities

Hualon Microelectronics Corporation  
Science-Based Industrial Park  
Number 1, R&D 4th Road  
Hsinchu, Taiwan  
Fab I and II  
Cleanroom size: 21,000 square feet  
Capacity (wafers/week): 34,000  
Wafer size: 125mm  
Processes: CMOS, NMOS, BiCMOS  
Products: Memory ICs, telecom ICs, consumer ICs, ASICs, discretes, foundry services  
Feature sizes: 0.5μm, 0.6μm CMOS, BiCMOS; 0.8μm CMOS; 1.0μm CMOS, BiCMOS; 1.2μm NMOS

In 1994, Hualon announced plans to build a new $400 million 200mm wafer fab that would be operational by the end of 1996. In early 1996, however, plans for the new facility were put on hold indefinitely.

## Key Agreements

- HMC holds a 10 percent stake in Seeq Technology and is providing foundry services for the supplier. The two companies also agreed to jointly develop and market network ICs.
HYUNDAI

Hyundai Electronics Industries Co., Ltd. (HEI)
Semiconductor Division
12th Floor, Hyundai Building
140-2, Kye-dong, Chongro-gu
Seoul, Korea  110-793
Telephone:  (82) (2) 6746/4288
Fax:  (82) (2) 4275/4277
Web Site:  www.hei.co.kr

IC Manufacturer

Regional Headquarters/Representative Locations

North America:  Hyundai Electronics America (HEA), Semiconductor Division • San Jose, California
Telephone:  (408) 232-8000 • Fax:  (408) 232-8125 • Web Site:  www.hea.com

Financial History ($M)

<table>
<thead>
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<tr>
<td>Sales (HEI)</td>
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<td>1,575</td>
<td>2,600</td>
<td>6,100</td>
<td>5,400</td>
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<tr>
<td>Sales</td>
<td>455</td>
<td>1,020</td>
<td>1,750</td>
<td>4,350</td>
<td>3,150</td>
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<tr>
<td>Capital Expenses</td>
<td>225</td>
<td>400</td>
<td>600</td>
<td>2,100</td>
<td>2,500</td>
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Company Overview and Strategy

Hyundai Electronics Industries Co., Ltd. (HEI) was founded in 1983 as a part of the Hyundai Business Group, a $70 billion Korean conglomerate involved in over 40 business areas ranging from steel fabrication, petrochemicals, engineering, and construction to electronics, automobiles, and finance.

HEI is made up of the following business divisions: Semiconductors, Semiconductor Assembly and Testing, Information Systems, Telecommunications, and Industrial Electronics. The Semiconductor Division is further divided into the Memory IC and System IC subdivisions. Its semiconductor assembly business was launched in 1985. By 1989, HEI had developed its own 4M DRAM, and by 1991, its own 16M part.
Today, Hyundai is among the world's leading memory IC producers, with a memory portfolio that includes DRAMs up to 64M in density, SRAMs up to 4M in density, mask ROMs up to 16M in density, VRAMs, and flash devices. The company is moving to become less dependent on the memory IC business by aggressively expanding its capabilities in logic ICs. A major part of this effort was the acquisition in early 1995 of the NCR Microelectronic Products Division of AT&T for $340 million. Renamed Symbios Logic Inc., the business operates as an independent, autonomous subsidiary of Hyundai Electronics America (HEA) offering products such as bus interface chips, ASICs, and Ethernet controller ICs.

In mid-1996, Hyundai Electronics America spun off its Digital Media Division into a separate entity, called Odeum Microsystems Inc. The new company will focus on the development of silicon and software solutions for home entertainment systems. Odeum plans to offer MicroSPARC-based programmable MPEG-2 solutions.

Management

Hyundai Electronics Industries

Young Hwan Kim  
President and Chief Executive Officer

Y.R. Rah  
Executive Vice President, Semiconductor Division

D.S. Kim  
Executive Vice President, Assembly and Test

I.B. Jeon  
Senior Vice President, Memory Sales and Marketing

S.I. Ju  
Senior Vice President, Semiconductor Manufacturing

I.S. Hwang  
Senior Vice President, Semiconductor Research and Development

K.S. Hwang  
Vice President, System IC Division and System IC Research and Development Laboratory

Hyundai Electronics America

C.S. Park  
President and Chief Executive Officer

Dennis McKenna  
Senior Vice President, Semiconductor Marketing and Sales

Steve Grossman  
Senior Vice President, Marketing, Flash Memory Division

H.S. Park  
Senior Vice President, Semiconductor Research and Development

Mark Ellsberry  
Vice President, Memory Marketing

Alex Chenok  
Vice President, Assembly and Test

James Hartman  
Chief Executive Officer, Hyundai Semiconductor America

Anil Sawe  
Chief Executive Officer, Odeum Microsystems Inc.

Gene Patterson (acting)  
Chief Executive Officer, Symbios Logic Inc.

Products and Processes

Hyundai manufactures and markets primarily DRAMs and SRAMs, but also offers other memory ICs, microperipheral ICs, logic ICs, ASSPs, and ASIC devices. Currently, the whole range of Hyundai's ICs are fabricated solely using CMOS process technology.
**Memory ICs**
- 256K, 1M, 4M, 16M, and 64M DRAMs (low voltage and wide versions are available).
- 16M and 64M synchronous DRAMs (SDRAMs).
- 4M video RAMs (VRAMs).
- 64K, 256K, 1M, and 4M SRAMs (high-speed 256K and 1M versions are available for cache applications).
- 1M, 4M, and 16M mask ROMs.
- 256K and 1M EPROMs.
- Serial EEPROMs.
- 4M and 16M flash memories.

**ASICs**
- Gate arrays based on a sea-of-gates architecture and 1.2μm and 0.8μm CMOS double-level-metal technologies or 0.8μm triple-level-metal technology. Usable gate counts vary from 800 to 200,000 gates.
- Standard cells based on 0.8μm CMOS double-level-metal technology.
- A limited line of PLDs based on technology from ICT Inc. are available.
- BiCMOS ASICs and mixed-signal capabilities are being developed.
**Other ICs**
- PC chipsets.
- PCMCIA peripheral function ICs.
- RAMDACs.
- ICs for digital audio and cordless phone applications.
- MPEG-2 audio/video decoder ICs.
- MPUs, DSPs, and MCUs are being developed.

**Semiconductor Fabrication Facilities**

In March 1997, Hyundai broke ground on its second overseas wafer fab, to be located in Scotland. The facility will manufacture DRAMs on 200mm wafers using a 0.3 μm process technology. Initial production of 64M DRAMs is expected to begin by the end of 1998, moving later to 256M DRAMs. Construction on the facility will take place in two phases, together costing an estimated $3.6 billion.

Production at Hyundai’s first overseas fab—a $1.3 billion 200mm, submicron CMOS production facility located in Eugene, Oregon—is expected in 2H97. Additionally, Hyundai is constructing a new fab in Ichon, Korea, that is also expected to begin operations in 1997.

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**Hyundai Electronics Industries Co.**
San 136-1, Ami-Ri, Bubal-Eub
Ichon-kun, Kyungki-Do
Korea 467-860
Telephone: (82) (2) 741-0661
Fab 1
Capacity (wafers/week): 6,250
Wafer size: 150mm
Process: CMOS
Products: SRAMs, EPROMs, EEPROMs, ASICs, logic ICs
Feature sizes: 1.0μm, 1.2μm

**Hyundai Electronics Industries Co.**
San 136-1, Ami-Ri, Bubal-Eub
Ichon-kun, Kyungki-Do
Korea 467-860
Telephone: (82) (2) 741-0661
Fab 2
Capacity (wafers/week): 6,250
Wafer size: 200mm
Process: CMOS
Products: DRAMs
Feature sizes: 0.45μm, 0.6μm, 0.8μm

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**Hyundai Electronics Industries Co.**
San 136-1, Ami-Ri, Bubal-Eub
Ichon-kun, Kyungki-Do
Korea 467-860
Telephone: (82) (2) 741-0661
Fab E-1
Capacity (wafers/week): 2,500
Wafer size: 200mm
Process: CMOS
Products: DRAMs
Feature size: 0.5μm

**Hyundai Electronics Industries Co.**
San 136-1, Ami-Ri, Bubal-Eub
Ichon-kun, Kyungki-Do
Korea 467-860
Telephone: (82) (2) 741-0661
Fab E-2
Capacity (wafers/week): 6,250
Wafer size: 200mm
Process: CMOS
Products: DRAMs
Feature sizes: 0.35μm, 0.5μm
Hyundai Electronics Industries Co.
San 136-1, Ami-Ri, Bubal-Eub
Ichon-kun, Kyungki-Do
Korea 467-860
Telephone: (82) (2) 741-0661
Fab 3
Capacity (wafers/week): 10,000
Wafer size: 150mm
Process: CMOS
Products: DRAMs
Feature sizes: 0.6μm-0.8μm

Hyundai Electronics Industries Co.
San 136-1, Ami-Ri, Bubal-Eub
Ichon-kun, Kyungki-Do
Korea 467-860
Telephone: (82) (2) 741-0661
R&D I and II Fabs
Capacity (wafers/week): 3,200
Wafer sizes: 150mm, 200mm
Process: CMOS
Products: R&D
Feature sizes: 0.35μm-0.6μm

Hyundai Semiconductor America
Eugene, Oregon
Fab E-4
Capacity (wafers/week): 7,500
Wafer size: 200mm
Process: CMOS
Products: DRAMs
Feature size: 0.25μm
(Operations to begin in 2H97)

Hyundai Semiconductor Europe Limited
Dunfermline, Scotland
Capacity (wafers/week): 7,500
Wafer size: 200mm
Process: CMOS
Products: DRAMs
Feature size: 0.3μm
(Operations to begin in late 1998)

Symbios Logic Inc.
(Subsidiary of HEA)
2001 Danfield Court
Fort Collins, Colorado 80525
Telephone: (303) 223-5100
Capacity (wafers/week): 4,300
Wafer sizes: 100mm, 150mm
Process: CMOS
Products: ASICs, ASSPs, foundry services
Feature sizes: 0.7μm-2.0μm

Symbios Logic Inc.
(Subsidiary of HEA)
1635 Aeroplaza Drive
Colorado Springs, Colorado 80916
Telephone: (719) 596-5795
Capacity (wafers/week): 5,000
Wafer sizes: 100mm, 200mm
Process: CMOS
Products: ASICs, ASSPs
Feature sizes: 0.5μm-2.0μm
Key Agreements

- Hyundai licensed Rambus technology for the development of 16M and 64M Rambus DRAMs (RDRAMs).

- Hyundai and its subsidiary Symbios Logic formed an alliance with Compass Design Automation in early 1995 to develop 0.35μm five-layer-metal CMOS technology for ASIC devices.

- Hyundai signed a licensing agreement with LSI Logic that gave it permission to develop products based on LSI Logic's 1.2μm and 2.0μm double-level-metal gate arrays.

- As a major equity holder in ICT Inc., Hyundai offers a limited line of PLDs based on ICT's designs.

- Hyundai is working with Metaflow Technologies to develop a superscalar SPARC microprocessor.

- Hyundai and Fujitsu formed a DRAM manufacturing and development alliance in 1993 under which 4M and 16M Hyundai-designed DRAMs are produced worldwide by both companies. They also are codeveloping 64M DRAM products.
LG SEMICON

LG Semicon Co., Ltd.
10th Floor, Hae-Sung Building
942, Daechi-Dong, Kangnam-gu
Seoul 135-280, Korea
Telephone: (82) (2) 528-2884
Fax: (82) (2) 528-2800/2880

IC Manufacturer

Regional Headquarters/Representative Locations

North America: LG Semicon America, Inc. • San Jose, California
Telephone: (408) 432-5000 • Fax: (408) 432-6067

Financial History ($M)

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<td>Corporate</td>
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<td>5,400</td>
<td>6,300</td>
<td>10,000</td>
<td>12,500</td>
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<td>Semiconductor</td>
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<td></td>
</tr>
<tr>
<td>Sales</td>
<td>690</td>
<td>1,000</td>
<td>1,800</td>
<td>3,600</td>
<td>2,500</td>
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<tr>
<td>Capital Expenditures</td>
<td>320</td>
<td>200</td>
<td>300</td>
<td>2,100</td>
<td>2,300</td>
</tr>
<tr>
<td>Employees</td>
<td>3,600</td>
<td>3,750</td>
<td>3,900</td>
<td>6,600</td>
<td>8,400</td>
</tr>
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</table>

Company Overview and Strategy

LG Semicon Company (formerly Goldstar Electron Company) was formed in 1989 through the consolidation of the memory chip business of LG Electronics (formerly Goldstar) and the ASIC/Micro businesses of Goldstar Semiconductor. It is now 62 percent owned by Goldstar Company, the flagship company of the $60 billion Korean conglomerate Lucky-Goldstar Group. Goldstar Company is Korea's largest maker of electrical appliances and consumer electronics.

LG Semicon is one of the world's leading DRAM suppliers. The company changed its name from Goldstar Electron to LG Semicon in February 1995 as part of its desire to be a major player in the global semiconductor business. The company felt the Goldstar name was too closely tied to consumer electronics.
Management

Chung-Hwan Mun  Vice Chairman
B.S. Koo  Vice President, Marketing
D.M. Koo  Vice President, Sales
Arun Kamat  Director, Marketing, LG Semicon America

Products and Processes

LG Semicon offers memory ICs (1M to 64M DRAMs, 64K to 1M SRAMs, 1M to 32M flash memories, and 1M to 32M ROMs), application-specific ICs (including gate arrays, standard cells, and full custom devices), bipolar and CMOS general-purpose logic ICs, and other specialized semiconductor devices such as ICs for personal computers (including sound generators and LCD panel controllers) and 8-bit and 16-bit microcontrollers. In 1996, LG Semicon began production of Mpact™ single-chip media processors, licensed from Chromatic Research Inc. (see Key Agreements). Volume production of the Mpact 3000 began in 2Q97 at LG Semicon’s Chungju facility. The company also offers a 2Mx9 Rambus DRAM for the multimedia buffer and plans to offer the associated Mpact glue logic integrated into an ASIC.
Future product development at LG Semicon will be directed more toward non-memory IC products in an effort to decrease its reliance on the memory market. Approximately 94 percent of total semiconductor sales in 1996 were from memory devices, primarily DRAMs. Over the next several years, the company plans to increase its sales of non-memory products to 30 percent of total chip sales. As part of this strategy, LG Semicon has adapted its 64M DRAM technology to a 0.35μm standard-cell ASIC process.

**Semiconductor Fabrication Facilities**

During 1996, LG Semicon announced its plans to build a $1.2 billion DRAM joint-venture fab facility in Malaysia with Hitachi. However, later in 1996, the two company put the plans on hold due to weak market conditions. The facility was originally planned to be on-line in 1998. In January 1997, LG Semicon began construction on its first fab facility outside of Korea. The facility, to be located in Newport, South Wales, will be used for 64M and 256M DRAM production and assembly, starting in 1999.

<table>
<thead>
<tr>
<th>LG Semicon Co., Ltd.</th>
<th>LG Semicon Co., Ltd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chungju Facility</td>
<td>Gumi Facility</td>
</tr>
<tr>
<td>Cleanroom size: 170,790 square feet</td>
<td>Cleanroom size: 44,463 square feet</td>
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<td>Capacity (wafers/week): 30,000</td>
<td>Capacity (wafers/week): 10,000</td>
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<tr>
<td>Wafer sizes: 150mm, 200mm</td>
<td>Wafer sizes: 100mm, 125mm</td>
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<td>Processes: CMOS, MOS</td>
<td>Processes: NMOS, CMOS, bipolar</td>
</tr>
<tr>
<td>Products: DRAMs, SRAMs, ROMs, ASICs, flash memories</td>
<td>Products: SRAMs, logic ICs, ASICs, MPUs, MCUs</td>
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<tr>
<td>Feature sizes: 0.35μm-1.0μm</td>
<td>Feature sizes: 0.8μm, 1.0μm, 1.2μm</td>
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<table>
<thead>
<tr>
<th>LG Semicon Co., Ltd.</th>
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<tbody>
<tr>
<td>Newport, South Wales</td>
</tr>
<tr>
<td>Capacity (wafers/week): 7,500</td>
</tr>
<tr>
<td>Wafer size: 200mm</td>
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<tr>
<td>Process: CMOS</td>
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<tr>
<td>Products: DRAMs</td>
</tr>
<tr>
<td>Feature sizes: 0.35μm, 0.25μm</td>
</tr>
<tr>
<td>(expected to begin production in 1999)</td>
</tr>
</tbody>
</table>

**Key Agreements**

- In 1996, LG Semicon licensed the Java processor from Sun Microsystems.
- In March 1996, LG Semicon announced an agreement with Crosspoint Solutions involving both licensing and manufacturing of Crosspoint’s FPGAs.
- In October 1995, LG Semicon announced a partnership agreement with Chromatic Research Inc. As part of the agreement, LG licensed the Mpact media processor. The single-chip media processor, along with the Mediaware software driver, offers seven multimedia functions for PC applications.
• In early 1996, LG Semicon entered into a two-year foundry agreement with Chips and Technologies, Inc. Under the agreement, Chips is guaranteed monthly wafer output for the production of its own graphics controllers.

• In late 1995, LG Semicon licensed the ARM7 RISC microprocessor core from Advanced RISC Machines Limited for use in ASIC and MCU applications.

• In April 1995, LG Semicon took a minority stake in flash memory developer SanDisk Corp., marking the company's first foray into flash memory. Initially, LG is producing SanDisk's 16M and 32M flash devices using 0.5μm CMOS technology. The partners will jointly develop future flash memory products.

• LG Semicon produces 1M, 4M, and 16M DRAMs utilizing Hitachi's manufacturing process. It was the first Korean semiconductor company to enter into a technical agreement with a major Japanese IC firm.

• LG Semicon became the first Korean IC manufacturer to license Rambus Inc.'s high-speed memory interface technology, which it will use for the manufacture of 16M DRAMs.

• LG Semicon signed an agreement with Siemens to develop 8-bit microcontrollers for use in consumer electronic products, automobiles, and communications equipment.
MACRONIX INTERNATIONAL (MXIC)

Macronix International Co., Ltd.
No. 3, Creation Road III
Science-Based Industrial Park
Hsinchu, Taiwan
Telephone: (886) (3) 5788-888
Fax: (886) (3) 5788-887
Web Site: www.macronix.com

IC Manufacturer

Regional Headquarters/Representative Locations

North America: Macronix America Co. Ltd. • San Jose, California
Telephone: (408) 453-8088 • Fax: (408) 453-8488

Europe: Macronix International Co., Europe Office • Strombeek, Belgium
Telephone: (32) (2) 267-7050 • Fax: (32) (2) 267-9700

Japan: Macronix International Co., Japan Office • Kawasaki-shi, Kanagawa, Japan
Telephone: (81) (44) 246-9100 • Fax: (81) (44) 246-9105

Financial History ($M)

<table>
<thead>
<tr>
<th>Year</th>
<th>Sales</th>
<th>Net Income</th>
<th>R&amp;D Expenditures</th>
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<td>980</td>
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<td>1994</td>
<td>221</td>
<td>35</td>
<td>29</td>
<td>113</td>
<td>1,440</td>
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<td>1995</td>
<td>328</td>
<td>114</td>
<td>29</td>
<td>113</td>
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<td>1996</td>
<td>373</td>
<td>95</td>
<td>34</td>
<td>250</td>
<td>2,000</td>
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</table>

Company Overview and Strategy

Macronix International Company (MXIC), was established in December 1989 in Taiwan to design, manufacture, and market memory ICs for the personal computer, telecommunications, and data communications market segments.

The company is divided into two groups: the Memory Product Group, which designs and develops non-volatile memory ICs, and the Logic Product Group, which designs and develops logic ICs for PC, communications, and high-end consumer applications.
Plans for 1997 include an increased focus on the U.S. market. The company announced its strategy to expand its U.S.-based subsidiary, Macronix America, to expose its flash, EPROM, and mask ROM products line to a broader range of OEMs. In particular, the company will promote the pin-to-pin compatibility of its non-volatile memory chips.

In addition, Macronix America is developing ASSPs with embedded non-volatile memory and has established three engineering units to work on communications, graphics, and mixed-signal applications. The company plans to acquire more intellectual property that will be used as building blocks for the ASSPs. The company is a Mips licensee and has developed its own microcontroller and DSP cores.

Management

Ding-Hua Hu  Chairman
Miin Wu  President
Ray Mak  Vice President and Chairman, Macronix America
Chris Kao  Vice President
Y.S. Tan  Vice President
Tom Yiu  Vice President
Alan Portnoy  President, Macronix America

Products and Processes

Macronix International's products include flash memories (1M to 16M capacities), EPROMs (256K to 8M), mask ROMs (1M to 64M), 32-bit RISC microprocessors, 16-bit DSPs, standard cell ASICs, graphics/video controllers, audio chips, clock generators, and LAN ICs.

Memory Products
- Flash memories—1M, 2M, 4M, 8M, and 16M densities
- Mask ROMs—1M, 2M, 4M, 8M, 16M, 24M, 32M, and 64M densities
- EPROMs—256K, 512K, 1M, 2M, 4M, and 8M densities
- Macronix is developing a new EPROM technology resembling flash memory that is called multiple-time-programmable EPROM.
Logic Products
- Video chips—GUI/video accelerators and JPEG circuits
- Audio chips—16-bit DSPs, codecs, and digital answering machine engines
- Networking chips—10Mbps Ethernet and 100Mbps Fast Ethernet LAN ICs
- ASICs—standard cells based on 0.8μm DLM, 0.6μm DLM/TLM, 0.5μm DLM/TLM, and 0.35μm DLM/TLM CMOS technologies. Its cell/core library consists of RAMs, ROMs, flash memories, DMAs, 8-/16-/32-bit microcontrollers, 16-bit DSPs, 32-bit FPU, timers, PLLs, DACs, ADCs, datapath elements, and others.

Other Products
- Auto focus ICs
- 32-bit RISC embedded processors compatible with the Mips R3000
- Clock generators
- RAMDACs

Semiconductor Fabrication Facilities

Macronix International Co., Ltd. 
No. 3, Creation Road III 
Science-Based Industrial Park 
Hsinchu, Taiwan 
Fab I
Cleanroom size:  62,500 square feet (Class 1) 
Capacity (wafers/week):  8,250 
Wafer size:  150mm 
Process:  CMOS 
Products:  EPROMs, ROMs, flash memories, DSPs, MPUs, MPRs, logic ICs 
Feature sizes:  0.4μm-0.8μm

Macronix International Co., Ltd. 
No. 3, Creation Road III 
Science-Based Industrial Park 
Hsinchu, Taiwan 
Fab II
Capacity (wafers/week):  10,000 
Wafer size:  200mm 
Process:  CMOS 
Products:  EPROMs, ROMs, flash memories, logic ICs 
Feature size:  0.35μm (0.2μm capability) 
(Began operations in 2Q97)

Key Agreements
- In April 1996, Macronix and IBM announced a mutual agreement on the cross licensing of patents.
- Macronix International licensed Mips Technologies’ RISC MPU architecture.
- Macronix jointly developed 4M and 16M flash memory devices and 4M ROMs with its Japanese partner NKK Corporation.
Mikron Corporation
Zelenograd, Moscow, 103460
Russia
Telephone: (7) (095) 535-1509
Fax: (7) (095) 535-6264

IC Manufacturer

Employees 5,900

Company Overview and Strategy

Mikron was one of the principle IC firms in the former USSR. Founded in 1964, the company's focus was traditionally in the field of bipolar technology. Today, Mikron is a private company focusing on advanced process technologies, including CMOS, BiCMOS, and GaAs. Its product offerings includes logic, memory, and linear ICs, as well as ASICs. It is the leading source for GaAs LSI and gate array ICs in Russia. The company's linear devices are expected to gain emphasis in the future.

Mikron's standard and custom IC products can be found in a variety of applications such as digital and analog watches, televisions, VCRs, supercomputers, and control systems. Roughly half of the company’s production output is sold in international markets.

Management

Gennady Ya. Krasnikov General Director
Evgenii Gornev Deputy General Director
Pavel S. Prikhodko Deputy General Director
Alexander P. Nechiporenko, Ph.D. Chief of External Department
Vitaly N. Panasuk Head of Technology and Research and Development

Products and Processes

Mikron uses bipolar, CMOS, BiCMOS, and GaAs process technologies for the production of general purpose logic ICs; ROMs and PROMs; SRAMs; MPUs; PLDs; CMOS, BiCMOS, and ECL gate arrays (up to 10K-gate complexity); linear ICs; and GaAs digital and analog ICs.
Semiconductor Fabrication Facilities

Mikron joined Hong Kong-based Hua Ko Electronics to create a joint venture facility, located in Russia, that will manufacture 150mm wafers on 0.8μm-1.2μm processes. In addition to funding, Mikron's investment into the joint venture includes its EEPROM technology and its cleanroom design experience.

Mikron Corporation
Zelenograd, Moscow, 103460
Russia
Cleanroom size: 73,200 square feet (Class 10)
Capacity (wafers/week): 15,000
Wafer sizes: 100mm, 150mm
Processes: CMOS, BiCMOS, bipolar, GaAs
Products: Logic, memory, and linear ICs; ASICs
Feature sizes: ≥0.8μm

Key Agreements

• Mikron has an alliance with Samsung under which Mikron produces ICs for the Korean company.
MOSEL-VITELIC

Mosel-Vitelic Inc.
1 Creation Road I
Science-Based Industrial Park
Hsinchu, Taiwan
Telephone: (886) (3) 5783344
Fax: (886) (3) 5792838
Web Site: www.moselvitelic.com

IC Manufacturer

Regional Headquarters/Representative Locations

North America: Mosel-Vitelic Corporation • San Jose, California
Telephone: (408) 433-6000 • Fax: (408) 433-0952

Japan: Mosel-Vitelic Japan • Nagano-ku, Tokyo, Japan
Telephone: (81) (3) 3365-2851 • Fax: (81) (3) 3365-2836

Financial History ($M)

<table>
<thead>
<tr>
<th>Year</th>
<th>Sales</th>
<th>Employees</th>
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<tr>
<td>1992</td>
<td>213</td>
<td>880</td>
</tr>
<tr>
<td>1993</td>
<td>238</td>
<td>1,411</td>
</tr>
<tr>
<td>1994</td>
<td>285</td>
<td>1,800</td>
</tr>
<tr>
<td>1995</td>
<td>540</td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>461</td>
<td>1,916</td>
</tr>
</tbody>
</table>

Company Overview and Strategy

Mosel-Vitelic was formed in October 1991 through the merging of MOS Electronics Taiwan Inc. (Mosel) and U.S.-based fabless chip firm Vitelic Corporation, both of which were originally established in 1983.

Mosel-Vitelic designs, manufactures, and markets high-performance, application-specific memory ICs and logic devices. The company's main business focus is on DRAMs and VRAMs for graphics accelerators used in workstations, and desktop, notebook, and subnotebook PCs. Other core markets for its DRAM products include data storage equipment, telecommunications peripherals, and printers. More than half of the company's DRAMs are sold in North America.
Management

Hung-Chiu Hu  Chairman and President
William Chen  Executive Vice President, Administration and Finance
John Fulton  Executive Vice President, Sales
John Seto  Executive Vice President, Memory Products
Hsing Tuan  Executive Vice President, Product Development
Rajit Shah  Vice President, Marketing
Thomas Chang  Vice President, Manufacturing
Nasa Tsai  President, ProMOS Technologies, Inc.

Products and Processes

Mosel-Vitelic offers specialized DRAMs (256K to 16M), standard SRAMs (16K to 1M), high-speed SRAMs (64K to 1M), VRAMs (256K and 1M), FIFOs and other specialty memories, SIMMs, and voice chips. The company plans to introduce a 120MHz version of a synchronous graphics RAM (SGRAM) by the end of 1997, as well as several new SRAM versions, including very low power parts (200μA standby current).

Semiconductor Fabrication Facilities

During 1996, Mosel-Vitelic sold its 51 percent share in its Hong Kong fab facility to Win Win International Holdings Ltd.

In early 1997, Mosel-Vitelic announced plans to break ground on a 256M DRAM 300mm wafer fabrication facility sometime after 1998, with full production to begin in 2003. The company has chosen the Science-Based Industrial Park near Tainan, Taiwan, as a possible location.
<table>
<thead>
<tr>
<th><strong>Mosel-Vitelic Inc.</strong></th>
<th><strong>ProMOS Technologies, Inc.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Creation Road I</td>
<td>(Joint venture between Mosel-Vitelic and Siemens)</td>
</tr>
<tr>
<td>Science-Based Industrial Park</td>
<td>Science-Based Industrial Park</td>
</tr>
<tr>
<td>Hsinchu, Taiwan</td>
<td>Hsinchu, Taiwan</td>
</tr>
<tr>
<td>Capacity (wafers/week): 7,500</td>
<td>Cleanroom size: 66,000 square feet</td>
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<tr>
<td>Wafer size: 150mm</td>
<td>Capacity (wafers/week): 5,000</td>
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<tr>
<td>Process: CMOS</td>
<td>Wafer size: 200mm</td>
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<tr>
<td>Products: Memory ICs</td>
<td>Process: CMOS</td>
</tr>
<tr>
<td>Feature sizes: 0.4(\mu)m-0.6(\mu)m</td>
<td>Products: Memory ICs</td>
</tr>
<tr>
<td></td>
<td>Feature size: 0.35(\mu)m (0.25(\mu)m capable)</td>
</tr>
</tbody>
</table>

(Operations started in mid-1997)

Supplementing its own internal production, Mosel-Vitelic has foundry relationships with Oki, Fujitsu, TSMC, and UMC.

**Key Agreements**

- In September 1996, Mosel-Vitelic announced the formation of ProMOS technologies, a $1.7 billion joint venture company with Siemens. The joint venture facility, located in Hsinchu, will be used to manufacture advanced high-density DRAMs using technology transferred from Siemens. The facility began production of 64M DRAMs in mid-1997 and expects to move to 256M DRAMs in 1998. Mosel holds 62 percent interest in the venture, while Siemens holds the remaining 38 percent.

- Mosel-Vitelic has a foundry and technology exchange partnership with Oki.
SOUTH AFRICAN MICRO-ELECTRONIC SYSTEMS (SAMES)

South African Micro-Electronic Systems Pty., Ltd.
2 Rooibok
Koedoespoort Industrial Area
Pretoria, South Africa
Telephone: (27) (12) 333-5406
Fax: (27) (12) 333-6021
Web Site: www.sames.co.za

IC Manufacturer

Financial History ($M)

<table>
<thead>
<tr>
<th></th>
<th>1995</th>
<th>1996</th>
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<tbody>
<tr>
<td>Sales</td>
<td>16</td>
<td>11</td>
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</tbody>
</table>

Company Overview and Strategy

South African Micro-Electronic Systems (SAMES) was founded in 1979 by Siemens and the Industrial Development Corporation of South Africa (IDC) to manufacture ICs for the South African telecommunications industry. The company is currently the only commercial manufacturer of ICs in South Africa, and the largest in advanced CMOS technology.

The company was originally controlled by the IDC, which held 70 percent of the company. Other minority shareholders included Allied Technologies Ltd., Grinaker Electronics Ltd., Plessey South Africa Ltd., Reunert Ltd., Siemens, and Telephone Manufacturers of South Africa Ltd. In 1995, Austria Mikro Systeme International AG (AMS) acquired a 51 percent controlling interest in SAMES and IDC held the remaining 49 percent of the shares. In 1996, however, IDC made an additional investment into SAMES, increasing its share to 81 percent, leaving AMS with a 19 percent interest. As part of its relationship with AMS, SAMES receives free technology transfers from AMS and the two companies share knowledge in the area of process technology, design, and products.

In 1990, with the completion of a new 150mm wafer facility, SAMES aimed at globalizing its activities in the field of ASICs and at providing foundry capacity. The new fab facility is designed to fulfill submicron requirements in CMOS technology, with 2.0μm to 1.0μm manufacturing processes currently in operation.

Products and Processes

SAMES manufactures ASICs in mixed-signal CMOS and BiCMOS technologies. In addition, the company provides system solutions such as single-chip telephones and electric meters for telecom and industrial applications.

SAMES has 1.0μm, 1.2μm, and 2.0μm manufacturing processes in operation.
Semiconductor Fabrication Facilities

SAMES
Pretoria, South Africa
Cleanroom size: 15,070 square feet (Class 10)
Capacity (wafers/week): 2,500
Wafer size: 150mm
Processes: CMOS, BiCMOS
Products: ASICs, foundry services
Feature sizes: 1.0μm, 1.2μm, 2.0μm
SAMSUNG

Samsung Electronics Co., Ltd.
Semiconductor Business
10th Floor, Samsung Main Building
250, 2-ka, Taepyung-ro, Chung-gu
Seoul 100-191, Korea
Telephone: (82) (2) 727-7114
Fax: (82) (2) 753-0967
Web Site: www.samsung.com

IC Manufacturer

Regional Headquarters/Representative Locations

North America: Samsung Semiconductor, Inc. • San Jose, California
Telephone: (408) 954-7000 • Fax: (408) 954-7286

Europe: Samsung Europe plc, Semiconductor Division • Brentford, Middlesex, United Kingdom
Telephone: (44) (181) 380-7132 • (44) (181) 380-7220

Japan: Samsung Electronics Japan Co., Ltd. • Chou-ku, Tokyo, Japan
Telephone: (81) (3) 5641-9850 • Fax: (81) (3) 5641-9851

Financial History ($M)

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Corporate</td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Sales (SEC)</td>
<td>7,900</td>
<td>10,300</td>
<td>14,600</td>
<td>21,000</td>
<td>18,800</td>
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<tr>
<td>Semiconductor</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sales</td>
<td>1,865</td>
<td>3,104</td>
<td>5,002</td>
<td>8,419</td>
<td>6,700</td>
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<td>IC Sales</td>
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<td>2,949</td>
<td>4,815</td>
<td>8,183</td>
<td>6,385</td>
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<td>Discrete Sales</td>
<td>120</td>
<td>155</td>
<td>187</td>
<td>236</td>
<td>315</td>
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<td>R&amp;D Expenditures</td>
<td>190</td>
<td>240</td>
<td>464</td>
<td>560</td>
<td>600</td>
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<tr>
<td>Capital Expenditures</td>
<td>550</td>
<td>930</td>
<td>1,300</td>
<td>2,200</td>
<td>2,300</td>
</tr>
<tr>
<td>Employees</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12,000</td>
</tr>
</tbody>
</table>
Company Overview and Strategy

Founded in 1969, Samsung Electronics Co. (SEC) is a business within The Samsung Group, a $87 billion highly diversified Korean conglomerate involved in a range of industries including electronics, machinery, chemicals, finance and insurance, and other businesses. Samsung Electronics Co. is comprised of the Semiconductor Business segment along with the Consumer Electronics, Telecommunications Systems, and Information Systems Business units.

By 1983, the company had developed Korea’s first domestic 64K DRAM. Samsung continued its rapid pace of product and process technology development. It quickly advanced its products offerings and brought numerous devices to market in a timely manner. Soon, rather than lagging the DRAM leaders in product development, Samsung was in step with them. In the early 1990’s Samsung passed the large Japanese memory suppliers in DRAM sales. In December 1994, Samsung announced it was the first to ship a fully functional 256M DRAM sample. Furthermore, the company succeeded in the development of a 1G DRAM (500mm² die) in 1996.

Today, Samsung is the world’s largest supplier of DRAM products. Additionally, it is the world’s leading producer of SRAM devices, which places Samsung in the position as the world’s leading supplier of MOS memory devices.

Although the core of Samsung Semiconductor’s current business is memory products, the company is aggressively expanding its product offerings into other areas, such as microcontrollers, multimedia video and audio devices, ASICs, and power semiconductor devices. The company is working to achieve a 50:50 ratio of memory to non-memory device production.
Management

Samsung Semiconductor (Korea)
- Yoon-Woo Lee, President and Chief Executive Officer
- Dae-Jae Chin, Executive Vice President and Chief Executive Officer, System LSI Division
- Seung-Kyu Lee, Executive Vice President and General Manager, Manufacturing Division
- Hyung-Kyu Lim, Senior Vice President and General Manager, Memory Division
- Chang-Ho Choi, Senior Vice President, Administration
- Jong-Gil Lee, Senior Vice President, Research and Development
- Sang-Wan Lee, Senior Vice President, AM LCD Division
- Ji-Sung Choi, Vice President, Sales and Marketing
- Min-Ho Tan, Vice President, Quality Assurance

Samsung Semiconductor (U.S.)
- Young Bae Rha, President and Chief Executive Officer
- W. Keith McDonald, Senior Vice President, Sales and Marketing
- Avo Kanadjian, Vice President, Marketing, Memory Products
- Jon Kang, Vice President, Sales and Marketing Supporting Services
- Gi Yong Lee, Vice President, Samsung Microwave Semiconductor
- Noel Park, Vice President and General Manager, Marketing, System LSI
- Ralph Waggitt, Vice President, Sales, General Accounts

Products and Processes

Samsung’s semiconductor products include standard and specialty DRAMs, SRAMs, flash memories, mask ROMs, 4-/8-bit and 16-/32-bit MCUs, Alpha 64-bit RISC MPUs, MPRs, DSPs, RAMDACs, LCD drivers, ASICs, ASSPs (system logic and multimedia chipsets, set-top box ICs, and graphics ICs), smart power devices, general purpose linear ICs, GaAs MMICs, and discrete devices.
Samsung's major product lines are outlined below.

**DRAMs**
A broad range of parts are offered: standard DRAMs in a variety of organizations and densities, ranging from 1M to 64M; 16M and 64M synchronous DRAMs (SDRAMs) capable of reading and writing bursts of information at 100MHz speeds; extended data out (EDO) DRAMs; 16M Rambus DRAMs (RDRAMs); specialty graphics memories designed specifically to meet the needs of graphical user interfaces; synchronous graphics RAMs (SGRAMs); and 2M and 4M video RAMs (VRAMs).

Samsung is developing what it calls an SDRAM-II, which doubles the data-transfer rate of existing SDRAMs by presenting data on each edge of the memory clock. The technique is similar to that used in Rambus DRAMs. Samsung plans to begin volume production of 64M SDRAM-II devices in mid-1998.

**SRAMs**
At the high end, Samsung offers synchronous pipelined burst SRAMs for Pentium and PowerPC based PCs. Other SRAM products include CMOS fast SRAMs (1M and 4M), BiCMOS fast SRAMs (64K, 256K, and 1M), synchronous SRAMs, low-power SRAMs, and low-voltage SRAMs. The low-power SRAMs have an access time of 55ns, while the BiCMOS fast SRAMs feature access times of 6ns, 8ns, 10ns, and 12ns.
Mask ROMs
Samsung is one of the world’s leading suppliers of mask ROMs, with parts available in densities ranging from 2M to 32M. Low-voltage (3.3V) ROMs are offered in 4M, 8M, and 16M densities.

Flash Memories
The company’s flash memory devices adhere to the NAND flash memory architecture standard and are second sourced by Toshiba and National Semiconductor. Samsung is currently shipping 4M, 16M, 32M, and 64M parts in volume.

In addition, the company offers audio flash memory devices, which are 4M flash memories designed specifically for voice storage applications such as digital telephone answering machines.

Video and Audio Multimedia Products
Samsung offers a highly integrated digital video chipset for such applications as full motion video on PCs, video editing on PCs, teleconferencing, and set-top boxes. The company also offers its OmniWave™ single-chip audio system core for makers of multimedia audio products, music synthesizers, and video games.

ASICs
Samsung’s ASIC products include gate arrays, embedded arrays, and standard cells. Its cell library includes MPU/MCU cores, DSP cores, audio codecs, RAMDACs, and PLL circuits. The company’s ASIC process technologies include 0.5μm and 0.6μm double- or triple-layer metal CMOS and 0.35μm triple- or quad-layer metal CMOS.

Samsung also offers ASICs with embedded configurable DRAM. The company’s MDL (Merged DRAM with Logic) ASIC devices are available with 1M to 4M of embedded DRAM and up to 100k gates of random logic using a 0.5μm process and 8M to 16M of DRAM/SDRAM/SGRAM with up to 400k gates of logic using a 0.35μm process. A 32M version is planned for 1998.

Microcomponents
The company’s microcontroller portfolio consists of 4-bit, 8-bit, and 32-bit CMOS products. Samsung is rapidly expanding its portfolio of microcontrollers and plans to introduce 50 new products by the end of 1997. The company also offers a line of digital signal processors.

Through a license obtained from Digital Semiconductor in 1996, Samsung expects to begin volume production of Alpha 64-bit RISC microprocessors before the end of 1997. The Alpha 21164 chips will be Samsung’s first microprocessors. In the future, the company expects to produce other high-end Alpha processors as well as low-end derivative devices.

Power Devices
The company offers a broad range of power semiconductor products, including linear ICs, MOSFETs, IGBTs, and bipolar transistors for power monitoring in motor control, power supplies, ballasts, computer, and automotive applications.
RF/Microwave Products

Samsung Microwave Semiconductor offers a wide selection of GaAs MMICs for wireless applications, including amplifiers, switches, attenuators, and mixers.

All of Samsung’s semiconductor devices are manufactured using primarily CMOS process technology, but also BiCMOS, bipolar, and GaAs, with the smallest design rule being 0.35μm in its CMOS technology and 0.25μm in its GaAs technology. The company plans for its CMOS technology to reach 0.25μm geometry by 1998 and 0.18μm by 1999.

Semiconductor Fabrication Facilities

Samsung has indicated its next three fab facilities will be located outside of South Korea—the first in the U.S. (already under construction), the second in Europe (probably in the U.K. or Germany), and the third in Malaysia or Indonesia.

<table>
<thead>
<tr>
<th>Samsung Semiconductor, Kiheung Plant</th>
<th>Samsung Semiconductor, Kiheung Plant</th>
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</thead>
<tbody>
<tr>
<td>San 24, Nonsuh-Ri, Kiheung-Eup, Yongin-Kun</td>
<td>San 24, Nonsuh-Ri, Kiheung-Eup, Yongin-Kun</td>
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<tr>
<td>Kyungki-Do, Korea</td>
<td>Kyungki-Do, Korea</td>
</tr>
<tr>
<td>Fab 1</td>
<td>Fab 2</td>
</tr>
<tr>
<td>Capacity (wafers/week): 8,750</td>
<td>Capacity (wafers/week): 8,750</td>
</tr>
<tr>
<td>Wafer size: 100mm</td>
<td>Wafer size: 150mm</td>
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<tr>
<td>Processes: CMOS, BiCMOS</td>
<td>Processes: CMOS, BiCMOS</td>
</tr>
<tr>
<td>Products: SRAMs, ROMs, ASICs</td>
<td>Products: SRAMs, ROMs, ASICs, MCUs</td>
</tr>
<tr>
<td>Feature size: 1.5μm</td>
<td>Feature size: 1.0μm</td>
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</table>

<table>
<thead>
<tr>
<th>Samsung Semiconductor, Kiheung Plant</th>
<th>Samsung Semiconductor, Kiheung Plant</th>
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<tbody>
<tr>
<td>San 24, Nonsuh-Ri, Kiheung-Eup, Yongin-Kun</td>
<td>San 24, Nonsuh-Ri, Kiheung-Eup, Yongin-Kun</td>
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<tr>
<td>Kyungki-Do, Korea</td>
<td>Kyungki-Do, Korea</td>
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<tr>
<td>Fab 3</td>
<td>Fab 4</td>
</tr>
<tr>
<td>Capacity (wafers/week): 8,750</td>
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</tr>
<tr>
<td>Wafer size: 150mm</td>
<td>Wafer size: 150mm</td>
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<tr>
<td>Processes: CMOS, BiCMOS</td>
<td>Process: CMOS</td>
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<tr>
<td>Products: DRAMs, SRAMs, ROMs, ASICs, MCUs</td>
<td>Products: DRAMs, SRAMs, ROMs, MPRs</td>
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<tr>
<td>Feature size: 0.8μm</td>
<td>Feature size: 0.6μm</td>
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<th>Samsung Semiconductor, Kiheung Plant</th>
<th>Samsung Semiconductor, Kiheung Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>San 24, Nonsuh-Ri, Kiheung-Eup, Yongin-Kun</td>
<td>San 24, Nonsuh-Ri, Kiheung-Eup, Yongin-Kun</td>
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<td>Kyungki-Do, Korea</td>
<td>Kyungki-Do, Korea</td>
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<tr>
<td>Fab 5</td>
<td>Fab 6</td>
</tr>
<tr>
<td>Capacity (wafers/week): 5,000</td>
<td>Capacity (wafers/week): 7,500</td>
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<td>Wafer size: 200mm</td>
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<tr>
<td>Process: CMOS</td>
<td>Process: CMOS</td>
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<tr>
<td>Products: DRAMs, flash memories, MPRs, ASICs</td>
<td>Products: DRAMs</td>
</tr>
<tr>
<td>Feature sizes: 0.4μm, 0.5μm</td>
<td>Feature size: 0.4μm</td>
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</tbody>
</table>
### Samsung Semiconductor, Kiheung Plant
- **San 24, Nongsuh-Ri, Kiheung-Eup, Yongin-Kun**, Kyungki-Do, Korea
- **Fab 7**
- **Capacity (wafers/week):** 5,000
- **Wafer size:** 200mm
- **Process:** CMOS
- **Products:** DRAMs
- **Feature size:** 0.35μm

### Samsung Semiconductor, Bucheon Plant
- **San 24, Nongsuh-Ri, Kiheung-Eup, Yongin-Kun**, Kyungki-Do, Korea
- **U-Line Fab**
- **Capacity (wafers/week):** 1,250
- **Wafer size:** 200mm
- **Process:** CMOS
- **Products:** Linear ICs, ASIC, logic ICs, MCUs, R&D
- **Feature sizes:** 0.25μm, 0.35μm

### Samsung Austin Semiconductor, LLC
- **Austin, Texas**
- **Cleanroom size:** 125,000 square feet
- **Capacity (wafers/week):** 6,250
- **Wafer size:** 200mm
- **Process:** CMOS
- **Products:** DRAMs, ASICs
- **Feature size:** 0.35μm
- **(Scheduled to begin production in 1Q98)**

### Samsung Microwave Semiconductor, Inc.
- **Milpitas, California 95035-7405**
- **Cleanroom size:** 10,000 square feet
- **Capacity (wafers/week):** 1,800
- **Wafer size:** 100mm
- **Process:** GaAs
- **Products:** Amplifiers, MMICs, RFICs, discretes
- **Feature sizes:** 0.25μm-1.0μm

### Key Agreements

- **In April 1997,** Samsung acquired 3DO Corp. for approximately $20 million. Just prior to the acquisition, the two companies discontinued their joint development of the much-publicized Media Signal Processor (MSP). Samsung will leverage the acquisition to form a Silicon Valley company that will concentrate on multimedia systems and semiconductors.

- **In early 1997,** Samsung became the fifth semiconductor manufacturer to license ferroelectric RAM (FRAM) technology from Ramtron.

- **Intel announced in early 1997** that it would make an equity investment in Samsung’s memory IC fabrication plant under construction in Austin, Texas. In exchange, Samsung will provide Intel with a reliable supply of DRAMs. Toshiba is also rumored to have taken a 20 percent stake in the fab facility.
• In mid-1996, Samsung signed a broad license for Digital Semiconductor’s Alpha 64-bit RISC microprocessor architecture and is manufacturing Alpha microprocessors as an independent alternate source of Alpha technology. Samsung will also use the Alpha processors in its own systems.

• In May 1996, Trident Microsystems and Samsung announced a long-term partnership. Samsung will provide manufacturing capacity to Trident in exchange for mixed-signal, multimedia RAMDAC, and clock technology. Samsung will incorporate Trident’s device technology into its ASIC library.

• Samsung licensed DSP core technology from SGS-Thomson in early 1996 as part of a second-sourcing and development agreement. At first the licensing agreement included rights to SGS-Thomson’s D950 16-bit fixed-point DSP core and a second-sourcing pact for ASICs based on the core. The partnership is eventually expected to include joint development of future product generations.

• In late 1995, Samsung announced it had licensed the PineDSPCore engine from DSP Group. Samsung said it would incorporate the 16-bit, general purpose, low-power, low-voltage, and high-speed engine in its ASIC library for 0.6µm- and 0.5µm-based multimedia and communications products.

• Samsung licensed Rambus’ proprietary DRAM interface technology. The company introduced its first 16M Rambus DRAM (RDRAM) in 1996.

• Information Storage Devices (ISD) was granted access to Samsung's wafer fabrication capacity and a joint development agreement was made between the two companies for products based on ISD's multilevel storage technology for the recording and playback of voices.

• Samsung has licensed several of the ARM RISC processor cores from Advanced RISC Machines, Ltd., including the ARM6, ARM610, ARM7, and ARM7TDMI.

• Samsung and NEC agreed to share information concerning 256M DRAM cell technology. As part of another agreement, Samsung licensed NEC’s 78K Series 16-bit microcontroller technology. Samsung is allowed to use the 78K series as a 0.8µm 16-bit core.

• Samsung reached an agreement with Texas Instruments in 1993 to jointly improve and operate TI’s test and assembly plant in Portugal. Each company operates separate, dedicated lines, which Samsung uses to assemble and test DRAMs.

• Samsung and Toshiba agreed to an eight-year alliance in 1992 in support of Toshiba’s NAND-type flash memory architecture. In 1993, Samsung began production of 8M and 16M flash devices that are pin-compatible with Toshiba’s devices. Similarly configured 32M parts were first delivered in 1994. In addition, the two companies agreed to codevelop 64M NAND-type flash memories. As part of a separate agreement, Toshiba is providing Samsung with consumer bipolar IC and high-definition TV chip production technologies.
- Samsung licensed Aspec Technology's high-density array (HDA) technology, which it has used to develop new ASICs. The partners expanded their alliance in early 1995 to include the joint development of a 0.6μm ASIC architecture for gate arrays and embedded arrays.

- Samsung has a second-source agreement with Mitsubishi for 4M and 16M cache DRAMs. The two companies also agreed to codevelop future cache DRAM products.
TOWER SEMICONDUCTOR

Tower Semiconductor Ltd.
P.O. Box 619
Migdal Haemek 23105
Israel
Telephone: (972) (6) 506-670
Fax: (972) (6) 547-788

IC Manufacturer

Regional Headquarters/Representative Locations

North America: Tower Semiconductor USA, Inc. • San Jose, California
Telephone: (408) 551-6500 • Fax: (408) 551-6509

Financial History ($M)

<table>
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Company Overview and Strategy

Tower Semiconductor is an independent foundry-dedicated IC manufacturer, formed by the partial buyout of a National Semiconductor fab in 1993. National began commercial production of wafers at the fab in 1988. Tower is a public company traded in NASDAQ (53.7 percent). The remainder of Tower's shares are divided between National Semiconductor Inc. (3.5 percent) and Tower Holdings (42.8 percent). Tower Holdings is owned by Data Systems and Software Inc. (60 percent) and the Israel Corporation (40 percent).

As a foundry, Tower manufactures wafers using its advanced production capability and the proprietary IC designs of its customers. Devices produced by the company are used in a wide variety of applications including personal computer products and peripherals, communications products, office automation equipment, and consumer products.
Management

Yoav Nissan-Cohen, Ph.D.  Co-Chief Executive Officer
Rafael M. Levin, Ph.D.  Co-Chief Executive Officer
Jeffrey Levy  Director, Fab Facility
Reuven Marko  Director, Marketing and Sales

Products and Processes

Tower manufactures primarily differentiated ICs rather than commodity products. Such products include digital signal processors, microprocessors, microcontrollers, and mixed-signal devices. It currently uses 1.0μm, 0.8μm, and 0.6μm, double- and triple-level metal CMOS technologies and intends to complete development of 0.5μm technology in 1997 and 0.35μm in 1998.

Semiconductor Fabrication Facilities

Tower is implementing a plan to increase its weekly wafer capacity from approximately 4,000 units to 5,750 units by the end of 1997, while advancing its technology with an investment of approximately $240 million.

Tower Semiconductor Ltd.
P.O. Box 619
Migdal Haemek 23105, Israel
Cleanroom size: 46,575 square feet
Capacity (wafers/week): 4,000
Wafer size: 150mm
Process: CMOS
Products: Foundry services
Feature sizes: 0.6μm, 0.8μm, 1.0μm (0.5μm in 1997 and 0.35μm in 1998)
Key Agreements

• Tower signed a three-year contract with National Semiconductor in early 1995 to supply National with 1,845 wafers per week.

• Tower also has supply agreements with Motorola and Chip Express.

• In January 1997, Tower signed a long-term technology exchange and foundry agreement with WSI, Inc. (Fremont, California). Under the agreement, the two companies will jointly develop manufacturing process technologies such as WSI’s AMG EPROM architecture using Tower’s 0.6μm technology. The agreement also guarantees WSI access to Tower’s wafer capacity.
TRITECH MICROELECTRONICS

TriTech Microelectronics Pte Ltd.
16A Science Park Drive #04-01/02
The Pascal
Singapore Science Park
Singapore 0511
Telephone: (65) 7757382
Fax: (65) 7736912
Web Site: www.tritech-sg.com

Fabless IC Supplier

Regional Headquarters/Representative Locations

North America: TriTech Microelectronics Inc. • Milpitas, California
Telephone: (408) 941-1300 • Fax: (408) 941-1301

Financial History ($M)

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<td>48</td>
<td>47</td>
<td>60</td>
<td>106</td>
<td>143</td>
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Company Overview and Strategy

TriTech Microelectronics designs and markets integrated circuits for telemedia applications which require the combination of multimedia and communications capabilities. TriTech’s ICs are offered as application-specific standard products (ASSPs) or as ASICs from the company’s comprehensive proprietary library of analog, mixed-signal, digital, and memory cells.

Since its founding in 1990, TriTech has focused on the design of complex analog and mixed-signal products, making this a core technology strength of the company. Its expertise in this area has enabled the company to be adept at designing mixed-signal chips in cost-effective, single-poly bulk CMOS processes. The company also uses its cell-based design approach to quickly turn new products into the market.

TriTech is a member of Singapore Technologies Semiconductors, a strategic business unit of Singapore Technologies.
Management

Keith Jackson  President and Chief Executive Officer
Bettina Briz   Vice President, Worldwide Marketing
Ted Friedland Vice President, Worldwide Sales
Winston Chen  Director, Marketing, Multimedia Division
Michael Harkins Director, Worldwide Regional Marketing
Chong Lim Neoh Director, Design Engineering

Products and Processes

TriTech's products are targeted at telemedia applications for the PC, including computer games and complex graphical interfaces; PC communications via e-mail, fax, and remote access; and communications/processor platforms for Internet appliances. Audio codecs are a flagship line, with nearly 40 million shipped since the company's founding. The Pyramid3D graphics processor, introduced in 1996, provides workstation-level graphics on a PC, making three-dimensional multimedia affordable for business and entertainment applications.

In addition, deep-submicron CMOS wafer foundry services and packaging, assembly, and test services are offered through sister companies Chartered Semiconductor and ST Assembly Test Services (STATS), respectively.

Semiconductor Fabrication Facilities

TriTech is a fabless IC supplier; its products are manufactured by Chartered Semiconductor.
TAIWAN SEMICONDUCTOR MANUFACTURING COMPANY (TSMC)

Taiwan Semiconductor Manufacturing Co., Ltd.
No. 121, Park Avenue III
Science-Based Industrial Park
Hsinchu 300, Taiwan
Telephone: (886) (3) 578-0221
Fax: (886) (3) 578-1546
Web Site: www.tsmc.com.tw

IC Manufacturer

Regional Headquarters/Representative Locations

North America: TSMC, USA • San Jose, California
Telephone: (408) 437-8762 • Fax: (408) 441-7713

Europe: TSMC, Europe • Amsterdam, The Netherlands
Telephone: (31) (20) 575-3105 • Fax: (31) (20) 575-3106

Financial History ($M)

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<td>465</td>
<td>730</td>
<td>1,092</td>
<td>1,435</td>
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<tr>
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<td>46</td>
<td>160</td>
<td>320</td>
<td>572</td>
<td>707</td>
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<td>R&amp;D Expenditures</td>
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<td>21</td>
<td>32</td>
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<tr>
<td>Capital Expenditures</td>
<td>108</td>
<td>147</td>
<td>270</td>
<td>574</td>
<td>780</td>
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<tr>
<td>Employees</td>
<td>1,893</td>
<td>2,294</td>
<td>2,681</td>
<td>3,412</td>
<td>4,117</td>
</tr>
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Company Overview and Strategy

Taiwan Semiconductor Manufacturing Company (TSMC) was founded in 1987 as a joint venture of the
Taiwan Development Fund, Philips Electronics of the Netherlands, and private-sector investors in Taiwan. It
is 21 percent owned by the government of Taiwan, 34 percent owned by Philips, and 45 percent owned by
private investors and employees.

TSMC is the largest of the world's pure integrated circuit foundries; it does not design product or second-
source its customers' products. Since its founding, the company has been dedicated to providing
manufacturing services for advanced ICs. TSMC believes its customers have the ability to bring their
products to market faster, more cost effectively, and without the large capital expenditures necessary for
state-of-the-art manufacturing facilities. In 1996, TSMC had over 250 customers worldwide, many of them
located in the U.S. and about two-thirds fabless.
In mid-1995, TSMC began offering customers an option to guarantee long-term wafer capacity through prepayments. The deposits are allowing the company to accelerate its fab facility construction. Customers that have entered into the option agreement include Acer Labs, Analog Devices, Oak Technology, S3, Trident Microsystems, and ISSI.

Management

Morris Chang, Ph.D. Chairman and President  
J.B. Chen Vice President, North-Site  
Y.C. Huang Vice President, Corporate Service  
Quincy Lin Vice President, Corporate Marketing and Sales  
Rick Tsai Vice President, South-Site  
Gary T.L. Tseng Vice President, Finance, and Chief Financial Officer  
Steve T. Tso Vice President, Research and Development  
John Luke President, TSMC USA

Products and Processes

The company offers state-of-the-art CMOS process technologies such as 0.35μm three-layer metal and four-layer metal logic, 0.35μm mixed-mode, and 0.35μm SRAM. Also in production is a 0.35μm DRAM process. To stay ahead of the swift upgrades in technology, TSMC continuously introduces next-generation processes to its production facilities. In early 1997, TSMC unveiled its so-called BlendIC process for combining DRAM and logic on the same chip. The 0.35μm triple-well process combines embedded three-poly, two-metal layer DRAM and a multilayer ASIC process using one ploy and four metal layers.

The company is in the process of developing 0.25μm logic/ASIC, 0.25μm mixed-mode, 0.3/0.25μm SRAM, and 0.3/0.25μm DRAM processes. In early 1997, TSMC began development of a 0.18μm process technology.
In addition to providing IC wafer manufacturing service, TSMC offers ASIC design services, mask making services, wafer probing services, and assembly and test services.

**Semiconductor Fabrication Facilities**

In November 1995, TSMC announced plans to build WaferTech, a $1.2 billion joint venture company, with Altera, Analog Devices, and ISSI. The company will be dedicated to providing wafer manufacturing services and is one of the first U.S.-based dedicated foundries. The facility underwent construction in July 1996 and will have a capacity of 7,500 200mm wafers per week when production starts in 2Q98.

In early 1997, TSMC announced its long-term plans for future wafer manufacturing facilities. The company announced its commitment to the Taiwanese government to invest approximately $14.5 billion over the next five years to build one 200mm and six 300mm wafer manufacturing facilities in a new Science-based industrial park in the southern part of Taiwan. Construction of the first facility, Fab VI, could begin as early as fall 1997.

---

**TSMC, Ltd.**

Building 67, No. 195, Section 4
Chung-Hsing Road
Chu-Tung, Hsinchu, Taiwan
Telephone: (886) (3) 5821-240
Fab I
Cleanroom size: 29,060 square feet
Capacity (wafers/week): 5,000
Wafer size: 150mm
Processes: CMOS, BiCMOS
Products: Foundry services
Feature sizes: 0.8µm-2.0µm

---

**TSMC, Ltd.**

No. 121, Park Avenue III
Science-Based Industrial Park
Hsinchu, Taiwan
Telephone: (886) (3) 5780-221
Fab IIA
Cleanroom size: 100,730 square feet
Capacity (wafers/week): 9,750
Wafer size: 150mm
Processes: CMOS, mixed-mode
Products: Foundry services
Feature sizes: 0.5µm, 0.6µm
TSMC, Ltd.
No. 121, Park Avenue III
Science-Based Industrial Park
Hsinchu, Taiwan
Telephone: (886) (3) 5780-221
Fab IIB
Cleanroom size: 100,730 square feet
Capacity (wafers/week): 9,875
Wafer size: 150mm
Processes: CMOS, mixed-mode
Products: Foundry services
Feature sizes: 0.35µm, 0.5µm

TSMC, Ltd.
No. 9, Creation Road I
Science-Based Industrial Park
Hsinchu, Taiwan
Telephone: (886) (3) 5772-069
Fab III
Cleanroom size: 113,915 square feet
Capacity (wafers/week): 9,250
Wafer size: 200mm
Process: CMOS
Products: Foundry services
Feature sizes: 0.35µm, 0.5µm (0.25µm capable)

TSMC, Ltd.
Hsinchu, Taiwan
Fab IV
Capacity (wafers/week): 7,500
Wafer size: 200mm
Process: CMOS
Products: Foundry services
Feature sizes: 0.35µm, 0.5µm (0.18µm capable)

TSMC, Ltd.
Hsinchu, Taiwan
Fab V
Capacity (wafers/week): 8,750
Wafer size: 200mm
Process: CMOS
Products: Foundry services
Feature sizes: 0.25µm, 0.35µm (0.18µm capable)
(Scheduled to start up in 1Q98)

WaferTech, LLC
Camas, Washington
Capacity (wafers/week): 7,500
Wafer size: 200mm
Process: CMOS
Products: Foundry services
Feature sizes: 0.25µm, 0.35µm (0.18µm capable)
(Scheduled to start up in 2Q98. Joint venture with Altera, Analog Devices, and ISSI.)
UNITED MICROELECTRONICS (UMC)

United Microelectronics Corporation
No. 3, Industry East Road
Science-Based Industrial Park
Hsinchu, Taiwan
Telephone: (886) (3) 5773131
Fax: (886) (3) 5774767
Web Site: www.umc.com.tw

IC Manufacturer

Regional Headquarters/Representative Locations

Japan: United Microelectronics Corporation K.K. • Minato-ku, Tokyo, Japan
Telephone: (81) (3) 3455-8306 • Fax: (81) (3) 3455-8307

Europe: United Microelectronics (Europe) B.V. • Br. Amsterdam Zuidoost, The Netherlands
Telephone: (31) (20) 697-0766 • Fax: (31) (20) 697-7826

Financial History ($M)

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<tr>
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<tr>
<td>Capital Expenditures</td>
<td>56</td>
<td>53</td>
<td>255</td>
<td>570</td>
<td>600</td>
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</table>

Employees | 1,770 | 1,968 | 2,275 | 2,982 | 2,750 |

Company Overview and Strategy

United Microelectronics Corporation (UMC) originated as a Taiwanese government research project, but was spun off as a private company in 1980. Then, UMC went public in 1985. Initially, UMC focused on producing consumer ICs, but over time, expanded its product portfolio to include memory ICs, PC chipsets and other computer-related ICs, microcontrollers and DSPs, and communications circuits. Additionally, foundry services have been an increasingly important business for UMC since it began producing devices in 1982. About 50 percent of UMC's fab capacity in 1996 was provided to foundry customers, up from 10 percent in 1991.
In 1995, UMC began spinning off its standard IC businesses as part of an ongoing shift to focus on the foundry business, as well as to align the company so that it does not directly compete with some of its foundry customers. First, its computer products business unit (computer chipsets, I/O circuits, and other computer-related products) was spun off in October 1995 to form a new company called Integrated Technology Express (ITE), based in Santa Clara, California. Then, in March 1996, the company’s communications IC business (Ethernet chips, fax/modem chipsets, and other communications-related products) was spun off to form Davicom Semiconductor Inc., also based in Santa Clara.

In early 1997, UMC announced it would spin off its remaining three standard IC businesses. The memory IC business, to be headquartered in Santa Clara, will develop and sell system-on-a-chip and embedded memory products. The consumer products unit will be based in Taiwan and will market UMC’s existing consumer ICs, including 4-bit and 8-bit MCUs, voice synthesizer and recognition ICs, LCD and telephone dialer chips, and A/D converters. The multimedia products business will become a separate, fabless IC design company based in Taiwan and will sell UMC’s existing multimedia lines, such as CD-ROM controllers and MPEG-1 chips. It will enter new markets, including MPEG-2 and DVD ICs.

Management

John Tsao  Chairman and Chief Executive Officer
John Hsuan  President
Ing Dar Liu  President, Business Group I
Ming-Kai Tsai  President, Business Group II
J.S. Aur  Senior Vice President, Business Group III
H.Y. Liu  Senior Director, Foundry Marketing and Sales
Peter Chang  President, United Semiconductor Corp.
C.Y. Shu  President, United Integrated Circuits Corp.

Products and Processes

Prior to 1997, UMC was known as a supplier of a wide variety of standard IC products, including high-speed SRAMs, ROMs, DSPs, MCUs, fax/modem chips, Ethernet devices, I/O chips, multimedia ICs, and PC chipsets. However, as discussed above, UMC began spinning off its standard IC businesses in 1996 in order to focus on foundry services. By mid-1997, all of UMC’s revenues will be from foundry services.
UMC’s range of foundry services include ASIC design, IC fabrication, mask production, wafer probing, packaging, and testing. The company offers CMOS process technologies for SRAM, logic, mixed-signal, and DRAM designs, with design rules varying from 0.35\(\mu\)m to 1.2\(\mu\)m and up to four layers of metal. A 0.25\(\mu\)m process is under development and is expected to be offered at UMC’s wholly owned fabs by 3Q97. It will later be transferred to UMC’s joint venture fabs.

**Semiconductor Fabrication Facilities**

UMC’s rapid transition to a pure-foundry supplier has been accomplished through the formation of joint ventures with strategic foundry partners (see Key Agreements). Though independent companies, the policies of UMC, USC, UICC, and USI are to second source each other and not compete on price. UMC is said to be talking to another company (or companies) about a further joint venture.

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<tr>
<th>United Microelectronics Corporation</th>
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<td>Science-Based Industrial Park</td>
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<td>Fab IC2</td>
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<tr>
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<td>Products: Foundry services</td>
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<tr>
<td>Feature sizes: 1.2(\mu)m-3.0(\mu)m</td>
<td>Feature sizes: 0.4(\mu)m-0.8(\mu)m</td>
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<td>(This fab is being phased out.)</td>
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<tr>
<td>Hsinchu, Taiwan</td>
<td>(Joint venture fab. See Key Agreements)</td>
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<td>Fab IC3A</td>
<td>Fab IC3B</td>
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<td>Cleanroom size: 57,800 square feet</td>
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<td>Capacity (wafers/week): 6,250</td>
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<td>Products: Foundry services</td>
<td>Products: Foundry services</td>
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<tr>
<td>Feature sizes: 0.35(\mu)m, 0.5(\mu)m</td>
<td>Feature sizes: 0.35(\mu)m, 0.5(\mu)m</td>
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</table>
United Silicon Inc. (USI) | United Integrated Circuits Corporation (UICC)
Science-Based Industrial Park | Science-Based Industrial Park
Hsinchu, Taiwan | Hsinchu, Taiwan
(Joint venture fab. See Key Agreements) | (Joint venture fab. See Key Agreements)
Fab IC3C | Fab IC3D
Capacity (wafers/week): 6,250 | Capacity (wafers/week): 6,250
Wafer size: 200mm | Wafer size: 200mm
Process: CMOS | Process: CMOS
Products: Foundry services | Products: Foundry services
Feature sizes: 0.25μm, 0.35μm | Feature size: 0.35μm, 0.5μm
(Scheduled to begin production in 1Q98) | (Production began in mid-1997)

Key Agreements

- In early 1996, UMC purchased a 10 percent stake in Catalyst Semiconductor as part of a foundry agreement. Also under the agreement, UMC and Catalyst will jointly develop 0.5μm and 0.35μm process technologies, geared for flash memory products. The first 0.5μm flash devices were shipped in 4Q96.

- In 4Q95, Alliance Semiconductor granted UMC a license to produce for itself a certain number of Alliance DRAM products in return for DRAM manufacturing capacity.

- UMC’s joint venture IC foundry, United Semiconductor Corporation (USC), was announced in 1995 in partnership with Alliance Semiconductor and S3 Inc. The fab began production in 3Q96 of 200mm wafers for UMC, Alliance, S3, and other semiconductor firms. UMC owns 50 percent of the venture.


- UMC’s third joint venture fab, United Silicon Inc. (USI), is a partnership with Alliance Semiconductor, Cirrus Logic, and Xilinx. The 200mm wafer fab is expected to begin production in 1Q98. UMC will own 50 percent of the venture.
VALENCE SEMICONDUCTOR

Valence Semiconductor (HK) Ltd.
Flat 7A, Tai Po Commercial Centre
152-172 Kwong Fuk Road
Tai Po New Territories
Hong Kong
Telephone: (852) 656-1151
Fax: (852) 652-2301

Fabless IC Supplier

Financial History ($M)

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<tr>
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<td>32</td>
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<td>35</td>
<td>40</td>
<td>42</td>
<td>45</td>
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</tr>
</tbody>
</table>

Company Overview and Strategy

Established in 1985, Valence Semiconductor was one of the first IC design houses in Hong Kong, offering a limited range of IC design services. Valence today is capable of providing a total solution for designs from specifications to delivery of prototypes.

Valence's objective is to bring the power of ASICs to all kinds of companies. It offers a range of design and consultancy services to choose from depending on its customers' design expertise or CAD capability.

Valence works with many leaders in the industry; among them Symbios Logic. With Symbios Logic's value-added design center in Hong Kong, customers benefit from Valence and Symbios' technology expertise in mixed-mode standard cell ASIC and full-custom designs.

Management

M. Samejima Director, ASIC Technology, Japan
Ricky Chow Managing Director, U.S.A.
Thomas Wan General Manager, Rest of World

Products and Processes

Valence Semiconductor's product portfolio includes 4-bit and 8-bit CMOS microcontrollers, core logic chipsets, graphics chips, audio and DSP circuits, DRAMs, and SRAMs.
Vanguard International Semiconductor (VIS)

Vanguard International Semiconductor Corporation
Science-Based Industrial Park
123 Park Avenue III
Hsinchu 30077, Taiwan
Telephone: (886) (3) 5770355
Fax: (886) (3) 5785026

IC Manufacturer

Employees 1,600

Regional Headquarters/Representative Locations

North America: VIS Micro Inc. • San Jose, California
Telephone: (408) 577-1833 • Fax: (408) 895-5595

Company Overview and Strategy

Vanguard International Semiconductor (VIS) is focused on the research, development, design, manufacture, packaging, testing, and marketing of standard and application-specific memory ICs, as well as related components and system products.

VIS was formed in 1994 as the result of privatization of the Sub-Micron CMOS Process Technology Development Project, a four-year research project sponsored by the Taiwanese government under the Electronics Research and Service Organization (ERSO) of the Industrial Technology Research Institute (ITRI). Among the devices developed by the project were 4M and 16M DRAMs and 4M SRAMs. In mid-1994, a local consortium led by TSMC bought the lab’s assets, including a small-scale 200mm wafer fab. VIS is now owned 23 percent by TSMC, 32 percent by the Taiwanese government, and the remainder by local investors.

VIS sells its products primarily to customers in the local market, but its customers can also be found in other Southeast Asian countries, Europe, and the United States. International sales represented approximately one-third of total revenues in 1996.

Management

Morris Chang, Ph.D. Chairman
Feng-Churng Tseng, Ph.D. President
S.J. Paul Chien Vice President, Sales and Marketing
Robert Hsieh Vice President, Finance
C.Y. Lu, Ph.D. Vice President, Operations
Steve Pletcher Managing Director, VIS Micro Inc.
Products and Processes

VIS’s semiconductor products include DRAMs, SRAMs, and application-specific memories (ASMs), but its fab currently produces mostly 16M DRAMs using 0.4μm and 0.37μm process technologies.

In March 1996, Vanguard claimed to be the first Taiwanese IC company to develop and show a fully functional 64M DRAM. The prototype part is based on a 0.4μm process, but the company plans to migrate the device down to 0.35μm in 1997. The earliest the 64M device is expected to enter limited production is in the second half of 1997. VIS will also begin shipping 16M and 64M synchronous DRAMs in 1997 and 1998, respectively. An 8M SGRAM for 3D graphics is also said to be under development.

Semiconductor Fabrication Facilities

VIS completed the expansion of Fab 1A and the construction of a second fab (Fab 1B) in Hsinchu. Fab 1B began production of 16M DRAMs on 200mm wafers in 2Q97 and plans to move to 64M DRAMs in 1998.

<table>
<thead>
<tr>
<th>VIS</th>
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<tbody>
<tr>
<td>Science-Based Industrial Park</td>
<td>Science-Based Industrial Park</td>
</tr>
<tr>
<td>Hsinchu, Taiwan</td>
<td>Hsinchu, Taiwan</td>
</tr>
<tr>
<td>Fab 1A</td>
<td>Fab 1B</td>
</tr>
<tr>
<td>Cleanroom size: 62,540 square feet</td>
<td>Cleanroom size: 100,640 square feet</td>
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<tr>
<td>Capacity (wafers/week): 4,000</td>
<td>Capacity (wafers/week): 6,250</td>
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<tr>
<td>Wafer size: 200mm</td>
<td>Wafer size: 200mm</td>
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<tr>
<td>Process: CMOS</td>
<td>Process: CMOS</td>
</tr>
<tr>
<td>Products: DRAMs, SRAMs</td>
<td>Products: DRAMs</td>
</tr>
<tr>
<td>Feature sizes: 0.37μm, 0.4μm (0.35μm capable)</td>
<td>Feature size: 0.35μm (0.25μm capable)</td>
</tr>
<tr>
<td>(Began production in 1Q97)</td>
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</tbody>
</table>
WINBOND ELECTRONICS

Winbond Electronics Corporation
Science-Based Industrial Park
Number 4, Creation Road III
Hsinchu, Taiwan
Telephone: (886) (3) 5770066
Fax: (886) (3) 5792668
Web Site: www.winbond.com.tw

IC Manufacturer

Regional Headquarters/Representative Locations

North America: Winbond Micro Electronics Corporation • San Jose, California
Telephone: (408) 943-6666 • Fax: (408) 943-6668

Financial History ($M)

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<tbody>
<tr>
<td>Sales</td>
<td>120</td>
<td>185</td>
<td>330</td>
<td>676</td>
<td>450</td>
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<tr>
<td>Net Income</td>
<td>12</td>
<td>12</td>
<td>81</td>
<td>342</td>
<td>170</td>
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<tr>
<td>R&amp;D Expenditures</td>
<td>12</td>
<td>19</td>
<td>25</td>
<td>31</td>
<td>35</td>
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<tr>
<td>Capital Expenditures</td>
<td>55</td>
<td>150</td>
<td>254</td>
<td>350</td>
<td></td>
</tr>
<tr>
<td>Employees</td>
<td>1,310</td>
<td>1,630</td>
<td>1,940</td>
<td>2,390</td>
<td>2,400</td>
</tr>
</tbody>
</table>

Company Overview and Strategy

Winbond Electronics was established in 1987 to design, produce, and market VLSI products to personal computer, telecommunications, and consumer electronics industries. Its primary IC products include consumer electronics ICs, clock generators, LAN products, PC and peripheral products, SRAMs, and non-volatile memory products. Winbond is moving beyond its traditional businesses to also provide advanced ICs such as image processing chips and RISC-based embedded processors. In addition, Winbond is planning to boost its foundry business to 40 percent of its present capacity.

Management

Ding-Yuan Yang, Ph.D.  President
Ching-Chu Chang  Executive Vice President
Chung-Shin Hsu  Senior Vice President, DRAM IC Business Group
Yung Chin  Vice President
Michael Liao  Assistant Vice President
Archie Yeh  Assistant Vice President
**Products and Processes**

Winbond’s IC products include memory ICs (256K to 1M high-speed and mixed-voltage high-speed SRAMs, low-power SRAMs, EPROMs, and flash memories), PC I/O controllers, LAN controllers (including Fast Ethernet controllers), telephone dialers, speech synthesizer ICs, 4-bit and 8-bit microcontrollers, 32-bit RISC embedded processors, MPEG-1 and MPEG-2 decoders, and JPEG decoders. The company also provides foundry services for 3.3V and 5.0V CMOS logic with 1P/2P2M and 1P/2P3M options, embedded SRAM and flash memory, and embedded DRAM (starting in 1998).

Winbond entered the RISC embedded processor business in April 1994 by sampling a line of low-cost chips based on Hewlett-Packard's PA-RISC technology. The 0.5μm, 1,000,000-transistor chips are designed for use in printers, X-Windows terminals, and other embedded applications.

Winbond had previously planned to enter the DRAM market during 1997 with a 16M part, but announced its decision to bypass development of a 16M DRAMs and move directly to 64M DRAMs. Winbond licensed both 16M and 64M DRAM technology from Toshiba.

Currently, Winbond’s logic IC products are manufactured using 0.5μm and 1.0μm CMOS process technologies. Its SRAM products are fabricated with 0.4μm and 0.6μm CMOS processes.

**Semiconductor Fabrication Facilities**

In October 1997, Winbond’s Fab III was shut down due to fire damage. The facility was in pilot production and planned to begin volume production in the first part of 1997. The company expects that Fab III could possibly reopen in the later part of 1997. Meanwhile, construction continues on Fab IV, which will share production with Toshiba (see Key Agreements).

<table>
<thead>
<tr>
<th>Winbond Electronics Corporation</th>
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<tbody>
<tr>
<td>Science-Based Industrial Park</td>
<td>Science-Based Industrial Park</td>
</tr>
<tr>
<td>Number 4, Creation Road III</td>
<td>Number 4, Creation Road III</td>
</tr>
<tr>
<td>Hsinchu, Taiwan</td>
<td>Hsinchu, Taiwan</td>
</tr>
<tr>
<td>Fab I</td>
<td>Fab II</td>
</tr>
<tr>
<td>Cleanroom size: 11,680 square feet (Class 10)</td>
<td>Cleanroom size: 35,000 square feet (Class 1)</td>
</tr>
<tr>
<td>Capacity (wafers/week): 5,000</td>
<td>Capacity (wafers/week): 8,750</td>
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<tr>
<td>Wafer size: 125mm</td>
<td>Wafer size: 150mm</td>
</tr>
<tr>
<td>Process: CMOS</td>
<td>Process: CMOS</td>
</tr>
<tr>
<td>Products: ASICs, logic ICs, foundry services</td>
<td>Products: SRAMs, EPROMs, RISC MPUs, multimedia ICs, PC and peripheral ICs, foundry services</td>
</tr>
<tr>
<td>Feature sizes: 0.8μm-5.0μm</td>
<td>Feature sizes: 0.4μm-0.6μm</td>
</tr>
</tbody>
</table>
Winbond Electronics Corporation
Number 4, Creation Road III
Science-Based Industrial Park
Hsinchu, Taiwan
Fab IV (Startup in 1998)
Capacity (wafers/week): 3,750
Wafer size: 200mm
Process: CMOS
Products: DRAMs
Feature sizes: 0.25μm, 0.35μm

Key Agreements

• In 1997, Winbond made a 20 percent equity investment in Taiwanese start-up, Worldwide Semiconductor Manufacturing Co. (WSMC), valued at $73 million. As part of the agreement, Winbond will provide technology and funding for WSMC’s first wafer fab, a dedicated wafer foundry, in return for wafer capacity.

• In 1996, Winbond licensed Aspec Technology Inc.’s Open Design Implementation Technology (DIT). The license includes use of Aspec’s gate array architecture, the EDA design kit, and custom compilers for Winbond’s 0.5μm process. Winbond will use the DIT technology to produce PC chipsets, multimedia products, and HP PA/RISC-based microcontrollers.

• Winbond and Toshiba entered into an alliance in late 1995 for the manufacture and cooperative development of leading-edge semiconductor memory products. The agreement calls for Toshiba to provide Winbond with production technologies for 16M DRAMs and next generation 1M high-speed SRAMs. In addition, Toshiba will use Winbond as a foundry for a portion of its 16M and 64M DRAM capacity. Production will take place in Winbond’s new 200mm Fab IV, 0.35μm fab, which is under construction and will begin operations in 1998. Winbond will also market the DRAMs under its own logo.

• Winbond increased its ownership of Symphony Laboratories from 58 percent to 100 percent. Under the terms of the agreement, Symphony became a division of Winbond, changing its name to Winbond Systems Laboratory.

• Winbond acquired flash technology from Silicon Storage Technology and the two companies are developing low-voltage EPROM chips.

• Winbond licensed Hewlett-Packard’s PA-RISC microprocessor technology and has the right to design, manufacture, and sell the chips for use in low-priced, high-volume products such as X-terminals, printers, and multimedia applications.