

## ANGSTREM

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

### IC Manufacturer

Employees 3,500

### 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**

Angstrom

103460 Zelenograd

Russia

Cleanroom size: 21,500 square feet (Class 10)

Capacity (wafers/week): 11,500

Wafer size: 100mm

Processes: CMOS, bipolar, BiCMOS

Products: Consumer electronics ICs, logic ICs

Feature sizes: 1.2 $\mu$ m-2.0 $\mu$ m (installing 0.8 $\mu$ m process)

Angstrom began the construction of a 150mm wafer fab in 1989 that was originally planned for completion in 1990. However, it was put on hold during the 1990-1991 timeframe due to the collapse of the former Soviet Union. Angstrom now plans for the facility to be operational in 1996. It will feature nearly 25,000 square feet of Class 10 cleanroom space for the production of ICs for consumer electronics, telecommunications, and data processing using 0.8 $\mu$ m to 2.0 $\mu$ m CMOS, bipolar, and BiCMOS process technologies.

## BHARAT ELECTRONICS

**Bharat Electronics Ltd.**  
**Integrated Circuits Division**  
**Bangalore Complex**  
**Jalahalli, Bangalore 560 013**  
**India**  
**Telephone: (91) (80) 3347760**  
**Fax: (91) (80) 3348322/5927**

**U.S. Representative:**  
**Bharat Electronics Ltd.**  
**53 Hilton Avenue**  
**Garden City, New York 11530**  
**Telephone: (516) 248-4020**  
**Fax: (516) 741-5894**

### IC Manufacturer

Employees (Integrated Circuits Division)      210

### Company Overview and Strategy

Bharat Electronics (BE) 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 of about \$300 million. Its products include radar, communication, and broadcast/television equipment; semiconductor devices; high-power vacuum devices; and television tubes.

BE'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.

### Management

Y. Gopala Rao	General Manager, Components
R. Ranganathan	Additional General Manager, Semiconductors
V. V. R. Sastry	Additional General Manager, Marketing
V. Muthuswamy	Deputy General Manager, ICs
H.V. Ananda, Ph.D.	Deputy General Manager, Design Centre and Mask Fab

### 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, 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: 5.0 $\mu$ m

## CHARTERED SEMICONDUCTOR MANUFACTURING (CSM)

Chartered Semiconductor  
Manufacturing Ltd. (CSM)  
60 Woodlands Industrial Park  
Street 2  
Singapore 738406  
Telephone: (65) 362-2838  
Fax: (65) 362-2938

U.S. Representative:  
Chartered Semiconductor  
Manufacturing, Inc.  
2290 North First Street, Suite 101  
San Jose, California 95131  
Telephone: (408) 456-2720  
Fax: (408) 456-2712

### IC Manufacturer

#### Financial History (\$M)

	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>
Sales	30	50	100	160	285
Capital Expenditures				100	550
Employees	350	450	600	600	1,800

#### 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 devices for companies in graphics, memory, computing, communications, and networking applications.

Chartered was established in 1987 by Singapore Technologies Semiconductors (STS), a technology-based engineering group made up of four companies that provide a full range of services for the semiconductor industry. STS is a strategic business division of Singapore Technologies, which comprises more than 100 companies.

Chartered offers submicron wafer processing for the broad-based digital logic market, and has a high level of expertise and experience in mixed-signal and non-volatile technologies.

## Management

Tan Bock Seng	President and Chief Executive Officer
Tom Gurnee	Chief Operating Officer
Kwek Buck Chye	Chief Financial and Administrative Officer
Chris Chi	Senior Vice President, Operations
Choong Chan Yong	Vice President, Business Development
Steve Della Rocchetta	Vice President, U.S. Sales and Marketing
C.K. Lau	Director, Research and Development

## Products and Processes

Chartered's process capabilities include a full complement of advanced CMOS processes ranging from 0.8 $\mu$ m to 0.35 $\mu$ m line widths and a variety of technologies including digital, mixed-signal, EEPROM, ROM, SRAM, and flash memory. The company's newest fab facility (Fab II) began operations in November 1995, producing such devices as FPGAs, logic devices, DSPs, graphics accelerators, and chips for communications, computing, and networking.

## Semiconductor Fabrication Facilities

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  
 Processes: CMOS  
 Products: Foundry services  
 Feature sizes: 0.8 $\mu$ m-0.6 $\mu$ m

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: 0.6 $\mu$ m-0.35 $\mu$ m (0.25 $\mu$ m 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  
 Processes: CMOS  
 Products: Foundry services  
 Feature sizes: 0.5 $\mu$ m, 0.25 $\mu$ m (0.18 $\mu$ m capability)  
 (To be operational by 1997).

### **Key Agreements**

- Since early 1994, Chartered has made several agreements with other companies that have involved investments in Chartered's Fab II facility in exchange for guaranteed wafer output. In February 1994, Actel and Brooktree each invested \$10 million in the project, and Rockwell International \$30 million. In February 1995, Alliance Semiconductor invested \$10 million to obtain a stake in the facility. In March 1995, LSI Logic announced it had obtained access to Chartered's fab capacity with a \$20 million investment. In April 1995, Standard Microsystems Corporation said it would invest \$20 million for wafer capacity, and in May 1995, Analog Devices announced it would make a similar investment, bringing the total equity investment in the plant to over \$100 million.
- In 1994, Chartered signed an agreement with VLSI Technology for technology consultation and wafer supply.
- Chartered and Toshiba Corporation have a licensing agreement for 0.5 $\mu$ m CMOS technology, and Toshiba has a minority stake in Chartered.

## FARADAY TECHNOLOGY

**Faraday Technology Corporation**  
7F, 9, Prosperity First Road  
Science-Based Industrial Park  
Hsinchu, Taiwan  
Telephone: (886) 35-787888  
Fax: (886) 35-787889

**U.S. Representative:**  
**ASIC Semiconductor International Corp.**  
993 Highland Circle  
Los Altos, California 94024  
Telephone: (415) 968-8855  
Fax: (415) 968-8885

### Fabless IC Supplier

Employees 40

### 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, 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 President

### Products and Processes

Faraday's ASIC products include high-performance, high-density 0.6 $\mu$ m triple-layer-metal CMOS gate arrays and 0.5 $\mu$ m triple-layer-metal CMOS standard cells.

#### Gate Arrays

- FG6000A series—0.6 $\mu$ m 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 (2Q96)

- 0.4 $\mu$ m double or triple 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—0.8 $\mu$ m 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
- FS7000A series—0.5 $\mu$ m 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: 230ps

**Semiconductor Fabrication Facilities**

Faraday's ASICs are manufactured by UMC 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) (35) 784888  
 Fax: (886) (35) 770879

U.S. Representative:  
 Holmate Technology Corporation  
 2342 Harris Way  
 San Jose, California 95131  
 Telephone: (408) 894-9046  
 Fax: (408) 894-0838

### IC Manufacturer

#### Financial History (\$M)

	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>
Sales	32	45	58	70	85
Capital Expenditures			8	10	25
Employees	550	580	660	680	690

#### Company Overview and Strategy

Holtek Microelectronics Inc. was established in 1983 as an ASIC design house, but in 1989 added a wafer fab. Today, Holtek is a manufacturer of not only ASICs, but also consumer electronics ICs, ranging from sound-effect ICs to microcontrollers.

Roughly 60 percent of Holtek's sales are from ASICs, including low-end gate arrays. The company has been putting more emphasis on its standard products, which include 4-bit microcontrollers, LCD drivers, encoder/decoder ICs, and peripheral and piano-sound chips.

Approximately 80 percent of the company's sales come from customers in Hong Kong, Korea, Singapore, and Taiwan, while only one to two percent are derived in the U.S. Holtek is hoping to expand its sales in the U.S. in the future.

#### Management

Keith Wu                                      President  
 James Y. Ting                                Assistant Manager, Sales

#### Products and Processes

Holtek produces ASICs (200 to 20,000 gates), 4-bit MCUs, encoder/decoder ICs, voltage regulators, voltage detectors, LCD drivers, PC peripheral ICs, telephone dialers, and voice/sound ICs.

**Semiconductor Fabrication Facilities**

Holtek Microelectronics Inc.  
No. 5 Creation Road II  
Science-Based Industrial Park  
Hsinchu, Taiwan  
Cleanroom: 16,500 square feet (Class 10)  
Capacity (wafers/week): 6,250  
Wafer size: 125mm  
Processes: CMOS, NMOS  
Products: MCUs, ASICs, ASSPs, linear ICs  
Feature sizes: 1.0 $\mu$ m-5.0 $\mu$ m

# 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 circuit 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 3.0 $\mu$ m to 2.0 $\mu$ m technology, and for bipolar, it uses 100mm wafers with 5.0 $\mu$ m to 3.0 $\mu$ m technology and 125mm wafers with 3.0 $\mu$ m to 2.0 $\mu$ m 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 currently constructing a new 150mm wafer fab for the production of MOS ICs with 0.8 $\mu$ m to 1.0 $\mu$ m feature size technology from AT&T Microelectronics (now Lucent Technologies). Scheduled for completion in 1997, the fab will have the capacity to produce about 2,500 wafers per week.

China Huajing Electronics Group

14 Liangxi Road

Wuxi, Jiangsu, China

Wafer sizes: 100mm, 125mm (upgrading to 150mm)

Processes: MOS, bipolar, BiCMOS

Products: Linear ICs, ASICs, MPUs, MCUs, memory ICs, BiCMOS ICs, discretes, hybrids

Feature sizes: 2.0 $\mu$ m-5.0 $\mu$ m (upgrading to submicron), 1.2 $\mu$ m (R&D)

**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) (35) 774945  
 Fax: (886) (35) 774305

U.S. Representative:  
 The Summa Group Ltd.  
 One California Street, 19th Floor  
 San Francisco, California 94111  
 Telephone: (415) 288-0390  
 Fax: (415) 288-0399

### IC Manufacturer

### Financial History (\$M)

	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>
Semiconductor Sales	101	112	128	150
IC Sales	91	97	108	125
Discrete Sales	10	15	20	25
Capital Expenditures		5	80	400
Employees	850	850	1,100	1,150

### 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

### Memory ICs

ROMs up to 16M in density, EPROMs up to 256K, EEPROMs up to 1M, SRAMs up to 1M

### Microcomponent ICs

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

### Consumer ICs

Speech synthesizer and recognition, watch, and calculator circuits

### Foundry Service

0.5 $\mu$ m to 3.0 $\mu$ m silicon gate

### ASICs

Gate arrays and standard cells

### CCDs

Image sensors, bar code chipsets, fax scanner ICs

### Telecom ICs

Dialers and controllers, receivers, cordless phone controllers

HMC's current facilities operate with CMOS, BiCMOS, and NMOS processes down to 0.5 $\mu$ m.

## Semiconductor Fabrication Facilities

Hualon Microelectronics Corporation

Science-Based Industrial Park

Number 1, R&D 4th Road

Hsinchu, Taiwan

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: 0.5 $\mu$ m, 0.6 $\mu$ m CMOS, BiCMOS; 0.8 $\mu$ m CMOS; 1.0 $\mu$ m CMOS, BiCMOS; 1.2 $\mu$ m NMOS

Hualon is building a new \$400 million 200mm wafer fab that will be operational by the end of 1996. It will consist of two modules that will each process 3,750 wafers per week.

## 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**  
**10th Floor, Hyundai Jeonja Building**  
**66, Jeokseon-Dong, Chongro-Ku**  
**Seoul, Korea 110-052**  
**Telephone: (82) (2) 398-4560/6**  
**Fax: (82) (2) 733-2145/7**  
**Web Site: www.hei.co.kr**

**U.S. Representative:**  
**Hyundai Electronics America (HEA)**  
**Semiconductor Division**  
**510 Cottonwood Drive**  
**Milpitas, California 95035**  
**Telephone: (408) 232-8000**  
**Fax: (408) 232-8131**  
**Web Site: www.he.com**

### IC Manufacturer

#### Financial History (\$M)

	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>
Corporate					
Sales (HEI)		1,150	1,575	2,600	6,100
Semiconductor					
Sales	260	455	1,020	1,750	4,350
Capital Expenditures	155	225	400	600	1,360

#### 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 up 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.



**Management**

Hyundai Electronics Industries

Joo-Yong Kim	President and Chief Executive Officer
Choo Hoon	Executive Vice President
Chang Seock Han	Senior Vice President, Semiconductor Operations
S.I. Kim	Senior Vice President, Memory IC Division
Wi Sik Min	Senior Vice President, System IC Division and System IC R&D Lab
Kye Hwan Oh	Vice President, Semiconductor R&D

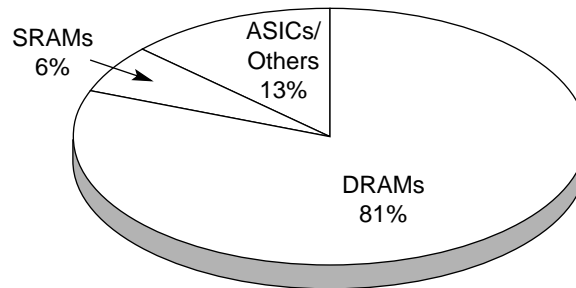
Hyundai Electronics America

Y.H. Kim	Chief Executive Officer
W. Tom Anderson	President, Flash Memory Division
Dennis McKenna	Senior Vice President, Semiconductor Marketing and Sales
Steve Grossman	Vice President, Marketing, Flash Memory Division

**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.

<p><b>MOS MEMORY</b></p> <table border="0"> <tr><td><input checked="" type="checkbox"/></td><td>DRAM</td></tr> <tr><td><input checked="" type="checkbox"/></td><td>SRAM</td></tr> <tr><td><input checked="" type="checkbox"/></td><td>Flash Memory</td></tr> <tr><td><input checked="" type="checkbox"/></td><td>EPROM</td></tr> <tr><td><input checked="" type="checkbox"/></td><td>ROM</td></tr> <tr><td><input checked="" type="checkbox"/></td><td>EEPROM</td></tr> <tr><td><input type="checkbox"/></td><td>Other (Including Non-Volatile RAM)</td></tr> </table>	<input checked="" type="checkbox"/>	DRAM	<input checked="" type="checkbox"/>	SRAM	<input checked="" type="checkbox"/>	Flash Memory	<input checked="" type="checkbox"/>	EPROM	<input checked="" type="checkbox"/>	ROM	<input checked="" type="checkbox"/>	EEPROM	<input type="checkbox"/>	Other (Including Non-Volatile RAM)	<p><b>ANALOG</b></p> <table border="0"> <tr><td><input type="checkbox"/></td><td>Amplifier</td></tr> <tr><td><input type="checkbox"/></td><td>Interface</td></tr> <tr><td><input type="checkbox"/></td><td>Consumer/Automotive</td></tr> <tr><td><input type="checkbox"/></td><td>Voltage Regulator/Reference</td></tr> <tr><td><input type="checkbox"/></td><td>Data Conversion</td></tr> <tr><td><input type="checkbox"/></td><td>Comparator</td></tr> <tr><td><input type="checkbox"/></td><td>Other (Includes Telecom)</td></tr> </table>	<input type="checkbox"/>	Amplifier	<input type="checkbox"/>	Interface	<input type="checkbox"/>	Consumer/Automotive	<input type="checkbox"/>	Voltage Regulator/Reference	<input type="checkbox"/>	Data Conversion	<input type="checkbox"/>	Comparator	<input type="checkbox"/>	Other (Includes Telecom)
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<p><b>MOS LOGIC</b></p> <table border="0"> <tr><td><input type="checkbox"/></td><td>General Purpose Logic</td></tr> <tr><td><input checked="" type="checkbox"/></td><td>Gate Array</td></tr> <tr><td><input checked="" type="checkbox"/></td><td>Standard Cell</td></tr> <tr><td><input checked="" type="checkbox"/></td><td>Field Programmable Logic</td></tr> <tr><td><input checked="" type="checkbox"/></td><td>Other Special Purpose Logic</td></tr> </table>	<input type="checkbox"/>	General Purpose Logic	<input checked="" type="checkbox"/>	Gate Array	<input checked="" type="checkbox"/>	Standard Cell	<input checked="" type="checkbox"/>	Field Programmable Logic	<input checked="" type="checkbox"/>	Other Special Purpose Logic	<p><b>DIGITAL BIPOLAR</b></p> <table border="0"> <tr><td><input type="checkbox"/></td><td>Bipolar Memory</td></tr> <tr><td><input type="checkbox"/></td><td>General Purpose Logic</td></tr> <tr><td><input type="checkbox"/></td><td>Gate Array/Standard Cell</td></tr> <tr><td><input type="checkbox"/></td><td>Field Programmable Logic</td></tr> <tr><td><input type="checkbox"/></td><td>Other Special Purpose Logic</td></tr> <tr><td><input type="checkbox"/></td><td>MPU/MCU/MPR</td></tr> </table>	<input type="checkbox"/>	Bipolar Memory	<input type="checkbox"/>	General Purpose Logic	<input type="checkbox"/>	Gate Array/Standard Cell	<input type="checkbox"/>	Field Programmable Logic	<input type="checkbox"/>	Other Special Purpose Logic	<input type="checkbox"/>	MPU/MCU/MPR						
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<input type="checkbox"/>	MPU/MCU/MPR																												
<p><b>MOS MICROCOMPONENT</b></p> <table border="0"> <tr><td><input type="checkbox"/></td><td>MPU</td></tr> <tr><td><input checked="" type="checkbox"/></td><td>MCU</td></tr> <tr><td><input checked="" type="checkbox"/></td><td>MPR</td></tr> <tr><td><input type="checkbox"/></td><td>DSP</td></tr> </table>	<input type="checkbox"/>	MPU	<input checked="" type="checkbox"/>	MCU	<input checked="" type="checkbox"/>	MPR	<input type="checkbox"/>	DSP	<p><b>OTHER</b></p> <table border="0"> <tr><td><input checked="" type="checkbox"/></td><td>Full Custom IC</td></tr> <tr><td><input type="checkbox"/></td><td>Discrete</td></tr> <tr><td><input type="checkbox"/></td><td>Optoelectronic</td></tr> </table>	<input checked="" type="checkbox"/>	Full Custom IC	<input type="checkbox"/>	Discrete	<input type="checkbox"/>	Optoelectronic														
<input type="checkbox"/>	MPU																												
<input checked="" type="checkbox"/>	MCU																												
<input checked="" type="checkbox"/>	MPR																												
<input type="checkbox"/>	DSP																												
<input checked="" type="checkbox"/>	Full Custom IC																												
<input type="checkbox"/>	Discrete																												
<input type="checkbox"/>	Optoelectronic																												



**1995 Semiconductor Sales  
by Device Type**

#### Memory ICs

- 256K, 1M, 4M, 16M, and 64M DRAMs (low voltage and wide versions are available).
- 16M 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 are being developed. The first parts are expected to be introduced in 2H96.

#### ASICs

- Gate arrays based on a sea-of-gates architecture and 1.2 $\mu$ m and 0.8 $\mu$ m CMOS double-level-metal technologies or 0.8 $\mu$ m triple-level-metal technology. Usable gate counts vary from 800 to 200,000 gates.
- Standard cells based on 0.8 $\mu$ m 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**

Near the end of 1995, Hyundai broke ground on its first U.S.-based wafer fab—a \$1.3 billion 200mm, submicron CMOS production facility. Located in Eugene, Oregon, the Fab E-4 factory will initially manufacture 16M and 64M DRAMs beginning in 1H97. The first phase (of three phases) will have a production capacity of 7,500 200mm wafers per week. Additionally, construction was begun on a new fab in Icheon, Korea, that is also expected to begin operations in 1997.

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: 125mm  
Process: CMOS  
Products: SRAMs, EPROMs, EEPROMs,  
ASICs, logic ICs  
Feature sizes: 1.0 $\mu$ m, 1.2 $\mu$ m

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: 150mm  
Process: CMOS  
Products: DRAMs, SRAMs  
Feature sizes: 0.45 $\mu$ m, 0.6 $\mu$ m, 0.8 $\mu$ m

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: 0.6 $\mu$ m-0.8 $\mu$ m

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: 0.5 $\mu$ m

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: 0.35 $\mu$ m, 0.5 $\mu$ m

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-3  
Capacity (wafers/week): 6,250  
Wafer size: 200mm  
Process: CMOS  
Products: DRAMs  
Feature sizes: 0.35 $\mu$ m, 0.5 $\mu$ m

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: 0.35 $\mu$ m-0.6 $\mu$ m

Hyundai Electronics America  
 Eugene, Oregon  
 Fab E-4  
 Capacity (wafers/week): 7,500  
 Wafer size: 200mm  
 Process: CMOS  
 Products: DRAMs  
 Feature size: 0.35 $\mu$ m  
 (Operations are scheduled to begin in 1H97)

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: 0.7 $\mu$ m-2.0 $\mu$ m

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: 0.5 $\mu$ m-2.0 $\mu$ m

### Key Agreements

- Hyundai and its subsidiary Symbios Logic formed an alliance with Compass Design Automation in early 1995 to develop 0.35 $\mu$ m 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 1.2 $\mu$ m and 2.0 $\mu$ m double-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**

**U.S. Representative:**  
**LG Semicon America, Inc.**  
**3003 North First Street**  
**San Jose, California 95134-2004**  
**Telephone: (408) 432-5000**  
**Fax: (408) 432-6067**

### IC Manufacturer

#### Financial History (\$M)

	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>
Corporate					
Sales (Goldstar Co.)	4,600	4,700	5,400	6,300	10,000
Semiconductor					
Sales	360	690	1,000	1,800	3,600
Capital Expenditures	380	320	200	300	2,100
Employees	3,500	3,600	3,750	3,900	6,600

#### 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
Y.S. Kang	Vice President and President, LG Semicon America
Y.K. Kim	Executive Director, Worldwide Marketing
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 16M 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 1995, approximately 88 percent of total semiconductor sales were from memory devices, primarily DRAMs. Through an early 1995 agreement with SanDisk Corp., LG entered into the flash memory market in 2H95 (See Key Agreements).

**MOS MEMORY**

<input checked="" type="checkbox"/>	DRAM
<input checked="" type="checkbox"/>	SRAM
<input checked="" type="checkbox"/>	Flash Memory
<input type="checkbox"/>	EPROM
<input checked="" type="checkbox"/>	ROM
<input type="checkbox"/>	EEPROM
<input type="checkbox"/>	Other (Including Non-Volatile RAM)

**ANALOG**

<input checked="" type="checkbox"/>	Amplifier
<input type="checkbox"/>	Interface
<input type="checkbox"/>	Consumer/Automotive
<input checked="" type="checkbox"/>	Voltage Regulator/Reference
<input checked="" type="checkbox"/>	Data Conversion
<input checked="" type="checkbox"/>	Comparator
<input checked="" type="checkbox"/>	Other (Includes Telecom)

**MOS LOGIC**

<input checked="" type="checkbox"/>	General Purpose Logic
<input checked="" type="checkbox"/>	Gate Array
<input checked="" type="checkbox"/>	Standard Cell
<input type="checkbox"/>	Field Programmable Logic
<input type="checkbox"/>	Other Special Purpose Logic

**DIGITAL BIPOLAR**

<input type="checkbox"/>	Bipolar Memory
<input checked="" type="checkbox"/>	General Purpose Logic
<input type="checkbox"/>	Gate Array/Standard Cell
<input type="checkbox"/>	Field Programmable Logic
<input type="checkbox"/>	Other Special Purpose Logic
<input type="checkbox"/>	MPU/MCU/MPR

**MOS MICROCOMPONENT**

<input checked="" type="checkbox"/>	MPU
<input checked="" type="checkbox"/>	MCU
<input checked="" type="checkbox"/>	MPR
<input type="checkbox"/>	DSP

**OTHER**

<input checked="" type="checkbox"/>	Full Custom IC
<input type="checkbox"/>	Discrete
<input type="checkbox"/>	Optoelectronic

**Semiconductor Fabrication Facilities**

LG Semicon Co., Ltd.  
 Chungju Facility  
 Cleanroom size: 170,790 square feet  
 Capacity (wafers/week): 30,000  
 Wafer sizes: 150mm, 200mm  
 Processes: CMOS, MOS  
 Products: DRAMs, SRAMs, ROMs, ASICs,  
 flash memories  
 Feature sizes: 0.35µm-1.0µm

LG Semicon Co., Ltd.  
 Gumi Facility  
 Cleanroom size: 44,463 square feet  
 Capacity (wafers/week): 10,000  
 Wafer sizes: 100mm, 125mm  
 Processes: NMOS, CMOS, bipolar  
 Products: SRAMs, logic and linear ICs, ASICs,  
 MPUs, MCUs  
 Feature sizes: 0.8µm, 1.0µm, 1.2µm

## Key Agreements

- In March 1996, LG Semicon announced an agreement with Crosspoint Solutions involving both licensing and manufacturing of Crosspoint's FPGAs.
- 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 0.5 $\mu$ m 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. In 1994, LG Semicon and Hitachi expanded their relationship, signing a new agreement to provide the Korean company with Hitachi's 64M DRAM designs. The two companies are also negotiating a partnership concerning Hitachi's 32-bit SH Family of RISC microprocessors.

In January 1996, LG Semicon and Hitachi announced plans to build a joint wafer fab facility in Kedah, Malaysia, for the production of 16M and 64M DRAMs. The \$1.4 billion plant is expected to produce 7,500 200mm wafers per week, using 0.3 $\mu$ m process technology. It is scheduled to begin production in early 1998.

- Motorola signed an agreement to second-source 4M DRAMs from LG Semicon and expects the pact to be expanded to encompass 16M DRAMs.
- 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) (35) 788-888  
 Fax: (886) (35) 788-887

**U.S. Representative:**  
**Macronix America Co. Ltd.**  
 1338 Ridder Park Drive  
 San Jose, California 95131  
 Telephone: (408) 453-8088  
 Fax: (408) 453-8488

### IC Manufacturer

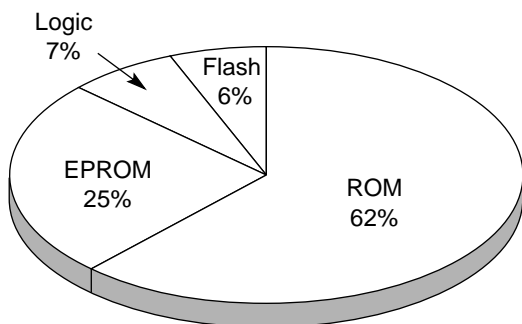
#### Financial History (\$M)

	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>
Sales	29	63	143	221	328
Net Income	(2)	(23)	18	35	114
Capital Expenditures			20	42	113
Employees		800	980	1,440	1,700

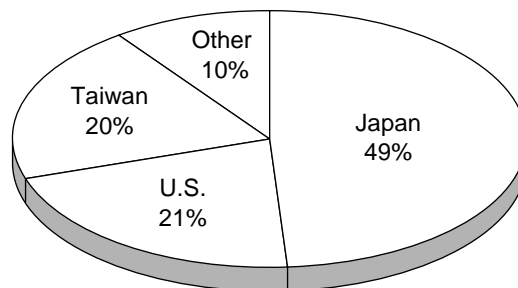
#### Company Overview and Strategy

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

The company is divided into two groups: the Memory Product Group, which designs and develops nonvolatile memory ICs, and the Logic Product Group, which designs and develops logic ICs for PC, communications, and high-end consumer applications.



1995 Sales by Product Type



1995 Sales by Geographic Region



## Management

Miin Wu	President
Ray Mak	Vice President
Chris Kao	Vice President
Y.S. Tan	Vice President
Tom Yiu	Vice President

## Products and Processes

Macronix International's products include flash memories (1M to 16M capacities), serial EEPROMs, EPROMs (256K to 4M), mask ROMs (1M to 16M), 8-bit and 16-bit microcontrollers, 32-bit RISC microprocessors, 16-bit DSPs, graphics/video coprocessors, clock generators, and Ethernet ICs. In 1996, the company plans to introduce 4M and 16M single 3-volt flash memories, 32M high-speed ROMs, and 64M ROMs.

## Semiconductor Fabrication Facilities

Macronix International Co., Ltd.

No. 3, Creation Road III

Science-Based Industrial Park

Hsinchu, Taiwan

Fab I

Cleanroom size: 28,000 square feet (Class 1)

Capacity (wafers/week): 8,250

Wafer size: 150mm

Process: CMOS

Products: EPROMs, ROMs, EEPROMs, flash memories,  
DSPs, MCUs, MPUs, graphic/video coprocessors,  
clock generators, and LAN devices

Feature sizes: 0.4 $\mu$ m-0.8 $\mu$ m

Macronix began construction of Fab II, a \$1.13 billion 200mm wafer plant in Hsinchu, in July 1995. It should be completed by the end of 1997 with the capability to produce 10,000 wafers per week.

## Key Agreements

- In April 1996, Macronix and IBM announced a mutual agreement on the cross licensing of patents.
- Macronix International licensed Mips Computer Systems' RISC MPU architecture.
- Macronix jointly developed 4M and 16M flash memory devices and 4M ROMs with its Japanese partner NKK Corporation.

# MIKRON

**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.

Roughly half of the company's production output is sold in international markets.

### Management

Gennady Ya. Krasnikov	General Director
Pavel S. Prikhodko	Deputy General Director
Evgenii Gornev	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 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:  $\geq 0.8\mu\text{m}$

### **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) (35) 783344**  
**Fax: (886) (35) 792838**

**U.S. Representative:**  
**Mosel-Vitelic Corporation**  
**3910 North First Street**  
**San Jose, California 95134-1501**  
**Telephone: (408) 433-6000**  
**Fax: (408) 433-0952**

## IC Manufacturer

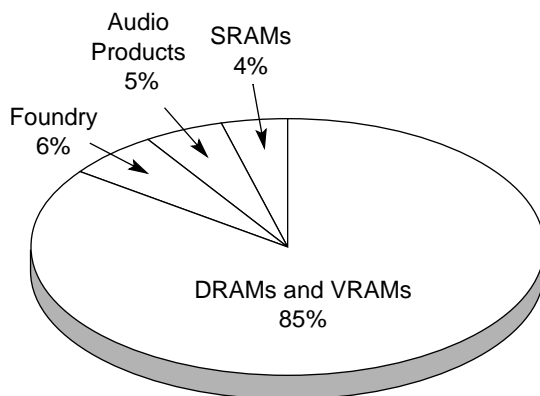
### Financial History (\$M)

	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>
Sales	165	213	238	285	540
Net Income			38	50	n/a
Employees			880	1,411	1,800

### 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, consumer chips, 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.



**1995 Sales by Product Type**

## Management

Hung-Chiu Hu	Chairman and President
William Chen	Vice President, Administration and Finance
John Fulton	Vice President, Sales
John Seto	Vice President, Memory Products
Rajit Shah	Vice President, Marketing
Nasa Tsai	Vice President, Fab Operations
Hsing Tuan	Vice President, Product Development

## Products and Processes

Mosel-Vitellic offers specialized DRAMs (256K to 4M), standard SRAMs (16K to 1M), high-speed SRAMs (64K to 1M), VRAMs (256K and 1M), FIFOs and other specialty memories, SIMMs, and voice chips. More than half of the company's DRAMs are sold in North America.

## Semiconductor Fabrication Facilities

In October 1995, Mosel-Vitellic began the construction of a 66,000 square-foot manufacturing facility in the Hsinchu Science-Based Industrial Park, Taiwan. The new wafer fab is scheduled to begin production in July 1997, with a potential capacity of about 7,000 wafers per week. In addition to IC manufacturing, the plant will be used for product testing and package assembly.

Mosel-Vitellic Inc.  
 1 Creation Road I  
 Science-Based Industrial Park  
 Hsinchu, Taiwan  
 Capacity (wafers/week): 7,500  
 Wafer size: 150mm  
 Process: CMOS  
 Products: Memory ICs  
 Feature sizes: 0.4 $\mu$ m-0.6 $\mu$ m

Mosel-Vitellic Inc.  
 Tai Po Industrial Estate  
 19 Dai Fu Street  
 Tai Po, NT, Hong Kong  
 Telephone: (852) 665-4883  
 Capacity (wafers/week): 875  
 Wafer size: 100mm  
 Process: CMOS  
 Products: Consumer ICs  
 Feature size: 1.5 $\mu$ m

Mosel-Vitellic Inc.  
 Science-Based Industrial Park  
 Hsinchu, Taiwan  
 Cleanroom size: 100,000 square-feet  
 Capacity (wafers/week): 7,000  
 Wafer size: 200mm  
 Process: CMOS  
 Products: Memory ICs  
 Feature size: 0.35 $\mu$ m  
 (Scheduled to begin production in mid-1997.)

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

**Key Agreements**

- Mosel-Vitelic has plans to form a DRAM alliance with Siemens AG and other parties. Under the proposed plan, Siemens would transfer 64M DRAM technology to Mosel's 200mm fab, which is currently under construction. In return, Siemens would gain access to Mosel-Vitelic's DRAM foundry capacity and possibly take a 30 percent equity stake in Mosel.
- Mosel-Vitelic has a foundry partnership with Oki. The companies also have an agreement providing Mosel-Vitelic with a license to use Oki's 0.6 $\mu$ m and 0.45 $\mu$ m process technologies. In 2Q93, it was agreed that Oki would transfer its shrink-version 4M DRAM technology to Mosel-Vitelic and in October 1994, Oki agreed to transfer its 16M technology.

## **SOUTH AFRICAN MICRO-ELECTRONIC SYSTEMS (SAMES)**

**South African Micro-Electronic Systems Pty., Ltd.**  
**2 Rooibok**  
**Koedoespoort Industrial Area**  
**Pretoria, South Africa**  
**Telephone: (27) (12) 333-6021**  
**Fax: (27) (12) 333-8071**

**IC Manufacturer**

### **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. However, in 1995, Austria Mikro Systeme International AG (AMS) acquired a 51 percent controlling interest in SAMES and IDC holds the remaining 49 percent of the shares.

As part of the AMS acquisition, SAMES will receive free technology transfers from AMS and the two companies will 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 2.0 $\mu$ m to 1.0 $\mu$ m 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 1.0 $\mu$ m, 1.2 $\mu$ m, and 2.0 $\mu$ m manufacturing processes in operation.

**Semiconductor Fabrication Facilities**

SAMES

Pretoria, South Africa

Cleanroom size: 15,000 square feet (Class 10)

Wafer size: 150mm

Processes: CMOS, BiCMOS

Products: ASICs, foundry services

Feature sizes: 1.0 $\mu$ m, 1.2 $\mu$ m, 2.0 $\mu$ m



## 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](http://www.samsung.com)

**U.S. Representative:**  
**Samsung Semiconductor, Inc.**  
 3655 North First Street  
 San Jose, California 95134-1713  
 Telephone: (408) 954-7000  
 Fax: (408) 954-7286

### IC Manufacturer

#### Financial History (\$M)

	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>
Corporate					
Sales (SEC)	7,200	7,900	10,300	14,600	20,000
Semiconductor					
Sales	1,590	1,865	3,104	5,002	8,419
IC Sales	1,487	1,745	2,949	4,815	8,183
Discrete Sales	103	120	155	187	236
R&D Expenditures	225	190	240	464	560
Capital Expenditures	435	550	930	1,300	2,200

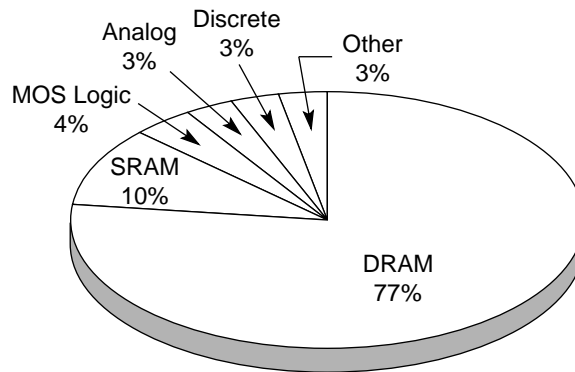
#### Company Overview and Strategy

Founded in 1969, Samsung Electronics Co. (SEC) is a business within The Samsung Group, a \$64 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. Furthermore, in December 1994, Samsung announced it was the first to ship a fully functional 256M DRAM sample.

The many years of DRAM device and manufacturing investments have paid rich rewards for Samsung. Today, it 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 devices. In the future, the company hopes to shift to a 50:50 ratio of memory to non-memory device production.



**1995 Semiconductor Sales  
by Device Type**

**Management**

**Samsung Semiconductor (Korea)**

- |              |  |
|--------------|--|
| Yoon-Woo Lee | President and Chief Executive Officer            |
| Dae-Jae Jin  | Executive Vice President, Memory Division        |
| Sung-Kyu Lee | Executive Vice President, Manufacturing Division |
| Y.K. Lee     | Executive Vice President, ASIC Division          |
| Hee-Sun Sul  | Executive Vice President, Sales and Marketing    |
| C.H. Choi    | Vice President, Administration                   |
| H0-Moon Kang | Vice President, Micro Division                   |
| J.K. Lee     | Vice President, Research and Development         |
| S.W. Lee     | Vice President, Special Business Division        |
| M.H. Tan     | Vice President, Quality Assurance                |

**Samsung Semiconductor, Inc. (U.S.)**

- |                      |   |
|----------------------|---|
| Young Bae Rha        | President and Chief Executive Officer                             |
| W. Keith McDonald    | Senior Vice President, Sales and Marketing                        |
| Yong Eue Park, Ph.D. | Senior Vice President, Engineering and Strategic Product Planning |
| Nam Yong Cho         | Vice President, Supporting Services                               |
| Robin L. Crandell    | Vice President, Sales   |
| Mark A. Ellsberry    | Vice President, Marketing, Memory Products                        |
| John Weekley         | Director, Marketing, Micro Products                               |

## Products and Processes

Samsung's semiconductor products include DRAMs, SRAMs, VRAMs, window RAMs (WRAMs), synchronous DRAMs (SDRAMs), flash memories, mask ROMs, 32-bit RISC MPUs, 4/8-bit MCUs, MPRs, 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 ICs, and discrete devices. All devices are manufactured using CMOS, BiCMOS, bipolar, and GaAs process technologies.

<b>MOS MEMORY</b>		<b>ANALOG</b>	
<input checked="" type="checkbox"/>	DRAM	<input checked="" type="checkbox"/>	Amplifier
<input checked="" type="checkbox"/>	SRAM	<input checked="" type="checkbox"/>	Interface
<input checked="" type="checkbox"/>	Flash Memory	<input checked="" type="checkbox"/>	Consumer/Automotive
<input type="checkbox"/>	EPROM	<input checked="" type="checkbox"/>	Voltage Regulator/Reference
<input checked="" type="checkbox"/>	ROM	<input checked="" type="checkbox"/>	Data Conversion
<input type="checkbox"/>	EEPROM	<input checked="" type="checkbox"/>	Comparator
<input checked="" type="checkbox"/>	Other (Including Non-Volatile RAM)	<input checked="" type="checkbox"/>	Other (Includes Telecom)
<b>MOS LOGIC</b>		<b>DIGITAL BIPOLAR</b>	
<input checked="" type="checkbox"/>	General Purpose Logic	<input type="checkbox"/>	Bipolar Memory
<input checked="" type="checkbox"/>	Gate Array	<input type="checkbox"/>	General Purpose Logic
<input checked="" type="checkbox"/>	Standard Cell	<input type="checkbox"/>	Gate Array/Standard Cell
<input type="checkbox"/>	Field Programmable Logic	<input type="checkbox"/>	Field Programmable Logic
<input checked="" type="checkbox"/>	Other Special Purpose Logic	<input type="checkbox"/>	Other Special Purpose Logic
<input type="checkbox"/>		<input type="checkbox"/>	MPU/MCU/MPR
<b>MOS MICROCOMPONENT</b>		<b>OTHER</b>	
<input type="checkbox"/>	MPU	<input checked="" type="checkbox"/>	Full Custom IC
<input checked="" type="checkbox"/>	MCU	<input checked="" type="checkbox"/>	Discrete
<input checked="" type="checkbox"/>	MPR	<input type="checkbox"/>	Optoelectronic
<input checked="" type="checkbox"/>	DSP		

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 synchronous DRAMs (SDRAMs) capable of reading and writing bursts of information at 100MHz speeds; specialty graphics memories designed specifically to meet the needs of graphical user interfaces; extended data out (EDO) DRAMs; 8M window RAMs (WRAMs), which are the company's highest performing graphic memory devices; synchronous graphics RAMs (SGRAMs), a relatively new development; and 2M and 4M video RAMs (VRAMs).

### 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, and 32M parts in volume, and is developing a 64M device. 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

Using 0.6μm double- and triple-layer metal CMOS technology, Samsung's gate array and embedded array ASICs provide up to 200K (double-level metal) and 420K (triple-level metal) usable gates with up to 440 I/Os. For its standard cell ASICs, the company offers a variety of cells including DSP functions and the ARM7 RISC processor core. ASICs based on 0.5μm CMOS technology are expected to become available in 1997.

### Microcontrollers

The company's microcontroller portfolio consists of 4-bit and 8-bit CMOS products. The 8-bit family is based on the Zilog Super 8 core. Samsung is rapidly expanding its portfolio of microcontrollers and plans to introduce 50 new products by 1997.

### Power Devices

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

**Semiconductor Fabrication Facilities**

Samsung Electronics Company  
 Kiheung Plant  
 San 24, Nongsuh-Ri, Kiheung-Eup, Yongin-Kun  
 Kyungki-Do, Korea  
 Capacity (wafers/week): 35,000  
 Wafer sizes: 100mm, 150mm (3 lines)  
 Processes: CMOS, BiCMOS  
 Products: DRAMs, SRAMs, EEPROMs,  
 flash memories, ROMs  
 Feature sizes: 0.5 $\mu$ m-1.5 $\mu$ m

Samsung Electronics Company  
 Bucheon Plant  
 82-3, Dodang-Dong Bucheon  
 Kyungki-Do, Korea  
 Capacity (wafer/week): 11,250  
 Wafer sizes: 100mm, 125mm  
 Processes: CMOS, bipolar  
 Products: Linear ICs, ASIC, logic ICs, MPUs,  
 MCUs, discretes  
 Feature sizes: 0.8 $\mu$ m-4.0 $\mu$ m

Samsung Semiconductor, Inc.  
 Austin, Texas  
 Capacity (wafers/week): 6,250  
 Wafer size: 200mm  
 Process: CMOS  
 Products: DRAMs, ASICs  
 Feature size: 0.35 $\mu$ m  
 (Scheduled to begin production by the end of 1997)

Samsung Electronics Company  
 Kiheung Plant  
 San 24, Nongsuh-Ri, Kiheung-Eup, Yongin-Kun  
 Kyungki-Do, Korea  
 Capacity (wafers/week): 20,000  
 Wafer size: 200mm (3 lines)  
 Process: CMOS  
 Products: DRAMs  
 Feature sizes: 0.5 $\mu$ m, 0.6 $\mu$ m

Samsung Microwave Semiconductor, Inc.  
 1530 McCarthy Boulevard  
 Milpitas, California 95035-7405  
 Telephone: (408) 433-2222  
 Cleanroom size: 10,000 square feet  
 Capacity (wafers/week): 1,800  
 Wafer size: 100mm  
 Process: GaAs  
 Products: Amplifiers, ICs, transformers  
 Feature sizes: 0.25 $\mu$ m-1.0 $\mu$ m

Samsung has indicated its next three fab facilities will be located outside of South Korea—the first in the U.S., the second in Europe (probably in the U.K. or Germany), and the third in Malaysia or Indonesia. Construction of the \$1.3 billion U.S. plant in Austin, Texas, began in 1Q96 and will be completed by 2Q97. Production of 16M DRAM fabrication on 200mm wafers is expected to begin in 4Q97; 64M DRAMs will be added later.

## Key Agreements

- 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 will incorporate the 16-bit, general purpose, low-power, low-voltage, and high-speed engine in its ASIC library for 0.6 $\mu$ m- and 0.5 $\mu$ m-based multimedia and communications products.
- NEC licensed to Samsung its 78K series 16-bit microcontroller technology in October 1995. Samsung is now a second source for the devices and is allowed to use the 78K series as a 0.8 $\mu$ m 16-bit core.
- Samsung licensed Rambus' proprietary DRAM interface technology. The company expects to introduce 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 licensed the ARM RISC processor core technology from Advanced RISC Machines, Ltd. for use in consumer electronics products.
- Samsung and Array Microsystems teamed to produce a family of image compression VLSI circuits for the video processing/multimedia market. The deal provides Array with access to Samsung's 0.8 $\mu$ m CMOS foundry to manufacture all of its products. Samsung has a 37 percent stake in Array Microsystems.
- Samsung and NEC agreed to share information concerning 256M DRAM cell technology. It has not been revealed whether or not the two companies will cooperate in 256M DRAM technology beyond the provisions of this agreement.
- Samsung entered a five-year technology exchange agreement with Oki regarding synchronous 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 0.6 $\mu$ m ASIC architecture for gate arrays and embedded arrays.
- Samsung has a second-source agreement with Mitsubishi in 4M and 16M cache DRAMs. The two companies will also 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**

**U.S. Representative:**  
**Data Systems and Software Inc. (DSSI)**  
**200 Route 17 South**  
**Mahwah, New Jersey 07430**  
**Telephone: (201) 529-2026**  
**Fax: (201) 529-8050**

## IC Manufacturer

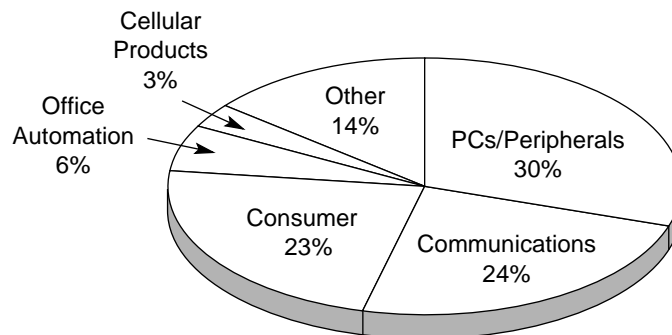
### Financial History (\$M)

	<u>1993</u>	<u>1994</u>	<u>1995</u>
Sales	38	58	100
Net Income	4	8	20
Capital Expenditures	5	20	45
Employees	400	455	680

### 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 (48.9 percent). The remainder of Tower's shares are divided between National Semiconductor Inc. (8.3 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.



**1995 Sales by End-Market Use**



**Management**

Rafael M. Levin	Co-Chief Executive Officer
Yoav Nissan-Cohen	Co-Chief Executive Officer
Jeffrey Levy	Manager, Fab Operations

**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 1.0 $\mu$ m, 0.8 $\mu$ m, and 0.6 $\mu$ m CMOS technologies and intends to complete development of 0.5 $\mu$ m technology in 1997.

**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: 0.6 $\mu$ m, 0.8 $\mu$ m, 1.0 $\mu$ m (0.5 $\mu$ m in 1997)

**Key Agreements**

- Tower signed a three-year contract with National Semiconductor in early 1995 to supply National with 1,250 wafers per week.
- Tower entered into a three-year agreement with Hewlett Packard (Palo Alto, CA). Under the agreement, HP transferred technology to Tower, which the company uses to produce wafers for HP and others. HP is obligated to purchase a certain number of wafers.
- Tower also has supply agreements with Motorola, DSP Group, and Chip Express.

## TRITECH MICROELECTRONICS

TriTech Microelectronics International Pte Ltd.  
 16A Science Park Drive #04-01/12  
 The Pascal  
 Singapore Science Park  
 Singapore 0511  
 Telephone: (65) 7757382  
 Fax: (65) 7760107  
 Web Site: [www.tritech-sg.com](http://www.tritech-sg.com)

U.S. Representative  
 TriTech Microelectronics  
 International, Inc.  
 2290 North First Street, Suite 213  
 San Jose, California 95131  
 Telephone: (408) 894-1900  
 Fax: (408) 894-1919

### Fabless IC Supplier

#### Financial History (\$M)

	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>
Sales	10	15	19	57	75
Employees	48	48	47	60	106

#### Company Overview and Strategy

TriTech Microelectronics is a member of the Singapore Technologies Group, a technology-based engineering group of over 60 companies. TriTech was previously part of IC manufacturer Chartered Semiconductor Pte Ltd. However, in 1991, TriTech was split off to form an independent fabless semiconductor company as Chartered went on to focus its business on providing foundry services.

The primary business focus of TriTech is designing customer specific integrated circuits (CSICs) and application specific standard products (ASSPs) for the communications, graphics, pen-based computer, data processing, and multimedia markets. Its major product strength is multimedia solutions. TriTech also provides an ASIC path using Cell Base Array (CBA) from Silicon Architects.

The technology strength of TriTech lies in its submicron CMOS mixed-signal design capabilities utilizing standard cell and custom approaches. TriTech also has high-volume in-house mixed-signal testing capability using state-of-the-art mixed-signal IC testers.

#### Management

Michael Kay	General Manager/Corporate Vice President
Ted Friedland	Vice President, Marketing and Sales

## TAIWAN SEMICONDUCTOR MANUFACTURING (TSMC)

Taiwan Semiconductor Manufacturing Co., Ltd.  
 No. 121, Park Avenue III  
 Science-Based Industrial Park  
 Hsinchu 300, Taiwan  
 Telephone: (886) 35-780-221  
 Fax: (886) 35-781-546  
 Web site: [www.tsmc.com.tw](http://www.tsmc.com.tw)

U.S. Representative:  
 TSMC, USA  
 1740 Technology Drive  
 Suite 660  
 San Jose, California 95110  
 Telephone: (408) 437-8762  
 Fax: (408) 441-7713

### IC Manufacturer

#### Financial History (\$M)

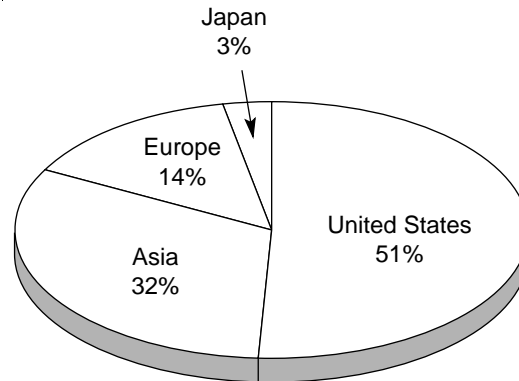
	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>
Sales	170	260	475	740	1,105
Capital Expenditures	160	45	160	400	600
Employees	900	1,700	2,000	2,300	3,000

#### 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 35 percent owned by the government of Taiwan, 35 percent owned by Philips, and 30 percent owned by private investors and employees.

In April 1996, Philips announced plans to sell 9 percent of its shares in TSMC, allowing TSMC to be listed on the New York Stock Exchange (NYSE). TSMC plans to use the public offering to fund the fab it is building in Camas, Washington.

TSMC is the largest of the world's few 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 1995, TSMC had over 130 customers worldwide, many of them being located in the U.S. and about 70 percent of them being fabless.



**1995 Sales by Geographic Region**

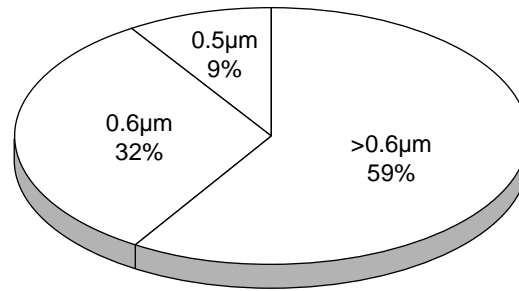
In mid-1995, TSMC began offering customers an option to guarantee long-term wafer capacity through prepayments. The deposits are allowing the company to accelerate its fab facility construction. Customers that have entered into the option agreement include Acer Labs, Altera, Analog Devices, Brooktree, Chips and Technologies, Oak Technology, S3, Sierra Semiconductor, and Trident Microsystems. In total, the commitments so far add up to about \$1 billion.

### Management

Donald W. Brooks	President
F.C. Tseng	Senior Vice President, Operations
John Y.T. Chen	Vice President, Research and Development
Y.C. Huang	Vice President, Corporate Service
Quincy Lin	Vice President, Corporate Marketing and Sales
John Luke	Vice President and President, TSMC USA
Chin-Yung Shu	Vice President, North-Site
Rick Tsai	Vice President, South-Site
Gary T.L. Tseng	Vice President, Finance and Administration, and Chief Financial Officer

### Products and Processes

Free from the need to design products, TSMC's strategy is in technology development and equipment investment. The company offers advanced CMOS process technologies such as 0.6 $\mu$ m, 0.5 $\mu$ m, and 0.35 $\mu$ m single-poly, double- and triple-layer metal processes for logic ICs and ASICs, as well as double-poly, double-metal processes for SRAMs and mixed-signal ICs. It is developing a 0.5 $\mu$ m double-poly, double-metal process for embedded flash memory and EPROM, in addition to a BiCMOS process. Engineering production of a 0.35 $\mu$ m, four-layer metal process began in 2Q96.



**1995 Sales by 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

TSMC announced plans to build a \$1.2 billion wafer fab facility in the U.S. to meet the high demand for its services in the region. The fab, which is expected to undergo construction in mid-1996, will be located in Camas, Washington. It will reportedly have a capacity of 7,500 200mm wafers per week and will initially produce devices with 0.35µm design rules, migrating to 0.25µm devices in the future. It has also been said that TSMC will only own half of the facility, which will not operate under the TSMC name.

TSMC, Ltd.

Building 67, No. 195, Section 4  
Chung-Hsing Road

Chu-Tung, Hsinchu, Taiwan

Telephone: (886) (35) 821-240

Fab I

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) (35) 780-221

Fab IIA

Capacity (wafers/week): 10,000

Wafer size: 150mm

Process: CMOS

Products: Foundry services

Feature sizes: 0.6µm, 0.8µm

TSMC, Ltd.

No. 121, Park Avenue III

Science-Based Industrial Park

Hsinchu, Taiwan

Telephone: (886) (35) 780-221

Fab IIB

Capacity (wafers/week): 8,750

Wafer size: 150mm

Process: CMOS

Products: Foundry services

Feature sizes: 0.5µm, 0.6µm

TSMC, Ltd.

No. 9, Creation Road I

Science-Based Industrial Park

Hsinchu, Taiwan

Telephone: (886) (35) 772-069

Fab III

Capacity (wafers/week): 10,000

Wafer size: 200mm

Process: CMOS

Products: Foundry services

Feature sizes: 0.35µm, 0.5µm

Macronix Fab (leased space)  
Hsinchu, Taiwan  
Capacity (wafers/week): 2,500  
Wafer size: 150mm  
Process: CMOS  
Products: Foundry services  
Feature size: 0.8 $\mu$ m

TSMC, Ltd.  
Hsinchu, Taiwan  
Fab V  
Capacity (wafers/week): 7,500  
Wafer size: 200mm  
Process: CMOS  
Products: Foundry services  
Feature sizes: 0.25 $\mu$ m, 0.35 $\mu$ m (0.18 $\mu$ m capable)  
(Scheduled to start up in June 1997)

TSMC, Ltd.  
Hsinchu, Taiwan  
Fab IV  
Capacity (wafers/week): 7,500  
Wafer size: 200mm  
Process: CMOS  
Products: Foundry services  
Feature sizes: 0.35 $\mu$ m, 0.5 $\mu$ m (0.25 $\mu$ m capable)  
(Scheduled to start up in 4Q96)

TSMC Joint Venture Fab  
Camas, Washington  
Capacity (wafers/week): 7,500  
Wafer size: 200mm  
Process: CMOS  
Products: Foundry services  
Feature sizes: 0.25 $\mu$ m, 0.35 $\mu$ m  
(Scheduled to start up in 1Q98)

## UNITED MICROELECTRONICS (UMC)

United Microelectronics Corporation  
 No. 3, Industry East Road  
 Science-Based Industrial Park  
 Hsinchu, Taiwan  
 Telephone: (886) (35) 773131  
 Fax: (886) (35) 774767

### IC Manufacturer

### Financial History (\$M)

	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>
Sales	215	255	375	565	900
R&D Expenditures	18	20	37	40	52
Capital Expenditures	50	56	53	255	570
Employees	1,720	1,770	1,968	2,275	2,982

### 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. The company currently produces memory ICs, PC chipsets, MOS microcomponents, consumer electronics ICs, graphics ICs, and communications ICs. Additionally, foundry services have been an increasingly important business for UMC since it began producing devices in 1982. About 30 percent of UMC's fab capacity in 1995 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. First, its computer products business unit was spun off in October 1995 to form a new company based in Milpitas, California. The new operation, called Integrated Technology Express Inc., is in charge of selling UMC's line of PC chipsets, I/O circuits, and other computer-related chips. Then, in March 1996, the company's communications IC business was spun off to form Davicom Semiconductor Inc., also based in California. Davicom is responsible for selling UMC's Ethernet chips, fax/modem chipsets, modem controllers, and other communications ICs. UMC's memory IC business unit will reportedly remain headquartered in Taiwan. These moves were made in part to align the company so that it does not directly compete with some of its foundry customers.

### Management

John Hsuan	President
Ing Dar Liu	Executive Vice President
Ming-Kai Tsai	Executive Vice President

## Products and Processes

UMC's product offering includes high-speed SRAMs (up to 1M in density), FIFO memories, mask ROMs (256K to 64M densities), 16-bit and 32-bit DSPs, 4-bit and 8-bit MCUs, fax/modem circuits, Ethernet devices, I/O chips, graphics and multimedia ICs, and PC chipsets. The company will enter the DRAM business with DRAMs based on technology licensed from Alliance Semiconductor. UMC is also reportedly working on a Sparc-based RISC microprocessor.

Under a settlement with Intel, UMC stopped producing and selling its 486 microprocessors, which were brought to market in 1994. Intel sued UMC for allegedly infringing its microprocessor patents.

## Semiconductor Fabrication Facilities

United Microelectronics Corporation

No. 3, Industrial East Road

Science-Based Industrial Park

Hsinchu, Taiwan

Fab I

Cleanroom size: 55,300 square feet

Capacity (wafers/week): 7,500

Wafer size: 100mm

Processes: CMOS, NMOS

Products: SRAMs, MPRs, MCUs, foundry services

Feature sizes: 1.0 $\mu$ m-3.0 $\mu$ m

(This fab is being phased out.)

United Microelectronics Corporation

No. 3, Industrial East Road

Science-Based Industrial Park

Hsinchu, Taiwan

Fab II

Cleanroom size: 47,600 square feet

Capacity (wafers/week): 12,000

Wafer size: 150mm

Processes: CMOS, NMOS

Products: SRAMs, ROMs, DSPs, MPRs, chipsets, foundry services

Feature sizes: 0.5 $\mu$ m-1.0 $\mu$ m

United Microelectronics Corporation

No. 3, Industrial East Road

Science-Based Industrial Park

Hsinchu, Taiwan

Fab IIIA

Cleanroom size: 113,400 square feet (A and B)

Capacity (wafers/week): 7,500

Wafer size: 200mm

Process: CMOS

Products: SRAMs, logic ICs, foundry services

Feature sizes: 0.35 $\mu$ m, 0.5 $\mu$ m

United Semiconductor Corporation

Fab IIIB (Joint venture fab. See Key Agreements)

Capacity (wafers/week): 6,250

Wafer size: 200mm

Process: CMOS

Products: Foundry services

Feature sizes: 0.35 $\mu$ m, 0.5 $\mu$ m

(Scheduled to begin production in 3Q96)

United Silicon Inc.

Fab IIIC (Joint venture fab. See Key Agreements)

Capacity (wafers/week): 6,250

Wafer size: 200mm

Process: CMOS

Products: Foundry services

Feature sizes: 0.35 $\mu$ m, 0.5 $\mu$ m

(Scheduled to begin production in mid-1997)

United Integrated Circuits Corporation

(Joint venture fab. See Key Agreements)

Capacity (wafers/week): 6,250

Wafer size: 200mm

Process: CMOS

Products: Foundry services

Feature size: 0.35 $\mu$ m

(Scheduled to begin production 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 0.5 $\mu$ m and 0.35 $\mu$ m process technologies, geared for flash memory products. The first 0.5 $\mu$ m flash devices are expected to be available 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, called United Semiconductor Corporation (USC), was announced in 1995 in partnership with Alliance Semiconductor and S3 Inc. The fab is expected to begin production in 3Q96 of 200mm wafers for UMC, Alliance, S3, and other semiconductor firms. UMC will own 50 percent of the venture.
- UMC's second joint venture foundry fab, United Silicon Inc. (USI), is a partnership with Trident Microelectronics, Alliance Semiconductor, ATI Technologies, Integrated Silicon Solution Inc., Opti Inc., Oak Technology, and others. The 200mm wafer fab is expected to begin production by mid-1997. UMC will own 50 percent of the venture.
- UMC's third joint venture fab, United Integrated Circuits Corporation (UICC), is a partnership with Lattice Semiconductor and Oak Technology. The 200mm wafer fab is expected to begin production in mid-1997. 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)

	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>
Sales	12	18	24	32	40
Employees	29	35	40	42	45

### 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 (VISC)

Vanguard International Semiconductor Corporation  
 123 Park Avenue III  
 Science-Based Industrial Park  
 Hsinchu 30077, Taiwan  
 Telephone: (886) (35) 770355  
 Fax: (886) (35) 785026

IC Manufacturer

### Financial History (\$M)

	<u>1995</u>
Sales	75
Employees	1,300

### Company Overview and Strategy

Vanguard International Semiconductor Corporation (VISC) is a developer and manufacturer of dynamic RAMs (DRAMs) and static RAMs (SRAMs). Its origins can be traced back to the Sub-Micron Laboratory, an R&D fab the Taiwanese government set up in 1990 to transfer advanced semiconductor technologies to local companies. Among the devices developed by the lab, which was operated by the government-sponsored Industrial Technology Research Institute (ITRI), were 4M and 16M DRAMs and 4M SRAMs.

The Taiwanese government decided in 1994 to end the lab's funding and solicit bids to sell the assets to private industry. In July 1994, a local consortium led by Taiwan Semiconductor Manufacturing Corporation bought the lab's assets, including a small-scale 200mm wafer fab. VISC is now owned 23 percent by TSMC, 32 percent by the Taiwanese government, and the remainder by local investors, including First International Computer, Silicon Integrated Systems, and Winbond Electronics.

Currently, VISC is selling its DRAM products primarily to customers in the local market, but also in other parts of Southeast Asia and Eastern Europe. VISC has not indicated when it will enter the U.S. market.

### Management

Bob O. Evans	President
Paul Chien	Vice President, Sales and Marketing
C.Y. Lu	Vice President

## Products and Processes

VISC began selling its first product, a 4M DRAM, in 1995, and started shipping its 16M EDO-based DRAM in early 1996. VISC has also developed 256K and 1M SRAMs. The 4M and 16M DRAMs are designed in 0.5 $\mu$ m CMOS technology.

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 0.4 $\mu$ m process, but the company plans to migrate it down to 0.35 $\mu$ m in 1997. The earliest the 64M device is expected to enter limited production is in the second half of 1997. VISC will also begin shipping 16M and 64M synchronous DRAMs in 1997 and 1998, respectively.

## Semiconductor Fabrication Facilities

VISC is enlarging its existing fab facility (Fab 1A) and constructing a second fab (Fab 1B) in Hsinchu. Fab 1B will process 16M DRAMs on 200mm wafers, beginning in the second quarter of 1997 and 64M DRAMs later. In addition, VISC plans to begin production in another new fab (Fab 2) in mid-1998. Fab 2 is expected to have a total capacity of 10,000 wafers per week.

### VISC

Science-Based Industrial Park

Hsinchu, Taiwan

Fab 1A

Cleanroom size: 35,700 square feet

Capacity (wafers/week): 3,500

Wafer size: 200mm

Process: CMOS

Products: DRAMs, SRAMs

Feature size: 0.35 $\mu$ m, 0.5 $\mu$ m

### VISC

Science-Based Industrial Park

Hsinchu, Taiwan

Fab 1B

Capacity (wafers/week): 4,000

Wafer size: 200mm

Process: CMOS

Products: DRAMs, SRAMs

Feature size: 0.35 $\mu$ m (0.25 $\mu$ m capability)

(Scheduled to begin production in 2Q97)

## WINBOND ELECTRONICS

**Winbond Electronics Corporation**  
**Number 4, Creation Road III**  
**Science-Based Industrial Park**  
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**Fax: (886) (35) 792668**  
**Web Site: www.winbond.com.tw**

**U.S. Representative:**  
**Winbond Electronics North America Corp.**  
**2730 Orchard Parkway**  
**San Jose, California 95134**  
**Telephone: (408) 943-6666**  
**Fax: (408) 943-6668**

### IC Manufacturer

#### Financial History (\$M)

	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>
Sales	96	120	185	330	676
R&D Expenditures	10	12	19	25	31
Capital Expenditures			55	150	254
Employees	895	1,310	1,630	1,940	2,360

#### 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 core logic chipsets, and SRAMs. 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
Yung Chin	Vice President
Jessica Chien	Controller
Frank C. Wen	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, telephone ICs, speech synthesizer ICs, 4-bit and 8-bit microcontrollers, 32-bit RISC embedded processors, and MPEG 1 and JPEG decoder ICs. The company also provides foundry services.

Currently, Winbond's logic IC products are manufactured using 0.8 $\mu$ m and 1.0 $\mu$ m CMOS process technologies. Its SRAM products are fabricated with 0.5 $\mu$ m and 0.6 $\mu$ m CMOS processes.

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 0.8 $\mu$ m, 480,000-transistor chips are designed for use in printers, X-Windows terminals, and other embedded applications.

## Semiconductor Fabrication Facilities

Winbond Electronics Corporation  
Number 4, Creation Road III  
Science-Based Industrial Park  
Hsinchu, Taiwan

### Fab 1

Cleanroom size: 11,680 square feet (Class 10)  
Capacity (wafers/week): 5,000  
Wafer size: 125mm  
Processes: CMOS, BiCMOS  
Products: SRAMs, ROMs, ASICs, logic ICs,  
foundry services  
Feature sizes: 0.8 $\mu$ m-5.0 $\mu$ m CMOS  
1.0 $\mu$ m BiCMOS

### Fab 2

Cleanroom size: 35,000 square feet (Class 1)  
Capacity (wafers/week): 8,750  
Wafer size: 150mm  
Processes: CMOS, BiCMOS  
Products: SRAMs, EPROMs, RISC MPUs,  
multimedia ICs, PC and peripheral ICs,  
foundry services  
Feature sizes: 0.4 $\mu$ m-0.8 $\mu$ m

### Fab 3 (Startup in 1997)

Capacity (wafers/week): 10,000  
Wafer size: 200mm  
Process: CMOS  
Feature size: 0.35 $\mu$ m (0.25 $\mu$ m capable)

## Key Agreements

- 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, 0.35 $\mu$ m fab, which is under construction and will begin operations in 2H96. Winbond will market the DRAMs under its own logo, beginning in 1997 or 1998.

- 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 is an investor in C-Cube Microsystems, San Jose, California, and a second source for C-Cube's image compression ICs.
- 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.