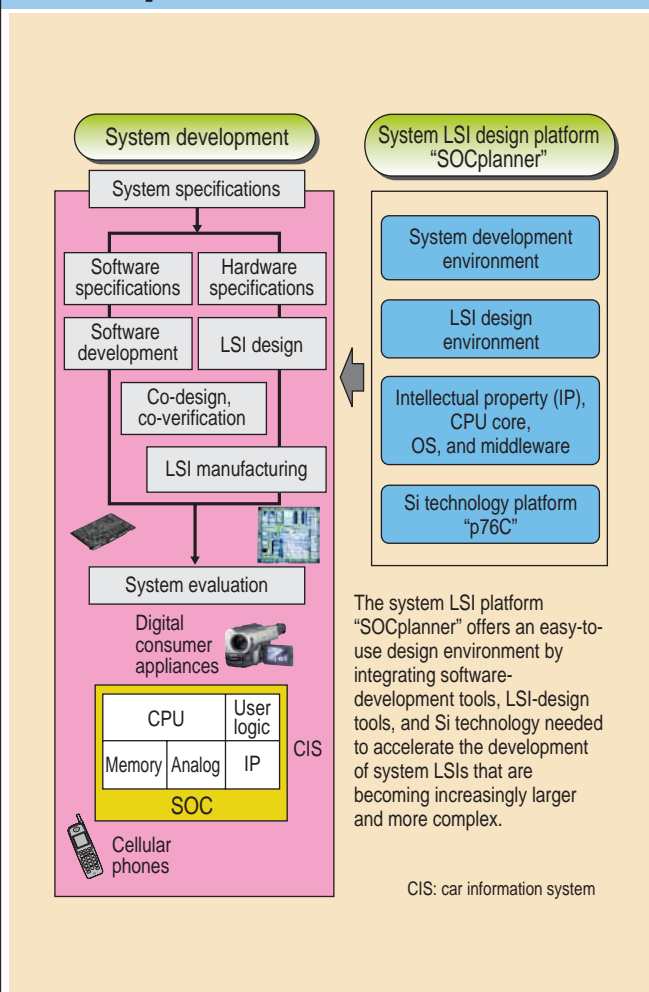# Electronics

The surging use of information technologies worldwide relies on system LSIs, color liquid crystal displays, and other advanced electronic components. In effect, portable telephones and new game machines using these components have changed our lifestyle overnight. In response to a rapid increase in the Internet-user population, the electronics industry is now focusing on network technologies. With these trends in mind, and using its expertise in the area of electronics, Hitachi has developed a system LSI design platform as well as advanced LSIs and innovative LCDs.

System LSI Design Platform "SOCplanner"

Configuration of system LSI design platform "SOCplanner"

The system LSI platform "SOCplanner" offers an easy-to-use design environment by integrating software-development tools, LSI-design tools, and Si technology needed to accelerate the development of system LSIs that are becoming increasingly larger and more complex.

CIS: car information system

Hitachi has developed a system LSI design platform called SOC (system-on-a-chip) planner. It enables faster design turnaround than any other SOC platform used in a wide range of applications from digital home appliances to communications networks. Hitachi plans to enhance the quality of this platform and increase the number of products based on this platform to make it a key technology in the SOC industry in the 21st century.

Configuration and main features of the platform are as follows.

(1) The platform is a system-development environment with software development tools, co-verification of hardware and software, and an emulator (on-chip debugger) for system evaluation.

(2) It provides a large-scale and high-speed SOC design environment based on Hitachi's unique "One-Pass Design" paradigm, which eliminates front-end-to-back-end design iterations.

(3) It can be used in CPU cores of SuperH and H8 microcomputers, in IPs (intellectual properties) for reusing analog modules, USB, IEEE1394 and JPEG, in middleware for voice synthesis, in industry-standard pre-installed real-time OS's, and so on.

(4) It is a Si technology platform that enables, for example, SuperH microcomputers, memories, and analog modules or other IPs based on the state-of-the-art CMOS (complementary metal-oxide semiconductor) technology with 0.14-μm gate length and 0.52-μm metal routing pitch.

# F-ZTAT Microcomputer with Built-in High-speed, High-density Flash Memory
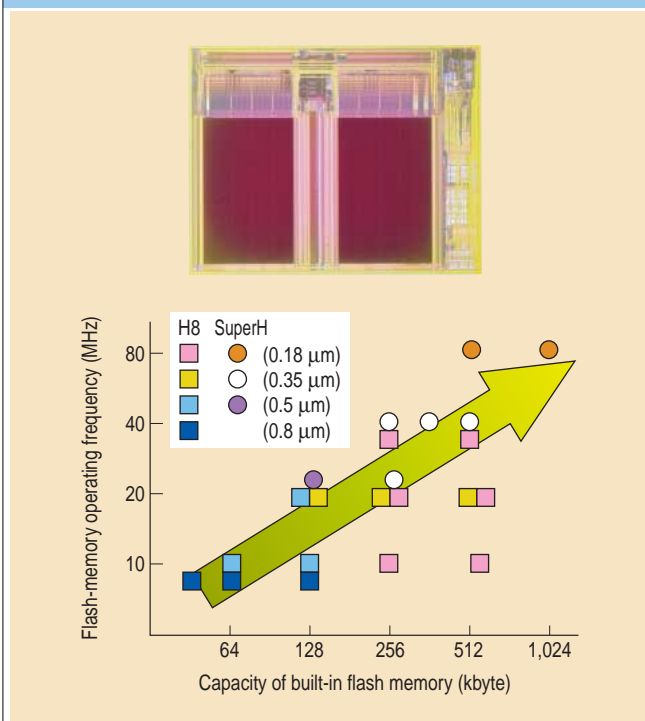
Flash memory to be installed in the 0.18-μm-generation F-ZTAT microcomputer (shown in the picture above), and future development of F-ZTAT microcomputers

The demand is increasing for microcomputers that enable rewriting their built-in flash memories in application systems where they are installed. Such microcomputers are used in a variety of systems and devices ranging from consumer products to PC peripherals, mobile telecommunication equipment, industrial and measuring equipment.

Microcomputers with built-in flash memory are generating significant changes in the process of system development right up to volume production. In 1993, Hitachi introduced an F-ZTAT (flexible zero turnaround time) microcomputer with a built-in 0.8-μm-generation flash memory. Since then, Hitachi has responded to increasingly more diversified user needs by introducing 8- to 32-bit CPU products. In the field of process technology, Hitachi has promoted the development of finer patterning from 0.5 μm to 0.35 μm to enable higher performance and density. With next-generation microcomputers having 0.18-μm gate length, Hitachi will support the diversified needs for more compact and higher performance systems with high-speed, large-capacity flash memories.

Secure MultiMediaCard™ for Keitaide-Music
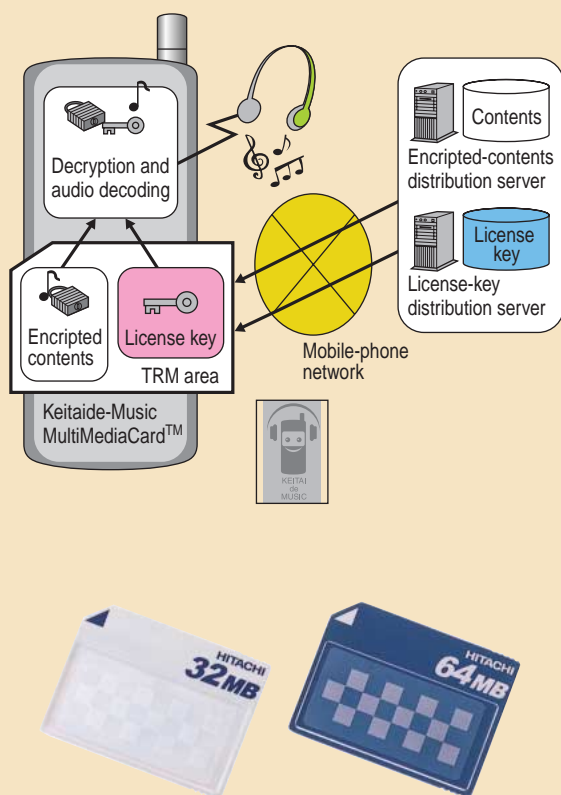

Secure MultiMediaCard™ for Keitaide-Music

Hitachi developed a Secure MultiMediaCard™* with content protection function to store digital contents such as music and images. The first product of this type was adopted for the "Keitaide-Music" music distribution system to mobile phone. "Keitaide-Music" based on the UDAC-MB (Universal Distribution with Access Control-Media Base) general-purpose content protction technology is jointly developed by SANYO Electric Co., Ltd. and Fujitsu Limited.

The card enables a significantly higher level of security than that offered by software: it has a cryptography processing engine, and protects security-related information, such as license keys, by storing them in the TRM (tamper-resistant module) area. The electronic specifications other than the security function, and the basic specifications of the card are the same as those of the conventional MultiMediaCard™ to ensure its upward compatibility.

In the future, this card can be used in other fields that require contents protection for large volumes of digital data, such as image data, electronic books, and teaching materials.

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* MultiMediaCard™ is a trademark of Infineon Technologies AG, Germany.

Compact and Highly Effective 128/256-Mbit SDRAM MCPs
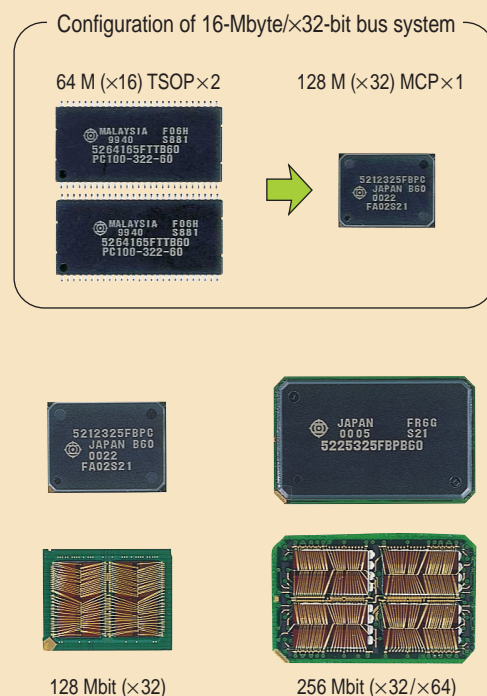

128/256-Mbit SDRAM MCPs

The demand for smaller and more effective digital home appliances has accelerated the need to develop an SDRAM (synchronous dynamic random access memory) that is more powerful yet more compact and that has a larger capacity and a broader bus.

In an attempt to respond to this demand, Hitachi developed an SDRAM MCP (multi-chip package) with multiple SDRAM chips assembled on a circuit board. When used in 16-Mbyte/$\times$32-bit bus system, such as digital camera, it reduces the mounting area to one fourth of that of a system using conventional 64-Mbit TSOP (thin small outline package). Unlike standard SDRAMs with bit widths of $\times$4, $\times$8, and $\times$16, this product is available with either $\times$32- or $\times$64-bit widths which is suitable for a 32- or 64-bit memory bus width system.

Only chips that have passed burn-in and KGD (known good die) tests are used for the MCPs of these SDRAMs. High-precision wire-bonding techniques are used to mount SDRAM chips on high-density circuit boards.

Currently, 128- and 256-Mbit products are available, and 512-Mbit and 1-Gbit products will be put into production in the near future.

Compact RF Module for Dual Bands
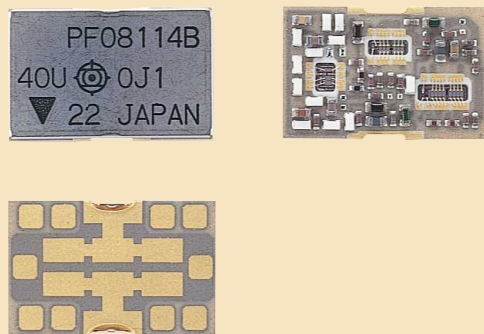
Mounting of PF08114B

Hitachi has developed a "PF08114B" high-frequency power-amplifier RF (radio frequency) module for cellular phones designed to support both GSM (global system for mobile communication) and DCS1800 band widely used in Europe and many other countries.

High-performance MOSFETs used in this product not only enable a smaller and more effective module but also generate higher output power (GSM: 34.5 dBm; DCS1800: 31.5 dBm) and higher efficiency (GSM: 54%; DCS1800: 52%). The use of dual-gate MOSFETs in respective driver stages also reduces power leakage in a standby mode. A multi-layer ceramic substrate is used for the package, and two amplifier circuits are incorporated into one package. The module is $12.3 \times 8.0 \times 1.6$ (mm), and its total volume is 0.16 cm^3 (Hitachi package code "RF-K1"). It also reduces the mounting area by employing LGA (land grid array) structure for terminals.

The product lineup will be expanded into higher-performance and cost effective products as well as products designed to support future systems, such as EDGE (enhanced data rates for GSM evolution).

Smart-card Microcomputers for High-security Applications
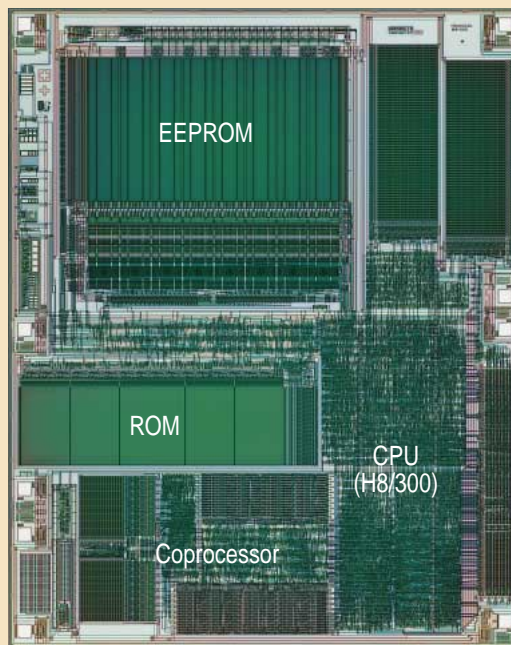
Smart-card microcomputer chip installed in ID cards

Smart cards are now attracting a lot of attention as a means to ensure security in computer-network-based EC (electronic commerce). Hitachi has been working to improve its smart-card microcomputers that are now equipped with built-in coprocessors (for high-speed cryptographic processing) and highly reliable EEPROMs (electrically erasable and programmable read-only memories).

Smart cards are now used not only as bank cards but also as ID cards, electronic tickets, and for many other purposes. Hitachi continues to invest in smart-card ICs by increasing their memory capacity, enhancing CPU processing power, and improving their security features. We will soon introduce 0.18-μm process technology for smart-card ICs.
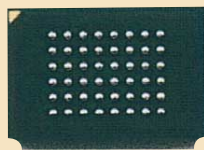
8-Mbit SRAM with a Larger Capacity That Requires a Smaller Mounting Area

9.8 mm

(Front side)

(Rear side)

An 8-Mbit SRAM CSP with a larger capacity and lower power consumption that requires a smaller mounting area

Hitachi has developed an 8-Mbit SRAM (static random access memory) for cellular phones and portable information appliances that has a large capacity and low power consumption, and requires a smaller mounting area.

This device is organized by 512 k words of 16 bits. It is fabricated using a 0.18-μm CMOS process and advanced-circuit technology that enables high-speed operation at low voltages. It has an access time of 55/70 ns (HM62V16512M) at 2.2-to-3.6 V and 70 ns (HM62A16512M) at 1.65-to-2.0 V. Its operating current is 25 mA (maximum) at a cycle time of 70 ns and the data retention current is 0.6 μA (standard). It can be effectively used for portable information systems that run on batteries.

The package is a 48-pin CSP (chip scale package), and it is as small as 6.5×9.8 (mm), effectively reducing the size and weight of user's system equipment.

# Plastic Mini-DIL for Optical Access Communication

Plastic Mini-DIL for optical access communication

In collaboration with Nortel Networks of Canada, Hitachi developed an inexpensive, low-profile product called "Plastic Mini-DIL" for optical access communication, and introduced a number of products.

The main features of the product are as follows.

(1) The height of the plastic package has been reduced to 2/3 of that of our current package due to enhanced moisture resistance of the laser diode and photodiode chips.

(2) The product is based on "passive alignment," in which the fiber and the diode chip are accurately assembled on a silicon substrate with a V groove. This technology has increased volume production. Currently, two transmitters for 155 Mbit/s and 622 Mbit/s and four PIN-AMP receivers for these bit rates are in mass production.

Super-IPS Display Modules with Ultra-wide Viewing Angle for Monitor
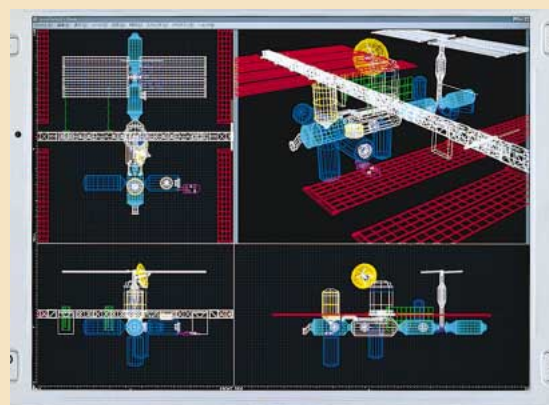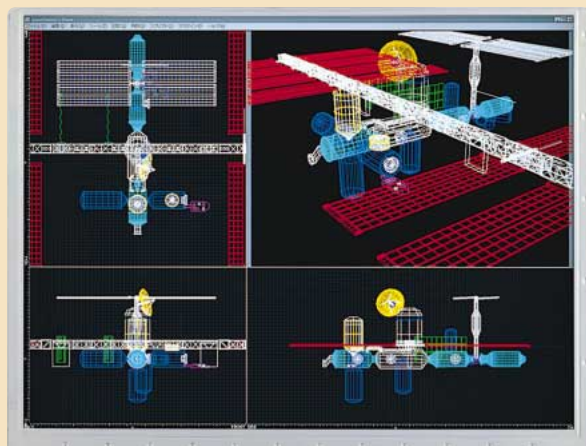
Characteristics of 19.0-inch UXGA Super-IPS display module (left) and high-brightness 15.0-inch XGA Super-IPS display module (right)

	19.0-inch UXGA Super-IPS display module	high-brightness 15.0-inch XGA Super-IPS display module
Resolution	$1{,}600 \times 1{,}200$ pixels	$1{,}024 \times 768$ pixels
Brightness	200 cd/m^2	400 cd/m^2
Color saturation	over 70%	over 70%
Viewing angle	170 degrees (horizontal and vertical)	170 degrees (horizontal and vertical)
Pixel pitch	0.2415×0.2415 mm	0.297×0.297 mm
Overall dimensions	415 (width) $\times$ 326 (height) $\times$ 27 (thickness) mm	350 (width) $\times$ 265 (height) $\times$ 25 (thickness) mm
Weight	1,800 g	1,200 g

48-cm (19.0-inch) (upper left) and 38-cm (15.0-inch) Super-IPS display modules

The demand for FPD (flat-panel display) monitors is increasing steadily, due to the advantages of compact size, low power consumption, and harm-free viewing. In addition, the progress in computer software and hardware is creating demand for higher resolution, response speed, brightness, and color saturation.

Hitachi has introduced the S-IPS (super in-plane switching) TFT display module and developed some technologies for S-IPS displays, such as (1) high-transmittance, large-color-saturation color filters, (2) high-brightness and thin-size direct backlight, (3) high-speed, low-voltage liquid crystals, and (4) high-aperture-ratio S-IPS.

Hitachi has already produced 38-cm (15.0-inch) and 46-cm (18.1-inch) Super-IPS display modules. Recently we have begun to produce high-resolution Super-IPS display modules in a 48-cm (19.0-inch) size and high-brightness display modules in a 38-cm (15.0-inch) size.

Development of a 15-inch SXGA+ Color LCD Module
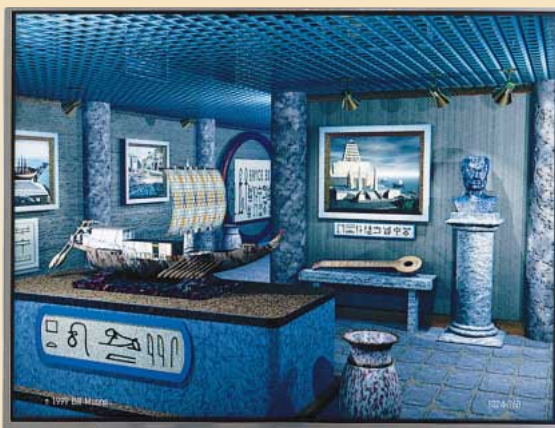
15.0-inch SXGA+ color LCD module

Recently, personal-computer suppliers have received many notebook computers with a 14.1-inch display. For high-end notebook computers, larger size displays are required. Hitachi has been providing 15.0-inch XGA modules to many computer suppliers.

The demand for higher resolution needed to exhibit images with excellent quality comparable to that of photographs has also increased.

Hitachi has developed a 15.0-inch SXGA+ TFT color LCD module for high-end notebook computers. This module is light and compact enabling the design of compact notebook computers.

This TFT color LCD module has the following features:

(1) Resolution: $1,400 \times 1,050$ pixels (super extended graphics array plus)
(2) Brightness: 150 cd/m^2
(3) Overall dimensions: 315 (width) $\times$ 240 (height) $\times$ 6.5 (thickness)(mm)
(4) Weight: 650 g
(5) Power consumption: 5.8 W
(6) Interface: 6 bit $\times$ R,G,B digital interface with the LVDS technology

Transflective Color STN LCD for Cellular Phones
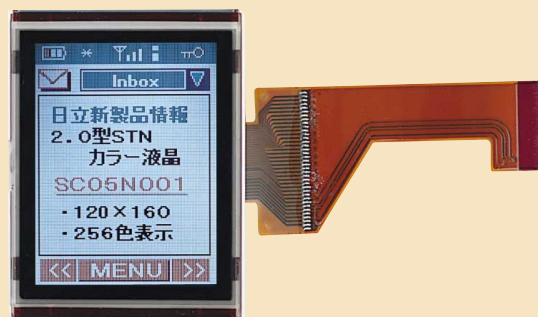
Transflective color STN LCD for cellular phones

The cellular phone market is growing enormously worldwide. In Japan as of 2000, the number of cellular phone users is greater than the number of home telephone users. The LCDs (liquid crystal displays) used in cellular phones are gradually being converted from B/W(black and white) to color, especially in Japan.
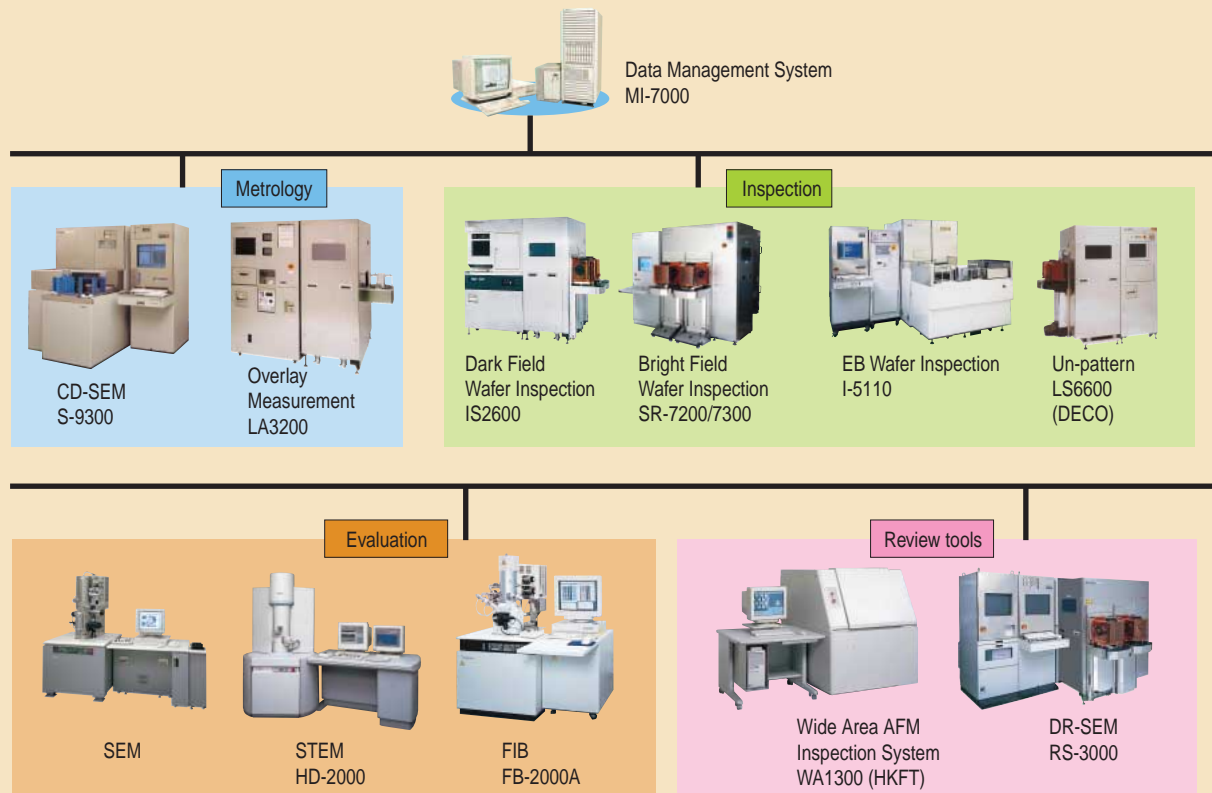
Hitachi has developed a transflective color STN (super twisted nematic) LCD for cellular phones. Based on technologies developed by Hitachi for transmissive LCDs for notebook PCs, this product features high performance and is the largest LCD available for this market.

Hitachi has also developed an internal reflection layer that can reflect and transmit light. It provides clear images that are parallax-free, and good visibility outdoors compared to transmissive LCDs. We have also develop a new optical simulation method and used an anti-reflection front-diffusion film configuration, contributing to high color purity, high reflectance, and high contrast.

Specifications are listed below.

(1) Size: 2.0"
(2) Dot number: 120 (H) $\times$ 160 (V)
(3) Dot pitch: 0.255 (H) $\times$ 0.255 (V) mm
(4) Reflectance: 33%
(5) Contrast (reflection mode): 14:1
(6) Contrast (transmission mode): 25:1

Semiconductor Inspection Systems for Yield Enhancement

Data Management System
MI-7000

Metrology

CD-SEM
S-9300

Overlay
Measurement
LA3200

Inspection

Dark Field
Wafer Inspection
IS2600

Bright Field
Wafer Inspection
SR-7200/7300

EB Wafer Inspection
I-5110

Un-pattern
LS6600
(DECO)

Evaluation

SEM

STEM
HD-2000

FIB
FB-2000A

Review tools

Wide Area AFM
Inspection System
WA1300 (HKFT)

DR-SEM
RS-3000

DECO: Hitachi Electronics Engineering Co., Ltd.
HKFT: Hitachi Kenki FineTech Co., Ltd.

Hitachi semiconductor inspection systems

Semiconductor devices are moving toward higher circuit integration and density. There is thus a need for device inspection equipment and systems that meet high performance requirements. A total inspection system that enables efficient operation at an appropriate investment level has been proposed. The inspection system includes both high-sensitivity and high-throughput equipment, as well as analytical systems for efficient analysis of yield parameters.

The major features of the proposed system are as follows.

1. Wafer Inspection Systems

Three models of wafer inspection systems are available from Hitachi.

(1) The SR-7200/7300 optical wafer inspection system detects pattern defects and particles. It has a bright-field optical system and is useful for etching processes or defect analysis.

(2) The IS2600 laser wafer inspection system detects particles on wafers with small steps, providing high sensitivity and high throughput. It uses a dark-field optical system.

(3) The I-5110 electron-beam wafer inspection system detects very small defects that are difficult to detect with optical systems, as well as non-conductive defects in via-plug processes by using a voltage-contrast image.

2. Defect review SEM: RS-3000

The RS-3000 is a high-speed review tool that achieves a defect-review speed of 600 DPH (defects per hour) with teaching-free automatic defect classification capability.
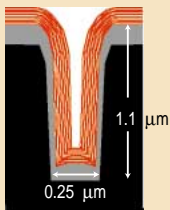
3. Yield enhancement system: MI-7000

One key feature of the MI-7000 is a trace report function that provides users with a report showing results from a large number of analyses collected from various types of inspection equipment and systems.

4. Analysis systems

To facilitate failure analysis of devices, Hitachi offers the FB-2000A focused ion beam system and the HD-2000 ultra-thin film evaluation system.

Film Profile Simulation for Copper Electroplating Processes

| Simulations additives	Filling profile simulations	SEM photographs
X	1.1 μm / 0.25 μm	Uniform growth
Y		Bottom up filling

Prediction of filling profiles

In Cu electroplating for next-generation ULSI devices, avoiding the formation of voids or seams in sub-micron-scale trenches and vias will be difficult.

Many experimental trials are required to optimize various conditions for electroplating including current-voltage relations and compositions of solutions. Therefore, we have developed a simulation technique for filling profiles in order to reduce the number of experimental trials.

In this simulation, one can predict the effect of an additive's properties and concentration on filling profiles. Hitachi applied this method to optimize the filling conditions for sub-micron-scale trenches and vias, and to design the shape of an electroplating apparatus to level the thickness distribution on a wafer.

Abrasive-free CMP Slurry for LSI Copper Wiring

M7
M6
M5
M4
M3
M2
M1

2 μm
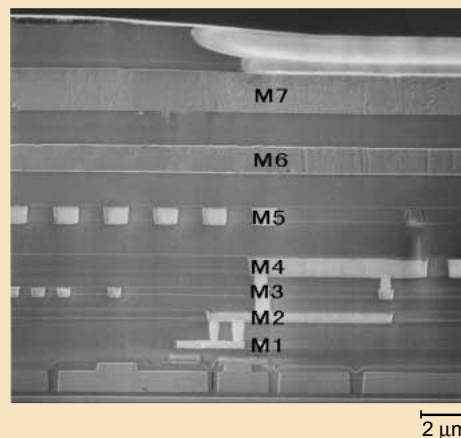
CMP for copper wiring was carried out from M2 to M5.

Cross-section of super computer MPU

With the latest high performance trends in LSI, the wiring material for circuits has shifted from aluminum alloys to copper metal. The resistivity of copper is half as much as that of aluminum alloys. The formation of copper wire is attractive for the Damascene method using CMP (chemical mechanical polishing) technology.

One of the issues in CMP for copper wiring formation is that the abrasive in CMP slurry produces circuit damage.

To address this issue, an abrasive-free CMP slurry that only includes chemicals such as an oxidizer and a solubilizer has been developed for commercial use.

Using this abrasive-free CMP slurry enables to realize robust processes for LSI production.