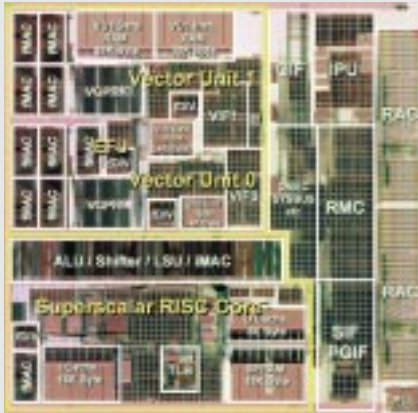


With the support of an advanced network environment, digital contents such as large-size images and audio data has become readily available more rapidly. Further enhancement of information devices that support this situation is required. The devices include high-performance microprocessors, high-quality display devices, high-speed communication devices, and large-capacity storage devices. Toshiba is developing the state-of-the-art key device and material that actualize devices of a new concept to satisfy these requirements.

## Emotion Engine Microprocessor



Emotion Engine chip

A microprocessor LSI, Emotion Engine has been jointly developed for the next generation video game console by Sony Computer Entertainment and Toshiba.

Its 6.2 G FLOPS (FLoating-point Operations Per Second) performance is crucial to 3D geometry calculation and physical simulation. This LSI integrates a 128-bit RISC (Reduced Instruction Set Computer) core with enhanced multi-media instructions, 10 floating-point accumulators and 4 floating-point dividers for high-speed 32-bit floating-point operation, etc.

Two order magnitude of performance leap over a conventional 32-bit game machine has been achieved.

## SmartMedia™ 64 Mbyte Memory Card



64 Mbyte SmartMedia™

SmartMedia™ are memory cards characterized by their compact-size, light weight, low-profile design and low cost.

Demand is increasing for data storage in devices such as digital cameras, mobile communication terminals, and silicon audio equipment and consumers are calling for large-capacity SmartMedia™.

To answer such needs, Toshiba has developed SmartMedia™ with 64 Mbyte capacity. These memory cards incorporate two pieces 256 Mbit NAND type flash memory, using 0.25  $\mu\text{m}$  design rule fine process and STI (Shallow Trench Isolation) technology, to realize the smallest chip size in the world.

Mass production of 64 Mbyte SmartMedia™ was started in September 1999.

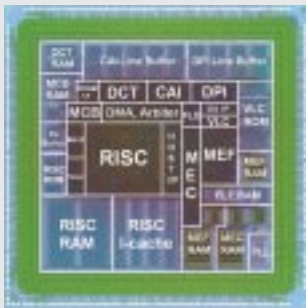
## MPEG-4 Video Codec LSI

Toshiba has developed its MPEG-4 Video Codec LSI, that realizes a pocket visual telephone in the next generation mobile-communications system (IMT-2000).

This LSI can perform image compression and decompression of animated images at a rate of 15 frames per second, under spec of MPEG-4 IS Version 1 spec at L1.

In application of LSI, widely available 16 Mbit Synchronous DRAM is used as frame memory, and since direct connection is available, the cost of the whole system can be reduced.

This LSI integrates the peripheral-interface-adaptor circuit required for visual telephone with power consumption of 250 mW, less than half that of its predecessors. Its low power consumption means it can be incorporated into battery-powered mobile terminals. Using this LSI, image quality has been improved dramatically by installing a dedicated filter engine.

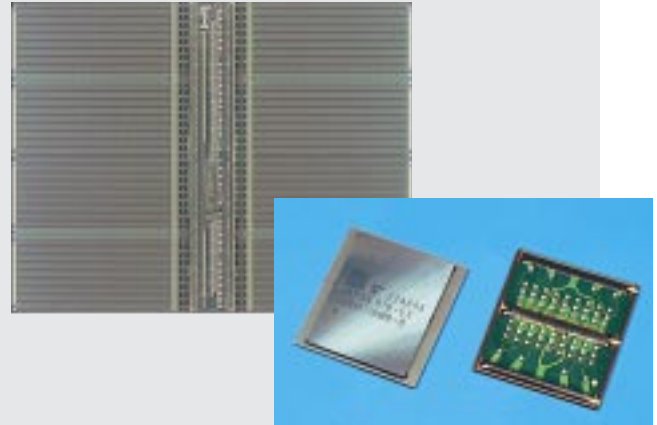


Chip micrograph

### Chip key features

Process	0.25 $\mu\text{m}$ CMOS process
Chip size	6.26 x 6.26 mm <sup>2</sup>
Package	176 pin QFP (Quad Flat Package)
Voltage	3.3 V(I/O), 2.5 V(internal)
Power consumption	250 mW @61.44 MHz
Frame transfer rate	15 frames/s (176 x 144 pixel)
Internal clock frequency	66 MHz

## 144 Mbit Direct Rambus® DRAM



144 Mbit Direct Rambus® DRAM

Toshiba has developed 144 Mbit Direct Rambus® DRAM.

Direct Rambus® DRAM are advanced DRAM architecture by Rambus Inc. of the US. Rambus' high speed operating characteristics offer an operating frequency of 800 MHz, pushing data transfer to up to 1.6 Gbyte per second. High level support for graphics and multimedia sources positions Rambus as the main-memory-of-choice for next-generation PCs.

In cooperation with Rambus Inc. of the US, Toshiba has combined Rambus' performance advantages and Toshiba's fine 0.2  $\mu\text{m}$  CMOS process technology to achieve the industry's smallest chip size (114 mm<sup>2</sup>).

Toshiba uses its original chip scale package (CSP). CSP package support a "mirror package" for large capacity memory modules, and realizes a capacity of 288 Mbyte RIMM (Rambus In-line Memory Module).

## 4,500 V IEGT

Toshiba has developed 3 types (Current 1,500A, 800A, and 750 A) 4,500 V withstand voltage IEGT (Injection Enhanced Gate Transistor). These IEGT are ideal for switching devices in various applications such as high-voltage, large capacity railroad vehicles and industrial inverters. Original electrode and gate structure are adopted, ON-state voltage is reduced and the energy loss decreased. A compact package has also been realized.

The main features are as follows:

- ON-state voltage was minimized and low power consumption operation attained by optimizing electrode and gate structures.
- Withstand voltage of 4,500 V, equivalent to twice that of conventional products, has made it possible to miniaturize equipment that uses the devices.
- Operating frequency has been raised to about 1 kHz, facilitating the smooth control of equipment that uses the devices.
- Plastic case module type has been commercialized for easy incorporation into equipment.



4,500 V IEGT

## Superhigh-Resolution 200 ppi Series TFT-LCDs



6.3-inch diagonal, XGA, low-temperature p-Si TFT-LCD



(a) 200ppi (b) 100ppi  
Comparison of images displayed at different resolutions

Toshiba has developed 200 pixels per inch (ppi) thin-film transistor liquid crystal displays (TFT-LCDs) using low-temperature polycrystalline silicon (LTPS) technology. The superhigh resolution of 200 ppi offers the same image quality as printed matter such as magazines. The 200 ppi series TFT-LCDs are expected to support further developments in areas such as electronic books (e-books) and personal digital-picture viewers.

Now Toshiba has a 200 ppi TFT-LCDs lineup with 4-inch displays (VGA: 640 x 480 pixels) for palmtop-size applications, 6.3-inch displays (XGA:1,024 x 768 pixels) for typical photograph or paperback book-size applications, and 10.4-inch displays (UXGA:1,600 x 1,200 pixels) for notebook PC applications.

## 46 cm 100° Super-High Deflection Sensitivity CDT

Toshiba has developed a 46 cm 100° SHS CDT (Super-High deflection Sensitivity Color Display Tube) for large screen, space-saving and power-saving, which is shorter than the conventional 46 cm 90° CDT (by approximately 48 mm).

To reduce deflection power, Toshiba has adopted the newly-designed Mini-Neck ( $\phi 22.5$  mm) electron gun with CDP-Stem (Co-axial Different diameter Pin circle-Stem) and the RAC-DY (Deflection Yoke for the CDT with RectAngular Cone) with 8-pole magnetic cored coil technologies.

In spite of wide-angle deflection, horizontal deflection sensitivity of the CDT is higher than the conventional 41 cm 90° CDT (by approximately 5%).

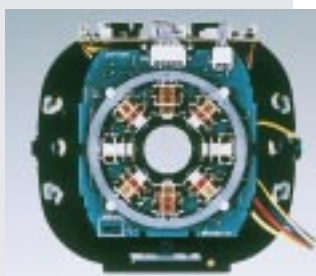
The main lens of the Mini-neck electron gun has an extended electric field and double focus. The base socket is compatible with a  $\phi 29.1$  mm neck CDT. Moreover, the temperature rise of DY is low enough for a high frequency scanning operation under 110 kHz, and the 8-pole magnetic cored coils corrects several different types of convergence error and geometric distortion.

As a result, the resolution of the CDT and the picture characteristics are as high as the conventional 46 cm 90° CDT.

These technologies are expected to be applied to flat CDTs in the near future.



46 cm 100° SHS CDT



RAC-DY with 8-pole magnetic cored coils



New mini neck electron gun (below) and a conventional electron gun (above)

## The World's Smallest SAW Filters for CDMA Systems

The spread of mobile communication services using CDMA (Code Division Multiple Access) technology, which has good features such as excellent tone quality, is quite remarkable. Toshiba has developed SAW filters for CDMA systems which are the smallest in the world. The SAW filters form a lineup of various frequencies corresponding to IF (Intermediate Frequency) and RF (Radio Frequency) of USA, Japanese and Korean CDMA services.

Toshiba has answered the demand for cellular-phone miniaturization by introducing several new technologies. By employing face-down bonding technology, the RF filters only occupy 56% of the mounting areas of conventional products. With regard to IF filters, miniaturization is achieved ranging from 40% to 70% range of mounting areas of conventional products by developing an original electrode design which is based on DART (Distributed Acoustic Reflection Transducer) technology.



SAW filters for CDMA

Characteristics of SAW filters for CDMA

Type name	for use	Center frequency (MHz)	Package size (mm x mm x mm)	Mounted area (Compared with conventional type)
SRF836NJC31	USA/Korea CDMA-RF (Tx)	836.5	2.5 x 2.0 x 1.0	56 %
SRF881NJC31	USA/Korea CDMA-RF (Rx)	881.5	2.5 x 2.0 x 1.0	56 %
SRF851NBC31	Japan CDMA-RF (Rx)	851.0	2.5 x 2.0 x 1.0	56 %
SRF906NBC31	Japan CDMA-RF (Tx)	906.0	2.5 x 2.0 x 1.0	56 %
SRF1880NCC31	USA CDMA (PCS) -RF (Tx)	1880.0	2.5 x 2.0 x 1.0	56 %
SRF1960NCC31	USA CDMA (PCS) -RF (Rx)	1960.0	2.5 x 2.0 x 1.0	56 %
SBF0901EC2C	USA/Korea CDMA-IF	85.38	13.3 x 6.5 x 1.7	70 %
SRF210WAC10	USA CDMA (PCS) -IF	210.38	7.0 x 5.0 x 1.6	40 %