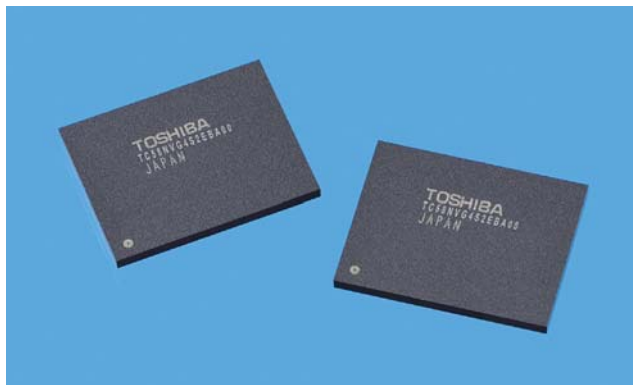


Electronic Components and Materials

In the electronic components and materials field, Toshiba supplies key devices taking full advantage of our leading-edge process technologies and high-level design and application technologies. As examples of our recent achievements, we have developed a 512 Gbyte solid-state drive with the largest capacity in the industry, and a new organic electroluminescence display featuring the lowest level of power consumption and longest life in the world.

Single-Level-Cell NAND Flash Memory



NAND flash memory incorporating a 16 Gbit chip

Toshiba has commercialized and shipped samples of single-level-cell (SLC) NAND flash memory products with capacities ranging from 512 Mbits to 64 Gbits in 16 versions using the leading-edge 43 nm process technology.

The new range includes three products, the 16 Gbit, 32 Gbit, and 64 Gbit models, that integrate 16 Gbit chips, the industry's highest density chips^(*1).

SLC NAND flash memories can read and write data at higher speed than multilevel-cell (MLC) chips and offer high reliability. For example, writing is performed 2.5 times faster^(*2).

We have recently developed new SLC products ranging from small to large capacity to handle increasingly diversifying applications that require high performance and reliability.

(*1) As of October 2008 (as researched by Toshiba)

(*2) Comparison between 16 Gbit SLC products fabricated by the 43 nm process and MLC products

Industry's Largest Capacity 512 Gbyte Solid-State Drive



512 Gbyte, 256 Gbyte, and 64 Gbyte SSDs (from left to right)

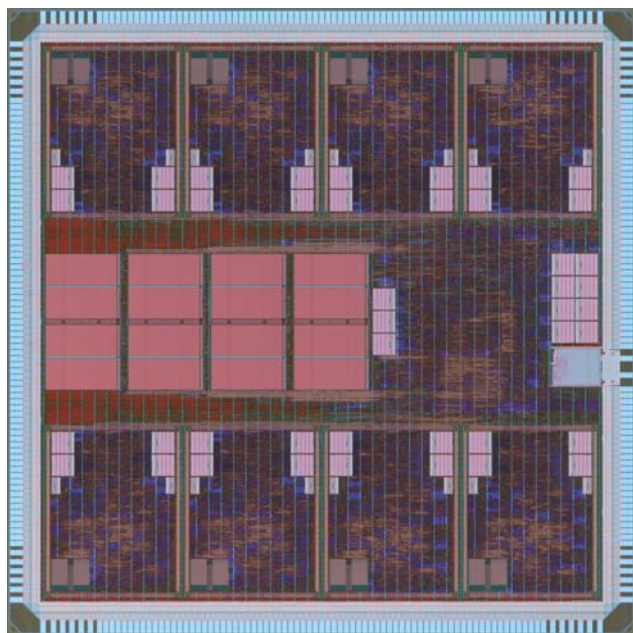
Toshiba has launched a lineup of 10 solid-state drives (SSDs) for PC application using 43 nm MLC NAND technology with capacities ranging from 64 Gbytes to 512 Gbytes, the largest capacity in the industry.

In their role as PC storage devices, SSDs are required to offer larger capacity and higher speed data transfer as their applications continue to expand. The 43 nm process MLC NAND adopted in the new SSDs realizes double the capacity of conventional models.

In addition, a newly developed controller compatible with this advanced process allows the MLC NAND to provide high-speed parallel operation, resulting in data processing speeds two times or more faster than those conventionally obtained.

We will continue to promote innovations that create new demand in the NAND flash market and support our continued leadership through expansion of our large-capacity SSD lineup as well as further improvements in performance.

VeneziaEX Multicore Media Processor for Cellular Phones

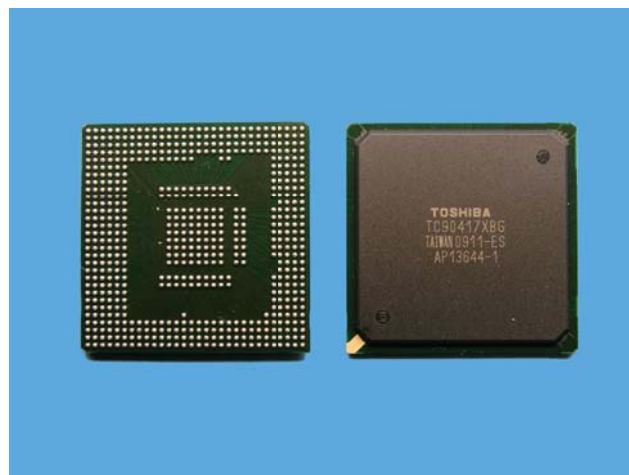


Micrograph of VeneziaEX chip

Toshiba has developed the VeneziaEX media processor, which allows a cellular phone to process high-definition (HD) images. The VeneziaEX contains eight signal processing cores and a shared level-two cache memory, where each core consists of our original media-embedded processor (MeP) and its co-processor for parallel operations. The software-based approach realizes easy reuse of developed software and flexible support of various audiovisual (AV) codec formats.

When high performance is not required, the VeneziaEX has functions to cut off its electric power supply or lower the voltage of individual processors to achieve low power consumption.

TC90417XBG System on Chip for Digital TV Sets



TC90417XBG SoC for digital TV sets

Toshiba has developed the TC90417XBG system on chip (SoC) for application to popular type digital TVs, using the 65 nm process.

The TC90417XBG is capable of achieving video and audio processing as well as H.264 decoding using a DDR2-800 MHz 32-bit type system memory, while the former products, the TC90415XBG and TC90490XBG (H.264 video decoder), used DDR2-677 MHz and DDR1-400 MHz 32-bit type system memories, respectively.

The new integration of an AV switch, an audio ADC/DAC, an analog sound multiplex demodulation function, and an audio processor allows decoding with a heavy load or sound effects such as Dolby volume™ to be processed without an external DSP.

The TC90417XBG also makes it possible to realize a double video plane and double graphics plane.

This device is network-ready with the MIPS32® 24KEf™ high-speed processor (533 MHz) incorporating a 32 Kbyte cache, as well as built-in EtherMAC, providing a speed of up to 1 066 MHz and a system memory capacity of up to 512 Mbytes.

ADC: Analog-to-digital converter

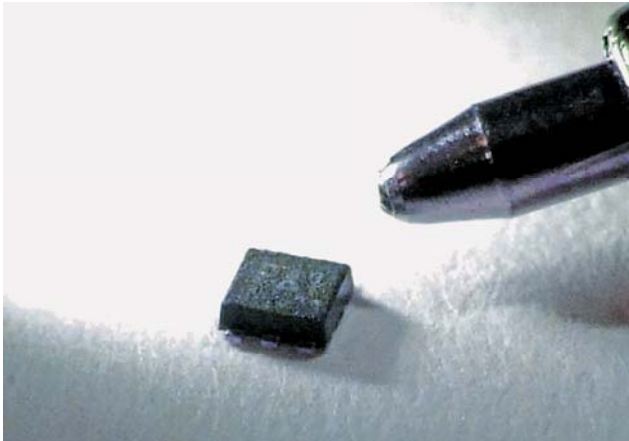
DAC: Digital-to-analog converter

DSP: Digital signal processor

“Dolby” and “Dolby volume” are trademarks of Dolby Laboratories.

“MIPS32” and “24KEf” are a registered trademark and a trademark of MIPS Technologies, Inc. in the United States and other countries.

Magnetic Sensor Using Si Hall Element



TCS10SPU magnetic sensor using Si Hall element

Mobile devices typified by clamshell type cellular phones use a magnetic sensor that detects the presence of an S-pole field, an N-pole field, or both pole fields to sense whether the device is open or closed.

Toshiba has developed a sensitive magnetic sensor applicable to small magnets to meet the need for downsizing of electronic devices.

The new sensor consists of a single chip using a silicon (Si) Hall element. To overcome the difficulty of increasing sensitivity caused by the unbalanced voltage being larger than the output voltage of a Si Hall element, we developed a circuit to cancel the unbalanced voltage and thereby achieved high sensitivity to a magnetic flux density of 1.8 mT (typ.). In addition, the intermittent operation of magnetic detection performed 20 times per second reduces current consumption. The lineup of this product has been expanded to a total of nine types categorized by detected magnetic pole and output type, in order to satisfy a wide variety of requirements.

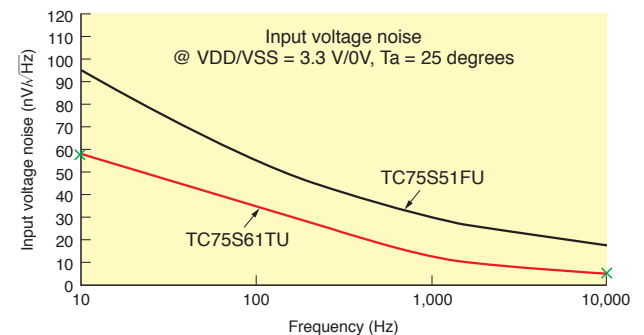
Low-Noise CMOS Operational Amplifier

With the advancement of hard disk drives (HDDs) offering high recording density in recent years, there has been rising demand for lowering of the noise level of the operational amplifier (op-amp) used for the signal of the shock sensor. To meet this demand, Toshiba has developed the TC75S61TU low-noise complementary metal oxide semiconductor (CMOS) type op-amp.

This op-amp realizes a compact package (2.0 mm×2.1 mm×0.7 mm) with a noise level of 15 nV/√Hz (1 kHz) in terms of input level, half that of our existing product, the TC75S51FU, based on optimization of the operating current and differential pair size of the input positive MOS (PMOS) transistor.

This performance is at a level of technology applicable to the detection system for vibration of a high-recording-density HDD of the 500 Gbytes/platter(*) class. We will continue to pursue the development of technologies to further lower noise level in the future.

(*) Metallic disk coated with magnetic materials in a HDD



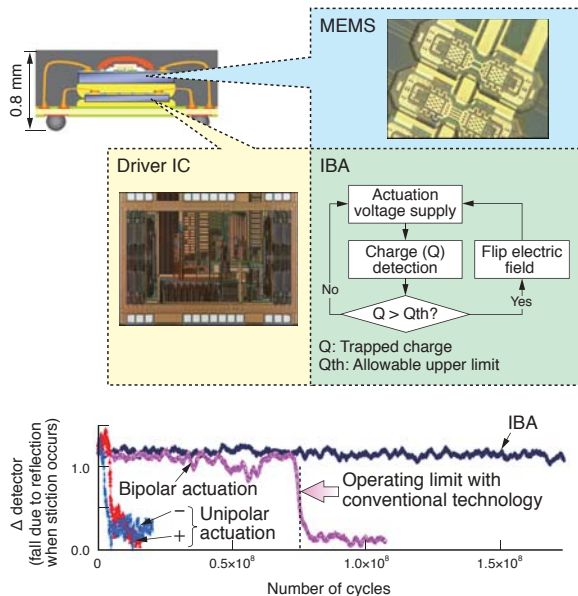
Input voltage noise of TC75S61TU low-noise op-amp

Electrostatically Driven MEMS Device with Variable Capacitor for RF Application and Wafer Level Packaging Technology

In response to the expanding range of multiband/multisystem applications for cellular phones, PCs, and other products, Toshiba has developed an electrostatically driven microelectromechanical systems (MEMS) device with a variable capacitor for radio-frequency (RF) applications.

By using an originally designed driver IC, eliminating the need for driving voltage supply, and operating the MEMS in a new intelligent bipolar actuation (IBA) that suppresses trapped charges, we have achieved excellent high-frequency characteristics and improved long-term reliability by two times or more compared with the conventional technology.

Furthermore, in terms of packaging technology, our newly developed hermetic wafer level package (WLP) technology realizes an ultra-thin multichip package (MCP) in 0.8 mm thickness.



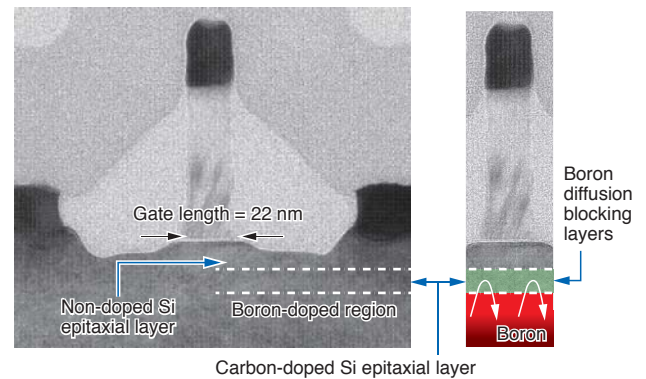
Variable capacitor using MEMS device and driver IC in a single package

Transistor with Carbon-Doped Si Layer for Steep Channel Profile

It is well known that, as the miniaturization of transistors progresses, it is essential to control the distribution of impurities. A key factor in realizing a transistor with high performance and low power consumption is to create a particular distribution with a steep channel profile (including a low-impurity concentration at the top channel level as well as a high impurity concentration produced toward the bottom level with steep angles). However, it has been difficult to achieve such a profile using the existing n-type transistor with an easily diffused boronic channel profile.

Toshiba has succeeded in creating a steep channel profile with controlled boronic diffusion by forming a carbon-doped silicon layer directly into the channel layer, thus achieving the technical advantages of an increase in performance of 20% or more and the scaling of threshold voltage.

This carbon-doped steep channel structure offers a likely scenario for high-performance, low-power-consumption devices in the future.



Transistor with carbon-doped Si layer for steep channel profile

Cost-Effective Air-Gap Interconnects

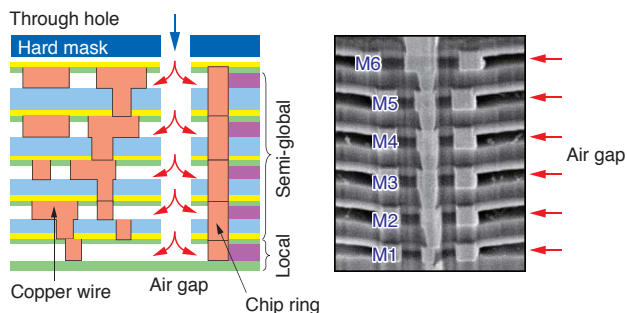
The development of a multilevel interconnects system with an air gap has recently been attracting global attention as an ultimate low- κ dielectric technology. The air gap (dielectric constant: 1) has been formed by eliminating an interlayer dielectric film from a copper damascene interconnect structure, and various integration schemes have been reported. However, these schemes have also led to concerns over reduced mechanical strength and increased costs associated with the formation of the air-gap region.

To solve these problems, Toshiba has developed a new scheme called the “multilevel air-gap all-in-one-formation process.” In our process, the air gap is selectively formed between adjacent metal lines simultaneously throughout the multilevel structure by a single etching process (after the multilevel interconnect has been fabricated using the conventional LSI process), achieving both high mechanical strength and low manufacturing cost. In a feasibility study of the air-gap structure in 6-level interconnects, we have been able to successfully achieve all-in-one-formation of 6-layer air gaps.

The electrical characterization of single damascene copper interconnects with the air gap was also performed and the wiring capacitance was reduced to the designed value.

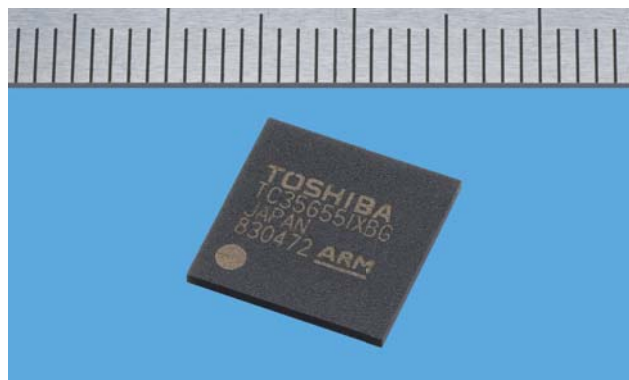
We will promote the use of our air-gap scheme for the next-generation LSI device nodes.

LSI: Large-scale integration



Air-gap interconnect process (left) and air-gap structure using 6-level interconnects (right)

EDR-Compliant Bluetooth™-Compatible Single Chip



Bluetooth™-compatible single chip for automotive applications

Toshiba has developed the TC35655IXBG, a Bluetooth™ version 2.1+EDR compliant 1 chip SoC LSI, offering automotive solutions such as car audio and car navigation systems.

We have created a single-chip device consisting of two main units. One is a baseband unit with an embedded ARM926[®](*2) central processing unit (CPU) for speech processing used for hands-free communication and audio-playback processing in cellular phones and other devices, and the other is an RF unit designed to optimize the allocation in each circuit using the RF CMOS technique and prevent interference of each signal. Miniaturization of equipment modules and reduction in cost were attained by reducing the chip area by about 28% compared with our conventional products.

In particular, the LSI has achieved the world's highest level^(*3) of receiver sensitivity over the operating temperature range by employing a unique temperature compensation technique using the bias current composition method^(*4), as well as the reduction of external parts by embedding transmitting-cutover switching, etc.

(*1) Approval must be obtained from Bluetooth SIG, Inc. before using Bluetooth™ technology.

(*2) ARM926 refers to the brand name of ARM Limited in the UK and other countries.

(*3) As of November 2008 (as researched by Toshiba)

(*4) A technique for reducing the temperature dependency of the gain of a low-noise amplifier that affects the receiver sensitivity of a wireless IC (ratio of output to input)

EDR: Enhanced data rate

SoC: System on a chip

DNA Chip for Detecting Infectious Diseases in Experimental Animals and Automatic Loading System for Genelyzer™



Monigene™ Helico kit



Automated DNA detection system with automatic loading system

Experimental animals are frequently used in research in the bioscience field and the development of medicines and cosmetics. For reliable experiments, animals need to be free of infection and must undergo occasional health checks. Genetic testing is a focus of expectations as a means of detecting infection at an early stage.

Toshiba has developed the Monigene™ Helico kit for experimental animals in cooperation with the Central Institute for Experimental Animals (CIEA), and commercialized this kit. This is a DNA chip kit for detecting Helicobacter, which has a profound effect on experimental animals. It is the first product in the non-medical field in Toshiba's original electrochemical DNA chip project.

In a pilot study using around 600 samples performed at the CIEA, the high specificity and accuracy of our DNA chip were proved. As a result, the CIEA has begun a genetic testing business using this DNA chip kit. In addition, we have started sales of the Monigene™ Helico kit to breeders and facilities for the breeding of experimental animals for their in-house testing.

We have also developed an automatic loading system for the Genelyzer™ automated DNA chip detection system to simplify the inspection process. Once up to 24 DNA chips have been set up manually, complicated exchanges of DNA chips are unnecessary and the inspections can be performed automatically.

DNA: Deoxyribonucleic acid

Organic Electroluminescence Display Featuring Low Power Consumption and Long Life

Toshiba Mobile Display Co., Ltd. (TMD) has developed a new organic electroluminescence (EL) display, which has the highest^(*) level of performance for mobile applications in the world. It features one-quarter the power consumption and 30 times the lifetime of a conventional organic EL display.^(**)



Organic EL display

This organic EL display, based on small-molecule technology, was jointly developed with Idemitsu Kosan Co., Ltd., which is a manufacturer of organic EL materials. TMD's poly-silicon thin-film transistor (TFT) and device technologies and Idemitsu Kosan's material technologies have made this high-performance display possible. The 2.2-inch QVGA (240×320 pixels) display has a power consumption in actual use of 100 mW and a half-luminescence lifetime of 60 000 hours.^(***) The power consumption corresponds to 40% of that of a liquid crystal display (LCD).

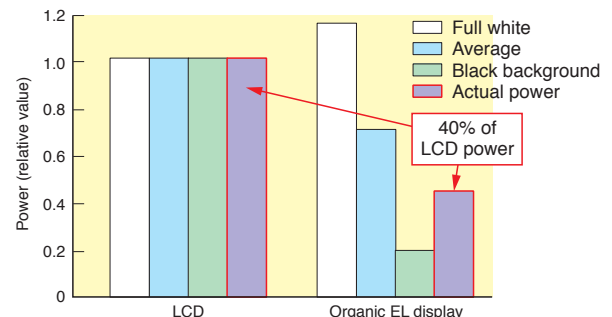
The organic EL display has finely processed thin organic layers on a glass substrate, which emit light themselves. This realizes its wide viewing-angle capability as well as sharp images with a high contrast ratio, especially sharp moving images without blur. Furthermore, the organic EL requires no backlight system, reducing the panel thickness and resource consumption.

(*) As of June 2008 (as researched by Toshiba)

(**) TMD's LTD035J060S product

(***) This performance is achieved when a white full screen with a luminance of 200 cd/m² is displayed.

QVGA: Quarter Video Graphic Array



Comparison of power consumption of organic EL display and LCD