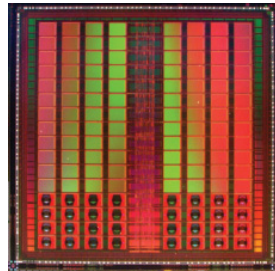


Toshiba provides system LSIs, memory, discrete devices, rechargeable batteries and liquid crystal display devices globally for advanced information equipment required in the ubiquitous age. Furthermore, we have developed a MeP (Media embedded Processor) that provides a system-on-chip software/hardware design platform.

## Next-Generation System-on-Chip Design Platform

Toshiba has developed a design platform for a next-generation SoC (System-on-Chip), which will satisfy the demanding requirements of customers.



Product example

In terms of device technology, we have developed an ultra-high density and ultra-low power consumption CMOS (Complementary Metal-Oxide Semiconductor) ASIC (Application Specific Integrated Circuit), TC300 family.

The TC300 family capitalizes on copper technology, low-k dielectric and the industry's most aggressive 90-nm CMOS process. The process technology also offers embedded DRAM capability.

We support an ever-growing lineup of IP (Intellectual Property) cores, and arrange digital/analog IP for network and multimedia systems as well as MPUs (Microprocessor Units), memory and high-speed input/output (I/O).

In terms of design methodology, while inheriting the well established existing design technology, we offer a robust, state-of-the-art design environment that lends itself to IP reuse and ensuring signal integrity while being geared to shortening the development time for complex SoC design.

### General product specifications of TC300

Design rule	90 nm (gate length: 65 nm), CMOS process, 11-layers Cu
Power supply	Core=1.2 V; Analog= 2.5 V; I/O:2.5V/3.3V (1.8 V optional)
Gate delay (F/O=1, CIVX4 gate)	14 ps (Low-power library), 11 ps (High-speed library), 9.5 ps (Very-high-speed library) * Three types of transistors are available with different threshold voltages.
Gate density	403 k gates/mm <sup>2</sup> or more
Power dissipation	7 nW/MHz/gate (CIVX1 gate)

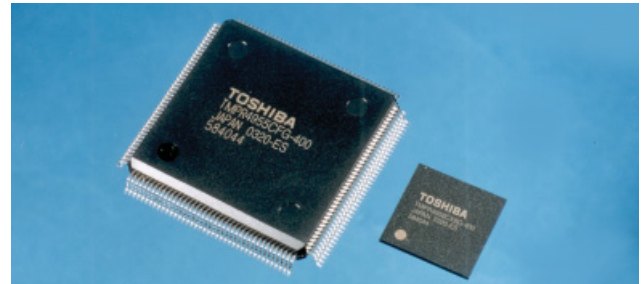
### IP cores

MPU	TX-RISC, ARM processors
Memory	DRAM, SRAM, FIFO, ROM
Protocol controllers	IEEE1394, USB2.0 host controller (PCI-I/F, AHB-I/F), USB 2.0 device controller, USB1.1 host controller, USB1.1 device controller
High-speed I/O	PCI controller (32 bit: 33 MHz, 66 MHz) PCI controller (64 bit: 33 MHz, 66 MHz)
Multimedia	SD card host controller, Smart Media™ controller, JPEG CODEC
Networking	10 M/100 Mbps Ethernet controller
Analog functions	ADC 8 bit/200 MHz, DAC 12 bit/110 MHz, Audio CODEC/Audio DAC PLL 100-600 MHz

USB: Universal Serial Bus    ADC: Analog to Digital Converter  
 PCI: Peripheral Component Interconnect bus    AHB: Advanced High-performance Bus  
 DAC: Digital to Analog Converter    JPEG: Joint Photographic coding Experts Group  
 PLL: Phase Locked Loop    FIFO: Fast In Fast Out memory

“ARM” is a registered trademark of ARM Limited in Europe and the U.S.

## TX49 Family 64-bit RISC Microprocessor Based on Leading-Edge 90 nm Process Technology



The TMPR4955CFG-400 (left) and TMPR4956CXBG-400 (right)

Toshiba has developed two new versions of its TX49 family of MIPS-based™ RISC (Reduced Instruction Set Computer) MPUs. The new MPUs, TMPR4955CFG-400 and TMPR4956CXBG-400, are fabricated with 90 nm process technology and are based on our TX49/H4 core. Power consumption is only 0.6 W when operating at their maximum frequency of 400 MHz; this is currently the lowest power consumption of any processor in this product category. The devices are targeted at embedded applications such as color laser printers, high-performance set-top boxes and networking devices that handle large amounts of graphics data.

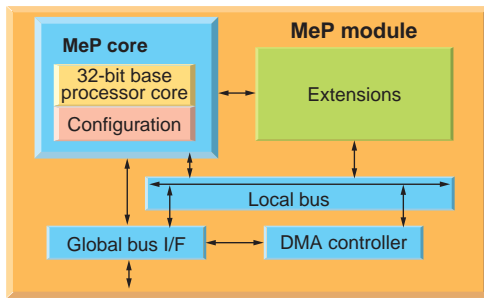
We have been developing high-performance TX-RISC series microprocessors since 1989 based on technology licensed from MIPS Technologies, Inc.

### Key features:

- Integrates our latest 64-bit core CPU, TX49/H4, which is fabricated with 90 nm CMOS process technology and operates at 400 MHz.
- Incorporates a four-way set-associative, large-capacity cache memory (32 Kbyte instruction cache and 32 Kbyte data cache.)
- Integrates a floating point unit (FPU) that is separate from the integer logic unit and realizes higher performance by making it possible to perform integer operations and floating point operations independently.
- Utilizes a 32-bit (TMPR4955CFG-400) or 64-bit (TMPR4956CXBG-400) SysAD Bus with multiplexed address and data as a system interface in order to interface with other SysAD-compatible devices.
- CPU core contains a dedicated debugging support unit (DSU) and uses an external enhanced JTAG (EJTAG) interface to perform execution control, such as setting breakpoints and performing real-time analysis while running at the maximum operating frequency.

“MIPS-based” is a trademark of MIPS Technologies, Inc.

## MeP Configurable Processor



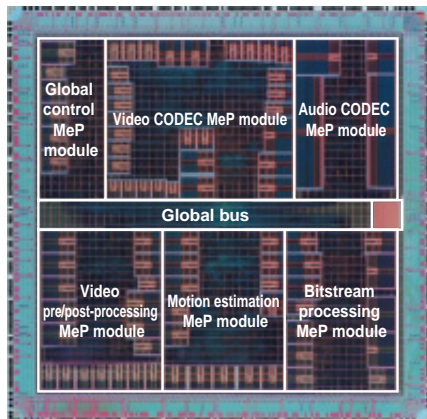
I/F: Interface DMA: Direct Memory Access

MeP architecture—block diagram of MeP module

MeP (Media embedded Processor) is a Toshiba original microprocessor family which provides both configurability and extensibility as inherent in its architecture. The MeP core, a key component of MeP, is a 32-bit processor core with high speed, small gate size and low power consumption.

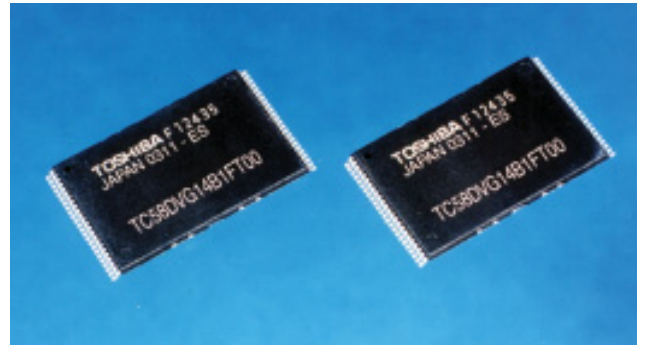
SoC designers can select memory sizes and optional instructions, such as multiply and divide instructions, and extend their customized instructions and hardware engines to the MeP core. It is integrated into digital media SoCs as IP and accelerates video, audio and communication processing.

For example, an MPEG-2 (Moving Picture Experts Group-phase 2) CODEC (Coder-Decoder) LSI consists of six processors (MeP modules) including a MeP core which is highly customized for specific tasks such as video CODEC and audio CODEC. This chip is fabricated with 0.18  $\mu\text{m}$  CMOS technology and operates at 150 MHz. Using MeP technology, optimized SoCs with good cost-performance can be developed in a short time.



Micrograph of MPEG-2 CODEC with six MeP modules

## 2 Gbit NAND Flash Memory



2 Gbit NAND flash memory

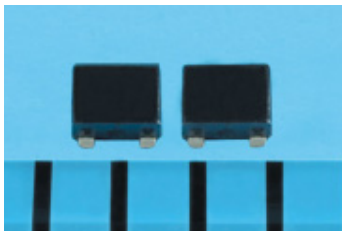
Utilizing 0.13  $\mu\text{m}$  fine process technology, Toshiba has developed industry-leading large-capacity 2 Gbit single-chip NAND flash memory.

Adoption of 0.13  $\mu\text{m}$  technology allows the 2 Gbit NAND flash memory to use the same package as our 1 Gbit NAND flash memory fabricated with 0.16  $\mu\text{m}$  process technology. We have also developed a 4 Gbit NAND flash memory IC that stacks two of the 2 Gbit NAND flash units in a single TSOP (Thin Small Outline Package).

NAND flash memory ICs offer high density, non-volatile data retention and are widely employed in flash memory cards and as embedded memory in digital consumer products such as digital still cameras, PDAs (Personal Digital Assistants) and mobile phones. The new memory will realize much higher capacity flash memory cards capable of supporting a wide range of applications.

The 2 Gbit NAND flash memory is the result of a collaborative effort by Toshiba and SanDisk Corporation, under a comprehensive agreement on the joint development of NAND flash memory.

## SiGe Microwave Transistors with Extremely Low Noise Figures



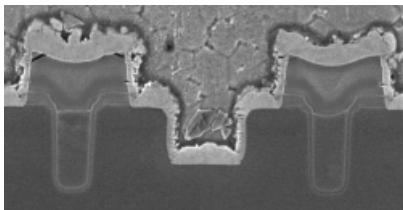
The SiGe transistor package (TESQ)

The demand for microwave transistors with lower noise figures and higher gain is growing for mobile phones or wireless applications.

To satisfy this demand, Toshiba has developed an original SiGe process (SMART3: Silicon Monolithic Architecture for Rf Technology-3), which has advanced SiGe epitaxial and ultra-fine process technologies, and has achieved the lowest noise figure at 0.58 dB and high insertion gain at 18 dB. The devices are packaged in a TESQ (Thin Extreme Super Mini Quad) package, which is the industry's smallest 4-pin package and is highly suited to mobile applications.

These devices are well suited for use as LNAs (Low Noise Amplifiers) in GPS (Global Positioning Systems) and 5.2 GHz wireless LAN.

## Low Switching Power Loss Trench MOSFETs for DC-DC Converters



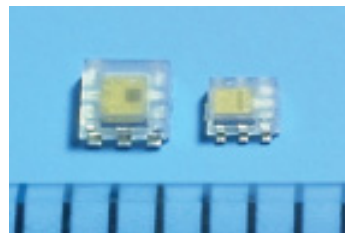
Developed MOSFET cross section

Small-package and high-speed power MOSFETs (Metal-Oxide-Semiconductor Field-Effect Transistors) with very low ON resistance and

capacitance are required for high-efficiency synchronous DC-DC converters used in power supplies. Toshiba has developed an N-channel trench power MOSFET (30 V/40 A/4.5-V drive) suitable for both high-current and high-power equipment to meet the increasing demand for high-performance power MOSFETs for DC-DC converters.

We have adopted both 0.35  $\mu\text{m}$  trench gate technology and trench contact structure, and have succeeded in reducing gate switch charge by 30 % as compared with that of previous products by optimizing the trench depth of both gate and contact. In addition, we have mounted the

## Micro Photo-IC for Illuminance Sensor



Conventional product TPS851 (left) and new product TPS852 (right)

The micro photo-IC TPS852 can detect the brightness of ambient light according to the average sensitivity of the eye (human eye sensitivity) and is now being produced commercially.

Power consumption has increased in line with the use of color LCDs (Liquid Crystal Displays) in personal equipment, such as cellular phones, PDAs (Personal Digital Assistants) and digital cameras. Reduced power consumption is made possible by detecting the brightness of ambient lighting with the illuminance sensor, and controlling the luminosity tone of the back light, and automatically turning off the light.

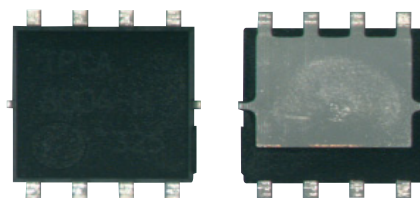
The TPS852 has attained industry leading miniaturization and a minimal package size (width: 1.6 mm, height: 1.6 mm, thickness: 0.55 mm).

This product has the following features compared with a photo-transistor.

- Built in linear amplification circuit, with high sensitivity (light current: 40  $\mu\text{A}$  typ.), and detection of low illumination is possible.
- Sensitivity variation is as small as  $\pm 25\%$  (at the time of rank specification).
- An LEC (Luminous Efficiency Correction) function was incorporated, reducing the difference in sensitivity according to light source (incandescent light and fluorescent light).

chip in an SOP (Small Outline Package) Advance package with quite low package resistance, and have developed an N-channel trench power MOSFET which achieves high performance under both high-current and high-power conditions.

The reduction improves switching characteristics and translates to a 1.5 % efficiency improvement in the DC-DC converter.



Outline of SOP Advance package

## Novel Input Display with New Concept Image Capture



Input display

Toshiba Matsushita Display Technology Co., Ltd. has developed the world's first input display that offers the ability to record images of text and photographs while maintaining all the functionality of a high performance LCD (Liquid Crystal Display). This display adds new capabilities to low-temperature polycrystalline silicon (poly-Si) LCDs utilizing system-on-glass (SOG) technology.

The prototype display, a 3.5-inch diagonal QVGA resolution (320×240) TFT (Thin Film Transistor) -LCD, has an input function in which any document, photograph, or other image (up to 960×240 resolution for monochrome) can be captured by simply placing the original face down on the display.

This enables the capture, save, redisplay, or mailing of the images without scanning, editing, or converting in any other scanner device.

This technology has been achieved by the integration of pixel TFT and photo-sensor elements in the same pixel on the poly-Si array substrate.

The new technology can be utilized for any size of display, and can be applied in a diverse range of products from cellular phones to personal computers. Its wide range of uses will include scanner-free recording of text, barcode reading on-line shopping and the like, saving personal data and images to a computer, and personal identification.

Future refinement of the input display will support higher resolutions and personal identification based on instantaneous identification of fingerprints in support of e-commerce and on-line transactions.

### Technical specifications

Feature	Display	Input function
Display size	8.9 cm (3.5 inch)	8.9 cm (3.5 inch)
Pixel resolution	320 (×RGB) × 240 QVGA	up to 960 × 240
Color	260 k colors	64-level gray scale
Type	Transparent type	2-dimensional photo sensor

QVGA: Quarter Video Graphics Array

## Development of New Version High Capacity Thin Prismatic Battery and Super Reliable Advanced Lithium-Ion Rechargeable Battery

In recent years, the necessity for higher energy density batteries has grown remarkably. Toshiba has developed a new version 443443 size prismatic lithium-ion battery (thickness:4.4 mm, width:34 mm, height:43 mm) having a nominal capacity of up to 700 mAh, which is one of the highest energy density cells of the 4 mm thickness type. An 8 % capacity increase is realized without diminishing the actual high rate discharge capacity or low temperature discharge characteristics.

On the other hand, lithium-ion rechargeable batteries, including Advanced lithium-ion batteries (AdLB), must be connected to a protection-circuit-module (PCM) to avoid intense exothermal reactions in overcharging states. The Super Reliable AdLB has been developed to enhance the safety properties by improvement of the separator structure or electrolyte composition of conventional AdLBs, which are themselves very safe. In consideration of possible direct connection to a car battery, even if the Super Reliable AdLB is overcharged up to 12 V with 2 A current, the intense exothermal reactions are suppressed. The Super Reliable AdLB will allow the replacement of an expensive PCM with lower priced devices.



The LGQ443443 thin prismatic lithium-ion rechargeable battery



The LAC383562 Advanced lithium-ion rechargeable battery