TOSHIBA REVIEW

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Special Reports

High-Power Semiconductor Devices and Application Products

In Expectation of Developments in Next-Generation High-Power Semiconductor Devices and Power Conversion Technologies
AKAGI Hirofumi

Power Conversion Technology Applying High-Power Semiconductors
MATSUMOTO Toshiaki / TAI Hiromichi / SHINOHE Takashi
Power conversion technology applying high-power semiconductors has now become an important technology that supports various social infrastructures including power systems, industrial systems, and railway systems. Due to its vital role in society, such power electronics equipment must provide high stability and high durability. Moreover, high efficiency is increasingly demanded due to the rising need for energy conservation in recent years.
Toshiba has been conducting research and development of core technologies in this field, including power devices, control circuits, cooling systems, mounting methods, simulation techniques, and techniques for the application of motors and power systems. We have achieved a power supply system with high stability, as well as miniaturization of an industrial plant system and a railway system. We will continue to supply various power electronics products offering high performance and high quality to meet the needs of customers.

High-Voltage and High-Current IEGT Devices
NISHITANI Kazunobu / OGURA Tsuneo / IESAKA Susumu
Thyristors are still used as power devices for MW-class power electronics equipment, however, there is an increasing need for high□performance devices offering compact and higher reliability for these equipment.
To meet these requirements, Toshiba has developed high□voltage and high□current injection enhanced gate transistors(IEGTs) with maximum blocking voltage of 4.5 kV and maximum current of 2.6 kA. Users are able to select from two types of package □ a plastic case module type and a press pack type □ according to the application. These devices have excellent switching performance due to a good balance of gate connection and optimized chip design. In addition to planar gate type IEGTs, lower saturation voltage is achieved by trench gate to make lower power loss of power devices.

IEGT Devices to Realize Small, Lightweight, and High-Efficiency Power Converters for Rolling Stock
NAKAZAWA Yosuke / AOYAMA Ikuya / YASUOKA Ikuo
Since the introduction of inverter-controlled induction motor drives to rolling stock drive systems, smaller and lighter main converters have been developed accompanying the advances made in the switching characteristics of power devices.
Toshiba has been developing injection enhanced gate transistors (IEGTs) with low loss characteristics for main converters with both high power density and high efficiency. We have released a variety of equipment applying these IEGTs, including main converters with world□s top-level power density for locomotives, main converters for Shinkansen trains featuring a natural-ventilation cooling system for the first time, and inverters for commuter trains that make it possible to drive four motors of more than 200 kW capacity.

IEGT Devices to Realize Energy-Saving, Small, and High-Efficiency Industrial Drive Equipment and Power Converters
YOSHIKAWA Tadamitsu / OGUSHI Koji / NOMURA Junichi
With the increasing global demand for steel as a basic industrial material in recent years, especially in Brazil, Russia, India, and China (collectively referred to as the BRICs), the construction of large-scale steel mills continues. In order to improve the productivity of steel rolling plants, lower energy consumption and easy maintenance are required for industrial drive equipment for motor control. Toshiba Mitsubishi-Electric Industrial Systems Corporation has applied injection enhanced gate transistors (IEGTs) to industrial drive equipment and flicker compensation equipment in power systems. In particular, we achieved high efficiency exceeding 99% and shortened the time required for troubleshooting by reducing the number of parts in the main control unit.

Innovative Technologies for AV Notebook PCs with SpursEngine™

New Value Creation by Convergence of Information and Audiovisual Technologies
MATOBA Tsukasa

Trends in and Prospects for High-Definition AV Notebook PCs
TOKORO Tsuyoshi / NAKASHIMA Nobu
Most audiovisual (AV) equipment has become digitalized in recent years and the quality of AV contents is becoming higher, as exemplified by digital photographs with high pixel resolution and high-definition (HD) video contents. Digitalized AV contents provide a wider range of experiences to users, but many improvements in hardware are required in order to process and store large amounts of information. Particularly in the case of PCs, which have become a platform for processing large volumes of AV contents, there is a strong need for improvements in HD image processing performance and storage capability.
To meet these requirements, in March 2006 Toshiba released the Qosmio™ series, the world□s first lineup of AV notebook PCs, featuring a digital terrestrial television tuner and HD image displaying capability. We have also developed the SpursEngine™ high-performance stream processor, which offers high-speed stream processing of HD contents, and have implemented this chip in the new Qosmio™ series.

LSI Architecture of SpursEngine™
YASUKAWA Hideki / GOTO Harutaka / UENO Kiyoji
Toshiba has developed SpursEngine™, a high-performance stream processor that offers high-speed stream processing of high-definition (HD) contents when connected to a PC system, and has implemented this chip in the new Qosmio™ AV notebook PCs. SpursEngine™ is connected to the PC system via a PCI (Peripheral Component Interconnect) Express interface, which can transfer data at up to 1 Gbyte/s. It also utilizes XDR™ DRAM as working memory, allowing it to support high data transfer rates of up to 12.8 Gbytes/s.
SpursEngine™ uses hybrid architecture featuring special-purpose hardware engines for fixed codec processing and synergistic processor elements (SPEs) derived from the Cell Broadband Engine™ (Cell/B.E.™), providing advanced and flexible processing such as a hand gesture application.

System Architecture of Qosmio™ AV Notebook PCs with SpursEngine™
SATO Shigenobu / SAKAI Akio / WATANABE Gen
Toshiba has developed the Qosmio™ AV notebook PCs, aiming at the creation of new value by the fusion of AV and PC technologies. The Qosmio™ series provide not only high-quality picture and sound but also convenience for enjoying AV contents.
With the increasing volume of high-definition (HD) video contents in recent years, high-speed processing of HD video data is required. To meet this requirement, we have released the Qosmio™ G50/F50 series incorporating the SpursEngine™, based on the technology of the Cell Broadband Engine™ (Cell/B.E.™). In order to implement a circuit board with embedded SpursEngine™ in the Qosmio™ PC, various problems had to be overcome including size minimization, lower power consumption, and high-efficiency cooling control. We succeeded in solving these issues by using a high-density board layout, shared cooling parts with the graphics processing unit (GPU), and a power-saving technology called □keep link power down□ (KLPD).

Software Architecture of Qosmio™ AV Notebook PCs with SpursEngine™
ARUGA Hideo / MORI Kenichi / HAYAMA Tatsuya
The SpursEngine™, a high-performance stream processor implemented in the new Qosmio™ AV notebook PCs, offers users the smooth handling of high-definition (HD) video contents by supporting the CPU and graphic processor to accelerate video recognition and processing tasks. Each function of SpursEngine™ is implemented in programs of synergistic processor elements (SPEs) controlled by the middleware, and applications are performed without concern for hardware control. This provides a software development environment in which SpursEngine™ can be easily utilized by various applications.

System Software and Middleware for SpursEngine™
SHIRAKAWA Kenji / HARASHIMA Takahiro / SAITO Natsuko
The system software for the SpursEngine™, a high-performance stream processor, provides the program execution environment to efficiently coordinate programs running on the host processor, synergistic processor elements (SPEs), and hardware codec engines.
Application programs utilizing the stream-oriented programming model and video codec middleware are able to perform video transcode functions simultaneously with various high-order processing on the video stream.

Super-Resolution Technology for Video Quality Enhancement
KUMAGAI Akira / IDA Takashi / TANAKA Akira
Digital high-definition broadcasting has disseminated in recent years. With the increasing emphasis on high picture quality, demand has been increasing for better video quality in the upscaling of standard-definition (SD) video contents on notebook PCs equipped with a large liquid crystal display (LCD).
Toshiba has released the Qosmio™ series audiovisual (AV) notebook PCs featuring enhanced video quality using proprietary color control technology. We have developed a new technology that allows users to experience SD video contents with high-definition quality on a large PC LCD, utilizing a high-performance stream processor named SpursEngine™ and a newly developed super-resolution technology.

Easy Video Scene Search using "Face Navigation"
KUBOTA Hidetoshi / MOMOSAKI Kohei / AOKI Hisashi / KAZAMA Hisashi
Demand has been increasing for effective searches of large volumes of accumulated data recordings due to the progress of digital video devices. In response to this trend, Toshiba has developed the "Face Navigation" function to make it easier to find scenes in a video utilizing the advanced video processing performance of the SpursEngine™ stream processor in the new Qosmio™ audiovisual (AV) notebook PCs.
"Face Navigation", based on our advanced video indexing technology, makes it possible to display a graphical view of highlight scenes, faces and audio scene changes in a video content.

Hand Gesture Interface Technology
SAKAMOTO Kei / OOTAKE Toshifumi / IKE Tsukasa / FUJITA Masahiro
In order to control equipment by hand gesture image recognition on a PC, both high-performance algorithm for image recognition and stress-free high-speed data processing technology are required.
Toshiba has developed a new hand gesture interface using images captured by a video camera and an image recognition technology, which eliminates the need for interface devices such as a keyboard, mouse, or remote controller. We have been able to successfully achieve comfortable operation for users by implementing an optimized hand gesture recognition algorithm on our SpursEngine™ media processor, which supports the smooth handling of image recognition and processing by cooperative processing with the PC□s host processor.

SpursEngine™ Reference Kit for SpursEngine™ System Application Engineering
UESUGI Kouki / HABA Shintaro / HAMAOKA Yoshiyuki
SpursEngine™ is a high-performance stream processor that consists of four synergistic processor elements (SPEs) derived from the Cell Broadband Engine™ (Cell/B.E.™) multicore processor, and an MPEG-2/H.264 Advanced Video Coding (AVC) hardware codec.
Toshiba has developed the SpursEngine™ Reference Kit (SRK) for system developers to accelerate the development of attractive applications for PCs. The SRK consists of a PCI Express x1 add-in card equipped with SpursEngine™ and a software development environment. Many vendors are expected to utilize the SRK to develop systems using SpursEngine™, thereby enhancing the ease of use of PCs.

Feature Articles

400/132 kV Fujairah Grid Station in UAE in Commercial Operation
KUROKAWA Norihito / TAKUBO Yoshimitsu / SAKAMOTO Shogo
The Abu Dhabi Water & Electricity Authority (ADWEA) in the United Arab Emirates (UAE) has been expanding the facilities of its 400 kV power system for improvement of system stability and reliability. The construction of a 400/132 kV grid station in Fujairah was planned as part of the project. This grid station is connected with the adjacent independent water and power producer (IWPP), and supplies 400 kV by transformation of the voltage from 132 kV.
Toshiba was able to complete the project successfully despite difficulties such as integration with the adjacent IWPP, by taking advantage of our advanced technologies and experience in substation project management and engineering. The grid station was eventually energized and started commercial operation in March 2008.

High-Efficiency X- and Ku-Band GaAs FETs
YAMAMURA Takuji / KIMURA Hideki / TAKAGI Kazutaka
Toshiba has recently succeeded in developing higher efficiency gallium-arsenide field-effect transistors (GaAs FETs) for solid-state microwave power amplifiers used in base stations for point-to-point or point-to-multipoint microwave communications, satellite microwave communications, and other applications. The newly developed FETs achieved a power-added efficiency of more than 36 % with output power levels of 2 W and 8 W in the X- and Ku-band frequency range (8-15 GHz).
To achieve both high drain efficiency and high power gain, we optimized electron-density distribution in the depth direction of the FET channel employing the advantages of ion-implantation technology. Of particular note is the fact that the new 8 W-class FET achieved an excellent poweradded efficiency of 39% in the frequency range from 10.7 to 11.7 GHz, representing a 7 % improvement compared with our existing products.

Frontiers of Research & Development

Design of Product Sound Quality for “Delight Design” Concept
Miniaturization of Magnetic Particles and Hard Disk Media Technologies for Higher-Capacity HDDs