TOSHIBA REVIEW

2014 VOL.69 NO.8

Special Reports

Advancing Semiconductor Technologies for Automotive Systems

Semiconductor Technologies for Ongoing Evolution of Automotive Innovation
HAYAKASHI Yoshiki

Trends in Semiconductor Technologies for Automotive Systems and Toshiba's Approach toward Reduced Environmental Impact, Greater Safety, and Enhanced Computerization
NAGAI Kentaro
Growing awareness of environmental impacts and safety in the automotive field coupled with the progress of information technologies (ITs) have led to the expanding use of onboard electronics and electroactuation in vehicles. From the environmental viewpoint, technologies to electronically control both motor-driven systems for hybrid electric vehicles (HEVs) and electric vehicles (EVs) and internal-combustion engines for gasoline-powered vehicles are required. From the standpoint of safety, there is a need for support and control technologies ranging from those for passive safety and driving assistance to automated driving. In terms of ITs, technologies allowing smooth access to Internet or cloud systems have become increasingly important. Hence, there is growing demand for semiconductors for automotive systems to fulfill these diverse high-level requirements.
Toshiba has been engaged in the development of state-of-art semiconductor technologies for automotive systems and has accumulated a wide array of technologies related to functional safety, in-vehicle environments, and improvement of the quality and reliability of automotive systems for more than three decades. We are also applying image processing, radio frequency integrated circuit (RFIC), control, and security technologies to this field, making use of our proprietary intellectual property in various sectors including industrial systems, home appliances, and digital products. Through these activities, we are making continuous efforts to achieve the further evolution of semiconductors for automotive systems aimed at realizing a sustainable, zero-traffic-accident automobile society.

Automotive Microcontrollers Providing High-Speed and High-Efficiency Motor Control
YOSHIDA Kazuyoshi / SATO Eiji / YAMAZAKI Akihiro
Motor control technology has become a key technology for the basic functions of driving, turning, and braking in the automotive field due to the increasing use of systems in which motor control technology is directly linked to the performance of an automobile, such as the drive systems of hybrid electric vehicles (HEVs), plug-in HEVs (PHEVs), and electric vehicles (EVs) as well as automotive electric power steering (EPS), regenerative braking, and electric braking systems.
Toshiba has developed a lineup of automotive microcontrollers equipped with three effective hardware features—vector engine (VE), resolver-to-digital converter (RDC), and advanced programmable motor driver (A-PMD)—to provide high-speed and high-efficiency motor control. These microcontrollers also incorporate fault detection mechanisms to ensure functional safety, allowing users to construct motor control systems conforming with Automotive Safety Integrity Level D (ASIL D) specified in the ISO (International Organization for Standardization) 26262 standard.

Motor Driver ICs Supporting Enhanced Performance and Electrification of Automotive Systems
HAGURA Junichiro / SUZUKI Kunio / MATSUO Takehiko
Accompanying the ongoing enhancement of performance and electrification of automotive systems and the diversification of needs for these systems, the number of motors installed in automobiles continues to increase. Currently, an automobile may be equipped with 40 to 100 such motors. Efficiency, low noise, compactness, and functional safety are keywords representing the requirements of the market for automotive motor driver integrated circuits (ICs).
Toshiba has been developing and supplying various motor driver ICs to solve technical issues related to these requirements for 30 years since delivering its first motor driver IC, the TA8050P, in 1984.

New-Generation Low-Voltage MOSFETs Contributing to High-Performance and Compact ECUs for Automotive Use
OKURA Gentaro
Automobiles are equipped with electronic control units (ECUs) of various types, which have been developed so as to comply with laws and regulations related to fuel consumption and emissions that are becoming increasingly strict year by year. In order to realize high-performance ECUs, it is essential to improve the performance of automotive power semiconductors such as low-voltage metal-oxide-semiconductor field-effect transistors (LV-MOSFETs).
To meet the demands of the automotive electronics market, Toshiba has developed p-channel and n-channel LV-MOSFET chips with low loss and low capacitance characteristics, as well as three types of surface mount packages and a known good die (KGD) that can be mounted directly on a circuit board to contribute to the miniaturization of ECUs.

Functional Safety Technologies for Automotive Lithium-Ion Battery Monitoring ICs
SUZUKI Atsuhisa / TAKADA Nobuyuki
Lithium-ion battery systems for hybrid electric vehicles (HEVs) and electric vehicles (EVs) are required to have functions to monitor the battery voltage and temperature in order not only to prevent overcharge and over-discharge but also to detect the remaining level of battery power. Since a lithium-ion battery in the overcharged condition could cause a critical problem, the battery monitoring integrated circuit (IC), which is at the core of the protection system, must have the functions and reliability to avoid such abnormal conditions under any circumstances.
Toshiba is promoting the development of lithium-ion battery monitoring ICs equipped with functional safety systems for detection of disconnection and other electrical faults. Our battery monitoring ICs are compliant with Automotive Safety Integrity Level D (ASIL D) specified in the ISO (International Organization for Standardization) 26262 standard.

TMPV7500 Image Recognition Processor Family for Advanced Driver Assistance Systems
OKADA Ryuzo / BANNO Moriyasu
Rapid progress has been made in the field of driver assistance systems for safe driving in recent years. Preventive safety systems such as autonomous emergency braking systems to prevent traffic accidents have already been commercialized, and the range of application of such systems is being expanded to autonomous driving technologies. In order to realize an advanced driver assistance system, it is necessary to detect the situation surrounding the vehicle and the driver's condition using various types of sensors.
Toshiba has developed and released the TMPV7500 family of image recognition processor large-scale integrations (LSIs), which can analyze video images from onboard cameras. These processor LSIs incorporate various types of image processing accelerators for image recognition, making it possible to execute sophisticated image recognition algorithms while maintaining low power consumption.

Functional Safety in Automotive Microcontrollers and Fault Injection Test System for Compliance with High Functional Safety Requirements
OMIZO Takashi / UNESAKI Tsutomu / TAKANO Hiroyuki
With the recent expansion of safety-critical control systems utilizing electrical and electronic functions in areas affecting human life, such as automobiles, functional safety standards including the IEC (International Electrotechnical Commission) 61508 and ISO (International Organization for Standardization) 26262 standards have been specified.
Toshiba has developed an automotive microcontroller complying with these functional safety standards, and offers users the TM-SIL™ functional safety support package consisting of device support, software support, and system support subpackages. To meet users' requirements for reduction of the costs incurred in the implementation of the increasing number of functional safety verification and validation tests, we have also developed a field-programmable gate array (FPGA)-based full in-circuit emulator (ICE) type fault injection test system as a core of the system support subpackage of the TM-SIL™ package.

Bluetooth(†) and Wireless LAN Combo Chips for Automotive Applications
KOTO Tsuyoshi / HORISAKI Koji / FUJIMOTO Ryuichi
Bluetooth(†) has traditionally been the mainstream technology for onboard automotive wireless communication systems to realize hands-free mobile phone operation. Recently, however, the demand for onboard wireless LAN systems has increased to provide high-speed data communication capability and access to cloud services via smartphone.
Toshiba has developed automotive-grade combo chips for Bluetooth(†) and wireless LAN employing proprietary technologies such as digital predistortion (DPD) and transmitter calibration as well as low-noise amplifier capability in the 5 GHz band, to meet the demand for various onboard communication requirements.

NAND Flash Memory for Car Infotainment Systems
UESUGI Koki / OHNO Eiji / TABE Koichi / MORI Wakaki
In recent years, conventional car navigation systems that provide mainly map information have evolved into car infotainment systems. These highly functional systems, which provide both information and entertainment, have become the mainstream in the market.
Toshiba has been developing and supplying the market with various NAND flash memory products such as the embedded multimedia card (*e*•MMC(†)), secure digital (SD) memory cards, and solid-state drives (SSDs) for car infotainment systems. Though the optimal utilization of these NAND flash memory products according to the application, system developers can construct high-performance and high-functionality car infotainment systems.

Feature Articles

HEVC Real-Time Software Video Encoder for Ultra-High Definition Video Contents Applying Parallel Distributed Processing
TANIZAWA Akiyuki / ASANO Wataru / ITOH Takayuki
Accompanying the wide dissemination of TVs with larger displays, 4K TVs with a resolution of 3,840 x 2,160 pixels, four times that of full high definition (HD), have been increasingly appearing on the market in recent years. In order to deliver such ultra-high definition (UHD) video contents with 4K or 8K (7,680 x 4,320 pixels) resolution to end users using the existing network and broadcasting infrastructure systems, a new video coding standard is necessary to reduce these large volumes of image data further compared with the conventional H.264/AVC (Advanced Video Coding) standard. This has led to the introduction of the HEVC (High Efficiency Video Coding) standard, which was standardized in January 2013 and achieves double the coding efficiency of the H.264/AVC standard.
Toshiba has developed a real-time video encoder for UHD video contents that is compliant with the HEVC standard, applying parallel distributed processing. This HEVC encoder is based on a full-software architecture and makes it possible to encode 4K images with high speed and high image quality using two general-purpose PC servers. It can be easily applied to cloud computing systems, including as a real-time video streaming system capable of handling various image data ranging from HDTV to UHDTV.

Technology to Extract State Machine Models from Source Codes for Model-Based Software Development
KAWAKATSU Noritaka / KAWATA Hideji
In recent software development, it has become necessary to rapidly respond to not only the increasing scale and complexity of software but also to frequent specification changes. Model-based software development utilizing descriptions at a higher level of abstraction compared with programming languages is now attracting attention as an effective countermeasure. However, it is difficult to shift from conventional development based on source codes and design documents accumulated as development assets to model-based development based on models requiring many worker hours to build from these conventional development assets.
As a solution to this issue, Toshiba has developed a technology to extract state machine models, one of the most frequently used types of models for model-based development, from source codes. This technology can efficiently build models as development assets and is expected to contribute to an acceleration of the shift to model-based development.

Stationary Traction Energy Storage System for Railway Transportation Systems
SATAKE Nobuhiko / NOGI Masayuki / HOSHINA Shunichiro
Accompanying the increase in demand for energy conservation solutions in railway transportation systems in recent years, there is a growing need for more effective use of regenerative energy generated by rolling stock during braking.
Toshiba has now developed a stationary traction energy storage system that is charged by regenerative energy during braking and discharges it during acceleration of rolling stock. This system not only achieves energy conservation, absorption of regenerative energy, and stabilization of feeding voltage, but also serves as an emergency power supply for rolling stock. High safety and a long lifetime of the system are assured through the adoption of our SCiB™ battery modules as a storage device.

Electrical Equipment for 1000 Series EMUs of Hankyu Corporation
HIROTA Kohsuke
Toshiba has been making efforts to develop electrical equipment for rolling stock that offers enhanced energy saving, easy maintenance, and high serviceability. With this as a background, we have delivered the main electrical equipment for the new 1000 series electric multiple units (EMUs) of Hankyu Corporation.
The propulsion system incorporates highly efficient, easy-to-maintain permanent magnet synchronous motors (PMSMs) that achieve a significant reduction in traction power consumption, as well as 4-in-1 traction inverters for the PMSMs that are smaller in size and lighter in weight than conventional inverters, resulting in a reduction in the required installation space. Furthermore, our newly developed integrated train information system with a simple configuration makes it possible to supply passengers with plentiful information, and the auxiliary power supply system with high redundancy contributes to improved serviceability.

Frontiers of Research & Development

Polyspector™ Platform for Software Execution Trace Analysis