

## Special Reports

### Technologies for Railway Transportation Systems

#### Dreams of Power Electronics and Railway Engineers

AKAGI Hirofumi

#### New Railway Technologies and Environmental Harmony

OHNISHI Toshiyuki

Consideration for the environment is necessary on a worldwide scale due to the global warming issue, and activities based on sustainability have been initiated in many companies. Sustainability means maintaining life in harmony with three aspects; namely, the environment, economy, and society.

Railways are considered to be an environmentally friendly system. They must be further developed along with the progress of technological innovations in order to support global sustainability. Toshiba goes on to develop the environment-friendly railway technologies on the basis of comprehensive railway-centered transportation system.

#### Next-Generation Shinkansen Drive Systems

HASEBE Toshio/YAMAMOTO Hajime

Toshiba has delivered two types of Shinkansen drive systems for next-generation models; namely, the N700 series Shinkansen and the E954/E955 type Shinkansen. The drive system for the N700 series is of the induction motor type, the mainstream system in current railways, that realizes a reduction of approximately 20% in the weight-power ratio. For the E954/E955 type, on the other hand, we have delivered a permanent-magnet synchronous motor drive system that achieves high output, light weight, low noise, and high efficiency.

Both types of Shinkansen are undergoing evaluation running tests on main lines. Mass-produced N700 series trains will be put into service from 2007, while the E954/E955 type will be evaluated through the running tests to determine whether the permanent-magnet synchronous motor drive system is an appropriate drive system for the next-generation Shinkansen.

#### Power Electronics Products for Railway Cars Realizing Low Noise and Energy Saving

YAMADA Toshiaki/NAKAZAWA Yosuke/SHIRAISHI Shigetomo

Rising social awareness of the need to prevent global warming has led to growing demands for global environmental protection and energy saving. Toshiba has developed a highly efficient permanent-magnet synchronous motor (PMSM) drive system without any rotational sensor, for use in railway car traction. This PMSM reduces the energy cost, which accounts for 90% of the total life-cycle cost (LCC) of a traction motor. In addition, the low amount of heat generated by the PMSM permits it to have a totally enclosed structure, which reduces acoustic noise and maintenance work, yet the motor has a large power output equivalent to that of a conventional self-ventilated motor. The adoption of sensorless control also improves the reliability and reduces the initial cost and maintenance work.

#### Locomotive and Container Car System Supporting Modern Distribution and Transportation

YAMAMOTO Joji/SAKURAI Kimio/NAGASE Mitsunori

There is generally a close connection between the trend in business conditions and freight demand, and expansion in the transportation sector is directly connected to the demand for locomotives. Locomotives used in Japan are comparatively small because of the limitation on axle weight, while electric locomotives with an axle weight of about 20 to 30 tons are commonly used in other countries. The performance and control functions of locomotives are becoming increasingly sophisticated. Moreover, locomotive systems for freight trains are required to offer not only high performance but also sufficient levels of safety and reliability.

Toshiba is supplying optimum locomotive systems incorporating the latest technologies, which are receiving high evaluations from customers both in Japan and overseas.

#### Superconducting Maglev Technology for Ultrahigh-Speed Transit System

NAKAO Hiroyuki/YAMASHITA Tomohisa/KOBAYASHI Yoshitaka

Development of the superconducting maglev system is steadily progressing. Running tests are being constantly conducted on the Yamanashi Maglev Test Line, and engineers are tackling challenges related to better performance and cost reduction.

In collaboration with Central Japan Railway Co. since 1999, Toshiba has successfully developed high-temperature superconducting (HTS) magnets that provide performance equivalent to that of conventional low-temperature superconducting (LTS) magnets. At present, these HTS magnets are being applied to a maglev test vehicle, which has run at a maximum speed of 553.9 kph. The ground coils and power converters of the system have also been remodeled and installed in the Yamanashi Maglev Test Line.

#### Transport Planning and Management System Meeting Current Railway Transportation Needs

TATEISHI Shogo/IKEDA Katsumi

Planning and management operations for railway transportation services, which are already systematized in major railway enterprises, are required to have additional functions as users' needs change and hardware capabilities advance.

Toshiba has developed a system providing three new functions in addition to conventional functions such as the preparation of run curves and service diagrams, and the planning of train routings and train personnel assignments. These new functions, which have gradually come to be required in the railway transportation sector, are the determination of interval times between trains, the readjustment of car allocations, and the readjustment of train personnel assignments. We have prepared various versions of this system so that it can be run on any operating system used by the customer.

#### Convenient IC Card System for Railway and Bus Use

NARUSE Tomoaki/SAITO Hiroki

The Japanese railway industry has been introducing integrated circuit (IC) cards, with the Suica system adopted by East Japan Railway Co. and the ICOCA system adopted by West Japan Railway Co. The number of people using IC cards as tickets has spread due to their ease of use and convenience.

Toshiba developed the entire IC card system for both railway and bus use for the Takamatsu-Kotohira Electric Railroad Co., Ltd. One and a half years have passed since the IC card system was introduced. The number of IC cards issued is expanding smoothly and the system has been favorably received by users.

#### Automatic Train Operation System with Adjustment of Run Times to Train Schedule and Energy Saving

OHYA Junko/KAMATA Keiichi/NAKAZAWA Hiroji

Automatic train operation (ATO) systems to operate trains automatically in place of drivers are being introduced into many railway companies as train service schedules become heavier and the use of platform door systems increases. An ATO system should ensure accurate stopping at stations and stable run times between stations.

Toshiba has developed a new ATO system that operates a train according to a running plan calculated to adjust its run time to the train schedule and to save energy. This system also controls braking based on prediction, to stop the train comfortably and accurately at the target positions.

We have confirmed accurate station stopping and run time recovery by recalculating a running plan through tests with an actual train and computer simulations.

#### Evolution of Train Information System into High-Performance Networked System

KAMO Yushi/TAKAHASHI Hideyuki/SUGIYAMA Atsushi

The control and monitoring of train instruments are greatly enhanced by the application of a high-technology transmission system to a train information system.

Toshiba has prepared an Ethernet environment conforming to the IEEE802.3 standard for such a transmission system and made it the core for implementing the functional enhancement of a train information system. In the next stage, the train information system is expected to collect all forms of train data and smoothly offer information including images and sound on the basis of real-time, high-speed, large-capacity networking of the train system.

#### Display Technology for Passenger Information Display System

YAMANAKA Tatsuya/UCHIDA Daisuke/KATO Naoya

Over the past several years, flat panel displays (FPDs) such as plasma display panels (PDPs) and liquid crystal displays (LCDs) have been increasingly used for display devices in railway passenger information display systems, in addition to the conventional light-emitting diode (LED) displays. With the progress of FPD technology, display devices have become thinner while offering higher resolution and larger screen sizes, and can display various contents from text to images.

In response to these trends, Toshiba Transport Engineering Inc. has developed a display control unit that has common display output and a control method for application to LED and FPD screen displays.

#### TECHNO RAINBOW TR2006R series modular type LED display unit

KURATOMI Seiichiro/YOSHIZAWA Nobukazu

Modular type light-emitting diode (LED) units have become necessary for exhibitions, concerts, and other events. A modular type LED unit is divided into small parts so that it can be easily set up to provide a large screen size, then disassembled and transported. The demand for movable, user-friendly products to be used in locations such as railway stations, studios and commercial facilities is also increasing.

In order to meet this demand, Toshiba Transport Engineering Inc. has produced the TECHNO RAINBOW TR2006R series modular type LED display unit. This product features a curvable screen, improved design, and ease of use. It has a dot pitch of 6 mm, brightness of 2,400 cd/m<sup>2</sup>, screen size of 384 x 384 mm, and weight of 9.5 kg.

#### Package Type Substation for DC Electrified Railway

OHTAKE Shirou/SHIOTA Hiromu/KANDA Koji

Toward practical use in Japan, the safety of the Translohr rubber-tire light rail transit (LRT) vehicle is currently under evaluation and verification on a test line constructed in Sakai City, Osaka Prefecture.

For this test line, Toshiba has developed a new type of package type substation that has every function required for feeding DC power to an electrified railway. After completion of the substation for this test line, the specifications for package type substations were reviewed and standardized so as to allow small- and medium-sized railway substations to be easily constructed.

We have prepared a lineup of package type substations that are applicable not only to the Translohr system but also to other small- and medium-sized railway systems in general including streetcar systems. These are high-value-added substations because their packaged structure enables them to be easily set up, including adjustment work, in a short time and in a small area.

#### Hybrid Inverter and Converter for Electric Railways

KATAOKA Akihisa/INAGAKI Katsuhisa/NOMURA Junichi

Electric power has recently been more effectively utilized by applying inverter equipment, which converts DC power to AC power, to electricity substations for DC traction service where rectifier equipment is installed. The inverter equipment regenerates AC power from the energy obtained from decelerating trains, and the power is used for station services such as elevators and escalators.

Toshiba has developed a hybrid inverter and converter system utilizing insulated gate bipolar transistors (IGBTs) and diode cells. This system realizes the combined function of converting AC to DC and DC to AC. This report provides an outline of the system and describes some of its features.

#### SCADA System for Railway Substation Integrated with Maintenance and Measurement System

MATSUI Mitsuhiro/TANNO Tsutomu/MATSUI Wataru

Supervisory control and data acquisition (SCADA) systems are widely used to efficiently perform the systematic operations of substations, while maintenance and measurement systems have been applied as a method of detecting deterioration or failure of substation equipment.

Although a maintenance and measurement system is generally used separately from a SCADA system, these two systems have some common elements in terms of hardware and information.

In response to the need for the use of these common elements, Toshiba has developed a SCADA system integrated with a maintenance and measurement system. It is planned to introduce this system to KEIO Corporation.

## Feature Articles

#### ALWAYS-G Elderly Care Insurance Administration Analysis System

KONDO Masafumi/OHARA Akiyoshi/SUGIYAMA Nobuki

A new elderly care insurance system was introduced in Japan from April 2006 to restrain the growth in expenses for elderly care.

The new system incorporates preventive care into the insurance system. Toshiba has proposed an elderly care insurance administration analysis system, called ALWAYS-G, to analyze the accumulated care insurance data of municipal governments (namely, data on the approved degrees of individual mental and physical care requirements, and individually provided care benefits).

Such analysis will support the efforts toward preventive care necessary for the elderly care insurance system.

#### EXPRESSPOS<sub>TM</sub> - World's First Payment System Using Electronic Tags and Electronic Money

UCHIYAMA Masami/UEMATSU Tsuguharu

Peak-hour crowding at convenience store checkout counters not only inconveniences customers by making them wait for a long time, but also degrades customer service and lowers sales opportunities. Providing more checkout counters and counter attendants requires extra floor space but does not lead to a real solution.

Together with FamilyMart Co., Ltd. and ITOCHU Corporation, Toshiba TEC Corp. has taken part in a demonstration experiment for the "Japanese Future Store Project" being promoted by the Ministry of Economy, Trade and Industry (METI). In this experiment, Toshiba TEC developed and introduced a new payment system called EXPRESSPOS<sub>TM</sub>, the world's first system combining identification of sales articles by IC tags and Electronic Funds Transfer at Point of Sales (EFT-POS) to drastically reduce checkout time.

## Frontiers of Research & Development

#### MRAM: The Ultimate Nonvolatile Memory Authentication Context for Biometrics (ACBio)