

TOSHIBA REVIEW

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Special Reports

Recent Advances in Power System Protection and Control Technologies

Sentinels of Power Systems to Support a Safe and Secure Society

YOKOYAMA Akihiko

Trends in Power System Protection and Control Technologies

ITO Hachidai/SUGA Noriyoshi

A protection relay is a device that detects abnormalities (system faults) such as short circuits and earth faults occurring in an electric power system or power equipment within several tens of milliseconds, and issues a command to isolate the faulty part from other normally functioning parts without delay.

This year marks the 100th anniversary of the manufacture of Japan's first protection relay in 1907. The configuration and deployment of protection relays and other control devices and systems have evolved during this period along with the development and expansion of electric power systems. Numerical protection relays, which are equipped with microprocessors and digital transmission units, are becoming popular in parallel with the development of digital control and monitoring systems. Protection relays have greatly improved in terms of performance and general features as well as reliability, which is essential for power system protection and control.

In the future, protection relays are expected to play a vital role in the protection and control of wider area power systems based on intelligent processing and communication networks.

Differential Protection Relays Applying Voice-Band Channel

OHNO Hirofumi/SUGIURA Hideaki/KIKUZAKI Tomohiro

Differential protection relays are widely used in the field of power system protection. Transmission lines are protected by a method in which differential currents are calculated after current data of all terminals are collected. For this purpose, optical fibers or microwave communication are required as the data communication channel between terminals. Usually, a set of communication equipment is also employed to create a high-capacity channel.

Toshiba has proposed a differential protective relay system that applies a voice-band channel as the communication line.

Accordingly, our system does not require the new installation of a communication channel but uses an existing voice-band channel to ensure power system protection.

Field Experience and Assessment of GPS Signal Receiving and Distribution System

ITAGAKI Daiju

A number of applications have emerged in the power systems field that require synchronized data samples having precise absolute time obtained from the Global Positioning System (GPS), such as power system protection, control, and monitoring. However, the actual performance and reliability of GPS signal reception within the substation environment has not been comprehensively assessed.

Toshiba has undertaken long-term assessments of the stability of GPS signal reception in a variety of substations, and confirmed stable reception of the GPS signal. We have also demonstrated methods for reliably applying GPS in the event of GPS signal loss or failure.

Our GPS synchronization system has already been widely applied in operational systems and protection relays. The results have been excellent to date.

GPS-Based Line Current Differential Relay

SUGIURA Hideaki/SAGA Masamichi

The numerical line current differential relay for transmission line protection requires a stable telecommunication system with an unchanging transmission delay time, because it simultaneously samples terminal currents by a synchronization system that runs on the telecommunication system.

Toshiba has developed a new numerical line current differential relay in which the Global Positioning System (GPS) is applied to make synchronous digital hierarchy (SDH) communication networks. The new relay can protect transmission lines even when the GPS signal has been lost or some fault has occurred in the telecommunication system, assuring highly reliable protection for transmission lines.

High-Speed and Highly Precise Distance Relay Technology

TAKANI Hideyuki/SAITA Yutaka

Distance relays are widely used for power system transmission line protection. A distance relay is activated according to the distance from the relaying point to the fault point given by the calculation of impedances. Conventionally, these devices have mainly been used for backup protection. Recently, however, there has been a movement toward using them also as a main protection because they are expected to provide higher reliability in power system protection. For this purpose, they are required to have high-speed and high precision.

Toshiba has developed a high-speed and highly precise distance relay with an operation time improved by as much as 40%. In addition, incorrect operation by overreach is prevented by minimizing transient fluctuating measurement errors.

Next-Generation Protection and Control System for Power Distribution Substations

INOUE Yasunori/MINAMI Yuji

Toshiba has developed a next-generation digitized and Ethernet LAN-based all-in-one protection and control system for power distribution substations. The new system contains fewer components because its constituent unit is improved in performance and has aggregated functions, thus facilitating system construction. This system incorporating a high-performance unit will contribute to the renewal of aging analog power distribution substations by providing a protection and control system with reduced cost and compact size.

Feeder Manager Relay for Protection and Control of Power Distribution Systems

KAWANO Fumio/TORIKOSHI Hideki

Accompanying the rapid development of information and communication technologies, demand has been growing for the reduction of both operation and maintenance costs of power distribution systems through the integration of various functions such as protection and control.

To meet this demand, Toshiba has developed a feeder manager relay (FMR) that integrates protection and control functions in one unit, targeted at overseas markets. The FMR is equipped with a large-size LCD monitor screen to display one-line diagrams or system power meters, a programmable logic control (PLC) function allowing sequential control logics to be freely customized, and PC tools to support engineering tasks. This product is a compact, multifunctional intelligent electronic device (IED) that offers easy customization and easy operation. FMRs are now used in a variety of applications in China, Southeast Asia, the Middle East, and other regions.

Digital Relays for Replacement of Analog Relays

TANAKA Toshio/KOSUGI Mitsugu

Electromagnetic type analog relays of both the induction cup type and induction disk type have been used to protect critical power systems and power equipment for approximately 60 years. However, these devices went out of production in 2002 because of aging production facilities, discontinued components and parts, and a shortage of manufacturing and testing technicians. At the same time, static type analog relays, or transistorized relays, are also facing a difficult situation with the exception of some special types, because of the discontinuation of electric and electronic parts.

Toshiba has developed a series of new digital relays to replace conventional analog relays, offering improved performance and reliability.

The lineup of these products was completed in 2000.

Feature Articles

Lanthanum Aluminate Gate Dielectric Technology with Direct Interface

SUZUKI Masamichi/YAMAGUCHI Takeshi/KOYAMA Masato

The further miniaturization of silicon large-scale integrated circuits (Si LSI)s has required the replacement of conventional silicon dioxide (SiO₂) gate dielectrics with a material having higher dielectric permittivity (i.e., high k), in order to realize thin gate dielectrics and suppress the gate leakage current.

Toshiba has proposed lanthanum aluminate (LaAlO₃) as a high-k gate material. We have succeeded in directly bonding LaAlO₃ film with Si substrate without any interface layer, thereby achieving an ultrathin equivalent oxide thickness (EOT) of 0.31 nm. Moreover, defects in the LaAlO₃ film were dramatically reduced at the same time, resulting in a remarkably low leakage current as small as one-millionth that of conventional SiO₂ gate dielectrics.

W47T CDMA2000 1xEV-DO Cellular Phone for Japanese Market

ISHIKAWA Jiro/OCHI Yoshiji/SHINTOME Junichi /YUKI Yoshinori

Japanese cellular phone service provider au introduced the CDMA2000 1xEV-DO Rev.A (code division multiple access 2000 1x evolution data only Revision A) service in December 2006.

In response to this service, Toshiba released the W47T cellular phone for the Japanese market in the same month, which has gained a favorable reputation. With this system, the peak data rate on the forward link has been increased to 3.1 Mbps and that on the reverse link to 1.8 Mbps. The system also allows control over users and applications with different levels of priority by the addition of an optional quality of service (QoS) function. The improved data rate permits high-speed downloading of large-volume contents and video call service. The W47T is the world's first commercial cellular phone to take advantage of the 1xEV-DO Rev.A system.

Completion of Osaka PCB Waste Treatment Facility

ADACHI Akira / KAWANO Kanj / NISHIZAWA Katsushi

Safe treatment and decomposition of polychlorinated biphenyls (PCBs), which had been kept in storage for more than 30 years, began in Japan in December 2004.

Toshiba participated in the project to construct the Osaka PCB Waste Treatment Facility, including its design, from December 2003.

Construction of the facility was completed in August 2006 after verification through trial operations. Over the coming decade, we will work cooperatively with the Japan Environmental Safety Corporation (JESCO) to safely and fully decompose PCBs in Japan before 2015.

Large-Scale Stationary Fuel Cell Demonstration Project and Hydrogen-Fuel PEFC

IWASAKI Waichi / KANEKO Takayuki / SAKATA Yoshiaki

Toshiba is preparing for the commercialization of 1 kW-class residential polymer electrolyte fuel cell (PEFC) cogeneration systems and has been participating in the Large-Scale Stationary Fuel Cell Demonstration Project since FY2005. Some systems have accomplished a running time of more than one year while maintaining the initial level of power efficiency of about 32% higher heating value (HHV), resulting in a total energy saving of 15% on average.

At the same time, we have also been engaged in a project entitled Technological Development of Hydrogen-Fuel PEFC Cogeneration System for Multiple Dwelling Houses. Toshiba's pure hydrogen fuel cell has achieved a good power efficiency of 46% HHV at a rated power of 500 W (AC).

Ultrasonic Gas Meter

UYAMA Hiroto / SAMEDA Yoshito / ISHINO Masaaki

Toshiba has developed a household ultrasonic gas meter in a joint project with Tokyo Gas Co., Ltd., Toho Gas Co., Ltd., and Aichi Tokei Denki Co., Ltd. Presently used gas meters have a large number of moving mechanical components and are very large in size because they measure gas volume by a diaphragm mechanism. The newly developed ultrasonic gas meter measures gas volume with no moving components, but instead uses electronic parts to measure the propagation time of an ultrasonic wave in the gas flow. This technology allows highly reliable and downsized gas meters to be realized.

Transmission Network System for Digital Terrestrial Broadcasting

MURAKAMI Hiroshi / SUGIYAMA Taiji / KANEKO Tomoaki

Digital terrestrial television broadcasting was inaugurated in Tokyo, Nagoya, and Osaka in December 2003. Since that time, local digital terrestrial television broadcasting services have been introduced in succession after parent stations began service in regional capital cities, toward the completion of nationwide broadcasting in Japan in December 2006. Henceforth, approximately 10,000 digital transmitting relay stations will be constructed to replace analog terrestrial broadcasting facilities, with completion scheduled for July 24, 2011.

There are various methods for transmitting broadcast programs from parent stations to relay stations to create a transmission network system. One example of such a method is to relay the broadcast wave from the parent station, while another example is to make a transmitter- to-transmitter link (TTL) using microwaves. An issue for the future is to select the best-fit relay methods and construct a stable transmission network system efficiently and economically within a short period.

Toshiba is making efforts to design a transmission network system, test it using simulation software, and also to develop digital terrestrial transmitters and TTL equipment, in order to create an optimum transmission network system. We are proposing the adoption of our system to clients throughout Japan.

DNCWARE ClusterPerfect™ EX for Accelerated Problem Determination by Autonomic Computing Technology

ANDO Shinya

Toshiba Solutions Corp. has newly developed an additional function for DNCWARE ClusterPerfect™ EX to accelerate problem determination in a clustered information system. This function, based on the concept of autonomic computing, uses common base event (CBE) standard format logs and a symptoms database that describes system problems and countermeasures against them. Appropriate combination of the logs and symptoms database makes it possible to easily determine the details of system problems from an overall perspective, which reduces the time required to identify the true cause.

Patent Information Classification System for Patent Research

TAIRA Hiroshi / MATSUMOTO Shigeru

In line with the increasing emphasis placed on patents, companies are promoting intellectual property (IP)-related activities typified by patent applications. Patent research activities, comprised of research, analysis, and visualization of patent movements, are one of the most important IP-related activities because they reveal technological trends and product development orientations while helping to prevent potential infringements by other companies (i.e., patent clearance).

On the other hand, IP-related activities require a great deal of time and effort, and the reduction of human resources devoted to such activities is a significant management issue. A further issue is that IP-related activities should not be confined to research activities but should serve as an impetus for the creation of new technologies and patents.

In response to these issues, Toshiba Solutions Corp. is developing a technology to classify patent documents. This technology is expected to speed up patent research work by companies and enhance their IP-related activities.

Frontiers of Research & Development

Semless Handover Technologies for Multiple Wireless Systems