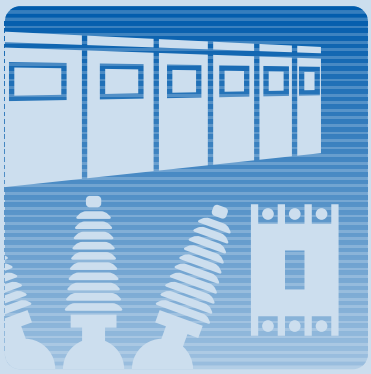
Energy Solutions in Power Electronics Systems



Energy Management
Power Supply and Facility Systems
Electric Distribution, Switching and Control Devices

Outlook

Energy Management

In the energy management field, Fuji Electric offers switchgear, transformers, power system protection relays, power system monitoring and control systems and distribution automation systems the social infrastructure and industry markets. These products are based on our core technologies, such as large-capacity power electronics technology for substation systems, power receiving and distribution substation equipment, and energy monitoring and control technology.

In Japan, we are mostly working to renew or extend the service life of existing facilities, but we are also engaged in meeting the needs of new facilities, such as those constructed for environmental or energy-saving needs or for the 2020 Tokyo Olympics and Paralympic Games. Overseas, there are some areas experiencing stagnation due to political instability, but on the whole, capital investment has been increasing slightly. We thus have been actively meeting this demand by strengthening our overseas bases.

In the electric power field, we have delivered 300-kV gas insulated switchgear (GIS) to a power company. In addition, we have developed and delivered 3-phase encapsulated gas insulated bus (GIB) in accordance with the standards of customer specifications.

In the industrial field, we have replaced an aging extra high voltage substation located in the vacant space in an existing substation using the structure directly connecting a cubicle-type gas insulated switchgear (C-GIS) with an extra high voltage transformer. Moreover, we have been working to develop the market for our small- and medium-capacity "S-Former Mini" along with the "S-Former" large-capacity rectifier for aluminum refining and chemical plants.

In the transportation field, we have delivered a regenerative power absorption system for a substation of an electric railway company. This system collects kinetic energy as electric power when trains brake, and then effectively use it as a power source for the lighting and electric facilities of train stations, thereby contributing to the reduction of electricity consumption. We have also delivered large-capacity storage battery equipment for emergency train running so that the trains can reach the nearest station even in the event of an extensive power outage caused by a disaster such as a large-scale earthquake.

In the power distribution field, for a power company, we have developed and delivered a motor and synchronous generator with a rated output of 300 kW to reduce the impact on power systems at times of power grid accidents caused by the large-scale introduction of renewable energies. Although the equipment is rather large for commercial applications, it runs on battery without consuming fuels. Since increasing importance has been placed on solving system problems due to the large-scale adoption of renewable energies, we are working on the development of smart inverters, of which Europe and North America have been leading. In addition, we have developed, and delivered a simulated smart grid power generation system that can be used in simulated training exercises that require a stable supply of power in response to cyber attacks on social infrastructure. Furthermore, we have developed and delivered a reusable storage battery system for consumers that is compatible with virtual power plant (VPP) used for VPP demonstration projects commissioned by the Ministry of Economy, Trade and Industry.

We will continue developing technologies that solve customer issues and contribute to the market so that we can meet expectations in delivering new technologies and techniques for the social infrastructure and industrial markets while also accelerating the development of power system innovation and hybrid energies and satisfying the increasing demand for power stabilization and voltage control.

Power Supply and Facility Systems

In the field of power supply and facility systems, we use our core power electronics technology to offer uninterruptible power systems (UPS), facility-use power supply equipment and air conditioning equipment for data centers.

UPSs for continuously growing data centers, spurred by advances in information and communication

systems and cloud technology, are required to become more efficient and supply power more reliably. The "UPS7400WX-T3U," developed for the North American market, has a redundant system and can recover by the replacement of a failure module while feeding electricity. Furthermore, each module is controlled to operate within a highly efficient operating range, thereby improving the efficiency of the UPS at a wider range of equipment loads. Moreover, to meet the demand for a smaller installation footprint, we have developed the "7000HX" (500 kVA) and "6000DX" (100 to 300 kVA) that employ lithium-ion batteries with a high power density.

We are working on the development of a highly-scalable modular UPS platform to promptly meet the growing demand for controlling heat-dissipation and optimal air conditioning owing to the scale expansion of data centers and various regional characteristics and market needs lead by globally expanding markets. In this manner, we intend to continuously develop products that meet market demands and provide power supply and facility systems laying the foundations of social infrastructure to contribute to society.

Electric Distribution, Switching and Control Devices

In the field of electric distribution, switching and control devices, there is growing demand for distribution equipment and switching devices to efficiently and safely utilize electricity and control equipment to automate and optimize the performance of production facilities and production machinery in renewable energy related facilities, building and facility electrical equipment, and factory production line control systems.

As for low-voltage distribution equipment and switching devices, we have developed the "GT-Λ" molded case circuit breaker and earth leakage circuit breaker, which uses spring terminals to reduce control panel wiring work, "SK" magnetic contactor, "TK" thermal overload relay, "CP30F" circuit protector, and sockets for relays and timers. The use of this push-in mechanism is a Japan first for components used with main circuit systems.

For the protective relay for distribution equipment, we have developed the "F-MPC60G Series" multifunctional digital relay with color-LCD that improves visibility and operability. It has improved reliability with self-diagnosis functions based on a duplicated CPU and other features.

Energy Management

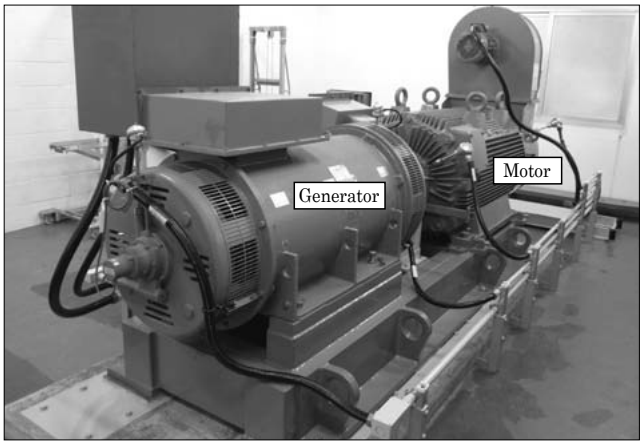
1 Motor and Synchronous Generator for Hateruma Power Plant of the Okinawa Electric Power Company, Incorporated

The Okinawa Electric Power Company, Incorporated was commissioned by Okinawa Prefecture to undertake the "Smart Energy Island Project" (a project for introducing renewable energy to a maximum extent at small remote islands). It is against this backdrop that Fuji Electric supplied the Hateruma Power Plant of the Okinawa Electric Power Company, Incorporated, with a motor and synchronous generator with a rated output of 300 kW. The main features are as follows:

(1) This recently delivered motor and synchronous generator are not restricted by the lower limit value of power generation, unlike conventional generators, thereby allowing it to contribute to the expanded use of renewable energy.

(2) The motor can run on storage batteries to create power to generate electricity, the power plant can thus interconnect with the grid by charging battery from renewable energies, instead of consuming fuel.

Fig.1 Motor-synchronous generator



Energy Management

2 Simulated Smart Grid and Power Generation System

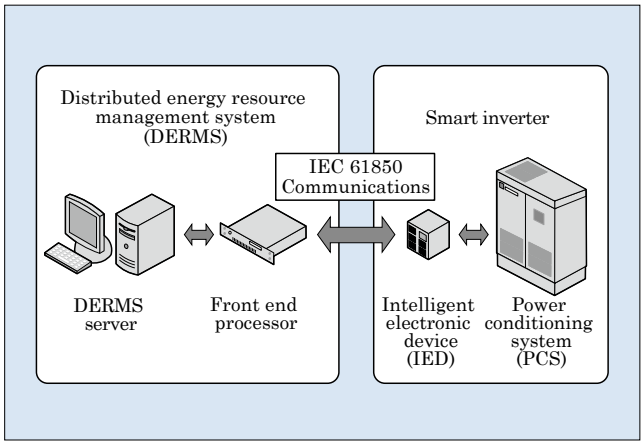
The Industrial Cyber Security Center of Excellence, Information-Technology Promotion Agency, Japan has been training personnel who will be able to respond to security risks through practical exercises and analysis of defense techniques against attacks by using a simulated plant to counteract the increasing number of cyber attacks launched on social infrastructure. Fuji Electric has delivered a simulated smart grid and power generation system to the Industrial Cyber Security Center of Excellence. The system is used to simulate an independent power system, such as one used on a small island, and is composed of an energy management system (EMS) and a simulated plant having a diesel generator, storage battery for frequency regulation, photovoltaic power plant, and wind power plant. The simulated plant simulates the operation that constantly maintain the grid frequency through governor free control for the diesel power generator and load frequency regulation of the EMS in response to demand fluctuations in the grid to provide a stable supply of electric power. In this way, it is used in exercises that simulate social infrastructure.

Fig.2 External appearance of simulated plant

3 Smart Inverters

The smart inverter is a power conditioning system (PCS) that has a grid support function with autonomous-control and communication interfaces conforming to international communication standards. In Europe and the United States, smart inverters have been increasingly used to address the system problems caused by the introduction of large amounts of renewable energy. Optimally operating smart inverters need to use a distributed energy resource management system (DERMS). Fuji Electric has developed a PCS equipped with grid support functions, such as Volt-Var control and Frequency-Watt control, and an intelligent electronic device (IED) that can connect the system via IEC 61850 communications. Furthermore, we have developed a DERMS system for verifying its remote monitoring and control functions between a smart inverter and DERMS through IEC 61850 communications. We have delivered this system to Tokyo Electric Power Company Holdings, Inc. and continue to verify it in the "Research and Development Project on Technologies to Respond to Power System Output Fluctuations" commissioned by the New Energy and Industrial Technology Development Organization (NEDO).

Fig.3 System configuration of smart inverter and DERMS



Power Supply and Facility Systems

1 Large-Capacity UPS Using Lithium-Ion Batteries (LiBs)

The development of information communication systems in our IT based society has led to growth in data center markets all over the world, and it is against this backdrop that there is increasing demand for UPS systems to provide more stable operation, higher efficiency and a smaller installation footprint. Fuji Electric has used lithium-ion batteries (LiBs) manufactured by Samsung SDI Co., Ltd in expectation of space-savings for our 400-V UPS "7000HX" (500 kVA) and 200-V UPS "6000DX" (100 to 300 kVA). Specifications of LiBs per rack are as follows:

(1) Life expectancy

15 years (ambient temperature 25°C; 5% discharge/24 times a year; 100% discharge/twice a year)

(2) Rated capacity

34.6 kWh (400-V type), 24.4 kWh (200-V type)

Fig.4 Lithium-ion Battery rack

Electric Distribution, Switching and Control Devices

1 "F-MPC60G Series" Multifunctional Digital Relay

Various types of protective relays are used to detect power abnormalities, maintain and control equipment in power distribution facilities. Fuji Electric has developed the "F-MPC60G Series" multifunctional digital relay based on the concepts of "improved visibility," "enhanced operability" and "globalized product" The main features are as follows:

(1) Comes with a color LCD that improves visibility and operability.
(2) Configured with a duplicated CPU and peripheral circuits, a self-diagnosis function detects malfunction and prevents unnecessary operation.
(3) Compatible with previous products with respect to external size, mounting structure and wiring.
(4) Equipped with an accident waveform recording function that helps investigate causes during protective operation, a PC support tool enables data extraction.
(5) Compliant with IEC standards (IEC 60255 series), it can meet specifications of overseas customers.

Reference: FUJI ELECTRIC REVIEW 2017, vol.63, no.3, p.163

Fig.5 "F-MPC60G Series"

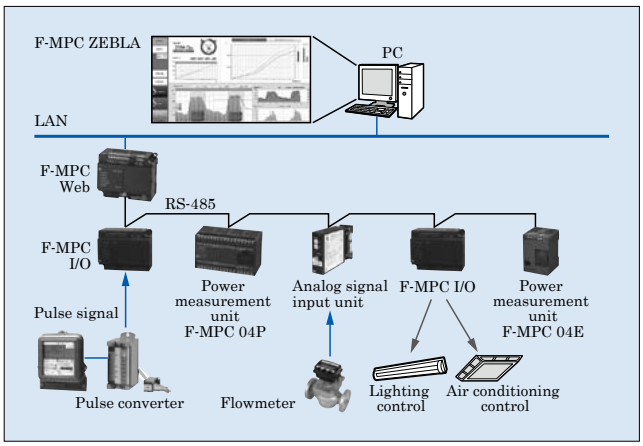
2 "F-MPC ZEBLA"

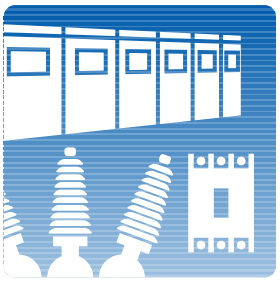
"F-MPC ZEBLA" is an energy management software package that has been developed for a medium and large scale building and energy management system (BEMS). The main features are as follows:

(1) Hourly demand for the day can be predicted on the basis of past energy demand data.
(2) As long as a user simply set annual energy reduction targets, the software automatically creates monthly and daily targets on the basis of past accumulated data and the operation schedule (calendar) of the plant. Energy-saving control based on hourly demand predictions is implemented so as not to exceed consumption targets.

Reference: FUJI ELECTRIC REVIEW 2017, vol.63, no.3, p.168

Fig.6 System configuration example of energy management system using "F-MPC ZEBLA"





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Innovating Energy Technology