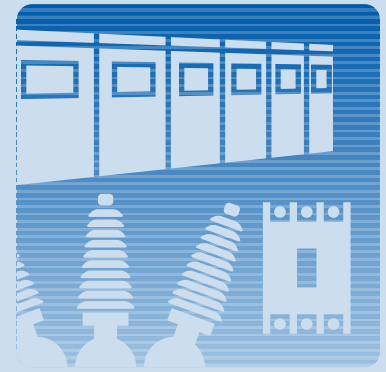


Energy Solutions in Power Electronics Systems

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



Outlook

Energy Management

Since the Great East Japan Earthquake, renewable energy sources have been introduced to a great extent, and the system of the electric power trading market has been reconsidered. Issues have been occurring in the power system, such as unsteady frequency and voltage increase due to reverse power flow from distributed power sources. Electric power companies are becoming increasingly demanded for creating business continuity plans (BCP) in the event of an earthquake disaster.

Fuji Electric has cultivated system stabilization technologies through various verification projects. It continues to provide, as the core of its stabilization measures, storage battery control systems and static var compensators (SVCs) with variable inductance that use those technologies. We are developing a SVC that uses silicon carbide (SiC) for the next generation. As disaster control measures, we will make full use of wide-area distributed system technology to support the stable operation of automated systems in electric power companies. As new efforts, we are participating in the verification project of virtual power plants (VPPs) and examining the technical aspect. This project is intended to adjust power by collectively managing the facilities of utility customers such as generators and power storage facilities. We will continue to contribute to society by developing and providing products that accurately satisfy market needs in a timely manner.

Substation Systems

For substation systems, we have been providing solution businesses such as reliability improvement, efficiency improvement and eco-friendliness by using electric distribution facilities and large-capacity power electronics devices. Outside Japan, in order to meet the expectation for infrastructure expansion in Asia, we set up a production base of transformers, switchgears and switchboards. We have been enhancing our organization toward completely localized businesses that include sales, engineering and service.

In the electric power field, Fuji Electric has developed and launched in the market an IEC standard-

compliant 145-kV gas-insulated switchgear (GIS) that achieved significant miniaturization and weight reduction and is aimed to have improved maintainability. In the industrial and facility electric equipment field, the use of new energy sources is increasing as a result of liberalization of the electricity market. Hence, we have delivered electric distribution facilities that take into consideration miniaturization and maintenance saving for biomass power generation. In the industrial power supply field, we have received an order for the "S-Former," a rectifier of the largest scale in the world, for Bahrain in the Middle East. In the transportation field, we have been conducting a business for supporting stable transportation. We received orders for replacing substation equipment and multiple power monitoring systems that have reached the end of the lifetime and delivered them.

Power Supply Systems

For power supply systems, power consumption in data centers has been sharply increasing due to the enhanced performance and increased density of servers, heightening the need for energy saving. In addition, energy saving policies should increase the demand for upgrading equipment to energy-saving one.

For air-conditioners of data centers, a high cooling capacity 56-kW type has been added to the line-up of the "F-COOL NEO" indirect outside type air conditioner. For uninterruptible power systems (UPSs), we have launched into the market a high-efficiency and large-capacity UPS (333 kVA) that uses SiC devices and helps to reduce power consumption. The "F-DC POWER" DC backup power supply for servers has been made to support the Open Compute Project (OCP) specifications, which is expected to rapidly penetrate the IT market. We will continue to identify new management issues of customers through providing EPC solutions for entire system building in Japan and other countries, and offer systems and products aimed at resolving problems.

Electric Distribution, Switching and Control Devices

For electric distribution, switching and control devices, there is increasing demand for distribution equipment to use electricity efficiently and safely, as well as control devices to automate and optimize manufacturing system and production machinery. This has been occurring in relation to renewable energy-related facilities, electrical equipment in buildings and facilities, and control systems in factory production lines.

For low-voltage distribution equipment, we have developed 70-mm-pitch versions of the “BV Series” and

“EV Series” bus plug-in-mounting circuit breakers. They can save labor and reduce wiring in installation work. Their operability has also been improved by using blank cover that does not require tools and the reduction of the insertion force. For medium-voltage distribution equipment, we have developed the “MULTI VCB,” a RoHS-compliant draw-out type medium-voltage vacuum circuit breaker. It reduces life cycle cost by improving the usability of the panel cutting profile, enhancing insulation performance and extending the greasing intervals.

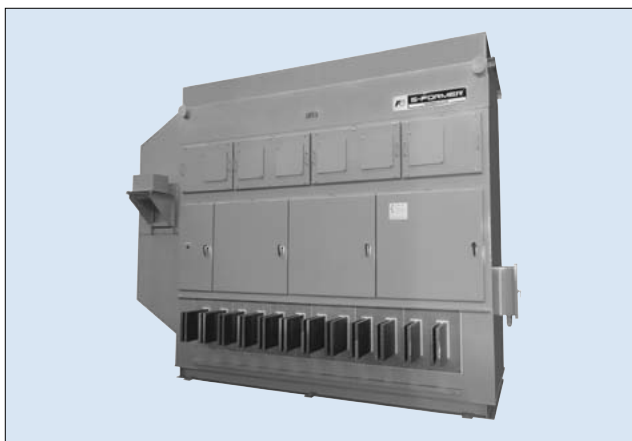
Substation Systems

1 “S-Former” Large-Capacity Transformer Rectifier for Indonesia: Replacement for Another Manufacturer’s Rectifier

Fuji Electric has manufactured and delivered many units of the “S-Former” large-capacity transformer and rectifier in applications such as aluminum refinement and soda electrolysis. This S-Former for Indonesia was installed to replace an existing rectifier made by another manufacturer, and after the replacement, it will be coupled with an existing transformer made by the manufacturer. The main features are as follows:

- (1) Considering future equipment expansion that may be requested by the customer, we have increased the rated direct current in the 6-pulse general connection system to 45 kA from 37 kA of the existing equipment.
- (2) Despite the increase in current, we have miniaturized the internal structure and adjusted it to the existing installation dimensions and the position of the interface of AC and DC terminals.
- (3) Fixing an aluminum terminal to the copper conductor inside the rectifier, we were able to connect the conductor to the existing aluminum DC busbar by welding.

Fig.1 “S-Former”



Power Supply Systems

1 “F-DC POWER” Power Supply Supporting OCP Specifications

In the data center market, which continues to expand attributing to the rapid proliferation of cloud computing, there is an urgent need to reduce the sharply increasing power consumption. Fuji Electric has already launched in the market the “F-DC POWER” DC backup power supply for servers which helps data centers save energy, and has developed a type that supports OCP (Open Compute Project) specifications. OCP provides specifications of IT equipment that is being promoted at the initiative of Facebook Inc. in the United States and is expected to rapidly penetrate the IT markets in North America and Japan. The main specifications are as follows:

- (1) Output power: 7.5 kW (3 + 1 redundant configuration)
- (2) Conversion efficiency: 94%
- (3) Outline dimensions: W450 × D740 × H89 (mm)

Fig.2 “F-DC POWER” power supply supporting OCP specifications



Power Supply Systems

2 Modular-Type Data Center for IDC Frontier Inc.

Fuji Electric has carried out the construction work of Buildings 3 and 4 of the Shirakawa Data Center of IDC Frontier Inc. We have undertaken the work from basic designing to the construction management and of installation work, including construction and civil engineering works. This has been done as the main EPC contractor (engineering, procurement and construction). We have delivered electric distribution facilities, uninterruptible power systems and indirect outside air conditioners, including energy-saving-type equipment. The modular design concept enabled us to complete the work in half the period (about half a year) compared to the construction of a building-type data center.

The construction required a wide range of knowledge, in fields such as electricity, air conditioning, construction and civil engineering; Fuji Electric gathered wide-ranging technologies from our factories, test departments, CE departments, affiliated companies and subcontracting companies, and undertook the work as a turnkey project. Making use of this know-how and experience, we will continue to contribute to the construction of energy-saving data centers.

Fig.3 External appearance of Shirakawa Data Center (Building 4)



3 Data Center for Kingsland in Singapore

Fuji Electric Asia Pacific received an order for a set of facilities for a data center from Kingsland, a major data center provider in Singapore. It completed the delivery in December 2016.

For this data center, Fuji Electric Asia Pacific delivered high-voltage and low-voltage panels, transformers, generators, uninterruptible power systems (UPS), air-conditioners, fire-fighting equipment, security equipment, and monitoring systems. The system was built by combining our products with products of other companies. This was the first case of Fuji Electric Asia Pacific managing an EPC project like this as the prime contractor. Our track record was highly evaluated and led to a follow-up order for a data center expansion project for the same company. The work for the expansion project started in April 2017.

Fig.4 External appearance of a data center of Kingsland



4 “co-IZmo/I” Indirect Outside Air Cooled Container-Type Data Center

Data centers are required to reduce their massive power consumption and have scalability, that is, equipment can be added in stages in accordance with the scale of business.

Fuji Electric has jointly developed the “co-IZmo/I” indirect outside air cooled container-type data center with Internet Initiative Japan Inc. and has launched it inside and outside Japan. In 2016, we delivered an environment-friendly data center to a certain Asian country as a full turnkey project. The main features are as follows:

- (1) Significant reduction in power consumption for air conditioning by cooling with outside air
(40% reduction in power consumption compared with conventional data centers)
- (2) Flexible expansion in accordance with scale by using modular connection
- (3) Reduction in the term of installation work by carrying out transportation and installation leaving servers mounted

Fig.5 “co-IZmo/I” (facility for verification in Japan)



Power Supply Systems

5 Cleanroom for Electronic Device Factories

Fuji Electric received an order for a cleanroom facility for manufacturing electronic devices for smartphones. This was an EPC project including the manufacture of equipment, procurement of interior materials, on-site installation and commissioning tests. We have delivered this facility.

The project involved renovating a building with general air-conditioners and with an area of approximately 6,500 m² into a cleanroom in a short work period of 3 months. In order to strike a balance between the short work period and high quality, we made common design specifications based on our delivery track records with similar facilities. By making equipment and materials common, we satisfied the demand for cost savings. The main specifications of the cleanroom are as follows:

- (1) Cleanliness: Class 1,000 (Fed.Std.209D)
- (2) Air flow type: Vertical laminar flow

Fig.6 Example of cleanroom



Electric Distribution, Switching and Control Devices

1 “EX Series” Electronic Earth Leakage Circuit Breaker

Power distribution facilities are required to have high power supply reliability in places such as hospitals and data centers. In recent years, they have come to need high-functionality electronic circuit breakers that have a leakage current pre-alarm, adjustable rated current and measuring functions. In order to meet these demands, Fuji Electric has developed the “EX Series” electronic earth leakage circuit breaker equipped with a compact earth leakage and measurement unit. The main features are as follows:

- (1) 30% miniaturization in setting area compared with a conventional product (the same external size as our molded case circuit breaker)
- (2) Leakage current pre-alarm function and setting of a wide range of sensitive currents
- (3) Communication function that supports current and voltage monitoring and remote control
- (4) Accessories that can be shared with existing series
- (5) Compliance with global standards: IEC, JIS and GB

Fig.7 “EX250RAE”

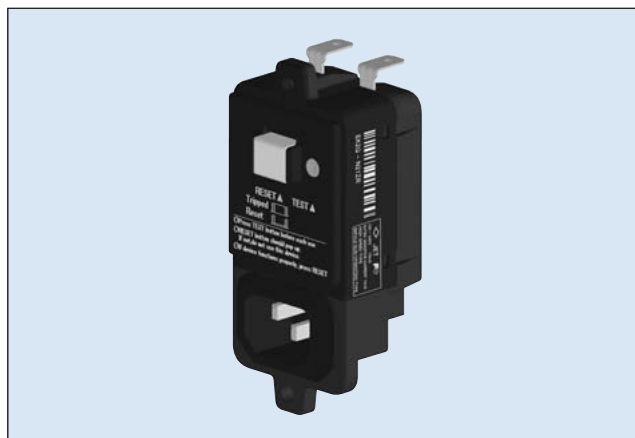


2 “EK2Q” Energy-Saving-Type Earth Leakage Circuit Breaker

Earth leakage circuit breakers, which are used in electric equipment such as copiers and printers, have come to be required in recent years to have even lower power consumption. Fuji Electric has developed the “EK2Q” energy-saving-type earth leakage circuit breaker. It supplies power by setting the phase difference between input voltage and current to approximately 90°. Thus power consumption of the power circuit is greatly reduced. The main features are as follows:

- (1) World's top-class energy-saving performance: Standby power consumption 15 mW/100 V AC (75% reduction)
- (2) Compatibility with the current product: The same external profile as the current product provides compatibility in terms of mounting.
- (3) Environmental measure: Free of cadmium in compliance with the RoHS directives
- (4) Compliance with global standards: cULus, TÜV (IEC), CCC, and PSE

Fig.8 “EK2Q”





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