May 2024 Technical Information

Energy

Green Energy & Mobility

#Carbon Neutral #Co-creation and Open Innovation #Sustainability #Generative AI #IoT/Data Utilization #Energy

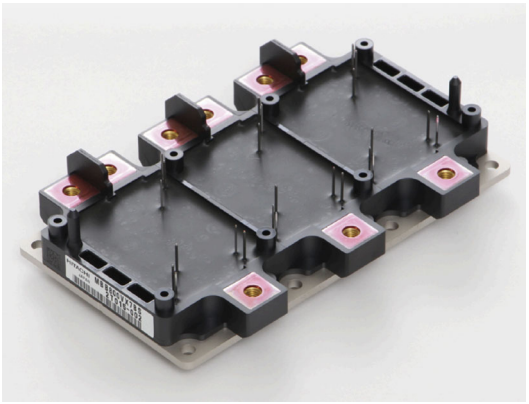
1. Resin-encapsulated Compact IGBT Power Module for EVs

Hitachi Power Semiconductor Device, Ltd. has developed a new insulated-gate bipolar transistor (IGBT) power module for drive-train inverters in electric vehicles (EVs) that features a 29% smaller package footprint and 27% lighter weight than the previous model. Despite this high level of miniaturization, the 6-in-1 module also features a rated voltage of 750 V and a maximum capacity of 800 A, performance made possible by use of Hitachi's proprietary side-gate IGBT chips. A copper lead frame is used in place of wire bonding to reduce steady-state thermal resistance by 6 to 9% and transient thermal impedance by 32 to 37%. The devices are also encapsulated in epoxy hard resin rather than silicon gel to enhance vibration resistance, a critical requirement for EVs.

A 750-V/600-A module with the same package is also planned for use in inverter units and e-Axles across a wide variety of vehicles in the rapidly growing xEV market. With these small and highly efficient power modules, Hitachi is accelerating the transition to EVs and sustainable societies.

[Hitachi Power Semiconductor Device, Ltd. (now Minebea Power Semiconductor Device Inc.)]

［01］750-V/800-A IGBT module MBB800VX7BS



2. Inspection System for Wind Turbine Towers Using Automatic Drone Functions

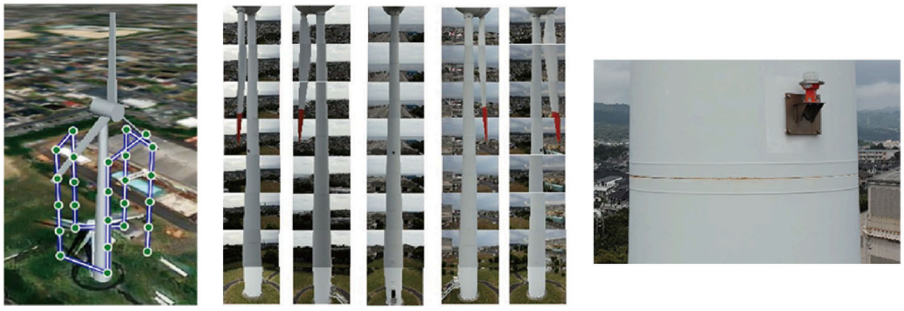
Many wind turbines built in Japan in the early 2000s are now approaching the end of their service lives of around 20 years. As the towers, in particular, are at risk of collapse due to age-related deterioration, highly reliable inspection practices are essential.

To date, monthly and other periodic inspections of wind turbines have been mainly performed from the ground using a telescope or camera, making it difficult to inspect the entire tower and maintain records. When a problem is found, it requires a close-up inspection using a crane or abseiling, something that is problematic in terms of both time and cost. Given these issues, what is needed is an efficient way to perform close inspections of entire towers.

To devise such a practice, Hitachi drew on techniques for precise flying and camerawork using automatic drones that it obtained in the development of a blade inspection system. This experience was used to develop an inspection system that could be used by anyone to obtain high-quality video data quickly.

In the future, Hitachi intends to combine the new tower inspection system with the blade inspection system. This will include developing functions to expand inspection capabilities and provide centralized management, and further enhancing related systems to provide a new drone-based inspection service for wind turbines.

［02］Inspection of wind turbine tower by automatic drone



Drone route planning　　Mosaic of inspection images　　Enlargement

3. Development of Electricity Generation Prediction and Optimization of Generation to Support Renewable Energy Aggregation

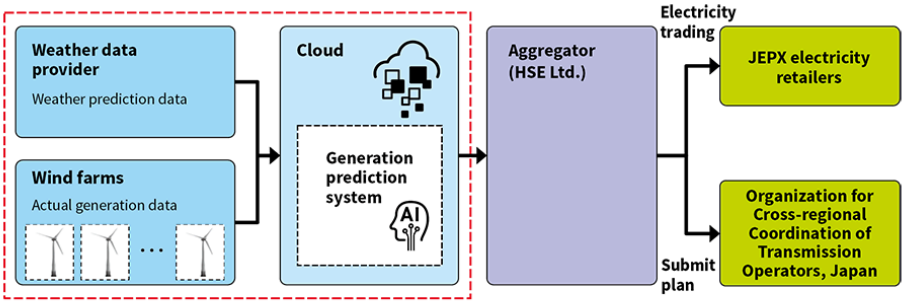
As part of its efforts to achieve carbon neutrality by 2050, the Japanese government has moved from a feed-in tariff (FIT) system of fixed prices for renewable energy to a market-linked feed-in premium (FIP) system. The purpose of this transition is so that renewable energy generators can operate as independent sources of electric power, incentivized to generate power based on the electricity market price.

HSE Ltd. is the owner of many power plants. Six of their power plants have switched to the FIP system and launched a renewable energy aggregation business in March 2023. To facilitate this, Hitachi Power Solutions Co., Ltd. is supplying an aggregation support service that draws on the skills and expertise it has acquired from past work.

Hitachi Power Solutions has built up this knowledge through the supply of maintenance services and other operational support under comprehensive long-term maintenance contracts that include utilization guarantees as well as the construction of wind power generation systems. While renewable energy output is influenced by weather conditions, Hitachi Power Solutions has developed an accurate generation prediction technique that uses artificial intelligence (AI) and accumulated data. The company is also able to support aggregation by enabling optimal generation plans to be devised that take account of these predictions along with other factors such as equipment condition.

(Hitachi Power Solutions Co., Ltd.)

［03］Business scheme for renewable energy aggregation



JEPX: Japan Electric Power Exchange

4. Energy Management System for Renewable Energy Dispatch and Demand Response

To help customers transition to carbon neutrality, Hitachi. Ltd. and Hitachi Power Solutions Co., Ltd. have launched an initiative that aims to use digital links between about 20 different Hitachi workplaces across the Kanto region of Japan for multi-site optimization of energy use. Along with practices such as demand response, this coordinates the dispatch of electricity from on-site and off-site renewable energy resources to balance supply and demand.

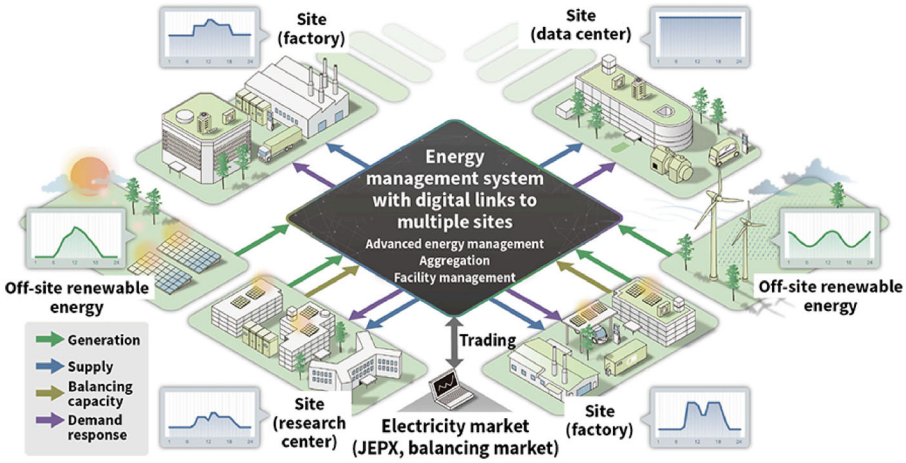
The multi-site system that Hitachi has installed for this purpose addresses the relationships between supply and demand at different sites. The system delivers both economic benefits and decarbonization, linking a large number of sites together and making use of excess power by dispatching renewable electricity to those sites that need it, when they need it, and in the required quantity.

In addition to progressively making functions available to customers after having first proved their technical and economic benefits, Hitachi also intends to establish a demonstration model in March 2025 in the form of a multi-site energy management system that contributes to decarbonization on both the supply and demand sides.

Hitachi also launched an integrated platform for equipment maintenance in September 2023 that utilizes the unification and visualization of equipment data to improve maintenance efficiency and optimize operational planning. Provided as a cloud service, the platform helps customers achieve digital transformation (DX), including assets. Through interoperation with the energy management system described above, Hitachi intends to provide services that link energy data and facility data to enable customers to reduce CO_2 emissions and optimize plant operation.

(Hitachi Power Solutions Co., Ltd.)

［04］Multi-site energy management system installed by Hitachi



5. Work on Fully Digital Substation Protection and Control Systems

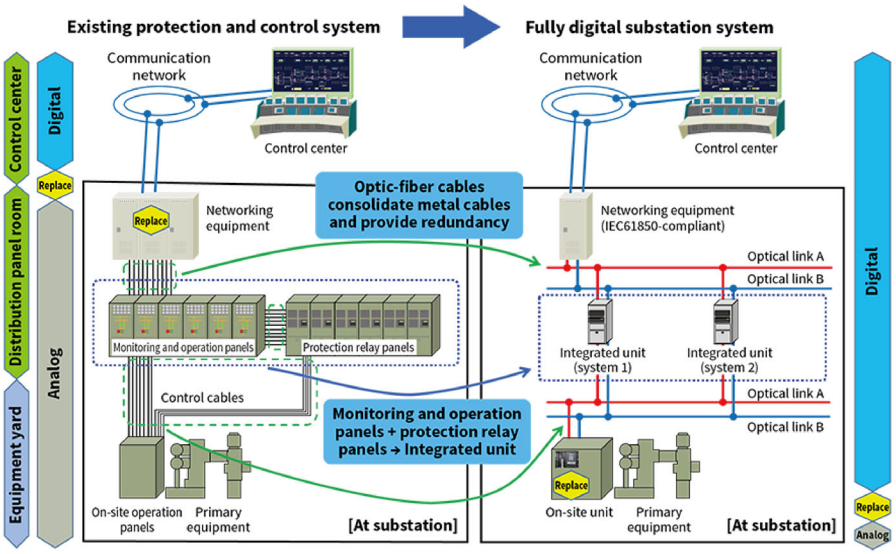
Existing protection and control systems use large amounts of control cabling to communicate between primary equipment and protection and control panels and among panels. This increases the amount of work time required for cable removal, laying, and connection work when replacing equipment, and the lack of available cable pits space. They sometimes become a bottleneck for protection and control panel replacement.

With the International Electrotechnical Commission (IEC) 61850 standards that we are applying, fully digital substation systems that conform to this standard address these problems by utilizing optical and digital communications that enable the large amounts of information exchanged among devices to be communicated onto a single optic-fiber cable. Furthermore, consolidating the functions of existing monitoring and operation panels and protection relay panels into an integrated unit can considerably reduce the number of panels, which can contribute to saving space and reducing installation work.

It is easy to realize redundant protection and control systems by applying integrated units with redundant configuration, which increases system reliability and can contribute to secure electricity supply.

These fully digital substation systems that comply with IEC 61850 are scheduled to be installed by a railway utility in Japan from FY2025 onwards, which will be the first application for Japanese railway utilities.

［05］Comparison of configurations for existing protection and control system and fully digital substation system



6. Development and Commercialization of Current-Differential Relays by HSR Communication

Protection relays ensure stability and high reliability. A standard practice in their system configurations has been to use data transmission formats purpose-designed for protection relays and communication networks specific to the electricity industry.

More recently, however, advances in information and communication technology have enabled the use of low-cost and configurable general-purpose networks in this application. Hitachi has been commercializing Internet protocol (IP) current differential relays that use the parallel redundancy protocol (PRP), a redundant communication technique with zero recovery time from communication faults.

Now, Hitachi has developed and commercialized IP current differential relays that use high-availability seamless redundancy (HSR), an alternative to PRP. Along with cost-benefits relative to PRP, requiring fewer layer 2 switches (L2SWs) and optic-fiber cables, current-differential relays by HSR communication that were developed by Hitachi also offer maintenance advantages that result from eliminating the need to manage information such as L2SW firmware and configuration settings. The product passed all tests conducted during development and evaluation, which were undertaken in accordance with the B-402 electricity industry standard.

［06］Current-differential relay

7. Remote Control Protocol Converter for IEC 61850 and FL-net

Hitachi has developed a protocol converter for its SUPERROL NS9/NS10 series of remote monitoring and control systems that adds support for the IEC 61850 international standard for digital substations and FL-net*, a network standardized by the Japan Electrical Manufacturers' Association (JEMA) for use at hydro power stations.

The protocol converter functions support the new IEC 61850 and FL-net standards associated with the digitalization of substations and power plants while still allowing for the continued use of existing standards. These latter include IP communication protocols such as the Protocol for Mission Critical Industrial Network Use (PMCN) that have been widely used between control centers and substations or power plants, and analog modem communications such as Cyclic Digital Data Transmission (CDT) and High-level Data Link Control (HDLC).

The benefits of using the new protocol converter include fewer control cables, enhancements made possible by transmitting more detailed data, and staged system migration. It is anticipated that the product will be used by electricity and railway companies as well as by others in the social infrastructure systems sector for applications such as remote monitoring and control systems as these are progressively migrated to more advanced systems over an extended period of time.

* See the list of “Trademarks.”

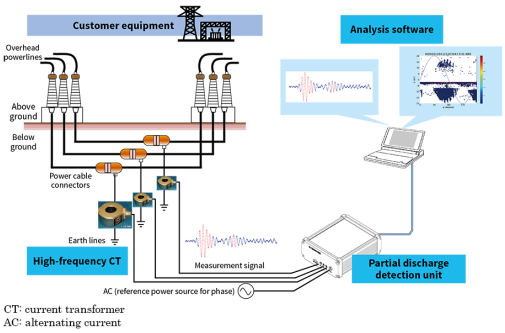
［07］Remote control protocol converter for IEC 61850 and FL-net

8. Cable Degradation Diagnosis Technique and Service

The aging of electricity transmission and distribution infrastructure over recent years calls for equipment maintenance practices in which maintenance plans are based on equipment condition. It is particularly difficult to assess the extent of degradation in underground cables, creating a strong demand for equipment inspection techniques that cut costs.

In response, Hitachi has developed an online diagnostic technique that combines analysis software with a partial discharge detection system that can perform measurements on equipment without taking it out of service. The analysis software processes Φ-q-n data acquired from the earth lines of electrical equipment and interprets it in terms of image characteristics, where Φ is the phase angle of the partial discharge signal, q is the charge signal magnitude, and n is the discharge frequency. By processing the test data using machine learning and then analyzing it, the software can efficiently identify partial discharges from large numbers of measurements. One of the issues found in field testing was an inability to identify valid partial discharges that are buried amid environmental noise and the various forms of noise generated by in-service equipment. This has been resolved by a combination of measurement techniques and data analysis. Using measurement techniques that exhibit repeatability for measurements from different sites, Hitachi is planning a new solution-based measurement and diagnosis service that also incorporates data analysis.

［08］Diagram of partial discharge detection system



Hitachi Review

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