

# Research and Development / Intellectual Property

## Research and Development

Fuji Electric is focused on research and development activities for creating competitive components and systems centered on power semiconductor technologies and power electronics technologies as well as activities for developing solutions that produce value for customers by combining fundamental technologies. The Company has designed its R&D system to accelerate R&D activities by delegating product development functions to the respective business groups while the corporate R&D group handles technology marketing, advanced research, and basic research.

### R&D Policies

- Create competitive components and systems utilizing cutting-edge technologies
- Develop competitive product technologies utilizing technology marketing
- Realize new innovation by combining Fuji Electric's fundamental technologies with open innovations



### Initiatives in Fiscal 2017

#### Creation of Competitive Components and Systems

##### ● Power Conditioning Sub-Systems for Large-Scale Solar Power Generation Systems

Fuji Electric has succeeded in the development of a compact, lightweight, and affordable independent power conditioning sub-system (PCS) for outdoor use. This PCS reduces current value by approximately 30% through conversion to higher voltages and thereby contributes to a massive reduction in the costs associated with power supplies for solar power generation systems. By revising the parts and designs used in this PCS, we were able to realize a 20% reduction in size and a 25% reduction in weight compared to our previous models.

Fuji Electric will leverage the increased competitiveness of this product to expand its operations in Southeast Asia and other overseas regions.



New PCS: PVI1000BJ-3/1000

##### ● All-SiC Module

Fuji Electric has developed and commercialized an all-SiC module equipped with SiC trench gate MOSFET. This device boasts a resistance level that is among the lowest in the world (1200 V, 3.5 mΩ cm<sup>2</sup>).

When incorporated into an inverter, this device can contribute to loss reductions of 78% in comparison to Fuji Electric's Si devices and can thereby realize significant energy savings.

Looking ahead, we intend to expand the range of products that employ all-SiC modules in order to bolster the competitiveness of Fuji Electric's power electronics products.

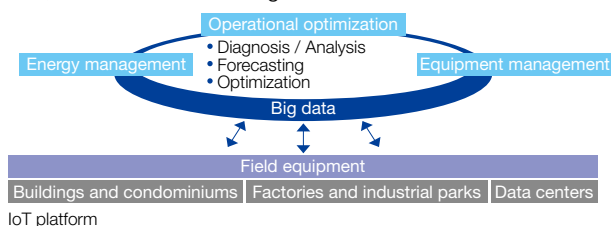


All-SiC module

#### Development of Product Technologies Utilizing Technology Marketing

##### ● IoT Platform

Fuji Electric has developed an IoT platform that tracks and optimizes plant and factory operations and energy usage. This platform utilizes sensing technologies and network connection technologies to conduct analyses of the big data collected from customers' field equipment. In this manner, the platform is able to function as a solution service that is capable of predicting facility abnormalities, improving productivity, reducing energy costs, and otherwise creating value for customers.



##### ● Automobile Tire Testing Machine Compatible with International Standards

The Company has developed an automobile tire testing machine that is compatible with the Worldwide harmonized Light vehicles Test Procedure (WLTP), an international standard for exhaust gas and fuel efficiency tests for automobile tires. Fuji Electric's electrical inertia control and other sophisticated control techniques enable this system to test tires for a wide variety of vehicles, ranging from lightweight passenger cars to four-ton trucks.

We hope to grow sales in new fields by providing offerings that combine this testing machine with FA systems.



Tire testing machine compatible with WLTP

#### Realization of New Innovation

Fuji Electric is advancing joint research with Japanese universities and research institutions based on comprehensive partnership agreements. In addition, we have endowed laboratories to the University of Tsukuba and the University of Yamanashi and

helped establish a collaboration center at Zhejiang University. Through these venues, we are advancing efforts in research and the development of human resources in the fields of power devices, power electronics, and IoT.

## Future Initiatives

Focuses of Fuji Electric's R&D activities going forward will include SiC power semiconductors, automotive power semiconductors, and SiC-equipped power electronics products as well as automotive and railroad power electronics products and other competitive components. We will also develop factory automation and process automation systems and IoT solutions that are synergetic with these components while fostering human resources through the process of tackling new challenges. Through these undertakings, we will seek to create new value for our customers.

## Intellectual Property

Positioning intellectual property (IP) rights as one of the most important management resources, Fuji Electric is working to implement IP strategies that are aligned with its business and R&D strategies to contribute to the strengthening and expansion of its globalization-compatible business.

### IP Policies

- Strengthen IP activities that extend back into the stages of business planning and R&D
- Investigate and respond to overseas IP systems and their current statuses and reinforce IP activities at overseas bases
- Promote international standardization activities

## Initiatives in Fiscal 2017

### IP Activities in the Initial Stages of Business

We endeavored to formulate IP strategies from the business and R&D theme planning stage. After confirming business and R&D directives, these strategies were drafted based on patent analysis and surveys. We also took steps to develop patent portfolios that ensure a strong advantage in business activities.

### Main Fields for Patent Applications

- Patents relating to increasing the efficiency and energy savings of power electronics products
- Patents pertaining to power semiconductors, such as those for SiC-related technologies
- Patents relating to vending machines and other areas of the food and beverage distribution field

### Global IP Activities

Fuji Electric continues to address overseas IP issues and implement measures against counterfeit products to minimize business risks related to IP.

In fiscal 2017, the patent survey and application functions in China that were enhanced during fiscal 2016 were used in advancing survey and application activities spearheaded by our local Chinese IP division. At the same time, we implemented measures for countering risks associated with counterfeit products and IP.

As part of its contributions to international standardization movements, we collaborated with the International Electrotechnical Commission (IEC), an international institution aimed at developing standards for electric and electronic technologies. Specifically, Fuji Electric contributed as a member

of the international committees responsible for establishing the IEC System for Certification to Standards Relating to Equipment for Use in Renewable Energy Applications (IECRE System). Most notably, Fuji Electric was chosen to represent Japan on the committee on solar power generation system operation and management.

As a result of these efforts, Fuji Electric was chosen, for the first time, to be included in the 2017 Top 100 Global Innovators by Clarivate Analytics, a global information service company located in Philadelphia in the United States.



Shiro Kondo (right), Corporate General Manager of the Corporate R&D Headquarters, receiving trophy from Clarivate Analytics

## Future Initiatives

Against a backdrop of increasing globalization, Fuji Electric will move ahead with initiatives linked to its business and R&D strategies as well as IP activities aimed at addressing IP issues faced overseas. We will also seek to contribute to business through proposal activities based on global standards in light of the trend toward IoT.