

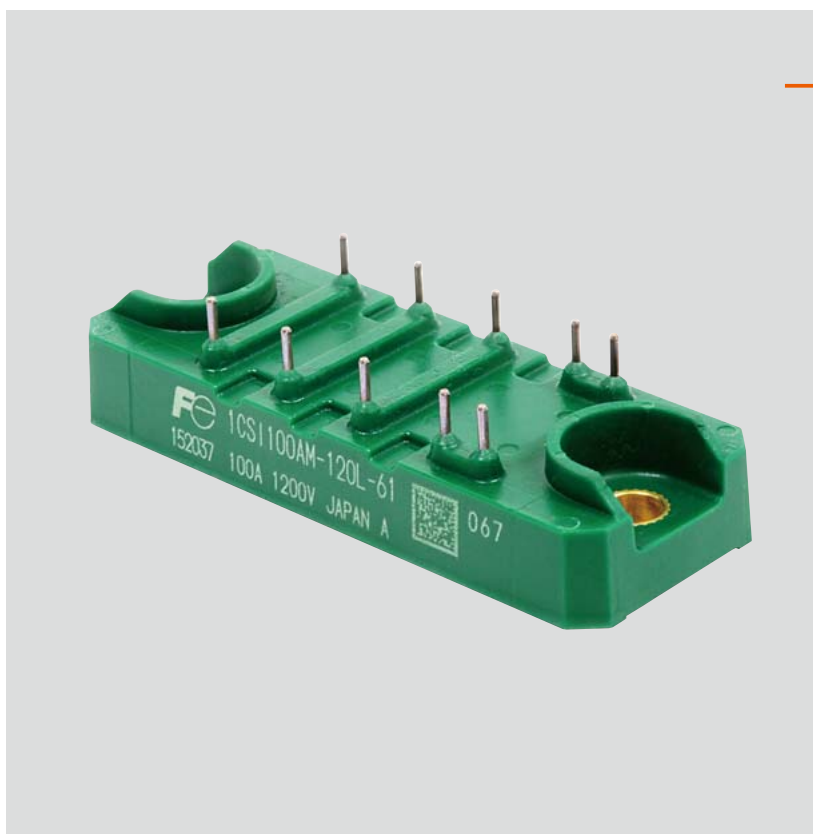


Mega Solar PCS Incorporating All-SiC Module “PVI1000AJ-3/1000”

In recent years, a higher degree of power generation performance and reliability has been demanded of photovoltaic power generation systems. Power conditioning sub-systems (PCS) have a central role in these systems, and are required to have a large capacity and high efficiency, as well as reliability that enables continuous operation even when disturbances occur in power supply systems. In addition to this, they must support the reduction of total costs for the systems.

Fuji Electric has developed the mega solar PCS “PVI1000AJ-3/1000.” The PCS employs an All-SiC module that consists of a silicon carbide metal-oxide-semiconductor field-effect transistor (SiC-MOSFET), as a next-generation semiconductor device, as well as an SiC Schottky barrier diode (SiC-SBD), enabling the unit to achieve a maximum efficiency of 98.8%, which is the industry’s highest level. Furthermore, the unit achieves miniaturization with a footprint size approximately 60% smaller than previous products.

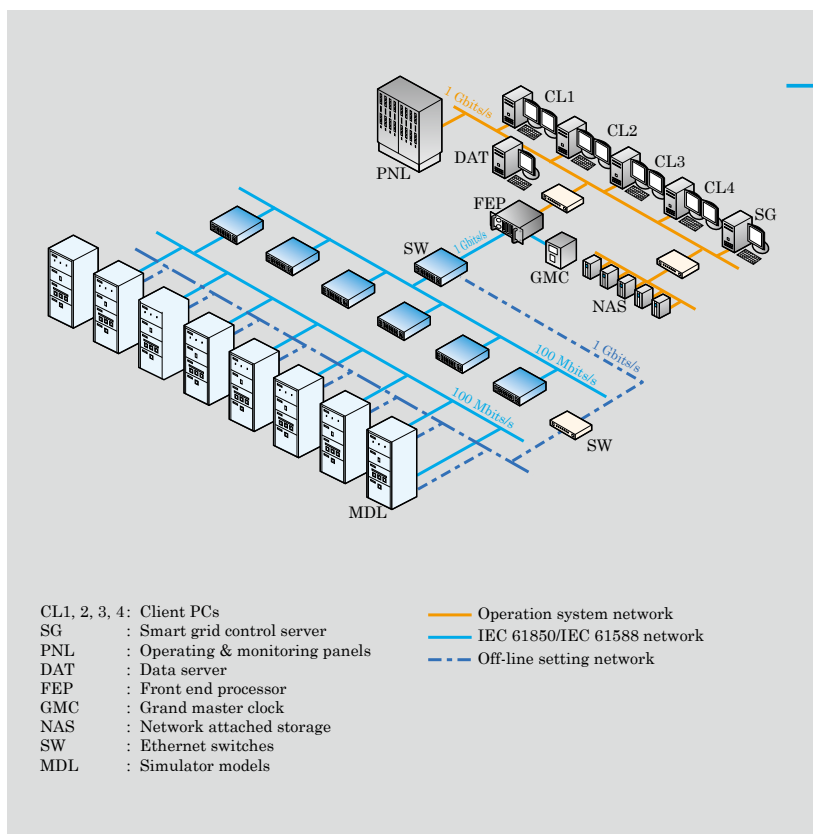
This product was awarded First Prize in the FY2015 (64th) Japan Electrical Manufacturers’ Association Technical Achievement Award.



All-SiC Module for Chopper Circuit

Silicon carbide (SiC) devices have attracted a lot of attention for their potential to help achieve a low-carbon society through their capability of significantly reducing power consumption. Fuji Electric has utilized the SiC metal-oxide-semiconductor field-effect transistor (SiC-MOSFET) and SiC Schottky barrier diode (SiC-SBD) devices being manufactured on the 6-inch line at the Matsumoto Factory to develop an All-SiC module for use in chopper circuits.

This module has a rated capacity of 1,200 V/ 100 A, and achieves miniaturization with a footprint size approximately 55% smaller than previous Si-IGBT modules. This module can be used in the booster circuits of power conditioning sub-systems (PCS) for photovoltaic power generation, and contributes to circuit miniaturization and significant reduction in power loss. These enhancements have achieved a 20% reduction in size for the PCS, and a conversion efficiency of 98.8%, which is the industry’s highest level.



Power System Analysis Simulator for Chubu Electric Power Co., Inc.

Fuji Electric has provided the Power System Analysis (PSA) Center of Chubu Electric Power Co., Inc. with a “hybrid power system analysis simulator” capable of simulating smart grids.

This facility is a power system analysis simulator that utilizes real voltage and current to perform electric power system analysis, while also enabling the simulation of a diverse range of system configurations including distributed power sources.

It adopts an electric power communication protocol (IEC 61850) and time synchronization system (IEC 61588) as information communication infrastructure and can also be utilized in the development and testing of control systems based on next-generation information communication technology.

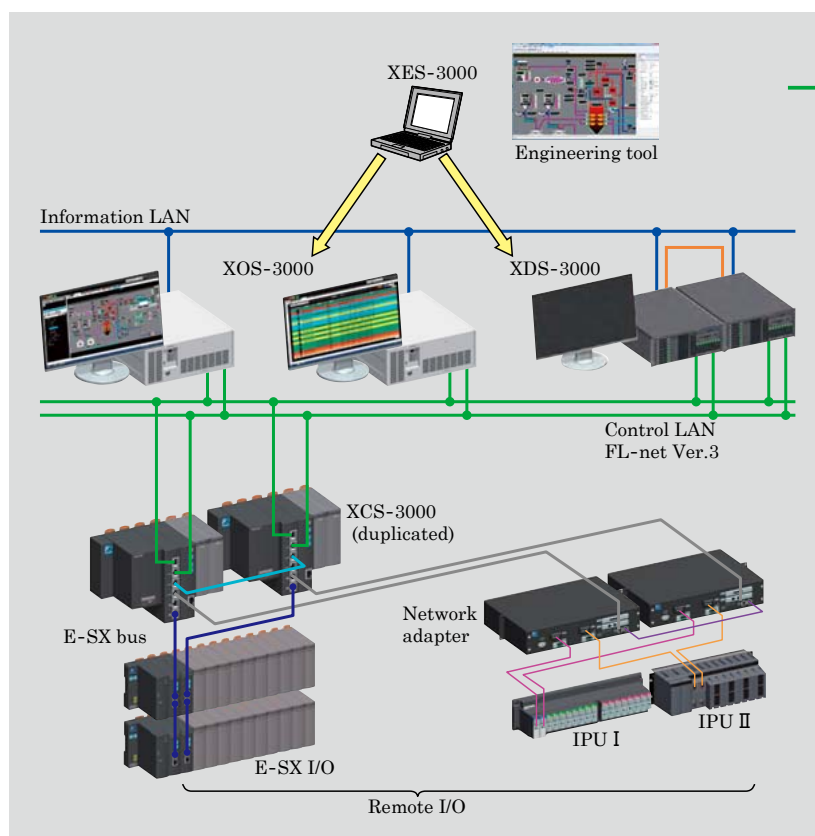
The simulator is expected to contribute to the assessment of the effect of a large amount of renewable energy on systems, as well as support the testing of smart grid technology capable of utilizing renewable energy at an optimal level.



Exhaust Gas Cleaning System for Ships (Cyclone Type SO_x Scrubber)

In order to prevent air pollution from marine vessels, exhaust gas regulations have been gradually reinforced based on the International Convention (MARPOL Annex VI). Fuji Electric has developed an exhaust gas cleaning system for marine vessels (SO_x removal cyclone scrubber) compliant with SO_x/PM regulations that have been reinforced in 2015. The unit sprays sea water on the exhaust gas and reduces SO_x by dissolving it in the sprayed droplets. The main features are as follows:

- (1) It achieves the industry's smallest size (diameter of 2 m, and height of 7 m) with a volume that is more than 50% smaller than previous products. It can be easily installed on both new and old ships.
- (2) The cyclone system creates swirl inside the unit to secure time for the SO_x absorption reaction.
- (3) The high-diffusion spray nozzle increases the SO_x reduction rate to over 98%, enabling the unit to meet the 2015 regulations applicable to Emission Control Area.
- (4) It achieves reduction in pressure loss and the droplet dispersal rate by making use of SO_x dissolution model experiments and fluid simulations.



Small- and Medium-Scale Monitoring and Control System “MICREX-View XX”

Fuji Electric has developed and commenced sales of the Small- and Medium-Scale Monitoring and Control System “MICREX-View XX (Double X)” as a system standardizing control system architecture in order to meet the requirements of industrial and social infrastructure. This product is a system that aggregates and integrates the technologies of Fuji Electric at an advanced level by incorporating a variety of concepts including “superior visibility and operability,” “integration of electric machine control and measurement control,” “high reliability,” “efficient engineering” and “high level of inheritability.”

This product is composed of a next-generation HCI with excellent monitoring and operability, a high-speed and high-capacity controller, a highly reliable system configuration (redundancy of components including the I/O, controller, database, and network) and a high-efficiency integrated engineering tool. By connecting a multi-function network adapter, it is possible to make effective use of existing assets, as well as upgrade to high-reliability systems quickly and inexpensively.



Inverter for Elevators in European Market “FRENIC-Lift LM2A”

In Europe, elevators are being required to comply with reinforced safety standards and adopt advanced control systems. In addition, there has been increasing demand for elevators not requiring a machine room in order to install them in existing buildings. As a result, it is essential that the control panel be miniaturized and have a low profile so that it can be installed in the narrow space of the elevator shaft and side of the entrance door. Fuji Electric has developed the “FRENIC-Lift LM2A” inverter for elevators in order to meet these needs.

The main features are as follows:

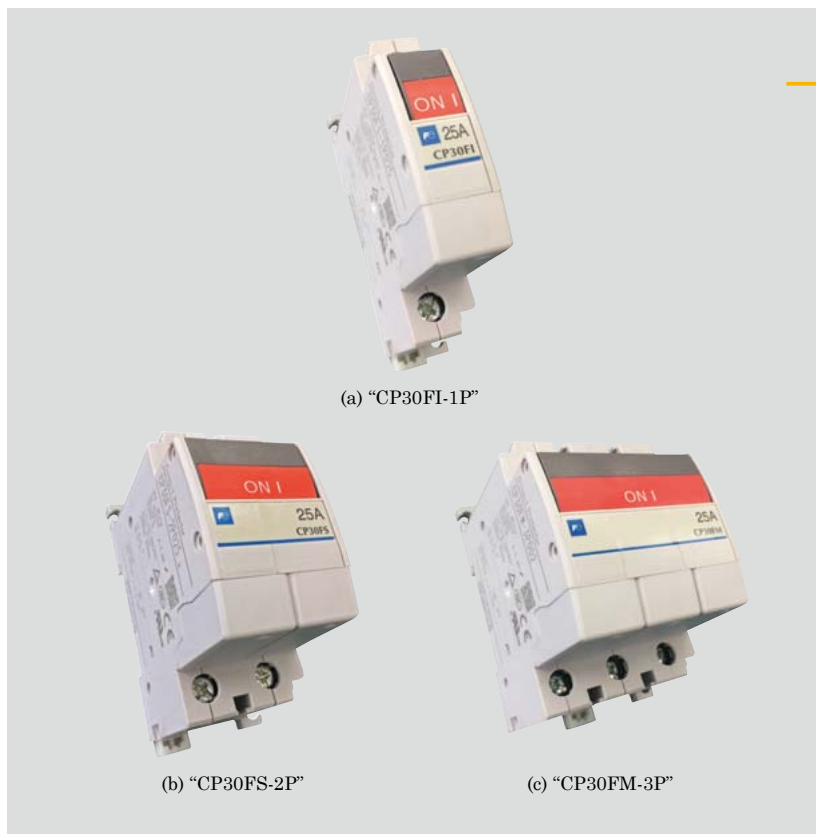
- (1) Has achieved the industry’s smallest class size through low profile enhancements that reduce the width from 220 mm to 140 mm compared with previous products (Built-in 7.5-kW EMC filter).
- (2) Has acquired third-party certification for European safety standards (EN81-20) (Compliant with contactless methods for motor output blocking).
- (3) Supports major encoders in the European market.
- (4) Scheduled in FY2015 to support 2 communication functions (DCP4/CiA DSP417) for elevator distance control.



Medium-Frequency Isolation Type Auxiliary Power Supply

We have developed a compact and lightweight auxiliary power supply based on a medium frequency isolation system that is suitable for subway cars and automated people movers. Recently, lightweight enhancements have been underway for electric rolling stock in order to increase energy savings and control a number of service devices, and as a result, compact and lightweight auxiliary power supplies are in very high demand. Conventionally, it has been mainstream to use a commercial frequency transformer to isolate 3-phase AC, but recently, it is becoming more common to use a medium-frequency transformer to isolate medium-frequency voltage that has been converted by a resonance inverter. Utilization of medium frequency reduces magnetic flux in the transformer core, allowing the transformer to reduce its weight to one-tenth that of the previous product. Furthermore, we have been aiming at reducing the switching loss of power devices through the utilization of a resonance inverter.

Compared to the previous system, this auxiliary power supply has achieved a reduction by 25% in volume and 35% in mass.



Lineup Enhancement for Circuit Protector “CP30F”

A circuit protector is a circuit breaker that is utilized in the protection of the control circuits and devices of various control panels. It is adopted in the circuit protection components of electronic devices. In recent years, there has been growing market demand for control panels and devices that are smaller, contribute to wire savings, improve safety and are global in scope of application. In order to meet these needs, Fuji Electric has enhanced its lineup of “CP30F” circuit protectors.

The main features are as follows:

- (1) Integrates terminal cover functionality into the product and achieves a reduced setting area of 20% compared with existing models
- (2) Employs a new terminal structure and contributes to reducing labor-hours related to connection electric wiring by 40% compared with existing models
- (3) Adopts IP20 as the degree of protection for the main terminal
- (4) Compliant with JIS, UL, IEC and GB standards



Fuji Electric's Top Runner Motor "Premium Efficiency Motor"

In recent years, there has been growing momentum toward the reduction of global energy usage as a means of preventing global warming. Japan has also been promoting the expansion of equipment that adopts and applies Top Runner Standards based on the "Act on the Rational Use of Energy" (Energy Conservation Act). Three-phase induction motors became part of the top runner system in 2013, and Fuji Electric has been supplying the market with its "Premium Efficiency Motor" as a motor compliant with these standards.

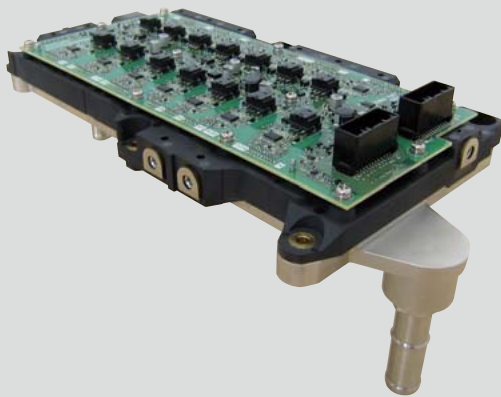
The main features are as follows:

- (1) Decreases loss by optimizing the groove dimensions, core material, etc., and achieves Top Runner Standard efficiency at an output between 0.75 and 375 kW.
- (2) Compliant with the frame number and mating dimensions specified in JIS C 4210, while also supporting easy replacement.
- (3) Improves insulation performance while suppressing temperature rise, and also expands the range of the cast iron frame to contribute to improved corrosion resistance and reduced acoustic noise. Furthermore, it adopts IP55 as the degree of protection for the outdoor specification in compliance with global standards.

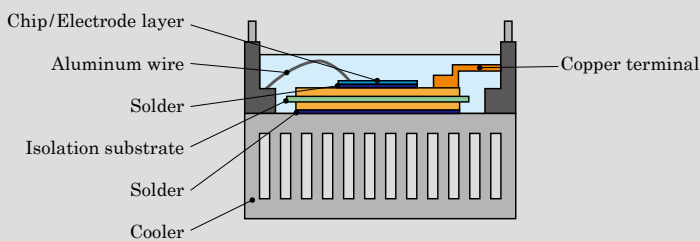


1,200-V Withstand Voltage SiC Hybrid Module

Fuji Electric is advancing in the development of SiC hybrid modules with a 1,200-V withstand voltage as power devices that can be utilized in inverters that contribute to energy conservation. The hybrid module utilizes an SiC Schottky barrier diode (SiC-SBD) chip that was developed in collaboration with the National Institute of Advanced Industrial Science and Technology. The chip is being manufactured on the 6-inch line at the Matsumoto Factory. The insulated gate bipolar transistor (IGBT) is equipped with Fuji Electric's latest 6th generation "V Series" IGBT chip. The package for this SiC hybrid module utilizes the same 2-in-1 package as the Si module in order to maintain compatibility. It reduces loss by about 25% compared with conventional Si modules with a rated capacity of 300 A.



(a) External appearance



(b) Cross-section view

2nd Generation IPM for Hybrid Vehicles

There has been an increasing demand for smaller and lighter weight intelligent power modules (IPM) for use in the motor control of hybrid electric vehicles (HEV) and electric vehicles (EV).

Fuji Electric has enhanced its 2nd generation aluminum direct water-cooled IPM by improving heat dissipation for the cooler and providing higher temperature stability for the bonding materials, as well as by reducing the footprint through the adoption of ultrasonic welding. As a result, it is much smaller than the 1st generation model. Specifically, we have developed the following: a cooler design technology for the aluminum direct water-cooled structure that integrates the heat sink and water jacket; high temperature stability materials (aluminum wire, electrode layer and solder) capable of 175°C continuous operation; and an ultrasonic welding of copper terminal technology capable of small footprint.

The development of these technologies has enabled the 2nd generation IPM to reduce its volume by 30% and mass by 60% compared with the 1st generation model.



ZERO Heating Power Vending Machine

Energy-efficiency is increasingly being requested for vending machines. Inspired by the goal of significantly reducing the power consumed in actual operation over the course of a year, Fuji Electric has developed a vending machine for which a high-thermal efficiency heat pump can be used all operating conditions, without employing the electric heaters that had been used selectively in the past. An approximate 15% reduction in annual power consumption can be achieved in comparison to a conventional energy-saving vending machine.

The main features are as follows:

- (1) Only heat pump heating is used inside all warehouses and in all operating conditions, and the heating efficiency in the major operating conditions has been improved by about 50% compared to conventional models.
- (2) The vending machine is equipped with a high-efficiency compressor, developed in collaboration with a compressor manufacturer, and modified for vending machine use.
- (3) A new of heat exchanger that uses high-density aluminum fins realizes high heat exchange efficiency.



Donut Fixture for Seven-Eleven Japan Co., Ltd.

As a follow-up to the “Seven Café” which was introduced to Seven-Eleven Japan Co., Ltd. in 2013, Fuji Electric has developed a fixture for selling “Seven Café donuts.” While maintaining the interior of the showcase at a constant cool temperature, the cooling method utilized by this product prevents donuts from drying out, and is capable of maintaining the good taste of donuts.

The main features are as follows:

- (1) Using a Peltier cooling unit as the cooler, precise cold storage performance was realized with an internal cool air circulation system.
- (2) Fuji Electric has developed an exterior that exhibits a sense of unity with “Seven Café” and also LED lighting tailored to round shape design that expresses ease and convenience.
- (3) In consideration of the ease of cleanup, an open and closing front glass structure and a detachable shelf plate structure were used. In addition, a sliding shelf system was used so that the donuts could be removed with greater ease.

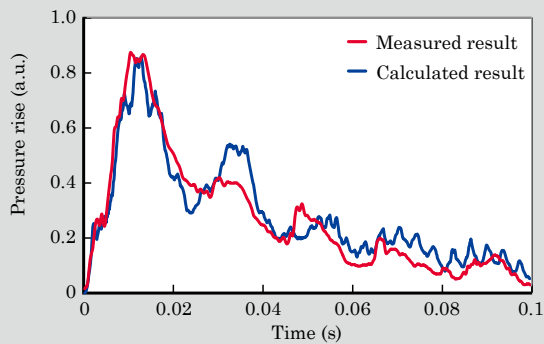


Equipment for Greenhouse Horticulture of Tomatoh Farm Co., Ltd.

To the Tomatoh Farm Co.’s greenhouse horticulture, which was built in Tomakomai, Hokkaido, Fuji Electric has delivered a composite climate control system, substation equipment, environmental measurement equipment, refrigeration equipment, the next-generation cold storage container “D-BOX,” and the like. The composite climate control system, which is of key importance to the plant, performs the centralized control of such information as temperature, humidity, and CO₂ concentration, and also performs high-level climate control that incorporates time periods and composite climate data. With this system, the full-year cultivation of stable and high-quality strawberries is targeted. In addition, because of the heat supplied from an energy supply center that utilizes wood biomass, a reduction in fossil fuel usage for facility operation is realized.

In the future, in addition to supplying various equipment and systems, Fuji Electric also intends to provide comprehensive engineering for greenhouse horticulture, including administrative and facilities operation know-how to the operators of greenhouse horticulture.





(a) Comparison of pressure rise inside the switchgear



(b) Internal arc test for the switchgear (third-party certification testing)

Arc Coupled Analysis Technology Anticipating Short-Circuit Faults Inside Switchgear

International standard (IEC 62271-200) stipulate safety performance regarding short-circuit faults that occur inside switchgears. The standard requires a structure that can correspond to arc related pressure rise at the time of a fault.

To comply with these standards, Fuji Electric has developed analysis tools for implementing thermo-fluid analysis utilizing a three-dimensional simple finite volume method specialized for switchgears, as well as arc coupled analysis for anticipating the arc energy to be generated. As a result, the following has become possible:

- (1) Consideration of shape and pressure discharge structure for the switchgear
- (2) Significant reduction in analysis time (about 1/100th of conventional methods)
- (3) High-precision prediction of pressure rise inside the switchgear (see Fig. (a))
- (4) Design capable of meeting safety requirements for inside and outside the switchgear through the use of high-temperature gas convection analysis and strength analysis

The analysis tools were used to create a switchgear design that passed a third-party certification test (see Fig. (b)), and as a result, we have developed and are supplying the market with IEC standard compliant switchgear.





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