

# Industrial Infrastructure

Substation Systems

Industrial Plants

Industrial Measuring Instruments



## Outlook

### Substation Systems

Our substation system business makes full use of electric distribution facilities and large capacity power electronics equipment for sectors including the electrical power, industrial, factory equipment and transportation sectors, while we also continue to develop business solutions for increasing reliability and efficiency, as well as measures for the environment. We are also developing equipment and devices for overseas markets so that we can achieve our goal of expanding our overseas business.

In the field of power substations, we are developing our business in order to support the supply of stable and highly reliable electric power. These developments are characterized in our 300-MVA transformer, which we delivered utilizing a freight car loading system for transportation, and our 66-kV substation facility, which we delivered for the Bahrain Electricity and Water Authority via a turnkey system. Furthermore, we are also advancing in the development of a new gas insulated switchgear (GIS) compliant with IEC standards.

In the field of industrial and electrical equipment we have been receiving orders to perform upgrade work of existing equipment, and have been making installations to ensure the stable operation of the equipment, while we are also actively developing solutions to improve reliability by means of maintenance services for performing equipment diagnostics of aging equipment, etc.

In the field of industrial power supplies, requirements have been increasing regarding the specifications of power quality improvement systems, and against this backdrop, we have completed the delivery of our first self-commutated frequency converter with a rated capacity of 20 MVA, as a unit that aims to implement bi-directional power interchange and stabilize frequency.

In the field of fixed installations of the railroad, we have been actively supplying and installing environmentally-friendly, energy-saving (energy conservation), maintenance-saving equipment, such as our dry air uti-

lizing 24-kV and 72-kV eco-friendly C-GIS, in order to carry out the upgrade work of existing substations for ensuring stable transportation.

### Industrial Plants

In Japan, there has been an expansion in the investment in assets to upgrade and streamline facilities, especially in the materials industry (metals, chemicals) and the assembly and machining industry (automobiles, electrical machinery). In addition, investment in equipment is expected to be continuously increased overseas in Asian markets, and expanded especially in markets in ASEAN.

Our industrial plant business is providing energy-conservation solutions centered on “electricity + heat,” as well as offering life cycle services to improve efficiency in energy usage during production processes and to stabilize the operation of equipment. We are continuing to develop total solution services packaged as problem solution systems for customers through the utilization of IoT (Internet of Things) and cloud technology developments based on core technologies including drive control technology, measurement control technology, electro-mechanics, energy management technology and AIR environmental technology.

In the field of metal industry, we have been developing products that are compliant with overseas standards, such as IEC and the CE marking, as part of our effort to increase the number of projects at high-grade steel production sites overseas. At the same time, there has been expanding demand for the upgrade of aging facilities in Japan, and we have been meeting this demand for upgrades with the launch of compatibility-friendly products such as our DC variable speed control unit “LEONIC-M Series” and AC variable speed control unit “FRENIC4000 Series,” as well as our migration-friendly products which include the small- and medium-scale monitoring and control system “MICREX-VieW XX.”

In the field of chemical industry, the trend has been to increase investment in equipment centered on new materials. We have been optimizing the batch

control package in the MICREX-VieW XX.

In the field of waste disposal industry, we have been enhancing principal facilities, while aiming to extend the operating life of 30 year-old facilities an extra 10 years. With regard to distributed control systems (DCS), we completed the upgrade of an inherited system. The upgrade work went smoothly and was completed in a short period of time. In the field of cement, we have achieved unitary management in mixed systems, while concurrently working on a similar DCS upgrade plan to extend equipment lifespan, as well as many partial upgrades as part of staged enhancements.

In the field of assembly and production industry, we have been supplying comprehensive equipment management services at all stages of the life cycle, as well as in-facility engineering that contributes to environmental optimization and line control and energy (electrical and heat) control in industrial facilities. We are aiming to expand our scope of business in light of the increase in investment in equipment in the field of assembly and machining in the Japanese and Asian markets. We have installed an optimized energy management system (EMS) and a cogeneration system utilizing a gas engine and fuel cell configuration at Fuji Electric's Yamanashi Branch Factory, and as a result, have succeeded in stabilizing electric power and minimizing energy costs. We have developed the "Integrated Cloud Service" as the foundation on which we plan to sequentially develop and offer other services, which include an EMS service, maintenance service and operation monitoring service.

In the field of AIR environmental industry, we have developed and have commenced sales of an energy-saving hybrid air conditioner utilizing indirect outside air, as well as an energy-saving module type data center that makes use of outside cold air, snow and ice.

### Industrial Measuring Instruments

Our industrial measuring instrument business is offering a range of products including measuring equip-

ment and sensors, controllers, industrial electric heating and radiation equipment and systems, while it is also working to create a sensor platform that can meet the requirements of customer environmental policies and safety and security standards, as well as meet the needs of an IoT generation.

We are also developing feature-rich measuring instruments and sensors for the environment and energy field. We are also the first in the industry to develop and commence sales of an aerosol compound analyzer, for use in performing atmospheric environment measurements, capable of analyzing in real-time the components of micro-sized particulate matter (PM2.5), as well as biomass gas analyzer, for use in biomass plants, capable of measuring CH<sub>4</sub>, CO<sub>2</sub>, H<sub>2</sub>S and O<sub>2</sub> via a single analyzer.

In the field of controllers, we have developed application-specific packages, which combine the MICREX-VieW XX, as the core component, with measuring equipment, power electronics equipment, control software and other components. In the future, we plan to expand our lineup of packages to meet the needs of various kinds of applications, such as combustion control and crane control.

We have developed and have started offering a new melting furnace for use in industrial electric heating applications. This high-efficiency and compact furnace utilizes a high-efficiency IGBT power supply and special coil. We plan to expand widely into Japanese and overseas markets.

With regard to radiation equipment and systems, we are focusing our efforts on products that can contribute to reconstructing Fukushima. We have developed and released to the market an exhaust pipe dust monitor capable of high-temperature operations at incineration facilities, as well as a high-sensitivity gamma-ray visualization Compton camera for supporting decontamination work. In addition to products that contribute to the reconstruction of Fukushima, we also plan to develop radiation measuring equipment that can help support anti-terrorism activities.



## Substation Systems

### 1 Completion of Supply and Installation of Additional “S-FORMER” for ALBA (Aluminum Bahrain B.S.C) Line 5.

Fuji Electric, which supplied six units of “S-FORMER” for aluminum smelting for ALBA of Bahrain in 2004, has completed full-turnkey works of installing an additional unit of S-FORMER. We surveyed an existing buried object, performed civil engineering and foundation works, installed equipment, four kinds of cooling water piping, DC bus bars and 220 kV cables, and performed commissioning tests. These tasks can be characterized as follows:

- (1) Additional equipment had to be installed in a limited space. We thus designed the layout and foundation optimally and constructed them based on the results of the survey on an underground buried object at the planned site.
- (2) The works for the additional installation were implemented during the continuous operation of the existing smelting facilities without causing power interruption. To connect the DC bus bar in particular, successful welding was achieved under conditions where there was a high magnetic field caused by large currents during the plant's operation. This was done while ensuring safety and confirming and managing the work procedures.

Fig.1 “S-FORMER” for aluminum smelting



### 2 Self-Commutated Frequency Changer for Minamata Factory of JNC Corporation

In January 2015, Fuji Electric delivered its first self-commutated frequency changer to the Minamata Factory of JNC Corporation. The unit interconnects a private power generation system (50 Hz) with the power system of Kyushu Electric Power Co., Inc. (60 Hz) and aims at implementing bi-directional power interchange and stabilizing frequency. The unit is configured from 3 multiplex transformers and inverter and has a rated capacity of 20 MVA. The main features are as follows:

- (1) Capable of effective/reactive power control via the self-commutated inverter
- (2) Capable of being operated while switching between fixed frequency control, fixed power control and autonomous-operation three-pattern high-speed control by making use of a high-performance digital control device
- (3) Employs a 3-level water-cooled inverter with a low-profile compact vertical shape that has contributed to suppressing the device height to reduce the size of the panel

Fig. 2 Self-commutated frequency changer

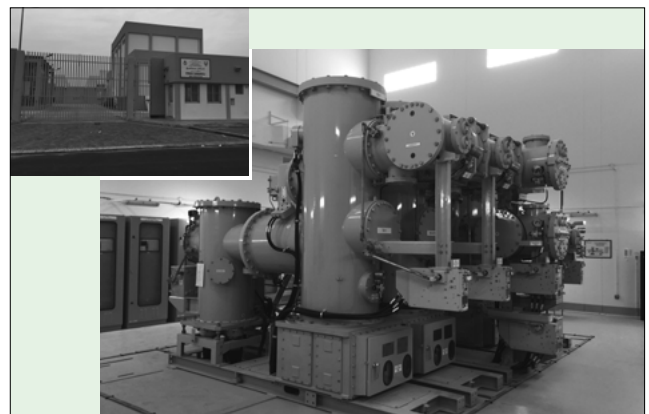


### 3 Start of Operations of ESL 66-kV Substation and HYL 66-kV Substation for Bahrain Electricity and Water Authority

The Eskan Samaheej (ESL) 66-kV substation and Huneniyah (HYL) 66-kV substation have been constructed to supply electricity to the new residential area in the Kingdom of Bahrain. The substations started operations, respectively, in January and March 2015. Each substation was configured with a 66-kV gas-insulated switchgear, 11-kV metal clad switchgear, control and protection panels, auxiliary power supply equipment, neutral earth resistor, high/low voltage cables and others.

This project was contracted as a turnkey project for handing over to the customer in condition of ready for operation, and most of the work for the project was undertaken at local project offices configured by the foreign engineers of each country. The project has been highly appreciated by the customer on account of the comprehensive activities that were carried out locally, such as the basic design of the substation, confirmation of equipment specifications, acquisition of price quotes, arrangement of manpower and equipment, progress management, installation work, testing and a number of meetings with customers.

Fig. 3 ESL 66-kV substation external appearance and 66-kV gas-insulated switchgear



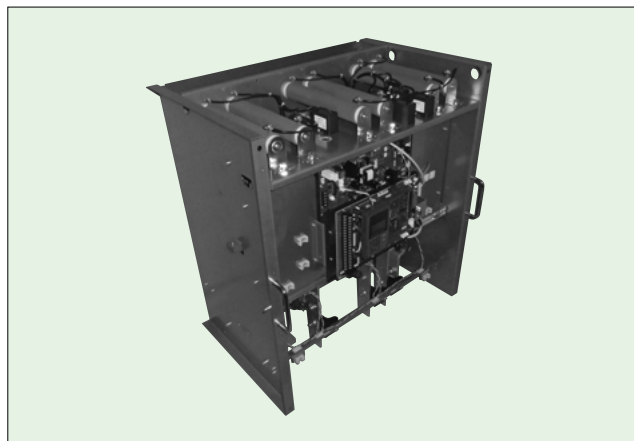
## Industrial Plants

### 1 Series Expansion for DC Motor Control Unit “LEONIC-M Compact”

We carried out additional development to enhance the performance of the “LEONIC-M Compact” DC motor control unit for use in factories, and as a result, we were able to expand the series of 150 kW units. The new armature main circuit stack has a rated voltage of 440 V DC, and comes in two models including a 320 kW, 850 A model and a 450 kW, 1,200 A model. The main features are as follows:

- (1) It is significantly smaller as a result of adopting a module type thyristor in place of the previous unit type.
- (2) The armature main circuit comes in a lineup of two types including a single-side type and a reversible type capable of reversible control.
- (3) A variation of options are available for the field circuit including a single-phase mixed bridge.
- (4) It inherits the features of previous LEONIC-M Compact units, making it easy to perform upgrade work and linking with existing facilities.

Fig. 4 Armature main circuit stack

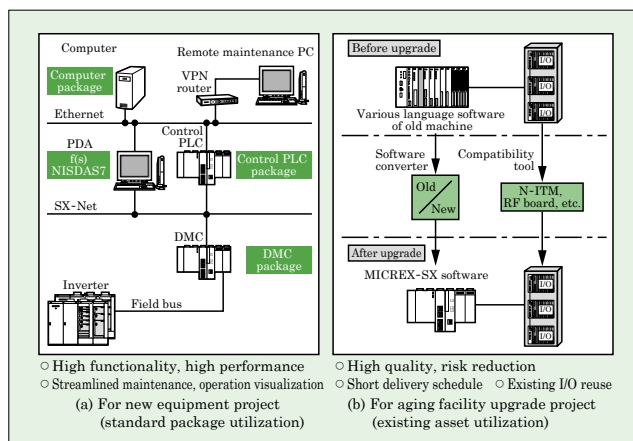


### 2 Packages and Upgrade Tools for Steel Plant Control System

The steel plant control system required a high performance and reliability, as well as enhanced functionality such as streamlined maintenance and operation visualization. Fuji Electric provided an optimized solution by developing and adopting various packages for the new equipment as well as various upgrade tools for the upgrade of the aging assets. The main features are as follows:

- (1) Standardized packages for each piece of equipment used for rolling mills, processing lines, and so forth.
- (2) Packaged high-speed drive control in the drive master controller (DMC)
- (3) High-speed data collection and visualization at the controller level via the use of “f(s) NISDAS7”
- (4) Effective use of existing system assets through use of a software converter and compatibility tools (compatible I/O series, compatible transmission board, compatible drive device)

Fig. 5 Packages and upgrade tools for steel plant control system



### 3 Functionality Enhancement for “MICREX-NX” Information and Process Control System

Fuji Electric is supplying the Information and Process Control System “MICREX-NX” to support “safety of production processes,” “continuation of processes” and “comfortable operations” at plants. We have recently made the following enhancements to the system’s functionality in order to better meet the needs of steel plant users.

- (1) Improved visibility

We adopted a universal design for the screen layout, instrument faceplate and overview.

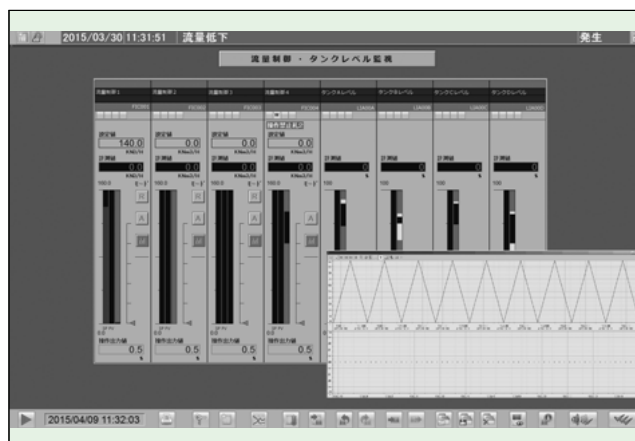
- (2) Advanced security measures

It is now possible to suppress load increases and defend against viruses by allowing only registered programs to execute.

- (3) Flexible update and expansion through a general-purpose interface

The use of a FL-net compliant LAN link device makes it possible to have a common memory interface between devices.

Fig. 6 Operation screen (universal design)





## Industrial Plants

#### 4 Monitoring and Control System for Chemical Plants

Fuji Electric upgraded the electrolytic cell control equipment at the Wakayama Factory of Nankai Chemical Co., Ltd. by replacing the aging monitoring and control system, initially installed by a different company, with the small- and medium-scale monitoring and control system “MICREX-View VX”.

This was our first time installing a monitoring and control system for a caustic soda (sodium hydroxide) manufacturing plant, but we proceeded with the work after ensuring there would be no problems through carrying out in-depth discussion with the customer and inspecting the site firsthand. The construction period for replacing the equipment at the plant only took 9 days. We successfully completed the upgrade work on schedule through joint efforts with Daiso Engineering Co., Ltd. to formulate the replacement plan.

We carried out the construction work by ensuring that the upgraded system would guarantee the reliability and maintainability required for long-term, stable use of the equipment, while also emphasizing economic aspects by reusing the cabinets of the existing equipment, etc.

Fig. 7 Electrolytic cell control system for Wakayama Factory of Nankai Chemical Co., Ltd.

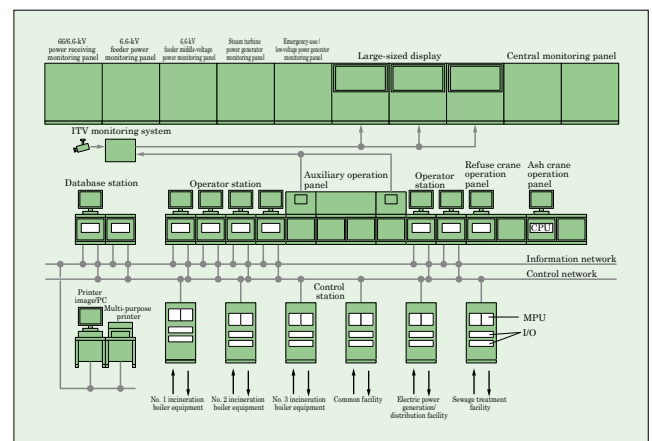


## 5 Distributed Control System for Waste Incineration Facilities

Waste incineration facilities that started operations before around 1990 are currently entering the upgrade period of their life cycle. However, the financial situation for many municipalities is quite severe, so there is increasing demand for the implementation of planned and efficient maintenance, management, and upgrading to preserve and extend the life of facilities. In order to achieve this, it is necessary to make effective use of the existing facilities (stock management) to decrease life cycle costs.

Against this backdrop, there is also an increasing need to upgrade distributed control systems (DCS), which are responsible for the main operation of the facilities. The figure shows a system for a harbor cleaning factory. The upgrade work was carried out in its entirety during the routine inspection period in September 2014. The construction period was greatly reduced by reusing existing equipment and materials such as cabinets and external line cables. The upgraded system started up without any trouble, and the upgrade work has contributed greatly to the stable operations of the facilities.

Fig. 8 Computer system for harbor cleaning factory plant control

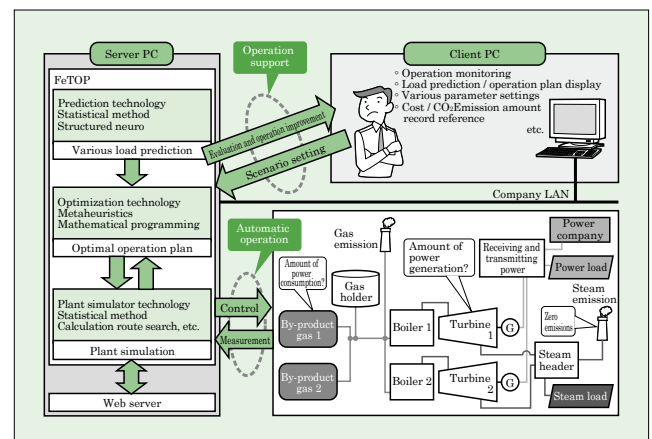


## 6 Optimal Operation System “FeTOP” for Energy Plants

Fuji Electric has developed and sold the “FeTOP” as a system that optimizes operations in order to decrease the cost and environmental burden of energy plants that supply electricity, heat and steam to factories and offices. In addition to assembly and processing factories and steel plants, the system has recently started being utilized at waste water treatment facilities and large hospitals.

- (1) High-precision prediction of energy supply and demand on a continual basis.
- (2) Capable of stand-alone operation in consideration of all of the various operating conditions (supply and demand, operating rules, constraints, characteristics, etc.) by means of a unique optimization technology that utilizes meta-heuristics.
- (3) Comes with an operation support environment including a plant simulator, and is capable of being used for degraded operation verification at the time of failure, operational training, etc. It can also be equipped to Fuji Electric's EMS platform "Energy GATE."

Fig. 9 Main functions of “FeTOP”



## Industrial Plants

### 7 Steam Generation Heat Pump

We have started the mass production design of a steam generation heat pump that recovers unused low-temperature exhaust heat (60 to 80°C) in factories, as well as regenerates steam at production sites. The main features are as follows:

(1) High efficiency

Based on our heat pump cycle technology cultivated in our vending machine business, the unit is capable of achieving a coefficient of performance (COP) of up to 3.5 by adopting a steam generation optimization method that utilizes unique two-phase heating.

(2) Small size and low cost

Cost effectiveness has been maximized by carrying out a critical design for the heat exchanger based on the use of a uniquely developed steam generation heat pump simulator. Furthermore, the unit achieves a setting area comparable to a vending machine, being within 1 m × 1 m. We have been carrying out field tests for the unit starting in FY2013 at our Mie Factory and continuing from FY2014 at our Iiyama Factory.

Fig. 10 Steam generation heat pump (field test machine)



### 8 Smart Factory System for Yamanashi Factory

Optimization EMS and cogeneration system has been installed at the Yamanashi Factory, utilizing a gas engine and a fuel cell, as part of the plan to introduce a smart factory system incorporating the ideal mix of electric power and heat. The main features are as follows:

- (1) Energy creation: Supplies the factory with its full load by utilizing the cogeneration electric power.
- (2) Energy conservation: Converts exhaust heat generated by the cogeneration into steam or cold water, thus supporting effective use by the factory facilities.
- (3) Energy optimization: Minimizes costs by creating the optimized operation plan for the energy supplying equipment based on power and heat demand predictions.
- (4) Power stabilization: Achieves stabilization by connecting the cogeneration and power company grid to create power supply redundancy, as well as by utilizing a 1-cycle VCB to compensate for power company-based interruptions and blackouts, sustaining the power supply for the factory load.

Fig. 11 External appearance of cogeneration system

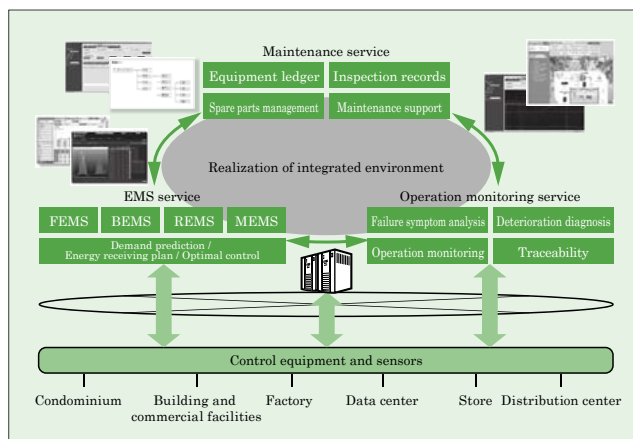


### 9 “Integrated Cloud Service”

We have developed an “Integrated Cloud Service” that comprehensively supports life cycle management of equipment. We will begin sequentially supplying the service during FY2015. This is a service that integrates an energy management system (EMS) service, operation monitoring service and maintenance service by means of an integrated cloud infrastructure based on several technologies including Fuji Electric’s specialized sensing technology, energy conservation analysis technology, demand prediction technology, quality trend analysis technology and equipment deterioration diagnosis technology.

It performs monitoring of operating conditions in a cloud environment, while comprehensively managing various data and information. As a result, the system contributes to achieving intelligence, safety and security of equipment at all stages of the life cycle including installation, operation and upgrade, while also supporting total optimization, including cost minimization and efficiency maximization from the viewpoint of management.

Fig. 12 “Integrated Cloud Service”



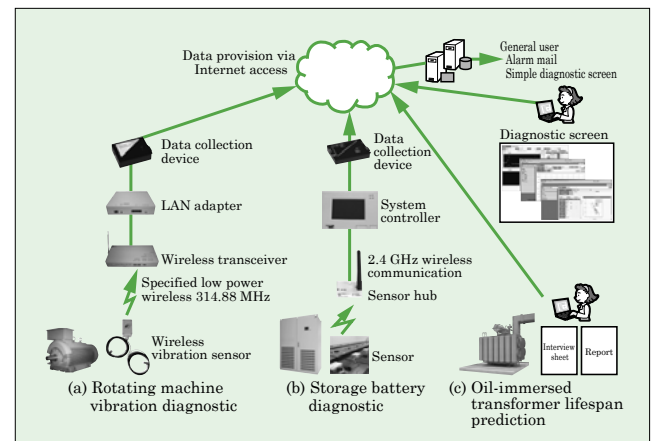
## Industrial Plants

### 10 Cloud-Based Equipment Maintenance Service

Fuji Electric have been engaged in the life cycle business in order to ensure stable and optimized operation for plant equipment at all stages of the life cycle including installation, operation and upgrading. In particular, equipment maintenance services have been facing several problems in recent years: aging of equipment, retirement of skilled maintenance engineers and maintenance of equipment in foreign countries. In order to solve these problems, we have established a cloud-based equipment maintenance service and have been enhancing its functionality. The service includes several functions such as operation monitoring, equipment diagnosis, failure symptom analysis, equipment management support and maintenance operation support. Recently, we have developed the following equipment diagnosis functions for compatibility with cloud environments.

- (1) Diagnosis for detecting and notifying abnormal vibration of rotating machine bearings
- (2) Diagnosis for the monitoring of storage battery degradation trends and early detection of abnormalities
- (3) Diagnosis to estimate the remaining life of oil-immersed transformers

Fig. 13 Cloud-based equipment maintenance service



### 11 Industrial Use Air Conditioning Control Software Platform

Fuji Electric has teamed up with Fuji Furukawa Engineering & Construction Co., Ltd. to develop a software platform for sequencers characterized by its enhanced efficiency in controlling industrial-use energy-conservation equipment. Applicable equipment include air conditioners, pumps, refrigerators and cooling towers. The main features are as follows:

- (1) It comes standard with a control function capable of changing the cooling water temperature based on the outside-air wet-bulb temperature, thus greatly improving the coefficient of performance for inverter refrigerators.
- (2) It comes standard with a dew point calculation function, thus greatly improving humidity control accuracy. Furthermore, it is more efficient than normal platforms because it can perform reheating and humidifying at the minimum required cooling level during constant temperature and humidity control.
- (3) There is no need to use a laptop PC for configuring settings. Control settings can be made easily from the touch panel.

Fig. 14 Configuration settings status screen

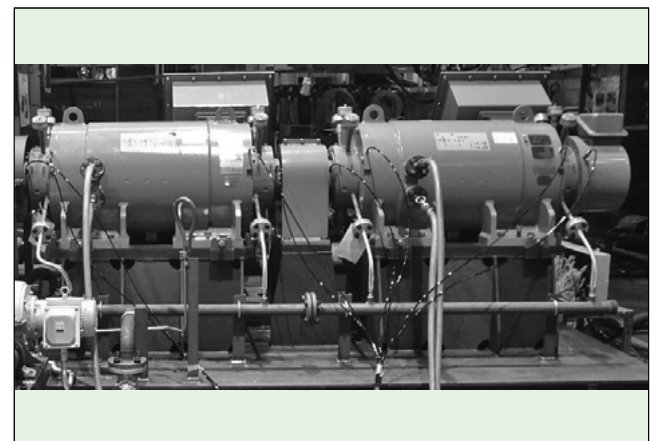


### 12 High-Speed Electric Power Generation System for Exhaust Heat Recovery Steam Turbines

We installed a high-speed electric power generation system for use with exhaust heat recovery steam turbines at a Japanese company. The generator has specifications of 350 kW, 440 V, 6 poles, 9,100 min<sup>-1</sup>, and 455 Hz. Two units in tandem are connected to a steam turbine. This power generation system was developed to utilize exhaust heat, and it improves generation efficiency by approximately 15% compared with previous products. The main features are as follows:

- (1) It directly connects the steam turbine with the generators without requiring a reducer, and this increases efficiency compared with previous methods, which suffered from a lower power generator rotational speed due to the use of a reducer.
- (2) It achieves frequency conversion by utilizing a vector-control inverter and power supply regenerative operation PWM converter.
- (3) It utilizes permanent magnet synchronous generators, resulting in higher efficiency than conventional winding generators.

Fig. 15 Two-unit configuration of high-speed generators



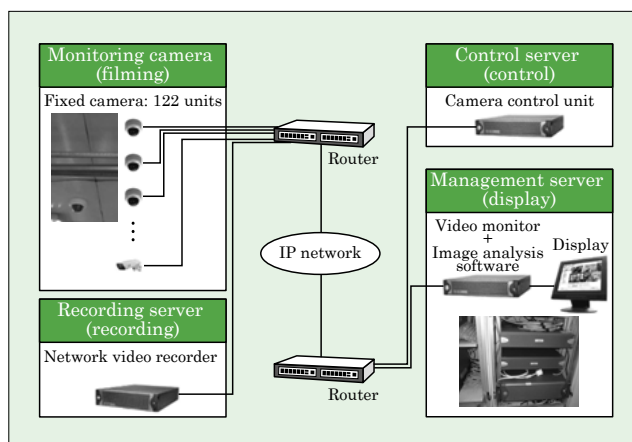
## Industrial Plants

### 13 Food Defense System for Ajinomoto General Foods, Inc.

Fuji Electric has been working on the development of an analysis system for preventing food contamination and improving productivity by means of food defense, which aims at resolving social problems related to the food industry. A food defense system is a system that automatically monitors for machinery malfunction and employee mistakes inside food factories by utilizing monitoring cameras (IP camera), recording servers and a network in combination.

We have recently installed a food defense system at Ajinomoto General Foods, Inc. The system is configured with 122 monitoring cameras, multiple management and recording servers, and a network (wired and wireless LAN). In the future, we plan to add functionality to the system so that the system can, in addition to recording monitoring states, improve convenience and provide enhanced accuracy for detecting malfunctions in the factory.

Fig. 16 Food defense system



### 14 Energy-Saving Hybrid Air Conditioner “F-COOL NEO,” Utilizing Indirect Outside Air

In an effort to save energy in data centers, outside air cooling systems have been increasing in usage as systems that use the natural energy of outside cold air. Fuji Electric has commenced sales of an indirect outside type air conditioner that only takes in outside cold air through the use of a heat exchanger. This air conditioner integrates both indoor and outdoor units, and more recently, we have developed a type that provides a high degree of installation flexibility by separating the indoor and outdoor units. The main features are as follows:

- (1) Yearly power consumption can be reduced to approximately one-third of that of general air conditioning systems by combining the operation of an outside air conditioner and built-in refrigeration unit.
- (2) Utilizing indirect outside air makes it less susceptible to corrosive substances, outside air moisture and dust such as PM2.5.
- (3) A power supply is the only required utility. No cooling water or cold water is required.

Fig. 17 “F-COOL NEO”



## Industrial Measuring Instruments

### 1 Controller “XCS-3000” for “MICREX-VieW XX”

We have developed and are supplying the market with the controller “XCS-3000” for the Small- and Medium-Scale Monitoring and Control System “MICREX-VieW XX”.

- (1) The use of a multiprocessor configured architecture makes it possible to carry out network processing and program operation processing in parallel.
- (2) It can be applied to both small- and medium-scale systems since it features a compact housing with dimensions of W145.0 × D69.8 × H113.1 (mm), super-fast high-speed processing at 8 ns per basic instruction, a large capacity memory with a 512 Ksteps for programs, etc.
- (3) It achieves high-speed and large-capacity transmission of data via a control network that has a line duplex function with 1-Gbit/s Ethernet.
- (4) It is possible to construct a highly reliable system by implementing an equalization protocol that transmits 512-Kword equalization data in 70 ms.

Fig. 18 “XCS-3000”





## Industrial Measuring Instruments

### 2 “MICREX-View XX” Network Adapter

We have developed and are supplying the market with a network adapter (NA) for connecting to the “XCS-3000” controller of the Small- and Medium-Scale Monitoring and Control System “MICREX-View XX”. Connection with the controller is made by using a NA bus equipped with a high-speed data transfer protocol for 1-Gbit/s Ethernet. The main features are as follows:

- (1) Connection can be made with not only Fuji Electric’s original network, but also with open networks by mounting various communication cards in a total of six slots.
- (2) It boasts of having a super-fast data refresh performance of 10 ms.
- (3) It achieves highly reliable performance through a redundant configuration.
- (4) In addition to improving system engineering efficiency through a standardized specification for the network adapter connection, it also makes it easy to expand and extend networks in the future.

Fig. 19 Network adapter



### 3 Programmable Display “MONITOUCH V9 Series”

In recent years, smartphones and tablets have been continuously gaining in popularity, and we have reached the point where nearly everyone has one. We have developed the programmable display “MONITOUCH V9 Series” based on the concept of maintaining the high level of quality required by manufacturers and raising the level of affinity with mobile devices used by consumers. The MONITOUCH V9 Series is very user friendly and comes with the latest network technology. It is characterized by the following features:

- (1) It utilizes an electrostatic capacity type touch switch to achieve a higher level of intuitive handling and operation.
- (2) It is compatible with VPN functionality and supports easy remote monitoring and operation without the need of VPN router or network skills.
- (3) It comes with a wireless LAN, making wireless data communication possible with mobile devices and notebook PCs.

Fig. 20 “MONITOUCH V9 Series”



### 4 Biomass Gas Analyzer “ZPAF”

Fuji Electric has commenced sales of the biomass gas analyzer “ZPAF,” which can measure generated gas at biomass plants via a single analyzer.

Biomass plants use generated gas, but the problem is that hazardous  $H_2S$  (hydrogen sulphide) is also generated. Up until now,  $H_2S$  measurements have been taken using continuous measurement methods, but these methods have not been able to deal with high concentrations (several hundred ppm). ZPAF utilizes a controlled potential electrolysis type sensor, making it possible to measure between 0 and 500 ppm or 0 and 2,000 ppm. Conventionally, multiple analyzers were combined to perform measurements for biomass, but ZPAF is capable of performing measurements via a single analyzer. The main features are as follows:

- (1) Measures  $CH_4$ ,  $CO_2$ ,  $H_2S$  and  $O_2$  via a single analyzer.
- (2) Makes it possible to replace the  $H_2S$  sensor with a  $O_2$  sensor directly at the work site.
- (3) Comes with automatic calibration, concentration alarm and 2-range measurement functions.

Fig. 21 “ZPAF”



## Industrial Measuring Instruments

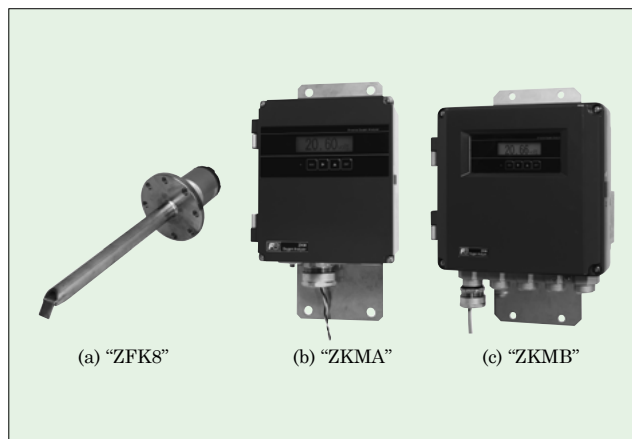
### 5 Zirconia Oxygen Analyzer “ZFK8,” “ZKMA” and “ZKMB,” Equipped with HART Communication Function

Fuji Electric has developed a zirconia oxygen analyzer equipped with the internationally standardized HART communication function.

Zirconia oxygen analyzers are used to increase equipment efficiency and energy conservation at various combustion management and combustion control work sites. Up until now, the work required to verify and/or change the internal parameters of instruments located throughout work sites was done at the specific areas of installation. HART communication superimposes a digital signal on an analog output (4 to 20 mA DC) to perform communication, and by providing this functionality, centralized operation can be carried out from remote locations. In addition to the HART communication function, the analyzer has the following features:

- (1) Comes with a detector that makes it easy to replace sensors on site
- (2) Equipped with a compact and lightweight converter not requiring the selection of an installation area
- (3) Comes with safety functions including an overheat prevention function for the heater

Fig. 22 Zirconia oxygen analyzer

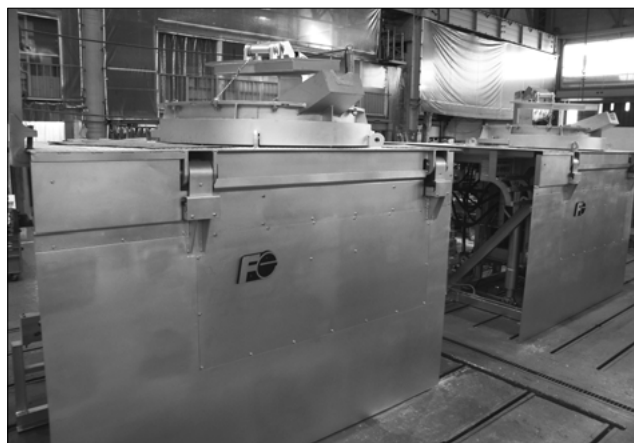


### 6 Energy Saving New Melting Furnace

There has been increasing demand for induction melting furnaces that achieve energy conservation, since they consume a large portion of the electric power energy at casting foundries. Fuji Electric has developed a new melting furnace that is characterized by its energy savings based on the adoption of a furnace body that utilizes our high-efficiency IGBT power supply and special coil. It achieves energy savings of 3 to 5% when compared with previous products. By combining an IGBT power supply with an optimally designed furnace component layout, the furnace reduces melting time and achieves energy savings efficiency, and it is expected that it will also be able to improve equipment productivity. We installed a 2-t melting furnace and a 3-t melting furnace during FY2014 after implementing field verification for the first unit.

In addition to its energy saving characteristics, the furnace reduces the coil replacement time to approximately one-third by implementing streamlining by means of a block assembly structure, as well as improves the quality and reliability of the coil by implementing cooling reinforcement to reduce the impact of vaporized zinc generated from the melting materials.

Fig. 23 Furnace body of new melting furnace (3 t, 2,250 kW)

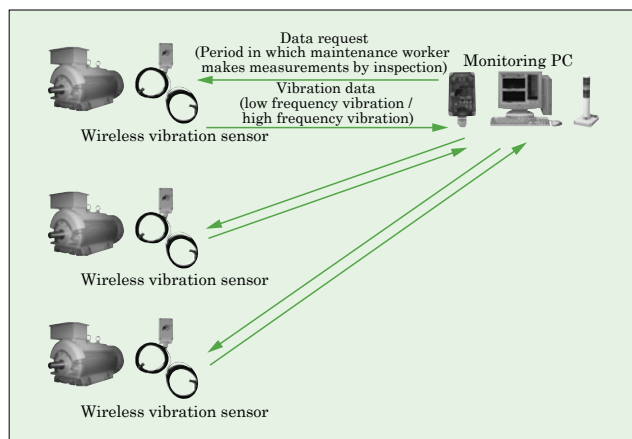


### 7 Wireless-Type Rotating-Machine Vibration Monitoring System “WISEROT” for Overseas Markets

The wireless-type rotating-machine vibration monitoring system “WISEROT” is designed to perform status monitoring for motors and machine equipment. It regularly measures the vibration and temperature of machine equipment and is capable of detecting equipment failure symptoms at an early stage by performing trend monitoring. Since it is a system that makes use of wireless communications, it can be applied to a wider range of applications and fields including applications that have been difficult to achieve for conventional wired-type online vibration monitoring systems or manual vibration measurement systems.

During FY2014, we achieved compliance for the system, meeting the requirements of overseas standards such as the CE marking and the R&TTE Directive, as well as acquired wireless certification for markets including the EU, Malaysia, Thailand, Singapore and Indonesia. In the future, we plan to gradually acquire wireless certification for other countries and increase the number of overseas services that we are providing.

Fig. 24 Configuration example for “WISEROT”



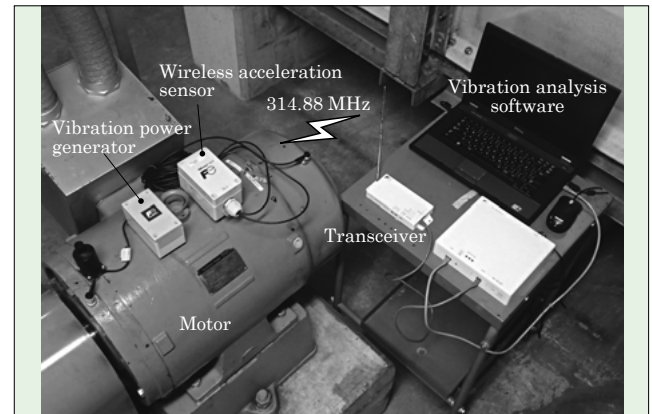
## Industrial Measuring Instruments

### 8 Energy Harvesting Technology for Wireless Sensors

We have developed an energy harvesting technology that does not require battery replacement or wiring for the power supply of wireless sensors. We have applied a vibration based power generation technology that generates power utilizing minute vibration of equipment and the installation environment to supply power to wireless sensors. We have also used a compressed sensing technology to reduce communication power, which consumes a large portion of the power used by wireless sensors.

- (1) The power generation system utilizes reverse magnetostrictive properties, and achieves an average generated power of approximately 330  $\mu$ W via a vibration with a vibration frequency of 100 Hz and acceleration of 0.98 m/s<sup>2</sup> (0.1 G).
- (2) Communication power has been reduced by at least 50% as a result of applying a selective compressed sensing technology, which we developed in collaboration with the University of Tokyo, based on traditional compressed sensing technology.
- (3) The figure shows an example of wireless vibration sensors used in a motor monitoring system that can operate without a power supply.

Fig. 25 Motor monitoring system utilizing vibration power generator

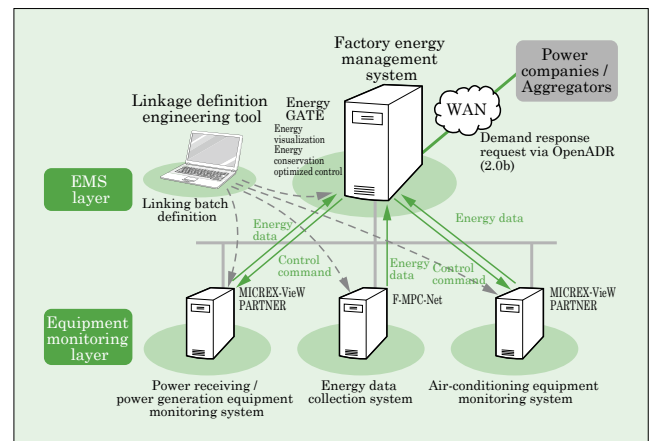


### 9 Engineering Linking Technology for EMS Layer and Equipment Monitoring Layer

We have enhanced the automatic linking function for factory energy management systems (EMS layer) and the multi-unit equipment monitoring layer. The equipment monitoring layer includes monitoring systems for power receiving, power generation and air-conditioning systems, as well as various energy data collection systems.

By making use of a linkage definition engineering tool, it is possible to link, at regular intervals, the measurements of multiple equipment monitoring systems with the EMS layer via a simple definition operation. By linking the function that optimally calculates energy savings (energy costs and CO<sub>2</sub> reduction) for the EMS layer with multiple equipment monitoring systems, it is also possible to achieve energy supply-and-demand balance control and energy conservation control for the entire factory. Furthermore, the utilization of OpenADR (2.0 b) on the EMS layer enables automatic control to be implemented by linking the equipment monitoring systems to demand response requests received from power companies or aggregators.

Fig. 26 Entire system configuration

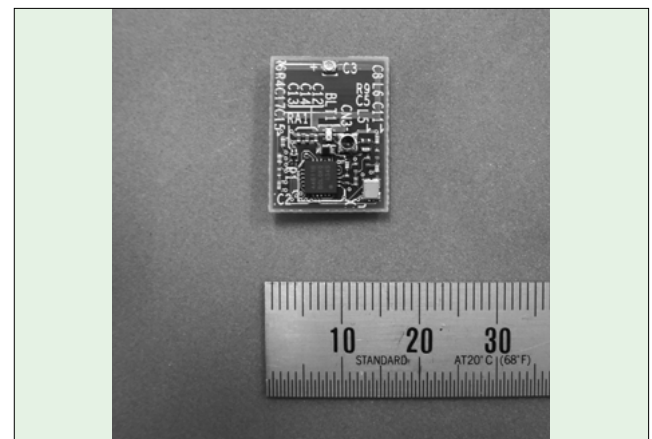


### 10 Ultra-Small Wireless Module with Built-In Antenna for Embedded Applications

Fuji Electric has successfully developed an ultra-small wireless module for the 920 MHz band. It incorporates an antenna on the substrate and has attained the industry's smallest class with dimensions of 15 × 20 (mm). Its ultra-small size makes it easy to be embedded into an existing device, and by connecting it to the serial communication interface of the existing device, it is possible to convert serial communication to a wireless configuration. In addition, it has two digital I/O interfaces and one analog input interface that enable I/O switching, and it can directly access the data on the device. Furthermore, it also comes equipped with Fuji Electric's original asynchronous communication protocol for suppressing power consumption, as well as a relay function for extending the communication range. The main features are as follows:

- (1) Operating frequency band: 922.4 to 928.0 MHz
- (2) Communication distance: 100 m (line-of-sight distance when using the built-in antenna)
- (3) Certification (in Japan): Scheduled to acquire ARIB STD-T108

Fig. 27 Ultra-small wireless module





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