

Power Electronics Industry

Factory Automation
Process Automation
Information Solutions
Social Solutions
Field Services



The Power Electronics Industry combines driving equipment, measuring instruments and control equipment with artificial intelligence (AI) and Internet of Things (IoT) to create systems and contribute to automation, energy saving and stable operation of equipment across all industrial fields. Furthermore, we also expand our products to the railway and marine sectors, contributing to the safety and security of social infrastructure and energy saving.

Factory Automation

In factory automation, Fuji Electric contributes to automation, energy saving, and optimal operation of equipment by using driving equipment, such as inverters and rotating machines, measuring instruments, such as pressure transmitters, and control equipment, such as programmable controllers and programmable operator interfaces.

In the field of driving equipment, we have worked to expand the functions of the “FRENIC-MEGA (G2) Series” of high-performance, multi-functional inverters and developed a line-up of zero-phase reactor built-in types and communication cards for major industrial networks.

In the field of measuring instruments, we have developed the “FCX-AIV Series” of pressure transmitters. It is certified to IEC 61508 (SIL2), the functional safety standard so that the transmitter can be used for systems that require high reliability.

In the field of control equipment, we have developed an “abnormality diagnosis solution” that uses AI to detect and analyze abnormalities in product processing in the production process. We have also developed the “SPH5000EC” CPU module for the “MICREX-SX Series” of programmable controllers that support EtherCAT, an open network. A high-speed, high-precision motion system can be constructed by combining this module with the “ALPHA 7” servo system.

In the field of FA systems, we have developed testing equipment for electric vehicles (EVs) in response to the needs of testing equipment for electrification of automobiles.

Process Automation

In process automation, highly reliable control of equipment, remote monitoring, and detection of abnormal signs are achieved based on know-how accumulated through a wide range of product line-ups and abundant delivery records.

In the field of driving control systems, we contribute to the stable operation of customer facilities by improving the reliability of medium-voltage inverters and expanding existing replacement tools, in addition to control systems based on the “XCS-3000 Type E” controller, which is capable of achieving high-speed control with a large capacity, and the “f(s)NISDAS7” high-speed data acquisition and analysis support device.

In the field of measurement systems, we reduce environmental impact by delivering an extra-high voltage substation equipment, monitoring and control system, analyzer, field equipment collectively to our customer plants such as waste treatment plant. We also provide predictive maintenance with abnormal sign monitoring, as well as control functions that utilize model prediction and AI functions. In addition, we have established an environment for remote monitoring and control system witness inspection and have begun to use this environment in the face of restrictions on human interaction due to the COVID-19 pandemic.

In the field of industrial electric heating, we have developed a refractory abrasion trend monitoring function and a maintenance parts management function to improve the maintainability of induction furnaces. This makes it easy to manage refractory replacement, and we contribute to labor saving in maintenance work by recording and visualizing the operating time and number of operations of consumable parts.

Information Solutions

In information solutions, we have been developing digital solutions and creating new products. We have been developing information business with DX (digital transformation) and carbon neutrality as the starting point, including factory DX and digitalization of offices in the new normal and administrative work.

Also in the field of information control systems, we

have developed a cluster energy management system using AI that contributes to energy saving and decarbonization.

Social Solutions

In the social solutions field, we contribute to the safety, security and energy saving in social infrastructure by developing electric systems for railcars, marine systems, transportation equipment systems, and radiation control systems.

In the railways field, we have developed a platform for door drive systems for railcars to enhance safety, reliability and maintainability by modularizing components to facilitate installation and replacement of equipment.

In the marine vessel field, we have developed a hybrid exhaust gas cleaning system (EGCS) for navigation in waters where wastewater discharge is prohibited. This enables switching between the conventional system and a circulation system in which wastewater is repeatedly used for exhaust gas purification without discharg-

ing it overboard. This makes it possible to operate the EGCS in accordance with the regulations of the sea area.

In the field of radiation monitoring equipment and systems, we have developed a new monitoring post that measures radiation in the environment continuously for 24 hours. The post is designed to work under extreme heat and cold as well as to improve the efficiency of maintenance operations.

Field Services

In the field services, in addition to conventional maintenance services such as periodic inspections and repairs, we have been developing equipment maintenance optimization solutions using IoT, analytics and AI.

For the “Comprehensive Service for Smart Industrial Safety,” which we have offered for customer facilities, a camera-based meter reading function and a predictive fire detection function have been added in conjunction with other companies’ systems.

Factory Automation

1 Zero-Phase Reactor Built-In Type of “FRENIC-MEGA (G2) Series”

One of the main applications of general-purpose inverters is energy saving of fans and pumps. Fuji Electric has been providing the “FRENIC-Eco Series” for this application. However, in order to comply with the standard specifications for public construction work supervised by the Ministry of Land, Infrastructure, Transport and Tourism, it was necessary to add reactors, which required cost reduction. To meet this requirement, we have added a line-up of zero-phase reactor built-in models to the “FRENIC-MEGA (G2) Series.” The products have the same basic functions and performance as the standard type of the FRENIC-MEGA (G2) Series, and they support a capacity range of 1.5 to 75 kW at 200 V and 1.5 to 75 kW at 400 V. Incorporating the zero-phase reactor helps reduce installation space and facilitate wiring work. We intend to expand use of the new line-up in fan and pump applications by making use of FRENIC-Eco Series compatible functions.

Fig.1 “FRENIC-MEGA (G2) Series”



Factory Automation

2 Ethernet Communication Card for the “FRENIC-MEGA (G2) Series” Low-Voltage Inverters

In recent years, Ethernet-based industrial open networks have rapidly come into wide use to achieve smart factories. Fuji Electric has developed an Ethernet communication card for the “FRENIC-MEGA (G2) Series” of low-voltage inverters, the card of which supports major industrial protocols in the global market. The main features are as follows:

- (1) Supports EtherNet/IP and PROFINET-I/O, which can be switched by a setting on the inverter (certified to each communication protocol standard).
- (2) Supports ring and daisy-chain topologies in addition to star, tree and bus topologies with two communication ports.
- (3) Supports switching of communication paths at the time of wire break in a ring configuration, enabling the building of highly reliable network.

Fig.2 Ethernet communication card for “FRENIC-MEGA (G2) Series”



3 “FRENIC-RHC (RHC-E) Series” PWM Converters

In motor control using general-purpose inverters, PWM converters are used to suppress input current harmonics and recover braking energy from the motor. They are increasingly used for large-scale systems recently and are required to have larger capacity and enhanced monitoring functions. Fuji Electric has accordingly developed new 400-V and 690-V stack types as the “FRENIC-RHC (RHC-E) Series” PWM converters.

- (1) Up to four stacks being parallelly connected without an isolation transformer, 400-V series stands at 3 MW and 690-V series, 1.7 MW.
- (2) High-speed, large capacity “E-SX bus” communications enable detailed monitoring by notifying high level systems of an operating state at a minimum cycle of 250 μ s.

Fig.3 “FRENIC-RHC (RHC-E) Series” (Stack type)



4 JF II Series Breaker-Shaped Watt-Hour Meter with Communication Function

Fuji Electric has developed the “JF II Series” breaker-shaped watt-hour meters with a communication function as a successor to the “JF Series” of watt-hour meters. The JF II Series can reduce wiring, installation man-hours, and outer dimensions. The main features of the JF II Series are as follows.

- (1) Bi-directional currents, forward and reverse, can be measured by a single unit, reducing installation costs of facilities such as solar power plants.
- (2) Visualizing power consumption help consumers save energy by collecting data every 30-minutes through Modbus/RTU communications and data can be stored for 45 days.
- (3) The incorrect wiring verification assistance function prevents incorrect measuring and wiring during installation work.
- (4) Users can confirm the validity period of certification and prevent expiration by setting expiration date (4 digits) on meter.

Fig.4 “F6JF-TN1” (Single-phase, 3-wire, 120-A type)



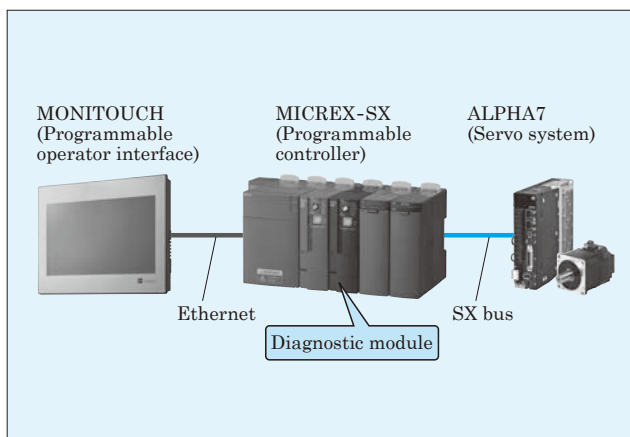
Factory Automation

5 “Abnormality Diagnosis Solution” Powered by Analytics and AI (MSPC)

At processing sites such as those for food packaging and metal processing, methods are being devised to detect the occurrence of defective products in real time on the basis of the behavior of machinery to improve productivity and prevent defective products from being passed on to the next process. Fuji Electric has developed a diagnostic module as a new module for programmable controllers to detect abnormalities during product processing and helps analyze the causes. This module is provided as an “abnormality diagnosis solution” in combination with a servo system and a programmable operator interface. By means of analytics and AI (MSPC*) technology, this solution detects abnormalities in real time by comparing operation data with a model generated based on data during normal processing of equipment. The history of diagnosis results is stored on a programmable operator interface, and the results (waveforms) to be checked can be selected and displayed to assist in determining the cause of the abnormality.

*MSPC: Multivariate statistical process control

Fig.5 System configuration example

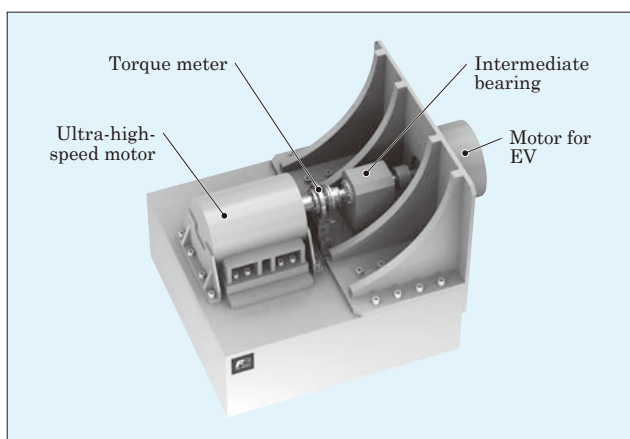


6 Test Equipment for EVs

With the global trend of emissions regulations and decarbonization, electrification of automobiles is progressing. In Japan, approximately 40% of automobiles sold in FY2030 are expected to be EVs, and demand for test devices for EVs is increasing. In response to this, Fuji Electric has developed a test device for EV motors that integrates the high-speed rotation design technologies used for our own ultra-high-speed motors, drive equipment, and intermediate bearings. The main features are as follows:

- (1) Tests can be performed with high-speed drive at a maximum speed of 20,000 r/min.
- (2) Grease lubrication of the intermediate bearing eliminates the need for pumps and other auxiliary equipment, thereby simplifying maintenance.
- (3) Installation of a thermostatic chamber enables reliability evaluations to be performed under simulated weather conditions.

Fig.6 Test equipment for EVs



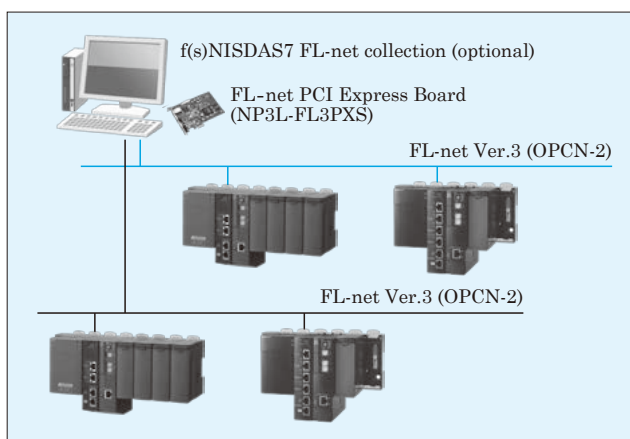
Process Automation

1 Enhancement of Functionality of “f(s)NISDAS7” Supporting Package Software for Data Acquisition and Analysis

Fuji Electric has enhanced the functionality of “f(s)NISDAS7” supporting package software for data acquisition and analysis, which supports operation monitoring and equipment maintenance operations. By increasing the amount of data collected and speeding up the collection cycle, the software contributes to reductions in the start-up time of production facilities and improvements in the accuracy of detecting signs of abnormalities in facilities. The enhanced functions are as follows:

- (1) Simultaneous data acquisition through two FL-net lines has been enabled.
- (2) NISDAS protocol specifications have been expanded to increase the amount of data acquired (Example: from 96 points to 16,256 points for the “MICREX-SX” and “MICREX-View XX”).
- (3) Continuous mode has been added to the data acquisition method to support high-speed acquisition of large-capacity data (up to 3,200 points with 150 ms cycle).
- (4) Remote usability has been enhanced, including sharing analyzer settings.

Fig.7 Simultaneous data acquisition via two FL-net lines

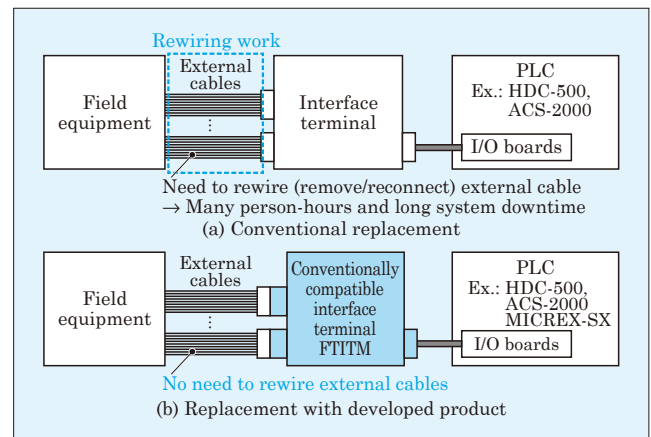


Process Automation

② Replacement of Existing I/O Using the “FTITM” Conventionally Compatible Interface Terminal

When replacing PLCs for the purpose of maintenance and repair of monitoring and control systems, on-site wiring work so far need reattaching all external cables connecting field devices and interface terminals, which required many person-hours and entailed risks such as mis-attachment and mis-wiring. To address this, Fuji Electric has developed the “FTITM” conventionally compatible interface terminal, which supports systems that use the “HDC-500” and the “ACS-2000” PLCs released in 1980’s. The current model “MICREX-SX” can be connected by simply replacing the existing interface terminal with the FTITM without relaying the external cables. Thus, PLCs, which are long-term operation devices, can be easily and quickly replaced while effectively utilizing the hardware assets of customers.

Fig.8 Connection image of “FTITM”

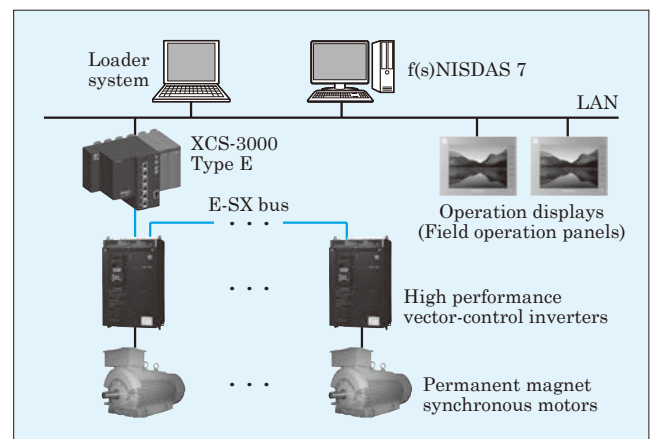


③ Delivery of Drive Control System for Film Manufacturing Facility

Fuji Electric has delivered a drive control system for a Japanese film manufacturer's latest film manufacturing equipment, which began operation in March 2022. The features of the system are as follows:

- (1) Delivers larger data capacity and high-speed control (up to 0.5 ms) using the “XCS-3000 Type E” as the main controller.
- (2) Achieves high-speed synchronous operation (60 units/5 ms) of multiple film conveyance mechanisms via the “E-SX bus” of the XCS-3000 Type E.
- (3) Highly improves the operating efficiency (IE3 level) with the use of permanent magnet synchronous motors (PM motors).
- (4) Supports failure cause analysis and optimal operation pattern creation based on long-term operation data speedily collected by “f(s) NISDAS7” supporting software for data acquisition and analysis.

Fig.9 System configuration diagram



④ “FRENIC4600FM6e” Medium-Voltage Inverter Increased in Reliability

In social infrastructure, such as electric power and water treatment facilities, and in materials industries, such as cement and petrochemistry, medium-voltage inverters have increasingly used for critical facilities in plants to save energy. These facilities are required to have high reliability not to stop operation. In order to improve the reliability of the medium-voltage inverter, Fuji Electric has taken measures for limited-life components with a high failure stop risk.

(1) Redundant cooling fans

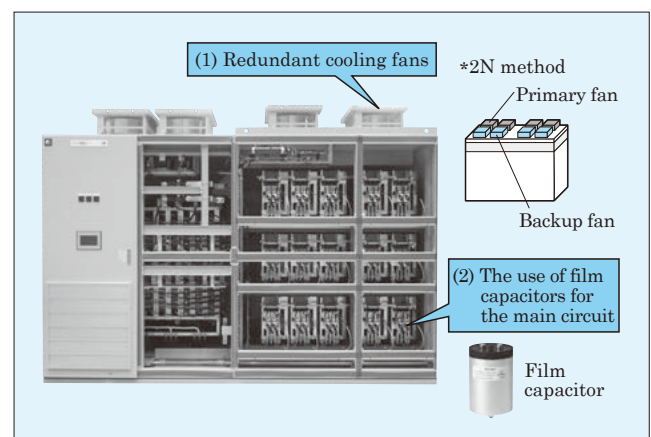
Two redundancy methods, complete duplex (2N*) and N + 1, are available to reduce the failure stop risk.

(2) The use of film capacitors for the main circuit

Aluminum electrolytic capacitors in the main circuit, which are limited-life components, have been changed to film capacitors, eliminating the need for future replacement.

*N: Number of cooling fans

Fig.10 “FRENIC4600FM6e” improvements



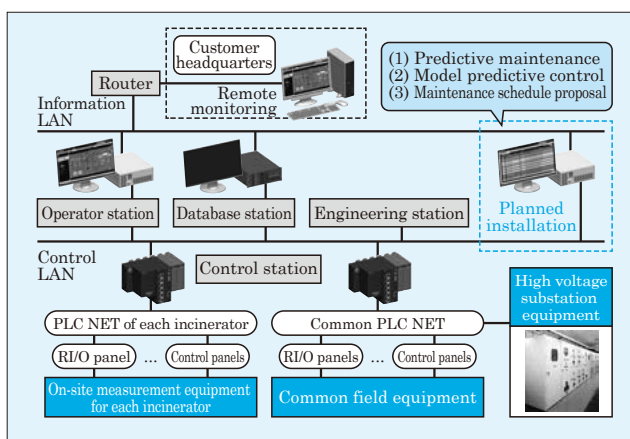
Process Automation

5 Delivery of Electrical and Instrumentation Equipment for Eco Cleanpeer Harima

Fuji Electric, through Kobelco Eco-Solutions Co.,Ltd., has delivered electrical and instrumentation equipment together to Eco Cleanpeer Harima (Toban Seaside Wide-Area Clean Center), including high voltage substation equipment, a monitoring and control system (DCS), field control panels, analyzers, and field measuring instruments. Receiving the bulk order resulted in a streamlined, integrated electrical and instrumentation system, and furthermore, the coordinated operation of the component equipment could be confirmed in advance, significantly shortening the time required to commission the equipment on site. In the future, we will contribute to the maintenance and management of the products and implement the following:

- (1) Predictive maintenance through the monitoring of abnormal signs
- (2) Advanced control with model predictive control and AI
- (3) Proposal of optimal maintenance schedules based on remote monitoring of equipment conditions

Fig.11 Delivery system configuration

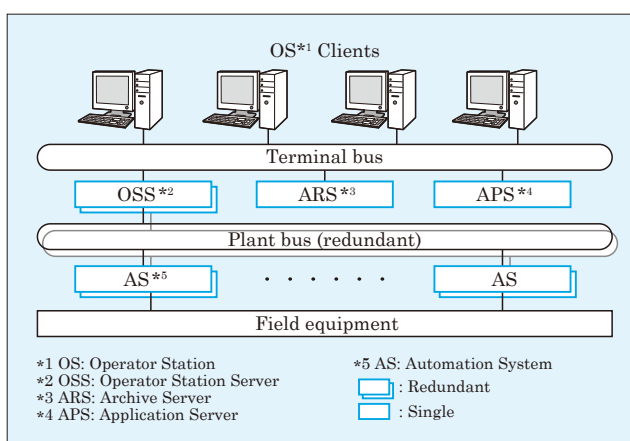


6 Monitoring and Control System for Off-Site Facilities of an Oil Refinery

Fuji Electric has delivered many monitoring and control systems to off-site facilities of oil refineries. However, we face challenges in dealing with unstable operation of hardware caused by long-term operation after delivery and security risks, such as malicious viruses and malware. In order to solve these issues, we took following measures when replacing a "MICREX-NX" monitoring and control system at the off-site facilities of an oil refinery:

- (1) Increasing processing speed by updating the CPUs of operator station clients from V6.1 to V9.0 and expanding memory capacity to speed up plant control.
- (2) Improving reliability with dual CPU configuration for Automation Stations.
- (3) Strengthening security to prevent unauthorized applications from being activated with white lists installed in the servers.

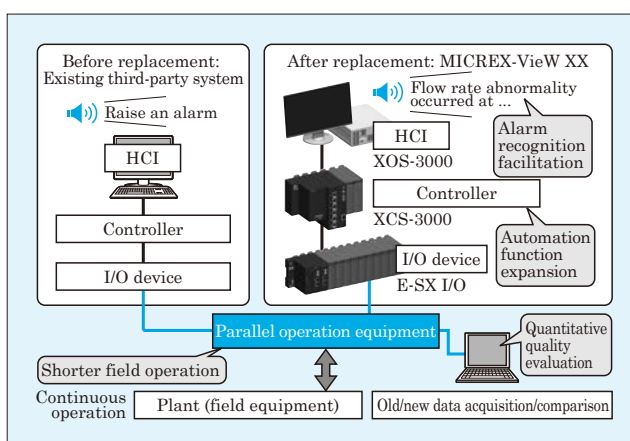
Fig.12 Monitoring and control system configuration



7 Replacement of Monitoring and Control System for Water Facilities at a Steelworks

Fuji Electric has replaced the monitoring and control system for the water facilities of a steelworks in Japan with a system using the "MICREX-VieW XX." Water facilities are continuously operating facilities, and they must continue to operate even when switching between old and new systems. However, in the past, the facilities had been temporarily stopped for the trial operations to evaluate a new system. To address this, we introduced a parallel operation equipment internally having a circuit switching function. The equipment can automatically compare and verify data during an old and new systems operate in parallel. This function allowed us to verify that the old and new controllers had equivalent control functions in a short period of time and replace the monitoring and control system without shutting down the water supply facilities. In addition, the new system has a voice annunciator that provides an audible indication of the type of plant abnormality, enabling rapid restoration after an alarm is issued.

Fig.13 Monitoring and control system configuration



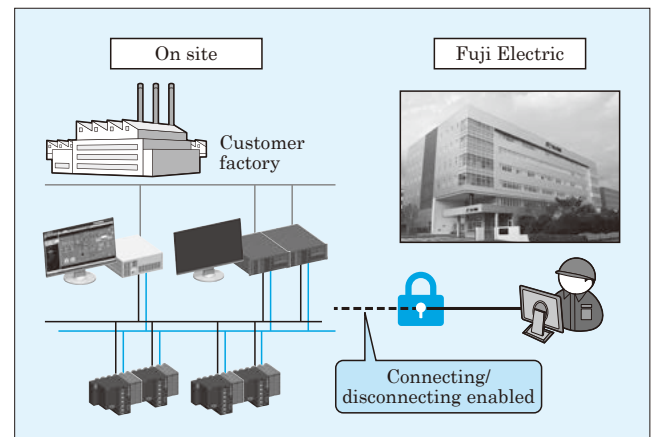
Process Automation

8 Remote Maintenance System for Industrial Monitoring and Control Systems

There is a growing need for remote equipment repair, maintenance and troubleshooting. Fuji Electric has constructed a remote maintenance system that guarantees cybersecurity and started providing a service to support on-site systems remotely. The main features are as follows:

- (1) Security is enhanced through the use of OpenVPN (encrypted communication) and the installation of firewalls.
- (2) An external access restriction function that turns VPN connections on and off locally enables flexible operation while ensuring security.
- (3) The system can be easily introduced at low cost by eliminating the need for dedicated software and dedicated lines for remote maintenance.

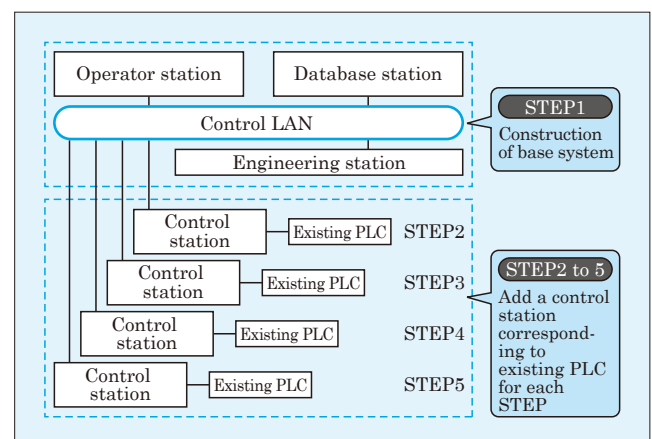
Fig.14 Remote maintenance system overview



9 Replacement of the Monitoring and Control System at a Chemical Plant

Fuji Electric has replaced the monitoring and control system at a chemical plant. In order to reduce the burden on the customer and minimize the impact on production, the project, the time period of which is divided in five steps until 2025, proceeds in stages. In Step 1, which was carried out in FY2021, we introduced a “MICREX-View XX” operator database control engineering station to build a base system. The customers remotely confirmed functionality during the witness inspection of the system using remote PC software provided by Fuji Electric. Since the software allows the customers to operate the system on their PC screen, they participated in the on-site witness inspection to verify and inspect the system functions from their own workplace.

Fig.15 Example of “MICREX-View XX” replacement in stages

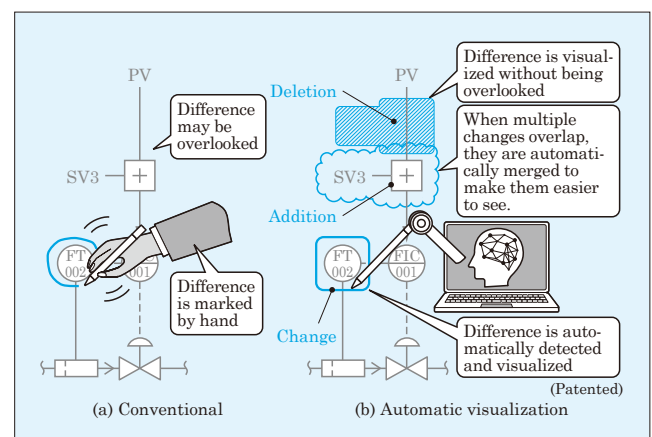


10 “HEART” Highly Efficiency Engineering Support Tool Automatically Visualizing Changes in Specifications and Diagrams

Specifications and diagrams, which are engineering documents, are changed according to changes in specifications and on-site modifications. Changes (differences) are usually indicated (marked) by circling them by hand, however, which leads oversights and mis-recognition caused by the individual notation. To address this, we have developed an automatic visualization function for differences and incorporated it into the “HEART” engineering support tool. The main features are as follows:

- (1) A database of text that makes up specifications and diagrams as well as software elements is created, and 17 types of changes, including additions, changes, and deletions, are automatically extracted using a proprietary algorithm. Extracted differences are automatically displayed and visualized so that oversights are prevented.
- (2) If multiple changes overlap and they are in the same classification, they are automatically combined and displayed in an easy-to-read manner.

Fig.16 Overview of automatic visualization



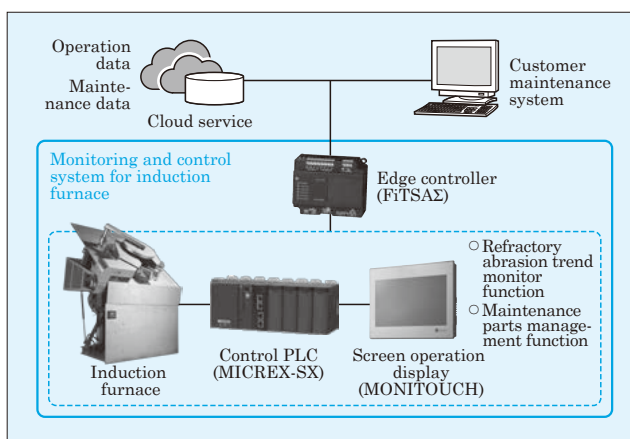
Process Automation

1 Maintenance System for Induction Furnace Operation

Fuji Electric has improved the data acquisition and recording function of the current system and developed a maintenance system for induction furnace operation equipped with a refractory abrasion trend monitoring function and a maintenance parts management function to improve the maintainability of induction furnaces and promote IoT.

- (1) The number of data acquisition items for the power supply and auxiliary equipment of induction furnace has been expanded to approximately three times that of the conventional system, and the collected data are stored in the "FiTSAΣ" and transmitted to the customer's maintenance system or Fuji Electric's cloud service to share information.
- (2) Abrasion trends of refractories are monitored on the basis of voltage, current, and other data to support proper management of equipment.
- (3) Preventive maintenance functions have been expanded, such as recording and visualizing the operating time and the number of operations of the consumable parts of equipment.

Fig.17 Entire system configuration

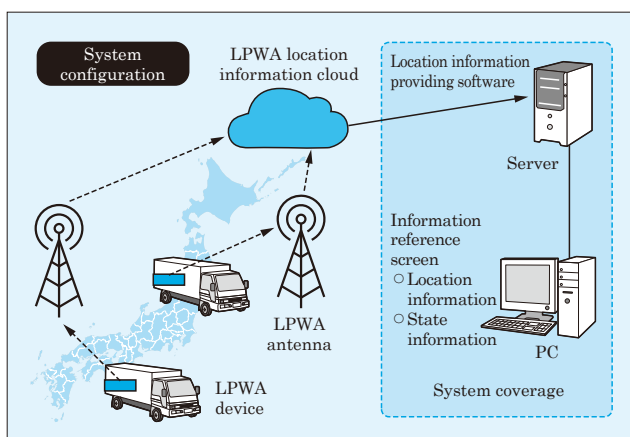


Information Solutions

1 Location Information Provision Software Using LPWA Devices

As part of its PORT 2030 medium- to long-term port policy, the Ministry of Land, Infrastructure, Transport and Tourism is promoting smart port areas. Currently, shipping work in the vicinity of ports is complex and requires efficiency improvement because the location information of containers and trailers is managed on paper by people. To address this challenge, Fuji Electric has developed software that supports work efficiency by managing location information using low power wide area (LPWA) devices. Positioning by LPWA uses electric field strength in communications with multiple base stations. The battery life of LPWA devices is more than 5 years, and operating costs start at approximately 100 yen per unit per year, which is very low compared with GPS. In the future, we will help achieve the PORT 2030 by deploying this software throughout the shipping industry in Japan.

Fig.18 Example of system configuration using location information provision software



Social Solutions

1 Door Drive System for Series 315 Conventional Line Commuter Train (Central Japan Railway Company)

Fuji Electric has delivered door drive systems for Series 315 conventional line commuter trains to Central Japan Railway Company through Nippon Sharyo, Ltd. This is the first delivery case of the door drive system for side sliding doors in the Tokai region. Revenue service of trains equipped with this system started in March 2022. This system, which is based on our domestic standard products with a proven track record in the Tokyo metropolitan area, realizes high safety, reliability, and maintainability with the following features:

- (1) Enhances passenger safety by improving the obstruction detection function to make it easier to pull out obstacles.
- (2) Increases reliability by using controllers with redundant control functions.
- (3) Improves maintainability by modularizing components to facilitate installation and replacement of equipment.

Fig.19 Series 315 conventional line commuter train



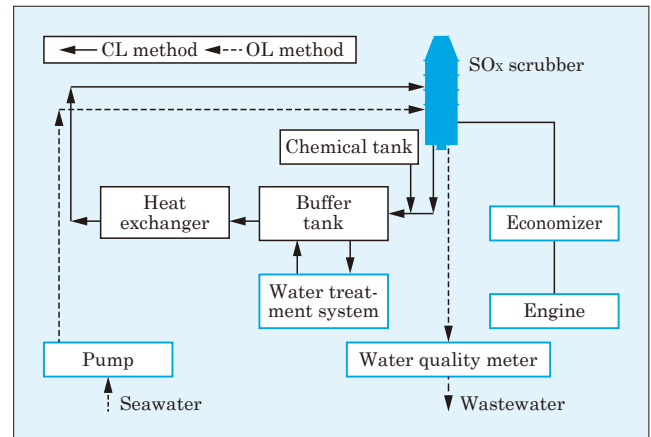
(Photo courtesy of Central Japan Railway Company)

Social Solutions

2 Exhaust Gas Cleaning System for Navigation in No-Discharge Zones

In addition to the International Maritime Organization's regulations on sulfur oxide (SO_x) concentrations in exhaust gas, a growing number of countries and regions are banning wastewater discharge from exhaust gas cleaning systems (EGCSs). To use EGCSs in countries and regions with these regulations, Fuji Electric has developed an exhaust gas cleaning system for navigation in no-discharge zones (hybrid EGCS). The hybrid EGCS allows the user to select between the conventional open loop (OL) method and the new closed loop (CL) method. The CL method features a system configuration in which the functions for supplying alkali components, preventing water temperature rise, removing soot, and defoaming of wash water have been added to the EGCS, and waste water is circulated through a SO_x scrubber and repeatedly used for cleaning exhaust gas. With this system, the operation method can be switched according to the regulations of the sea area, and the marine route can be selected flexibly.

Fig.20 Exhaust gas cleaning system for navigation in no-discharge zones

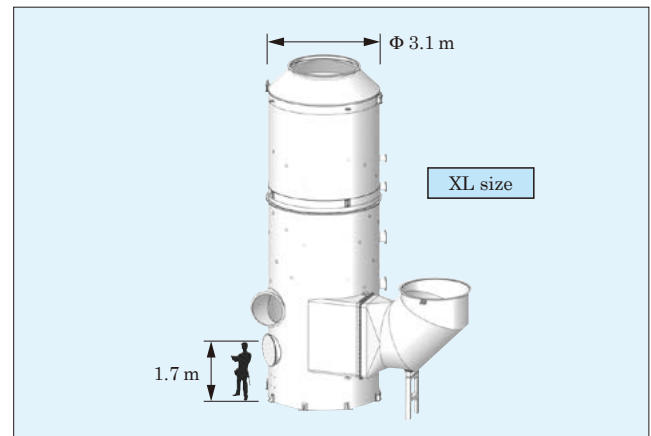


3 Capacity Expansion of the SO_x Scrubber for Marine Vessels

Fuji Electric provides SO_x scrubbers that comply with the sulfur oxide (SO_x) discharge regulations for marine vessels, as well as an exhaust gas cleaning system (EGCS) for marine vessels equipped with the scrubber. For large-scale marine vessels such as a very large crude carriers (VLCC), we have developed and added to our line-up an XL size SO_x scrubber for engine outputs of up to 24 MW. The main features are as follows:

- (1) By redesigning the internal structure of the scrubber, the pressure loss has been reduced and the exhaust gas has been brought into contact with seawater efficiently, resulting in high desulfurization treatment efficiency even in the XL size.
- (2) The diameter of the tower has been reduced to 3.1 m (27% smaller than other company's products).
- (3) To facilitate installation work in shipyards, a hanging structure has been provided.

Fig.21 SO_x scrubber



4 New Monitoring Post

Fuji Electric has developed a new monitoring post that measures radiation in the environment continuously for 24 hours in the vicinity of nuclear power facilities. Since continuity of measurement is required in the field of environmental measurement, the internal components of the detector, which affect measurement performance, are the same as those of conventional products to ensure measurement reliability and accuracy. Conventional products were divided into a NaI scintillation detectors for detecting radiation and measuring sections for recording measurement data. However, the new product has the structure in which the measuring section is removed and integrated into the detector, reducing cost and saving space. In addition, the enclosure for the detector has a new structure to endure severe heat and cold (snowfall). We will continue to contribute to the safety and security of local communities with this product and other products for environmental radiation management.

Fig.22 New monitoring post



Field Services

1 “Comprehensive Service for Smart Industrial Safety” Additional Functions

Fuji Electric started providing on May 2021 its “Comprehensive service for smart industrial safety” that enables centralized management and analysis of operation and maintenance information for power distribution equipment, which is an IoT-based system solution called “Promizer.” The following two items has been added to the Remote Monitoring Service Menu:

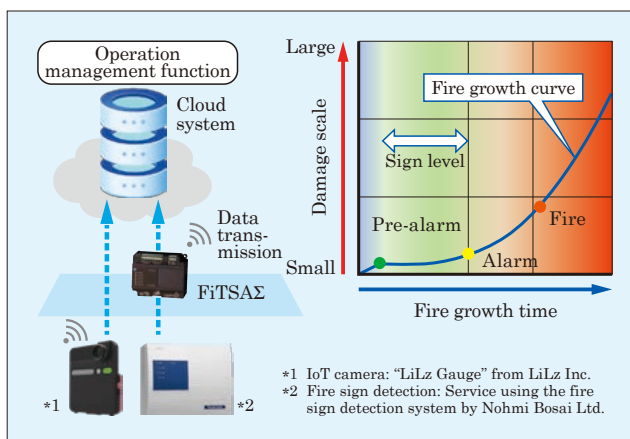
(1) IoT camera for meter reading

The meter images captured by the camera are converted into numerical values by AI and saved to reduce person-hours for patrol and inspection work, as well as to facilitate trend display and report creation.

(2) Fire sign detection

Fire prevention is supported by notifying security guards of abnormalities that could lead to electrical fires at an early stage through synchronization with a fire sign detection system that uses high-sensitivity smoke sensors.

Fig.23 Additional service options



2 “Fuji Wearable Remote Operation Support Package (FWOSP-Glass)” Additional Functions

The number of skilled maintenance personnel is on the decline, and passing on skills and improving efficiency in inspection and maintenance work has become a challenge. In response to this, Fuji Electric offers a “wearable remote operation support package” cloud service. Latest additional features are as follows:

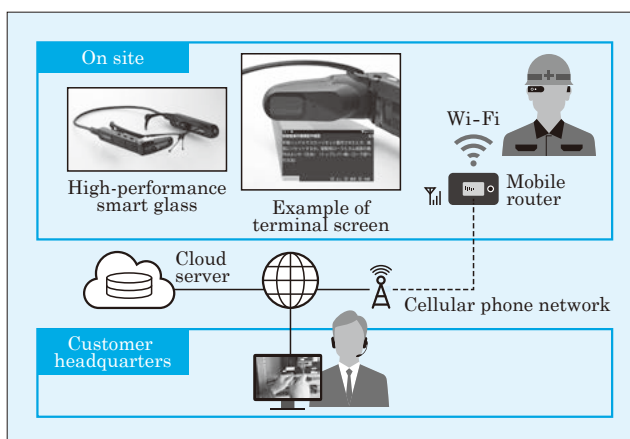
(1) High-performance smart glass

A lightweight smart glass with environmental endurance (IP67 compliant) can be used, which has been upgraded from the previous model. Hands-free operation with voice recognition reduces the workload.

(2) Linkage to a web conferencing system

Sharing high-quality audio and video between smart glass in the field and PCs in the customer headquarters improves the quality of remote support operations. In addition, the recorded data can be stored on a cloud server, allowing the parties concerned to share them, supporting passing on skills.

Fig.24 Function overview





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