Development of Comprehensive Monitoring and Control System for Power Plants

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OVERVIEW: Hitachi offers environmentally conscious integrated solutions for generating, transmitting, and consuming electric power based around its HIACS Series, which brings together the company's extensive experience and skills in control technology. Hitachi has now developed a new generation of integrated monitoring and control systems for power generation that form the core of these solutions. This development included updating the control panel design and the Hi³Station program maintenance software as well as controllers, I/O, and other modules. These new products retain the high reliability and performance that are a feature of the current HIACS generation and are designed to deliver superior installation compatibility (compact and adaptable system) and easier maintenance and expansion. Compatibility between generations was also considered to provide a system that is easier to use.

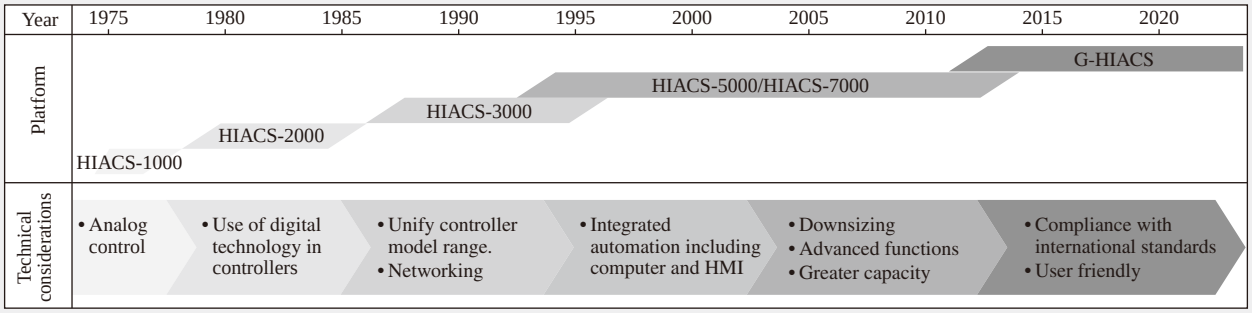
INTRODUCTION

THE bulk of the Japanese market for monitoring and control systems for thermal and hydro power plants involves upgrades to existing equipment. The key requirements for this market are high reliability, the ability to undertake upgrade work quickly, an emphasis on compatibility with existing control equipment, and ease of maintenance.

In markets outside Japan, meanwhile, demand for electric power is growing particularly in emerging economies. Furthermore, concern for the global environment is driving demand for high levels of operating efficiency. The key requirements in these markets are reductions in both construction and generation costs, networks that comply with international standards, and ease of maintenance.

Hitachi embarked on the development of upgrades to the Hi³Station maintenance software, control panel design, and the modules that make up the HIACS (Hitachi integrated autonomous control system), an integrated monitoring and control system for power generation. The concept behind the development was to improve installation compatibility (compact and adaptable system), ease of maintenance, compatibility with existing systems, and expandability while maintaining the existing high levels of reliability and performance. "Hi³" is an abbreviation for "high security × high reliability × high value added."

This article describes the features of the next-generation HIACS that were enhanced in the development.



HIACS: Hitachi integrated autonomous control system HMI: human-machine interface

Fig. 1—System Roadmap.
Hitachi has been supplying leading-edge integrated monitoring and control systems for power plants that have taken advantage of the latest technology available at the time.

TABLE 1. Enhancements to New HIACS Generation Classified by Concept
The new generation of HIACS is designed for improved functionality while maintaining the strengths of the current system.

Concept		Current HIACS	Enhancements in new HIACS generation
(1) Improved installation compatibility		• Use of PCMs to make protection functions more compact • Adoption of field network and cable-less connectivity	• Simplify panel design. • Increase flexibility of mounting design. • Front-panel maintenance features
(2) Easier maintenance	Software (maintenance tool)	• Maintenance software includes CAD function/ hierarchical logic • Full range of maintenance functions in maintenance software (monitor, trending, tuning, etc.)	• Easier to use • Enhance trend graph function. • Enhance help function. • Enhance security.
	Hardware	• Hot-swapping of modules (live installation and removal)	• Simplify hot-swapping.
(3) Easier expansion		• High degree of expandability provided by horizontal autonomous distributed system architecture (distributed at each level: unit, system, device, and field)	• Maintain compatibility between old and new systems. • Comply with international network standards. • Remote monitoring via a web browser
(4) High reliability and performance		• Controller integration and use of PCM for distributed functionality	• Improved performance of controllers and PCMs • Improved performance of control network • Improved performance of I/O network

PCM: programmable control module CAD: computer aided design I/O: input/output

CHANGES TO HIACS

HIACS, the brand name traditionally applied to Hitachi's platforms for power generation systems, dates back more than 35 years to the first-generation HIACS-1000 controller and has undergone considerable progress since then. The technical considerations behind the development of the next HIACS generation include making the system compliant with international standards as well as more user friendly and easier to use (see Fig. 1).

FEATURES OF NEXT-GENERATION HIACS

The new HIACS is designed to be easier to use due to a number of added enhancements, while still retaining the high reliability and performance features of the existing HIACS. The underlying concept was to improve the system's installation compatibility (compact and adaptable system), ease of maintenance, compatibility with existing systems, and ease of expansion.

Table 1 lists the enhancements to the next-generation HIACS intended to implement these objectives.

ENHANCEMENTS TO NEXT-GENERATION HIACS

The following sections describe the enhanced functions of the next-generation HIACS.

Improved Installation Compatibility

Tasks like panel assembly and the connection of external cables to I/O modules were made easier by

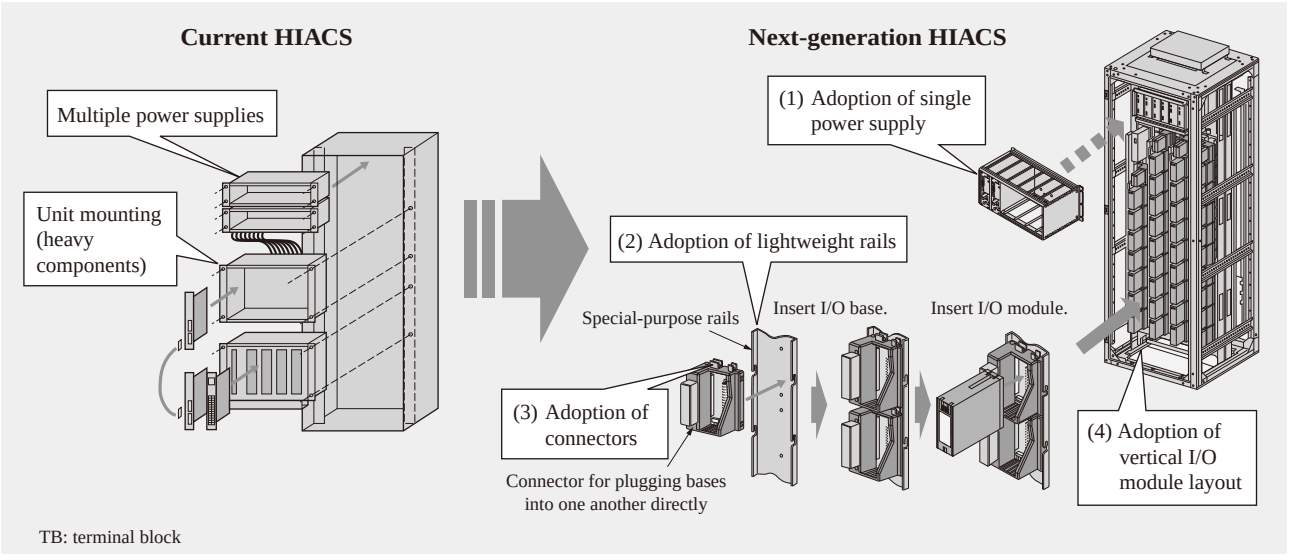


Fig. 2—Comparison of Panel Designs.
The diagrams show the different panel designs used on the old and new HIACS.

simplifying the panel design for the next-generation HIACS as described in points (1) to (4) below (see Fig. 2). Furthermore, the degree of freedom in design of implementation was increased as described in points (5) and (6) to better utilize the space in the panels and allow more compact mounting with greater flexibility.

(1) Adoption of single power supply

The aims were to rationalize spare parts management and simplify voltage regulation by having all outputs at 24 V. Whereas the current system requires a range of output voltages (5 V, ±12 V, 15 V, and 24 V), all modules in the new HIACS have a standardized input voltage of 24 V, and therefore can run off a single power supply.

(2) Adoption of lightweight rails

Changing from a unit- to a rail-based design cut the number of components required to build the units. Additionally, the rails were made of aluminum to reduce their weight and make assembly easier.

(3) Use of connectors to link I/O bases

Connectors were adopted for connections between I/O bases to eliminate the power supply and signal cabling between them. This elimination of signal cabling between I/O bases also improved immunity to noise.

(4) Adoption of vertical I/O module layout

Connection of external cables was simplified by adopting a vertical arrangement for I/O modules so that the cables could be run straight up to connect directly to the I/O module.

(5) Reduced number of power supplies when using dual power supply configuration

Whereas a dual power supply configuration requires two power supply units on the current HIACS, it can be configured to operate with a single unit using the new power supply.

(6) Variable I/O rack length

The current unit-based design means that units take up the same amount of space even if they only contain a small number of I/O modules. Using the new rail-based design, in contrast, the length of the I/O rack can be varied to match the number of I/O modules being used, which makes panel mounting more compact and allows the supply of control panels to take account of transport restrictions.

Easier Maintenance

The next-generation HIACS includes a comprehensive upgrade of the Hi^{3}Station maintenance software to reduce the time required for engineering work by providing a more intuitive operation, easier tuning during commissioning, and easier troubleshooting. These include the operational improvements and enhanced functions listed in points (1) to (5) below (see Fig. 3). They also include the maintenance improvements listed in points (6) to (8) that result from the new I/O design and the changes to the diagnostic information passed to controllers.

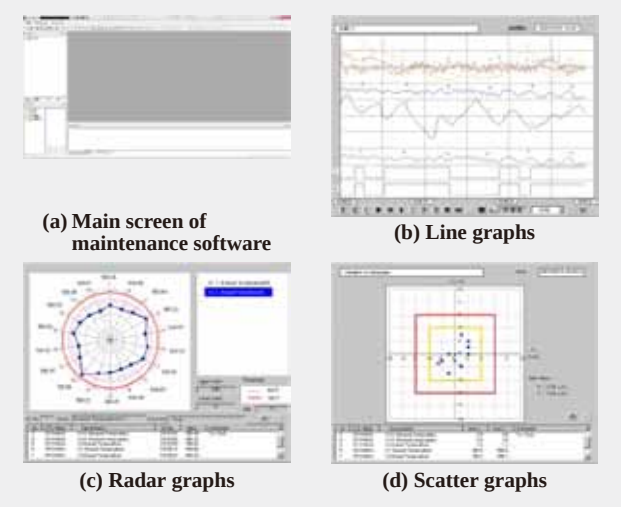


Fig. 3—Trend Graph Screens.
These are examples of the available trend graph screens.

(1) Adoption of latest GUI

The system uses a GUI (graphical user interface) similar to the Windows*1 interface with which users are familiar. It provides more intuitive operation as the system configuration, documents, and other information are displayed using a tree structure that allows users to see at a glance their overall structure and hierarchical arrangement.

(2) Enhanced trend graph function

The enhancements to the trend graph function as described below not only convey information about the status of the plant and control system more accurately, they also simplify tasks such as tuning control parameters during commissioning by presenting information more clearly.

(a) Larger number of values that can be trended and longer data collection time

(b) Added a function for collecting trend data at the timing interval used for control (20 ms to 500 ms) in addition to the 1-s trend.

(c) Three different display formats are available for different applications: line graphs (a standard feature in the previous version), radar graphs (used to display information such as flue gas temperature), and scatter

*1 Windows is a registered trademark of Microsoft Corporation in the United States and other countries.

graphs (used for purposes such as turbine shaft vibration monitoring).

(3) Enhanced help function

Troubleshooting is facilitated by a function that uses the help screens to check the reasons for errors and how to respond.

(4) Enhanced security

The following detailed security settings are available to provide more secure operation of the maintenance software.

(a) Separate password for each user.

(b) Access rights (such as limiting access to monitoring functions only) can be allocated independently to each user.

(c) Which control devices [APC (automatic plant control), etc.] each user can access

(5) Online software updates (under development)

As downloads can be performed selectively to only those controllers that required updating, software patches can be installed safely with the system online.

(6) Easy hot-swapping of I/O modules

TBs (terminal blocks) and I/O modules have been made completely independent of each other to make replacing I/O modules easier. As the current I/O modules have TBs attached to the panel, the external cables connected to the TBs need to be handled carefully when swapping modules. The new I/O modules, in contrast, have been designed so that they can be replaced without having to touch the external cables. The I/O modules are also easier to handle as they have been made fully enclosed and do not have any exposed live components.

(7) Prevention of incorrect insertion of I/O modules

When swapping a faulty I/O module, a model check is performed when the new I/O module is inserted to prevent insertion of the wrong I/O module.

(8) Monitoring device allows easy identification of faulty components in I/O communication link.

As a monitoring device can be used to identify any faulty components in the communication link between a controller and I/O module, fault-finding tasks that were required on the previous system, such as checking the ERR (error) LEDs (light emitting diodes) on each module in the panel, are now no longer needed.

Compatibility with Existing Systems

Compatibility with existing systems is an important factor for reducing the time required to conduct an upgrade. As the new controllers can connect to the old I/O, this allows partial upgrades that reuse older model I/O and existing external cables. This shortens the time required for the upgrade as it avoids the need for recabling and the associated retesting.

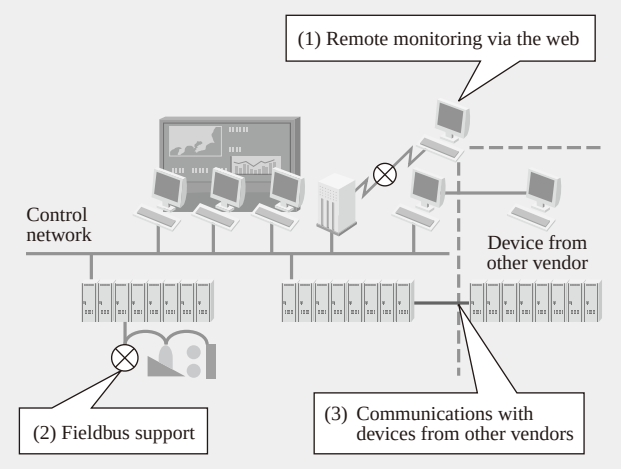


Fig. 4—Various Types of Network Connectivity Available with Next-generation HIACS.
Next-generation HIACS offers remote monitoring via the web, better support for international standards, and support for communications with devices from other vendors.

Easier Expansion

The next-generation HIACS supports connections to the different types of networks listed in (1) to (3) below to facilitate system expansion, including remote monitoring of the plant, use of Fieldbus, or system designs that incorporate other devices (see Fig. 4).

(1) Remote monitoring via web

The system supports remote monitoring via a web browser which means the plant status can be viewed from a remote office.

(2) Fieldbus support (under development)

As the system supports PROFIBUS[*2], HART (highway addressable remote transducer)[*3] protocol, and other Fieldbus implementations that are demanded by the global market, cabling costs can be reduced by using digital communications with on-site equipment.

(3) Communication with devices from other vendors

As the system supports OPC (object linking and embedding for process control)[*4], Modbus[*5], GSM [GEDS (GE drive system) standard message format], and other global standards for connecting to devices

*2 PROFIBUS is a registered trademark of the PROFIBUS User Organization.
*3 HART is a registered trademark of the HART Communication Foundation.
*4 OPC is a trademark of the OPC Foundation.
*5 Modbus is a trademark or registered trademark of Schneider Electric in France, the USA and other countries.

from other vendors, system designs that combine HIACS with devices from other vendors are possible.

High Performance

The next-generation HIACS is intended to improve the performance of its controllers, PCMs, control network, and I/O network, which contributes to superior control performance and reducing controller load ratios. In particular, the control network and I/O network are the fastest available for control applications and allow the implementation of large high-speed communication systems.

CONCLUSIONS

This article has described the features of the next-generation HIACS that were enhanced in the development.

The next-generation HIACS seeks to provide superior installation compatibility (compact and adaptable system) through a simplified panel design and better mounting design flexibility. In addition to making progress on supporting a wider range of networks and allowing for easier expansion, it is an easier system to use being designed for easier maintenance of both software and hardware.

Further work is planned on compliance with overseas standards including UL (Underwriters Laboratories) standards and the CE (Conformité Européenne) mark.

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