Control Station for the Integrated Control System MICREX-IX

Akira Nishikawa
Kouichi Sakagami
Tetsuo Koyama

1. Introduction

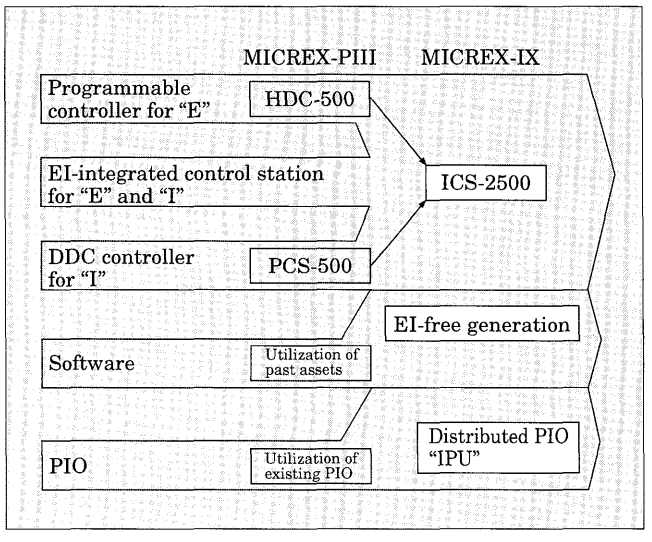
In recent years, the distributed control system has grown into an "EIC-integrated control system" and the controller into an "EI-integrated controller." The newly developed EI-integrated control station ICS-2500 has systematically unified electrical (E) control and instrumentation (I) control based on MICREX, and has realized true EI-integration with common hardware, software and engineering (see Fig. 1).

The ICS-2500 system is designed so that the performance ratio between loop control in "I" control and high-speed sequence control in "E" control may be set freely. In addition, previous application software may be used as it is, and load distribution and execution sequences may be set as desired using a newly developed EI-free scheduler.

Furthermore, the ICS-2500 has an optional fuzzy control function which provides equipment and plants, which have been difficult to automate, in the past, with a powerful and intelligent control station. And this enables the creation of an optimum system.

This paper introduces the control station's functions and features.

Fig. 1 Development of the EI-integrated control station



2. System Outline

2.1 Hardware

The hardware of the EI-integrated control station ICS-2500 is mounted in the dedicated cabinet (see Figs. 2 and 3). The hardware configuration has been simplified and compacted as compared with the former controller.

(1) Front power supply

The power source is the "front power supply" (see Fig. 4) and consists of AC (or DC) modules and DC-DC converter modules.

AC (or DC) modules can be arranged in a duplex configuration and operated by 2-system feeding (for example, 100V AC and 110V DC).

DC-DC converter modules convert the output of AC (or DC) modules into 24V DC, which is then supplied to the input terminal boards of each MPU shelf, the DPC (Distributed Process Communication) bypass units, the optical link units and the IPU. These DC-DC converter modules may be operated in parallel.

As described above, it is possible to accommodate varied power supply environments by utilizing a combination of power supply modules.

Furthermore, the ICS-2500 is equipped with highly advanced. Two function are elimination of distortion in the power supply waveform for both the rush currents control circuit and switching regulator, and maintenance of the output current as a sine wave.

(2) MPU (for control operation processing) shelf

Basic parts, such as an MPU board and a memory board, as well as a transmission board are mounted on the MPU shelf. Each board has adopted the MULTIBUSII*1 , which is a 32-bit international standard bus, in addition to the conventional architecture.

In previously duplicating the MPU, two shelves were necessary to mount the MICREX-PIII. Now, only one shelf is needed because the number of boards decreased due to a high-density mounting technology.

The MPU uses a 32-bit processor to execute sequence instructions at the minimum speed of 0.125 μ s.

*1 MULTIBUS II is a trademark of Intel Corp.

Fig. 2 EI-integrated control station ICS-2500

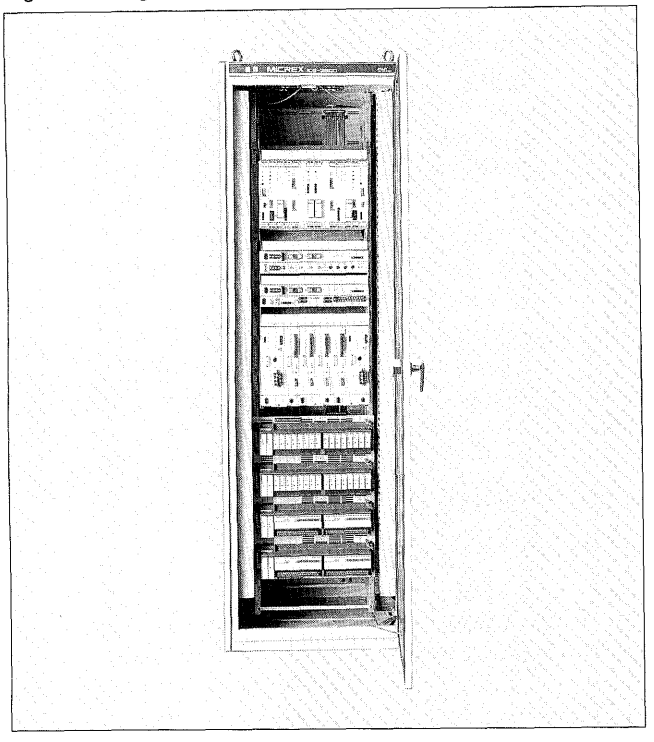
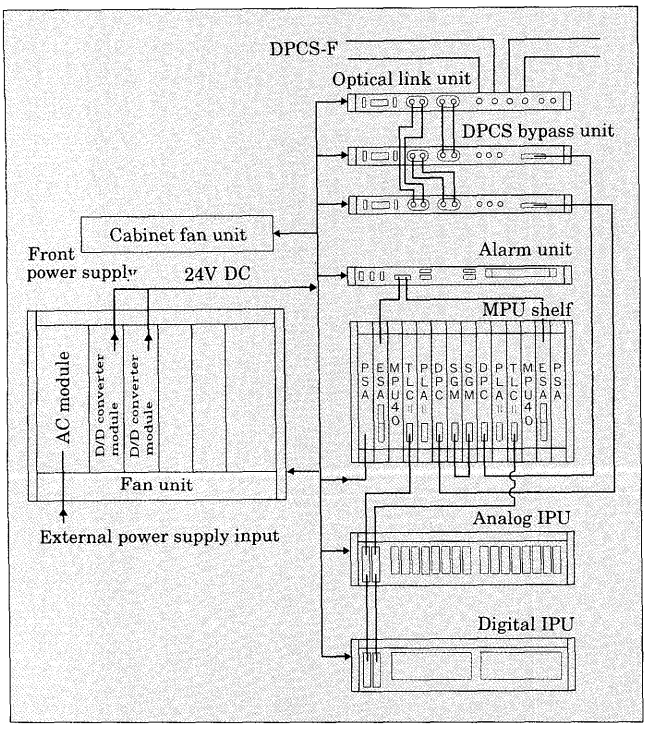
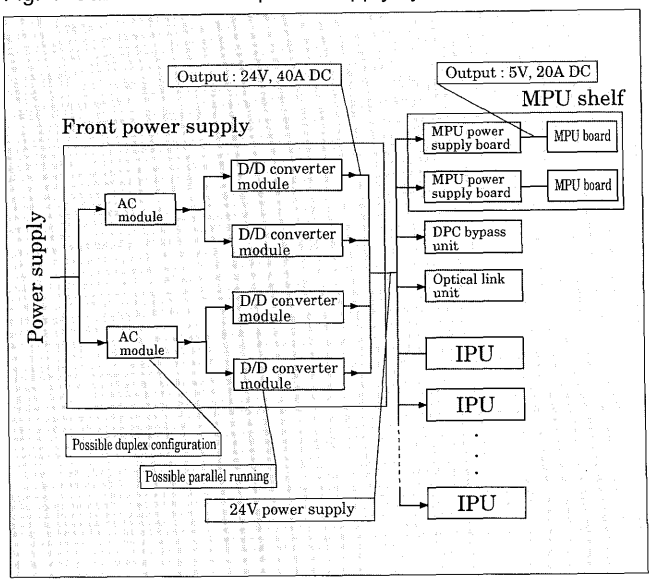


Fig. 3 Basic hardware configuration of the ICS-2500



The duplex system employs a "warm stand-by system" in which each basic unit of the master and a slave systems operates independently. The control data and the PIO input/output data of the basic unit of the master system are essential. To perform value equalization synchronized control, this data is always transmitted to the basic part of the slave system via the SGM (Sameness data Gathering Memory control), which has

Fig. 4 Cabinet interior of power supply system



an equalizing function for the duplex configuration.

In addition, this equalizing function can be used with application data.

(3) Process input/output unit (PIO)

When the ICS-2500 is used as an electrical control station, direct-coupled high-speed PIO boards mounted on the 19- or 24-inch MPU shelf execute line control, high-speed position control and motor control.

Also, an intelligent distributed PIO [IPU] connected through a T-link can be used by the ICS-2500. For further details on this IPU, refer to the report in this same volume titled, "I/O System for Integrated Control System MICREX-IX.".

(4) Transmission interface

The transmission interface can be connected to both a DPCS-F data way of 10M bits/sec by a DPC board and to two lines of DPCS-Fs by two mounted DPC boards. One line is connected to a man-machine interface (IOS-2500, IDS-2500) to transfer control data for setting and monitoring. The second line is connected to another system and can be used either for applications or as a gate way.

The transmission interface can also be connected by a PLA board to a P-link used for transmission between processors and to four P-links using four PLA boards. By using P-links it is possible to quickly connect several ICS-2500s to each other so that they function as a single controller. Integration with the MICREX-IX is achieved by connection of the MICREX-MS geared towards small to medium scale systems to the general purpose programmable controller (PC) MICREX-F, located in the setting equipment.

With the use of PLA II boards, the transmission interface can be connected to PE-links for transmission between processors with improved P-links, and using four PLAII boards, connection can be made to four P-links. PE-links can connect up to 64 stations, four times the number of stations connected by P-links.

Also, broadcast communication capacity has been tripled and its message data capacity is five times, or 500 words maximum. Furthermore, both master and slave systems of the MPU shelf operate on the same station number, broadcast and message communication data transmitted from other stations can be received, and data to other stations can be transmitted from the master system. Consequently, the application can be utilized without awareness of the duplex configulation.

2.2 EI control function

(1) Software execution management

Application programs are managed by μ-OS, which is a fast-response and high-performance OS executing "interrupt control, task control" and "execution processing" in parallel.

Application programs have five levels of priorities which μ-OS can simultaniously take into account during scheduling.

A frequentry used program is registered as a function module (FM) and utilized as a subroutine.

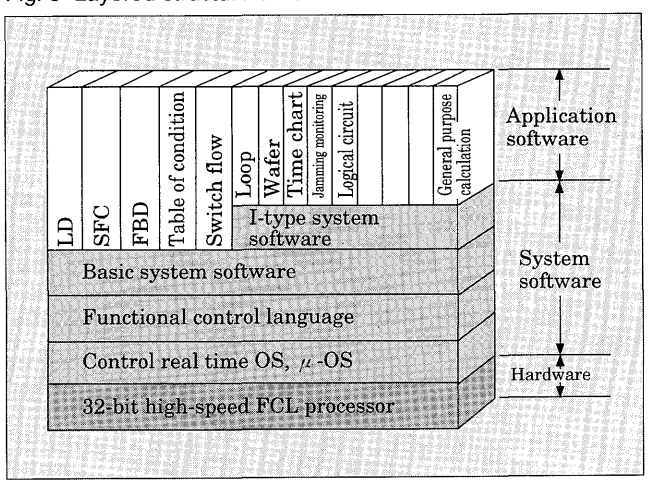
The ICS-2500 adopts FCL (Functional Control Language) as a control language, which permits description of various programs such as LD (Ladder Diagram), FBD (Function Block Diagram) and SFC (Sequential Function Chart). System software, instrumentation (I) type system software, and various package software realizing electrical and instrumentation control functions are all described in the FCL (see Fig. 5).

When I-type system software is mounted on the ICS-2500, the ICS-2500 operates as an "EI free type" or "I type."

In this operation, available I-control functions are time chart sequences, internal instruments of loop control functions, annunciators, analog upper/lower limit setters, switches, jamming monitoring, logical circuits, conditional data transfer counters, and so on.

The ICS-2500 operates as an "E type" high-speed electrical control PC when not mounted with I-type system software.

Fig. 5 Layered structure of ICS-2500's software



(2) EI free scheduler

The EI free scheduler permits the ICS-2500 to independently set the performance ratio and the execution order of the "E" and "I" controls. In addition, synchronized operation of ladder diagrams for electrical control and internal instruments for instrumentation control are possible, thus enhancing the adaptability of the control.

Ladder diagrams for electrical control and package software for instrumentation control are both prepared as FMs, of which 1,500 execution definitions can be registered. The registered FMs are allocated and executed as one control unit, and their execution cycles and phases are controlled. The control unit is referred to as a block diagram, and 50 of these diagrams can be registered. The block diagrams are allocated for use by plant equipment and working units.

3. Market Demands

Fuji Electric has delivered a number of MICREX controllers namely the PCS-500 and the HDC-500. The former is an EIC-integrated control system. With the increase in the number of delivered systems, many demands have been made to the company by customers. An outline of the improvements made in the ICS-2500 to meet these demands follows.

(1) Reduction of cabinets installation area

The number of cabinets was reduced from two

Fig. 6 Comparison of cabinet construction

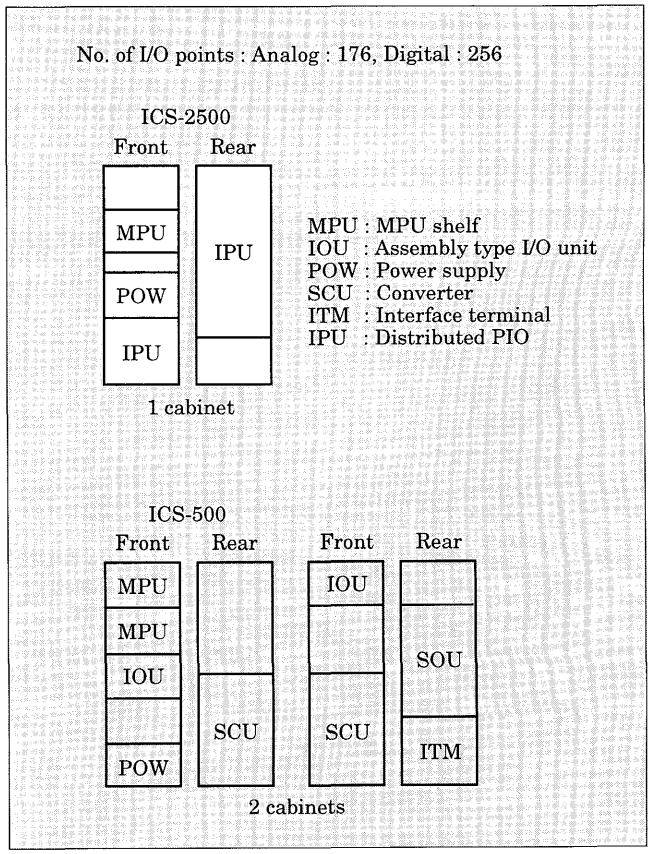
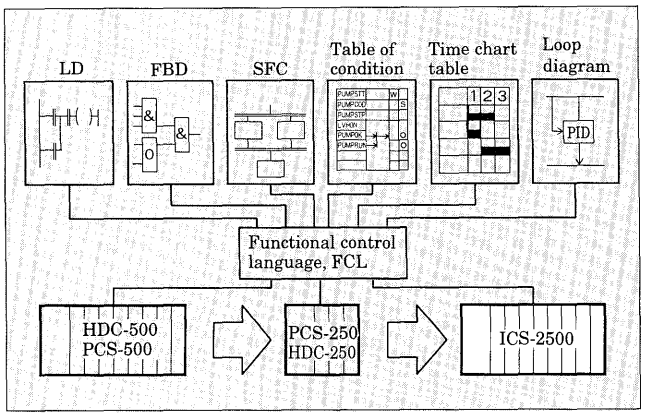


Fig. 7 Functional Control Language (FCL)



shelves to one by eliminating P/T-link adapters and adopting distributed PIOs [IPUs]. As a result, efficiency of the mounting spsce was increased .

For example, Figure 6 shows the cabinet configuration of the ICS-2500 and the PCS-500 with an analog input/output of 176 points and a digital input/output of 256 points. The installation area of the ICS-2500 was reduced to half of the PCS-500.

(2) Adoption of application software using field results

The ICS-2500 has adopted the FCL (Functional Control Language) used in existing MICREX systems.

FCL is an intermediate language, falling between a program described by diversified methods of expression and a machine language inherent to controllers. Examples of the former include LD, FBD, SFC, condition tables, time chart sequences and loop diagrams.

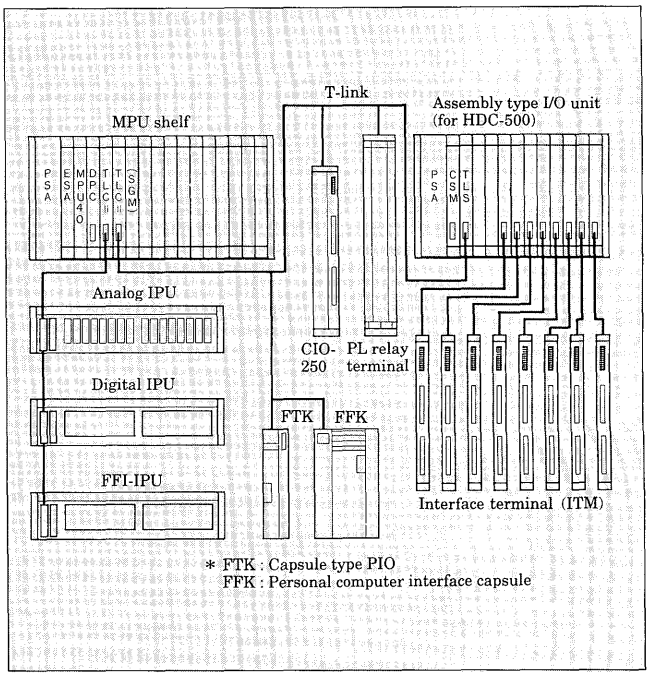
Since this FCL severs interdependence between the controller's hardware and software, software assets accumulated in the past can be utilized in porting software to different controllers as well as to the new generation of controllers (see Fig. 7).

(3) Connection of various PIOs for specific uses

A direct-coupled PIO mounted on the MPU shelf is suitable for high-speed electrical control, such as line control positioning.

By mounting a T-link transmission interface board (TLC II) for PIO transmission in addition to the direct-coupled PIO, various PIOs (such as IPU, IOU, CIO200, FTK, FTU and FFK) can be connected to a T-link transmission and used depending upon the application (see Fig. 8).

Fig. 8 Remote PIO system



When an IPU is used as a remote PIO in constructing a duplex system, a highly reliable system which duplicates both a basic unit of the ICS-2500 and a T-link connected to a remote PIO can be obtained.

(4) Faciliated maintenance and reduction of spare parts

Because the basic hardware of the ICS-2500 is commonly used in "E", "I" and "EI" controls, problems in hardware maintenance were reduced. Also because of their common use, spare parts for the basic hardware were reduced in kind and number.

4. Conclusion

The basic architecture of the ICS-2500 has superior expansibility in taking future technical developments into account. Its connection to a fieldbus, its link to varied networks and its supported systems will hereafter be provided . Fuji Electric is determined to continue improving application packages for various applications, development support systems and advanced control technology.