1. Introduction

Automation systems are evolving as they are supported by product technology for a wide variety of control devices, such as programmable controllers (PLCs), programmable operation displays (PODs), inverters, servo systems and various sensors. Since these control devices have increased their network connection capabilities in recent years, automation systems are now able to construct up to large-scale distributed systems using general-purpose control devices. Meanwhile, with the performance improvement of these individual devices, their application is being developed to different fields than in the past.

Under these circumstances, improved reliability, improved development efficiency, shorter development time span, multi-functionality and lower cost are also being sought for the development of automation system devices.

This paper describes the latest product technologies of programmable control equipment fields, as well as the technological trends and application.

2. Technical Trends of Automation Systems

2.1 PLC technical trends

(1) Efforts toward achieving high-reliability systems

Higher reliability is requested of the PLCs used in automation systems so that even if a partial system failure occurs, system control will be maintained and continued to keep ensuring the system operation from shutting down.

Ever since its debut, the MICREX-SX series of integrated controllers has been provided with redundant power supply modules and CPU modules to realize high-reliability systems. Table 1 lists the MICREX-SX CPU series lineup.

The SPH2000-256H of CPU module has been newly released as the latest model of the SPH2000 series enabling the realization of a system handling large amounts of data. The characteristic feature of this model is stronger redundant functionality through

<table>
<thead>
<tr>
<th>Series name</th>
<th>Type of shape</th>
<th>CPU series name</th>
<th>Features</th>
<th>Corresponding program capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>MICREX-SX</td>
<td>Building block</td>
<td>SPH200</td>
<td>Low price products</td>
<td>2 k 4 k 8 k 16 k 32 k 48 k 74 k 117 k 245 k 256 k</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPH300</td>
<td>Highest CPU performance</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPH300EX</td>
<td>Equipped with 2 high-performance CPUs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPH2000</td>
<td>Equipped with Ethernet in standard</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Board</td>
<td>FBC-2000</td>
<td>Onboard SPH2000 functions and performance</td>
<td></td>
</tr>
<tr>
<td>SPB</td>
<td>Block</td>
<td>20 I/O basic unit</td>
<td>Compact integration with CPU, I/O &amp; power supply</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 I/O basic unit</td>
<td>Compact integration with CPU, I/O &amp; power supply</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>40 I/O basic unit</td>
<td>Compact integration with CPU, I/O &amp; power supply</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>60 I/O basic unit</td>
<td>Compact integration with CPU, I/O &amp; power supply</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Board</td>
<td>FBC-SPB</td>
<td>SPB CPU board equipped with RS-485 communication capability in standard</td>
<td></td>
</tr>
</tbody>
</table>

*The SPB program capacity is the value in SX mode (IEC language) operation.
larger capacity of equalized data among CPUs and high-speed data equalization. By using Ethernet*1 port as a dedicated equalization bus, which is a standard feature of the CPU module, an equalization data capacity of 320 kwords, which is 40 times larger than before, and an equalization data transfer speed that is 4 to 26 times faster than before are realized. This high-speed and large capacity equalization bus enables compact flash (CF) card data equalization and function block (FB) instance equalization, which have not been realized in the past. Therefore automation systems can be constructed with even higher reliability.

The features are listed below:

- A maximum of 320 kwords can be equalized
- FB instance equalization and CF equalization are possible
- The CPU can be replaced during the operation with hot-plug base board.

*1: Ethernet is a registered trademark of Fuji Xerox Co., Ltd. in Japan.

<table>
<thead>
<tr>
<th>Table 2 Comparison of SPH redundancy capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPH2000-256H Redundant CPU</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Maximum equalization capacity</td>
</tr>
<tr>
<td>Equalization performance</td>
</tr>
<tr>
<td>Equalization bus</td>
</tr>
</tbody>
</table>

(2) Network technology

The network connectivity of a PLC is requested in all hierarchical levels, i.e., the plant level, controller level and device level. (See Fig. 1.)

Under these circumstances, Ethernet and Ethernet-based network technology applications to automation systems are rapidly being advanced. A characteristic feature of such applications is implementation of a protocol suitable for both the data processing and automation control applications on an Ethernet, which is realization of industry use of an Ethernet. (See Fig. 2.)

The MICREX-SX series supports an Ethernet and other various open networks with dedicated communication modules. So that the systems ranging from small-scale process control systems to large-scale hierarchical distributed systems can be constructed.

Adapting to such the network trends as above, the SPH2000 series is equipped with an Ethernet port as a standard feature. Furthermore, various network functions shown in Figs. 3 to 5 were released in 2007.

(3) Deployment of PLC technology to built-in control devices

In recent years, applications of PLC-based automation systems have been increasing toward built-in applications for machines and process equipment.

Previously, it was commonplace for a built-in controller to be developed with a dedicated control board and a custom built-in software. Such a method was in the mainstream because, under these conditions, the controller had to utilize the available hardware resources (processing capability, memory capacity and the like) to the maximum extent in order to satisfy the specific requirement for control devices. Moreover, C language was commonly used in the development of the software, and assembly language was also used in products that sought even higher performance.

Meanwhile, as development constraint for electronic devices, various electronic parts are being discontinued at an accelerating pace in order to increase performance and environmental friendliness of the materials used. As a result, conditions are occurring that compel the redevelopment of hardware and software controllers for built-in control devices. As electronic parts are expected to be discontinued at increasingly shorter cycle times in the future, countermeasures will be needed in order to ensure a future stable supply of electronic devices which ensure the same specifications as existing one.

In response to such change of constraint, in some fields where custom built-in controllers had been developed, a trend has emerged in recent years that general-
purpose PLCs which have been improved their computing capability are replacing such custom controller.

A major reason for this trend is to have guaranteed more than 10 years for the supply period of the product in the case of a PLC. Even if electronic components are discontinued during this time, hardware with same specifications should be guaranteed by the PLC supplier, and therefore, the OEMs of a built-in controller do not take on any hardware procurement risk.

Another reason for this trend is the maintainability of the software. The PLC software development environment is adequate as long as dedicated programming software can run on a PC and a communication cable linking the PC and PLC are available. Comparing with the custom controller, there is no need to prepare custom development software corresponding to each installed microprocessor or custom type debugging equipment such as an ICE (in circuit emulator). Moreover, since the PLC development equipment is lightweight, software debugging and revising at the on-site location where the controller is installed, software analysis and revision in the case of malfunction, and so on can be performed easily. For the following reasons, the PLC programming language presents a low barrier for the developer of custom controller software to migrate towards the use of a PLC.

- A conventional ladder diagram language
- Structured programming of Data and program conforming to the international standard IEC language
- ST (structured text) language suitable for control programming than C language can be used

In response to these requests, board-type controllers that are smaller and thinner than a PLC but that still maintain the functions, performance and ease of use of PLCs based on the MICREX-SX series are also being developed in Fuji Electric’s PLC product line.

The FBC (Fuji-board controller) -SPB based on the MICREX SX SPB series and the FBC-2000 based on the SPH2000 of the MICREX-SX SPH series are available as board type controllers. As well as the module type SPH2000 series, the FBC-2000 is also equipped with an Ethernet port and a compact flash memory slot. Moreover, since the FBC-2000 board is equipped with a standard SX bus, various MICREX-SX series modules, inverters, servo systems, PODs and the like equipped with an SX bus can be connected as needed, so that they enable a flexible and expandable system construction.

(4) Deployment in the motion control field

Accompanying the recently increasing CPU performance of PLCs and the improved data communication performance of servo amplifiers and other control devices, the conventional implementation of motion control by a custom controller is being replaced by PLC-based systems in an increasing number of instances. In particular, in the case where a multi-axis control device is applied to a large printing press or the like that had previously been synchronized mechanically, synchronous control can be implemented in the same manner as before by electronic multi-axis control provided by servo motors networked with a PLC which are directly coupled to the control axis. This method has many characteristic features: mechanical adjustments are unnecessary, structural machine changes are easily implemented, machine operation specification changes can be realized by the software only, and the machine cost can be reduced. Controllers capable of supporting this multi-axis motion control require even greater capability, such as multi-axis synchronization, high-speed computation, high-speed data exchange performance, and the like.

For this type of multi-axis motion control, Fuji Electric provides the SPH300EX as a CPU module of the MICREX-SX series. The SPH300EX module contains two processing cores of the SPH300 series’ CPU module, which have the highest computing capacity in
the series, and thus the computing capacity and I/O area increased by a factor of two. These enable the efficient system construction that meets the demands of the motion control field.

(5) Packaged machine controller products

Fuji Electric provides a multi-axis motion control system consisting of the MICREX-SX series equipped with a built-in motion control program and the POD equipped with a built-in custom numeric control (NC) program editing screen. This multi-axis motion control system is known as “Simple NC.” By packaging the hardware and software required for NC into these products, machine set OEMs can easily realize NC-based motion control by installing the Simple NC (Fig. 6). A functional aspect of this system is that instead of NC programming using the standard G-code for the NC system, the programming can be implemented graphically by operations on the POD screen. These products enable machine set OEMs and end users to perform flexible machine control and machine operations.

We expect to expand PLCs as well as the application of these products to the motion control field in the future.

(6) New functions for development support

In recent automation systems, sophisticated control systems are often constructed using an Ethernet network. In these cases, there is demand for functions that enable program development and device maintenance via the network from the remote network-connected devices.

In response to this demand, a transparent communication function have been newly provided for the CPU module SPH300 series and the SPH2000 series of the MICREX-SX series.

In the case of the MICREX-SX series, control devices such as an inverter, servo amplifier, POD and the like can be connected to the SX bus which is the main bus. Although the tasks of setting and adjusting numerous control parameters as well as programming are necessary for these control devices, custom support tools for each device were individually connected to perform such tasks in the past.

With the newly developed transparent communication function, however, the CPU module of the MICREX-SX series serves as a relay router for the SX bus to communication interface modules (RS-422, USB and Ethernet) or Ethernet port of CPU module. Thus, the control devices connected to the SX bus can be operated remotely, thereby enabling significant improvements in development efficiency and maintainability.

On the foundation of this transparent communication function, an integrated support environment was realized for the control devices, including the MICREX-SX series. As a next step, Fuji Electric is working to integrate the support tools for the various control devices, and to develop integrated support tools for realizing more efficient and higher quality development for the entire control system.

2.2 Technical trends of PODs

The POD in an automation system is an essential device for interfacing with the operator. With recent advances in peripheral device technology, the display expressiveness, data processing capability, network connectivity and so on of PODs have been strengthened considerably.

Under these circumstances, the MONITOUCH V8 series has been added to the main MONITOUCH series. Table 3 lists the product lineup of the MONITOUCH V8 series.

With the MONITOUCH V8 series, communication and network performance have been improved with an 8-way communication function, drawing performance has been improved significantly, and external interface functions have been extended. The product lineup contains many models having different screen sizes, drawing capacities and external interface functions in order to support various user needs.

Moreover, in recent years PLCs have increasingly been applied to such instrumentation systems for instance plant control systems which have conventionally been realized by distributed control systems (DCS). An instrumentation system requires a POD to display the monitoring data. However, in order to display many

![Fig.6 Application of simple NC](image)

<table>
<thead>
<tr>
<th>Model</th>
<th>Type</th>
<th>6-inch (screen size)</th>
<th>8-inch</th>
<th>10-inch</th>
<th>12-inch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>STN monochrome</td>
<td>STN color</td>
<td>TFT color</td>
<td>TFT color</td>
</tr>
<tr>
<td>High performance</td>
<td>Full spec</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>V808iS</td>
</tr>
<tr>
<td></td>
<td>Basic</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>V808S</td>
</tr>
<tr>
<td>Standard</td>
<td>Full spec</td>
<td>V806iMD</td>
<td>V806iCD</td>
<td>V806iTD</td>
<td>V808iC</td>
</tr>
<tr>
<td></td>
<td>Basic</td>
<td>V806MD</td>
<td>V806CD</td>
<td>V806TD</td>
<td>V808C</td>
</tr>
</tbody>
</table>
types of data monitored on a POD screen by a PLC, a large effort is required to develop PLC software and to create the POD screen linked to them.

To resolve this problem, Fuji Electric has recently released an “SX instrumentation package” that combines the CPU module of the MICREX-SX SPH2000 series for the PLC, and a UG30 (MONITOUCH V7) series for the POD. A feature of this product is that the POD display screen corresponding to the FB will be generated automatically by simply using the instrumentation FB of the “Expert” development support tool to specify the data to be displayed on the POD, and then activating a data linking tool. The automatically generated POD screen is known as a face plate (FP), and the FPs are provided as well as instrumentation FBs in a library format.

This function not only makes the development of PLC control software and the POD screen more efficient but also simplifies the user task of debugging the POD screen and PLC control software. Therefore it enables a significant reduction in the time required for system development.

3. Postscript

The latest technology used in Fuji Electric’s automation system devices and the target application fields have been discussed above. The application fields are expected to expand as the performance and multi-functionality of individual devices continue to improve in the future. In particular, since the evolution of network technology is predicted to accelerate in the future, even higher technical development capabilities will be needed.

As a comprehensive manufacturer of automation system devices, Fuji Electric intends to continue to provide latest-technology products in order to meet the needs of our customers.
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