Development of Industrial PC "SMAC-PC" and "S-MAC" Components

Shigeki Satou Hiroshi Okino Hiroshi Yoshikawa

1. Introduction

Following the "FA open architecture declaration" in November 1996, we have developed "S-MAC" system to provide a FA total solution. In June 1998, we started receiving orders. In order to optimize "S-MAC" system, we have also started developing the main components as well. To promote the open architecture, we have been marketing the main components of "S-MAC" system since October 1998.

This paper introduces the development concept of "S-MAC" components and the key components of Industrial PC "S-MAC PC" system. "SMS-10" of "S-MAC PC" series is explained in some detail along with some specific examples of application.

2. "S-MAC" Components

In general, an FA intelligent system requires the components or elements marked Ⓐ to Ⓖ in the hierarchy shown in Fig. 2.1.

Sanyo Denki has developed various components providing a total solution to facilitate the integration of customers' systems.

To create an FA intelligent system, the 4th and 5th levels of the CIM hierarchy mainly utilize:

Ⓐ factory control systems such as production control systems
Ⓑ assistant software for shop layer control, especially languages for motion description and sequence description

while the 2nd and 3rd levels mainly utilize:

Ⓒ industrial personal computers (PCs) for real-time operations
Ⓓ software or firmware capable of real-time operations such as motion cards and motion software

the 1st and 2nd levels mainly utilize:

Ⓔ open (hardware and software) communication interfaces for motion networks
Ⓕ various drivers supporting motion networks, such as SERCOS and DeviceNet
Ⓖ various motors and sensors (rotation type or linear type) connected to the open architecture drivers

In the remainder of this section, we introduce the specific products corresponding to each of Sanyo Denki's "S-MAC" components.

Component Ⓐ products are customer-specific and thus will not be covered in this paper.

Component Ⓑ products are mainly:

(a) object-oriented (such as electronic shaft and electronic cam) synchronizing control motion language, AML, for which both development and runtime are available (see Fig. 2.2)
(b) The "Code System" used to develop robots, using 3D simulation programs

Component Ⓒ products are so-called FA PCs. Sanyo Denki has individually

developed "S-MAC PC" series as a part of "S-MAC" components. "SMS-10" model (see Fig. 2.3) can be installed with SERCOS execution routines as a standard feature. Sections 3 and 4 discuss the features and applications of "SMS-10".

Component Ⓓ products are motion control circuit boards available from various manufacturers. "SMS-10", which can be installed with "AML" execution routines ("AMS" runtimes), does not require this circuit board because the corresponding function is provided by software.

Component Ⓔ products of Sanyo Denki currently support SERCOS and DeviceNet of the open motion networks. Especially for SERCOS, three types of communication interface cards (see Fig. 2.4) are available (PC/104 type, PC-AT1/2 type and PCI type).

A component Ⓕ product had already been on the market as a driver with open network support (see Fig. 2.6). We have added this product to "S-MAC" series while developing new "PQ" multi-axis AC amplifiers (see Fig. 2.5)to make "S-MAC" components even more complete. This environment simplifies the process of system integration for customers while allowing the customers to choose between products, thus leading to truly open architecture systems.

Furthermore, "PQ" series supports DI/DO as a standard feature, thus greatly simplifying the system configuration in cooperation with the PLC function of "AML" software.

As for DeviceNet, drivers such as "PU", "PM" and "ROBUSTSYN" have been developed, allowing customers to choose between motors more freely (see Fig. 2.7).

As component Ⓖ products, we are planning to add "S" series and "Hyperlinear" series motors to "S-MAC" components in addition to "P" series motors, thus increasing the number of possible configurations (see Fig. 2.8).

Fig. 2.9 illustrates where "S-MAC" components fit into an actual FA intelligent system.

As shown in Fig. 2.10, "S-MAC" components are designed to connect with the upper layer, the lower layer and the same-level layer in the hierarchy. This design eliminates redundancy in the system without restricting choice, thus optimizing the system without compromising freedom of choice.

3. Development of Industrial PC "S-MAC PC"

3.1 Concepts in developing "S-MAC PC"

The concept in developing "S-MAC PC" is clear from its market position illustrated in Fig. 3.1. "S-MAC PC" is an industrial personal computer (PC) whose environment resistance characteristics have been improved without compromising its low costs, by limiting its functions to use only as "S-MAC" components. Limiting its functions does not mean loss of flexibility, as shown in Fig 3.2. Due to its improved network communication interface with the upper and lower layers, its range of application is broader than that of general-purpose FA PCs.

The software functions installed in each of the cases A to H are listed below. More specific cases of systems will be discussed in the following section.

A. Full-software controller
   when "AML" execution routines are installed (use as "S-MAC" Type C target PC)
B. PC NC
   when a PC104-type motion card is installed
C. DeviceNet master
   when a DeviceNet communication I/F is installed
D. PC PLC
   when software PLCs such as ISaGRAF are installed

E. Cell controller
when used as an FMS or FMC controller
F. Image processing
when image processing control software is installed
G. Measurements using PC
when an A/D conversion board and data acquisition software are installed
H. Control using PC
when used as a process control PC taking advantage of its real-time processing abilities
I. Dedicated 3D Controller
when the CODE system is installed (used as "S-MAC" Type A target PC)

We have developed "SMS-10" as a part of "S-MAC PC" series, which will be discussed in the following subsection.

3.2 "SMS-10" Basic Configuration

3.2.1 Hardware

Fig. 3.3 illustrates an example of the configuration of "SMS-10".

We have avoided using parts with rotating mechanisms in "SMS-10", opting for vibration- and shock-resistant CompactFlash instead of a hard disk, while the CPU is naturally cooled only by a heat sink.

Reliability has been further improved by such functions as a watchdog timer and optional error-free memory, referred to as Reliability, Availability, Serviceability (RAS) functions.

As a networking environment, an Ethernet interface is provided as standard, while PC/104 module interfaces are provided as standard to connect to other networks. With an optional PCMCIA module, various PC cards can be used.

The outline of each configuration parts are listed below.

(a) CPU module (see Fig. 3.4)
(1) Ethernet interface (NE2000 compatible) on-board
(2) upgradable to 32MB EDO DRAM
supports error-free memory
(3) IDE hard disk interface on-board
(4) 2 serial interface ports
(RS-232/422/485 x 1ch, RS-232 x 1ch)
(5) digital I/O (4 inputs, 4 outputs, TTL compatible)
(6) PC/AT compatible keyboard interface
(7) 5V single power source

(b) RAS module (see Fig. 3.5)
(1) PC/104 interface expansion connector on-board
(2) watchdog timer circuit on-board
(3) digital I/O (2 isolated inputs, 2 isolated outputs)

(c) SERCOS I/F module (see Fig. 3.6)
(1) optical fiber interface conforming with IEC61491 (SERCOS) standard
(2) 2Mbps or 4Mbps communication rate

(d) PCMCIA module (see Fig. 3.7)
(1) conforms with PCMCIA v. 2.10 and JEIDA v. 4.1
(2) can contain two Type I/II PC cards or one Type III PC card

(e) Encoder module (see Fig. 3.8)
(1) counter for 32-bit encoder on-board
(2) 90-degree phase A/B signal
connected with line driver or open collector
(3) digital I/O
position latch signal, 4 isolated inputs, 4 isolated outputs

(f) DI/DO module (see Fig. 3.9)

(1) 24 inputs and outputs, TTL compatible
(2) simulates 8255PPI mode (port C0 cannot be separated)
(g) VGA module (see Fig. 3.10)
(1) CHIPS65535 chip
(2) VGA (640x480 pixels) 256 colors
(h) DeviceNet module (see Fig. 3.11)
(1) 5-pin CAN connector (DeviceNet compatible)
(2) network status 2-color LED
(3) 16KB shared memory on-board (for interface with the host)
(4) 125K, 250K, 500Kbps transfer rates
(i) Motion module (see Fig 3.12)
(1) optical fiber interface conforming with IEC61491 (SERCOS) standard
(2) 2Mbps or 4Mbps communication rate
(3) DSP for motion control on-board
(4) C programming environment with C function library (over 250 types) available
(j) Storage device (see Fig. 3.13)
(1) CompactFlash (15 to 45MB) or HDD (2.5" IDE Harddisk)

3.2.2 "SMS-10" Basic Specifications

Table 3.1 illustrates the basic specifications of "SMS-10". Table 3.2 illustrates the general specifications of "SMS-10".

3.2.3 Software

Because "S-MAC PC" is functionally PC/AT compatible, various applications are possible. It is also a key component of Sanyo Denki's total solution when used as a runtime application of AML (for details, see SANYO DENKI Technical Report No. 5, May-1998, Harada et al., "Application of S-MAC TYPE C").

AML is an application for iRMX (Radysis RTOS). Therefore, the "iRMX version" allows use of AML.

A VxWorks version and WindowsNT version are also available, because AML is currently being modified to run on both VxWorks (WindRiver RTOS) and RTX/WindowsNT (VentureCom RTOS).

3.2.4 Panel Example

Fig. 3.14 illustrates an example of the panel layout on "SMS-10". In this case, the panel contains the CPU, RAS, PCMCIA, SERCOS I/F, Encoder, DI/DO and VGA modules.

---

4. Application Examples of "S-MAC PC"

4.1 Application to Food Packaging Machine

In Fig. 4.1, "S-MAC PC" is applied to a food packaging machine as an FA intelligent system.

"S-MAC PC" executes a program written in the AML control language to act as a device controller. It is connected to the servo amplifier via the SERCOS network. To exchange simple parameters, a commercially-available intelligent display is connected via RS-232C as a human machine interface (HMI). Since "S-MAC PC" comes standard with an Ethernet interface, connection to LAN is simple. A LAN connection may be used for such tasks as production control.

4.2 Application to Printing Machine

In Fig. 4.2, "S-MAC PC" is applied to a printing machine.

"S-MAC PC" executes a program written using the AML control language to act as a device controller. To exchange complex parameters and data, a commercially-

available panel computer is connected via RS-232C as an HMI. The LAN is accessible through the panel computer and may be used for such tasks as production control.

4.3 Application to Wire Winding Machine

In Fig. 4.3, "S-MAC PC" is applied to a wire winding machine.

In this case, two "S-MAC PCs" are utilized, one executes a program written in the AML control language to act as a device controller, and the other acts as an HMI controller. The HMI "S-MAC PC" has a VGA to display information on the panel display. By using two "S-MAC PCs" the system does not need a hard disk.

5. Conclusion

In this paper, we have discussed various key elements in creating an FA intelligent system, focusing on Sanyo Denki's product groups. "S-MAC PC", a key component in "S-MAC" components, has been described in detail along with detailed specifications and applications of "SMS-10".

Because the architecture of each component is open, our components may be utilized in combination with products from other domestic or overseas manufacturers. We hope this paper will help customers develop their systems.

* Names of companies, products, and registered trade marks are those of the respective companies.

Shigeki Satou
Joined company in 1984.
Servo Systems Division, Control System Dept.
Worked on the development of the S-MAC system.

Hiroshi Okino
Joined company in 1996.
Servo Systems Division, Control System Dept.
Worked on the development of controllers.

Hiroshi Yoshikawa
Joined company in 1996.
Servo Systems Division, Control System Dept.
Worked on the development of controllers.

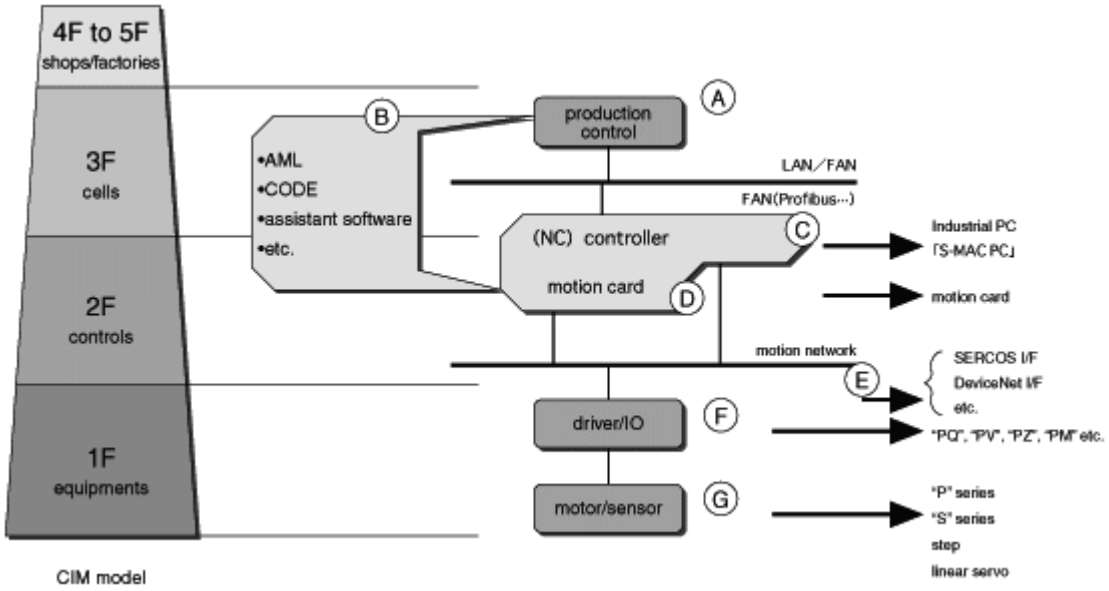

Fig. 2.1 CIM hierarchy and "S-MAC" components

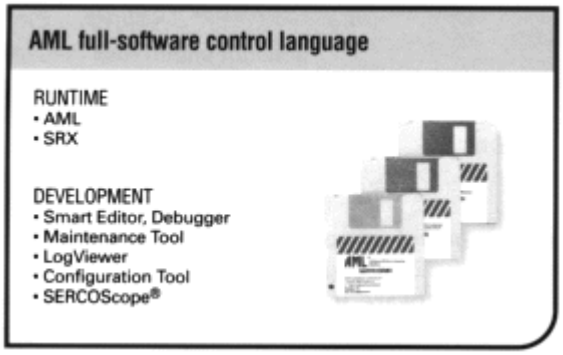

Fig. 2.2 "AML" full-software control language

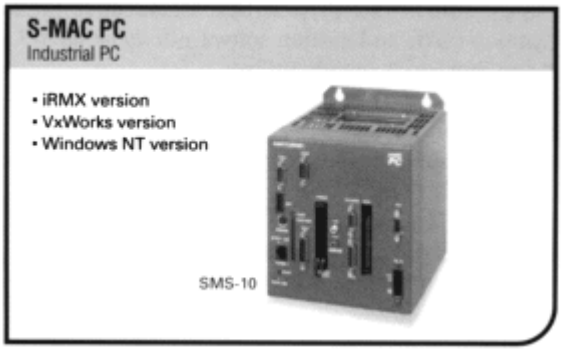

Fig. 2.3 Industrial PC "S-MAC PC"

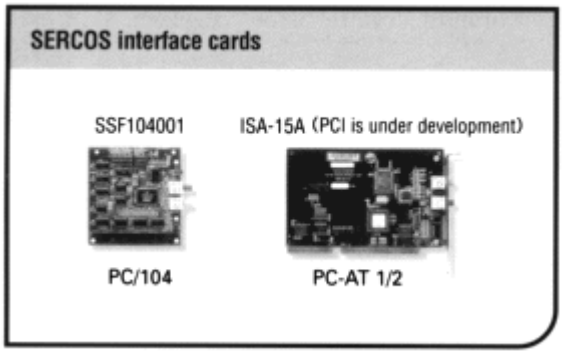

Fig. 2.4 SERCOS interface cards

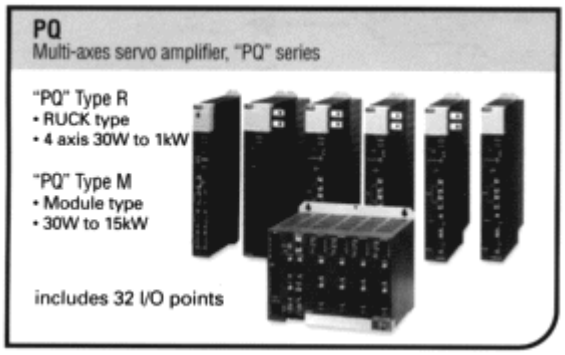

Fig. 2.5 Multi-axis servo amplifier, "PQ" series

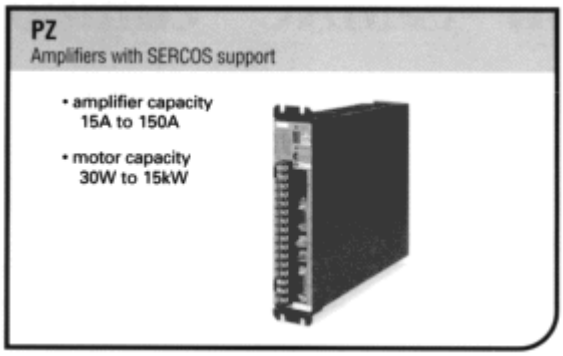

Fig. 2.6 "PZ" amplifier with SERCOS support

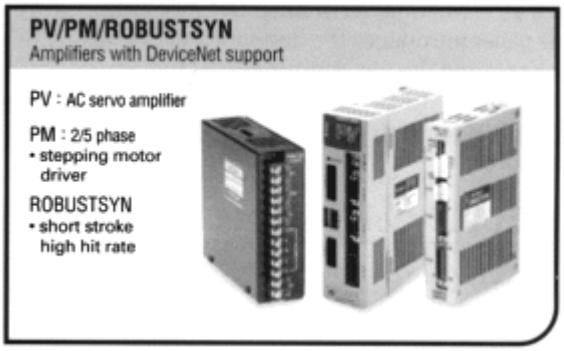

Fig. 2.7 Amplifiers with DeviceNet support

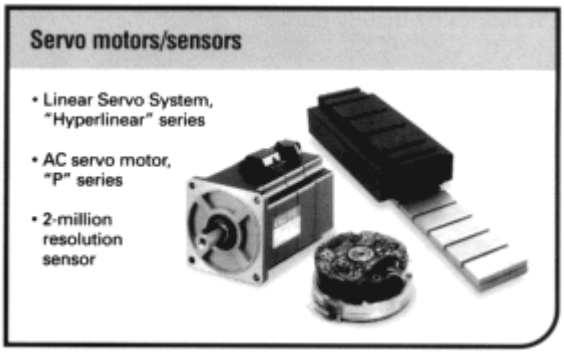

Fig. 2.8 Servo motors and sensors

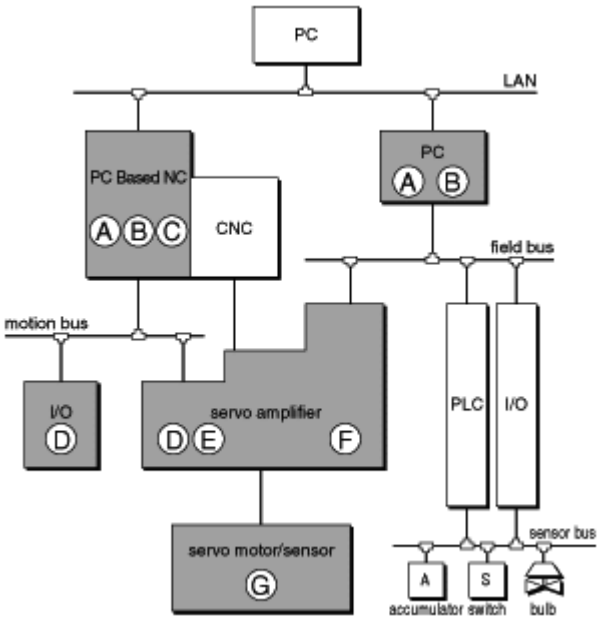

Fig. 2.9 Example of installation in an actual system

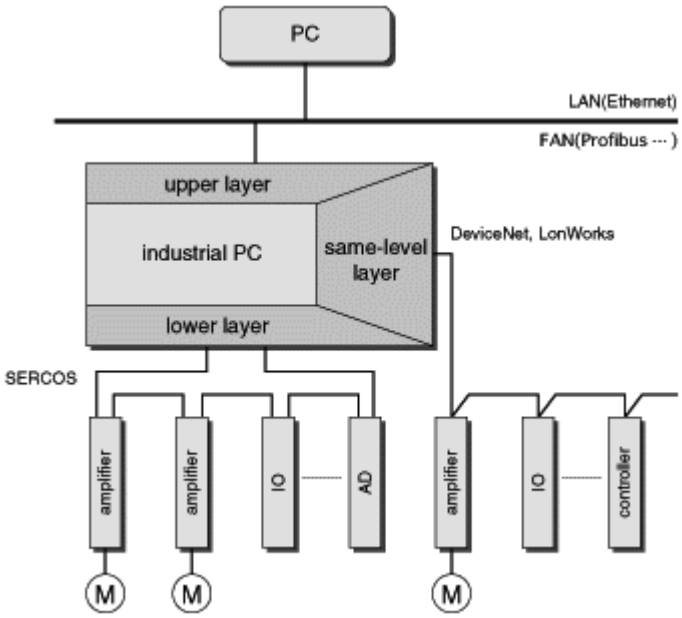

Fig. 2.10 Design concept of "S-MAC" components (for "S-MAC PC")

Table 3.1 Basic specifications of "SMS-10"

Basic specifications	
CPU	Am5x86-P75/133MHz
BIOS	made by AWARD
Main memory	16MB to 32MB
	72-pin SIMM socket×1
	error-free memory (optional)
Storage	CompactFlash (15MB to 45MB)
	HDD (optional)
Serial	COM1:RS-232×1
	COM2:RS-232/422/485×1
Keyboard	MINI DIN 6-pin
Ethernet	10Base-T (RJ-45)
	Chipset: Realtek RTL8019
I/O	4 inputs, 4 outputs (TTL compatible)
	2 insulated inputs, 2 insulated outputs
Expansion interface	PC/104 interface (up to 5 modules)
RAS functions	watchdog timer,etc.

Table 3.2 General specifications of "SMS-10"

General specifications	
Voltage requirement	DC4.75 to 5.25V
Temperature	0 to 50℃ (operating)
	-10 to 60℃ (non-operating)
Humidity	20 to 90% (operating, no condensation)
	90% or less (non-operating, no condensation)
Vibration	4.9m/s^2 (operating) 9.8m/s^2 (non-operating)
Shock	98m/s^2 (non-operating)

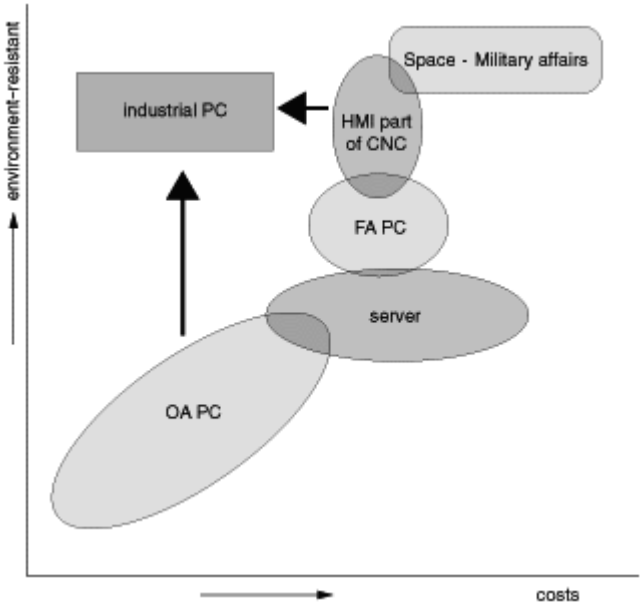

Fig. 3.1 Product position

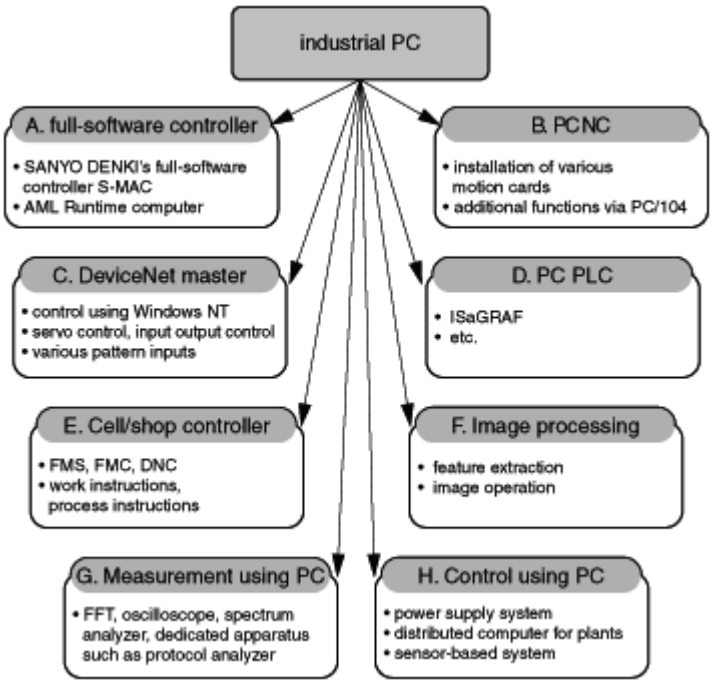

Fig. 3.2 Application examples

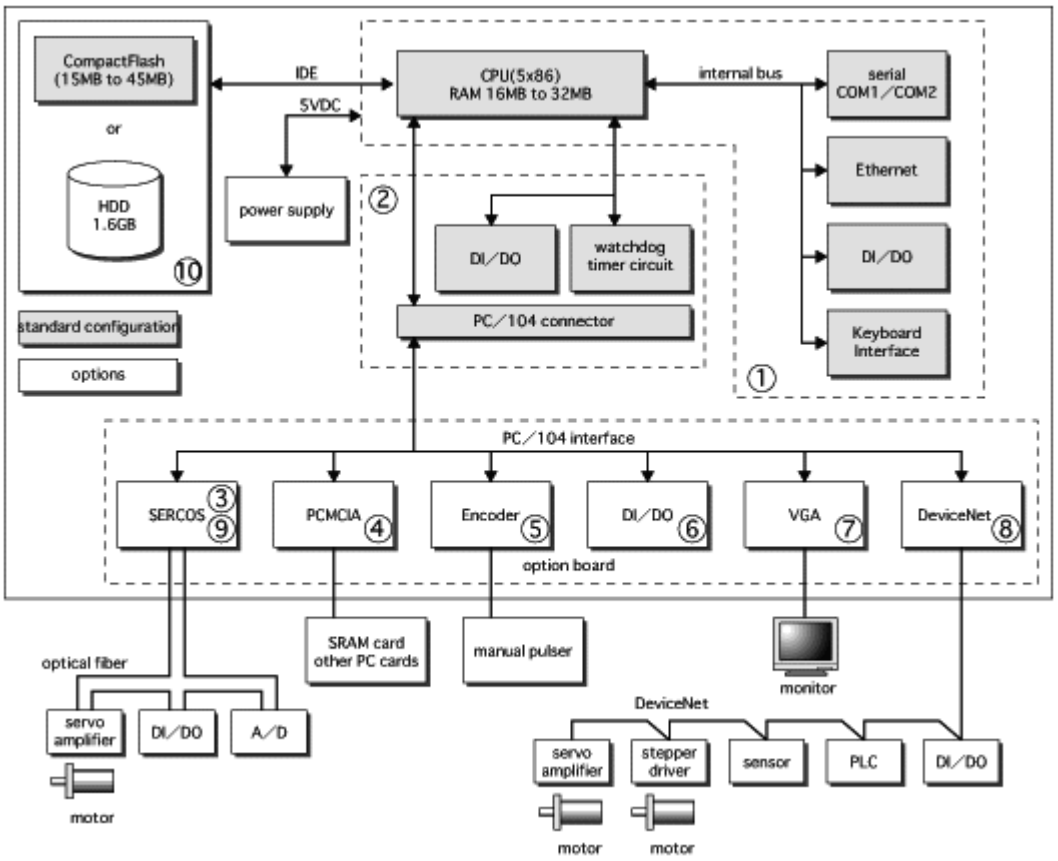

Fig. 3.3 Example of "SMS-10" configuration

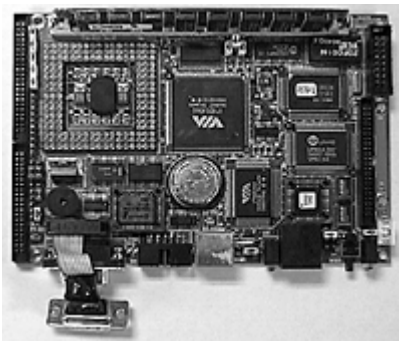

Fig. 3.4 External appearance of CPU module

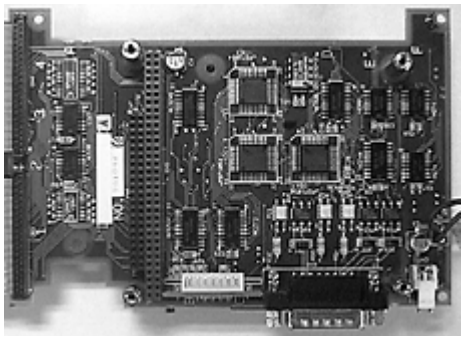

Fig. 3.5 External appearance of RAS module

Fig. 3.6 External appearance of SERCOS I/F module

Fig. 3.7 External appearance of PCMCIA module

Fig. 3.8 External appearance of Encoder module

Fig. 3.9 External appearance of DI/DO module

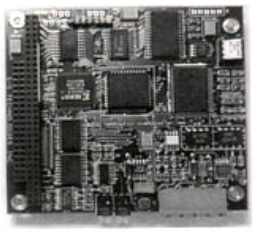

Fig. 3.10 External appearance of VGA module

Fig. 3.11 External appearance of DeviceNet module

Fig. 3.12 External appearance of motion module

Fig. 3.13 External appearance of storage devices

Fig. 3.14 Example of panel layout on "SMS-10"

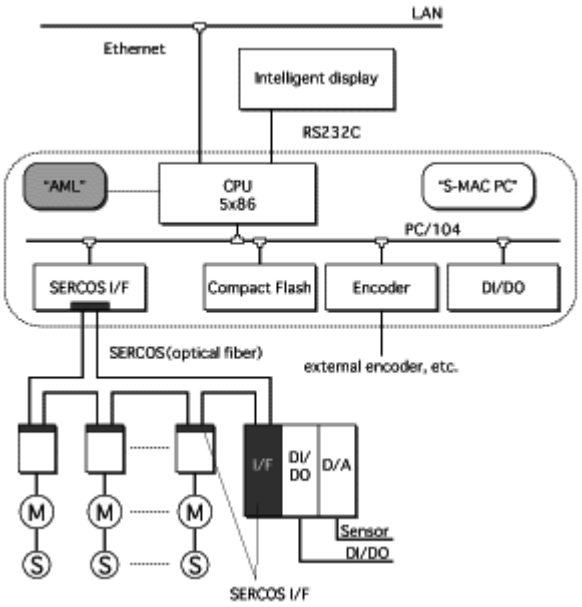

Fig. 4.1 Example of applying "S-MAC PC" to packaging machine

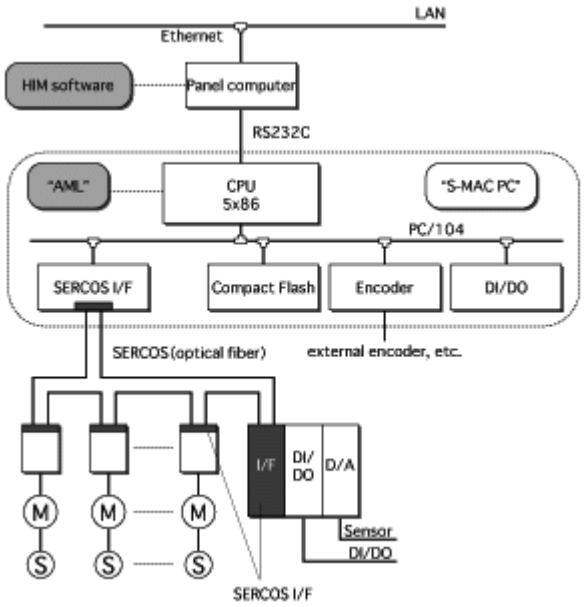

Fig. 4.2 Example of applying "S-MAC PC" to printing machine

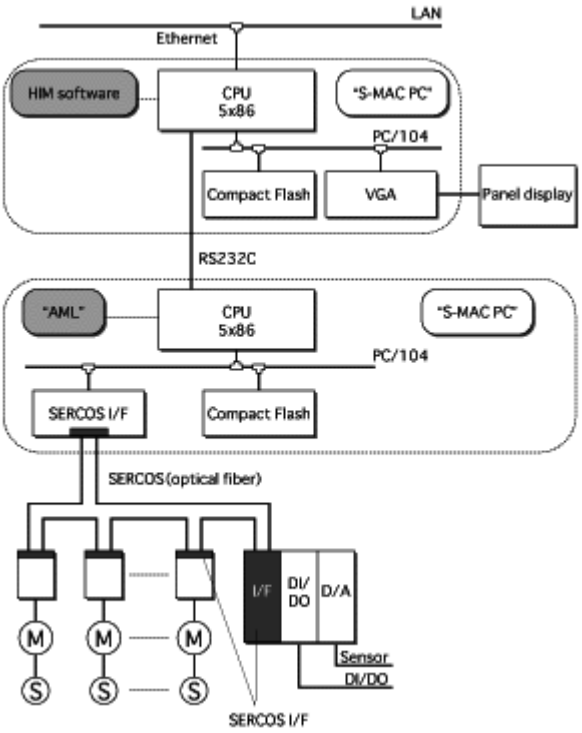

Fig. 4.3 Example of applying "S-MAC PC" to wire winding machine