APPLICATION OF PROGRAMMABLE CONTROLLER TO MECHANICAL AUTOMATION

Yoshiyuki Koido

1. FOREWORD

In machine tool machining and assembly work, the programmable controller (PC) has been widely used in control centered about dedicated machines, transfer machines, and other sequence control from times past.

However, the growth of FA and FMS of the factory in recent years has also expanded PC applications from control of a single machine to control of multiple machines and an entire line.

Therefore, the data link function between PCs and between PC and host computer and peripheral devices, processing capacity, etc. have become important PC selection standards.

The MICREX-F series placed on sale by Fuji Electric in 1985 is an advanced functions distributed type PC which meets the needs of this FA age.

Application of the MICREX-F series to facilities monitoring and production control systems is described here.

2. FACILITIES MONITORING SYSTEM

2.1 System overview

Stopping of the production line by a fault has a large effect with speeding up of the production line. The purpose of this system is one-dimensional monitoring centered about the state of the line and to provide support so that action can be taken positively and quickly when an abnormality occurs in the line.

2.2 Composition and functions

The system composition is shown in *Fig. 1*. This system consists of a PC MICREX-F, industrial microstation L25, and an process network (P-link) which connect these.

2.2.1 PC MICREX-F

The PCs are installed in a control panel and distributed about the plant floor. Since the L25 and other MICREX-F can be connected by one P-link (coaxial cable), even line expansion and layout changes can be easily dealt with. This system has the following functions:

Fig. 1 Facilities monitoring system composition
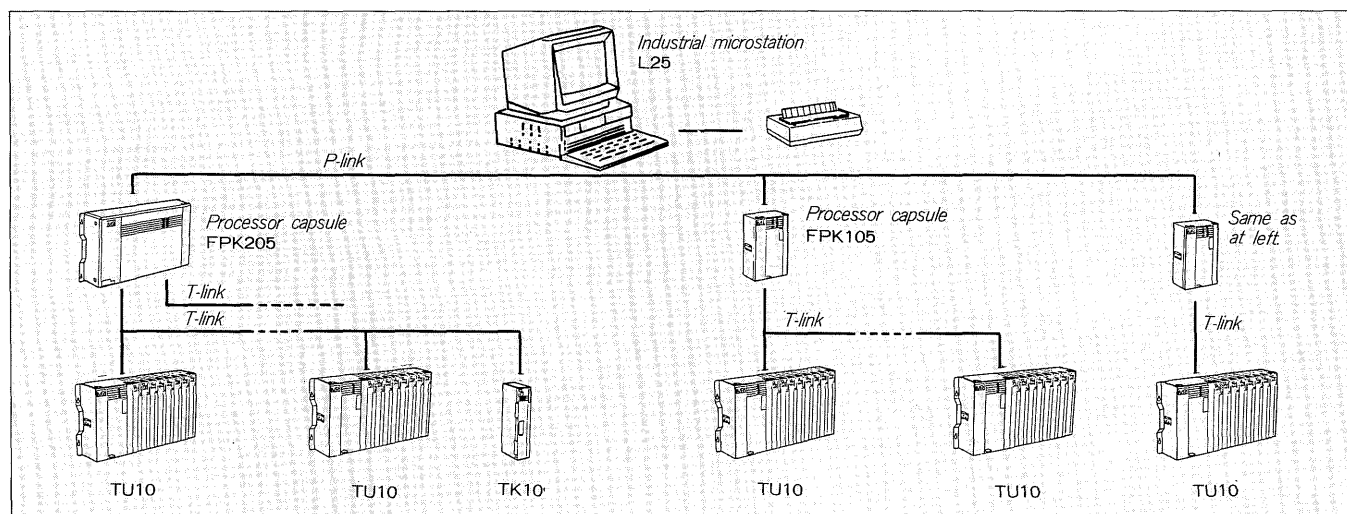
(1) Conveyor line sequence control
(2) Limit switch, actuator, etc. abnormality detection
(3) Tact time, actuator operating time, etc. measurement
(4) Transmission control of the information of items (2) and (3) above and status signals to a high level L25.

2.2.2 Industrial microstation L25

The L25 is a high performance general purpose microcomputer station capable of the real-time multi-task processing indispensable in industrial use. High-speed data transmission with the MICREX-F is also possible by using a dedicated P-link interface board. The specifications of the L25 are shown in *Table 1*.

With this system, the L25 is installed in the central monitoring room together with a color graphic display and printer and has the following functions:
(1) Graphic display of the line status to the color graphic display
(2) Alarm display when trouble occurs
(3) Alarm summary management and display
(4) Daily report printing

2.2.3 P-link

The P-link is the MICREX-F series process netowrk. Data exchange between PCs and between PC and mainframe computer system can be implemented simultaneously with one P-link.

Since the P-link is a common memory system, it can be used without being aware of transmission by only writing/reading the P-link memory. The P-link memory is divided into three areas and has a total size of 8k words.
(1) High-speed bit data area   8,192 bits
(2) High-speed word data area   1,152 words
(3) Low-speed word data area   6,142 words

In this system, the interlock signals between PC and the status signal and alarm signals transferred to the L25 use the high-speed bit data area and the tact time and other numerical data transferred to the L25 use word data area.

3. PRODUCT CONTROL SYSTEM

3.1 System overview

A flexible product control system which can easily cope with an increase of product type and model changes and design changes due to diversification of market needs. This system performs product control by shop level based on the production plan prepared by plant host computer.

3.2 Composition and functions

The system composition is shown in *Fig. 2*. The bar code reader and other peripheral devices are connected to an interface function capsule (IFK) by RS-232-C. The IFK is connected to a MICREX-F processor capsule with other I/O capsule by an terminal network (T-link). The processor capsules become a hierarchy system which is connected to an FASMIC G500/32 super microcomputer by P-link.

3.2.1 IFK

In a product control system, bar codes are widely used to identify work, pallets, etc. Therefore, a bar code reader and label printer must be connected to the product control system. However, most of these devices have an RS-232-C interface and using them in a medium or large scale system presents the following problems:
(1) Transmission over a long distance is impossible.
(2) Individual cables are necessary for 1-to-1 communication.

Therefore, in this system, the IFK is installed near the site peripheral device. With such a system, the IFK and peripheral device can be connected over a wide range of up to 1km by multi-drop system by one pair of T-link (twisted pair) cable. General digital I/O and analog I/O capsules can also be connected to this T-link.

Even through the bar code reader, label printer, and other peripheral devices have the same RS-232-C interface, their transmission speed, parity, text format, etc. are different. However, with the IFK, since these can be freely defined by software, most types of peripheral devices can be connected.

3.2.2 MICREX-F processor capsule

The MICREX-F processor capsule is installed at the site and performs the following processing:
(1) Transmission control with bar code reader, label printer, and other peripheral devices
(2) Transmission control with host FASMIC G500/32
(3) Buffer function for transfer data from high level to low level and from low level to high level

Table 1 Industrial microstation L25 specifications

| Item		Specification
CPU	Processor Operation processor Memory size	8088 (8MHz) 8087 ROM 64k bytes DRAM 864k bytes w/ECC
Auxiliary storage	Configuration	5.25 inch FD (1MX) × 2 RAM disk (471kB) × 1 or 5.25 inch FD (1MB) × 1 3.5 inch HD (20MB) × 1
	Expansion configuration	8 inch FD (1MB) × 1 3.5 inch HD (20MB) × 1
Man-machine interface	CRT	14 inch or 20 inch Color graphics 640 × 400 dots 8 colors
	Keyboard	JIS arrangement with alias ten keys 18 Function keys 20
	Printer I/F	Centronics
Options	Number of slots	1, 3, 5, 7
	Kinds of boards	Internal PIO (4 kinds) Serial interface GP-IB + serial I/F MICREX-F P-link LIO interface Remote terminal interface
Software	OS	Real-time OS LRS-III General-purpose OS MS-DOS
	Language	LR-BASIC interpreter MS-FORTRAN compiler MACRO assembler C compiler
	Packages	Graphics package Tabulation calculation package, etc.

Fig. 2 Product control system composition
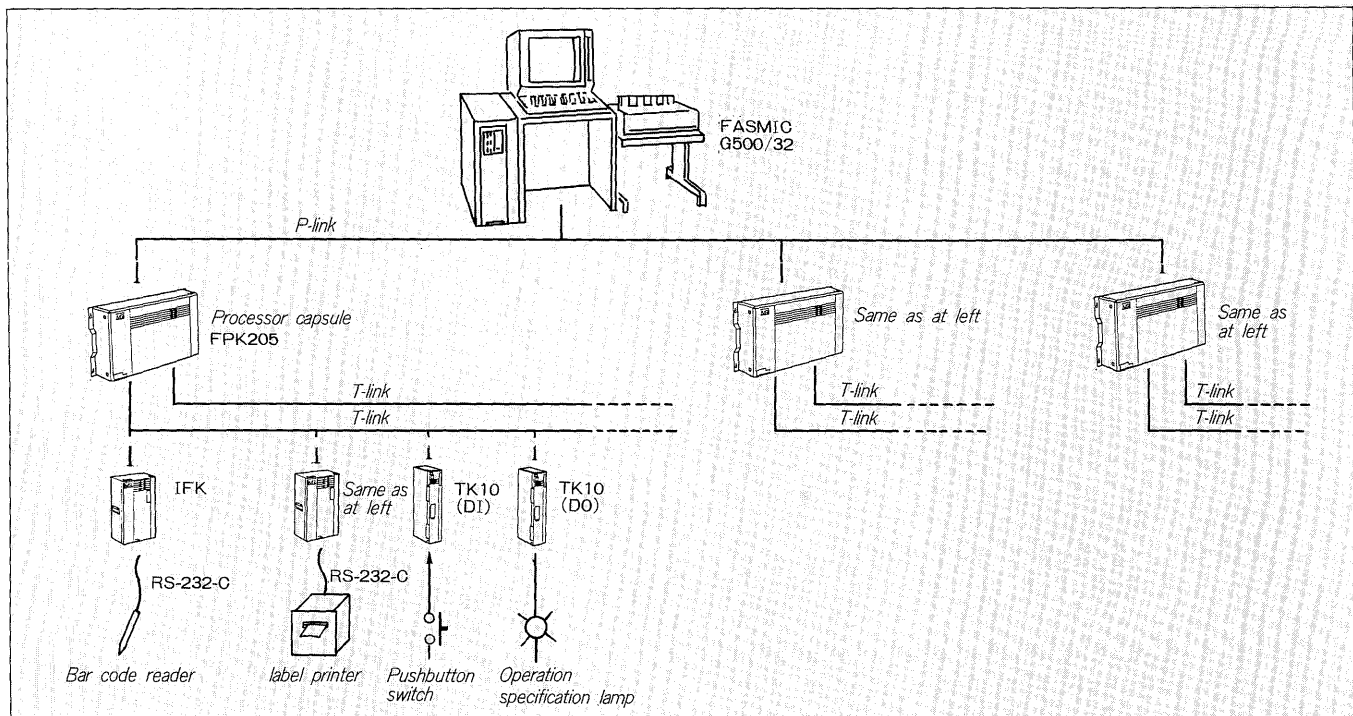
Fig. 3 Data flow when bar code reader connected
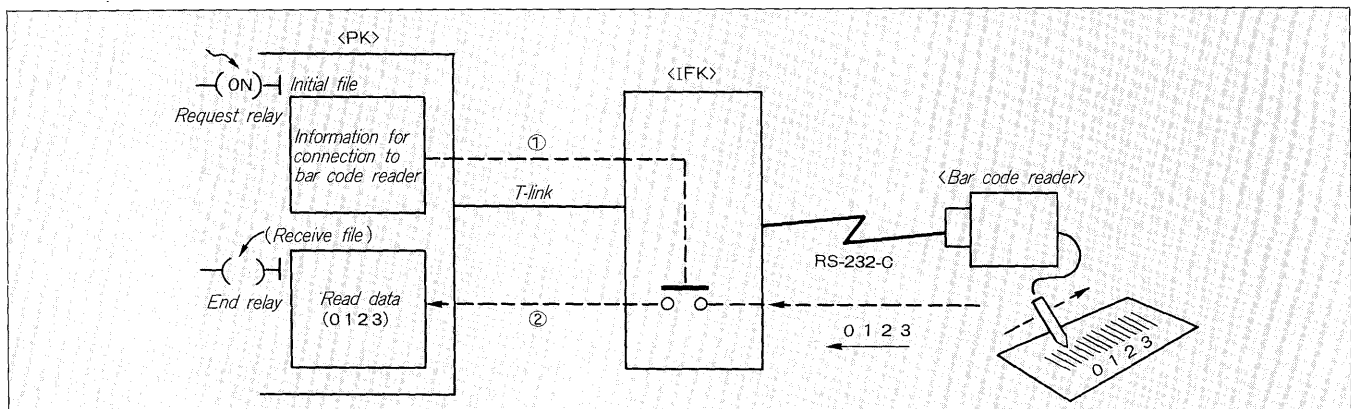
(4) Timing control by pushbutton switch and limit switch input

(5) Work instruction by lamp output

Transmission control with host computer and peripheral devices is generally a difficult thing which requires a special knowledge. However, with the MICREX-F, consideration has been given so that it can be implemented easily. In the bar code reader example shown in *Fig. 3*:

(a) When the request relay to write the transmission speed and other information to the initial file is turned on, the information is transferred to the IFK and reception is enabled.

(b) When a bar code is read, this information is written to the processor capsule receive file

automatically. The application program is informed of this by turning on the end relay.

3.2.3 FASMIC G500/32

The FASMIC G500/32 is a supermicrocomputer using a 68020 full 32-bit microprocessor. High-speed data transmission with the MICREX-F is possible by dedicated P-link interface, the same as the L25. The specifications of the FASMIC G500/32 are shown in *Table 2*.

With this system, the FASMIC G500/32 performs the following processing:

(1) Production plan input from plant host computer via floppy disk

(2) Production instruction

(3) Tracking control

(4) Production record control

Table 2 FASMIC G500/32 specifications

Item		Specification
Processor	Processor Operation processor Logical address	68020 (16.7MHz) 68881 (16.7MHz) Max 4 16MB
Main memory (memory size Max 11MB)	Processer memory	DRAM (with ECC) 1st processor: Max 8MB 2nd and subsequent processors: Max 4MB
	Common memory	SRAM (with parity) Battery backup possible DRAM (with ECC)
External storage	Floppy disk Hard disk Cartridge MT	5.25/8 inch 1MB 5.25 inch 20/40/130MB 8 inch 240MB x 1 or x 2 120MB
Options	I/O device controller	RS-232-C Current loop RS-422 FACOM low-speed interface Centronics
	Communication controller	BSC, HDLC, GPIB
	MICREX-F connection	P-link, T-link
	Detaway	DPCS-E
Software	OS	High-speed real-time processing GOS-F/GOS-D Interactive processing GOS-1
	Language	C compiler FORTRAN77 compiler BASIC interpreter PL/F compiler MACRO assembler
Installation		Desk side type (3 types) Locker type

4. CONCLUSION

Application of the MICREX-F series to a facilities monitoring system and a product control system was described as applications of the PC to processing and assembly work.

The important of the PC as a key component in building an FA system is expected to increase. We will make efforts to make it easier to use as a total FA system.