

OUTLINE OF FUJI MICRO CONTROL SYSTEM

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I. ABSTRACT

Fuji Micro Control System (FUJI MICREX) is a total system of process control consisting of microcontroller group using Microprocessor as the nucleus and is recently drawing much attention in the world. This system has been developed aiming at system of microcontroller for process control that makes it possible to create new control system having close relation with,

- (1) industrial electronic control engineering centered around transidyne, F-MATIC or process measurement control engineering based on TELEPERM IS system
- (2) as sub-type of process computer system based on U-series computer. Hardware that realizes this system is systematized under consolidated idea and forms the framework of all the microcontroller groups.

This paper introduces suitable form of the these micro-control systems and characteristics and specifications of hardware related to these.

II. SHAPE APPLICABLE TO FUJI MICRO CONTROL SYSTEM

Fuji micro control system, is designed so that entire control system may be separately controlled by multipiece controller whose each piece is independently controlled so that fault in one part does not effect entire system by ideally dividing control range and control content as far as possible based on thinking of ideal splitting of function and thinking of dangerous separation of control of each system. In other words, one of the following forms is chosen to apply microcontroller to process control.

- (1) As replacement for conventional system

To install aiming at improvement of function or replacement of function of electronic control device or conventional measurement control device by function of each microcontroller.

- (2) Together with conventional system

To use in combination and united with process computer control device and conventional measurement control device and electronic control device by installing prominent features of microcontroller with regard to parts which could not be accomplished sufficiently by conventional

function or partial replacement of system. As regards method of installation, any one of the following system compositions is used for operation. (Further details of system composition are described in section V.)

- (1) Independent installation

Used by independent installation (stand-alone) corresponding to function of each microcontroller.

- (2) Broken up control system

A number of microcontrollers are installed after breaking up according to each function and by operating organically coupling with each other, broken up control system permitting function grade up and elimination of danger is composed.

- (3) Hierarchy system

By having process computer system in the center position and coupling this with microcomputer hierarchy control system is composed.

III. CHARACTERISTICS OF FUJI MICRO CONTROL SYSTEM

Each microcontroller composing the system consists of a consolidated unit system of hardware, is supported by program system based on exclusive language corresponding to control function, and possesses the following characteristics.

- 1) Improved reliability
- (1) Improvement of production test control by consolidation of hardware.
- (2) Split up control system based on separate microcontroller for separate function.
- (3) Improvement of system by packaging of software, hardware.
- 2) Improvement of function
- (1) Introduction of LSI for making hardware compact.
- (2) Better flexibility of design by development of exclusive language.
- (3) Shortening of development time.
- 3) Improved maintainability
- (1) Perfection of testing, troubleshooting system.
- (2) Improvement of user maintainability of software by introduction of exclusive language.

Moreover, as sub-system of process computer system,

- 4) Perfection of transmission function
- 5) Perfection of troubleshooting function
- 6) Perfection of support system

IV. PHYSIQUE OF FUJI MICRO CONTROL SYSTEM

Fuji micro control system is a total system consisting of packaged micro controllers. Each of these controllers is in fact a terminal or intelligent controller carrying micro-processor, various functions of control are split up, software and hardware are combined in each of these and made in the form of system package. Specification of each controller is characteristic of that system, operating method and program of software are made intended for application engineer, specifications can be decided easily and amendment is also easy. Physical construction of Fuji micro control system is shown below.

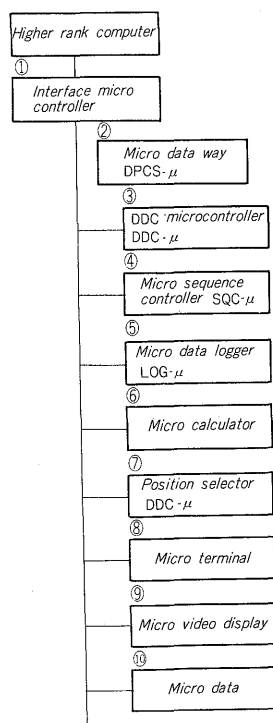


Fig. 1 Organization of Fuji micro control system

V. HARDWARE OF FUJI MICRO CONTROLLER

Each micro controller consists of a combination of standard cards. The process use I/O card (PIO) that acts as interface of process is connected to CPU bus through the PIO adapter card and consists of various kinds of card according to process signal. Signal of process use I/O card is connected to process by cable through I/O card. List of cards of logic section shown in Fig. 2 is given in Table 1. Table 2 shows the list of standard process interface units.

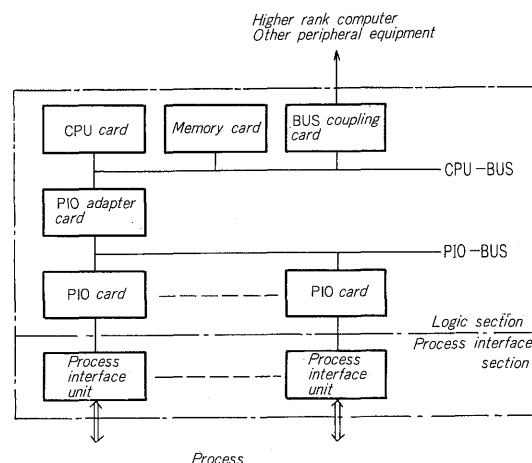


Fig. 2 Fuji micro controller's architecture

Table 1 List of standard logic cards

Item	Sub-Item	Specifications
CPU	CPU card (8 bit)	I 8080 (Intel.)
	CPU card (16 bit)	MN 1610 (Pana Facom)
	IC PROM card	4K Byte/card
	IC RAM card	4K Byte/card
Memory	IC PROM/RAM card	PROM 2K Byte RAM 2K Byte card
	Core memory card	4K Byte card
	PIO adapter card	PIO connecting bus
PIO	Interrupt input card	Level 1 ... 8 points Level 2 ... 8 points (1 point is interval timer)
	Analog input card	16 points Depends on input/output specifications
	Digital input card	64 points Depends on input/output specifications
	Pulse input card	8 bit × 4+1 bit × 32 Depends on input/output specifications
	Analog output card	2 points voltage of current Depends on input/output specifications
	Digital output card	64 points Depends on input/output specifications
	Pulse output card	8 bit × 2 points Depends on input/output specifications
	Series code transmission card	110, 1200, 2400, 4800, 9600 bit/sec. 1 pair for transmission/reception
	Parallel code transmission card	Byte/Word transfer
	DPCS-μ coupling code	For micro data way

VI. COMPOSITION OF FUJI MICRO CONTROL SYSTEM

Process control system series can be composed by putting various micro controllers together. For this micro control system, connection between micro controllers and

Table 2 List of standard process interface units

Logic card	Process interface unit	
	Type	Specification
Analog input card	Low speed type	Multiplexer: reed relay 16 points Conversion system: V/F Conversion time: 30 msec/point
	Medium speed	Multiplexer: semiconductor 16 points Conversion system: successive Conversion time: 250 μ sec/point
Digital output card Pulse output card	Contact input type	32 point, photocoupler green, with LED indicator Impressed voltage DC 48V, 10mA, Delay time 10 msec
	Open collector input type	32 point, photocoupler insulation, with LED indicator Impressed voltage DC 12V, 10mA
	Voltage input type	32 point, photocoupler insulation, with LED indicator Receive voltage DC 12V, 10mA Delay time (contact) 10msec (other) none
Digital output card Pulse output card	Open collector output type	32 point, photocoupler insulation, with LED indicator Impressed voltage DC5~24V, 150mA
	Contact output type	32 point, N type relay insulation, with LED indicator Impressed voltage AC 250V max., 7.5A max.
Series code transmission card	Voltage output type	MODEM interface without insulation
	Current output type	ASR interface with insulation

connection to upper rank process computer system is easy and composition of split control system and hierarchy control system easy.

1) Stand alone type (Fig. 3)

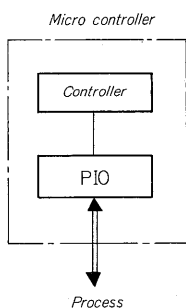


Fig. 3 Stand alone type micro controller

2) Split control system

In split control system, generally system using transmission unit (Fig. 5) for connecting to line, channel and connecting though PIO is used, but specially this time in development of micro control system, since easy transmission between a number of micro controllers is indispensable for realization of split control, by using for micro controller the transmission idea of data way process control system (DPCS) (1) in practice from past performance is graded up it is being produced and announced as micro data way

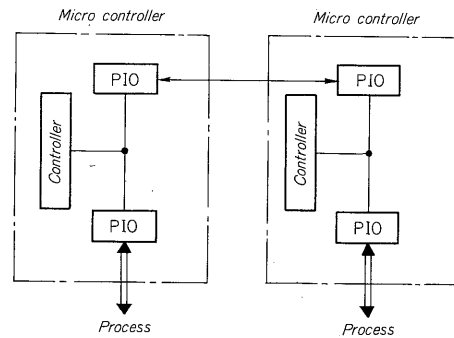


Fig. 4 Decentralized control system (PIO coupling)

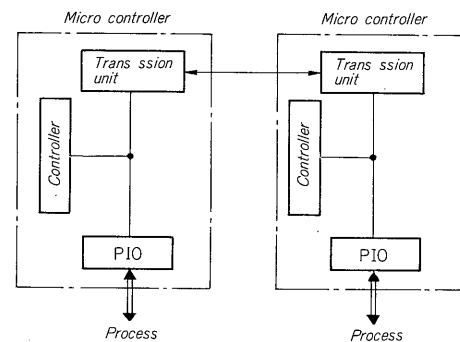


Fig. 5 Decentralized control system (transmission unit coupling)

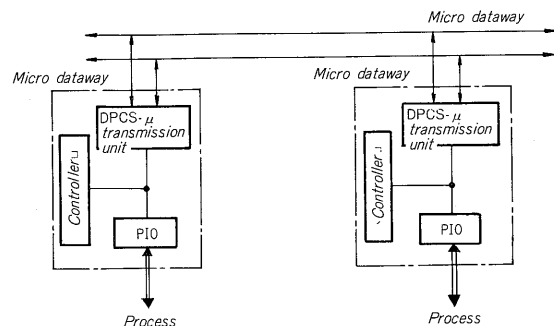


Fig. 6 Decentralized control system (micro dataway coupling)

(DPCS- μ). An example of decentralized control system based on micro dataway coupling is shown in Fig. 6.

3) Hierarchy control system

3 examples of hierarchy higher rank computer control system and coupling system are shown in Fig. 7.

(1) PIO coupling

(2) Transmission unit coupling (channel coupling) is the case when higher rank computer and micro controller are coupled 1:1.

(3) Through interface micro controller

Becomes 1:N coupling using micro dataway.

Moreover, it is also possible to couple through higher

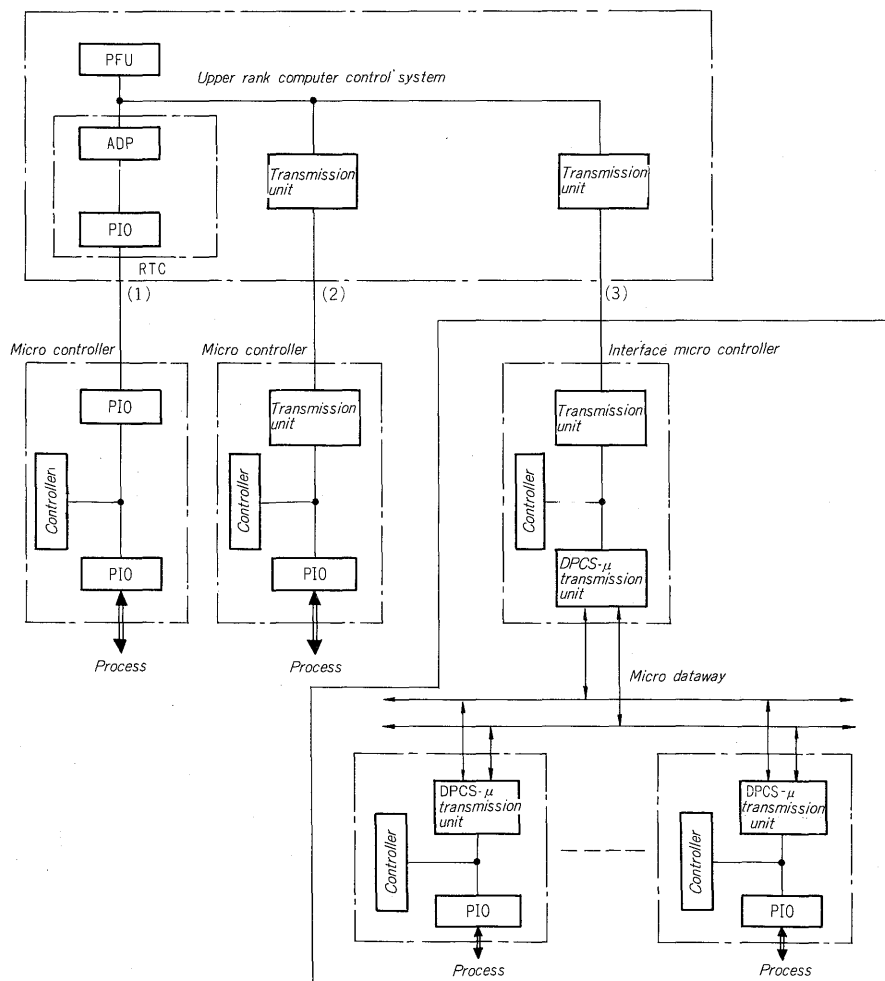


Fig. 7 Configuration examples of hierarchy control system

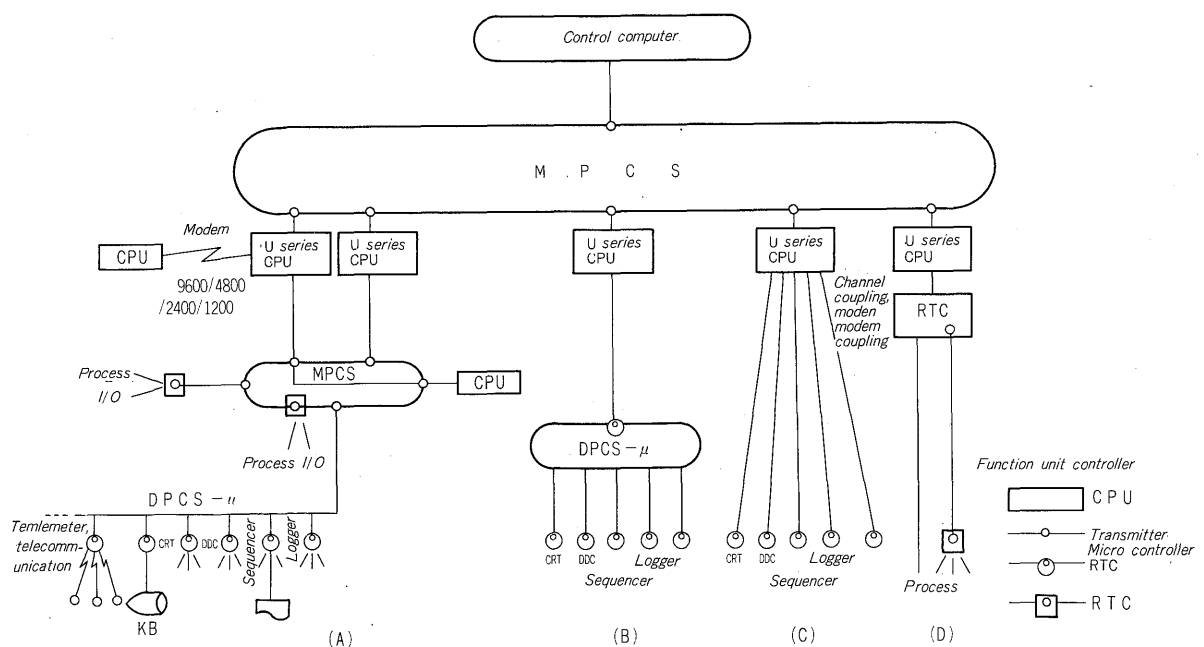


Fig. 8 Over view of the Fuji hierarchy control system

rank computer system and MPCS (2). MPCS is a dataway system suitable for coupling in common at high speed between process computers, process computer and upper rank control use computer, process computer and PIO, terminal, etc.

By making separate use of the above mentioned MPCS and the micro dataway system DPCS- μ suitable for common coupling between micro controllers, micro controller and process computer, etc., it is possible to construct hierarchy system suitable for various kinds of applied system.

Various systems of the Fuji hierarchy control system are shown in Fig. 8.

The control use computer and factory unit's process computer are coupled by means of a high speed, high performance dataway system MPCS. In the Fig., (A) is the system in which there is MPCS loop in the center and to it one port is coupled microcontroller through micro dataway (N:N coupling), (B) is the system in which it is directly coupled to each micro controller by micro dataway through the interface micro controller from the process computer (1:N coupling), (C) is the system in which coupling between the process computer and each micro controller is accomplished using 1:1 transfer unit (1:1 coupling), and (D) is the conventional process computer system composition not including micro controller. If necessary, remote RTC can be added.

VII. DIAGNOSIS SYSTEM OF MICRO CONTROLLER

Since micro controller is used directly with printed

board or equipment, high reliability is required. Moreover, it is also necessary that when trouble occurs, it must be possible to promptly locate and judge the faulty points.

An example of general diagnosis system of micro controller is shown here. Table 3 shows the diagnosis system at off line and Table 4 shows the diagnosis system at on line.

VIII. SOFTWARE OF MICRO CONTROLLER

When method of using micro controller are considered, first classification should be made in this area as main processing elements as,

- 1) sequence control
- 2) analog control modified as digital control
- 3) data handling with the numerical value as the main factor

Now if we again consider application from the point of view of way of composition of software, it can be classified into the following cases.

- 1) When it can be contained in a certain fixed general framework, and when it can be composed by simple combinations of these.
- 2) In cases other than those mentioned above, when combination of processing elements is extremely difficult and it is not possible to construct exclusively economically and also from the point of view of speed.

By the former, standard program can be prepared on comparatively large scale and it is easy to make schemes without regard to so called "Programming" from the point of view of usage. Contrary to this, at the most standard

Table 3 Diagnosis of logic

Name of Device	Diagnosis Method	Diagnosis Range	Remarks
Controller (No.1)	Check by inserting the check program (card)	All instructions of CPU BUS memory	Micro checker is necessary. NO-GO is decided by the operator.
Controller (No.2)	Check by transmitting test program by means of host CPU	All instructions of CPU BUS memory	
Various kinds of process I/O (No.1)	Insert PI/O indicator unit and read existing data of each PI/O. (on line)	Various types of device operation, a part of CPU monitor	PI/O indicator unit is necessary.
Various kinds of process I/O (No.2)	Insert the micro checker possessing the standard signal generating and indicating functions at the connector, combine with off-line check program and perform device check.	Accuracy of operation of all kinds of device	Micro checker is necessary. NO-GO is decided by the operator.
Various kinds of process I/O (No.3)	Same as above, but micro checker is automatic and message of NO-GO is automatically sent out.	Same as above	Micro checker is necessary.

Table 4 Diagnosis of logic cards (through on line)

Name of Device	Diagnosis Method	Diagnosis Range	Remarks
Entire system	Watched timer (depends on software)	CPU, memory, motor program fixed period interruption	
Memory	Parity check (hardware)	CPU, memory, BUS	
Digital output card	Read after write (with control bit)	Up to register inside card	
Digital input card	Perfect doubling	Entire card	Applicable to only special system.
Analog input card	Read standard voltage	From ADC onward	
Analog output	Read after write (with control bit)	Up to register in card	
DPCS- μ transfer card	Read after write	Entire card	

programs on small scale can be prepared, if at all possible, and if their coupling part is generalized not only that the scale becomes smaller but efficiency drops, speed decreases and economical problems are encountered so that it becomes impractical. In this case, the problem from the point of view of use would be to construct a system that can make entire programs without regard to the so called "Programming" also taking into consideration economy and performance of micro control system.

Software system of FUJI-MICREX can be mainly classified as follows.

- 1) Application software
- 2) Support system
- 1) Basic conception and fundamental idea of configuration of application software comes from the explanations given before. That is,
- (1) System must be such that parts which can be standardized must be dealt with "Suitable for problems"

For this,

- 1) package of FIF (Fill in the Form) type must be offered
- 2) a system by which problem-oriented language can be easily specified by simple procedure must be offered

These can be considered in the following 3 forms.

- 3) system in which problem-oriented external language is executed by interpreting when interpreter is running.

This system has problems with regard to process-

ing speed and memory capacity but shows much influence with regard to maintenance.

- 4) system in which, corresponding subroutine is coupled and compiled by means of program and one object program is constructed.

As regards the method of preparing subroutine, by using macro language as the external language program of consolidated control system can be offered in a fairly wide range of area.

- 5) system in which object program is composed by compiling problem-oriented external language.
- (2) Prepare as module by finely dividing so that the part so called control program (also called monitor program) can also be combined as a part of application program.
- (3) System in which correction, etc. is possible without decreasing the level of language as far as possible even after installation at the site considering maintainability, offer of means of assistance should be adjustable.
- 2) The idea of support system

Considering improvement of efficiency when constructing standard program or package program, etc. and when it is not possible to cope with within the range ((1)~(4) described before) of standard program, conventional support system in which construction of program based on computer is possible is offered as the U series as the host computer. This system is made of a system capable of dealing in general without being effected by CPU of the micro system.