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DISTRIBUTED DIGITAL INSTRUMENTATION CONTROL SYSTEM (MICREX-P SERIES)

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1 FOREWORD

The first generation of distributed digital instrumentation control systems steadily announced by domestic companies from 1975 was greeted with praise from all industrial fields as a new model of process control equipment, and their models and functions have been expanded together with fixing of their evaluation.

As a leader in this field, Fuji Electric announced the multi loop distributed type DDC <MICREX-P DDC-μ, CRT-μ> system in 1975 and added the <MICREX-E> industrial controller in 1978 and the <CC-F> single loop digital controller in 1979 and increased its delivery record under enhancement of the system.

However, recent advances in LSI semiconductor technology, data transmission and system architecture technology have been amazing and more reliability control and high performance man-machine functions have been demanded. Under this background, we have pursued user needs and have developed the <PCS-100, OCS-1100/100, DPCS-E> series of new MICREX-P distributed digital instrumentation control system incorporating the newest hardware/software design technology and the process control know-how used up to now.

The process station <PCS> itself and an operator station <OCS> can be combined through a dataway <DPCS> and can also be combined with <U-1000> series process computer and <S-3000>, as well as meeting the flexibility for diverse application systems, and development into a advanced integrated hierarchal system is also easy.

2 BASIC DEVELOPMENT STRATEGY

The development strategy of this system is shown below.

1) Securing of continuity with the existing MICREX serie
   (1) Consistency of programming language (POL, wafer).
   (2) Continuation of shelf, card, bus, and other basic hardware construction.
   (3) Continuation of the system concept and features in intersystem linkage.
2) High process control reliability
   (1) Functional independence of card units and shelf units.
   (2) Realization of duplex configuration of basic card units (option), and of online card replacement.
   (3) Reduction of the number of electronic components through the use of custom LSI and natural convection cooling by low power consumption design.
   (4) Completeness of self-diagnosis and localization of generated faults.
3) User friendly man-machine system
   (1) Detailed display by high functions full graphic CRT display and simple picture generation by dialogue method.
   (2) Expansion of process operation functions and substantial improvement of controller support functions.
   (3) Process back-up operation by CRT operation.
4) Realization of high-speed and high performance dataway
   (1) Realization of high-speed communications which is not conscious of the distribution of the hardware.
   (2) Software interface reducing the burden of the application.
   (3) Independent transmission function provision of fault-tolerant system.

3 FEATURES OF SYSTEM

Concerning the direction of development of digital instrumentation control systems, with <centralization of information management and distribution of control> as the basic concept, the transition of multiloop central control → single loop distributed control and panel operation → panelless operation has become the demand of the age.

PCS, OCS, and DPCS pursue individual functions which each should have along this basic concept and application flexibility, easy use, and easy understanding are demanded and adequate partition of functions, data linkage simplification, simplification of application correspondence, and so forth have been followed in detail.

Its main features are shown below:

1) Diverse system configuration which meets user needs
   (1) Compact medium and small scale supervisory and control system by desktop type operator station.
   (2) Integrated hardware hierarchy control system incorporating S-3000 and U-1000 series computer.
   (3) Electric and instrumentation complex control system combined with MICREX-E HDC series industrial controller.
2) High performance and high reliability controller with both single loop independence and multiloop complex control functions (PCS)
   (1) 1-2 loop/card independent loop control.
   (2) Process control functions connected at shelf level.
   (3) Complex control functions can be easily realized by software wiring.
3) High reliability system by unit redundancy (PCS, DPCS)
   (1) Redundant configuration of basic part is possible (option).
   (2) Fail soft system under fully devided unit functions.
   (3) Online card replacement on a unit basis.
4) Flexible programming by wafer wiring and POL (PCS)
   (1) Feedback control, sequence control, and data processing by problem-oriented language wafer/POL.
   (2) Easy design, manufacture, and testing by block structured programming.
   (3) Computation and processing function also applicable to complex advance control.
5) Panelless CRT operation man-machine system (OCS)
   (1) Full system lineup from high functions centralized type to compact desktop type.
   (2) Instrument image process supervision and control.
   (3) Alarm display can be classified and desired panel can be displayed by one-touch P.B.S operation.
   (4) Realization of panelless backup operation by interaction with CRT.
   (5) Dialogue type panel generation function and detailed plant image display by 4000 characters full graphic CRT display.
   (6) Complete controller support functions.
6) High-speed, high reliability dataway (DPCS)
   (1) 1.5M bits/second high-speed data transmission.
   (2) N:N arbitrary interstation communication without common unit.
   (3) Combination use of optical fiber cable and coaxial cable is possible.
   (4) Retrasmission, bypass, loopback, and other fault tolerant functions.

4 SYSTEM CONFIGURATION AND BASIC SPECIFICATIONS

The configuration concept of a total hierarchy system in distributed digital instrumentation control is shown in *Fig. 1*. With such a system, a management computer for overall plant facility operation planning and data management or process computer for plant operation instructions and control is installed at a higher level and man-machine system which supervise and operate the processes and multiple process controllers which directly control the field instrument are installed under it.

The distributed digital instrumentation cotnrol system described in this paper is positioned at the center of *Fig. 1* and consists of a man-machine system, process controller, dataway, and other subsystems. Specifically, as shown in *Fig. 2*,

- Process station : PCS-100
- Operator station : OCS-1100/100
- Dataway : DPCS-E

are the nucleus. Generally, the actual control system also contains the <MICREX-E HDC Series> industrial controller, the <CC-F/E> single loop controller. But a description for these controllers is omitted here.

The <PCS-100> process station consists of a basic section having a 19 inch rack mounting type shelf construction which can be easily installed in a locker and a block construction process interface section. Besides basic feedback control, it has sequence control, data collection and processing functions, and is applicable to a wide range of fields. In addition to a maximum 16 loops/shelf feedback control capacity, ordinaly PIO or remote PIO function can be equipped. The basic configuration of the <PCS-100> is shown in *Fig. 3* and its basic specifications are shown in *Table 1*.

The <OCS-1100/100> operator station is a man-machine system with process operation functions which utilize the features of the high resolution CRT and abundant support functions for a controller. The <OCS-1100> has a function which controls up to 32 <PCS-100> through the <DPCS-E> dataway of up to four lines and supports control loops of a maximum 512 points and monitoring loops of a maximum 1536 points. On the other hand, the small type <OSC-100> is a desktop type compact man-machine system. It controls up to 8 <PCS-100> and supports control loops of a maximum 128 points and monitoring loops of a maximum 256 points.

Besides a standard panel for process supervision and control, both models are easy-to-use man-machine systems with a function which allows simple creation of a dedicated plant image display, diverse format data logging, and various other functions. The basic specifications of the OCS are shown in *Table 2*.

The <DPCS-E> dataway is a control use communication system made up of card structure communication unit and block structure line interface unit, and 1.5 megabits/second transmission speed, no common units N:N arbitrary interstation communication and maximum 32 stations/line transmission control functions. Moreover, it has communication line redundancy, faulty station bypass, transmission line loopback functions, etc. and a high reliability communication system with detailed troubleshooting functions is realized.

5 INSTALLATION CONDITIONS

Since the temperature, humidity, supply power, and

Fig. 1 Hierarchy control system configuration (example)

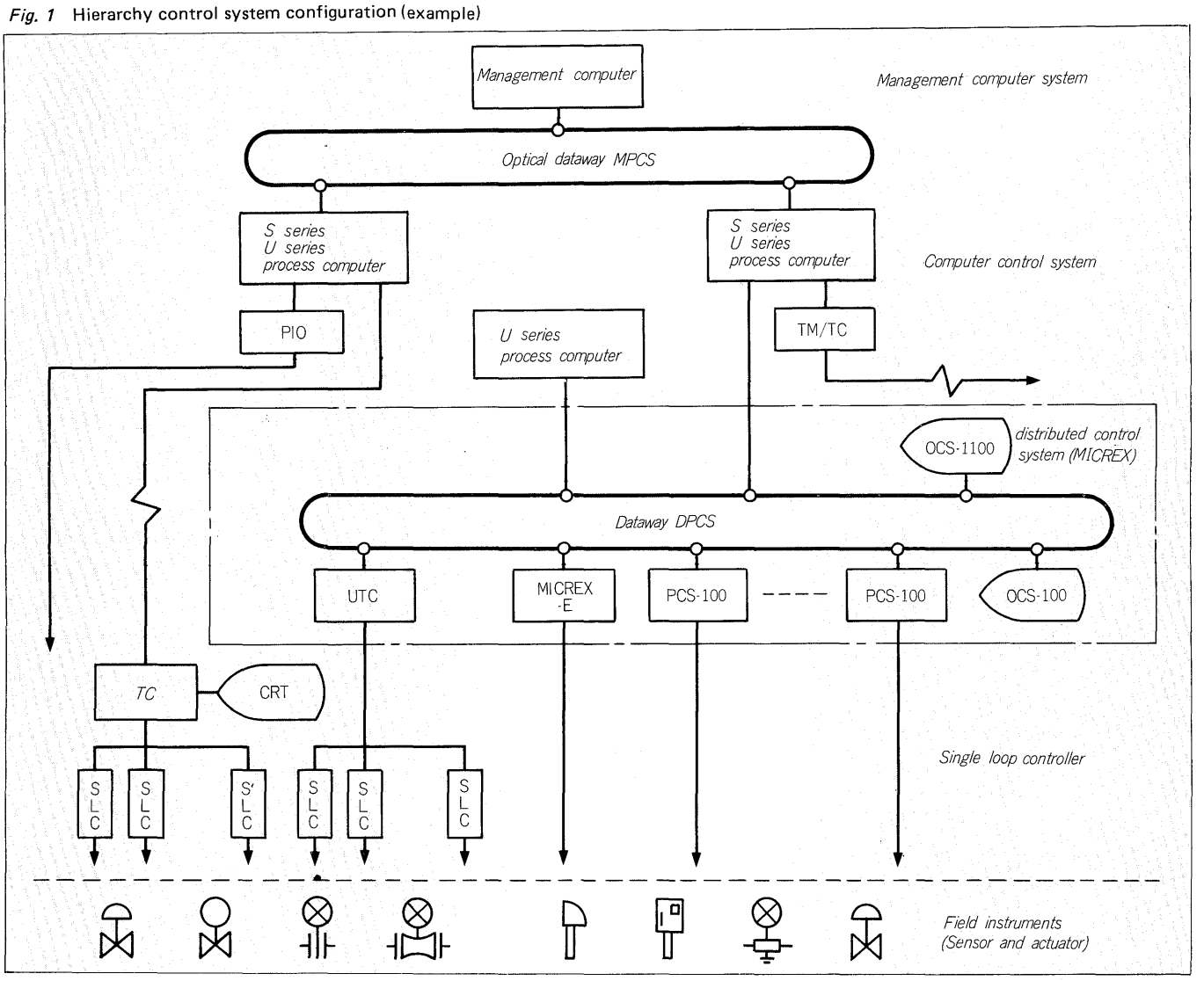


Fig. 2 Configuration of MICREX system for instrumentation control

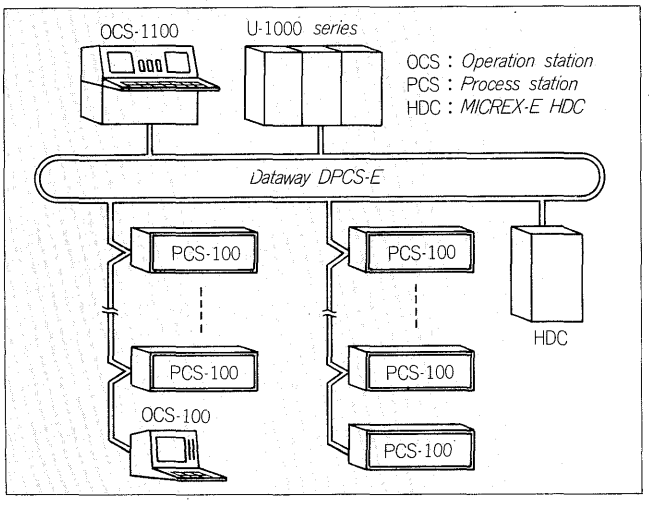


Fig. 3 PCS-100 basic configuration

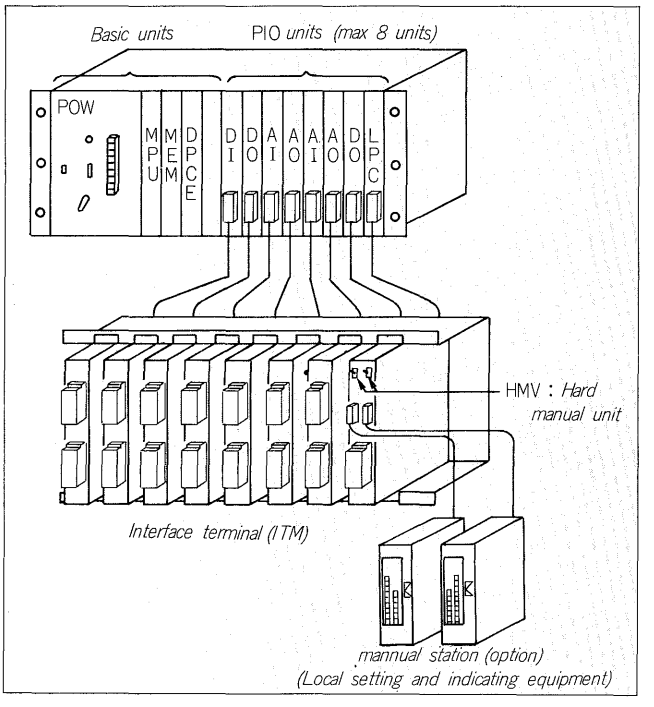


Table 1 PCS-100 basic specifications

Item		Specification		
Input/output points	Loop control unit Current output type (LPC-C)	Analog input Control output Digital input Digital output	: DC 1~5 V, 4 points : DC 4~20 mA, 2 points : 4 points : 4 points	Up to 8 units/basic shelf or up to 7 units/basic shelf + up to 8 units/remote PIO shelf (Loop control unit cannot be mounted in remote PIO shelf.)
	Loop control unit Pulse width output type (LPC-S)	Analog input Opening input Control output Digital input Digital output	: DC 1~5 V, 4 points : DC 1~5 V or 10-100-10Ω potentiometer, 2 points : Pulse width (increase, decrease), 2 points : 4 points : 4 points	
	Analog input unit (AI)	DC 1~5 V, 16 points (15 points, if reference voltage check is provided) mV input (0~±20 mV, . . . 0~±10 V) Pt 100 Ω input (3-wire type, with linearizing) Thermocouple input (with cold junction compensation and linearizing)		
	Analog output unit (AO)	DC 1~5 V, 8 points		
	Digital input unit (DI)	32 points		
	Digital output unit (DO)	32 points		
	Digital input/output unit (DIO)	16 points/16 points		
	Pulse input unit (PI)	20 kHz or less, 16 points High level input type; H: +8 ~ 24 V, L: 0 ~ +3 V, Low input type; H: +3 ~ 8 V, L: 0 ~ +1 V		
Control and computing functions	Loop control block	1/2 loop feedback control and computing function; maximum 32 wafers, basic cycle; 0.2 sec		
	Sequence control block	POL; maximum 256 steps, timer; 16 points		Maximum 8 blocks
	General computation block	Maximum 32 wafers		
	Indication and alarm block	Analog input indication and alarm 16 points		
	Status change block	Contact input status change supervision 16 points		
	Wafer	PID position output, PID velocity type output, ratio operation, program setting, analog count, pulse number count, addition, subtraction, multiplication, and divition, square root extraction, limiter, selector, dead time, moving average, and others		
	POL	Sequence control instructions, (transfer, computation, timer/counter, branch), general word operation instructions (value, logic, shift), and others		
Power failure protection		Protection function is provided (memory back-up: 2 weeks), auto restart/manual restart can be specified		
RAS functions		Various self-diagnosis and mutual diagnosis		
Communication functions		Connection to DPCS-E dataway; maximum 32 stations/DPCS-E line Station: PCS-100, HDC Series, OCS-1100/100, U-1200/1400/1500		
Operator station		Connection to OCS-1100, OCS-100 via DPCS-E		
Setter		Two types available (Current output type and pulse width output type) Connected with loop control unit if necessary		

other environmental conditions depend on the kind of hardware used, they are specified separately for the PCS and OCS.

Taking installation of the PCS at the plant site into account, besides the natural convection cooling system without cooling fan provided as standard, environment resistance is strengthened by using gold plated contact and coating the printed circuit boards as required.
required.

The basic installation conditions are shown below.

(i) Ambient temperature : 0~50°C (shelf ambient temperature)
Locker ambient temperature is 0~40°C.

(ii) Ambient humidity : 20~90% RH (no condensation)

(iii) Power supply : AC 100 V + 10%, −15%, 50/60 Hz ±3 Hz

(iv) Ground : Ground resistance 100 Ω or less independent grounding

On the other hand, concerning the OCS, since the same installation environment as the operator working environment from the functions and usage methods of the equipment and the are environmental limits on the CRT display and floppy disk, printer, and other hardware, the basic installation conditions are:

(i) Ambient temperature : 5~35°C

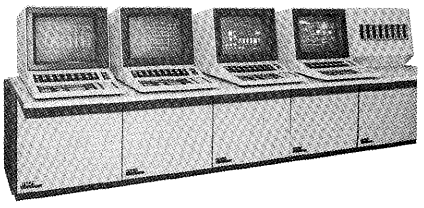
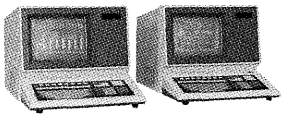
(ii) Ambient humidity : 20~80% RH (no condensation)

(iii) Power supply : AC 100 V ±10%

(iv) Ground : Ground resistance 100 Ω or less Independent grounding

However, environment resistance has been improved by strengthening the dustproof construction of the CRT display and floppy disk unit, etc. so that they can be directly installed in general supervisory and control rooms.

Table 2 OCS basic specifications

Item			OCS-1100 Large scale, centralized type	OCS-100 Medium scale, compact type
Type				
Number of processing points		Control loop	512 points	128 points
		Monitoring points	1,536 points	256 points
Number of connectable units		Controller	32	8
		Dataway	DPCS-E maximum 4 lines	DPCS-E 1 lines
CRT display	Size		20 inch CRT	14 inch CRT
	Type (color/monochrome)		Color, full graphics	Color, full graphics
	No. of display characters		4,000 characters	2,000 characters
	Display colors		8 colors	8 colors
Number of operation keyboards			1/desk	1/desk (shared)
Number of engineer keyboards			1/system	
Remote CRT connection			Possible, macimum 500 m	–
Standard panels			New alarm, overview, group, loop, trend, system condition, multipoint, system alarm, plant, historical message, multipattern	New alarm, overview, group, loop, trend, system condition, operation guide, multipoint, system alarm, plant, historical message, multipattern
Alarm	Process		Upper and lower limit of PV, SV, MV, upper and lower limits of PV change rate, deviation, others	Upper and lower limit of PV, SV, MV, upper and lower limits of PV change rate, deviation, others
	System		Operator station: WDT, Process station: WDT, others	Operator station: WDT, Process station: WDT, broken wire of analog, others
	Others		Message output possible by connecting a printer.	Message output possible by connecting a printer.
Logging	Number of print out items		128	70
	Number of TW		1	1
Features			(1) User's panel can be freely created by dialogue type panel creation function. (2) Autotuning of PID parameter (3) System definition can be freely performed by system building function. (4) Complete support function for process station. (5) Daily report/monthly report can be freely generated by dialogue type logging definition function.	(1) User's panel can be freely created by dialogue type panel creation function. (2) System can be freely defined by system building function. (3) Complete support function for process station. (4) Daily report/monthly report can be freely generated by dialogue type logging definition function.

6 CONCLUSION

The CRT operation system has been applied mainly to large scale plant centralized supervision and control and has been developed as a high quality and high efficiency system. However, recent technological advances have made it possible to construct system ranging from large scale complex factory automation systems including production control to small scale process control use stand-alone systems under a uniform design concept, and have expanded the field of a uniform design concept and have expanded the field of applications of CRT operation substantially.

The new distributed digital instrumentation systems mainly composed of PCS and OCS introduced in this article are realized by pursuing meeting the needs of their users, flexible system construction and high reliability control, and simple software manufacturing and promise a wide range of application by all users.