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CONFIGURATION OF DISTRIBUTED CONTROL SYSTEM MICREX-MS

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1. FOREWORD

The Fuji Electric distributed control system MICREX started when the MICREX-P was sent out to the world in 1975. After that, many functions were offered and the system was expanded by substantial improvement of the architecture and the third generation MICREX was announced in 1987.

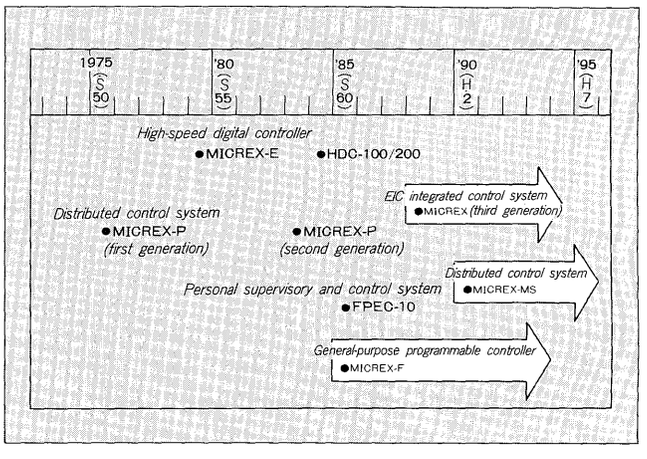
This third generation is gaining attention and is favorably evaluated as a control system which realizes an EIC integrated control system and as a control system which can be expanded up to large-scale plants not possible in the past.

The EIC integration concept is considered to be realized by a system which integrates the three fields of electric control (E), instrumentation (I), and computer (C) that were considered individually in the past. The EIC integrated control system is realized by a simple architecture that unifies both hardware and software and realizes balanced functions, performance, and reliability over the entire system. By realizing a single window which performs plant operation at the same operator station, the operator handles control objectives of three different fields in the same supervision environment. Further, the tools which perform engineering are standardized and engineering in the same software development environment is made easy. With such an EIC integrated control system, user having all resources can be efficiently managed in plant operation and maintenance.

Up to now, this concept centered about large-scale systems was a basic need unrelated to system scale. On the other hand, many small-scale systems in which electric and instrumentation control coexist were being built individually by combining single loop controller, personal computer, programmable controller (PC), etc. and were disadvantageous from the standpoints of equipment operation and maintenance. Therefore, the merit which realize EIC integration realized with a large-scale system economically with a small-scale is large.

The MICREX-MS (Mini-Automation System) announced in July 1990 is an EIC-integrated control system (mini-EIC) developed especially with small-scale plants as the target and is without question the leading system in the world. (The transition of the distributed control system MICREX is shown in *Fig. 1*.)

Fig. 1 Transition of distributed control system MICREX



This paper introduces the configuration and features of this MICREX-MS system.

2. DEVELOPMENT CONCEPT AND FEATURES

2.1 Technical inheritance from conventional systems

The know-how of the third generation MICREX developed for large-scale plants was inherited and the MICREX-MS was developed for small-scale plants as the target.

Engineering, control functions configuration method, supervisory and control method, etc. inherited the following techniques:

(1) Use of touch screen (OCS-250)
(2) Interactive engineering (OCS-250)
(3) Interactive image generating function (OCS-250)
(4) Sequence by time chart (PCS-250)
(5) Loop wiring by internal instrument (PCS-250)
(6) Realization of high-speed arithmetic processing and sequence control (HDC-250)
(7) Realization of high-speed fuzzy control (HDC-250)

2.2 Standardization of hardware

For an integrated control system, unifying the hardware architecture is important in standardizing the hardware and increasing efficiency by reducing the number of

maintenance parts. With the third generation MICREX, the operator station and controller architecture was unified by making the MICREX-F500 which used MULTIBUSII[note] a common element.

On the other hand, the MICREX-MS uses an EI integrated controller that used the same architecture as the MICREX-F250 general-purpose PC in common. The F250 is the highest level of general-purpose PC developed as the successor to the F200 Series, and has a sequence processing speed of three times and bit operation of 15 times those of the F200.

A process station (PCS-250) mounting an instrumentation package at this EI integrated controller and a high-speed digital controller (HDC-250) mounting an electric control package are available for the MICREX-MS.

The PCS-250 and HDC-250 are operated by function control language (FCL), the same as the high-level F500 Series. Therefore, software of MICREX-MS and large scale MICREX is interchangeable and effective use of precious software resources is possible.

On the other hand, the OCS-250, which is the MICREX-MS man-machine interface (MMI), uses an FA personal computer (FMR-50FA) as basic component. Therefore, the abundant peripheral devices of the FA personal computer can be used. It also has the merit that software interchangeability is maintained even when the hardware functions are upgraded. These basic compornents also have high generality and a cost merit which lowers the hardware price of the MICREX-MS system.

Table 1 OCS-250 specifications

Number of support tags	User tags 4864 Internal instruments 768	
Plant panel	32 pages, 128 points/page	
Trend panel	32 pages, 4 pens/page	
Group panel	128 pages, 8 tags/page	
Loop panel	768 pages, 1 tag/page	
Alarm panel	32 pages, 16 points/page	
Annunicator panel	4 pages, 48 points/page	
Operation guide panel	8 pages, 10 points/page	
Construction	20 inch CRT desk type	14 inch CRT desktop type
Processor	80286	
Memory	Main memory 1M bytes	
Auxiliary memory device	5 inch FDD (1M bytes) x 2 3.5 inch HDD (40M bytes) x 1 3.5 inch FDD (1M bytes) x 1 (Option)	5 inch HDD (1M bytes) x 2 3.5 inch HDD (40M bytes) x 1
CRT	20 inch color	14 inch color
Number of display dots	640 x 400	
Display colors	8 colors (red, magenta, yellow, blue, cyan, green, white, black)	
Displayable characters	8x8 dot size, 4000 characters Alphanumeric characters, *Katakana* 8x16 dot size (en). 2000 characters Alphanumeric characters, *Katakana* 16x16 dot size (em). 1000 characters Alphanumeric characters, Katakana, kanji (JIS Level 1, Level 2)	

2.3 Economical and flexible system configuration

The HDC-250, FA personal computer, high-level computer, etc. can be connected without a gateway, with one OCS-250 and one PCS-250 basic system as the nucleus and system expandability is excellent.

In case of connection with a high-level distributed control system MICREX, high-level MMI (OCS-1500) is possible to monitoring, data transmission, and alarm monitoring of PCS-250, HDC-250 by connecting a P link to a high-level controller (PCS-500, HDC-500). This allows fusion as a component of a large-scale control system. A system configuration example is shown in *Fig. 2*.

The MS maximum system configuration is:

(1) Monitoring control loop 768 loops
(2) Number of digital input/outputs
PCS-250 512 points
HDC-250 8704 points
(3) Number of controller connected (PCS-250 and HDC-250 total) 8
(4) Number of OCS-250 connected 6

2.4 Use of touch screen

Since equipment operation and screen switching are performed easily by only touching the CRT with your finger, direct observation operation is performed by using a keyboard. Especially, a touch switch input function by EXIT mode (pull switch) is used as an erroneous operation prevention function. This touch screen has functions inherited from the third generation MICREX previously mentioned. These are revolutionary functions for this class.

Touch screen functions are screen switching, data item selection, and equipment operation and can be constantly known by touch cursor which displays the position touched by your finger on the screen by touch tracking function. Further, in the range of the operation items, a touch mark is displayed instead of touch cursor and the operation item position can be known easily.

2.5 Simple engineering

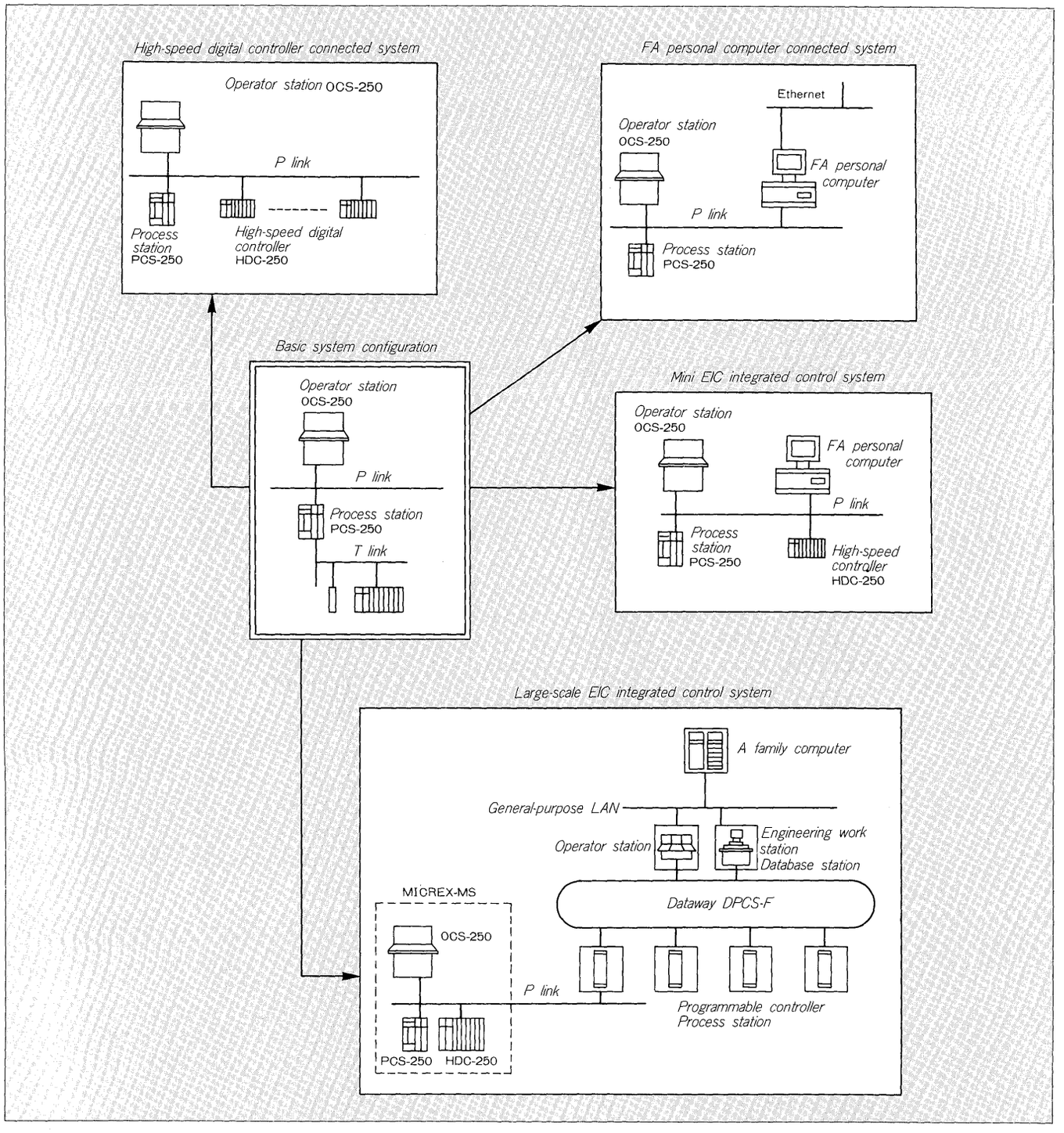
All the engineering functions, which perform loop control, sequence control function configuration, and grafic generation, can be generated interactively.

A system can be configured easily even without sequence and software experts with these powerful engineering functions. Therefore, engineering is possible by the customer himself at plants which cannot be opened to the outside and plant remoduling by the customer himself, etc. and it has reduction of engineering expenses, and other merits.

2.6 Fuzzy control can also be installed

High-speed fuzzy control is performed as an HDC-250

Fig. 2 Development of MICREX-MS system configuration



FM (Function Module). An automated system combined with PID control, sequence control, and other conventional control can also be realized.

The control loop is created by using the general-purpose fuzzy control support system FRUITAX under the ES50, which is the F250 program development support software. Loading, etc. are also performed the same as the ES50.

2.7 Recipe management system

Recipe management systems developed for chemical, foodstuffs, pharmaceuticals, fine chemicals, and other Batch plant are also available for the MICREX-MS as options.

The operator specifies the production amount and lot No. of the recipe selected from a database in accordance with the production plan and starts the recipe production sequence and monitors the recipe production conditions during production. Moreover, after the end of the recipe, the used material and production amount, etc. are printed

Fig. 3 A family computer

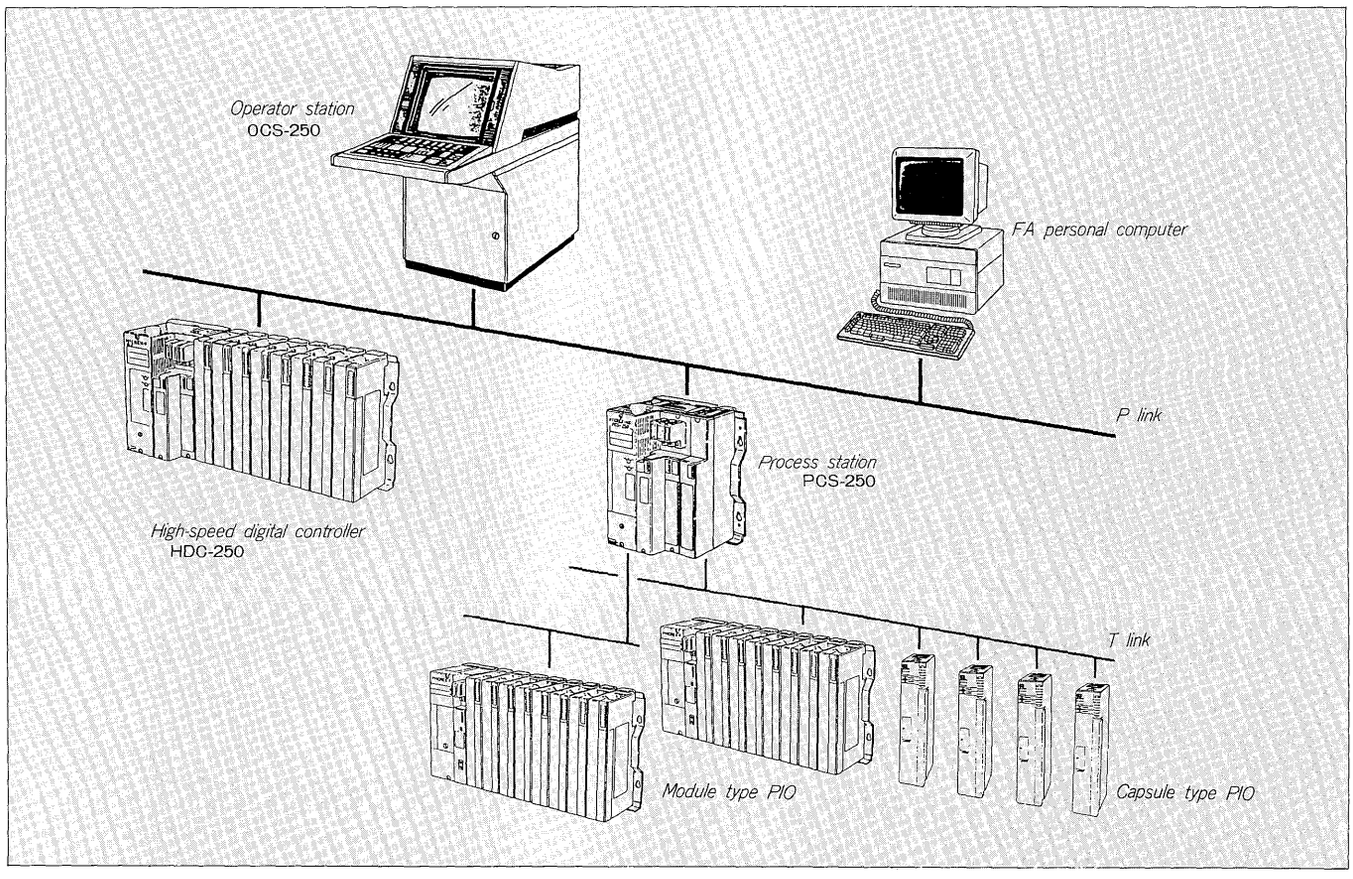
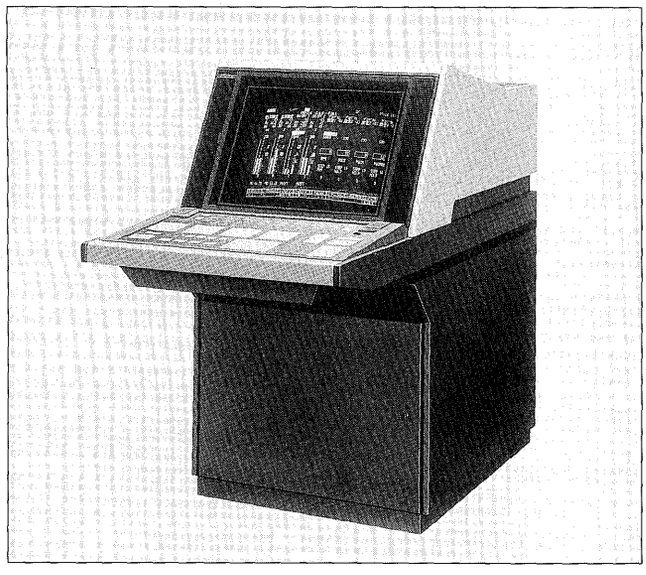


Fig. 4 Operator station (OCS-250)



as a document.

Recipe system functions are recipe engineering, recipe reservation and starting, recipe monitoring, recipe results collection and printing, and recipe utility.

3. MICREX-MS SYSTEM CONFIGURATION

MICREX-MS consists of an operation station (OCS-250) that performs plant monitoring operation and engineering and a process station (PCS-250) and high-speed digital controller (HDC-250) that perform control functions. The stations are interconnected by 5M bps high-speed P link that is the gateway between the MICREX-F processor. An FA personal computer and PC (MICREX-F) can also be connected, as required. The system configuration is shown in *Fig. 3*.

3.1 Operation station (OCS-250)

The OCS-250 is an MMI having functions of operation station (OCS) and engineering work station (EWS).

A 20 inch screen type with touch screen and 14 inch desktop type are available. The 20 inch type has a 20 inch CRT and flat keyboard installed to a refined design console desk and while being a small-scale system, it is abundantly environment-proof even when installed in a conventional instrument room. Moreover, a PCS-250, 40M bytes hard disk, and 3.5 inch floppy disk can be built in by type specification.

On the other hand, the 14 inch desktop type is an inexpensive operator station suitable for monitoring plant and engineering and maintenance use.

An exterior view of the 20 inch type OCS-250 is shown in *Fig. 4* and its specifications are shown in *Table 1*.

(1) High-level functions CRT

A touch screen at which screen swiching and equipment operation are performed easily by touching the screen with your finger is provided.

Fig. 5 Process station (PCS-250)

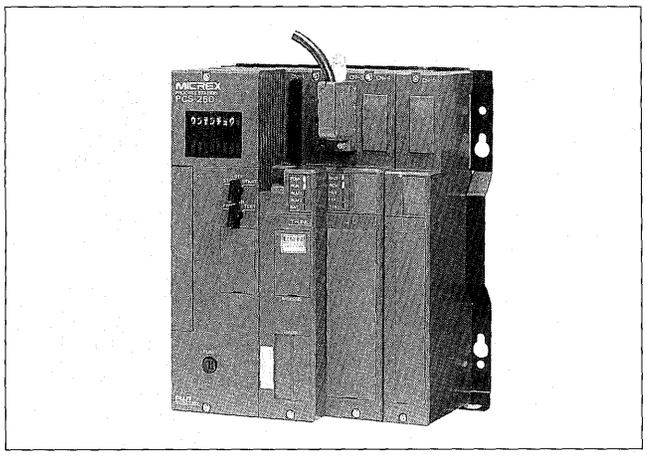
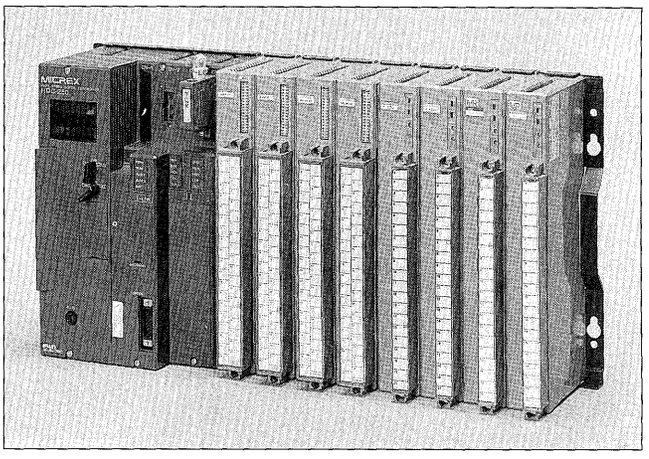


Fig. 6 High-speed digital controller (HDC-250)



(2) Operation keyboard
Inheritability of the operation method is maintained by the same arrangement of the one touch keys, analog up down key, and other conventional OCS. Consideration is also given to operator erroneous operation by lock key and warning tag comment function.

(3) Single window
All the data in the system can be called at the screen on the OCS-250 by simple operation. PCS-250, HDC-250 process data, FA personal computer data, and other data needed in control can be displayed on one screen.

3.2 Process station (PCS-250)

The PCS-250 is a instrumentation use process controller which realizes loop control and sequence control at one unit. Loop control can be configured easily by only software wiring by interactive engineering function. Sequence control programming uses a time chart method and can be configured without using program language. An exterior view of the PCS-250 is shown in *Fig. 5*.

(1) Control period 1 sec (0.2 sec also possible)
(2) Internal instruments 96
(3) Number of sequence steps 128 (simultaneous execution 32)

3.3 High-speed digital controller (HDC-250)

This is a controller which realizes the high-speed sequence control demanded in the electric control, and other electric fields. The specifications of the HDC-250 are shown in *Table 2*. Since 10ms period processing and interrupt processing functions are provided, it is suitable for position control and other systems which demand fast response. Programming uses the intelligent loader D50 with the F250 program development support software ES50 installed to a lap top type FMR and ladder, FB chart (function block chart), and SFC (Sequential Function Chart) can be used.

An exterior view of the HDC-250 is shown in *Fig. 6*.

Table 2 HDC-250 Specifications

Item			Specification
Task control method	Priority level and maximum number of tasks		Level 2 : 8 Level 3 : 8 Level 4 : 16 Level P : 40 Priority order 2 > 3 > 3 > P Level P is cyclic level.
	Interrupt control		Periodic interrupt : 24 Event interrupt : 8 Periodic interrupt or event interrupt is specified by system definition
	Subroutine		Number of subroutines : 512 Nesting level : 32 nests
Data type			Bit, word, double word
Program description			Ladder chart, function block diagram, SFC
	Kinds of instruction words		a.b contact, coil, timer, counter, arithmetic operation, logic operation trigonometric operation, analog operation, data transmission, file processing, SPC, program control.
	Instruction execution time		Sequence operation : 0.17μs/contact, 0.33μs/coil Addition : 0.68μs~3μs Multiplication/division : 0.74μs~10μs Analog operation : 10μs~30μs
Memory capacity			Program memory : 128K steps (system: 64K steps, application: 64K steps) Data memory : 192K words
Input/output points	Maximum		Digital : 8704 points Analog : 2176 points
		Direct connection	Digital : 512 points Analog : 128 points
		Remote	Digital : 8192 points Analog : 2048 points Updating period : 512 points/10ms
Self-check functions			Watchdog timer check, battery check, input/output check
Programming/debugging device			Intelligent loader D50

3.4 Dataway

The MICREX-MS dataway uses the MICREX-F series P link. Since a controller, PC FA personal computer, and high-level computer can be connected to this P link without a gateway, a reliable and economical system can be built. The PCS and HDC collect and send the data inside the controller by screen data send request from the OCS-250

and receive operation signals and setting data from the OCS-250. When an alarm is generated, the controller adds the time the alarm was detected and sends a report. Furthermore, the controller also contains OPERATION PROHIBITED, CAUTION, and other warning tag information corresponding to the status of the internal instruments. Therefore, unified management of alarms and unified management of data are performed even when monitoring with multiple OCS-250.

The functions above are all supported by the controller standard P link transmission package and the OCS-250 transmission processing program load is reduced and can be displayed as the same data on the screen.

3.5 PIO

The abundant PIO of the MICREX-F are used with the MICREX-MS. Especially, for the HDC-250, a PL relay terminals with noise blocking, signal amplification, valve operation, and protection circuits at the relay terminals function can be connected as the interface with numerous sensors and valves and the peripheral devices are simplified and reliability is improved and at the same time. maintenance work is rationalized. A CIO-200 electric compact processor terminal can also be connected.

(1) Compact capsule type, integrated module type, etc. can be selected according to the number and installation site of the PIO used.
(2) At existing plants using the MICREX-F, the site PIO can be used directly and the high-level controller can be repressed to an MS system so that construction cost can be reduced substantially.
(4) Since they can be shared by PCS and HDC, maintenance is lightened and maintenance parts are common.

4. COMPONENTS SPECIFICATIONS

4.1 Operator station OCS-250

Since the OCS-250 was used at the FA personal computer control function to realize wywtem functions expandability and generality and the abundant monitoring functions were software packaged.

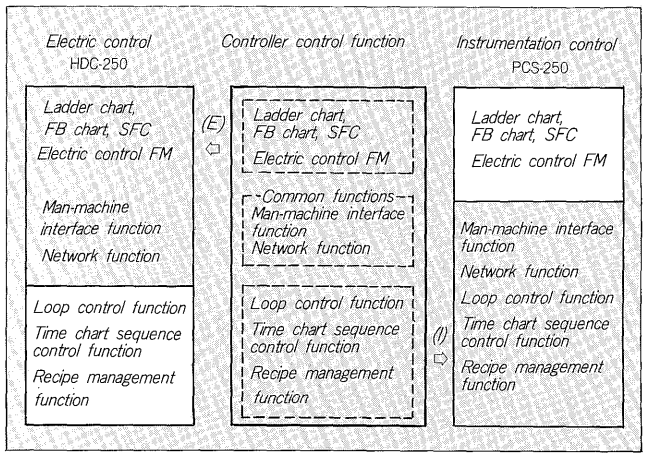
The 20-inch CRT desk type is a full-scale edition as a man-machine interface (MMI) with dustproof operation key board and touch screen as standard. Flexible operation is possible at any screen by high operability and recognition. (See *Table 1.*)

The OCS-250 touch operation uses the input by EXIT mode (input is turned on when your finger is removed from the screen) acclaimed with the MICREX Series and erroneous operation is prevented.

The desktop type uses an FA personal computer as is and monitoring, operation, setting, engineering, and system maintenance are performed by JIS arrangement standard keyboard.

With the desktop type, one expansion hard disk and one floppy disk (3.5 inch) can be built in.

Fig. 7 Controller concept



4.2 Controller

The component elements of an EIC system are supervisory and control system, hierarchal network system, high-speed sequence function in the electric control field, and DDC function in the instrumentation control field. These are integrated and called an EI controller.

For the MICREX-MS, the electric control and instrumentation control software are packaged and are installed in the controller as an EI integrated controller so that a controller corresponding to the application can be arbitrarily built by selecting packages. (See *Fig. 7*).

Functional control language FCL was used as the internal language so that software interchangeability with the high-level MICREX-F500 Series is maintained and the use of various package software was made possible.

(1) Loop control function.

Eight internal instruments, including PID controller, Ratio calculation, and program setter, and processing by input processing package to each internal instrument are realized. Cascade control, proportional control, and program control are performed by combining these controllers.

(2) Sequence control function

Sequence control uses the step sequence system and control combined with internal instruments can be realized.

Sequence design and generation are performed by time chart system so that the processing contents and order for each process can be grasped.

Eight inputs and one outputs operation conditions two-step function is provided at the process switching condition and output definition screen and analog comparison can also be performed at the switching condition.

Complex sequences are also time-charted for each function and generation and maintenance can be performed easily by hierarchal design.

(3) Recipe management

The recipe management function is package software ideal for variable type, variable amount production batch plants.

It has simultaneous operation, tracking, shirt-sleeves operation, and other operation functions by time chart

system definition.

(4) Electric control FM

Various function generators, position control modules, and other package software, including fuzzy control module, is available and various application design and generation are performed easily.

The PCS-250 is the suitable controller for loop control, time chart sequence control, and other instrumentation control use.

The HDC-250 is a high-speed and high-level functions controller that is suitable for fast response control of the electric control field.

The specifications of the HDC-250 are shown in *Table 2.*

5. CONCLUSION

The features and configuration of the MICREX-MS were introduced above from the standpoint of an integrated control system.

The capabilities of the MICREX-MS system far exceed those of conventional small-scale control equipment and linkage with a high-level computer system, and field side FFI (fiber optics field instrumentation) system will be made possible from the standpoint of expandability. We are confident that the expectations of users will be met and it will be widely used as a high expandable mini EIC system by connecting these systems.