

NEW TEMPERATURE CONTROLLER SERIES

MICRO CONTROLLER E/H

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1 FOREWORD

Recently, the amazing advance of microcomputer technology has pushed digitalization rapidly into the ordinary instrumentation field and manufacturers are even marketing high-function, low-cost controllers, which are the nucleus of a control system.

Fuji Electric has delivered many ordinary controllers ever since the first one called Z Series was placed on sale and now supplies more than 30 models. We have now developed a new series of ordinary controllers to better meet the specifications and price demanded by the market.

The new series called Micro-Controllers is described below.

2 DEVELOPMENT AIMS

The Micro-Controller development aims are described below.

2.1 Two series: general-purpose type and high-functions type

The new series, developed to meet the needs of the market for low price and high functions, is serialized into two series: general-purpose type Micro Controller-E and high-functions type Micro Controller-H.

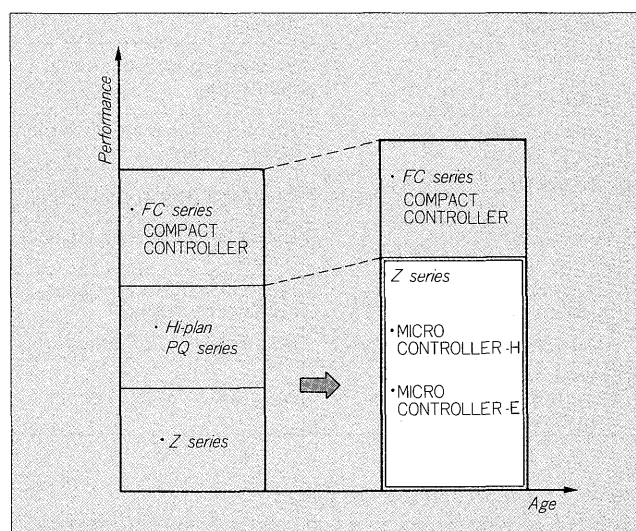
The Micro Controller-E is a low cost type to meet the market demand for low price. The Micro Controller-H is a high functions type with the various high functions demanded by users.

2.2 Use of the newest technology

The newest design technology, device technology, and production technology were used in product design and production.

Specifically, high functions single-chip microcomputer custom LSI and PCB surface mounting technology were used. As a result, costs were lowered by reduction of the number of parts, functions were increased, and size was reduced by reduction of the mounting area.

Fig. 1 Fuji Electric new controller line



2.3 Serialization of Fuji Electric Controllers

The new product line is shown in Fig. 1.

Originally, there were three series of controllers, FC series Compact Controller, Hi-plan PQ series, and Z series, from high rank to low rank. By the development of this new microcontroller, the Hi-plan PQ series and Z series are integrated, and the Compact Controller-S is positioned at a high range of the Micro Controller-H.

2.4 Unification into seven models in DIN standard

This time, the models were adjusted to make their selection and management easier and were classified into four DIN standard sizes of 48(H) × 48(W) mm, 72(H) × 72(W) mm, 96(H) × 96(W) mm, and 96(H) × 48(W) mm and seven models in total.

2.5 New design

In step with digitalization of the internal circuit, the front panel was changed from the conventional analog or digital switch setting and meter indication system to a digital setting LED indication system. At the same time, the front panel was given dustproofing and waterproofing

functions by using a flat key. The front panel was also designed to be common to all models.

2.6 Realization of product stockpiling and shorter delivery time

To realize end user and original equipment manufacturer stockpiling and shorter delivery time, the following product design was considered. That is, a multi-input system by which a total of ten kinds of thermocouple and platinum resistance input signals can be selected by switch and key operation and programmable range, positive/negative action switching function, etc. were installed.

2.7 Linkage with other systems

A Fuji programmable controller MICREX-F data transmission line T-link interface and general-purpose transmission interface RS-485 are available with the Micro Controller-H so that linkage with other systems and communication with a computer and various controllers are possible. As a result, expansion to new applications fields is also possible.

3 INTRODUCTION TO MODELS

Exterior views of the Micro Controllers are shown in Fig. 2.

The Micro Controller-E and H are introduced below.

3.1 Micro Controller-E

3.1.1 Overview

The Micro Controller-E is a low-cost, compact digital temperature controller with thermocouple, platinum resistance, thermistor, voltage, and current as its input signal. Abundant functions, from on-off control to PID control, are available. A dual type that controls heating and cooling with one controller is also available.

3.1.2 Features

(1) Abundant inputs

Thermocouple, platinum resistance, thermistor, and other voltage and current inputs are available as temperature sensor direct input and an economical control system

configuration matched to the sensor and final control element is possible.

(2) Multi-input, programmable range

For example, J, K, R, and many other kinds of thermocouples are available, depending on the measurement range and usage environment. Eight kinds of thermocouples can now be handled with one controller. The input is switched from the front panel. This allows input changes at the site. The input range can also be freely selected.

(3) Improved controllability

Controllability better than that of the old Z series was obtained by realizing a $\pm 0.5\%$ FS setting and indication accuracy and 500 ms control cycle, while being low cost.

(4) PID auto tuning function as standard

An auto tuning function which allows the controller itself to automatically calculate the optimum PID parameters even if the controller user does not have expertise of instrumentation is standard equipment.

(5) Dual type also available

Control of plastic molding and extruders, etc. requires a controller that controls heating and cooling with one controller. A heating and cooling control dual type has now been made available, in addition to the standard type, to meet this need.

(6) Process alarm, open heater alarm

Two points can be selected as process alarms from among more than 18 modes, including upper and lower limit deviation (with lower limit hold) and upper and lower limit absolute value alarm. Since the general-purpose controller is frequently used in temperature control of equipment that use a heater, an open heater alarm function that senses the primary current of the heater at a fixed cycle and outputs an alarm when the sensed current drops below a preset current value was also provided.

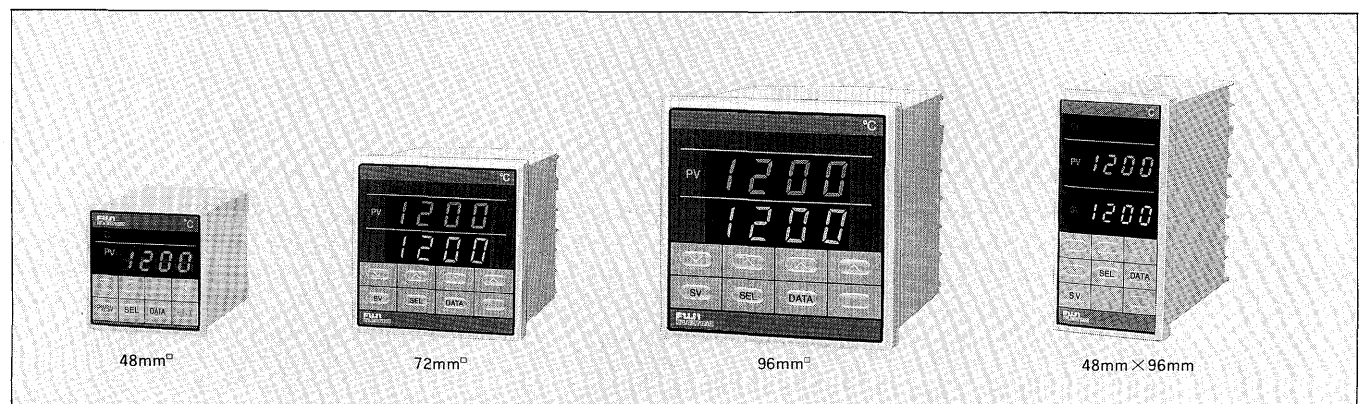
(7) Variable power supply

A variable power supply which can handle any power source from 85 to 265 V AC without switching a switch or changing terminals was used. Various power source voltages can be easily dealt with by this.

(8) Front panel dustproofing and waterproofing functions

The front panel was given dustproofing and waterproofing functions conforming to IEC529IP55 so that it

Fig. 2 Micro Controller exterior views



can be used in adverse environments.

(9) Four DIN standard sizes

Four DIN standard sizes of 48(H) × 48(W) mm, 72(H) × 72(W) mm, 96(H) × 96(W) mm and 96(H) × 48(W) mm are available to meet diverse user demands. The depth is an extremely compact 87 mm or 100 mm. The best model matched to the size of the panel can be selected.

3.1.3 Specifications

The Micro Controller-E specifications are listed in Table 1.

3.2 Micro Controller-H

3.2.1 Overview

The Micro Controller-H is a compact, high functions

digital controller that can be used in pressure, flow level, and other control systems, including temperature control. Since it has ratio, cascade, and other sophisticated control functions, as well as constant value control, of course, it is suitable for most control systems. An application system configuration incorporating various digital equipment can be easily realized by using a transmission function.

3.2.2 Features

The Micro Controller-H has the following features, besides the functions of the Micro Controller-E:

(1) Full multi input, programmable range

A full multi input function which allows one controller to handle many kinds of input signals was used. Since the

Table 1 Micro Controller specifications

Item			Specification	
			Micro Controller-E	Micro Controller-H
Input	PV	Thermocouple	J, K, R, B, T, E, S, PR40/20 cold-junction compensation, internal burn-out circuit	
		Platinum resistance	Pt100Ω/JIS, Pt100Ω/IEC internal burn-out circuit	
		Thermistor	Available	
		Voltage	1 to 5 V DC input impedance 400kΩ	
		Current	4 to 20mA DC input impedance 250Ω	
	Auxiliary	Analog	—	2 points
		Digital	—	3 points
		Valve position	—	1 point
		Heater current	1 point	
	Other functions		Multi input, programmable range	Full multi input, programmable range
Accuracy		±0.5% FS	±0.2% FS	
Control cycle		500 ms	100 ms	
Control operation	Proportional band		0 to 999.9%	
	Integral time		0 to 3,600 s	
	Derivative time		0 to 3,600 s	
	Ratio		—	0.01 to 2.00
	Bias		—	0 to 50% FS
	Other functions		Auto tuning, positive/negative action switching, integration saturation prevention	
Output	MV	Contacts	220 V AC, 3 A 1 c contacts	
		Current	4 to 20 mA DC	
		Voltage	60 mA/24 V at ON	
		Motor valve operation	—	220 V AC, 3 A, 1 a contacts × 2
		Inverter control	—	4 to 20 mA DC
	Auxiliary	Analog	—	1 point
		Digital	—	3 points
		FAULT	—	1 point
	Other functions		Time proportioning cycle 1~150 s variable, dual output possible	
Alarm	Process		2 points deviation/absolute value 220 V AC, 1 A	
	Open heater		1 point setting range 1.0~50 A 220 V AC, 1A	
Additional functions	Manual control		—	YES
	Transmission		—	T-LINK, RS-485
	Calculation function		—	Square root, filter
Usage conditions	Ambient temperature		-10 to 50°C	
	Ambient humidity		90% RH or less	
	Power requirement		85 to 265 V AC variable power supply	
Size (mm)			48 (H) × 48 (W) × 87 (D) 72 (H) × 72 (W) × 100 (D) 96 (H) × 96 (W) × 100 (D) 96 (H) × 48 (W) × 100 (D)	72 (H) × 72 (W) × 150 (D) 96 (H) × 96 (W) × 150 (D) 96 (H) × 48 (W) × 150 (D)

input signal is changed from the front panel, application changes at the site are also easy.

(2) High controllability

Realization of $\pm 0.2\%$ FS setting and indication accuracy and 100 ms control cycle allows use not only with temperature control, but also with pressure, flow, level, and other kinds of control systems.

(3) Abundant control functions

Ratio and cascade control, as well as constant value control, of course, is possible. Since a square root calculation, linearization, filtering, and other basic calculation functions are also provided, it can be used in a wide range of fields.

(4) Various control outputs

The kinds of final control elements that can be connected has also been increased by providing inverter control (DC 4 to 20 mA), motor valve control (increase-decrease pulse width), and dual (heating, cooling) outputs, besides current (DC 4 to 20 mA), contact (time proportion), and voltage (SSR, SSC drive) outputs.

(5) Transmission function

Two kinds of interfaces, general-purpose transmission interface RS-485 and MICREX-F transmission line T-link interface, can be used to communicate with various digital functions.

RS-485 is an electrical interface defined by EIA Standard, together with RS-232-C, RS-422, etc. The biggest feature of RS-485 is that bus line format multiplex (two-way communication) multipoint system is stipulated. The greatest difference between RS-485 and RS-422 is that whereas RS-422 is a one driver, 10 receivers simplex (one-way communication) multipoint system, a 32 drivers, 32 receivers multiplex multipoint system is possible with the RS-485. The RS-485 is expected to become the main transmitter interface in the future. Since it was predicted from this that the Micro Controller-H would also be used in many forms by connecting multiple units to a computer, this interface was used.

Because the T-link interface communicates by connection to the data transmission line between MICREX-F-F processor and PI/O capsules, and can be used with the same image as a PI/O capsule, a composite control system configuration combining sequencers and controllers can be easily realized. Moreover, since many Fuji Electric computers also support the T-link interface, they can be linked by using this interface.

(6) Three DIN standard sizes

Three DIN standard sizes of 72(H) \times 72(W) mm, 96(H) \times 96(W) mm and 96(H) \times 48(W) mm are available. The depth is compactly designed despite its high functions.

3.2.3 Specifications

The Micro Controller-H specifications are listed in Table 1.

4 EXPANSION TO AN APPLICATION SYSTEM

Recent technological advances have made it possible to offer sequencers, controllers, and other control equipment,

including the computer, at a low price. From such a background, a serial transmission function which allows communication between various digital equipment has become indispensable. On the other hand, Fuji Electric also wanted to develop a control system which can be configured at a low price for small scale processes. The Fuji simple process supervisory and control system (Free and Free System) which allows configuration of a system freely combined with a personal computer and sensors, together with providing the Micro Controller-H developed this time with a transmission function, is introduced below.

4.1 P&Z system

4.1.1 Overview

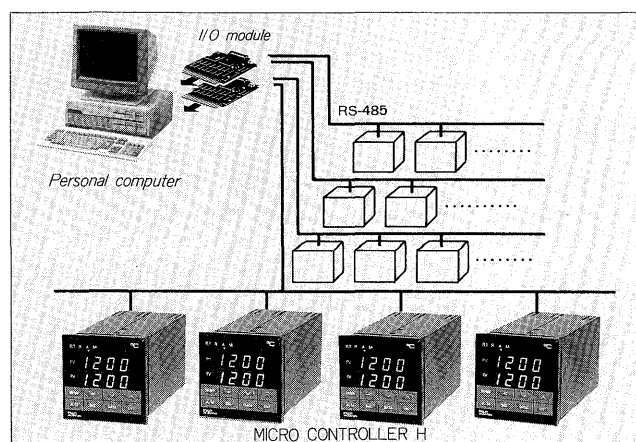
This is a centralized supervisory and control system built by combining a personal computer and multiple controllers (Micro Controller-H). Since many users of this system are in the general-purpose instrumentation field, a Micro Controller-H, RS-485 transmission board, and standard packages for the user's personal computer and immediate operation by systemization only and easy system modification by the user are demanded. This system is not only for Fuji Electric personal computers, but also for most personal computers on the market. An example of a system using a general-purpose personal computer is described below.

4.1.2 System architecture

The system architecture is shown in Fig. 3.

This system connects the Micro Controller-H to a general-purpose personal computer by RS-485 multipoint transmission. There are also personal computers for which an RS-485 interface is not yet available on the market. In this case, a method which uses a multiplexer, converter, etc. and connects the Micro Controllers to the personal computer by RS-232-C interface can also be considered. However, this method is undesirable because of the transmission speed problem. Since the maximum architecture takes several seconds to several tens of seconds to scan all the points, it may not be usable with pressure, flow, and other fast response control systems and is not very practical. Therefore, the use of the bus direct type RS-485

Fig. 3 P&Z system architecture



transmission board as much as possible is desirable. Since PV, SV, alarm information, etc. must be constantly written and stored, two floppy disk drives or a hard disk drive must be added to the personal computer as auxiliary storage.

4.1.3 System features

(1) Reduction of operator work

Monitoring of the PV, SV, MV, status, and other conditions of multiple Micro Controllers and modification and setting of parameters are performed centrally at one place.

⇒ Walking around the site has already become unnecessary.

(2) Small scale process supervisory and control system can be built cheaply

A control system matched to the scale and production processes of the plant can be built easily and cheaply with a personal computer available on the market.

⇒ Free and Free System

(3) Equipment safety control and product quality control are easy

Since the alarm generation contents and time can be displayed and recorded, safety control and quality control are possible.

⇒ Personal computer is the watchman

(4) Process data recording

Since the process data can be recorded at each specified time, quality control and process analysis are possible.

⇒ Personal computer plays the role of a recorder

(5) Risk dispersion

The Micro Controller and central computer are connected by a serial transmission line, but local operation by the Micro Controller itself is possible even if the central computer should be shut down.

⇒ Risk dispersion concept

(6) Nonstandard specifications can be easily handled

Because image creation and display data specification are performed interactively, the system specifications can be changed easily.

⇒ Applicable to all needs

4.1.4 Functions

The main functions are described below.

(1) Process supervision and control

Process control is performed by Micro Controller-H. Display and modification of the various parameters, control mode (R/L, A/M, etc.), needed by process supervision and controller are possible from the personal computer. The personal computer displays the process conditions in real time and the operator can be informed when an alarm is generated.

(2) Data recording

The process data and controller data necessary for safety control and quality control are recorded on an auxiliary recorder.

When the system has a printer, the data is printed in the specified printing format at the specified time.

(3) System definition

This function registers the architecture of this system. The controller No., TAG No., name, kind of input, scale, units, etc. are defined for each Micro Controller.

(4) Interactive image creation

All the Micro Controller-H data is managed by signal name.

Image creation specifies the signal name to be displayed, together with the display color and display mode (digital, trend, bar graph, etc.). A knowledge of programming language is unnecessary.

An example of a P&Z system was introduced here. However, development to a system with higher functions is also possible.

4.2 F&Z system

4.2.1 Overview

This system is designed to unify sequence control and loop control by connecting controllers (Micro Controller-H) to a MICREX-F data transmission line, T-link. Recent sequencers such as MICREX-F have analog signal processing and various calculation processing in addition to sequence control. For example, expansion to various applications, such as setting of the controller SV from the MICREX-F at a fixed time, was performed. An example is introduced below.

4.2.2 System architecture

The system architecture is shown in *Fig. 4*.

Data is exchanged with the processor capsule by connecting multiple Micro Controller-H on the MICREX-F T-link, MICREX-F PI/O capsules can also be mixed on the same T-link and the Micro Controller-H can also be used with the same image as the PI/O capsule. Devices from a personal computer up to digital switch + LED simple operator console are considered as F&Z system display and setter. Fuji Electric is developing many products having P-link and T-link interfaces and various systems can be configured. A system architecture using the Industrial Microstation L25 is shown in *Fig. 4*.

4.2.3 System features

(1) Unified loop control and sequence control

In the past, control was divided into loop control by controller and sequence control by sequencer. However, by communicating by T-link, system design synchronized

Fig. 4 F&Z system architecture

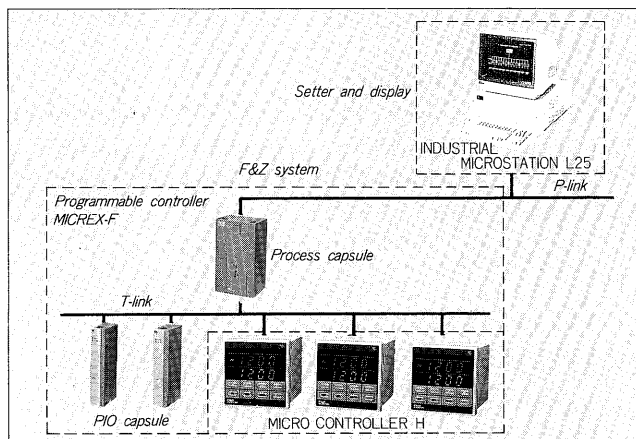
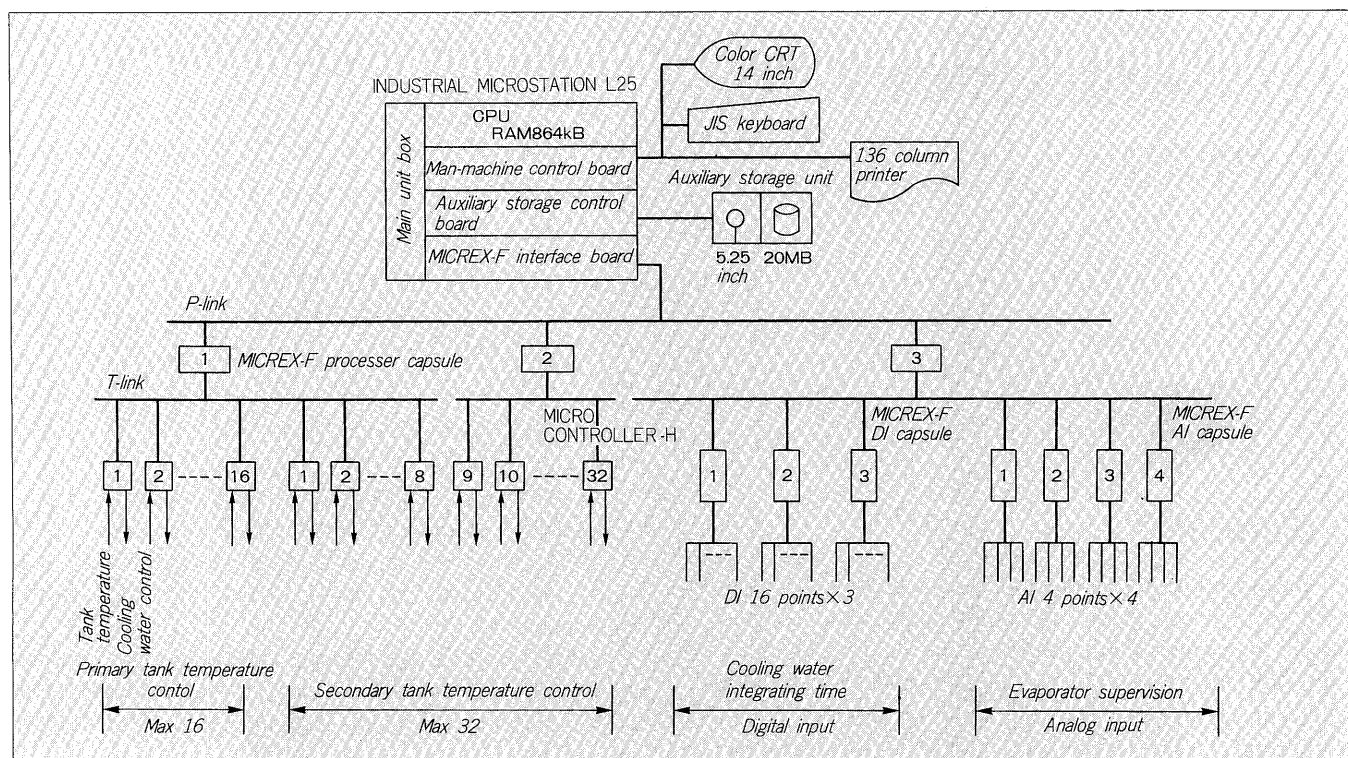


Fig. 5 Distillery supervisory and control system



with the loop data from the beginning of sequence design is possible.

(2) Free system architecture

Numerous systems can be configured by connecting various Fuji Electric digital devices to the T-link. Commercial personal computers can also be used through the personal computer interface.

(3) System safety

System safety is maintained by disconnection from the T-link even if the Micro Controller-H should be shut down for some reason

(4) Processor capsule as command post

By loading the program at the MICREX-F processor capsule, it becomes the command post of multiple Micro Controller-H. For example, operation as the program setter of all the controllers is possible by storing a different temperature pattern for each product in the processor capsule.

4.2.4 Functions

(1) Basic functions

The PV, status, and other real time data of Micro Controller-H is written at the I/O relay area on the MICREX-F T-link at a fixed period. The various data that do not require a real time nature can also be transferred by user program to the MICREX-F data module by message communication. Because the F&Z system can be freely configured with various types which connect to the T-link, it has no fixed system specifications. Its functions are outlined below by using a practical example.

(2) Practical example

An example of application to a spirits distillery super-

visory and control system is shown in Fig. 5.

It is outlined below.

Distilled spirits are a typical luxury and demand precise management and control of the production process to maintain fragrance and taste. Alcoholic liquors are controlled by law and production history data must be maintained. This system consists of Industrial Microstation L25, Micro Controller-H with T-link transmission function which can also be controlled independently, and programmable controller MICREX-F. Special fermentation process software packages are installed to this and automatic control and management by production lot are performed. If the temperature in the fermentation tank is taken in and the optimum temperature change pattern deduced from the relationship between temperature change and quality and available percentage by long years of experience is input in advance, the cooling water valve is operated automatically and program control is performed in accordance with the ideal temperature change.

5 CONCLUSION

The newly developed Micro Controller and its expansion to an application system was described. Since the development was accomplished by the newest technology of design, production, and device as well as Fuji Electric's abundant know-how of measuring and control, we are confident that the Micro Controller will be accepted by every user and used in wide applications.