

SYSTEM ARCHITECTURE OF MICREX-F SERIES

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1 FOREWORD

In the environment of rapid electronization and accelerated technological innovations of control and automatic equipment, programmable controllers (hereinafter called PC) are constituting the nucleus of the control system. Besides miniaturization of size, enhancement of functionality, lowering of costs and a rapid systematization is under way.

Fuji Electric has announced its first PC's in 1971. Since then, it has endeavored after their promotion as the central equipment of the digital control system and has come to supply products meeting the requirements of the time.

At present, FUJILOG Series as medium and small type of general purpose PC's and MIREX-E Series as industrial type large-scale and high-function PC's are available. Both series have a variety of characteristic equipment in their own series covering wide range of market demand.

However, movement toward FA (Factory automation) and FMS (Flexible manufacturing system) is rapid, and together with latest progress of IC and LSI technologies as well as that of communication technologies, production of compact high function PC's that can cope efficiently with installation automatization as composing of hierarchy and dispersion control is much expected.

The MICREX-F Series (hereinafter called F series) introduced in this report is a new PC series developed by throwing in the latest device design technique, communication technologies, system composition technique and software technique aiming at meeting the needs of our users. This series includes various PC types conforming to the scale and function of the system, and its basic notion is independent and dispersed composition with individual function units and they can cover all systems from medium and small scale stand-alone system to large scale dispersion control system with expandabilities.

2 FEATURES OF THE SYSTEM

F Series PC's have many outstanding features in the flexible system composition, compact capsule structure,

high speed computation and processing, high speed data transmission, and the like.

The following is their main features.

(1) Hierarchical dispersion control system

By the high speed network system (F-net), F series has functions of inter-processor coupling and existing controller (MECREX-E, PMS and others), computer and personal computer coupling. So that, F series can easily cope with highly advanced hierarchified dispersion control system.

(2) Compact capsule structure

Each processor unit and PIO unit constituting F series is housed in robust capsule structure and each one is independent from another in its function. So that they can cope with the universal requirement of dispersed installation, e.g. housing into individual control panel. Not only that, but their handling can also become easy and the maintenance of the system, simplified.

(3) Systematized software

A high powered programming language, common to all F series, is available. And this language has capability of computing various sorts of operations as sequence, arithmetics, adjusting control, function, data processing, etc. systematized as a new Programming Language (FPL). The FPL can directly express ladder diagram, block diagram and line diagram directly indicating numerical value operating formula. Consequently, symbolic programming of the application software can be made, and their making out will be simplified.

(4) High speed architecture

Thanks to development of custom LSI for bit processing, logical operations as sequence control is made speedier. Also in the high version F series processors, by development of custom LSI's for word processing and OS processing, improvements have been made on control and processing functions, e.g. high speed BCD operations and interruption control and also in data transmission function, high speedization and high functionalization have been realized, through custom LSI and hybrid IC.

(5) Easy-to-use software supporting tool

Compact program loaders equipped with highly maneuverable flat keyboard and a easy to read large size

LCD with back light have been developed. Connection between loaders and the processors is standardized both in their hardware and software, and these loaders are usable with all types in F series. Also, as they are provided with F-Net coupling function, they can cope with remote programming and remote monitoring as well as simultaneous use of two units within the same system, high efficiency in testing and maintenance can be expected.

Also as peripheral equipment, cassette MT, printer, ROM writer, and floppy discs will be provided.

(6) Improvement in reliability and maintainability

Besides the system is provided with measures for improving the global reliability through large scale reduction of number of parts used by adopting custom LSI's and hybrid IC's, suppression of temperature rise by lowering consumption power as well as reduction in number of external connections through F-Net coupling, the maneuverability as well as protection of electronic parts through capsule construction are greatly improved. Also, auto diagnosis function is completed so that failure can become localized on each capsule level.

3 SYSTEM COMPOSITION

The F Series is composed of various types of function units such as processors and PIO's, and F-Net couples them organically. Each function unit has capsule structure that can be installed dispersely and each one independent one from another. Coupling with other systems (PHS, FASMIC-G, etc) are all made through F-Net. F-Net coupling interface that is incorporated by each individual capsule is unified and standardized. So that the connection with each function unit can be easily done. So that the system can flexibly cope with complicated application, and an optimum system can be configured with high efficiency.

3.1 Composition of control system

For F series, F-100 series and F-200 series are provided as processors, while various system components, such as TK 10, TU 10 and others are provided as PIO's. (For the details, see other articles of the brochure.)

The control systems meeting the users' needs is composed by combining suitably these components and by combining them through F-Net. For example, small scale concentrated control system and PIO dispersion system are composed by one processor and PIO's of necessary numbers. The typical example is shown in *Fig. 1* below. In a large scale dispersion type control system, computers in supervisory and operating level and managing level, more than two processors are coupled with F-Net and thus they meet requirements by dispersing the control function.

As we have been, F series realizes wide range control system comfortably having ample flexibility and adaptability.

Fig. 2 shows an example of system configuration of hierarchical dispersion control system. Likewise, *Fig. 3* shows another example of system component coupled through F-Net.

3.2 Dispersion of PIO

There have been various remote PIO systems conventionally as control system separating processor unit from PIO unit, and all of these, almost, were the type of system that have been made possible to install dispersely by adding information and transmission functions to assembled type PIO's, and that the number of connectable couplings were comparatively small.

In F series, resolving the problem of remote PIO function, the following concept has been adopted for coping with the problem of independence and dispersion of PIO units.

- (1) Coupling between processor unit and PIO unit will be by a network (T link).
- (2) In order to eliminate the processor-independent system, T link interface of PIO units are unified and standardized.
- (3) Division of PIO function would be as small a unit as possible. (DI, DO: 16 points and 32 points, AI, AO: 4 points)

As the result, compatibility among different processor types are secured, and when it is necessary to upgrade the capabilities of the existing system, it will be possible to

Fig. 1 Configuration of small scale system (example)

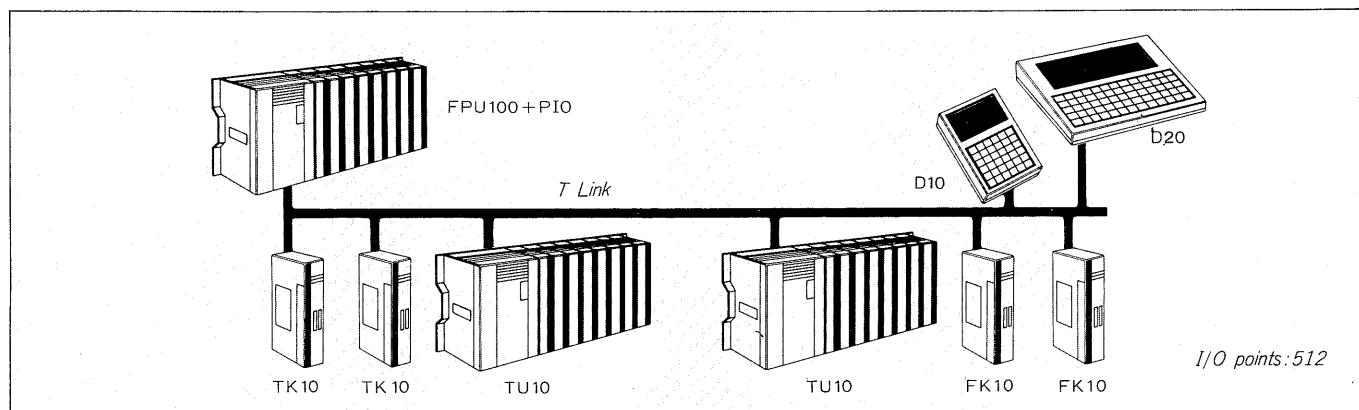


Fig. 2 Configuration of hierarchified dispersion type control system (example)

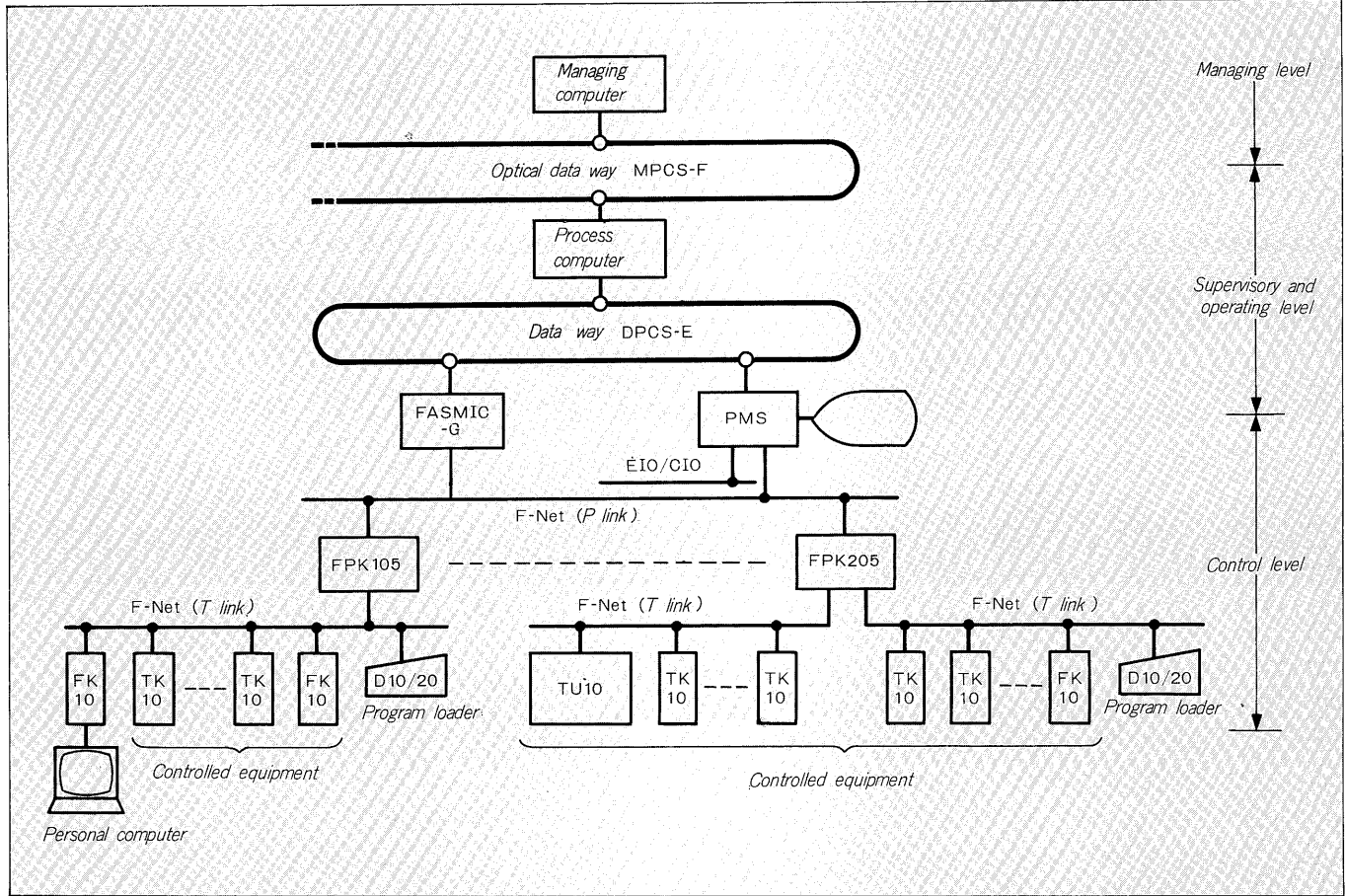
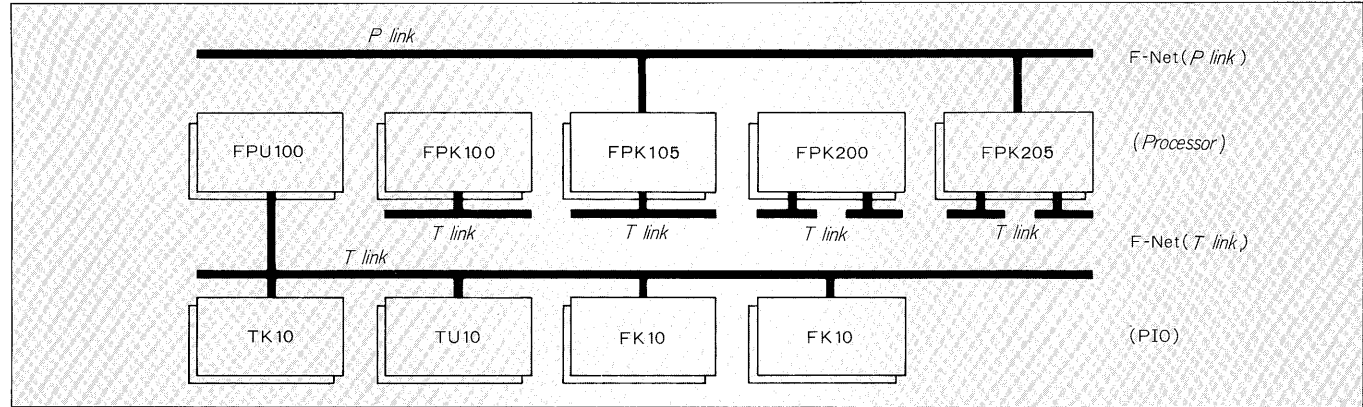


Fig. 3 F-Net and system components



do that only by replacing the processor units, so that the flexibility for remodeling and expansion is largely increased. Also, as the dispersion of PIO reduces the cable laying works, a larger reduction of installation cost and space saving due to decrease of control panels can be expected.

4 HARDWARE

4.1 Hardware composition

Hardware component of the F series can be classified

into the following three types as seen from their composition.

- (1) Capsule: System components as processor or PIO which are independent in function. Control power supply and F-Net interface function are individually incorporated and they can be installed individually.
- (2) Module: Unit mounting type processor and PIO's. They can not be installed individually but they function when they are mounted on base board as modular units.
- (3) Unit: This is a collective body of modules whose structure is mounting board type, and its control power supply and F-Net interface are commonly provided.

In due consideration of their maneuverability and practical use, these capsules, modules and units have unified outer dimensions of 250 mm (height) × 100 mm (depth). Their widths are standardized in several kind of sizes depending on mass of hardware.

4.2 Processor (FPK and FPU)

Processors of F series are classified into two series, namely F100 series and F200 series, their classification are made according to their function level. Further, F100 series are classified, from the point of view of their mechanism, into two types: that of unit and another of capsule. Table 1 shows F series processor types.

FPU 100 is a building block type processor unit in a combined form with PIO module. Through bus-coupling, a maximum of 8 PIO modules can be mounted together, and through T link coupling IO points can be expanded, and the unit has, as a standard practice, 512 input/output control functions.

Fig. 4 shows the outer view and structure of FPU 100.

FPK 100/105 is an independent type processor in capsule structure, and it can be installed singularly. The control computing function is identical to FPU 100 and IO points are the same, except that PIO's are all connected through T links. FPK 105 incorporates inter-processor link function (P link), so that it can be applied also for multi-controller system in which control functions are dispersely installed.

Fig. 5 shows the outer view and structure of FPK 100/105.

FPK 200/205 is a high-function independent type processor equipped with various computing functions as

adjustment control, function, data processing, etc. Through use of custom LSI, bit processing and word processing are made speedier, and it includes all functions of F100 series processors including programming language. Up to 2 lines of T links can be connected and 1,024 inputs and outputs can be controlled as standard practice. Also, FPK 205 incorporates P link coupling function, so that it can be used as a central controller for dispersed type control system.

Fig. 6 shows the outer view and structure of FPK200/205

4.3 PIO (TK, TU, and FK)

F series are available in two types, namely, independent PIO (TK and FK) in capsule structure having T link interface function and PIO (TU) in unit mounting module structure, and they can be used for different purposes.

Table 2 shows the use of PIO.

TK 10 is a general designation for capsule-structured independent type PIO, and is provided with, besides the general digital inputs and outputs, analog I/O, high-speed counter and others. They are, all, connected to processors through T link.

Fig. 7 shows the outer view and structure of TK 10.

TU 10 is a unit-type PIO in building block structure in

Table 1 F series processor types

Series name/Structure	Unit type	Capsule type
F100 Series	FPU 100	FPK 100 FPK 105
F200 Series	—	FPK 200 FPK 205

Fig. 4 FPU100

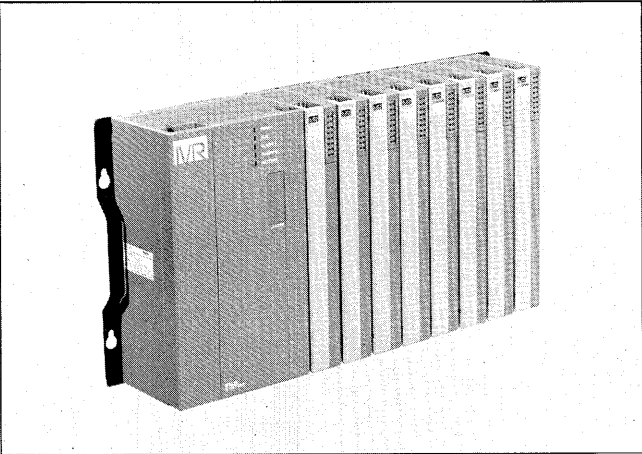


Fig. 5 FPK100/105

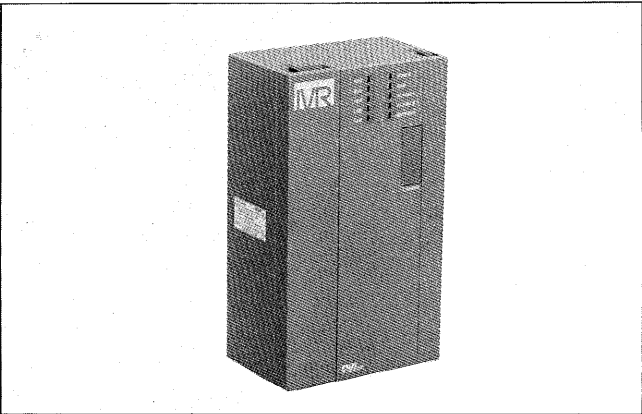


Fig. 6 FPK200/205

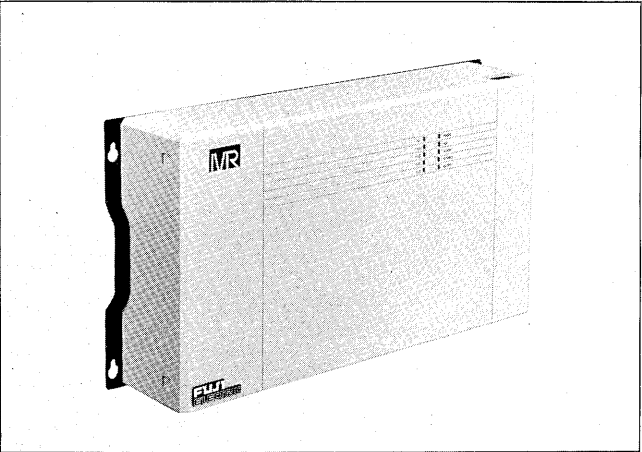
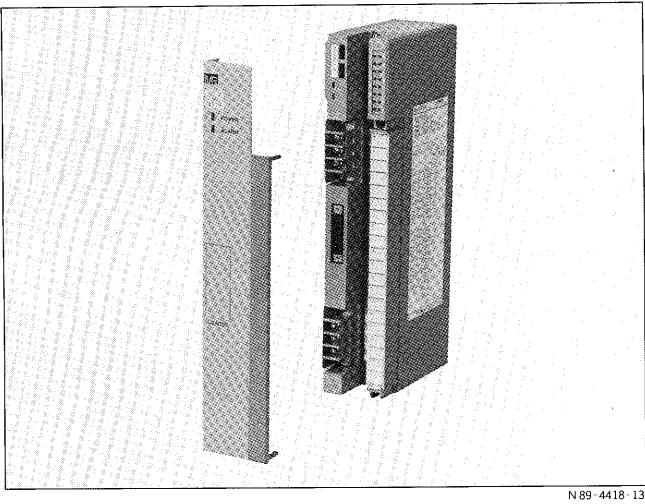


Table 2 F series PIO equipment type

PIO type Processor name		PIO for T-link connection		Module type
		Capsule type	Unit type	
F 100 series	FPU 100	TK 10 FK 10	TU 10	PIO module for FPU 100 unit mounting (Identical to PIO module of TU 10)
	FPK 100 FPK 105			—
F 200 series	FPK 200 FPK 205			—

Fig. 7 TK 10



which PIO modules are mounted, and has a T link interface function which is common to all units. Maximum of 8 PIO modules can be mounted on TU 10, which has a capacity of 128 inputs and outputs, in standard type.

Fig. 8 shows the outer view and structure of TU 10.

FK 10 is a general designation for intelligentified function capsules, which are used exclusively for expanding PC functions such as coupling with personal computers, position control and others. They are connected to processors through T link.

4.4 Program loader (D10/20)

Program loaders are important not only for creating PC programs and conservating tools but also for machine interface during document creation, testing and maintenance. And their functions play a big role for maneuverability of PC's.

F Series program loaders are available in two types, namely, hand-held type D10 and portable type D20 provided with large size LCD with backlight. Both types can be used for all processors of F Series. Also, as they incorporate F-Net interface function and can be connected to PIO capsules, as remote programming and remote monitoring can be used efficiently.

Fig. 10 shows the outer view of D20.

Fig. 8 TU 10

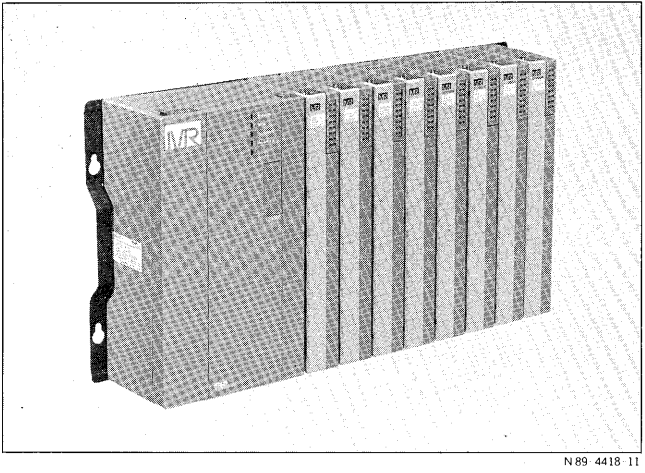
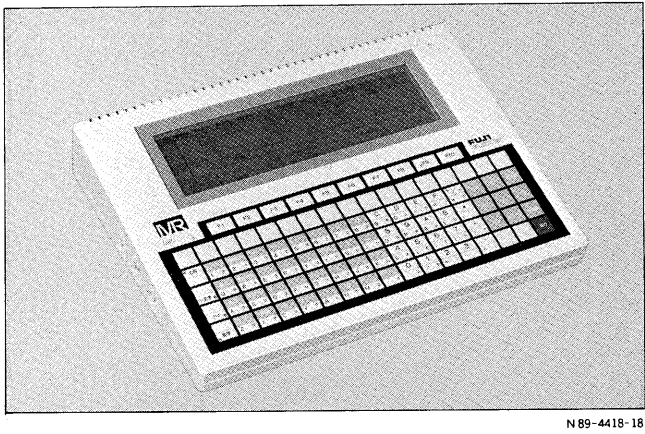


Fig. 9 D20



4.5 F-Net

F-Net is developed as high-speed network system aiming at data transmission in controller level. F-Net is classified into two links, that is, P links with main object of inter-processor communications and T links with main object of communication between processor and PIO. Both links are made much speedier than conventional similar links, and can be used with sufficient margin for high-speed control systems aiming at FA and FMS.

P link is the inter-processor communication system of dispersion type common memory refresh system having transmission speed of 5 Mbit/sec. and a maximum of 16 processors can be connected to the link. On the transmission line, coaxial cables with high economicity and functionality are used normally, but optical transmission cable can also be applied as required.

T link is a data transmission system between processor and PIO having transmission speed of 500 kbit/sec. On the link, a processor and a maximum of 32 TK, TU and FK can be connected, as well as two program loaders simultaneously. For transmission line, twisted pair cables easily obtainable and economic are used normally, but optical transmission cable can also be applied as required.

Since for both P link and T link, data transmissions are effectuated automatically by hardware and software, application program can be designed without need of conscious effort on transmission.

Fig. 10 shows various control systems through T link coupling and Fig. 11, control system through P link coupling.

Fig. 10 Control system through T link coupling

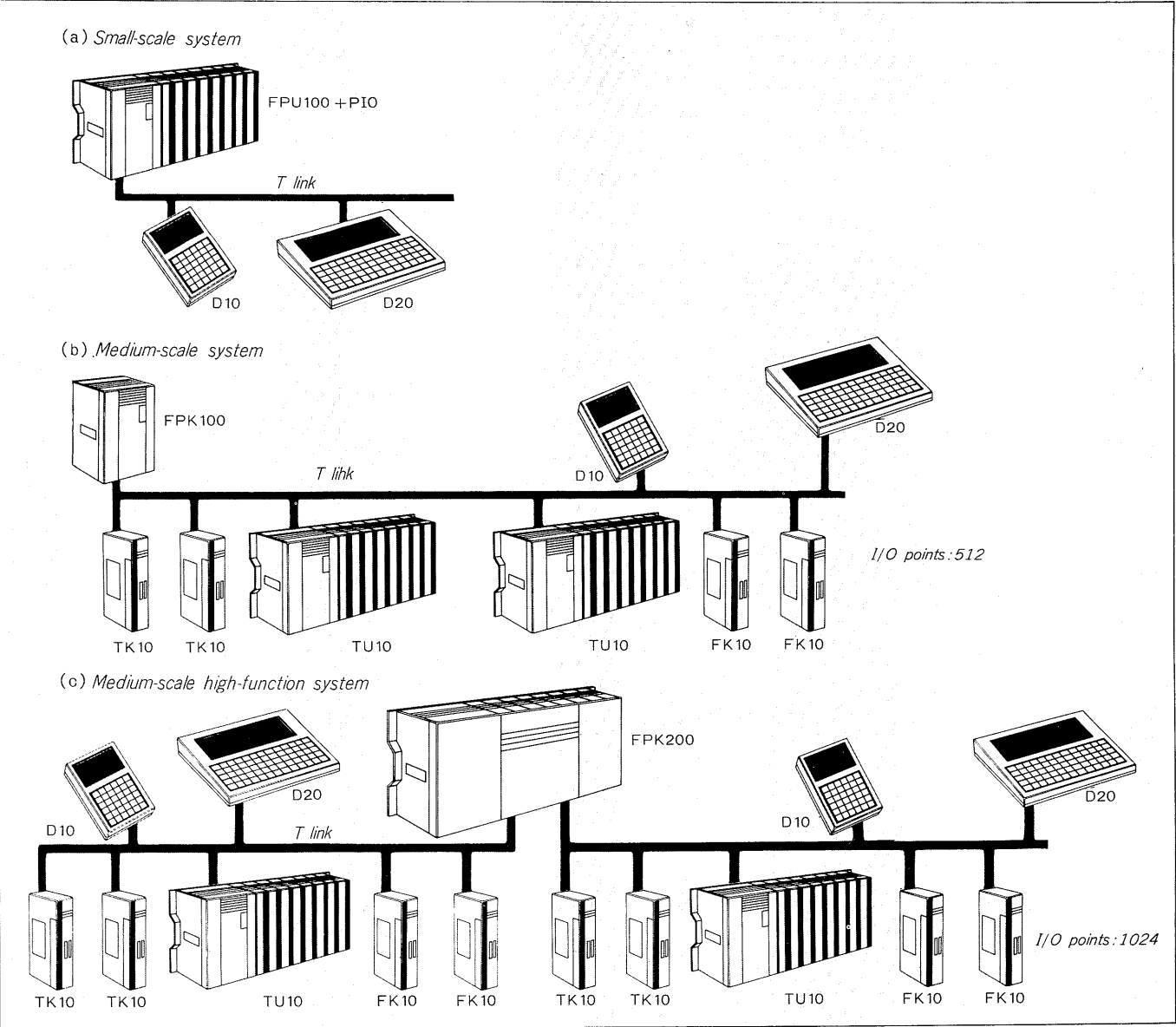


Fig. 11 Control system through P link coupling

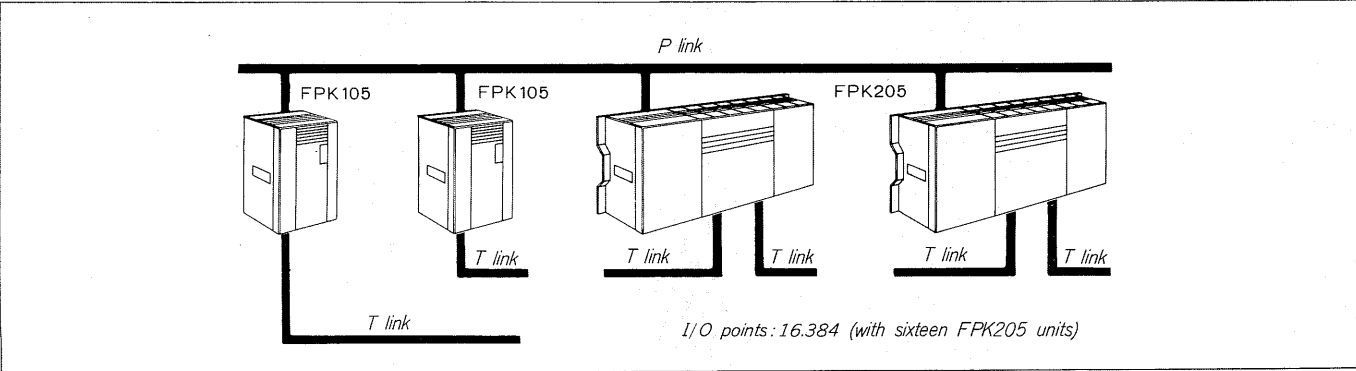


Table 3 Power supply specifications

Item	Specifications
Power supply	AC 100/110V, 1 ϕ , 50/60 Hz AC 200/220V, 1 ϕ , 50/60 Hz
Permissible voltage variation	AC 85–121V (In case of AC 100/110) AC 170–242V (In case of AC 200/220)
Permissible frequency variation	47–63 Hz
Permissible waveform distortion	10% or less
Permissible power interruption	10 ms or less

5 SOFTWARE

The application program of F series is described in symbolic programming language FPL common to all types of equipment. In FPL, powerful commands such as sequence control, arithmetic operation, function, adjustment control, and data processing are available. As all of these are graphically presented in ladder diagram, block diagram and line diagram, elaboration of application program is much simplified. (See the separate article in this brochure for the details.)

6 BASIC SPECIFICATIONS

As the basic specifications of the main components constituting F series, power supply and environment condition for installation are described in the following. (As for the details of individual functions and performance of each component, see the article regarding the components of this brochure.)

6.1 Power supply conditions

Each component of F series, except PIO module, incorporates independently its own power supply unit. Each power supply unit is designed to operate in either 100V AC or 200V AC as power source of exclusive use for components. They can supply power not only to internal logic circuits but also to external input/output signal and small-sized program loader (D10).

The specifications of the power supplies are as shown in Table 3.

6.2 Installing environment conditions

This system is composed with various types of components in compact capsule structure that will not give impression of being an electronic apparatus, and its handling is extremely easy. The capsule case is made of resin molding, and thanks to up-to-date circuit configura-

Table 4 Installing environment conditions

Item	Specifications
Ambient temperature	0~+55°C
Ambient humidity	20~90% (No condensation allowed)
Storage temperature	-20~+70°C
Storage humidity	20~90% (No condensation allowed)
Atmosphere	There should be no corrosive gas.
Noise immunity (Test condition)	By noise simulator of Noise voltage: 1,000 Vp-p, Noise width: 1 μ s, rising time: 1 ns
Dielectric strength	AC External terminal, global to FG AC 1,500V, 1 minute.
Insulation resistance	AC external terminal to FG 10 M Ω or more (by DC 500V megger)
Earthing	100 Ω or less

tion and heat emitting construction, it fully meets the natural air cooling condition and, at the same time, retains a high adaptability to the environment.

Table 4 shows the installing environment conditions of the main body of F Series. As for the details of programming loader, refer to the separate article of this brochure. this brochure.

7 CONCLUSION

Movement toward the automatization of installation in every sector of industries is rapid and together with expansion of domain of application, demand structure for control equipment is greatly changing. At the same time, the users' needs also the diversified and at present the realization of systematized control system easily including large scale system as well as small scale system is much expected.

The F series introduced in this article have been developed with a main purpose of coping with FA and FMS. The serialized processors and PIO's have both compact capsule structure that can be installed dispersely, and as they can freely coupled through F-Net, they can constitute flexibly the control systems that just meet the users' needs. In addition to coping with the new needs such as dispersion of PIO's to sensor/actuator units area, the F series have many features such as systematized system configuration including small scale system as well as large scale dispersion system and symbolic programming that simplifies the creation of application program.

We are determined further to research for better ways for expansion and enhancement of functionality of equipment in order to meet our clients' variegated requirements.