

MICREX-F SERIES NETWORK SYSTEM

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1 FOREWORD

MICREX-F series network system (F-Net) is a high-speed data transmission system constituting the basic element of MICREX-F series (control system abbreviated as F series) programmable controller (hereinafter abbreviated PC) for distributed .

F-Net couples in organic form processor capsules (P capsules), process input/output capsules (T capsules), program loader, and function capsules, and have many characteristic functions that permit to construct efficiently the distributed control system.

F-Net consists of terminal link (T link) aiming at transmission of process input/output data and processor link (P link) aiming at communications among controllers.

2 FEATURES OF F-NET

F-Net realizes a data transmission architecture common to all equipment of the F series being of high-speed and high-efficiency transmission system having exclusive use custom LSI and hybrid IC's as its nucleus.

Its features are as follows.

- (1) Realization of flexible system composition by unifying the transmission interface through high-efficiency and high-reliability transmission protocol optimum for input/output data transmission.
- (2) Realization of compact and high-reliability transmission system through its structure with exclusive use LSI and hybrid IC for the transmission control unit.
- (3) Possibility of elaborating the application program without need of worrying the transmission through easy data handling by FPL (F-series Programming Language) command and high-speed of transmission.
- (4) The topology of transmission line is serial bus so that maintenance operations give only little adverse influence to the system.
- (5) For the transmission line, economic twisted pair cable (in case of T link) or coaxial cables (in case of P link) will be used. By using optical converters converting the system into that of optical transmission also is possible.

3 T LINK

3.1 Out line and features

T link is a serial data transmission system coupling T Capsules installed dispersedly in the local of control equipments and desks, with P capsules in high-speed and in the most economic way.

Table 1 shows its specifications.

For transmission lines, twisted pair cable economic and easy to lay will be used but the use of optical fiber cable also is possible.

Its features are as follows.

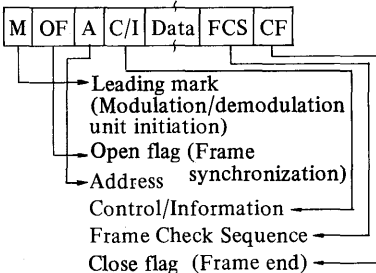
- (1) Through use of exclusive use LSI, a transfer speed as high as 500 k bits/sec. is attained and it has a function of high-speed data transmission refreshing digital inputs/outputs in 10 ms.
- (2) A high-reliability data transmission system having functions of error detection by 16-bit CRC (Cyclic Redundancy Check) code, carrier detection on transmission lines and data collision detection.
- (3) Possibility of connecting plural loaders at a time so that remote programming and remote monitoring at the local spot are possible.
- (4) Possibility of connecting plural loaders at a time permitting loader operations by different operators at different working spots.
- (5) As it is of multi-drop construction, mounting and dismounting of capsules on line are freely made
- (6) The transmission line can be extended up to the maximum of 1 km, so that a dispersed installation in a wide region of the distributed control system can be architected.

3.2 Transmission function

T link is provided with process input/output data transmission function and message communication function.

These functions are managed and controlled by communication operating system located within P capsule. In the communication operating system, an optimum scheduling is effectuated so that the high-speed of input/output data transmission should not be spoiled even when loader

Table 1 Specifications of T link

Item		Specifications
System specifications	Connecting capsule	P capsules: 2 units, max. Loaders: 2 units, max. F capsules 32 units, in total, max. T capsules
	I/O points	Digital I/O: 512 points, max. Analog I/O: 100 points, max.
	Topology of transmission line	Serial bus (multi-drop) optical loop coupling through optical converter among each bus. (Dualization in the loop parts is possible.)
	Transmission line	Bus transmission line: Twisted pair cable, total length: 1 km, max. Optical transmission line: Multi-component component glass optical fiber (Interval between optical converters: 1 km, max.
Communications specifications	Transmissionsystem	Half duplex serial transmission
	Data exchange system	1: N (polling/Selecting) System (IO data transmission Message data transmission)
	Transmission speed	500 k bits/ sec.
	Effective transmission speed	7 k bytes/sec. (10 ms/digital 512 points)
	Modulation system	PDM (Pulse Duration Modulation)
RAS function	Frame Format	
	Error check	FCS (CRC-CCITT: $X^{16} + X^{12} + X^5 + 1$) Data length check Collision detection
	Status mode	P capsule gathers status of T capsule, F capsule, and loader. P capsules inform each capsules of operating mode of each capsule
RAS function	Dualization of transmission line	Dualization of optical transmission line through use of optical converters is possible.

operating, message communications with general purpose personal computers take place.

(1) Process input/output data transmission

The transmission concerns that of input/output data between P capsule and T capsule, and 512 digital inputs/outputs are refreshed at 10 ms.

Input/output data are always transmitted by transmission LSI, together with execution of application program and refreshed in high speed with a short overhead time.

Also, in P capsule, before the application program starts, data transfers between the input/output data region that is accessed by the program and the transmission memory are made, so that no data will change during the execution of the program.

Table 2 Example of input/output data transfer protocol

Frame	Protocol and Frame Format	Applied TK
Polling	PK [A C FCS] TK [A I データ FCS]	Input capsule
Selecting	PK [A C データ FCS] TK [A I FCS]	Output capsule
Polling/ Selecting	PK [A C データ FCS] TK [A I データ FCS]	Input/output capsule

A: Address field C: Control field
I: Information field FCS: Frame Check Sequence field

(2) Message communication function

This is the communication function that takes place between P capsules and program loaders or personal computers, and besides the program load/save and memory read/write functions, it is provided with control functions as system start/stop.

3.3 Transmission protocol

T link transmission is effectuated by Polling/selecting system with P capsule as the main station, together with input/output data transmission and message communication.

The transfer protocol uses a high-efficiency and high-reliability system that is optimum for transmission for control purpose.

Table 2 shows an example of input/output data transmission protocol.

3.4 Hardware configuration

Fig. 1 shows the hardware configuration of T link. A pulse transformer insulates the transmission live from the capsules. The transmission and reception of data are carried out by link control unit composed of hybrid IC for transceiver and LSI of exclusive use.

The link control unit of P capsule differs from that of T capsule.

(1) P capsule link control unit

The unit is composed of LSI of exclusive use and carries out conversion series/parallel of transferred data, composition and decomposition of frames, as well as modulation and demodulation.

Further, it is provided with an interface function with processor path within the capsule, and carries out the DMA operation for processor memory and analysis on transfer command.

(2) T capsule link control unit

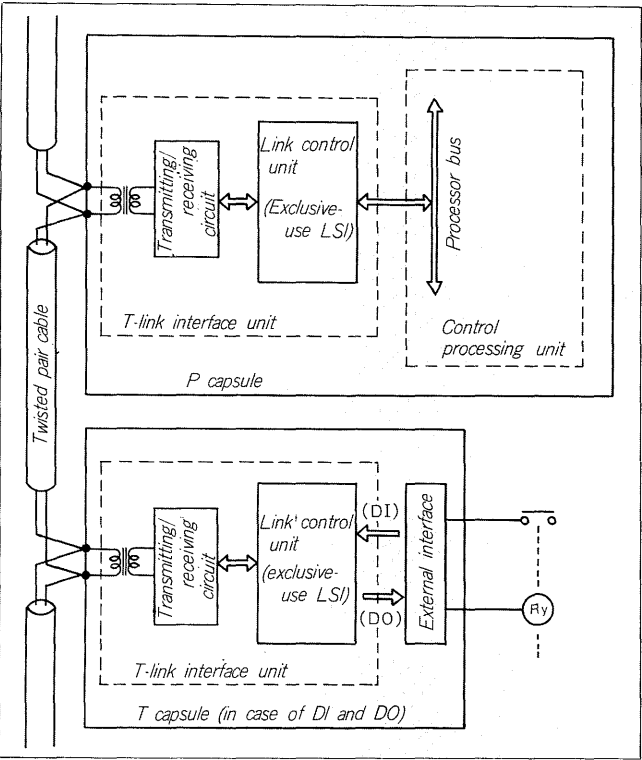
The unit consists of exclusive-use LSIs having T link interface function and port input/output function.

4 P LINK

4.1 Outlines and features

P link is a high-speed, high-efficiency and high-reliability

Fig. 1 T link link hardware configuration



lity serial transfer system for coupling P capsules that are installed dispersedly in a wide region.

Table 3 shows its specifications.

For transmitting line, a coaxial cable is used, but use of optical fiber cable is possible, too.

A maximum of 16 units of P capsules can be connected to P link and N:N communications are made among capsules by effectuating control on transmission right of taken passing system. Its features are as follows.

The following is the features of the P link.

- (1) Its transmission speed is as high as 5 M bits/sec. and it is provided with a broadcast communication function and 2 k words of high-speed region are refreshed at 10 ms. In FPK205, it has further 6 k words in low-speed region and they are refreshed at 100 ms.
- (2) In case of coaxial cables, a maximum of 500 m, and in case of optical fiber cable, a maximum of 1 km extension of vaste transmission network can be architected
- (3) It is a high-reliability transmission system having such functions as: error detection by 16-bit CRC code, carrier detection on transmission lines and data collision detection.
- (4) Refreshing of transmitting/receiving data and execution cycles of the application program are synchronized so that no data will be change during the execution.
- (5) It has adopted a token control system so that no special operation is necessary even for initiating time and at the time of link composition change.
- (6) Its composition is of "multi-drop" system so that even

when capsules are mounted or dismounted during the data transmission, no adverse influence can be exerted to the transmission among other capsules.

4.2 Hardware configuration

Fig. 2 shows the hardware confignration of P link.

- (1) Transfer path interface unit
The unit consists of a pulse transformer and a hybrid IC for transceiver.
- (2) Link control unit
The unit consists of exclusive-use LSIs having modulation/demodulation function, transmission control function

Table 3 P link specifications

Item		Specifications
System specifications	Connecting capsule	P capsule: 16 units, max.
	Topology of transmission line	Serial bus (multi-drop) Light loop coupling through light converters among each bus. Dualization in the loop parts is possible
	Transmission line	Bus transmission line: Coaxial cable Total length 500 m, max. Optical transmission line: Multi-component glass optical fiber (Optical converter interval: 1 km, max.)
Communication specifications	Transmission system	Half duplex serial transmission
	Data exchange system	N: N (token pass) system Memory refresh system
	Transmission speed	5 M bits/sec.
	Effective transmission speed	400 k bytes/sec.
	Modulation system	PDM (Pulse Duration Modulation)
	Frame format	<div><div>M</div><div>OF</div><div>Header</div><div>Data</div><div>FCS</div><div>CF</div><div>Leading Mark (Modulation/demodulation unit initiation)</div><div>Open flag (Frame synchronization)</div><div>Header (8 bytes)</div><div>Data (2 k bytes, max.)</div><div>Frame Check Sequence</div><div>Close flag (Frame end)</div></div>
RAS function	Error Check	FCS (CRC-CCITT: $X^{16} + X^{12} + X^5 + 1$) Data length check Collision detection
	Data transfer	Broadcast communication (transfer to all capsules)
	System control	P capsule start, stop, reset operation from other capsules
	IPL	P capsule IPL from other capsules
	Notification of failure information	Notification of capsule failure and alarm informations to other capsules Supervision of transmission line from each capsule
RAS function	Dualization of transmission line	Dualization of optical loop part between optical converters is possible

Fig. 2 P link hardware configuration

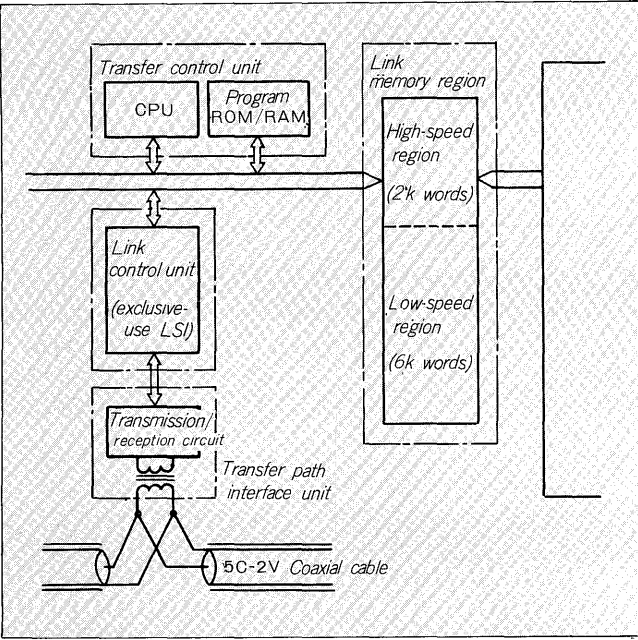
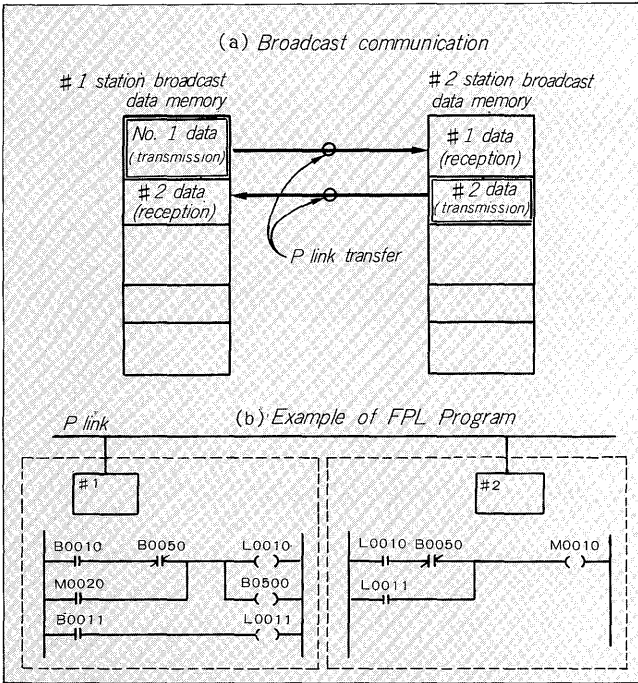


Fig. 3 Broadcast communication



and DMA function for high-speed transfer.

(3) Transfer control unit

Composed of microprocessor, ROM and RAM, it carries out supervision and control on link control unit and exchanges informations with controller side.

(4) P link memory region

It is 2-port memory accessible from both sides of transmitting unit and controller unit. It consists of high-speed refresh region and low-speed refresh region.

Fig. 4 Example of light network composition

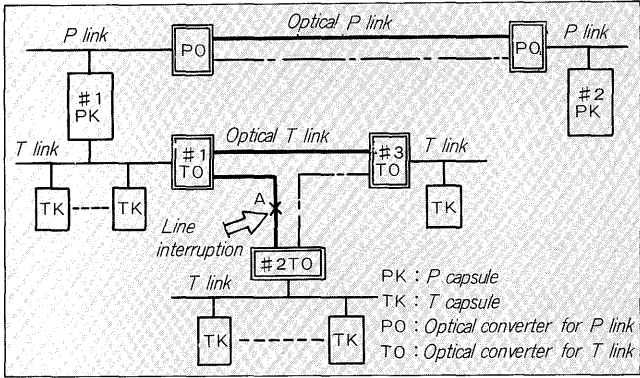


Table 4 Specifications of optical converter

Item \ Classification		T link	P link
Transmission speed		500 k bits/sec.	5 M bits/sec.
Repeater control unit		Exclusive-use LSI	
Power supply		AC 100V (Back up DC 12V)	
Optical module	Optical transmission unit Optical emitting element	Infrared optical emitting diode	
	Optical reception unit Optical receiving element	pin photodiode	
	Sign error rate	10 ⁻⁹ or less	
	Signal transmission speed	DC ~ 10 M bits/sec. (NRZ)	
	Input/output interface	TTL level	
	Power supply	± 5V ± 5%	
	Transmission distance	1 km, max.	
	Light fiber applied	SI type quartz fiber, multi-component glass fiber	
	Connector applied	FC type connector compatible	

4.3 Broadcast communication

As shown in Fig. 3 (a), each capsule divides P link memory to assign it for its own transmission region.

The broadcast data transmitted by capsule that has gained transmission right through token control are simultaneously received by all other capsules and stored in the corresponding capsule region.

Thus, all capsules connected to P link will have P link memory as common memory thus, possess data in common with all capsules.

P link memory is freely accessible through a FPL command from the application program, so that programming that needs no consideration for transmission can be made.

Fig. 3 (b) shows an example of program having bit data L0010 and L001 in common with No. 1 capsule and No.2 capsule.

5 OPTICAL NETWORK SYSTEM

For F-Net, by using optical converters, building up of

the optical network system is possible.

As shown in *Fig. 4*, the optical converter converts electric transmission line constituting a bus construction into optical transmission line, and it is available in two types: ones for T link and others for P link. *Table 4* shows its specifications.

5.1 Features

- (1) Transmission and reception are made by one optical fiber cable. It is single-cored bidirectional transmission so that a large-scale reduction in cable cost can be attained.
- (2) By connecting two optical converters in a loop topology the dualization of transmission line is possible.
- (3) The transmission distance between two optical converters is 1 km, as the maximum, and a vast optical network system can be architected.
- (4) By reproduction and repeating functions through use of exclusive-use LSI, the reliability of the transfer data is increased.

5.2 Dualization of the transmission line

As the solid lines of *Fig. 4* shows, the optical transmission cable is single-cored bidirectional transmission system, and only one optical fiber cable connects two optical converters.

Further, by connecting the posts as shown in dot-and-dash line of *Fig. 4*, in a topology of loop, the transmission line can be dualized.

For example, the data transmitted from #1 PK onto T link, will be sent to #2TO and #3TO passing through #1 TO and transmitted to each electric transmission line. If there should be a line interruption at point A, when there is connection of only solid line, no data will be transmitted to #2TO. However, in case of loop composition, data will be transmitted to #2TO passing through #3TO, thus keeping the transmission without receiving any adverse influence from the line interruption.

6 SUMMARY

The article described the features and specifications of the network system F-Net which constitutes a nucleus of the F series.

The F-Net is a high-speed and high-reliability data transmission system for realizing the efficient distributed control system. We believe it to be PC network system worthy of era of FA and FMS.

We will be extremely glad if many systems using F-Nets are applied to various fields of activities and that will help for promotion of FA and FMS.

TOPICS

SUBSTATION FACILITIES FOR OVERSEAS POWER PLANTS

In 1980, we have completed deliveries of substation facilities as assistance projects for overseas power plant facilities, seven 154kV substations for Indonesia, one 66kV substation for Singapore, three 132kV substations for Saudi Arabia and others. Furthermore, for the portions to be delivered in 1981, we are now constructing facilities for seven 132kV substations for Saudi Arabia plus two 33kV substations, and three 154kV substations for Indonesia. These facilities were awarded in an open international tenders by offering competent prices thanks to collaboration among Japanese manufacturers who have contributed for lowering prices by offering their speciality in their own fields. Fuji Electric for this project, taking advantage of its vast experience in plant technology, has coordinated the work for setting up substation facilities including 39 units of 132kV GIS which have fallen to its charge, and contributes to the development of countries in the Middle and Near East as well as those in Southeast Asia.

PUB Raffles substation in Singapore

