

NETWORKS FOR FLEX-PC N SERIES

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1. FOREWORD

In the recent programmable controller (PC) development trend, networks have become an extremely important technique for achieving advanced informationalization of systems and a flexible system configuration.

The FLEX-PC N Series is a PC for machine control with the field device and controller level areas as its objective. However, coping with computer integrated manufacturing (CIM), which is a natural outgrowth from the overall flow of the manufacturing industry, is being pursued in this field too. It is also expected to be a means of allowing total cost reduction in this field on the machinery and equipment level.

To meet this need, an N Series network system and product line aimed at quick response, simplified wiring inside the machine control panel, simplification of hand-

ing, and improvement of environmental resistance with "offering of a network system that just fits the machine control field" as the basic concept of network system development are planned.

The networks supported by the N Series are outlined and a new network are introduced below.

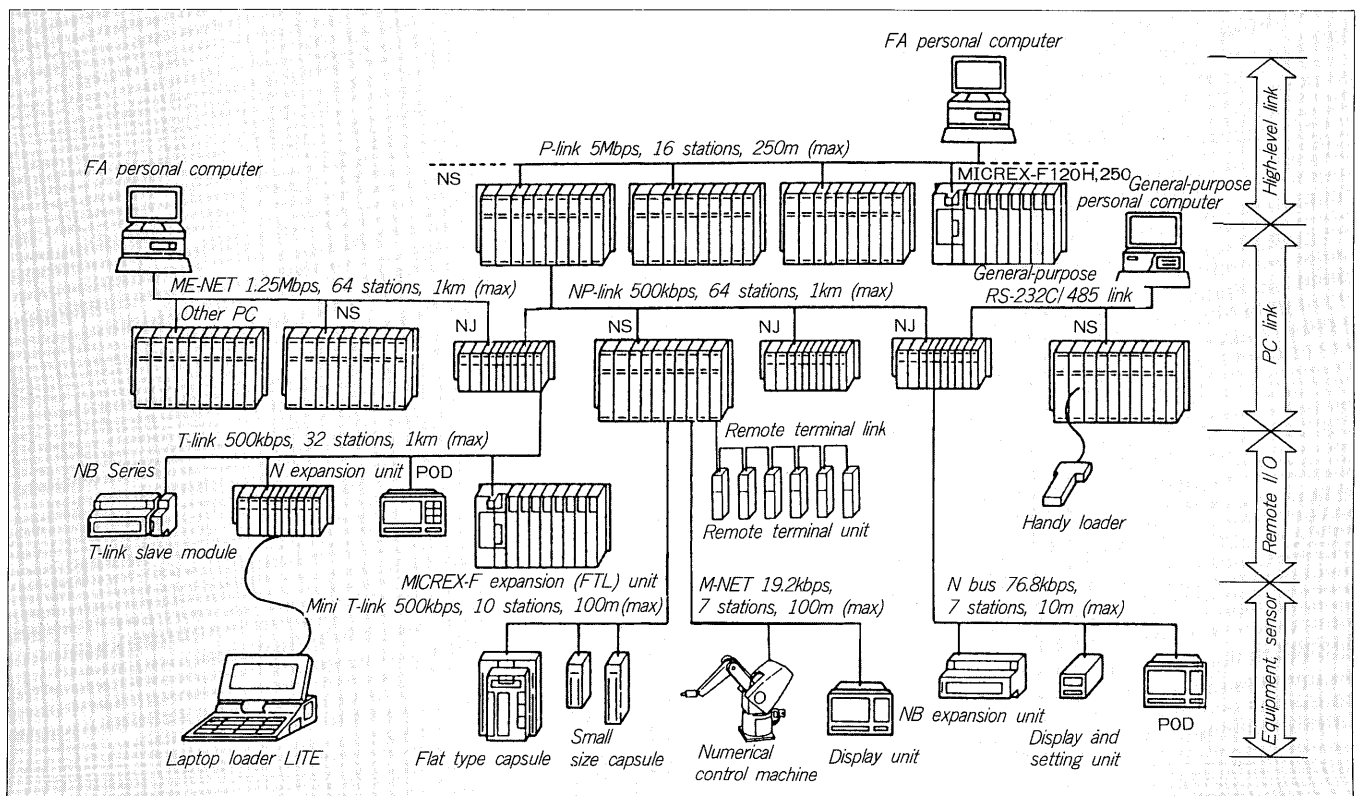
2. NETWORK CONFIGURATION AND FEATURES

2.1 Network configuration

For CIM models, the N Series supports 10 field device and controller level networks. A typical network system configuration is shown in Fig. 1. The network table is shown in Table 1.

By making the Fuji Electric field network processor

Fig. 1 Typical network system configuration



link (P-link) and terminal link (T-link)/mini terminal link (Mini T-link) that gained public favor with the Fuji Electric general-purpose PC MICREX-F Series the base, the N Series with its abundant connectable devices can be used.

An NP-link, which connects the N-bus designed to simplify the wiring inside the machine control panel and N Series PC distributed inside the machine or the machine and equipment, was also newly established for machine control.

ME-NET (Mechatro-network), which all manufacturers are currently beginning to support, and the M-NET (Module-network), which has an equal record, are supported as multi vendor networks.

2.2 Features

The N Series network system is made up of 10 models with a flexible configuration which extends from large CIM to simplification of wiring inside the control panel and has the following features:

(1) Quick response suitable for the machine control field

High-speed refreshing of data by F-Net, N Series Processor Link (NP-link) and other Fuji Electric original hardware and protocols permits construction of a machine control system that demands quick response.

(2) High reliability

Network transmission control is compactly configured by custom LSI and hybrid IC or RS-485 standard interface. Combined with use of a highly reliable protocol, a highly reliable transmission system is realized.

(3) High serviceability and economy

The transmission line of all the N Series networks is based on a multi-drop (serial bus) system using twisted pair cable or coaxial cable so that wiring work and maintenance are simple and economical.

3. NP-LINK

3.1 Positioning

NP-link (link between N Series PCs) is a high-speed serial transmission system aimed at data exchange between the basic units (NJ/NS) of the N Series installed inside the machine equipment or distributed among equipments.

3.2 Features and specifications

The specifications of the NP-link are shown in Table 2. Twisted pair cable, which is economical and easy to wire, is used as the transmission line. The NP-link can connect up to 64 processors up to 1 km. N:N communication is performed between processors by token passing transmission control. The features of the NP-link are:

(1) High-speed refresh processing

The refresh time for 500 kbps transmission speed, 8 connected units, and 128 words (2048 bits) of broadcast data is approximately 10 ms.

(2) Transmission speed can be selected

Table 1 N Series networks table

Network name	Outline (application)	NB	NJ	NS
N bus	Small distributed system that can reduce the wiring cost of the I/O devices around the machine facility.	⊙	○	○
Mini T-link master		—	○	○
M-NET	Multi-vendor network that connects the N Series with other NCs.	—	○	○
T-link master	Serial transmission system capable of substantially reducing the wiring cost of I/O devices distributed over a long distance.	—	○	○
T-link slave		○	○	○
Remote terminal link		—	—	○
General-purpose RS-232C/485 link	Data link system that interconnects N Series processors.	○	○	○
NP-link		—	○	○
ME-NET	Multi-vendor link that connects the N Series with other PCs	—	○	○
P-link	Highest level data link system capable of interconnecting N Series and F Series system processors and connection to a host computer.	—	—	○

⊙: Standard, ○: By adding a communication module or unit

Table 2 NP-link specifications

Item		Specification
System specifications	Connecting capsule	Max 32 stations/system (including standby station for duplex) Expandable up to 64 stations by using T-link repeater.
	Topology	Multi-drop (serial bus)
	Total cable length	Total length 1km (For 500kbps, maximum 3km by series connection of two repeaters)
	Communication line	Token passing system
	Transmission line	Shielded twisted pair cable
Communication specifications	Transmission system	Half-duplex, serial transmission
	Transmission speed	250kbps/500kbps (by selector switch)
	Data exchange system	N:N system
	Modulation system	PDM (Pulse Duration Modulate)
Communication functions	Broadcast communication	Data of each station divided into 1024 words and refreshed (Supports three kinds of station transmission area addressing)
	Message communication	Supports MSGT and MSGR instructions. Send/receive also possible by communication module
	System control communication	Supports remote loader function. Control by start/stop, monitor, and other loader commands. Program up/down loading possible
RAS functions	Error check	16-bit CRC (Cyclic Redundancy Check: $X^{16} + X^{12} + X^5 + 1$)
	Notification of failure information	Communication of unit failure and alarm information to other units. State of transmission line is monitored at each unit.

The transmission speed can be switched according to the system noise environment and transmission line cable length. (250 kbps or 500 kbps by switch)

(3) Simplification of link starting

Broadcast communication is possible by simply setting the station address switch on each NP-link module.

3.3 Communication functions

The NP-link supports three communication functions: broadcast communication that divides and uses up to 1024 words and performs data exchange between all modules cyclically, message communication that is executed when collected data must be sent and received by program, and N Series loader command communications that can control PC starting and stopping, program writing, RAS (Reliability, Availability, and Serviceability) data read, etc., are supported.

3.3.1 Broadcast data link function

With conventional broadcast data links, various parameters had to be set to perform actual data linking. However, with the NP-link, a new method was also established to simplify link starting work according to the usage objective as follows:

- (1) Broadcast communication is possible by simply setting a station address on each NP-link module. (The master station automatically allocates the transmission area and capacity of each station using a predetermined value.)
- (2) Broadcast communication of the same number of words is possible by simply setting the desired number of transmit words as a master station parameter.
- (3) The transmit area of the local station can be set for each module. (Detailed transmission area allocation can be performed by the conventional method.)

3.3.2 Message communication function

Message communication is a technique for performing data communication between intelligent devices and modules that do not require quick response. Message transmission by message transmission (MSGT) instruction, message reception (MSGR) instruction, and communication module are supported. Data exchange with the F Series is also possible.

3.3.3 N Series system control communication function

Programs and data can be read and written for other

N Series PCs on the NP-link (interprocessor link) and PC starting and stopping and other remote loader operations are performed.

3.4 Hardware organization

The NP-link consists of a transmission cable and RS-485 standard interface which make up the physical layer and custom LSI and microprocessor which make up the logical application (lower level) layer.

This is almost the same as the hardware configuration of the T-link master module and both high reliability and low cost are realized. The topology is multi-drop serial bus. It also has no affect on the system during maintenance work.

3.5 System organization

For the NJ/NS Series, up to eight NP-link modules can be installed at the basic unit. By combining these, (1) data link system with up to 32 data links (expandable up to 64 by using a T-link repeater) between basic PCs, (2) parallel connection system: up to eight basic link systems of 64 units/system can be controlled simultaneously, (3) hierarchal system: hierarchal network system built by dividing and using the link register area, and other flexible system configurations are possible.

4. N BUS

4.1 Position

The N bus is a medium-speed transmission system designed to simplify the wiring between devices in the control panel at low cost for replacement of the expansion I/O bus of PC usually connected by a parallel bus.

The NB Series is equipped with the N bus as standard. For the NJ and NS Series, an N bus master module is available as an option.

4.2 Features and specifications

The N bus is a transmission system for connecting devices with machine control as its objective. Its specifications are shown in *Table 3*.

The features of this new network, which was established to meet the needs inherent to machine control as a network which is connected directly to the machine, are described below.

- (1) An NB Series expansion unit which allows free selection of the I/O specifications point by point can be connected and an economical system can be built.
- (2) Display and setting unit (N-DSET) that combines eight external timer/counters in one unit and other devices prepared in advance to rationalize the control panel periphery can be connected and the number of design man-hours can be reduced.
- (3) Since it is handled the same as a parallel expansion bus which extends the basic unit bus in parallel, link device control can be implemented without adding a special program.

Table 3 N bus specifications

Item	Specifications
Connecting capsule	NB expansion unit Max 3 Function unit Max 4 Total 7
I/O points	NB expansion unit Max 384 points Function unit Max 512 words
Topology	Multi-drop (bus)
Transmission line	Custom cable w/modular jack
Transmission system	Half-duplex, serial transmission
Transmission speed	76.8kbps
Total length	10m

Fig. 2 N bus interface hardware configuration

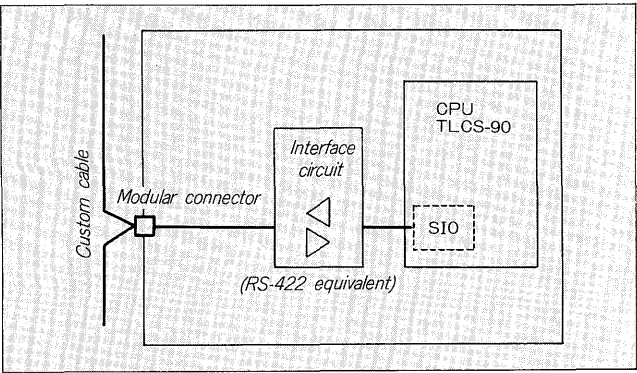
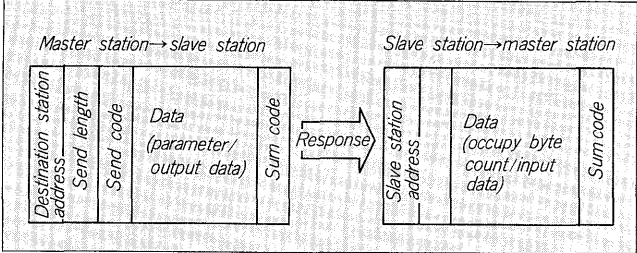


Fig. 3 N bus basic frame format



4.3 Hardware configuration

The hardware configuration of the N bus is shown in Fig. 2.

Low cost, compactness, and high reliability are realized with a simple configuration which only connects the transmission line to a one-chip microcomputer with serial controller via an RS-422 equivalent interface circuit.

4.4 Transmission system

The basic frame format of the N bus is shown in Fig. 3. Since the transmission speed is a medium speed 76.8 kbps, improvement of the transmission efficiency is indispensable in achieving fast response. Therefore, N bus expandability was taken into account and this format, which reduced everything but the net data part, was selected.

With this format, transmission is repeated, but for one refresh cycle, it is connected directly to the I/O and is used in display, etc. with all the NB expansion units that require quick response and only one of the function units which do not have to be so fast is refreshed as shown in Fig. 4. The NJ/NS Series N bus master module also has a function which increases the refresh rate for a specific NB expansion unit by setting the station address by parameter from the user as shown in Fig. 5.

A unit which allows selection of whether it is treated as an NB expansion unit or as a function unit, etc. are provided even at the slave unit side so that it is a network which allows construction of a system that meets user desires.

Fig. 4 N bus refresh cycle

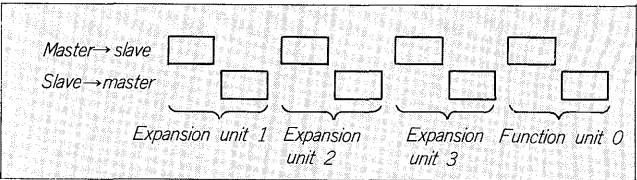


Fig. 5 N bus special refresh cycle

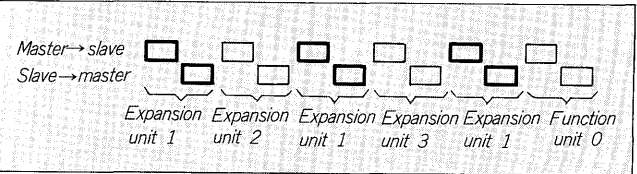
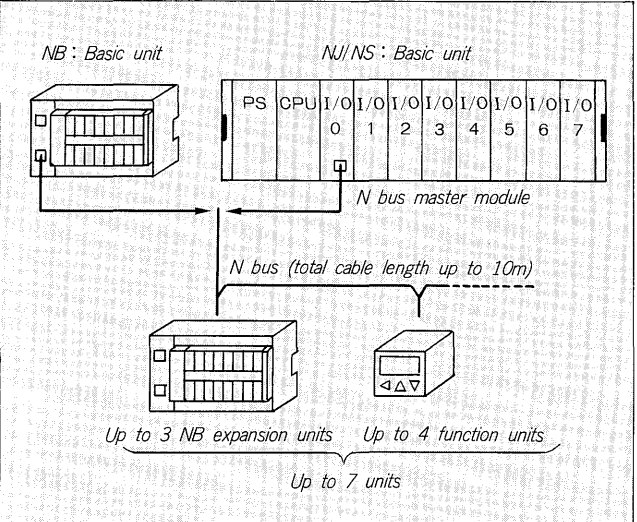


Fig. 6 N bus system configuration



4.5 System configuration

The N bus system configuration is shown in Fig. 6. For the NB Series, the maximum configuration is three expansion units and four function units. However, for the NJ/NS Series, up to eight modules can be used simultaneously on the basic unit, the same as other network modules, so that eight N bus systems can be built.

5. CONCLUSION

The N Series network systems were introduced above. The N Series networks are network systems which just fit the machine control field. We are confident that they are PC network systems which are suitable for the CIM age. We will be happy if numerous machines using the N Series network are installed in each factory and serve to promote CIM and simplify wiring.