I/O System for the Integrated Control System MICREX-IX

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1. Introduction

Recently, with the introduction of the remarkable advance in electronic device technology, the process I/O units (PIO) for distributed control systems have achieved compactness and advanced functions.

Anticipating the use of such seeds, we developed a new type of compact and intelligent process I/O unit system which can be used not only for electric machine control but also for instrumentation control for the new MICREX-IX, which has long been a problem.

In this paper we will introduce the design concept of the distributed PIO [IPU] (Intelligent process I/O unit) for the MICREX-IX and in ways which to solve its problems.

2. Developmental Background

We have developed the MICREX-IX as an EIC (Electrical control, Instrumentation control and Computer) integrated system. In addition, we have developed the IPU as a process I/O unit for this integrated system, in order to achieve the following goals:

(1) Integration with the former process I/O system (used for the MICREX-PIII)
(2) Cost reduction and compactsizing
(3) Improvement of plant operation and maintenance with intelligent functions
(4) Architecture with potential future expansion

3. Outline of the IPU System

Figure 1 shows the system configuration of the IPU. The IPU is integrated with three kinds of I/O; namely, analog I/O, digital I/O, and FFI (Fiber optic Field Instrumentation) I/O, It is connected with the upper level control MPU via T-link, one of Fuji Electric's original I/O links.

One control MPU can be connected with up to four channels of T-links, and one channel can be intermingled with the three kinds of I/O units. In this way, a maximum of 32 I/O units can be connected. To configure a highly reliable system, a duplex system can be composed of two control MPUs. In this case, the IPU's T-link modules are also arranged in a duplex configuration. About 20 patents for this duplex method are now being applied.

Fig. 1 System configuration of the IPU

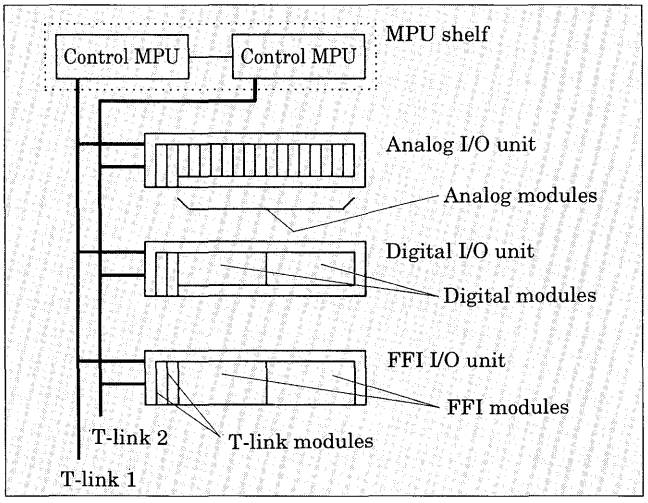


Fig. 2 External view of the analog I/O unit

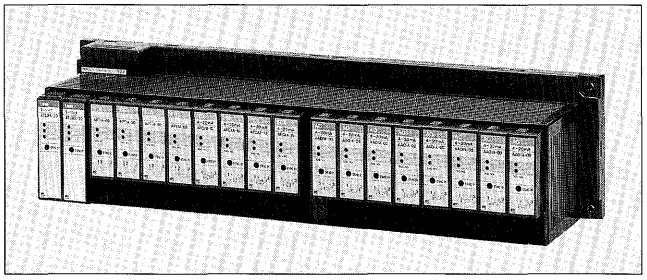
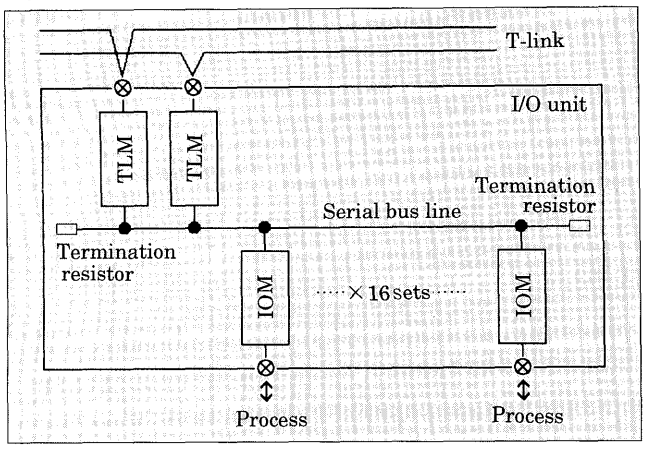


Figure 2 shows the external view of an analog I/O unit. The external size of the digital and the FFI I/O units are the same as the analog.

In one analog I/O unit, 16 of the one point I/O modules can be mounted. In one digital unit, two of the 16/32 point modules can be mounted. In one FFI unit, two of the one optical channel modules can be mounted. Moreover, FFI modules can be made into a duplex configuration by using two modules.

Figure 3 shows the internal configuration of an analog I/O unit. Within the unit, the T-link module (TLM)

Fig. 3 Inner configuration of the analog I/O unit



and The I/O module (IOM) are connected to each other via a high speed (2 Mbps) serial bus line. The IOM can be replaced without shutting down the system.

The internal configurations of the digital and the FFI I/O units are the same as that of the analog, but the number of IOM modules which can be connected to a serial bus line is limited to two.

4. Steps to Solve Problems

4.1 Integration with the former process I/O system

Figure 4 shows a comparison of the two process I/O systems, MICREX-IX and the former MICREX-P III.

As shown in Fig. 4, the two types of units in the former process I/O system, the electrical controller (HDC), and the instrumentation controller (PCS), have been integrated into the IPU system for the MICREX-IX. In addition, application in small to medium scale control systems (HDC/PCS-250) has become possible.

Many types of I/O modules have been integrated. For example, about 200 kinds of modules for the thermocouples and the resistance temperature sensors were integrated into two types, thus shortening the manufacturing lead time and simplifying maintenance. This was achieved by the measures below.

(1) Setting of the software range by providing I/O modules with intelligent functions
(2) Connection to a control MPU via T-link
(3) High density mounting of the signal conditioning part, and mounting of the A/D and D/A conversion parts on one board

Moreover, the I/O module is insulated from ground. The insulation can withstand up to 2,000V AC; thus, E and I can both be used. Table 1 shows a list of the I/O modules of the IPU.

4.2 Cost reduction and compactsizing

Cost reduction and compactness of the IPU were achieved by fully introducing a low price and small surface mounting parts, and by the adoption of automatic mouting of parts and testing.

Fig. 4 Integration of the process I/O unit system

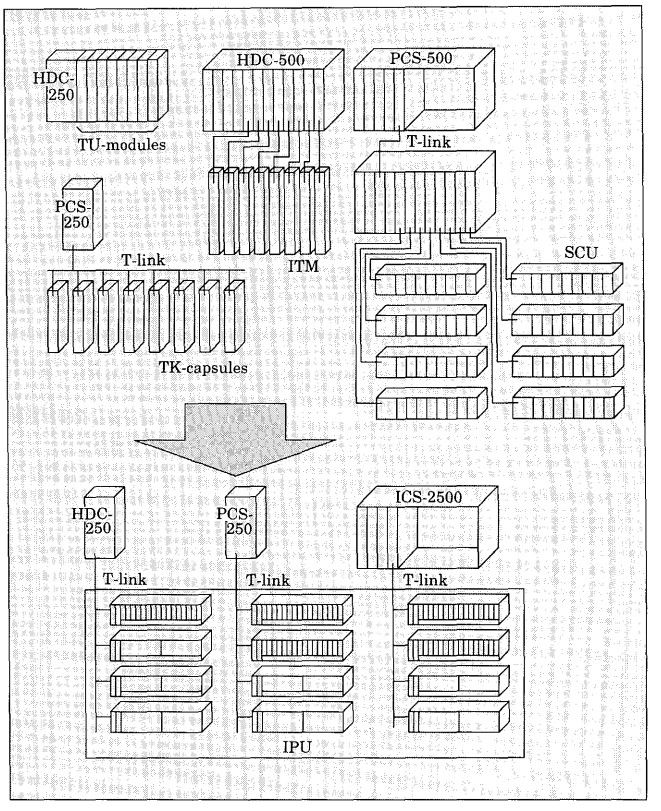


Table 1 List of the IPU I/O modules

Modules	Specifications
FCX input	4 to 20mA, Modem : HART protocol
Current input	4 to 20mA
Voltage input	1 to 5V, 0 to 5V, 0 to 10V, ±5V, ±10V
Thermo-couples input	B, R, S, K, E, J, T types (JIS specified)
Resistance temperature sensor input	Pt type (New/old JIS specified)
Current output	4 to 20mA
Voltage output	1 to 5V, 0 to 5V, 0 to 10V, ±5V, ±10V
Pulse input	Voltage, dry contact
Pulse width output	Transistor
Digital input	Dry contact
Digital output	Transistor, relay
FFI	Linked to optical field apparatuses via fiber optic transmission line

In addition, a reliable design was also considered. For example, for electrolytic capacitors used in power supplies, careful selection and heat design of the parts was performed so that its lifetime would exceed 10 years. This greatly surpasses the 5 years that is recommended by JEMA (Japan Electric Manufacturers' Association) as the standard replacement interval for this type of part.

The I/O units can be easily mounted in locker type cabinets with the T-links wired in advance. Thus, the

units can be connected by a single touch to the T-link via only one connector.

4.3 Improvement of plant operation and maintenance with intelligent functions

In order to upgrade and improve efficiency of plant operation, the IPU has been provided with the following intelligent functions:

(1) Free range setting of the I/O modules

The types and ranges of I/O modules for thermocouple and resistance temperature sensor can be set in the software. These can be set or changed by the upper level support tool IES-2500.

Set data is stored in nonvolatile memories. Therefore, except in the event of changing this data, resetting is not necessary, even though problems such as a power failiure may occur.

(2) Simplified adjustment and expansion of the I/O system configuration

When the power supply is started, the IPU automatically understands the mounting status of the I/O modules and begins operation. If necessary, specification of the empty and/or reserved slots is possible. The IPU compares the mounting information of the I/O modules set in advance with actually mounted ones, and informs its control MPU of any discrepancy.

All this is achieved with coordination between the IPU and the control MPU, facilitating modification and expansion of the control system.

(3) Improvement of the remote diagnosis function

It is possible to collect RAS (Reliability, Availability and Serviceability) data and set information of the intelligent sensors or actuators by way of FFI or FCX modules from the operator station, in addition to RAS data of the I/O module itself.

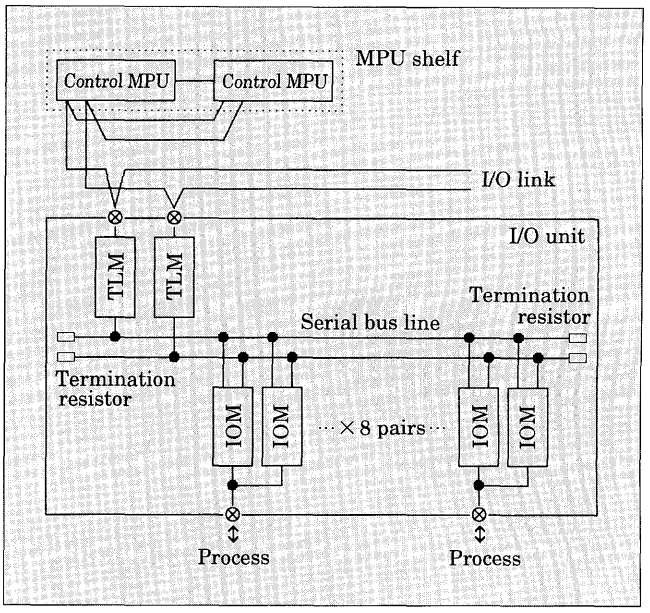
Compared with the former system, monitoring of the system's operating status is easier and more detailed.

4.4 Architecture expandable in the future

As previously explained in the system configuration, the IPU consists of both I/O and transmission modules, connected by a high speed serial bus line.

Due to such architecture, the IPU can even be applied to an I/O link other than the T-link by exchanging only the transmission modules. As the serial bus line in the I/O units runs with a high speed simple protocol, it might be someday possible to apply the IPU to a higher speed I/O link.

Fig. 5 General concept of the highly reliable IPU



5. Future Problems

5.1 The Highly reliable IPU

To meet user demands only the FFI modules are designed to configure the IPU duplex system for the MICREX-IX.

In the future, we shall expand this duplex configuration into the analog and digital modules as well as realize the duplex system at the distributor level, something which some users demand in earnest.

At the same time, we plan to develop a highly reliable and dually configured IPU that include the control MPU, I/O link and I/O module, which are all independent (Fig. 5).

5.2 Conformity to the fieldbus system

As an international standard for a multi-vendor I/O link, the standardization of the fieldbus system is progressing, with Fuji Electric actively participating. It is necessary for the IPU to conform to this standardization.

6. Conclusion

With emphasis on its design concept and problem solutions, the IPU for the integrated control system MICREX-IX was introduced.

The process I/O system is entering an age of revolution based on the progress of the fieldbus system. Fuji Electric will make every possible effort to offer the latest, state-of-the-art systems which meet the needs of the age.