DISTRIBUTED CONTROL SYSTEM MICREX

SYSTEM CONFIGURATION

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1 FOREWORD

During the last half of the 1960s, the microprocessor appeared and changed the world at an amazing speed. A distributed control system using this microprocessor also appeared in the measurement and control field. In 1975, Fuji Electric announced the "distributed control system MICREX-P" and has steadily expanded the MICREX family, including the "programmable controller MICREX-E. These control systems are used in the steel, water treatment, chemicals, petroleum, foods, cement, and many other fields and are highly evaluated.

However, the world economy has shifted from a high growth age to a low growth age through the second oil shock. This has narrowed the market and many enterprises are facing severe sales competition. Manufacturers must shift to low volume production and high added value products and the necessity to meet the needs of diverse and individual consumers flexibly and quickly is increasing.

Under such conditions, the demand for control systems with more functions, more sophisticated functions, and more flexibility is rising.

(1) Movement toward total automation

Factory automation (FA) in the vertical direction, that is, production control and management control centered about the manufacturing process, is necessary. The horizontal direction, that is, automation of raw material storage, transportation, conveyence, product transportation, and other material handling, automation of storage control, and organic coupling of these manufacturing processes, is necessary. Realization of total automation (TA) aimmed at rationalization of the entire factory by fusing process automation (PA) with FA is desired.

(2) System flexibility

The development of new products by quickly forecasting consumer needs and the production of these products at high quality and cheaply and quickly is a major topic for manufacturers. Therefore, batch plants for multi-type, small lot production are increasing.

With multi-purpose batch plants, the control system changes frequently and plant remodeling and control system software modifications are daily occurrences. Plant secrecy is also high and system configuration and reconfiguration are often performed by the user.

For this reason, systems which can be easily configured and reconfigured even by those who are not software specialists are demanded.

(3) Unmanned operation

Under the recent unstable economic situation, the steel, petroleum petrochemical, and other industries are being pressed to cope with the following to escape from the current severe conditions:

    (a) Optimum operation aimmed at saving resources and energy

    (b) Unmanned operation aimmed at saving labor and power

    (c) Coping with low-load operation and frequent load changes

    (d) Reliable and safe operation

    (e) Rationalization of system inspection and maintenance

(4) Complex information society

The data handled in the manufacturing process is temperature, pressure, flow, level, and other primary data and achievement records, operating history, and other secondary data. There is the production plan which is sent from the production control level, achievement record data which is sent to the control level, state of progress of preprocesses and postprocesses, plant and machinery status, raw materials inventory, and various other data.

That is, the current control system must exchange data with large computers and personal computers. It must also exchange material handling data, not only production process data.

A system which processes and stores an increasingly large amount of data and makes it available to man in a simple form is desirable.

2 SYSTEM DEVELOPMENT CONCEPT AND FEATURES

Fuji forecast the trend of the industrial world previously mentioned and future conditions and increased the functions of the "distributed control system MICREX" substantially. The features of the system are described next.

(1) Large-scale system which realized total automation

The fact that advancing rationalization of the entire factory and the efficient manufacture of high quality products are important topics has already been touched on.

MICREX has large-scale control, data acquisition, and management functions for managing and entire factory. The system scale covered by the MICREX system is shown below.

    (a) Control loops, monitoring loops
                                  : Max 17,280 points
    (b) Status change of contacts, etc. : Max 30,720 points
    (c) Other data   : Max 17,280 points
    (d) Controllers   : Max 60
    (e) Number of operator stations × number of CRTs
                                    : Max 8 × 3 = 24

(2) Flexible system architecture

Various system architectures corresponding to the control and management objective and scale are available with the MICREX system. "Process station (PCS-500)" duplication and "CRT operator station (OCS-1500)" redundancy can be realized as required.

A "programmable controller (HDC-500)" and "telemeter telecontrol system (SAS-500)" are available as part of the MICREX family and allow a system architecture corresponding to the objective.

Connection to the "Fuji Fiber Optic field Instrumentation System (FFI)" and a "Distributed Optical Instrumentation Control System" configuration with optical and digital field instruments (transmitter, converter) are possible.

(3) Powerful man-machine interface

The MICREX system man-machine interface and CRT operator station OCS-1500 allow calling of all the data points on the system by simple operation. A "single window" concept by which process data, computer data, the data of other systems, and all other data necessary for total control can be used with the same CRT was realized.

(4) Use of unified data base

The MICREX system collects and records all the events which occur in the system with the "data base station DBS-1500". The controller control and computation data, operator station definition data, image data, batch receipt management data, and other application data are stored. The data stored at the DBS-1500 can be used by arbitrary operator stations or computers or other systems.

(5) Use of engineering work-station

The controller control program, operation images, and

Fig. 1 Distributed control system MICREX system architecture
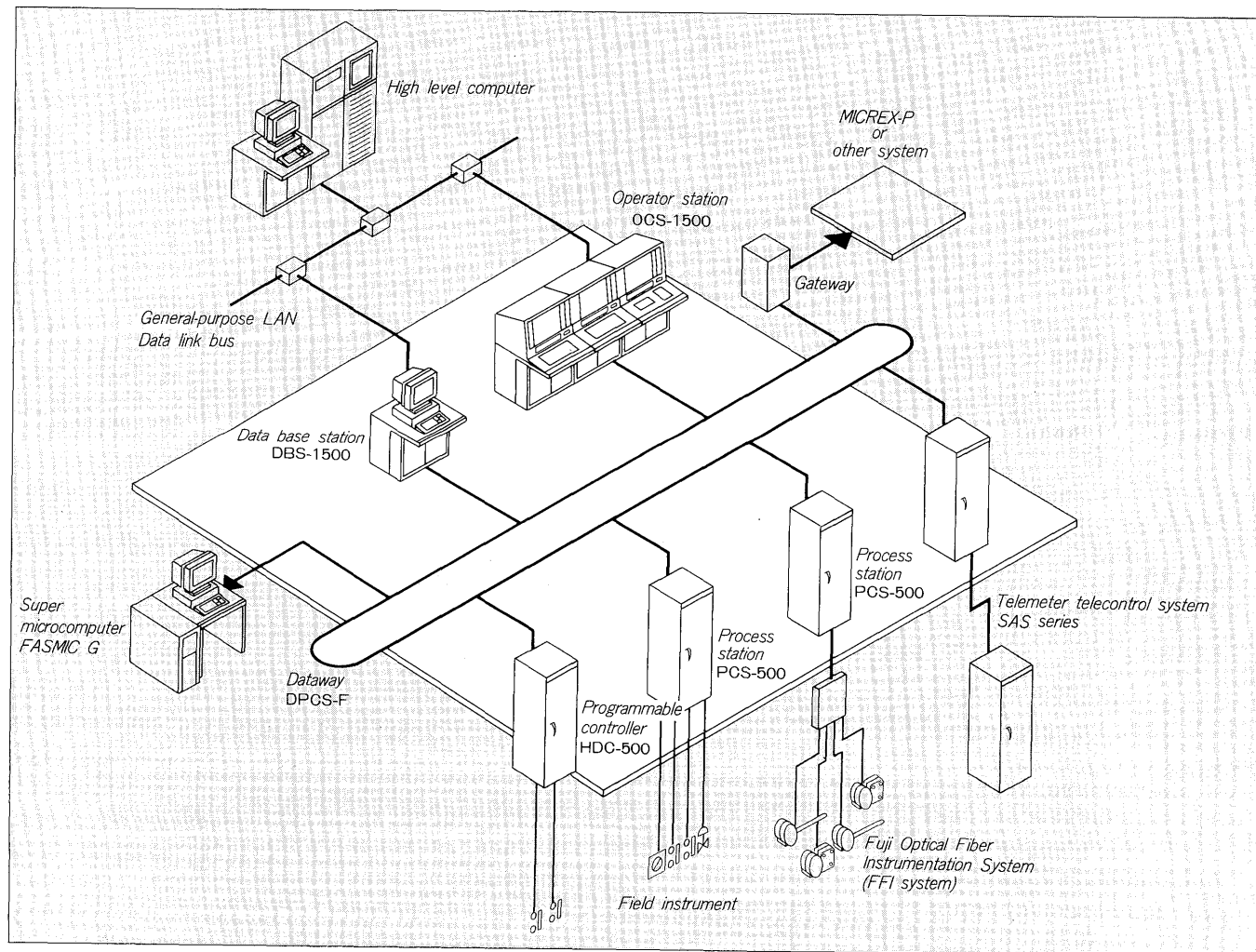
slips are created and modified by using the "engineering work-station EWS-500".

The EWS-500 was fostered by the OCS-200 and FPEC-10 of the conventional system and has an interactive control configuration function acclaimed by users. Since a system can be configured interactively without using BASIC, FORTRAN, or other general purpose programming language, a control system can be easily configured and reconfigured even if you are not a software specialist.

(6) Full network

All the controllers, operator stations, and computers systems in the MICREX system are connected over a high-speed 10M bits/sec "dataway DPCS-F". This is $N:N$ communication system, with no common parts, loop-type duplex transmission line high speed and highly reliable optical dataway.

Data can also be exchanged with other systems. Connection to FA, PA, OA, and LA systems is also possible by using a general-use network.

(7) Use of international standard and high reliability hardware

MULTIBUS® II is used as the controller, operator station, and data base station internal bus. MULTIBUS® II is a registered trademark of Intel Co. of the United States and its standardization as IEEE-P1296 is currently being studied.

An IEEE 802.3 (ETHERNET®: registered trademark of Zerox Co.) compatible data link bus is used as the general-use LAN (Local Area Network).

By using these international standards, the improved degree of connection with other systems, availability at part level, etc. MICREX system is a system which has been amply considered as an open system.

As for the hardware, the number of parts is reduced and reliability is increased by using custom LSI, such as the controller microprocessor, T link bus, internal bus, etc.

③ SYSTEM ARCHITECTURE

With the MICREX system, the process station (PCS-500) is responsible for the control function and the operator station (OCS-500) is responsible for the operator and process interface function, including operation. The basic system consists of data base stations (DBS-1500), which collectively manage the system data, and are the greatest feature of the MICREX. Functions are interconnected by a high speed and highly reliable dataway (DPCS-F) and risk dispersion of functions and tight connection of functions are realized simultaneously. An interactive format system architecture is possible by connecting the dedicated engineering work-station EWS-500 of the system to the DBS-1500.

A programmable controller and telemeter/telecontrol system or a computer can also be connected, as required.

3.1 Operator station (OCS-1500)

The OCS is the part actually touched by the operator to operate and monitor the plant. Quick and positive opera-

tion is necessary, no only in daily operation, but also in emergency situations. OCS has various refinements which simplify operation by the operator and provided the operator with a superior monitoring and operating environment.

(1) Functional CRT
- "Touch screen" which allows screen switching and operation device selection with only a touch
- Connection of up to three 20 inch CRTs per station
- Full graphics, 16 colors display
- Four-fold scroll image, window function, split image
- Eye-smoothing CRT filter

(2) Full operation keyboard
- Dedicated operation keyboard
- Keys color-coded by function group
- Image call by one-touch key with LED

(3) Simple console desk
- Japan Electric Measuring Instrument Manufacturing Association Standard console desk with built-in CRT controller, memory, etc.

(4) Single window
- Process data (loop control data, sequence control data)
- Computer data (management data, computation data)
- Other systems data (data of conventional system and other systems via gateway)

3.2 Process station (PCS-500)

The PCS-500 can flexibly cope with all process control, from continuous control and batch control to instrumentation and electromachinery sequence control, and is a new controller which realizes installation space saving and high reliability. Implementation of control functions and other engineering tasks are performed interactively on the CRT of the EWS-500.

(1) Flexible control
- PID control and other loop control and sequence control are executed simultaneously and data transfer between both control functions is realized easily.
- 32 loops control/station and analog monitoring of 256 points and processing of up to 512 digital inputs and outputs are possible.

(2) Installation space saving by high density mounting technology
- Spacing saving of 1/2 to 1/3 compared to conventional system
- Analog converter and distributor are mounted in a locker as standard (external converter panel is unnecessary)

(3) High reliability
- MPU shelf with control operation, transfer function, etc. and internal bus can be collectively duplicated.
- Duplication of loop control output section and duplication of instrumentation power supply
- Full RAS functions (RAS information display by OCS)

(4) FFI system connection
The entire system, from the field to the dataway, can

be made optical fiber cable and lightning, etc. noise and explosion-proof measures can be eliminated by connecting the FFI system, which connects the transmitters and actuators and central control room by optical fiber cable, as the input and output.

3.3 Data base station (DBS-1500)

The DBS-1500 collects, stores, and collectively manages general data from the system as a unified database in the MICREX system.
(1) Unified database
   - Process data trend record
   - Alarm generation information time series record (process alarm, system alarm)
   - Logging print function, operation print function, message print function
   - System definition information storage
(2) Data unification in system
   - Posting of definition data modified by an arbitrary operator station from the DBS-1500 to all the related operator stations.
   - Data unification at duplication
(3) High reliability
   - Duplication of data base station possible
   - Data unification function at duplication
(4) Expandability
   - Various operations and management programs can be executed by using general-use programming language "C".
   - Since a general-use LAN (IEEE 802.3) can be connected, data exchange with a high-level computer is easy.

3.4 Engineering work-station (EWS-500)

When the plant becomes large and the system architecture and control computations become complex, system engineering becomes sophisticated, complex, and difficult, and a special engineer is needed even for little modifications. This trend becomes more noticeable as the plant becomes larger and more complex. An engineering work-station (EWS-500) is used with the MICREX system to standardize and simplify engineering. All engineering can be realized by interactive format and engineering costs can be reduced and the system configured and modified without the need for an engineer experienced with programming languages by means of this. Interactive type engineering uses conventional system know-how and takes easier use into account.

3.5 Dataway (DPCS-F)

DPCS-F increases the speed and functions of the old "Micro Dataway DPCS-E", while maintaining the same high reliability.
(1) Specifications (*Table 1*)
(2) High reliability design
   - Automatic loop-back function at open line by duplicate transmission line

Table 1 Dataway DPCS-F specifications

Item	Specification
Communication speed	10 M bits/sec
Access method	Token passing method
Transmission line and distance	Coaxial cable: 250 m (between stations) Optical fiber cable: 4 km (between stations) Can be mixed in same system.
Transmission line topology	Loop (duplication standard)
Transmission line length (total)	Max 32 km
Number of stations	Max 64 stations

Table 2 General-use LAN specifications

Item	Specification
Communication speed	10 M bits/sec
Transmission line control	CSMA/CD (Carrier Sense Multiple Access/ Collision Detection
Transmission distance	Max 500 m (Max 2.5 km by repeater)
Transmission line topology	Bus
Standard	IEEE (Institute of Electrical and Electronic Engineers) 802.3 (802 committee WG3)

   - Automatic disconnection of faulty station by bypass function
   - Communication unit of each station can be duplicated
(3) Connection to conventional system
   Connection to conventional system MICREX-P is possible through the dataway.

4 CONNECTION OF GENERAL-USE LAN

To raise the efficiency in an enterprise and increase productivity, not only automation in the plant, but also connection to a production management and other high-rank computer is indispensable. Since a general-use LAN, as well as the dataway DPCS-F, can be connected with MICREX, connection to another system and computer system is easy. The specifications are shown in *Table 2*.

5 CONCLUSION

The MICREX distributed control system is a new generation control system incorporating the newest technology. It far exceeds past control system knowledge. Coping with international LAN, coping with medium and small scale, and other future needs are amply considered and are supported by growing power and high reliability technology and we are confident that the control system world of the future will change considerably.