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EXPANSION OF FIBER-OPTIC FEILD INSTRUMENTATION SYSTEM FFI FAMILY

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1. FOREWORD

Fiber optic transmission element technology has advanced tremendously about application to communication systems. The features of fiber optics as a communication path are (1) low loss, (2) high insulation properties, (3) noninductive, (4) no crosstalk, (5) explosionproof, (6) noncorrosive, (7) small diameter, etc. The application of fiber optics to various fields of industry, including public telephone circuits and fiber optics CATV, is expanding rapidly, and its related technology is becoming one of the key technologies in modern basic technology. In 1988, optical industry production reached 2 trillion 336 million yen and can also be understood from the fact that approximately one half of all communication cables have been replaced with optical fiber cable (production total).

On the other hand, various breakthroughs have also been tried in instrumentation control systems, including research and development on an optics applied measurement control system (1979 ~ 1985) by the Ministry of Labor Industrial Technology Institute. These were suitable as the prelude of opening of the age of fiber optics of the 1980s in the instrumentation control fields. In 1985, Fuji Electric commercialized and began to ship a fiber optic field instrumentation system (FFI) as the instrumentation system for a new age. Since the FFI system incorporates the above mentioned features of fiber optics, it has gained more attention overseas that in Japan as a third generation instrumentation system following the pneumatic system and electronics (DC 4 ~ 20mA) system of the past. Currently, many are being used independently as optical instrumentation systems and in various plants (process) in concert will the electronic and pneumatic systems.

The FFI system and its various components have already been introduced in this and many other publications. Therefore, only the new products added to the FFI system line-up are outlined here.

2. NEW SYSTEM COMPONENTS

The overall configuration of the FFI system is shown in *Fig. 1*.

Fig. 1 Overall FFI system configuration

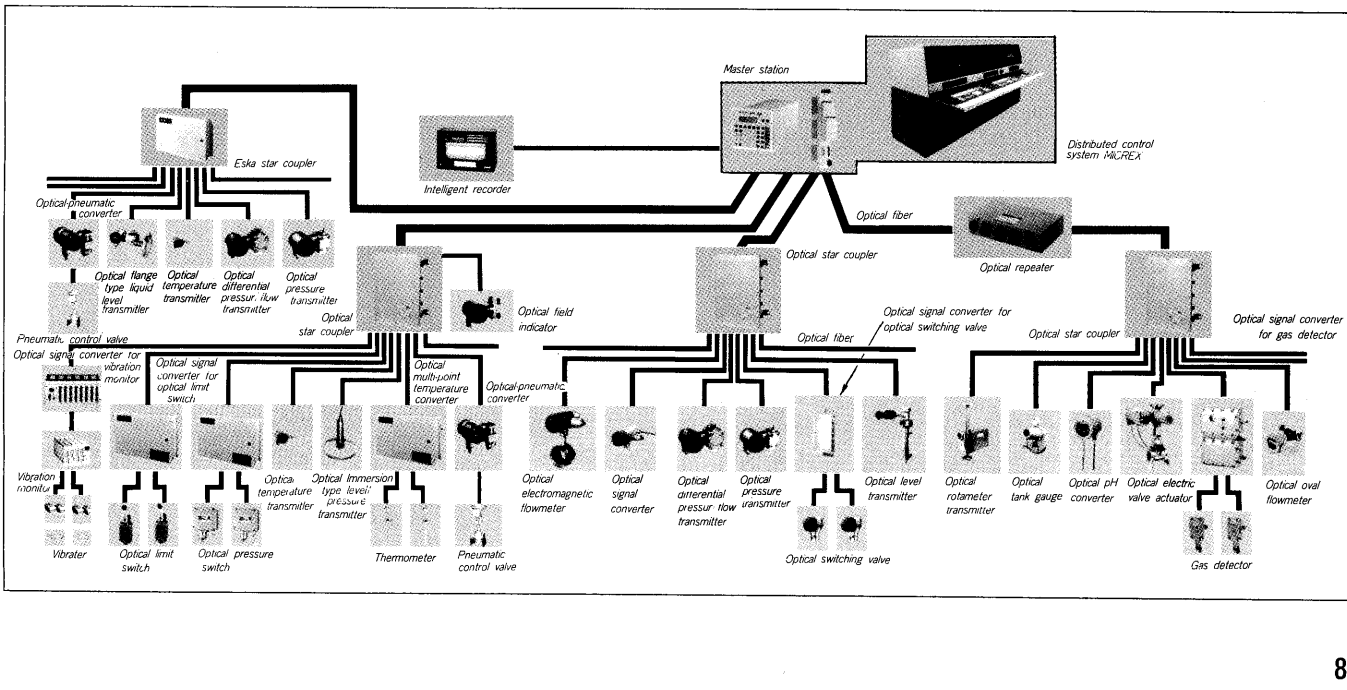
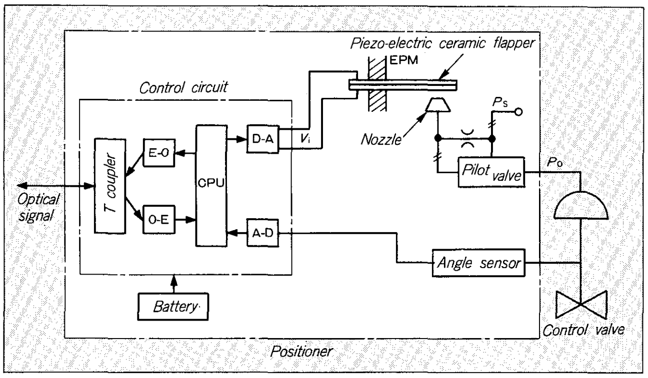


Fig. 2 Optical-pneumatic positioner (ZLF) configuration



2.1 Optical-pneumatic positioner

This device converts the control output signal (optical digital signal) from a master station to a pneumatic signal and drives a diaphragm control valve and feeds back the valve position to this device through a link and accurately positions the operation position.

2.1.1 Configuration

The configuration of the optical-pneumatic positioner is shown in *Fig. 2*. The optical-pneumatic positioner consists of four parts: optical-pneumatic converter, electric-pneumatic converter, angle-electric converter, and battery.

A coded 16-bit optical digital signal from the master station is input to the control circuit every 0.2 second. An angle sensor converts the valve opening (stem position) to an electric signal through a link mechanism and feeds it back to the control circuit. A microprocessor performs comparison, integration, and differentiation on the deviation of this input and the feedback signal and generates a voltage Vi corresponding to the deviation.

The electric-pneumatic converter consists of a piezoelectric ceramic flapper and a nozzle pilot valve. Voltage Vi above is applied to the piezoelectric ceramic flapper and is converted to deflection (several 10μm) and the nozzle back pressure is changed by its piezo effect.

The pilot valve amplifies the nozzle back pressure and converts it to output pressure Po. The battery consists of a lithium battery, common for FFI field instruments, and current control thick film resistor. The entire device is intrinsically safe and explosionproof.

2.1.2 Features

The features of the optical-pneumatic positioner are:

(1) Realization of direct optical-pneumatic conversion by single fiber optic transmission.
(2) Large deflection obtained as a pneumatic conversion element and improved reliability and low power realized by using a piezo-electric bimorph with excellent low temperature characteristics.
(3) Intrinsically safe and explosionproof achieved by low power circuit design and built-in lithium battery drive.
(4) Abnormal input and output and other self-check functions.
(5) Abnormal input (when there is no input due to a broken fiber) output hold function .... Output value immediately before abnormal input or deviation of −10%, +110% can be set.
(6) Pneumatic output direct feedback function.

2.1.3 Specifications

The main specifications of the optical-pneumatic positioner are:

(1) Input signal: Optical digital signal (FFI specifications) coded 16 bits
(2) Output signal: $0.2 \sim 1.0$ kgf/cm^2, $0.4 \sim 2.0$ kgf/cm^2, $3 \sim 15$ psi, $3 \sim 27$ psi, $6 \sim 30$ psi
(3) Accuracy: ±1.0%
(4) Response characteristic: Approx. 3 secs
(5) Diagnosis function: Input/output abnormal, low battery voltage
(6) Feedback function: Output air pressure feedback
(7) Emergency operation: Holding of immediately preceding output value or −10%, +110% output at abnormal input or no input

2.2 Flow integrator < differential pressure type >

This device is a stand-along type field flow integrator which processes and displays instantaneous flow and integrated flow from the detected differential pressure. It is used in flow measurement of various liquids.

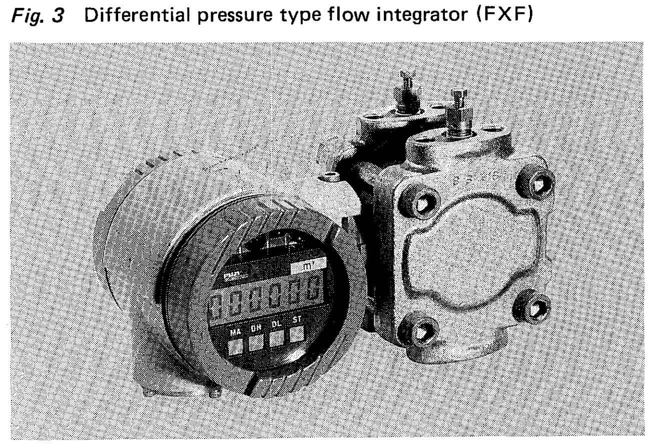
2.2.1 Configuration

The exterior view of the differential pressure type flow integrator is shown in *Fig. 3*. This device consists of a detector, detection circuit, processor, display, and battery. The detector and detection circuit have the same construction as the fiber optics type differential pressure flow transmitter. The detection circuit consists of a floating cell type electrostatic capacitance (ΔC) detector and ΔC measurement circuit. The processor has a built-in micro-processor and performs instantaneous flow/integrated flow processing. The display displays the processed result on an LCD (liquid crystal display).

2.2.2 Features

(1) Power is self-supplied by an internal battery (FFI field device common). Supply from the outside is unnecessary.
(2) The measurement range, integration constant, and

Fig. 3 Differential pressure type flow integrator (FXF)



division ratio can be set.

(3) The measuring unit material (measuring unit cover, pressure receiving diaphragm, etc.) can be selected according to the measurement flow specifications.

2.2.3 Specifications

(1) Measurement flow: Fluid, gas, vapor

(2) Measurement span: 10 ··· 100 mmH_2O ~ 30,000 ··· 300,000 mmH_2O

(3) Operating pressure range: 10, 30, 63, 140, 420 kgf/cm^2

(4) Display: LCD 6 digits (integrated value, instantaneous value)

(5) Setting: Measurement range (span), integration constant, scalar

(6) Low flow cut point: 7% ~ 20%

(7) Power requirement: Built-in lithium battery

(8) Self-check: Abnormal measurement range, abnormal detector, low battery voltage

2.3 Optical field indicator

This device is a field indicator which receives and displays the measurement signal from an optical field device via an optical star coupler or optical relay.

2.3.1 Configuration

An exterior view of the optical fiber field indicator is shown in *Fig. 4*. Its systems connection diagram is shown in *Fig. 5*.

2.3.2 Features

Selection of the measured value to be displayed can be arbitrarily made by setting the station No. of the partinent field device. Optical fiber cable connection modification is unnecessary.

2.3.3 Specifications

(1) Display: LCD 4 digits (% display, real scale display)

(2) Setting: Station No., channel No., real scale factor of field device to be displayed

(3) Power requirement: Built-in lithium battery (life approximately 4 years)

Fig. 4 Optical field indicator (FXH)

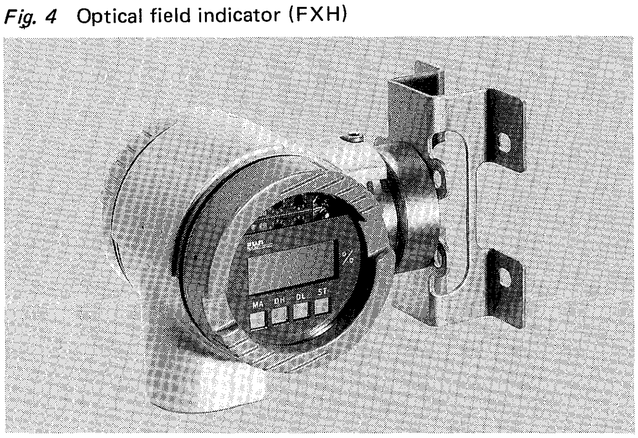
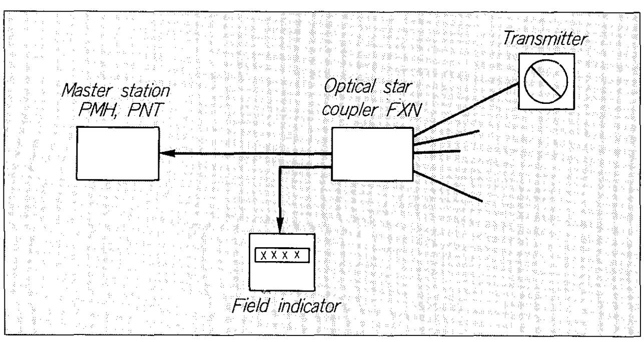


Fig. 5 Optical field indicator system connection diagram



2.4 Master station < rack mounting type >

This device supports eight field devices and connects to a host system by analog input/output signal and serial interface. The panel mounting type master station, optical/electric converter, and MICREX (DCS) dedicated master station of the existing line-up can be combined and selected according to the system scale.

2.4.1 Configuration

The exterior view of the device is shown in *Fig. 6*.

Fig. 6 Master station (PNT, rack mounting type)

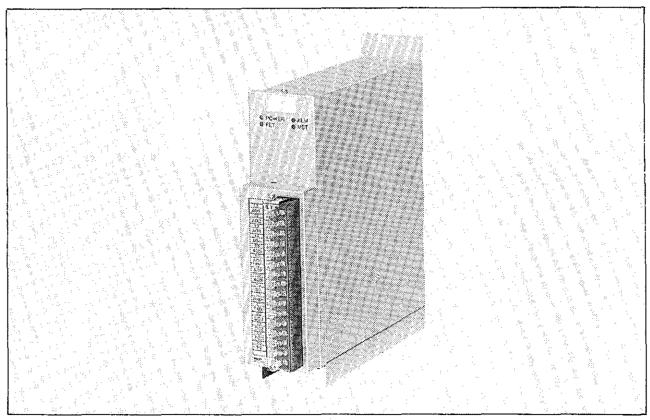
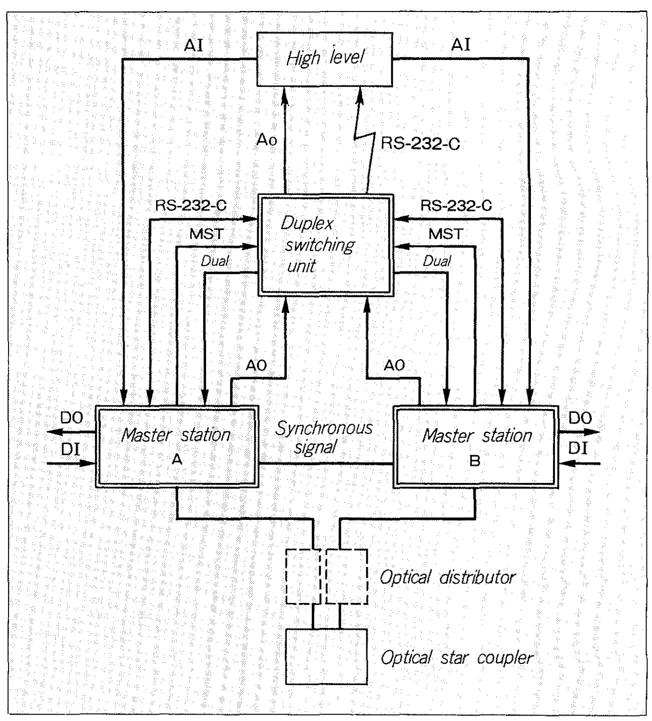


Fig. 7 Master station redundancy system configuration



2.4.2 Specifications

Field device interface

(1) Transmission system: Half duplex bi-directional optical transmission by single optical fiber

(2) Number of transmission lines: 1 channel (field devices 8)

(3) Transmission range: Master station-field device Max. 1.2km

Receiving instrument interface

(4) Analog input: 8 points (DC 1 ~ 5V)

(5) Analog output: 8 points (DC 1 ~ 5V)

(6) Serial interface: RS-232C

Redundancy

(7) Redundant configuration consisting of two master stations and a duplexed conversion unit is possible.

The duplexed system configuration is shown in *Fig. 7.*

2.5 MICREX/FFI system

The MICREX/FFI system is an FFI system linked to a distributed control system (MICREX). For details, see "Expansion of Distributed Control System MICREX" of this issue (page 93 ~ 97).

3. CONCLUSION

Expansion of the new development line-up of the FFI system was described above. Besides new additions to the devices introduced here, the FFI system will be expanded and developed as a field instrumentation system which does not stop at intelligent (smart) transmitters, but encompasses everything from sensors to actuators.

The FFI bus, which forms the FFI system, is proposed as an international field bus by conforming to IEC (International Electrotechnical Commission) SC65C/WG6 and is becoming fixed internationally for instruments. The FFI devices and system have been evaluation tested by WIB (Working-party on Instruments Behavior).

Exhibition of the devices (FFI family) of 10 companies which use the FFI system at one time at INTEROPTO '89 held on the theme "The world of light, more brighter" is new in memory. Exhibition and introduction of the FFI system as the advance of the world of light and as a total system = MICREX/FFI system with "the world of measurement connected by light" as the catch phrase at the '89 JEMIMA international exhibition in October is scheduled.