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FUJI FIELD INSTRUMENTATION SYSTEM

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1 INTRODUCTION

Including field instruments, mainly sensors and actuators, the systematization at the area mostly closed to a process has been delayed. It is assumed the reasons are that these instruments are widely distributed in the field, density of the data is low, requirements for the reliability and safety are severe, and then the systematization is comparatively difficult.

However, this delay will cause increases of costs for the maintenance, wiring and installation, and as the result, to achieve man power saving and resource saving, the systematization will be demanded more strongly.

Taking the above facts into considerations and aiming at the rationalization and improved reliability in the field-region, we developed a new Fuji Field Instrumentation System, which is composed of optical signal line and intelligent field instrument. This paper introduces it.

2 SYSTEM CONFIGURATION AND FEATURES

Fig. 1 shows the system configuration. This system consists of a master, field box and field instruments, and these components are joined through optical fibers for instrumentation. The master is connected to a host system.

Fig. 2 shows the optical fiber signal line. In this line, multiplication of 1 : 8 is realized by a star-coupling, and four sets of signal line can be processed by one master. The star-coupling is made by a star coupler of 2 : 8 within the field box. With this construction, a redundancy can be made in between the master and field box by a dual arrangement. Within the range of master and field instruments, data are processed entirely by a micro-processor.

Featurse of the system are introduced below.

(1) Accomplished rationalization
   a. The adaptability to a higher level system can be improved by using digital signals.
   b. Conversational remote setting, diagnosis and instrucollation for instrument-tag-number can be made by dialogical procedure, accomplishing rationalization of the maintenance.
   c. Rationalizations of wiring cost, panel space, etc. can be accomplished by the multiple signal line.
   d. The accuracy can be improved because of the digital measuring and compensating process.

(2) Improved reliability and safety
   a. Use of the optical fiber eliminates troubles due to noise, surge and insulation.
   b. Execution of the essentially safe explosion-proof countermeasures.
   c. The reliability improved by flexible applications of digital signal error check and dual arrangement for redundancy.

As described above, the system has many features.

3 SPECIFICATIONS OF THE SYSTEM

The general specificatons of this system are indicated below.

(1) Interface with a host system
   Exclusive interface with Fuji's higher system (MICREX, etc.)
   General purpose interface IEC625

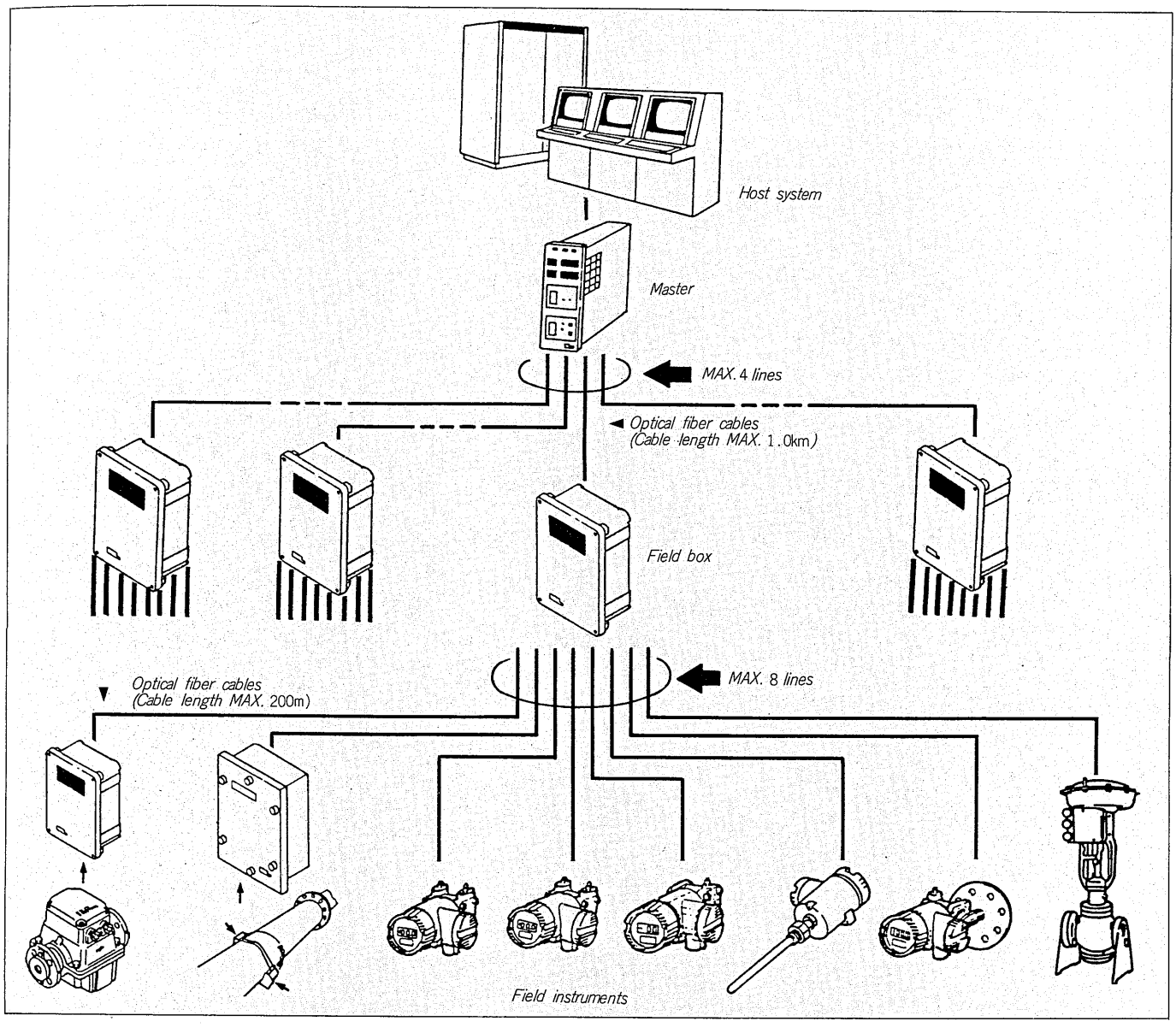
(2) Number of equipment connected
   Master: Up to four field boxes can be connected.
   Field box: Up to eight field instruments can be connected.

(3) Signal line
   Optical fiber: Quartz step index 110/150 μm
   Connector: FC compatible
   Between master and field box: Maximum 1 km; Dual arrangement can be made for redundancy.
   Between field box and field instrument: Maximum 200 meters.

(4) Transmission
   Signal: Non-modulated bit serial NRZ signal
   Transmission: Bidirectional half-duplex through one fiber and 1 : N transmission by master-slave system
   Sampling time: Minimum 0.2 sec/32 field instruments

(5) Transmitted data
   Measuring and actuating data
   Remote setting data: Zero, span, damping time constant, function mode, etc.

Fig. 1 Fuji field instrumentation system



Diagnostic data: Sensor, power supply, electronic circuit and optical circuit fault data
Management data: Collation of type, range code instrument-number, etc.

(6) Explosion-proof system
Field box and instrument for one-fiber-system: Essential safety realized by optical fiber system. Power supplied type field instrument: Primarily, intrinsically safe explosion-proof or frame proof-explosion-proof.

(7) Environmental conditions
Field: –30 to +60°C, 0 to 95% RH
Panel: 0 to 50°C, 40 to 85% RH

4 SYSTEM COMPONENT

As described in 2 above, the system consists of master, field box and field instruments.

(1) Master

Fig. 3 shows the block diagram construction of the master. The optical unit is an E/O, O/E element which performs bidirectional data transmission through a single fiber. *Fig. 4* shows the optical unit. This unit consists of an LED, PD, T-coupler and connector. This unit is used commonly for field instrument also.

In the format determined by the CPU, signals poll the field instruments cyclically, and send and receive data of the memory. In the memory within the master, the data of the same description of the memory of each field instrument are always copied. The host system reads the memory within the master, and accomplishes the necessary operations.

Various diagnoses, parameter-setting, etc. can also be executed from the keyboard on the master.

Fig. 2 Optical fiber signal line

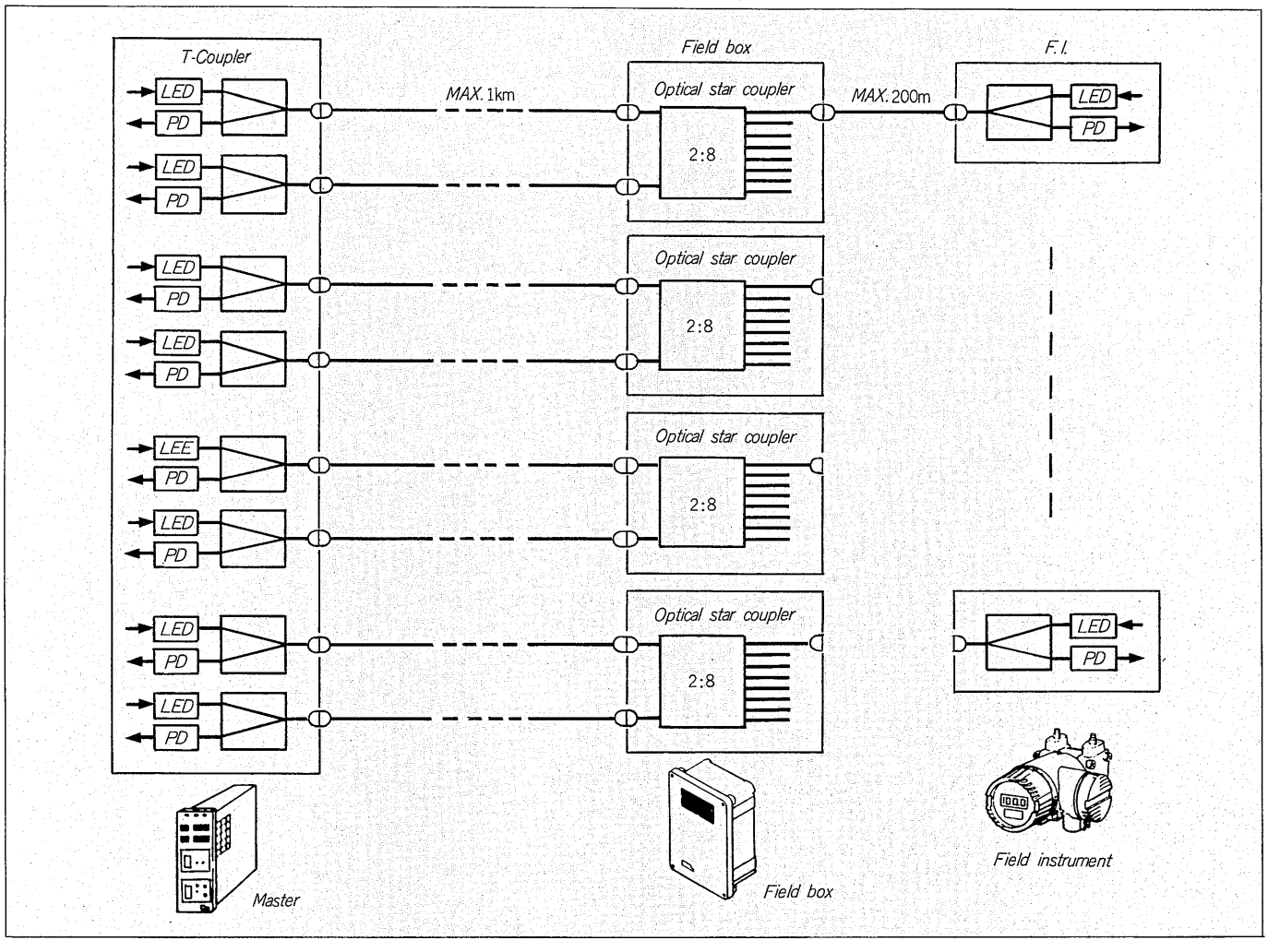
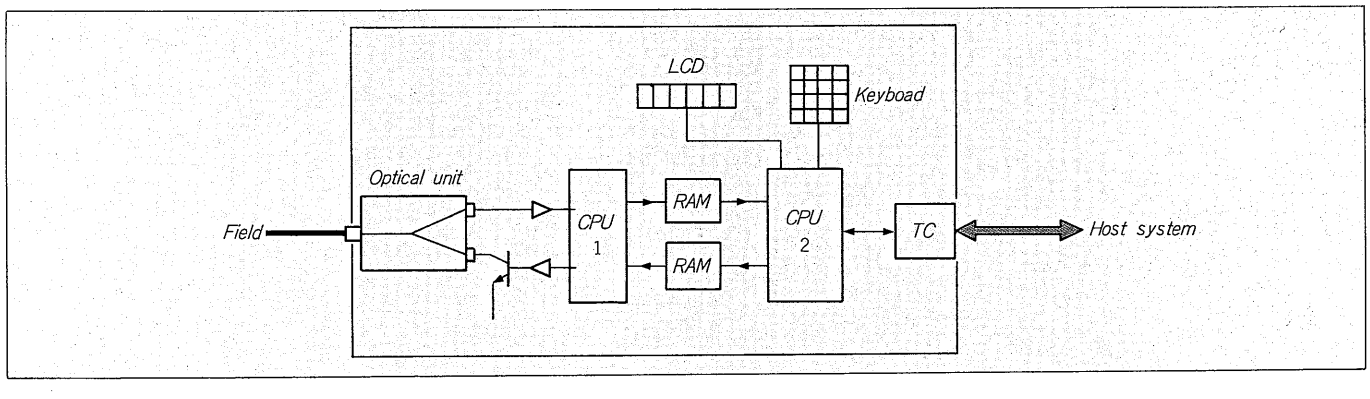


Fig. 3 Block diagram for master.



(2) Field box

The star coupler, the appearance of which is shown in *Fig. 5* is used in the field box. This star coupler is a 2 : 8 type coupler which uses a large bore quartz fiber as a mixing rod.

A signal sent from the master is equally divided into eight, distributed in parallel, and sent to each field instrument. Signals from a accessed field instrument are sent to the master after being collected by the coupler. Hence, each optical signal is transmitted bidirectionally within the star coupler.

The field box is connected to the master and field instruments through optical connectors.

(3) Field instrument

The field instruments are classified into one-fiber-system-instrument and power supplied type instrument.

(a) One-fiber-system-instrument

For those instruments which can be operated with a

Fig. 4 Optical unit

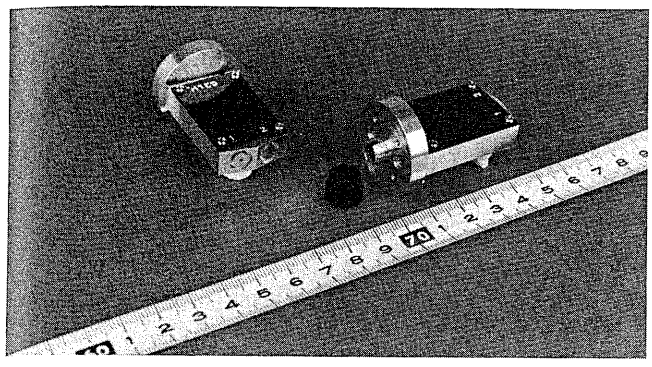
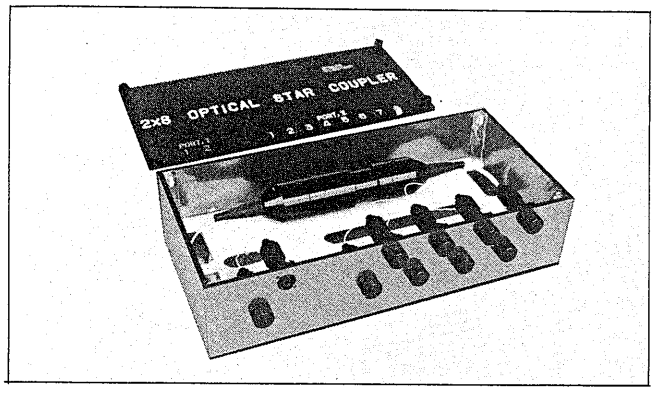


Fig. 5 2/8 Optical star coupler



low power, the simplist one fiber system can be accomplished by driving it with a built-in battery (lithium). *Fig. 6* shows one-fiber-system-transmitter. This system essentially solves problems of noise, surge, insulation, explosion-proof, etc. *Fig. 7* is a block diagram of the transmitter for one fiber system.

Analogue signals (C, R, mV, F) sent from a sensor are converted into pulse width by a counter, and after counting them, they are sent to the CPU as digital inputs. For various analogue values, a common digital unit can be used.

For the CPU, an 8-bit one tip C-MOS is used, and the CPU performs various functions, parameter settings, dia-

Fig. 6 One fiber system transmitter

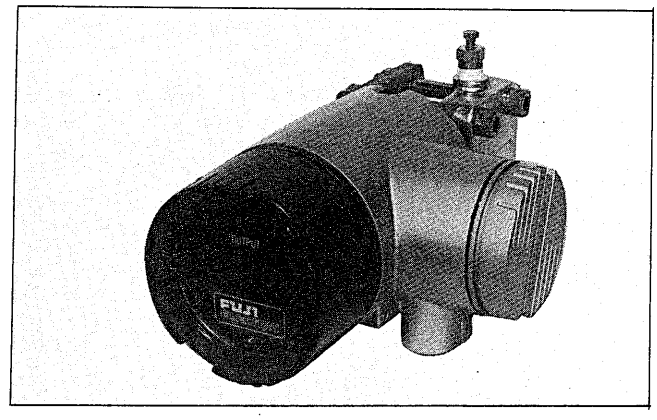


Fig. 7 One fiber system transmitter for FFI

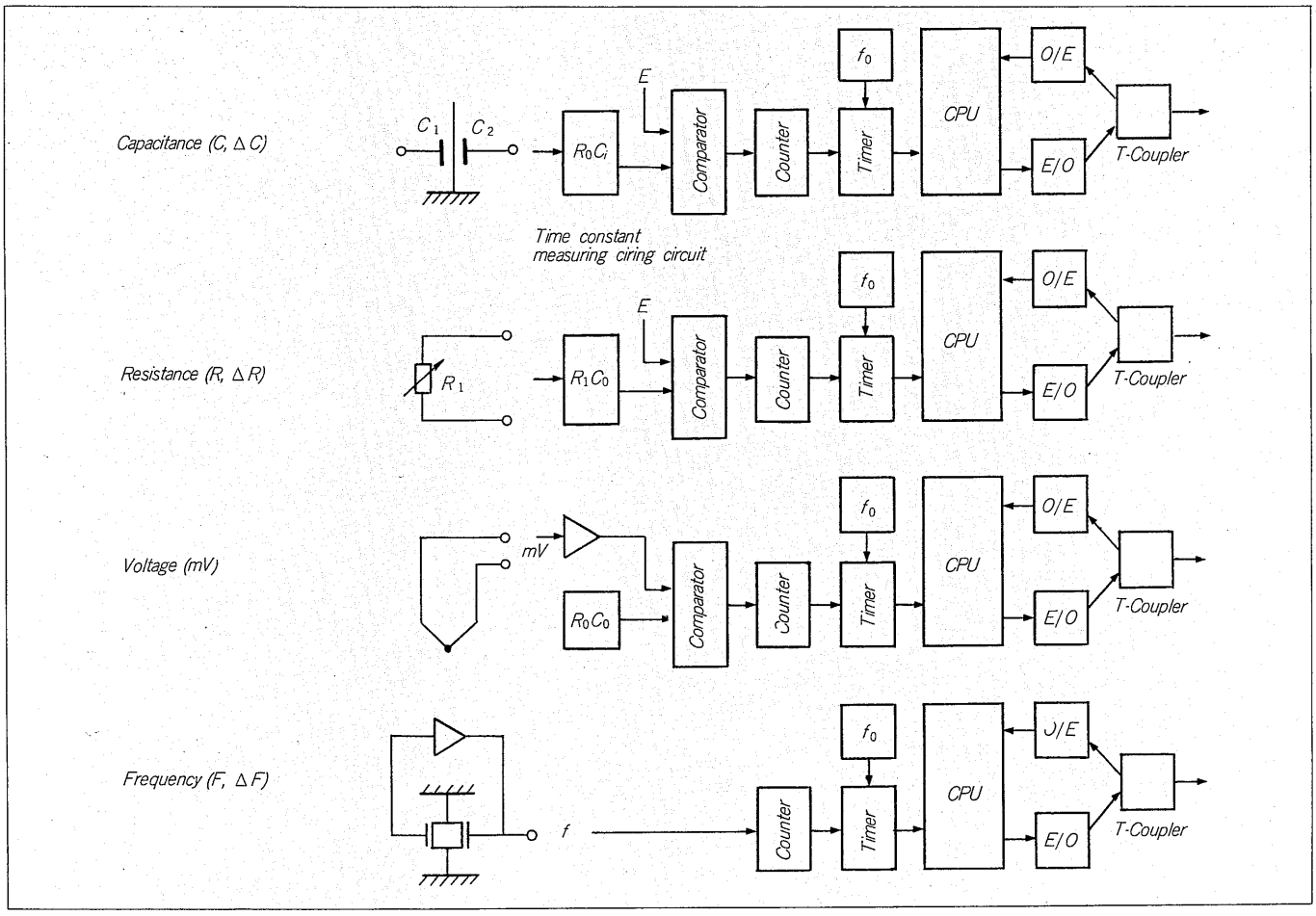
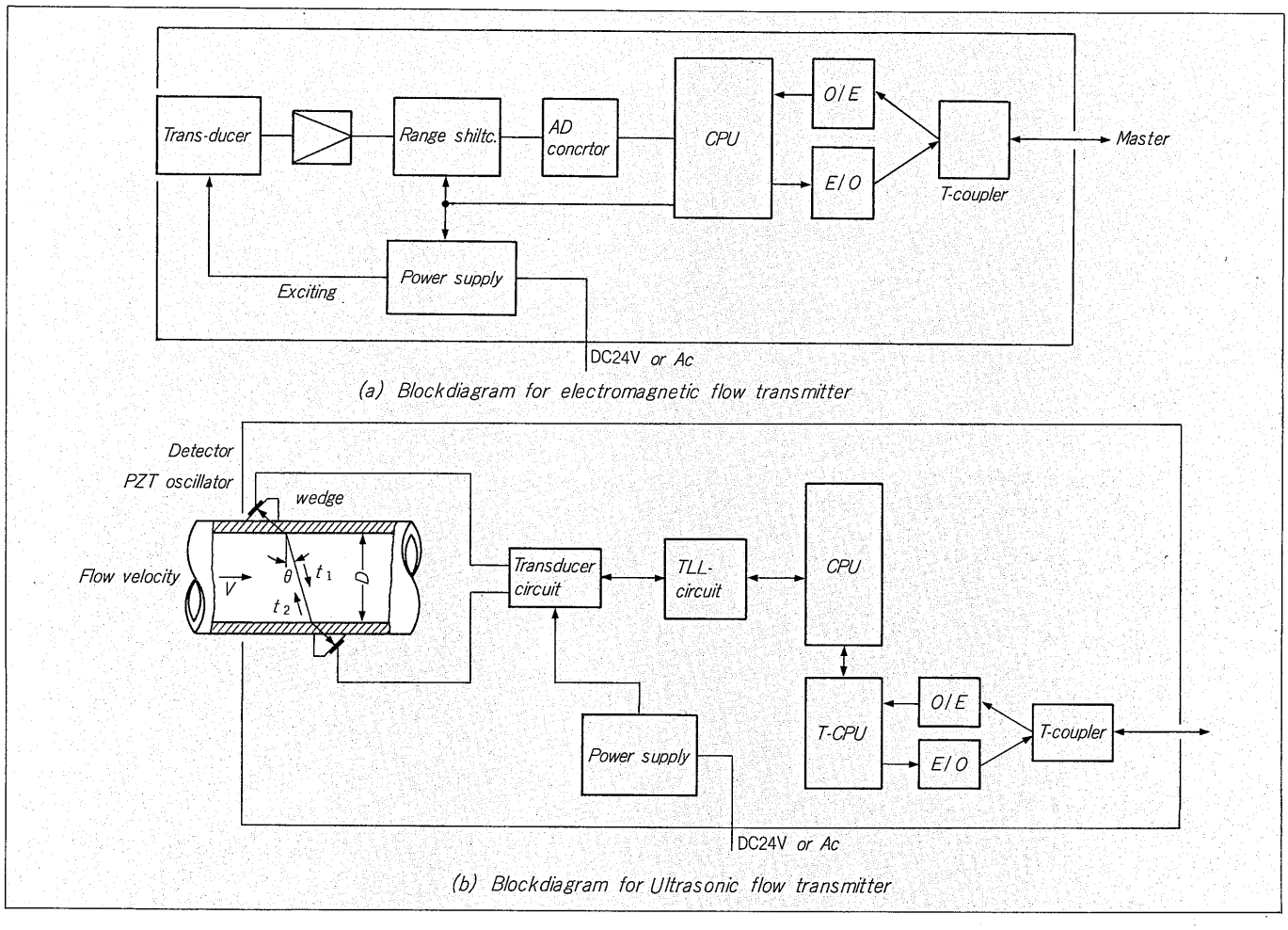


Fig. 8 Power supplied type transmitter.



gnosis and transmission. All of these operations are performed based on the synchronous signals sent from the master.

The CPU is connected to the optical unit and coupled with the fiber transmission line.

Output signals can be designated by liquid-crystal-device (LCD) in the field.

All the circuits, optical unit, indicator, etc. can be driven by lithium battery, accomplishing low voltage operation and low power consumption, and the lithium battery features its long service life over two years.

The major one fiber system instruments are composed of followings.

Differential pressure, pressure and temperature transmitters.

Light-air pressure converters, Air pressure-light converters.

Temperature multiplexers.

(b) Power supplied type field instruments

To those instruments which cannot be operated by a lower power, power (DC 24 V, etc.) is supplied externally.

Fig. 8 is a block diagram of a flowmeter. (a) is an example of electromagnetic flowmeter, and this is of a one CPU type. (b) is an example of ultrasonic flowmeter of a multi-CPU type which uses a transmission CPU.

The major power supplied instruments are composed of followings.

Electromagnetic and ultrasonic flow transmitters

Multi-E/O converters (for both analogue and digital)

Multi-O/E converters (for both analogue and digital)

5 CONCLUSION

As described above, this new system uses new elements such as digital circuit and optical element for the field instr-instruments. Since the early 1983, system reliability test and element environmental test have been conducted in the field, and excellent performance is still continuing.

Transmitters whitch have DC 4 ~ 20 mA signal using two wire system have used very widely because of adoption for standardized interface of IEC. In future, it is expected that standardized interface for digital signals will be investigated and arrived conclusion by influential commitee or organization.

Further, this system is expected to be developed to a advanced distributed system including field controllers.

We are intending to exhibit the new system at JEMIMMA, ISA, etc., and after receiving the evaluations, we will further develop the system to be a new system in the 1985's.