

# FUJI ELECTRONIC FC SERIES TRANSMITTERS

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## 1 INTRODUCTION

The FC series transmitters are electrostatic capacity type sensors which measure pressure, flow, level and other fluid process values.

This series was first sold in Japan 1978, and in 1980, all the models were made available for the market. To the world markets, first exported to Siemens of West Germany in 1981, and in the next year, OEM export was started to ITT BARTON on U.S.A. As these transmitters are used actually in the fields, the high performance and reliability have been proved, and they are highly evaluated.

## 2 FEATURES OF THE FC-SERIES TRANSMITTER

The differential pressure transmitters of electrostatic capacity method can be made to an almost completely symmetrical construction. With this construction, only the differential pressure to be measured can be taken out differentially, and adverse affects of conditional values such as temperature and static pressure can be eliminated. Further, a long term stability and wide measuring range can be realized advantageously because the static capacity change ratio which is a signal for the base static capacity is large. The FC series transmitters have essentially outstanding features as introduced above.

With the high technologies developed by Fuji Electric such as high precision detector element manufacturing technologies and floating cell construction, the FC series transmitters have exceeded the conventional electrostatic capacity methods.

Figs. 2 and 3 respectively show the principle diagrams of the differential pressure transmitters and pressure transmitters. The floating cell construction stationarily sets a detector element (cell) on the body with a floating pipe or diaphragm. In this construction, the cell is hardly to be affected by adverse effects due to process conditions and atmospheric conditions because they are absorbed by the floating pipe or diaphragm.

The small in dimensions yet highly accurate cell has an extremely superior linearity at a low and fine differential

Fig. 1 FC-series transmitters

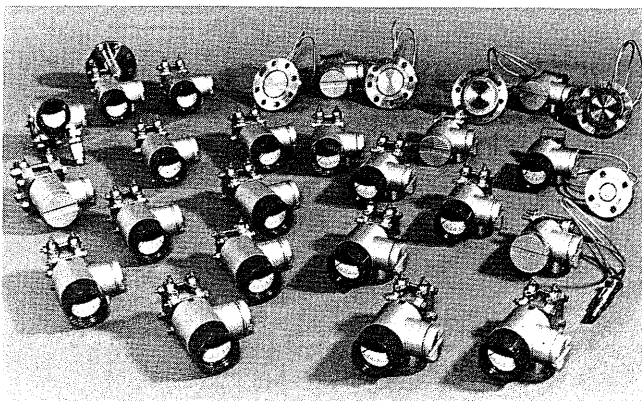


Fig. 2 Principle diagram of differential pressure transmitter

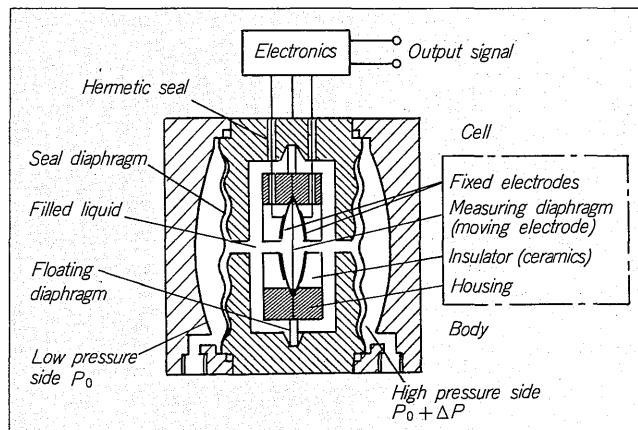
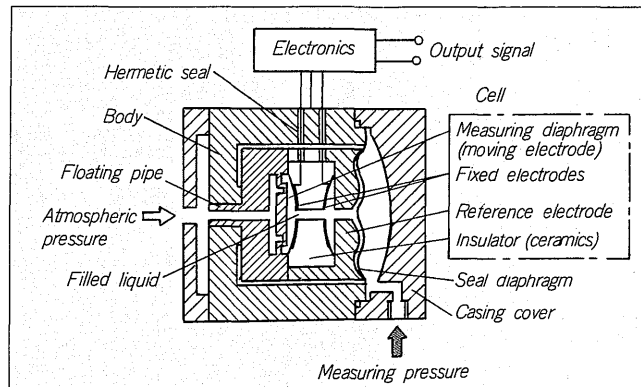


Fig. 3 Principle diagram of pressure transmitter



pressure range, realized by the special manufacturing technology (The diaphragm is stretched by applying a high tension).

The main features of the FC series transmitters are:

- (1) A group of various types, wide measuring range and high accuracy of all types

Including the flow transmitter ( $\sqrt{\Delta P}$ ), various types are available. From such an extremely low differential pressure as 10 mm H<sub>2</sub>O up to 500 kg/cm<sup>2</sup>, all types feature the high accuracies of  $\pm 0.2\%$  or  $\pm 0.25\%$ .

For all types, the range ability is  $\times 10$  ( $\times 5$  for flow transmitters only). Therefore, measurement can be made toward a wide range with only one transmitter.

- (2) High performance

The characteristics against conditions such as static pressure, over-pressure and temperature under which the transmitters are used and installed are outstanding.

- (3) High reliability and long term stability

The transmitters use the totally welded simple floating cell construction. Since no organic material is used, the reliability and long term stability are high.

- (4) Maintenance ease

Since the transmitters are small in dimensions, light in weight, and the external dimensions are unified, they can be handled easily in the fields.

Maintenance and adjustment of the transmitter unit can be made easily.

- (5) Worldwide international specifications

The transmitters have acquired certifications from various standards, approved by evaluation tests and treated for special application fields so that they can respond to the demands of various fields in the world markets as detailed in III below.

### 3 SPECIFICATIONS AND PERFORMANCE

Table 1 outlines the acquired certifications and special specifications.

For the explosion-proof approvals, the FC series transmitters have acquired the PTB (West Germany) certification for intrinsic safety and FM (U.S.A.) or CSA (Canada) certification for both intrinsic safety and flameproof. At present, the transmitters are applied to the intrinsic safety certification by SAA (Australia). Table 2 shows the connectable barriers and applicable gas groups of the intrinsic safety authorized by FM and CSA.

The high performance of FC series transmitters has been proved at the evaluation test by WIB (Working party of Instrument Behaviour). They have also been proved that they are satisfactory in the handling and maintenance.

The transmitters of sanitary specifications are used to measure level, pressure, flow, etc. of a food tank. They are so designed that sanitary management and handling can be made easily at food and pharmaceutical industries, and they satisfy the IDF (International Dairy Federation) standards.

Those for a lower power are capable of responding to such requirements as low voltage and stabilized power con-

Table 1 Approval and special specifications

Acquired Certification	Explosion-proof certification	Intrinsic safety JIS i 3nG 5 PTB EEx ib 11C T6 FM Class I Division I Group A, B, C, D CSA Class I Division I Group A, B, C, D SAA Exia II C T 6 (Being applied) Flameproof JIS ds2G 4 FM Class I Division I Group B, C, D CSA Class I Division I Group C, D
	For marine use	Lloyd NK
	Custody	PTB certification
Evaluation test		Evaluation test by WIB
For special applications	For sanitary applications: IDF (International Dairy Federation) standard For lower power applications: DC 10V, 15 mW NACE specifications: NACE MR-01-75 For nuclear power applications: LOCA Spec. For low temperature: $-50 \sim 60^{\circ}\text{C}$ For vacuum very minor differential pressure, Oxygen measurement, Chlorine measurement, Teflon coating, Others	

Table 2 Connecting barrier and applicable gas groups for FM and CSA

Maker	Model	FM	CSA
MTL	MTL128-	A, B, C, D	A, B, C, D
	MTL188+	A, B, C, D	A, B, C, D
	MTL188R+	A, B, C, D	A, B, C, D
	MTL322	A, B, C, D	A, B, C, D
Honeywell	38545-0000-0110-113	A, B, C, D	A, B, C, D
	38545-0000-0110-111	C, D	A, B, C, D
	38545-0000-0110-111	C, D	A, B, C, D
	38545-0000-0110-112	C, D	A, B, C, D
Taylor	1130FF (G) 21000	C, D	C, D
	1130FF (G) 21000	C, D	C, D
	1130FF (G) 21000	C, D	C, D
	1135FF (G) 21000	C, D	C, D
	1135FF (G) 21000	C, D	C, D
Stahl	8901/33-092/000/79	A, B, C, D	A, B, C, D
	8903/51/200/050/70	A, B, C, D	A, B, C, D
	8903/31-315/050/70	A, B, C, D	A, B, C, D
Foxboro	2AI-12V-FGB (CGB)	B, C, D	B, C, D
	2AI-13V-FGB (CGB)	B, C, D	B, C, D
	2AS-13I-FGB (CGB)	B, C, D	B, C, D
	3A2-12D-FGB (CGB)	B, C, D	B, C, D
	3A2-13D-FGB (CGB)	B, C, D	B, C, D
Westing house	75SB02	A, B, C, D	not approved

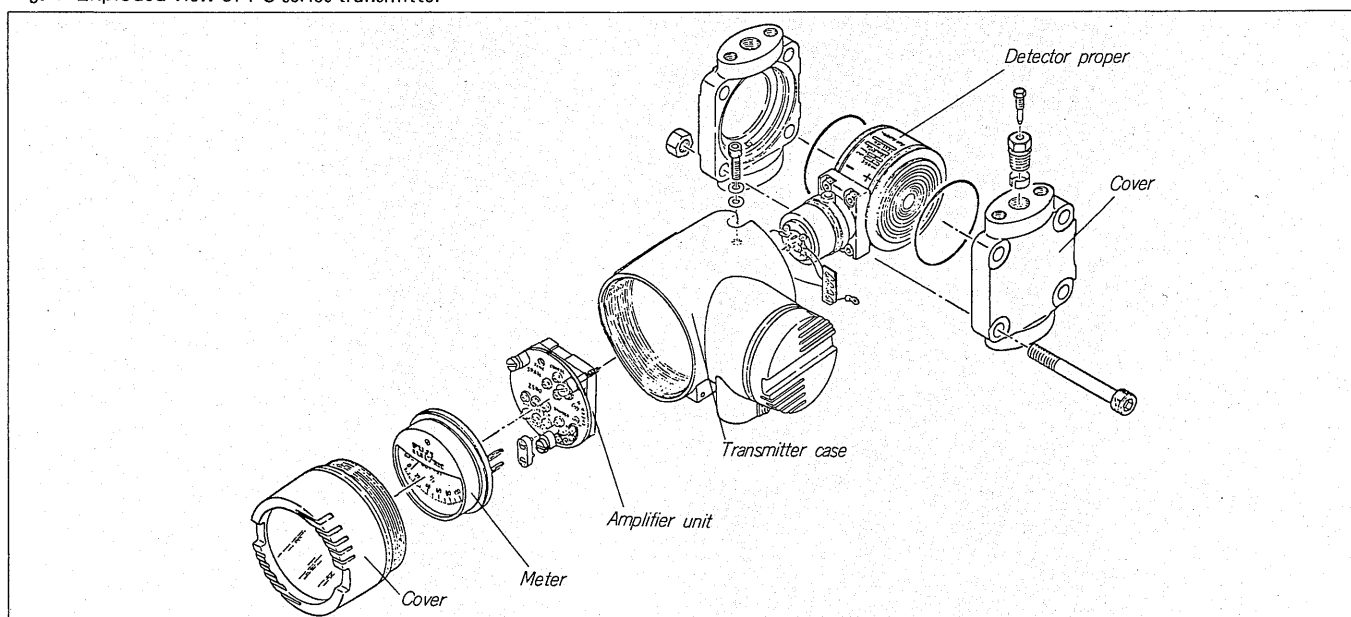
sumptions, which are required especially in case of a battery drive.

NACE (National Association of Corrosion Engineers) specifications are for use at the atmosphere of sulphuric

Table 3 General specifications of FC series transmitter

Functional and physical specifications	Wiring method	2-wire
	Output system	DC4~20 mA, DC10~50 mA Differential pressure $<\Delta P>$ Linear DC4~20 mA, DC10~50 mA Flow $<\sqrt{\Delta P}>$ Linear
	Permissible maximum load resistance	$R_{\max} = \frac{U - 12}{20} \times 10^3 \Omega$ , $R_{\max} \leq \frac{U - 25}{50} \times 10^3 \Omega$
	Power supply	12V DC $\leq U \leq 45$ V DC, 25V DC $\leq U \leq 70$ V DC
	Ambient temperature	$-30^\circ\text{C} \leq T_a \leq 80^\circ\text{C}$ , $-40^\circ\text{C} \leq T_a \leq 60^\circ\text{C}$
	Weather resistance	DIN 40040HQC
	Water/rust-proof construction	JIS C 0920 Dip-proof type IEC IP65 NEMA 4
	Explosion-proof	Shown on a separate table
	Rangeability	1 : 10 (1 : 5 in case of $\sqrt{\Delta P}$ )
	Adjustable zero range	-32 to 100% of the maximum span (-20% to 20% in case of $\sqrt{\Delta P}$ ) (-100 to 100% in case of $FPA$ )
	Damping time constant	Time constant changeable (4 steps)
	Electrical connection	PF1/2. NPT1/2. Pg13.5 Female threads
	Transmitter case	Aluminum alloy, Epoxy Polyurethane double paint; Silver color
Specifications	Attachment	Field meter: Built in the transmitter case Arrester: Built in the transmitter case; Z-Wrap (Gapless arrester element)
	Effect by power fluctuation	Zero point change $\pm 0.005\%/V$
	Load effect	Zero point change $\pm 0.01\%/100\Omega$
	Noise resistance	Common mode noise: $\pm 0.2\%$ or less against AC 50/60 Hz, 100V HF noise: $f < 100$ kHz; $\pm 0.2\%/V_{p-p}$ $f \geq 100$ kHz; $\pm 0.5\%/0.1$ MHz $\cdot V_{p-p}$ Transceiver noise: $\pm 0.2\%$ or less with transceiver (27 MHz), 30 cm

Fig. 4 Exploded view of FC series transmitter



acid gas, and the transmitters of NACE specifications are manufactured based on the NACE standard.

Those for a low temperature respond to use at cold place, and can be used at temperature down to  $-50^\circ\text{C}$ .

Those for nuclear power satisfy LOCA (Loss-Of-Coolant Accident) specifications, and FC series transmitters for these applications are manufactured in accordance with the order.

For those standards and specifications not listed on the table also, Fuji Electric is ready to respond them.

Tables 3 and 4 indicate other general specifications.

#### 4 MAINTENANCEABILITY

The construction is of a unit type as shown in Fig. 4, and therefore, the maintenance is easy.

The parts to be adjusted are concentrated in front of the transmitter unit as shown in Fig. 5, and access to these parts is easy.

The amplifier unit can be used commonly for all types of the FC series, the characteristics are interchangeable among the types, and the amplifier unit can be replaced easily because of its connector connection.

The field meter can be installed in a single motion simply by inserting the meter terminal to the check terminal on the face of the amplifier unit. The meter can also be used as a field checker.

The flow transmitter ( $\sqrt{\Delta P}$ ) uses a special amplifier unit which combines a square-root extractor. This amplifier unit can also be used as a linear differential pressure transmitter by switching the terminal.

#### 5 RELIABILITY AND LONG TERM STABILITY

Through the many uses at various fields after starting

Table 4 Types, specifications and performance of FC series transmitter

Object		Differential pressure (Types FFB·FFC·FFF), Flow (Type FJQ)					Differ- ential pressure with dia- phragm	Pressure	Pressure with dia- phragm seal	Absolute pressure	Flange liquid level	
		Fine dif- ferential pressure	Low dif- ferential pressure	Medium dif- ferential pressure	High dif- ferential pressure	Super high dif- ferential pressure						High static dif- ferential pressure
Type		FFB11 FJQ11	FFB22 FJQ22	FFC33 FFC34 FJQ33 FJQ34	FFF35 FJQ35	FFF36	FFC44 FFF45 FFF46 FJQ44 FJQ45	FFD13 FFD14 FFD15 FFD33 FFD34 FFD35	FBC1 FBC2 FBC3 FBC4	FBD1 FBD2 FBD3 FBD4	FBA1 FBA2 FBA3 FBA4	FPA13 FPA14 FPA15 FPA33 FPA34 FPA35
Functional and physical specifications	Measuring range* Unit for (1): (mmH <sub>2</sub> O); Unit for (2): (kg/cm <sup>2</sup> ); Unit for (3): (mmHg abs)	0~10... 100 (1)	0~25... 250 (1)	0~130... 1,300 (1) 0~640... 6,400 (1)	0~3,200 ..32,000 (1)	0~3... 30(2)	0~640... 6,400 (1) 0~3,200 ..32,000 (1) 0~3... 30(2)	0~130... 1,300 (1) 0~640... 6,400 (1) 0~3,200 ..32,000 (1)	0~0.4... 4(2) 0~2... 20(2) 0~10... 100 (2) 0~50... 500 (2)	0~0.4... 4(2) 0~2... 20(2) 0~10... 100 (2) 0~50... 500 (2)	0~12... 120 (3) 0~60... 600 (3) 0~300... 3,000 (3) 600... 800(3) (3)	0~130... 1,300 (1) 0~640... 6,400 (1) 0~3,200 ..32,000 (1)
	Maximum working pressure	10	30	100			420	10.30	—	—	5	10.30
	Material	Standard: Diaphragm, 316 LSS, others, 316SS (The casing cover of high static differential pressure is iron) Corrosion-resisting materials: Hastelloy C, Monel, Tantalum (applied to medium/high differential pressure, differential pressure/pressure with diaphragm, and pressure flange liquid level)										
	Fluid temperature	-30 to 100 (-30 to 180°C for differential pressure/pressure with diaphragm and flange liquid level)										
	Weight (kg)	6.5				12		14~29	5	7.5~11	5	12~21
	Process connection	PT¼ Female threads, NPT¼ Female threads, (or PT1/2 female threads with an oval flange used), NPT female threads, Flange: JIS, ANSI, DIN										
	Others	*Measuring range of FJQ is up to 1/5 of the maximum differential pressure										
Performance	Accuracy	FFC: ±0.2%, Others: ±0.25% (For FJQ, ±0.25 when flow is 20% or more; or ±0.5% when flow is 10 to 20%)										
	Temperature effect	FFC: Zero shift, ±0.3%/60°C of the maximum span FJQ: At 25% flow, ±0.6%/60°C in case of FJQ [ ] 3.4; ±1.2%/60°C for other cases Others: Zero shift; ±0.6%/60°C of the maximum span										
	Over-pressure effect	FFB, FFC, FFF: Zero shift; ±0.3% of the maximum span/Maximum working pressure, (±0.8%/420 kg/cm <sup>2</sup> for high static pressure) FJQ: At 25% flow, FJQ1, 2 and 3: ±0.6% of the maximum span/Maximum working pressure; FJQ4: ±2%, FJQ6: ±0.6%										
	Static pressure effect	FFB: ±0.2% of the maximum span/Maximum working pressure FFC, FFF: Zero shift: ±0.2% of the maximum span/100 kg/cm <sup>2</sup> , Span shift; +0.25%/100 kg/cm <sup>2</sup> FJQ: At 25% flow, ±0.4% of the maximum span/Maximum working pressure, however, 0.4%/100 kg/cm <sup>2</sup> for high static pressure										

Fig. 5 Internal view of transmitter

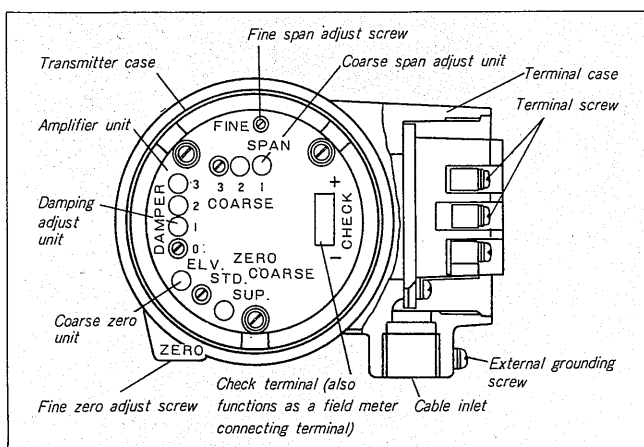


Table 5 Field data of FC series transmitter

Plant where surveyed		Water processing plant		Chemical plant		Steel mill		
Measured year month		79.10	80.9	79.7	80.4	79.12	80.9	81.4
Number of operated months		3	14	3	12	4	13	20
Zero shift $\epsilon$ Distribution of (%)	Number of transmitters measured	35	35	22	26	45	46	29
	$ \epsilon  \geq 0.1$	32	27	9	13	32	31	21
	$0.1 <  \epsilon  \leq 0.2$	2	6	8	4	8	6	4
	$0.2 <  \epsilon  \leq 0.3$	1	1	1	6	4	6	2
	$0.3 <  \epsilon $	0	1	4	3	1	3	2
	Mean value	+0.003	+0.004	-0.026	+0.014	+0.01	-0.02	-0.02
	Fluctuation (standard tolerance)	0.07	0.105	0.178	0.195	0.12	0.13	0.15

the sales, the high reliability and long term stability have been actually proved.

Table 5 shows an example of the long term stability data measured in the actual field. The value indicated in the table shows distributions of zero shift from the initial data, and the distribution is indicated in error percentage (%) against the maximum span. This error contains all the errors caused by various characteristics, measuring conditions, etc. being changed by the circumferential or environmental condition changes. Change of the mean error value is very minor, the distribution is small, and these data indicate that the long term stability is very excellent.

## 6 REARRANGEMENT AND EXTENSION OF THE MANUFACTURING SYSTEM

Taking the opportunity on the OEM export to the

United States of America and Europe, number of orders is rapidly increasing. To cope with this, the highly automated series manufacturing system which covers from the manufacturing of parts to the final test has been established, realizing the expanded manufacturing ability and shortened delivery time. The system is capable of supplying the products faster than the standard delivery time for urgent orders.

## 7 POSTSCRIPT

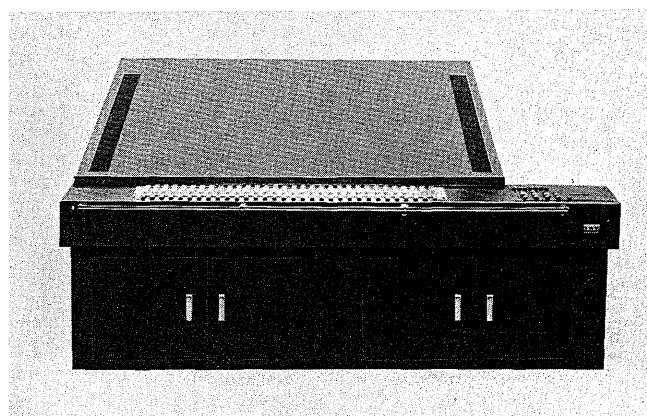
We regret that we could not introduce more data regarding the performance, reliability, etc. due to the limitation on the Fuji Review. It is confident that the FC series transmitters will completely satisfy the users.

# TOPICS

## INK CONTROLLER FOR PRINTING MACHINE

Fuji Electric has completed an ink supply controller for offset printers, and exported many number of them to the overseas. Technology revolution is essential in the offset printing industries as well as other industries. Micro-processors are developed remarkably during recent years, and they are applied to the machines related to printing business for quality improvement, manpower saving and resource saving.

In an offset printing machine, volume of supplied ink must be optimized in response to patterns and pictures on a press plate. In other words, to maintain a high quality of printed matters, supplied ink volume must be controlled in accordance with thickness of patterns and pictures. The data for thickness of picture on a press plate are received from a picture area ratio meter available in the commercial market. The micro-processor built in the ink controller makes calculations with the characteristics of the machine taken into consideration, causing the actuator ink bottle control motor to turn forward or reversely. Further, the data for best condition of the printing quality is stored into a cassette magnet tape which helps great cut down of time required in setting up the system when repeating the print-



ing.

The ink controller was completed by applying Fuji Electric's own micro-processor. Fuji Electric is intending to apply its own high technologies such as measurement control technique for control and management of printing machines.