TECHNICAL GUIDANCE

FW-9000N Series

SUPER INTELLIGENT TANK GAUGE

OUTLINE

FW-9000N Series is the successor to the well received and widely used FW-9000 series for its reliability and variety of application.
Making the most of reliable, durable and highly accurate mechanism of FW-9000, **FW-9000N** has become more reliable and user-friendly by improving the other parts.
Consequently, **FW-9000N** has the interchangeability with the current FW-9000 series in terms of installation methods and interfaces with other equipment.
Its noise resistivity and lightening protection performance have improved significantly.
The intensified automatic self-diagnosis and self-adjustment functions have made **FW-9000N** more user friendly.
Including ATEX certified version intended for use in potentially explosive atmosphere **FW-9000N** is ready to serve world-wide users.

APPLICATIONS

❑ For bonded tanks

❑ For LPG, LNG, Petroleum, Fuels, Water supply and sewage systems, Chemicals, Power plants, Food and Beverages.

❑ For versatile applications such as various kinds of liquid measurement, 2-liquids interface, a-point-measurement of liquid density, multi-points measurement of liquid density for profile presentation.

FEATURES

Those items marked as ☆ are added or improved features from existing models.

☆ For bonded tanks
The increased noise resistivity and lightening protection assure you reliable operation as complying with superb level 4 or more stipulated in IEC61000-4,5.

☆ Complying with RoHS requirements.

☆ Having the same dimensions and materials as existing models, FW-9000N compatible to Japanese explosion-proof requirements are interchangeable with them to make replacement easy.

☆ FW-9000N has additionally complied with ATEX Directive 94/9/EC-equipment and protective systems intended for use in potentially explosive atmospheres.

☆ Parameters can be set without opening housing with 4 magnet sensors attached to the indicating windows.

☆ FW-9000N accepts wide range of supply voltage from 100 to 240 VAC, 50/60Hz.

☆ Standardized 2 sizes of measuring drums cover wide measuring ranges from small to gigantic tanks.

❑ Eco-friendly low power consumption as small as Max. 25VA.

❑ FW-9000N covers high design pressure up to 3.0 MPa.

❑ Electronic circuits are housed in the electric compartment which is isolated from drum compartment.

❑ FW-9000N can be connected to the existing spot type temperature sensors and multipoint averaging temperature sensors.

❑ Precision type stepping motor has realized high accurate measurement with micro processor unit.

❑ Reliable operation with powerful self-diagnosis functions.

❑ High durability with non-contact type balancer without using slip ring.

❑ In addition to the high-speed serial data communication, FW-9000N have various communication tools which are compatible to TOKYO KEISO's existing well-established transmitters. Therefore, FW-9000N serves with ease for your renovation and replacement of the existing tank monitoring system.

❑ In combination with DIR-110N series Max. 6 contact signals transmitted between field and control room serve for monitoring and control of equipment around the tank yard in addition to liquid level monitoring.

❑ Other measuring analog 4 to 20 mA signals such as pressure or flow can be digitalized and transmitted.

❑ Analog 4 to 20mA signals such as level and temperature can be output additionally to serve high speed data processing carried by host computers.

MODEL CODE

FW-9 ☐ ☐ ☐ N ☐

MEASURING RANGE

1	0 to 5m
2	0 to 10m
3	0 to 15m
4	0 to 18m
5	0 to 25m
6	0 to 30m
7	0 to 40m
8	0 to 60m
9	SPECIAL

WIRE DRUM SIZE

1	400mm
2	800mm
9	SPECIAL

PRESSURE RATING

1	ATOMOSPHERIC
2	0 to 1MPa
3	0 to 2MPa
4	0 to 3MPa
9	SPECIAL

ENCLOSURE

W	WATERTIGHT
E	FLAMEPROOF

OPERATION PRINCIPLE

A very thin measuring wire B is wound onto measuring drum C having 400 mm/r or 800 mm/r precisely machined spiral groove.

Measuring drum C is connected to Driving shaft F through magnet coupling D, E and rotates forward and backward according to movement of gear-down unit J, K and stepping motor N. A worm gear J, which is located on the same axis as Driving shaft F, is connected to Driving shaft F through Spring I.

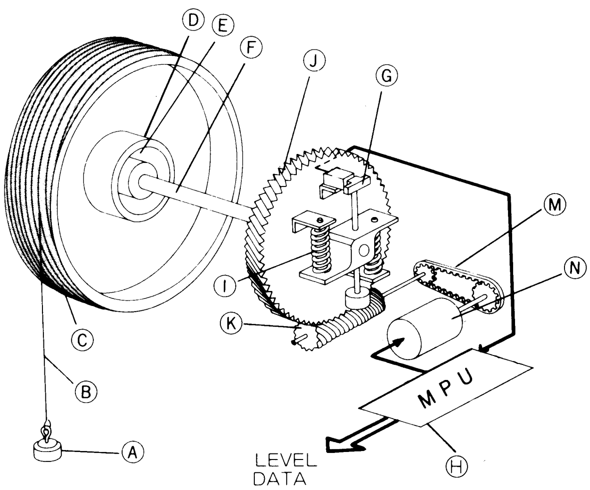
By this arrangement, tension onto Measuring wire B can be precisely detected by measuring distortion of Spring I by Balancer G. A Displacer A, of which density is higher than that of liquid to be measured, is connected to one end of Measuring wire B. The weight of Displacer A always gives downforce tension to Driving shaft F. In normal measurement condition, Stepping motor N is controlled by signal from Balancer G to give Measuring wire B a slightly less and constant tension than the welght of Displacer A. In this way, Displacer A always follows liquid surface with stable draft line.

Thus, rotating angle of Measuring drum C which corresponds to length of unwound Measuring wire B represents height of liquid in tank.

By adjusting the control level of tension T onto measuring wire B, interface of two liquids having different density can also be measured. Also, by sinking displacer into liquid and measuring the tension T onto measuring wire B, the liquid density can be detected and measured.

In FW-9000N, signal from Balancer G is fully digitalized. Stepping motor N, having high resolution, is controlled by Microprocessor unit H. This digitalized servo operation system offers high liquid following capability and stability in operation compared to existing analog control method.

The angle of Measuring drum rotation is obtained from the number of steps of Stepping Motor N. This remarkably improves the resolution of liquid level measurement of 0.1 mm.



STANDARD SPECIFICATION

Mechanical specification

- **Liquid level detection** : Digital controlled electric servo balancing type consisting of small size displacer, measuring wire and wire drum
- **Displacer** : Dia. ø140, ø110, ø90, ø70, ø50, ø30
  Mass 250g (Standard)
  Material SUS304, SUS316, SUS316L, MA (Equiv. to Hastelloy), PTFE, others
- **Measuring wire** : Standard SUS316 (ø0.2, single)
  Option *1 MA (Equiv. to Hastelloy) (ø0.3, single)
  FEP covered (ø0.6, stranded core)
  *1 Small type wire drum may be unable to be used in case of measuring wires other than standard (ø0.2) even in short measuring range. Consult factory for details.
- **Wire drum size** : 400 mm/r (FW-9□1□N□)
  800 mm/r (FW-9□2□N□)
- **Tension detection** : By perfect Non-contact magnetic field response type Hall element sensor
- **Driving motor** : High resolution type stepping motor
- **Drive shaft sealing** : Strong magnet coupling
- **Measuring range**

0~5m	(FW-91□□N□)	*2
0~10m	(FW-92□□N□)	*2
0~15m	(FW-93□□N□)	*2
0~18m	(FW-94□□N□)	*2
0~25m	(FW-95□□N□)	*2
0~30m	(FW-96□□N□)	*2
0~40m	(FW-97□□N□)	*3
0~60m	(FW-98□□N□)	*3
Special	(FW-99□□N□)	*3

*2 Small size drum (400 mm/r, FW-9□1□N□) or large size drum (800 mm/r, FW-9□2□N□) is applicable.
*3 Large size drum (800 mm/r, FW-9□2□N□) is applicable.

- **Temp. range** : Liquid -200 to +300˚C
  Ambient -20 to + 60˚C
  (Temperature of main body)
  However, the liquid and the moisture inside the wire drum room shall not freeze over, nor adhere.
  * Not suitable for the use environment where the mass of displacer changes by the attachment of liquid.
- **Operating pressure** :

Prees.	Op. press. (MPa)	MODEL	Material of pressurized part
Low press.	ATM	FW-9□□1N□	AC2A, SCS13, SCS14
High press.	0 ~ 1	FW-9□□2N□	SCS13, SCS14
	0 ~ 2	FW-9□□3N□	SCS13, SCS14
	0 ~ 3	FW-9□□4N□	SCS13, SCS14

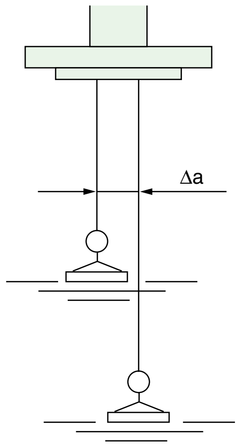
- **Accuracy*** (Indication and digital output) :
  1) Liquid level measurement

$$\pm(0.1 + \frac{20}{\rho \cdot A} \cdot b + 0.06L) \text{ mm}$$

  ρ : Density of liquid to be measured
  A : Cross section area of displacer (cm^2)
  L : Measuring range (m)
  b : Coefficient Standard ball bearing spec. (Shaft dia. Ø3)...b = 1
  PTFE Shaft spec. (Shaft dia. Ø3) ...b = 2
  Example : In case of density (ρ) 0.8g/cm^3 and with ϕ90 displacer
  ± (0.5 + 0.06L) mm
  2) Interface measurement
  In case of density difference of 0.2
  ± (1.7 × a + 0.06L) mm
  a: coefficient depending on interface conditions 1 to 5
  3) Density measurement
  ± 0.01g/cm^3

* Under reference conditions.

- **Process connection** : Flange
  Flange size 3", 4", 5", 6"or others
  (Horizontal movement of displacer for tank height to be considered for decision of flange size)
  Flange rating JIS5K/10K/20K/30KRF,
  ANSI 150/300,
  JPI 150/300, Others
- **Displacer guiding** : Standard : By stand pipe
  Option : Non guide *4
  By guide wire *4
  Special *4
  *4 : Specified accuracy not applicable. Consult factory for further details.
- **Displacer horizontal movement** :
  For small size drum
  (400 mm/r, FW-9□1□N□)
  for 1 m liquid level movement
  Δa=2.5mm, 1.9mm, 1.4mm
  For large size drum
  (800 mm/r, FW-9□2□N□)
  for 1 m liquid level movement
  Δa=1.25mm, 0.95mm, 0.7mm



- **Construction** : Watertight (FW-9□□□NW) or
  Flameproof ExdIICT6 (FW-9□□□NE)
  (TIIS certification No. TC14583)

ELECTRONICS AND SOFTWARE SPECIFICATION

● Signal

1) External input

Besides normal level measurement by FW-9000N, the following external devices can be connected to FW-9000N. Data from such external instruments are digitalized and transferred to control room through serial data signal:

a. Temperature sensors

(Temperature conversion range :-200 to +320°C)

1) Pt100Ω spot temp. sensor (TS type of Tokyo Keiso or equivalent)
2) Average temp. sensor (ATM type of Tokyo Keiso or equivalent)
3) Multi-spot average temp, sensor (ATS type of Tokyo Keiso or equivalent)

b. Analog signal

4 to 20mA, 1 point (Input resistance 250Ω)

2) External output :

a. Serial data output for remote control room receiver (Electric or optical pulse, Refer to ◆ COMMUNICATION FUNCTION for further details.)

b. Serial data coded output for explosion-proof tank side receiver (Electric)

c. Contact output

Number of contacts : 2

Configuration : SPST(1a or 1b)

d. Analog output

4 to 20 mADC ×2 (Level and Temperature)

conversion accuracy ± 0.5% F.S.

● Alarm monitoring :

2 Points of liquid level alarms or temperature alarms

Max.6 points when tank side indicator (DIR-110N series) is used.

When input signals exceed set points :

1) Specified alarm message is indicated on LCD.
2) Specified bit of serial output is “ON".
3) Assigned open collector output is actuated.

● Control and parameter setting :

All parameters can be set by the following procedures:

1) Dialogue type setting with magnetic sensor on indicator shown as arrows.
The registered password allows parameter settings for security reason.
(Control and parameter setting are possible without opening housing cover with power "ON".)
2) Through 2-way data communication from remote control room.
3) Dialogue type setting by tank side indicator (DIR-110N)

● Contents of control :

Designation of measuring objects such as liquid level, interface, density. Hoisting, lowering , stoppage and others of float

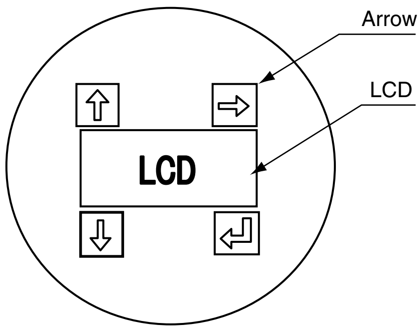
● Contents of parameter setting :

Hoisting (Maximum, Minimum), Adjustment of level indication, Displacer operation PID mode, Alarm set point / Reset span / Alarm action / Relay allotment (Level, Temperature), Connection thermometer classification, Point changing of temperature element, Type of external input, etc.

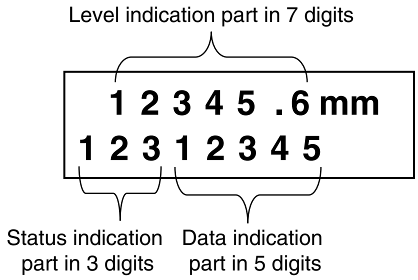
● Self-diagnostis function

Error status Indication of status LCD			Diagnosis
1			Motor power suppy not in order
2			Wire under tension
3			Wire over tension
4			Balancer signal not in order
5			Repeatability error
6			Breaking of temperature wire
7			Temperature scale over
8			Internal counter error
9			4 to 20 mA scale over
A			Non-volatile memory check sum error
B			Sensor communication error
C			Density measurement error
E			Slit sensor error

● Indication part



● Details of LCD presentation



● Cable entry : Standard G(=PF) or NPT female (Flameproof cable glands available as option)

Size 3 × 3/4 inch + 1 × 1inch

● Cabie termination : Plug type terminal connection

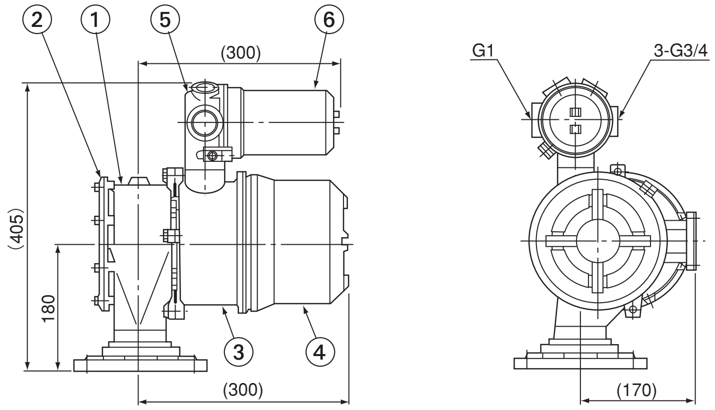
● Power supply : 100 to 240 VAC, 50/60Hz

● Power consumption : Max. 25VA

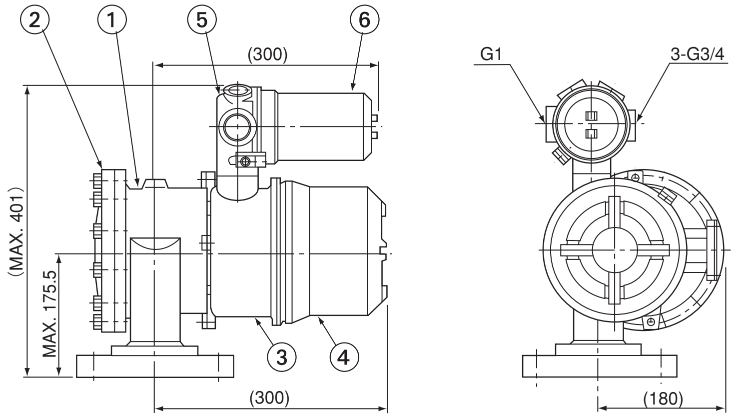
● Arrester : Provided as standard

DIMENSION AND WEIGHT

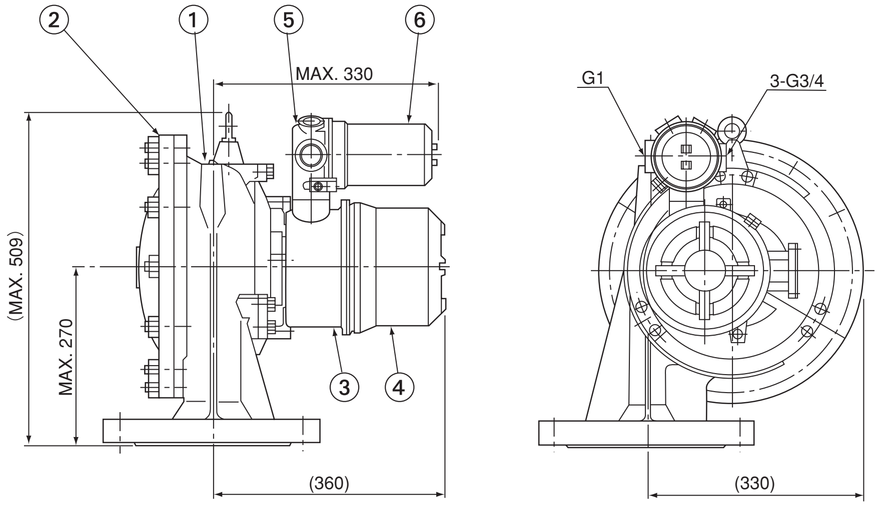
Small size drum, Low pressure type



Small size drum, High pressure type



Large size drum, High pressure type

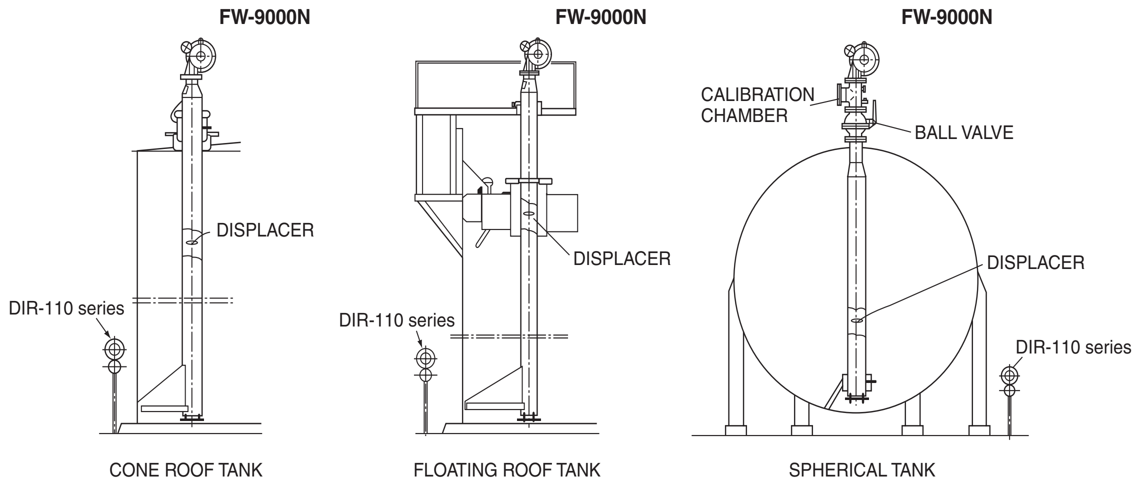


No.	Description
1	Wire drum compartment
2	Drum compartment cover
3	Electric compartment
4	Electric compartment cover
5	Terminal box
6	Terminal box cover

Wire drum compartment material	Wire drum size	
	Small	Large
AC2A	16kg	—
SCS13/14	35kg	90kg

INSTALLATION

Following examples show how to install the instruments on cone-roof tank, floating roof tank and sphere tank using stand pipes.



COMMUNICATION FUNCTION

The following different communications are available for FW-9000N SUPER INTELLIGENT TANK GAUGE:

1) STANDARD OUTPUT FORMAT OF FW-9000N

Transmission type	2 way-2 wire serial data transmission
Baud rate	2400 bps
Wiring	Bus line wiring (16 tanks/BUS)
Distance	Max.5 km (Subject to 20 /one way and inter-core capacitance 0.5 μ F/m)

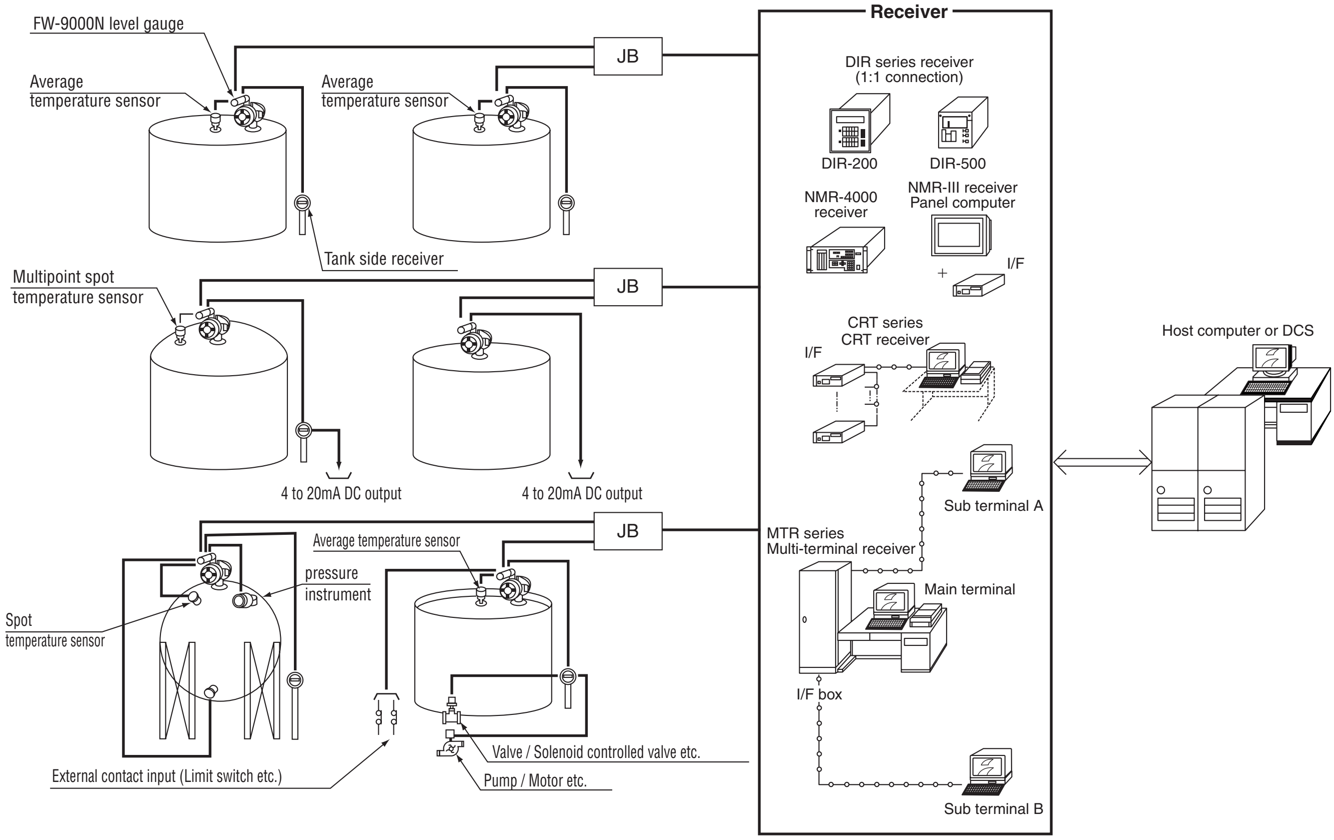
2) COMPATIBLE FORMATS FOR TOKYO KEISO'S EXISTING TANK DATE TRANSMITTERS
   a. DM-II type
   b. DB-M type
   c. DM type
   d. FW-7000 series

3) OPTICAL PULSE OUTPUT
   TOKYO KEISO's Optical fiber tank gauging system

4) Other serial communications
   a. RS-485 MODBUS
      Transmission type : RS-485 (2-wire)
      Baud rate : 2400/4800/9600bps
      Distance : 1.2km
   b. TRL/2 compatible
      *Field bus communication of Rosemount
   c. V1 compatible
      *Corresponding to E+H company

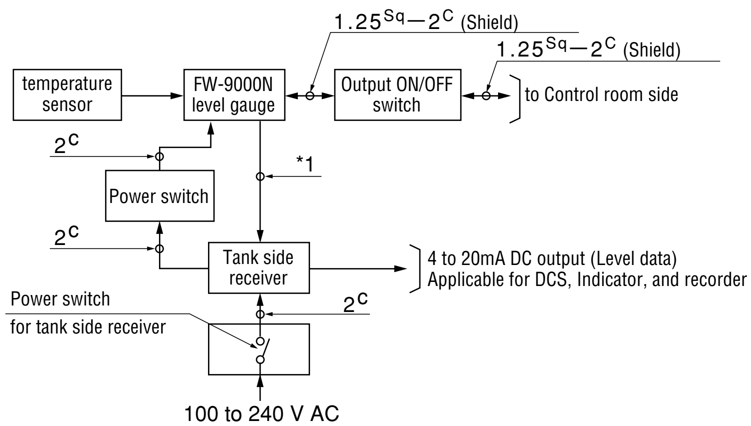
EXAMPLE OF CONFIGURATION

1) Example of system configuration instruments

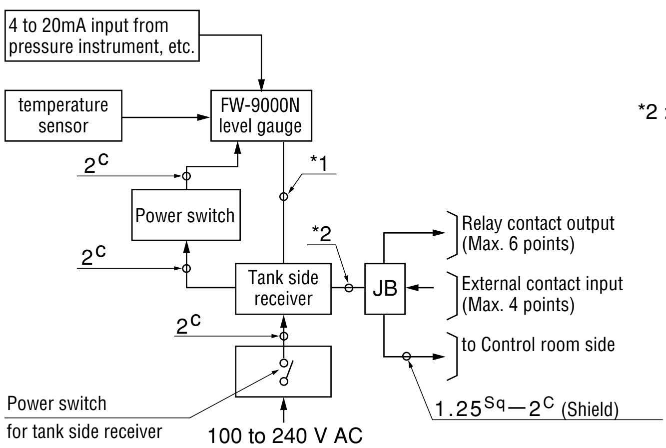


2) Local configuration / Wiring system figure

Example 1.



Example 2.



*1 : 1.25^{Sq}–n^{C} (Shield)
n : Total of following
For signal to control room 2^{C}
For signal to tank side receiver 2^{C}

*2 : 1.25^{Sq}–m^{C} (Shield)
m : Total of following
For signal to control room 2^{C}
For relay contact output $(2+\text{point})^{C}$
For external contact inputs $(2+\text{point})^{C}$

ORDERING FORM

TANK SPECIFICATION	
LIQUID NAME	
DENSITY	
VISCOSITY	mPa·s
LIQUID TEMP.	°C
PRESSURE	MPa
TANK TYPE	☐ CONE ROOF ☐ FLOATING ROOF ☐ SPHERICAL ☐ ( )
MEASURING RANGE	mm
MAX. LEVEL CHANGE SPEED	mm/min.
MODEL CODE	**FW-9☐☐☐N☐**
PROCESS CONNECTION	
FLANGE SIZE	☐ 150mm (6") ☐ 125mm (5") ☐ 100mm (4") ☐ 80mm (3") ☐ Others ( )
FLANGE RATING	☐ JIS 5K RF ☐ JIS 10K RF ☐ JPI #150 ☐ ANSI#150 ☐ JIS 20K RF ☐ ANSI#300 ☐ JIS30KRF ☐ OTHERS ( )
DISPLACER GUIDING	☐ NON-GUIDE ☐ STAND PIPE ☐ GUIDE WIRE ☐ SPECIAL ( )
MATERIAL	
DRUM COMPARTMENT	☐ AC2A ☐ SCS13 ☐ SCS14 ☐ Others ( )
DISPLACER	☐ SUS304 ☐ SUS316 ☐ SUS316L ☐ MA (Equiv. to HASTELLOY) ☐ PTFE ☐ OTHERS ( )
MEASURING WIRE	☐ SUS316 ☐ MA (Equiv. to HASTELLOY) ☐ FEP COVERED ☐ OTHERS ( )
OUTPUT AND INPUT	
A. REMOTE OUTPUT*	☐ WITHOUT DIGITAL OUTPUT ☐ FW-9000 (STANDARD) ☐ DM-II ☐ DM ☐ DB-M ☐ FW-7000 ☐ FW-9000 optical pulse (std.) ☐ RS-485 MODBUS ☐ TRL/2 ☐ V1
B. 4 TO 20mA OUTPUT*	☐ NOT REQUIRED ☐ REQUIRED (☐ LEVEL, ☐ TEMPERATURE) ☐ REQUIRED (HART) (☐ LEVEL, ☐ TEMPERATURE)
C. CONNECTED THERMOMETER*	☐ NOT REQUIRED ☐ SPOT TYPE (TS) ☐ AVERAGE TYPE (ATM or ATS)
EXTERNAL CONTACT OUTPUT	☐ NOT REQUIRED ☐ REQUIRED (POINTS)
EXTERNAL ANALOG INPUT(4 TO 20mA DC)	☐ NOT REQUIRED ☐ REQUIRED
POWER SUPPLY	
VOLTAGE	V AC (100 to 240 V AC acceptable)
CABLE ENTRY	☐ G (=PF)FEMALE ☐ NPT FEMALE ☐ Others ( )
CABLE GLAND	☐ CUSTOMER'S SCPOE ☐ TOKYO KEISO SCOPE (Cable diameter mm)
SPECIAL MEASUREMENT FUNCTION	
INTERFACE MEASUREMENT	☐ NOT REQUIRED ☐ REQUIRED (DENSITY : UPPER LOWER)
DENSITY MEASUREMENT	☐ NOT REQUIRED ☐ REQUIRED
APPLICATION	☐ GENERAL ☐ CUSTODY
CONSTRUCTION	☐ GENERAL ☐ SANITARY FINISH
	☐ LOW AMB TEMP ☐ SPECIAL ( )
ACCESSORIES	
CALIBRATION CHAMBER	☐ NOT REQUIRED ☐ TOKYO KEISO SCOPE ☐ C USTOMER'S SCORE
ISOLATION BALL VALVE	☐ NOT REQUIRED ☐ TOKYO KEISO SCOPE ☐ CUSTOMER'S SCORE
LOCAL POWER SWITCH	☐ NOT REQUIRED ☐ TOKYO KEISO SCOPE ☐ CUSTOMER'S SCORE

*: Up to two instruments are available.

* Specification is subject to change without notice.

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