User's
Manual

Model DM8
Vibration Type Density Meter

IM 12T03A01-02E

vigilantplant.®

YOKOGAWA ◆
Yokogawa Electric Corporation

IM 12T03A01-02E
3rd Edition

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◆ INTRODUCTION

This manual describes the specifications, installation, operation, maintenance, and trouble-shooting for the Model DM8 Vibration Type Density Meter. To use this manual correctly, read this manual thoroughly.

For the Model VD6SM Sampling System, refer to IM 12T3S1-01E.

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◆ For the safe use of this equipment

■ Safety, Protection, and Modification of the Product

- In order to protect the system controlled by the product and the product itself and ensure safe operation, observe the safety precautions described in this user's manual. We assume no liability for safety if users fail to observe these instructions when operating the product.
- If this instrument is used in a manner not specified in this user's manual, the protection provided by this instrument may be impaired.
- Be sure to use the spare parts approved by Yokogawa Electric Corporation (hereafter simply referred to as YOKOGAWA) when replacing parts or consumables.
- Modification of the product is strictly prohibited.
- The following symbols are used in the product and user's manual to indicate that there are precautions for safety:

■ Notes on Handling User's Manuals

- Please hand over the user's manuals to your end users so that they can keep the user's manuals on hand for convenient reference.
- Please read the information thoroughly before using the product.
- The purpose of these user's manuals is not to warrant that the product is well suited to any particular purpose but rather to describe the functional details of the product.
- No part of the user's manuals may be transferred or reproduced without prior written consent from YOKOGAWA.
- YOKOGAWA reserves the right to make improvements in the user's manuals and product at any time, without notice or obligation.
- If you have any questions, or you find mistakes or omissions in the user's manuals, please contact our sales representative or your local distributor.

■ Warning and Disclaimer

The product is provided on an "as is" basis. YOKOGAWA shall have neither liability nor responsibility to any person or entity with respect to any direct or indirect loss or damage arising from using the product or any defect of the product that YOKOGAWA can not predict in advance.

Symbol Marks

Throughout this user's manual, you will find several different types of symbols are used to identify different sections of text. This section describes these icons.

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

IMPORTANT

Indicates that operating the hardware or software in this manner may damage it or lead to system failure.

NOTE

Draws attention to information essential for understanding the operation and features.

Tip

This symbol gives information that complements the current topic.

SEE ALSO

This symbol identifies a source to be referred to.

◆ After-sales Warranty

■ Do not modify the product.

■ During the warranty period, for repair under warranty consult the local sales representative or service office. Yokogawa will replace or repair any damaged parts. Before consulting for repair under warranty, provide us with the model name and serial number and a description of the problem. Any diagrams or data explaining the problem would also be appreciated.

- If we replace the product with a new one, we won't provide you with a repair report.
- Yokogawa warrants the product for the period stated in the pre-purchase quotation Yokogawa shall conduct defined warranty service based on its standard. When the customer site is located outside of the service area, a fee for dispatching the maintenance engineer will be charged to the customer.

■ In the following cases, customer will be charged repair fee regardless of warranty period.

- Failure of components which are out of scope of warranty stated in instruction manual.
- Failure caused by usage of software, hardware or auxiliary equipment, which Yokogawa Electric did not supply.
- Failure due to improper or insufficient maintenance by user.
- Failure due to modification, misuse or outside-of-specifications operation which Yokogawa does not authorize.
- Failure due to power supply (voltage, frequency) being outside specifications or abnormal.
- Failure caused by any usage out of scope of recommended usage.
- Any damage from fire, earthquake, storms and floods, lightning, disturbances, riots, warfare, radiation and other natural changes.

■ Yokogawa does not warrant conformance with the specific application at the user site. Yokogawa will not bear direct/indirect responsibility for damage due to a specific application.

■ Yokogawa Electric will not bear responsibility when the user configures the product into systems or resells the product.

■ Maintenance service and supplying repair parts will be covered for five years after the production ends. For repair for this product, please contact the nearest sales office described in this instruction manual.

Model DM8
Vibration Type Density Meter

IM 12T03A01-02E 3rd Edition

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1. GENERAL

Density is one of the fundamental physical quantities required when the property or composition of a liquid sample is being determined in industrial processes. Especially, density measurement of a sample liquid is indispensable in many industries such as electric manufactures, chemical industries, oil refineries and food-related applications.

The Model DM8 Vibration Type Density Meter is a higher reliable meter full of operation and maintenance functions. The meter consists of a detector and a converter. The detector has a vibrator and an RTD (resistance temperature detector), and outputs detected density signal (frequency) and temperature signal (voltage) to the converter. The converter is equipped with a microprocessor to convert the frequency signals from the detector into density values and display them. It also calculates the density at the reference temperature according to these signals and digitally displays them. Moreover, the converter outputs digital transmission signals besides analog transmission signals and is further provided with a variety of functions such as one-touch calibration, selfdiagnosis.

1.1 Standard Specifications

1.1.1 General Specifications

Measurement object: Liquid density

Measurement principle: Vibration density measurement

Measurement range:

- Density: 0.5 to 2.0 g/cm^3
- Temperature: –10 to 100 °C

Distance between Detector and Converter: Up to 2 km

Power supply: 90 to 132 V AC or 180 to 264 V AC, 50/60 Hz

Power consumption: 20 VA

Characteristics

(overall characteristics after combing the detector and the converter)

Repeatability: 5 x10^{-4} g/cm^3 (for digital output)
1 % of span (for analog output)

Linearity: ±0.5 % of span (when span is 0.2 g/cm^3 or less)
±1 % of span (when span is more than 0.2 g/cm^3)

Temperature characteristics: ±0.5 % of span/±10 °C (Compensating error for changes in the measuring liquid temperature and detector temperature)

Flow characteristics: ±0.1 % of span in the range of 0 to 5 l/min

Pressure characteristics: ±0.0005 g/cm^3/±98 kPa change

Viscosity error: ±0.1 % of span in the range of 0 to 1500 cP

1.1.2 Detector

(1) General Purpose Detector Model VD6D

Detector construction: Non-explosion protection, rain-proof construction
Case material: Cast Aluminum alloy
Case coating: Epoxy resin, baked finish
Case color: Jade green (equivalent to Munsell 7.5BG4/1.5)
Wetted part materials:
Base: SUS316
Vibrator: SUS316 or Ni (Au Brazing: BAu·4)
Measuring liquid temperature: –10 to 100 °C
Measuring liquid pressure: 2 MPa G or less
Maximum pressure: 4.9 MPa G
Steam tracing: Available
Process connection: Rc1/4
Electrical connection: G3/4
Mounting: 2-inch. pipe mounting
Ambient temperature: –10 to 50 °C
Weight: Approx. 12 kg

(2) Flameproof (Explosionproof) Detector Model VD6DF

Detector construction: TIIS; d2G3 or FM; Class I, Division 1, Groups C and D, Flameproof construction
Process connection: Rc1/4 or 1/4NPT female (only for VD6DF-□□*B/FM)
Electrical connection: G3/4 or 3/4NPSM female (only for VD6DF-□□*B/FM)
Specifications are the same as for the (1) General Purpose Detector except for the above construction.

(3) Sanitary Use Detector Model VD6DS

Process connection: Special joint for connection to JIS 6A (6 mm dia.) pipe (within gasket)
Wetted part materials: Added to the standard model
Gasket: Teflon
O-Ring: Viton
Stream tracing: Not available
Specifications are the same as for the (1) General Purpose Detector except for the above two items.
Temperature detector protecting tubes are detachable.

Note: These detectors cannot be used with highly corrosive liquids and solutions likely to stick to sensors. If it is desired to be applied to solutions containing slurry or sludge, consult with YOKOGAWA. For measuring NaOH solutions, use sensors with a nickel vibrator.

1.1.3 Converter Model DM8C

Display: Digital display, five digits LED

Display contents:

Density (g/cm^3) after conversion to reference temperature (center temperature)

Density (g/cm^3) at the measuring temperature

Measuring liquid temperature (°C)

Set density value for the calibration liquid (g/cm^3) (displayed on call)

Temperature coefficient set value for the calibration liquid (x10^{-5} g/cm^3/°C) (displayed on call)

Output signal set value (%) (displayed on call)

Setting for output range low limit (g/cm^3) (displayed on call)

Setting for output range high limit (g/cm^3) (displayed on call)

Reference temperature (center temperature) set value (°C) (displayed on call)

Temperature coefficient set value for the measuring liquid (x10^{-5} g/cm^3/°C) (displayed on call)

Fault contents display

Output signal:

Analog output: 4 to 20 mA DC (load resistance 550 Ω or less), and 0 to 1 V DC (load resistance 250 kΩ or more), isolated output.

Density (g/cm^3) after conversion to the reference temperature

Digital output: RS-232-C

(1) Communication specifications

- Asynchronous system

  Start bit; 1 bit, Stop bit; 2 bit, Parity; none
- Baud rate; 1200 bps
- Data format; ASCII, Data length; 8 bit
- Wiring system; Two-wire system (output only)

(2) Output signal

- Transmitting contents

  Measured data; Density (g/cm^3) after conversion to the reference temperature, density (g/cm^3) at the measured temperature, measured liquid temperature (°C)

  Calibration state; calibration start, error No., calibration end

  Failure alarm; error No.
- Signal level

  Output voltage; ON; 9 ±3 V, OFF; -9 ±3 V

  Output impedance; 300 Ω

- Output format

  Measured data

  # * . * * * * _ * . * * * * _ * * * . * C_RL_F

  space ↑ space ↑

  (Note) Data are output in the order of density (data converted into that at a reference temperature), density (at measuring temperature), and measuring liquid temperature. Hold data (data immediately before entering the mode) is output during the time of calibration or maintenance mode. However, holding is released immediately after calibration or maintenance mode.

  Calibration status

  # CALIBRATION _ START C_RL_F

  space ↑

  (Note) Nothing is output during calibration. However, when a parameter error occurs, output becomes as follows.

  # ERROR - *C_RL_F (*: 5 or 6)

  # CALIBRATION _ END C_RL_F

  space ↑

  Fail alarm

  # ERROR - * _ ERROR - * · · · · · C_RL_F

  space ↑

  (Note) When multiple errors occur, each error No. for the respective errors is output.

  Example: # ERROR - 1 _ ERROR - 3 C_RL_F

  space ↑

Output signal span: 0.05 to 0.5 g/cm^3 settable

Reference temperature set range: 0 to 100 °C (in increments or decrements of 1 °C)

Contact output on failure: One point. Contact closed on failure or power failure. Contact open when normal.

Permissible voltage: 220 V DC, 250 V AC

Permissible current: 2A (resistive load)

Permissible contact power: 60 W

Fault detecting contents: Detector failure and converter failure

Failure output:

Analog signal: Falls down to about –10 % of the output signal span

Digital signal: Error message outputs

Output signal hold: Holds in the CAL. or Maintenance mode.

Settable range for temperature coefficient: 0 to 0.002 g/cm^3/°C

Calibration procedure: One-touch calibration by strong calibration liquid density (onepoint calibration)

Ambient temperature: –10 to 55 °C

Power supply: 90 to 132 V AC or 180 to 264 V AC, 50/60 Hz

Case construction: Dust and rain proof construction

Coating color: Door: Equivalent to Munsell 2.8GY6.4/0.9

Case: Equivalent to Munsell 2.0GY3.1/0.5

Coating finish: Baked finish epoxy resin

Mounting: To panel, wall or 2-inch pipe

Air purge connector: Rc1/8, Rc1/4, or 1/4NPT female is also optionally available

Electrical connection: Five holes, 27 mm dia.

Attached with four plastic waterproof plugs equivalent to JIS A15, and one plastic waterproof plug equivalent to JIS A20.

Weight: Approx. 7.5 kg

1.1.4 Special Cable Model DM8W

Type: Six-conductor double shield cable

Insulator: Polyethylene

Sheath: Polyvinyl chloride

Insulation resistance: 1000 MΩ/km

Conductor resistance: 15.31 Ω/km

Finished O.D.: 15.8 mm

Weight: Approx. 0.3 kg/m

1.1.5 Standard Accessories

Syringe (for injecting standard solution or solvenet)	1 pcs	for Detector (VD6)
Brush (for cleaning the detector)	1 pcs	
Allen wrench for terminal box	1 pcs	
Allen wrench for locking the cover	1 pcs	
O-Ring	1 bag	
Silica gel	2 packs	
Fuse for the converter (3A)	1 pcs	for Converter (DM8C)

1.2 Models and Suffix Codes

1.2.1 General Purpose Detector

Model	Suffix Code		Option Code	Description
VD6D	••••••••••••••••••		•••••••••••••••••	General purpose detector
Vibrator material	-S3 -N1		••••••••••••••••• •••••••••••••••••	SUS316 Ni
—		*B	•••••••••••••••••	Style B

1.2.2 Flameproof Detector

Model	Suffix Code		Option Code	Description
VD6DF	••••••••••••••••••		•••••••••••••••••	Flameproof detector
Vibrator material	-S3 -N1		••••••••••••••••• •••••••••••••••••	SUS316 Ni
—		*B	•••••••••••••••••	Style B
(Option)			/FM	NEC Class I,Division 1,Group C and D, explosionproof

1.2.3 Sanitary Use Detector

Model	Suffix Code		Option Code	Description
VD6DS	••••••••••••••••••		•••••••••••••••••	Sanitary use detector
Vibrator material	-S3		•••••••••••••••••	SUS316
—		*B	•••••••••••••••••	Style B

1.2.4 Converter

Model	Suffix Code		Option Code	Description
DM8C	••••••••••••••••••		•••••••••••••••••	Converter
Power supply	-A1 -A2		••••••••••••••••• •••••••••••••••••	90 to 132V AC, 50/60Hz 180 to 264V AC, 50/60Hz
—		*C	•••••••••••••••••	Style C
(Option) Air purge connector			/AP1 /AP2	Rc1/4 1/4NPT female

1.2.5 Special Cable

Model	Suffix Code		Option Code	Description
DM8W	••••••••••••••••••		•••••••••••••••••	Special cable
Cable length	-L□□□□		•••••••••••••••••	Length (unit: m)
—		*A	•••••••••••••••••	Style A

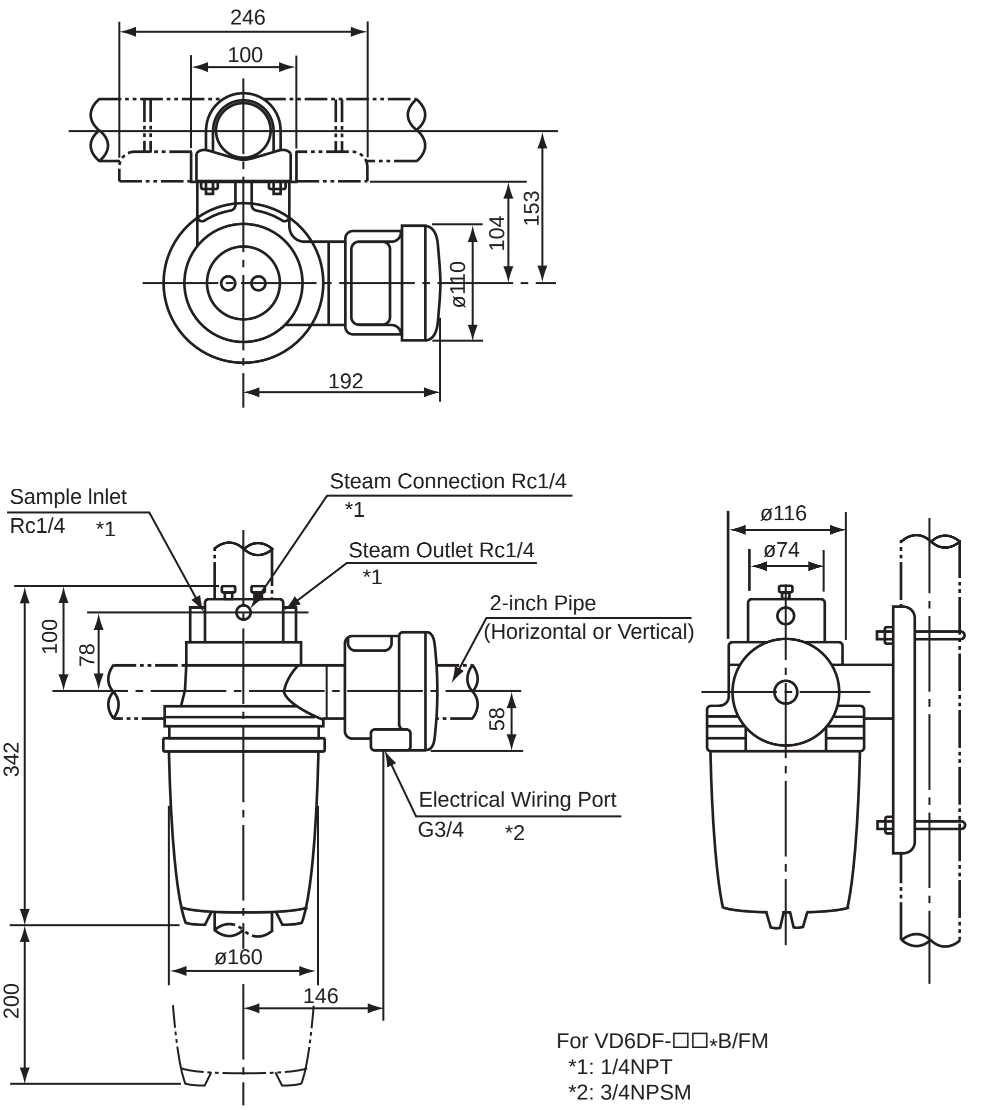
(Note) Enter the cable length in "-L□□□□ in m."
[Example] L0050 for 50 m
L0100 for 100 m
L2000 for 2 km

1.3 External Dimensions

1.3.1 Detector

General Purpose and Flameproof Detector Models VD6D and VD6DF

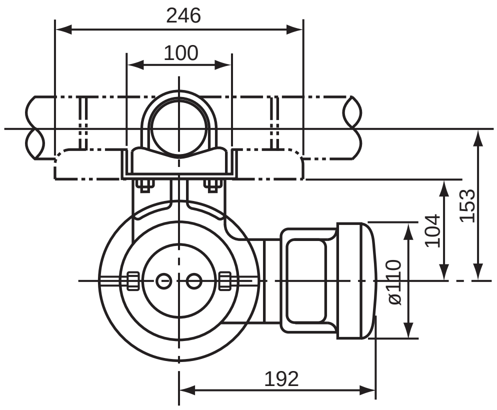
Unit : mm

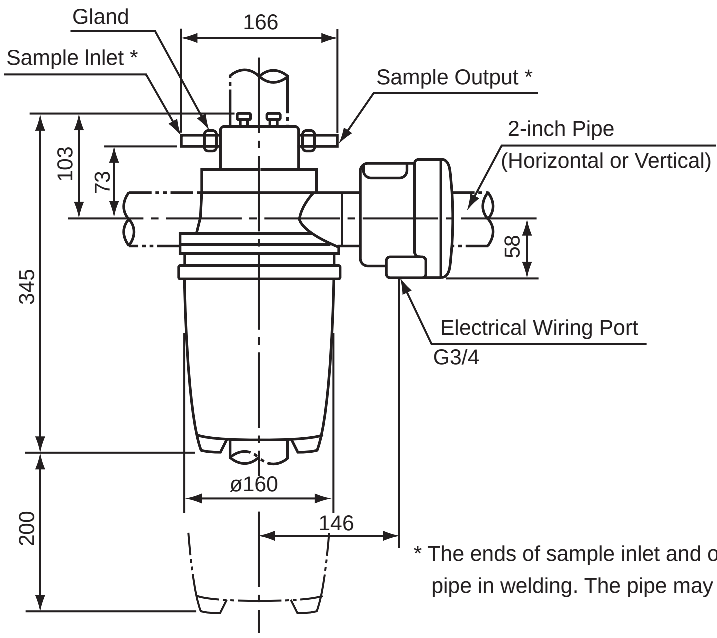


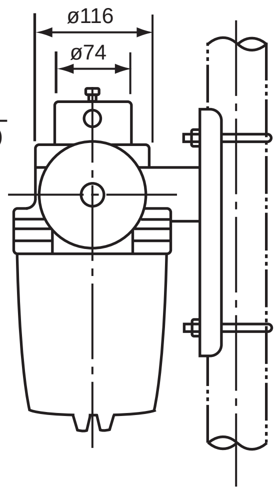
For VD6DF-☐☐*B/FM
*1: 1/4NPT
*2: 3/4NPSM

Sanitary Use Detector Model VD6DS

Unit : mm

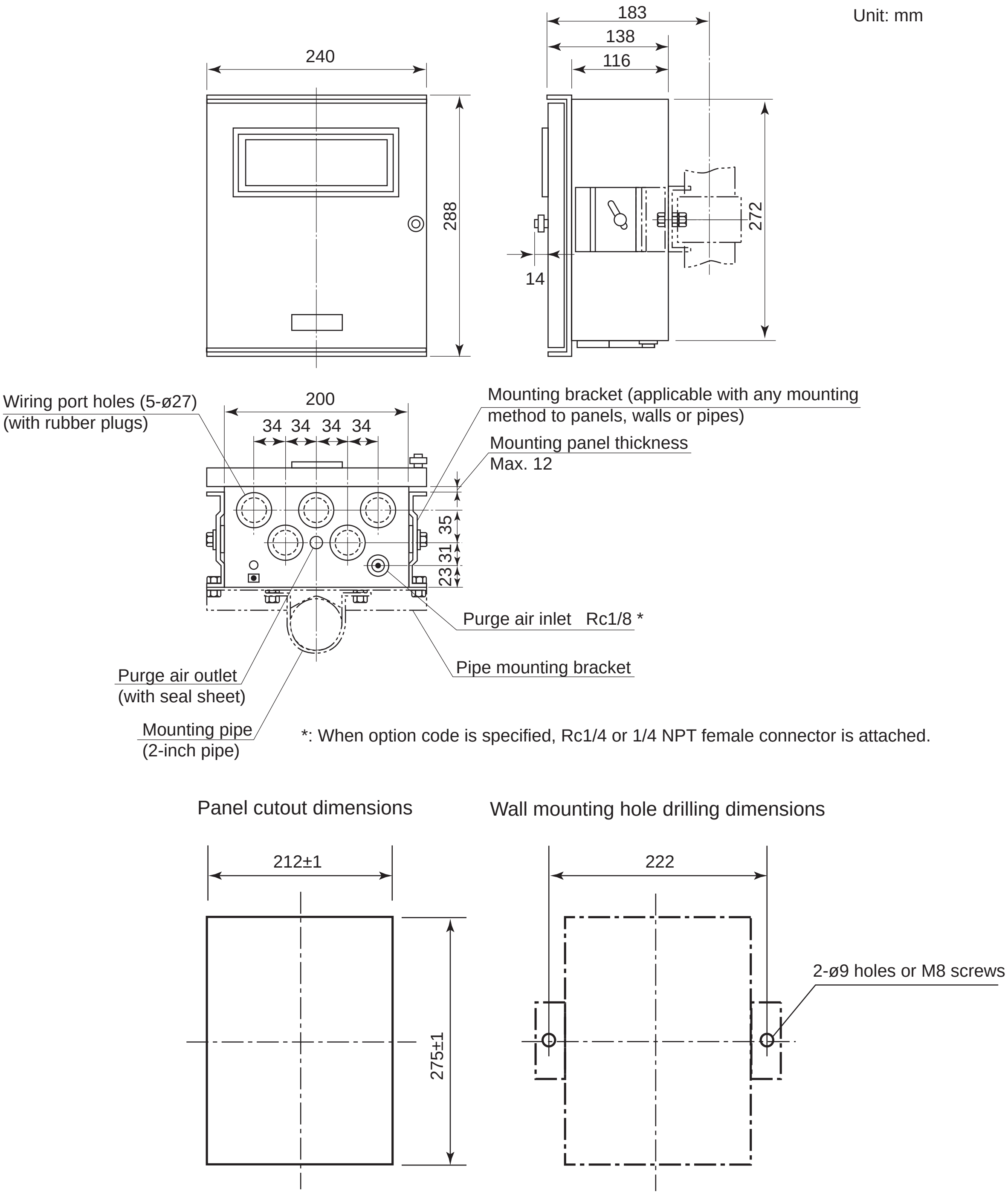






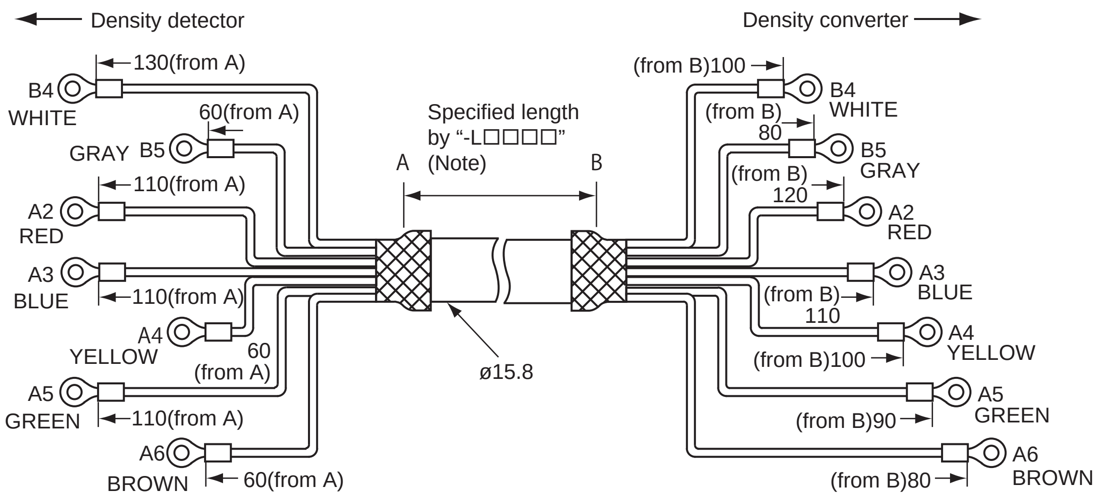
* The ends of sample inlet and outlet are connected with 1/8-inch pipe in welding. The pipe may be removed by loosing the gland.

1.3.2 Converter Model DM8C



1.3.3 Special Cable Model DM8W

Unit : mm



(Note) Cable length is specified by the suffix code of "-L□□□□", □ is specified in meter.
e.g. for 50 m, -L0050
for 100 m, -L0100
for 2 km, -L2000

1.4 Cautions in Handling Flameproof, Explosionproof Instruments

1.4.1 Outline of Explosionproof Instruments

Specifications of “Explosionproof Instruments” conform to the regulations of relevant public organizations.

Model DM8 Vibration Type Liquid Density Meter consists of a density detector and a density converter. Model VD6DF density detector, explosionproof instrument, can be installed in hazardous area where explosive gases may be generated.

It should be noted, however, that the method of installation, ambient conditions, and the handling of these instruments must conform to the regulations of relevant public organizations. The applicable explosionproof regulations and the cautions marked on the analyzer shall be strictly observed when using Model VD6DF in a hazardous location.

CAUTION

Model VD6D and Model VD6DS Density Detector, which are not “explosionproof instrumment”, cannot be installed in hazardous location.

Model VD6DF density detector has either TIIS or FM flameproof type of explosionproof specifications. The TIIS type has passed tests conducted by a public authority in accordance with the Labor Safety and Health Law (Japan) which regulates domestic explosionproof electrical equipment. The FM type has been certified to have an explosionproof construction meeting the requirements of NEC (National Electrical Code) by Factory Mutual Research Corporation, U.S.A. (FM), a testing organization. It also conforms to requirements of OSHA (Occupational Safety and Health Act, U.S.A.).

Items 1.4.2 to 1.4.6 cover general cautions in using the Model VD6DF density detector. For further details, see the following publications:

- For TIIS flameproof requirements

  ‘RECOMMENDED PRACTICE’ for Electrical Equipments for Use in Explosive Gas Atmosphere published by The Research Institute of Industrial Safety, Ministry of Labor.

- For FM Flameproof requirements

  National Electrical Code, Chapter 5, Special Occupancies.

1.4.2 Labeling the Explosionproof Specifications

TIIS Flameproof type of explosion-protected construction

The Model VD6DF density detector is labeled data plate on which type of the explosion-protection constructions, approval number, symbols for the type and working ambient temperature range.

Table 4.1 TIIS Flameproof Type (Explosionproof) Construction of Vibration Density Detector

Model and codes	Type Approval No.	Symbol for the type (including explosion class and ignition group)
Model VD6DF-N1 Model VD6DF-S3	No. T21726 No. T21727	d2G3 d2G3

FM Explosionproof Specifications

The Model VD6DF density detectors complying with FM explosionproof specifications is labeled data plate which is marked with an approval mark, classification of hazardous location, working ambient temperature range, and handling cautions.

1.4.3 Installation Area and Ambient Conditions

Model VD6DF density detector can be installed in hazardous area where specified gases are present.

However, do not install the detector at the place where explosive gases may be continuously present, and in which the gas concentration is continuous or for long period, equal to or more than, the lowest gas explosion limit.

Environmental conditions at the installation site are very important to the detector.

Before installing the detector, check the temperature, humidity and altitude of the site.

The conditions shall not exceed the specified ranges. The temperature range (-10 to 50 °C) in indicated on the data plate, and the altitude shall be 1000 meters or less above sea level and the relative humidity range 45 to 85 %.

1.4.4 External Wiring Work

External wiring for flameproof detector shall be carried out according to the flameproof metal conduit wiring. For TIIS explosionproof specifications, the flameproof packing type is used for leading external cables.

1.4.5 Maintenance Procedure

Do not remove the detector cover in a hazardous area unless power is OFF. However, if detector maintenance with power on is unavoidable, a gas detector check should first be made to determine whether a hazardous atmosphere exits in the installation area.

1.4.6 Repairs

The following points must be observed during repairs.

The detector must be restored to their original conditions, electrically and mechanically to maintain their flameproof properties.

The gaps, path lengths and mechanical strength of enclosures are important factors in establishing flameproof properties. Therefore, service staff should be careful not to damage point surfaces and not to shock enclosures.

2. PRINCIPLES OF OPERATION

2.1 Measuring Principle

2.1.1 Density Detector

Model VD6D Density Detector is a vibration type density meter. Measuring principle is that the lateral free oscillation of a pipe is a function of the density of the liquid contained in the pipe.

Assuming that the pipe is filled with a liquid as shown in Figure 2.1, the lateral free oscillation of the pipe can be shown as the following equation:

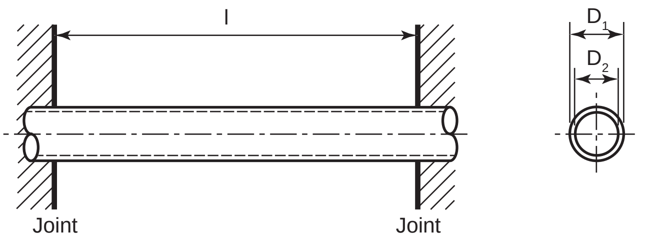


Figure 2.1 Pipe Filled with Liquid

$$f_x = \frac{C}{4\,l^2}\sqrt{\frac{E}{\rho_l}}\sqrt{\frac{D_1^2 + D_2^2}{1 + \frac{\rho_l}{\rho_x} \times \frac{D_2^2}{D_1^2 - D_2^2}}} \quad \cdots\cdots (1)$$

f_x : Free transfers oscillation frequency for ρ_x [Hz]
C : Constant determined by oscillation mode
l : Oscillating pipe length [m]
E : Young's modulus of pipe [kg/m^3]
ρ_l : Density of pipe material [kg/cm^3]
ρ_x : Density of liquid measured [kg/cm^3]
D_1 : Pipe outside diameter [m]
D_2 : Pipe inside diameter [m]

In equation (1), the values other than f_x and ρ_x are determined by the pipe material and construction. Thus, the density ρ_x of the liquid can be obtained by measuring the free transfers oscillation frequency f_x.

2.1.2 Density Converter

The density converter computes the liquid density using the oscillation frequency signal and voltage of the temperature.

Each value of I, E, ρ_1, D_1, D_2 or rx in equation (1) is a function of liquid temperature, hence the value of f_x is also a function of temperature. To obtain the correct density, the factors $A_{(t)}$ and $B_{(t)}$ depending temperature should be previously compensated for the temperature as follows.

$$f_x = \frac{A(t)}{\sqrt{1 + \rho_x B(t)}} \quad \cdots\cdots \quad (2)$$

where, $A(t) = A_1 (1.0060 - 1.9814 \times 10^{-4} \bullet T - 9.7683 \times 10^{-8} \bullet T^2)$

$B(t) = B_1 \{ 1 + 4.5 \times 10^{-5} (T - 30) \}$

$A(t) = (A + 131072) / 100$

$B_1 = B / 300$

T : Liquid temperature (°C)

(Note) Both A and B are constants of the detector which has inherent values.

From equation (2) and (3), the density ρ_x can be obtained.

$$\rho_x = \frac{\left\{\frac{A(t)}{f_x}\right\}^2 - 1}{B(t)} \quad \cdots\cdots \quad (3)$$

The ρ_x in equation (3) represents the liquid density at measuring temperature. The density ρT_B at the reference temperature can be obtained by the following equation (4):

$$\rho T_B = \rho_x + \alpha (T_x - T_B) \quad \cdots\cdots \quad (4)$$

α : Temperature coefficient of density for measuring liquid (g/cm^3/°C)

T_x : Liquid temperature at density measurement (°C)

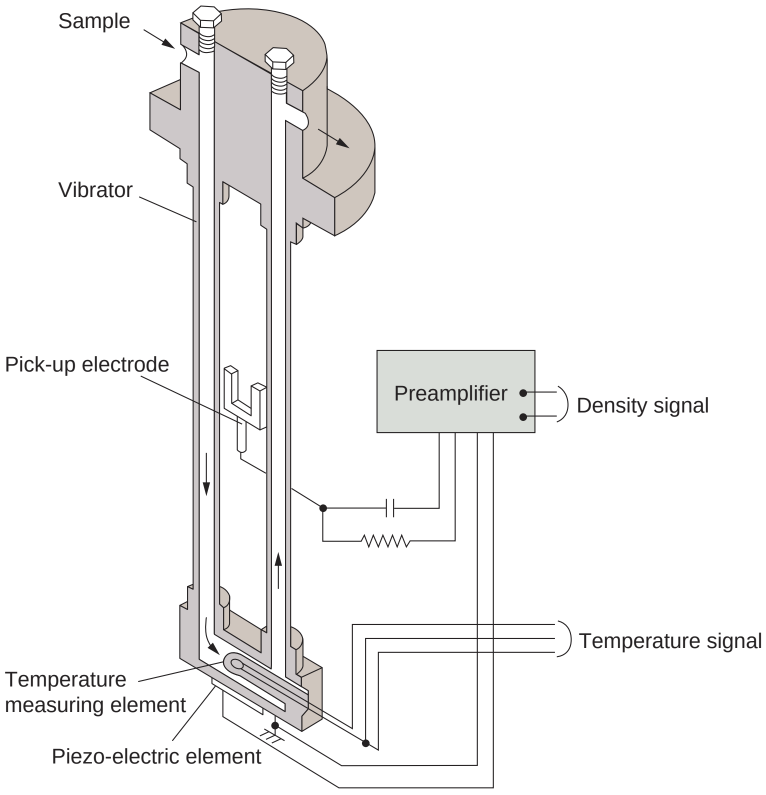
T_B : Reference temperature (°C)

2.2 Main Components

2.2.1 Density Detector

Figure 2.2 is a schematic diagram of the density detector.

As shown in the figure, the density detector consists mainly of a vibrator assembly, a capacitance pickup electrode, and an amplifier.



Vibrator cross sectional view of Density Detector

Figure 2.2 Schematic Diagram of Density Detector

The vibrator assembly consists of a sample path formed by connecting the ends of two thin tubular vibrators whose upper ends are connected to a base. The connector incorporates an RTD to measure the sample liquid temperature. The vibrator assembly also contains a piezoelectric element to maintain vibration corresponding to the sample liquid density.

The capacitance pickup electrode installed between the two vibrating pipes detects the lateral oscillation frequency of the vibrator.

The amplifier converts the output of the capacitance pickup electrode into an AC voltage to amplify it. This frequency signal is, together with the temperature signal from the RTD, transmitted to the converter. A part of the frequency signal is fed back to the piezoelectric element to maintain the vibrator oscillation.

2.2.2 Density Converter

Figure 2.3 is a block diagram of the density converter.

As shown in the diagram, the density converter receives the density signal (frequency) F_ρ and temperature signal (voltage) V_T from the density detector and finally outputs a 4 to 20 mA analog signal and 0 to 1 V DC signal corresponding to the liquid density converted to that at reference temperature. The digital signals of densities at measuring temperature and reference temperature, and measuring temperature and measuring temperature value are also output. The converter circuit comprises three printed circuit boards. Changing displayed items or setting constants are performed by keys or transfer switches on the front panel.

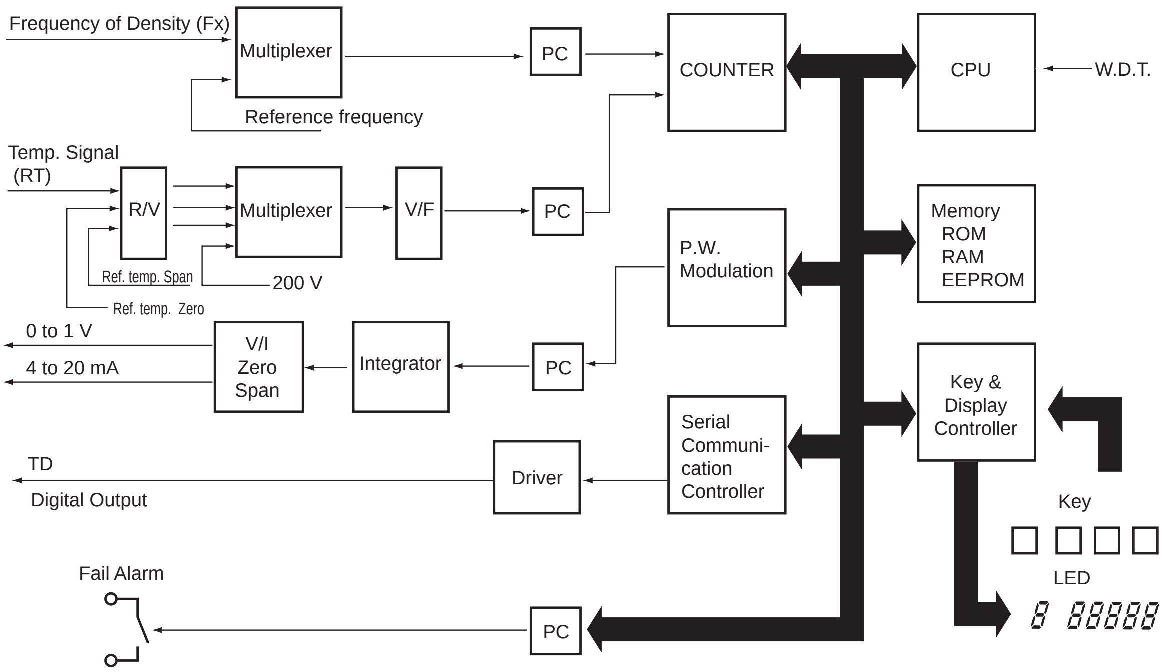


Figure 2.3 Block Diagram of Density Converter

3. INSTALLATION, PIPING AND WIRING

Model DM8 vibration type density meter consists of a density detector and a density converter. The density detector is generally installed in field and sampling piping is made to conduct measuring liquid. The density converter is generally installed in the vicinity of the density detector. It must not be installed in hazardous area. It can be installed in a control room, though it is far away from the detector, receiving digital signal.

3.1 Installation of Density Detector

The density detector is shipped with a sampling unit if it is specified. For the detector without the sampling unit, user should install sampling device suitable to measuring system.

3.1.1 Mounting Density Detector

The detector (without the sampling unit) should be installed vertically (note). The pipe mounting bracket is applicable to vertical or horizontal pipe (JIS 50A) as shown in Figure 3.1 and 3.2.

(Note) The detector should be installed vertically to keep the vibrator pipe vertical.

(1) Pipe Mounting

The pipe mounting bracket is attached to the detector to mount it on a vertical pipe. For mounting on a horizontal pipe, remove the mounting bracket from the detector to turn it 90° and fix it again to the detector. Figure 3.1 shows installation on a vertical pipe and Figure 3.2 shows on a horizontal pipe.

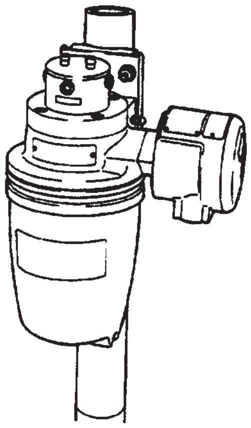


Figure 3.1 Installation on a Vertical Pipe

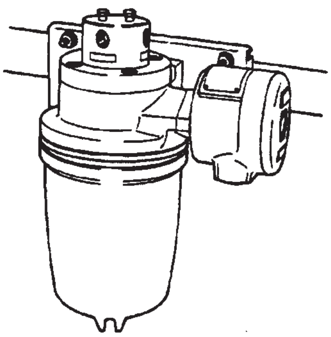


Figure 3.2 Installation on a Horizontal Pipe

(2) Bracket Mounting

This bracket is not the pipe mounting bracket. Release the four bolts (with spring washers) to remove the pipe mounting bracket from the detector. Using the four bolts and spring washers, fix the detector on the bracket as shown in Figure 3.4. Figure 3.3 shows position of holes to be drilled on the bracket.

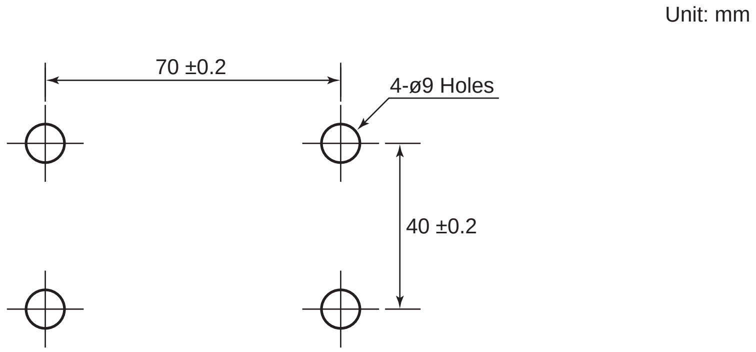


Figure 3.3 Position of Holes on the Bracket

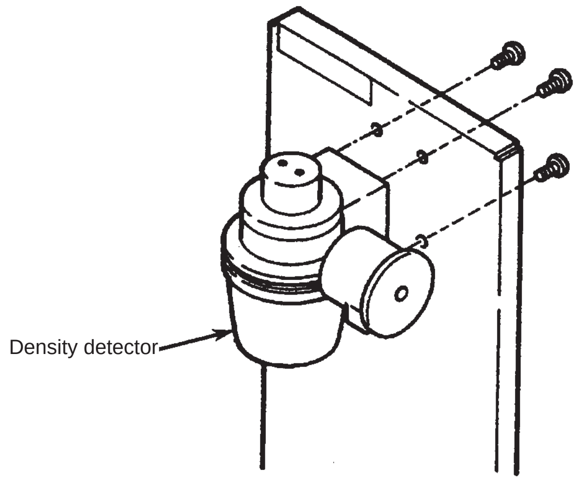


Figure 3.4 Mounting on the Bracket

3.1.2 Sampling Unit for Vibration Type Density Meter

This section describes a sampling that is provided by user for the density meter.

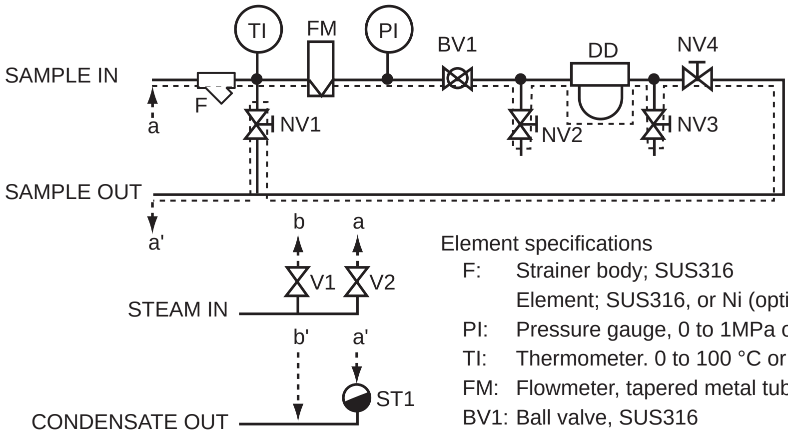
The sampling equipment is equipped with valves, a thermometer, a flowmeter, etc., and is located near to process pipe and the density detector.

The sampling equipment is used to provide good condition to measure liquid density, easy to monitor measuring and maintenance condition such as calibration and cleaning the vibrator.

Install the sampling equipment according to the following. For details of piping from process to the equipment, refer to the section 3.3.

(1) Flow Diagram

Figure 3.5 shows a flow diagram of a typical sampling equipment. Model VD6SM sampling unit of Yokogawa is also designed according to this diagram.



Element specifications
- F: Strainer body; SUS316
  Element; SUS316, or Ni (option)
- PI: Pressure gauge, 0 to 1MPa or 0 to 2MPa, SUS316
- TI: Thermometer. 0 to 100 °C or 0 to 150 °C, SUS316
- FM: Flowmeter, tapered metal tube flowmeter, 1 to 10 l/min, SUS316
- BV1: Ball valve, SUS316
- NV1 to 4: Needle valve, SUS316
- DD: Density detector
- V1, V2: Valve
- ST1: Steam trap

Figure 3.5 Flow Diagram

In Figure 3.5, each element of the sampling equipment is shown F (filter) is usually 80 meshes, prevents a solid from entering into the sampling line. TI (thermometer), FM (flowmeter) and PI (pressure gauge) are necessary to monitor measuring liquid. NV1 (needle valve) is required to control flow rate of a sample liquid. BV1 (ball valve) and NV4 (needle valve) are used for stopping measuring liquid when the vibrator is cleaned or calibration is performed using standard solution. (The needle valve is also used for adjusting flow rate.) NV2 (needle valve) and NV3 (needle valve) are used for draining liquid from the vibrator or for picking up sample for manual analysis.

When viscosity of a measuring liquid is to be lowered, for example, the pour point of measuring liquid is high, arrange the density detector and the liquid pipe should be warmed individually. Steam pipe can be connected to the density detector and the liquid pipe can also be traced by steam pipe. V1 (“stop” valve) is to supply the steam to the density detector and V2 (“stop” valve) is to supply the steam to tracing pipe. ST1 (steam trap) is used to drain condensed water.

(Note 1) Kind of valve used in the sampling equipment varies with the purpose of use. This instruction manual gives a detailed name of equipment (for example, ball valve) used for limited purpose, and shows a general name within “ ” when equipment type is not restricted (for example “stop” valve).

(Note 2) Density Detectors of Model VD6D (general purpose type) and VD6DF (flameproof) have steam pipe connections, however, Model VD6DS (sanitary use) has not the connections.

(Note 3) Model VD6SM sampling unit, a product of Yokogawa, is applied to Model VD6D (general purpose type) or Model VD6DF (flameproof type). It is not recommended for the Model VD6DS (sanitary use) used for food.

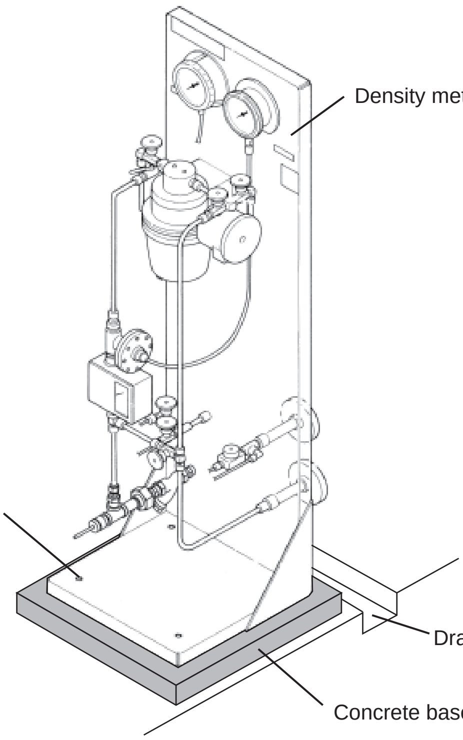


Figure 3.6 Installation Example for Sampling Unit (Model VD6SM)

(2) Note of Designing a Density Meter Sampling Unit

- Minimize liquid pipe length to improve response.
- Design the piping not to allow air bubbles to remain in the pipe which may cause an error.
- Piping should not have sharp bending where solids may accumulate.
- Maintenance such as cleaning should be made easily.
- Select element material most suitable for measuring liquid. Especially, for foodstuff measurement, the selection should be done strictly.

(3) Installation of a Density Meter Sampling Unit

For the density detector with the sampling unit or with the sampling equipment user provided, installing place must

- be near to sample tap on the main pipe.
- be free from vibration
- meet the ambient conditions specified by the hazardous area (when the detector is model VD6DF flameproof type).

Moreover, the sampling unit should be fixed to a concrete base drained well.

(4) Removing a Packing Sheet for Transportation from the Density Detector

The vibrator is fixed to the amplifier case to avoid being damaged during transportation.

Remove the rubber sheet used for the fixing. The rubber sheet is inserted between the case and the coupler of the vibrator assembly. Remove the sheet according the steps below. For component names, refer to the section 4.1.1.

(a) Remove the lock with a hexagonal bar wrench. Release the cover by turning it counterclockwise and pull it down not to touch the internal assembly.

(b) Remove the cover (with desiccant) from the vibrator.

⚠ CAUTION

The vibrator tube has extremely thin wall, hence must be carefully handled.
Since assembling the vibrator tube requires special skill, the exchange of the vibrator should be made by Yokogawa.

(c) Release the lock-screw for the vibrator turning the screw counterclockwise completely with a flat chip screw driver. Turn it enough, if not, the vibrator may touch the screw during measurement causing an error. In addition, pay attention not to bend or damage the vibrator because it is made of a thin pipe.

(d) Pull out the rubber sheet avoiding applying force to the vibrator (refer to Figure 3.7).

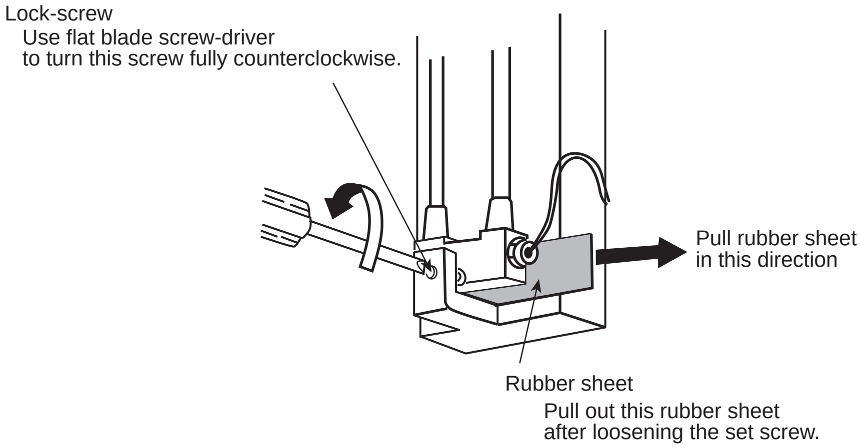


Figure 3.7 How to Remove the Rubber Sheet

(e) Remount the cover removed in the item (b). Also remount the cover in the item (a) to the case and lock it.

Now the removing the rubber sheet finishes. Keep the rubber sheet which is necessary for transportation of the density converter.

3.2 Installation of Density Converter

3.2.1 Installation Area

The density converter should be installed in the place described below;

(1) The vicinity of the sampling unit where maintenance or calibration is made easy. The density converter is designed dustproof and rainproof structure so that it can be installed outdoors. However, when it is used with the Model VD6DF flameproof detector, it cannot be installed the hazardous area, must be installed in the nonhazardous area. Further, when digital output signal is used for a receiver, able length between the converter and the receiver should be 10 m or less.

(2) Free from vibration.

Vibration may cause illegal contact in electric circuits.

(3) Avoiding from direct sunshine.

This instrument can be used in an ambient temperature of -10 to 55 °C. However, direct sunshine in summer may heat the instrument over the range.

(4) Free from corrosive gases and dusts.

The structure of this converter is dustproof and rainproof. However, for maintenance (with opening front door of the converter), installation in better environment is recommended. For the same reason, the following (5) and (6) are conditions for selecting installation area.

(5) Avoiding excessive humidity.

(6) Avoiding wide temperature variation.

3.2.2 Installation of Density Converter

The density converter can be installed on a panel or a wall or 2-inch pipe. The pipe should be vertical to fix the mounting bracket on it (see Figure 3.8).

(Note) Mounting attitude is free from the converter performance. Mounting should be made of the following procedures.

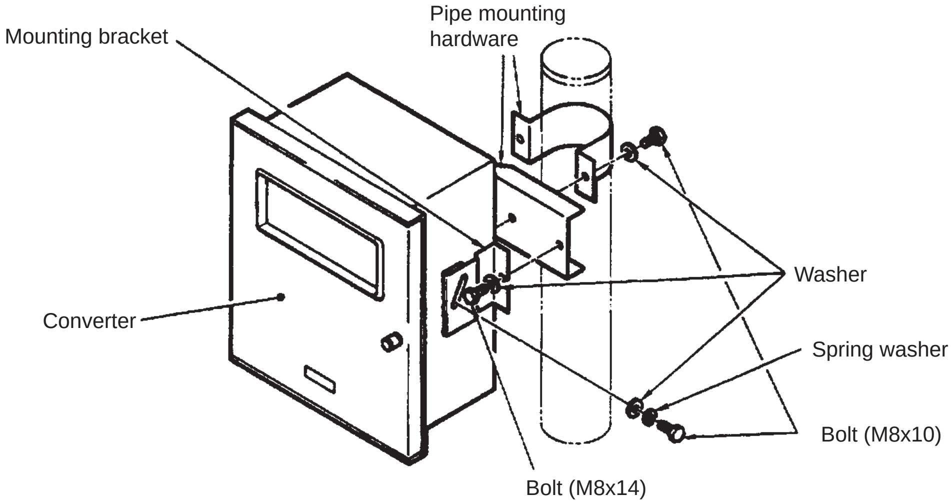


Figure 3.8 Pipe Mounting

(1) Panel Mounting

The pipe mounting bracket should be removed from the converter before panel mounting.

Panel cutout dimensions are shown in Figure 3.9.

Before inserting the converter into front of the panel, remove the clumping brackets from both sides of the converter case. After the case is inserted into a panel, remount the clumping brackets on the same pace to hold the converter on the panel.

Figure 3.10 illustrates that the converter is mounted on a panel.

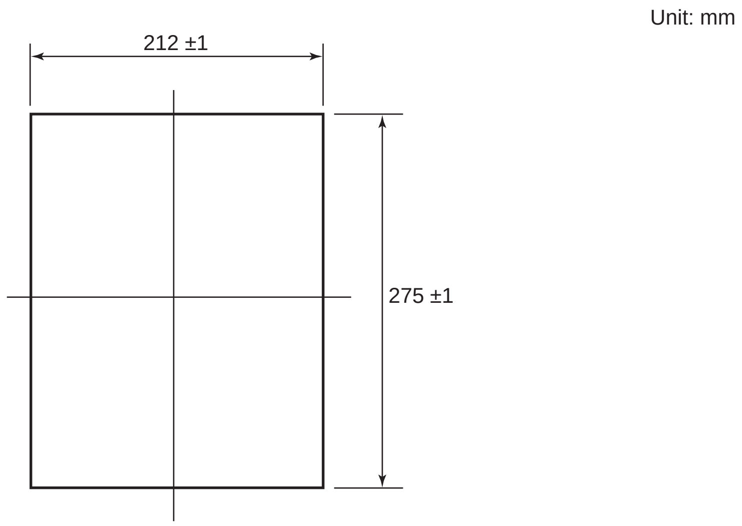


Figure 3.9 Panel Cutout Dimensions

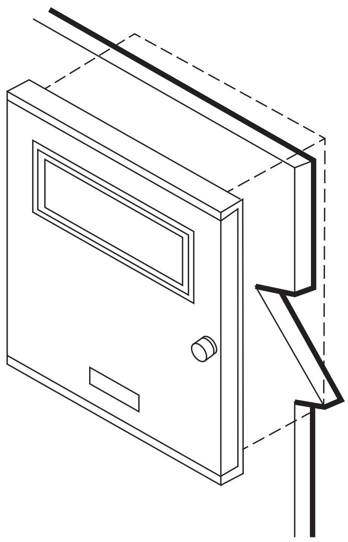


Figure 3.10 Panel Mounting

(2) Wall Mounting

Remove the pipe mounting bracket from the converter before wall mounting. Make two holes for 8 mm screws in a wall as illustrated in Figure 3.11.

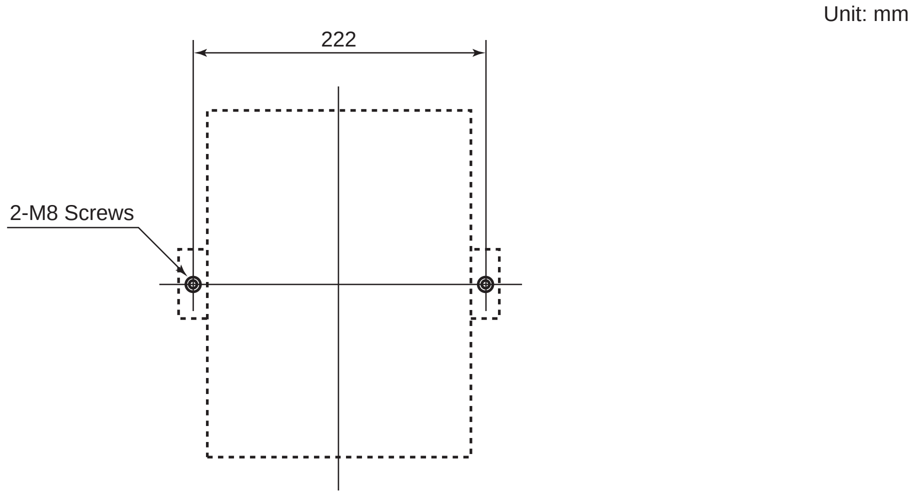


Figure 3.11 Holes for Wall Mounting

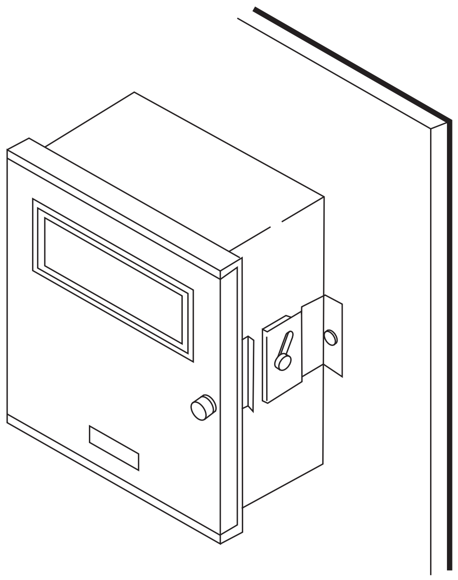


Figure 3.12 Wall Mounting

Using two mounting brackets, mount the converter on the wall (see Figure 3.12).

(3) Pipe Mounting

Mounting bracket is applied to the pipe of nominal size 50A (diameter 60.5 mm). As shown in Figure 3.13 mount the converter on the vertical pipe (inclination causes no problem).

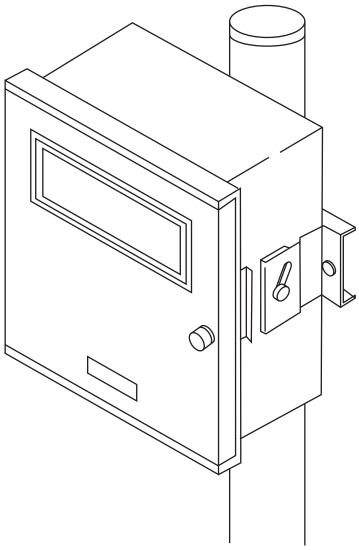


Figure 3.13 Pipe Mounting

3.3 Piping

The vibration type density meter requires the following piping;

(1) Sample liquid conduit

(2) Air piping for maintenance

(3) Steam piping

(4) Piping for air purge

Sample liquid conduit is a pipe to conduct measuring liquid to the density detector. Air piping for maintenance is to obtain air to blow away liquid from the vibrator at maintenance (vibrator cleaning, calibration with standard solution). Steam piping which is installed according to requirement is to obtain a steam to heat the sample liquid conduit. Air purge piping is necessary when the converter is installed in dusty environment.

The sample liquid conduit referred here indicates pipes between the main process pipe and the sampling equipment. For piping within the sampling equipment, refer to Section 3.1.2.

3.3.1 Sample Liquid Conduit

This piping conducts the measuring liquid to the sampling unit. The main process pipe should have two sampling taps (sample inlet and sample return) as shown in Figure 3.14. The sample conduit from the sample inlet is connected to 'SAMPLE IN' of the sampling unit and the other conduit from the sample return to 'SAMPLE OUT' of the sampling unit.

The piping procedure is as follows:

(1) Select the tap locations for the sample inlet and the sample return to make the pressure difference between them become at least 0.1 MPa.

(2) The pipe length between the sample inlet and the SAMPLE IN should not exceed 10 m. Use stainless steel pipe of nominal diameter 15 mm or Sch 40 to 80.

(3) Install stop valves and drain valves near the sampling unit.

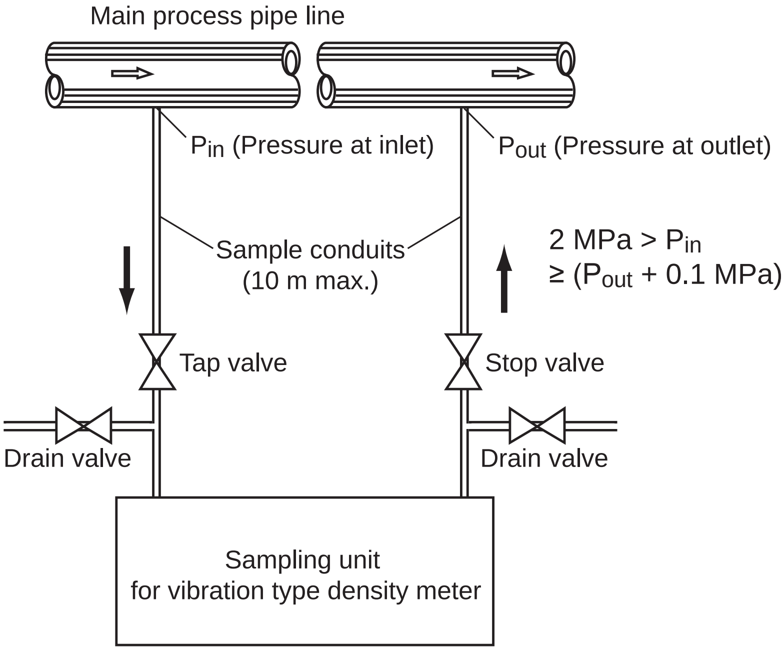


Figure 3.14 Sample Liquid Conduits

(4) Avoid sharp bending of the pipe to prevent accumulation of sludge.

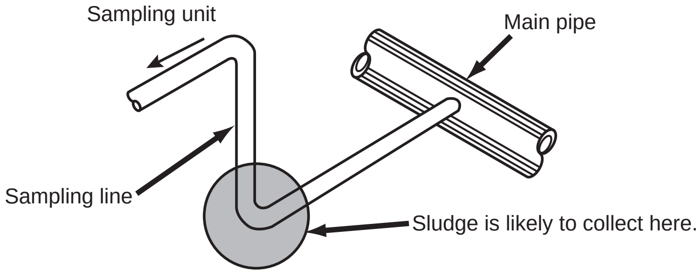


Figure 3.15 Example of Wrong Piping

3.3.2 Air Piping for Maintenance

When cleaning the vibrator or calibrating the meter with standard solution, blow away liquid from the vibrator by air pressure. Air should be clean and dried with 0.3 to 0.5 MPa G.

Mount a ‘stop’ valve and a ‘pressure regulator’ on the pipe from the air source, and fix a flexible tube with a copper tube with outside diameter 10 mm should be provided for connecting with the detector. Connect the air pipe to the sampling unit only for cleaning the vibrator or calibration with the standard solution.

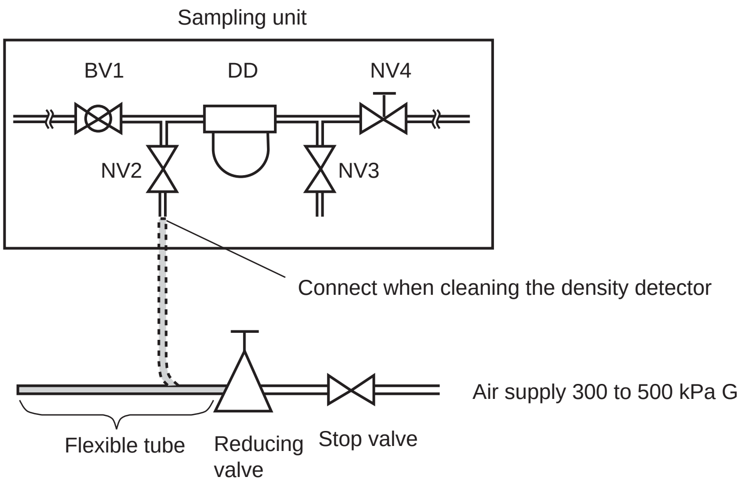


Figure 3.16 Air Piping for Maintenance

3.3.3 Steam Piping

This is installed to heat measuring liquid whose pour point is high, and to decrease its viscosity. The sampling unit with steam trace pipes should be used for this purpose.

Connect a pipe from steam source to the sampling unit ‘STEAM IN’ inlet. The sample liquid conduit also should have a steam tracer pipe. Steam of pressure 0.3 to 0.5 MPa and temperature of 140 to 160 °C is preferable.

Installing the tracer pipe for the sample liquid conduit should be performed after pressure retentive and leak test of the conduit.

Notes for the tracer piping are as follows.

(1) The tracer pipe of the sample liquid conduit should be installed such that the entire conduit can be heated. The pipe should also be covered with insulating material (see Figure 3.17).

(2) The steam trap discharge outlet should be open to the atmosphere (see Figure 3.18).

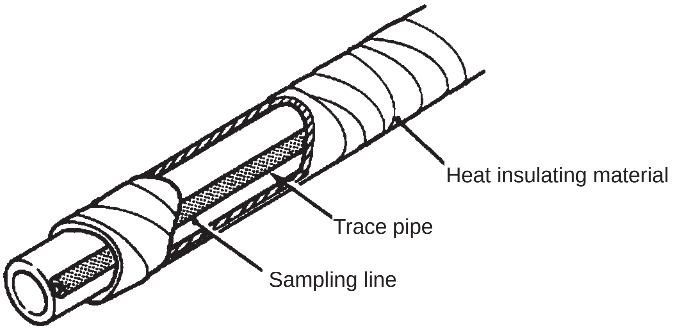


Figure 3.17 Steam Tracer Pipe

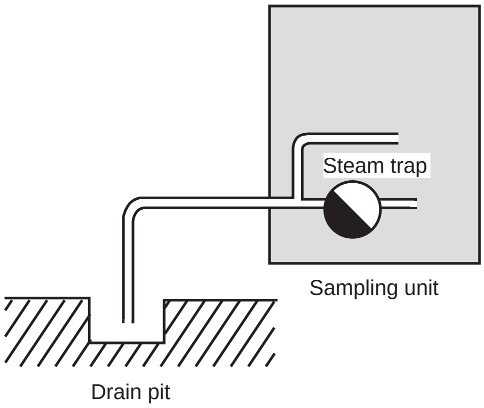


Figure 3.18 Piping at Steam Trap Discharge Outlet

3.3.4 Piping for Air Purge

If the density converter is installed in dusty environment, air purging is recommended.

Air purge should be performed continuously by clean dried air with pressure of 50 kPa G. Size Ø6 x Ø4 mm copper or stainless pipe should be used to connect air source to the purge air inlet of the converter.

The air inlet is Rc1/8 female connection. If specified, a connector for an Rc1/4 female or 1/4NPT female screw is provided.

3.4 Wiring

The vibration type density meter requires the following wirings:

(1) Wiring between analog output signal

(2) Wiring for analog output signal

(3) Wiring for digital output signal (10 m or less length is recommended).

(4) Wiring for contact output for abnormal status

(5) Wiring for power supplying

(6) Wiring for grounding

Figure 3.19 is a diagram of these wirings.

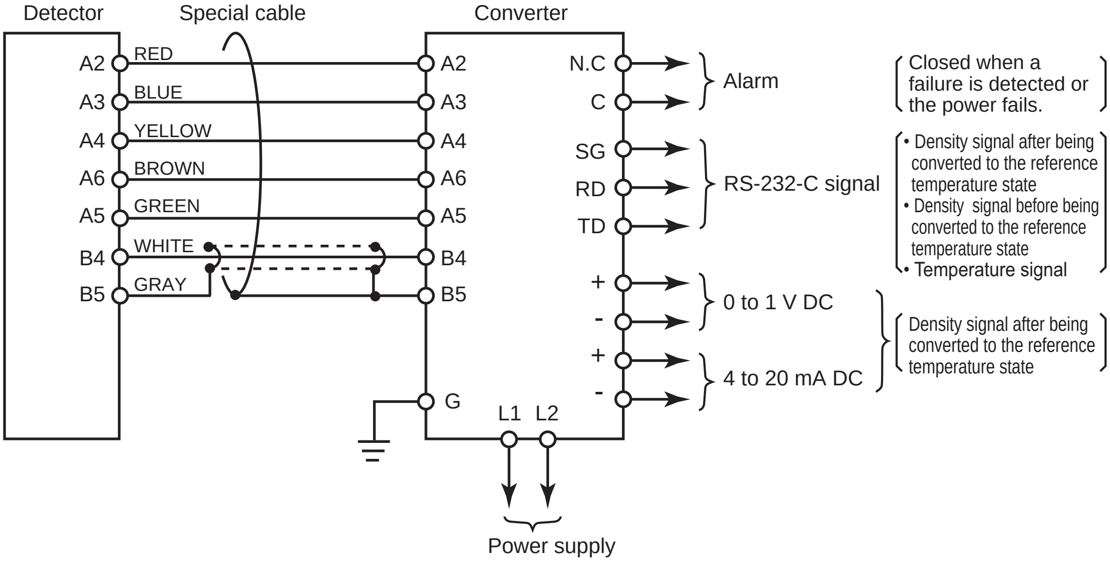


Figure 3.19 Wiring Diagram

The cable inlet of the density detector is located at the bottom of the terminal box. The density converter has five cable inlets and their size is 27 mm. A cable can pass any inlet of them (one cable to one inlet). Figure 3.20 shows an example of allocated inlets.

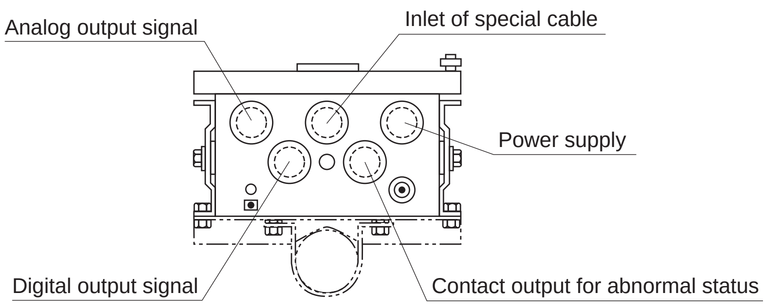
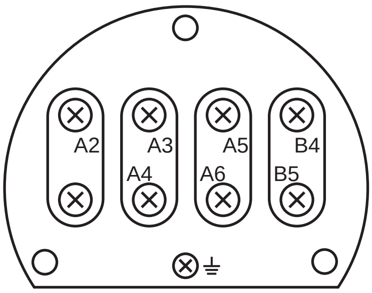


Figure 3.20 Cable Inlet of Density Converter

Figure 3.21 shows terminal arrangement of the density detector.



Terminals	Function
B4	Output Frequency
B5	
A2	Temperature Sensor
A3	
A4	
A5	Power Supply for Pre-amp
A6	Impressed Voltage for Pick-up Electrode
⏚	Earth Terminal

Figure 3.21 Terminal Arrangement of Density Detector

3.4.1 Wiring between Detector and Converter

This wiring is to be carried out with special cable of specified length. The cable is terminated as illustrated in Figure 3.22. Pay attention not to stain or wet terminated.

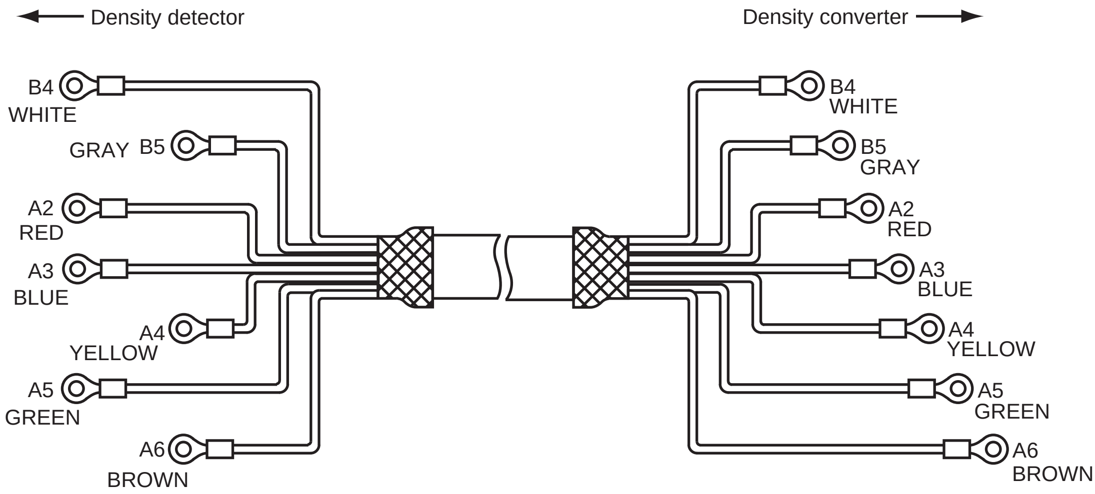


Figure 3.22 DM8W Cable

(Connection to Density Detector)

Remove the cover of the terminal box, using the spanner in accessories, and insert the special cable into the cable inlet. Connect each conductor to the respective terminals.

A flexible fitting is used at the inlet of the density detector (note) and the cable from the detector runs though metal conduit to the duct. For Model VD6DF explosionproof detector, wiring should be made complying with the Recommended Practice.

The explosionproof flexible fitting for wiring should be used at the cable inlet (G3/4 female) of the detector.

(Note) The flexible fitting is not inevitable. The Detector not moved for usual check or maintenance does not require the flexible tube.

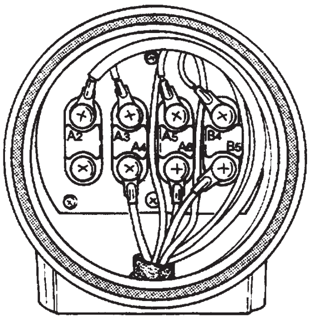


Figure 3.23 Wiring to Density Detector Terminals

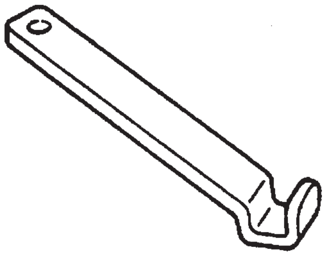


Figure 3.24 Spanner for Open/closing Terminal Box Cover

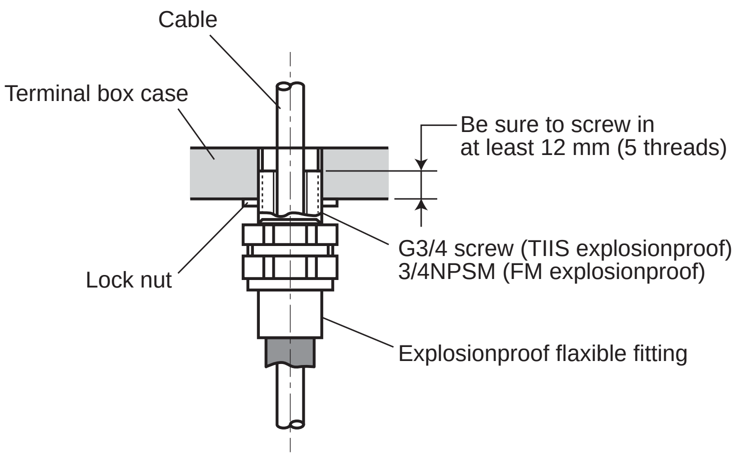


Figure 3.25 Explosionproof Flexible Fitting

(Connection to Density Converter)

The density converter is installed in field or indoors (control room). The connector for passing through cable should be sealed for air purge. The connector with a ring packing as shown in Figure 3.26 should be used, or the inlet of metal conduit is filled with silicon sealing compound. Duct or protective pipe for the cable should be provided to prevent the cable from damage.

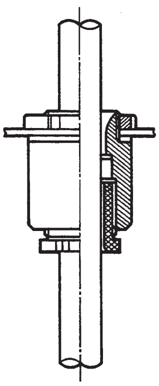


Figure 3.26 Packing Gland Type Connector for Passing through Cable

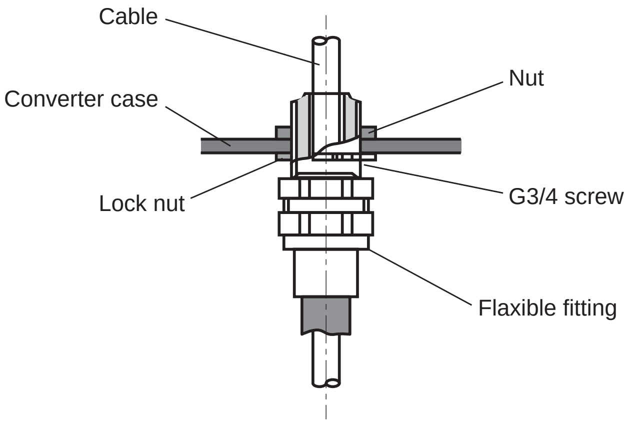


Figure 3.27 Cable Inlet for Metal Conduit

Take the special cable into the converter from the leftmost inlet and connect the each conductor to the respective terminals.

3.4.2 Wiring for Analog Output Signal

Output signal of 4 to 20 mA DC output (load resistance 550 Ω or less) and 0 to 1 V DC (load resistance 250 kΩ or more) are provided. Carry out either or both of wirings as necessary.

Shielded 2-conductor (for one signal) or 4-conductor (for two signals) cable are used for wiring. For connecting the cable to the converter, remove the sheath of conductor about 50 mm from its end, and attach a solderless lug for M4 screw omit. The shield of the cable should be grounded at the receiving unit.

Wiring method (metal conduit and others) is same as that of Section 3.4.1.

3.4.3 Wiring for Digital Output Signal

The Model DM8C density converter outputs digital signals through RS-232C interface besides analog signal (for details of digital signal, refer to “Standard Specifications” in Chapter 1).

When using this signal, use a shielded 3-conductor cable for wiring. Cable length from the converter to a receiving unit should be 10 m or less.

Cable termination is same as that of Section 3.4.2, however, remove the sheath of conductor 80 mm from the end.

Wiring method is also same as that of Section 3.4.1.

3.4.4 Wiring for Abnormal Status Contact Output

When an error (see Table 4.2) occurs with an abnormality in the density measuring system, a contact signal is output.

For wiring of this contact output, use 2-conductor cable. When connecting the cable to the converter, remove the sheath of conductor 80 mm from its end and attach a solderless terminal for M4 screw.

Wiring method is same as that of Section 3.4.1.

3.4.5 Wiring for Power Supply

This wiring is to supply the converter with power.

Use shielded 2-conductor cable for wiring. Cable termination and wiring method are the same as those for analog output signal in Section 3.4.2.

3.4.6 Wiring for Grounding

As a rule, the case of the density detector and the density converter should be earthed.

The grounding terminal of the detector is located on the base for the mounting bracket, and of the converter, on the bottom of the case. Perform wiring so that ground resistance is 100 Ω or less (Class D) using a wire of 2 mm^2 nominal cross-sectional area.

4. OPERATION

4.1 Component Names and Function

4.1.1 Density Detector

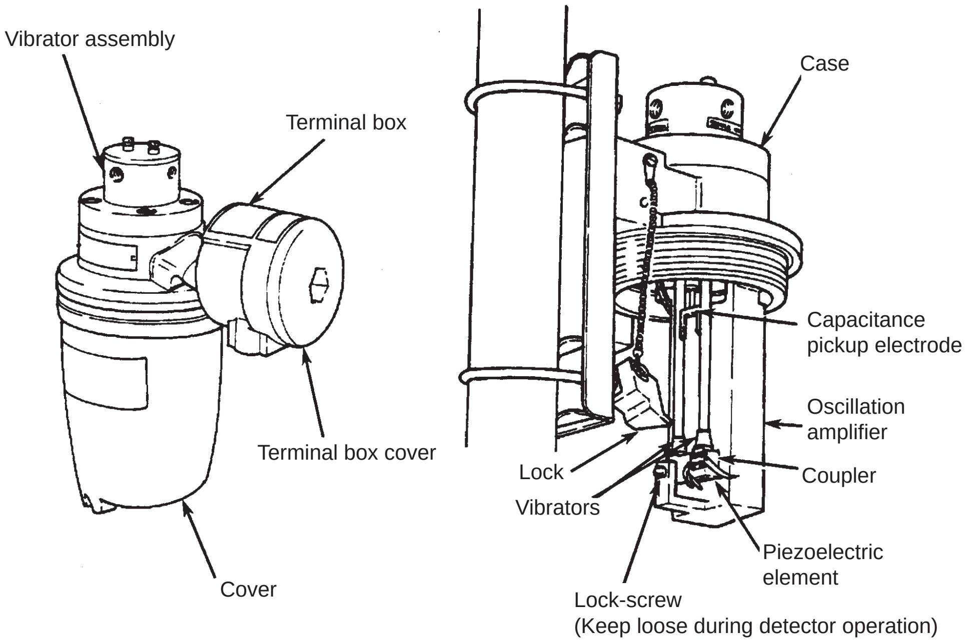
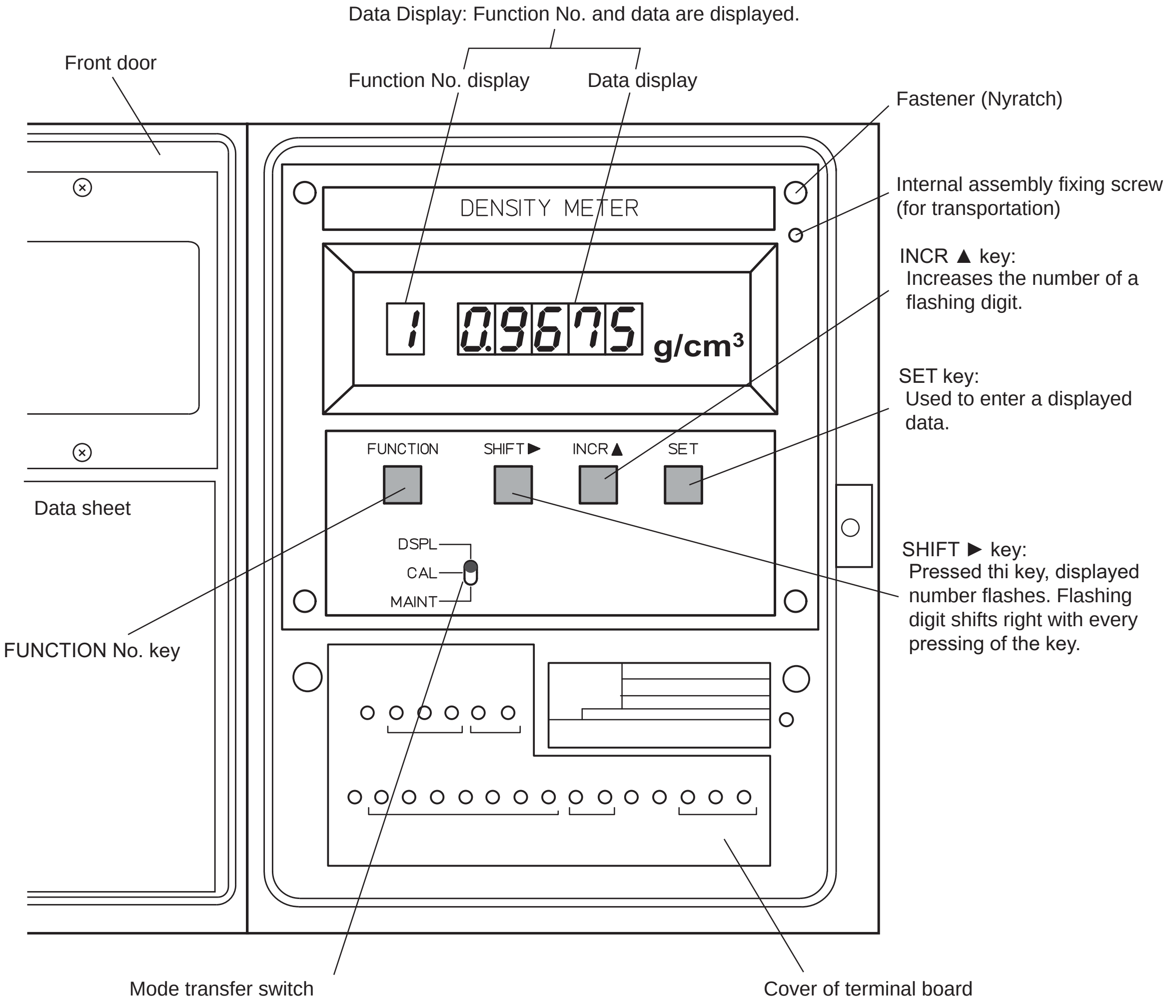


Figure 4.1 Density Detector

4.1.2 Density Converter



DSPL (measuring mode):
Mode for normal operation. In this mode, density at the reference temperature, density at measuring temperature or measuring temperature value is displayed by transferring function No.
CAL (calibration mode):
Mode for calibration
MAINT (maintenance mode):
Mode for check of operating condition; setting a detector constant, a reference temperature.

Figure 4.2 Component Names of Density Converter

4.2 Operation

4.2.1 Operation Mode

Operation of the Model DM8 vibration type density meter ruled by the mode as shown in Table 4.1. Measuring mode (DSPL), calibration mode (CAL) and maintenance mode (MAINT) are transferred with the mode transfer switch.

Table 4.1 Operation Modes and Function No.

MODE SW	FUNCTION NO.	Contents	Display
Measuring	No display	Displays density (at reference temperature)	g/cm^3
mode	1	Displays density (measured value)	g/cm^3
(DSPL)	2	Displays measuring liquid temperature	°C
Calibration	3	Sets density of calibration solution 1	□.□□□□ g/cm^3
mode (CAL)	4	Sets temperature of calibration solution 1	□□□.□ °C
	5	Sets temperature coefficient of calibratio solution 1	–□□□x10^{-5} g/cm^3/°C
	6	Starts calibration 1 (press SET key)	CAL-1 (displays density after calibration)
	7	Sets density of calibration solution 2	□.□□□□ g/cm^3
	8	Sets temperature of calibration solution 2	□□□.□ °C
	9	Sets temperature coefficient of calibratio solution 2	–□□□x10^{-5} g/cm^3/°C
	A	Starts calibration 2 (press SET key)	CAL-2 (displays density after calibration)
Maintenance	1.	Canceles protect (enter 77)	7 7
mode	2.	Displays frequency (density)	Hz
(MAINT)	3.	Displays frequency (temperature)	Hz
	4.	Checks output signal	□□□ %
	5.	Checks LED (press SET key)	- LED - (flash 5 times)
	6.	Sets low limit of the output range	□.□□□□ g/cm^3
	7.	Sets high limit of the output range	□.□□□□ g/cm^3
	8.	Sets reference temperature of measuring liquid	□□□.□ °C
	9.	Sets temperature coefficient of measuring liquid	–□□□x10^{-5} g/cm^3/°C
	A.	Sets detector constant A	□□□□□
	B.	Sets detector constant B	□□□□□
	C.	Displays detector calibration coefficient C (span)	
	D.	Displays detector calibration coefficient D (zero)	

(1) Measuring mode (DSPL): Mode for normal operation

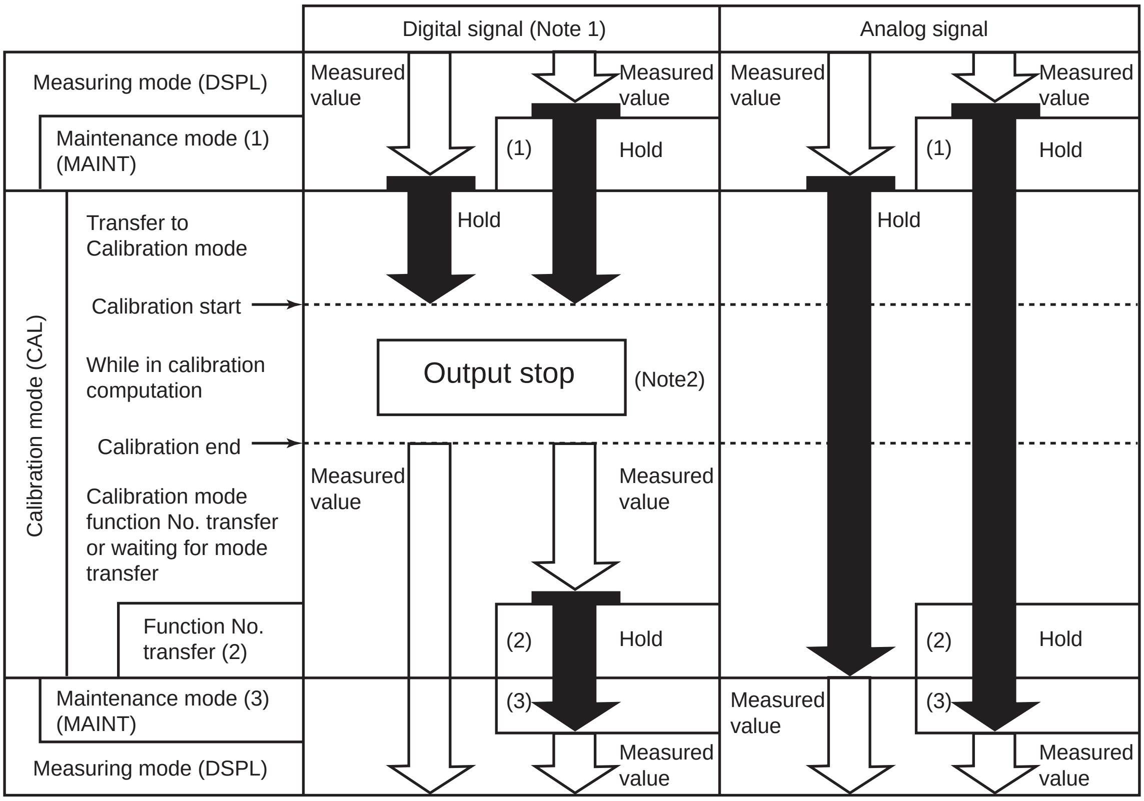
An analog output in this mode is density value at the reference temperature.

Moreover, density value at measuring liquid temperature and temperature of measuring liquid are digitally output. The density value at the reference temperature (without function No. display), the density value at measuring liquid temperature (No.1) or the measuring liquid temperature (No.2) can be displayed by selecting function No. Use FUNCTION key to select the FUNCTION No.

(2) Calibration mode (CAL): Mode for calibration. Sets or specifies data required for calibration.

During this mode the analog and digital outputs are held (at the values just before the holding). However, digital data output stops during calibration function No. '6' or 'A'.

When calibration computation ends holding is released and measured data are again output until function No. '6' or 'A' is transferred to another No.



Note 1: The density value after temperature conversion, density value at the measuring temperature and measuring liquid temperature are transmitted in digital form. (Only the density value after temperature conversion is transmitted in analog form.)
Note 2: The density converter displays CAL-1 or CAL-2.

Figure 4.3 Digital and Analog Signal Output Statuses

Eight function Nos. from '3' to 'A' are provided in the calibration mode (see Table 4.1). Among them, '6' and 'A' are to specify the calibration computation and others are to input data required for the calibration.

Function No. '3': Sets density of calibration solution 1

Density value (g/cm^3) of a calibration solution for one-point calibration or 1st calibration of two-point calibration can be input. The input density is a data at the reference temperature.

(Note) If relation between temperature and density is well known, a density at a temperature can be set. However, the density data at the reference temperature is recommended to achieve accurate calibration.

Function No. '4': Sets temperature of calibration solution 1

Input the temperature of the calibration solution 1 of which density at the reference temperature is set at '3'.

Function No. '5': Sets temperature coefficient of calibratio solution 1

Enter the value which is -100000 times the temperature coefficient (g/cm^3/°C) of the liquid for calibration 1.

(Note) The temperature coefficient -0.00086 g/cm3/°C becomes the value 086.

Function No. '6': Starts calibration 1 (press SET key)

Pressing "SET" key executes calibration computation, or also executes the first calibration of the two-point calibration.

(Note) For calibration procedure, refer to Section 4.4.

Function No. ‘7’: Sets density of calibration solution 2

Density data (g/cm^3) for the 2nd calibration (calibration solution 2) of two-point calibration can be input. As a rule, the input density is data at the same reference temperature as that of ‘4’.

(Note) If relation between temperature and density is well known, a density at a temperature can be input. However, the density data at the reference temperature which is same as that of ‘4’ is recommended to achieve accurate calibration.

Function No. ‘8’: Sets temperature of calibration solution 2

Enter the temperature of calibration solution 2 of which density at the reference temperature is set at ‘7’.

Function No. ‘9’: Sets temperature coefficient of calibratio solution 2

Enter the value which is -100000 times the temperature coefficient (g/cm^3/°C) of the calibration solution 2.

Function No. ‘A’: Starts calibration 2 (press SET key)

Pressing “SET” key executes 2nd calibration computation of two-point calibration.

(3) Maintenance mode (MAINT): Mode for adjusting and checking operating conditions.

During this mode, analog and digital outputs are held (at the value just before holding).

Function No. in maintenance mode is from ‘1.’ to ‘D.’ (see table 4.1).

Function No. ‘1.’: Canceles protect (enter 77)

Function to avoid data changing due to carelessness. When “0” is displayed, a function No. is not entered. To release the protection, display “77” and press “SET” key. When protecting again, display any number other than “77” (for example 78) and press “SET” key. This operation is invalid unless some operation is made after the protection release (for example, setting function No. ‘2’).

Function No. ‘2.’: Displays frequency (density)

Checks operation of this converter. Frequency corresponding to measured density are displayed. When the converter is normal, the frequency ranges from 600 to 700 Hz to 1000 or 1500 Hz.

(Note) Displayed frequency varies with measured density, liquid temperature and detector constant. If density is 0.5 to 2.0 g/cm^3, temperature is 25 °C, detector constant (A) is 17074 and detector constant (B) is 36384, the frequency is 640 to 1400 Hz for normal operation.

Function No. ‘3.’: Displays frequency (temperature)

Checks operation of this converter. A frequency signal converted from liquid temperature voltage is displayed. If temperature is 25 °C, the frequency is about 25000 to 35000 Hz for normal operation.

Function No. ‘4.’: Checks output signal

Checks zero point and span of an analog output signal.

(Note) The data at shipping is described in a data sheet in the converter.

Function No. ‘5.’: Checks LED (press SET key)

Function to check LED data display. When “SET” key is pressed, all displays flash five times if it is normal.

Function No. ‘6.’: Sets low limit of the output range

Sets a low limit density value (g/cm^3) of an analog output range.

Function No. '7.': Sets high limit of the output range

Sets a high limit density value (g/cm^3) of an analog output range.

(Note) Difference between high and low limit value should be 0.05 g/cm3 or more. If an inadequate value is set, the function No. returns to '6.' operations of '6.' and '7.' are related; when setting is made at '6.' setting should also be made at '7.'.

Function No. '8.': Sets reference temperature of measuring liquid

Sets a reference temperature (°C) of measuring solution.

Function No. '9.': Sets temperature coefficient of measuring liquid

Sets the value which is -1 x 10^5 (= -100000) times the temperature coefficient of measuring solution (g/cm^3/°C) to change it to plus integer.

(Note) Purified water is an exception; its maximum density is at approx. 4 °C. Generally, temperature coefficients of any liquids are minus number.

Function No. 'A.': Sets detector constant A

Sets the detector constant A. Since the detector constant A is an inherent characteristic of the detector, this is indicated in each detector.

(Note) Detector constant A changes with each calibration.

Function No. 'B.': Sets detector constant B

Sets the detector constant B. Since the detector constant B is also an inherent characteristic of the detector, this is indicated in each detector.

Function No. 'C.': Displays detector calibration coefficient C (span)

Indicates either the one-point or two-point calibration has been performed. 1 is indicated for one-point calibration and calibration coefficient (span) for twopoint.

Function No. 'D.': Displays detector calibration coefficient D (zero)

Indicates either the one-point or two-point calibration has been performed. 0 is displayed for one-point calibration, and calibration coefficient (zero point) than 0 is displayed for two-point calibration.

4.3 Preparation for Measurement

4.3.1 Check for Piping

Check the following points.

(1) Is the pressure difference 100 kPa or more between both sampling tap?

(2) Is the diameter of the sampling pipe appropriate? Is length of the inlet pipe too long?

(Note) The sample inlet pipe is usually JIS 15A or Sch 40 to 80 stainless steel pipe.
The pipe length between sampling tap and the detector should be 10 m or less.

(3) Are valves and meters (pressure gauge, thermometer) provided in the sampling pipe for normal operation and maintenance?

(4) Is air for cleaning the detector provided?

(Note) Dried 0.3 to 0.5 MPa G air is requires for cleaning the detector.

(5) Can heating steam for the density detector be stopped during operating time?

4.3.2 Check for Wiring

Check that whole wiring of the measuring system including a receiving unit (for example, recorder) is completed.

When the detector is explosionproof type, place the terminal box cover as completely as before if it is once released.

4.3.3 Measuring Liquid Flow

Operating procedure for introducing sampling liquid is explained here, assuming the piping in Figure 3.5 in Section 3.1.2 is equipped. When pipe arrangement is different from that of Figure 3.5, carry out corresponding operations described here. It is important that air bubble does not remain in the pipe.

If calibrating is to be made with standard solution, conduct the measuring liquid after calibration work to omit cleaning the vibrator. However, if pressure compensation is to be made (see Section 4.3.6), conduct the measuring liquid to obtain compensation value beforehand.

(1) First, set each valve in the sampling unit as follows.

Ball valve “BV1”: Fully closed
Needle valve “NV1”: Fully closed
Needle valve “NV2”: Fully closed
Needle valve “NV3”: Fully closed
Needle valve “NV4”: Fully closed
* ‘Stop’ valve “V1”: Fully closed
* ‘Stop’ valve “V2”: Fully closed

(Note) V1 and V2 marked by * are used only for steam tracer.

(2) For the sampling conduit with the steam tracing pipe, open the steam main valve to heat the sampling conduit.

Keep the ‘stop’ valve “V1” closed, not heat the detector if it is not remarkably cooled.

(3) Prepare a sample receptacle (liquid pan) just under the ‘drain’ valve provided in the sample conduit. First, fully open the ‘drain’ valve, then gradually open the ‘tap’ valve.

When the sample liquid begins to flow out of the drain valve, close the ‘tap’ valve.

(4) The same procedure as (3) should be made for the sample return conduit. Prepare a sample receptacle (liquid pan) just under the drain valve. First, fully open the ‘drain’ valve, then gradually open the ‘stop’ valve. When the sample liquid begins to flow out of the ‘drain’ valve, close the ‘stop’ valve.

(5) Fully open “BV1” and “NV4” and half open “NV1” in the sampling unit. Close ‘drain’ valve opened in (3). Gradually open the ‘tap’ valve located on the sample inlet conduit. As sample begins to flow out of the ‘drain’ valve on the sample return conduit, fully open the ‘stop’ valve and fully close the ‘drain’ valve when no retaining air is found in the liquid.

(6) Open “NV2” to exhaust retaining air in the pipe. When the sample liquid without air flows out from the ‘drain’ port, fully close the “NV2”.

(7) Adjust opening of NV1 to make sample flow rate approx. 5 l/min for the detector.

Flow rate shown by FM in the VD6SM sampling unit of Yokogawa varies according to viscosity of sample. If the viscosity of sample liquid becomes higher, flow rate indication also becomes higher than real flow rate (see Figure 4.4).

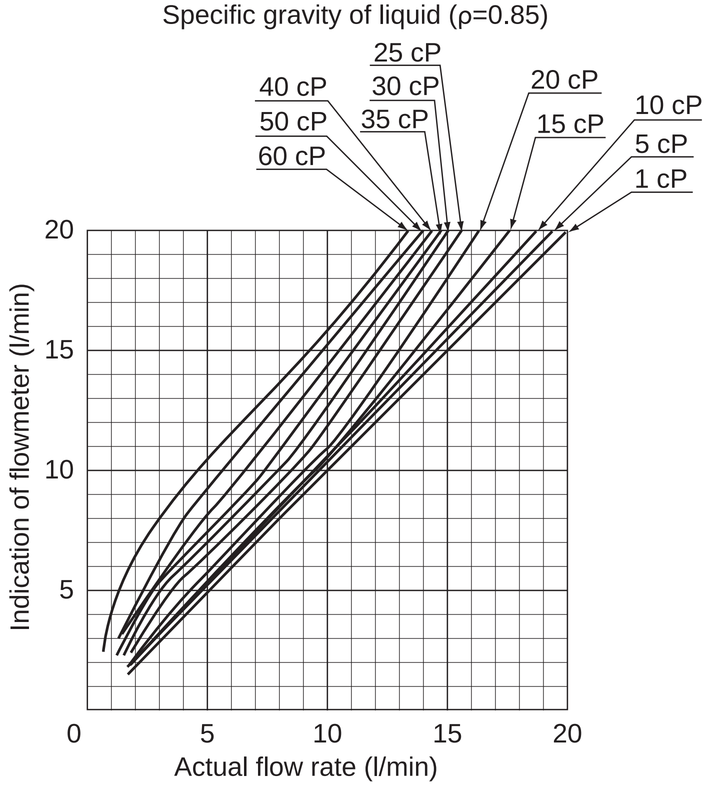


Figure 4.4 Flow Rate Characteristics for Sample Liquid Viscosity

(8) Confirm that the sample liquid temperature T and pressure P are in the specified range.

(9) Visually check that the sample liquid is not leaking from the connections.

4.3.4 Turning ON the Power

Supply the converter and a receiving unit (recorder, computer, etc.) with power with specified voltage and frequency. The receiving unit should be ready to receive the data and controller should be adjusted to perform accurate control.

4.3.5 Data Input

Set the mode transfer switch to “MAINT” (maintenance mode) and input data to the function No. ‘6.’, ‘7.’, ‘8.’, ‘9.’, ‘A.’ and ‘B.’. For details of data to be input, refer to Section 4.2. Data is input with “SHIFT”, “INCR” and “SET” keys. For details of these keys operation, refer to Figure 4.1.2.

When temperature coefficient of measuring liquid that is to be input into function No. ‘9.’ is unknown jet, refer to ‘4.4.2 Calibration with Sample Liquid (2)’.

4.3.6 Pressure Compensation

Pressure compensation means to compensate the shift generated by measurement under operating pressure. The compensation should be carried out as necessary only for calibration under atmospheric pressure.

Measured value is affected up to +0.00005 g/cm^3 by 100 kPa pressure variance.

Therefore, for liquid under pressure approximating to the atmospheric pressure calibrated value under atmospheric pressure can be used. Pressure compensation is to be carried out to minimize effects generated by high operating pressure.

Compensation data is obtained by conducting sample liquid. Measure the data according to the following procedure when the liquid density is stable. The procedure assumes that sample liquid is already conducted according to Section 4.3.3.

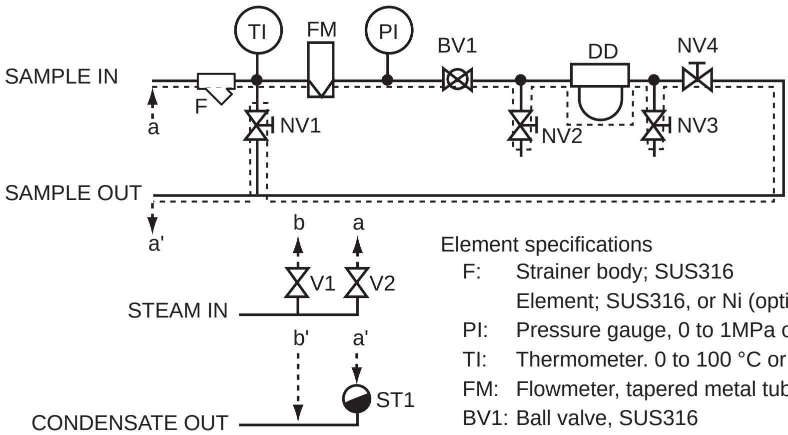
(1) Fully open the needle valve “NV4” and read P from the pressure gauge. At the same time, obtain density at the reference temperature indicated on the density converter.

(2) Fully close the ball valve “BV1”, and open the needle valve “NV3” to equalize the sample liquid pressure in the detector to the atmospheric pressure. Obtain density at the reference temperature indicated on the density converter.

(3) Calculate the compensation data using the densities obtained in (1) and (2).

Compensation data (g/cm^3) =
Density under working pressure – density under atmospheric pressure

When calibration the compensation data should be subtracted from the density value of the standard solution.



Element specifications
F: Strainer body; SUS316
Element; SUS316, or Ni (option)
PI: Pressure gauge, 0 to 1MPa or 0 to 2MPa, SUS316
TI: Thermometer. 0 to 100 °C or 0 to 150 °C, SUS316
FM: Flowmeter, tapered metal tube flowmeter, 1 to 10 l/min, SUS316
BV1: Ball valve, SUS316
NV1 to 4: Needle valve, SUS316
DD: Density detector
V1, V2: Valve
ST1: Steam trap

Figure 4.5 Flow Diagram

4.4 Calibration

The vibration type density meter should be calibrated as occasion demands to keep the specified accuracy.

Calibration has two methods: one-point calibration and two-point calibration, and each method is carried out by either sample liquid or standard solution. The calibration with sample liquid is not requiring stopping operation and pressure compensation resulting in assurate measurement. On the other hand, in calibration with standard solution, the solution density is once determined at the fixed value, density measurement of sample liquid should not be repeated at a laboratory.

The one-point calibration is equal to that omitting the 2nd calibration two-point calibration, so, the two-point calibration using standard solution and sample liquid is described as follows. Since the following is described assuming that the density converter is installed in the vicinity of the density detector, for the connector installed away from the detector, please edit the manual for it and carry out the calibration according to the manual.

4.4.1 Calibration with Standard Solution

Provide two kinds of standard solution whose density at reference temperatures is already known (*1). One density (standard solution 1) should be near to the low limit of the measuring range and the other to the high limit (standard solution 2). Temperature coefficients (g/cm^3/°C) of these standard solutions should be obtained beforehand.

(*1) When measuring the density of the standard solution, use a hydrometer whose minimum scale is 0.0005 kg/cm^3.

Calibration should be made in the following procedure. During calibration, only the density detector and the density converter are to be drived and the unit to receive output signals from the converter can remain stopped.

(1) Set the converter to “CAL” mode and input data corresponding to function No. ‘3’, ‘4’, ‘5’, ‘7’, ‘8’ and ‘9’. For pressure compensation, subtract the compensation value obtained in Section 4.3.6 from density of standard solution, and set them to function No. ‘3’ and ‘7’.

(Note) When the compensation value is a minus number, the set value becomes large than the standard solution density.

(2) Purge the inside of the vibrator with air as follows. Fully close the ball valve “BV1” and the needle valve “NV4” in the sampling unit. Fully open the needle valve “NV2” and “NV3”, connect an air pipe to the outlet port of the needle valve “NV3” and blow air for one or two minutes. Pneumatic pressure should be 0.2 to 0.3 MPa (*2).

(*2) For sample liquid remains in the vibrator, blow it out by 0.05 MPa G pneumatic pressure, and increase the pressure up to 0.2 to 0.3 MPa to dry the inside of the vibrator.

(3) Pouring 18 to 20 ml of standard solution 1 into the vibrator, avoiding air bubble entering it is described here.

Firstly, remove the blind plugs from the pouring ports for the standard solution (two places) located on the detector base plate. Secondly, pour the standard solution into the pouring ort using the injector (accessory) so that the solution flows along the inner wall of the vibrator tube. Using the pouring port near to the sample inlet is recommended. If the injector is stained, clean it with alcohol.

(4) Read the measured density value at the reference temperature. It is displayed with the mode selector switch 3 set to “DSPL” and function No. not displayed.

(5) Since calibration with standard solution 1 is made two times, blow out the used standard solution from the vibrator. Before blowing, plug the pouring orts (two places), and blow air according to (2).

(6) Carry out the operations of (3) and (4) to confirm that the same results as that of (4) is achieved.

(Note) If the result differs from (4), repeat the operations of (3) and (4).

(7) For the calibration 1 computation, press “SET” key at the function No. ‘6’. ‘CAL-1’ flashes during computation and the density at the reference temperature is displayed after the computation finishes (Note 1). Check that this value is the correct density (Note 2) of the standard solution 1.

(Note 1) Time for calibration computation varies with density value difference between pre-calibration and after-calibration. The larger the difference is, the longer the time is.

(Note 2) The density value after calibration doesn't always coincide with the density of the standard solution 1 even if they are compared in the same temperature.
Especially when the solution temperature during calibration largely different from the reference temperature an error is apt to occur.
However, the error is usually within allowable range, if it is too large, examine each set value.

(8) The first calibration is finished by (7). Then, use the standard solution 2 carry out the second calibration whose procedure is same as the first calibration. Repeat the operations of (1) to (7). For the calibration computation, set the function No. to 'A' (CAL-2 display flashes seven times).

When the second calibration is finished, purge the standard solution from the vibrator and screw the blind plug into the pouring port, fully close the needle valves "NV2" and "NV3" and remove the connected air pipe.

4.4.2 Calibration with a Sample

Calibration with sample liquid should be made according to the following procedure.

(1) Sample the measuring liquid which is measured by a hydrometer. Sampling should be made when the liquid density is stable.

(Note) The density of the sample liquid should not change between sampling the liquid and finishing the first calibration.

(2) Measure the density using the hydrometer and the temperature of the sampled liquid.

Examine the temperature coefficient if it is not known. Using densities at high temperature (reference temperature + approx. 5 °C) and low temperature (reference temperature - approx. 5 °C), the temperature coefficient should be calculated as following.

Temperature coefficient ($g/cm^3/°C$) =
(Density at high temperature – Density at low temperature)
/Difference between high and low temperatures

(Note 1) The density values should be those at the reference temperature as far as possible.

(3) Set the mode transfer switch of the converter to "CAL" and input the data corresponding to function No. '3', '4' and '5'.

(4) For specify the first calibration computation, select the function No. '6' and press "SET" key. 'CAL-1' display flashes during computation and the density at the reference temperature is displayed after computation.

Confirm that the density value is almost the same as that of measured at (2).

(5) Before carrying out the second calibration, change the density of the measuring solution in the sampling unit. Perform the operations of (1) to (4). In the operation corresponding to (3), input the data to function No. '7', '8' and '9'. In the operation corresponding to (4), use the function No. 'A' to specify calibration computation.

4.4.3 Calibration Error

If an error indication (E005 in the first calibration or E006 in the second calibration) is displayed when calibration computation finishes, examine the data input to function No. '3', '4', '5', '7', '8' or '9' and repeat the computation using the incorrect data.

4.5 Operation

4.5.1 Operation Procedure

Start the density measuring system, and monitor operating conditions for a while to confirm that there is no abnormality. Adjustment for the density measuring system during operation is unnecessary, however, daily check of liquid flow rate and pressure is preferable. When the steam tracing pipe is installed in the sampling unit, do not heat the detector.

If an error indication is displayed, make a countermeasure immediately. Errors are listed in Table 4.2.

Table 4.2 Error Table

Display	Contents	Error Release and Remedy
E001	Abnormal detector density signal	When cause is removed
E002	Abnormal detector temperature sinal	When cause is removed
E003	Abnormal on converter	
E004	Overrang of measuring temperature	
E005	Abnormal first calibration	Check and reset the data required for calibration.
E006	Abnormal second calibration	
E007	Illegal data of EEPROM	Check and reset the loaded constant

(Note) E001, 002, 003, 004 and 007 are cancelled temporally by pressing the FUNCTION No. key in maintenance or calibration mode, however in the measuring mode, the error indication is displayed again. These errors are detected only in the measuring mode.

E005 and 006 occur only in the calibration mode and are displayed for one second when calibration computation finishes and are cleared. After that, the density at the reference temperature by the previous calibrating data is displayed.

4.5.2 Check of Measured Density Value

It is recommended that measured density values are checked at intervals of several weeks to determine the period for calibration and cleaning.

(1) Measure the density using a hydrometer to compare it with the density indication (at the reference temperature) on the vibration type density meter. When sampling the liquid, check the pressure and the temperature are not largely different from those of the normal state.

(2) Measure density correctly at the reference temperature which is same as the sample liquid temperature.

(3) Compare the density measured at (2) with the displayed value when sampling the liquid. If the difference of them exceeds the allowable error range, clean the vibrator.

For cleaning procedure, refer to Section 5.1.1.

4.5.3 Shutdown

When shutdown sample following steps and the vibration type density meter also stops, drain the sample from the detector.

5. MAINTENANCE

5.1 Daily Inspection/Maintenance

5.1.1 Cleaning the Vibrator in the Detector

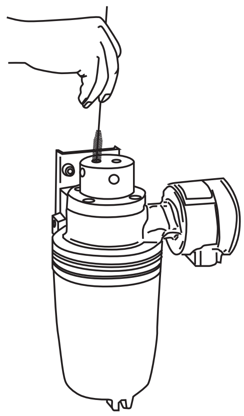
Dirt particles may be deposited on the inner wall of the vibrator pipe, depending upon the nature of the process liquid. This can cause an error. Clean the pipe at regular intervals in the following manner.

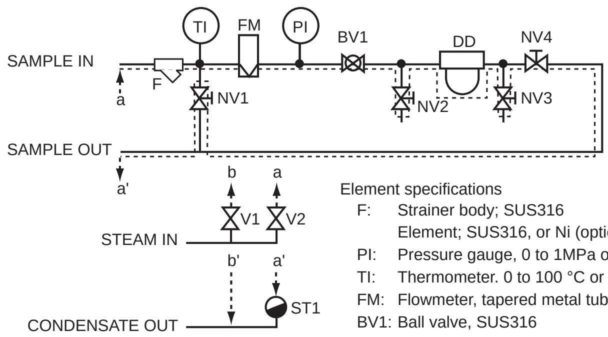
(1) Close valves BV1 and NV4 and open NV2 and NV3.

(2) Connect the air pipe to the outlet of the needle valve NV2. Purge the sample liquid in the vibrator from the drain port of the needle valve NV3 by blowing 0.05 MPa G air.

(3) Remove the blind plugs from the pouring port of the standard solution (two places) and pour cleaning liquid about 200 ml into the vibrator.

(4) After a while, fix blind plugs again on the pouring ports and purge the cleaning liquid in the vibrator as described in (2). Wash the inside of the vibrator pipe with a brush (accessory) as shown in Figure 5.1.





Element specifications
- F: Strainer body; SUS316
  Element; SUS316, or Ni (option)
- PI: Pressure gauge, 0 to 1MPa or 0 to 2MPa, SUS316
- TI: Thermometer. 0 to 100 °C or 0 to 150 °C, SUS316
- FM: Flowmeter, tapered metal tube flowmeter, 1 to 10 l/min, SUS316
- BV1: Ball valve, SUS316
- NV1 to 4: Needle valve, SUS316
- DD: Density detector
- V1, V2: Valve
- ST1: Steam trap

Figure 5.1 Cleaning the Vibrator **Figure 5.2 Flow Diagram**

(5) Remove the blind plugs again from the pouring ports of the standard solution and pour the cleaning liquid about 200 ml. After a while, fix the blind plugs and purge the sample liquid by blowing 0.05 MPa G air. After the liquid is blown out, increase the air pressure up to 0.2 to 0.3 MPa G blowing air for 2 or 3 minutes to dry the inside of the vibrator.

5.1.2 Exchange of Desiccant in the Detector

Desiccant is used to protect the oscillation amplifier in the detector from humidity.

Checks the detector terminal box one or two times a year and replace the desiccant if humidity is detected. Two desiccants are provided as accessories. For the explosionproof detector, confirm that there are no explosive gases using a gas detector before removing the terminal box cover.

5.2 Troubleshooting

Experiences are required for repair of the vibration type density meter; after parts are replaced, adjustment may be necessary. If trouble occurs, as a rule, repair should be made by Yokogawa. In this case, detailed information on abnormal phenomena will be effective for speedy recovery.

Searching method for abnormality is explained below. For the explosionproof detector, confirm that there are no explosive gases using a gas detector before removing the terminal box cover.

5.2.1 Checking the Vibrators

Remove the cover of the detector, so that the vibrator can be visually inspected.

Carefully check the entire surface of the two tubular vibrators. If they have dents, scratches, holes or show signs of the sample liquid leakage, the vibrator assembly should be exchanged. (CAUTION)

Make sure that the lock-screw is not in contact with the vibrator assembly.

CAUTION

The vibrator tube has extremely thin wall, hence must be carefully handled.
Since assembling the vibrator tube requires special skill, the exchange of the vibrator should be made by Yokogawa.

5.2.2 Checking the RTD

Measure electrical resistance between the terminal A2 and A3. When the RTD is normal, the resistance shows the value indicated in the following table.

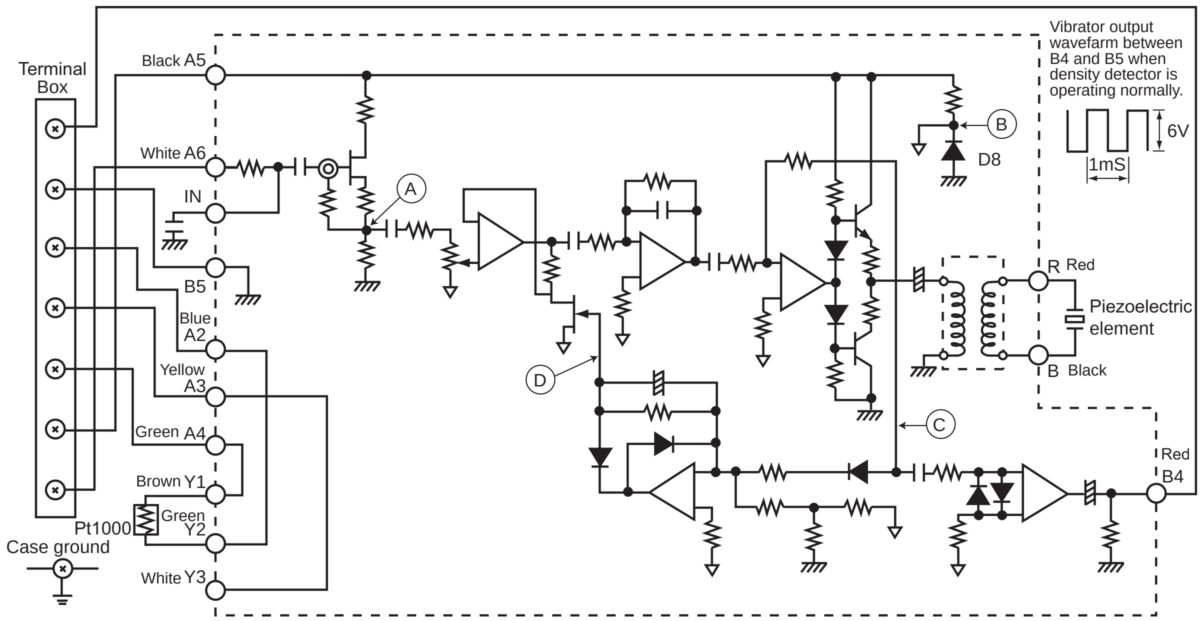
Table 5.1 Resistance at each temperature of RTD (Pt 1000Ω)

Temperature (°C)	10	15	20	25	30	35	40	45	50
Resistance (Ω)	1039.0	1058.5	1077.9	1097.3	1116.7	1136.1	1155.4	1174.7	1194.0

5.2.3 Checking the Oscillation Amplifier

First, visually inspect the capacitance pickup electrode. This electrode should be unstalled near the vibrator with a small gap between them. Without this gap, the electrode will not function properly. If there is moisture or dirt between the electrode and vibrator, clean the gap with a cloth. Take care not to damage the vibrator.

Then, check the electrical circuitry using a DC voltmeter and other appropriate measuring instruments. For the types of instruments and the checkpoints, see Figure 5.3.



Check point	Measuring instrument	Measuring conditions	Normal value	Remedial measure for abnormal value
① A5 – B5	DC voltmeter		12 V±10 %	Check converter INPUT
② A6 – B5	For measurement of ②, the meter input impedance should be at least 10 MΩ		200 V±10 %	assembly.
③ Ⓑ– B5			5.8 to 6.4 V	Replace D8.
④ IN – ⏚	Multimeter		∞ (X 10 kΩ Range)	Check pickup electrode.
⑤ B4 – B5	Oscilloscope	Disconnect leadwires from terminals	6 to 8 V p-p	Check for defective circuit
⑥ R – B5		IN, R, and B, on PCB, connect an	150 to 200 V p-p	components and replace
⑦ Ⓐ– B5		oscillator (0 to 2000 Hz, output 5 V),	200 mV p-p	them.
⑧ Ⓒ– B5		and apply an input of 100 mV rms.	4 to 6 V p-p	
⑨ Ⓓ– B5	DC voltmeter	Lower 100 mV rms input	-3 to 0 V	

F0502.ai

(Note) Regading to repair parts, consults with service personnel.

Figure 5.3 Oscillation Amplifier Check Points

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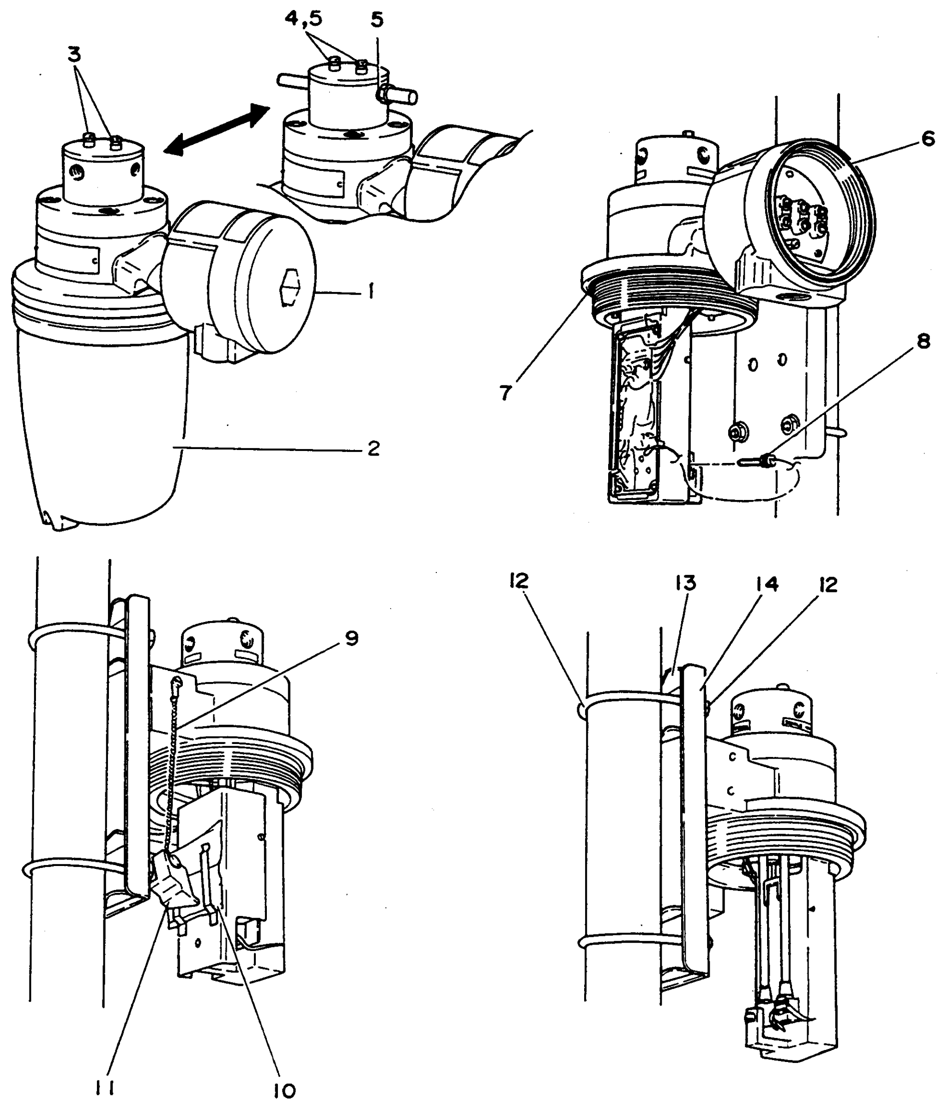
Customer Maintenance Parts List

Model VD6D, VD6DF, VD6DS

Density Detector



Item	Part No.	Qty	Description
1	—	1	Terminal Box Cover
2	K9000SK	1	Cover
3	K9000CC	2	Plug (for Models VD6D and VD6DF)
4	K9000DB	2	Plug (for Model VD6DS)
5	L9818JB	4	Gasket (for Model VD6DS)
6	G9303AR	1	O-Ring
7	G9303BA	1	O-Ring
8	G9303NE	2	O-Ring (for Model VD6DS)
9	K9000AK	1	Chain Assembly (for Model VD6DF)
10	K9324PC	1	Desiccant (2 packs)
11	K9000AC	1	Clamp
12	D0117XL-A	2	U-Bolt Assembly
13	L9826AG	2	Bracket
14	L9826AC	1	Bracket

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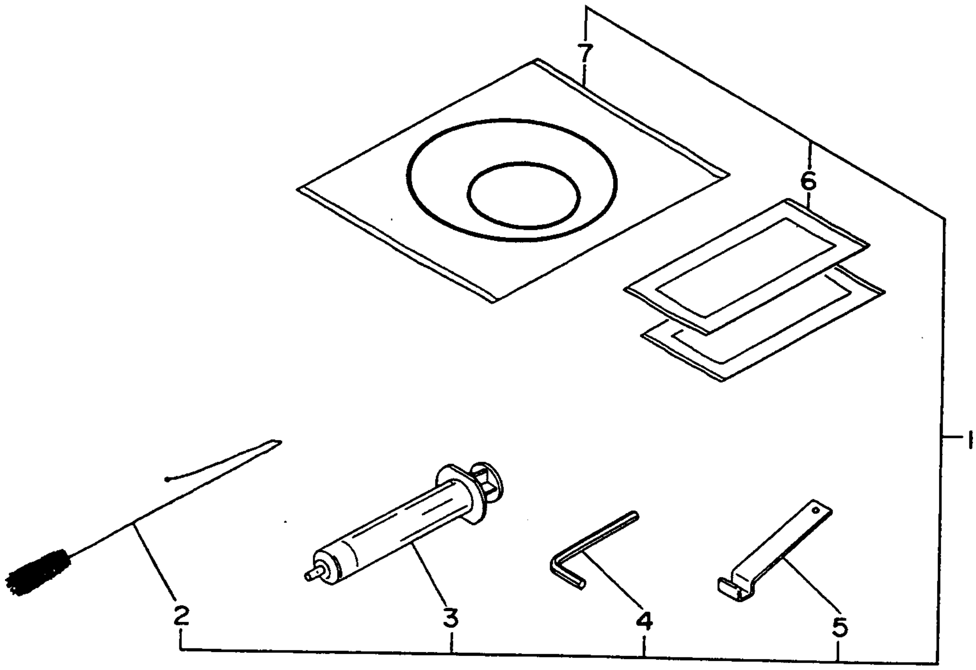
5th Edition : Apr. 2009 (YK)

Accessories Assembly

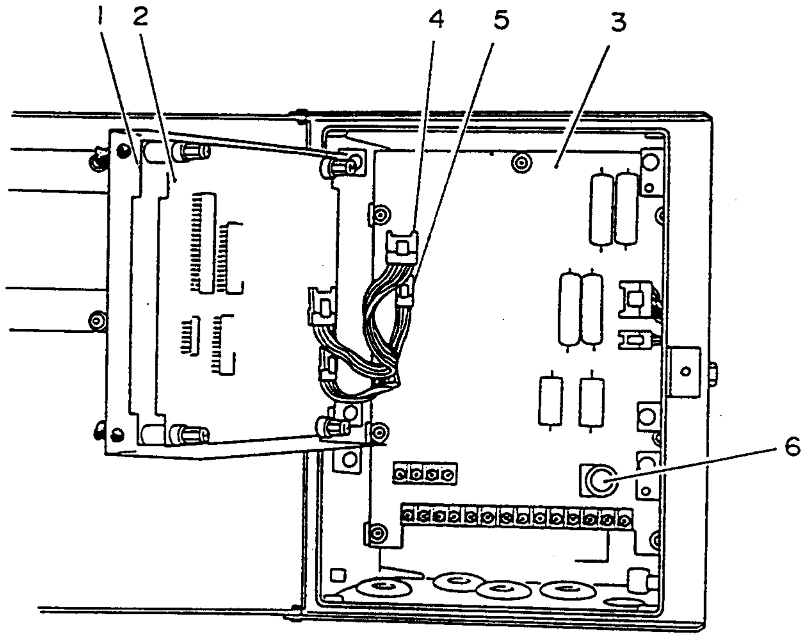


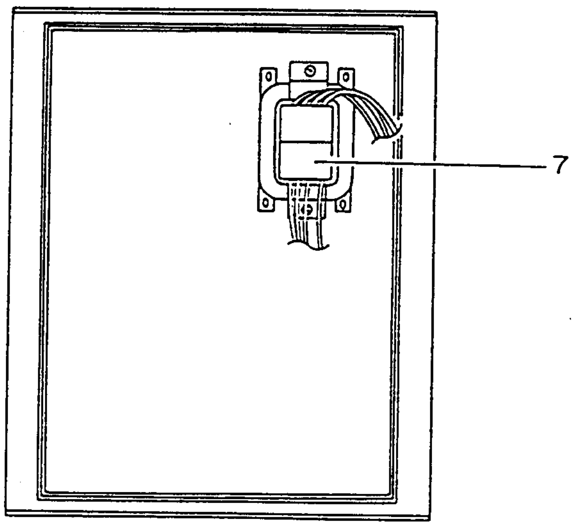
Item	Part No.	Qty	Description
1	K9000PQ	1	Accessories Assembly
2	L9827AR	1	Brush
3	K9000NB	1	Injector
4	L9827AE	1	Allen wrench
5	E9135GZ	1	Spanner
6	K9324PC	1	Desiccant (2 packs)
7	K9003NG	1	O-Ring Set (used for item 6 and 7 in page 1)

Customer Maintenance Parts List

Model DM8C

Density Converter



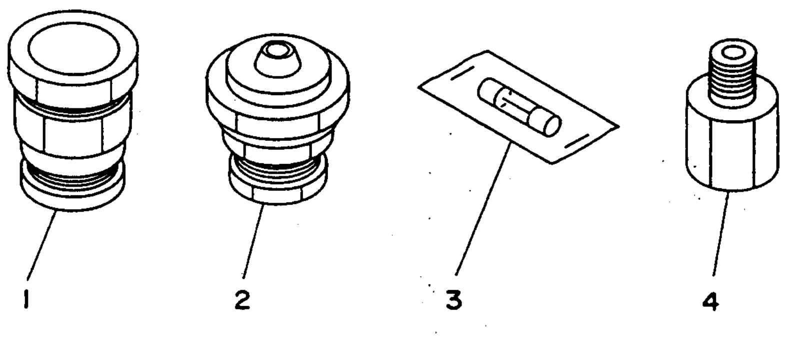


Item	Part No.	Qty	Description
*1	K9000ZM	1	Spare Display Unit (for style *B)
	K9000VV	1	Display Board Assembly (for style *C)
*2	K9000YJ	1	CPU Board Assembly
*3	K9000YH	1	Main Board Assembly
4	K9000YR	1	Cable Assembly (7 pins)
5	K9000YQ	1	Cable Assembly (5 pins)
6	K9141TV	1	Fuse (250 V, 3 A)
*7	K9000ZE	1	Transformer Assembly

*: Do not change these parts, call service personnel.

YOKOGAWA ◆
Yokogawa Electric Corporation

Accessories Assembly



Item	Part No.	Qty	Description
1	B1003JZ	1	Cable Gland
2	L9811FP	4	Cable Gland
3	K9141TV	1	Fuse (250 V, 3 A)
4	G9612BC	1	Connector Rc1/4 (for /AP1)
	G9612BE	1	Connector 1/4NPT (for /AP2)

Revision Information

- Title : Model DM8 Vibration Type Density Meter
- Manual No. : IM 12T03A01-02E

Jun. 2012/3rd Edition Page layout changed by InDesign

P.4-9 Figure 4.5 Flow Diagram added, P.5-1 Figure 5.2 Flow Diagram added,
CMPL 12T3H1-01E revised to 6th edition.

Apr. 2009/2nd Edition

P.1-4 Standard Accessories, P.1-5 DM8C Style B to C, change of CMPL 12T3E1-01E P.2 Item 3 and CMPL 12T3H1-01E P.1 Item 1.

Dec. 2006/1st Edition

Newly published (For Style *B)

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Home page: http://www.yokogawa.com/an

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