Tuning Fork Density Meters
ESD300 | INSERTION TYPE

Product Introduction

ESD300 is kind of vibrating fork density meter that is designed based on the principle of tuning fork vibration.

This density meter sensor composed of two piezoelectric crystals. One piezoelectric crystal- located at the root of the fork, generates vibration, and the other piezoelectric crystal detects vibration. The fork body is stabilized at its natural resonant frequency through a phase shift and amplification circuit. When a medium flows through the fork, the medium's mass continuously changes, causing a corresponding change in the resonant frequency. Therefore, the density of the medium can be calculated by measuring the vibration frequency of the fork after the medium flows through it.

The density sensor has a built-in temperature sensor to compensate for the temperature of the piezoelectric crystal vibration.

The maximum length of the split tuning fork densitometer split line is usually 2 meters. In order to reduce interference with the tuning fork sensor circuit, a single-strand wire with an outer protective sleeve is used. On-site, protect the sensor wire from interference and damage.

ESD300 density meter adopts insertion installation and is widely suitable for medium density detection in pipelines, open tank containers, and closed tank containers. It does not require a lot of maintenance and can measure the density of mixed media containing bubbles or even solids.

Please pay attention and refer to the manufacturer in case of high electromagnetic interference or medium crystallization.

Highlight Features

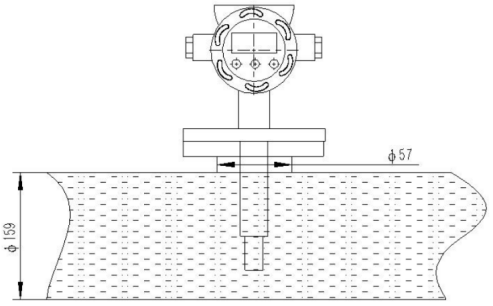
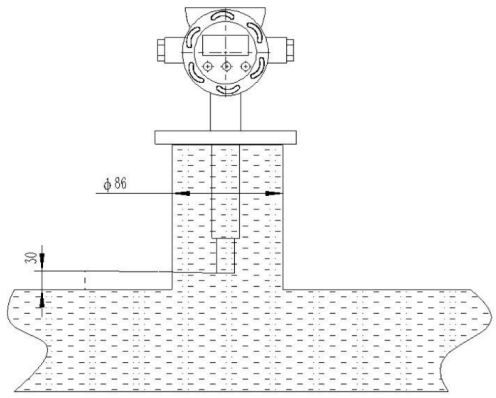
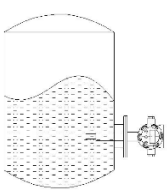
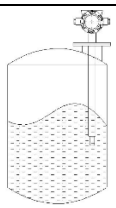
- Equipped with microprocessor-based electronic converter that integrates signal processing, calculation, and diagnostic functions.
- Be stable at its natural resonant frequency, unaffected by fluid properties such as viscosity, pressure, and density.
- Strong resistance to foam and bubble interference.
- Ideal for measuring viscous media, semi-solids, and solid materials.
- Highly stable measurement results, suitable for measuring various fluid property changes.
- Simple structure, easy installation, and low maintenance costs.

1. Integral transmitter with optional local operation interface
2. Process connection
3. Vibrating tines
4. RTD measures

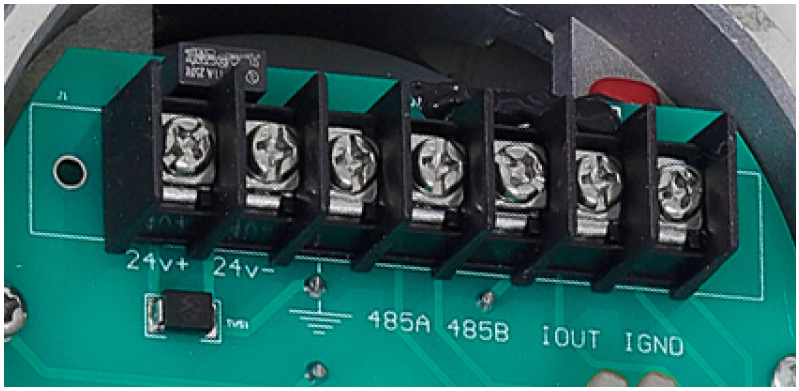
Performance Specification

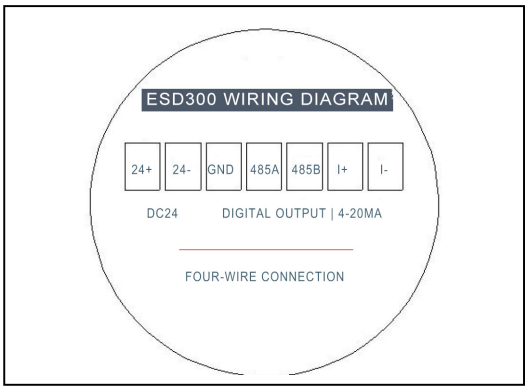
Electrical Specification	
Measurement Range	0.00~3.00 g/cm³
Insertion Depth	150mm (standard), 6 meters (maximum)
Output	4-20mA | RS485 | HART
Accuracy	0.2% (real-time range) or 0.001 g/cm³
Resolution	0.0001 g/cm³
Fluctuation	Repeatability 0.0002 g/cm³
Installation Method	DN50, DN80, DN100, and Threads (with mounting base)
Medium Temperature	-30~150℃
Maximum Working Pressure	200bar
Ingress Protection	IP65
MOC of Fork & Wetted Parts	Stainless steel 304, 316L, HC276, titanium alloy, zirconium, etc.
Coating of Fork	Teflon coating (excellent hydrophobicity and non-adhesion to impurities in liquids).
Please contact manufacturer to consult in case of: *>200 bar working pressure; special requirement for insert length or installation method; special requirement for material used.*	

Installation

01: Insertion	RECOMMENDATION
	*To ensure accurate and stable readings from the density meter:* ➢ *The flow velocity of the measured medium should **not exceed 0.5 m/s**.* ➢ *The inner diameter of the pipeline at the density meter's installation location should be **≥150mm**.* ➢ *If the on-site pipeline is smaller than **150mm**, a pipe expansion installation is required.* ➢ *A straight pipe section of **≥300mm** is required before the meter, and a straight pipe section of **≥150mm** is required after the meter to ensure that the fluid is in laminar flow when passing through the fork body.* ➢ *For vertical installation, the fluid should **flow from bottom to top.***
02: Insertion	RECOMMENDATION
	*To ensure accurate and stable readings from the density meter:* ➢ *The flow velocity of the measured medium must **not exceed 2.0 m/s.*** ➢ *The inner diameter of the pipe at the density meter's installation location must be **≥ 80mm**,* ➢ *The distance from the lower end of the fork to the main pipeline must be **≥ 30mm.*** ➢ *In case of tank installation, please makes sure no mixing inside the tank.*
	

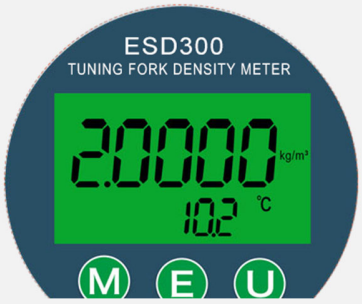
Electrical Connections & Buttons





Display & Buttons Instruction

3	Lower range limit	Value @ 4 mA, <10000
4	Upper range limit	Value @ 20 mA, 10000<c<30000
5	4-20mA output direction	0: 4-20mA; 1: 20-4mA
6	Temperature correction factor	Linear correction
7	4-20mA current correction factor	Linear correction
8	Density correction factor	Linear correction
9	Modbus address	1-254
10	Density migration correction	Highest digit: 10 for addition, 0 for subtraction, fixed four decimal places, (g/cm3) *Set to: 1.0008 represents adding 0.0008 to the entire range* *Set to: 0.0008 represents subtracting 0.0008 from the entire range* *【Debug password】: 1 1 1 1 1 (press U to modify, press M to shift), after modification, press E to enter the menu*



M	Shift Key
E	Units Switch (g/cm³ Kg/m³)
U	+Plus / -Minus

11	Standard condition density factor (for switching between standard condition density and operating condition density, or coefficient setting)	The highest bit (sign bit) is 0 for positive and 1 for negative. The next highest bit represents the decimal point. The remaining bits represent the numerical value. If the numerical value is 0, it represents the working condition density. For example: 05079 means the coefficient is 0.00079. 15079 means the coefficient is -0.00079. When the value is 0, it indicates that the working condition density is displayed.
12	First-order filter coefficient	4-bit fixed-point decimal, range 0.5000--1.0000 First-order filtering is also called first-order lag filtering or first-order low-pass filtering. The algorithm formula for first-order low-pass filtering is: ***Y(n)=αX(n) + (1-α)Y(n-1)*** Where: α = filtering coefficient; X(n) = current sample value; Y(n-1) = previous filtered output value; Y(n) = current filtered output value. The first-order low-pass filtering method weights the current sample value and the previous filtered output value to obtain an effective filtered value, so that the output has a feedback effect on the input.
13	Refresh filter constant	Arithmetic mean of refresh filter constant over n unit times, range 1-100
14	Change threshold	(4-digit fixed-point decimal g/cm³): Baseline threshold or sensitivity threshold.

NOTE:

- *The boundary effect of a tuning fork densitometer refers to the change in the measured value of the densitometer as the pipe diameter increases within a certain range. This phenomenon is called the boundary effect.*
- *In practical applications of tuning fork densitometers, to obtain more accurate measurement results, it is necessary to select the appropriate densitometer based on different pipe diameters. In addition, changes in flow rate can also affect the measurement results of the tuning fork densitometer. If the flow rate is too fast or too slow, it may affect the stability of the densitometer, thus affecting the accuracy of the measurement results. Therefore, when using a tuning fork densitometer, it is necessary to select a suitable flow rate range based on the actual situation.*
- *To obtain more accurate measurement results, attention should be paid to the influence of pipe diameter and flow rate when using a tuning fork densitometer, and an appropriate densitometer should be selected for measurement.*

Communication Protocol

This ESD300's communication protocol complies with the MODBUS-RTU communication protocol, with 1 start bit, 8 data bits, and 1 stop bit. The following instruction definitions assume the instrument parameters are: instrument address set to 1, communication baud rate 9600, and no parity.

Data Format							
1. Read Command (03H)							
Address	Function Code	Data Start	Data Start	Number of Data	Number of Data	CRC16	CRC16
0X01	0X03	0X00	0X04	0X00	0X01	0XC5	0XCB
Return Write Data Format: Example							
Address	Function Code	Data Length	Data	Data	CRC16	CRC16	
0X01	0X03	0X02	0X00	0X01	0x79	0x84	
Write Command (06H)							
Address	Function Code	Data Start	Data Start	Data	Data	CRC16	CRC16
0X01	0X06	0X00	0X00	0X00	0X02	0X08	0X0B
Return Write Data Format: Example							
Address	Function Code	Data Start	Data Start	Data	Data	CRC16	CRC16
0X01	0X06	0X00	0X00	0X00	0X02	0X08	0X0B

Address Instruction				
Address	Meaning of data	Number of data		Note
0x00	Instrument Address	1		Rw
0x01	For Calibration Use	1		
0x02	For Calibration Use	1		
0x03	Concentration Value	1		
0x04	Density Value	1		R
0x05	Temperature Value	1		R
0x06	Density Coefficient	1		Rw
0x07	Temperature Coefficient	1		Rw
0x08	Density/Concentration Current Lower Limit	1		Rw
0x09	Density/Concentration Current Upper Limit	1		Rw
0x0a	Current Transmission Direction	1		Rw
0x0b	Current Coefficient	1		Rw
0x0c	Density Upper/Lower Adjustment Value	1		Rw
0x0d	Standard Condition Density Coefficient Integer Part	1		Rw
0x0e	Standard Condition Density Coefficient Decimal Places	1		Rw
0x0f	First-Order Filtering Coefficient	1		Rw
0x010	Refresh Filtering Constant	1		Rw

Note:

- The instrument is suitable for all explosion-proof environments.
- After installation, the instrument can withstand 1.2 times the maximum working pressure.
- Store and transport the instrument in its original packaging.
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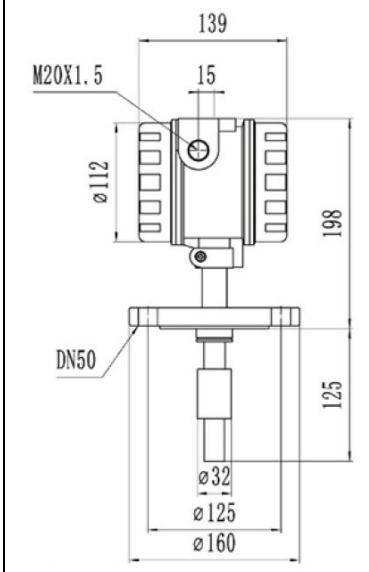
Precaution:

- *Do not drop or throw the instrument.*
- *Do not use the instrument to measure strongly corrosive liquids.*
- *Do not operate the instrument above its rated pressure.*
- *Do not exceed the specified test pressure during pressure testing.*

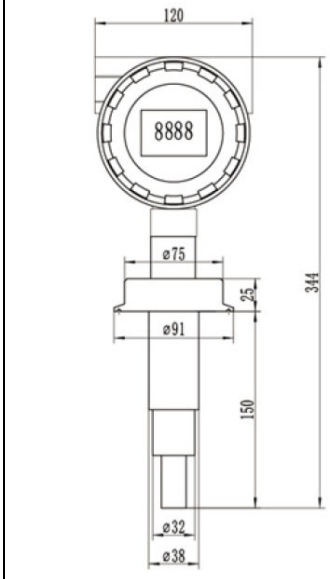
Structure Size Outline Dimension (mm)

Below structures are the standard types, please refer to your sales representative for the possibility of customization

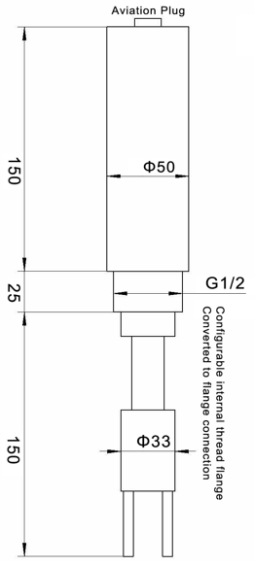
S01



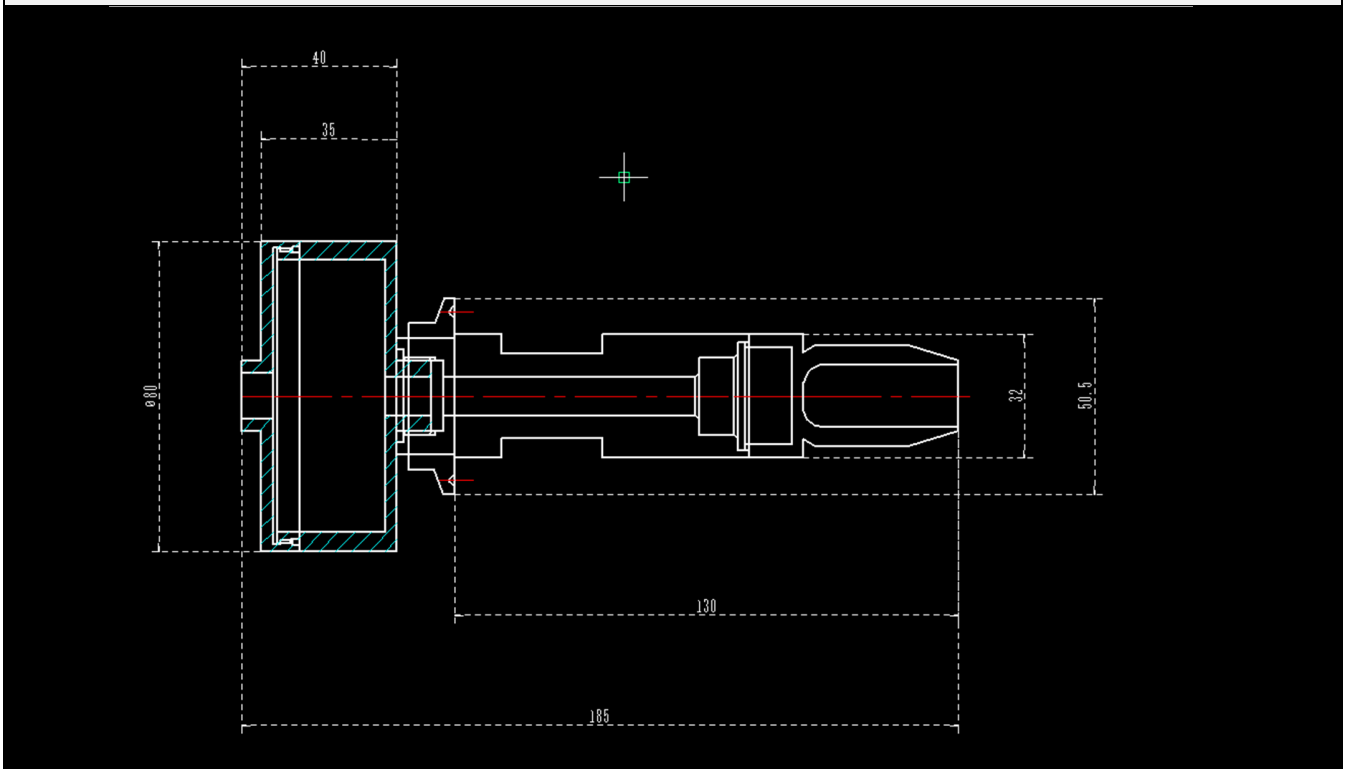
S02



S03



Below structure is kind of customization type for reference



Frequent Ask Question

What are the common faults & solutions?

Fork density meter displays density as zero

- *Medium not filling the tube*
- *Fork tines are in air and not contacting the medium*

Solution: *Loosen the fork density meter flange, vent, or reinstall in a different location*

Fork density meter displays full scale

- *Fork density meter not vibrating (fork tines have deposits)*
- *Fork density meter not vibrating (flow rate at the fork does not meet requirements)*
- *Fork density meter not vibrating (medium viscosity is too high)*
- *Fork density meter not vibrating (fork tines were impacted, causing piezoelectric ceramic damage)*
- *Fork density meter range set lower than medium density*

Solution: *Change the measurement range*

Fork density meter displays fluctuation

- *Fork density meter unstable (flow rate at the fork does not meet requirements)*

Solution: *Add a bypass to resolve flow rate issues, or adjust the first-order filter coefficient*

Fork density meter not vibrating (uneven force on the fork tines)
Solution: *Change the fork density meter installation location to ensure the tines experience even force*

Fork density meter not vibrating (fork tines located in a turbulent area)
Solution: *Change the fork density meter installation location to ensure the fork is in a smoother fluid environment (recommend 10 pipe diameters upstream and 5 downstream of straight pipe)*

Fork density meter displays inaccurate readings

- *Fork density meter boundary effects not corrected*

Solution: *Correct the boundary effect*
Boundary effect: *Adjust the density correction coefficient*

What technical data I shall provide if I want to customize my installation method?

Fixed installation kits provide customers with a one-stop solution, Eastsensor will design a set of buffer connection mechanisms according to the specific working conditions of the customer.

The following parameters need to be provided:

- *Pipe diameter*
- *Flow rate*
- *Medium viscosity*
- *Temperature*
- *Connection method (flange or thread)*
- *F. Spatial distance*

In which case I can use the installation method of oblique installation?

Classic Installation Conditions for oblique installation method:

A. Main pipe diameter is not limited, inclined pipe inner diameter is not less than 50 mm.
B. Tuning fork retracts 30 mm.
C. Wide flow rate range, applicable to main pipe flow rates no greater than 3 m/s.
D. Viscosity range: ≤20000cP

Notes:
A. If the inclined side pipe diameter is too small, the vibration wave reflection will affect the tuning fork vibration, resulting in low accuracy (it is recommended to use a pipe diameter greater than 50 mm).
B. Failure to install the tuning fork density meter according to requirements will lead to reduced accuracy and stability.
C. Direct insertion welding and direct insertion flange connection methods are the same. (Threaded connections will include a welded base).
D. Slow temperature response, which may lead to temperature compensation errors due to inconsistent temperature changes.

Ordering Procedure

ESD300	Tuning Fork Density Meter

Code	Range
R1	0.8-1.4g/ cm³
R2	1.4-2g/ cm³
R3	Others

Code	Structure Type
S01	Flange type with display
S02	Clamp type with display
S03	Clamp type without display
S04	Separated type with display
S10	Customization

Code	Output Signal
C	4～20mA
RS	RS485
C+RS	4～20Ma+RS485

Code	Pressure Rating
P1	16bar
P2	40bar
P3	60bar
P4	100bar
P5	Others

Code	Process Connection	
D1	DN50-Flange	*By default, the flange pressure rating follows the specified pressure class unless an alternative rating is explicitly requested with the order.*
D2	DN65-Flange	
D3	DN80-Flange	
D4	DN100-Flange	
D5	DN125-Flange	
D6	DN150-Flange	
D7	DN200-Flange	
D8	DN250-Flange	
D9	G1-1/4-Thread	
D10	Others	

Code	Material of Wetted Parts
M1	SS304
M2	SS316
M3	PTFE
M4	Other

ESD300	R1	S01	C	P2	D1	M2

LIMITED WARRANTY

Seller warrants that the product hereby purchased is, upon delivery, free from defects in material and workmanship and that any such product which is found to be defective in such workmanship or material will be repaired or replaced by Seller (Ex-works, Factory, Xi'an China. INCOTERMS); provided, however, that this warranty applies only to equipment found to be so defective within a period of 12 months from the date of manufacture by the Seller. Seller shall not be obligated under this warranty for alleged defects which examination discloses are due to tampering, misuse, neglect, improper storage, and in any case where products are disassembled by anyone other than authorized Seller's representatives. EXCEPT FOR THE LIMITED WARRANTY OF REPAIR AND REPLACEMENT STATED ABOVE, SELLER DISCLAIMS ALL WARRANTIES WHATSOEVER WITH RESPECT TO THE PRODUCT, INCLUDING ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. specifications subject to change without notice.

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