



Tuning Fork Densimeter

Operation manual



1. GENERAL INFORMATION

1.1 General information

This manual refers to the following products: DTS500 and must be kept near the equipment for easy reading and consultation. It must be read, understood, and strictly follow in order to avoid and prevent accidents and/or malfunctions. Dwel will not be liable for any injury to people and/or damage to property deriving from disregard of this manual.

1.2 Copyright

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2. PRINCIPLE

The DWEL DTS500 series online density/concentration meter operates by exciting a metal tuning fork using an acoustic frequency signal, causing it to vibrate freely at its natural resonant frequency. This resonant frequency has a direct correlation with the density of the liquid in contact with the tuning fork. By analyzing the frequency, the device accurately measures the liquid's density. Temperature compensation is applied to eliminate any effects of system temperature drift. The concentration of the liquid is then determined using the established relationship between density and concentration, providing the concentration value standardized to 20°C.

3. SPECIFICATIONS

- **Output Signal:** 4–20mA 4-wire (active) /HART/ RS485 / Modbus
- **Power Supply:** 24VDC (external resistive loads or PLC series connections not allowed)
- **Concentration Range:** 0–100% (at 20°C); can be calibrated to a specific range as needed
- **Density Range:** 0–2g/mL; can be calibrated to a specific range as needed
- **Concentration Accuracy:** $\pm 0.5\%$, Resolution: 0.1%, Repeatability: $\pm 0.2\%$
- **Density Accuracy:** $\pm 0.003\text{g/mL}$, Resolution: 0.0001g/mL, Repeatability: $\pm 0.0005\text{g/mL}$
- **Explosion Protection:** Flameproof Exd II Bt6
- **Operating Pressure:** $< 1\text{MPa}$
- **Medium Temperature:** -10°C to 120°C (liquid)
- **Ambient Temperature:** -40°C to 85°C
- **Medium Viscosity:** $< 2000\text{mPa}\cdot\text{s}$
- **Process Connection:** Multiple flange and clamp options

4. INSTALLATION

Due to process requirements, the online density/concentration meter is often installed in harsh operating environments. To minimize the impact of adverse conditions on the instrument, it should be installed in locations with minimal vibration and no mechanical shock. When installed on flowing pipelines, it is recommended to position the meter in areas with low fluid velocity.

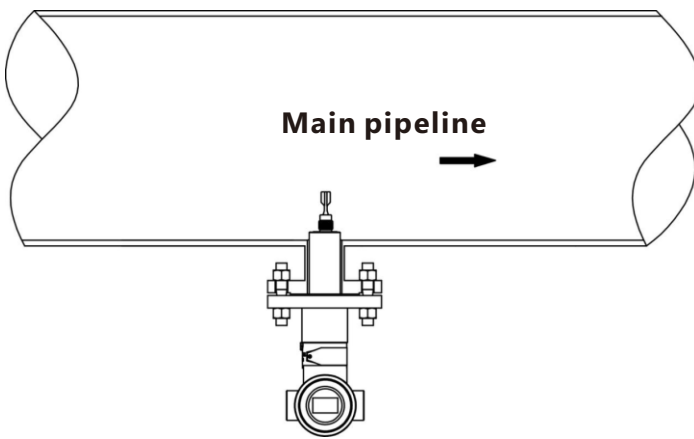


Important

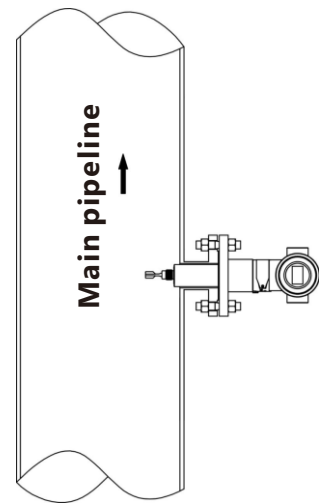
When installing the instrument in a pipeline, ensure that the process fluid flows through the tuning fork sensor.

Installation Requirements

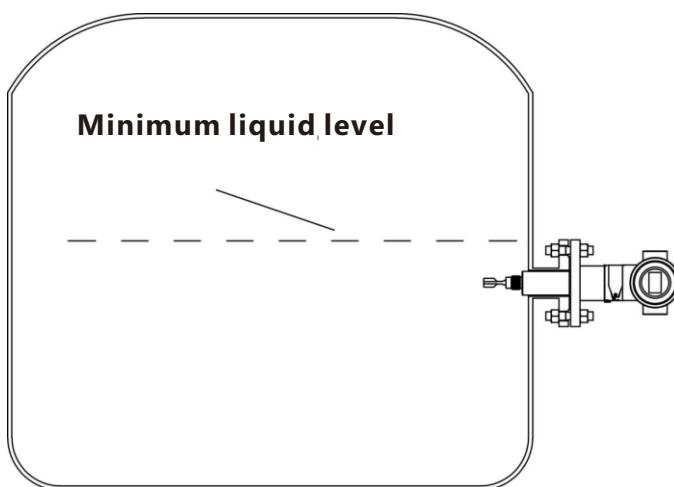
The instrument should be installed in a location that allows convenient operation and maintenance. Ensure that the sensor is fully immersed in and in complete contact with the process liquid at all times. If the pipeline may not remain completely full during operation, the sensor should be installed on the side or bottom of the pipe rather than at the top. Failure to maintain full liquid contact with the sensor may result in reduced measurement accuracy. Refer to the installation diagrams below.



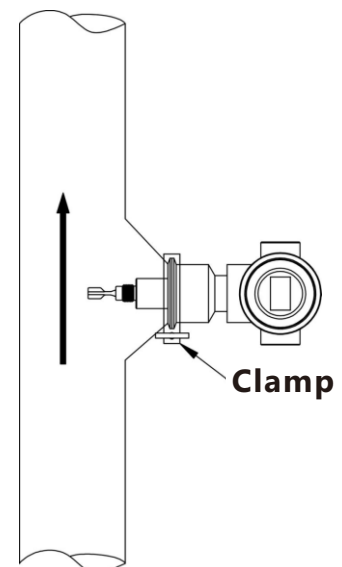
Horizontal Pipeline Installation
Can be installed on the side of the pipe as well



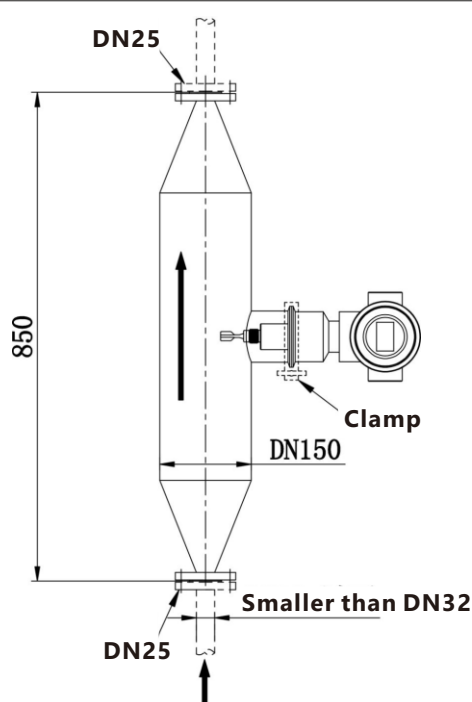
Vertical Pipeline Installation
For upright pipelines



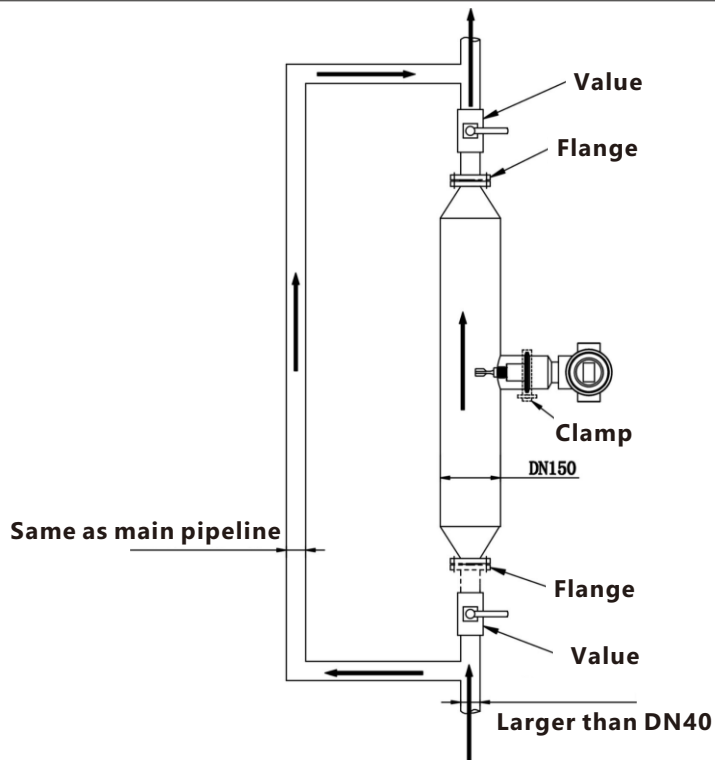
Storage Tank Flange Installation



Recommended Installation for Viscous
Slurries or Media Containing Sediment



Installation for DN32 and Smaller
Pipelines (Flow Velocity > 0.5 m/s)



Installation for DN40 and Larger
Pipelines (Flow Velocity > 0.5 m/s)

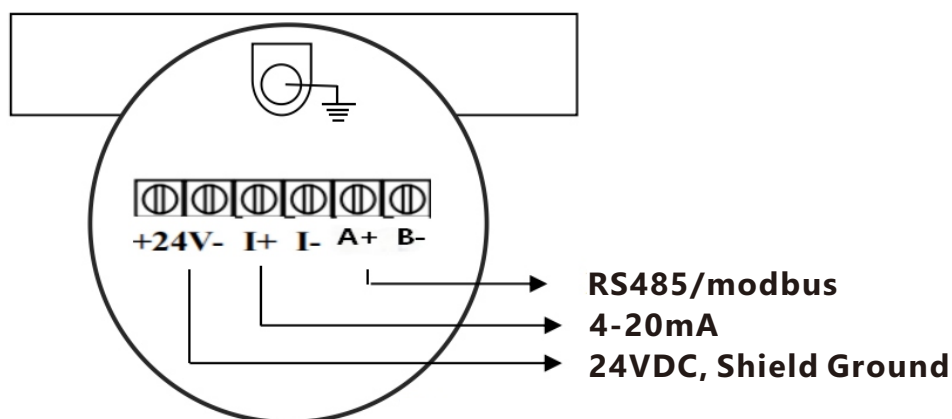
5. ELECTRICAL CONNECTION

The signal terminals are located in a separate compartment within the electrical housing. To access the terminals, unscrew the cover on the wiring side of the enclosure. Connect the 24 VDC power supply and the signal cables according to the terminal markings provided.

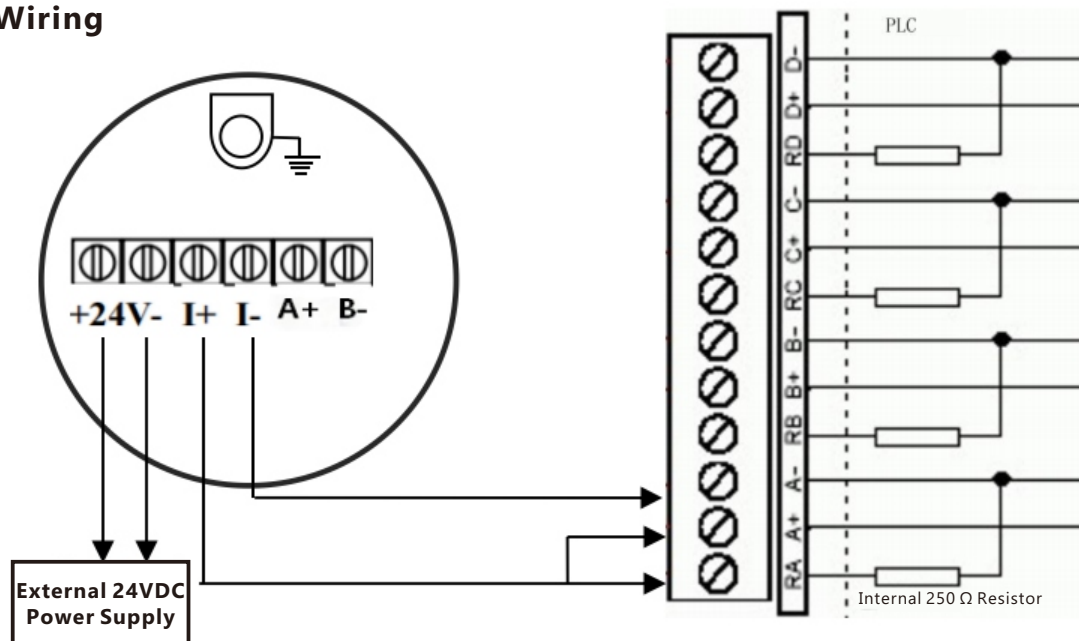
To ensure reliable operation and measurement accuracy:

- Do not route the signal cables together with high-voltage or high-current power cables.
- Avoid placing signal cables in the same cable tray or conduit as power cables.
- Do not route signal cables near equipment that generates strong electromagnetic fields.
- Ensure that the density/concentration meter housing is properly grounded.

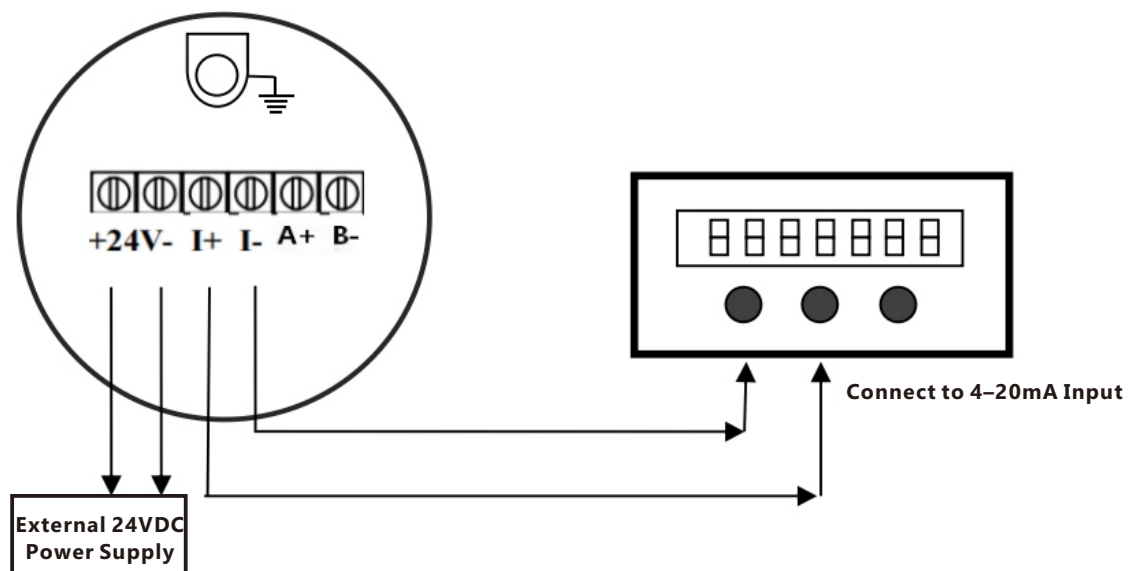
When measuring insulation resistance, the test voltage applied to the circuit must not exceed **45 VDC**. The maximum output current of the tuning-fork density/concentration meter is **30 mA DC**.



PLC Wiring



Remote Display Unit Wiring



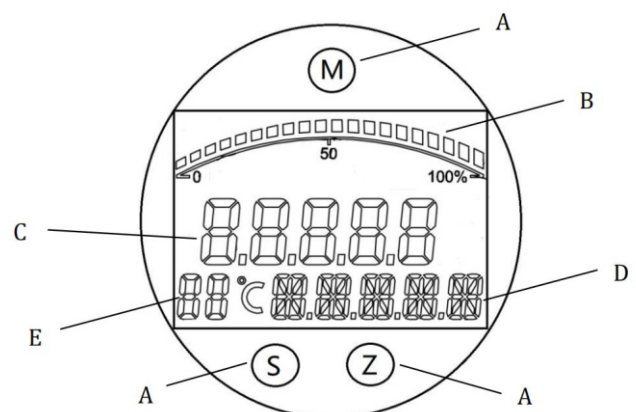
6. DISPLAY & OPERATION

Display panel

- A. Button M, Button S, Button Z
- B. Percentage area
- C. Main variable area
- D. Status area
- E. Function area

Button description

- Button M: Menu / Confirm / Password (long press)
- Button S: Move / Return (long press)
- Button Z: Select / Switch



Operating mode

Mode	Description
Measurement mode	Main Variable Area: Main Variable Data
	Percentage Area: Main Variable Percentage Data
	Status Area: Main Variable Unit
	Status Area (Flashes): Error Alarm Code
	Function Area: Measure Temperature
	Key M: Enter menu mode
	Key M (hold): Enter Quick Parameters Mode
	Key S (hold): Enter password mode
Menu mode (Function area flashes)	Function Area (Flashes): Parameter Number
	Main Variable Area: Parameter Values
	Status Area: Parameter Unit/Function
	Key Z: Switch parameter number to view parameter data
	Key M: Select parameters to enter parameter mode
	Key S: Back
Parameter mode (Main Variable Area flashes/ Status Area flashes)	Main Variable Area (Flashes): Select data to modify
	Status Area (Flashes): Select to modify
	Status Area: Parameter Unit/Function
	Key Z: Switch selected data/Function
	Key S: Move selected data bits
	Key S (hold): Back
	Key M: Confirm modify parameters

Parameter Modification Procedure

Step 1: In measurement mode, press the M key to enter the menu mode. The function area will flash, displaying the parameter number.

Step 2: Press the Z key to scroll through the parameter numbers and select the desired parameter.

Step 3: Press the M key to enter parameter edit mode. The selected parameter value will flash in the status/main variable area.

Step 4: Modify the parameter value by pressing the Z key to change the digits or the S key to move the selection cursor until the desired value is set.

Step 5: Press the M key to save the parameter and return to the menu mode.

Example: Modifying the Main Variable Lower Limit (Parameter 20) to 10kg/m³

Step 1: In measurement mode, press the M key to enter menu mode.

Step 2: Press the Z key repeatedly until the flashing parameter number displays 20.

Step 3: Press the M key. The first digit of the parameter value will flash.

Step 4: Press the Z key until the first digit changes to 1.

Step 5: Press the S key to move the cursor to the second digit. The second digit will flash.

Step 6: Press the Z key until the second digit changes to 0. The main variable area now displays 10.000.

Step 7: Press the M key to save the parameter and return to menu mode.

Parameter Menu

Parameter Number	Parameter name	Default	Explanation
1	Density Unit	kg/m ³	91:g/cm ³ 92:kg/m ³ 95:g/mL 96:kg/L 97:g/L
2	Density damping	2.56s	
3	Low-density resection	200kg/m ³	
4	Density coefficient	1	
5	Density Offset	0kg/m ³	
6	Concentration Model	Customized	0: Alcohol content 255: Customized
10	Modbus/RS485 Address	1	
11	Modbus/RS485 baud Rate	38400	0:2400 1:4800 2:9600 3:19200 4:38400 5:57600 6:115200
20	Main Variable Data	Density	0: Mass Flow Rate 1: Volumetric flow rate 2: Standard Flow Rate 3: Density 4: Temperature 5: Gain 6: Concentration
21	Main Variable Lower Limit	0	Variable value corresponding to the 4 mA output signal
22	Main Variable Upper Limit	3000	Variable value corresponding to the 20 mA output signal
30	Display updating time	500ms	

31	Display Variables	Density, Concentration	1: Density 2: Concentration 3: Density and Concentration
32	Display Variable Scan Interval	5 seconds	`
40	Linear high concentration	0%	
41	Linear low concentration	0%	
42	Density at Upper Linear Concentration Limit	0kg/m ³	
43	Density at Lower Linear Concentration Limit	0kg/m ³	
44	Maximum linear concentration	100%	
45	Linear low concentration	0%	
86	C ¹		
87	C ²		
88	D ¹		
89	D ²		
90	High-density calibration	999.8kg/m ³	
91	Low-density calibration	1.1kg/m ³	
98	Parameter Restoration		1: Restore backup parameters 2: Restore default parameters
99	Parameter Backup		1: Save Parameters 27123: Save backup parameters

Communication Interface

Communication Parameters

Protocol: Modbus RTU

Modbus Address: 1 (default)

Byte Order: 1-0-3-2

Baud Rate: 2400–115200 bps (default: 38400 bps)

Parity: NoneData

Bits: 8

Stop Bits: 1

Modbus Data Table

Address	Data	Data type	Explanation
30001	Error Status	U32	Bit0: Not oscillating
30003	Warning Status	U32	Bit0: Parameter error Bit1: Device information is abnormal
30005	Density	F32	Unit: Density Unit
30007	Concentration	F32	Unit: %
30009	Temperature	F32	Unit: Temperature Unit
30011	Gain	F32	Unit: %
30013	Mass Flow Rate	F32	Unit: Mass Flow Unit
30015	Mass Accumulation	F32	Unit: Cumulative unit of mass flow
30017	Quality Inventory	F32	Unit: Cumulative unit of mass flow
30019	Volume flow	F32	Unit: Volume flow rate unit
30021	Total volume accumulation	F32	Unit: Cumulative unit of volumetric flow rate
30023	Volume Inventory	F32	Unit: Cumulative unit of volumetric flow rate
30025	Standard Flow Rate	F32	Unit: Standard Flow Rate Unit
30027	Bidding Total	F32	Unit: Cumulative unit of standard flow rate
30029	Bid Inventory	F32	Unit: Cumulative unit of standard flow rate
30031	Mass Accumulation	F64	Unit: Cumulative unit of mass flow
30035	Quality Inventory	F64	Unit: Cumulative unit of mass flow
30039	Total volume accumulation	F64	Unit: Cumulative unit of volumetric flow rate
30043	Volume Inventory	F64	Unit: Cumulative unit of volumetric flow rate
30047	Bidding Total	F64	Unit: Cumulative unit of standard flow rate
30051	Bid Inventory	F64	Unit: Cumulative unit of standard flow rate
30114	Save Parameters	U16	1: Save Parameters 27123: Save backup parameters

Address	Data	Data type	Explanation
30115	Parameter Restoration	U16	1: Restore backup parameters 2: Restore default parameters
30118	Firmware Version	U16	The firmware version V4.00 corresponds to value 400
30151	Modbus address	U16	
30152	Modbus baud Rate	U16	0:2400 1:4800 2:9600 3:19200 4:38400 5:56700
30153	Modbus Check Bit	U16	6 115200 0:None 1:Odd 2:Even
30162	Maximum Pulse Frequency	F32	Unit: Hz
30164	Impulse ratio	F32	
30303	Temperature Damping	F32	Unit: s
30305	Temperature Unit	U16	32:°C 35:K
30407	Left channel frequency	F32	Unit: Hz
30409	Right channel frequency	F32	Unit: Hz
30411	Left channel voltage	F32	Unit: V
30413	Right channel voltage	F32	Unit: V
30503	Traffic Damping	F32	Unit: s
30519	Mass Flow Unit	U16	70:g/s 74:kg/min 75:kg/h
30520	Volume Flow Unit	U16	17:l/min 19:m³/h
30521	Standard Flow Unit	U16	121:Nm³/h
30522	Mass Flow Accumulation Unit	U16	60:g 61:kg 62:t
30523	Volume Flow Accumulation Unit	U16	41:l 43:m³
30523	Standard Flow Rate Accumulation Unit	U16	166:Nm³
30563	Small-flow resection	F32	Unit: Flow Unit
30565	Clear Total Sum	U16	255: Clear all total accumulation
30567	Flow Zero Point Calibration Status	116	-2: Failure due to high noise - 1: Failed 0: Success 1: During calibration

Address	Data	Data type	Explanation
30568	Flow Zero Point Calibration	U16	1: Execute zero adjustment
30603	Density damping	F32	Unit: s
30625	Density Unit	U16	91:g/cm ³ 92:kg/m ³ 95:g/ml 96:kg/l 97:g/l
30634	Density coefficient	F32	
30636	Density Offset	F32	Unit: kg/m ³
30657	Low-density resection	F32	Unit: Density Unit

7. CALIBRATION

Calibration Preparation

Before performing calibration, ensure the following conditions are met:

- The calibration fluid must be either water or another fluid with a known density value measured in a laboratory.
- The instrument must be powered on and operating for at least 10 minutes before calibration.
- Ensure the sensor is securely mounted and the tuning fork is clean and free of contamination.

Low-Density Calibration

Low-density calibration is typically performed using air (with the tuning fork exposed to ambient air).

Calibration via NMLink Software

1. Securely mount the instrument and leave the tuning fork exposed to air.
2. Allow the instrument to stabilize for at least 2 minutes.
3. In NMLink, switch to the Density menu.
4. Enter the air density value (1.2 kg/m³) in the Standard Density field.
5. Click Low Density Calibration to start the calibration.
6. The calibration status will change to Calibrating. The calibration process takes approximately 20 seconds.
7. When completed, the status changes to Calibration Successful, indicating that the low-density calibration has been completed successfully.

Calibration via Display Panel

1. Securely mount the instrument and leave the tuning fork exposed to air.
2. Allow the instrument to stabilize for at least 2 minutes.
3. In Measurement Mode, press the M key to enter Menu Mode.
4. Press the Z key until parameter 91 is displayed, then press M to confirm.

5. The default density value is 1.2 kg/m^3 . Press M again to start calibration.
6. During calibration, the Main Variable display shows a 20-second countdown.
7. When calibration is complete, the Status Area displays "OK", indicating successful low-density calibration.

High-Density Calibration

High-density calibration is typically performed using pure water.

Calibration via NMLink Software

1. Securely mount the instrument and immerse the tuning fork completely in the calibration liquid, ensuring that no air bubbles are present on the sensor surface.
2. Allow the instrument to stabilize for at least 5 minutes.
3. In the NMLink software, switch to the Density menu.
4. Enter the liquid density value (999.8 kg/m^3) in the Standard Density field.
5. Click the High Density Calibration button to start the calibration. The calibration status will change to Calibrating.
6. The calibration process takes approximately 20 seconds.
7. When calibration is complete, the status changes to Calibration Successful, indicating that the high-density calibration has been completed successfully.

Calibration via Display Panel

1. Securely mount the instrument and immerse the tuning fork completely in the calibration liquid, ensuring that no air bubbles are present on the sensor surface.
2. Allow the instrument to stabilize for at least 5 minutes.
3. In Measurement Mode, press the M key to enter Menu Mode.
4. Press the Z key until parameter 90 is displayed, then press M to confirm.
5. The default liquid density value is 999.8 kg/m^3 . Press the M key again to start the calibration.
6. During calibration, the Main Variable Display Area shows a 20-second countdown timer.
7. When calibration is complete, the Status Display Area shows "OK", indicating that the high-density calibration has been completed successfully.

8. COMMISSIONING

The density/concentration meter is factory-calibrated and temperature-compensated before shipment. The concentration reading is automatically compensated and displayed as the concentration value referenced to 20°C .

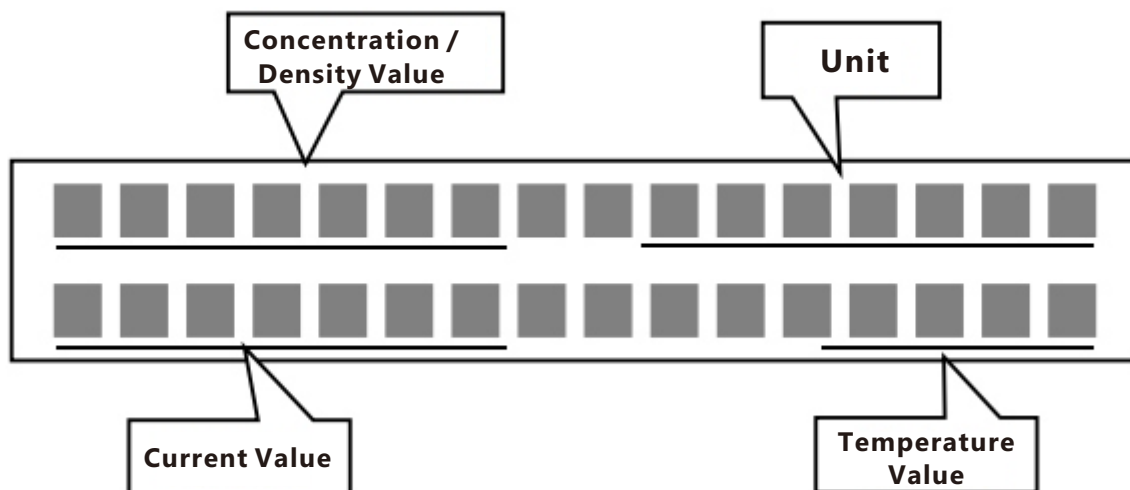
After proper installation, verify the instrument using pure water:

- Apply power to the instrument and allow it to operate normally.
- When pure water is used as the test medium, the concentration reading should be approximately 0.0%.
- The corresponding density reading should be approximately 0.997 g/mL (or 997 kg/m^3 , depending on the configured unit).

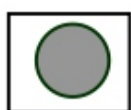
If the displayed value differs significantly from the expected value, perform an on-site calibration using the pure water method. The calibration procedure is described in the following section.

Note: Ensure that the sensor is completely immersed in the liquid and free of air bubbles during verification and calibration. This is essential for obtaining accurate measurement results.

Display Indications



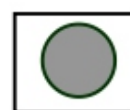
Key Functions



Z



M



S

- a) In normal display mode, the three keys (M, S, Z) have no function.
- b) When entering the main menu:
 - Z and S keys are used for menu navigation (scrolling through menu items).
 - M key is used to select and enter a menu function.
- c) When operating within a selected menu:
 - S key: moves the cursor to select the digit to modify.
 - Z key: changes the value of the selected digit (0–9 and "." cycles).
 - M key: confirms the current setting.

User Menu Access:

Press and hold the M key for 5 seconds to enter the User Function Menu. Only the following parameters can be modified in this menu: Measuring Range, Units, Instrument Coefficient, Zero Adjustment, Damping

Menu Structure:

All menus are displayed as shown in the figure.

1. Measuring Range	4. Calibration	7.PV Trim	10.ADC Value
2. Units	5. Temp CAL	8.CAL. H2O	11.Temp Comp
3. 4-20mA	6.Temp Comp	9.Damping	12.EXIT

Menu Functions and Descriptions

1. Measuring Range: Both the upper and lower limits of the range can be set independently; however, the upper and lower limits cannot be equal

2. Units

Pre-set at the factory-Density: g/mL ,Volumetric concentration: %v Mass concentration: %w

3. Current Calibration: The 4–20 mA output has been calibrated at the factory.

4. Formatting : This function is restricted to manufacturer use only.

5. Temperature Calibration: This function is restricted to manufacturer use only.

6. Temperature Compensation: Used for compensating liquid temperature effects. This function is restricted to manufacturer use only.

7. Measurement Value Fine Adjustment

Allows adjustment when the measurement is not sufficiently accurate.

- **Example / Important Note:** For special liquids in the field, the measurement may be inaccurate. A single-point calibration can be performed using a standard solution or a laboratory-measured reference value. Enter the menu, adjust the value accordingly, and the instrument will provide accurate measurements.

8. Pure Water Calibration

- Used to correct drift or inaccurate readings after long-term use.
- Procedure: Move the instrument indoors, fill with 25°C pure water, wait until the measurement stabilizes, enter this menu, and select "YES" to confirm.
- This method is a density-based calibration, suitable for both density meters and concentration meters.

9. Damping

- When liquid flow fluctuates in the pipeline, the measurement may become unstable.
- Increasing this value (0–255) smooths the measurement readings.

10. ADC Value: This function is read-only and cannot be modified.

11. Temperature Compensation Switch: Enable or disable the temperature compensation function as required.

12. Exit Menu : Exits the menu settings.

9. TROUBLESHOOTING

No.	Fault Phenomenon	Cause Analysis
1	No display	• Check that the power supply is connected correctly. • Verify wiring connections and polarity. • Ensure no load is connected in series with the power supply. • Check for short circuits and confirm the supply voltage is normal.
2	Large Measurement Error or Unstable Output	• Clean any deposits from the sensor. • Check for excessive vibration or electromagnetic interference from nearby equipment. • Ensure there are no excessive air bubbles, excessive flow velocity, or incomplete liquid contact with the sensor.
3	Constant Output Reading	• Check whether the tuning fork is blocked and unable to vibrate. • If no blockage is found, the instrument may be faulty.