ALiA ®

ALIADP

Smart Differential Pressure Transmitter

APT9000/9000L Series

Operation Manual

CE

Index

1. Outline

1.1 Introduction

APT9000/9000L series smart differential pressure transmitter is a smart multi-functional digital instrument researched & developed by ALIA. It's uniquely designed from advanced single-chip technology and smart digital sensor technology on the basis of mature and reliable sensor technology.

Its core component is 16 bit single-chip, of whose strong function and high-speed calculation will guarantee transmitter's quality. The whole design focuses on reliability, stability, high-precision and intelligence. It also meets field industrial application requirements. Software adopts digital signal processing technology, enhancing transmitter good anti-interference ability, zero point stability, Zero Sensitive Capability (ZSC) and Temperature Sensitive Capability (TSC).

1.2 Characteristics

APT9000/9000L not only has excellent anti-interference ability, zero point stability, Zero Sensitive Capability (ZSC) and Temperature Sensitive Capability (TSC), but also HART communication capability from optional HART modules.

2. Principle and Wiring Diagram

2.1 Principle

When pressure or differential pressure is externally input, sensor's resistance will change and be converted into frequency signals by digital signal, and then sent to microprocessor. The microprocessor will output a current control signal to current output control circuit after its calculation, turning into 4-20 mA analog current output and displays finally.

2.2 Wiring Diagram
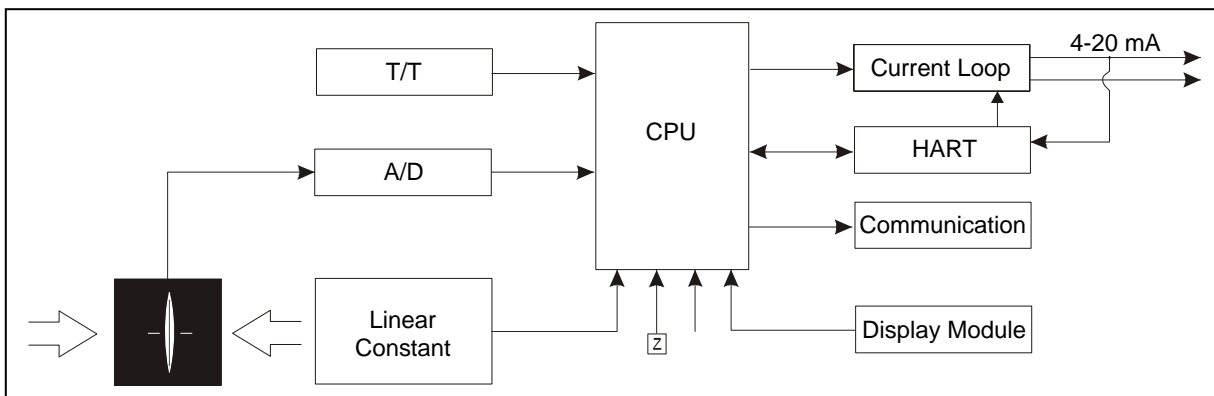
APT9000/9000L output is 2-wire 4-20 mA output.
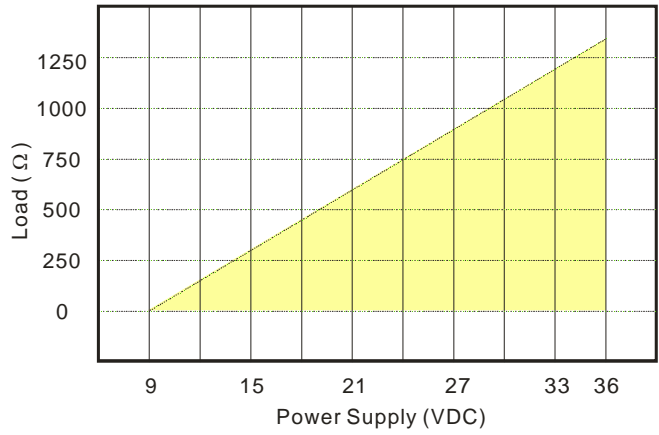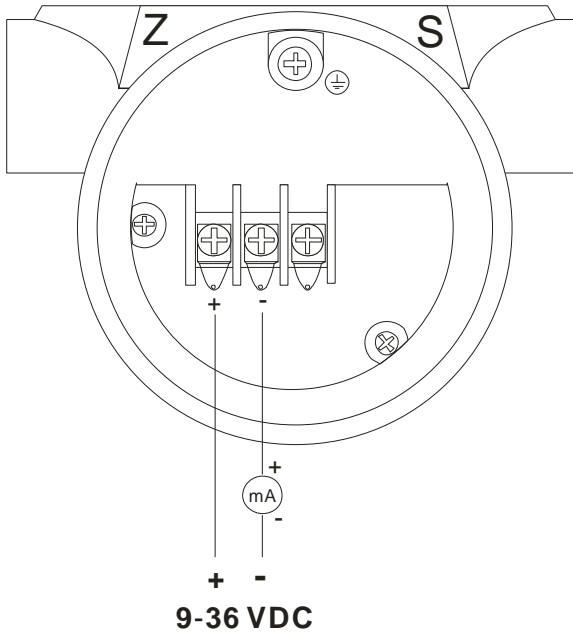
3. Transmitter Rotation

Available clockwise rotation angle: 0-200°; available counterclockwise rotation angle: 0-160°. See figure below:

Before Rotation

After Rotation

4. Interface Display

4.1 Normal Display

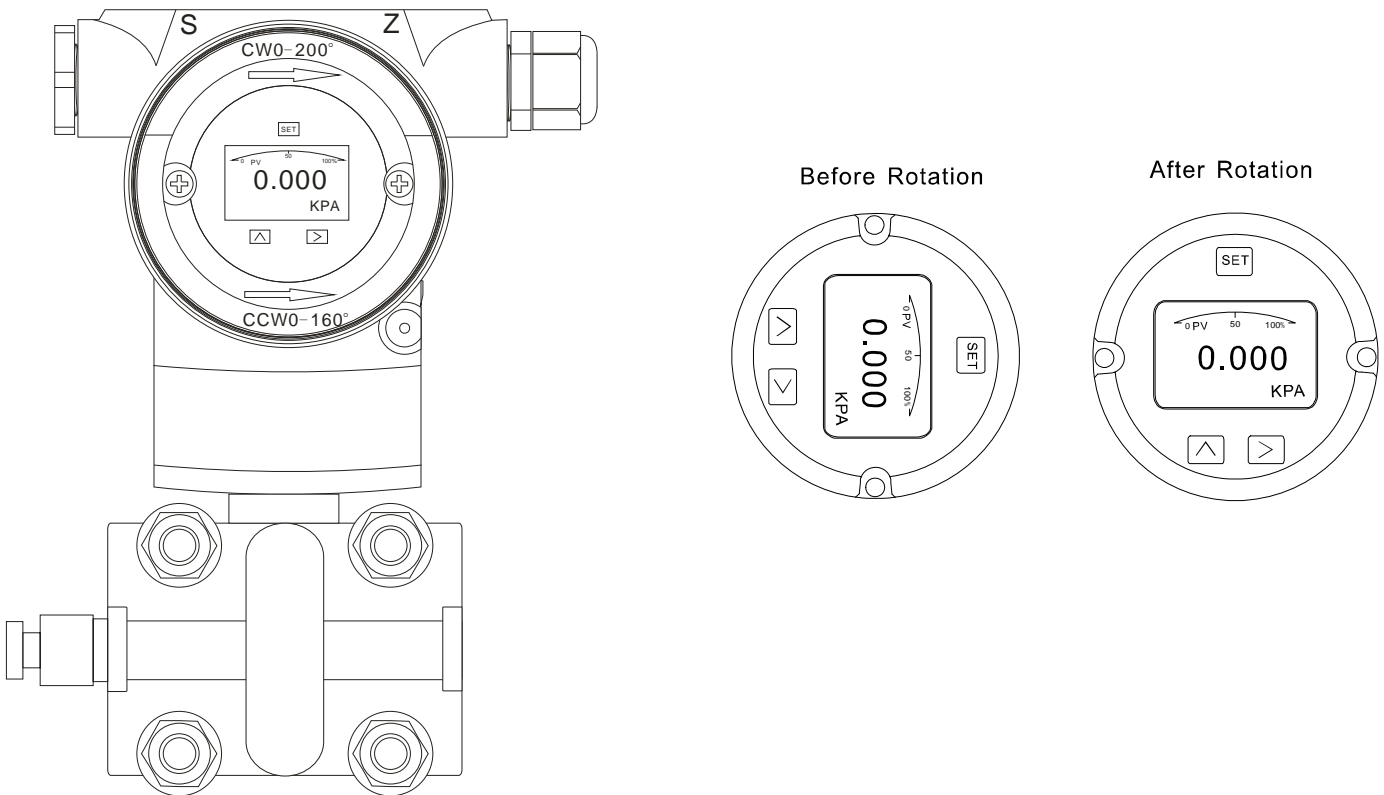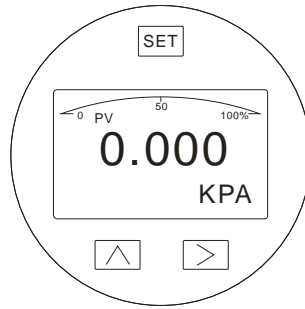This transmitter can be rotated clockwise / counterclockwise 180° for your convenience to check display.

Code	Code Function
PV	Normal Display (Measuring Status)
%	Percentage
InH$_2$O, InHg, FtH$_2$O, mmH$_2$O, mmHg, PSI, bar, mbar, g/cm^2, kg/cm^2, Pa, kPa, Torr, ATM, MPa, InH$_2$O@4 °C, mH$_2$O@4 °C, mH$_2$O, mHg, m, cm, mm, Special.	Display measuring unit. "Special" means customer's unit can be written by HART.

4.2 Setting Status
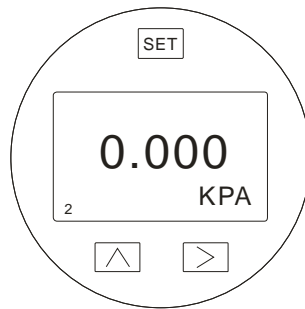
Code	Code Function
2	Window code ("2": unit selection window)
KPA	Measuring unit

4.3 Keypad

Key Name	Button Sign	Setting Function
SET	SET	Enter Parameter setting; save configuration; shift to next page
MOVE	>	Move the cursor to the right
UP	∧	Increase the values and decimal point position

1. Hold ▷ button for 2 seconds then release to enter main menu settings.If there is no response for 10 seconds in the window 0, it will return to the normal display automatically. If there is no response for 2 minutes in the non-window 0, it will return to the normal display automatically.
2. Hold SET+▷ button for 5 seconds then release to enter menu setting window 6 for zero clearance. Press ∧ button and choose "YES" to clear zero.
3. Hold ∧+▷ button for 5 seconds then release and enter the menu setting window 7 for zero shift and full span shift. Hold ▷ button for 5 seconds then release to finish Zero Shift; hold ∧ button for 5 seconds then release to finish full span shift.

5. Specific Application and Typical Installation

5.1 Typical Installation for Flow Measurement

This illustration shows a typical example for steam flow rate measurement. Differential pressure transmitter is located below the differential pressure output port of the process pipe.

After piping work, make sure that the connecting pipe, 3-way manifold valve and transmitter have no pressure leaks. Pipe installation for steam flow rate measurement is as follow:
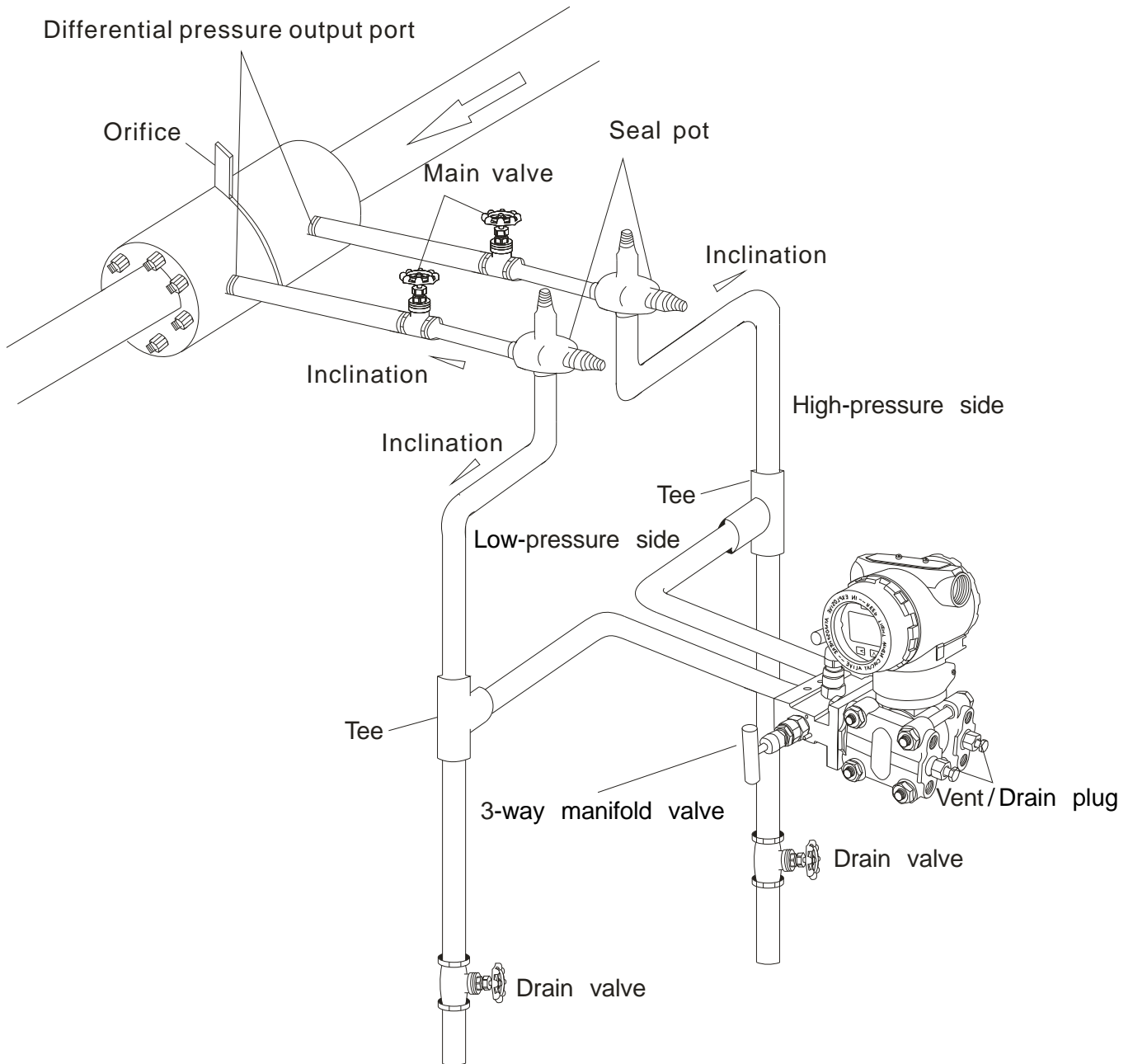
**Note: APT9000 Over Pressure Limit is 150% of Full Scale.
        Pay attention to valve switch and pressure control while using to protect the APT9000.**

5.2 Typical Installation for Liquid Level Measurement

When using dry-leg method, connect the high-pressure side of the transmitter to the lower part of the tank. Connect the low-pressure side to the gas-sealing pipe of the tank.

After completing piping work, check for pressure leaks around the connecting pipe, the transmitter and 3-way manifold valve. The following shows a typical installation.

Always connect the high-pressure side of this transmitter to the lower part of the tank.

Install this transmitter below the lowest liquid level to be measured.
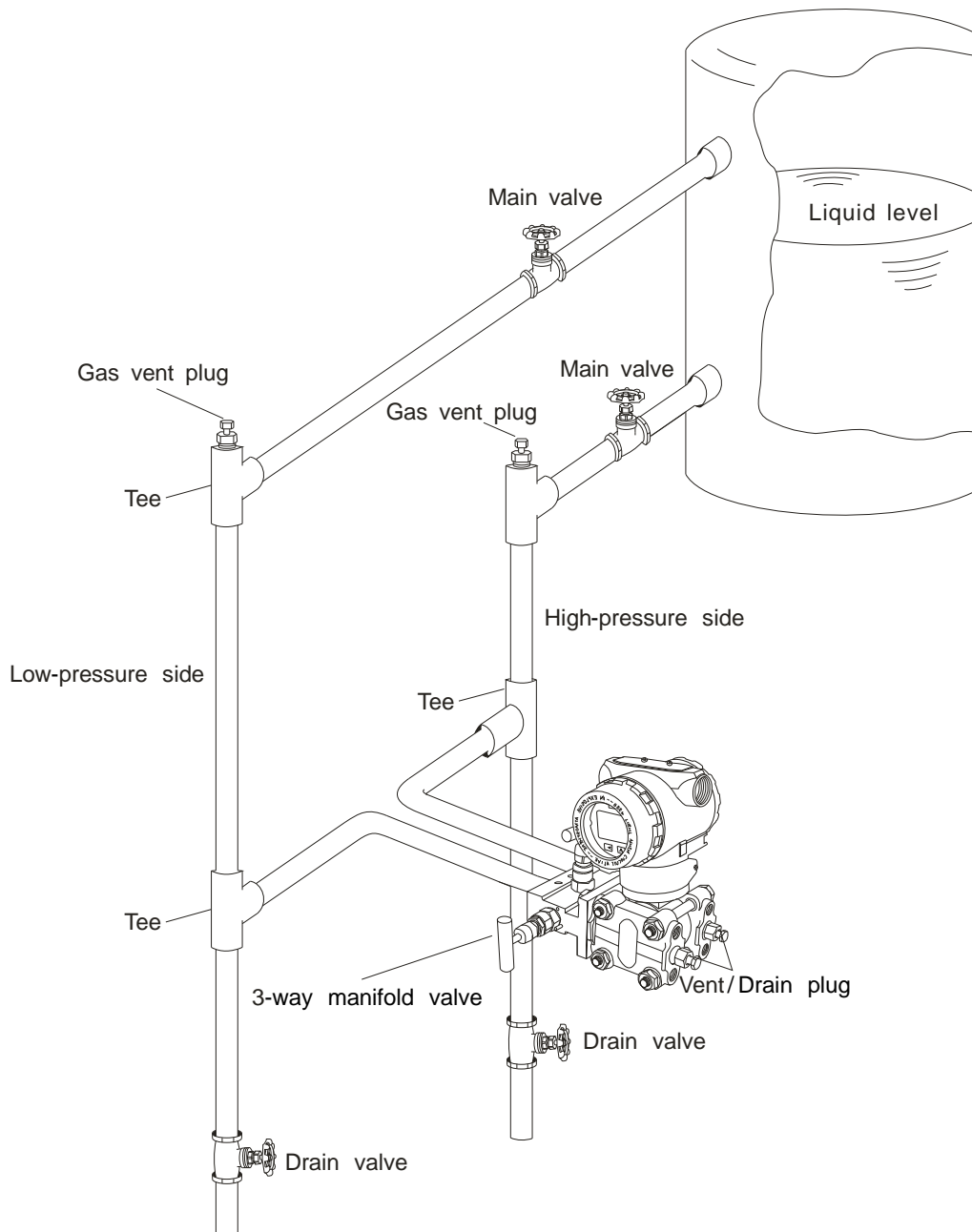
6. APT9000L Applications

6.1 Closed Tank

When it is closed tank, there will be pressure given inside tank. It's supposed to choose either APT9000L+D1 or APT9000+D2.

When setting the zero point, make sure the diaphragm area of high-pressure side to be fully wet with measured liquid for higher accuracy. The center diaphragm of high-pressure side is the right zero point. See figure as below:
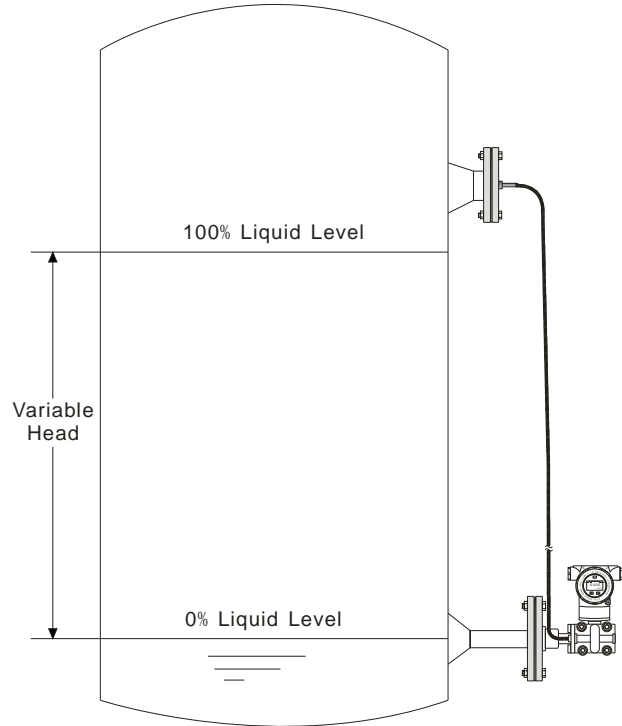
6.2 Open Tank

When it is open tank, liquid above will be directly contacted with atmosphere. It's supposed to choose directly-connected APT9000L or APT9000+D1.
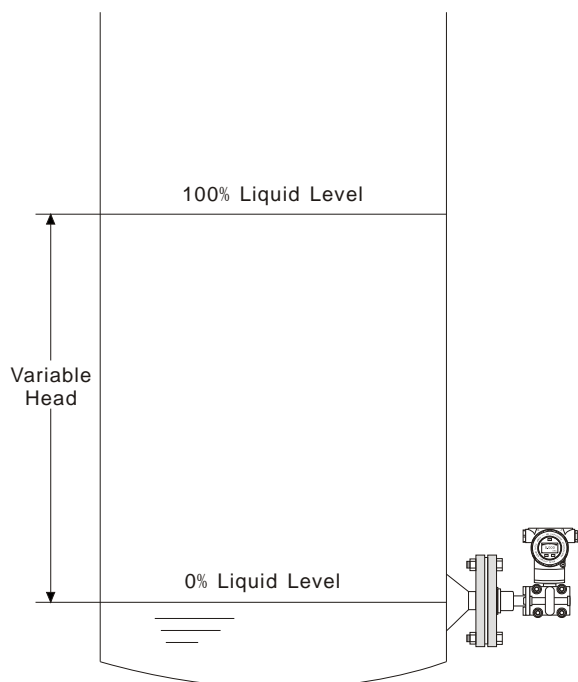
When setting the zero point, make sure the diaphragm area of high-pressure side to be fully wet with measured liquid for higher accuracy. The center diaphragm of high-pressure side is the right zero point. See figure as below:
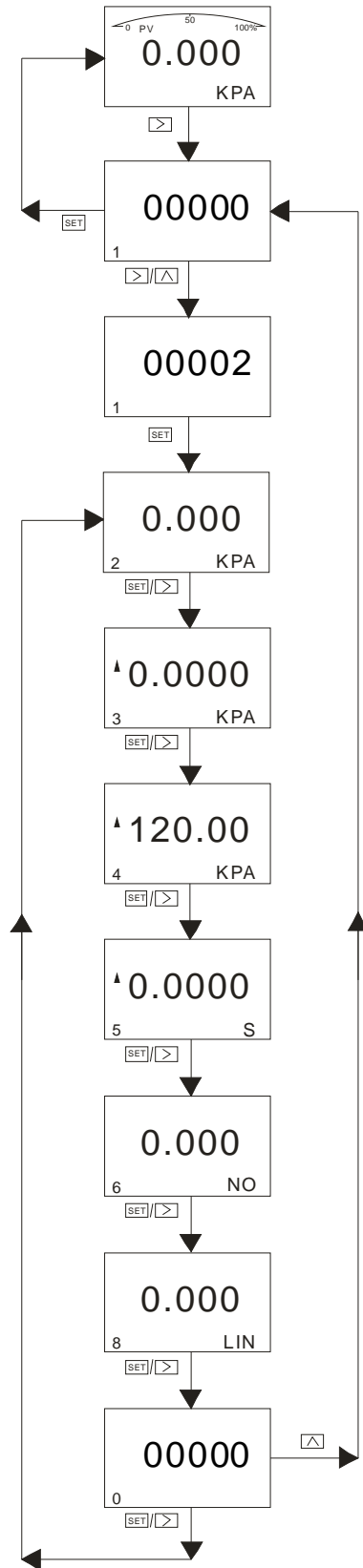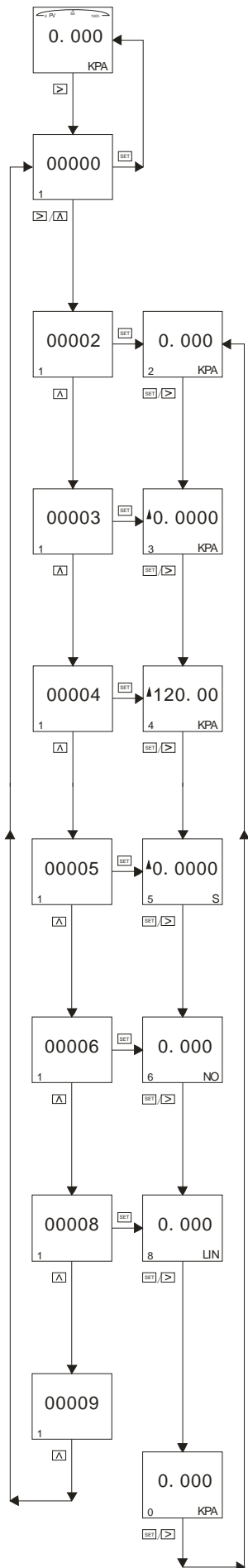
7. Operation Instructions

7.1 Operation Flow Chart

7.2 System Menu Operation

Normal Display

Hold ▷ for 2 seconds, then release to enter main setting menu.

Code Setting Window (Code 1)

Press ▷ to move cursor position and press △ to change the value.
If there is no response for 10 seconds, it will return to normal display automatically.

Unit Setting Window (Code 2)

Press SET to enter unit selection, then press △ to activate the cursor and press △ again to select unit as follows: InH₂O, InHg, FtH₂O, mmH₂O, mmHg, PSI, bar, mbar, g/cm², kg/cm², Pa, kPa, Torr, ATM, MPa, InH₂O@4˚C, mH₂O@4˚C, mH₂O, mHg, m, cm, mm, Special. ("Special" means customer's unit can be written by HART.)
Press SET / ▷ to confirm and enter next window Code 3.

Low Range Limit Setting Window (Code 3)

Press SET to enter Low Range Limit Setting Window, and then press △ to activate cursor. Press △ again to change the symbol to "-". Or press ▷ directly to move cursor and then press △ to change value. When cursor moves to rightmost, press ▷ and all decimal points will flash. At this time, press △ to change decimal position.
Press SET or ▷ to confirm and enter next window Code 4.

Up Range Limit Setting Window (Code 4)

Press SET to enter Up Range Limit Setting Window, and then press △ to activate cursor. Press △ again to change the symbol to "-". Or press ▷ directly to move cursor and then press △ to change value. When cursor moves to rightmost, press ▷ and all decimal points will flash. At this time, press △ to change decimal position.
Press SET or ▷ to confirm, and enter next window Code 5.

Damping Setting Window (Code 5)

Press SET to enter Damping Setting Window, and then press △ to activate cursor, and press △ again to change the symbol to "-". Or press ▷ directly to move cursor and then press △ to change value. When cursor moves to rightmost, press ▷ and all decimal points will flash. At this time, press △ to change decimal position.
Press SET or ▷ to confirm, and enter next window Code 6.

Zero Calibration (Code 6)

Press SET to enter Zero Calibration, and then press △ to activate cursor, and press △ again to choose whether calibrate zero or not.

1. YES   2. NO
Press SET or ▷ to confirm, and enter next window Code 8.

Output Setting (Code 8)

Press SET to enter Output Setting, and then press △ to activate cursor, and press △ again to choose output type.

1. LIN   2. SQRT   (Choose SQRT, normal display will show "√")
Press SET or ▷ to confirm, and enter next window Code 0.

Exit Window (Code 0)
1. If there is no response for 10 seconds, it will return to the normal display automatically.
2. Press SET or ▷ to confirm, and enter next window Code2.
3. Press △ to activate and press SET to enter window Code1 to set window-code input.
4. Input "00000/000007/000009" in window Code 1, and press SET to return Normal Display.

(1) Up / Low Range Limit Correspondence to 4-20 mA

In settings, if necessary, low / up range Limit will be given standard current value (4 mA / 20 mA) respectively. Preconditions: Two reference voltages should be supplied by processing or pressure transmitter. After setting pressure transmitter, actual setting range might be different from the range marked in measuring plate. For different serial number and measuring range, turndown ratio can be up to 1:100.

Measuring pressure is linearly related to output current. Current value can be calculated from given formula below. I means output current, P measured pressure, ME up limit value and MA low limit value.

$$I = \frac{P-MA}{ME-MA} \times 16\text{ mA} + 4\text{ mA}$$

Actually because of change of measuring demands or conditions, transmitter's range needs to be changed too. However, changing range means changing slope of transmitter's input / output, like from curve 1 to curve 2, it means up range limit increasing adjustment; from curve 2 to curve 3, it means low range limit increasing adjustment. See figure below:
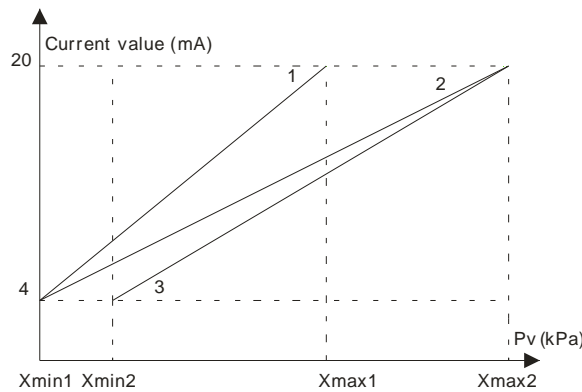

(2) Damping Settings

Available setting time is 0-32s. The bigger this value is, the more stable measuring value will be (Fluctuations will be more moderate). Increasing damping time will lead to signal delay.

(3) Zero Calibration

Because of zero drift, the measured zero point will not be 0. Zero calibration enhances better measuring accuracy.

(4) Output Settings

e.g. Transmitter's pressure range "0-100 kPa", if output setting as "lin", current output will be curve 1.

If set "sqrt", current output will be curve 2. For example, if pipe pressure as 25 kPa, under "sqrt" condition current output will be 12 mA.
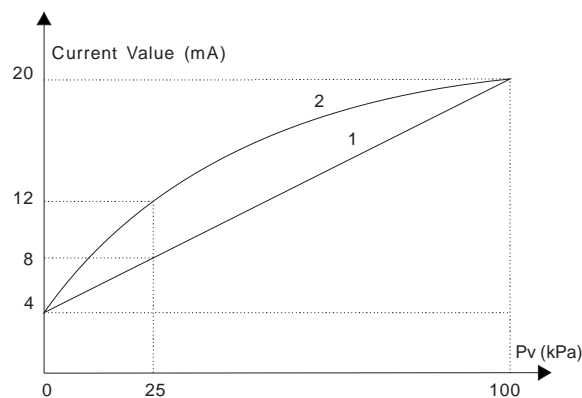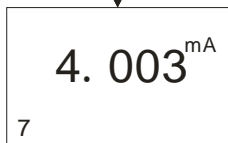
7.3 How to Set Positive Shift and Negative Shift

7.3.1 Zero Shift and Full Span Shift Operation

This is hidden window, so it can not display if you directly input code 7 in the code window. You have to hold $\triangle$+$>$ for 5 seconds until it displays.
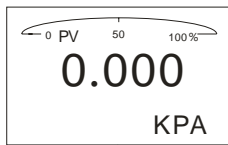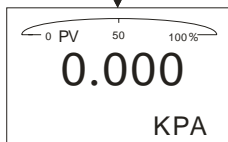
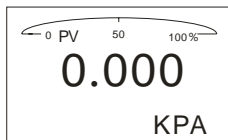|	
0 PV 50 100% **0.000** KPA	**Normal Display** Hold $\triangle$+$>$ for 5 seconds and then release to enter menu-setting window 7, setting the zero shift and full span shift.

$>$+$\triangle$
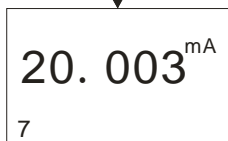
4. 003mA 7	**Zero Shift** Hold $>$ for 5 seconds, and release to finish zero shift. If there is no key operation within 2 minutes, it will be back to normal display automatically.

0 PV 50 100% **0.000** KPA	**Normal Display**

0 PV 50 100% **0.000** KPA	**Normal Display** Hold $\triangle$+$>$ button for 5 seconds then release and enter window 7 for zero shift and full span shift.

$>$+$\triangle$

|	
20. 003mA 7	**Full Span Shift** Hold $\triangle$ for 5 seconds, and release to finish full-span shift. If there is no key operation within 2 minutes, it will be back to normal display automatically.
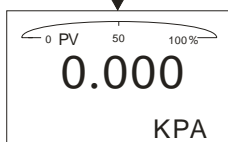
0 PV 50 100% **0.000** KPA	**Normal Display**

When it comes to actual measurement, as request from customer, the initial measuring point needs to be shifted to a certain value (positive or negative). This is so called zero shift and full span shift.

(1) Zero Shift (Elevated Span / Suppressed Span)
    After zero shift, measuring range will change toward positive (increase) direction, namely positive shift. For example, pressure transmitter is installed at point A, the liquid head AB that is formed by medium that comes into pressure-guiding pipe will send a pressure to transmitter, turning the measuring result into AC's pressure (measured pressure BC plus liquid head's pressure). At this time, when liquid level is at point B, give positive zero shift to transmitter, the initial value of corresponding 4-20 mA will move from point A to point B, making it convenient for customer to control application.

    If transmitter's range is 0-80 kPa and AB pressure of pressure guiding pipe is 15 kPa, after zero shift, change will be like figure below: curve 1 to curve 2.
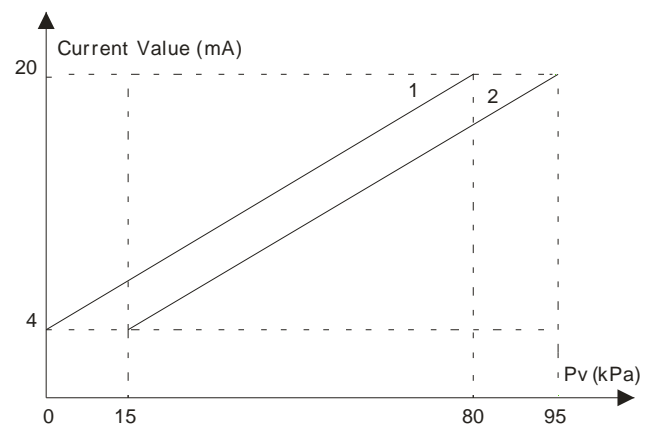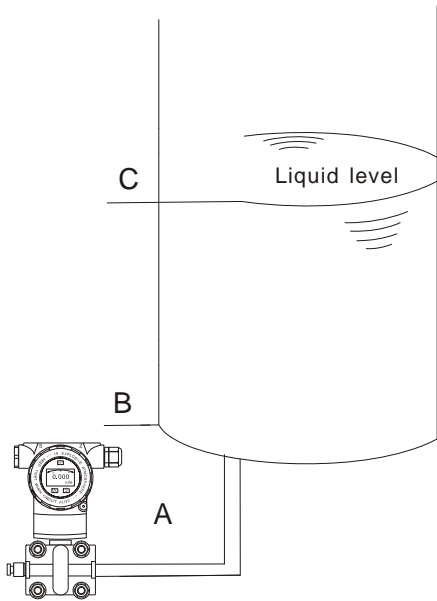
(2) Full Span Shift
    After full span shift, measuring range will change toward negative (decrease) direction, namely negative shift. For example, when pressure transmitter measures liquid level's pressure and operator just needs the pressure of level AB (lower than AC pressure), full span shift can be start.

    If trasmitter's range is 10-100 kPa and AB pressure of liquid level is 65 kPa, after full span shift, change will be like figure below: curve 2 to curve 1.
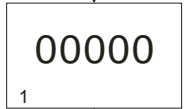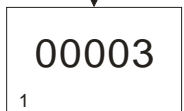

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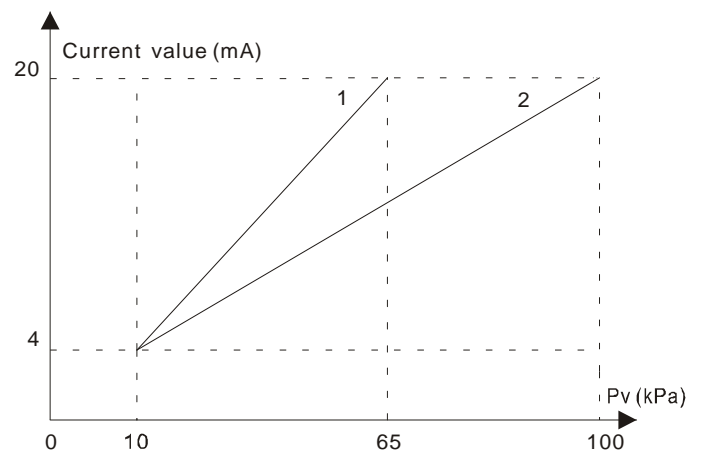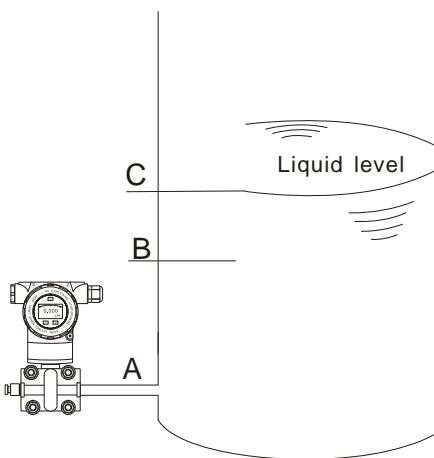
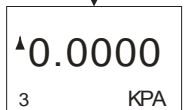## 7.4 How to set Decimal Point and Negative Value

Example: Set zero as "-15 kPa".
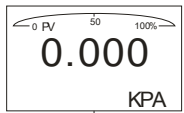
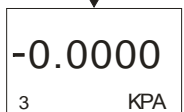| Display	Description
0.000 KPA	**Normal Display** Hold $>$ for 2 seconds and then release to enter main menu setting.
00000 1	**Code Setting Window (Code 1)** Press $>$ to move cursor position and press $\wedge$ to change value. If there is no key operation within 10 seconds, it will return to normal display automatically.
00003 1	**Code Setting Window (Code 1)** Press $\wedge$ to change value and set numeric value to 00003, and then press SET to enter zero setting.
▲0.0000 3 KPA	**Zero Setting Window (Code 3)** Press SET to enter zero setting.
-0.0000 3 KPA	**Zero Setting Window (Code 3)** Press $\wedge$ to activate cursor. Press $\wedge$ again to change symbol as "-" ("-" symbol will be added to leftmost position). Press $>$ to move cursor position, and then press $\wedge$ to change the numeric value. Enter next window:
-1.5000 3 KPA	**Zero Setting Window (Code 3)** Press $>$ to move cursor. When the cursor moves to the rightmost, continue to press $>$ until all the decimal points flash. Enter next window:
-1.5000 3 KPA	**Zero Setting Window (Code 3)** Press $\wedge$ to change decimal position after all decimal points flash, Press $\wedge$ twice to enter next window:
-15.000 3 KPA	**Zero Setting Window (Code 3)** Press SET to confirm and enter next window Code 4.
▲120.00 4 KPA	**Span Setting Window (Code 4)**
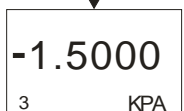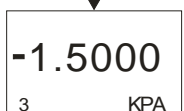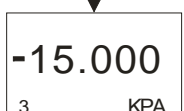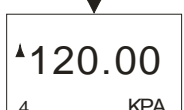
7.5 Displayed Variables Settings

LCD can be set to display "Process Variable", "mA value", "%". These 3 displaying contents can be displayed either constantly one of them or alternatively 2 of them.

If first displayed variable and second displayed variable are the same, this will be constant display.
If first displayed variable and second displayed variable are different, this will be alternative display (interval is 4 secs).
In normal display interface, hold △ button to change displayed variable (In bottom left corner, function code is 30).

Different variables in normal interface mean alternative display, for example, "process variable" and "mA value" display alternatively (first variable: "process variable"; second variable: "mA value").

Same variables in normal interface means constant display, for example, "process variable" displays constantly (first variable and second variable are both the same: "process variable").
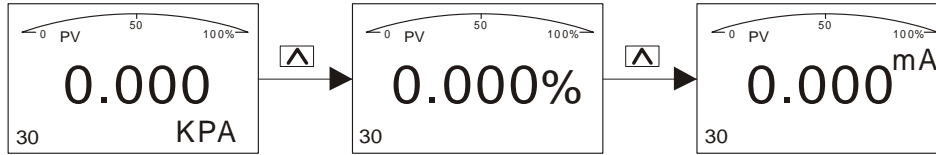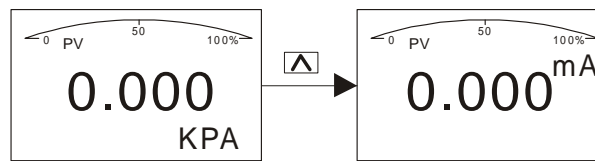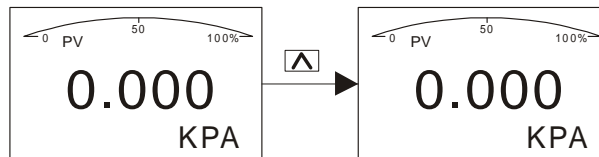
e.g. 1 **When displayed contents are "process variable" and "mA value", which means alternative display,** to change to constant display and make displayed content as "process variable", you need to change "mA value" to "process variable", namely, making the first variable same as the second.

Procedures: When screen displays "mA value", hold △ and do not release until screen shows "process variable". Namely "mA value" is changed to "process variable". At this time, screen will constantly display "process variable".

e.g. 2 **When displayed contents are "process variable", which means constant display,** to change to alternative display and make displayed content as "process variable" and "mA value", you need to change "process variable" to "mA value", namely, making the first variable different from the second.

Procedures: When screen displays "process variable", hold △ and do not release until screen shows "mA value". Namely "process variable" is changed to "mA value". At this time, screen will alternatively display "process variable" and "mA value".

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8. Flow Measurement Settings

Differential pressure transmitter measures flow and displays flow rate. As long as flow range and differential pressure's range is certain, flow can be measured and flow rate can be displayed.

If your purchased product has HART communication function, you can set parameters by yourself. As a result, to measure flow, it's recommended to order this product that has HART communication function.

Let's take an example of HART function settings (Should be with the help of ALIA AHT520 and software):

EX.1: Differential pressure's range is 0-500 mbar and corresponding flow range is 0-200 m^3/hr.

Steps: 1. Build Hart communication between our product and AHT520. Run software.

2. In Configuration column, single click Range ⟶ Range values ⟶ PV Unit ⟶ Special.

3. Input up range value and low range value, namely "PV URV"=200.000 and "PV LRV"=0.000.

4. Click "write" to save settings.

Shown as below:

5. In Configuration, click "Output func" ⟶ "Output" ⟶ Related Var.of Xfer fnctn ⟶ choose "Current and PV" ⟶ PV Xfer fnctn ⟶ choose "Square Root".
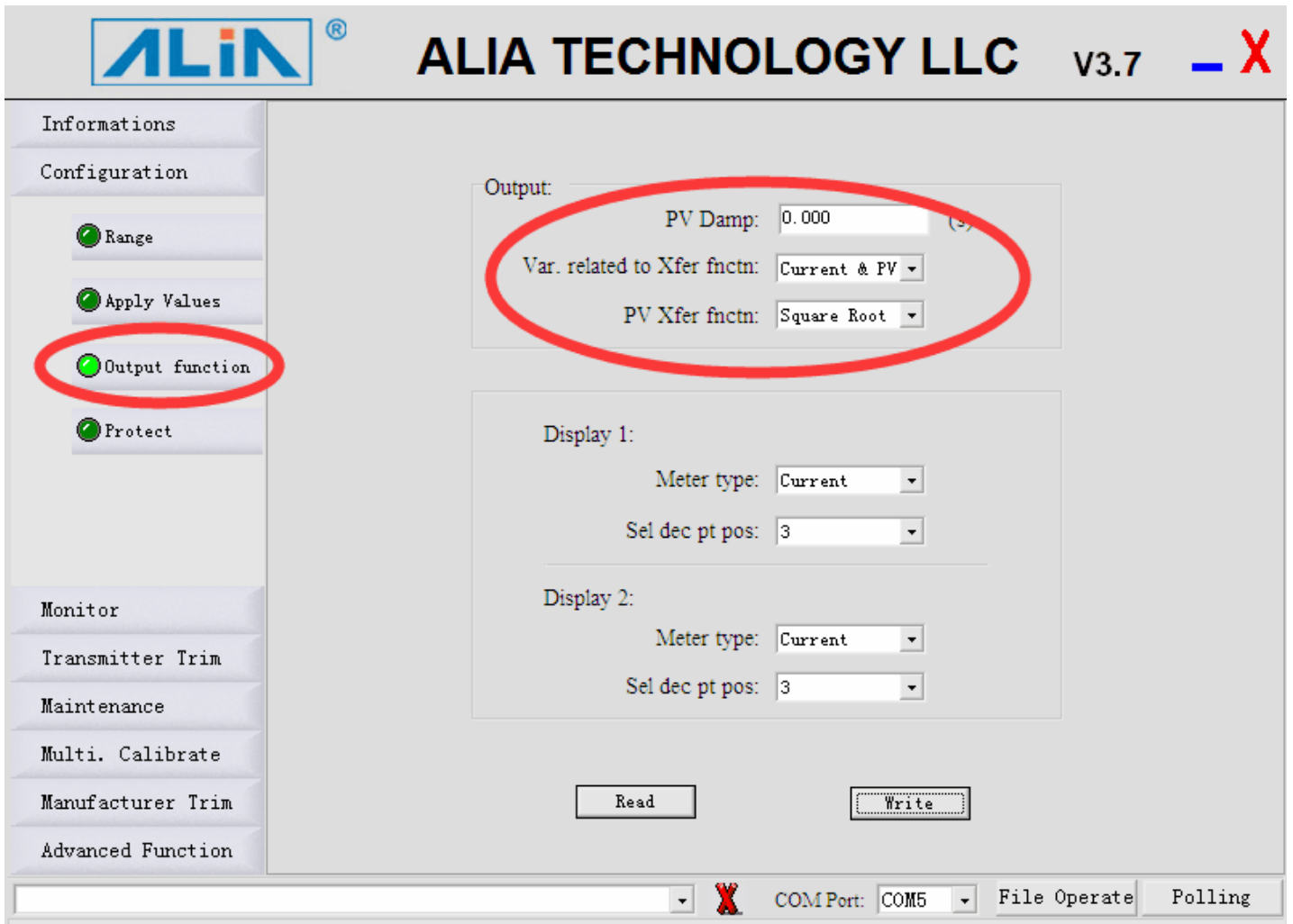
6. In "User Unit", set it as "m^3/hr".

7. Input "Coefficient" value.

The calculation formula of Coefficient value =△P (kPa) / Max. Flowrate.

500 mbar=50 kPa

Now coefficient value is =50/200=0.25 and you should input 0.25 in Coefficient.

8. Click write to save settings.

Shown as below:

Note: If actual value and displayed value are different, please trim coefficient value.

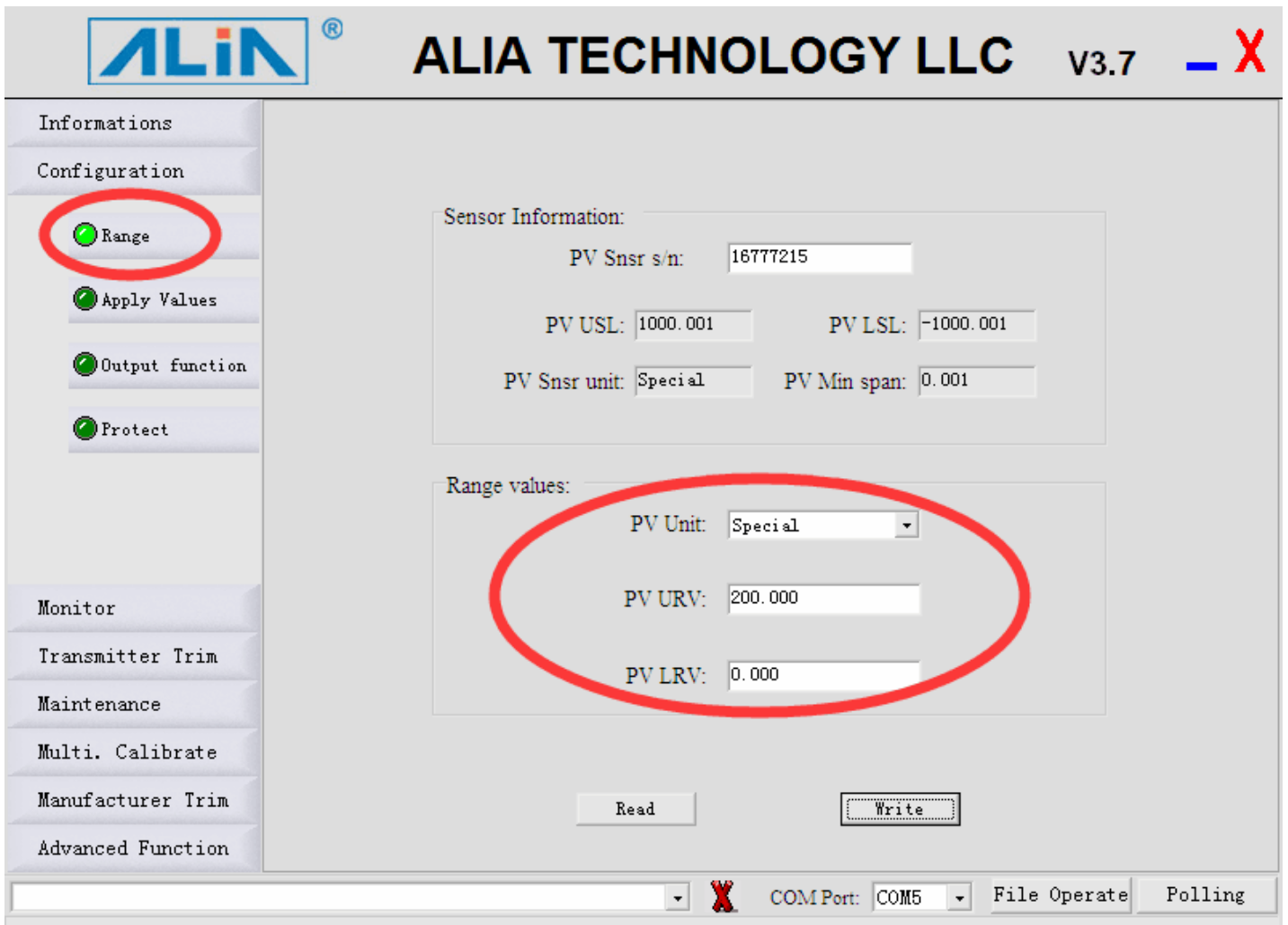**EX.2: Differential pressure's range is 0-6000 mmH$_2$O and corresponding flow range is 0-300 NM^3/H.**

Steps: 1. Build Hart communication between our product and AHT520. Run software.

2. In Configuration column, click Range ⟶ Range values ⟶ PV Unit ⟶ Special

3. Input up range value and low range value, namely "PV URV"=300.000, "PV LRV"=0.000.

4. Click "write" to save settings.

5. In Configuration column, click "Output func" ⟶ Output ⟶ Related Var.of Xfer fnctn ⟶ choose "Current and PV" ⟶ PV Xfer fnctn ⟶ choose "Square Root".

6. In "User Unit", set it as "NM^3/H".

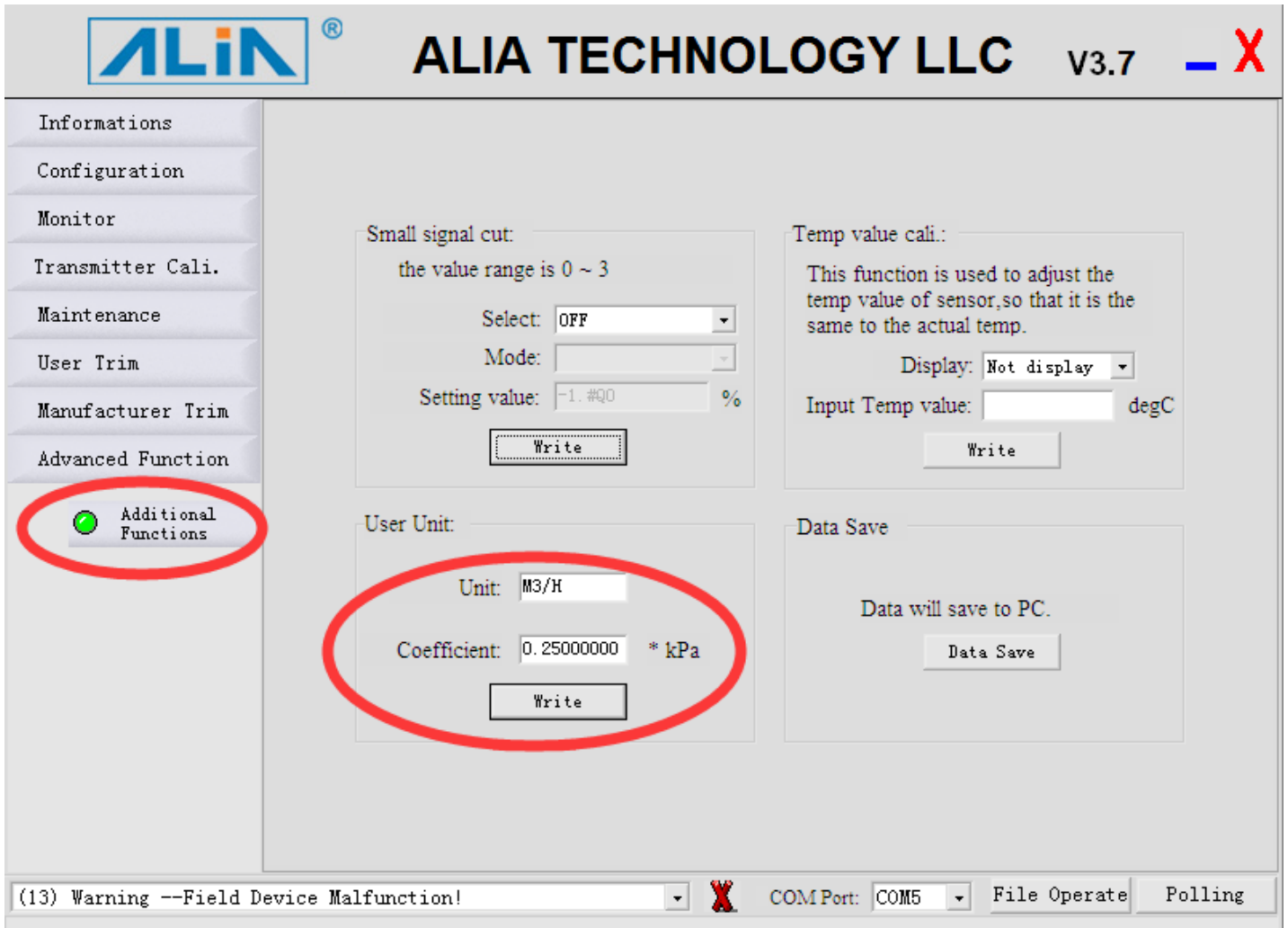7. Input Coefficient value.

   The calculation formula of Coefficient value =△P (kPa) / Max. Flowrate.

   6000 mmH$_2$O=58.84 kPa

   Now coefficient value is =58.84/300=0.196 and you should input 0.196 in Coefficient.

8. Click write to save settings.

APPENDIX I: HART Communications Option

Introduction
Highway Addressable Remote Transmitter Interface or H.A.R.T. as it is commonly known permits the operator to remotely access the transmitter's configuration variables and uses can modify them as required. Additionally, historical data and event information (i.e. last calibration date) can be stored directly in the transmitter.

Setup

Hardware:
A HART Modem is connected across a 250 to 350ohm resistor that is inserted somewhere in the transmitter's 4-20 mA output loop. The modem should then be connected to a computer.
Software:
The ALIA software should be installed in the computer and started up. Across the bottom of the panel that opens will be a drop down menu titled *COM port*. Select the port to which the modem is connected.   Then click on the *Polling* button.   This will display a menu, if there is only one transmitter connected select *Polling 0.*   If there is more than one transmitter then select *Polling Number* of the desired transmitter.
Assuming a successful connection the HART software activates, the activity LED's on the modem will flash and the window interface block will be displayed. The 6 Blocks are: ***1. Information, 2. Configuration, 3. Monitor, 4. Transmitter Trim, 5. Maintenance, 6. Multi Calibrate, 7. Manufactureer Trim and 8. Advanced Function***
If connection does NOT happen confirm cable connections throughout or call your local Alia rep.

Configuration

1. Information
Basic Info - Contains a) Read only basic info on the pressure sensor (Sensor units, Upper Sensor Limit-USL, Lower Sensor Limit-LSL, Minimum span, Sensor S/N) and b) Read / Write basic info on the electronic transmitter (Process units, Upper range value-URV, Lower range value-LRV, Damping, Output characterization).
Poll addr - A single transmitter poll address will be 0.   Multiple transmitters will show an address from1-15 however the mA output will be fixed at 4 mA.
Dev Info - Read / Write of device information including Tag #, Final Ass'y #, Last date modified, Description and any message (i.e. last calibration date).
More - Read only summary of all device information.
2. Configuration
Range - Read only display of sensor information and Read / Write Transmitter Range Values that can be modified.
Apply Values - Displays Transmitter PV Range Values.   Allows remote modification of 4-20 mA output value to comply with calibration bias.
Output func - Read / Write damping & output characterization (linear or square root), Set units display (constant or alternate) Define 'Special' Engineering units (characters: A - Z, /, 2, 3, &4) Also multiplication coefficient (1.000 - kPa).
Protect - Security (write protect) & mA current alarm output (low=3.8 mA; high=22 mA).
3. Monitor
Process Variable - Real time recording of PV and 4-20 mA output.
4. Transmitter Trim
D / A Trim - Permits manual multi-point trimming of current loop and subsequent loop output confirmation.
Two points trim - Permits manual two points trimming of current loop.
Zero Trim - Permits manual zero point trimming.
Cancel Trim - Displays trim summary and permits cancellation of prior manual trims.
5. Maintenance
Material - Displays materials of construction of instrument.   Permits temperature calibration of transmitter and permit display of sensor temperature on actual transmitter display.
Self-Check - Provides Read only display of results of transmitter component's internal self-test.
Keys Test - Real time test of on-board Transmitter keys.
6. Multi Calibrate
Calibrate - Read / Write manual calibration of transmitter.
7. Manufactureer Trim
Linearity - It is used for meter accuracy calibration by the manufacturer, please do not modify it.
Temperature Compensation - It is used for meter temperature compensation by the manufacturer, please do not modify it.
8. Advanced Function
Manu config - It is the advanced configuration in the meter, please do not modify.
Auto config - It is the advanced configuration in the meter, please do not modify.
Additional Functions - please modify under the instruction of ALIA engineers.

APPENDIX II: Pressure Conversion Factors

To convert a given PSI value from *pound-force per square inch (PSI)* to any of the units below, simply multiply the PSI value by the corresponding factor. Conversely if you require the PSI value, then divide.

Multiplier	Desired Units
0.068 948	bar
5.712	cm Hg@0 deg C
70.309	cm H_2O@4 deg C
68 948	dyn/cm^2
1885.8	ft of air@60 deg F
27.708	Inch of water@60 deg F
2.309	ft of water@60 deg F
70.307	gf/cm^2 (gram force)
6.894 76	kN/m^2 or kPa
51.72	mm Hg@0 deg C
2304	oz/ft^2
4633	pdl/ft^2 (poundal=0.031 lbf)
0.072	tnf/ft^2 (tn=2000# ton)
5 x 10 E –4	tnf/in^2
0.703 267	tf/m^2 (tonne force)