AT3000 Intelligent Pressure Transmitter

*Please read the instructions before using the product
Appendix B Statement of Product Warranty Period ...(45)
Introduction

AT3000 Intelligent Pressure Transmitter (hereinafter referred to as AT3000) is an on-site measuring instrument with micro-processor developed by Hangzhou Hollysys Automation Co., Ltd, and applicable for communication in accordance with HART protocol.

AT3000 with advanced digital technology and frequency shift keying (FSK) technology used has improved the integral performance and the liability, which ease the connection between the site and the control room.

In addition to its remote communication, the AT3000 has been designed with keys to adjust the Range and Zero for on-site adjustment after installation. The output of the transmitter can be linear or square-root which can be set by software.

The electronic part of AT3000 consists of only one circuit board (based on SMT-Surface Mounting Technology) to ensure the stability and reliability of the circuit.

Section 1 Operation Principal

1. Operation Principal

This section describes the basic operation principal of AT3000. Shown in figure 1-1 is the Electrical Block Diagram which illustrates AT3000 operation principle, and the functions of each portion and their relationship in between.

1.1 Pressure Sensor (sensitive element)

The core of AT3000 is a capacitive pressure sensor called “δ-Cell” (see Figure 1-2), which is a completely sealed part. Process pressure is transmitted via the isolating diaphragm and the filling silicon oil to the sensing diaphragm which then been displaced. Capacitive difference between the two capacitor plates of the sensing diaphragm is converted into electrical signal of 4–20mA DC in two wires.

Such conversation is given by:

\[ P = \frac{K_1 C_1 - C_2}{C_1 + C_2} \]

Where:
- \( P \) = Pressure to be measured
- \( K_1 \) = Constant
- \( C_1 \) = Capacitance between the high-pressure plate and the diaphragm
- \( C_2 \) = Capacitance between the low-pressure plate and the diaphragm
The memory is non-volatile to store all configurations, characterizations, and digital trimming.

The D/A conversion circuit converts the digital signal coming from the microprocessor to analog and realizes digital communication. It also supports transmitter linearization, range and damping adjustments.

The keys Z and S are for on site adjustment, the Z key for zero and the S for span.

\[
V_{p-p} = \frac{I_{ref}}{(C_1 + C_2)} \cdot f
\]

Where: \( I_{ref} \) = Constant reference current
\( V_{p-p} \) = Peak to peak value of oscillating
\( f \) = Oscillating frequency

Where: \( I_{ref} = f \cdot (C_1 + C_2) \)

Where: \( C_1, C_2 \) = Currents difference between C1 and C2
\( I_{ref} = K_2 \cdot I_{ref} \)

Where: \( K_2 = \text{Constant} \)

Therefore:

\[
I_{ref} = K_2 \cdot \frac{C_1 - C_2}{C_1 + C_2} \times P
\]

Where: \( P \) = Pressure to be measured

The process pressure is transmitted through the isolating diaphragm and the filling liquid to the sensing diaphragm in the "δ-Cell", and the reference pressure is transmitted in the same way to the other side of the sensing diaphragm. The displacement of sensing diaphragm is proportional to the pressure difference. The position of sensing diaphragm is determined by the capacitor plates of its two sides.

The capacitance between sensing diaphragm and either of the plates is about 150pF. The sensor is driven by an oscillator at the frequency of about 32kHz with the amplitude \( V_{p-p} \) about 20V, of which the output is commutated by a demodulator.

1. Temperature Compensation
The temperature character of the transmitter is optimized through a temperature compensation circuit on which the temperature on-site is acquired, converted by the A/D converter and then compensated by the micro-processor.

1. A/D Converter
The A/D converter circuit converts the analog signal coming from the demodulator to digital signal which is then input to the microprocessor.

1.4 Microprocessor
The microprocessor of transmitter controls the conversions of A/D and D/A, performs self-diagnostic and realizes digital communication. It also supports transmitter linearization, range and damping adjustments.

1.5 Memory
The memory is non-volatile to store all configurations, characterizations, and digital trimming parameters, so that the stored data will be kept well from power off.

1.6 D/A Conversion
The D/A conversion circuit converts the digital signal coming from the microprocessor to analog value of 4~20mA which then be output to other circuit loop.

1.7 Digital Communication
At3000 is tested and configured through a hand held communicator or a host which supports HART communication protocol. Functions of this transmitter may be fully utilized by using of AT3000’s DD issued by the HART Foundation Association. HART protocol applies industry standard, the BELL202 of FSK technology. The digital signal in 1200Hz or 2200Hz overlapped on 4~20mA analog signal will not affect the 4~20mA process output.

1.8 Z and S Keys
The keys Z and S are for on site adjustment, the Z key for zero and the S for span.

### Table 2-1 Model name of transmitter

<table>
<thead>
<tr>
<th>Code</th>
<th>Type</th>
<th>Necessary</th>
<th>Optional</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP</td>
<td>Differential pressure transmitter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP</td>
<td>High static differential pressure transmitter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TG</td>
<td>Direct-mounting pressure transmitter (threaded connector)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA</td>
<td>Direct-mounting absolute pressure transmitter (threaded connector)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GP</td>
<td>Pressure transmitter (flange port)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LT</td>
<td>Flange level transmitter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VDP</td>
<td>Teletransmission pressure/pressure transmitter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VCP</td>
<td>Teletransmission pressure/pressure transmitter</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Output</th>
<th>Structural material</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4-20mA DC, square root output</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>4-20mA DC, linear output</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Range (upper range limit kPa)</th>
<th>AT3000DP pressure transmitter</th>
<th>AT3000HP high static pressure transmitter</th>
<th>AT3000GP pressure transmitter</th>
<th>AT3000GP absolute pressure transmitter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0~0.5</td>
<td>×</td>
<td>0</td>
<td>×</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0~0.75</td>
<td>×</td>
<td>0</td>
<td>×</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0~0.935</td>
<td>×</td>
<td>0</td>
<td>×</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0~1.5</td>
<td>×</td>
<td>0</td>
<td>×</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0~3.467</td>
<td>×</td>
<td>0</td>
<td>×</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0~6.935</td>
<td>×</td>
<td>0</td>
<td>×</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>0~12.724</td>
<td>×</td>
<td>0</td>
<td>×</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>0~17.253</td>
<td>×</td>
<td>0</td>
<td>×</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>0~20.680</td>
<td>×</td>
<td>0</td>
<td>×</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0~105.2</td>
<td>×</td>
<td>0</td>
<td>×</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: “0” indicates this specification is available. “×” indicates this specification is not available.

Example of model ordering: AT3000DP4S2M3B1
2. Function Specifications

Service: Liquid, gas and steam applications.
Ranges: See Table 2-1
Output Signal: Two-wire 4–20mA DC signal overlapped with HART digital signal.
Selectable of linear or square-root output.

Power Supply:
1. Voltage: 9～45VDC;
2. When LC module and back light display are selected, the voltage will be changed to 14～45VDC;
3. General operating power is 24VDC.

Load characteristic:
1. Load characteristic of LC module without back light display: \( R = \frac{(V-9)}{0.023} \) (Ω)
2. Load characteristic of LC module with back light display: \( R = \frac{(V-14)}{0.023} \) (Ω)

\[ R = \frac{(V-9)}{0.023} \] (Ω)

\[ R = \frac{(V-14)}{0.023} \] (Ω)

Figure 2-1 Load Characteristics

Display module:
English words can be displayed and back lighted in matrix in tow linens, 7 characters in each line with the display module.
The display can be the PV value (the pressure or differential pressure value which will not mentioned later), percentage of PV value, electric current output value and corresponding engineering unit. The important system status can also be displayed. The instrument display status can be selected via dedicated HART command. When the back light display is wanted, the user may plug in the wires connected on the display module into the communication module.

The display can be divided into three areas:
1. Engineering value display area: Displays process PV value, percentage PV value and electric current output value at the first line of the display.
2. Engineering unit display area: Displays the corresponding engineering unit when the PV is displayed. Displays "mA" when percentage PV value is displayed. And displays "mA" when electronic current output value is displayed.
3. System status display area: This display is the first 2 characters at the second line.

- **Alarm status display:** when alarm status is changed by turning micro-switch, the corresponding high alarm "AH" and low alarm "AL" will be displayed, which will be re-set in 5s.
- **Write-protect status:** when write-protect status is changed by turning micro-switch, write-protect "WP" and no write-protect "WE" will be displayed correspondingly, which will be re-set in 5s.

3. Performance Specification

(Zero based calibrated range, reference conditions, silicon oil fill and 316L isolating diaphragms)

Accuracy: ±0.1% at measurement ratio 10:1 for DP of range code 4-8; and ±0.2% for other transmitter and other range codes of the DP.

Temperature Effect: ±0.2% URL for HP 32MPa static pressure, or ± 0.4% for range code 3, which can be corrected by adjust the zero under pipe pressure.

- **Parameter Modification:** If there is a necessity to shut off the power supply, be aware to shut the power supply off in 30 seconds after the parameters of the transmitter has been modified, otherwise those parameters will be recovered to its original. If the instrument is ordered with LCD, thus "EW" will be displayed in the system status display area after the parameters are modified, indicating the data are being saved, and will be cleared automatically. The power supply could be shut off at this time if required.

3. Performance Specification

Pressure transmitter: The maximum Zero Elevation of the transmitter is the difference between upper range limit (hereinafter referred to as URL) and measurement range.
The maximum Zero Suppression is -URL.

- **Static Pressure Effect:**
  - Full scale: Total error <±0.20% URL per 10℃ change; the error will be doubled for other transmitters and other range codes of the DP. 
  - Zero based calibrated range, reference conditions, silicon oil fill and 316L isolating diaphragms
  - Accuracy: ±0.1% at measurement ratio 10:1 for DP of range code 4-8; and ±0.2% for other transmitter and other range codes of the DP.
  - Temperature Effect: ±1% URL per 10℃ change; the error will be doubled for other transmitters and other range codes of the DP.
  - Static Pressure Effect: ±0.2 % URL for DP of 14MPa static pressure, or ± 0.4% for range code 3, which can be corrected by adjust the zero under pipe pressure.
  - ± 0.4% URL for HP 32MPa static pressure which can be corrected by adjust the zero under pipe pressure.
Vibration Effect: 0.1% URL, at 10-55Hz, in any direction S=0.15mm.

Power Source Effect: <0.005% output range /V

Mounting Position Effect: Not greater than 0.24kPa. System error may occur when the operation diaphragm is not installed vertically, which can be eliminated by zero adjustment without affecting the range.

Structural Material: See the Model Ordering table, the pressure compartment, connectors, drain/vent valves, isolating diaphragm and other wetted parts can be found.

- Bolts: Galvanized carbon steel
- Electrical Housing: Low copper aluminum alloy
- Coating of Electrical Housing: Epoxy sprayed

Process Connections: The threaded holes in the pressure compartments are NPT1/4, while the holes in the adapters are NPT1/2. The center distance between the two holes is adjustable by reversing the adapter when assembly.

Electrical Connection: There are two threaded holes of M20×1.5 in the housing of the transmitter which are used to connect the cable pipe. Inside the housing are the terminals and gaskets for testing on which the connections can be fixed to connect the communicator.

Weight: 5kg approximately (accessories are not included. Exception is the flanged transmitters)

Explosion Protection:
(1), Explosion-proof type Exd II CT4–6
(2), Intrinsic safe type Exia II CT4–6

4. Mounting (See Figure 2-2)
Installation methods as the Figures shown below (optional)

Figure 2-2a Bend bracket, pipe mounting, with 3-valve manifold Bracket Order No. B01

Figure 2-2b Bend bracket, panel mounting Order No. B02

Figure 2-2c Flat bracket, pipe mounting Order No. B03

5. Transmitter Dimensions

- Code of measurement: A (mm)
  - 3, 4, 5: 54.0
  - 6, 7, 8: 55.5
  - 9: 57.2

1. Nameplate
2. Release valve
3. Pressure compartment (reversible)
4. NPT1/4 threads (for release valve)
5. The hole is NPT1/2 female threads for process connection. Note: the adapter can be reversed; and size of A can be changed to A=3mm
6. The hole on the pressure compartment is NPT1/4 female threads for process connection if the adapter is not assembled.

Figure 2-3 External sizes of AT3000 DP/HP/GP transmitter
Section 3 AT3000TG Pressure Transmitter

1. Operation Principle
AT3000TG series pressure transmitter adopting capacitive and diffused silicon sensor assembled is a kind of pressure transmitter for general purpose application. Thanks to its high ratio of its performance against to its price, high stability and reliability in performance, high resistance corrosive mediums, and compact and rigid in its structure, it is widely applied to industries with strict requirements for pressure measurement such as in petrochemical industry, power station, water treatment and food processing and other industrial fields and has wins higher reputation in its industry. Figure 1-1 is its basic operation principle. The core components of AT3000TG series pressure transmitter can be divided into two categories: the metal diaphragm capacitance pressure sensor and the diffused silicon metal diaphragm sensor.

2. Transmitter Model Denomination

<table>
<thead>
<tr>
<th>Code</th>
<th>Type</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG</td>
<td>Pressure transmitter</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Explosion-proof Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blank</td>
<td>Conventional</td>
</tr>
<tr>
<td>i</td>
<td>Intrinsically safe Exia II CT4-6</td>
</tr>
<tr>
<td>d</td>
<td>Explosion isolation Exd II CT4-6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>M20x1.5 external thread</td>
</tr>
<tr>
<td>B</td>
<td>NPT1/2 internal thread</td>
</tr>
<tr>
<td>C</td>
<td>NPT1/2 internal thread</td>
</tr>
<tr>
<td>D</td>
<td>NPT1/4 internal thread</td>
</tr>
</tbody>
</table>

Note: "0" indicates the availability of this specification. "×" indicates the unavailability of this specification. Example for model ordering: AT3000TG6SAM3B15

3. Technical Specifications
Range: 0-5kPa~35MPa (see Table)
Output Signal: 4~20mA DC signal in two wires with HART digital signal overlapped; linear or square root is optional.
Power Supply:
1. Voltage: 9~45VDC;
2. When LC module and back light display are ordered, the voltage will be changed to 14~45VDC;
3. General operating power is 24VDC.
Load characteristic:
1. Load characteristic of LC module without back light display: R<sub>L</sub>=(V<sub>L</sub>=9)0.023 (Ω)
2. Load characteristic of LC module with back light display: R<sub>L</sub>=(V<sub>L</sub>=14)/0.023 (Ω)
R<sub>L</sub>: Maximal load resistance (Ω); V<sub>L</sub>: Voltage (V)

Diagram of load characteristics

Range Ratio: 40:1 10:1 is recommended.
Operating Environment:
Normal operating temperature is -20℃~+70℃ (for diffused silicon); -40℃~+85℃ (for metal membrane capacitance);
Storage temperature for transmitter is -40℃~+85℃; relative humidity is 5~95%;
Accuracy: ±0.1% FS, 0.1 grade for non-linearity (range ratio ≤10:1);
≤±0.2%FS 0.2 grade for non-linearity:
Stability: 0.2%FS/year long-term stability
Temperature Effect: ±0.1%/0℃temperature factor in full range,
±0.1%/10℃heat hysteresis in full range
Mounting Position Effect: None
RFI (Radio Frequency Interference)
Effect: range change is not greater than 0.1% under 3V/m RFI in 1MHz~1GHz.
RMII (External Magnetic Interference): Can be used in the field of 400A/m condition.
Vibration Effect: Can be used in conditions of vibration frequency 10~60Hz, amplitude 0.07mm and vibration frequency 60~150Hz, accelerated amplitude 9.8ms².
Process Connection:
M20x1.5 external thread;
NPT1/2 external thread;
G1/2 external thread;
NPT1/2 internal thread;
NPT1/4 internal thread
Weight: 1kg
4. Dimensions and Mounting

AT3000TG Pressure Transmitter Dimension

AT3000TG Dimension Diagram for Installation

Pipe installation

Wall-mounting

Section 4 Calibration

AT3000TG has been characterized before shipment, and the configuration data has been stored in the electronic part. Refer to the instructions in this section if you want to change the instrument calibration.

1. 1-1 Adjust the Range by using of “Zero” and “Span” keys if LCD display is not available
1) The position of “Zero” and “Span” buttons are shown as Figure 4-1.
2) Depress both “Zero” and “Span” buttons and keep depressing for at least 5 seconds to activate the local buttons.
3) After the local buttons have been activated, release the “Span” button and depress the “zero” button for 5 seconds, and apply a pressure corresponding to 4mA to the compartment of “H” to adjust the Zero that is to make the output at 4mA, then release the “Zero” button. If “Zero” button is keeping depressed and the “Span” button has been released, the instrument will perform Zero drift in every 5s.
4) After the local buttons have been activated, release the “Zero” button and depress the “Span” button for 5 seconds, and apply a pressure corresponding to 20mA to the compartment of “H” to adjust the Span that is to make the output at 20mA, then release the “Span” button. If “Span” button is keeping depressed and the “Zero” button has been released, the instrument will perform Span adjustment in every 5s.
5) Release “Zero” and “Span” buttons for 60s simultaneously, local keys will be under self-lock status thus any operation will not be responded by hitting a single button.

Figure 4-1 Position of the keys on the transmitter

1-2 Refer to section 9 for detailed operation with LCD display

2. Adjustment by handheld communicator HHT375

HHT375 is a universal intelligent HART instrument configuration tool which can communicate with pressure transmitter, temperature transmitter, flow transmitter etc. registered with device description (DD) in the HART Foundation. When HHT375 communicates with a transmitter, it firstly read out the DD information stored in the transmitter, and search for corresponding DD information in the database of HHT375. If successful, the DD information will be used for communication with the transmitter. Refer to HHT375 hand held communicator specification for detailed operation.

3. Alarming and Write-protect Switch

Alarm mode can be changed by selecting the write-protect contact pin and the position of the contact pin if needed.
3.1 Alarming

Self-diagnosis
AT3000 smart transmitter can perform self-diagnosis continuously. If a malfunction is detected in the transmitter, any HART host equipped with DD will indicate the special self-diagnosis information about this transmitter.
If the self-diagnosis detects a malfunction, the analog output will be 22mA (high) or 3.8mA (low) as the current alarm which can be selected in accordance with Figure 4-2 or Figure 4-3.

3.2 Write-protect Switch

The default of the electronic component is Write-protect Off. The setting can be modified. When the configuration parameters in the transmitter are not expected to be changed, insert the short-circuit contact pin which is an accessory. Refer to Figure 4-2.
When digital display is provided, the switch at WE position is Write-protect Off. The setting can be modified. The switch at WP position is Write-protect On., which users can't modify the setting. Refer to Figure 4-3.
Section 5 Installation

1. General
AT3000 smart transmitter can be used for flow measurement, level measurement and other applications where accurate pressure or differential pressure measurements are needed. The accuracy of the pressure measurement will be affected by installations of the transmitter and the process connections, so that it is of great importance to handling correct installation of the transmitter and the process connection.

Due to the requirements of the process or for economical reasons, the transmitter is often installed on a site under inclement working conditions. In order to minimize the inclemency of the working conditions of the transmitter, it is requested to install the transmitter possibly at a place with minimal temperature gradient, minimal temperature fluctuation, no shock and no vibration.

Attention!
The medium to be measured must not freezes; otherwise, the separation diaphragm of the sensor will be damaged which will resulting in the damage of the transmitter.

2. Process Connection
The following contents are of great importance to the proper installation of the AT3000 smart transmitter. The installation position, steam measurement and error reducing methods are described as follows:

2.1 Installation Position
The installation position of the transmitter on the process pipe varies with the medium to be measured. To obtain the optimized installation and good working conditions, the following situations shall be taken into account:

1. The transmitter shall not be contacted with the corrosive or high-temperature medium to be measured.
2. Measures shall be taken to prevent the dregs from depositing in the impulse piping.
3. The impulse piping shall be as short as possible.
4. The liquid head in the impulse piping of the two sides shall be kept in balance.
5. The impulse piping shall be installed in a place with minimum temperature gradient and temperature fluctuation.

2.1.1 Liquid Measurement
For the measurement of liquid flow, the process tap shall be located at the side of the process pipe to avoid the sediment. The transmitter shall be installed beside or below the pressure tap so that the bubbles could be vented into the process pipe.

2.1.2 Gas Measurement
For the measurement of gas flow, the process tap shall be located at the top or side of the process pipe, and the transmitter shall be installed beside or over the process pipe so that the accumulated liquid could flow into the process pipe easily.

When a transmitter with a drain/vent valve installed on the pressure chamber is installed, the process tap on the process pipe to the transmitter. During the pressure transfer, the causes that bring errors are as follows:

1) Leakage;
2) Abrasion loss (especially when detergent is used);
3) Gas exists in the liquid pipe (causing head errors);
4) Liquid accumulates in the gas pipe (causing head errors);
5) Different densities in the connecting pipes of the two sides due to temperature differences (causing head errors).

The methods to reduce the errors are as follows:

1) The impulse piping shall be as short as possible;
2) When liquid or steam is measured, the impulse piping shall connect upwards to the process pipes with a slope of no less than 1/12;

2.2 Methods of Reduce Errors
The impulse piping connects the transmitter with the process pipe, and transfers the pressure at the process tap on the process pipe to the transmitter. During the pressure transfer, the causes that bring errors are as follows:

1) Leakage;
2) Abrasion loss (especially when detergent is used);
3) Gas exists in the liquid pipe (causing head errors);
4) Liquid accumulates in the gas pipe (causing head errors);
5) Different densities in the connecting pipes of the two sides due to temperature differences (causing head errors).

The methods to reduce the errors are as follows:

1) The impulse piping shall be as short as possible;
2) When liquid or steam is measured, the impulse piping shall connect upwards to the process pipes with a slope of no less than 1/12;

2.2.1 Measurement of Steam
For the measurement of steam flow, the pressure port shall be located at the side of the process pipe, and the transmitter shall be installed below the pressure tap so that the condensate could accumulate into the connecting pipe.

It shall be noted that, for the measurement of steam or other high-temperature medium, the temperature shall not exceed the maximum operation temperature of the transmitter.

When the medium measured is steam, the impulse piping shall be filled with water to protect the transmitter from direct contacting with steam. Because the change of the volume of the transmitter is neglectable during its operation, a condensation tank is unnecessary to be installed.

Figure 5-1 Installation

When the medium measured is steam, the impulse piping shall be filled with water to protect the transmitter from direct contacting with steam. Because the change of the volume of the transmitter is neglectable during its operation, a condensation tank is unnecessary to be installed.

When the medium measured is steam, the impulse piping shall be filled with water to protect the transmitter from direct contacting with steam. Because the change of the volume of the transmitter is neglectable during its operation, a condensation tank is unnecessary to be installed.
3) When gas is measured, the impulse piping shall connect downwards to the process pipes with a slope of no less than 1/12;
4) Impulse piping for liquid shall be so arranged to avoid any high points in the middle, while impulse piping for gas shall be so arranged to avoid any low points in the middle;
5) The two impulse piping shall be kept at the same temperature;
6) To avoid the influence of friction, the diameter of the impulse piping shall be large enough;
7) The impulse piping filled with liquid shall have no gas;
8) When sealing liquid is used, the liquid in the impulse piping of the two sides shall be the same;
9) When detergent is used, the connection of the detergent pipe shall be adjacent to the process pipe pressure tap. For the pipes through which the detergent passes, the length and diameter shall be same size. It shall be avoided to let the detergent get into the transmitter.

3. Mounting

The transmitter can be mounted directly at the measurement point or on the wall, or on the bracket which is clamped on a 2” (approximately Ø50mm) pipe.

The thread of the connecting hole on the pressure chamber of the transmitter is NPT1/4. The thread of the connecting on the adapter is NPT1/2. The user can select the connector whose thread is NPT1/2 to match the adapter. Unscrew the two bolts on the adapter to disconnect the transmitter from the process pipe. Moreover, by rotating the adapter, the distance between the centers of the two connection holes can be changed. The transmitter can be mounted directly on the orifice ring chamber, or on the flange, or on the bracket which is fixed on the process pipe.

To ensure the tightness of the connection, the following steps shall be followed for the fastening: tighten the 2 fastening bolts with a wrench evenly and alternately. The final torque of this fastening is about 40N•m. Never tighten a bolt at a time. Sometimes, to facilitate the mounting, it is possible to rotate the pressure chamber on the transmitter body. As long as the pressure chamber is at the vertical position, the rotation of the transmitter body will not cause the Zero changed. If the pressure chamber is mounted horizontally (e.g. when measuring the flow in vertical pipes), the Zero must be readjusted to eliminate the affection for liquid head caused by the height difference of the connecting pipes.

When differential pressure/pressure transmitter with flanged remote seals is mounted, the application and mounting of both flanged remote seal and transmitter shall be taken into consideration, to guarantee optimum performance.
(1) The length of capillary tube shall be as short as possible;
(2) When the transmitter with one flanged remote seal is mounted, the transmitter shall be below the flange and the connector, or kept at the same level. If the two flanged remote seals are mounted at different place, for example to measure the level in a tank, the transmitter must be mounted at or below the middle point between two flanges/flow connectors. The mounting position of the transmitter and flanges is shown as Figure 5-2.

Figure 5-2 Mounting Positions of the Transmitter and Flange

(3) The flanged remote seal and capillary tubes shall not be mounted under sunshine.
(4) If two flanged remote seals are used, the length of their two capillary tubes shall be identical.
(5) The Zero of the transmitter shall be readjusted on season's basis.

4. Wiring

The signal terminals are located in a separate compartment in the housing. During wiring, the cover at the terminal side can be removed. The power supply is connected to the transmitter through the signal wires. No additional wiring is required.

Twisted pair wires can be used as the signal wires. In the places where the electromagnetic interference is quite severe, shielded wires are suggested, and shall be grounded properly. The section of the wire shall be 0.5mm² ≤ S ≤ 2.5mm². The signal wires shall neither be laid in a same metal conduit or tray with other power wires, nor pass through the vicinity of heavy-current equipment.

The wiring hole on the housing of the transmitter shall be blocked (with sealant) by a seal plug (M20×1.5 bolts) to prevent moisture from accumulating into the housing. If the wiring hole is not sealed, the transmitter shall be installed with the wiring hole facing downwards in order to discharge the liquid.

The signal wires can be suspended, or grounded at any point in the signal circuit. The housing of the transmitter can be grounded or not grounded.

The transmitter is grounded through the capacitance coupling, so it is not allowed to use a megger of higher than 100V for checking the insulation resistance. A voltage of no higher than 45V shall be used for circuit inspection.

When explosion-proof products are used, the contents of Section 7 must be satisfied.

Field wiring diagram for AT3000 smart transmitters:

5. Using the Instrument with Flanged Remote Seals

5.1 Liquid Level Transmitter

When the liquid level transmitter is used, the plate flange shall be used for medium with ordinary viscosity. Insertion flange shall be used for the medium with high-viscosity, easy for sedimentation and suspension. Make sure to let the measuring diaphragm of the flange inserted deep into the tank, at least in tangent with the inner wall of the tank.
5.1.1 Liquid Level Measurement with Zero Fixed
Instrument shall be mounted at the same horizontal position with the lowest level. When measure the level in an open tank, the negative pressure chamber of the instrument is ventilated. When measure the level in a closed tank, the upper part of the tank is connected to the negative pressure chamber. If the upper part is dry, condensation tank is not required. If a condensation tank is installed, the condensed fluid shall be discharged regularly; when fluid is discharged, the normally open valve shall be closed, to prevent transmitter undertaking unidirectional pressure shown as Figure 5-3.

5.1.2 Liquid Level Measurement with Zero Elevation
If the instrument is mounted above the process pipe, zero elevation will be required as shown in Figure 5-4.

For instance: the specific gravity of filled inert liquid \( r_f = 1.9 \text{g/cm}^3 \), \( h=750 \text{mm} \), the specific gravity of measured medium \( r_p = 1.1 \text{g/cm}^3 \), \( H=3000 \text{mm} \), what's the testing value of the Range of this transmitter? Refer to Figure 5-4.

Calculation: as known: \( r_f = 1.9 \text{g/cm}^3 \), \( r_p = 1.1 \text{g/cm}^3 \), \( g \times 1 \text{mmH}_2\text{O}=9.81 \text{Pa} \) \( H=3000 \text{mm} \), \( h=750 \text{mm} \), what's the testing value of the Range?

Answer: the testing value of the Range is -13.98kPa~18.39kPa.

5.1.3 Level Measurement with Zero Suppression, see Figure 5-5
Zero suppression shall be required when the position of the transmitter is mounted below the lowest level. With Zero suppression, the measurement sensitivity can be enhanced.

For instance:
Measured medium specific gravity \( r_f = 1.1 \text{g/cm}^3 \), \( H=910 \text{mm} \), \( H_0=820 \text{mm} \), \( g \times 1 \text{mmH}_2\text{O}=9.81 \text{Pa} \)
Range \( =H_r\times g \times (1.1×9.81)=9.82\text{kPa} \)
Zero suppression value \( =H_r\times g \times (820+1.1×9.81)=8.849\text{kPa} \)
The Range of the transmitter must be adjusted to 8.849~18.669kPa before mounting.

5.2 Differential Pressure/Pressure Transmitter with Flanged Remote Seals
Some medium will be crystallized when it flows into the impulse piping, which can not be prevented though measures of heat keeping have been made. In this case, the flanged remote seals are to be applied. There are three types of flanged remote seals as options, double flat flanges, double insert flanges and one flat flange + one insert flange, selected in accordance with the crystallization of the measured medium.

5.2.1 Liquid Level Measure with Double Flanged Remote Seals shown as Figure 5-6
To measure level in a closed tank with double flanged remote seals, the transmitter must be installed in the middle while its negative pressure chamber shall be connected to the top of the tank and its positive pressure chamber shall be connected to the bottom of the tank, so a negative pressure difference will occur which is not so big and can be eliminated by adjusting the Zero. If the pressure difference reaches a certain value, then the Zero elevation or suppression is applied to. Be aware that the adjustment of Zero elevation or suppression only depends on the difference between the two flanges and the height \( H_0 \), but the height of the position where the transmitter is installed does not related.
For instance:
Known: H=800mm, \(H_0\)=250mm, h=1300mm \(r=1.2\text{g/cm}^3\), \(r_0\)=1.04\text{g/cm}^3, g (1\text{mmH}_2\text{O}=9.81\text{Pa})

What's the testing value before installation of instrument?

Calculation:

Range: \(r \cdot H \cdot g=800 \times 1.2 \times 9.81=9.4\text{kPa}\)

Negative drift value: \(r_0 \cdot h \cdot g-r \cdot H_0 \cdot g=(1.04 \times 1300-1.2 \times 250) \times 9.81=10.32\text{kPa}\)

Answer: Range shall be regulated to -10.32kPa~-0.92kPa (-10.32kPa~-9.4kPa) before installation.

5.2.2 Flow Measure with Double-Flanged Remote Seals

For the medium which can't be led out with impulse piping, the flow can be measured by differential pressure transmitter with double flanged remote seals.

(1) When horizontal pipe is measured, two flanges will be on the same level without Zero drift problem shown as Figure 5-7.

(2) When measuring flow in a vertical pipe shown as Figure 5-8, the lower flange should be connected to the positive pressure compartment of the transmitter, and the upper flange shall be connected to the negative pressure compartment of the transmitter. In this application, there is a constant liquid head pressure, the \(r_0 \cdot H\) which shall be balanced by Zero suppression.

2. Steps of Disassembly

2.1 Disassembly of the Sensor

1) Before disassemble the sensor, the transmitter shall be dismounted from the process pipe.
2) Remove the 4 bolts (M10×80), then the positive and negative pressure chambers can be taken off. Be careful not to scratch or damage the separation diaphragm.
3) The separating diaphragm shall be cleaned with a piece of soft cloth soaked with neutral detergent, and then rinsed with clean water. Note, not to use any solutions containing chloride or acid for cleaning.
4) To facilitate installation, the connectors and the positive & negative pressure chambers can be rotated or assembled reversely.
5) After reassembly, a temperature circulation needs to be carried out to ensure the performance, which has been described in Reassembly Steps below in paragraph 3.

2.2 Electrical Compartment

1) Terminals of the signal (power supply terminals) and the field indicator are accessible by removing the cover from the wiring terminal side of the transmitter.
2) Remove the cover at the circuit side of the transmitter to access the intelligent electronic component. A good custom shall be maintained: disconnect the power supply first, and then remove the cover from the circuit side of the transmitter.

2.3 Disconnection the Sensor Subassembly from Housing

1) Dismount the intelligent electronic component (pay attention to the static protection);
2) Loosen the locknut;
3) Unscrew the sensor subassembly from the housing. Be careful not to damage the leads on the subassembly. Pull the lead plug of the sensor subassembly off the hole of the housing carefully. Please pay special attention not to damage the separation diaphragm of the subassembly when unscrewing the sensor subassembly.
4) The sensor subassembly is an integral welded component, and can not be disassembled.

**Attention**

* For a characterized transmitter, it must be re-characterized after its electronic component or working sensor assembly is exchanged!
* If M3 digital display is assembled, when "write-protect" or "alarm" position on the panel are changed, position can be only changed via plug and insert!

**Section 6 Maintenance**

1. General

AT3000 transmitters have no moving mechanical parts, so it seldom needs regular maintenance. The procedures for the adjustment or for change of measurement ranges have been described in above sections. This section introduces the testing methods for the sensor, assembly, steps of reassembly and failure recovery guides. When explosion-proof products are used, the contents of Section 7 must be satisfied.

**Attention**

After a period of operation, transmitter with flanged remote seals which are installed in the environment with higher vacuum and higher temperature must be re-adjusted under operation condition to correct the initial variation. Operating condition of transmitter: medium temperature must be no more than 200°C.
3. Reassembly Steps

3.1 Preparation Works
1) Inspect all the O-rings, and replace them if necessary. Slightly coating these O-rings with silicon oil to ensure full joggle.
2) Inspect the connection threads. Due to the explosion-proof requirements, 5 complete and intact threads which can engage sufficiently must be ensured.

3.2 Connection the Sensor Subassembly onto Housing
1) Pull the lead plug of the sensor subassembly into the terminal side of the transmitter.
2) Apply sealant onto the connection threads of the sensor assembly to ensure secure watertightness;
3) When the sensor is screwed onto the housing, there shall be 5 turns of threads completely engaged. Be careful not to damage or twist the lead of the sensor tight;
4) To facilitate installation, pay attention to the orientation of the high and low pressure sides of the sensor assembly;
5) Tighten the locknut to a torque of about 40N•m.

3.3 Electrical Compartment
1) Check if the electrical board is clean;
2) Insert the intelligent electronic component into the circuit side of the transmitter;
3) The sockets on the connection board must be kept clean;
4) Screw the 2 locking screws tight on the intelligent electronic component.

3.4 Process Sensor
1) Place the wetted O-ring onto the separation diaphragm carefully;
2) Place the pressure chambers according to the required orientation, and tighten the 4 bolts;
3) Follow the following steps to make the pressure chambers be seated onto the enclosure of the sensor evenly;
   a. Tighten all the bolts with fingers;
   b. Tighten a bolt until the pressure chamber is seated.
   c. Apply torque onto a pair of bolts that are located diagonally;
   d. Apply torque onto the first pair of bolts;
   e. Apply torque onto the other pair of bolts;
   f. Inspect the conditions that the pressure chambers are seated on the sensor. Ensure that the pressure chambers are not warped;
   g. Check the 4 bolts are tightened to 40N•m securely;
   h. For transmitters with Range codes 2&3, Two temperature circulations shall be carried out before this inspection step. The circulation temperature shall exceeds the working range required.

3.5 Field Indicator
1) The indicator can be rotated for some separate 90° on its bracket to facilitate reading.
2) If for some reasons to remove the cover from the housing, it is necessary to make sure to check whether the position of the O-ring between the cover and the electrical compartment is correct.
   To ensure reliable sealing, never remove the glass on the cover for any reasons.

3.6 Exchange of Components
Some mechanical parts such as pressure chamber, connector, housing, cover and bracket are exchangeable on the instrument, whatsoever the ranges, calibrations and output signals are.

4. Troubleshooting
If the transmitter has malfunctions, the following steps can help you to find the trouble and to determine whether it is necessary to remove these parts for repair. These knacks can help you in diagnosing and repair 3 basic malfunction symptoms. For each symptom, first deal with the condition that is the easiest for inspection. If it is impossible to repair, please contact with the service center of our factory.

4.1 Over-Output
The possible causes and solutions:
1) Check the measurement ranges of the primary elements (such as the orifice);
2) Impulse piping:
   a. Check whether there is leakage or blockage in the impulse piping.
   b. Check whether the shut-off valve is fully open;
   c. Check whether liquid exists gas in the impulse piping or whether gas exists in the liquid impulse piping;
   d. Check whether there is any deposit in the pressure chamber of the transmitter;
   e. Check whether the specific gravity of the liquid in the impulse piping is changed.
3) Electrical connection of the transmitter:
   a. Make certain that the contact area of the plug-in components is clean. Inspect the connection conditions of the sensor;
   b. Check whether the voltage of the power supply is within the range of 12 ~ 45 V DC.
4) Circuit failure of the transmitter:
   a. Enter the "Self Test" mode with the HART communicator to judge whether the electronic component is failure or not.
   b. Replace the defective electronic components.
5) Sensor Subassembly:
   Refer to the inspection of the sensor subassembly described in this section.
6) Power supply:
   Check whether the output of the power supply conforms to the expected voltage.

4.2 Lower Output or No Output
The possible causes and solutions:
1) Primary elements:
   a. Check the installation and working conditions of the elements;
   b. Check whether the characteristics of the measured medium have been changed. It may affect the output.
2) Wiring circuit
   a. Check whether the voltage applied on the transmitter is normal;
   b. Check whether the circuit is shorted or grounded at multiple points;
   c. Check the connections of the +/- polarities of the circuit;
   d. Enter the "Loop Test " mode with the HART communicator to check whether the impedance of the circuit meets the requirements.
3) Impulse piping
   a. Check whether the connection of the impulse piping is correct;
   b. Check whether there is any leakage or blockage in the impulse piping;
   c. Check whether gas exists in the liquid impulse piping;
   d. Check whether there is any deposit in the pressure chamber of the transmitter;
   e. Check whether the shut-off valve is fully open, and the balance valve is closed tightly;
   f. Check whether the specific gravity of the liquid in the impulse piping is changed.
4) Electrical connection of the transmitter:
   a. Check whether the leads of the sensor assembly of the transmitter are shorted;
   b. Make certain that the contact area of the plug-in components is clean. Inspect the connection conditions of the sensor assembly.
   c. Check whether the torques of the adjustment screws are within the control ranges.
5) Circuit failure of the transmitter:
   a. Enter the "Self Test" mode with the HART communicator to judge whether the electronic component is failure;
   b. Replace the defective electronic components.
6) Sensor subassembly:
   Refer to the contents of this section concerning the inspection of the sensor assembly.

4.3 Unstable Output
The possible causes and solutions:
1) Wiring circuit:
   a. Check whether the transmitter has intermittent short-circuits, open-circuits, multiple-point grounding etc;
   b. Check whether the voltage applied on the transmitter is suitable.
2) Fluctuation of the liquid measured
   Adjust the damping value of the circuit.
3) Impulse piping
   Check whether the liquid exists in the gas impulse piping or gas exists in the liquid impulse piping.
4) Electrical connection of the transmitter
   a. Check whether intermittent short-circuits or open-circuits exist in the transmitter circuit;
   b. Make certain that the contact area of the plug-in components is clean. Inspect the grounding conditions of the sensor assembly.

4.4 Transmitter cannot Communicate
The possible causes and solutions:
1) Abnormal power supply
   Check whether the voltage of the power supply meets the requirements.
2) Load resistance
   Check whether the load resistance meets the requirements (refer to the load characteristics shown as Figure 2-1), the minimum is 250Ω.
3) Circuit failure of the transmitter
   Replace the defective electronic components.

Section 7 Uncrating and Completeness of the Product
1. Uncrating
   During uncrating, inspect whether the package is intact; check the type and specification of the transmitter against the order contract; check whether the documents provided along with the unit are complete.
2. Accessories
   2.1 Usage's Instructions 1 copy
   2.2 Product conformity certificate 1 copy
   2.3 Mounting bracket 1 set (LT type isn't provided with this accessory)
   2.4 Clamping hoop 1 pc (LT type isn't provided with this accessory)
   2.5 Hex bolt M10 4 pcs (M10×40 used for the kidney flange, and M10×25 for T connector)
   2.6 Hex nut M8 2 pcs (LT type isn't provided with this accessory)
   2.7 Washer 8 2 pcs (LT type isn't provided with this accessory)
   2.8 Washer 10 4 pcs
   2.9 Hex bolt M10x16 4 pcs
   2.10 Kidney flange or T connector (optional) 2 pcs (provide one for GP, AP, LT and DP single flange)
   2.11 Short-circuit contact pin 1 pc (no accessory with digital display)
3. Spare parts
   3.1 Ø25 O-ring (2 pcs for DP and HP types)
   3.2 Ø35 O-ring (2 pcs for DP and HP types)
4. Transportation and storage
1. The transmitter meets the requirements for on-road transportation, water-borne transportation and freightage loading.
2. The transmitter and its accessories shall be stored indoors with the original packages. The ambient temperature shall be –40ºC ~ +85ºC, and the relative humidity shall be no higher than 85%. The air shall not contain harmful substances which can cause corrosion to the transmitter.

Section 8 Notes for Explosion-proof Transmitters
The explosion-proof products of AT3000 intelligent transmitters have been verified by the national-level Instrument Explosion-proof Safety Supervision & Inspection Station (NEPSI) to conform to the applicable provisions of the national standards GB3836.1-2000 (universal requirement), GB3836.2-2000 (explosion isolation type) and GB3836.4-2000 (intrinsic safe type). The explosion-proof identifications are Exd II CT4-6 and Exia II CT4-6 respectively. The numbers of the explosion-proof certificates are GYB06592 and GYB06593. These products can be used in the corresponding explosion hazardous locations.

When ordering explosion-proof transmitters, the user must pay attention to the following points:
1. The explosion-proof products of AT3000 smart transmitters have two types available: explosion isolation type and intrinsic safe type. The user shall select and maintain them on the basis of the on-site requirements and in accordance with PRC Safety Specifications for Electrical Apparatuses in Explosion Hazardous Places and GB50058-92 "Design code for electrical installations in explosion & fire hazardous environment". The installation site shall have no harmful gases which are corrosive to aluminum alloy.
2. Make clear the hazardous places on site and the compositions of the flammable medium in these places. Check the explosion-proof grades and groups against GB3836 standard.
3. The transmitter selected shall have an explosion-proof grade and temperature group higher than or equal to those of the flammable medium. During the operation, it must be ensured that the temperature group of the transmitter conforms to the temperature of the medium measured (see the following table):
4. The permitted ambient temperature range for the operation of the explosion-proof products is –40ºC~+60ºC.
5. When ordering intrinsic safe type transmitters, it is necessary to purchase the corresponding safety barriers in accordance with the requirements of the nameplate or instructions. And they shall be wired as per the requirements. (Normally the safety barriers are supplied by our company. Refer to the usage instructions of the safety barriers.)

Notes for AT3000 smart pressure transmitters (explosion isolation type)
When using the explosion-proof products, the user must pay attention to the following points:
1. Operating ambient temperature range of intelligent pressure transmitter (-40~+60)ºC.
2. The relationship between temperature group and process medium temperature of intelligent pressure transmitter is as Table below:

<table>
<thead>
<tr>
<th>Temperature group</th>
<th>Process medium temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>T6</td>
<td>≤80ºC</td>
</tr>
<tr>
<td>T5</td>
<td>≤95ºC</td>
</tr>
<tr>
<td>T4</td>
<td>≤130ºC</td>
</tr>
</tbody>
</table>

3. The intelligent pressure transmitter enclosure is equipped with grounding terminal, and it shall be reliably grounded when user uses it.
4. The warning "Remove the cover after power-off!" must be abided by for installation, operation and maintenance.
5. The installation site shall not have corrosive gas harmful to aluminum alloy.

6. The outside diameter of lead-in cable sheath must not be less than 08, the compression nut shall be tightened at the site, so that the inside of the sealing ring can clamp the cable sheath tightly. If the sealing ring or cable sheath is aged, it shall be replaced, and the redundancy lead-in port shall be blocked with blind plate.
7. Maintenance must be performed at safe place; Maintenance can be performed where no flammable gas exists in the installation site.
8. User cannot replace the electrical components in the product randomly.
9. When installs, operates and maintains intelligent pressure transmitter, the user must abided by simultaneously relevant provisions of GB3836.13-1997 "Electrical apparatus for explosive gas atmospheres Part 13: Repair and overhaul for apparatus used in explosive gas atmospheres", GB3836.15-2000 "Electrical apparatus for explosive gas atmospheres-Part15: Electrical installations in hazardous areas (other than mines)" and GB50257: 1996 "Code for construction and acceptance of electric device for explosion atmospheres and fire hazard electrical equipment installation engineering".

Notes for AT3000 smart pressure transmitters (intrinsic safety type)
When using the intelligent pressure transmitter, the following items shall be taken into account:
1. Operating ambient temperature range of intelligent pressure transmitter (-40~+60)ºC.
2. The relationship between temperature group and process medium temperature of intelligent pressure transmitter is as Table below:

<table>
<thead>
<tr>
<th>Temperature group</th>
<th>Process medium temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>T6</td>
<td>≤80ºC</td>
</tr>
<tr>
<td>T5</td>
<td>≤95ºC</td>
</tr>
<tr>
<td>T4</td>
<td>≤130ºC</td>
</tr>
</tbody>
</table>

3. Parameters of intelligent intrinsic safety type pressure transmitter
U=28V I=93mA Pi=0.65W C=51nF L=0

4. The intelligent pressure transmitter must be used with associated device approved by NEPSI and meeting provisions of national standards GB3836.1-2000 and GB3836.4-2000 to compose intrinsic safety system which then can be used in the explosive dangerous site. The intrinsic safety system composed of the product and the associated device must meet the following conditions simultaneously: Uo≤Ui Io=Ii Po≤Pi Co≥Cc +Ci Lo≥Lc + Li
Note: Cc and Lc are the cable distribution parameters: Uo, Io and Po are the output parameters of associated device, Co and Lo are the maximal external capacitance and inductance of associated device.

5. The connecting cable between intelligent pressure transmitter and intrinsic safety connection of the associated device is a two-core shielding cable (cable must have insulation sleeve), the section area of the core >0.5mm², the shielding layer is grounded at non-dangerous place and insulated with product enclosure. The influence of electromagnetic interference can be eliminated with the most possibility for the cable wiring.

6. The associated device must be installed at safe place, and operation manual must be abided by for installation, operation and maintenance.
7. User cannot replace the electrical components in the product randomly.
8. When installs, operates and maintains intelligent pressure transmitter, the user must abided by simultaneously relevant provisions of GB3836.13-1997 "Electrical apparatus for explosive gas atmospheres Part 13: Repair and overhaul for apparatus used in explosive gas atmospheres", GB3836.15-2000 "Electrical apparatus for explosive gas atmospheres-Part15: Electrical installations in hazardous areas (other than mines)" and GB50257: 1996 "Code for construction and acceptance of electric device for explosion atmospheres and fire hazard electrical equipment installation engineering".
Section 9  AT3000 Menu Operation Manual

So long as the display module is ordered, general parameters of transmitter can be set via this menu.

I. The display menu tree is as follows:

Start with "Enter" key
- EXIT (Exit)
- VIEW (Variable view)
  - Primary Variable (Current value of pressure/differential pressure)
  - Percent Value (Percent value of current pressure/differential pressure value to range)
  - Analog Output (Output current value)
- GET 0% (Analog range apply zero drift)
- GET 100% (Analog range apply full position setting)
- SET 0% (Analog range zero setting)
- SET 100% (Analog range full range setting)
- SHIFT ZERO (zero adjustment for pressure/differential pressure)
- DAMPING (Damping setting)
- DISPLAY (Selection of display type)
  - Primary Variable (Current pressure/differential pressure value)
  - Percent Value (Percent value of current pressure/differential pressure value to range)
  - Analog Output (Output current value)
- UNIT (Unit selection)
  - inH20
  - inHg
  - ftH20
  - mmH20
  - mmHg
  - psi
  - bar
  - mbar
  - g/cm²
  - kg/cm² (Abbreviation of kg/cm²)
  - Pa
  - kPa
  - torr
  - atm
  - MPa
- FUNCTION (Selection of characteristic function)
  - Linear (Linear)
  - Square Root (Square root)
- SOFT VER (Software version)
  - WTR206 R60

II. Operation Instructions

1. Definition of Keys

Definitions for three buttons by depression local "Zero" and "Span" button are described below:
1.1 "Enter" button: depress the "Zero" and "Span" button simultaneously, release them after holding them for 0.2~10s; "Enter" button will be input once by performing this operation every time;
1.2 "Left" button: press the "Span" button, release it after holding it for 0.2~10s, "Left" button will be input once by performing this operation every time;
1.3 "Right" button: press the "Zero" button, release it after holding it for 0.2~10s, "Left" button will be input once by performing this operation every time;

Note: When local buttons are manipulated, non-magnetic material tool is recommended; otherwise it will be of invalidity by pressing single button or result in two buttons effect with only one button depressing.

2. Menu startup and exit

2.1 When the menu isn't activated, it'll startup by pressing "Enter" button once shown as Figure 1.

2.2 Under the state as Figure 1, press "Enter" button to exit the menu, and the menu will be return to un-startup state.

2.3 When keys have not been pressed for continual 60s, program will automatically exit the menu, namely the menu will be return to un-startup state.

3. Browse Menu

After menu is started, it can be browsed by pressing "Left" button and "Right" button.

3.1 "Left" button is used to display various menu items of the menu tree from bottom to top in cycle, as shown in Figure 1. Press "Left" button once and display will be as Figure 2, and then press "Left" button again, display will be as Figure 3.

3.2 "Right" button is used to display various menu items of the menu tree from top to bottom in cycle, as shown in Figure 1. Press "Right" button once and display will be as Figure 4, and then press "Right" button again, display will be as Figure 5.
4. Menu Selection
When menu is browsed, press "Enter" button once, program will run corresponding function of this menu.

5. Data Input
When user sets instrument parameters via menu, data can be input in two modes.

5.1 Data Selection
For instance: if current unit is "kPa" and menu isn't started, the steps will be as follows to change the unit to "bar":
5.1.1 Press "Enter" button (start menu) once and display will be as Figure 1;
5.1.2 Press "Left" button twice or "Right" button ten times (menu browse), the display will be as Figure 3;
5.1.3 Press "Enter" button (menu selection) once, if write-protect switch is at "Not protected", program will enter unit setting function shown as Figure 6; otherwise error prompt will be given as Figure 7, press "Enter" button again to clear prompting message, program will return to menu browse state shown as Figure 3.
5.1.4 Press "Left" button five times or "Right" button nine times (data selection), display will be as Figure 8;
5.1.5 Press "Enter" button (data input) once, program will change unit to "bar" and the prompting message will be displayed as Figure 9;
5.1.6 Press "Enter" button once to clear prompting message, program will return to the menu browse state as Figure 3;
5.1.7 Press "Left" button ten times or "Right" button twice (menu browse), the display will be as Figure 1;
5.1.8 Press "Enter" button once to exit the menu, and the menu will return to un-startup state.

5.2 Data Edit
For instance: if current damping value is 0.1s and the menu isn't started, to change damping value from 0.1s to 1.0s, the steps will be as follows:
5.2.1 Press "Enter" button (start menu) once and display will be shown as Figure 1;
5.2.2 Press "Left" button four times or "Right" button eight times (menu browse), display will be as Figure 10;
5.2.3 If write-protect switch is at "Not protected", Press "Enter" button (menu selection) once, program will enter damping setting function as Figure 11; otherwise error prompt will be given as Figure 7, press "Enter" button again to clear prompting message, program will return to menu browse state as Figure 10.
5.2.4 Press "Left" button or "Right" button once to enter data edit state, the blink cursor will appear on the character "0" above damping value unit "s".
5.2.5 Press "Left" button twice and move cursor to character "1";
5.2.6 Press "Right" buttons nine times to change character "1" to "0" at the cursor position.
5.2.7 Press "Left" button once to move cursor on the first character "0" at the left of decimal point;
※ Terms Explanation ※
Cursor Blink: When cursor appears, display will be as Figure 12; when cursor disappears, the original character will be still displayed;

Cursor Move: After entering the data edit state, press "Left" button once and cursor will move one step to the left. If this position is decimal point, cursor will automatically move one more step to the left. If it reaches the most left digit, cursor will be moved to the final right digit.
Digit Turnover: After entering the data edit state, press "Right" button once, the digit at cursor position will be increased by 1, namely "0" is changed to "1", "1" is changed to "2", special change is "9" to "0", space character " " is changed to "0", "+" is changed to "-";
Prompt: When cursor is moving, cursor will automatically jump over decimal point.
5.2.8 Press "Right" button once, the character "0" at cursor position will be changed to "1" shown as Figure 13;
5.2.9 Press "Enter" button (data input) once, program will change damping value to 1.0s and display prompting message shown as Figure 9. If the input data exceeds allowable scope of program, error will be prompted as Figure 14. Press "Enter" button again to clear the prompting message, and program will return to the menu browse state shown as Figure 10.

The unit has been changed to "bar".
5.2.10 Press "Enter" button once to clear the prompting message, program will return to the menu browse state shown as Figure 10;

5.2.11 Press "Left" button eight times or "Right" button four times (menu browse), display will be as shown in Figure 1;

5.2.12 Press "Enter" button once to exit the menu, and the menu will return to un-startup state.

III. Operation Guide

1. Menu Startup and Exit

1.1 When menu isn't started, it'll be started by pressing "Enter" button once shown as Figure 1:

1.2 Under the state shown as Figure 1, press "Enter" button to exit the menu, and the menu will be un-startup.

2. Variable View

2.1 Startup the menu.

2.2 Browse the menu and select "VIEW" item shown as Figure 4;

2.3 Press "Enter" button once to enter variable view function. The first variable "Current pressure/differential pressure value", engineering unit and variable serial number will be displayed shown as Figure 15 (supposed engineering unit is "kPa");

Prompt: "*******" indicates unconfirmed pressure/differential pressure value.

2.4 Press "Right" button once to display the second variable "percent value of current pressure/difference pressure", percentage "%" and variable serial number shown as Figure 16;

Prompt: "*******" indicates unconfirmed range value of pressure/differential pressure in percentage.

2.5 Press "Right" button once to display the third variable "Output current value", unit "mA" and variable serial number shown as Figure 17;

Prompt: "********" indicates unconfirmed output current value.

2.6 Press "Right" button once and the first variable will be displayed again shown as Figure 15;

2.7 If "Left" button is pressed in turns, the first variable, the second and third will be displayed according in reverse sequence.

2.8 Press "Enter" button once to return to menu browse state shown as Figure 4.

Prompt: In the "VIEW" menu function, the function of "Left" button and "Right" button is similar to menu browse.

3. Analog Range and Zero Shift

Please refer to the contents in "Calibration" of corresponding product operation manual for cautions of this operation.

For instance:

If there is a differential pressure transmitter installed at the project site, the upper range limit of the sensor is 40kPa, range is 0~20kPa; under actual operation. When differential pressure of the pipe is 0~20kPa, the display will be 0.1-20.1kPa and the output current will be 4.08~20.08mA.

Requirement: Keep the display unchanged and change the output current value to 4~20mA.

Operation steps are as follows:

3.1 When pipe differential pressure is 0kPa, display will be +0.1kPa;

3.2 Set write-protect switch on "Not protected" state;

3.3 Start menu and browse it, select "GET 0%" menu as Figure 5;

3.4 Press "Enter" button once and program will change analog range to 0.1~20.1kPa, and display prompting message shown as Figure 9;

3.5 Press "Enter" button once to clear prompting message, program will return to menu browse state shown as Figure 5;

3.6 On "VIEW" menu, the first variable is 0.1kPa and the third is 4mA;

3.7 Make the pipe differential pressure to 20kPa;

3.8 In the "VIEW" menu, the first variable is 20.1kPa and the third is 20mA;

3.9 Exit the menu and the operation ends.

4. Analog range apply full position setting

Please refer to contents of "Calibration" in corresponding product operation manual for cautions of this operation.

For instance:

If there is a differential pressure transmitter installed at the project site, the upper range limit of sensor is 40kPa, analog range is 0~40kPa. Under actual operation, when the pipe differential pressure is 0~20kPa, the display will be 0~20kPa and the output current will be 4~12mA.
Requirement: Keep the display unchanged and change the output current value to 4~20mA.

Operation steps are as follows:
4.1 Make the pipe differential pressure to 20kPa and +20kPa is displayed;
4.2 Set write-protect switch on “Not protected” state;
4.3 Start the menu and browse it, select “GET100 %” menu shown as Figure 18;
4.4 Press “Enter” button once and program will change analog range to 0-20kPa, and display prompting message shown as Figure 9;
4.5 Press “Enter” button once to clear prompting message, program will return to the menu browse state shown as Figure 18;
4.6 On "VIEW" menu, the first variable is 20kPa and the third is 20mA;
4.7 Make the pipe differential pressure to 0kPa;
4.8 On "VIEW" menu, the first variable is 0kPa and the third is 4mA;
4.9 Exit menu and operation ends.

5. Analog Range Zero Setting

Please refer to the contents of “Calibration” in corresponding product operation manual for cautions of this operation.

For instance: If there is a differential pressure transmitter installed at the project site, the upper range limit of sensor is 40kPa, range is 0~20kPa; under actual operation, when the pipe differential pressure is -4~20kPa, the output current will be 3.9~20mA.

Requirement: Keep the display unchanged and change the output current value to 4~20mA.

Operation steps are as follows:
5.1 Set write-protect switch on “Not protected” state;
5.2 Start the menu and browse it, select “SET 0 %” menu shown as Figure 19;
5.3 Press “Enter” button once and the display displays 0kPa as the analog range lower limit shown as Figure 20;
5.4 Press "Left" button or "Right" button once to enter into data edit state, and the cursor blinks on the display;
5.5 Press "Left" button three times and move the cursor next to the first character "0" on the left of the decimal point;
5.6 Press "Right" button four times and change the character "0" to "4";
5.7 Press "Left" button twice and move the cursor to character "+";
5.8 Press "Right" button once to change the character "=" to "+" shown as Figure 21;
5.9 Press "Enter" button once and program will change the upper limit of analog range to -4kPa shown as Figure 9;
5.10 Press "Enter" button once to clear prompting message, program will return to the menu browse state shown as Figure 19;
5.11 Make the pipe differential pressure to -4kPa;

5.12 Through “VIEW” menu, the first variable is -4kPa and third variable is 4mA;
5.13 Make the pipe differential pressure to 20kPa;
5.14 On "VIEW" menu, check that the first variable is 20kPa and the third is 20mA;
5.15 Exit menu and the operation ends.

6. Full Analog Range Setting

Please refer to the contents of "Calibration" in corresponding product operation manual for cautions of this operation.

For instance: If there is a differential pressure transmitter installed at the project site, the upper limit range of sensor is 40kPa, analog range is 0~40kPa. Under actual operation, when the pipe differential pressure is 0~20kPa, the display will be 0-20kPa, and the output current will be 4~12mA.

Requirement: Keep the display unchanged and change the output current value to 4~20mA.

Operation steps are as follows:
6.1 Set write-protect switch on "Not protected" state;
6.2 Start the menu and browse it, select “SET100 %” menu shown as Figure 22;
6.3 Press "Enter" button once and the display displays that the analog range lower limit is 40kPa

6.4 Press "Left" button or "Right" button once to enter into the data edit state, and the cursor blinks on the display;
6.5 Press "Left" button four times and move the cursor to character "4";
6.6 Press "Right" button eight times and change character "4" to "2" shown as Figure 24;
6.7 Press "Enter" button once and program will change the upper limit of analog range to 20kPa shown as Figure 9;
6.8 Press "Enter" button once to clear prompting message, program will return to menu browse state as Figure 22;
6.9 Make the pipe differential pressure to 0kPa;
6.10 On the "VIEW" menu, the first variable is 0kPa and the third is 4mA;
6.11 Make the pipe differential pressure to 20kPa;
6.12 On the "VIEW" menu, the first variable is 20kPa and the third is 20mA;
6.13 Exit menu and the operation ends.

7. Zero Adjustment
Please refer to the contents of "Calibration" in corresponding product operation manual for cautions of this operation.

For instance: If there is a differential pressure transmitter installed at the project site, the upper limit range of sensor is 40kPa, analog range is 0–20kPa. Under actual operation, when the pipe differential pressure is 0–20kPa, the display will be 0.1–20.1kPa and the output current will be 4.08–20.08mA.

Requirement: Keep the display unchanged at 0–20kPa and change the output current to 4–20mA.

Operation steps are as follows:
7.1 When pipe differential pressure is 0kPa, display will be +0.1kPa;
7.2 Set write-protect switch on "Not protected" state;
7.3 Start the menu and browse it, select "SET" and "ZERO" shown as Figure 25;
7.4 Press "Enter" button once, program will modify the Zero and display promoting message shown as Figure 9;
7.5 Press "Enter" button once to clear the prompting message, program will return to the menu browse state shown as Figure 25;
7.6 On "VIEW" menu, the first variable is 0kPa and the third is 4mA;
7.7 Make pipe differential pressure at 20kPa;
7.8 On "VIEW" menu, the first variable is 20kPa and the third is 20mA;
7.9 Exit menu and the operation ends.

8. Analog Span Offset
For instance: If there is a differential pressure transmitter installed at the project site, its upper range limit is 40kPa, range is 0–40kPa. When in actual operation, the pipe differential pressure is -20~20kPa, so the display will be -20~20kPa and output current will be 3.9~12mA.

Requirement: Display isn't changed and output current value is changed to 4–20mA.

Adjustment steps are as follows:
8.1 Make the pipe differential pressure at 0kPa, display will be 0kPa;
8.2 Set write-protect switch on "Not protected" state;
8.3 Start the menu and browse it, select "OFFSET " and "SHIFT" shown as Figure 26;
8.4 Press "Enter" button once and percent value of current pressure/differential pressure is displayed to +0.00% shown as Figure 27;
8.5 Press "Left" button or "Right" button once to enter data edit state, and cursor blinks on the display;
8.6 Press "Left" button three times and move the cursor to the first null character " " on the left next to the decimal point;
8.7 Press "Right" button five times to change null character " " to "5" shown as Figure 28;
8.8 Press "Enter" button once and program will perform offset to analog range, namely modify the upper limit and lower limit of analog range, the modified value and direction are the same. The modification is performed as the following formula:
1) Range difference = upper range limit - lower range limit = 40-0 = 40kPa
2) Percent value of modification = percent value after offset - percent value before offset = 50.00% -0.00% = 50.00%
3) Modification = range difference × percent value of modification = 40×50.00% = 20kPa
4) Upper range limit after drift = original upper range limit - modified value = 40-20 = 20kPa
5) Lower range limit after drift = original lower range limit - modified value = 0-20 = -20kPa
Meanwhile, the prompting message will be displayed as Figure 9;
8.9 Press "Enter" button once to clear prompting message, program will return to the menu browse state shown as Figure 26;
8.10 On the "VIEW" menu, the first variable is 0kPa and the third is 12mA;
8.11 Make the pipe differential pressure to 20kPa;
8.12 On the "VIEW" menu, the first variable is 20kPa and the third is 20mA;
8.13 Make the pipe differential pressure to -20kPa;
8.14 On the "VIEW" menu, the first variable is -20kPa and the third is 4mA;
8.15 On the "SET0%" menu, the range lower limit has become -20kPa;
8.16 On the "SET100%" menu, the range lower limit has become +20kPa;
8.17 Exit menu and the operation ends.

9. Damping Setting
Please refer to the contents in "II. Operation instruction" "5. Data Input" and "5.2 Data Edit" in this section.

**Prompt:** The valid damping value is 0.1s~16s. If the input parameter exceeds this range, program will reject the modification and display error message shown as Figure 14.

10. Selection of Display Type
When the menu isn't started, the display will only display one of the three variables in the "VIEW" menu, which can be set via the "DISPLAY" menu.

**For instance:** If current display is the second variable "percent value of pressure/differential pressure value range".

**Requirement:** Change the display to the first variable "pressure/differential pressure value".

**Operation steps are as follows:**
10.1 Set the write-protect switch on "Not protected" state;
10.2 Start the menu and browse it, select "DISPLAY" as shown in Figure 29;
10.3 Press "Enter" button once to display the second variable as shown in Figure 30;
10.4 Press "Left" button once or "Right" button twice to display the first variable as shown in Figure 31;
10.5 Press "Enter" button once and program will change the display type to the first variable as shown in Figure 32.

11. Unit Selection
Please refer to the contents in "II. Operation instruction" "5. Data Input" and "5.1 Data Selection" in this section.

12. Characteristic Function Selection
Characteristic function includes linear and linear square root which can be selected and set via "FUNC-" and "TION".

**For instance:** Supposing that current characteristic function is linear.

**Requirement:** Change characteristic function to linear square root.

**Operation steps are as follows:**
12.1 Set write-protect switch on "Not protected" state;
12.2 Start the menu and browse it, select "FUNC-" and "TION" shown as Figure 2;
12.3 Press "Enter" button once and display will display current linear characteristic function shown as Figure 30;
12.4 Press "Left" button once or "Right" button once, display will display the linear square root characteristic function shown as Figure 31;
12.5 Press "Enter" button once and program will change the characteristic function to linear square root and display the prompting message shown as Figure 9;
12.6 Press "Enter" button once to clear prompting message, program will return to the menu browse state as Figure 2;
12.7 Exit menu and current characteristic function has been changed to linear square root shown as Figure 32. When characteristic function is linear, display will be as Figure 33.

**Prompt:** **"** indicates unconfirmed display.

13. Viewing Software Version
Software version displays the code and version of current instrument software.

**Operation steps are as follows:**
13.1 Start the menu and browse it, select "SOFT" and "VER";
13.2 Press "Enter" button once and display will display the code and version "WTR206" and "R60" of current software;
13.3 Press "Enter" button once to clear software version information, and program will return to menu browse state.
Appendix A

Handheld HART Communicator (model 375)

I. HART Handheld Communicator

HART Hand-held Communicator is able to carry out basic communication with compatible HART instruments. With this device, we can perform HART communication at the work station or in the control room, with the local instruments which are installed on the field.

II. Wiring

1. Back wiring of HHT

II. Wiring

I. Back wiring of HHT

Figure 1 HART Hand-held Communicator 375

Figure 2 Back of HART Hand-held Communicator 375

2. Connecting HHT with instrument (Figure 3)

Figure 3 Wiring of HHT loop

Note: Resistance of 230~600Ω must be connected between hand-held communicator and the power loop. Do not try to measure the loop current directly by hand-held communicator.

III. Keys of communicator

3.1 Power switch

Power switch , press down the power switch key to turn on or off the power off the HHT.

3.2 Up arrow

Up arrow , use the up arrow key to move the cursor up on the menu or in a list of choices.

3.3 Down arrow

Down arrow , use the down arrow key to move the cursor down on the menu or in a list of choices.

3.4 Left arrow

Left arrow , use this key to move the cursor left or to return to the previous menu.

3.5 Right arrow

Right arrow , use this key to move the cursor right or to select a menu item.

3.6 Action key

Action key , use this key to verify the soft key command.

Note: The soft key command refers to appear at the bottom of the screen, not more than four command options, such as “ABORT”、“ESC”、“ENTER”、“BACK”、“DEL”.

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3.7 Alphanumeric keys and shift keys
Alphanumeric keys are mainly responsible for data input, as shown in figure 4.

![Alphanumeric keys of HHT](image)

Figure 4 Alphanumeric keys of HHT

3.8 Use the shift keys to input data
When some menu requires the input of data, the Alphanumeric keys and shift keys are used to input text and digital information. If press the Alphanumeric keys directly, it means you chose the bold symbol keys in the middle of the Alphanumeric keys, including the numbers from 0 to 9, the decimal point (.) and the dash number (-). If you need to input other symbols, associate the character and numeric keys to enter digits and characters. For example, when you need to enter the letter “R”, please press on [ ] and then [ ] .

IV. Menu
After turning the HART communicator on, it will automatically polling online equipment at address 0. When there is no HART device in the loop, it will display "NO device found at address 0, Poll?", press "NO", and the main menu appears, as shown in figure 5.

When there is a HART device in the loop, it directly enters the online menu, as shown in figure 6. Press left arrow key in the online menu to return to the main menu.

Note: for details of main menu and its related operation, please see HART communicator.

![Main menu](image)

Figure 5 Main menu

For online menu, please see figure below.
Appendix B

Statement of Product Warranty Period:

1. The warranty period for whole unit is 18 months;
2. If the product is reworked within the warranty period, the warranty period for repaired or replaced component shall be extended by one year from the date of its shipment. If the original warranty period of 18 months does not expire after one year is extended, the original warranty period of 18 months will be adopted, and the warranty period for not repaired components shall remain.
3. If product is reworked out of the warranty period, the warranty period of repaired or replaced component will be extended by one year. No warranty is provided for other part;
4. The warranty period for products provided by the third party shall be performed according to the warranty period confirmed by the third party. For instance: the warranty period for three-valve manifold is one year.