AUTROL® Series

Operation Manual : M3700N-K01E

APT3700N

Smart Pressure Transmitter for Nuclear Service

Operation Manual

DUON SYSTEM CO., LTD

AUTROL® NUCLEAR

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Notice-2

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“Smart Pressure Transmitter for Nuclear service Operational Manual”

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K01B	'05.07.18	4-8 Revised
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K01E	'10.10.15	Front Revised

The following Manual may change without the user's notice.

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Main Point

Duon System Co., LTD's model APT3700N Series depending on the user Calss 1E should follow the IEEE Std 323 & 344's verification demand process, and produce Quality assuring system of KEPIC-ENA.

Smart Pressure Transmitter for Nuclear Service verification result is shown in the following TEST REPORT.

G401-635 “Equipment Qualification Test Procedure”
G401-637 “Aging Analysis Report”
G401-638 “Environmental Test Report”
G401-639 “EMC test Report”
G401-640 “Seismic Test Report”

Notes

Table of Contents

1. Introduction

DUON SYSTEM CO., LTD

1.1. Overview

The following manual contains how to install, run and maintain the DUON SYSTEM CO., LTD's Smart Pressure Transmitter APT3700N Model Series.

The following Manuel as follows consists of 6 categories.

2. Installation

It gives information about the mechanical part, electrical connecting parts and what may happen while installing the transmitter.

3. Calibration

It gives information about the transmitter's calibration.

4. Operation

It gives information about the transmitter's operation.

5. Maintenance and Troubleshooting

It gives information about the basic hardware's troubleshooting and sensor module's installation steps and test.

6. Specification and Reference Data

It gives information about the product's performance, functional and physical properties, ordering list and spare part list.

1.2. Smart Pressure Transmitter

The Model APT3700N Series follows the technical specification of the new nuclear power plant of 9-183-J230C of claims postulated, and performance of IEEE Std 323-2003 and IEEE Std 344- 2004's requirement, and shows the result of the Test Report of the G401-635, G401-637, G401-638, and G401-639, G401-640.

The using environment of APT3700N Series is a Mild Environment, and the radioactivity of the Harsh Radiation Environment (≤100Gy) shows a requirement.

The model APT3700N Series is divided into Class 1E and SEISMIC Category I, and the occurrence of Pressure(PT), Water Level(LT), Flux(FT) process of the

nuclear energy of the power plant of the high rank system shows a function of the 4~20mA signal of the Digital communication HART Protocol transmitter.

Notes

2. Installation

2.1. Overview

The following describes the following information about installing.

- **General Consideration**
- **Mechanical Consideration**
  - Process connection
  - Conduit
- **Electrical Consideration**
- **Installation Consideration**
  - Installation Procedure
    Mechanical
    Electrical

2.2. General Consideration

Pressure, flux, water level's measurement can show an effect with the pipe and valve's combination. Also the transmitter's installation should require at least the minimum temperature change, vibration, and shock.
A wrong installation may give a measurement error. Transmitter's verification measurement is effected in the installation of the surrounding temperature.

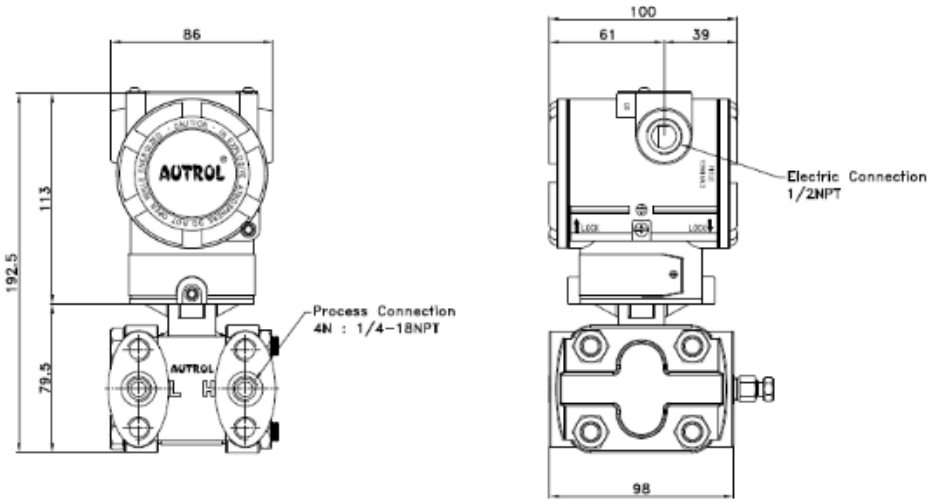
2.3. Mechanical Consideration

The following content contains information about transmitting Mounting, and the user should acknowledge this before installing the transmitter. Refer to [Figure 1 Transmitter Layout]

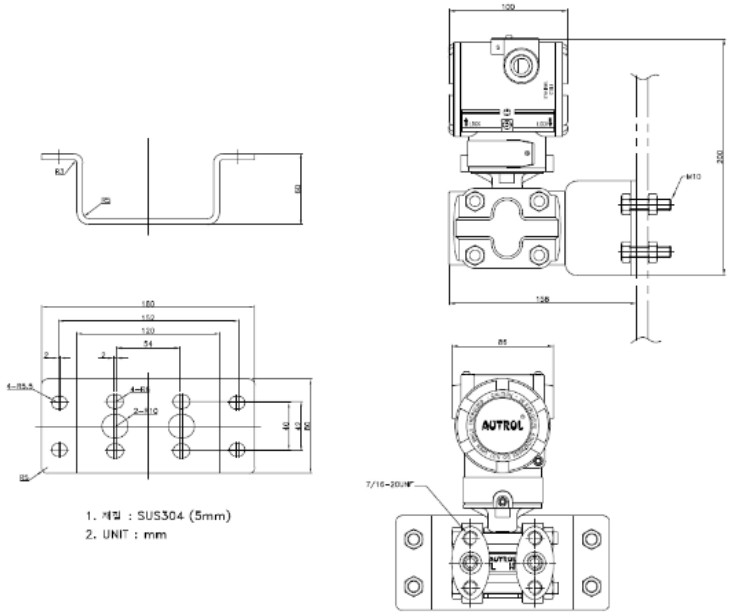
When installing APT3700N Series' the types of Mounting Brackets that were used were divided into 3 categories of Flat Type, Angle Type, and Wall Type. The Bracket that is used at the nuclear energy plant without the user's special notice is the Wall Type Bracket.

[Figure 2 Wall Type Bracket], shows the supply and verification of the Mounting.

If the user uses the Mounting way and Bracket's shape [Figure 2] changes its shape or gets installed in a place where it is not sturdy, the user must not over J230C-ER-A01-01(G401-640)'s standard of the Duon System Co., LTD verification.



[Figure 1 Transmitter Layout]



[Figure 2 Wall Type Braket],

2.3.1. Process Connection

The plumbing job must prevent the technical stress of affecting the transmitter by an earthquake.

The transmitter Flange's basic standard is 1/4-18 NPT, and the nuclear power plant's basic standard uses 3/8-in. (The nuclear power plant's basic standard is given to the Buyer. Reference to KHNP's Technical Specification 9-183-J230C)

Transmitter Flung type is divided into Differential, Gage, and Absolute, with the manufacturer's basic standard shipped as 1/4-18 NPT.

There should be not water leak at the scene when connecting the pipelines when using the connecter of 3/8-in by the Buyer, and also should use shorter pipelines. As for sealing the pipelines, we prohibit using Teflon when the environment is poor.

There should be no pressure between process and the transmitter, a water leak from pressure, the density change between the temperature change of High and Low of an attachment, and if the certain item is liquid that can change to gas, the error should be minimum.

Especially with the attachment, we should consider the following.

- We should keep both temperatures of both High and Low.
- If it is sea water, the water level should be the same for both High and Low pipelines.
- It is not allowed to Purge while transmitting while Purging, and the transmitter should be installed considering this, and the transmitter should physically use the locking mechanism of the High and Low.

2.3.2. Conduit

The transmitter's pipe standard uses 1/2-14 NPT. When connecting the pipes, consideration is as follows.

- The moisture should be prevented that can happen inside the housing terminal whether it functions accordingly or during an accident.
- There should be protection of a technical stress to the transmitter during an earthquake.
- Installation should follow such as [Figure 3. Transmitter Installation Example] (maker's choice) or refer to the installation of the professional company's specifications.

NOTE
When installing the nuclear power plant, the pipeline connecting and supplying is through a Buyer.

2.4. Electric Consideration

The following page describes the electric transmitter's connection.
The worker should acknowledge the area of the transmitter when installing.

Duon System Co., LTD Model is a machine that uses the DC power to signal 4~20mA dc of the 2 Wire way of fluctuating load.
The power should function at least at 12Vdc@ No-load(ZERO ohm), and a max of 21.1mA.
The transmitter's electric connection should refer to [Figure 3. transmitter's own purchase material].

The transmitter's output range is shown as followed

.

The following voltage change can be shown the transmitter's output of the impressed voltage.

$T_{vin} = V_I - V_c$

T_{vin} : The input of power supply of transmitter voltage

V_I : Impressed Voltage

V_c : Voltage Loss

$$(V_c = Current \times Load(R))$$

If the power supply is $24V_{dc}$ and the output is 4mA.....

$$V_c = 4 \times 250 = 1\, V_{dc} \quad (1)$$

$$T_{vin} = V_I - V_c = 24 - 1 \quad (2)$$

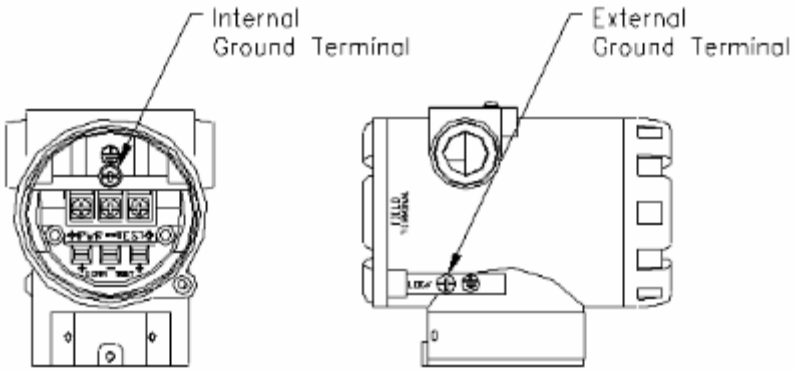
$$T_{vin} = 23\, V_{dc} \quad (3)$$

It does not affect the Transmitter even though of a protection against an accidental earthling in the Transmitter's Electric Terminal Wiring of the Wire. However if the electric noise atmosphere that is exposed, the Twisted pairs wire can make the lowest atmosphere.

Protection against an accidental earthling must satisfy the electric standard of the nation, and should try to make lowest of the protection. (Example: Below 10 ohm)

NOTE
If it is possibly embedded in the lightening protection, it should certainly satisfy the KS Standard (protecting resistance: Below 10 ohm).

Ground Terminal is in the Personal Socket inner and outer box, and using any of it is fine. Wire quality and requirement is satisfying of the technique specifications of the requirement.

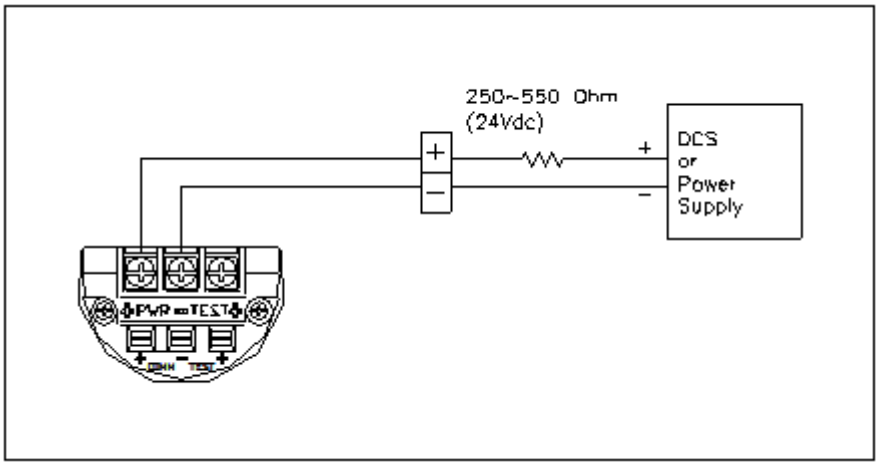


APT3700N Smart Pressure Transmitter
Internal and External Ground Terminal

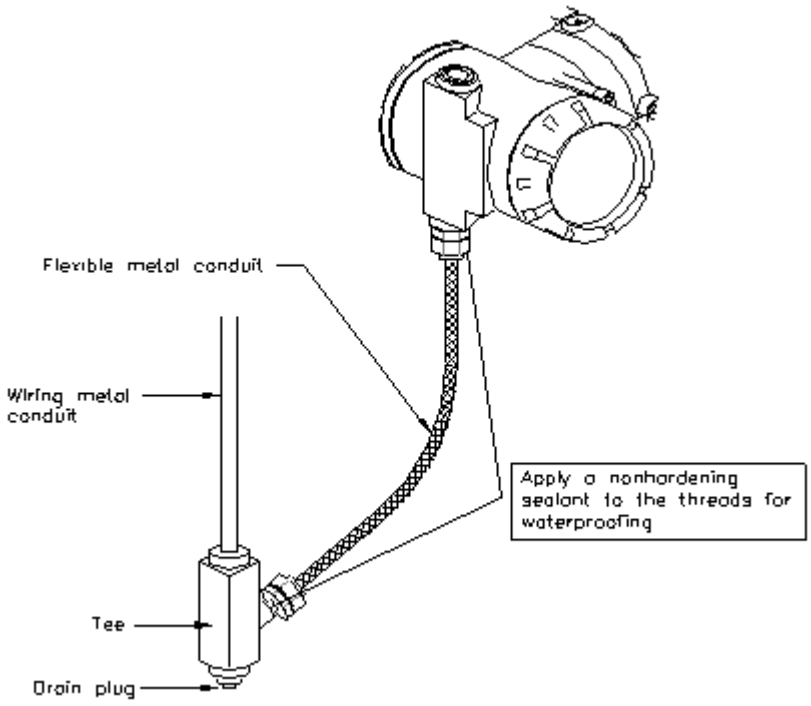
▲ Warning

Explosion can lead to death or give fatal damage :

- ◈ Do not open the Transmitter's cover when the power supply is entered in the Transmitter during an Explosive Atmosphere.
- ◈ Make sure the measurement Check if the measuring equipment if it is installed to the power line following the essential safety regulation before connecting the Explosive Atmosphere of HHT.



[Figure 3 Connecting to Personal Socket Transmitter]



[Figure 4 Typical Wiring Using Flexible Metal Conduit]

2.4.1. Power Supply and Load Resistance

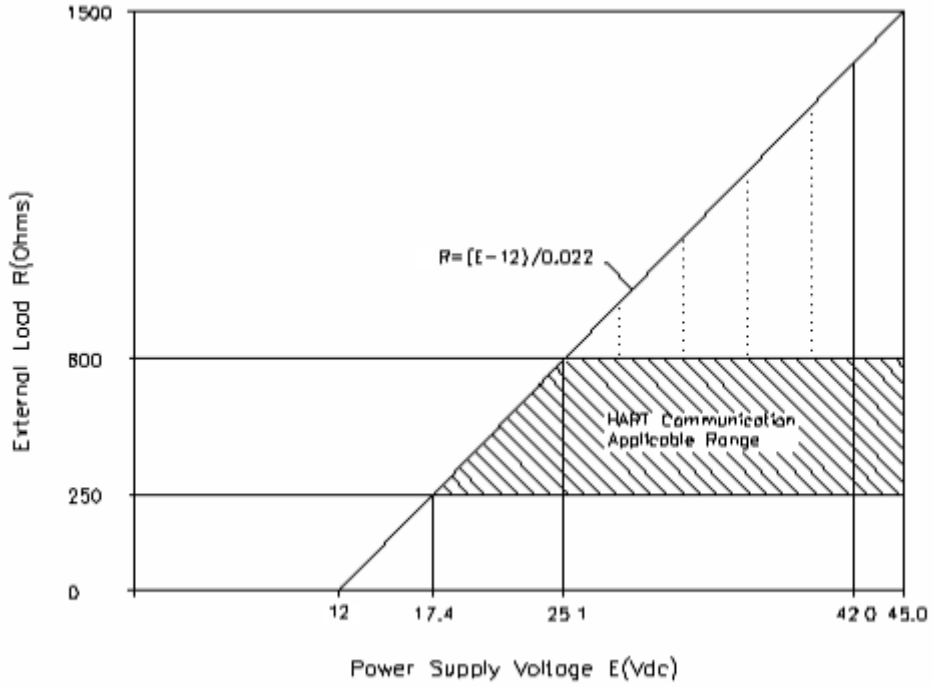
When choosing the Loop, check if the outer load resistance is within the range of the Figure(Figure 5). Inner transmitter's terminal voltage is

General standard : 12 to 45Vdc and
HART communication : 17.5 to 45 Vdc,

Transmitter's max electricity is 21.1mA so it becomes

R = (E-12) / 0.0211

Here it is R = Outer Load Resistance, E = Source Voltage.
To have HART communication, external resistance above 250 ohm is needed.



[Figure 5 Transmitter Power Limit Supply]

2.5. Install Consideration

2.5.1. Mechanical

Product's outside view should refer to [Figure 1].

Installing Bracket and installing way should follow the same way as [Figure 2].

2.5.2. Electronic

The following Transmitter uses the capacitance or Piezo-electric type's pressure sensor and if the approved pressure is changed, the following sensor's capacitance changes slightly. These distinct electric signal changes in the settings of the analog setting range. The following measure value's accuracy is Transmitter's setting and impulse piping as a difference. To receive a good accuracy, the Transmitter has to Fixation the process closely and shortens the pipe's length. Transmitter's easy handling, a person's safety handling and actual field easy correction should be considered. Also the vibration and other impact and temperature change is installed in the lowest transmitter. Transmitter inner housing is separated into two different parts. One part is electronic circuit, the other part is personal socket (Terminal Block). Personal Socket part is the Transmitter back side

and the Transmitter outer housing has to show “Field Terminal”. When opening the housing cover, inside the housing cover is a transmitter Personal Socket (Terminal Block). Transmitter’s supply power is Personal Socket’s connection of considers the polarity. HART’s power supply configurator is connected to the power supply terminal’s “COMM” plate. The site installed outside the Indicator can connect to the “TEST” pin.

Transmitter’s power service is terminal voltage’s entry of between 12 ~ 45V D.C. voltage, the power service has to be below the 2% Ripple. Loop resistance is the total resistance in the loop area and the Intrinsic Safety Barrier usage both includes the barrier resistance.

Greatest Loop Resistance $[W] = \frac{(E-12)\ Vdc}{0.0211\ A}$

Here, the loop resistance of HART communication is recommended of supplying voltage when it is 24Vdc, it is between value of 250 ~ 550 Ohm.

a. Caution in the finals

Cable should be installed in the greatest capacitive transformer, motor, power supply unit and same electric static root.

Before finishing, the electric Final Connection (Cap) should be placed.

All parts with screw pair should use the waterproof suture.
(recommended suture silicone type that does not harden and is used in the field)

To avoid material noise, duct should not be installed in both the signal line and power line. Shield wire should be used at the material noise influence electronically.

Cable should be used that can satisfy the instrument regulation of handling the temperature above the surrounding temperature or area in a low ground.

There is a need for wire and cable for atmosphere to handle poor gas, solvent, corrosive gas or liquid.

b. Link Procedure

1) Open the housing cover named “FIELD TERMINAL”.

2) Connect the power to the “+ PWR” terminal(left terminal) “+” and connect the power to the PWR “-“ terminal(middle terminal) “-“ . The side that is shown “TEST” “+” terminal should not connect to the “+” power. TEST terminal’s connectivity will damage the Test diode.

3) Housing’s Personal Socket side to prevent moisture prevention should use the (Conduit) to stop the connecting piece.

4) Transmitter’s power supply is supplied through the (Signal Wiring) and the common wire should not be installed near the power line and the heavy electric machine equipment. While connecting the common wire, the signal loop’s one side is ground connected, and the other side is not ground connected to the other side. The power supply “-“ side should be ground connected.

5) To connect well, the screw terminal should be strengthened.

6) Transmitter cover closes normally.

▲Warning
Do not approve High Voltage (Meaning AC Power Supply) of Transmitter terminal. It can damage the transmitter.

7) To have HART communication’s supply voltage 24Vdc, power supply and Transmitter’s Current Loop of 250~550 ohm’s has to connect to Loop Resistor. Refer to Figure 3.

3. Calibration

3.1. Overview

User requirements of the measurement range and measurement way of setting is the production setting part, and can be checked with the factory examination.
The following page is the change or process movement after installing the site or the change or the process movement of the alteration figure.

ZERO / ZERO Adjustment / ZERO Trim

SPAN

Damping Adjustment

Button Function

Model APT3700N Series's setting pressure range has been written in the template HART Communicator and can be identified with communication. Setting pressure range should change with button function of HART Communicator's resetting.

NOTE
● HART Communicator : Handheld Terminal 275/375/475, UMPC ● Button Function : safety relation(Class 1E) can not be used with the equipment. Button Function is using LCD to send a message, and the safety transmitter LCD is not installed, however ZERO adjustment and SPAN adjustment is possible.

ZERO/SPAN's adjustment can be divided into analog and digital concept, and the following description article should be explained.

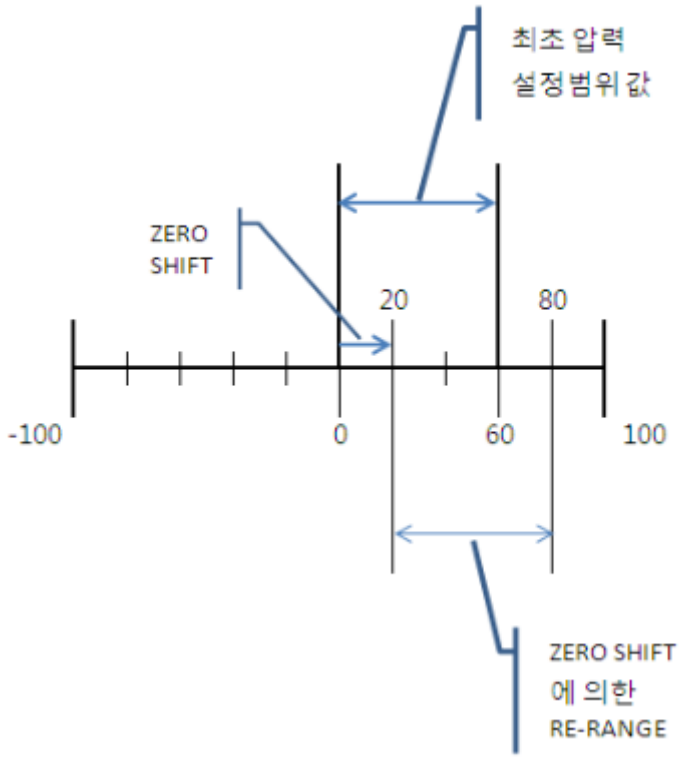
3.2. ZERO

It is possible to set the value 4mA to a setting function. This should adjust to a setting of pressure range.

Example) Pressure range is 0~60psig.

Currently the value of Transmitter is 20psig.

Case of 3.7 button operation way can follow the ZERO function to fulfill the pressure range change of 20~80 psig. Refer to [Figure 6]



[Figure 6. Re-Range of ZERO SHIFT]

3.3. ZERO Adjustment

It is able to adjust to the value of what the user wants. If the field needs an adjustment, the following can be used.

Pressure range is 0~50 psig.

The current pressure value is 25 psig.

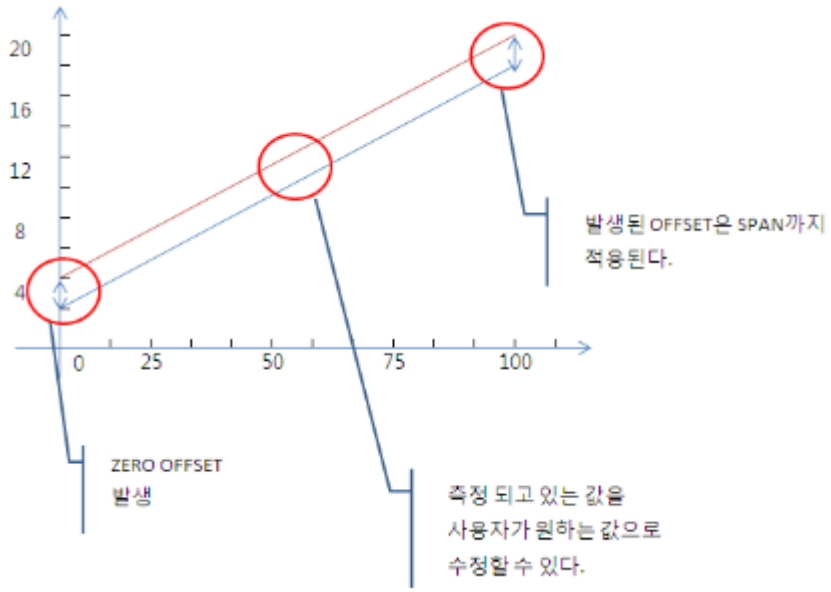
The user should use a fine tuning of setting into a 25.7 psig.

3.7 case button usage or HART Communicator should use the user as wanting 25.7 psig's pressure value. The pressure range does not have change, Offset 0.7 psig is saved, the saved offset is output in the inner arithmetic operation. Offset value is pressure range is a section. Refer to [Figure 7]

3.4. ZERO Trim

Measured Pressure PV value can be changed into a function of '0' (ZERO), ZERO Trim and Transmitter memory is saved in the PV Offset. 3.3 case's ZERO Adjustment and ZERO Trim is the same One Point adjustment, before the section pressure of the offset setting is applied.

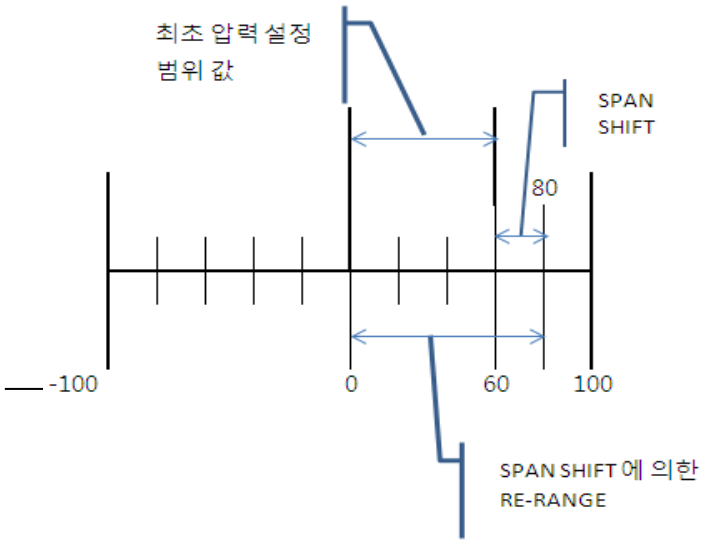
ZERO Trim is functional below the total 10%.



[Figure 7 ZERO offset correction function]

3.5. SPAN

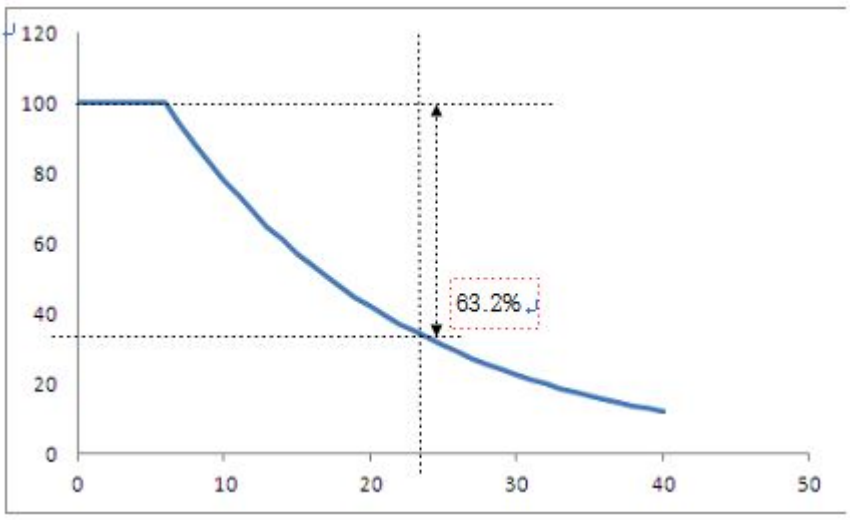
Place the current pressure to 20mA (SPAN) setting. ZERO function is when ZERO changes, it ignores the SPAN and with the amount of change of ZERO, it effects the total pressure area above or below in a shift, with the possibility of the SPAN, ZERO does not change to SPAN and is changed to setting.



[Figure 8 SPAN Re-range]

3.6. Damping Adjustment

Delay the transmitter's response speed process about the sudden pressure change, and it is a function that outputs well. The setting value can be from 0.25 ~ 60 seconds of setting. The setting damping value's meaning is the time of the approved pressure value reaching 63.2%.



$$DR = PRVV - NWV \times \frac{(2.0 \times DS) - UpdateTime}{(2.0 \times DS) + UpdateTime} + NWV$$

DR	: Damping Results
$PRVV$	: Old value
NWV	: New value
DS	: Damping second
$UpdateTime$	: software update time

3.7. Button Function

Transmitter's settings of zero, span buttons are as followed.

The following button type is available of the adhered LCD.

1) When pressing the right side back of the top transmitter's both name plate bolt's from the Name Plate, the zero/span button appears.

2) zero setting way

The current value process that is given is set to **Lower Range Value(4mA)**.

The stable pressure of Zero setting should be confirmed for at least 10 seconds and when pressing the Zero button for more then 3 seconds, the LCD shows a message of "**ZERO**". After checking the message and letting go the button off of Zero. After 1 second, by pressing the Zero button for more then 3 seconds, "**-ZE-**" appears as a LCD message and is finished as a zero setting,

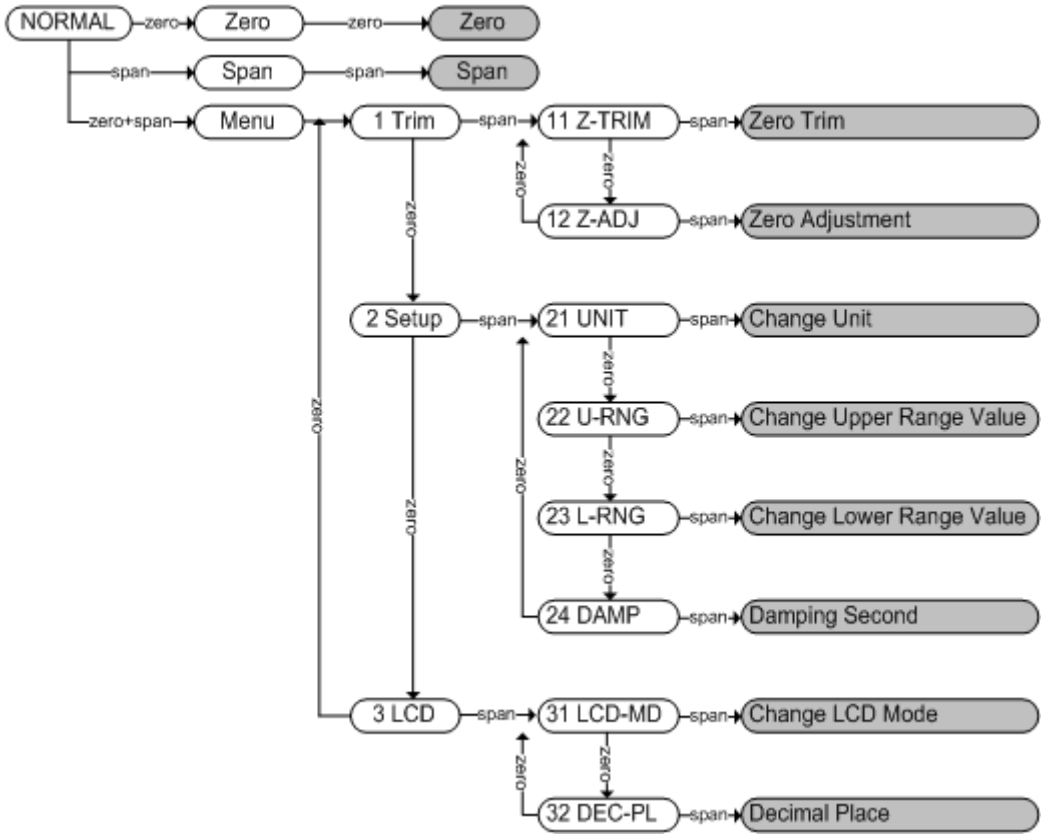
3) Span setting Way

The current setting Process value is **Upper Range Value(20mA).**

After confirming with the safety pressure of above second span setting and pressing span button for more 3 seconds shows an LCD message of "**SPAn**" appears. After checking the message, take the hand off the span button. After 1 second, while pressing the Span button for more then 3seconds shows a LCD message of "**-SP-**" and the Span setting is finished.

Button Error and LCD Display Message should refer to **Appendix I**.

The other functions to this is pressing ZERO+SPAN of performing the new menu form function. Menu method and movement way should refer to the diagram below.



[Button Entering Diagram]

(1) Menu Article Movement : Zero
(2) Lower Menu Movement or function skill : Span
(3) Top Menu Movement : Zero+Span

To fulfill each function, the waiting time of the button is at least 3seconds and if it goes over 3 seconds while pressing the ZERO + SPAN button, LCD Display is changed from Menu screen to a TRIM. To see the following menu, the ZERO button is keep pressed and next the (Setup) Menu is Displayed, and the menu movement is carried out with the ZERO Button. To choose, pressing the SPAN button will show a menu with a display. Low Rank Menu of course shows a ZERO button when the low menu is displayed and to perform this, the SPAN button is pressed.

Warning : After pressing the button for 30 seconds, if no activity occurs, it goes above the menu function system.

Step Recording Way

(1) Step Recording needs function : **12 Zero Adjustment, 22 Change Upper Range Value, 23 Change Lower Range Value, 24 Damping Second functions** needs functions of step recording.

(2) Step Recording Way : First select the Addition(**10^n**) and after changing the desired value of Increase/decrease of changing value.

(3) For example of inserting 3810 : select 1000 increase -> increase 1000 3 times -> select 100 increase -> increase 100 per 8 -> select 10 increase -> 10 times increase per 1

(4) Increase, Decrease Step selection : Message of SelInc is shown at the button of LCD. Select Step with Zero Button : While pressing the Zero button, 10unit is changed. After having a step setting, the span button should be pressed of performing 2 times.

(5) Zero, Span wants a value setting change : the bottom LCD has a VALUE message shown When pressing the Zero button should increase the setting clause in an increase Step When pressing the Span, the setting step decreases from the 1st clause After hanging to a value wanted, Zero+Span button should be pressed to carry out the 1st clause.

(6) Repeat the forward number (4) and (5) of the desired value setting finally in the value of desire value in the finished setting of fulfilling number(4)of the Zero+Span button of finishing the input procedure.

Function Accompanying Performance

ZERO TRIM

- Press the ZERO+SPAN button and perform the pressing menu.
- When the **1 TRIM** message is shown, the SPAN button should be pressed to move to the lower menu.
- If the **11 Z-TRIM** message is shown, the SPAN button is pressed to function ZERO TRIM.
- **Zero Adjustment : PV should be revised to 14**
- ZERO+SPAN button is pressed to execute the menu

- **1 TRIM** message is shown, the span button is pressed to move to the lower menu.
- If **11 Z-TRIM** message is shown, the Zero button is pressed to change menu.
- If **12 Z-ADJ** message is shown, press the San button to perform the Zero Adjustment.
- If the **SelInc** message is shown, the expression of LCD **10.0** presses the Zero button repeatedly and if the LCD shows **10.0,** Span button is pressed to revise

the Value.

- When the **VALUE** message is shown, the Zero button should be pressed once to change the LCD displayed value to 10.0 and press the Zero+Span later.
- If the **SelInc** message is shown, the LCD of **1.0** indicator will press the Zero button repeatedly to indicate the LCD of **1.0** Span revised Value button. If the **VALUE** message is shown, the Zero button should be pressed 4 times to a LCD displayed changed value of **14.0** and press the Zero+Span button
- If the **SelInc** message is shown, the Zero+Span button is pressed to save the setting value

Change Unit

- Zero+Span button is pressed to activate the Menu.
- **If 1 TRIM** message is indicated press the Zero button to change.
- **If 2 SETUP** message is indicated, press the span button to move to the lower menu.
- **21 UNIT** message is indicated of pressing San button of performing Change Unit function.
- Until the lower LCD shows a unit is shown, the zero buttons should be pressed rapidly to show the Unit that wants to be indicated by pressing the Span button of saving the setting value

Change Upper Range Value

- Press the Zero+Span button to process the Menu
- **If 1 TRIM** message is indicated press the Zero button to change.
- **If 2 SETUP** message is indicated, press the span button to move to the lower menu.
- **21 UNIT** message is indicated Zero button of moving to menu.
- **22 U-RNG** message is indicated Span button pressing of performing function.
- Step Recording Way is same as Zero Adjustment

Change Lower Range Value

- Zero+Span button is pressed to perform Menu
- **1 TRIM** message is indicated Zero button pressing to move menu
- **2 SETUP** message is indicated Span button pressing to move to lower menu
- **21 UNIT** message is indicated Zero button pressing to move menu
- **22 U-RNG** message is indicated Zero button pressing to move menu
- **23 L-RNG** message is indicated Span button pressing to move to perform function
- Step Recording Way is the same as Zero Adjustment

Change LCD Mode

- Zero+Span button should be pressed to activate Menu
- **1 TRIM** message is indicated Zero button pressing to move menu
- **2 SETUP** message is indicated Zero button pressing to move menu
- **3 LCD** message is indicated Span button pressing to move to lower menu
- **31 LCD-MD** message is indicated Span button pressing to move to perform function
- LCD Mode setting function performance shows the LCD mode possible for the 2nd line of the LCD of showing the LCD mode, and the following content indication is as follows.

content indication	describe	note
NOR_RO	Normal Rotation Mode. PV, %, mA is shown rotating	
NOR_PV	Normal PV Mode. shows the only measured PV	
NOR_%	Normal Percent Mode. shows the measured PV value of the Percent Range	
NOR_mA	Normal mA Mode. measured PV value is shown in 4~20mA electricity	
ENG_RO	Engineering Rotation Mode. Engineering PV, %. mA rotating	
ENG_PV	Engineering PV Mode. setting value of the Engineering Range PV change.	

- While pressing the Zero button, the LCD Mode changes and the wanted mode should be selected and the Span button should be pressed to save the setting value

Decimal Place

- Zero+Span button should be pressed to perform the Menu.
- **1 TR**IM message is indicated press the Zero button to change.
- **2 SETUP** message is indicated Zero button pressing to move menu.
- **3 LCD** message is indicated Span button pressing to move to lower menu.
- **31 DEC-PL** message is indicated Span button pressing to move to perform function.

Decimal Place setting function performing shows a LCD in the second line of the point indicated shows a content indication as follows.

content indication	Description	Greatest Value Shown	note
AUTO	shows the number automatically Decimal is established (same as the original way)	99999	
5-0	Decimal does not show the decimal place.	99999	
4-1	Decimal shows the first decimal place	9999.9	
3-2	Decimal shows the second decimal place	999.99	
2-3	Decimal shows the third decimal place	99.999	
1-4	Decimal shows the fourth decimal place	9.9999	

- The first line of LCD is expressed in the selection way of **0.0**.
- Everytime time pressing the Zero button shows a display system of selecting a display system of span button of saving a setting value
- The set Decimal Place content is PV value and is valid in the engineering value, mA and % is irrespectively a setting area not in 3-2's format.
- While operating the LCD, the greatest value shown of the second LCD line shows a **LCD_OV** message and rotates the current setting of the Unit text.

4. OPERATION

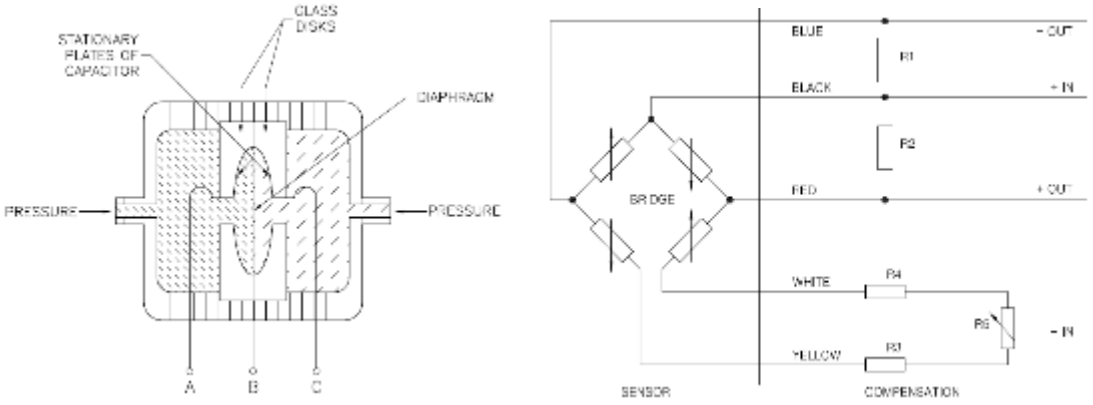
4.1. Overview

The following page has a basic smart Transmitter's movement in the following content below.

- Transmitter Operation & Sensor
- Transmitter's greatest output current
- Protecting the side power supply injection
- Installation Place
- condition of beginning movement
- connection of the pressure
- Limit of the wireless transmitter

4.2. Transmitter Operation & Sensor

Duon System Co., LTD's smart pressure Transmitter model APT3700N Series uses a sensor of 2 different kinds. The first is Capacitance Type sensor and the second is the Piezo electric Type sensor. These sensors refer to the [Figure 9].



[Figure 9 Sensor Type (Capacitance, Piezoelectric)]

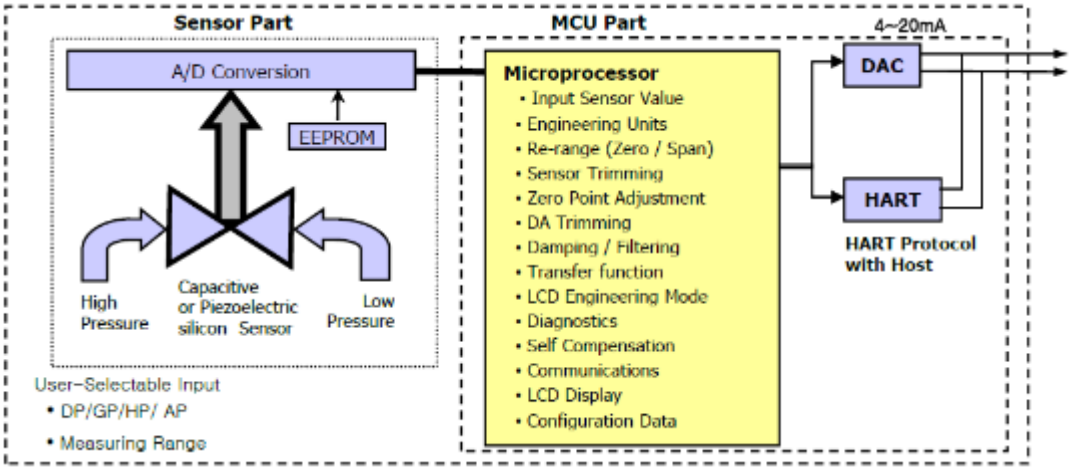
Capacitance Type sensor is being used in the attachment of the certain measurement, and it is a sensor that has a capacitance of changing sensor. High and Low side of the equivalent pressure (air pressure included) shows a High, Low each capacitance has 150pF's capacitance. Also High, Low measuring range of the great pressure given is 100pF and has the opposite 300pF's capacitance. These capacitance's surrounding change sense the pressure variation.

Capacitance Type sensor of the pressure of the linear characteristics perform the sector work, and have the capacitance type sensor of the sector work as the 1st equation below of the linearization model, and the 2nd linearization model should be when manufacturing and producing.

$$1^{'}st\ L_{pressure} = K\frac{C_{low} - C_{high}}{C_{high} + C_{low}}$$

Piezo electric type sensor capacitance type sensor and the following mechanical energy should change to electric energy, and the Piezoelectric Type sensor is resistance change in the physical pressure change. The resistance bridge shows the outer form, and the resistance value is approximately a value of 3.5k ohm(±20%), and have approximately ±200 ohm's change.

Piezo electric Type sensor input has a output of Linear Design.



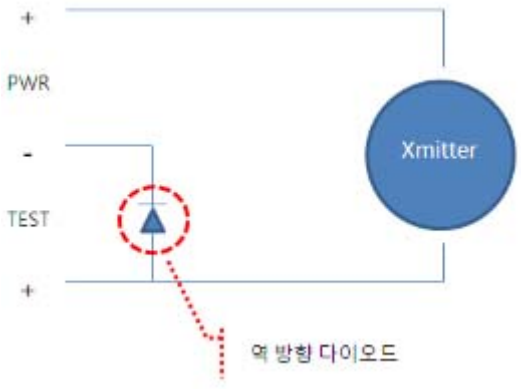
[Figure 10 Transmitter Block Diagram]

4.3. Transmitter's Greatest Output Current

APT3700N Series's greatest output current is 21.75mA. This is a defunction as the Transmitter, and as a failed sensor, it is the output of electricity. Transmitter's output electricity case should refer to article 2.4.

4.4. Reverse Direction safety of inserting power supply

The following inner composition of the Transmitter's power supply follows below.



[Figure 11 Power Supply reverse direction safety connection diode]

Inserting the Figure 11 of the same transmitter has a inner carelessness of the power supply reverse direction safety connection of the safety diode.

However “TEST" terminal's ”+,-“ power supply connection is prohibited, if this is connected, the power supply feeder's trouble induction and Reverse Direction diode's malfunction can occur.

4.5. Installation Place

Transmitter is installed to with stand in the worst condition, however to with stand in a long term and safely, the installation place should consider the following.

1) Avoid the great temperature change or change rate of the location. If the installed location receive the radiant heat, enough temperature block or ventilation is needed,

2) Choose a location where chemical product corrosion does not appear. If the corrosion environment is installed, the Transmitter's sensor and flange etc quality should be selected. Also even if it is not a corrosion environment, the electric conduit should have a ventilation to avoid corrosion of rain and others.

3) Choose a location where there is no vibration and impact.

4) Choose an easy place for Maintenance.

4.6. Condition after installing the early movement

After installing the scene, the installer should bear the installing of the following below. Instrument's installation condition can follow error mistake can occur. This communication can be from a communicator's zero dream can be processed to correction.

Difference pressure flowmeter should maintain the High line and low line of the Zero tream of the pressure's safety time standby as a caution.

4.7. Pressure's Connection

▲Warning
◈ The installed transmitter has the processors' pressure. The processor's fluid can not be too loose or too smooth. ◈ The accumulated processor's fluid can be poisonous or harmful, the processor's line of Maintenance of the separated should avoid physical contact and inhale of the steam.

To move the Transmitter safety, the following cases should be watched.

1) Working Pressure of the high pressure should not be approved.
2) Transmitter's pressure connection specifications should be checked of the standard or quality of the material.
3) Poor inadequate atmosphere or the regulation requirement should be leaked and have a sealing arrangement.

4.8. Restricted Transmitter

▲Warning

◈ Transmitter is installed to handle a high frequency of electric noise, when using the radio Transmitter or a Transmitter's outer wiring can show an effect in the transmitter of the high frequency noise. To test these influence, the transmitter should be observed from the transmitter from a far distance slowly.
After this, transmitter should always be used outside the noise's influence.

5. Maintenance and Troubleshooting

5.1. Overview

The following pages are providing a guide for the managing method of components for transmitter and the troubleshooting.

5.2. Safety Message

The following page of the content procedure and work directions needs special caution for the user's safety. The ones with special Safety because of the danger is shown in a mark of an alarm display (▲). When following this display, it should refer to the safety message of performing operations.

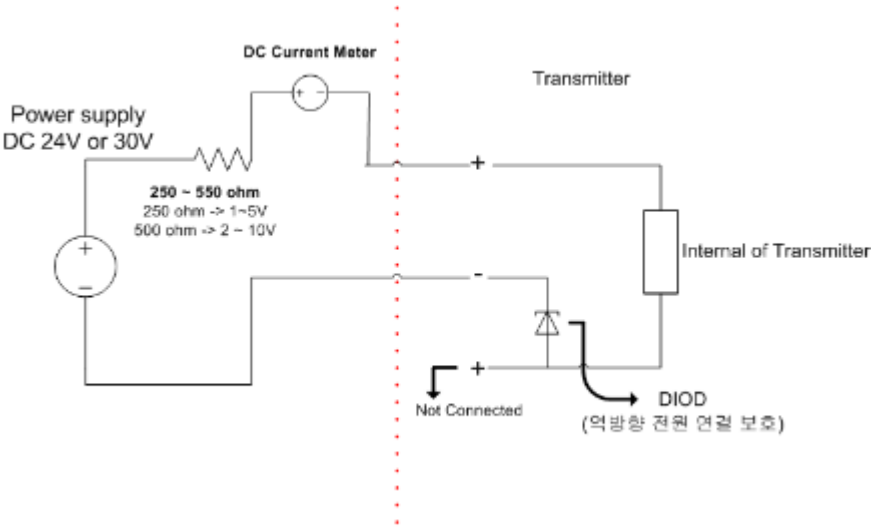
▲Warning
Explosion can lead to death and fatal damage ◈ When the power energy has been inserted to the transmitter, the explosive Atmospheres should not open the cover of the transmitter's cover. ◈ In the atmosphere of the explosiveness, checking the power line of the measuring instruments of the HHT with the intrinsic safety regulations

▲Warning
Not following this installation procedure can lead to death or a fatal wound. ◈ Only a person with the education can install the transmitter.

▲Warning
Electric impact can lead to death and fatal wound. ◈ Power line and terminal contact should be avoided. Lead line can lead to a shock in the high voltage shock.

5.3. Test Terminal

The following voltage below can check the output of the transmitter in the correction room.



[Figure 12 way to check the output of the transmitter terminal]

Transmitter terminal approval voltage load resistance of the voltage decrease is decided of the diode's flow. For example, the Transmitter's approval is voltage 24Vdc and the output electricity is 12mA and with the Load resistance being 250ohm, can lead to the following voltage of the following Transmitter terminal.

$$TV = Power\ Volt - ((Load\ Resistor \times Current) + Diod\ Volt)$$

$$24 - ((0.012 \times 250) + 0.7) = 20.3\ V_{dc}$$

With the following terms, the approved transmitter terminal voltage is actually 20.3 Vdc.

5.4. Board

The electric board built inside the Transmitter is set up as the following.

1) Terminal Board
2) Main & Power Board
3) Analog Board
4) LCD Board (*include in Non-Safety Product*)

The terminal board of the Transmitter input of the power supply is composed of the 2nd noise filter. Power supply and high frequency noise's parts are removed from the 1, 2nd filter. 1st filter is connected to the terminal block and terminal board of the attached EMI filter.

Terminal board has a fixed housing in the housing, however it can not replace just the terminal board. So the above terminal board should be handled with the housing change.

The main and power board has 1,2nd filtering of the power supply of the inner semiconductor of the filter of creating (3.3 Vdc), processing a pressured value using a micro controller to measure it.

Main and power board is easy to dissemble and assemble, however when exchanging with a new board, the parameter has to be reset.

Analog board has a sensor's change should change to a main board’s mike to control easily, and send with the micro controller.

Analog board is fixed in the sensor module so just exchanging the terminal board is impossible. The memory inside the analog board has insertion of the transmitter manufacturer so the analog board's sensor body should be exchanged.

LCD board Safety-Related equipment does not apply.
LCD board Non-Safety-Related equipment does not function, and Transmitter’s measured value can decipher and display in the field.
LCD board and dissemble and reassemble is easy.

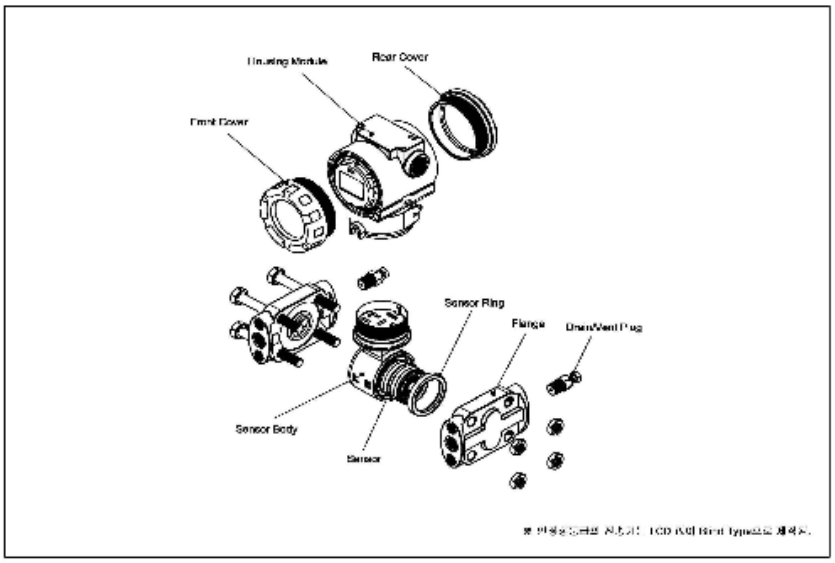
5.5. Maintenance

Also APT3700N Series Transmitter is installed in a function unit that is easy to Maintenance. It if seems to malfunction, check should be made to see if there is an outside error before the program of error diagnosis is run.

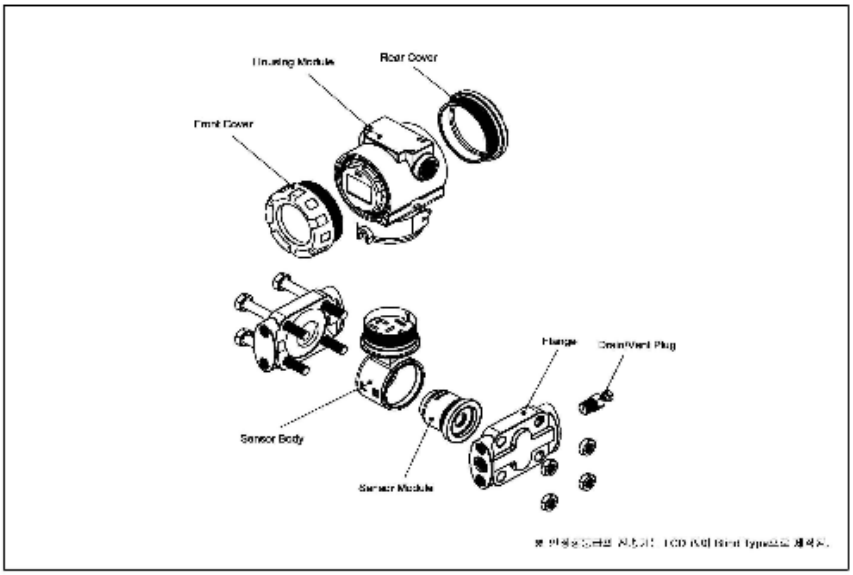
5.5.1. Test Terminal

There is a test terminal named Personal Socket as a Test. Test terminal and power line Loop (-) terminal is connected to the each side of the power supply line. Normally it is following through the Loop current diode.

While testing, connecting test terminal and Loop(-)terminal to the amperemeter can help measure the Loop current. The measured current diode is not leaked but both an amperemeter so it should be set below 10 ohm as an internal resistance amperemeter. Both ends of the amperemeter electric pressure diode has to be lower than the voltage control (Threshold Voltage). If the amperemeter‘s inner resistance 30 ohm, the difference is the current value error of 10%. Refer to [Figure 12]



[Figure 13-1] APT3700N's outer floor plan (pressure form : DP, GP, HP)



[Figure 13-2] APT3700N's outer floor plan (pressure form : GP, HP, AP)

5.5.2. Quick Manual

Steps	Key Point Contents	key point detailed contents	Tool Use
1	Unpacking	a) Unpacking Transmitter	
2	Model and inspect specifications	a) Inspect if the Transmitter is same ordered and the attached plate with specifications.	
3	Storage	a) Not exposed to water and does not have vibration or impact, it is stored in the surrounding temperature 25 ℃ relative humidity 65%RH.	
4	Correction in the correction room	a) Range (Zero/Span setting), Unit setting, Tag setting , Damping Time setting, Transfer Function setting, DA dream, other parameter's setting	HHT, Pressure Source(Need) amperemeter
5	Choosing Installation place	a) The surrounding temperature is not severe. b) where corrosion does not appear according to corrosion substance. c) where vibration and impact is not rough. d) maintenance and management is easy.	(While Engineering)
6	Instrumental Case	a) Installed in the transmitter that is manageable. b) Pressure is not leaked.	(While Engineering)
7	Electrical Case	a) D.C. voltage power line is connected. (Terminal input voltage 12 Vdc ~ 45 Vdc) b) For HART communication, the Transmitter Personal Socket of the total resistance is 250 ~ 550 Ohm.	(While Engineering)
8	Fixation and Installation	a) Transmitter's Fixation uses the certain Bracket b) fixes the Transmitter not to shake.	(Fixation and Installation)

9	Correction in the field	a) After choosing an attachment to zero for safety (after 10 seconds pass) set to sensor zero. b) Transmitter's PV value is zero and check if the current is 4 mA.	HHT or Zero/Span button
10	Approval Pressure	a) Do not approve the standard attachment and line pressure b) 3 Way Valve Manifold's Equalizing Valve should be locked at High side and Low side's Stop Valve with a slow open.	(Approving Pressure)
11	Check Function	a) Check if the transmitter functions perfectly.	naked eye and HHT

5.6. Troubleshooting

The basic check cases of malfunctioning Transmitter cases are followed below.

Status	Reason	Problem Solving
The Transmitter does not HHT and communicate.	Loop Wiring	o. Inspect HHT and Power Supply's resistance at least 250 ohmd. o. Check if a satisfying voltage is raised in the Transmitter. Transmitter power plug voltage is always between 12V~45VDC. o. Inspect the grounds for Disconnected Tracks and paragraphs.
	Sensor Input Fail	o. Connect the HHT and place the Transmitter into Test mode to check Sensor Fail
	Loop Wiring	o. Check if the terminal contact is protective, and check if there is dust or damaged.
	Power Supply	o. Transmitter terminal voltage is always between 12V~45VDC. (It does not matter with loop current size)
output signal is high	electronic circuit Module	o. Connect HHT and set Transmitter into Test mode to inspect sensor limit to check Calibration if it is in sensor range.
	Loop Wiring	o. Check if the Transmitter terminal's voltage is always between 12V~45VDC. o. Inspect the grounds for Disconnected Tracks and paragraphs. o. Connect to HHT and have the current flow fixed through 4mA or 20mA.
output signal is unstable	electronic circuit Module	o. Inspect Connect HHT and Transmitter in Test mode settings.
	Sensor Element	o. Connect HHT and connect Transmitter in Test mode and check Sensor Fail o. Check to see if it is out of range with PV value.

output signal is low or none	Loop Wiring	o. Check if the Transmitter terminal's voltage is always between 12V~45VDC. o. Inspect the grounds for Disconnected Tracks and paragraphs. o. Inspect signal terminal's polarity o. Inspect Loop's Impendence
output signal is low or none	electronic circuit Module	o. Connect to HHT and set the Transmitter into Test mode and inspect the sensor Limit to check the Calibration Sensor Range.

5.7. Spare Part

NO.	Part Description	Model APT3700N Order NO.
1	Housing Lock Screw	A3700-81219
2	Name Plate Screw	A3700-141619
3	Jumper (at include LCD board)	A3700-1016
4	LCD Screw	A3700-1219
5	Vent Plug	A3700-2216
6	Flange Bolts & Nuts	A3700-6214- Sensor Code(G8 or D4 or A5 etc)
7	Bracket Bolt & Nuts	
	Angle Type (U Bolts & Nuts)	A3700-212
	Flat Type (U Bolts & Nuts)	A3700-262
	Wall Type	A3700-2232
8	Main Board	A3700-132
9	LCD Board	A3700-122
10	Sensor O-Ring	A3700-191518

Note : APT3700N's spare parts' pressure. Pneumatic Test does not cleanse.

5.8. Spare Parts Storage, Preservation Way and Period

All Transmitter and the spare parts of KEPIC QAP-2, follows II.2 of saving level of B Storage and preservation.

Former electron and O-ring's possibility of Equipment Verification follows the life expectancy verification performance.

When spare parts's storage temperature is stored below 30℃, the storage life expectancy can be seen as a typical Nuclear Energy power plant in the design fatigue life of 40 years and above.(Refer to equipment Verification Report G401-637)
If it is a lubricant or a sealing compound, it has a life expectancy of at least 6 months from purchase.

The other spare parts do not have an expiration date.

5.9. LCD Code

Message	Description	Remarks
ADJ-U	While performing with the Zero Adj button, Zero leaves the set territory(Upper Part)	
ADJ-L	While performing with the Zero Adj button, Zero leaves the set territory(Lower Part)	
ZERO	Zero Button is pressed	
SPAN	Span Button is pressed	
BT-ERR	Button Pressing Sequence Error	
P-LOCK	Protect is Locked in the state of Button Use Error	
ZT-ERR	Zero Trim range of Error is Produced (10%)	
-TR-	Zero Trim Finished	
ZR-ERR	Zero button system Range of Performance Error	
SP-ERR	Span button system Range of Performance Error	
-ZR-	Zero button system Finished	
-SP-	Span button system Finished	
-ZA-	Zero Adjustment Finished	
-DONE-	Finished Using button of changing other settings	
RNGOVR	Using button of changing other settings when going over input scale	
LCD_OV	Shown number of LCD expression possibility going over the input scale	
SCD-ER	Sensor Code Error	
F-RST	Flash system data Reset	
F-LOCK	While Flash system data Reset, the Protect is Locked.	
F-FAIL	Flash system data Reset is failed	
-FR-	Flash Reset Finished	

A-RST	Analog EEPROM Initialization Start	
A-STOR	Analog EEPROM Total Writing	
A-FAIL	Analog EEPROM Total Writing fail	
-AC-	Analog EEPROM Whole Write Finished	
S-FL	Sensor Fail	
S-OP	Sensor Overpressure	
AEP-RF	Analog EEPROM read checksum error	
TS-FL	Temperature Sensor Error	
AEP-WF	Analog EEPROM write fail	
EOSC	Crystal Poor Eruption	
FAVE	Flash Access Violation	

6. Specification and Reference Data

6.1. Overview

The following page describes the equipment's verification and application code of the case.

6.2. Nuclear Specification

Duon System Co., LTD's APT3700N Series is IEEE Std. 323-2003 and IEEE Std. 344-2004, and USNRC RG. 1.180 Rev.1 verification was processed, and the processed result of the Report shown the verification as followed.

G401-635	"Equipment Qualification Test Procedure"
G401-637	"Aging Analysis Report"
G401-638	"Environmental Test Report"
G401-639	"EMC test Report"
G401-640	"Seismic Test Report"

6.3. Environment Condition & SEISMIC Condition

Environment condition and Seismic condition of Shin Go Lee nuclear power plant number 3.4 of the Package NO. J230C's has been verified by KHNP's 9-183-J230C technical specification.

6.4. Quality Assurance Program

Electric Industry Techology (KEPIC)'s nuclear power quality guarantee that has been certified by KEPIC-EN. [Refered to www.kepic.or.kr's present business condition]

6.4.1. Nuclear Cleaning

Perform a Cleaning job of the KEPIC Nuclear Energy Quality skill requirement of QAP-II.1's water quality requirement.

6.4.2. Hydrostatic and Pneumatic Pressure Testing

Test the design pressure to 1.5 times the pressure in the case of Hydrostatic user, and Test the design pressure to 1.2 times in the case of Pneumatic Pressure.

6.4.3. Traceability

KEPIC QAP-1 included.

Transmitter's pressure related part of the quality material should use ASTM standard.

6.4.4. Qualified Life

Duon System Co.,LTD operation manual should use the Transmitter's surrounding atmosphere of surrounding reference G401-635 , G401-637, G401-638.

6.5. Performance Specification

Accuracy

±0.075% of Calibration Span (Linearity, Hysteresis, Repeatability is included).

Dead Band

None (Able to set user)

Stability

±0.125% URL for 12 Months

Temperature Effect

±[0.019%URL+0.125% Span] / 28 ℃

Working Pressure Limits (silicone oil)

• Model DP & GP	0 ~ 13.79 MPa --- # 3 ~ 8
• Model GP	0 ~ 31.02 MPa --- # 9
	0 ~ 51.71 MPa --- # 0
• Model HP	0 ~ 31.02 MPa --- # 4 ~ 7
• Model AP	0 ~ 400 KPa --- # 4
	0 ~ 1500 KPa --- # 5
	0 ~ 3000 KPa --- # 6

Power Supply & Load Requir

Transmitters operate on 12 to 45 V dc.

* 250 ohm load-- 17.4 Vdc

* up to a 550 ohm load -- 24 Vdc

Max. Loop Resistance = (E - 11.9) / 0.022

(E = Power Supply Voltage)

Loop Load

0 ~ 1500 ohm -- Operation

250 ~ 550 ohm -- HART Communications

Power supply Effect

±0.005% of Span per Volt

Static Pressure Effects

ZERO : ±0.1% of URL Per 7MPa

SPAN : ±0.2% of reading per 7MPa

Mounting Position Effects

ZERO Shift up to 350Pa No SPAN Effect

6.6. Functional Specification

Service Liquid, gas

Output

Analog 4 to 20 mA dc and Digital HART Communication

Power supply

12.0 ~ 45 Vdc -- operation

17.4 ~ 45 Vdc -- HART Communications

SPAN and ZERO

Using a button (Non-Safety Related Equipment)

HART Communication (Safety Related Equipment)

Temperature Limit

Operation Temp. : -40 ~ +85℃ (Non-LCD)

-30 ~ +80℃ (LCD)

Process Temp. : -40 ~ +120℃

Humidity Limit

5 ~ 100% RH (IP67)

Turn-On Time

MAX. 3 seconds

Response Time : 200 ms

Pressure Range

Code	DP/GP/HP				AP
Code	Calibrated Span	Lower Range (LRL) (KPa)			Calibrated Span
Code	Calibrated Span	D.P	G.P	H.P	Calibrated Span
2	0.075 ~ 1.5	-1.5	-1.5	NA	NA
3	0.25 ~ 7.5	-7.5	-7.5	NA	NA
4	0.373 ~ 37.3	-37.3	-37.3	-37.3	2 ~ 200
5	1.865 ~ 186.5	-186.5	-100	-186.5	10 ~ 1000
6	6.9 ~ 690	-690	-100	-690	21 ~ 2100
7	20.68 ~ 2068	-2068	-100	-2068	NA
8	68.95 ~ 6895	-6895	-100	NA	NA
9	206.8 ~ 20680	NA	-100	NA	NA
0	413.7 ~ 41370	NA	-100	NA	NA

6.7. Physical Specification

Material Construction

Isolating Diaphragms

316L SST, Monel, Tantalum, HAST-C

Drain/Vent Valves

316 SST, HAST-C

Flanges and Adapters

CF8M(316 SST), HAST-C

O-ring

Viton, PTFE, 316SST

Fill Fluid

Silicone oil or Inert fill

FLANGE Bolts & NUTs

Stainless Steel ASTM A193/194

Electronics Housing

Aluminum, 316SST, Flameproof and Waterproof (IP67)

Cover O-ring

Buna-N

Paint

Epoxy-Polyester or Polyurethane

Mounting Bracket

2-inch Pipe, 304 SST, Painted Carbon Steel with 304 SST U-bolt

Nameplate

304 SST

Electrical connections

1/2-14 NPT conduit with M4 Screw Terminals

Process Connections

1/4-18 NPT on 2.126 inch (54.0 mm) centers on flanges for Standard

1/2-14 NPT on Process Adapter (option)

Weight

5.5 kg (excluding options)

6.8. Ordering Information

MODEL	Code	Description					
Type	D	Differential Pressure Transmitter (Static Pressure 13.79 MPa / 2000psi)					
	G	Gauge Pressure Transmitter					
	H	Differential Pressure Transmitter for High Line Pressure (Static Pressure 31.02MPa / 4500psi)					
	A	Absolute Pressure Transmitter					
Ranges		DP/GP/HP					AP
		Calibrated Span Min. to Max	Lower Range Limit APT3700N-D	Lower Range Limit APT3700N-G	Lower Range Limit APT3700N-H	Upper Range Limit	Range APT3700N-A
	2	0.075 ~ 1.5 KPa (0.302~6.022 inH2O)	-1.5 KPa (-6.022 inH2O)	-1.5 KPa (-6.022 inH2O)	NA	1.5 KPa (6.022 inH2O)	NA
	3	0.15 ~ 7.5 KPa (0.6~30 inH2O)	-7.5 KPa (-30 inH2O)	-7.5 KPa (-30 inH2O)	-7.5 KPa (-30 inH2O)	7.5 KPa (30 inH2O)	NA
	4	0.373 ~ 37.3 KPa (1.5~150 inH2O)	-37.3 KPa (-150 inH2O)	-37.3 KPa (-150 inH2O)	-37.3 KPa (-150 inH2O)	37.3 KPa (150 inH2O)	0~200 KPa
	5	1.865 ~ 186.5 KPa (7.5~750 inH2O)	-186.5 KPa (-750 inH2O)	-98KPa (-14.7 psi)	-186.5 KPa (-750 inH2O)	186.5 KPa (750 inH2O)	0~1000 KPa
	6	6.9 ~ 690 KPa (1~100 psi)	-690 KPa (-100 psi)	-98KPa (-14.7 psi)	-690 KPa (-100 psi)	690 KPa (100 psi)	0~2100 KPa
	7	20.68 ~ 2068 KPa (3~300 psi)	-2068 KPa (-300 psi)	-98KPa (-14.7 psi)	-2068 KPa (-300 psi)	2068 KPa (300 psi)	NA
	8	68.95 ~ 6895 KPa (10~1000 psi)	-6895 KPa (-1000 psi)	-98KPa (-14.7 psi)	NA	6895 KPa (1000 psi)	NA
	9	206.8 ~ 20680 KPa (3~3000 psi)	NA	-98KPa (-14.7 psi)	NA	20680 KPa (3000 psi)	NA
	0	413.7 ~ 41370 KPa (60~6000 psi)	NA	-98KPa (-14.7 psi)	NA	41370 KPa (6000 psi)	NA
Mounting Flange /Material		Flange / Adapters		Vent Plug		Diaphragm	
	M11	316 SST		316 SST		316L SST	
	M12	316 SST		316 SST		HAST - C	
	M13	316 SST		316 SST		MONEL	
	M14	316 SST		316 SST		Tantalum	
	M22	HAST – C		HAST – C		HAST – C	
	M23	MONEL		MONEL		MONEL	
	M24	Tantalum		Tantalum		Tantalum	
	M31	CS		CS		316L SST	
Electronic Housing	S	316 SST					
	A	Aluminum					
Fill Fluid	1(L)	Silicone					
	2(H)	Inter Fill					
Process Connection	4N	1/4 - 18 NPT (Standard)					
	3N	3/8 – 18 NPT Female (Adapter)					
	2N	1/2 - 14 NPT Female (Adapter)					
Electrical Connection	1	1/2-14NPT					
	2	G 1/2					

	X	Special				
Nuclear Data *1		Safety Class	Seismic Category	Quality Class	Environmental Zone	Electric Class
		S (Safety)	1	Q*2	O	1 E*2
		NS(Non – Safety)	2	T	O1	NE (Non – 1E)
			3	R		
				S		
Option	M1	LCD Indicator				
	W	SUS 304 Bolts and Nuts				
	C6	Engineering Unit				
	C7	Custom Calibration				
	K	Oil Free Finish				
	BA	Stainless Steel Bracket (Angle type) with SST Bolts				
	BF	Stainless Steel Bracket (Flat type) with SST Bolts				
	CA	Painted Steel Mounting Bracket (Angle Type) with SST Bolts				
	CF	Painted Steel Mounting Bracket (Flat Type) with SST Bolts				