

AUTROL®

HART®
FIELD COMMUNICATIONS PROTOCOL



Smart Pressure Transmitter for Nuclear Service (Differential / Gauge / Absolute)



MODEL APT3700N



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Smart Pressure Transmitter

APT3700N

Description of Product

The APT3700N Smart Pressure Transmitter is a micro-processor based high performance transmitter, which has flexible pressure calibration and output, automatic compensation of ambient temperature and process variable, configuration of various parameters, communication with HART protocol. The application is very various, as measuring pressure, flow and level by application method.

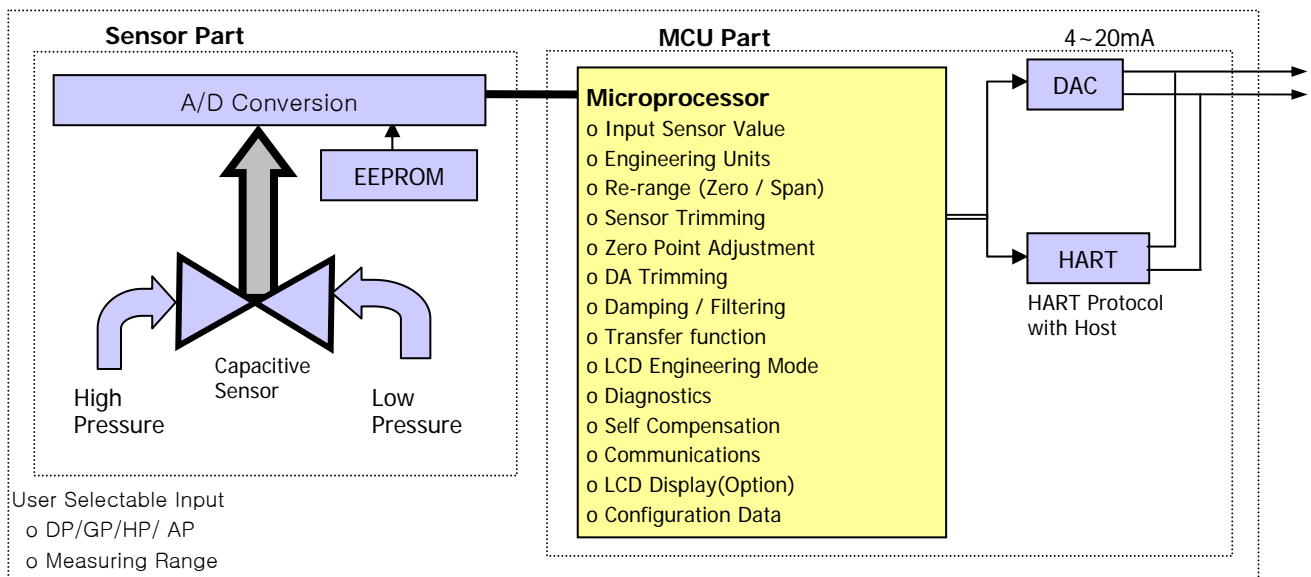
Features

Function

- Flexible Sensor Input : DP, GP, AP, Vacuum
- Various Output : 4 ~20mA , Digital Signals
- Setting Various Parameters : Zero/Span, Trim, Unit, Fail-mode, etc.
- Self Diagnostic Function : Sensor, Memory A/D Converter, Power, etc
- Digital Communication with HART protocol
- Qualified per IEEE Std 344-1987 and IEEE Std 323-1983, Regulatory Guide 1.180

- Superior Performance
 - High Reference Accuracy : $\pm 0.075\%$ of Calibrated Span
 - Long-Term Stability : $\pm 0.25\%$ URL per 24 months
 - High Rangeability (100 : 1)
- Flexibility
 - Data Configuration with HART Configurator
 - Zero Point Adjustment & Suppression
- Reliability
 - Continuous Self-Diagnostic Function
 - Automatic Ambient Temperature Compensation
 - Fail-mode Process Function
 - EEPROM Write Protection
- Equipment Qualifications
 - Environmental Qualification
 - Series Qualification and EMI / REI Test

Functional Block Diagram



Transmitter Description

Electronics Module

The Electronics module consists of a circuit board sealed in an enclosure.

There are a MCU module, a power module, an analog module, a LCD module and a terminal module in a transmitter.

The MCU module acquires the digital value from the analog module and apply correction coefficients selected from EEPROM. The output section of the power module converts the digital signal to a 4~20 mA output.

The MCU module communicates with the HART-based Configurator or Maintenance Systems such as HTT 275 or 375 and AMS.

The Power module have a DC-to-DC Power conversion circuit and an Input/output isolation circuit.

An optional LCD module plugs into the MCU module and displays the digital output in user-configured unit.

Sensor Inputs

The model APT3700N-D,G,H is available in a differential pressure sensor of a capacitance type.

The capacitance pressure sensor measures differential and absolute, gauge pressure and is commonly used in flow and level applications. Both sides in the capacitance sensor transmit process pressure from the process isolators to the sensor.

The sensor module converts the capacitance or the resistance to the digital value. The MCU module calculates the process pressure based on the digital value.

The sensor modules include the following features

- 0.075% accuracy – the most accurate sensor in the industry.
- The software of the transmitter compensates for the thermal effects, improving performance.
- Precise Input Compensation during operation is achieved with temperature and pressure correction coefficients that are characterized over the range the transmitter and stored in the sensor module EEPROM memory
- EEPROM stores sensor information and correction coefficients separately from MCU module, allowing for easy repair, reconfiguration and replacement

Class 1E safety related Applications

Seismic test : IEEE Std 344-1987 at 5 OBE and 1 SSE response spectrum

Environment test : IEEE Std 323-1983 (Thermal, Radiation, Functional Aging)

EMI / RFI Test : MIL-STD-461D & 462D,RG 1.180, IEC61000-4-2 (EMC, ESD, EFT/Burst, Surge)

Basic Setup

ATP3700N Pressure transmitter can be easily configured from any host that support the HART protocol.

- Operational Parameters.
- 4~20mA Points (Zero/Span)
- Engineering Units
- Damping Time : 0.25 ~ 60 sec
- Tag : 8 alphanumeric characters
- Descriptor : 16 characters
- Message : 32 characters.
- Date : day/month/year

Calibration and Trimming

- Lower/Upper Range (zero/span)
- Sensor Zero Trimming
- Zero Point Adjustment
- DAC Output Trimming
- Transfer Function
- Self-Compensation

Self-Diagnosis and Others

- CPU & Analog Module Fault Detection
- Communication Error
- Fail-mode Handling
- LCD Indication
- Temperature Measurement of Sensor Module

Performance Specifications**Reference Accuracy of Calibrated Span**

for Ranges 3 through 7

$\pm 0.075\%$ of Span

for $0.1\text{URL} \leq \text{Span} \leq \text{URL}$

$\pm [0.025 + 0.005 \times (\text{URL}/\text{Span})]\%$ of Span

for $0.01\text{URL} \leq \text{Span} < 0.1\text{URL}$

for Ranges 2

$\pm 0.075\%$ of Span

for $0.5\text{URL} \leq \text{Span} \leq \text{URL}$

$\pm [0.025 + 0.025 \times (\text{URL}/\text{Span})]\%$ of Span

for $0.05\text{URL} \leq \text{Span} < 0.5\text{URL}$

for 8,9 and 0

$\pm 0.1\%$ of Span

for $0.1\text{URL} \leq \text{Span} \leq \text{URL}$

$\pm [0.05 + 0.005 \times (\text{URL}/\text{Span})]\%$ of Span

for $0.01\text{URL} \leq \text{Span} < 0.1\text{URL}$

for Square Root Transfer Function Output

Same as reference accuracy

for Output ≥ 0.5 Span

Reference accuracy $\times 0.5$ Span / Output

for Output < 0.5 Span

Ambient Temperature Effects

Total Effects per 28°C (50°F) Change :

$\pm [0.019\% \text{URL} + 0.125\% \text{Span}]$

for Span $\geq 0.1\text{URL}$

$\pm [0.025\% \text{URL} + 0.125\% \text{Span}]$

for Span $< 0.1\text{URL}$

Static Pressure Effects

Zero Error (can be corrected at line pressure)

$\pm 0.1\%$ of URL per 7MPa

Span Error

$\pm 0.2\%$ of Reading per 7MPa (Span Error)

Mounting Position Effects

Zero shifts up to $\pm 0.35\text{ kPa}$, which can be calibrated out . No effect on span

Stability

$\pm 0.25\%$ of URL per 24 months

Power Supply Effect

$\pm 0.005\%$ of Output Span per Volt

Update Time and Turn-On Time

Update Time : 0.20 seconds (normal mode)

: 0.12 seconds (fast mode)

Turn-On Time : 2.5 seconds

Failure Mode

Fail High : Current $\geq 21.75\text{ mA}$

Fail Low : Current $\leq 3.75\text{ mA}$

Physical Specifications**Range and Sensor Limits** (Refer to Table 1)**Zero and Span Adjustment Limits**

Zero and span values can be set anywhere within the range limits stated in Table 1.

Span must be greater than or equal to the minimum span stated in Table 1

Output (Analog Current and Digital Data)

Two wire 4~20mA , user-configurable for linear or square root output. Digital process value superimposed on 4~20mA signal, available to any host that conforms to the HART protocol

Power Supply & Load Requirement

External power supply required.

Transmitters operate on 11.9 to 45 V dc.

With 250 ohm load, 17.4 Vdc power supply is required

With 24 Vdc Supply, up to a 550 ohm load can be used

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

(E = Power Supply Voltage)

Supply Voltage

11.9 to 45 Vdc for Operation

17.4 to 45 Vdc for HART Communications

Loop Load

0 to 1500 ohm for Operation

250 to 550 ohm for HART Communications

Ambient Humidity Limits

5% ~ 100%RH (Relative Humidity)

Ambient Temperature Limits

-40°C to 85°C (without condensing)

-30°C to 80°C (with LCD module)

Storage Temperature

-40°C to 85°C (without condensing)

Process Temperature Limits

(Range codes and approval codes may effect limits)

-40°C to 120°C (-40 to 248°F)



APT3700N

Smart Pressure Transmitter

Performance Specifications

Wetted Materials

Isolating Diaphragms : 316L SST, Monel,
Tantalum, HAST-C
Drain/Vent Valves : 316 SST, HAST-C
Flanges and Adapters : 316 SST, HAST-C
O-ring : Viton, PTFE, 316 SST

Non-wetted materials

Fill Fluid : Silicone oil or Inert fill
Bolts : Stainless Steel
Electronics Housing : Aluminum, 316SST
Flameproof and Waterproof (IP67), NEMA4
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

3/4 inch NPT or
1/2-14 NPT conduit with M4 Screw Terminals

Process connections

3/8 inch swagelok fitting or 3/4 inch NPS RF
flange if capillary tubing is used

Weight

5.5 kg (excluding options)

Performance Specifications

Quality Assurance Program

In accordance with KEPIC-QAP & KEPIC-EN

Nuclear Cleaning

To 1 ppm chloride content

Hydrostatic

All Transmitters are tested for a minimum of 10 minutes at 1.5 times the design pressure with no detectable leakage.

Seismic

Accuracy within $\pm 0.25\%$ of upper range limit during and after seismic disturbance of 1 SSE and 5 OBE.

EMI/RFI

EMC : MIL-STD-461D & 462D, REG GUIDE 1.180
ESD : IEC61000-4-2
EFT/Burst : REG GUIDE 1.180
Surge : REG GUIDE 1.180

Pressure Limits & Hydrostatic Test Conditions

| Model | Range Code (x) | Static Pressure and Overpressure Limits | Hydrostatic Test Pressure |
|-------------|------------------|---|---------------------------|
| APT3700N-Dx | Range 2 – 8 | 0 ~ 13.79 MPa (0 psia ~ 2,000 psig) | 23.7 MPa (3,000 psi) |
| APT3700N-Hx | All Range | 0 ~ 13.02 MPa (0 psia ~ 4,500 psig) | 46.5 MPa (6,750 psi) |
| APT3700N-Gx | Range 2 – 8 | 0 ~ 13.79 MPa (0 psia ~ 2,000 psig) | 13.8 MPa (2,000 psi) |
| | Range 9 | 0 ~ 31.02 MPa (0 psia ~ 4,500 psig) | 31.0 MPa (4,500 psi) |
| | Range 0 | 0 ~ 31.02 MPa (0 psia ~ 4,500 psig) | 51.7 MPa (7,500 psi) |
| APT3700N-Dx | Range 4 | 0 ~ 400 kPa (58 psi) | 400 kPa (58 psi) |
| | Range 5 | 0 ~ 1,500 kPa (218 psi) | 1,500 kPa (218 psi) |
| | Range 6 | 0 ~ 3,000 kPa (435 psi) | 3,000 kPa (435 psi) |

Model APT3700N – Dx Differential Pressure Transmitter

Model APT3700N – Gx Gauge Pressure Transmitter

Model APT3700N – Hx Differential Transmitter for High Line Pressure

Model APT3700N – Ax Absolute Pressure Transmitter



Duon System Co., Ltd.

General Specifications

1. APT3700N Pressure Sensor Range & URL

< Table 1 >

| Range Code | DP/GP/HP | | | | | AP | |
|------------|-----------------------|-------------------------|-------------------------|-------|--------|-----------------------|-------------|
| | Calibrated Span (KPa) | Upper Range (URL) (KPa) | Lower Range (LRL) (KPa) | | | Calibrated Span (KPa) | Range (KPa) |
| | | | D.P | G.P | H.P | | |
| 2 | 0.075 ~ 1.5 | 1.5 | -1.5 | -1.5 | NA | NA | NA |
| 3 | 0.25 ~ 7.5 | 7.5 | -7.5 | -7.5 | NA | NA | NA |
| 4 | 0.373 ~ 37.3 | 37.3 | -37.3 | -37.3 | -37.3 | 2 ~ 200 | 0 ~ 200 |
| 5 | 1.865 ~ 186.5 | 186.5 | -186.5 | -95 | -186.5 | 10 ~ 1000 | 0 ~ 1000 |
| 6 | 6.9 ~ 690 | 690 | -690 | -95 | -690 | 20 ~ 2000 | 0 ~ 2000 |
| 7 | 20.68 ~ 2068 | 2068 | -2068 | -95 | -2068 | NA | NA |
| 8 | 68.95 ~ 6895 | 6895 | -6895 | -95 | NA | NA | NA |
| 9 | 206.8 ~ 20680 | 20680 | NA | -95 | NA | NA | NA |
| 0 | 413.7 ~ 41370 | 41370 | NA | -95 | NA | NA | NA |

| Range Code | KPa | Kg/cm ² | bar | psi | inH ₂ O@4℃ | mmH ₂ O@4℃ | inHg@0℃ |
|------------|-------|--------------------|-------|--------|-----------------------|-----------------------|---------|
| 2 | 1.5 | 0.015 | 0.015 | 0.216 | 6 | 152 | 0.440 |
| 3 | 7.5 | 0.076 | 0.075 | 1.082 | 30 | 762 | 2.203 |
| 4 | 37.3 | 0.38 | 0.373 | 5.409 | 150 | 3810 | 11.013 |
| 5 | 186.5 | 1.901 | 1.865 | 27.045 | 750 | 19050 | 55.065 |
| 6 | 690 | 7.031 | 6.90 | 100 | 2773 | 70434 | 204 |
| 7 | 2068 | 21 | 21 | 300 | 8319 | 211302 | 611 |
| 8 | 6895 | 70 | 69 | 1000 | 27730 | 704340 | 2036 |
| 9 | 20680 | 211 | 207 | 3000 | 83190 | 2113020 | 6108 |
| 0 | 41370 | 422 | 414 | 6000 | 166380 | 4226040 | 12216 |

2. Electrical Specifications

| | | | |
|----------------------|---------------|---------------|---------------------|
| Power Supply | 11.9 ~ 45 Vdc | Output Signal | 4 ~ 20 mA dc / HART |
| HART loop resistance | 250 ~ 550 ohm | Isolation | 500 Vrms (707 Vdc) |

3. Performance Specifications (for Range Code 3,4,5,6, and 7)

| | | | |
|-------------------------|---|----------------------------|--------------------------------|
| Reference Accuracy | $\pm 0.075\%$ of Span ($0.1URL \leq \text{Span} \leq URL$) $\pm [0.025 + 0.005 \times (URL/\text{Span})]\%$ of Span $(0.01URL \leq \text{Span} < 0.1URL)$ | Ambient Temperature | -40 ~ +85 ℃ |
| | | LCD Meter Ambient Temp. | -30 ~ +80 ℃ |
| | | Humidity Limits | 5% ~ 100% RH |
| Ambient Temp. Effect | $\pm [0.019\%URL + 0.125\% \text{Span}] / 28 \text{ }^{\circ}\text{C}$ | Process Temperature Limits | -40℃ ~ +120 ℃ |
| Stability | $\pm 0.125\%$ URL for 12 Months | Power Supply Effects | $\pm 0.005\%$ of Span per Volt |
| Static Pressure Effects | $\pm 0.1\%$ of URL per 7MPa (Zero Error) $\pm 0.2\%$ of Reading per 7Mpa (Span Error) | Mounting Position Effects | Zero Shift up to 350Pa |
| | | | No Span Effect |

4. Physical Specifications

| | | | |
|------------------------|------------------|---------------------------------|----------------------|
| Isolating Diaphragm | 316L SST | Process Connection Size | 1/4 - 18 NPT |
| Drain & Vent Valve | 316 SST | (Adapter – Option) | 1/2 – 14 NPT |
| Flange & Adapter | 316 SST | Electrical Connections | 1/2 – 14 NPT with M4 |
| O-ring | Viton, 316SST | Weight (excluding Option Items) | 5.5 Kg |
| Electronic Housing | Aluminum, 316SST | 2" Pipe Stanchion Type bracket | Angle or Flat type |
| Bolts & Bolting Flange | 304 SST | Housing Class | NEMA 4 |

Ordering Information

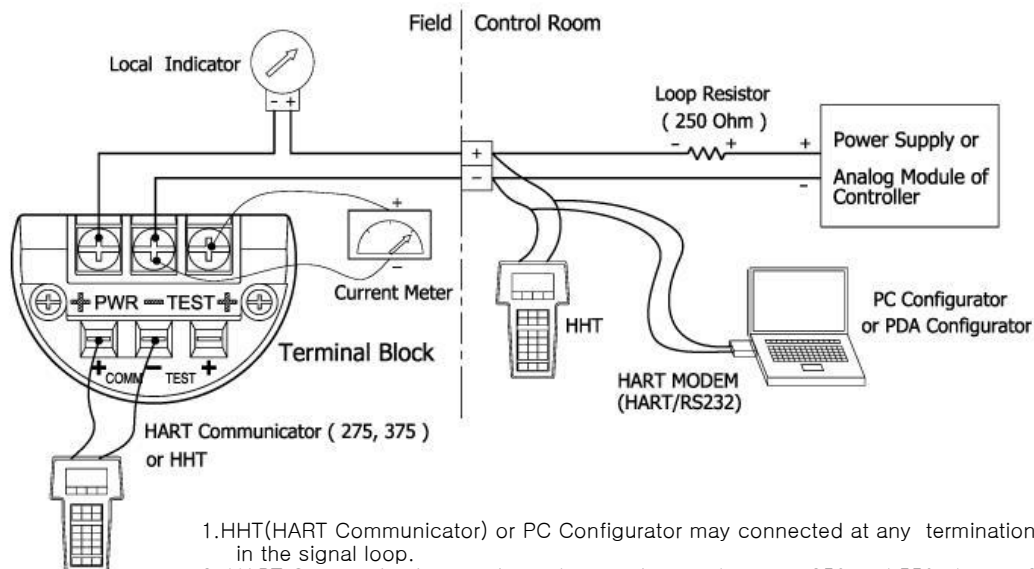
| MODEL | Code | Description | | | | | |
|-------------------------------|---|---|---|---|---|---------------------------------------|---------------------|
| Type | D | Differential Pressure Transmitter (Static Pressure 13.79 MPa / 2000psi) | | | | | |
| | G | Gauge Pressure Transmitter | | | | | |
| | 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 | | | Upper Range Limit | Range APT3700N-A |
| | | | APT3700N-D | APT3700N-G | APT3700N-H | | |
| | 2 | 0.075 ~ 1.5 KPa (0.302~6.022 inH ₂ O) | -1.5 KPa (-6.022 inH ₂ O) | -1.5 KPa (-6.022 inH ₂ O) | NA | 1.5 KPa (6.022 inH ₂ O) | NA |
| | 3 | 0.15 ~ 7.5 KPa (0.6~30 inH ₂ O) | -7.5 KPa (-30 inH ₂ O) | -7.5 KPa (-30 inH ₂ O) | -7.5 KPa (-30 inH ₂ O) | 7.5 KPa (30 inH ₂ O) | NA |
| | 4 | 0.373 ~ 37.3 KPa (1.5~150 inH ₂ O) | -37.3 KPa (-150 inH ₂ O) | -37.3 KPa (-150 inH ₂ O) | -37.3 KPa (-150 inH ₂ O) | 37.3 KPa (150 inH ₂ O) | NA |
| | 5 | 1.865 ~ 186.5 KPa (7.5~750 inH ₂ O) | -186.5 KPa (-750 inH ₂ O) | -98KPa (-14.7 psi) | -186.5 KPa (-750 inH ₂ O) | 186.5 KPa (750 inH ₂ O) | 0~2000 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) | 0~1000 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) | 0~2000 KPa |
| | 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 | |
| M31 | | CS | | CS | | 316L SST | |
| M32 | | CS | | CS | | HAST – C | |
| M33 | | CS | | CS | | MONEL | |
| M34 | | CS | | CS | | Tantalum | |
| 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} | | Quality Class | Seismic Category | Safety Class | Environmental Zone | Electric Class | |
| | | Q ² | 1 | S (Safety) | O | 1 E ² | |
| | | T | 2 | N (Non – Safety) | O1 | NE (Non – 1E) | |
| | | R | 3 | | | | |
| Option | | S | | | | | |
| | 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 | | | | | | |

Example : APT3700N-D5-M11A1L3N1-T3NONE-WBA

*1 : KHNP, Spec. NO. 9-183-J230C " Intelligent Type Field Instrument"

*2 : Request to manufacturer for Safety Class Items

Connection Diagram of Signal, Power, HHT for Transmitter



1. HHT (HART Communicator) or PC Configurator may be connected at any termination point in the signal loop.
2. HART Communication requires a loop resistance between 250 and 550 ohm at 24 Vdc.
3. Transmitter operates on 11.9 to 45.0 Vdc transmitter terminal voltage.
[Applied Power]
 - * 11.9 ~ 45.0 Vdc for General Operation
 - * 17.4 ~ 45.0 Vdc for HART Communication

Dimensions of Transmitter (mm)

