SMV 3000
Smart Multi-Variable Transmitter Overview
Types of Pressure Transmitters

- Differential Pressure (DP)
- Absolute (AP) & Gauge (GP) Pressure
- In-line Absolute & Gauge Pressure
- Dual Head GP
- Flange Mounted Liquid Level
- Differential Pressure (DP) w/ Remote Seals
- Gauge Pressure (GP) w/ Remote Seal
- Multi-Variable
SMV 3000 Smart Multivariable Flow Transmitter

**Historic Field Instrument Milestones**

- 1983 - Honeywell introduces the ST 3000 the world’s first smart transmitter
- 1989 - Honeywell introduces (DE) digital integration of the ST 3000 with TDC 3000 system
- 1995 - Honeywell introduces the SMV 3000, the world’s first single sensor MV transmitter
- 1997 - Honeywell introduces first Multivariable Flow Transmitter to fully support mass flow through Meriam Laminar Flow Element
SMV 3000 Smart Multivariable

- **Smart Multivariable Transmitter (or flow meter)**
  - A transmitter or flow meter which utilizes a combination of sensors/transducers to measure and transmit more than one process variable.
  - Differentiated from:
    - **Coriolis Meters** measure mass flow of liquids and gases, density and temperature using vibrating tubes. *Mass flow is proportional to the vibrations.*
    - **Magnetic Meters** measure volumetric flow rate of liquids, density and temperature using electric coils. *Conductive fluids generate a voltage proportional to flow rate.*
    - **Vortex Meters** measure standard volumetric and mass flow of both conductive and non-conductive liquids, gases and vapors using a standard bluff body and counting of the vortices generated. *Flow rate is proportional to the frequency of vortices generated.*
    - **Ultrasonic Meters** independently measure conductivity, viscosity, temperature, density and pressure by measuring the time it takes to go from one side of the pipe to the other. *Time is proportional to flow rate.*
SMV 3000 Overview

• Multivariable Flow Transmitter
  - New single Piezoresistive Sensor for DP and SP
  - Based on proven ST 3000 Sensor Technology
  - Accurately Measures DP, AP or GP and T

• Calculates Mass and Volumetric flowrates
  - Steam, air, gases and liquids
  - Dynamic Compensation allows greater accuracy
  - ±1% of mass flowrate accuracy
  - Dynamic Compensation allows larger flow turndown

• Supports a variety of Primary Flow Elements
  - Orifice, Venturi and Nozzle
  - Meriam Laminar Flow Element
  - Preso Averaging Pitot Tubes and others
Why was SMV 3000 designed?

- Customer need for more process data without more process pipe intrusions and field wiring

- **Savings and multivariable digital communications**
  - Reduced waste and conservation of fuel
  - Higher efficiency and throughput
  - Lower maintenance costs

- **Improved performance for all flow measurements**
  - Today most customers compensate their gas flows only in high value-added applications
  - Now SMV allows you to compensate cost-effectively in many applications
The “Heart” of the SMV 3000

CURRENT ST 3000 DESIGN

PV diaphragm and sensing elements

Static and temp. sensing elements

SMV 3000 SENSOR DESIGN

• AP sensor 25:1 greater sensitivity vs ST3000

PV diaphragm and sensing elements

Static and temp. sensing elements

HONEYWELL - CONFIDENTIAL
SMV 3000 Sensor Differences

Current ST 3000 Design
• Common Mode Pressure (Static) measured by differential compressibility of silicon on glass
• Output ~ 20 mV at 3,000 psi

SMV 3000 Design
• Common Mode Pressure (Static) measured by deflection of secondary diaphragm
• Output ~ -1,000 mV at 3,000 psi
SMV 3000 Smart Multivariable

Multivariable Sensor Technology

3,000 psig Gauge
0 - 400” DP

Multivariable DP & GP

Atmospheric Reference
Low DP
High Side DP
Benefits of SMV 3000 Sensor Technology

• Single sensor measures DP, SP & sensor temperature
  • Characterized as single unit for highest accuracy in Industry
    • ±0.075% of Span accuracy for both DP and SP
  • Accurate sensor leads to accurate flowrates
  • Fewer Components = Higher Reliability

• Broad application capability
  • Compound Characterization - Improves Bi-directional flow capability
SMV 3000 Benefits

• All Standard Smartline Functionality Included
• Reduced Costs
  – SMV 3000 vs. 3 separate transmitters
  – Installation and Commissioning
  – Maintenance and Inventory
• Increased Flow Accuracy means more Profits
  – Better accuracy than DP alone
  – Better accuracy than 3 separate transmitters
• Digital Integration
  – Digital accuracy and database protection
  – Savings in wiring cost
SMV 3000 Features

- Multiple process variables from one instrument
  - DP, SP from accurate sensor
  - Temperature from RTD or Thermocouple (only Honeywell)
  - All process variables over one twisted pair - DE

- Mass or Volume Flow Calculation
  - Equations utilize all 3 measurements (DP, AP and T)
  - Choose Standard Equation for density compensation only
  - Or Choose full Dynamic Flow Compensation:
    - Discharge Coefficient, Thermal Expansion
    - Gas Expansion Factor, Velocity of Approach
    - Density and Viscosity
SMV 3000 Features – Temperature Input

• An Important Measurement in Flow Calculation

• Maximum Flexibility for Your Application
  – Same circuit for RTDs and thermocouples
  – 2, 3, or 4 wire RTD
  – Type J,K,T,E thermocouples (Only Honeywell)

• Sensor Fault Detection Diagnostic
  – Configurable Flow Failsafe (High or Low)
  – Or, Choose Non-Temperature Comp. Flow
Typical SMV Application - Before

Three Separate Transmitters:
Compensated Flow Measurement

Calculation and control done in DCS, PLC or Flow computer

\[ Q_m = NCE_v Y_1 d^2 \sqrt{h_w \rho} \]
Typical SMV Application - After

The “Enhanced” Flow Approach

Dynamic compensation of Flow inside SMV 3000

\[ Q_m = NCY_1 d^2 \sqrt{h_w} \rho \]

Control done in DCS, PLC or Single Loop Controller

SMV 3000 Transmitter

Temperature Probe

FIC
SMV 3000 Smart Multivariable Flow Transmitter

Dynamic Flow Compensation done inside SMV 3000

Control done in DCS, PLC or Single Loop Controller

FIC
SMV 3000 Smart Multivariable

- Smart Multivariable Transmitter (SMV 3000) or flow meter

- SMA110 - Smart Multivariable Absolute
  - 0 - 25” H₂O, 0 - 100 psia, Temp., Flow rate
  - Typical applications: Small DP producing devices - Averaging Pitot Tubes, Laminar Flow Elements

- SMA125 - Smart Multivariable Absolute
  - 0 - 400” H₂O, 0 - 750 psia, Temp., Flow rate
  - Typical applications: Orifice plates, Venturi, Nozzle and others

- SMG170 - Smart Multivariable Gauge
  - 0 - 400” H₂O, 0 – 3,000 psig, Temp., Flow rate
  - Typical applications: For higher pressure (gauge), Flow applications ...
SMV 3000 Smart Multivariable Flow Transmitter

Compensated Flow Purchase Price Comparison

• Old Flow Approach with 3 separate transmitters
  DP Transmitter List Price = $1,015
  GP Transmitter List Price = $1,065
  Temperature Transmitter Price = $685
  Type J Thermocouple with 316SS Thermowell = $190
  (Plus a flow computer of your choice) = estimated $800
  Total = $2,955 (does not include price of flow calculation)

• Enhanced Flow Approach with SMV 3000
  SMV 3000 List Price = $2,135
  Type J Thermocouple with 316SS Thermowell = $190
  Total = $2,325

• You save at least $630 in equipment cost for each compensated Flow application by using the SMV 3000
• New approach offers large Installation savings too
SMV 3000 Smart Multivariable Flow Transmitter

Compensated Flow Commissioning Cost Comparison

- Installation at a Chemical Company in Bogalusa, Lousiana

<table>
<thead>
<tr>
<th>Device</th>
<th>Process Hrs.</th>
<th>Electrical Hrs.</th>
<th>Checkout Hrs.</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>DP</td>
<td>8.7</td>
<td>9.0</td>
<td>1.0</td>
<td>18.7</td>
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<tr>
<td>AP</td>
<td>7.7</td>
<td>9.0</td>
<td>1.0</td>
<td>17.7</td>
</tr>
<tr>
<td>Temp.</td>
<td>6.0</td>
<td>9.0</td>
<td>1.0</td>
<td>16.0*</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>52.4</strong></td>
</tr>
<tr>
<td>SMV</td>
<td>10.7</td>
<td>9.0</td>
<td>1.0</td>
<td>20.7</td>
</tr>
</tbody>
</table>

*does not include RTD and Thermowell installation or wiring

- Old Approach = 52.4 hours while Enhanced Approach = 20.7 hours

- Based on $30/hour labor rate - $906 savings for each flow application
What is Dynamic Flow Compensation using SMV 3000?

- The process of measuring the **differential pressure** produced by a primary flow element, the **absolute pressure** and the **temperature** of the flowing media and using these measurements with other data (pipe size, bore and type of flow element, etc.) to **compensate for error producing variables** while calculating flow rate.

- A single-variable DP transmitter **does not** compensate for such variables.

- The SMV 3000 **compensates for the following variables** to increase mass flow accuracy over a larger flow turndown:
  - Discharge Coefficient
  - Gas Expansion Factor
  - Thermal Expansion Factor
  - Velocity of Approach Factor
  - Viscosity
  - Density
SMV 3000 Temperature Compensation

BENEFITS OF TEMPERATURE COMPENSATION ONLY

Gas measurement % error if meters are *not temperature compensated*

% error* 

(°F)  

Flowing temperature

* - assumes 60 F reference design temperature
SMV 3000 Pressure Compensation

BENEFITS OF PRESSURE COMPENSATION ONLY

Gas measurement % error if meters are *not pressure compensated*

![Graph showing the relationship between % error and tolerance around nominal pressure for different nominal pressures.](image)

- **Nominal pressure**:
  - 2 psig
  - 10 psig
  - 20 psig
  - 50 psig
  - 75 psig
  - 100 psig
  - 125 psig

- **% error**

- **Tolerance around nominal pressure**:
  - 0.25 psig
  - 1 psig
  - 2 psig
  - 5 psig
  - 10 psig
• ASME Mass Flow Equation for Liquids, Gases and Steam

\[ Q_m = N \cdot C \cdot Y_1 \cdot E_v \cdot d^2 \sqrt{h_w \cdot \rho} \]

- \( Q_m \): Mass Flow
- \( h_w \): differential pressure
- \( N \): Units Factor
- \( C \): Discharge Coefficient
- \( Y_1 \): Gas Expansion Factor = 1 for Liquid
- \( E_v \): Velocity of Approach Factor
- \( d \): bore diameter
- \( \rho \): density
SMV 3000 Targeted Applications

Gas and Steam Flow
- Combustion air
- Fuel Flow
- Superheated Steam Flow
- Saturated Steam Flow

Liquid Flow
- Boiler Feedwater
- Thermal Oils
- Liquefied Gases
- Fuel Oils

Liquid Level*
- Boiler Drum Level
- Simplified HTG
- Interface Level

*provides measurements

General
- Dual PV Applications
- Triple PV Applications
  distillation columns
Typical SMV 3000 Application

3-Element Boiler Control

SMA125

Steam Density Correction

Feedwater Density Correction

SMV 1

SMV 2

SMV 3
SMV 3000 Smart Multivariable Flow Transmitter

Lead-lag fuel/air ratio Control

Fuel Gas

SMV 3000

Furnace

SMV 3000

Air

Chimney
SMV 3000 Smart Multivariable Flow Transmitter

Multivariable Measurements - Vacuum Distillation Column

SMV 3000

P = 1.2 - 4 psia

Condensor

FT

Waste Gas

SMV 3000

Pump

SCM 3000

FT

Tray

Column

DP

T

SCM 3000

FT
Steam Measurement in Pulp and Paper Manufacturing

- Chipper
- Pulp Digester
- Refining Bleaching Process
- Dryers & Rollers
- Recovery Furnace & Disolving Tank
- Chemical & Heat Recovery Process
- Recovery Process & Evaporators.

SMV 3000 Smart Multivariable Flow Transmitter
SMV 3000 Smart Multivariable Flow Transmitter

SMV 3000 DIGITAL INTEGRATION with TDC/TPS 3000

SMV 3000 Transmitter

DE protocol

Process Manager or Advanced Process Manager

STI MV Processor

STI FTA
Digital Integration with STI-MV Card

- Smart Transmitter interface multi-variable I/O processor
  - Each STIMV IOP supports the following DE inputs:
    - 16 single PV inputs
    - 4 multivariable devices with up to four PVs each
    - mix of single and multivariable field devices that equals up to 16 inputs per IOP
  - Also used to digitally integrate ST 3000 and STT 3000, transmitters in the DE mode
Other Digital Integration Options

- SMV 3000 Integration with Allen-Bradley 1771 and 1746 I/O Platform for PLC or SLC
  - Utilizes Prosoft Technology 3700-DEM or 3750-DEM Module
    - Many similar features as Honeywell DE Integration
    - 16 PV inputs for 3700-DEM and 8 PV inputs for 3750-DEM
    - Mix of single and multivariable field devices
    - Uses standard BTR/BTW commands
    - Interfaces directly with Honeywell FTA
    - Only software necessary is standard ladder package

Also supports ST 3000 and STT 3000
MVA - Multi-Variable Analog Interface

- **Single Variable Output**
  - Configure SMV 3000 4-20 mA output for DP, AP, T or Flow

- **MVA Multi-Variable to Analog Interface**
  - Use MVA - Multivariable Analog Card, send SMV 3000 digital signal (DE) via single twisted pair to MVA. MVA will provide all 4 process variables as analog outputs, 1 - 5 volts.
SMV 3000 Smart Multivariable Flow Transmitter

MTS Multivariable Trip Switch

SFC

"smart" status

Maintenance Shop

TDC Control System (optional)

Trip

Analog (optional)
SMV 3000 Smart Multivariable Flow Transmitter

Smart Configuration Capabilities

• Smart Configuration Toolkit - SCT 3000
  - Flexible PC Desktop Configuration Toolkit
  - Used to configure, calibrate and monitor the SMV 3000 and other Smartline Instruments
  - Used to simulate your Flow Application
  - Configure database off-line, save and download later
  - New Flow Wizard simplifies SMV configuration
  - Used for all Smartline Instruments

• Smart Field Communicator - SFC III
  - Used to calibrate, monitor process variables and diagnose potential problems with SMV 3000
  - Used for all Smartline Instruments
Orifice Plate

- An orifice plate is a device used to measure the rate of fluid flow.

- It uses the same principle as a Venturi nozzle, namely Bernoulli's principle which says:
  - That there is a relationship between the pressure of the fluid and the velocity of the fluid.
  - When the velocity increases, the pressure decreases and vice versa.

\[ \Delta p = p_1 - p_2 \]
Primary Elements for SMV 3000

- Dynamic Compensation Equation supports:
  - Venturi
  - Orifice Plate
  - Flow Nozzle
  - Preso Averaging Pitot Tube
  - Laminar Flow Element

- Standard Equation supports
  - All Flow Elements

SMV 3000 mounted to Preso Averaging Pitot Tube
Primary Elements for SMV 3000

• Venturi
  - A Venturi tube is a flow tube that has a tapered inlet and a diverging exit.
  - The DP transmitter measures pressure drop and uses this value to calculate flowrate.
  - The Venturi Effect may be derived from a combination of Bernoulli's principle and the equation of continuity.
  - The fluid velocity must increase through the constriction to satisfy the equation of continuity, while its pressure must decrease due to conservation of energy:
    - The gain in kinetic energy is supplied by a drop in pressure or a pressure gradient force.
Flow Nozzles

- A flow nozzle is a flow tube with a smooth entry and a sharp exit.
- The DP transmitter computes flowrate based on the difference between upstream pressure and downstream pressure.
- Flow nozzles are mainly used for high-velocity, erosive, non-viscous flows.
- Flow nozzles are sometimes used as an alternative to orifice plates when erosion or cavitation would damage an orifice plate.
- The flow nozzle offers some distinct advantages over the thin plate orifice in that it produces less differential pressure for a given beta ratio, resulting in an overall lower permanent pressure loss.
Primary Elements for SMV 3000

- **Averaging Pitot Tube**
  - Self Averaging Pitot tubes consist of a single sensor with multiple sensing ports. These sensing ports enable the pitot tube to *average the flow profile* in the pipeline to give an accurate flow measurement.
  
  - A multiport averaging Pitot tube has multiple ports to *measure impact pressure and static pressure* at different points.
  
  - The DP transmitter computes flowrate by taking the *average of the differences in pressure readings* at different points.
Primary Elements for SMV 3000

• Laminar Flow Element (LFE)
  - The LFE works on the principle of effective differential pressure - similar to more widely used measurement methods such as nozzles or orifice plates.
  - LFEs are the most accurate and stable flow elements available for low gas flow.
  - LFEs with appropriate calibration and sensors are perfectly suited for measurement with highest precision demands, which come close to national and international reference standards.
SMV 3000 Smart Multivariable Flow Transmitter

The Most Cost-Effective Mass Flow Solution for Gases, Steam and Liquids

+ Primary Flow Element

= Integrated Flow Solution

SMV 3000