

# Venture Development Corporation Industrial Automation and Control Practice

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*A White Paper On:*

## ***GLOBAL PROCESS LEVEL MEASUREMENT AND INVENTORY TANK GAUGING MARKETS***

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Level measurement is a widely measured process variable and there are a large number of sensing technologies utilized. The purpose of level measurement devices is to determine the height of various materials in tanks, containers, silos, or any other container capable of holding liquids and/or granular solids.

Level sensors are divided into two classes: point level switches and continuous level gauges. Some of the same basic technologies are used for both point and continuous measurement. Point level indicates whether material is at, above, or below a certain point in a vessel. Depending on position, these can signal when a vessel is full, empty, or at some level in between. Continuous level gauges provide information about material level at all points.

Inventory Tank Gauging (ITG) is the use of level measuring for inventory storage and custody transfer applications as opposed to process control. Many of the ITG systems provide greater accuracy than process level measurement devices, and over greater heights.

## **PRODUCT FOCUS**

This white paper summarizes top-level findings from a study of the global market for these products completed in August 2005. The products studied can be classified as using electronic or mechanical sensing technologies, and include the following:

### **For Process Level Measurement**

- Electronic Continuous: capacitance, conductive, hydrostatic (electronic pressure), laser, load cell/strain gauge, magnetostrictive, contact microwave/radar (RF reflectometry), non-contact microwave/radar, nuclear, resistance tape, servo, and sonic/ultrasonic;
- Mechanical Continuous: bubbler, displacer, float, hydrostatic (mechanical pressure), and weight & cable;
- Electronic Point: capacitance, conductive, hydrostatic, non-contact microwave/radar, nuclear, optical, sonic/ultrasonic, thermal, vibration; and
- Mechanical Point: diaphragm, displacer, float, paddlewheel and tilt switch.

### **For Inventory Tank Gauging**

- Electronic ITG: capacitance, Hydrostatic Tank Gauging (HTG), load cell/strain gauge, magnetostrictive, microwave/radar (RF reflectometry), non-contact microwave/radar, nuclear, resistance tape, servo, and sonic/ultrasonic; and
- Mechanical ITG: float, float & tape, HTG, paddlewheel, and weight & cable.

### **Why So Many Technologies?**

Why are there so many technologies applied to level measurement? The reasons vary. There are application considerations and price considerations. In an application is continuous measurement needed, or will point level indications suffice, such as at the top and bottom of the tank? If point level sensing is all that is needed, there may be significant savings. Globally, the average price for continuous process level measurement sensors is almost 5 times that of point level measuring devices.

Another reason relates to what has historically been used. As a class, the mechanical level measurement device were used before electronic types. These were found to be suitable, and have continued to be used.

One reason often is lower price. The average worldwide price of electronic continuous measurement devices is only about 6% higher than the average price for mechanical continuous level measurement devices. However, for both process level measurement point devices, and for inventory tank gauging systems, the average worldwide selling prices for the electronic products are over two times the average price for the mechanical products.

It should also be noted that many of the level measurement application markets are mature, and many of the purchases are for existing facilities, as replacement parts, or minor additions. For these, the likely purchase of the same products as currently in use is high, and these may well be mechanical devices.

Nonetheless, the shipment shares in mechanical devices has declined over the years. In general the electronic products provide easier interfacing to other systems, better performance, higher reliability, and are easier to maintain. The decline in usage of mechanical sensors is most apparent in the continuous process level measurement and inventory tank gauging markets. Globally, mechanical continuous process level measurement products account for less than 10% of continuous process level measurement shipments on both monetary and unit bases. Global shipments of mechanical ITG systems account for about 10% of the total on a monetary basis and around 20% on a unit basis.

All the sensing technologies used have certain qualities that make some more attractive for given applications than others. Some of these include, depending on the application:

Ability to use with harsh & corrosive substances	Foam sensitivity
Ability to operate in a vacuum	Maintenance requirements
Ability to provide surface & interface measurements	Pressure sensitivity
Density dependency	Scaling sensitivity
Dielectric constant dependence	Sensitivity to atmosphere between medium and sensors
Dust sensitivity	Temperature sensitivity

A minority, but significant portion of the level measurement products studied are shipped for measurement of solids (granules, powders, etc.). Some of the technologies, such as the hydrostatic and displacer sensors are not suitable for solids applications, while the shipments of others such as weight & cable, and paddlewheel are predominantly used in solids applications.

## **MARKET SIZES, AND FORECASTS**

### **Overall Process Level Measurement Market**

Worldwide shipments of process level measurement devices exceed \$US 1.32 billion. VDC expects shipment of these to increase at a Compound Annual Growth Rate (CAGR) of 4.4%, reaching \$US 1.64 billion in 2009.

Markets for these products rank as follows:

1. North America
2. Europe
3. Asia-Pacific
4. Latin America\*
5. Middle East & Africa

*\*-Includes Mexico, Central and South America*

In each of the major geographic regions the two largest consuming markets for process level measurement sensors are the chemical and gas & petroleum industries. The next three largest consuming segments typically included electric power, food & beverage, pharmaceutical and water/waste water.

The Middle East & African market is forecast to have the highest growth rate through 2009, followed by that in the Asia-Pacific region, then Latin America, Europe, and North America. A high market growth rate in the Middle East & African market is expected to be propelled by applications in the gas and petroleum industry, as a results of expanding exploration, oil field production, and refinery capacity.

Applications in several industries are expected to lead to a relatively high market growth rate for the Asia-Pacific region. Among these:

- The emerging and expanding gas & petroleum industry in China will be a primary driver of the region's growing gas & petroleum industry.
- The Asia-Pacific chemical and petrochemical market segments should benefit from a trend to shifting of production in these industries from North America to Asia. This will cause a rising regional demand for the level sensing technologies predominantly used in the chemical and petrochemical industries.
- Shipment growth rates for the significant electric power and water/waste water market segments are expected to be driven by infrastructure building in China, but also in other areas of the region.

The largest worldwide shipments (in dollar volume) are for the following technologies in ranked order:

1. Hydrostatic (Electronic Pressure Transmitters) Electronic Continuous
2. Sonic/Ultrasonic Electronic Continuous
3. Vibration Electronic Point
4. Displacer Mechanical Continuous
5. Float Mechanical Point

The hydrostatic products alone account for one-third of the worldwide market, and together these 5 technologies account for about 66%.

The largest forecast worldwide shipment growth rates through 2009 are for the following in ranked order:

1. Contact Microwave/Radar Electronic Continuous
2. Non-Contact Microwave Radar Electronic Continuous
3. Float Mechanical Point
4. Vibration Electronic Point
5. Paddlewheel Mechanical Point

Nonetheless hydrostatic electronic continuous sensors will still account for by far the largest market share in 2009. Displacement of these by other technologies such as microwave/radar and sonic/ultrasonic products in applications is not proceeding very fast.

The persistent dominance of hydrostatic level sensing can be attributed to a number of considerations, depending on the application. Attributes of hydrostatic level sensing may include low product and/or maintenance cost, ease of installation, ruggedness, proven reliability, broad media compatibility, as well as user familiarity.

Still, the largest market share gains are expected for microwave/radar (both contact and non-contact). Users are turning to these two technologies, which are easier to use, maintain, and calibrate, and are often more accurate than older mechanical technologies.

### **Process Level Measurement Market For Solids**

For solids applications the largest worldwide shipments (in dollar volume) are for the following technologies in ranked order:

1. Sonic/Ultrasonic Electronic Continuous
2. Load Cell Electronic Continuous
3. Vibration Electronic Point
4. Contact Microwave/Radar Electronic Continuous
5. Capacitance Electronic Point

These 5 technologies account for almost 77% of worldwide shipments for process solids level applications.

The largest worldwide shipment growth rates forecast through 2009 are for the following technologies in ranked order:

1. Contact Microwave/Radar Electronic Continuous
2. Tilt Switch Mechanical Point
3. Vibration Electronic Point
4. Paddlewheel Mechanical Point
5. Non-contact Microwave/Radar Electronic Continuous

Typically, the largest shipments of level measurement sensors in the major geographical regions of the world are for the following industries, listed alphabetically:

- |   |  |
|---|--|
| <ul style="list-style-type: none"><li>• Aggregates</li><li>• Chemical</li><li>• Food &amp; Beverage</li></ul> | <ul style="list-style-type: none"><li>• Mining</li><li>• Pharmaceutical</li><li>• Plastics</li></ul> |
|---|--|

The Asia-Pacific market is forecast to have the highest growth rate through 2009 of process level measurement device shipments for solids applications, followed by the market in the Middle East & Africa, then Europe, Latin America, and North America.

Aggregates and mining are the largest consuming industries of process level measurement devices for solids applications in the Asia-Pacific region. Furthermore, these are the only two segments in this region accounting for significant shipments that are expected to grow at above-average rates through 2009.

- Rising prices of metals and other mined commodities are the primary mining industry growth drivers. Solids sensing technologies that will benefit most from the mining industry expansion are expected to be continuous contact and non-contact microwave/radar types and point capacitance and sonic/ultrasonic technologies.
- For continuous aggregate level sensing, non-contact and contact microwave/radar and ultrasonic technologies dominate. Aggregate point level sensing relies mostly on capacitance and ultrasonic technologies.

### **Inventory Tank Gauging System Market**

Worldwide shipments of inventory tank gauging systems are about \$US 327 million. VDC forecasts this market will increase at a 5.7% CAGR reaching \$US 431 million in 2009.

The geographic markets for these systems rank as follows:

1. Asia-Pacific
2. Europe
3. North America
4. Middle East & Africa
5. Latin America\*

*\*-Includes Mexico, Central and South America*

Shipments of inventory tank gauging systems to Asia-Pacific markets far exceed those to either Europe or North America. The reason is that the market for marine applications is concentrated in this region. Although shipments for usage in non-marine applications are fairly comparable in all three regions, the massive Asian shipbuilding industry purchases vastly more systems than are used in the other regions' marine industries.

The Middle East & Africa market is forecast to have the highest growth rate through 2009, followed by that in the Asia-Pacific region, then Europe, North America, and Latin America.

The gas & petroleum industry accounts for a high majority of inventory tank gauging system shipments to the Middle East & Africa. This market segment also is forecast to have an above-average growth rate. Growth in the region's gas & petroleum industry will be driven by the rising cost of fuels, the growing global demand for Middle-Eastern petroleum products, and the need to more accurately monitor inventory levels.

The gas & petroleum industry is the second largest consuming market for inventory tank gauging systems in the Asia-Pacific region, and is forecast to be the fastest-growing market segment. Reasons for this high growth are the same as for the Middle East and Africa region. Expectations are particularly high for rapid growth of China's gas and petroleum industry.

Above-average shipment growth rates are forecast in both these regions for the chemical and petrochemical industries, both small market segments. The primary growth applications in these are expected to be for monitoring high-value process inventories.

The largest worldwide shipments (in dollar volume) are for the following technologies in ranked order:

1. Non-Contact Microwave Radar
2. Servo
3. HTG (Hydrostatic Tank Gauging)
4. Float
5. Load Cell

The non-contact microwave radar systems alone account for about 60% of worldwide shipments, and these 5 technologies combined to account for approximately 90%.

Worldwide, the highest shipment growth rates are forecast for systems using capacitance, contact microwave/radar, float & tape, non-contact microwave/radar for non-marine applications, and sonic/ultrasonic sensing technologies. However, shipments using capacitance, and sonic/ultrasonic technologies are small, and will remain so.

The worldwide shipment share using mechanical sensing technologies is less than 11% and is forecast to continue to decline through 2009. The largest gains in shares over this period are expected for systems using microwave/radar (both contact and non-contact) technologies. Reasons include ease of use, maintenance, and calibration, and high accuracy, at increasingly attractive prices. The sharpest price declines are expected in these type systems over the forecast period.

### **Digital Network Connectivity**

**Continuous Process Level Measurement Devices** – The share of continuous process level measurement device shipments to the regional markets having digital network connectivity ranges from about 61% to 83%. Surprisingly, the 83% is for shipments to Asia-Pacific markets. However, this is primarily due to the fact that Yokogawa and Yamatake, the dominant suppliers of hydrostatic transmitters to the region only ship these with digital interfaces.

Shipments shares with digital interfaces are expected to increase in all the geographical regions, with increasing shares ranging from up to 5%.

HART accounts for the dominant share of shipments in each region, and will continue to do so through 2009, although with declining shares. In some of the regions, proprietary protocols also account for significant market shares. For most of the regions, the largest share gains over the forecast period are forecast for shipments with Foundation Fieldbus connectivity, with lower gains for Profibus. Shipments with Ethernet and wireless connectivity are also expected to grow, but to still account for small shares in 2009.

**Inventory Tank Gauging Systems** – The share of shipments to regional markets with digital network connectivity ranges from 66% to about 97%. Incremental share increases are expected in each of the regions over the forecast period.

In most regions, the largest shipment shares of those with digital interfaces were for Modbus. However, in all the regions shipments with proprietary protocols also account for significant shares. Modbus and proprietary protocols are expected to continue to account for the largest although declining shares over the forecast period.

Wireless connectivity is finding greater acceptance in these applications than for process level measurement sensors, and shipment shares are expected to grow in all regions. Most of this growth is expected for systems with proprietary wireless protocols. There appears to be no necessity at this time to offer systems with standard protocols.

To a lesser, but still significant extent, Ethernet is also expected to gain acceptance over the forecast period.

## **USER REQUIREMENTS**

As part of this market study, interviews were conducted with purchasers/specifiers of process level measurement devices and inventory tank gauging systems. These were with end users, engineering/construction firms & contractors, OEMs, and systems integrators. A Web survey also was conducted with purchasers/specifiers of these products. The following summarize some of these findings.

### **Product Selection Criteria**

The four most identified product selection criteria by the process level measurement and ITG users surveyed and interviewed were:

#### **For Process Level Measurement:**

1. Accuracy
2. Reliability
3. Ease of Maintenance
4. Durability

#### **For ITG Systems**

1. Accuracy
2. Reliability
3. Durability
4. Ease of Maintenance



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## Accuracy Needs

It should be noted that high accuracy has different meanings to different users. In some applications, the acceptable level of accuracy may be well below what would work in others. Users cited a wide range of accuracy requirements. For process level measurement they cited accuracy requirements from plus or minus 1 millimeter to plus or minus 1 foot, and for ITG systems from plus or minus 1 millimeter to plus or minus 8 inches. The median figures cited were plus or minus 1 inch, and plus or minus 0.5 inch respectively.

## Configuration and Setup

Extensive use is being made of integrated displays and portable PCs in configuring and setup of level measurement devices and inventory tank gauging systems. Eighty-four percent of continuous level measurement device users indicated they use one or both these products. The share was even higher at about 88% for the inventory tank gauging systems. For point process level usage the share was lower at 58%. Integrated displays are used more extensively than portable computers.

The shares using either integrated displays and/or portable PCs for configuration and setup are expected to increase.

## Battery & Solar Powering of Products

Of the surveyed process level device users, 21% are currently using battery or solar sources to power some of these. Thirty-five percent expect to have requirements for battery and solar power in 2009. The share among the inventory tank gauging system users is 20% currently, with 30% expecting to have requirements for battery and/or solar powered products in 2009. In both cases, battery power is more popular than solar.

## Non-Product Vendor Selection Criteria

The four most identified non-product (or commercial) vendor selection criteria by users in ranked order were:

### Process Level Measurement:

1. Application Assistance
2. Vendor Reputation
3. Experience With Vendor
4. Availability of Parts

It is interesting that among these users price was seldom identified as one of their most important selection criteria.

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### Inventory Tank Gauging:

1. Technical Support
2. Customer Service/Support
3. Price
4. Application Assistance

Among these users, price was among the most identified criteria, perhaps due to the relatively high price of many types of inventory tank gauging systems. However, it was not the overriding consideration. Three of the four most frequently mentioned non-product or “commercial” vendor selection criteria related to assistance and support.

We’re not certain why this service and support theme was so overwhelmingly important. It may stem from the complexity of the applications, from problem plagued hardware and software, from inadequately trained users, or even from previous unsatisfactory customer service experiences.

### **Sources of Information On Products & Vendors**

Ranked by frequency of mention, users in our survey rely most strongly on the following information sources:

5. Articles in trade periodicals
6. The Internet
7. Vendor product literature and catalogs
8. Vendor sales people

### **COMPETITION**

#### **Major Suppliers To Worldwide Markets**

Worldwide, the five leading suppliers are:

#### Process Level Measurement Devices:

1. Rosemount
2. Yokogawa Electric
3. VEGA Grieshaber
4. Siemens Milltronics Process Instruments
5. Endress + Hauser

Rosemount and Yokogawa are the leading suppliers of hydrostatic (pressure transmitter) products for process level measurement applications. VEGA Grieshaber has an extensive process level measurement product line that includes capacitance, conductive, hydrostatic, microwave/radar (contact & non-contact), nuclear, ultrasonic, and vibration products. Their largest shipments are in microwave/radar products. Siemens Milltronics is principally a supplier of ultrasonic products, with lower shipments of capacitance, non-contact microwave/radar, and tilt switch products. Endress + Hauser supplies capacitive, conductive, hydrostatic, microwave radar (contact & non-contact), nuclear, paddlewheel, ultrasonic, and vibration products for process level measurement. Their largest shipments are in the vibration devices.

Inventory Tank Gauging Systems:

1. Saab Rosemount Tank Radar
2. Enraf Terminal Automation
3. Musasino
4. Enraf Auxitrol Marine
5. Kongsberg Marine

Saab Rosemount Tank Radar and Enraf Terminal Automation are the leading suppliers of non-contact microwave/radar systems. The other three leading suppliers specialize in systems for marine applications. Musasino is principally a supplier of float systems with lower shipments of non-contact microwave/radar systems. Enraf Auxitrol Marine and Kongsberg Marine supply only non-contact microwave/radar systems.

**Vendor Ratings**

Users were asked to rate process level measurement device and ITG system vendors they use and are aware of on the following 9 performance criteria:

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|--|--|
| <ul style="list-style-type: none"> <li>• Availability of Products</li> <li>• Breadth of Offerings</li> <li>• Customer Service/Support</li> <li>• Ease of Product Usage</li> <li>• Knowledgeable Sales Force</li> </ul> | <ul style="list-style-type: none"> <li>• Performance of Products</li> <li>• Prices</li> <li>• Product Quality/Reliability</li> <li>• Reputation</li> </ul> |
|--|--|

Each were rated on these as:

Excellent	5
Good	4
Average	3
Fair	2
Poor	1

Rating comparisons are provided in the study on vendors for which sufficient data was obtained. These ratings were also combined to obtain overall average ratings for each. While no company achieved an excellent overall average rating, the following six stand out: Fisher Controls, Garner Industries, Krohne Messtechnik, Rosemount, Saab Rosemount Tank Radar, and Siemens Milltronics.

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## ABOUT THE STUDY

This white paper summarizes some findings from a VDC market study titled ***The Global Process Level Measurement & Inventory Tank Gauging Industry***. The findings of the study are contained in six volumes covering the following geographic markets:

Asia-Pacific  
Europe  
Latin America\*  
Middle East & Africa  
North America  
Global Overview

*\*-Includes Mexico, Central and South America*

The reports for each region provide market sizes, segmentation, and forecasts by sensing technologies, by consuming industries, by digital network connectivity, and by channels of distribution. The following additional data is provided for inventory tank gauging systems:

- Maintenance & Repair Revenues
- Market Size & Forecast of Systems With Temperature Sensors (Averaging, Spot & Multi-Spot Inputs)
- Market Size & Forecast of Systems With Water Bottom Sensor Inputs

The study includes results of an extensive investigation into user needs and perspectives regarding process level measurement devices and ITG systems. Included are findings relative to product selection criteria, accuracy requirements, batter & solar powering requirements, means of configuration and setup, mounting configurations, output signal requirements, output signal destinations, system integration needs (for ITG systems), vendor non-product (commercial) selection criteria, and information sources used to obtain data about these products and product vendors.

Vendor shipments and market shares are presented, overall, by classes of products, and by sensing technologies. Vendor views and information is provided separately for process level measurement devices and ITG systems on:

- Key Success Factors
- R&D Funding
- R&D Staff Sizes

These findings are compared to user needs obtained from the user survey, and some major discrepancies between the two are noted.

The reports contain in depth profiles on vendors containing:

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|---|---|
| <ul style="list-style-type: none"> <li>- Corporate Overview</li> <li>- Level Measurement Product Shipments</li> <li>- Production Locations</li> <li>- Geographic Distribution of Shipments</li> <li>- Industries and Applications Served</li> </ul> | <ul style="list-style-type: none"> <li>- Channels of Distribution</li> <li>- Perceived Strengths &amp; Weaknesses</li> <li>- Research &amp; Development</li> <li>- Strategic Direction &amp; Outlook</li> </ul> |
|---|---|

Based on the study findings, VDC presents recommendations on how suppliers to the markets covered can enhance their competitive positions. These cover new product opportunities, product features & performance, customer service & support, turnkey systems & service, consuming markets (industries & applications), channels of distribution, promotion, and R&D budgets/new product development.

These reports are available for purchase at a price of \$5,450 for each region, \$7,950 for any two, \$10,450 for any three, \$11,750 for any 4, and \$12,950 for all 5 plus the global overview volume in PDF files by e-mail. Printed volumes are an extra \$200 each.

## STUDY SOURCE

Venture Development Corporation (VDC) is an independent technology market research and strategy consulting firm that specializes in a number of industrial, embedded component, and defense markets. VDC has been operating since 1971, when the firm was founded by graduates of the Harvard Business School and Massachusetts Institute of Technology. Today, we employ a talented collection of analysts and consultants who offer a rare combination of expertise in the market research process; experience in technology product and program management; and formal training in engineering and marketing. VDC's clients include thousands of the largest and fastest-growing tech suppliers in the world and the most successful investors participating in the markets we cover.

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