

---

# A Comparison of Tank Gauging Technologies

## MTG and Other Methods

---

### Brief Tank Gauging Survey

What is the Criteria for the ideal Tank Gauging System :

1. System should accurately provide full information about the product including level, multi-point and/or average temperature, density, mass, water content, and net volume.
2. System should be reliable – preferably no moving parts.
3. System must be low maintenance – preferably self-calibrating and easily configurable.
4. System should be bottom referenced. Even the highly accurate level device may have an error of a few inches if the tank roof is taken as a reference, because of its movement. Such devices must be installed on a stilling well, which is not always available.
5. The ideal system should require only one tank entry with wide options of different opening sizes.
6. The System should work with most products and tank storage applications.
7. Open communications standard in which data is obtained from the instrument.

### The above criteria was used for the MTG design

MTG provides all possible information of the product in the tank including level, volume, mass, water interface, density and density distribution over the tank height, percentage of water above any given level, multiple and average temperatures and even option of pressure of vapor/gas and density of vapor/gas below the tank roof.

MTG has no moving parts and rigid stainless steel construction.

MTG is fully self calibrating and easy to configure. Transmitter boards are interchangeable and not linked to a particular probe. A technician has an option either to configure it via software or by putting an EPROM chip in and setting the MODBUS address switch.

MTG probe stands on the bottom and is not affected by roof movement whatsoever. It is a bottom referenced and does not require a stilling well.

MTG requires only one tank entry and may be installed on wide variety of flanges.

MTG is compatible to a large variety of products. The limitation would be only solidifying products such as asphalt and bitumen.

MTG is digital directly from the transmitter head. It uses a MODBUS RTU protocol over an RS 485 Electrical standard bus.

---

## Gauging Systems Inc. (GSI)

910 Industrial Blvd., Suite A - Sugar Land, Texas 77478

Phone: (281) 980-3999 - Fax: (281) 980-6929 - E-mail: [gsihoutx@msn.com](mailto:gsihoutx@msn.com)

[Http://www.gaugingsystemsinc.com](http://www.gaugingsystemsinc.com)

In comparison with other technologies, such as Radar, Servo, Magnetostrictive, and Mechanical Float Gauge, let us use the same criteria:

**1. System should accurately provide full information about the product including level, multi-point and/or average temperature, density, mass, water content, net volume.**

**Radar** provides level only. Additional equipment such as pressure transmitter or separate temperature probe is necessary to get more gauging parameters. If radar is used for inventory control or custody transfer purposes, an (obtrusive) averaging temperature probe is necessary.

**Servo-gauge** provides level and very limited capabilities for density and water interface. Additional equipment is necessary for temperature or accurate density measurements.

**Magnetostrictive Probe** provides level, multi-point or average temperature and water interface level. There is no mass, density, or volume information available from the probe. One manufacturer has attempted integration of a single pressure transducer with mixed success. Magnetostrictive technology and any other method using a float, cannot measure emulsified products, or products with close specific gravities.

**Mass Tank Gauge Systems** using bubbler technology, Nitrogen, and a single transducer will not be considered relevant to these comparisons, i.e., they lack accuracy and repeatability.

**Mechanical Float Gauge** provides level only. Additional equipment such as pressure transmitter or separate temperature probe is necessary to gather more gauging parameters.

*MTG provides all possible information of the product in the tank including level, mass, water interface, percentage of water, density and density distribution over the tank height, multiple point and average temperatures, net volume. MTG is successfully used for emulsified products. In addition MTG measures vapor pressure (gas blanket, frozen/stuck relief vent, hydrocarbon emissions) and the vapor temperature.*

**2. System should be reliable – preferably no moving parts and rigid construction**

**Radar** has no moving parts and meets this criterion. However when installed on cone roof tank, the instrument can move with the roof movement thus affecting the measurement accuracy.

**Servo-gauge** includes critical moving parts such as servomotor and drum with bearing – all subject to wear and regular maintenance.

**Magnetostrictive** has one or two moving parts - floats. The magnets within these floats attract any metal fragments in product that can fall from the tank roof or be pumped into the tank from the source (pipeline, ship, barge, etc.). If a buildup of metal fragments occurs around the float it may cause the float to hang. Most of the aboveground storage tanks are equipped with the flexible probe that has a tendency to flex in tank due to product movement and/or mixing

**Mechanical Float gauge** includes many moving parts, which must be accurately aligned. Its installation also involves cable guide arrangements to provide for moving cable and float. The hang-ups of the mechanical float gauge and associated damages such as tank overfills are not uncommon.

*MTG has no moving parts and very rigid stainless steel construction*

**3. System must be low maintenance – preferably self-calibrating and easily configurable.**

**Radar** requires very knowledgeable technicians highly trained in radar technology for configuration, troubleshooting, testing, and maintenance.

**Servo-gauge** is capable in some cases of conducting the calibration procedure by operator command. Very high maintenance requirements of dedicated personnel trained and specialized in servo-gauge equipment

**Magnetostrictive** to our knowledge does not include a self-calibration feature, only level offset via the software. The probe and the electronics have to be factory calibrated together and stay together during the probe lifetime. No interchangeability of electronic cards between probes is possible. When repair needs to be done then in many cases both probe and the card should be dismantled and sent back to the factory for service and re-calibration.

**Mechanical Float Gauge** transmitters can be set to hold offset values upon hand gauging.

*MTG is fully self calibrating and very easily configurable. Electronics boards are fully interchangeable. A technician has an option either to configure it via software or by putting an EPROM chip in and setting the MODBUS address switch.*

- 4. System should be bottom referenced. A high accuracy level device may have an error of a few inches if mounted to the roof, because of roof fluctuation or shell movement. High accuracy level devices must be installed on a stilling well, which is not always available.**

**Radar, Servo Gauges** and **Magnetostrictive** as well **Mechanical Float Gauge** are all roof-referenced devices. All require the use of a stilling well / standpipe for accurate measurement.

*MTG probe is standing on the bottom and is not affected by roof movement whatsoever. MTG is bottom referenced and does not require a stilling well.*

- 5. The ideal system should require only one tank entry.**

**Radar** systems require tank entries for the level measurement (stilling well or shell mounted) and for averaging temperature (obtrusive). Optional water interface, density, and mass would require additional entries into the tank.

**Servo Gauges** require a stilling well or standpipe. Additional tank entries for averaging temperature and optional pressure transducers are required.

**Magnetostrictive** requires only one tank entry, however provides for only level, free water, and multi-point temperature measurement parameters.

**Mechanical Float Gauge** requires a gauge hatch entry and a minimum of three tank penetrations on a cone roof tank. This doesn't include entries required for temperature (and density or mass measurement) required for inventory accuracy measurement.

*MTG requires only one tank entry and may be installed on a wide variety of flange sizes.*

- 6. The System should work with multiple products.**

**Radar** is applicable to wide range of products.

**Servo Gauge** is applicable to many products, however may cause problems and increased maintenance on crude and sticky products. Attempts to measure water cut in such applications may easily cause product penetration onto the drum with the winding wire and eminent system malfunction.

**Magnetostrictive** probe cannot be used on crude or any viscous or sticky product. The water interface function of this probe based on a second float may not work if the tank is used with different products, stratified products, or emulsion due to the fact that it must be tuned for a

product within a specific range of density.

**Mechanical Gauge** may be used with a wide variety of products but the float material should be chosen compatible to the type of product.

*MTG is compatible with most products. The only limitations are products that can solidify such as asphalt and products with a storage pressure over 50 psi.*

## 7. Open communications standard in which data is obtained from the instrument.

**All Technologies** depending on manufacturer, may use a dedicated protocol directly from the transmitter. The protocol used by a manufacturer is a direct indication of their corporate marketing philosophy. Is it their intent to sole source, i.e., restrict the customer to their solution based upon the bus protocol and electrical standard? How many manufacturers or technologies for Inventory Tank Gauging can be applied using FSK, Bi-phase Mark, DDA, Tankway, Hart, etc.? Some companies, only because of third party suppliers and customer demands, are now supplying optional MODBUS RTU protocol using an IEEE RS 485 electrical standard. However, how many of these MODBUS RTU offerings are truly MODBUS RTU compliant or modified (vendor dedicated) versions?

*MTG incorporates a fully digital transmitter using MODBUS RTU protocol with configurable register map and RS 485 electrical standard for field wiring. Thus, you can communicate directly to the transmitter from a variety of host systems or devices (PLC's, RTU's, Etc.)*

## 8. Data requirements and communications topology will influence the project cost.

**Radar** (Inventory accuracy) use hardwire and conduit, i.e., higher power requirements.

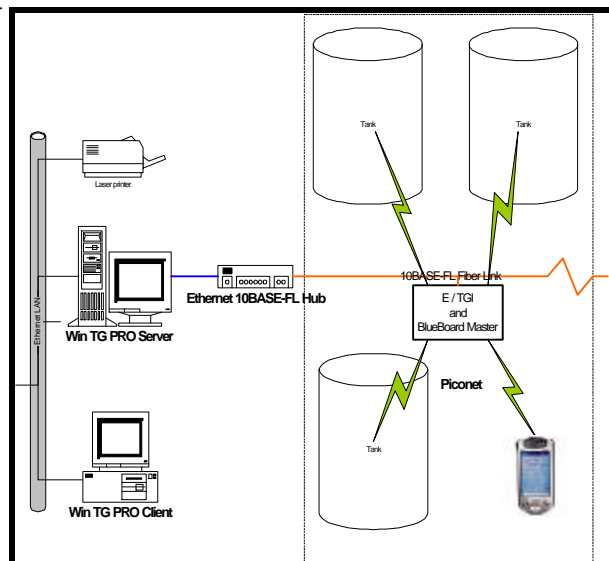
**Servo Gauges** use hardwire and conduit, i.e., higher power requirements.

**Magnetostrictive** use hardwire and conduit traditionally, radio, and battery systems under test.

**Mechanical Float Gauge** and transmitter can be battery or solar powered, low current consumption, allowing Hardwire, Fiber, BlueBoard™, Radio, Cellular, Satellite, and WEB enabled communications.

*MTG can be battery or solar powered, low current consumption, allowing Hardwire, Fiber, BlueField™, Radio, Cellular, Satellite, and WEB enabled communications.*

MTG also supports a new topologies designed to reduce infrastructure cost (cabling, electrical & structural modifications) in a tank gauging (capital) project. **BlueField™** is a combination of Ethernet 10BASE-FL "Fiber Link" bus with BlueBoard™ 802.11b wireless communication between the bus and gauge. An Ethernet hub is used as the field interface, no integration costs, faster data throughput, network connectivity extended to the tank farm, no electrical surges or lightning damage over fiber or radio to bring down the bus, no water in conduit, few or no junction boxes, etc.



MTG is the only gauge with existing applications running under the BlueField™ Topology in whole or part. Current plans include Net Ready MTG transmitter card and remote (Field) application software.

### Technology Comparison Summary

Here: 0 – is the worst grade, meaning that the given criterion is not met or very poorly met  
 1 – is the low grade, meaning that the criterion is met from poor to mediocre level  
 2 – is the good grade, meaning that the criterion is met from average to good level  
 3 – is the excellent grade, meaning that the criterion is fully satisfied

	<u>Criteria</u>						
<u>Technology</u>	Multiple Parameters	Reliability	Maintenance Calibration & Configuration	Bottom Reference	Tank Entry	Product Compatibility	Communications
<b>MTG</b> "Multi-function Tank Gauge"	3	3	3	3	3	2	3
Magnetostrictive	2	1	1	0	2	1	2
Radar	1	3	2	0	2	3	2
Servo Gauge	2	1	1	0	1	2	1
Mechanical Float Gauge	1	1	1	0	0	2	3

### Cost Considerations

**Cost of ownership** rather than a purchase price comparison is essential in evaluating options. How many times are companies burned for contracting the lowest bid. The hidden cost of things not included in the bid, the high cost of spare parts, field service, or software modifications. This is standard practice for some vendors.

Second, the cost of integration and the cost of data. What are the costs of making the data from the tank gauging systems available to everyone that needs it?

Third, what is the projected life cycle and annual maintenance cost? How long can it be maintained by the manufacturers vendors? Replacement cost and options?

Aboveground Storage Tank	MTG	Radar	Radar / w	Radar	Servo / w	Servo	Magneto-	Mech.
40 Ft. / Atmospheric		Cone Ant.	Still Well	Hybrid	Still Well	Hybrid	strictive	
Gauge Technology	\$8,600	\$6,550	\$8,300	\$8,300	\$3,850	\$6,780	\$6,525 ?	\$3,850
Average Temperature	N/C	\$1,880	\$1,880	\$1,880	\$3,435	\$3,435	N/C ?	\$2,495
Local Display	\$2,395	\$1,200	\$1,200	\$1,200	\$2,495	\$2,495	\$1,795 ?	N/C
IS Zenner Barriers	\$1,000	N/A	N/A	N/A	N/A	N/A	\$1,000 ?	N/A
Current Card or Float	N/R	\$900	\$900	\$900	N/A	N/A	\$175	N/A
Water Bottom	N/C	N/R	N/R	\$1,995	N/R	N/R	\$250	N/A
Density	N/C	N/A	N/A	\$1,825	N/R	\$1,895	N/A	N/A
Multiple Density Strata	N/C	N/A	N/A	N/A	N/R	N/R	N/A	N/A
MODBUS Interface	N/C	\$1,950	\$1,950	\$1,950	\$2,695	\$2,695	\$3,475 ?	N/C
<b>Hardware Sub-Total</b>	\$11,995	\$12,480	\$14,230	\$18,050	\$12,475	\$17,390	\$13,220	\$6,345
Self Calibrating	Yes	No	No	No	No	No	No	No
Bottom Referenced	Yes	No	No	No	No	N/R	No	No
Density Stratification	Yes	No	No	No	No	N/R	No	No
In Service Installation	Yes	No	N/R	No	No	No	N/R	No
Tank Entries	1	2	2	3	2	2 to 3	1	2 to 3
Hot Taps (\$1,500 each)	No	N/A	N/A	\$1,200	N/A	\$1,500	N/A	N/A
Stilling Well or Stand Pipe	No	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	No
Conduit to the tank top	\$2,500	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$2,500	N/R
Additional AC Conduit	No	\$1,500	\$1,500	\$1,500	\$1,500	\$1,500	No	No
Installation (Hardware)	\$700	\$1,500	\$700	\$3,000	\$1,500	\$3,000	\$700	\$1,500
10 year Maint. / Spares	\$3,000	\$5,000	\$5,000	\$15,000	\$15,000	\$25,000	\$15,000	\$7,000
<b>Install /Maint. Sub-Total</b>	\$5,700	\$15,000	\$14,200	\$27,700	\$25,000	\$38,000	\$21,200	\$8,500
Aboveground Storage Tank	MTG	Radar	Radar / w	Radar	Servo / w	Servo	Magneto-	Mech.
40 Ft.		Cone Ant.	Still Well	Hybrid	Still Well	Hybrid	strictive	
Hardware Sub-Total	\$11,995	\$12,480	\$14,230	\$18,050	\$12,475	\$17,390	\$13,220	\$6,345
Install /Maint. Expense	\$5,700	\$15,000	\$14,200	\$27,700	\$25,000	\$38,000	\$21,200	\$8,500
<b>TOTAL</b>	<b>\$17,695</b>	\$27,480	\$28,430	\$45,750	\$37,475	\$55,390	\$34,420	\$14,845
<b>Key:</b>	N/A	Not Available		Benefit				
	N/C	No Charge		Negative				
	N/R	Not Recommended		Does Not Apply				

## Conclusion

GSI believes that the MTG "Multi-function Tank Gauge" is the best tank gauge technology for the majority of liquid products. MTG measurement parameters including level, volume, mass, Free water, water volume, multi-point spot temperatures, density or API gravity distribution. Thus, MTG is the only gauge that can calculate net volume in real time based upon the parameters it measures, not secondary instrumentation.

What is the additional cost incurred when measuring net volume with your existing system? A gauger taking samples, a lab analyzing the data, lab data input to your inventory accounting system, etc.

First, MTG is bottom referenced and not subject to reference point movement. Second, MTG is the only gauge to provide Level Net Volume using Class A, 4 Wire, 100 ohm Platinum RTD's. What is the level change for a One degree F uncertainty in a 40 ft. gasoline storage tank? In calculating net volume, Temperature measurement is just as important as level. So why do other manufacturers use inferior temperature devices? Third, MTG also provides Mass Net Volume (without the influence of temperature).

Between bottom referencing, accurate temperature instrumentation, and both net volumes; MTG reduces your inventory yield and provides the best inventory accuracy available. Other MTG features also provide operational and economic benefits beyond other tank gauging technologies.