Rosemount™ Tank Gauging System

High-performance bulk liquid measurement and overfill prevention

Secure efficient operations and reduce risk with scalable and open architecture tank gauging technology.

- Get certified custody transfer accuracy based on innovative radar technology.
- Comply with safety and overfill prevention standards such as API 2350 and IEC 61511.
- Simplify automation and expansion with Emerson wireless solutions.
- Improve inventory management and oil movement operations.
- Use emulation to easily replace old gauges from other vendors.
What if you could meet every challenge today and tomorrow?

Protect the value of your investment

There are always new challenges to face in a tank storage facility. Expansion or refurbishing projects mean you have to connect new equipment to your installation. This is also the case when you replace damaged or outdated technology. Emerson’s Rosemount Tank Gauging System lets you meet your challenges so you can increase plant efficiency and protect the value of your assets.

Works everywhere

The Rosemount Tank Gauging System is suitable for all applications and tank types: pressurized or non-pressurized, with fixed or floating roofs. Applications include bulk liquid storage tanks in:

- Tank storage terminals
- Refineries
- Aviation fuel depots
- Lube oil depots
- Liquefied gas storage plants (LPG, LNG, other liquefied gases)
- Petrochemical industries
- Biofuel plants
- Vegetable oil depots
- Distilleries
- Power plants

Floating roof tank.

Pressurized LPG tank.

Fixed roof tank.

Full containment cryogenic tank for LNG, etc.
System overview

The Rosemount Tank Gauging System measures and calculates tank data for custody transfer, inventory management, product movement, mass balance and loss control, as well as leak detection and overfill prevention.

Functions include:
- Complete inventory management and custody transfer functions as per OIML and API standards
- Multiple spot temperature measurement
- Free water interface level measurement
- Vapor pressure and hydrostatic pressure measurement giving online density
- IEC 61508 certified SIL2/SIL3 independent overfill prevention
- Interoperability with all major DCS and host systems
- Automatic proof-testing without affecting tank operations
- Floating roof monitoring
- Cool-down and leak detection for LNG tanks and other cryogenic storage tanks

The two-wire Intrinsically Safe (IS) self-configuring Tankbus enables cost-efficient and safe installation.
Make the most of your tank farm

Boost plant efficiency

Having access to reliable and accurate real-time tank inventory data is key to high plant productivity. Operators can handle more tanks, and safely fill them higher to better utilize the storage capacity. Rosemount Tank Gauging System is based on a scalable technology with open architecture, allowing you to improve efficiency step by step.

- Possible to combine devices freely including devices from previous systems
- Automatic configuration of devices speeds up commissioning
- Wired and wireless networks can co-exist within the same system
- Installation can be done with tanks in operation (except for pressurized tanks)

Raise the level of safety

Lawmakers, corporate management, insurance companies, members of the community – demands for increased safety come from just about everywhere. Rosemount Tank Gauging System allows you to meet existing and future requirements at the same time as you protect plant assets, the environment, and human lives.

- Continuous surveillance – radar level gauges are always in operation
- Two-wire intrinsically safe cabling on tanks
- IEC 61508 certified SIL 2 and SIL 3 capable level and alarm output devices
- 2-in-1 gauging allowing simultaneous level measurement and independent alarm functionality
- API 2350 overfill prevention guidelines and expertise available whenever you need it
- Automatic proof-testing without affecting tank operations
- Continuous automatic monitoring of floating roofs

Certified SIL 2 or SIL 3 capable overfill safety.

Unique 2-in-1 solution with full separation.
Ensure precise measurements

The Rosemount Tank Gauging System gives you precise data for certified custody transfer, inventory management, and loss control. The level measurement accuracy of ±0.5 mm (0.02 in.), together with the highest precision average temperature measurement, ensures exact net volume calculations. In cases where medium accuracy is sufficient, we offer a number of cost-effective gauging instruments.

- Level gauges with no moving parts and only the antenna inside the tank
- Custody transfer certification by OIML as well as many national institutes
- Precise measurement lets you stay in control of the inventory and custody transfer
- Keep accurate track of leaks and overfills
Use modern technology to go further

Reach more tanks at less cost

Wireless tank gauging allows for installation cost savings by up to 70 percent. The Rosemount Tank Gauging System supports Emerson’s wireless technology, based on the wireless field network industry standard IEC 62591 (WirelessHART®). The wireless network is self-organizing and automatically finds the best way around any obstacle.

Wireless data transmission gives you a lot of benefits and opportunities:
- No need for digging and trenching in a potentially complicated and dangerous tank environment
- Possible to connect tanks located far away and divided by water or roads
- Easy to automate all bulk liquid storage measurement
- Redundant communication can be created without time-consuming cabling work
- Downtime for expansion, upgrading, and maintenance is kept to a minimum

Meet the future with emulation

Emulation technology lets you replace old level gauges from all major vendors, with modern radar-based tank gauging using your existing field wiring and host system.
- Easy way to upgrade your tank gauging system at a pace that suits you
- New and accurate devices make it possible to improve efficiency and safety
- Precise data strengthens tank inventory control allowing increased throughput
Stay in control with Rosemount TankMaster

TankMaster is a powerful, easy-to-use Windows™-based inventory management software package. It is easy to configure with no software engineering time required. Data can be shared with users on all levels and information can be accessed wherever you are. Graphic plant layout with customized views for efficient operations:

- Gives the operator a complete tank content overview
- Provides inventory and custody transfer functions with API net volume calculations
- Collects all tank gauging data from the measurement devices on the tanks
- Offers alarm handling and reporting
- Allows proof-testing from the control room
- Provides system configuration and service

TankMaster distributes essential inventory tank gauging data.
Key devices for tank gauging

For decades, Rosemount radar level gauges have been the obvious choice when precision is critical. The 5900S gauge builds upon this legacy by offering level measurement accuracy of ±0.5 mm (0.02 in.). Even if accuracy is important, the need can vary. This is why we include gauging solutions for both demanding custody transfer with full inventory management functionality as well as applications where accuracy is less critical. See Appendix A for list/links to product data sheets for each device.

Radar level gauges

**Rosemount 5900S Radar Level Gauge**
Non-contacting, ±0.5 mm (0.02 in.) ultra-high performance level measurement. Antennas available for all tank types.

**Rosemount 5900C Radar Level Gauge**
Reliable ±3 mm (0.12 in.) non-contacting measurement. Antennas available for all tank types.

**Rosemount 5300 and 5400 Radar Level Transmitters**
Guided wave radar and non-contacting radar level transmitters for medium accuracy, non-inventory grade applications.

Temperature and free water level

**Rosemount 2240S Multi-input Temperature Transmitter**
Ultra-stable temperature measurement. Connects up to 16 spot temperature sensors for average liquid temperature measurement and online temperature stratification monitoring.

For measuring shell temperature in cryogenic applications, the flange connection is designed to allow connection of separate individual spot sensors.

**Rosemount 565, 566, 765, and 614 Sensors**
Four-wire calibrated temperature sensors and free water level measurement. Up to 16 Pt-100 spot elements per sensor/transmitter.

**Rosemount 644 Temperature Transmitter**
For single-point temperature measurement.

**Rosemount 214C Single Point Temperature Sensors**
For single-point Pt-100 temperature measurement.
Rosemount Tank Gauging System

Pressure

**Rosemount 3051S Pressure Transmitter**
Enables online density, mass, and vapor pressure measurement.

**Rosemount 2180 Field Bus Modem**
Used for connecting a TankMaster PC to the TRL2 field bus (if not using the system hub).

Communication and accessories

**Rosemount 2410 Tank Hub**
Collects and transfers data from one or several tanks. Enables emulation, wireless communication and SIL certified overfill prevention.

**Rosemount 2460 System Hub**
Transfers tank gauging data to TankMaster Inventory Management System and to Host/DCS.

**Rosemount 2230 Graphical Field Display**
Remote data access at tank top or ground level.

**Emerson Wireless 1410/1420 Gateway**
Connects wireless self-organizing networks with any host system.

**Emerson Wireless 775 THUM Adapter**
Adds wireless to all measurement points.

**TankMaster Inventory Management Software**
Gain control over your inventory data. In addition, use it for system configuration and remote proof-testing.

**Rosemount 2100 Series Liquid Level Switch**
Alternative option with point level switch when gauge in constant operation is not used for overfill prevention.

**Connection Cabinets**
Customized cabinets for wiring connections, communication devices and servers.
System functions

The Rosemount Tank Gauging System performs a number of important tank storage facility functions. The exact scope can vary according to specific user requirements. (For a more detailed list of inventory management functions, see Rosemount TankMaster Inventory Management Software Product Data Sheet, document number 00813-0100-5110.)

Measurements

- Tank level
- Level rate
- Free water level (interface)
- Average liquid temperature
  (only elements in liquid are considered)
- Spot temperature
- Temperature for cool-down monitoring and leak detection in LNG and other cryogenic tanks
- Vapor and liquid pressure
- Density
- Gross volume based on up to 5000 strapping points
- Net volume according to API standards
- Mass
- Floating roof position

Data communication functions

- Communication with other systems, DCS, SCADA, PLC, Enterprise system etc (Ethernet, RS485/232, Modbus TCP/RTU etc)
- Emulation of other vendor’s field bus/gauges
- Emulation or other vendor’s control room HMI
- Modbus or FOUNDATION Fieldbus wired transmission of data
- WirelessHART transmission of data

Other functions

- Operator graphics and Human Machine Interface
- Alarm handling
- Relay outputs for overfill prevention alarms (SIL)
- 4-20 mA SIL output
- Relay outputs for overfill prevention and other alarms (non-SIL)
- Remote proof-testing
- Leak alarms
- Batch reporting
- Log reports
- Mass balance reports
- Historical data sampling
- Floating roof monitoring
- System configuration and setup
Technology

Radar level gauging

Rosemount radar level gauges provide outstanding reliability with no moving parts and only the antenna inside the tank.

For radar level measurement, there are mainly two modulation techniques:

- **Frequency Modulated Continuous Wave, FMCW** is used by high-performance radar level gauges. Rosemount 5900S uses FMCW, together with digital reference and filter technology, which enables custody transfer accuracy.

- **Pulse method** measures the time it takes for a pulse to travel to the surface and back. The time difference is converted to a distance, from which the level is calculated. Rosemount 5400 uses this technique. One special case of the pulse method is the Time Domain Reflectometry (TDR) technology, as used in Rosemount 5300, where a low-power nano-second pulse is guided down a probe towards the process media surface, where it is reflected back.

The radar gauge/transmitter consists of a transmitter head and an antenna. The transmitter head can be combined with any antenna type in the same gauge series, minimizing spare parts requirements. No matching of transmitter head and antenna is required, which means the transmitter head can easily be replaced without opening the tank.

**The FMCW method**

The FMCW-based radar gauge transmits microwaves towards the surface of the liquid. The microwave signal has a precise linear frequency variation.

When the signal has traveled down to the liquid surface and back to the antenna, it is mixed with the signal that is being transmitted at that moment.

The reflection from the liquid surface has a slightly different frequency compared with the signal transmitted from the antenna.

The difference in frequency is measured, and it is directly proportional to the distance to the liquid surface.

This technology provides a measured value with high accuracy.

Technology for real-world tank applications

Since the Rosemount 5900 Series antennas have an inclined polished surface where microwaves are emitted, they are less susceptible to condensed water or product. The drops of condensation do not cover the active part of the antenna, and the radar signal is not attenuated. This results in higher accuracy and better reliability.
The Rosemount 5900 Series radar level gauges with parabolic antennas are designed also for harsh environments like bitumen tanks.

The antenna is in operation after having been exposed to blown bitumen at 220 °C (430 °F) for several months.

The Rosemount 5900 Series with still-pipe array antenna uses the Low Loss Mode technology transmitting radar waves close to the pipe centerline. This technology virtually eliminates signal and accuracy degradation due to rust and product deposits on the inside of the pipe wall.

The still-pipe used for LNG and LPG ensures adequate signal strength from the surface, also when the liquid is boiling.

The Low Loss Mode enables full accuracy also in old and worn still-pipes.

For best measurement performance in LPG applications, an integrated pressure sensor enables corrections for vapor influence. Measurements in closed tanks with liquefied gases including LNG can be verified using a permanently installed verification pin with a known distance to the antenna.

Antenna design with no horizontal surfaces according to the American Petroleum Institute Standard (API ch. 3.1B ed.1).
Open and scalable system architecture

The system can include a wide range of devices making it easy to build a large or small customized tank gauging system. Thanks to the modular design, a system can easily be expanded or upgraded.

All field devices are connected on the Tankbus, which is based on the open FOUNDATION Fieldbus industry standard.

Lower cost and easier commissioning

The Rosemount Tank Gauging System supports plug-and-play technology for trouble-free installation.

All fieldbus segments in a system are autoconfigured minimizing the need for specific FOUNDATION Fieldbus knowledge. The existing field cabling can normally be used. No special tools are required, and all parts can easily be carried to the tank roof.

Installation can be done with tanks in operation, except for cryogenic storage and pressurized tanks such as Liquefied Petroleum Gas (LPG) tanks.

Intrinsically safe cabling on tank

The system is designed to minimize power consumption, which enables the use of two-wire intrinsically safe technology. The field devices are powered by the Tankbus via the Rosemount 2410 Tank Hub using FISCO (FOUNDATION Fieldbus Intrinsically Safe Concept). This solution has several advantages:

- Increased safety at system start-up and operation
- Quicker and easier installation due to less cabling
- Cable usage without conduits
Integration with other systems

The Rosemount system can be connected to all major suppliers of DCS, SCADA systems, plant host computers, or terminal automation systems. Integration can be made in several ways via:

- TankMaster PC
- Rosemount 2460 System Hub
- Rosemount 2410 Tank Hub
- Direct connection to the tank devices if the host system is based on FOUNDATION Fieldbus (no Rosemount 2410 or Rosemount 2460 hub included in this case)

Using a connection to TankMaster gives the advantage of communicating both measured values and comprehensive inventory data. The Rosemount 2460 system hub can also provide inventory data.

Connection to a host system can be made via Rosemount 2410, Rosemount 2460, a TankMaster PC, or directly.
Reduce the risk of tank overfills

The Rosemount Tank Gauging System can be used as part of a highly reliable automatic or manual overfill prevention system. In such Safety Instrumented System (SIS) applications, level measurement is duplicated in one Basic Process Control System (BPCS) layer and one independent Functional Safety layer.

The Rosemount 5900 Series gauges and tank hubs are IEC 61508 certified SIL 2 or SIL 3 capable. They include separate certified alarm loop relays or analog output functionality.

The innovative 2-in-1 technology saves installation cost and reduces complexity by enabling the Rosemount 5900S gauge to provide dual level data in two independent layers of protection using only one housing and a single tank nozzle. The level output from the safety layer sensor is available as redundant level measurement data.

One important advantage is that the Rosemount 5900 Series gauge is in constant operation. Unlike a conventional switch, it provides continuous information about its status and performance, since it is being used in everyday tank farm operations.

In addition, the alarm level can easily be set to any chosen value. The level value from the radar level gauge is transferred on the digital bus to a TankMaster PC or other host system, whereas the alarm signal uses the separate relay or analog output in the Tank Hub. Follow the recommendations in the Safety Manual (document number 00809-0200-5100). See also some available SIS/BPCS configuration examples on page 24 to 27.

The Rosemount gauging system supports all categories covered by the API 2350 revision 4, which is the first internationally recognized tank gauging standard for overfill prevention. It covers not only instrumentation but also procedures and processes for the whole plant/terminal life cycle, including the requirements for establishing a detailed risk assessment. See “The Complete Guide to API 2350”, document number 00821-0100-5100 and “The Engineer’s Guide to Overfill Prevention”, document number 00805-0100-1042.
Automatic remote proof test

TankMaster includes a proof-test manager, which allows operators to safely perform proof-testing of overfill alarm functionality remotely from the control room. The proof-testing made at regular intervals can be combined with the continuous product level monitoring.

The proof-test manager performs a number of tests:
- High-level alarm verification using a reference reflector
- High-level alarm verification with simulated reference reflector
- One-point level verification by hand-dipping to verify automatic level measurements
- Analog output verification
- Relay output verification

A step-by-step proof-test wizard guides the user through the selected tests.

Once the selected proof-tests are done, a summary will show a list of the performed tests with the results.

The proof-test functionality supports wired systems with Rosemount 2410 tank hubs and Rosemount 5900 gauges, both non-SIL and SIL.

Proof-test report

When the proof test is finalized and approved, a test report is automatically created. The test report includes field device-specific information, detailed test results, when the test was performed, who performed the test, and who approved it.

Proof-test history

All proof-test reports can easily be displayed on a later occasion using the proof-test history option.

Proof-test scheduling

The proof-test scheduling lets the user specify when the next proof-test should be performed. The test frequency and the desired type of reminder may also be set (pop-up message and/or e-mail).

The high-level alarm verification proof test can be based on either a simulated reference reflector or a physical reference reflector.
Use wireless technology to reach more tanks at less cost

The Rosemount Tank Gauging System supports Emerson’s wireless technology, based on IEC 62591 (WirelessHART), the industry standard for wireless field networks. Reducing field wiring leads to substantial savings in infrastructure, design, and labor required for installation and commissioning.

In addition, the time between project start-up and an up-and-running wireless system is drastically reduced. Wireless tank gauging allows for cost savings up to 70 percent, and gives other benefits as well.

Better utilization of tank capacity

Wireless functionality allows tank gauging data from remotely located tanks, previously collected manually or not at all, to be integrated into the system. This results in a more efficient tank capacity utilization, as well as better inventory and loss control functionality.

Self-organizing field network increases reliability

A wireless device can transmit its own data as well as relay information from other devices in the network. The self-organizing field network automatically finds the best way around any fixed or temporary obstacle. Nodes can identify a network, join it, and self-organize into dynamic communication paths. Reliability increases when the network expands - the more devices, the more communication paths. For fastest update rate, direct hops to the gateway are required.

Secure data transmission

Emerson’s wireless field network is designed for best-in-class security. Data is protected by 128-bit encryption, authentication, verification, anti-jamming, and key management.

All wireless devices communicate with the host system through the Wireless Gateway. A Rosemount Tank Gauging System can consist of both wired and wireless networks.
Wireless connection of tank gauging equipment

The Wireless Gateway is the network manager that provides an interface between field devices and the TankMaster inventory software or host/DCS systems.

Each wireless node in the Rosemount Tank Gauging System consists of a Rosemount 2410 Tank Hub and either a Rosemount 5900 Series gauge or one or several Rosemount 5300/5400 transmitters plus the other tank devices. Rosemount 2410 is connected to the mains power, and a THUM Adapter. The tank gauging system can be complemented with other wireless devices such as pressure and temperature transmitters.

The wireless transmission supports measurement data handled by the tank devices such as level, temperature, free water level, and pressure.
Easy step-by-step installation using emulation

The Rosemount gauging system is compatible with all other major tank gauge vendors. Step-by-step modernization of an existing tank gauging system is possible using available field and control room solutions.

**Gauge emulation**

Many old mechanical float or servo gauges from other vendors can be upgraded with modern Rosemount level and temperature devices and a Rosemount 2410 Tank Hub, using the existing tank openings, field cabling, and control system. By replacing mechanical gauges, it is possible to avoid re-calibration work, the expenses associated with spare parts and maintenance.

The new radar gauge is normally installed with the tank in operation. No hot work is required. The Rosemount 2410 has an open design, covering everything from electrical interface and communication protocol to utilization of different power sources.

Seamless control room connectivity

In addition, other tank management systems can be seamlessly replaced with the Rosemount TankMaster software. Since the Rosemount 2460 System Hub supports emulation of other vendors’ control room devices, Rosemount TankMaster can replace an existing inventory management system and still be able to communicate with the field devices in use. This solution provides interoperability, and problem-free communication with existing field devices, often with a better update rate than before.
Tank gauging as a system application

Tank gauging is an integrated system application, which has specific requirements on the measuring devices in the system. These requirements vary depending on how the system is used. A Rosemount gauging system can be configured with highest accuracy for custody transfer/inventory control, or with medium accuracy required for less critical applications.

- Custody transfer
- Inventory control
- Oil movement/operations
- Overfill prevention
- Leak detection

The Rosemount Tank Gauging System includes equipment for high-accuracy measurement and calculations such as:

- Level: Rosemount 5900S
- Temperature and Free Water Level: Rosemount 2240S with Rosemount 565/566/614 or 765 Sensors (four-wire sensor with up to 16 spot elements)
- Pressure: Rosemount 3051S
- Volume calculations as per API standards: TankMaster WinOpi software and Rosemount 2460 System Hub

System devices exchange measured data between units to optimize functionality. For instance, product temperature measurement functions use level information for calculating average product liquid temperature. Data from pressure transmitters is used to calculate density, etc.

High-performance inventory and custody transfer applications

A Rosemount gauging system used for custody transfer gives accurate measurement values for volume calculations. These calculations require a selection of suitable devices to obtain high performance for measurement of level, free water level, average temperature, and in some cases reference density. If any of these sensors is poorly matched, the result of the standard volume calculation may suffer. Similar conditions apply for inventory measurements, for which the net standard volume is important. For mass balance and loss estimation, the calculated mass is in focus.

Inventory parameters are calculated based on input data available for the current tank. The figure shows an example of how the measured product level is converted to a standardized volume.
Non-inventory grade applications
In a system primarily intended for oil/product movement only, level and observed volume (TOV) are important parameters, but do not necessarily require the highest accuracy. The Rosemount gauging system includes the following equipment for non-inventory grade measurement and calculations:
- Level: Rosemount 5300 or Rosemount 5400
- Temperature: Rosemount 644 Transmitter with Rosemount 214C Sensor
- Volume calculations: TankMaster WinView software or Rosemount 2460 System Hub

Operation and configuration
The TankMaster software is the operator’s interface to the system. This user-friendly software is easy to configure and start up. No specialized software engineering is required. It gives the operator a good overview and quick access to any measured values.

This software provides a wide range of inventory and custody transfer functions such as net volumes according to API/ISO standards, reporting, alarms, graphics, trends, batch handling, etc. It also supports floating roof monitoring and proof-testing.

In addition, the TankMaster software is the primary configuration tool. Basic configuration can also be done with a Field Communicator, the AMS Suite or DeltaV.

Protocols for communication with major suppliers of plant host computers, such as DCS or SCADA systems, have been developed and certified. In many cases the plant’s DCS/SCADA system works as the operator’s interface for tank management data from the Rosemount gauging system.

Floating roof monitoring
Floating roofs on storage tanks offer advantages in terms of reduced need for vapor recovery but can also create operational and safety issues. A sinking, tilting, leaking, or collapsing roof can cause significant mechanical damage, create overfills and the release of explosive hydrocarbon vapor. The cause of the tank malfunctioning may be that the roof is stuck due to damaged or wrongly mounted rim seals.

Leaking pontoons, overfills, strong winds, and inadequate draining during heavy rain or snowfall can also dangerously affect buoyancy and roof position.

By measuring the floating roof position, the Rosemount Tank Gauging System can continuously monitor the roof and give alarms for roof tilting and other hazardous tank conditions. Normally the roof monitoring is combined with liquid level measurement in a still-pipe for complete tank overview in the control room operator’s interface.
System layout configurations

Open architecture enables the most cost-effective layout

The Rosemount Tank Gauging System supports a large number of configuration combinations. It can incorporate both Rosemount 5900S-, 5900C-, 5300-, or 5400-based configurations, networks with previous generations of Rosemount radar gauges (TRL2, Rex, Pro), and even gauges from other vendors.

Wired and wireless networks can co-exist within the same system. This flexibility enables a step-by-step upgrade.

1. Requires Rosemount 2460 System Hub.
Custody transfer and inventory tank gauging – 5900S system configuration

The Rosemount 5900S-based tank gauging configuration is used for the highest demands on accurate measurements for inventory management and custody transfer. Precise net volumes are calculated using tank strapping tables and compensation for temperature and tank characteristics.

For temperature measurements, the Rosemount 2240S Temperature Transmitter is combined with the Rosemount 565, 566 or 765 Multiple Spot Temperature Sensors. The Rosemount 3051S transmitter is used for pressure measurements.

Each tank has a designated Rosemount 2410 Tank Hub. All values are transferred to the TankMaster software, which has a complete set of inventory and custody transfer functions. TankMaster includes an API/ISO calculator for volume and density. Alternatively, inventory data can be transferred directly from the Rosemount 2460 System Hub to the DCS/Host without going via TankMaster.

When highest transfer precision is not required, the Rosemount 5900S can be replaced by the Rosemount 5900C Radar Level Gauge.

High-precision system
Functional safety configurations for overfill prevention

The process and terminal industries apply independent protection layers (IPLs) to minimize the risk of a potential hazard such as tank overfills.

The Rosemount Tank Gauging System supports a number of SIS (Safety Instrumented Systems) configurations designed for overfill prevention. Which configuration is most suitable depends on a number of factors such as the type of storage tank, existing instrumentation, Safety Integrity Level, etc.

Integrated Emerson Solution for Automatic Overfill Prevention System (AOPS) and Tank Gauging

Automatic Overfill Prevention System (AOPS)  
- Rosemount 5900S Radar Level Gauge  
- DeltaV SIS  
- SIL-PAC (Fisher™ DVC + Bettis™ Actuator)

Automatic Tank Gauging (ATG)  
- Rosemount 2240S with Multiple Spot Temp.  
- THUM Adapter  
- Fisher Valve  
- Emerson Wireless Gateway

Connection to TankMaster (optional)  
- Includes Visual & Audible Level Alert High and Level Alarm High-High

SIL 3

Incorporates Visual & Audible Level Alert High and Level Alarm High-High

Emerson.com/Rosemount
Floating Roof AOPS 2-in-1

Automatic Overfill Prevention System (AOPS)

Automatic Tank Gauging (ATG)

Safety Instrumented System (SIS)

SIL 2 relay or 4-20 mA analog signal

Rosemount 2410 Tank Hub

Connection to TankMaster (optional)

Rosemount 2460 System Hub

TankMaster Inventory Management Software

Sphere AOPS 2-in-1

Automatic Overfill Prevention System (AOPS)

Automatic Tank Gauging (ATG)

Safety Instrumented System (SIS)

SIL 2 relay or 4-20 mA analog signal

Rosemount 2410 Tank Hub

Connection to TankMaster (optional)

Rosemount 2460 System Hub

TankMaster Inventory Management
Fixed Roof AOPS

Automatic Overfill Prevention System (AOPS)

- Safety Instrumented System (SIS)
- Rosemount 2410 Tank Hub
- Connection to TankMaster (optional)
- Rosemount 2460 System Hub
- TankMaster Inventory Management

Automatic Tank Gauging (ATG)

- Rosemount 2240S with Multiple Spot Temp.
- Rosemount 5900S Radar Level Gauge
- Rosemount 2230 Graphical Field Display

Pressure Vessel AOPS

Automatic Overfill Prevention System (AOPS)

- Safety Instrumented System (SIS)
- 4-20 mA analog signal

Automatic Tank Gauging (ATG)

- Rosemount 5300 Guided Wave Radar Level Transmitter
- Rosemount 644 with Single Point Temperature Sensor
- Rosemount 2460 System Hub
- TankMaster Inventory Management
Fixed MOPS 5900S Including Level Switch

Manual Overfill Prevention System (MOPS)

- Relay signal
- Rosemount 2100 Level Switch
- Connection to TankMaster (optional)
- Independent Alarm Panel
- High-High Alarm

Automatic Tank Gauging (ATG)

- Rosemount 2240S with Multiple Point Temp.
- Rosemount 5900S Radar Level Gauge
- Rosemount 2230 Graphical Field Display
- TankMaster Inventory Management
- Rosemount 2460 System Hub
- Rosemount 2410 Tank Hub
Wired and wireless combination

Wired and wireless communication may be combined within the Rosemount Tank Gauging System for most cost-effective access to data. It is possible to connect a wireless Rosemount gauging system to any existing wired tank gauging system. It is also possible to add a wireless connection to a tank with wired communication to achieve system redundancy (see Figure on page 6).
Improve system reliability with redundancy

The Rosemount Tank Gauging System supports several redundancy designs, allowing two identical devices for critical operations.

Redundancy can be utilized for some or all equipment, from the control room to the field devices:

- Two TankMaster PCs – both active and separately asking for data, or one primary active and the secondary in hot standby backup mode.
- Two System Hubs – the primary unit is active, the other is in backup mode. A control signal is sent between the two units.
- Two Tank Hubs – enables two separate Tankbuses on the same tank.
- Tank Device Redundancy – dual-level measurement devices (e.g. two Rosemount 5900 Series gauges or a Rosemount 5900S 2-in-1), dual temperature transmitters with associated sensors, etc.

If the backup unit is not receiving it, or if the primary unit is not working properly, a failure message is sent to TankMaster (or a DCS system), and the backup unit is activated.

See illustration below for a fully redundant system.
Emulation enables flexible system configuration

The Rosemount 2410 Tank Hub and the Rosemount 2460 System Hub support emulation of field devices from other vendors. In addition, the Rosemount 2460 hub enables exchange of an existing control room operator system to Rosemount TankMaster Inventory Management Software.

The TankMaster software allows the configuration of the emulated field devices. TankMaster can also send commands to the connected servo gauges.

By using the Rosemount 2410 for tanks equipped with other vendor’s level devices, you can add a Rosemount 2240S with multiple spot temperature sensors and benefit from getting more measurement data integrated in the system. The Rosemount 2410 Tank Hub also adds wireless capability to the emulated devices, either for primary communication or to achieve redundant communication. Wireless communication enables previously stranded data and diagnostics to be included in the automated tank gauging system.
Cryogenic storage applications

In cryogenic storage tank applications, such as Liquefied Natural Gas (LNG), Ethylene etc., the tank cannot normally be opened for service except during scheduled maintenance, which often occurs at intervals of more than 10 years. System configurations for cryogenic applications are focused on non-interrupted operation and redundant functionality enabling backup measurement of level and temperature. Application-specific functionality, such as leak detection and cool-down sensors, shell temperature and roll-over prediction, is often included.

The Rosemount 5900S level gauge for liquefied gas tanks include a verification pin functionality allowing operation to be tested against a reference echo in the still-pipe when the tank is closed. A ball valve is often included to allow service when the tank is closed.

A. Separate device for temperature and density profiling (LTD)
B. Rosemount 5900S primary radar level gauge
C. Rosemount 2240S temperature transmitters, each with up to 16 spot temperature sensors to cover the entire tank height for average liquid temperature measurement and online redundant temperature stratification monitoring
D. Rosemount 5900S secondary radar level gauge
E. Rosemount 5900 radar gauge allocated for high-level alarm
F. Rosemount 2240S temperature transmitters with separate temperature elements for skin/cool-down temperature measurement and leak detection
Operational control with Rosemount 5300 or Rosemount 5400 system configuration

A Rosemount 5300 or Rosemount 5400 system configuration is a cost-efficient alternative for non-inventory grade operational control at tank terminals, as well as applications in the biofuels industry, chemical plants, etc. This configuration is a good choice for medium accuracy applications. For level measurements, Rosemount 5300 (guided wave radar) or Rosemount 5400 (non-contacting radar) is used.

For temperature measurements, the Rosemount 644 Temperature Transmitter with a Rosemount 214C Single Point Temperature Sensor is used. The Rosemount 2240S Temperature Transmitter is an even better alternative if more than one temperature element is required. All values are transferred to the TankMaster WinView tank management software.
Floating roof monitoring

Shell Mounted installation with non-contacting radar

Up to six non-contacting radar transmitters are placed on top of the tank at equal distances. Reflector plates on the floating roof enable measurements without any object protruding from the roof surface. Roof tilt is tracked by comparing the distance between each radar gauge and the floating roof. This non-contacting solution can be retrofitted to existing tank gauging systems without taking the tank out of operation. Adding the tank level measurement as a reference means that roof buoyancy can also be monitored.

Roof-mounted installation with guided wave radar

An alternative solution is to use up to six guided wave radar level transmitters directly on the floating roof, with rigid probes penetrating through the roof and into the liquid below. Roof tilt is tracked by comparing the distance from the floating roof down to the product surface. The roof buoyancy is also monitored automatically. An advantage of the on-roof configuration is that it uses wireless transmission, battery power and existing nozzles.

Fully automatic solution

Measurement data is transmitted via wired or wireless communication to the control room, where an operator can monitor the roof status and make configurations using the Rosemount TankMaster software. Drain sump monitoring and liquid hydrocarbon detection can be added to the TankMaster roof monitoring function by installing a Rosemount 2160 Wireless Vibrating Fork Detector and a Rosemount 702 Wireless Discrete Transmitter with Liquid Hydrocarbon Detection. Automatic alarms are given for out-of-limit roof tilt, buoyancy, roof sticking, as well as drain sump blocking and hydrocarbon detection.
Specifications

System key performance specifications

Rosemount Tank Gauging System meets or exceeds requirements specified in industry-relevant standards e.g. API MPMS Ch 7.3, Ch 3.1B and Ch 12.1.1, ISO 4266 and OIML R85.

Level measurement

Instrument accuracy Rosemount 5900S

±0.5 mm (0.02 in.)

Instrument accuracy Rosemount 5900C

±3 mm (0.12 in.)

Temperature stability of gauge

Typically <±0.5 mm (0.02 in.) in -40 to +70 °C (-40 to +158 °F)

Update time of gauge

New measurement every 0.3 s

Update time for wireless systems

Depends on the number of hops to the gateway. Fastest update rate <8 s requires devices with direct communication to the gateway.

Repeatability

0.2 mm (0.008 in.)

Maximum level rate

Up to 200 mm/s

Temperature measurement

Rosemount 2240S Multi-input Temperature Transmitter

Temperature conversion accuracy

0.05 °C (0.09 °F) over measuring range and ambient temperature 20 °C (68 °F)

Ambient temperature effect

±0.05 °C (0.09 °F)

Measuring range

-200 to 250 °C (-328 to 482 °F) for Pt-100

Resolution

±0.1 °C (0.1 °F) according to API chapter 7 and 12

Update time

4 s

Temperature sensor calibration

Deviations deriving from the Pt-100 elements are repeatable and can be eliminated with a unique manufacturing calibration procedure, where the Callendar – Van Dusen equation is used. The whole process is computer-controlled and up to 16 elements in each sensor are automatically calibrated at the same time.

Sensor element type

Four-wire Pt-100 spot elements according to IEC/EN 60751.

Number of elements per sensor

1-16
Volume uncertainty comparison

The uncertainty of the calculated net volume depends not only on the accuracy of the devices, but also on the application. Below is an example to compare the difference between typical Rosemount 5900S, 5900C, and Rosemount 5300/5400 configurations.

- **Crude oil**, 887 kg/m³ density at 20 °C (68 °F) product temperature
- **Tank height**: 10 m (33 ft)
- **Tank diameter**: 15 m (49 ft)
- **Number of inventories per year**: 12
- **Number of batch transfers per year**: 24
- **Ambient temperature**: 5 to 35 °C (41 to 95 °F)

Under these conditions, the typical measurement accuracy is:

- **5900S**: ±1 mm (0.04 in.), 0.17 °C (0.30 °F)
- **5900C**: ±3 mm (0.12 in.), 0.17 °C (0.30 °F)
- **5300/5400**: ±10 mm (0.4 in.), 1.2 °C (2.2 °F)[(1)]

According to API Manual of Petroleum Measurement Standards, chapter 11: considering both level and temperature uncertainty, the total volume uncertainty in liters is shown in Table 3.

Consequently the Rosemount 5900S configuration reduces volume uncertainty in this example with approximately 90% compared to the Rosemount 5300/5400 system configuration.

Moreover, a Rosemount 5300/5400 system configuration reduces the volume uncertainty with approximately 50% compared to a mechanical tape and float system.

Although calculated for a specific application, this is a representative value for any hydrocarbon storage tank, independent of size.

| Table 1. Temperature Accuracy for Rosemount 565 or 765 Temperature Sensor |
|-------------------------------------------------|---------|---------|---------------|
| Cable 20 m                                      | PT-100 [0 °C (32 °F)] | PT-100 [0 °C (32 °F)] | Total sensor accuracy [0 °C (32 °F)] |
| Four-wire connection, 1/6 DIN B                  | ± 0.001 °C (± 0.002 °F) | ± 0.13 °C (± 0.234 °F) | ± 0.19 °C (± 0.342 °F) |
| Four-wire connection, calibrated                | ± 0.001 °C (± 0.002 °F) | ± 0.045 °C (± 0.081 °F) | ± 0.025 °C (± 0.045 °F) |

1. Root Mean Square values for wiring error and the largest platinum element error for the given range.

2. X8 calibration extrapolated under use of standard Callendar-Van Dusen C constant from EN 60751.

| Table 2. Net Standard Volume (NSV) Uncertainty in a Tank with a Radius of 20 m (66 ft) and a Level of 18.5 m (60.7 ft) |
|-------------------------------------------------|---------|----------|
| Four-wire connection, 1/6 DIN B | ± 0.19 °C (± 0.342 °F) | 3.8 m³ (23.9 bbl) |
| Four-wire connection, calibrated | ± 0.025 °C (± 0.081 °F) | 0.5 m³ (3.1 bbl) |

Pressure measurement

**Reference accuracy Rosemount 3051S**

**Coplanar pressure transmitter**

Up to ±0.025% of span for ultra version, up to ±0.035% of span for classic version.

**Liquid level pressure transmitter**

Up to ±0.055% of span for ultra version, up to ±0.065% of span for classic version.
System design specifications

System layout

Communication on the self-configuring Tankbus connected to the Rosemount 2410 Tank Hub is based on the FOUNDATION Fieldbus. It is also possible to connect previous Rosemount tank gauging devices to the system via Modbus, integrate a wireless system and a system from another vendor (see Table 5).

The below data can give guidance when customizing the system:

- The Rosemount 2410 Tank Hub delivers 250 mA to the Tankbus.
- The number of tanks and units connected to the Tank Hub depends on which field devices are connected, and their power consumption. Current requirement per field device is listed in Table 4.
- One Rosemount 2410 Tank Hub per tank is recommended for a Rosemount 5900 Series system configuration.
- Rosemount 2410 Tank Hub supports maximum 5 tanks for a Rosemount 5300 or 5400 system configuration.
- Minimum voltage supply to the devices is 9 V.

Table 4. Power Budget

<table>
<thead>
<tr>
<th>Field device</th>
<th>Current consumption (9V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rosemount 5900 Series Radar Level Gauge</td>
<td>50 mA</td>
</tr>
<tr>
<td>Rosemount 5900S Radar Level Gauge, 2-in-1</td>
<td>100 mA</td>
</tr>
<tr>
<td>Rosemount 5300 or Rosemount 5400 Series Radar Level Transmitter</td>
<td>21 mA</td>
</tr>
<tr>
<td>Rosemount 2230 Graphical Field Display</td>
<td>30 mA</td>
</tr>
<tr>
<td>Rosemount 2240S Multi-input Temperature Transmitter</td>
<td>30 mA including temperature sensors</td>
</tr>
<tr>
<td>Rosemount 644 Temperature Transmitter</td>
<td>11 mA</td>
</tr>
<tr>
<td>Rosemount 3051S or Rosemount 2051 Pressure Transmitter</td>
<td>18 mA</td>
</tr>
</tbody>
</table>

Examples:

250 mA from the Rosemount 2410 Tank Hub supplies power to:

One tank with:
- One Rosemount 5900S 2-in-1 Radar Level Gauge
- One Rosemount 2240S Multi-input Temperature Transmitter with sensor
- Two Rosemount 2230 Displays
- Two Rosemount 3051S Pressure Transmitters

Five tanks with:
- Five Rosemount 5300 or 5400 Radar Level Transmitters
- Five Rosemount 644 Temperature Transmitters with sensors
- One Rosemount 2230 Display
Tankbus cable requirements

Recommended cabling is shielded twisted pairs, 0.75 mm² (AWG 18). Other possibilities are shielded twisted pairs, 0.5-1.5 mm² (AWG 22-16). Tankbus cabling must fulfill FISCO cable and installation requirements and be approved for use at minimum 85 °C (185 °F).

FISCO (Fieldbus Intrinsically Safe Concept)

The following cable characteristics are specified for FISCO according to IEC 60079-27.

### Table 5. FISCO Cable Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop resistance</td>
<td>15 to 150 Ω/km</td>
</tr>
<tr>
<td>Loop inductance</td>
<td>0.4 to 1 mH/km</td>
</tr>
<tr>
<td>Capacitance</td>
<td>45 to 200 nF/km</td>
</tr>
<tr>
<td>Maximum length of each spur(1) cable</td>
<td>60 m (197 ft) in gas Group IIC</td>
</tr>
<tr>
<td>Maximum length of each trunk(2) cable</td>
<td>1000 m (0.60 miles) in gas Group IIC, and 1900 m (1.18 miles) in gas Group IIB</td>
</tr>
</tbody>
</table>

1. The spur is an unterminated part of the network. It is allowed to have an up to 60 m (197 ft) long spur. For longer distances, an alternative network configuration should be considered.
2. The trunk is the part of the network which has terminators at both ends. In the system, a trunk can be the part of the network between the Tank Hub and a segment coupler or the last device in a daisy-chain configuration.

Reuse of existing cabling

It is recommended to install new Tankbus cabling according to the specification above. However, in most cases it is possible to re-use the existing cabling if compliant with FISCO requirements.

Examples

Typical characteristics for such a cable is:
- 0.75 mm² (AWG 18)
- 42 Ω/km (loop resistance)
- 115 nF/km
- 0.65 mH/km

The following examples show the allowed cabling distances for different system configurations. It is assumed that the devices are installed at the end of the cabling for a full load scenario. In reality that is not the case, which is why the allowed distances might be longer.

**Maximum Distance with Maximum Power Usage for a Rosemount 5900S Configuration:**

The Rosemount 2410 Tank Hub can deliver 250 mA (12.5 VDC) to the devices on the tank. A voltage drop of 3.5 V is allowed. This means that the total worst-case cable resistance can be up to 14 Ω (3.5/0.250). The maximum cable length is 333 m (1092 ft).

**Maximum Distance with Typical Power Usage for a Rosemount 5900S Configuration:**

A more typical current value is 128 mA for a tank equipped with one Rosemount 5900S gauge, one Rosemount 2230 display, one Rosemount 2240S temperature transmitter, and one Rosemount 3051S pressure transmitter. In this case a cable with a length of 650 m (2130 ft) can be used.

Total cable distance A+B+C+D must not exceed the values in Table 6.
Maximum Distance with Typical Power Usage for a 5900S 2-in-1 Configuration:

If the tank instrumentation is the same as in the previous example, but instead is equipped with a Rosemount 5900S 2-in-1 gauge, the typical current value is 178 mA. The cable can then be 468 m (1535 ft).

Table 6 is a guide to how long cables are allowed for a Rosemount 5900 Series system configuration with some common cable types.

Maximum Distance with Typical Power Usage for a Rosemount 5300/5400 Configuration:

For a tank equipped with one Rosemount 5300 or Rosemount 5400 Transmitter, and one Rosemount 644 Temperature Transmitter, the typical current value is 32 mA. This means the cable can be up to 2604 m (8543 ft).

It is possible to have five such Rosemount 5300- or 5400-based tanks connected to one Rosemount 2410 Tank Hub if the total cable length is not exceeded.

Table 7 is a guide to how long cables are allowed for a Rosemount 5300 or Rosemount 5400 system configuration with some common cable types.

### Table 6. Maximum Cabling Distance for a Rosemount 5900 Series Configuration

<table>
<thead>
<tr>
<th>Cable diameter</th>
<th>Loop resistance</th>
<th>Distance in m (ft)</th>
<th>Distance in m (ft)</th>
<th>Distance in m (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 AWG (0.5 mm²)</td>
<td>66 Ω/km</td>
<td>212 (695)</td>
<td>414 (1358)</td>
<td>298 (978)</td>
</tr>
<tr>
<td>18 AWG (0.75 mm²)</td>
<td>42 Ω/km</td>
<td>333 (1092)</td>
<td>651 (2136)</td>
<td>468 (1535)</td>
</tr>
<tr>
<td>17 AWG (1.0 mm²)</td>
<td>33 Ω/km</td>
<td>424 (1391)</td>
<td>829 (2720)</td>
<td>596 (1955)</td>
</tr>
<tr>
<td>16 AWG (1.5 mm²)</td>
<td>26 Ω/km</td>
<td>538 (1765)</td>
<td>1000 (3281)</td>
<td>756 (2480)</td>
</tr>
</tbody>
</table>

Total cable length A+B+C+D+E+F+G+H must not exceed the values given in Table 7.

### Table 7. Maximum Cabling Distance for a 5300/5400 Configuration

<table>
<thead>
<tr>
<th>Cable diameter</th>
<th>Loop resistance</th>
<th>Total cable length from power source (2410) to all devices on the tank, m (ft) with typical power usage of 32 mA per tank with 5300/5400 and 644</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Five tanks Distance in m (ft)</td>
</tr>
<tr>
<td>20 AWG (0.5 mm²)</td>
<td>66 Ω/km</td>
<td>331 (1085)</td>
</tr>
<tr>
<td>18 AWG (0.75 mm²)</td>
<td>42 Ω/km</td>
<td>520 (1706)</td>
</tr>
<tr>
<td>17 AWG (1.0 mm²)</td>
<td>33 Ω/km</td>
<td>662 (2171)</td>
</tr>
<tr>
<td>16 AWG (1.5 mm²)</td>
<td>26 Ω/km</td>
<td>841 (2759)</td>
</tr>
</tbody>
</table>
TRL2 field bus cable recommendations

In a Rosemount Tank Gauging System, the Rosemount 2410 Tank Hub communicates with a Rosemount 2460 System Hub using the TRL2 Modbus protocol.

The TRL2 field bus requires twisted and shielded pair wiring with a minimum area of 0.50 mm² (AWG 20 or similar).

The maximum length of the TRL2 field bus is approximately 4 km (2.5 miles). The TRL2 field bus can normally use existing cables in the tank area.

Typical Tankbus wiring in a Rosemount 5900 Series system configuration

Available installation configurations enable easy and cost-efficient cabling. The Rosemount Tank Gauging System has a daisy chain feature for convenient wiring of the Tankbus.

The devices in a Rosemount 5900 Series system configuration have an on/off selectable built-in bus terminator (the last device on the bus must be terminated).

No external segment couplers or bus terminators are needed when the last device on the bus is a Rosemount 5900 Series gauge, a Rosemount 2240S, or a Rosemount 2230.
System certifications

Refer to each device PDS/Reference manual for details.

**Accuracy/legal metrological approvals**
- OIML R 85 edition 2008
- Algeria, ONML
- Australia, NMi
- Belgium, BMS
- Bulgaria, Type Approval
- China, CPA
- Croatia, Custody Transfer Certificate
- Czech Republic, CMI
- Estonia, TJA
- France, LNE
- Germany, PTB Eich
- India, W&M
- Indonesia, MIGAS
- Italy, Ministero dello Sviluppo Economico
- Kazakhstan, GOST
- Malaysia, SIRIM
- Norway, Justervesenet
- Poland, GUM
- Portugal, IPQ
- Russia, GOST
- Serbia, Custody Transfer Certificate
- Switzerland, METAS
- The Netherlands, NMi
- Tunisia, ANM

**Hazardous location certifications**
- ATEX
- ECEx
- FM-US
- FM-Canada
- Inmetro (Brazil)
- KC (South Korea)
- EAC/GOST (Russia, Belarus, Kazakhstan)
- NEPSI (China)
- PESO (India)
- TIIS (Japan)

**Safety/overfill protection approvals**
- IEC 61508 certified SIL 2 and SIL 3 capable (depending on device)
- TÜV/DIBt WHG for overfill protection (Germany)
- SVTI for overfill protection (Switzerland)
- Vlarem II for overfill protection (Belgium)
# Appendix A

## Technical documentation for the Rosemount Tank Gauging System

### Product data sheets
- Rosemount 5900S Radar Level Gauge (00813-0100-5900)
- Rosemount 5900C Radar Level Gauge (00813-0100-5901)
- Rosemount 5300 Level Transmitter (00813-0100-4530)
- Rosemount 5400 Level Transmitter (00813-0100-4026)
- Rosemount 2240S Multi-input Temperature Transmitter (00813-0100-2240)
- Rosemount 565/566/765 Multiple Spot Temperature and Water Level Sensors (00813-0100-5565)
- Single Point Temperature Measurement (00813-0100-5102)
- Rosemount 214C Temperature Sensors (00813-0500-2654)
- Rosemount 3051S Pressure Transmitter (00813-0300-4801)
- Rosemount 2230 Graphical Field Display (00813-0100-2230)
- Rosemount 2140 and 2140:SIS Level Detectors (00813-0100-4140)
- Rosemount 2160 Wireless Level Switch Vibrating Fork (00813-0100-4160)
- Rosemount 2410 Tank Hub (00813-0100-2410)
- Rosemount 2460 System Hub (00813-0100-2460)
- Rosemount Tank Gauging Accessories (00813-0100-5101)
- Rosemount Control Cabinets (00813-0100-1860)
- Emerson Wireless 1420 Gateway (00813-0200-4420)
- Emerson Wireless 1410D Gateway (00813-0300-4410)
- Emerson Wireless 775 THUM Adapter (00813-0100-4075)
- Rosemount TankMaster Inventory Management Software (00813-0100-5110)

### Reference manuals
- Rosemount 5900S Radar Level Gauge (00809-0100-5900)
- Rosemount 5900C Radar Level Gauge (00809-0100-5901)
- Rosemount 5300 Series (00809-0100-4530)
- Rosemount 5400 Series (00809-0100-4026)
- Rosemount 2240S Multi-input Temperature Transmitter (00809-0100-2240)
- Rosemount 644 Temperature Transmitter with FOUNDATION Fieldbus Protocol (00809-0400-4728)
- Rosemount 3051S Series Pressure Transmitter with FOUNDATION Fieldbus Protocol (00809-0200-4801)
- Rosemount 2230 Graphical Field Display (00809-0100-2230)
- Rosemount 2140 Level Detector Vibrating Fork (00809-0100-4140)
- Rosemount 2140:SIS Level Detector (00809-0100-4140)
- Rosemount 2160 WirelessHART Vibrating Fork Liquid Level Switch (00809-0100-4160)
- Rosemount 2410 Tank Hub (00809-0100-2410)
- Rosemount 2460 System Hub (00809-0100-2460)
- Emerson Wireless 1420 Gateway (00809-0200-4420)
- Emerson Wireless 1410 Gateway (00809-0200-4410)
- Emerson Wireless 775 THUM Adapter (00809-0100-4075)
- Rosemount TankMaster Software Installation (00809-0400-5110)
- Rosemount Tank Gauging System Configuration (00809-0300-5100)
- Rosemount TankMaster WinOpi Inventory Management Software (00809-0200-5110)
- Rosemount TankMaster WinView Tank Management Software (00809-0300-5110)
- Rosemount Floating Roof Monitoring (00809-0500-5100)
- Rosemount Tank Gauging Wireless System (00809-0100-5200)
## Appendix B

### When to use a Rosemount 5900 Series or a Rosemount 5300/5400 system configuration

For more information, see “Appendix C” on page 43.

<table>
<thead>
<tr>
<th>Devices</th>
<th>Rosemount 5900 Series system configuration: The 5900S gauge is recommended for high performance solutions for custody transfer, inventory control, oil/product movement &amp; operations, overfill prevention &amp; leak detection</th>
<th>Rosemount 5300- or 5400 system configuration: For oil/product movement &amp; operations and overfill prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level, Temperature, and Inventory management</td>
<td>Rosemount 5900 Series gauge, 2240S with 565/566/765 multiple spot temperature sensor and TankMaster WinOpi</td>
<td>5300 and/or 5400 transmitter, 644 with 214C single spot temperature sensor, and TankMaster WinView</td>
</tr>
</tbody>
</table>

### Features

**Instrument accuracy**

<table>
<thead>
<tr>
<th>Level</th>
<th>Rosemount 5900S: ± 0.5 mm (0.02 in.)(^1)</th>
<th>Rosemount 5900C: ± 3 mm (0.12 in.)(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Transmitter: ± 0.1 °C (0.18 °F)</td>
<td>Transmitter: ± 0.22 °C (0.40 °F)</td>
</tr>
<tr>
<td></td>
<td>Sensors: ± 0.07 °C (0.13 °F)</td>
<td>Sensor: ± 0.41 °C (0.74 °F)</td>
</tr>
</tbody>
</table>

**Typical system performance**

<table>
<thead>
<tr>
<th>Level</th>
<th>Rosemount 5900S: ± 1.0 mm (0.04 in.)</th>
<th>Rosemount 5900C: ± 3.0 mm (0.12 in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature(^3)</td>
<td>± 0.17 °C (0.31 °F)</td>
<td>± 1.2 °C (2.16 °F)</td>
</tr>
</tbody>
</table>

**Volume Uncertainty**

| Rosemount 5900S: 90% reduction compared with a 5300/5400 configuration |

**Safety**

<table>
<thead>
<tr>
<th>SIL 3</th>
<th>Yes, certified (Rosemount 5900S)</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIL 2</td>
<td>Yes, certified</td>
<td>Yes, FMEDA(^5)</td>
</tr>
<tr>
<td>Overfill prevention approvals</td>
<td>Yes, TÜV/DIBt WHG and other national approvals(^6)</td>
<td>Yes, TÜV/DIBt WHG and national approvals</td>
</tr>
<tr>
<td>proof-testing</td>
<td>Yes, extended &amp; certified (TankMaster WinOpi)</td>
<td>Yes</td>
</tr>
<tr>
<td>Relay outputs for direct control</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

### System output

| Spot temperature | Yes | Yes |
| Average temperature | Yes | No |
| Free water level | Yes | No |
| Pressure | Yes | No |
| Total observed volume (TOV) | Yes | Yes |
| Gross observed volume (GOV) | Yes | No |
| Gross standard volume (GSV)\(^7\) | Yes | No |
| Net standard volume (NSV)\(^7\) | Yes | No |
| Density | Yes | No |
| Mass | Yes | No |
| Alarm handling | Yes | Yes |
| Batch handling feature | Yes | No |
| On-line density | Yes | No |
| Scheduled on-line reports | Yes | No |

### Legal metrological approvals

| OIML R85 | Yes (Rosemount 5900S) | No |
| NMI, PTB | Yes (Rosemount 5900S) | No |
| Other national approvals | Yes (Rosemount 5900S). See page 40 | No |

### Redundancy

| 2-in-1 radar gauge | Yes (Rosemount 5900S) | No |

### Communication

| Emulation | Yes | Yes |
| Wireless field network | Yes | Yes |

---

1. At reference conditions.
2. Accuracy in temperature range 5 to 30 °C (41 to 86 °F).
3. Summary of transmitter and sensor values for total accuracy at 20 °C (68 °F).
4. Including ± 0.6 °C (1.08 °F) in stratification effect.
5. SIL 2 requires the 4-20 mA HART version of Rosemount 5300 or 5400. 5400 is suitable for SIL 2 applications on basis of prior use according to IEC 61511-1.
6. Requires a Rosemount 2410 Tank Hub with applicable safety output.
7. According to API/ISO.
Appendix C

Radar level device selection

Below is a guideline on which radar level device and antenna/probe to use for various tanks and applications. In general, use Rosemount 5900S for custody transfer and inventory control, which requires highest accuracy and reliability.

See “When to use a Rosemount 5900 Series or a Rosemount 5300/5400 system configuration” on page 42 for more guidance.

<table>
<thead>
<tr>
<th>Tank and Application</th>
<th>Recommended</th>
<th>Second Choice</th>
<th>Alternative Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Roof Tanks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 in. or larger nozzle, no disturbing objects in tank</td>
<td>Rosemount 5900S with parabolic antenna</td>
<td>Rosemount 5900C with parabolic antenna</td>
<td>Rosemount 5402 with 4-in. cone antenna or Rosemount 5301 with flexible twin(1)/single lead probe</td>
</tr>
<tr>
<td>8 in. to 17 in. nozzle, no disturbing objects in tank</td>
<td>Rosemount 5900S with horn antenna</td>
<td>Rosemount 5900C with horn antenna</td>
<td>Rosemount 5402 with 4-in. cone antenna or Rosemount 5301 with flexible twin(1)/single(2) lead probe</td>
</tr>
<tr>
<td>4-6 in. nozzle, no disturbing objects in tank</td>
<td>Rosemount 5900C with cone antenna</td>
<td>Rosemount 5402 with 4-in cone antenna</td>
<td>Rosemount 5301 with flexible single lead probe</td>
</tr>
<tr>
<td>2-3 in. nozzle, no disturbing objects in tank</td>
<td>Rosemount 5900C with 1-in or 2-in still-pipe antenna</td>
<td>Rosemount 5301 with flexible single lead probe</td>
<td>Rosemount 5402 with 2 or 3-in cone antenna</td>
</tr>
<tr>
<td>Objects in tank</td>
<td>Rosemount 5900S with parabolic antenna</td>
<td>Rosemount 5900C with parabolic antenna</td>
<td>Rosemount 5301 with coaxial(1)(3), flexible twin(1) or single lead probe or Rosemount 5402 with cone antenna</td>
</tr>
<tr>
<td>5-12 in. still-pipe</td>
<td>Rosemount 5900S with still-pipe array antenna</td>
<td>Rosemount 5900C with still-pipe array antenna</td>
<td>Rosemount 5301 with flexible single lead probe and a centering disk</td>
</tr>
<tr>
<td>2-4 in. still-pipe measurement</td>
<td>Rosemount 5900C with 1-in or 2-in still-pipe antenna</td>
<td>Rosemount 5900C with cone antenna</td>
<td>Rosemount 5301 with flexible single lead probe and centering disks(4)</td>
</tr>
<tr>
<td><strong>Floating Roof Tanks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-12 in. still-pipe</td>
<td>Rosemount 5900S with still-pipe array antenna</td>
<td>Rosemount 5900C with still-pipe array antenna</td>
<td>Rosemount 5301 with flexible single lead probe and a centering disk</td>
</tr>
<tr>
<td>Measurement towards tank roof</td>
<td>Rosemount 5900S with parabolic antenna</td>
<td>Rosemount 5900C with parabolic antenna</td>
<td>Rosemount 5402 with 4-in. cone antenna</td>
</tr>
<tr>
<td>**Bullet</td>
<td>Sphere Shaped Tanks**</td>
<td></td>
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</tr>
<tr>
<td>Pressurized LPG sphere, &gt; 6 m (20 ft)</td>
<td>Rosemount 5900S with LPG/LNG antenna</td>
<td>Rosemount 5900C with LPG/LNG antenna or 2-in still-pipe antenna</td>
<td>Rosemount 5301 with flexible twin lead probe(1) and centering disks</td>
</tr>
<tr>
<td>Pressurized LPG bullet, &lt; 6 m (20 ft)</td>
<td>Rosemount 5900S with LPG/LNG antenna</td>
<td>Rosemount 5900C with LPG/LNG antenna or 1-in(5) or 2-in still-pipe antenna</td>
<td>Rosemount 5301 with coaxial probe(1) or flexible twin lead probe</td>
</tr>
<tr>
<td>Other bullet tanks (e.g. additive tanks) &lt; 6 m (20 ft)</td>
<td>Rosemount 5900S with LPG/LNG antenna</td>
<td>Rosemount 5900C with 1-in or 2-in still-pipe antenna</td>
<td>Rosemount 5301 with coaxial probe(1)</td>
</tr>
<tr>
<td><strong>Water Interface Measurement</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Upper Liquid Level + Free Water Interface Level</td>
<td>Rosemount 5900S and a 765 water level sensor(6)</td>
<td>Rosemount 5900C and a 765 water level sensor(6)</td>
<td>Rosemount 5302 with flexible twin lead(1)(7) or coaxial(1)(3) probe or Rosemount 5302 with flexible single lead probe(8)</td>
</tr>
</tbody>
</table>

1. For clean products, with no risk for build-up.
2. Special considerations for 10 in. or larger nozzles. Consult factory.
3. Best alternative choice for measuring distance up to 6 m (20 ft).
4. Maximum 20 m (66 ft). Centering disks required to be placed along the probe, with a separation distance of 5 m (16 ft).
5. Maximum 3 m (10 ft).
6. When the free water interface level is < 1000 mm (3.3 ft).
7. Upper liquid thickness typically up to 25 m (82 ft) for oil/water interface.
8. Upper liquid thickness typically up to 15 m (49 ft) for oil/water interface.
High-Performance Bulk Liquid Measurement and Overfill Prevention Solutions

- Rosemount 5900S Radar Level Gauge (2-in-1 option available)
- Rosemount 5900C Radar Level Gauge
- Rosemount 2240S Multi-input Temperature Transmitter
- Rosemount 3051S Pressure Transmitter
- Rosemount 3051S Multiple Spot Temperature Sensors
- Rosemount 3308 Wireless Guided Wave Radar Level Transmitter
- Rosemount 2410 Tank Hub
- Rosemount 2160 Liquid Level Switches
- Rosemount 2410 Horn
- Rosemount 5900S 2-in-1 Alarm
- Rosemount 5900C Radar Level Gauge
- Rosemount 5300 Guided Wave Radar Level Transmitter
- Rosemount 5300 Multiple Spot Temperature and Water Level Sensor
- Rosemount 5400 Radar Level Transmitter
- Rosemount 5400 Radar Level Transmitter
- Rosemount 2410 Field Communicator
- Rosemount 2120/2130/2160 Liquid Level Switches
- Rosemount 2230 Graphical Field Display
- Rosemount 565/566 Multiple Spot Temperature Sensors
- Rosemount 2240S Multi-input Temperature Transmitter
- Rosemount 644 Temperature Transmitter with 214C Single Point Sensor
- Rosemount 3308 System Hub
- Emerson Wireless 1410/1420 Gateway
- TankMaster PC in network
- Safety Instrumented System (SIS)