System Data Sheet
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Raptor

Rosemount Raptor

Tank Gauging System

ROSEMOUNT®
Tank Gauging

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1 Raptor
– scalable, and open architecture tank gauging system

Raptor is a new, groundbreaking inventory and custody transfer radar tank gauging system, coming from the inventor of the technology.

Raptor's unique scalable architecture, based on open standardized communication, provides superior flexibility and installation benefits. In addition, the system sets a new standard in performance, and also includes unique safety features. With its innovative technology, Raptor can help you improve plant efficiency, productivity and safety.

The system is developed for complete bulk liquid management at refineries, tank farms and fuel depots, and it fulfills the highest requirements on performance and safety.

Raptor is based on more than 30 years of experience in radar level gauging, with over 100 000 radar gauges installed.

Emerson's Rosemount Tank Gauging representatives are located worldwide, providing you with service and support from over 200 highly trained service engineers, in more than 80 countries.

1.1 APPLICATIONS

Applications include bulk liquid storage tanks at/in:

- Refineries
- Independent tank terminals
- Marketing terminals
- Pipeline terminals
- Petrochemical industries
- Liquefied gas terminals (LPG and LNG)
- Aviation fuel depots
- Power plants
- Biofuel plants
- Distilleries

The Raptor system provides complete tank gauging inventory data. It includes excellent radar level gauges, suitable for all applications and tank types; pressurized or non-pressurized, with fixed or floating roofs.

System Features

- Highest accuracy with custody transfer approvals, including OIML R85:2008 certificate
- Uniquely SIL 2 and SIL 3 certified by Exida according to IEC 61508 Part 1-7
- Compliant with all API 2350 safety category requirements
- Scalable design for maximum flexibility
- Open system architecture to protect your investment
- 2-wire low voltage Tankbus for cost efficient and safe installation
- Autoconfigured Tankbus based on FOUNDATION™ fieldbus
- Redundant level device (2-in-1 gauge)
- Smart Wireless connection between tanks and control room
- Full emulation capability for cost-effective installation in systems supplied by other vendors
- Powerful inventory management software package for complete tank farm monitoring

1.2 RAPTOR TANK GAUGING SYSTEM OVERVIEW

The Raptor system measures and calculates tank data for:

- Custody transfer
- Inventory management
- Oil movement
- Mass balance & Loss estimation/control
- Operational & blending control
- Leak detection and overfill prevention

The system can be configured to provide the following tank data and functions:

- Level, level rate, temperature, and water interface level measurement
- Multiple temperature inputs for average calculations
- Relay outputs for SIL 2/SIL 3 high level alarms and customized functions
- Vapor pressure and hydrostatic pressure measurement
- Total Observed Volume (TOV), and observed density calculations in the 2410 Tank Hub
- Net volume calculations according to API (with the TankMaster software package)
- Complete inventory, hybrid and custody transfer functions (with the TankMaster software package)

The Raptor system can include equipment such as:

- Rosemount 5900S Radar Level Gauge, 5300 and 5400 Radar Level Transmitters. See pages 30, 117 and 135
- Rosemount 2240S Multi-input Temperature Transmitter. See page 48
- Rosemount 644 Temperature Transmitter. See page 148
- Rosemount 565 and 566 Multiple Spot Temperature Sensor. See pages 58 and 59
- Rosemount 765 Multiple Spot Temperature Sensor with integrated Water Level Sensor. See page 60
- Rosemount 65 and 68 Single Point Temperature Sensors. See page 148
- Rosemount 3051S, Scalable Pressure Transmitters. See page 72
- Rosemount 2051 Pressure Transmitter. See pages 38 and 41
- Rosemount 2230 Graphical Field Display. See page 85
- Rosemount 2100 Series Liquid Level Switch. See page 161
- Rosemount 2410 Tank Hub. See page 91
- Rosemount 2160 Field Communication Units. See page 105
- Rosemount 2180 Field Bus Modem. See page 108
- Smart Wireless Gateway (pages 8 & 110) and THUM Adapter (pages 8, 92, 97, 99 - 104)
- TankMaster PC workstations in a network. See page 175

Measured values are communicated on the FOUNDATION™ fieldbus based Tankbus to the Rosemount 2410 Tank Hub. Rosemount Field Communication Units collect data from different 2410 hubs (see “Raptor System Configuration Examples” on page 15 and onwards). Data is then transferred to a TankMaster PC and/or a DCS/host system.

Alternatively the measured values can be communicated directly to a FOUNDATION™ fieldbus host system, without using a Rosemount 2410.

Raptor level gauges can be incorporated in other tank gauging manufacturers’ systems using the proven emulation feature. See “Emulation” on page 10.

1.3 OPEN SYSTEM ARCHITECTURE PROTECTS YOUR INVESTMENT

The Raptor Tankbus is based on an open industry standard, FOUNDATION™ fieldbus, which allows integration of any device supporting this communication protocol.

Moreover, the emulation capability enables step-by-step modernization of a tank farm, from level gauges to control room solutions. See “Emulation” on page 10.

The system can also connect to host systems via Modbus, OPC, or IEC 62591 (*Wireless*HART). See pages 11 and 94.

1.4 SCALABLE TECHNOLOGY FOR UNIQUE SYSTEM FLEXIBILITY

Raptor includes a wide range of components to build a small or large customized tank gauging system.

The system offering includes devices for different requirements on:

- accuracy/performance
- functionality
- system output

Thanks to the modular design, a system can easily be expanded/upgraded.

1.5 TWO-WIRE INTRINSICALLY SAFE CABLING ON TANK

The Raptor system is designed to minimize power consumtion, which enables the use of 2-wire intrinsically safe technology for the connected devices. These devices are all powered by the fieldbus (Tankbus).

This solution has several advantages:

- It is safer both at system start-up, and in operation
- Installation is quicker and easier due to less cabling
- It is possible to install without using conduits

1.6 LOWER COSTS AND EASIER COMMISSIONING

A design requirement for the Raptor system was that configuration and setup of the Tankbus and units should be as much plug-and-play as possible, minimizing the need for specific and comprehensive FOUNDATION™ fieldbus knowledge.

By using standard devices, included in this technical description, the FOUNDATION™ fieldbus segments in a Raptor system are autoconfigured.

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 the tanks in operation, except for pressurized tanks, such as LPG.

The Emerson Smart Wireless solution can be used for connection between tanks and further on to the control room, saving cable and infrastructure spendings. See “Reach More Tanks at Less Cost with Smart Wireless” on page 8.

1.7 SIL DESIGN FOR OVERFILL PREVENTION

All refineries, tank farms and fuel depots have a responsibility to ensure that overfill incidents do not occur.

Raptor is SIL 2 and SIL 3 certified for overfill prevention according to IEC 61508 Part 1-7.

The system provides reliable High-High level alarm functionality, based on a separate SIL 2- or SIL 3-rated relay function (see pages 16, 30, 92, and 94).

Rosemount 5900S Radar Level Gauge with SIL option is configured to activate a separate alarm loop at a predetermined product level. The alarm loop triggers the safety relay output from the Rosemount 2410 Tank Hub.

1.8 2-IN-1 GAUGE FOR REDUNDANT LEVEL MEASUREMENT

Raptor is designed for cost-efficient redundancy. The 5900S gauge is delivered with either one or two electronics packages integrated in the transmitter head.

The 2-in-1 solution makes it possible to buy a level gauge, and get one primary plus one backup unit, or one primary level gauge plus an independent state-of-the-art radar based High-High level alarm.

The 2-in-1 solution enables real-time delta verification by configuring the transmitter to compare signals on both units.

Compared to having two separate gauges, the 2-in-1 solution makes mechanical and electrical installation easier.

For system redundancy, see pages 13 and 23.

5900S with two galvanically separated gauges within the same housing (2-in-1 solution).

1.9 API 2350

5900S with 2-in-1 option uniquely meets all categories defined in the standard, by combining level measurements and an independent alarm functionality, using a single tank penetration.

The new release of API 2350, revision 4, is the first internationally recognized tank gauging standard for overfill prevention. It is a total system safety concept, covering not only instrumentation but also procedures and processes for the whole plant/terminal life cycle, including the requirement for establishing a detailed risk assessment .

Emerson was one of the leading forces behind the development of API 2350. Combined with our industry experience, we have the know-how and products to deliver solutions for applying this standard, for new as well as existig tanks.

For different API safety level examples, see page 19 and “The Complete Guide to API 2350”, document number 901030En.

1.10 TANK GAUGING AS A SYSTEM APPLICATION

Tank gauging is an integrated system application which has quite specific requirements on the measuring devices in the system.
These requirements vary depending on how the system is used.

A Raptor system can be configured with highest accuracy for custody transfer/inventory control, or with medium accuracy required primarily for operational control. See “When to use a 5900S-, or 5300/5400 System Configuration” on page 23 for total system performance.

1) Also suitable for operational control

1.10.1 Inventory & Custody Transfer

A custody transfer system must give accurate measurement values for volume calculation.
This calculation requires a careful selection of devices to obtain high performance for measurement of level, water level, 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 an inventory system, for which the net standard volume is important.
For mass balance and loss estimation, the calculated mass is in focus.

The Raptor system includes equipment for high accuracy measurement and calculations:

- Level: Rosemount 5900S
- Temperature and Water Level: Rosemount 2240S with 565/566 or 765 Sensors (3-or 4-wire sensor with up to 16 spot elements)
- Pressure: Rosemount 3051S
- TankMaster WinOpi

The devices in a tank gauging system must also be able to digitally exchange measured data between units.

For instance, product temperature measurement needs level information for calculation of average product temperature.

The level gauge needs temperature data for correction of measured level, and pressure data from pressure transmitters to calculate density etc.

Such data exchange is normally not available for standard measurement equipment, so a careful selection of devices is important to achieve the necessary functionality for making correct tank gauging calculations.

1.10.2 Operational Control

In a system primarily intended for operational control, level and observed volume (TOV) are important parameters, but are not necessarily requiring highest accuracy.

The Raptor system includes the following equipment for cost-efficient measurement and calculations:

- Level: Rosemount 5300 or 5400
- Temperature: 644 Transmitter with 65 or 68 Sensor
- TankMaster WinView

1.10.3 Configuration and Operation

The Rosemount TankMaster software is the primary configuration tool, and in many cases also the operator's interface to the Raptor system.

Basic configuration of the Raptor system can also be done with a Field Communicator, the AMS™ Suite or DeltaV.

The user-friendly TankMaster software package complies with the OPC data access industry standards.

It gives the operator a good overview and quick access to any measured values. The software also 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.

Protocols for communication with major suppliers of plant host computers , such as DCS or SCADA, 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 Raptor system.

A full-featured Raptor system supports various communication interfaces between the Rosemount 2410 Tank Hub and a TankMaster PC or other host computers.

1.11 RADAR LEVEL GAUGING

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

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

- **Frequency Modulated Continuous Wave, FMCW**. This method is used by high performance radar level gauges. Rosemount 5900S uses FMCW, together with digital reference and filter technology, which enables real custody transfer accuracy. More FMCW information follows in the next section.
- **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.
  The Time Domain Reflectometry (TDR) technology is a special case, when a low power nano-second pulse is guided down a probe towards the process media surface, where it is reflected back.

Raptor comprises three series of radar level measurement devices:

- **Rosemount 5900S**, is a non-contact, FMCW based, high-precision radar level gauge for inventory and custody transfer requirements. See page 30.
- **Rosemount 5300** is a guided wave radar level transmitter, based on TDR, for medium accuracy applications. See page 117.
- **Rosemount 5400** is a non-contact, pulsed, radar level transmitter for medium accuracy applications. See page 135.

The radar level gauge/transmitter measures the distance to the surface of the product. Using tank distances stored locally in the memory of the gauge, it calculates the level of the liquid's surface.

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.

1.11.1 The FMCW Method

The radar gauge transmits microwaves towards the surface of the liquid. The microwave signal has a continuously varying frequency, around 10 GHz for 5900S.

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

The FMCW-method (Frequency Modulated Continuous Wave) means that the transmitted radar signal has a linear frequency variation. The reflection from the liquid surface has a slightly different frequency compared with the signal transmitted from the antenna when the reflection is received.
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.

Illustrating example: The FMCW-method is based on a radar sweep with varying frequency.

1.11.2 Accuracy Enhancement

The robust Rosemount 5900S design, in combination with the wide ambient temperature range, contribute to making it a very stable and accurate level measurement device, suitable for all climate zones. To enhance accuracy further, 5900S has some built-in, and unique features:

Digital reference

A radar gauge needs an internal reference to make the radar sweep absolutely linear. Each deviation from the linearity produces a corresponding inaccuracy. To achieve highest precision, 5900S has an on-line adjustment of transmitter frequency. It uses a crystal oscillator to control the output frequency.

Drip-off means no condensation

Since the antenna has an inclined polished PTFE surface where microwaves are emitted, it will be less susceptible to condensed water or product. The drops of condensation will not coat the active part of the antenna, and the radar signal will be less weakened. This results in a higher accuracy and better reliability.

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

Measurement close to the tank wall

A standard manway (or flange) is normally situated close to the tank wall, 0.3-1 m (1-3 feet). The parabolic antenna with its 18-inch large antenna diameter, and narrow radar beam is the perfect choice for such tanks. It can also be adjusted ± 3° after installation.

A horn antenna, with 4° flange inclination, or a still-pipe solution are other possible options.

Patented method for detecting the surface echo

Rosemount 5900S uses a patented method for detecting the surface echo.

The measured signal passes through several steps of signal calculation, starting with the well established Fast Fourier Transformation (FFT) signal processing technique, to obtain a frequency spectrum of all echoes in the tank.

From this frequency spectrum, echoes stronger than a threshold value are identified and the surface level is extracted.

Then a patented narrow high accuracy filter “window” is placed around the detected surface echo resulting in a very accurate measurement. This method uses the calculating power of the processor very efficiently and focuses on accuracy as well as fast and reliable results.

The FHAST™ filter limits the region around the liquid surface, resulting in much more efficient signal processing.

1.11.3 No Microwave Exposure risk from the Antenna

There are no health hazards connected to the microwaves emitted by the Raptor level gauge antennas. Since the microwave power from each transmitter is extremely low, there is no health hazard even when you are very close to the antenna.

Most international standards state that a power density of up to 1 mW/cm^2 is considered safe for continuous human exposure. The power density close to the antenna is 0.001 mW/cm^2 and further down in the tank it is much lower. The transmitted microwave power is less than 0.1 mW. As a comparison, the sunshine a person is exposed to on a sunny day corresponds to a power density of 100-150 mW/cm^2.

1.12 REACH MORE TANKS AT LESS COST WITH SMART WIRELESS

The Raptor system supports Emerson's Smart Wireless solution, based on IEC 62591 (*Wireless*HART), the industry standard for wireless field networks.

Greatly reducing field wiring leads to large savings in infrastructure, design and labor required for installation and commissioning.

No hot work is required and production downtime is minimized.

In addition, compared to other systems, the time between project start-up and an up-and-running wireless system is drastically reduced. No costly site surveys are required.

Wireless tank gauging allows for cost savings up to 70%, but lower cost is only part of the equation.

1.12.1 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, better inventory and loss control.

1.12.2 Intelligent Self-organizing Field Network Increases Reliability

A Smart 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 actually increases when the network expands – the more devices, the more communication paths.

This results in a data reliability of more than 99% – even in a harsh and dynamic environment.

The self-organizing field network automatically finds the best way around any fixed or temporary obstacle. All wireless devices communicate with the host system through the Smart Wireless Gateway. A Rosemount tank gauging system can consist of both wired and wireless networks.

1.12.3 Smart Wireless for More Secure Data Transmission

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

With this type of design, the field network can offer a higher level of security than many traditional wired networks.

1.12.4 Wireless Connection of Tank Gauging Equipment

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

A single gateway supports up to 100 nodes.

Each wireless node in the Raptor tank gauging system consists of a Rosemount 2410 Tank Hub and either a 5900S gauge or one or several 5300/5400 transmitters. Rosemount 2410 is connected to mains power, and a Smart Wireless THUM™ Adapter.

The wireless transmission supports measurement data handled by the gauge, such as level, temperature, water level and pressure.

The tank gauging system can be complemented with other wireless devices, such as pressure transmitters and temperature sensors.

See also "Wireless Communication" on page 92 and "Smart Wireless Gateway" on page 110.

For more technical details on the Gateway and THUM™ Adapter, see their respective Product Data Sheet (00813-0200-4420 and 00813-0100-4075).

Smart Wireless THUM™ Adapter and Smart Wireless Gateway.

1.13 EMULATION

The Raptor system is compatible with all other major tank gauge vendors. Step-by-step modernization of an existing tank gauging system is possible thanks to flexible field and control room solutions.

Gauge Emulation

It is possible to replace old mechanical or servo gauges with modern Raptor level gauges and a Rosemount 2410 Tank Hub, using the existing tank openings, field cabling, and control system .
The gauge is normally installed with the tank in operation. No hot work is required.

Rosemount 2410 has an open design, covering everything from electrical interface and communication protocol to utilization of many different power sources.

A gauge seamlessly replaces another device, independent of measurement technology. Data from the integrated radar gauge is displayed as before on the existing inventory management system. By replacing old servo gauges, you can avoid re-calibration and the expenses associated with spare parts and maintenance.

Seamless control room connectivity

It is also possible to seamlessly replace other tank management systems with the powerful Rosemount TankMaster software solution. Data from different types of units is collected and displayed.

The Field Communication Unit allows emulation of most host systems and other control room devices. Rosemount TankMaster can replace an existing inventory management system, still being able to communicate with the field devices in use.

This solution provides seamless connectivity, and problem-free communication with existing field devices, often with a better update rate than before.

You can replace your old tank monitoring software with Rosemount TankMaster.

1.14 CONNECTION TO OTHER SYSTEMS

The Raptor system can be connected to all major suppliers of DCS, SCADA systems, plant host computers or terminal automation systems.

Connnection can be made in several ways:

- Via a Rosemount TankMaster PC
- Via a Rosemount 2160 Field Communication Unit
- Via a Rosemount 2410 Tank Hub
- Directly to the units on the tank if the host system is based on FOUNDATION™ fieldbus

The advantage of connecting to TankMaster is that not only the measured values, but also the calculated inventory data can be communicated.

Raptor devices directly connected to a FOUNDATION™ fieldbus host system.

(1) Intrinsically safe Tankbus complies with FISCO FOUNDATION™ fieldbus standards.

Connection to a host system can be made via Rosemount 2410, Rosemount 2160/2165/2175 or a TankMaster PC.

1.15 LEVEL, VOLUME, DENSITY AND MASS MEASUREMENT

The Raptor system includes devices for measuring level, water level, pressure, spot and average temperature.

Data is calculated according to API and ISO standards. The level value can be software corrected for changes in tank reference height.
Product temperature calculations include API algorithms to handle elements close to the tank bottom.

The Rosemount 2410 Tank Hub handles the following data:

- Level (corrected for thermal effects on the tank wall)
- Spot- and Average Temperature
- Oil/water interface level
- Total Observed Volume (TOV)
- Observed density (if a pressure sensor is connected)

The TankMaster PC software package can in addition calculate flow, density mass, and volume parameters such as GOV, GSV, and NSV.
See “Rosemount TankMaster” on page 175.

TankMaster can present accurate volume calculations based on up to 5000 strapping points. Normally less than 100 points per tank are required. TankMaster is using quadratic interpolation for spheres and horizontal cylinders, which increases volume accuracy and reduces the number of required strapping points.

1.15.1 Hybrid Tank Gauging System

There are two basic principles for measuring tank content, based on mass or volume calculations.

With a high accuracy hybrid tank gauging system there is no need for manual density sampling.

With tank gauging data such as level, pressure and temperature you get automatic density measurement and mass calculation from the TankMaster system. The density measurement is made in real time just like the level measurement.

The Raptor hybrid system configuration consists of the best products on the market for pressure, temperature, and level measurement.

A Raptor hybrid system confguration includes high quality level, temperature and pressure measurement instruments for high performance mass, density, volume, and level gauging.

The Rosemount 5900S Radar Level Gauge is the best choice for highly accurate level measurements.

By complementing the level measurement with temperature and pressure measurement, the density of the product in the tank can be continuously calculated.

One or more pressure transmitters with different scalings can be used on the same tank to measure liquid and vapor pressure.

The accuracy of the density calculation largely depends on the accuracy of the pressure transmitter.

Rosemount 3051S is the standard pressure transmitter supplied with the system. It has an industry leading performance with 0.025% accuracy.

The 3051S Series consists of transmitters and flanges suitable for all kinds of applications, including crude oil tanks, pressurized tanks and tanks with / without floating roofs.

For more information, see “Rosemount 3051S Scalable Pressure Transmitter” on page 72 and http://www.emersonprocess.com/Rosemount.

The Rosemount Raptor system can interface to any other pressure transmitter with a FOUNDATION™ fieldbus output.

Temperature is measured by sensors connected to the Rosemount 644 or 2240S Temperature Transmitters.

1.16 IMPROVE SYSTEM RELIABILITY BY UTILIZING REDUNDANCY

By designing a tank gauging system with two identical (redundant) devices for critical operations, it is possible to get higher built-in reliability.

The Raptor system supports several possible redundancy designs, from control room to the field units.

1.16.1 Redundant TankMaster PC:s

A system can have two redundant TankMaster PC:s connected via two different group buses to one or several field communication units (see page 105 for more information about group buses).

There are two possible TankMaster configurations:

- Both PCs active, and separately asking for data
- One primary active PC, and the other silent in backup mode (hot standby)

1.16.2 Redundant 2160 Field Communication Units

The 2160 Field Communication Unit is a data concentrator which continuously polls data from the field devices.

Two 2160 Field Communication Units can be connected in parallel. One of the units will be configured as the primary, and it will be in an active state. The other will be in a backup state.

A control signal is sent between the two units.
If the backup unit is not receiving this signal, or if the primary unit is having a problem, then the backup unit will take over the active role.

A message is sent to TankMaster (or a DCS system) that the primary unit has failed and that the backup unit has taken over the communication.

1.16.3 Tankbus Redundancy

It is possible to have two Rosemount 2410 Tank Hubs with two separate Tankbuses on the same tank.

All field devices can also be configured in pairs:

- Double level measurement devices
- Double temperature transmitters with associated sensors
- Double liquid pressure transmitters

Level Measurement Redundancy

Level measurement redundancy can be achieved in two different ways, either with two separate level measurement devices or by installing a 5900S 2-in-1 Radar Level Gauge. See page 4.

TankMaster
Client PCs
Switch
Switch
TankMaster
Servers
2180 Field Bus Modems
2160/2165/2175 Field
Communication Units
2410 Tank Hubs
Temperature x 2
Level x 2
Pressure x 2
Two alternatives for level redundancy
Tank Hubs
Tank Hubs
or
Two 5900S/5300/5400
Level Gauges
Rosemount 5900S,
2-in-1 Level Gauge

1.17 RAPTOR SYSTEM CONFIGURATION EXAMPLES

1.17.1 Custody Transfer and Inventory Tank Gauging – 5900S System Configuration

The Raptor inventory tank gauging configuration is used for the highest demands on accurate measurements for inventory control and custody transfer functions.

Accurate net volume is calculated, using tank strapping tables and compensation for temperature and tank characteristics.

This state-of-the-art custody transfer and inventory system uses the 5900S non-contacting radar level gauge.

For temperature measurements, the Rosemount 2240S Temperature Transmitter is used together with the 565 or 765 Multiple Spot Temperature Sensors.

Rosemount 3051S is used for pressure measurements.

Each tank has a designated Rosemount 2410 Tank Hub.

All values are transferred to TankMaster, which features a complete set of inventory and custody transfer functions. TankMaster includes an API/ISO calculator for volume and density.

Raptor system with Foundation™ fieldbus communication for custody transfer and inventory management.

1.17.2 SIL 2 or SIL 3 for Certified Overfill Prevention

In addition to measuring level, a Rosemount 5900S Radar Level Gauge can be used as a highly reliable and accurate overfill prevention device. 5900S can be equipped with a separate SIL certified alarm output.

Due to the 2-in-1 feature, a 5900S gauge can be delivered with the unique SIL 3 safety certification.

By providing both level measurements and alarm functionality (High and/or High High), a 5900S gauge can replace two separate units which enables easier installation and better utilization of available tank nozzles – only one nozzle is required. However most important, it is in continuous use.

Unlike a conventional switch, it gives the operator continuous information about its status and performance, since it is being used in the everyday operations in the tank farm. Additionaly, 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 a separate relay output in the Tank Hub (see “SIL Design for Overfill Prevention” on page 3). Follow the recommendations in the Raptor Safety Manual (document number 300540EN).

SIL 2 Safety Certification

SIL 2 safety certification is achieved with one 5900S gauge, and a 2410 Tank Hub equipped with a SIL 2 relay output.

Certified by Exida to IEC 61508 Part 1-7 for single input use in SIL 2 safety instrumented systems

The alarm signal is connected to an Emergency Shut-Down system (ESD system).

SIL 3 Safety Certification with Patented 2-in-1 Gauge

SIL 3 safety certification can be achieved using one 5900S with 2-in-1 option, together with a 2410 Tank Hub equipped with a SIL 3 relay output.

Certified by Exida to IEC 61508 Part 1-7 for dual input use in SIL 3 safety instrumented systems.

The alarm signal is connected to an Emergency Shut-Down system (ESD system).

SIL 3 Safety Certification with Dual Gauges

SIL 3 safety certification can be achieved using two separate 5900S gauges, each connected to a 2410 Tank Hub equipped with a SIL 2 relay output.

Certified by Exida to IEC 61508 Part 1-7. For input use in safety instrumented systems up to safety integrity level 3 (SIL 3).

The alarm signals are connected to an Emergency Shut-Down system (ESD system).

1.17.3 Additional High Level Alarm Configurations

A Raptor radar level gauge can at the same time be used both to measure level and to detect a possible overfill.

The flexible and scalable system makes it possible to combine different requirements on accuracy performance for the primary level device, with various options for a separate high level alarm device.

Below follows some examples:

High Precision Level with Continuous High Level Alarm

Requirements

- **High accuracy level measurements**
- **Separate high level alarm device**
- **Continuous measurements**
- **Continuous verification of level value**

Solution

- **One Rosemount 5900S gauge for high precision level measurement**
- **One Rosemount 5300 or 5400 transmitter for high level alarm**

Floating Roof Tank with Continuous High Level Alarm

Requirements

- Track the nearest surface, which normally is the floating roof, but in case of a stuck roof it may be the liquid level
- High accuracy level measurements
- Separate high level alarm device
- Continuous measurements
- Continuous verification of level value

Free propagation measurement towards the tank roof must be verified against national radio licence regulations.

Solution

- One Rosemount 5900S gauge for high precision level measurement
- One Rosemount 5900S gauge or 5400 transmitter for high level alarm

High Precision Level Gauge and Point Level Switch

Requirements

- High accuracy level measurements
- Separate level switch for one specific alarm level

Solution

- One Rosemount 5900S gauge for high precision level measurement
- One Rosemount 2120 Liquid Level Switch for high level alarm

Level Transmitter and Point Level Switch

Requirements

- Level measurement, but highest accuracy is not required
- Separate level switch for one specific alarm level

Solution

- One Rosemount 5300 or 5400 transmitter for level measurement
- One Rosemount 2120 Liquid Level Switch for high level alarm

API 2350 Safety Level Solution Examples

- Category 1: Periodic verification by comparing the automatic level gauge reading to manual hand-dipping, at one or more points in the tank
- Category 2: Continuous measurement and verfication by using an automatic tank gauge (ATG) such as the high accuracy Rosemount 5900S or TankRadar Rex
- Category 3: Two independent sensors for alarm and level provide highest safety

For more information, see “The Complete Guide to API 2350”, document number 901030En.

API 2350 Category 2 Compliant System

API 2350 Category 3 Compliant System

1.17.4 Wired and Wireless Combination

You may combine both wired and wireless in your Raptor system for the most economical solution to access data.

It is also possible to connect a wireless Raptor network to any existing wired tank gauging system.

1.17.5 Operational Control with 5300- or 5400 System Configuration

A 5300- or 5400 system configuration is a cost efficient alternative for operational control at tank terminals, as well as applications in the biofuels industry, chemical plants, marketing terminals 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 65 or 68 Single Point Temperature Sensor is used.

The Rosemount 2240S Temperature Transmitter is an even better alternative if more than one temperature element is required, in one or several tanks.

All values are transferred to the TankMaster WinView tank management software.

Raptor system based on 5300 or 5400 level transmitters for cost efficient measurement.

1.17.6 System Integration

The Raptor system can have a large number of configuration combinations.

It can incorporate both 5900S, and 5300 or 5400 system configuration networks with previous generations of Rosemount TankRadar gauges (2900 TRL2, Rex, Pro), and even mechanical servo gauges.

Wired and wireless networks can co-exist within the same Raptor system.

This flexibility enables a step-by-step upgrade of a tank gauging system.

Raptor system; 5900S system configuration

(1) *Requires Rosemount 2165 or 2175.*

1.18 WHEN TO USE A 5900S-, OR 5300/5400 SYSTEM CONFIGURATION

For more information, also see Appendix A: Radar Level Device Selection.

Devices	5900S System Configuration for Custody Transfer & Inventory & Operational Control	5300- or 5400 System Configuration for Operational Control
Level	5900S gauge	5300 and/or 5400 transmitter
Temperature	2240S transmitter with 565, 566 or 765 sensor	644 transmitter with 65 or 68 sensor
Inventory management	TankMaster WinOpi	TankMaster WinView
Features		
Instrument accuracy		
Level	± 0.5 mm (0.020 in.)	± 3 mm (0.12 in.)(1)
Temperature(2)	Transmitter: ± 0.1 °C (0.18 °F) Sensors: ± 0.07 °C (0.13 °F)	Transmitter: ± 0.22 °C (0.40 °F) Sensor: ± 0.41 °C (0.74 °F)
Typical system performance		
Level	± 1.0 mm (0.039 in.)(3)	± 10 mm (0.39 in.)(3)
Temperature(4)	± 0.17 °C (0.31 °F)	± 1.2 °C (2.16 °F)(5)
Volume Uncertainty	90% typical reduction for a 5900S configuration compared with a 5300/5400 configuration	
Safety		
SIL 3	Yes, certified	No
SIL 2	Yes, certified	Yes, FMEDA(6)
Overfill approvals	Yes, TÜV/DIBt WHG and national approvals(7)	Yes, TÜV/DIBt WHG and national approvals(6)
Proof testing	Yes, extended & certified (TankMaster WinOpi)	Yes
Relay outputs for direct control	Yes	No
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)(8)	Yes	No
Net standard volume (NSV)(8)	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	No
NMI, PTB	Yes	No
Other national approvals	Yes, consult factory for your local approvals	No
Redundancy		
2-in-1 radar gauge	Yes	No
Communication		
Emulation	Yes	Yes
Wireless field network	Yes	Yes

(1) At reference conditions. See specifications on pages 124 and 140.
(2) Accuracy at 20 °C (68 °F).
(3) Accuracy in temperature range 5 to 30 °C (41 to 86 °F).
(4) Summary of transmitter and sensor values for total accuracy at 20 °C (68 °F).
(5) Including ± 0.6 °C (1.08 °F) in stratification effect.
(6) SIL 2 requires the 4-20 mA HART version of Rosemount 5300. 5400 is suitable for SIL 1 applications according to IEC 61508, and suitable for SIL 2 applications when selected on basis of prior use according to IEC 61511-1, section 11.4.4.
(7) Requires a Rosemount 2410 Tank Hub with relay output.
(8) According to API/ISO.

1.18.1 Volume Uncertainty Comparison

The uncertainty of the calculated net volume depends not only on the accuracy of the measurements, but also on the application itself.

An example is therefore required to compare the difference between 5900S and 5300/5400 configurations (using the same instrumentation as listed in “When to use a 5900S-, or 5300/5400 System Configuration” on page 23).

Example:

- Crude oil, 887 kg/m^3 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)
- 5300/5400: ± 10 mm (0.4 in.), 1.2 °C (2.2 °F)(1)
- A traditional mechanical tape and float system: ± 25 mm (1 in.), 1.5 °C (2.7 °F)(1)

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

	5900S	5300/5400	Tape & Float
Per inventory(1)	290	2370	4840
Per batch(1)	320	2870	6490
Total uncertainty per year(1)(2)	2600	22260	48560

(1) Statistical error, root mean square value (RMS).
(2) 12 inventories and 24 batches.

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

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

(1) Low estimate. According to API chapter 7: In large tanks not thoroughly mixed,vertical temperature differences of as much as 3 °C (5.4 °F) are normal, and differences of 5 °C (9.0 °F) are common.

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

With the 5900S system configuration you will typically reduce volume uncertainty with 90% compared to a 5300- or 5400 system configuration.

1.18.2 5900S Configuration

A 5900S system configuration consists of Rosemount 5900S Radar Level Gauges for custody transfer/inventory control, but may also incorporate Rosemount 5300 and/or Rosemount 5400 Radar Level Transmitters to be used either as separate high level alarm devices or on smaller tanks with less requirements on measurement accuracy.

These level measurement devices can be supplemented with a wide range of other high accuracy instruments and software for complete tank inventory management.

There is always a solution for your tank, application, and required functionality.

1.18.3 5300/5400 Configuration

A 5300/5400 system configuration consists of 5300 and/or 5400 Radar Level Transmitters for medium accuracy level measurements.

As a general rule, either the 5300 or 5400 transmitters can be used for such applications. Which device is better depends on tank geometry (nozzle size, tank height etc) and process conditions.

Details can be found in Appendix A: Radar Level Device Selection, and in the sections for each product (page 117 for Rosemount 5300 and page 135 for Rosemount 5400).

There are however some applications where our recommendation points to a specific product type and configuration.

These level measurement devices can be supplemented with a wide range of other instruments and software for complete tank inventory management.

1.19 SYSTEM SPECIFICATION AND CONSIDERATIONS

1.19.1 System Design

Raptor is a flexible system, designed with an open interface which enables integration of most FOUNDATION™ fieldbus based instruments available on the market.

You can of course also connect your previous Rosemount Tank Gauging devices, integrate a wireless system or a system from a different vendor. See “System Integration” on page 22.

Communication at the tank and with the Rosemount 2410 Tank Hub is based on FOUNDATION™ fieldbus.

Some guidelines to help customize your 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. Power consumption per field device is listed in the power budget table below
- It is recommended to use one Rosemount 2410 Tank Hub per tank for a 5900S system configuration
- The Rosemount 2410 Tank Hub supports maximum 5 tanks(1) for a 5300- or 5400 system configuration
- The minimum voltage supply to the devices is 9 V

1.19.2 Power Budget

Field device	Power consumption
5900S Radar Level Gauge	50 mA
5900S Radar Level Gauge, 2-in-1 solution	100 mA
5300 or 5400 Series Radar Level Transmitter	21 mA
Rosemount 2230 Graphical Field Display	30 mA
Rosemount 2240S Multi-input Temperature Transmitter	30 mA including 565, 566 and 765 temperature sensors
Rosemount 644 Temperature Transmitter	11 mA
Rosemount 3051S, and Rosemount 2051 Pressure Transmitters	18 mA

(1) In-rush current limitation

Examples:

The available 250 mA from the 2410 Tank Hub can be used to supply the following equipment with power:

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

1.19.3 Tankbus Cable Requirements

Recommended cabling is shielded twisted pairs, 0.75 mm^2 (AWG 18).

Other possibilities are shielded twisted pairs, 0.5-1.5 mm^2 (AWG 22-16). The Tankbus cabling must fulfill the FISCO cable and installation requirements.

Tankbus cabling must also be approved for use in minimum 85 °C (185 °F).

FISCO (Fieldbus Intrinsically Safe Concept)

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

Parameter	Value
Loop resistance	15Ω/km to 150Ω/km
Loop inductance	0.4 mH/km to 1 mH/km
Capacitance	45 nF/km to 200 nF/km
Maximum length of each spur(1) cable	60 m in gas Group IIC
Maximum length of each trunk(2) cable	1000 m in gas Group IIC, and 1900 m in gas Group IIB

(1) The spur is an unterminated part of the network. It is allowed to have an up to 60 m 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 Raptor 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

Re-use of Existing Cabling

We recommend to install new Tankbus cabling according to the specification on the previous page. 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 mm^2 (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.

We assume 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 even longer.

We calculate the total distance between the power source (Tank Hub) to all devices on the tank/tanks.

The total cable distance A+B+C+D must not exceed the values given in the following examples/table.

Maximum Distance with Maximum Power Usage for a 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 5900S Configuration: A more typical current value is 128 mA for a tank equipped with one 5900S gauge, one 2230 display, one 2240S temperature transmitter, and one 3051S pressure transmitter. In this case a 651 m (2136 ft) long cable can be used.

Maximum Distance with Typical Power Usage for a 5900S 2-in-1 Configuration: If you have the same tank as in the previous example, but have a 5900S 2-in-1 gauge, the typical current value is 178 mA. The cable can then be 468 m (1535 ft).

Below you find a guiding table on how long cables are allowed for a 5900S system configuration with some common cable types:

Cable diameter	Loop Resistance	Maximum cabling distance from power source to all devices on the tank		
		with maximum power usage of 250 mA. Distance in m (ft)	with typical power usage of 128 mA for 5900S, 2240S, 2230, 3051S. Distance in m (ft)	with typical power usage of 178 mA for 5900S 2-in-1, 2240S, 2230, 3051S. Distance in m (ft)
20 AWG (0.5 mm^2)	66 Ω/km	212 (695)	414 (1358)	298 (978)
18 AWG (0.75 mm^2)	42 Ω/km	333 (1092)	651 (2136)	468 (1535)
17 AWG (1.0 mm^2)	33 Ω/km	424 (1391)	829 (2720)	596 (1955)
16 AWG (1.5 mm^2)	26 Ω/km	538 (1765)	1000 (3281)	756 (2480)

Maximum Distance with Typical Power Usage for a 5300/5400 Configuration: For a tank equipped with one Rosemount 5300 or 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 5300- or 5400-based tanks, consuming 160 mA in total, if the cabling allows.

Below you find a guiding table on how long cables are allowed for a 5300 or 5400 system configuration with some common cable types:

The total cable length A+B+C+D+E+F+G+H must not exceed the values given in the table below.

Cable Diameter	Loop Resistance	Maximum total cable length from power source to all devices on the tank, m (ft)				
		with typical power usage of 32 mA per tank with 5300/5400 and 644				
		5 tanks	4 tanks	3 tanks	2 tanks	1 tank
		Distance in m (ft)	Distance in m (ft)	Distance in m (ft)	Distance in m (ft)	Distance in m (ft)
20 AWG (0.5 mm^2)	66 Ω/km	331 (1085)	414 (1358)	552 (1811)	828 (2716)	1000 (3281)
18 AWG (0.75 mm^2)	42 Ω/km	520 (1706)	651 (2135)	868 (2847)	1000 (3281)	1000 (3281)
17 AWG (1.0 mm^2)	33 Ω/km	662 (2171)	828 (2716)	1000 (3281)	1000 (3281)	1000 (3281)
16 AWG (1.5 mm^2)	26 Ω/km	841 (2759)	1000 (3281)	1000 (3281)	1000 (3281)	1000 (3281)

1.19.4 TRL2 Bus Cable Recommendations

In a Raptor system, a Rosemount 2410 Tank Hub communicates with a Rosemount 2160 Field Communication Unit using the TRL2 Modbus protocol.

The TRL2 bus requires twisted and shielded pair wiring with a minimum area of 0.50 mm^2 (AWG 20 or similar). The maximum length of the TRL2 bus is approximately 4 km (2.5 miles). The TRL2 fieldbus can normally use existing cables in the tank area.

1.19.5 Typical Tankbus Wiring in a 5900S System Configuration

Different installation possibilities enable easy and cost efficient cabling. The Raptor system has a daisy-chain feature for convenient wiring of the Tankbus.

The devices in a 5900S 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 5900S, a 2240S or a 2230.

1.19.6 Wiring Examples in a 5300-or 5400 System Configuration

A bus terminator must be connected to the last device on the bus.
There is no need for a separate bus terminator if a 2230, 2240S, or 5900S is the last device on the bus.

Part Number	Segment Coupler / Fieldbus Terminator	Notes
6853511-493	Tankbus segment coupler with integrated termination	Segment coupler with integrated user selectable on/off termination. Connections: trunk input, trunk output, 6 spurs (short circuit protection, max 60 mA/spur), M20x1.5. Wall mounted, IP 67. Delivered with junction box. Entity and FISCO compliant.
6853511-494	Tankbus termination, external, ½ NPT male thread	Termination for external installation. Mounted on a junction box or a transmitter field housing, IP 67. Entity and FISCO compliant.

2 Rosemount 5900S Radar Level Gauge

Rosemount 5900S is a premium non-contact radar level gauge with custody transfer accuracy, suitable for any application in refineries and tank terminals with high requirements on level measurements.

The measurement is unaffected by most liquid property changes, such as density etc.

There are four types of Rosemount 5900S gauges(1) suitable for various storage tanks:

- **Rosemount 5900S with parabolic antenna**, for general use in tanks without still-pipe. Can also be used in a demanding tank environment, to measure on sticky liquids etc
- **Rosemount 5900S with horn antenna**, for fixed roof installation without still-pipe
- **Rosemount 5900S with still-pipe array antenna**, for measurement in existing still-pipes
- **Rosemount 5900S with LPG/LNG antenna**, for liquiefied gas, such as LPG and LNG

The radar level gauge measures the distance to the surface of the product in the tank. Using tank distances stored locally in the gauge memory, it calculates the level of the liquid's surface. The level value is communicated on the digital fieldbus (Tankbus) via the Rosemount 2410 Tank Hub to TankMaster and other host systems.

2.1 SIL SAFETY FUNCTIONS

Raptor is SIL 2 and SIL 3 certified for overfill prevention according to IEC 61508 Part 1-7.

The 5900S Radar Level Gauge with SIL option is configured to activate a separate alarm loop at a preset liquid level. The alarm loop triggers the safety relay output on the Rosemount 2410 Tank Hub.

SIL 2 safety is achieved with one 5900S, and a 2410 equipped with a SIL relay output.

SIL 3 safety is achieved with a 2-in-one 5900S, and a 2410, both equipped with the SIL option.

For more information see "SIL 2 or SIL 3 for Certified Overfill Prevention" on page 16, "Output Relay Functionality" on page 92 (Rosemount 2410), and "Technical Data for Rosemount 2410 Tank Hub" on page 94.

5900S Radar Level Gauge with parabolic antenna.

2.2 TRANSMITTER HEAD

A radar gauge consists of a transmitter head and an antenna. The same transmitter head is used for all 5900S antenna types, minimizing spare part requirements.

5900S has a dual compartment transmitter housing with electronics and cabling separated. It can be replaced without opening the tank.

The robust transmitter head is protected against lightning, moisture/rain, and it has a surface protection against sulphur and salt spray atmospheres.

(1) For level device guidance, see "When to use a 5900S-, or 5300/5400 System Configuration" on page 23, and Appendix A: Radar Level Device Selection.

2.2.1 Transmitter Head Electronics

The radar gauge transmitter head electronics consists of one or two encapsulated electronic units which include boards for various functions:

- Microwave board: transmits, receives, and samples the FMCW signal
- Processing board: for advanced signal processing
- Communication board: for communication on the Tankbus

The output frequency is digitally controlled using a crystal oscillator for maximum stability and outstanding accuracy, which is one of the reasons why there is no need for gauge recalibration.

5900S with 2-in-1 solution

The 2-in-1 solution is a cost-efficient way to have two independent radar level gauges, sharing the same antenna / tank opening. The duplicate, galvanically isolated electronic units are located in the same housing.

5900S with redundant 2-in-1 level solution: two electronic units, one per gauge, are located within the same transmitter head.

2.3 ANTENNAS

The 5900S antennas have a drip-off design which for some versions also include inclined polished PTFE surfaces where microwaves are emitted. Condensation on the antenna is minimized, and the radar signal remains strong. This results in maintenance free operation and high reliability.

There is always a suitable antenna for a specific tank type, tank opening and application.

2.3.1 Parabolic Antenna

This is the ideal antenna for installation on tanks with fixed roofs. The design of the parabolic antenna gives extreme tolerance against sticky and heavily condensing products, such as bitumen and asphalt.

The parabolic antenna has a high antenna gain and a high signal to noise ratio. The large antenna diameter gives a narrow radar beam, which means the gauge can be installed close to a tank wall.

The parabolic antenna can be installed on existing manhole covers. The parabolic reflector has a diameter of 440 mm (17 in.) and it typically fits a standard 500 mm (20-inch) manway.

In certain cases, Rosemount 5900S with parabolic antenna can be used on tanks with floating roofs. The gauge is then installed at the tank top and measures the distance down to a target plate on the floating roof.

The parabolic antenna is installed on the manway cover by using the flange ball. It is designed for easy adjustment of the antenna inclination and orientation within the specified limits.

The flexible flange ball can be installed on both horizontal or inclined manways without any special arrangements.

Installation is normally made with the tank in service.

5900S with parabolic antenna.

2.3.2 Horn Antenna

The horn antenna is designed for easy installation on fixed roofs tanks, with 200 mm (8-in.) or larger nozzles.

It measures on a variety of oil products and chemicals except asphalt or similar for which the parabolic antenna is recommended.

The horn antenna is delivered with a flange for either straight or inclined installation.

The straight flange is used when highest accuracy and reliability is required. The 4° inclined version can be used to maintain high accuracy when the gauge is installed close to the tank wall.

Installation is normally made with the tank in service.

5900S with horn antenna.

2.3.3 Still-pipe Array Antenna

The small-sized array antenna has a drip-off design, with an inclined surface, and it is made for installation on new or existing still-pipes.

Typical applications are crude oil tanks with floating roofs and gasoline/product tanks with or without inner floating roofs.

To get highest accuracy, required for custody transfer applications, the antenna uses the Low Loss Mode technology, invented for Rosemount Tank Gauging products, to transmit radar waves in the pipe center. This virtually eliminates signal and accuracy degradation due to rust and product deposits inside the pipe.

The still-pipe array antenna is available in two models, the fixed and hinged hatch versions, both suitable for installation on 5-, 6-, 8-, 10- and 12-in. pipes.

The hinged hatch version enables full pipe size product sampling or verification hand-dips.

Installation is normally made with the tank in service.

5900S with still-pipe array antenna, fixed version.

5900S with still-pipe array antenna, hinged hatch version.

2.3.4 LPG/LNG Antenna

This antenna is designed for level measurements on pressurized or cryogenic liquefied gas, such as LPG or LNG.

Radar signals are transmitted inside the still-pipe which enables the gauge to have a sufficiently strong echo even under surface boiling conditions.

The pressure seal is equipped with a double-block function, consisting of a quartz/ceramic window and a fire-proof ball valve. A pressure sensor enables correction due to vapor for best measurement performance.

A patented reference device function enables measurement verification with the tank in service.

A verification pin mounted in a still-pipe hole, and a deflection plate with a verification ring at the lower pipe end provide reference echos at fixed and well-known distances.

Installation is made with the pressurized tank taken out of service.

5900S LPG/LNG antenna.

2.4 INSTALLATION CONSIDERATIONS

This section includes some installation information. For complete guidance, see the Rosemount 5900S Reference Manual (document number 300520EN) and supporting installation drawings. If you miss information valid for your tank/application, you can also consult your local Rosemount Tank Gauging representative.

Rosemount 5900S gauges are easily carried to the tank roof. Installation can be done on existing or new tanks. The installation procedure is easy, and no special tools are required. The antenna and transmitter head can be delivered as separate units. When the antenna is installed it is possible to seal the tank, thereby enabling a step-by-step installation.

2.4.1 Mechanical Considerations

When designing new tanks, minimize horizontal surfaces inside the tank, e.g. construction bars or pipes with a diameter larger than 2 inches.

Such obstacles within the radar beam are generally not accepted, since these can result in interfering echos. In most cases, a smooth tank wall will not have any significant influence on the radar beam.

Antenna lobe comparison between parabolic and horn antenna. Avoid objects within the radar beam which may interfere with the surface echo.

When constructing new tanks, an 8-in. still-pipe or larger is recommended. This is especially relevant for tanks with sticky, viscous products.

For still-pipe considerations, please refer to the 5900S Reference Manual (document number 300520EN) and installation drawings.

2.4.2 Cable Connections

Communication and power supply can be daisy-chained to all devices on the Tankbus, including the Rosemount 5900S.

Rosemount 5900S has a built-in terminator which can be connected if required. For details see page 37.

The radar level gauge has different layout of terminal blocks and cabling depending on version: Standard 5900S, 2-in-1, or SIL.

For more information, see “Ordering Information” on page 44 and “Tankbus Cable Requirements” on page 25.

2.4.3 Configuration

The Raptor system is based on FOUNDATION™ fieldbus. Pre-programming of devices and built-in support, such as wizards for configuration, facilitate the system setup.

Configuration is preferably done with Rosemount TankMaster WinSetup, but can also be done with a Field Communicator, the AMS™ Suite, DeltaV or any other DD compatible host system. For advanced configuration features, TankMaster is required. This user-friendly, Windows based software package provides easy configuration, service and operation of a tank gauging system.

Advanced Plantweb Functionality

Rosemount 5900S powers PlantWeb through innovative measurement technologies and advanced diagnostics that provide more reliability, easier configuration, reduced process downtime, and lower installation and operating costs for a better bottom line.

2.5 SPECIFICATION

General	
Product	Rosemount 5900S Radar Level Gauge
Measurement principle	FMCW (Frequency Modulated Continuous Wave)
Antennas	Horn antenna, parabolic antenna, still-pipe array antenna, LPG/LNG antenna
Instrument accuracy[(1)]	± 0.5 mm (0.020 in.)
Temperature stability	Typically < ± 0.5 mm (0.020 in.) in -40 to +70 °C (-40 to +158 °F)
Fieldbus (standard)	FOUNDATION™ fieldbus FISCO (Tankbus)
Update time	New measurement every 0.3 s
Repeatability	0.2 mm (0.008 in.)
Maximum level rate	Up to 200 mm/s
Metrology sealing possibility	Yes
Legal custody transfer type approval	OIML R85:2008, and national certifications such as PTB, NMi etc
Hazardous location certifications	ATEX, FM-C, FM-US, IECEx, and national certifications. For details, see page 39
Safety/overfill	SIL 2 and SIL 3 certified (pages 3, 16, and 30). TÜV tested and WHG approved for overfill prevention. For national approvals, consult your local Rosemount Tank Gauging representative
CE-mark	93/68/EEC: complies with applicable EU directives (EMC, ATEX, LVD, and R&TTE). Based on the low emitted effects from the gauges (below 0.1 mW) compared to limits given by the Rec. 1999/519/EC, no additional measures are needed
Ordinary location certification	Complies with FM 3810:2005 and CSA: C22.2 No. 1010.1
Communication / Display / Configuration	
Output variables and units	Level, and ullage: meter, centimeter, millimeter, feet, or inch Level rate: meter/second, meter/hour, feet/second, feet/hour, inch/minute Signal strength: mV
Configuration tools	Rosemount TankMaster WinSetup, Field Communicator
FOUNDATION™ fieldbus characteristics	
Polarity sensitive	No
Quiescent current draw	51 mA
Lift-off minimum voltage	9.0 VDC
Device capacitance / inductance	See “Certificates” on page 39
Class (Basic or Link Master)	Link Master (LAS)
Number of available VCRs	Maximum 20, including one fixed
Links	Maximum 40
Minimum slot time / maximum response delay / minimum intermessage delay	8 ms/40 ms/8 ms
Blocks and Execution time	1 **Resource** block 5 **Transducer** blocks (Level, Register, Adv_Config, Volume, and LPG) 6 **Analog Input** (AI) blocks: 10 ms , 2 **Analog Outpu**t (AO) blocks: 10 ms 1 **Proportional/Integral/Derivate** (PID) block: 15 ms 1 **Signal Characterizer** (SGCR) block: 10 ms, 1 **Integrator** (INT) block: 10 ms, 1 **Arithmetic** (ARTH) block: 10 ms, 1 **Input Selector** (ISEL) block: 10 ms 1 **Control Selector** (CS) block: 10 ms, 1 **Output Splitter** (OS) block: 10 ms For more information, see the FOUNDATION™ fieldbus Blocks manual (document number 00809-0100-4783)
Instantiation	Yes
Conforming FOUNDATION™ fieldbus	ITK 5.2
PlantWeb alert support	Yes
Action support wizards	Restart measurement, write protect device, factory reset - measurement configuration, start/stop device simulation, set as surface, reset statistics, change all modes, register/remove false echo, refresh echo peaks, pin verification, change vapor pressure, change vapor temperature
Advanced diagnostics	Failure/Maintenance/Advisory alerts: Software, memory/database, electronics, internal communication, simulation, level correction, level measurement, ambient temperature, vapor pressure/temperature correction, LPG verification pin, and manual measurement values

Electric	
Power supply	Powered by Rosemount 2410 Tank Hub (9.0-17.5 VDC, polarity insensitive)
Bus current draw	50 mA (100 mA for the 2-in-1 version)
Microwave output power	< 1 mW (also see “No Microwave Exposure risk from the Antenna” on page 7)
Mechanical	
Housing material & surface treatment	Polyurethane-coated die-cast aluminum
Cable entry (connection/glands)	Two ½ - 14 NPT entries for cable glands or conduits. One metal plug to seal any unused port is enclosed in the transmitter delivery. Optional: • M20 x 1.5 conduit / cable adapter • Cable glands in metal (½ - 14 NPT) • 4-pin male Eurofast connector or A size Mini 4-pin male Minifast connector
Tankbus cabling	0.5-1.5 mm^2 (AWG 22-16), twisted shielded pairs
Dimensions	See “Dimensional Drawings” on page 42
Total weight	**5900S transmitter head:** 5.1 kg (11.2 lbs) for the single version and 5.4 kg (11.9 lbs) for the 2-in-1 version **5900S with horn antenna:** Appr. 12 kg (26 lbs) **5900S with parabolic antenna:** Appr. 17 kg (37 lbs) **5900S with still-pipe array antenna:** Appr. 13.5-24 kg (30-53 lbs) **5900S with LPG/LNG antenna:** Appr. 30 kg (66 lbs) for 6-in. 150 psi, and 40 kg (88 lbs) for 6-in. 300 psi
Environment	
Ambient operating temperature	-40 to +70 °C (-40 to +158 °F). Minimum start-up temperature is -50 °C (-58 °F)
Storage temperature	-50 to +85 °C (-58 to +185 °F)
Humidity	0-100% relative humidity
Ingress protection	IP 66/67 and Nema 4X
Vibration resistance	IEC 60770-1 level 1 and IACS UR E10 test 7
Telecommunication (FCC and R&TTE)	Compliance with: • FCC 15B Class A, and 15C • R&TTE (EU directive 99/5/EC) • ETSI (EN 302 372-1 V.1.1.1) • IC (RSS210-5)
Electromagnetic compatibility	• EMC directive 2004/108/EC, and EN61326-3-1 • OIML R85:2008
Transient / built-in lightning protection	According to IEC 61000-4-5, level 2 kV line to ground. Complies with IEEE 587 Category B transient protection and IEEE 472 surge protection
Pressure Equipment Directive (PED)	97/23/EC
5900S standard version	
Built-in Tankbus terminator	Yes (to be connected if required)
Daisy chain possibility	Yes
5900S 2-in-1 version	
Instrument accuracy(1)	± 0.5 mm (0.020 in.)(2)
Separation	Galvanically separated gauge electronics, and shared antenna for the two units
Wiring	Separated or common
Tank hub connection	• Connection of both units to one hub, or • Separate connection of units to two different hubs
Built-in Tankbus terminator	Single Tankbus connection: Yes (to be connected if required) Dual Tankbus connection: Possible to terminate the primary Tankbus
Daisy chain possibility	No

5900S SIL version	
Separation	Galvanically separated gauge electronics, and shared antenna for the SIL 3 version
Built-in Tankbus terminator	No
Daisy chain possibility	No
Electric properties for intrinsically safe alarm signal	12.5 VDC, 1-2 mA for normal condition (no alarm)
Wiring	• Additional separate 2-wire cable for alarm or • A single cable incorporating two 2-wire cables (alarm and level) For cable specification, see page 36
5900S with parabolic antenna	
Operating temperature in tank	Max. +230 °C (+445 °F)
Measuring range	0.8 to 30 m (2.6 to 100 ft) below flange Possibility to measure 0.5 to 50 m (1.6 to 164 ft). Accuracy may be reduced For longer measuring range, please consult your Rosemount Tank Gauging representative
Pressure range	Clamped/threaded: -0.2 to 0.2 bar (-2.9 to 2.9 psig) Welded: -0.2 to 10 bar (-2.9 to 145 psig)
Material exposed to tank atmosphere	Antenna: material corresponds to AISI 316/316L and EN 1.4401 /1.4404 Sealing: PTFE O-ring: FPM (Viton)
Antenna dimension	440 mm (17 in.)
Manway size	500 mm (20-in.) opening
Tank connection	The gauge is clamped in a 96 mm (3.78 in.) diameter hole, or welded in a 117 mm (4.61 in.) diameter hole
5900S with horn antenna	
Operating temperature in tank	Max. +230 °C (+445 °F)
Measuring range	0.8 to 20 m (2.6 to 65 ft) below flange Possibility to measure 0.5 to 30 m (1.6 to 100 ft). Accuracy may be reduced
Pressure range	-0.2 to 2 bar (-2.9 to 29 psig)
Material exposed to tank atmosphere	Antenna and flange: material corresponds to AISI 316/316L and EN 1.4401 /1.4404 Sealing: PTFE O-ring: FPM (Viton)
Antenna dimension	175 mm (7 in.)
Nozzle diameter	Minimum 200 mm (8 in.)
Tank connection	8 in. hole pattern according to ANSI 8 in. Class 150 / DN 200 PN 10. The flange can be horizontal or 4° inclined for installation close to the tank wall. Other flanges are available on request
5900S with still-pipe array antenna	
Operating temperature in tank	-40 to 120 °C (-40 to 248 °F)
Measuring range	0.8 to 30 m (2.6 to 100 ft) below flange Possibility to measure 0.5 to 40 m (1.6 to130 ft). Accuracy may be reduced For longer measuring range, please consult your Rosemount Tank Gauging representative
Pressure range	Fixed version: -0.2 to 2 bar (-2.9 to 29 psig) at 20 °C Hinged hatch version: -0.2 to 0.5 bar (-2.9 to 7.2 psig) for 5 to 8-in. pipes -0.2 to 0.25 bar (-2.9 to 3.6 psig) for 10 and 12-in. pipes
Material exposed to tank atmosphere	Antenna: Polyphenylenesulphide (PPS) Sealing: PTFE O-ring: Fluorosilicone Flange: material corresponds to AISI 316/316L and EN 1.4401 /1.4404
Still-pipe dimensions	5-, 6-, 8-, 10- or 12 in.
Tank connection	8 in. hole pattern according to ANSI 8 in. Class 150 / DN 200 PN 10

5900S with LPG/LNG antenna	
Operating temperature at ball valve	-55 to 90 °C (-67 to 194 °F)
Operating temperature in tank	-170 to 90 °C (-274 to 194 °F)
Measuring range	1.2 m to 30 m (3.9 to 100 ft) below flange Possibility to measure 0.8 to 60 m (2.6 to 200 ft). Accuracy may be reduced For longer measuring range, please consult your Rosemount Tank Gauging representative
Pressure range	-1 to 25 bar (-14.5 to 365 psig). Note! Flanges may have higher pressure rating than 25 bar, but maximum tank pressure is still 25 bar
Pressure sensor (option)	Rosemount 2051. It is available with different hazardous location certifications, see “Product Certifications Rosemount 2051” on page 41. For more information see the 2051 Product Data Sheet (document number 00813-0100-4101)
Material exposed to tank atmosphere	Antenna and flange: material corresponds to AISI 316/316L and EN 1.4401 /1.4404 Sealing: Quartz and PTFE
Still-pipe dimension compatibility	Antenna choices for 4-in. sch. 10, 4-in. sch 40, or 100 mm (99 mm inner diameter) still-pipe dimensions
Flange size & rating	4 in. class 150/300 6 in. class 150/300 8 in. class 150/300

(1) Instrument accuracy is under reference conditions. Reference conditions are: Measurement in test bench at Rosemount Tank Radar AB in Göteborg Sweden. Test bench is calibrated minimum yearly by an accredited laboratory (SP Technical Research Institute of Sweden. Measuring range is up to 30 m (98 ft). Ambient temperature and humidity is close to constant during tests. Total uncertainty in test bench is below 0.15 mm (0.006 in.).
(2) Some degradation of accuracy may be expected on the secondary unit.

2.6 PRODUCT CERTIFICATIONS ROSEMOUNT 5900S

OIML R85:2008

The OIML metrology certificate, issued by the SP Technical Research Institute of Sweden, covers the Raptor Tank Gauging system, including the level gauges equipped with different antennas.

Certificate number is R85/2008-SE-11.01.

SIL Certification

The SIL safety certificate, issued by exida in Switzerland, includes the SIL alarm channel within the 5900S radar level gauge and the 2410 Tank Hub. Both units are SIL 2 and SIL 3 capable according to IEC 61508, parts 1-7.

Certificate number is Rosemount 091243 P0017 C001.

German WHG Certification

The certificate for the 5900S radar level gauge and the 2410 Tank Hub is issued by DIBt (Deutsches Institut für Bautechnik) according to the German WHG regulations for overfill prevention. It is based on technical evaluation and testing conducted by TÜV NORD CERT GmbH.

Certificate number is Z-65.16-500.

2.6.1 Hazardous Location Certifications

European ATEX Directive Information

EC-Type Examination Certificate Number: FM09ATEX0057X

Control Drawing: 9240 040-917

I1[(1)] Intrinsically Safe

FISCO Field Device:

II 1/2 G CE 0682 0575

Ex ia IIC T4 (-50 °C<T_a<+80 °C)

For each channel: U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i=1.1 nF, L_i=1.5 µH.

Entity:

II 1 G CE 0682 0575

Ex ia IIC T4 (-50 °C<T_a<+80 °C)

For each channel: U_i=30 VDC, I_i=300 mA, P_i=1.3 W, C_i=1.1 nF, L_i=1.5 µH.

SPECIAL CONDITIONS FOR SAFE USE (X-MARKING)

The enclosure contains aluminum and is considered to present a potential risk of ignition by impact or friction. Care must be taken during installation and use to prevent impact or friction.

Parabolic and Array antennas with plastic surfaces and the painted surface of the enclosure may, under certain extreme conditions, generate an ignition-capable level of electrostatic charge for IIC applications. Therefore, when these antennas are used in Category 1G, Group IIC, appropriate measures must be taken to prevent electrostatic discharge.

US Factory Mutual (FM-US) Certification

Certificate of Compliance: 3035466

Control Drawing: 9240 040-917

I5[(1)] Intrinsically Safe

FISCO Field Device:
Intrinsically safe for Class 1, Division 1, Groups A, B, C, and D
For each channel: U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i=1.1 nF, L_i=1.5 µH

Entity:
Intrinsically safe for Class 1, Division 1, Groups A, B, C, and D
For each channel: U_i=30 VDC, I_i=300 mA, P_i=1.3 W, C_i=1.1 nF, L_i=1.5 µH
Dust ignition proof for Class II/III, Division 1, Groups E, F, and G.
Temperature Code T4.
Ambient Temperature Limits: -50 to +80 °C

SPECIAL CONDITIONS OF USE

Parabolic and Array antennas with plastic surfaces and the painted surface of the enclosure may, under certain extreme conditions, generate an ignition-capable level of electrostatic charge. Appropriate measures must be taken to prevent electrostatic discharge.

(1) Ordering Information code for Product Certificates, see page 44.

Canadian Factory Mutual (FM-C) Certification

Certificate of Compliance: 3035466C
Control Drawing: 9240 040-917

I6[(1)] Intrinsically Safe

FISCO Field Device:
Intrinsically safe for Class 1, Division 1, Groups A, B, C, and D
For each channel: U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i=1.1 nF, L_i=1.5 µH

Entity:
Intrinsically safe for Class 1, Division 1, Groups A, B, C, and D
For each channel: U_i=30 VDC, I_i=300 mA, P_i=1.3 W, C_i=1.1 nF, L_i=1.5 µH
Dust ignition proof for Class II/III, Division 1, Groups E, F, and G.
Temperature Code T4.
Ambient Temperature Limits: -50 to +80 °C

IECEx Certification

Certificate of Conformity Number: IECEx FMG 09.0009X
Control Drawing: 9240 040-917

I7[(1)] Intrinsically Safe

FISCO Field Device:
Ex ia IIC T4 Ga/Gb (-50 °C<T_a<+80 °C)
For each channel: U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i=1.1 nF, L_i=1.5 µH.

Entity:
Ga Ex ia IIC T4 (-50 °C<T_a<+80 °C)
For each channel: U_i=30 VDC, I_i=300 mA, P_i=1.3 W, C_i=1.1 nF, L_i=1.5 µH.

SPECIAL CONDITIONS OF CERTIFICATION (X-MARKING)

The enclosure contains aluminum and is considered to present a potential risk of ignition by impact or friction. Care must be taken during installation and use to prevent impact or friction.

Parabolic and Array antennas with plastic surfaces and the painted surface of the enclosure may, under certain extreme conditions, generate an ignition-capable level of electrostatic charge for IIC applications. Therefore, when these antennas are used in Category EPL Ga, Group IIC, appropriate measures must be taken to prevent electrostatic discharge.

Combination Approvals

The radar level gauge can be ordered with dual certifications (indicated at the main label).
The following combinations are possible:

KA=I1+I5 (ATEX + FM-US)
KC=I1+I7 (ATEX +IECEx)
KD=I5+I6 (FM-US+FM-C)

For more information on product certificates, refer to the Rosemount 5900S Reference Manual (document number 300520EN).

2.7 PRODUCT CERTIFICATIONS ROSEMOUNT 2051

European ATEX Directive Information

IA FISCO Intrinsic Safety

Certification No. Baseefa08ATEX0129X Ⓔx II 1 G
Ex ia IIC T4 (T_{amb} = –60 to +60 °C)
IP66
CE 1180
Input Parameters: U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i≤5 µF, L_i=10 µH.

SPECIAL CONDITIONS FOR SAFE USE (X):

The device is not capable of withstanding the 500V insulation test required by Clause 6.3.12 of EN60079-11.

This must be taken into account when installing the apparatus.

US Factory Mutual (FM-US) Certification

IE Intrinsically Safe for use in Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1 when connected per Rosemount drawing 02051-1009; Non-incendive for Class I, Division 2, Groups A, B, C, and D.

Temperature Code:T4 (T_a = 40 °C), T3 (Ta = 85 °C)

Enclosure Type 4X

For input parameters see control drawing 02051-1009.

Canadian Factory Mutual (FM-C) Certification

IF Intrinsically safe approval. Intrinsically safe for Class I, Division 1, Groups A, B, C, and D when connected in accordance with Rosemount drawings 02051-1008.

Temperature Code T3C.

Dust-Ignition-Proof for Class II and Class III, Division 1, Groups E, F, and G. Suitable for Class I, Division 2 Groups A, B, C, and D hazardous locations. Enclosure type 4X, factory sealed

For input parameters see control drawing 02051-1008.

IECEx Certification

IA FISCO Intrinsic Safety

Certification No. IECExBAS08.0045X Ⓔx II 1 G
Ex ia IIC T4 (T_{amb} = –60 to +60 °C)
IP66
CE 1180
Input Parameters: U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i≤5 µF, L_i=10 µH.

SPECIAL CONDITIONS FOR SAFE USE (X):

The device is not capable of withstanding the 500V insulation test required by Clause 6.3.12 of EN60079-11.

This must be taken into account when installing the apparatus.

2.8 DIMENSIONAL DRAWINGS

Dimensions are in mm (inches)

2.8.1 Dimensions for Rosemount 5900S with Horn Antenna

Flange	Minimum Nozzle Diameter	Maximum Nozzle Height
Horizontal flange	180 mm (7.1 in.)	330 mm (13.0 in.)
4° flange	185 mm (7.3 in.)	330 mm (13.0 in.)

2.8.2 Dimensions for Rosemount 5900S with Parabolic Antenna

2.8.3 Dimensions for Rosemount 5900S with Still-pipe Array Antenna

Dimensions are in mm (inches)

Antenna Diameter (D)	B	A
5 in. / DN125 (Ø 120 mm)	56 (2.2)	470 (18.5)
6 in. / DN150 (Ø 145 mm)	59 (2.3)	470 (18.5)
8 in. / DN150 (Ø 189 mm)	65 (2.6)	480 (18.9)
10 in. / DN150 (Ø 243 mm)	73 (2.9)	490 (19.3)
12 in. / DN150 (Ø 293 mm)	79 (3.1)	490 (19.3)

2.8.4 Dimensions for Rosemount 5900S with LPG/LNG Antenna

Antenna Diameter (D)	B
4 in. Sch10 (Ø 107 mm)	752 (29.6)
4 in. Sch40 (Ø 101 mm)	534 (21.0)
DN100 (Ø 99 mm)	502 (19.8)

(1) 302 (11.9) with pressure transmitter option

2.9 ORDERING INFORMATION

2.9.1 Transmitter Head (TH)

Model (Pos 1)	Product Description	Note
5900S	Radar Level Gauge	
Code (Pos 2)	**Performance Class**	**Note**
P	Premium: ±0.5 mm (0.020 in.) instrument accuracy	
Code (Pos 3)	**Safety Certification (SIS)**	**Note**
3	SIL 3-certification as per IEC 61508(1)	Requires Rosemount 2410 with Relay Output (SIS/SIL), code 3. 1oo2 configuration: alarm if one of the two gauges is in alarm mode
2	SIL 2-certification as per IEC 61508	Requires Rosemount 2410 with Relay Output (SIS/SIL), code 2
F	None. Ready for upgrade of safety certification (SIS)	
0	None	
Code (Pos 4)	**Redundancy**	**Note**
2	2-in-1; Independent radar level gauge electronics	See “5900S 2-in-1 version” on page 36
F	None. Ready for upgrade to 2-in-1	
1	None. Single radar level gauge electronics	
Code (Pos 5)	**Tankbus: Power and Communication**	**Note**
F	Bus powered 2-wire FOUNDATION™ fieldbus (IEC 61158)	
Code (Pos 6)	**Hazardous Location Certification**	**Note**
I1	ATEX Intrinsic Safety	
I2	Brazil Inmetro Intrinsic Safety	
I5	FM-US Intrinsic Safety	
I6	FM-Canada Intrinsic Safety	
I7	IECEx Intrinsic Safety	
KA	ATEX Intrinsic Safety+FM-US Intrinsic Safety(2)	
KC	ATEX Intrinsic Safety+IECEx Intrinsic Safety(2)	
KD	FM-US Intrinsic Safety+FM-Canada Intrinsic Safety(2)	
NA	None	
Code (Pos 7)	**Custody Transfer Type Approval**	**Note**
R	OIML R85 E 2008 performance certification	Requires Rosemount 2410 Tank Hub with OIML R85 E custody transfer type approval
C	PTB Eich (approval plate and sealing kit included)	Requires calibration certificate (Q4 on page 47)
0	None	
Code (Pos 8)	**Radar Measurement Method**	**Note**
1	10 GHz FMCW radar technology	
2	10 GHz FMCW radar technology for the US market	
Code (Pos 9)	**Housing**	**Note**
A	Standard enclosure	Polyurethane-covered aluminium. IP 66/67
Code (Pos 10)	**Cable / Conduit Connections**	**Note**
1	½ - 14 NPT	Female thread. 1 plug included
2	M20 x 1.5 adapters	Female thread. 2 adapters and 1 plug included
G	Metal cable glands (½ - 14 NPT)	Min. temperature -20 ˚C (-4 ˚F). ATEX / IECEx Exe approved. 2 glands and 1 plug included
E	Eurofast male connector	1 plug included
M	Minifast male connector	1 plug included

(1) Requires Pos 4 “Redundancy” code 2 (2-in-1).
(2) Not available with LPG/LNG antenna.

2.9.2 Antenna Selection

Choose one of the following antennas.

Parabolic Antenna

Code (Pos 11)	Antenna	Note
1P	Parabolic antenna	
Code (Pos 12)	**Antenna Size**	**Note**
F	20 in. / DN 500, Ø=440 mm (17.3 in.)	
Code (Pos 13)	**Antenna Material**	**Note**
S	Stainless steel (material type corresponding to AISI 316/316L and EN 1.4401 /1.4404)	
Code (Pos 14)	**Tank Seal**	**Note**
PF	PTFE with FEP fluoropolymer o-ring	
Code (Pos 15)	**Tank Connection**	**Note**
WE	Welded installation	Flange not included
CL	Clamped/threaded installation	Flange not included
Code (Pos 16)	**Special**	**Note**
0	None	

Horn Antenna

Code (Pos 11)	Antenna	Note
1H	Horn antenna	
Code (Pos 12)	**Antenna Size**	**Note**
8	8 in. / DN 200, Ø=175 mm (6.9 in.)	
Code (Pos 13)	**Antenna Material**	**Note**
S	Stainless steel (material type corresponding to AISI 316/316L and EN 1.4401 /1.4404)	
Code (Pos 14)	**Tank Seal**	**Note**
PV	PTFE with Viton fluoroelastomer o-ring	
Code (Pos 15)	**Tank Connection**	**Note**
ANSI Flanges (SST AISI 316 / 316 L)		
8A	8 in. Class 150	
8Z	8 in. Class 150, 4° inclined	
EN Flanges (SST EN 1.4401 / 1.4404)		
LA	DN 200 / PN 10	
LZ	DN 200 / PN 10, 4° inclined	
Code (Pos 16)	**Special**	**Note**
0	None	

Still-pipe Array Antenna

Code (Pos 11)	Antenna	Note
1A	Still-pipe array antenna	
Code (Pos 12)	**Antenna Size**	**Note**
5	5 in. / DN 125, Ø=120 mm (4.7 in.)	
6	6 in. / DN 150, Ø=145 mm (5.7 in.)	
8	8 in. / DN 200, Ø=189 mm (7.4 in.)	
A	10 in. / DN 250, Ø=243 mm (9.8 in.)	
B	12 in. / DN 300, Ø=293 mm (11.8 in.)	
Code (Pos 13)	**Antenna Material**	**Note**
S	Stainless steel (AISI 316L / EN 1.4404) and PPS (Polyphenylenesulphide)	
Code (Pos 14)	**Tank Seal**	**Note**
FF	Fixed flange installation with fluorosilicone o-ring	
HH	Integrated hatch installation with fluorosilicone o-ring	
Code (Pos 15)	**Tank Connection**	**Note**
ANSI Flanges (SST AISI 316 L)		
5A	5 in. Class 150	
6A	6 in. Class 150	
8A	8 in. Class 150	
AA	10 in. Class 150	
BA	12 in. Class 150	
EN Flanges (SST EN 1.4404)		
KA	DN 150 PN 16	
LA	DN 200 PN 10	
MB	DN 250 PN 16	
Code (Pos 16)	**Special**	**Note**
0	None	
C	Clamp flange in galvanized steel (for still-pipes without a flange)	Same size as tank connection

LPG/LNG Antenna

Code (Pos 11)	Antenna	Note
G1	LNG still-pipe antenna	Including integrated ball valve
G2	LPG still-pipe antenna	Including integrated ball valve and pressure transmitter
Code (Pos 12)	**Antenna Size**	**Note**
A	4 in. Schedule 10, Ø=107 mm (4.2 in.)	
B	4 in. Schedule 40, Ø=101 mm (4.0 in.)	
D	DN 100, Ø=99 mm (3.9 in.)	
Code (Pos 13)	**Antenna Material**	**Note**
S	Stainless steel (material type corresponding to AISI 316/316L and EN 1.4401 /1.4404)	
Code (Pos 14)	**Tank Seal**	**Note**
QA	Quartz sealing	
Code (Pos 15)	**Tank Connection**	**Note**
ANSI Flanges (SST AISI 316L)		
4A	4 in. Class 150	
4B	4 in. Class 300	
6A	6 in. Class 150	
6B	6 in. Class 300	
8A	8 in. Class 150	
8B	8 in. Class 300	
Code (Pos 16)	**Special**	**Note**
V	Measurement verification kit	Includes one verification pin and a pipe-end deflector kit
0	None	

2.9.3 5900S Radar Level Gauge Options

Code	Options – none or multiple selections are possible. Specify in the same order as below	Note
QT	IEC 61508 certificate and FMEDA-data(1)	
Q4	Calibration certificate	
S4	Witnessed calibration certificate	Calibration certificate witnessed by factory selected third part metrology certified institute
Q8	Antenna material traceability certification per EN 10204 3.1(2)	
ST	Engraved SST tag plate	
P1	Antenna hydrostatic pressure testing	
U1	TÜV/DIBt WHG Approval for Overfill protection	

(1) Requires Pos 3 "Safety Certification (SIS)" code 2 or 3 (SIL 3 or SIL 2).
(2) Certificate includes all pressure retaining wetted parts.

Model code example, Rosemount 5900S with still-pipe array antenna

5900S - P 3 2 F I1 R 1 A 1 - 1A 8 S HH 8A 0 - QT Q4

3 Rosemount 2240S Multi-input Temperature Transmitter

The ultra-stable high performance 2240S Multi-input Temperature Transmitter is approved for demanding custody transfer applications, which require very accurate level and temperature measurements for net standard volume calculations.

2240S can connect up to sixteen 3- or 4-wire temperature spot elements and an integrated water level sensor.

The value from each individual spot temperature element, in combination with the level value from the radar gauge is used for average liquid temperature calculation.

2240S has an impressive temperature conversion accuracy of ± 0.05 °C (± 0.09 °F).

It supplies the measured data to the Tankbus, which utilizes the FOUNDATION™ fieldbus communication protocol.

The IP 66/67 and Nema 4X certified robust design makes it suitable for installation in harsh environments.

The water level sensor is factory calibrated. If any adjustment is necessary during installation, it can easily be done with the 2240S built-in on-line calibration feature.

Rosemount 2240S Multi-input Temperature Transmitter installed together with a sensor.

3.1 INSTALLATION CONSIDERATIONS

This section includes some installation information. For complete guidance, see the Rosemount 2240S Reference Manual (document number 300550EN) and supporting installation drawings. If you miss information valid for your tank/application, you can also consult your local Rosemount Tank Gauging representative.

The 2240S is preferably pre-mounted with the Rosemount 565 or 765 temperature / water level sensor and flange prior to installation on the tank.

2240S can also be installed remotely on a pipe or a wall, connected to any Pt-100 or Cu-90 temperature sensor. For remote installation, an M32 cable gland can be used to enable connection of a cable with larger diameter.

Communication and power supply can be daisy-chained to all devices on the Tankbus, including the Rosemount 2240S.

2240S has a built-in bus termination jumper which can be connected if required.

Rosemount 2240S can be installed on top of a Rosemount multiple spot temperature / water level sensor, or it can be installed on a pipe or wall away from the sensor.

The Tankbus autoconfiguration feature, handled by the Rosemount 2410 Tank Hub, supports 2240S.

2240S is easily configured with Rosemount TankMaster.

3.2 SPECIFICATION

General	
Product	Rosemount 2240S Multi-Input Temperature Transmitter
Number of spot elements and wiring	Up to 16 RTD spot elements or averaging sensors can be connected to a 2240S. **Rosemount temperature / water level sensors (models 565, 566 and 765)** Three wiring types can be used: • 3-wire RTD with common return (1-16 spot elements) • 3-wire RTD individual (1-16 spot elements with Rosemount 565, 1-6 spot elements with Rosemount 566, and 1-14 spot elements with Rosemount 765) • 4-wire RTD individual (1-16 spot elements with Rosemount 565, 1-4 spot elements with Rosemount 566, and 1-10 spot elements with Rosemount 765)
Standard temperature sensor types	Supports Pt-100 (according to IEC/EN60751, ASTM E1137) and Cu-90
Metrology sealing possibility	Yes
Write protect switch	Yes
Hazardous location certifications	ATEX, FM-C, FM-US, and IECEx. For details, see “Product Certifications” on page 51
CE-mark	Complies with applicable EU directives (EMC, ATEX)
Ordinary location certification	Complies with FM 3810:2005 and CSA: C22.2 No. 1010.1
Measuring Performance	
Temperature conversion accuracy(1)	±0.05 °C (±0.09 °F)
Ambient temperature effect	±0.05 °C (±0.09 °F)
Temperature measuring range	Supports -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
Configuration	
Configuration tool	TankMaster WinSetup is the recommended tool for easy configuration of 2240S. The Tankbus autoconfiguration feature, handled by the Rosemount 2410 Tank Hub, supports 2240S
Configuration parameters (examples)	*Temperature:* • Number of temperature sensor elements • Temperature element type (spot or average) • Temperature element position in tank *Water Level Sensor:* • Level offset (difference between tank zero level and water zero level) • Probe length (autoconfigured by Rosemount 765)
Output variables and units	Spot and average temperature: °C (Celsius), and °F (Fahrenheit) Free water level (FWL): meter, centimeter, millimeter, feet, or inch
FOUNDATION™ fieldbus characteristics	
Polarity sensitive	No
Quiescent current draw	30 mA
Lift-off minimum voltage	9.0 VDC
Device capacitance / inductance	See “Certificates” on page 51
Class (Basic or Link Master)	Link Master (LAS)
Number of available VCRs	Maximum 20, including one fixed
Links	Maximum 40
Minimum slot time / maximum response delay / minimum intermessage delay	8 ms/40 ms/8 ms

Blocks and Execution time	1 **Resource** block, 3 **Transducer** blocks (Temperature, Register, AVG_Temp) 2 **Multiple Analog Input** (MAI) blocks: 15 ms, 6 **Analog Input** (AI) blocks: 10 ms , 1 **Analog Output** (AO) block: 10 ms, 1 **Signal Characterizer** (SGCR) block: 10 ms, 1 **Proportional/Integral/Derivate** (PID) block: 15 ms, 1 **Integrator** (INT) block: 10 ms 1 **Arithmetic** (ARTH) block: 10 ms, 2 **Input Selector** (ISEL) block: 10 ms 1 **Control Selector** (CS) block: 10 ms, 1 **Output Splitter** (OS) block: 10 ms For more information, see the FOUNDATION™ fieldbus Blocks manual (document number 00809-0100-4783)
Instantiation	Yes
Conforming FOUNDATION™ fieldbus	ITK 5.2
PlantWeb alert support	Yes
Action support wizards	Restart/stop measurement, write protect device, factory reset - measurement configuration, reset statistics, start/stop device simulation
Advanced diagnostics	Failures/Maintenance/Advisory alerts: Software, memory/database, electronics, internal communication, simulation, auxiliary device, auxiliary device measurement, ambient temperature, average temperature measurement, temperature measurement, configuration
Electric	
Power supply	Powered by Rosemount 2410 Tank Hub, 9.0-17.5 VDC, polarity insensitive (10.0-17.5 VDC for non-IS installations)
Internal power consumption	0.5 W
Bus current draw	30 mA
Cable entry (connection/glands)	Three ½ - 14 NPT entries for cable glands or conduits. Two metal plugs to seal any unused ports are enclosed in the delivery. Optional: • M20 x 1.5 conduit / cable adapter • Cable glands in metal (½ - 14 NPT) • 4-pin male Eurofast connector or A size Mini 4-pin male Minifast connector. An M32 adapter can be used if the 2240S is installed away from the sensor
Tankbus cabling	0.5-1.5 mm^2 (AWG 22-16), twisted shielded pairs
Built-in Tankbus terminator	Yes (to be connected if required)
Tankbus to sensor isolation	Minimum 700 V_{AC}
Auxiliary sensor input	Digital bus connection for water level sensor
Mechanical	
Housing material	Polyurethane-coated die-cast aluminum
Installation	The 2240S can be installed directly on top of the temperature / water level sensor or remotely installed on a 33.4-60.3 mm (1 to 2-in) pipe or on a wall
Dimensions	See “Dimensional Drawings” on page 53
Weight	2.8 kg (6.2 lbs)
Environment	
Ambient temperature	-40 to 70 ºC (-40 to 158 ºF). Minimum start-up temperature -50 °C (-58 °F)
Storage temperature	-50 to 85 ºC (-58 to 185 ºF)
Humidity	0-100% relative humidity
Ingress protection	IP 66 and 67 (Nema 4X)
Transient / built-in lightning protection	According to IEC 61000-4-5, level 1 kV line to ground. Complies with IEEE 587 Category B transient protection and IEEE 472 surge protection

(1) Over measuring range and ambient temperature 20 °C (68 °F).

3.3 PRODUCT CERTIFICATIONS

European ATEX Directive Information

EC-Type Examination Certificate Number: FM09ATEX0047X
Control Drawing: 9240 040-976

SPECIAL CONDITIONS FOR SAFE USE (X-MARKING), ATEX AND IECEX
SPECIAL CONDITIONS OF USE, FM-US AND FM-C

The enclosure contains aluminum and is considered to present a potential risk of ignition by impact or friction. Care must be taken during installation and use to prevent impact or friction.

Rating II 2(1) G Ex ib [ia IIC] IIC T4 T_a=-50 °C to 70 °C FISCO 9240040-976;IP 66/IP 67 is only applicable when supplied from a certified Ex [ib] FISCO Power Supply with triplicated output voltage limitation meeting the requirements for two faults (“ia” voltage limitation) e.g. a Rosemount 2410 Tank Hub.

The Rosemount 2240S Multi-input Temperature Transmitter will not pass the 500 Vrms dielectric strength test and this must be taken into account during installation.

I1(1) Intrinsically Safe

FISCO Field Device (Fieldbus Terminals):
II 1 G CE 0575
Ex ia IIC T4 (-50 °C ≤ T_a ≤ +70 °C)
U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i=2.2 nF, L_i=2.0 µH

When supplied from a certified Ex [ib] FISCO Power Supply with triplicated voltage limitation meeting the requirements for two faults (“ia” voltage limitation), e.g. a Rosemount 2410 Tank Hub:

II 2(1) G CE 0575
Ex ib [ia IIC] IIC T4 (-50 °C ≤ T_a ≤ +70 °C)
U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i=2.2 nF, L_i=2.0 µH

Entity (Fieldbus Terminals):
II 1 G CE 0575
Ex ia IIC T4 (-50 °C ≤ T_a ≤ +70 °C)
U_i=30 VDC, I_i=300 mA, P_i=1.3 W, C_i=2.2 nF, L_i=2.0 µH

RTD Terminals:
U_o=5.9 VDC, I_o=398 mA, P_o=585 mW
Group IIC: C_o ≤ 43 µF, L_o ≤ 0.2 mH
Group IIB: C_o= unlimited, L_o ≤ 0.7 mH
Group IIA: C_o= unlimited, L_o ≤ 1.8 mH
When no connections are made to the Sensorbus Terminal:
U_o=5.9 VDC, I_o=100 mA, P_o=150 mW, C_o= 43 µF, L_o=3 mH

Sensorbus Terminal:
U_o=6.6 VDC, I_o=223 mA, P_o=363 mW
Group IIC: C_o ≤ 22 µF, L_o ≤ 0.7 mH
Group IIB: C_o ≤ 500 µF, L_o ≤ 3.3 mH
Group IIA: C_o =unlimited, L_o ≤ 6 mH

US Factory Mutual (FM-US) Certification

FM APPROVED

Certificate of Compliance: 3035518
Control Drawing: 9240 040-910

I5(1) Intrinsically Safe

FISCO Field Device (Fieldbus Terminals):
Intrinsically safe for Class I, II, III Division 1, Groups A, B, C, D, E, F and G
Temperature Class T4, Ambient Temperature Limits: -50 to +70 °C
Class I Zone 0 AEx ia IIC T4 (-50 °C ≤ T_a ≤ +70 °C)
U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i=2.2 nF, L_i=2.0 µH

When supplied from a certified AEx [ib] FISCO Power Supply with triplicated voltage limitation meeting the requirements for two faults (“ia” voltage limitation), e.g. a Rosemount 2410 Tank Hub:
Class 1 Zone 1 AEx ib [ia IIC] IIC
U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i=2.2 nF, L_i=2.0 µH

Entity (Fieldbus Terminals):
Intrinsically safe for Class I, II, III, Division 1, Groups A, B, C, D, E, F and G
Temperature Class T4, Ambient Temperature Limits: -50 to +70 °C
Class I Zone 0 AEx ia IIC T4 (-50 °C ≤ T_a ≤ +70 °C)
U_i=30 VDC, I_i=300 mA, P_i=1.3 W, C_i=2.2 nF, L_i=2.0 µH.

RTD Terminals:
U_o=5.9 VDC, I_o=398 mA, P_o=585 mW
Group A, B, IIC: C_o ≤ 43 µF, L_o ≤ 0.2 mH
Group C, E, IIB: C_o= unlimited, L_o ≤ 0.7 mH
Group D, F, G, IIA: C_o= unlimited, L_o ≤ 1.8 mH
When no connections are made to the Sensorbus Terminal:
U_o=5.9 VDC, I_o=100 mA, P_o=150 mW, C_o= 43 µF, L_o=3 mH

Sensorbus Terminal:
U_o=6.6 VDC, I_o=223 mA, P_o=363 mW
Group A, B, IIC: C_o ≤ 22 µF, L_o ≤ 0.7 mH
Group C, E, IIB: C_o ≤ 500 µF, L_o ≤ 3.3 mH
Group D, F, G, IIA: C_o =unlimited, L_o ≤ 6 mH

(1) Ordering Information code for Product Certificates, see page 54.

Canadian Factory Mutual (FM-C) Certification

Certificate of Compliance: 3035518C
Control Drawing: 9240 040-910

I6[1] Intrinsically Safe

FISCO Field Device (Fieldbus Terminals):
Intrinsically safe for Class I, II, III Division 1, Groups A, B, C, D, E, F and G
Temperature Class T4, Ambient Temperature Limits: -50 to +70 °C
Class I Zone 0 Ex ia IIC T4 (-50 °C ≤ T_a ≤ +70 °C)
U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i=2.2 nF, L_i=2.0 µH

When supplied from a certified Ex [ib] FISCO Power Supply with triplicated voltage limitation meeting the requirements for two faults (“ia” voltage limitation), e.g. a Rosemount 2410 Tank Hub:
Class 1 Zone 1 Ex ib [ia IIC] IIC FISCO system
U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i=2.2 nF, L_i=2.0 µH

Entity (Fieldbus Terminals):
Intrinsically safe for Class I, II, III, Division 1, Groups A, B, C, D, E, F and G
Temperature Class T4, Ambient Temperature Limits: -50 to +70 °C
Class I Zone 0 Ex ia IIC T4 (-50 °C ≤ T_a ≤ +70 °C)
U_i=30 VDC, I_i=300 mA, P_i=1.3 W, C_i=2.2 nF, L_i=1.5 µH.

RTD Terminals:
U_o=5.9 VDC, I_o=398 mA, P_o=585 mW
Group A, B, IIC: C_o ≤ 43 µF, L_o ≤ 0.2 mH
Group C, E, IIB: C_o= unlimited, L_o ≤ 0.7 mH
Group D, F, G, IIA: C_o= unlimited, L_o ≤ 1.8 mH
When no connections are made to the Sensorbus Terminal:
U_o=5.9 VDC, I_o=100 mA, P_o=150 mW, C_o= 43 µF, L_o=3 mH

Sensorbus Terminal:
U_o=6.6 VDC, I_o=223 mA, P_o=363 mW
Group A, B, IIC: C_o ≤ 22 µF, L_o ≤ 0.7 mH
Group C, E, IIB: C_o ≤ 500 µF, L_o ≤ 3.3 mH
Group D, F, G, IIA: C_o =unlimited, L_o ≤ 6 mH

IECEx Certification

Certificate of Conformity Number: IECEx FMG 10.0010X
Control Drawing: 9240 040-976

I7[1] Intrinsically Safe

FISCO Field Device (Fieldbus Terminals):
Ex ia IIC Ga T4 (-50 °C ≤ T_a ≤ +70 °C)
U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i=2.2 nF, L_i=2.0 µH

When supplied from a certified Ex [ib] FISCO Power Supply with triplicated voltage limitation meeting the requirements for two faults (“ia” voltage limitation), e.g. a Rosemount 2410 Tank Hub:
Ex ib IIC [ia IIC Ga] Gb T4 (-50 °C ≤ T_a ≤ +70 °C)
U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i=2.2 nF, L_i=2.0 µH

Entity (Fieldbus Terminals):
Ex ia IIC Ga T4 (-50 °C ≤ T_a ≤ +70 °C)
U_i=30 VDC, I_i=300 mA, P_i=1.3 W, C_i=2.2 nF, L_i=2.0 µH

RTD Terminals:
U_o=5.9 VDC, I_o=398 mA, P_o=585 mW
Group IIC: C_o ≤ 43 µF, L_o ≤ 0.2 mH
Group IIB: C_o= unlimited, L_o ≤ 0.7 mH
Group IIA: C_o= unlimited, L_o ≤ 1.8 mH
When no connections are made to the Sensorbus Terminal:
U_o=5.9 VDC, I_o=100 mA, P_o=150 mW, C_o= 43 µF, L_o=3 mH

Sensorbus Terminal:
U_o=6.6 VDC, I_o=223 mA, P_o=363 mW
Group IIC: C_o ≤ 22 µF, L_o ≤ 0.7 mH
Group IIB: C_o ≤ 500 µF, L_o ≤ 3.3 mH
Group IIA: C_o =unlimited, L_o ≤ 6 mH

Combination Approvals

KA=I1+I5 (ATEX + FM-US)
KC=I1+I7 (ATEX +IECEx)
KD=I5+I6 (FM-US+FM-C)

For more information on product certificates, refer to the Rosemount 2240S Reference Manual (300550EN).

3.4 DIMENSIONAL DRAWINGS

Dimensions are in mm (inches)

Can be installed together with a multiple spot temperature sensor or separately on a 33.4-60.3 mm (1 to 2-in.) pipe, or on a wall

3.5 ORDERING INFORMATION

Model (Pos 1)	Product Description	Note
2240S	Multi-input Temperature Transmitter	
Code (Pos 2)	**Performance Class**	**Note**
P	Premium: ±0.05 °C(0.09 °F) instrument accuracy	
Code (Pos 3)	**Number of Temperature Sensor Inputs**	**Note**
16	Up to 16xRTD spot elements(1)	
08	Up to 8xRTD spot elements(1)	
04	Up to 4xRTD spot elements(1)	
00	None(2)	
Code (Pos 4)	**Leads per Temperature Element**	**Note**
4	4-wire or 3-wire (individual or common return)	
3	3-wire (individual or common return)	
0	None(2)	For water level, no temperature sensors
Code (Pos 5)	**Auxiliary Inputs**	**Note**
A	Rosemount 765 temperature and water level sensor input(2)	
0	None	
Code (Pos 6)	**Tankbus: Power and Communication**	**Note**
F	Bus powered 2-wire FOUNDATION™ fieldbus (IEC 61158)	
Code (Pos 7)	**Hazardous Location Certification**	**Note**
I1	ATEX Intrinsic Safety	
I2	Brazil Inmetro Intrinsic Safety	
I5	FM-US Intrinsic Safety	
I6	FM-Canada Intrinsic Safety	
I7	IECEx Intrinsic Safety	
KA	ATEX Intrinsic Safety+FM-US Intrinsic Safety(3)	
KC	ATEX Intrinsic Safety+IECEx Intrinsic Safety(3)	
KD	FM-US Intrinsic Safety+FM-Canada Intrinsic Safety(3)	
NA	No Hazardous Location Certification	
Code (Pos 8)	**Custody Transfer Type Approval**	**Note**
0	None	
Code (Pos 9)	**Housing**	**Note**
A	Standard enclosure	Polyurethane-covered aluminium. IP 66/67
Code (Pos 10)	**Cable/Conduit Connections**	**Note**
1	1/2–14 NPT	Female thread. Includes 2 plugs
2	M20 x 1.5 Adapters	Female thread. Includes 2 plugs, and 3 adapters
G	Metal cable glands (1/2–14 NPT)	Min. temperature -20 ˚C (-4 ˚F). ATEX / IECEx Exe approved. Includes 2 plugs, and 3 glands(4)
E	Eurofast male connector and 1/2–14 NPT	Includes 2 plugs
M	Minifast male connector and 1/2–14 NPT	Includes 2 plugs

Code (Pos 11)	Mechanical Installation	Note
M	Integrated installation with Rosemount 565, 566 or 765 (standard)	M33x1.5 female threaded connection. As standard, the transmitter is not pre-assembled with any temperature sensor
W	Mounting kit for wall installation(5)	
P	Mounting kit for wall and pipes(5)	1-2 in. vertical and horizontal pipes
0	None	
Code	**Options - none or multiple selections are possible**	**Note**
ST	Engraved SST tag plate	
Q4	Calibration Certificate	
Model Code Example: 2240S – P 16 4 A F I1 0 A 1 M - ST		

(1) Temperature sensors of Pt-100 or Cu-90 type, for use in -200 to 250 ºC (-328 to 482 ºF), can be connected to the Rosemount 2240S.
(2) Water level sensor only requires Pos 3 code 00, Pos 4 code 0, and Pos 5 code A.
(3) Not available with LPG/LNG antenna.
(4) Includes an M32 gland if combined with Pos 11 code W or P.
(5) For separate installation of temperature sensor and transmitter.

4 Multiple Spot Temperature and Water Level Sensors

Product temperature is an important parameter for accurate custody transfer and inventory measurement in bulk liquid storage tanks. The highly accurate 3-or 4-wire multiple spot temperature sensors used in Raptor systems measure liquid temperature with up to 16 spot elements. Available versions are:

- Rosemount 565 Multiple Spot Temperature Sensor
- Rosemount 566 Multiple Spot Temperature Sensor for Cryogenic Applications
- Rosemount 765 Multiple Spot Temperature Sensor with integrated Water Level Sensor

A multiple spot temperature sensor, with an optional integrated water level sensor, is connected to a Rosemount 2240S Multi-input Temperature Transmitter. The measured values are distributed to TankMaster or a DCS/host system via the Rosemount 2410 Tank Hub. See “When to use a 5900S-, or 5300/5400 System Configuration” on page 23 for total system performance.

4.1 SPOT ELEMENT PRINCIPLE AND ELECTRICAL PROPERTIES

Resistance Temperature Detectors (RTD) are sensors used to measure temperature.

The passive RTD element is made from a pure material, which has a predictable change in resistance as the temperature changes. This change is used to determine the temperature.

By using a known current, the voltage across the RTD is measured, which gives the resistance, and consequently also the temperature.

4.1.1 Description of RTD Types

Platinum RTD’s, made according to IEC/EN 60751, are due to their high stability, today’s common standard.

RTD’s can be wire-wound or made on substrate, and encapsulated in different ways.

Wire-wound platinum elements are used for the petrochemical industry.

The platinum elements are coiled from a wire with the length and the diameter to give exactly 100 ohm at 0 °C (32 °F) .

4.1.2 RTDs Temperature Dependance and Tolerance Classes

In IEC/EN 60751 and ASTM E1137, the relationship between resistance and temperature is defined.

Two grades or classes are stated for temperature element tolerances (t is the temperature in °C):

Grade A / Class A: ± (0.15 + 0.002 * | t |)

Grade B / Class B: ± (0.30 + 0.005 * | t |)

When Classes A and B are not sufficient, suppliers often deliver improved sensor versions; 1/3, 1/5, 1/6 and 1/10 of Class B – slightly better than Class A.

At temperatures close to 0 °C, only the fixed part is divided in the expression for the Class B / DIN B tolerance.

1/6 DIN B: ± (0.05 + 0.005 * | t |)

1/10 DIN B: ± (0.03 + 0.005 * | t |)

In order to get a platinum element within 1/6 or 1/10 of Class B at 0 °C, the platinum wire has to be very pure.

4.2 MULTIPLE SPOT TEMPERATURE SENSORS FOR THE RAPTOR SYSTEM

The temperature sensors supplied by Emerson Process Management / Rosemount Tank Gauging, are made from a very pure platinum material with predictable and stable characteristics for very accurate temperature measurement. The tolerance is even better than what the standard states.

The temperature dependent part in the expression is more similar to the one for Grade A, which means that Grade B delivered by Emerson has ± (0.30 + 0.002 * | t |) tolerance. The following applies:

1/6 DIN B: ± (0.05 + 0.002 * | t |)

1/10 DIN B: ± (0.03 + 0.002 * | t |)

Comparison between DIN A and DIN B according to the standard and 1/6 and 1/10 of DIN B delivered by Emerson.
DIN A= ± (0.15 + 0.002 * I t I)
DIN B= ± (0.30 + 0.005 * I t I)
1/6 DIN B: ± (0.05 + 0.002 * | t |)
1/10 DIN B: ±(0.03 + 0.002 * | t |)

4.2.1 3- or 4-wire Temperature Sensors

The accurate 1/6 and 1/10 DIN B RTD elements in the above diagram are used in Rosemount 565/566 and 765 multiple spot temperature sensors.

These can be ordered either with three or four wires.

The 3-wire version is very accurate due to wire resistance compensation.

However, to get highest total temperature accuracy, the 4-wire version is recommended. In a 4-wire configuration, the resistance from wires and terminals will not effect measurement accuracy.

Example, 3-wire

The typical accuracy influence from wires is ± 0.0066 °C/m for -100 to 100 °C (-148 to 212 °F).

The wiring influence for a 20 m (66 ft) 3-wire cable at 50 °C (122 °F) typically is 0.0066*20 °C.

The sensor tolerance is 0.15 °C (see diagram above or table on the next page).

The total accuracy (sensor and wiring) is equal or better than ± SQRT $(0.15^2 + (0.0066*20)^2)$= ± 0.200 °C (± 0.36 °F).

Example, 4-wire

For a 4-wire temperature sensor, the resistance from wires and terminals will not effect the measurement accuracy. The total accuracy is equal or better than ± 0.15 °C (± 0.27 °F) at -50 to 50 °C (-58 to 122 °F). See diagram above or table on the next page.

4.2.2 Calibration

Verification of spot elements may be required for very low temperatures, such as in LNG applications. The 4-wire cryogenic temperature sensor can for this reason be ordered with calibration to achieve a higher accuracy than possible with a specific tolerance class. Such sensors are delivered with a calibration certificate, to be used as an input during configuration via TankMaster for superior measurement accuracy.

During calibration the sensor is compared in liquid with a traceable reference sensor in one or several temperature points.

Calibration is done by using Callendar-van Dusen coefficients (R_0, A, B, C):

$R(t) = R_0 * (1 + A * t + B * t^2 + C * (t – 100) * t^3)$

where $A = 3.9083*10^{-3}$ °C^{-1}, $B = -5.775*10^{-7}$ °C^{-2}

t is the temperature in °C
C = 0 °C^{-4} if t > 0,
C = $-4.183*10^{-12}$ °C^{-4} if t < 0
R_0=100 Ω for Pt-100

The table below shows a comparison between calibrated and standard DIN B muliple spot sensors supplied by Emerson / Rosemount Tank Gauging:

The 565 sensor is mounted with a flange or a thread at the top of the tank.

The spot elements are placed in a flexible gas tight protection tube, made from convoluted stainless steel, for easier handling during installation.

All spot elements are attached to a wire, which runs from the top to the bottom of the sensor. An anchor weight can be hung at the bottom, or the tube can be fixed to the bottom, to keep the sensor vertical, and avoid floating when the tank is filled.

API chapter 7 recommends minimum one element per 10 feet (3 m) tank height for custody transfer applications.

Multiple spot temperature sensor.

	Tolerance for 4-wire Sensor at						
	-200 °C (-328 °F)	-100 °C (-148 °F)	-50 °C (-58 °F)	0 °C (32 °F)	50 °C (122 °F)	100 °C (212 °F)	200 °C (392 °F)
1/6 DIN B	± 0.45 °C (± 0.81 °F)	± 0.25 °C (± 0.45 °F)	± 0.15 °C (± 0.27 °F)	± 0.05 °C (± 0.09 °F)	± 0.15 °C (± 0.27 °F)	± 0.25 °C (± 0.45 °F)	± 0.45 °C (± 0.81 °F)
1/10 DIN B	± 0.43 °C (± 0.77 °F)	± 0.23 °C (± 0.41 °F)	± 0.13 °C (± 0.23 °F)	± 0.03 °C (± 0.05 °F)	± 0.13 °C (± 0.23 °F)	± 0.23 °C (± 0.41 °F)	± 0.43 °C (± 0.77 °F)
Calibrated	± 0.020 °C (± 0.036 °F)	± 0.012 °C (± 0.022 °F)	± 0.008 °C (± 0.014 °F)	± 0.005 °C (± 0.009 °F)	± 0.008 °C (± 0.014 °F)	± 0.012 °C (± 0.022 °F)	± 0.020 °C (± 0.036 °F)

4.3 ROSEMOUNT 565 MULTIPLE SPOT TEMPERATURE SENSOR

Rosemount 565 measures temperature with one to sixteen Pt-100 spot elements placed at different heights to provide a tank temperature profile and an average temperature.

The temperature sensor is easily installed on the tank nozzle, and is then connected either directly on the 2240S multi-input temperature transmitter or via cable.

The calculated average liquid temperature, based on fully immersed elements, is used as an input for accurate volume calculations in storage tanks.

Recommended temperature sensor positions for custody transfer according to API. Example: 4 spot elements, H=9 m. A=3 m.

Rosemount 565 is designed for atmospheric tanks up to 0.5 Bar (7.3 psi). For pressurized tanks it can be installed in a closed thermowell, enabling service or inspection while the tank is in operation.

Fixed roof tank:
The 565 sensor is attached to a flange mounted on a suitable nozzle. The multiple spot temperature sensor can be equipped with 16 spot elements. An anchor weight keeps it in position. It can alternatively be clamped to the tank bottom.

Floating roof tanks: The 565 sensor can be installed in a still-pipe.

A vapor boot is used to guide and protect the sensor if installed on a floating roof tank.

4.4 ROSEMOUNT 566 TEMPERATURE SENSOR FOR CRYOGENIC APPLICATIONS

The 566 sensor is equipped with type A elements, suitable for low temperatures. It is used for measurements in LNG tanks.

The spot elements are encapsulated in a stainless steel tube, filled with Argon gas to prevent condensation of water inside the sensor at low temperatures.

If the sensor is used in pressurized tanks, it must be protected by a thermowell with ambient pressure inside. The recommended minimum inner diameter of the thermowell is 49.8 mm (1.96 in.).

Rosemount 566 is supplied with a non-adjustable flange.

4.5 ROSEMOUNT 765 WATER LEVEL SENSOR INTEGRATED WITH MULTIPLE SPOT TEMPERATURE SENSOR

The capacitive water level sensor continuously measures free water level below the oil surface and provides an input for on-line net inventory calculations.
The integrated multiple spot temperature sensor is Rosemount 565 (see page 58).

The 765 sensor is available in two versions, open and closed. The open version is suitable for crude oil applications and the closed version is suitable for lighter fuels such as diesel oil etc.

One of the Pt-100 temperature sensors can be installed inside the water level probe allowing temperature measurements at low levels.

The water level sensor delivers a high-speed digital signal, which is connected to the Rosemount 2240S Multi-input Temperature Transmitter.

Rosemount 765 is delivered in a stainless steel (AISI 316) housing, welded to the flexible temperature sensor tube to get a hermetic design. It has a heavy duty design with no moving parts.

Offset calibration can be done with an integrated calibration feature in the 2240S transmitter.

Rosemount 765, open version to the left and closed version to the right. It is hung vertically from the top of the tank, and the position/length is chosen according to the actual bottom water range. The 765 sensor should be anchored to the tank bottom to ensure a fixed position in case of turbulence.

Open and closed water level sensor versions.

A weight can be mounted in the bottom eye bolt and / or above the water level sensor, in which case the weight is hollow and fitted on the temperature sensor. The eye bolt can be removed for close bottom measurements.

The mark on the label shows the distance to the sensor zero level. Ideally this zero level should correspond to the tank zero level. If not an offset is defined during calibration.
10800
Type: WLS
Serial No.:
Nuts to adjust sensor position.
Adjustable threads:
± 125 mm (4.92 in.)
350 mm (13.8 in.)
Maximum filling level
Min. 1000 mm (40 in.)
Min. 500 mm (20 in.) to highest spot element
L_C (used for configuration)
L_0
L
L_T
Highest temperature element ≤ T_{16}
Min. 150 mm (5.9 in.)
Weight
Max. level
T_2
T_1
Active length: 500 mm (1.6 ft) as standard, or 1000 mm (3.3 ft) as an option
Tank zero level
Min. level
L_W
Weight
Note:
Always use the largest possible weight that your tank/application allows
Recommended distance:
0.5-1.5 m (1.6-4.9 ft)

4.6 SPECIFICATION

Multiple Spot Temperature Sensor (Rosemount 565, 566, 765)	
Product	Rosemount 565 and Rosemount 566 (cryogenic version) Multiple Spot Temperature Sensors. This is also the temperature specification for Rosemount 765
Elements type	Pt-100 spot elements according to EN 60751. 3-wire or 4-wire design
Accuracy	1/6 DIN Class B (standard), 1/10 DIN Class B (option). See diagram on page 5. MST sensor for cryogenic use: DIN Class A. DIN Class A and B are specified in EN 60751
Liquid pressure range	0-4 Bar (0-58 Psi). Designed for atmospheric non-pressurized tanks. Handles liquid pressure from hydrocarbons and petrochemical products equivalent to a level of 40 m (130 ft).
Liquid temperature range	-50 to 250 °C (-58 to 482 °F) -170 to 100 °C (-274 to 212 °F) for cryogenic use
Number of elements	Max. 16 spot elements. See page 64
Overall length	Standard is 5-70 m (16.4-230 ft). Maximum 60 m (197 ft) for Rosemount 765. Other lenghts on request
Protective sheath	Stainless steel, AISI 316. Wall thickness 0.3 mm (0.012 in.). Ø=1 in.
Top fitting / mounting thread	Steel pipe with 1/2-in. BSP thread or M33 x 1.5. Thread length 253 mm (10.0 in.)
Tank opening	Minimum Ø= 2 in. (50.8 mm)
Flange (option)	1½ to 4 in. according to standards. Stainless steel (AISI 304 is standard, AISI 316 on request)
Immersed material	Stainless steel (AISI 316)
Lead wire length	0.4 m (16 in.) is standard for integrated installation with 2240S temperature transmitter. Longer wires up to 10 m (32.8 ft) are available as an option.
No of wires	• Three or four independent wires per element or • Three wires with common return
Bottom weight	2.5-15 kg (5.5-33 lbs). 2.5-4 kg (5.5-9 lbs) for still-pipe installation. Stainless steel (AISI 304)
Minimum distance from the bottom of the sensor to the first spot element	150 mm (5.9 in.)
Minimum distance from the top of the sensor to the uppermost spot element	850 mm (33.5 in.)
Declaration of Conformity	Designed according to EN 60751. Accuracy approved by PTB. • ISO 15156-06-2009 (NACE MR0175) for all wetted parts CE-mark: • ATEX Directive 94/9/EC. • Low voltage directive (LVD): 2004/108 EC • EMC directive: 2006/95/EC
Hazardous location certifications	IECEx, ATEX, FM-US, and FM-C. See “Product Certifications” on page 65
Ingress protection	IP 68

Water Level Sensor (Rosemount 765)	
Product	Rosemount 765 Temperature Sensor with Integrated Water Level Sensor. Temperature specification same as above
Open model	Recommended for crude oil and heavy duty products
Closed model	Recommended for lighter fuels such as diesel oil
Active measuring range	500 mm (20 in.), 1000 mm (40 in.)
Output	High-speed RS485/Modbus communication with Rosemount 2240S
Accuracy	± 2 mm (0.08 in.) [500 mm active length] ± 4 mm (0.16 in.) [1000 mm active length]
Repeatability	± 0.5 mm (0.02 in.)
Measuring principle	Capacitive
Calibration	Zero to full range factory calibration, and on-tank calibration possibility
Storage temperature	-40 to +80 °C (-40 to +180 °F)
Operating temperature	0 to +120 °C (+32 to +250 °F). Maximum temperature at mounting flange is 80 °C (180 °F)
Operating pressure	0-4 Bar (0-58 Psi). Designed for atmospheric non-pressurized tanks. Handles liquid pressure from hydrocarbons and petrochemical products equivalent to a level of 40 m (130 ft).
Mechanical dimensions	Connection thread M33x1.5 mm
Immersed material	Stainless steel (AISI 316), FEP, PTFE, and PEEK with 30% glass
Length of water level sensor	Active length + 140 mm (5.5 in.)
Outer diameter of water level sensor	Closed: Ø=38 mm (1.5 in.) Open: Ø=48 mm (1.9 in.)

Sensor Type(1)	Temperature Range	Conductors	Maximum Number of Spot Elements
Rosemount 565	-50 to 120 °C (-58 to 248 °F) or -20 to 250 °C (-4 to 482 °F)	3-wire individual wiring	16
		4-wire, individual wiring	16
		3-wire, common return wiring	16
Rosemount 566	-170 to 100 °C (-274 to 212 °F)	3-wire, individual wiring	6
		4-wire, individual wiring	4
		3-wire, common return wiring	16
Rosemount 765	-50 to 120 °C (-58 to 248 °F)	3-wire, individual wiring	14
		4-wire, individual wiring	10
		3-wire, common return wiring	16

(1) All types have: Pt-100 spot elements. Protective sheath made of stainless steel (AISI 316). Maximum 70 m (230 ft) length.

4.7 PRODUCT CERTIFICATIONS

SPECIAL CONDITIONS FOR SAFE USE

The WLS and the RTDs are intrinsically safe circuits. At connection facilities the requirements in clause 6.2.1 in EN 60079-11 for separation between intrinsically safe circuits and possibly non-intrinsically safe circuits shall be strictly followed.

The WLS and the RTDs are two separate intrinsically safe circuits. They must not be interconnected and the requirements for separation listed in clause 6.2.1 in EN 60079-11 shall be followed.

Terminating and connecting the WLS cable and the wires from the RTDs, requirements in the local installation codes shall be followed.

Connecting WLS and junction box adequate the strain relief shall be provided.

European ATEX Directive Information

EC-Type Examination Certificate Number: FM08ATEX0060X

Control Drawing: 800-9020-FM

Rosemount 765

II 1 G Ex ia IIC T4/T6(1)
Temperature element parameters: U_i=7.2 VDC, I_i=400 mA, P_i=700 mW, L_i=40 µH, C_i=500 nF
Communication/transmitter parameters: U_i=7.2 VDC, I_i=250 mA, P_i=700 mW, L_i=130 µH, C_i=0 nF

Rosemount 565

II 1 G Ex ia IIC T2/T4(2)
U_i=7.2 VDC, I_i=400 mA, P_i=700 mW, L_i=40 µH, C_i=500 nF

Rosemount 566

II 1 G Ex ia IIC T5(3)
U_i=7.2 VDC, I_i=400 mA, P_i=700 mW, L_i=40 µH, C_i=500 nF

US Factory Mutual (FM-US) Certification

Certificate of Compliance: 3032389

Control Drawing: 800-9020-FM

Rosemount 765

Intrinsically safe for Class I, Division 1, Groups A, B, C, and D and Class I, Zone 0 Group IIC hazardous locations; Temperature class T4 below the flange at an ambient temperature range of -50 °C ≤ T_a ≤ +120 °C, and T6 above the flange at an ambient temperature range of -50 °C ≤ T_a ≤ +70 °C.
Temperature element parameters: U_i=7.2 VDC, I_i=400 mA, P_i=700 mW, L_i=40 µH, C_i=500 nF
Communication/transmitter parameters: U_i=7.2 VDC, I_i=250 mA, P_i=700 mW, L_i=130 µH, C_i=0 nF

(1) Below flange: T4: -50 °C ≤ T_a ≤ +120 °C
Above flange: T6: -50 °C ≤ T_a ≤ +70 °C

(2) T2: -50 °C ≤ T ≤ +70 °C above flange,
-50 °C ≤ T ≤ +250 °C below flange
T4: -50 °C ≤ T ≤ +70 °C above flange,
-50 °C ≤ T ≤ +130 °C below flange

(3) T5: -50 °C ≤ T ≤ +70 °C above flange,
-200 °C ≤ T ≤ +95 °C below flange

Rosemount 565

Intrinsically safe for Class I, Division 1, Groups A, B, C, and D and Class I, Zone 0 Group IIC hazardous locations; Temperature class as indicated(2)
U_i=7.2 VDC, I_i=400 mA, P_i=700 mW, L_i=40 µH, C_i=500 nF

Rosemount 566

Intrinsically safe for Class I, Division 1, Groups A, B, C, and D and Class I, Zone 0 Group IIC hazardous locations; Temperature class as indicated(3)
U_i=7.2 VDC, I_i=400 mA, P_i=700 mW, L_i=40 µH, C_i=500 nF

Canadian Factory Mutual (FM-C) Certification

Certificate of Compliance: 3032389C

Control Drawing: 800-9020-FM

Rosemount 765

Intrinsically safe for Class I, Zone 0 Group IIC hazardous locations; Temperature class T4 below the flange at an ambient temperature range of -50 °C ≤ T_a ≤ +120 °C, and T6 above the flange at an ambient temperature range of -50 °C ≤ T_a ≤ +70 °C.
Temperature element parameters: U_i=7.2 VDC, I_i=400 mA, P_i=700 mW, L_i=40 µH, C_i=500 nF
Communication/transmitter parameters: U_i=7.2 VDC, I_i=250 mA, P_i=700 mW, L_i=130 µH, C_i=0 nF

Rosemount 565

Intrinsically safe for Class I, Zone 0 Group IIC hazardous locations; Temperature class as indicated(2)
U_i=7.2 VDC, I_i=400 mA, P_i=700 mW, L_i=40 µH, C_i=500 nF

Rosemount 566

Intrinsically safe for Class I, Zone 0 Group IIC hazardous locations; Temperature class as indicated(3)
U_i=7.2 VDC, I_i=400 mA, P_i=700 mW, L_i=40 µH, C_i=500 nF

IECEx Certification

Certificate of Conformity Number: IECEx FME 08.0007X

Control Drawing: 800-9020-FM

Rosemount 765

Ex ia IIC T4/T6(1)
Temperature element parameters: U_i=7.2 VDC, I_i=400 mA, P_i=700 mW, L_i=40 µH, C_i=500 nF
Communication/transmitter parameters: U_i=7.2 VDC, I_i=250 mA, P_i=700 mW, L_i=130 µH, C_i=0 nF

Rosemount 565

Ex ia IIC T2/T4(2)
U_i=7.2 VDC, I_i=400 mA, P_i=700 mW, L_i=40 µH, C_i=500 nF

Rosemount 566

II 1 G Ex ia IIC T5(3)
U_i=7.2 VDC, I_i=400 mA, P_i=700 mW, L_i=40 µH, C_i=500 nF

4.8 ORDERING INFORMATION

NOTE
Spot element positions should be specified separately in Required System Information (RSI), document number GSP-2010-0003.

4.8.1 Rosemount 565 Multiple Spot Temperature Sensor

Model (Pos 1)	Product Description	Note
0565	Multiple Spot Temperature Sensor	
Code (Pos 2)	**Overall Length (L_0)**	**Note**
Mxxxxx	Metric units, xxxxx in millimeters (mm). Range: 02000-70000	Specify in steps of 10 mm. Longer on request.
Exxxxx	English units, xxxxx in inches (in.). Range 00400-02700	Longer on request.
Code (Pos 3)	**Sheath Type**	**Note**
A	1 in. AISI 316 SST	
Code (Pos 4)	**Tank Connection**	**Note**
ANSI Flanges (SST AISI 304)		
A	1 ½-in. Class 150	
B	1 ½-in. Class 300	
C	2 in. Class 150	
D	2 in. Class 300	
E	3 in. Class 150	
F	3 in. Class 300	
G	4 in. Class 150	
H	4 in. Class 300	
EN Flanges (SST AISI 304)		
1	DN 50 PN 16	
2	DN 50 PN 40	
3	DN 65 PN 16	
4	DN 65 PN 16	
5	DN 80 PN 16	
6	DN 80 PN 40	
7	DN 100 PN 16	
Threaded Connection		
0	M33x1.5	
Code (Pos 5)	**Temperature Sensor Wiring**	**Note**
4	4-wire	
3	3-wire, individual	
C	3-wire, common return	
Code (Pos 6)	**Number of Temperature Spot Elements**	**Note**
01 to 16	Specify number	
Code (Pos 7)	**Element Type**	**Note**
P	Pt-100	
Code (Pos 8)	**Performance Class**	**Note**
1	1/6 DIN Class B	IEC/EN60751
2	1/10 DIN Class B	IEC/EN60751. Pos 5 “Temperature Sensor Wiring” code 4 (4-wire) is recommended

Code (Pos 9)	Temperature Range	Note
1	-50 to +120 °C (-58 to +248 °F)	
2	-20 to +250 °C (-4 to +482 °F)	
Code (Pos 10)	**Lead Wires, Temperature Sensor**	**Note**
00	For integrated installation with Rosemount 2240S (standard)	
04-10	Specify other length in metres	
13-33	Specify other length in feet	
Code	**Options – none or multiple selections are possible. Specify in the same order as listed below**	**Note**
Certificate		
Q8	Material certificate EN10204 3.1	
Stabilization Weights (SST AISI 304)(1)		
AA	Anchor weight. 2.0 kg (4.4 lbs), Ø= 40x200 mm (Ø=1.6x7.9 in.)	For still-pipes
AB	Anchor weight. 3 kg (6.6 lbs), Ø= 50x200 mm (Ø=2.0x7.9 in.)	For still-pipes
AC	Anchor weight. 4 kg (8.8 lbs), Ø= 45x330 mm (Ø=1.8x13.0 in.)	For still-pipes
AD	Anchor weight. 5 kg (11 lbs), Ø= 100x85 mm (Ø=3.9x3.3 in.)	For free-hanging
AE	Anchor weight. 10 kg (22 lbs), Ø= 95x175 mm height (Ø=3.7x6.9 in.)	For free-hanging
AF	Anchor weight. 15 kg (33 lbs), Ø= 140x130 mm (Ø=5.5x5.1 in.)	For free-hanging
AP	Anchor Weight 3 kg (6.6 lbs), Ø=48,5x270 mm (1.9 x 10.6 in.)	Installed in section(s) around sensor hose
AR	Anchor Weight 6 kg (13.2 lbs), Ø=48.5x570 mm (1.9 x 22.4 in.)	Installed in section(s) around sensor hose
AS	Anchor Weight 9 kg (19.8 lbs), Ø=48.5x870 mm (1.9 x 34.3 in.)	Installed in section(s) around sensor hose
AT	Anchor Weight 12 kg (26.4 lbs), Ø=48.5x1170 mm (1.9 x 46.1 in.)	Installed in section(s) around sensor hose
AU	Anchor Weight 15 kg (33.1 lbs), Ø=48.5x1470 mm (1.9 x 57.9 in.)	Installed in section(s) around sensor hose
Vapor Boot(1)		
VA	Vapor boot with a 2-in. NPS threaded tank connection	
VB	Vapor boot with a 3-in. NPS threaded tank connection	
VC	Vapor boot for a 3-in. ANSI Class 150 flange	
VD	Vapor boot for a 4-in. ANSI Class 150 flange	
VE	Vapor boot for a 6-in. ANSI Class 150 flange	
VF	Vapor boot for an 8-in. ANSI Class 150 flange	
Hose Kit(1)		
HA	Hose kit including glands, 3 m (10 ft), ½-in. 14 NPT connection	
HB	Hose kit including glands, 10 m (33 ft), ½-in. 14 NPT connection	
Adapters		
IA	Adapter M33x1.5 female to 1 in. NPT male (connecting 565 to hose)(2)	Drawing number: 304-1708
IB	Adapter 1 in. NPT female to M33x1.5 male (connecting hose to remote 2240S)(2)	Drawing number: 304-1709
Model Code Example: 0565 – M25000 A 0 4 16 P 2 2 00 - Q8 AE VE - temperature sensor positions(3)		

(1) Mutually exclusive options under this category.
(2) Both adapters, IA and IB, are needed.
(3) Temperature sensor positions are specified in separate document: Required System Information (RSI), document number GSP-2009-0002.

4.8.2 Rosemount 566 Multiple Spot Temperature Sensor for Cryogenic Use (NL-Cryo)

Model (Pos 1)	Product Description	Note
0566	Multiple Spot Temperature Sensor for Cryogenic Applications	
Code (Pos 2)	**Overall Length (L_0)**	**Note**
Mxxxxx	Metric units, xxxxx in millimeters (mm). Range: 02000-70000	Specify in steps of 10 mm. Longer on request.
Exxxxx	English units, xxxxx in inches (in.). Range 00400-02700	Longer on request.
Code (Pos 3)	**Sheath Type**	**Note**
A	1-in. AISI 316	
Code (Pos 4)	**Tank Connection**	**Note**
ANSI Flanges (SST AISI 304)		
A	1 ½-in. Class 150	
B	1 ½-in. Class 300	
C	2 in. Class 150	
D	2 in. Class 300	
E	3 in. Class 150	
F	3 in. Class 300	
G	4 in. Class 150	
H	4 in. Class 300	
EN Flanges (SST AISI 304)		
1	DN 50 PN 16	
2	DN 50 PN 40	
3	DN 65 PN 16	
4	DN 65 PN 16	
5	DN 80 PN 16	
6	DN 80 PN 40	
7	DN 100 PN 16	
Threaded Connection		
0	M33x1.5	
Code (Pos 5)	**Temperature Sensor Wiring**	**Note**
4	4-wire	Max. 4 spot elements
3	3-wire, individual	Max. 6 spot elements
C	3-wire, common return	
Code (Pos 6)	**Number of Temperature Spot Elements**	**Note**
01 to 16	Specify number(1)	
Code (Pos 7)	**Element Type**	**Note**
P	Pt-100	
Code (Pos 8)	**Temperature Accuracy Class**	**Note**
A	DIN Class A	IEC/EN60751
Code (Pos 9)	**Temperature Range**	**Note**
3	- 170 to +100 °C (-274 to +212 °F)	
Code (Pos 10)	**Lead Wires, Temperature Sensor**	**Note**
00	Integrated installation with Rosemount 2240S (standard)	
04-10	Specify other length in metres	
13-33	Specify other length in feet	

Code	Options – none or multiple selections are possible. Specify in the same order as below	Note
Certificate		
Q8	Material certificate EN10204 3.1	
Stabilization Weights (SST AISI 304)(2)		
AA	Anchor weight. 2.0 kg (4.4 lbs), Ø= 40x200 mm (Ø=1.6x7.9 in.)	For still-pipes
AB	Anchor weight. 3 kg (6.6 lbs), Ø= 50x200 mm (Ø=2.0x7.9 in.)	For still-pipes
AC	Anchor weight. 4 kg (8.8 lbs), Ø= 45x330 mm (Ø=1.8x13.0 in.)	For still-pipes
AD	Anchor weight. 5 kg (11 lbs), Ø= 100x85 mm (Ø=3.9x3.3 in.)	For free-hanging
AE	Anchor weight. 10 kg (22 lbs), Ø= 95x175 mm height (Ø=3.7x6.9 in.)	For free-hanging
AF	Anchor weight. 15 kg (33 lbs), Ø= 140x130 mm (Ø=5.5x5.1 in.)	For free-hanging
Hose Kit(2)		
HA	Hose kit including glands, 3 m (10 ft), ½-in. 14 NPT connection	
HB	Hose kit including glands, 10 m (33 ft), ½-in. 14 NPT connection	
Adapters		
IA	Adapter M33x1.5 female to 1 in. NPT male (connecting 565 to hose)(3)	Drawing number: 304-1708
IB	Adapter 1 in. NPT female to M33x1.5 male (connecting hose to remote 2240S)(3)	Drawing number: 304-1709
Calibration		
X8	Sensor calibration over specified temperature range with A, B, C, and Callendar-van Dusen constants(4)	
Other		
DN	Drain nipple on flange	
Model Code Example: 0566 – M25000 A E 4 16 P A 3 00 - Q8 AA VC DN - temperature sensor positions(5)		

(1) Can have up to 16 spot elements for 3-wire common return, 6 spot elements for 3-wire individual return, and 4 spot elements for 4-wire individual return.
(2) Mutually exclusive options under this category.
(3) Both adapters, IA and IB, are needed.
(4) Requires Pos 5 "Temperature Sensor Wiring" code 4 (4-wire).
(5) Temperature sensor positions are specified in separate document: Required System Information (RSI), document number GSP-2009-0002.

4.8.3 Rosemount 765 Water Level Sensor with Multiple Spot Temperature Sensor

Model (Pos 1)	Product Description	Note
0765	Water Level Sensor Integrated with Multiple Spot Temperature Sensor	
Code (Pos 2)	**Overall Length (L_0)**	**Note**
Mxxxxx	Metric units, xxxxx in millimeters (mm). Range: 02000-60000	Specify in steps of 10 mm. Longer on request
Exxxxx	English units, xxxxx in inches (in.). Range 00400-02300	Longer on request
A	1-in. AISI 316	
ANSI Flanges (SST AISI 304)		
A	1 ½-in. Class 150	
B	1 ½-in. Class 300	
C	2 in. Class 150	
D	2 in. Class 300	
E	3 in. Class 150	
F	3 in. Class 300	
G	4 in. Class 150	
H	4 in. Class 300	
EN Flanges (SST AISI 304)		
1	DN 50 PN 16	
2	DN 50 PN 40	
3	DN 65 PN 16	
4	DN 65 PN 16	
5	DN 80 PN 16	
6	DN 80 PN 40	
7	DN 100 PN 16	
Threaded Connection		
0	M33x1.5	
Code (Pos 5)	**Temperature Sensor Wiring**	**Note**
4	4-wire	Max. 10 spot elements
3	3-wire, individual	Max. 14 spot elements
C	3-wire, common return	
Code (Pos 6)	**Number of Temperature Spot Elements**	**Note**
01 to 16	Specify number(1)	
00	No temperature sensor – Water Level Sensor only	
Code (Pos 7)	**Element Type**	**Note**
P	Pt-100	
0	No temperature sensor – Water Level Sensor only	
Code (Pos 8)	**Temperature Accuracy Class**	**Note**
2	1/10 DIN Class B	IEC/EN60751. Pos 5 “Temperature Sensor Wiring” code 4 (4-wire) is recommended
1	1/6 DIN Class B	IEC/EN60751
0	No temperature sensor – Water Level Sensor only	
Code (Pos 9)	**Temperature Range**	**Note**
1	0 to +120 °C (+32 to +248 °F)	

Code (Pos 10)	Lead Wires, Temperature Sensor	Note
00	Integrated installation with Rosemount 2240S (standard)	
03-10	Specify other length in metres	
10-33	Specify other length in feet	
Code (Pos 11)	**Water Level Sensor**	**Note**
C05	Closed; suitable for light products. 500 mm (19 in.) range	
C10	Closed; suitable for light products. 1000 mm (39 in.) range	
H05	Open; suitable for crude and heavy duty products. 500 mm (19 in.) range	
H10	Open; suitable for crude and heavy duty products. 1000 mm (39 in.) range	
Code	**Options – none or multiple selections are possible. Specify in the same order as below**	**Note**
Certificate		
QD	Water level sensor calibration certificate	
Q8	Material certificate EN10204 3.1	
Stabilization Weights (SST AISI 304)(2)		
AA	Anchor weight. 2.0 kg (4.4 lbs), Ø= 40x200 mm (Ø=1.6x7.9 in.)	For still-pipes
AB	Anchor weight. 3 kg (6.6 lbs), Ø= 50x200 mm (Ø=2.0x7.9 in.)	For still-pipes
AC	Anchor weight. 4 kg (8.8 lbs), Ø= 45x330 mm (Ø=1.8x13.0 in.)	For still-pipes
AD	Anchor weight. 5 kg (11 lbs), Ø= 100x85 mm (Ø=3.9x3.3 in.)	For free-hanging
AE	Anchor weight. 10 kg (22 lbs), Ø= 95x175 mm height (Ø=3.7x6.9 in.)	For free-hanging
AF	Anchor weight. 15 kg (33 lbs), Ø= 140x130 mm (Ø=5.5x5.1 in.)	For free-hanging
BA	Top weight, water level sensor, 5 kg (11 lbs), Ø=79x165 mm (Ø=3.1x6.5 in.)	Inside hole Ø=42 mm (1.65 in.)
Vapor Boot(2)		
VA	Vapor boot with a 2-in. NPS threaded tank connection	
VB	Vapor boot with a 3-in. NPS threaded tank connection	
VC	Vapor boot for a 3-in. ANSI Class 150 flange	
VD	Vapor boot for a 4-in. ANSI Class 150 flange	
VE	Vapor boot for a 6-in. ANSI Class 150 flange	
VF	Vapor boot for an 8-in. ANSI Class 150 flange	
Hose Kit(2)		
HA	Hose kit including glands, 3 m (10 ft), ½-in. 14 NPT connection	
HB	Hose kit including glands, 10 m (33 ft), ½-in. 14 NPT connection	
Adapters		
IA	Adapter M33x1.5 female to 1 in. NPT male (connecting 565 to hose)(3)	Drawing number: 304-1708
IB	Adapter 1 in. NPT female to M33x1.5 male (connecting hose to remote 2240S)(3)	Drawing number: 304-1709
Model Code Example: 0765 - M25000 A 3 4 10 P 2 1 00 C05 - QD Q8 AA BA VC - temperature sensor positions(4)		

(1) Can have up to 16 spot elements for 3-wire common return, 14 spot elements for 3-wire individual return, and 10 spot elements for 4-wire individual return.
(2) Mutually exclusive options under this category.
(3) Both adapters, IA and IB, are needed.
(4) Temperature sensor positions are specified in separate document: Required System Information (RSI), document number GSP-2009-0002.

5 Rosemount 3051S Scalable Pressure Transmitter

The pressure transmitter used in a Raptor hybrid system is the Rosemount 3051S Scalable Pressure Transmitter which delivers cutting edge pressure measurement performance with 0.025% accuracy and 200:1 rangedown.

It supplies the measured pressure data to the Tankbus, which utilizes the FOUNDATION™ fieldbus communication protocol. 3051S is powered by the Rosemount 2410 Tank Hub.

The 3051S series consists of transmitters and flanges suitable for all kinds of applications, including crude oil tanks, pressurized tanks and tanks with / without floating roofs.

3051S is also available as a wireless device, which can be used in an IEC 62591 (*Wireless*HART) network. It is powered by a long-life intrinsically safe power module, and has the same outstanding performance as the wired version.

3051S Liquid Level Transmitter for viscous liquids such as crude oil.

3051S Coplanar Pressure Transmitter for vapor measurements, and 3051S Coplanar Pressure Transmitter for measurements on non-viscous liquids such as diesel.

3051S Wireless Scalable Pressure Transmitter.

5.1 PRESSURE AND DENSITY MEASUREMENT IN A HYBRID TANK GAUGING SYSTEM

By complementing the level measurement with temperature and pressure measurement, the density and mass of the product in the tank can be continuously calculated.

One or more pressure transmitters with different scalings can be used on the same tank to measure liquid and vapor pressure.

The accuracy of the density calculation largely depends on the accuracy of the pressure transmitter.

Also see “Hybrid Tank Gauging System” on page 12.

5.2 INSTALLATION CONSIDERATIONS

Pressure transmitters are used in two main configuration alternatives:

- Tank ventilated to atmosphere:
  There is one pressure transmitter installed at the bottom of the tank (P_1) to measure liquid pressure (P_L).
- Pressurized, non-ventilated tank (possibly with a vapor recovery system), and blanketed tanks (nitrogen): One pressure transmitter is installed at the bottom of the tank (P_1), and one pressure transmitter is installed at the top (P_3) to measure vapor pressure.
  The liquid pressure, $P_L=P_1-P_3$

The pressure transmitter installed to measure vapor pressure should always be of coplanar type, non-flanged version (E12 in model code).

The pressure transmitter which measures liquid pressure, should be of either flanged liquid level or coplanar type. The liquid level pressure transmitter is used for crude oil applications, and the coplanar pressure transmitter is used for any other liquid type.

One 3051S transmitter measures vapor pressure, and the other measures liquid pressure.

5.2.1 Calibration

Use a T-connection with drain valve, which is necessary for zero calibration of the pressure transmitter installed to measure liquid pressure at the bottom of the tank. Should be done a couple of times per year.

Shut-off isolation and drain valves used for zero calibration of the pressure transmitter.

For more information, see the 3051S Product Data Sheet (00813-0100-4801) or Reference Manual (document number 00809-0100-4801).

5.3 SPECIFICATION

General	
Product	Rosemount 3051S Pressure Transmitter; • Coplanar pressure transmitter • Liquid level pressure transmitter For complete information and offering, see the Rosemount 3051S Product Data Sheet (document number 00813-0100-4801).
Hazardous location certifications	Factory Mutual (FM), ATEX, Canadian Standards Association (CSA), and IECEx. See “Product Certifications” on page 76.
ATEX directive	94/9/EC
Ordinary location certification	As standard, the transmitter has been examined and tested to determine that the design meets basic electrical, mechanical, and fire protection requirements by FM, a nationally recognized testing laboratory (NRTL) as accredited by the Federal Occupational Safety and Health Administration (OSHA)
Measuring Performance	
Pressure range	-393 to 1000 inH_2O (-0.98 to 2.5 bar). 1000 inH_2O <=> 25 mH_2O
Reference accuracy	Coplanar Pressure Transmitter: up to ± 0.025% of span for ultra version, up to ± 0.055% of span for classic version Liquid Level Pressure Transmitter: up to ± 0.065% of span
Typical density accuracy	According to API chapter 3.6
Display / Configuration / Communication	
Integral display	Yes
Configuration tools	Field Communicator, AMS Suite, DeltaV or any other DD (Device Description) compatible host system
FOUNDATION™ fieldbus blocks	Resource block, Transducer block, LCD block, 2 AI blocks, PID block, ISEL block, SGCR block, ARTH block, and OSPL block
FOUNDATION™ fieldbus class (basic or link master)	Link Master (LAS)
FOUNDATION™ fieldbus block execution time	AI-block: 20 ms. PID-block: 35 ms. ARTH-, ISEL-, OSPL-block, SGCR-block: 20 ms
FOUNDATION™ fieldbus PlantWeb Alert support	Yes
Electric	
Power supply	Powered by Rosemount 2410 Tank Hub
Bus current draw	17.5 mA
Mechanical	
Tank connection	See ordering information on page 83 and 81
Housing / enclosure	Polyurethane-covered aluminum
Cable entry (connection/glands)	½ - 14 NPT and M20 x 1.5 entries for cable glands and conduits
Tankbus cabling	0.5-1.5 mm^2 (AWG 22-16), twisted shielded pairs
Dimensions	See “Dimensional Drawings” on page 78
Weight	4 to 15 kg (9-33 lbs) including tank connection, depending on transmitter choice

Environment	
Ambient temperature	-40 to 85 °C (-40 to 185 °F). LCD readable in: -20 to 80 °C (-4 to 175 °F)
Storage temperature	-46 to 85 °C (-50 to 185 °F). LCD: -40 to 85 °C (-40 to 185 °F)
Process temperature	Coplanar Pressure Transmitter: -40 to +149 °C (-40 to +300 °F) Liquid Level Pressure Transmitter: -45 to +205 °C (-49 to +401 °F)
Humidity	0 - 100% relative humidity
Ingress protection	IP 66, IP 68(1), Nema 4X
Vibration effect	Less than ±0.1% of URL when tested per the requirements of IEC60770-1 field or pipeline with high vibration level (10-60 Hz 0.21mm displacement peak amplitude / 60-2000 Hz 3g).
Telecommunication (FCC and R&TTE)	R&TTE 1999/5/EC
Electromagnetic compatibility	EMC (2004/108/EC) EN 61326-1:2006 EN 61326-2-3:2006EN61326 and NAMUR recommendations NE21
Transient / built-in lightning protection	Tested in accordance with IEEE C62.41.2-2002, Location Category B 6 kV crest (0.5 µs - 100 kHz) 3 kA crest (8 × 20 microseconds) 6 kV crest (1.2 × 50 microseconds)
Pressure Equipment Directive (PED)	97/23/EC

(1) Not available with wireless output.

Wireless	
Output	*Wireless*HART, 2.4 GHz DSSS
Radio frequency power output from antenna	Long Range (WK option) antenna: Maximum of 10 mW (10 dBm) EIRP Extended Range (WM option) antenna: Maximum of 18 mW (12.5 dBm) EIRP
Update Rate	*Wireless*HART, user selectable 4 sec. to 60 min.
Power Module	Intrinsically Safe Lithium-thionyl chloride power module with polybutadine terephthalate (PBT) enclosure. Ten-year life at one minute update rate
Telecommunication (FCC and R&TTE)	R&TTE 1999/5/EC. Also see “Product Certifications for Wireless Output” on page 76

5.4 PRODUCT CERTIFICATIONS

Factory Mutual (FM) Approval

IE Intrinsically Safe for use in Class I, Division 1, Groups A, B, C, and D, T4 (T_a = 70 °C for output options A or X; T_a = 60°C for output option F); Class II, Division 1, Groups E, F, and G; Class III, Division 1; Class I, Zone 0 AEx ia IIC T4 (T_a =70 °C for output options A or X; T_a = 60 °C for output option F) when connected in accordance with Rosemount drawing 03151-1006; Non-Incendive for Class I, Division 2, Groups A, B, C, and D; T4 (Ta = 70 °C for output options A or X; Ta = 60 °C for output option F) Enclosure Type 4X
For entity parameters see Rosemount control drawing 03151-1006.

ATEX Approval

IA ATEX Intrinsic Safety
Certificate No.: BAS01ATEX1303X Ex II 1G

Ex ia IIC T4 (Ta = -60 to 70 °C) -HART/Remote Display/Quick Connect/HART Diagnostics
Ex ia IIC T4 (Ta = -60 to 70 °C) -FOUNDATION fieldbus
Ex ia IIC T4 (Ta = -60 to 40 °C) -FISCO

CE 1180

Input Parameters

Loop / Power	Groups
U_i = 30 V	FOUNDATION™ fieldbus
U_i = 17.5 V	FISCO
I_i = 300 mA	HART / FOUNDATION fieldbus
I_i = 380 mA	FISCO
P_i = 1.3 W	FOUNDATION fieldbus
P_i = 5.32 W	FISCO
C_i = 0	FOUNDATION fieldbus / FISCO
L_i = 0	FOUNDATION fieldbus/ FISCO

SPECIAL CONDITIONS FOR SAFE USE (X)

1. The apparatus, excluding the Types 3051 S-T and 3051S-C (In-line and Coplanar SuperModule Platforms respectively), is not capable of withstanding the 500V test as defined in Clause 6.3.12 of EN 60079-11.
   This must be considered during installation.
2. The terminal pins of the Types 3051 S-T and 3051 S-C must be protected to IP20 minimum.

Canadian Standards Association (CSA) Approval

IF Intrinsically Safe for Class I, Division 1, Groups A, B, C, and D when connected in accordance with Rosemount drawings 03151-1016; Dual Seal.
For entity parameters see Rosemount control drawing 03151-1016.

IECEx Approval

IG IECEx Intrinsic Safety
Certificate No.: IECExBAS04.0017X
Ex ia IIC T4 (Ta = -60 to 70 °C) -HART/Remote Display/Quick Connect/HART Diagnostics
Ex ia IIC T4 (Ta = -60 to 70 °C) -FOUNDATION fieldbus
Ex ia IIC T4 (Ta = -60 to 40 °C) -FISCO
IP66

Input Parameters

Loop / Power	Groups
U_i = 30 V	FOUNDATION™ fieldbus
U_i = 17.5 V	FISCO
I_i = 300 mA	HART / FOUNDATION fieldbus
I_i = 380 mA	FISCO
P_i = 1.3 W	FOUNDATION fieldbus
P_i = 5.32 W	FISCO
C_i = 0	FOUNDATION fieldbus / FISCO
L_i = 0	FOUNDATION fieldbus/ FISCO

SPECIAL CONDITIONS FOR SAFE USE (X)

1. The 3051S HART 4-20 mA, 3051S FOUNDATION fieldbus, 3051S Profibus and 3051S FISCO are not capable of withstanding the 500V test as defined in clause 6.3.12 of IEC 60079-11. This must be taken into account during installation.
2. The terminal pins of the Types 3051S-T and 3051S-C must be protected to IP20 minimum.

5.4.1 Product Certifications for Wireless Output

Telecommunication Compliance

All wireless devices require certification to ensure that they adhere to regulations regarding the use of the RF spectrum. Nearly every country requires this type of product certification. Emerson is working with governmental agencies around the world to supply fully compliant products and remove the risk of violating country directives or laws governing wireless device usage.

FCC and IC Approvals

This device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions: This device may not cause harmful interference this device and must accept any interference received, including interference that may cause undesired operation.

This device must be installed to ensure a minimum antenna separation distance of 20 cm (8 in.) from all persons.

Factory Mutual (FM) Approval

I5 FM Intrinsically Safe, Non-Incendive, and Dust Ignition-proof.
Intrinsically Safe for Class I/II/III, Division 1, Groups A, B, C, D, E, F, and G.
Zone Marking: Class I, Zone 0, AEx ia IIC
Temperature Codes T4 (T_{amb} = -50 to 70 °C)
Non-Incendive for Class I, Division 2, Groups A, B, C, and D.
Dust Ignition-proof for Class II/III, Division 1, Groups E, F, and G.
Ambient temperature limits: -50 to 85 °C
For use with Rosemount SmartPower options 00753-9220-0001 only.
Enclosure Type 4X / IP66

Canadian Standards Association (CSA) Approval

Process Sealing
All CSA hazardous approved transmitters are certified per ANSI/ISA 12.27.01-2003.

I6 CSA Intrinsically Safe
Intrinsically Safe for Class I, Division 1, Groups A, B, C, and D.
Temp Code T3C
Enclosure Type 4X / IP66
For use with Rosemount SmartPower options 00753-9220-0001 only.

ATEX Approval

I1 ATEX Intrinsic Safety
Certificate No.: BAS01ATEX1303X Ex II 1G
Ex ia IIC T4 (Ta = -60 to 70 °C)
IP66
For use with Rosemount SmartPower options 00753-9220-0001 only.

CE 1180

Country	Restrictions
Bulgaria	General authorization required for outdoor use and public service
France	Outdoor use limited to 10mW e.i.r.p.
Italy	If used outside of own premises, general authorization is required
Norway	May be restricted in the geographical area within a radius of 20 km from the center of Ny-Alesund
Romania	Use on a secondary basis. Individual license required

SPECIAL CONDITIONS FOR SAFE USE (X)

The surface resistivity of the antenna is greater than one gigaohm. To avoid electrostatic charge build-up, it must not be rubbed or cleaned with solvents or a dry cloth.

IECEx Approval

I7 IECEx Intrinsic Safety
Certificate No.: IECEx BAS 04.0017X
Ex ia IIC T4 (Ta = -60 to 70 °C)
For use with Rosemount SmartPower options 00753-9220-0001 only.
IP66

SPECIAL CONDITIONS FOR SAFE USE (X)

The surface resistivity of the antenna is greater than one gigaohm. To avoid electrostatic charge build-up, it must not be rubbed or cleaned with solvents or a dry cloth.

5.5 DIMENSIONAL DRAWINGS

All dimensions are in mm (inches).

5.5.1 Coplanar Pressure Transmitter

Wireless Version

Pipe Installation

All dimensions are in mm (inches).

Panel Installation

5.5.2 Liquid Level Pressure Transmitter

All dimensions are in mm (inches).

Class	Pipe Size	Flange Thickness A	Bolt Circle Diameter B	Outside Diameter C	No. of Bolts	Bolt Hole Diameter	H
ASME B16.5 (ANSI) 150	51 (2)	18 (0.69)	121 (4.75)	152 (6.0)	4	19 (0.75)	143 (5.65)
	76 (3)	22 (0.88)	152 (6.0)	191 (7.5)	4	19 (0.75)	143 (5.65)
	102 (4)	22 (0.88)	191 (7.5)	229 (9.0)	8	19 (0.75)	143 (5.65)
ASME B16.5 (ANSI) 300	51 (2)	21 (0.82)	127 (5.0)	165 (6.5)	8	19 (0.75)	143 (5.65)
	76 (3)	27 (1.06)	168 (6.62)	210 (8.25)	8	22 (0.88)	143 (5.65)
DIN 2501 PN 10–40	DN 50	20 mm	125 mm	165 mm	4	18 mm	143 (5.65)
DIN 2501 PN 25/40	DN 80	24 mm	160 mm	200 mm	8	18 mm	143 (5.65)
	DN 100	24 mm	190 mm	235 mm	8	22 mm	143 (5.65)
DIN 2501 PN 10/16	DN 100	20 mm	180 mm	220 mm	8	18 mm	143 (5.65)

5.6 ORDERING INFORMATION

This section includes a selection of Rosemount pressure transmitter products and options.
For complete information, see the 3051S Product Data Sheet (00813-0100-4801).

5.6.1 Rosemount 3051S Coplanar Pressure Transmitter

For density measurement of non-viscous liquids such as diesel, and vapor pressure measurement

Model (Pos 1)	Product Description	Note
3051S	Scalable pressure transmitter	
Code (Pos 2)	**Performance Class**	**Note**
1	Ultra: 0.025 % span accuracy, 200:1 rangedown, 10-year stability	
2	Classic: 0.055% span accuracy, 100:1 rangedown, 5-year stability	
Code (Pos 3)	**Connection Type**	**Note**
C	Coplanar	
Code (Pos 4)	**Measurement Type**	**Note**
G	Gage	
Code (Pos 5)	**Pressure Range**	**Note**
1A	-25 to 25 inH_2O (-62.2 to 62.2 mbar), 1000 inH_2O <=> 25 mH_2O	For vapor pressure measurement (P3)
3A	-393 to 1000 inH_2O (-0.98 to 2.5 bar), 1000 inH_2O <=> 25 mH_2O	For liquid pressure measurement (P1)
Code (Pos 6)	**Isolating Diaphragm / Tank Connection Material**	**Note**
2	316L SST	
Code (Pos 7)	**Tank Connection**	**Note**
Connection for Vapor Pressure Transmitter (SST/316 SST)		
E12	1/4 - 18 NPT	
Vertical Mount ANSI Flanges (SST/316 SST)		
G11	2 in. Class 150	
G12	2 in. Class 300	
G21	3 in. Class 150	
G22	3 in. Class 300	
Vertical Mount EN Flanges (SST/316 SST)		
G31	DN50 PN40	
G41	DN80 PN40	
Code (Pos 8)	**Tank Bus: Power and Communication**	**Note**
F	Bus powered 2-wire FOUNDATION™ fieldbus (IEC 61158)	
X	Wireless(1)	
Code (Pos 9)	**Housing and Cable/Conduit Connections**	**Note**
1A	PlantWeb housing (aluminum), 1/2-14 NPT	
1B	PlantWeb housing (aluminum), M20 x 1.5	
5A	Wireless PlantWeb housing (aluminum), 1/2-14 NPT	

Code	Wireless Options	Requires Pos 8 code X & Pos 9 code 5A. Also see next section for Hazardous Location Certification
Update Rate		
WA	User configurable update rate	
Operating Frequency and Protocol		
3	2.4 GHz DSSS, *Wireless*HART	
Omnidirectional Wireless Antenna		
WK	External antenna	
WM	Extended range, external antenna	
SmartPower™		
1(2)	Intrinsically s afe power module adapter (power module is separate)	
Code	**Other Options – none or multiple selections are possible**	
Hazardous Location Certification for FOUNDATION™ fieldbus		
IA	ATEX FISCO Intrinsic Safety	
IE	FM FISCO Intrinsically Safe	
IF	CSA FISCO Intrinsically Safe	
IG	IECEx FISCO Intrinsically Safe	
Hazardous Location Certification for Wireless		
I1	ATEX Intrinsic Safety	
I5	FM Intrinsically Safe	
I6	CSA Intrinsically Safe	
I7	IECEx Intrinsically Safe	
Other		
M5	PlantWeb LCD Display	
P1	Hydrostatic testing with certificate	
Q4	Calibration certificate	
Q8	Material Traceability Certification per EN 10204 3.1.B	
GE	M12, 4-pin, male connector (Eurofast)	
GM	A size Mini, 4-pin, male connector (Minifast)	
Model Code Example: 3051S - 1 C G 3A 2 G11 F 1A - IA Q4		

(1) Requires Pos 9 "Housing and Cable/Conduit Connections" code 5A and "Wireless Options".
(2) Long-Life Power Module must be shipped separately, order Part #00753-9220-0001.

5.6.2 Rosemount 3051S Liquid Level Pressure Transmitter

For density measurement of viscous liquids such as crude oil

Model (Pos 1)	Product Description	Note
3051SAL	Scalable Advanced Level Transmitter for Liquid Level Applications	
Code (Pos 2)	**Performance Class**	**Note**
2	Classic: 0.065% span accuracy, 100:1 rangedown, 5-year stability	
Code (Pos 3)	**Configuration Type**	**Note**
C	Liquid Level Transmitter	
Code (Pos 4)	**Pressure Module and Sensor Type**	**Note**
G	Coplanar module; Gage sensor	
Code (Pos 5)	**Pressure Range**	**Note**
3A	-393 to 1000 inH_2O (-0.98 to 2.5 bar)	1000 inH_2O <=> 25 mH_2O
Code (Pos 6)	**Tank Bus: Power and Communication**	**Note**
F	Bus powered 2-wire FOUNDATION™ fieldbus (IEC61158)	
X	Wireless(1)	
Code (Pos 7)	**Housing and Cable/Conduit Connections**	**Note**
1A	PlantWeb housing (aluminum), 1/2-14 NPT	
1B	PlantWeb housing (aluminum), M20 x 1.5	
5A	Wireless PlantWeb housing (aluminum), 1/2-14 NPT	
Code (Pos 8)	**Direct-mount Extension (between transmitter flange and seal)**	**Note**
10	No extension	
Code (Pos 9)	**Transmitter Reference Pressure Connection**	**Note**
20	316 L SST isolator with SST transmitter flange	
Code (Pos 10)	**Seal Fill Fluid**	**Note**
D	Silicone 200	-45 to 205 °C (-49 to 401 °F)
Code (Pos 11)	**Tank Connection**	**Note**
FF	Flush flanged seal	
Code (Pos 12)	**Tank Connection Size (High Side)**	**Note**
G	2 in. / DN50	
7	3 in	
Code (Pos 13)	**Flange Rating (High Side)**	**Note**
1	ANSI/ASME B16.5 Class 150	
2	ANSI/ASME B16.5 Class 300	
Code (Pos 14)	**Material: Isolating Diaphragm, Upper Housing and Flange**	**Note**
DA	316L SST, 316L SST, and flange in 316 SST	
Code (Pos 15)	**Flushing Connection Ring (lower housing)**	**Note**
A	316 SST	
0	None	

Code (Pos 16)	Flushing Connection Quantity & Size	Note
3	Two ¼-18 NPT	
0	None	
Code	**Wireless Options**	**Requires Pos 6 code X & Pos 7 code 5A. Also see next section for Hazardous Location Certification**
Update Rate		
WA	User configurable update rate	
Operating Frequency and Protocol		
3	2.4 GHz DSSS, *Wireless*HART	
Omnidirectional Wireless Antenna		
WK	External antenna	
WM	Extended range, external antenna	
SmartPower™		
1(2)	Adapter for power module (intrinsically safe power module is sold separately)	
Code	**Other Options – none or multiple selections are possible**	**Note**
Flushing Connection Ring Plugs		
SG	SST plug(s) for flushing connection(s)	
SH	SST drain/vent(s) for flushing connection(s)	
Seal Options: Material Certification		
ST	Wetted materials compliance to NACE MR0175/ISO 1516, MR0103	
Product Certifications for FOUNDATION™ fieldbus		
IA	ATEX FISCO Intrinsic Safety	
IE	FM FISCO Intrinsically Safe	
IF	CSA FISCO Intrinsically Safe	
IG	IECEx FISCO Intrinsic Safety	
Product Certifications for Wireless		
I1	ATEX Intrinsic Safety	
I5	FM Intrinsically Safe, Division 2	
I6	CSA Intrinsically Safe	
I7	IECEx Intrinsic Safety	
Other		
M5	PlantWeb LCD Display	
P1	Hydrostatic testing with cerrtificate	
Q4	Calibration certificate	
Q8	Material Traceability Certification per EN 10204 3.1.B	
GE	M12, 4-pin, male connector (Eurofast)	
GM	A size Mini, 4-pin, male connector (Minifast)	
Model Code Example: 3051SAL - 2 C G 3A F 1A 10 20 D FF G 1 DA 0 0 - IA Q4		

(1) Requires Pos 9 "Housing and Cable/Conduit Connections" code 5A and "Wireless Options".
(2) Long-Life Power Module must be shipped separately, order Part #00753-9220-0001.

6 Rosemount 2230 Graphical Field Display

Rosemount 2230 Graphical Field Display presents inventory tank gauging data such as level, temperature, and pressure. This back-lit userfriendly display is designed for tough environments, and can be installed in hazardous (Ex) areas, on the tank roof or foot. It is approved for legal custody transfer.

Rosemount 2230 can display data from devices connected to a 2410 tank hub for maximum 10 tanks.

The four softkeys allow you to navigate through the different menus to provide all tank data, directly in the field.

The 2230 display is powered by the FISCO Tankbus.

Rosemount 2230 with easily readable tank data presented on the back-lit display.

6.1 DIFFERENT VIEW OPTIONS

The menu system allows the user to:

- **Select View:** The preferred view is selected; Single Value, simultaneously display Two Values or Four Values. The single value view presents large-sized digits, 25 mm (1 in.) in height.
- Choose **Options:** Units, tanks (all/default/custom), variables to display, toggle time, and display language.
  For more information, see “Specification” on page 87.
- Select **Service**: To adjust LCD contrast, show custody transfer view, make a factory reset, or activate an LCD test feature.

6.2 INSTALLATION CONSIDERATIONS

The 2230 display can be installed either on the tank roof or at the foot of the tank for a flexible and convenient read-out of tank data.

The cabling can be daisy-chained via the 2230 terminals to other devices on the Tankbus.

A terminator is required at each end of the Tankbus to ensure the fieldbus network will have proper signal levels.

Generally, one is at the fieldbus power supply and the other terminator is in the last device in the network.

Rosemount 2230 has a built-in terminator which can be connected if required.

It is designed to be mounted on a plate, towards a wall or similar. The display is attached to the plate with four M4 screws. It is important to provide space for opening the lid.

The protecting lid prevents degradation of the LCD display due to sunlight exposure.

For more information, see the Rosemount 2230 Reference Manual (document number 300560EN).

6.2.1 Configuration

The 2230 display can easily be configured via the menu or by using TankMaster WinSetup. The user can choose how the data should be presented (Select View), and which variables to display (Options).
For more information, see the Rosemount 2230 Reference Manual (document number 300560EN) or the Rosemount TankMaster WinSetup Reference Manual (document number 300510EN).

6.3 SPECIFICATION

General	
Product	Rosemount 2230 Graphical Field Display
Toggle time	The time each value or set of values are shown on the display: 2-30 s
Language selection possibilities	English, French, German, Spanish, Italian, and Portuguese
Variables to display	Level, level rate, ullage, signal strength, volume (TOV), liquid average temperature, 1-16 spot temperature, vapor average temperature, ambient temperature, free water level, vapor pressure, liquid pressure, air pressure, observed density, and flow rate
Units to display	Level, free water level, and ullage: meter, millimeter, feet, or imperial 1/16 Level rate: meter/second, meter/hour, feet/second, or feet/hour Flow rate: meter^3/hour, liter/minute, feet^3/hour, barrel/hour, or US gallon/hour Total Observed Volume (TOV): meter^3, liters, feet^3, barrel, or US gallon Temperature: °F, °C, or °K. Pressure: psi, psiA, psiG, bar, barA, barG, atm, Pa, or kPa Density: kg/m^3, kg/liter, or °API Signal strength: mV
Hazardous location certifications and IS parameters	ATEX, FM-C, FM-US, and IECEx. For details, see “Product Certifications” on page 88
CE-mark	Complies with applicable EU directives (EMC, ATEX)
Ordinary location certification	Complies with FM 3810:2005 and CSA: C22.2 No. 1010.1
Electric	
Power supply	Powered by Rosemount 2410 Tank Hub (9.0-17.5 VDC, polarity insensitive)
IS parameters	See “Product Certifications” on page 88
Bus current draw	30 mA
Display type	Back-lit LCD monochrome display, 128x64 pixels
Start-up time	5 s
Update rate	New values to display once every two seconds
Response time	< 0.5 s from released button to new image
Cable entry (connection/glands)	Three entries, two M20×1.5 and one M25×1.5. Two metal plugs to seal any unused ports are included in the delivery. Optional: • ½ - 14 NPT conduit / cable adapter • Cable glands in metal (½ - 14 NPT) • 4-pin male Eurofast connector or A size Mini 4-pin male Minifast connector
Tankbus cabling	AWG 0.5-1.5 mm^2 (22-16), shielded twisted pairs
Built-in Tankbus terminator	Yes (to be connected if required)
Mechanical	
Housing material	Polyurethane-covered die-cast aluminum
Dimensions (width x height x depth)	150 x 120 x 78 mm (5.9 x 4.7 x 3.1 in.)
Weight	1.2 kg (2.6 lbs)
Environment	
Ambient temperature	-20 to 70 °C (-4 to 158 °F)
Storage temperature	-30 to 85 °C (-22 to 185 °F)
Humidity	0-100% relative humidity, non-condensing
Ingress protection	IP 66 and 67 (Nema 4)
Metrology sealing possibility	Yes
Write protect switch	Yes
Transient / built-in lightning protection	According to IEC 61000-4-5, level 1 kV line to ground. Complies with IEEE 587 Category B transient protection and IEEE 472 surge protection

6.4 PRODUCT CERTIFICATIONS

SPECIAL CONDITIONS FOR SAFE USE (X-MARKING), ATEX AND IECEX
SPECIAL CONDITIONS OF USE, FM-US AND FM-C
The non-metallic parts incorporated in the enclosure of this equipment may generate an ignition-capable level of electrostatic charge. Therefore particularly when it is used for applications that specifically require Division 1 and Group II, Zone 0 located equipment, the equipment shall not be installed in a location where the external conditions are conducive to the build-up of electrostatic charge on such surfaces. Additionally, the equipment shall only be cleaned with a damp cloth.

The enclosure contains aluminum and is considered to present a potential risk of ignition by impact or friction. Care must be taken during installation and use to prevent impact or friction.

The Model 2230 Graphical Field Display will not pass the 500 Vrms dielectric strength test and this must be taken into account during installation.

European ATEX Directive Information

EC-Type Examination Certificate Number: FM10ATEX0046X
Control Drawing: 9240 040-949

I1[(1)] Intrinsically Safe
FISCO Field Device (Fieldbus Terminals):
II 1 G CE 0575
Ex ia IIC T4 (-50 °C ≤ T_a ≤ +70 °C)
U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i=2.1 nF, L_i=1.1 µH

Entity (Fieldbus Terminals):
II 1 G CE 0575
Ex ia IIC T4 (-50 °C ≤ T_a ≤ +70 °C)
U_i=30 VDC, I_i=300 mA, P_i=1.3 W, C_i=2.1 nF, L_i=1.1 µH

US Factory Mutual (FM-US) Certification

Certificate of Compliance: 3037177
Control Drawing: 9240 040-949

I5[(1)] Intrinsically Safe
FISCO Field Device (Fieldbus Terminals):
Intrinsically safe for Class I, II, III Division 1, Groups A, B, C, D, E, F, and G
Temperature Class T4, Ambient Temperature Limits: -50 °C to +70 °C
Class 1 Zone 0 AEx ia IIC T4 (-50 °C ≤ T_a ≤ +70 °C)
U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i=2.1 nF, L_i=1.1 µH

Entity (Fieldbus Terminals):
Intrinsically safe for Class I, II, III Division 1, Groups A, B, C, D, E, F, and G
Temperature Class T4, Ambient Temperature Limits: -50 °C to +70 °C
Class 1 Zone 0 AEx ia IIC T4 (-50 °C ≤ T_a ≤ +70 °C)
U_i=30 VDC, I_i=300 mA, P_i=1.3 W, C_i=2.1 nF, L_i=1.1 µH

Canadian Factory Mutual (FM-C) Certification

Certificate of Compliance: 3037177C
Control Drawing: 9240 040-949

I6[(1)] Intrinsically Safe
FISCO Field Device (Fieldbus Terminals):
Intrinsically safe for Class I, II, III Division 1, Groups A, B, C, D, E, F, and G
Temperature Class T4, Ambient Temperature Limits: -50 °C to +70 °C
U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i=2.1 nF, L_i=1.1 µH

Entity (Fieldbus Terminals):
Intrinsically safe for Class I, II, III Division 1, Groups A, B, C, D, E, F, and G
Temperature Class T4, Ambient Temperature Limits: -50 °C to +70 °C
U_i=30 VDC, I_i=300 mA, P_i=1.3 W, C_i=2.1 nF, L_i=1.1 µH

IECEx Certification

Certificate of Conformity Number: IECEx FMG 10.0021X
Control Drawing: 9240 040-949

I7[(1)] Intrinsically Safe
FISCO Field Device (Fieldbus Terminals):
Ex ia IIC Ga T4 (-50 °C ≤ T_a ≤ +70 °C)
U_i=17.5 VDC, I_i=380 mA, P_i=5.32 W, C_i=2.1 nF, L_i=1.1 µH

Entity (Fieldbus Terminals):
Ex ia IIC Ga T4 (-50 °C ≤ T_a ≤ +70 °C)
U_i=30 VDC, I_i=300 mA, P_i=1.3 W, C_i=2.1 nF, L_i=1.1 µH

Combination Approvals

KA=I1+I5 (ATEX + FM-US)
KC=I1+I7 (ATEX +IECEx)
KD=I5+I6 (FM-US+FM-C)

For detailed information, refer to the Rosemount 2230 Reference Manual (document number 300560EN).

(1) Ordering Information code for Product Certificates, see page 90.

6.5 DIMENSIONAL DRAWINGS

Dimensions are in mm (inches)

6.6 ORDERING INFORMATION

Model (Pos 1)	Product Description	Note
2230	Graphical Field Display	
Code (Pos 2)	**Default Language**	**Note**
E	English	
S	Spanish	
G	German	
F	French	
P	Portuguese	
I	Italian	
C	Chinese	
Code (Pos 3)	**Tankbus: Power and Communication**	**Note**
F	Bus powered 2-wire FOUNDATION™ fieldbus (IEC 61158)	
Code (Pos 4)	**Software**	**Note**
S	Standard	
Code (Pos 5)	**Hazardous Location Certification**	**Note**
I1	ATEX Intrinsic Safety	
I2	Brazil Inmetro Intrinsic Safety	
I5	FM-US Intrinsic Safety	
I6	FM-Canada Intrinsic Safety	
I7	IECEx Intrinsic Safety	
KA	ATEX Intrinsic Safety+FM-US Intrinsic Safety	
KC	ATEX Intrinsic Safety+IECEx Intrinsic Safety	
KD	FM-US Intrinsic Safety+FM-Canada Intrinsic Safety	
NA	No Hazardous Location Certification	
Code (Pos 6)	**Custody Transfer Type Approval**	**Note**
R	OIML R85 E performance certification	
0	None	
Code (Pos 7)	**Housing**	**Note**
A	Standard enclosure	Polyurethane-covered aluminium. IP 66/67
Code (Pos 8)	**Cable/Conduit Connections**	**Note**
1	1/2–14 NPT and 3/4-14 NPT Adapters	Female thread. Includes 2 plugs and 3 adapters
2	M20 x 1.5 and M25 x 1.5	Female thread. Includes 2 plugs
G	Metal Cable Glands (M20 x 1.5 and M25 x 1.5)	Min. temperature -20˚C (-4˚F). ATEX / IECEx Exe approved. Includes 2 plugs
E	Eurofast Male, M20 x 1.5 and M25 x 1.5	3 plugs included
M	Minifast Male, M20 x 1.5 and M25 x 1.5	3 plugs included
Code (Pos 9)	**Mechanical Installation**	**Note**
W	Wall installation kit included	
P	Mounting Kit for both wall and pipe installation	1-2 in. vertical and horizontal pipes
Code	**Options – none or multiple selections are possible**	**Note**
ST	Engraved SST tag plate	Provide tag information in order
Model Code Example: 2230 - E F S I1 0 A 1 W - ST		

7 Rosemount 2410 Tank Hub

7.1 COMMUNICATION BETWEEN TANKS AND CONTROL ROOM

Rosemount 2410 is handling communication between the field devices and the control room, and it is available in two versions, for single or multiple tanks. It also feeds power to the units on the Tankbus.

The Rosemount 2410 Tank Hub handles communication from the field devices on the Tankbus to the control room.

7.1.1 Tankbus Communication

The Rosemount 2410 Tank Hub communicates with the devices on one or several tanks via the intrinsically safe Tankbus. The Tankbus complies with FISCO (Fieldbus Intrinsically Safe Concept) FOUNDATION™ fieldbus.

By using FISCO, there is no need to take entity parameters into considerations. This makes interconnection of devices easy.
In addition, the available power from a FISCO power supply is higher compared to a conventional entity power supply. This enables connection of more devices on the Tankbus.

7.1.2 Autoconfiguration of Tankbus

The 2410 supports autoconfiguration of the Tankbus which is a patented feature within the Raptor system. It acts as a FOUNDATION™ fieldbus master on the Tankbus, which means it identifies and auto-addresses the different field devices in the network, manages communication, and supervises the status of all connected devices.

7.1.3 Data Handling

Rosemount 2410 collects measurement values, such as level, temperature, and pressure.
It calculates average temperature, observed density and strapping table based volume.
Such data can be presented on the optional integrated back-lit display, a separate 2230 display, or be sent to TankMaster or a host system.

7.1.4 Data Security

All tank hubs have a software write protection function. In addition, the Rosemount 2410 with display option is equipped with a hardware write protection switch.

7.1.5 Control Room Communication

Rosemount 2410 has slots for two independent communication boards (primary and secondary fieldbus) for TRL2 Modbus, RS485 Modbus, emulation (pages 10, 94, and 102) and wireless communication (pages 8, 92, 94 and 102).

Emulation: The tank hub enables replacement of old mechanical/servo gauges with 5900S level gauges, or 5300/5400 transmitters using the existing tank openings, field cabling, and control system.

7.2 POWER SUPPLY WITH BUILT-IN CABLE TERMINATOR

Rosemount 2410 supplies power to the units on the Tankbus (see “Power Budget” on page 25). It is equipped with an integrated FISCO-certified IS barrier, has power conditioner functionality, and built-in electronics for bus termination.
A terminator is needed at each end of the Tankbus to ensure the fieldbus network will have proper signal levels. All these features enable easy setup and installation of a Raptor system.

7.3 OUTPUT RELAY FUNCTIONALITY

Rosemount 2410 can be equipped with two solid state relays which can be configured to be controlled by level, temperature, and water level (Non-SIL in “Ordering Information” on page 102). The output can be connected to an external system for alarm indication or process control. These relays are user configurable for normally open or closed operation.

A third relay is dedicated for SIL overfill functionality. It is part of a separate SIL alarm channel, which has an independent software function, controlling the relay and providing extensive diagnostics. This relay is activated both if the alarm level is reached and/or if a device malfunction occurs.

It operates in a normally closed mode, and the output can be connected to an emergency shut-down (ESD) system. The Raptor system is SIL 2 and SIL 3 certified for overfill prevention according to IEC 61508 Part 1-7.

7.4 ANALOG INPUT/OUTPUT

The 2410 Tank Hub can be ordered with:

- An analog input which can be used for connection of hybrid calculation pressure transmitters or
- An analog output for connection to a host system

7.5 WIRELESS COMMUNICATION

The Smart Wireless THUM™ Adapter acts as a wireless data link between the Tank Hub and a Smart Wireless Gateway in a *Wireless*HART field network. See “Wireless Connection of Tank Gauging Equipment” on page 9.

Smart Wireless THUM™ Adapter with integrated connection box.

7.6 INSTALLATION CONSIDERATIONS

This section includes some installation information. For complete guidance, see the Rosemount 2410 Reference Manual (document number 300530EN) and supporting installation drawings. If you miss information valid for your tank/application, you can also consult your local Rosemount Tank Gauging representative.

7.6.1 Mechanical Considerations

Rosemount 2410 can be mounted on a wall or a pipe with 33.4-60.3 mm (1-2 in.) diameter.

Installation options for the Rosemount 2410 Tank Hub.

The 2410 tank hub is normally installed at ground level close to the tank, but can also be installed on top of the tank to facilitate re-use of existing cabling.

7.6.2 Cable Connections

Typical cabling distances are:

- From the hub to the last device on the Tankbus, up to 500 m (1600 ft)

From the hub towards the control room, up to 4 km (2.5 miles) depending on which protocol is used.

Rosemount 2410 has two separate compartments, one for Non-IS and the other for IS cable connections.

Non-IS cable connections for communication towards the control room (non-SIL, and SIL terminal block layout).

The intrinsically safe side of the Rosemount 2410 connects to the Tankbus which communicates with field devices on the tank using FOUNDATION™ fieldbus. In addition it allows connection of devices using analog inputs/outputs. (Non-SIL, and SIL terminal block layout).

For more wiring information, see “Specification” on page 94, “Ordering Information” on page 102 or the Rosemount 2410 Reference Manual (document number 300530EN).

7.6.3 Configuration

Basic configuration of Rosemount 2410 and the connected devices can easily be done with TankMaster WinSetup.

The 2410 autoconfigures the Tankbus and its units. It also includes extensive built-in diagnostics.

7.7 SPECIFICATION

7.7.1 Technical Data for Rosemount 2410 Tank Hub

General	
Product	Rosemount 2410 Tank Hub
Single tank version	• Supports one 5900S 2-in-1 gauge or two radar level gauges, type 5300, 5400, or 5900S • Total Observed Volume (TOV) calculation with 100-point strapping table
Multiple tank version	For a 5300/5400/5900S system configuration: • The software supports 16 field devices and 10 tanks per hub • Maximum five gauges, type 5300 or 5400 per hub The actual number of tanks/instruments a hub supports depends on the configuration, which types of units are connected and how many. See “Power Budget” on page 25: • Hybrid calculations (mass and density) for up to three tanks • Total Observed Volume (TOV) calculation with 100-point strapping table for one tank
Examples of connected field devices	Radar Level Gauges (type 5900S(1), 5300, and 5400), Rosemount 2240S Multi-input Temperature Transmitter, Rosemount 644 Temperature Transmitter, Temperature / Water Level Sensors, Rosemount 3051S Scalable Pressure Transmitter, Rosemount 2230 Graphical Display
Start-up time	Less than 30 s
Legal custody transfer type approval	OIML R85:2008, and national certifications such as PTB, NMi etc
Hazardous location certifications	ATEX, FM-C, FM-US, IECEx, and national certifications. For details, see “Product Certifications” on page 98 and “Ordering Information” on page 102
Safety/overfill	SIL 2 and SIL 3 certified. See pages 3, 16, and 92. TÜV tested and WHG approved for overfill prevention. For national approvals, consult your local Rosemount Tank Gauging representative
CE-mark	Complies with applicable EU directives (EMC, ATEX)
Ordinary location certification	Complies with FM 3810:2005 and CSA: C22.2 No. 1010.1
Communication / Display / Configuration	
Tankbus	The intrinsically safe side of the Rosemount 2410 connects to the Tankbus which communicates with field devices on the tank using FOUNDATION™ fieldbus
Fieldbus	**Primary fieldbus:** Rosemount 2410 communicates with a host or a field communication unit via TRL2 Modbus, RS485 Modbus, Enraf or HART **Secondary fieldbus(2):** TRL2 Modbus, Enraf (other options available soon), *Wireless*HART for Smart Wireless THUM™ Adapter
Relay outputs	**SIL safety relay output(3):** One SIL 2/SIL 3 certified relay is available for overfill prevention. This non-intrinsically safe solid state relay is closed/energized during normal operation Maximum voltage and current: 260 VAC/VDC, 80 mA **Relay outputs (Non-SIL):** Maximum two relays, controlled by 10 independent virtual relay functions which can be configured for different tanks and process variables. The two non-intrinsically safe solid state relays are user configurable for normally energized or de-energized operation. Maximum voltage and current: 350 VAC/VDC, 80 mA

Analog input/output	**Analog Input** Maximum number of input channels: 1 Input Current range: 0 - 23 mA Configurable Min and Max alarm limits. Lift-off voltage (Passive IS and NON-IS): 10.5 V Max input voltage (Passive IS and NON-IS): 30 V Output voltage (Active): Non-IS: 22 ±2.0 V (open loop); 20.8 ±2.0 V@3,75 mA; 14.8 ±2.0 V @ 21.75 mA IS: 21 ±2.0 V (open loop); 18.8 ±2.0 V@3,75 mA; 8.2 ±2.0 V @ 21.75 mA See 'Product Certifications' for IS parameters HART Master: Maximum 5 HART Slave Devices (Passive). Maximum 3 HART Slave Devices (Active). **Analog Output** Maximum number of output channels: 1 Output range: 3.5-23 mA SW Configurable High and Low Alarm Limits. Separate SW Configurable Alarms for process failures and HW failure. Low voltage and invalid loop current detection. Lift-off voltage (Passive IS and NON-IS): 10.5 V Max input voltage (Passive IS and NON-IS): 30 V Output voltage (Active): Non-IS: 22 ±2.0 V (open loop); 22.8 ±2.0 V@3,75 mA; 16.8 ±2.0 V @ 21.75 mA IS: 21 ±2.0 V (open loop); 20.8 ±2.0 V@3,75 mA; 10.2 ±2.0 V @ 21.75 mA See Product Certifications for IS parameters HART slave configurable HART 5 or HART7[(4)] (HART 5 default)
Integral display output variables	The integral digital read-out display can toggle between: level, level rate, ullage, signal strength, volume (TOV), liquid average temperature, 1-16 spot temperature, vapor average temperature, ambient temperature, free water level, vapor pressure, liquid pressure, air pressure, observed density, reference density, and flow rate
Display output units[(5)]	Level, free water level, and ullage: meter, millimeter, feet, or imperial 1/16 Level rate: meter/second, meter/hour, feet/second, or feet/hour Flow rate: meter^3/hour, liter/minute, barrel/hour, or US gallon/hour Total Observed Volume (TOV): meter^3, liters, barrel, or US gallon Temperature: °F, °C, or °K Pressure: psi, psiA, psiG, bar, barA or barG, atm, Pa, or kPa Density: kg/m^3, °API, or 60/60DegF Signal strength: mV
Configuration tools	Rosemount TankMaster
Autoconfiguration support	Yes (Tankbus addressing)
Electric	
Power supply (nominal values)	24-48 VDC or 48-240 VAC, 50/60 Hz
Power consumption	Max. 20 W depending on configuration
Cable entry (connection/glands)	Non-IS side: Two ½ - 14 NPT and Two ¾-14 NPT entries for cable glands or conduits IS side: Two ½ - 14 NPT entries for cable glands or conduits Three metal plugs to seal any unused ports are included in the delivery. Optional: • M20 x 1.5 and M25 x 1.5 conduit / cable adapter • Cable glands in metal (½ - 14 NPT and ¾-14 NPT) • 4-pin male Eurofast connector or A size Mini 4-pin male Minifast connector
Tankbus cabling	0.5-1.5 mm^2 (AWG 22-16), twisted shielded pairs
Power and relay cabling	0.5-2.5 mm^2 (AWG 22-14), twisted shielded pairs
Maximum Tankbus cable lengths	Depends on cable. See “Tankbus Cable Requirements” for FISCO cable parameters, and “Re-use of Existing Cabling” on page 26
Built-in Tankbus terminator	Yes (to be disconnected if required)

Mechanical	
Housing material	Polyurethane-covered die-cast aluminum
Installation	Can be installed on a 33.4-60.3 mm (1-2 in.) diameter pipe or wall
Dimensions	See “Dimensional Drawings” on page 101
Weight	4.7 kg (10.4 lbs)
Environment	
Ambient temperature	-40 to 70 °C (-40 to 158 °F). Minimum start-up temperature is -50 °C (-58 °F). With LCD display: -25 to 70 °C (-13 to 158 °F)
Storage temperature	-50 to 85 °C (-58 to 185 °F) With LCD display: -40 to 85 °C (-40 to 185 °F)
Humidity	0 - 100% relative humidity
Ingress protection	IP 66 and IP 67 (Nema 4X)
Metrology sealing possibility	Yes
Write protect switch	Yes
Transient / built-in lightning protection	According to IEC 61000-4-5, level 4 kV line to ground. Complies with IEEE 587 Category B transient protection and IEEE 472 surge protection

(1) One Rosemount 5900S with 2-in-1 solution or maximum two Rosemount 5900S gauges installed on separate tanks can be connected to one tank hub. If two Rosemount 5900S gauges are installed on the same tank, two separate tank hubs are required.
(2) Not available with SIL option.
(3) Can not be combined with a secondary fieldbus.
(4) HCF registration is pending.
(5) Density, mass, and more volume parameters are calculated in Rosemount TankMaster (GOV, GSV, NSV, WIA/WIV).

Guiding Matrix for Primary and Secondary Bus options and SIL combination

Primary Bus	Secondary Bus	SIL
TRL2	Wireless	No
Enraf	Wireless	No
RS485	Wireless	Yes
Analog out	Wireless	No
TRL2	Analog out/Analog in	No
Enraf	Analog out/Analog in	No
RS485	Analog out/Analog in	Yes

7.7.2 Technical Data for Smart Wireless THUM™Assembly

For more information, see the Smart Wireless THUM™ Adapter Product Data Sheet (document number 00813-0100-4075)

General	
Product	Smart Wireless THUM™ Adapter. The THUM allows *Wireless*HART communication according to the IEC 62591 standard between the device it is connected to and the Smart Wireless Gateway. The THUM™ is integrated with a connection box
Transmission range	Application dependent. Consult factory
Hazardous location certifications	FM, CSA and ATEX (see “Ordering Information” on page 102) and the Smart Wireless THUM™ Product Data Sheet (document number 00813-0100-4075)
CE-mark	Complies with applicable directives (EMC, ATEX)
Ordinary location certification	Meets requirements
Telecommunication compliance	Yes (often national wireless device requirements regarding the use of RF spectrum)
Communication	
Communication protocol	IEC 62591 (*Wireless*HART)
Radio characteristics	• Standard IEEE 802.15.4 radio • 2.4 GHz ISM band sliced into 16 radio-channels • Continually “hop” across channels to avoid interference and increase reliability • Direct sequence spread spectrum (DSSS) delivers high reliability in challenging radio environment
Update rate	User selectable, 8 seconds to 60 minutes
Electric	
Power supply	Powered by Rosemount 2410 tank hub
Output cabling	Shielded twisted pair wiring, 0.5-2.5 mm^2 (AWG 22-14). Maximum cable length depends on cable characteristics
IS parameters	U_i=30 V, I_i=200 mA, P_i=1.0 W, C_i=L_i=0
Mechanical	
Housing / enclosure	Polyurethane painted, low-copper aluminum housing
Installation	The THUM can be installed on a vertical or horizontal 1 to 2-in. pipe, away from the Tank Hub at the best possible tank roof position. It should be positioned approximately 2 m (6 ft) or more from any large structure or conductive surface.
Dimensions	See “Dimensional Drawings” on page 101
Antenna	Poly-butadine terephthalate (PBT) / polycarbonate (PC) integrated omnidirectional antenna
Weight	Connection box and THUM adapter: 2.0 kg (4.4 lbs.)
Environment	
Ambient temperature	-40 to 85 °C (-40 to 185 °F)
Storage temperature	-40 to 85 °C (-40 to 185 °F)
Humidity	0 - 100% relative humidity
Ingress protection	IP 66 and NEMA 4X
Electromagnetic compatibility (EMC)	Meets all relevant requirements of EN 61326-1 (2006) and (2004/108/EC). The THUM™ and tank hub should be installed with shielded wiring
Approvals	FCC part 15, R&TTE (99/5/EC), and IC (RSS210). See above for hazardous location certifications.

7.8 PRODUCT CERTIFICATIONS

OIML R85:2008

The OIML metrology certificate, issued by the SP Technical Research Institute of Sweden, covers the Raptor Tank Gauging system, including the level gauges equipped with different antennas.

Certificate number is R85/2008-SE-11.01.

SIL Certification

The SIL safety certificate, issued by exida in Switzerland, includes the SIL alarm channel within the 5900S radar level gauge and the 2410 Tank Hub. Both units are SIL 2 and SIL 3 capable according to IEC 61508, parts 1-7.

Certificate number is Rosemount 091243 P0017 C001

German WHG Certification

The certificate for the 5900S radar level gauge and the 2410 Tank Hub is issued by DIBt (Deutsches Institut für Bautechnik) according to the German WHG regulations for overfill prevention. It is based on technical evaluation and testing conducted by TÜV NORD CERT GmbH.
Certificate number is Z-65.16-500.

7.8.1 Hazardous Location Certifications for Rosemount 2410

European ATEX Directive Information

EC-Type Examination Certificate Number: FM10ATEX0012

Control Drawing: 9240040-901

E1(1) Flameproof with Intrinsically Safe Output

FISCO Power Supply:

II 2(2) G

Ex de [ib] IIB T4 (-50 °C≤T_a≤+70 °C)
U_o=15 VDC, I_o=354 mA, P_o=5.32 W
U_m=250 VDC

HART/4-20 mA Entity IS I/O Option:

Active Current Loop:

II 2(1) G

Ex de [ia IIC] IIB T4 (-50 °C<T_a<+70 °C)
U_o=23.1 VDC, I_o=95.3 mA, P_o=550 mW
Group IIC: C_o≤0.14 µF, L_o≤3.9 mH
Group IIB: C_o≤1.0 µF, L_o≤15 mH
Group IIA: C_o≤3.67 µF, L_o≤33 mH

Passive Current Loop:

II 2(2) G

Ex de [ib IIC] IIB T4 (-50 °C<T_a<+70 °C)
U_i=30.0 VDC, I_i=300 mA, C_i=0 µF, L_i=0 mH

US Factory Mutual (FM-US) Certification

Certificate of Compliance: 3035492

Control Drawing: 9240040-901

E5(1) Explosionproof with Intrinsically Safe Output

Temperature Class T4
Ambient Temperature Limits -50 °C to +70 °C

FISCO Power Supply:

Explosion proof Class I, Division 1, Groups C, and D
Dust-ignitionproof Class II and III, Division 1, Groups E, F, and G

Associated Intrinsically Safe Class I, Division 1, Groups C and D

Class I Zone 1 AEx de[ib] IIB
U_o=15 VDC, I_o=354 mA, P_o=5.32 W

HART/4-20 mA Entity IS I/O Option:

Active Current Loop:

XP-AIS CL I, DIV. 1 GP C & D

AEx de[ia IIC] IIB

U_o = 23.1 VDC, I_o = 95.3 mA, P_o = 550 mW

Group IIC: Co≤0.14 µF, Lo≤3.9 mH

Group C, IIB: Co≤1.0 µF, Lo≤15 mH

Group D, IIA: Co≤3.67 µF, Lo≤33 mH

Passive Current Loop:

AEx de[ib IIC] IIB

U_i = 30.0 VDC, I_i = 300 mA, C_i = 0 µF, L_i = 0 mH

(1) Ordering Information code for Product Certificates, see page 103.

Canadian Factory Mutual (FM-C) Certification

Certificate of Compliance: 3035492C
Control Drawing: 9240040-901

E6[1] Explosionproof with Intrinsically Safe Output
Temperature Class T4
Ambient Temperature Limits -50 °C to +70 °C
FISCO Power Supply:
Explosion proof Class I, Division 1, Groups C, and D
Dust-ignitionproof Class II and III, Division 1, Groups E, F, and G
Associated Intrinsically Safe Class I, Division 1, Groups C and D
Class I Zone 1 Ex de[ib] IIB
U_o=15 VDC, I_o=354 mA, P_o=5.32 W
HART/4-20 mA Entity IS I/O Option:
Active Current Loop:
XP-AIS CL I, DIV. 1 GP C & D
Ex de[ia IIC] IIB
U_o = 23.1 VDC, I_o = 95.3 mA, P_o = 550 mW
Group IIC: Co≤0.14 µF, Lo≤3.9 mH
Group C, IIB: Co≤1.0 µF, Lo≤15 mH
Group D, IIA: Co≤3.67 µF, Lo≤33 mH
Passive Current Loop:
Ex de[ib IIC] IIB
U_i = 30.0 VDC, I_i = 300 mA, C_i = 0 µF, L_i = 0 mH

IECEx Certification

Certificate of Conformity Number: IECEx FMG 10.0005
Control Drawing: 9240040-901

E7[1] Flameproof with Intrinsically Safe Output (FISCO)
FISCO Power Supply:
Ex de[ib] IIB Gb T4 (-50 °C≤T_a≤+70 °C)
U_o=15 VDC, I_o=354 mA, P_o=5.32 W
U_m=250 VDC
HART/4-20 mA Entity IS I/O Option:
Active Current Loop:
Ex de [ia IIC Ga] IIB Gb T4 (-50 °C<T_a<+70 °C)
U_o=23.1 VDC, I_o=95.3 mA, P_o=550 mW
Group IIC: C_o≤0.14 µF, L_o≤3.9 mH
Group IIB: C_o≤1.0 µF, L_o≤15 mH
Group IIA: C_o≤3.67 µF, L_o≤33 mH
Passive Current Loop:
Ex de [ib IIC Gb] IIB Gb T4 (-50 °C<T_a<+70 °C)
U_i=30.0 VDC, I_i=300 mA, C_i=0 µF, L_i=0 mH

Combination Approvals

K1=E1+E5 (ATEX + FM-US)
K3=E1+E7 (ATEX +IECEx)
K4=E5+E6 (FM-US+FM-C)

For more information on product certificates, refer to the Rosemount 2410 Reference Manual (document number 300530EN).

7.8.2 Hazardous Location Certifications for Smart Wireless THUM™

SPECIAL CONDITIONS FOR SAFE USE (X), ATEX & IECEX

The surface resistivity of the antenna is greater than one gigaohm. To avoid electrostatic charge build-up, it must not be rubbed or cleaned with solvents or a dry cloth.
The enclosure is made of aluminium alloy and given a protective polyurethane paint finish; however, care should be taken to protect it from impact or abrasion if located in a zone 0.

European Directive Information

The EC declaration of conformity for all applicable European directives for this product can be found at www.rosemount.com. A hard copy may be obtained by contacting an Emerson Process Management representative.

ATEX DIRECTIVE (94/9/EC)

Emerson Process Management complies with the ATEX Directive.

ELECTROMAGNETIC COMPATIBILITY (EMC) (2004/108/EC)

Emerson Process Management complies with the EMC directive.

RADIO AND TELECOMMUNICATIONS TERMINAL EQUIPMENT DIRECTIVE (R&TTE) (1999/5/EC)

Emerson Process Management complies with the R&TTE directive.

Telecommunication Compliance

All wireless devices require certification to ensure that they adhere to regulations regarding the use of the RF spectrum. Nearly every country requires this type of product certification. Emerson is working with governmental agencies around the world to supply fully compliant products and remove the risk of violating country directives or laws governing wireless device usage.

FCC and IC

This device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions: This device may not cause harmful interference. This device must accept any interference received, including interference that may cause undesired operation.This device must be installed to ensure a minimum antenna separation distance of 20 cm (8 in.) from all persons.

Ordinary Location Certification for FM

As standard, the transmitter has been examined and tested to determine that the design meets basic electrical, mechanical, and fire protection requirements by FM, a nationally recognized testing laboratory (NRTL) as accredited by the Federal Occupational Safety and Health Administration (OSHA).

European ATEX Directive Information

I1 ATEX Intrinsic Safety

Certificate No.: Baseefa09ATEX0125X Ex II 1G
Ex ia IIC T4 (-50 °C ≤ T_{amb} ≤ +70 °C)
IP66. U_i = 30 V, L_i = 200 mA, P_i = 1.0 W, C_i = 0, L_i = 0
CE 1180

N1 ATEX Type n

Certificate No.: Baseefa09ATEX0131 Ex II 3G
Ex na IIC T4 (-50 °C ≤ T_{amb} ≤ +70 °C)
IP66. U_i = 45 Vdc max.
CE 1180

Factory Mutual (FM) Approvals

I5 FM Intrinsic Safety and Non-incendive

Intrinsically Safe for Class I/II/III, Division 1, Groups A, B, C, D, E, F, and G.
Zone Marking: Class I, Zone 0, AEx ia IIC
Temperature Codes T4 (-50 °C ≤ T_{amb} ≤ +70 °C)
Non-incendive for Class I, Division 2, Groups A, B, C, and D.
Intrinsically safe and non-incendive when installed according to Rosemount drawing 9240040-901
Enclosure Type 4X/IP66

CSA – Canadian Standards Association

I6 CSA Intrinsic Safety

Intrinsically Safe for Class I, Division 1, Groups A, B, C, and D.
T3C (-50 °C ≤ T_{amb} ≤ +70 °C)
Intrinsically safe when installed according to Rosemount drawing 9240040-901
Suitable for Class I, Division 2, Groups A, B, C, and D

IECEx Certifications

I7 IECEx Intrinsic Safety

Certificate No.: IECEx BAS 09.0050X
Ex ia IIC T4 (-50 °C ≤ T_{amb} ≤ +70 °C)
IP66. U_i = 30 V, L_i = 200 mA, P_i = 1.0 W, C_i = 0, L_i = 0

N7 IECEx Type n

Certificate No.: IECEx BAS 09.0058
Ex na IIC T4 (-50 °C ≤ T_{amb} ≤ +70 °C)
U_i =45 Vdc max. IP66

INMETRO Certifications

I2 INMETRO Intrinsic Safety

BR-Ex ia IIC T4 (-50 °C ≤ T_{amb} ≤ +70 °C) Ga

N2 INMETRO Type n

BR-Ex na IIC T4 Gc(-50 °C ≤ T_{amb} ≤ +70 °C)

China (NEPSI) Certifications

I3 China (NEPSI) Intrinsic Safety

Ex ia IIC T4

CCoE Certifications

IW Intrinsic Safety

Ex ia IIC T4

KOSHA Certifications

IP Intrinsic Safety

Ex ia IIC T4

GOST Certifications

IM Intrinsically Safe

Ex ia IIC T4 (-50 °C ≤ T_{amb} ≤ +70 °C)
Ex na IIC T4 (-50 °C ≤ T_{amb} ≤ +70 °C)
IP66

For more or updated information, see the Smart Wireless THUM™ Adapter product data sheet (document number 00813-0100-4075)

7.9 DIMENSIONAL DRAWINGS

Dimensions are in mm (inches)

7.9.1 2410 Dimensions

7.9.2 Smart Wireless THUM™ Dimensions

7.10 ORDERING INFORMATION

7.10.1 Rosemount 2410 Tank Hub

Model (Pos 1)	Product Description	Note
2410	Tank Hub	
Code (Pos 2)	**Tankbus: Number of Tanks**	**Note**
S	Single tank	
M	Multiple tanks	Maximum 5 Rosemount 5300/5400 transmitters can be connected to one Tank Hub
Code (Pos 3)	**Tankbus: Power and Communication**	**Note**
F	Intrinsically safe FOUNDATION™ fieldbus (IEC 61158) power supply	
Code (Pos 4)	**Primary Fieldbus**	**Note**
R	TRL2 Modbus (standard)	
4	RS485 Modbus	
E	Enraf Bi-phase Mark GPU(1)	
Code (Pos 5)	**Secondary Fieldbus**	**Note**
R	TRL2 Modbus (standard)(2)	
E	Enraf Bi-phase Mark GPU	
W	*Wireless*HART (IEC 62591) connectivity (IS)(3)	
A	Analog Output 4-20 mA/HART, active (Non-IS)	For connection to a 3rd party system. Integrated power-supply. Maximum Tankbus current is reduced to 200 mA
C	Analog Output 4-20 mA/HART, active (IS)	For connection to a 3rd party system. Integrated power-supply. Maximum Tankbus current is reduced to 200 mA
B	Analog Output 4-20 mA/HART, passive (Non-IS)	For connection to a 3rd party system
D	Analog Output 4-20 mA/HART, passive (IS)	For connection to a 3rd party system
6	Analog Input 4-20 mA/HART, active (Non-IS)	For connection of a 3rd party instrument. Integrated power-supply. Max Tankbus current reduced to 200 mA
8	Analog Input 4-20 mA/HART, active (IS)	For connection of a 3rd party instrument. Integrated power-supply. Max Tankbus current reduced to 200 mA
7	Analog Input 4-20 mA/HART, passive (Non-IS)	For connection of a 3rd party instrument
9	Analog Input 4-20 mA/HART, passive (IS)	For connection of a 3rd party instrument
F	None, but ready for upgrade of secondary bus(4)	
0	None	
Code (Pos 6)	**Relay Output (SIS/SIL)**	**Note**
3	SIL 3-certified output as per IEC 61508(5)	Requires Rosemount 5900S with Safety Certification (SIS), code 3
2	SIL 2-certified output as per IEC 61508(5)	Requires Rosemount 5900S with Safety Certification (SIS), code 2
F	None, but ready for upgrade of safety certification (SIS)(6)	
0	None	
Code (Pos 7)	**Relay Output (Non-SIS/SIL)**	**Note**
2	Two (2xSPST)	
1	One (1xSPST)	
F	None. Ready for upgrade of Relay Output (Non-SIS/SIL)	
0	None	

Code (Pos 8)	Integral Display	Note
1	LCD	
0	None	
Code (Pos 9)	**Power Supply**	**Note**
P	Extended input range: 48-240 VAC at 50/60 Hz, and 24-48 VDC	
Code (Pos 10)	**Software**	**Note**
S	Standard	
Code (Pos 11)	**Hazardous Location Certification**	**Note**
E1	ATEX Flameproof with intrinsically safe output	
E2	Brazil Inmetro Flameproof	
E5	FM-US Explosionproof with intrinsically safe output	
E6	FM-Canada Explosionproof with intrinsically safe output	
E7	IECEx Flameproof with intrinsically safe output	
K1	ATEX Flameproof + FM-US Explosionproof	
K3	ATEX Flameproof + IECEx Flameproof	
K4	FM-US Explosionproof + FM-Canada Explosionproof	
NA	No hazardous location certification	
Code (Pos 12)	**Custody Transfer Type Approval**	**Note**
R	OIML R85 E(7) 2008 performance certification	
C	PTB Eich	Approval plate and sealing kit included
0	None	
Code (Pos 13)	**Housing**	**Note**
A	Standard enclosure	Polyurethane-covered aluminium. IP 66/67
Code (Pos 14)	**Cable/Conduit Connections**	**Note**
1	½–14 NPT and ¾-14 NPT	Female thread. Includes 3 plugs
2	M20 x1.5 and M25x1.5 adapters	Female thread. Includes 3 plugs, and 3 adapters
G	Metal cable glands (½-14 and ¾-14 NPT)	Min. temperature -20 ˚C (-4 ˚F). ATEX / IECEx Exe approved. Includes 3 plugs, and 3 glands
E	Eurofast male, ½–14 NPT and ¾-14 NPT	Includes 3 plugs
M	Minifast male, ½–14 NPT and ¾-14 NPT	Includes 3 plugs
Code (Pos 15)	**Mechanical Installation**	**Note**
P	Mounting kit for both wall and pipe installation	1-2 in. vertical or horizontal pipes
W	Mounting kit for wall installation	
0	None	
Code	**Options – none or multiple selections are possible**	**Note**
QT	IEC 61508 certificate and FMEDA-data(8)	
ST	Engraved SST tag plate	
U1	TÜV/DIBt WHG Approval for Overfill protection	
Model Code Example: 2410 - S F R 0 3 2 1 P S E1 R A 1 P - ST		

(1) Requires Secondary Fieldbus (Pos 5), code A-F, W, 0, 6-9.
(2) Requires Primary Fieldbus (Pos 4) code R or 4.
(3) Requires a separate Smart Wireless THUM Adapter (not included, to be ordered as a separate item). Maximum Tankbus (FF) current is reduced to 200 mA.
(4) Requires Relay Output (Pos 6) code 0 or F.
(5) Requires Secondary Fieldbus (Pos 5), code 0 and Tankbus (Pos 2) code S, or Primary Fieldbus (Pos 4) code 4 and Secondary Fieldbus (Pos 5) code W, C, D, 8 or 9 and Tankbus (Pos 2) code S.
(6) Requires Secondary Fieldbus (Pos 5), code 0 or F and Tankbus (Pos 2) code S.
(7) Requires a Rosemount 5900S gauge with the corresponding custody transfer approval. A Rosemount 2230 display or TankMaster is required for an approved read-out.
(8) Requires Relay Output (Pos 6) code 2 or 3 (SIL 3 or SIL 2).

7.10.2 Smart Wireless THUM™ Adapter

Model (Pos 1)	Product Description	Note
775	Smart Wireless THUM Adapter	Requires THUM Connection Box (Pos 11+)
Code (Pos 2)	**Output**	**Note**
X	Wireless	
Code (Pos 3)	**Housing**	**Note**
D	Aluminum	
Code (Pos 4)	**Mounting Connection**	**Note**
2	M20 conduit adapter	
Code (Pos 5)	**Plantweb Functionality**	**Note**
1	HART data	
Code (Pos 6)	**Certification**	**Note**
NA	No approval	
I1	ATEX intrinsically safe	
I2	INMETRO intrinsically safe	
I3	NEPSI	
I4	TIIS	
I5	FM intrinsically safe, non-incendive	
I6	CSA intrinsically safe	
I7	IECEx intrinsically safe	
N1	ATEX Type n	
N2	INMETRO Type n	
N7	IECEx Type n	
IP	KOSHA intrinsically safe	
IW	CCOE intrinsically safe	
IM	GOST intrinsically safe	
Code (Pos 7)	**Wireless Transmit Rate**	**Note**
WA	User configurable burst rate	
Code (Pos 8)	**Operating Frequency and Protocol**	**Note**
3	2.4 GHz DSSS, IEC 62591 (*Wireless*HART)	
Code (Pos 9)	**Wireless Antenna**	**Note**
WK	Omnidirectional integral antenna	
Code (Pos 10)	**SmartPower™**	**Note**
9	Power scavenging	

7.10.3 Smart Wireless Tank Gauging Options

Code (Pos 11)	Device Connection	Note
T	2410 Tank Hub	
Code (Pos 12)	**Cable / Conduit Connection**	**Note**
0	None	
J	Metal cable gland M20x1.5	Min. temperature -20 ˚C (-4 ˚F). ATEX / IECEx
F	½ NPT Adapter (female thread)	
Code	**Options – none or multiple selections are possible**	**Note**
PT	Printed tag for unit identification	
Model Code Example: 775 - X D 2 1 I1 WA 3 WK 9 - T F PT		

8 Rosemount 2160 Field Communication Unit

The Rosemount 2160 Field Communication Unit is a data concentrator that continuously polls data from Raptor field devices via the Rosemount 2410 Tank Hub. Rosemount 2160 also supports connection of older Rosemount Tank Gauging instruments such as TankRadar Pro and TankRadar Rex gauges.

The 2160 stores data in a buffer memory. Whenever a request is received from a host, the field communication unit can immediately send data from the updated buffer memory.

Rosemount 2160 acts as a slave on the group bus and as a master on the fieldbus. The unit has six communication ports. These ports can be individually configured as either group bus ports or as fieldbus ports according to one of the alternatives below:

Alternative	Number of fieldbus ports	Number of group bus ports
1(1)	4	2
2	3	3
3	2	4

(1) Standard

An interface board can be connected for each communication port. These boards can be ordered either for TRL2 bus or RS485 communication. Two group bus ports can also be configured as RS232.

Each radar level gauge / Rosemount 2410 Tank Hub has an individual address on the fieldbus.

Rosemount 2160 Field Communication Unit.

8.1 REDUNDANT FIELD COMMUNICATION UNITS

Two field communication units can be connected in parallel with one unit operational and one working as “hot” redundant backup for the other. The units are software monitored and the backup unit is automatically triggered and activated in case of a primary unit failure.

In addition, buddy mode functionality enables use of redundant fieldbus ports.

For more information on redundancy, see page 13.

8.2 INSTALLATION CONSIDERATIONS

The field communication unit is wall-mounted with four screws.

8.3 SPECIFICATION

General	
Product	Rosemount 2160 Field Communication Unit
Hazardous location certifications	None
CE-mark	Complies with applicable EU directives (EMC, ATEX and LVD)
Configuration / Communication	
Number of tanks per field communication unit	Max 32
Communication	Fieldbus ports: TRL2 bus, and RS485 Recommended number of tank hubs per fieldbus port: Maximum 8 if TRL2, and 32 if RS485 Group bus ports: TRL2 Bus, RS232 or RS485 Group bus baud rate: Programmable up to 19 200 Baud Host communication protocol: Modbus RTU
Electric	
Power supply	115 or 230 VAC, +10% to -15%, 50-60 Hz, max. 10 W
Cable entry (connection/glands)	Seven M20 x 1.5 entries for cable glands and conduits (plastic glands included in the delivery).
Mechanical	
Dimensions	See page 105
Weight	4.5 kg (9.9 lbs)
Environment	
Ambient operating temperature	-40 to 70 °C (-40 to 158 °F)
Ingress protection	IP 65
Write protect switch	Yes

8.4 ORDERING INFORMATION

Model (Pos 1)	Product Description	Note
60	Field Communication Unit	
Code (Pos 2)	**Power Supply**	**Note**
1	115 VAC	
2	230 VAC	
Code (Pos 3)	**Port 1**	**Note**
G1	Group bus, TRL2 bus	
G3	Group bus, RS485 bus	
G5	Group bus, RS232 bus	
Code (Pos 4)	**Port 2**	**Note**
G1	Group bus, TRL2 bus	
G3	Group bus, RS485 bus	
G5	Group bus, RS232 bus	
Code (Pos 5)	**Port 3**	**Note**
F1	Fieldbus, TRL2 bus	
Code (Pos 6)	**Port 4**	**Note**
F1	Fieldbus, TRL2 bus	All
Code (Pos 7)	**Port 5**	**Note**
F1	Fieldbus, TRL2 bus	
G1	Group bus, TRL2 bus	
G3	Group bus, RS485 bus	
Code (Pos 8)	**Port 6**	**Note**
F1	Fieldbus, TRL2 bus	
G1	Group bus, TRL2 bus	
G3	Group bus, RS485 bus	
Code (Pos 9)	**Communication Protocol**	**Note**
S	TankMaster	
M	Modbus RTU to other host	Required for communication with host
Code (Pos 10)	**Extended Function**	**Note**
0	None	
R	Redundancy function	Requires a second FCU with redundancy
B	Buddy mode	Maximum 16 devices
Code (Pos 11)	**Special**	**Note**
0	None	
Code (Pos 12)	**Accessory**	**Note**
0	None	
W	Sun shelter kit	
Code (Pos 13)	**Sign**	**Note**
S	Standard sign	
X	Other specified in order	
Model Code Example: 2160 - 2 G1 G5 F1 F1 F1 F1 S R 0 W S		

9 Rosemount 2180 Field Bus Modem

The Rosemount 2180 Field Bus Modem is used for connecting a TankMaster HMI software PC to the TRL2 fieldbus. The modem is connected to the PC using either the RS232 or the USB interface.

It has LEDs indicating power on and communication.

There are front panel switches to set gain and termination, if required.

The modem is fitted on a standard DIN rail with the mounting kit included in all deliveries.

The field bus modem is delivered with cables for RS232 and USB connection. The USB cable also supplies power to the modem. A separate power supply cable (included in delivery) is only necessary for the RS232 option.

Rosemount 2180 Field Bus Modem.

The 2180 modem in a typical tank gauging system.

9.1 SPECIFICATION

General	
Product	Rosemount 2180 Field Bus Modem
Explosion protection	None
Power supply (only used for RS232)	AC/DC converter supplied (7-12 V, 50 mA)
Cable to PC	RS232: 3 m (10 ft). USB: 3 m (10 ft). Included in delivery
Fieldbus over-voltage protection	Galvanic insulation, and transient suppressors

9.2 ORDERING INFORMATION

Model	Product Description
2180	TRL2 Fieldbus Modem

10 Smart Wireless Gateway

The Smart Wireless Gateway is the network manager that connects self-organizing field networks with Rosemount TankMaster and any host system.

It provides easy configuration and management of such networks, and facilitates integration into control systems and data applications through serial and Ethernet connections.

A single gateway supports up to 100 nodes.

Each wireless node in the Raptor tank gauging system consists of a Rosemount 2410 Tank Hub connected to either a 5900S gauge, or one or several 5300 or 5400 transmitters. Rosemount 2410 is connected to mains power, and a Smart Wireless THUM™ Adapter.

The wireless transmission supports measurement data, such as level, temperature, water level and pressure.

Smart Wireless Gateway.

The self-organizing field network automatically finds the best way around any fixed or temporary obstacle. All wireless devices communicate with the host system through the Smart Wireless Gateway. A Rosemount tank gauging system can consist of both wired and wireless networks.

10.1 SELF-ORGANIZING FIELD NETWORKS

With excellent reliability and ease of use, self-organizing field networks are perfect in any environment. Multiple communication paths and automatic path configuration means there is no need for costly site surveys, saving you both time and money.

10.2 OPEN INTEGRATION

With a variety of options, the Smart Wireless Gateway gives you the freedom to choose the Smart Wireless Solutions best suited for your installation:

Using OPC or Modbus TCP allows flexible integration of your wireless field network with any host system.

The Smart Wireless Gateway supports Modbus RTU for integration into legacy host systems.

Every gateway comes with a web interface that provides easy network configuration.

10.3 LAYERED SECURITY KEEPS YOUR NETWORK SAFE

Emerson Process Management's layered approach to wireless network security ensures a protected network, and secure data transmissions via encryption, authentication, verification, anti-jamming and key management methods.

10.4 *WIRELESS*HART INDUSTRY STANDARD

The Smart Wireless Gateway is designed according to the IEC 62591 (*Wireless*HART) standard which has the following characteristics:

Self-Organizing, Adaptive Mesh Routing

- No wireless expertise required, since devices automatically find the best communication paths
- Network continuously monitors paths for degradation and repairs itself
- Adaptive behavior provides reliable, hands-off operation, simplifies network deployments, expansion and re-configuration
- Supports both star and mesh topologies

Self-Healing Network

- If an obstruction is introduced into the mesh network, devices will automatically find the best alternative communication path. This path will be created and the information will continue to flow.

Industry standard radio with channel hopping

- Standard IEEE 802.15.4 radios
- 2.4 GHz ISM band sliced into 16 radio channels
- Time synchronized channel hopping to avoid interference and increase reliability
- Direct sequence spread spectrum (DSSS) technology delivers high reliability in challenging radio environment

10.5 INSTALLATION CONSIDERATIONS

For optimal wireless coverage, the gateway remote antenna should be positioned as high as possible.

The gateway is recommended to be located in the tank area, where the maximum number of connections with wireless devices can be achieved. The gateway can be installed both indoors and outdoors. It is suitable for field installation in any Zone 2/Division 2, general purpose area and is NEMA 4x/IP65 rated.

Configuration

Nodes can identify a network, join it, and self-organize into dynamic communication paths. Configuration and management of self-organizing networks is easy.

The AMS Wireless Configurator is a tool which uses the power of Enhanced EDDL to assist in the setup and configuration of your Smart Wireless Field Devices and it is shipped with every Smart Wireless Gateway.

10.6 SPECIFICATION

See the Smart Wireless Gateway Product Data Sheet (00813-0200-4420) for complete information.

General	
Product	Smart Wireless Gateway
Power supply	10.5 - 30 VDC (500 mA start-up, 250 mA continuous)
Hazardous location certifications	ATEX, IECEx, FM, and CSA. See “Product Certifications” on page 113
Communication	
Isolated RS485	2-wire communication link for Modbus RTU multidrop connections Baud rate: 57600, 38400, 19200, or 9600 Protocol: Modbus RTU Wiring: 0.75 mm^2 (AWG 18), twisted shielded pairs. Wiring distance is approximately 1524 m (4000 ft.)
Ethernet	10/100base-TX Ethernet communication port Protocols: Modbus TCP, OPC, HART-IP, https (for Web Interface) Wiring: Cat5E shielded cable. Wiring distance 100 m (328 ft.)
Modbus	Supports Modbus RTU and Modbus TCP with 32-bit floating point values, integers, and scaled integers. Modbus Registers are user-specified
OPC	OPC server supports OPC DA v2, v3
Self-organizing Network	
Protocol	IEC 62591 (*Wireless*HART) standard, 2.4 - 2.5 GHz DSSS
Maximum network size	100 wireless devices at 8 s update rate, 50 wireless devices at 4 s update rate
Latency	100 devices: less than 10 s. 50 devices: less than 5 s
Supported device update rates	1 second. to 60 minutes (depends on the devices in the network)
Data reliability	>99 %
System Security	
Ethernet	Secure Sockets Layer (SSL)- enabled (default) TCP/IP communications
Smart Wireless Gateway access	Role-based Access Control (RBAC) including Administrator, Maintenance, Operator, and Executive. Administrator has complete control of the gateway and connections to host systems and the self-organizing network
Self-organizing network	AES-128 Encrypted *Wireless*HART, including individual session keys. Drag and Drop device provisioning, including unique join keys and white listing
Internal firewall	User Configurable TCP ports for communications protocols, including Enable/Disable and user specified port numbers. Inspects both incoming and outgoing packets
Mechanical	
Antenna	Integrated omnidirectional antenna (Optional remote mount omnidirectional antenna)
Material of construction	• Housing: Low-copper aluminum, NEMA 4X • Paint: Polyurethane • Cover Gasket: Silicone rubber • Antenna: PBT/PC integrated omnidirectional antenna
Weight	4.5 kg (10 lbs)
Environment	
Operating temperature	-40 to 65 °C (-40 to 149 °F)
Operating humidity	10 - 90% relative humidity
Radio frequency power output from antenna	Max. 10 mW (10 dBm) EIRP
EMC performance	Complies with EN61326-1:2006

10.7 PRODUCT CERTIFICATIONS

Approved Manufacturing Locations

Rosemount Inc. – Chanhassen, Minnesota, USA
Emerson Process Management GmbH & Co. - Karlstein, Germany
Emerson Process Management Asia Pacific Private Limited - Singapore
Beijing Rosemount Far East Instrument Co., Limited - Beijing, China

Telecommunication Compliance

All wireless devices require certification to ensure that they adhere to regulations regarding the use of the RF spectrum. Nearly every country requires this type of product certification. Emerson is working with governmental agencies around the world to supply fully compliant products and remove the risk of violating country directives or laws governing wireless device usage.

FCC and IC

This device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions. This device may not cause harmful interference. This device must accept any interference received, including interference that may cause undesired operation. This device must be installed to ensure a minimum antenna separation distance of 20 cm from all persons.

Ordinary Location Certification for FM

As standard, the Gateway has been examined and tested to determine that the design meets basic electrical, mechanical, and fire protection requirements by FM, a nationally recognized testing laboratory (NRTL) as accredited by the Federal Occupational Safety and Health Administration (OSHA).

North American Certifications

N5 FM Division 2, Non-Incendive
Certificate Number: 3028321

Nonincendive for Class I, Division 2, Groups A, B, C, and D.
Suitable for Class II, III, Division 1,
Groups E, F, and G; Indoors/outdoor locations;
Type 4X
Temperature Code: T4 (-40 °C < T_a < 60 °C)

Canadian Standards Association (CSA)

N6 CSA Division 2, Non-Incendive
Certificate Number: 1849337
Suitable for Class I, Division 2, Groups A, B, C, and D.
Dust Ignition-proof for Class II, Groups E, F, and G;
Suitable for Class III Hazardous Locations.;
Install per Rosemount drawing 01420-1011.
Temperature Code: T4 (-40 °C < T_a < 60 °C)
CSA Enclosure Type 4X

European Union Directive Information

The EC declaration of conformity for all applicable European directives for this product can be found on the Rosemount website at www.rosemount.com. A hard copy may be obtained by contacting your local sales representative.

ATEX Directive (94/9/EC)

Emerson Process Management complies with the ATEX Directive.

Electro Magnetic Compatibility (EMC) (2004/108/EC)

Emerson Process Management complies with the EMC Directive.

Radio and Telecommunications Terminal Equipment Directive (R&TTE)(99/5/EC)

Emerson Process Management complies with the R&TTE Directive

European Certification CE

N1 ATEX Type n
Certificate Number: Baseefa 07ATEX0056X
ATEX Marking: Ex II 3 G
Ex nA nL IIC T4 (-40 °C < T_a < 60 °C)

Special condition for safe use (X):

The surface resistivity of the antenna is greater than one gigaohm. To avoid electrostatic charge build-up, it must not be rubbed or cleaned with solvents or a dry cloth.

The Apparatus is not capable of withstanding the 500V insulation test required by Clause 9.4 of EN 60079-15: 2005. This must be taken into account when installing the apparatus.

ND ATEX Dust
Certificate Number: Baseefa 07ATEX0057
ATEX Marking: Ex II 3 G
Ex tD A 22 IP66 T135 (-40 °C < T_a < 60 °C)
Maximum working Voltage = 28V

N7 IECEx Type n
Certificate Number: IECEx BAS 07.0012X
Ex nA nL IIC T4 (-40 °C =< T_a <=60 °C)
Maximum working voltage = 28V

Special condition for safe use (X):

The surface resistivity of the antenna is greater than one gigaohm. To avoid electrostatic charge build-up, it must not be rubbed or cleaned with solvents or a dry cloth.

The Apparatus is not capable of withstanding the 500V insulation test required by Clause 9.4 of EN 60079-15: 2005. This must be taken into account when installing the apparatus.

NF IECEx Dust
Certification Number: IECEx BAS 07.0013
Ex tD A22 IP66 T135 (-40 °C < T_a < 60 °C)
Maximum working voltage = 28V

Combinations of Certifications

KD Combination of N5, N6, and N1.

10.8 DIMENSIONAL DRAWINGS

Dimensions are in mm (in)

Gateway with Remote Omni-antenna kit

The Remote Omni-Antenna kit includes sealant tape for remote antenna connection, as well as mounting brackets for the antenna, Lightning Arrestor, and the Smart Wireless Gateway.

Lightning protection is included on all the options. WL3 and WL4 provide lightning protection along with the ability to have the gateway mounted indoors, the antenna mounted outdoors, and the lightning arrestor mounted at the building egress.

****Note that the coaxial cables on the remote antenna options WL3 and WL4 are interchangeable for installation convenience.***

10.9 ORDERING INFORMATION

Model (Pos 1)	Product Description
1420	Smart Wireless Gateway
Code (Pos 2)	**Power Input**
A	24 VDC nominal (10.5-30 VDC)
Code (Pos 3)	**Ethernet Communications – Physical Connection**
1	Ethernet(1) (2)
2	Dual Ethernet(3) (4)
Code (Pos 4)	**Wireless Update Rate, Operating Frequency, and Protocol**
A3	User Configurable Update Rate, 2.4 GHz DSSS, *Wireless*HART
Code (Pos 5)	**Serial Communication**
N	None
A	Modbus RTU via RS485(5)
Code (Pos 6)	**Ethernet Communication – Data Protocols**
2	Webserver, Modbus TCP/IP, AMS Ready, HART-IP
4	Webserver, Modbus TCP/IP, AMS Ready, HART-IP, OPC(6)
5	DeltaV Ready(7)
8	Webserver, EtherNet/IP, AMS Ready, HART-IP
9	Webserver, EtherNet/IP, Modbus TCP/IP, AMS Ready, HART-IP
Code	**Options – none or multiple selections are possible**
	Product Certifications
N1	ATEX Type n
N3	China Type n
N4	TIIS Type n
N5	FM Division 2, Non-incendive
N6	CSA Division 2, Non-incendive
N7	IECEx Type n
ND	ATEX Dust
NF	IECEx Dust
KD	FM & CSA Division 2, Non-incendive and ATEX Type n
	Redundancy
RD	Gateway redundancy(8) (9) (10)
	Adapters
J1	M20 Conduit Adapter
J3	¾ NPT Conduit Adapter
	Antenna Options(11)
WL2	Remote Omni-antenna kit, 15.2 m (50 ft) cable, lightning arrestor
WL3	Remote Omni-antenna kit, 6.1 m (20 ft) and 9.1 m (30 ft) cables, lightning arrestor
WL4	Remote Omni-antenna kit, 3 m (10 ft) and 12.2 m (40 ft) cables, lightning arrestor
Model Code Example: 1420 - A 1 A3 A 4 - KD	

(1) Single active 10/100 baseT Ethernet port with RJ45 connector.
(2) Additional ports disabled.
(3) Dual active 10/100 baseT Ethernet ports with RJ45 connectors.
(4) Multiple active ports have separate IP addresses, firewall isolation, and no packet forwarding.
(5) Convertible to RS232 via adapter.
(6) Required for TankMaster.
(7) Includes Webserver, Modbus TCP/IP, AMS Ready, OPC.
(8) Requires Pos 3 "Ethernet Communication - Physical Connection" code 2 (dual Ethernet).
(9) Not available with Pos 6 "Ethernet Communication - Data Protocol" code 5 (DeltaV ready).
(10) Not available with Ethernet/IP option codes 8 and 9.
(11) The WL2-WL4 options require minor assembly.

11 Rosemount 5300 Series Radar Level Transmitter

Rosemount 5300 is a premium 2-wire guided wave radar transmitter for level measurements on liquids, to be used in a wide range of medium accuracy applications(1) under various tank conditions. The measurement is unaffected by most liquid property changes, such as density etc.

Rosemount 5300 Series for tank gauging applications includes:

- Rosemount 5301 for liquid level measurements
- Rosemount 5302 for liquid level and interface measurements

Rosemount 5300 is well suited for LPG bullets and other small tanks.

5300 is a good choice for underground tanks with limited installation space.

5300 measures the distance to the surface of the product in the tank. Using tank distances stored locally in the memory of the gauge, it calculates the level of the liquid's surface. The level value is communicated on the Tankbus via the 2410 tank hub to TankMaster or other host systems.

A Rosemount 5300 transmitter consists of a transmitter housing, a tank connection and a probe. Probe and tank connection are the only parts in contact with the tank atmosphere. 5300 is based on a modular design, which means there is no matching between probe styles and transmitter housing. Any probe can be used with any transmitter housing, giving full flexibility.

5300 is delivered as a single assembly, including flange, for easy out-of-box installation (no special tools required).

(1) For level device guidance, see "When to use a 5900S-, or 5300/5400 System Configuration" on page 23, and Appendix A: Radar Level Device Selection.

11.1 SAFETY & OVERFILL FUNCTIONS

5300 with HART communication is suitable for use in SIL 2 overfill prevention applications, and is also TÜV-tested and approved for overfill prevention according to the German WHG regulations.

In addition, 5300 can be used as a complementary separate high level alarm device in a 5900S inventory/custody transfer system.

For more information see "Specification" on page 124 and "Additional High Level Alarm Configurations" on page 17.

11.2 TRANSMITTER HOUSING

The dual compartment transmitter housing can be removed without opening the tank. It has cabling and electronics separated for increased moisture resistance.

The housing has two entries for conduit/cable connections. A ½-14 NPT cable entry is standard, but adapters to other connection types are available, see "Ordering Information" on page 132.

5300 transmitter parts.

11.3 TANK CONNECTION AND PROBES

The tank connection consists of a tank seal, a flange or a threaded tank connection.

The transmitter can be equipped with different probes – coaxial, flexible single and twin lead probes – to fulfill various application requirements.
For guidance in probe selection, see page 118.

11.3.1 Probe Selection

In the table below: G=Good, NR=Not Recommended, AD=Application Dependent (consult factory).

	Coaxial	Flexible Single Lead	Flexible Twin Lead(1)
This table gives guidelines on which probe to select, depending on application.			
Measurements			
Level	G	G	G
Interface	G	G	G
Liquid Characteristics			
Changing density	G	G	G
Changing dielectric(2)	G	G	G
Wide pH variations	G	G	G
Pressure changes	G	G	G
Temperature changes	G	G	G
Condensing vapors	G	G	G
Foam	AD	NR	NR
Clean liquids	G	G	G
Materials with very low dielectric	G	G(3)	G(3)
Coating/sticky liquids	NR	AD	NR
Viscous liquids	NR	G	AD
Crystallizing liquids	NR	AD	NR
Tank Environment Considerations			
Probe is close (< 0.3 m / 12 in.) to tank wall/disturbing objects	G	AD	G
Probe might touch tank wall, nozzle or disturbing objects	G	NR	NR
Turbulence(4)	G	AD	AD
Tall, narrow nozzles	G	AD	AD
Still-pipes	NR	G(5)	NR
Liquid or vapor spray might touch probe above surface	G	NR	NR
Disturbing EMC environment in tank	G	AD	AD
Cleanability of probe	NR	G	AD

(1) Especially suitable for interface, close-to-tank wall and long range measurements.
(2) For overall level applications, a changing dielectric has no affect on the measurement. For interface measurements, a changing dielectric of the top fluid will degrade the accuracy of the interface measurement.
(3) With limited measuring range, see page 119.
(4) The probe should be anchored for sideway forces. See "Specification" on page 125.
(5) Requires centering disk.

11.4 MEASURING RANGE

The measuring range, which is application dependent, is given for each probe in the following table. Use it as a guideline for clean liquids.

A. Oil, gasoline or other hydrocarbons, and petrochemicals (ε_r =1.9-4.0).
B. Liquefied gas such as LPG or LNG (ε_r =1.4-1.9)
C. Conductive liquids, e.g. water based solutions, dilute acids, and alkalis (ε_r>10.0).

Maximum Recommended Measuring Range

Probe Type	Dielectric Constant		
	A	B	C
Coaxial	6 m (20 ft)	6 m (20 ft)	6 m (20 ft)
Flexible Single Lead	35 m (115 ft)	15 m (49 ft)(1)	50 m (164 ft)
Flexible Twin Lead	35 m (115 ft)	15 m (49 ft)(1)	50 m (164 ft)

(1) 5900S is recommended.

Different parameters affect the echo and therefore the maximum measuring range differs depending on application according to:

- Disturbing objects close to the probe
- Media with higher dielectric constant has a better reflection and allows for a longer measuring range
- Surface foam and particles in the tank atmosphere might affect measuring performance
- Heavy coating / contamination(1) on the probe may reduce the measuring range and cause erroneous level readings. In such a case, consider using a single lead probe or a non-contacting radar transmitter (5400 or 5900S). Single lead probes are preferred when there is a risk of contamination (coating can result in product bridging across the two leads for twin versions or between the inner lead and outer pipe for the coaxial probe)

(1) Measurements on asphalt are not recommended due to coating problems, but crude oil measurements are ok.

11.5 OIL AND WATER INTERFACE MEASUREMENTS

Rosemount 5302 is capable of measuring the interface level between oil and water, or other liquids with significant dielectric differences. It is suitable to use when the water level exceeds the maximum range for a Rosemount 765 water level sensor (see “Rosemount 765 Water Level Sensor Integrated with Multiple Spot Temperature Sensor” on page 60), typically for oil storage in rock caverns and underground tanks.

Interface measurement with a Rosemount 5302.

When measuring interface, part of the pulse not reflected at the upper product surface, continues until reflected at the lower product surface. The speed of this pulse depends on the dielectric constant of the upper product.

The upper product thickness must be larger than 0.13 m (5.1 in.) to distinguish echoes from the two liquids.

For the flexible probes, the maximum measuring range will be reduced based on the maximum upper product thickness according to the following diagram.

Maximum upper product thickness comparison between the flexible single and twin lead probes with waterlike lower product.

11.6 INSTALLATION CONSIDERATIONS

This section includes some installation information. For complete guidance, see the Rosemount 5300 Series Reference Manual (document number 00809-0100-4530). If you miss information valid for your tank/application, you can also consult your local Rosemount Tank Gauging representative.

Total probe length is defined from the upper reference point to the end of the probe (weight included if applicable).

11.6.1 Mechanical Considerations

Typically the transmitter is top mounted with a flanged or threaded tank connection, and with the probe positioned vertically in the tank. The probe can also be installed at an angle of up to 90° from vertical (consult factory).

When the transmitter is installed, the housing can be rotated 360° for easy cable connection and LCD display view.

To make a measurement, the surface needs to be in contact with the probe. It needs to hang straight down.

To get best possible performance, the following must be considered before installing the transmitter:

- Maximum recommended nozzle height is 0.1 m (4 in.) + the nozzle diameter for all probes except the coaxial probe which has no such restrictions

- When using single flexible probes in tall and narrow nozzles, a Long Stud (LS option) is recommended to prevent the probe from contacting the nozzle
- Probes should be installed so they are not impacted by product filling
- Avoid physical contact between probes and agitators as well as applications with strong liquid movement unless the probe is anchored. If the probe can move to within 0.3 m (1 ft) of any object during operation then probe tie-down is recommended
- To stabilize the probe for side forces, it is possible to fix or guide the probe to the tank bottom, or use a weight

Flexible single lead probe with chuck

- If there is a chance the probe may come into contact with a wall, nozzle or other tank obstruction, the coaxial probe is recommended. Minimum clearance is given in the table below

- Select probe length according to the required measuring range.
  However, probes can be cut in field, but there are some restrictions for the coaxial probe:
  It can be cut up to 0.6 m (2 ft). Probes shorter than 1.25 m (4.1 ft) can be cut to the minimum length of 0.4 m (1.3 ft).
- Avoid 0.25 m (10 in.) or larger diameter nozzles for single lead probes, especially in an application with a low dielectric constant product in the tank

See the following table for nozzle and clearance details.

	Coaxial	**Flexible Single Lead**	**Flexible Twin Lead**
Recommended nozzle diameter	Enough space to fit the probe	0.15 m (6 in.) or more	0.10 m (4 in.) or more
Min. nozzle diameter (1)	Enough space to fit the probe	0.05 m (2 in.)	0.05 m (2 in.)
Min. clearance to tank wall (L) or obstruction(2)	No clearance restriction	0.1 m (4 in.) if smooth metallic wall. 0.5 m (20 in.) if disturbing objects, rugged metallic or concrete/plastic wall.	0.1 m (4 in.)

(1) Requires special configuration. May affect the maximum measuring range.
(2) Minimum clearance from tank bottom for the coaxial and rigid single probes is 5 mm (0.2 in.).

11.6.2 Cable Connections

HART intrinsically safe power supply

FOUNDATION™ fieldbus intrinsically safe power supply

HART Explosionproof/Flameproof power supply

11.6.3 Configuration

Basic configuration can easily be done either with Rosemount TankMaster, Rosemount RadarMaster, a Field Communicator, the AMS™ Suite, DeltaV or any other DD (Device Description) compatible host system.

TankMaster is a user-friendly, Windows based software package that provides easy configuration and service. A wizard guides the user to enter the required parameters for a basic configuration.

For advanced configuration features RadarMaster is required.

The “Measure & Learn” functionality is accessed through RadarMaster. It enables automatic suggestion of level threshold values and disturbance echo settings, thereby making tough applications easy to configure.

The optional integral display is easily configured with TankMaster or the Field Communicator.
The user can choose which variable to display or if toggling between different variables should be applied.

Advanced Plantweb Functionality

Rosemount 5300 powers PlantWeb through innovative measurement technologies and advanced diagnostics that provide more reliability, easier configuration, reduced process downtime, and lower installation and operating costs for a better bottom line.

For more information, see the 5300 Product Data Sheet (00813-0100-4530) or Reference Manual (document number 00809-0100-4530).

11.7 SPECIFICATION

See the Rosemount 5300 Series Product Data Sheet (00813-0100-4530) for complete information.

General	
Product	Rosemount 5300 Guided Wave Radar; Model 5301 Liquid Level Transmitter Model 5302 Liquid Level and Interface Transmitter For level device guidance, see “When to use a 5900S-, or 5300/5400 System Configuration” on page 23, and Appendix A: Radar Level Device Selection.
Measurement principle	Time Domain Reflectometry (TDR)
Reference conditions	Single standard probe, 25 °C (77 °F) in water and ambient pressure
Microwave output power	Nominal 300 µW, Max. 45 mW
Hazardous location certifications	Factory Mutual (FM), ATEX, Canadian Standards Association (CSA), and IECEx. See “Product Certifications” on page 127
Safety/overfill	HART version: • FMEDA suitable for SIL 2: The 5300 Series has been evaluated by Exida per hardware assessment IEC 61508. With a SFF > 90% it is Prior-use SIL 2 suitable. For more information, go to: http://www.emersonprocess.com/rosemount/safety/. Option code QS in Ordering Information • WHG (TÜV) overfill approval
CE-mark	93/68/EEC: complies with applicable EU directives (EMC, ATEX, LVD, and R&TTE)
Ordinary location certification	Complies with FM 3810:2005 and CSA C22.2 No. 142-M1987
Measuring Performance	
Measuring range	0.4 m (16 in.) to 50 m (164 ft). See “Measuring Range” on page 119
Instrument accuracy at reference conditions	± 3 mm (0.12 in.) or 0.03% of measured distance, whichever is greatest
Repeatability	± 1 mm (0.04 in.)
Temperature drift	± 0.2 mm (0.008 in.) /°K or ± 30 ppm/°K of measured value, whichever is greatest
Update interval	1 second
Display / Configuration / Communication	
Integral display	The 5-digit optional integral display presents the data listed below. If more than one variable is chosen, it can toggle between the values. The display also shows diagnostics and error information.
Output variables	5301 and 5302: Level, Distance (Ullage), Level Rate, Volume, Signal Strength, Internal Temperature. In addition for 5302: Interface Level, Interface Distance, Interface Level Rate, Upper Volume, Lower Volume, and Upper Product Thickness
Output units	Level, Interface and Distance: ft, inches, m, cm or mm. Level Rate: ft/s, m/s, in./min, m/h. Volume: ft^3, $inch^3$, US gals, Imp gals, barrels, yd^3, m^3 or liters. Temperature: °F and °C
Configuration tools	Rosemount TankMaster, Rosemount RadarMaster, Field Communicator, AMS Suite, DeltaV or any other DD (Device Description) compatible host system
FOUNDATION™ fieldbus blocks	Resource block, 3 Transducer blocks, 6 Analog Input (AI) blocks, Proportional /Integral/Derivate (PID) block, Input Selector (ISEL) block, Signal Characterizer (SGCR) block, Arithmetic (ARTH) block, and Output Splitter (OS) block
FOUNDATION™ fieldbus class (basic or link master)	Link Master (LAS)
FOUNDATION™ fieldbus block execution time	AI-block: 30 ms. PID-block: 40 ms. ARTH-, ISEL-, OS-block: 65 ms. SGCR-block: 75 ms
Conforming FOUNDATION™ fieldbus	ITK 5.0
FOUNDATION™ fieldbus PlantWeb Alert support	Yes

Electric	
Power supply	Powered by Rosemount 2410 Tank Hub. FOUNDATION™ fieldbus: 9-17.5 VDC 4-20 mA HART: 16-42.4 VDC (16-30 VDC in IS applications, 20-42.4 VDC in Explosion-proof / Flameproof applications)
Bus current draw	21 mA
Internal power consumption	< 50 mW in normal operation
Output	FOUNDATION™ fieldbus or HART 4-20 mA current loop
Signal on alarm (4-20 mA HART)	Standard : Low = 3.75 mA, High = 21.75 mA. Namur NE 43: Low = 3.60 mA, High = 22.50 mA
Saturation levels (4-20 mA HART)	Standard: Low = 3.9 mA, High = 20.8 mA. Namur NE 43: Low = 3.8 mA, High = 20.5 mA
Built-in Tankbus terminator	No
Mechanical	
Probes	Coaxial: 0.4 to 6 m (1.3 to19.7 ft). Flexible single lead: 1 to 50 m (3.3 to164 ft). Flexible twin lead: 1 to 50 m (3.3 to164 ft). For further information, see the probe table on page 118
Tensile strength	4 mm flexible single lead probe (model code 5A, 5B): 12 kN (2698 lb) Flexible twin lead probe: 9 kN (2023 lb)
Collapse load	4 mm flexible single lead probe (model code 5A, 5B): 16 kN (3597 lb)
Sideway torque capacity	100 Nm or 1.67 kg at 6 m (73.7 ftlb or 3.7 lb at 19.7 ft) for the coaxial probe
Probe angle	0 to 90 degrees
Material exposed to tank atmosphere	316 / 316L SST (EN 1.4404), PTFE, PFA(1) and O-ring materials (page 132)
Flanges, threads	See pages 126 and 132
Housing / enclosure	Polyurethane-covered aluminum
Cable entry (connection/glands)	Two ½ - 14 NPT entries for cable glands or conduits. One metal plug to seal any unused port is enclosed in the transmitter delivery. Optional: • M20 x 1.5 conduit / cable adapter • Cable glands in metal (½ - 14 NPT) • 4-pin male Eurofast connector or A size Mini 4-pin male Minifast connector
Tankbus cabling	0.5-1.5 mm^2 (AWG 22-16), twisted shielded pairs
Dimensions	See “Dimensional Drawings” on page 129
Weight	Transmitter Head (TH): 2 kg (4.4 lbs). Flange: depends on size. Coaxial probe: 1 kg/m (0.67 lbs/ft). Flexible single lead probe: 0.08 kg/m (0.05 lbs/ft). 0.4 kg (0.88 lbs) end weight. Flexible twin lead probe: 0.14 kg/m (0.09 lbs/ft). 0.6 kg (1.3 lbs) end weight
Environment	
Ambient temperature	IS/EEx ia and XP/EEx d, FOUNDATION™ fieldbus communication: -40 to 60 °C (-40 to 140 °F). LCD readable in: -20 to 70 °C (-4 to 158 °F) IS/EEx ia and XP/EEx d, HART communication: -40 to 70 °C (-40 to 158 °F). No hazardous location approval, HART communication: -40 to 80 °C (-40 to 176 °F)
Storage temperature	-50 to 90 °C (-58 to 194 °F). LCD: -40 to 85 °C (-40 to 185 °F)
Process / flange temperature(2)	-40 to +150 °C (-40 to +302 °F). See page 126.
Process pressure(2)	Full vacuum to -1 to 40 Bar (580 psig). See page 126.
Humidity	0 - 100% relative humidity
Viscosity (max)	Coaxial probe: 500 cP. Single lead probe: 8000 cP. Twin lead probe: 1500 cP
Ingress protection	IP 66 and IP 67 (Nema 4X)
Vibration resistance	IEC 60770-1 level 1
Telecommunication (FCC and R&TTE)	FCC part 15 (1998) subpart B and R&TTE (EU directive 99/5/EC). Considered to be an unintentional radiator under the Part 15 rules
Electromagnetic compatibility	Emission and Immunity: EMC directive 204/108/EC. EN61326-1:2006 (IEC 61326-1:2006). NAMUR recommendations NE21
Transient / built-in lightning protection	IEC 61000-4-5:2001. T1 option: C62.41.2-2002 (IEEE), C37.90.1-2002 (IEEE)
Pressure Equipment Directive (PED)	97/23/EC

(1) PFA is a fluoropolymer with properties similar to PTFE.
(2) Final rating may be lower depending on flange and O-ring selection. See “Temperature and Pressure” on page 126.

11.7.1 Temperature and Pressure

Flange Temperature

The temperature at the flange is limited by the probe, the tank seal, and O-rings (if applicable).

NOTE
Flange temperature depends on process and ambient temperature, and mounting conditions such as nozzle position, distance to max product level, nozzle height, presence of insulation, etc.

Ambient Temperature

The transmitter housing must be installed so the ambient temperature is not exceeded (see “Specification” on page 124). The ambient temperature may be limited by the selected product certificate (see “Product Certifications” on page 127).

Operating Pressure

The maximum operating pressure must not exceed the specified pressure for the antenna and process connection.

The following diagrams show the process temperature (max product temperature at the lower part of the flange) and pressure rating.

The final rating depends on flange and O-ring selection.

The following 5300 flanges have the same p/T rating as the corresponding blind flanges:

ANSI: according to ANSI B16.5 Table 2-2.3.

EN: according to EN 1092-1 Table 18, material group 13E0.

The following table gives the temperature range for the standard tank seal.

Tank seal with different O-ring material	Min. Temperature °C (°F) in air	Max. Temperature °C (°F) in air
Viton	-15 (5)	150 (302)

11.8 PRODUCT CERTIFICATIONS

SAFETY NOTE

A safety isolator such as a zener barrier is always needed for intrinsic safety.

Probes covered with plastic and/or with plastic discs may generate an ignition-capable level of electrostatic charge under certain extreme conditions. Therefore, when the probe is used in a potentially explosive atmosphere, appropriate measures must be taken to prevent electrostatic discharge.

EU Conformity

The most recent revision of the EC declaration of conformity can be found at www.rosemount.com.

Safety Instrumented Systems (SIS)

The Rosemount 5300 Series has been evaluated by a third party, Exida, against hardware requirements according to IEC 61508. With a FMEDA (Failure Modes, Effects and Diagnostics Analysis) report with a Safe Failure Fraction (SFF) above 90%, 5300 is suitable in SIS according to the Prior Use methodology. For more information, go to: http://www.emersonprocess.com/rosemount/safety/. To order the certificate of FMEDA data use option code QS.

Factory Mutual (FM) Approval

Project ID: 3020497

E5(1) Explosion Proof for Class I, Div. 1,
Groups B, C and D;
Dust Ignition Proof for Class II/III, Div. 1, Groups E, F and G;
With Intrinsically Safe connections to
Class I, II, III, Div. 1, Groups B, C, D, E, F and G.
Temp. Code T4
Ambient temperature limits: -50 °C to +70 °C(2).
Seal not required.

I5, IE(1) Intrinsically Safe for Class I, II, III, Div. 1, Groups A, B, C, D, E, F and G,
Class I, Zone 0, AEx ia IIC T4 when installed per Control Drawing: 9240 030-936.
Non-Incendive Class I, II, Div. 2, Groups A, B, C, D, F and G;
Suitable for Class III, Div. 2
4-20 mA / HART model: U_i=30 V dc, I_i=130 mA, P_i=1.0 W, C_i=7.26 nF, L_i=0 H.
FOUNDATION™ fieldbus model: U_i=30 V dc, I_i=300 mA, P_i=1.3 W, C_i=0 nF, L_i=0 H.
FISCO model: U_i=17.5 V dc, I_i=380 mA, P_i=5.32 W, L_i=C_i=0.
Temp. Code T4
Ambient temperature limits: -50 to +70 °C(2)

ATEX Approval CE

Nemko 04ATEX1073X

SPECIAL CONDITIONS FOR SAFE USE (X)

The intrinsically safe circuits do not withstand the 500 V ac test as specified in EN 50020 clause 6.4.12.

Impact and friction hazards need to be considered according to EN 60079-0 clause 8.1.2 when the transmitter and part of antennas exposed to the exterior atmosphere of the tank is made with light metal alloys and of category II 1G EPL Ga.

The Ex ia version of model 5300 FISCO field device may be supplied by an [Ex ib] FISCO power supply when the power supply is certified with three separate safety current limiting devices and voltage limitation which meets the requirements for type Ex ia.

E1(1) Flameproof:
II 1/2 G T4
II 1D T79°C(3).
Ex ia/db ia IIC T4 Ga/Gb (-40 °C ≤ T_a ≤ +70 °C(2))
Ex ta IIIC T79°C(3) (-40 °C ≤ T_a ≤ +70 °C(2))
U_m = 250 V.

I1, IA(1) Intrinsically Safe:
II 1 G T4
II 1/2 G T4
II 1 D T79 °C(3).
Ex ia IIC T4 (-50 °C ≤ T_a ≤ +70 °C(2)).
Ex ia/ib IIC T4 Ga/Gb (-50 °C ≤ T_a ≤ +70 °C(2)).
Ex ta IIIC T79 °C(3) (-50 °C ≤ T_a ≤ +70 °C(2)).
4-20 mA / HART model: U_i=30 V dc, I_i=130 mA, P_i=1.0 W, C_i=7.26 nF, L_i=0 H.
FOUNDATION™ fieldbus model: U_i=30 V dc, I_i=300 mA, P_i=1.5 W, C_i=0 nF, L_i=0 H.
FISCO model: U_i=17.5 V dc, I_i=380 mA, P_i=5.32 W, C_i=0 nF, L_i<1 µH.
Installation Drawing: 9240 030-938

(1) Ordering information code for product certificates, see page 132.
(2) +60 °C with FOUNDATION™ fieldbus or FISCO option.
(3) +69 °C with FOUNDATION™ fieldbus or FISCO option.

Canadian Standards Association (CSA) Approval

This product meets the Dual Seal Requirements of ANSI/ISA 12.27.01-2003.
Cert. no. 1514653

E6(1) Explosionproof with internal Intrinsically Safe Circuits [Exia]
Class I, Div. 1, Groups B, C and D;
Temp Code T4.
Class II, Div. 1 and 2, Groups E, F and G;
Class III, Div. 1
Ambient temperature limits -50 °C to +70 °(2)

I6, IF(1)Intrinsically Safe Exia:
Class I, Div. 1, Groups A, B, C and D.
Temp Code T4.
4-20 mA / HART model: U_i=30 V dc, I_i=130 mA, P_i=1.0 W, C_i=7.26 nF, L_i=0 H.
FOUNDATION™ fieldbus model: U_i=30 V dc, I_i=300 mA, P_i=1.3 W, C_i=0 nF, L_i=0 H.
FISCO model: U_i=17.5 V dc, I_i=380 mA, P_i=5.32 W, L_i=C_i=0.

Installation Drawing: 9240 030-937
Ambient temperature limits -50 to +70 °C(2).

IECEx Approval

IECEx NEM 06.0001X

CONDITIONS OF CERTIFICATION (X)

The intrinsically safe circuits do not withstand the 500 V ac test as specified in EN 50020 clause 6.4.12.

Impact and friction hazards need to be considered according to EN 60079-0 clause 8.1.2 when the transmitter and part of antennas exposed to the exterior atmosphere of the tank is made with light metal alloys and of category II 1G EPL Ga.

The Ex ia version of model 5300 FISCO field device may be supplied by an [Ex ib] FISCO power supply when the power supply is certified with three separate safety current limiting devices and voltage limitation which meets the requirements for type Ex ia.

E7(1) Flameproof:
Ex ia/db ia IIC T4 Ga/Gb (-40 °C ≤ T_a ≤ +70 °C(2))
Ex ta IIIC T79°C(3) (-40 °C ≤ T_a ≤ +70 °C(2))
U_m = 250 V.

I7, IG(1)Intrinsically Safe:
Ex ia IIC T4 (-50 °C ≤ T_a ≤ +70 °C(2)).
Ex ia/ib IIC T4 Ga/Gb (-50 °C ≤ T_a ≤ +70 °C(2)).
Ex ta IIIC T79°C(3) (-50 °C ≤ T_a ≤ +70 °C(2)).
4-20 mA / HART model: U_i=30 V dc, I_i=130 mA, P_i=1.0 W, C_i=7.26 nF, L_i=0 H.
FOUNDATION™ fieldbus model: U_i=30 V dc, I_i=300 mA, P_i=1.5 W, C_i=0 nF, L_i=0 H.
FISCO model: U_i=17.5 V dc, I_i=380 mA, P_i=5.32 W, L_i<1 µH C_i=0 nF.
Installation Drawing: 9240 030-938

For detailed information, refer to the 5300 Series Reference Manual (document number 00809-0100-4530).

(1) Ordering information code for product certificates, see page 132.
(2) +60 °C with FOUNDATION™ fieldbus or FISCO option.
(3) +69 °C with FOUNDATION™ fieldbus or FISCO option.

11.9 DIMENSIONAL DRAWINGS

All dimensions are in mm (inches).

11.9.1 Coaxial Probe with Flange Connection

11.9.2 Coaxial Probe with Threaded Connection

11.9.3 Flexible Single Lead Probe with Flange Connection

All dimensions are in mm (inches).

11.9.4 Flexible Single Lead Probe with Threaded Connection

11.9.5 Flexible Twin Lead Probe with Flange Connection

All dimensions are in mm (inches).

11.9.6 Flexible Twin Lead Probe with Flange Connection

11.10 ORDERING INFORMATION

If you require other options than listed here, please refer to the Rosemount 5300 Series Product Data Sheet (document number 00813-0100-4530) or consult your local Rosemount Tank Gauging sales representative.

11.10.1 Model Code 5301 and 5302

Model (Pos 1)	Product Description	Note
5301	Guided Wave Radar Level Transmitter (pulse technology)	
5302	Guided Wave Radar Level and Interface Transmitter (pulse technology)	
Code (Pos 2)	**Tank Bus: Power and Communication**	**Note**
U	Raptor Tankbus(1)	For connection to a Rosemount 2410 Tank Hub
F	FOUNDATION™ fieldbus (IEC 61158)	For connection to generic host/DCS system
H	4-20 mA with HART communication	For use as a stand-alone overfill alarm
Code (Pos 3)	**Housing**	**Note**
A	Standard enclosure	Polyurethane-covered aluminium. IP 66/67
Code (Pos 4)	**Cable / Conduit Connections**	**Note**
1	½ - 14 NPT	
4	Two M20 x 1.5 adapters	
G	Two metal cable glands (½-14 NPT)(2)	Min. temperature -20 °C (-4 °F)
E	Eurofast male connector(2)	
M	Minifast male connector(2)	
Code (Pos 5)	**Operating Temperature and Pressure**	**Note**
S	Standard	Vacuum to 40 bar (580 psig). Temperature depends on o-ring selection, see page 126
C	Cryogenic(3)	Min. operating temperature is -196 °C (-321 °F)
Code (Pos 6)	**Material of Construction: Process Connection / Probe**	**Note**
1	AISI 316L / EN 1.4404 SST	
Code (Pos 7)	**Sealing, O-ring Material**	**Note**
V	Viton fluoroelastomer(4)	
N	Not applicable, no o-ring(5)	
Code (Pos 8)	**Probe Type**	**Probe Lengths**
5A	Flexible Single Lead with weight	1 to 50 m (4 to 164 ft)
5B	Flexible Single Lead with chuck(6)	1 to 50 m (4 to 164 ft). Extra length for tightening the probe is added in factory
3A	Coaxial	0.4 to 6 m (2 to 20 ft)
2A	Flexible Twin Lead with weight (for clean products)	1 to 50 m (4 to 164 ft)
Code (Pos 9)	**Probe Length Units**	**Note**
E	English (feet, in.)	
M	Metric (meters, centimeters)	
Code (Pos 10)	**Total Probe Length (7) (feet/m)**	**Note**
xxx	0-164 ft or 0-50 m	(see Pos 8 notes)
Code (Pos 11)	**Total Probe Length (7) (in./cm)**	**Note**
xx	0-11 in. or 0-99 cm	(see Pos 8 notes)

Code (Pos 12)	Tank Connection	Note
ANSI Flanges (AISI 316L / EN 1.4404)		
AA	2 in. Class 150	
BA	3 in. Class 150	
BB	3 in. Class 300	
CA	4 in. Class 150	
CB	4 in. Class 300	
DA	6 in. Class 150	
EN (DIN) Flanges in 316L SST (EN 1.4404)		
HB	DN50, PN40	
IA	DN80, PN16	
IB	DN80, PN40	
JA	DN100, PN16	
JB	DN100, PN40	
KA	DN150, PN16	
Threaded Connections		
RA	1 ½ in. NPT thread	
RB	1 in. NPT thread	For standard temperature and pressure
RC	2 in. NPT thread	For standard temperature and pressure
SA	1 ½ in. BSP (G 1 ½ in.) thread	
SB	1 in. BSP (G 1 in.) thread	For standard temperature and pressure

Code (Pos 13)	Hazardous Locations Certifications	Note
IA	ATEX FISCO Intrinsic Safety(8)	
IE	FM FISCO Intrinsic Safety(8)	
IF	CSA FISCO Intrinsic Safety(8)	
IG	IECEx FISCO Intrinsic Safety(8)	
I1	ATEX Intrinsic Safety	
I5	FM Intrinsic Safety and Non-Incendive	
I6	CSA Intrinsic Safety	
I7	IECEx Intrinsic Safety	
E1	ATEX Flameproof	
E5	FM Explosionproof	
E6	CSA Explosionproof	
E7	IECEx Flameproof	
NA	No hazardous location certification	

Code	Options – none or multiple selections are possible	Note
M1	Integral digital display	
P1	Hydrostatic pressure testing(9)	
LS	Long stud(10), 250 mm (9.8 in) to prevent probe from contacting wall/nozzle	Standard height is 100 mm (3.9 in)
BR	Mounting bracket for 1.5 in. NPT process connection (Pos 12 code RA)	
Special Certificates		
Q4	Calibration Data Certification	
Q8	Probe Material Traceability Certification per EN 10204 3.1(11)	
QS	Prior use certificate of FMEDA data (SIS/SIL)(12)	
U1	TÜV/DIBt WHG approval for overfill prevention(12)	
Centering Discs		**Outer Diameter**
S2	2 in. Centering disc SST(13)	1.8 in. (45 mm)
S3	3 in. Centering disc SST(13)	2.7 in. (68 mm)
S4	4 in. Centering disc SST(13)	3.6 in. (92 mm)
S6	6 in. Centering disc SST(13)	5.55 in. (141 mm)
S8	8 in. Centering disc SST(13)	7.40 in. (188 mm)
Model Code Example: 5301 - F A1 S 1 V 5A M02500 CA IA - M1 S4 **M02500 means 25 m.**		

(1) Requires Pos 13 “Hazardous Location Certification” codes IA, IE, IF, IG, or NA
(2) Not available with Pos 13 “Hazardous Location Certification” codes E1, E5, E6 or E7.
(3) Requires Pos 7 “Sealing, O-ring Material” code N (No o-ring) and Pos 8 “Probe Type” code 3A, 5A or 5B.
(4) Requires Pos 5 “Operating Temperature and Pressure” code S.
(5) Requires Pos 5 “Operating Temperature and Pressure” code C.
(6) Extra length for fastening is added in factory.
(7) Probe weight included if applicable. Give the total probe length in feet and inches or meters and centimeters, depending on selected probe length unit. If tank height is unknown, please round up to an even length when ordering. Probes can be cut to exact length in field. For maximum probe length, see “Notes” in Pos 8 “Probe Type”. The maximum allowable length is also affected by process conditions. See “Avoid physical contact between probes and agitators as well as applications with strong liquid movement unless the probe is anchored. If the probe can move to within 0.3 m (1 ft) of any object during operation then probe tie-down is recommended” on page 120 for more probe length guidance.
(8) Requires Pos 2 “Tank Bus: Power and Communication” code F. For use with Rosemount 2410 Tank Hub.
(9) For flanged tank connections.
(10) Requires Pos 8 “Probe Type” 5A or 5B.
(11) Certificate includes all pressure retaining wetted parts.
(12) Requires Pos 2 “Tank Bus: Power and Communication” code H.
(13) Requires Pos 8 “Probe Type” 2A or 5B.

12 Rosemount 5400 Radar Level Transmitter

Rosemount 5400 is a reliable 2-wire non-contact radar level transmitter for liquids, to be used in a wide range of medium accuracy applications[1] under various tank conditions. The measurement is unaffected by most liquid property changes, such as density etc. The 5402 model is used for tank gauging applications.

Rosemount 5400 radar level transmitter.

Rosemount 5400 measures the distance to the surface of the product in the tank. Using tank distances stored locally in the memory of the gauge, it calculates the level of the liquid's surface. The level value is communicated on the Tankbus via the 2410 tank hub to TankMaster or other host systems.

The 5400 transmitter consists of the housing and an antenna assembly.

The transmitter housing contains all electronics.

The antenna assembly is the only part in contact with the tank atmosphere. It seals off the tank atmosphere from the transmitter housing and its surroundings.

5400 is delivered as a single assembly, including flange, for easy out-of-box installation (no special tools required).

(1) For level device guidance, see "When to use a 5900S-, or 5300/5400 System Configuration" on page 23, and Appendix A: Radar Level Device Selection.

12.1 SAFETY FUNCTIONS

5400 with HART communication is suitable for SIL 1 applications according to IEC 61508, and suitable for SIL 2 applications when selected on basis of prior use according to IEC 61511-1, section 11.4.4. It is also TÜV-tested and approved for overfill prevention according to the German WHG regulations.

In addition, 5400 can be used as a complementary separate high level alarm device in a 5900S inventory/custody transfer system.

For more information see "Specification" on page 140 and "Additional High Level Alarm Configurations" on page 17.

12.2 TRANSMITTER HOUSING

The dual compartment transmitter housing can be removed from the antenna assembly for service or replacement, without opening the tank. It has cabling and electronics separated for increased moisture resistance.

The transmitter housing has two integral ½-in. NPT cable entries for conduit / cable connections. Adapters to other connection types are available, see "Ordering Information".

12.3 ANTENNAS

The antenna assembly is the only part in contact with the tank atmosphere, and it consists of an antenna, an O-ring, and tank connection (tank seal and flange).

The 5400 level transmitter is equipped with high performance cone antennas in various sizes. The antenna focuses the radar beam. It is recommended to use the largest possible antenna to achieve the highest gain.

12.4 MEASURING RANGE

The measuring range depends on the antenna size, the dielectric constant (ε_r) of the liquid, and process conditions. A higher dielectric constant value means a stronger reflection (see the following tables). The figures below are guidelines for optimum performance. Larger measuring ranges may be possible. For more information, contact your local Rosemount Tank Gauging sales representative.

A. Oil, gasoline or other hydrocarbons, and petrochemicals (ε_r =1.9-4.0).
   In pipes or with ideal surface conditions, for some liquefied gases (ε_r =1.4-4.0)
B. Alcohols, concentrated acids, organic solvents, oil/water mixtures, and acetone (ε_r =4.0-10.0).
C. Conductive liquids, e.g. water based solutions, dilute acids, and alkalis (ε_r>10.0).

Maximum Recommended Measuring Range, m (ft)

Free propagation

5402 Cone Antenna Size	Dielectric Constant		
	A	B	C
4 in.	20 (66)	25 (82)	35 (115)

Still-pipe

5402 Cone Antenna Size	Dielectric Constant		
	A	B	C
4 in.	25 (82)	35 (115)	35 (115)
3 in.	25 (82)	35 (115)	35 (115)
2 in.	25 (82)	35 (115)	35 (115)

12.5 INSTALLATION CONSIDERATIONS

This section includes some installation information. For complete guidance, see the Rosemount 5400 Series Reference Manual (document number 00809-0100-4026). If you miss information valid for your tank/application, you can also consult your local Rosemount Tank Gauging representative

12.5.1 Mechanical Considerations

The transmitter is top mounted with a flanged tank connection.

When the transmitter is installed, the housing can be rotated 360° for easy cable connection and LCD display view.

The transmitter should be installed off-center, and at a location away from disturbing inlets or metallic objects within the radar beam. Because of circular polarization, there is no clearance distance requirement from the tank wall if it is flat and free from obstructions.

The antenna can be recessed in smooth nozzles up to 2 m (6 ft), but if the inside of the nozzle contains disturbing objects, use the extended cone.

The 5400 transmitter can be installed to measure on floating roof tanks. If no still-pipe is available, it is possible to install the transmitter on a bracket, and measure towards a reflector on the floating roof. The size of the horizontal metallic reflector should be according to the illustration. The distance from the reflector to the tank wall should be approximately the same as the reflector size.
Note! Free propagation measurement towards the tank roof must be according to national radio licence regulations.

Maximum Measured Distance, m (ft)	Reflector Size (W or Ø), Rosemount 5402 with 4-in. cone antenna, m (in)
5 (16)	0.3 (12)
10 (33)	0.4 (16)
15 (49)	0.5 (20)
20 (66)	0.6 (24)
30 (98)	0.7 (28)
35 (115)	0.8 (31)

12.5.2 Cable Connections

FOUNDATION™ fieldbus intrinsically safe power supply

HART intrinsically safe power supply

HART Explosionproof/Flameproof power supply

12.5.3 Configuration

Basic configuration and modifications can easily be done with Rosemount TankMaster, Rosemount RadarMaster, a Field Communicator, the AMS™ Suite, DeltaV or any other DD compatible host system.

TankMaster is a user-friendly, Windows based software package that provides easy configuration and service. A wizard guides the user to enter the required parameters for a basic configuration.

For advanced configuration features, RadarMaster is required.

For more information, see the 5400 Product Data Sheet (00813-0100-4026) or Reference Manual (document number 00809-0100-4026).

The optional integral display is easily configured with TankMaster or the Field Communicator. The user can choose which variable to display or if toggling between different variables should be applied.

Advanced Plantweb Functionality

Rosemount 5400 powers PlantWeb through innovative measurement technologies and advanced diagnostics that provide more reliability, easier configuration, reduced process downtime, and lower installation and operating costs for a better bottom line.

12.6 SPECIFICATION

See the Rosemount 5400 Product Data Sheet (00813-0100-4026) for complete information.

General	
Product	Rosemount 5402 Radar Level Transmitter. For level device guidance, see “When to use a 5900S-, or 5300/5400 System Configuration” on page 23, and Appendix A: Radar Level Device Selection.
Measurement principle	Pulsed, free propagating radar (~26 GHz)
Reference conditions	Ideal metal plate with no disturbing objects. Temperature: 20 °C (+ 68 °F). Pressure: 960-1060 mbar (14-15 psi). Humidity: 25-75 % RH.
Microwave output power	< 1 mW
Hazardous location certifications	Factory Mutual (FM), ATEX, Canadian Standards Association (CSA), and IECEx. See “Product Certifications” on page 143
Safety/overfill	HART version: • 5400 with HART communication is suitable for SIL 1 applications according to IEC 61508, and suitable for SIL 2 applications when selected on basis of prior use according to IEC 61511-1, section 11.4.4. • WHG (TÜV) overfill approval (HART version)
CE-mark	93/68/EEC: complies with applicable EU directives (EMC, ATEX, LVD, and R&TTE)
Ordinary location certification	Complies with FM 3810:2005 and CSA C22.2 No. 142-M1987
Measuring Performance	
Measuring range	Maximum 35 m (115 ft) from flange. The measuring range depends on the microwave frequency, antenna size, the dielectric constant (ε_r) of the liquid, and process conditions. For more information, see “Measuring Range” on page 136
Instrument accuracy at reference conditions	± 3 mm (± 0.1 in.)
Repeatability	± 1 mm (0.04 in.) at 5 m (16.4 ft) distance
Temperature drift	0.05 %/10 K in temperature range -40 to 80 °C (-40 to 176 °F)
Update interval	1 second
Near zone distance	0.4 m (1.3 ft) from lower end of the antenna
Near zone accuracy	± 15 mm (± 0.6 in.)
Transition zone(1)	From lower end of the antenna and 150 mm (6 in.) below
Display / Configuration / Communication	
Integral display	The 5-digit optional integral display presents the data listed below. If more than one variable is chosen, it can toggle between the values. The display also shows diagnostics and error information.
Output variables	Level, Distance, Volume, Level Rate, Signal Strength, Internal Temperature, Analog Output Current(2), and % of Range(2)
Output units	Level and Distance: ft, inch, m, cm or mm Volume: ft^3, $inch^3$, US gals, Imp gals, barrels, yd^3, m^3, or liters Level Rate: ft/s, m/s Temperature: °F, °C
Configuration tools	Rosemount TankMaster, Rosemount RadarMaster, Field Communicator, AMS Suite, DeltaV or any other DD (Device Description) compatible host system
FOUNDATION™ fieldbus blocks	Resource block, 3 Transducer blocks, 6 Analog Input (AI) blocks, Proportional /Integral/Derivate (PID) block, Input Selector (ISEL) block, Signal Characterizer (SGCR) block, Arithmetic (ARTH) block, and Output Splitter (OS) block
FOUNDATION™ fieldbus class (Basic or Link Master)	Link Master (LAS)
FOUNDATION™ fieldbus block execution time	AI-block: 30 ms. PID-block: 40 ms. ARTH-, ISEL-, OS-block: 65 ms. SGCR-block: 75 ms
Conforming FOUNDATION™ fieldbus	ITK 4.6
FOUNDATION™ fieldbus PlantWeb Alert Support	Yes

Electric	
Power supply	Powered by Rosemount 2410 Tank Hub. FOUNDATION™ fieldbus: 9-17.5 VDC 4-20 mA HART : 16-42.4 VDC (16-30 VDC in IS applications, and 20-42.4 VDC in Explosion-proof / Flameproof applications
Bus current draw	21 mA
Internal power consumption	< 50 mW in normal operation
Output	FOUNDATION™ fieldbus or HART 4-20 mA current loop
Signal on alarm (4-20 mA HART)	Standard : Low = 3.75 mA, High = 21.75 mA. Namur NE 43: High = 22.50 mA
Saturation levels (4-20 mA HART)	Standard: Low = 3.9 mA, High = 20.8 mA. Namur NE 43: Low = 3.8 mA, High = 20.5 mA
Built-in Tankbus terminator	No
Mechanical	
Antennas	Free propagation: 4-in. cone antenna Still-pipe installation: 2, 3, or 4-in. cone antennas
Material exposed to tank atmosphere	• 316 / 316 L SST (EN 1.4404) • PTFE fluoropolymer • O-ring material
Flanges, threads	See “Temperature and Pressure” on page 142 and “Ordering Information” on page 146
Housing / enclosure	Polyurethane-covered aluminum
Cable entry (connection/glands)	Two ½ - 14 NPT entries for cable glands or conduits. One metal plug to seal any unused port is enclosed in the transmitter delivery. Optional: • M20 x 1.5 conduit / cable adapter • Cable glands in metal (½ - 14 NPT) • 4-pin male Eurofast connector or A size Mini 4-pin male Minifast connector
Tankbus cabling	0.5-1.5 mm^2 (AWG 22-16), twisted shielded pairs
Dimensions	See “Dimensional Drawings” on page 144
Weight	**Transmitter housing:** 2.0 kg (4.4 lbs) **Antennas:** 1.0 kg (2.2 lbs) **Tank connection:** ANSI flanges: 3.0 kg (6.6 lbs), EN (DIN) flanges: 4.0 kg (8.8 lbs)
Environment	
Ambient temperature	IS/EEx ia and XP/EEx d, FOUNDATION™ fieldbus communication: -40 to 60 °C (-40 to 140 °F). LCD readable in: -20 to 70 °C (-4 to 158 °F) IS/EEx ia and XP/EEx d, HART communication: -40 to 70 °C (-40 to 158 °F). No hazardous location approval, HART communication: -40 to 80 °C (-40 to 176 °F).
Storage temperature	-50 to 90 °C (-58 to 194 °F). LCD: -40 to 85 °C (-40 to 185 °F)
Process / flange temperature	See page 142
Process pressure	See page 142
Humidity	0 - 100% relative humidity, non condensating
Ingress protection	IP 66 and IP 67 (Nema 4X)
Vibration resistance(6)	IEC 60770-1 level 1
EU directive compliance	CE mark, 93/68/EEC
Telecommunication (FCC and R&TTE)(3)(4)	FCC part 15C (1998)(5), R&TTE (EU directive 99/5/EC), and IC (RSS210-5)
Electromagnetic compatibility(6)	Emission and Immunity: EMC directive 204/108/EC. EN61326-1:2006 NAMUR recommendations NE21
Transient / built-in lightning protection(6)	IEC 61000-4-5:2001 T1 option: C62.41.2-2002 (IEEE), C37.90.1-2002 (IEEE)
Pressure Equipment Directive (PED)	97/23/EC

(1) Transition zones are areas where measurements are not recommended.
(2) Not applicable for FOUNDATION™ fieldbus.
(3) Only a limited selection is presented. Contact your local Emerson representative for more information.
(4) For Japan: “Install device on tanks or pipes made of metal”.
(5) This device is authorized for use in tank-mounted applications, including metal tanks as well as concrete, plastic, glass and other non-conductive tanks.
(6) The device may also comply with other standards. Consult your local Emerson representative.

12.6.1 Temperature and Pressure

Process temperature and pressure diagram.

Flange Temperature

The temperature at the flange is limited by the antenna, the tank seal, and O-rings (if applicable).

NOTE
Flange temperature depends on process and ambient temperature, and mounting conditions such as nozzle position, distance to max product level, nozzle height, presence of insulation, etc.

Ambient Temperature

The transmitter housing must be installed so the ambient temperature is not exceeded, to protect the elecronics (see “Specification” on page 140). The ambient temperature may be limited by the selected product certificate (see “Product Certifications” on page 143).

Operating Pressure

The maximum operating pressure must not exceed the specified pressure for the antenna and process connection.

The final rating depends on flange and O-ring selection.

The following 5400 flanges have the same p/T rating as the corresponding blind flanges:

ANSI: according to ANSI B16.5 Table 2-2.3.

EN: according to EN 1092-1 Table 18, material group 13E0.

The following table gives the temperature range for the standard tank seal.

Tank seal with O-ring material	Min. Temperature °C (°F) in air	Max. Temperature °C (°F) in air
Viton	-20 (-4)	150 (302)

12.7 PRODUCT CERTIFICATIONS

SAFETY NOTE & SPECIAL CONDITIONS FOR SAFE USE (X-MARKING IN ATEX, AND IECEX CERTIFICATES)

A safety isolator such as a zener barrier is always needed for intrinsic safety.

The intrinsically safe circuits do not withstand the 500 Vac test as specified in IEC 60079-11 clause 6.4.12.

Impact and friction hazards need to be considered according to EN 60079-0 clause 8.1.2 when the transmitter and part of antennas exposed to the exterior atmosphere of the tank is made with light metal alloys and of category II 1G EPL Ga.

The Ex ia version of model 5400 may be supplied by an Ex ib certified safety barrier. The whole circuit shall then be regarded type Ex ib. The antenna is classified EPL Ga and electrically separated from the Ex ia or ib circuit.

EU Conformity

The most recent revision of the EC declaration of conformity can be found at www.rosemount.com.

Safety Instrumented Systems (SIS)

The Rosemount 5400 Series has been evaluated by a third party, the SP (Technical Research Institute of Sweden), against hardware requirements according to IEC 61508. With a FMEDA (Failure Modes, Effects and Diagnostics Analysis) report with a Safe Failure Fraction (SFF) above 80%, 5400 is suitable in SIS according to the Prior Use methodology. For more information, go to: http://www.emersonprocess.com/rosemount/safety/. To order the certificate of FMEDA data use option code QS.

Canadian Registration Number

Cert no: 0F06878.2

The product design has been accepted and registered for use in Canada.

ATEX Approvals CE

Nemko 04ATEX1073X

E1(1) Flameproof:

Ex II 1/2 G T4.
II 1D T79 °C(2).
Ex ia/db ia IIC T4 Ga/Gb (-40 °C ≤ T_a ≤ +70 °C(3)).
Ex ta IIIC T79 °C(2) (-40 °C ≤ T_a ≤ +70 °C(3)).
U_m=250 V

I1, IA(1)Intrinsically Safe:

Ex II 1/2 G T4.
II 1 D T79 °C(2).
Ex ia IIC T4 Ga/Gb (-50 °C ≤ T_a ≤ +70 °C(3)).
Ex ta IIIC T79 °C(2) (-50 °C ≤ T_a ≤ +70 °C(3)).
4-20 mA / HART model: U_i=30 V dc, I_i=130 mA, P_i=1.0 W, C_i=7.26 nF, L_i=0 H.
FOUNDATION™ fieldbus model: U_i=30 V dc, I_i=300 mA, P_i=1.5 W, C_i=0 nF, L_i=0 H.
FISCO model: U_i=17.5 V dc, I_i=380 mA, P_i=5.32 W, C_i=0 nF, L_i<1 µH.
Installation Drawing: 9150079-907.

(1) Ordering Information code for product certificates, see page 146.
(2) +69 °C with FOUNDATION™ fieldbus or FISCO option.
(3) +60 °C with FOUNDATION™ fieldbus or FISCO option.

Factory Mutual (FM) Approvals

Project ID: 3020497

E5(1) Explosion Proof for Class I, Div. 1, Groups B, C and D;
Dust Ignition Proof for Class II/III, Div. 1, Groups E, F and G;
With Intrinsically Safe connections to Class I, II, III, Div. 1, Groups B, C, D, E, F and G.
Temp. Code T4
Ambient temperature limits: -50 °C to +70 °C(3).
Seal not required.

I5, IE(1)Intrinsically Safe for Class I, II, III, Div. 1, Groups A, B, C, D, E, F and G,
Class I, Zone 0, AEx ia IIC T4 when installed per Control Drawing: 9150079-905.

Non-Incendive Class I, II Div. 2, Groups A, B, C, D, F and G; Suitable for Class II, III.

4-20 mA / HART model: U_i=30 V dc, I_i=130 mA, P_i=1.0 W, C_i=7.26 nF, L_i=0 H.

FOUNDATION™ fieldbus model: U_i=30 V dc, I_i=300 mA, P_i=1.3 W, C_i=0 nF, L_i=0 H.
FISCO model: U_i=17.5 V dc, I_i=380 mA, P_i=5.32 W, L_i=C_i=0.

Temp. Code T4
Ambient temperature limits: -50 to +70 °C(3).

Canadian Standards Association (CSA) Approvals

This product meets the Dual Seal Requirements of ANSI/ISA 12.27.01-2003.

Cert. no.: 1514653

E6(1) Explosionproof with internal Intrinsically Safe Circuits [Exia]
Class I, Div. 1, Groups B, C and D;

Temp Code T4.

Class II, Div. 1 and 2, Groups E, F and G;

Class III, Div. 1

Ambient temperature limits -50 °C to +70 °(3)

I6, IF(1)Intrinsically Safe Exia:
Class I, Div. 1, Groups A, B, C and D.

Temp Code T4.

4-20 mA / HART model: U_i=30 V dc, I_i=130 mA, P_i=1.0 W, C_i=7.26 nF, L_i=0 H.

FOUNDATION™ fieldbus model: U_i=30 V dc, I_i=300 mA, P_i=1.3 W, C_i=0 nF, L_i=0 H.
FISCO model: U_i=17.5 V dc, I_i=380 mA, P_i=5.32 W, L_i=C_i=0.

Installation Drawing: 9150079-906
Ambient temperature limits -50 to +70 °C(3).

IECEx Approval

IECEx NEM 06.0001x

E7[1] Flameproof:
Ex ia/db ia IIC T4 Ga/Gb (-40 °C ≤ T_a ≤ +70 °C[2]).
Ex ta IIIC T79 °C[3] (-40 °C ≤ T_a ≤ +70 °C[2])
U_m=250 V

I7, IG[1] Intrinsically Safe:
Ex ia IIC T4 Ga/Gb (-50 °C<T_a<+70 °C[2])
Ex ta IIIC T79 °C[3] (-50 °C<T_a<+70 °C[2]).
4-20 mA / HART model: U_i=30 V dc, I_i=130 mA, P_i=1.0 W, C_i=7.26 nF, L_i=0 H.
FOUNDATION™ fieldbus model: U_i=30 V dc, I_i=300 mA, P_i=1.5 W, C_i=0 nF, L_i=0 H.
FISCO model: U_i=17.5 V dc, I_i=380 mA, P_i=5.32 W, C_i=0 nF, L_i<1 µH.

Installation Drawing: 9150079-907.

For more information , refer to the Reference Manual (document number 00809-0100-4026).

(1) Ordering Information code for product certificates, see page 146.
(2) +60 °C with FOUNDATION™ fieldbus or FISCO option.
(3) +69 °C with FOUNDATION™ fieldbus or FISCO option.

12.8 DIMENSIONAL DRAWINGS

12.8.1 Rosemount 5402 with SST Cone Antenna

All dimensions are in mm (inches).

Standard SST Cone

Cone size (inches)	A	B	Antenna Code
2	165 (6.5)	50 (2.0)	2S
3	150 (5.9)	67 (2.6)	3S
4	225 (8.8)	92 (3.6)	4S

Extended SST Cone[1]

Max. nozzle height	A	Option Code
500 (20)	518 (20.4)	S3

(1) The extended cone antennas are available in 5-in. step increments from 10 to 50 inches. Consult your local Rosemount Tank Gauging representative for more information. Expect longer lead times for other sizes than the 500 mm (20 in.) version.

12.8.2 Bracket Mounting

All dimensions are in mm (inches).

Pipe mounting (vertical pipe)

Pipe mounting (horizontal pipe)

Wall mounting

Hole pattern wall mounting

12.9 ORDERING INFORMATION

If you require other options than listed here, please refer to the Rosemount 5400 Series Product Data Sheet (document number 00813-0100-4026) or consult your local Rosemount Tank Gauging sales representative.

12.9.1 Model Code for Rosemount 5400 Radar Level Transmitter

Model (Pos 1)	Product Description	Note
5402	Radar Level Transmitter (pulse technology, 26 GHz)	
Code (Pos 2)	**Housing**	**Note**
A	Standard enclosure	Polyurethane-covered aluminium. IP 66/67
Code (Pos 3)	**Tank Bus: Power and Communication**	**Note**
U	Raptor Tankbus(1)	For connection to a Rosemount 2410 Tank Hub
F	FOUNDATION™ fieldbus (IEC 61158)	For connection to generic host/DCS system
H	4-20 mA HART communication	For use as a stand-alone overfill alarm
Code (Pos 4)	**Cable / Conduit Connections**	**Note**
1	½ - 14 NPT	
4	Two M20 x 1.5 adapters	
G	Two metal cable glands (½-14 NPT)(2)	Min. temperature -20 °C (-4 °F)
E	Eurofast male connector(2)	
M	Minifast male connector(2)	
Code (Pos 5)	**Hazardous Location Certification**	**Note**
IA	ATEX FISCO Intrinsic Safety(3)	
IE	FM FISCO Intrinsic Safety(3)	
IF	CSA FISCO Intrinsic Safety(3)	
IG	IECEx FISCO Intrinsic Safety(3)	
I1	ATEX Intrinsic Safety	
I5	FM Intrinsic Safety and Non-Incendive	
I6	CSA Intrinsic Safety	
I7	IECEx Intrinsic Safety	
E1	ATEX Flameproof	
E5	FM Explosionproof	
E6	CSA Explosionproof	
E7	IECEx Flameproof	
NA	No hazardous location certification	
Code (Pos 6)	**Antenna - Size and Material**	**Note**
SST Cone Antennas (AISI 316L / EN 1.4404)		
4S	4 in. / DN100 (Ø=92 mm).	Preferred option for free propagation (non-pipe) installations due to its longer measuring range
3S	3 in. / DN80 (Ø=67 mm)	
2S	2 in. / DN50 (Ø=50 mm)	
Code (Pos 7)	**Tank Sealing**	**Note**
PV	PTFE with Viton fluoroelastomer o-rings	

Code (Pos 8)	Tank Connection	Note
ANSI Flanges (AISI 316 / 316L SST)		
AA	2 in. Class 150	
BA	3 in. Class 150	
CA	4 in. Class 150	
DA	6 in. Class 150	
EA	8 in. Class 150	
EN Flanges (EN 1.4404 SST)		
HB	DN50 PN40	
IB	DN80 PN40	
JA	DN100 PN16	
JB	DN100 PN40	
KA	DN150 PN16	
LA	DN200 PN16	
Other		
BR	Bracket Mounting, AISI 316L / EN 1.4404 SST(4)	
Code	**Options – none or multiple selections are possible**	**Note**
M1	Integral digital display	
Special Certificates		
Q4	Calibration Data Certificate	
Q8	Antenna Material Traceability Certification per EN 10204 3.1(5)	
QS	Prior use certificate of FMEDA data (SIS/SIL)(6)	
U1	TÜV/DIBt WHG approval for overfill prevention(6)	
Special Procedures		
P1	Hydrostatic pressure testing(4)	
Antenna Modification		
S3	Cone antenna extension, 500 mm (20 in), made of 316 / 316L / EN 1.4404 SST	Only to be used if there are disturbances inside the nozzle
Model Code Example: 5402 - AF 1 IA 4S PV AA - M1 Q4		

(1) Requires Pos 5 “Hazardous Location Certification” codes IA, IE, IF, IG, or NA
(2) Not available with Pos 5 “Hazardous Location Certification” codes E1, E5, E6 or E7.
(3) Requires Pos 2 “Tank Bus: Power and Communication” code F. For use with Rosemount 2410 Tank Hub.
(4) Bracket mounting (BR) is not available with hydrostatic testing (P1).
(5) Certificate includes all pressure retaining wetted parts.
(6) Requires Pos 2 “Tank Bus: Power and Communication” code H.

13 Single Point Temperature Measurement

Single point temperature sensors are used in applications with lower requirements on volume measurements, or when it is not possible to use a multiple spot temperature sensor due to installation restrictions (e.g. an LPG tank with thermowell).

A Rosemount 65 or 68 series, platinum RTD (Resistance Temperature Detector) single point temperature sensor is ordered integrated with the 644 Temperature Transmitter. Temperature data is distributed to TankMaster or a DCS/host system via the 2410 tank hub.

The Rosemount 644 Single Point Temperature Transmitter connects to a sensor.
It supplies the measured data to the Tankbus, which utilizes the FOUNDATION™ fieldbus communication protocol.

13.1 ROSEMOUNT 644 TEMPERATURE TRANSMITTER

Rosemount 644 Temperature Transmitter can be used with Rosemount single point sensors to transfer temperature values on the Tankbus to the 2410 tank hub. A selection of these sensors is described in “Rosemount 65 and 68 Single Point Temperature Sensors” on page 148.

Left: 644 Temperature Transmitter.
Right: 644 Temperature Transmitter with display option.

13.2 ROSEMOUNT 65 AND 68 SINGLE POINT TEMPERATURE SENSORS

The 65 and 68 series single point temperature sensors can be ordered pre-installed in a thermowell.

The temperature sensor can be connected with a flange or a thread (see Ordering information on page 156-160 for details) and is delivered with Class B tolerance as standard according to EN 60751. See page 57 for sensor accuracy diagram and page 24 for temperature/volume uncertainty.

Different Resistance Temperature Detectors (RTD) sensors and housing options.

13.3 INSTALLATION CONSIDERATIONS

65 series sensors may be ordered as complete assemblies, by specifying type of sensing element, length, extension, enclosure (connection head) and thermowell. They can be ordered with flying leads, or a terminal block.

Ordered with flying leads, the sensor is designed to be used with the 644 Temperature Transmitter attached directly to the sensor. The flying lead configuration allows removal of the sensor and transmitter as one assembly.

68 series sensors may be ordered as complete assemblies, by specifying type of sensing element, length, extension, and thermowell. They can be ordered with flying leads, or an enclosure (connection head) with terminal block.

Ordered with flying leads, the sensor is designed to be used with the 644 Temperature Transmitter with enclosure (connection head), attached directly to the sensor.

Rosemount 65 sensor in thermowell pre-assembled to the Rosemount 644 Temperature Transmitter with LCD option. An extension can be used to keep the electronics further away from a heated tank.

Stainless steel thermowell

Single point temperature sensors in thermowells are used for pressurized tanks and when there is a requirement to be able to replace a sensor without having to drain or evacuate the process. They can be connected with a flange or a thread (see ordering information for details).

65 and 68 Series RTD Flying Leads

Single Element

Series 65 RTD Terminal Block Termination

Single Element

13.4 SPECIFICATION

See the Rosemount 644, 65 and 68 Series Product Data Sheets (00813-0100-4728, 00813-0200-2654, and 00813-0100-2654) for complete information.

Rosemount 644	
Product	Rosemount 644 Single Point Temperature Transmitter
Wiring	644 with integrated 4-wire Rosemount 65 or 68 Single Point Temperature Sensor
Metrology sealing possibility	No
Write protect switch	No
Hazardous location certification and IS parameters	ATEX, FM, CSA, and IECEx. For details, see “Certifications for Rosemount 644” on page 152
CE-mark	Meets all requirements listed under IEC 61326: Amendment 1, 1998
Ordinary location certification	Complies with FM 3810:2005 and CSA C22.2 No. 142-M1987
Measuring Performance	
Reference accuracy	± 0.15 °C (± 0.27 °F) over the whole temperature measuring range. For temperature sensor accuracy, see page 151
Temperature measuring range	– 50 to 450 °C (–58 to 842 °F) or –196 to 600 °C (–321 to 1112 °F) depending on option
Resolution	± 0.1 °C (± 0.1 °F) according to API chapter 7 and 12
Update time	≤ 0.5 seconds
Display / Configuration / Communication	
Local display	The optional five-digit integral LCD Display includes a floating or fixed decimal point. It can also display engineering units such as °F, °C, and percent of span. The display can be configured to alternate between selected display options. Display settings are preconfigured at the factory according to the standard transmitter configuration. They can be reconfigured in the field using FOUNDATION™ fieldbus communication
Electric	
Power supply	Powered by Rosemount 2410 Tank Hub (9.0-17.5 VDC, polarity insensitive)
Internal power consumption	Typical 70 mW
Bus current draw	11 mA
Cable entry (connection/glands)	M20 x 1.5 and ½-in. NPT entries for cable glands and conduits
Tankbus cabling	0.5-1.5 mm^2 (AWG 22-16), twisted shielded pairs
Built-in Tankbus termination	No
Tankbus to sensor isolation	Tested to 500 VAC rms (707 VDC) at 50/60 Hz
Tankbus to sensor isolation	500 VAC
Mechanical	
Enclosure (connection head)	There are two choices available, one when the 644 transmitter is installed together with the 68 sensor and the other which is used if the transmitter is ordered stand-alone (see page 155). If the 644 transmitter is used with a Rosemount 65 sensor, the enclosure is ordered with the sensor (see page 156)
Dimensions	See “Rosemount 644 Dimensions” on page 153
Weight	< 0.8 kg (1.8 lbs), depending on options
Environment	
Ambient operating temperature	-40 to 85 °C (-40 to 185 °F). LCD(1): -20 to 85 °C (-4 to 185 °F)
Storage temperature	-50 to 120 °C (-58 to 248 °F). LCD: -45 to 85 °C (-50 to 185 °F)
Humidity	0 - 99% relative humidity

(1) The LCD display may not be readable and LCD updates will be slower at temperatures below -20 °C (-4 °F).

Rosemount 65	
Product	Rosemount 65, platinum RTD temperature sensors
Element type	Pt-100 spot elements according to EN 60751. 4-wire, single element design
Accuracy	DIN Class B (standard). See diagram on page 57.
Pressure range	According to flange/thermowell pressure rating
Temperature range (standard)	– 50 to 450 °C (–58 to 842 °F)
Temperature range (optional)	–196 to 600 °C (–321 to 1112 °F)
Ambient temperature, enclosure (connection head)	– 40 to 85 °C (–40 to 185 °F)
Sheath material	316 SST / 321 SST
Tank connection	½-in, ¾-in, or 1-in. NPT, M20 x 1.5, 1-in. 1.5-in. or 2-in. 150 or 300 lbs flanges
Immersion length	500 mm (20 in.) to 1000 mm (40 in.)
Extension length	An extension of 135 mm (5.3 in.) as standard can be used to have the sensor housing and transmitter installed further away from a heated tank. The extension material is stainless steel.
Enclosure (connection head)	Aluminium
Ingress protection	Rosemount Series 65 sensor assemblies are IP68 and NEMA 4X. This rating is applicable only for complete assemblies including either: • a connection head, extension, and sensor • a connection head, extension, and barstock thermowell including sensor
Approvals	Considered as a “simple apparatus” when used with Rosemount 644 or Rosemount 2240S in a Raptor system
Thermowell dimensions	See “Rosemount 65 Dimensions” on page 153
Thermowell material	Stainless steel 1.4404 (AISI 316L)

Rosemount 68	
Product	Rosemount 68, platinum RTD temperature sensors. Mainly intended for the North American market.
Element type	Pt-100 spot elements according to EN 60751. 4-wire, single element design
Accuracy	DIN Class B (standard). See diagram on page 57.
Pressure range	According to flange/thermowell pressure rating
Temperature range	– 50 to 400 °C (–58 to 752 °F)
Sheath material	316 SST / 321 SST
Tank connection	1-in or 1½-in NPT, 1-in. 1½-in 2-in. or 3-in 150 lbs flanges
Immersion length	1 to 48 in. 36 in. is standard for Raptor
Extension length	3 in. is standard for Raptor. Extension material is stainless steel
Ingress protection	Rosemount 68 sensor assemblies are suitable for indoor and outdoor NEMA 4X and CSA Enclosure Type 4X installations. This rating is applicable only for complete assemblies including either: • a connection head, extension, and sensor • a connection head, extension, and thermowell including sensor
Approvals	Considered as a “simple apparatus” when used with Rosemount 644 or Rosemount 2240S in a Raptor system
Thermowell dimensions	See “Rosemount 68 Dimensions” on page 154
Thermowell material	316 stainless steel

13.5 PRODUCT CERTIFICATIONS

13.5.1 Certifications for Rosemount 644

For complete information, see the Rosemount 644 Product Data Sheet (00813-0100-4728).

Factory Mutual (FM) Approval

I5 FM Intrinsic Safety
Intrinsically Safe (Entity) / FISCO for use in Class I, II, III, Division 1, Groups A, B, C, D, E, F, and G; when installed per control drawing 00644-2075.
Temperature Code: T4A (T_{amb} = – 50 to 40 °C).
Nonincendive for use in Class I, Division 2, Groups A, B, C, and D.
Temperature Code:
T4 (T_{amb} = – 50 to 85 °C);
T5 (T_{amb} = – 50 to 70 °C)

ATEX Approval CE 1180

I1 ATEX Intrinsic Safety
Certificate Number: Baseefa03ATEX0499X
ATEX Marking:

Ex II 1 G

EEx ia IIC T4 (-50 °C ≤ T_{amb} ≤ 60 °C)

Entity Parameters
I.S. Loop/Power Terminals:
U_i = 30 V, I_i = 300 mA, P_i = 1.3 W, C_i = 2.1 nF, L_i = 0
FISCO Loop/Power Terminals:
U_i= 17.5 V, I_i = 380 mA, P_i = 5.32 W, C_i = 2.1 nF, L_i = 0
Sensor Terminals:
U_i= 13.9 V, I_i = 23 mA, P_i = 79 mW, C_i = 7.7 nF, L_i = 0

Special Conditions for Safe Use (X)
The apparatus must be installed in an enclosure which affords it a degree of protection of at least IP20.
Non-metallic enclosures must have a surface resistance of less than 1G, light alloy or zirconium enclosures must be protected from impact and friction when installed.

Canadian Standards Association (CSA) Approval

I6 CSA Intrinsic Safety
Intrinsically Safe and FISCO for Class I, Division 1, groups A, B, C, and D when connected per Rosemount drawing 00644-2076.
Temperature code: T4 (T_{amb} = – 50 to 60 °C);
Suitable for Class I, Division 2, groups A, B, C, and D (must be installed in a suitable enclosure)
Temperature Code:
T4 (T_{amb} = – 50 to 60 °C);
T5 (T_{amb} = – 50 to 85 °C)

IECEx Approval

I7 IECEx Intrinsic Safety (FISCO)
Certificate Number: IECEx BAS 07.0053X
Ex ia IIC T4/T5/T6

Conditions for Safe Use (X)
1. The apparatus must be installed in an enclosure which affords it a degree of protection of at least IP20.
2. Non-metallic enclosures must have a surface resistance of less than 1 G; light alloy or zirconium enclosures must be protected from impact and friction when installed.

13.6 DIMENSIONAL DRAWINGS

13.6.1 Rosemount 644 Dimensions

If the expected process temperature is near or beyond the transmitter specification limits, consider the use of additional thermowell extension length (ordered with the sensor), or a remote installation configuration to isolate the transmitter from these excessive temperatures

Example

The rated ambient temperature specification for the transmitter is 85 °C (185 °F). If the maximum ambient temperature is 40 °C (104 °F) and the temperature to be measured is 540 °C (1004 °F), the maximum allowable housing temperature rise is the rated temperature specification limit minus the existing ambient temperature (85 – 40), or 45 °C (81 °F).

As shown in the following diagram, an "N" dimension of 90 mm (3.5 in.) will result in a housing temperature rise of 22 °C (40 °F). An "N" dimension of 100 mm (3.9 in.) would therefore be the minimum recommended length, and would provide a safety factor of about 25 °C (40 °F).

A longer "N" dimension, such as 150 mm (5.9 in.), would be desirable, although in that case the transmitter may require extra support.

13.6.2 Rosemount 65 Dimensions

13.6.3 Rosemount 68 Dimensions

Dimensions are in inches (mm)

Sensor with Extension (No Thermowell)

Sensor Installed in Connection Head (Flat Cover) with Union and Nipple Extensions and Thermowell

13.7 ORDERING INFORMATION

The following is a selection of possible temperature transmitter and sensor options. If you require other options, please consult your local Rosemount Tank Gauging sales representative.
More information can be found in the Rosemount 644, 65 and 68 Series Product Data Sheets (00813-0100-4728, 00813-0200-2654, and 00813-0100-2654).

13.7.1 Rosemount 644

Model (Pos 1)	Product Description	Note
644	Single Point Temperature Transmitter	If integrated with the Rosemount 65 sensor, the enclosure (connection head) is ordered with the 65 sensor. If integrated with the Rosemount 68 sensor, or stand-alone usage of the 644 transmitter, the enclosure (connection head) is ordered in Pos 5+ Options code J6 or R2
Code (Pos 2)	**Transmitter Type**	**Note**
H	Head mount	
Code (Pos 3)	**Output**	**Note**
F	Bus powered 2-wire FOUNDATION™ fieldbus (IEC 61158)	
Code (Pos 4)	**Hazardous Location Certification**	**Note**
I1	ATEX Intrinsic Safety(1)	
I5	FM Intrinsic Safety(1)	
I6	CSA Intrinsic Safety(1)	
I7	IECEx Intrinsic Safety(1)	
NA	No hazardous location certification(1)	
Code (Pos 5+)	**Options**	**Note**
XA	Rosemount 65 or 68 Single Point Temperature Sensor assembled to the transmitter. The sensor is specified separately(2)	
M5	LCD display(3)	
GE	Eurofast male connectors	
GM	Minifast male connectors	
J6	Enclosure (connection head)	Universal head with 2 in. SST pipe bracket. For stand-alone 644 usage, or when the 644 is integrated with the 68 sensor(4)
R2	Enclosure (connection head)	Rosemount connection head. Used when the 644 is integrated with the 68 sensor(4)
Model Code Example: 644 - H F I1 - XA M5 C2 C4 Q4		

(1) Best practice is to install the associated single point temperature sensor in a thermowell, but for ATEX and IECEx certification it is a requirement when connecting Rosemount 644 Transmitter to the Rosemount 2410 Tank Hub.
(2) If ordering option XA (pre-assembly), specify XA for both the 644 transmitter and 65/68 sensor.
(3) Requires Pos 2 "Enclosure (Connection Head)" code 1 or 2 for Rosemount 65 Single Point Temperature Sensor.
(4) Either of J6 or R2 enclosure (connection head) is required for integration of the 68 sensor.

13.7.2 Rosemount 65 Single Point Temperature Sensor, without Thermowell

Model (Pos 1)	Product Description	Note
0065	Single Point Temperature Sensor, Pt-100 RTD, Class B standard	To be installed in existing thermowell
Code (Pos 2)	**Enclosure (Connection Head)**	**Note**
C	Aluminum. M20 x 1.5 cable entry. IP 68	
D	Aluminum. ½-in. NPT cable entry. IP 68	
1	Aluminum with LCD meter cover. M20 x 1.5 cable entry. IP 68	
2	Aluminum with LCD meter cover. ½-in. NPT cable entry. IP 68	
Code (Pos 3)	**Sensor Lead Wire Termination**	**Note**
0	Flying leads. Use when ordering with Rosemount 644	
2	Terminal block. Use when ordering with Rosemount 2240S or as a stand-alone sensor	
Code (Pos 4)	**Sensor Type**	**Note**
1	RTD, single element, 4-wire (Class B)	– 50 to 450 °C (–58 to 842 °F)
3	RTD, single element, 4-wire (Class B)	–196 to 600 °C (–321 to 1112 °F)
Code (Pos 5)	**Extension Type**	**Note**
D	DIN – standard, 12 x 1.5	Head Connection: M24 x 1.5 Instrument Connection:½-in NPT Stainless Steel (minimum length N = 35 mm)
X	Special	
Code (Pos 5)	**Extension Length (N)**	**Note**
0135	135 mm (5.3 in.)	
XXXX	Customized length in mm (minimum 35 mm)	
Code (Pos 6)	**Thermowell Material**	**Note**
N	No thermowell	
Code (Pos 7)	**Sensor/Immersion Length (L)**	**Note**
0500	500 mm (19.7 in.)	
0600	600 mm (23.6 in.)	
0700	700 mm (27.6 in.)	
0800	800 mm (31.5 in.)	
0900	900 mm (35.4 in.)	
1000	1000 mm (39.4 in.)	
Code (Pos 8+)	**Options – none or multiple selections are possible**	**Note**
XA	Assemble sensor to Rosemount 644 temperature transmitter(1)	
Model Code Example: 0065 - C 0 1 D 0135 N 1000 - XA		

(1) If ordering option XA (pre-assembly), specify XA for both the 644 transmitter and 65 sensor.

13.7.3 Rosemount 65 Single Point Temperature Sensor, with Barstock Thermowell

Model (Pos 1)	Product Description	Note
0065	Single Point Temperature Sensor, Pt-100 RTD, Class B standard	
Code (Pos 2)	**Enclosure (Connection Head)**	**Note**
C	Aluminum. M20 x 1.5 cable entry. IP 68	
D	Aluminum. ½-in. NPT cable entry. IP 68	
1	Aluminum with LCD meter cover. M20 x 1.5 cable entry. IP 68	
2	Aluminum with LCD meter cover. ½-in. NPT cable entry. IP 68	
Code (Pos 3)	**Sensor Lead Wire Termination**	**Note**
0	Flying leads. Use when ordering with Rosemount 644	
2	Terminal block. Use when ordering with Rosemount 2240S or as a stand-alone sensor	
Code (Pos 4)	**Sensor Type**	**Note**
1	RTD, single element, 4-wire (Class B)	– 50 to 450 °C (–58 to 842 °F)
3	RTD, single element, 4-wire (Class B)	–196 to 600 °C (–321 to 1112 °F)
Code (Pos 5)	**Extension Type**	**Note**
D	DIN – standard, 12 x 1.5	Head Connection: M24 x 1.5 Instrument Connection:½-in NPT Stainless Steel (minimum length N = 35 mm)
X	Special	
Code (Pos 5)	**Extension Length (N)**	**Note**
0135	135 mm (5.3 in.)	
XXXX	Customized length in mm (minimum 35 mm)	
Code (Pos 6)	**Thermowell Material**	**Note**
D	SST 1.4404 (AISI 316L)	
Code (Pos 7)	**Sensor/Immersion Length (U)**	**Note**
0500	500 mm (19.7 in.)	
0600	600 mm (23.6 in.)	
0700	700 mm (27.6 in.)	
0800	800 mm (31.5 in.)	
0900	900 mm (35.4 in.)	
1000	1000 mm (39.4 in.)	

Code (Pos 8)	Tank Connection	Note
Threaded process connection		
T44	½-in. NPT, threaded	
T46	¾-in. NPT, threaded	
T48	1-in. NPT, threaded	
T98	M20 x 1.5, threaded	
Flanged connection		
F04	ANSI 1 in. Class 150	
F10	ANSI 1 ½-in. Class 150	
F16	ANSI 2 in. Class 150	
F22	ANSI 1 in. Class 300	
F28	ANSI 1 ½-in. Class 300	
F34	ANSI 2 in. Class 300	
D16	EN DN40 PN16	
D22	EN DN40 PN25/40	
Code (Pos 9+)	**Options – none or multiple selections are possible**	**Note**
XA	Assemble sensor to Rosemount 644 temperature transmitter(1)	
Q8	Thermowell material certification, DIN EN 10204 3.1	
Model Code Example: 0065 - C 0 1 D 0135 D 1000 T44 - XA		

(1) If ordering option XA (pre-assembly), specify XA for both the 644 transmitter and 65 sensor.

13.7.4 Rosemount 68 Single Point Temperature Sensor, without Thermowell

Model (Pos 1)	Product Description	Note
0068	Single Point Temperature Sensor, Pt-100 RTD, Class B standard	To be installed in existing thermowell
Code (Pos 3)	**Sensor Lead Wire Termination**	**Note**
N	Sensor only with 6 in. PTFE insulated, 22 AWG lead wires. For use with Rosemount 644	
P	Aluminum enclosure (connection head), 6 terminals, flat cover, painted. For use with Rosemount 2240S or as a stand-alone sensor	
Code (Pos 4)	**Sensor Type**	**Note**
21	Spring loaded style	
Code (Pos 5)	**Extension Type**	**Note**
A	Nipple coupling	
Code (Pos 5)	**Extension Length (E)**	**Note**
30	3 in. standard	
60	6 in. optional	
Code (Pos 6)	**Thermowell Material**	**Note**
N	No thermowell required	
Code (Pos 7)	**Sensor/Immersion Length (L)**	**Note**
360	36 in.	
010-480	1-48 in.	
Code (Pos 8+)	**Options – none or multiple selections are possible**	**Note**
XA	Assemble sensor to Rosemount 644 temperature transmitter(1)	
Model Code Example: 0068 - N 21 A 30 N 360 - XA		

(1) If ordering option XA (pre-assembly), specify XA for both the 644 transmitter and 68 sensor.

13.7.5 Rosemount 68 Single Point Temperature Sensor, with Thermowell

Model (Pos 1)	Product Description	Note
0068	Single Point Temperature Sensor, Pt-100 RTD, Class B standard	
Code (Pos 3)	**Sensor Lead Wire Termination**	**Note**
N	Sensor only with 6 in. PTFE insulated, 22 AWG lead wires. For use with Rosemount 644	
P	Aluminum enclosure (connection head), 6 terminals, flat cover, painted. For use with Rosemount 2240S or as a stand-alone sensor	
Code (Pos 4)	**Sensor Type**	**Note**
21	Spring loaded style	
Code (Pos 5)	**Extension Type**	**Note**
A	Nipple coupling	
Code (Pos 5)	**Extension Length (E)**	**Note**
30	3 in. standard	
60	6 in. optional	
Code (Pos 6)	**Thermowell Material**	**Note**
A	316 stainless steel	
Code (Pos 7)	**Sensor/Immersion Length (U)**	**Note**
360	36 in.	
010-480	1-48 in.	
Code (Pos 8)	**Thermowell Style**	**Note**
Threaded Process Connection		
T28	1 in. NPT	
T30	1½ in. NPT	
Flanged Process Connection		
F58	1 in. Class 150	
F60	1½ in. Class 150	
F62	2 in. Class 150	
F12	3 in. Class 150	
Code (Pos 8+)	**Options – none or multiple selections are possible**	**Note**
XA	Assemble sensor to Rosemount 644 temperature transmitter(1)	
Q8	Thermowell material certification	

(1) If ordering option XA (pre-assembly), specify XA for both the 644 transmitter and 68 sensor.

14 Rosemount 2100 Series Liquid Level Switches

Rosemount 2100 Series vibrating fork liquid level switch is an alternative to a radar level gauge if a separate high level alarm device is required in a Raptor system (see “Additional High Level Alarm Configurations” on page 17). The 2100 Series consists of different models such as:

- Rosemount 2120 Liquid Level Switch
- Rosemount 2160 Wireless Liquid Level Switch

Rosemount 2100 Series are liquid point level switches based on the vibrating short fork technology. The “fast drip” fork design together with a short switching delay allow it to react more quickly and have greater sensitivity to density variations.

It is suitable for virtually all liquid applications, including coating liquids (avoid product bridging of forks), and can be used as a high or low level alarm to complement a level gauge.

Features include a complete range of process connections, housing alternatives, a choice of wetted parts materials, dry-to-wet and wet-to-dry switching functions, extended fork lengths, and hazardous area approvals.

Rosemount 2120 is TÜV-tested and approved for overfill prevention according to the German WHG regulations. It is also suitable for SIL 2 applications.

Rosemount 2120 Vibrating Fork Liquid Level Switch.

14.1 ROSEMOUNT 2160 LIQUID LEVEL SWITCH FOR *WIRELESS*HART NETWORKS

Rosemount 2160 combines Emerson’s wireless expertise with the Rosemount 2120 vibrating short fork technology. It can be used as a separate alarm switch with the capability to transmit and receive tank data within the Smart Wireless tank gauging network.

Rosemount 2160 Vibrating Fork Liquid Level Switch for IEC 62591 (*Wireless*HART) networks.

14.2 SHORT FORK TECHNOLOGY FOR MINIMUM TANK INTRUSION

A piezo-electric crystal is used to oscillate the forks at their natural frequency (~1300 Hz which is chosen to avoid interference from plant vibration – false switching is avoided). Changes to this frequency are continuously monitored.

When the 2100 series is used as a low alarm, the liquid in the vessel drains down past the fork, resulting in a change of the natural frequency; this is detected by the electronics which switches the output state.

When used as a high alarm, the liquid rises in the vessel, makes contact with the fork and the output switches.

Fixed roof tank with Rosemount 2120 switch.

14.3 HEARTBEAT LED CONFIRMS CORRECT FUNCTIONALITY

Rosemount 2120 has a status indicating heartbeat LED which can be seen at all times and from all angles through a lens in the cover (no lens in metal housings). The LED will flash when the 2120 is ‘off’ and will be constantly lit when it is ‘on’. The LED gives constant indication that the 2120 is functioning correctly (different flash rates are used to indicate product malfunction) and gives local indication of the process state.

14.4 INSTALLATION CONSIDERATIONS

Rosemount 2100 series is suitable for both horizontal and vertical installation. It can be ordered with an extended, customized fork length to get the forks positioned at the alarm level in the tank.

14.4.1 Magnetic Test Point for Functional Test

A magnetic test point is located on the side of the housing, allowing the user to perform a functional test of Rosemount 2120 and the system connected to it. By holding a magnet to the target, the output will change state for as long as the magnet is held.

Functional verification of Rosemount 2160 can be done via the AMS™ Suite or a Field Communicator.

14.5 SPECIFICATION

For more information, see the Rosemount 2120 Product Data Sheet (00813-0100-4030) and Rosemount 2160 Product Data Sheet (00813-0100-4160).

General	
Product	• Rosemount 2120 Vibrating Fork Liquid Level Alarm Switch • Rosemount 2160 Wireless Vibrating Fork Liquid Level Alarm Switch
Measurement principle	Vibrating short fork technology
Special features	**Mode switch / Adjustable time delay** Can be set to switch if the forks get either wet (typically high alarm) or dry (typically low alarm). The time delay for Rosemount 2120 is selectable: 0.3, 1, 3, 10 or 30 s (dry to wet / wet to dry). The time delay for Rosemount 2160 is fully configurable. **Heartbeat LED (Rosemount 2120)** The status indicating LED gives constant indication of whether or not the switch is functioning correctly. The LED is constantly lit when the switch is on and it flashes if it is off. **Magnetic Test point (Rosemount 2120)** The test point, located on the side of the housing, can be used for alarm simulation
Wireless characteristics, Rosemount 2160	**Antenna** Integrated omnidirectional antenna. **Output** IEC 62591 (*Wireless*HART) 2.4 GHz DSSS **Transmit Rate** User selectable: 4 s to 60 minutes
Liquid density range	Rosemount 2120: Minimum 600 kg/m^3 (37.5 lb/ft^3) Rosemount 2160: Minimum 500 kg/m^3 (31.2 lb/ft^3)
Liquid viscosity range	0.2 to 10,000 cP (centiPose)
Hysteresis (water)	± 1 mm (± 0.039 in.)
Switching point (water)	13 mm (0.5 in.) from tip (vertical) / from edge (horizontal) of fork (this will vary with different liquid densities)
Hazardous location certification, Rosemount 2120	**FM Explosion Proof:** Explosion Proof for Class I, Div. 1, Groups A, B, C and D. T6. 4X. **FM IS:** Intrinsically Safe for Class I, Div. 1, Groups A, B, C and D Class I, Zone 0, AEx ia IIC. T5. **CSA Explosion Proof:** Explosion Proof for Class I, Div. 1, Groups A, B, C, and D. T6. 4X **CSA IS:** Intrinsically Safe for Class I, Div. 1, Groups A, B, C, and D Class 1, Zone 0, Ex ia IIC. T5. **CSA Non-Incendive:** Non-Incendive for Class I, Div. 2, Groups A, B, C, and D. T5. **ATEX Flameproof:** II 1/2 G D EEx d IIC T6. **ATEX IS:** II 1 G D EEx ia IIC T5.
Hazardous location certification, Rosemount 2160	**FM IS:** Intrinsic Safety, and . Intrinsically safe for Class I/II/III, Div. 1, Groups A, B, C, D, E, F, and G. Zone marking: Class I, Zone 0, AEx ia IIC. T4. Non-incendive for Class I, Div. 2, Groups A, B, C, and D. Dust Ignition proof for Class II/III, Div. 1, Groups E, F, and G. 4X/IP66 **CSA IS:** Intrinsically Safe for Class I, Div. 1, Groups A, B, C, and D. T3C. 4X/IP66. **ATEX IS:** II 1 G Ex ia IIC T5-T2. IP66. **IECEx:** Ex ia IIC T5-T2. IP66.
Safety/overfill, Rosemount 2120	**Overfill prevention:** Rosemount 2120 can be ordered with DIBt/WHG **SIL Declaration of Conformity:** Rosemount 2120 with IS Namur electronics has demonstrated proven reliability. It is manufactured and supported in a manner suitable for applications up to SIL 2 of IEC 61508 as a Type B Safety Related Subsystem when configured as a high level alarm
CE-mark	93/68/EEC: complies with applicable directives (EMC, ATEX, LVD, and R&TTE)

Electric	
Electric connection/Alarm indication and Power supply for Rosemount 2120	**Direct Load Switching (two-wire):** U=20 to 264 VAC (50/60 Hz) or 20 to 60 VDC. I_{OFF} < 3 mA, I_L=20-500 mA. Rosemount 2120 is connected in series with a load to achieve direct load switching. **Solid state PNP output for direct interface to PLC's (3-wire):** U=20 to 60 VDC. $I_{L(max)}$=0-500 mA. **SPCO single relay for voltage free contacts:** In: U=20 to 264 VAC (50/60 Hz), I < 6 mA. Out: U_{max}=250 VAC, I_{max}=5 A, P_{max}=1250 VA, resistive, 1000 VA, inductive. U_{max}=60 VDC, I_{max}=5 A if U< 30 VDC, I_{max}=1.5 A if U< 60 VDC. **Intrinsically Safe (IS) NAMUR, DIN 19234, IEC 60947-5-6:** I_{ON} = 2.2 to 2.5 mA, I_{OFF} =0.8 to 1.0 mA Rosemount 2120 is polarity insensitive and has over-current, short-circuit and load-missing protection. Surge protection according to IEC61326.
Power supply Rosemount 2160 & Alarm indication	The 2160 switch is powered by the Lithium-Thionyl Chloride wireless power module which has a PBT enclosure. The power module is replaceable and intrinsically safe. It incorporates SmartPower™ benefits, which means reduced power consumption. The power module has ten years life time at one minute transmit rate Alarm signals are transferred over the wireless network to the Smart Wireless Gateway
Mechanical	
Fork length	50 mm (2 in.) to 3 m (118 in.)
Housing	Rosemount 2120: Glass Filled Nylon or Aluminum Rosemount 2160: Aluminum
Cable entry (connection/glands)	Two M20, 1/2-in. or 3/4-in. NPT entries for cable glands and conduits
Terminal connection	Wire diameter maximum 2.5 mm^2 (0.1 in^2). National regulations
Process connection	**Threaded** • 3/4-in. BSP or NPT • 1-in. BSP or NPT **Flanges** • ANSI, 1.5-4 in. 150-300 lb • DIN (EN), DN 40-100, PN 10/16-25/40
Wetted material	316L SST (EN 1.4404)
Environment	
Process temperature	-40 to 150 °C (-40 to 302 °F), depending on process pressure and ambient temperature
Ambient temperature	-40 to 80 °C (-40 to 176 °F)
Process pressure	-1 to 100 barg (-14.5 to 1450 psig), depending on the process temperature. Note: If the Rosemount 2120 switch is used with a clamp gland, maximum operating pressure is limited to 1.3 barg (18.85 psig)
Ingress protection	Ingress protection: IP 66/67 or Type 4X
Vibration resistance	EN60721 level 3M6/4M6
Telecommunication (FCC and R&TTE) for Rosemount 2160	Compliance with: • **FCC** part 15 Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.This device must be installed to ensure a minimum antenna separation distance of 7.9 in. (20 cm) from all persons. • **R&TTE** (EU directive 1999/5/EC) • **IC**
Electromagnetic compatibility	Rosemount 2120: EN61326 Emissions to Class B. Rosemount 2160: EMC directive 2004/108/EC, and EN61326-1:2006
Pressure Equipment Directive (PED)	97/23/EC

14.5.1 Temperature and Pressure Diagrams for Rosemount 2120

14.5.2 Temperature and Pressure Diagrams for Rosemount 2160

14.6 DIMENSIONAL DRAWINGS

Dimensions are in mm (in.)

14.6.1 Rosemount 2120

Threaded Connection

Flanged Connection

Fork Length

Thread	Standard Length Model Code A	Minimum Length Model Code M (E)	Maximum Length Model Code M (E)
3/4-in.	44 (1.73)	95(3.74)	3000 (118.11)
1-in.	44 (1.73)	94 (3.70)	3000 (118.11)
Flange	**Standard Length Model Code H**	**Minimum Length Model Code M (E)**	**Maximum Length Model Code M (E)**
Stainless Steel	102 (4)	89 (3.50)	3000 (118.11)

Housing Dimensions

Material	B	C	D(1)
Aluminum	68 (2.68)	102 (4.02)	156 (6.14)

(1) Will vary with flange rating and thickness. "D" is nominal maximum thickness and allows a flange up to 45 mm (1.77 in.) thick. This equates to a 4-in. ANSI, 600 lb. RF.

14.6.2 Rosemount 2160

Dimensions are in mm (in.)

Threaded Connection

Threaded Connection, Extended Length

Dimensions are in mm (in.)

Note: Dimensions are in inches (millimeters)

Process Connection	Standard Length Model Code A	Minimum Length Model Code M (E)	Maximum Length Model Code M (E)
3/4-in. Thread	44 (1.73)	95 (3.75)	3000 (118.1)
1-in. Thread	44 (1.73)	94 (3.74)	3000 (118.1)

Flanged Connection, Standard Length

Dimensions are in mm (in.)

Flanged Connection, Extended Length

Dimensions are in mm (in.)

Process Connection	Standard Length Fork Length Code H	Minimum Length Fork Length Code M (E)	Maximum Length Fork Length Code M (E)
3/4-in., 1-in. or larger flange	102 (4.0)	94 (3.7)	3000 (118.1)

14.7 ORDERING INFORMATION

This is a selection of the Rosemount switch offering, especially suitable for tank gauging applications. See Rosemount 2120 Product Data Sheet (00813-0100-4030) and Rosemount 2160 Product Data Sheet (00813-0100-4160) for the complete product range.

14.7.1 Rosemount 2120

Model (Pos 1)	Product Description	
2120	Vibrating Fork Liquid Level Switch	
Code (Pos 2)	**Material of Construction: Process Connection/Fork**	
D	316L Stainless Steel (1.4404)	
Code (Pos 3)	**Process Connection Size / Type**	
Threaded		
0A	¾-in. BSPT (R) thread	
0B	¾-in. BSPP (G) thread	
0D	¾-in. NPT thread	
1A	1-in. BSPT (R) thread	
1B	1-in. BSPP (G) thread	
1D	1-in. NPT thread	
ANSI Flanges		
5G	1.5-in. ANSI, 150 lb. RF	
5H	1.5-in. ANSI, 300 lb. RF	
2G	2-in. ANSI, 150 lb. RF	
2H	2-in. ANSI, 300 lb. RF	
3G	3-in. ANSI, 150 lb. RF	
3H	3-in. ANSI, 300 lb. RF	
4G	4-in. ANSI, 150 lb. RF	
4H	4-in. ANSI, 300 lb. RF	
DIN (EN) Flanges		
5K	DN40, PN 10/16	
5L	DN40, PN 25/40	
2K	DN50, PN 10/16	
2L	DN50, PN 25/40	
7K	DN65, PN 10/16	
7L	DN65, PN 25/40	
3K	DN80, PN 10/16	
3L	DN80, PN 25/40	
4K	DN100, PN 10/16	
4L	DN100, PN 25/40	
Code (Pos 4)	**Electronic Type**	**Available for Certifications**
S	Direct load switching (2-wire) 20 to 264 VAC 50/60 Hz, 20 to 60 VDC	NA, E1, E5, E6, E7
B	PNP/PLC low voltage switching (3-wire) 20 to 60 VDC	NA, E1, E5, E6, E7
R	Relay (SPDT/SPCO)	NA, E1, E5, E6, E7
C	IS NAMUR (Ex ia)(1)	I1, I3, I5, I6, I7
Code (Pos 5)	**Surface Finish (wetted parts)**	
1	Standard surface finish	

Code (Pos 6)	Product Certifications	Available for Electronic	Available for Housing
NA	No Hazardous Locations Certifications	S, B, R	A, D
E1	ATEX Flameproof	S, B, R	X
E5	FM Explosion Proof	S, B, R	Y
E6	CSA Explosion Proof	S, B, R	Y
E7	IECEx Explosion Proof	S, B, R	X
I1	ATEX Intrinsic Safety	C	A, D
I5	FM Intrinsic Safety	C	A, D
I6	CSA Intrinsically Safe and Non-Incendive	C	A, D
I7	IECEx Intrinsic Safety	C	A, D
Code (Pos 7)	**Housing**		**Available for Certification**
A	Glass Filled Nylon, M20 conduits/cable threads		NA, I1, I3, I5, I6, I7
D	Glass Filled Nylon, 1/2-in. NPT conduits/cable threads		NA, I1, I3, I5, I6, I7
X	Aluminum Alloy, M20 conduits/cable threads		E1, E7
Y	Aluminum Alloy, 3/4-in. NPT conduits/cable threads		E5, E6
Code (Pos 8)	**Fork Length**		**Available for Connection**
A	Standard length 44 mm (1.7 in.)		All except flanged models
H	Standard length flange 102 mm (4.0 in.)		All flanged models
B	Ext 150 mm (5.9 in.)		7.40 in. (188 mm)
C	Ext 300 mm (11.8 in.)		All
D	Ext 500 mm (19.7 in.)		All
Specific Extended Fork Length			
EXXXX	Extended, customer specified length in tenth of inches(2)		All
MXXXX	Extended, customer specified length in millimeters(2)		All
Code	**Options – none or multiple selections are possible**		
Calibration Data Certificate			
Q4			
Material Traceability Certification			
Q8	Material Traceability Certification per EN 10204 3.1B(3)		
Special Procedures			
P1	Hydrostatic testing(4)		
Overfill			
U1	DIBt/WHG overfill prevention		
Model Code Example: 2120 - D 0A C 1 I1 Y A - Q8			

*(1) Rosemount 2120 IS Namur Vibrating Fork Level Sensor models 2120***C*I** has demonstrated proven reliability. It is manufactured and supported in a manner suitable for applications up to SIL 2 of IEC 61508 as a Type B Safety Related Subsystem when configured as a high level alarm in conjunction with a Namur Barrier.*
(2) Minimum length available for 3/4-in. threaded connection is 95 mm (3.8 in.). For 1-in. threaded connection it is 94 mm (3.7 in.), and for flanged connection it is 89 mm (3.5 in.) . Maximum length is 3000 mm (118.1 in.). Example: Code E1181 is 118.1 inches. Code M3000 is 3000 millimeters.
(3) Only available for wetted parts.
(4) Option limited to units of no more then 1500 mm (59.1 in.) extended lengths.

14.7.2 Rosemount 2160

Model (Pos 1)	Product Description	
2160	*Wireless*HART Vibrating Fork Liquid Level Switch	
Code (Pos 2)	**Output**	
X	Wireless	
Code (Pos 3)	**Housing Material**	
D	Dual Compartment Housing - Aluminum (Aluminium)	
Code (Pos 4)	**Conduit Entry / Cable Threads**	
8	½-in. NPT thread	
Code (Pos 5)	**Operating Temperature**	
S	Standard	
Code (Pos 6)	**Material of Construction: Process Connection / Fork**	
S	316/316L Stainless Steel (1.4401/1.4404)	
Code (Pos 7)	**Process Connection Size**	
Threaded		
9NNB	¾-in. BSPT (R) thread	
9NNG	¾-in. BSPP (G) thread	
9NNN	¾-in. NPT thread	
1NNB	1-in. BSPT (R) thread	
1NNG	1-in. BSPP (G) thread	
1NNN	1-in. NPT thread	
ANSI Flanges		
5AAR	1.5-in. ANSI, 150 lb. RF	
5ABR	1.5-in. ANSI, 300 lb. RF	
2AAR	2-in. ANSI, 150 lb. RF	
2ABR	2-in. ANSI, 300 lb. RF	
3AAR	3-in. ANSI, 150 lb. RF	
3ABR	3-in. ANSI, 300 lb. RF	
4AAR	4-in. ANSI, 150 lb. RF	
4ABR	4-in. ANSI, 300 lb. RF	
DIN (EN) Flanges		
5DAR	DN40, PN 10/16	
5DBR	DN40, PN 25/40	
2DAR	DN50, PN 10/16	
2DBR	DN50, PN 25/40	
7DAR	DN65, PN 10/16	
7DBR	DN65, PN 25/40	
3DAR	DN80, PN 10/16	
3DBR	DN80, PN 25/40	
4DAR	DN100, PN 10/16	
4DBR	DN100, PN 25/40	
Code (Pos 8)	**Fork Length**	**Available for Connection**
A0000	Standard length 44 mm (1.7 in.)	All except flanged models
H0000	Standard length flange 102 mm (4.0 in.)	All flanged models
Specific Extended Fork Length		
EXXXX	Extended, customer specified length in tenth of inches(1)	All
MXXXX	Extended, customer specified length in millimeters(1)	All

Code (Pos 9)	Surface Finish (wetted parts)	
1	Standard surface finish	
Code (Pos 10)	**Product Certifications**	
NA	No Hazardous Locations Certifications	
I1	ATEX Intrinsic Safety	
I5	FM Intrinsic Safety	
I6	CSA Intrinsically Safe and Non-Incendive	
I7	IECEx Intrinsic Safety	
Code (Pos 11)	**Wireless Options**	**Available for Certification**
Wireless Update Rate, Operating Frequency and Protocol		
WA3	User configurable update rate, 2.4 GHz DSSS, IEC 62591 (*Wireless*HART)	
Omnidirectional Wireless Antenna and SmartPower Options		
WK1	Long range, integral antenna, long life power module adapter, intrinsically safe	Long-life power module must be shipped separately, order part number 00753-9220-0001
Code	**Options – none or multiple selections are possible**	
Calibration Data Certificate		
Q4		
Material Traceability Certification		
Q8	Material Traceability Certification per EN 10204 3.1B(2)	
Special Procedures		
P1	Hydrostatic testing(3)	
Model Code Example: 2160 - X D 8 S S 1NNN A0000 1 I5 - Q8		

(1) Minimum length available for 3/4-in. threaded connection is 95 mm (3.8 in.). For 1-in. threaded connection it is 94 mm (3.7 in.), and for flanged connection it is 89 mm (3.5 in.) . Maximum length is 3000 mm (118.1 in.). Example: Code E1181 is 118.1 inches. Code M3000 is 3000 millimeters.
(2) Only available for wetted parts.
(3) Option limited to units of no more then 1500 mm. (59.1 in) extended lengths.

15 Rosemount TankMaster

TankMaster is a powerful easy-to-use Windows-based inventory management software package. It provides configuration, service, setup, inventory and custody transfer functions for Rosemount tank gauging systems.

TankMaster gives the most important inventory data for a specific tank in one easy-to-read window.

TankMaster comes in two versions:

- WinOpi is a complete custody transfer and inventory software package. All calculations are based on current API and ISO standards. Configuration of the Raptor system is made with WinSetup, which is included in the delivery.
- WinView is a software package with basic inventory capabilities. It is a cost efficient alternative for operational control at smaller tank terminals, marketing terminals, biofuels and chemical plants, etc. Configuration is made with WinSetup, which is included in the delivery.

There is also a web version available, TankMaster.net. With TankMaster.net it is possible to get an automatic real-time inventory overview of a tank farm via intranet or any PC with internet access.

In TankMaster you can for example choose to see inventory data in a bargraph group, giving a quick overview of tank farm activities.

TankMaster WinView is a cost efficient alternative for basic inventory management.

TankMaster is easily integrated with most host systems on the market, such as DeltaV, Yokogawa, ABB etc.

It has customized views with graphic plant layouts, and advanced group configuration in geographical or product groups etc.

You can easily organize tanks in geographical or product groups, with associated sub-groups.
The "tank farm explorer" makes it easy to navigate in TankMaster. Just like in "Windows explorer" it is possible to expand and minimize fields and get direct group and tank access by double-clicking the specific group or tank icon.

TankMaster includes a user manager with different access levels for personnel.

TankMaster has a setup wizard for guided configuration and installation of all devices in a Raptor system.

It is easily translated to other languages than English.

15.1 COMPARISON BETWEEN TANKMASTER WINOPI AND WINVIEW

Feature	WinOpi	WinView
Alarms	Yes	Yes
Host communication, Modbus and OPC	Yes	Yes
Custody transfer	Yes	No
API tables	Yes	No
Batch handling	Yes	No
Reports	Yes	Yes, partly
Translation	Yes	Yes
TankMaster network support	Yes	No
TM.net	Yes	No
Customization	Yes	No
Create new group of tanks	Yes	No(1)
Redundancy	Yes	No
HTG (hybrid tank gauging)	Yes	No
Supported (measured or calculated) data parameters	**WinOpi**	**WinView**
Level	Yes	Yes
Ullage	Yes	No
Level rate	Yes	Yes
Flow rate	Yes	Yes
Average temperature	Yes	Yes
Spot temperature	Yes	Yes
Vapor temperature	Yes	No
Air temperature	Yes	No
Free water level	Yes	Yes
Free water volume	Yes	Yes
Total observed volume (TOV)	Yes	Yes
Gross observed volume (GOV)	Yes	No
Gross standard volume (GSV)	Yes	No
Net standard volume (NSV)	Yes	No
Vapor, liquid, and air pressure	Yes	No
Observed density	Yes	Yes(2)
Reference density	Yes	No
Mass calculations	Yes	Yes(3)

(1) Possibility to edit existing group ("All tanks").
(2) Manually entered.
(3) Limited

15.2 INVENTORY AND CUSTODY TRANSFER FUNCTIONS

- Real-time tank gauging data such as level, temperature, water interface level and pressure
- Real-time, gross and net volume inventory calculations based on API and ISO
- Hybrid tank gauging with pressure inputs giving data for density and mass calculation
- Metrologically sealed data
- Inventory and transfer calculator
- Batch handling makes it possible to control and follow transferred volumes, from the control room

15.3 TANKMASTER NETWORKS

It is possible to build a network of several server and client PCs with TankMaster software. It is also possible to have redundant servers within the TankMaster network. For redundancy, see “Improve System Reliability by Utilizing Redundancy” on page 13.

TankMaster distributes essential inventory tank gauging data.

15.4 INTEROPERABILITY WITH LEGACY HOST SYSTEMS

- OPC server with browser for easy interface with other plant computer systems
- SCADA / DCS communication via Modbus
- SCADA / DCS communication via OPC
- Integration with other tank gauging systems by taking in and displaying data from other vendors' gauges

15.5 ALARMS

- Reliable alarm handling of measured values with high, high-high, low and low-low level alarms
- Alarms via e-mail, or to mobile phones via an SMS Gateway
- Leakage alarms, visualized and by sound. Such alarms are based on net volume and/or level

15.6 REPORTS AND DATA SAMPLING

- Batch report for internal and external transfers.
- Reports via pdf, text file or e-mail
- Audit log for events
- Historical data sampling

15.7 EMULATION

TankMaster supports a wide range of protocols for gauge and control room emulation. See "Emulation" on page 10 and "Connection to other Systems" on page 11.

15.8 TANKMASTER HYDROSTATIC TANK GAUGING

The TankMaster HTG system is an intelligent direct mass measuring system which uses product hydrostatic pressure measurement to derive both the specific gravity and liquid level. See "Level, Volume, Density and Mass Measurement" on page 12 and the Rosemount TankMaster HTG Technical Description (document number 705010EN) for more information.

For more information, see Rosemount TankMaster Technical Description (document number 705020EN), Rosemount TankMaster WinSetup Reference Manual / System Configuration Manual (document number 300510EN), and Rosemount TankMaster WinOpi Reference Manual (document number 303028EN).

15.9 SPECIFICATION

15.9.1 Rosemount TankMaster WinOpi, WinSetup and WinView

General	
Product	Rosemount TankMaster (WinOpi, WinSetup, WinView)
Operating system requirements	English version of any of the following: • Windows XP Professional, 32-bit version with service pack 3 (SP 3) • Windows Vista, 32-bit version with service pack 1 (SP 1) • Windows 7 Professional, 32- and 64-bit versions, with service pack 1 (SP 1) • Windows Server 2003 Standard, 32-bit version with service pack 2 (SP 2) • Windows Server 2008 Standard, 32- and 64-bit versions with service pack 2 (SP 2)
Required TankMaster PC hardware	
Processor	Windows XP: 2 GHz multi-core processor Windows Vista / Windows 7 / Windows Server 2003 and 2008: 2.5 GHz, multi-core processor
RAM memory	Windows XP: 1 GB for client PCs, and 2 GB for server PCs Windows Vista / Windows 7 / Windows Server 2003: 3 GB Windows Server 2008: 4 GB
Disk drive	40 GB (TankMaster combined with SQL Server 2005 Express, needs approximately 600 MB)
Graphics card	1152*864 pixels, 65536 colors (16 bit)
Serial port	RS232, or USB if FBM 2180 is used (see “Rosemount 2180 Field Bus Modem” on page 108)
Hardware key	The TankMaster server needs one USB port for the hardware key

15.9.2 Rosemount TankMaster.net

General	
Product	Rosemount TankMaster.net
Operating system requirements	English version of: • Windows XP Professional, 32-bit version with service pack 3 (SP 3) • Windows Vista Business, 32-bit version with service pack 2 (SP 2) • Windows 7 Professional, 32-bit version with service pack 1 (SP 1) • Windows Server 2008 Standard, 32-bit version with service pack 2 (SP 2) Installation of Internet Information Services (IIS) is recommended for TankMaster.net servers
Server PC hardware requirements	
Processor	1.8 GHz (single processor) or better
RAM memory	256 MB (1024 MB recommended)
Disk drive	20 GB
Graphics card	1152*864 pixels, 65536 colors (16 bit)
Bandwidth to each TankMaster PC	20 kbps for each connected tank
Internet bandwidth	64 kbps (256 kbps recommended)
Client PC hardware requirements	
Processor	1.3 GHz (single processor) or better
RAM memory	256 MB (1024 MB recommended)
Disk drive	20 GB
Graphics card	1152*864 pixels, 65536 colors (16 bit)
Network connection	LAN or internet
Internet bandwidth	64 kbps (256 kbps recommended)
Required TankMaster.net client Palm or phone hardware	
Network connection	WAP 2.0, internet connectivity

15.10 ORDERING INFORMATION

NOTE
TankMaster WinOpi, WinView, and WinSetup are always delivered with a USB dongle.

15.10.1 Rosemount TankMaster Software

Model (Pos 1)	Product Description	
TM	Rosemount TankMaster Software	
Code (Pos 2)	**License**	**Note**
DM	TankMaster Demo	No dongle included
05	TankMaster WinOpi, with TankServer for up to 5 tanks(1)	
20	TankMaster WinOpi, with TankServer for up to 20 tanks(1)	
50	TankMaster WinOpi, with TankServer for up to 50 tanks(1)	
MX	TankMaster WinOpi Max(1)	Unlimited number of tanks.
V2	TankMaster WinView, with TankServer for up to 20 tanks(2)	
V5	TankMaster WinView, with TankServer for up to 50 tanks(2)	
WS	TankMaster WinSetup(3)	Configuration only.
Code (Pos 3)	**Host Communication**	
0	None	
C	TankMaster communication module(4)	
S	TankMaster communication module with office link(4) (5)	
Code (Pos 4)	**Network**	
0	None	
1	One TankMaster client can connect and read data(6)	
2	Two TankMaster client can connect and read data(6)	
3	Three TankMaster client can connect and read data(6)	
4	Four TankMaster client can connect and read data(6)	
5	Five TankMaster client can connect and read data(6)	
6	Six TankMaster client can connect and read data(6)	
7	Seven TankMaster client can connect and read data(6)	
X	Specify number of clients(6)	

Code (Pos 5)	Custody Transfer
0	None
C	TankMaster custody transfer functions(7)
P	TankMaster custody transfer functions PTB Eich(8)
Code (Pos 6)	**Batch Handling**
0	Default batch functions
B	Extended batch functions(9)
Code (Pos 7)	**HTG**
0	None
P	TankMaster hydrostatic tank gauging functions and calculations
Code (Pos 8)	**Customization**
0	None
C	Customized views
Code (Pos 9)	**Redundancy**
00	None
RT	TankMaster redundancy(10)
Model Code Example: TM - 20 S N C C P C RT	

(1) Configuration, view and alarm handling. Volume calculations according to API. Includes WinSetup.
(2) Configuration, view, alarm handling and limited inventory calculations. Includes WinSetup. Requires code “0” or “00” for Pos 4-9.
(3) Configuration and installation of devices and tanks.
(4) For connection between TankMaster and SCADA / DCS/PLC via Modbus (RS232) and/or OPC DA. Requires WinOpi.
(5) For connection between TankMaster and Microsoft Office via OPC server. Includes OPC Office Client / Site Server License.
(6) Number of other TankMaster PCs that can connect and read data. This other TankMaster PC can be a TankMaster client or another TankMaster server.
(7) Custody transfer windows. Includes hardware key, custody transfer seal and metrological seal for custody transfer approvals.
(8) Custody transfer windows. Includes hardware key, PTB sticker, custody transfer seal and metrological seal for custody transfer approvals.
(9) Stores closed batches up to 365 days, re-calculation of delivery ticket, Microsoft Access database files and “Tank Transfer Calculator”.
(10) Requires two identical dongles (can be ordered separately), meaning duplicate redundancy licenses as well as other options (one per dongle).

15.10.2 TankMaster.net Software

Model (Pos 1)	Product Description
RTM39EL	Rosemount TankMaster.net(1), Single Licence (one user)
RTM39EM	Rosemount TankMaster.net(1), Limited Licence (up to 3 users)
RTM39ES	Rosemount TankMaster.net(1), Site Licence (unlimited number of users)

(1) Tank data availability through Internet / Intranet. Requires TankMaster WinOpi.

Appendix A Radar Level Device Selection

Below is a guideline to which radar level device with antenna/probe to use for which tank and application.
In general, use 5900S for custody transfer and inventory control, which require highest accuracy and reliability.
For operational control, or as a separate high level alarm, 5900S, 5300, or 5400 can be used.

Also see “When to use a 5900S-, or 5300/5400 System Configuration” on page 23 for more guidance.

Tank and Application	Recommended	Second Choice	Third Choice
Fixed Roof Tanks			
18 in. or larger nozzle, no disturbing objects in tank	5900S, with parabolic antenna	5402, with 4-in. cone antenna	5301, with flexible twin(1)/single lead probe
8 in. to 17 in. nozzle, no disturbing objects in tank	5900S, with horn antenna	5402, with 4-in. cone antenna	5301, with flexible twin(1)/single(2) lead probe
4-8 in. nozzle, no disturbing objects in tank	5402, with 4-in. cone antenna	5301, with flexible single lead probe	Not applicable
2-3 in. nozzle, no disturbing objects in tank	5301, with flexible single lead probe	5402, with 2- or 3-in. cone antenna	Not applicable
Objects in tank	5900S, with parabolic antenna	5301, with coaxial(1)(3), flexible twin(1) or single lead probe	5402, with cone antenna
5-12 in. still-pipe	5900S, with still-pipe array antenna	5301, with flexible single lead probe and a centering disk	Not applicable
2-4 in. still-pipe measurement	5402, with cone antenna (2, 3, or 4 in.)	5301, with flexible single lead probe and centering disks(4) for 3 or 4-in. still-pipes	Not applicable
Floating Roof Tanks			
5-12 in. still-pipe	5900S, with still-pipe array antenna	5301, with flexible single lead probe and a centering disk	Not applicable
Measurement towards tank roof	5900S, with parabolic antenna	5402, with 4-in. cone antenna	Not applicable
Bullet/Sphere Shaped Tanks			
Pressurized LPG sphere, > 6 m (20 ft)	5900S, with LPG/LNG antenna	5301, with flexible twin lead probe(1)	5301, with flexible single lead probe
Pressurized LPG bullet, < 6 m (20 ft)	5900S, with LPG/LNG antenna	5301, with coaxial probe(1)(3)	5301 with flexible twin(1) or single lead probe
Other bullet tanks (e.g. additive tanks) < 6 m (20 ft)	5900S, with LPG/LNG antenna	5301, with coaxial(1)(3), flexible twin(1) or single lead probe	5402, with 4 in. cone antenna
Water Interface Measurement			
Upper Liquid Level + Interface Level	5900S, and a 765 water level sensor(5)	5302, with flexible twin lead(1)(6) or coaxial(1)(3) probe	5302 with flexible single lead probe(7)

(1) For clean products, with no risk for build-up.
(2) Special considerations for 10 in. or larger nozzles. Consult factory.
(3) Best 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) When the interface level is < 1000 mm (3.3 ft). See “Rosemount 765 Water Level Sensor Integrated with Multiple Spot Temperature Sensor” on page 60.
(6) Upper liquid thickness typically up to 25 m (82 ft) for oil/water interface.
(7) Upper liquid thickness typically up to 15 m (49 ft) for oil/water interface.

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AVAILABLE TECHNICAL DOCUMENTATION FOR THE ROSEMOUNT RAPTOR TANK GAUGING SYSTEM

- Raptor Technical Description (704010EN)
- Rosemount 5300 Product Data Sheet (00813-0100-4530)
- Rosemount 5400 Product Data Sheet (00813-0100-4026)
- Raptor System Configuration Manual (300510EN)
- Raptor 5900S Reference Manual (300520EN)
- Raptor 2410 Reference Manual (300530EN)
- Raptor 2240S Reference Manual (300550EN)
- Raptor 2230 Reference Manual (300560EN)
- Rosemount 5300 Series Reference Manual (00809-0100-4530)
- Rosemount 5400 Series Reference Manual (00809-0100-4026)
- Rosemount TankMaster WinOpi Reference Manual (303028EN)
- Wireless Tank Gauging System Setup Using AMS Wireless Configurator Reference Manual (308520EN)
- Raptor Wireless Tank Gauging System Reference Manual (300570EN)
- Rosemount Raptor Installation Drawings

Rosemount Raptor Tank Gauging System

For additional information please contact:

Radar Tank Gauging Ltd

7 Weller Drive
Finchampstead
Wokingham
RG40 4QZ, United Kingdom

Tel: +44 (0)118 973 6670
Email: info@radartg.com
Web: www.radartg.com

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