

## Technical Description

704010EN, Rev BA

March 2011

# Raptor

# Raptor

## Tank Gauging System



**ROSEMOUNT**<sup>®</sup>  
Tank Gauging

[www.rosemount-tg.com](http://www.rosemount-tg.com)

  
**EMERSON**<sup>™</sup>  
Process Management



# Table of Contents

<b>1</b>	<b>Raptor</b>	
	<b>– scalable, and open architecture tank gauging system</b>	<b>1</b>
1.1	Applications	1
1.2	Raptor Tank Gauging System Overview	2
1.3	Open System Architecture Protects Your Investment	3
1.4	Scalable Technology for Unique System Flexibility	3
1.5	Two-wire Intrinsically Safe Cabling on Tank	3
1.6	Lower Costs and Easier Commissioning	3
1.7	SIL Design for Overfill Protection	4
1.8	2-in-1 Gauge for Redundant Level Measurement	4
1.9	Tank Gauging as a System Application	4
1.9.1	Inventory & Custody Transfer	5
1.9.2	Operational Control	5
1.9.3	Configuration and Operation	5
1.10	Radar Level Gauging	5
1.10.1	The FMCW Method	6
1.10.2	Accuracy Enhancement	7
1.10.3	No Microwave Exposure risk from the Antenna	7
1.11	Reach More Tanks at Less Cost with Smart Wireless	8
1.11.1	Better Utilization of Tank Capacity	8
1.11.2	Intelligent Self-organizing Network Increases Reliability	8
1.11.3	Smart Wireless for More Secure Data Transmission	9
1.11.4	Wireless Connection of Tank Gauging Equipment	9
1.12	Emulation	10
1.13	Connection to other Systems	11
1.14	Level, Volume, Density and Mass Measurement	12
1.14.1	Hybrid Tank Gauging System	12
1.15	Improve System Reliability by Utilizing Redundancy	13
1.15.1	Redundant TankMaster PC:s	13
1.15.2	Redundant 2160 Field Communication Units	13
1.15.3	Tankbus Redundancy	13
1.16	Raptor System Configuration Examples	15
1.16.1	Custody Transfer and Inventory Tank Gauging – 5900S System Configuration	15
1.16.2	SIL 2 or SIL 3 for Certified High Level Alarms	16
1.16.3	Additional High Level Alarm Configurations	17
1.16.4	Wired and Wireless Combination	19
1.16.5	Operational Control with 5300- or 5400 System Configuration	20
1.16.6	System Integration	21
1.17	When to use a 5900S-, or 5300/5400 System Configuration	22
1.17.1	Volume Uncertainty Comparison	23
1.17.2	5900S Configuration	23
1.17.3	5300/5400 Configuration	23

---

1.18	System Specification and Considerations . . . . .	24
1.18.1	System Design . . . . .	24
1.18.2	Power Budget . . . . .	24
1.18.3	Tankbus Cable Requirements . . . . .	24
1.18.4	TRL2 Bus Cable Recommendations . . . . .	26
1.18.5	Typical Tankbus Wiring in a 5900S System Configuration . . . . .	27
1.18.6	Wiring Examples in a 5300-or 5400 System Configuration . . . . .	28
<b>2</b>	<b>Rosemount 5900S Radar Level Gauge . . . . .</b>	<b>29</b>
2.1	SIL Safety Functions . . . . .	29
2.2	Transmitter Head . . . . .	29
2.2.1	Transmitter Head Electronics . . . . .	30
2.3	Antennas . . . . .	30
2.3.1	Parabolic Antenna . . . . .	30
2.3.2	Horn Antenna . . . . .	31
2.3.3	Still-pipe Array Antenna . . . . .	31
2.3.4	LPG/LNG Antenna . . . . .	32
2.4	Installation Considerations . . . . .	33
2.4.1	Mechanical Considerations . . . . .	33
2.4.2	Cable Connections . . . . .	33
2.4.3	Configuration . . . . .	33
2.5	Specification . . . . .	34
2.6	Product Certifications Rosemount 5900S . . . . .	37
2.7	Product Certifications Rosemount 2051 . . . . .	38
2.8	Dimensional Drawings . . . . .	39
2.8.1	Dimensions for Rosemount 5900S with Horn Antenna . . . . .	39
2.8.2	Dimensions for Rosemount 5900S with Parabolic Antenna . . . . .	39
2.8.3	Dimensions for Rosemount 5900S with Still-pipe Array Antenna . . . . .	40
2.8.4	Dimensions for Rosemount 5900S with LPG/LNG Antenna . . . . .	40
2.9	Ordering Information . . . . .	41
2.9.1	Transmitter Head (TH) . . . . .	41
2.9.2	Antenna Selection . . . . .	42
2.9.3	5900S Radar Level Gauge Options . . . . .	44
<b>3</b>	<b>Rosemount 2240S Multi-input Temperature Transmitter . . . . .</b>	<b>45</b>
3.1	Installation Considerations . . . . .	45
3.2	Specification . . . . .	46
3.3	Product Certifications . . . . .	48
3.4	Dimensional Drawings . . . . .	50
3.5	Ordering Information . . . . .	51



---

<b>4</b>	<b>Multiple Spot Temperature and Water Level Sensors</b>	<b>53</b>
4.1	Spot Element Principle and Electrical Properties	53
4.1.1	Description of RTD Types	53
4.1.2	RTDs Temperature Dependence and Tolerance Classes	53
4.2	Multiple Spot Temperature Sensors for the Raptor System	53
4.2.1	3- or 4-wire Temperature Sensors	54
4.2.2	Calibration	55
4.3	Rosemount 565 Multiple Spot Temperature Sensor	55
4.4	Rosemount 566 Temperature Sensor for Cryogenic Applications	56
4.5	Rosemount 765 Water Level Sensor Integrated with Multiple Spot Temperature Sensor	57
4.6	Specification	60
4.7	Product Certifications	62
4.8	Ordering Information	63
4.8.1	Rosemount 565 Multiple Spot Temperature Sensor	63
4.8.2	Rosemount 566 Multiple Spot Temperature Sensor for Cryogenic Use (NL-Cryo)	65
4.8.3	Rosemount 765 Water Level Sensor with Multiple Spot Temperature Sensor	67
<b>5</b>	<b>Rosemount 3051S Scalable Pressure Transmitter</b>	<b>69</b>
5.1	Pressure Measurement in a Hybrid Tank Gauging System	70
5.2	Installation Considerations	70
5.2.1	Calibration	70
5.3	Specification	71
5.4	Product Certifications	73
5.4.1	Product Certifications for Wireless Output	73
5.5	Dimensional Drawings	75
5.5.1	Coplanar Pressure Transmitter	75
5.5.2	Liquid Level Pressure Transmitter	77
5.6	Ordering Information	78
5.6.1	Rosemount 3051S Coplanar Pressure Transmitter	78
5.6.2	Rosemount 3051S Liquid Level Pressure Transmitter	80
<b>6</b>	<b>Rosemount 2230 Graphical Field Display</b>	<b>82</b>
6.1	Different View Options	82
6.2	Installation Considerations	83
6.2.1	Configuration	83
6.3	Specification	84
6.4	Product Certifications	85
6.5	Dimensional Drawings	86
6.6	Ordering Information	87

---

<b>7</b>	<b>Rosemount 2410 Tank Hub</b>	<b>88</b>
7.1	Communication Between Tanks and Control Room	88
7.1.1	Tankbus Communication	88
7.1.2	Autoconfiguration of Tankbus	88
7.1.3	Data Handling	88
7.1.4	Data Security	88
7.1.5	Control Room Communication	89
7.2	Power Supply with Built-in Cable Terminator	89
7.3	Output Relay Functionality	89
7.4	Wireless Communication	89
7.5	Installation Considerations	90
7.5.1	Mechanical Considerations	90
7.5.2	Cable Connections	90
7.5.3	Configuration	90
7.6	Specification	91
7.6.1	Technical Data for Rosemount 2410 Tank Hub	91
7.6.2	Technical Data for Smart Wireless THUM™	93
7.7	Product Certifications	94
7.7.1	Certifications for Rosemount 2410	94
7.7.2	Certifications for Smart Wireless THUM™	95
7.8	Dimensional Drawings	96
7.8.1	2410 Dimensions	96
7.8.2	Smart Wireless THUM™ Dimensions	96
7.9	Ordering Information	97
7.9.1	Rosemount 2410 Tank Hub	97
7.9.2	Smart Wireless THUM™ Adapter	99
7.9.3	Smart Wireless Tank Gauging Options	99
<b>8</b>	<b>Rosemount 2160 Field Communication Unit</b>	<b>100</b>
8.1	Redundant Field Communication Units	100
8.2	Installation Considerations	100
8.3	Specification	101
8.4	Ordering Information	102
<b>9</b>	<b>Rosemount 2165/2175 Field Communication Unit</b>	<b>103</b>
9.1	Specification	104
9.2	Ordering Information	105
<b>10</b>	<b>Rosemount 2180 Field Bus Modem</b>	<b>106</b>
10.1	Specification	107
10.2	Ordering Information	107

<b>11</b>	<b>Smart Wireless Gateway</b>	<b>108</b>
11.1	Self-Organizing Networks	109
11.2	Open Integration	109
11.3	Layered Security Keeps Your Network Safe	109
11.4	WirelessHART Industry Standard	109
11.5	Installation Considerations	109
11.6	Specification	110
11.7	Product Certifications	111
11.7	Approved Manufacturing Locations	111
11.7	Telecommunication Compliance	111
11.7	FCC and IC	111
11.7	Ordinary Location Certification for FM	111
11.7	European Union Directive Information	111
11.8	Dimensional Drawings	112
11.9	Ordering Information	114
<b>12</b>	<b>Rosemount 5300 Series Radar Level Transmitter</b>	<b>115</b>
12.1	Safety & Overfill Functions	115
12.2	Transmitter Housing	115
12.3	Tank Connection and Probes	115
12.3.1	Probe Selection	116
12.4	Measuring Range	117
12.5	Oil and Water Interface Measurements	117
12.6	Installation Considerations	118
12.6.1	Mechanical Considerations	118
12.6.2	Cable Connections	120
12.6.3	Configuration	121
12.7	Specification	122
12.7.1	Temperature and Pressure	124
12.8	Product Certifications	125
12.9	Dimensional Drawings	127
12.9.1	Coaxial Probe with Flange Connection	127
12.9.2	Coaxial Probe with Threaded Connection	127
12.9.3	Flexible Single Lead Probe with Flange Connection	128
12.9.4	Flexible Single Lead Probe with Threaded Connection	128
12.9.5	Flexible Twin Lead Probe with Flange Connection	129
12.9.6	Flexible Twin Lead Probe with Flange Connection	129
12.10	Ordering Information	130
12.10.1	Model Code 5301 and 5302	130

---

<b>13</b>	<b>Rosemount 5400 Radar Level Transmitter</b>	<b>133</b>
13.1	Safety Functions	133
13.2	Transmitter Housing	133
13.3	Antennas	134
13.4	Measuring Range	134
13.5	Installation Considerations	135
13.5.1	Mechanical Considerations	135
13.5.2	Cable Connections	136
13.5.3	Configuration	137
13.6	Specification	138
13.6.1	Temperature and Pressure	140
13.7	Product Certifications	141
13.8	Dimensional Drawings	142
13.8.1	Rosemount 5402 with SST Cone Antenna	142
13.8.2	Bracket Mounting	143
13.9	Ordering Information	144
13.9.1	Model Code for Rosemount 5400 Radar Level Transmitter	144
<b>14</b>	<b>Single Point Temperature Measurement</b>	<b>146</b>
14.1	Rosemount 644 Temperature Transmitter	146
14.2	Rosemount 65 Single Point Temperature Sensor	146
14.3	Installation Considerations	147
14.4	Specification	148
14.5	Product Certifications	150
14.5.1	Certifications for Rosemount 644	150
14.5.2	Certifications for Rosemount 65	150
14.6	Dimensional Drawings	151
14.6.1	Rosemount 644 Dimensions	151
14.6.2	Rosemount 65 Dimensions	151
14.7	Ordering Information	152
14.7.1	Rosemount 644	152
14.7.2	Rosemount 65 Single Point Temperature Sensor, without Thermowell	153
14.7.3	Rosemount 65 Single Point Temperature Sensor, with Barstock Thermowell	154
<b>15</b>	<b>Rosemount 2100 Series Liquid Level Switches</b>	<b>156</b>
15.1	Rosemount 2160 Liquid Level Switch for WirelessHART networks	156
15.2	Short Fork Technology for Minimum Tank Intrusion	157
15.3	Heartbeat LED Confirms Correct Functionality	157
15.4	Installation Considerations	157
15.4.1	Magnetic Test Point for Functional Test	157
15.5	Specification	158
15.5.1	Temperature and Pressure Diagrams for Rosemount 2120	160
15.5.2	Temperature and Pressure Diagrams for Rosemount 2160	160
15.6	Dimensional Drawings	161
15.6.1	Rosemount 2120	161
15.6.2	Rosemount 2160	162
15.7	Ordering Information	166
15.7.1	Rosemount 2120	166
15.7.2	Rosemount 2160	168

<b>16</b>	<b>Rosemount TankMaster</b> .....	<b>170</b>
16.1	Comparison between TankMaster WinOpi and WinView .....	171
16.2	Inventory and Custody Transfer Functions .....	172
16.3	TankMaster Networks .....	172
16.4	Interoperability with Legacy Host Systems .....	173
16.5	Alarms .....	173
16.6	Reports and Data Sampling .....	173
16.7	Emulation .....	173
16.8	TankMaster Hydrostatic Tank Gauging .....	173
16.9	Specification .....	174
16.9.1	Rosemount TankMaster WinOpi, WinSetup and WinView .....	174
16.9.2	Rosemount TankMaster.net .....	174
16.10	Ordering Information .....	175
16.10.1	Rosemount TankMaster Software .....	175
16.10.2	TankMaster.net Software .....	176
 <b>APPENDIX A</b>		
	<b>Radar Level Device Selection</b> .....	<b>177</b>

# 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 61508-2 and 61508-3
- 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:

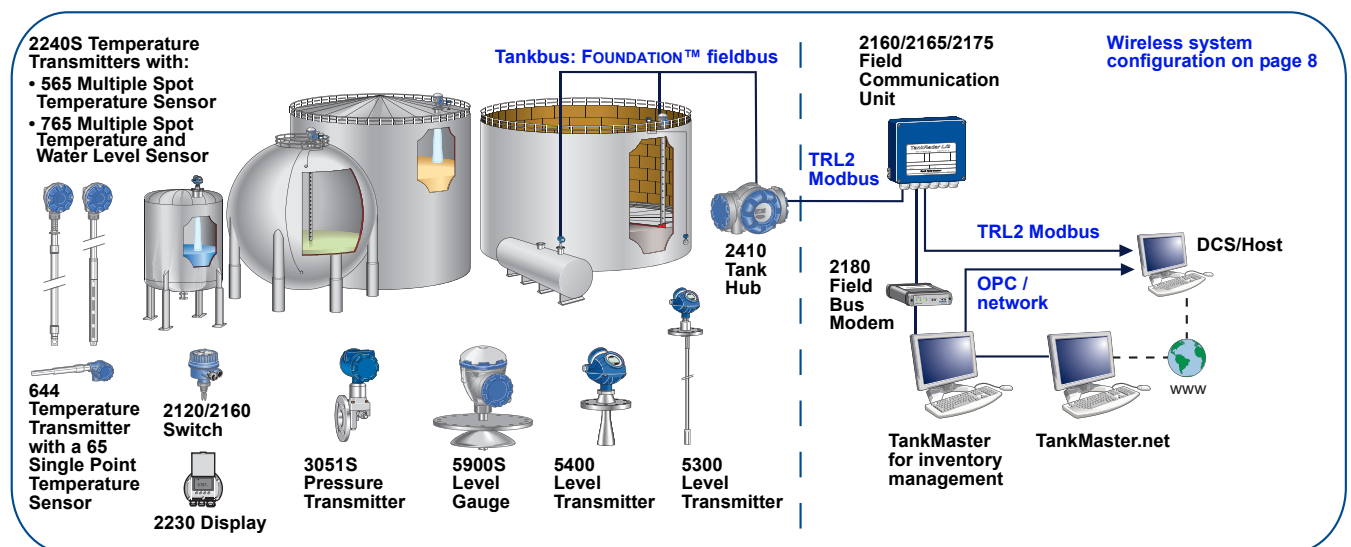
- Custody transfer
- Inventory management
- Oil movement
- Mass balance & Loss estimation/control
- Operational & blending control
- Leak detection and overfill prevention

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 29, 115 and 133
- Rosemount 2240S Multi-input Temperature Transmitter. See page 45
- Rosemount 644 Temperature Transmitter. See page 146
- Rosemount 565 and 566 Multiple Spot Temperature Sensor. See pages 55 and 56
- Rosemount 765 Multiple Spot Temperature Sensor with integrated Water Level Sensor. See page 57
- Rosemount 65 Single Point Temperature Sensor. See page 146
- Rosemount 3051S, Scalable Pressure Transmitters. See page 69
- Rosemount 2051 Pressure Transmitter. See page 36
- Rosemount 2230 Graphical Field Display. See page 82
- Rosemount 2100 Series Liquid Level Switch. See page 156
- Rosemount 2410 Tank Hub. See page 88
- Rosemount 2160/65/75 Field Communication Units. See pages 100, and 103
- Rosemount 2180 Field Bus Modem. See page 106
- Smart Wireless Gateway (pages 8 & 108) and THUM Adapter (pages 8, 89, 93, 95 - 99)
- TankMaster PC workstations in a network. See page 170



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 (*WirelessHART*). See pages 11 and 91.

### 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 consumption, 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 PROTECTION

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 protection according to IEC 61508-2 and 61508-3.

The system provides reliable High-High level alarm functionality, based on a separate SIL 2- or SIL 3-rated relay function (see pages 16, 29, 89, and 91).

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

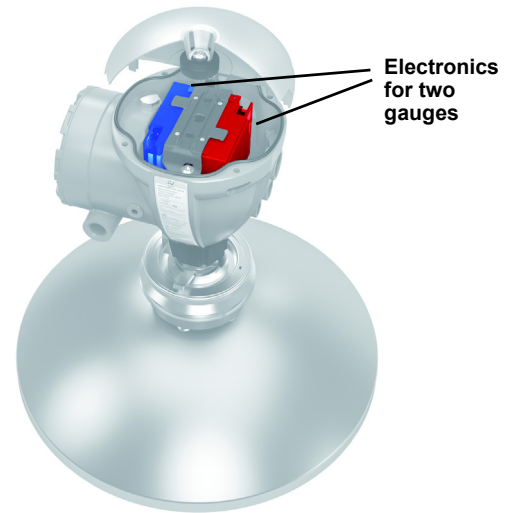
Raptor is designed for cost-efficient redundancy. The 5900S gauge is delivered with either one or two electronics packages integrated in the transmitter head.

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 22.



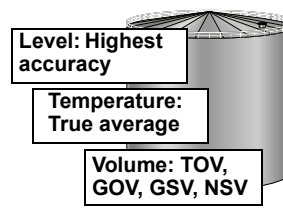
5900S with two galvanically separated gauges within the same housing (2-in-1 solution).

## 1.9 TANK GAUGING AS A SYSTEM APPLICATION

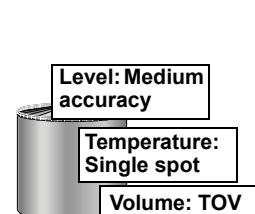
Tank gauging is an integrated system application which has quite specific requirements on the measuring devices in the system. These requirements vary depending on how the system is used.

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 22 for total system performance.

### Custody Transfer / Inventory Control<sup>1)</sup>



### Operational Control



1) Also suitable for operational control

### 1.9.1 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.

### 1.9.2 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 Sensor
- TankMaster WinView

### 1.9.3 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.

## 1.10 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 29.
- **Rosemount 5300** is a guided wave radar level transmitter, based on TDR, for medium accuracy applications. See page 115.
- **Rosemount 5400** is a non-contact, pulsed, radar level transmitter for medium accuracy applications. See page 133.

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.

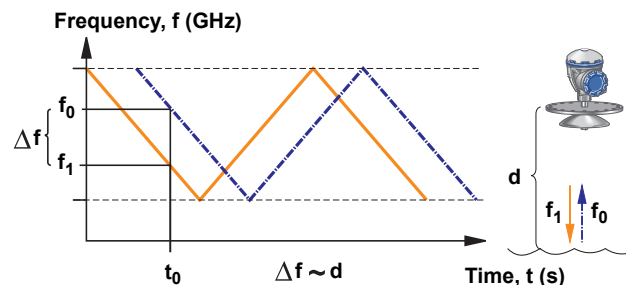
## 1.10.1 The FMCW Method

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.



### 1.10.2 Accuracy Enhancement

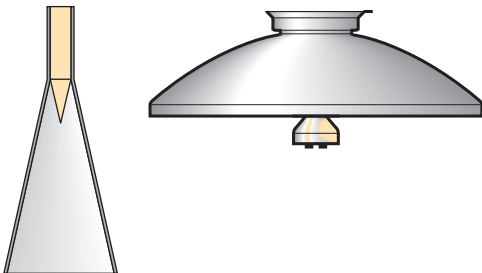
The robust Rosemount 5900S design, in combination with the wide ambient temperature range, contribute to making it a very stable and accurate level measurement device, suitable for all climate zones. To enhance accuracy further, 5900S has some built-in, and unique features:

#### 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  $\pm 3^\circ$  after installation.

A horn antenna, with  $4^\circ$  flange inclination, or a still-pipe solution are other possible options.

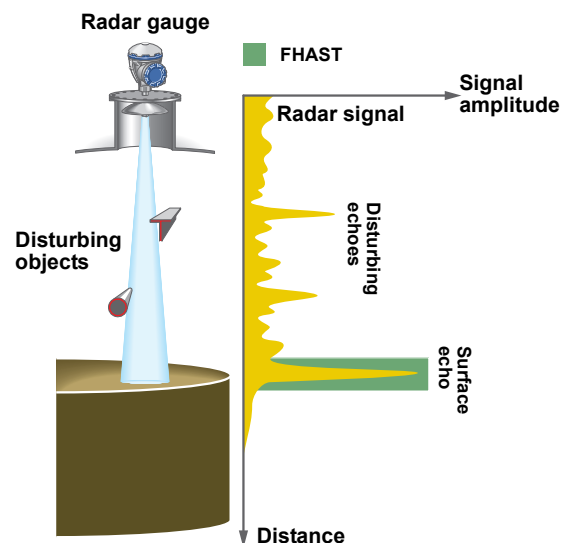
#### Patented method for detecting the surface echo

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

### 1.10.3 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  $1 \text{ mW/cm}^2$  is considered safe for continuous human exposure. The power density close to the antenna is  $0.001 \text{ mW/cm}^2$  and further down in the tank it is much lower. The transmitted microwave power is less than 1 mW. As a comparison, the sunshine a person is exposed to on a sunny day corresponds to a power density of  $100\text{-}150 \text{ mW/cm}^2$ .



## 1.11 REACH MORE TANKS AT LESS COST WITH SMART WIRELESS

The Raptor system supports Emerson's Smart Wireless solution, based on IEC 62591 (*WirelessHART*), 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.

### 1.11.1 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.

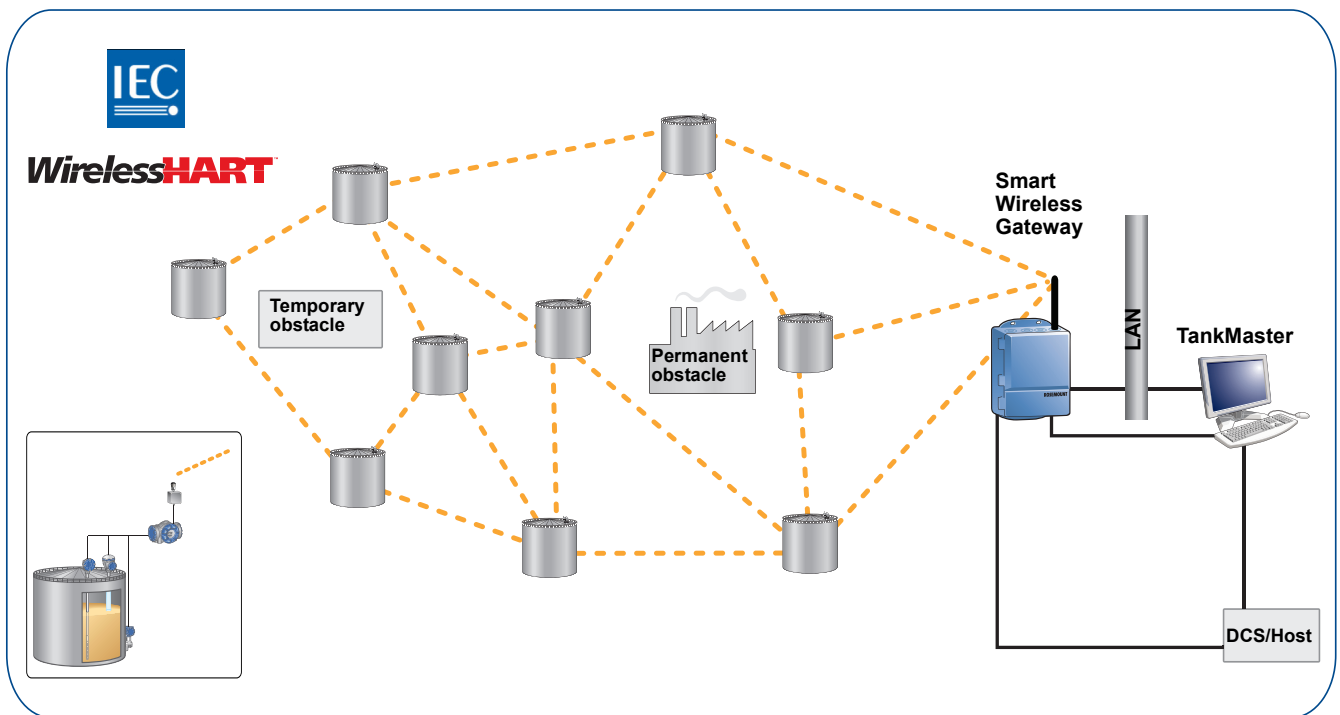
### 1.11.2 Intelligent Self-organizing Network Increases Reliability

A Smart Wireless device can transmit its own data as well as relay information from other devices in the network.

The self-organizing 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 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.

### 1.11.3 Smart Wireless for More Secure Data Transmission

Emerson's Smart Wireless 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, a Smart Wireless network can offer a higher level of security than many traditional wired networks.

### 1.11.4 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 approximately 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 89 and "Smart Wireless Gateway" on page 108.

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.**

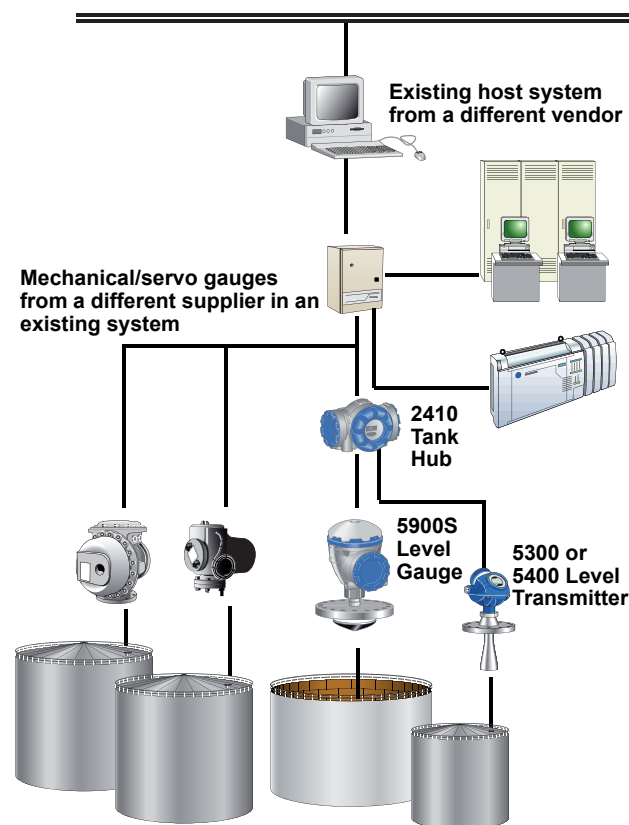
## 1.12 EMULATION

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.



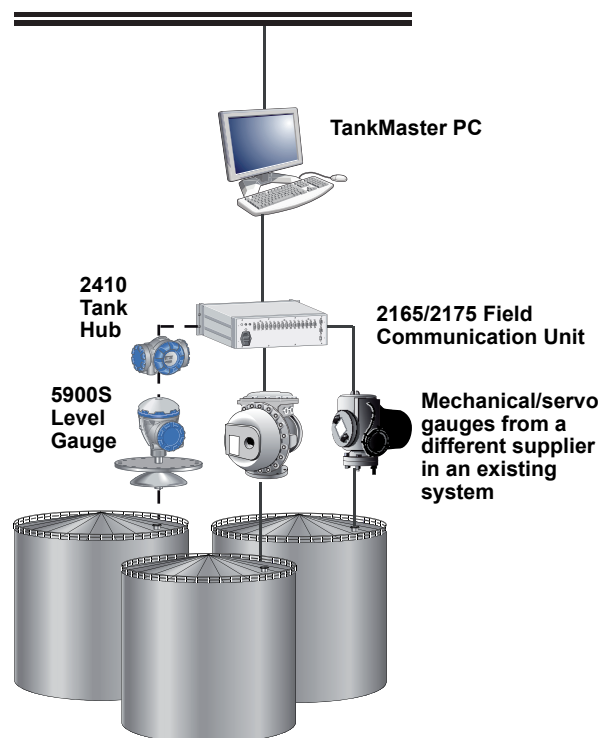
A gauge seamlessly replaces another device, independent of measurement technology. Data from the integrated radar gauge is displayed as before on the existing inventory management system. By replacing old servo gauges, you can avoid re-calibration and the expenses associated with spare parts and maintenance.

### 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 2165/2175 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.

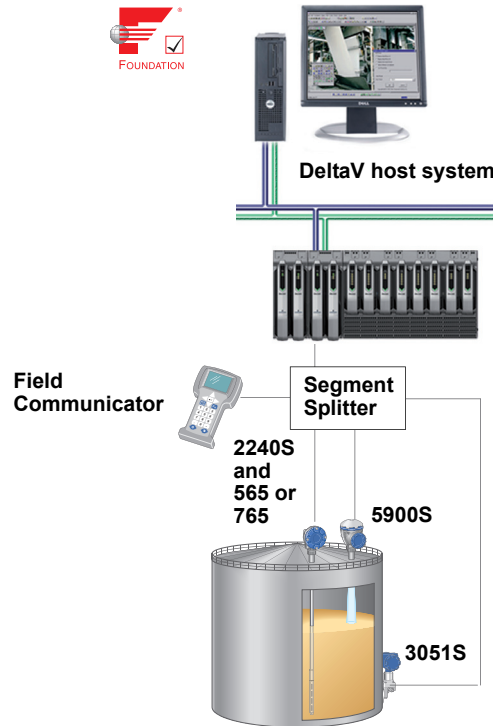
### 1.13 CONNECTION TO OTHER SYSTEMS

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

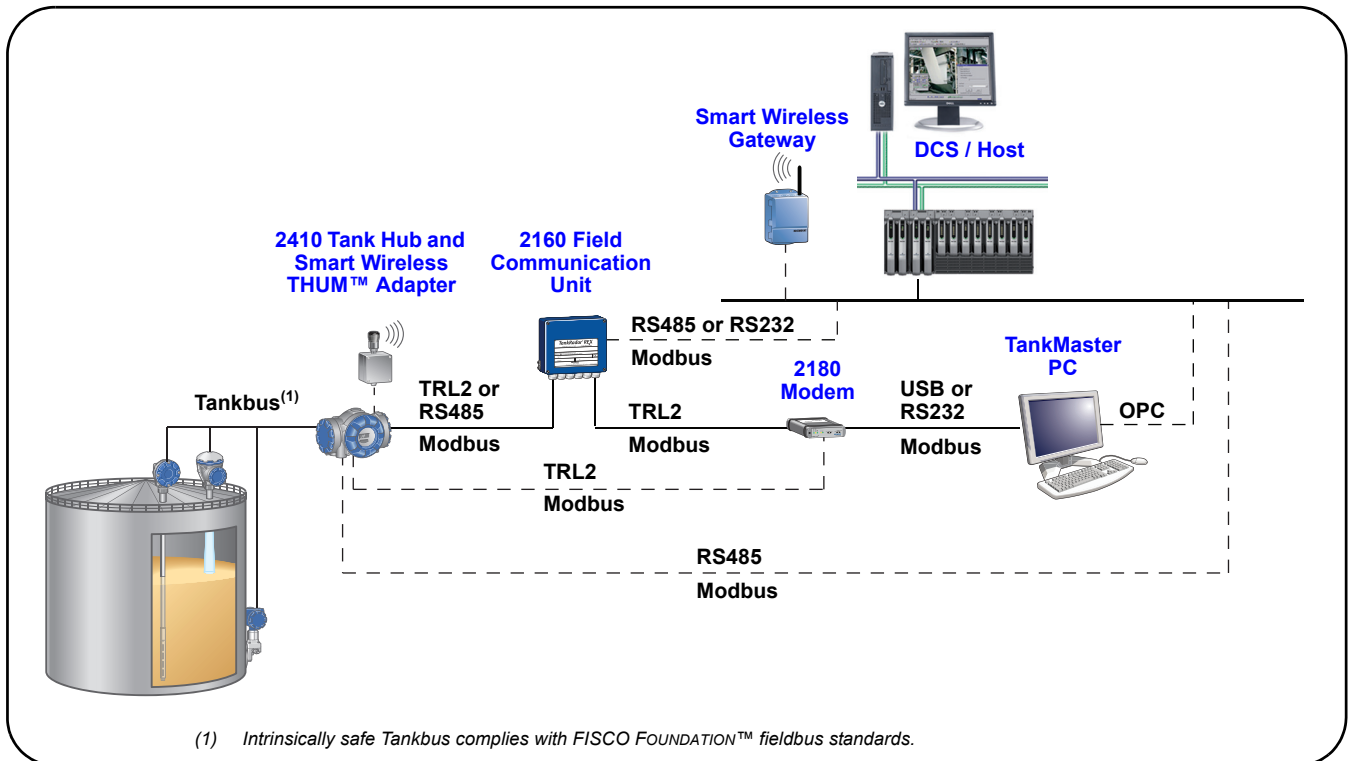
Connection can be made in several ways:

- Via a Rosemount TankMaster PC
- Via a Rosemount 2160/2165/2175, 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.

## 1.14 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 170.

TankMaster can present accurate volume calculations based on up to 5000 strapping points. Normally less than 100 points per tank are necessary for 1 liter accuracy. TankMaster is using quadratic interpolation for spheres and horizontal cylinders, which increases volume accuracy and reduces the number of required strapping points.

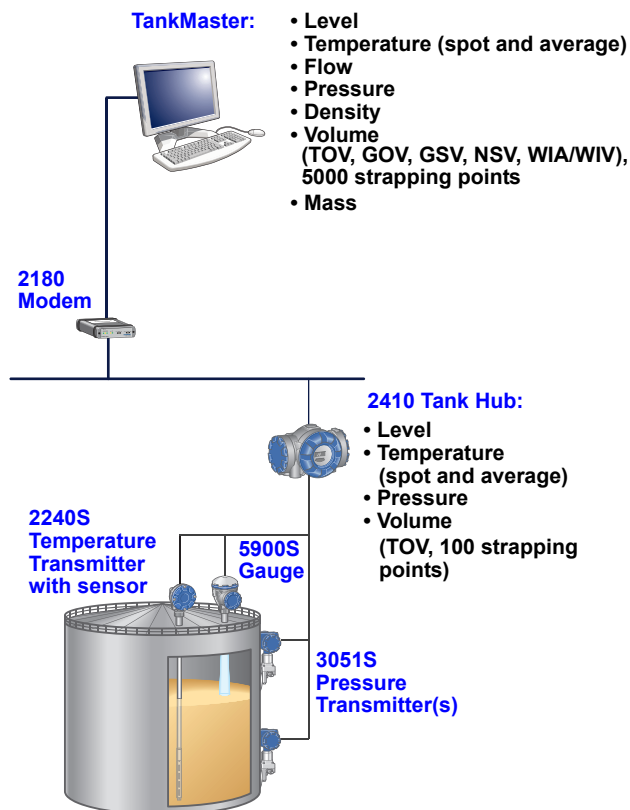
### 1.14.1 Hybrid Tank Gauging System

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 configuration 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 69 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.

### **1.15 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.

#### **1.15.1 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 100 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)

#### **1.15.2 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.

#### **1.15.3 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

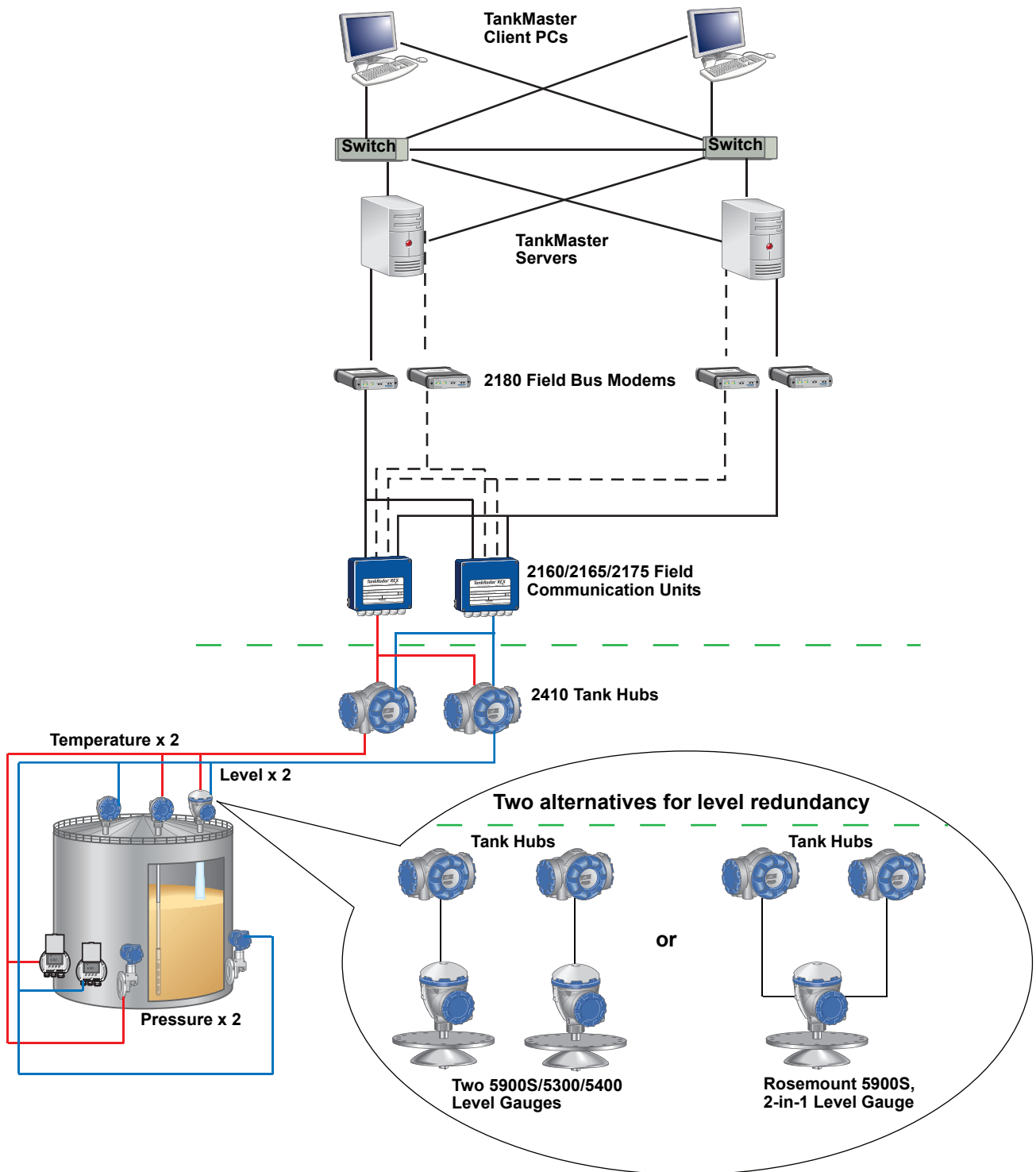
#### **Level Measurement Redundancy**

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.



# Technical Description

704010EN, Rev BA  
March 2011



## 1.16 RAPTOR SYSTEM CONFIGURATION EXAMPLES

### 1.16.1 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.

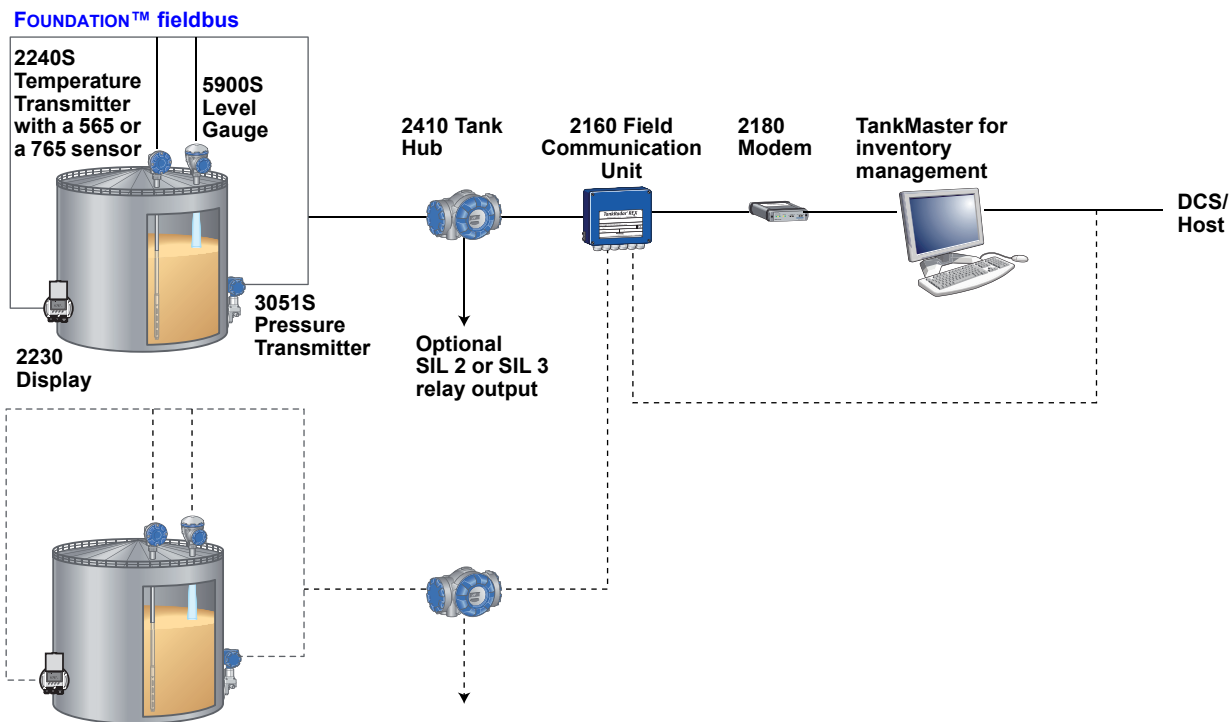
This state-of-the-art custody transfer and inventory system uses the 5900S non-contacting radar level gauge.

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.

## 1.16.2 SIL 2 or SIL 3 for Certified High Level Alarms

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

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

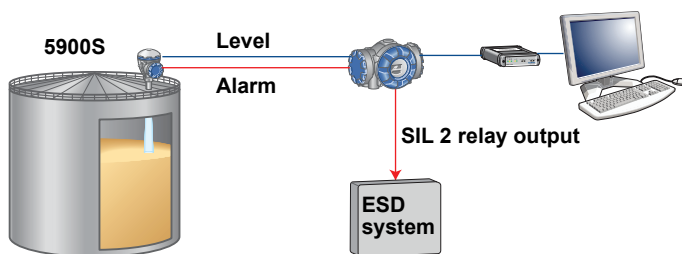
By providing both level measurements and alarm functionality (High and/or High High), a 5900S gauge can replace two separate units which enables easier installation and better utilization of available tank nozzles – only one nozzle is required.

Moreover, the radar level gauge is reliable, accurate, and most important, 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. Additionally, 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 Protection” on page 4). Follow the recommendations in the Raptor Safety Manual (document number 300540EN).

### SIL 2 Safety

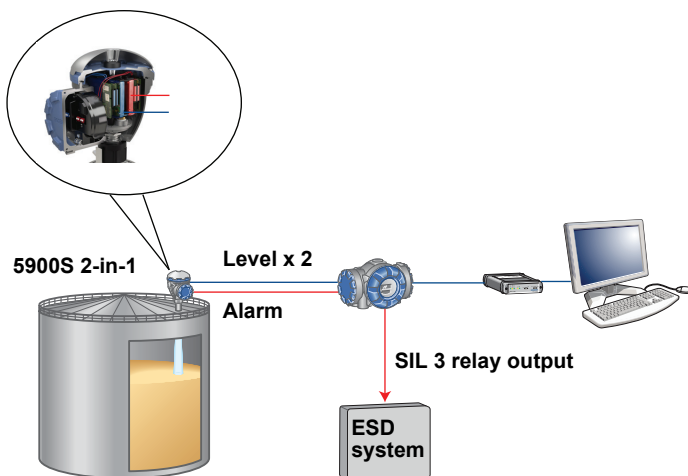


SIL 2 safety is achieved with one 5900S gauge, and a 2410 tank hub equipped with a SIL 2 relay output.

Certified by Exida to IEC61508-2 and IEC61508-3 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 with Patented 2-in-1 Gauge

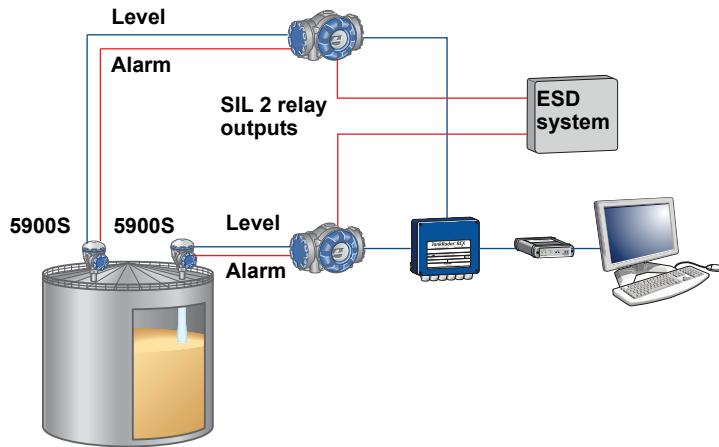


SIL 3 safety can be achieved using one 5900S with 2-in-1 option, together with a 2410 tank hub equipped with a SIL 3 relay output.

Certified by Exida to IEC61508-2 and IEC61508-3 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 with Dual Gauges**



SIL 3 safety 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 IEC61508-2 and IEC61508-3. 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).

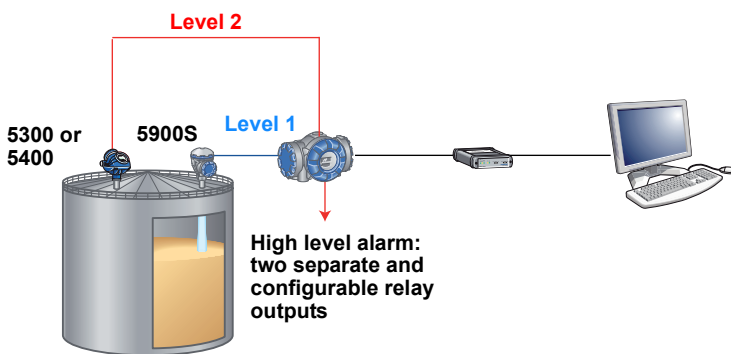
**1.16.3 Additional High Level Alarm Configurations**

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

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**

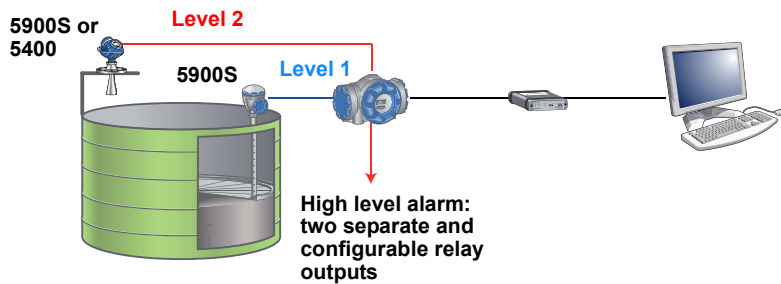
- One Rosemount 5900S gauge for high precision level measurement
- One Rosemount 5300 or 5400 transmitter for high level alarm

# Technical Description

704010EN, Rev BA

March 2011

## Floating Roof Tank with Continuous High Level Alarm



### Requirements

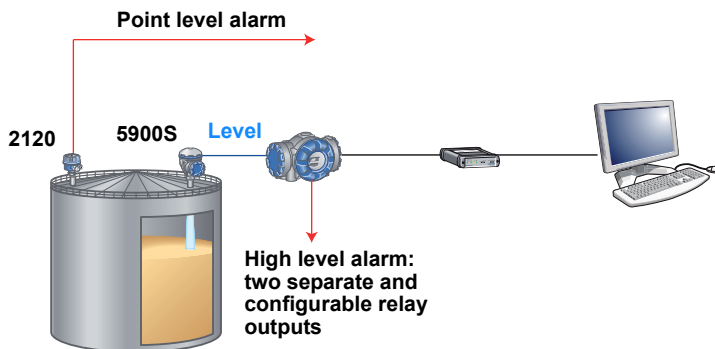
- Track the nearest surface, which normally is the floating roof, but in case of a stuck roof it may be the liquid level
- High accuracy level measurements
- Separate high level alarm device
- Continuous measurements
- Continuous verification of level value

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



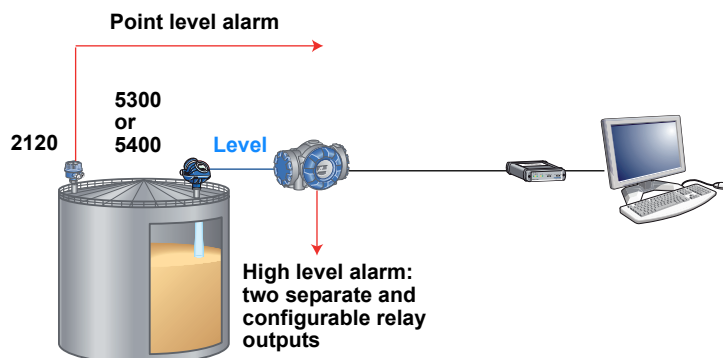
### Requirements

- 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

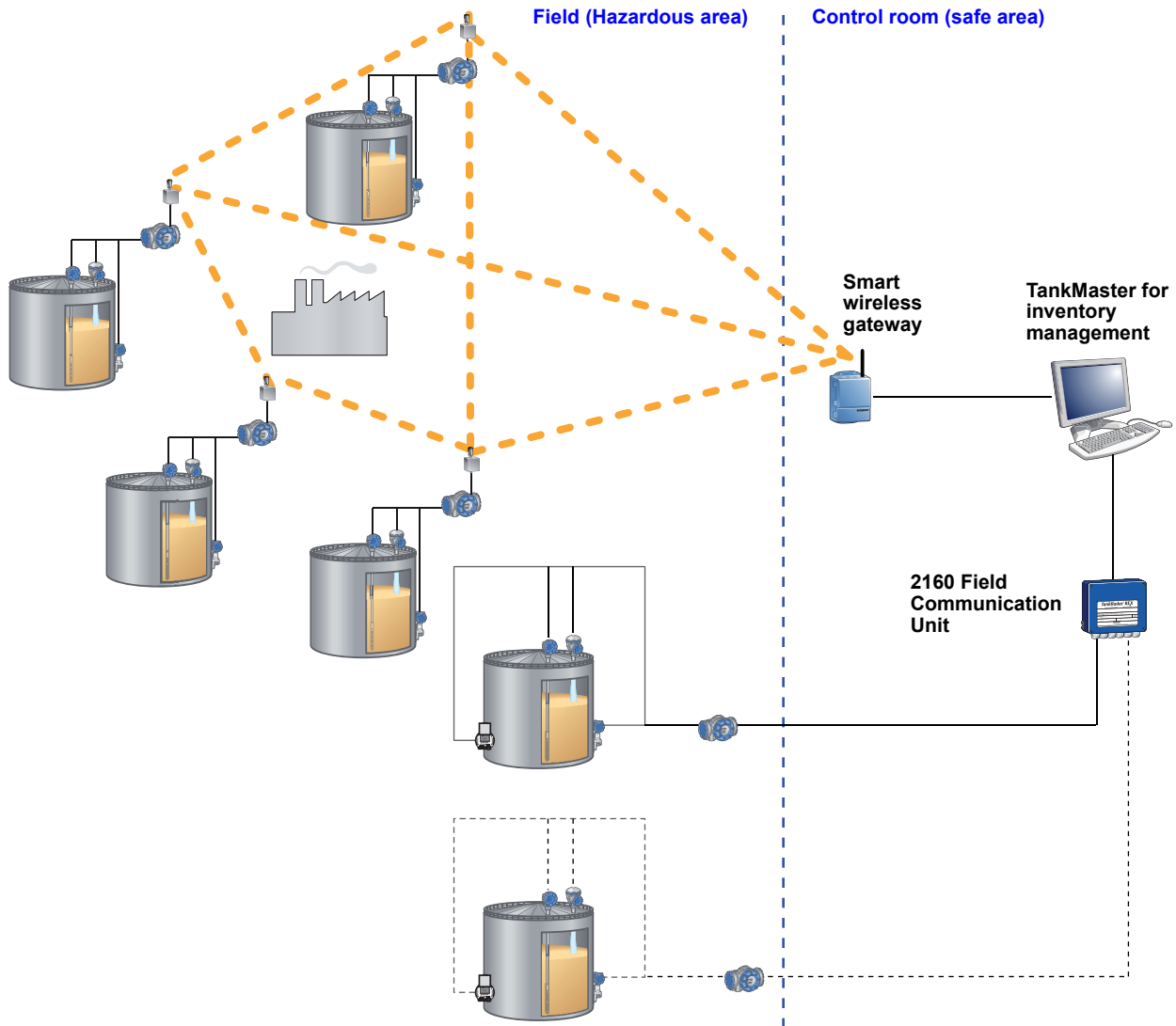
### Solution

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

### 1.16.4 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.





## Technical Description

704010EN, Rev BA

March 2011

Raptor System

### 1.16.5 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.

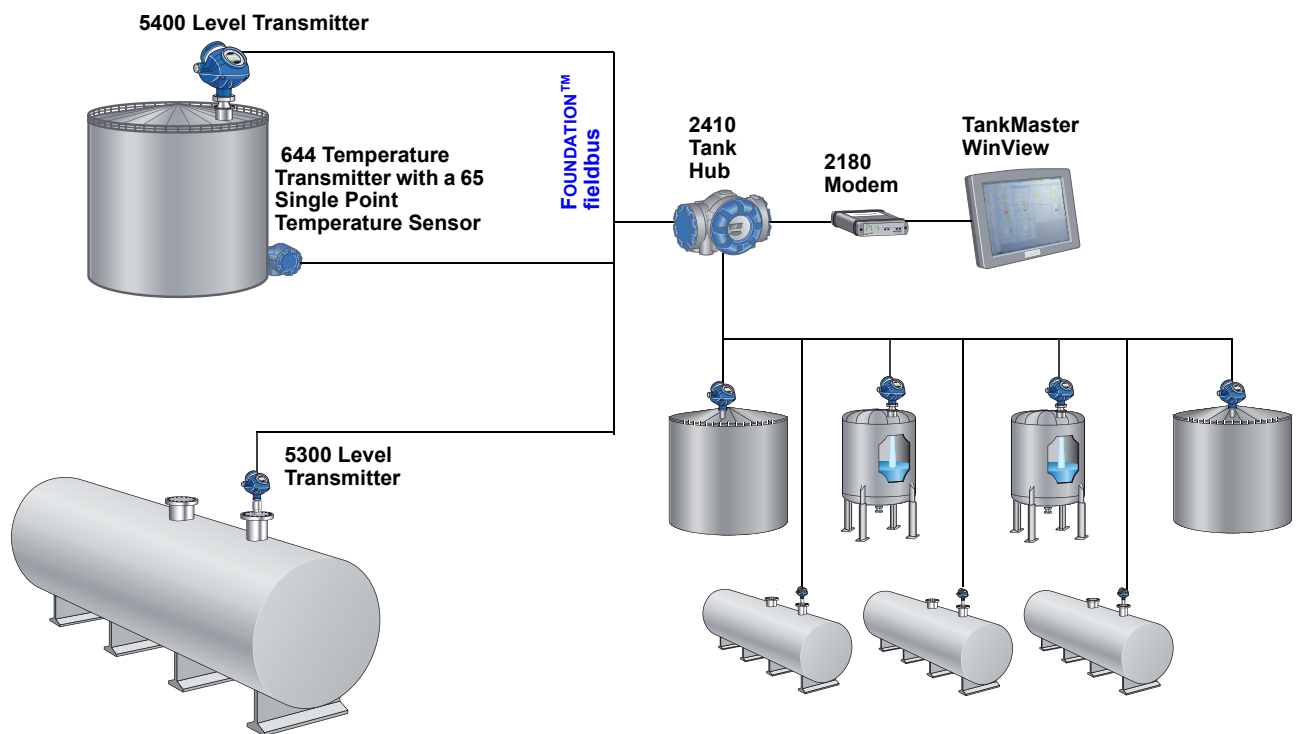
This configuration is a good choice for medium accuracy applications.

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 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 in up to 10 tanks per tank hub.

1.16.6 System Integration

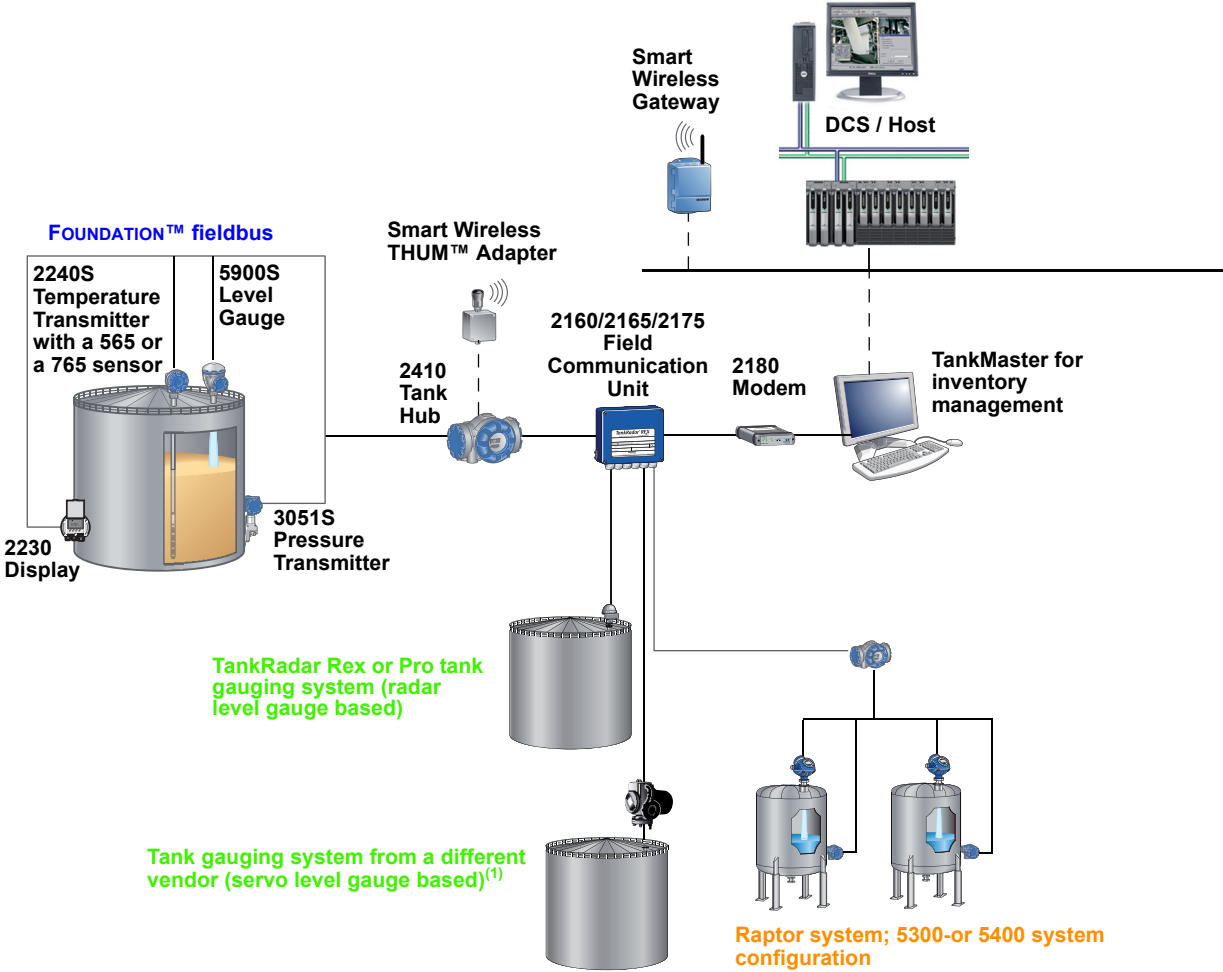
The Raptor system can have a large number of configuration combinations.

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.

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

The table below is a guide to which typical basic configuration fits your plant. Other combinations are possible. 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
<b>Level</b>	5900S gauge	5300 and/or 5400 transmitter
<b>Temperature</b>	2240S transmitter with 565, 566 or 765 sensor	644 transmitter with 65 sensor
<b>Inventory management</b>	TankMaster WinOpi	TankMaster WinView
<b>Features</b>		
<b>Instrument accuracy</b>		
<b>Level</b>	± 0.5 mm (0.020 in.)	± 3 mm (0.12 in.) <sup>(1)</sup>
<b>Temperature<sup>(2)</sup></b>	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)
<b>Typical system performance</b>		
<b>Level</b>	± 1.0 mm (0.039 in.) <sup>(3)</sup>	± 10 mm (0.39 in.) <sup>(3)</sup>
<b>Temperature<sup>(4)</sup></b>	± 0.17 °C (0.31 °F)	± 1.2 °C (2.16 °F) <sup>(5)</sup>
<b>Volume Uncertainty</b>	90% typical reduction for a 5900S configuration compared with a 5300/5400 configuration	
<b>Safety</b>		
<b>SIL 3</b>	Yes, certified	No
<b>SIL 2</b>	Yes, certified	Yes, FMEDA <sup>(6)</sup>
<b>Overfill approvals</b>	Yes, TÜV/DIBt WHG and national approvals <sup>(7)</sup>	Yes, TÜV/DIBt WHG and national approvals <sup>(6)</sup>
<b>Proof testing</b>	Yes, extended & certified (TankMaster WinOpi)	Yes
<b>Relay outputs for direct control</b>	Yes	No
<b>System output</b>		
<b>Spot temperature</b>	Yes	Yes
<b>Average temperature</b>	Yes	No
<b>Free water level</b>	Yes	No
<b>Pressure</b>	Yes	No
<b>Total observed volume (TOV)</b>	Yes	Yes
<b>Gross observed volume (GOV)</b>	Yes	No
<b>Gross standard volume (GSV)<sup>(8)</sup></b>	Yes	No
<b>Net standard volume (NSV)<sup>(8)</sup></b>	Yes	No
<b>Density</b>	Yes	No
<b>Mass</b>	Yes	No
<b>Alarm handling</b>	Yes	Yes
<b>Batch handling feature</b>	Yes	No
<b>On-line density</b>	Yes	No
<b>Scheduled on-line reports</b>	Yes	No
<b>Legal metrological approvals</b>		
<b>OIML R85</b>	Yes	No
<b>NMI, PTB</b>	Yes	No
<b>Other national approvals</b>	Yes, consult factory for your local approvals	No
<b>Redundancy</b>		
<b>2-in-1 radar gauge</b>	Yes	No
<b>Communication</b>		
<b>Emulation</b>	Yes	Yes
<b>Wireless field network</b>	Yes	Yes

(1) At reference conditions. See specifications on pages 122 and 138.

(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 use in SIL 1 applications.

(7) Requires a Rosemount 2410 Tank Hub with relay output.

(8) According to API/ISO.

### 1.17.1 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 22).

**Example:**

- Crude oil, 887 kg/m<sup>3</sup> 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)<sup>(1)</sup>
- A traditional mechanical tape and float system: ± 25 mm (1 in.), 1.5 °C (2.7 °F)<sup>(1)</sup>

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 <sup>(1)</sup>	290	2370	4840
Per batch <sup>(1)</sup>	320	2870	6490
<b>Total uncertainty per year<sup>(1)(2)</sup></b>	2600	22260	48560

(1) Statistical error, root mean square value (RMS).

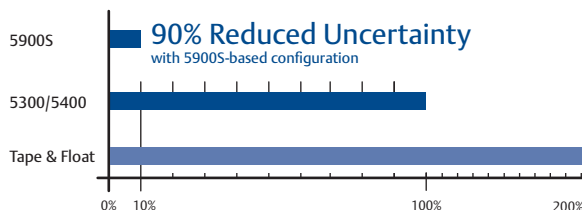
(2) 12 inventories and 24 batches.

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.

### 1.17.2 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.

### 1.17.3 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 115 for Rosemount 5300 and page 133 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.

## 1.18 SYSTEM SPECIFICATION AND CONSIDERATIONS

### 1.18.1 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 21.

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
- The Rosemount 2410 Tank Hub supports maximum one tank for a 5900S system configuration
- The Rosemount 2410 Tank Hub supports maximum 10 tanks for a 5300- or 5400 system configuration
- The minimum voltage supply to the devices is 9 V

### 1.18.2 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 MST and WLS
Rosemount 644 Temperature Transmitter	11 mA
Rosemount 3051S, and Rosemount 2051 Pressure Transmitters	18 mA

### 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

Six tanks with:

- Six Rosemount 5300 or 5400 Radar Level Transmitters
- Six Rosemount 644 Temperature Transmitters with sensors
- One Rosemount 2230 Display

### 1.18.3 Tankbus Cable Requirements

Recommended cabling is shielded twisted pairs, 0.75 mm<sup>2</sup> (AWG 18).

Other possibilities are shielded twisted pairs, 0.5-1.5 mm<sup>2</sup> (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 <sup>(1)</sup> cable	60 m in gas Group IIC
Maximum length of each trunk <sup>(2)</sup> 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 splitter 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<sup>2</sup> (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.

*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).

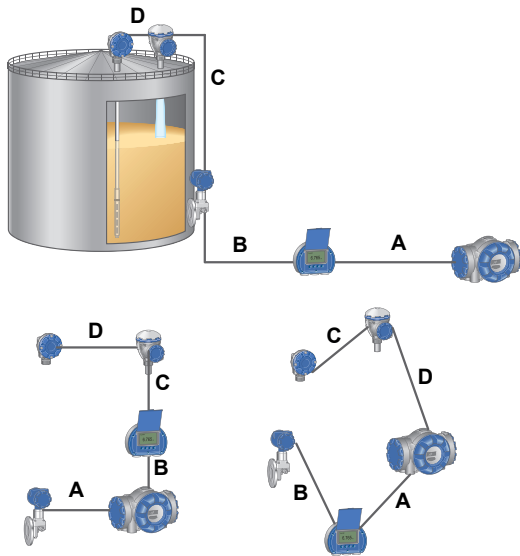
*Maximum Distance with Typical Power Usage for a 5900S Configuration:*

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:



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

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 <sup>2</sup> )	66 Ω/km	212 (695)	414 (1358)	298 (978)
18 AWG (0.75 mm <sup>2</sup> )	42 Ω/km	333 (1092)	651 (2136)	468 (1535)
17 AWG (1.0 mm <sup>2</sup> )	33 Ω/km	424 (1391)	829 (2720)	596 (1955)
16 AWG (1.5 mm <sup>2</sup> )	26 Ω/km	538 (1765)	1000 (3281)	756 (2480)

## Technical Description

704010EN, Rev BA

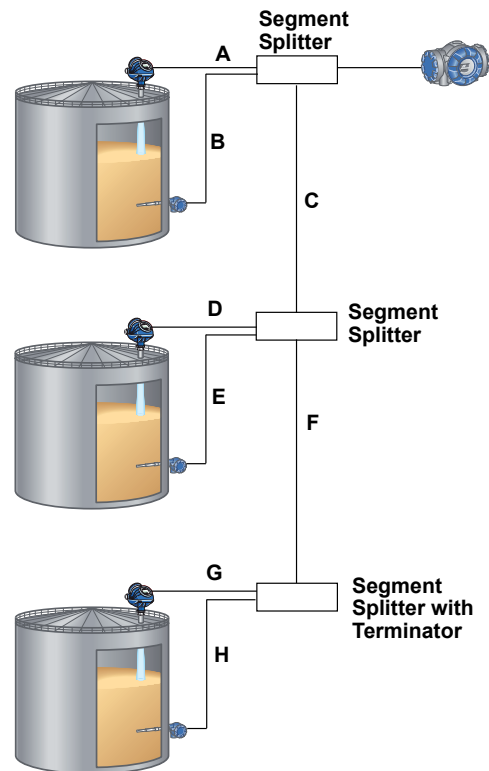
March 2011

Raptor System

**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 seven such 5300- or 5400-based tanks, consuming 224 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)						
		7 tanks	6 tanks	5 tanks	4 tanks	3 tanks	2 tanks	1 tank
with typical power usage of 32 mA per tank with 5300/5400 and 644								
		Distance in m (ft)	Distance in m (ft)	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 <sup>2</sup> )	66 Ω/km	236 (774)	276 (905)	331 (1085)	414 (1358)	552 (1811)	828 (2716)	1000 (3281)
18 AWG (0.75 mm <sup>2</sup> )	42 Ω/km	372 (1220)	434 (1423)	520 (1706)	651 (2135)	868 (2847)	1000 (3281)	1000 (3281)
17 AWG (1.0 mm <sup>2</sup> )	33 Ω/km	473 (1551)	552 (1811)	662 (2171)	828 (2716)	1000 (3281)	1000 (3281)	1000 (3281)
16 AWG (1.5 mm <sup>2</sup> )	26 Ω/km	600 (1968)	701 (2299)	841 (2759)	1000 (3281)	1000 (3281)	1000 (3281)	1000 (3281)

### 1.18.4 TRL2 Bus Cable Recommendations

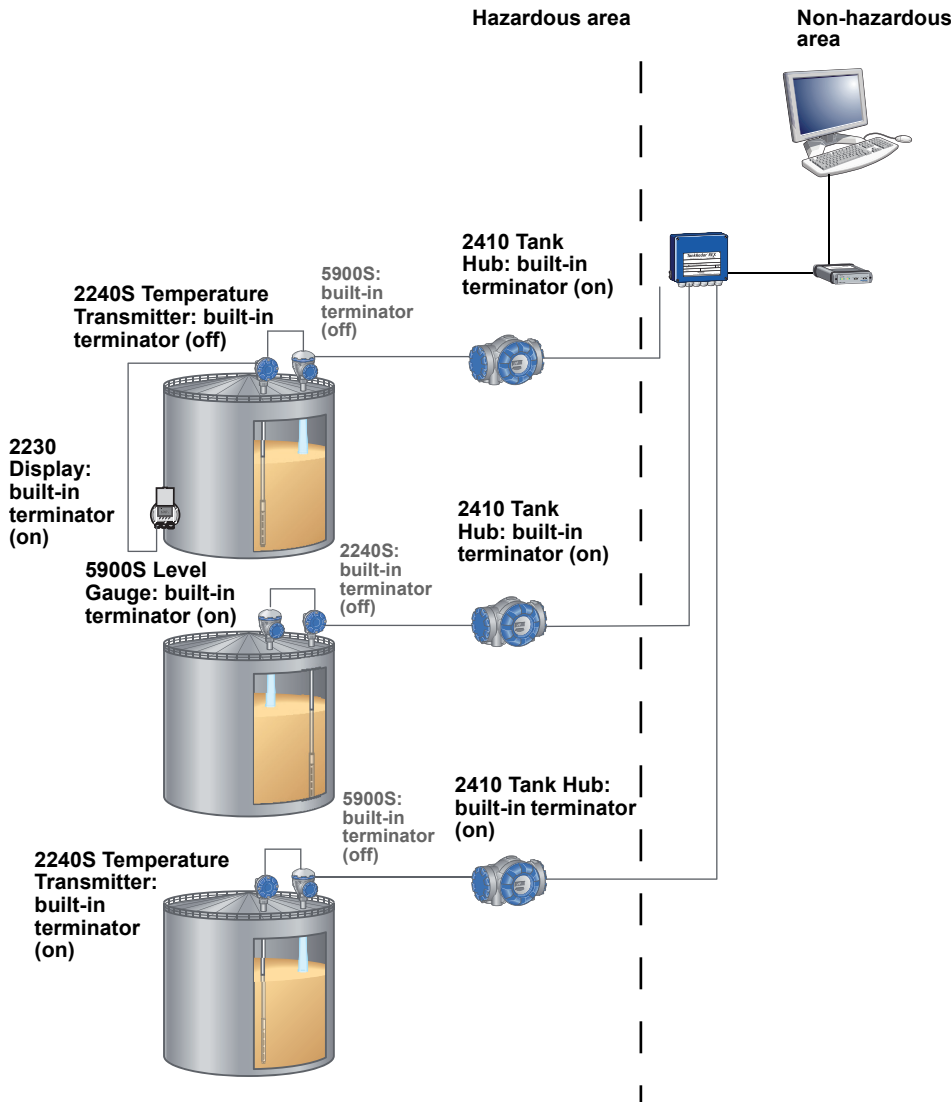
In a Raptor system, a Rosemount 2410 Tank Hub communicates with a Rosemount 2160 Field Communication Unit using the TRL2 Modbus protocol.

The TRL2 bus requires twisted and shielded pair wiring with a minimum area of 0.50 mm<sup>2</sup> (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.

### 1.18.5 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 splitters or bus terminators are needed when the last device on the bus is a 5900S, a 2240S or a 2230.

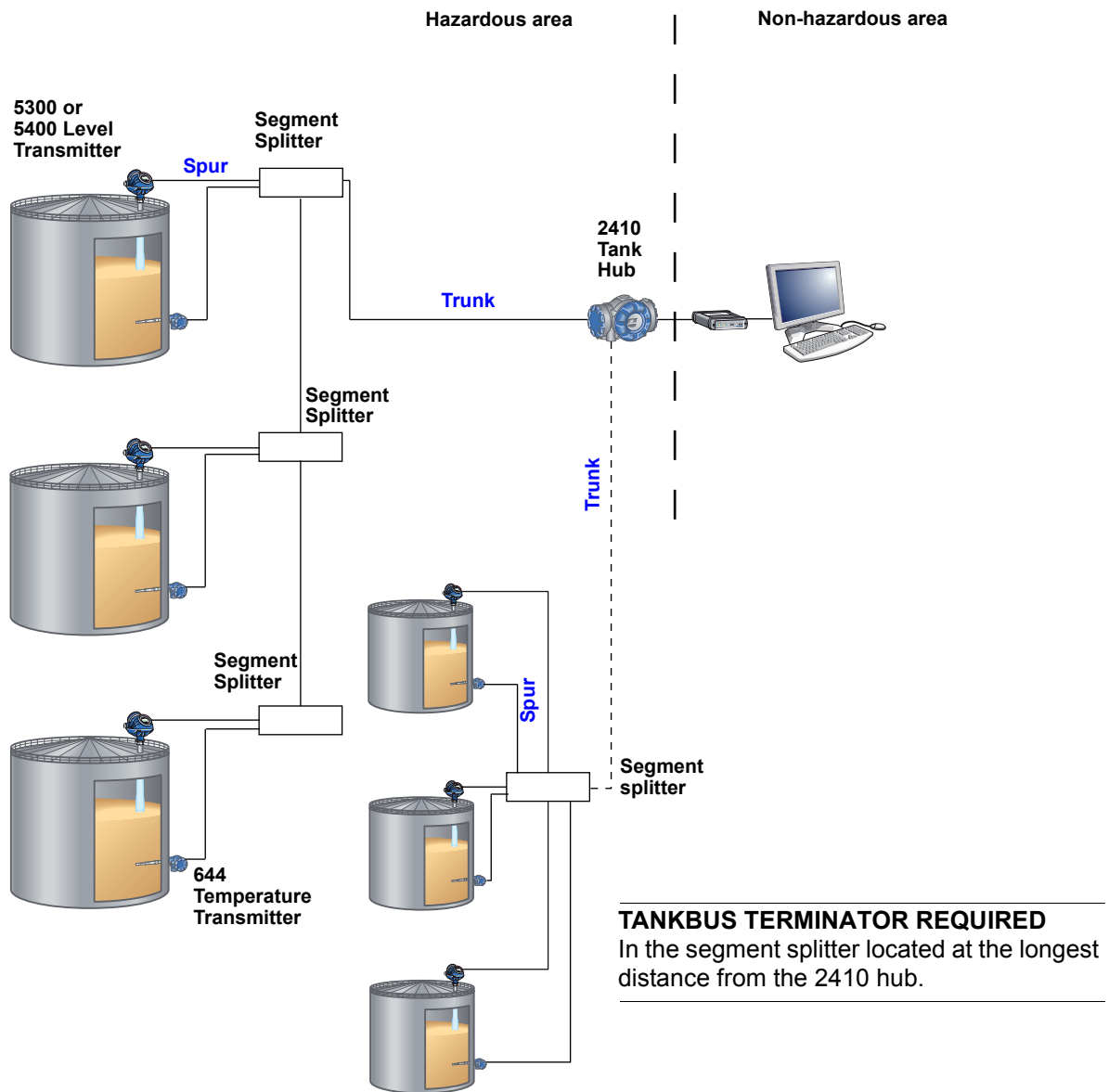


# Technical Description

704010EN, Rev BA

March 2011

## 1.18.6 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.

## 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<sup>(1)</sup> 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 liquefied 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 overflow protection according to IEC 61508-2 and 61508-3.

The 5900S Radar Level Gauge with SIL option is configured to activate a separate alarm loop at a preset liquid level, such as High or Low. 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.

(1) For level device guidance, see "When to use a 5900S-, or 5300/5400 System Configuration" on page 22, and Appendix A: Radar Level Device Selection.

For more information see "SIL 2 or SIL 3 for Certified High Level Alarms" on page 16, "Output Relay Functionality" on page 89 (Rosemount 2410), and "Technical Data for Rosemount 2410 Tank Hub" on page 91.



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.

### 2.2.1 Transmitter Head Electronics

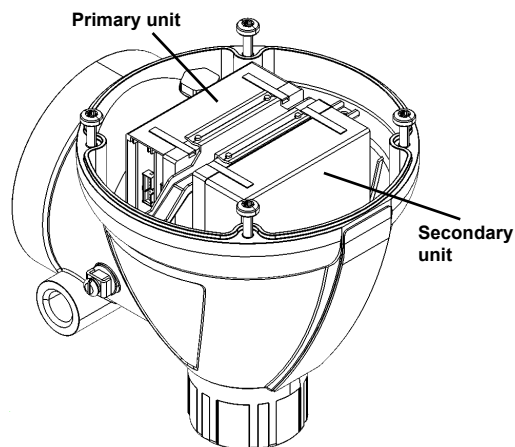
The radar gauge transmitter head electronics consists of one or two encapsulated electronic units which include boards for various functions:

- 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 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 vertical and non-vertical 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.

## Technical Description

704010EN, Rev BA

March 2011

Raptor System

### 2.3.4 LPG/LNG Antenna

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

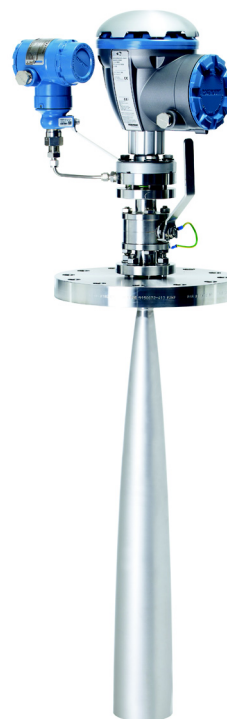
Radar signals are transmitted inside the still-pipe which enables the gauge to have a sufficiently strong echo even under surface boiling conditions.

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 volume 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

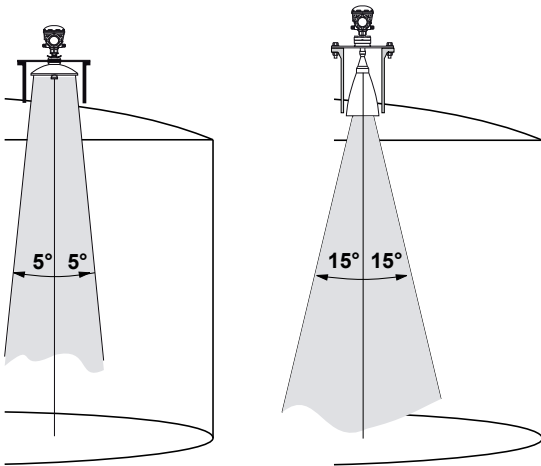
This section includes some installation information. For complete guidance, see the Rosemount 5900S Reference Manual (document number 300520EN) and supporting installation drawings. If you miss information valid for your tank/application, you can also consult your local Rosemount Tank Gauging representative.

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.

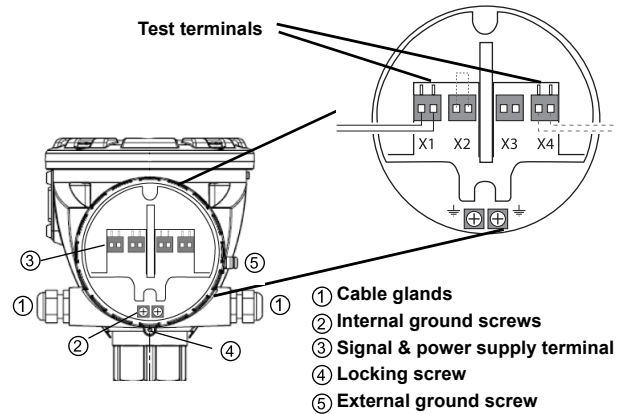
### 2.4.2 Cable Connections

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 35.

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 41 and "Tankbus Cable Requirements" on page 24.



### 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	
<b>Product</b>	Rosemount 5900S Radar Level Gauge
<b>Measurement principle</b>	FMCW (Frequency Modulated Continuous Wave)
<b>Antennas</b>	Horn antenna, parabolic antenna, still-pipe array antenna, LPG/LNG antenna
<b>Instrument accuracy<sup>(1)</sup></b>	± 0.5 mm (0.020 in.)
<b>Temperature stability</b>	Typically < ± 0.5 mm (0.020 in.) in -40 to +70 °C (-40 to +158 °F)
<b>Fieldbus (standard)</b>	FOUNDATION™ fieldbus FISCO (Tankbus)
<b>Update time</b>	New measurement every 0.3 s
<b>Repeatability</b>	0.2 mm (0.008 in.)
<b>Maximum level rate</b>	Up to 200 mm/s
<b>Metrology sealing possibility</b>	Yes
<b>Legal custody transfer type approval</b>	OIML R85:2008, and national certifications such as PTB, NMI etc
<b>Hazardous location certifications</b>	ATEX, FM-C, FM-US, IECEx, and national certifications. For details, see “Product Certifications Rosemount 5900S” on page 37 and “Ordering Information” on page 41
<b>Safety/overflow</b>	SIL 2 and SIL 3 certified. See pages 4, 16, and 29 Consult your local Rosemount Tank Gauging representative for information about national approvals such as the WHG (TÜV) overflow protection option
<b>CE-mark</b>	93/68/EEC: complies with applicable EU directives (EMC, ATEX, LVD, and R&TTE)
<b>Ordinary location certification</b>	Complies with FM 3810:2005 and CSA: C22.2 No. 1010.1
Communication / Display / Configuration	
<b>Output variables and units</b>	Level, and ullage: meter, centimeter, millimeter, feet, or inch Level rate: meter/second, meter/hour, feet/second, feet/hour, inch/minute Signal strength: mV
<b>Configuration tools</b>	Rosemount TankMaster WinSetup, Field Communicator
Electric	
<b>Power supply</b>	Powered by Rosemount 2410 Tank Hub (9.0-17.5 VDC, polarity insensitive)
<b>Bus current draw</b>	50 mA (100 mA for the 2-in-1 version)
<b>Microwave output power</b>	< 1 mW (also see “No Microwave Exposure risk from the Antenna” on page 7)
Mechanical	
<b>Housing material &amp; surface treatment</b>	Polyurethane-coated die-cast aluminum
<b>Cable entry (connection/glands)</b>	½ - 14 NPT for cable glands or conduits. Optional: • M20 x 1.5 conduit / cable adapter • Cable glands in metal • 4-pin male Eurofast connector or A size Mini 4-pin male Minifast connector
<b>Tankbus cabling</b>	0.5-1.5 mm <sup>2</sup> (AWG 22-16), twisted shielded pairs
<b>Dimensions</b>	See “Dimensional Drawings” on page 39
<b>Total weight</b>	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



<b>Environment</b>	
<b>Ambient operating temperature</b>	-40 to +70 °C (-40 to +158 °F). Minimum start-up temperature is -50 °C (-58 °F)
<b>Storage temperature</b>	-50 to +85 °C (-58 to +185 °F)
<b>Humidity</b>	0-100% relative humidity
<b>Ingress protection</b>	IP 66/67 and Nema 4X
<b>Vibration resistance</b>	IEC 60770-1 level 1 and IACS UR E10 test 7
<b>Telecommunication (FCC and R&amp;TTE)</b>	Compliance with: <ul style="list-style-type: none"> <li>• FCC 15B Class A, and 15C</li> <li>• R&amp;TTE (EU directive 99/5/EC)</li> <li>• ETSI (EN 302 372-1 V.1.1.1)</li> <li>• IC (RSS210-5)</li> </ul>
<b>Electromagnetic compatibility</b>	<ul style="list-style-type: none"> <li>• EMC directive 2004/108/EC, and EN61326-3-1</li> <li>• OIML R85:2008</li> </ul>
<b>Transient / built-in lightning protection</b>	According to IEC 61000-4-4-5, level 2 kV to ground. Complies with IEEE 587 Category B transient protection and IEEE 472 surge protection
<b>Pressure Equipment Directive (PED)</b>	97/23/EC
<b>5900S standard version</b>	
<b>Built-in Tankbus terminator</b>	Yes (to be connected if required)
<b>Daisy chain possibility</b>	Yes
<b>5900S 2-in-1 version</b>	
<b>Instrument accuracy<sup>(1)</sup></b>	± 0.5 mm (0.020 in.) <sup>(2)</sup>
<b>Separation</b>	Galvanically separated radar level gauge electronics, and shared antenna for the two units
<b>Wiring</b>	Separated or common
<b>Tank hub connection</b>	Separated or common
<b>Built-in Tankbus terminator</b>	Single Tankbus connection: Yes (to be connected if required) Dual Tankbus connection: Possible to terminate the primary Tankbus
<b>Daisy chain possibility</b>	No
<b>5900S SIL version</b>	
<b>Separation</b>	Galvanically separated radar level gauge electronics, and shared antenna for the SIL 3 version
<b>Built-in Tankbus terminator</b>	No
<b>Daisy chain possibility</b>	No
<b>5900S with parabolic antenna</b>	
<b>Operating temperature in tank</b>	Max. +230 °C (+445 °F)
<b>Measuring range</b>	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
<b>Pressure range</b>	Clamped: -0.2 to 0.2 bar (-2.9 to 2.9 psig) Welded: -0.2 to 10 bar (-2.9 to 145 psig)
<b>Material exposed to tank atmosphere</b>	Antenna: Acid proof steel type EN 1.4436 (AISI 316) Sealing: PTFE O-ring: FPM (Viton)
<b>Antenna dimension</b>	440 mm (17 in.)
<b>Manway size</b>	500 mm (20-inch) opening
<b>Tank connection</b>	Gauge is clamped in a 96 mm (3.78 in.) diameter hole, or welded in a 117 mm (4.61 in.) diameter hole

## Technical Description

704010EN, Rev BA

March 2011

Raptor System

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: Acid proof steel type EN 1.4436 (AISI 316) 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 mounting close to 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 to 130 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: Polyphenylensulfid (PPS) Sealing: PTFE O-ring: Fluorosilicone Flange: Acid Proof Steel EN 1.4404 (AISI 316L)
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 38. For more information see the 2051 Product Data Sheet (document number 00813-0100-4101)
Material exposed to tank atmosphere	Antenna: Acid proof steel type EN 1.4436 (AISI 316) 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	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

### European ATEX Directive Information

EC-Type Examination Certificate Number: FM09ATEX0057X

Control Drawing: 9240 040-917

I1<sup>(1)</sup> Intrinsically Safe

FISCO Field Device:



II 1/2 G  0682 0575  
Ex ia IIC T4 (-50 °C <math>T\_a</math> <math><+80\text{ °C}</math>)

For each channel:  $U_i=17.5\text{ VDC}$ ,  $I_i=380\text{ mA}$ ,  $P_i=5.32\text{ W}$ ,  
 $C_i=1.1\text{ nF}$ ,  $L_i=1.5\text{ }\mu\text{H}$ .

Entity:



II 1 G  0682 0575  
Ex ia IIC T4 (-50 °C <math>T\_a</math> <math><+80\text{ °C}</math>)

For each channel:  $U_i=30\text{ VDC}$ ,  $I_i=300\text{ mA}$ ,  $P_i=1.3\text{ W}$ ,  
 $C_i=1.1\text{ nF}$ ,  $L_i=1.5\text{ }\mu\text{H}$ .

### 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<sup>(1)</sup> Intrinsically Safe

FISCO Field Device:

Intrinsically safe for Class 1, Division 1, Groups A, B, C, and D

For each channel:  $U_i=17.5\text{ VDC}$ ,  $I_i=380\text{ mA}$ ,  $P_i=5.32\text{ W}$ ,  
 $C_i=1.1\text{ nF}$ ,  $L_i=1.5\text{ }\mu\text{H}$

Entity:

Intrinsically safe for Class 1, Division 1, Groups A, B, C, and D

For each channel:  $U_i=30\text{ VDC}$ ,  $I_i=300\text{ mA}$ ,  $P_i=1.3\text{ W}$ ,  
 $C_i=1.1\text{ nF}$ ,  $L_i=1.5\text{ }\mu\text{H}$

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.

### Canadian Factory Mutual (FM-C) Certification



Certificate of Compliance: 3035466C

Control Drawing: 9240 040-917

I6<sup>(1)</sup> Intrinsically Safe

FISCO Field Device:

Intrinsically safe for Class 1, Division 1, Groups A, B, C, and D

For each channel:  $U_i=17.5\text{ VDC}$ ,  $I_i=380\text{ mA}$ ,  $P_i=5.32\text{ W}$ ,  
 $C_i=1.1\text{ nF}$ ,  $L_i=1.5\text{ }\mu\text{H}$

Entity:

Intrinsically safe for Class 1, Division 1, Groups A, B, C, and D

For each channel:  $U_i=30\text{ VDC}$ ,  $I_i=300\text{ mA}$ ,  $P_i=1.3\text{ W}$ ,  
 $C_i=1.1\text{ nF}$ ,  $L_i=1.5\text{ }\mu\text{H}$

Dust ignition proof for Class II/III, Division 1, Groups E, F, and G.

Temperature Code T4.

Ambient Temperature Limits: -50 to +80 °C

(1) Ordering Information code for Product Certificates, see page 41.

## Technical Description

704010EN, Rev BA

March 2011

Raptor System

### IECEX Certification

Certificate of Conformity Number: IECEx FMG 09.0009X

Control Drawing: 9240 040-917

I7<sup>(1)</sup> Intrinsically Safe

FISCO Field Device:

Ex ia IIC T4 Ga/Gb (-50 °C < T<sub>a</sub> < +80 °C)

For each channel: U<sub>i</sub>=17.5 VDC, I<sub>i</sub>=380 mA, P<sub>i</sub>=5.32 W,  
C<sub>i</sub>=1.1 nF, L<sub>i</sub>=1.5 μH.

Entity:

Ga Ex ia IIC T4 (-50 °C < T<sub>a</sub> < +80 °C)

For each channel: U<sub>i</sub>=30 VDC, I<sub>i</sub>=300 mA, P<sub>i</sub>=1.3 W,  
C<sub>i</sub>=1.1 nF, L<sub>i</sub>=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  II 1 G

Ex ia IIC T4 (T<sub>amb</sub> = -60 to +60 °C)

IP66

CE 1180

Input Parameters: U<sub>i</sub>=17.5 VDC, I<sub>i</sub>=380 mA, P<sub>i</sub>=5.32 W,  
C<sub>i</sub>≤5 μF, L<sub>i</sub>=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<sub>a</sub> = 40 °C), T3 (T<sub>a</sub> = 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  II 1 G

Ex ia IIC T4 (T<sub>amb</sub> = -60 to +60 °C)

IP66

CE 1180

Input Parameters: U<sub>i</sub>=17.5 VDC, I<sub>i</sub>=380 mA, P<sub>i</sub>=5.32 W,  
C<sub>i</sub>≤5 μF, L<sub>i</sub>=10 μH.

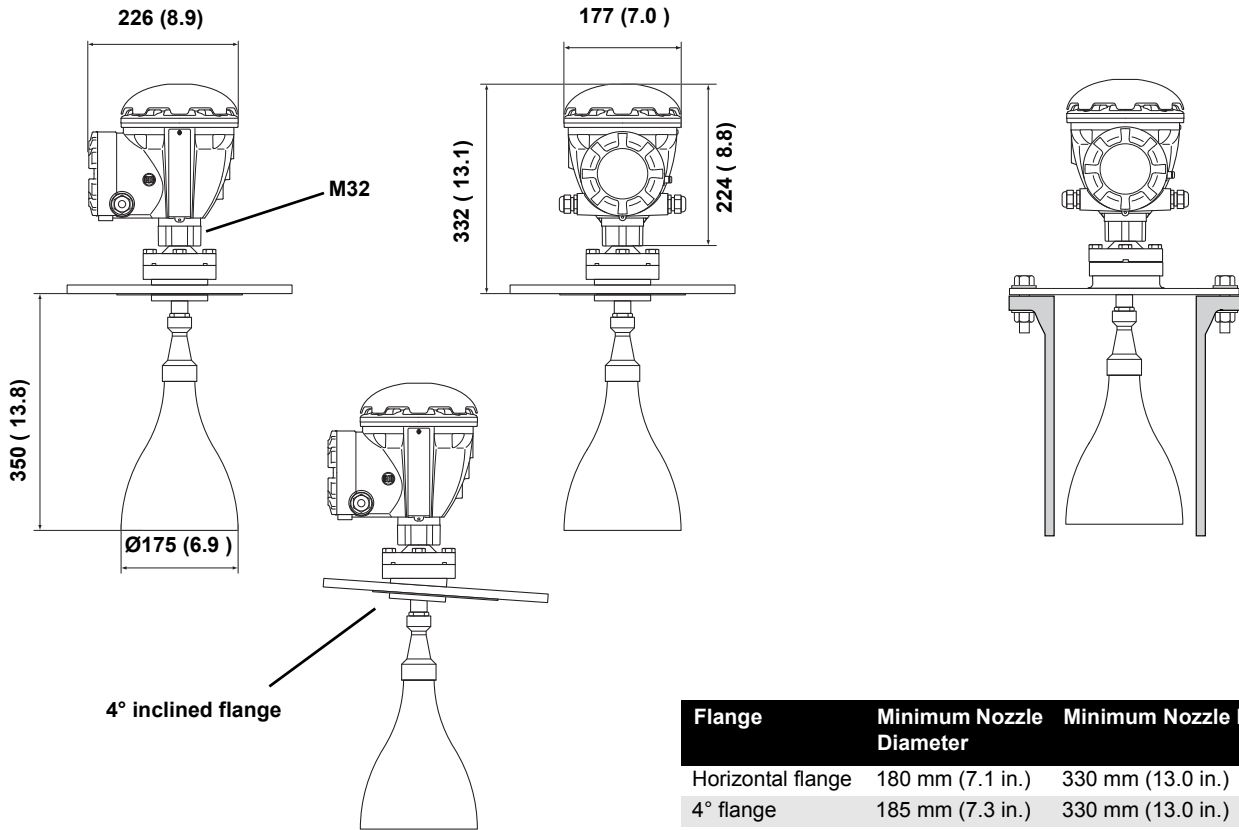
### SPECIAL CONDITIONS FOR SAFE USE (X):

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

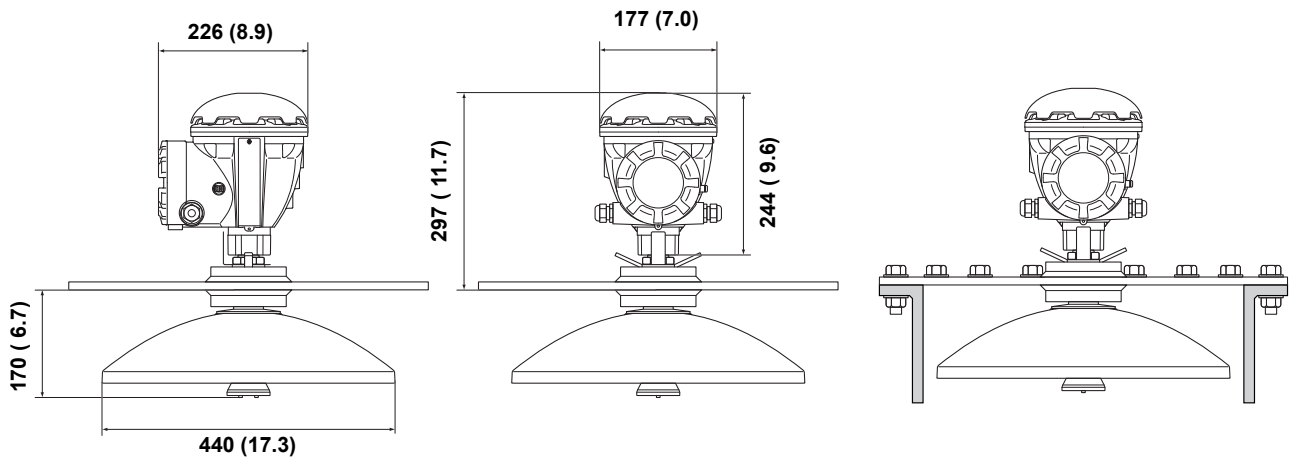
This must be taken into account when installing the apparatus.

2.8 DIMENSIONAL DRAWINGS

2.8.1 Dimensions for Rosemount 5900S with Horn Antenna



2.8.2 Dimensions for Rosemount 5900S with Parabolic Antenna



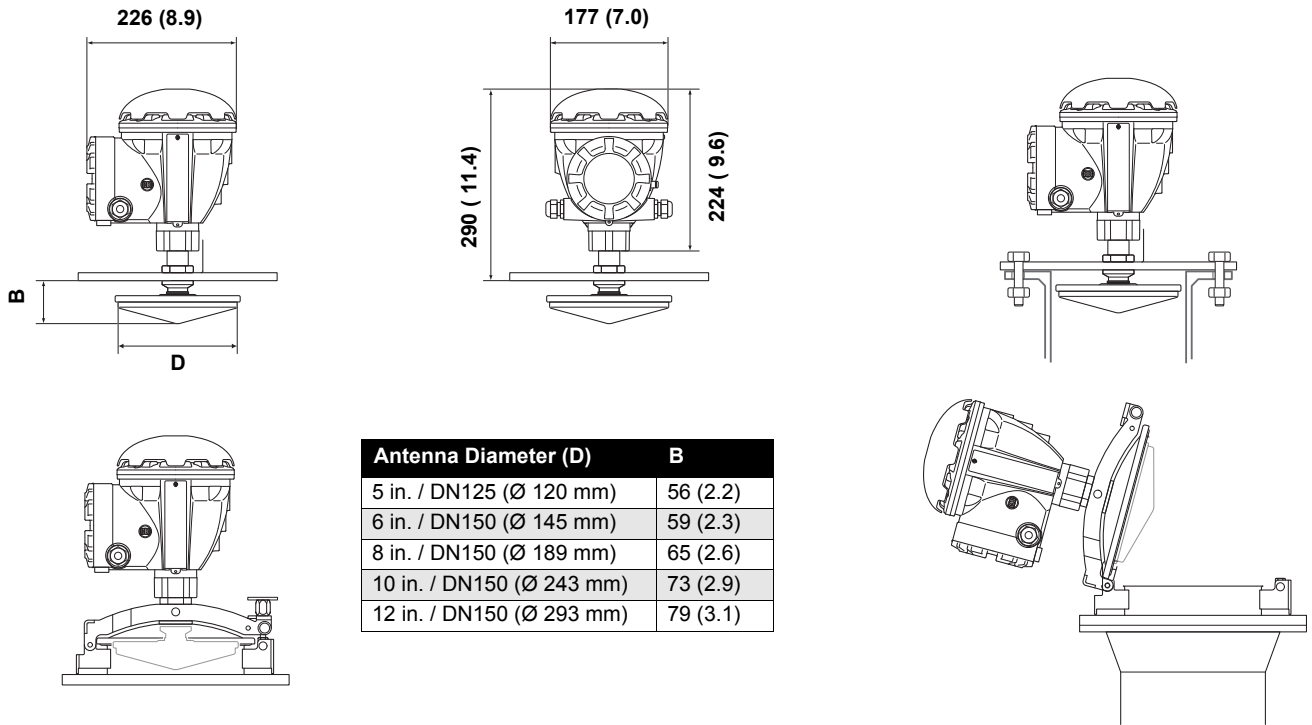
# Technical Description

704010EN, Rev BA

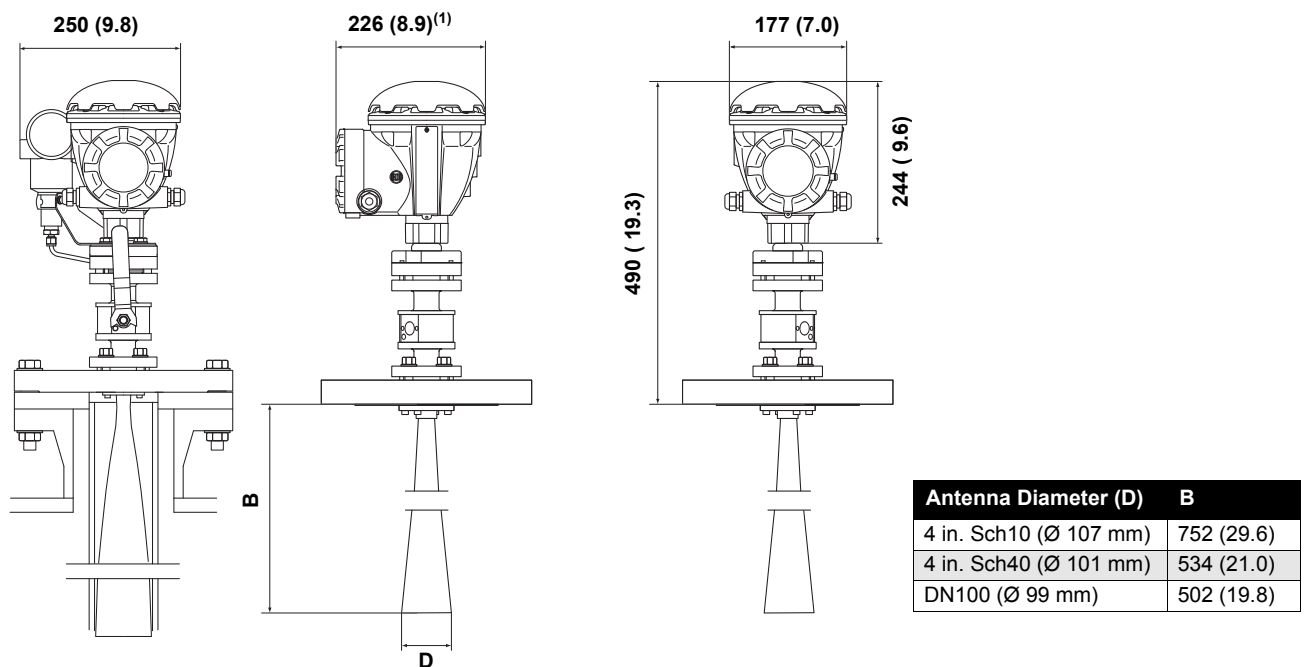
March 2011

Raptor System

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



## 2.8.4 Dimensions for Rosemount 5900S with LPG/LNG Antenna



(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) <sup>(1)</sup>	Note
3	SIL3-certification as per IEC 61508 <sup>(2)</sup>	Requires Rosemount 2410 with Relay Output (SIS/SIL), code 3. 1oo2 configuration: alarm if one of the two gauges is in alarm mode
2	SIL2-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 35
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	
I5	FM-US Intrinsic Safety	
I6	FM-Canada Intrinsic Safety	
I7	IECEX Intrinsic Safety	
KA	ATEX Intrinsic Safety+FM-US Intrinsic Safety <sup>(3)</sup>	
KC	ATEX Intrinsic Safety+IECEX Intrinsic Safety <sup>(3)</sup>	
KD	FM-US Intrinsic Safety+FM-Canada Intrinsic Safety <sup>(3)</sup>	
NA	None	
Code (Pos 7)	Custody Transfer Type Approval	Note
R	OIML R85 E performance certification	Requires Rosemount 2410 Tank Hub with OIML R85 E custody transfer type approval
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) Available in March 2011.

(2) Requires Pos 4 "Redundancy" code 2 (2-in-1).

(3) Not available with LPG/LNG antenna.



## Technical Description

704010EN, Rev BA

March 2011

Raptor System

### 2.9.2 Antenna Selection

Dimensions are in mm (inches)

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

Dimensions are in mm (inches)

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 (Polyphenylene sulfide)	
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
<b>ANSI Flanges (SST AISI 316 L)</b>		
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	
<b>EN Flanges (SST EN 1.4404)</b>		
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

## Technical Description

704010EN, Rev BA

March 2011

Raptor System

### 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
<b>ANSI Flanges (SST AISI 316L)</b>		
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 <sup>(1)</sup>	
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 <sup>(2)</sup>	
ST	Engraved SST tag plate	
P1	Antenna hydrostatic pressure testing	

(1) Requires Pos 3 "Safety Certification (SIS)" code 2 or 3 (SIL3 or SIL2).

(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  $\pm 0.05$  °C ( $\pm 0.09$  °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

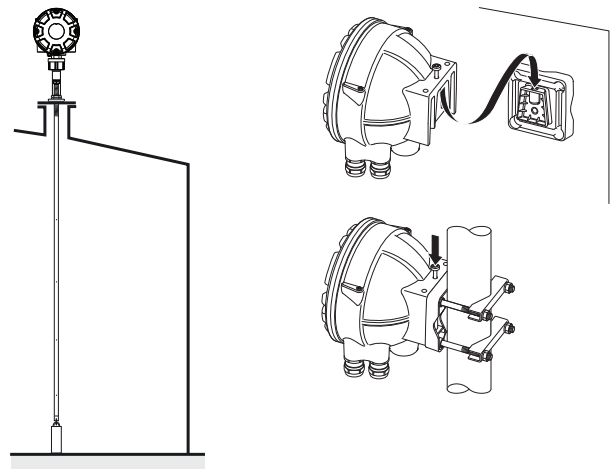
*This section includes some installation information. For complete guidance, see the Rosemount 2240S Reference Manual (document number 300550EN) and supporting installation drawings. If you miss information valid for your tank/application, you can also consult your local Rosemount Tank Gauging representative.*

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	
<b>Product</b>	Rosemount 2240S Multi-Input Temperature Transmitter
<b>Number of spot elements and wiring</b>	Up to 16 RTD spot elements or averaging sensors can be connected to a 2240S.
	<p><b>Rosemount temperature / water level sensors (models 565, 566 and 765)</b></p> <p>Three wiring types can be used:</p> <ul style="list-style-type: none"> <li>• 3-wire RTD with common return (1-16 spot elements)</li> <li>• 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)</li> <li>• 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)</li> </ul>
<b>Standard temperature sensor types</b>	Supports Pt-100 (according to IEC/EN60751, ASTM E1137) and Cu-90
<b>Metrology sealing possibility</b>	Yes
<b>Write protect switch</b>	Yes
<b>Hazardous location certifications</b>	ATEX, FM-C, FM-US, and IECEx. For details, see "Product Certifications" on page 48
<b>CE-mark</b>	Complies with applicable EU directives (EMC, ATEX)
<b>Ordinary location certification</b>	Complies with FM 3810:2005 and CSA: C22.2 No. 1010.1
Measuring Performance	
<b>Temperature conversion accuracy<sup>(1)</sup></b>	±0.05 °C (±0.09 °F)
<b>Ambient temperature effect</b>	±0.05 °C (±0.09 °F)
<b>Temperature measuring range</b>	Supports -200 to 250 °C (-328 to 482 °F) for Pt-100
<b>Resolution</b>	± 0.1 °C (± 0.1 °F) according to API chapter 7 and 12
<b>Update time</b>	4 s
Configuration	
<b>Configuration tool</b>	TankMaster WinSetup is the recommended tool for easy configuration of 2240S. The Tankbus autoconfiguration feature, handled by the Rosemount 2410 Tank Hub, supports 2240S
<b>Configuration parameters (examples)</b>	<p><i>Temperature:</i></p> <ul style="list-style-type: none"> <li>• Number of temperature sensor elements</li> <li>• Temperature element type (spot or average)</li> <li>• Temperature element position in tank</li> </ul> <p><i>Water Level Sensor:</i></p> <ul style="list-style-type: none"> <li>• Level offset (difference between tank zero level and water zero level)</li> <li>• Probe length (autoconfigured by Rosemount 765)</li> </ul>
<b>Output variables and units</b>	Spot and average temperature: °C (Celsius), and °F (Fahrenheit) Free water level (FWL): meter, centimeter, millimeter, feet, or inch

<b>Electric</b>	
<b>Power supply</b>	Powered by Rosemount 2410 Tank Hub, 9.0-17.5 VDC, polarity insensitive (10.0-17.5 VDC for non-IS installations)
<b>Internal power consumption</b>	0.5 W
<b>Bus current draw</b>	30 mA
<b>Cable entry (connection/glands)</b>	Five ½ - 14 NPT entries for cable glands or conduits (of which two are plugged at delivery). Optional: • M20 x 1.5 conduit / cable adapter • Metal cable glands (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
<b>Tankbus cabling</b>	0.5-1.5 mm <sup>2</sup> (AWG 22-16), twisted shielded pairs
<b>Built-in Tankbus terminator</b>	Yes (to be connected if required)
<b>Tankbus to sensor isolation</b>	Minimum 700 V <sub>AC</sub>
<b>Auxiliary sensor input</b>	Digital bus connection for water level sensor
<b>Mechanical</b>	
<b>Housing material</b>	Polyurethane-coated die-cast aluminum
<b>Installation</b>	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
<b>Dimensions</b>	See "Dimensional Drawings" on page 50
<b>Weight</b>	2.8 kg (6.2 lbs)
<b>Environment</b>	
<b>Ambient temperature</b>	-40 to 70 °C (-40 to 158 °F). Minimum start-up temperature -50 °C (-58 °F)
<b>Storage temperature</b>	-50 to 85 °C (-58 to 185 °F)
<b>Humidity</b>	0-100% relative humidity
<b>Ingress protection</b>	IP 66 and 67 (Nema 4X)

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

# Technical Description

704010EN, Rev BA

March 2011

Raptor System

## 3.3 PRODUCT CERTIFICATIONS

### European ATEX Directive Information

EC-Type Examination Certificate Number: FM09ATEX0047X

Control Drawing: 9240 040-976

I1<sup>(1)</sup> Intrinsically Safe

FISCO Field Device (Fieldbus Terminals):



II 1 G

Ex ia IIC T4 (-50 °C ≤ T<sub>a</sub> ≤ +70 °C)

U<sub>i</sub>=17.5 VDC, I<sub>i</sub>=380 mA, P<sub>i</sub>=5.32 W, C<sub>i</sub>=2.2 nF, L<sub>i</sub>=1.5 μH

FISCO System when Supplied from Rosemount 2410 Tank Hub (FM10ATEX0012):



II 2(1) G

Ex ib [ia IIC] IIB T4 FISCO system (-50 °C ≤ T<sub>a</sub> ≤ +70 °C)

U<sub>i</sub>=17.5 VDC, I<sub>i</sub>=380 mA, P<sub>i</sub>=5.32 W, C<sub>i</sub>=2.2 nF, L<sub>i</sub>=1.5 μH

Entity (Fieldbus Terminals):



II 1 G

Ex ia IIC T4 (-50 °C ≤ T<sub>a</sub> ≤ +70 °C)

U<sub>i</sub>=30 VDC, I<sub>i</sub>=300 mA, P<sub>i</sub>=1.3 W, C<sub>i</sub>=2.2 nF, L<sub>i</sub>=1.5 μH

RTD Terminals:

U<sub>o</sub>=5.9 VDC, I<sub>o</sub>=398 mA, P<sub>o</sub>=585 mW

Group IIC: C<sub>o</sub> ≤ 43 μF, L<sub>o</sub> ≤ 0.2 mH

Group IIB: C<sub>o</sub>= unlimited, L<sub>o</sub> ≤ 0.7 mH

Group IIA: C<sub>o</sub>= unlimited, L<sub>o</sub> ≤ 1.8 mH

When no connections are made to the Sensorbus Terminal:

U<sub>o</sub>=5.9 VDC, I<sub>o</sub>=100 mA, P<sub>o</sub>=150 mW, C<sub>o</sub>= 43 μF, L<sub>o</sub>=3 mH

Sensorbus Terminal:

U<sub>o</sub>=6.6 VDC, I<sub>o</sub>=223 mA, P<sub>o</sub>=363 mW

Group IIC: C<sub>o</sub> ≤ 22 μF, L<sub>o</sub> ≤ 0.7 mH

Group IIB: C<sub>o</sub> ≤ 500 μF, L<sub>o</sub> ≤ 3.3 mH

Group IIA: C<sub>o</sub> ≤ unlimited, L<sub>o</sub> ≤ 6 mH

### US Factory Mutual (FM-US) Certification



Certificate of Compliance: 3035518

Control Drawing: 9240 040-910

I5<sup>(1)</sup> 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<sub>a</sub> ≤ +70 °C)

U<sub>i</sub>=17.5 VDC, I<sub>i</sub>=380 mA, P<sub>i</sub>=5.32 W, C<sub>i</sub>=2.2 nF, L<sub>i</sub>=1.5 μH

FISCO System when Supplied from Rosemount 2410 Tank Hub:

Class 1 Zone 1 AEx ib [ia IIC] IIB FISCO system

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<sub>a</sub> ≤ +70 °C)

U<sub>i</sub>=30 VDC, I<sub>i</sub>=300 mA, P<sub>i</sub>=1.3 W, C<sub>i</sub>=2.2 nF, L<sub>i</sub>=1.5 μH.

RTD Terminals:

U<sub>o</sub>=5.9 VDC, I<sub>o</sub>=398 mA, P<sub>o</sub>=585 mW

Group IIC: C<sub>o</sub> ≤ 43 μF, L<sub>o</sub> ≤ 0.2 mH

Group IIB: C<sub>o</sub>= unlimited, L<sub>o</sub> ≤ 0.7 mH

Group IIA: C<sub>o</sub>= unlimited, L<sub>o</sub> ≤ 1.8 mH

When no connections are made to the Sensorbus Terminal:

U<sub>o</sub>=5.9 VDC, I<sub>o</sub>=100 mA, P<sub>o</sub>=150 mW, C<sub>o</sub>= 43 μF, L<sub>o</sub>=3 mH

Sensorbus Terminal:

U<sub>o</sub>=6.6 VDC, I<sub>o</sub>=223 mA, P<sub>o</sub>=363 mW

Group IIC: C<sub>o</sub> ≤ 22 μF, L<sub>o</sub> ≤ 0.7 mH

Group IIB: C<sub>o</sub> ≤ 500 μF, L<sub>o</sub> ≤ 3.3 mH

Group IIA: C<sub>o</sub> ≤ unlimited, L<sub>o</sub> ≤ 6 mH

### SPECIAL CONDITIONS FOR SAFE USE (X)

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.

(1) Ordering Information code for Product Certificates, see page 51.

**Canadian Factory Mutual (FM-C) Certification**

Certificate of Compliance: 3035518C

Control Drawing: 9240 040-910

Temp. Code T4. Amb. Temp. Limits -50 to +70 °C

**I6<sup>(1)</sup> 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<sub>a</sub> ≤ +70 °C)

U<sub>i</sub>=17.5 VDC, I<sub>i</sub>=380 mA, P<sub>i</sub>=5.32 W, C<sub>i</sub>=2.2 nF, L<sub>i</sub>=1.5 μH

FISCO System when Supplied from Rosemount 2410 Tank Hub:

Class 1 Zone 1 Ex ib [ia IIC] IIB FISCO system

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<sub>a</sub> ≤ +70 °C)

U<sub>i</sub>=30 VDC, I<sub>i</sub>=300 mA, P<sub>i</sub>=1.3 W, C<sub>i</sub>=2.2 nF, L<sub>i</sub>=1.5 μH.

RTD Terminals:

U<sub>o</sub>=5.9 VDC, I<sub>o</sub>=398 mA, P<sub>o</sub>=585 mW

Group IIC: C<sub>o</sub> ≤ 43 μF, L<sub>o</sub> ≤ 0.2 mH

Group IIB: C<sub>o</sub>= unlimited, L<sub>o</sub> ≤ 0.7 mH

Group IIA: C<sub>o</sub>= unlimited, L<sub>o</sub> ≤ 1.8 mH

When no connections are made to the Sensorbus Terminal:

U<sub>o</sub>=5.9 VDC, I<sub>o</sub>=100 mA, P<sub>o</sub>=150 mW, C<sub>o</sub>= 43 μF, L<sub>o</sub>=3 mH

Sensorbus Terminal:

U<sub>o</sub>=6.6 VDC, I<sub>o</sub>=223 mA, P<sub>o</sub>=363 mW

Group IIC: C<sub>o</sub> ≤ 22 μF, L<sub>o</sub> ≤ 0.7 mH

Group IIB: C<sub>o</sub> ≤ 500 μF, L<sub>o</sub> ≤ 3.3 mH

Group IIA: C<sub>o</sub> ≤ unlimited, L<sub>o</sub> ≤ 6 mH

**IECEx Certification**

Certificate of Conformity Number: IECEx FMG 10.0010X

Control Drawing: 9240 040-976

**I7<sup>(1)</sup> Intrinsically Safe**

FISCO Field Device (Fieldbus Terminals):

Ex ia IIC Ga T4 (-50 °C ≤ T<sub>a</sub> ≤ +70 °C)

U<sub>i</sub>=17.5 VDC, I<sub>i</sub>=380 mA, P<sub>i</sub>=5.32 W, C<sub>i</sub>=2.2 nF, L<sub>i</sub>=1.5 μH

FISCO System when Supplied from Rosemount 2410 Tank Hub (IECEx FMG 10.0005):

Ex ib IIB [ia IIC Ga] Gb T4 FISCO system

(-50 °C ≤ T<sub>a</sub> ≤ +70 °C)

U<sub>i</sub>=17.5 VDC, I<sub>i</sub>=380 mA, P<sub>i</sub>=5.32 W, C<sub>i</sub>=2.2 nF, L<sub>i</sub>=1.5 μH

Entity (Fieldbus Terminals):

Ex ia IIC Ga T4 (-50 °C ≤ T<sub>a</sub> ≤ +70 °C)

U<sub>i</sub>=30 VDC, I<sub>i</sub>=300 mA, P<sub>i</sub>=1.3 W, C<sub>i</sub>=2.2 nF, L<sub>i</sub>=1.5 μH

RTD Terminals:

U<sub>o</sub>=5.9 VDC, I<sub>o</sub>=398 mA, P<sub>o</sub>=585 mW

Group IIC: C<sub>o</sub> ≤ 43 μF, L<sub>o</sub> ≤ 0.2 mH

Group IIB: C<sub>o</sub>= unlimited, L<sub>o</sub> ≤ 0.7 mH

Group IIA: C<sub>o</sub>= unlimited, L<sub>o</sub> ≤ 1.8 mH

When no connections are made to the Sensorbus Terminal:

U<sub>o</sub>=5.9 VDC, I<sub>o</sub>=100 mA, P<sub>o</sub>=150 mW, C<sub>o</sub>= 43 μF, L<sub>o</sub>=3 mH

Sensorbus Terminal:

U<sub>o</sub>=6.6 VDC, I<sub>o</sub>=223 mA, P<sub>o</sub>=363 mW

Group IIC: C<sub>o</sub> ≤ 22 μF, L<sub>o</sub> ≤ 0.7 mH

Group IIB: C<sub>o</sub> ≤ 500 μF, L<sub>o</sub> ≤ 3.3 mH

Group IIA: C<sub>o</sub> ≤ unlimited, L<sub>o</sub> ≤ 6 mH

**SPECIAL CONDITIONS FOR SAFE USE (X)**

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.

**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).

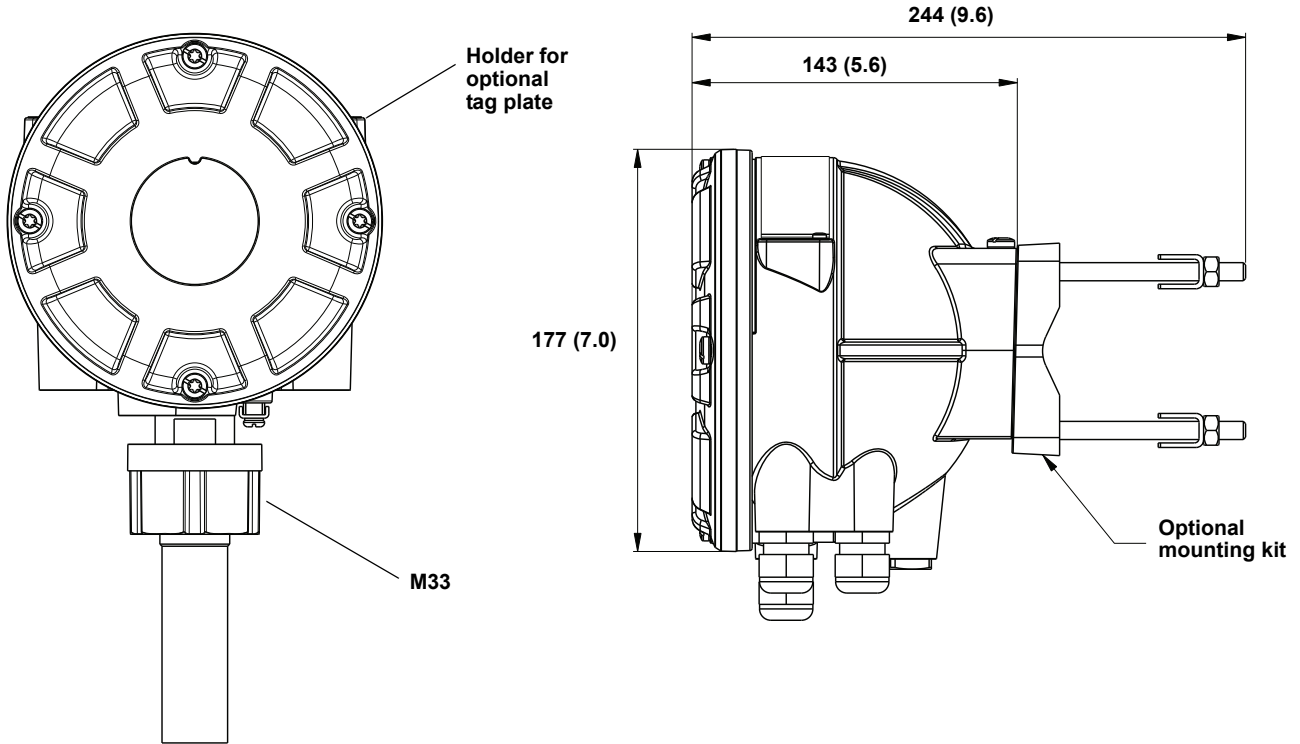


# Technical Description

704010EN, Rev BA  
March 2011

## 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: $\pm 0.05$ °C (0.09 °F) instrument accuracy	
Code (Pos 3)	Number of Temperature Sensor Inputs	Note
16	Up to 16xRTD spot elements <sup>(1)</sup>	
08	Up to 8xRTD spot elements <sup>(1)</sup>	
04	Up to 4xRTD spot elements <sup>(1)</sup>	
00	None <sup>(2)</sup>	
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 <sup>(2)</sup>	For water level, no temperature sensors
Code (Pos 5)	Auxiliary Inputs	Note
A	Rosemount 765 temperature and water level sensor input <sup>(2)</sup>	
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	
I5	FM-US Intrinsic Safety	
I6	FM-Canada Intrinsic Safety	
I7	IECEX Intrinsic Safety	
KA	ATEX Intrinsic Safety+FM-US Intrinsic Safety <sup>(3)</sup>	
KC	ATEX Intrinsic Safety+IECEX Intrinsic Safety <sup>(3)</sup>	
KD	FM-US Intrinsic Safety+FM-Canada Intrinsic Safety <sup>(3)</sup>	
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 <sup>(4)</sup>
E	Eurofast male connector and 1/2–14 NPT	Includes 2 plugs
M	Minifast male connector and 1/2–14 NPT	Includes 2 plugs

## Technical Description

704010EN, Rev BA

March 2011

Raptor System

Code (Pos 11)	Mechanical Installation	Note
M	Integrated installation with Rosemount 565, 566 or 765 (standard)	M33x1.5 female threaded connection
W	Mounting kit for wall installation	
P	Mounting kit for both wall and pipe installation	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	
<b>Model Code Example: 2240S – P 16 4 A F I1 0 A 1 M - ST</b>		

- (1) Temperature sensors of Pt-100 or Cu-90 type, for use in -200 to 250 °C (-328 to 482 °F), 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.

## 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 22 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 Dependence 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:  $\pm ( 0.15 + 0.002 * | t | )$

Grade B / Class B:  $\pm ( 0.30 + 0.005 * | t | )$

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:  $\pm ( 0.05 + 0.005 * | t | )$

1/10 DIN B:  $\pm ( 0.03 + 0.005 * | t | )$

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  $\pm ( 0.30 + 0.002 * | t | )$  tolerance. The following applies:

1/6 DIN B:  $\pm ( 0.05 + 0.002 * | t | )$

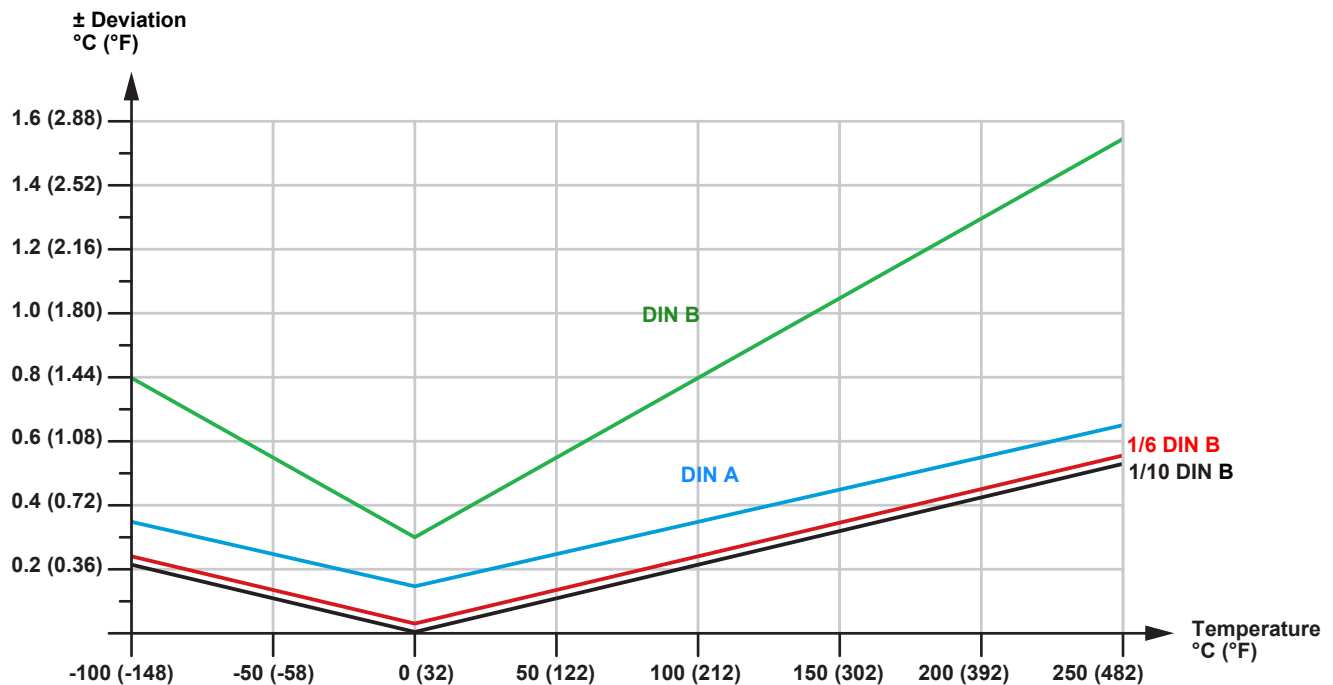
1/10 DIN B:  $\pm ( 0.03 + 0.002 * | t | )$

## Technical Description

704010EN, Rev BA

March 2011

Raptor System



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 =  $\pm (0.15 + 0.002 * |t|)$

DIN B =  $\pm (0.30 + 0.005 * |t|)$

1/6 DIN B =  $\pm (0.05 + 0.002 * |t|)$

1/10 DIN B =  $\pm (0.03 + 0.002 * |t|)$

### 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  $\pm 0.0066$  °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  $\pm \text{SQRT} (0.15^2 + (0.0066 * 20)^2) = \pm 0.200$  °C ( $\pm 0.36$  °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  $\pm 0.15$  °C ( $\pm 0.27$  °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  $A = 3.9083 * 10^{-3} \text{ } ^\circ\text{C}^{-1}$ ,  $B = -5.775 * 10^{-7} \text{ } ^\circ\text{C}^{-2}$

t is the temperature in  $^\circ\text{C}$

$C = 0 \text{ } ^\circ\text{C}^{-4}$  if  $t > 0$ ,

$C = -4.183 * 10^{-12} \text{ } ^\circ\text{C}^{-4}$  if  $t < 0$

$R_0 = 100 \text{ } \Omega$  for Pt-100

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

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)
<b>1/6 DIN B</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)
<b>1/10 DIN B</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)
<b>Calibrated</b>	± 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 separately.

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

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

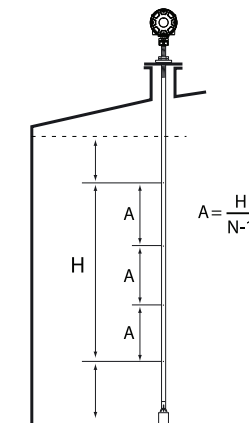
The spot elements are placed in a flexible gas tight protection tube, made from convoluted stainless steel, for easier handling during installation.

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.

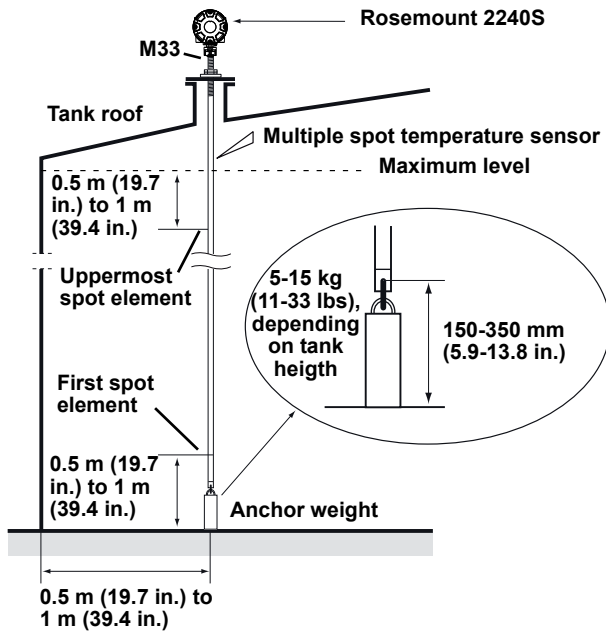


Recommended temperature sensor positions for custody transfer according to API. Example: 4 spot elements, H=9 m. A=3 m.

# Technical Description

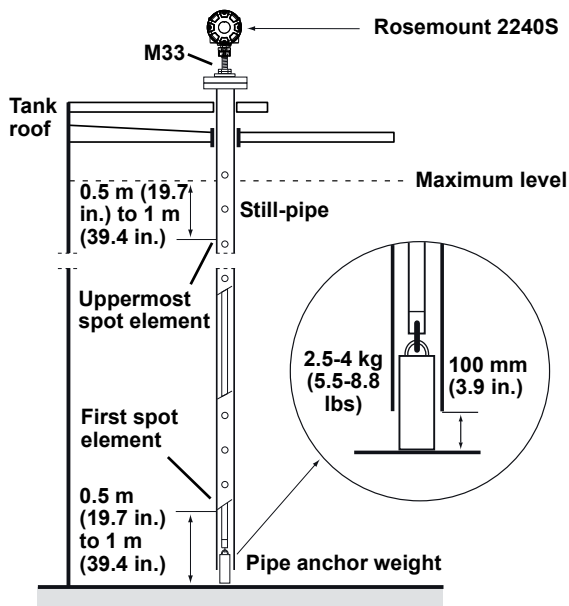
704010EN, Rev BA  
March 2011

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.

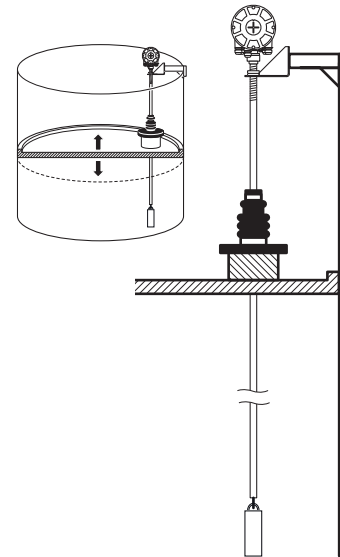
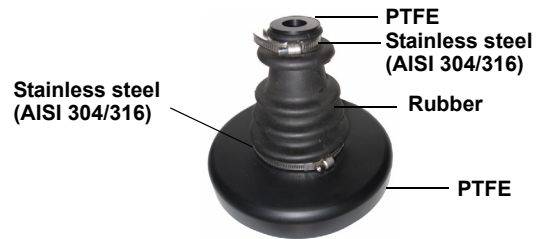


**Fixed roof tank:**

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 55).

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.

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

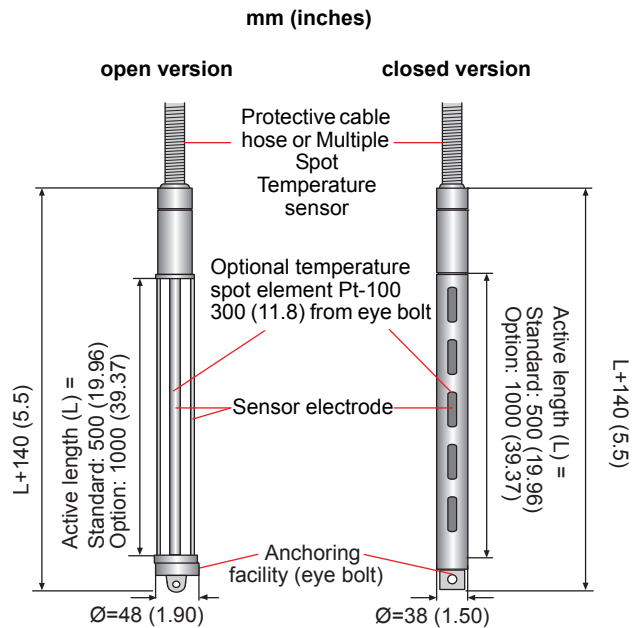
One of the Pt-100 temperature sensors can be installed inside the water level probe allowing temperature measurements at low levels.

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.

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.



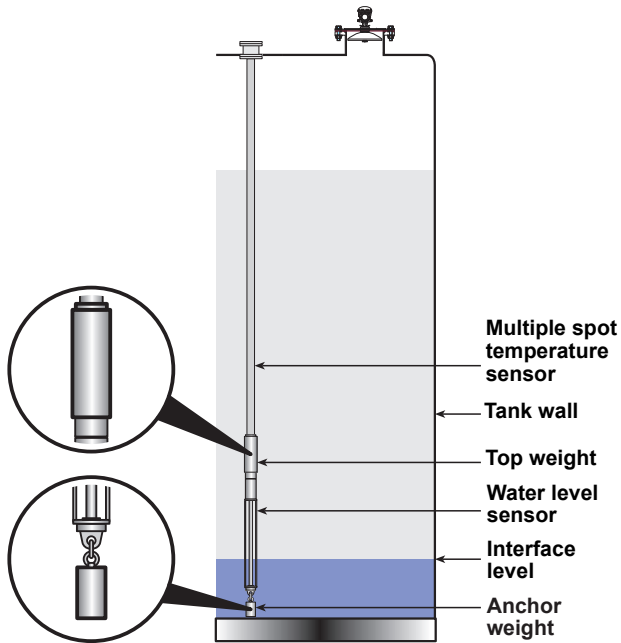
Open and closed water level sensor versions.



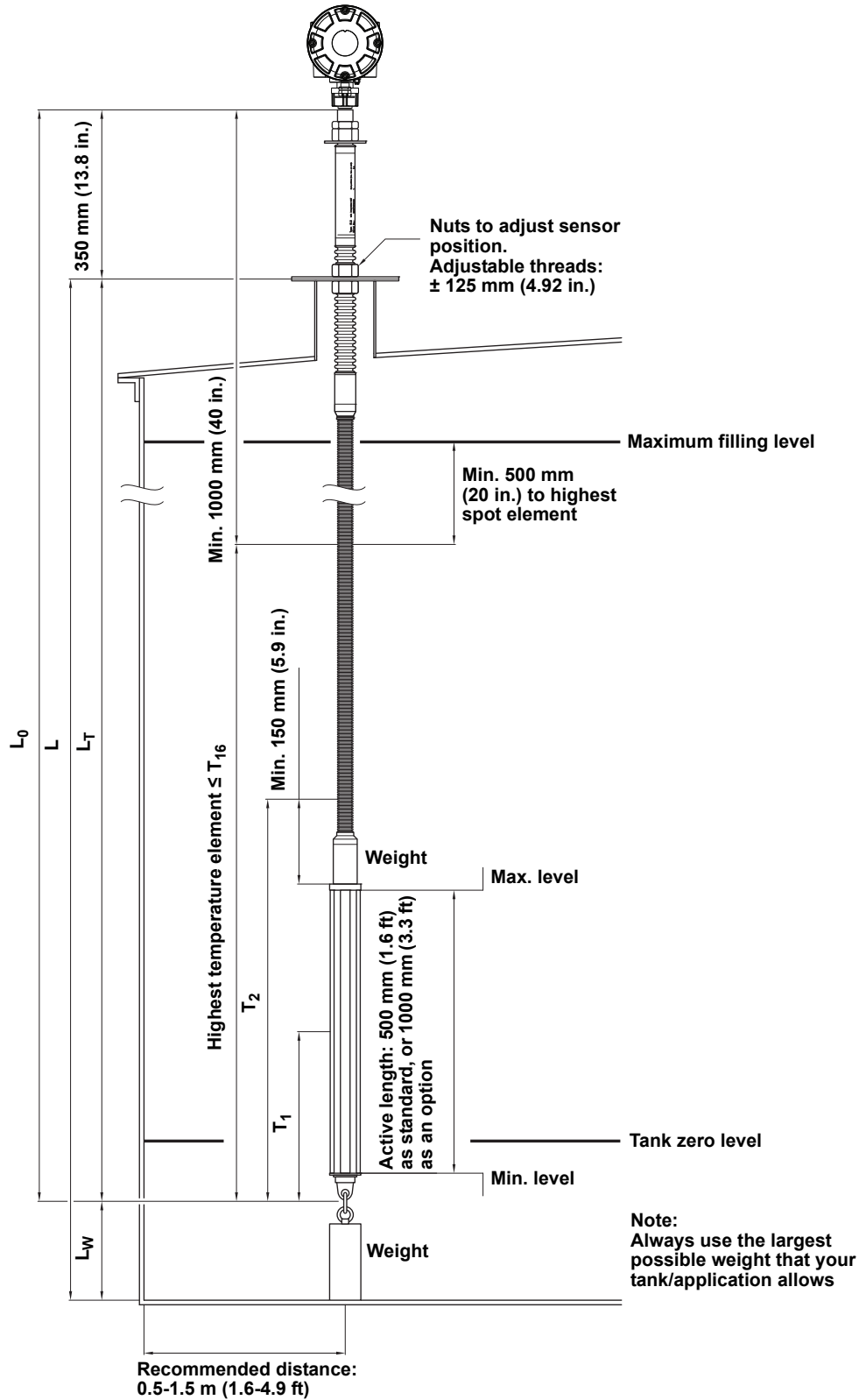
## Technical Description

704010EN, Rev BA  
March 2011

Raptor System



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.



## 4.6 SPECIFICATION

<b>Multiple Spot Temperature Sensor (Rosemount 565, 566, 765)</b>	
<b>Product</b>	Rosemount 565 and Rosemount 566 (cryogenic version) Multiple Spot Temperature Sensors. This is also the temperature specification for Rosemount 765
<b>Elements type</b>	Pt-100 spot elements according to EN 60751. 3-wire or 4-wire design
<b>Accuracy</b>	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
<b>Liquid pressure range</b>	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).
<b>Liquid temperature range</b>	-50 to 250 °C (-58 to 482 °F) -170 to 100 °C (-274 to 212 °F) for cryogenic use
<b>Number of elements</b>	Max. 16 spot elements. See page 61
<b>Overall length</b>	Standard is 5-70 m (16.4-230 ft). Maximum 60 m (197 ft) for Rosemount 765. Other lengths on request
<b>Protective sheath</b>	Stainless steel, AISI 316. Wall thickness 0.3 mm (0.012 in.). Ø=1 in.
<b>Top fitting / mounting thread</b>	Steel pipe with 1/2-in. BSP thread or M33 x 1.5. Thread length 253 mm (10.0 in.)
<b>Tank opening</b>	Minimum Ø= 2 in. (50.8 mm)
<b>Flange (option)</b>	1½ to 4 in. according to standards. Stainless steel (AISI 304 is standard, AISI 316 on request)
<b>Immersed material</b>	Stainless steel (AISI 316)
<b>Lead wire length</b>	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.
<b>No of wires</b>	<ul style="list-style-type: none"> <li>• Three or four independent wires per element or</li> <li>• Three wires with common return</li> </ul>
<b>Bottom weight</b>	2.5-15 kg (5.5-33 lbs). 2.5-4 kg (5.5-9 lbs) for still-pipe installation. Stainless steel (AISI 304)
<b>Minimum distance from the bottom of the sensor to the first spot element</b>	150 mm (5.9 in.)
<b>Minimum distance from the top of the sensor to the uppermost spot element</b>	850 mm (33.5 in.)
<b>Declaration of Conformity</b>	Designed according to EN 60751. Accuracy approved by PTB. <ul style="list-style-type: none"> <li>• ISO 15156-06-2009 (NACE MR0175) for all wetted parts</li> </ul> CE-mark: <ul style="list-style-type: none"> <li>• ATEX Directive 94/9/EC.</li> <li>• Low voltage directive (LVD): 2004/108 EC</li> <li>• EMC directive: 2006/95/EC</li> </ul>
<b>Hazardous location certifications</b>	IECEx, ATEX, FM-US, and FM-C. See "Product Certifications" on page 62
<b>Ingress protection</b>	IP 68

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

<b>Sensor Type<sup>(1)</sup></b>	<b>Connection</b>	<b>Temperature Range</b>	<b>Conductors</b>	<b>Maximum Number of Spot Elements</b>
<b>Rosemount 565</b>	1 in.	-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
<b>Rosemount 566</b>	1 in.	-170 to 100 °C (-274 to 212 °F)	3-wire, individual wiring	6
			4-wire, individual wiring	4
			3-wire, common return wiring	16
<b>Rosemount 765</b>	1 in.	-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<sup>(1)</sup>

Temperature element parameters:  $U_i=7.2$  VDC,  $I_i=400$  mA,  $P_i=700$  mW,  $L_i=40$   $\mu$ H,  $C_i=500$  nF

Communication/transmitter parameters:  $U_i=7.2$  VDC,  $I_i=250$  mA,  $P_i=700$  mW,  $L_i=130$   $\mu$ H,  $C_i=0$  nF

#### Rosemount 565

II 1 G Ex ia IIC T2/T4<sup>(2)</sup>

$U_i=7.2$  VDC,  $I_i=400$  mA,  $P_i=700$  mW,  $L_i=40$   $\mu$ H,  $C_i=500$  nF

#### Rosemount 566

II 1 G Ex ia IIC T5<sup>(3)</sup>

$U_i=7.2$  VDC,  $I_i=400$  mA,  $P_i=700$  mW,  $L_i=40$   $\mu$ H,  $C_i=500$  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  $\leq T_a \leq +120$  °C, and T6 above the flange at an ambient temperature range of  $-50$  °C  $\leq T_a \leq +70$  °C.

Temperature element parameters:  $U_i=7.2$  VDC,  $I_i=400$  mA,  $P_i=700$  mW,  $L_i=40$   $\mu$ H,  $C_i=500$  nF

Communication/transmitter parameters:  $U_i=7.2$  VDC,  $I_i=250$  mA,  $P_i=700$  mW,  $L_i=130$   $\mu$ H,  $C_i=0$  nF

(1) Below flange: T4:  $-50$  °C  $\leq T_a \leq +120$  °C

Above flange: T6:  $-50$  °C  $\leq T_a \leq +70$  °C

(2) T2:  $-50$  °C  $\leq T \leq +70$  °C above flange,

$-50$  °C  $\leq T \leq +250$  °C below flange

T4:  $-50$  °C  $\leq T \leq +70$  °C above flange,

$-50$  °C  $\leq T \leq +130$  °C below flange

(3) T5:  $-50$  °C  $\leq T \leq +70$  °C above flange,

$-200$  °C  $\leq T \leq +95$  °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<sup>(2)</sup>

$U_i=7.2$  VDC,  $I_i=400$  mA,  $P_i=700$  mW,  $L_i=40$   $\mu$ H,  $C_i=500$  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<sup>(3)</sup>

$U_i=7.2$  VDC,  $I_i=400$  mA,  $P_i=700$  mW,  $L_i=40$   $\mu$ H,  $C_i=500$  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  $\leq T_a \leq +120$  °C, and T6 above the flange at an ambient temperature range of  $-50$  °C  $\leq T_a \leq +70$  °C.

Temperature element parameters:  $U_i=7.2$  VDC,  $I_i=400$  mA,  $P_i=700$  mW,  $L_i=40$   $\mu$ H,  $C_i=500$  nF

Communication/transmitter parameters:  $U_i=7.2$  VDC,  $I_i=250$  mA,  $P_i=700$  mW,  $L_i=130$   $\mu$ H,  $C_i=0$  nF

#### Rosemount 565

Intrinsically safe for Class I, Zone 0 Group IIC hazardous locations; Temperature class as indicated<sup>(2)</sup>

$U_i=7.2$  VDC,  $I_i=400$  mA,  $P_i=700$  mW,  $L_i=40$   $\mu$ H,  $C_i=500$  nF

#### Rosemount 566

Intrinsically safe for Class I, Zone 0 Group IIC hazardous locations; Temperature class as indicated<sup>(3)</sup>

$U_i=7.2$  VDC,  $I_i=400$  mA,  $P_i=700$  mW,  $L_i=40$   $\mu$ H,  $C_i=500$  nF

### IECEX Certification

Certificate of Conformity Number: IECEx FME 08.0007X

Control Drawing: 800-9020-FM

#### Rosemount 765

Ex ia IIC T4/T6<sup>(1)</sup>

Temperature element parameters:  $U_i=7.2$  VDC,  $I_i=400$  mA,  $P_i=700$  mW,  $L_i=40$   $\mu$ H,  $C_i=500$  nF

Communication/transmitter parameters:  $U_i=7.2$  VDC,  $I_i=250$  mA,  $P_i=700$  mW,  $L_i=130$   $\mu$ H,  $C_i=0$  nF

#### Rosemount 565

Ex ia IIC T2/T4<sup>(2)</sup>

$U_i=7.2$  VDC,  $I_i=400$  mA,  $P_i=700$  mW,  $L_i=40$   $\mu$ H,  $C_i=500$  nF

#### Rosemount 566

II 1 G Ex ia IIC T5<sup>(3)</sup>

$U_i=7.2$  VDC,  $I_i=400$  mA,  $P_i=700$  mW,  $L_i=40$   $\mu$ H,  $C_i=500$  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 <sub>0</sub> )	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

## Technical Description

704010EN, Rev BA

March 2011

Raptor System

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
<b>Certificate</b>		
Q8	Material certificate EN10204 3.1	
<b>Stabilization Weights (SST AISI 304)</b>		
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
<b>Vapor Boot</b>		
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	
<b>Hose Kit</b>		
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	
<b>Model Code Example: 0565 – M25000 A 0 4 16 P 2 2 00 - Q8 AE VE - temperature sensor positions<sup>(1)</sup></b>		

(1) 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 <sub>0</sub> )	Note
Mxxxx	Metric units, xxxxx in millimeters (mm). Range: 02000-70000	Specify in steps of 10 mm. Longer on request.
Exxxx	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
<b>ANSI Flanges (SST AISI 304)</b>		
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	
<b>EN Flanges (SST AISI 304)</b>		
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	
<b>Threaded Connection</b>		
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 <sup>(1)</sup>	
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	



# Technical Description

704010EN, Rev BA

March 2011

Raptor System

Code	Options – none or multiple selections are possible. Specify in the same order as below	Note
<b>Certificate</b>		
Q8	Material certificate EN10204 3.1	
<b>Stabilization Weights (SST AISI 304)</b>		
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
<b>Hose Kit</b>		
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	
<b>Calibration</b>		
X8	Sensor calibration over specified temperature range with A, B, C, and Callendar-van Dusen constants <sup>(2)</sup>	
<b>Other</b>		
DN	Drain nipple on flange	
<b>Model Code Example: 0566 – M25000 A E 4 16 P A 3 00 - Q8 AA VC DN - temperature sensor positions<sup>(3)</sup></b>		

(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) Requires Pos 5 "Temperature Sensor Wiring" code 4 (4-wire).

(3) 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 <sub>0</sub> )	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 <sup>(1)</sup>	
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
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)	
04-10	Specify other length in metres	
13-33	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
<b>Certificate</b>		
QD	Water level sensor calibration certificate	
Q8	Material certificate EN10204 3.1	
<b>Stabilization Weights (SST AISI 304)</b>		
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	Water level sensor top weight 5 kg (11 lbs)	
<b>Vapor Boot</b>		
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	
<b>Hose Kit</b>		
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	
<b>Model Code Example: 0765 - M25000 A 3 4 10 P 2 1 00 - QD Q8 AA BA VC - temperature sensor positions<sup>(2)</sup></b>		

(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) 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.

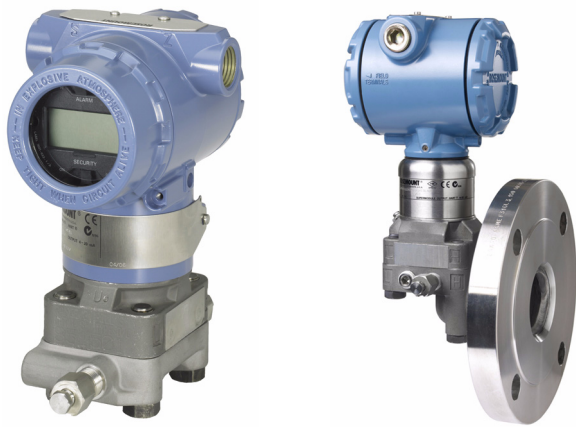
It supplies the measured pressure data to the Tankbus, which utilizes the FOUNDATION™ fieldbus communication protocol. 3051S is powered by the Rosemount 2410 Tank Hub.

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 (*WirelessHART*) 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 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.

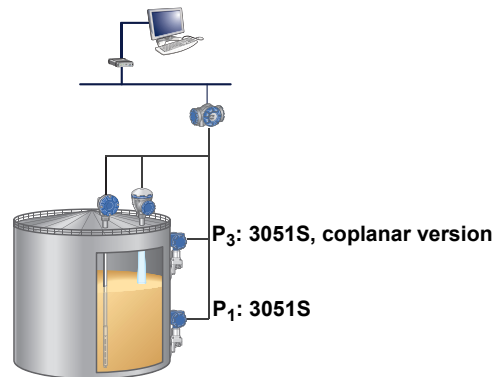
## 5.2 INSTALLATION CONSIDERATIONS

Pressure transmitters are used in two main configuration alternatives:

- Ventilated tank:  
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): 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).

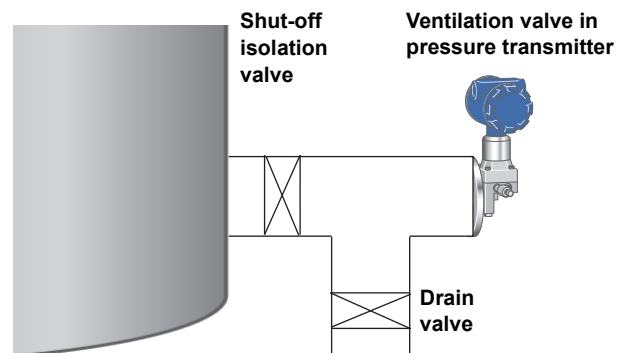
The pressure transmitter which measures liquid pressure, should be of either flanged liquid level or coplanar type. The liquid level pressure transmitter is used for crude oil applications, and the coplanar pressure transmitter is used for any other liquid type.



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	
<b>Product</b>	Rosemount 3051S Pressure Transmitter; <ul style="list-style-type: none"> <li>• Coplanar pressure transmitter</li> <li>• Liquid level pressure transmitter</li> </ul> <p>For complete information and offering, see the Rosemount 3051S Product Data Sheet (document number 00813-0100-4801).</p>
<b>Hazardous location certifications</b>	Factory Mutual (FM), ATEX, Canadian Standards Association (CSA), and IECEx. See "Product Certifications" on page 73.
<b>ATEX directive</b>	94/9/EC
<b>Ordinary location certification</b>	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	
<b>Pressure range</b>	-393 to 1000 inH <sub>2</sub> O (-0.98 to 2.5 bar). 1000 inH <sub>2</sub> O <=> 25 mH <sub>2</sub> O
<b>Reference accuracy</b>	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
<b>Typical density accuracy</b>	According to API chapter 3.6
Display / Configuration / Communication	
<b>Integral display</b>	Yes
<b>Configuration tools</b>	Field Communicator, AMS Suite, DeltaV or any other DD (Device Description) compatible host system
<b>FOUNDATION™ fieldbus blocks</b>	Resource block, Transducer block, LCD block, 2 AI blocks, PID block, ISEL block, SGCR block, ARTH block, and OSPL block
<b>FOUNDATION™ fieldbus class (basic or link master)</b>	Link Master (LAS)
<b>FOUNDATION™ fieldbus block execution time</b>	AI-block: 20 ms. PID-block: 35 ms. ARTH-, ISEL-, OSPL-block, SGCR-block: 20 ms
<b>FOUNDATION™ fieldbus PlantWeb Alert support</b>	Yes
Electric	
<b>Power supply</b>	Powered by Rosemount 2410 Tank Hub
<b>Bus current draw</b>	17.5 mA
Mechanical	
<b>Tank connection</b>	See ordering information on page 80 and 78
<b>Housing / enclosure</b>	Polyurethane-covered aluminum
<b>Cable entry</b>	½ - 14 NPT and M20 x 1.5 conduit / cable adapter
<b>Tankbus cabling</b>	0.5-1.5 mm <sup>2</sup> (AWG 22-16), twisted shielded pairs
<b>Dimensions</b>	See "Dimensional Drawings" on page 75
<b>Weight</b>	4 to 15 kg (9-33 lbs) including tank connection, depending on transmitter choice

## Technical Description

704010EN, Rev BA

March 2011

Raptor System

Environment	
<b>Ambient temperature</b>	-40 to 85 °C (-40 to 185 °F). LCD readable in: -20 to 80 °C (-4 to 175 °F)
<b>Storage temperature</b>	-46 to 85 °C (-50 to 185 °F). LCD: -40 to 85 °C (-40 to 185 °F)
<b>Process temperature</b>	Coplanar Pressure Transmitter: -40 to +149 °C (-40 to +300 °F) Liquid Level Pressure Transmitter: -45 to +205 °C (-49 to +401 °F)
<b>Humidity</b>	0 - 100% relative humidity
<b>Ingress protection</b>	IP 66, IP 68 <sup>(1)</sup> , Nema 4X
<b>Vibration effect</b>	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).
<b>Telecommunication (FCC and R&amp;TTE)</b>	R&TTE 1999/5/EC
<b>Electromagnetic compatibility</b>	EMC (2004/108/EC) EN 61326-1:2006 EN 61326-2-3:2006EN61326 and NAMUR recommendations NE21
<b>Transient / built-in lightning protection</b>	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)
<b>Pressure Equipment Directive (PED)</b>	97/23/EC

(1) Not available with wireless output.


Wireless	
<b>Output</b>	WirelessHART, 2.4 GHz DSSS
<b>Radio frequency power output from antenna</b>	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
<b>Update Rate</b>	WirelessHART, user selectable 4 sec. to 60 min.
<b>Power Module</b>	Intrinsically Safe Lithium-thionyl chloride power module with polybutadine terephthalate (PBT) enclosure. Ten-year life at one minute update rate
<b>Telecommunication (FCC and R&amp;TTE)</b>	R&TTE 1999/5/EC. Also see "Product Certifications for Wireless Output" on page 73

## 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 ( $T_a = 70\text{ }^\circ\text{C}$  for output options A or X;  $T_a = 60\text{ }^\circ\text{C}$  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 ( $T_a = 70\text{ }^\circ\text{C}$  for output options A or X;  $T_a = 60\text{ }^\circ\text{C}$  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 ( $T_a = 70\text{ }^\circ\text{C}$  for output options A or X;  $T_a = 60\text{ }^\circ\text{C}$  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  II 1G  
Ex ia IIC T4 ( $T_a = -60$  to  $70\text{ }^\circ\text{C}$ ) -HART/Remote Display/Quick Connect/HART Diagnostics  
Ex ia IIC T4 ( $T_a = -60$  to  $70\text{ }^\circ\text{C}$ ) -FOUNDATION fieldbus  
Ex ia IIC T4 ( $T_a = -60$  to  $40\text{ }^\circ\text{C}$ ) -FISCO

 1180

#### Input Parameters

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

#### SPECIAL CONDITIONS FOR SAFE USE (X)

- 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.
- 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 ( $T_a = -60$  to  $70\text{ }^\circ\text{C}$ ) -HART/Remote Display/Quick Connect/HART Diagnostics  
Ex ia IIC T4 ( $T_a = -60$  to  $70\text{ }^\circ\text{C}$ ) -FOUNDATION fieldbus  
Ex ia IIC T4 ( $T_a = -60$  to  $40\text{ }^\circ\text{C}$ ) -FISCO  
IP66

#### Input Parameters

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

#### SPECIAL CONDITIONS FOR SAFE USE (X)

- 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.
- 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.



## Technical Description

704010EN, Rev BA

March 2011

Raptor System

### Factory Mutual (FM) Approval

- 15 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.

- 16 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

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

 1180

### 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

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

### SPECIAL CONDITIONS FOR SAFE USE (X)

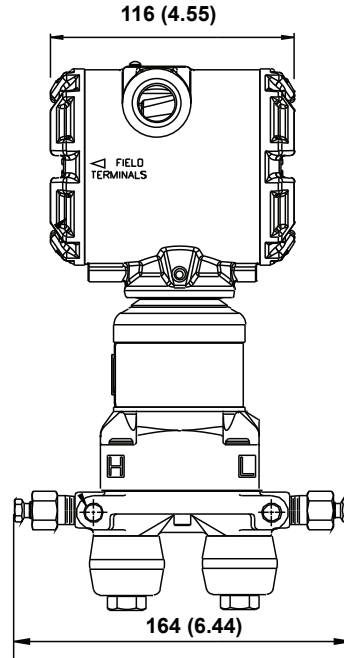
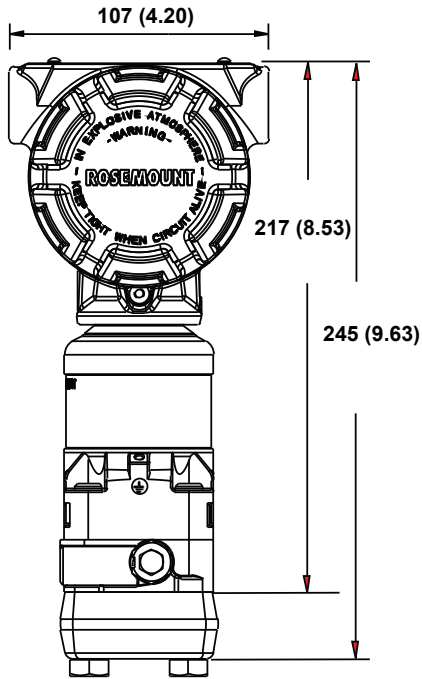
The surface resistivity of the antenna is greater than one gigaohm. To avoid electrostatic charge build-up, it must not be rubbed or cleaned with solvents or a dry cloth.

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

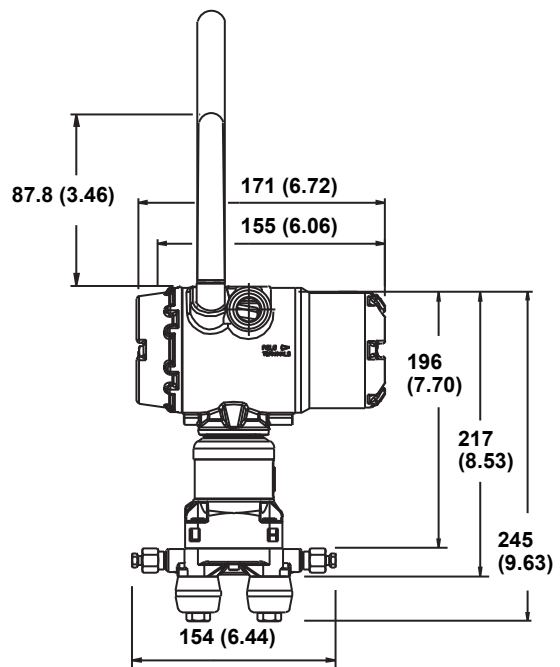
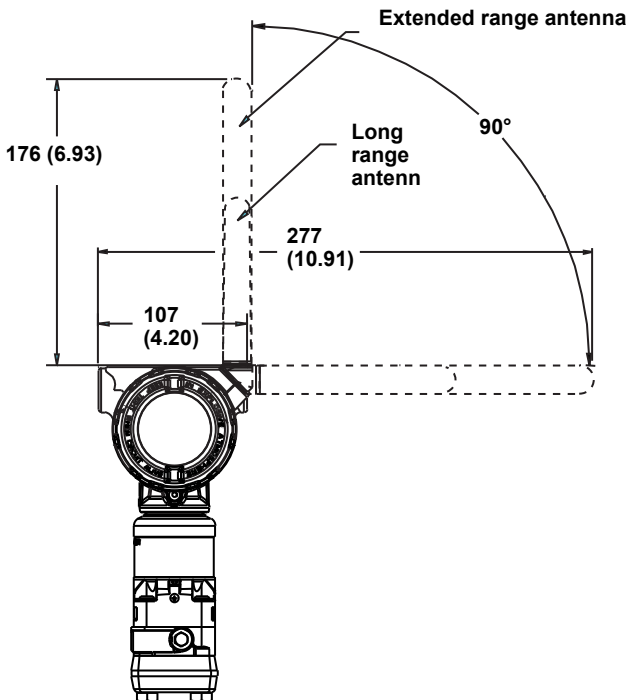
5.5 DIMENSIONAL DRAWINGS

All dimensions are in mm (inches).

5.5.1 Coplanar Pressure Transmitter



Wireless Version

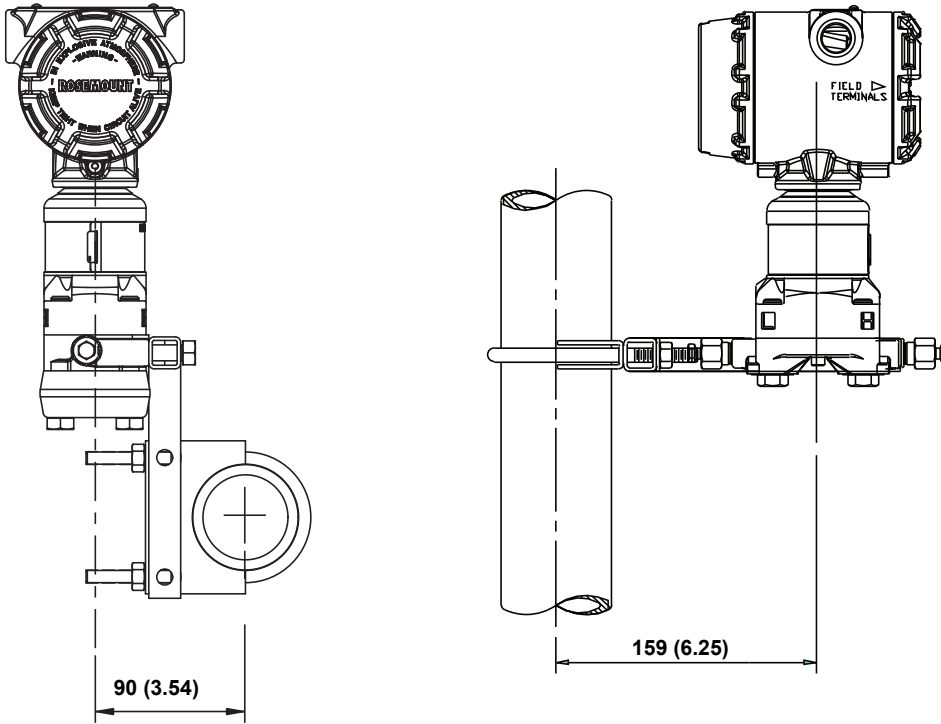


# Technical Description

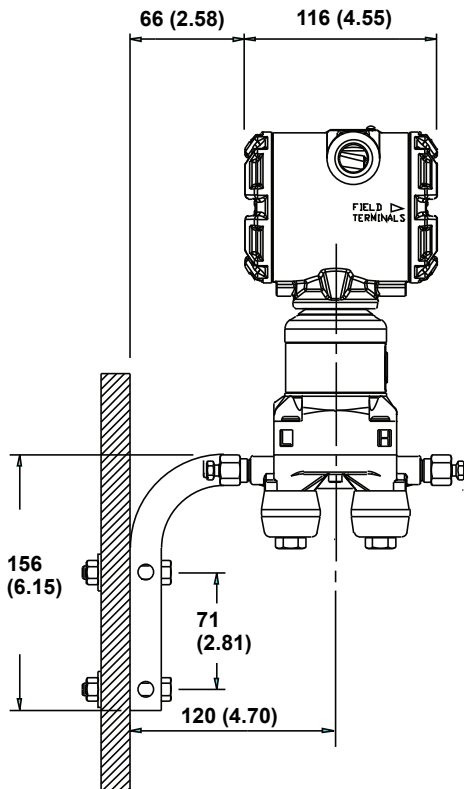
704010EN, Rev BA  
March 2011

## Pipe Installation

All dimensions are in mm (inches).

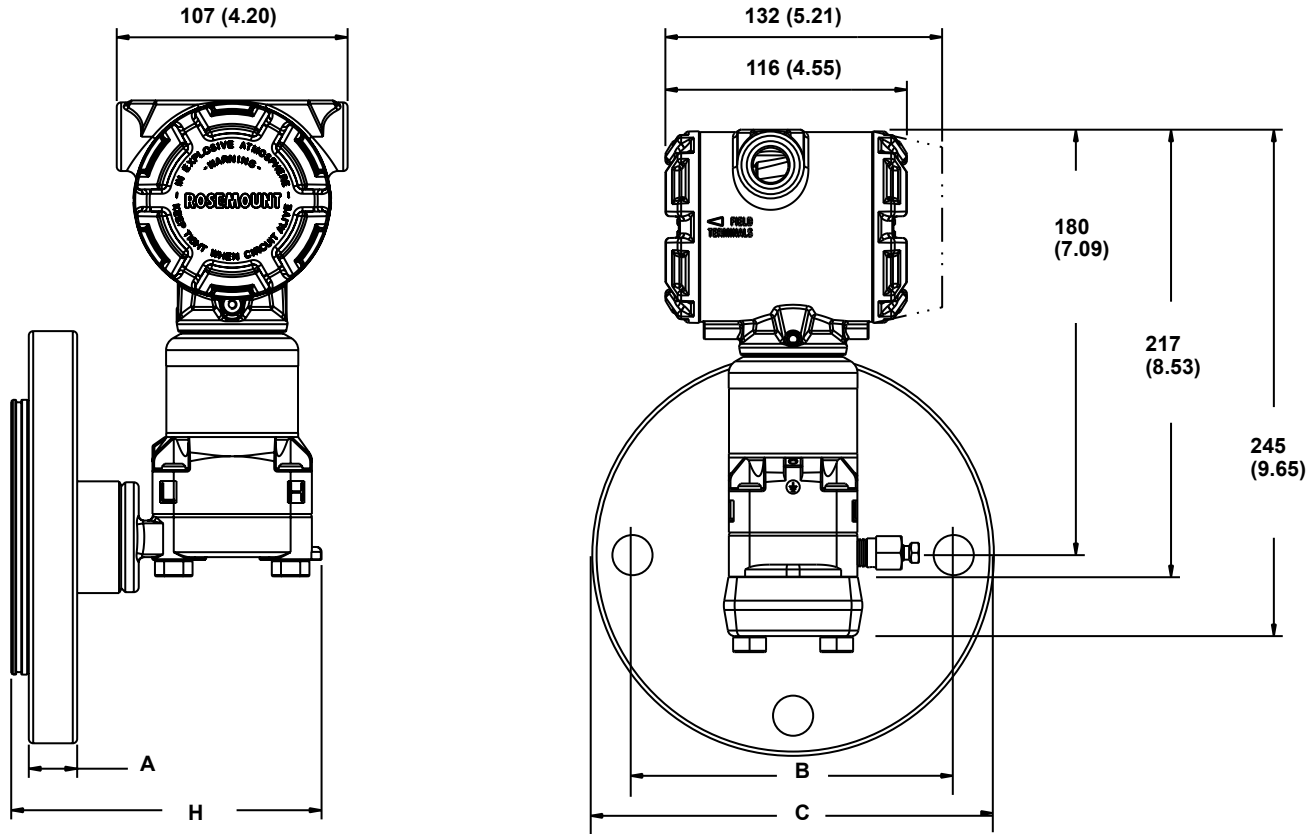


## Panel Installation



**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)

## Technical Description

704010EN, Rev BA

March 2011

Raptor System

### 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 <sub>2</sub> O (-62.2 to 62.2 mbar), 1000 inH <sub>2</sub> O <=> 25 mH <sub>2</sub> O	For vapor pressure measurement (P3)
3A	-393 to 1000 inH <sub>2</sub> O (-0.98 to 2.5 bar), 1000 inH <sub>2</sub> O <=> 25 mH <sub>2</sub> O	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 <sup>(1)</sup>	
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
<b>Update Rate</b>			
WA		User configurable update rate	
<b>Operating Frequency and Protocol</b>			
3		2.4 GHz DSSS, <i>WirelessHART</i>	
<b>Omnidirectional Wireless Antenna</b>			
WK		External antenna	
WM		Extended range, external antenna	
<b>SmartPower™</b>			
1 <sup>(2)</sup>		Intrinsically safe power module adapter (power module is separate)	
Code		Other Options – none or multiple selections are possible	
<b>Hazardous Location Certification for FOUNDATION™ fieldbus</b>			
IA		ATEX FISCO Intrinsic Safety	
IE		FM FISCO Intrinsically Safe	
IF		CSA FISCO Intrinsically Safe	
IG		IECEX FISCO Intrinsically Safe	
<b>Hazardous Location Certification for Wireless</b>			
I1		ATEX Intrinsic Safety	
I5		FM Intrinsically Safe	
I6		CSA Intrinsically Safe	
I7		IECEX Intrinsically Safe	
<b>Other</b>			
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)	
<b>Model Code Example: 3051S - 1 C G 3A 2 G11 F 1A - IA Q4</b>			

(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.

## Technical Description

704010EN, Rev BA  
March 2011

Raptor System

### 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 <sub>2</sub> O (-0.98 to 2.5 bar)	1000 inH <sub>2</sub> O <=> 25 mH <sub>2</sub> O
Code (Pos 6)	Tank Bus: Power and Communication	Note
F	Bus powered 2-wire FOUNDATION™ fieldbus (IEC61158)	
X	Wireless <sup>(1)</sup>	
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	
<b>Code</b>	<b>Wireless Options</b>	<b>Requires Pos 6 code X &amp; Pos 7 code 5A. Also see next section for Hazardous Location Certification</b>
<b>Update Rate</b>		
WA	User configurable update rate	
<b>Operating Frequency and Protocol</b>		
3	2.4 GHz DSSS, <i>WirelessHART</i>	
<b>Omnidirectional Wireless Antenna</b>		
WK	External antenna	
WM	Extended range, external antenna	
<b>SmartPower™</b>		
1 <sup>(2)</sup>	Adapter for power module (intrinsically safe power module is sold separately)	
<b>Code</b>	<b>Other Options – none or multiple selections are possible</b>	<b>Note</b>
<b>Flushing Connection Ring Plugs</b>		
SG	SST plug(s) for flushing connection(s)	
SH	SST drain/vent(s) for flushing connection(s)	
<b>Seal Options: Material Certification</b>		
ST	Wetted materials compliance to NACE MR0175/ISO 1516, MR0103	
<b>Product Certifications for FOUNDATION™ fieldbus</b>		
IA	ATEX FISCO Intrinsic Safety	
IE	FM FISCO Intrinsically Safe	
IF	CSA FISCO Intrinsically Safe	
IG	IECEx FISCO Intrinsic Safety	
<b>Product Certifications for Wireless</b>		
I1	ATEX Intrinsic Safety	
I5	FM Intrinsically Safe, Division 2	
I6	CSA Intrinsically Safe	
I7	IECEx Intrinsic Safety	
<b>Other</b>		
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)	
<b>Model Code Example: 3051SAL - 2 C G 3A F 1A 10 20 D FF G 1 DA 0 0 - IA Q4</b>		

(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.

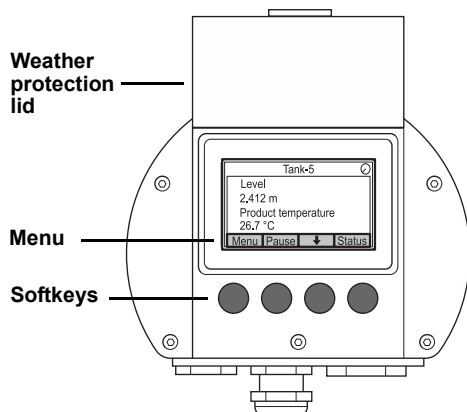
Rosemount 2230 can display data from devices connected to a 2410 tank hub for maximum 10 tanks.

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 84.
- 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	
<b>Product</b>	Rosemount 2230 Graphical Field Display
<b>Toggle time</b>	The time each value or set of values are shown on the display: 2-30 s
<b>Language selection possibilities</b>	English, French, German, Spanish, Italian, and Portuguese
<b>Variables to display</b>	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
<b>Units to display</b>	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 <sup>3</sup> /hour, liter/minute, feet <sup>3</sup> /hour, barrel/hour, or US gallon/hour Total Observed Volume (TOV): meter <sup>3</sup> , liters, feet <sup>3</sup> , barrel, or US gallon Temperature: °F, °C, or °K. Pressure: psi, psiA, psiG, bar, barA, barG, atm, Pa, or kPa Density: kg/m <sup>3</sup> , kg/liter, or °API Signal strength: mV
<b>Hazardous location certifications and IS parameters</b>	ATEX, FM-C, FM-US, and IECEx. For details, see "Product Certifications" on page 85
<b>CE-mark</b>	Complies with applicable EU directives (EMC, ATEX)
<b>Ordinary location certification</b>	Complies with FM 3810:2005 and CSA: C22.2 No. 1010.1
Electric	
<b>Power supply</b>	Powered by Rosemount 2410 Tank Hub (9.0-17.5 VDC, polarity insensitive)
<b>IS parameters</b>	See "Product Certifications" on page 85
<b>Bus current draw</b>	30 mA
<b>Display type</b>	Back-lit LCD monochrome display, 128x64 pixels
<b>Start-up time</b>	5 s
<b>Update rate</b>	New values to display once every two seconds
<b>Response time</b>	< 0.5 s from released button to new image
<b>Cable entry<sup>(1)</sup> (connection/glands)</b>	Three entries, two M20×1.5 and one M25×1.5. Optional: • ½ - 14 NPT conduit / cable adapter • Metal cable glands (½ - 14 NPT) • 4-pin male Eurofast connector or A size Mini 4-pin male Minifast connector
<b>Tankbus cabling</b>	AWG 0.5-1.5 mm <sup>2</sup> (22-16), shielded twisted pairs
<b>Built-in Tankbus terminator</b>	Yes (to be connected if required)
Mechanical	
<b>Housing material</b>	Polyurethane-covered die-cast aluminum
<b>Dimensions (width x height x depth)</b>	150 x 120 x 78 mm (5.9 x 4.7 x 3.1 in.)
<b>Weight</b>	1.2 kg (2.6 lbs)
Environment	
<b>Ambient temperature</b>	-20 to 70 °C (-4 to 158 °F)
<b>Storage temperature</b>	-30 to 85 °C (-22 to 185 °F)
<b>Humidity</b>	0-100% relative humidity, non-condensing
<b>Ingress protection</b>	IP 66 and 67 (Nema 4)
<b>Metrology sealing possibility</b>	Yes
<b>Write protect switch</b>	Yes

(1) Make sure that unused ports are properly sealed to prevent moisture or other contamination from entering the electronics housing. Use the enclosed metal plug for this purpose.

## 6.4 PRODUCT CERTIFICATIONS

### SPECIAL CONDITIONS FOR SAFE USE (X-MARKING), ATEX AND IECEx

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 associated apparatus through which the equipment is supplied shall provide galvanic isolation between the input and output of the associated apparatus.

### European ATEX Directive Information

EC-Type Examination Certificate Number: FM10ATEX0046X

Control Drawing: 9240 040-949

#### I1<sup>(1)</sup> Intrinsically Safe

FISCO Field Device (Fieldbus Terminals):



II 1 G 0575

Ex ia IIC T4 (-50 °C ≤ T<sub>a</sub> ≤ +70 °C)

U<sub>i</sub>=17.5 VDC, I<sub>i</sub>=380 mA, P<sub>i</sub>=5.32 W, C<sub>i</sub>=2.1 nF, L<sub>i</sub>=1.1 μH

Entity (Fieldbus Terminals):



II 1 G 0575

Ex ia IIC T4 (-50 °C ≤ T<sub>a</sub> ≤ +70 °C)

U<sub>i</sub>=30 VDC, I<sub>i</sub>=300 mA, P<sub>i</sub>=1.3 W, C<sub>i</sub>=2.1 nF, L<sub>i</sub>=1.1 μH

### US Factory Mutual (FM-US) Certification



Certificate of Compliance: 3037177

Control Drawing: 9240 040-949

#### I5<sup>(1)</sup> 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<sub>a</sub> ≤ +70 °C)

U<sub>i</sub>=17.5 VDC, I<sub>i</sub>=380 mA, P<sub>i</sub>=5.32 W, C<sub>i</sub>=2.1 nF, L<sub>i</sub>=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<sub>a</sub> ≤ +70 °C)

U<sub>i</sub>=30 VDC, I<sub>i</sub>=300 mA, P<sub>i</sub>=1.3 W, C<sub>i</sub>=2.1 nF, L<sub>i</sub>=1.1 μH

### Canadian Factory Mutual (FM-C) Certification



Certificate of Compliance: 3037177C

Control Drawing: 9240 040-949

#### I6<sup>(1)</sup> 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<sub>i</sub>=17.5 VDC, I<sub>i</sub>=380 mA, P<sub>i</sub>=5.32 W, C<sub>i</sub>=2.1 nF, L<sub>i</sub>=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<sub>i</sub>=30 VDC, I<sub>i</sub>=300 mA, P<sub>i</sub>=1.3 W, C<sub>i</sub>=2.1 nF, L<sub>i</sub>=1.1 μH

### IECEx Certification

Certificate of Conformity Number: IECEx FMG 10.0021X

Control Drawing: 9240 040-949

#### I7<sup>(1)</sup> Intrinsically Safe

FISCO Field Device (Fieldbus Terminals):

Ex ia IIC Ga T4 (-50 °C ≤ T<sub>a</sub> ≤ +70 °C)

U<sub>i</sub>=17.5 VDC, I<sub>i</sub>=380 mA, P<sub>i</sub>=5.32 W, C<sub>i</sub>=2.1 nF, L<sub>i</sub>=1.1 μH

Entity (Fieldbus Terminals):

Ex ia IIC Ga T4 (-50 °C ≤ T<sub>a</sub> ≤ +70 °C)

U<sub>i</sub>=30 VDC, I<sub>i</sub>=300 mA, P<sub>i</sub>=1.3 W, C<sub>i</sub>=2.1 nF, L<sub>i</sub>=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 87.

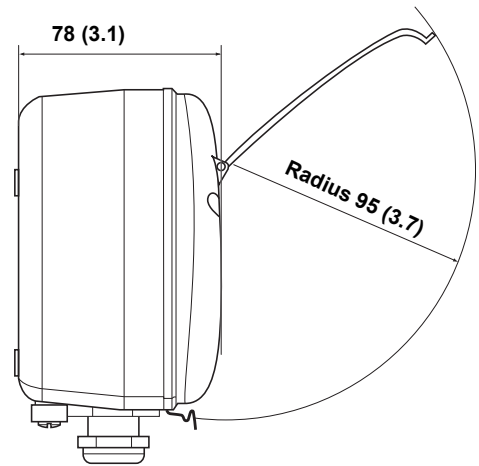
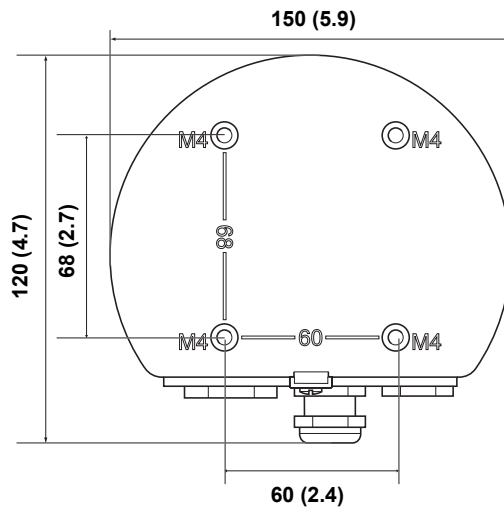
# Technical Description

704010EN, Rev BA  
March 2011

Raptor System

## 6.5 DIMENSIONAL DRAWINGS

Dimensions are in mm (inches)



## 6.6 ORDERING INFORMATION

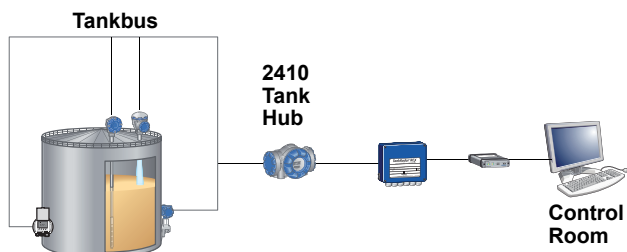
Model (Pos 1)	Product Description	Note
2230	Graphical Field Display	
Code (Pos 2)	Default Language	Note
E	English	Other languages are software selectable
Code (Pos 3)	Tankbus: Power and Communication	Note
F	Bus powered 2-wire FOUNDATION™ fieldbus (IEC 61158)	
Code (Pos 4)	Software	Note
S	Standard	
Code (Pos 5)	Hazardous Location Certification	Note
I1	ATEX Intrinsic Safety	
I5	FM-US Intrinsic Safety	
I6	FM-Canada Intrinsic Safety	
I7	IECEX Intrinsic Safety	
KA	ATEX Intrinsic Safety+FM-US Intrinsic Safety <sup>(1)</sup>	
KC	ATEX Intrinsic Safety+IECEX Intrinsic Safety <sup>(1)</sup>	
KD	FM-US Intrinsic Safety+FM-Canada Intrinsic Safety <sup>(1)</sup>	
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	
Code	Options – none or multiple selections are possible	Note
ST	Engraved SST tag plate	Provide tag information in order
<b>Model Code Example: 2230 - E F S I1 0 A 1 W - ST</b>		

(1) Not available with LPG/LNG antenna.

## 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 autoaddresses the different field devices in the network, manages communication, and supervises the status of all connected devices.

#### 7.1.3 Data Handling

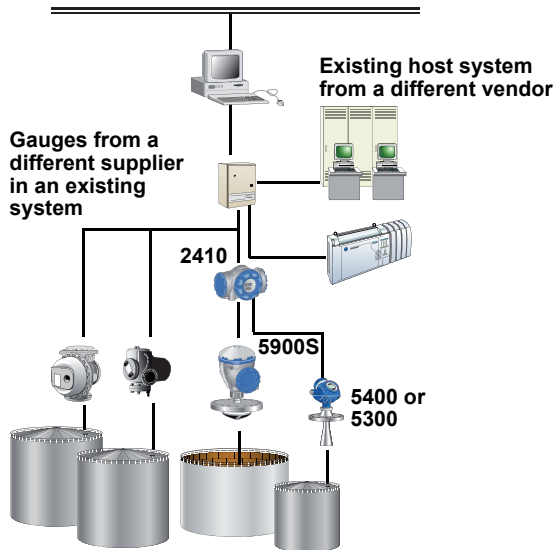
Rosemount 2410 collects measurement values, such as level, temperature, and pressure. It calculates average temperature, observed density and strapping table based volume. Such data can be presented on the optional integrated back-lit display, a separate 2230 display, or be sent to TankMaster or a host 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, 91, and 97) and wireless communication (pages 8, 89, 91 and 97). If the hub is delivered with the SIL option, the second slot is used for relay functionality.



**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 24).

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 97). 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. The relay 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 protection according to IEC 61508-2 and 61508-3.

### 7.4 WIRELESS COMMUNICATION

The Smart Wireless THUM™ Adapter acts as a wireless data link between the tank hub and a Smart Wireless Gateway in a *WirelessHART* network. See "Wireless Connection of Tank Gauging Equipment" on page 9.



Smart Wireless THUM™ Adapter with integrated connection box.



# Technical Description

704010EN, Rev BA

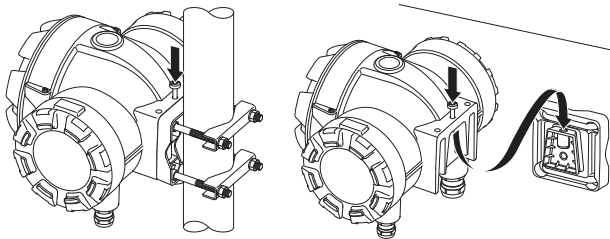
March 2011

## 7.5 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.

### 7.5.1 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.

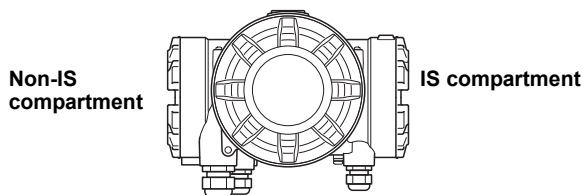
The 2410 tank hub is normally installed at ground level close to the tank, but can also be installed on top of the tank to facilitate re-use of existing cabling.

### 7.5.2 Cable Connections

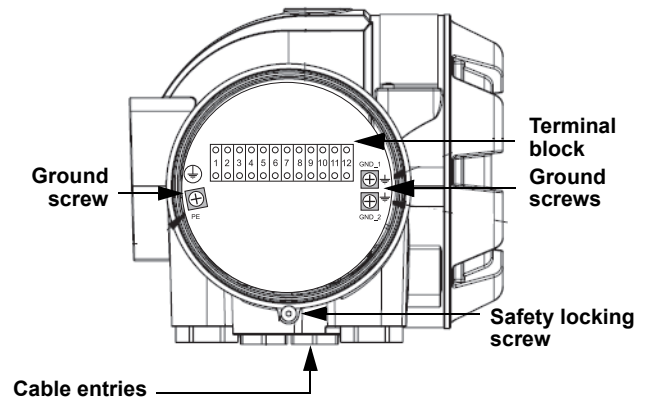
Typical cabling distances are:

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

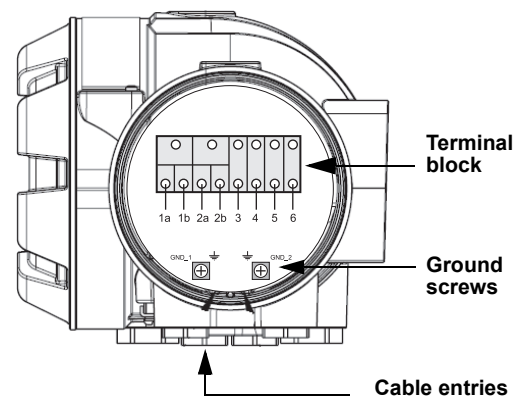
From the hub towards the control room, up to 4 km (2.5 miles) depending on which protocol is used.



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.



The intrinsically safe side of the Rosemount 2410 connects to the Tankbus which communicates with field devices on the tank using FOUNDATION™ fieldbus.

For more wiring information, see “Specification” on page 91, “Ordering Information” on page 97 or the Rosemount 2410 Reference Manual (document number 300530EN).

### 7.5.3 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.

## 7.6 SPECIFICATION

### 7.6.1 Technical Data for Rosemount 2410 Tank Hub

General	
<b>Product</b>	Rosemount 2410 Tank Hub
<b>Single tank version</b>	<ul style="list-style-type: none"> <li>• Supports one tank in a 5900S system configuration</li> <li>• Total Observed Volume (TOV) calculation with 100-point strapping table</li> </ul>
<b>Multiple tank version</b>	<ul style="list-style-type: none"> <li>• For a 5300/5400/5900S system configuration</li> <li>• Total Observed Volume (TOV) calculation with 100-point strapping table for one tank</li> </ul> <p>The actual number of tanks it supports depends on the configuration, which types of units are connected and how many. See "Power Budget" on page 24:</p> <ul style="list-style-type: none"> <li>• The software supports 16 field devices and 10 tanks per tank hub</li> <li>• Hybrid calculations for up to three tanks</li> </ul>
<b>Examples of connected field devices</b>	Radar Level Gauges (type 5900S <sup>(1)</sup> , 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
<b>Start-up time</b>	Less than 30 s
<b>Legal custody transfer type approval</b>	OIML R85:2008, and national certifications such as PTB, NMI etc
<b>Hazardous location certifications</b>	ATEX, FM-C, FM-US, IECEx, and national certifications. For details, see "Product Certifications" on page 94 and "Ordering Information" on page 97
<b>Safety/overflow</b>	SIL 2 and SIL 3 certified. See pages 4, 16, and 89. Consult your local Rosemount Tank Gauging representative for information about national approvals such as the WHG (TÜV) overflow protection option
<b>CE-mark</b>	Complies with applicable EU directives (EMC, ATEX)
<b>Ordinary location certification</b>	Complies with FM 3810:2005 and CSA: C22.2 No. 1010.1
Communication / Display / Configuration	
<b>Tankbus</b>	The intrinsically safe side of the Rosemount 2410 connects to the Tankbus which communicates with field devices on the tank using FOUNDATION™ fieldbus
<b>Fieldbus</b>	<p><b>Primary fieldbus:</b> Rosemount 2410 communicates with a host or a field communication unit via TRL2 Modbus, RS485 Modbus, Enraf or HART</p> <p><b>Secondary fieldbus<sup>(2)</sup>:</b> TRL2 Modbus, Enraf (other options available soon), <i>WirelessHART</i> for Smart Wireless THUM™ Adapter</p>
<b>Relay outputs</b>	<p><b>SIL safety relay output<sup>(3)</sup>:</b> One SIL 2/SIL 3 certified relay is available for overflow protection or dry-run detection. This non-intrinsically safe solid state relay is closed/energized during normal operation</p> <p>Maximum voltage and current: 260 VAC/VDC, 80 mA</p> <p><b>Relay outputs (Non-SIL):</b> Maximum two relays, controlled by 10 independent virtual relay functions which can be configured for different tanks and process variables.</p> <p>The two non-intrinsically safe solid state relays are user configurable for normally energized or de-energized operation.</p> <p>Maximum voltage and current: 350 VAC/VDC, 80 mA</p>
<b>Analog inputs/outputs</b>	Future options
<b>Integral display output variables</b>	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
<b>Display output units<sup>(4)</sup></b>	<p>Level, free water level, and ullage: meter, millimeter, feet, or imperial 1/16</p> <p>Level rate: meter/second, meter/hour, feet/second, or feet/hour</p> <p>Flow rate: meter<sup>3</sup>/hour, liter/minute, barrel/hour, or US gallon/hour</p> <p>Total Observed Volume (TOV): meter<sup>3</sup>, liters, barrel, or US gallon</p> <p>Temperature: °F, °C, or °K</p> <p>Pressure: psi, psiA, psiG, bar, barA or barG, atm, Pa, or kPa</p> <p>Density: kg/m<sup>3</sup>, °API, or 60/60DegF</p> <p>Signal strength: mV</p>
<b>Configuration tools</b>	Rosemount TankMaster
<b>Autoconfiguration support</b>	Yes (Tankbus addressing)

## Technical Description

704010EN, Rev BA

March 2011

Raptor System

Electric	
<b>Power supply (nominal values)</b>	24-48 VDC or 48-240 VAC, 50/60 Hz
<b>Power consumption</b>	Max. 20 W depending on configuration
<b>Cable entry</b>	Four ½ - 14 NPT and Two ¾-14 NPT entries for cable glands or conduits. Optional: <ul style="list-style-type: none"><li>• M20 and M25 x 1.5 conduit / cable adapter</li><li>• Metallic cable glands (½ - 14 NPT and ¾-14 NPT)</li><li>• 4-pin male Eurofast connector or A size Mini 4-pin male Minifast connector</li></ul> See "Ordering Information" on page 98
<b>Tankbus cabling</b>	0.5-1.5 mm <sup>2</sup> (AWG 22-16), twisted shielded pairs
<b>Power and relay cabling</b>	0.5-2.5 mm <sup>2</sup> (AWG 22-14), twisted shielded pairs
<b>Maximum Tankbus cable lengths</b>	Depends on cable. See "Tankbus Cable Requirements" for FISCO cable parameters, and "Re-use of Existing Cabling" on page 25
<b>Built-in Tankbus terminator</b>	Yes (to be disconnected if required)
Mechanical	
<b>Housing material</b>	Polyurethane-covered die-cast aluminum
<b>Installation</b>	Can be installed on a 33.4-60.3 mm (1-2 in.) diameter pipe or wall
<b>Dimensions</b>	See "Dimensional Drawings" on page 96
<b>Weight</b>	4.7 kg (10.4 lbs)
Environment	
<b>Ambient temperature</b>	-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)
<b>Storage temperature</b>	-50 to 85 °C (-58 to 185 °F) With LCD display: -40 to 85 °C (-40 to 185 °F)
<b>Humidity</b>	0 - 100% relative humidity
<b>Ingress protection</b>	IP 66 and IP 67 (Nema 4X)
<b>Metrology sealing possibility</b>	Yes
<b>Write protect switch</b>	Yes

- (1) One Rosemount 5900S with 2-in-one 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) Density, mass, and more volume parameters are calculated in Rosemount TankMaster (GOV, GSV, NSV, WIA/WIV).

## 7.6.2 Technical Data for Smart Wireless THUM™

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

General	
<b>Product</b>	Smart Wireless THUM™ Adapter. The THUM allows <i>WirelessHART</i> 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
<b>Transmission range</b>	Approximately 170 m (500 ft)
<b>Hazardous location certifications</b>	FM, CSA and ATEX (see “Ordering Information” on page 97) and the Smart Wireless THUM™ Product Data Sheet (document number 00813-0100-4075)
<b>CE-mark</b>	Complies with applicable directives (EMC, ATEX)
<b>Ordinary location certification</b>	Meets requirements
<b>Telecommunication compliance</b>	Yes (often national wireless device requirements regarding the use of RF spectrum)
Communication	
<b>Communication protocol</b>	IEC 62591 ( <i>WirelessHART</i> )
<b>Radio characteristics</b>	<ul style="list-style-type: none"> <li>• Standard IEEE 802.15.4 radio</li> <li>• 2.4 GHz ISM band sliced into 16 radio-channels</li> <li>• Continually “hop” across channels to avoid interference and increase reliability</li> <li>• Direct sequence spread spectrum (DSSS) delivers high reliability in challenging radio environment</li> </ul>
<b>Update rate</b>	User selectable, 8 seconds to 60 minutes
Electric	
<b>Power supply</b>	Powered by Rosemount 2410 tank hub
<b>Output cabling</b>	Shielded twisted pair wiring, 0.5-2.5 mm <sup>2</sup> (AWG 22-14). Maximum cable length depends on cable characteristics
<b>IS parameters</b>	$U_i=30\text{ V}$ , $I_i=200\text{ mA}$ , $P_i=1.0\text{ W}$ , $C_i=L_i=0$
Mechanical	
<b>Housing / enclosure</b>	Polyurethane painted, low-copper aluminum housing
<b>Installation</b>	Vertical or horizontal mounting on a 1 to 2-in. pipe. Should be positioned approximately 2 m (6 ft) or more from any large structure or conductive surface. Connected to the tank hub via cable as above
<b>Dimensions</b>	See “Dimensional Drawings” on page 96
<b>Antenna</b>	Poly-butadine terephthalate (PBT) / polycarbonate (PC) integrated omnidirectional antenna
<b>Weight</b>	Connection box and THUM adapter: 2.0 kg (4.4 lbs.)
Environment	
<b>Ambient temperature</b>	-40 to 85 °C (-40 to 185 °F)
<b>Storage temperature</b>	-40 to 85 °C (-40 to 185 °F)
<b>Humidity</b>	0 - 100% relative humidity
<b>Ingress protection</b>	IP 66 and NEMA 4X
<b>Electromagnetic compatibility (EMC)</b>	Meets all relevant requirements of EN 61326-1 (2006) and (2004/108/EC). The THUM™ and tank hub should be installed with shielded wiring
<b>Approvals</b>	FCC part 15, R&TTE (99/5/EC), and IC (RSS210)



## 7.7 PRODUCT CERTIFICATIONS

### 7.7.1 Certifications for Rosemount 2410

#### European ATEX Directive Information

EC-Type Examination Certificate Number: FM10ATEX0012  
Control Drawing: 9240040-901

E1<sup>(1)</sup> Flameproof with Intrinsically Safe Output (FISCO)  
FISCO Power Supply:

 II 2(2) G   
Ex de [ib] IIB T4 (-50 °C ≤ T<sub>a</sub> ≤ +70 °C)  
U<sub>o</sub>=15 VDC, I<sub>o</sub>=354 mA, P<sub>o</sub>=5.32 W  
U<sub>m</sub>=250 VDC

#### US Factory Mutual (FM-US) Certification

Certificate of Compliance: 303592  
Control Drawing: 9240040-901



E5<sup>(1)</sup> Explosionproof with Intrinsically Safe Output (FISCO)  
FISCO Power Supply:

Explosion proof Class I, Division 1, Groups C, and D  
Associated Intrinsically Safe Class I, Division 1, Groups C,  
and D  
Temperature Class T4  
Ambient Temperature Limits -50 °C to +70 °C  
U<sub>o</sub>=15 VDC, I<sub>o</sub>=354 mA, P<sub>o</sub>=5.32 W

#### Canadian Factory Mutual (FM-C) Certification

Certificate of Compliance: 303592C  
Control Drawing: 9240040-901



E6<sup>(1)</sup> Explosionproof with Intrinsically Safe Output (FISCO)  
FISCO Power Supply:

Explosion proof Class I, Division 1, Groups C, and D  
Associated Intrinsically Safe Class I, Division 1, Groups C,  
and D  
Temperature Class T4  
Ambient Temperature Limits -50 °C to +70 °C  
U<sub>o</sub>=15 VDC, I<sub>o</sub>=354 mA, P<sub>o</sub>=5.32 W

#### IECEX Certification

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

E7<sup>(1)</sup> Flameproof with Intrinsically Safe Output (FISCO)  
FISCO Power Supply:  
Ex de[ib] IIB Gb T4 (-50 °C ≤ T<sub>a</sub> ≤ +70 °C)  
U<sub>o</sub>=15 VDC, I<sub>o</sub>=354 mA, P<sub>o</sub>=5.32 W  
U<sub>m</sub>=250 VDC

#### 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).

(1) Ordering Information code for Product Certificates, see page 97.

## 7.7.2 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](http://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  II 1G

Ex ia IIC T4 (-50 °C ≤ T<sub>amb</sub> ≤ +70 °C)


IP66. U<sub>i</sub> = 30 V, L<sub>i</sub> = 200 mA, P<sub>i</sub> = 1.0 W, C<sub>i</sub> = 0, L<sub>i</sub> = 0



#### N1 ATEX Type n

Certificate No.: Baseefa09ATEX0131  II 3G

Ex na IIC T4 (-50 °C ≤ T<sub>amb</sub> ≤ +70 °C)

IP66. U<sub>i</sub> = 45 Vdc max.  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<sub>amb</sub> ≤ +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<sub>amb</sub> ≤ +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<sub>amb</sub> ≤ +70 °C)

IP66. U<sub>i</sub> = 30 V, L<sub>i</sub> = 200 mA, P<sub>i</sub> = 1.0 W, C<sub>i</sub> = 0, L<sub>i</sub> = 0

#### N7 IECEX Type n

Certificate No.: IECEX BAS 09.0058

Ex na IIC T4 (-50 °C ≤ T<sub>amb</sub> ≤ +70 °C)

U<sub>i</sub> = 45 Vdc max. IP66

### INMETRO Certifications

#### I2 INMETRO Intrinsic Safety

BR-Ex ia IIC T4 (-50 °C ≤ T<sub>amb</sub> ≤ +70 °C) Ga

#### N2 INMETRO Type n

BR-Ex na IIC T4 Gc(-50 °C ≤ T<sub>amb</sub> ≤ +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<sub>amb</sub> ≤ +70 °C)

Ex na IIC T4 (-50 °C ≤ T<sub>amb</sub> ≤ +70 °C)

IP66

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

## Technical Description

704010EN, Rev BA

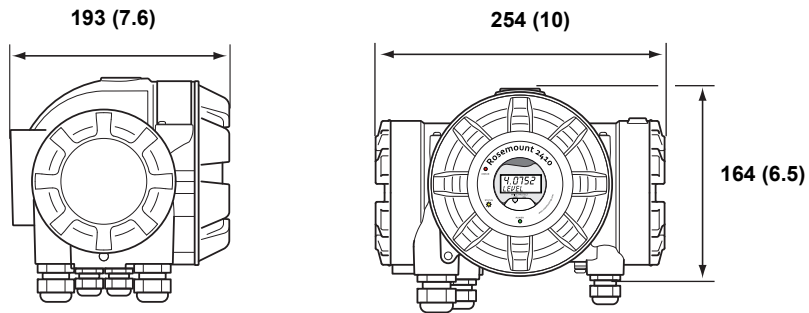
March 2011

Raptor System

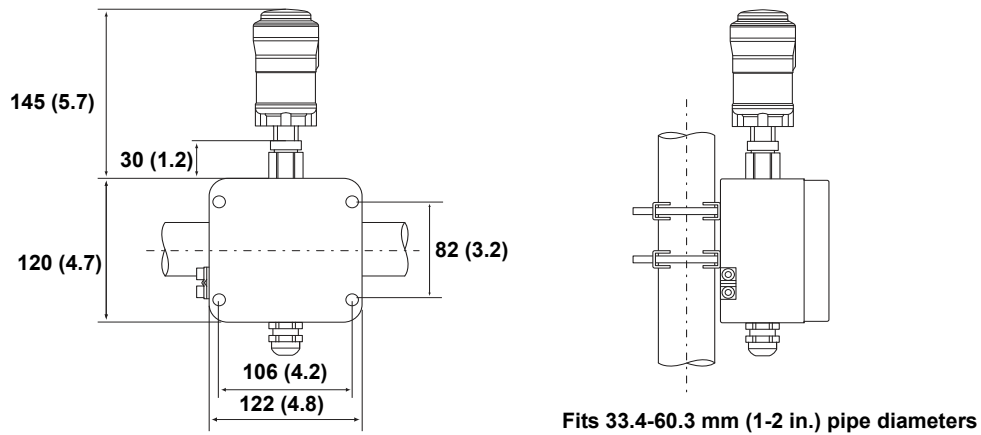
### 7.8 DIMENSIONAL DRAWINGS

Dimensions are in mm (inches)

#### 7.8.1 2410 Dimensions



#### 7.8.2 Smart Wireless THUM™ Dimensions



## 7.9 ORDERING INFORMATION

### 7.9.1 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 <sup>(1)</sup>	
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	
Code (Pos 5)	Secondary Fieldbus	Note
R	TRL2 Modbus (standard)	
E	Enraf Bi-phase Mark GPU	
W	IEC 62591 ( <i>Wireless</i> HART) connectivity (IS) <sup>(2)</sup>	
F	None, but ready for upgrade of secondary bus	
0	None	
Code (Pos 6)	Relay Output (SIS/SIL)	Note
3	SIL 3-certified output as per IEC 61508 <sup>(3)</sup>	Requires Rosemount 5900S with Safety Certification (SIS), code 3
2	SIL 2-certified output as per IEC 61508 <sup>(3)</sup>	Requires Rosemount 5900S with Safety Certification (SIS), code 2
F	None, but ready for upgrade of safety certification (SIS)	
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	
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	



## Technical Description

704010EN, Rev BA

March 2011

Raptor System

Code (Pos 12)	Custody Transfer Type Approval	Note
R	OIML R85 E <sup>(4)</sup> performance certification	
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	
W	Mounting kit for wall installation	
0	None	
Code	Options – none or multiple selections are possible	Note
ST	Engraved SST tag plate	
<b>Model Code Example: 2410 - S F R 0 3 2 1 P S E1 R A 1 P - ST</b>		

(1) Feeds maximum 250 mA. Can support maximum 10 tanks or 2x5900S. For information on power budget, see page 24.

(2) Requires a separate Smart Wireless THUM™ Adapter (not included).

(3) Requires Secondary Fieldbus (Pos 5), code 0.

(4) Requires a Rosemount 5900S gauge with the corresponding custody transfer approval. A Rosemount 2230 display or TankMaster is required for an approved read-out.

## 7.9.2 Smart Wireless THUM™ Adapter

Model (Pos 1)	Product Description	Note
775	Smart Wireless THUM™ Adapter	Requires THUM™ Connection Box. See next section
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
I1	ATEX intrinsically safe	
I2	INMETRO intrinsically safe	
I3	NEPSI	
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 ( <i>WirelessHART</i> )	
Code (Pos 9)	Wireless Antenna	Note
WK	Omnidirectional integral antenna	
Code (Pos 10)	SmartPower™	Note
9	Power scavenging	

## 7.9.3 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 Exe approved.
F	½ NPT Adapter (female thread)	
Code	Options – none or multiple selections are possible	Note
PT	Printed tag for unit identification	
<b>Model Code Example: 775 - X D 1 1 I1 WA 3 WK 9 - T F PT</b>		

# 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 <sup>(1)</sup>	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.

## 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.

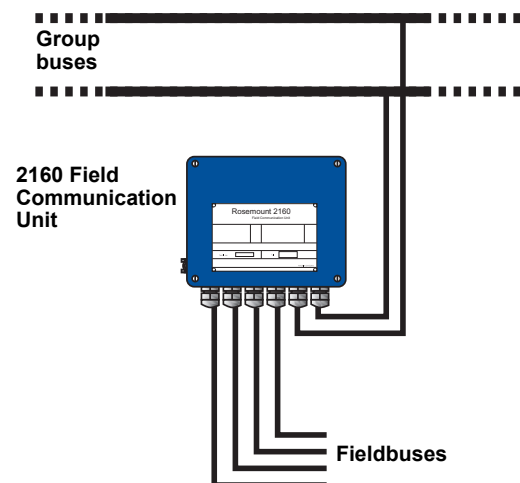
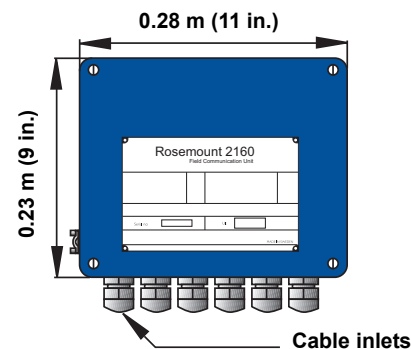
For more information on redundancy, see page 13.

## 8.2 INSTALLATION CONSIDERATIONS

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



Rosemount 2160 Field Communication Unit.



## 8.3 SPECIFICATION

<b>General</b>	
<b>Product</b>	Rosemount 2160 Field Communication Unit
<b>Hazardous location certifications</b>	None
<b>CE-mark</b>	Complies with applicable EU directives (EMC, ATEX and LVD)
<b>Configuration / Communication</b>	
<b>Number of tanks per field communication unit</b>	Max 32
<b>Communication</b>	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
<b>Electric</b>	
<b>Power supply</b>	115 or 230 VAC, +10% to -15%, 50-60 Hz, max. 10 W
<b>Cable entry</b>	Seven entries for M20 x 1.5 cable (glands included in delivery)
<b>Mechanical</b>	
<b>Dimensions</b>	See page 100
<b>Weight</b>	4.5 kg (9.9 lbs)
<b>Environment</b>	
<b>Ambient operating temperature</b>	-40 to 70 °C (-40 to 158 °F)
<b>Ingress protection</b>	IP 65

## Technical Description

704010EN, Rev BA

March 2011

Raptor System

### 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	
<b>Model Code Example: 2160 - 2 G1 G5 F1 F1 F1 F1 S R 0 W S</b>		

## 9 Rosemount 2165/2175 Field Communication Unit

The 2165/2175 Field Communication Unit is a data concentrator that continuously polls data from field devices such as radar and servo tank gauges from different vendors, 2410 tank hubs, other field communication units, Enraf CIU:s etc and stores data in a buffer memory. Whenever a request for data is received from a host, the 2165/2175 can immediately send data from the updated buffer memory.

It can handle communication with a wide range of hosts/DCS systems such as Rosemount TankMaster, Enraf Entis, Yokogawa, ABB, Honeywell, Foxboro among others.

It is possible to connect any system using the Modbus protocol.

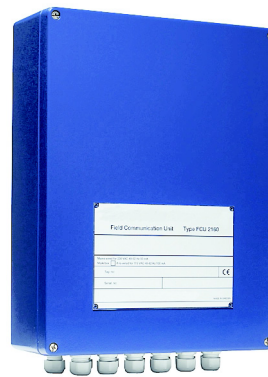
Each of the ports can be configured either as a master or slave connection, providing ultimate configuration flexibility.

Rosemount 2165 has 10 ports of which 6 can be used as fieldbus ports. Rosemount 2175 can be ordered with 8, 16, 24 or 32 ports. Port configuration flexibility along with the scalable solution make the field communication unit meet the needs of different users, ranging from the small terminal operator to the largest refinery – also for the most demanding applications.

The number of devices per port varies between different manufacturers and may also have physical limitations imposed by the quality and length of field cables and distribution of devices. Maximum 256 devices can be supported by one Rosemount 2165/2175.

For applications requiring more capacity or when devices are distributed over a large area, multiple 2165/2175 units can be used. Two units can also be connected in parallel with one unit operational and the other as a redundant backup. The backup unit is automatically activated in case of a primary unit failure (hot standby).

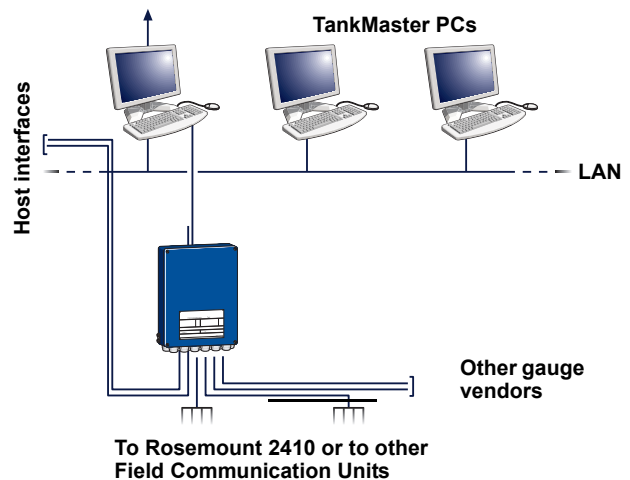
For more information on redundancy, see page 13.



Rosemount 2165 Field Communication Unit.



Rosemount 2175 Field Communication Unit.



Typical system with a Rosemount 2165.

# Technical Description

704010EN, Rev BA

March 2011

Raptor System

## 9.1 SPECIFICATION

General	
Product	Rosemount 2165/2175 Field Communication Unit
Hazardous location certifications	None
CE-mark	Complies with applicable EU directives (EMC, ATEX and LVD)
Configuration / Communication	
Fieldbus ports	TRL2 Bus, Enraf BPM, Whessoe Current Loop, L&J, GPE, Varec, RS232, RS422, RS485
Baud rates	Programmable up to 38400
Number of tanks / gauges per FCU	Up to 256 (host dependent, 160 for TankMaster)
Hosts	<ul style="list-style-type: none"><li>• Modbus Slave, Generic (DCS, SCADA etc)</li><li>• TankMaster Modbus (TankMaster PC, DCS, SCADA)</li><li>• Microlect™ emulation (OMS, DCS, SCADA)</li><li>• CIU 858 emulation (Entis™, DCS, SCADA)</li></ul>
Field slaves and total number of gauges / devices per fieldbus port	Dependent on vendor, see the following tables
Electric	
Power supply	115 or 230 VAC, +10% to -15%, 50-60 Hz
Cable entry	Rosemount 2165: Thirteen entries for M20 x 1.5 cable
Power consumption (max)	Rosemount 2165: 25 W Rosemount 2175: 60 W
Electrical interface	See table on page 105
Mechanical	
Dimensions	Rosemount 2165: 111x313x404 mm (4.37x12.32x15.91 in.) Rosemount 2175: 19 in. (3U rack)
Weight	8 kg (17.6 lbs)
Environment	
Ambient operating temperature	0 to 55 °C (32 to 131 °F)
Ingress protection	Rosemount 2165: IP 65 Rosemount 2175: IP 20

The number of gauges on each field port is limited by the gauge vendor protocol and / or the electrical interface capability. Typically these are as follows:

Field Slaves	Interface type (connected equipment)	Electrical Interface	Devices / gauges per port
<b>Enraf</b>	CIU 858 bus (CIU 858 or CIU 880 Prime configured for 858 emulation) <sup>(1)</sup>	RS232	1 CIU (30 gauges)
	CIU 880 Prime <sup>(1)</sup>	RS232	1 CIU (50 gauges)
	GPP bus (801, 802, 811, 812, 813, 856, and others)	BPM	10
	GPU bus (811, 812, 813, 854, 872, 873, 877, 970, 971, 973, and others)	BPM	10
<b>Whessoe</b>	WM 500	Current Loop	16 Outstations (256 gauges)
	WM 550 (WM 550, ITG 50, 60, and 70)	Current Loop	32
<b>Rosemount</b>	Field communication Unit	RS232	1 Rosemount 2160 Field Communication Unit
	Field communication Unit	RS485	32 Rosemount 2160 Field Communication Units
	Field communication Unit	TRL2	8 Rosemount 2160 Field Communication Units
	2410, 2900, Rex, Pro	TRL2	8
	Rex, 2410	RS485	32
<b>Motherwell</b>	Motherwell 4000	–	1
	Motherwell 2800 i (MCS 2800)	–	32
<b>Generic</b>	Modbus Master (Modbus RTU)	–	–

(1) Rosemount 2165/2175 can replace an Enraf Microlect or CIU unit.

As a master (fieldbus) port the field communication unit can talk to a wide range of different tank gauges such as:

- Rosemount radar level gauges
- Enraf servo and radar
- Whessoe servo and level/temperature transmitters
- Motherwell

As a slave port the field communication unit can service requests from a wide range of hosts using various protocols:

- TankMaster
- Enraf Entis
- Generic host using Modbus RTU

## 9.2 ORDERING INFORMATION

Contact your local Emerson Process Management / Rosemount Tank Gauging representative ([www.rosemount-tg.com](http://www.rosemount-tg.com))



## 10 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.

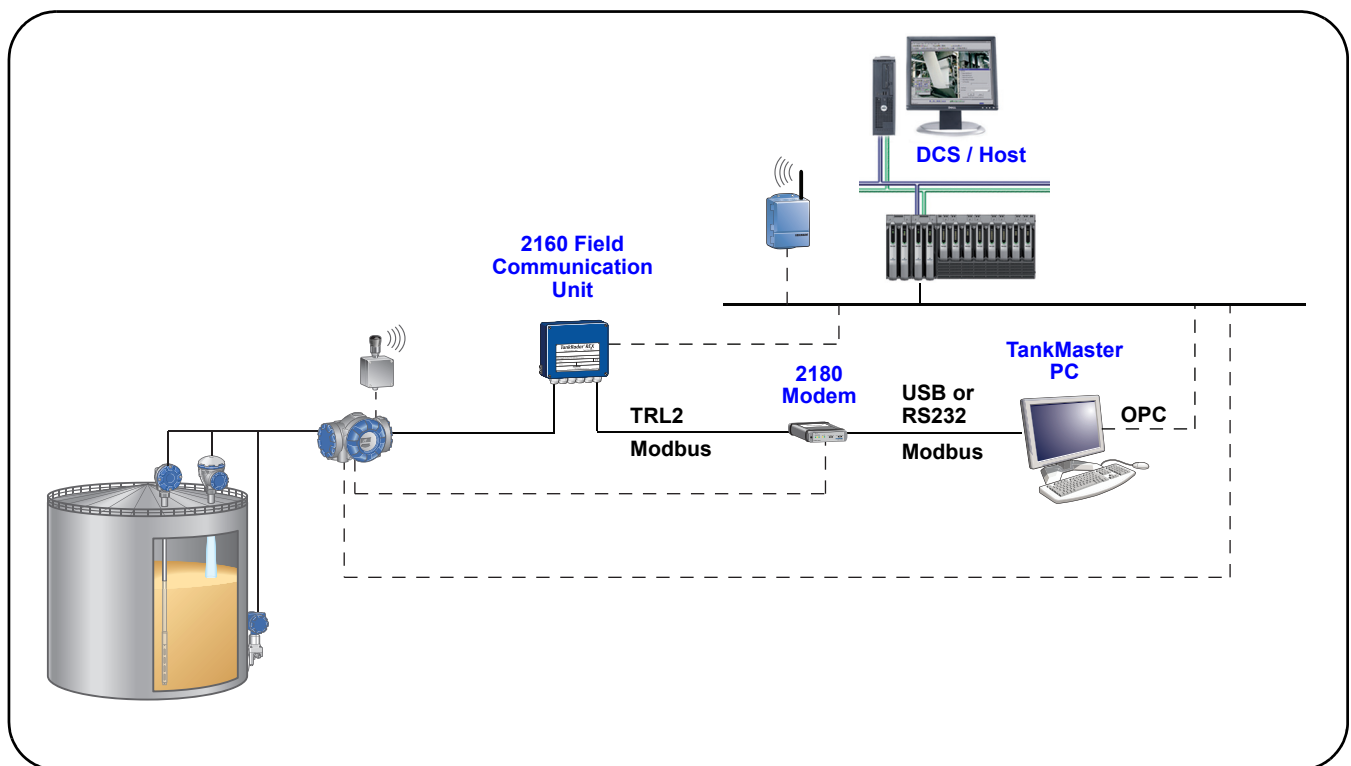
There are front panel switches to set gain and termination, if required.

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

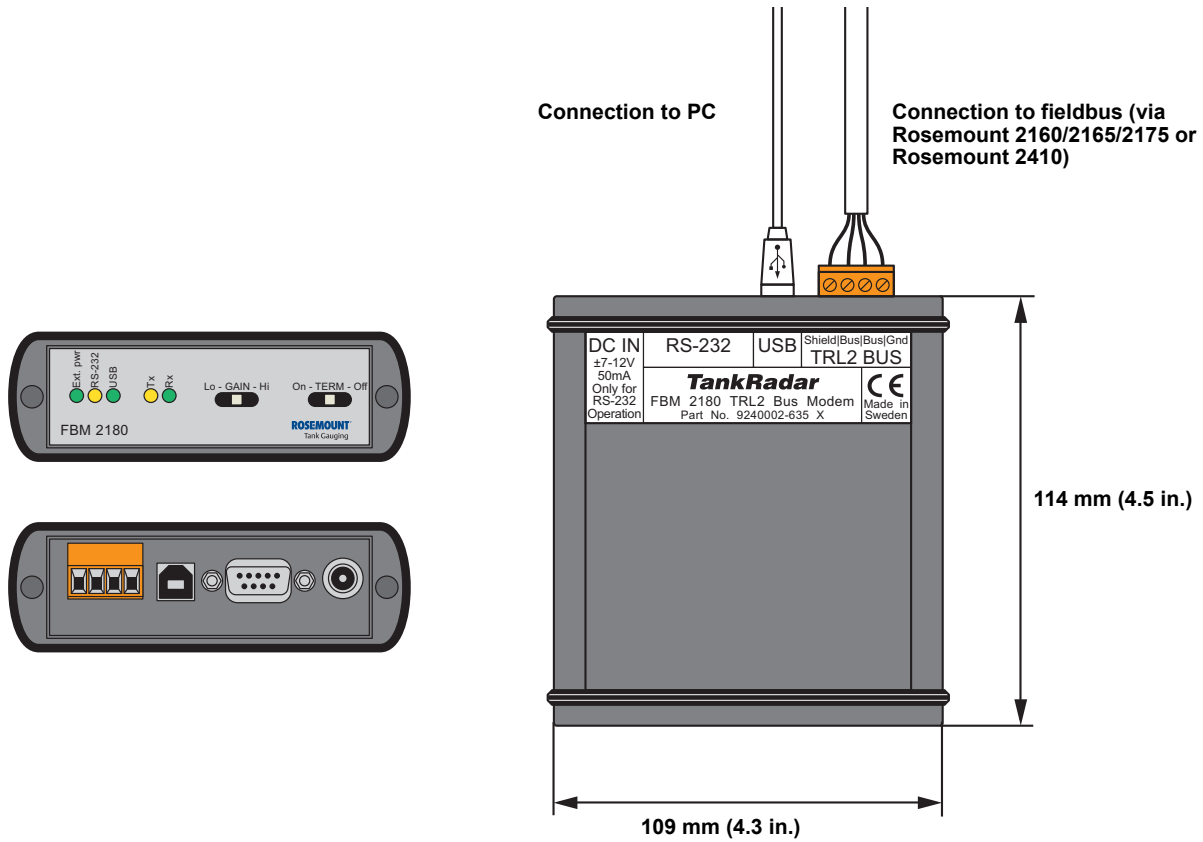
The field bus modem is delivered with cables for RS232 and USB connection. The USB cable also supplies power to the modem. A separate power supply cable (included in delivery) is only necessary for the RS232 option.



Rosemount 2180 Field Bus Modem.



The 2180 modem in a typical tank gauging system.



## 10.1 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

## 10.2 ORDERING INFORMATION

Model	Product Description
2180	TRL2 Fieldbus Modem

# 11 Smart Wireless Gateway

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

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

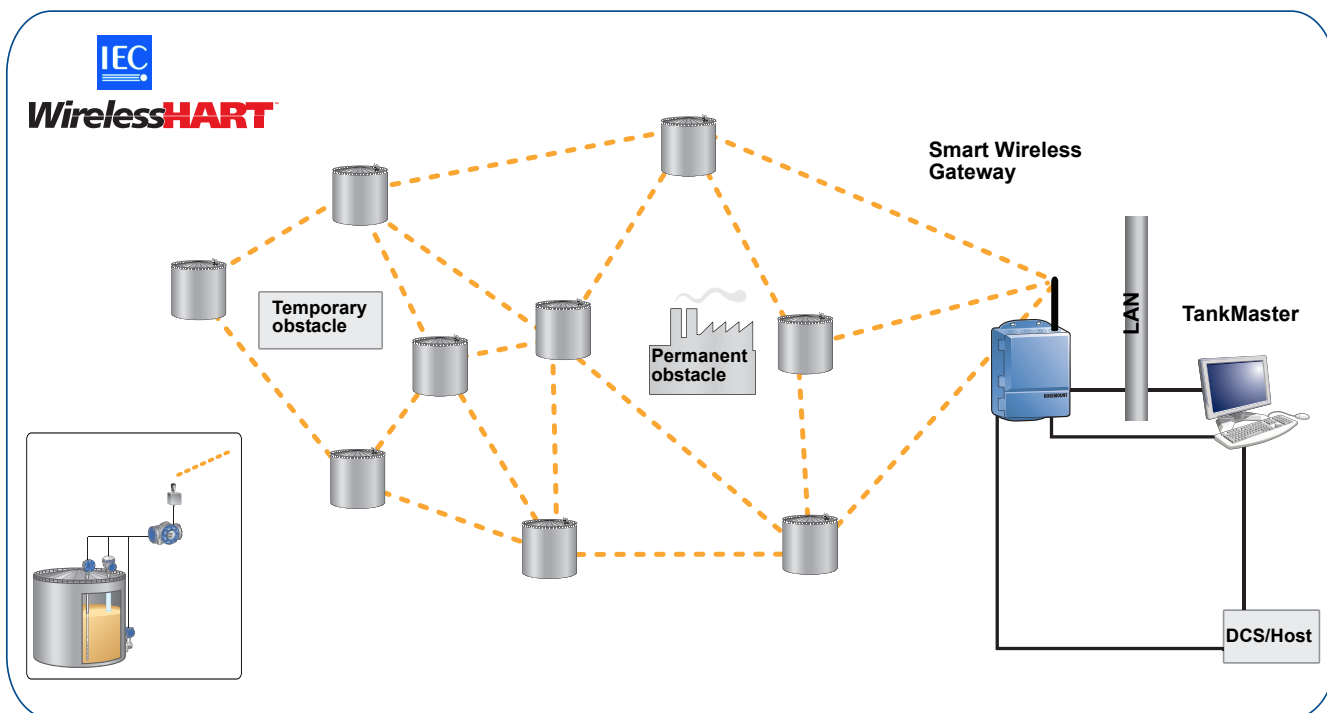
A single gateway supports approximately 100 nodes.

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 mesh 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.

## 11.1 SELF-ORGANIZING NETWORKS

With excellent reliability and ease of use, self-organizing 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.

## 11.2 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 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 configuration of your wireless network.

## 11.3 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.

## 11.4 WIRELESSHART INDUSTRY STANDARD

The Smart Wireless Gateway is designed according to the IEC 62591 (*WirelessHART*) 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

## 11.5 INSTALLATION CONSIDERATIONS

The Smart Wireless Gateway 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.

## Technical Description

704010EN, Rev BA  
March 2011

Raptor System

### 11.6 SPECIFICATION

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

General	
Product	Smart Wireless Gateway
Power supply	19.2-28.8 VDC (500 mA start-up, 250 mA continuous)
Certification	See "Product Certifications" on page 111
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 <sup>2</sup> (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.)
Fiber optic Ethernet	100BaseFx optical Ethernet communication port. Wavelength: 1300 nm Multimode. SC connectors. Protocols: Modbus, TCP, OPC, HART-IP, https (for Web Interface). Wiring: 50/125 um or 62.5/125 um fiber, 4 km (2.48 miles) maximum distance.
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 ( <i>WirelessHART</i> ) 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 <i>WirelessHART</i> , 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	<ul style="list-style-type: none"><li>• Housing: Low-copper aluminum, NEMA 4X</li><li>• Paint: Polyurethane</li><li>• Cover Gasket: Silicone rubber</li><li>• Antenna: PBT/PC integrated omnidirectional antenna</li></ul>
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

## 11.7 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<sub>a</sub> < 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<sub>a</sub> < 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](http://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

- N1 ATEX Type n  
 Certificate Number: Baseefa 07ATEX0056X  
 ATEX Marking:  II 3 G  
 Ex nA nL IIC T4 (-40 °C < T<sub>a</sub> < 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:  II 3 G  
 Ex tD A 22 IP66 T135 (-40 °C < T<sub>a</sub> < 60 °C)  
 Maximum working Voltage = 28V
- N7 IECEX Type n  
 Certificate Number: IECEX BAS 07.0012X  
 Ex nA nL IIC T4 (-40 °C =< T<sub>a</sub> <=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<sub>a</sub> < 60 °C)  
 Maximum working voltage = 28V

### Combinations of Certifications

**KD** Combination of N5, N6, and N1.

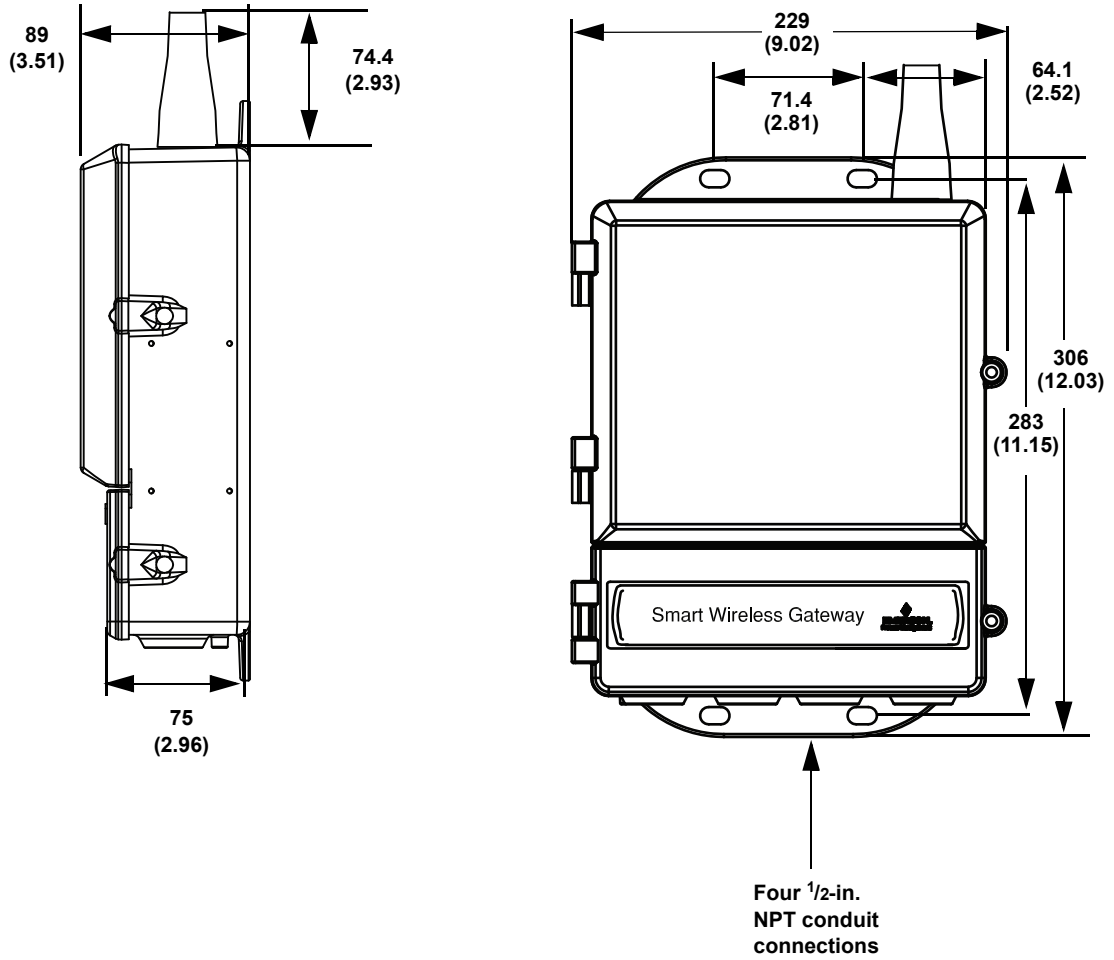
# Technical Description

704010EN, Rev BA  
March 2011

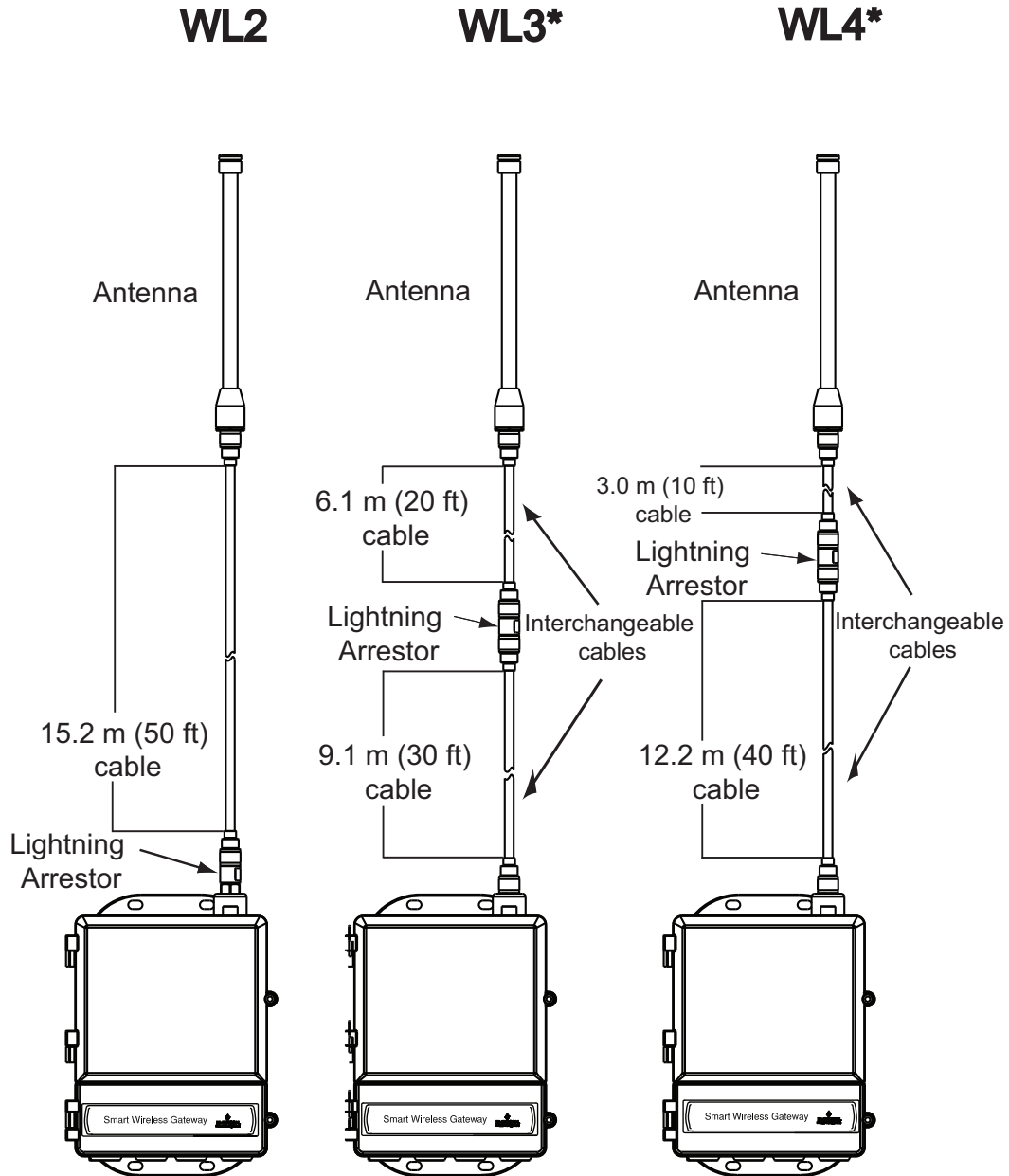
Raptor System

## 11.8 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.**



## 11.9 ORDERING INFORMATION

Model (Pos 1)	Product Description
1420	Smart Wireless Gateway
Code (Pos 2)	Power Input
A	24 VDC, 500 mA
Code (Pos 3)	Ethernet Communications – Physical Connection
1	Ethernet <sup>(1)</sup> (2)
2	Dual Ethernet <sup>(3)</sup> (4)
3	Fiber Optic Ethernet <sup>(5)</sup> (6)
Code (Pos 4)	Wireless Update Rate, Operating Frequency, and Protocol
A3	User Configurable Update Rate, 2.4 GHz DSSS, <i>WirelessHART</i>
Code (Pos 5)	Serial Communication
N	None
A	Modbus RTU via RS485 <sup>(7)</sup>
Code (Pos 6)	Ethernet Communication – Data Protocols
2	Webserver, Modbus TCP/IP, AMS Ready
4	Webserver, Modbus TCP/IP, AMS Ready, OPC
5	DeltaV Ready <sup>(8)</sup>
7	HART-IP <sup>(9)</sup>
Code	Options – none or multiple selections are possible
	<b>Product Certifications</b>
N5	FM Division 2, Non-incendive
N6	CSA Division 2, Non-incendive
N1	ATEX Type n
ND	ATEX Dust
N7	IECEX Type n
NF	IECEX Dust
KD	FM & CSA Division 2, Non-incendive and ATEX Type n
	<b>Adapters</b>
J1	M20 Conduit Adapter
J3	¾ NPT Conduit Adapter
	<b>Antenna Options<sup>(10)</sup></b>
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
<b>Model Code Example: 1420 - A 1 A3 A 4 - KD</b>	

(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) 1300 nm Multimode Optical fiber connection with separate SC connectors for Rx and Tx.

(6) Includes features in option 1.

(7) Convertible to RS232 via adapter.

(8) Includes Webserver, Modbus TCP/IP, AMS Ready, OPC.

(9) Includes Webserver, Modbus TCP/IP, AMS Ready

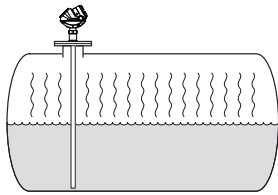
(10) The WL2-WL4 options require minor assembly.

# 12 Rosemount 5300 Series Radar Level Transmitter

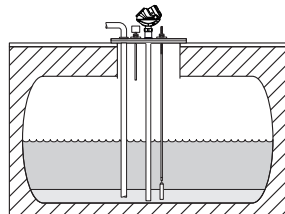
Rosemount 5300 is a premium 2-wire guided wave radar transmitter for level measurements on liquids, to be used in a wide range of medium accuracy applications<sup>(1)</sup> under various tank conditions. The measurement is unaffected by most liquid property changes, such as density etc.

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 22, and Appendix A: Radar Level Device Selection.

## 12.1 SAFETY & OVERFILL FUNCTIONS

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

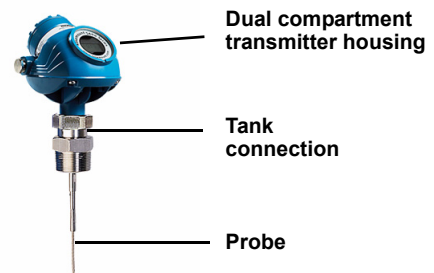
In addition, 5300 can be used as a complementary separate high level alarm device in a 5900S inventory/custody transfer system.

For more information see "Specification" on page 122 and "Additional High Level Alarm Configurations" on page 17.

## 12.2 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 130.



5300 transmitter parts.

## 12.3 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 116.

## Technical Description




704010EN, Rev BA

March 2011

Raptor System

### 12.3.1 Probe Selection

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

	Coaxial	Flexible Single Lead	Flexible Twin Lead <sup>(1)</sup>
This table gives guidelines on which probe to select, depending on application.			
<b>Measurements</b>			
Level	G	G	G
Interface	G	G	G
<b>Liquid Characteristics</b>			
Changing density	G	G	G
Changing dielectric <sup>(2)</sup>	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 <sup>(3)</sup>	G <sup>(3)</sup>
Coating/sticky liquids	NR	AD	NR
Viscous liquids	NR	G	AD
Crystallizing liquids	NR	AD	NR
<b>Tank Environment Considerations</b>			
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 <sup>(4)</sup>	G	AD	AD
Tall, narrow nozzles	G	AD	AD
Still-pipes	NR	G <sup>(5)</sup>	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 effect 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 117.

(4) The probe should be anchored for sideways forces. See "Specification" on page 123.

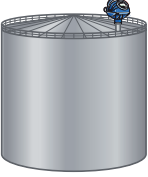
(5) Requires centering disk.

## 12.4 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 ( $\epsilon_r = 1.9-4.0$ ).
- B. Liquefied gas such as LPG or LNG ( $\epsilon_r = 1.4-1.9$ )
- C. Conductive liquids, e.g. water based solutions, dilute acids, and alkalis ( $\epsilon_r > 10.0$ ).

### 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) <sup>(1)</sup>	50 m (164 ft)
Flexible Twin Lead	35 m (115 ft)	15 m (49 ft) <sup>(1)</sup>	50 m (164 ft)

(1) 5900S is recommended.

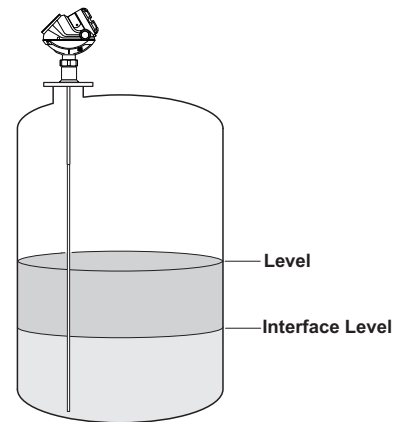
Different parameters affect the echo and therefore the maximum measuring range differs depending on application according to:

- 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<sup>(1)</sup> 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.

## 12.5 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 57), 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.

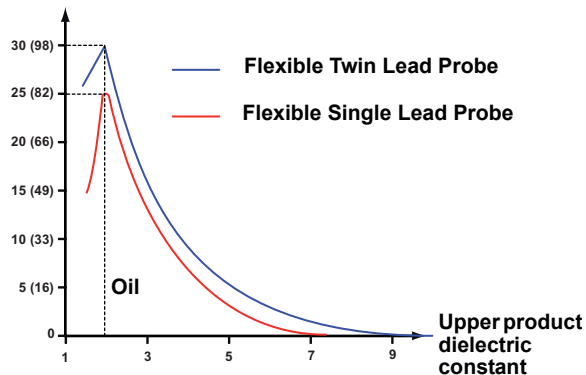
For the flexible probes, the maximum measuring range will be reduced based on the maximum upper product thickness according to the following diagram.

# Technical Description

704010EN, Rev BA

March 2011

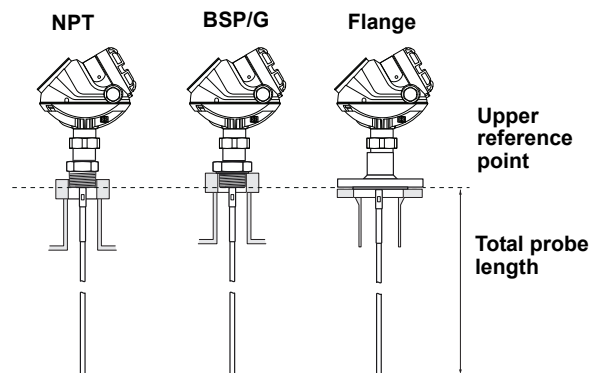
Maximum upper product thickness in m(ft)



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

## 12.6 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).

### 12.6.1 Mechanical Considerations

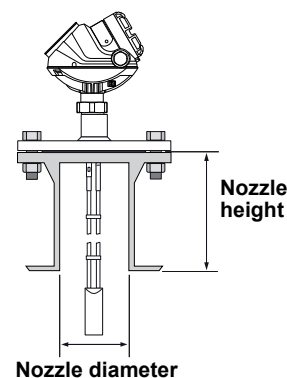
Typically the transmitter is top mounted with a flanged or threaded tank connection, and with the probe positioned vertically in the tank. The probe can also be installed at an angle of up to 90° from vertical.

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

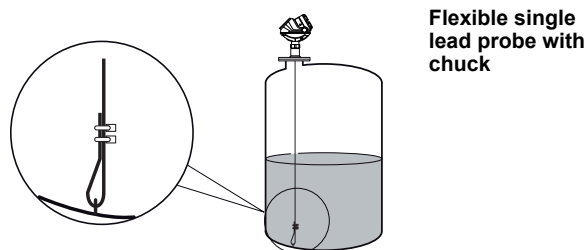
To make a measurement, the surface needs to be in contact with the probe. It needs to hang straight down.

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

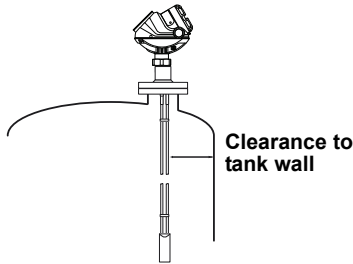
- Maximum recommended nozzle height is 0.1 m (4 in.) + the nozzle diameter for all probes except the coaxial probe which has no such restrictions



- 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



- 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



**Avoid direct contact of probe with the tank bottom**

- 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

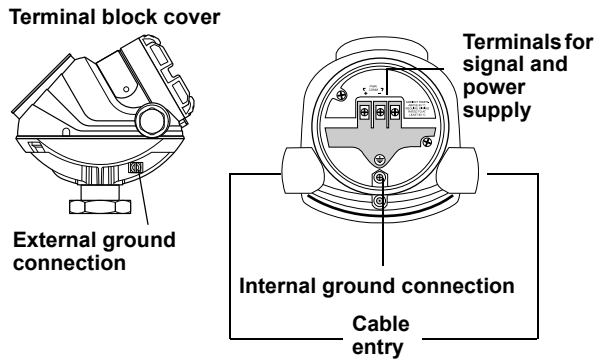
See the following table for nozzle and clearance details.

	Coaxial	Flexible Single Lead	Flexible Twin Lead
<b>Recommended nozzle diameter</b>	Enough space to fit the probe	0.15 m (6 in. ) or more	0.10 m (4 in. ) or more
<b>Min. nozzle diameter <sup>(1)</sup></b>	Enough space to fit the probe	0.05 m (2 in.)	0.05 m (2 in.)
<b>Min. clearance to tank wall (L) or obstruction<sup>(2)</sup></b>	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. )

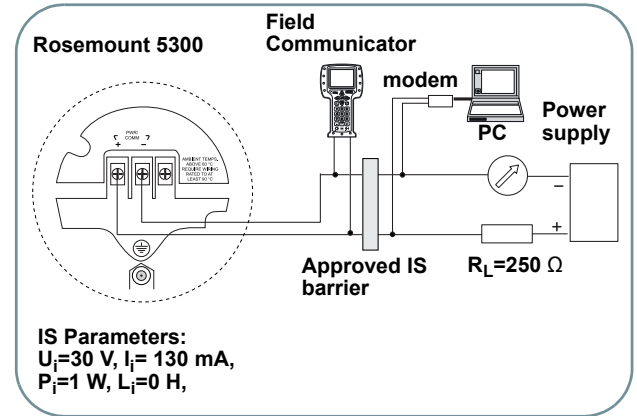
(1) Requires special configuration. May affect the maximum measuring range.

(2) Minimum clearance from tank bottom for the coaxial and rigid single probes is 5 mm (0.2 in.).

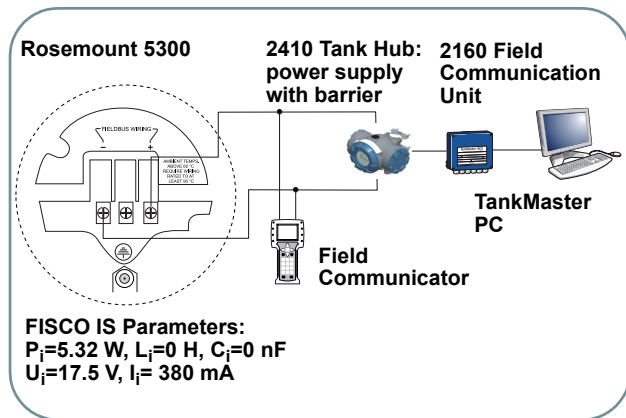
**12.6.2 Cable Connections**



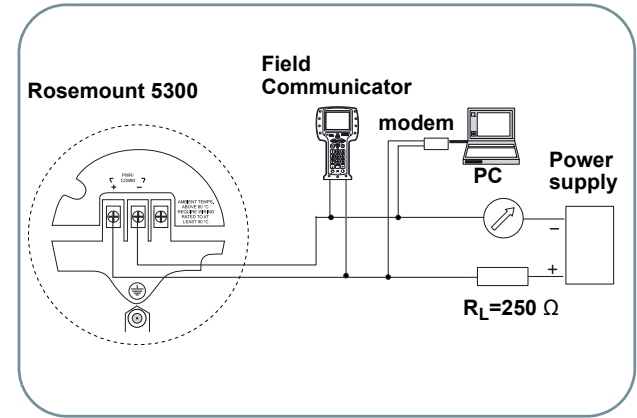
**HART intrinsically safe power supply**



**FOUNDATION™ fieldbus intrinsically safe power supply**



**HART Explosionproof/Flameproof power supply**



### 12.6.3 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).



## 12.7 SPECIFICATION

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

General	
<b>Product</b>	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 22, and Appendix A: Radar Level Device Selection.
<b>Measurement principle</b>	Time Domain Reflectometry (TDR)
<b>Reference conditions</b>	Single standard probe, 25 °C (77 °F) in water and ambient pressure
<b>Microwave output power</b>	Nominal 300 µW, Max. 45 mW
<b>Hazardous location certifications</b>	Factory Mutual (FM), ATEX, Canadian Standards Association (CSA), and IECEx. See "Product Certifications" on page 125
<b>Safety/overflow</b>	<ul style="list-style-type: none"> <li>• FMEDA suitable for SIL 2: The 5300 Series has been evaluated by Exida per hardware assessment IEC61508. With a SFF &gt; 90% it is Prior-use SIL 2 suitable. For more information, go to: <a href="http://www.emersonprocess.com/rosemount/safety/">http://www.emersonprocess.com/rosemount/safety/</a>. Option code QS in Ordering Information</li> <li>• HART version: WHG (TÜV) overflow approval</li> </ul>
<b>CE-mark</b>	93/68/EEC: complies with applicable EU directives (EMC, ATEX, LVD, and R&TTE)
<b>Ordinary location certification</b>	Complies with FM 3810:2005 and CSA C22.2 No. 142-M1987
Measuring Performance	
<b>Measuring range</b>	0.4 m (16 in.) to 50 m (164 ft). See "Measuring Range" on page 117
<b>Instrument accuracy at reference conditions</b>	± 3 mm (0.12 in.) or 0.03% of measured distance, whichever is greatest
<b>Repeatability</b>	± 1 mm (0.04 in.)
<b>Temperature drift</b>	± 0.2 mm (0.008 in.) /°K or ± 30 ppm/°K of measured value, whichever is greatest
<b>Update interval</b>	1 second
Display / Configuration / Communication	
<b>Integral display</b>	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.
<b>Output variables</b>	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
<b>Output units</b>	Level, Interface and Distance: ft, inches, m, cm or mm. Level Rate: ft/s, m/s, in./min, m/h. Volume: ft <sup>3</sup> , inch <sup>3</sup> , US gals, Imp gals, barrels, yd <sup>3</sup> , m <sup>3</sup> or liters. Temperature: °F and °C
<b>Configuration tools</b>	Rosemount TankMaster, Rosemount RadarMaster, Field Communicator, AMS Suite, DeltaV or any other DD (Device Description) compatible host system
<b>FOUNDATION™ fieldbus blocks</b>	Resource block, 3 Transducer blocks, 6 AI blocks, PID block, ISEL block, SGCR block, ARTH block, and OS block
<b>FOUNDATION™ fieldbus class (basic or link master)</b>	Link Master (LAS)
<b>FOUNDATION™ fieldbus block execution time</b>	AI-block: 30 ms. PID-block: 40 ms. ARTH-, ISEL-, OSPL-block: 65 ms. CHAR-block: 75 ms
<b>Conforming FOUNDATION™ fieldbus</b>	ITK 5.0
<b>FOUNDATION™ fieldbus PlantWeb Alert support</b>	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 to 19.7 ft). Flexible single lead: 1 to 50 m (3.3 to 164 ft). Flexible twin lead: 1 to 50 m (3.3 to 164 ft). For further information, see the probe table on page 116
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 <sup>(1)</sup> and O-ring materials (page 130)
Flanges, threads	See pages 124 and 130
Housing / enclosure	Polyurethane-covered aluminum
Cable entry	½ - 14 NPT for cable glands or conduit entries. Optional: M20 x 1.5 conduit / cable adapter, M12 4-pin male Eurofast connector or A size Mini 4-pin male Minifast connector
Tankbus cabling	0.5-1.5 mm <sup>2</sup> (AWG 22-16), twisted shielded pairs
Dimensions	See "Dimensional Drawings" on page 127
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/Ex ia and XP/Ex d, FOUNDATION™ fieldbus communication: -40 to 60 °C (-40 to 140 °F). LCD readable in: -20 to 70 °C (-4 to 158 °F) IS/Ex ia and XP/Ex 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 <sup>(2)</sup>	-40 to +150 °C (-40 to +302 °F). See page 124.
Process pressure <sup>(2)</sup>	Full vacuum to -1 to 40 Bar (580 psig). See page 124.
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 124.

## 12.7.1 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

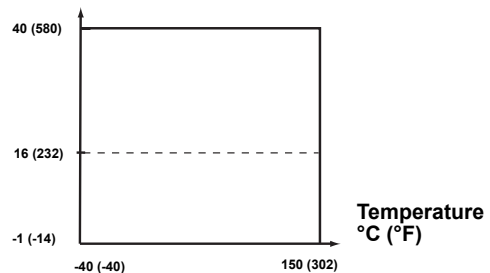
The transmitter housing must be installed so the ambient temperature is not exceeded (see "Specification" on page 122). The ambient temperature may be limited by the selected product certificate (see "Product Certifications" on page 125).

### Operating Pressure

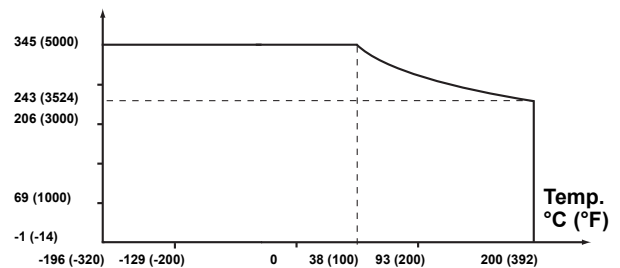
The maximum operating pressure must not exceed the specified pressure for the antenna and process connection.

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

**Pressure bar (psig),  
Standard transmitter version**



**Pressure bar (psig),  
Cryogenic transmitter version**



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)

## 12.8 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.

### Factory Mutual (FM) Approval

Project ID: 3020497

E5<sup>(1)</sup> 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<sup>(2)</sup>.  
Seal not required.

I5, IE<sup>(1)</sup>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<sup>(2)</sup>

### 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.

- (1) Ordering information code for product certificates, see page 130.  
(2) +60 °C with FOUNDATION™ fieldbus or FISCO option.

### ATEX Approval

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<sup>(1)</sup> Flameproof:

 II 1/2 G T4  
II 1D T79 °C<sup>(3)</sup>.  
Ex ia/db ia IIC T4 Ga/Gb (-40 °C ≤ T<sub>a</sub> ≤ +70 °C<sup>(2)</sup>)  
Ex ta IIIC T79 °C<sup>(3)</sup> (-40 °C ≤ T<sub>a</sub> ≤ +70 °C<sup>(2)</sup>)  
U<sub>m</sub> = 250 V.

I1, IA<sup>(1)</sup>Intrinsically Safe:

 II 1 G T4  
II 1/2 G T4  
II 1 D T79 °C<sup>(3)</sup>.  
Ex ia IIC T4 (-50 °C ≤ T<sub>a</sub> ≤ +70 °C<sup>(2)</sup>).  
Ex ia/ib IIC T4 Ga/Gb (-50 °C ≤ T<sub>a</sub> ≤ +70 °C<sup>(2)</sup>).  
Ex ta IIIC T79 °C<sup>(3)</sup> (-50 °C ≤ T<sub>a</sub> ≤ +70 °C<sup>(2)</sup>).  
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

- (3) +69 °C with FOUNDATION™ fieldbus or FISCO option.

# Technical Description

704010EN, Rev BA

March 2011

Raptor System

## Canadian Standards Association (CSA) Approval

This product meets the Dual Seal Requirements of ANSI/ISA 12.27.01-2003.

Cert. no. 1514653

E6<sup>(1)</sup> 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 °C<sup>(2)</sup>

I6, IF<sup>(1)</sup>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<sup>(2)</sup>.

## 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<sup>(1)</sup> Flameproof:

Ex ia/db ia IIC T4 Ga/Gb (-40 °C ≤  $T_a$  ≤ +70 °C<sup>(2)</sup>)

Ex ta IIIC T79°C<sup>(3)</sup> (-40 °C ≤  $T_a$  ≤ +70 °C<sup>(2)</sup>)

$U_m = 250$  V.

I7, IG<sup>(1)</sup>Intrinsically Safe:

Ex ia IIC T4 (-50 °C ≤  $T_a$  ≤ +70 °C<sup>(2)</sup>).

Ex ia/ib IIC T4 Ga/Gb (-50 °C ≤  $T_a$  ≤ +70 °C<sup>(2)</sup>).

Ex ta IIIC T79°C<sup>(3)</sup> (-50 °C ≤  $T_a$  ≤ +70 °C<sup>(2)</sup>).

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 130.

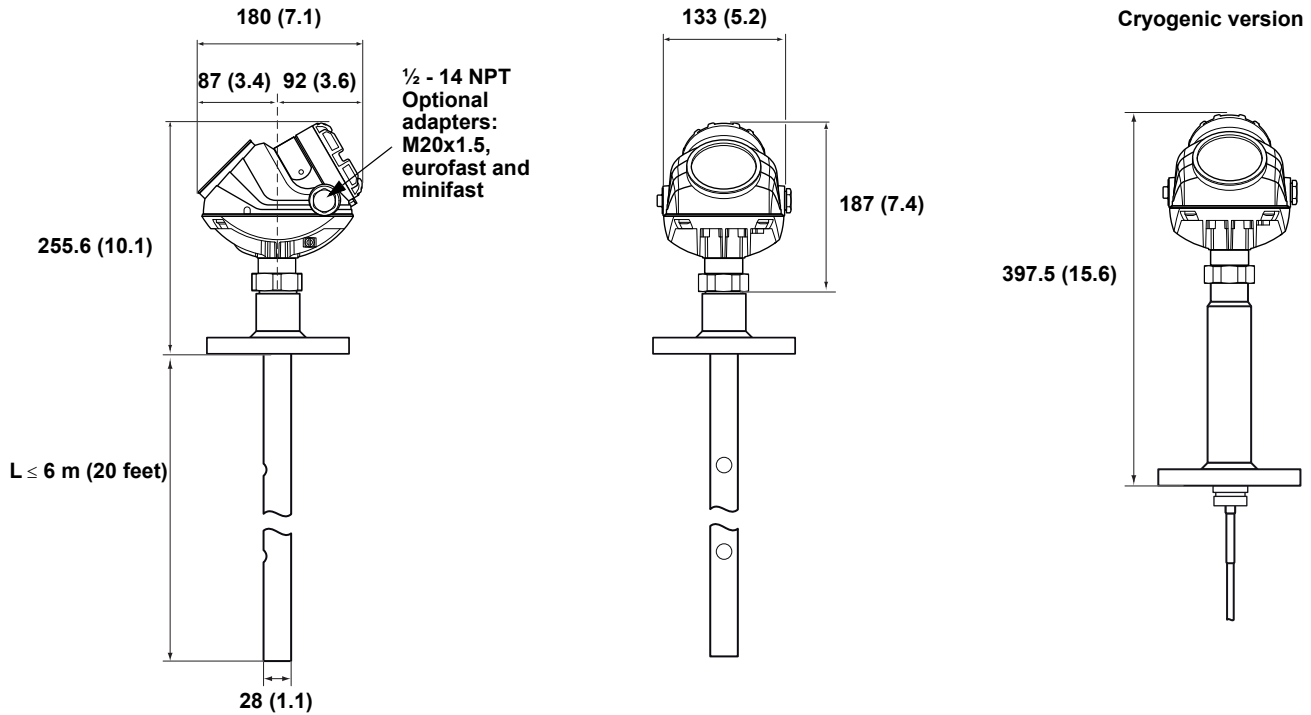
(2) +60 °C with FOUNDATION™ fieldbus or FISCO option.

(3) +69 °C with FOUNDATION™ fieldbus or FISCO option.

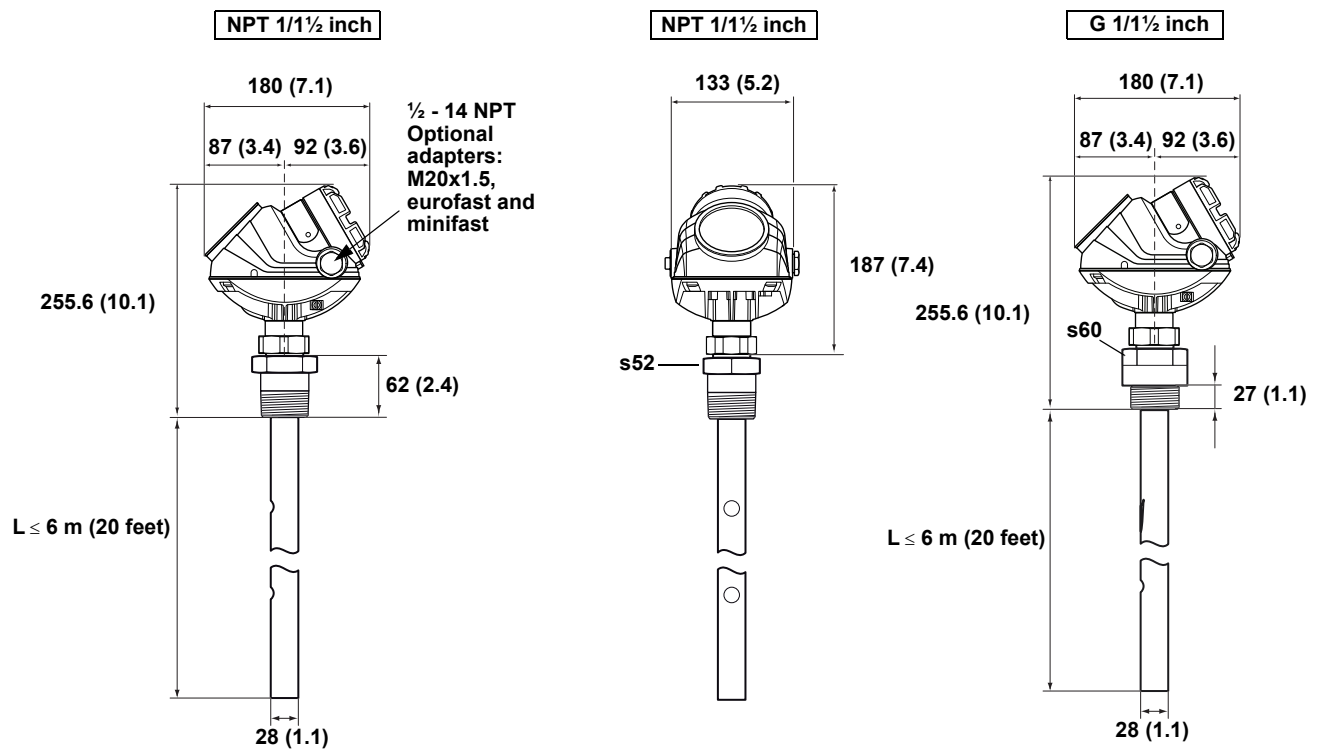
12.9 DIMENSIONAL DRAWINGS

All dimensions are in mm (inches).

12.9.1 Coaxial Probe with Flange Connection



12.9.2 Coaxial Probe with Threaded Connection



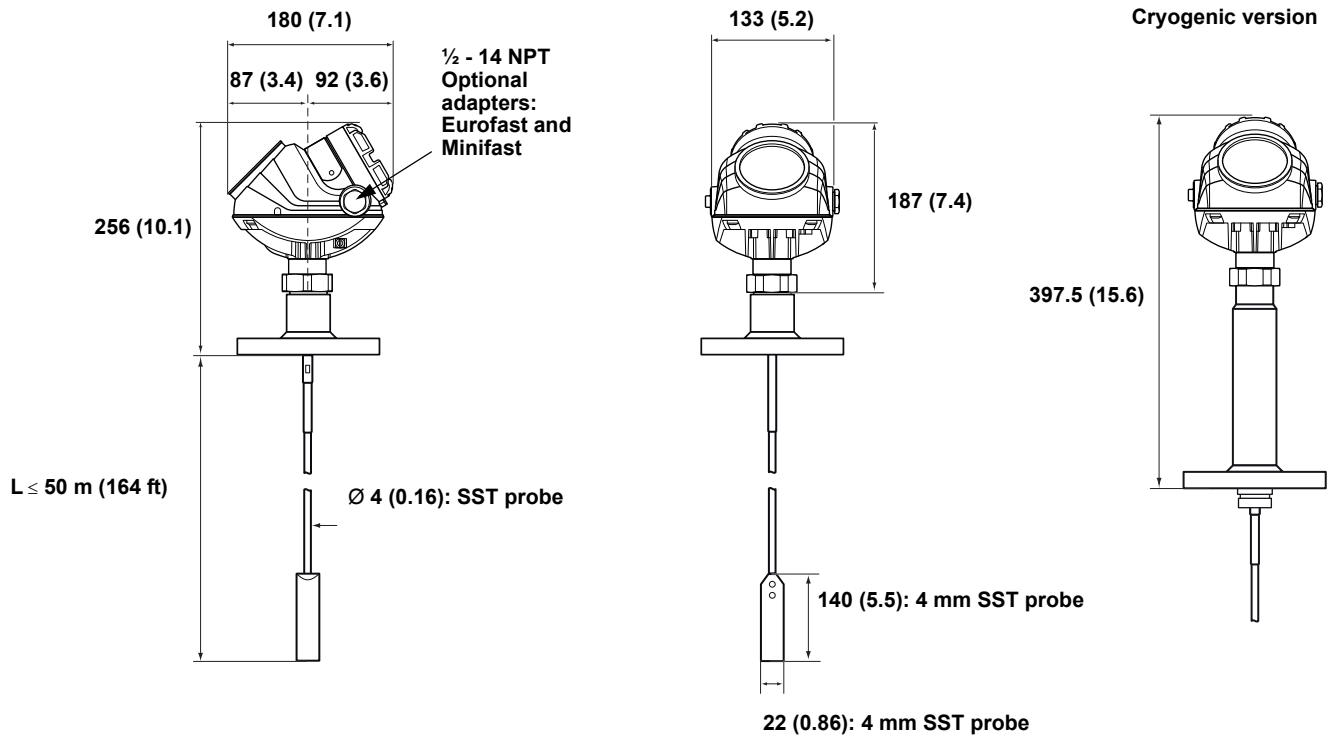
# Technical Description

704010EN, Rev BA  
March 2011

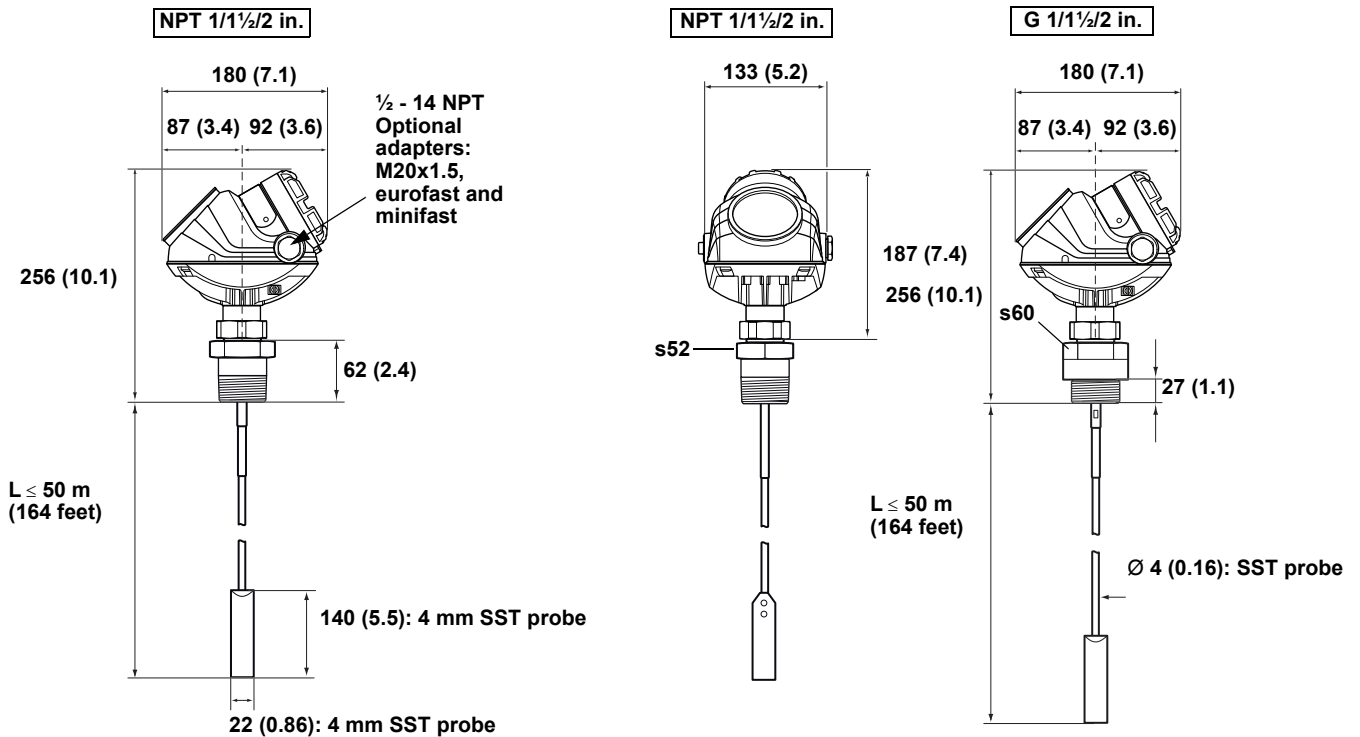
Raptor System

## 12.9.3 Flexible Single Lead Probe with Flange Connection

All dimensions are in mm (inches).

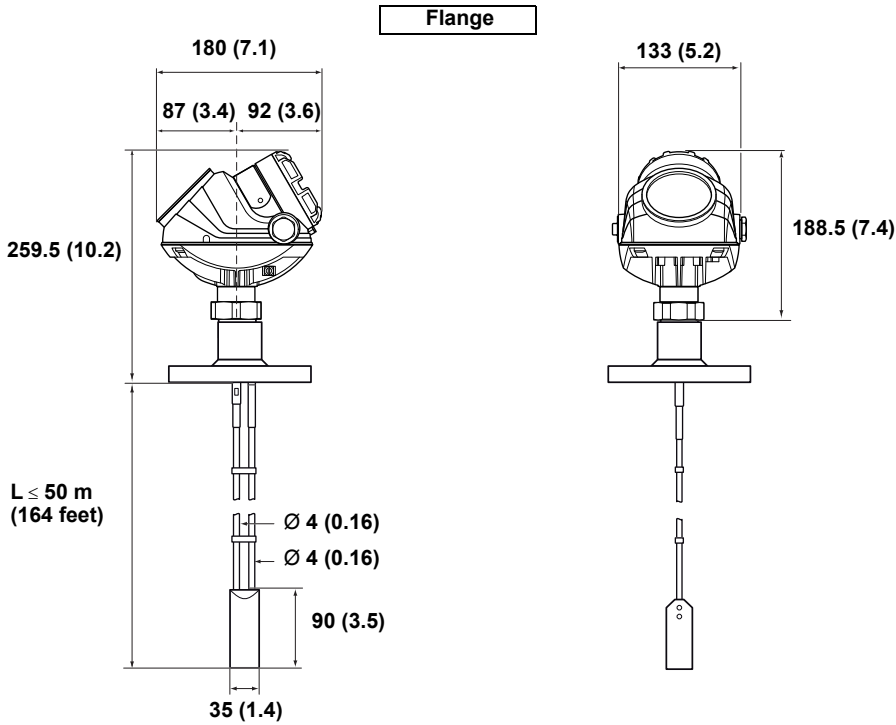


## 12.9.4 Flexible Single Lead Probe with Threaded Connection

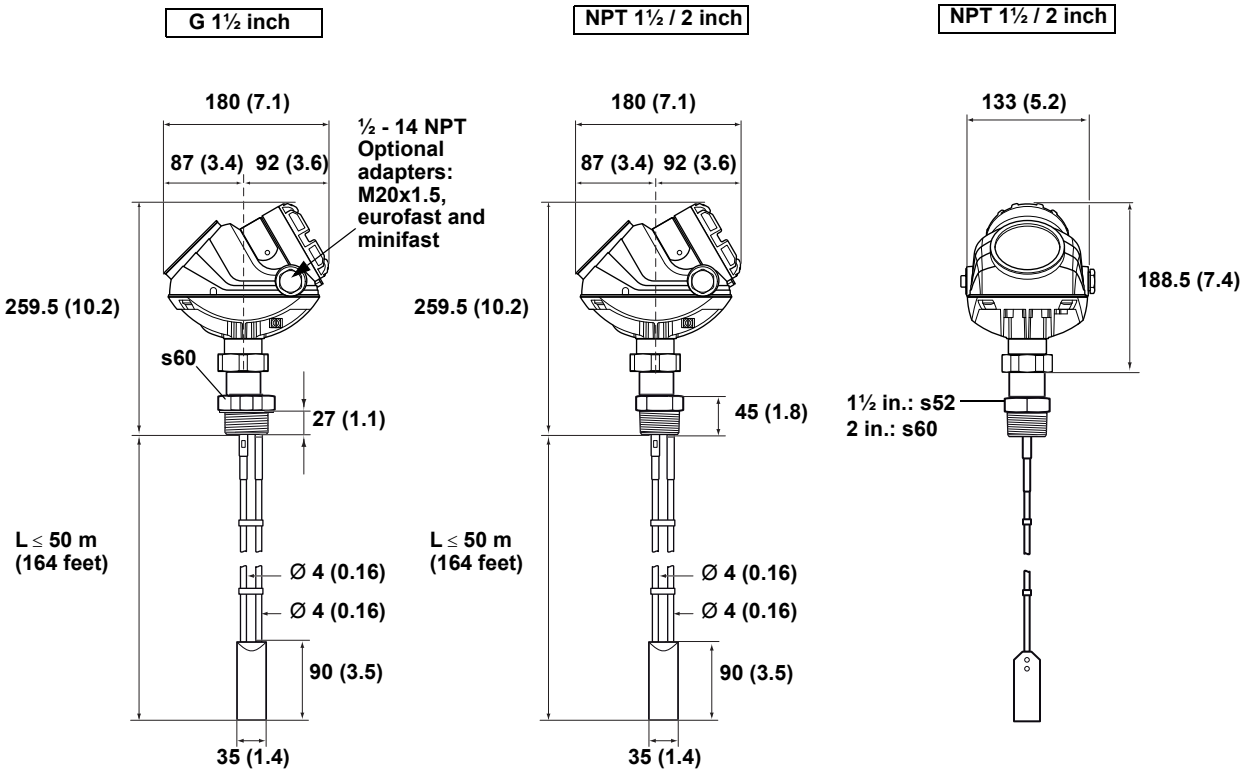


12.9.5 Flexible Twin Lead Probe with Flange Connection

All dimensions are in mm (inches).



12.9.6 Flexible Twin Lead Probe with Flange Connection





## Technical Description

704010EN, Rev BA

March 2011

Raptor System

### 12.10 ORDERING INFORMATION

#### 12.10.1 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
F	Bus powered 2-wire FOUNDATION™ fieldbus (IEC 61158)	For use with Rosemount 2410 Tank Hub
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) <sup>(1)</sup>	Min. temperature -20 °C (-4 °F)
E	Eurofast male connector <sup>(1)</sup>	
M	Minifast male connector <sup>(1)</sup>	
Code (Pos 5)	Operating Temperature and Pressure	Note
S	Standard	Vacuum to 40 bar (580 psig). Temperature depends on o-ring selection, see page 124
C	Cryogenic <sup>(2)</sup>	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 <sup>(3)</sup>	
N	Not applicable, no o-ring <sup>(4)</sup>	
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 <sup>(5)</sup>	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 <sup>(6)</sup> (feet/m)	Note
xxx	0-164 ft or 0-50 m	(see Pos 8 notes)
Code (Pos 11)	Total Probe Length <sup>(6)</sup> (in./cm)	Note
xx	0-11 in. or 0-99 cm	(see Pos 8 notes)

Code (Pos 12)	Tank Connection	Note
<b>ANSI Flanges (AISI 316L / EN 1.4404)</b>		
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	
EA	8 in. Class 150	
<b>EN (DIN) Flanges in 316L SST (EN 1.4404)</b>		
HB	DN50, PN40	
IA	DN80, PN16	
IB	DN80, PN40	
JA	DN100, PN16	
JB	DN100, PN40	
KA	DN150, PN16	
LA	DN200, PN16	
<b>Threaded Connections</b>		
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 <sup>(7)</sup>	
IE	FM FISCO Intrinsic Safety <sup>(7)</sup>	
IF	CSA FISCO Intrinsic Safety <sup>(7)</sup>	
IG	IECEX FISCO Intrinsic Safety <sup>(7)</sup>	
I1	ATEX Intrinsic Safety	
I5	FM Intrinsic Safety	
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	

# Technical Description

704010EN, Rev BA

March 2011

Raptor System

Code	Options – none or multiple selections are possible	Note
M1	Integral digital display	
P1	Hydrostatic pressure testing <sup>(8)</sup>	
LS	Long stud <sup>(9)</sup> , 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)	
<b>Special Certificates</b>		
Q4	Calibration Data Certification	
Q8	Probe Material Traceability Certification per EN 10204 3.1 <sup>(10)</sup>	
QS	Prior use certificate of FMEDA data (SIS/SIL) <sup>(11)</sup>	
U1	TÜV/DIBt WHG approval for overfill protection <sup>(11)</sup>	
<b>Centering Discs</b>		<b>Outer Diameter</b>
S2	2 in. Centering disc SST <sup>(12)</sup>	1.8 in. (45 mm)
S3	3 in. Centering disc SST <sup>(12)</sup>	2.7 in. (68 mm)
S4	4 in. Centering disc SST <sup>(12)</sup>	3.6 in. (92 mm)
S6	6 in. Centering disc SST <sup>(12)</sup>	5.55 in. (141 mm)
S8	8 in. Centering disc SST <sup>(12)</sup>	7.40 in. (188 mm)
<b>Model Code Example: 5301 - F A1 S 1 V 5A M02500 CA 1A - M1 S4</b>		
M02500 means 25 m.		

(1) Not available with Pos 13 "Hazardous Location Certification" codes E1, E5, E6 or E7.

(2) Requires Pos 7 "Sealing, O-ring Material" code N (No o-ring) and Pos 8 "Probe Type" code 3A, 5A or 5B.

(3) Requires Pos 5 "Operating Temperature and Pressure" code S.

(4) Requires Pos 5 "Operating Temperature and Pressure" code C.

(5) Extra length for fastening is added in factory.

(6) 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 118 for more probe length guidance.

(7) Requires Pos 2 "Tank Bus: Power and Communication" code F. For use with Rosemount 2410 Tank Hub.

(8) For flanged tank connections.

(9) Requires Pos 8 "Probe Type" 5A or 5B.

(10) Certificate includes all pressure retaining wetted parts.

(11) Requires Pos 2 "Tank Bus: Power and Communication" code H.

(12) Requires Pos 8 "Probe Type" 2A or 5B.

## 13 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<sup>(1)</sup> 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.

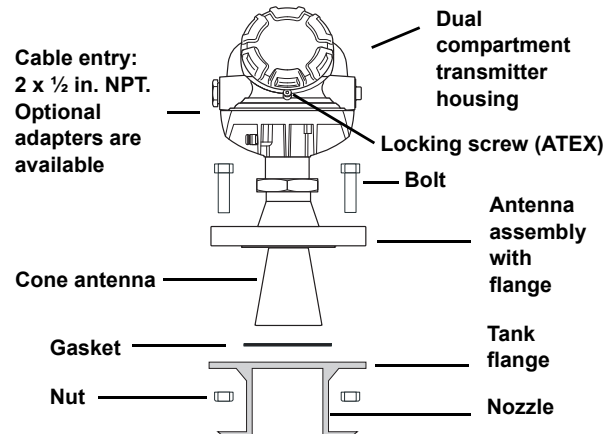
The 5400 transmitter consists of the housing and an antenna assembly.

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 22, and Appendix A: Radar Level Device Selection.



### 13.1 SAFETY FUNCTIONS

5400 with HART communication is suitable for use in SIL 1 overfill protection applications, and is also TÜV-tested and approved for overfill protection 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 138 and "Additional High Level Alarm Configurations" on page 17.

### 13.2 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 1/2-in. NPT cable entries for conduit / cable connections. Adapters to other connection types are available, see "Ordering Information".

### 13.3 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.

### 13.4 MEASURING RANGE

The measuring range depends on the antenna size, the dielectric constant ( $\epsilon_r$ ) 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 ( $\epsilon_r = 1.9-4.0$ ).  
In pipes or with ideal surface conditions, for some liquefied gases ( $\epsilon_r = 1.4-4.0$ )
- B. Alcohols, concentrated acids, organic solvents, oil/water mixtures, and acetone ( $\epsilon_r = 4.0-10.0$ ).
- C. Conductive liquids, e.g. water based solutions, dilute acids, and alkalis ( $\epsilon_r > 10.0$ ).

**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)

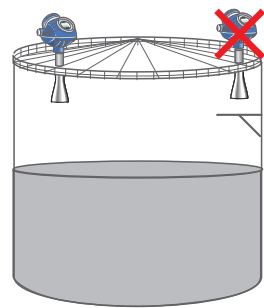
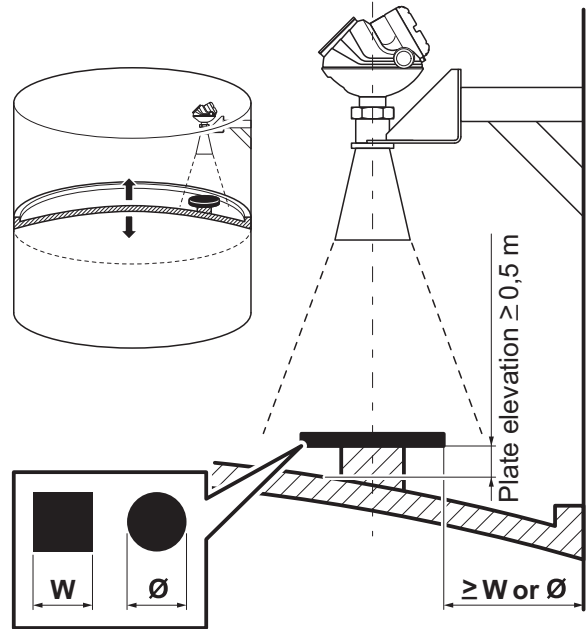
### 13.5 INSTALLATION CONSIDERATIONS

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

#### 13.5.1 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.

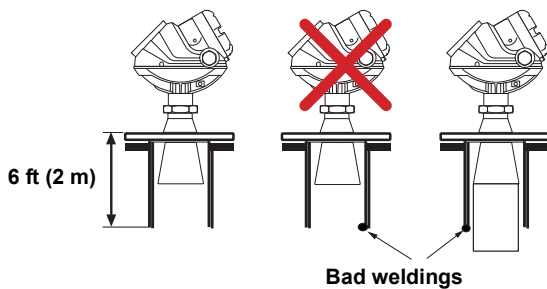


The transmitter should be installed off-center, and at a location away from disturbing inlets or metallic objects within the radar beam. Because of circular polarization, there is no clearance distance requirement from the tank wall if it is flat and free from obstructions.

The 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)



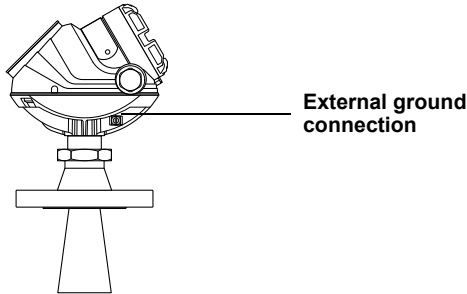
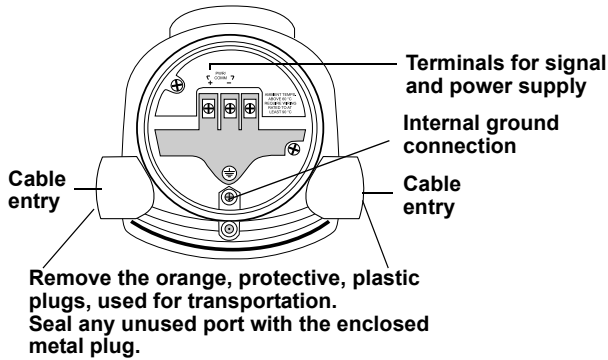
The antenna can be recessed in smooth nozzles up to 2 m (6 ft), but if the inside of the nozzle contains disturbing objects, use the extended cone.

# Technical Description

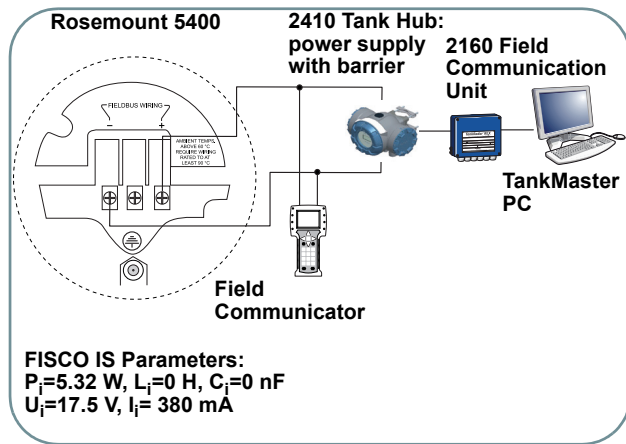
704010EN, Rev BA

March 2011

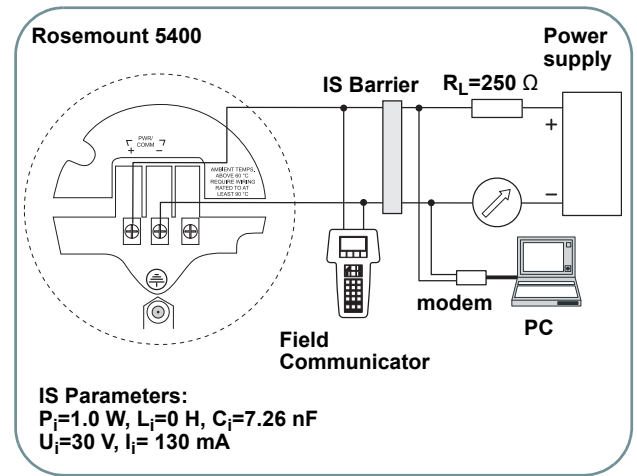
## 13.5.2 Cable Connections



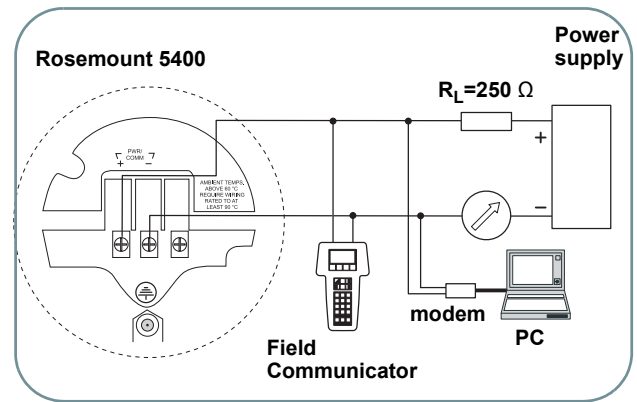
### FOUNDATION™ fieldbus intrinsically safe power supply



### HART intrinsically safe power supply



### HART Explosionproof/Flameproof power supply



### 13.5.3 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.



## 13.6 SPECIFICATION

See the Rosemount 5400 Product Data Sheet (00813-0100-4026) for complete information.

General	
<b>Product</b>	Rosemount 5402 Radar Level Transmitter.  For level device guidance, see "When to use a 5900S-, or 5300/5400 System Configuration" on page 22, and Appendix A: Radar Level Device Selection.
<b>Measurement principle</b>	Pulsed, free propagating radar (~26 GHz)
<b>Reference conditions</b>	Ideal metal plate with no disturbing objects. Temperature: 20 °C (+ 68 °F). Pressure: 960-1060 mbar (14-15 psi). Humidity: 25-75 % RH.
<b>Microwave output power</b>	< 1 mW
<b>Hazardous location certifications</b>	Factory Mutual (FM), ATEX, Canadian Standards Association (CSA), and IECEx. See "Product Certifications" on page 141
<b>Safety/overflow</b>	WHG (TÜV) overflow approval (for HART version)
<b>CE-mark</b>	93/68/EEC: complies with applicable EU directives (EMC, ATEX, LVD, and R&TTE)
<b>Ordinary location certification</b>	Complies with FM 3810:2005 and CSA C22.2 No. 142-M1987
Measuring Performance	
<b>Measuring range</b>	Maximum 35 m (115 ft) from flange. The measuring range depends on the microwave frequency, antenna size, the dielectric constant ( $\epsilon_r$ ) of the liquid, and process conditions. For more information, see "Measuring Range" on page 134
<b>Instrument accuracy at reference conditions</b>	± 3 mm (± 0.1 in.)
<b>Repeatability</b>	± 1 mm (0.04 in.) at 5 m (16.4 ft) distance
<b>Temperature drift</b>	0.05 %/10 K in temperature range -40 to 80 °C (-40 to 176 °F)
<b>Update interval</b>	1 second
<b>Near zone distance</b>	0.4 m (1.3 ft) from lower end of the antenna
<b>Near zone accuracy</b>	± 15 mm (± 0.6 in.)
<b>Transition zone<sup>(1)</sup></b>	From lower end of the antenna and 150 mm (6 in.) below
Display / Configuration / Communication	
<b>Integral display</b>	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.
<b>Output variables</b>	Level, Distance, Volume, Level Rate, Signal Strength, Internal Temperature, Analog Output Current <sup>(2)</sup> , and % of Range <sup>(2)</sup>
<b>Output units</b>	Level and Distance: ft, inch, m, cm or mm Volume: ft <sup>3</sup> , inch <sup>3</sup> , US gals, Imp gals, barrels, yd <sup>3</sup> , m <sup>3</sup> , or liters Level Rate: ft/s, m/s Temperature: °F, °C
<b>Configuration tools</b>	Rosemount TankMaster, Rosemount RadarMaster, Field Communicator, AMS Suite, DeltaV or any other DD (Device Description) compatible host system
<b>FOUNDATION™ fieldbus blocks</b>	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
<b>FOUNDATION™ fieldbus class (Basic or Link Master)</b>	Link Master (LAS)
<b>FOUNDATION™ fieldbus block execution time</b>	AI-block: 30 ms. PID-block: 40 ms. ARTH-, ISEL-, OSPL-block: 65 ms. CHAR-block: 75 ms
<b>Conforming FOUNDATION™ fieldbus</b>	ITK 4.6
<b>FOUNDATION™ fieldbus PlantWeb Alert Support</b>	Yes

Electric	
<b>Power supply</b>	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)
<b>Bus current draw</b>	21 mA
<b>Internal power consumption</b>	< 50 mW in normal operation
<b>Output</b>	FOUNDATION™ fieldbus or HART 4-20 mA current loop
<b>Signal on alarm (4-20 mA HART)</b>	Standard : Low = 3.75 mA, High = 21.75 mA. Namur NE 43: High = 22.50 mA
<b>Saturation levels (4-20 mA HART)</b>	Standard: Low = 3.9 mA, High = 20.8 mA. Namur NE 43: Low = 3.8 mA, High = 20.5 mA
<b>Built-in Tankbus terminator</b>	No
Mechanical	
<b>Antennas</b>	Free propagation: 4-in. cone antenna Still-pipe installation: 2, 3, or 4-in. cone antennas
<b>Material exposed to tank atmosphere</b>	<ul style="list-style-type: none"> <li>• 316 / 316 L SST (EN 1.4404)</li> <li>• PTFE fluoropolymer</li> <li>• O-ring material</li> </ul>
<b>Flanges, threads</b>	See "Temperature and Pressure" on page 140 and "Ordering Information" on page 144
<b>Housing / enclosure</b>	Polyurethane-covered aluminum
<b>Cable entry</b>	Two ½ - 14 NPT entries for cable glands or conduits. Adapters are available, see Ordering Information. One metal plug to seal any unused ports is enclosed with the transmitter delivery.
<b>Tankbus cabling</b>	0.5-1.5 mm <sup>2</sup> (AWG 22-16), twisted shielded pairs
<b>Dimensions</b>	See "Dimensional Drawings" on page 142
<b>Weight</b>	<b>Transmitter housing:</b> 2.0 kg (4.4 lbs) <b>Antennas:</b> 1.0 kg (2.2 lbs) <b>Tank connection:</b> ANSI flanges: 3.0 kg (6.6 lbs), EN (DIN) flanges: 4.0 kg (8.8 lbs)
Environment	
<b>Ambient temperature</b>	IS/Ex ia and XP/Ex d, FOUNDATION™ fieldbus communication: -40 to 60 °C (-40 to 140 °F). LCD readable in: -20 to 70 °C (-4 to 158 °F) IS/Ex ia and XP/Ex 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).
<b>Storage temperature</b>	-50 to 90 °C (-58 to 194 °F). LCD: -40 to 85 °C (-40 to 185 °F)
<b>Process / flange temperature</b>	See page 140
<b>Process pressure</b>	See page 140
<b>Humidity</b>	0 - 100% relative humidity, non condensating
<b>Ingress protection</b>	IP 66 and IP 67 (Nema 4X)
<b>Vibration resistance<sup>(6)</sup></b>	IEC 60770-1 level 1
<b>EU directive compliance</b>	CE mark, 93/68/EEC
<b>Telecommunication (FCC and R&amp;TTE)<sup>(3)(4)</sup></b>	FCC part 15C (1998) <sup>(5)</sup> , R&TTE (EU directive 99/5/EC), and IC (RSS210-5)
<b>Electromagnetic compatibility<sup>(6)</sup></b>	Emission and Immunity: EMC directive 204/108/EC. EN61326-1:2006 NAMUR recommendations NE21
<b>Transient / built-in lightning protection<sup>(6)</sup></b>	IEC 61000-4-5:2001 T1 option: C62.41.2-2002 (IEEE), C37.90.1-2002 (IEEE)
<b>Pressure Equipment Directive (PED)</b>	97/23/EC

(1) Transition zones are areas where measurements are not recommended.

(2) Not applicable for FOUNDATION™ fieldbus.

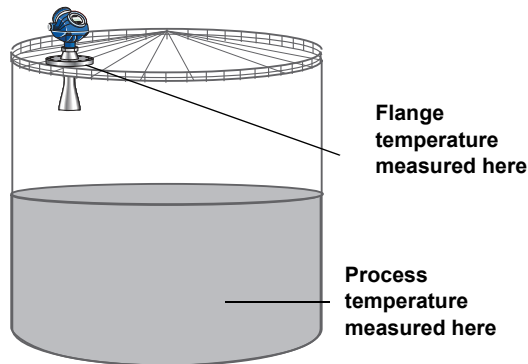
(3) Only a limited selection is presented. Contact your local Emerson representative for more information.

(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.

### 13.6.1 Temperature and Pressure



#### Flange Temperature

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

#### NOTE

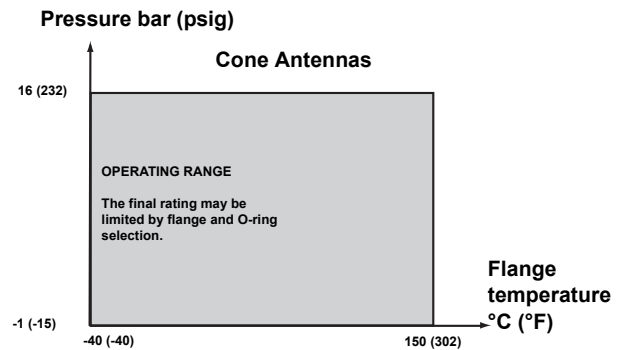
Flange temperature depends on process and ambient temperature, and mounting conditions such as nozzle position, distance to max product level, nozzle height, presence of insulation, etc.

#### Ambient Temperature

The transmitter housing must be installed so the ambient temperature is not exceeded, to protect the electronics (see “Specification” on page 138). The ambient temperature may be limited by the selected product certificate (see “Product Certifications” on page 141).

#### Operating Pressure

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



Process temperature and pressure diagram.

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)

## 13.7 PRODUCT CERTIFICATIONS

### SAFETY NOTE & SPECIAL CONDITIONS FOR SAFE USE (X-MARKING IN ATEX, AND IECX 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.

### 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.

### ATEX Approvals

Nemko 04ATEX1073X

E1<sup>(1)</sup> Flameproof:



II 1/2 G T4.

II 1D T79 °C<sup>(2)</sup>.

Ex ia/db ia IIC T4 Ga/Gb (-40 °C ≤ T<sub>a</sub> ≤ +70 °C<sup>(3)</sup>).

Ex ta IIIC T79 °C<sup>(2)</sup> (-40 °C ≤ T<sub>a</sub> ≤ +70 °C<sup>(3)</sup>).

U<sub>m</sub>=250 V

I1, IA<sup>(1)</sup>Intrinsically Safe:



II 1/2 G T4.

II 1 D T79 °C<sup>(2)</sup>.

Ex ia IIC T4 Ga/Gb (-50 °C ≤ T<sub>a</sub> ≤ +70 °C<sup>(3)</sup>).

Ex ta IIIC T79 °C<sup>(2)</sup> (-50 °C ≤ T<sub>a</sub> ≤ +70 °C<sup>(3)</sup>).

4-20 mA / HART model: U<sub>i</sub>=30 V dc, I<sub>i</sub>=130 mA, P<sub>i</sub>=1.0 W, C<sub>i</sub>=7.26 nF, L<sub>i</sub>=0 H.

FOUNDATION™ fieldbus model: U<sub>i</sub>=30 V dc, I<sub>i</sub>=300 mA, P<sub>i</sub>=1.5 W, C<sub>i</sub>=0 nF, L<sub>i</sub>=0 H.

FISCO model: U<sub>i</sub>=17.5 V dc, I<sub>i</sub>=380 mA, P<sub>i</sub>=5.32 W, C<sub>i</sub>=0 nF, L<sub>i</sub><1 μH.

Installation Drawing: 9150079-907.

(1) Ordering Information code for product certificates, see page 144.

(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<sup>(1)</sup> 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<sup>(3)</sup>.  
Seal not required.

I5, IE<sup>(1)</sup>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<sub>i</sub>=30 V dc, I<sub>i</sub>=130 mA, P<sub>i</sub>=1.0 W, C<sub>i</sub>=7.26 nF, L<sub>i</sub>=0 H.

FOUNDATION™ fieldbus model: U<sub>i</sub>=30 V dc, I<sub>i</sub>=300 mA, P<sub>i</sub>=1.3 W, C<sub>i</sub>=0 nF, L<sub>i</sub>=0 H.

FISCO model: U<sub>i</sub>=17.5 V dc, I<sub>i</sub>=380 mA, P<sub>i</sub>=5.32 W, L<sub>i</sub>=C<sub>i</sub>=0.

Temp. Code T4

Ambient temperature limits: -50 to +70 °C<sup>(3)</sup>.

### Canadian Standards Association (CSA) Approvals

This product meets the Dual Seal Requirements of ANSI/ISA 12.27.01-2003.

Cert. no.: 1514653

E6<sup>(1)</sup> 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 °C<sup>(3)</sup>

I6, IF<sup>(1)</sup>Intrinsically Safe Exia:

Class I, Div. 1, Groups A, B, C and D.

Temp Code T4.

4-20 mA / HART model: U<sub>i</sub>=30 V dc, I<sub>i</sub>=130 mA, P<sub>i</sub>=1.0 W, C<sub>i</sub>=7.26 nF, L<sub>i</sub>=0 H.

FOUNDATION™ fieldbus model: U<sub>i</sub>=30 V dc, I<sub>i</sub>=300 mA, P<sub>i</sub>=1.3 W, C<sub>i</sub>=0 nF, L<sub>i</sub>=0 H.

FISCO model: U<sub>i</sub>=17.5 V dc, I<sub>i</sub>=380 mA, P<sub>i</sub>=5.32 W, L<sub>i</sub>=C<sub>i</sub>=0.

Installation Drawing: 9150079-906

Ambient temperature limits -50 to +70 °C<sup>(3)</sup>.

# Technical Description

704010EN, Rev BA

March 2011

Raptor System

## IECEX Approval

IECEX NEM 06.0001x

E7<sup>(1)</sup> Flameproof:

Ex ia/db ia IIC T4 Ga/Gb (-40 °C ≤ T<sub>a</sub> ≤ +70 °C<sup>(2)</sup>).

Ex ta IIIC T79 °C<sup>(3)</sup> (-40 °C ≤ T<sub>a</sub> ≤ +70 °C<sup>(2)</sup>)

U<sub>m</sub>=250 V

I7, IG<sup>(1)</sup>Intrinsically Safe:

Ex ia IIC T4 Ga/Gb (-50 °C < T<sub>a</sub> < +70 °C<sup>(2)</sup>)

Ex ta IIIC T79 °C<sup>(3)</sup> (-50 °C < T<sub>a</sub> < +70 °C<sup>(2)</sup>).

4-20 mA / HART model: U<sub>i</sub>=30 V dc, I<sub>i</sub>=130 mA, P<sub>i</sub>=1.0 W, C<sub>i</sub>=7.26 nF, L<sub>i</sub>=0 H.

FOUNDATION™ fieldbus model: U<sub>i</sub>=30 V dc, I<sub>i</sub>=300 mA, P<sub>i</sub>=1.5 W, C<sub>i</sub>=0 nF, L<sub>i</sub>=0 H.

FISCO model: U<sub>i</sub>=17.5 V dc, I<sub>i</sub>=380 mA, P<sub>i</sub>=5.32 W, C<sub>i</sub>=0 nF, L<sub>i</sub><1 μH.

Installation Drawing: 9150079-907.

For more information , refer to the Reference Manual (document number 00809-0100-4026).

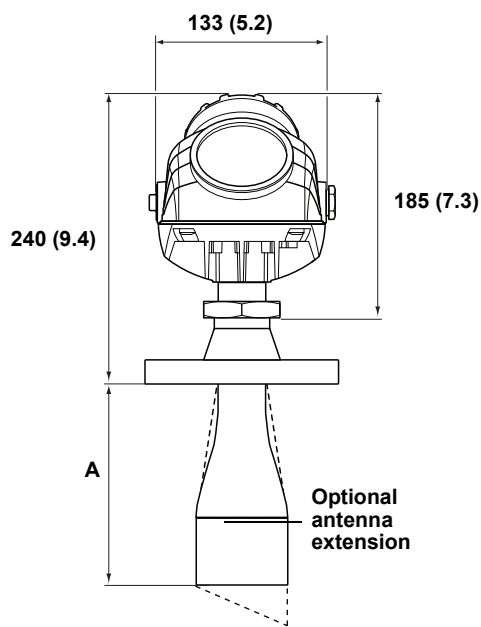
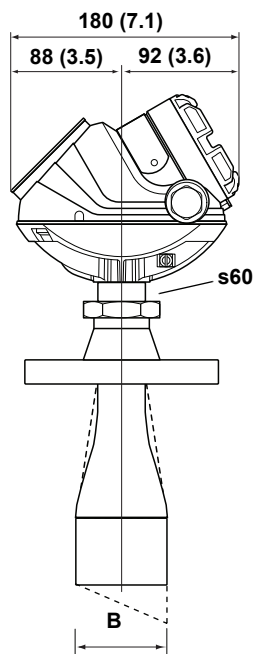
(1) Ordering Information code for product certificates, see page 144.

(2) +60 °C with FOUNDATION™ fieldbus or FISCO option.

(3) +69 °C with FOUNDATION™ fieldbus or FISCO option.

## 13.8 DIMENSIONAL DRAWINGS

### 13.8.1 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

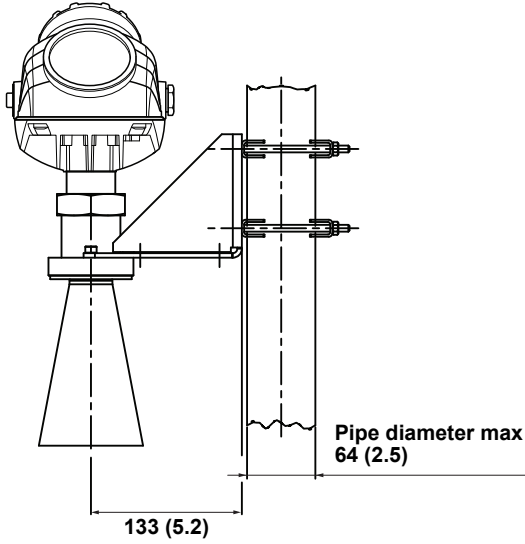
Extended SST Cone<sup>(1)</sup>

Max. nozzle height	A	Option Code
500 (20)	518 (20.4)	S3

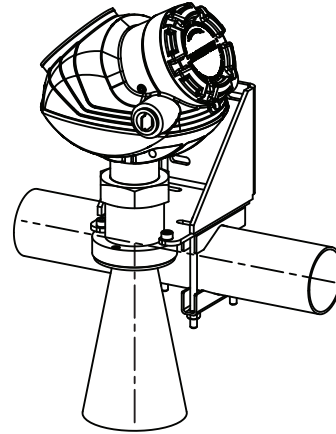
(1) The extended cone antennas are available in 5-in. step increments from 10 to 50 inches. Consult your local Rosemount Tank Gauging representative for more information. Expect longer lead times for other sizes than the 500 mm (20 in.) version.

13.8.2 Bracket Mounting

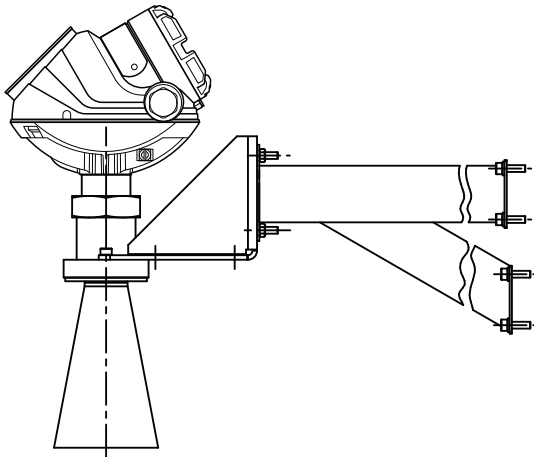
All dimensions are in mm (inches).



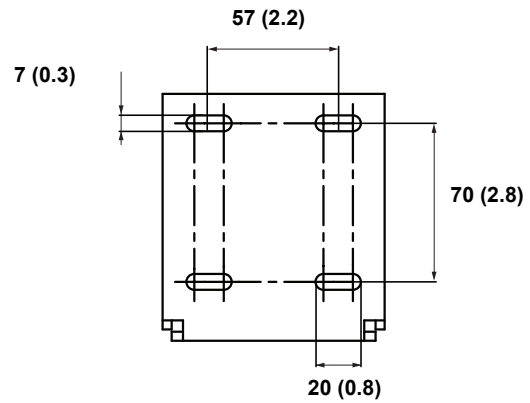
Pipe mounting  
(vertical pipe)



Pipe mounting  
(horizontal pipe)



Wall mounting



Hole pattern  
wall mounting

## Technical Description

704010EN, Rev BA  
March 2011

Raptor System

### 13.9 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.

#### 13.9.1 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
F	Bus powered 2-wire FOUNDATION™ fieldbus (IEC 61158)	For use with Rosemount 2410 Tank Hub
H	4-20 mA HART communication	For use as a stand-alone overflow 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) <sup>(1)</sup>	Min. temperature -20 °C (-4 °F)
E	Eurofast male connector <sup>(1)</sup>	
M	Minifast male connector <sup>(1)</sup>	
Code (Pos 5)	Hazardous Location Certification	Note
IA	ATEX FISCO Intrinsic Safety <sup>(2)</sup>	
IE	FM FISCO Intrinsic Safety <sup>(2)</sup>	
IF	CSA FISCO Intrinsic Safety <sup>(2)</sup>	
IG	IECEX FISCO Intrinsic Safety <sup>(2)</sup>	
I1	ATEX Intrinsic Safety	
I5	FM Intrinsic Safety	
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
<b>SST Cone Antennas (AISI 316L / EN 1.4404)</b>		
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
<b>ANSI Flanges (AISI 316 / 316L SST)</b>		
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	
<b>EN Flanges (EN 1.4404 SST)</b>		
HB	DN50 PN40	
IB	DN80 PN40	
JA	DN100 PN16	
JB	DN100 PN40	
KA	DN150 PN16	
LA	DN200 PN16	
<b>Other</b>		
BR	Bracket Mounting, AISI 316L / EN 1.4404 SST <sup>(3)</sup>	
<b>Code</b>	<b>Options – none or multiple selections are possible</b>	<b>Note</b>
M1	Integral digital display	
<b>Special Certificates</b>		
Q4	Calibration Data Certificate	
Q8	Antenna Material Traceability Certification per EN 10204 3.1 <sup>(4)</sup>	
QS	Prior use certificate of FMEDA data (SIS/SIL) <sup>(5)</sup>	
U1	TÜV/DIBt WHG approval for overfill protection <sup>(5)</sup>	
<b>Special Procedures</b>		
P1	Hydrostatic pressure testing <sup>(3)</sup>	
<b>Antenna Modification</b>		
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
<b>Model Code Example: 5402 - AF 1 IA 4S PV AA - M1 Q4</b>		

- (1) Not available with Pos 5 "Hazardous Location Certification" codes E1, E5, E6 or E7.
- (2) Requires Pos 2 "Tank Bus: Power and Communication" code F. For use with Rosemount 2410 Tank Hub.
- (3) Bracket mounting (BR) is not available with hydrostatic testing (P1).
- (4) Certificate includes all pressure retaining wetted parts.
- (5) Requires Pos 2 "Tank Bus: Power and Communication" code H.



# 14 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 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.



Left: 644 Temperature Transmitter.

Right: 644 Temperature Transmitter with display option.

## 14.2 ROSEMOUNT 65 SINGLE POINT TEMPERATURE SENSOR



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.

### 14.1 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 Single Point Temperature Sensor” on page 146.

The 65 series single point temperature sensor 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 153 and 154 for details).

In EN 60751 the relationship between resistance and temperature is defined.

Two grades or classes are stated for temperature element tolerances:

Grade A / Class A:  $\pm ( 0.15 + 0.002 * | t | )$

Grade B / Class B:  $\pm ( 0.30 + 0.005 * | t | )$

t is the temperature in °C.

Class B is used for temperatures close to 0 °C, and Class A is used for temperatures far away from 0 °C.

The 65 series temperature sensor is delivered with Class B tolerance as standard, and as Class A as an option. See details in sensor accuracy diagram on page 53, and temperature/volume uncertainty on pages 22-23.

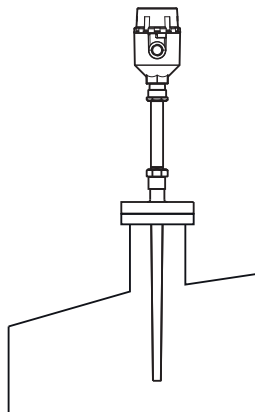


Different Resistance Temperature Detectors (RTD) sensors and housing options.

### 14.3 INSTALLATION CONSIDERATIONS

65 series sensors may be ordered as complete assemblies, by specifying type of sensing element, length, extension, housing and thermowell. The 65 series sensor can be ordered with flying leads, or a terminal block.

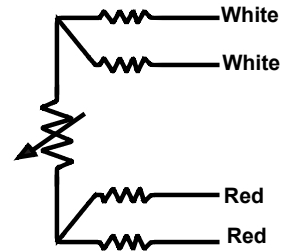
Ordered with flying leads, the sensor is designed to be used with the 644 Temperature Transmitter attached directly to the sensor. The flying lead configuration allows removal of the sensor and transmitter as one assembly.



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.

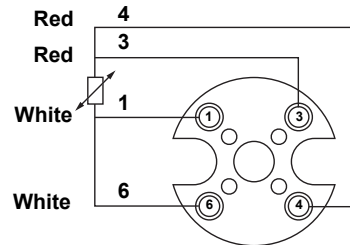
#### 65 Series RTD Flying Leads (Code 0)

Single Element



#### Series 65 RTD Terminal Block Termination (Code 2)

Single Element



### 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. It can be connected with a flange or a thread (see ordering information for details).

## 14.4 SPECIFICATION

See the Rosemount 644 and 65 Series Product Data Sheets (00813-0100-4728 and 00813-0100-2654) for complete information.

Rosemount 644	
<b>Product</b>	Rosemount 644 Single Point Temperature Transmitter
<b>Wiring</b>	644 with integrated Rosemount 65 Single Point Temperature Sensor: <ul style="list-style-type: none"> <li>• 4-wire</li> <li>• 3-wire</li> </ul>
<b>Metrology sealing possibility</b>	No
<b>Write protect switch</b>	No
<b>Hazardous location certification and IS parameters</b>	ATEX, FM, CSA, and IECEx. For details, see "Certifications for Rosemount 644" on page 150
<b>CE-mark</b>	Meets all requirements listed under IEC 61326: Amendment 1, 1998
<b>Ordinary location certification</b>	Complies with FM 3810:2005 and CSA C22.2 No. 142-M1987
Measuring Performance	
<b>Reference accuracy</b>	± 0.15 °C (± 0.27 °F) over the whole temperature measuring range. For temperature sensor accuracy, see "Specification" on page 149 (Rosemount 65)
<b>Temperature measuring range</b>	– 50 to 450 °C (–58 to 842 °F) or –196 to 600 °C (–321 to 1112 °F) depending on option
<b>Resolution</b>	± 0.1 °C (± 0.1 °F) according to API chapter 7 and 12
<b>Update time</b>	≤ 0.5 seconds
Display / Configuration / Communication	
<b>Local display</b>	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	
<b>Power supply</b>	Powered by Rosemount 2410 Tank Hub (9.0-17.5 VDC, polarity insensitive)
<b>Internal power consumption</b>	Typical 70 mW
<b>Bus current draw</b>	11 mA
<b>Cable entry (connection/glands)</b>	M20 x 1.5 and ½-in. NPT
<b>Tankbus cabling</b>	0.5-1.5 mm <sup>2</sup> (AWG 22-16), twisted shielded pairs
<b>Built-in Tankbus termination</b>	No
<b>Tankbus to sensor isolation</b>	Tested to 500 VAC rms (707 VDC) at 50/60 Hz
<b>Tankbus to sensor isolation</b>	500 VAC
Mechanical	
<b>Housing / Installation</b>	Enclosure is ordered with the Rosemount 65 sensor. See page 153
<b>Dimensions</b>	See "Rosemount 644 Dimensions" on page 151
<b>Weight</b>	< 0.8 kg (1.8 lbs), depending on options
Environment	
<b>Ambient operating temperature</b>	-40 to 85 °C (-40 to 185 °F). LCD <sup>(1)</sup> : -20 to 85 °C (-4 to 185 °F)
<b>Storage temperature</b>	-50 to 120 °C (-58 to 248 °F). LCD: -45 to 85 °C (-50 to 185 °F)
<b>Humidity</b>	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).

<b>Rosemount 65</b>	
<b>Product</b>	Rosemount 65, platinum RTD temperature sensors
<b>Element type</b>	Pt-100 spot elements according to EN 60751. 3-wire or 4-wire, dual or single element design
<b>Accuracy</b>	DIN Class B (standard). See diagram on page 54.
<b>Pressure range</b>	According to flange/thermowell pressure rating
<b>Temperature range (standard)</b>	– 50 to 450 °C (–58 to 842 °F)
<b>Temperature range (optional)</b>	–196 to 600 °C (–321 to 1112 °F)
<b>Ambient temperature</b>	– 40 to 85 °C (–40 to 185 °F)
<b>Sheath material</b>	316 SST / 321 SST with mineral-insulated cable construction
<b>Tank connection</b>	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
<b>Immersion length</b>	500 mm (20 in.) to 1000 mm (40 in.)
<b>Extension length</b>	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.
<b>Housing</b>	Aluminium
<b>Ingress protection</b>	Rosemount Series 65 sensor assemblies are IP68 and NEMA 4X. This rating is applicable only for complete assemblies including either: <ul style="list-style-type: none"> <li>• a connection head, extension, and sensor</li> <li>• a connection head, extension, and barstock thermowell including sensor</li> </ul>
<b>Approvals</b>	See "Certifications for Rosemount 65" on page 150
<b>Thermowell dimensions</b>	See "Rosemount 65 Dimensions" on page 151
<b>Thermowell material</b>	Stainless steel 1.4404 (AISI 316L)

## 14.5 PRODUCT CERTIFICATIONS

### 14.5.1 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 1180

- I1 ATEX Intrinsic Safety  
Certificate Number: Baseefa03ATEX0499X  
ATEX Marking:

 II 1 G

EEx ia IIC T4 ( $-50$  °C  $\leq T_{amb} \leq 60$  °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.

### 14.5.2 Certifications for Rosemount 65

For complete information, see the Rosemount 65 Product Data Sheet (00813-0100-2654).

- I1 ATEX/IBExU Intrinsic Safety Approval  
ATEX Marking  II 2 G  
EEx ia IIC T6 ( $T_{amb} = -51$  to  $60$  °C)  
The Intrinsically Safety Approval is valid for Series 65 RTD Sensors and Series 185 thermocouples.

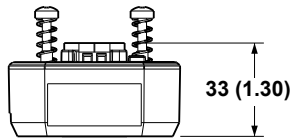
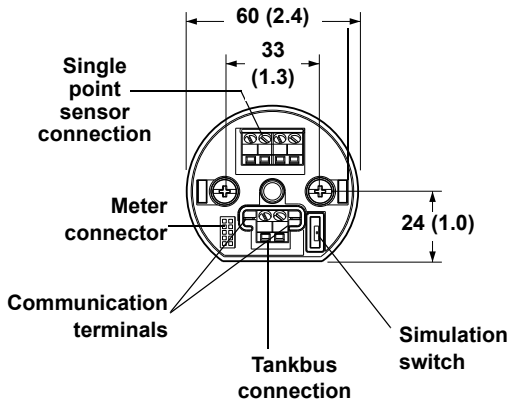
These certified sensors can only be applied in Zone 1.

The marking of intrinsically safe circuits is effected by color codes or print, Ex i. A mounted-on connection head is provided with a ground screw for earth connection and a blue painted cable gland.

14.6 DIMENSIONAL DRAWINGS

All dimensions are in mm (inches)

14.6.1 Rosemount 644 Dimensions



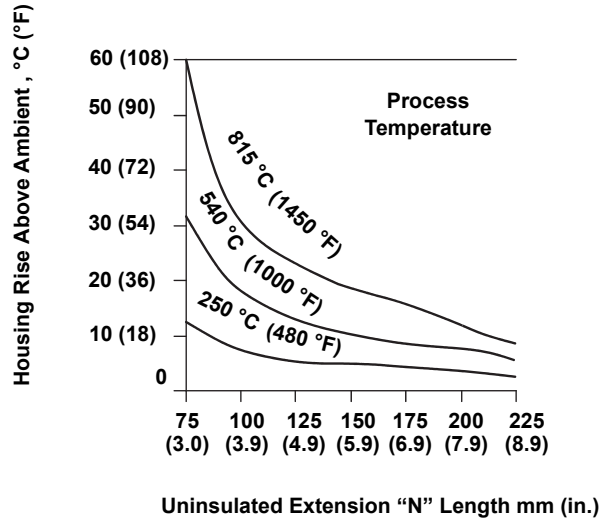
If the expected process temperature is near or beyond the transmitter specification limits, consider the use of additional thermowell extension length (ordered with the 65 sensor), or a remote installation configuration to isolate the transmitter from these excessive temperatures

Example

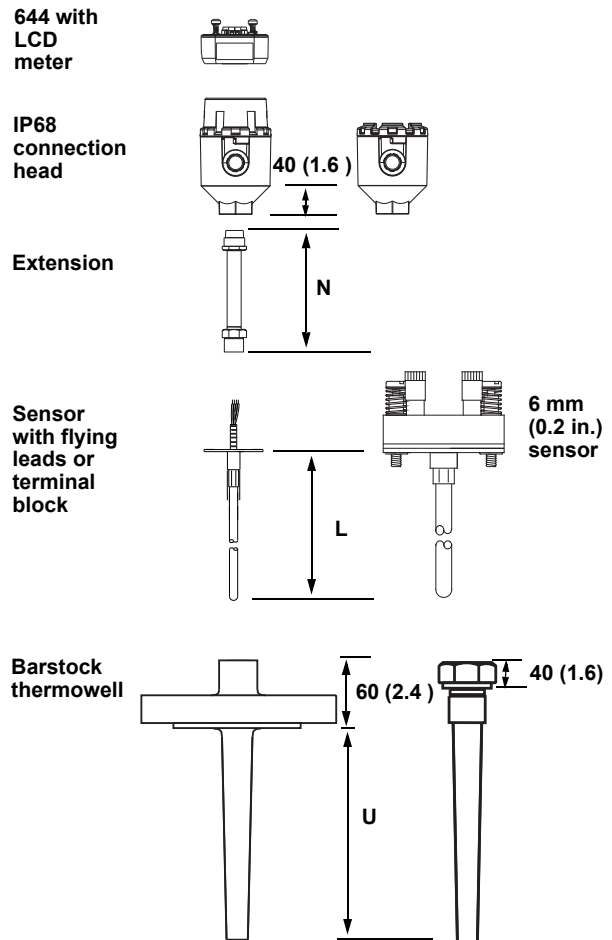
The rated ambient temperature specification for the transmitter is 85 °C (185 °F). If the maximum ambient temperature is 40 °C (104 °F) and the temperature to be measured is 540 °C (1004 °F), the maximum allowable housing temperature rise is the rated temperature specification limit minus the existing 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.



14.6.2 Rosemount 65 Dimensions



## Technical Description

704010EN, Rev BA

March 2011

Raptor System

### 14.7 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 Product Data Sheet (document number 00813-0100-4728) and in the Rosemount 65 Series Product Data Sheet (00813-0100-2654)

#### 14.7.1 Rosemount 644

Model (Pos 1)	Product Description	Note
644	Single Point Temperature Transmitter	Enclosure is ordered with the Rosemount 65 sensor
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 <sup>(1)</sup>	
I5	FM Intrinsic Safety <sup>(1)</sup>	
I6	CSA Intrinsic Safety <sup>(1)</sup>	
I7	IECEx Intrinsic Safety <sup>(1)</sup>	
NA	No hazardous location certification <sup>(1)</sup>	
Code (Pos 5+)	Options	Note
XA	Rosemount 65 Single Point Temperature Sensor assembled to the transmitter. The sensor is specified separately <sup>(2)</sup>	
M5	LCD display <sup>(3)</sup>	
GE	Eurofast male connectors	
GM	Minifast male connectors	
<b>Model Code Example: 644 - H F I1 - XA M5 C2 C4 Q4</b>		

(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 sensor.

(3) Requires Pos 2 "Housing" code 1 or 2 for Rosemount 65 Single Point Temperature Sensor.

## 14.7.2 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)	Housing	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 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	Options – none or multiple selections are possible	Note
I1	EEx ia – ATEX/IBExU Intrinsic Safety Approval	
XA	Assemble sensor to Rosemount 644 temperature transmitter <sup>(1)</sup>	
<b>Model Code Example: 0065 - C 0 1 D 0135 N 1000 - XA</b>		

(1) If ordering option XA (pre-assembly), specify XA for both the 644 transmitter and 65 sensor.



## Technical Description

704010EN, Rev BA  
March 2011

Raptor System

### 14.7.3 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)	Connection Head Material	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)	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
<b>Threaded process connection</b>		
T44	½-in. NPT, threaded	
T46	¾-in. NPT, threaded	
T48	1-in. NPT, threaded	
T98	M20 x 1.5, threaded	
<b>Flanged connection</b>		
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	Note
I1	EEx ia – ATEX/IBExU Intrinsic Safety Approval	
XA	Assemble sensor to Rosemount 644 temperature transmitter <sup>(1)</sup>	
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.*

## 15 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 protection according to the German WHG regulations. It is also suitable for SIL 2 applications.

### 15.1 ROSEMOUNT 2160 LIQUID LEVEL SWITCH FOR *WIRELESSHART* 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 2120 Vibrating Fork Liquid Level Switch.



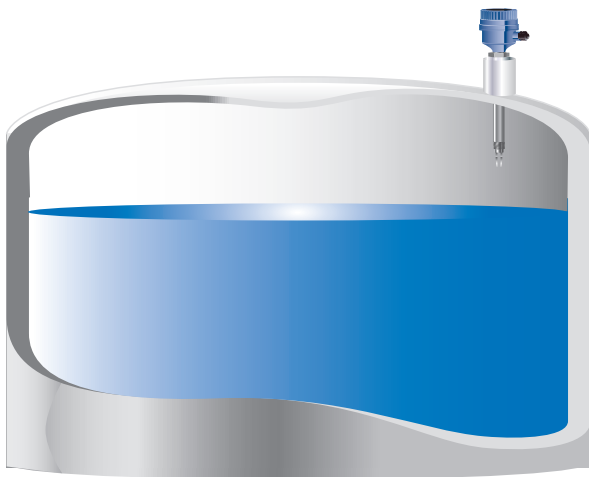
Rosemount 2160 Vibrating Fork Liquid Level Switch for IEC 62591 (*WirelessHART*) networks.

## 15.2 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.

## 15.3 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.

## 15.4 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.

### 15.4.1 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.

## 15.5 SPECIFICATION

For more information, see the Rosemount 2120 Product Data Sheet (00813-0100-4030) and Rosemount 2160 Product Data Sheet (00813-0100-4160).

General	
<b>Product</b>	<ul style="list-style-type: none"> <li>Rosemount 2120 Vibrating Fork Liquid Level Alarm Switch</li> <li>Rosemount 2160 Wireless Vibrating Fork Liquid Level Alarm Switch</li> </ul>
<b>Measurement principle</b>	Vibrating short fork technology
<b>Special features</b>	<p><b>Mode switch / Adjustable time delay</b> 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.</p> <p><b>Heartbeat LED (Rosemount 2120)</b> 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.</p> <p><b>Magnetic Test point (Rosemount 2120)</b> The test point, located on the side of the housing, can be used for alarm simulation</p>
<b>Wireless characteristics, Rosemount 2160</b>	<p><b>Antenna</b> Integrated omnidirectional antenna.</p> <p><b>Output</b> IEC 62591 (<i>WirelessHART</i>) 2.4 GHz DSSS</p> <p><b>Transmit Rate</b> User selectable: 4 s to 60 minutes</p>
<b>Liquid density range</b>	<p>Rosemount 2120: Minimum 600 kg/m<sup>3</sup> (37.5 lb/ft<sup>3</sup>) Rosemount 2160: Minimum 500 kg/m<sup>3</sup> (31.2 lb/ft<sup>3</sup>)</p>
<b>Liquid viscosity range</b>	0.2 to 10,000 cP (centiPose)
<b>Hysteresis (water)</b>	± 1 mm (± 0.039 in.)
<b>Switching point (water)</b>	13 mm (0.5 in.) from tip (vertical) / from edge (horizontal) of fork (this will vary with different liquid densities)
<b>Hazardous location certification, Rosemount 2120</b>	<p><b>FM Explosion Proof:</b> Explosion Proof for Class I, Div. 1, Groups A, B, C and D. T6. 4X. <b>FM IS:</b> Intrinsically Safe for Class I, Div. 1, Groups A, B, C and D Class I, Zone 0, AEx ia IIC. T5. <b>CSA Explosion Proof:</b> Explosion Proof for Class I, Div. 1, Groups A, B, C, and D. T6. 4X <b>CSA IS:</b> Intrinsically Safe for Class I, Div. 1, Groups A, B, C, and D Class 1, Zone 0, Ex ia IIC. T5. <b>CSA Non-Incendive:</b> Non-Incendive for Class I, Div. 2, Groups A, B, C, and D. T5. <b>ATEX Flameproof:</b> II 1/2 G D EEx d IIC T6. <b>ATEX IS:</b> II 1 G D EEx ia IIC T5.</p>
<b>Hazardous location certification, Rosemount 2160</b>	<p><b>FM IS:</b> 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 <b>CSA IS:</b> Intrinsically Safe for Class I, Div. 1, Groups A, B, C, and D. T3C. 4X/IP66. <b>ATEX IS:</b> II 1 G Ex ia IIC T5-T2. IP66. <b>IECEx:</b> Ex ia IIC T5-T2. IP66.</p>
<b>Safety/overflow, Rosemount 2120</b>	<p><b>Overflow protection:</b> Rosemount 2120 can be ordered with DIBt/WHG <b>SIL Declaration of Conformity:</b> 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</p>
<b>CE-mark</b>	93/68/EEC: complies with applicable directives (EMC, ATEX, LVD, and R&TTE)

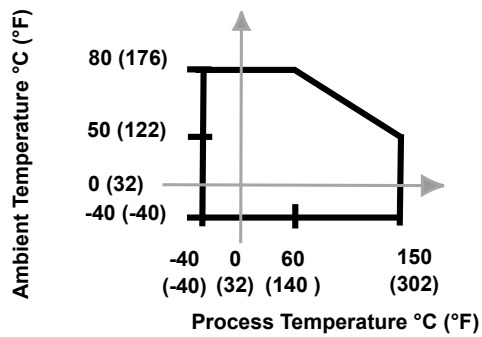
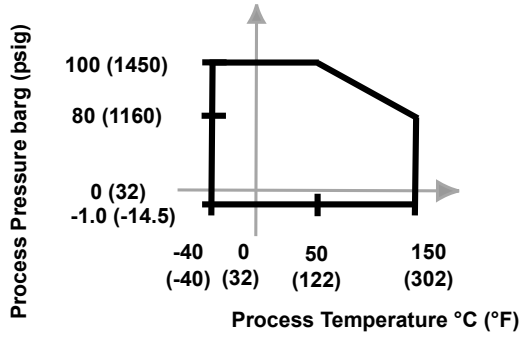
Electric	
<b>Electric connection/Alarm indication and Power supply for Rosemount 2120</b>	<p><b>Direct Load Switching (two-wire):</b>  <math>U=20</math> to 264 VAC (50/60 Hz) or 20 to 60 VDC. <math>I_{OFF} &lt; 3</math> mA, <math>I_L=20</math>-500 mA.  Rosemount 2120 is connected in series with a load to achieve direct load switching.</p> <p><b>Solid state PNP output for direct interface to PLC's (3-wire):</b>  <math>U=20</math> to 60 VDC. <math>I_{L(max)}=0</math>-500 mA.</p> <p><b>SPCO single relay for voltage free contacts:</b>  In: <math>U=20</math> to 264 VAC (50/60 Hz), <math>I &lt; 6</math> mA.  Out: <math>U_{max}=250</math> VAC, <math>I_{max}=5</math> A, <math>P_{max}=1250</math> VA, resistive, 1000 VA, inductive.  <math>U_{max}=60</math> VDC, <math>I_{max}=5</math> A if <math>U &lt; 30</math> VDC, <math>I_{max}=1.5</math> A if <math>U &lt; 60</math> VDC.</p> <p><b>Intrinsically Safe (IS) NAMUR, DIN 19234, IEC 60947-5-6:</b>  <math>I_{ON} = 2.2</math> to 2.5 mA, <math>I_{OFF} = 0.8</math> to 1.0 mA</p> <p>Rosemount 2120 is polarity insensitive and has over-current, short-circuit and load-missing protection. Surge protection according to IEC61326.</p>
<b>Power supply Rosemount 2160 &amp; Alarm indication</b>	<p>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</p>
Mechanical	
<b>Fork length</b>	50 mm (2 in.) to 3 m (118 in.)
<b>Housing</b>	Rosemount 2120: Glass Filled Nylon or Aluminum Rosemount 2160: Aluminum
<b>Conduit entry</b>	Two cable / conduit entries, M20, 1/2-in. or 3/4-in. NPT
<b>Terminal connection</b>	Wire diameter maximum 2.5 mm <sup>2</sup> (0.1 in <sup>2</sup> ). National regulations
<b>Process connection</b>	<p><b>Threaded</b></p> <ul style="list-style-type: none"> <li>• 3/4-in. BSP or NPT</li> <li>• 1-in. BSP or NPT</li> </ul> <p><b>Flanges</b></p> <ul style="list-style-type: none"> <li>• ANSI, 1.5-4 in. 150-300 lb</li> <li>• DIN (EN), DN 40-100, PN 10/16-25/40</li> </ul>
<b>Wetted material</b>	316L SST (EN 1.4404)
Environment	
<b>Process temperature</b>	-40 to 150 °C (-40 to 302 °F), depending on process pressure and ambient temperature
<b>Ambient temperature</b>	-40 to 80 °C (-40 to 176 °F)
<b>Process pressure</b>	-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)
<b>Ingress protection</b>	Ingress protection: IP 66/67 or Type 4X
<b>Vibration resistance</b>	EN60721 level 3M6/4M6
<b>Telecommunication (FCC and R&amp;TTE) for Rosemount 2160</b>	<p>Compliance with:</p> <ul style="list-style-type: none"> <li>• <b>FCC</b> 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.</li> <li>• <b>R&amp;TTE</b> (EU directive 1999/5/EC)</li> <li>• <b>IC</b></li> </ul>
<b>Electromagnetic compatibility</b>	Rosemount 2120: EN61326 Emissions to Class B. Rosemount 2160: EMC directive 2004/108/EC, and EN61326-1:2006
<b>Pressure Equipment Directive (PED)</b>	97/23/EC

# Technical Description

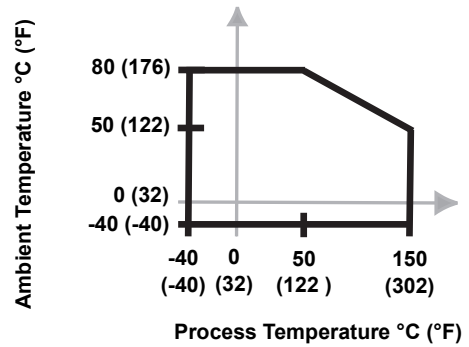
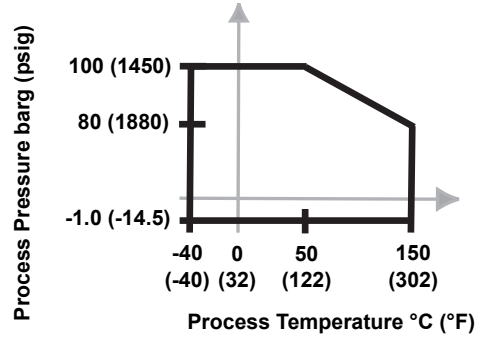
704010EN, Rev BA  
March 2011

Raptor System

## 15.5.1 Temperature and Pressure Diagrams for Rosemount 2120



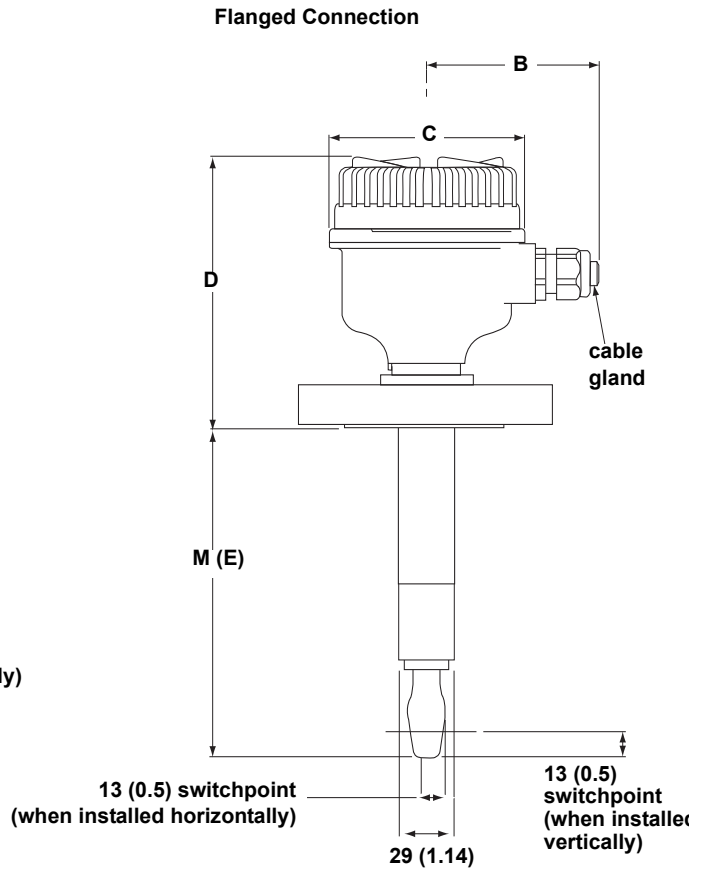
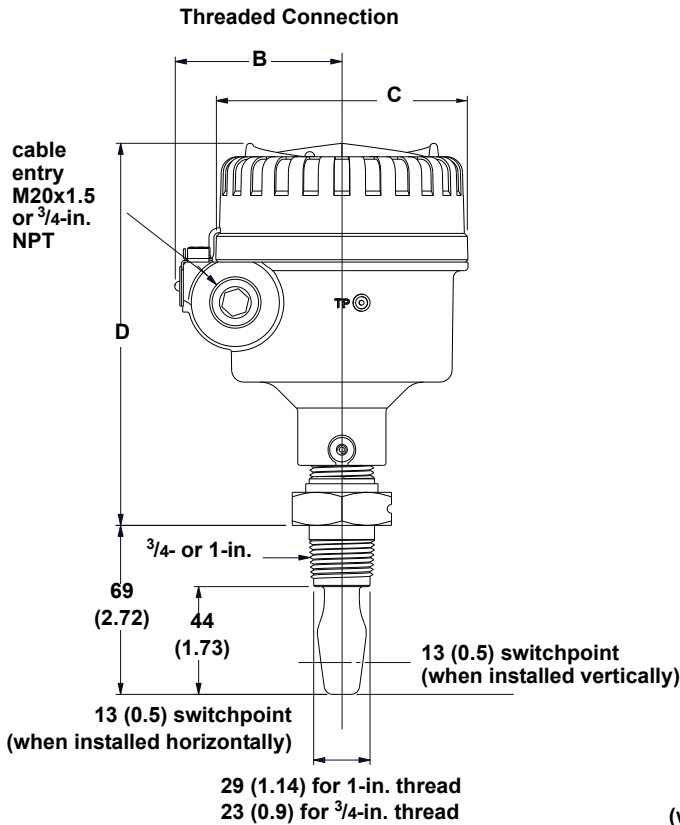
## 15.5.2 Temperature and Pressure Diagrams for Rosemount 2160



15.6 DIMENSIONAL DRAWINGS

Dimensions are in mm (in.)

15.6.1 Rosemount 2120



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 <sup>(1)</sup>
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.



# Technical Description

704010EN, Rev BA

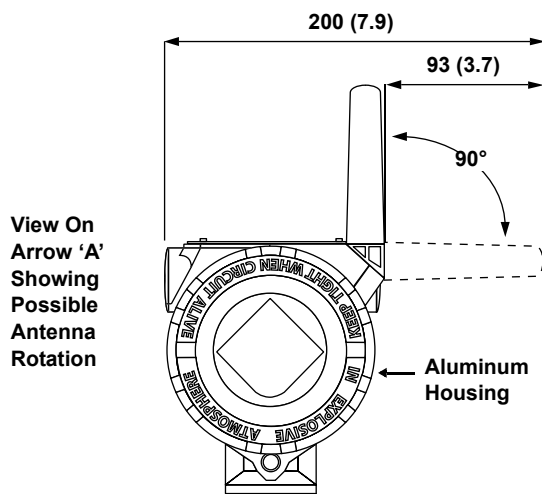
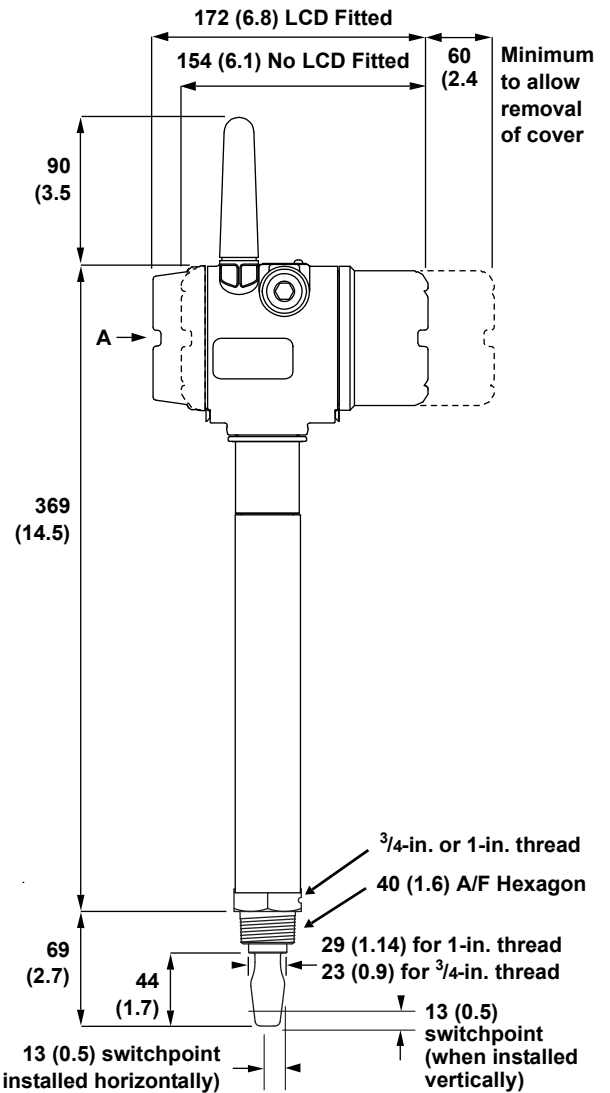
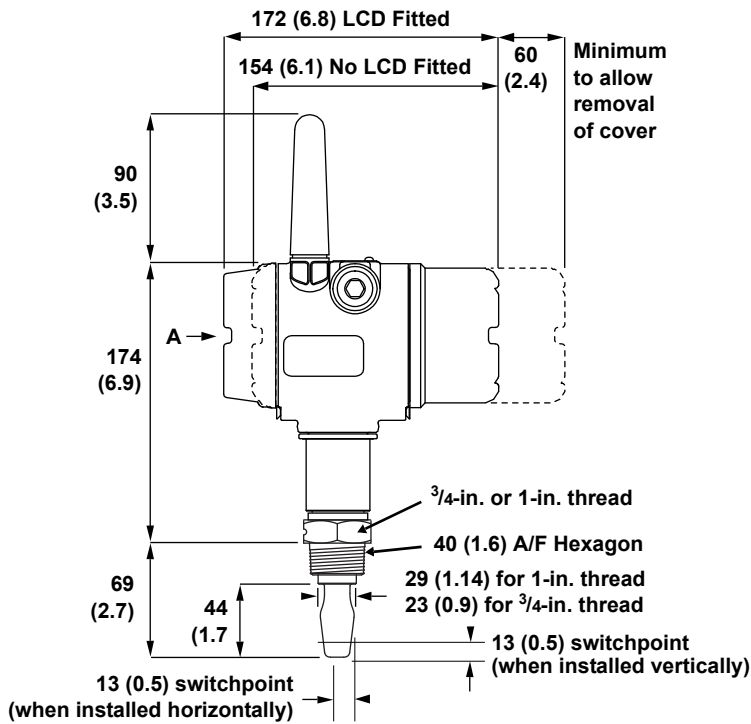
March 2011

Raptor System

## 15.6.2 Rosemount 2160

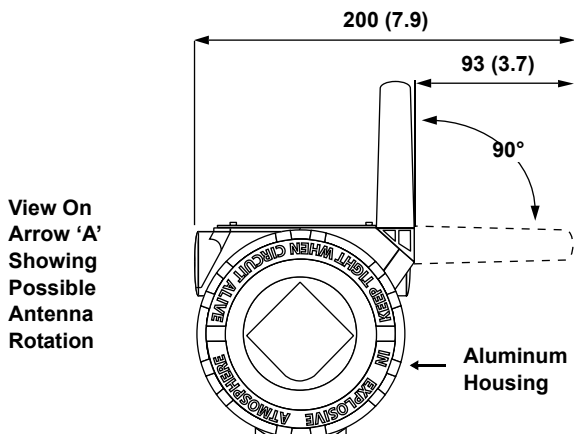
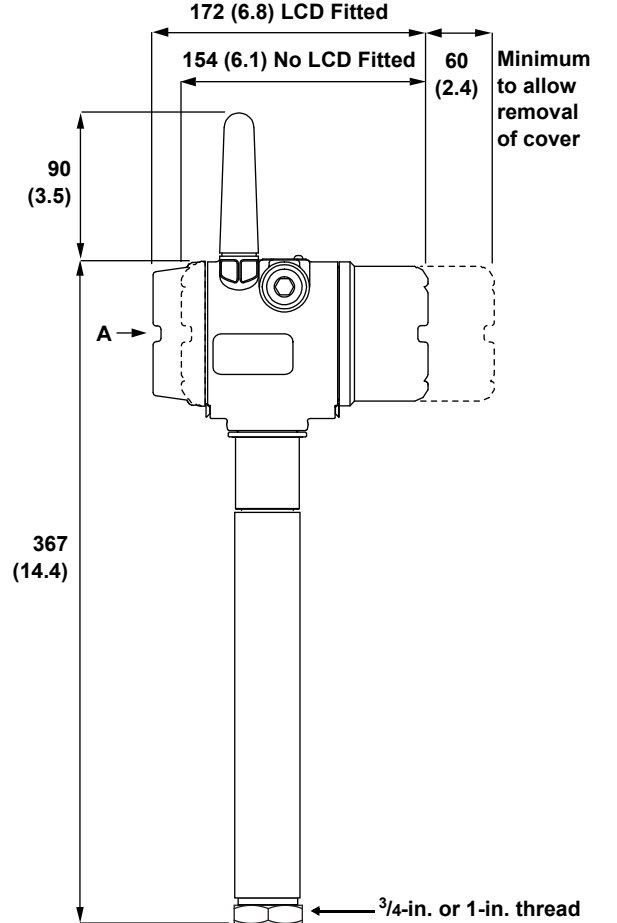
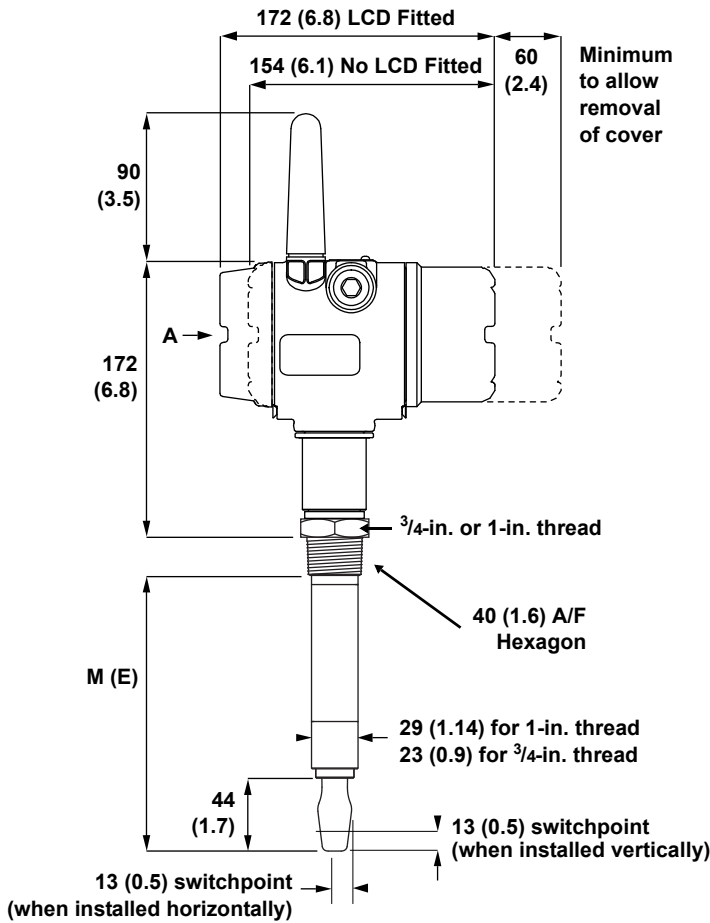
Dimensions are in mm (in.)

### 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)

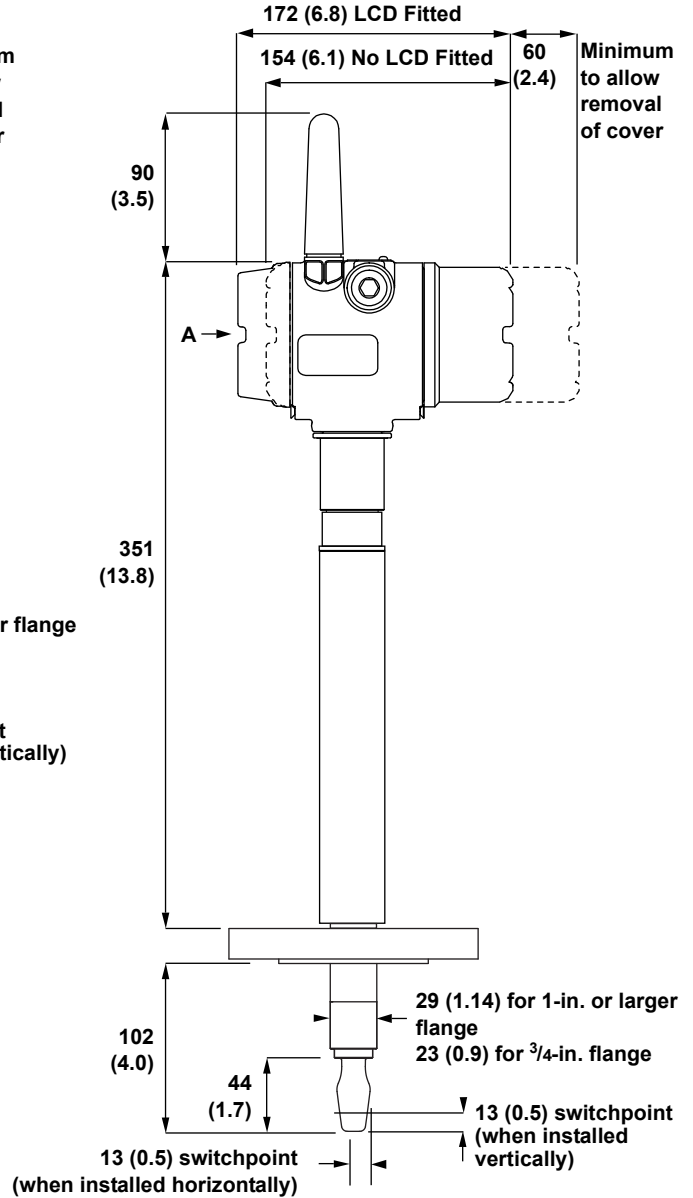
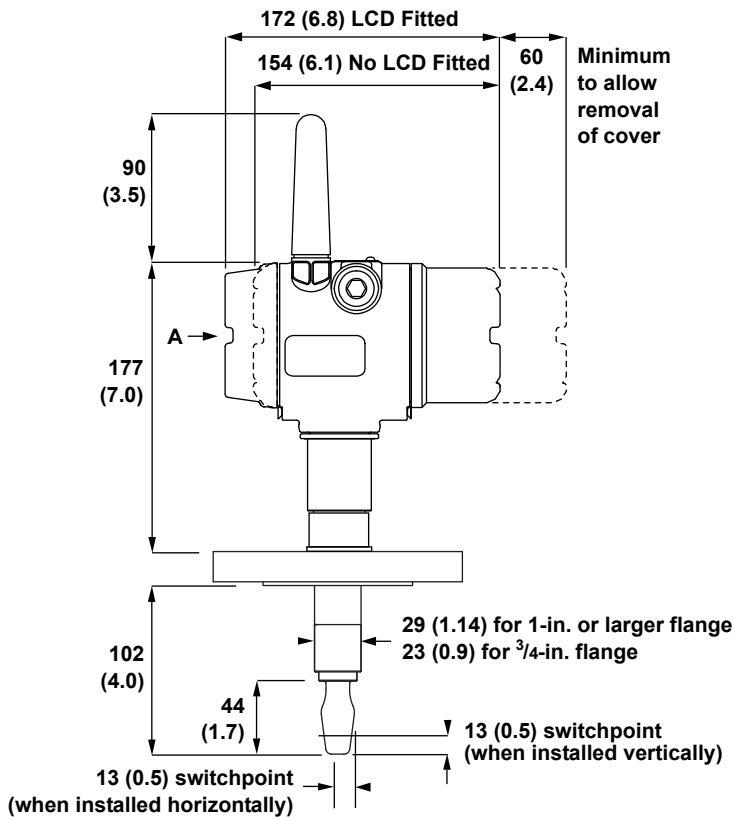
# Technical Description

704010EN, Rev BA  
 March 2011

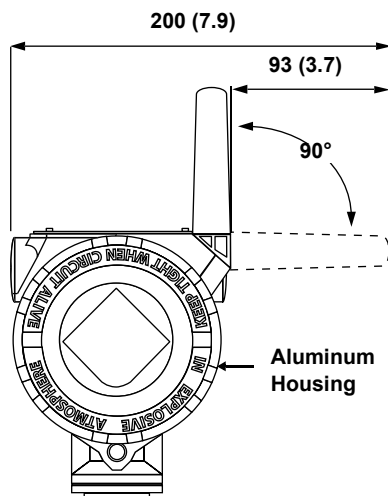
Raptor System

## Flanged Connection, Standard Length

Dimensions are in mm (in.)

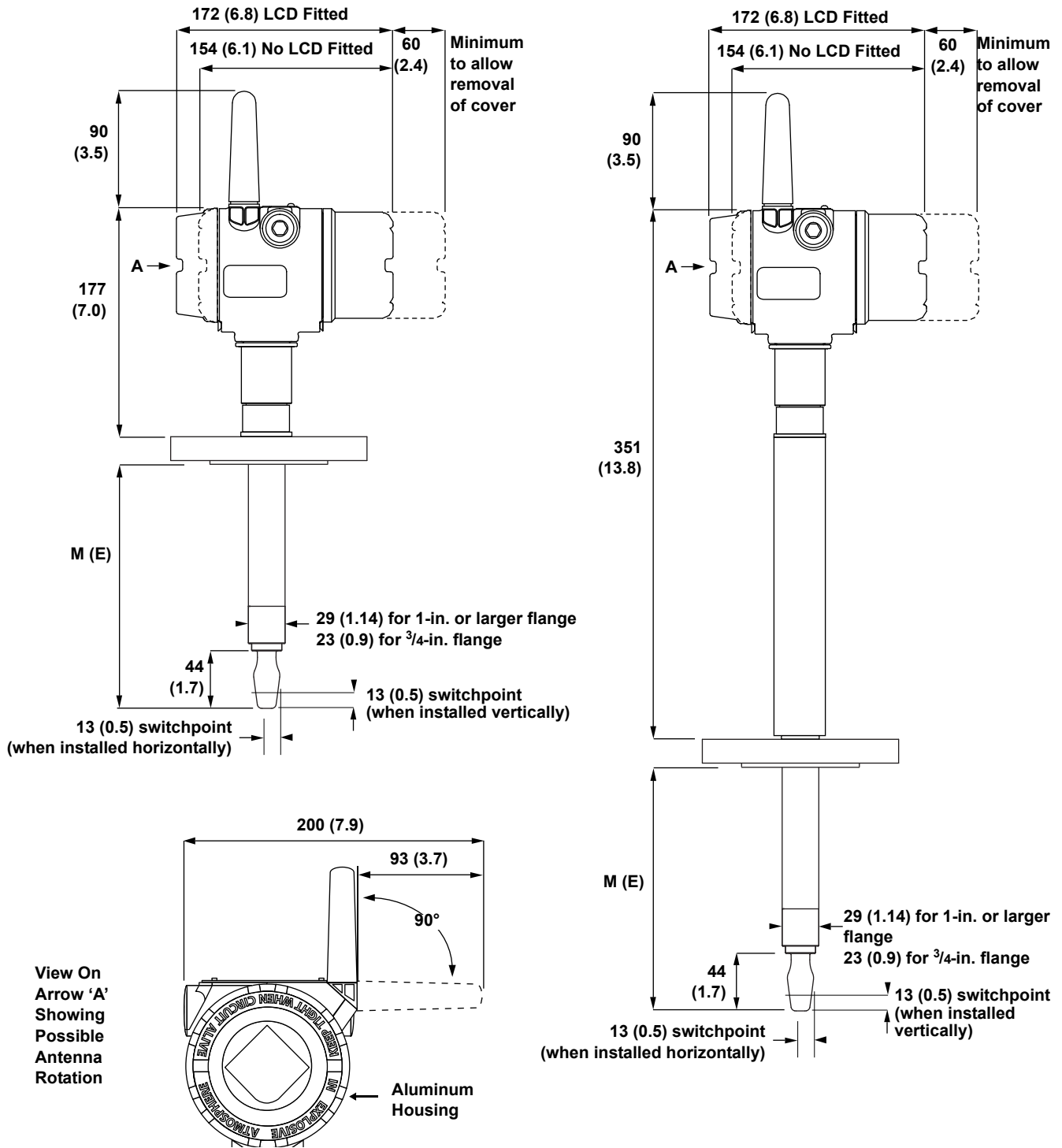


View On Arrow 'A' Showing Possible Antenna Rotation



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)

## Technical Description

704010EN, Rev BA

March 2011

Raptor System

### 15.7 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.

#### 15.7.1 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	
<b>Threaded</b>		
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	
<b>ANSI Flanges</b>		
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	
<b>DIN (EN) Flanges</b>		
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) <sup>(1)</sup>	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 <sup>(2)</sup>	All	
MXXXX	Extended, customer specified length in millimeters <sup>(2)</sup>	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 <sup>(3)</sup>		
Special Procedures			
P1	Hydrostatic testing <sup>(4)</sup>		
Overfill			
U1	DIBt/WHG overfill protection		
Model Code Example: 2120 - D 0A C 1 I1 Y A - Q8			

- (1) Rosemount 2120 IS Namur Vibrating Fork Level Sensor models 2120\*\*\*C\*!\*\*\* 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 than 1500 mm (59.1 in.) extended lengths.

## Technical Description

704010EN, Rev BA

March 2011

Raptor System

### 15.7.2 Rosemount 2160

Model (Pos 1)	Product Description	
2160	WirelessHART 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 <sup>(1)</sup>	All
MXXXX	Extended, customer specified length in millimeters <sup>(1)</sup>	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 (WirelessHART)	
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 <sup>(2)</sup>	
Special Procedures		
P1	Hydrostatic testing <sup>(3)</sup>	
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.

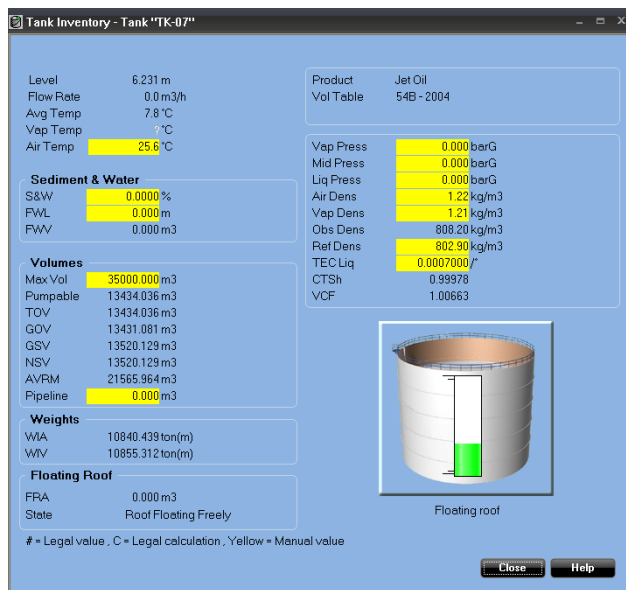
(2) Only available for wetted parts.

(3) Option limited to units of no more than 1500 mm. (59.1 in) extended lengths.



# 16 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.

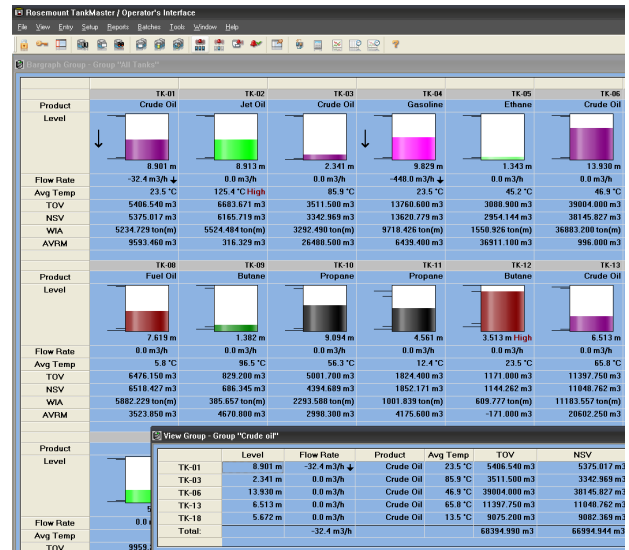


TankMaster gives the most important inventory data for a specific tank in one easy-to-read window.

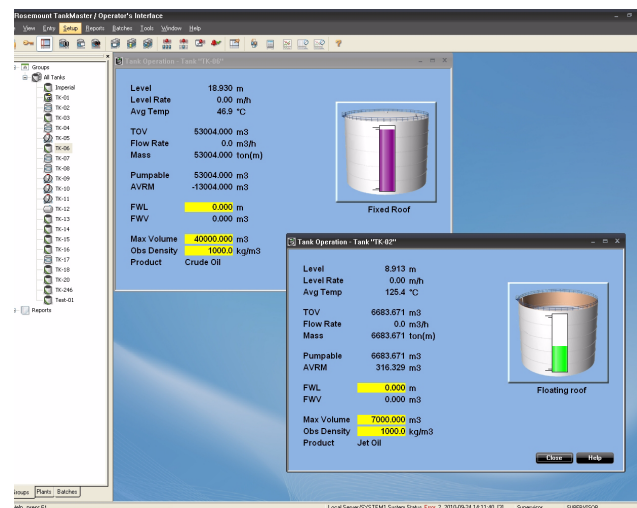
TankMaster comes in two versions:

- 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.



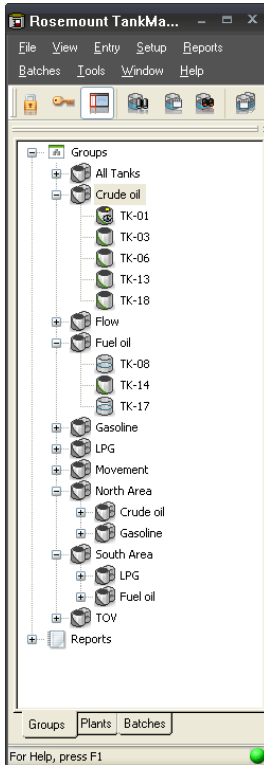
In TankMaster you can for example choose to see inventory data in a bargraph group, giving a quick overview of tank farm activities.



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.

## 16.1 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 <sup>(1)</sup>
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 <sup>(2)</sup>
Reference density	Yes	No
Mass calculations	Yes	Yes <sup>(3)</sup>

(1) Possibility to edit existing group (“All tanks”).

(2) Manually entered.

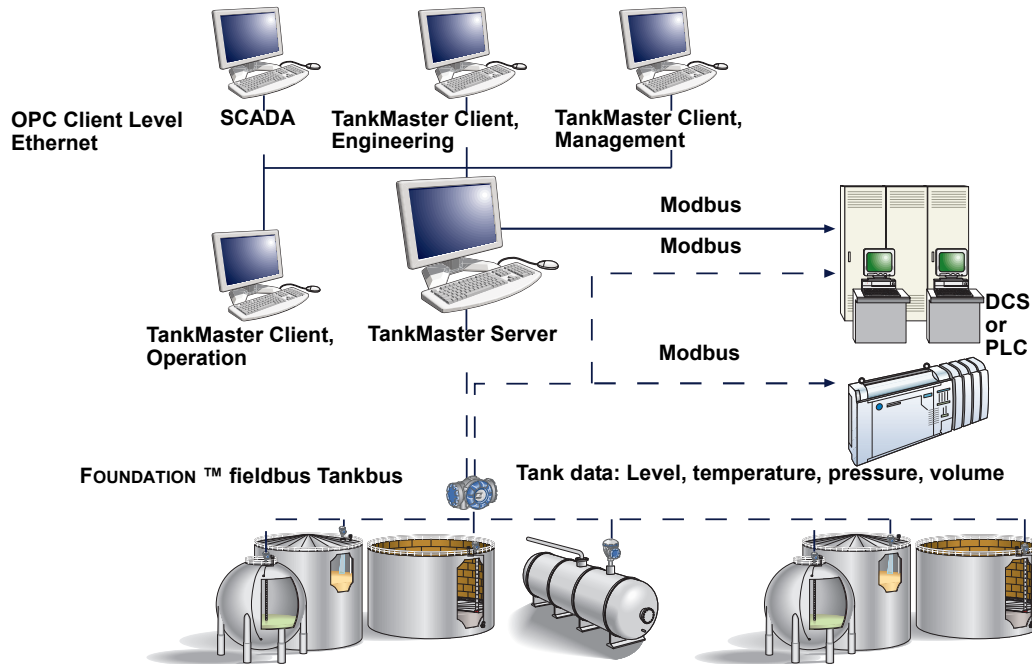
(3) Limited

### 16.2 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

### 16.3 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.

## 16.4 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

## 16.5 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 or by sound. Such alarms are based on net volume and/or level

## 16.6 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

## 16.7 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.

## 16.8 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).

## 16.9 SPECIFICATION

### 16.9.1 Rosemount TankMaster WinOpi, WinSetup and WinView

General	
<b>Product</b>	Rosemount TankMaster (WinOpi, WinSetup, WinView)
<b>Operating system requirements</b>	English version of any of the following: <ul style="list-style-type: none"> <li>• Windows XP professional edition. Service pack: SP 2 or SP 3</li> <li>• Windows Vista with service pack 1 (SP 1)</li> <li>• Windows 7 (32-bit)<sup>(1)</sup></li> <li>• Windows 2003 Server with service pack 2 (SP 2)</li> </ul>
Required TankMaster PC hardware	
<b>Processor</b>	Windows XP: 2 GHz multi-core processor Windows Vista / Windows 7 / Windows 2003 Server: 2.5 GHz, multi-core processor
<b>RAM memory</b>	Windows XP: 1 GB for client PCs, and 2 GB for server PCs Windows Vista / Windows 7 / Windows 2003 Server: 3 GB
<b>Disk drive</b>	40 GB (TankMaster combined with SQL Server 2005 Express, needs approximately 600 MB)
<b>Graphics card</b>	1152*864 pixels, 65536 colors (16 bit)
<b>Serial port</b>	RS232, or USB if FBM 2180 is used (see "Rosemount 2180 Field Bus Modem" on page 106)
<b>Hardware key</b>	The server needs one USB port for the hardware key. If TankMaster is ordered with custody transfer functions, a parallel port is also required

*(1) Should not be used for a redundant TankMaster system.*

### 16.9.2 Rosemount TankMaster.net

General	
<b>Product</b>	Rosemount TankMaster.net
<b>Operating system requirements</b>	English version of Windows XP professional edition (SP 2), Windows 2000 server and Windows 2003 Server, with IIS, are recommended for TankMaster.net servers
Server PC hardware requirements	
<b>Processor</b>	1.8 GHz (single processor) or better
<b>RAM memory</b>	256 MB (1024 MB recommended)
<b>Disk drive</b>	20 GB
<b>Graphics card</b>	1152*864 pixels, 65536 colors (16 bit)
<b>Bandwidth to each TankMaster PC</b>	20 kbps for each connected tank
<b>Internet bandwidth</b>	64 kbps (256 kbps recommended)
Client PC hardware requirements	
<b>Processor</b>	1.3 GHz (single processor) or better
<b>RAM memory</b>	256 MB (1024 MB recommended)
<b>Disk drive</b>	20 GB
<b>Graphics card</b>	1152*864 pixels, 65536 colors (16 bit)
<b>Network connection</b>	LAN or internet
<b>Internet bandwidth</b>	64 kbps (256 kbps recommended)
Required TankMaster.net client Palm or phone hardware	
<b>Network connection</b>	WAP 2.0, internet connectivity

## 16.10 ORDERING INFORMATION

### NOTE

TankMaster WinOpi, WinView, and WinSetup are always delivered with a USB dongle.

### 16.10.1 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 <sup>(1)</sup>	
20	TankMaster WinOpi, with TankServer for up to 20 tanks <sup>(1)</sup>	
50	TankMaster WinOpi, with TankServer for up to 50 tanks <sup>(1)</sup>	
MX	TankMaster WinOpi Max <sup>(1)</sup>	Unlimited number of tanks.
V2	TankMaster WinView, with TankServer for up to 20 tanks <sup>(2)</sup>	
V5	TankMaster WinView, with TankServer for up to 50 tanks <sup>(2)</sup>	
WS	TankMaster WinSetup <sup>(3)</sup>	Configuration only.
Code (Pos 3)	Host Communication	
0	None	
C	TankMaster communication module <sup>(4)</sup>	
S	TankMaster communication module with office link <sup>(4) (5)</sup>	
Code (Pos 4)	Network	
0	None	
1	One TankMaster client can connect and read data <sup>(6)</sup>	
2	Two TankMaster client can connect and read data <sup>(6)</sup>	
3	Three TankMaster client can connect and read data <sup>(6)</sup>	
4	Four TankMaster client can connect and read data <sup>(6)</sup>	
5	Five TankMaster client can connect and read data <sup>(6)</sup>	
6	Six TankMaster client can connect and read data <sup>(6)</sup>	
7	Seven TankMaster client can connect and read data <sup>(6)</sup>	
X	Specify number of clients <sup>(6)</sup>	

## Technical Description

704010EN, Rev BA

March 2011

Raptor System

Code (Pos 5)	Custody Transfer
0	None
C	TankMaster custody transfer functions <sup>(7)</sup>
P	TankMaster custody transfer functions PTB Eich <sup>(8)</sup>
Code (Pos 6)	Batch Handling
0	Default batch functions
B	Extended batch functions <sup>(9)</sup>
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 <sup>(10)</sup>
<b>Model Code Example: TM - 20 S N C C P C RT</b>	

(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).

### 16.10.2 TankMaster.net Software

Model (Pos 1)	Product Description
RTM39EL	Rosemount TankMaster.net <sup>(1)</sup> , Single Licence (one user)
RTM39EM	Rosemount TankMaster.net <sup>(1)</sup> , Limited Licence (up to 3 users)
RTM39ES	Rosemount TankMaster.net <sup>(1)</sup> , 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 22 for more guidance.

Tank and Application	Recommended	Second Choice	Third Choice
<b>Fixed Roof Tanks</b>			
<b>18 in. or larger nozzle, no disturbing objects in tank</b>	5900S, with parabolic antenna	5402, with 4-in. cone antenna	5301, with flexible twin <sup>(1)</sup> /single lead probe
<b>8 in. to 17 in. nozzle, no disturbing objects in tank</b>	5900S, with horn antenna	5402, with 4-in. cone antenna	5301, with flexible twin <sup>(1)</sup> /single <sup>(2)</sup> lead probe
<b>4-8 in. nozzle, no disturbing objects in tank</b>	5402, with 4-in. cone antenna	5301, with flexible single lead probe	Not applicable
<b>2-3 in. nozzle, no disturbing objects in tank</b>	5301, with flexible single lead probe	5402, with 2- or 3-in. cone antenna	Not applicable
<b>Objects in tank</b>	5900S, with parabolic antenna	5301, with coaxial <sup>(1)(3)</sup> , flexible twin <sup>(1)</sup> or single lead probe	5402, with cone antenna
<b>5-12 in. still-pipe</b>	5900S, with still-pipe array antenna	5301, with flexible single lead probe and a centering disk	Not applicable
<b>2-4 in. still-pipe measurement</b>	5402, with cone antenna (2, 3, or 4 in.)	5301, with flexible single lead probe and centering disks <sup>(4)</sup> for 3 or 4-in. still-pipes	Not applicable
<b>Floating Roof Tanks</b>			
<b>5-12 in. still-pipe</b>	5900S, with still-pipe array antenna	5301, with flexible single lead probe and a centering disk	Not applicable
<b>Measurement towards tank roof</b>	5900S, with parabolic antenna	5402, with 4-in. cone antenna	Not applicable
<b>Bullet/Sphere Shaped Tanks</b>			
<b>Pressurized LPG sphere, &gt; 6 m (20 ft)</b>	5900S, with LPG/LNG antenna	5301, with flexible twin lead probe <sup>(1)</sup>	5301, with flexible single lead probe
<b>Pressurized LPG bullet, &lt; 6 m (20 ft)</b>	5900S, with LPG/LNG antenna	5301, with coaxial probe <sup>(1)(3)</sup>	5301 with flexible twin <sup>(1)</sup> or single lead probe
<b>Other bullet tanks (e.g. additive tanks) &lt; 6 m (20 ft)</b>	5900S, with LPG/LNG antenna	5301, with coaxial <sup>(1)(3)</sup> , flexible twin <sup>(1)</sup> or single lead probe	5402, with 4 in. cone antenna
<b>Water Interface Measurement</b>			
<b>Upper Liquid Level + Interface Level</b>	5900S, and a 765 water level sensor <sup>(5)</sup>	5302, with flexible twin lead <sup>(1)(6)</sup> or coaxial <sup>(1)(3)</sup> probe	5302 with flexible single lead probe <sup>(7)</sup>

(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 < 500 mm (1.6 ft). See “Rosemount 765 Water Level Sensor Integrated with Multiple Spot Temperature Sensor” on page 57.

(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.



## Technical Description

704010En, Rev BA  
March 2011

Raptor System

---

Copyright © March 2011  
by Rosemount Tank Radar AB, Sweden.  
Ref. no. 704010En. Rev BA

Technical data is subject to change without prior notice. Rosemount Tank Radar AB accepts no responsibility for any errors that may appear in this description.

The Emerson logo is a trademark and service mark of Emerson Electric Co.  
Rosemount and the Rosemount logotype are either registered trademarks or trademarks of Rosemount Inc.  
PlantWeb is either a registered trademark or a trademark of one of the Emerson Process Management group of companies.

AMS Suite is a trademark of Emerson Process Management.

DeltaV is a trademark of Emerson Process Management group of companies.

FOUNDATION is a trademark of the Fieldbus Foundation.

HART is either a registered trademark or a trademark of the HART Communication Foundation.

Viton, and Kalrez are either registered trademarks or trademarks of Du Pont Performance Elastomers.

Eurofast and Minifast are either registered trademarks or trademarks of Turck Inc.

Microsoft, and Windows are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

Allen-Bradley, Bailey, DEC, Enraf, Fisher, Foxboro, GPE, Honeywell, IBM, L&J, Profibus, Rosemount, TankRadar, Siemens, Tiway, Varec, Vega, Whessoe, and Yokogawa are either registered trademarks or trademarks of these organizations and companies.

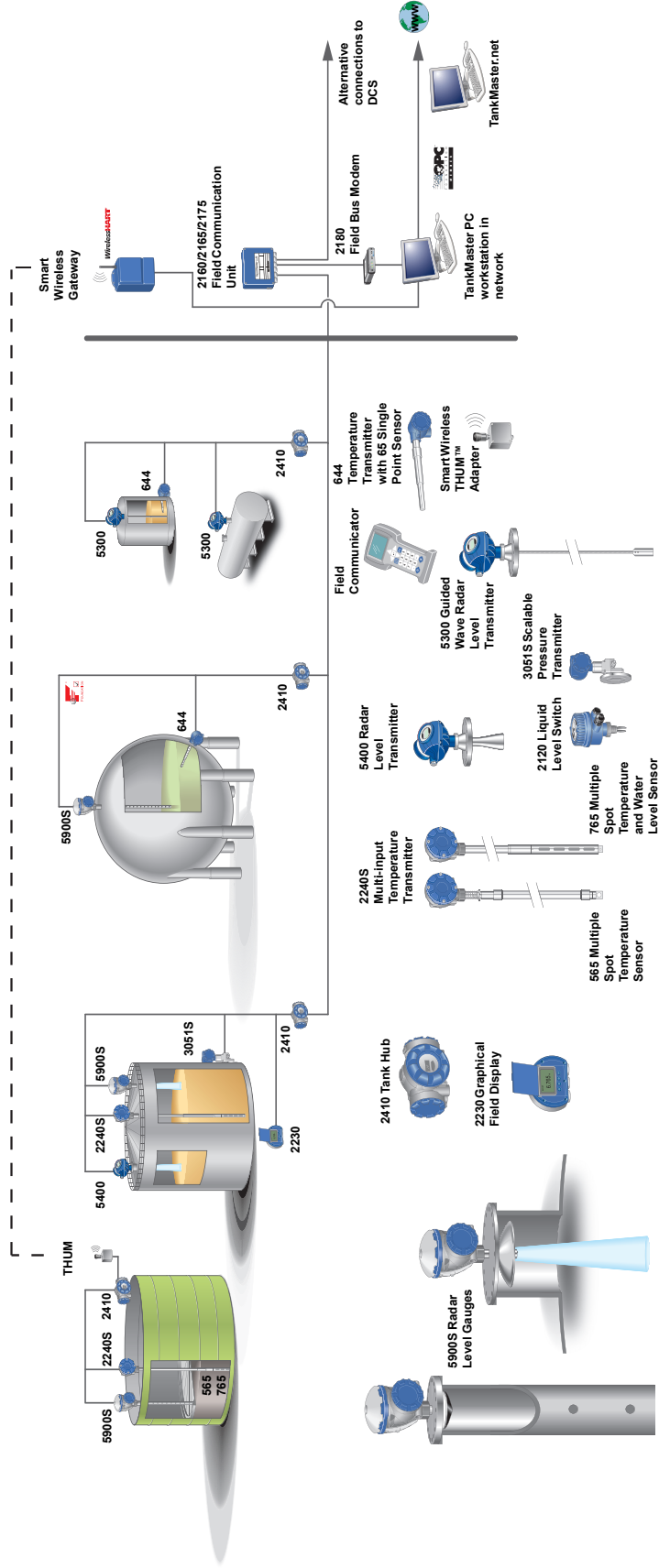
All other marks are the property of their respective owners.

## 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)
- Rosemount Raptor Installation Drawings



# Raptor Tank Gauging System



## Technical Description

704010EN, Rev BA

March 2011

Raptor System

---

### Emerson Process Management Rosemount Tank Gauging

Box 130 45

SE-402 51 Göteborg

SWEDEN

Tel (International): +46 31 337 00 00

Fax (International): +46 31 25 30 22

E-mail: [sales.srt@emersonprocess.com](mailto:sales.srt@emersonprocess.com)

[www.rosemount-tg.com](http://www.rosemount-tg.com)

