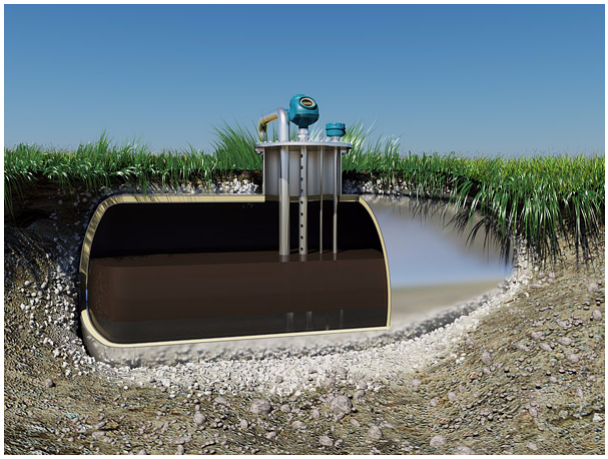
Technical Note
00840-2600-4811, Rev BA
April 2009

Guided Wave Radar Application Guidelines

INTRODUCTION

This document is a guideline for Guided Wave Radar (GWR) applications. Besides providing information on application advantages, product features, different types of applications, and probe styles, it also compares the 5300 and 3300 Series GWRs to assist with radar device selection for optimal performance.



Example of a GWR application.

APPLICATION ADVANTAGES OF GUIDED WAVE RADAR

Advantages of Guided Wave Radar compared to other level technologies include:

- Measures level directly, and is not impacted by density, dielectrics, or conductivity changes
- Measures through heavy vapors
- Handles turbulent and low dielectric fluids
- Can measure through most foams
- Measures interface applications
- Measures solids, powders, and granules
- Measures in small tanks, geometrically difficult tanks, and long nozzles
- Has no moving parts
- Displacer and capacitance are easily replaced

ROSEMOUNT GUIDED WAVE RADAR PRODUCT FEATURES

There are two Guided Wave Radar products offered by Rosemount: the 3300 and the 5300.

Common Features

The Rosemount 3300 and Rosemount 5300 are multivariable and can measure both level and interface, with a dual compartment head to protect electronics from moisture. The electronics housing can be rotated 360° and separated from an installed probe without opening the tank. Both provide application flexibility and are available with a full range of probe styles to meet application requirements. The configuration tools have installation wizards with waveform plots to provide easy and powerful configuration and service.

Rosemount 5300 Features

The Rosemount 5300 has Direct Switch Technology and Probe End Projection to provide long measuring ranges and reliable measurements on low dielectric media, even with a single probe. The Rosemount 5300 offers accuracy of ±3 mm with advanced timing method, increased plant availability with Advanced PlantWeb® functionality, and improved electromagnetic performance from a smart galvanic interface. The 5300 series products are available with 4–20 mA analog/HART or FOUNDATION™ fieldbus output.

Rosemount 3300 and 5300 Series

Rosemount 3300 Features

The Rosemount 3300 has proven reliability, is versatile and easy to use. It is available with 4–20 mA analog/HART or Modbus® output.

APPLICATIONS

Most industrial level measurements

- Easy upgrade (existing and small openings can be used)
- Few application rules
- Wide range of probe styles

Liquified gases

Guided Wave Radar can handle heavy vapors, and it works well in low dielectric, turbulent applications.

Solid applications

- It is virtually unaffected by dust, moisture, density changes, and temperature
- The shape of the material cone is not critical

Replacement of displacer

Guided Wave Radar is an ideal, low maintenance replacement for displacers, because it has no moving parts and is unaffected by density changes. The use of a single lead probe further ensures minimal maintenance since it is more tolerant of material coating. Guided Wave Radar is available with flanges that can match the proprietary cage flanges or major displacer manufacturers. A robust high pressure and temperature probe solution is also available for these installations.

Replacement of capacitance probes

Guided Wave Radar is an excellent replacement for capacitance probes since it requires no calibration and can handle heavy coating. It has a long-lasting microwave electronics that provides extended lifetime compared to capacitance probes.

Level and interface measurements

The cost for wiring and installation is reduced because there is one tank penetration and a single pair of wires. There are some basic conditions which must be met in interface measurements:

- The lower dielectric fluid must be on top
- The two liquids must have a dielectric difference of at least 6
- The upper layer dielectric must be known (in-field determination is possible)

- For the interface to be detectable, the upper fluid layer thickness must be at least 4 in. (10 cm) for 3300 rigid probes, and 8 in. (20 cm) for 3300 flexible probes. The HTHP coaxial probes' minimum upper layer thickness is 8 in. (20 cm) for both the 3300 and 5300; for the 5300 with all other probes it is 5 in. (12.5 cm)
- The maximum thickness of the upper layer depends on the dielectric, probe type and transmitter
- Target applications: low upper layer dielectric (< 3), high lower layer dielectric (>20)

TABLE 1. Sample of Guided Wave Radar Applications in Different Industries

Oil & Gas	Refining	Petrochemical	Chemical	Power (and plant utilities)	Food & Beverage (non-hygienic)	Pulp & Paper
Anhydrous Ammonia	Distillation Towers	Distillation towers	Ammonia	Condenser	Corn	White Water
Cement	Accumulators/ Feed Tanks	Olefin as propylene	Freon	Derators	Flour	Lignin
Drilling Rig Mud Pits	Separators/ Settlers/ Knockout Drums	Decanters/ Separators	Liquid Chlorine	Feedwater heaters	Wheat	Starch
Water & Fuel Storage	Liquified Gas as Propane	VCM	Carbon black	Scrubbers	Soy Beans	Chemical tanks
Chemical Tanks	Intermediate/ Buffer Tanks	Plastics	Urea	Cooling Tower Basins	Vegetable oils	Small oil tanks
Condensate Oil & Water Tanks	Ammonia	LNG	Hexane	Waste Water Sumps	Soy flakes	Turpentine & water interface
Separators	Gas & Water		Methanol	Chemical Storage	Liquid CO_2	Ammonia
Oil &Water Skim Tanks	Desalters		Ethanol	Coal	Propylene glycol	Calcium Carbonate
Flare Knock Out Tanks	Compressors		Toluene	Lime	Hexane	Resin
Accumulators/ Feed Tanks	Seal Pots		Benzene	Fly Ash	Starch	
Liquified Gas as Natural Gas	Sumps		MEK	Fuel Oil	Acids	
	Small Storage Tanks		Methyl alcohol		Glycerin	
			Interface solvents and water		Biodiesel	
			Calcium Carbonate		Soda Ash	
			Urea powder		Ethanol	

COMPARE AND SELECT ROSEMOUNT GUIDED WAVE RADARS

The Rosemount 5300 can be used for the same applications as the Rosemount 3300, plus in applications with longer ranges, lower dielectrics, or where Fieldbus is needed. The application conditions described below are where the 5300 is the right choice.

Low Dielectrics with Single Probe

Both level and interface measurements can be handled with a single lead probe in sticky fluids (e.g. crude oil, waxy oil), which would leave deposits on twin lead spacers.

Extended Measurement Range

High dielectric materials, such as water based liquids, solids, ammonia, in vessels up to 50 m (165 ft).

Low dielectric (≤ 1.4) materials, such as liquified gas, oil and solids, in vessels up to 25 m (82.5 ft).

FOUNDATION™ fieldbus

The Rosemount 5300 is available with FOUNDATION™ fieldbus.

TABLE 2. Compare and Select Rosemount Guided Wave Radars

	 **Rosemount 5300 Series - Superior Performance & Functionality**	 **Rosemount 3300 Series - Versatile and Easy-to-Use**
Reference Accuracy	± 3 mm, and improved ambient temperature effect	± 5 mm
Max/Min Temperature / Pressure	-320 (-196) to 752 (400) °F (°C) / -14 (-1) to 5000 (345) psig (bar)	- 76 (-60) to 752 (400) °F (°C) / -14 (-1) to 5000 (345) psig (bar)
Communications	HART®, FOUNDATION Fieldbus	HART®, Modbus®
Customized Configuration Tools	RadarMaster, AMS, Delta V and other FF hosts, 375	Radar Configuration Tools, AMS, 375
Enhanced EDDL (HART)	Yes	Not Available
SIL 2	Suitable	No
Direct Switch Technology	Yes patented! Provides 2-5 times stronger signal than any other GWR	No
Maximum Measuring Range	164 ft. (50 m) for DC 6	77 ft. (23.5 m) for DC 2.4 for twin and 7.5 for single
Lowest Dielectric Constant (DC)	1.2 with coaxial probe 1.4 with other probes twin up to 82 ft. (25 m) or single up to 49 ft. (15 m)	1.4 with coaxial probe 1.6 with twin probe up to 33 ft. (10 m) 2.5 with single probe up to 36 ft. (11 m)
Probe End Projection	Yes! Good for low DC and long ranges as plastics and boiling HC	No
Smart Galvanic Interface	Yes patented! Gives improved EMI performance, good for non-metallic tanks	No
Modular Design	Yes! All probes can be used with all electronics	Partly. All rigid probes for short range electronics and all flexible probes for long range electronics
Dynamic Vapor Compensation	Yes! Good for steam compensation in boilers.	No
Increased Diagnostic Capabilities	Yes including signal quality metrics, and advanced full tank detection	No
Upper Transition Zone	4.3 - 7.1 in (11 - 18 cm) depending on probe style and dielectric value	3.9 - 19.7 in. (10 - 50 cm) depending on probe style and dielectric value
Power Supply	16 - 30 Vdc for IS 20 - 42. 4 Vdc for Ex d	11 - 30 Vdc for IS 16 - 42 Vdc for Ex d
Applications	Even for the toughest applications, including long range and low DC storage with a single probe, and process vessels and control	Most liquid storage and monitoring applications

PROBE STYLES

Common Uses for Coaxial Probes

- Acts as a mini stilling well, isolating the probe from external conditions and obstacles
- In low dielectric and high turbulent applications
- Where foam requires isolation from liquid surface
- Where there is contact with a metallic object
- Where the probe may contact inlet fluid flow or internal tank structures

Avoid using with sticky, viscous, coating media and in submerged applications.

Common Uses for Twin Rigid and Flexible Probes

- Where top-of-foam measurement is desired
- If the coaxial probe cannot be used
- If guidelines recommend outside installation and/or if the dielectric is too low for a single probe

Avoid using with media that coats and where the probe may contact walls or obstacles.

Common Uses for Single Rigid and Flexible Probes

- Only option for powders and granules
- Can be used in sticky and viscous media
- Is the preferred choice for bypass chambers

Avoid using for 3300 interface applications with restrictive nozzles and where the probe may contact walls or obstacles.

Avoid using with restrictive nozzles or when the probe could come in contact with metallic objects in the vessel.

GUIDED WAVE RADAR PROBE SELECTION GUIDE

GD GOOD AD APPLICATION DEPENDENT NR NOT RECOMMENDED/RELEVANT

	Coaxial		Rigid Twin		Flexible Twin		Rigid Single		Flexible Single	
	3300	5300	3300	5300	3300	5300	3300	5300	3300	5300
Maximum length[1]	19'-8" (6m)	19'-8" (6m)	9'-10" (3m)	9'-10" (3m)	77'-1" (23.5m)	165' (50m)	9'-10" (3m)	9'-10" (3m)	77'-1" (23.5m)	165' (50m)
Minimum Dielectric Constant at Maximum Range	1.4[6]	1.2[7]	1.9	1.4	2.4	6[4]	2.5[5]	1.4	7.5	6[4]
Minimum Dielectric Constant	1.4[6]	1.2[7]	1.9	1.4	1.6	1.4	2.5[5]	1.4[8]	2.5	1.4
Measurements										
Level	GD	GD	GD	GD	GD	GD	GD	GD	GD	GD
Interface (liquid/liquid)	GD	GD	GD	GD	GD	GD	GD	GD	GD	GD
Process Medium Characteristics										
Changing Density	GD	GD	GD	GD	GD	GD	GD	GD	GD	GD
Changing Dielectric[2]	GD	GD	GD	GD	GD	GD	GD	GD	GD	GD
Wide pH Variations	GD	GD	GD	GD	GD	GD	GD	GD	GD	GD
Pressure Changes	GD	GD	GD	GD	GD	GD	GD	GD	GD	GD
Temperature Changes	GD	GD	GD	GD	GD	GD	GD	GD	GD	GD
Condensing Vapors	GD	GD	GD	GD	GD	GD	GD	GD	GD	GD
Bubbling/Boiling Surfaces	GD	GD	GD	GD	GD	GD	GD	GD	AD	AD
Foam (Mechanical Avoidance)	AD	AD	NR	NR	NR	NR	NR	NR	NR	NR
Foam (Measurement of Top of Foam)	NR	NR	AD	AD	AD	AD	AD	AD	AD	AD
Foam (Measurement of Foam & Liquid)	NR	NR	AD	AD	AD	AD	NR	AD	NR	AD
Clean Liquids	GD	GD	GD	GD	GD	GD	GD	GD	GD	GD
Materials with Very Low Dielectric	AD	GD	AD	GD	AD	GD	AD	GD	AD[18]	GD[18]
Coating, Sticky Liquids	NR	NR	NR	NR	NR	NR	AD	AD	AD	AD
Viscous Liquids	NR	NR	AD	AD	AD	AD	AD	AD	GD	GD
Crystallizing liquids	NR	NR	NR	NR	NR	NR	AD	AD	AD	AD
Solids, Granules, Powders[3]	NR	NR	NR	NR	NR	NR	AD	AD	AD	GD
Fibrous Liquids	NR	NR	NR	NR	NR	NR	GD	GD	GD	GD
Tank Environment Considerations										
Probes Will Be Close (<12in/30cm) to Tank Wall / Disturbing Object	GD	GD	GD	GD	GD	GD	AD	AD	AD	AD
Probe Might Touch Tank Wall or Disturbing Objects	GD	GD	NR	NR	NR	NR	NR	NR	NR	NR
Turbulence	GD	GD	GD	GD	AD	AD	GD	GD	AD	AD
Turbulent Conditions Causing Breaking Forces	NR	NR	NR	NR	AD	AD	NR	NR	AD	AD
Tall, Narrow Nozzles	GD	GD	AD	AD	AD	AD	NR	NR	NR	NR
Angled or Slanted Surfaces (Viscous or Solids Materials)	NR	NR	AD	AD	AD	AD	GD	GD	GD	GD
Liquid or Vapor Spray May Touch Probe Above Surface	GD	GD	NR	NR	NR	NR	NR	NR	NR	NR
Disturbing Electromagnetic Interference in Tank	GD	GD	AD	AD	AD	AD	NR	AD	NR	AD
Cleanability of Probe	NR	NR	AD	AD	AD	AD	GD	GD	GD	GD

1.) Overall distance of flexible probes is limited with low dielectric material

2.) For overall level applications, a changing dielectric has no affect on the measurements, for interference applications a changing dielectric in top fluid will degrade accuracy

3.) See Tech note 00803-0100-4811 (Guided Wave Radar for Solid Applications) and PDS 00813-0100-4530 for details

4.)Probe end projection may allow lower dielectric constant in longer ranges, Consult factory.

5.)1.7 if installing in metallic bypass for stilling well

6.) 1.6 for HP probe or 2.0 for HTHP probe

7.) 1.4 for HP probe or 2.0 for HTHP probe

8.) 1.25 if installed in bypass or stilling well

Rosemount 3300 and 5300 Series

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00840-2600-4811 Rev BA, 04/09

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