Guided Wave Radar in Solid Level Applications

KEY POINTS

- Measuring Range
- Tensile Strengths and Collapse Loads
- Mounting Considerations
- Installation in Non-Metallic Silos

Guided Wave Radar is a very reliable method for measuring solids since it is unaffected by moisture, dust, and material changes

OVERVIEW

Guided Wave Radar is a very reliable method for measuring solids, such as powders, granulates, or pellets with a grain size of up to 0.8 in. (20 mm). Materials include plastics, fly-ash, cement, sand, sugar, cereals, and many others. With the Rosemount 5300, measurements can be made even on fine powders in dusty environments and in silos without horizontal surfaces, where free-propagation radar transmitters may be unsuitable. The measured value is where the probe comes in contact with the material. Measurements are also independent of moisture, material fluctuations such as density and temperature. Even electrostatic discharges which can occur for plastics, cannot harm the 5303 transmitter.

MEASURING RANGE

For Rosemount 5303 with a flexible single lead probe, the maximum probe length is 164 ft. (50 m). The Rosemount 3301 with a flexible single lead probe, has a maximum probe length of 77 ft. (23.5 m).

The graph shows the maximum measuring range depending upon the dielectric constant of the product

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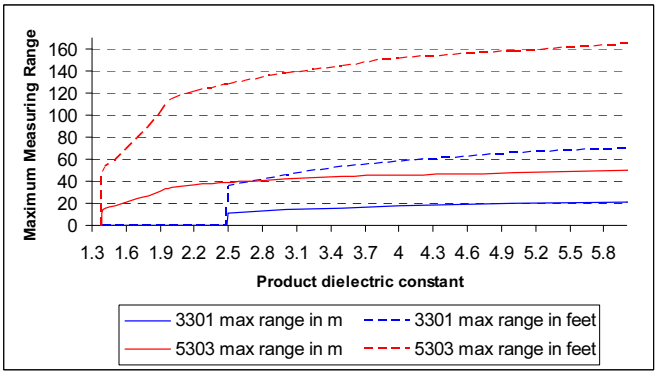

The graph shows the maximum measuring range depending on the dielectric constant of the product.

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Different parameters affect the echo and therefore the maximum measuring range could be reduced if any of the following are present:

- Objects close to the probe which could disturb the signal
- Particles in tank atmosphere
- Extremely loose surfaces of low-weight bulk solids
- Disturbing electromagnetic interference (EMI) in tank
- Non-metallic vessel material

5303 Probe End Projection function may improve the minimum dielectric constant for longer ranges. Consult factory for details.

Table 1 shows typical dielectric constants (DC) for several solids.

TENSILE STRENGTH AND COLLAPSE LOAD

The flexible single lead probe is recommended for solids. It is available in two versions to handle different loads and lengths:

- 0.16 in. (4 mm) diameter; Minimum tensile strength is 1698 lb. (12kN); Maximum collapse load is 3597 lb. (16 kN)
- 0.24 in (6 mm) diameter; Minimum tensile strength is 6519 lb. (29 kN); Maximum collapse load is 7868 lb. (35 kN)

Tensile strength is the amount of force the probe can withstand before any deformation occurs.

The definition for collapse load is the maximum amount of force needed to break the probe. The collapse load value should be less than what the roof can withstand. If the collapse load is reached, the probe will break before enough force is exerted on the roof to cause collapse. If the probe breaks, the process seal remains intact.

It is important to keep the following in mind when planning for installation:

- In solid applications, there might be considerable tensile load caused by the media. The tensile load of the media should not exceed the tensile strength of the probe
- The silo roof must be able to withstand the probe collapse load or at least the maximum probe tensile load
- The tensile load depends on the silo size, material density, and friction coefficient. Forces increase with buried length, silo, and probe diameter
- Forces on probes are generally 2–10 times greater on probes that are tied down than on probes with ballast weights. The weight should not be fixed for 100 ft. (30 m) or longer probes

Typical values for the tensile load from some different solids with loosely-suspended probes (not tied down) are shown in Table 2. The specified tensile loads are typical values for the bulk solid's mass flow. The same forces also act on the silo roof. If there is moisture in the product, the tensile load can be much larger. Please consult the factory for more information.

TABLE 1. Dielectric Constants of Typical Bulk Solids

Dielectric Constants	Typical Bulk Solids	3300	5300
1.2 - 1.9	• Plastic powder, granulate • White lime, special cement • Dry sawdust • Sugar granulate • Cement, plain	No	Limited*
1.9 - 2.5	• Fly ash • Burnt Lime • Coal dust, dry • Portland cement • Plaster	No	Limited*
2.5 - 4.0	• Starch • Grain, seeds • Ground stones • Carbon black • Sand	Limited*	Limited*
4.0 - 7.0	• Naturally moist (ground) • Stones, ores • Salt • Cement powder	Limited*	Limited*
> 7.0	• Carbon black • Coal dust, moist • Brown coal • Metallic powders • Calcium Carbonate	OK	OK

*Limited range see graph

Dielectric values can differ depending on particle size and the amount of air or moisture in the material. More air will tend to lower the dielectric value while more moisture will tend to increase it. These tables provide a rough guideline.

Table 2. Tensile Load Values

Material	Tensile load for 0.16 in (4 mm) flexible single lead probe, lb (kN)				Tensile load for 0.24 in (6 mm) flexible single lead probe, lb (kN)			
	Probe length 49 ft (15 m)		Probe length 115 ft (35 m)		Probe length 49 ft (15 m)		Probe length 115 ft (35 m)	
	Tank Ø= 10 ft (3 m)	Tank Ø= 39 ft (12 m)	Tank Ø= 10 ft (3 m)	Tank Ø= 39ft (12 m)	Tank Ø= 10 ft (3 m)	Tank Ø= 39 ft (12 m)	Tank Ø= 10 ft (3 m)	Tank Ø= 39 ft (12 m)
Wheat	670 (3)	1120 (5)	1800 (8)	4500 (20) Exceeds tensile strength limit	900 (4)	1690 (7.5)	2810 (12.5)	6740 (30) Exceeds tensile strength limit
Polypropylene Pellets	340 (1.5)	670 (3)	810 (3.6)	2360 (10.5)	450 (2)	920 (4.1)	1190 (5.3)	3510 (15.6)
Cement	900 (4)	2020 (9)	2470 (11)	7310 (32.5) Exceeds tensile strength limit	1350 (6)	2920 (13)	3600 (16)	10790 (48) Exceeds tensile strength limit

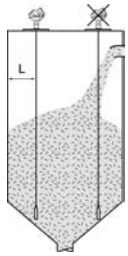
A safety factor 2 is included for the figures

MOUNTING CONSIDERATIONS

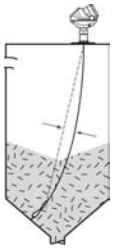
- Mount the probe as far away as possible from filling and emptying ports. This will minimize load and wear and will help to avoid disturbances from the incoming product
- Installing the probe at about $^1/_6$ to $^1/_4$ of the silo diameter is recommended to compensate for measurement errors caused by centered filling of the material cone
- Minimum probe distance to tank wall or disturbing object is 20 in. (50 cm), unless the wall is comprised of smooth metal, then the distance is 4 in. (10 cm)
- Avoid high, narrow mounting nozzles

To prevent an extremely high tensile load when fixing the probe, and to reduce the risk of probe breakage, the probe has to be slack. Select a probe longer than the required measuring range so that there is a sag in the middle of the probe that is greater than or equal to 1.5 in. per 10 feet (1 cm per m) of the probe length

Abrasive media can wear out the probe so consider using a non-contacting radar for those materials.



Recommended mounting position



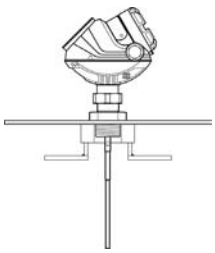
Fixing probe with slack

INSTALLATION IN NON-METALLIC SILOS

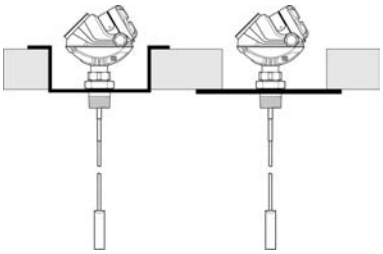
The principle of guided wave radar with a single probe requires a metal surface for the process connection. Therefore, a probe must be mounted with a 2 in. (DN50) or larger metallic flange, or on a metal sheet with diameter of a least 8 in. (200 mm).

On a concrete silo with a thick roof, the probe must be made flush with the lower edge. Use metal shielding.

The single probe is more sensitive to disturbing EMI. It should not be used in silos with electrically disturbing equipment inside and non-metallic silos with disturbing equipment outside the silo. The Rosemount 5303 is less sensitive to EMI disturbances than is the 3301.



Installation with metal sheet in non-metallic vessels



Installation in concrete silo with metal shielding

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