

Non-contacting Radar Tank Level Transmitter

A practical guide to non-contacting radar tank level transmitter, covering the reader intent, the relationship to non-contacting radar tank level transmitter, key evaluation criteria, common risks, and the information the intended project audience should confirm before taking the next step.



levelmeter.org
Main topic: Main Page
<https://www.level-meters.com/>

In the landscape of industrial process control, the non-contacting radar tank level transmitter has emerged as a cornerstone technology for accurate and reliable liquid and solid level measurement. Unlike contact-based methods that are susceptible to wear, corrosion, and mechanical failure, non-contacting radar offers a maintenance-free solution capable of operating in extreme temperatures, high pressures, and chemically aggressive environments. This guide provides a detailed technical overview of how these instruments function, how to select the correct frequency for specific applications, and the critical installation factors that ensure long-term performance.

| Measurement Principles of Non-contacting Radar

To understand the efficacy of a non-contacting radar tank level transmitter, it is essential to distinguish between the two primary measurement methodologies: Pulse Radar and Frequency Modulated Continuous Wave (FMCW).

| Pulse Radar

Pulse radar transmitters emit short microwave pulses toward the product surface. The instrument measures the "time of flight"—the duration between the emission of the pulse and the reception of the reflected echo. Since the speed of light is constant, the distance is calculated as:

$$\text{Distance} = (\text{Speed of Light} \times \text{Time of Flight}) / 2.$$

Pulse radar is generally energy-efficient and suitable for simple liquid level applications where extreme precision is not the primary requirement.

| FMCW (Frequency Modulated Continuous Wave)

Modern high-performance transmitters, such as those found on the Welk Main Page, frequently utilize FMCW technology. Instead of discrete pulses, the transmitter emits a continuous signal with a constantly changing frequency (a frequency sweep). The reflected signal is received and compared to the signal currently being emitted. The frequency difference between the transmitted and received signals is directly proportional to the distance. FMCW provides a significantly higher signal-to-noise ratio, allowing for greater accuracy (often up to ± 1 mm) and better performance in tanks with internal obstructions or turbulent surfaces.

| Frequency Selection: 26GHz vs. 80GHz

The frequency of the microwave signal determines the beam angle and the instrument's ability to handle specific process conditions. Selecting the right frequency is the most critical step in the engineering phase.

26GHz Radar: Often referred to as "high frequency" in traditional contexts, 26GHz transmitters are versatile workhorses. They offer a balance between beam focus and the ability to penetrate moderate dust or steam. They are commonly used in large storage tanks and vessels with moderate agitation.

80GHz Radar: The current state-of-the-art for non-contacting radar tank level transmitters. The higher frequency allows for an extremely narrow beam angle (as low as 3 degrees). This precision makes 80GHz ideal for small tanks, vessels with complex internal structures (like agitators or heating coils), and applications requiring measurement through narrow nozzles. The narrow beam significantly reduces the risk of "false echoes" from tank walls or internals.

| Key Evaluation Criteria for Selection

When specifying a non-contacting radar tank level transmitter, engineers must evaluate the following four factors to ensure compatibility with the process.

| 1. Dielectric Constant (Dk)

Radar relies on the reflection of electromagnetic waves. The strength of this reflection depends on the dielectric constant of the medium. Materials with high Dk, such as water ($Dk \approx 80$), reflect signals strongly. Hydrocarbons and oils often have low Dk ($Dk < 2$), which results in weaker echoes. For very low Dk fluids, a high-sensitivity FMCW transmitter is required to distinguish the surface echo from background noise.

| 2. Process Conditions

Temperature and pressure fluctuations do not affect the speed of radar waves (unlike ultrasonic waves), making radar superior for vacuum or high-pressure reactors. However, the transmitter's housing and antenna seal must be rated for the specific process temperature (e.g., -40°C to $+250^{\circ}\text{C}$) and pressure (e.g., up to 40 Bar / 4 MPa).

| 3. Surface Turbulence and Foam

Heavy agitation or boiling surfaces can scatter radar signals. Similarly, thick, dense foam can absorb the microwave signal entirely. In cases of light foam, the radar may see through it to the liquid, but heavy aqueous foam often requires specialized signal processing or a transition to guided wave radar if non-contacting methods fail.

| 4. Tank Geometry and Obstructions

The presence of ladders, pipes, or agitator blades can create interference. Utilizing a transmitter with a narrow beam angle and advanced "false echo suppression" software allows the device to map out these static obstructions and ignore them during measurement.

Technical Comparison Table

The following table compares non-contacting radar with other common level measurement technologies to assist in selection.

Feature	Non-contacting Radar	Ultrasonic Level	Guided Wave Radar (GWR)
Measurement Type	Non-contact	Non-contact	Contact (Probe)
Accuracy	High (up to $\pm 1\text{mm}$)	Moderate ($\pm 0.25\%$ of range)	High ($\pm 2\text{mm}$)
Vacuum Performance	Excellent	Not suitable	Excellent
Effect of Vapor/Steam	Negligible	Significant (speed of sound changes)	Negligible
Dk Sensitivity	High (requires $Dk > 1.4$)	N/A (mechanical reflection)	Very High ($Dk > 1.2$)
Maintenance	Extremely Low	Low	Moderate (probe cleaning)
Typical Range	Up to 120m	Up to 15m - 30m	Up to 75m

Installation Considerations

Correct physical installation is paramount for the performance of a non-contacting radar tank level transmitter. Even the most advanced electronics cannot compensate for poor mounting.

1. Nozzle Height and Diameter: The antenna should ideally extend slightly past the bottom of the mounting nozzle to prevent signal ringing within the nozzle itself. If using a long nozzle, a lens antenna or 80GHz frequency is preferred to keep the beam narrow.

2. **Positioning:** The transmitter should be mounted at 1/6th to 1/4th of the tank diameter from the side wall. Mounting too close to the wall causes interference, while mounting in the exact center can lead to multiple reflections from the tank roof or vortexes in agitated liquids.

3. **Obstruction Avoidance:** Ensure the signal beam path is clear of inflow streams, ladders, and limit switches. If an agitator is present, the transmitter should be configured with a "masking" function to ignore the blades as they rotate.

4. **Antenna Alignment:** For solid materials (silos), an alignment flange is often necessary to aim the radar at the angle of repose of the material, ensuring the best possible echo return.

| Limitations and Risks

While highly versatile, non-contacting radar is not a universal solution. Engineers should be aware of the following risks:

Signal Absorption: Certain types of chemical foam (specifically thick, micro-bubble foam) can act as a black hole for microwaves. In these rare instances, the radar will report a "loss of echo" error.

Condensation and Buildup: While many radar antennas are designed with PTFE covers to shed droplets, heavy crystalline buildup or thick coating on the antenna can attenuate the signal. For these applications, a transmitter with a purging connection (using compressed air or nitrogen) should be used to keep the antenna face clean.

Minimum Dielectric Limits: If the product has an extremely low dielectric constant (e.g., liquid nitrogen or certain liquefied gases), the signal may pass through the product and reflect off the tank bottom instead. This requires specialized "bottom echo" tracking or high-gain antennas.

| Frequently Asked Questions (FAQ)

Q: Can non-contacting radar measure through a plastic tank roof?

A: Yes. Microwaves can penetrate non-conductive materials like plastic (PE, PP), fiberglass, and glass. This allows the transmitter to be mounted outside the tank, avoiding contact with corrosive chemicals entirely.

Q: Is a 4-20mA loop-powered radar sufficient for complex tanks?

A: Yes, most modern non-contacting radar tank level transmitters are 2-wire loop-powered (4-20mA with HART). They provide enough power for sophisticated FMCW processing while simplifying wiring in industrial plants.

Q: How does dust affect the measurement in solids?

A: Unlike ultrasonic sensors, radar is largely unaffected by dust. However, extremely high dust concentrations during pneumatic filling may cause temporary signal attenuation. 26GHz or 80GHz units with high-gain antennas are typically used for these conditions.

| Conclusion and Project Confirmation

Before finalizing the specification for a non-contacting radar tank level transmitter, project managers and engineers should confirm the following data points:

1. The minimum dielectric constant of the media at process temperature.
2. The presence and type of foam (aqueous vs. chemical/dry).
3. Detailed tank drawings showing the location of all internal obstructions.
4. Connection requirements, such as flange size (DN/ANSI) or thread type.

By addressing these factors, facilities can leverage the precision and durability of radar technology to improve process safety and inventory accuracy. For technical support and to review specific product options, professionals can refer to the Main Page for a comprehensive range of Welk industrial level measurement solutions.