

Non Contact Radar Level Transmitter

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



level-measurement

Main topic: Radar Level Meters

<https://www.level-meters.com/products/radar-level-meters/>

In the landscape of industrial automation, the ability to accurately monitor liquid and solid levels without physical contact has revolutionized process control. The non contact radar level transmitter stands at the forefront of this evolution, providing a reliable, high-precision solution for challenging environments where traditional float or pressure-based systems might fail. As a professional manufacturer, Welk specializes in these advanced Radar Level Meters, ensuring that industrial operators in water treatment, chemical processing, and oil and gas sectors can maintain safety and efficiency through superior measurement technology.

Selecting the right instrumentation requires a deep understanding of the underlying physics, the mechanical constraints of the vessel, and the chemical properties of the media being measured. This guide explores the technical foundations and practical application of non-contact radar technology to assist engineers in making informed procurement decisions.

| Understanding the Measurement Principles

Non-contact radar technology operates on the principle of microwave propagation. Unlike ultrasonic sensors, which rely on sound waves and are susceptible to air temperature and pressure changes, radar uses electromagnetic waves that travel at the speed of light. This makes them inherently more stable in vacuum or high-pressure conditions.

| Time of Flight (ToF) / Pulse Radar

Pulse radar transmitters emit short microwave pulses toward the surface of the medium. The device measures the time it takes for the pulse to travel to the surface and reflect back to the antenna. Since the speed of light is a known constant, the distance is calculated using the formula:

Distance = (Speed of Light × Travel Time) / 2.

Pulse radar is often favored for its lower power consumption and is suitable for many standard liquid level applications where extreme precision is not the primary driver.

| Frequency Modulated Continuous Wave (FMCW)

FMCW radar technology is the preferred choice for high-precision industrial applications. Instead of sending discrete pulses, the transmitter emits a continuous signal with a constantly changing frequency (a frequency sweep). When the reflected signal is received, it is compared to the signal being emitted at that exact moment. The frequency difference between the transmitted and received signals is directly proportional to the distance.

FMCW offers a higher signal-to-noise ratio and better resolution, making it ideal for measuring low-dielectric liquids or materials in tanks with internal obstructions.

| Frequency Considerations in Radar Technology

The frequency of a non contact radar level transmitter significantly impacts its performance, beam angle, and suitability for specific environments. Modern industrial radar typically operates in three main bands:

1. 6 GHz (C-Band): These lower-frequency units are less affected by foam, steam, or heavy dust. They are often used in applications where the surface is extremely turbulent or where heavy condensation occurs on the antenna. However, they require larger antennas to maintain a focused beam.
2. 26 GHz (K-Band): The industry standard for many years, 26 GHz radar offers a balance between antenna size and accuracy. It features a narrower beam than 6 GHz models, allowing for easier installation in tanks with internal structures like agitators or heating coils.
3. 80 GHz (W-Band): The latest advancement in radar technology. The high frequency allows for an extremely narrow beam angle (often as low as 3 degrees). This precision makes it possible to measure through narrow nozzles and ignore internal tank interferences. 80 GHz transmitters are also highly effective for measuring solids and powders due to their ability to handle uneven surface reflections.

| Key Advantages of Non-Contact Measurement

The shift toward non-contact radar technology is driven by several operational benefits that directly impact the total cost of ownership (TCO):

Zero Maintenance: With no moving parts and no contact with the process media, there is no mechanical wear, corrosion of the sensing element, or buildup of material that could lead to sensor failure.

High Accuracy: Modern transmitters can achieve accuracies of ± 1 mm to ± 3 mm, even over long ranges (up to 30 meters or more).

Versatility: Radar is largely unaffected by changes in process temperature, pressure, or the presence of vapors and gases in the headspace. This makes it superior to ultrasonic and hydrostatic methods in volatile chemical environments.

Safety: By keeping the sensor outside the medium, the risk of leaks through seals is minimized, and technicians do not need to open tanks for routine sensor cleaning.

| Selection Criteria for Industrial Applications

When specifying a non contact radar level transmitter, engineers must evaluate the following four factors to ensure reliable performance:

| 1. Dielectric Constant (ϵ_r)

The dielectric constant of the material is the most critical factor in radar measurement. It determines how much of the microwave energy is reflected back to the sensor.

High ϵ_r (>10): Water-based liquids provide strong reflections and are easy to measure.

Low ϵ_r (1.4 to 4): Hydrocarbons, oils, and some solvents reflect very little energy. In these cases, high-sensitivity FMCW radar or specific antenna designs are required.

| 2. Vessel Geometry and Obstructions

The presence of agitators, ladders, or cooling pipes can create "false echoes." While modern software can perform "false echo suppression" to map out these obstacles, choosing a transmitter with a narrow beam angle (high frequency) is the best preventative measure.

| 3. Process Conditions

Temperature and Pressure: Ensure the antenna material (typically PTFE, PFA, or Stainless Steel) and the process connection can withstand the maximum ratings of the vessel.

Foam and Turbulence: Heavy, dense foam can absorb radar signals. If foam is a constant factor, a lower frequency radar or a guided wave radar (contact-based) might be considered, though non-contact 80 GHz units often perform well on light foam.

| 4. Measurement Range

Transmitters are rated for specific distances. While a unit might be rated for 30m (approx. 98 ft), its effective range may decrease if the material has a very low dielectric constant or if the surface is highly agitated.

| Installation Guidelines and Best Practices

Correct installation is essential to prevent signal interference and ensure the longevity of the Radar Level Meters.

Nozzle Height and Diameter: The antenna should ideally extend slightly beyond the mounting nozzle to prevent the nozzle edges from interfering with the signal. For 80 GHz units, the narrow beam allows for longer nozzles, but for 26 GHz units, the nozzle should be as short and wide as possible.

Positioning: Never install the transmitter in the center of a tank with a domed top, as this can cause multiple reflections to converge on the sensor. The ideal position is usually 1/6th to 1/4th of the tank diameter from the wall.

Avoiding the Fill Stream: Ensure the radar beam does not intersect the path of the incoming material, as this will result in false high-level readings.

Dead Zone (Blocking Distance): Every radar has a minimum detection distance (typically 50mm to 200mm from the antenna). Ensure the maximum expected level does not enter this zone.

| Limitations and Troubleshooting

While highly versatile, the non contact radar level transmitter is not a universal solution for every scenario. Engineers should be aware of the following limitations:

1. **Extremely Low Dielectric Media:** Materials with a dielectric constant below 1.4 may not reflect enough energy for a non-contact sensor. In these rare cases, Guided Wave Radar (GWR) is often used.
2. **Heavy Dust and Build-up:** While radar can penetrate some dust, extreme buildup on the antenna face can attenuate the signal. Transmitters with integrated air purging or lens antennas are recommended for these environments.
3. **Vacuum Effects:** In a vacuum, the propagation of the wave is unaffected, but the mechanical seals of the transmitter must be rated for vacuum service to prevent internal damage.

| Selection Table for Radar Level Meters

Application Type	Recommended Frequency	Key Benefit	Typical Accuracy
Water/Wastewater Tanks	26 GHz	Cost-effective, handles condensation well	±3 mm
Small Chemical Vessels	80 GHz	Narrow beam avoids internal obstructions	±1 mm
Solid Silos (Grain/Cement)	80 GHz	High sensitivity for uneven surfaces	±2 mm
Corrosive Acids	26 GHz / 80 GHz	PTFE-coated antennas prevent corrosion	±2 mm
High-Pressure Boilers	6 GHz / 26 GHz	Stable in high steam/temperature	±5 mm

Frequently Asked Questions (FAQ)

Q: Can a non contact radar level transmitter measure through a plastic tank lid?

A: Yes. Microwaves can penetrate non-conductive materials like plastic, fiberglass, or glass. This allows the sensor to be mounted outside the tank entirely, provided the lid material does not contain metal or carbon reinforcement.

Q: How does the dielectric constant affect the accuracy?

A: The dielectric constant does not change the accuracy of the distance measurement itself, but it affects the strength of the returned signal. If the ϵ_r is too low, the signal may be lost in the background noise, leading to intermittent or failed readings.

Q: Is calibration required frequently?

A: Unlike pressure transmitters that may drift over time, radar transmitters are digital and time-based. Once calibrated to the tank height, they rarely require re-calibration unless the mounting position or tank geometry changes.

Q: What is the difference between a horn antenna and a lens antenna?

A: Horn antennas are traditional and robust, often used for 26 GHz models. Lens antennas (often made of PTFE or PFA) are typically used for 80 GHz models; they are flush-mounted, easier to clean, and highly resistant to chemical attack.

For engineers seeking to optimize their process control, Welk provides a range of high-performance Radar Level Meters designed for the rigors of modern industry. By selecting the appropriate frequency and antenna configuration, operators can achieve maintenance-free, high-precision level monitoring across even the most demanding applications.