

What Is the Difference Between Ultrasonic and Radar Level Transmitter

A practical engineering guide to what is the difference between ultrasonic and radar level transmitter, explaining operating principles, selection criteria, installation constraints, application risks, and the information an international buyer should confirm before choosing equipment for industrial level measurement.



[levelmeter.org](https://www.levelmeters.com)

Main topic: Radar Level Meters

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

In the field of industrial process automation, selecting the correct level measurement technology is critical for operational safety, efficiency, and cost management. Two of the most common non-contact technologies used today are ultrasonic and radar transmitters. While both serve the same primary purpose—measuring the distance to a liquid or solid surface without physical contact—they operate on fundamentally different physical principles.

Understanding what is the difference between ultrasonic and radar level transmitter requires a deep dive into how waves interact with the environment, the process media, and the physical constraints of the storage vessel. This guide provides an engineering-focused comparison to help technical buyers and plant managers make informed decisions.

| Understanding the Measurement Principles

Before comparing the two technologies, it is essential to understand the physics governing their operation.

| Ultrasonic Level Measurement Principle

Ultrasonic level transmitters utilize mechanical sound waves. The sensor's transducer contains a piezoelectric crystal that converts electrical energy into mechanical vibrations, emitting ultrasonic pulses (typically in the range of 20 kHz to 200 kHz). These sound waves travel through the air or gas space above the medium, reflect off the surface, and return to the transducer.

The device measures the "Time of Flight" (ToF). Since the speed of sound in air is approximately 340 meters per second (at 20°C), the distance can be calculated using the formula:

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

Because sound waves are mechanical, they require a medium (usually air) to propagate. Consequently, anything that alters the properties of that medium—such as temperature fluctuations, pressure changes, or heavy vapors—will directly affect the speed of sound and, therefore, the accuracy of the measurement.

| Radar Level Measurement Principle

Radar Level Meters utilize electromagnetic (EM) waves, specifically microwaves. These waves travel at the speed of light (approximately 300,000 kilometers per second). Like ultrasonic sensors, radar units use the Time of Flight principle or Frequency Modulated Continuous Wave (FMCW) technology to determine distance.

Unlike sound waves, electromagnetic waves do not require a physical medium to travel. They can propagate through a vacuum and are largely unaffected by the composition, temperature, or pressure of the gas layer above the product. The reflection of the radar signal depends on the Dielectric Constant (DK) of the material being measured; materials with higher dielectric constants reflect more energy, providing a stronger signal return.

| Key Differences: Ultrasonic vs. Radar

When evaluating what is the difference between ultrasonic and radar level transmitter, several operational factors must be considered.

| 1. Influence of Atmospheric Conditions

Ultrasonic: Highly sensitive to the environment. Changes in air temperature significantly alter the speed of sound. While most ultrasonic sensors include internal temperature compensation, they cannot account for temperature gradients (where the temperature at the sensor differs from the temperature near the liquid surface). Furthermore, wind, heavy dust, steam, and foam can attenuate or scatter the sound waves, leading to signal loss.

Radar: Virtually immune to atmospheric conditions. Since microwaves are electromagnetic, their speed is constant regardless of air temperature or pressure. Radar is the preferred choice for applications involving heavy steam, dust (such as in grain silos), or fluctuating gas compositions.

| 2. Pressure and Vacuum Constraints

Ultrasonic: Because sound waves require a medium, ultrasonic transmitters cannot function in a vacuum. They are also generally limited to near-atmospheric pressures (typically up to 3 bar or 0.3 MPa), as high pressure increases the density of the air, affecting wave propagation.

Radar: Can operate in a total vacuum and under high-pressure conditions (often up to 40 bar or 4 MPa, with specialized models going much higher). This makes radar ideal for pressurized process vessels and reactors.

| 3. Measurement Range and Accuracy

Ultrasonic: Generally effective for shorter ranges, typically up to 15 or 20 meters. Accuracy is usually around 0.25% of the span, provided the environment is stable.

Radar: Offers significantly longer ranges, with some high-frequency (80 GHz) models reaching up to 100 meters or more. Radar also provides superior accuracy, often within ± 2 mm or better, even in turbulent conditions.

| 4. Surface Characteristics and Foam

Ultrasonic: Sound waves reflect well off solid, flat surfaces but struggle with foam. Foam absorbs mechanical sound energy, often resulting in a "lost echo" or false readings.

Radar: While thick, dense foam can also challenge radar, the technology is generally more robust. High-frequency radar can often penetrate light foam layers to detect the liquid level beneath, or at least provide a more reliable reflection than ultrasonic pulses.

| Selection Criteria Table

To simplify the decision-making process, the following table compares the two technologies across standard industrial parameters:

Feature	Ultrasonic Transmitters	Radar Level Meters
Wave Type	Mechanical (Sound)	Electromagnetic (Microwave)
Medium Required	Yes (Air/Gas)	No (Works in Vacuum)
Max Temperature	Typically < 80°C	Up to 250°C+ (with cooling)
Max Pressure	< 3 bar (0.3 MPa)	Up to 40+ bar (4 MPa)
Accuracy	±0.25% to ±0.5%	±1 mm to ±5 mm
Dust/Vapor Resistance	Poor	Excellent
Foam Resistance	Poor (Absorbs signal)	Moderate to Good
Typical Cost	Lower	Higher
Installation	Top-mounted	Top-mounted

Practical Installation Considerations

Regardless of the technology chosen, proper installation is paramount to ensuring reliable data. Both Radar Level Meters and ultrasonic sensors share some common installation requirements, but their sensitivities differ.

Dead Zones (Blocking Distance)

Every non-contact sensor has a "dead zone" or "blocking distance" directly beneath the sensor face where measurement is impossible.

For ultrasonic sensors, this is the time required for the transducer to stop vibrating after emitting a pulse before it can listen for the return.

For radar, this is usually much smaller, but still exists.

Engineers must ensure the maximum liquid level never enters this dead zone, or the sensor will report an error or a false "full" reading.

| Beam Angle and Obstructions

The "beam angle" defines the spread of the signal. If the beam hits internal tank structures like ladders, agitators, or heating coils, it will create false echoes.

Ultrasonic beams tend to be wider (typically 10° to 15°).

Modern high-frequency radar (80 GHz) has a very narrow beam angle (as low as 3°), allowing it to be installed in tall, narrow nozzles or tanks with many internal obstructions.

| Nozzle Geometry

The mounting nozzle should be as short and wide as possible. If a nozzle is too long or narrow, the signal may reflect off the nozzle walls before even reaching the tank interior. This is particularly problematic for ultrasonic sensors due to their wider beam spread.

| Limitations and Application Risks

| When to Avoid Ultrasonic

High-Temperature Processes: If the liquid is boiling or the headspace is significantly hotter than the sensor, the measurement will drift.

Vacuum Tanks: Ultrasonic will not work; there is no medium to carry the sound.

Chemical Vapors: If the tank contains chemicals that change the gas density (like heavy solvents), the speed of sound changes, leading to massive errors.

| When to Avoid Radar

Extremely Low Dielectric Media: Some non-polar hydrocarbons (like liquid nitrogen or certain oils) have very low dielectric constants ($DK < 1.5$). Standard radar may struggle to see the surface unless a stilling well or guided wave radar is used.

Budget Constraints: In simple water tank applications where conditions are stable and the tank is vented to the atmosphere, the higher cost of radar may not be justified compared to a cost-effective ultrasonic solution.

| Frequently Asked Questions (FAQ)

Q: Can ultrasonic sensors measure the level of solids?

A: Yes, but with limitations. Solids like grain or plastic pellets create an uneven surface that scatters sound waves. You often need to derate the effective range of the sensor by 50% or more when measuring solids.

Q: Does the color of the liquid affect radar measurement?

A: No. Radar is an electromagnetic wave and is unaffected by the optical properties (color, transparency) of the liquid. It only cares about the dielectric constant.

Q: Is radar safer than ultrasonic?

A: Both are safe for industrial use. Radar emissions are extremely low power—much lower than a mobile phone—and pose no risk to personnel when installed according to manufacturer guidelines.

Q: How do I handle heavy turbulence or agitation?

A: For both technologies, turbulence can scatter the signal. Software filtering (damping) can help, but for extreme cases, installing the sensor inside a stilling well (a vertical pipe that stabilizes the surface) is the best engineering practice.

| Conclusion for International Buyers

When deciding what is the difference between ultrasonic and radar level transmitter, the choice usually comes down to the complexity of the environment. Ultrasonic transmitters offer a budget-friendly solution for simple, ambient-pressure water and wastewater applications. However, for industrial processes involving chemicals, high temperatures, pressure, or dust, Radar Level Meters provide the reliability and precision required for modern automation.

For international procurement, always confirm the following with your supplier:

1. **Process Temperature and Pressure:** Ensure the sensor housing and flange can withstand the maximum possible ratings.
2. **Chemical Compatibility:** Verify that the wetted parts (the face of the sensor) are resistant to the process media.
3. **Dielectric Constant:** For radar, provide the DK of your material to ensure the sensor has sufficient sensitivity.
4. **Tank Drawings:** Share internal tank dimensions to help the manufacturer recommend the correct beam angle and mounting position.