

Difference Between Ultrasonic Radar Level Transmitter

A practical guide to difference between ultrasonic radar level transmitter, covering the reader intent, the relationship to difference between ultrasonic 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 field of industrial automation, selecting the correct instrumentation for level measurement is critical for operational efficiency, safety, and cost-effectiveness. Two of the most common non-contact technologies used today are ultrasonic and radar. While both serve the purpose of measuring the distance to a liquid or solid surface, they operate on fundamentally different physical principles. Understanding the technical difference between ultrasonic radar level transmitter systems is essential for engineers and plant managers tasked with optimizing process control.

At Welk, we specialize in providing high-precision Radar Level Meters and ultrasonic sensors tailored for industries ranging from wastewater treatment to complex chemical processing. This guide provides a factual, engineering-focused breakdown of these technologies to assist in informed decision-making.

| Understanding Measurement Principles

Before comparing their applications, it is necessary to understand how each technology interacts with the environment and the target medium.

| Ultrasonic Level Measurement Principle

Ultrasonic transmitters utilize a piezoelectric crystal to generate high-frequency sound waves (typically between 20 kHz and 200 kHz). These sound pulses 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)—the duration between the emission of the pulse and the reception of the echo. Since the speed of sound in air is known (approximately 343 m/s at 20°C), the distance can be calculated.

However, because sound is a mechanical wave, it requires a physical medium (gas or liquid) to propagate. Its speed is highly sensitive to the density, temperature, and composition of that medium.

| Radar Level Measurement Principle

Radar (Radio Detection and Ranging) transmitters use electromagnetic waves, typically in the microwave frequency range (6 GHz, 26 GHz, or 80 GHz). Like ultrasonic sensors, radar also uses the ToF principle or Frequency Modulated Continuous Wave (FMCW) technology. The primary difference is that electromagnetic waves do not require a medium; they can travel through a vacuum and are largely unaffected by the gas composition in the tank.

Radar waves travel at the speed of light. When the wave hits a surface with a different dielectric constant (Dk) than the surrounding gas, a portion of the energy is reflected back to the antenna. The strength of this reflection depends heavily on the dielectric property of the material being measured.

| Environmental Factors and Media Influence

The most significant difference between ultrasonic radar level transmitter performance lies in how they respond to environmental variables within a vessel.

| Temperature and Pressure

Ultrasonic: The speed of sound changes by approximately 0.17% per degree Celsius. 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, ultrasonic sensors are generally limited to atmospheric or near-atmospheric pressures (typically up to 3 Bar).

Radar: The speed of light is constant regardless of temperature or pressure. This makes radar level meters the preferred choice for high-pressure reactors or cryogenic storage where temperatures can fluctuate from -40°C to over +400°C.

| Dust, Steam, and Vapor

Ultrasonic: Sound waves are easily attenuated or scattered by heavy dust, thick steam, or chemical vapors. In a wastewater tank with heavy fog, an ultrasonic signal may be lost entirely.

Radar: Microwaves penetrate dust and steam with minimal signal loss. This makes radar superior for applications like cement silos, fly ash bins, or boiling chemical liquids where vapor clouds are prevalent.

| Surface Conditions and Foam

Ultrasonic: Sound waves reflect poorly off turbulent surfaces or foam. Foam, in particular, acts as an acoustic absorber, often resulting in a "lost echo" condition.

Radar: While heavy, dense foam can also challenge radar, many high-frequency radar sensors (such as 80 GHz models) can penetrate light foam or reflect off the liquid surface beneath it. Radar is also much more resilient to surface agitation and ripples.

| Performance Comparison: Accuracy, Range, and Reliability

When evaluating the difference between ultrasonic radar level transmitter options, technical specifications regarding accuracy and range are often the deciding factors.

Feature	Ultrasonic Transmitters	Radar Level Meters
Typical Accuracy	±2 mm to ±10 mm	±1 mm to ±3 mm
Maximum Range	Up to 15-30 meters	Up to 100+ meters
Measurement Speed	Slower (Sound travels ~340 m/s)	Instantaneous (Light speed)
Dielectric Sensitivity	None (Reflects off any solid/liquid)	High (Requires Dk > 1.4)
Vacuum Compatibility	No (Sound cannot travel)	Yes

Radar technology generally offers higher precision and much longer measurement ranges. For tall grain silos or deep oil storage tanks exceeding 20 meters, radar is the standard. Ultrasonic sensors are often sufficient and more cost-effective for shallow open-channel flow or small plastic water tanks.

Selection Matrix: Which Technology Fits Your Application?

Choosing between these two technologies requires a checklist of the process conditions. Use the following table as a practical engineering reference.

Application Condition	Recommended Technology	Reason
Open Sump / Water Tank	Ultrasonic	Cost-effective, no vapor/pressure issues.
Chemical Storage (Corrosive)	Radar (PTFE Flange)	Non-contact, ignores chemical vapors.
Vacuum Distillation	Radar	Ultrasonic fails in a vacuum.
High-Dust Solid Silo	Radar	Microwaves penetrate dust clouds.
Food & Beverage (Steam CIP)	Radar	Unaffected by steam or rapid temp changes.
Simple Fuel Storage	Ultrasonic or Radar	Both work; radar offers higher safety/accuracy.

Installation and Maintenance Considerations

Both technologies are non-contact, which significantly reduces maintenance compared to hydrostatic or float-based systems. However, installation requirements differ.

Beam Angle and Obstructions

Radar level meters, especially high-frequency 80 GHz models, have very narrow beam angles (as small as 3°). This allows them to be installed in tanks with internal obstructions like agitators, ladders, or heating coils without interference. Ultrasonic sensors typically have wider beam angles (8° to 15°), meaning they require a clear "path" to the target to avoid false echoes from tank walls.

Mounting and Dead Zones

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

Ultrasonic dead zones are usually larger (0.25m to 0.5m) because the transducer needs time to stop vibrating before it can listen for an echo.

Radar dead zones are typically much smaller (often less than 0.1m), allowing for measurements closer to the top of the tank.

| Maintenance

Since there are no moving parts, maintenance is minimal. However, in applications with heavy condensation, ultrasonic transducers may require a PTFE face to shed droplets, as water on the sensor face can block the sound pulse. Radar antennas are also susceptible to buildup, but many modern radar units feature "lens" antennas that are self-cleaning or highly resistant to coating.

| Limitations and Common Pitfalls

While radar is often viewed as the "superior" technology, it has its own limitations. The most critical is the Dielectric Constant (Dk). Materials with a very low Dk (like liquid nitrogen or certain dry solvents) do not reflect radar waves well. In these cases, a guided wave radar (GWR) or a high-sensitivity ultrasonic sensor might be necessary.

Conversely, the primary limitation of ultrasonic is the Medium Dependency. If the gas composition in the tank changes (e.g., carbon dioxide replaces air), the speed of sound changes, leading to massive measurement errors unless the sensor is recalibrated for the specific gas mix.

| Frequently Asked Questions (FAQs)

Q: Is radar always more expensive than ultrasonic?

A: Historically, yes. However, with the advancement of microchip technology, the price gap has narrowed significantly. For many industrial applications, the total cost of ownership for radar is lower due to higher reliability and less downtime.

Q: Can I use an ultrasonic sensor in a pressurized tank?

A: Generally, no. Most ultrasonic sensors are rated for atmospheric pressure. High pressure increases the density of the air, which changes the acoustic impedance and can prevent the transducer from functioning correctly.

Q: How do I handle foam in a liquid level application?

A: If the foam is light and airy, radar can often see through it to the liquid. If the foam is thick and dense (like shaving cream), it may reflect the signal, giving a reading of the foam top. In such cases, a guided wave radar or a mechanical float may be required.

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

A: No. Neither ultrasonic nor radar is affected by the color or transparency of the medium, unlike optical or laser sensors.

| Conclusion

The difference between ultrasonic radar level transmitter systems comes down to the physics of waves. Ultrasonic is a reliable, budget-friendly solution for stable, atmospheric conditions like water management. Radar is a robust, high-precision technology designed to handle the rigors of industrial processing, including extreme temperatures, pressures, and vapors.

For professional assistance in selecting the right instrument for your facility, explore our range of Radar Level Meters or contact the Welk engineering team for a customized application review. Ensuring the right fit today prevents costly measurement errors tomorrow.