

Radar Level Transmitter for Solids

A practical guide to radar level transmitter for solids, covering the reader intent, the relationship to radar level transmitter for solids, 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 industrial process automation, measuring the level of bulk solids presents a unique set of challenges compared to liquid level measurement. From the steep angles of repose in grain silos to the heavy dust clouds in cement production, selecting the right instrumentation is critical for operational efficiency and inventory accuracy. Among the various technologies available, the radar level transmitter for solids has emerged as the industry standard due to its non-contact nature and ability to perform in extreme environments.

This guide explores the measurement principles, selection criteria, and installation best practices for Radar Level Meters specifically designed for solid materials.

| Understanding the Measurement Principle

Radar level measurement is based on the Time-of-Flight (ToF) principle. The instrument, mounted at the top of a vessel, emits electromagnetic pulses (microwaves) toward the material surface. These pulses travel at the speed of light, reflect off the material, and are received by the sensor's antenna. The distance is calculated based on the time interval between transmission and reception.

For solids, two primary radar technologies are utilized:

| 1. Pulse Radar

Pulse radar emits short microwave bursts and measures the time delay of the return signal. While effective for many liquid applications, standard pulse radar can struggle with the diffuse reflections common in solid materials unless the signal processing is highly advanced.

| 2. FMCW (Frequency Modulated Continuous Wave)

FMCW radar is often the preferred technology for a radar level transmitter for solids. Instead of pulses, it emits a continuous signal with a constantly changing frequency. The difference between the transmitted frequency and the received frequency at any given moment is proportional to the distance. FMCW offers a significantly higher signal-to-noise ratio, which is essential when dealing with the weak reflections characteristic of uneven solid surfaces and low-dielectric materials.

| Why Solids Require Specialized Radar Solutions

Unlike liquids, which maintain a flat, horizontal surface, solids behave unpredictably. Engineering a reliable measurement system requires accounting for several physical factors:

Angle of Repose: When bulk solids are loaded into a silo, they form a cone. This sloping surface reflects radar signals away from the antenna rather than directly back to it. High-frequency radar with narrow beam angles is required to capture enough return signal.

Dust and Steam: Processes like pneumatic conveying or lime production create intense dust. While radar waves penetrate dust much better than ultrasonic waves, heavy buildup on the antenna can still attenuate the signal.

Low Dielectric Constants: Many solids, such as plastic pellets or dry wood chips, have low dielectric constants (ϵ_r). This means they reflect only a small portion of the radar energy, allowing the rest to pass through the material. Specialized high-sensitivity transmitters are needed to detect these faint echoes.

Internal Obstructions: Silos often contain ladders, braces, and agitators. A radar level transmitter for solids must utilize sophisticated software to "map out" these static reflections and distinguish them from the actual material level.

| Frequency Selection: 26GHz vs. 80GHz

The frequency of the radar signal determines the beam angle and the instrument's ability to handle difficult geometries.

| 26GHz Radar

Historically the workhorse of the industry, 26GHz transmitters are versatile and cost-effective. They typically have a beam angle of 8° to 12°. They are suitable for medium-sized bins and materials with moderate dust levels. However, in narrow silos, the wider beam may hit the vessel walls or internal structures, causing interference.

| 80GHz Radar

Modern high-frequency 80GHz radar is the gold standard for solids. The higher frequency allows for a much narrower beam angle, often as small as 3°.

Advantages of 80GHz for solids include:

Better Focusing: The narrow beam avoids wall reflections and internal obstructions.

Stronger Signal Return: It provides a much stronger reflection from the uneven surfaces of bulk solids.

Smaller Process Connections: High-frequency antennas can be smaller while maintaining a narrow beam, allowing for installation on smaller nozzles.

| Selection Table for Bulk Solids Applications

Material Type	Typical Dielectric (εr)	Recommended Radar Type	Key Consideration
Cement / Fly Ash	2.0 – 3.0	80GHz FMCW	Requires air purging for heavy dust.
Grain / Corn	1.7 – 2.5	80GHz FMCW	Narrow beam avoids wall interference in tall silos.
Plastic Pellets	1.1 – 1.5	High-Sensitivity 80GHz	Very low reflection; requires advanced signal processing.
Coal / Ores	2.5 – 10.0	26GHz or 80GHz	High durability needed; swivel mounts for angle of repose.
Aggregates/Sand	3.0 – 5.0	26GHz Pulse or FMCW	Robustness against vibration and impact during filling.

Installation Considerations for Solids

Proper installation is as important as selecting the right instrument. Even the most advanced radar level transmitter for solids will fail if positioned incorrectly.

1. Mounting Location

The transmitter should generally be mounted 1/3 of the radius away from the vessel wall. Mounting it too close to the wall leads to interference, while mounting it directly over the center (the peak of the cone) or the discharge point (the bottom of the cone) can lead to inaccurate readings during filling or emptying.

| 2. The Use of Aiming Flanges (Swivel Mounts)

Because solids form a cone, the radar beam often hits a sloped surface. An adjustable aiming flange allows the technician to tilt the radar sensor, directing the beam toward the center of the material cone to maximize the reflected signal strength.

| 3. Nozzle Geometry

The antenna should ideally extend slightly beyond the bottom of the mounting nozzle. If the antenna is recessed deep within a narrow nozzle, the "ringing" effect from the nozzle walls can create a large dead zone at the top of the tank, preventing measurement when the silo is full.

| 4. Dust Management

In environments with heavy dust or condensation, an air purge connection is vital. A small, continuous flow of clean dry air into the antenna housing prevents material buildup on the lens, ensuring long-term reliability without manual cleaning.

| Limitations and Common Risks

While radar is highly reliable, engineers should be aware of the following risks:

Extreme Low Dielectric Materials: If the material's dielectric constant is below 1.4, non-contact radar may struggle. In these cases, Guided Wave Radar (GWR), which uses a physical cable to guide the signal, may be a more appropriate choice.

Rapid Level Changes: During high-speed pneumatic filling, the air density and turbulence can momentarily disrupt the signal. Selecting a transmitter with a high update rate and robust tracking algorithms is necessary.

Vessel Shape: Horizontal cylindrical silos or silos with complex internal bracing require careful mapping during commissioning to avoid false echoes.

| Frequently Asked Questions (FAQs)

Q: Can a radar level transmitter for solids measure through a plastic window?

A: Yes. Since radar waves pass through non-conductive materials, it is possible to measure through a PTFE or PEEK window to isolate the sensor from extreme heat or corrosive dust inside the vessel.

Q: How does moisture content in the solid affect the measurement?

A: Generally, moisture increases the dielectric constant of the material, which actually makes the radar reflection stronger and easier to detect. However, if the moisture causes the material to stick to the antenna, an air purge is required.

Q: Is 80GHz always better than 26GHz?

A: Not necessarily. While 80GHz is superior for narrow silos and low-dielectric solids, 26GHz is often more than sufficient for large open stockpiles or materials with high reflectivity, and it may be more cost-effective.

Q: What maintenance is required for a radar level transmitter?

A: Radar units are solid-state and have no moving parts, making them very low maintenance. The primary task is ensuring the antenna remains clean, either through periodic inspection or an automated air-purging system.

| Conclusion

Selecting a radar level transmitter for solids requires a thorough understanding of the material properties and the physical constraints of the storage vessel. By utilizing high-frequency 80GHz technology, employing proper aiming techniques, and accounting for the angle of repose, industrial facilities can achieve precise, maintenance-free level monitoring. For critical applications, always consult with a professional manufacturer to ensure the instrument's frequency, antenna type, and signal processing are optimized for your specific bulk solid challenges.