



## Level Measurement 101:

Through-Air Radar Does It All

**Radar is one of the most common level measurement technologies on the instrumentation market. Whether measuring liquids or solids, from chemical plants to wastewater facilities to ready-mix cement manufacturers, radar provides accurate, reliable level measurement without ongoing maintenance and frequent recalibration. Radar sensors are not only a trusted means of pinpoint level control, they are easy to use as well.**

When the process automation community discusses radar for level measurement, the conversation veers in one of two directions: Through-air radar and guided wave radar, or GWR. This paper explains how through-air radar operates and its advantages and limitations in industrial applications.

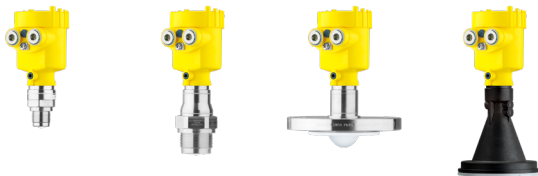
### How through-air radar works

Radio microwaves are transmitted by the antenna system of the sensor to the measured product, reflected by the product surface, and received by the antenna system. The microwaves travel through the air, hence the label, through-air radar. The time of flight from emission to reception of the signals is proportional to the distance to the product surface: The longer the time of flight, the greater the distance. This distance is inversely proportional to the level in the tank. The greater the distance, the lower the level.

Many parameters determine the strength of the signal returned to a radar sensor. An agitated, turbulent surface will affect signal strength, and distance to the product surface will, too. Even normal process conditions like buildup on the antenna system may influence a return signal. Signal strength also depends partially on chemical composition, as not every product reflects microwaves equally.

Conductive products reflect almost all microwave energy and non-conductive products reflect only a portion of the energy. Non-conductive products with low dielectric constant, oil for instance, produce weaker signals than those with high dielectric constant, like water. The range of signals a radar sensor can detect is called its dynamic range. Sensors with large dynamic range are sensitive enough to register weak signals as well as strong ones. Radar sensitivity varies from manufacturer to manufacturer and they even differ from sensor to sensor in a manufacturer's instrument line.

A user might think that highly sensitive radar would be more susceptible to noise created by buildup. I can't speak for all level instrumentation manufacturers, but VEGA radar sensors come equipped with software that filters out near-range signals caused by buildup. Users measure only their product—it's as if the buildup isn't even there.



Process fitting	¾"	1½"	2"	3"
Beam angle	14°	7°	6°	3.6°

The focus of the microwave beam depends on a radar transmitter's antenna size and its transmission frequency. The smaller the antenna, the wider—and less focused—the beam. The larger the antenna, the more focused the beam. That's why the development of liquid level sensors operating at 80 GHz transmission frequency was such enormous news in process automation.

### Radar level measurement with 80 GHz

At VEGA, we have seen the practical benefits of our 80 GHz level sensors, the VEGAPULS 64 and VEGAPULS 69, in over 70,000 installations worldwide. In containers and silos with many internal installations, enhanced focusing helps reduce the influence of noise created by microwave energy reflecting back to the antenna from something other than the product surface. Noise is commonplace in vessels with agitators, baffles, or heating coils, and it is sometimes created by the walls of the vessel itself. Noise is a problem because it distorts level measurement, but it can be overcome.



In a Shanghai pharmaceutical application, VEGA 80 GHz radar delivers liquid level measurement in a [mixing vessel where a scraper is continuously turning](#). The same technology delivers [accurate measurements in a German carrot processing facility](#), even installed on a conical vessel with heating coils lining the bottom. Further, the focusing of 80 GHz sensors makes liquid level measurement on a ball valve possible. Those are just the liquids installations.

VEGA's 80 GHz through-air radar sensors have been just as successful measuring bulk solids. The narrow beam angle has [improved operations at an Italian salt mine](#), [monitored clinker cooler levels](#) for a lime producer, and [accurately measured the level in an ash silo](#) at a German wastewater treatment facility. These are just a few of the applications where through-air radar has successfully provided an accurate level measurement and there are thousands more.

### **Advantages of through-air radar sensors**

The most obvious advantage to using a through-air radar sensor is that it is a non-contact level measurement that requires less maintenance due to a lack of moving parts and a lack of contact with corrosive product. Users also do not have to worry about the level sensor being damaged or plugged by adhesive solids.

Through-air radar sensors are unaffected by fluctuating product properties or by changing process conditions such as temperature, pressure, or intense dust generation because they use radio waves to make a measurement. Few process variables can disturb the flight of a radio wave, making through-air radar sensors a reliable option for level measurement.

Another benefit of using a through-air radar sensor is that initial setup and adjustment can be done while the vessel is in use. Installing a level device without stopping the process saves time and avoids the costs of a shutdown.

### **How a radar level sensor converts a signal to a measurement**

An instrument's integrated electronics convert the measured value into an analogue or digital signal for transmission. This signal can be used for an external display or a process control system. Additional components for hazardous areas, overvoltage protection, or wireless communication enable a wide range of applications in all industrial sectors.

### **Common applications for through-air radar**

Radar level transmitters are used for non-contact level measurement of liquids and bulk solids, even under high pressure and extreme temperatures. They can be used in simple as well as in aggressive liquids and are suitable for applications with stringent hygiene requirements. Radar level sensors measure light as well as heavy bulk solids with absolute reliability, even in the presence of dust and noise, without being affected by buildup or condensation.

### **Limitations**

Through-air radar has tremendous capabilities and offers many benefits to users. However, through-air radar is not a level measurement panacea; it's not right for use with every product. In applications with rampant, heavy foam, radar is sometimes not the right solution because microwaves can be absorbed right into the foam. Another limitation is that in order to use radar for level, a user must have a connection at the top of the tank. The connection can be small, but it has to be present.

Through-air radar is a great fit for the vast majority of applications, even ones with foam, but not all of them. Users would be wise to discuss the specifics of their level application with their instrument providers before choosing a technology.

### **Conclusion**

There has never been a better time than right now to use through-air radar for level measurement. The instruments are more focused than ever before, making them a reliable option in vessels with obstructions or applications that require isolation valves. Some instrumentation manufacturers are pairing that hyper-focus with incredible sensitivity and intelligent software so users can measure non-conductive products and suppress noise from false signals. High transmission frequency sensors have made antenna sizes smaller than ever, so retrofitting and mounting are less costly and less burdensome than ever before. Any users who have shied away from radar in the past should rethink their position; any users relying on an older radar sensor should consider an upgrade. The instruments are just that good.

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