

Technical Article

Industrial Radar Sensors Need 77GHz



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Although specialized applications (primarily within the military) have used radar technology for sensing for nearly a century, simplification and size reductions through integration and higher operating frequencies have expanded the use of radar sensing to include automotive and industrial applications.

In the past, radar technology was reserved for operating frequencies 24GHz or less. But with the development of single-chip 77GHz millimeter-wave (mmWave) sensors, as well as the promising future for 60GHz, broad applications can finally benefit from higher operating frequencies and larger continuous bandwidth, as shown in Figure 1.

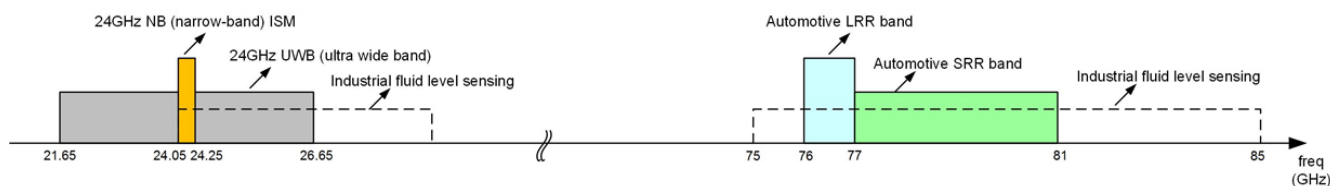


Figure 1. 77GHz offers higher operating frequencies and larger continuous bandwidth compared to 24GHz

High-range-resolution Sensing

A 77GHz operating frequency permits an ultra-wide continuous bandwidth spanning from 77 to 81GHz. By using 4GHz of bandwidth, it's possible to achieve a range resolution less than 4cm, compared to 60cm with the 250MHz available in 24GHz. This resolution is particularly beneficial in industrial or factory applications, where there is likely a significant amount of clutter and objects of interest tend to be smaller. Such fine resolution enables the generation of a very rich and detailed point cloud of reflections, making it possible to distinguish two nearby objects that in 24GHz would appear as one large object.

Object separation is a critical requirement in process-level sensing. A typical tank used in process control comprises many internal structures such as agitators and heating coils. To accurately measure the level of the liquid in the tank, it's important to separate the internal structures from the surface of the water. Smaller bandwidths enable liquid measurements as close as possible to internal structures.

Smaller Sensors and a Focused Beam

The high 77GHz operating frequency brings several benefits to industrial markets over 24GHz. 77GHz enables smaller antenna designs, which in turn result in smaller sensors. To achieve the same field of view, a 77GHz antenna can be 3x smaller than a 24GHz antenna without sacrificing accuracy. A smaller form factor enables many applications that couldn't traditionally use radar sensing at all, because the sensors were too large to achieve the required performance.

Building automation requires small-form-factor sensors because they will be integrated into the building infrastructure and remain unobtrusive while sensing the environment. The smaller sensors enable increased flexibility in finding a mounting location that best suits the environment for more accurate sensing.

Robotics is another application that requires robust sensing in a small form factor. Typical robots are designed to have a small chassis in order to reduce the overall power consumption while moving. Bigger sensors require larger chassis that will increase the weight of the robot and increase the overall power consumption. Reducing antenna and overall sensor size directly impacts the power-saving capabilities of a robotic system.

On the other hand, if the antenna size remains the same (between 77GHz and 24GHz), 77GHz can achieve a 3x narrower field of view. A focused beam is critical in industrial applications. For example, in level-sensing applications, it is important to avoid detecting the walls of the tank itself and minimize reflection from any obstacles inside the tank. A narrow field of view focuses the chirp beam and avoids side reflections, as shown in Figure 2.

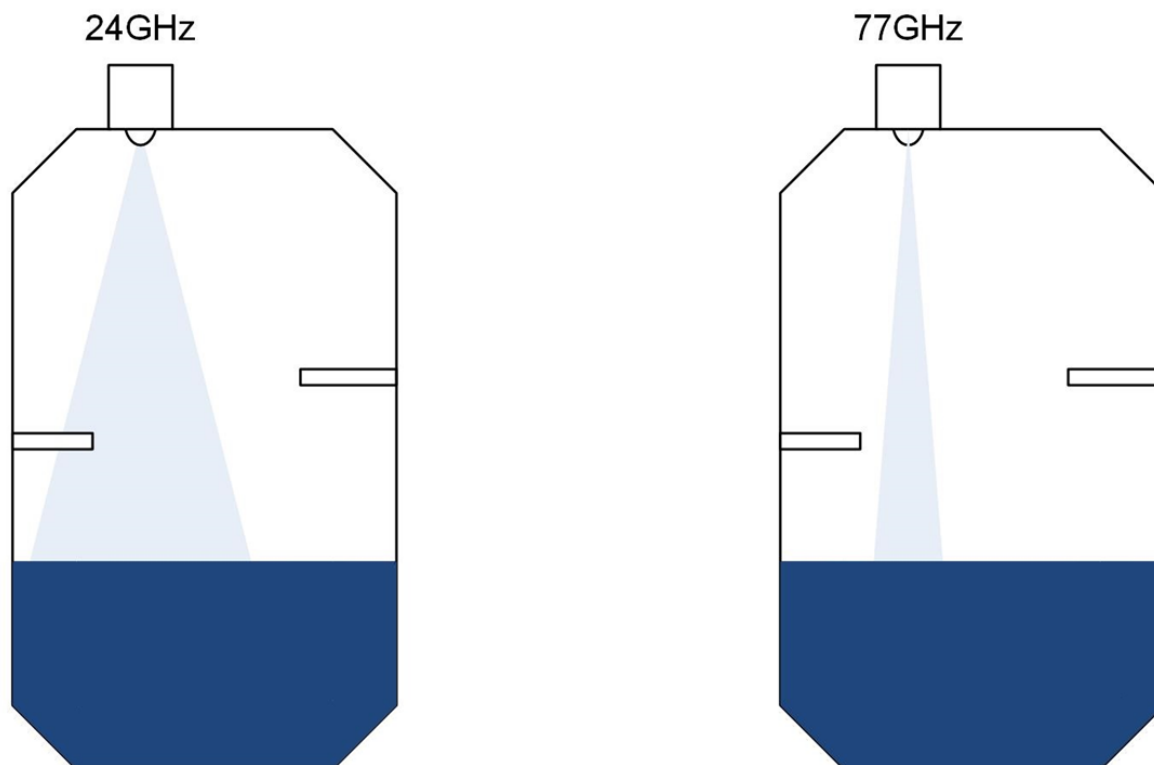


Figure 2. A Narrow Field of View, Enabled by 77GHz Radar, Focuses the Chirp Beam and Avoids Side Reflections

TI's mmWave sensors use state-of-the-art 77GHz radio-frequency sensing integrated into an easy-to-use system on chip. Small and robust sensor designs with high resolution and highly accurate detection are exactly why the industrial sensors need high-frequency 77GHz operation. These improvements differentiate TI's mmWave sensors in applications such as level sensing, traffic monitoring, robotics and building automation.

Additional Resources

- Learn more about [the 77GHz advantage in our white paper](#)
- Learn more about [level sensing using 77GHz in our white paper](#)
- Learn how [automotive applications can benefit from 77GHz radar in our blog](#)

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