10 Things You Should Know About Radar

The Reliable, Environment-Resistant, All-Around Automation Sensing Solution

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more sensors, more solutions

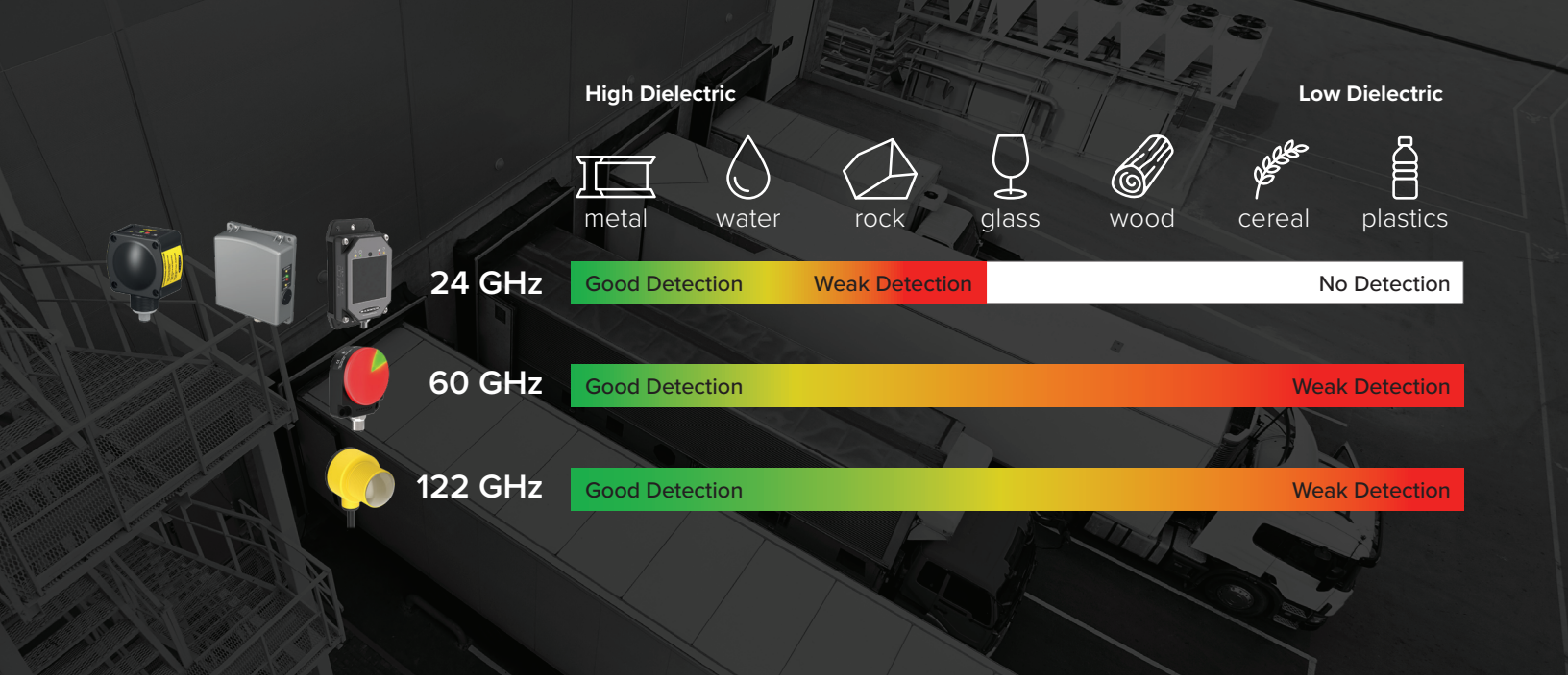
Sensing in particular environments can present a number of challenges that don't exist in close-quarter, climate-controlled settings. Temperature extremes, precipitation, swirling dust and dirt, objects in motion both near and far, and a variety of surfaces and materials require a device able to sort through it all. There's one type of device that can resist all these problems and detect only what's necessary whether indoors or outside—the radar sensor.

What Is Radar?

Radar stands for Radio Detection And Ranging. It's an object detection system in which electromagnetic radio waves are sent out by an emitter, returned to a receiver, and used to determine the distance, position, and presence of an object. Banner uses two types of radar sensor technologies: FMCW and PCR.

Sensors that employ FMCW (Frequency Modulated Continuous Wave) radar send out a continuous signal. The steady stream of radio waves means the sensor is constantly looking, making object detection very reliable. The constant stream also excels at distinguishing among different objects at various distances from the sensor.

PCR (Pulsed Coherent Radar) sensors send radio waves in pulses. Sending pulses uses less power than a continuous signal, resulting in energy cost savings. To further reduce energy use, PCR sensors often employ energy-saving, lower-powered transmitters which don't send radar waves as far as FMCW sensors. This makes PCR sensors better suited to shorter-range applications that require an ability to distinguish among targets.

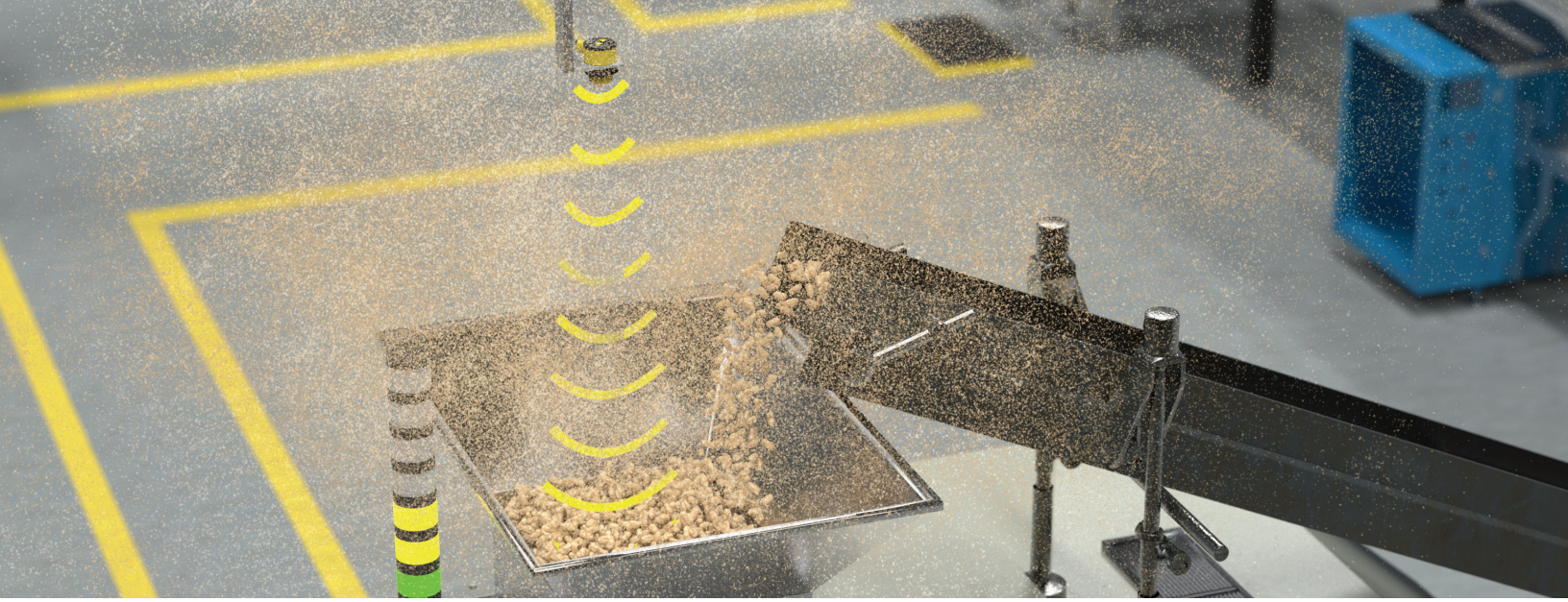


An object's shape, size, and material affect radar's detection ability. This ability to be detected is an object's radar cross section. Large targets are easier to recognize than smaller targets or those with curved surfaces. Materials that have a high dielectric constant (materials that conduct electricity well), like metal and water, will return a stronger radar signal than those with a lower dielectric constant (materials that absorb electricity), including wood, glass, and plastics.

Another crucial part of radar is the operating frequency. Different frequencies are able to detect different types of material. Large objects and high-dielectric materials are easily detected by long-range 24 GHz radar. Sensors that use 122 GHz radar are more capable at detecting small objects and a wider range of materials, especially materials with a lower dielectric constant. The middle ground is covered by 60 GHz sensors, able to detect a reasonably wide variety of object sizes and materials.

While familiar uses of radar include tracking aircraft and checking driving speeds, radar sensors are valuable in many industries. They can be used on vehicles for collision avoidance on cranes to maintain safe distances between them and their cargo, and detect the presence of vehicles in a parking garage or drive thru. Radar should not, however, be used for detecting people.

Radar sensors are also a key component of industrial automation. For example, they can measure solid or liquid volumes in containers. Fill levels are communicated to nearby workers via LED indicator lights or to employees monitoring remotely using alerts sent through a cloud service like Banner CDS. Radar sensors can let warehouse workers know when trucks have arrived, or tell robotic picking arms if items are on a conveyor belt.



10 Things You Should Know About Radar

1. Radar works in extreme temperatures, precipitation, dirt, dust, and low light
2. Radar used in Banner sensors can recognize both moving and stationary objects
3. Radar doesn't care about surface color or finish
4. Radar works equally well both inside and outdoors
5. Different operating frequencies have different advantages
6. Radar can be mounted and used in enclosures
7. Radar can detect objects through plastic or glass, even if the material is opaque or dirty
8. Some radar sensors can focus on the primary target while ignoring other objects
9. Radar can measure and detect within a long range
10. Radar sensors with a wide beam angle are not thrown off by varying shapes and surfaces

1 Radar works in extreme temperatures, precipitation, dirt, dust, and low light

Radar sensors ensure appropriate fill levels in a hopper are maintained to keep production moving. When materials such as grain or concrete mix are loaded into a hopper, dry dusty particles fill the air. Dust will cause many optical sensors to suffer signal loss, while ultrasonic devices may give incorrect readings if dirt builds up on the sensor. Radar waves, on the other hand, pass through the airborne particles to accurately measure the hopper levels.

Someone working a drive-thru window at a restaurant, bank, or pharmacy needs to respond quickly when a customer arrives. A K50R radar sensor can detect cars in snow, rain, fog, sunlight, or low light—conditions that may cause false or no detection when using other sensor technology. Quick and efficient vehicle recognition lets businesses analyze traffic patterns and eliminate bottlenecks, minimizing wait times and ensuring timely service.

Extreme temperature swings, fog, steam, and water spray inside an automated car wash can make detecting a vehicle's position problematic, even by commonly used ultrasonic sensors. Temperature variations affect the speed of ultrasonic sound waves, resulting in false vehicle location information. Noise from equipment and changing air currents inside a wash can also interfere with ultrasonic sensors. However, a single T30R radar sensor configured for retroreflective mode can reliably determine a vehicle's position, telling the wash system to turn each section on and off at the correct times. This makes the process more efficient by saving water and cleaning agents, prevents equipment from contacting and damaging vehicles, and ensures a high-quality wash.

2 Radar used in Banner sensors can recognize both moving and stationary objects

Each day there are more than 100,000 commercial flights worldwide. These require a great number of ground support vehicles like belt loaders, passenger boarding stairs, and catering trucks. This constant traffic on the tarmac greatly increases the potential for accidents and damage to aircraft.

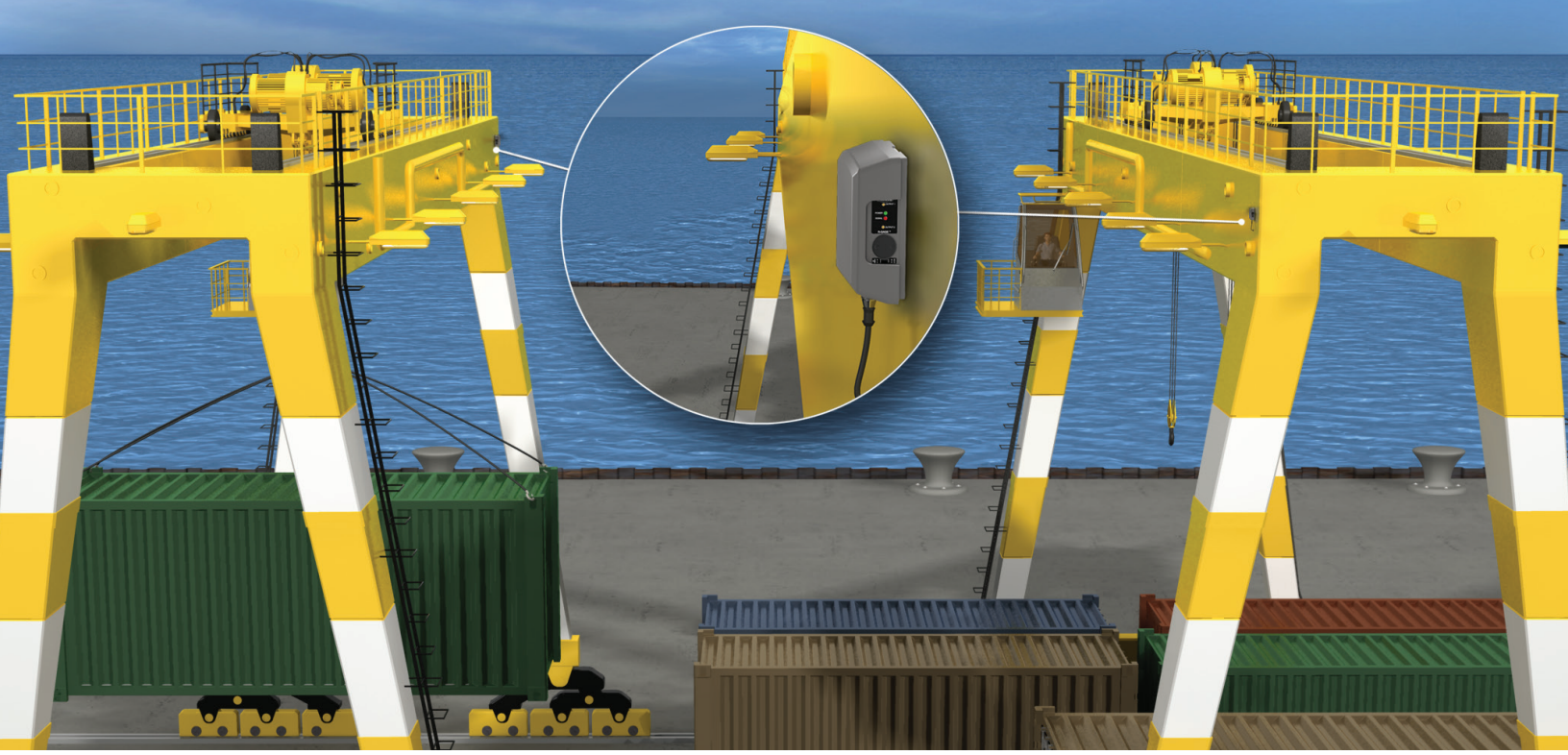
New standards require certain ground support vehicles to include collision-avoidance sensors. Instead of a narrow beam pattern, a radar sensor with a wider beam, like the 45-degree beam found in the T30R-4545, can detect an aircraft being moved by a tug or parked on the tarmac. The sensor constantly monitors the distance between a vehicle and the aircraft and sends that information to the vehicle's controller. If the vehicle gets too close to a plane, the controller automatically slows the vehicle, reducing the chance of a collision that costs both money and time.

3 Radar doesn’t care about surface color or finish

In an automotive assembly plant, new wheels need to be identified by a sensor and picked up by robotic arms from an assembly line conveyor. The wheels are difficult for optical sensors to accurately recognize because the shiny, metallic curved surfaces reflect light away from the sensor’s receivers.

Radar sensors, such as Banner’s T30R series, can identify objects that have uneven surfaces; are glossy, reflective, matte black, or any other color; or have mirrors or windows. This allows the T30R radar sensor to reliably detect the position of each wheel on the automotive plant’s conveyor. The sensors send that location information to the robotic arms' controllers so they know precisely where to find each part.

By detecting any objects on the assembly line regardless of color, shape, or reflectivity, production can continue with less downtime.

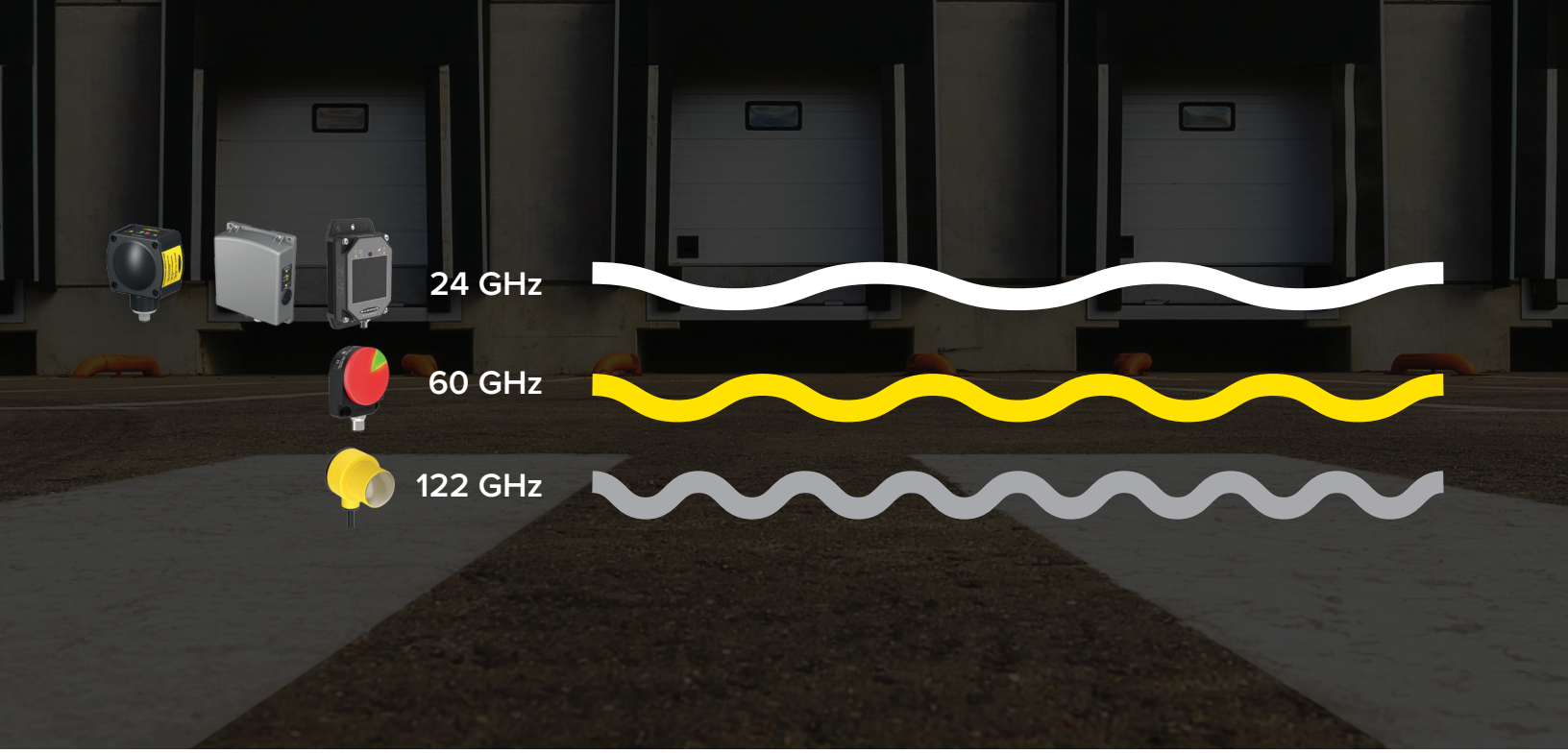


4 Radar works equally well both inside and outdoors

Large gantry cranes moving heavy loads through outdoor shipping yards often work in close proximity to one another. A collision could result in damaged cargo, expensive crane repairs, and cause a long-term shutdown of the yard, halting cargo movement indefinitely. Long-range radar sensors with a narrow beam pattern, such as the Q130R or Q240R, can reliably detect obstacles and other cranes before a collision occurs while ignoring nearby cargo containers.

Warehouse lifting equipment, like reach stackers and forklifts, can collide with and damage shipping containers. These collisions result in lost time, damaged goods, and broken equipment. T30R and K50R sensors can be used for shorter-range collision-avoidance protection. When mounted on lifting equipment, these sensors detect the shipping containers and send a signal to the equipment to automatically slow down and approach at a safe speed.

Because radar is not susceptible to changing environmental conditions, sensors can even be used to monitor equipment that operates both indoors and out, such as lifts transporting cargo from indoor loading bays to vehicles waiting outside. Using the same sensors across all equipment also minimizes maintenance costs.



5 Different operating frequencies have different advantages

Some radar sensors operate at a lower frequency, such as the QT50R which emits waves at 24 GHz. Others use a higher frequency, including the T30R which operates at 122 GHz. Then there are those, like the K50R, which operate somewhere in the middle at 60 GHz. Whether low, high, or in between, each of these frequencies have their benefits.

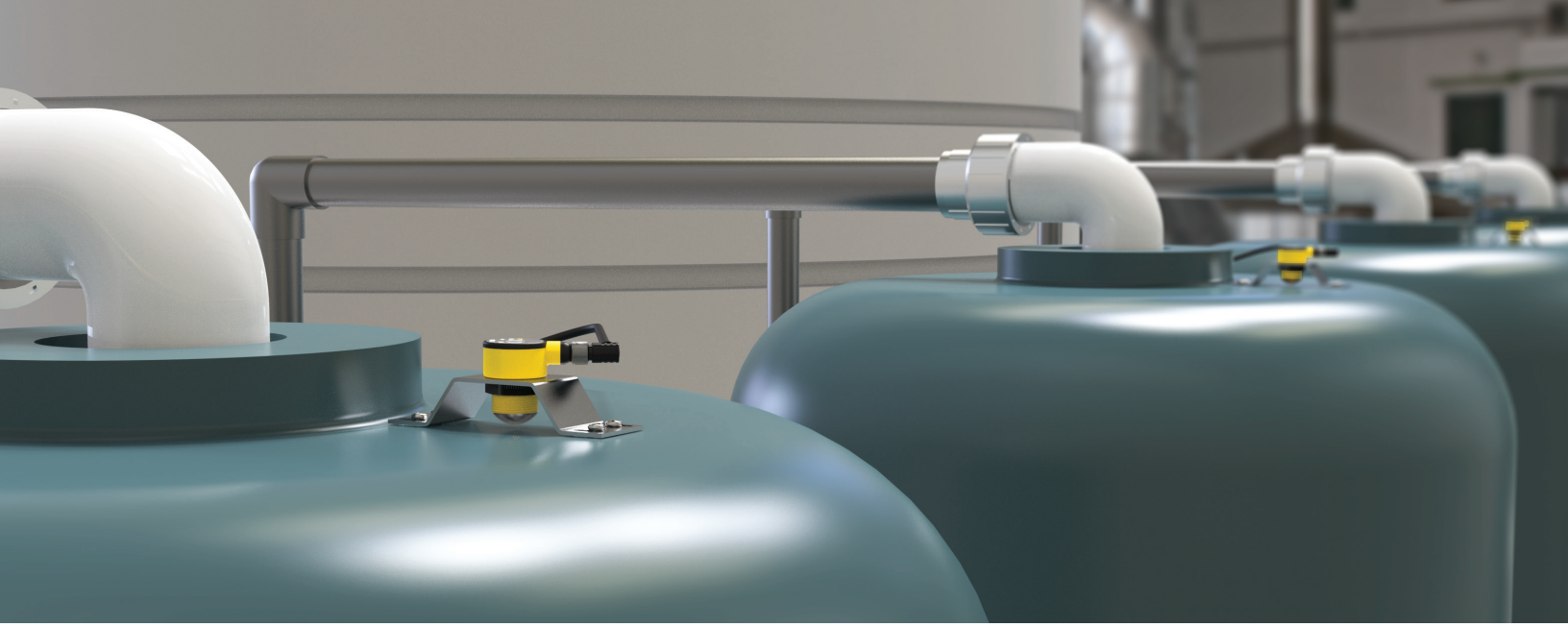
Most useful for detecting large objects, a lower-frequency 24 GHz sensor produces long wavelengths. Long-range detection and an ability to ignore ambient weather like heavy rain or snow make it the most effective outdoor sensing solution. Conversely, a higher-frequency 122 GHz sensor produces short waves which excel at small-object detection, deliver superior accuracy, and are able to detect a wider range of dielectric materials.

Radar sensors operating at 60 GHz have abilities similar to sensors with higher operating frequencies to detect a wide range of materials both indoors and out. They also can ignore precipitation like their lower-frequency counterparts.

6 Radar can be mounted and used in enclosures

As electric vehicles (EVs) become more commonplace, so will EV charging stations located in public places. Not only must charging stations be resistant to vandalism, their use can be blocked by people parking non-EVs in front of them. A system is needed to reliably identify unauthorized vehicles while also being hidden and protected from damage.

Radar sensors like the K50R are ideal for use inside EV charging stations because they can function properly even when mounted inside plastic enclosures. When cars park at an EV charging station, the K50R detects the vehicles' presence, no matter the weather. If a vehicle is detected but not plugged in to the charging station, a signal is sent to a central location to alert the appropriate people of a violation or improper use of the parking space. The offending vehicle can be removed, keeping charging stations available for EVs that rely on them.



7 Radar can detect objects through plastic or glass, even if the material is opaque or dirty

Monitoring liquid levels in tanks has often required a sensor mounted inside the tank. However, sometimes an external sensor solution is required, especially if direct contact with the liquid could damage or adversely affect the sensor. With their ability to penetrate most plastic and glass, radar sensors can be installed outside tanks where they are easier to mount and maintain.

A T30R radar sensor can be installed on a plastic tank's outer wall or a metal tank's sight glass. The sight glass or tank may be dusty or dirty, the plastic may be opaque, or the material inside the tank may be shrouded in mist. Even if the liquid has an uneven surface or is stored under pressure or in a vacuum, the high-frequency radio waves pass through the plastic or glass to measure the liquid level inside. When connected to an illuminated indication system, personnel can be visually alerted to the tank's fluid level without the need for an external controller.

To recognize vehicles entering an auto repair bay, K50R radar sensors can be mounted under heavy-duty plastic flush-mounted with the driving surface. The radar waves penetrate dirt and water left behind by vehicles on the repair bay's floor and detect cars as they pull in. As part of an indication system, these sensors can let employees know a customer has arrived so they can quickly greet the customer, minimizing wait times and improving check-in efficiency.

8 Some radar sensors can focus on the primary target while ignoring other objects

There are certain situations in which sensors monitoring a large area must recognize only certain objects while ignoring others, such as disregarding objects in the background or smaller items near the sensor.

A truck approaching a loading dock can be detected by a horizontally mounted T30R-4545 wide beam sensor. By instructing the sensor to recognize the nearest target, it detects the truck parts closest to the dock instead of an axle or truck body that might return a stronger signal. Strip lighting connected to the sensor can give real-time feedback to the driver so they know exactly how close the truck is to the dock.

Using Banner's radar configuration software, the detection distances of the T30R can be set so the sensor only looks within a predetermined range. Vehicles driving in the background, posts close to the dock, and other unwanted objects both near and far will be ignored.

9 Radar can measure and detect within a long range

A busy rail yard is a large-scale dynamic work environment with numerous operations occurring simultaneously. Vehicles and rail cars of different shapes and sizes, moving at varying speeds on and around multiple tracks, and carrying myriad types of materials present a serious object detection challenge.

Trains consist of locomotives and a wide assortment of rolling stock including boxcars, flatbeds, hoppers, tankers, and more. Being able to track numerous trains and types of cargo on trailers at different distances, even while they are moving, can be handled by a radar sensor like the Q130R. The ability to detect both moving and stationary targets makes FMCW radar a more reliable solution than Doppler radar, which is only able to detect moving targets.

Despite dust swirling around the yard or dirt building up on the Q130R sensor, the radar signal can still detect objects up to 40 meters away. The radar sensor can be set to ignore trains parked in the background on one track while recognizing other trains as they pass in front, triggering RFID antennas so operators know the precise locations of cargo in the yard. The long-range detection afforded by radar sensors, plus radar's ability to "ignore" ambient weather conditions and airborne dust and dirt, make it an ideal rail yard solution.

10 Radar sensors with a wide beam angle are not thrown off by varying shapes and surfaces

Sharp edges and flat surfaces mounted at an angle can act like mirrors, deflecting radar signals and preventing a radar system from receiving accurate information. To ensure reliable object detection, a radar sensor with a wide beam angle can monitor large areas and consistently recognize rounded surfaces and angled objects.

A busy surface mine has equipment of all shapes and sizes, both mobile and stationary. Powerful haul trucks transport both mined and waste material, and their enormous size creates numerous blind spots all around the vehicle. With little room for error, collision avoidance is key to an efficient operation. The outdoor environment also presents other sensing challenges including wind, rain, and snow, plus dirt and dust churned up by mining operations.

Wide-angle radar sensors like the Q130R and QT50R can be deployed on the front and rear of haul trucks as a primary component in collision avoidance systems. Not only do they ignore ambient weather conditions, sensors can be configured to detect objects in blind spots regardless of the object's shape, size, color, material, or surface finish. By connecting a Q130R or QT50R to LED indicator lights, the truck's operator can quickly see when to check blind spots and slow down or stop the equipment and reduce the chance of a potentially costly collision.

Glossary

Beam pattern: The way a transmitted radar signal is concentrated. A narrow beam pattern focuses on a smaller area, allowing more precise object detection. A wide beam pattern reaches a larger area to better detect irregular surfaces and targets at angles.

Dead zone: An area near the transmitter in which a radar cannot detect or measure a target.

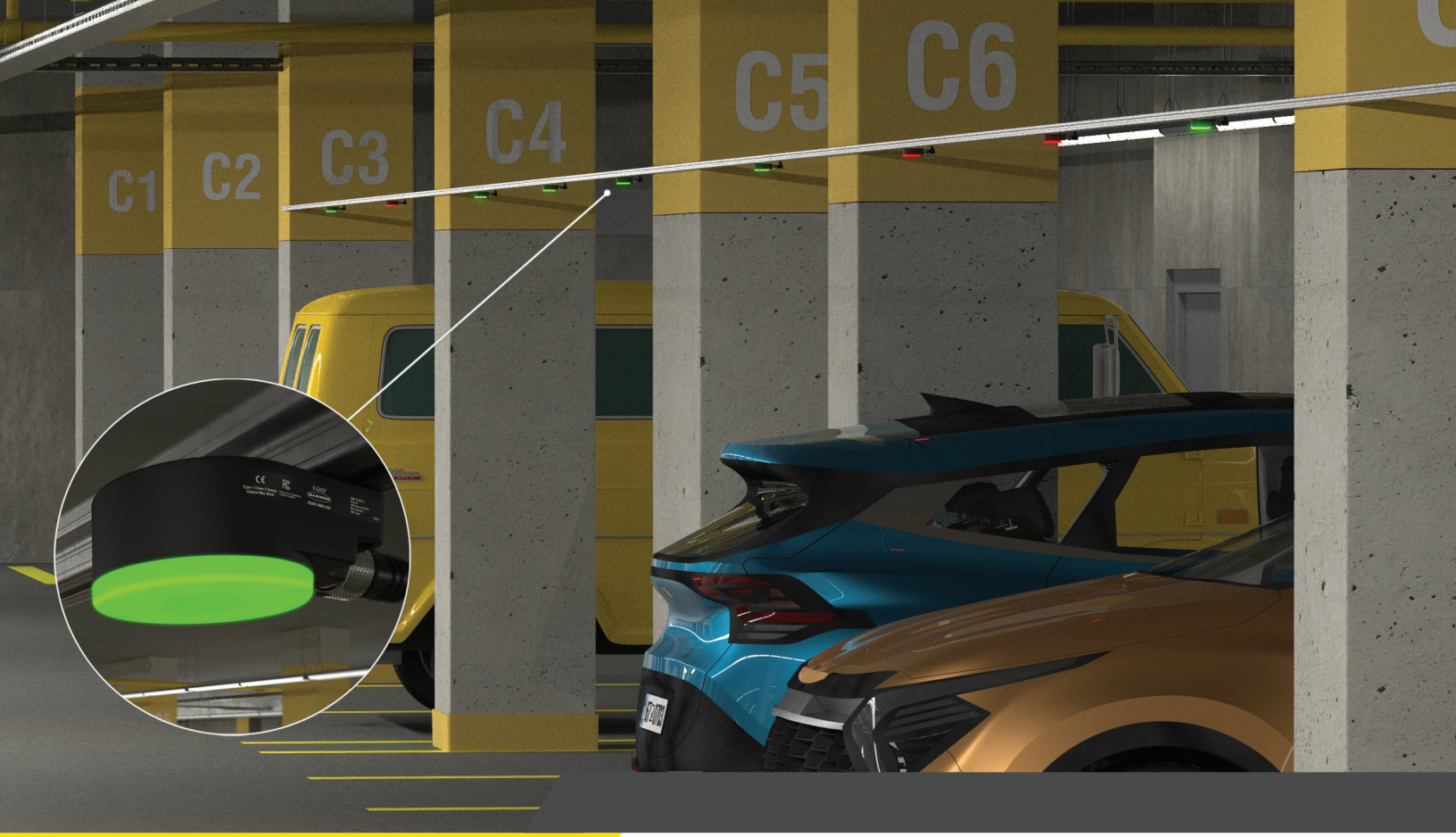
Dielectric constant: The measure of an object's ability to develop an electrical field and store energy. High-dielectric materials, such as metal and water, are more electrically conductive and reflect radar signals better than wave-absorbing materials like plastic, wood, cloth, and other organics.

Frequency Modulated Continuous Wave (FMCW) radar: Sends a continuous signal from a transmitter and receiver and compares the transmitted and received frequencies. FMCW can reliably measure the distance of the target from the radar system.

ISM bands: 24 GHz, 60 GHz, and 122 GHz are frequencies of the radio spectrum set aside for use by Industrial, Scientific, and Medical purposes. The frequencies at which industrial radar sensors operate fall within these designated ISM bands.

Pulsed Coherent Radar (PCR): Sends a series of pulses toward the target instead of a continuous wave. The PCR sends a pulse, turns the transmitter off, receives echoes from the target, then turns the transmitter back on to send a new pulse and continue the cycle.

Radar Cross Section (RCS): A measure of a target's ability to reflect electromagnetic signals back toward the receiver. The greater an object's RCS, the easier it is to detect. While the target's size is one factor, the material, shape, orientation, direction of travel, and angle at which radar waves reflect off the target also affect the RCS.



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Radar Sensors Improve Reliability and Operational Efficiency

On their own, radar sensors are a durable and reliable method for object and vehicle detection, collision avoidance, positioning feedback, and more. They can do all of this either indoors or out, at short ranges or long distances, even when the environment presents unusual challenges that might trip up other sensor technology. But when incorporated as part of an automated system comprising sensing, real-time indication, and instant feedback, radar becomes an incredibly powerful—and necessary—component of a reliable and efficient operation.

For more information about radar sensors, please visit bannerengineering.com.

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