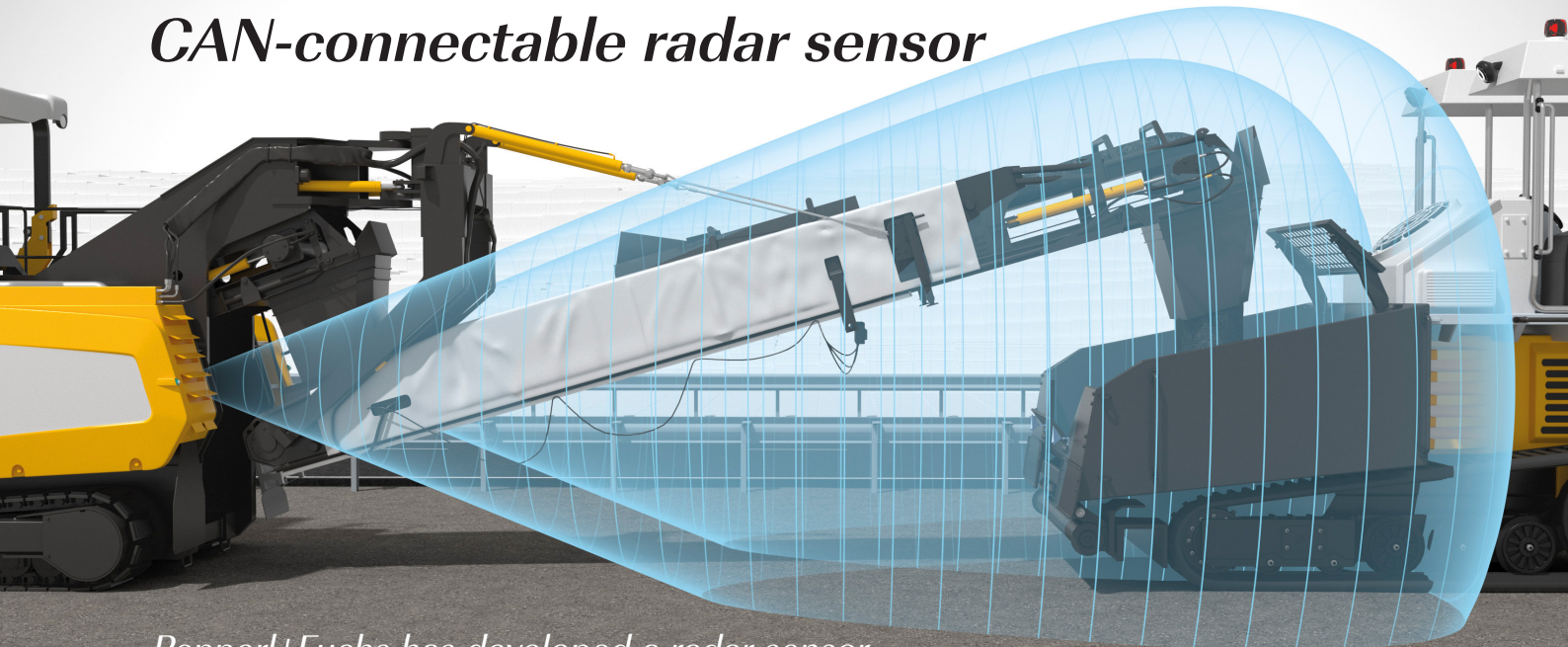
CAN-connectable radar sensor



Pepperl+Fuchs has developed a radar sensor featuring CANopen and J1939 connectivity. The product is suitable for use in agricultural machinery and mobile equipment.

Figure 1: Radar sensors are suitable for distance and speed measurements between mobile equipment, i.e., road-construction machines (Source: Pepperl+Fuchs)

The device makes use of the fact that radar waves are reflected or partially penetrated by different materials to varying degrees. On this physical basis, the industrial radar sensors offer three different measurement modes:

- *"Closest distance"* detects the object nearest to the sensor, regardless of the material. For example, distance measurement reliably detects a wide variety of objects in the exit area of a vehicle.
- *"Best reflection"* detects the object with the highest reflection, whereas interfering objects are simply suppressed. For example, the sensor can measure the fill level of a tank through the plastic wall.
- *"Fastest velocity"* uses velocity measurement to detect the object that moves towards or away from the sensor the fastest. This operating mode is used, for example, to monitor the travel path of automated-guided vehicles (AGVs).

Methodological stability

Radar waves are resistant to interference such as rain, fog, wind, dust, and temperature fluctuations. Using the frequency-modulated continuous wave (FMCW) method, the industrial radar sensor generates stable signals for comprehensive detection within the detection range. The hardware is housed in a compact housing with an IP68/69 degree of protection. The rotatable and tiltable sensor head can be aligned to the target area in virtually all installations.

A key advantage of FMCW principle is that the detection of nearly all materials is not limited to specific objects. However, the possible detection range and the measuring range depend on the reflective properties of the target object, the so-called radar cross section (RCS). The larger the RCS, the better the electromagnetic waves are reflected back to the sensor. Depending on the material, the radar waves are reflected back to the radar sensor to different degrees and are therefore detected to a greater or lesser extent. This degree of reflection is also influenced by the thickness, size, and shape of the target object. A flat metal surface offers sufficient reflection and is therefore suitable as a target object.

Multiple corner reflectors are available as accessories. These consist of three orthogonal metal plates and create an effective reflective surface. If a corner reflector made of metal is attached to a weakly reflective object or an object that is not ideally aligned with the radar sensor, its effective reflection area increases considerably. This allows to stabilize measurements on the intended target object and therefore optimize the application.

CAN connectivity

The CAN interface is accessible by means of various connector variants such as M12, Deutsch, and AMP Superseal. Users can choose between variants with CANopen CC (classic) and J1939-21/71 protocol stacks transmitting the measured values and parameterization messages. This enables to integrate the devices into CAN-based networks running at a configurable bit rate, with a default of 250 kbit/s. The CANopen variant uses a proprietary profile with parameters in the object-dictionary address range from 2000_h to 5999_h and the J1939 variant is based on proprietary parameter groups (PGs) as specified in the SAE J1939DA digital annex. Parameters that can be transmitted are status register, distance, signal quality, velocity, and a cycle counter.

The measuring principle, hardware, and signal transmission are designed for robustness. This means that the radar sensor is optimized for use in vehicles and mobile machines both indoors and outdoors. With their long range of up to more than 25 m, they detect an extensive area within the ▷

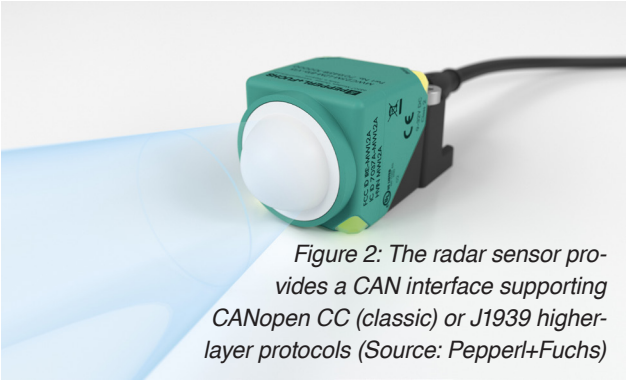


Figure 2: The radar sensor provides a CAN interface supporting CANopen CC (classic) or J1939 higher-layer protocols (Source: Pepperl+Fuchs)

radius of action of vehicles or their booms. To cover multiple areas, several devices can be mounted in close proximity to each other. They do not interfere with each other's function.

Application possibilities

The radar sensor can be used for velocity and environment monitoring in transport systems, crane booms, and construction machinery, among other things. When applied in outdoor machines such as for agriculture, it has to withstand harsh conditions. It can serve different purposes on agricultural machinery, such as speed measurement on seed drills, level measurement on field sprayers, or collision protection on harvesting machines.

The device can measure the actual movement of the vehicles relative to the ground (speed over ground). Bumpy ground is reliably detected and interfering objects such as plants are suppressed. In spray agent tanks, the device measures the fill level through the plastic tank wall and can also be retrofitted. The sensor therefore enables continuous monitoring of consumption to optimize the use of spraying agents. In intralogistics and merchandise management, the industrial radar sensor can perform similar control and safety tasks. It is used on vehicles and transport systems with and without drivers (forklifts, automated-guided vehicles, autonomous modular robots, etc.).

In road construction, a tandem of paver and feeder can be used for placing the pavement. The feeder continuously feeds the paver with material, such as asphalt, while the paver is on the move. It must be ensured that the distance and alignment to each other are correctly maintained at all times. The use of two radar sensors increases precision. Mounted on the feeder, they measure on two corner reflectors attached to the paver. Minimal distance or track deviations can therefore be registered and corrected.

Key features of the industrial radar sensor

- Distance measurement over more than 25 m
- Velocity measurement up to ±80 m/s
- Sampling rate of up to 200 Hz
- Integrated CAN interface supporting CANopen or J1939
- Ambient temperature range from -40 °C to +70 °C
- Working in rainy, foggy, windy, or dusty environments
- Interference-free measurement of the target object through objects with a lower reflection amplitude
- Safety level up to PL c

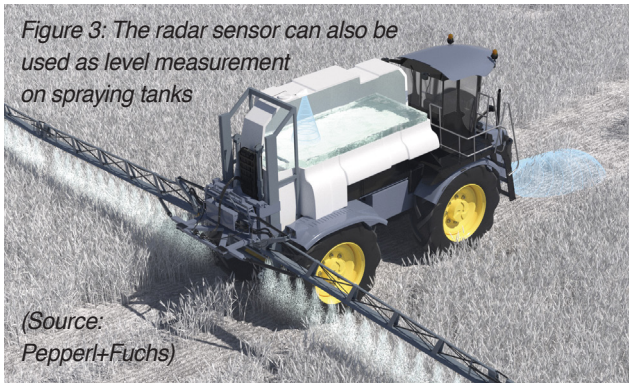


Figure 3: The radar sensor can also be used as level measurement on spraying tanks (Source: Pepperl+Fuchs)

The radar sensor can be utilized in controlling crane booms. The lobe of a radar sensor mounted in the main boom is directed at a corner reflector positioned in the tip of the hydraulic telescopic element. If this telescopic element moves forward or backward when the boom is extended or retracted, the sensor registers this change in distance and transmits these values to the crane control system as the basis for further positioning operations. Contaminants such as hydraulic oil residues inside the crane arm do not impair the performance of the radar sensors.

Integrated into agricultural machinery, the radar sensor can measure the actual movement of the vehicle in relation to the ground even in rough surface environments. This enables a precise control of agricultural equipment such as field sprayers, harvesters, and seed drills. The efficiency of the process is increased, overlaps and gaps are minimized and the use of seeds, fertilizers, and pesticides can be optimized. The radar sensor can also play a role in level measurement on spraying tanks. It enables monitoring of the fill level through the plastic tank wall, depending on the thickness of the wall, without the need for physical intervention in the tank. This also makes retrofitting possible. In addition, this enables continuous monitoring of the fill level to ensure the correct amount of spray agent is used, maximizing the efficient use of resources, and avoiding overdosing and wastage, while early warning of low levels can optimize operations.

In general, a high speed is an advantage in outdoor logistics. However, forklifts, AGVs, and AMRs operated in factories and warehouses need to consider certain speed restrictions. To relieve personnel of this responsibility, a vertically aligned radar sensor that detects the hall ceiling or metallic cross bracing below can determine whether the vehicle has reached an indoor area. If this is the case, the maximum possible speed is automatically limited to a tolerable level and released again when the vehicle leaves the hall. Due to the reflectivity of the metal crossbars, the installation of a corner reflector is not necessary here.

The safe use of heavy-duty AGVs for liquid or gaseous media places special demands on sensor technology. The dimensions of the vehicles and the associated large monitoring area must be taken into account, as well as the weather influences in outdoor areas. Due to their long measuring range, it is also possible to monitor the flanks of long vehicles. Hereby, outdoor weather conditions do not affect the measurement accuracy. ◀

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