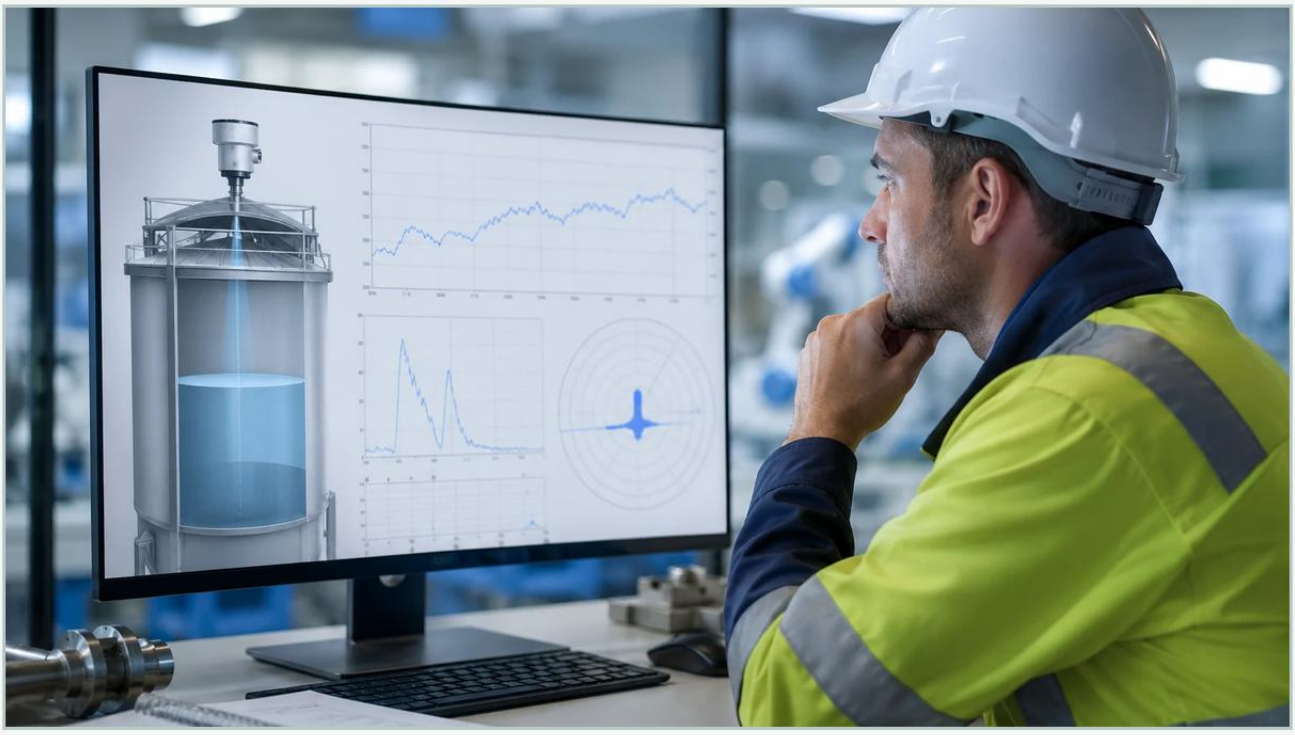
# Vegapuls 21

A practical guide to vegapuls 21, covering the reader intent, the relationship to vegapuls 21, key evaluation criteria, common risks, and the information the intended project audience should confirm before taking the next step.



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In the field of industrial level measurement, the transition from ultrasonic technology to high-frequency radar has significantly improved process reliability. The Vegapuls 21 represents a specific category of compact 80 GHz radar sensors designed primarily for the water and wastewater industry, as well as auxiliary processes in various industrial sectors. This article provides a detailed engineering reference for understanding the operation, application, and installation of the vegapuls 21, while offering a comparative perspective on modern radar technology.

## 1. Measurement Principle: 80 GHz FMCW Radar

Before evaluating specific hardware like the vegapuls 21, it is essential to understand the underlying physics of its measurement method. The sensor operates using Frequency Modulated Continuous Wave (FMCW) technology at a frequency of 80 GHz.

## The FMCW Method

Unlike older pulse-radar systems that measure the time-of-flight of a single microwave pulse, FMCW sensors emit a continuous signal with a constantly changing frequency. This frequency "sweep" is transmitted toward the medium, reflected by the surface, and received by the antenna. Because the frequency of the transmitted signal changes over time, there is a distinct frequency difference between the transmitted signal and the reflected signal received at any given moment. This frequency delta is directly proportional to the distance between the sensor and the material surface.

## Advantages of 80 GHz Frequency

The choice of 80 GHz (W-band) over traditional 6 GHz or 26 GHz radar offers several technical advantages:

Narrow Beam Angle: Higher frequencies allow for a much tighter signal focus with a smaller antenna. The vegapuls 21 typically features a beam angle of approximately 4°, which minimizes the risk of false reflections from tank walls or internal obstructions like pipes and ladders.

Superior Signal Sensitivity: The 80 GHz signal is better reflected by media with low dielectric constants and is less affected by surface turbulence or foam compared to lower-frequency alternatives.

Compact Design: The short wavelength allows the entire sensor electronics and antenna to be housed in a small, integrated package, suitable for tight installation spaces.

## 2. Technical Evaluation of the Vegapuls 21

The vegapuls 21 is engineered as a cost-effective, non-contact level sensor for simple applications. It is often utilized in environments where maintenance-free operation is a priority. For engineers seeking a broader range of industrial instrumentation, including customized OEM/ODM services for radar and ultrasonic level measurement, visiting the Main Page provides access to comprehensive technical documentation and alternative product catalogs.

## Key Specifications

| Parameter | Value (Metric) | Value (Imperial) |
|---|---|---|
| Measuring Range | Up to 15 m | Up to 49.2 ft |
| Accuracy | ±2 mm | ±0.079 in |
| Frequency | 80 GHz | 80 GHz |
| Beam Angle | 4° | 4° |
| Process Temperature | -40 to +80 °C | -40 to +176 °F |
| Process Pressure | -1 to 3 bar | -14.5 to 43.5 psi |
| Protection Rating | IP66/IP67/IP68 (3 bar) | NEMA 4X, 6P |
| Output Signal | 4…20 mA / HART, Modbus, SDI-12 | 4…20 mA / HART, Modbus, SDI-12 |

## Connectivity and Setup

One of the defining features of this series is the integration of Bluetooth communication. This allows for wireless adjustment and diagnostics via a smartphone or tablet. In industrial environments where sensors are mounted in hard-to-reach locations—such as atop tall silos or inside deep pump sumps—this feature significantly reduces commissioning time and improves safety for maintenance personnel.

# 3. Selection Criteria for Compact Radar Sensors

When selecting between the vegapuls 21 and other level measurement technologies, engineers must consider the specific environmental conditions of the application.

## Radar vs. Ultrasonic

For many years, ultrasonic sensors were the standard for water level measurement. However, radar technology has largely superseded ultrasonic in critical applications for several reasons:

1. Atmospheric Conditions: Ultrasonic signals rely on air as a medium. Changes in air temperature, pressure, or the presence of vapors and gases change the speed of sound, leading to measurement errors. Radar (microwaves) is unaffected by these factors.

2. Wind and Turbulence: Strong winds can "blow away" an ultrasonic signal, whereas radar remains stable.

3. Dead Zones: While ultrasonic sensors have a significant "blocking distance" (often 250 mm to 500 mm) where they cannot measure, the vegapuls 21 has a near-zero dead zone, though signal quality is highest when the medium is at least 50 mm (2 in) from the antenna.

## Chemical Compatibility

The housing of the vegapuls 21 is typically constructed from PVDF (Polyvinylidene fluoride), which offers excellent resistance to a wide range of acids and alkaline solutions. This makes it suitable for chemical storage tanks in water treatment facilities.

# 4. Installation and Engineering Best Practices

Proper installation is critical to ensuring the long-term accuracy of the vegapuls 21. Despite its narrow beam angle, certain geometric rules must be followed.

## Positioning and Mounting

Avoid the Center: The sensor should not be mounted in the center of a cylindrical tank, as multiple reflections from the walls can converge and interfere with the primary signal.

Nozzle Geometry: If the sensor is mounted on a nozzle, the nozzle should be as short as possible. The antenna should ideally extend slightly beyond the bottom of the nozzle to prevent "ringing" or internal reflections.

Obstructions: Ensure the 4° signal cone is clear of agitators, heating coils, or inflow streams. If an obstruction is unavoidable, the sensor's software can often perform a "false signal suppression" to ignore the static reflection.

## Mounting Hardware

The vegapuls 21 generally uses a G1½ or 1½ NPT thread. In open-air applications, such as river level monitoring or open channels, a mounting bracket is typically used. For closed tanks, a flange adapter or a threaded socket is standard.

# 5. Industrial Applications and Use Cases

The vegapuls 21 is versatile but excels in specific scenarios where simplicity and reliability are paramount.

## Water and Wastewater Management

In sewage treatment plants, the sensor is used for level monitoring in grit chambers, primary clarifiers, and sludge tanks. Its IP68 rating allows it to withstand temporary submersion, which is a common risk in flood-prone pumping stations.

## Pumping Stations and Rain Overflows

Because the sensor is unaffected by the high humidity and condensation typical of underground sumps, it provides a more stable signal than ultrasonic devices. The SDI-12 and Modbus outputs are particularly useful for battery-powered data loggers used in remote environmental monitoring.

## Small Chemical Tanks

In industrial manufacturing, many processes require the storage of additives or cleaning agents in plastic IBCs (Intermediate Bulk Containers) or small polyethylene tanks. The vegapuls 21 can often measure through the plastic roof of an IBC, allowing for level monitoring without opening the container, which maintains the integrity of the chemicals and reduces vapor exposure.

# 6. Limitations and Risk Assessment

While the vegapuls 21 is a robust instrument, it is not a universal solution for every industrial challenge. Engineers should be aware of the following limitations:

Pressure and Temperature Limits: With a maximum pressure of 3 bar (43.5 psi) and a temperature limit of 80 °C (176 °F), it is not suitable for high-pressure boilers or high-temperature chemical reactors. In those cases, heavy-duty industrial radar sensors with stainless steel housings and cooling elements are required.

Extreme Foaming: While 80 GHz radar handles light foam well, extremely thick, dense foam (like that found in some fermentation processes) can absorb the microwave signal. In such instances, a guided wave radar (TDR) or a specialized low-frequency radar may be necessary.

Solid Media: While it can measure solids, its 15-meter range and compact antenna are better suited for liquids. For tall grain silos or dusty cement bunkers, larger radar sensors with higher power and specialized dust protection are recommended.

## 7. Frequently Asked Questions (FAQs)

Q: Can the vegapuls 21 be used in hazardous areas?

A: Yes, versions are available with ATEX, IECEx, and other regional explosion-proof certifications for use in Zone 0, 1, or 2 environments.

Q: Does the sensor require regular calibration?

A: No. Radar sensors are generally maintenance-free and do not require periodic recalibration because the speed of light is a constant. However, periodic verification of the output signal is recommended as part of standard plant maintenance.

Q: How does condensation on the antenna affect the measurement?

A: The 80 GHz signal and the convex shape of the antenna lens are designed to minimize the impact of condensation. Droplets usually bead off, and the signal processing software can compensate for the slight attenuation caused by a thin film of moisture.

Q: Is it possible to integrate the sensor into an existing PLC system?

A: Yes, the standard 4...20 mA HART output is compatible with almost all industrial PLC (Programmable Logic Controller) and SCADA systems. For digital-first architectures, Modbus RTU is also an option.

## Conclusion

The vegapuls 21 is a highly capable 80 GHz radar sensor that brings the precision of FMCW technology to applications previously dominated by less reliable ultrasonic sensors. By understanding the 4° beam dynamics and the environmental limits of the PVDF housing, engineers can implement a level measurement solution that is both accurate and virtually maintenance-free. For those requiring a wider array of measurement technologies—from hydrostatic transmitters to magnetic level gauges—the Main Page serves as a vital resource for technical selection and application support.