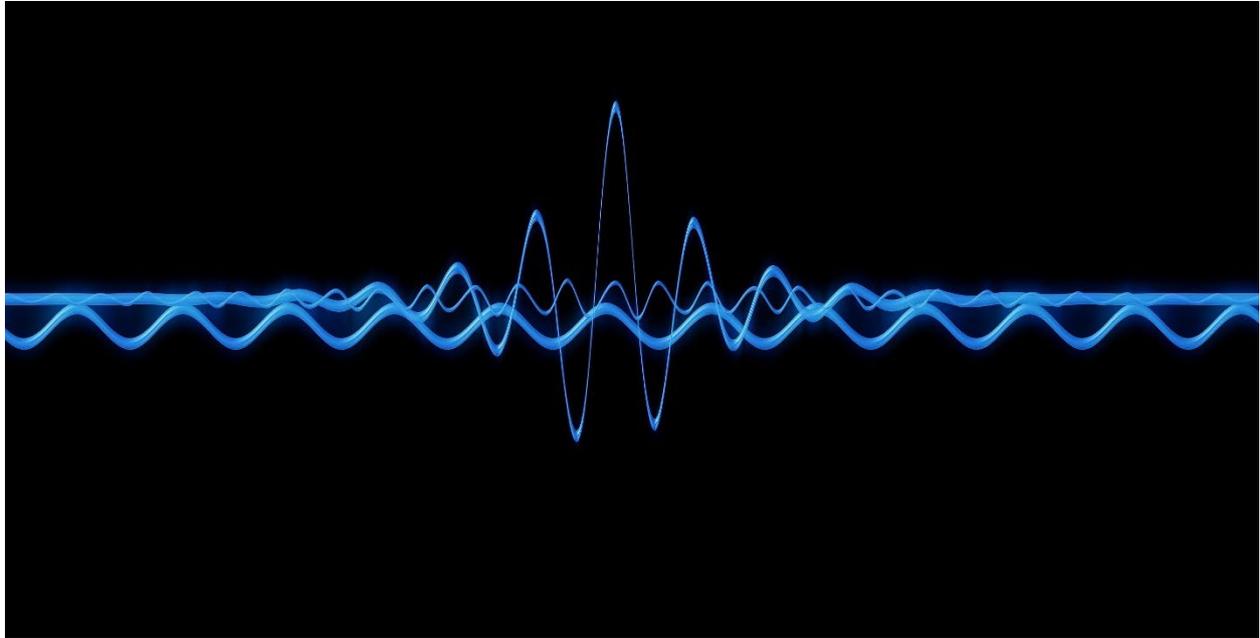# Dielectric Constant: The DK Value as the Key to Accurate Level Measurement

What the DK Value Reveals About the Measurability of Media

The dielectric constant (DK value, ε_r) is a fundamental material parameter in level measurement. It indicates how strongly a medium affects an electric field and is crucial in capacitive measurement methods as well as in signal reflection in radar technologies (FMCW or TDR).

Whether powders, granulates, or liquids: the DK value determines how clearly and consistently a measurement signal is produced — and therefore how reliably level conditions can be detected.

What is Meant by the Dielectric Constant?

The dielectric constant indicates how well a medium can store electrical energy or become polarised in an electric field. It is dimensionless and always specified relative to vacuum.

Formula for calculating the relative dielectric constant (relative permittivity):

$$\varepsilon_r = \frac{\varepsilon}{\varepsilon_0}$$

- **ε** = Permittivity of the material
- **ε_0** = Electric field constant (8.854×10^{-12} F/m)

The higher ε_r, the more strongly the material influences electric fields — an effect that plays a decisive role in level measurement.

How the DK Value Influences Signal Quality in Level Measurement

The higher the DK value, the more significantly the electric or electromagnetic field used for level measurement is affected.

This has a positive impact on:

- Signal strength

- Measurement stability

- Reliable detection despite dust, vapour, internal structures, pipes, or long measuring distances.

Signal Quality as a Function of the DK Value

| DK = 1.1 | DK = 3 | DK = 10+ |
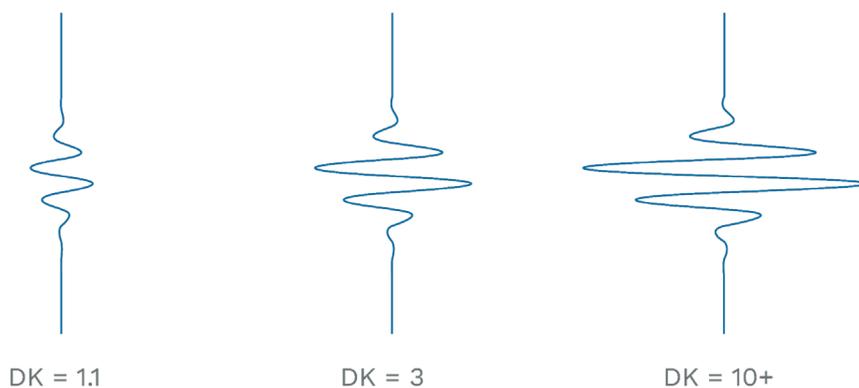
As the DK value increases, signal strength rises significantly — from weak echoes to clearly defined amplitudes.

Examples:

- **DK 1,1** → low signal response; measurement possible, but technically demanding depending on process conditions

- **DK 3** → noticeably more stable signal variation or reflection

- **DK 10+** → very clear signals and high measurement reliability, even under challenging conditions

Capacitive Technology: Measurement Signal Through DK-Dependent Capacitance Change

Capacitive level switches like our Capanivo® and RFnivo® series operate based on the capacitor principle.

$$C = \varepsilon_0 \cdot \varepsilon_r \cdot \frac{A}{d}$$

As the level rises, the medium displaces the air at the sensor. The DK value increases, the capacitance changes — and the sensor detects the level or point level accordingly.

**Radar: Measurement Signal Through DK-Dependent Reflection**

- The intensity of the radar echo is likewise influenced by the DK value:

- Low DK values → weaker echoes

- High DK values → strong reflections

Modern FMCW radar sensors such as the NivoRadar® series operate reliably even at DK values ≥ 1.1.

Guided radar (TDR), used in the NivoGuide® series, is less affected by dust or turbulent surfaces. However, the same principle still applies:
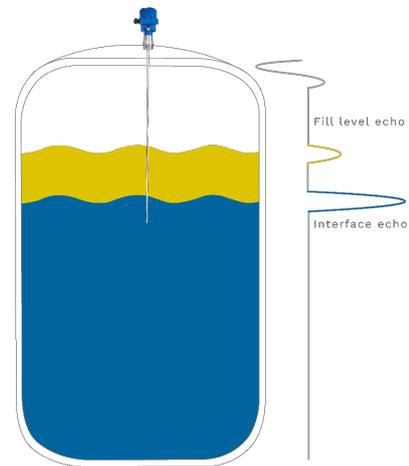**A higher DK value results in clearer and more stable signals.**

Non-contact radar – Comparison of Real Media

EPS / PPS
DK = 1,1 – 1,3

▢ Weak echo = low DK

Water
DK = 80
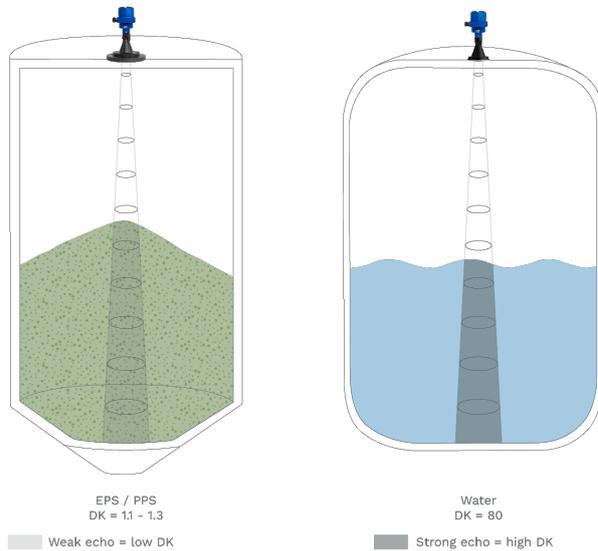
▧ Strong echo = high DK

With an identical measuring range, water generates a significantly stronger radar echo than EPS due to its high DK

Guided Radar (TDR) – Interface Measurement

Fill level echo

Interface echo

The signal curve shows two distinct echoes — the level and the interface — resulting from the different DK values of, for example, oil and water

The result: clear measurement points, stable processes, and reliable detection — regardless of the measurement principle used.

DK Values of Typical Materials from UWT Applications

Many industrial media differ significantly in their permittivity, which directly affects measurement behavior.

Medium	DK Value (approx.)
Air	1,0
EPS / EPP	1,1 – 1,3
Plastic granules	1,5 – 3
Wood pellets	~ 2
Grain, corn, soybeans	2 – 5
Cement, lime, gypsum	3 – 6
Coffee / cocoa powder	2 – 4
Oils	2 – 4
Alcohol (ethanol	~ 25
Water	~ 80
Milk	50 – 60

DK values vary depending on moisture, temperature, and density — our sensors are specifically designed to operate reliably under these real-world conditions.

EPS / Aerosil
DK = ~ 1.1 - 1.3

Granules / Grain
DK = ~ 2 - 4

Water
DK = ~ 80
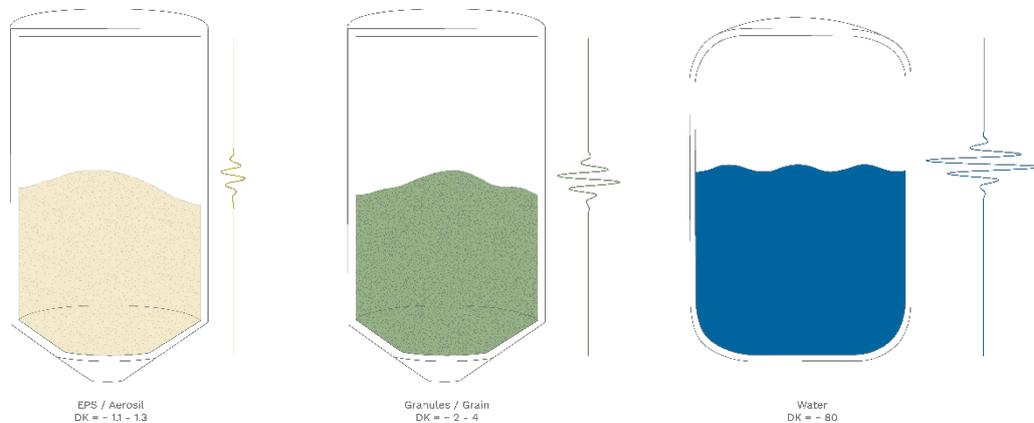
The DK value determines measurement behavior: depending on their permittivity, different materials generate measurement signals of varying strength

Additional DK Values at a Glance
For a more comprehensive overview, our compact PDF is available:

[Download DK Value Table]

Perfectly Matched Sensor Technology – for Every Medium

Capacitive Level Switches (Capanivo® and RFnivo®)

- Measure based on changes in the electric field distribution within the medium.
- Reliable even at low to medium DK values (≥ 1.5).
- Flexible designs for powders, granulates, pasty products, and liquids — from compact vessels to large industrial installations.

Radar Sensors (NivoRadar® and NivoGuide® Series)

- Operate reliably even at very low DK values (≥ 1.1) and benefit from higher DK values through stronger reflections and clearer measurement signals.
- In free-space FMCW sensors, echo quality increases significantly as the DK value increases — ideal for long measuring distances, dust, or turbulent surfaces.
- Guided radar (TDR) is less sensitive to surface turbulence; however, here as well, higher DK values improve signal stability and reflection quality.
- Depending on the model, both technologies are suitable for demanding applications involving bulk solids and liquids.

Echo Curve & Diagnostics with the UWT LevelApp

The UWT LevelApp enables wireless control of level sensors such as NivoRadar® and NivoGuide®. Using a mobile device, all sensor settings are easily accessible for straightforward and intuitive commissioning.

As part of sensor diagnostics, the echo curve is displayed clearly and comprehensively. It shows signal strength over the measuring distance and makes distinct echo peaks as well as potential interference directly.

Level and diagnostic data can be assessed transparently, with all relevant information easily accessible at any time via smartphone or tablet—offering valuable support for commissioning, service, and operation.
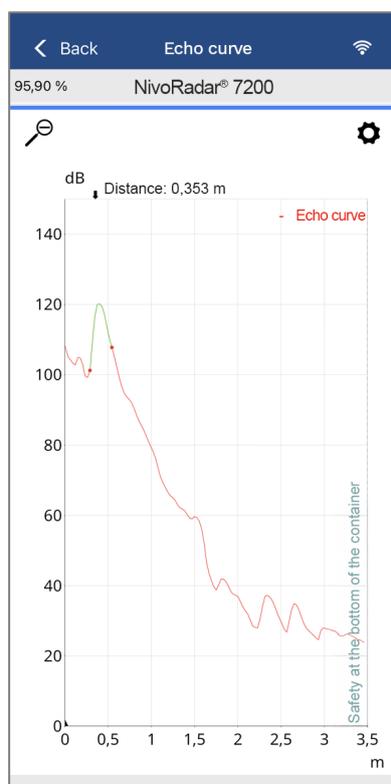
Example of an echo curve from the NivoRadar® NR 7: The distinct echo peak (green) marks the current level and indicates signal quality over the measuring distance.

DOWNLOAD UWT LevelApp

For easy and user-friendly setup and diagnostics of UWT radar sensors

App Store

Google Play

Level and diagnostic data can be evaluated transparently, and all relevant information is conveniently accessible at any time via smartphone — providing valuable support for commissioning, service, and operation.

Our commitment: Technology. Performance. Partnership.
Our sensors are designed to support industrial processes safely, reliably, and efficiently — across all industries and applications.