

# Calibration free Biosensing with Differential Signal Signature for Point of Care Testing

## Abstract

Conventional sensors face challenges in differentiating small dielectric changes under varying environmental conditions. Quad-stub microwave differential sensor with a single electromagnetic transparency window and Fano resonance under symmetrical conditions. A second transparency window appears upon small dielectric variations, linked to the imbalance extent. Resolves ethanol concentrations in aqueous solutions down to 2.5% v/v with minimal sample volume (~20  $\mu$ L).

## Methodology

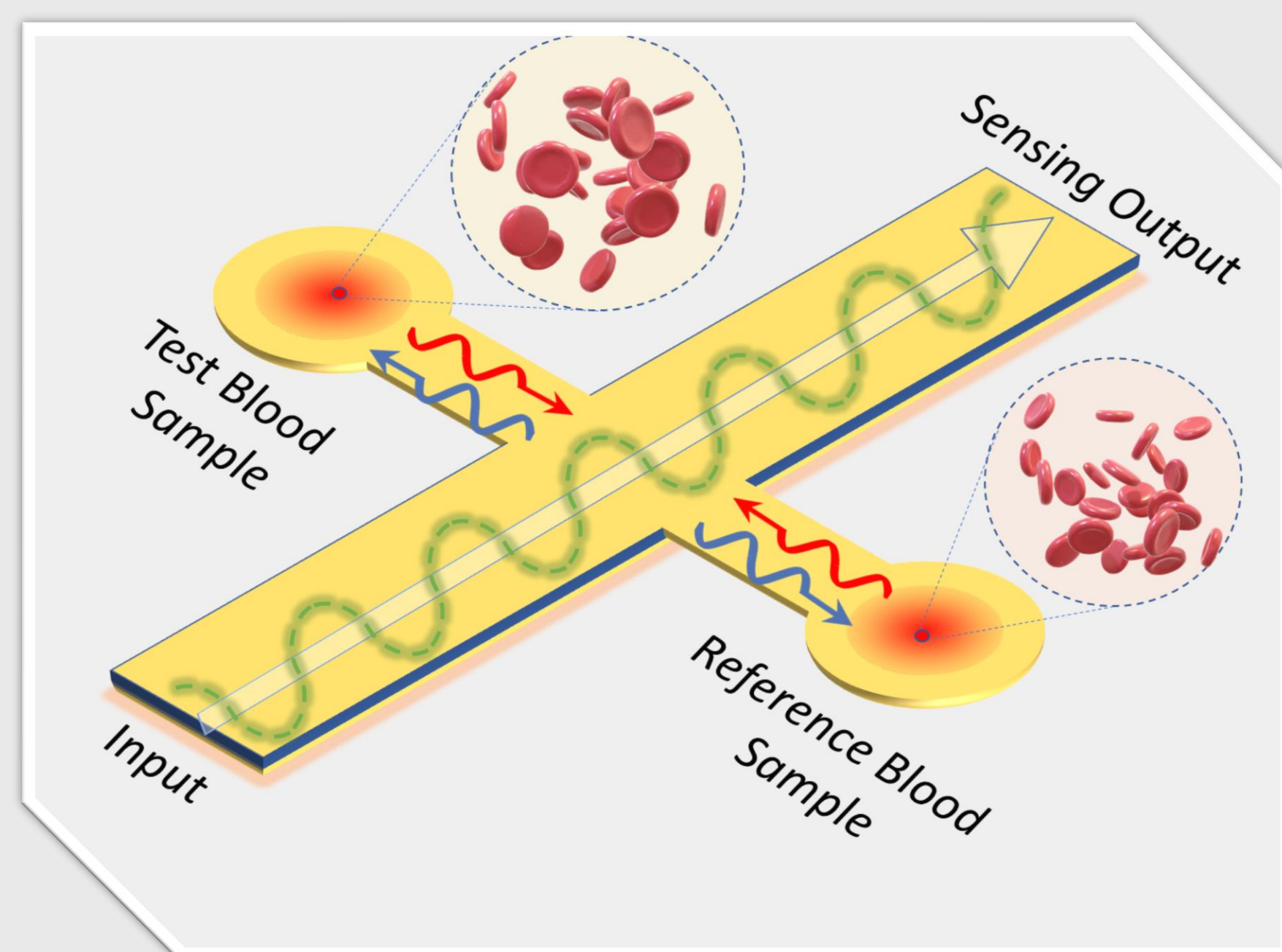
**Sensing:** Quad-stub structure ensuring differential resonance under slight perturbations.

**Operation:** Balanced configurations produce a single Fano resonance; unbalanced conditions introduce a second resonance.

**Validation:** Experimental setup used ethanol-aqueous solutions in capillaries (~20  $\mu$ L) for testing.

## Introduction

The study builds on Lorentz and Fano resonance principles, pivotal in optical and microwave sensing.



## Motivation

**Increased Accuracy:** By comparing signals from a control and test sample, the system reduces noise and interference.

**Simplified Workflow:** No need for constant recalibration, making it easier for healthcare providers and patients to use the device in a variety of settings.

## Applications

**High Sensitivity:** Detected ethanol concentrations as low as 2.5% v/v with ~20  $\mu$ L sample volumes, demonstrating precise differential sensing in the 2.25–2.5 GHz range.

**Scalability:** Adapted the design for THz frequencies using a metal slot waveguide, broadening applications to optical and terahertz domains.

**Practical Applications:** Effective for biomedical sensing, offering a compact, high-sensitivity solution for diverse industries.

## Contact

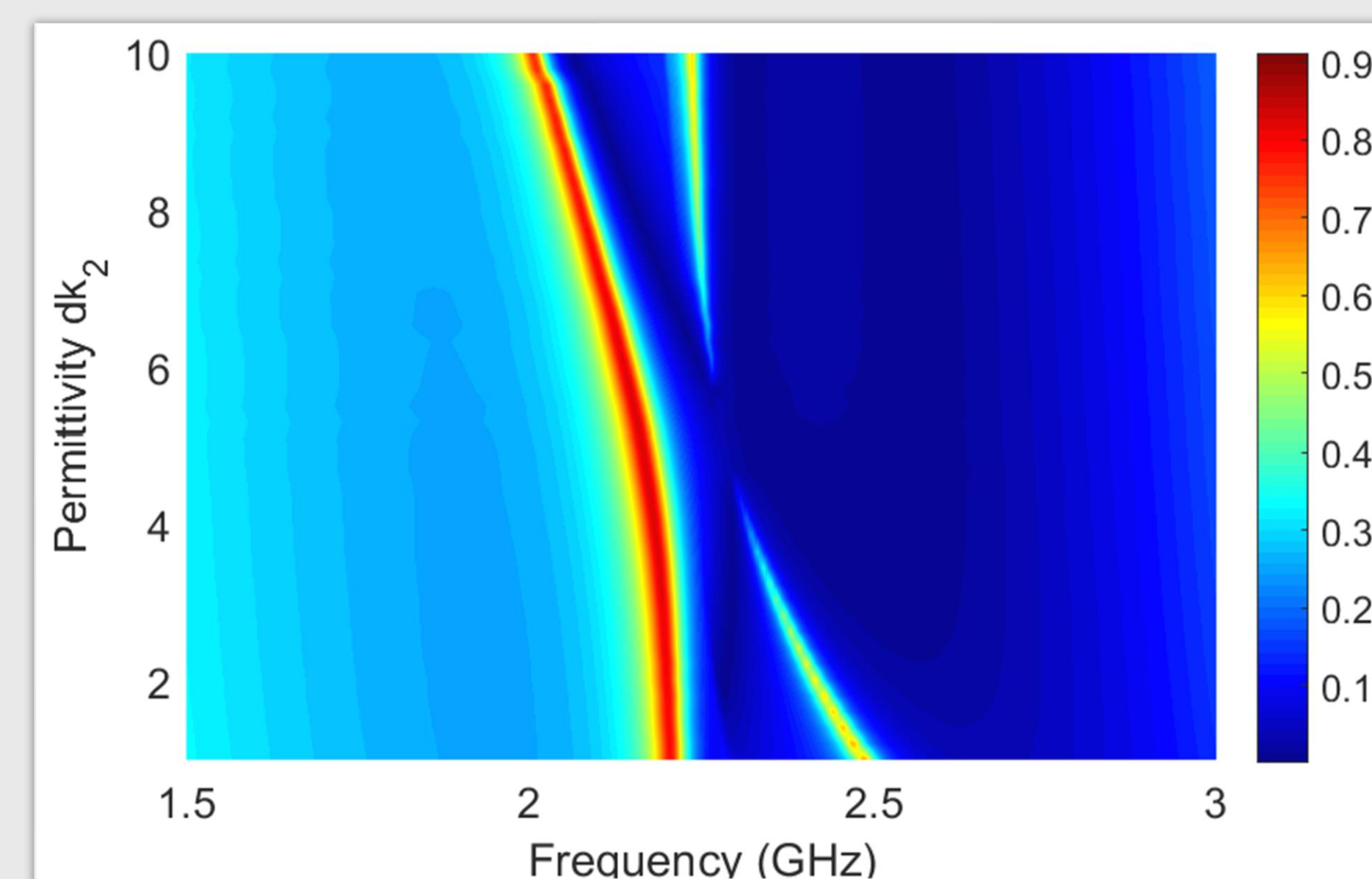
H. F. Abutarboush, M. Amin, R. Ramzan, O. F. Siddiqui, D. A. Sehrai, R. H. Atta “**Differential Dielectric Constant System and Method**” US Patent No: 12,105,031 Granted, Oct 01, 2024

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