

# High Q Microwave Bent-microstrip Sensor for Interface Detection in Immiscible Solutions

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WLR or water liquid ratio determination is one of the most significant steps in oil industries for their extraction and processing. When water and oil is mixed, an undesirable layer known as the rag layer is formed consisting of water, minute solid particles and dispersed oil. However, when leakage in tanks or filtering systems of the oil pipelines takes place, determine of the interface between the oil and the water becomes a crucial task. This interface is also critical to determine the quality of oil and tailing loss during oil processing. Conventional or offline detection, usually installed in the microwave or lower frequency regime, involves large amount of data and huge time to provide accurate results. To detect this concern in offline fields, a very sensitive and robust sensor is required that can easily be installed for detecting the issue in a limited time frame.

In this work, a complementary split ring resonator (CSRR) sensor with improved sensing performance is proposed to detect the oil-water interface for several immiscible solutions. Such sensors are recently gaining popularity than other planar RF sensors like split ring resonator (SRR), interdigitated capacitor (IDC) sensor etc., because of their high field confinement and ease of sample placement. The sensor novelty attributes in incorporating a lumped resistive element that is tuned to obtain an optimum performance for a specific value of  $47 \Omega$  in the modified top microstrip feed line that improves the fractional sensitivity up to 12.3 %, absolute sensitivity of 253 MHz, twice the electric field intensity and quality factor (Q) improvement up to 3000 which in the order of twice the magnitude as compared to a conventional CSRR ( $\sim 4.5$  %, 25 and 90 respectively) without the feeding element. After the electromagnetic validation of the sensor, it is then fabricated in Taconic ( $\epsilon_r=2.2$ ) substrate to carry out measurement of several oil-water solutions to detect their interface and immiscibility.

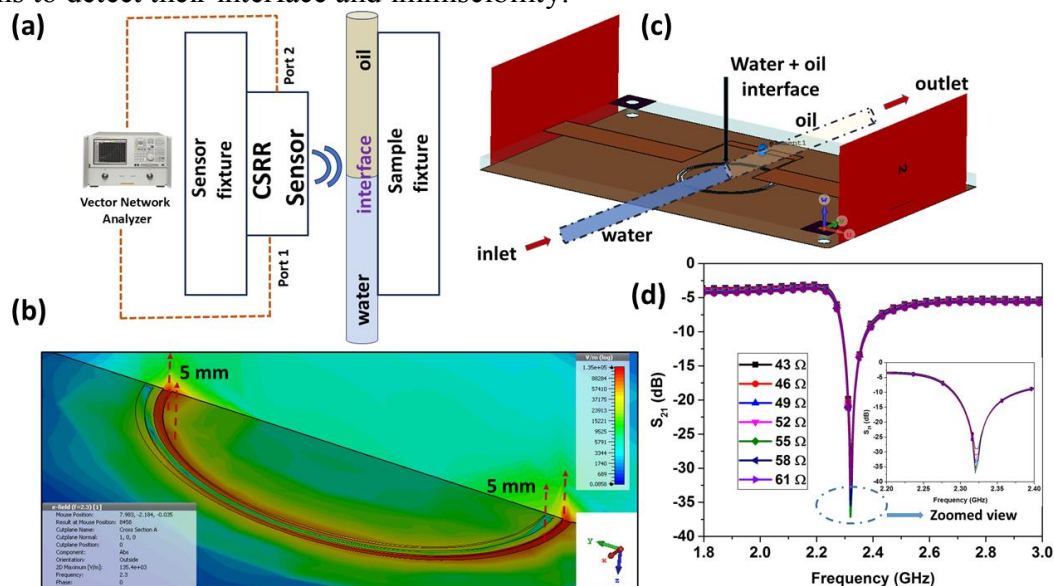


Figure 1. (a) Schematic of the proposed sensing prototype (b) Arrangement of the sensor and sample for oil water interface detection (c) Field diagram of the proposed CSRR sensor (d) Simulated response of the sensor for an optimum resistive value of  $47 \Omega$