# Homodyne Detection Based System for Continuous Glucose Monitoring

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## I. Introduction

A glucose test today is not convenient, accessible or even inexpensive and it is highly invasive, often using metal needles for skin puncture. Recent advances in detection techniques using microwaves [3], allow foreseeing new promising devices for glucose monitoring [1], [2].

A particularly important problem that microwave sensing may solve is that of reliably determining blood glucose levels in a painless manner. In this context, we report on the implementation of a waveguide cavity resonator at 3.6 GHz, used for demonstrating a homodyne detection scheme adapted for continuous glucose monitoring.

## II. Implementation

Figure 1 shows the custom made sensor cavity and the connection scheme for homodyne detection. The front-end circuitry around the new glucose sensor was developed using commercially available components. The only active RF equipment needed is a signal generator.

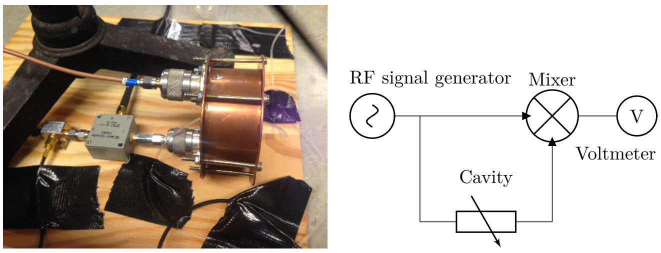


Fig. 1. The sensor measurement setup and connection schematics.

The microwave sensor has a central frequency of 3.5 GHz when holding a sample and acts as a band pass filter. A capillary tube, of internal diameter 15 mils, protrudes the cavity in its centre, maximizing the sensitivity. The read out circuit implements phase detection, using an RF mixer. The sensing signal is mixed down with a reference signal into a DC voltage, to be measured with an oscilloscope or a simple voltmeter.

The cable lengths and operating frequency were carefully adjusted so that the phase difference was close to 90° between the two signals going to the mixer. This increases the sensitivity of the homodyne detection.

## III. Results

We performed different standardized measurements with pure deionized (DI) water, and DI water with different glucose concentrations. Direct measurements on the cavity are shown in figure 2. The center frequency increases with higher glucose concentrations, which creates an increased phase shift through the cavity.

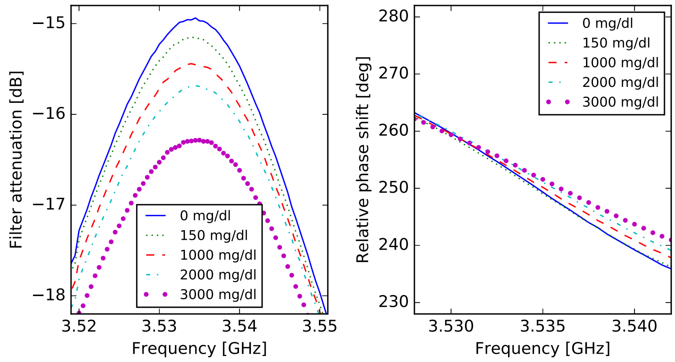


Fig. 2. The frequency response measured with a network analyzer.

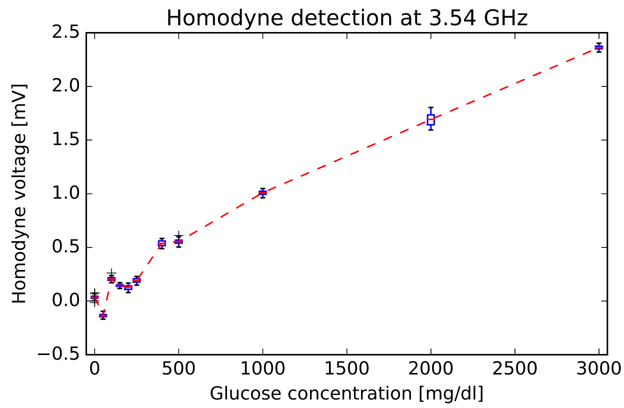


Fig. 3. The homodyne voltage for different concentrations.

The homodyne output voltage from the circuit is shown in figure 3. Notice that the voltage increases almost linearly with glucose concentration.

## IV. Conclusions

A novel microwave based glucose measurement sensor system has been developed, allowing measuring glucose concentrations within the clinical range.

## References

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[3] Maximilian Hofmann, Thomas Fersch, Robert Weigel, Georg Fischer, and Dietmar Kissinger. A novel approach to non-invasive blood glucose measurement based on rf transmission. In *Medical Measurements and Applications Proceedings (MeMeA), 2011 IEEE International Workshop on*, pages 39–42. IEEE, 2011.