

A Fast Active Differentiator Capacitance Transducer for Electrical Capacitance Tomography

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Abstract - This paper describes the development of a sensitive and fast transducer for use in electrical capacitance applications. The sensor works by supplying a short voltage pulse to an active differentiator. The sensor has been tested in a twelve electrode configuration mounted around a cylinder of 30 cm.

Keywords : tomography, capacitance, differentiator, transducer

THE OBJECTIVE

Electrical Capacitance Tomography (ECT) is a young, promising and developing technology with many possible applications. There are recent improvements in the software, particularly the deconvolution routines. However, these must clearly be matched by commensurate developments in the hardware, both the electrodes and the electronics [1,2]. The improvements required are both in sensitivity and speed. An increase in sensitivity will allow more electrodes and will allow the tomographic slice to be thinner. An increase in speed will widen the range of applications. This paper describes the development and testing of a new transducer for use in ECT applications.

THE TRANSDUCER

The transducer has been developed to measure capacitance of the order of 1 pF. It considers the unknown capacitance to be an element of an active differentiator. A constant, negative pulse with well-defined fall and rise times is created by an active differentiator circuit. Its potential fall and rise time are chosen to be 200 ns, and the high potential is kept constant for 1 µs. This pulse is supplied as the input signal for the active differentiator, as shown in Figure 1. At the output of the differentiator a positive and a negative peak result (point B in Figure 1). These peaks are separated using a peak-to-peak detector and are summed by a differential amplifier giving an output potential U_{out} . The sum of these peaks is independent of the baseline potential. Therefore, offsets on these peaks due

to a baseline drift have no effect on the measurement.

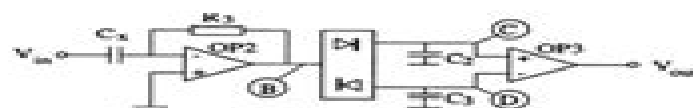


Figure 1: Active differentiator circuit, which forms the output signal proportional to unknown capacitance

The value of the sum of the peaks is determined by a 12-bit Analog Digital Converter. It directly serves as a measure of the unknown capacitance C_x .

$$C_x = \frac{U_{out}}{2 R_3 (\Delta U_{in} / \Delta T)} \quad (1)$$

The minus-input of the operational amplifier in Figure 1 is virtually grounded. Hence, the potential at the minus-input will not vary, and there is no influence of a parasitic capacitance to ground on the measured value.

After detection, it takes about 9 µs to digitise the signal, to write it to memory, and to reset the peak-to-peak detector to zero for the next measurement. One single capacitance measurement thus takes about 10 µs. Each electrode is equipped with identical input and measurement circuits which are mounted directly

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