Rani Holani/ Prof. P. C. Pandey (supervisor), "A bioimpedance simulator for impedance cardiography", M.Tech. Dissertation, Biomedical Engineering, Indian Institute of Technology Bombay, June 2014.

ABSTRACT

Impedance cardiography is a non-invasive plethysmographic technique for assessing the haemodynamic parameters which may be useful in the diagnosis of cardiac disorders. It involves monitoring of the variation in the thoracic bioimpedance during a cardiac cycle. A bioimpedance simulator is needed for simulating the thoracic impedance to test and calibrate the impedance cardiograph instrument. A bioimpedance simulator is developed for providing a continuously time-varying resistance with settable basal resistance, frequency, waveform, and peak-to-peak variation. It is designed as an interconnection of four blocks: resistance variation circuit, controller circuit, serial interface, and power supply circuit. The resistance variation circuit consists of a parallel combination of a voltage-controlled resistor (VCR) circuit for the time-varying component of the resistance and a digitally controlled resistance for the basal resistance. Novel circuits for realizing a VCR using JFETs and MOSFETs are investigated to generate resistance variation in accordance with the desired test waveforms. The VCR circuit used in the bioimpedance simulator is implemented using matched-pair n-channel JFETs, with SD-bootstrapped gate for eliminating nonlinearities occurring due to quadratic term of the drain current of JFET and self-tracking for stabilizing the channel resistance of JFET against variations due to device parameters. The voltages for controlling the channel resistance of JFET are generated by the controller circuit using a microcontroller with on-chip DAC. The switch-resistance network is implemented using a parallel combination of digitally controlled analog switches and fixed-value resistors. An isolated serial interface is provided for setting the simulation parameters of the control voltages from a PC to the microcontroller.