

Akshaya Prasad Mishra, A synchronous demodulator with automatic baseline restoration for impedance cardiography, M. Tech. Thesis, Department of Biosciences and Bioengineering, Indian Institute of Technology Bombay, June 2011.

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Abstract: Impedance cardiography is a noninvasive technique used for estimating the stroke volume and cardiac output by sensing the variations in the electrical impedance of the thorax during each cardiac cycle. The impedance is measured by injecting a high-frequency low-level current into the thorax using a pair of electrodes and sensing the voltage developed across it using another pair of electrodes. The sensed voltage is demodulated to extract the impedance variation signal. The objective of the project is to develop a demodulator for extracting a noise- and distortion-free signal. A demodulator based on synchronous current steering and sampling at the peaks has been developed to improve noise rejection, interference rejection, carrier ripple rejection, and sensitivity. A baseline restoration has been incorporated in the demodulator in order to extend the range of the basal impedance over which the impedance can be measured. The demodulator has been realized as part of a microcontroller-based instrument. A direct digital synthesizer (DDS) has been used for generating the sinusoidal excitation waveform with high amplitude stability and digital control over frequency. A digital potentiometer is used to set the amplitude of the excitation current from a voltage-to-current converter. Another digital potentiometer controls the signal amplitude for baseline correction. Another DDS is used to generate a square wave, synchronous with the sinusoidal waveform and with a settable phase shift, to serve as the reference for synchronous demodulation. The microcontroller has an isolated serial interface for control and data transfer. The entire circuit operates with a single supply. The operation of the demodulator has been verified for ripple and noise rejection and baseline restoration. The circuit has to be assembled as an impedance cardiograph and detailed tests need to be carried out before its clinical use.