Pravin K. Survase, Impedance cardiography, M. Tech Thesis, Department of Electrical Engineering, Indian Institute of Technology, Bombay, January 1996

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Abstract- In impedance cardiography, the cardiac output is obtained from stroke volume which in turn is obtained by monitoring the changes in the impedance of the thoracic region due to the flow of blood. Various attempts were made since 1932 to develop a system which is reliable, portable and gives satisfactory results while measuring cardiac output. Several methods have been proposed for estimating the stroke volume from impedance waveform, using different models. In one such system under development at IIT Bombay, the instrument generates 100 kHz low intensity sinusoidal current which is injected into thoracic region and the voltage resulting from modulation of the current waveform because of the variation in the thoracic impedance is amplified and demodulated to get impedance waveform z(t). The waveforms z(t), its derivative dz/dt, ECG waveform e(t), and its derivative d(ecg)/dt, are fed through signal isolator to the ADC card installed in PC. The cardiac output is calculated by ensemble averaging of dz/dt.

In this project, a thoracic impedance simulator is designed and developed for testing and calibration of instrument. This simulator can be used for introducing a variation of 0.2% to 1% on a base impedance of 22 ohms. To make the existing system portable, instrument is interfaced to 8-channel, 8-bit ADC, data logger. Software supporting data logger interface and to calculate cardiac output is developed. Finally experiments were carried out on six subjects under rest and four subjects exercising on exercise bicycle. The results showed that at rest base impedance and cardiac output are almost constant. A large variation in stroke volume was observed in all subjects both under rest and while exercising.