T. S. Susmi / Prof. P. C. Pandey (Supervisor), “An impedance cardiograph using synchronous demodulation with integrated baseline correction,” *M.Tech. Dissertation*, Department of Electrical Engineering, Indian Institute of Technology Bombay, June 2019.

ABSTRACT

Impedance cardiography is a noninvasive technique for estimating the stroke volume and cardiac output by sensing the thoracic impedance, which has a basal impedance of 20−200 Ω with 0.1−2% time-varying component related to variation in the blood volume during the cardiac cycle. The instrumentation for impedance measurement generally comprises injection of a high-frequency low-amplitude current (20−100 kHz, < 5 mA) in the thorax region through a pair of electrodes, sensing the resulting voltage using another pair of electrodes, amplitude demodulation to extract the impedance signal, and separation of the time-varying component and its differentiation to get the impedance cardiogram (ICG). The project objective is to develop an impedance cardiograph using synchronous demodulation with integrated baseline correction to improve the demodulation sensitivity, noise rejection, and ripple rejection, and to reduce the circuit complexity for body-wearable applications.

The present design is realized using the impedance converter IC TI/AFE4300 having a DDS for sinusoidal excitation voltage with settable frequency, and an impedance measuring circuit using synchronous demodulation with in-phase and quadrature (I/Q) outputs; a microcontroller and additional circuit blocks consisting of balanced V/I converter, voltage sensing amplifier with improved CMRR, and a baseline correction arrangement. A V/I converter with balanced current output is used for stray-insensitive excitation.The voltage across the electrode pair is amplified by a sensing amplifier, with an instrumentation amplifier configuration along with a common-mode negative feedback for enhanced CMRR. The baseline correction is performed before the synchronous demodulation by subtracting a sinusoidal voltage obtained from the excitation source with digitally controlled amplitude to improve the resolution of impedance measurement. In order to allow independent control on the amplitude of the current excitation and the baseline correction signal, two digital potentiometer ICs are used. A microcontroller is used for setting all the measurement parameters, reading the measured impedance, and transferring the data wirelessly via Bluetooth to an external device like a PC for processing and visualization.