Polygraph II

Project Report

Electronic Design Lab (EE 389)

Group No. 15

Indra Kumar (06d07032)

Manish Kumar (06d07036)

Tarakant (06d07038)

Abstract :

Polygraph is lie detecting device which derives its conclusion on distinctive patterns generated in blood pressure, breathing rate and others during questioning. Whenever abnormal behaviour is found in these, polygraph should give decision against the subject.

In this project we have explored the 'oscillometric' method for measurement of blood pressure.

Concept of Oscillometric method:

A limb of the subject is compressed by winding an inflatable compression cuff around the limb. The principle of 'oscillometric' method is the measurement of pressure change in the cuff as the cuff is inflated from above the systolic pressure. The amplitude suddenly grows larger as the pulse breaks through the occlusion. This is the systolic pressure. As the cuff pressure is reduced, the pulsation increases in amplitude, reaches a maximum and diminishes rapidly. Diastolic pressure is taken where this rapid transition begins.

The subject's arm will be cuffed and air will be pumped into the cuff to be around 20 mmHg above average systolic pressure (about 120 mmHg for an average). After that the air will be slowly released from the cuff causing the pressure in the cuff to decrease. As the cuff is slowly deflated, we will be measuring the tiny oscillation in the air pressure of the arm cuff. The systolic pressure will be the pressure at which the pulsation starts to occur. The diastolic pressure will be taken at the point in which the oscillation starts to disappear.

Block Diagram :

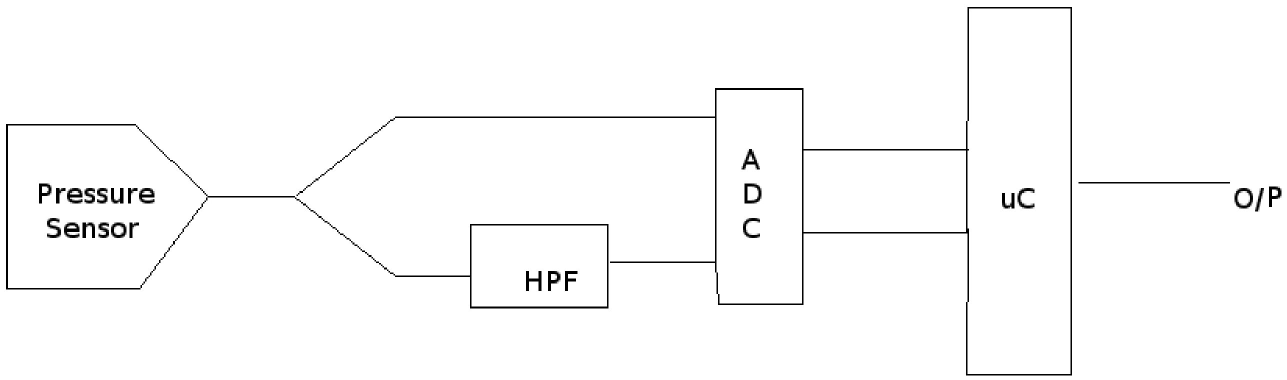

Fig.1. Block Diagram

Hardware Description and operation:

The major units in the design are:

A) Pressure cuff

B) Pressure transducer

C) High pass filter

D) Analog-digital Conversion

E) Microcontroller

F) Output

Pressure Sensor:

We use MPX5050GP as the cuff pressure sensor.

The output of the sensor consists of two signals:

a) Oscillation signal : around ~ 1 Hz

b) Cuff pressure signal : < 0.04 Hz

Decoupling circuit is used for the pressure sensor to reduce the noise effects in the power supply and isolate it from the rest of the circuit.

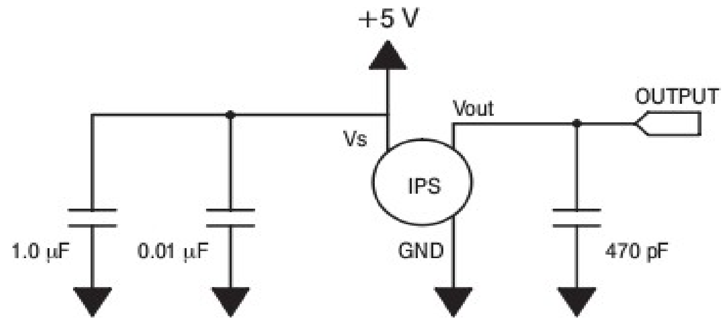

Fig.2. Power supply decoupling for Pressure Sensor

High pass filter:

We design a two-pole high pass filter to completely block the CP signal before the amplification of the oscillation signal. Also assuming heart rate to be at least 50 pulse/ min which corresponds to frequency of 0.83 Hz, we choose 3dB frequency to be same.

Oscillation signal typically varies from less than 1mmHg to 3mmHg, which correspond to 12 mV to 36 mV o/p voltage of pressure sensor. Filter attenuation makes it to 3.1mV to 9.3 mV. Thus we choose amplification factor of 200 to keep it within the o/p limit of the amplifier. We also had to DC bias it with 2 V to make it positive for input to ADC.

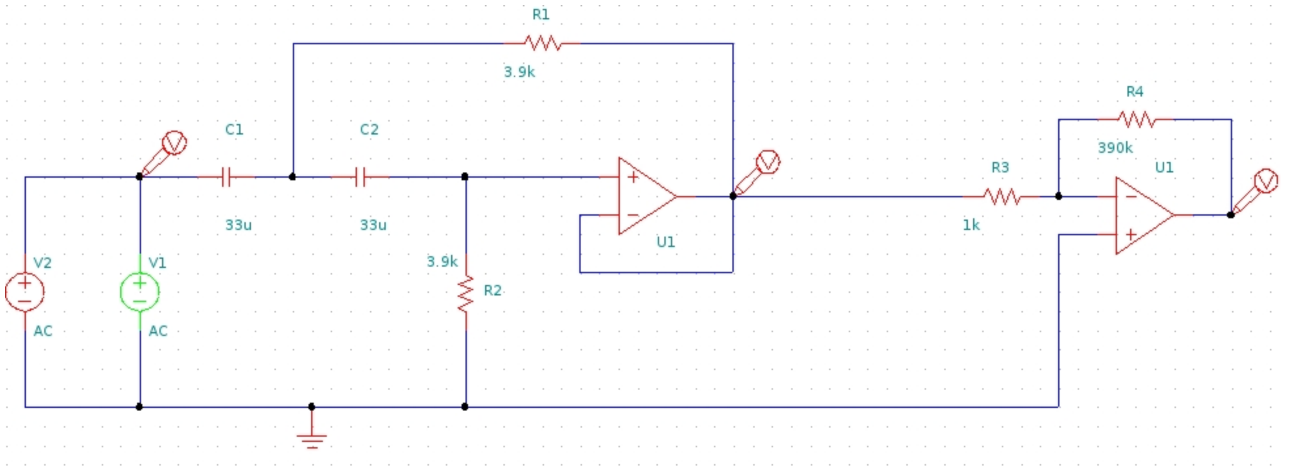

Fig. 3. Schematic circuit for Oscillation signal amplifier

We simulated the above circuit with an input of the form 24mV p-p sinusoidal signal (Oscillation signal) of frequency 1.2 Hz (72 pulse/min.) laden on 4 V p-p sinusoidal signal (CP signal) of 0.02 Hz. The simulation results showed pretty good removal of CP signal and amplification of oscillation signal.

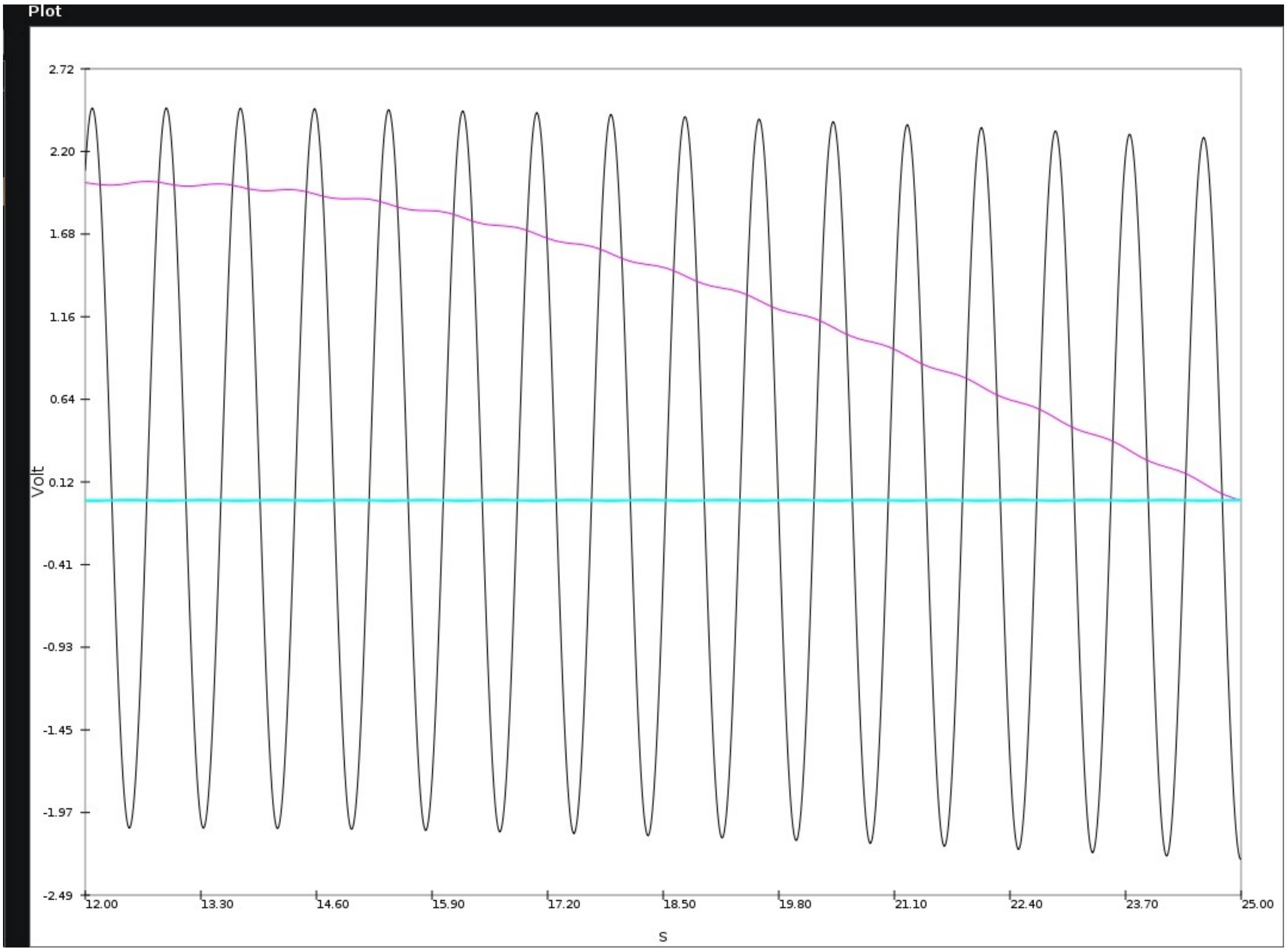

Fig.4. Simulated output of the Oscillation signal amplifier

We used Sallen-key high pass filter for its simplicity.

ADC :

Direct pressure sensor signal o/p to microcontroller is 0.2V at 0mmHg to 3.5V at 250mmHg. Whereas, output signal after filtering, amplification and proper DC biasing, is beween 0.005V to 4.0V. Hence to maximize resolution, we provide reference voltages for two A/D conversions as:

V(ref) + : 4.0V

V (ref) - : 0.0V

Program description:

During the the pumping of the inflation bulb, the microcontroller should ignore the i/p signal. When there is a decrease in CP for continous duration of more than 0.75 seconds, the uC will assume that the user is no longer pumping the bulb and can start to anlyze the oscillaion signal.

Threshold level of a valid pulse can be set to 2.5V to eliminate noise or spikes. As soon as the amplitude of a pulse is identified, the uC can ignore signal for next 450 ms to prevent any false identification due to presence of any premature pulse overshoot. This will limit the working to less than 133 beats per minute. Now the amplitudes are stored in the memory for further analysis.

Problems faced:

We got the cuff and the pressure sensor ready, but could not find an effective way to mount the sensor on the cuff. So, we could not test the sensor for the original signal from the transducer.

Also, we hit a roadblock as the ADC was not working properly. We were planning to give the output of the transducer and the high pass filter to two different channels on the ADC for further processing and display of the results. The display was all right, but we could not get correct signal values output from the ADC.