UNIVERSITY OF SECINCE AND TECHNOLOGY

FACULTY OF ENGINEERING

BIOMEDICAL ENGINEERING DEPARTMENT

Project Title:

LOW COST PULSE OXIMETER FOR MEASURE SATURATION OF OXYGEN AND PULSE RATE

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Submitted by:

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1-Motivation and the goal

Pulse oximetry has gained wide acceptance as a non-invasive method for monitoring oxygenation of hemoglobin in arterial blood and heart beat. However, pulse oximeters are widely used for this purpose, as well as it is an integral part of numerous medical procedures, including patient monitoring in the operating room and intensive care situations, pulmonary evaluations, neonatal diagnoses, oral surgeries, and the use of general anesthesia. It is not surprising therefore, that pulse oximeters one of the most requested pieces of medical equipment in developing world hospitals.

The economic limitations of providing healthcare in developing nations forces many hospitals to be dependent on external sources for inexpensive and often antiquated medical instrumentation. However, the cost of pulse oximeter devices poses a huge challenge, especially in developing nations.

As a result, EWH continually faces the challenge of obtaining such theses devices. For this reason, EWH has requested the design pulse oximeter with very low cost with the donated medical equipment. . For this reason humanistic STARS FUTURE team decided donate our time and talents for design low- cost pulse oximeter to help the third world countries to positively impact the quality of healthcare in disadvantaged areas around the world

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The purpose of this project is to design a low-cost pulse oximeter that delivers to the EWH to help the third world countries.

In this design we observe choosing parts with low cost and high efficiency that could reduce the cost of our design, we also add to our consider that our circuits has to be simple and easy made circuits so it also can be made by other biomedical engineers to provide a higher number of this devices to cover every hospital in development countries. In additions it can be owned and delivered to every person needs to track his personal health more efficiently, and monitor the status of another individual periodically.

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2. Design Project:

2.1 Probe / Sensor system design:

The optical sensor consists of both red and infrared LED’s with peak emission wavelengths of 660 nm and 940 nm respectively, and a photodiode. The photodiode is the main input device of the pulse oximeter system and should have a broad range of spectral responses that overlap the emission spectra of both the red and infrared LED’s. These devices, found in the probe, sense the intensity of light emitted by each LED after the light passes through the tissue. The photodiode produces current linearly proportional to the intensity of light striking it. A photodiode cannot distinguish between red and infrared light, but to accommodate this, the microcontroller system alternately turns each LED on and off. The pulse oximeter repeatedly samples the photodiode output while the red LED is on, while the infrared LED is on and while both are off. By sampling with both LED’s off, the pulse oximeter is able to subtract any ambient light that may be present.

We develop probe with sufficient noise rejection that assists in acquiring a good signal without the need of extra algorithms or signal conditioning circuits to eliminate the effect of ambient light and decrease the motion artifacts.

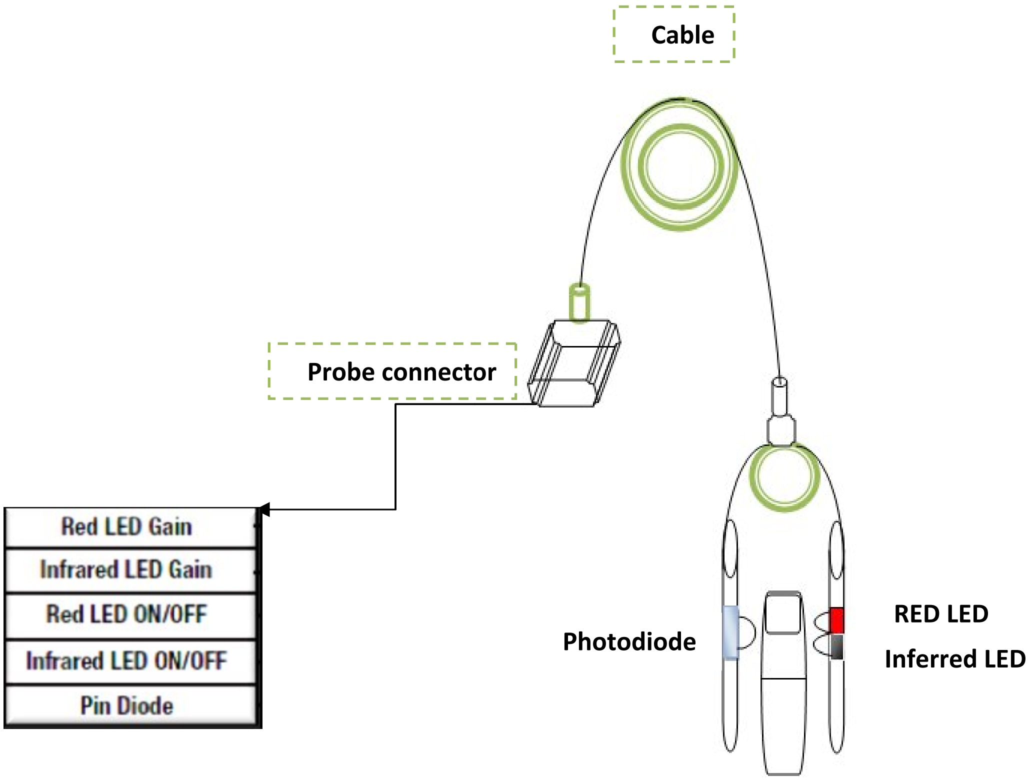
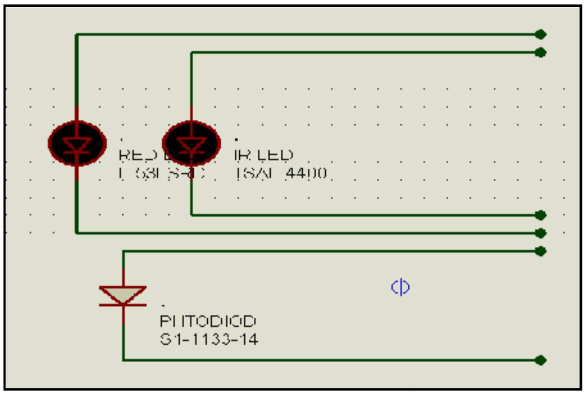


Figure (1): The Probe

2.2 Basic electric Probe with pin Configuration:

The probe contains the photodiode which detects the light. The photodiode requires up to 5 V to run. In total, the probe will connect to a bundle of 6 wires. This wire connected to some driver circuit and then to microcontroller.

The basic electric probe shown in the **Figure (2)**



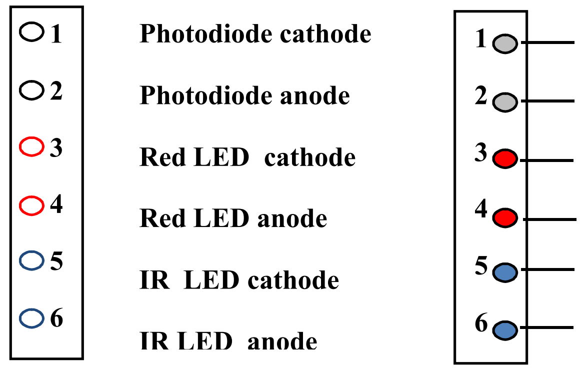


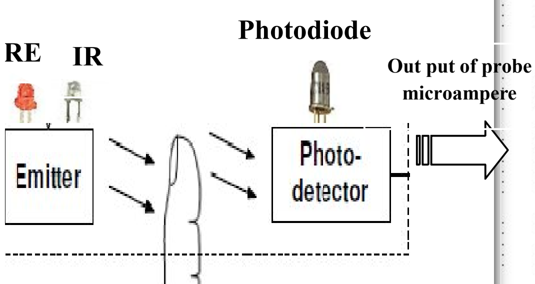
Figure (2) basic finger clip **6-PIN female &6-PIN male connector**

2.3 Amplification circuits:

The pulsating changes in transmitted light through the patient are very weak, and so the analog signal output of the frequency to voltage stage is also very small in amplitude. Therefore, a high gain amplifier stage is required to provide a waveform suitable for an analog to digital conversion system.

2.3.1 Current to Voltage Convertor:

After the optical signal is converted to current, by using a resistor this signal gets converted to an electrical voltage signal. The current flows through the resistor producing an output voltage signal with the following relation for this circuit topology.



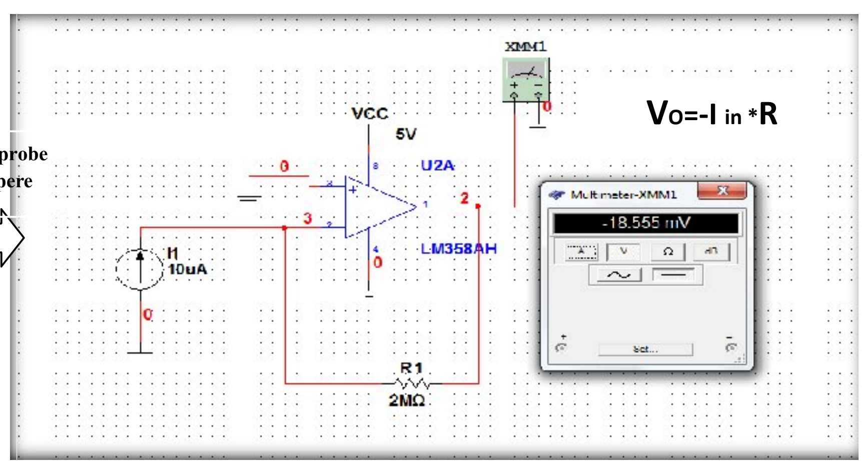


Figure (3): Current to Voltage & Amplification circuits

2.3.2 Filtration signal

In this project, low power dual operational amplifier LM358 op-amp is chosen for its simplicity and routine.

According to its data sheet, the operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. It consists of dual op-amps in a single package and it can operate at supply voltages as low as 3.0 V or as high as 32 V.

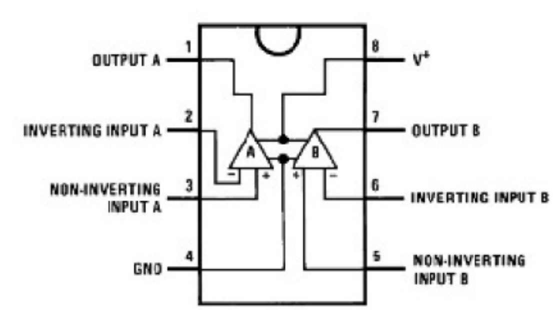


Figure (4): Low Power Dual Operational Amplifier LM358

First stage: The signal sensed by the Photo Diode D1 (Figure 5) passes through a high-pass filter formed by C1 and R2 that removes slow drift to noninverting input of first op-amp (pin3). Figure 5 also explains that the high frequency noise is decoupled by a low-pass filter formed by C2 and R4 fed back from output of first op-amp,(pin1) to inverting input of first op-amp (pin2). It amplifies the signal in the pass-band which is centered at 100 bpm (beats per minute), by a factor of 100.

The second stage of LM358 is configured as the previous stage in combination of filters and amplifier fabricated around second op-amp. The value of 500 is gained in the second stage. The overall gain of the two stages can be regulated with Rv1, 10K potentiometer. The output of first op-amp (pin1) in Figure 5 generates considerable amount of voltage with ripple at the peak of around 2.5V which is sufficient enough to be converted by 10-bit ADC 0809 .This amplified signal includes both DC and AC components representing infrared and visible red alternately.

The second stage output (pin7) is connected to a driver circuit to light the LED, indicating signal activity (Figure 5).

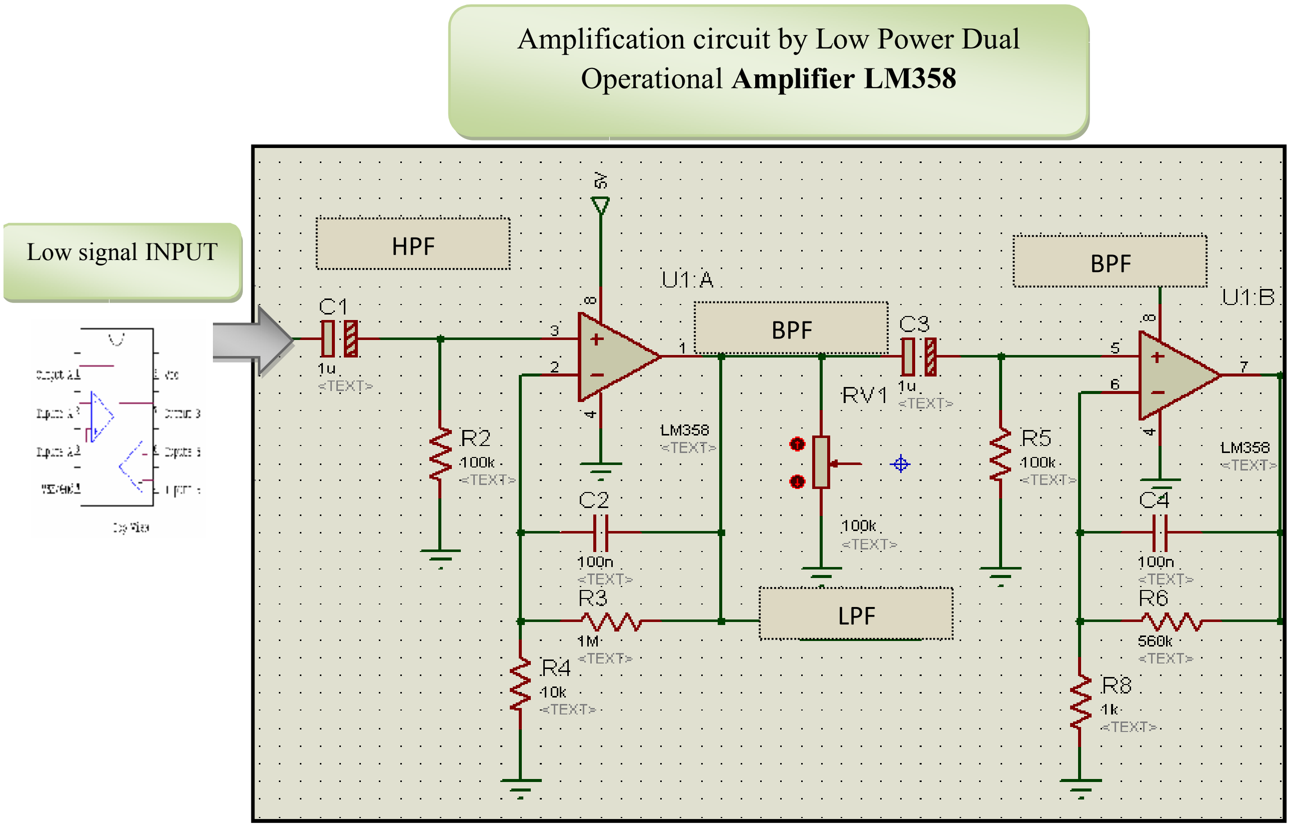


Figure (5): Amplification circuit by Low Power Dual Operational Amplifier LM358

The purpose of the filter circuit is to keep any frequency content between 0-5Hz and eliminate above and below this range. This has been implemented with the band pass.

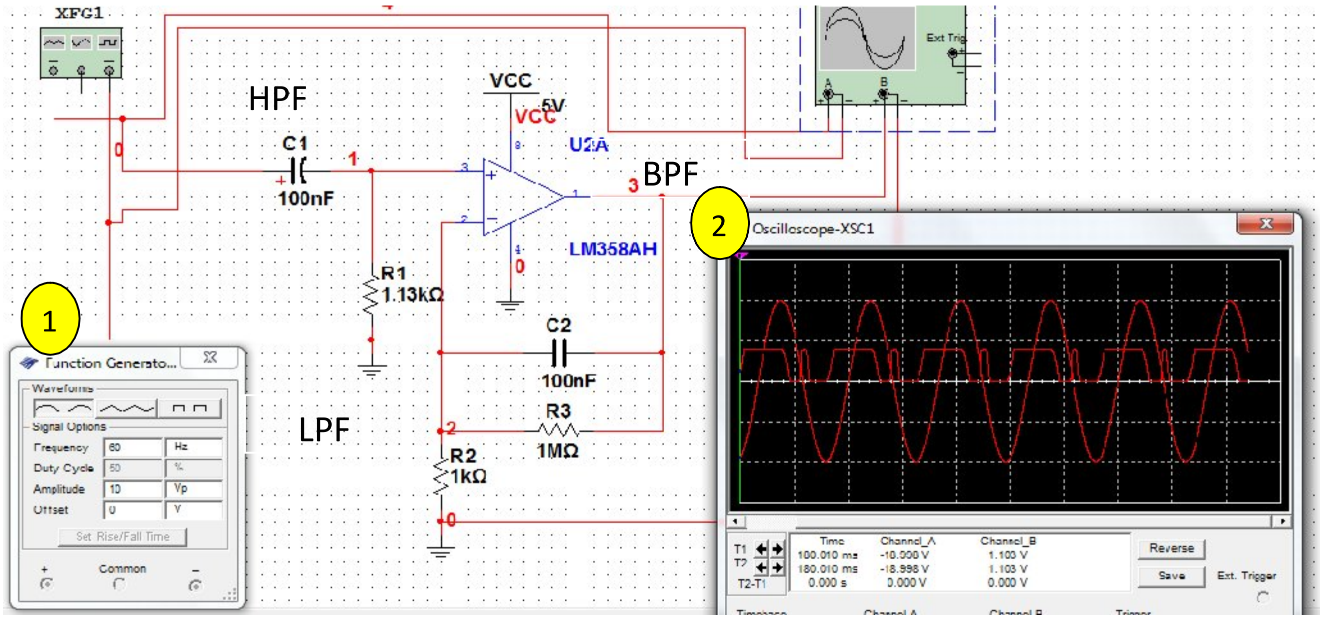


figure (6): signal filteration circuit

The signal output of current –to-voltage well filtered by a band-pass filter (with 0.5 Hz and 5 Hz cut-off frequencies) in order to remove primarily the dc component but also high frequency noise.

1- Indicate to the value signal output of current –to-voltage which has frequency noise between 50hz-60hz.
2- The signal before pass through filtration circuit by (high pass filter and low pass filter).
3- The signal after filtration circuit by BPF.

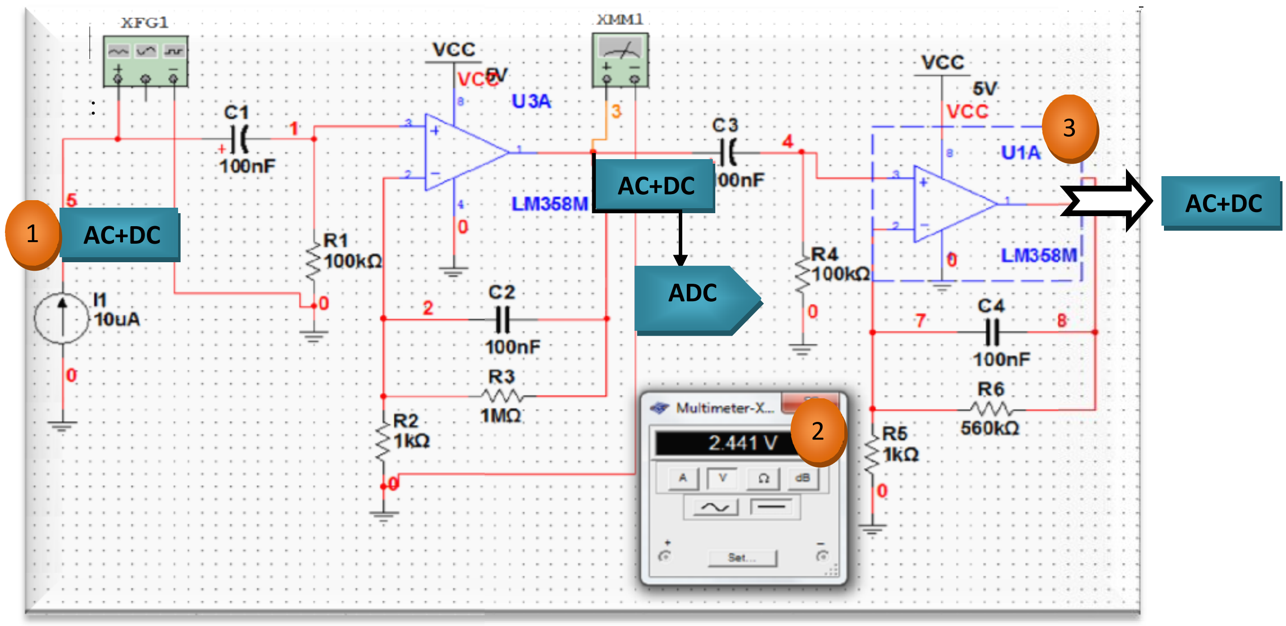


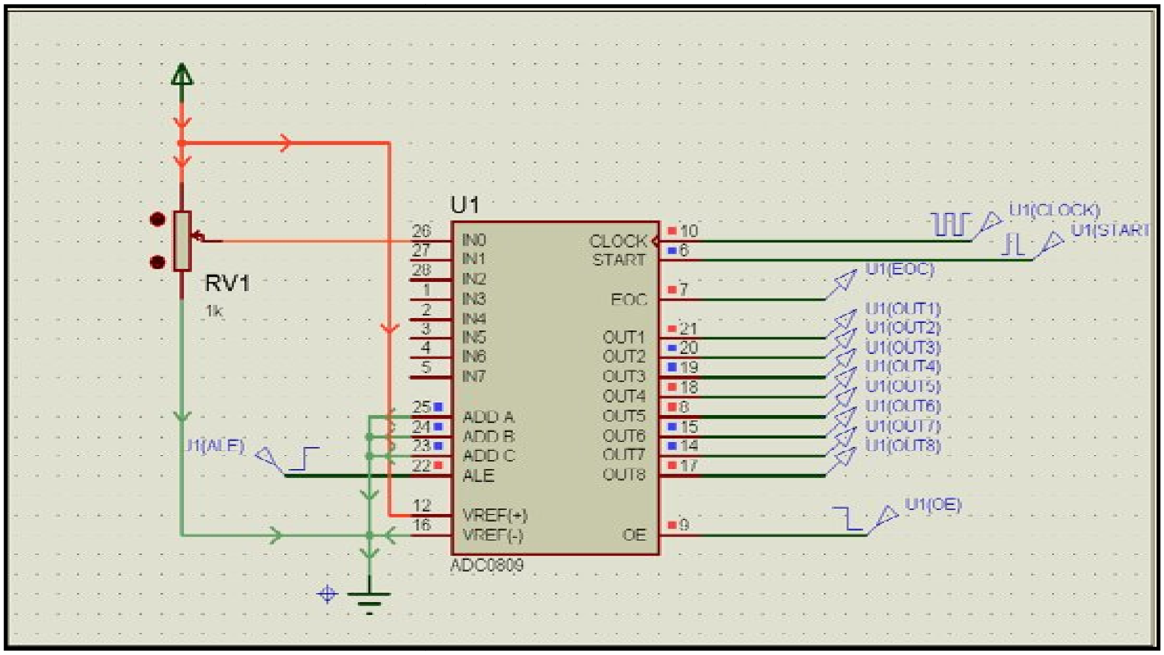
Figure (7): levels of transformer AC to DC

1- The output of photodiode is current so the value of theses current measured by microampere, Also the signal is has high noise and extract the signal of interest. Noise can arise from an external source such as the 60 Hz power-line or due to internal artifacts in the signal caused by motion and tremor through unavoidable movements. so we need filter for remove the noise .
2- The output of first stage amplifier circuit is measure by volt ,the amount of voltage with ripple at the peak of around 2.5V which is sufficient enough to be converted by 10-bit ADC 0809
3- The output of this second stage (LM358) is connected to a driver circuit to light the LED

2.4. Oximeter controller:

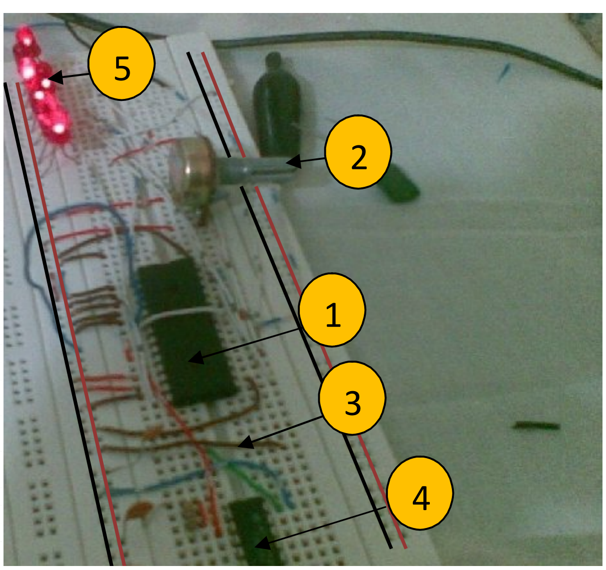
2.4.1. ADC 0808/0809

Connection Diagrams ADC0809



<u>Schematic of ADC 0809 module with out put</u>

1-poenteiomer refers to the value of analog input.
2- Input start of SC (start conversion)
3- Clock in put to ADC.
4- out of ADC which refers to the converted digital number



1- ADC 0809 look data sheet in appendix B
2- Potentiometer (10K) refers to the value of analog input..
3- Input start of SC (start conversion)
4- MC74HC14AN which generate clock for input to ADC (look data sheet in appendix B .)
5- out of ADC which refers to the converted digital number that change when change the input (2).

2.4.2 Micro-controller (AT89c51):

The control center of Pulse Oximeter design is AT89c51 micro-controller. The micro-controller co-ordinates the pushing of the pulsing

The control center of Pulse Oximeter design is AT89c51 micro-controller. The micro-controller co-ordinates the pushing of the pulsing of the LED's in the finger probe , and analyzes A/D converted pulse amplitudes from the photo diodes to make oxygen saturation determinations.

2.4.3 Display:

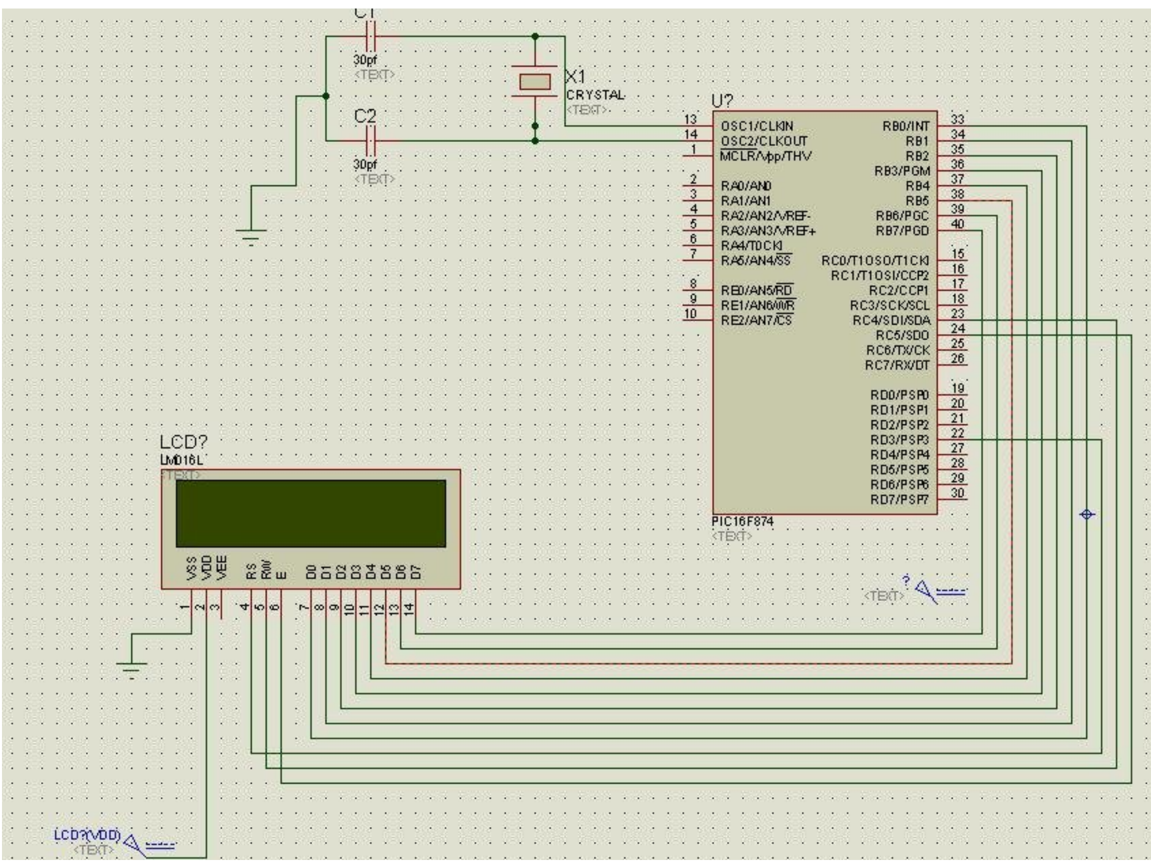
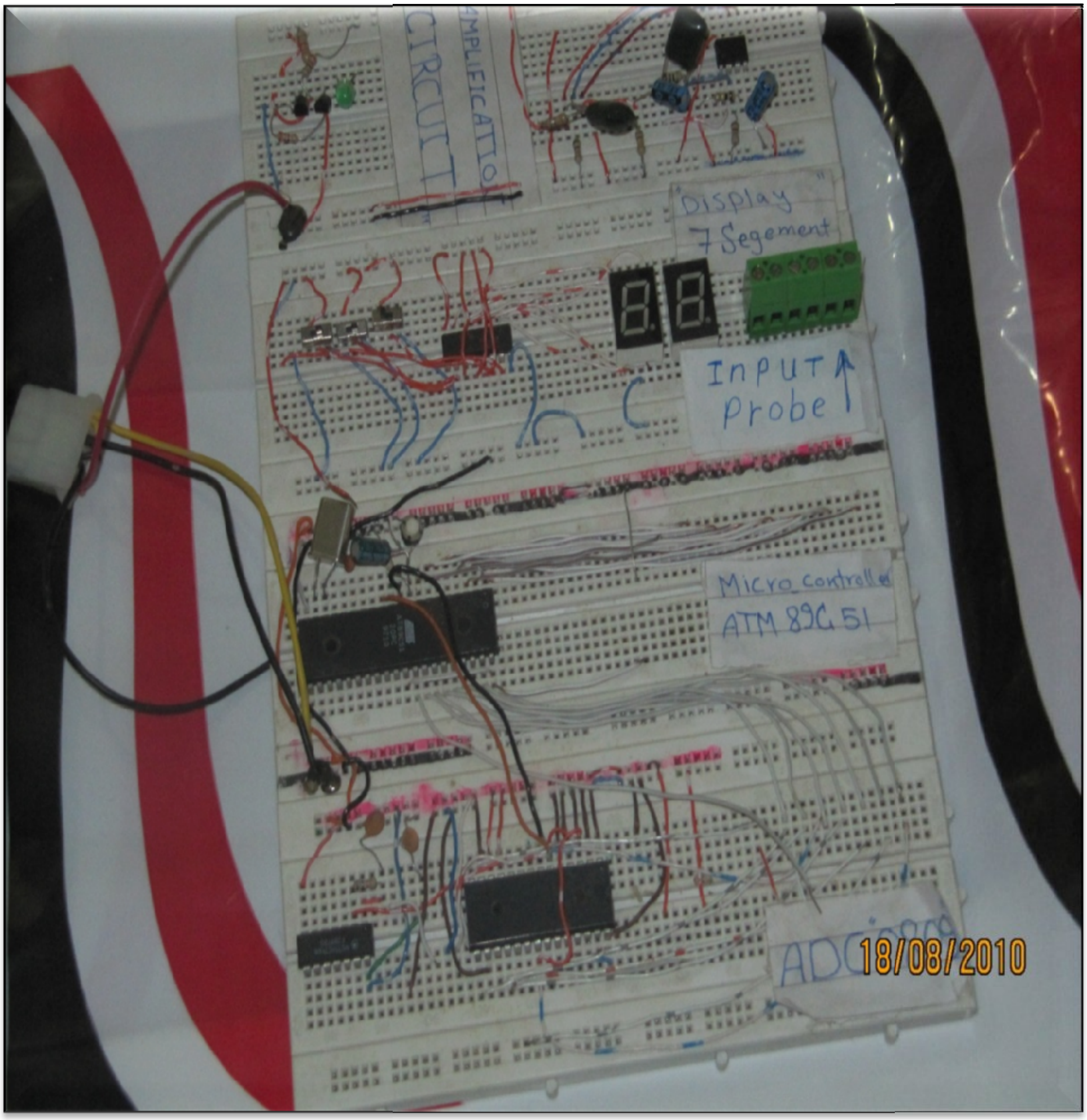
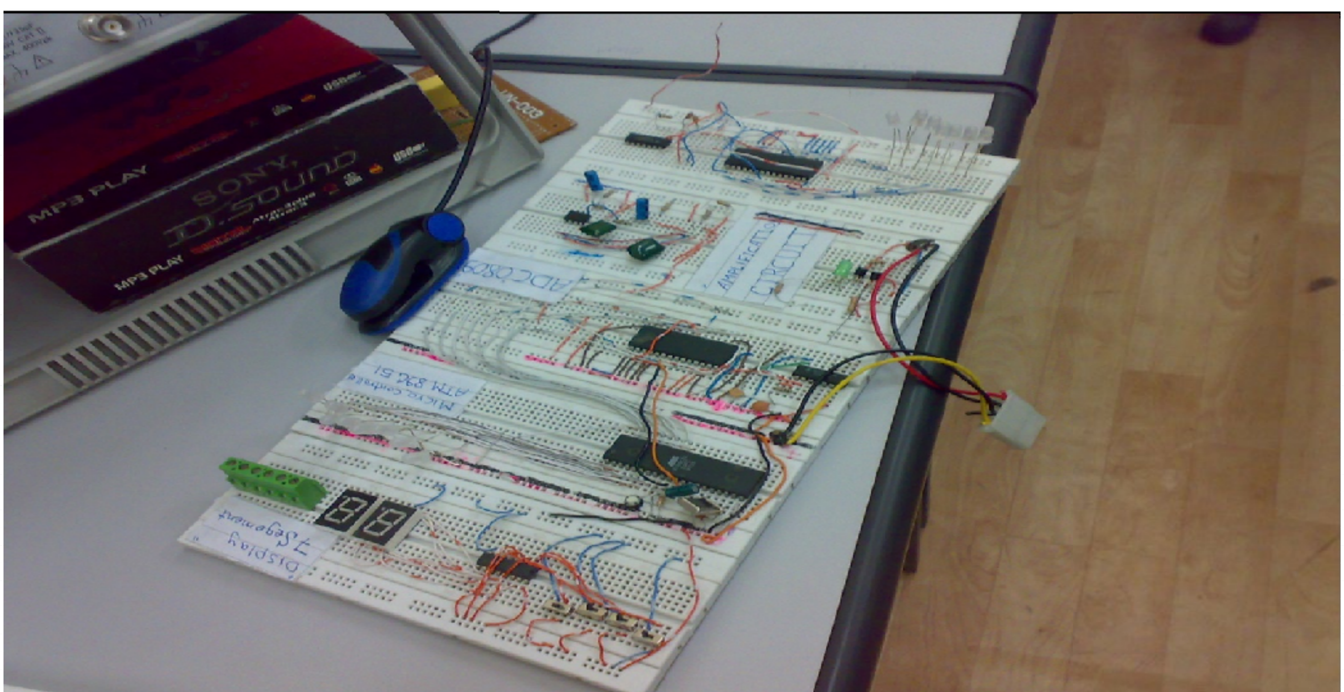


Figure (8): Connected Microcontroller With Display (LCD)

FINAL CIRCUIT (PULSE OXIMETER):




MP3 PLAY
SONY
D.SOUND
ADC0809

The STARS FUTURE team has, through laboratory experimentation and extensive engineering research, determined that this device is the best solution to the design problem presented by Engineering World Health so, this design will meet the needs of the developing world by:

- Providing an accurate method for measure saturation of oxygen as well as heart beat.
- Ensuring ease of use with simple, easy to understand user-input controls
- it can be owned and delivered to every person needs to track his personal health more efficiently, and monitor the status of another individual periodically
- reducing the cost of pulse oximeter may be freely distributed in developing countries

By incorporating inexpensive and precisely programmed electronic components into a simple, compact, and easy-to-use device, this design well be optimal design approach to meet the needs of the Engineering World Health organization.