B.V.M Engineering College

(AN AUTONOMOUS INSTITUTION)

(ELECTRONICS ENGINEERING DEPARTMENT)

ACADEMIC YEAR: AY 2020-21

SUBJECT: 2EL31: MINI PROJECT

Institute Vision: "Produce globally employable innovative engineers with core values"

Institute Mission:

1. Re-engineering curricula to meet global employment requirements
2. Promote innovative Practices at all levels
3. Imbibe core values
4. Reform policies, systems and processes at all levels
5. Develop faculty and staff members to meet the challenges

Department: Electronics Engineering

Vision: "Produce globally employable, innovative Electronics engineers with core values"

Mission:

1. Promote Innovative Practices to strengthen teaching and learning process in electronics engineering
2. Develop faculty and staff to meet challenges in Electronics engineering
3. Adapt Engineering curricula to meet global requirements for Electronics engineering program me.
4. Reform policies, systems and processes at all levels
5. Imbibe core Values.

Program Educational Objectives (PEOs):

1. Study and analysis of Electronics engineering systems.
2. Adapt state-of-art developments in Electronics engineering and eco friendly technologies.
3. Design and develop Electronic hardware and software based applications.

A Project Report On

Biometric Pulse Detection using PIC Microcontroller

Mini Project

(2EL31)

SUBMITTED BY:

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Hrushikesh Vegad (ID No. 19EL092)

IN PARTIAL FULFILLMENT FOR THE AWARD OF THE DEGREE

OF

BECHELOR OF TECHNOLOGY

IN

Electronics Engineering

BIRLA VISHWAKARMA MAHAVIDALAYA

Engineering Collage, Vallabh Vidyanagar, 388120
[An Autonomous Institution]
Electronics Department

Lab Teacher **Course Coordinator & Guide**

Dr. M.M. Solanki

ELECTRONICS ENGG DEPARTMENT

BIRLA VISHWAKARMA MAHAVIDYALAYA ENGG COLLEGE V V NAGAR

CERTIFICATE

This is to certify that M/r. MEHTA HARSH ANILKUMAR **ID No**. 19EL083, of B.Tech. (Electronics Engineering) SEM-IV has satisfactorily completed the term work of the subject **Mini Project (2EL31)** prescribed by BVM an Autonomous Institution during the Academic Year **2020-2021**

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CERTIFICATE

This is to certify that M/r. HRUSHIKESH MAYURBHAI VEGAD **ID No**. 19EL092, of B.Tech. (Electronics Engineering) SEM-IV has satisfactorily completed the term work of the subject **Mini Project (2EL31)** prescribed by BVM an Autonomous Institution during the Academic Year **2020-2021**

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Acknowledgment

Firstly, we offer thanks to our guide and Course coordinator Dr. M.M.Solanki Electronics Department, Birla Vishvakarma Mahavidyalaya, our Lab teacher: Dr. M.M.Solanki Lecturer, Birla Vishvakarma Mahavidyalaya, Electronics Department, for their invaluable support, guidance and advice given throughout this semester and for helping to establish our direction.

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Harsh Mehta

Hrushikesh Vegad

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ABSTRACT

The present work is aimed at measurement of heartbeat and display the information on an alphanumeric Seven segment display. The heartbeat monitor uses LED and a LDR based sensor to determine the heartbeat. This system detects the pulses person when the sensor is positioned on a appropriate location of the user's skin (e.g.: Fingertip) and generates a heartbeat signal associated with the pulsing condition. The output of a heartbeat sensor gives a very low voltage signal. Hence this needs to be amplified using an amplifier. The amplified signal is given to the Microcontroller unit for actual measurement of heartrate. This processed heartbeat information is sent to a output display.

Heart Beat Monitor

- A heart rate monitor is a personal monitoring device which allows one to measure his or her heart rate in real time or record the heart rate for later study. It is largely used by performers of various types of physical exercise.
- Widely used in hospitals for checking the health of the patient.

Why Monitoring ..?

- More than 2 million people are at high risk of having heart attack.
- It would be helpful if there was a way for these people to monitor their heart.
- So we have a problem. That is the way our project focuses on how we can utilize this problem and find a solution.

INTRODUCTION TO THE PROJECT

This project describes the design of a simple, low-cost microcontroller-based heart rate with seven segment display output. Heart rate of the subject is measured from the thumb finger using IRD (Infrared Device sensors and the rate is then averaged and displayed on a output display.). The device displaying the heart beat rate and counting values through sending pulses from the sensor. The Pulse monitor works both on battery or mains supply. This project uses regulated 5V, 500mA power supply. 7805 three terminal voltage regulator is used for voltage regulation.

METHODS FOR SENSING HEART RATE

- Using Body-Surface Bio potential Electrodes
- Using Finger Plethysmography

1) USING BODY-SURFACE BIO POTENTIAL ELECTRODES: Electrodes that can be placed on the body surface for recording bioelectric signals. The integrity of the skin is not compromised when these electrodes are applied, and they can be used for short- term diagnostic recording such as taking a clinical electrocardiogram or long-term chronic recording such as occurs in cardiac monitoring.

Limitations of this method:

- May cause skin irritation on contact with skin for long period of time.
- Not reliable if there are any electronic devices which may cause electrical interference.
- Storage problems, requires special storage environment.
- Mobility restricted due to wired connection between sensor and device.

2) FINGER PLETHYSMOGRAPHY:

This project is based on the principle of Photo Plethysmography (PPG) which is a non-invasive method of measuring the variation in blood volume in tissues using an IR light source and a detector. Since the change in blood volume is synchronous to the heart beat, this technique can be used to calculate the heart rate.

Advantages of Finger Plethysmography over Body-Surface Bio potential Electrodes:

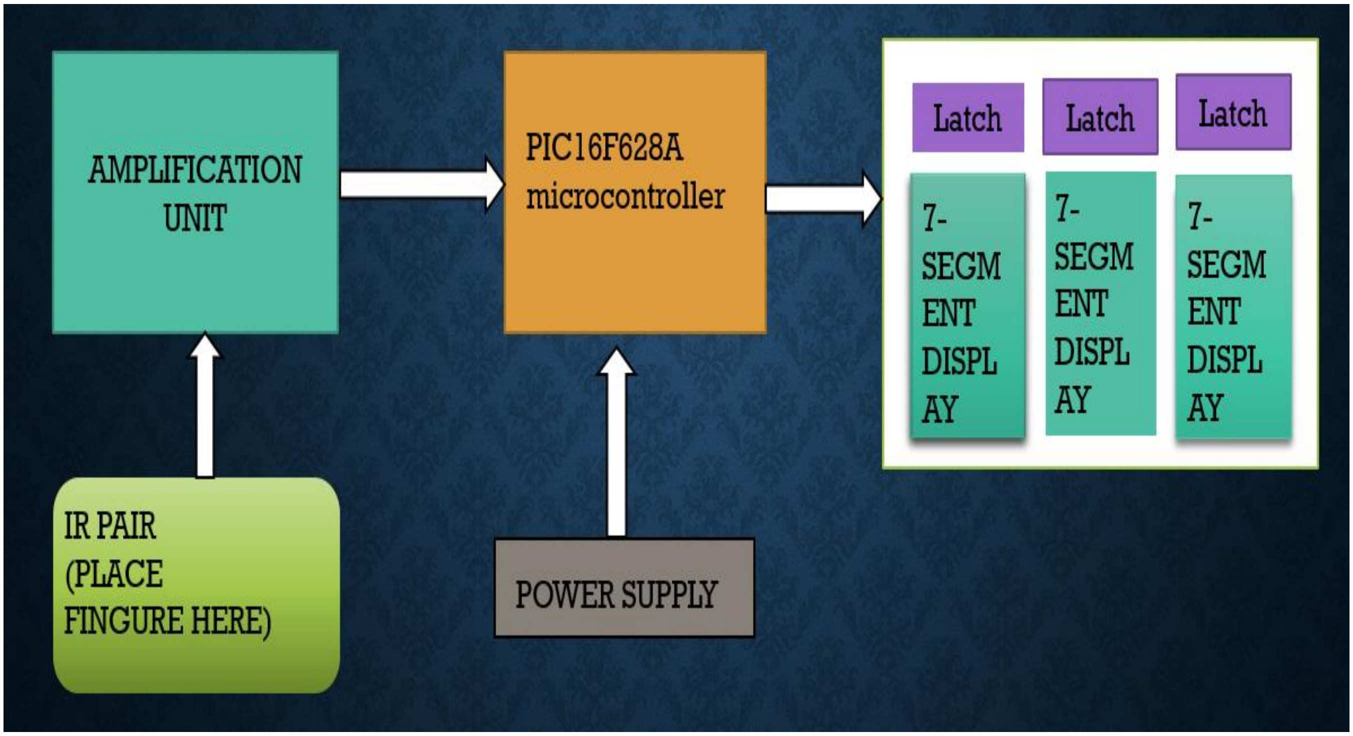
- Does not cause Skin irritation problem.
- No need to stick to the skin.
- Can be removed and reused many times.
- No Storage problems.

Limitations:

- Not reliable if there are any electronic devices which may cause IR interference.
- Mobility restricted due to wired connection between sensor and device.

INTRODUCTION WITH BLOCK DIAGRAM:

The block diagram of the project and the description of the blocks in the block diagram are considered. Block diagram is shown below.



HARDWARE COMPONENTS

- LM324 IC (quad op-amp IC)
- PIC16F628A microcontroller
- PIC programmer (Pickit 3)
- Latches
- 7-Segment Displays (Common Anode)
- 5-volt battery
- IR pair
- Capacitors
- Resistors
- Potentiometer
- 11.0592Mhz crystal Oscillator

INTRODUCTION TO PIC MICROCONTROLLER

PIC stands for Peripheral Interface Controller given by Microchip Technology to identify its single-chip microcontrollers. These devices have been very successful in 8-bit microcontrollers. The main reason is that Microchip Technology has continuously upgraded the device architecture and added needed peripherals to the microcontroller to suit customers' requirements.

Popularity of the PIC microcontrollers is due to the following factors.

1. Speed: Harvard Architecture, RISC architecture, 1 instruction cycle = 4 clock cycles.

2. Instruction set simplicity: The instruction set consists of just 35 instructions (as opposed to 111 instructions for 8051).

3. Power-on-reset and brown-out reset. Brown-out-reset means when the power supply goes below a specified voltage (say 4V), it causes PIC to reset; hence malfunction is avoided. A watch dog timer (user programmable) resets the processor if the software/program ever malfunctions and deviates from its normal operation.

4. PIC microcontroller has four optional clock sources.

- Low power crystal
- Mid-range crystal
- High range crystal
- RC oscillator (low cost).

5. Programmable timers and on-chip ADC.

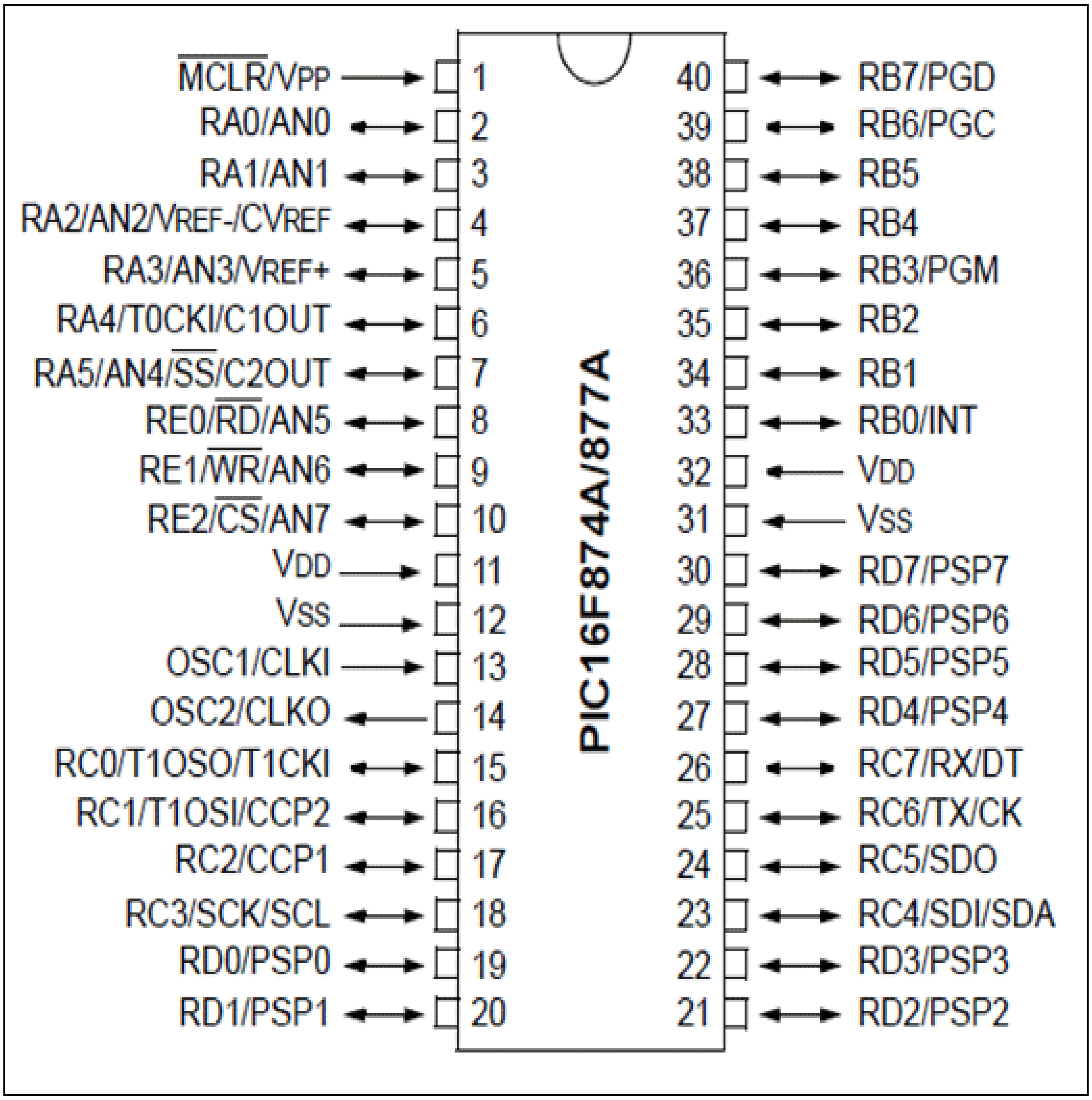
6. Up to 12 independent interrupt sources.

7. Powerful output pin control (25 mA (max.) current sourcing capability per pin.)

8. EPROM/OTP/ROM/Flash memory option

9. Input output expansion capability

PIN DISCRIPTION



Name	Function	Input Type	Output Type	Description
RA0/AN0	RA0	ST	CMOS	Bi-directional I/O port
	AN0	AN	—	Analog comparator input
RA1/AN1	RA1	ST	CMOS	Bi-directional I/O port
	AN1	AN	—	Analog comparator input
RA2/AN2/VREF	RA2	ST	CMOS	Bi-directional I/O port
	AN2	AN	—	Analog comparator input
	VREF	—	AN	VREF output
RA3/AN3/CMP1	RA3	ST	CMOS	Bi-directional I/O port
	AN3	AN	—	Analog comparator input
	CMP1	—	CMOS	Comparator 1 output
RA4/T0CKI/CMP2	RA4	ST	OD	Bi-directional I/O port
	T0CKI	ST	—	Timer0 clock input
	CMP2	—	OD	Comparator 2 output
RA5/$\overline{\text{MCLR}}$/VPP	RA5	ST	—	Input port
	$\overline{\text{MCLR}}$	ST	—	Master clear. When configured as $\overline{\text{MCLR}}$, this pin is an active low RESET to the device. Voltage on $\overline{\text{MCLR}}$/VPP must not exceed VDD during normal device operation.
	VPP	—	—	Programming voltage input.
RA6/OSC2/CLKOUT	RA6	ST	CMOS	Bi-directional I/O port
	OSC2	—	XTAL	Oscillator crystal output. Connects to crystal or resonator in Crystal Oscillator mode.
	CLKOUT	—	CMOS	In RC/INTOSC mode, OSC2 pin can output CLKOUT, which has 1/4 the frequency of OSC1
RA7/OSC1/CLKIN	RA7	ST	CMOS	Bi-directional I/O port
	OSC1	XTAL	—	Oscillator crystal input
	CLKIN	ST	—	External clock source input. RC biasing pin.
RB0/INT	RB0	TTL	CMOS	Bi-directional I/O port. Can be software programmed for internal weak pull-up.
	INT	ST	—	External interrupt.
RB1/RX/DT	RB1	TTL	CMOS	Bi-directional I/O port. Can be software programmed for internal weak pull-up.
	RX	ST	—	USART receive pin
	DT	ST	CMOS	Synchronous data I/O.
RB2/TX/CK	RB2	TTL	CMOS	Bi-directional I/O port. Can be software programmed for internal weak pull-up.
	TX	—	CMOS	USART transmit pin
	CK	ST	CMOS	Synchronous clock I/O.
RB3/CCP1	RB3	TTL	CMOS	Bi-directional I/O port. Can be software programmed for internal weak pull-up.
	CCP1	ST	CMOS	Capture/Compare/PWM I/O

Legend: O = Output; — = Not used; TTL = TTL Input; CMOS = CMOS Output; I = Input; OD = Open Drain Output; P = Power; ST = Schmitt Trigger Input; AN = Analog

Name	Function	Input Type	Output Type	Description
RB4/PGM	RB4	TTL	CMOS	Bi-directional I/O port. Interrupt-on-pin change. Can be software programmed for internal weak pull-up.
	PGM	ST	—	Low voltage programming input pin. When low voltage programming is enabled, the interrupt-on-pin change and weak pull-up resistor are disabled.
RB5	RB5	TTL	CMOS	Bi-directional I/O port. Interrupt-on-pin change. Can be software programmed for internal weak pull-up.
RB6/T1OSO/T1CKI/PGC	RB6	TTL	CMOS	Bi-directional I/O port. Interrupt-on-pin change. Can be software programmed for internal weak pull-up.
	T1OSO	—	XTAL	Timer1 oscillator output.
	T1CKI	ST	—	Timer1 clock input.
	PGC	ST	—	ICSP Programming Clock.
RB7/T1OSI/PGD	RB7	TTL	CMOS	Bi-directional I/O port. Interrupt-on-pin change. Can be software programmed for internal weak pull-up.
	T1OSI	XTAL	—	Timer1 oscillator input.
	PGD	ST	CMOS	ICSP Data I/O
VSS	VSS	Power	—	Ground reference for logic and I/O pins
VDD	VDD	Power	—	Positive supply for logic and I/O pins

Legend: O = Output; — = Not used; TTL = TTL Input; CMOS = CMOS Output; I = Input; OD = Open Drain Output; P = Power; ST = Schmitt Trigger Input; AN = Analog

LM324 ICs (quad op-amp IC)

LM324 is a Quad op-amp IC integrated with four op-amps powered by a common power supply. The differential input voltage range can be equal to that of power supply voltage. The default input offset voltage is very low which is of magnitude 2mV. The operating temperature ranges from 0˚C to 70˚C at ambient whereas the maximum junction temperature can be upto 150˚C. Generally, op-amps can perform mathematical operations.

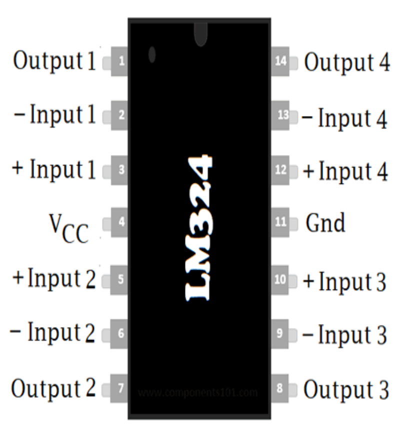
LM324 Quad Op-Amp IC features and specifications

- Integrated with four Op-Amps in a single package
- Wide power supply Range

1. Singe supply – 3V to 32V
2. Dual supply – ±1.5V to ±16V

- Low Supply current – 700uA
- Single supply for four op-amp operation enables reliable operation
- Operating ambient temperature – 0˚C to 70˚C
- Soldering pin temperature – 260 ˚C (for 10 seconds – prescribed)

PIN DIAGRAM:-

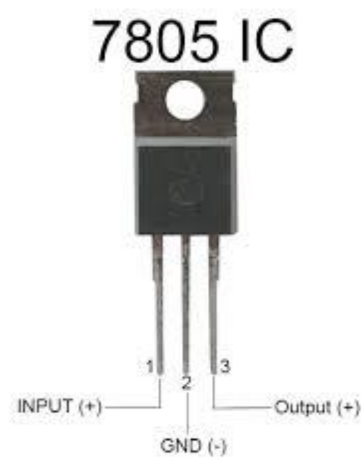


Pin Configuration

Pin Number	Pin Name	Description
1	OUTPUT1	Output of Op-Amp 1
2	INPUT1-	Inverting Input of Op-Amp 1
3	INPUT1+	Non-Inverting Input of Op-Amp 1
4	VCC	Positive Supply Voltage
5	INPUT2+	Non-Inverting Input of Op-Amp 2
6	INPUT2-	Inverting Input of Op-Amp 2
7	OUTPUT2	Output of Op-Amp 2
8	OUTPUT3	Output of Op-Amp 3
9	INPUT3-	Inverting Input of Op-Amp 3
10	INPUT3+	Non-Inverting Input of Op-Amp 3
11	VEE,GND	Ground or Negative Supply Voltage
12	INPUT4+	Non-Inverting Input of Op-Amp 4
13	INPUT4-	Inverting Input of Op-Amp 4
14	OUTPUT4	Output of Op-Amp 4

1. **VOLTAGE REGULATOR:**

A voltage regulator (also called a regulator) with only three terminals appears to be a simple device, but it is in fact a very complex integrated circuit. It converts a varying input voltage into a constant „regulated“ output voltage. Voltage Regulators are available in a variety of outputs like 5V, 6V, 9V, 12V and 15V. The LM78XX series of voltage regulators are designed for positive input. For applications requiring negative input, the LM79XX series is used. Using a pair of "voltage-divider“ resistors can increase the output voltage of a regulator circuit. It is not possible to obtain a voltage lower than the stated rating. You cannot use a 12V regulator to make a 5V power supply. Voltage regulators are very robust. These can withstand 11 over-current draw due to short circuits and also over-heating. In both cases, the regulator will cut off before any damage occurs. The only way to destroy a regulator is to apply reverse voltage to its input. Reverse polarity destroys the regulator almost instantly.

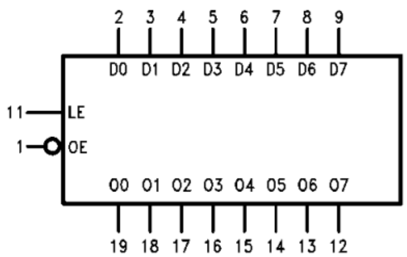


LM7805 Voltage Regulator

74LS573 Octal D-Type Latch with 3-State Outputs

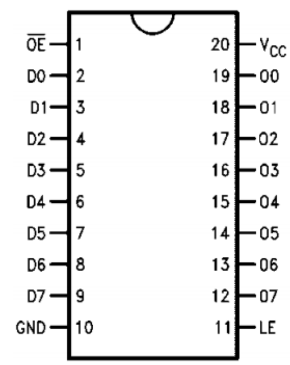
The 74LS573 is a high speed octal latch with buffered common Latch Enable (LE) and buffered common Output Enable (OE) inputs. This device is functionally identical to the 74LS373, but has different pinouts.

Logic Symbol



V_{CC} = Pin 20
GND = Pin 10

Connection Diagram



Pin Descriptions

Pin Names	Description
D0–D7	Data Inputs
LE	Latch Enable Input (Active HIGH)
$\overline{OE}$	3-STATE Output Enable Input (Active LOW)
O0–O7	3-STATE Latch Outputs

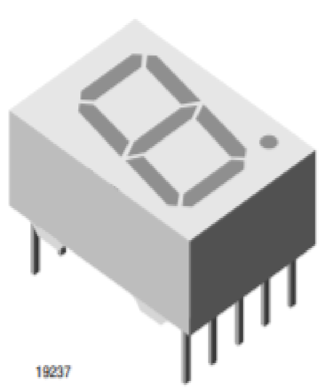
Function Tables

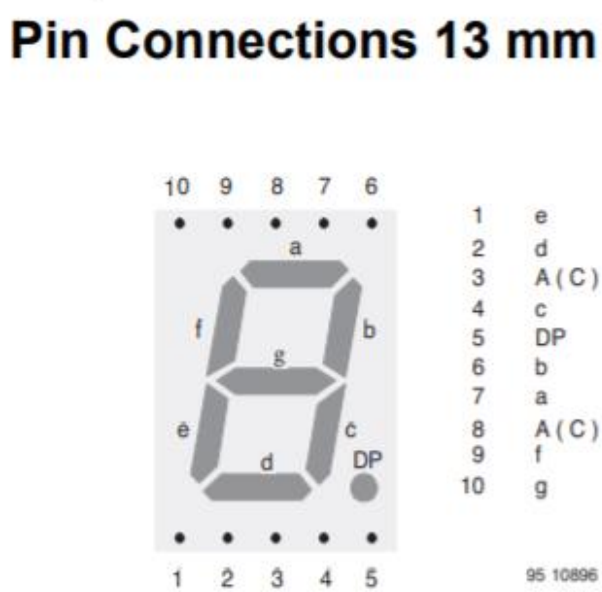
$\overline{\text{Output}}$ Enable	Latch Enable	D	Output O
L	H	H	H
L	H	L	L
L	L	X	Q_O
H	X	X	Z

L = LOW State
H = HIGH State
X = Don't Care
Z = High Impedance State
Q_O = Previous Condition of O

Seven Segment Display

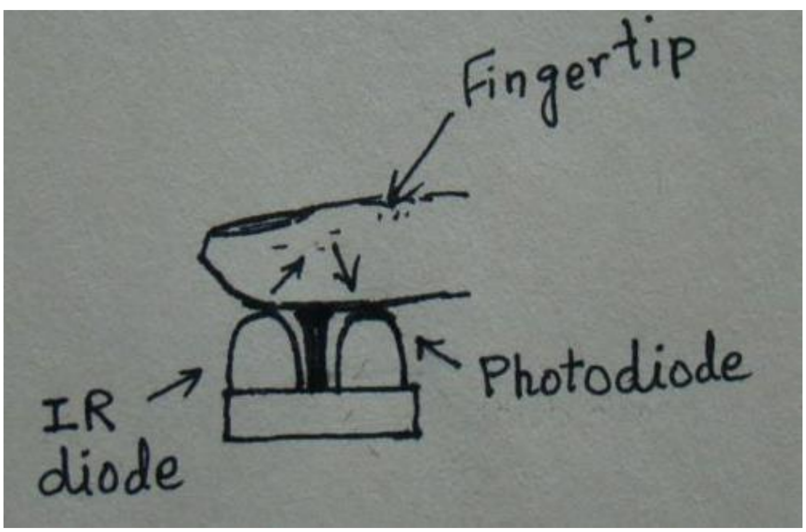
- The TDS. 51.. series are 13 mm character seven segment LED displays in a very compact package.
- The displays are designed for a viewing distance up to 7 m and available in four bright colors. The grey package surface and the evenly lighted untainted segments provide an optimum on-off contrast.
- All displays are categorized in luminous intensity groups. That allows users to assemble displays with uniform appearance. Typical applications include instruments, panel meters, point-of-sale terminals and household equipment.



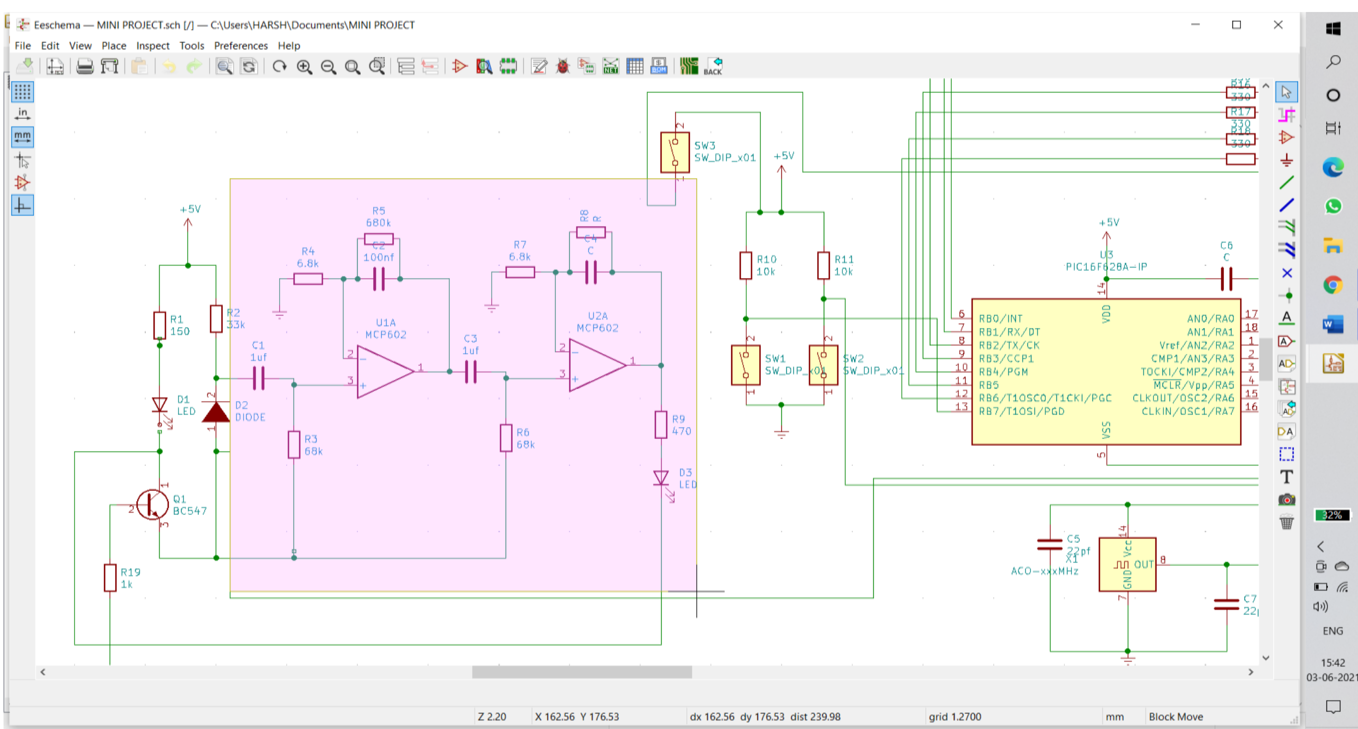


WORKING OF OUR PROJECT

- As we know, when the heart pumps blood, the density of volume increases.
- So when the patient will put his/her finger on IR pair, and the heart beats so, the concentration of blood increases and the infrared lighted transmitted through IR Diode, will strikes and received by the photo diode.
- After this the output of the sensor will be passed through OP-amp to amplify output, which will be input to micro controller.
- And here, micro controller will increment the counter, and will displayed on the seven segment displays.



- When the patient will put finger on IR pair, due to increase in concentration of blood, the infrared light will strikes and would be received by photo diode.
- Now the output was measured at sensor, it was approx. 0.075 v. But this output cannot be directly given to the micro controller as it requires minimum 1-2 volts.
- So to amplify it, we used operational amplifier, and then input to micro controller.
- After that, micro controller will count each pulse using programming logic.
- And later through latches it will displayed on Seven segment display.



Amplification Circuit

The project is implemented using the following two softwares.

1. Proteus
2. PIC compiler (MikroC software)

PIC compiler (MikroC software)

- PIC compiler is software used where the machine language code is written and compiled. After compilation, the machine source code is converted into hex code which is to be dumped into the microcontroller for further processing. PIC compiler also supports C language code.

- Its important that you know C language for microcontroller which is commonly known as Embedded C. As we are going to use PIC Compiler, hence we also call it PIC C.

- This is due to the fact that the PIC has no stack to push variables onto, and also because of the way the compilers optimize the code. The compilers can efficiently implement normal C constructs, input/output operations, and bit twiddling operations. All normal C data types are supported along with pointers to constant arrays, fixed point decimal, and arrays of bits.

- PIC C is not much different from a normal C program. If you know assembly, writing a C program is not a crisis. In PIC, we will have a main function, in which all your application specific work will be defined. In case of embedded C, you do not have any operating system running in there. So you have to make sure that your program or main file should never exit. This can be done with the help of simple while (1) or for (;) loop as they are going to run infinitely.

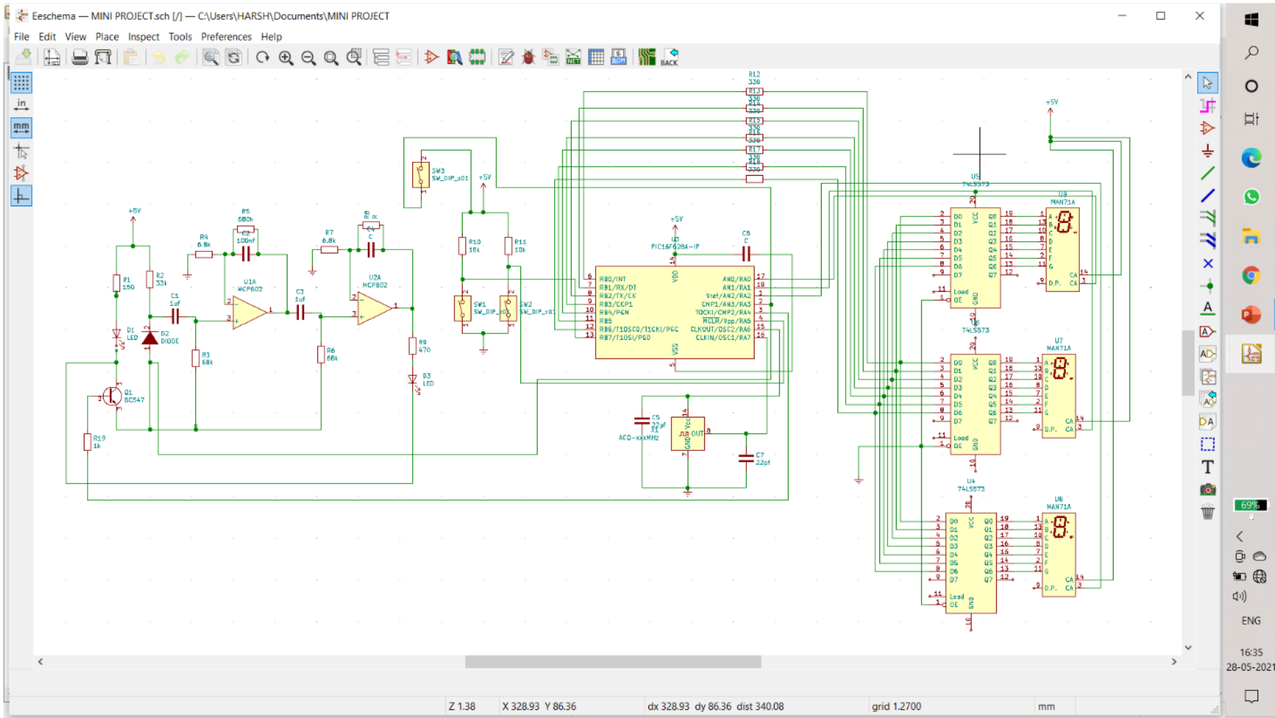
- ❖ We have to add header file for controller you are using, otherwise you will not be able to access registers related to peripherals.

- ❖ #include <16F876.h> // header file for PIC

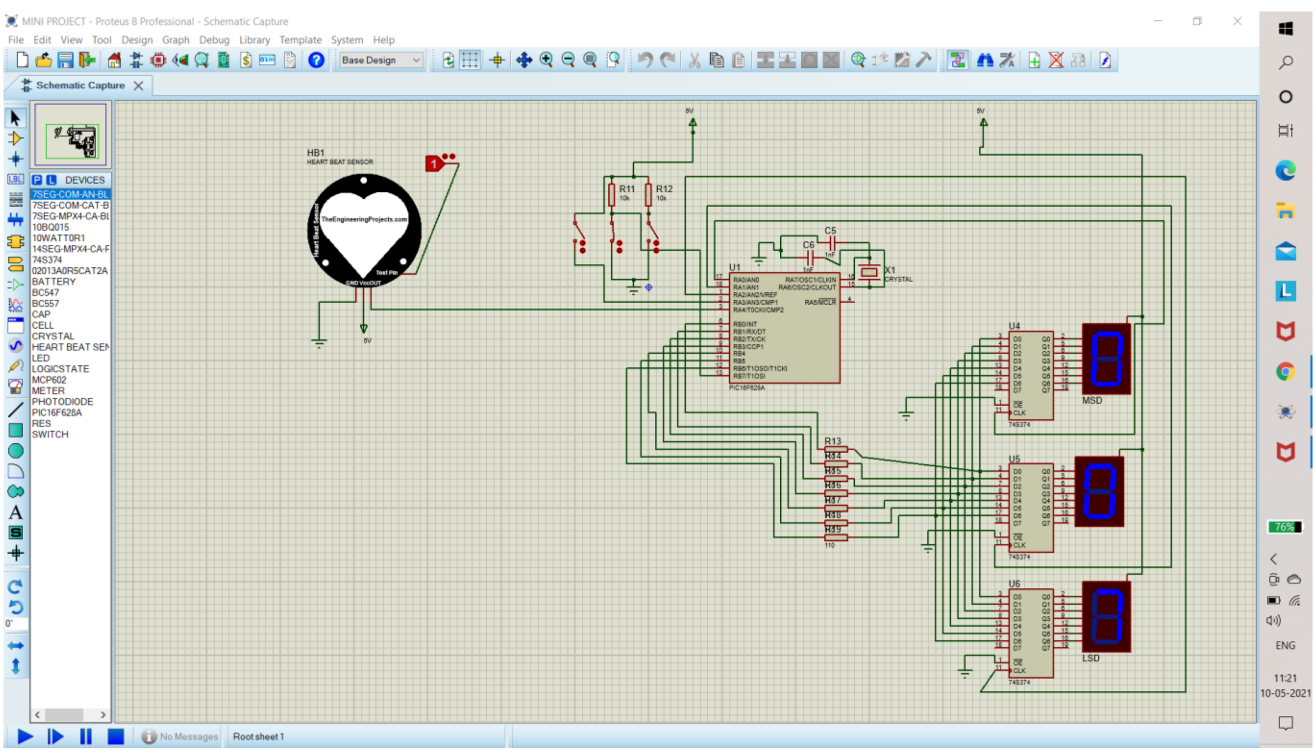
PROTEUS:

Proteus is software which accepts only hex files. Once the machine code is converted into hex code, that hex code has to be dumped into the microcontroller and this is done by the Proteus. Proteus is a programmer which itself contains a microcontroller in it other than the one which is to be programmed. This microcontroller has a program in it written in such a way that it accepts the hex file from the pic compiler and dumps this hex file into the microcontroller which is to be programmed. As the Proteus programmer requires power supply to be operated, this power supply is given from the power supply circuit designed and connected to the microcontroller in proteus. The program which is to be dumped in to the microcontroller is edited in proteus and is compiled and executed to check any errors and hence after the successful compilation of the program the program is dumped in to the microcontroller using a dumper.

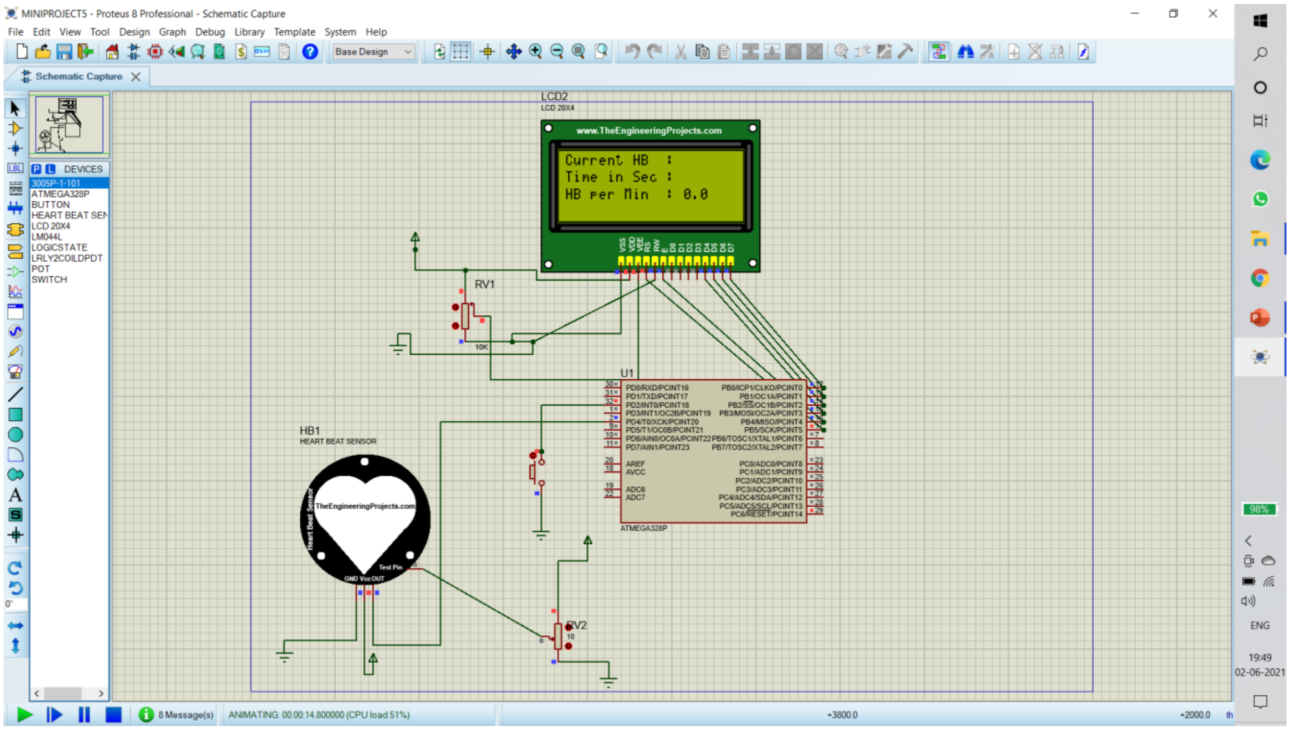
Schematic Diagram



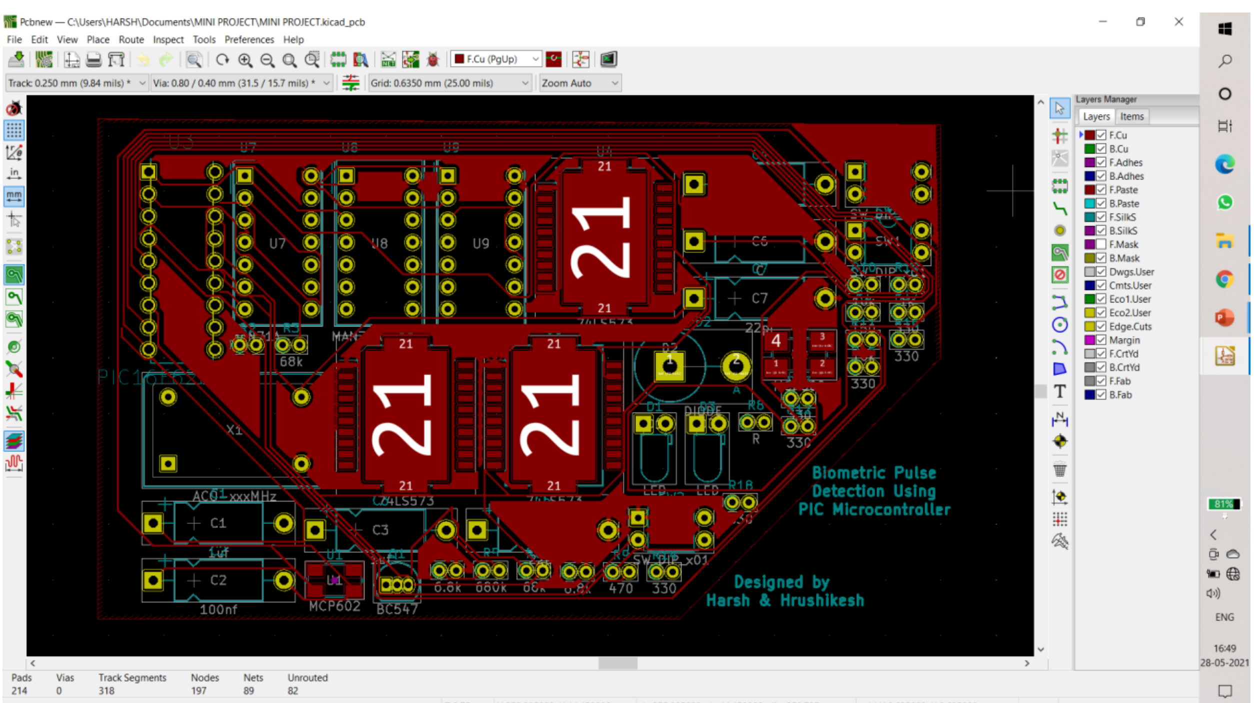
Software Simulation (Using PIC)



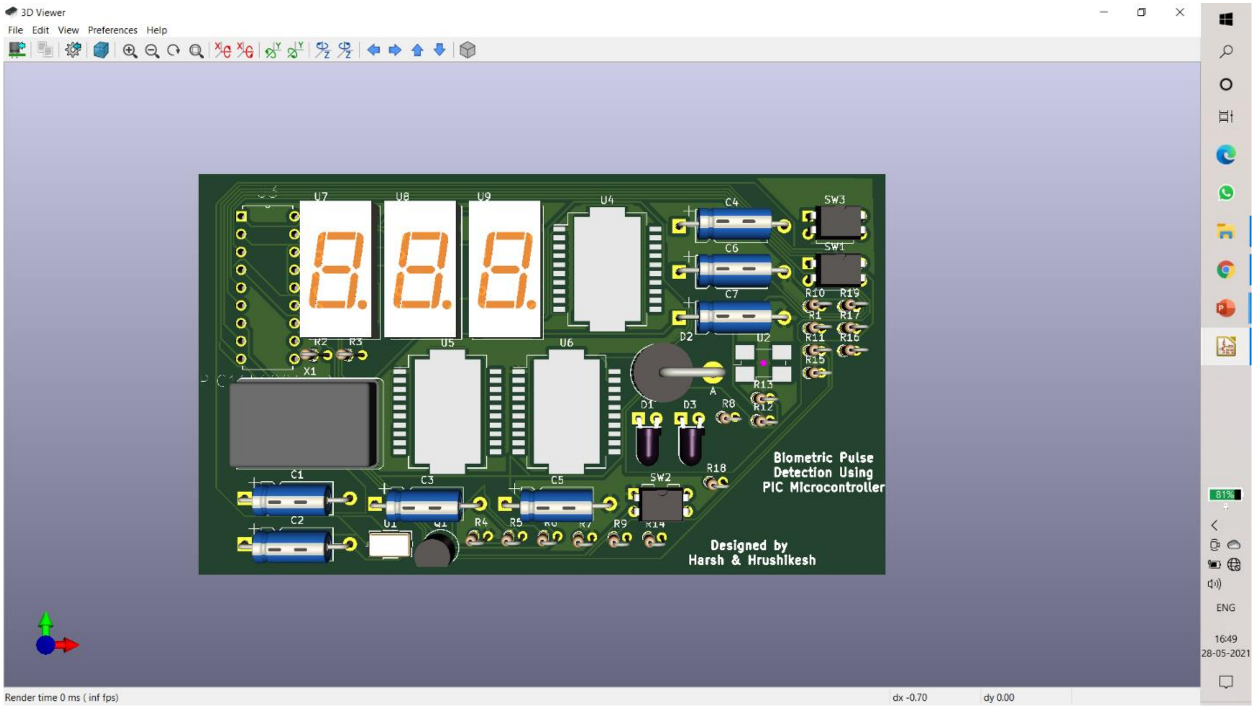
Software Simulation (Using AVR)

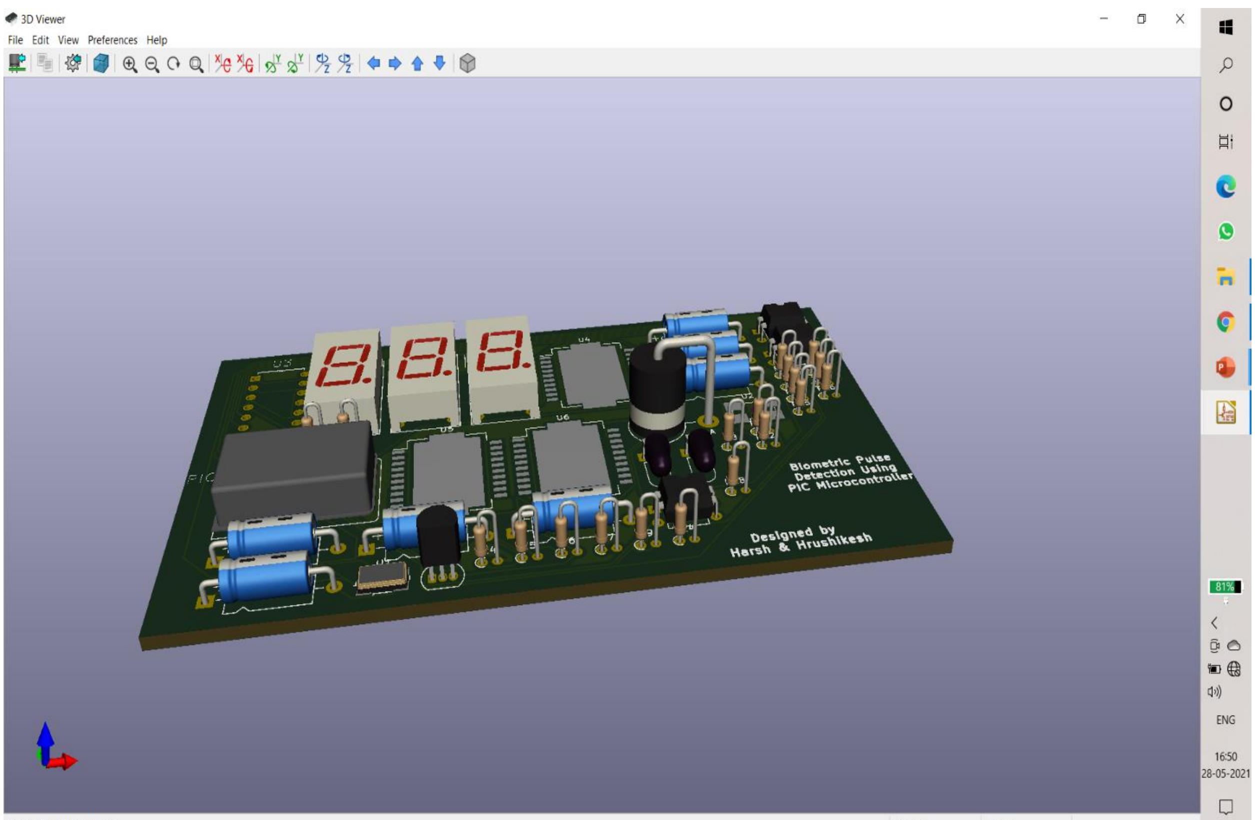


PCB Design Gerber View

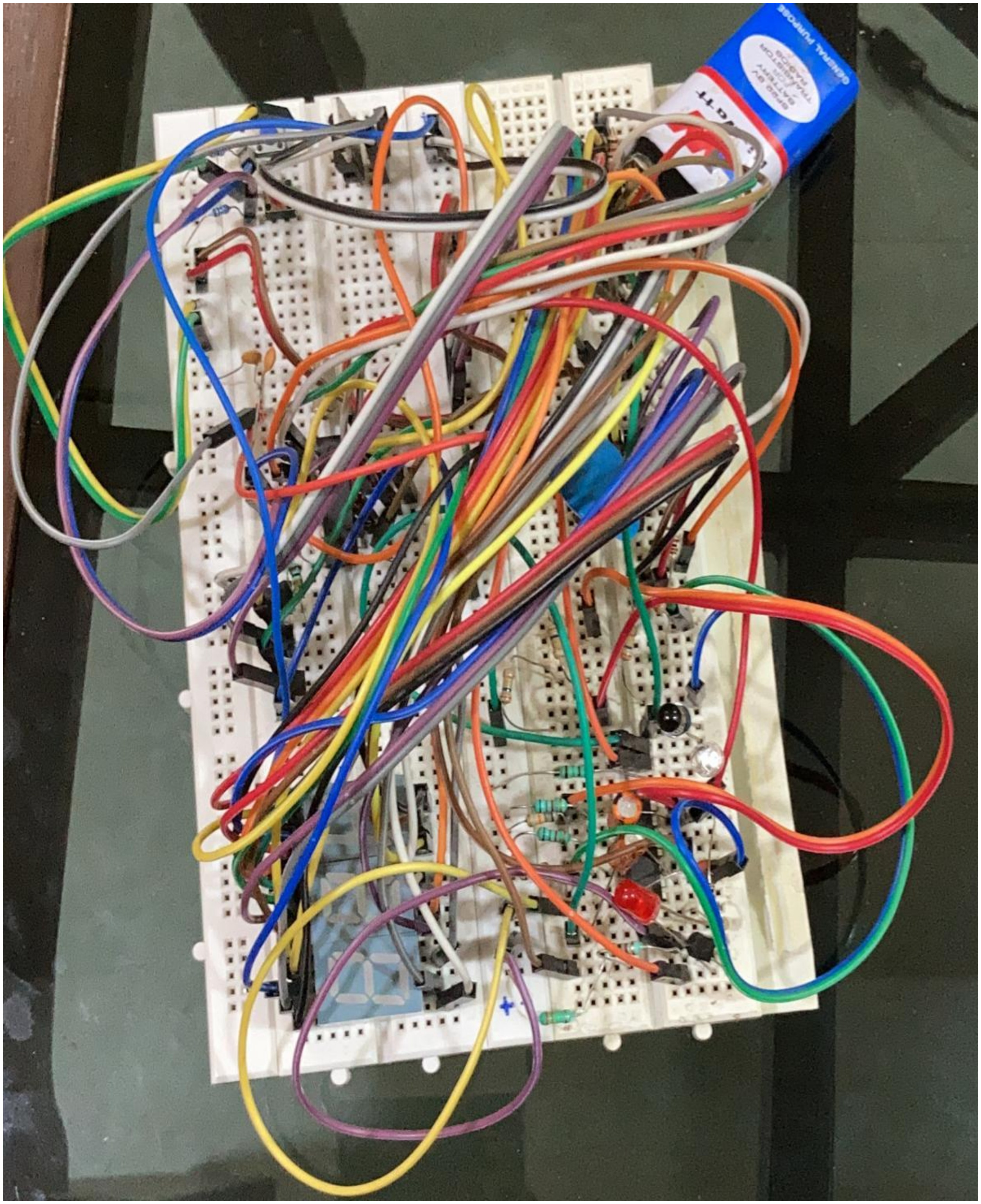


PCB Design 3D View





Hardware Implementation



CONCLUSIONS:

Heart beat monitoring system is designed using a PIC micro controller (PIC16F628A). The device is designed to provide continuous access to the patient's heart rate through the 7-segment display. Functioning of this device is based on the blood circulation for every one heart beat which can be sensed by using a circuit formed by the combination of a photodiode and IR LED. Depending upon the rate of circulation of blood per second the heart beat rate per minute is calculated. The prototype model is tested and verified for the basic functionality. Complete evaluation on multiple targets is yet to be carried out.

APPLICATION

- Have become a widely used training aid for a variety of sports.
- Hospitals / Dispensaries
- At homes
- A set point can help in determining whether a person is healthy or not checking his/her heart beat and comparing with set point.

FUTURE SCOPE

Our project “Biometric Pulse Detection Using PIC Microcontroller” is mainly intended to design a system, which gives very accurate result than the existing devices in the present Corona Pandemic Situation. This system has IR Pair diodes, and output display interfaced to the microcontroller. The microcontroller is programmed in such a way that it takes input from the IR Pair diodes when a finger is inserted into it and displays the value on the 7-segment display.

This project can be extended as follows:

1. A graphical LCD can be used to display a graph of the change of heart rate over time.

2. Serial output can be attached to the device so that the heart rates can be sent to a PC for further online or offline analysis.

3. The whole health monitoring system, which we have proposed can be integrated into a small compact unit as small as a cell phone or a wrist watch.

4. The project can be implemented as complete patient health monitoring system by measuring B.P, Temperature etc., which can be done by connecting corresponding sensors to the MCU.

5. An alphanumeric keypad can be included in order to store the phone number, name etc. instantaneously.

6. GPS can be included in order to know the location of the user

FUTURE WORK

After Successful implementation of the pulse detector our plan is to implement Pulse Oximeter within this circuit only.

References

[1] Hokanson, D.Eugene; Sumner, David S.; Strandness, D.Eugene, "An Electrically Calibrated Plethysmograph for Direct Measurement of Limb Blood Flow," in Biomedical Engineering, IEEE Transactions on , vol.BME-22, no.1, pp.25-29, Jan. 1975

[2] PIC Microcontroller by Muhammad Ali Mazidi, Rolin McKinlay, Danny Causey (z-lib.org) Using Assembly and C, Pearson Education

[3] PIC16F628A Datasheet

[4] LM324 IC Datasheet

[5] 74LS5783 Datasheet

[6] 7-Segment Display (Common Anode) Datasheet

APPENDIX PROGRAM CODE

The program code is written in the embedded c language.

```
sbit pc at RA4_bit;

sbit IR_Tx at RA3_bit;

sbit DD0_Set at RA2_bit;

sbit DD1_Set at RA1_bit;

sbit DD2_Set at RA0_bit;

sbit start at RB7_bit;

unsigned short j, DD0, DD1, DD2, DD3,x;

unsigned short pulserate, pulsecount;

unsigned int i;

// Function to Return mask for common anode 7-seg. display

unsigned short mask(unsigned short num) {

 switch (num) {

 case 0 : return 0xC0;

 case 1 : return 0xF9;
```

```
 case 2 : return 0xA4;
 case 3 : return 0xB0;
 case 4 : return 0x99;
 case 5 : return 0x92;
 case 6 : return 0x82;
 case 7 : return 0xF8;
 case 8 : return 0x80;
 case 9 : return 0x90;
 } //case end
}

void display(){
  DD0 = pulserate%10;
  DD1 = (pulserate/10)%10;
  DD2 = pulserate/100;
    DD0_Set = 0;
    DD1_Set = 1;
    DD2_Set = 1;
```

```
    PORTB = mask(DD0);//display LCD
    DD0_Set = 1;
    DD1_Set = 0;
    DD2_Set = 1;
    PORTB = mask(DD1); //display mid. digit
    DD0_Set = 1;
    DD1_Set = 1;
    DD2_Set = 0;
    PORTB = mask(DD2); //display MCD
    DD2_Set = 1;
}

void main()
{
 CMCON = 0x07;    // Disable Comparators
 TRISA = 0b00111000; // RA4/T0CKI input, RA5 is I/P only
 TRISB = 0b10000000; // RB7 input, rest output
 OPTION_REG = 0b00101000;
```

```
while(1)
{
 x=0;

 while(IR_Tx){
    while(pc<=0){}
    while(pc>0){}
            x=x++;
    }
 pulsecount = x;
 pulserate = x;//here some modification required bcz pulse rate
=pulse count/time required
 display();
 Delay_ms(5000);
}
}
```