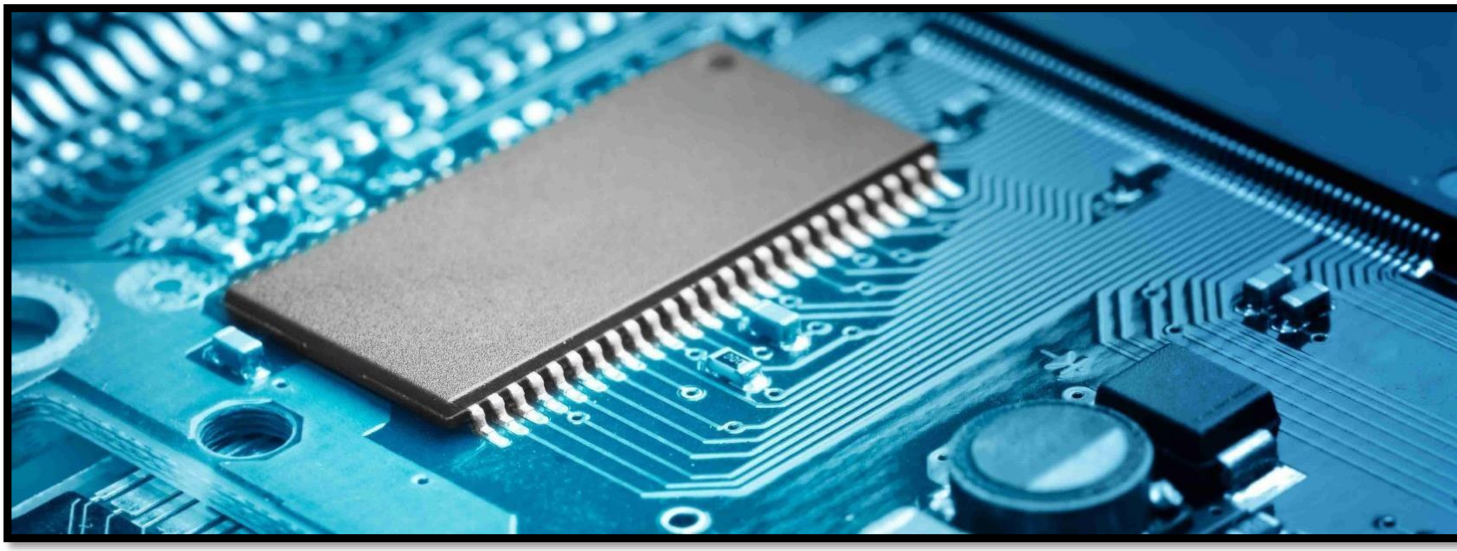
# MICROCONTROLLERS AND EMBEDDED SYSTEMS

Project Report

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# PROJECT 0: GENERIC BOARD USING ATMEGA328P MICROCONTROLLER


## ABSTRACT:

The origins of both the microprocessor and the microcontroller can be traced back to the invention of the MOSFET (metal-oxide-semiconductor field-effect transistor), also known as the MOS transistor. While microprocessor designers focus on larger word width and address space, a microcontroller designer focuses on integrating peripherals needed to support fast control within an embedded environment.

Simply stated, a microcontroller is a single integrated circuit that at least contains the necessary elements of a complete computer system: CPU, memory, a clock oscillator, and input and output. Microcontrollers commonly contain additional peripheral modules, such as serial and timer units. A microcontroller can be considered a self-contained system with a processor, memory and peripherals and can be used as an embedded system. Most microcontrollers in use today are embedded in other machinery, such as automobiles, telephones, appliances, and peripherals for computer systems.


## INTRODUCTION:

A microcontroller is a compact integrated circuit designed to govern a specific operation in an embedded system. A typical microcontroller includes a processor, memory, and input/output (I/O) peripherals on a single chip. A microcontroller is embedded inside of a system to control a singular function in a device. It does this by interpreting data it receives from its I/O peripherals using its central processor. The temporary information that the microcontroller receives is stored in its data memory, where the processor accesses it and uses instructions stored in its program memory to decipher and apply the incoming data. It then uses its I/O peripherals to communicate and enact the appropriate action. Microcontrollers are used in a wide array of systems and devices. Devices often utilize multiple microcontrollers that work together within the device to handle their respective tasks. For example, a car might have many microcontrollers that control various individual systems within, such as the anti-lock braking system, traction control, fuel injection or suspension control. All the microcontrollers communicate with each other to inform the correct actions. Some might communicate with a more complex central computer within the car, and others might only communicate with other microcontrollers. They send and receive data using their I/O peripherals and process that data to perform their designated tasks.

In this project, our main objective and goal is to make a generic board using a microcontroller and connect it with connectors to make connections to its pins. We then must upload a program to it using an Arduino board or an FTDI serial communication port and run a heartbeat test using an LED. The microcontroller we used is There are different approaches to accomplish this goal and all the steps we performed to reach that goal are described below.

## PROJECT OBJECTIVES:

- Designing a schematic in PROTEUS as well as a PCB board.
- Making a PCB practically with name on it.
- Writing a C# or Assembly code to make an LED blink.
- Uploading the code to the microcontroller to test the code practically.

## COMPONENTS AND BILL OF MATERIALS:

| COMPONENTS | QUANTITY | COST |
|---|---|---|
| Arduino-Compatible single layer PCB that you will design on Fiber PCB sheet | 1 | 160 PKR |
| ATMega328p with boot bootloader | 1 | 450 PKR |
| 5mm Green LED | 5 | 10 PKR |
| 5mm Red LED | 5 | 10 PKR |
| 220 Ohm Resistor | 5 | 20 PKR |
| 10kOhm Resistor | 5 | 20 PKR |
| 16MHz Crystal | 1 | 20 PKR |
| 22pF Ceramic Capacitors | 5 | 10 PKR |
| 0.1uF Ceramic Capacitors | 5 | 10 PKR |
| 10uF Electrolytic Capacitors | 5 | 20 PKR |
| LM7805 5V Regulator | 1 | 30 PKR |
| Diode 1N4001 | 5 | 10 PKR |
| 28-Pin DIP Socket (To seat your Atmega328p) | 1 | 50 PKR |
| Push Button Reset Switch | 2 | 10 PKR |
| 6-Pin Female Headers | 1 | 40 PKR |
| 8-Pin Female Headers | 1 | 40 PKR |
| 0.1uF Capacitor | 5 | 10 PKR |
| DC Barrel Jack, USB jack like on Arduino | 1 | 50 PKR |
| 2-pin screw terminal | 1 | 20 PKR |
| **TOTAL COST** | | **1000 PKR** |

## ATMEGA328p PIN CONFIGURATION:

The Atmel® ATmega328P is a low-power CMOS 8-bit microcontroller based on the AVR® enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328P achieves throughputs approaching 1MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

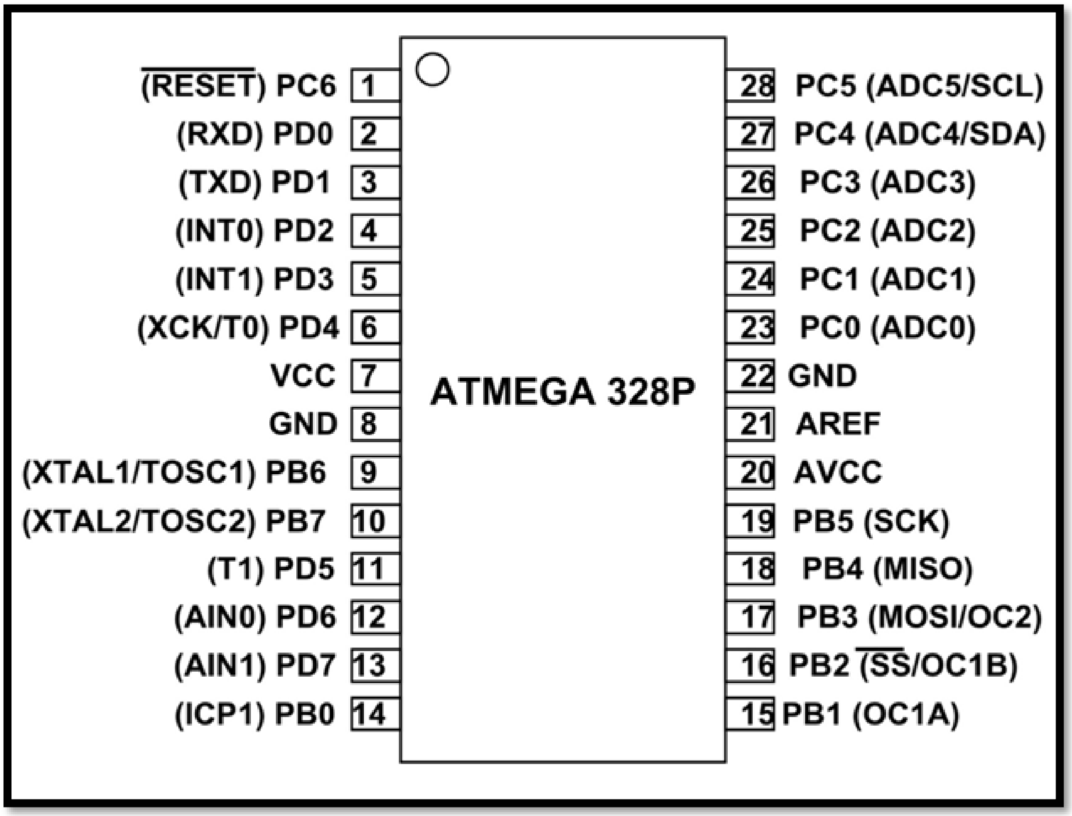



Fig 1.0: Atmega328p Pin Configuration

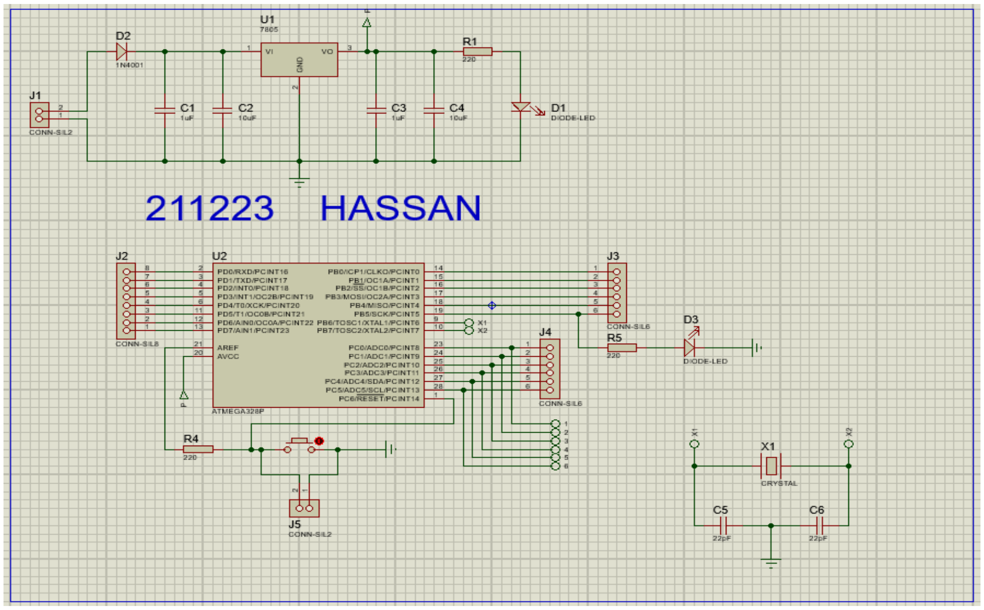
| ATmega328 Features | |
|---|---|
| No. of Pins | 28 |
| CPU | RISC 8-Bit AVR |
| Operating Voltage | 1.8 to 5.5 V |
| Program Memory | 32KB |
| Program Memory Type | Flash |
| SRAM | 2048 Bytes |

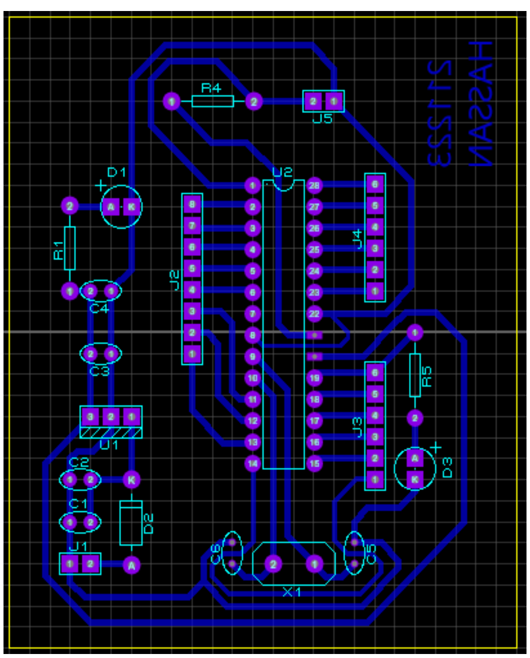
Fig 1.1: Atmega328p basic features

## DESIGN PROCESS:

1. **Making the schematic and PCB on PROTEUS:**

The first step on any project is to plan it and then apply it step by step. Thus, the first stage of this project was making a schematic on PROTEUS in order to test the circuit we had for the generic board. We used all the components mentioned above and simulated the circuit to test the heartbeat at Pin 13. We then created its PCB layout and placed components and made connections accordingly. The results of schematic and PCB are shown below.



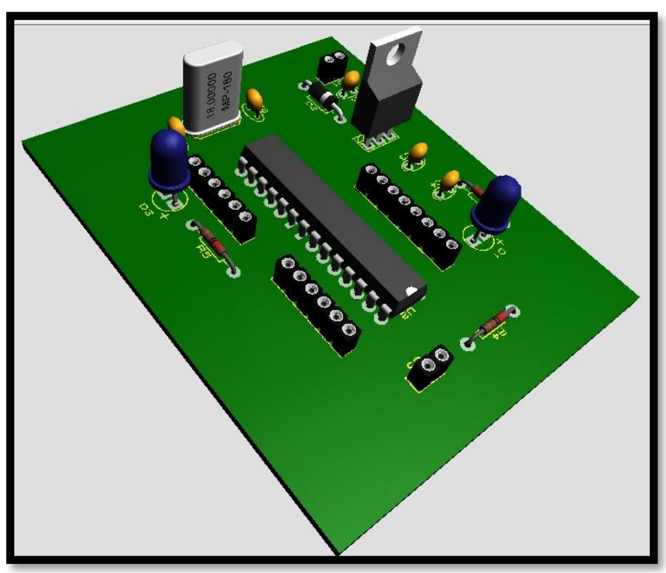


Fig 2.1: PCB 3D Visualizer

2. **Printing the PCB and Drilling:**

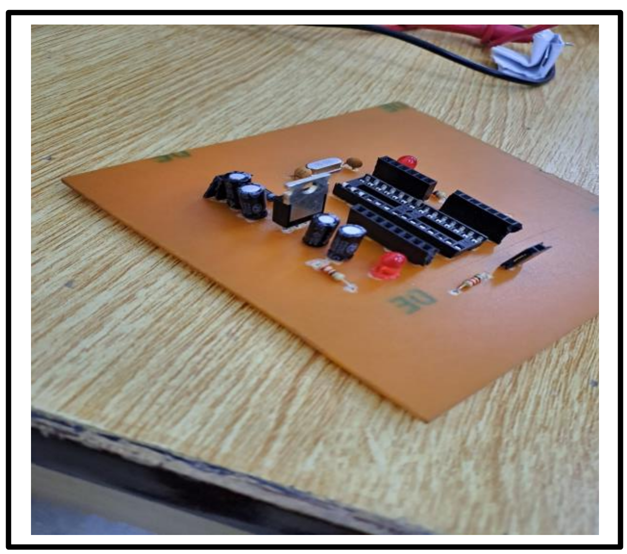
After completing and simulating the schematic and making the PCB, the next step was to print the PCB on a photopaper and etching it onto a copper board using heat and $FeCl_3$ solution. The results are shown below.

Fig 2.2: Results during printing on Copper Board

Fig 2.3: PCB Drilling

3. **Connecting the components and completing the design:**

After the circuit design was completely etched on the copper board, the components were soldered onto it in their respectiveplaces. The final product is shown below;



## APPLICATIONS OF MICROCONTROLLERS:

1. **Consumer electronics:**
    - Toys
    - Cameras
    - Robots
    - Washing Machine
    - Microwave Ovens
2. **Instrumentation and Process Control:**
    - Oscilloscopes
    - Multi-meter
    - Leakage Current Tester
    - Data Acquisition and Control
3. **Medical instruments:**
    - ECG Machine
    - Accu-Check
4. **Office equipment:**
    - Fax
    - Printers

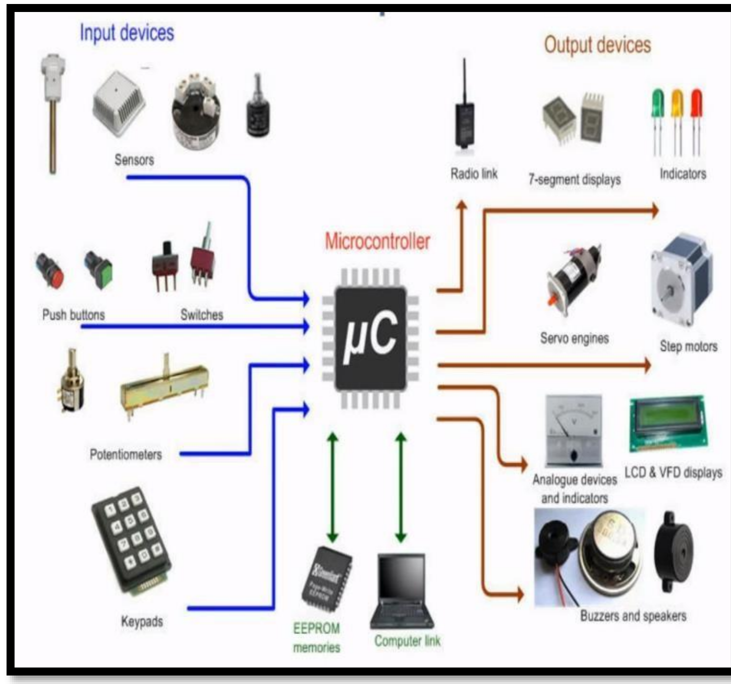



Fig 3.1: Microcontroller Applications

## CONCLUSIONS:

The main objectives and aims of this project were achieved successfully by our project team. We simulated and tested the circuit on PROTEUS and implemented it practically onour PCB board. All the results as well as the heartbeat test is shown. A microcontroller offers a vast range of useful applications which can make complex tasks very simple. We can perform complex and advanced use of microcontrollers in robotics and electronics as well as in many other fields of applied sciences and electronics. This minute chip on a board has paved way for many future technologies and advancements.

Apart from the objectives, the problems faced during the project were mainly encountered in the soldering phase of the design process as it required acute precision and accuracy as well as durability. Even a single misconnection or looseend could malfunction and damage the entire circuit. Other than that, this project provided us with lifelong learning and skills and other crucial skills such as teamwork, time management andorganization.