# ATmega328P LED Blinker PCB Project Documentation

## 📘 Project Overview

**Goal**: Design and build a custom 2-layer PCB using the ATmega328P microcontroller to blink an LED at regular intervals (1s ON, 1s OFF), showcasing core embedded hardware design skills.

## 🧠 Key Learning Outcomes

- Custom schematic design with microcontroller integration

- Power regulation using LDO

- Oscillator circuit design

- PCB layout with signal routing and decoupling

- Creating fabrication-ready Gerber files

- Programming via ISP and hardware testing

## 🗂️ Bill of Materials (BoM)

| No. | Component | Value/Part No. | Package | Quantity |
|---|---|---|---|---|
| 1 | ATmega328P-PU | Microcontroller | DIP-28 | 1 |
| 2 | Crystal Oscillator | 16 MHz, ±20 ppm | HC-49U | 1 |
| 3 | Capacitor | 22 pF | Ceramic | 2 |

| 4 | Capacitor | 100 nF (0.1 µF) | Ceramic | 2 |
|---|---|---|---|---|
| 5 | Resistor | 10kΩ | 1/4W | 1 |
| 6 | Resistor | 330Ω | 1/4W | 1 |
| 7 | LED | Red (any color) | 5mm | 1 |
| 8 | Tactile Button | Reset | Through-hole | 1 |
| 9 | LDO Voltage Regulator | AMS1117-5.0 or LM7805 | TO-220 or SOT-223 | 1 |
| 10 | Electrolytic Capacitor | 10 µF or 47 µF | Any | 2 |
| 11 | 6-pin ISP Header | Male | 2.54 mm | 1 |
| 12 | Power Jack or Header | Input 7–12V | Any | 1 |

## 🔌 Pin Connections and Nets

| ATmega328P Pin | Connected To | Net Label |
|---|---|---|
| VCC (Pin 7, 20) | 5V Regulated Output | VCC |
| GND (Pin 8, 22) | GND | GND |
| Pin 1 (RESET) | 10kΩ to VCC, button to GND | RESET |
| Pin 9, 10 | Crystal (16 MHz) | XTAL1, XTAL2 |
| Crystal Caps | 22pF to GND | — |
| Pin 19 (PB5) | LED → 330Ω → GND | LED_OUT |
| ISP Pins | MISO, MOSI, SCK | From Pins 17–19 |
| Power Input | 7–12V → Regulator | VIN |

Unused pins can be:

- Left floating (for analog)

- Pulled low via 10kΩ resistors (optional)

- Marked as NC in schematic

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## 🖥️ Schematic Overview

- Central MCU with clear power and signal lines

- Decoupling capacitors close to VCC pins

- Crystal oscillator circuit for timing

- Reset circuit with tactile switch and pull-up

- LED on digital pin with series resistor

- ISP header for flashing code

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## 🧩 PCB Design Highlights

- 2-layer board (Top = signals; Bottom = mostly GND)

- Short, direct traces for crystal and decoupling

- Proper trace widths (e.g., 0.25–0.5 mm for signals)

- Via and hole sizes as per manufacturer specs

- Silkscreen labels for pins, components, net names

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## 🏗️ Fabrication Notes

- Export Gerber, NC Drill, BOM, Pick-and-Place files

- Confirm trace clearance ≥ 6 mil, drill ≥ 0.3 mm

- Double-check orientation of polarized parts (LED, caps, IC)

- Use JLCPCB, PCBWay, or local options if available

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# 🧪 Testing Procedure

1. Connect regulated 5V or 7–12V input

2. Flash hex file via USBasp or Arduino as ISP

3. Check LED blink pattern (1s ON/OFF)

4. Debug: Check voltage at VCC, RESET, LED output pin

5. Use multimeter and oscilloscope if needed

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# 💾 Sample Code

```
void setup() {
  pinMode(13, OUTPUT);  // LED on PB5 (Pin 19)
}

void loop() {
  digitalWrite(13, HIGH);
  delay(1000);
  digitalWrite(13, LOW);
  delay(1000);
}
```

Flash with **AVRDUDE** or **Arduino as ISP** method.

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# 📦 Project Folder Structure (for GitHub or Report)

```
/ATmega328P_LED_Blinker_PCB
├── Schematic/
│   └── LED_Blink_Schematic.PDF
```

```
├── PCB_Layout/
│   └── PCB_Top_Bottom.Gerber
├── Firmware/
│   └── LED_Blink.ino
├── BoM/
│   └── Bill_of_Materials.xlsx
├── Images/
│   └── Final_Board_Top.png
├── Documentation/
│   └── README.md
│   └── PCB_Report.pdf
```

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## 🔮 Future Improvements

- Add 3-pin voltage selector jumper (USB/Ext)

- Add push buttons for interaction

- Replace DIP with SMD ATmega328P

- Add USB-to-Serial (CH340/FT232) for programming

- Create modular header for future shields or sensors