Electronic Basics #5: How to Multiplex

LED Multiplexing Using Arduino Nano, TLC5940, and MOSFETs

Introduction

LED multiplexing is a technique used to control multiple LEDs using fewer microcontroller pins by rapidly switching between them. This method reduces the number of required connections while maintaining the ability to control individual LEDs. It is commonly used in LED displays, signage, and lighting projects. In this project, we will use an **Arduino Nano**, **TLC5940 LED driver**, and **P-channel MOSFETs** to build an efficient LED multiplexing system.

Principle of LED Multiplexing

The core idea behind LED multiplexing is to arrange LEDs in a **matrix format** where:

- **Anodes (positive terminals) are connected in rows.**
- **Cathodes (negative terminals) are connected in columns.**

Instead of controlling each LED individually, the microcontroller lights up one row at a time, switching between them very quickly. Due to the **persistence of vision (PoV)**, the human eye perceives all LEDs as being on simultaneously.

However, when multiple LEDs are turned on at the same time, **current limitations and power distribution issues** arise. To solve this, we use **a P-channel MOSFET** as a switch to control the rows, along with **TLC5940**, which manages the column outputs efficiently.

Components Required

- **Arduino Nano** – The microcontroller that controls the multiplexing.
- **TLC5940 LED Driver** – A specialized LED driver IC used for handling multiple LEDs with precise current control.
- **P-Channel MOSFET** – Acts as a switch to control each row of the LED matrix.
- **Resistors (2KΩ, 1KΩ)** – Used for proper current limiting and biasing.

Understanding the TLC5940 LED Driver

The **TLC5940** is a **16-channel PWM LED driver** with **constant current sinking** capabilities, which makes it ideal for LED multiplexing. Some key features of the TLC5940 include:

- **16 individual outputs** to control LEDs with precise brightness control.
- **PWM dimming support** for smooth LED transitions.
- **Daisy-chaining capability**, allowing multiple TLC5940 chips to be connected together for larger displays.

Wiring Connections

1. **Connecting the TLC5940:**

- The **output pins (OUT0 to OUT9)** of the TLC5940 connect to the cathodes (columns) of the LED matrix.
- The **control pins (SIN, SCLK, BLANK, GSCLK, and XLAT)** of the TLC5940 connect to the Arduino Nano for communication.

2. **Connecting the P-Channel MOSFET:**
   - The **source** is connected to the **+V supply** (for example, 5V).
   - The **drain** is connected to the anodes (rows) of the LED matrix.
   - The **gate** is controlled by the Arduino via a **pull-down resistor** to ensure proper switching.
3. **Power Supply Considerations:**
   - A **sufficient power source** (like a 5V adapter) is required to handle multiple LEDs.
   - **Current-limiting resistors** prevent damage to LEDs.

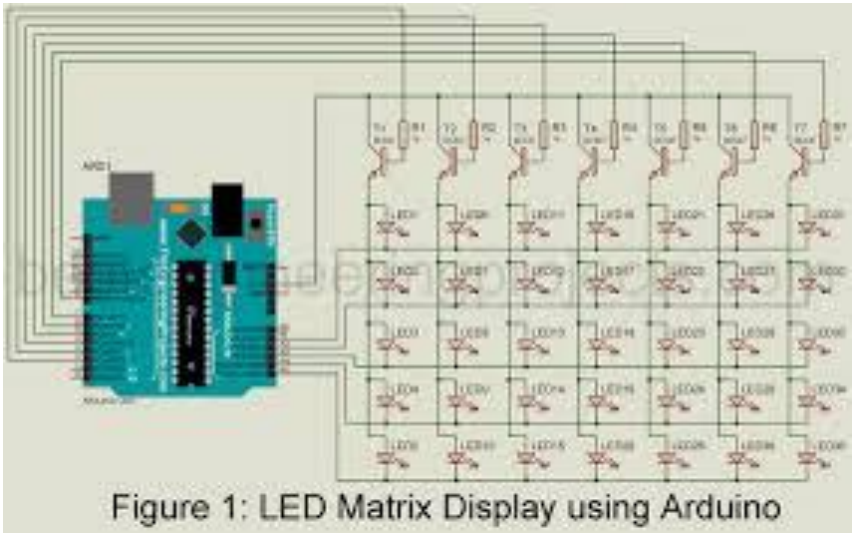

Fig5.1: LED Multiplexing using Arduino

Arduino Code for LED Multiplexing

The following Arduino code demonstrates how to control an LED matrix using **TLC5940 and MOSFETs** for multiplexing.

```
#include "Tlc5940.h"


int rowPins[] = {2, 3, 4, 5}; // Control P-channel MOSFETs (Rows)

int numRows = 4;


void setup() {
```

```
  Tlc.init(); // Initialize TLC5940

  // Set MOSFET control pins as outputs
  for (int i = 0; i < numRows; i++) {
    pinMode(rowPins[i], OUTPUT);
    digitalWrite(rowPins[i], HIGH); // Default OFF (P-Channel)
  }
}

void loop() {
  for (int row = 0; row < numRows; row++) {
    digitalWrite(rowPins[row], LOW); // Turn ON row (MOSFET active)

    // Light up specific LEDs in this row
    for (int col = 0; col < 10; col++) {
      Tlc.set(col, 4095); // Maximum brightness for TLC5940
    }
    Tlc.update(); // Apply changes

    delay(2); // Small delay for persistence of vision
    digitalWrite(rowPins[row], HIGH); // Turn OFF row
  }
}
```

How the Code Works

- **Tlc5940 Library**: Handles communication with the LED driver.
- **Row Selection**: The Arduino activates one row at a time by controlling the MOSFETs.
- **Column Control**: The TLC5940 manages which LEDs in the selected row should light up.
- **Fast Switching**: The delay ensures smooth multiplexing, making LEDs appear always on.

Conclusion

This project demonstrates **efficient LED multiplexing** using **Arduino Nano, TLC5940, and MOSFETs**.
By leveraging **PWM control** and **high-speed switching**, we can control **multiple LEDs with fewer pins**,

making this technique useful for display panels, indicator systems, and more. Expanding this concept further, we can build **larger LED grids** or **dynamic light effects** using additional TLC5940 chips.

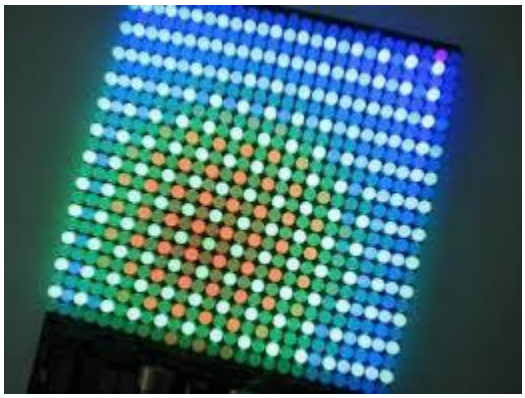

Fig5.2: LED Matrix