Physical Installation Guide for The Pick by Light

Introduction

This guide details the physical installation of the pick-by-light system using the custom MCP23008/MCP23017 24-Channel I/O board. The system includes a Raspberry Pi connected to one or more of these boards, each supporting 12 LED push buttons via two 18x0.5 multi-conductor cables. The MCP23017 supports 8 buttons using its 16 pins (PA0–PA7, PB0–PB7), and the MCP23008 supports 4 buttons with its 8 pins (GP0–GP7), utilizing all 24 I/O pins. The maximum setup uses 1 Raspberry Pi and 4 boards for 48 buttons.

Note: Work in a static-free environment and disconnect power before connections. Verify board-specific details (e.g., pin assignments) with any included documentation. Ensure proper cable termination and strain relief.

1 Prerequisites and Tools

- Raspberry Pi board (e.g., Model 4 or compatible).

- MCP23008/MCP23017 24-Channel I/O boards (1–4).

- LED push buttons (12–48, with 4 terminals: 2 for switch, 2 for LED).

- Two 18x0.5 multi-conductor cables per board (e.g., LAPPKABEL or equivalent).

- Jumper wires (for I2C connection to Raspberry Pi).

- Power supply for Raspberry Pi (5V micro-USB or USB-C).

2 Step 1: Understand the Board Layout

- **MCP23017:** Provides 16 I/O pins across Port A (PA0–PA7) and Port B (PB0–PB7), accessible via terminal blocks, supporting 8 buttons.

- **MCP23008:** Adds 8 I/O pins (GP0–GP7), also on terminal blocks, supporting 4 buttons.

- **I2C Interface:** Connects via SDA, SCL, VCC, and GND terminals.

- **Address Jumpers:** Three jumpers (A0, A1, A2) per expander allow 8 unique addresses (e.g., 0x20–0x27 for MCP23017, 0x20–0x27 for MCP23008 if separately addressable).

- **Power:** Can be I2C-bus powered or externally powered via VCC terminal.

3 Step 2: Connect the Board(s) to the Raspberry Pi

1. **Identify Pins on Raspberry Pi:**

   - Pin 3: GPIO 2 (I2C SDA).
   - Pin 4: 5V Power (VCC).
   - Pin 5: GPIO 3 (I2C SCL).
   - Pin 6: Ground (GND).

2. **Connect the First Board:**

   - Wire Raspberry Pi Pin 4 (5V) to MCP VCC terminal.
   - Raspberry Pi Pin 6 (GND) to MCP GND terminal.
   - Raspberry Pi Pin 3 (SDA) to MCP SDA terminal.
   - Raspberry Pi Pin 5 (SCL) to MCP SCL terminal.
   - Optionally, connect external power to VCC terminal if required.

3. **Set I2C Addresses:**

   - Use jumpers A0, A1, A2 to set the MCP23017 address (e.g., 0x20 if all open).
   - If MCP23008 has separate jumpers, set its address (e.g., 0x21 for the first board, adjusting for multiples).
   - For multiple boards, use combinations:
     - Board 1: MCP23017 = 0x20, MCP23008 = 0x21.
     - Board 2: MCP23017 = 0x22, MCP23008 = 0x23.
     - Board 3: MCP23017 = 0x24, MCP23008 = 0x25.
     - Board 4: MCP23017 = 0x26, MCP23008 = 0x27.

4. **Daisy-Chain Additional Boards:**

   - Connect VCC, GND, SDA, and SCL in parallel to additional boards via terminal blocks.

   - Set unique addresses for each board's MCP23017 and MCP23008 as above.

4 Step 3: Connect the LED Push Buttons via Cables

1. **Identify Terminal Blocks:**

   - MCP23017 Port A: PA0–PA7 (for buttons 1–4, one wire per pin).
   - MCP23017 Port B: PB0–PB7 (for buttons 5–8, one wire per pin).
   - MCP23008: GP0–GP7 (for buttons 9–12, one wire per pin).

2. **Prepare the 18x0.5 Cables:**

   - **First Cable (for MCP23017, 8 buttons):** Strip to expose 18 conductors. Assign wires 1–8 for PA0–PA7, 9–16 for PB0–PB7, wire 17 for common GND, wire 18 unused.
   - **Second Cable (for MCP23008, 4 buttons):** Assign wires 1–8 for GP0– GP7, wire 9 for common GND, wires 10–18 unused.
   - Label each wire (e.g., PA0, PB0, GP0, GND).

3. **Wire Each LED Button:**

   - **Buttons 1–4 (MCP23017 Port A):**
     - Connect PA0–PA3 to first cable wires 1–4 (e.g., PA0 to Wire 1 for output, PA1 to Wire 2 for input, alternating).
     - Connect PA4–PA7 to wires 5–8 (e.g., PA4 to Wire 5 for output, PA5 to Wire 6 for input).
     - Wire 17 to common GND.
     - At the button: Wire 1 to Button 1 LED, Wire 2 to Button 1 Switch, etc., with cathodes to GND via 330Ω.
   - **Buttons 5–8 (MCP23017 Port B):**
     - Connect PB0–PB3 to wires 9–12, PB4–PB7 to wires 13–16 (alternating output/input).
     - Wire 17 to common GND.
     - At the button: Wire 9 to Button 5 LED, Wire 10 to Button 5 Switch, etc.
   - **Buttons 9–12 (MCP23008):**
     - Connect GP0–GP3 to second cable wires 1–4, GP4–GP7 to wires 5–8 (alternating output/input).
     - Wire 9 to common GND.
     - At the button: Wire 1 to Button 9 LED, Wire 2 to Button 9 Switch, etc.
   - Repeat for additional boards if using 2–4.

4. **Secure Connections:** Clamp cable wires into terminal blocks. Use crimps or solder at button ends. Test with a multimeter.

5. **Mount the Buttons:** Attach to shelves or panels, securing cables with glands or ties (keep under 1m).
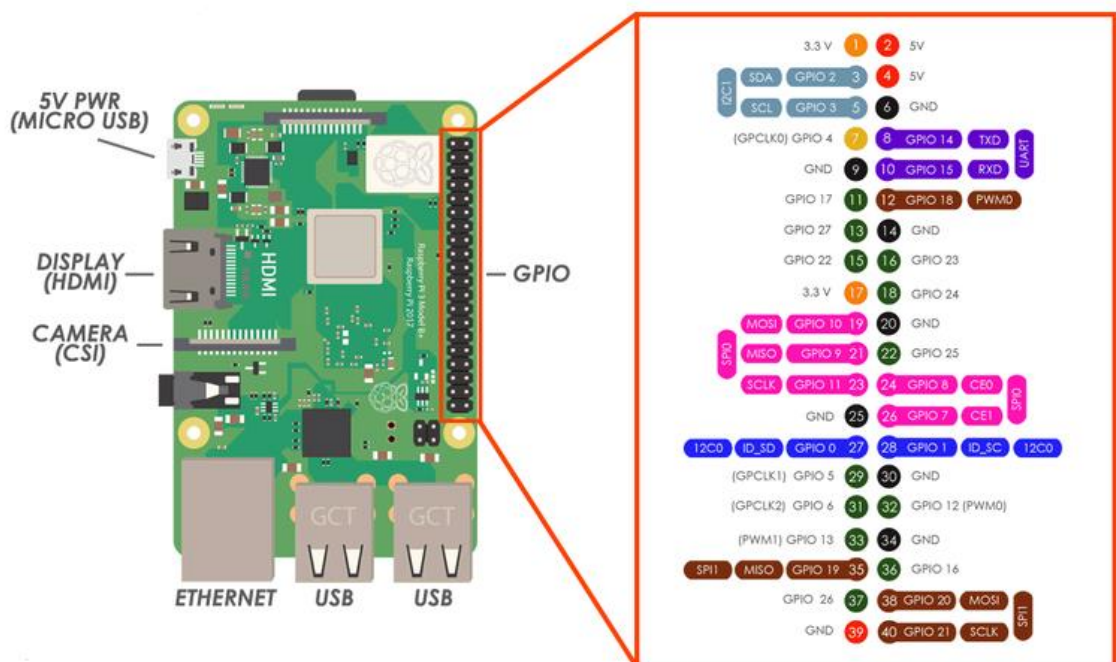
5 Step 4: Final Assembly and Testing

1. **Mount the System:** Secure the Raspberry Pi and boards in an enclosure or on a rail.

2. **Power On:** Connect the power supply.

3. **Test Connections:** Verify 5V on VCC terminal. Check addresses with 'i2cdetect -y 1'.

4. **Safety Checks:** Ensure no exposed wires. Test LEDs and button presses.

If issues occur, recheck wiring and addresses. Adjust software configuration (e.g., I2C in raspi-config) as needed. This setup supports up to 48 buttons with 4 boards.

6 Terminal Block Diagrams

Below are detailed tabular representations of the terminal block connections with the two 18x0.5 cables, optimized to fit within the page.

6.1 I2C Connection Terminal Block

Pin	Label	Connection to Raspberry Pi
1	VCC	Pin 4 (5V)
2	GND	Pin 6 (GND)
3	SDA	Pin 3 (SDA)
4	SCL	Pin 5 (SCL)

6.2   MCP23017 Port A Terminal Block (PA0–PA7) with First Cable

Terminal	Pin 1 (VCC)	Pin 2 (GND)	Pin 3 (SIG)
PA0 Block	-	Wire 17 (GND)	Wire 1 (Output)
PA1 Block	-	Wire 17 (GND)	Wire 2 (Input)
PA2 Block	-	Wire 17 (GND)	Wire 3 (Output)
PA3 Block	-	Wire 17 (GND)	Wire 4 (Input)
PA4 Block	-	Wire 17 (GND)	Wire 5 (Output)
PA5 Block	-	Wire 17 (GND)	Wire 6 (Input)
PA6 Block	-	Wire 17 (GND)	Wire 7 (Output)
PA7 Block	-	Wire 17 (GND)	Wire 8 (Input)

Button Assignment: PA0–PA7 correspond to Buttons 1–4 (alternating LED/Switch).

6.3   MCP23017 Port B Terminal Block (PB0–PB7) with First Cable

Terminal	Pin 1 (VCC)	Pin 2 (GND)	Pin 3 (SIG)
PB0 Block	-	Wire 17 (GND)	Wire 9 (Output)
PB1 Block	-	Wire 17 (GND)	Wire 10 (Input)
PB2 Block	-	Wire 17 (GND)	Wire 11 (Output)
PB3 Block	-	Wire 17 (GND)	Wire 12 (Input)
PB4 Block	-	Wire 17 (GND)	Wire 13 (Output)
PB5 Block	-	Wire 17 (GND)	Wire 14 (Input)
PB6 Block	-	Wire 17 (GND)	Wire 15 (Output)
PB7 Block	-	Wire 17 (GND)	Wire 16 (Input)

Button Assignment: PB0–PB7 correspond to Buttons 5–8 (alternating LED/Switch).

6.4   MCP23008 Terminal Block (GP0–GP7) with Second Cable

Terminal	Pin 1 (VCC)	Pin 2 (GND)	Pin 3 (SIG)
GP0 Block	-	Wire 9 (GND)	Wire 1 (Output)
GP1 Block	-	Wire 9 (GND)	Wire 2 (Input)
GP2 Block	-	Wire 9 (GND)	Wire 3 (Output)
GP3 Block	-	Wire 9 (GND)	Wire 4 (Input)
GP4 Block	-	Wire 9 (GND)	Wire 5 (Output)
GP5 Block	-	Wire 9 (GND)	Wire 6 (Input)
GP6 Block	-	Wire 9 (GND)	Wire 7 (Output)
GP7 Block	-	Wire 9 (GND)	Wire 8 (Input)

Button Assignment: GP0–GP7 correspond to Buttons 9–12 (alternating LED/Switch).